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Kerala State Council for Science, Technology and Environment  
Sasthra Bhavan, Thiruvananthapuram



# Abstracts

Focal Theme

**Pandemics: Risks, Impacts and Mitigation**







# 33<sup>rd</sup> KERALA SCIENCE CONGRESS

25-30 January 2021

**Focal Theme**  
**Pandemics: Risks, Impacts and Mitigation**

## Abstracts



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

# **33<sup>rd</sup> Kerala Science Congress - Abstracts**

Focal Theme

**Pandemics: Risks, Impact and Mitigation**

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**Pinarai Vijayan**  
**Chief Minister of Kerala**



### **MESSAGE**

I am extremely glad that Kerala State Council for Science, Technology and Environment (KSCSTE) is organizing the 33<sup>rd</sup> session of the Kerala Science Congress (KSC) on virtual platforms amidst the crisis of COVID-19 pandemic. In this context, the focal theme-*Pandemics: Risks, Impacts and Mitigation*- that KSCSTE has chosen is highly significant and I appreciate the organizers for the selection of the relevant theme. Our health system and diagnosis proved highly efficient during this COVID-19 outbreak and an institute of global importance in virology research - Institute of Advanced Virology (IAV) started functioning in 2020. I sincerely hope that the 33<sup>rd</sup> KSC shall serve as a platform for the budding scientist, young researchers and scientists in Kerala to present their scientific research outcomes which will support our efforts in combating the pandemics.

The Government of Kerala gives prime focus in strengthening the R&D in the State through various programmes, developing skilled human resource in S & T, popularising science and developing new technologies. I take this opportunity to congratulate the young researchers and budding scientists of the state who are participating and showcasing their research in the 33<sup>rd</sup> KSC.

My sincere wishes to 33<sup>rd</sup> Kerala Science Congress, which is being conducted on virtual platform for the first time in it's history. We look forward to have fruitful deliberations and recommendations from this 5-day event which could be made use of in the development of the State.

**Pinarai Vijayan**





## Kerala State Council for Science, Technology and Environment



### FOREWORD

Kerala Science Congress (KSC) is a major annual event of the Kerala State Council for Science, Technology and Environment (KSCSTE) which is scheduled during the last week of January. The event provides a platform for scientists, researchers, upcoming researchers and students to share, discuss and disseminate their research results. It is for the first time, that KSCSTE is organizing the event on a virtual platform owing to the Covid-19 pandemic situation.

Every year the Kerala Science Congress focuses on a special theme; and this year's focal theme is "Pandemics: Risks, Impacts, and Mitigation" which is quite relevant considering the threat that the Covid-19 virus causes and the challenges that the world faces. The discussions and interactions during the Science Congress can support the State in tackling the pandemic situation.

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 and Scientific Social Responsibility. Another important highlight of Kerala Science Congress is Memorial Lectures named after great scientists and visionaries of Kerala by eminent scientists. Besides these, the Kerala Science Congress has PG Students' Interactive Session in which the budding scientists interact with Scientists in different 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 33<sup>rd</sup> KSC. I thank all the contributors to the work mentioned in the book. The great efforts of experts who reviewed all the papers and judiciously chose the papers for 33<sup>rd</sup> 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 33<sup>rd</sup> KSC all success

**Prof. K.P. Sudheer**

Executive Vice President, KSCSTE





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## 01.Agriculture & Food Science

### 01.01

#### *Piriformospora indica* Confers Resistance Against Bhendi Yellow Vein Mosaic Virus in Okra

Chippy<sup>1</sup>, Joy Michal Johnson<sup>1\*</sup>, Radhika N. S.<sup>2</sup>, Heera G.<sup>1</sup> and Sarada S.<sup>3</sup>

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**Background:** Okra is one of the most important multipurpose vegetable crops cultivated worldwide. Bhendi yellow vein mosaic disease (BYVMD) is the most devastating disease that causes heavy yield loss and major constraint in production of okra. In the present study, potential of beneficial fungal root endophyte *P. indica* in suppression of BYVMD under high natural incidence was evaluated.

**Method:** The work involves evaluation of *P. indica* in management of Bhendi yellow vein mosaic virus (BYVMV), effect of *P. indica*-colonisation on growth parameters, and changes in biochemical characters viz., chlorophyll, total soluble protein and antioxidant enzymes under natural incidence of BYVMD.

**Results:** *P. indica*-colonisation significantly reduced BYVMD incidence by 57 and severity (V.I.) by 56 per cent over the control along with the enhanced plant growth and increased root and shoot biomass after 40 days of sowing under high natural incidence. Viral accumulation was less in *P. indica*-colonised plants. Biochemical analysis revealed a 3 - fold increase in total chlorophyll, and 121 per cent increase in total soluble protein content in *P. indica*-colonised okra plants. Antioxidant enzymes viz., peroxidase, polyphenol oxidase and catalase activities were enhanced by 94, 226 and 48 per cent in *P. indica*-colonised naturally infected plants. *P. indica*-colonisation could effectively prevent the reduction of phosphatase activity in the diseased plants.

**Conclusion:** *P. indica* - colonisation could effectively manage BYVMD through enhanced growth and antioxidant enzyme activities in okra plants.

**Keywords:** *Piriformospora indica*, Bhendi yellow vein mosaic virus, chlorophyll, total soluble protein, peroxidase, poly phenol oxidase, catalase, phosphatase

**Acknowledgement:** Kerala Agricultural University for facilities and funding; KSCSTE and Kerala State Planning Board for funding.

### 01.02

#### *Piriformospora indica* Enhances Early Seed Germination and Growth in Vegetable Crops

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**Background:** *P. indica* is a novel beneficial root endophyte that promotes growth and vigour in addition to enhanced protection against biotic as well as abiotic stresses in the colonized plants. The present study focusses to comprehend the role of *P. indica* in improving the germination rate and biomass of the colonized vegetable seedlings in order to enhance the yield and quality of the produce.

**Method:** The study compares the biometric parameters of *P. indica*-colonized and control seedlings of chilli, tomato, cowpea, bhendi, cucumber and amaranth. This work encompasses the raising of the seedlings in high through put *P. indica*-multiplied medium and control medium (without *P. indica*) followed by recording the observations.

**Results:** A high through put medium for the mass multiplication of *P. indica* had been developed. *P. indica*-colonized seedlings exhibited early and higher germination percentage with increased seedling vigour. Enhanced shoot and root biomass, secondary and tertiary roots, number and size of leaves were shown by the *P. indica*-colonized seedlings of different vegetable crops compared to the control. Microscopic observations of the roots revealed mature chlamydospores within the root cells of the colonized seedlings and plants.

**Conclusions:** The study highlights the significance of *P. indica* in early seed germination, growth promotion, increasing the shoot and root biomass, and its root colonization efficiency in vegetable seedlings.

**Keywords:** *Piriformospora indica*, seed germination, growth promotion, biometric parameters, chlamydospores

**Acknowledgement:** Kerala Agricultural University and KSCSTE for facilities and funding; Department of Science and Technology, Government of India for the Inspire fellowship.

### 01.03

#### Morphological Variability in *Rhizoctonia solani* Isolates From Rice, Cowpea and Amaranth in Southern Kerala

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**Background:** The ubiquitous pathogen *Rhizoctonia solani* Kuhn is a major constraint in the cultivation of major crops like rice, cowpea and vegetables like amaranth in Kerala. The present work was done to assess the cultural variability in eighteen isolates of *R. solani* infecting rice, cowpea and amaranth collected from two locations of three southern districts of Kerala such as Thiruvananthapuram, Kollam and Pathanamthitta.

**Method:** The work involves evaluation of morphological variability of 18 isolates *R. solani* collected from rice, cowpea and amaranth using macroscopical and microscopical characters.

**Results:** Microscopic characters showed variation in mean hyphal width and shape of moniloid cells. Mean hyphal width of the isolates ranged from 3.81 to 6.95 fm. There was considerable macroscopic variation in size, texture, shape, weight, diameter, number, orientation, position, colour, clump formation and exudation in the culture of sclerotial bodies produced by the isolates. There was



no correlation found between size of sclerotia and virulence. Sclerotia were grouped into smooth bordered and rough bordered. Sclerotia were arranged in the culture as peripheral, central scattered, central and peripheral; and position of the sclerotia was aerial and embedded. Sclerotial number in the culture was ranging from 15 to 230. Weight of single sclerotia in the culture was ranging from 2-10 mg. All sclerotia producing cultures of rice and vegetable cowpea exhibited honey dew secretion on it. Based on the aggregation of sclerotia, cultures were divided into more, moderate and less clump formed culture. Sclerotia formation was absent in all amaranth cultures and vegetable cowpea culture such as TRC1 (Vellayani) and KRC2 (Pooyapalli).

**Conclusion:** Evaluation of morphological variability of *R. solani* isolates of rice, cowpea and amaranth from Southern Kerala revealed considerable diversity among the isolates.

**Keywords:** *R. solani*, Morphological variability, Honeydew secretion, Monilioid cells, Sclerotia.

**Acknowledgement:** Kerala Agricultural University for facilities & funding; and Indian Council of Agricultural Research for Junior Research Fellowship.

01.04

### Pulse Nutri-Foods: Processing, Quality and Applications

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Pulses occupy an important place in human nutrition due to their high protein content than cereal grains. They also contain certain carbohydrates, dietary fibre, minerals (Ca, Mg, Zn, Fe, K, and P) and vitamins like thiamine, riboflavin and iron. Pulses have gained increasing importance because of its desired functional properties, including gelling and emulsifying properties, and are proposed as a potential supplement in great number of food applications. Consumption of pulses as a replacement to some animal protein also helps to limit the intake of saturated fats and increases the intake of fibres. It helps to lower blood cholesterol and attenuate blood glucose, which is a key factor in against diabetes and cardiovascular disease. This review provides an overview of the nutritional composition; technology of pulse processing, current and emerging techniques for producing their protein concentrates / isolates their major functional properties and applications in food industry. Pulses meet all the demands of the consumers such as rich in nutrients, affordable, convenient, delicious and store well for long duration, a factor which has become increasingly desirable during COVID-19 pandemic.

**Keywords:** Pulses, protein concentrates, isolates, functional properties.

01.05

### Growth Enhancement of *Oryza sativa* by Native Endophytic Diazotrophic *Lysinibacillus sphaericus*

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Nitrogen is the major limiting nutrient required for rice cultivation next to water. The large potential demand of nitrogen for plant growth is mainly achieved using chemical N fertilizers. Considering the risk factors associated with N over fertilization and requirement of plant growth and yield, researches are now focusing on extension of biologically fixed N effectively to non-leguminous plants. We have attempted to study the growth enhancement of rice crop under greenhouse conditions using the endophytic diazotrophic bacteria *Lysinibacillus sphaericus*. The effect of inoculation of *L. sphaericus* on yield and nutrient uptake was studied. All the parameters studied showed significantly higher values than that obtained in uninoculated absolute control. The highest yield was given by treatment T7 (seed and foliar) followed by T9 (soil and foliar) and T5 (seed and soil) and were statistically at par. The highest dry weight of grains was found to be in treatment T2 (13.0 g<sup>-1</sup> plant) which received soil treatment of *L. sphaericus* followed by T9 (12.2 g<sup>-1</sup> plant) which received combined application of *L. sphaericus* as soil and foliar treatment. There was no remarkable change in the soil N content in the treatments which received *L. sphaericus* application revealing the fact that the N content of straw came mainly from biological nitrogen fixation. The highest values of total N was shown by treatment T10 (1.58%) followed by T7 (1.54%). While the soil N content was found to be lower in pots which received treatments of Standard Pseudomonas sp. compared to *L. sphaericus*. The least N content (1.1%) was recorded in T23 absolute control, where the plant utilized the inorganic nitrogen provided in the soil. It can be deduced from the results, there is a high influence of endophytic bacteria *L. sphaericus* in plant growth despite the mode of inoculation. This confirms the potential of diazotrophic endophyte *L. sphaericus* to limit the use of industrial N fertilizers thereby enhancing the fertility of the soil and establishing sustainable agriculture.

**Keywords:** *L. sphaericus*, endophytic diazotroph, biological nitrogen fixation, non-leguminous plants

01.06

### Influence of Organic and Biological Agents on the Disease Complex of *Rhizoctonia solani* and *Meloidogyne incognita* Infecting Okra

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**Introduction** Okra (*Abelmoschus esculentus*) commonly called as okra, is one of the most important nutrients rich vegetable crop. India ranks first in the production of okra (FAO 2019). Several pathogens like viruses, fungi, nematodes etc. attack on it and cause diseases. Root-knot nematode, *Meloidogyne incognita* and root-rot fungus, *Rhizoctonia solani* are the most important pathogens and damages to the root system of okra. When both pathogens interacted they form disease complex and resulting in greatest reduction in production of okra (Safiuddin and Shahab, 2012; Al-Hazmi and Al-Nadary, 2015). Amendment of organic and bio-inoculants played an important role for managing the diseases and subsequently improving the soil fertility. Poultry manure is waste of poultry farm; Trichoderma is a useful fungus while Azotobacter is a free living nitrogen fixing bacterium.

**Method** The density of inoculums was tested in the soil before the experiment. Seeds of local variety of okra were sown in the 2x2.5m plots. *Trichoderma* and *Azotobacter* was mixed with poultry manure and applied in plots @ 600g per plot. Necessary watering and weeding were done. Experiment was terminated after ninety days.

**Results:** Result showed that highest improvement was observed in growth and yield attributes of okra such as plant length, fresh

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and dry weights, ascorbic acid content, number of flowers and fruits and chlorophyll content when treated concomitantly with poultry manure, *T. harzianum* and *A. chroococcum* as compared with plants treated with either poultry manure or *T. harzianum* or *A. chroococcum*. The application of poultry manure along with bio-inoculants also suppresses the root-knot and root-rot index, number of root-galls and nematode population.

**Conclusions:** This investigation suggests that their soil applications are not only enhance the efficacy of growth promoting substances and suppress disease parameters by various ways but also improve the soil fertility (Tian et al. 2007; Ogbenin 2011; Rehman et al. 2013; El-Nagdi et al. 2019).

**Keywords:** *Meloidogyne incognita*, *Rhizoctonia solani*, Soil nutrient, *Azotobacter chroococcum*, *Trichoderma harzianum*

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01.07

### Immunity Enhancement Through Traditional Rice Varieties

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Since the outbreak of the pandemic COVID-19, immunity of individual and community became the first line of defence. The nutritional status of an individual has been considered as a pointer of resilience against destabilization. Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population. Nutrient rich rice is important in countries like India where rice is present in every meal. There are reports on nutrition richness of traditional rice varieties from different parts of the world and it is important to bring the less known traditional rice varieties to lime light. As there are many factors influencing the availability of nutrition content in rice, we investigated the nutrition content of six selected rice accessions at different locations of Wayanad district. There was significant difference in proximate composition and mineral content among the selected six traditional rice accessions of Wayanad. Moreover, proximate composition in all the rice accession was similar in replications at different regions of the district and it significantly varied among replications in mineral contents. The highest protein content (10.23±0.56) % observed in *Chenthadi* and highest fibre content was observed in *Chomala* (1.25±0.11) %. Similarly, highest fat content was observed in *Adukkan* (1.91±0.15) %. Highest Fe content was observed for the accession Chennellu at location two and highest Zn content was observed for Kodu veliyan at location one. The result points to the importance of traditional rice varieties in terms of nutrition and immunity and it also highlights the need for more studies on factors affecting micronutrient absorbance of rice accessions.

**Keywords:** Traditional rice varieties, Wayanad, Proximate composition, Micronutrients.

01.08

### One Step Green Synthesis of Fluorescent N-Doped Carbon Dots from Waste Biomass for the Detection of Cancer Cells

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**Background:** Jackfruit peel is a cellulose rich crude fiber that can be transformed into a valuable nanomaterial. Since the major portion of jackfruit, the state fruit of Kerala, is discarded as peel, the synthesis provides a novel approach for the fabrication of carbon dots from waste biomass. The synthesised nitrogen doped carbon dots are highly active against Dalton's Lymphoma ascites tumour cells and opens up wide applications in the field of biomedicine.

**Method:** Hydrothermal treatment of jackfruit peel produced blue fluorescent carbon dots with inherent nitrogen doping. The sample was characterised by standard physicochemical techniques. Anticancerous activity was studied using Dalton's Lymphoma ascites cells (DLA) in mice. Trypan blue exclusion method was employed for this in vitro cytotoxicity analysis.

**Results:** The synthesised dots emit strong excitation dependent fluorescence in the blue region. Amorphous nature was proved by X-ray diffraction. Surface functionalization was confirmed by FT-IR studies and nitrogen doping by X-ray photoelectron spectroscopy. The average size of synthesized dots estimated from transmission electron images is 6.4nm and quantum yield is found to be 13.04%. Significant anti-cancerous activity of the as-prepared carbon dots could be detected with DLA tumour cells extracted from mice.

**Conclusions:** It is an innovative work that merges green synthetic strategy with efficient photoluminescent properties. Food waste disposal being a relevant crisis faced by the society in the current scenario, the present work receives considerable attention. The synthesised nitrogen doped carbon dots exhibit good quantum yield and high solubility in water, making it useful. The antioxidant potential of these dots makes them a promising material against cancer cells.

**Keywords:** Jackfruit peel, hydrothermal, cytotoxicity



01.09

### Post-harvest Application of Hexanal Formulation for Improving Physical Qualities of Nendran Banana

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**Background:** Short storage life of banana fruits in the tropics continues to be a pressing problem for small and marginal farmers. Postharvest dipping of fruits in hexanal formulation is a viable option to extend the shelf life and quality of Nendran banana. To slow down the ripening process of Nendran banana, it is needed to inhibit ethylene synthesis by an ethylene inhibitor like hexanal.

**Method:** Nendran banana bunches of uniform maturity were selected, de-handled and treated with hexanal at three different concentrations for 10 minutes. The treatment consists of T1- Hexanal 0.5%, Hexanal 1.0%, Hexanal 1.5%, T4- Ethanol (control) and T5- Absolute control (without any treatment). Treated banana fruits were air dried and stored under room temperature in Corrugated Fiber Board Boxes till the end of shelf life. Physical parameters like pulp %, peel %, pulp to peel ratio, peel colour and fruit firmness were observed at an interval of 3 days till the end of shelf life.

**Results:** Nendran banana fruits treated with Hexanal 0.5% recorded minimum pulp percentage, maximum peel percentage and minimum pulp to peel ratio after 15 days of storage. Maximum fruit firmness with good peel colour was also observed when compared to ethanol (control) and absolute control (without any treatment).

**Conclusions:** Postharvest treatment with Hexanal 0.5% for 10 minutes showed better retention of physical quality attributes and delayed ripening in Nendran banana during storage period of 15 days.

**Keywords:** Hexanal, Nendran banana, Postharvest, Physical properties

01.10

### Genome Wide Association Mapping of Foliar Blast Resistance Genes in Pearl Millet Using SNP Markers

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**Background:** Foliar blast (FB), aka leaf spot, caused by *Magnaporthe grisea*, became major threat to pearl millet growing areas affecting both forage and grain production of pearl millet hybrids, and parental lines. Even though there exists a huge genetic variability in pearl millet against FB, no systematic efforts were undertaken to identify new resistance genes or map them. Identifying novel alleles and gene associated with FB resistance will help to deploy various resistance genes over large geographical area.

**Methods:** A panel of 250 genotypes was evaluated at five environments under natural epiphytic conditions. The disease score for each genotype at five environments was assessed following the 0-9 progressive scale and their SNP genotyping was carried out using Genotype-by-sequencing (GBS) protocol. A set of 74K SNP genotyping data of these genotypes were used for Genome-wide association study (GWAS) to identify genes/alleles for FB resistance in pearl millet.

**Results:** The relative magnitude of each association was represented by the  $R^2$  value as the portion of variation explained by the marker at the threshold  $-\log_{10}$  p-value  $>5.00$ . Forty six most significant marker trait associations for foliar blast resistance were identified on pseudo molecules 1, 2, 3, 5 and 7 using MLM analysis. Moreover, analysis of the upstream and downstream in a window  $\pm 2$  kb of the SNP loci detected a total of 10 putative candidate genes at the target regions.

**Conclusion:** The present work reports the resistance genes and its chromosomal locations which are associated with Pearl millet-*Magnaporthe* interaction for first time in the world.

**Keywords:** Pearl millet, Foliar blast, GWAS, SNP-genotyping, resistant genes etc

01.11

### Influence of Exogenous Compounds and Crop Residues on Osmoregulation of Maize Grown in Saline Soil

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A green house experiment was conducted at Agricultural College, Bapatla during kharif, 2017 to study the effect of supplementation of 25 per cent extra nitrogen through maize stover or its compost along with foliar spray of humic acid / proline /  $\text{KNO}_3$  on properties of maize grown on saline soil. The experiment was conducted in CRD design with thirteen treatments and three replications. Results indicated that integrated organic with foliar sprays ameliorate salinity stress through stabilization of the plasma membrane materials, since it decreased the rate of ion leakage and increased the ratio of  $\text{K}^+/\text{Na}^+$ ,  $\text{Ca}^{2+}/\text{Mg}^{2+}$  ions in maize leaves. Among foliar sprays  $\text{KNO}_3$  was found to be superior and compost superior to raw residue and integrated imposition of compost with  $\text{KNO}_3$  augmented the overall performance of maize plant.

**Keywords:**  $\text{Ca}^{2+}/\text{Mg}^{2+}$ ,  $\text{Na}^+/\text{K}^+$ , total sugars, proline, osmoregulation

01.12

### ***Piriformospora indica* Helps in Establishment of Tissue Cultured Banana Plantlets with Enhanced growth and Tolerance to *Fusarium wilt***

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**Background:** *Fusarium wilt* (Panama wilt), caused by *Fusarium oxysporum* f. sp. *cubense* (FOC), leads to extensive yield loss in banana. The disease is difficult to manage as the fungus spread through soil and infected suckers. Tissue cultured (TC) banana plantlets are extensively used as the planting material especially in the infected fields; but is difficult to establish. Beneficial root-colonizing endophytic basidiomycete fungus, *Piriformospora indica* results in enhanced plant growth and yield in addition to conferring resistance/tolerance to abiotic stress in crop plants. Present study elucidates the role of *P. indica* in the establishment of TC banana plantlets and its evaluation against *Fusarium wilt*.

**Method:** Work deals with colonization of *P. indica* with major TC banana varieties and its evaluation in hardening process and against FOC, compatibility study of *P. indica* with fungicides and insecticides used in banana cultivation, and shelf-life of mass multiplied *P. indica* in organic substrate.

**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, robusta and red banana. *P. indica*-colonized TC plants produced more number of roots, rootlets and root hairs, thus improved the root architecture compared to the non-colonized plantlets. The colonized plantlets also produced more number of leaves with increased leaf area. *P. indica* inhibited the growth of FOC through antibiosis, lysis, coiling and overgrowth. *P. indica*-colonized plantlets could inhibit *Fusarium wilt* pathogen successfully, thus helps in its establishment in the field. *P. indica* was compatible with many fungicides and insecticides used in the crop protection. *P. indica* in the mass multiplied medium had more than one and half year of shelf life.

**Conclusion:** The present study demonstrated that the root endophytic fungus *P. indica* helped in the establishment of banana TC plantlets and conferred resistance to *Fusarium wilt* with enhanced growth.

**Keywords:** *Piriformospora indica*, TC banana plantlets, *Fusarium wilt*, Growth promotion, Disease resistance

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

## 02. Biotechnology

02.01

### **Inhibition of Autophagy Potentiates the Anti-Tumor Efficacy of Uttroside B in Hepatocellular Carcinoma**

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**Background:** Liver cancer has been estimated as the sixth most commonly diagnosed cancer and the fourth leading cause of cancer death worldwide in 2018 (GLOBOCAN). Our team has isolated a furostanol saponin, uttroside B, from the leaves of *Solanum nigrum* Linn, which exhibits exceptional cytotoxicity towards liver cancer cells and is more than 10 times cytotoxic than sorafenib, the only FDA approved drug against hepatocellular carcinoma.

**Methods:** Solvent extraction of *Solanum nigrum* Linn leaves; MTT assay, Western blotting, Transfection, Clonogenic assay, Wound healing assay, Annexin V-PI staining, FACS, EMSA, Toxicological studies in Swiss albino mice, Anti-tumor studies in NOD-SCID mice, histopathology, immunohistochemistry, TUNEL Assay.

**Results:** Previous studies from our lab have demonstrated that Uttroside B, a compound isolated in the lab from the medicinal plant, *Solanum nigrum* Linn, exhibits exceptional antitumor efficacy against liver cancer. Besides inducing apoptosis in liver cancer cells, Uttroside B also induces vacuolated structures, indicative of autophagy in these cells as assessed by activation of autophagy markers such as LC3 II, Beclin-1, Atg7, Atg5, Atg12 and. The increase in autophagy flux in HepG2 cells treated with uttroside B was confirmed using bafilomycin A1 and quantitated by RFP-GFP-LC3 tagged protein assay. The study revealed that uttroside B induces activation of autophagy followed by apoptosis. The pharmacological (using bafilomycin A1 and 3-MA) and genetic blockage (using Beclin-1 si-RNA) of autophagy enhance uttroside B-induced apoptosis, which illustrates that autophagy is the negative regulator of uttroside B-mediated apoptosis. Hence, we investigated whether the anti-malarial drug, chloroquine, which is a known inhibitor of autophagy, can enhance the cytotoxic effect of uttroside B against liver cancer cells and found an enhancement of uttroside B-mediated apoptosis, when liver cancer cells were co-treated with chloroquine. A synergistic combination of Chloroquine (10 µM) with Uttroside B (250 nM) produced the same cytotoxicity induced by 500 nM of uttroside B in liver cancer cells. Our studies in NOD-SCID mice bearing liver cancer xenografts confirmed the efficacy of the combination, *in vivo*.

**Conclusions:** This study reveals the pro-survival facet of Uttroside B induced-autophagy, which is capable of delaying the apoptotic program induced by the compound. Hence, we presume that chloroquine can be used along with uttroside B for inhibiting uttroside B-induced autophagy, so that the combination can be used as an effective chemotherapeutic regimen against HCC.

**Keywords:** Uttroside B; HCC; Autophagy; Chloroquine mTOR; AMPK.



## 02.02

### Alarming Presence of Colistin Resistance Genes in XDR *Klebsiella pneumoniae* Isolated from Healthy Broilers.

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Emergence of antimicrobial resistance in livestock sector and its zoonotic transfer to society is an emerging threat to manage the infectious diseases. In addition to the therapeutic use in livestock, various classes of antibiotics are fortified in animal feed for the prophylaxis and growth enhancement. This may favor the evolution of antibiotic-resistant bacterial pathogens specially under the class of enterobacteriaceae. Such resistance accumulation in the bacterial pathogens can be effectively studied using the whole-genome sequence analysis. In this study, an extensively drug resistant *Klebsiella pneumoniae* isolated from the poultry faeces and were subjected to the detailed investigation through the whole-genome sequencing. Here, the fecal samples collected from the commercial poultry farms of Kottayam and Ernakulam districts were used for the study. The resistance pattern of the *Klebsiella pneumoniae* isolates was analysed by antibiotic sensitivity test and confirmed with VITEK-2. The antibiotic susceptibility test result showed resistance to colistin, chloramphenicol, aztreonam, ciprofloxacin, gentamycin and ceftriaxone. Further genome sequence analysis of the *Klebsiella pneumoniae* revealed heavy deposition of AMR genes both in genome and in plasmids. These extensively drug-resistant strains were also shown to have the presence of colistin resistance genes such as *arnT*, *eptB* 1 and *KpnH* which is the very first report of livestock associated AMR in Kerala. This may due to the addition of antibiotics in poultry feeds and the result indicates the emerging health risk to the society. Hence, the usage of medicated feed in poultry farms should be strictly monitored to avoid further resistance evolution and dissemination.

**Keywords:** AMR, Whole genome sequencing, *Klebsiella pneumoniae*, colistin resistance

## 02.03

### Virtual Screening of Natural Compounds and Identification of Anti Sars Cov-2 Leads

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**Background:** Covid-19 caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) represents a pandemic worldwide. Currently, over 76.3 million cases have been confirmed and 1.7 million deaths reported by World Health Organization as on 22 December, 2020. Vaccine developments are underway and currently no approved vaccine or drug is available against this viral disease. It is striking to note that new variants of SARS-CoV-2 are rapidly spreading which made hardship to find out a suitable remedy. In this circumstance, identification of natural remedy is the best option to fight against this virus.

**Methods:** Corona virus main protease (M<sup>pro</sup>), which plays a pivotal role in viral gene expression and replication, was screened against the natural product database InterBioScreen. Virtual screening was performed using Glide XP docking to identify the hit molecules. Further interaction study (Maestro), drug-likeness score prediction (MolSoft) and ADME analysis (Qikprop) were conducted to identify the best lead molecule.

**Results:** A total of 84,099 natural compounds (1,27,699 including its stereoisomers) from InterBioScreen database was screened against corona virus main protease (M<sup>pro</sup>) and the results revealed that eight compounds showed docking score <-8. However, the top eight molecules along with the natural inhibitor were further analyzed for interaction analysis and identified seven compounds. Finally, drug-likeness and ADME analysis exposed the potentiality of the compound, taxifolin as the best lead molecule.

**Conclusions:** The overall results revealed the efficacy of the natural compound, taxifolin to inhibit the SARS CoV-2 virus. The study recommends the use of nutraceuticals with taxifolin to fight against SARS CoV-2 virus. However, certainly needs experimental confirmation through *in vitro* and *in vivo* studies to recommend the natural compound, taxifolin as the best drug candidate.

**Keywords:** COVID-19, SARS-CoV-2, M<sup>pro</sup>, ADME, Virtual Screening

## 02.04

### Differential Expression of Small Hsps in Small Cardamom Under Heat Stress

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**Background:** Being temperature specific, cardamom is easily affected by the fluctuating climatic scenario which in turn affects its growth and productivity pattern. In order to mitigate such situations, plants usually come up with cavalries called heat shock proteins. One such defender is a highly divergent, less conserved category of heat shock proteins called small heat shock proteins (sHsps) which have a significant role in tackling heat stress. This study is primarily focused on determining the changes in expression pattern of selected sHsp genes at transcriptional level under heat stress in cardamom.

**Method:** The cardamom plants were subjected to heat shock at 40 °C and leaf samples were collected at instants viz. 30 min, 1 hr, 2 hr and 3 hr intervals. Untreated samples were left as control. Total RNA was isolated from control as well as treated samples and converted to cDNA. Real-Time PCR analysis was performed using sHsp gene specific primers designed from cardamom transcriptome data. Data analysis was conducted using Comparative Ct method.

**Results:** The expression kinetics varied between each sHsps; peak expression was observed during the first 30 min after heat shock at 40 °C. Small Hsps 178 and 181 showed considerable fold change value of 5571 and 5000 respectively during the initial 30 min. Compared to 178 and 181 sHsps, 186 and 179 showed less expression (198.8 and 435 times). With prolonged exposure to heat, a sharp decline was observed in the expression pattern.

**Conclusion:** The results indicated that the sHsp genes studied have a direct link with thermotolerance in cardamom. On the basis



of the results, it can be speculated that 178 and 181 sHsps could be used as potential biomarker candidates for screening tolerance to heat stress in cardamom. In addition to that, the present work could form the basis of future lines of studies in molecular aspects of thermotolerance in cardamom.

**Keywords:** Thermotolerance, Biomarker, Small heat shock protein, Cavalries

## 02.05

### DNA Barcode Based Screening of Market Samples of "Kurunthotty" aka "Bala" Used in Ayurveda

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**Background:** The *Sida* genus (Family: Malvaceae) has 19 species reported from India. Among them *Sida cordifolia* Linn, *Sida cordata* (Burm.f.) Borss.Waalk., *Sida rhombifolia* Linn. were recommended to be used in Ayurvedic drug preparations of Bala (root), Nagabala (aerial part), Mahabala (root) respectively as per the Ayurvedic pharmacopeia of India (API) and *Abutilon indicum* (Linn.) Sw. was to be used as Atibala (root). However all the above species are commonly known in the Indian herb market as "Bala" (Language: Hindi), or "Kurunthotty" (Language: Malayalam) and usually available as chopped pieces of dried stems and root along with few dried leaves making it impossible to identify taxonomically. The DNA barcoding may be the ideal tool for establishing the identity of materials from bulk suppliers through random sampling studies.

**Method:** In the present study, the practicality and intricacies associated with DNA barcode based identification of market samples using ITS2 and *trnH-psbA* loci was evaluated. Procedures followed for DNA isolation from raw sample drugs of "Kurunthotty/Bala" was successful right up to sequencing and authentication.

**Results:** The present study very clearly revealed problems with identity of species used by Santhosh Kumar et al., (2015). Based on the ITS2 sequence, the Kottakkal market sample was identified as *S. alnifolia*. The *trnH-psbA* data showed that both *S. alnifolia* and *S. scabrida* are very close to each other and that Kottakkal samples falls within this common cluster. The second market sample from Changaramkulam was found to be adulterated with *S. acuta* based on the ITS and *trnH-psbA* analysis. An additional fragment amplified for the same sample was found to be grouping with the earlier Kottakkal sample where it was forming a part of *S. scabrida/S. alnifolia* cluster, probably indicating the possibility of having either of these species as additional adulterating species other than *S. acuta*.

**Conclusions:** The study clearly concludes that the traded market samples are mainly adulterated with allied species of *Sida cordifolia*, as the study could not provide any evidence of the presence of barcode signatures of *S. cordifolia*.

**Keywords:** DNA barcode, ITS2, *trnH-psbA*, *Sida* species, Adulteration

## 02.06

### Recapitulating Developmental Cues of Neural Stem Cells into Cancer Stem Cell Maintenance: Is Pleiotropic Hes-1 Responsible?

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**Background:** In our lab, we have demonstrated that during neocortical development Notch Independent Hes-1 (NIHes-1) activation is required for the maintenance of neural stem cells, whereas Notch Dependent Hes-1 (NDHes-1) expression is required for the maintenance of neural progenitors/Radial Glial Cells (RGCs) (Dhanesh et al., Cerebral Cortex 27:2017, 3943-3961). These results prompted us to investigate whether the same scenario exist in Neuroblastoma.

**Method:** This work utilizes an IMR32 neuroblastoma cell line with CBFRE-DsRedexpressDR-mtCBF-1-d2EGFP, a reporter construct that can differentiate between NI/NDHes-1 expressing cells. The NI/NDHes-1 expressing cells were FACSsorted and performed gene expression studies, limiting Dilution Hanging Drop Sphere formation assay, migration assay, invasion assay and in vivo subcutaneous injection to understand the properties of these cells.

**Results:** Recapitulating developmental scenario, neural origin cancers exhibit pleiotropic Hes-1 expression in vitro. NIHes-1 expressing stem cells show enhanced stem cell properties over NDHes-1 expressing cancer progenitors. The increased migration and invasion potential of the NIHes-1 expressing cells makes the cellcapable of metastasis and secondary tumor formation.

**Conclusion:** NIHes-1 expressing more potent cancer stem cells that can transit to NDHes-1 expressing cells and are masked inside the vibrant, actively growing NDHes-1 expressing cells. These NIHes-1 expressing cells are not included in the spectrum of current notch targeted therapeutic drugs. So, the relevance of considering NIHes-1 expressing cells along with the NDHes-1 expressing cells remains very crucial in treating neuroblastoma/glioblastoma.

**Keywords:** Notch signalling, Hes-1, IMR32, Neuroblastoma





02.07

### Epstein-Barr Virus Infection Upregulates Gls1 Isoforms KGA And GAC Promoting Mitochondrial Metabolism and Cell Proliferation

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**Background:** Epstein-Barr virus or human herpesvirus 4 (EBV/HHV-4) is associated with malignant neoplasms of epithelial and lymphoid origin. The interaction between EBV latent proteins and host cellular molecules often leads to the development of EBV-associated cancers. The objective of his study is to investigate the involvement of glutaminase (GLS1) isoforms, kidney type glutaminase (KGA) and glutaminase C (GAC), in the oncogenic cellular energy metabolism and cell proliferation as well as its connection with the aberrantly expressed c-Myc in EBV-associated cancers.

**Method:** The current study used Real-Time PCR, Western Blot and Immunofluorescence assay to identify the expression and localisation of GLS1 isoforms KGA and GAC. Glutamate and alpha-ketoglutarate in mitochondrial metabolism were studied by measuring the levels of glutamate and alpha-ketoglutarate. c-Myc regulation of GLS1 was studied using lentiviral shRNA mediated knockdown of c-Myc. The functionality of GLS1 isoforms in the proliferation and viability of EBV infected cells were determined using BrdU cell proliferation and MTT assays.

**Results:** Our data identifies an upregulated expression and mitochondrial localisation of KGA and GAC in EBV infected cells. c-Myc regulated upregulation of KGA and GAC protein levels which was associated with increased intracellular glutamate levels, a major component in host cellular mechanism. Further investigation demonstrated an elevated expression of mitochondrial glutamate dehydrogenases GLUD1 and GLUD2 followed by an increase in alpha-ketoglutarate levels. KGA/GAC as well as GLUD1 inhibitors could markedly inhibit proliferation and viability of EBV infected cells. This study ascertains a functional role of GLS1 isoforms KGA and GAC in regulating mitochondrial energy metabolism thereby promoting EBV infected cell proliferation and viability.

**Conclusion:** Our data suggest that c-Myc dependent regulation of KGA and GAC augments mitochondrial functions and triggers glutaminolysis to support rapid proliferation of the EBV infected cells, and these metabolic processes could be therapeutically exploited by targeting KGA/GAC and GLUD1 to prevent EBV-associated cancers.

**Keywords:** EBV; KGA; GAC; mitochondrial metabolism; cell proliferation

02.08

### Biofilm Inhibition of *Aeromonas hydrophila* by Pomegranate Seed Extract

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**Background:** Biofilm formation is a major concern in the microbial infections. The uncontrolled use of antibiotics leads to further complications like drug-resistance. Plant derived compounds have found a major role in controlling infections from the time immemorial. The present study aims to utilize compounds from pomegranate seed, a waste by product in juice industry, as a potential candidate to prevent biofilm formation. *Aeromonas hydrophila* was used as the model organism in the study.

**Methods:** The crude acetone extract of pomegranate seed (PSMW) was used in inhibition study of biofilm forming *Aeromonas hydrophila*. The active fraction was characterized using LCMS. The effect of PSMW on the extracellular virulence factors were assayed as well as the quorum sensing molecule viz, acyl homoserine lactone (AHL). qRT-PCR was performed in the cDNA synthesized from total RNA isolated from *Aeromonas hydrophila* subjected to biofilm formation in the presence of extract.

**Results:** The LCMS showed that the main compounds present in the active fraction were ellagic acid, gallic acid and minor levels of catechin, ferulic acid, rutin and p-coumaric acid. LCMS quantified drastic reduction in the C4-HSL (87%) and C6-HSL (95%) in the culture supernatant containing the extract as compared to the control. The qRT-PCR assay also showed major fold reduction in the gene products of *ahyI*, *ahyR* and *fla A* at varying time intervals, when compared to the control.

**Conclusion:** This study validates the quorum quenching effect of PSMW by reduction in AHL production and also a down regulation in the genes involved (*ahyI* and *ahyR*). The reduction of motility and down regulation of *flaA* gene suggests that the extract PSMW is effective in preventing the adhesion of *Aeromonas hydrophila* and further formation of biofilm on surfaces.

**Keywords:** biofilm inhibition, quorum sensing, AHL

02.09

### Identification of MHC-Class I Epitopes from Spike Protein of Severe Acute Respiratory Syndrome-Coronavirus-2 (Sars-Cov-2) In Kerala Population: An Immunoinformatics Method

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**Background:** Covid 19, the novel pandemic going on is caused by the novel SARS coronavirus (SARS-CoV-2). It has been on focus of research for vaccines and antiviral treatments now. Spike proteins are critical in the viral life cycle. Major histocompatibility complex (MHC) class I molecules present viral antigens to the cytotoxic T lymphocytes. Activated CD8<sup>+</sup> T lymphocytes will kill the cells by cell-mediated cytotoxicity. The identification of SARS-CoV-2 spike protein epitopes of HLA class I alleles, most frequent in the Kerala population, will be a great contribution to the development of vaccines and diagnostic tests in our population.

**Method:** Here we are attempting to identify the most frequent HLA class I alleles in the Kerala population and to predict potential HLA class I epitopes on the SARS-CoV-2 spike protein using different bioinformatics tools and servers namely, NetCTL1.2, MHC-NP, and NetMHCpan servers.

**Results:** We could identify a set of potential epitopes of class I HLA molecules from the SARS-CoV-2 spike protein.

**Conclusions:** Knowledge of prominent HLA class I epitopes of SARS-CoV-2 virus provides further directions for the disease management via vaccines and immune-based antiviral therapies. An important factor to be considered during the development of a vaccine is the population coverage since the distribution of HLA varies according to ethnicity and geographical region. Here we

could identify some of the high binding SARS-CoV-2 spike protein epitopes of HLA-class I molecules among the Kerala population through various bioinformatics approaches. These data can be further evaluated and more works to be done in the development of new strategies for the management of the pandemic worldwide.

**Keywords:** SARS-CoV-2, spike protein, HLA-class I, epitope, MHC, prediction, Kerala population

## 02.10

### *In silico* Evaluation of Anti-SARS-CoV-2 Activity in *Aegle marmelos*

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**Background:** COVID-19 is a pandemic viral disease caused by Severe Acquired Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), and is rapidly spreading throughout the world. Currently, no specific remedy is available against this viral disease and recent reports indicate that different mutated strains of virus are evolved. Identification of natural compounds with anti SARS-CoV-2 activity in nutraceuticals/medicinal plants is the instant option to address the problem since such natural sources can be recommended for consumption as raw material for enhancing immunity and also the lead molecule identified from it can be recommended for drug discovery. Hence, present study aimed to evaluate the efficacy of phytochemicals from *Aegle marmelos* against SARS-CoV-2 and identification of lead molecules through in silico method.

**Method:** A total of 88 phytochemicals reported from *Aegle marmelos* (L.) Correa were selected as ligands and its structures were downloaded from Pubchem database and converted into 3D structure for docking using the tool CORINA. Different therapeutic proteins of SARS-CoV-2 such as Mpro, ACE2 receptor, Spike protein receptor binding domain and Nsp12 were selected as target proteins and its 3D structures were retrieved from Protein Data Bank. Docking was carried out following the standard procedure and the docked complex having free energy of binding  $-6$  kcal/mol were considered as hit molecules. Ten top ranked hit molecules were further analysed for pharmacokinetics properties, ADMET and protein-ligand interaction and identified the best lead molecule.

**Results:** Docking results indicated that among the top ranked ten hits obtained against each target (Mpro, Spike protein, ACE2 and Nsp12) five compounds viz  $\gamma$ -cerane,  $\gamma$ -sitosterol,  $\alpha$ -amyrin,  $\beta$ -sitosterol and marmelosin are the common hit. However, based on the protein-ligand interaction, pharmacokinetics properties and ADMET analysis the compound  $\gamma$ -sitosterol was selected as the best lead against M<sup>pro</sup> and  $\beta$ -sitosterol was found as the best lead against all other three targets, Spike protein, ACE2 and Nsp12. Hence,  $\beta$ -sitosterol can be suggested as the best lead from *Aegle marmelos* against SARS-CoV-2, however, its experimental demonstration in live system is necessary for confirmation

**Keywords:** SARS-CoV-2, COVID-19, Mpro, ACE2, Spike protein, RdRp, *in silico* screening

## 02.11

### Development of a Microbial System for Controlling Quorum Sensing Mediated Biofilm Formation.

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**Background:** Prokaryotic biofilms that predominate in a diverse range of ecosystems are often composed of highly structured multispecies communities. Besides causing problems in cleaning and hygiene biofilms can seriously affect many fields such as drinking water distribution system, industrial appliances, medical appliances etc. The current practices to address biofouling are energy intensive (high cost) or not environment friendly. In this study, potential bacteria exhibiting anti quorum sensing properties were isolated through enrichment culture with N-hexanoyl Homoseriene lactone as the sole carbon source.

**Methods:** Enrichment culture strategy is adopted to promote the growth of QQ bacteria by providing external AHL molecule in the culture media. Initial inoculum for the study was chosen as activated sludge from SWTP Muttathara, Trivandrum, Kerala. Isolated bacterial strains from the enrichment culture were screened for their quorum quenching ability with the help of the biosensor strain *Chromobacterium violaceum* CV026 and the wild strains such as *Chromobacterium violaceum* sp.NIIST, *Serratia marcescens* sp. NIIST and *Pseudomonas aeruginosa* (ATCC27853). Potential quorum quenching isolate was identified using phenetic and genetic characterization.

**Results:** Using enrichment culture, the growth of quorum quenching bacteria was promoted. A novel strain of *Bacillus velezensis* (isolate PM7) isolated from the enrichment culture was found to have significant quorum quenching activity in the cognate AHL producing gram negative bacteria *C.violaceum* and *S.marcescens*. The bacterium is able to disrupt only the communication network without showing any bacteriocidal activity

**Conclusion:** The current practices to address biofilm formation are energy intensive (high cost) or not environment friendly. Development of microbial system, screening its Quorum Quenching property, testing its viability for applying in biofilm control are some of the major R&D challenges. In this scenario, the present study focuses on developing a bacterial system exhibiting QQ property that can be translated for controlling biofouling.

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



### 03.Chemical Sciences

#### 03.01

##### Marine-derived Polygalactofucan and its $\beta$ -2-Deoxy-amino Substituted Glucopyranan Composite Attenuate 3-hydroxy-3-methylglutaryl-CoA Reductase: Prospective Natural Anti-dyslipidemic Leads

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**Background:** Cardiovascular risk assessments and its complications drawn significant attention in the introduction of anti-hypercholesterolemic and anti-obesity drugs and medications. It has been reported that medication using statin drugs have severe side effects, which provided insights to develop potential anti-dyslipidemic derivatives from natural origin.

**Method:** A polygalactofucan from marine macroalga *Sargassum wightii* and its composite with marine-derived  $\beta$ -(2-deoxy)-amino substituted glucopyranan were purified. Structural elucidation of the polygalactofucan was carried out by glycosidic linkage analysis using the method of methylation and the methylated and partially methylated alditol acetates (PMMA) obtained were characterized using extensive spectroscopic experiments. *In vitro* HMG-CoA reductase (HMGCR) enzyme inhibitory potential and *in vivo* studies were conducted to establish the anti-dyslipidemic efficacy of the purified oligosaccharide motifs. Molecular docking simulation studies were conducted to establish the modes of inhibition of HMGCR by the titled compounds. Acute and sub-chronic toxicity studies were carried out as part of the safety evaluation, for selecting a safe dose to use the isolated compounds against dyslipidemia.

**Results:** The polysaccharide composite constituting the titled polysaccharide motifs showed significant HMGCR inhibitory potential (IC<sub>50</sub> 0.12 mg mL<sup>-1</sup>) and an increase in HMG-CoA/mevalonate ratio (1.68 mg dL<sup>-1</sup>) compared to the high-fat diet (HFD)-treated animals (1.04 mg dL<sup>-1</sup>), which recognized its hypo-lipidemic efficacy. *In vivo* results demonstrated about 70 percent reduction in the triglyceride levels with the concomitant increase (~39 %) of hepatic lipoprotein-lipase (LPL) activity in the HFD-fed Wistar rats treated with 500 mg kg<sup>-1</sup> body weight. The results illustrated the use of marine-derived polygalactofucan composite as potential anti-dyslipidemic agent.

**Conclusion:** The studied polysaccharide derivatives were found to be effective in lowering serum LDL levels, and furthermore, the reduction in atherogenic index caused a significant diminution in the LDL/HDL index in the experimental groups fortified with the isolated fractions. The overall study demonstrated that the marine-derived polygalactofucan and its composite with the amino-substituted glucopyranan derivative constituted promising candidates to combat the pathologies leading to hyper-lipidemic and hyper-cholesterolemic conditions.

**Keywords:** Anti-dyslipidemic agent; polygalactofucan composite;  $\beta$ -(2-deoxy)-amino substituted glucopyranan; partially methylated alditol acetates; 3-hydroxy-3-methylglutaryl-CoA reductase; hypo-lipidemic efficacy

#### 03.02

##### Xenicane-Type Anti-Inflammatory Diterpenoid from an Intertidal Brown Seaweed *Sargassum ilicifolium*

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**Background:** Overproduction of arachidonic acid intermediates by various pro-inflammatory enzymes results the elevation of inflammatory responses. Several adverse side effects of synthetic non-steroidal anti-inflammatory drug (NSAID) have triggered an urge to focus on the discovery of anti-inflammatory analogues from natural sources. Being an imperative source of bioactive metabolites, chemical investigation of brown seaweed, *Sargassum ilicifolium* has resulted structurally and functionally unique bioactive xenicane diterpenoid.

**Method:** Dried seaweed sample was extracted with organic solvent to prepare crude extract of *S. ilicifolium*. Bioactivity guided liquid chromatographic fractionation of crude extract resulted a xenicane type diterpenoid from the most active fraction. Isolated xenicane diterpenoid was subjected for free radical scavenging and anti-inflammatory assays. Activity-structure correlation study validated the potent bioactivity. Pharmacokinetics and *in silico* molecular docking study was performed to evaluate oral bioavailability and drug target interaction of the studied xenicane.

**Results:** The studied xenicane exhibited prospective free radical quenching potential (IC<sub>50</sub> 1.2-1.4 mM). Attenuation property of isolated diterpene against 5-lipoxygenase (IC<sub>50</sub> 4.70 mM) was comparable with non-steroidal anti-inflammatory agent ibuprofen (IC<sub>50</sub> 4.51 mM). The greater selectivity index of xenicane exhibited selective attenuation potential against inducible cyclooxygenase-2 and 5-lipoxygenase enzymes. The higher electronic parameters (topological polar surface area, 82.06) and balanced hydrophobic-hydrophilic property (octanol-water partition coefficient 2.94) coupled with lower binding energy (-9.61 kcal mol<sup>-1</sup>) with the active site of 5-lipoxygenase supported the significant anti-inflammatory properties of the studied xenicane-type diterpenoid.

**Conclusion:** The study revealed the isolation and characterization of bioactive xenicane-type diterpenoid as promising pharmacophore for preparation of pharmaceutical formulations against inflammatory mediated diseases.

**Keywords:** *Sargassum ilicifolium*; Sargassaceae; xenicane type diterpenoid; cyclooxygenase and lipoxygenase; anti-inflammatory



03.03

### Sustainable Synthesis, Photophysical Studies, Theoretical and Experimental Determination of Dipole Moment of 1, 8- Dioxo-octahydroxanthenes

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Global warming issues are raising more concern in favour of introducing new green methods in chemistry. One among them is deep eutectic solvents (DESs), a new generation solvent, first introduced by Abbott et al. DESs are binary compositions of two constituents, which are liquids at ambient temperature with melting points much lower than the pure constituents. DESs are prepared by heating the constituents with gentle heating (40-60°C) for 10-15 minutes at different molar ratios until a clear, colourless, homogeneous liquid is formed. In this work, a simple, clear, eco-friendly and recyclable method was established for the preparation of 9-aryl-1,8- dioxooctahydroxanthenes using DES. The catalytic activity of six DESs (DES 1- DES 6) formed from  $ZrOCl_2 \cdot 8H_2O/CeCl_3 \cdot 7H_2O$  with urea/ethylene glycol/glycerol was compared. Among them DES 2 was found to be a better catalyst for the synthesis of 1,8-dioxooctahydroxanthene derivatives. The recyclability of the catalyst was also checked and the catalyst was reused up to five runs without significant loss in its activity. The photophysical studies and ground state dipole moments (both theoretical and experimental) of the synthesised products were conducted. The compounds showed absorption maxima around 285-295 nm and emission maxima of all the molecules were around 403 nm. The dipole moment was determined by Debye-Guggenheim method using toluene as a non-polar solvent. All the synthesised molecules showed significant dipole moment values and are in good agreement with theoretical values.

**Keywords:** Deep eutectic solvents, Green synthesis, 9-aryl-1,8- dioxooctahydroxanthenes, Dipole moment

03.04

### Portable Raman Spectrometer Based Iodine Value Estimator

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**Background:** Edible oils are essential components of the human diet and are nutritional sources for human tissue development. Any changes in edible oil composition adversely affect the lipid metabolism leading to cancer, cardiovascular, neurodegenerative and metabolic diseases. Iodine value (IV), saponification value (SV) and peroxide value (PV) are a few of the important characteristics of edible oils that are routinely used to assure their quality. Presently, the estimation of these analytical parameters is done through classical wet-laboratory experiments and require additional chemicals and solvents. On the other hand, Raman spectroscopy has advantages such as portability, non-invasiveness, non-destructiveness, and fingerprinting capability. When incorporated with specific spectral analysis algorithms and software, it becomes an ideal device for fast, easy and on-site edible oil quality estimation.

**Method:** The present work focuses on developing a portable Raman spectroscopic system for estimating the iodine value of coconut oils. The acquired Raman spectra are subjected to a series of online signal processing methods such as background subtraction and high-frequency noise removal. The preprocessed spectrum thus obtained is used to derive specific relation between Raman spectral intensity and iodine value of coconut oil. An algorithm is designed to automate the entire process of data acquisition, signal processing, analysis and iodine value estimation and a stand-alone graphical user interface (GUI) is created and incorporated into the device.

**Results:** The iodine value of the coconut oil is estimated through conventional *wij's* method and is found to be in the range 8-10 *wij's*. The Raman spectrum of coconut oil exhibited the peaks at 1750  $cm^{-1}$ , 1650  $cm^{-1}$ , 1440  $cm^{-1}$ , 1300  $cm^{-1}$ , 1125  $cm^{-1}$ , 1080  $cm^{-1}$  and 868  $cm^{-1}$  and corresponds to C=O symmetric stretching, C=C stretching, C-H bending (scissoring), C-H bending (twisting), C-C stretching, CH<sub>3</sub> bending and C-C stretching respectively. Iodine value is a measure of unsaturation in oils and fats and taking the relative intensity ratio of the peaks at 1657  $cm^{-1}$  (C=C stretching) and 1441  $cm^{-1}$  (CH<sub>2</sub> bending model) for different composition of coconut oil and sunflower oil agrees excellent matching with the iodine value obtained from *wij's* method.

**Conclusions:** This work established a simple and portable system for the easy one step estimation of iodine value of coconut oil. The estimated values matched well with those obtained through standard *Wij's* method illustrating the potential for establishing it as authentication device and can assist food safety officers.

**Keywords:** Edible Oils, Coconut oil, quality analysis, Adulteration, Iodine Value, Raman Spectroscopy.

03.05

### Sensing of 5-Hydroxyindoleacetic Acid Based on Aggregation Induced Emission Enhancement of Thioglycolic Acid-Capped Cadmium Sulphide Quantum Dots

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**Background:** A 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 work explores the development of a turn-on fluorescence sensor for the determination of 5-hydroxyindoleacetic acid (HIAA) using TGA-CdS QDs. A yellow fluorescence with emission maximum centred at 560 nm has been obtained for the QDs when excited at 380 nm. Sensing of HIAA has been studied by adding different volumes of HIAA in an increasing order while keeping the volume of the probe as a constant. A linear range was obtained by plotting the I/I<sub>0</sub> value against the concentration of the analyte, where I and I<sub>0</sub> are the intensity of the probe in presence and absence of HIAA.

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**Results:** Under the optimal analytical conditions, a linear enhancement in fluorescence intensity with the concentration of 5-HIAA was observed in the range of  $2.5 \times 10^{-6}$  M to  $8.0 \times 10^{-5}$  M. The limit of detection obtained was  $8.4 \times 10^{-7}$  M. By comparing the results obtained from TEM, DLS, zeta potential analysis and FTIR data the mechanism behind the sensing of HIAA by TGA-CdS QDs was supposed to be an aggregation induced emission enhancement of QDs by the analyte. 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:** Sensing of HIAA has been done using the aggregation induced fluorescence enhancement of TGA-CdS QDs by the analyte. Under optimal conditions, a linear concentration range has been obtained from  $2.5 \times 10^{-6}$  M to  $8.0 \times 10^{-5}$  M with a detection limit of  $8.4 \times 10^{-7}$  M. Application study of the proposed sensor has been done in artificial urine and blood serum.

**Keywords:** Fluorescence sensor, 5-hydroxyindoleacetic acid, quantum dots, aggregation induced emission enhancement

### 03.06

#### Catalytic Hydrothermal Liquefaction of Biomass with Plastic Waste for High Productivity of Bio-derived Hydrocarbons

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**Background:** The bio-oil (bio-crude) which is produced from biomass through thermo-chemical processes offers an attractive solution from both the environmental and implementation perspectives. It is produced as viscous liquid that can be easily processed, stored and 'dropped-in' into supply chain safely for chemical conversions. The aim of this work is to catalytically convert biomass-prosopis juliflora (PJ) to bio-oil by catalytic hydrothermal liquefaction (HTL) method. In order to increase the bio-oil yield and quality, H<sub>2</sub> rich polypropylene (PP) waste was used as a co-reactant to biomass.

**Method:** For the HTL experiments, Mo/alumina, Ni/alumina, Nb/alumina and W/alumina catalysts were prepared by simple wetness impregnation method. HTL experiments were carried out in a 250mL capacity stainless steel closed high-pressure batch auto-reactor.

**Results:** The HTL of biomass and polypropylene waste yielded bio-oil, aqueous phase, gas and biochar. In terms of bio-oil yield, 420 °C was found to be the optimum temperature. Among the different PP and PJ blends, the maximum yield (59.4 %) was acquired for the PP: PJ (1:3) with Nb/alumina. Evidently, the catalyst suppressed the formation of gases from PP and produced more hydrocarbon liquids that facilitated the conversion of PJ by acting as a hydrocarbon solvent as well as a H<sub>2</sub> source for hydrocarbon production.

**Conclusions:** 25 % substitution of biomass with polypropylene enabled high production of bio-oil. The use of catalyst has improved further the bio-oil yield. Nb based catalysts showed selectivity and high efficiency for deoxygenation of liquid phases resulting high hydrocarbons.

**Keywords:** Prosopis Juliflora, Hydrothermal Liquefaction, Catalytic liquefaction, Plastic waste, Hydrocarbons, Biofuels, Nb<sub>2</sub>O<sub>5</sub>

### 03.07

#### Development of Surface Enhanced Raman spectroscopic Substrate and Machine Learning tools for Lung Cancer Studies

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**Background:** Cancer is one of the deadliest diseases, and today it has become a common household word. Lung cancer is the second most prevalent cancers among Indian males. Late diagnosis is the primary reason for the high mortality rate among cancer patients. This is due to the lack of an adequate number of diagnostics centres and the cost that is not affordable to the common man in India. Cancer cells/tissues, due to the alterations in biochemical pathways, can exhibit Raman spectral features that are distinct from normal samples and forms the basis of diagnosis. However, low sensitivity imposed by low scattering efficiency prohibits its direct usage for diagnostic application. The evolution of 'Surface-Enhanced Raman Scattering (SERS)' has helped to revolutionize the field, improving the sensitivity for even trace-level analysis. Yet the reproducibility and uniformity of the substrate and difficulty in distinguishing Raman signals of cancerous cells from that of normal cells are the bottlenecks to overcome for cancer diagnosis. Method: This work explores a novel strategy for the development of a highly uniform and reproducible SERS substrate through the thermal evaporation process. The thickness and rate of evaporation are optimized to yield the best sensitivity. The substrate thus obtained are used to acquire the Raman spectrum cancer model cells, A549 and normal cells, WI38. The acquired Raman spectra are first subjected to spectral preprocessing such as noise and background removal, normalization. The distinction of the cancerous and normal cells are achieved through the principal component analysis.

**Results:** The morphological analysis of the developed plasmonic SERS substrate showed the presence of highly uniform 60 nm sized silver nanoparticles over a large area (>1cm<sup>2</sup>). The SERS performance evaluation with standard reporter molecules, MPBA, exhibited sensitivity up to 50 uM. The comparison of spectra taken from different locations of the same substrate exhibited < 5 % variation in intensity for the identified peak illustrating the uniformity in SERS performance. SERS of the cancerous tissue are heavily enhanced at around 1078 cm<sup>-1</sup> (symmetric PO 2-stretching), 1150 cm<sup>-1</sup> (C-C stretching), 1279 (CH contortion), 1394 (C = O stretching), 1460 (ringbreathing), 1531 (C = C stretching), 1591 (C = C stretching), 1653 (C-C stretching). While SERS of the normal tissues are significantly strengthened at around 1005 (C-C skeletal), 1257 (N-H surface deformation), 1381 (C-H ring asymmetric), 1495 (C-H bending), 1539 (COO-), 1609 (C-O stretching), and 1648 cm<sup>-1</sup> (C-O stretching). Principal component analysis of 100 number of for each class of cells showed a clear distinction between the A549 and WI38 cells.

**Conclusions:** This work establishes a simple and facile methodology for the fabrication of highly uniform and reproducible SERS substrate that can cater to the need of different analytical sectors. The high enhancement of the substrate made it possible to easily acquire the Raman spectra of cell samples. The application of principal component analysis methodology for Raman spectral analysis is found to be efficient for distinguishing cancerous cells from that of normal cells.

**Keywords:** Raman Spectroscopy, SERS, lung cancer, diagnosis, machine learning, principal component analysis.

03.08

### Anti-Inflammatory Polyether Triterpenoids from *Gracilaria salicornia*: Natural Leads Attenuate 5-Lipoxygenase and Cyclooxygenase-2

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**Background:** 5-Lipoxygenase (5-LOX)/cyclooxygenase-2 (COX-2) were found to be the two major inducible pro-inflammatory enzymes catalyzing the rate-limiting stage in the development of pro-inflammatory prostaglandins/thromboxanes by COX-2 pathway and leukotrienes by 5-LOX pathway. Instantaneous quenching of COX-2/5-LOX-associated cascade is an important therapeutic objective in the attenuation of inflammatory pathologies.

**Methods:** This work detailed the isolation and spectroscopic characterization of two polyether derivatives attenuate COX-2/5-LOX from the organic extract of the marine macroalgae *Gracilaria salicornia* harvested from southeast-coastal zones of the Indian peninsula. The bio-potencies of these natural leads were established with their physico-chemical and docking parameters.

**Results:** Polyether analogue bearing trimethyl-2H-pyran-3-yl butyrate moiety disclosed potent attenuation properties against 5-LOX (IC<sub>50</sub> 1.89 mM) and COX-2 (IC<sub>50</sub> 1.87 mM) enzymes. In-silico molecular docking methods designated the anti-inflammatory mechanisms of isolated compounds and their comparison of docking factors assigned that polyether derivative displayed the smallest binding energy of -10.29 and -10.96 kcal mol<sup>-1</sup> in COX-2 and 5-LOX active sites, respectively and designated competent hydrogen-bonding associations with the enzymatic catalytic regions. Greater electronic factors along with lesser steric bulk of the polyether bearing furanyl-furo[3,2-b]pyran-2H-pyran moiety was found to have noteworthy functional roles to attenuate the inflammatory enzymes. Proposed bio-synthetic origin leading to the polyether analogues comprising the cyclization of squalene epoxides through the sequences of enzyme-catalysed cascade corroborated their structural attributions.

**Conclusions:** These reports designated that polyether triterpenoid enclosing furanyl-furo[3,2-b]pyran-2H-pyran skeleton might be considered as a prospective anti-inflammatory therapeutic source to alleviate COX-2 and 5-LOX-mediated inflammatory pathologies.

**Keywords:** Polyether triterpenoids, Pro-inflammatory 5-LOX/COX-2, *In silico* molecular docking

03.09

### Polyether Marocyclic Polyketide from the Muricid Gastropod *Chicoreus ramosus* – A Prospective Bioactive Lead Against Inflammation.

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**Background:** The stage of chronic inflammation elicited without an actual stimulus has numerous adverse consequences in physiological responses leading to serious risk of chronic disorders and diseases. Reactive oxygen species (ROS) being prominent intermediaries that exacerbate inflammatory processes, the neutralization of these oxidant species by antioxidants and radical scavengers could help to attenuate inflammation.

**Method:** The ethyl acetate-methanol fraction (EtOAc-MeOH) of the gastropod *C. ramosus* subjected to bioactivity-led chromatographic purification resulted in the isolation and structural characterization of a previously undescribed polyether macrocyclic polyketide based on extensive spectral experiments. In vitro anti-inflammatory properties evaluated by studying the inhibition of 5-LOX enzyme, the antioxidant properties by 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical decolorization assays. Molecular docking study of the studied polyether macrocyclic polyketide was performed using with the software AutoDock 4 (AutoDock Tools version-1.5.6).

**Results:** Bioactivity-led chromatographic fractionation of the organic extract yielded a 16-membered polyether marocyclic polyketide, characterized as 6-(butoxy)-13,15,22-trihydroxy-3,18-dioxatricyclo[18.3.1.0<sup>16,6</sup>] tricos-9,20-diene-4,8-dione with potential anti-inflammatory and antioxidative properties. The attenuation potential of the compound isolated from *C. ramosus* against pro-inflammatory 5-LOX enzyme was greater than those displayed by the non-steroidal anti-inflammatory agent ibuprofen (IC<sub>50</sub> 0.90 mg/mL), and it possessed greater antioxidant properties than that exhibited by commercial antioxidant agent  $\alpha$ -tocopherol (IC<sub>50</sub> 0.60 mg/mL). The molecular docking studies of the isolated compound with LOX-5 receptor also suggested that the docked ligand was potentially bound to the target site of the selected enzyme with minimum binding energy (-9.33 kcal mol<sup>-1</sup>) and less docking score (-10.23 kcal mol<sup>-1</sup>), which described its attenuation property against the pro-inflammatory enzyme.

**Conclusion:** The results suggested that the marocyclic polyketide could be subjected to advanced biomedical investigation so as to be used as a nature-inspired anti-inflammatory lead in pharmaceutical applications.

**Keywords:** Gastropod mollusk, *Chicoreus ramosus*, polyether macrocyclic polyketide, antioxidant, anti-inflammatory, pro-inflammatory 5-lipoxygenase.

03.10

### Dietary Citrus Flavonoids as Inhibitors Against Sars-Cov-2 Main Protease: Computational Investigations

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COVID-19 pandemic caused by SARS-CoV-2 has become a big concern and challenge as it has spread rapidly all over the world. Right now, hospitalization may not be possible for all COVID 19 patients. We can prevent the severity of this disease by home care for patients using effective dietary supplements. SARS-CoV-2 Protease, Mpro, is identified as one of the potential targets in the drug discovery process for COVID 19 treatment. We investigated the binding mechanism of some dietary bioactive citrus



flavonoids, which were established to have excellent biological and pharmacological properties, to the active site of SARS COV-2 crystal structure (PDB ID 6LU7). The results of Molecular Docking and Simulations followed by MM-PBSA Binding Energy calculations showed that Naringin and Naringenin fit well into the active site of the protein with better binding energy and have dominant inhibitory activity from the results obtained from Docking and MM-PBSA calculations. This study also recognizes some of the key amino acid residues, MET165, CYS145, HIS41, VAL42, GLN192, SER144, ASP187, MET49 and TYR54 of SARS COV-2 MPro that may involve in the interaction with potential inhibitors. To the best of our knowledge, Naringin and Naringenin, widely available nutritional supplements are introduced for the first time as a potential inhibitor of SARS COV-2 Protease that may act as a lead compound for drug development against COVID-19.

### 03.11

#### Determination of Biliverdin and Bilirubin- A Dual Channel Optical Sensing Strategy

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**Background:** The linear tetrapyrroles biliverdin (BVD) and bilirubin (BLR) are naturally occurring bile pigments and are formed during heme catabolism. Both of these compounds have potential antioxidant and anti-mutagenic properties and participate in various body functions. Excess concentration of BVD is called the health condition hyperbiliverdinemia where the plasma and urine are found to be green in colour. BLR is the end product of heme catabolism and it is a major biomarker for jaundice, where its concentration exceeds 50  $\mu\text{M}$ . Therefore early detection and determination of these bile pigments is highly significant in current research. In this context, we have developed a fluorimetric and colorimetric sensor for the determination of BVD and BLR based on glutathione capped copper nanoclusters (GSH-CuNCs).

**Method:** GSH-CuNCs were synthesized according to a reported procedure. For fluorimetric determination, fluorescence spectra were recorded upon exciting the sample at 360 nm with an emission maxima at 440 nm. The relative fluorescence intensity (I0/I) was used for quantifying these analytes. For colorimetric analysis, absorbance of the system at 400 nm is measured for its quantification. Results: The required sensor parameters were optimized and under such conditions, the sensor enabled the quantification of BVD and BLR in wide linear ranges with low detection limit. The detection limit was found to be  $3.40 \times 10^{-8}$  M (BVD) and  $4.92 \times 10^{-8}$  M (BLR), colorimetrically and  $1.55 \times 10^{-7}$  M (BVD) and  $1.48 \times 10^{-7}$  M (BLR), fluorimetrically. Mechanism behind the sensing was found to be a ground state complex formation between probe and analytes molecules. Also, feasibility of the sensor has been checked in artificial blood serum and urine samples.

**Conclusions:** A dual channel optical sensor has been developed for the individual determination of BVD and BLR based on GSH-CuNCs. Under optimal analytical conditions, the sensor achieved the quantification of BVD and BLR in wide linear ranges and low detection limit. Reliability of the developed sensor has been attested in synthetic physiological samples which demonstrate its practical application in real time analysis.

**Keywords:** fluorescence sensor, biliverdin, bilirubin, copper nanoclusters

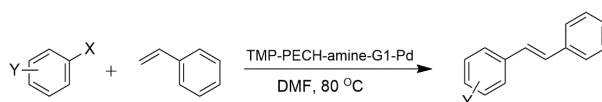
### 03.12

#### Palladium Loaded Dendritic Polymer as Efficient Catalyst in Heck Coupling Reaction

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Palladium metal catalysts play a significant role in organic synthesis because of their outstanding catalytic performance for carbon-carbon coupling reactions. The high cost of Palladium and removal of the catalyst residue from the reaction mixture are the two main challenges addressed by Palladium catalysis. This problem can be solved upon immobilization of palladium into various homogeneous and heterogeneous supports. Here, a dendritic polymer supported palladium complex (TMP-PECH-amine-G1-Pd) was effectively synthesized and properly characterized with different analysis techniques. Similar to higher generation dendrimer, the newly developed dendritic system showed high palladium content in the lower generation level itself. TMP-PECH-amine-G1-Pd could act as an efficient catalyst for the synthesis of stilbene derivatives via the Heck coupling reaction between alkyl halides and styrene (Scheme 1). Various factors affecting the catalyst's performance such as the amount of catalyst, effect of solvents, nature of base, time and temperature were studied. Due to water soluble nature of this catalyst, it can be easily separated and reused up to six cycles of reaction without any additional activation treatment.



Scheme 1: Synthesis of stilbene derivatives using TMP-PECH-amine-G1-Pd catalyst

**Keywords:** Homogeneous catalyst, Reusable catalyst, Palladium complexed dendritic polymer, Stilbene derivatives, Heck reaction

### 03.13

#### Voltammetric Sensor for the Simultaneous Determination of Melanoma Biomarkers

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**Background:** Simultaneous determination of the biomolecules L-Dopa and L- Tyrosine is important since their ratio can be used to detect the stage of the skin cancer melanoma. Voltammetric technique allows the simultaneous determination of these molecules using a simple modification of the working electrode using poly para toluene sulphonic acid, with good limit of detection.





**Method:** The glassy carbon electrode was modified with the electrocatalytic conducting polymer poly para tolunesulphonic acid. It was characterized and sensor parameters were optimized and applied for the simultaneous as well as individual determination of L- Dopa and L-Tyrosine in blood serum and urine samples.

**Results:** Poly para tolunesulphonic acid modified glassy carbon electrode can be used for the simultaneous determination of L- Dopa in the linear concentration range  $9.00 \times 10^{-5}$  M to  $2.00 \times 10^{-5}$  M and  $1.00 \times 10^{-5}$  M to  $1.00 \times 10^{-6}$  M and for L- Tyrosine in the range  $7.00 \times 10^{-5}$  M to  $2.00 \times 10^{-5}$  M and  $1.00 \times 10^{-5}$  M to  $1.00 \times 10^{-6}$  M with limit of detection  $1.20 \times 10^{-7}$  M and  $2.1 \times 10^{-7}$  M respectively.

**Conclusion:** A simple and sensitive voltammetric sensor has been developed for the simultaneous determination of melanoma biomarkers which can be applied in real sample analysis.

**Keywords:** Melanoma, voltammetry, Glassy carbon electrode, L- Dopa, L- Tyrosine

03.14

### Comparison of Chemical Composition and Bioactivities of Rhizomes of *Zingiber zerumbet* and *Zingiber nimmonii*

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**Background:** The family Zingiberaceae possess various pharmacological and physiological effects and it is one of the inevitable components in the folklore medicines as well as a raw material for various Ayurvedic formulations. The plants in this family is well explored for a wide spectrum of pharmacological properties. Hence, a comparative study on its phytochemical constituents of rhizomes of two plant species of this family offers a sensible approach to better drug formulation for various pharmaceutical studies.

**Methods:** Fresh rhizomes of *Zingiber zerumbet* (Zz) and *Zingiber nimmonii* (Zn) were collected, dried, powdered and extracted using hexane and acetone at room temperature. Gravity column chromatography was performed using 100-200 mesh silica gel, mixtures of hexane-ethyl acetate were used for elution. Nuclear magnetic resonance spectra (<sup>1</sup>H NMR, <sup>13</sup>C NMR, 2D NMR) of isolated compounds were recorded on a Bruker Advance DPX 300 and Bruker AV 500 spectrophotometers (CDCl<sub>3</sub> as solvent). Mass spectra were recorded under ESI/HRMS at 61800 resolution using Thermo Scientific Exactive mass spectrometer. IR spectra were recorded on Bruker Alpha FT-IR spectrometer.

**Results:** The main compounds of *Zingiber zerumbet* were  $\alpha$ -humulene, zerumbone, zerumbol, zerumbone epoxide, kaempferol, isokaempferide and diacetylfazelin; and those of *Zingiber nimmonii* were  $\beta$ -caryophyllene,  $\alpha$ -humulene, zerumbone, galangin derivatives, germacrone, flavokavain B and lupeol.

**Conclusion:** The phytochemicals of terpenoids and flavonoids, which constitute the major class of secondary metabolites, together relevant to the effect for the reported actions of antioxidative, anticancer, antidiabetic, antiglycation, etc.

**Keywords:** *Z. nimmonii*, *Z. zerumbet*, Zerumbone, humulene, caryophyllene, NMR.

03.15

### Advanced Glycation End-Products (AGE) Trapping Agents: Design and Synthesis of Nature Inspired Indeno [2,1-C] Pyridinones

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**Background:** Advanced glycation end products (AGEs) are proteins or lipids that become glycated as a result of exposure to sugars. They are a bio-marker implicated in aging and the development or worsening of many degenerative diseases, such as diabetes, atherosclerosis, chronic kidney disease, and Alzheimer's disease. Diabetes is one of the disorder caused by AGEs. MG (Methylglyoxal) is found to be high in diabetic patients attributed to its formation mainly due to hyperglycemia. Few naturally derived and synthetic compounds are used for the treatment of diabetes. Thus, we have designed a novel natural product inspired indeno[2,1-c]pyridinone molecular templates with MG (Methylglyoxal) trapping potential through the scaffold hopping approach and synthesized via facile two-step synthetic route.

**Methods:** Synthesized Indeno[2,1-c]pyridinone templates are characterized by a different spectroscopic technique such as IR, Mass, <sup>1</sup>H NMR, <sup>13</sup>C NMR, etc. The selected compounds were tested for their Anti-glycation potential using BSA-MG model, MG trapping capacity by HPLC, Quantification of MG trapping using LC-MS, and Cytotoxicity using the MTT assay method.

**Results:** We have synthesized Indeno[2,1-c]pyridinone motifs by facile two-step synthetic through scaffold hopping approach. Most of the selected compounds showed better activity. Three of the synthetic analogs have excellent MG scavenging activity than positive control amino-guanidine. Cytotoxicity of all the selected compounds was also performed by using the MTT assay method. None of the compounds shows any sign of toxicity.

**Conclusion:** As anticipated, among all the pharmacophoric indeno[2,1-c] pyridinone analogues, three compounds, 4i, 4x and 4aa have showed potent MG scavenging activity and Anti-glycation potential.

**Keywords:** Glycation end-products, Metabolic disorders, AGE inhibitors, Indeno[2,1-c]pyridinones, Methylglyoxal trapping.



03.16

### **Stomopneulactone D From Sea Urchin *Stomopneustes variolaris*: Anti-Inflammatory Macrocylic Lactone Inhibiting Cyclooxygenase-2**

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**Background:** Cyclooxygenase-2 is one of the significant enzymes to cause an elevated production of prostaglandins during inflammation and immune responses and could be used for screening compounds with anti-inflammatory potential. The investigation of marine natural products with the ability to inhibit various inflammatory modulators gains more importance in the recent years.

**Method:** The bioactive compounds macrocyclic lactones (stomopneulactones A-D) were isolated from the sea urchin *Stomopneustes variolaris* by extensive chromatographic purification. These compounds were characterized by detailed spectroscopic methods including NMR, FTIR and mass spectral experiments. The anti-inflammatory activities of the isolated compounds were evaluated by in vitro assays. The active compound was analyzed for detailed mechanism of anti-inflammatory activity on LPS-activated macrophages by methods like gene expression studies using quantitative real time-polymerase chain reaction (qRT-PCR).

**Results:** The bioactivity guided purification of the solvent extract of *S. variolaris* resulted in four macrocyclic lactone compounds (stomopneulactones A-D). Stomopneulactones D exhibited significantly greater anti-inflammatory activity (IC<sub>50</sub>-2mM). Stomopneulactone D also inhibited the generation of inducible nitric oxide synthase, intracellular reactive oxygen species, along with 5-lipoxygenase and cyclooxygenase-2 in the lipopolysaccharide-stimulated macrophage cells. Additionally, stomopneulactone D decreased the mRNA expression of cyclooxygenase-2 in the inflammatory cells in a dose-dependent manner.

**Conclusion:** The study demonstrated the therapeutic potential of the macrocyclic lactone, stomopneulactone D, in down-regulating the inflammatory pathogenesis.

**Keywords:** *Stomopneustes variolaris*, stomopneulactones A-D, macrocyclic lactones, anti-inflammatory, lipopolysaccharide-stimulated macrophages, pro-inflammatory cyclooxygenase-2

03.17

### **Highly Efficient Engineered Dye-Sensitized Indoor Photovoltaic Devices**

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Dye sensitized solar cells (DSSCs) is considered as the most promising indoor photovoltaic solar cellsexhibiting outstanding performance in indoor/artificial/diffused light conditions.<sup>1-3</sup>However, higher power conversion efficiency with long term stability of photovoltaic devicesis always a concern for solar cells over the years. One of the foremost problem is the leakage of electrolyte when performance and stability are concerned. Indeed, the choice of appropriate sealants can address the leakage issues and maintain the PV stability and performance.<sup>4</sup>

In the present studythe influence of different sealing materials such as surlyn, bynel and UV epoxy along with various TiO<sub>2</sub> deposition methods (doctorblading and screen printing) on the photovoltaic performance of DSSCs under outdoor and indoor light irradiation were studied.Here we used the standard ruthenium based dye (N719) as the sensitizer and iodide/triiodide as the redox mediator for the device fabrication, all devices showed greater than 10% efficiency under one sun illumination (100 mw/cm<sup>2</sup>). Performance ofTiO<sub>2</sub> doctor bladed devices declined with passage of time, whereasdevices fabricated with screen printed TiO<sub>2</sub> film showcased better efficiency and stability under both one sun and indoor/artificial illumination (1000 lux CFL).This demonstrates the influence of TiO<sub>2</sub> deposition method on the PV performance for highly efficient devices.Compared to doctor bladed devices, the screen printed devices exhibit a record efficiency of 29% under 1000 luxindoor light illumination using CFL.Also, there was an improvement of a17% on switching sealing gasket from surlyn to UV epoxy adhesives.Detailed charge transfer study was carried out using small perturbation and large perturbation technique in a way to understand the difference in PV performance.

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03.18

### **Molecular Docking Studies on the use of Phytochemicals from Some Common Natural Products for the Treatment of COVID-19**

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**Background:** COVID-19 is a pandemic in the world for the past year, and human beings are struggling even to meet their basic needs in this period since the disease is airborne and also life-threatening. Extensive research is in progress to find out suitable medications and vaccines. Some vaccines got approval, and some countries had started to supply. But it may take a few years for all the people to get vaccinated. The success rate also has to be evaluated with time. There are no effective medicines available for the pandemic. Drug repurposing for COVID-19 treatment is ongoing since it is for immediate need, and will take years for the production, trials, and approval of new drugs. Among the different existing drugs, those derived from or available in nature have the additional advantages, since most of them have known safety profiles on their use and are already having an essential role in the treatment of several diseases. Molecular docking is an advanced method of preliminary studies of drug design; here we are doing some preliminary in-silico molecular docking studies to investigate the use of phytochemicals from some common natural

products of medicinal value on COVID-19 treatment.

**Method:** In-silico rigid docking studies have been performed with phytochemicals from natural products in inhibiting SARS CoV2 main protease, Mpro, with the use of Autodock vina software, and the interactions were investigated using Biovia Discovery studio. A comparison with the activity of commonly suggested hydroxychloroquine and antiviral medicine saquinavir (using the same in-silico model study) is also incorporated.

**Results:** Suitability of phytochemicals of natural products turmeric (*Curcuma longa*), garlic (*Allium sativum*), tulsi (*Ocimum tenuiflorum*), amla (nelli, *Phyllanthus emblica*), and ginger (*Zingiber officinale*) in inhibiting the main protease, Mpro (the protein essential for viral replication), of SARS CoV2 is investigated here since many of the phytochemicals are commonly recommended antivirals and immune boosters. Docking studies reveal that among the different natural products investigated, phytochemicals agapanthagenin present in garlic as well as apigenin and luteolin present in tulsi have comparatively higher inhibiting action (with binding energy -8.4 Kcal/mole) towards the Mpro. Most of the phytochemicals showed better performance when compared with hydroxychloroquine (binding energy -6.3 Kcal/mole), but with reduced activity than the antiviral medicine saquinavir (binding energy -9.3 Kcal/mole).

**Conclusions:** Immediate and important information regarding the suitability of the phytochemicals derived from some common natural products in the treatment of COVID-19 is obtained from in-silico molecular docking experiments. Further evaluation of these promising phytochemical drugs in COVID-19 treatment should be established via both in vitro and in vivo trials. Data of non-toxic phytochemicals matching the Lipinski rule (with one exception as already allotted) is only included in this study since the ultimate target is drug repurposing for COVID-19.

**Keywords:** COVID-19, In-Silico Studies, Natural products, Phytochemicals

### 03.19

#### DNA Binding, Cleavage and Docking By Cu(II) Salen Complexes: Factors Affecting Bioactivity

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**Background:** The report of WHO on cancer reveal some fearful results which tell us the fact that as of 2015 approx. 8.8 million people have succumbed to death worldwide owing to this deadly disease. Also, National Centre for Health Statistics in 2016 predicted that around 1,685,210 new cancer cases and 595,690 were projected to occur in United States. If this is the case in well developed countries like USA, we could expect even worse in other developing countries. So there is a pressing need to develop a drug which could effectively interact and destroy the affected cell. Herein we are presenting our attempt to develop a metallo-drug based on tetra dentate Schiff bases.

**Method:** In order to develop an effective chemotherapeutic agent. Simple molecular systems from Schiff base family having an effective interaction with DNA was predesigned theoretically and synthesized accordingly. DNA binding studies were done via UV vis titration and fluorescence method. Cleavage studies were also performed with PUC19 DNA and also the probable binding sites were analyzed theoretically.

**Results:** The Pre designed molecules were synthesized and characterized. The interaction of synthesized compounds with the target molecules were assessed experimentally as well as theoretically. The experimental results showed an intercalative type of binding mechanism with high binding constant values. Cleavage of DNA strands occurs via the formation of hydroxyl radical intermediate and the cleavage of phosphate backbone. The noncovalent interactions of the phenolic and methoxy oxygens with DNA base pairs were confirmed theoretically using molecular docking method.

**Conclusions:** We were able to develop different novel Cu(II) metallodrugs which display intercalative DNA binding mechanism with surprising Kb values. This work is significant not only due to its binding efficiency but also due to its cleavage ability towards the target molecule. Moreover, our compounds satisfy the required criteria for a good metallodrug and we believe that this work will definitely contribute towards the development of efficient drugs against the life threatening deadly disease cancer.

**Keywords:** Chemotherapeutic agents, Salen Cu(II) compounds, DNA binding, Cleavage, Docking

### 03.20

#### Development of Nanostructured Conducting Poly (3,4-Ethylenedioxythiophene) Fibres as an Amperometric Sensor for Ascorbic Acid

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The present work describes the development of water dispersible electrically conducting poly (3, 4 ethylene dioxythiophene) using a novel renewable resource based amphiphilic dopant 3- pentadecyl phenyl phosphoric acid (PDPPA). The amphiphilic dopant so designed is found to form stable emulsion with ethylene dioxythiophene (EDOT) in a wide range of composition in water. The rheo-optical studies showed that 3-PDPPA and EDOT ratio plays a major role in the formation of shape of the micelle. The critical micelle concentration of the surfactant at 300 °C is about  $1 \times 10^{-3}$  M, as obtained from surface tension measurements. The lyotropic behaviour of the surfactant is found to be complex in nature. At higher concentration higher than cmc mesophase has been identified, which acts as template for the formation of organised nanofibrils of PEDOT. The morphology was confirmed by the scanning electron microscopy and transmission electron microscopy analysis. Wide angle X-ray diffraction spectra of the nanofibrils showed peak at  $2\theta = 3.8$  (d spacing = 23 Å) corresponding to the three dimensional solid state ordering of PEDOT- dopant chains. PEDOT Nano fibrils are freely dispersible in water and thermal stability is found to be 300 °C. Interest in the comprehensive phase behaviour of the amphiphilic dopants is based on the desire to integrate the system to obtain potentially conducting self-assembled hybrid nanostructures. Present work includes the synthesis of nanostructured PEDOT and envisages its performance as a modifier for an amperometric sensor for Ascorbic acid at Pt electrode.

**Keywords:** PEDOT, Nano silver, emulsion polymerization, liquid crystalline template, sensing of ascorbic acid.



## 04. Earth & Planetary Sciences

### 04.01

#### An Assessment of Seawater Intrusion in the Unconfined Aquifer and the Impact of Naturally Induced Influential Factors Along the SW Coast of India

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**Background:** Coastal zones are the most diverse, dynamic environment as well as transition zones from land to sea. They consist of a wide range of hydrogeological settings influenced by both terrestrial and marine processes. Coastal aquifers are considered an important component of water resources on the earth. Sea-level rise, recharge variation, seasonal tidal fluctuation, and over-exploitation of groundwater are the major environmental issues faced by coastal aquifers that disturbs the hydrodynamic equilibrium between the freshwater and the seawater in the interface zone, which leads to contaminate wells near to the shoreline. The present study elucidate the risk of seawater intrusion and bring out influential factors on the coastal aquifer vulnerability.

**Method:** The watertable elevation of the area from the mean sea level was calculated and interpolated in the GIS platform. The extent of freshwater/saline water interface shifts towards the coastal aquifer was delineated based on a range of TDS values measured from the wells. Resistivity surveys also provide information on spatial extension of interface zone. Sea level trend along the coast was calculated by using the Mann-Kendell method and its contribution on coastal inundation was calculated in the GIS platform. To understand the tidal influence on the coastal aquifer, the monthly-wise tidal data for the period 2017 to 2018 were compared with the shape and the location of the toe of interface zone along with annual recharge variations in the study area.

**Results:** The sea level trend along the west coast of India has an increasing monotonic trend over time. Increasing sea level rise by 1m could be inundated the area of 26.9003 Km<sup>2</sup>. This means that about 8.5% of the total geographical area of the study area was impacted by the effect of 1m SLR, whereas due to a 2m rise, the area of inundation would be 37.0162 Km<sup>2</sup> which covers about 9.8% of the study area. In general, it was found that the depth to the fresh-saline water interface from the mean sea level was found to be increased in the year 2018 compared to 2017 as the groundwater level in the area increased.

**Conclusions:** The reduction in the water table altitude from the mean sea level is most intense during the pre-monsoon season. If the monthly rainfall rate would be reduced in the area, the intensity of the coastal aquifer vulnerability accelerate. The areas where coastal alluvium acts as a major aquifer system, fluctuations in the tidal heights cause unexpected imbalance in the depth to the fresh-saline water interface which adversely affects the shoreline wells.

**Keywords:** Coastal Aquifer, Sea Level Rise, Freshwater-Saltwater Interface, Seawater Intrusion,

### 04.02

#### Seasonal variability of Deep Convective Clouds Over the Tropical Region using SAPHIR/Megha-Tropiques

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The occurrence frequency of deep convective cloud (DC) cores and Overshooting (OS) clouds, that penetrate tropopause, over the entire tropical belt are studied using Level-1 brightness temperature data from Sondeur Atmosphérique du Profil d'Humidité Intertropicale par Radiométrie (SAPHIR) payload, aboard the Megha-Tropiques (MT) satellite. The MT has a low inclination orbit which provides the measurements at a different local times of the day unlike polar satellites. The MT-SAPHIR channels has the unique advantage such as, high sensitivity to frozen hydrometeors in precipitating clouds, different sensitivities to vertical distribution of frozen hydrometeors and negligible impact of ground surface. A method to detect DC and convective OS using brightness temperature difference between the water vapor channels ( $183.3 \pm 0.2$ ,  $183.3 \pm 1.1$ ,  $183.3 \pm 2.8$ ,  $183.3 \pm 4.2$ ,  $183.3 \pm 11.0$  GHz) of Megha-Tropiques are presented [1] [2] [3]. The seasonal occurrence frequency of DC clouds from 2011-December to 2018-November are analyzed and the results of 2017-December to 2018-November will be presented. The migration of Inter Tropical Convergence Zone (ITCZ), double ITCZ over the Pacific ocean, and other circulation features of ITCZ are well evident from the map of occurrence frequency of DC and OS clouds. The maximum occurrence frequency in the southern hemisphere during December - February. The maximum occurrence frequency of DC is seen in the northern hemisphere during June-August with a high occurrence over the ocean. The summer hemisphere has more convective activity than winter hemisphere. The occurrence frequency of OS convection is found to be more over tropical land than over tropical ocean. Maximum occurrence of OS clouds is found over central America and head Bay of Bengal over the oceanic region. The amount of DC over the entire tropics is about 4-5% and around 30-40% of them can penetrate tropopause. The main regions of DC and convective OS are ITCZ, SPCZ, tropical Africa, tropical America and the Indian Ocean [4]. Although the amount of DC that penetrate the TTL in the entire tropics is small, it has important impacts on the physical and chemical processes in the TTL and lower stratosphere. The SAPHIR on board Megha-Tropiques can highly contribute in improved understanding of role of DC in the tropics like the diurnal variation of DC and the corresponding variation of the net diurnal variation of radiative flux. The correlation of occurrence frequency of DC and humidity in the upper troposphere lower stratosphere region, role of SST and SST gradient over oceanic region on the occurrence frequency of DC. This unique data set with high temporal and spatial sampling can be used to study the diurnal variation associated with radiative fluxes, effect of latent heat calculations for the wrong identification of deep convective clouds [2]. The role of sea surface temperature in regulating the occurrence of DC and OS over the entire tropical belt is studied. The role of atmospheric thermodynamical parameters such as surface convergence, upper tropospheric divergence, mid tropospheric winds are also analyzed to study the variation of occurrence of DC.

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#### 04.03

### Analysis of Hydrocarbon Fluid Inclusions Using Non- destructive Fluid Inclusion Techniques

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**Background:** Fluid inclusions are fluid filled vacuoles sealed within minerals. Fluid inclusions trapped within diagenetic minerals are the only direct means of examining the fluids present in sedimentary Palaeo-environments. Micron-sized hydrocarbon bearing fluid inclusions can provide valuable information on the quality oil within a sedimentary basin. Our aim was to detect oil in a dry well in a non-proven basin (Kerala- Konkan basin) using non-destructive analytical techniques.

**Method:** Drilled core/side wall cutting samples from Kerala- Konkan basin were made into doubly polished wafers by using specialized wafer preparation method developed by NCESS. Fluid inclusions from these sedimentary rock sections have been analysed with various analytical tools like petrography, microthermometry and Raman spectroscopy to understand the characteristics of fluid inclusions especially hydrocarbon fluid inclusions (HCFIs).

**Results:** It is found that most of the hydrocarbon fluid inclusions from Kerala- Konkan basin are monophasic and they are in secondary trails with migrating trend. Microthermometric study reveals that temperatures of homogenisation (Th) of coeval aqueous inclusions are falling in the oil- window temperature range (i.e., 60-140°C). Laser Raman study throws light on the composition of hydrocarbon fluid inclusions and gives an important peak corresponds to hydrocarbon species such as methane (2898 cm<sup>-1</sup>, 2913 cm<sup>-1</sup>, 3019cm<sup>-1</sup>), ethane (2850cm<sup>-1</sup>, 2895cm<sup>-1</sup>, 2952cm<sup>-1</sup>) propane (2939cm<sup>-1</sup>, 2938cm<sup>-1</sup>, 2886cm<sup>-1</sup>) and butane (2875cm<sup>-1</sup>, 2878cm<sup>-1</sup>) etc.

**Conclusions:** HCFIs of Kerala- Konkan basin got entrapped due to post crystal fracture healing mechanism. The HCFIs in the form of blebs of bitumen are common throughout this basin. The study shows the presence of micron sized oil trails in Kerala- Konkan basin.

**Keywords:** Kerala-Konkan basin, Hydrocarbon fluid inclusions, Petrography, Microthermometry, Raman Spectroscopy.

#### 04.04

### Millimeter/ submillimeter Wave Radiometry for Studying Planetary Atmospheres

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Millimeter (mm) and sub-millimeter wave radiometry has been proven to be a powerful tool to study constituents of the planetary atmospheres such as Martian atmosphere, mesospheric altitudes of Venus, upper tropospheric and stratospheric altitudes of the Earth and atmosphere of Jupiter. The goal of the present study is to investigate the possibility of millimetre/sub-millimeter wave radiometry to detect various atmospheric constituents or species present in the atmosphere of Venus such as SO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub> spectral features, O<sub>2</sub> and H<sub>2</sub>O lines with some minor O<sub>3</sub> features for Earth's upper atmosphere, very narrow emission lines due to H<sub>2</sub>O, CO for Mars, and PH<sub>3</sub> (phosphine) emission line for Jupiter. In addition to that to determine the abundances of these atmospheric constituents by inversion of measured radiances using radiative transfer computations. Therefore, the optimum frequencies for the measurements of these constituents need to be determined and the brightness temperatures corresponding to the constituents need to be computed and analyzed. The radiative transfer model ARTS (Atmospheric Radiative Transfer Simulator), provides the facility to simulate the brightness temperatures measured for different planets at given instrument height and viewing geometry including the required input climatological data base. These simulations have great importance in designing the instrument for future planetary explorations and retrieval of atmospheric constituents for the available sensor capabilities.

#### 04.05

### Basement Deep Lonar Impact Event: Evidence from Impact-melt Bearing Rock

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**Background:** The involvement of Archean basement rocks (Peninsular Gneissic Complex) in the Lonar meteorite impact is highly debatable. A few studies provide geochemical evidence of the melting of the basement rocks in the impact event. In this scenario the present study provides direct evidence of the involvement Archean basement rocks in the Lonar meteorite impact.

**Method:** Melt rock samples were collected from the premises of the Lonar Impact Crater through geological field work following proper literature survey. Subsequently melt rock samples were subjected to petrographical observation, followed by spectral and geochemical studies of powdered samples and separated grains.

**Results:** The geochemical studies of the melt rock resemble both target basalts and Archean basement rocks in some aspects. The U-Pb geochronology of the zircon grains separated from the melt rock also reveal Mesoarchean ages in addition to showing a transitional trend between magmatic and hydrothermal zircons.

**Conclusion:** With robust evidence it is confirmed that the Lonar impact event have not only affected the target basaltic rocks, it also penetrated to the Archean basement rocks( Peninsular Gneissic Complex).

**Keywords:** Meteorite impact crater, Lonar Crater, Deccan Volcanic Province, Zircon U-Pb geochronology

#### 04.06

### Reconstructing the Paleo-Positions of Gondwanian Impact Craters

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**Background:** The Gondwana supercontinent started coalescing during Neoproterozoic (650 Ma) and its assembly culminated around 600-550 Ma. The breakup of Gondwana initiated with rifting between West and East Gondwana at 185 Ma and completed by 100 Ma (Condie 2016). Of around 200 impact craters recorded on the Earth, only 10 impact craters have formed in the Gondwana

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Supercontinent since its final assemblage to the initial breakup. The craters include Glikson, Lawn Hill, Piccaninny, Gweni-Fada, Aorounga, Ouarkiz, Riachao Ring, Araguainha, Serra de Cangalha and Saqqar.

**Method:** We reconstruct the paleo-positions of the impact craters formed in this supercontinent and the fate it has undergone owing to the splitting of this supercontinent. Subsequent distance travelled and displacement undergone as well as the velocity of these craters was quantified using GPlates, an interactive GIS-based plate tectonic reconstruction model.

**Results:** The rifted plates of Gondwanaland forced the craters to chart an itinerary through different latitudinal and longitudinal way points from their paleo-positions before ephemerally mooring at the current positions. The apparent movement characteristics, patterns and velocity data of the plates are linked among each other and thus different plates and tectonic elements can be arrived by studying the paleo-positions of impact craters. The most travelled crater is Glikson with a distance of 26975.76 km. The least distance is covered by Araguainha with 7873.22 km. For the overall displacement, the Saqqar crater records the maximum value of 10527.37 km and Piccaninny crater records the lowest 606.53 km displacement.

**Conclusion:** This study as a whole was capable of creating a vast database generated on the paleo-coordinates, and the distance and displacement the craters have experienced will be robust information that can be used for other studies on Gondwanian craters. Also the haphazard movement of impact craters, owing to plate tectonics, opens a new avenue for studying the plate tectonic history of the earth and also helps in reconstructing paleo-history, especially for a supercontinent like Gondwanaland whose constituent plates are still debatable.

**Keywords:** Impact craters, Gondwana, plate tectonics, paleo-position, plate reconstruction

## 05. Engineering & Technology

### 05.01

#### Synergy of Graphene Oxide/ Nano Silica Hybrid Filler for Improving Mechanical Strength of Natural Rubber Nanocomposite for Green Tyre Application

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**Background:** Major area of application of natural rubber is in tyre industry. Petroleum based carbon black is the major reinforcing filler used in tyres. Replacing the petroleum based carbon black by a green hybrid filler of graphene oxide and nano silica and thereby by improving the mechanical strength of the composite is the addressed problem over here. The synergistic effect of these fillers improves the properties such as mechanical strength and lowering the rolling resistance and thereby improved the fuel efficiency of the green tyres.

**Method:** Graphene oxide/ nano silica hybrid filler is synthesized and incorporated into the natural rubber latex via latex stage mixing at varying phr (0,1,2,3,4). Then vulcanising additives are added into the coagulated latex via two roll mill mixing method. The compression moulded samples were analysed by morphological, curing, tensile, dynamic mechanical analysis etc.

**Results:** Cure time analysis shows that the cure time is increased by the addition of fillers up to a level then decreased. The increase in cure time due to the presence of functional groups present in graphene oxide which absorb the accelerators results in increase in onset of vulcanization. Incorporation of hybrid filler at different composition gives good properties. At 3 phr composition there is 55.53% increase in tensile strength and 32.4% increase in modulus and 17.29% reduction in rolling resistance.

**Conclusions:** The synergistic effect of graphene oxide/nano silica hybrid filler results in improving mechanical strength and reducing rolling resistance which can improve the fuel efficiency of the tyre.

**Keywords:** Hybrid fillers, Mechanical strength, Natural rubber nanocomposites, Green tyre.

### 05.02

#### A 3D Printed Low Volume Hybrid Enzyme Fuel Cell for Low Power Applications

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**Background:** Monitoring of various environmental conditions which could lead to hazardous conditions can be done by internet of things (IoT) technology. Compact construction of glucose-based enzyme fuel cell offers an environmentally friendly energy generation for the powering of the IoT networks with minimal environmental impact. The compactness of these power sources will ensure that they can be deployed in space constrained areas.

**Method:** This work employs an electrochemical deposition of reduced graphene oxide (rGO) on carbon cloth for the construction of the fuel cell electrodes. The rGO is then electrographed with para-amino benzoic acid (pABA) in both acidic and basic media. The anode is constructed on neutral medium electrographed pABA with Os complex - GOx. The cathode catalyst is Prussian blue (PB) deposited on acidic media electrographed pABA. A low volume membrane less 3D printed container is used as the fuel cell device whose performance is then analysed.

**Result:** The anode exhibited a current density of 3mA/cm<sup>2</sup> for 100mM glucose in phosphate buffer saline at pH 7.4. Cathode electrode was able to deliver a reduction current density of 6.5mA/cm<sup>2</sup> for 5mM peroxide in PBS (pH 7.4). The fuel cell device exhibited an open circuit voltage (OCV) of ca 200mV with a maximum current density of 300mA/cm<sup>2</sup> and a power density of 16 mW/cm<sup>2</sup>. The power density reduced by a factor of 44% after 24 hours.

**Conclusion:** This work details the construction of a low volume low power enzyme fuel cell. A single molecule, pABA has been utilised to bring about suitable anode and cathode modification for catalyst immobilisation. The fuel cell was realised in a 3D low volume container with competitive performance characteristics.

**Keywords:** rGO, pABA, electrographing, glucose oxidase, Prussian blue, 3D printed fuel cell.

05.03

### Analysis and Implementation of Compact MIMO Antenna for 5G Communication

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**Background:** With the rapid growth in wireless communication technologies, the interest in achieving high data rates for the easy transmission and reception of large multimedia files has also escalated. The introduction of communication standards like 4G and 5G, models the dream of achieving high data rates up to Gbps into reality. These are implemented with the help of the technology called Multiple Input Multiple Output (MIMO) that uses multiple antennas on the same substrate, which can increase the channel capacity without sacrificing spectrum efficiency or consuming additional transmitted power.

**Method:** This work presents a sub-6 wave antenna that operates at 3.4 GHz for a 5G mobile application. Here, the MIMO antenna consists of 1 x 2, 1 x 4, 1 x 6, 1 x 8, 1 x 10 array combinations. The proposed antenna size is 50 x 40 mm<sup>2</sup> which is printed on 1.575 mm thick FR4-epoxy substrate with the dielectric constant of  $\epsilon_r = 4.4$  and loss tangent  $\delta = 0.02$ .

**Results:** The simulated results show that the single element antenna had a reflection coefficient of -25.63 dB less than -10 dB in the frequency range of 3.33 to 3.48 GHz. With the increase of elements in the array combination, there was a rise in the value of S(1,1). However, there wasn't much difference in the bandwidth.

**Conclusion:** This work introduces a low-cost compact microstrip antenna radiating in 3.4GHz for 5G mobile application.

**Keywords:** 5G, Antenna array, MIMO Antenna

05.04

### Perchlorate Remediation in a Bench Scale Bio-Barrier System

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**Background:** Perchlorate (rocket fuel) is an emerging groundwater contaminant reported to cause hypothyroidism. Among different states in India, the highest level of groundwater ClO<sub>4</sub><sup>-</sup> contamination (~50 mg/L against USEPA guidance level of 15µg/L) was reported near an ammonium perchlorate inventory in Aluva, Kerala. A spatio-temporal study in this area revealed spreading of the persistent contaminant (half-life ~100 years) to wider areas up to 2 km distance. Therefore, practical solutions to control the mobility of perchlorate is highly important. This study focuses on developing and validating technically feasible and economically viable solution for the problem. A proof of concept was successfully tested in a bench scale unit, and the relevant data generated is presented in this paper.

**Method:** A low cost "Permeable Reactive Bio-barrier" (PRB) was developed and tested in this study. Permeable Reactive Bio-barrier are in-situ physical barriers constructed across a contaminated water source (ground water plume or canal), that will degrade perchlorate while the contaminated water passing through it. A bench scale (3 litres) PRB was fabricated and tested its efficiency to decontaminate perchlorate contaminated aqueous phase. Leachate from an organic waste treating anaerobic digestion unit (volume 7 litres) was used as the substrate (carbon and electron source) for the bacterial activity within the PRB.

**Results:** The bio-barrier system could reduce 98.5% of perchlorate when organic waste leachate was supplied as sole substrate for microbial growth at an HRT of 6.15 hrs. The SCOD of the effluent was less than 20 mg/l and hence minimize the chance of organic contamination and bacterial proliferation in the treated water.

**Conclusion:** The installation of bio-barrier system developed not only decontaminate the polluted groundwater stream, but also prevent the spreading of contamination to wider areas. The compatible design of the system is suitable for installation along the perchlorate contaminated effluents streams from perchlorate inventories. The use of organic waste leachate as carbon source will further reduce the operational cost of the process.

**Keywords:** Perchlorate, Permeable reactive bio-barriers, *in-situ* bioremediation.

05.05

### Effect of Annealing Temperature on Low Power Organic Field Effect Transistors with Cobalt Phthalocyanine as Active Layer

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**Background:** Organic electronics is an emerging technology for low temperature and portable applications. The major problems in the realization of low power organic field effect transistors (OFETs) are the reduction of the expense, particularly when scaling up to satisfy modern needs. Low power consumption, high mobility and low cost are the advantages of OFETs. An efficient way to reduce the overall size of the device is the use of thin organic semiconducting and inorganic dielectric layers. Among various organic semiconductors that have been studied for transistor applications, phthalocyanines attained a lot of research interests. These materials have potential applications for various electronic components such as light emitting diodes, thin film transistors etc. In this work, cobalt phthalocyanine (CoPc) is used as the active material for OFET fabrication. The use of thinner gate insulator is another effective way to reduce the operating voltage. The aim of this study is to report the performance of CoPc based OFETs for low power applications.

**Method:** In this work, bottom gate top contact p-type OFETs were fabricated on a silicon (Si) wafer with CoPc as the channel layer. Before starting the deposition, the substrates were cleaned in an ultrasonic bath. N-type Si wafer acts as substrate and gate electrode with a 50 nm thick thermally grown oxidized silicon dioxide (SiO<sub>2</sub>) on top, which functioned as the gate insulator. The optimized thickness of 50 nm CoPc film was thermally deposited on the gate insulator. Finally, 100 nm silver electrodes were deposited onto the CoPc film through a shadow mask by thermal evaporation. The OFETs were fabricated with a constant channel width of 1000 fm and a channel length of 175 µm. Finally, the electrical characterizations of the OFETs were done in air using a probe-station connected to an Agilent B2900A semiconductor parameter analyzer.

**Results:** The optical, morphological and electrical properties of CoPc thin films are investigated before and after thermal annealing. CoPc thin films after annealing have better conductivity in comparison to the as-deposited thin film in spite of having much better crystallinity and stacking of organic molecules. The output characteristic of the fabricated devices with and without irradiation was



also studied and shows excellent output characteristics with clear saturation and gate dependence. The OFET revealed an effective mobility of  $0.52 \pm 0.03 \text{ cm}^2/\text{Vs}$  with  $-4.51 \pm 0.06 \text{ V}$  threshold voltage, subthreshold swing of the transistors appears to be  $0.69 \pm 0.08 \text{ V/decade}$  after annealing at  $80^\circ\text{C}$ .

**Conclusion:** In conclusion, the effects of annealing temperature on the electrical properties of CoPc based OFETs were investigated. The properties of CoPc films were studied through morphological and optical characterizations. It can be concluded that CoPc thin films after annealing have better conductivity in comparison to the as-deposited thin film in spite of having much better crystallinity and stacking of organic molecules. Compared to the conventional OFETs that work at large operating voltages, large threshold voltages and having low mobility, our devices work at much lower operating voltages with reasonably good carrier field effect mobility. These operating parameters show that CoPc based OFETs can be promising for scalable and low power flexible applications.

**Keywords:** Organic field effect transistor, Cobalt phthalocyanine, Mobility, Subthreshold swing.

## 05.06

### Performance Improvement of an AlGaIn/GaN HEMT on BGO Substrate Using Gate Recess Technique

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In this paper a recess gate AlGaIn/GaN HEMT on beta gallium oxide (BGO) is designed and analysed using Silvaco ATLAS TCAD software. The DC and RF performance of the device is compared with a schottky gate AlGaIn/GaN HEMT on BGO substrate. For optimizing the gate recess depth, three variations with recess depths 6 nm, 12 nm and 20nm is also simulated. A highest transconductance of  $0.4 \text{ mS}/\mu\text{m}$  is observed for recess gate AlGaIn/GaN HEMT on BGO substrate with a recess gate depth of 20 nm with a decrease in current density. The radio frequency performance is also highest for the recess gate AlGaIn/GaN HEMT with recess gate depth of 20 nm. The device exhibited a maximum oscillation frequency of 2.6 THz which is highest till reported.

## 05.07

### Nanostructured Multimetallic Fiber Optic Surface Plasmon Resonance Biosensors

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**Background:** Accurate and quick sensing of different biomolecules relevant to different health condition monitoring are very essential in the modern diagnosis and treatment procedure. Sensors based on the principle of surface plasmon resonance (SPR) have proved to yield quick and accurate sensing. The fibre optic SPR sensors harness the advantages of optical fibres. single metallic layer and bimetallic SPR sensors possess many disadvantages when considering the tradeoff between sensitivity and signal to noise ratio (SNR) and low sensitivity. Three layer metallic SPR sensors are found to yield larger sensitivity and figure of merit.

**Method:** A small portion of the cladding of a plastic clad silica (PCS) fiber is removed and three layer of metals are coated over there. The resonance wavelength ( $\lambda_{res}$ ), spectral width and depth of the SPR curve gives ample information for various sensor applications. In the present work, three layer metallic fiber optic SPR sensors based on Kretschmann configuration with wavelength interrogation is modelled with Matlab software.

**Results:** Sensitivity and figure of merit higher than that of bimetallic SPR sensors are observed. Higher sensitivities of  $11750 \text{ nm/RIU}$  is observed with three layer sensors.

**Conclusions:** The proposed sensors are suitable for analytes of refractive index 1.34 to 1.41, which ensures efficient biosensors.

**Keywords:** SPR, biosensor, multimetallic nanostructure.

## 05.08

### Development of Espi Based Surrogate Method for Surface Roughness Analysis of Thin Films

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**Background:** Film quality analysis is of more considerable importance due to its diversified applications in various fields of science and technology. Nondestructive evaluation (NDE) techniques have gained greater importance in assessing the material's physical and morphological properties. The Electronic Speckle Pattern Interferometry technique (ESPI) technique is one of the important nondestructive evaluation methods that offers high sensitivity, accuracy, and full-field inspection with high spatial resolution.

**Method:** In this work, molybdenum oxide incorporated  $\text{Nb}_2\text{O}_5$  nanostructures are grown on glass substrates using RF magnetron sputtering technique. The commercially available  $\text{Nb}_2\text{O}_5$  powder was mixed with  $\text{MoO}_3$  powder at doping concentrations of 0, 1, 2, 3.5 and 10 wt%. The deposited films were annealed in the air for 1 hour at a temperature of  $400^\circ\text{C}$ , and the effect of incorporation on the structural and morphological properties of the films are studied. The prepared films are subjected to speckle interferometric study employing inertia moment (IM) and cross-correlation analyses to understand the surface modifications and an attempt has also been made to correlate the result with atomic force microscopic (AFM) data.

**Results:** The structure and morphological analysis reveals that the  $\text{Nb}_2\text{O}_5$  film doped at 5 wt%  $\text{MoO}_3$  (MN5) shows a smooth surface with uniform distribution of grains and lower surface roughness. From speckle analysis, it is found that the IM value increases with the increase of surface roughness. The study elucidates that IM values show a direct relationship with the surface roughness, further suggesting that MN5 is the best among the films prepared. The cross-correlation coefficient between the extracted images during heating reveals that the frames are getting more and more uncorrelated upon heating.

**Conclusion:** In the present work, molybdenum incorporated niobium oxide films have successfully been grown by radio frequency (RF) magnetron sputtering technique. The study reveals a direct relationship between the IM value and surface roughness and suggests that the film MN5 is the best among the films prepared. Thus, the study elucidates that the speckle analysis can be considered as a surrogate method for measuring the surface properties of films.

**Keywords:** Radio-frequency (RF) Magnetron Sputtering, Electronic Speckle Pattern Interferometry, Cross-Correlation Coefficient, Inertia Moment





05.09

### Morphology Driven Distribution of Carbon Black in Natural Rubber/Butadiene Rubber Blend Composites

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**Background:** Polymer blends and composites are the pioneers in the polymer industry. Among this large number of rubber blends are produced in different rubber manufacturing industries to obtain a product with ideal properties and least cost. Blends of Natural rubber (NR) and Polybutadiene rubber (BR) are mostly utilized for tire applications (e.g. tire treads). Carbon black (CB) has been used as a reinforcing filler in the rubber industry for the past several decades. The end-use properties of the filled rubber blend (NR/BR) depend on the filler partition in different rubber blend phases. Partition of CB in RRB's is a challenging problem in the rubber industry. Therefore, the present study aims to quantify CB's partitioning in NR/BR RRB's at different blending ratios using relative damping height measurements from the dynamic mechanical analysis [DMA].

**Method:** Rubber blends of NR and BR by varying blend ratio (70NR/30BR:50NR/50BR:30NR/70BR) were prepared with and without the addition of Carbon black on a two-roll mill. The partition of CB in the BR phase of NR/BR blends were quantified using the relative height measurements obtained from dynamic mechanical analysis. The results were then corroborated with solid-state NMR and DMA.

**Results:** The relative height measurement using  $\tan\delta_{\max}$  analysis confirmed the presence of 80 % of CB partitioned towards BR phase in 70/30 NR/BR blends. For 50/50 NR/BR blends, 6.4% of CB is partitioned towards BR phase and 38% of CB was partitioned towards BR phase in 30/70 NR/BR blends. This indicated preferential migration of CB to one of the phases based on rubber blend composition. Solid State NMR studies were in agreement with DMA analysis. TEM images of CB filled rubber blends represent a near to homogenous state of dispersion, where in the identification of individual rubber phases becomes more difficult at the nanometre scale.

**Conclusions:** CB filled NR/BR RRB's were prepared and analysed using DMA, TEM and Solid state-NMR to determine the CB partitioning in filled NR/BR RRB's. Height of  $\tan\delta_{\max}$  curve from DMA, confirmed 80%, 6.4% and 39% towards BR phase in filled NR70, filled NR50 and filled NR30. We have found that the partitioning of CB was more towards the dispersed phases of NR/BR RRB's irrespective of the blend composition. CB partition determined via DMA was corroborated with solid state - NMR and TEM data. Shift and intensity of peaks in solid-state NMR spectra also confirmed the maximum partition of CB towards the dispersed phase.

**Keywords:** Rubber - Rubber blends, Carbon black, Distribution, Transmission Electron Microscopy, Dynamic Mechanical Thermal Analysis.

05.10

### Modelling the Impact Scenarios for Flooding in Kerala – A Case Study of Pamba River Basin

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**Background:** The state of Kerala, located in the south western part of India experienced extensive flooding in the month of August, 2018, resulting in significant loss of life and property. With the projected increase in extreme rainfall events across the Western Ghats, modelling approaches that can mimic the flooding situation can help to minimize the adverse impacts of the riverine floods to a large extent. In the present study, the flooding events of August-2018 of the Pamba river basin is modelled using the MIKE FLOOD model and the inundation libraries for different scenarios has been generated.

**Method:** The flood inundation simulation for the Pamba River was carried out using modelling tool MIKE-FLOOD, which integrates the 1-D MIKE-11 model with the 2-D MIKE-21 model. Initially, the 1D model MIKE 11 was calibrated using river water level and discharge data of various gauging sites from the year 1991-2000. Subsequently, the calibrated set up was validated using both discharge and water level data for the period 2001-2018.

**Results:** Hydrometeorological analysis of the Pamba river basin indicated a changing pattern of the monsoon rainfall, particularly the frequency of extreme rainfall events and the proportion of total monsoon rainfall from the highest 4 rainfall events. The flood inundation scenarios from different flooding situation were modelled for the Pamba river basin using MIKE FLOOD model and a library of flood inundation and vulnerability maps were generated for different permutations and combinations of all possible flood-generating conditions.

**Conclusion:** Impact scenario model for flooding events was developed for Pamba river using MIKE FLOOD model. Such an approach will aid in providing a near real time prediction of the possible flood inundation for the given input conditions thereby providing the decision makers the aerial extent of the possible flooding zone well in advance for aiding in evacuation and protection measures.

**Keywords:** Flood Modelling, MIKE FLOOD, Inundation, Pamba River, Kerala

05.11

### A Study on the Mechanical Properties of Concrete Containing Plastic Waste as Aggregate

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**Background:** Plastic waste is one of the most hazardous wastes in the globe because of its low biodegradability and the disposal of these wastes poses a great threat to the environment. The rapid growth of the construction sector and the environmental



problems caused by improper waste treatment of plastic waste has lead to the production of new building materials from plastic waste. Plastic waste has recently been incorporated into various types of concrete mixes due to its lightweight and long service life to remove or mitigate its environmental concerns.

**Method:** The current article provides a summary of the existing knowledge about the successful use of plastic waste in sustainable concrete. The effects of waste plastic on the mechanical properties of concrete, when used as a replacement for natural aggregates, are presented in this paper. This paper focuses on the mechanical properties such as compressive strength, flexural strength, split tensile strength, and modulus of elasticity of the concrete incorporating plastic waste as aggregate. The future perspective on the use of plastic waste in the construction industry is also explained in detail.

**Results:** From the review, it is evident that the inclusion of plastic aggregates in concrete mixes results in a decrease in compressive, flexural, and split tensile strengths, in particular, a significant reduction in the compressive strength of the concrete. This is due to the poor adhesion between cementitious materials and plastic aggregates. Besides, the elastic modulus of concrete containing plastic aggregates decreases with increasing plastic waste. This is owing to the porous characteristics of concrete consisting of waste plastic, the greater w/c ratio of concrete with waste plastic and reduced modulus of elasticity of plastic aggregates.

**Conclusions:** The integration of plastic aggregate for sustainable concrete production solves the problems associated with plastic waste and also conserves natural resources. The use of waste plastic in the construction industry would contribute to a cleaner environment.

**Keywords:** Plastic Waste, Compressive Strength, Flexural Strength, Split Tensile Strength, Modulus of Elasticity

05.12

### Compact Uni-Planar Asymmetric Single Split Meta-Resonator for 5G Applications

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**Background:** The application of artificial metamaterials created a new paradigm in the design of present-day compact and high geared electronic gadgets. Microwave planar circuits with a low profile and high selectivity are very much desired for 5G networks which rather imply the necessity of high-performance filters and compact sensors. The choice of metamaterials incorporated with microwave systems is a good solution for the same.

**Methods:** The authors propose a new Asymmetric Single Split Resonator (ASSR) structure on FR4 substrate for single negative and/or double negative metamaterial applications with its band-stop characteristics at 1.63 GHz. The compact uniplanar structure is a single split ring resonator with the inner ring shifted onto one side which introduces asymmetry. The fabricated prototype is analyzed based on reflection and transmission coefficients from PNA E8362B Vector network analyzer and unit cell simulations using CST Microwave studio.

**Results:** A single fabricated unit cell of miniaturized ASSR has a footprint area of  $\lambda_0/7.5 \times \lambda_0/7.5$  sq. cm where  $\lambda_0$  is the measured free-space wavelength. It exhibits high field confinement as compared to split-ring resonators, so best suited for a compact high-performance filter, sensor, and RFID applications in the 1-6 GHz category of fifth-generation (5G) radio access spectrum for Enhanced Mobile Broadband (eMBB) and Ultra-Reliable and Low Latency Communications (uRLLC) services.

**Conclusions:** The proposed ASSR structure is best suited for high performance 5G sensor and filter applications.

**Keywords:** Filter, metamaterial, sensor, split ring resonator

## 06. Environmental Sciences, Forestry and Wild Life

06.01

### Carotenoid Pigments from Marine Yeasts and Their Varied Applications

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Carotenoids are natural pigments found in plants and microorganisms that find application as functional food and pharmaceutical supplement and in cosmetic industries as dyes/colorants. Mangroves are the unique ecosystem that harbors a diverse pigment producing marine yeasts. These yeasts are promising natural sources of bioactive compounds including pigments. Nine strains of pigmented yeasts isolated from different mangroves in Central Kerala (MA19, MU30, PV56, PV77, VA 115, PV 148, VA 242, K352, and K353) were used for the study. For the production of pigment the yeasts were inoculated in YM broth and incubated for 7 days at 30±2°C. The strains VA 242 and K352 isolates gave a total carotenoid production of 145.98µg/g and 119.46µg/g respectively. Pigments from K352 exhibited inhibitory activity against *Escherichia coli*, *pseudomonas sp.*, *bacillus sp.*, and *staphylococcus sp.* while VA242 inhibited the growth of *Escherichia coli*, *salmonella sp.*, *bacillus sp.*, and *staphylococcus sp.* It was interesting to note that all extracted pigments were able to impart its colour to the cotton fabric, however the shades obtained were different, and they ranged from light yellow to pink to coral. Highest colour intensity was noted for pigments from K352 and VA 242. A similar observation was made when pigments were used as food colourant. From this preliminary study it is clear that K352 and VA242 are promising candidates for carotenoid production. It is also noted that the pigments from K352 and VA242 has potential for varied application and it is possible to come out with an eco friendly product.

**Keywords:** Carotenoid, Mangrove, Marine yeast, Food color, Fabric dye

06.02

### Earthworms Communities in the Paddy Fields of Kottayam District, Kerala

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**Background:** As earthworms are important biological resources that have great potential in agro-ecosystems, the present study has been taken up to look into the earthworm communities of paddy fields of Kottayam.

**Method:** The study was conducted in the Kottayam district. Earthworm population dynamics, diversity indices, and their relationship with soil physico-chemical parameters were analyzed.

**Results:** A total of 7 earthworm species/genus belonging to 5 families and 7 genera were recorded: *Drawida* sp., *Pontoscolex corethrurus* (Müller, 1857), *Eukerria kuekenthali* Michaelsen 1910, *Megascolex konkanensis* Fedarb, 1898, *Lampito mauritii* Kinberg, 1867, *Metaphire houlleti* (Perrier, 1872) and *Glyphidrilus annandalei* Michaelsen, 1910. Shannon diversity, index of dominance, and species evenness of earthworms were 0.90, 0.50, and 0.39 respectively. *E. kuekenthali* showed the highest abundance and density whereas *P. corethrurus* showed the highest frequency and biomass. The average density and biomass of earthworms recorded were 10.17 ind.m<sup>-2</sup> and 1.96 g.m<sup>-2</sup>, respectively.

**Conclusions:** Monoculture paddy agro-ecosystem supports moderate diversity and dominance of earthworm species due to homogenous habitat conditions with anthropogenic effects. The exotic peregrine species dominate the paddy ecosystem. The occurrence of earthworms in the present study has a significant relation with soil properties at the study site.

**Keywords:** Earthworm diversity, dominance, physico-chemical parameters, population dynamics, Paddy, *Eukerria kuekenthali*

06.03

### Political Ecology of the Pink Bloom: The Case of Invasive Alien Plant, *Cabomba furcata* in Kerala

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The phenomenon of Pink bloom which happened in late November 2020 at Avalappandi, Kozhikkode triggered massive responses from the general public. The submerged, perennial, invasive alien aquatic plant- *Cabomba furcata*- which had established in a stretch of nearly 4.5 km in the Avalappandi canal flowered gregariously turning the entire water body into pink colour. The place immediately transformed into a domestic tourism hotspot with a footfall of 2000 persons per day. Temporary shops sprang up and sale of the species was also initiated fast. This study analysed the factors which contributed to this pink bloom phenomenon, its likely impact and suggests recommendations to thwart its adverse impacts. The study shows that the phenomenon was a result of sequential convergence of biotic, abiotic and socio-political factors. The plant has had a presence in Kerala for the past 70 years initially brought in small aquariums while describing a fish species, *Laubuca dadiburjori*. Tracing its spread based on reported cases indicate an initial discontinuous distribution in and around Kochi and then spreading to Kuttanad and later infesting the Pamba and Achenkovil rivers. Recently it had gained entry into the Kole wetlands of Thrissur district. The biotic factors which favoured its spread at Avalapandi included the aggressive growth and reproductive strategies of the plant and its ecological characteristic of establishing fast in shallow, slow flowing waters. The abiotic factors which favoured the pink bloom includes the change in water flow due to widening of the canal and the increased availability of sunlight due to the replacement of riverine vegetation with granite bunds. The socio-political factors were the absence of quarantine mechanism to prevent the entry of the species to Kerala, the extended Covid-19 induced lockdown which stopped all human activity in the canal like bathing, washing and bathing of domestic animals, and the stream vitalization programme which significantly reduced the flow of water facilitating the establishment and spread of the species. The spread of the species to near and far locales was facilitated by the domestic tourism which sprang up in the area and domestic trade of the plant species.

**Keywords:** Political Ecology, *Cabomba furcata*, Aquatic invasive alien Plant

06.04

### Pharmacognostic Evaluation and Assessment of Pharmacological Properties of an Ethnomedicinal Plant *Myristica beddomei* King Ssp. *Ustulata* W.J De Wilde

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**Background:** *Myristica beddomei* King ssp. *ustulata* W.J. de Wilde is an ethnomedicinal plant belonging to the family Myristicaceae. The present study involves the analysis of pharmacognostic properties, preliminary phytochemical screening and antifungal activity of different parts of this tree sps.

**Methods:** In this study, different parts such as bark, leaf, pericarp, mace and seed were used to determine physico-chemical constants and antifungal activity. The parts were extracted with different solvents and antifungal activity of methanol extract was determined by disc diffusion method.

**Results:** Pericarp showed the highest ash value (9.82%) and mace showed the lowest (1.52%) value compared to the other parts. The highest yield of solid residue was obtained in the dichloromethane extract of seed (63.6%) and the lowest solid residue was in the hexane extract of bark (1.6%). The qualitative phytochemical screening demonstrated alkaloids, flavonoids, phenol, tannin, steroids glycosides, proteins, amino acids, and carbohydrates in all plant parts. In the antifungal activity, mace showed high activity to *Cryptococcus luteolus* and *Cryptococcus neoformans* at the concentration of 200 µg ml<sup>-1</sup>.

**Conclusions:** *Myristica beddomei* King ssp. *ustulata* W.J. de Wilde has potential biological activity and this study on this endangered sps is very important for conservation and sustainable use.

**Keywords:** Antioxidant activity, Antifungal activity, Phytochemical screening, Myristicaceae.



06.05

### Impact of the Environmentally Relevant Exposure Dosage of Bisphenol-S on Neonatal Thyroid Morphology

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**Background:** Bisphenol-S (BPS) is an organic compound used as a safe replacement for bisphenol-A (BPA) in several consumer goods. The frequent detection of BPS in different environmental matrices is an emerging health hazard. The mounting evidence suggests that as an endocrine disruptor, BPS may interfere with neonatal thyroid functions. But the morphological changes in the thyroid gland towards an environmentally relevant exposure dosage of BPS are poorly understood. Hence the current study is designed to evaluate the effect of low dose BPS exposure on neonatal thyroid morphology.

**Methods:** Neonatal Wistar female rats (PND: 25) were orally exposed with BPS for 28 days. The distribution of BPS in the thyroid was confirmed by MS/MS analysis. The tissue biochemical parameters like SOD, GSH, CAT, and MDA were analyzed. The serum level thyroid-stimulating hormone (TSH), triiodothyronine (T<sub>3</sub>), and thyroxine (T<sub>4</sub>) were analyzed by the ELISA plate method. The morphological and histopathological analysis of the thyroid gland was also performed.

**Results:** The presence of BPS was confirmed in neonatal thyroid tissue of experimental animals exposed to BPS. The decreased level of the tissue antioxidant enzymes (SOD, GSH, and CAT) and increased lipid peroxidation indicate the adverse effect of the distributed BPS on the thyroid gland. The significant changes in the level of TSH, T<sub>3</sub>, and T<sub>4</sub> in BPS exposed groups compared to normal control also indicate the functional alternation in the thyroid gland. Moreover, the oral exposure dosage of BPS exhibited morphological abnormalities of the thyroid gland. Thyroid dysfunctions are evident in BPS exposed neonatal thyroid histology.

**Conclusions:** The study reveals that the low dose BPS exposure disturbs the homeostasis of the neonatal thyroid gland by altering the biochemical parameters, morphology, and histology of the thyroid gland.

**Keywords:** Bisphenol-S, Thyroid gland, Thyroid hormones, Morphology, Histology.

06.06

### Screening and Characterization of Pigments from Yeast, *Rhodotorula mucilaginosa* Present in Mangrove Sediments of Kerala

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Carotenoids are natural pigments having important role in food, feed, pharmaceutical and cosmetic industries. Their role as strong antioxidant and essential food coloring agent has received major attention during recent years. Though carotenoids are present in plants and animals, its production from microbes are more advantageous due to their faster growth rate, cheaper cultural requirements, ease of manipulation and extraction, and safety considerations. Among the microbes, pigmented yeasts specifically those belonging to genus *Rhodotorula* are found to be the most reliable candidates for the large scale production of carotenoids due to their higher rate of growth and simple unicellular structure. This makes them a promising candidate in the biotechnological and commercial production of carotenoids. The present study aimed at isolation and identification of yeast *Rhodotorula mucilaginosa* from the mangrove sediments of Northern Kerala along with the characterization of their pigments.

**Method:** Sediment samples were collected from the mangroves of the five districts along North Kerala coast in eight sites during the period 2018-2019. Yeast colonies were isolated on Wickerham media; red coloured colonies were selected and purified for further studies. The isolates were subjected to morphological, biochemical and molecular characterization. The pigment was extracted using DMSO-acetone solvent in to petroleum ether and characterized using NMR spectrophotometer. The antimicrobial effect of the extracted pigment and the whole yeast isolate was tested against potent pathogens *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Salmonella typhi*, and *Streptococcus pyogenes* using disk diffusion method. Also, the optimization of growth conditions for maximum biomass yield and hence maximum carotenoid production was also studied using UV-Visible spectrometry.

**Results:** A total of 24 isolates showed orange/red/pink pigmentation were selected for the study. Morphological examination of the colonies of *R. mucilaginosa* in malt extract medium showed that they were smooth and mucoid in nature. Microscopic examination showed oval shaped, aseptate cells which are asexually reproducing with the help of multi-lateral budding. The results of biochemical characterization also helped in confirming the isolates up to genus level. The amplification and sequencing of the ITS region of the yeast DNA confirmed the species as *R. mucilaginosa* when compared with the GenBank database with 100% sequence homology. The sequence obtained was deposited in the GenBank with accession no MT 131387. The NMR analysis of the extracted pigments from *R. mucilaginosa* confirmed the carotenoid present in our sample as  $\beta$ -carotene. Both *R. mucilaginosa* whole yeast isolate and their extracted pigment were tested for antimicrobial activity against bacterial cultures of *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Salmonella typhi*, and *Streptococcus pyogenes* using disk diffusion method. The whole yeast isolate did not show any antimicrobial effect against the tested potent pathogens. But, the extracted carotenoid pigment of *R. mucilaginosa* showed zone of inhibition against *Staphylococcus aureus* measuring 10 mm in diameter indicating the antimicrobial effect carotenoids present in them. Also, from the growth optimization studies, it has been found that the optimum growth conditions needed for the maximum growth and biomass yield of *R. mucilaginosa* was found to be pH 7, with 5 ppt salt concentration at 25°C in malt extract broth.

**Conclusions:** Coloured yeasts due to their unicellular nature and high growth rate are considered as the best source for large scale production of carotenoids compared to bacteria, algae and fungi. Among the *Rhodotorula* species, *Rhodotorula mucilaginosa* is one of the most potential pigment producing yeasts which can be fermented using cheap industrial by-products and wastes as nutrient sources. The present study emphasize on the use of yeast *R. mucilaginosa* as the safest and most cost effective source for large scale carotenoid production that can be utilized in food, feed, pharmaceutical and other related industries.

**Keywords:** *Rhodotorula mucilaginosa*, mangrove sediments,  $\beta$ -carotene, antimicrobial activity, optimization



06.07

### The Host-Agent-Environment Epidemiologic Triad in Function on Host-Parasite Equilibrium and Manifestation of Parasitic Disease in Nilgiri Tahr (*Nilgiritragus hylocrius*)

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**Background:** Nilgiri tahr (*Nilgiritragus hylocrius*) is a caprine ungulate endemic to the tropical mountains, and the species is listed in the endangered category. Suitable strategies are needed for the long term conservation of the species, and monitoring the health and studying the disease epidemiology in the species is of much importance in conservation programme. In that premise, this study was designed to observe the epidemiologic triad of host-parasite-climate interaction with reference to Nilgiri tahr in its natural habitat, which is of much significance now when spillover diseases from wildlife pose threat to human and domestic animal health.

**Method:** The study was done in the seasons of summer, monsoon and post-monsoon in selected habitats. The incidence of parasitic infection was found by examination of parasitic ova in the faecal samples from the herds, and the degree of infection was assessed by parasitic egg counts. The foraged grass species in each habitat were identified and the nutrient composition of the grasses was estimated. The physical health of the herds was judged by body condition scoring.

**Results:** The overall incidence of parasitic infection observed was 38.9 per cent, and both mixed and single type infections were observed. Strongyles and coccidia were the major parasites, followed by *Moniezia*, *Trichuris*, *Capillaria* and *Strongyloides*. There was significant difference in parasitic incidence between seasons, with higher share in monsoon followed by summer and post-monsoon. The degree of infection was assessed to be mild. The forage analysis showed significant difference in nutritional composition of grasses between seasons. The body condition of the animals revealed the herds to be physically healthy in all seasons.

**Conclusions:** There observed significant presence of different parasites in Nilgiri tahr population with a host-parasite equilibrium as influenced by seasons. The healthy co-existence of both host and parasite population in an ecosystem was evinced here, which along with effective weeding out of unhealthy animals by predation curbed the manifestation of parasitic diseases in the herds.

**Keywords:** Nilgiri tahr, Parasite Infection, Forage Nutrient Composition, Seasonal Changes

06.08

### Differential Response of Arsenic in *Acanthus ilicifolius* L.

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**Background:** Wetlands are the most productive ecosystems on the Earth and provide many important services to human society. Mangrove swamps are coastal wetlands, characterized by halophytic (salt loving) trees, shrubs and other plants growing in brackish to saline tidal waters. Human interference negatively affects and cause deleterious impacts on mangrove wetlands that can disrupt the natural ecological processes of these forested wetlands. Pollutants from sewage treatment plants, leaching from domestic garbage dumps, boating, mining and chemical spills get into the coastal wetland and are deposited in the soil and act as act as the sink of toxic heavy metals.

**Method:** Long healthy stem cuttings (20-30 cm) of *A. ilicifolius* were collected and treated with 15  $\mu$ M indole butyric acid (IBA) for 2h and transferred to distilled water for root formation. After 2 weeks, each rooted cutting was transferred to half-strength, modified Hoagland solution containing various concentration of  $\text{Na}_2\text{AsO}_4 \cdot 7\text{H}_2\text{O}$ . As the plantlets of *A. ilicifolius* showed tolerance upto 80  $\mu$ M  $\text{Na}_2\text{AsO}_4 \cdot 7\text{H}_2\text{O}$ , for further studies this particular concentration was taken as stress imparting concentration. Second and third pairs of leaves from the tip of the shoots were harvested for the study.

**Results:** The treatment of *A. ilicifolius* with 80  $\mu$ M  $\text{Na}_2\text{AsO}_4 \cdot 7\text{H}_2\text{O}$  showed an enhanced generation of ROS such as superoxides than the control and also showed an increase in electrolyte leakage, although there was reduction in dry weight of arsenic treated plants, the decrease was very less. The antioxidants contents in the plantlets such as phenolics and glutathione content in response to 80  $\mu$ M arsenic was higher as compared to control. The accumulation of osmolyte; sugar was found to be increased in *A. ilicifolius* in response to arsenic stress.

**Conclusion:** The mangrove *A. ilicifolius* was able to effectively counter the deleterious effects of arsenic stress by augmenting phenolics, sugar and glutathione contents. The less change in dry weight of arsenic treated plants than control also revealed it has less change in biomass even under arsenic stress condition. *A. ilicifolius* can be regarded as a suitable candidate for phytoremediation in arsenic contaminated soil.

06.09

### Occurrence of Pathogenic Bacteria In The Mangrove Sediments of North Kerala

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Mangroves provide a unique ecological niche to different microbes which play a significant role in nutrient recycling as well as various environmental activities. However, with the increase in urbanization, estuarine mangrove ecosystems are getting affected in different ways. The current study aims to isolate and identify the bacteria from mangrove sediments from 8 different sites of North Kerala. Spread plate method was employed and 16S rRNA gene sequencing was used for the bacterial identification. The prevalence of opportunistic pathogens such as *Klebsiella* sp., *Serratia* sp., *Alcaligenes* sp., *Providencia* sp., *Pseudomonas* sp. and *Bacillus* sp. indicates high degree of anthropogenic pollution of these habitats. Despite of their atypical environment, these pathogens can adapt, survive and persist in the mangrove. Human interference adds pathogens directly or indirectly to the mangrove swamps. The continuous acclimatization of pathogens to this alien environment may turn out to be an indigenous niche, resulting in the permanent persistence of such pathogenic strains in these pristine ecosystems. Mangroves may thus turn out to be major reservoirs for pathogenic microorganisms which are critical for human health. There is a need for general awareness



about this microbial contamination, protection of this ecosystem from adding undesirable microbial populations through human interference and appropriate policies/regulations should be implemented.

**Keywords:** Mangroves, bacteria, opportunistic pathogens, 16S rRNA gene sequencing, anthropogenic activity, North Kerala

## 06.10

### Response of the Nostoc Species to Cadmium Heavy Metal Stress

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**Background** Cadmium is a non-essential element known to be highly toxic for living organisms. The introduction of Cd in water occurs from fertilizers, cadmium plating, mining, power stations, and heating systems. Chronic exposure to cadmium will increase the risk of many health problems. Heavy metal toxicity in cyanobacteria have been extensively studied. The present study was carried out to examine cadmium tolerance in four *Nostoc* species viz. *Nostoc paludosum*, *Nostoc punctiformae*, *Nostoc muscorum*, *Nostoc ellipsosporum*, which are commonly found in the soils of Kerala.

**Materials and methods:** Test organisms were treated with different concentrations of Cadmium (10mg/l, 20 mg/l, 30 mg/l, 40 mg/l). The metal tolerance was evaluated in terms of photosynthetic pigments and protein content and atomic absorption spectroscopic studies.

**Result:** The study depends upon a concentration dependent effect on metal absorption. Metal absorption increased with increase in Cadmium concentration and became saturated after a certain concentration. The chlorophyll-a level was reduced with increasing metal concentration and incubation period. But the carotenoid pigment did not showed any significant change from 10th day to 20<sup>th</sup> day of incubation. Results obtained from the study showed that *N. paludosum*, *N. muscorum* and *N. ellipsosporum* showed highest protein content under control and Cadmium treated condition. This indicates that the three species such as *N. paludosum*, *N. muscorum* and *N. ellipsosporum* were comparatively metal tolerant compared to *N. punctiformae*.

**Conclusion:** the biochemical characters such as chlorophyll-a, protein, phycobiliproteins and carotenoids had a high impact with heavy metal stress. The study suggested that *N. paludosum*, *N. muscorum* and *N. ellipsosporum* can withstand more metal stress compared to *N. punctiformae*. So it can be inferred that *N. paludosum*, *N. muscorum* and *N. ellipsosporum* are more effective heavy metal tolerant strains and are good candidates for Cd removal from heavy metal polluted environment. It can be effectively used for the biosorption of cadmium and hence they are highly promising strains as a bioremediation agent of metal polluted environment.

## 06.11

### A Study on Woody Plants Endemic to Kerala: Taxonomy, Distribution and Population Ecological Information for Conservation and Management

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**Background:** Endemics are of high conservation value, as they are close to rare groups and very much restricted in distribution. The species could be lost forever due to human-induced threats apart from own biological constraints. In Kerala, studies on conservation of endemic plants have not gained momentum mainly due to lack of information. The poor databank leaving doubt even on existence of certain species. The present study provides information through preparation of handbooks on woody plants endemic to Kerala.

**Method:** The details of plants were collected through literature study, field visits and hands-on experience of the authors. Each species provided with notes on taxonomy, population ecological information and status assessments supplemented with images and distribution map.

**Results:** Distribution of 53 woody endemic plants belonging to 32 genera under 21 families was recorded. The plants ranged from large to small trees (34 spp.), large shrubs (15 spp.) and 4 as stragglers and climbers. IUCN conservation status available to seven species was reassessed as per current data. Sixteen species under 'Not Evaluated' category were assessed as per IUCN guidelines. Thirty recently described species were assessed and suggested conservation status. Twenty three species identified for high conservation priority where the area of occupancy, extent of occurrence, number of mature individuals were less than 1 km<sup>2</sup>, 10 km<sup>2</sup> and 50nos. respectively. Major threats in situ, uses reported etc. of species were also included. The handbook prepared in English and Malayalam languages.

**Conclusions:** The Information provided through Handbooks will serve as a source of ready reference of woody plants endemic to Kerala to define priorities in policy making for forest management and species conservation.

**Keywords:** Woody endemics, Kerala, Information, Conservation, Management

## 06.12

### Comparative Study of Physico-Chemical Parameters of River Kuppam and River Anjarakandy, Kannur, Kerala, India

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**Background:** River Kuppam flows adjacent to River Valapattanam which is the largest river in North Malabar. Many studies have pointed out exceeding pollution levels in River Valapattanam. Both rivers meet at Azhikkal Port before being drained into the Arabian Sea. River Anjarakandy is home to the largest cinnamon plantation in Asia. Both rivers are used for irrigational and domestic purposes by the local populace.

**Method:** In this study, a total of 17 Physico-chemical water quality parameters were analyzed using APHA standard methods for the examination of water and wastewater. The parameters were compared with the WHO and BIS water quality standards for drinking water and domestic use. Statistical Correlation and Water Quality Index was ascertained.

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**Results:** Values of 8 parameters were high for the Kuppam and Anjarakandy rivers. The values showed an incremental increase as the distance from the sea decreased. Both the rivers seem to be suffering from serious saltwater intrusion in the summer months. This follows a similar pattern of increased water quality as the distance from the Arabian Sea gets increased.

**Conclusions:** The results substantiate a serious case of saltwater intrusion in the rivers of Kerala. Assessment of the Water Quality Index (WQI) signifies the deteriorating river water quality of Kerala.

**Keywords:** Surface water, Water quality, Physico-chemical parameters, Salt-water intrusion.

06.13

### Preliminary Studies on Sustainable Harvesting of *Persea macrantha* (Nees) Kosterm. - A Jigat Species of South India

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**Background:** In Agarbatti industry, the glutinous binding material (Jigat) is used to be extracted from stem bark powder of *Litsea deccanensis*, *Litsea glutinosa* and *Persea macrantha*. However, the unscientific bark harvest of these species were directly affected the recouping ability and subsequent degeneration of existing genetic stock. The present study is aimed to standardize, sustainable harvesting practice of *Persea macrantha* as part of its conservation and subsequent availability of raw material for the industry.

**Method:** Longitudinal stripping of stem bark was carried out in two age classes of 24 trees classified under pre reproductive and reproductive. The depth of the stripping was limited up to the middle layer (Cortex and secondary phloem). Bark thickness of each individuals were measured by using the equipment, Bark gauge.

**Results:** The girth range and bark thickness of pre reproductive individuals attained from 50 to 85cm and 5mm to 10mm respectively. Similarly, girth range and bark thickness of reproductive individuals measured from 100 to 350 cm and 10mm to 40mm for the species. During recouping phase, the stripping made at the level of inner layer (cambium) showed an edge growth due to the higher hormonal activity stimulated by stress in order to restore water conductivity and this could help wound close mechanism compared to sheet growth in stripping was limited at secondary phloem level.

**Conclusion:** The preliminary field study conclude that the longitudinal bark stripping pattern up to middle layer cells was found promoting fast recouping within 6 months of period. The practice standardized could be utilized as sustainable harvesting practice of the species for jigat production.

**Keywords:** Jigat species, sustainable harvest, conservation, material availability

06.14

### Trace Metals Associated with Fine Particulate Matter in Kochi Urban Area

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**Background:** Particulate matter (PM) is one among the major air pollutants. The content of PM is increasing in cities and rural areas in an alarming rate. The physical and chemical characteristics of PM has significant influence on the health impact. Various pollutants such as trace metals are also associated with PM is a serious health concern due to their long-range transport, long life time in the atmosphere etc. Air pollution studies reports that Industrial areas in Kochi exceed the NAAQS value for  $PM_{10}$ . No studies reported on  $PM_{2.5}$  pollution in the Kochi urban area and the present study is an attempt to quantify the elemental characterisation of  $PM_{2.5}$ .

**Method:** Sampling was done in industrial and residential areas of Kochi Urban area. Trace metals associated with fine particulate matter ( $PM_{2.5}$ ) is analysed using inductively coupled plasma mass spectroscopy (ICP-MS).

**Results:** The present study reported high concentration of Fe, Zn and Ni in the industrial locations whereas Fe, Zn and Pb in the residential areas. The trace metal concentration ( $ng/m^3$ ) associated with  $PM_{2.5}$  decreased in the order of Fe (32.58)>Zn (31.93)>Ni (10.13)>Cr (5.48)>Pb (5.37)>Cu (3.24). Industrial areas reported higher concentration of metals studied than residential area. All the trace metals reported a higher EF value and the source can be traced to anthropogenic emission.

**Conclusion:** The presence of metals in the atmosphere of Kochi is of serious concern as various health impacts can be triggered due to their presence. The study is the first of its kind in Kerala to understand the elemental composition of particulates in air and more studies to be continued to understand the source and fate of trace metals in Kochi urban area.

**Keywords:** Air Pollution, Particulates, Trace Metals, Enrichment factor

## 07. Fisheries & Veterinary Sciences

07.01

### Effect of Bedding Systems on Milk Yield, Somatic Cell Count and Body Condition Score in Crossbred Cows

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**Background:** The bedding systems on which the dairy cows are reared has vital impact on the milk yield, somatic cell count and body condition score. Present study was carried out to analyse the effect of different bedding systems on milk yield, somatic cell count and body condition score in crossbred cows.

**Method:** Total 24 crossbred cows were allotted to four treatment groups (six per group) under different bedding systems viz., Concrete floor ( $T_1$ ), Rubber mats ( $T_2$ ), Coir pith bed ( $T_3$ ) and Dried Solid Manure (DSM) ( $T_4$ ). The body condition score was studied by the score card method. Daily milk yield from the experimental animals were recorded. The somatic cell count of milk was analysed for a period of one year.

**Results:** The milk yield was highest in cows maintained on coir pith ( $T_3$ ) (588.3  $\pm$  1708) followed by DSM ( $T_4$ ) (567.15  $\pm$  12.53). The somatic cell counts were lower in cows maintained on concrete floor (161.22  $\pm$  1.16) followed by cows on rubber mat (164.49  $\pm$  0.97). Cows reared on coir pith bedding materials had lower cell counts in milk (167.69  $\pm$  0.56) compared those on DSM. Cows on coir pith had higher body condition score (4.24  $\pm$  0.02) followed by DSM (3.51  $\pm$  0.10). The cows reared on concrete floor showed lesser BCS (1.68  $\pm$  0.11) than on rubber mat (2.13  $\pm$  0.1).



**Conclusions:** The cows maintained on bedding materials such as coir pith and dried solid manure showed improved body condition score, lesser somatic cell count and thereby more milk yield than on concrete floor and rubber mat bedding.

**Keywords:** Crossbred cows-concrete floor-rubber mats-coir pith & dried solid manure- milk yield, somatic cell count and body condition score analysis

## 07.02

### Development and Validation of Taqman Probe Based Real-Time Reverse Transcriptase Polymerase Chain Reaction for Detection of Porcine Reproductive and Respiratory Syndrome Virus

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**Background:** Animal husbandry and livestock sector play a vital role in enhancing the rural livelihood and economic development of the country. Pig rearing is one among the major livestock farming. Pigs are affected by many infectious diseases and porcine reproductive and respiratory syndrome is one among them. The syndrome is caused by an arterivirus, the PRRS virus (PRRSV). The virus has been reported from India and there have been reports of PRRSV outbreak in Kerala also. The diagnosis of PRRS based on clinical signs is confusing as the symptoms overlap with that of some other infectious diseases of swine especially porcine circovirus 2 infections. Hence there is a need for developing sensitive confirmatory laboratory diagnostic tests for detecting this virus.

**Method:** In this study, primers and TaqMan probe for real-time reverse transcriptase polymerase chain reaction (rt RT-PCR) were designed on the basis of ORF7 sequences of Kerala and Indian isolates of PRRSV. Cloned template of PRRSV was used for determination of detection limit of rt RT-PCR. A total of 40 PRRSV suspected tissue samples of pig were subjected to TaqMan rt RT-PCR and the results were compared to that obtained when the samples were tested by ORF6 based RT-PCR.

**Results:** The detection limit of the ORF7 based rt RT-PCR was 3298 copies of the viral genome. Slope, R<sup>2</sup> and efficiency were calculated to be -3.778, 0.999 and 83.94 per cent respectively. When 40 samples were tested, 15 (37.5 per cent) and 12 (30 per cent) samples were positive by ORF7 based rt RT-PCR and ORF6 based RT-PCR respectively indicating an increased sensitivity of the former. Analysis of the results by Kappa statistics revealed fair agreement between the tests. No cross reactivity was observed against classical swine fever virus positive samples.

**Conclusion:** ORF7 based TaqMan rt RT-PCR is a sensitive test that could be used for rapid and specific diagnosis of PRRSV.

**Keywords:** PRRSV, ORF7, TaqMan real-time RT-PCR

## 07.03

### Molecular Characterization of *M. pachydermatis* Isolates Obtained from Cases of Dermatitis and Otitis externa in Dogs

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**Background:** *Malassezia* spp. are commensals of the normal cutaneous microbiota of humans and animals. These yeasts may become opportunistic pathogens under certain conditions and cause dermatitis in dogs. *Malassezia pachydermatis* is the most common cause of malassezia dermatitis and otitis in dogs. Though this condition has become fairly common in dogs in Kerala, only very few attempts have been made to isolate and characterise this yeast from these cases.

**Method:** Skin and ear swabs from suspected cases were cultured on Sabouraud dextrose agar (SDA) with 0.05 per cent chloramphenicol. The isolates obtained were initially characterized on the basis of colony characteristics, result of Gram staining and microscopic morphology. Total DNA was extracted from the pure cultures of the isolates and subjected to confirmation by polymerase chain reaction (PCR) targeting large subunit ribosomal RNA gene followed by nucleic acid sequencing. Phylogenetic analysis was carried out using MEGA X software.

**Results:** Twelve isolates suggestive of *Malassezia* spp. were obtained. Of these, eight were isolated from skin lesions of dogs and the rest were obtained from cases of otitis externa. All the twelve isolates were positive in the PCR. The sequences showed similarity to sequences of *Malassezia pachydermatis*. Molecular typing grouped all the 12 isolates as Type I.

**Conclusions:** *Malassezia* yeast isolated from cases of dermatitis and otitis externa in dogs were characterised as *Malassezia pachydermatis* (Type I).

**Keywords:** *Malassezia pachydermatis*, dermatitis, otitis externa, PCR, phylogeny, dogs

## 07.04

### Analysis of E2 Glycoprotein Gene of Classical Swine Fever Virus Prevalent in Kerala from 2009 to 2020

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**Background:** Pig rearing provides a significant source of income for farmers in Kerala. Pigs are prone to viral and bacterial diseases, many of which are highly contagious and can spread easily in the farm. Classical swine fever (CSF) is one of the important viral diseases of pigs causing high mortality and subsequent economic loss. The disease was first reported in Kerala in 2007 and since then there have been various reports of incidence of the disease in the State. Available reports suggest that the CSF virus (CSFV) in Kerala belong to subgroup 2.2. This paper reports the molecular characterization of CSFV isolates obtained in 2020, and comparison of CSFV prevalent in Kerala during the period from 2009 to 2020 based on the nucleotide sequence of E2 glycoprotein gene of the virus.

**Method:** Clinical samples were collected from three farms where there has been incidence of infectious disease in pigs with high mortality and symptoms suggestive of CSF. Total RNA and cDNA were synthesized using commercially available kits. The presence of CSFV in the samples were detected by nested reverse transcriptase polymerase chain reaction (RT-PCR) targeting E2 region of





the virus using previously published primers. The positive 272 bp amplicons were gel extracted and sequenced. The obtained sequences along with all the previously reported E2 gene sequences from Kerala and representative CSFV sequences from India and abroad were analyzed by MEGA X software. Selection pressure on the gene was determined by relative abundance of synonymous and nonsynonymous substitutions that have occurred in the gene sequences.

**Results:** All the three samples were positive for CSFV and on phylogenetic analysis it was observed that the three sequences clustered together. The new sequences were of the same subgroup of CSFV that was reported from Kerala previously (subgroup 2.2). On analysis of the Kerala sequences T to C transitions were observed in 5 sites, three of which were unique to sequences obtained in 2020. Two A to G transitions were also observed in the newly obtained sequences and which were not recorded previously from Kerala. Of these, one transition resulted in a change in amino acid from lysine (K) to glutamic acid (E). It was observed that, in case of E2 gene region studied, the substitutions were all synonymous indicating that the CSFV in Kerala are undergoing purifying selection indicating recent population expansion.

**Conclusion:** The CSFV in Kerala recorded from 2009 to 2020 belong to subgroup 2.2 and are undergoing purifying selection.

**Keywords:** CSFV, E2 glycoprotein, subgroup 2.2, purifying selection

## 07.05

### Influence of Sardine Fish, Flax Seed and Basil Leaves on Serum Lipid Profile of Layers

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**Background:** Egg is the most nutritious, unadulterated and easily digestible food with the highest biological value. Humans have utilized hen's egg as a nutrient rich food since times immemorial; because it supplies most of the essential nutrients, in right proportion in a readily absorbable form. Health of layer is important for its production. Active principles in plant based materials plays a crucial role in upgrade the health status of layers and its production efficiency. In this study was conducted to examine the effect of flax seed, sardine fish and basil leaf meal on health status of layers.

**Method:** A biological study of six weeks duration was carried out to study the effect of dietary full-fat flaxseed (FFFS), oil rich sardine fish, basil (tulasi) leaf meal (BLM), vitamin E and organic selenium (Sel-plex) on serum lipid profile of layers. A total of 144 single comb 'Forsgate' strain White Leghorn (SCWL) pullets of 27 weeks of age, belonging to the same hatch, and of uniform body size were randomized into 24 groups of 6 hens each. This experiment is a 2 x 3 factorial design consisting of two types of layer feeds namely, standard layer mash (control) and special designer egg layer mash (DELM); each with three levels of Basil leaf meal (BLM) i.e. 0, 1 and 2g/kg levels. On the last day of the study, blood samples were collected from one layer for each replicate. The serum was separated and the serum samples were used to estimate the total cholesterol (TC), High density lipoprotein-Cholesterol (HDL-C), Low density lipoprotein-Cholesterol (LDL-C) and Very low density lipoprotein-Cholesterol (VLDL-C) and Triglycerides levels.

**Results:** Designer egg diet and Basil leaves feeding had resulted in significant reduction in serum TG, TC, VLDL-C, LDL-C and significant increase in HDL-C compared to the control. The designer feed, dietary BLM as well as their combinations had significantly and favorably altered the serum lipid profile of hens.

**Conclusions:** The synergistic effect of designer diets with BLM was prominently observed by favorably altering the serum lipid profile. The bad TG, TC, VLDL-C and LDL-C levels were significantly reduced both by the designer diet and BLM; whereas, the good HDL-C levels were increased by feeding designer diet as well as BLM. Moreover, the BLM effect was "dose related".

**Keywords:** Flax seed, Sardine fish, Serum, Triglyceride, Cholesterol

## 07.06

### Studies on Differentially Expressed Genes in the Skin of Vechur Cattle and Holstein Friesian Crossbred Calves Following *Rhipicephalus annulatus* Infestation

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**Background:** An attempt was made to identify the differentially expressed genes in the skin of Vechur (*Bos indicus*) and Holstein Friesian crossbred (CBHF) cattle in response to *Rhipicephalus annulatus* infestation.

**Methods:** Vechur and CBHF crossbred calves (two each) of comparable age were artificially infested four times with about 20,000 larvae to ensure stable resistance against tick infestation. These calves were then challenged with about 10,000 larvae. Skin biopsies from both genetic groups were collected before the challenge (T0) and 24 hours after infestation (T24) from the neck area for gene expression profiling using microarray analysis on the Agilent platform.

**Results:** Microarray results revealed significant upregulation of 27 genes and downregulation of 54 genes in Vechur in T24 sample when compared to T0 sample. In CBHF 26 genes were upregulated and 52 genes were downregulated in T24 sample compared to T0. Comparison of genes which were differentially expressed in Vechur and CBHF after tick challenge revealed very few common genes indicating stimulation of different immune response pathways among the genetic groups studied. In Vechur animals, genes involved in T cell activation and wound healing were upregulated while cell signalling genes, transcription regulators leading to B cell activation were upregulated in CBHF animals. The downregulated genes in Vechur animals could be grouped under genes of the metabolic pathway, genes regulating cell migration, transcription factors affecting T cell differentiation. In CBHF animals, the downregulated functional categories were lipid and protein metabolism and immune genes involved in the regulation of inflammatory changes.

**Conclusion:** The observations made in the present study emphasized the difference in host immune response mechanisms to *R. annulatus* infestation between cattle of *Bos indicus* and *Bos taurus* lineage.

**Keywords:** *Rhipicephalus annulatus*, Microarray analysis, *Bos indicus*, crossbred cattle

## 07.07

### Detection of Point Mutation in *ParC* Gene of Quinolone Resistant *Escherichia coli* Isolated from Retail Chicken of Kerala by a Rapid Mismatch PCR

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**Background:** Chicken has been incriminated as a common cause of food borne infection especially with *E. coli*. The indiscriminate use of quinolones in the treatment of broiler chicken has resulted in development of quinolone resistant *E. coli* in chicken. Mismatch amplification mutation assay (MAMA) PCR is a rapid and economical means of detecting point mutation in the *parC* gene which contributes to quinolone





resistance.

**Methods:** One hundred and eighty chicken meat samples weighing 250 g each were collected from different retail outlets located at various districts of Kerala. The samples were subjected to isolation and identification of *E. coli* followed by the detection of virulence genes (*eaeA*, *aggR* and *ipaH* genes) by multiplex PCR. The antibiotic susceptibility pattern was assessed by standard disc diffusion method using nalidixic acid (30µg) and ciprofloxacin (5µg) discs. Point mutation in *parC* gene was detected using MAMA PCR.

**Results:** *Escherichia coli* was detected in 65.5 per cent of the samples. The virulence genes viz., *eaeA*, *aggR* and *ipaH* were detected in 75.4, 5.08 and 3.38 per cent samples respectively. The results of ABST revealed resistance to nalidixic acid and ciprofloxacin in 45.45 and 17.58 per cent isolates respectively. The presence of *parC* gene was detected in 89.65 per cent of the samples. Point mutation at *parC* gene was detected in 42.3 per cent of the quinolone resistant isolates.

**Conclusion:** The present study has shown a clear molecular evidence of quinolone resistance in *E. coli* isolates tested. Therefore the study stresses the need for prudent use of the drug and implementation of active surveillance programmes.

**Keywords:** *E. coli*, quinolone resistance, *parC*, MAMA PCR

07.08

### Modulation of Steroid Hormone Synthesis by Methanolic Extracts of *Boerhavia diffusa*

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**Background:** Steroid hormones such as progesterone and oestrogen play multifactorial role in regulation of reproduction, neuroendocrine and metabolic functions in humans and animals. Phytoestrogens are compounds derived from plants that can bind with classical oestrogen receptors and mimic their action. Since phytoestrogens play a role in the management of fertility as well as therapy of hormone dependent cancers, the present study explores the possibility of use of *Boerhavia diffusa* as a drug or adjuvant to such therapies.

**Method:** *Boerhavia diffusa* was collected locally, shade dried, pulverised and extracted using methanol, concentrated and was used for study. The cytotoxicity of methanolic extract was explored using MTT assay in MCF-7 cells and IC<sub>50</sub> was calculated. The cells were exposed to extracts of *B. diffusa* in the concentrations 340, 170 and 85µg for 96 hours. The culture media were collected every 48 and 96 hours and replaced with fresh media. The collected media was stored at -80°C and used for the estimation of progesterone and oestrogen by ELISA.

**Results:** The qualitative phytochemical analysis revealed the presence of alkaloids, glycosides, tanins, flavonoids, saponins and phenols. The extract decreased the viability of the cells at doses above 160µg/mL and the IC<sub>50</sub> was calculated as 170µg/mL. The methanolic extract of *B. diffusa* showed significant increase in the progesterone concentration and significant decrease oestrogen concentration when exposed to doses above and below the IC<sub>50</sub>. The effect of the extract on the hormone concentrations were dose dependent.

**Conclusion:** It could be inferred that the effect of *B. diffusa* may be some where in the interconversion steps of progesterone to oestrogen, most probably at aromatase which is the key rate limiting step.

**Keywords:** *B. diffusa*, MCF-7 cells, Progesterone, Oestrogen.

07.09

### Influence of Structural Components of Cattle Shelters on the Welfare of Dairy Cattle in Kerala

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**Background:** Farm animal welfare is a growing societal concern in modern livestock farming. Structural characteristics of cattle shelters have profound influence on the overall welfare of dairy animals. In Kerala intensive system of rearing cattle is widely practiced where cows spend most of their productive life inside the shelter necessitating the need for providing favourable microclimatic conditions. Diverse factors such as air temperature, humidity, solar radiation, wind speed, precipitation influence the environmental conditions interior to the cattle shelter and induces thermal stress during summer months (Schüller et al., 2013). Animal integrates these environmental conditions and responds to it adaptively by evoking certain physiological, behavioural, and immunological responses.

**Method:** A detailed field study was conducted in four THI zones of Kerala including three higher zones such as H1 (Moncombu), H2 (Vellanikkara), H3 (Pattambi) and one lower zone L1 (Pambadumpara) during the summer months in February and March of 2020. Macroclimatic and microclimatic data of the cattle shed were collected using electronic loggers. Topographical, structural, and physiological responses of the animals were also collected and the entire was analysed using IBM SPSS Statistics Version 24.0.

**Results:** The mean ambient temperature and HLI exceeded the upper critical range of 28.4°C and 86 respectively. The physiological responses of the animal such as body temperature and respiration rate, ambient temperature inside the shelter, roof and floor temperature exhibited a significant positive correlation with HLI ( $p < 0.01$ ). While altitude of the area ( $p < 0.01$ ) and Influence of shade trees ( $p < 0.05$ ) showed a statistically significant negative correlation with HLI. Although not significant, a negative correlation between HLI and other structural parameters was evident.

**Conclusion:** Thermal environment had profound influence on the health, productivity, and welfare of dairy cattle. It was inferred that more than 90 per cent of the total farms from different THI zones of Kerala are experiencing thermal stress of varying degrees of severity. Designing and selection of construction materials for shelters should consider the climatic variables to reduce thermal stress on dairy cattle.

07.10

### Nematocyst Venom Proteome Analysis of Three Common Jellyfishes (*Chrysaora caliparea*, *Cyanea nozakii* and *Lychnorhiza malayensis*) (Cnidaria: Scyphozoa) from the Kerala Coast.

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**Background:** In the recent past jellyfish has been increased public awareness due to the risk encountering jellyfish blooms and the resultant human casualties. The jellyfish venom stored in nematocysts contains highly toxic compounds comprising of polypeptides, enzymes and other proteins, which form their chemical defence armoury against predators. We have characterized the proteome of crude venom extract from three bloom-forming scyphozoan jellyfish along the Kerala coast.

**Method:** We performed proteome analysis of the nematocyst venom from the tentacles and oral arms of a total of ten similar sized matured specimens each of *Chrysaora caliparea*, *Cyanea nozakii* and *Lychnorhiza malayensis* were collected from the different stations along the Kerala coast using a Quadrupole-Time of Flight (Q/TOF) mass spectrometry analysis. Identification of proteins has been performed by searching against the jellyfish and toxin protein database.

**Results:** The most abundant toxin identified from *Chrysaora caliparea* and *Lychnorhiza malayensis* is similar to the pore-forming toxins and metalloproteinases. A protective antioxidant enzyme called peroxiredoxin was found abundantly in *Cyanea nozakii*. Metalloproteinase identified from the *C. caliparea* shows similarity with the venom of pit viper (*Bothrops pauloensis*), while that of *L. malayensis* was similar to the venom of snakes such as the *Bothrops insularis* and *Bothrops asper*. Kininogen-1 is a secreted protein, identified for the first time from the jellyfish *L. malayensis*.

**Conclusions:** Our study characterized the proteome map of crude venom extract from *L. malayensis* and *C. caliparea* for the first time, and the venom profile is compared with published information elsewhere. Proteomic data from this study has been made available in the public domain.

**Keywords:** Jellyfish, Nematocyst, Venom, Proteomics, Metalloproteinase, Kininogen-1

## 07.11

### Application of Single Nucleotide Polymorphism Markers as Potential Tools for Breed Genetic Traceability of Attappady Black Goats

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**Background:** The objective of this study was to develop a breed genetic traceability system for Attappady Black goats using single nucleotide polymorphism (SNP) markers.

**Method:** A total of 495 goats from two breeds; Attappady Black (n=270) and Malabari (n=225) sampled from farmers' flock in their respective breeding tracts were included in the study. In the first phase, a reference population of 48 goats (24 each of Attappady Black and Malabari) were subjected to whole genome SNP genotyping using Illumina goat SNP50 BeadChip. Attappady Black breed-specific alleles were sorted out by analysing the allele frequencies. Among these, nine preponderant candidate markers were chosen and authenticated for breed specificity in validation population (Attappady Black, n=246; Malabari goats, n=201) by converting them into polymerase chain reaction-restriction fragment length polymorphism markers. The efficiency of each marker for breed identification was evaluated by calculating probability of identification (Pi) and probability of mis-judgment (Pm).

**Results:** After quality control, 47,100 SNP marker information per sample were available for downstream analysis. Genome-wide scan of high throughput marker data revealed 605 numbers of Attappady breed specific candidate markers in the reference population. Among nine preponderant candidate markers authenticated for breed specificity in validation population, four candidate markers retained their breed specificity on validation, with Pi ranging from 0.24 to 0.66. Panel of these four Attappady Black breed specific markers had Pi of 0.92 with low Pm of 0.04.

**Conclusion:** The low cost technology based on PCR-RFLP developed in the present study for breed genetic traceability of Attappady Black goats contributes to the prevention of falsified trade of Attappady Black goats and its products and guarantee the purebred stock to public. It can also boost up the efforts to pursue protected geographical indication status to Attappady Black goats with obvious impact on tribal economy and breed conservation.

**Keywords:** Breed genetic traceability, single nucleotide polymorphism, goats

## 08. Health Sciences

### 08.01

#### A Modified Porcine Cholecystic Extracellular Matrix Scaffold for Diabetic Wound Healing Application

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**Background:** Delayed wound healing is one of the major complications of diabetes mellitus because of sub-optimal angiogenesis. A porcine cholecystic extracellular matrix scaffold (CEMS) has been found effective for healing skin-full thickness excision and burn wounds in animal models. However, the ability of this material to promote the healing of diabetic wound has not been studied. Against this background, the objective of the present study is to evaluate the suitability of a gelatin-modified cholecystic extracellular matrix scaffold for diabetic wound healing application.

**Methods:** A cholecystic extracellular matrix scaffold was prepared by a non-detergent and non-enzymatic method described previously from the host laboratory and then modified it by coating with gelatin. The prepared material was characterized by trinitrobenzene sulphonic acid assay, scanning electron microscopy, Fourier transform infrared spectroscopy and enzymatic biodegradation assay. Keratinocytes were cultured on modified scaffolds and performed Alamar blue assay. Endothelial cells were cultured on scaffolds and performed live/dead assay, Alamar blue assay and phalloidin- fluorescein isothiocyanate. The angiogenic potential of the modified scaffold was studied by chick chorioallantoic membrane assay. The use of the modified CEMS for wound healing was demonstrated in diabetic rat. The histomorphology of the healing wounds was evaluated by Hematoxylin and eosin staining and Herovici's staining and immunohistochemistry for CD80, CD163, CD31 and alpha smooth muscle actin.

**Results:** Successful surface modification of CEMS with gelatin was demonstrated by trinitrobenzene sulphonic acid assay and scanning electron microscopy. Fourier transform infrared spectra suggested that the modification did not affect the original chemical composition of the scaffold. Moreover, the modified scaffold was less amenable for proteolytic degradation. The in vitro cell culture studies suggested that the modified scaffold promoted the viability of keratinocytes and endothelial cells. The chick chorioallantoic membrane assay demonstrated that the modified scaffold had higher angiogenic potential. Moreover, graft-assisted healing with the modified scaffold resulted in faster healing of full-thickness skin wounds in diabetic animals with rapid re-epithelialization, decreased inflammation, enhanced angiogenesis and favourable collagen maturation.

**Conclusion:** The study concluded that the gelatin modified CEMS is a promising candidate scaffold for graft assisted healing of diabetic wounds.

**Keywords:** extracellular matrix scaffold, diabetic wound, angiogenesis



08.02

### A Meta-Barcoding Exploration of Bacterial Diversity of Biofilms in Indwelling Urinary Catheters

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**Background:** Urinary catheters are hollow tubular devices ordinarily used to provide relief to urinary incontinence and retentions, measure urine output or to support patients who had undergone surgery or suffering from other diseases. However, these catheters are an idyllic surface for bacterial colonization and subsequent biofilm formation.

**Method:** This study explored the bacterial diversity of biofilms in urinary catheters using culture-independent meta-barcoding analysis. For this, following metagenomic DNA isolation, V3 and V4 region of 16S rDNA was amplified and sequenced using Illumina MiSeq system.

**Results:** Taxonomic classification was prepared at various levels. *Proteobacteria* was the predominant phylum. *Gammaproteobacteria* was the predominant class under phylum *Proteobacteria*. However, *Betaproteobacteria* and *Alphaproteobacteria* were also present in one of the catheters. The catheters showed the predominance of *Enterobacteriales*. The other major orders were *Pasteurellales*, *Pseudomonadales* and *Rhodocyclales*. *Morganella Haemophilus*, *Klebsiella* and *Pseudomonas* were the dominant genera.

**Conclusion:** Molecular analyses showed that most of the species identified in this study were known human opportunistic or true pathogens which can cause Urinary Tract Infections.

**Keywords:** Urinary Catheter, Biofilm, Urinary Tract Infections, Metagenomics, Next -Generation Sequencing

08.03

### Natural Calcium Containing Siloxane Methacrylate Pre-Polymers for Hard Tissue Restorative Applications

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**Background:** Bone and Tooth are the hard bio-mineralized tissue demanding restorations due to trauma, infection, fracture and ageing. Generally, bone/dental restoratives comprised of methyl methacrylate (MMA), Bisphenol glycidyl methacrylate (BisGMA), Urethane Dimethacrylate/ epoxy as resin matrix. However the problems of post- polymerization shrinkage induce a gap between the interface of tooth/bone and the restoratives. This leads to aseptic loosening, secondary infection, and finally failure of the restorative and even tooth/bone loss. This insisted the need of low polymerization shrinkage and bioactive resin particularly in this pandemic situation to increase the life of restoratives.

**Method:** Powdered aragonite was extracted from the shells of *Pinctada fucata* and characterized by SEM, FTIR and DLS. Natural calcium containing ladder like siloxane methacrylate (CSM) prepolymer was synthesized via the patented modified sol gel method using the precursor 3-(trimethoxysilyl)propyl methacrylate. CSM was characterized by spectroscopic techniques and chromatography. Physico-chemical properties and cytotoxicity of the cured samples were studied.

**Result:** CSM was synthesized and spectroscopy techniques confirmed the ladder like siloxane network with calcium integration. As calcium act as network modifier in a polymeric silica network, reduction in molecular weight of CSM was observed. The cured CSM samples exhibited low linear polymerization shrinkage, good mechanical properties and bioactivity. Direct contact, MTT and cell adhesion proved the cytocompatibility and non-cytotoxic nature of CSM.

**Conclusion:** Thus the bioactive and low polymerization shrinkage CSM resin is an ideal candidate for hard tissue restorative applications.

**Keywords:** siloxane methacrylate, inorganic-organic hybrid resin, dental resin, sol gel method, low polymerization shrinkage resin

08.04

### Multiplexed IHC Provides Comprehensive Prognostic Information of Breast Carcinoma

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**Background:** Immunohistochemical (IHC) methods for the in-situ analysis of protein expression is a powerful prognostic tool for tumors. For solid tumors like breast cancer, multiple markers need to be investigated before treatment decision making. However, conventional IHC enables the labeling of only one marker per section which enhances the outlay of patient samples. Multiplexed IHC has emerged to be promising technique to circumvent these limitations over the past decade and provide a comprehensive information about cell composition and spatial arrangement of biomarkers. The current study focusses on the development and validation of a multiplex IHC technique for the breast cancer prognostic markers ER, PR, Her2 and NM23A using different platforms

**Methods:** Multiplex Immunofluorescence in breast cancer cell line MCF7 for ER, PR and Her2 conjugated with Alexa fluor and Quantum dots. Tissue Microarray: TMA blocks with a capacity of 15 individual tissue blocks of 1.5mm thick each were made using UNITMA plunger. Multiplex Chromogenic Immunohistochemistry in TMA for Breast cancer prognostic markers ER, Her2 and NM23A.

**Results:** Colocalization of ER and Her2 by dual staining with Alexa fluor 546 and Alexa fluor 488 conjugated secondary antibodies is demonstrated using immunofluorescence in breast cancer cell line MCF7 which was substantiated with flow cytometric analysis. Signals were distinct and non-overlapping. The technique was further translated to breast cancer tissue samples which are routine formalin fixed paraffin embedded. Triplex fluorescent IHC labeling of ER, PR and Her2 using secondary antibodies conjugated to Alexa fluor and quantum dots and Triplex chromogenic IHC labeling with different enzyme conjugated secondary antibodies revealed differential expression of these markers on the same slide and was visualized using confocal microscope. Negative control slides did not show any specific staining above background tissue autofluorescence confirming that all signal is specific to the targets recognized by the primary antibodies.

**Conclusion:** The study demonstrated multiplexing of breast cancer prognostic markers ER, PR, Her2 and NM23A by IHC by means



of various platforms for the identification. This technique is validated to be comparable to routine IHC and hence can be easily translated to clinical practice for patient benefit. This technique also saves tissue, time, effort and reagents used.

## 08.05

### Effect of the Anti-Fungal Agent, Fluconazole, on Mortality of 4<sup>th</sup> Instar Larvae of *Aedes albopictus* (Skuse)

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**Background:** Mosquitoes can be considered as life threatening organisms due their potential in spreading deadly diseases like dengue, malaria, filariasis etc. Several studies on the larval gut has shown the presence of extracellular microbes like fungi and bacteria inside the larval gut. The role of bacteria in larval development is reported. Exploiting the host- microbiome interaction will be helpful in designing mosquito control strategies.

**Methods:** The fourth instar *Aedes albopictus* larvae were treated with different concentrations of fluconazole (10ftg/ml, 30ftg/ml and 50ftg/ml) in 100 ml of water. A control was also kept without the addition of fluconazole. The larvae were fed with yeast granules. The number of live and dead larvae, pupae and adults were noted every 24 hours. Percentage mortality and percentage emergence was calculated. Experiments were repeated thrice.

**Results:** The overall percentage mortality, increased with increase in concentration of fluconazole and was 31%, 35% and 50% at 10, 30 and 50µg/ml fluconazole respectively. At 50µg/ml we observed 50% mortality on 6th day of the experiment. The Minimum Inhibitory Concentration of Fluconazole (MIC<sub>90</sub>) for fungi is 64µg/ml. Other toxic effects at higher concentrations are ruled out as we used concentration below MCI. The delay in mortality also indicated there is no acute toxicity. Percentage emergence was the lowest (50%) for 50µg/ml and for 10µg/ml and 30ftg/ml fluconazole, the percentage emergence was found to be same (68.75±6.25%). This is the first report of effect of an anti-fungal agent on the larvae of mosquito.

**Conclusions:** The treatment of *Aedes albopictus* larvae with fluconazole, an anti-fungal agent, has significantly reduced the larval survival rate and adult emergence. The mortality may be due to the loss of fungi that inhabits the digestive tract of the larvae. This is the first report of effect of an anti-fungal agent on the larvae of mosquito. Exploring the role of fungi in the survival and development of mosquito will be helpful in designing mosquito control strategies.

**Keywords:** *Aedes albopictus*, Larval gut fungi, fluconazole.

## 08.06

### Pleiotropic Effects of Epoxyazadiradione in Human Triple Negative Breast Cancer Cells

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**Background:** Most of the currently available cancer chemotherapeutics are either molecules which are plant-derived molecules or their synthetic derivatives. For several decades the medicinal plants have been widely explored for the development of lead compounds with no or lesser side effects compared to the existing anticancer drugs. Epoxyazadiradione is a limonoid found in neem plant, with several pharmacological properties.

**Aim:** In this study we investigated the anticancer activity of Epoxyazadiradione (EAD) on human triple negative breast cancer cell line (MDA-MB-231).

**Methodology:** MTT assay, staining techniques (DAPI, Acridine orange/EtBr, Annexin V, JC-1), lactate dehydrogenase release assay, caspase 3 & 9 activity assay, ELISA, gelatin zymography, scratch wound assay, western blotting, flow cytometry analysis, colony formation assay, anoikis assay and immunofluorescence analysis were employed.

**Result & conclusion:** The results revealed that EAD caused 50% inhibition in MDA-MB-231 cells at 12±1.04µM, with no significant toxicity on normal cell lines (H9C2) up to 50 µM. The apoptotic cell death was revealed by increased nuclear fragmentation, membrane breakage, phosphatidyl serine translocation, LDH leakage, mitochondrial membrane depolarization, activation of caspases (3,9) and upregulation of apoptosis -indicator proteins (bax, cleaved parp). The EAD also reduced cell migration, matrix metalloproteinase 9 (MMP9) activity, fibronectin expression and colony formation, which in turn indicates the compound's antimetastatic potential. EAD was also found to reduce glucose uptake, increase intracellular ROS, induce cell cycle arrest at G2/M phase and revert anoikis resistance. And finally nuclear translocation/expression of NF-κB and EGFR is found to be reduced under the treatment in a dose dependent manner. Taken together, our results strongly suggest that EAD has dose- and time-dependent antineoplastic effects, suggesting its potential usage against triple negative breast cancer.

**Keywords:** Triple negative breast cancer; apoptosis; anoikis; antimigration; EGFR; epoxyazadiradione

## 08.07

### Fractal Kinetics and Inertia Moment *Invitro* Study of Coronavirus proliferation Through Replication

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**Background:** Coronavirus Diseases (COVID-19), caused by Coronavirus (CoV), is a pandemic as adjudged by the World Health Organization (WHO), killing millions. The investigation of the replication kinetics of CoV and interaction with host cell can give valuable information in getting control over its spreading.

**Method:** The present study investigates the replication of CoV employing the principles of fractal and inertia moment analyses. The work employs 388 frames sequentially extracted from the video of the interaction of the CoV with normal cells in a culture medium. Fractal analysis by finding the box-counting and power spectral fractal dimension of the images is utilized to understand the evolution of the complexity in the CoV-cell interaction with time. The images are also subjected to inertia moment analysis to study the kinetics of the virus replication.





**Results:** The box-counting fractal dimension of the frames, calculated from the thresholded images, reflects the stages of virus infection resulting in the proliferation by the replication of the virus RNA and thereby damaging the living cells. The power spectral analysis of these images by finding the power spectral fractal dimension also supports the box-counting fractal analysis. The inertia moment value increases linearly with time indicating the proliferation of CoV through replication and the damage to the host cell.

**Conclusion:** The study reveals the potential of the fractal and inertia moment analyses to unveil the replication kinetics of CoV and the possibility of using these methods in biomedical field to understand the virus infection dynamics.

**Keywords:** COVID-19, Coronavirus, Image analysis, Fractal dimension, Inertia moment

08.08

### Detection of Sars-Cov-2 in the Tears and Conjunctival Secretions of Covid-19 Patients by Reverse Transcription Polymerase Chain Reaction

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**Background:** The ocular surface is exposed to organisms from the external environment and from the upper respiratory tract via the nasolacrimal duct. The detection of SARS-CoV-2 in the ocular surface may provide a more patient friendly method to diagnosis COVID-19 and justify the adoption of protective measures during eye examination. This study was done to determine the proportion of COVID-19 patients in whom SARS-CoV-2 can be detected by conjunctival swab reverse transcription polymerase chain reaction (RT-PCR) testing.

**Methods:** Cross sectional study. The conjunctival swabs taken from fifty four patients admitted in the COVID ward of Government Medical College Hospital, Thiruvananthapuram were subjected to RT-PCR testing for corona virus in the Central Microbiology laboratory, Government Medical College Hospital, Thiruvananthapuram.

**Results:** Out of the 54 patients, 35 patients (65 %) were males. 67 % were in age group 45 - < 75 years age group. None of the patients had travelled outside Kerala. Fever, cough and breathlessness were common systemic complaints in these patients. No ocular complaints. The conjunctival swab taken from 4 patients (3 males and 1 female) was corona virus RT-PCR positive (7.4 % COVID patients had positive conjunctival swab result).

**Conclusion:** This study shows that corona virus can be detected in the conjunctival swabs taken from COVID-19 patients. Since the positivity rate of detecting corona virus in conjunctival swabs is low, conjunctival swab testing cannot replace nasal swab testing for COVID-19 diagnosis and care should be exercised during the ocular examination of patients to prevent the spread of corona virus infection.

**Keywords:** Conjunctival swab, RT-PCR testing, coronavirus

08.09

### Epidemiological Investigations on Autochthonous Leishmaniasis in Western Ghats of Kerala State

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**Background:** Leishmaniasis is a vector-borne disease caused by flagellated protozoans of the genus *Leishmania* and transmitted by phlebotomine sand flies. The disease exists in 3 main forms: cutaneous (CL) which is most common, visceral (VL), also well-known as kala-azar which is most severe; and mucocutaneous (MCL). The Indian sub-continent is endemic for both CL and VL. In India, a total of 3143 VL cases were reported in 2019, of which more than 75% were from Bihar state. In Kerala, both CL and VL are being reported from the Western Ghats region, mainly among the tribal population since the last decade.

**Method:** Epidemiological survey of leishmaniasis was conducted in the Western Ghats region of Kerala, mainly among the tribal population inhabitant areas in different districts. The survey focussed on case surveys of VL/CL and prevalence of vector species. Molecular studies were performed for the identification of parasite species/strain by following multiple genetic marker approach.

**Results:** This study elucidated the epidemiological factors involved in the autochthonous transmission of CL/VL in the tribal settlements of Western Ghats, Kerala. Zymodeme MON-37 strain of *Leishmania donovani* was found to be the parasite causing both visceral and cutaneous leishmaniasis in this area. The study findings suggested that the *Phlebotomus argentipes* is the predominant vector species in this area which prefers to feed on different mammalian species blood meal.

**Conclusions:** Zymodeme MON-37 strain of *L. donovani* is causing both CL and VL in this region, so there is a need for carrying out further studies to find out the mechanism of dual manifestation of this particular strain of *Leishmania* parasite. As the Western Ghats region belongs to one of the protected bio-reserves of international interest, no insecticide based vector-control operations can be adopted in this region. The proposed studies would yield information on the strategies which could be undertaken towards management and containment of VL/CL in Western Ghats region of Kerala.

**Keywords:** Leishmaniasis, Autochthonous, *Leishmania donovani*, Zymodeme-MON-37, *Phlebotomus argentipes*, Western Ghats

08.10

### Utilization of Oral Fluid Metabolites as Diagnostic and Prognostic Markers in Oral Tongue Cancer

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**Background:** The Oral Tongue Cancer (OTC) represents an aggressive type of tumour in oral cavity, usually formed in the squamous epithelium of the tongue. OTC received reasonable importance especially in developing countries due to its significant morbidity and mortality rates. The introduction of modern high throughput method "Metabolomics" in the field of salivary biomarker discovery, bring more potential and reliable biomarkers for the early detection of oral cancer.

**Method:** The salivary metabolomic profiling conducted in three different group of study subjects. The groups were normal control, early stage tongue cancer and late stage tongue cancer. Each of the group contain ten study participants (n=30). The metabolomics assay conducted in WATERS QTOF Mass spectrometer coupled with UHPLC.

**Results:** The comparison between metabolite profiles of normal control samples with both early stage oral tongue cancer and late

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tongue cancer significantly altered each other. Statistical analyses identified 310 significantly altered metabolites in oral cancer and from which six signature metabolites selected as biomarker(s) for OTC diagnosis and prognosis. Its validation is being done.

**Conclusion:** Our finding demonstrated that the salivary untargeted metabolomics approach could be a reliable and efficient non-invasive method for early detection of oral tongue cancer.

**Keywords:** Oral Tongue Cancer, Metabolomics, Cancer Metabolism, Saliva.

08.11

### In Silico Analysis of Leptospiral Surface Adhesion Protein (LSA 46) as a Potential Vaccine Candidate

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**Background:** Leptospirosis is one of the neglected diseases caused by spirochete, *Leptospira interrogans*. The common treatment available to the disease is using of antibiotics such as penicillin, cephalosporin, amoxicillin etc. and also as a mode of management of the disease several peptides as vaccines were also been developed. But available vaccine till now cannot induce a serovar specific immunization in the host tissues. Thus there is a need for a well conserved vaccine candidate which can show cross protection against number of serovars present for pathogenic leptospire. Lsa46 is a surface exposed outer membrane protein plays a major role in colonization in host tissues. Lsa46 acts as laminin and plasminogen binding protein which enables the protein to easily enter into host cells inducing infection. The major target for the development of vaccine in current era is focussing on surface exposed outer membrane proteins, as they can induce strong and fast immune response in hosts.

**Method:** In this study, Lsa46 physiochemical parameters, subcellular localization, secondary structure analyses, antigenicity, conserved domain analyses etc were analysed through computational tools. The structure of the Lsa46 were predicted by threading based method in I-TASSER server and validated by Ramachandran plot analyses. The B cell epitope prediction shows 4 major sequential B cell epitopes of Lsa46. All the epitope score were found to be of a higher value. Out of the four predicted epitopes two of the epitopes were predicted as antigenic and used for further docking studies.

**Results:** The molecular docking studies with antigenic epitope and the ligand, human IgG show a good docking score. The dynamic simulation studies carried out with the molecular docked complex gives a stable binding energy.

**Conclusions:** All results of the present study help to elucidate the structural and functional characterization of Lsa46 and a deep insight for epitope based design. Wet lab analysis is required to clarify the scientific validation of the predicted epitope as an ideal vaccine candidate. Also pre-clinical and clinical findings are required based on the bioinformatics approaches used in this study for a validating it scientifically

**Keywords:** Leptospirosis, Lsa46, Molecular docking, Epitope

08.12

### Investigation of Anti-Diabetic Potential of Resveratrol Tetramer Isolated from *Hopea ponga*- A Mechanistic Approach

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**Background:** Diabetes mellitus is a severe metabolic disorder characterized by prolonged hyperglycemia and impairment in insulin secretion and/or action. Besides, this is coupled with metabolic defects and serious complications. The increasing prevalence in diabetes, its connection with various signaling pathways, inconstant pathogenesis and complications of type 2 diabetes highlight a critical requirement for a molecule with various actions.

**Method:** In traditional Ayurveda, many plants were reported for various ailments. One such family is Dipterocarpaceae in which *Hopea ponga* belongs to. A resveratrol tetramer, NIIST C2 was isolated from the stem bark of this tree and was evaluated for the antidiabetic potential in terms of glucose uptake potential and its molecular mechanism using skeletal muscle cell lines.

**Results:** The compound concentration at 75  $\mu$ M which showed less than 20% cytotoxicity were selected for glucose uptake studies using a fluorescent tagged glucose moiety 2-NBDG on a fluorescence microscope and flow cytometry. The results showed that the compound possessed significant glucose uptake potential, which is the utmost downstream incident in the insulin dependent and insulin independent pathway. To establish, the signaling pathway sensible for the resulted glucose uptake, inhibitory studies were performed and found to be activated by AMPK signaling pathway.

**Conclusions:** The outcomes from the study revealed the anti-diabetic potential of the resveratrol oligomer and its molecular mechanistic approach in stimulating glucose uptake. This would specify new perceptions for the therapeutic benefits.

**Keywords:** Diabetes, L6 cell lines, glucose uptake, resveratrol tetramer

08.13

### An Exploratory Study to Find Out the Working Case Definition of Covid-19 Infection at Cherlai Division of Cochin Corporation

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**Background:** The episode of Covid19 pandemic caused by SARS CoV2 virus strain has been marking its toll on human population all over the globe for a year. The symptomatology of this pandemic is varied and had been a topic for discussion since a year in many platforms. In this study we would be analyzing the clinical picture of Covid19 obtained from the population of Cherlai division of Kochi Cooperation to put forward a working case definition of this pandemic.

**Methods:** we conducted this study in descriptive design. The population selected was COVID 19 affected people of Cherlai division of Cochin cooperation. The sample size selected is the COVID 19 positive cases who were 28 in total. The tool used is a structured questionnaire developed specifically for the current study.

Inclusion criteria are cases from Cherlai division of Cochin cooperation and cases tested positive for Covid 19. Exclusion criteria are cases from the population other than the Cherlai division of Cochin cooperation and cases tested negative for Covid 19. The sampling method used was convenient sampling. Descriptive statistical analysis was employed in this study.

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**Results:** In total of 28 positive cases studied, the major symptoms shown were fever(96.4%), weakness (71.4%), Cough (64.3%), body pain (46.4%) tastelessness (35.7%), throat pain (32.1%), anosmia (32.1%) and others include difficult breathing, diarrhoea, vomiting, somnolence, chest pain and coryza. The intensity of each symptom was rated on a scale of 4 according to the severity(mild, moderate, severe, very severe)

**Conclusion:** This study was beneficial in finding out the working case definition of Covid 19 in Cherlai division of Cochin cooperation through descriptive research methodology. According to the statistical data, clinical definition of Covid 19 for the population of Cherlai, Cochin cooperation for November 2020 is an acute onset of fever, weakness, cough, body pain, tastelessness, anosmia, throat pain, diarrhea.

08.14

### Prevalence of BRAF and TERT gene Mutations in Papillary Thyroid Carcinoma

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**Background:** The classical type of well-differentiated thyroid cancer (WDTC) is the most common endocrine tumor with generally excellent prognosis. However, in about 10% of WDTC patients, the tumor loses its ability to take up radioiodine and becomes poorly differentiated or dedifferentiated one leading to recurrent disease and death (generally considered as aggressive). Prevalence of BRAF and TERT promoter mutations in thyroid cancer patients of our population is not yet studied systematically. Elucidation of significance of BRAF and TERT mutations in thyroid cancer pathogenesis may help to generate better treatment approach in thyroid cancer.

**Methods:** Fresh frozen or Paraffin embedded formalin fixed thyroid tumor tissue samples were procured from the Surgical division and Pathology archives of the Regional Cancer Centre, Trivandrum, after obtaining signed informed consent from the patient. BRAF and TERT gene mutation analysis will be done by PCR amplification followed by Sanger's sequencing.

**Results:** BRAFV600E mutation occurred in thirty three out of fifty samples. BRAF V600E is a point mutation (substitution of a thymine with adenine at position 1799 on exon 15) that results in the change of amino acid 600 from valine (V) to glutamate (E). The presence of TERT promoter mutations (C228T) detected in sixteen out of fifty samples. Mostly two hotspots mutation regions are seen in TERT promoter which are C228T (-124 bp upstream start codon) and C250T (-146bp upstream start codon).

**Conclusion:** Result shows that high frequency of BRAF and TERT mutations occurred in thyroid carcinoma and its significance in thyroid cancer pathogenesis being evaluated. It may help to generate better treatment approach for thyroid cancer.

Keywords: WDTC, BRAF, TERT, Papillary thyroid carcinoma.

08.15

### Mitigation of Host Tissue Reaction to Polypropylene Mesh by Surface Modification with Porcine Cholecystic Extracellular Matrix Hydrogel

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**Background:** Polypropylene (PP) meshes are widely used for repairing skeletal muscle defects, like abdominal hernia, despite the chances of undesirable pro-inflammatory adverse tissue reactions that demand revision surgeries in about 45% cases. Researchers have attempted to address the problem by modifying mesh surface and architecture. However, these procedures have yielded only incremental improvements in the overall post-operative complications and the search for a clinically viable therapeutic strategy continues.

**Methods:** This study deployed a tissue engineering approach for mitigating PP induced adverse tissue reaction by dip coating PP mesh with a hydrogel formulation of porcine cholecystic extracellular matrix (CECM). The biomaterial properties of the CECM-hydrogel coated polypropylene (C-PP) meshes were evaluated and its biocompatibility was established by *in vitro* and *in vivo* test based on ISO-standards. Further, the nature of tissue reaction induced by a commercial hernia repair graft and the hydrogel coated mesh were compared in a rat model of partial thickness abdominal wall defect.

**Results:** Histomorphologically, in comparison with the PP graft-induced tissue reaction, C-PP caused a favourable graft-acceptance response characterized by reduced numbers of pro-inflammatory M1-macrophages and cytotoxic-lymphocytes. Remarkably, the differential inflammatory response of C-PP graft assisted healing was associated with a fibrotic reaction predominated by deposition of type I collagen, as desired during skeletal muscle repair.

**Conclusion:** CECM-hydrogel is a potential biomaterial for surface modification of polymeric biomedical devices.

Keywords: Cholecyst, extracellular matrix, biomaterial, biocompatibility, polypropylene, hydrogel

08.16

### Cytogenetic Profile of De Novo Acute Lymphoblastic Leukemia in Adults: Identification of Novel Chromosomal Aberrations

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**Background:** Acute lymphoblastic leukemia (ALL) is characterized by an excess of lymphoblasts of either the B- or T-lineage. The identification of cytogenetic and molecular abnormalities offers prognostic information regarding the markers for therapy and targets for drug development, and pathobiologic insights. The current study aims to identify the rare and novel chromosomal abnormalities among ALL patients using conventional and molecular cytogenetics.

**Methods:** Conventional (GTG banded) karyotype of 91 ALL patients were analysed from March 2019 to November 2020. For the molecular confirmation of rare translocations and numerical abnormalities, Fluorescence *in situ* Hybridisation (FISH) analysis and Spectral karyotyping (HiSKY spectral imaging system, ASI) were performed.

**Results:** In the study population, 58 (63%) cases were B-cell acute lymphoblastic leukemia (B-ALL) and 33 (37%) cases were T-cell acute lymphoblastic leukemia (T-ALL). Cytogenetic analysis was successful in 79 (87%) patients but was failed in 12 (13%) cases. Among those patients with successful cytogenetics, numerical abnormalities were found in 6(9%) cases which include polyploidy (3 cases), hyperdiploidy (2 cases) and hypodiploidy (2 case). Philadelphia chromosome (Ph+) was detected in 7 (8%) patients that were

confirmed by FISH. Apart from the normal karyotype and recurrent chromosomal abnormalities, we identified two novel complex abnormalities in our study subjects these cases were Ph\*.

**Conclusion:** Karyotypes with t(9;22) indicates poor prognosis, normal karyotype and polyploids indicates intermediate prognosis, hyperdiploids is a measure of good prognosis and those cases in which analysis failed have an unpredictable prognosis. The detailed characterization of the abnormalities and the clinical output of these patients will help to improve risk stratification and novel innovations in the current treatment strategy.

**Keywords:** Acute lymphoblastic leukemia, Cytogenetics, Fluorescence in situ hybridisation, Karyotype

08.17

### A Study on the Effect of Dose Distribution Using Pinewood Slab and Carbon Couch in Radiation Therapy MV Beam

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**Background:** The study aims on evaluation of the isodose depths, surface and attenuation doses for pinewood slab and carbon couch table. The present study aimed to evaluate the feasibility of using pinewood slab for developing an in-house breast board in our radiotherapy.

**Materials and Methods:** The electron density of pinewood and couch are calculated with the help of Hounsfield unit from CT. The dose distribution such as, attenuation factor, PDD, gantry angle attenuation was noted using pinpoint chamber. The surface dose and depth doses measurement was done using parallel plate chamber. The measurement was performed for 6MV/10MV and 15MV photon of Elekta versa HD linac.

**Results:** The attenuation factor for pinewood slab for larger field such as 15x15, 20x20 cm<sup>2</sup> were too close to the couch attenuation factor. For both material maximum beam attenuation was seen in gantry angle 140° & 130° (for pinewood it is 40° & 50°) and in small field. The depth for max dose for pinewood also shows close result with couch. It was also noted that the surface dose was increased by 38- 45% when using both couch and pinewood.

**Conclusion:** The result provides the data of attenuation and depth dose distribution of pinewood slab and couch. It was found that from this study the attenuation properties and dose distribution of pinewood are more or less similar to the treatment carbon couch, thereby pinewood can be considered as one of the material in making breast board for the treatment of ca breast.

**Keywords:** pinewood, carbon-couch, attenuation, surface dose, immobilization devices

08.18

### Prevalence of Stress and Anxiety Among the Bank Employees During Lockdown Due to COVID 19

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**Background:** The World Health Organization (WHO) has declared the novel Coronavirus outbreak as global pandemic, forcing nations to impose nationwide lockdown in order to prevent the widespread of the disease and to terminate the outbreak in their various states. The pandemic has inflicted heightened levels of stress amongst individuals. Bank employees usually face high degree of stress which was further heightened during lockdown.

**Methods:** An online cross-sectional study was performed during the first phase of lock down. The link of the survey was circulated among the bank employees.

**Results:** The statistical analysis of the data was done using IBM SPSS software Version 20.0. One sample Chi square Goodness of fit test & Pearson chi square test were used for statistical analysis of the data. P<0.05 was considered as statistically significant. The data gathered from the study strongly suggest that stress and anxiety was highly prevalent among the bankers due to work in lockdown.

**Conclusion:** High level of stress is prevalent among the bank employees irrespective of the bank in which they were employed. Spreading awareness, counselling and AYUSH system immune boosters may help to reduce the stress and anxiety among the bankers.

**Keywords:** Stress, Anxiety, Bankers in India , COVID 19.

08.19

### Covid-Anosmia Checker: A Quantitative and Rapid Alternative Tool for Mass Screening of COVID-19

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**Background:** COVID-19 curve can be flattened by adopting mass screening protocols with aggressive testing and isolating infected populations. The current approach largely depends on RT-PCR/rapid antigen tests that require expert personnel resulting in higher costs and reduced testing frequency. Loss of smell is reported as a major symptom of COVID-19, however, a precise olfactory testing tool to identify COVID-19 patient is still lacking.

**Methods:** To quantitatively check for the loss of smell, we developed an odor strip, "COVID-Anosmia checker", spotted with gradients of coffee and lemon grass oil. We validated its efficiency in healthy and COVID-19 positive subjects. A trial screening to identify SARS-CoV-2 infected persons was also carried out to check the sensitivity and specificity of our screening tool.

**Results:** It was observed that COVID positive participants were hyposmic instead of being anosmic when they were subjected to smelling higher odor concentration. Our tool identified 97% of symptomatic and 94% of asymptomatic COVID-19 positive subjects after excluding most confounding factors like concurrent chronic sinusitis. Further, it was possible to reliably predict COVID-19 infection by calculating a loss of smell score with 100% specificity. We coupled this tool with a mobile application, which takes the input response from the user, and can readily categorize the user in the appropriate risk groups.



**Conclusion:** Loss of smell can be used as a reliable marker for screening for COVID-19. Our tool can be used for first-line screening to trace out COVID-19 infection effectively. It can be used in difficult to reach geographical locations.

**Keywords:** Anosmia, Hyposmia, Parosmia, COVID-19, SARS-CoV-2

08.20

### Wound Healing and Stem Cell Differentiation

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**Background:** Regardless of the labyrinth of meticulously woven synthetic scaffolds, the lack of biocompatibility hinders the effective clinical translation, which is the ultimate destination of any biomedical system or device.

**Methods:** Scaffolds were prepared using electrospinning, in vitro cell line studies and in vivo wound healing studies were conducted. Stem cell differentiation studies were also conducted in vitro and in vivo.

**Results:** The current investigation effectively fabricated scaffolds with improved bioactivities using a natural polysaccharide PST001 isolated from tamarind seed kernel. In-house synthesized biogenic silver nanoparticles were decorated onto the scaffolds to render them with antibacterial potential which was well observed in the murine models. The newly synthesized scaffolds presented appealing wound healing capacity as compared with the commercially available wound healing materials, which were employed as the positive control for the study. Differentiation screening showed that adipogenesis was more prominent in cells attached to the scaffolds.

**Conclusion:** We hope that the scaffolds mediated stem cell differentiation in wounds and promoting positive healing response. Results obtained were very promising and further studies need to embark on to establish the combined role in all aspects studied here.

**Keywords:** Scaffolds; wound healing; stem cells

## 09. Life Sciences

09.01

### Sulfated Polygalactan from Seafood *Crassostrea madrasensis*: Prospective Anti-Inflammatory Lead Attenuates Nuclear Factor- $\kappa$ B Activation and Cytokine Production in Lipopolysaccharide-Activated Macrophages

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**Background:** Nuclear factor- $\kappa$ B is an important transcription factor stimulating a series of signalling processes, including the expression of various enzymes, cytokines, adhesion molecules, and chemokines, which are the prominent targets to regulate inflammatory disorders. Marine bivalves were recognized as the culinary delicacy in many cultures and the isolated polysaccharides from edible oyster possessed potential anti-inflammatory potencies.

**Method:** A polygalactosamino-glucopyranosyl fucopyranose was purified from the crude polysaccharide of *Crassostrea madrasensis* sequentially partitioned by anion exchange chromatography (DEAE cellulose-52). The purified polysaccharide was characterized utilising extensive spectroscopic methods. Anti-oxidant and anti-inflammatory activities of the polysaccharide were performed using *in-vitro* assays. *In silico* molecular docking was performed against COX-2 and 5-LOX. *Ex-vivo* study was conducted to inhibit inflammatory responses in lipopolysaccharide (LPS)-induced murine macrophage RAW 264.7 cells.

**Results:** The purified polysaccharide exhibited prospective anti-inflammatory activity against cyclooxygenase-2 and 5-lipoxygenase ( $IC_{50} < 50 \mu\text{g mL}^{-1}$ ) on lipopolysaccharide-induced macrophages. The polygalactan attenuated inducible nitric oxide synthase ( $IC_{50}$  65.7  $\mu\text{g mL}^{-1}$ ) in lipopolysaccharide-prompted inflammation leading to the reduction of pro-inflammatory cytokine nitric oxide (236.2  $\mu\text{g mL}^{-1}$  lysate), nuclear factor- $\kappa$ B, tumor necrosis factor- $\alpha$ , and interleukins (0.19-0.22 units  $\text{mg}^{-1}$  protein at 100  $\mu\text{g mL}^{-1}$ ) by inhibiting cyclooxygenase-2. The polygalactan suppressed the mRNA of nuclear factor- $\kappa$ B and cyclooxygenase-2 in lipopolysaccharide-induced macrophages. Western blot experiment revealed the polygalactan attenuated the migration of nuclear factor- $\kappa$ B- $p^{65}$  to the nucleus from cytoplasm, and suppressed the phosphorylation of  $\kappa$ -subunit of  $\kappa$ B inhibitor. The greater selectivity index of sulfated polygalactan (3.93) towards inducible cyclooxygenase-2 as compared with the anti-inflammatory agent ibuprofen (1.11), and the potential to inhibit nuclear factor- $\kappa$ B cascade to generate chemokine production.

**Conclusion:** The species could be utilized as functional food ingredients to combat oxidative stress and subsequently attenuates the inflammation related disorders.

**Keywords:** *Crassostrea madrasensis*; polygalactosamino-glucopyranosyl fucopyranose; cyclooxygenase-2; lipopolysaccharide-induced macrophages; cytokines; nuclear factor- $\kappa$ B

09.02

### Syringic Acid Alleviates Oxidative Stress and Apoptosis in the Pancreas of Streptozotocin Induced Diabetic Rats

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**Background:** Diabetes mellitus (DM) is a complex disorder mainly characterized by hyperglycemia which arises due to complex interaction between genetic, metabolic and lifestyle factors. The consistent and chronic hyperglycemia associated with diabetes can lead to increased risk of developing serious health problems. The purpose of this study is to evaluate whether syringic acid (SA), a bioactive phenolic compound exert any protective effect in the pancreas of streptozotocin induced diabetic rats.



**Methods:** Diabetes was induced to male Sprague-Dawley rats by single intraperitoneal injection (40 mg/kg) of streptozotocin. Syringic acid (SA) was administered orally at a dose of 50 mg/Kg body weight daily once for 60 days. The levels of plasma insulin, glucose, glycated hemoglobin, toxicity markers, antioxidant enzymes and mRNA expression of apoptotic genes were analyzed. Results were compared with diabetic rats provided with the standard drug glimepiride (0.1 mg/kg).

**Results:** Administration of syringic acid to diabetic rats at a dose of 50 mg/Kg body weight, significantly ameliorated hyperglycemia, elevated insulin levels, decreased HbA1c and toxicity markers. In addition, Syringic acid could also restore the activities of antioxidant enzymes super oxide dismutase, catalase, glutathionereductase and glutathione peroxidase in the pancreas. In addition, supplementation of SA could downregulate the expression of proapoptotic markers such as caspase 3, caspase 9 and Bax and upregulate the expression of antiapoptotic marker Bcl2.

**Conclusion:** These findings suggests that syringic acid exhibits excellent pancreatoprotective effect in streptozotocin induced diabetic rats through its ability to modulate hyperglycemia, attenuate oxidative stress, and regulate apoptosis.

**Keywords:** Syringic acid, Glimepiride, Oxidative stress, apoptosis.

09.03

### *In Silico* Evaluation of Anti-diabetic Activity in *Plectranthus vettiveroides*

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**Background:** *Plectranthus vettiveroides* (Jacob) N.P. Singh & B.D. Sharma has been used as a polychrestin traditional treatment system including diabetes but its efficacy and mode of molecular mechanism of biological activity have not been evaluated scientifically. The present study was aimed to evaluate antidiabetic activity of phytochemicals derived from the essential oil of *P. vettiveroides* and determined the best lead molecule through *in silico* approach.

**Methods:** The root derived essential oil of *Plectranthusvettiveroides* was analysed in GCMS and determined the chemical constituents. The identified chemical molecules structures were procured from open access databases. To determine the inhibitory activity of these chemical molecules against diabetes a target proteinvizDipeptidylPeptidase-4 (DPP IV), which has pivotal role in insulin synthesis in human body, was selected and its structural details was retrieved from PDB. Docking between the target protein and each of the 102 chemical compounds derived from the plant was carried out using the tool Autodock 4.2. Ten compounds with binding energy  $\leq -7$  kcal/mol were considered as lead molecules. Thebinding interactions, molecular properties, toxicity and ADME properties of these molecules were analysed using computational tools and identified the best lead molecule.

**Results:**The GC-MS analysis of the root derived essential oil from *P. vettiveroides* contains 102 phytochemicals.The docked results between each of the phytochemicaland target protein DPP IV revealed that several molecules have inhibitory ability on the targetand the docked molecules with free energy of binding less than -70 kcal/mol were further analysed for hydrogen bonding pattern, toxicity and ADMET properties. Based on the forgoing analysis the compound, 4-(1-adamantanecarboxamidol)-2-ethyl-6-methyl-3-pyridyl 1-adamantanecarboxylate was selected as the best lead molecule for further study.

**Keywords:** *Plectranthus vettiveroides*, Phytochemicals, Antidiabetic,Dipeptidyl peptidase-4.

09.04

### Development of IgY Therapeutics Against *Aeromonas caviae* and its Neutralization Efficacy by *In-Vitro*

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**Background:** More than 100 years ago, Klemperer (1983) first demonstrated that avian maternal antibodies are transferred from serum to egg yolk in order to protect the developing embryo from potential pathogens but at that time there was no scientific application for this knowledge. However, when animal welfare became a matter of serious ethical concern for the scientific community, the results of Klemperer began to receive more interest, particularly since the 1980s. Since 1996, IgY technology (i.e. the production and use of IgY) has become an internationally accepted practice (Schade, 1996).

*Aeromonascaviae* is one of the fish pathogen among the *Aeromonas* species. This bacterium found rarely in fishes and infection advancement leads to the kidney and liver lesions. The aim of thisstudy is to develop effective method to prevent the prevalence of aeromonas infection among fishes.

**Method:**Twenty four week old white leghorn chickens were procured and immunized with formalin killed *Aeromonascaviae* (MTCC-6541) to produce Egg Yolk antibodies (IgY). The amount of egg yolk antibody increased gradually as the booster injection antigen concentration increases. The antibodies were partially purified from immunized chicken egg yolk by poly ethylene glycol (PEG)/ammonium sulphate precipitation method and further purification was done by DEAE cellulose ion exchange column chromatography. The antibodies (IgY) was eluted by passing linearly increasing sodium chloride (0- 2M) through the column. Egg yolk antibodies were detected by indirect antigen capture ELISA. The antibodies were detected by indirect antigen capture ELISA. High peak titre of 1:10000 was observed during 63rd day or week of observation. Total protein concentration varied in the range of 0.5 - 4.1 mg/ml of yolk throughout the immunization period. In inhibition ELISA there was a decrease in absorbance with increasing concentration of IgY.

**Results:**It indicates that chicken egg yolk antibodies (IgY) effectively neutralize the antigens. It is a cost effective and eco-friendly method.

**Conclusion:**The results indicated that chicken IgY could be used as therapeutic agents in aquatic fish farming.

**Keywords:** *Aeromoanscaviae*, IgY antibodies, therapeutic agents, fish pathogen.





09.05

### Systematic Relationships on the Genus *Dendrocalamus* Nees (Poaceae: Bambusoideae)

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Bamboo, the fastest growing perennial, evergreen, arborescent plant is a member of the grass family (i.e., Poaceae) and constitutes a single subfamily Bambusoideae. One of the important genus of tribe Bambuseae, *Dendrocalamus* Nees is widely distributed in the Indian subcontinent, China, and Southeast Asia. A study on systematic and phenetic analysis of the genus was conducted based on 31 qualitative and 6 quantitative morphological characters. Among the multivariate methods, Cluster analysis, Principal Component analysis and Principal Co-Ordinate analysis were used. The study shows that the members of the genus *Dendrocalamus* formed distinct group and not embedded within *Bambusa* as shown in previous studies. The closely related species are identified in the phenogram.

**Keywords:** Bamboo, *Dendrocalamus*, Phenetic analysis

09.06

### A Potential Anti-dengue Lead from *Andrographis paniculata*: An *In silico* Study

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**Background and objectives:** Dengue fever is a serious mosquito-borne global health concern caused by Dengue virus. Currently there is no effective vaccine or anti-viral drugs against dengue despite the fact that several drugs are under developmental stages. In traditional system of health care that mainly depend on medicinal herbs, there is effective but not evaluated medicine for various type of diseases caused by bacteria, virus and other micro-organisms. In this scenario, the present study focussed on identifying the inhibitory potential of phytochemicals from a well-known antipyretic plant *Andrographis paniculata* (Burm.f.) Nees.

**Methods:** The structural details of the target Dengue virus NS5 was retrieved from protein databank (PDB ID: 4VOQ). Phytochemicals of the selected plant, *Andrographis paniculata* was obtained from PubChem database. Gypsum-LD was used to generate various 3D conformers of the phytochemical compounds. *In silico* molecular docking approach was employed to identify the hit compounds and further drug-likeness, pharmacokinetics and toxicity studies were carried out to ascertain a lead candidate.

**Results:** Through molecular docking studies five hit molecules were identified based on least free energy of binding and molecular interaction. Subsequent lead optimization analysis revealed oleanolic acid, a naturally occurring pentacyclic triterpenoid as the best lead candidate against NS5.

**Conclusion:** The results substantiate the traditional knowledge of antipyretic activity of the plant. It also emphasized Oleanolic acid as the best lead candidate since triterpenoids normally possess anti-viral activity. However, further in vitro and in vivo studies are essential to propose oleanolic acid as an anti dengue lead for drug development.

**Keywords:** *In silico*, Phytochemicals, Oleanolic acid, Dengue virus, Medicinal herbs, *Andrographis paniculata*

09.07

### Enhanced Production of the Bioactive Alkamide 'Spilanthol' in 'Tooth Ache Plant' *Acmella ciliata* (Kunth) Cass. via Cell Suspension Culture System

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**Background:** *Acmella ciliata* (kunth) Cass. (Family Asteraceae) a medicinal cum ornamental plant widely distributed in tropical and subtropical regions of the world has got various pharmacological activities due to the presence of various phytochemicals like alkaloids, tannins, saponins, flavonoids, coumarins, etc. Important among them is an alkamide 'spilanthol' which account for most of its biological activities.

**Methods:** The present study focused on the enhanced production of the alkamide spilanthol via cell suspension culture and subsequent elicitation. Various concentrations of abiotic and biotic elicitors viz. Methyl jasmonate (10, 50, 100 and 200 ppm), Salicylic acid (SA) (10, 50, 100 and 200  $\mu$ l), Yeast extract (0.5, 1.0, 2.0 and 4%) and Chitosan (25, 50, 100 and 200 mg l<sup>-1</sup>) were added to the cell suspension cultures and after 24-72 hours of elicitation, cells were harvested for HPLC analysis.

**Results:** The bioactive alkamide production was maximum (7125.668  $\mu$ g g<sup>-1</sup>) in elicitation with Methyl jasmonate at 200 ppm concentration. In Salicylic acid amending, maximum alkamide content i.e., 5356.826  $\mu$ g g<sup>-1</sup> was noticed after 48 hours of elicitation at 50  $\mu$ l concentration. A maximum of 6011.431  $\mu$ g g<sup>-1</sup> alkamide was observed in 24 hours of elicitation in 0.5% yeast extract augmented medium, after which it dropped to 4345.010  $\mu$ g g<sup>-1</sup> and then to 3483.945  $\mu$ g g<sup>-1</sup> at 48 and 72 hours of elicitation exposure.

**Conclusion:** The study offers the establishment of a system for bioproduction of bioactive alkamide 'spilanthol' in *A. ciliata* which can be further extended for the large scale production of spilanthol using bioreactor technology thus offering the conservation and sustainable utilization of this genetic resource.

**Keywords:** *Acmella ciliata*, Abiotic and biotic elicitors, Elicitation.

09.08

### Essential Oil Therapy for the Control of Fresh and Marine Water Borne Pathogen *Aeromonas hydrophila*

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Occurrence of water borne pathogens in fresh water and marine water is a serious cause of concern. Since, exposure to fresh and marine water, carrying pathogens can be hazardous for us as well as for animals as well. *Aeromonas hydrophila* is frequently isolating bacteria from fresh water as well as from marine water and it has been reported that the bacteria is accomplished

with opportunistic pathogenic traits. It can cause severe infection such as septicemia, severe diarrheal disease of short duration or chronic loose stools in children, the elderly, or the immuno-compromised individuals as well as cirrhosis, and also various infections such as urinary tract infections, surgical wound infections, meningitis, peritonitis, and endocarditis. Therefore, urgent attention is needed to control such pathogens from the water. Hence, in the current study, we have isolated *Aeromonas hydrophila* from the fresh water and characterized it by using biochemical and molecular techniques (16rRNA sequencing). On the basis of sequencing it was confirmed that the isolated bacteria belongs to *Aeromonas hydrophila* and named as *Aeromonas hydrophila* C4. Furthermore, antibiotic resistant profile of C4 was done by using "Kirby bauer disk diffusion method and the test depicted that C4 is a multiple drug resistant bacteria as well. Pathogenic characteristic of C4 was also explored by using biofilm forming assay, motility and hemolytic test. Pathogenic revealed that the bacteria have virulence properties. Hence, for the control of C4, we have used different essential oils (Cinnamon oil, Eucalyptus oil, Peppermint oil, Lavender oil and Licorice oil). As we know, essential oils exhibited medicinal properties and they have been employed in medicine since ancient time. Herein, we adopted old remedy for control MDR pathogenic C4 bacteria. The result indicated that eucalyptus, cinnamon and peppermint had most significant inhibition activity. To explore the mechanism, in-silico analysis was also done by using molecular docking.

## 09.09

### Regulation of Notch Mediated T- Cell Receptor Activation Upon Supplementation of Njavara Rice Bran Oil in Experimentally Induced Atherosclerosis

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**Background:** The evolutionary conserved Notch signaling is vital for T cell development, activation, proliferation and differentiation into T helper subsets. Thus an understanding of the molecular mechanisms that regulate T lymphocyte activation and functions is necessary to raise immune defence and to develop effective therapies against the disease. Rice bran oil (RBO) is an edible oil of preference having multi-beneficial health properties by improving serum cholesterol levels and lipoprotein profiles due to its peculiar components  $\gamma$ -oryzanol, triterpene alcohols and tocotrienols. Njavara is considered as exotic medicinal rice variety, often equated to gold. The present study is to bring about the specific anti-atherogenic role of Njavara rice bran oil (NjRBO) in notch mediated T cell activation in the context of atherosclerosis in rat models.

**Methods:** Our study was to explore the possible therapeutic effect of NjRBO on Notch regulated T-cell activation. For this adult male Sprague-Dawley rats, weighing 150-200g were used for the study and was fed with standard diet formulae. Experimental design consists of animals grouped into 4 groups of 6 rats each. Duration of study was 60 days after which expression studies of various parameters of T cell receptor mediated activation including T-cell signalosome complex, Notch pathway components on CD4<sup>+</sup>T cells were quantified using ELISA and real-time PCR methods.

**Results:** In the present study, the mRNA expression pattern of Notch1 was upregulated in splenic CD4<sup>+</sup> T cells of high fat fed rats. Upregulation in expression of TCR activated signalosome complexes or CBM complex in the diseased, fed on a high fat diet (HFD) showed an increase, indicating that Carma 1-Bcl10-Malt1 (CBM) is a crucial event for T- cell receptor induced NF- $\kappa$ B activation. Quantitative real-time PCR showed that the mRNA expression of Notch1C in CD4<sup>+</sup> T cells of high fat fed group increased compared with the healthy controls. In addition, the mRNA expression of Th1 and T2 master transcription factors T-bet, GATA3 and its signature cytokines IFN- $\gamma$  and IL-4 was both upregulated in HFD. Furthermore NF- $\kappa$ B translocation was enhanced in diseased group causing increase in inflammatory cytokine levels. Njavara rice bran oil supplementation resulted in the reversal in the expression patterns of these genes.

**Conclusions:** In this study, we present evidence that Notch regulated TCR-mediated activation of CD4<sup>+</sup>T cell components were altered by NjRBO and this reveals a novel role of NjRBO in controlling TCR mediated inflammatory milieu.

**Keywords:** CD4<sup>+</sup>T cells, NjRBO, CBM complex, T-bet, GATA3

## 09.10

### Forest Gaps and Regeneration of *Cullenia exarillata*: A Case Study in the Forest Ecosystem of Silent Valley in the Western Ghats, India

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**Background:** Open areas formed in forest canopies by the death of trees, lightning, animal trampling or other means causing physical damage to the existing vegetation in forests are called 'forest gaps'. Regeneration of trees in forest gaps has high significance in maintaining the prevailing population of trees intact in a forest ecosystem. This process is influenced by factors like the presence of established seedlings in the area before the formation of gaps, dispersal of seeds in to the gaps, response of plants growing in the gaps to light etc.

*Cullenia exarillata* A.Robyns (Bombacaceae) is a tree endemic to the southern Western Ghats. It is a dominant component in the evergreen forests as a constituent of the *Palaquium - Cullenia - Mesua* association. This species assumes vital importance in the ecosystem as it provides food to a number of vertebrates, especially during the trough period in the forest ecosystem. Any threat to the population of *Cullenia exarillata* can negatively affect the existence of dependent vertebrate community and the services they deliver to the forest ecosystem. So, maintaining the population of *Cullenia* in the ecosystem has high ecological importance. Silent Valley harbors good populations of *Cullenia exarillata* as a dominant component in the evergreen forest. Forest gaps are commonly observed within these populations, which are eventually filled by the vegetation due to the regeneration of different tree species. Migration of different tree species into these gaps has great ecological significance as such processes effect changes in the species composition of the ecosystem. However, there is no information about the pattern of tree species regenerating in such gaps in Silent Valley forest ecosystem. This paper discusses the regeneration of trees in forest gaps in Silent Valley giving special emphasis to the regeneration of *Cullenia exarillata* so as to assess the impact of this process on its population in Silent Valley forest ecosystem.

**Methods:** Fifty forest gaps were selected for the study. They were identified by randomly surveying an area of 10 km<sup>2</sup> in the wet evergreen forests in Silent Valley where *Cullenia exarillata* is dominant in the vegetation. Outline of gap areas and the longest and shortest dimensions of these areas were recorded. The plant species growing in the gaps were identified. Number of seedlings,



saplings and adults coming up in the gaps were recorded. Plants which measured >15cm GBH around the gap areas were accounted giving special emphasis to the presence or absence of *Cullenia exarillata*.

**Results:** A total of 64 species were identified regenerating in the gaps. Among them, 44 were trees, four were shrubs/small trees, eight were shrubs, six were climbers and one was a herb. Of the 50 gaps studied, 32 gaps (64%) recorded individual plants of *Cullenia*. Among the 32 gaps, 26 gaps were occupied by adult *Cullenia exarillata* (individuals >50 cm height). These gaps might probably get dominated by *Cullenia* in future. All the *Cullenia exarillata* individuals in the gaps were recruited in the gap areas before the formation of gaps.

**Conclusion:** It was found that 81% of the gaps occupied with *Cullenia exarillata* had reproductively matured *Cullenia exarillata* around 10 m from the periphery of the gaps. This indicated that these gap areas promoted the regeneration of *Cullenia exarillata* trees ensuring stabilized populations of *Cullenia exarillata* in near future in the Silent Valley forest ecosystem.

**Keywords:** *Cullenia exarillata*, Forest Gaps, Regeneration, Silent Valley

## 09.11

### Isolation, Identification and Characterization of Anti-Cancer Principles from the Medicinal Plant *Corallocarpus epigaeus* Effective Against Melanoma

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*Corallocarpus epigaeus* (Cucurbitaceae) is a plant widely used in traditional medicine for various illness and ailments. It is a climbing, monoecious plant found in the rain shadow regions of the Western Ghats. Although, the anti-proliferative property of this plant is reported, none of them has yet analyzed its anti-cancer potential in detail. The present study has established the anticancer property of the plant and isolated, purified and characterised the anti-cancer compounds.

**Method:** Tubers of the plant were subjected to serial exhaustive extraction of compounds using solvents of increasing polarity. The tuber extracts and fractions were analyzed for its anticancer potential by cell viability assays. The cytotoxic mechanism exhibited by the active extract was analyzed by FACS and Western blot analysis. Isolation and characterization of the anti-cancer principles from the active fraction was done by TLC, column chromatography, NMR (<sup>13</sup>C and <sup>1</sup>H) and Mass spectrometry.

**Results:** Ethyl acetate and methanolic extracts of the tuber of *C. epigaeus* exhibited potent anti-proliferative activity. Active fraction FFC from ethyl acetate tuber extract was found to be most effective against melanoma cell lines. The cytotoxic mechanism exhibited by FFC involves caspase dependent apoptosis in melanoma cells. Chemical characterization revealed, Cucurbitacin B as the major compound in the FFC fraction from ethyl acetate extract of the tuber. This is the first ever study reporting the presence of Cucurbitacin B in the plant *Corallocarpus epigaeus*. Chemical analysis of the methanolic extract of the tuber also revealed the presence of a cucurbitane-type triterpene glycoside distinct from that of Cucurbitacin B, and the anti-cancer potential of the same is being analysed.

**Conclusion:** The plant *C. epigaeus* possess significant anticancer property. The anticancer compounds identified through chemical characterization are Cucurbitacin B and a cucurbitane-type triterpene glycoside. Studies are in progress to delineate the anti-tumor as well as anti-metastatic effect of cucurbitacin B against melanoma and the anti-cancer potential of the novel cucurbitane-type triterpene glycoside.

**Keywords:** Anticancer principle, *Corallocarpus epigaeus*, Cucurbitacin B, Cucurbitane type glycoside

## 09.12

### Evaluation of the Role of Natural Compound NIIST F1 in Alleviation of ER Stress Induced Complications in Rat Skeletal Muscle Cells

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**Background:** Type 2 Diabetes mellitus (DM) is a chronic metabolic disorder characterised by impaired insulin secretion and insulin resistance (IR). Endoplasmic reticulum stress is one of the underlying causes of IR and emerging as a potential target for Type 2 Diabetes. Natural products targeting and reducing ER stress offers an innovative strategic approach to treat T2DM. Natural products are gaining importance because of their low cost, abundance and fewer side effects.

**Method:** Tunicamycin(TM) was used to induce ER stress in L6 cell lines. NIIST F1, a main component in orange peels was studied for its efficacy in alleviating TM induced oxidative stress and insulin resistance in skeletal muscle cells.

**Results:** The dose of TM for inducing the ER stress induced complications was determined as 0.25µg/ml by the MTT assay and glucose uptake assay. The working concentrations, 20fM and 50µM of NIIST F1 which showed less than 20% cytotoxicity individually and in combination with TM were selected for further studies. The efficacy of the compound against ER stress induced oxidative stress parameters and insulin resistance. NIIST F1 was found to be effective against TM induced oxidative stress parameters by lowering the reactive oxygen species, lipid peroxidation and protein carbonyl content. The glucose uptake potential was evaluated using the fluorescent glucose analog 2-NBDG by flow cytometry.

**Conclusions:** The results from the study indicate the efficacy of NIIST F1 against TM induced oxidative stress and insulin resistance. Future studies to determine the mechanism of action of the compound against TM induced stress is undergoing. Therefore, NIIST F1 can become an antidiabetic candidate for T2DM by modulating ER stress induced pathways.

**Keywords:** Type 2 Diabetes, Endoplasmic reticulum stress, L6 cell lines, Tunicamycin

## 09.13

### Bergenin Exerts Anti-inflammatory and Displays Synergistic Activity with Sorafenib on HepG2 Cells.

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**Background:** Hepatocellular carcinoma is the fifth most common cancer prevalent in the world and accounts for a credible number of fatalities every year on a global scenario. Though the factors that cause HCC appear diverse from alcohol intoxication to viral infections, inflammation of the liver is known to be a common symptom irrespective of the factor involved. Most chemotherapeutic



drugs used for the treatment of HCC tend to increase inflammatory conditions in the liver thereby causing more complex dysfunctions. Hence, the searches for natural chemotherapeutics or supplements that reduce such conditions are of great importance in HCC chemotherapy. Bergenin, a natural polyphenolic compound found in plants such as *Woodfordia fruticosa* was selected and evaluated for its anti-inflammatory and plausible synergy with standard HCC drug, Sorafenib *in-vitro*.

**Method:** HepG2 cell line was treated with bacterial lipopolysaccharide to mimic inflammatory condition. Cytotoxicity was assessed using MTT assay. Inflammatory parameters such as 5-lipoxygenase (5-LOX), total cyclooxygenase (COX), inducible nitric oxide synthase (iNOS) and myeloperoxidase (MPO) were assessed using standard protocols. Variation in the expression of genes such as NF- $\kappa$ B, IL-6, TNF- $\alpha$  and MMP-9 was studied using reverse transcriptase PCR followed by AGE. Activity of bergenin with standard HCC drug Sorafenib was studied on HepG2 cells using fixed ratio method. Cytotoxicity of the combination on HCC cells was assessed using MTT assay. Annexin V - FITC staining was used to detect extent of apoptosis and Hoechst 33342/propidium iodide based assay was used to determine cell cycle arrest induced by the combination on HepG2 cells.

**Results:** Cytotoxicity of bergenin on HepG2 cells was found to be 68.85 $\mu$ g/mL. Increased production of 5-lipoxygenase (5-LOX), total cyclooxygenase (COX), inducible nitric oxide synthase (iNOS) and myeloperoxidase (MPO) was reduced by bergenin significantly along with the expression of NF- $\kappa$ B, IL-6, TNF- $\alpha$  and MMP-9. A combination of bergenin and Sorafenib imparted higher cytotoxicity and enhanced apoptosis and cell cycle arrest upon HepG2 cells which suggested that the compound could augment chemotherapeutic efficacy of sorafenib.

**Conclusions:** Bergenin, a plant polyphenolic compound showed potent anti-inflammatory activity in HepG2 cells. It also enhanced the activity of HCC drug Sorafenib when tested in upon HepG2 cells suggesting that the compound could prove to be a potential candidate for the development of synergistic therapies for liver cancer.

**Keywords:** Hepatocellular carcinoma, bergenin, Sorafenib, anti-inflammatory activity, apoptosis, cell cycle arrest.

09.14

### Systematic Relationships of the Subtribe Aeridinae; Orchidaceae

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**Background:** Although the circumscription of sub-tribe Aeridinae has been clearly defined relationships within the group remain unresolved because of morphological diversification and possible parallelism of vegetative and reproductive features. Specifically, the present study investigated the Phenetic relationships among some selected genera in the subtribe Aeridinae which are found in Kerala.

**Methods:** Multivariate analysis is used to access the phenetic relationship among the 19 species, out of which 57 collected characters, 9 were quantitative and 48 were qualitative. Quantitative characters were measured to the nearest millimeters and centimeters using calibrated tapes.

**Result:** The dendrogram consisted of three major clusters and four minor clusters with a cophenetic correlation (r) of 0.86553 using Average Taxonomic Distances showing systematic relationships.

**Conclusions:** Understanding the relationship within Aeridinae is difficult because of the morphological diversification and possible parallelism of vegetative and reproductive features. To confirm the relationship of such species with subtribe Aeridinae, a phylogenetic study using molecular data is recommended.

**Keywords:** Aeridinae, Phenetic, Multivariate analysis.

09.15

### Ameliorative Effect of Menthol on Oxidative Stress in Stz Induced Diabetic Encephalopathic Rats

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**Background:** Diabetic encephalopathy (DE) is a chronic complications of diabetes mellitus that affects the central nervous system characterized by altered mental state, cognitive decline, changes in personality, memory lapses, or severe impairment like dementia. The objective of the present study is to investigate the protective effect of menthol (monoterpenol) in streptozotocin induced diabetic encephalopathic rats.

**Methods:** Diabetes was induced in male Sprague-Dawley rats by a single intraperitoneal injection of streptozotocin (40mg/kg body weight). The treatment started after 4 weeks of diabetes induction after confirming DE by Morris water maze test. DE rats were orally supplemented with menthol (50 mg/kg bodyweight) for 60 days. The levels of serum glucose, plasma insulin, glycated hemoglobin (HbA1c), toxicity markers, antioxidant enzymes, neurotransmitters and brain histopathology were analyzed. Results were compared with diabetic rats supplemented with standard drug metformin (100mg/kg body weight).

**Results:** Supplementation of menthol to diabetic rats at a dose of 50mg/kg body weight, significantly reduced the escape latency time, serum glucose, HbA1c, toxicity markers and increased plasma insulin and activity of antioxidant enzymes in the brain. In addition to this administration of menthol also reduced the level of lipid peroxidation products in brain. Then histopathological analysis of the hippocampus showed that menthol could afford protection against oxidative damage without affecting cellular function and structural integrity.

**Conclusion:** These findings demonstrated that menthol could significantly regulate hyperglycemia, oxidative stress and affords neuroprotective effect on DE rats.

**Keywords:** Diabetic encephalopathy, Menthol, Oxidative stress.

09.16

### In silico Characterisation of Anti-Inflammatory Properties of Phytochemicals from Six Indian Medicinal Plants

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Background: Inflammation is our body's natural response to infection or injury. Inflammatory response plays an important role in the defence of the host against pathogenic organisms. Since pre-historic time, plants and plant products have been used to cure





various kinds of ailments. Many of the well known drugs including quinine, aspirin and morphine are either natural compounds or their derivatives. Several medicinal plants are employed in Ayurveda to cure inflammatory conditions. The present study is aimed at elucidating the molecular mechanisms involved in therapeutic effects of six medicinal plants used by traditional practitioners.

**Methods:** 64 phytochemicals selected from six medicinal plants were subjected to computational drug-likeness predictions to analyse druggability parameters. Pharmacokinetic properties, which are used to evaluate a compound's absorption, distribution, metabolism and excretion, were also calculated. Phytochemicals with good druggability parameters and desirable ADME properties are subjected to molecular docking simulations with the well-established anti-inflammatory target Peroxisome proliferator activated receptors (PPARs) using SwissDock server. Binding and interactions were compared with that of known inhibitors.

**Results:** Computational analyses show seven phytochemicals have good docking results with PPAR target and also satisfies all the ADME features and physicochemical properties according to the Lipinski rule of drugability. In the seven phytochemicals, Boeravinone-J and Luteolin are from the plant *Boerhaavia diffusa*, Gama terpinene, Quinazoline, and vascione are from *Sida cordifolia*, Chavicol from *Alpinia galangal*, and niacin from *Ricinus communis*.

**Conclusions:** Our work identified a list of small molecular agents from traditional medicine which predicted to have interesting therapeutic activities in inflammatory pathways and desirable physicochemical parameters.

**Keywords:** Phytochemicals, Druggability parameters, Pharmacokinetic properties, ADME, Molecular docking

09.17

### Role of Alcohol Based Sanitizers in Pandemics-Composition and Analysis

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**Background:** The Covid-19 pandemic caused by SARS-CoV-2 remains as a major threat to human kind as no effective treatment has been reported so far. Alcohol based hand sanitizers are a vital control measure against Covid-19, in which the active components ethanol or isopropanol are effective in destroying the virus. Several alcohol based hand sanitizer formulations are commercially available and are widely being used, and the situation demands confirmation of their efficacy through standardization of its composition as WHO stipulates. In this background, the present study reports validated analytical methods for alcohol based sanitizers.

**Method:** The major constituents ethanol and isopropyl alcohol (IPA), along with the minor constituent glycerol were analysed through GC-MS. Shimadzu GC-MS 2030 with SH-Stabilwax polar column was used for the analyses. Oven temperature; 35 °C (2 minute), 3 °C /minute to 50°C, 60 °C /minute to 240°C (4 minute), split ratio; 50:1 and flow rate 1.44ml/minute. Another critical component H<sub>2</sub>O<sub>2</sub> was detected through iodometric titrimetric method.

**Results:** The validated GC-MS method could resolve peaks corresponding to methanol (2.4 min.), ethanol (2.9 min.), IPA (2.7 min.) and glycerol (11.5 min.). Iodometric titrations could precisely detect the amount of H<sub>2</sub>O<sub>2</sub> which was found to be within the range recommended by WHO (0.125%).

**Conclusion:** Sanitizers play a vital role in maintaining hand hygiene and thereby curbing the spread of Covid-19. Standardization of hand sanitizers is necessary for maintaining the efficacy of the commercially available alcohol based hand rubs. GC-MS analysis proved to be an efficient technique for the qualitative and quantitative analysis of the components in the sanitizer.

**Keywords:** Alcohol sanitizers, GC-MS, Covid -19

09.18

### *Cissus quadrangularis* Extract Integrated Osteoinductive Chitosan-collagen Scaffold for Regenerative Bone Tissue Engineering

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**Background:** Plant derived therapeutic options have become more prevalent for regenerative tissue engineering applications in the recent years as it performs the intended function without any unfavourable side effects. *Cissus quadrangularis* Linn (CQ) is a medicinal plant having several active components and is known for its bone fracture healing potential. However systematic investigation of CQ extracts that unravel the active roles of the components in invoking osteogenesis has not been investigated properly so far. This study systematically investigates 5 different CQ extracts and after phytochemical screening based on in vitro experiments further explore the in vitro biomineralization and osteoinduction potential CQ extract integrated degradation tuned porous chitosan-collagen tissue engineering scaffolds towards regenerative bone tissue engineering.

**Methods:** Sequential extraction of CQ stem was carried out based on polarity (lower to higher; from hexane to water) and a series of *in vitro* experiments were conducted and results authenticated hexane and aqueous CQ extracts are having highest osteogenic potential. Porous chitosan-collagen scaffolds of varying ratio were prepared and physico-chemical properties of these scaffolds were tuned to optimize the scaffold to serve as a good tissue engineering platform. CQ extracts were then integrated into the optimized scaffolds and *in vitro* proliferation index (Human osteosarcoma cells; MTT assay), cell-material interactions (cell cytoskeleton staining: Actin/DAPI), biomineralization (von kossa and alizarin red S staining) and Alkaline phosphatase- the early bone marker expression etc. were evaluated.

**Results:** Phytochemical quantification results authenticated presence of steroids and terpenoids as the bioactive metabolites responsible for osteoinduction. Swelling and degradation profile of the scaffolds in physiological medium exemplified its suitability to serve as controlled degrading scaffold for bone tissue regeneration. Cellular response and the morphological architecture (MTT assay and F-actin/DAPI staining) demonstrated cytocompatibility of the scaffolds. Alizarin Red S and von Kossa staining (day 7) in HOS cells validated significant biomineralization while ALP expression authenticated bone regeneration.

**Conclusions:** *Cissus quadrangularis* stem extracts (HE and WE) integrated porous chitosan-collagen scaffolds with tuneable degradation has been demonstrated to have osteoinductive potential in vitro and hence could be proposed as a prospective candidate for regenerative bone tissue engineering.

**Keywords:** Biodegradation, Biomineralization, *Cissus quadrangularis*, Osteoinductive



09.19

### Acute oral toxicity study and antiproliferative effects of butanol fraction of *Gardenia gummiifera* L. f

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**Gardenia gummiifera** Linn. f. belongs to the family Rubiaceae, which is found in rocky highlands, widely used in traditional medicine. The different fractions from the crude ethanol extract of root bark of *Gardenia gummiifera* Linn. f. were analyzed for qualitative and quantitative phytochemical analysis, antioxidant activity, and antiproliferative effects on hepatocellular carcinoma cell lines. The most active fraction identified was subjected to HPLC-MS analysis for compound identification and acute toxicity studies on Wistar rats. The acute toxicity effect of butanol fraction (BUGG) was evaluated with five different doses (100, 250, 500, 1000, 2000 mg/kg body weight), administered orally to female Wistar rats for 14 days. Our study revealed that the selected plant contains different classes of secondary metabolites especially polyphenolic compounds. Among the different fractions, ethyl acetate (EAGG) and acetonitrile fractions (ANGG) exhibited maximum availability of flavonoids and tannins. The butanol fraction (BUGG) had the highest scavenging potential with the lowest IC<sub>50</sub> value than the ethyl acetate (EAGG) and acetonitrile fractions (ANGG). Also, the same butanol fraction showed profound cytotoxicity upon HepG2 cell when analyzed using the MTT assay. HPLC-MS analysis of the butanol fraction spectrum profile exhibited some polyphenolic compounds. The acute toxicity studies revealed that the BUGG did not display any visible signs of toxicity up to the dose of 2000 mg/kg body weight. Hence this work highlights the importance of butanol extract as a promising chemotherapeutic agent with polyphenolic components that might be contributing to the potent free radical scavenging activity and antiproliferative efficacy.

**Keywords:** *Gardenia gummiifera* ; anticancer properties; bioactive constituents; cytotoxic effects; antiproliferative; MTT assay; HPLC-MS analysis

09.20

### Biomonitoring of River Muthirapuzha with Special Reference on Biological Water Quality Criteria And Biomapping

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**Background:** River Muthirapuzha, the major tributary of River Periyar, is under the pollution stress due to tourism activity at Munnar hill station laying in the catchment area of this stream. Benthic macroinvertebrate communities are targeted to predict the changes of aquatic ecosystem as a component of bio-monitoring protocol and identify the level of pollution in the river. Bio-mapping of river Muthirapuzha was aimed at concentrating on macroinvertebrates and also to explore the degree of pollution in the river basin.

**Method:** Biological water quality was evaluated through a Saprobic score and Diversity score developed by CPCB. This method first assigning the water quality class with respect to combinations of saprobic and diversity score of the biological samples using Biological Water Quality Criteria (BWQC). Then translating the biological water quality class of each location on river basin map into respective colors assigned in BWQC.

**Results:** High level of pollution was reported in the post-monsoon seasons. October November, December and January months form the post- monsoon season and these months coincide with the tourism season of Munnar. Heavy load of pollutants are deposited in river Muthirapuzha during the tourism season due to the unplanned waste management from tourism related centers like hotels, restaurants etc. that is clearly reflected in BWQC based on saprobic and diversity score.

**Conclusions:** River Muthirapuzha was polluted during the tourism season of Munnar. Increasing level of pollution in this river will adversely affect ecological balance of river Periyar. Proper waste management systems and eco- friendly tourism activities will be essential to the sustainability of this ecologically sensitive area of Western Ghats.

**Keywords:** Muthirapuzha, biomonitoring, BWQC, saprobic score, diversity score, bio-mapping, tourism

## 10. Mathematical & Statistical Sciences

10.01

### Leveraging Emotions for Fake News Detection: A Special Emphasis on COVID-19 Fake News

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**Background:** Fake news is a piece of fallacious content presented often as a fact. The prevalence of fake news has rapidly increased with the upsurge of social media. Even during COVID-19 pandemic times, there is a fast proliferation of massive amounts of fake news, due to which the WHO warns the global citizens with the term 'infodemic'. Hence the circumstance demands enormous necessity and significance for automated computational methods to recognize fake pieces of information from legitimate ones.

**Methods:** In this paper, we examine the efficacy of the emotion content in an article to classify fake news in the context of COVID-19. Our interrogation is cast based on the assertion that fake and legitimate news contents adopt diverse kinds of affective character that improve their classification. We present a method of emotion amplification to intensify the emotion contents in documents, in supervised and unsupervised contexts, using emotion lexicons.



**Results:** We implement classification on the original documents and their emotion amplified versions, to appraise the performance of our algorithm. We appropriate two deep learning classifiers, a Convolutional Neural Network, and a Long-Short Term Memory network for supervised learning that works on the word vector sequences in the documents, applicable to identify the sequential patterns for classification. For the unsupervised learning we implement the k-means and db-scan algorithms. The differences in the accuracies achieved for the emotion amplified documents over the corresponding original documents manifest a notable amount of gain accomplished by our emotion amplification process.

**Conclusion:** The elevated results for the emotion amplified documents in the outcomes reveal that the learning models studied over the emotion amplified documents are more powerful for fake news detection. This confirms that emotion amplification of the documents promotes the learnings since the fake and real contents possess variation in their emotion information.

**Keywords:** Fake News Detection, COVID-19, Document Emotion, Infodemic

## 10.02

### Wavelet and Phase Portrait as Potential Mathematical Tools for High Fidelity Feature Extraction and Classification of Cough Sounds: A Machine Learning Approach

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**Background:** An interdisciplinary approach of mathematics and biomedical sciences has gained much gravity in areas of non-invasive analysis of various physiological signals. Powerful mathematical tools applied in the evaluation of cough signals for understanding the respiratory health has now become imperative from the outset of the crisis posed by the pandemic, COVID-19. The present work suggests a surrogate, cost-effective technique for the classification of cough signals - croup cough (CC) and pertussis (PT) - based on wavelet analysis and their identification and prediction using machine learning techniques (MLTs) with nonlinear time-series parameters as attributes.

**Methods:** Wavelet and nonlinear time series analyses are efficient mathematical tools that can analyse time-varying signals to bring out their hidden characteristics. Wavelet analysis is employed to study the time of occurrence of the frequency components of the cough sounds. Nonlinear time series analysis reveals information about the underlying multidimensional aspects of the continuous-time nonlinear signals. Sample entropy (S) reflects the uncertainty in a time series data. The complexity and self-similarity of the cough signals are investigated through fractal analysis. Supervised MLTs - Cubic KNN (CKNN) and neural network pattern recognition tool (NNPR) - based on nonlinear parameters are used for the classification and prediction of CC and PT signals.

**Results:** The wavelet analysis of CC reveals the presence of multiple frequency components, which is originating from the swollen vocal cords, producing a barking sound while coughing, which is its characteristics. A lesser value of S for CC (0.546), when compared to PT (1.003) agrees to the fact that CC has a musical nature. For the same reason, the divergence of the phase trajectory reflected through maximal Lyapunov exponent, L also holds a lesser value for CC. The croup cough signal tends to revert to a long-term mean, displaying its nature to be more antipersistent than the pertussis cough signal. The modifications in the internal morphology of the respiratory tract, associated with the complex airflow dynamics, accounts for the higher value of the fractal dimension, D of CC. Among the two supervised MLTs employed in this work with nonlinear parameters as the input variables, NNPR gives a greater prediction accuracy of 94.7 % compared to CKNN.

**Conclusion:** This study opens the possibility of employing powerful mathematical tools for the cough analysis which is a biomarker for the diagnosis of pulmonary pathological conditions like Severe Acute Respiratory Syndrome (SARS) and Coronavirus disease (COVID-19).

**Keywords:** Croup Cough, Pertussis, Fractal Dimension, Phase Portrait, Sample Entropy, Machine Learning Techniques

## 10.03

### Connecting People – The Role of Social Network in COVID-19 Pandemic

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**Background:** One of the reasons for the large investment the scientific community has made in the study of social networks is their connection to the spread of disease. Covid-19 is transmitted through social networks that are formed primarily by the social connections. It is very common to use SN perspective to study the advancing development and dynamics of epidemiological diseases, those spread over networks of contacts between individuals. SNA tools are very useful for analysing social change communications.

**Methods:** Through this paper, the emotional sharing, intellectual sharing, information sharing and financial sharing among 40 teenagers in a classroom network during precovid-19 and Covid-19 periods is studied by forming corresponding networks. Also, tried to explain the Covid-19 pandemic situation using the tools of Social Network Analysis.

**Results:** Reciprocity (arc, diad), geodesic distance, average graph distance, graph diameter, radius and density of the sharing graphs (the emotional sharing, intellectual sharing, information sharing and financial sharing) are calculated during Precovid-19 and covid-19 period. The importance of the Basic Reproduction Number,  $R_0$ , the time dependent SIR modelling and the idea of six degrees of separation is briefly explained in the context of Covid-19.

**Conclusion:** When we go through the sharing among students in a classroom during precovid-19 and covid-19 period, it is quite interesting to see, the intellectual sharing network is much stronger during the covid-19 period. Even the classroom atmosphere is totally changed, the density of the information network and emotion network is almost same. But the average graph distance of the financial network is considerably small when compared with the precovid-19 period.

The fundamental premise is that the elements of pandemic growth portrayed by the definition of the basic reproduction number, defined as the number of infected people infected by one infected person is well captured by a geometric progression. Mathematical modelling of epidemics predates the study of networks by numerous years. There are numerous sort of models are available in the literature viz; SI Model, SIR Model, SIS Model, Logistic growth Model, Random Graph Model etc.

**Keywords:** Social Network, SNA, Covid-19, Social distance, Connection, Geometric Progression, SIR model, Six degrees of separation

10.04

### Statistical methods for estimating cure fraction of Covid-19 patients in India

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**Abstract:** Human race is under the COVID-19 pandemic menace since beginning of the year 2020. Even though the disease is easily transmissible, a massive fraction of the affected people is recovering. Most of the recovered patients will not experience death due to COVID-19, even if they observed for a long period. They can be treated as long term survivors in the context of lifetime data analysis. In this article, we present statistical methods to estimate the proportion of long term survivors (cure fraction) of the COVID-19 patient population in India. The proportional hazards mixture cure model is used to estimate the cure fraction and the effect of the covariates gender and age, on lifetime. The data available on the website 'https://api.covid19india.org' is used in this study. We can see that the cure fraction of the COVID-19 patients in India is more than 90%, which is indeed an optimistic information.

**Keywords:** Censoring; COVID -19; Cure rate model; Lifetime; Proportional hazards model.

10.05

### New Error Distribution for Microarray Gene Expression Data

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**Background:** Microarrays have become an important tool for studying the molecular basis of complex disease traits and fundamental biological processes. A common purpose of microarray experiments is the detection of genes that are differentially expressed under two conditions such as treatment versus control. In the present study we developed an asymmetric double Pareto-type distribution and explored various properties. The maximum likelihood estimation procedure is employed to estimate the parameters of the proposed distribution and an algorithm in R package is developed to carry out the estimation. A simulation study is conducted to validate the algorithm. Finally, we show that the asymmetric double Pareto-type distribution is suitable for modeling microarray gene expression data.

**Methods:** Asymmetric Double Pareto Type Distribution

The probability density function (pdf) Asymmetric Double Pareto Type distribution with parameters denoted by ADPT() is given by

Where and parameters () are the location, shape, scale and skewness parameters, respectively.

**Results and conclusions:** The asymmetric new double Pareto type (ADPT) distribution introduced in this paper is useful in analysing datasets that are asymmetric, leptokurtic, bimodal and heavy-tailed and it can model impulsiveness and skewness observed in gene expression data.

**Keywords:** Asymmetric new double Pareto type distribution, Pareto type distribution, Microarray gene expression

10.06

### Graph Semigroups and Their Biordered Set

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**Background:** The concept of a biordered set was introduced by the Kerala mathematician K.S.S. Nambooripad in his celebrated paper "Structure of regular semigroups.1" -Memoirs of the American Mathematical Society, volume 22- Number 224. A biordered set is a characterization of the set of idempotents of a semigroup. For a partial algebra E he described two quasiorders  $\omega^r$  and  $\omega^l$  and the structure  $(E, \omega^r, \omega^l)$  abstractly characterize a biordered set. Biordered set played a fundamental role in the structure theory of regular semigroups.

**Method:** In this paper we introduce the graph semigroup  $S(\Gamma)$  of a directed graph  $\Gamma$ . Graph semigroup is a semigroup with zero constructed from a given directed graph. Here we describe the set of idempotents  $E(S(\Gamma))$  of the semigroup  $S(\Gamma)$  as the biordered set  $(E(S(\Gamma)), \omega^r, \omega^l)$ .

**Results:** The set of vertices and edges of a directed graph  $\Gamma$  together with zero generate the graph semigroup  $S(\Gamma)$ . A nonzero element in  $S(\Gamma)$  is a path  $p$  in  $\Gamma$  such that  $p$  does not contain any  $C^k$  for  $k \geq 2$  where  $C$  is a nontrivial cycle in  $\Gamma$ . If  $\Gamma$  is acyclic then  $S(\Gamma)$  is the path semigroup  $\text{Path}(\Gamma)$ .  $E(S(\Gamma))$  contains all cycles  $C'$  in  $\Gamma$  such that  $C'$  does not contain any  $C^k$  for  $k \geq 2$  where  $C$  is a nontrivial cycle in  $\Gamma$ . The right and left quasiorders  $\omega^r$  and  $\omega^l$  are the prefix comparison and suffix comparison on the cycles respectively.  $(E(S(\Gamma)), \omega^r, \omega^l)$  is a biordered set and the quasiorders  $\omega^r$  and  $\omega^l$  are partial orders and 0 is the maximum element in  $E(S(\Gamma))$  with respect to both the partial orders.

**Conclusion:** We describe the biordered set of idempotents of a graph semigroup.

**Keywords:** Directed graph, Semigroup, Biordered set.



## 11. Physical Sciences

### 11.01

#### An Innovative and Disruptive Technique for Growing Large Area Perovskite Single Crystalline Wafers for Solar Cell Applications

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**Background:** The latest news of realizing more than 30% efficiency in perovskite-Silicon tandem architecture regenerates all the dream possibilities of flexible and printable solar cells like large-scale building integration and cheap electric automobiles. Such impact will become further disruptive if Single crystal wafer - based perovskite solar cells could be realized, as it offers not only better carrier generation and charge transport efficiencies, but also a broader absorption spectrum. However, with carrier diffusion lengths in the order of several hundred micrometers single crystalline wafer technology seems to be distant or near impossible possibility so far. The USP of this report is that we show this is not impossible, and rather it is easier than forming Si single crystalline wafers. In this context, this report reveals a simple and cost-effective technique to grow single crystalline wafers of hybrid perovskites with thickness much less (less than 30 micrometers) than the required threshold for highly efficient solar cell application.

**Methods:** A simplified version of inverse temperature crystal growth (ITC) method will be developed for growing Methylammonium lead halide perovskite single crystals and wafers for application as perovskite solar cells. Thin Single crystal wafers with thickness in the range of 20 micrometers of  $\text{MAPbBr}_3$  and  $\text{MAPbI}_3$  are to be grown on a hole transport layer (HTL) coated ITO by a modified ITC-method called Diffusion facilitated inverse temperature crystal growth. Growing single crystalline perovskite wafers on hole transport layers has the advantage that such grown wafers are in a ready to use form for solar cell fabrication.

**Results:** The largest, to the best of our knowledge, perovskite single crystal wafer with a thickness of 15  $\mu\text{m}$  has been realized here - 25mm<sup>2</sup> large  $\text{MAPbBr}_3$  single crystal wafer grown on a hole transport layer (HTL) coated ITO substrate by diffusion facilitated inverse temperature crystal growth. A 5 mm sized bulk single crystal of  $\text{MAPbBr}_3$  single crystal is also grown by ITC and the XRD, TGA shows that the obtained single crystal is of high quality in material and phase. A six-mm<sup>2</sup>  $\text{MAPbI}_3$  single crystal wafer of 25-micrometre thickness is also grown by the same method. The advantage of this method is that the single crystals are grown on Hole conducting layer coated ITO substrates. Therefore, we can directly load the wafers in to the fabrication line of the solar cell ready to complete the fabrication by depositing electron transport layer and the metal cathode on the wafer. UV-Visible spectroscopy of  $\text{MAPbBr}_3$  vouches for its excellent light-harvesting capability with a sharp absorption edge at 570nm, which is 20 nm broader than its polycrystalline film counterparts. The single crystal  $\text{MAPbI}_3$  perovskite shows an extended absorption up to 820 nm, that is 30nm broader absorption than polycrystalline thin films. This extended absorption increases the value of the short circuit current,  $J_{sc}$  in perovskite solar cells.

**Conclusions:** The so far largest single crystalline perovskite wafer below 30 micrometres in ready to fabricate solar cell form has been reported for the first time for methylammonium lead bromide. Further, a simple and cost effective modified version of diffusion facilitated space confined crystal growth method for perovskite wafers is revealed. Optimised wafer growth conditions for large-area single crystalline thin wafers of  $\text{MAPbBr}_3$  and  $\text{MAPbI}_3$  are also presented.

**Keywords:** Perovskite Solar Cells, Single Crystal Perovskite Wafers, Inverse Temperature Crystal growth

### 11.02

#### Diverse Thermal Quenching in $\text{Sr}_2\text{NaMg}_2\text{V}_3\text{O}_{12}:\text{Eu}^{3+}$ PHOSPHOR: A Bifunctional Platform for Optical Thermometry and Safety Sign

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**Background:** The optical temperature sensors based on luminescence is a key solution which offers high accuracy and consistency in which the method based on the intensity ratio has high detection sensitivity. And the intensity ratio method based on dual emitting  $\text{Eu}^{3+}$  doped vanadate garnets are still limited. Hence to understand the potentiality of vanadate garnets in the field of thermometry and thermochromic applications, we selected  $\text{Sr}_2\text{NaMg}_2\text{V}_3\text{O}_{12}$  as the host material and  $\text{Eu}^{3+}$  as an activator due to its better luminescence properties.

**Method:** Polycrystalline samples of  $\text{Sr}_2\text{NaMg}_2\text{V}_3\text{O}_{12}:\text{xEu}^{3+}$  phosphors were synthesized via conventional solid-state reaction route.  $\text{SrCO}_3$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{MgO}$ ,  $\text{NH}_4\text{VO}_3$ ,  $\text{Eu}_2\text{O}_3$  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 samples are analysed by XRD and crystal structure is confirmed by Rietveld refinement. The photoluminescence spectra present dual emission from  $\text{VO}_4^{3-}$  and  $\text{Eu}^{3+}$  and confirmed the energy transfer from  $\text{VO}_4^{3-}$  to  $\text{Eu}^{3+}$ . The temperature dependent PL studies points out the existence of diverse thermal quenching in which  $\text{VO}_4^{3-}$  undergo rapid quenching compared to  $\text{Eu}^{3+}$ . The maximum relative sensitivity,  $S_r$  calculated based on the FIR method is 1.61% at 420 K and also material shows high repeatability in 300 -500 K making it suitable for optical thermometry applications. Moreover, the temperature response of CIE coordinate is evaluated in which a rapid colorific shift from white to deep red (0.353, 0.335) to (0.611, 0.360) for a short temperature range of 300-500 K is obtained. This temperature dependent colorific behaviour implies that they have a potential application as a safety sign in high temperature environment. In comparison with the CIE coordinates of other reported inorganic phosphors for safety sign applications, the present  $\text{Sr}_2\text{NaMg}_2\text{V}_3\text{O}_{12}:\text{8% Eu}^{3+}$  exhibits superior colorific shift than the reported materials till date and hence is a promising candidate for safety sign applications in high temperature environment.

**Conclusions:** In summary, based on the diverse thermal response of  $\text{VO}_4^{3-}$  and  $\text{Eu}^{3+}$  emission, temperature sensing properties of  $\text{Sr}_2\text{NaMg}_2\text{V}_3\text{O}_{12}:\text{8% Eu}^{3+}$  were investigated via FIR method. The maximum relative sensitivity of 1.61%/K was obtained at 420 K. Besides, a rapid colorific shift from white to deep red for the temperature range of 300-500 K was observed and thus confirmed its potentiality as a superior candidate for safety sign application in high temperature environment.

**Keywords:** Garnet type, Thermal quenching, Optical thermometer, Safety sign

### 11.03

#### Broadband Electromagnetic Response of $\text{MgFe}_{1.98}\text{O}_4$ - $\text{BaFe}_{12}\text{O}_{19}$ Composites

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**Background:** Composite formation is an effective and proven methods to synthesis materials with desired characteristics. By choosing suitable constituents for composite synthesis it is possible to produce the desired properties. A composite of spinel and



hexagonal ferrites are found to have wide application frequency and its dielectric losses are also very low. Hence such composites will be useful for antenna substrate application.

**Method:** This work explores the broadband electromagnetic response of the composite  $(1-x)\text{MgFe}_{1.98}\text{O}_4 + x\text{BaFe}_{12}\text{O}_{19}$ . The composites were synthesised by solid state reaction route method and variation in broadband electro-magnetic properties were studied with respect to the variation in  $\text{BaFe}_{12}\text{O}_{19}$  (from 20 to 80 wt%) concentration using Keysight E4991B impedance analyser from 1MHz to 1GHz.

**Results:** The phase pure formation of the composites were confirmed using XRD, FTIR and Raman spectroscopic analysis. The permittivity of the composites with 20, 40, 60, 80 wt%  $\text{BaFe}_{12}\text{O}_{19}$  is 9.2, 10.9, 9.7 and 9.9 and permeability values are 3.4, 3.3, 2.4, 1.9 respectively at 300 MHz. As the amount of  $\text{BaFe}_{12}\text{O}_{19}$ , which has lower permittivity than  $\text{MgFe}_{1.98}\text{O}_4$  increased from 40 to 80 wt%, the permittivity was decreased from 11.1 to 9.9. Similar sort of an effect is there in permeability also. When the concentration of  $\text{BaFe}_{12}\text{O}_{19}$  was increased from 20 to 80 wt% the static permeability was decreased from 3.4 to 1.9 and it is called the dilution effect. Since the resonance is occurring near to 300 MHz, the composites offer a wide application frequency. The dielectric losses of the composites with 20,40,60,80 wt%  $\text{BaFe}_{12}\text{O}_{19}$  at 300 MHz are 0.006, 0.005, 0.003, 0.002 respectively and the magnetic losses are in the order of  $10^{-1}$  for all the composites over the entire frequency range from 1 MHz to 1 GHz.

**Conclusions:** From this study, the composite  $(1-x)\text{MgFe}_{1.98}\text{O}_4 + x\text{BaFe}_{12}\text{O}_{19}$  with  $x=20$  wt% is found to have better matching between  $\epsilon'$  and  $\mu'$ . The dielectric losses of this composite are in the order of  $10^{-3}$  and magnetic losses are in the order of  $10^{-1}$ . The variations in properties of the composites with variation in constituent compounds concentration was also studied in detail. Further improvement in relative impedance value could make the composites (20M-B) suitable for the very high frequency antenna substrate application.

**Keywords:** Permittivity, permeability, broadband electromagnetic properties

## 11.04

### Modification of Curie Temperature in PMN-PT due to $\text{Sr}^{2+}$ Doping

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**Background:** The use of refrigerators, air conditioners and other cooling devices are increasing day by day. These devices use Freon gas for cooling, which apart from being less efficient, causes serious environmental problems. So, need to be substituted. Researches to find alternative methods for cooling have identified Electrocaloric effect as an alternative for the conventional cooling method. Moreover, materials showing electrocaloric effect also show piezoelectric effect, which has many applications in sensors, speakers and also used for actuator purposes. PMN-PT is a lead-based compound with enhanced electrocaloric, ferroelectric and piezoelectric properties at its curie temperature. The properties depend upon its composition and the nature of dopants hence curie temperature depends on these.

**Methods:** For the synthesis of PMN-PT solid state reaction method is used.  $\text{MgO}$  and  $\text{Nb}_2\text{O}_5$  are used to form  $\text{MgNb}_2\text{O}_6$ . Then,  $\text{MgNb}_2\text{O}_6$  is combined with  $\text{PbO}$  and  $\text{TiO}_2$  to form PMN-PT of the composition  $(1-x)\text{PMN}_x\text{PT}$  where  $x = 0.37$ . Partial covering method is used to avoid pyrochlore phase formation during the reaction. The dielectric, piezoelectric and ferroelectric studies of the PMN-PT doped with 2%  $\text{Sr}^{2+}$ , are done with compositions close to morphotropic phase boundary. Earlier studies have shown that materials exhibiting high dielectric and piezoelectric properties also show high electrocaloric properties.

**Results:** •Piezoelectric coefficient  $d_{33} = 470\text{pC/N}$ , Saturation polarization  $P_{\text{sat}} = 18.12\mu\text{C/cm}^2$ , remnant polarization  $P_r = 12.82\mu\text{C/cm}^2$  and coercivity  $EC = 5.35\text{ kV/cm}$ . •Curie temperature of 2%  $\text{Sr}^{2+}$  doped sample is  $T_c = 155^\circ\text{C}$ . •The loss tangent is found low for frequencies above 100 kHz.

**Conclusion:** When we doped PMN-PT of  $x = 0.37$  with 2%  $\text{Sr}^{2+}$  the curie temperature decreased from  $T_c = 185^\circ\text{C}$  (un-doped sample) to  $155^\circ\text{C}$  without losing any of its properties- electrocaloric, dielectric, piezoelectric etc. Thus, we found a material with high electrocaloric, dielectric and piezoelectric properties at the curie temperature of  $155^\circ\text{C}$ .

**Keywords:** Electrocaloric effect, Dielectric effect, Piezoelectric effect, Ferroelectric effect, Piezoelectric coefficient, Curie temperature

## 11.05

### Cold Sintered Strontium Hexaferrite – Lithium Molybdate Composites Towards Microwave Applications

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**Background:** Ferrites, particularly hexaferrites, are ideal candidate for microwave applications owing to their excellent physical properties. However, their relatively high sintering temperature limits its applications in microwave devices. The recently reported novel technique called cold sintering is an efficient way to densify these materials in a comparatively low temperature without sacrificing its physical properties.

**Method:** In the present work,  $x\text{SrFe}_{12}\text{O}_{19} - (1-x)\text{Li}_2\text{MoO}_4$  ( $x = 0.6, 0.5, 0.4$  and  $0.3$ ) composites were prepared by novel cold sintering technique. The microstructure, broadband electromagnetic parameters and room temperature magnetic properties of SFO-LMO composites were systematically investigated.

**Results:** It is observed that the density of the composites increases from 66% for  $x = 0.6$  to 90% for  $x = 0.3$  which is further confirmed through microstructural analysis. The relative permittivity increased with decrease in  $x$  value while the relative permeability decreased. The dielectric and magnetic losses were found to be in the range of  $10^{-3}$  and  $10^{-2}$ , respectively. The saturation magnetization has decreased from 62 emu/g for  $x = 0.6$  to 34 emu/g for  $x = 0.3$ .

**Conclusions:** This work indicates that cold sintering is an effective way to fabricate magnetodielectric composites in comparatively lower temperatures. The SFO-LMO cold sintered composites having desirable properties and easy synthesis procedure are potential candidates for microwave antenna applications.

**Keywords:** Cold sintering, Hexaferrite, Broadband Electromagnetic properties, Microwave Applications.

## 11.06

### Lasing Studies of LDS 821 Dye in Different Solvents

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Well resolved equally spaced resonant modes of wavelength greater than 805 nm is observed from dye solution kept inside a quartz cuvette, when excited with second harmonic output of an Nd: YAG laser.

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**Introduction** Recently large size donor-acceptor connected via polymethine chain such as hemicyanine dyes shows promising applications in optical switches and as optical sensors. The short fluorescence lifetime and low quantum yield of these type of dyes are due to the ultrafast nonradiative process that occurs due to photoinduced trans-cis isomerization of one of the C-C bonds of the polymethine chain.

**Experimental** Laser emission from LDS 821 dye in different solvents were studied by dissolving 1mM of dye in methanol, ethanol, DCM, chloroform, DMSO and acetone. Lasing studies of dye were carried out by taking the dye solution in a quartz cuvette with 1cm path length.

**Result and discussion** For protic hydrogen bond donating solvents, the laser emission does not show any significant shift, and also no laser emission is observed for these type of solvents as polarity decreases, which may be due to decrease in reflectivity. In the case of apolar aprotic non hydrogen bond donating solvents the laser emission from the dye solution is blue shifted as polarity increases.

**Conclusion** The lasing threshold and gain of LDS 821 dye in different solvents were investigated. The reflections from the two parallel walls of the cuvette offers the necessary optical feedback for lasing.

11.07

### Nonlinear Optical Properties of CdTe and CdZnTe Embedded Polyvinyl Alcohol Composites

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**Background:** The dispersion of alloyed semiconductor quantum dot materials in polymer matrices offers hybrid nanocomposites exhibiting excellent optical and nonlinear properties. The advantage of size and composition tunable structural, optical and nonlinear properties favors in the fields of optical limiters, fluorescent probes and photovoltaic materials. The binary Cadmium Telluride (CdTe) and its ternary alloy Cadmium Zinc Telluride (CdZnTe) quantum dots embedded in polyvinyl alcohol (PVA) composites synthesized via in-situ chemical method were encouraged due to the simplicity and lower processing temperature. The hybrid polymer composites with improved tailored properties which can be placed as excellent candidates for optical and nonlinear materials.

**Method:** The open aperture Z-scan technique with 532 nm Continuous Wave (CW)- diode pumped solid state laser employed here to analyze the nonlinear absorption. The polymer nanocomposites prepared using the precursors cadmium acetate, zinc acetate and 3- mercaptopropionic acid in 100 ml double distilled water and stirred at pH 8. To this solution 3 weight percentage PVA, sodium tellurite and sodium borohydride were added under stirring and followed by a heating 60°C for 4 hours under open air condition. For CdTe-PVA composites the procedure repeated without using zinc precursor.

**Results:** The CdTe-PVA and CdZnTe-PVA hybrid polymer composites have good nonlinear response. The nonlinear absorption coefficient of the composites found of the order 10<sup>-4</sup> cm/W and the alloy composite CdZnTe-PVA have higher value. The alloy composites exhibit red shifted and higher absorption value than the CdTe-PVA. The values of bandgap energy, urbach energy, optical constants and optical response compared between the binary and ternary polymer composites and the values suggest the possibility of tunable properties.

**Conclusions:** The CdTe-PVA and CdZnTe-PVA composites synthesized by in situ method with tunable and improved optical and nonlinear properties. The good nonlinear and optical characteristics indicates the applicability as potential materials for optical limiter and photovoltaic.

**Keywords:** Nonlinear optics, Z-scan technique, CdTe, CdZnTe, PVA

11.08

### Proximity Distance in Spatial Epidemic

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Mathematical modeling of infectious disease has a significant role in understanding epidemics and controlling them by recommending optimal strategies and interventions. Applying epidemic models on a spatially embedded population network gives a better idea about its real-world behavior. In this work, we consider the concept of the maximal spatial distance up to which an individual can spread infection called the proximity distance (PD) and its impact on the dynamics of the epidemic. Our quantitative analysis shed light on the elevated importance of self-isolation and mask usage especially in a densely populated community in the present scenario of the COVID19 pandemic.

11.09

### 2D Sheets of Cesium Titanium Bromide (CsTiBr<sub>3</sub>) Perovskite Thin Films by In-house Deposition Technique

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A lead free two dimensional perovskite thin films of Cesium Titanium Bromide (CsTiBr<sub>3</sub>) is synthesized on commercial glass substrate by a two stage deposition method for the first time. Cesium Bromide (CsBr) thin film is prepared by vacuum thermal evaporation and is used as the substrate for Titanium Bromide (TiBr<sub>4</sub>) deposition in an in-house deposition arrangement. The height of CsBr substrate from TiBr<sub>4</sub> vapor source plays a key role in the formation of CsTiBr<sub>3</sub> thin film. The structural and compositional analysis of the samples confirms the formation of CsTiBr<sub>3</sub>. CsTiBr<sub>3</sub> forms a stack of two dimensional sheets which enhances surface area for photon absorption. The synergic properties viz bandgap of 1.72eV, lead free nature and two dimensional sheet like structure makes it a promising candidate for environment friendly solar cell and photodiode applications

## 11.10

### Luminescence Characteristics of $\text{Er}^{3+}/\text{Dy}^{3+}/\text{Sm}^{3+}$ Triply-Doped Fluoroborosilicate Glasses for White Light Generation

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**Background:** Combination of red, green and blue (RGB) colors emitted from a single host can effectively produce the white light. Thus, tailoring the luminescence by varying rare earth ions in different systems are frequently employed by the researchers and proposed several  $\text{RE}^{3+}$  ion single and co-doped materials for this context. Among these, pursuit for ample fluorescent materials research has been lately concentrated on triply doped luminescent glasses.

**Method:**  $\text{Er}^{3+}/\text{Dy}^{3+}/\text{Sm}^{3+}$  triple doped with fluoroborosilicate glasses were synthesized by conventional melt quench technique. Raw materials were crushed in an agate mortar and about 6 g of each batch was melted at  $950^\circ\text{C}$  for 1 hour by placing it in a porcelain crucible. The melt was quickly moved onto a foreheated brass mould with spherical channels and annealed at  $400^\circ\text{C}$  for 10 hours. The characterizations used for the interpretation are optical absorption (Varian Cary 5000) and Photoluminescence (PL) measurements (Horiba fluorolog-3 with an integrating sphere attachment).

**Results:** Based on the photoluminescence excitation and emission spectral profiles, the presence of energy transfer processes between  $\text{Dy}^{3+}$ ,  $\text{Sm}^{3+}$  and  $\text{Er}^{3+}$  were confirmed. Further, for  $\text{Dy}^{3+}/\text{Sm}^{3+}/\text{Er}^{3+}$  triply-doped glasses, an enhancement in  $\text{Er}^{3+}$  green luminescence and a noticeable decrement in  $\text{Dy}^{3+}$  and  $\text{Sm}^{3+}$  emissions were detected with the increase in  $\text{Er}^{3+}$  concentration. The precise characteristic colors emanated from the as-prepared samples were evaluated using CIE coordinates and CCT values and it suggests its suitability in white light emission.

**Conclusions:** the photoluminescent spectral profiles with 379 nm excitation wavelength confirmed the presence of energy transfer and the altering content of  $\text{Er}^{3+}$  ions facilitate to examine the energy transfer mechanism in detail. The estimated CIE color coordinates and CCT values of all the samples with different excitation wavelengths have been confirmed that our glassy system can emanates cool white light.

**Keywords:**  $\text{Dy}^{3+}/\text{Er}^{3+}/\text{Sm}^{3+}$  triply doped fluoroborosilicate glasses, Energy transfer mechanism, CIE chromaticity coordinates

## 11.11

### Structural and Optical Properties of rGO Doped $\text{MoO}_3$ Synthesised by Citrate-Sol Gel Method

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**Background:** Molybdenum trioxide ( $\text{MoO}_3$ ) belonging to binary transition-metal oxides family crystallizes in the orthorhombic structure and exhibits high chemical and thermal stability. The effect of incorporation of rGO on the structural, morphological and optical properties of  $\text{MoO}_3$  is investigated by X-ray diffraction, SEM and UV-visible spectroscopy respectively.

**Method:** Structural and optical properties of rGO doped  $\text{MoO}_3$  synthesised by sol-gel method were studied. Pure rGO was synthesized by modified hummer's method and  $\text{MoO}_3$  nanopowder was synthesized by citrate sol-gel method and different concentrations of rGO were doped with  $\text{MoO}_3$ .

**Results:** XRD analysis shows that both pure and rGO doped  $\text{MoO}_3$  have an orthorhombic crystal structure. The XRD spectra of the undoped and the doped  $\text{MoO}_3$  samples shows the presence of (020), (040), (060) peaks characteristic of  $\alpha\text{-MoO}_3$  orthorhombic structure. The SEM images of various concentrations of rGO doped  $\text{MoO}_3$  samples shows densely packed irregularly shaped agglomerated particles. The absorption spectra of the pure and doped  $\text{MoO}_3$  samples have strong peaks in the UV region. The absorption intensity increases with doping of rGO and an extension of absorption in the visible area is also observed which is due to synergistic effect between rGO and  $\text{MoO}_3$ . Optical band gap was found to be less for doped samples.

**Conclusion:** The increase in the absorption intensity of the composite as evident from the UV-vis analysis makes it suitable for applications like solar cells, energy storage, photocatalytic etc.

**Keywords:** Citrate sol-gel method, Modified hummer's method

## 11.12

### Stability Enhancement of Methylammonium Lead Bromide Quantum Dots with Copper Incorporation

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**Background:** Huge attention has been drawn to organic inorganic hybrid perovskites having promising optoelectronic properties for light harvesting as well as light emitting device applications. Lead Halide Perovskites exhibits Photo conversion efficiency upto 25%. Here we report the synthesis of Methylammonium lead bromide, a suitable candidate for solar cell application with a bulk band gap of 2.3 eV. Considering lead toxicity as well as instability issues associated with this material, synthesis of a copper based hybrid material was done where the possibility of partial replacement of Pb with copper was explored.

**Method:** The synthesis was done using Ligand Assisted Reprecipitation strategy. The optical characterisation of the prepared samples were done through Optical absorption measurement using UV-Visible spectroscopy and Photoluminescence measurement. Quantum confinement of  $\text{MAPbBr}_3$  was confirmed using Transmission Electron Microscopy (TEM).

**Results:** Transmission Electron Microscopy confirms the presence of spherical quantum dots. Optical Absorption peaks obtained for the samples confirms the formation of quantum dots. Optical absorption studies shows that increase in Cu concentration results in shift in absorption peak position. The Photoluminescence spectra was recorded by giving an excitation wavelength 400 nm (3.1 eV). The PL emission suggest the possibility of formation of defect states 0.22 eV- 0.26 eV below the conduction band as a result of the Cu substitution. Consistent optical properties were obtained from the samples for a period of 11 months (presently).

**Conclusions:** This work gives out a simple solution-based method for the synthesis of Quantum dots. Due to the existing drawbacks of Perovskite based materials on stability and toxicity of lead, attempts were done to substitute lead partially with copper by incorporating copper halide into the precursor solution. An enhancement in stability was noted with the incorporation of Copper with optical studies based on our present 11 months data and analysis.

**Keywords:** Perovskite, Methyl Ammonium lead Bromide, Copper incorporation, LARP, Photoluminescence



## 11.13

### Electrochemical Performance Study of Vacuum Filtered Dry $Ti_3C_2T_x$ $MX_{ene}$ Powder

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**Background:**  $MX_{enes}$  ( $M_{n-1}X_nT_x$ ) as a family of 2D materials is different from graphene and 2D transition metal dichalcogenides (TMDs) because of hydrophilicity, good conductivity ( $6000 - 8000 \text{ Scm}^{-1}$ ) and presence of functional groups.  $Ti_3C_2T_x$   $MX_{ene}$  which is the first reported  $MX_{ene}$  synthesized by chemical etching of  $Ti_3AlC_2$  MAX phase is useful for supercapacitor application due to its ability to reversibly intercalate various cations ( $NH_4^+$ ,  $Mg^{2+}$ ,  $Al^{3+}$ ) and the presence of rich surface functionalities ( $-O$ ,  $-F$ ,  $-OH$ ,  $-$ ).  
**Method:** In this work  $Ti_3C_2T_x$   $MX_{ene}$  powder was prepared from  $Ti_3AlC_2$  MAX phase via chemical etching in hydrofluoric acid (HF) and was vacuum filtered to completely remove water. The powder obtained after drying at  $60^\circ\text{C}$  overnight was used as supercapacitor electrodes.

**Results:** The prepared working electrode on stainless steel substrate showed supercapacitor behaviour. Cyclic voltammetry (CV) and galvanic charge discharge (GCD) studies were carried out using three electrode set up and it was found that the material exhibits electric double layer capacitor (EDLC) behaviour. The CV curve has no redox peaks and were smooth for different scan rates from  $2\text{mV/s}$  to  $80\text{mV/s}$ .

**Conclusions:** The work shows possibility of using  $Ti_3C_2T_x$   $MX_{ene}$  in supercapacitor applications. The specific capacitance is calculated from cyclic voltammogram for different scan rates. Highest specific capacitance of  $12 \text{ F/g}$  is obtained for the lowest scan rate of  $2 \text{ mV/s}$ .

## 11.14

### Hydrothermal Synthesis of Layered $MoS_2$ /RGO Composite for Super Capacitor Application

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**Background:** 2D Transition Metal Dichalcogenides (TMDCs) is a class of materials which shows unique electrical, optical, mechanical and thermal properties which makes them an attractive candidate in energy storage applications. Molybdenum disulphide ( $MoS_2$ ), a member of two dimensional transition metal dichalcogenides is a potential candidate for energy storage applications due to the abundance of its elemental constituents, nontoxicity and ease of synthesis via cost effective techniques. In  $MoS_2$  the S-Mo-S trilayers are separated by weak van der Waals force and hence it can be considered as a suitable alternative to graphene and has high surface area and large in plane conductivity of  $43.4 \times 9.1 \text{ Wm}^{-1}\text{K}^{-1}$ . As  $MoS_2$  has sufficient space between the layers to host ions during charging, it can be considered as a suitable electrode material for Li-ion batteries and supercapacitors. But  $MoS_2$  has certain limitations when used as an electrode due to its volume expansion and pulverization during charging process which results in poor cycle stability and rate capability. In this work  $MoS_2$ -RGO (reduced graphene oxide) composites were synthesized to overcome these limitations.

**Method:** In this work we prepare  $MoS_2$ -RGO nanocomposites using Ammonium Molybdate Thiourea and RGO by hydrothermal method. Hydrothermal growth is an attractive and relatively simple method in which crystal growth occurs at mild conditions in water, producing high purity samples. RGO was prepared by modified hummers method. XRD, SEM and Raman studies were employed for the characterization of synthesized sample. Electrochemical measurements were done by Electrochemical workstation.

**Results:** X-ray diffraction studies revealed the incorporation of RGO, which made the peaks weak and broad. The FESEM and TEM images indicate the 3D sphere like morphology with increased surface area due to the presence of RGO in layered  $MoS_2$ . Hydrothermally synthesized  $MoS_2$ -RGO composite electrode had a very large specific capacitance than  $MoS_2$  electrode confirming that the  $MoS_2$ -RGO composites can be used as an efficient electrode material for energy storage application.

**Conclusions:** In this work  $MoS_2$ /RGO composite were successfully prepared with enhanced specific capacitance by simple hydrothermal method.

**Keywords:** Ammonium Molybdate, Thiourea, Hydrothermal growth

## 11.15

### Plasmon Enhanced Fluorescence in Styryl 7: Gold Nanostar Composites

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**Background:** Gold (Au) nanostars are capable of enabling metal enhanced fluorescence (MEF) in the near-infrared (NIR) window and are considered promising materials for the development of diagnostic devices. The conjugation of organic dye Styryl 7 (S7) to Au nanostars in the present study show significant fluorescence enhancement which can be attributed to both enhanced excitation and increased radiative decay rate. This MEF property finds application in biodetection techniques for contrast enhancement.

**Methods:** MEF studies were carried out by mixing dye ( $1 \times 10^{-6} \text{ M}$ ) with different volume ratios of colloidal Au nanostars. Absorption and fluorescence properties of both S7 and Au have been recorded. Fluorescence imaging studies were performed using a laser scanning confocal microscopy in order to confirm the fluorescence enhancement.

**Results:** Fluorescence spectra of the S7 dye in the presence of Au nanostars reveals an enhanced fluorescence intensity of the dye with the addition of  $40 \mu\text{l}$  of colloidal Au nanostars. However, the intensity was found to decrease with further addition of Au. The results of confocal imaging have shown that the cells treated with S7-Au is more bright and exhibited strong fluorescence when compared to cells treated with S7 alone. This provided further evidence for Au nanostars enhancing the fluorescence from S7. The results demonstrated the use of S7-Au nanostar hybrids as a potential probe for cell imaging.

**Conclusion:** This work explores the use of Au nano stars to induce metal enhanced fluorescence in S7 dye. We expect that the study will provide valuable insight to the development of imaging agents based on MEF.

**Keywords:** Nanostar, Fluorescence, Imaging, Metal

## 12. Scientific Social Responsibility

### 12.01

#### Recovering Water and Manure from Urine

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**Background:** As the population demography evolves man will have to eventually live with recycling his resources for sustained living on the face of earth. More than 95% of human Urine is water. Inorganic salts and organic compounds makeup rest of the constituents. The largest solid constituent of urine is Urea. The major constituent of Urea is Hydrogen, Carbon, Oxygen and Nitrogen. Bacteria produce urease enzymes which hydrolyze urea to bicarbonate and ammonia which results in strong odor. This makes the practical storage and recycling of the urine very difficult. It is difficult to treat urine by conventional treatment method for the purpose of recycling, especially because of the strong odor emitted from ammonia. Recycling of human urine using a sequential process of solar distillation and solar electrolysis was the main focus of this research work. The electrolysis takes place in the absence of an electrolyte which manifests as a technical achievement of our work.

**Methods:** A solar distillation unit was fabricated in house in order to conduct the distillation studies. A solar concentrator was also developed in order to increase the flux of solar radiation on the distillation unit. An electrolysis unit was developed in the lab using electrode materials grown in the laboratory. The electrolysis unit was powered by a 12 V 0.5 W Si solar panel. A random sample of urine was first subjected to solar distillation. The distilled product was then subjected to electrolysis.

**Results:** Solar distillation of urine resulted in obtaining a clear colourless water sample with pungent smell of urea. The biochemistry of the distilled sample showed that all of the chemical constituents could be reduced by over 90% as a result of the 6 hour distillation process except that of the chlorine content. The solar distilled solution when subjected to electrolysis resulted in complete removal of proteins and uric acid. All of the other chemical constituents could be further reduced with the electrolysis step. Electrolysis resulted in reduction of chloride content in the solution.

**Conclusions:** A random urine sample of 100 ml could be distilled in 6 hours' time using the solar still facility. Nutrients like Nitrogen, Phosphorus and Potassium could be recovered from the solar still. Our analysis on the recycled water proves that it may be used for domestic purposes. The residual mass sediment obtained after solar distillation and electrolysis contain rich plant nutrients. The lowered COD and TOC in the recycled water warrant merit and scope for further improvement. The conduct of electrolysis without an electrolyte in the present work opens up several opportunities in study of the efficacy of nutrient and water recovery using targeted electrolytes and chemicals.

**Keywords:** Urine recycling, Solar distillation, Electrolysis

### 12.02

#### Non-woven Polypropylene-Nitrile Rubber Blend: A Novel Method for the Recycling of Medical Face Mask to an Engineering Product

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**Background:** Massive production and usage of disposable face masks in the current situation of COVID-19 pandemic, counters on the waste management system, taking plastic pollution to be the primary concern. In this scenario, despite from the trajectories of research done on the recycling of used disposable medical face masks, the current study emphasizes on a novel method for the recycling of used N95 face mask by incorporating the non-woven polypropylene fibre (PP), which is taken off from the mask after disinfecting it, in acrylonitrile butadiene rubber (NBR) matrix with the help of a potential compatibilizer, results in PP/NBR blends with astonishing properties.

**Method:** A series of PP/NBR blends with different mass fractions of PP in NBR matrix were prepared. Maleic anhydride (MA), which can act as an interfacial agent, is used to make immiscible PP and NBR to get blended. The material identification and morphological properties were done using Attenuated Total Reflection (ATR) and Field Emission Scanning Electron Microscope (FE-SEM) respectively. The tensile strength, elongation at break and hardness of prepared blends were studied using Universal Testing Machine (UTM) and Shore D Durometer. The miscibility of the prepared blends were studied using Dynamic Mechanical Analysis (DMA). The thermal studies was done using Thermogravimetric Analysis (TGA).

**Results:** From the ATR results, there confirmed the material in consideration is PP since the multi-layered medical face mask contains more than one material in it and FE-SEM shows a typical fibrous morphology for neat PP. The mechanical properties like tensile strength and elongation at break of the blends increases as the PP content is increased and likewise the hardness and this can be due to the network formation within the blend. From the DMA results, the  $\tan \delta$  vs. temperature plot gives two peaks corresponding to the glass transition temperature of each monomers and this indicates, MA will act as an interfacial agent and anchor the PP and NBR together rather than making PP and NBR miscible. The blends with 70 and 60 wt % PP content have intermediate thermal stability compared to neat PP and NBR due to better interfacial adhesion between PP and NBR.

**Conclusion:** The work demonstrates a novel and potential scientific method for the recycling of medical face masks which would be a boon for the environment as well as for the human kind and the birth of an engineering product from the trash towards remarkable applications.

**Keywords:** Polypropylene, Acrylonitrile butadiene rubber, Polymer blend, Recycling of medical face mask, Waste management



## 12.03

## Global Trends in Research on Human Viral Diseases

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**Background:** Viral diseases have been a matter of concern with regard to the health of human beings. The frequent re-emergence of viral diseases and restricted scope of treatment or prevention make viral diseases more important. To understand the present state a bibliometric analysis of the scientific literature on human viral diseases was carried out and presented in this paper.

**Method:** The NCBI PubMed database was used to retrieve data on articles in the area of human viral diseases. The extracted data was analysed using three software namely Sci2 and VOS viewer.

**Results:** Influenza was the research item that was investigated from a very long back time, 1802. The most investigated research area as reflected in the number of publications was viral diseases with 10,37,507 items. The most common keyword was humans followed by COVID 19. For most of the research areas, though research had started many years back, most of the research papers have come up in last 10 years. COVID 19 research was the most recent and there were 86,972 papers getting published in a single year (2020).

**Conclusions:** The scientific community was found to be contributing to the field of human viral diseases in a satisfactory manner. Almost all the regions were represented in the research data. It is expected that scientists will be able to devise measures to ensure prevention and therapy of viral diseases.

**Keywords:** COVID 19, influenza, viral disease

## 12.04

## Turmeric During COVID 19 and its Effect on Storage Stability of Ginger

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**Background:** The pandemic situation of COVID 19 affected all the parts of the world including Antarctica. Storage of fruits and vegetables is very important especially during the pandemic situation. The consequence of the pandemic is not only limited to health sector, but food supply, its storage stability due to difficulty in transportation and expected shortage due to the reduced cultivation. Though, the research and development activities during the COVID 19 pandemic situation focussed mainly on vaccine development, attempts to improve the individual immunity by combining the various treatment modalities, improved sanitation with new antimicrobial face masks, PPE kits, sanitizers and various materials for oral hygiene are going on actively by various research groups to mitigate the risks and impacts of the COVID 19 pandemic.

Ginger belongs to the *Zingiberaceae* family is a native of Southeast Asia, is common in food and used as a medicine around the world. Ginger is one of the most commonly consumed spice and has a very long history of use in various forms of traditional and alternative medicine to aid digestion, reduce nausea and help fight the flu and common cold, in treating respiratory illnesses, especially Asthma. Overall, ginger is used to promote health and wellness. However, rotten ginger root produces a powerful toxin called safrole, which is highly toxic and can cause liver damage. Even small amounts can damage the liver cells. As a natural product, turmeric is nontoxic and has diversified effects in various oral diseases.

Turmeric and ginger are among the most popular herbal substitute used by the public with the hope of getting protection from the attack of corona virus. The present paper discusses the effect of turmeric on storage stability of ginger.

**Materials and Methods:** A comparison of storage stability of peeled ginger washed with saline, vinegar, alcohol or solution of baking powder was made with ginger washed in water containing turmeric powder. The samples were stored under refrigeration and the comparison was made in terms of surface texture, change in smell and colour.

**Results:** The storage stability of ginger stored in fridge was found to be dependent on the washing media, moisture content and duration in fridge. Ginger washed in saline, baking powder/vinegar containing water was found to be fresh in fridge upto 1 week followed by colour change and softness of surface, whereas, ginger washed with water contains turmeric was remained fresh for more than 2 months. Rotten ginger produces a highly toxic substance safrole known as natural hepatotoxin which leads to liver cell degeneration and necrosis and may induce liver cancer and is strongly poisonous. The present study showed that turmeric is very effective in improving the storage stability of ginger. The effect is mainly due to decontamination of the ginger surface due to the antimicrobial properties of turmeric. Moreover, presence of turmeric adhered to the surface of ginger prevents the rotting process by inhibiting the adverse chemical reactions leading to the formation of the highly toxic safrole during storage. Simple washing with turmeric containing water can prevent the rotting of ginger which in turn helps to prevent the liver damage.

**Keywords:** Turmeric, safrole, hepatotoxin, Ginger, storage stability

## 12.05

## Effect of Special Very Low Calorie Diet on Obese Respondents

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**Introduction:** The incidence of obesity and overweight is increasing among children and adults. WHO recommends lifestyle modification for sustained weight loss. When the degree of obesity increases, intense modifications are needed. Extremely restricted diets can be used to initiate weight loss in a person who is not responding to conventional lifestyle modifications for two or three weeks. Such diet should be started only after consulting a qualified dietician and that too for short duration.

**Aim of the study:** To implement special very low calorie diet plans in morbidly obese respondents and test their response to the same.

**Methodology:** This study was a sub experiment of a research work on nutritional management of obesity. Inclusion criteria for selecting to the present study were adults aged 18-50 years with BMI above 28Kg/m<sup>2</sup> and below 50 Kg/m<sup>2</sup>, with no history of





diabetes, cardiac diseases, renal diseases or hepatic diseases. About 14 respondents showed interest in this study and were issued very low calorie diet plan and suggested to follow the diet plan for 7 to 10 days to initiate weight loss and then changed to regular low calorie diet plans. Out of this, 7 respondents completed the trial and turned up for follow up. Very low calorie diet plan providing 750 kcals/day was formulated for this experiment. A 7 day cyclic menu along with some motivational tips was given in the form of a booklet. The energy provided through the cyclic menu ranged from 566 kcals to 867 kcals, fat from 5.66 g to 17.5g, protein from 19.58 g to 32.72g, carbohydrates from 100.4 g to 168.47g and total fiber from 18.36 g to 27.85g. Respondents could adhere to the diet plan for 7 to 10 days. They were asked to report for follow up investigations when they felt that the diet cannot be complied longer

**Results:** One male respondent and 6 female respondents completed this trial. Age of the respondents ranged from 21-47 years with a mean value of  $32.86 \pm 7.51$ . The BMI of the respondents ranged from 29-38 Kg/m<sup>2</sup>. The income level ranged from Rs 2500 to 41500 per month with mean income of  $17905 \pm 14038.5$ . Each individual responded differently to the diet intervention. Four out of the seven subjects had lost 1.0 to 1.5 Kg weight after one week, two subjects remained the same and one person gained 0.5 Kg weight. Similar trend was observed in the case of waist circumference too. The change in biochemical parameters were not noticeable. As the duration of the study was very short, the overall change in these parameters were not significant. This diet regimen did not induce ketosis.

The dietary habits were good with respect to quality but the use of unhealthy foods were in a moderate level. The dietary composition of these respondents were not healthy as protein, thiamine, vitamin D, calcium and iron content were considerably low.

**Conclusion:** Very low calorie diet plans are useful for very short term weight reduction as an adjuvant therapy along with regular low calorie diet and exercise plans. Though the planned special diet could help trigger weight loss without inducing ketosis, it was difficult to comply long term. Public health programs targeting weight reduction is essentially needed in our community but at the same time, hidden hunger in obesity should also be addressed.



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