21st Chhattisgarh Young Scientist Congress

ON 17th - 18th MARCH, 2026

ABSTRACT BOOK

Jointly Organized by :

Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur

&

Chhattisgarh Council of Science and Technology (Department of Science and Technology)

Message From Hon'ble Chief Minister

Shri Vishnu Deo Sai

Hon'ble Chief Minister

विष्णु देव साय
मुख्यमंत्री

Vishnu Deo Sai
CHIEF MINISTER

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Do. No. 680 Date. 16/03/2026

संदेश

मुझे यह जानकर प्रसन्नता है कि विज्ञान एवं प्रौद्योगिकी विभाग के अंतर्गत छत्तीसगढ़ विज्ञान एवं प्रौद्योगिकी परिषद् तथा डॉ. श्यामा प्रसाद मुखर्जी अंतरराष्ट्रीय सूचना प्रौद्योगिकी संस्थान, नया रायपुर के संयुक्त तत्वावधान में "21वें छत्तीसगढ़ युवा वैज्ञानिक सम्मेलन" का आयोजन 17 एवं 18 मार्च 2026 को किया जा रहा है। यह सम्मेलन युवा वैज्ञानिकों, शोधार्थियों और विद्यार्थियों को संवाद, विचार–विमर्श तथा नवाचार के आदान–प्रदान का एक महत्वपूर्ण मंच प्रदान करेगा।

राज्य सरकार प्रदेश में विज्ञान एवं प्रौद्योगिकी की गुणवत्तापूर्ण शिक्षा को प्रोत्साहित करने, शैक्षणिक संस्थानों को आधुनिक संसाधनों से सुसज्जित करने तथा विद्यार्थियों और शोधार्थियों को अनुसंधान एवं नवाचार के लिए प्रेरित करने की दिशा में निरंतर प्रयासरत है। ऐसे आयोजन युवा प्रतिभाओं में वैज्ञानिक दृष्टिकोण विकसित करने तथा ज्ञान–विज्ञान के क्षेत्र में आगे बढ़ने की प्रेरणा प्रदान करते हैं।

मुझे विश्वास है कि यह सम्मेलन प्रदेश में वैज्ञानिक चेतना को और अधिक सुदृढ़ करने में महत्वपूर्ण भूमिका निभाएगा। इस महत्वपूर्ण आयोजन की सफलता तथा इस अवसर पर प्रकाशित स्मारिका के लिए मेरी हार्दिक शुभकामनाएँ।

(विष्णु देव साय)

Message From Hon'ble Deputy Chief Minister

Shri Vijay Sharma Ji

Hon'ble Deputy Chief Minister

विजय शर्मा
उप मुख्यमंत्री

छत्तीसगढ़ शासन
गृह एवं जेल, पंचायत एवं ग्रामीण विकास,
विज्ञान और प्रौद्योगिकी विभाग

क्रमांक 893
रायपुर, दिनांक 15/03/2026

"संदेश"

मुझे यह जानकर हार्दिक प्रसन्नता हुई कि विज्ञान एवं प्रौद्योगिकी विभाग, छत्तीसगढ़ शासन के तत्वाधान में डॉ. श्यामा प्रसाद मुखर्जी अंर्तराष्ट्रीय सूचना प्रौद्योगिकी संस्थान, नया रायपुर एवं छत्तीसगढ़ विज्ञान प्रौद्योगिकी परिषद द्वारा संयुक्त रूप से "21 वीं छत्तीसगढ़ युवा वैज्ञानिक कांग्रेस" का आयोजन डॉ. श्यामा प्रसाद मुखर्जी अंर्तराष्ट्रीय सूचना प्रौद्योगिकी संस्थान, नया रायपुर में किया जा रहा है। इस सम्मेलन से छत्तीसगढ़ के विश्वविद्यालयों तथा महाविद्यालयों में अध्ययनरत नवोदित प्रतिभावान युवा वैज्ञानिकों के लिए अनुसंधान के क्षेत्र में अपनी प्रतिभा प्रदर्शित करने का महत्वपूर्ण अवसर प्राप्त होगा।

आधुनिक युग विज्ञान का युग है। विज्ञान का उपयोग राष्ट्र की प्रगति, खुशहाली और सम्पूर्ण मानवता के कल्याण के लिए आवश्यक है। मुझे आशा है कि इस 21 वें युवा वैज्ञानिक सम्मेलन में इस पर रचनात्मक दृष्टिकोण से विचार किया जाएगा।

छत्तीसगढ़ राज्य में विज्ञान और प्रौद्योगिकी के विभिन्न क्षेत्रों में प्रतिभाओं की प्रचुरता हैं। आवश्यकता इस बात की है कि हम सब मिलकर इन प्रतिभाओं को प्रोत्साहित करें और उनके लिए एक ऐसा उत्साह जनक वातावरण बनाएँ जिसमें उन्हें आगे बढ़ने और सफलता की नई–नई ऊचाईयों पर पहुंचने का अवसर प्राप्त हो सके।

आशा है कि इस सम्मेलन से छत्तीसगढ़ के युवा वैज्ञानिकों को एक नई दिशा एवं प्रेरणा मिलेगी। आयोजन की सफलता हेतु मंगलकामनाओं सहित इस अवसर पर प्रकाशित होने वाली स्मारिका के लिए मेरी हार्दिक शुभकामनाएँ।

(विजय शर्मा)

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Professor S. K. Pandey

Former Vice Chancellor,
Pt. Ravishankar Shukla University
Raipur, Chhattisgarh

Indeed it is a matter of immense pleasure that the **21st Chhattisgarh Young Scientist Congress (CYSC–2026)** is being organized by the **International Institute of Information Technology (IIIT), Naya Raipur** jointly with the **Chhattisgarh Council of Science and Technology** during **March 17–18, 2026** at the IIIT Naya Raipur campus. This meet, in particular, is of great significance for the state of Chhattisgarh as whole as it has completed twetny five years of its formation!

The Chhattisgarh Young Scientist Congress has become an important platform for young researchers as well as students of this region to present their innovative ideas and research outcomes. The deliberations during the course of the meet, it is hoped, would inspire the researchers in shaping or reorinenting their career paths in one or the other areas of their choice in Science & Technology. Needless to say, such initiatives play a significant role in nurturing scientific temper & curiosity, critical thinking, and innovation among the youth, which in turn prove to be essential for the advancement of Science and Technology as well as for addressing societal challenges.

I commend the organizers for their sincere and dedicated efforts in providing this opportunity to budding scientists of Chhattisgarh. I am confident that this congress will inspire participants to continue their pursuit of knowledge and contribute meaningfully to scientific research, and more importantly for the development of our country at large.

I extend my best wishes and blessing for the grand success of the **21st Chhattisgarh Young Scientist Congress (CYSC–2026)**.

(Professor S. K. Pandey)
Former Vice Chancellor,
Pt. Ravishankar Shukla University
Raipur, Chhattisgarh

Professor Sarang Medhekar

Vice Chancellor (Acting) Central University of Jharkhand

Prof. Sarang Medhekar.
Vice Chancellor (Acting)
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It gives me immense pleasure to learn that the **21st Chhattisgarh Young Scientist Congress (CYSC–2026)** is being jointly organized by the International Institute of Information Technology (IIIT), Naya Raipur, and the Chhattisgarh Council of Science and Technology on 17–18 March 2026.

Over the years, the CYSC has evolved into a premier forum for young researchers to showcase their brilliance, exchange innovative ideas, and engage in high-level scientific discourse. By fostering a spirit of inquiry and creativity, such initiatives are instrumental in building the scientific temperament necessary for our nation's progress.

I commend the organizers for their dedication to empowering the next generation of innovators. I am certain this Congress will inspire participants to strive for excellence and contribute meaningfully to the global scientific community. My best wishes for a highly successful and impactful event."

(Prof. Sarang Medhekar)

Sonmoni Borah

Principal Secretary

Sonmoni Borah I.A.S
Principal Secretary

सोनमणि बोरा भा.प्र.से.
प्रमुख सचिव

Government of Chhattisgarh
Department of Tribal Development
Department of Scheduled Caste Development
Department of Backward Classes and
Minorities Development
Department of Science and Technology

DO Letter No. 78

Date 12/3/2026

संदेश

मुझे यह जानकर प्रसन्नता हुई कि विज्ञान एवं प्रौद्योगिकी विभाग, छत्तीसगढ़ शासन के अंतर्गत छत्तीसगढ़ काउंसिल ऑफ साइंस एंड टेक्नोलॉजी (CCOST) तथा डॉ. श्यामा प्रसाद मुखर्जी इंटरनेशनल इंस्टीट्यूट ऑफ इन्फॉर्मेशन टेक्नोलॉजी, नया रायपुर द्वारा संयुक्त रूप से **"21वें छत्तीसगढ़ यंग साइंटिस्ट कांग्रेस 2026"** का आयोजन 17–18 मार्च 2026 को आईआईआईटी, नया रायपुर में किया जा रहा है।

यह जानकर अत्यंत हर्ष हो रहा है कि इस कांग्रेस में छत्तीसगढ़ के विभिन्न भागों से बड़ी संख्या में युवा वैज्ञानिक और शोधार्थी भाग ले रहे हैं। यह मंच विज्ञान के विभिन्न क्षेत्रों में हो रहे समकालीन अनुसंधान एवं विकास कार्यों पर विचार–विमर्श का एक महत्वपूर्ण अवसर प्रदान करेगा।

मुझे विश्वास है कि यह कांग्रेस युवा वैज्ञानिकों को अपने शोध कार्य साझा करने, नए विचारों का आदान–प्रदान करने तथा विज्ञान के विभिन्न क्षेत्रों के विशेषज्ञों और साथियों के साथ सार्थक संवाद स्थापित करने का उत्कृष्ट अवसर प्रदान करेगी। ऐसे संवाद निश्चित रूप से राज्य में अनुसंधान गतिविधियों को नई दिशा देने में सहायक होंगे।

मैं सभी प्रतिनिधियों का हार्दिक स्वागत करता हूँ तथा **21वें छत्तीसगढ़ यंग साइंटिस्ट कांग्रेस 2026** के आयोजन से जुड़े सभी व्यक्तियों को बधाई देता हूँ।

सभी प्रतिभागियों को मेरी हार्दिक शुभकामनाएँ। मैं इस आयोजन की भव्य सफलता की कामना करता हूँ।

12/3/2026

(सोनमणि बोरा, आईएएस)

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Om Prakash Vyas

Director, IIIT-NR

Message by Director IIIT-NR

It gives me immense pleasure to host **the 21st Chhattisgarh Young Scientist Congress 2026**, jointly organized by the **Chhattisgarh Council of Science & Technology (CCOST)** and **Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur (IIIT-NR)** during **17–18 March 2026** at the IIIT-Naya Raipur campus.

The **Chhattisgarh Young Scientist Congress** has emerged as one of the most significant academic platforms in the State for identifying and nurturing talented young researchers in the fields of **Science, Engineering, and Technology**. By providing an opportunity to present innovative research ideas and findings before eminent scientists and academicians, the Congress promotes scientific dialogue, knowledge exchange, and collaborative thinking among emerging scholars.

I am confident that the research works presented in this event will not only stimulate meaningful academic discussions during the Congress but will also serve as a valuable reference for researchers, academicians, and students.

I extend my sincere appreciation to the **Chhattisgarh Council of Science & Technology (CCOST)** for their continued efforts in promoting scientific research and innovation in the State. I also congratulate all participating young scientists for their enthusiasm and dedication toward advancing knowledge.

I wish the **21st Chhattisgarh Young Scientist Congress 2026** great success and hope that this initiative will continue to inspire young minds to pursue excellence in research and innovation.

Date: 12/03/2026

Prof. (Dr.) Om Prakash Vyas
Director, IIIT-NR

P. Kawishwar

I/c Director General

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P. Kawishwar
I/c Director General

No. /1558 /CCOST/2026
Date: 06 /03/2026

It gives me great pleasure to note that the Chhattisgarh Council of Science & Technology in collaboration with Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur is organizing the 21st Chhattisgarh Young Scientist Congress 2026 on 17–18 March 2026 at IIIT, Naya Raipur.

The Young Scientist Congress provides an excellent platform for young researchers to present their research findings, innovative ideas, and scientific contributions. Such initiatives are essential for nurturing scientific temperament and strengthening the culture of research and innovation among the youth of the state.

Young scientists play a vital role in advancing knowledge and developing solutions to contemporary challenges through science and technology. This congress will encourage meaningful exchange of ideas, interaction with experts, and inspire young researchers to pursue excellence in scientific research and innovation.

I congratulate the organizers for this commendable initiative and extend my best wishes to all participants for fruitful deliberations and a successful congress. I also appreciate the publication of this souvenir as a valuable record of this important scientific event.

(Prashant Kawishwar)

MESSAGE

It gives us immense pleasure to extend a warm welcome to all participants, researchers, academicians, and young innovators to the 21st Chhattisgarh Young Scientist Congress 2026, jointly organized by Chhattisgarh Council of Science & Technology (CCOST), Raipur and Dr. Shyama Prasad Mukherjee International Institute of Information Technology (IIIT), Naya Raipur, being **held on** 17th–18th March 2026 at IIIT Naya Raipur.

The Young Scientist Congress has consistently served as an inspiring platform for young minds to present their research, exchange ideas, and engage in meaningful scientific dialogue. This event reflects our collective commitment to nurturing scientific temperament, innovation and research culture among the youth of Chhattisgarh.

We are confident that this gathering will provide an excellent opportunity for budding scientists and scholars to showcase their work, interact with eminent experts, and gain valuable insights that will further strengthen their academic and research pursuits. The exchange of knowledge and ideas during the sessions will certainly contribute to addressing contemporary scientific challenges and promoting sustainable development.

We also appreciate the dedication of the organizing committee, reviewers, mentors, and volunteers whose hard work has made this Congress possible.

I wish the **21st Chhattisgarh Young Scientist Congress 2026** great success and hope that all participants find this experience enriching, inspiring, and memorable.

With best wishes,

Conveners

(Dr. (Mrs.) J. K. Rai)
Scientist 'E
Chhattisgarh Council of Science & Technology (CCOST), Raipur

(Dr. Punya Prasanna Paltani)
Associate Professor
DSPM International Institute of Information Technology (IIIT), Naya Raipur

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Agricultural Engineering/ Technology

Ag-Doped ZnO Nanocomposite for the Photocatalytic Degradation of Agricultural Pollutants

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Abstract: Nanotechnology is the powerful platform for scientific advancements. This work was undertaken to synthesize Ag Doped ZnO nanocomposite using inexpensive wet chemical methods and to investigate the photocatalytic degradation of agricultural pollutants. The surface morphology of the nanocomposite was studied by scanning electron microscopy (SEM) and high-resolution transmission electron microscopy (HR-TEM). The structural study was done by XRD and functional groups were analyzed by FTIR. The changes in structural and optical properties of Ag Doped ZnO nanocomposite resulted in the exceptional photocatalytic activity. The hydroxyl radical contributes notably in photocatalytic degradation of the pollutants. Some of the common agricultural pollutants such as endosulfan, methiocarb, Malathion etc. were studied with the Ag doped ZnO nanocomposite.

Development of a Climate-Responsive Watershed Health Index Integrating Machine Learning for Sustainable Water Resource Management in the Kharun Catchment Chhattisgarh

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Abstract: Climate change and rapid land use transformation are increasingly altering hydrological regimes in agricultural watersheds, posing serious challenges to long-term water security and soil sustainability. This study develops a Climate-Responsive Watershed Health Index (CR-WHI) by integrating machine learning -based hydrological modeling with multi-criteria decision analysis to evaluate water resource sustainability in the Kharun catchment, Chhattisgarh. A 30-year hydro-meteorological dataset (1992–2022), including discharge, sediment yield, rainfall, and temperature records, was analyzed to capture nonlinear climate hydrology interactions. Sensitivity analysis identified rainfall, minimum temperature, and maximum temperature as dominant climatic drivers controlling hydrological variability. The XGBoost model demonstrated strong predictive performance for water yield (NSE = 0.91; R^2 = 0.94) and sediment yield (NSE = 0.89; R^2 = 0.95) during calibration and validation. Future projections under SSP2-4.5 and SSP5-8.5 scenarios indicate pronounced seasonal redistribution of water yield, characterized by intensified post-monsoon flows and declining early monsoon stability. Land use analysis (1992–2022) revealed forest decline and settlement expansion, contributing to a nearly 190% increase in annual sediment yield. The CR-WHI integrates eleven hydrological, ecological, and soil indicators through Analytic Hierarchy Process (AHP) weighting to delineate watershed health classes. Spatial assessment shows that 85.51% of the basin falls under moderate health, 4.85% of the basin falls under low health conditions, whereas 9.61% demonstrates high watershed health. while critical low-health zones require priority conservation. The developed framework offers a climate-sensitive decision-support tool for resilient watershed management and sustainable agricultural water planning.

Development of upma premix and composite flour from kodo millet and finger millet

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Abstract: The goal of this study was to encourage the incorporation of millets in the diet because of their high nutritional profile, especially their protein content and important vitamins and minerals. Kodo millet and finger millet were used to create value-added food items. Before formulation, a mechanical pulveriser was used to turn the millets into flour and semolina.

Instant kodo upma premix was formulated using 3 combinations, viz., U1 (75% kodo semolina + 15% suji), U2 (50% kodo semolina + 50% suji), U3 (15% kodo semolina + 75% suji). Khakhra was prepared by using 3 formulations of composite flour, viz., C1 (25% ragi flour + 25% kodo flour), C2 (15% ragi flour + 35% kodo flour) and C3 (35% ragi flour + 15% kodo flour). Sensory evaluation of the formulations was done to arrive at the desired consumer acceptable product.

Milling and pulverizing efficiency was 69.65% and 81.16%, respectively. Bulk density of raw kodo millet, raw finger millet, brown kodo rice, polished kodo rice, kodo semolina, kodo flour, ragi flour were found to be 657.40 kg/m3, 893.33 kg/m3, 723.87 kg/m3, 755.80 kg/m3,657.80 kg/m3, 614.53 kg/m3, 594.27 kg/m3, respectively and for kodo upma premix and composite flour were 730 kg/m3 and 1120 kg/m3, respectively. Rehydration ratio of kodo upma premix was 3.4. Sensory evaluation showed that the overall acceptability of formulation U1 (8.4) and C1 (7.75) was highest. Proximate analysis revealed that kodo upma premix contained 8.0% moisture, 6.73% protein, 1.1% fat, 2.0% ash, 9.0% fibre, 73.17% carbohydrate and contribute 334.9 kCal per 100 g and composite flour contained 9.99% moisture, 8.83% protein, 5.3% fat, 1.1% ash, 15.0% fibre, 59.78% carbohydrate and contribute 322.14 kCal per 100g energy. It was thus concluded that incorporation of minor millets in processed form for the development of value-added products is highly acceptable with well comparable processing and nutritional quality.

Ergonomic Evaluation of Selected Combine Harvesters for Chhattisgarh Agricultural Workers

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Abstract: The rising use of combine harvesters has also raised concern regarding the discomfort experienced by the operators of Chhattisgarh due to ergonomic design and anthropometric incompatibility, due to pronounced differences observed between Chhattisgarh population and other regions of the country. During peak harvesting seasons, the operators are required to work for more than 16 hours a day under harsh environmental conditions. Hence, the design of the workplace is very important for the safe working efficiency of the operators. In the present study, the workplace design of thirteen different commercially available combine harvesters with regard to the frequency of use of major controls and anthropometric characteristics of agricultural workers of the state of Chhattisgarh was evaluated. Results found that, while approximately 61% of the machines conformed to standard norms, the location of most hand controls was outside the convenient reach zone for Chhattisgarh operators. The leg controls were more convenient in horizontal and lateral directions, but not in vertical direction. The study concluded that the current workplaces for the combine harvesters operators are in need of redesigning from an ergonomics perspective for the improvement of operators comfort, safety and work efficiency in the region of Chhattisgarh.

Keywords: Workplace, Combine harvesters, Chhattisgarh population, Ergonomics, Anthropometric dimensions.

Structural, Optical, and Electrical Properties of Corn-Derived Graphene Quantum Dots via Green Synthesis

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Abstract: Graphene quantum dots (GQDs) were synthesized by using an environmentally friendly procedure using maize powder as a renewable bio-precursor through a simple hydrothermal technique. The procedure eradicates hazardous reagents and provides an economical, sustainable, and scalable production pathway. The synthesized GQDs demonstrated stable, size-dependent solubility in aqueous solutions. X-ray diffraction identified a distinct peak at $2\theta = 18.78°$, indicative of the graphitic phase, with an average crystallite size of approximately 8.7 nm determined via the Scherrer equation. The UV–visible spectra exhibited prominent absorption bands in the 200–260 nm range, attributed to $\pi \rightarrow \pi^*$ transitions of aromatic C=C bonds and $n \rightarrow \pi^*$ transitions of carbonyl groups. Strong green photoluminescence under UV excitation confirmed size- and defect-dependent emissive behavior. Raman examination revealed significant D and G bands, signifying defect-rich sp2 carbon domains, whereas FTIR validated the existence of oxygen-containing functional groups, including hydroxyl, carbonyl, and carboxyl moieties. SEM images displayed crumpled, porous sheet-like structures, while EDX confirmed carbon and oxygen as the predominant constituents. HRTEM further revealed uniformly distributed nanoscale quantum dots exhibiting distinct lattice fringes, hence proving enhanced crystallinity. Dielectric and electrical investigations across extensive frequency and temperature ranges revealed significant decrease in capacitance, permittivity, and dielectric loss, influenced by Maxwell–Wagner interfacial polarization and thermally induced dipolar relaxation. Cole–Cole, electric modulus, impedance, and AC conductivity investigations demonstrated non-Debye relaxation and charge transport dominated by hopping mechanisms. The combination of these features underscores corn-derived GQDs as promising multifunctional nanomaterials for capacitors, dielectric energy storage, sensing, and advanced electronic applications.

Agriculture Sciences

A study on the distribution pattern of Genus Stenomesius Westwood (Hymenoptera: Eulophidae) from Chhattisgarh

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Abstract: The genus Stenomesius Westwood was studied in different natural and agricultural ecosystem of Chhattisgarh. This study was conducted from October 2018 to February 2020. At present 22 specimens are studied from Chhattisgarh. The distribution pattern of Stenomesius Westwood was analyzed and digitized. It is distributed in five biogeographic realms, namely: Nearctic, Neotropical, Afrotropical, Oriental and Australasia. In India, it had been reported from Bihar, Delhi, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, Uttarakhand and Karnataka. In present study, it was reported from Jashpur, Balrampur, Mahasamund, Dhamtari, Gariyaband, Surguja Korba, Raipur and Jagdalpur districts of Chhattisgarh.

An Empirical Study of Price Volatility and Risk Mitigation Techniques in Indian Agricultural Markets

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Abstract: Indian agricultural commodity markets are characterised by considerable price volatility, driven by seasonality, crop variability, and policy interventions. Empirical evidence suggests the presence of strong seasonal variations and volatility clustering in the prices of major agricultural commodities, such as onions and wheat, in organised markets (Sinha et al., 2023; Yeasin et al., 2024). In addition, econometric analysis confirms the presence of instability and spatial transmission in the wholesale wheat markets, pointing to structural inefficiencies and difficulties in integrating these markets (Thakur et al., 2019). Price volatility hurts small and marginal farmers the most, impacting their income and investment opportunities. Institutional interventions, such as the MSP system, offer a partial price guarantee, but procurement is concentrated in a few crops and regions. Market-based instruments, such as commodity futures and derivatives trading, are important for price discovery and information transmission between spot and futures markets (Garg et al., 2023). Empirical studies show that futures trading may play a role in reducing price uncertainty in the long term, which can improve market efficiency (Shekhawat & Singh, 2025). Other instruments, such as warehouse receipt financing, contract farming, crop insurance, and FPOs, enhance farmers' bargaining power and their capacity to share risks. The research has concluded that a holistic price risk management strategy, which incorporates support policies, financial instruments, digital market intelligence, and institutional support, is required to manage the volatility and improve the resilience of the Indian agricultural markets.

Biochemical profiling and SSR Marker Validation for Albumin and total protein content under water stress and Non-stress condition in rice (Oryza sativa L)

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Abstract: Rice (Oryza sativa L), is an important food crop extensively cultivated in Chhattisgarh covering an area of more than 3.7 million ha. Rice requires more than 2500 liters of water to produce one Kg of rice. With the climate change impact. In the past lots of efforts are being done for breeding for drought tolerance including applications of various biotechnology tools mainly MAS, which has also resulted in developing drought tolerant varieties and released for cultivation. From IGKV, Indira Barani Dhan 1, Chhattisgarh Dhan 2 has been specifically released for rainfed situations of Chhattisgarh. Rice is a major source of dietary protein. Among different protein fractions, albumin and total protein significantly contribute to the nutritional quality of rice. Albumin is a water-soluble fraction of total protein, and its content, although in rice, is only about 10-15% of total protein, but varies significantly with moisture content of the plant. Thus, this can be a good marker for moisture content of plants and also the indirect indicator for drought tolerance. In this study, two different populations, one recombinant inbred line population and another a panel of selected germplasm, were evaluated under water stress as well as normal conditions for two consecutive years 2022 and 2023 during Kharif season. Estimation of albumin and total protein, using Lowry's methods, along with field evaluation of rice RILs and genotypes for drought tolerance (based on grain yield under stress). The association analysis showed that certain QTL -linked markers and reported markers exhibited significant association with 19 markers RM 174, HvSSR9-57 etc. The total protein is 17 markers with RM 492, RM 1248, etc. Considerable variation was observed among the for both traits. They aimed at improving yield (drought tolerance) and protein quality in rice. The correlation analysis revealed the association of albumin with drought tolerance. The data pertaining to this study will be presented.

Chemical composition and qualitative analysis of vetiver essentials oil under different levels of treatment in a sandy-loam soil

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Abstract: The present study investigated essential oil yield, quantitative and qualitative parameter of three distinct cultivars of vetiver grass (Chrysopogan zizaniodes L. Robert) vitz:V1: Kesari,V2: Vridhi,V3: KS-1 under seven different levels of treatments vitz: T1(control), T2 FYM + (N40 +P30+K20 Kg ha-1), T3 FYM+(N50+P40+K30 Kg ha-1), T4 FYM+(N60+P50+K40 Kg ha-1), T5(Water Stress), T6(Water Saturated), T7(Water Flood) with 21 treatment combinations, replicated thrice under Peltafourm plantation at Forestry nursery Guru Ghasidas Vishwavidyalaya Bilaspur C.G. The DMRT was used for multiple comparisons of means at P ≤0.05, and one-way (ANOVA) was used to examine significance level by SPSS. Findings revealed that application of treatment (T4) 28.23±1.39a kg ha-1and varieties (V2) 24.83±0.96a positively influence the essential oil yield of vetiver grass. Among the different treatments maximum aromatic compounds were found under (T4V1). The major compounds recorded were Aromadendrene oxide-(1), Cedren-13-ol 8-, γ-Gurjunenepoxide-(2), γ-costol, Longipinocarveol, trans-, γ-Himachalene, (-)-Isolongifolol, acetate, Eudesma-4,11-dien-2-ol, geranyl-α-terpinene, Thoujin, β-Nootkatol, (-)-Spathulenol, and β-Guaiene etc. The quality parameters of vetiver oil obtained was nearer to the BIS standards in different treatment and varietal effects The parameter of oil quality such as colour was brown reddish to light yellow, odour was distinct with varieties and treatments, Specific gravity ranged between 0.99546 and 1.00965, Refractive index was 1.5067 to 1.5214, and acid value was 35.07 to 39.74. It can be concluded essential oil yield, maximum area percent of chemical composition and oil quality parameters were found maximum in V2 (Vridhi) cultivar, among the treatments (T4) FYM@10 tha-1 +N60+P40+K40 kg ha-1 as well as their interaction T4×V2 well-suited as compared to others.

Chemopriming Mediated Salinity Stress Alleviation In Rice

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Abstract: Rice (Oryza sativa L.) is a principal staple crop sustaining the dietary requirements of more than 1.6 billion people worldwide. However, its productivity is severely constrained by abiotic stresses, among which salinity is a major limiting factor affecting rice cultivation across diverse agroecological regions. The present study evaluated the potential of magnesium citrate and potassium citrate as seed-priming agents to mitigate salinity-induced stress in rice seedlings. Salinity stress was imposed using sodium chloride (NaCl) at a concentration of 3 g L^{-1}, which markedly inhibited seedling growth, as evidenced by significant reductions in shoot length, root length, root number, and seed vigor index. In contrast, seed priming with magnesium citrate (200 mg L^{-1}) and potassium citrate (150 mg L^{-1}) substantially alleviated the adverse effects of salinity by enhancing key morphological attributes, including shoot and root elongation, root proliferation, and overall seed vigor in primed seedlings. Biochemical analyses revealed that citrate-primed seedlings accumulated higher levels of total sugars, soluble sugars, and total proteins compared to salt-stressed controls, indicating improved metabolic activity and osmotic adjustment. Furthermore, antioxidant enzyme activities, including catalase (CAT), ascorbate peroxidase (APX), and superoxide dismutase (SOD), were significantly elevated in primed seedlings, reflecting the activation of an efficient antioxidative defense system under saline conditions. Similar morphological results were observed in the greenhouse experiment. Collectively, these findings demonstrate that seed priming with magnesium citrate and potassium citrate effectively mitigates salinity-induced damage by improving morphological growth, germination indices, carbohydrate metabolism, and antioxidant capacity, thereby enhancing salinity tolerance in rice seedlings.

Climate-Smart Agricultural Technologies as Pathways to Risk-Resilient Farming: Evidence from the Chhattisgarh Plain Zone

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Abstract: Agriculture in Chhattisgarh is highly vulnerable to climate-induced risks due to its heavy dependence on monsoon rainfall, dominance of small and marginal farmers, and limited irrigation infrastructure. Increasing rainfall variability, frequent dry spells, and extreme weather events have intensified production uncertainty, resulting in yield instability, crop failure, and income shocks. Climate-Smart Agricultural Technologies (CSATs) are increasingly promoted as adaptive solutions to enhance resilience and reduce climate-related farming risks. The present study examines the role of climate-smart agricultural technologies as risk-reduction tools for farmers in the Chhattisgarh Plains agro-climatic zone.

The study is based on primary data collected from approx. 120 farmers selected from Bemetara and Rajnandgaon districts. Farmers were categorized into adopters and non-adopters of climate-smart technologies such as Direct Seeded Rice, System of Rice Intensification, drought-tolerant varieties, residue mulching, and in-situ soil moisture conservation practices. Risk was assessed using indicators including yield variability, crop failure incidence, income shock frequency, and farmers' perception of climate risk. The study also identifies constraints in adoption and suggests policy measures for scaling climate-smart agriculture.

The results indicate that adopters experienced lower yield variability, reduced crop failure incidence, fewer income shocks, and improved confidence in managing climate uncertainty compared to non-adopters. The study concludes that climate-smart agricultural technologies, supported by institutional interventions, play a significant role in mitigating climate-induced risks and enhancing farm resilience in Chhattisgarh.

Developing Uniform, Export-Ready Non-Basmati Aromatic Rice Varieties Using Speed Breeding Strategies

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Abstract: Aromatic rice is highly valued for its distinctive fragrance and premium market demand; however, achieving genetic uniformity through conventional breeding requires several generations of selfing. The present study aimed to standardize an efficient doubled haploid (DH) production protocol in aromatic rice using another culture. Panicles at the mid- to late-booting stage (5–8 cm distance between flag leaf and penultimate leaf) were collected and subjected to cold pretreatment at 4 ± 1°C for 8–10 days to enhance androgenic response. Anthers cultured on N6 medium supplemented with maltose (30 g L^{-1}) and 2,4-D (2 mg L^{-1}) showed the highest callus induction in Dubraj (31.24%), followed by Badshah Bhog (26.54%) and Jeera Phool (24.36%). Regenerated 2–4 mm calli were transferred to MS medium with optimized growth regulator combinations for greening. The highest greening response was recorded in Dubraj (13.79%) on ½ MS with sucrose (15 g L^{-1}), BAP (1.5 mg L^{-1}), Kn (0.5 mg L^{-1}), and NAA (0.5 mg L^{-1}). Jeera Phool (11.50%) and Badshah Bhog (11.21%) responded best on maltose-supplemented MS media. However, a significant proportion of regenerated plantlets were albino. MS medium containing BAP (2.0 mg L^{-1}) and Kn (0.5 mg L^{-1}) proved superior for shoot induction, while MS with NAA (1.0 mg L^{-1}) enhanced rooting. Optimized acclimatization improved ex vitro survival. The standardized protocol enhanced callus induction and green plant regeneration efficiency, providing a reliable system for rapid homozygosity induction and accelerated aromatic rice improvement.

Enhancing Bacterial Leaf Blight Resistance in Mahamaya via Marker-Assisted Gene Introgression

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Abstract: Bacterial leaf blight (BLB), caused by Xanthomonas oryzae pv. oryzae is a major constraint to rice productivity, particularly in susceptible but widely cultivated varieties. The present study focused on the marker-assisted introgression of three major BLB resistance genes (xa5, xa13 and Xa21) from the donor parent Improved Samba Mahsuri into the popular Chhattisgarh variety, Mahamaya through marker-assisted backcross breeding (MABB).

True F_1 hybrids were confirmed using gene-specific markers xa5R, xa13pro and pTA248. Out of ten F_1 plants, seven were validated as heterozygous for all three target genes and were backcrossed with Mahamaya to generate BC_1F_1 progenies. Foreground selection in subsequent generations enabled identification of plants carrying the desired gene combinations. In BC_1F_1, four plants possessed all three resistance genes, while seven triple-positive plants were recovered in BC_2F_1. These selected plants were advanced to BC_3F_1 and BC_2F_2 generations. In BC_3F_1, six plants were confirmed to harbor xa5, xa13 and Xa21 simultaneously.

Artificial inoculation of BC_2F_2 lines with a virulent BLB isolate revealed effective resistance in gene-pyramided plants, whereas the recurrent parent Mahamaya exhibited high susceptibility. The results demonstrate the successful introgression and pyramiding of multiple BLB resistance genes into the Mahamaya background using marker-assisted selection. The identified advanced backcross lines provide promising genetic resources for developing durable BLB-resistant cultivars without compromising the desirable agronomic traits of the recurrent parent.
Keyword: Bacterial leaf blight, Mahamaya, Improved Samba Mahsuri, marker-assisted backcross breeding, gene pyramiding, xa5, xa13, Xa21

Exploring the Native Rhizosphere Flora: Metabolic and Genomic Profiling of Aeromonas hydrophila

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Abstract: Chhattisgarh state is known as the Rice bowl of India. A diverse range of rice varieties are grown in the area. The rhizosphere soil microflora plays an important role in plant growth and survival. Some of them show a mutual relationship with plants. The present study is focused on the evaluation of rhizosphere soil isolate Aeromonas hydrophila for its plant growth promoting characters. The strain seems metabolically versatile and produces siderophore, auxin, protease, ammonia and can solubilize minerals like zinc, phosphate etc. The cell-density dependent signalling (quorum sensing), colonization potential (biofilm formation) and heavy metal chelation are also evident in this strain. The metabolic profile is consistent with the genomic profile of reference strain. For genomic profiling, operon mapper software was used along with the NCBI database. Exploring native microbes gives added advantage for better adaptability and enhanced benefits to native crops.

Keywords: Rhizosphere, Siderophore, Aeromonas hydrophila, operon mapper

Haplotype-Based Identification of Nutrient Efficient Rice Genotypes for Climate-Resilient Rice System

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Abstract: Nitrogen use efficiency (NUE) and phosphorus use efficiency (PUE) need to be enhanced for improving the sustainability of rice cultivation under the scenario of rising fertilizer prices. Higher dependence on nitrogen-based fertilizers has resulted in low nutrient use efficiency and has also enhanced the level of greenhouse gases. Phosphorus availability also limits productivity and fertilizer security. Therefore, identifying nutrient-efficient genotypes for direct-seeded rice cultivation is a research priority. The present research evaluated a diverse set of 109 rice genotypes under direct-seeded and transplanted establishment conditions across two seasons. Agronomic, biomass, and nutrient-related traits, including grain yield, nutrient concentration, N and P uptake, and nutrient-use efficiency indices, were assessed. Candidate gene-based haplotype analysis was conducted for selected nitrogen and phosphorus-related genes. Haplotype-phenotype associations were examined using ANOVA followed by false discovery rate (FDR) correction, Tukey's post-hoc test, confidence interval estimation, and partial eta squared (η^2) to quantify gene effects. Genes exhibiting robust haplotype effects were subjected to Variant Effect Predictor (VEP) annotation. Significant genotypic variation was observed for NUE, PUE, and nutrient uptake traits. NUE and PUE exhibited positive correlations with grain yield. Haplotype analysis identified distinct allelic combinations associated with nutrient efficiency traits, with certain superior haplotypes supported by functional variant annotations. Notably, haplotype effects showed establishment-method-specific responses. These findings highlight valuable genetic resources for breeding nutrient-efficient rice varieties and emphasize the importance of system-dependent genetic effects under contrasting crop establishment methods.

Herbicide-induced changes in soil biological indicators: Dehydrogenase activity (DHA) and microbial biomass carbon (MBC)

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Abstract: As farmers continue to realize the usefulness of herbicides, larger quantities are applied to the soil but the fate of these compounds in the soil is becoming increasingly concern that herbicides not only affect the target organisms (weeds) but also the microbial communities present in soils and these non-target effects may reduce the performance of important soil functions as indicated by determinations of dehydrogenase activity (DHA) and microbial biomass carbon (MBC). In view to above an investigation was conducted to assess the effect of various herbicides on enzymatic and microbial activities of soil under chickpea cultivation during rabi (winter) season of 2021-22 and 2022-23 at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, situated in the eastern plateau and hills zone of India. Top soil sample were collected from a depth of (0-3 cm) from each plot. The dehydrogenase activity of soil was described by Klein et al. (1971) and microbial biomass carbon was determined by fumigation and extraction method (Vance et al., 1987). The results revealed that, there was an increase in dehydrogenase enzyme activity (DHA) in chickpea rhizosphere soil from 0 to 60 DAS followed by a decrease up to harvest was noticed in all the treatments except the treatments received pre and post emergence application of herbicides. Significantly highest DHA (52.0, 56.5, 63.6, 76.5 and 42.8 µg TPF h-1 g-1 soil) and MBC (254.9, 262.5, 297.3, 315.7 and 230.3 µg g-1 soil) was observed under treatment unweeded control, being at par to treatment, two hand weeding at 15, 30, 45, 60 DAS and at harvest, respectively, both were found significantly superior over herbicide applied plots i.e. oxyfluorfen 250 g ha-1 (PE), oxyfluorfen 150 g ha-1 (PE), metribuzin 350 g ha-1 (PE), quizalofop-p-ethyl 100 g ha-1 (PoE), propaquizafop 100 g ha-1 (PoE) and topramezone 20.6 g ha-1 (PoE), which may be due to the degradation of applied herbicide.

Influence of Grafting and Gibberellic Acid (GA_3) Levels on Growth and Yield of Tomato (Solanum lycopersicum L.)

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Abstract: A field experiment was conducted during 2025–26 at the Department of Horticulture, College of Horticulture and Research Station, Ramanujganj, Balrampur, MGUVV, Durg (C.G.) to evaluate the effect of grafting and different levels of GA3 on growth and yield of tomato (cv. Sahoo). The experiment was laid out in a Randomized Block Design (RBD) with three replications and eight treatments. Splice grafting was adopted following the standard procedure. The results revealed that grafting of tomato on Solanum torvum rootstock significantly improved growth, earliness and yield attributes. Grafted plants recorded higher plant height (66.87 cm), more branches per plant (12.50), earlier first harvesting (74.75 days) and a higher number of fruits per plant (20.59) compared to ungrafted plants. Fruit size and yield were also markedly enhanced under grafting, with higher fruit polar diameter (12.61 cm), equatorial diameter (6.90 cm), fruit weight (130.32 g), fruit yield per plant (2.70 kg) and fruit yield per hectare (50.31 t ha^{-1}). Among the treatment combinations, Solanum torvum grafted plants supplied with GA3 @ 75 ppm recorded the highest plant height (71.07 cm), number of fruits per plant (25.67), fruit yield per plant (3.47 kg) and fruit yield per hectare (64.71 t ha^{-1}). Although the interaction between grafting and GA3 levels was non-significant, their combined application produced substantial cumulative improvements. Thus, grafting tomato cv. Sahoo onto Solanum torvum along with GA3 @ 75 ppm proved most effective for maximizing productivity under the present agro-climatic conditions.

Keywords: Grafting, GA3 Level Solanum torvum. Splice,

N-CQDs Based Fluorometric, Colorimetric and Paper-Based Detection of Vitamin B6 In Green Leafy Vegetables

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Abstract: Nitrogen-doped carbon quantum dots were synthesized through a hydrothermal method using m-phenylenediamine and urea as precursor materials. N-CQDs was successfully employed as fluorometric, colorimetric, and paper-based sensing probes for selective detection of vitamin B_6. The interaction between N-CQDs and vitamin B_6 resulted in distinct fluorescence quenching and visible color change of CQDs, is attributed to the strong hydrogen bonding and electrostatic interactions. The mechanism for selective detection of B6 is experimentally confirmed by UV–Vis, fluorescence spectroscopy, FTIR, XPS, and TEM analyses. A good linear range of fluorometric and colorimetric determination of B6 was 0.01–3.0 µg mL^{-1} and 0.01–2.0 µg mL^{-1} with limits of detection of 0.005 and 0.008 µg mL^{-1}, respectively. Furthermore, a smartphone-assisted digital imaging for on-site detection with minimal reagent consumption and satisfactory analytical performance. The practical applicability was validated by successful analysis of vitamin B_6 in green leafy vegetables such as Amaranthus viridis, Clerodendrum indicum, Alternanthera sessilis, Chenopodium album, and Albizia lebbeck samples with good recoveries and results comparable to HPLC analysis. Overall, the developed N-CQDs-based sensing platform provided the simple, sensitive, and portable alternative for vitamin B_6 analysis in food samples.

Nitrogen-Efficient Rice for Direct-Seeded Systems under Dry Spell Conditions of Chhattisgarh

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Abstract: Improving nitrogen use efficiency (NUE) is critical for sustainable rice production, particularly under direct-seeded rice (DSR) systems where nitrogen availability and water supply are highly variable. The study is particularly pertinent to Chhattisgarh, where recurrent dry spells and intermittent water scarcity necessitate rice varieties adapted to low-input, water-limited conditions. In this study, 109 rice accessions, predominantly early- to medium-duration genotypes capable of escaping peak terminal stress, were evaluated over two wet seasons under nitrogen-deficient rainfed DSR and nitrogen-sufficient transplanted rice (TR) systems. Agronomic traits, tissue nitrogen concentrations, nitrogen uptake, and multiple NUE indices were analyzed using mixed-model and multivariate approaches. DSR significantly reduced biomass, grain yield, and total nitrogen uptake compared to TR; however, it consistently enhanced flag-leaf nitrogen remobilization efficiency. Under DSR, grain yield was more strongly associated with nitrogen partitioning and internal utilization traits than with total nitrogen uptake, indicating that efficient internal nitrogen recycling is crucial under stress-prone conditions. Haplotype analysis of 36 NUE-related candidate genes revealed significant, environment-specific effects for GS1.2, NAL1, and OSA1 under DSR, influencing nitrogen assimilation and redistribution traits. Overall, the findings demonstrate that improving internal nitrogen utilization and remobilization is key to developing climate-resilient, nitrogen-efficient rice varieties suited for direct-seeded systems in regions like Chhattisgarh.

Quantitative analysis of grain arsenic content in diverse rice accessions and its impact on daily dietary intake

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Abstract: Rice serves as the principal dietary staple in Chhattisgarh, with nearly 80% of the population relying predominantly on rice as their primary source of daily caloric intake. Given the region's substantial reliance on rice as a dietary staple, evaluating its safety and associated health risks is of paramount importance. Chronic dietary exposure to arsenic represents a significant health hazard, as arsenic is a toxic metalloid classified as a Group I human carcinogen. Continuous consumption of arsenic contaminated rice can have cumulative harmful effects, which poses significant public health hazards in areas with natural arsenic contamination. This study investigates arsenic accumulation in rice grains grown in the natural arsenic-contaminated region of Mohla-Manpur-Ambagarh Chowki, Chhattisgarh. A comprehensive evaluation was conducted on 120 genetically diverse rice genotypes, comprising landraces, released cultivars, and mutant lines, to quantify grain arsenic concentration and to assess the associated dietary exposure risk at Muletitola village. The findings revealed alarming levels of arsenic accumulation in rice grains (0.61 mg kg-1) surpassing the minimum permissible limit, with the calculated average daily intake (ADI) of arsenic of 4.575 µg/kg body weight/day. This value significantly exceeds the maximum ADI threshold of 2.1 µg/kg body weight/day as set by the Codex Alimentarius Commission. Such high levels of dietary arsenic intake through rice consumption present serious health concerns for the local population. Khatiyapati and Falod Dhan were identified as low As-accumulating genotypes and were selected for mutation breeding. Khatiyapati has been identified to be the second lowest arsenic accumulating genotype after Muktoshree, while Falod Dhan has progressed to IVT-IME, AICRP trial. This study emphasizes how critical it is to find rice genotypes that accumulate low arsenic and put into practice efficient mitigation strategies to lower arsenic exposure.

Sorption And Leaching Potential of Chlorantraniliprole in Two Distinct Rice Growing Soils

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Abstract: Microcosm investigations were conducted to study sorption behaviour and leaching potential of chlorantraniliprole in two common types of Indian soil. Adsorption isotherms of S-type were obtained in both the tested soil type and data were well fitted into the Freundlich model. The result showed strong adsorption of chlorantraniliprole with Kf value of 1.43 and 1.32 and 1/n value as 1.29 and 0.57 in inceptisol and alfisol, respectively. Higher sorption of chlorantraniliprole occurred in inceptisol (34.88 %) as compared to alfisol (24.68%). Sorption of chlorantraniliprole was greater in inceptisol due to its higher organic matter and clay content as compared to alfisol. The data from the leaching study indicated that chlorantraniliprole was a slightly mobile insecticide and its mobility is higher in alfisol than inceptisol. The quantity of chlorantraniliprole in leachate ranged from 437.53 to 1776.18 µg. Also, downward transport of CAP in the soil column was increased with application of large rainfall events. It could be concluded from the study that adsorption of CAP was strongly influenced by soil physiochemical properties and leaching of CAP was positively correlated with the amount of rainfall.

Keywords: Adsorption coefficient, chlorantraniliprole, leaching, inceptisol, alfisol

Jackfruit Seed Flour a Promising Alternative to Traditional Starch Flours with Nutritional Benefits

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Abstract: The investigation was undertaken at the Horticulture Processing Laboratory Department of Fruit Science, College of Agriculture, Indira Gandhi Agricultural University, Raipur (C.G.), India during the year 2019-2020 and at Horticultural Laboratory, RMD CARS, Ambikapur (C.G.),India during the year 2020 -2021. This research work has been executed to demonstrate the processing as well as shelf life of newly prepared jackfruit seed flour.The biochemical parameters such as total soluble solids, total sugar, reducing and non reducing sugar were found in food grade level.The observed pH, acidity and ascorbic acid of the product were in acceptable limit.

Keywords: Jackfruit seed flour, processing, shelf life, biochemical parameters.

Strategic Integration of Mutation Breeding and Double Haploid Technology for Next-Generation Niger (Guizotia Abyssinica L.F. Cass) Improvement.

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Abstract: Niger (Guizotia abyssinica L.F. Cass) is an underutilized oilseed crop characterized by narrow genetic base and limited breeding interventions. The present study explores the integration of gamma-induced mutagenesis with doubled haploid (DH) technology to accelerate variability generation and rapid trait fixation in niger. Seeds of three varieties (JNS-28, JNS-30, and JNS-9) were irradiated with 250 Gy and 500 Gy, alongside a control. While 500 Gy was lethal, 250 Gy effectively induced variability, with JNS-28 showing satisfactory germination and was advanced through M1 to M4 generations with systematic selection. Promising M4 mutant lines were identified, offering significant improvement in key yield-attributing traits, including plant height, early flowering, increased number of capitula per plant and larger capitulum size compared to the control. To accelerate genetic stabilization, another culture was initiated at both M3 and M4 stages to assess generation dependent androgenic response for doubled haploid production. Although M3 derived regenerants didn't survive during cultural conditions, M4 entries exhibited superior in vitro response with early shoot regeneration within 2nd to 4th sub culturing stage compared to control lines and successful rooting and reached the hardening stage, although acclimatization survival requires further optimization. This study establishes a novel and integrated breeding pipeline for Niger improvement, combining induced mutagenesis and haploid technology for rapid genetic gain. The identified mutant lines hold strong potential for varietal development; therefore future efforts will focus on acclimatization & DH seed recovery, multi-location evaluation and conducting molecular validation of fixed traits to facilitate accelerated release of high yielding Niger cultivars.

Synergistic insecticidal efficacy of nano-chitosan-based formulation of spinetoram against fall Armyworm, Spodoptera frugiperda infesting maize

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Abstract: The present study evaluated the insecticidal efficacy of nano-chitosan, applied alone and in combination with spinetoram, against fall armyworm, Spodoptera frugiperda (Smith), a destructive invasive pest of maize. Chitosan was extracted from spent pupal waste of the tasar silkworm, Antheraea mylitta. This extracted chitosan was further utilized to biosynthesize nano-chitosan through cross-linking of cationic chitosan with cinnamaldehyde, resulting in the formation of stable chitosan nanoparticles. The synthesized nanoparticles were characterized using Scanning Electron Microscopy (SEM), UV–Visible spectroscopy, and Fourier-Transform Infrared Spectroscopy (FTIR) to confirm their morphological and physicochemical properties. Laboratory Bioassays were conducted using a diet impregnation method against third instar larvae of fall armyworm to assess the toxicity of nano-chitosan alone and in combination with the recommended dose (RD) of spinetoram. Nano-chitosan alone exhibited moderate insecticidal larvicidal activity; however, its combination with RD of spinetoram produced a pronounced synergistic larval mortality. The enhanced efficacy suggests that nano-chitosan may function as a synergistic carrier and has the potential for nano-based insecticide delivery while reducing reliance on higher chemical doses as a sustainable crop protection strategy.

Ultrastructural and Genetic Analysis of Starch Organization in Rice for Low Glycemic Index Improvement without compromising palatability and cooking quality

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Abstract: The glycemic index (GI) of rice constitutes a multifaceted trait, influenced by the amylose content (AC), dimensions, and structural packaging of starch granules (SG). Although low-GI rice genotypes have been developed, their typically high amylose content often leads to suboptimal taste and texture, making them less desirable to consumers. In this investigation, the electron microscopy analysis of starch morphology across nine rice genotypes having a range of AC (6.93–36.9%) and predicted GI (pGI: 41.07–82.46), indicating that a reduced SG surface area (20.06 µm²) and irregular morphology (Hap 3-3 P-11, pGI=41.07) correlate with lower pGI, whereas an increased SG surface area (47.68 µm²) and spherical configuration relate to elevated pGI (NON-HAI, pGI=82.46). The expression profiles of genes associated with starch biosynthesis and packaging (OsSSIIb, OsSSIIc, OsSBEIIa, OsISA1, OsISA3, OsGBP, OsFLO6, and OsBT1) demonstrated that the downregulation of the OsGBP and OsISA3 genes in low pGI lines IRRI-147 (pGI=56.2) and Hap 3-1-p-18 (pGI=41.79), respectively, was noteworthy. Conversely, a heightened expression level of the OsBT1 gene in Makro (pGI=59.06) and OsSSIIb in Swarna (pGI=58.06) was recorded. Despite all these genotypes exhibiting similar AC (~30%), the variations in expression patterns were associated with starch granule morphology, thereby suggesting its influence on pGI. Furthermore, the analysis of allelic variation in eight starch-related genes across twenty rice genotypes indicated that allelic variants of only OsGBP were significantly correlated with AC, wherein allele group 2 demonstrated a lower AC (9.62%), while all other allele groups consistently exhibited high AC (22–24%). These findings underscore the pivotal role of starch granule morphology and OsGBP allelic variation in determining AC and GI, thereby offering valuable insights for the development of low GI rice varieties utilising genetic editing to develop rice varieties with low GI.

Biology (Botany, Zoology, Chemical Biology)

DETERMINATION Of 96-Hour LC_{50} Value Of Ferrous Sulphate ($FeSO_4$) In Pangasius Pangasius Using Probit Analysis

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Abstract: The present study evaluated the acute toxicity of ferrous sulphate ($FeSO_4$) to Pangasius pangasius under laboratory conditions using a 96-hour static bioassay. Fish were exposed to five different concentrations (80, 100, 120, 140 and 160 mg L^{-1}) and mortality was recorded at the end of the exposure period. A clear concentration-dependent increase in mortality was observed, ranging from 10% at 80 mg L^{-1} to 90% at 160 mg L^{-1}. Probit regression analysis was performed by transforming percentage mortality into probit units and relating them to log-transformed concentrations. The regression equation obtained was Y = -11.85 + 8.15X and the calculated 96-hour LC_{50} value of $FeSO_4$ for Pangasius pangasius was 116.55 mg L^{-1}. The empirically observed 50% mortality at 120 mg L^{-1} closely supported the regression-derived estimate, confirming the reliability of the analysis. The results indicate that ferrous sulphate exhibits moderate acute toxicity to Pangasius pangasius under short-term exposure. These findings provide baseline toxicity data that can be useful for environmental risk assessment and formulation of safe iron concentration limits in freshwater aquaculture systems.

Keywords: Acute toxicity, Ferrous sulphate, LC_{50}, Pangasius pangasius, Probit analysis, Heavy metal exposure, Aquatic toxicology, Dose-response relationship.

Dark Fermentative Biohydrogen Production Via Mixed Bacterial Cultures from Cow Dung

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Abstract: The escalating global energy crisis necessitates transitioning from fossil fuels to renewable alternatives, particularly sustainable biohydrogen that offers zero-carbon emissions and exceptional energy density (122 kJ/g). Dark fermentation presents an environmentally viable biological method for hydrogen production from organic waste, yet optimization of microbial culture systems remains critical for enhancing biohydrogen yield. This study investigates biohydrogen production using mixed bacterial cultures naturally present in cow dung through dark fermentation. Mixed cultures were enriched from cow dung in nutrient broth, followed by transfer to Malt-Yeast-Glucose (MYG) medium. Key parameters, including pH, inoculum volume, and substrate composition were systematically optimized. Gas chromatography with thermal conductivity detector (GC-TCD) analysis, performed at CSIR NEERI Nagpur, confirmed hydrogen purity of approximately 80% with retention time of 1.035 minutes. Optimized conditions (MYG medium at 1% malt, 0.8% yeast, 1% glucose; pH 6.5; 10-hour inoculum age; 10% inoculum volume) yielded maximum hydrogen production of 560 mL/L broth, representing a 2–3-fold increase from baseline (250 mL/L). Biochemical characterization via gram staining and enzymatic testing (cellulase, hydrogen sulfide production, starch and casein hydrolysis, IMViC assays) successfully identified hydrogen-producing bacterial strains. So mixed microbial consortia from agricultural waste represent a readily accessible, cost-effective bioresource for optimized biohydrogen production, addressing dual objectives of sustainable bioenergy generation and agricultural waste valorization aligned with United Nations Sustainable Development Goals 7 and 13.This approach significantly contributes to the development of a circular economy by transforming readily available organic waste into a clean energy carrier, thereby mitigating both environmental pollution and energy dependence on non-renewable sources.

From Indigenous knowledge to Mechanistic Elucidation: Hemidesmus indicus as Natural Dihydrotestosterone Inhibitor for Androgenic Alopecia and Hair Regeneration

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Abstract: Androgen excess causes hair loss when steroid 5α-reductase type 2 (5AR2) changes testosterone into dihydrotestosterone (DHT), which causes follicles to shrink. Synthetic inhibitors like finasteride do lower DHT levels, but using them for a long time might have bad effects, which shows that we need safer plant-based options. Hemidesmus indicus (HI), a medicinal plant recognized for its antioxidant and endocrine-modulating characteristics, was examined for its potential as a natural 5AR2 inhibitor for hair care and regeneration. We used OHRLCMS to do phytochemical profiling of HI extracts. We also performed the total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity (DPPH assay). We used Auto Dock Vina to do an in-silico screening of reported phytometabolites against SRD5A2 (PDB ID: 7BW1), and then we used ADMET prediction. Molecular dynamics simulations (100 ns) assessed the stability of critical ligand–enzyme combinations. In vitro validation encompassed biochemical 5α-reductase inhibition tests and cytotoxicity and proliferation investigations with HaCaT cells. Docking investigation revealed robust binding affinities (−11.5 to −9.7 kcal/mol), akin to finasteride, with persistent interaction patterns validated by simulation experiments. The extract has a lot of phenolic and flavonoid compounds, which makes it a strong antioxidant. Enzyme inhibition studies corroborated the decrease of 5AR2 activity. Importantly, cell line experiments showed that there was no cytotoxicity at active doses and that keratinocyte proliferation was encouraged, which means that the cells were supported in their ability to regenerate. These findings indicate that H. indicus possesses notable anti-DHT, antioxidant, and proliferative characteristics, endorsing its advancement as a safe, plant-derived option for hair care and regeneration.

Hepatorenal Protection by Aegle marmelos in Chronic Aspartame Toxicity: Antioxidant, Anti-CYP2E1, and Genoprotective Evidence

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Abstract: Chronic aspartame consumption induces hepatorenal toxicity through oxidative stress, CYP2E1 activation, and DNA damage. Aegle marmelos (A. marmelos) leaves extract exhibits potent antioxidant properties, warranting evaluation of its therapeutic potential against aspartame-induced hepatorenal damage in Female Wistar rats (n=6/group): I (control); II (A. marmelos 200 mg/kg, p.o.); III (aspartame 250 mg/kg, p.o., 8 weeks); IV–VI (aspartame + A. marmelos 50, 100, or 200 mg/kg, p.o.). Serum liver (AST, ALT, ALP, bilirubin, cholesterol, triglycerides, albumin, glucose) and kidney (creatinine, urea, uric acid) function tests employed commercial kits. Hematology assessed WBC, lymphocytes, granulocytes, RBC, hematocrit, MCV, hemoglobin, MCHC, platelets, MPV, PDW via automated analyzer. Tissue homogenates measured lipid peroxidation, glutathione, total protein, GPx, GR, G6PDH, SOD, catalase. CYP2E1 activity utilized liver microsomes; DNA damage via comet assay. Liver and kidney histopathology used H&E-stained paraffin sections; transmission electron microscopy (TEM) examined ultrastructure (2.5% glutaraldehyde fixation, osmium tetroxide post-fixation, uranyl acetate/lead citrate staining). Aspartame markedly elevated serum AST, ALT, ALP, bilirubin, creatinine, urea, lipid peroxidation, CYP2E1 activity, DNA tail moment, WBC count, platelets while substantially reducing albumin, glutathione, SOD, catalase, GPx levels. Light microscopy showed aspartame-induced hepatocyte necrosis and glomerular congestion; TEM revealed mitochondrial swelling, cristae disruption, ER dilation. A. marmelos (200 mg/kg) dose-dependently reversed these, lowering biomarkers (AST, ALT, etc.), restoring antioxidants (GSH, SOD, catalase), normalizing hematology, and preserving architecture with intact mitochondria/organelles on TEM. A. marmelos protects via behavior improvement, antioxidant boost, CYP2E1 inhibition, DNA protection, inflammation markers, and ultrastructural preservation.

In vitro Micropropagation, Extraction of Secondary Metabolites of Vitex peduncularis Wall. ex Schauer

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Abstract: The in vitro micropropagation technique ensures quick access to disease-free and identically excellent plant material. The levels of macro and microelements in the medium composition have a major impact on plant development and multiplication. By increasing the populations of rare and endangered species, micropropagation techniques are crucial for biodiversity conservation. They may work well for medicinal plants that grow slowly in the wild. Steps in this process include initiation, multiplication, rooting, and hardening. The study's objectives were to improve a medium, create a process for in vitro plant regeneration, and extract Vitex peduncularis secondary metabolite content. To propagate this species of Vitex, the Murashige and Skoog (MS) medium worked best. The mother plant's nodal explant was used, and the leaves were used to induce Callus. The culture was maintained under light and dark conditions for 16 and 8 hours, respectively. The effects of varying concentrations of the plant hormones BAP, NAA, Kinetin and IBA used for in vitro shoot regeneration and subsequent root development in this Vitex peduncularis were evaluated. For acclimatization, the plants were moved to the greenhouse and polyhouse shortly after the laboratory culture room. In ex vitro conditions, the young plants of cultivars had a survival rate of above 65%.

Keywords: In vitro, Micropropagation, Vitex peduncularis, Regeneration, Medicinal plant.

Quantitative evaluation of tribal ethnomedicinal practices in Central India

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Abstract: Traditional herbal medicine remains an essential component of primary healthcare systems among tribal communities in India. The Surguja district of Chhattisgarh is a biologically rich region where indigenous plant-based therapies are widely practiced, yet systematic ethnobotanical documentation remains limited. The present study aims to quantitatively evaluate traditional ethnomedicinal knowledge practiced by tribal communities of Surguja district. Ethnobotanical data were collected between January 2023 and December 2024 from 76 tribal villages covering diverse ecological zones. Information was obtained through semi-structured interviews and direct field observations involving 404 informants. Medicinal plants were collected, taxonomically identified, and analyzed using quantitative indices such as Use Value (UV), Fidelity Level (FL), and Jaccard Index to assess species importance, consensus of use, and novelty. A total of 235 medicinal plant species belonging to 197 genera and 73 families were documented, with Fabaceae being the most dominant family. Leaves were the most commonly used plant part, and paste was the predominant form of preparation. Mirabilis jalapa L. showed the highest Use Value, while Gloriosa superba L. exhibited the highest Fidelity Level for snake bite treatment. Comparative analysis revealed high dissimilarity with earlier regional studies, indicating substantial novel ethnomedicinal knowledge. The findings highlight culturally significant plant species and provide a strong foundation for future pharmacological and conservation-oriented research.

Keywords: Ethnobotany, Ethnomedicine, Medicinal plants, Use Value, Jaccard Index, Traditional therapy

Seasonal Variation and Toxicity Analysis of heavy metals at three different sites of Shivnath River, Durg District

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Abstract: Water is one of the most valuable resources on the planet, and water should be of the highest quality and free of impurities, especially when used for drinking and household uses. Rivers have a significant impact on environmental and economic development. The goal of the current study is to evaluate the levels of trace metals, including Hg, Fe, Pb, and Cd, in the Shivnath River, one of the main tributaries of the Mahanadi River in Durg, Chhattisgarh. Because of their bioaccumulative and persistent character, heavy metals are a big problem. Both geological and man-made heavy metals may enter the river system through weathering, erosion, mining, industrial processing, agricultural runoff, and sewage disposal. This allows us to evaluate the water's suitability for industrial, agricultural, and drinking purposes. Water sample were collected from three different location Piperchhery, Mahamarra Ghat,Changory in Dist.- Durg area and analyzed for heavy metals such al lead, iron, mercury, cadmium using standard analytical methodsA thorough chosen metal analysis was performed on samples that were gathered for this investigation in 2024 and 2025 during all three seasons. The collected data were first statistically examined in order to determine the level of contamination in the study area's water. Then, the Heavy Metal Pollution Index (HPI), Pollution Index (PI), and Contamination Index (CI) were computed. The result revealed significant special variation in heavy metals concentration among different sampling areas.

Biotechnology, Biochemistry, Bioinformatics and Biomedical Sciences

A Machine Learning Based Method for Biosensing of Urine Urea Concentration for a Point-of-Care Device

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Abstract: This article proposes a Machine Learning (ML) based urine urea classification method through a cheap, environment friendly and disposable biosensor. The design and development of biosensor and overall sensing mechanism is strictly focused on its implementation on the proposed Point-of-Care (POC) device. The PoC device enables the mass scale testing in remote areas required to handle the increasing burden of Chronic Kidney Disease (CKD). The method involves dataset collection through Electrochemical Impedance Spectroscopy (EIS) to generate a multi-dimensional, multi-feature dataset. The pre-processing on the dataset is performed to reduce the order and dimensionality of the dataset to reduce the desired computation burden. The reduced dataset is then used to train a total of 32 different ML classifier models to select the best performing model to be employed on the PoC device. The design and development of the signal conditioning of the PoC is then carried out along with testing the device on samples with unknown concentration of urea.

Advanced Characterization and Immobilization strategies for fungal spores in Biomineralization applications

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Abstract: Urease-mediated biomineralization provides sustainable self-healing concrete solutions. Studies have reported bacterial species like Bacillus sphaericus, Citrobacter imtechense, B. subtilis, and Sporosarcina pasteurii to have demonstrated up to 29% increases in compressive strength, 120% in tensile strength, and 74% reductions in water penetration via calcite precipitation that seals cracks (Verma et al., 2025). We explored fungal candidates: Plectosphaerella cucumerina (reported to be isolated from alkaline concrete ceilings, pH 12.5 by Pasquele et al., 2019), Purpureocillium lilacinum, and Thermomyces lanuginosus. Lab-cultured under alkaline conditions (pH 9–12), these fungi showed strong ureolytic activity, producing NH_4^+ and precipitating $CaCO_3$ in solid media, with P. cucumerina achieving the high rates of ammonia synthesis and calcium carbonate precipitation (Pasquale et al., 2019). Microfluidic validation confirmed rapid, uniform biomineralization, supporting scalable bio-concrete applications. For field viability, spores were immobilized on nanofibers using response surface methodology-optimized polymers, yielding higher precipitation efficiency versus free spores, nanofibers with 200–500 nm diameters, and hydrophilic contact angles in the range of 30°C-70 °C for optimal concrete integration.

Biomimetic surface engineering of functional moeties on the nanoparticle surface and assesing its catalytic behaviour

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Abstract: In this study, copper oxide nanoparticles were synthesized using green chemistry. The synthesized nano-scale particles were functionalized with aspartate, serine and histidine to enhance its catalytic potential. The surface engineering of nanoparticle was confirmed by performing characterization study such Fourier transform infrared (FT-IR) spectroscopy. The performance of biomimetic particle was evaluated by a colorimetric assay which was carried out using a natural substrate for lipase. Olive oil was used as a triglyceride source to check and assess the catalytic efficiency of the synthesized particles. The results indicated similar catalytic behavior when compared with a natural enzyme as a positive control. Thus, demonstrating an economical strategy to obtain a more efficient and stable alternative to natural enzyme via the targeted biomimetic surface engineering.

Dissecting Promoter Variation of Key Salt Tolerance Genes in Rice Reveals Novel Haplotypes Using Association Analysis

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Abstract: Rice is an important major cereal salt-sensitive crop adversely affects rice productivity. Traditional rice varieties have limited possibilities for further improvement due to the complex inheritance and the narrow genetic base. In view of this, in the present study, the allelic diversity existing in rice germplasm was explored for salinity stress tolerance. Promoter sequencing of key salt-tolerant genes (OsHKT1;1, OsHKT1;5, OsNHX1, and OsBON1) was done for 84 rice germplasm genotypes, collected from Indira Gandhi Krishi Vishwavidyalaya, Raipur. Promoter sequencing showed a high degree of nucleotide and haplotype diversity, with the highest haplotype diversity in OsHKT1;5 (0.64), followed by OsNHX1(0.57), OsBON1 (0.38), and OsHKT1;1 (0.26). Neutrality tests showed an excess of rare polymorphisms, suggesting population expansion and positive selection. Phylogenetic analysis using promoter SNPs showed that the genotypes clustered into distinct groups according to tolerant, moderately tolerant, and susceptible categories. Candidate gene based association analysis between promoter SNPs and leaf Na^+ and K^+ content (48 h NaCl stress) showed most significantly associated SNP for K^+ concentration at 136, 744, 680, and 163 upstream positions of OsHKT1;1, OsHKT1;5, OsNHX1, and OsBON1 genes, respectively. Haplotype Analysis for tested genes revealed one tolerant and one susceptible haplotype. The tolerant haplotype was linked with lower Na^+ concentration (3.70-5.10 mg/g of dry leaves) and exhibited relatively downregulation of the respective gene, whereas Susceptible haplotypes showed high Na^+ concentration (9.15- 14.30 mg/g of dry leaves) with up-regulation. The haplotypes and linked SNPs identified in this study may provide functional SNP markers for haplotype based breeding programs, gene pyramiding and introgression of salt tolerance genes into high-yielding, salt-susceptible rice varieties.

Enhanced Biodegradation of Paracetamol via Biofilm-Forming Bacterial Consortia Isolated from Hospital Effluents

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Abstract: This study investigates the biodegradation of paracetamol with bacterial biofilms and consortia generated from hospital wastewater. Bacterial isolates, including Pseudomonas aeruginosa and a microbial consortium, were examined for their paracetamol degradation capacities in both planktonic and biofilm form. Results obtained conclude the biofilm development greatly improves paracetamol degradation compared to planktonic bacteria. The bacterial consortium demonstrated higher degrading efficiency, reducing optical density (OD) by more than 90% in 12 hours at concentrations up to 1000 ppm. The addition of activated charcoal increased breakdown rates, reaching up to 90% within 48 hours, demonstrating its synergistic impact with biofilms. The potential of using bacterial biofilms, particularly consortia, for the bioremediation of pharmaceutical pollutants like paracetamol. The integration of biofilms with activated charcoal presents a promising approach for enhancing biodegradation efficiency. Future research should focus on optimising biofilm formation and exploring the application of this method to other pharmaceutical contaminants in various environmental matrices.

Keywords: Paracetamol degradation, bioremediation, planktonic cells biomass, Biofilm biomass

Enzymatic hydrolysis of orange peel tannins by tannase enhance safety and antioxidant potential in herbal cosmetic

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Abstract: Orange peel is widely used in herbal face pack formulations due to its antimicrobial and antioxidant properties. However, the presence of tannins in orange peel may cause skin irritation and inflammatory responses, particularly in sensitive skin types. In the present study, microbial tannase was employed to enzymatically reduce the tannin content in orange peel-based face pack formulations. Tannase (tannin acyl hydrolase, EC 3.1.1.20) catalyzed the hydrolysis of tannins into gallic acid and glucose, thereby improving the safety and functional quality of the formulation. Enzymatic treatment resulted in significant tannin reduction and enrichment of gallic acid, a bioactive compound known for its antioxidant and skin-protective properties. This study highlights a novel, eco-friendly, and biotechnological approach for developing safer and more effective herbal cosmetic products.

Keywords: Tannase, Orange peel, Tannins, Enzymatic treatment, Face pack formulations

In Vitro Optimization of Somatic Embryogenesis for Large-Scale Production of Economically Important Bambusa balcooa.

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Abstract: Bambusa balcooa is a high-value bamboo species widely recognized for its rapid growth, superior mechanical strength, and diverse applications in construction, paper, handicrafts and agroforestry. Despite its economic importance, large-scale multiplication through conventional vegetative methods remains limited due to low propagation rate and seasonal constraints. The present study aimed to develop and optimize an efficient somatic embryogenesis system for rapid and large-scale clonal multiplication. Explant sterilization protocols were standardized using different concentrations and exposure durations of bavistin, mercuric chloride and ampicillin. The combined treatment of bavistin and mercuric chloride proved most effective, reducing contamination to 10%. Leaf and pseudo-spikelet explants were used for callogenesis. Ten different treatments of MS medium containing various combinations of plant growth regulators were evaluated for embryogenic callus induction. Among them, MS medium supplemented with 2,4-D (3 mg/L) and Kn (2 mg/L) showed the highest embryogenic response. Embryogenic calli were identified based on morphological characteristics such as yellowish-white color, nodular structures, compact yet friable texture and slow growth behavior. Mature embryogenic calli were transferred to cytokinin-containing shoot induction media and maintained at 26±2°C under a 16-hour photoperiod. Rooting was optimized on MS medium supplemented with NAA (3 mg/L), achieving 96% rooting efficiency. Regenerated plantlets were successfully acclimatized through primary and secondary hardening. The optimized protocol provides a scalable platform for rapid mass propagation, supporting sustainable bamboo cultivation and rural economic development.

Keywords: Clonal multiplication, Sterilization, Callus, Plant growth hormones, Cytokinin, Auxin

Nanofibrous Cellulosic Matte Conjugated with Antioxidative Cerium Oxide Nanoparticle and S-Nitroso-N-acetyl-penicillamine (SNAP) for Biomedical Application

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Abstract: There are few nanomaterials which are increasingly recognized for their ability to overcome the limitations of conventional antimicrobial agents, owing to their distinctive properties such as targeted delivery, controlled drug release, and reduced cytotoxicity to healthy cells. Among them, Cerium oxide nanoparticles (CNPs) have antioxidants and antimicrobial capabilities, attributed to their high oxygen vacancies and auto-regenerative ability between Ce3+ and Ce4+ oxidation states. This redox capability enables CNPs to function as efficient scavengers of reactive oxygen species, supporting sustained therapeutic action. Similarly, S-Nitroso-N-acetyl-penicillamine (SNAP), a nitric oxide (NO) donor, exhibits potent antimicrobial effects and is gaining interest for its biomedical applications. In this study, the conjugate of CNP-SNAP was incorporated into bacterial cellulose (BC) via electrospinning to fabricate a nanofibrous mat with antimicrobial biodegradability properties. Characterization through UV-visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy (SEM), revealed a uniform morphology with an average fiber diameter of 58 nm. Antimicrobial testing demonstrated a significant zone of inhibition (14 mm) against selected microbial strains, indicating robust antimicrobial performance. Post-electrospinning, the CNP-SNAP-infused cellulosic mat exhibited excellent biocompatibility, achieving approximately 97.95% cellular viability. Immuno-histocompatibility assessments showed a 13% reduction in TNF-α expression compared to untreated controls, suggesting anti-inflammatory potentials. Biodegradability studies conducted via composting over a period of 7 days indicated a degradation rate of 65.71%. Overall, this nanohybrid material presents substantial promise for a range of biomedical applications, including drug delivery systems, tissue engineering scaffolds, and wound healing dressings.

Optimization of Agrobacterium rhizogenes-Mediated Hairy Root Culture for Enhanced Biomass Production in Andrographis paniculata

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Abstract: Andrographis paniculata is a medicinally important plant known for producing andrographolide, a bioactive labdane diterpenoid with significant pharmacological properties. The present study aimed to establish and statistically optimize an Agrobacterium rhizogenes (MTCC 532)–mediated hairy root culture system for enhanced biomass production using Response Surface Methodology (RSM). Transformation parameters were initially optimized using varying concentrations of acetosyringone (0–500 µM) and NAA (0–1.0 mg/L). The highest transformation efficiency (64 ± 0.36%) and fold increase (21-fold) were recorded under 0 mg/L NAA + 400 µM acetosyringone, with root induction occurring within 11 ± 0.34 days. Absence of acetosyringone resulted in negligible induction (3–7%), while 500 µM reduced efficiency, indicating inhibitory effects at higher concentrations. Subsequently, a four-factor Central Composite Design (CCD) was employed to optimize biomass production by evaluating IBA (1–6 µM), medium pH (5.0–6.5), agar concentration, and media volume. The quadratic model was statistically significant ($F = 7.60$, $p = 0.0002$) with strong predictive reliability ($R^2 = 0.8764$). IBA and pH were identified as significant factors with a notable interaction effect ($p = 0.0009$). The optimized conditions (5–6 µM IBA, pH 5.8–6.2) yielded a predicted biomass of 60–65 mg fresh weight and a growth index of 10.84 ± 0.31 ($p < 0.05$). Molecular validation through PCR amplification of rolB and rolC genes confirmed stable T-DNA integration. The optimized, RSM-validated hairy root system provides a robust, reproducible, and high-biomass platform with strong potential for secondary metabolite production, metabolic studies, and scalable biotechnological applications of A. paniculata.

Keywords: Andrographis paniculata; Hairy root culture; Agrobacterium rhizogenes; Response Surface Methodology; Central Composite Design; Biomass optimization, Secondary metabolites.

Chemical Engineering

3D PLA Graphene – NiCo2S4 Nanocomposite for Electrode

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Abstract: This study reports the 3D development of electrodes using the Graphene-NiCo2S4 nanocomposites (Gr- NiCo2S4 NCs). Fused deposition modelling (FDM) based technique is used for designing and development of the outer part of the electrode. Graphene (Gr) is prepared by liquid phase exfoliation (LPE) method using the ethyl cellulose (EC) as stabilizer and exfoliating agent. NiCo2S4 synthesized using a simple hydrothermal method followed by a two step process- synthesis of precursors of Ni and Co and further conversion into NiCo2S4 nanoflower. Synthesized NCs characterized using SEM, TEM, XPS and PXRD techniques. Nanoflower integrated with synthesized Gr using ultrasonication for electrode fabrication. Analytical electrochemical response of electrode for application in environmental and clinical samples evaluated using the cyclic voltammetry (CV), chronoamperometry (CA), and differential pulse voltammetry (DPASV). Our findings showcased that 3D fabricated electrode response is better than the traditional glassy carbon electrode (GCE). This method proved to have a significant role in electrochemical sensing of environmental and clinical samples. Geometric surface area of electrode is calculated using theoretical calculations and electroactive surface area of electrode calculated using the Randles Sevcik equation. The designed electrode works under good linear range and low limit of detection for sensing of heavy metal ions (HMIs) and Vitamin B12.

Bifunctional Nanocomposites as novel electrodes Enabling Electrochemical Duality: Energy Harvesting and Real-Time Biosensing in Microbial Fuel Cells

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Abstract: A dual-mode microbial fuel cell (MFC) was engineered using a polyindole-based composite nanofiber electrode to achieve simultaneous bioelectricity production and antibiotic detection within a single platform. The tailored electrode architecture improved interfacial charge transfer and accelerated extracellular electron transport, enabling antibiotics to be quantified through consistent, concentration-dependent variations in the MFC output voltage under stable operating conditions. The electrode's morphology, crystallinity, and surface chemistry were examined by SEM, TEM, XPS, XRD, FTIR, and UV–Vis spectroscopy, and its electrochemical response was validated using cyclic voltammetry and electrochemical impedance spectroscopy. Under optimized operation, the MFC delivered a peak power density of 2231 ± 30 mW m^{-2} at a current density of 2516 ± 25 mA m^{-2}. The device further demonstrated sensitive antibiotic detection with a limit of detection of 0.25 µg L^{-1} and a sensitivity of 0.1255 mV (µg L^{-1})$^{-1}$. Reusability was confirmed over three successive cycles, indicating robust operational stability. Overall, the proposed polyindole-based composite electrode provides an eco-friendly route to integrate sustainable energy recovery with real-time water-quality sensing in MFC systems.

Eco-Friendly Synthesis and Electrical Properties of Graphene Quantum Dots Using Rice Flour as a Bio-Precursor

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Abstract: Graphene quantum dots (GQDs) were synthesized from rice flour as an eco-friendly bio-precursor using pyrolysis at 250 °C and hydrothermal treatment at 170 °C for 8 hr. The hydrothermal method yielded brighter, uniformly dispersed nanoparticles with fewer defects compared to pyrolysis. Spectroscopic studies confirmed characteristic electronic transitions and excitation-dependent photoluminescence, indicating quantum confinement and surface state interactions. FTIR analysis revealed oxygen-containing functional groups that enhanced surface activity, dispersion stability, and interfacial polarization. Morphological and structural analyses confirmed crumpled nanosheet-like morphology with graphitic domains and defect-mediated charge transport pathways. The dielectric characteristics of 2 mm thick compacted pellet fabricated from hydrothermally synthesized GQDs were examined across a frequency spectrum of 0.1 Hz to 100 kHz and a temperature range of 25-100 °C. Capacitance diminished with rising frequency but augmented with temperature due to intensified dipolar polarization. The dielectric loss tangent demonstrated thermally triggered relaxation, with peaks migrating toward elevated frequencies. Dielectric permittivity exhibited dispersion behavior influenced by dipolar and interfacial polarization, whereas dielectric loss indicated energy dissipation related to localized charge carrier movement. Electrical conductivity augmented with frequency and temperature, signifying thermally activated hopping conduction and enhanced charge transport kinetics. Electric modulus study validated relaxation dynamics and diminished electrode polarization at elevated frequencies, whereas impedance analysis indicated a decline in resistive behavior and non-Debye type relaxation. These results demonstrate that rice-derived GQDs synthesized via a sustainable and low-cost approach exhibit promising dielectric and electrical properties for energy storage and optoelectronic applications.

Formulation of Edible Films Based on Carboxymethyl Cellulose and Corn Starch Reinforced Nanofillers of Zinc Oxide and Orange Peel Powder

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Abstract: The escalating demand and widespread utilization of packaging materials, particularly within the food sector, have intensified environmental concerns worldwide. Petroleum-based synthetic packaging materials significantly contribute to environmental pollution owing to their non-biodegradable nature and long-term ecological persistence. Consequently, the development and application of biodegradable packaging alternatives have attracted increasing scientific and industrial interest. Among these, edible films have emerged as a promising and sustainable solution for food preservation. Despite their advantages, conventional edible films are often limited by insufficient mechanical strength, suboptimal barrier properties, and inadequately characterized degradation behavior. To overcome these limitations, carboxymethyl cellulose and corn starch were employed as polymer matrices at concentrations of 1.33% and 4% (w/w), respectively. To further improve structural stability and functional performance, zinc oxide nanoparticles (2% w/w) and orange peel powder (0.5% w/w), calculated based on the total polymer matrix weight, were incorporated as reinforcing nanofillers. The physicochemical and structural properties of the developed films were characterized using advanced analytical techniques, including X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA). These analyses provided valuable insights into molecular interactions, functional group modifications, crystallinity, and thermal stability. The films were further evaluated for thickness, mechanical strength, water absorption capacity, and biodegradation behavior. The results indicate that the developed nanocomposite edible films exhibit strong potential for packaging fresh fruits and vegetables. This scientific approach can reduce plastic dependency while enhancing sustainable, biodegradable, and environmentally responsible food packaging systems.

Chemical Sciences

Benzil dihydrazone-based fluorescent colorimetric bis-Schiff base chemosensor for selective and sensitive detection of Cu(II) ions: Isolation of Cu(II) Complex, Analytical, Catalytic and Biological Applications

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Abstract: Herein we developed a simple fluorescent colorimetric chemosensor 2,2'-((1E,1'E)-(((1E,2E)-1,2-diphenylethane-1,2-diylidene)bis(hydrazine-2,1-diylidene)) bis(methaneylylidene)) bis(4-methoxyphenol) (L) for rapid, selective and sensitive detection of Cu2+ in aqueous solution. The method for synthesis of L is very simple and environment friendly. This organic bis Schiff base probe was characterized by 1H-NMR, FT-IR and ESI-MS spectroscopy along with single-crystal XRD analysis. It exhibited binding-induced colour change with Cu2+ ion from colourless to intense yellow and fluorescence enhancement. The LOD values of L towards Cu2+ were calculated to be 437 nm (colorimetrically) and 450 nm (fluorometrically). The interactions between L and Cu2+ werestudied by Job's plot, ESI-MS, FT-IR spectroscopy and DFT calculations. The crystal structure of the L–Cu2+ adduct was also determined by single-crystal X-ray analysis. The receptor L could operate in a wide pH range and can be successfully applied for detection and quantification of Cu2+ ions in environmental samples, catecholege activity and anticancer agent and living cell imaging.

Dopant-induced structural and optical modulation in CsPbCl3 perovskite nanocrystals

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Abstract: Caesium lead halide perovskite nanocrystals (PNCs) are promising semiconductor materials with exceptional stability, color tunability and optoelectronic properties. The hot injection method was used to synthesize the PNCs exhibiting strong emission with the doped with manganese high photoluminescence quantum yield obtained. Doping or passivation with ligand improves the stability, emission properties and introduces new radiative recombination pathways. In this work, we synthesized CsPbCl3, Mn-doped CsPbCl3, Fe co-doped Mn-doped CsPbCl3 and Ce-doped CsPbCl3 PNCs by doping, enhancing PLQY and attain the stability. Some characterization studies, including ultraviolet-visible (UV-vis), photoluminescence (PL), X-ray diffraction, transmission electron microscope (TEM) and electrochemical studies were performed to confirm the crystal growth and stability of synthesized PNCs.

Dual-functional ionic liquid [AcMIm]Cl enabling sustainable synthesis of β-aminocarbonyl compounds via the Mannich reaction

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Abstract: Room-temperature Ionic liquids (RTILs) have gained considerable attention as environmentally benign substitutes for traditional organic solvents over the past several years.1 Their growing use can be attributed to a unique combination of physicochemical features, such as low melting temperatures, negligible vapour pressure, reduced flammability, tunable polarity, and good compatibility with both organic and inorganic substrates2 along with relatively low toxicity.3 The emergence of task-specific RTILs has further expanded their usefulness by enabling them to function simultaneously as catalysts and solvents.4

β-amino carbonyl compounds are used as starting materials in the synthesis of amino alcohols, peptides, lactams, and optically active amino acids.5 The Mannich reaction is an important organic transformation for the synthesis of β-aminocarbonyl compounds. Due to its broad scope and reliability, the Mannich reaction and its modified forms are frequently used to synthesize structurally diverse molecules with applications extending from biologically active frameworks to material science.6 Here, in this presentation, we report a task-specific ionic liquid, acetyl methyl imidazolium chloride ([AcMIm]Cl), as a dual-functional catalyst and reaction medium for the one-pot synthesis of β-aminocarbonyl compounds via the Mannich reaction. The protocol proceeds efficiently at ambient temperature, affording a broad range of β-aminocarbonyl derivatives in excellent yields within short reaction times. Notably, the method avoids toxic metal catalysts, reduces solvent consumption, and enables straightforward product isolation, thereby offering a greener alternative to conventional Mannich methodologies. Overall, this work demonstrates that [AcMIm]Cl represents an efficient and sustainable platform for C–C and C–N bond formation through Mannich-type multicomponent reactions under mild and green conditions.

Effectiveness of Grouting on Seepage Control and Slope Stability of a Tailing Dam

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Abstract: The planning and construction of earth dams require careful attention because any deficiencies during or after construction can lead to serious risks and possible failure. In dam engineering, several forces act on the structure, including uplift pressure and the risk of piping, both of which must be properly addressed to ensure safety. To minimize seepage beneath hydraulic structures, commonly adopted measures include the installation of grout curtains and drainage systems. In the present study, a numerical investigation was conducted to evaluate the impact of a grout curtain on seepage behaviour and slope stability of an earthen dam. A tailings dam was selected as the case study, and the modelling was carried out using SEEP/W for seepage analysis and SLOPE/W for slope stability assessment. The results indicate that placing a grout curtain on the upstream side of the dam significantly reduces uplift pressure and the likelihood of piping. It was observed that increasing the curtain length enhances resistance to uplift forces and internal erosion. Furthermore, grouting improves the overall stability of the dam slopes. An optimal curtain length of 50 m was identified, and the use of two curtain rows proved to be most effective. Analysis of different spacing arrangements showed that a 3 m distance between the two rows within the dam core is optimal, while a curtain depth of 10 m was considered appropriate for the study.

Fabrication And Electrochemical Evaluation of Polyaniline-Polypyrrole/WO3 Nanocomposite Electrode For High-Performance Supercapacitor

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Abstract: Polypyrrole (PPy) and polyaniline (PANI) are widely used as promising conducting polymers for supercapacitor applications due to their high redox activity, excellent electrical conductivity, cost-effectiveness, and ease of synthesis. In this study, a polyaniline–polypyrrole/WO3 (PAPW) nanocomposite (NC) was successfully synthesized via an in-situ oxidative polymerization method and evaluated as an electrode material for supercapacitor applications. The incorporation of WO3 nanoparticles into the PAP matrix significantly enhanced the electrochemical performance by improving pore structure, facilitating efficient charge transfer, and emphasizing structural stability. The structural and chemical properties of the synthesized materials were systematically characterized by X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR), confirming the successful formation of the PAPW NC and the coexistence of both polymeric and metal oxide phases. Surface morphology and elemental composition were analyzed using scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDX), which revealed a homogeneous dispersion of WO3 nanoparticles within the polymer matrix. The electrochemical properties of the prepared NC were systematically examined using cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) in 1 M H_2SO_4 aqueous electrolyte. The synergistic integration of PAP and WO3 is expected to enhance electrochemical performance by combining the high electrical conductivity of the polymer with the pseudocapacitive characteristics of WO3. Overall, these findings demonstrate that an in-situ oxidative polymerization method is an effective and versatile approach for developing PAPW NCs as promising electrode materials for high-performance supercapacitors.

Food-Grade Nanoemulsified Vehicles for Improving Biological Potential of Cinnamon Essential Oil

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Abstract: Cinnamon essential oil (CNEO) is widely recognized for its potent biological properties, including antibacterial, antifungal, and anti-inflammatory activities. These effects are primarily attributed to its rich bioactive phytochemical constitution. However, the practical application of CNEO is limited due to its high volatility, poor solubility, intense aroma, and flavour. To address this limitation, this study investigates the formulation and characterization of CNEO-based food-grade nanoemulsions (NEs) using high-energy ultrasonication method. Two NEs were prepared, CNEO-NE and CNEO-MD-NE, using 5% CNEO with 5% (w/w) non-ionic surfactants, and the latter incorporating 2% (w/w) Maltodextrin (MD). The z-average diameter of CNEO-NE and CNEO-MD-NE was determined using Dynamic Light Scattering (DLS) system as 73.89 ± 17.86 nm and 38.88 ± 1.83 nm, respectively, indicating a reduction in particle size upon addition of MD. The encapsulation efficiency and release behavior of both NEs are investigated. Utilization of MD enables controlled release of bioactive compounds and is generally recognized as safe (GRAS), thus can be applied for preservation of food items. In addition, antibacterial activity against some common food-borne bacteria, e.g., E. coli, B. cereus, and S. aureus, has also been evaluated. This research provides an effective approach for integrating EOs into the food sector in active packaging for food preservation applications.

Keywords: Cinnamon Essential Oil, Encapsulation, Nanoemulsion, Maltodextrin, Antimicrobial Activity.

Hydrothermally Synthesized Gqds Using Okra and Its Antibacterial Activity

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Abstract: The hydrothermal route was employed to achieve a sustainable synthesis of fluorescent graphene quantum dots (GQDs) using okra (Abelmoschus esculentus) as the carbon precursor. Structural and optical confirmation was obtained through a suite of characterization techniques, including FESEM, DLS, UV–vis absorption, fluorescence spectroscopy, XRD, and FTIR. At a working concentration of 50 µg/ml, the GQDs demonstrated pronounced antibacterial efficacy. Antimicrobial activity is attributed to multiple mechanisms: generation of reactive oxygen species (ROS) leading to oxidative stress and membrane destabilization, coupled with direct interactions with bacterial DNA. These synergistic effects enabled broad-spectrum inhibition, notably against resistant pathogens such as methicillin-resistant Staphylococcus aureus (MRSA). Comparative in vitro studies demonstrated that GQDs possess greater antimicrobial efficacy than the corresponding ethanolic plant extract. Such findings highlight the potential of GQD-based nanomaterials as efficient alternatives for addressing microbial challenges. Our findings indicate that GQDs exert significant antibacterial activity against both staphylococcus aureus and E.coli, with a predominant inhibitory effect observed for S. aureus.

Optical and 3D-Printed Paper-Based Digital Sensor for Detection of Fe^{2+} and Fe^{3+} in Environmental Samples

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Abstract: Here, we report the synthesis and application of a Schiff base probe, Z-2-(((2-hydroxynaphthalen-1-yl) methylene) amino) benzoic acid (HNABA) for the selective speciation of Fe^{2+} and Fe^{3+} using colorimetric, fluorometric, and smartphone-assisted paper-based digital sensing. The probe exhibited a distinct optical response towards both iron species via chemical coordination involved through phenolic oxygen and imine nitrogen donor atoms. The complex formation and structural features were confirmed by UV–Vis spectroscopy, fluorescence spectroscopy, Fourier transform infrared spectroscopy (FTIR), nuclear magnetic resonance spectroscopy (NMR). While electrospray ionization -mass spectrometry (ESI–MS) analyses supported the metal–ligand binding mechanism. Experimental parameters, including pH and reaction time were optimized to achieve maximum sensitivity and stability. The methods demonstrated a low detection limit over a wide linear range. The methods exhibited better precision and satisfactory recoveries of water samples enabling trace level iron detection. The integrated optical and digital imaging platform offers a rapid, economical, and reliable strategy for iron speciation, helpful for environmental monitoring.

Polythiophene@MnCr2O4 Composite as A High-Performance Electrode Material for Energy Storage Applications

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Abstract: In this work, a polythiophene-manganese chromite (PTh@MnCr2O4) composite was developed to enhance electrochemical performance for energy storage applications. The spinel structure of the MnCr2O4 plays an important role in enhancing electrochemical performance by providing multiple redox-active sites and structural stability. PTh was synthesized by using chemical oxidative polymerization method, while MnCr2O4 was synthesized by using the co-precipitation method. The composite was characterized by using FTIR, UV-Vis, XRD, and FESEM to analyze its structural, optical, and morphological properties. Electrochemical performance was evaluated in a three-electrode system using cyclic voltammetry (CV), galvanostatic charge-discharge (GCD), and electrochemical impedance spectroscopy (EIS). The results showed improved electrochemical activity, higher charge storage capacity, and better cyclic stability compared to the individual materials. Uniform dispersion of MnCr2O4 in the PTh matrix and good structural stability contributed to the enhanced performance. These findings demonstrate the synergistic effect between PTh and MnCr2O4, suggesting that the PTh@MnCr2O4 composite is a promising material for advanced energy storage applications

Schiff Base Chemistry: Synthesis, Characterization, In-Vitro and In-Silico Studies

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Abstract: The present work focuses on the synthesis of a Schiff base, (E)-4-(1-(2-aminophenylimino)ethyl)benzene-1,3-diol (APEB), and characterization by different spectroscopic techniques. The antibacterial and antioxidant activity of the synthesized compound was evaluated by MIC method and DPPH assay. The Schiff base, APEB, shows antibacterial activity against a bacterium (E. coli). Additionally, antioxidant potential has been evaluated through DPPH assay, indicating antioxidant properties. To define the interaction of the synthesized Schiff base with the target protein, molecular docking studies have been performed against the protein (PDB ID: 1AI6). This study highlights the significance of Schiff bases in medicinal chemistry and their potential application in the development of bioactive compounds.

Sustainable Synthesis of N-Aryl Dithiocarbamate Derivatives Using Self-assembled CuCo2O4 as a Reusable Catalyst

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Abstract: Recently, spinel-structured mixed-metal oxides of transition metals with the general formula (AB2O4) have attracted much attention due to their excellent catalytic properties. These materials consist of binary and ternary mixtures of metal oxides with two or more metal cations in mixed valence states, which facilitate electron transfer between them with relatively low activation energies. In this context, cobaltite materials (MCo2O4), particularly copper cobaltite (CuCo2O4), are of great interest due to their low cost, high natural abundance, and non-toxic nature. Due to these properties, they have been widely engaged in the preparation of various energy storage devices, Li-ion batteries, electrodes for oxygen evolution reactions, as well as water oxidation reactions, and sensors, etc.

Here, in this presentation, we report the synthesis of a self-assembled CuCo2O4 material by the co-precipitation method with analysis of its crystalline structure and morphology by powder X-ray diffraction, field-emission scanning electron microscopy, transmission electron microscopy, energy dispersive X-ray, BET, UV-Visible spectroscopy, thermogravimetric analysis, X-ray photoelectron spectroscopy, and FT-IR analytical techniques. The self-assembled CuCo2O4 material showed remarkable catalytic activity in the direct one-pot multicomponent synthesis of N-aryl dithiocarbamate derivatives under additive- and solvent-free reaction conditions. The CuCo2O4 material was recovered from the reaction mixture and reused for at least ten runs without appreciable loss of catalytic activity, making this protocol efficient and sustainable.

Synergistic Cu@Ni-MOF/CQDs Nanozymes with Peroxidase-Like Activity for Dual-Mode Sensing of Biomolecules and Toxicants

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Abstract: In this study, we prepared a Cu@Ni-MOF/carbon quantum dots (Cu@Ni-MOF/CQDs) nanozyme with enhanced catalytic and electroactive properties for dual-mode fluorometric and electrochemical sensing of GSH. The synergistic interaction between Cu and Ni metal centers along with conductive CQDs improves electron transfer and provides abundant active sites. In the fluorometric mode, the fluorescence intensity of CQDs changes in the presence of GSH due to electron transfer interactions and its strong reducing nature, enabling sensitive detection. In the electrochemical mode, the Cu@Ni-MOF/CQDs-modified electrode exhibits enhanced redox response, and the addition of GSH produces a noticeable change in current signal, allowing quantitative analysis.

Interaction Of Human Serum Albumin with Binary System of Gemini And Conventional Surfactants

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Abstract: The interaction of human serum albumin (HSA) with the gemini surfactant and non-ionic polymeric surfactant and their binary mixtures was thoroughly investigated using a combination of surface tensiometry and fluorescence spectroscopy, at a controlled temperature of 300 K. These techniques provided comprehensive insight into both the physicochemical and structural changes associated with the interaction of surfactant systems with HSA. The critical micelle concentration (CMC) of the binary mixtures was determined at various mole fractions of the gemini surfactant. It was observed that in all examined compositions, the experimental CMC values were consistently lower than those predicted by ideal mixing rules. This deviation indicates the presence of synergistic interactions between the gemini and conventional surfactants, resulting in more thermodynamically favourable micelle formation than would occur in ideal mixtures. The results showed that both micellization and adsorption processes were significantly influenced by the composition of the mixed surfactant systems, particularly by the proportion of gemini surfactant present. Overall, the study underscores the importance of surfactant composition in modulating protein–micelle interactions. The observed synergistic micellization and increased protein interaction with higher gemini content point to the potential of gemini–Pluronic systems as tunable carriers in drug delivery, protein stabilization, and other biomedical applications. The combined experimental approach offers valuable insights into the physicochemical basis of these complex interactions, paving the way for the rational design of surfactant-based formulations in pharmaceutical and biotechnological contexts.

Keywords: Human Serum Albumin, Mixed Micellization, Gemini Surfactant, Binding affinity

Civil and Architecture Engineering

Assessing Climate Vulnerability and Long-Term Hydroclimatic Variability in Chhattisgarh, India

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Abstract: This study delivers a comprehensive district-level assessment of climate vulnerability and long-term variability across Chhattisgarh, India, spanning 1961–2023. Using daily rainfall, mean temperature (Tmean), and maximum temperature (Tmax) records, spatial variability was characterized through descriptive statistics and coefficients of variation, while monotonic trends were evaluated with the Mann-Kendall test and Sen's slope estimator. A composite Climate Vulnerability Index (CVI) was constructed by integrating historical climate signals with future projections derived from observed trends, with uncertainty quantified via 95% confidence intervals. Results reveal a pronounced rainfall decline in northern and central districts (e.g., Jashpur: –2.86 mm/year; Surguja: –2.38 mm/year), alongside consistent Tmax increases (0.006–0.009 °C/year) across all districts. Central plains exhibit the highest rainfall variability (>22%), intensifying hydro-climatic stress in rainfed regions. The dual pressures of declining rainfall and rising heat underscore escalating risks for agrarian livelihoods, particularly in northern uplands. CVI values ranged from 0.297 (Sukma) to 0.716 (Balrampur), highlighting stark spatial heterogeneity. Northern and eastern districts such as Balrampur (0.716), Korba (0.709), Bilaspur (0.659), Raigarh (0.618), and Raipur (0.611) emerged as Very High vulnerability zones, while central districts showed High vulnerability. Southern districts, including Sukma and Bastar, reflected comparatively lower risk. Narrow confidence intervals (±0.01–0.03) confirm the robustness of the index.

Bio-Based Composites as Sustainable Alternatives to Conventional Construction Materials

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Abstract: The construction sector is one of the largest consumers of natural resources and a major contributor to global CO_2 emissions due to the extensive use of conventional materials such as Portland cement concrete and steel. In response to sustainability imperatives and circular economy principles, this study investigates bio-based composites integrated with cementitious concrete systems as environmentally responsible alternatives for structural and non-structural applications. The research focuses on the development of hybrid bio-concrete composites incorporating natural fibers (jute, bamboo, and coir), supplementary cementitious materials (SCMs) such as metakaolin and fly ash, and bio-derived fillers to enhance mechanical performance while reducing embodied carbon. The study evaluates fresh properties, mechanical strength (compressive, split tensile, flexural), durability characteristics (water absorption, sorptivity, chloride penetration), microstructural behavior (SEM and XRD analysis), and thermal performance of developed composites. Comparative analysis is conducted against conventional M30–M40 grade concrete to determine structural viability and sustainability indices. Results are expected to demonstrate improved ductility, crack resistance, and reduced density, alongside a measurable reduction in carbon footprint and material cost.The research contributes to sustainable construction by proposing a performance-optimized, low-carbon bio-based composite concrete suitable for rural infrastructure, affordable housing, and green building applications, aligning with long-term sustainable development goals and climate resilience strategies.

Climate Variability and Hydrological Response in a Rapidly Urbanizing Basin: A Case Study of Raipur District, Chhattisgarh, India

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Abstract: In rapidly urbanising tropical areas, hydrological regimes are progressively affected via climate variability. This study evaluates how hydrological processes in Raipur District, Chhattisgarh, India, are affected by shifting climatic conditions. For the years 1991–2023, a sophisticated integrated technique that combined land use analysis founded on remote sensing, Mann–Kendall trend analysis, Standardised Precipitation Index (SPI), and Soil and Water Assessment Tool (SWAT) modelling was applied. Hydro-climatic interactions were simulated employing hypothetical but geographically accurate statistics of rainfall, temperature, streamflow, evapotranspiration, and groundwater levels. The findings reveal a non-uniform rainfall distribution with a 12% increase in severe storms and an 18% increase in the frequency of dry spells, along with a statistically significant increase in the annual mean temperature of 0.42°C/decade. As a result of both urbanisation (23% increase in built-up area) and variability in the climate, surface runoff rose 9.6% while groundwater recharge declined 14.3%. According to model projections, if current trends continue, pre-monsoon base flow could drop by 17%, hardening water shortages, while peak discharge after the monsoon may increase by 21% by 2040, boosting the danger of urban flooding. According to the study's outcomes, Raipur's climate-driven hydrological mismatch is typified by "flood-drought duality," in which excessive rainfall and depleting groundwater coexist. There is an urgent need for adaptive watershed planning that incorporates regulated aquifer recharge, urban drainage designs, and climate forecasts.

Drought Hotspot Identification and Hydrological Modelling for Climate Change Adaptation in Chhattisgarh

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Abstract: Drought is a major climate-induced hazard affecting the predominantly rainfed agricultural systems of Chhattisgarh, India. This study presents a district-level assessment of meteorological drought characteristics using the Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) for the period 1981–2023 based on high-resolution gridded precipitation and temperature data from the India Meteorological Department (IMD). The indices were computed at 3-, 6-, and 12-month time scales to evaluate drought frequency, duration, and severity. Trend analysis was performed using the Mann Kendall test and Sen's slope estimator to identify significant changes in drought patterns under changing climatic conditions. SPEI-based analysis revealed more intense drought conditions than SPI, emphasizing the growing role of temperature-driven evapotranspiration in drought intensification. To assess hydrological and agricultural implications, SWAT model simulations were used to analyze the response of streamflow, soil moisture, and baseflow under drought years, showing reductions of 20–35% in surface runoff and significant declines in soil moisture availability. These hydrological deficits were further linked with district-level crop yield anomalies for major crops (rice), indicating yield reductions of 15–30% during severe drought years.

Keywords: Drought assessment; SPI; SPEI; SWAT model; Climate change; District-level analysis; Hydrological response

Effectiveness of Grouting on Seepage Control and Slope Stability of a Tailing Dam

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Abstract: The planning and construction of earth dams require careful attention because any deficiencies during or after construction can lead to serious risks and possible failure. In dam engineering, several forces act on the structure, including uplift pressure and the risk of piping, both of which must be properly addressed to ensure safety. To minimize seepage beneath hydraulic structures, commonly adopted measures include the installation of grout curtains and drainage systems. In the present study, a numerical investigation was conducted to evaluate the impact of a grout curtain on seepage behaviour and slope stability of an earthen dam. A tailings dam was selected as the case study, and the modelling was carried out using SEEP/W for seepage analysis and SLOPE/W for slope stability assessment. The results indicate that placing a grout curtain on the upstream side of the dam significantly reduces uplift pressure and the likelihood of piping. It was observed that increasing the curtain length enhances resistance to uplift forces and internal erosion. Furthermore, grouting improves the overall stability of the dam slopes. An optimal curtain length of 50 m was identified, and the use of two curtain rows proved to be most effective. Analysis of different spacing arrangements showed that a 3 m distance between the two rows within the dam core is optimal, while a curtain depth of 10 m was considered appropriate for the study..

Estimation Of Vehicle Kilometer Travelled for Road Freights In India by Fuel Consumption Method

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Abstract: India's logistics sector is predominantly road-based, accounting for the transportation of over 4.6 billion tonnes of freight annually. As freight volumes continue to rise, the need for accurate estimation of Vehicle Kilometers Travelled (VKT) becomes imperative for transport infrastructure planning, emission modeling, and policy formulation. This study presents a comprehensive assessment of VKT estimation using a fuel consumption-based approach, applied across all Indian states. The methodology integrates secondary data from authoritative government sources and commercial databases to derive state-wise VKT figures for road freight vehicles.

The research further investigates the influence of key macro and micro-level factors—such as population distribution, warehousing infrastructure, gross state domestic product (GSDP), road network classifications (National Highways, State Highways, and rural roads), and industrial activity—on VKT intensity. States are categorized into policy and logistics clusters based on their industrial development and logistics readiness, enabling a comparative evaluation of how regional logistics strategies and infrastructure policies impact freight mobility.

Significant disparities in VKT patterns are observed across states, reflecting variations in economic structure, freight demand, and transport infrastructure quality. The study also highlights major data limitations, particularly in time-series availability and state-level disaggregation, and emphasizes the need for transparent, dynamic, and publicly accessible data systems. The findings contribute to the broader discourse on sustainable freight transport in India and offer a replicable framework for state-level VKT modeling to inform evidence-based planning and policy decisions.

Geometry Controlled Seismic Response of Open Ground Storey Buildings: Implications for Resilient Urban Infrastructure

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Abstract: The aim of this study is to examine the seismic resilience of six-storey open ground storey (OGS) RC frame buildings designed using a performance-based seismic design (PBD) approach by varying the plan aspect ratio while maintaining an identical plan area of 144 m². For this purpose, two OGS frame analytical models with a height of 18 m and identical plan area were developed. Plan aspect ratios of 1.5 and 2.5 were selected by altering the bay configuration in both principal directions. Seismic performance was evaluated through nonlinear time history analysis using fourteen spectrum-compatible far-field ground motions. Peak roof displacement, inter-storey drift ratio, and base shear were considered as resilience indicators. The results indicate that the higher aspect ratio model developed greater base shear demand, with an increase of about 21%, but exhibited approximately 13–15% lower drift than the lower aspect ratio model, indicating reduced vulnerability and improved post-earthquake functionality. The findings highlight the importance of optimising plan geometry to mitigate soft-storey effects and enhance the seismic resilience of urban RC building infrastructure in high-seismic regions.

Parametric study of the properties of concrete produced using GGBS and Steel Slag powder

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Abstract: This study examines the individual use of Ground Granulated Blast Furnace Slag (GGBS) and Steel Slag Powder (SSP) as partial replacements of cement in M40 grade concrete. The experimental program included compressive strength, split tensile strength, flexural strength, and Ultrasonic Pulse Velocity (UPV) tests to evaluate the mechanical and quality performance of concrete. Results showed that GGBS significantly enhanced later-age strength and internal matrix densification, with an optimum replacement level of 30%, achieving higher compressive, tensile, and flexural strengths along with improved UPV values. Steel Slag Powder contributed to better early-age strength due to its high calcium content; however, excessive replacement led to performance reduction. The optimum level for Steel Slag Powder was identified as 15%, providing balanced strength and satisfactory UPV results. The findings confirm that both materials, when used individually at optimum levels, can produce durable and sustainable concrete with reduced cement content.

Statistical Geospatial Prioritization of Drought-Prone Watersheds for Soil Conservation and Socio-Ecological Development in the Shivnath River Basin, Chhattisgarh, India

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Abstract: A watershed is defined as a geo hydrological unit draining to a common point by a system of drains. India as a growing country depends largely on water for irrigation, electricity, transportation, food consumption etc. As a wave of urbanization has taken over India, the need to save this resource is the need of the hour. A watershed, also called a drainage basin or catchment area, is defined as an area in which all water flowing into it goes to a common outlet. People and livestock are an integral part of watersheds, and their activities affect the productive status of watersheds and vice versa. From the hydrological point of view, the different phases of the hydrological cycle in a watershed are dependent on various natural features and human activities. This study focuses on the Shivnath River Basin's morphometric parameters to understand the watershed's hydrological characteristics related to soil erosion conservation analysis. A correlation analysis based on a weighted sum approach was adopted to address the objectives of the research. In this study the watershed boundary was marked with the help of satellite database and physical inspection, the stream order is defined by 'Stahler's method'. The standard formulas were employed to calculate about 23 different morphometric parameters. The Shivnath River Basin is classified into seven watersheds (WS-1 to WS-7). The classification of the watershed is based on geographical survey of the selected area and the catchment is cut on the bases of ridge line theory along with field observation. The selected area has low crop production and in Chhattisgarh state the area has the highest migration. With the aid of watershed prioritization and statistical analysis of the corresponding morphometric characteristics utilizing remote sensing and GIS techniques, the current study aimed to identify the crucial watershed that requires prompt conservative soil erosion management.

Computer Sciences, Electronics, Information Technology, Instrumentation etc.

Block-wise image and video-based focus stacking algorithm for microscopy and embedded systems

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Abstract: Multi-focus imaging is widely used in microscopy and macro photography, where the limited depth of field causes only a small portion of the scene to remain sharply focused at any given frame. This paper presents a computationally efficient block-based focus stacking algorithm that integrates spatially localized focus measurement, block-wise best-frame selection, and smooth blending to reconstruct an all-in-focus image from multi-focus video sequences. The method supports multiple focus metrics including gradient magnitude, intensity variance, and Laplacian variance. A Tukey-window based smoothing function is introduced to eliminate block artifacts and ensure seamless transitions between fused regions. Experiments demonstrate that Laplacian-variance focus measurement combined with block-level fusion yields high-quality extended-depth-of-field imagery suitable for microscopy, biological imaging, and embedded imaging systems

A Vocal Biomarker Based Framework for Hcg Hormone Levels Shift Detection in First, Second and Third Trimester of Pregnancy

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Abstract: Speech signal analysis has emerged as a promising non-invasive tool for detection of physiological and hormonal variations which can be helpful in monitoring pregnancy conditions in women. One frequent method used by doctors is Human Chorionic Gonadotropin (HCG) hormone level detection through pathological testing of blood sample for confirming a woman's pregnancy and to monitor pregnancy progression, estimate fetal age, diagnose ectopic pregnancies or miscarriages and screening for Down Syndrome etc. Apart from this the presented work proposes a novel, non-invasive technique for measuring HCG hormones level shift based on speech signal processing. As human speech reflects the intricate physiological features of the human body. Analysis of Speech Feature like pitch, energy, Formant, power spectral density (PSD) can reveal the physiological condition of the human body. The study was made on 25 Non-Pregnant healthy women and 25 Pregnant women of 21-40 years of age. The Hindi language speech samples of non-pregnant women recorded for consecutive 30 days whereas the speech samples of pregnant women were recorded in their various pregnancy weeks. Further the PRAAT speech signal analysis tool and MATLAB software were used for noise removal and PSD extraction from the recorded speech samples. The power spectral density analysis of the speech samples reveals the HCG Hormone level shift detection in various weeks of pregnancy in women as per the clinical standards.

Keywords: Power Spectral Density (PSD), Human Chorionic Gonadotrophin (HCG) hormone, Speech Signal Analysis.

A Mobile-based Application for Ripeness Detection of Amrapalli Mango using BIS+ML Approach

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Abstract: Determining the precise maturity stage of the Amrapali mango is critical for optimizing harvest timing, ensuring export quality, and minimizing post-harvest losses. Traditional methods of ripeness detection are often destructive or subjective. This study proposes a novel, non-invasive framework that fuses Bio-Impedance Spectroscopy (BIS) with machine learning algorithms to accurately classify ripening stages. The methodology utilizes a dual-sensing approach, capturing both internal bio-electrical properties and external chromatic features of the fruit. To overcome the challenges of manual labeling, an unsupervised machine learning technique was employed on the combined dataset to mathematically cluster the mangoes into four distinct natural physiological stages: pre-ripe, ripe, overripe, and decay. These cluster-derived labels served as the ground truth to train a robust supervised classifier. This hybrid strategy leverages the sensitivity of bio-impedance to internal tissue changes alongside visual data, resulting in a highly reliable classification model. Experimental validation demonstrates that this approach achieves superior accuracy in identifying the specific maturity levels of Amrapali mangoes. The proposed system offers a scalable technological solution for stakeholders in the supply chain, facilitating better decision-making in sorting and grading processes.

A Theoretical Analysis of Machine Learning in Zero-Day Attack Detection

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Abstract: Zero-day cyberattacks pose a significant risk to contemporary digital systems as they take advantage of unknown vulnerabilities for which no existing signatures are available. Conventional security measures are unable to detect such attacks, prompting researchers to explore machine learning-based approaches for early threat identification. Although machine learning has demonstrated potential in recognizing abnormal behaviours, it also encounters fundamental theoretical and practical challenges when used for detecting zero-day attacks.

This paper provides a theoretical examination of the limitations of machine learning in identifying zero-day cyber attacks, focusing on issues such as data dependency, concept drift, adversarial manipulation, a lack of explainability, and challenges related to real-time deployment. The study contends that machine learning cannot ensure complete detection of zero-day threats and highlights the necessity for hybrid, adaptive, and human-assisted cybersecurity frameworks.

In addition, the paper highlights the importance of continuous learning and contextual awareness in zero-day attack detection. As cyber threats evolve rapidly, static models trained on historical data become increasingly ineffective, necessitating systems that can adapt to new patterns and incorporate domain expertise. By combining automated detection techniques with human intelligence and adaptive security strategies, organizations can improve resilience against sophisticated zero-day attacks and reduce the risk of catastrophic security breaches.

An Explainable and Computationally Efficient Radiomics-Based Framework for Brain Age Prediction from Structural MRI

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Abstract: Early diagnosis of neurological disorders and assessment of brain health require an understanding of the underlying physiological and structural changes that occur in the brain with aging. MRI based brain age prediction has therefore surfaced as an important tool for studying brain aging and identifying abnormal aging patterns. While numerous studies have used complex machine learning models to achieve higher accuracy, these approaches demand high computational resources and have limited interpretability. This study, however, proposes a computationally efficient and interpretable radiomics based framework for brain age prediction using T1-weighted MRI scans from the publicly available IXI dataset. First, a set of statistical and radiomics features describing intensity distribution, histogram characteristics, and structural variability was extracted from the MRI scans to characterize brain tissue properties. These features were normalized with StandardScaler and further reduced using Principal Component Analysis and feature selection. Interpretable machine learning algorithms such as Linear Regression, Ridge Regression, and Random Forest were trained and evaluated using cross-validation and standard regression metrics. The best performing model was further optimized using hyperparameter tuning. To analyze model interpretability, measures such as feature importance, SHAP based interpretation and permutation importance were used to extract key features. The proposed framework achieved MAE of 8.99 years and R squared score of 0.494 providing accurate brain age prediction while maintaining transparency and computational efficiency. This approach provides a practical and interpretable alternative to complex models and may support future research in neurological aging and explainable artificial intelligence.

Development of a Dataset for Flowchart-Based Vector Diagram Extraction from Academic Research Papers

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Abstract: Research papers and technical documents widely use diagrams such as flowcharts and block diagrams to clearly explain complex ideas. However, extracting these diagrams from PDF files is difficult because they are often vector-based, mixed with text, and lack embedded image information. This project proposes an automated, model-free approach to detect and extract vector-based diagrams from research PDFs using image processing techniques. PDF pages are first rendered into high-resolution images, followed by preprocessing steps such as grayscale conversion, contrast enhancement, edge detection, and morphological operations. Diagram regions are identified through contour analysis and edge density filtering, while text-heavy areas are suppressed. The extracted diagrams are saved as high-quality images, demonstrating effective and scalable diagram extraction without using deep learning models.

Lightweight Deep Learning Models with Explainable AI for Real-World Winter Crop–Weed Classification Using WinterCropWeedDB

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Abstract: Effective weed management is essential for sustainable agriculture, as it directly influences crop yield, resource efficiency, and economic viability. Although machine learning–based weed classification has been extensively studied in summer crops such as rice and maize, winter cropping systems remain underrepresented in publicly available benchmarks. To address this gap, this study introduces WinterCropWeedDB, the first publicly available dataset dedicated to winter crop–weed classification, comprising 1,136 high-resolution images of six winter crops and four predominant weed species collected under real-field conditions in central India (Bilaspur and Mungeli districts, Chhattisgarh). The dataset captures natural variability in soil background, illumination, and crop growth stages. To demonstrate its utility, four lightweight deep learning architectures—Custom CNN, MobileNetV3-Small, EfficientNet-B0, and ConvNeXt-Tiny—are systematically evaluated across three experimental protocols: a stratified 70/30 hold-out evaluation on raw data, a stratified 5-fold cross-validation, and a stratified 70/30 evaluation with data augmentation. Given the pronounced class imbalance, balanced accuracy and class-wise recall are emphasized alongside overall accuracy, while computational efficiency is assessed using parameter count, FLOPs, and inference time. Results show that stratified cross-validation improves performance stability without increasing inference complexity. EfficientNet-B0 achieves the most favorable accuracy–efficiency trade-off, while ConvNeXt-Tiny attains the highest accuracy at a higher computational cost. MobileNetV3-Small offers competitive performance suitable for embedded deployment, and data augmentation improves minority weed recall. Explainable AI analyses using Grad-CAM, LIME, and SHAP confirm that predictions rely on agronomically meaningful plant structures rather than background artifacts, enhancing trust and deployment readiness.

Reinforcement Learning Guided Knowledge Distillation Framework Cross-Lingual Transfer from Hindi to Chhattisgarhi

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Abstract: Low-resource languages continue to face significant challenges in neural language processing due to the scarcity of annotated data and limited representation in large multilingual models. Chhattisgarhi, a widely spoken regional language of central India, is one such language that remains underrepresented despite its close linguistic relationship with Hindi, a high-resource language. This paper proposes a reinforcement learning guided knowledge distillation framework to enable effective cross-lingual transfer from Hindi to Chhattisgarhi. The approach builds upon a multilingual pretrained backbone and introduces a teacher-student distillation mechanism where a reinforcement learning agent dynamically controls transfer decisions during training. Instead of applying static fine-tuning strategies, the proposed framework learns to selectively transfer linguistic knowledge based on model confidence and performance feedback. This design allows more efficient utilization of high-resource language representations while reducing negative transfer. The work focuses on methodological design and experimental setup for low-resource cross-lingual adaptation, laying the foundation for scalable support of underrepresented Indian languages through adaptive transfer learning. On the Hindi-Chhattisgarhi NLLB validation set, our full RL + KD + backtranslation pipeline improves translation quality from 11.26 → 27.37 BLEU and 29.8 → 44.53, demonstrating the complementary benefits of adaptive layer training and synthetic data augmentation.

Earth and Atmospheric Sciences

(Geology, Geography, Meteorology, Oceanography etc.)

Analytical Hierarchy Process Integrated with Remote Sensing and GIS for Identification of Spring Potential Zones in the Arpa River Basin Chhattisgarh, India

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Abstract: This research presents the comprehensive assessment of spring occurrence zones (current and potential) to date in the Arpa River Basin region utilizing integrated Analytical Hierarchy Processes (AHP), Remote Sensing, and Geographic Information Systems (GIS) for multi-criteria analysis (MCA) on a spatial basis. Analysis was performed on twenty (20) individual parameters broadly defined as Topographic, Geological, Hydrological, and Land-Surface/Environmental characteristics. The dataset used included satellite products and other publicly available data sources at a 30-meter spatial resolution. Each thematic layer was classified according to its correlation with spring emergence using the GIS and weighting assigned utilizing AHP with consistency checks. The combined thematic overlays created three classes of potential springs; low, moderate and high. The majority of the basin has moderate spring potential with 96.97 percent part of study area, it also reflects as neutral behaviour on Spring emergence depicted in field validation. The 2.37 percent area of the basin is classified with high potential of spring occurrence (primarily along structurally fractured areas of the uplands and valley fill/terrace areas) and approximately 0.66 percent of the basin is classified with low potential for spring occurrence (primarily the steepest and least permeable portion of the Basin). A validation of model generated spring locations based on field verified spring locations, utilizing a receiver operating characteristic (ROC) analysis yielded an area under the curve (AUC) of 0.942 indicating excellent predictive accuracy. The results of this study will support the development of targeted spring rejuvenation plans and sustainable groundwater management practices.

Keywords: Spring Potential Zone, Analytical Hierarchy Process (AHP), Arpa River Basin, Remote Sensing, Geographic Information Systems (GIS).

Geological Control on Avian Biodiversity in Urban Lakes: A Case Study on Dalpat Sagar Lake of Bastar Region

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Abstract: Urban lakes and ponds function as ecological hubs that support both migratory and resident avifauna. Although the biological and climatic factors shaping bird distribution are well documented, geological determinants of avian biodiversity remain comparatively underexplored. This study examines how lithology and hydro geochemistry influence avian biodiversity in Dalpat Sagar; a plateau lake located within the Bastar Craton of central India. The crystalline basement geology, lateritic and alluvial soil cover, and seasonal hydroperiod collectively regulate nutrient cycling, littoral zone development, and trophic productivity, thereby affecting habitat suitability for birds. A multidisciplinary approach-comprising geological surveys, hydro-chemical analysis and avian diversity surveys-is proposed. The results indicate that geology indirectly shapes lake-based food webs and the stability of migratory habitats. A geology-informed conservation framework is recommended to support sustainable lake management for sound preservation of such vital biodiversity hotspots like: Dalpat Sagar.

Keywords: Lithology, Hydro-geochemistry, Avian Biodiversity, nutrient cycling.

Integrating Soil Quality Index and Growth Modeling Framework for Forecasting Post-Mining Land Reclamation Timelines

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Abstract: Quantifying the recovery trajectory of degraded mine soils remains a persistent challenge in applied geology, particularly in evaluating post-mining land stability and long-term soil system rehabilitation. Accurate assessment of recovery pathways is essential for measuring reclamation effectiveness, guiding adaptive land management, and predicting the re-establishment of functional soil–geological systems. This study presents an integrated applied geological framework that combines a tree-based Reclaimed Mine Soil Quality Index (RMSQI) with asymptotic growth modeling to estimate the reclamation age of degraded limestone mine substrates. Soil physico-chemical, microbial, and enzymatic parameters were assessed under four dominant forest tree species across a restoration chronosequence of 5, 15, and 25 years, along with non-planted soil (NPS) and reference normal soil (RNS) representing geological baseline conditions. Principal Component Analysis (PCA) condensed 18 soil variables into a minimum dataset explaining 88.09% of total variance, forming the quantitative basis of the RMSQI as a proxy for soil system recovery. RMSQI values increased significantly with reclamation age, from 0.230–0.249 at 5 years to 0.607–0.627 at 25 years, approaching the geological reference benchmark (0.656). Among multiple predictive approaches, the asymptotic growth model most accurately represented restoration trajectories ($R^2 > 0.99$), indicating progressive convergence toward stable soil conditions. Monte Carlo simulations projected vegetation-driven median recovery timelines of 29–34 years to achieve reference soil quality, with species-specific uncertainty envelopes reflecting variability in pedogenic development. The proposed framework offers a biologically grounded and statistically robust applied geological tool for forecasting reclamation timelines and supporting evidence-based species selection in post-mining landscapes.

Study of atmospheric PM_1 Carbonaceous matter over an urban atmosphere

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Abstract: Atmospheric particulate matter (PM) significantly influences regional climate, air quality, and human health. Among its size fractions, submicron particles (PM1) are particularly important due to their longer atmospheric lifetime and deeper respiratory penetration. This study presents first-hand information on PM1 mass concentration and associated carbonaceous components in an urban-industrial environment of Raipur, Chhattisgarh, central India.

Twenty-four-hour PM1 samples were collected during winter and summer seasons from four environmentally distinct sites representing urban-background, industrial, residential, and road-traffic environments. Samples were analyzed for organic carbon (OC) and elemental carbon (EC) using a multiwavelength thermal optical OC/EC carbon analyzer (DRI Model 2015). PM1 exhibited clear seasonal and spatial variability, with concentrations following the order: industrial > residential > traffic > background. Winter levels were consistently higher than summer, indicating the influence of stable atmospheric conditions and enhanced combustion activities.

Carbonaceous matter constituted more than 50% of the total PM1 mass, highlighting its dominant contribution to submicron aerosol loading. OC and EC also showed similar spatial trends, suggesting strong anthropogenic influence from industrial emissions, vehicular exhaust, and biomass burning.The study provides baseline scientific evidence on carbonaceous PM_1 in central India and supports the development of targeted mitigation strategies for sustainable urban air quality management.

Keywords: Particulate matter; PM1; carbonaceous matter; OC-EC

Electrical Engineering, Electronics and Telecommunication Engineering.

A Novel Arbiter PUF Using VGSOT-MTJ with Cascaded Writing Mechanism for Lightweight and Energy-Efficient

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Abstract: Physical Unclonable Functions (PUFs) are emerging as a promising hardware primitive for lightweight security in resource constrained IoT systems. However, many existing spintronic PUF designs suffer from high write overhead, complex control circuitry, and limited resistance against modeling attacks. In this work, we introduce an arbiter PUF based on Voltage-Gated Spin-Orbit Torque Magnetic Tunnel Junction (VGSOT-MTJs) that departs from conventional per-cell write architectures. The proposed design employs a cascaded writing mechanism, where a single shared write path progressively drives multiple MTJs. This approach simplifies control logic, reduces transistor count, and naturally introduces controlled delay diversity along the path. Unlike traditional designs with serialized readout, the proposed architecture adopts an individual read mechanism, enabling stable and consistent response extraction. A mathematical analysis is presented to explain the cumulative write-current behavior and its impact on switching dynamics. Comprehensive simulations demonstrate strong reliability, near-ideal entropy, and robustness under process and environmental variations. Furthermore, extended machine-learning evaluations using an enlarged CRP space highlight improved resistance against prediction attacks. These results indicate that the proposed VGSOT-MTJ arbiter PUF offers a compact, energy-efficient, and secure solution for next-generation IoT hardware security, while opening new design possibilities for scalable spintronic PUF architectures.

Effect of TSV Geometry on Thermo-Mechanical Stress and Fracture Parameters Under- Thermal Loading

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Abstract: With the growing complexity and miniaturization of semiconductor devices, three-dimensional integrated circuits (3D ICs) have emerged as a pivotal advancement over conventional two-dimensional (2D) architectures. Through-silicon vias (TSVs) play a central role in enabling vertical interconnections and achieving enhanced functional density. Despite their advantages, the mechanical reliability of TSV structures remains a significant challenge due to stress development within heterogeneous material systems. Defects such as voids, micro-cracks, and interfacial imperfections may exist in TSVs and can act as stress concentration regions. Under thermal loading induced by coefficient of thermal expansion (CTE) mismatch, these defects may propagate, leading to localized stress amplification and structural degradation. Although prior studies have examined TSV reliability, the comparative influence of TSV geometry, particularly solid and hollow configurations, on stress interaction with defects and defect evolution has not been sufficiently addressed. This work presents a comparative analysis of solid and hollow TSV designs to evaluate stress distribution and defect growth under applied thermal loading. Finite element analysis (FEA) is employed to model the thermo-mechanical response, focusing on stress concentration, deformation behavior, and defect propagation characteristics. A notable improvement in structural reliability is observed, as the stress intensity factor (SIF) and energy release rate reduced by approximately 25% and 43%, respectively. The results provide insights for optimizing TSV structures, enhancing mechanical robustness, and supporting long-term reliability in advanced 3D integrated systems.

Enabling 6G Ultra-Reliable V2X Through Constraint-Preserving Graph Learning and Scalable Resource Allocation

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Abstract: Ultra-reliable and low-latency communication (URLLC) in sixth generation (6G) vehicle-to-everything (V2X) networks demand intelligent joint subchannel and power allocation, where safety-critical vehicle-to-vehicle (V2V) links reuse uplink spectrum assigned to vehicle-to-infrastructure (V2I) transmissions. Each V2V link must satisfy a 100 ms latency constraint with at least 95% reliability while operating under strong inter-V2V and cross-tier interference. This results in a mixed-integer nonlinear optimization problem whose search space scales exponentially as O((m|P|)^k), making exhaustive optimization infeasible in dense vehicular deployments. Existing graph-based reinforcement learning approaches improve scalability but primarily optimize average reward without explicitly guaranteeing strict outage constraints required for mission-critical communication. The problem is reformulated as a reliability constrained throughput maximization task, where aggregate V2I capacity is maximized subject to probabilistic V2V outage limits derived from queue deficit evolution over 1 ms time slots. A graph-based supervised policy framework is developed to model interference through a dynamic communication graph and learn allocation strategies from near-optimal solutions. The proposed constraint-preserving graph learning approach reduces inference complexity to linear order O(k) while retaining structural interference awareness. Simulations under 3GPP TR 36.885 channel conditions demonstrate up to 5% absolute improvement in V2V success probability over GNN-DDQN, sustained reliability above 95%, higher V2I throughput, and improved robustness across vehicular densities from 20 to 100 vehicles.

Precise Beam Control in Multi-hop RIS via High-Resolution Coding and Spatial Analysis

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Abstract: Multi-hop reconfigurable intelligent surface (RIS)-enabled communication offers a powerful framework for tackling signal degradation and coverage limitations in complex 6G wireless environments. The analysis examines the impact of key design parameters, including RIS location, number of RIS hops, unit-cell code sequences, and three-dimensional (3D) Rx positioning across single-hop and 2-hop RIS scenarios in environments with multiple blockages. The 2-bit coding scheme offers finer phase resolution, enabling more precise and controlled beam steering toward spatially distributed receivers across diverse 3D configurations. Results demonstrate that the 2-bit coding strategy significantly narrows the reflected beam toward the Rx, maximizing signal strength and reducing interference in complex propagation environments. Furthermore, the analysis reveals that optimal selection of RIS coding sequences based on the known receiver location plays a critical role in maximizing received signal power. These findings suggest that optimal RIS coding strategies can significantly improve spectral efficiency and overall system performance, offering valuable insights into effective RIS deployment strategies for next-generation 6G wireless networks.

Stenosis-Aware Molecular Communication for IoBNT: Modulation Reliability in Non-Newtonian Vascular Channel

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Abstract: The Internet of Bio-Nano Things (IoBNT) aims to enable cooperative nano-scale communication networks within the human body for continuous health monitoring and intelligent therapeutic delivery. Reliable information exchange in such systems depends critically on molecular communication channels shaped by biological transport phenomena. This paper studies the influence of arterial stenosis on molecular communication reliability in vascular IoBNT scenarios. A stenosis-dependent non-Newtonian blood flow model is integrated with molecular transport dynamics to characterize channel impulse responses under realistic physiological conditions. The bit error rate (BER) performance of On–Off Keying (OOK) and Concentration Shift Keying (CSK) modulation schemes is evaluated across multiple stenosis levels (0–40%) and signal-to-noise ratios. Simulation results show that increasing stenosis introduces significant dispersion-induced channel memory, shifting system behavior from noise-limited to intersymbol interference (ISI)-dominated communication. At moderate operating conditions (SNR ≈ 3–4 dB), BER values remain around {10}^{-1}, while reliable communication (BER ≈ {10}^{-3}) is achieved only beyond approximately 10 dB SNR. OOK consistently outperforms CSK across all stenosis levels, providing approximately 20–35% relative BER improvement compared to CSK in the low-to-moderate SNR regime. The findings demonstrate that vascular geometry fundamentally alters modulation reliability and must be incorporated into modulation design for IoBNT systems, motivating adaptive communication strategies tailored to physiological channel states.

Keywords: Internet of Bio-Nano Things (IoBNT), Molecular Communication, Stenosed Blood Vessel, Bit Error Rate (BER)

Wearable Sensor-Driven System for Supporting Physiotherapists in Upper Limb Rehabilitation Training

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Abstract: Everyday tasks such as lifting and placing a bottle may appear simple, yet they can become challenging for individuals recovering from muscular or neurological disorders. Wearable sensor technologies provide an opportunity to objectively monitor muscle activity during rehabilitation and support physiotherapists in assessing patient progress. In this work, we present a wearable sensor-driven framework for supporting upper limb rehabilitation training through automated analysis of muscle activation patterns during functional daily tasks. The study utilizes a publicly available dataset by Lucchetti et al., containing synchronized kinematic and surface electromyography (sEMG) recordings from 10 healthy and 10 post-stroke subjects performing common upper-limb activities.

A standardized signal processing pipeline is employed in which raw EMG signals are preprocessed to reduce noise and segmented into fixed 1-second windows. From each segment, representative EMG features, Mean Absolute Value, Root Mean Square, Variance, Integrated EMG, Waveform Length, and Zero Crossing are extracted to characterize muscle activation behavior. These features are used to train and evaluate multiple machine learning classifiers, including Support Vector Machine, K-Nearest Neighbor, Logistic Regression, and Random Forest. Model performance is comparatively analyzed using Leave-One-Out Cross-Validation (LOOCV), and classification metrics are used to determine the most robust model for functional task recognition.

By automatically identifying rehabilitation tasks and analyzing muscle activation patterns, the proposed framework provides objective feedback on movement execution, assisting physiotherapists in monitoring patient progress and adjusting therapy programs. The study highlights the potential of wearable sensor-based systems for future real-time rehabilitation monitoring and assistive exoskeleton control applications.

Environmental Sciences, Environmental Engineering and Forestry

Asymptotic Growth Modeling Framework Derived from Tree-Based Soil Quality Indices for Predicting the Reclamation Age of Degraded Mine Soils

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Abstract: Quantifying the recovery trajectory of degraded mine soils remains a major challenge in ecological restoration. Accurately tracking this trajectory is essential for evaluating reclamation success, guiding adaptive management strategies, and predicting long-term ecosystem stability and functionality. This study proposes an integrated framework combining a tree-based Reclaimed Mine Soil Quality Index (RMSQI) with asymptotic growth modeling to predict the reclamation age of degraded limestone mine soils. Soil physico-chemical, microbial, and enzymatic parameters were evaluated under four dominant forest tree species (Dalbergia sissoo, Azadirachta indica, Tectona grandis, and Albizia procera) across a restoration chronosequence of 5, 15, and 25 years, alongside non-planted soil (NPS) and reference normal soil (RNS). Principal Component Analysis (PCA) reduced 18 soil variables into a minimum dataset explaining 88.09% of total variance, forming the basis of the RMSQI. RMSQI values increased significantly with plantation age, ranging from 0.230–0.249 at 5 years to 0.607–0.627 at 25 years, approaching the RNS benchmark (0.656). Among several predictive models tested, the asymptotic growth model best described restoration trajectories ($R^2 > 0.99$). Monte Carlo simulations estimated median recovery timelines of 29–34 years to attain reference soil quality, with species-specific uncertainty ranges. Dalbergia sissoo demonstrated the fastest recovery potential, whereas Tectona grandis exhibited greater variability. The framework provides a biologically realistic and statistically robust tool for forecasting restoration timelines and supports evidence-based species selection in mine reclamation planning. By integrating ecological indicators with predictive modeling, it strengthens decision-making, optimizes resource allocation, and accelerates the recovery of soil health and ecosystem resilience.

Biomass to Bio-Power: Low-cost Biodegradable green Membranes for MFC-Based Bioelectricity and Wastewater Treatment

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Abstract: Reducing internal resistance in microbial fuel cells (MFCs) requires separator membranes that provide continuous hydrated ion pathways while minimizing dimensional instability and oxygen/substrate crossover, while also supporting efficient wastewater treatment. Here, decellularized herbaceous leaf scaffolds were engineered into proton-exchange membrane (PEM) candidates through SDS-assisted decellularization, $CaCl_2$-mediated ionic stabilization, and poly(vinyl alcohol) (PVA) impregnation, enabling hydrogen-bond-driven consolidation of the hydroxyl-rich plant matrix while preserving native vascular microchannel connectivity. Composite membranes derived from Syzygiumcumini, Ficus benjamina, Plumeria rubra, and Terminalia catappa were evaluated via ion-exchange capacity (IEC), water uptake/swelling, contact angle, FTIR, SEM, tensile testing, XRD, and impedance-based conductivity. Although membranes with higher IEC also showed stronger hydration, excessive water uptake produced a pronounced stability penalty, emphasizing that maximum IEC does not necessarily translate to optimal separator function. XRD revealed that the top-performing membrane retained the strongest semi-crystalline PVA ordering, consistent with reduced free volume and controlled water sorption; this structural balance correlated with superior tensile strength (14.4 MPa) and improved dimensional stability. In a double-chamber MFC treating wastewater, the selected membrane achieved a peak output of 260 mV, 2166.67 mA m^{-2}, and 563.33 mW m^{-2}, while maintaining 370.86 mW m^{-2} on Day 15, and concurrently delivered a COD removal efficiency of 74 ± 0.6%. Overall, crystallinity–hydration balance emerged as a key design lever for suppressing separator resistance growth while sustaining hydrated ion conduction and wastewater remediation in MFC operation.

Development of Nanoparticle-Impregnated Biochar Composites Encapsulated in Chitosan-Alginate Beads for Removal of Anionic and Cationic dyes from Textile Wastewater

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Abstract: The textile industry is a major contributor to global water pollution, consuming approximately 93 billion cubic meters of water annually, with demand projected to increase by 50% by 2030. Of the 0.7 million tons of dyes produced each year, nearly 0.28 million tons are discharged into surface water, making textile dyeing the second largest water polluter and responsible for about 20% of global industrial water pollution. This study focuses on the preparation and characterization of biochar derived from three agro-food wastes—coconut shell, bamboo, and mango stone—for the removal of Methylene Blue (MB) and Congo Red (CR) dyes from wastewater. Biochars were synthesized via slow pyrolysis at 500°C and characterized using SEM, FTIR, BET, and XRD. Mango stone biochar (MSB) showed the highest adsorption capacity for both dyes. To improve performance, MSB was impregnated with ZnO, Fe_3O_4, and MgO nanoparticles. The effects of contact time (5–240 min), dye concentration (10–200 mg/L), pH (2–12), adsorbent dose (0.5–5 g/L), and temperature (25–55°C) were evaluated. Kinetic and isotherm studies were conducted to understand the adsorption mechanism and surface interactions. The best-performing nanocomposite was encapsulated in chitosan-alginate beads to enhance reusability and ease of separation. Desorption using 0.1 M NaOH and ethanol confirmed good regeneration efficiency. The developed composite beads show strong potential as a sustainable, low-cost, and reusable adsorbent for efficient treatment of dye-contaminated textile wastewater with minimal secondary pollution.

Enhanced and Synergistic Antifungal Efficacy of Green Synthesized Ag-Cu Bimetallic Nanoparticles

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Abstract: The development of novel, sustainable therapeutic approaches is required due to the rise of drug-resistant fungal infections and the poor effectiveness of traditional antifungal medications. In this study, green synthesis of bimetallic nanoparticles (BMNPs) is presented as a novel platform for synergistic antifungal action. BMNPs were synthesized via an eco-friendly approach employing plant-based phytochemicals as a natural reducing and capping agent. In this study, we have synthesized AgNPs, and AgCuNPs using Tamarindus indica leaf extract. Optimal AgCuNPs synthesis condition was achieved using 10 mM precursor salts (pH 7) at 37º C. Comprehensive characterizations were performed using Ultraviolet Visible Spectroscopy (UV-Vis spectra), Fourier Transform Infrared Spectra (FTIR), X-ray diffractometer (XRD), FESEM (Field Emission and Scanning Electron Microscope), EDX (Energy Dispersive X-ray Spectroscopy. The antifungal activity was tested using AgNPs and AgCuNPs through disc diffusion method and minimum inhibitory concentration (MIC). The AgCuNPs exhibited markedly superior antifungal efficacy than AgNPs, suggesting a synergistic effect arising from the combined action of Ag and Cu. BMNPs generate reactive oxygen species (ROS), rupture membranes, and release metal ions, to show potent antifungal action against a wide range of pathogenic microorganisms, including bacteria and fungus. In conclusion, this study demonstrates that green synthesized AgCuNPs serve as an eco-friendly and highly efficient antifungal agent. Future research should focus on integrating these materials into developing nanocomposite disinfection platforms, assessing their long-term stability and possible toxicological effects, and performing pilot-scale evaluations to support real-world water treatment applications. BMNPs represent a sustainable and effective strategy for next-generation water disinfection.

Keywords: Tamarindus indica, bimetallic nanoparticles (BMNPs), antifungal activity.

Magnetized MAG-Algabot based Flocculation for retrieval of microplastics

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Abstract: Microplastic contamination in aquatic systems has become a critical environmental challenge due to its persistence, bioaccumulative behavior, and capacity to transport hazardous pollutants across ecosystems. Existing remediation strategies remain limited by low efficiency, poor selectivity, and limited environmental sustainability. Here, we report a biohybrid remediation strategy employing Spirulina platensis functionalized with superparamagnetic Fe_3O_4 nanoparticles for rapid and efficient microplastic removal from aqueous environments. Magnetic nanoparticles were immobilized onto the helical microalgal surface through glutaraldehyde-mediated crosslinking, preserving the intrinsic morphology and bioadhesive extracellular matrix of Spirulina.The resulting magnetic biohybrids demonstrated enhanced interactions with polyethylene and polystyrene microplastics via extracellular polymeric binding and electrostatic surface charge complementarity. External magnetic fields enabled controlled aggregation and rapid magnetic retrieval of microplastic–biohybrid flocs. Flocculation experiments performed under varying physicochemical conditions, including pH and ionic strength, revealed substantial removal efficiencies within short treatment durations. Comparative analyses with non-functionalized Spirulina and isolated magnetic nanoparticles confirmed the synergistic performance arising from the biohybrid architecture. Physicochemical characterization using zeta potential measurements, Fourier-transform infrared spectroscopy, and scanning electron microscopy verified nanoparticle conjugation, interfacial interactions, and microplastic attachment mechanisms. The proposed magnetically actuated microalgal platform provides a sustainable, efficient, and environmentally compatible approach for microplastic remediation, highlighting the potential of biohybrid systems for advanced water purification technologies.

Reclamation of Coal Mine Spoil Using Invasive Plant–Derived Biochar in the Korba District, Chhattisgarh

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Abstract: The Gevra opencast mine, located in the Korba district of Chhattisgarh, is renowned as Asia's largest opencast mine. Extensive mining activities in this region have degraded a large area of land and produced undesirable waste called coal mine spoil (CMS). CMS is characterized by unfavourable pH, high bulk density, and low water-holding capacity, which hinder plant growth. Although biochar has gained significant attention for soil amendment, the application of invasive plant-based biochar in coal mine spoil reclamation remains underexplored. Therefore, this study critically evaluates the properties of biochar derived from the invasive plant Pistia stratiotes L. (PSB) and assesses its potential for coal mine spoil reclamation. Biochar was produced at varying temperatures of 300, 500, and 700℃ with a residence time of 30 min. A pot experiment was conducted to study the effect of PSB at different application rates on mine spoil properties and the growth of Albizia procera. Significant improvements were observed at a 5% application rate. Bulk density decreased by 5.13%, and moisture content increased by 28%. Cation exchange capacity improved by 2.2-fold, water-holding capacity by 1.2- fold, and organic carbon increased from 0.22 to 1.85%. Soil pH also became favourable. Dehydrogenase activity increased remarkably by 10- fold. Significant improvements were also recorded for macronutrients and plant growth parameters. These findings suggest that invasive plant-derived biochar can offer a sustainable and cost-effective method for CMS reclamation. It also provides the dual advantage of managing invasive plants and restoring degraded mine lands.

Keywords: Coal mining; Coal mine spoil; Biochar; plant growth; physico-chemical properties; Reclamation

Study of Removal of Organic Dyes by Magnetic Nanoparticles and Graphene oxide/Magnetic Nanocomposite for Sustainable Wastewater Remediation

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Abstract: Methylene blue (MB) and bromophenol blue (BB) are widely used organic dyes which imparts colour to the textiles, plastics etc. MB and BB are some of the common water contaminants present in industrial effluents which leads to environmental and health risk factors. It poses ecological risks due to persistence, toxicity and complex structure. Magnetic nanoparticles (MNPs) and graphene oxide/magnetic nanocomposite (MNCs) have emerged as promising materials for environmental remediation due to their unique physical and chemical properties like large surface area, high adsorption capabilities and magnetic recoverability. MNPs were synthesized using standard chemical co-precipitation methods and MNCs by hydrothermal route. Comprehensive characterization using XRD, FTIR, FESEM, HRTEM and VSM which confirms the structure, surface functional group, morphology, size and superparamagnetic behavior of the synthesized material respectively. The synthesized materials were evaluated for their comparative removal efficiency for MB and BB dye. Removal study of MB and BB was performed by varying various parameters such as dosage, concentration of dyes, pH and contact time. The photocatalytic degradation activity was performed under visible light irradiation and demonstrated a significant enhancement in dye degradation efficiency. This enhancement was due to the generation of free radicals such as reactive oxygen species (ROS) including OH. and superoxide .O2- radicals which actively participates in the breakdown of complex dye structure. The reusability of the material by magnetic separation highlights the practical applicability and cost effectiveness of the material for large scale wastewater treatment. The material is overall cost friendly, environment friendly and economically sustainable for wastewater treatment.

Keywords: Magnetic nanoparticles, graphene oxide, photocatalytic degradation, sustainable wastewater treatment

Utilization of Water Hyacinth (Eichhornia crassipes) in Compost Production and Its Application for Sustainable Agriculture

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Abstract: Water hyacinth (Eichhornia crassipes) is one of the most invasive aquatic weeds, causing serious environmental and economic impacts in water bodies. However, it has the potential to be composted as an organic fertilizer because of its high nutrient content. The purpose of this study was to make compost from water hyacinth and assess its suitability for use in agriculture. Water hyacinth biomass was harvested, mechanically chopped, mixed with carbon-rich bulking agents (rice straw, cow dung, ash, and soil), and composted for four months with periodic turning. Fertilityassays were used to examine the germination%, relative root growth and elongation of shooting and rooting of the compost.The results indicated a seed germination index >80%, showing that the compost was non-toxic and safe for agricultural application. When compared to control soil, plant height and quality were enhanced by the compost application. According to the research, water hyacinth compost can serve as an inexpensive sustainable fertilizer that lessens reliance on chemical fertilizers and aids the environment by controlling invasive weeds.

Home Science and Behavioral Sciences
(Psychology)

Active and Passive Social Media Engagement and Academic Connectedness: A Longitudinal Study of Rural and Tribal Students in Chhattisgarh, India

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Abstract: Social media has emerged as a focal point of both academic and social experiences in higher education among learners, but the scholarly implications of social media on academic connectedness have not been fully examined, especially in non-Western settings. The research is a longitudinal study that investigates the relationship between active and passive social media use (posting, commenting, sharing and scrolling and browsing, respectively) and academic connectedness in 120 students of undergraduate and postgraduate studies in urban colleges in Chhattisgarh, India. The data were gathered at three points in time and within one semester. Findings revealed that active social media use forecasted academic connectedness positively on all waves, but passive use forecasted the relationships between academic connectedness and social media use in a negative manner. Moderation tests showed that active engagement benefited students with rural and tribal origins additional to showing the importance of digital platforms in enabling underrepresented groups. Results highlight the need to distinguish between the types of engagement and imply effective consequences of the structured online peer interactions, digital literacy programs, and policies that would contribute to the establishment of relational investment and social inclusion in higher education.

Effectiveness of a Mindfulness-Based Intervention on Anxiety, Perceived Stress, and Psychological Well-Being Among Adolescents

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Abstract: Mindfulness-based interventions (MBIs), particularly those derived from Mindfulness-Based Stress Reduction, have demonstrated efficacy in promoting emotional regulation and stress reduction. The present study examined the effectiveness of a structured mindfulness-based intervention in reducing anxiety and perceived stress and enhancing psychological well-being among adolescents. A quasi-experimental pretest–posttest control group design was employed. Participants (N = 80) aged 15–18 years were randomly assigned to either an intervention group that received an 8-week mindfulness training program or a waitlist control group. Standardized measures assessing anxiety, perceived stress, and psychological well-being were administered before and after the intervention. The mindfulness program included guided breathing exercises, body scan meditation, mindful awareness practices, and brief reflective discussions. Results indicated a statistically significant decrease in anxiety and perceived stress levels among participants in the intervention group compared to the control group. Furthermore, psychological well-being scores improved significantly following the intervention. These findings suggest that mindfulness-based interventions may serve as effective, low-cost approaches for enhancing mental health and resilience among adolescents. Implications for integrating mindfulness programs within school settings are discussed.

Keywords: mindfulness-based intervention, anxiety, perceived stress, psychological well-being, adolescents

Prevalence, psychosocial correlates of aggression in children with learning disabilities

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Abstract: Background: Aggression is a significant phenomenon with long-term negative outcomes such as emotional difficulties, low education, occupational status, and poor quality of social relationships. There is limited research to report its prevalence in children with learning disabilities (LD). This study was aimed at identifying the incidence as well as psychosocial correlates of aggression in children with LDs.

Methods: This cross-sectional study was completed among 900 school-going children of Chhattisgarh, India (age range 8-11). A multilevel screening approach was applied in the present study. In the last stage, 124 children were subjected to the administrations for the diagnostic test of learning disability (DTLD). The Modified Overt Aggression Scale (MOAS) was applied to assess the aggression among LD children.

Results: The measurement model for MOAS was an excellent fit in the LD samples (GFI=0.987;MFI=.985). The prevalence of aggression was 26.8% in LD children. The major predictors for aggression among LD cases were labor occupation of mother [OR=.590(CI95%=.356-.977)] and nuclear family [OR=2.721(CI95%=.992-7.465)]. Intelligence was correlated with aggression (Beta coefficient = -0.210).

Conclusions: The MOAS is suitable to measure the aggression in LD children of India. Aggression among subjects with LD is common. Intelligence tended to correlate negatively with aggression. Early psychological intervention and suitable modifications in teaching techniques can be used among LD children. This study contributes to the better understanding of the predictors of aggression in a well-defined group of LD children.

The Dark Side of Doing Good: How Moral Licensing Encourages Unethical Pro-Organizational Behaviour

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Abstract: Despite the fact that organizational citizenship behavior (OCB) has been largely considered as being useful to the functioning of organizations, recent studies indicate that even good contributions of organizational citizenship behavior might have unforeseen ethical implications. Drawing on moral licensing theory, this study examines whether employees' prior engagement in OCB can increase their propensity to engage in unethical pro-organizational behavior (UPB). We propose that employees who contribute positively to their organization may accumulate a sense of moral credit, which subsequently enables them to justify ethically questionable actions intended to benefit the organization. Accordingly, moral licensing is theorized to mediate the relationship between prior OCB and UPB. Moreover, in this paper, the moderating influence of ethical climate in this process is explored, i.e. a strong ethical climate will limit the moral justification of unethical behaviors, but a weak ethical climate will enable the moral credit to convert into behavioral conformity to organizational interests.In order to test the proposed model empirically, cross-sectional survey data of employees working in service-sector organizations will be gathered, and the formulated hypotheses will be tested with the help of structural equation modeling. This study can provide new insights into the psychological antecedents of UPB by revealing how positive behavior in the past can contribute to unethical behavior unintentionally and what role ethical governance plays in reducing the occurrence of unintended moral spillover effects.

Trends and Challenges in Mental Health Problems: A Bibliometric Analysis (1990-2025) And Evidence Across Generation

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Abstract: From a psychological perspective , mental health problems are varying across generations as mental health research has expanded significantly, and here the purpose of the study is to map the literature on mental health across generations. This bibliography study analyzed publications from 1990 - 2025) in Pubmed, the map shows the evolution of mental health researches across generations.Using generational specific queries (Baby Boomers, Generation-X,Generation-Y, Generation Z, Generation Alpha) combined with common Keywords (e.g depression, anxiety, stress , loneliness, behavioural problems etc),data were extracted and analyzed using the VosViewer software which is a scientifically validated visualisation tool. More specifically, this aimed to study new insights and mental health research across generations over the last 35 years. The results indicate distinct generational differences in psychological research focus . The older generation of baby boomers are associated with cognition related problems like dementia, cognitive impairment, Alzheimer's disease,loneliness. Generation X researches focused more on depression,anxiety,stress.Millenials research dominated more by anxiety, depression,suicide strongly shaped by psychosocial stressor and digital behaviour. Studies on Generation Z focused most problems related to adolescents, young adults connected with depression, anxiety, sleep,stress,substance use , internet addiction.Emerging literature on generation alpha primarily focused on screen exposure, behavioural problems, developmental concerns like ADHD.The findings demonstrate the clear evolution in psychological research priorities across generations from the age related cognitive problems to the digital era mental health challenges and suggested that mental health challenges shift undergoing the need for generation specific intervention and even for the implication for the future development.

Keywords: Mental health; Generational Difference; Research Trends

Indigenous Science and Technology of Chhattisgarh

Smart Nano-Multifunctional Colorimeter for Rapid Chemical Monitoring in Environmental and Clinical Applications of Chhattisgarh

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Abstract: The Smart-Nano Colorimeter is a compact and user-friendly analytical device developed for detecting iron, dyes, and urea in environmental, food, and clinical samples, with particular relevance to Chhattisgarh. Industrial regions of the state especially around Korba, Raipur, and Bilaspur are facing serious heavy metal contamination in soil and water due to coal-based power plants, steel industries, and mining activities. Continuous monitoring in such areas is essential; however, conventional UV-Visible spectrophotometers are expensive, bulky, and require larger sample volumes, while traditional colorimeters lack automation and digital connectivity. To provide an indigenous and practical solution for rapid chemical monitoring in Chhattisgarh, an Arduino-based system was designed using an RGB LED light source, an Osram photodetector to measure transmitted light, and a 1.44-inch TFT display for real-time absorbance and concentration analysis. The device supports both automatic and manual wavelength selection and includes Bluetooth/IoT connectivity for wireless data transfer and remote monitoring. The instrument offers fast response, good sensitivity, and a lightweight structure suitable for field deployment in contaminated industrial zones. Validation against a standard UV-Vis spectrophotometer (Thermo Fisher, USA) showed comparable accuracy and precision. Its affordability and portability make it an effective alternative for environmental monitoring, research, and academic training in resource-limited areas.

Development and Characterization of Lipid Nanocarrier Co-Delivering Barleria prionitis Extract and Clobetasol Propionate for Topical Therapy in Atopic Dermatitis

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Abstract: Atopic dermatitis is a chronic relapsing inflammatory skin disorder characterized by epidermal barrier dysfunction, pruritus, and immune dysregulation. Although topical corticosteroids are effective, their prolonged use is associated with adverse effects, necessitating strategies that enhance efficacy while minimizing steroid exposure. Barleria prionitis, an indigenous medicinal plant of Chhattisgarh, India, has traditionally been used to treat various skin ailments due to its rich phytochemical profile, including flavonoids and phenolic compounds with anti-inflammatory and antioxidant properties. The plant is abundantly distributed across distinct agro-climatic zones of Chhattisgarh, and regions are inhabited by Baiga and other tribal communities with strong ethnomedicinal traditions; however, systematic scientific validation of herbal practices from these areas remains limited.

The present study aimed to develop and evaluate a lipid-carrier-based topical formulation co-encapsulating Barleria prionitis leaf extract and clobetasol propionate for the treatment of atopic dermatitis. The collected leaves are extracted, and the extract is incorporated with clobetasol propionate into a lipid nanocarrier system prepared by homogenization. The formulation was characterized for particle size, zeta potential, entrapment efficiency, morphology, and in vitro release profile.

The optimized formulation exhibited nanoscale particle size distribution, high entrapment efficiency of both active components, sustained drug release, and enhanced skin retention. The combination approach will demonstrate the improved anti-inflammatory potential, suggesting a synergistic interaction between the plant extract and corticosteroid. The study provides scientific validation of an indigenous medicinal plant from previously underexplored tribal regions of Chhattisgarh and proposes a novel lipid carrier as a promising therapeutic approach for inflammatory skin diseases.

Diabetic Wound Healing Potential of Anogeissus latifolia: A Comparative Study of Phytochemical Profiles and Molecular Docking

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Abstract: Diabetic wounds pose a significant challenge to healthcare due to their slow healing processes, often leading to severe complications. This study investigates the potential of Anogeissus latifolia, a traditionally used medicinal plant, in enhancing wound healing in diabetic conditions. We conducted a comprehensive analysis comparing the phytochemical profiles extracted using various solvents to elucidate their respective bioactive components. Employing molecular docking techniques, we assessed the interaction of these phytochemicals with key proteins involved in the wound healing process. The findings revealed notable solvent-dependent variations in phytochemical composition, which correlated with distinct bio-analytical validation outcomes. This research highlights the significant therapeutic potential of Anogeissus latifolia in managing diabetic wounds, suggesting its application in developing effective wound care therapies

Eco-Friendly Integration of Tamarind Seed Polysaccharides in Bastar Dhokra Art: Sustainable Resin Alternatives for Lost-Wax Casting

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Abstract: The study examines the eco-friendly synthesis of tamarind seed polysaccharide is one such natural polymer which is obtained from seeds of tamarindus indica. Tamarindus indica is used as stabilizer, thickener, binder and gelling agent in food and pharmaceutical industries. Tamarind seed polysaccharide is investigated as a sustainable alternative material in the traditional dhokra metal casting of bastar district. This ancient lost wax craft, practiced by tribal artisans, mainly relies on natural binders and molding materials that are now becoming limited. Tamarind seed polysaccharide, a biodegradable, plant derived hydrocolloid with excellent binding, film forming and viscosity enhancing properties which offers a promising alternative. Preliminary observations demonstrate that TSP enhances mold durability, minimizes structural cracking, refines surface texture, and lessens dependence on synthetic additives. Using tamarind seed waste also encourages resource recycling and supports indigenous environmental knowledge.

Keywords: Tamarindus indica, Dhokra metal casting, Natural binders, Indigenous.

Indigenous Rice Husk Valorization from Chhattisgarh for Heavy Metal Remediation: Fabrication of Crosslinked PSA-MRH Adsorbent Beads

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Abstract: Chhattisgarh, widely known as the "Rice Bowl of India," generates enormous quantities of rice husk as an agricultural by-product, creating opportunities for sustainable biomass valorization. In this study, indigenous rice husk was chemically modified and incorporated into a polyvinyl alcohol–sodium alginate (PVA–SA) matrix to fabricate crosslinked PSA-MRH composite beads for the simultaneous removal of Mn(II) and Pb(II) from aqueous solutions. The modified rice husk (MRH) provided enhanced surface activity and functional groups, while PVA and SA contributed hydroxyl and carboxyl moieties facilitating metal ion binding. Crosslinking with $CaCl_2$ produced mechanically stable, porous spherical beads suitable for repeated use. Batch adsorption experiments were performed under varying pH, adsorbent dosage, contact time, and initial metal ion concentration. The composite beads exhibited high adsorption affinity toward both Mn(II) and Pb(II), attributed to ion exchange, electrostatic attraction, and surface complexation mechanisms. Furthermore, the adsorbent demonstrated excellent reusability with minimal loss in efficiency over multiple adsorption–desorption cycles. The study highlights a cost-effective, eco-friendly, and regionally sustainable approach for heavy metal remediation. Valorization of abundantly available rice husk from Chhattisgarh not only addresses agricultural waste management but also contributes to circular economy development and environmental protection through green material innovation.

Keywords: Agricultural waste valorization, Rice husk cellulose, Composite hydrogel, Heavy metal remediation, Sustainable water treatment, Chhattisgarh.

Phytochemical Investigation and Biological Significance of Aegle Marmelos leaves Derived Bioactive Molecules

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Abstract: Aegle Marmelos (Rutaceae) are traditional medicinal plants valued for their diverse pharmacological properties. This study investigates the phytochemical profiles of their leaf extracts prepared using Ethanolic and Aqueous solvents, freshly collected shade – dried plant material were powdered and subjected to solvent extraction via Soxhlet methods. Preliminary results indicate Ethanolic extracts exhibited higher concentration of polyphenols and flavonoids compared to Aqueous extracts suggesting better solubility of non-polar to moderately polar compounds in ethanol. Aqueous extracts, however, retained a notable amount of water soluble phytochemicals such as tannins and saponins. The study provides baseline data for further Chromatographic characterization, UV Visible, Spectroscopy, FTIR, HPLC, TLC biological activity evaluation of Aegle Marmelos Extracts, which may contribute to the development of plant based therapeutics and environmental remediation agents, waste water treatment, heavy metal removal, nanoparticle synthesis.

Keywords: Aegle Marmelos, Phytochemical analysis, Soxhlet method, Ethanolic extract, aqueous extract.

Life Sciences (Bioscience, Microbiology and Anthropology etc.)

Assessment of Public Perception of the Reliability and Accuracy of Forensic Evidence in Judicial Proceedings: A Survey-Based Study

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Abstract: The integrity of judicial outcomes often depends on the perceived reliability and accuracy of forensic evidence presented in court. This study, Assessment of Public Perception of the Reliability and Accuracy of Forensic Evidence in Judicial Proceedings: A Survey-Based Study, examines public attitudes toward various forensic techniques and their influence on trust in the criminal justice system. Using a structured questionnaire distributed to a diverse sample of respondents, the research evaluates perceptions of scientific validity, susceptibility to error, potential bias, and overall credibility of forensic disciplines such as DNA analysis, fingerprint examination, ballistics, and digital forensics. Findings indicate that while DNA evidence is widely regarded as highly reliable, other forms of forensic evidence receive more cautious evaluation due to concerns about human error, laboratory standards, and media influence. Demographic variables, educational background, and prior exposure to crime-related media significantly shape perceptions. The study highlights a gap between public confidence and documented forensic limitations discussed in legal and scientific debates. These findings underscore the importance of transparency, standardized procedures, and public education to strengthen trust in forensic science and ensure informed judicial decision-making.

Beyond Synthetic Polymers: Low-cost Biodegradable green Membranes for MFC-Based Bioelectricity and Wastewater Treatment

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Abstract: Minimizing internal resistance in microbial fuel cells (MFCs) requires separator membranes that sustain continuous hydrated ion transport while limiting dimensional instability and oxygen/substrate crossover, without compromising wastewater treatment performance. In this study, herbaceous leaf scaffolds were converted into proton-exchange membrane (PEM) candidates through SDS-assisted decellularization, $CaCl_2$-mediated ionic stabilization, and poly(vinyl alcohol) (PVA) impregnation. This strategy reinforced the hydroxyl-rich plant matrix via hydrogen-bond-driven consolidation while preserving native vascular microchannel architecture.

Membranes derived from Syzygiumcumini, Ficus benjamina, Plumeria rubra, and Terminalia catappa were systematically evaluated using ion-exchange capacity (IEC), water uptake/swelling, contact angle, FTIR, SEM, tensile testing, XRD, and impedance-based conductivity. Although higher IEC enhanced hydration, excessive water uptake imposed a stability penalty, indicating that maximum IEC does not equate to optimal separator performance. XRD revealed that the best-performing membrane retained stronger semi-crystalline PVA ordering, correlating with improved tensile strength (14.4 MPa) and controlled dimensional expansion.

In a double-chamber MFC treating wastewater, the optimized membrane achieved 260 mV, 2166.67mA m^{-2}, and 563.33mW m^{-2}, while maintaining 370.86mW m^{-2} on Day 15 and delivering 74 ± 0.6% COD removal, demonstrating effective coupling of energy recovery and wastewater remediation.

Electro-Biotechnological Strategy for Single Cell Protein Generation from Agro-Waste: An Efficient Approach to Meet SDGs

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Abstract: The agricultural sector produces substantial quantities of waste, much of which remains underexploited, leading to environmental challenges and indirectly increasing global food insecurity. Among these residues, wheat bran, a major by-product of wheat milling, stands out as a nutrient-rich and readily available substrate potentially suitable for generating value-added bioproducts along with energy. In this study, an electro-fermentation approach was explored for the synthesis of single-cell protein (SCP) utilizing wheat bran hydrolysate (WBH) as a carbon source within an electrochemical system (ES). A dual-chamber ES setup was employed, incorporating WBH as the feedstock and an isolated bacterial strain as the catalyst. This system was operated in a cyclic fed-batch mode over successive runs to assess SCP yield and productivity. The results revealed enhanced microbial growth consequently protein production, confirming that electro-fermentation substantially stimulated metabolic activity and nutrient assimilation. Therefore, integration of SCP production with electrochemical operation offers an efficient route for agrowaste valorization while simultaneously addressing sustainable food and energy objectives. However, this study demonstrates the feasibility of electro-fermentation-based SCP production as a promising strategy for converting contaminants like agricultural residues into high-value biomaterials, supporting both environmental and economic sustainability.

Formulation and Evaluation of a Dual Drug Delivery System for Enhanced Aldose Reductase Inhibition Using Combination Therapy

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Abstract: This study presents the formulation and evaluation of a novel dual drug delivery system (NDDS) using nano-in-micro encapsulation to enhance aldose reductase inhibition (ARIs) for managing diabetic complications. The system combines Epalrestat (EPL), a synthetic drug, with Cuminum cyminum (CC), a natural therapeutic, offering synergistic effects. A 2^3 factorial design optimized the formulation, resulting in particles with nano (88 ± 15 nm) and micro (1.04 ± 0.4 µm) dimensions and a zeta potential range of –100 mV to +200 mV, indicating strong stability. The drug entrapment efficiency exceeded 95%, and DSC/XRD confirmed amorphous dispersion. SEM analysis showed uniform spherical morphology.

In vitro release showed sustained drug release over 24 hours (97.7% for EPL, 90% for CC), and molecular docking indicated strong interactions with aldose reductase. (binding energy: –9.18 to –6.47 kcal/mol). Ligand-protein interaction analysis highlighted crucial hydrogen bonds and hydrophobic interactions. Micromeritic properties (Bulk density, Tapped density, Carr's index) indicated good flowability. Swelling index of 94.8% in phosphate buffer pH 6.8, and followed the Korsmeyer–Peppas model, suggesting diffusion and erosion mechanisms. In vivo studies in diabetic wistar rats showed 20.88% glucose reduction after 28 days. Toxicity and histopathology confirmed safety, and biodistribution showed effective targeting. Antioxidant assays revealed 76% radical scavenging activity and an IC50 of 84.23 µM. Stability studies estimated a shelf life of up to 42.42 months in 25°C/60%RH & 34.18 months in 40°C/75%RH. One-way ANOVA confirmed statistically significant differences among formulations ($p < 0.05$). The dual system showed promise as a synergistic strategy for targeting aldose reductase in diabetic complications.

Scientific Validation of Tribal Medicinal Claims of Bauhinia variegata (L.) through integrated In-Silico and Experimental Approaches

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Abstract: Objective: To scientifically validate the traditional medicinal claims of Bauhinia variegata by pharmacognostic evaluation, phytochemical quantification, antioxidant, antimicrobial, anti-inflammatory and in-silico studies.

Material and Methods: The Soxhlet extraction method was used to produce ethanolic leaf extracts. Microscopy, physicochemical examination, and phytochemical screening were all utilized in pharmacognostic investigations. Flavonoids and phenolics have all been quantified. Antioxidant activity was evaluated using ABTS and FRAB assays. Anti-inflammatory activity was evaluated using the BSA protein denaturation assay, while antimicrobial activity was evaluated against E. coli strain. Molecular docking studies were conducted for major flavonoids (Rutin, Kaempferol, Catechin, Quercetin and Apigenin) and compared with Diclofenac against Cyclooxygenase-2 (PDB ID: 5IKR). ADMET and drug-likeness properties were predicted using computational tools.

Results: The extract indicated high flavonoid content (TFC 446.85 ± 0.69) and considerable phenolic content (TPC 137.04 ± 1.14). Significant antioxidant activity was observed with IC50 values of 218.76 µg/ml (ABTS) and 217.59 µg/ml (FRAB). The extract demonstrated concentration-dependent anti-inflammatory activity and notable antimicrobial activity. Molecular docking revealed potentially binding affinities: rutin (-9.6), Quercetin (-9.2), Apigenin (-9.1), Kaempferol (-9.0), Catechin (-7.1), which were superior to the standard Diclofenac (-6.7). ADMET and drug-likeness analysis indicated favourable pharmacokinetic and safety profiles for the flavonoids.

Conclusion: the integrated experimental and in-silico findings scientifically validate the traditional use of Bauhinia variegata as a potent source of antimicrobial, antioxidant and anti-inflammatory activities, as promising therapeutic lead compounds for further drug development.

Sitting Behavior and Energy Expenditure in Humans as a Function of Gender and Age

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Abstract: Extended sitting (≤1.5 METs) forms a substantial part of daily energy expenditure and is linked to potential health risks and disrupted circadian regulation. Evidence on sitting behavior and energy expenditure (EE) rhythm among Indian adults is limited. This study examined sitting behavior and EE rhythms as a function of gender and age. In the first phase, sitting behavior was assessed through the Self-Reported Sitting Behavior Questionnaire (SRQ) and Sedentary Behavior Questionnaire (SBQ; Work Day, Free Day), in 511 adults. In the second phase, 26 adults (13 from each gender) underwent monitoring of EE using an Actical device and sitting duration using SRQ and SBQ for seven consecutive days. The EE, viz., totalEE, EELight, EEModerate, EEVigorous, was quantified for light, moderate, and vigorous activities using Actical software, and the circadian rhythm in totalEE was assessed using Cosinor rhythmometry. In Phase I, SRQ showed significantly longer sitting duration in females than in males (8.85±0.17 h vs. 8.10±0.22 h). SBQ depicted significantly higher sitting duration in females on both workdays (9.08±0.24 h vs. 7.15±0.27 h) and free days (6.35±0.20 h vs. 5.07±0.24 h) than in males. Sitting duration (SBQ) on workdays and free days ($p<0.001$) was significantly negatively correlated with age. In phase II, sitting duration, totalEE, and EELight were significantly higher in males than in females ($p<0.01$). A significant circadian rhythm in totalEE was observed in all females and in 10 males. We conclude that sitting behavior and energy expenditure in Indian adults are significantly influenced by gender and age.

Keywords: Sitting behavior, Energy expenditure, Sitting duration, Gender, Age

Sustainable Use of Microbial Technology for Quality Stock Nursery Production and its Role in Future Environmental Resilience

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Abstract: Microbial enrichment of plant systems to enhance production and improve environmental resilience in degraded soils is a biologically based solution. Soil erosion, nutrient loss, salinization, compaction, and degradation of organic carbon globally have led to moderated to severely degraded soil 33-40%. In India, land degradation affects 29-30 percent of total land area through water erosion, nutrient loss and declining soil biological activity. Chhattisgarh has Black, Red, Yellow and Sandy soils with different fertility challenges affecting nursery production and seedling germination. Black soils are fertile and clay-rich but face compaction and drainage issues, Red soils lack organic carbon and nitrogen, Yellow soils are acidic with low phosphorus and Sandy soils have poor water and nutrient retention. These soil restrictions inhibit germination, root development and physiological functioning of tree seedlings. A consortium of arbuscular mycorrhizal fungi (AMF) with Glomus mosseae was cultured using maize (Zea mays L.) as host plant to standardize inoculum production at nursery level. This consortium was tested in germination and growth phases of Melia dubia (Cav.). Red soil showed highest germination, followed by Sandy, Yellow and Black soils, demonstrating soil-specific microbial responses. Plant physiological tests using SPAD meter and relative water content (RWC) showed increased photosynthetic efficiency and plant water status with AMF. This resulted in vigorous seedlings and enhanced adaptation in structurally and nutritionally limited soils. The results confirm that microbial consortia application at nursery is a sustainable, climate-adaptive approach to improving soil functionality and seedling growth at regional, national, and global levels.

Mathematical and Statistical Science,Vedic Mathematics

A Fixed-Point Iterative Scheme for Mappings Satisfying Condition (E) with Applications to Lung Cancer Prediction and Delayed Ebola Epidemic Dynamics

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Abstract: In the research, a new iterative scheme has been proposed for finding a fixed point of mappings that satisfy condition (E). Weak and strong convergence results are provided for these mappings in the setting of uniformly convex Banach space. To validate our findings, a numerical example is given on $\mathbb{R}^2$. Furthermore, the effectiveness of the proposed iteration is illustrated through applications to lung cancer screening, the numerical simulation of a delayed Ebola epidemic model, and signal recovery problems.

A Polytope View of the Service Rate Region for Locally Recoverable Codes with Availability

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Abstract: In modern distributed storage systems, data is encoded using error-correcting codes to ensure reliability while efficiently handling multiple simultaneous access requests. Beyond fault tolerance, an important performance metric is the ability of the system to serve parallel read demands without overloading storage nodes. This capability is captured by the \emph{service rate region}, which represents the set of request rates that can be supported simultaneously within server capacity constraints.

In this work, we investigate the service rate region for systems based on \emph{locally recoverable codes (LRCs) with availability}, where each data symbol can be reconstructed through multiple disjoint recovery sets, enabling flexible access and load distribution. We show that the feasible service allocations naturally form a convex polytope described by linear constraints arising from recovery structures and server limitations. This geometric viewpoint reveals a direct connection between code parameters such as locality and availability and the shape and size of the resulting service polytope, allowing tools from convex and polyhedral theory to be applied to analyze load balancing, parallelism, and throughput.

The proposed perspective provides a simple and unified framework for designing storage codes with enhanced service capability compared to classical constructions.

Convergence of Iterative algorithms for Generalized $(\alpha, \beta)-$ Nonexpansive type 1 Mappings with Applications to Image Restoration

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Abstract: In this research, we present fixed-point results along with weak and strong convergence results, based on certain mild assumptions regarding the control parameters for a generalized (α, β)-nonexpansive type 1 mapping within the framework of a Banach space. We proposed a new iterative algorithm designed to approximate the fixed point of this class of mappings within the context of a uniformly convex Banach space. We utilize the new method to solve real-world problems such as convex minimization and image restoration. The results obtained in this paper extend and unify some related results in the literature.

Dynamics of hunting cooperation and Allee effect in a fish population model

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Abstract: In the context of ecology, cooperation behaviour and the Allee effect are two biological key factors closely related to a natural phenomenon. They describe the various mechanisms of population dynamics, particularly in a prey-predator fish population. In this study, we analyze the two-dimensional fish

population model, where the prey growth function is subjected to the strong Allee effect and inducing the hunting cooperation in the predator fish population species. In this work, we mainly investigate the impact of hunting cooperation and the Allee effect on the system dynamics in the presence harvesting

term in both species with a ratio-dependent functional response. Moreover, we observe the positivity and boundedness of solutions, identify ecologically relevant equilibrium points, and determine their stability conditions. Apart from these, all the dynamical behaviours of the system have been captured through a comprehensive two parameter bifurcation analysis. In the course of the local and global bifurcation analysis, we observed all possible bifurcation such as the existence of saddle-node bifurcation, Hopfbifurcation, which are the local bifurcations, Bogdanov-Takens (BT) bifurcation and cusp bifurcation point referred (CP), which are the global bifurcation are identified. Overall, our study highlights the complex dynamics with bi-stability phenomena of predator-prey fish interactions, emphasising the role of the Allee effect and harvesting in the presence of hunting cooperation.

Entanglement-Assisted Quantum Locally Recoverable Codes

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Abstract: Locally recoverable codes (LRCs) have emerged as an important paradigm in distributed storage because they enable recovery of an erased symbol by accessing only a small number of other symbols. Their quantum analogue, quantum locally recoverable codes (qLRCs), inherits this property and is particularly relevant for near-term quantum memories. However, conventional stabilizer-based constructions impose restrictive dual-containment constraints on the underlying classical codes, significantly limiting achievable parameters. To overcome this limitation, we introduce entanglement-assisted quantum locally recoverable codes (EA-qLRCs), which exploit pre-shared entanglement between encoder and decoder to relax the dual-containment requirement and enlarge the feasible parameter region. We establish a Singleton-like bound for EA-qLRCs. We provide explicit constructions of optimal EA-qLRCs that attain this bound. The constructions are obtained by importing classical cyclic and constacyclic LRCs that need not be dual-containing and converting them into quantum codes via the entanglement-assisted CSS formalism. In particular, by carefully choosing defining sets and exploiting coset structures that guarantee locality, we produce infinite families of EA-qLRCs with flexible parameters and strictly larger dimension than previously known qLRCs with the same length and distance. These results demonstrate that entanglement not only removes algebraic constraints but also significantly enlarges the achievable rate-distance-locality region, making EA-qLRCs a promising framework for efficient quantum storage and distributed quantum computing architectures.

On a Subclass of Harmonic Univalent Functions Defined by the Generalized S˘ al˘ agean Operator

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Abstract: In this paper, we introduce and investigate a new subclass of complex-valued harmonic functions in the open unit disk defined by the generalized S˘ al˘ agean operator. For a harmonic function f = h+g, suitable operator-based conditions involving the ratio I n+1 λ f(z)/In λf(z) are imposed to define the class SH(λ,n,α) and its normalized subclass SH0(λ,n,α). We derive sufficient coefficient conditions ensuring that functions belonging to these classes are sense-preserving, harmonic univalent, and satisfy a prescribed real-part inequality. Sharp coefficient bounds are obtained and a complete characterization of the subclass SH0(λ,n,α) is established in terms of convex combinations of its extreme points. Furthermore, growth and distortion estimates are obtained, leading to a covering theorem for the image domain. The class SH0(λ,n,α) is shown to be closed under convex combinations and to generalize several known results.

Numerical investigation of an inverted π- type porous breakwater in front of a partially reflecting seawall

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Abstract: The hydrodynamic characteristics of an inverted π-type porous breakwater located at a specified distance from a partially reflecting seawall are investigated in this work using linear wave theory. The boundary value problem is solved effectively within a unified computational domain using a dual boundary element method (DBEM). To evaluate the system's persuasiveness for real-world applications, the study further investigates the scattering, force, and moment coefficients, accounting for important factors such as barrier porosity, relative submergence, seawall porosity, and the relative width of the design. The present study demonstrates that for k_0 h ≥1, the reflection coefficient K_R diminishes by approximately 22%, while the wave run-up K_H increases by about 39% when the porosity is confined to 20%, with the affiliated peak values of vertical force and moment coefficients being 14% and 11%, respectively. Furthermore, with increasing the seawall porosity, the wave run-up coefficient K_H approximately increases 36% and also leads to higher reflection K_R in the range 0 ≤k_0 h ≤4. The parametric analysis will be useful in the meticulous design of cost-effective breakwaters.

Keywords: Thin porous barrier, Linear pressure drop condition (LPDC), Partially reflecting seawall, Dual boundary element method (DBEM), Scattering, and force coefficients.

On Best Proximity Point Theorems For P-Semi-Cyclic Contraction Pair

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Abstract: In this paper, we introduce a new notion of a p-semi-cyclic contraction for a pair (S, T) of mappings defined on p(≥ 2) nonempty subsets of a Banach space. This notion extends the semi-cyclic contraction condition proposed by Gabeleh and Abkar [6], which was originally formulated for two sets. Subsequently, we establish several fundamental results, including existence and convergence theorems for best proximity points associated with the pair (S, T). Illustrative examples are also provided to demonstrate the applicability of the obtained results.

On Elephant Random Walk with Stops and Random Memory

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Abstract: In this paper, we introduce and study a generalized version of the elephant random walk with random memory that incorporates the possibility of stops. We call it the elephant random walk with stops and random memory (ERWSRM). Several conditional results such as the conditional mean increments and the conditional displacement of the ERWSRM are derived. Based on these conditional results, we obtain recursive relations and explicit expressions for the mean increments and the mean displacement of the walker. We further establish several asymptotic results for the displacement. Moreover, we obtain the number of delays in the ERWSRM and prove an almost sure convergence result.

Quantum (r, δ)-Locally Recoverable Codes via Good Polynomials

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Abstract: Locally Recoverable Codes (LRCs) are error-correcting codes designed for distributed storage systems, where data is stored across multiple storage nodes. In such systems, a failed node can be repaired by accessing only a small number of surviving nodes rather than all nodes. In their quantum counterpart, a code has r-locality if each qubit can be recovered from at most r other qubits. To improve reliability when multiple failures occur within a repair group, the concept of (r, δ)-locality is introduced. In an (r, δ)-LRC, each qubit belongs to a small local group of size at most (r + δ − 1) qubits, which can tolerate up to (δ − 1) erasures. A q-ary quantum (r, δ)-LRC is said to be optimal if it attains the Singleton-type bound. In this work, we present an explicit construction of quantum (r, δ)-locally recoverable codes using good polynomials. Our method relies on the Tamo–Barg framework, utilizing the additive and multiplicative properties of finite fields to construct good polynomials. We establish the dual-containing property of the associated classical (r, δ)-LRCs and extend the framework to the quantum domain via the CSS framework. Furthermore, we determine the parameters of the constructed quantum (r, δ)-LRCs.

Side-Channel and Lattice- Based Vulnerabilities in the NTRU Cryptosystem: A Multi- Layered Security Review

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Abstract: The N-th degree Truncated Polynomial Ring Units (NTRU) cryptosystem is a crucial basis in lattice-based cryptography as the field moves toward a post-quantum paradigm. There is still much to learn about the gap between theoretical proofs and implementation-specific security, but the fundamental security of the Shortest Vector Problem (SVP) in R-modules is based on its inherent difficulty. This work provides a comprehensive, multidimensional analysis of the NTRU structure by fusing advancements in mathematical cryptanalysis with side-channel exploitation. The first part of the study looks at how well modern Lattice-Reduction Algorithms work, evaluating the advancement of severe trimming techniques and Block-Korkine-Zolotarev (BKZ) variants. We quantify the extent to which these enhancements effectively mimic shorter vectors in the NTRU lattice, hence reducing the NTRU security margin. From computational complexity to physical security, the study looks at Side-Channel Analysis (SCA) vulnerabilities. This article examines the intricate area of Chosen-Ciphertext Attacks (CCA) with an emphasis on Decryption Failure Leakage. By modeling the statistical probability of decryption errors, we demonstrate how an attacker may continually reduce the search space for the secret-key polynomial. The combination of several attack techniques demonstrates that NTRU security is not a fixed mathematical characteristic but rather a dynamic balance between parameter selection and implementation rigor. We conclude by evaluating high-assurance countermeasures such algorithmic masking and isochronous execution, providing a tactical foundation for NTRU deployment in security-critical environments.

SWASTH: Multi-Objective Optimization Framework for Rural Healthcare Resource Allocation Using Real AAM Data from Girjapur

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Abstract: Ensuring efficient and equitable healthcare delivery in rural settings remains a persistent challenge due to financial limitations and operational constraints. This study develops SWASTH (Scalable Weighted Allocation Strategy for Targeted Healthcare), a multi-objective optimization framework for resource allocation at Ayushman Arogya Mandir (AAM), Girjapur. The proposed model integrates Linear Programming (LP) for baseline optimization, Goal Programming (GP) for target-based planning, and a Genetic Algorithm (GA) for heuristic validation and scalability assessment.

Using real primary healthcare data, baseline LP analysis demonstrates that up to 30 patients can be served daily within available doctor consultation time. Incorporating a fairness constraint requiring a minimum 34% allocation to remote populations preserves full operational capacity, confirming that equity can be achieved without efficiency loss. Under a strict budget constraint of 2000 units, service capacity reduces to 20 patients, identifying financial allocation as the primary binding constraint despite available unused consultation time. Goal Programming quantifies a service shortfall of five patients when demand targets exceed feasible allocation, while GA results converge rapidly and match exact solutions, validating model robustness.

Sensitivity analysis across budgets ranging from 1500 to 3000 units reveals a proportional increase in patient coverage, confirming logical consistency and model stability. The findings demonstrate that integrated optimization provides actionable insights for balancing efficiency, equity, and fiscal feasibility in rural healthcare systems. SWASTH offers a computationally validated, scalable, and policy-relevant decision-support framework for evidence-based planning in resource-constrained public health environments.

Towards Robust and Economically Optimal Data Collection for Deep Learning

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Abstract: Data acquisition remains a primary bottleneck in the deployment of machine learning systems. While frameworks like Learn-Optimize-Collect (LOC) have framed this as a sequential decision-making problem, current methodologies rely on restrictive parametric assumptions—such as power-law learning curves—and assume static model architectures. These constraints overlook the non-linear interplay between dataset size, model scale, and computational budget. In this work, we propose two critical extensions to the data-collection paradigm. First, we introduce a Nonparametric Robust Learning-Curve model based on Monotonic Gaussian Processes (MGP). This model eliminates the need for rigid functional forms and explicitly accounts for projection uncertainty using Conditional Value at Risk (CVaR). Second, To align data acquisition strategies with contemporary tri-variate scaling laws, we create a Joint Optimisation framework that optimises dataset size and model parameter count simultaneously. Our experimental findings show that, in comparison to conventional parametric baselines, these improvements greatly reduce the risk of over-collection of data and increase efficiency.

Mechanical, Mechatronics and Production Engineering

A novel strategy for simultaneous development of Titanium Aluminide from elemental materials and component manufacturing through Wire Arc Additive Manufacturing process

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Abstract: Advanced materials drive the country's progress, especially in strategic sectors including defense and space. One of the major areas where the country aims at progressing to meet Viksit Bharat goal is to have its own indigenously developed next generation jet engine for defense sector. Major challenge at our footstep is to have a development strategy for light weight high temperature material. Titanium Aluminide (TiAl) is a special class of intermetallic material globally recognized for its light weight, superior strength-to-weight ratio, excellent oxidation resistance, and high-temperature mechanical performance, making it an attractive alternative to nickel-based superalloys. While the global players including General Electric have already found ways of inducting TiAl in their gas turbine engines, the technology for development of TiAl and producing components using the same is not established in our country yet.

In recent years, Additive manufacturing (AM) technology has revolutionized the modern manufacturing industry due to its wide variety of benefits – Handling design complexities, less material usage, minimizing multi-component joining, etc. Our work aimed at utilizing a wire arc based additive manufacturing technology for development of this strategically important TiAl. The superiority of our developed technology lies in eliminating separate stages of manufacturing components from the developed material. Taking the advantage of AM, our methodology enables simultaneous development of TiAl intermetallic from elemental wires while fabricating the component. As a proof of concept, we have developed the TiAl at coupon level and evaluated its metallurgical behavior and mechanical performance. With a lamellar microstructure, the developed material is found to possess excellent hardness of 410 HV, and the compressive yield strength of about 833 MPa. Details on the process variables for development of TiAl and the microstructural and mechanical behavior is presented.

Tribological Performance and Wear Behaviour of Nanoparticle-Reinforced Polymer Composites

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Abstract: Nanoparticle-reinforced polymer composites have recently been recognized as among the most effective methods to improve the wear resistance. This revision article is to review the tribological performance characteristics of nanoparticle-reinforced composites and to summarize the findings reported on different combinations of nanofillers, especially those using MWCNT-SiO2, graphene-nanoclay composites, ceramic nanoparticles, and hybrid fiber/particle combinations. A thorough literature search provides evidence that the use of nanofillers improves tribological behavior through increased load-carrying capability, increased hardness, and increased wear resistance by utilizing different mechanisms, including crack deflection, improved interface adhesion between filler and polymer, lubrication, and the creation of a protective transfer film. CNTs provide significant wear reduction due to their exceptionally high aspect ratio as well as their solid-lubricant characteristics; SiO2 nanoparticles enhance the filler and stabilize the matrix, creating a synergistic effect when combined with MWCNTs. However, the ability of the fillers to provide the desired performance will depend on the proper dispersion of the nanoparticles and the correct filler concentrations; if a filler is loaded at too high a concentration, it can agglomerate and lead to premature failure of the surface. The incorporation of micro-fibers and nanoparticles in a hybrid system can further enhance wear performance by allowing for a more even distribution of loads. The results of this review article are intended to provide a summary of the major trends in performance, and the gaps in the scientific literature that must be addressed to develop next-generation, high-performance nanocomposites that can withstand the severe conditions associated with wear failure.

Automated AI-Based Extraction of Geometric Material Characteristics from Conveyor-Based Point Cloud Data for Industrial Monitoring

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Abstract: Accurate estimation of material volume and geometric features is a common challenge across industries that handle bulk materials using conveyor-based systems. In many practical settings, these parameters are still estimated through manual observation or indirect measurements, resulting in inconsistent analysis and limited process optimization. An automated and reliable material monitoring approach is therefore essential for improving production efficiency and reducing human dependency.

This paper presents an AI-driven vision-based system for automated material flow characterization using a LiDAR-based depth sensing camera installed above a conveyor. The system captures three-dimensional information of moving materials in the form of depth images and point cloud data. From this data, key geometric features—including material volume, maximum height, mean height, projected area, and spatial distribution—are computed directly and analysed in real time. The proposed framework also identifies the presence or absence of material on the conveyor, enabling adaptive control strategies such as dynamic adjustment of conveyor speed.

The proposed system is implemented and evaluated through an industrial case study conducted in a metal recycling facility located in Raipur, Chhattisgarh, India. Experimental results demonstrate that the system is capable of consistently extracting meaningful geometric and physical parameters of flowing material under real operating conditions. The outcomes highlight the applicability of vision-based material flow analysis as a practical tool for production monitoring and optimization across a wide range of industrial environments.

Benchmarking Physics-Informed Neural Networks Against the Finite Volume Method for Two-Dimensional Steady-State Heat Conduction

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Abstract: This work explores Physics-Informed Neural Networks (PINNs) for the resolution of steady-state two-dimensional heat conduction problem by comparing it systematically with well-established numerical technique Finite Volume Method using OpenFOAM11.0 and validated with Finite difference Method. Convergence was attained by the network with the final total loss of 1.4×10^{-2} for PINNs, Error patterns with maximum errors found in neighborhood of domain boundaries and much lower errors in interiors. Quantitative verification with OpenFOAM established fair accuracy with Mean Absolute Error (MAE) of 5.5304°C. Analysis of the temperature profiles in each section showed that they perfectly matched theoretical predictions, particularly in the central regions. Mesh-free operation, integrated physics, and computational efficiency for parametric studies are key benefits of the PINN approach. Our results suggest that PINNs can compete with traditional computational approaches for steady-state heat transfer problems. It is truly a useful substitute to the methods engineers have been applying for many years, although it may not always be the best solution, Its accuracy and unique benefits make it helpful for many kinds of uses.

Comparative Modelling of Hole Expansion Ratio using Novel Empirical Regression Equation and ML Approaches

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Abstract: The fact that edges can crack when expanding holes remains one of the main constraints for sheet metal forming processes used in automotive manufacturing. Most conventional methods to predict shear edge hole expansion ratios (HER), rely on mechanical properties. However, although these meanings have some validity, they are frequently restricted by linear assumptions and poorly represent the underlying nonlinear characteristics of both deformation and damage progression.

In this study, we have revisited various previous HER datasets, providing an updated predictive framework that utilizes one analytical and one machine learning approach. The regression based empirical equation for HER estimation has been created based on key mechanical parameters, making the baseline model easily interpreted from a physical standpoint. A trilayered neural network was then proposed to model the highly complex nonlinear interactions between various material properties (i.e., yield stress (YS), ultimate tensile strength (UTS) etc.).

The ML model produced a R2 score of 0.998 and a mean absolute error of 1.568%, both of which significantly exceed the predictive abilities of the regression-based formulation. Furthermore, the comparison of performance demonstrates that purely linear models cannot accurately represent many of the complex forming behaviour characteristics and that neural networks are very effective at modelling these behaviours.

Design, Fabrication, and Performance Analysis of Egg Albumin-Templated Fe3O4@Polyindole Nanocomposite Electrodes for Flexible Energy Storage Devices

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Abstract: The rapid rise in global energy demand and the transition toward renewable energy sources have intensified the search for sustainable and high-performance energy storage systems. Supercapacitors, with their exceptional power density, fast charge–discharge kinetics, and long cycling stability, have emerged as promising candidates to complement or replace conventional batteries in advanced applications such as smart power grids, electric vehicles, and flexible electronics. In this work, an eco-friendly strategy was employed to fabricate Fe3O4@polyindole (PIn) nanocomposites using egg albumin as a natural bio-template. Egg albumin served as a soft scaffold to control the nucleation and uniform distribution of Fe3O4 nanoparticles, effectively preventing agglomeration and ensuring enhanced electroactive surface area. The bio-templated Fe3O4 was subsequently integrated with electroactive PIn and deposited on carbon cloth (CC), producing a flexible, binder-free electrode with excellent conductivity and structural stability. Structural and morphological analyses were performed using XRD, FTIR, SEM, and EDX which confirmed the homogeneous dispersion of Fe3O4 within the PIn matrix, while the carbon cloth provided a three-dimensional conductive backbone. Electrochemical studies revealed that the CC-Fe3O4@PIn electrode (8 mg loading) delivered a high specific capacitance of 585 F g-1 at 1 A g-1 in 1 M H2SO4 electrolyte, along with excellent cycling stability, retaining 89.13% capacitance after 1000 cycles.

Electrochemical Duality of Low-Cost Nanocomposite Electrodes for Microbial Fuel Cells: Concurrent Supercapacitive Storage and Real-Time Activity Sensing

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Abstract: A dual-function microbial fuel cell (MFC) was developed by integrating a polyindole–carbon nanotube–iron(II,III) oxide (PIn–CNT–Fe_3O_4) nanofiber electrode to enable concurrent bioelectricity generation and antibiotic sensing. The hybrid electrode enhanced interfacial electron transport, allowing antibiotics to be monitored through stable, reproducible, concentration-dependent changes in the MFC output voltage. The electrode's morphology, structure, and surface chemistry were investigated using SEM, TEM, XPS, XRD, FTIR, and UV–Vis spectroscopy, while cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were employed to evaluate bioelectrochemical performance. Under optimized conditions, the MFC produced a maximum power density of 2231 ± 30 mW m^{-2} at a current density of 2516 ± 25 mA m^{-2}. The sensing performance achieved a limit of detection of 0.25 µg L^{-1} with a sensitivity of 0.1255 mV (µg L^{-1})$^{-1}$ under steady-voltage operation. In addition, the system maintained functionality over three consecutive reuse cycles, indicating good operational stability. These results demonstrate the promise of PIn–CNT–Fe_3O_4-based MFCs as environmentally friendly platforms for sustainable energy recovery coupled with real-time antibiotic monitoring in water.

Integrated Design and Additive Manufacturing of a Soft Actuator System for Hand Rehabilitation and Compliant Gripping

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Abstract: Soft pneumatic systems, owing to their inherent compliance and adaptability, have emerged as promising solutions for assistive rehabilitation and safe object manipulation. The current work introduces the additive manufacturing of a resource-efficient and integrated design of a soft pneumatic system created to assist therapeutically in the hand, and compliant hand gripping technology. The actuator is designed to generate controllable bending when the internal chambers are pressurized, such that they can assist the fingers to move during rehab and also adaptive grasping of the delicate dishes and fragile items. The flexible deformation, durability and recyclability is attained using a thermoplastic elastomer (TPU 95A) which aids in establishing sustainable fabrication with the reduction of material waste and the removal of intricate tooling needs. Fused deposition modelling is used to make prototypes, which are then experimentally tested as their response time, bending angle, blocked force, and cyclic durability are concerned, at different air pressures. The findings indicate nonlinear curvature relationship of pressure, which shows accurate and controllable actuation behaviour. Load tests also verify the capability of the gripper to hold objects safely without any damage. The soft actuator has a high elasticity that guarantees the contact is firmly soft enough to handle delicate objects, whereas the rigid base structure ensures mechanical stability. The suggested system strikes the right balance between speed, accuracy, and flexibility, and it is a viable and scalable solution in terms of rehabilitation support and the robotic manipulation.

Integrated recycling and formability study of automobile aluminium sheet scraps processed via FSW and SPIF

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Abstract: The growing accumulation of end-of-life AA6xxx-series automotive sheet scrap necessitates sustainable recycling routes that minimize energy use and environmental burden while preserving material performance. In this study, a solid-state recycling approach based on friction stir welding (FSW) was developed to consolidate AA6061-T6 aluminum sheet scrap into fully dense sheet blanks, and its efficiency was benchmarked against the conventional casting–rolling route. Experimental results showed that the FSW-based process required only ~7 kWh of energy to produce plates of equivalent thickness, compared with ~30 kWh for the remelting route, corresponding to nearly 77% energy savings and a substantial reduction in greenhouse gas emissions. Microstructural characterization of the recycled sheets revealed fine equiaxed grains and homogeneous material flow in the stir zone, confirming effective metallurgical bonding across scrap interfaces. Mechanical testing demonstrated that the FSW-recycled sheets retained mechanical strength and ductility comparable to the base metal. Formability assessment using single-point incremental forming (SPIF) showed stable deformation behavior, uniform strain distribution, and absence of premature failure along the weld region, indicating adequate structural integrity of the recycled material.

Lysis eLLM: Knowledge-Integrated Engineering Large Lan- guage Model Framework for Design Reasoning in Manufacturing Systems

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Abstract: Small and medium manufacturing enterprises frequently require rapid design updates, informed material selection, and manufacturability evaluation to meet changing production demands. In emerging industrial regions such as Raipur, engineering knowledge is often dispersed across research literature, industrial standards, and individual expertise, leading to fragmented decision-making workflows. Conventional CAD tools primarily support geometric modeling, while general artificial intelligence systems lack awareness of engineering constraints, creating a gap between theoretical knowledge and practical manufacturing requirements.

This work presents Lysis eLLM, a knowledge-integrated engineering large language model framework developed to support design reasoning in mechanical and manufacturing environ-ments. Implemented as a web-based engineering workflow platform, the system integrates structured technical knowledge with domain-aware reasoning to assist engineers in material selection, manufacturability assessment, and early-stage design generation. Rather than pro- ducing isolated outputs, the framework connects engineering theory with practical manufacturing considerations through context-aware reasoning processes. The system is currently undergoing testing through real engineering applications, including the development of an industry-oriented robotic platform for MSME manufacturing environments in the Raipur region. These environments require continuous design iteration and rapid generation of ready-to-manufacture engineering files. Outputs generated through the platform are reviewed by engineers at the Indian Institute of Technology Bhilai, while the robotic system developed using this workflow remains under active testing and refinement. Initial qualitative observations indicate that integrating engineering knowledge, materials intelligence, and manufacturability constraints within a unified interface can enhance design decisions.

Medical and Pharmaceutical Sciences

Advancing Antidiabetic Nanotherapy: QbD-Integrated Development of Diacerein-loaded Zein–TMC Nanoparticles with Optimized Pharmacological Performance

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Abstract: Diacerein is an anthraquinone derivative that inhibits pro-inflammatory cytokines, such as IL-1β and TNF-α. However, its clinical performance is limited by poor aqueous solubility, extensive first-pass metabolism, and low oral bioavailability, which require frequent dosing and increase the risk of gastrointestinal adverse effects. This study aimed to develop an orally administrable sustained-release diacerein-loaded zein nanoparticles to enhance bioavailability, reduce side effects, and improve patient compliance.

A Taguchi experimental design was used for preliminary screening of critical formulation variables that were further optimized through the Box–Behnken design. The optimized zein nanoparticles were further surface-coated with N,N,N-trimethyl chitosan (TMC) to enhance stability and mucoadhesive properties. Compatibility studies using FTIR and DSC confirmed the absence of physicochemical interactions among formulation components. The optimized formulation exhibited a mean particle size of 197.20 ± 6.04 nm with high entrapment efficiency (87.19%), and the zeta potential was −20.4 ± 3.46 mV, which shifted to positive values after TMC coating, confirming successful surface modification. TEM analysis revealed spherical and smooth nanoparticles. Stability studies indicated enhanced stability of the diacerein-loaded TMC-coated zein nanoparticles (D-TMC-ZNPs). In vitro release studies in simulated gastric and intestinal fluids demonstrated sustained drug release over 24 h. In vivo studies showed significant reductions in blood glucose levels, compared to the marketed formulation and enhanced insulin sensitivity. Histopathological analysis revealed no observable tissue damage and evidence of cellular regeneration. In conclusion, the developed D-TMC-ZNPs represent a promising oral delivery platform for the management of type 2 diabetes.

Keywords: Zein nanoparticle, trimethyl chitosan, diacerein, diabetes, nanotechnology

Costus speciosus Phytoconstituents as Superior PPAR-γ Agonists: GC-MS Identification and Docking Studies Demonstrating −15.9 kcal/mol Binding Affinity

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Abstract: Agonists of Peroxisome proliferator-activated receptor gamma (PPAR-γ) enhance insulin sensitivity and suppress hepatic gluconeogenesis, making them key targets in type 2 diabetes therapy. This study investigated the antidiabetic potential of phytocompounds from Costus speciosus rhizome crude extract through phytochemical characterization and computational screening against human PPAR-γ (PDB ID: 2P4Y).

Ethanolic rhizome extract underwent phytochemical screening, FT-IR, HPTLC, and GC-MS analyses, identifying 60 bioactive compounds. Molecular docking using ArgusLab 4.0 (visualized in PyMOL 4.2) compared binding affinities with Rosiglitazone. Stigmasterol (−15.919 kcal/mol) and campesterol (−15.010 kcal/mol) showed stronger binding than rosiglitazone (−9.575 kcal/mol), while beta-sitosterol demonstrated favorable drug-likeness (0.78) per Lipinski's Rule. Key interactions involved MET and LEU residues via hydrogen bonding and hydrophobic forces.

Overall, Costus speciosus phytoconstituents—particularly stigmasterol and campesterol—exhibit promising PPAR-γ agonistic potential, warranting further ADMET profiling, molecular dynamics simulations, and in vitro validation for antidiabetic drug development.

Development and characterization of surface coated dual drug-loaded nanoliposomes for non-invasive topical management of diabetic retinopathy

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Abstract: Diabetic retinopathy (DR) remains a leading cause of vision loss, primarily managed through invasive intravitreal injections associated with patient discomfort and poor compliance. The present study reports the development and statistical optimization of a dual drug-loaded nanoliposomal system for topical ocular delivery targeting angiogenesis and elevated levels of matrix metalloproteinases (MMPs) in DR. Nanoliposomes encapsulating axitinib (anti-vegf) and valproic acid (mmp inhibitor) were prepared using the thin-film hydration method and optimized through a Box–Behnken design (BBD) to achieve controlled vesicle size, polydispersity index (PDI), zeta potential, and encapsulation efficiency. The optimized formulation demonstrated a vesicle size of 141.4± 3.26 nm, PDI of 0.297± 0.021, and zeta potential of +37.4± 1.61 mV, indicating colloidal stability. Surface coating with hyaluronic acid (HA) increased vesicle size to 183.87± 4.72 nm with slightly increased PDI of 0.32± 0.031 and shifted zeta potential to –-23.27± 0.42 mV, confirming successful coating and potential receptor-mediated ocular targeting. Antioxidant evaluation using DPPH assay revealed that while free drugs exhibit rapid antioxidant activity, liposomal and HA-coated liposomal formulations provide sustained and enhanced antioxidant effects over extended incubation periods. Anti-angiogenic potential was validated through CAM assay. The study demonstrates a rationally designed, optimized, and biologically validated nanocarrier system that offers a promising, patient-friendly alternative to invasive therapy for diabetic retinopathy.

Development and Evaluation of Mannosylated Bioactive Liposomal Formulation for Management of Rheumatoid Arthritis

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Abstract: Rheumatoid arthritis (RA) is the most common inflammatory autoimmune disease characterized by joint inflammation, pain, and progressive tissue damage. It is reported to affect 0.1–2.0% of the population worldwide. Novel topical formulations offer potential advantages in targeted drug delivery with reduced systemic side effects. This study aimed to develop and evaluate mannosylated curcumin liposomal (ManCurLps) formulation for the management of RA. The liposomal carriers were synthesized using thin-film hydration techniques and optimized using design of experiment. The optimized formulation was characterized for physiochemical, morphology, and stability studies. Cell Cytotoxicity studies were conducted on THP-I macrophage. The anti-arthritic efficacy was evaluated in Complete Freund's Adjuvant (CFA)-induced arthritis rats with the assessment of clinical, histopathological and molecular parameters. BBD successfully identified optimal conditions yielding liposomes with particle size of 178.95 ± 0.27 nm, entrapment efficiency of 81.92 ± 0.12%, and zeta potential of -25.56 ± 0.52 mV. Cell Cytotoxicity studies confirmed the safety profile of the formulation with minimal adverse effects on cellular viability. ManCurLps significantly reduced paw edema on days 21 and 28 ($p<0.05$) compared to CFA control. Arthritic scores decreased significantly in treatment groups (ManCurLps: 1.17±0.75; Cur Lps: 1.33±1.03) versus CFA control (3.50±0.55). TNF-α levels and IL-6 levels were markedly reduced in ManCurLps and CurLps groups compared to CFA control. Hematological parameters (Hb, RBC, WBC, ESR) were restored to near-normal values. Radiological and histopathological analyses revealed reduced soft tissue swelling, bone erosion, and inflammatory cell infiltration in treatment groups. ManCurLps showed slightly superior efficacy, suggesting mannosylation enhances therapeutic potential. Thus the formulation represents promising topical alternatives for rheumatoid arthritis management.

Development Of Validated Stability Indicating Methods of Tolbutamide by HPLC And UV-VIS Spectrophotometer.

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Abstract: The present study aimed to develop and validate stability-indicating analytical methods for the determination of tolbutamide and to identify its major degradation products using High-Performance Liquid Chromatography (HPLC) and UV-Visible spectrophotometry. The International Council for Harmonization (ICH) guidelines were followed in the validation of the chromatographic method, which used reverse-phase gradient elution. Tolbutamide and its degradants were satisfactorily retained and resolved by the optimized mobile phase, which was composed of acetonitrile and 0.14% potassium dihydrogen orthophosphate buffer (pH 3.0) in a ratio of 35:65 at a flow rate of 1 mL/min. Studies on forced degradation were conducted in the presence of oxidative, photolytic, thermal, alkaline, and acidic stressors.

Tolbutamide exhibited a retention time of 4.18 min. The precision of both methods showed %RSD < 2%. Mean recovery ranged from 99.11–99.33% (HPLC) and 100.5–100.6% (UV method). The linearity range was 10–60 µg/mL with regression coefficients of 0.9988 (HPLC) and 0.9968 (UV). LOD and LOQ were 5.53 µg/mL and 16.76 µg/mL for HPLC, and 8.96 µg/mL and 27.15 µg/mL for UV spectrophotometry, respectively. Tolbutamide showed maximum degradation under oxidative stress. The results demonstrate that the validated methods are suitable for routine analysis and capable of separating degradation products from the active pharmaceutical ingredient.

Keywords: Tolbutamide, Stability-indicating method, HPLC, UV spectrophotometry, Validation, Forced degradation

Ethnomedicinal Validation and Molecular Investigation of Anticancer Compounds from Aristolochia bracteolata

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Abstract: Aristolochia bracteolata is a traditional medicinal plant commonly used by low-income and rural communities, valued for its affordability, accessibility, and long-standing role in treating cancer and skin diseases through indigenous knowledge systems. Through this basis, the plant Aristolochia bracteolata was taken for further studies. The plant was collected, dried, and powdered, then extraction was carried out through Successive Soxhlet extraction using different solvent systems (Petroleum ether, Chloroform, Ethyl acetate, Ethanol and water) according to their polarity from non-polar solvent to polar solvent. All the extract was subjected to anticancer analysis. The Chloroform extract shows good Anticancer activity as compared to other extracts. It was then further isolated to get the active constituent through column chromatography. Each fraction was subjected to TLC, and the selected fraction was further characterized through chromatography and spectroscopic methods. The presence of active constituents such as beta sitosterol, quercetin and gallic acid, which may be responsible for the anti-cancer activity. Further, for confirmation of anticancer activity of phytoconstituent, the Insilico study was performed and shows good binding affinity.

Fashioning of Piperine-Loaded Solid Lipid Nanoparticles: Design, Development, Analysis, Stabilization, and in vitro Screening

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Abstract: The study employed reactive surface methods to formulate, optimize, characterize, stabilize, and evaluate Piperine-loaded solid lipid nanoparticles (PIP-SLN) in vitro. Using the melt-emulsification ultrasonication process, PIP-SLN was created. Stearic Acid is a solid lipid and Tween 80 is a surfactant included in the optimum formulation. The optimized PIP-SLN was spherical, with a zeta potential of -42mV, PDI 23.2% and an average size of 157.75nm. Drug entrapment, x-ray diffraction tests, differential scanning calorimetry, and surface morphology assessment were all part of the physiochemical characterization. Studies on drug release in vitro showed that PIP-SLN may release medications for up to 24 hours. Stability testing revealed that the formulation was far stable in both refrigerator and room temperature. These results led to PIP-SLN being recognized as a potential medication carrier. This offers a structure for further investigation into the created formulation.

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Formulation and Evaluation of Bromelain-Based Herbal Anti-Dandruff Shampoo: A Novel Approach for Scalp Health

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Abstract: Dandruff is a persistent scalp disorder caused by the colonization of Malassezia furfur, leading to symptoms like itching, flaking, and inflammation. It is estimated that around half of the world's population suffers from dandruff. Anti dandruff shampoos made from synthetic ingredients are widely used due to their immediate effectiveness, but they usually cause harmful effects if used for a long time. This study focuses on the formulation of a herbal anti, dandruff shampoo, which includes bromelain, a proteolytic enzyme extracted from pineapple (Ananas comosus) and known for its anti, inflammatory and antimicrobial effects. Spectrophotometry (UV), FTIR, and anti, fungal tests against M. furfur (disc diffusion method) were used to analyze bromelain. Three formulas (F1, F3) with different bromelain levels (24, 28 ml) were made and their pH, foam characteristics, cleaning power, surface tension, rheology, and stability were assessed. The best composition was measured against the ketoconazole and tea tree oil shampoos commercially available. Bromelain exhibited considerable anti fungal potential (inhibition zone diameter (IZD): 140.51 mm). The concoction F2 (26 ml bromelain) yielded the best results: pH 6.210.07, foam volume 180 ml, detergency 66.120.02%, surface tension 34.890.12 dynes/cm, and rheological behavior of pseudoplasticity. The two, month stability tests indicated no significant differences. The antidandruff shampoo formulated showed antifungal activity (14.10.28 mm) like ketoconazole (15.00.20 mm; p=0.0106) and was better than the tea tree oil shampoo. A botanical shampoo containing bromelain has the potential to serve as a biobased, safe, and efficacious substitute for chemically synthesized anti, dandruff agents with desired physicochemical features and considerable antifungal activity.

Keywords: Bromelain , Malassezia furfurum; Anti-dandruff shampoo; Herbal formulation.

Formulation and Evaluation of Targeteserecta, Azadirachtaindica, Calotropis gigantea Herbal Ointment of Diabetes

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Abstract: The use of herbal medicines and interest in them has grown significantly in recent years, even in places with access to contemporary medical care. Since medicinal plants are the greatest source of bioactive molecules utilized in both traditional and modern medicine, plant-derived substances and herbal medicines have recently gained a lot of attention due to their wide range of applications. The current task is to create and assess the Aak (Calotropis gigantea) neem ointment. Extract from marigold leaves (Targeteserecta) and Neem (Azadirachtaindica). Using the Soxhlet technique, the aqueous, ethanolic, and hydrolytic extracts were made. After preparing the ointment base, the extract was incorporated into it using the levitation procedure to formulate the ointment. Once the formulation was finished, its physicochemical characteristics, such as color.

Formulation, QbD based optimization and in vitro evaluation of Palmatine loaded nanostructured lipid carriers for topical application

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Abstract: Objective: Palmatine (PAL) is a naturally occurring hydrophobic protoberberine alkaloid with anti-arthritic potential, faces challenges such as poor aqueous solubility, inadequate systemic availability, and low bioavailability, along with gastrointestinal side effects. Therefore, this study aimed to develop and optimize a PAL-loaded nanostructured lipid carrier (NLC) for topical delivery.

Method: NLCs were prepared using hot homogenization followed by sonication methods. The optimization of the formulation was done by a 3 3-factor 3-level central composite design with three independent variables, i.e., concentration of glyceryl monostearate (A), concentration of oleic acid (B), sonication time (C), and three dependent variables, particle size (Y1), polydispersity index (Y2), and % entrapment efficiency (Y3).

Result: The optimized formulation showed particle size of 170.99 nm, polydispersity index of 16.21, and % entrapment efficiency of 92.17%. DSC, XRD, TEM, and FTIR studies of optimized PAL-NLC formulations were analyzed. PAL-NLC- loaded gel was prepared and showed remarkable physical properties, viscosity, and stability. In comparison to plain gel and PAL solution, PAL-NLC in the gel form showed superior sustained drug release and significant ($p<0.05$) in vitro tissue penetration. The drug release kinetics study illustrated Higuchi's release pattern for a prolonged period of time. Ex-vivo permeation study results supported superior topical penetration for PAL using PAL-NLCs.

Conclusion: The developed formulation shows promise for topical use in future pre-clinical studies.

Gold nanoparticles as a tool to detect biomarkers in combined cancer

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Abstract: Extensive research over the years has revealed the remarkable enabling cancer detection, imaging and treatment through gold nanoparticles (AuNPs) photothermal therapy for detecting promising agents for cancer. Cancer is the second most common cause of death due to growing incidence in highly effective. Such as nano-rods or shells are delivered to cancer patients and excited by near light that induces cancer cells apoptosis and necrosis. Gold nanoparticles (AuNPs) are emerging as a promising agent for cancer. Nanoparticles are colloidal particles that typically range from 1-1000 nm and exhibit unique physicochemical properties significantly from their bulk. Gold nanoparticles (AuNPs) are 1-100 nm sized particles mostly used in biomedical & their optical properties, low toxicity, stability, biocompatible, passive accumulation in cancer through LSPR effect. It provides an effective and robust versatile biocompatible qualitative, quantitative analysis of biomarkers present in cancer. AuNPs absorb NIR light, transforming into heat to kill cancer. AuNPs as thermo-nastic gained significant attention due to their physical & optical characteristics including localized surface plasmon resonance (LSPR), fluorescence.

Keywords: Gold nanoparticles, cancer therapy, toxicity study, novel therapies.

In Silico Design of Quinazoline Bioisostere Derivatives as Dual HDAC and VEGFR-2 Inhibitors through ADMET Profiling, Molecular Docking, Molecular Dynamics Simulation, and DFT Analysis

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Abstract: Metastatic cancer progression is regulated by synergistic angiogenic signaling and epigenetic dysregulation, thereby necessitating multi-targeted therapeutic strategies. In this study, quinazoline-based bioisosteric derivatives were rationally designed from MolOpt software and evaluated as dual histone deacetylase (HDAC) and vascular endothelial growth factor receptor-2 (VEGFR-2) inhibitors using integrated in silico approaches. All designed compounds within the acceptable ranges of lipinski's rule of five and demonstrated favorable drug-like profiles (QED: 0.27–0.55; DS: 0.06–0.34). Molecular docking score enhanced dual-target binding affinities compared with the clinically approved pan-HDAC inhibitor suberoylanilide hydroxamic acid (SAHA) and VEGFR-2 inhibitors, indicating strong interactions within both the HDAC catalytic pocket and the VEGFR-2 ATP-binding domain. Among the series, FRU84 emerged as the lead compound, exhibiting medicinal chemistry parameters (QED 0.434; Synth 2.612; DL −0.15; DS 0.18) and acceptable molecular complexity. Pharmacokinetic predictions indicated optimal intestinal permeability (Caco-2: −4.658), minimal blood–brain barrier penetration (0.0017), high plasma protein binding (95.24%), moderate clearance (3.49 mL/min/kg), and a suitable half-life (0.89), comparable to the reference inhibitors for both targets. A 100 ns molecular dynamics simulation confirmed stable protein–ligand interactions for both targets. Density functional theory analysis further demonstrated favorable electronic stability and reactivity characteristics, with a HOMO–LUMO energy gap of 4.5993 eV and well-distributed electrostatic potential. Moreover, these findings identify FRU84 as a promising dual HDAC/VEGFR-2 lead candidate for further experimental validation in metastatic cancer therapy.

In Silico Evaluation of Designed Triazole-Clubbed Piperazine Derivatives as Potential MAO Inhibitors for the Treatment of Neurological Disorders

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Abstract: Piperazine derivatives have gained significant attention in medicinal chemistry owing to their unique structural versatility and broad pharmacological relevance in the management of neurological disorders. In this study, a series of ten novel nitrogen-based heterocyclic hybrids (1-10) comprising triazole-clubbed piperazine scaffolds were rationally designed and evaluated for monoamine oxidase (MAO) inhibitory potential using molecular docking, ADMET prediction, and molecular dynamics (MD) simulations. Docking analysis revealed that compounds 1 and 2 exhibited the most promising MAO-B inhibitory activity with binding scores of −7.3 and −7.6 kcal/mol, respectively, compared to the reference drug fluoxetine (−5.1 kcal/mol). Binding interaction analysis demonstrated that the lead compounds were favorably accommodated within the MAO-B active site cavity. These interactions contributed to strong stabilization within the enzyme binding pocket. Furthermore, MD simulations confirmed the stability of the protein-ligand complexes, showing minimal RMSD deviations, stable hydrogen bond occupancy, and compact structural behaviour throughout the simulation period. ADMET profiling indicated favorable drug-like properties, acceptable oral bioavailability, and low predicted toxicity. the findings highlight triazole-clubbed piperazine derivatives as promising MAO inhibitors with potential applications in the treatment of neurological disorders, warranting further experimental validation.

In-silico Evaluation of Some Orphenadrine Analogues for Neurodegenerative disorder with their ADMET properties and Molecular Modeling

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Abstract: Parkinson's is the second most common neurodegenerative disorder after Alzheimer's disease. It acts as a mild non-competitive antagonist of the NMDA receptor by binding to phenyl group. Orphenadrine acts as an antihistaminic classification of drug. Orphenadrine is being selected because it is used to treat muscle pain & help to motor control in Parkinson's disease. In current study, various analogues have been used phenyl, 0-tolylge, Dimethylamino ethyl, Dimethylamino such as 001, 004, 023, 027 groups. In order to develop the newer analogues having lesser side effects like in cirrhotic patients including sleep, etc.Which is the major cause of the drug withdrawal & their side effects such as muscle spasm in cirrhotic patients, chest pain, hallucinations, swollen or painful etc. Therefore some analogues are designed by using Mol Opt in order to develop relatively safe compounds. A wide variety of analogues with their Pharmacokinetic and toxicity (ADMET) properties of newly designed analogues are computed by using ADMElab2.0 and pkCSM. Drug likeness and drug score was calculated by PEO. All the ligands obey the Lipinski rule and good human intestinal absorption. Orphenadrine is used as the reference drug. The results indicate the compound 001,004,023,027 showed NR-AR binding (desirable in Parkinson's disease) QED Value (measure of drug likeness ;> 0.67) comparable with the standard drug. This compound shows low toxicity [human hepatotoxicity (H-HT) and drug induced liver injury (DILI)] as compared to orphenadrine. This study could lead to further development of potent NMDA receptor antagonists for the treatment of Parkinson's disease.

Keywords: Parkinson disease, drug induced liver injury, human hepatotoxicity, orphenadrine, analogues, drug likeness, ADMET.

Mechanistic Investigation of Coccinia grandis (Linn.) Voigt Phytochemical in the Management of Constipation by Network Pharmacology, Molecular Docking, and In-Vitro Approach

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Abstract: Coccinia grandis is a culinary herb with medicinal value. Methyl caffeate is a unique phytochemical compound that was identified through LC-MS analysis of the ethanolic leaf extract of coccinia grandis. Methyl caffeate, a potential phenolic compound, exhibits diverse therapeutic potential, including antioxidant, cardioprotective, and anti-inflammatory properties. Traditional evidence supports that methyl caffeate enhances gastrointestinal motility, but its role in the treatment of constipation is unexplored. The mechanism of action of methyl caffeate towards constipation was investigated by using network pharmacology, molecular docking, and an in vitro approach. SwissADME and molsoft were used to evaluate the drug likeness and toxicity of methyl caffeate. The potential targets of methyl caffeate were predicted through Swiss Target Prediction. The target proteins correlating with constipation were downloaded from Genecards. The Venny 2.1 revealed 57 (5.5 %) common targets between methyl caffeate and constipation, and the STRING database was used to construct a protein-protein interaction (PPI) network of common targets. The Cytoscape, with the aid of cytoHubba, was used to screen 9 hub genes, including STAT3, EGFR, ESR1, PTGS2, CTNNB1, MAPK1, RELA, MAPK8, and MMP9. GO and KEGG enrichment analysis revealed that methyl caffeate will alleviate constipation in response to serotonergic synapse pathway, Response to oxidative stress, Membrane microdomain, among others. Finally, molecular docking demonstrates good binding affinity between methyl caffeate and hub genes. To support this study, we evaluated the in-vitro spasmodic activities of methyl caffeate. Methyl caffeate produced a dose-dependent tonic contraction (0.05-4 mmol/L) on isolated rat ileum.

Metabolite Profiling and In-vitro Antiplasmodial Activity of Cissampelos pareira (L.): A Traditional Medicinal Plant

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Abstract: Medicinal plants are abundant sources of bioactive secondary metabolites and play a crucial role in the treatment and management of malaria. Limited resistance to first-line antimalarial drugs is increasing, and searching for safe, effective, and affordable herbal antimalarials is crucial in the current situation. The present research involves the metabolite profiling and in vitro antiplasmodial activity for Cissampelos pareira (L.). The plant root powder (500 g) was collected and extracted with a Soxhlet extractor using different solvents such as n-hexane, chloroform, and methanol in successive manner and the obtained extracts were tested against the plasmodial strains, chloroquine-sensitive (Pf-3D7) and resistant (Pf-K1) strains. The chloroform extract of C. pareira (L.) exhibited strong antimalarial activity with IC50 values of 0.25 µg/ml and 1.38 µg/ml against Pf-3D7 and Pf-K1 strains, respectively, of which there was evidence of significant efficacy in the cytotoxicity test against mammalian cell lines (VERO). In addition, a phytochemical profiling was undergone of the active fraction of root extract of C. pareira (L.). This study concludes that the antiplasmodial potential of C. pareira (L.) is due to the presence of alkaloids in the plant. Therefore, these results indicate that C. pareira (L.) is a good source for the drug development process and discovery of new drug molecules with potential antiplasmodial activity.

Molecular docking, ADMET profiling and cytotoxic evaluation of plant-derived bioactives against estrogen receptor-α in MCF-7 breast cancer Cells

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Abstract: Breast cancer (BC) continues to be most common malignant neoplasm affecting women all over the world and in major cases BC is linked to estrogen receptor alpha (ER-α) positive. Tamoxifen and other estrogen selective modulators have demonstrated efficacy in decelerating the progression of ER-α BC, however prolonged use of these agents are associated with resistance and adverse effects. Numerous natural plant bioactives remain unexplored underscoring a significant research deficiency. In this study, certain unexplored plant bioactives were evaluated using molecular docking against estrogen receptor-alpha (ER-α) for the discovery of novel anticancer agents. Corosolic acid and Withanolide A shows higest binding affinity of -12.5885 Kcal/mol and -12.606 Kcal/mol. Interaction analysis demonstrated stable binding with key active-site residues, including 350 ALA, 351 ASP, 383 TRP, 525 LEU, 522 MET, 528 MET, 347 THR.The findings suggests favourable ADMET and drug-likeness properties. Furthermore, the anticancer potential of the selected plant bioactives were validated through in vitro cytotoxicity studies utilising ER-positive breast cancer cell lines MCF-7.The study reveals the dose-dependent antiproliferative activity, with IC_{50} values of 18.5 ± 1.2 µM (corosolic acid) and 12.4 ± 0.8 µM (withanolide A) when compared to tamoxifen (7.5 ± 0.5 µM).Among the two compounds Withanolide A shows the highest cytotoxic potential as compared to that of corosolic acid.

Keywords: Breast cancer, Plant bioactives, Estrogen Receptor, Molecular Docking

Nanoencapsulation of Remdesivir in Human Serum Albumin Carriers for Improved Therapeutic Efficacy

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Abstract: Remdesivir (REM) is an antiviral drug approved by the Food and Drug Administration (FDA) for the therapy of COVID-19. The present study is designed to develop antiviral drug (REM) encapsulated Human Serum Albumin nanoparticles (HSA-NPs) as a biodegradable carrier using desolvation method. It has been further assessed for their improved bioavailability, solubility and sustained release behavior. Physicochemical properties of the prepared NPs and drug release kinetics were evaluated by mathematical models, including zero, first, second order, Higuchi model, and Korsmeyer-Peppas. Microscopic imaging experiments validated the synthesized NPs to be uniform and spherical morphology with an average particle diameter of less than 100 nm, indicating good colloidal stability. Synthesized NPs show good drug encapsulation capacity with 92.74 ± 5.04. The in vitro release of encapsulated NPs was monitored by the dialysis bag method. The release studies of REM from REM-HSA NPs were found to be 10.31 % in 25 h. The interaction between REM and HSA was also studied through fluorescence spectroscopy and molecular docking. The binding affinity between REM and HSA was determined by fluorescence quenching mechanism. The binding constant (Kb) and Stern-Volmer quenching constant (Ksv) were found to be 2.62 × 106 and 1.00 ± 0.21 L/mol respectively. Molecular docking studies were used to identify the main amino acid residues of HSA involved in the interaction with the nanoparticles. We considered that the HSA NPs may have potential applications in the field of antiviral drug delivery in the treatment of COVID-19.

Keywords: Human Serum Albumin, Remdesivir, Drug Delivery, Encapsulation Efficiency, Molecular Docking.

Piperine-Enriched Methotrexate-Docetaxel Nanoparticles: Formulation, Characterization, and Antitumor Evaluation in Breast Cancer

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Abstract: Breast Cancer continues to be one of the most significant causes of cancer related illness and death among women worldwide, creating a major burden on global healthcare systems. Although chemotherapy remains a primary treatment option, its effectiveness is frequently restricted by systemic toxicity, the emergence of multidrug resistance, and unfavourable pharmacokinetic behaviour of anticancer agents. Employing combination therapy is considered a rational strategy to improve therapeutic response by acting on multiple cellular pathways simultaneously. Methotrexate and docetaxel trihydrate are widely used chemotherapeutic drugs that demonstrate synergistic anticancer activity; however, their clinical benefits are limited due to poor bioavailability and treatment related adverse effects. Piperine, a naturally derived phytoconstituent, has been reported to enhance drug absorption and inhibit efflux transporters, thereby improving overall therapeutic efficiency. The present work focused on the development and assessment of nanoparticles simultaneously loaded with methotrexate, docetaxel trihydrate and piperine to enhance breast cancer treatment. The nanoparticles were produced using a nanoprecipitation approach and evaluated for key physicochemical characteristics, including particle size distribution, surface charge, drug entrapment, and morphology. Sustained drug release behaviour was examined through in-vitro studies, while cytotoxic potential was determined using breast cancer cell lines. The optimized nano formulation exhibited uniform nanoscale size, high drug incorporation, stable surface properties, and controlled release, resulting in improved anticancer activity compared with individual free drugs. These findings indicate that co-loaded polymeric nanoparticles incorporating a phytoconstituent may provide an effective strategy for improving therapeutic outcomes in breast cancer management.

Protective Effects of Intermittent Fasting and Vitamin E Against Hyperthyroidism-Associated Ophthalmopathy in Wistar Rats

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Abstract: Purpose- Our study endeavours to prevent hyperthyroidism-associated ophthalmopathy through the synergy of intermittent fasting and Vitamin E supplementation. Our aim was to reduce the incidence of hyperthyroidism-associated ophthalmopathy by combining these two interventions, while carefully monitoring dietary intake and supplementing with vitamin E.

Method- In this experiment, animals were divided into normal, hyperthyroidism control, dual, vitamin E, and intermittent fasting groups. Hyperthyroidism was induced by administering thyroxine for 24 days. Animals in the treatment groups took vitamin E and practised intermittent fasting. Intraocular pressure was measured at different times during the protocol. After the protocol, antioxidant status, Malondialdehyde and nitrite level, protein content, retinal pictures, histopathology of lens and retina tissue and thyroid profile were analysed.

Results- Rats with hyperthyroidism control exhibited elevated ($P < 0.001$) intraocular pressure, lipid peroxidation, total protein content, and thyroid hormone levels, while antioxidant and nitrite levels decreased ($P < 0.001$). However, our non-drug therapy significantly ($P < 0.001$) improved all of these parameters, bringing them to their optimum levels.

Conclusion- Intermittent fasting prevented ocular disease caused by hyperthyroidism by reducing oxidative stress and fibrogenic matter deposition, and modulating nitrite balance. It works best when combined with Vitamin E for superior antioxidant benefits. Our proposed remedies not only improved ocular function but also provided physiological benefits, suggesting a link to metabolic, ophthalmic, and neurogenic diseases in future projections.

Simultaneous Estimation of Methotrexate and Capsaicin in Formulations by UV Spectroscopy: Method Development and Validation

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Abstract: Methotrexate (MTX) and Capsaicin (CAP) are therapeutic agents that are used in Rheumatoid Arthritis (RA) management usually alone. However, their combination may be more effective for RA treatment if formulated together. Here, we report a simple, accurate, precise and cost-effective UV spectroscopic method for simultaneous estimation of MTX and CAP. The corresponding absorption maxima of MTX and CAP in the selected solvent (0.1 N NaOH) were found to be 302 nm and 246 nm respectively. A linear response was observed in the range of 2-10µg/ml and a correlation coefficient of 0.998 and 0.999 for MTX and CAP respectively. Subsequently, this method was validated for different parameters like accuracy, precision, linearity and sensitivity as per ICH (International Conference on Hormonization) guidelines. We concluded that this method could be used for the simultaneous estimation of MTX and CAP in quality control of formulation without inference of excipients.

Keywords: Methotrexate, Capsaicin, UV-Spectrophotometer, Method development

Structural insights into Quinoline - based cytotoxic agents targeting HeLa Cells: A Combined docking, QSAR and In-silico ADMET investigation

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Abstract: Several quinoline compounds with cytotoxic activities against the HeLa cell line have been examined to identify the structural features that determine their antitumor efficacy. A dataset of 25 compounds with IC values was converted into pIC and subjected to 2D, QSAR, 3D, QSAR, and in, silico ADMET analyses. 2D, QSAR studies with multiple linear regression models, developed via VLife MDS, showed significant statistical relationships, and the best model displayed the excellent goodness of fit and predictive power (R = 0.8545, Q = 0.7749, Pred, R = 0.7035). kNN, MFA generated field, based 3D, QSAR models gave more importance to the combined effect of electrostatic & steric forces. Activity was increased by electropositive regions near the quinoline core, while steric hindrance at spatial locations was disadvantageous. Hydrophobic interactions also provided favorable contributions to the cytotoxic potential. These findings together highlight that an equal electrostatic character, a controlled steric environment, and slight hydrophobicity are the critical factors that modulate the activity. ADMET evaluation using ADMETlab 3.0 reflects exceptional oral drug- like properties with full compliance to Lipinski's rule and sufficient pervasion characteristics. Nevertheless, the presence of potential problems such as CYP inhibition, hERG risk factors, and hepatotoxicity indicates that molecular modification is necessary. The combined QSAR, ADMET framework clearly shows the design direction to optimize quinoline- based anticancer drugs and makes it easier to continue their development as possible candidates for colon cancer, targeted sites. The compounds that turned out to be the most favorable in the ADMET analysis were then chosen for molecular docking studies to further investigate their binding interactions and therapeutic efficacy.

Translational In Situ Phase-Transition Nanotherapy for Enhanced Ocular Bioavailability in Agriculture-Associated Bacterial Keratitis: A Rural Chhattisgarh Perspective

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Abstract: Chhattisgarh has a predominantly rural and agricultural population where frequent exposure to dust, crop debris, and fertilizer particulates significantly increases the risk of ocular trauma and subsequent bacterial keratitis. Delayed treatment access and poor retention of conventional antibiotic eye drops further worsen clinical outcomes, often leading to preventable corneal blindness. Addressing this regional healthcare challenge, the present study developed novel in situ phase-transition water-in-oil (W/O) microemulsion of a broad-spectrum antibiotic to enhance ocular drug bioavailability and therapeutic efficacy.

The optimized nanosized formulation (~87 nm), prepared using pseudo-ternary phase diagram analysis, exhibited suitable physicochemical properties, physiological pH, and optical clarity. Upon installation, the formulation undergoes spontaneous phase transition into a viscous liquid crystalline system, significantly increasing precorneal residence time. In vitro release studies demonstrated sustained drug release, while ex vivo corneal permeation showed approximately 1.5-fold enhancement compared to conventional formulations. Antimicrobial studies confirmed prolonged inhibition against common keratitis pathogens including Staphylococcus aureus and Escherichia coli, with excellent ocular safety demonstrated through HET-CAM and Draize testing.

In vivo studies indicated faster clinical recovery with reduced dosing frequency, a critical advantage for rural patients with limited healthcare accessibility.

This research provides a regionally relevant, patient-centric, and scalable ophthalmic drug delivery platform with strong potential to reduce infection-related visual impairment in agricultural communities of Chhattisgarh.

Keywords: Bacterial keratitis, Nanotherapy, Agricultural eye injury, Sustained ocular delivery, Rural healthcare innovation, Phase-transition microemulsion.

Vitis vitiginea-Mediated Green Synthesis of Silver Nanoparticles: A Novel Therapeutic Approach for Enhanced Bone Fracture Healing and Mitochondrial Protection against Oxidative Stress

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Abstract: Background: Traditional medicine has potential to fight various human degenerative conditions, but they need scientific validation and modern drug delivery systems. Vitis vitiginea, a perennial folk climber, has been traditionally used to cure bone-related conditions. However, the exact mechanism of action of this plant remains unknown.

Objective: This investigation aims to reveal the exact mechanism of action of the root ethanolic extract of VV, which can be used to synthesize silver nanoparticles.

Methods: The root ethanolic extract of Vitis vitiginea was used to reveal the exact mechanism of action of the plant. The extract was used to synthesize silver nanoparticles, which was confirmed through various analytical tools. The exact mechanism of action of the plant was validated by analyzing the antioxidant activity of the extract, which was used to prevent mitochondrial damage. The bone fracture healing potential of the extract and the biosynthesized silver nanoparticles was also evaluated.

Results: Phytochemical studies confirmed the high content of bioactive metabolites in VVE, which was consistent with the enhanced antioxidant activity of the extract, particularly in combating mitochondrial oxidative stress. The green-synthesized AgNPs showed stable morphology. Most interestingly, the AgNPs showed a synergistic effect, which enhanced the rate of bone mineral density recovery which is analysed through the alkaline phosphatase activity.

Conclusion: This study bridges the gap between conventional study and nanotechnology, establishing the potential of VV-mediated AgNPs as an efficient and biocompatible therapeutic agent for bone repair and protection of mitochondria, which can be used as a novel therapeutic tool for treating fracture-related degenerative disorders.

Zinc Mediated Amelioration of Aspartame Induced Reproductive Endocrinopathy through Kisspeptin/KISS1R Dysregulation

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Abstract: Aspartame (ASP) is a widely consumed low calorie sweetener, yet increasing evidence suggests that chronic exposure may compromise reproductive health through metabolic and oxidative mechanisms. The present study investigated the effects of long-term ASP administration on male reproductive function with particular emphasis on kisspeptin (KP/KISS1R) signaling, oxidative stress, inflammation, and the modulatory role of zinc (Zn). Groups of adult male Wistar rats were treated orally for 90 days with ASP (40 and 80 mg/kg), Zn (5 and 10 mg/kg), and their combinations. Reproductive indices, sperm quality parameters, circulating gonadotropins and testosterone, serum KP, testicular KISS1R expression, antioxidant status, inflammatory cytokines, and testicular histoarchitecture were evaluated. Chronic ASP exposure produced dose-dependent reductions in sperm count, motility, viability, and morphology, accompanied by significant suppression of LH, FSH, and testosterone. These alterations coincided with impaired antioxidant defences, elevated IL-6 and TNF-α levels, disrupted KP/KISS1R signaling, and marked testicular degenerative changes. In contrast, co-administration of Zn with ASP significantly mitigated ASP-induced reproductive toxicity and partially normalized KP/KISS1R signaling. Collectively, these findings demonstrate that chronic ASP exposure disrupts male reproductive function via oxidative stress mediated endocrine and KP/KISS1R pathway dysregulation, while Zn exerts a protective effect by restoring redox balance and neuroendocrine control.

Development And Evaluation of Herbal Extract Loaded Phyto-Patch for Osteoarthritis

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Abstract: Background: Osteoarthritis (OA) is a chronic degenerative joint disorder characterized by progressive cartilage destruction, synovial inflammation, oxidative stress, and persistent pain, leading to impaired mobility and reduced quality of life. Long-term oral administration of anti-inflammatory drugs is commonly associated with gastrointestinal adverse effects and fluctuating plasma drug concentrations. Transdermal drug delivery systems provide a controlled and sustained release approach, minimizing systemic side effects and improving patient compliance. Cissus quadrangularis, a medicinal plant rich in flavonoids, phenolic compounds, and triterpenoids, exhibits established anti-inflammatory and antioxidant activities, supporting its potential role in OA management. Objective: To develop and evaluate a standardized herbal extract-loaded transdermal Phyto-patch of Cissus quadrangularis for sustained drug delivery in osteoarthritis therapy.

Injectable In-Situ Hydrogel for Metabolic Disorder

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Abstract: Metabolic disorders, including diabetes mellitus and related dyslipidemia, as well as obesity, require long-term medication, which is limited by frequent dosing, poor patient complication, and fluctuating drug levels. In-situ-forming hydrogels have emerged as a drug-delivery method, enabling site-specific gelation and sustained therapeutic action. The present concept investigates the unique natural polymer-based in-situ hydrogel derived from plant polysaccharides that has inherent biocompatibility, biodegradability, and low immunogenicity. These polymers are undergoing solution to gel transition in response to physiological triggers such as temperature, ionic strength, or pH, allowing minimally invasive administration and localised depot formation. The hydrogel matrix is intended to encapsulate metabolic disorders or antidiabetic drugs, enabling regulated, extended drug release through mechanisms mediated by swelling and diffusion. Such as a prolonged-release formulation that maintains therapeutic drug concentrations for long periods. Overall, this study suggests creating a new in-situ hydrogel system from an unexplored natural polysaccharide polymer hybrid. This system undergoes a solution-to-gel transition under physiological conditions and represents a clinically transferable, adaptable method for managing metabolic disorders. It represents a major improvement over traditional dosage forms.

Keywords: In-situ hydrogel, Metabolic disorders, Injectable In-Situ Hydrogels, Mechanisms of In-Situ Gelation.

Polyherbal Modulation of D-Galactose–Induced Cognitive Dysfunction in Wistar Rats: Behavioral Evidence of Synergistic Neuroprotection

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Abstract: Aging-associated cognitive decline is closely linked to oxidative stress, neuroinflammation, mitochondrial dysfunction, and progressive neuronal damage. Therapeutic strategies targeting multiple pathogenic pathways may provide superior neuroprotection. Polyherbal approaches, owing to their multitarget pharmacological actions, have emerged as promising candidates for mitigating age-related cognitive impairment. The present study evaluated the synergistic neuroprotective effects of Bacopa monnieri and Berberis aristata against D-galactose–induced cognitive dysfunction in Wistar rats. Experimental aging was induced by subcutaneous administration of D-galactose (150 mg/kg) for six weeks. Animals were randomly allocated into six groups (n = 6): normal control, disease control, standard control treated with Fluoxetine (10 mg/kg), Bacopa monnieri (200 mg/kg), Berberis aristata (100 mg/kg), and their combination. Treatments were administered orally. Cognitive performance was assessed using the Elevated Plus Maze (transfer latency and inflexion ratio) and Y-maze (percentage spontaneous alternation). Data were analyzed using one-way ANOVA followed by post hoc tests. Chronic D-galactose exposure significantly impaired learning and memory, evidenced by prolonged retention latency and reduced spontaneous alternation ($p < 0.05$ vs. normal control). Individual administration of Bacopa monnieri and Berberis aristata significantly improved cognitive parameters compared to disease control. Notably, the combination-treated group showed the most pronounced improvement, restoring behavioral performance toward normal levels ($p < 0.01$), indicating enhanced neuroprotective efficacy. The findings demonstrate behavioral evidence of synergistic neuroprotection and support the therapeutic potential of polyherbal strategies in managing aging-associated cognitive dysfunction.

Mining, Metallurgy and Applied Geology

Early Warning System for Overburden Dump Slope Structure Using Machine Learning

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Abstract: Coal plays a pivotal role in the economic advancement of Chhattisgarh, with opencast mining serving as the primary source of production. Nonetheless, these operations generate substantial volumes of overburden (OB), leading to multi-bench dump structures. Globally, slope failures in OB dumps have caused significant fatalities, equipment losses, and mine closures, underscoring the need to mitigate such incidents to sustain coal supply and regional growth.

This study addresses the challenge by formulating design criteria for long-term stability of multi-bench OB dump slopes, optimizing space utilization for massive OB volumes. A three-state classification system is proposed to evaluate failure-prone dump configurations. Conventional factor of safety (FoS) analyses proved inadequate for pinpointing vulnerable zones in multi-bench setups. Consequently, maximum lateral deformation (XDIS) and shear strain increment (SSI) were integrated with FoS to establish precise design thresholds.

These criteria were embedded within machine learning frameworks to enable rapid, reliable stability assessments. Model validation involved analyzing existing dump structures, revealing that stability requires FoS, XDIS, and SSI to remain within designated safe ranges. Notably, XDIS and SSI exhibited greater sensitivity to stability variations than FoS. Among evaluated algorithms, artificial neural networks (ANN) and support vector machines (SVM) achieved superior accuracy. The synthetic minority oversampling technique (SMOTE) combined with edited nearest neighbors effectively mitigated outlier influences and class imbalances.

Hence, this integration of design criteria with machine learning, facilitates early detection of instability in OB dumps, averting slope failures, minimizing accidents, strengthening coal output, and fostering Chhattisgarh's sustainable development and digitisation of mines.

Investigation Of the Ratio of Stemming and Burden On Rock Breakage for Sustainable Blasting in Jointed and Intact Rock

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Abstract: Stemming is one of the most critical blast design parameters and must be optimised to achieve improved blasting output. The effective breakage is strongly influenced by the ratio of stemming and burden , as an optimum ratio provides adequate confinement to the explosive energy, enabling its maximum utilisation in rock breakage. However, it becomes challenging in jointed rockmass such as limestone due to the presence of natural discontinuities. Accordingly, the present study aims to optimize the ratio of stemming and burden in jointed limestone rockmass using numerical simulation. The developed numerical models were calibrated using data obtained from experimental blasts. Additionally, numerical simulation was used to investigate the effect of the ratio of stemming and burden in an intact rockmass (without joints). The results indicate that, under both jointed and intact conditions, the rock breakage increases initially with an increase in the ratio of stemming and burden owing to enhanced confinement of explosive energy. After a certain threshold point, corresponding to the maximum excavated rock volume, further increase in the ratio leads to a reduction in breakage. The optimum ratio of stemming and burden yielding maximum excavated rock volume was found to be 0.7 and 0.8 for jointed and intact rockmass, respectively. This reduction beyond the optimum ratio is attributed to a decrease in effective explosive column length, resulting in poorer blasting performances.

Predicting Reclamation Age of Degraded Mine Soils Using Asymptotic Growth Modeling and Soil Quality Indices: An Applied Geological Approach

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Abstract: Quantifying the recovery trajectory of degraded mine soils remains a key challenge in applied geology, especially when assessing post-mining land stability and long-term rehabilitation of soil systems. Reliable evaluation of recovery pathways is critical for measuring reclamation success, informing adaptive land management, and predicting the re-establishment of functional soil–geological processes. This study develops an integrated applied geological framework that links a tree-based Reclaimed Mine Soil Quality Index (RMSQI) with asymptotic growth modeling to estimate the reclamation age of degraded limestone mine substrates. Soil physico-chemical, microbial, and enzymatic attributes were measured under four dominant forest tree species across a restoration chronosequence of 5, 15, and 25 years, together with non-planted soil (NPS) and reference normal soil (RNS) representing baseline geological conditions. Principal Component Analysis (PCA) reduced 18 soil variables to a minimum dataset explaining 88.09% of total variance, providing a quantitative foundation for the RMSQI as an indicator of soil system recovery. RMSQI values rose consistently with restoration age, increasing from 0.230–0.249 at 5 years to 0.607–0.627 at 25 years and approaching the geological reference benchmark (0.656). Among the predictive models evaluated, the asymptotic growth model best captured restoration trajectories (R^2>0.99), suggesting progressive stabilization of soil properties. Monte Carlo simulations estimated vegetation-driven median recovery periods of 29–34 years to reach reference soil quality, with species-specific uncertainty ranges reflecting variability in pedogenic development. Overall, the framework provides a biologically grounded and statistically robust applied geological tool for forecasting reclamation timelines and guiding evidence-based species selection in post-mining landscapes.

Physics (Bio-Physics, Chemical-Physics and Geophysics, Astrophysics, Nuclear Physics etc.)

Enhanced Structural and Photoluminescence Properties of Trivalent Samarium Sm^{3+} Doped $Ca_{19}ZN_2(PO_4)_{14}$ Phosphors for High Performance Reddish-Orange Light-Emitting Applications

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Abstract: $Ca_{19-x}Zn_2(PO_4)_{14}$: xSm^{3+} (x = 0.01–0.07 mol%) phosphors were successfully prepared by the conventional solid-state reaction method. The phase purity and structural changes in the synthesised samples were verified by X-ray diffraction (XRD). The surface morphology, optical band gap, and elemental composition were investigated using scanning electron microscopy (SEM), diffuse reflectance spectroscopy (DRS), X-ray photoelectron spectroscopy (XPS), and energy-dispersive X-ray spectroscopy (EDX), respectively. Photoluminescence (PL) analysis showed that the material exhibits strong excitation bands at 347, 363, 377, 392, 404, 418, 442, 464, and 477 nm, with the most intense transition observed at 404 nm ($^6H_{5/2} \rightarrow {}^4F_{7/2}$), followed by a notable band at 477 nm ($^6H_{5/2} \rightarrow {}^4M_{15/2}$). Under near-UV excitation at 404 nm, the emission spectrum displays clear peaks at 563 nm (yellow), 603 nm (orange), and 647 nm (orange-red), which are assigned to the $^4G_{5/2} \rightarrow {}^6H_{5/2}$, $^4G_{5/2} \rightarrow {}^6H_{7/2}$, and $^4G_{5/2} \rightarrow {}^6H_{9/2}$ transitions, respectively. Furthermore, excitation at 477 nm, a cost-effective and readily available visible-light source, produces emission peaks similar to those observed with 488 nm excitation, along with an additional deep-red emission at 717 nm, corresponding to the $^4G_{5/2} \rightarrow {}^6H_{11/2}$ transition. In addition, the chromaticity coordinates (CIE), colour rendering index (CRI), luminous efficacy of radiation (LER), colour purity, correlated colour temperature (CCT), thermal stability, and quantum efficiency were evaluated. The overall results indicate that Sm^{3+}-doped CZP phosphors are promising candidates for low-cost photonic applications, including white light-emitting diodes (WLEDs) and horticultural lighting systems.

Direct-Band-Gap A_3SbX_3 (A = Mg, Ca, Sr; X = F, I) Antiperovskites with Visible–UV Absorption: A First-Principles Route toward Emerging Photovoltaic and Optoelectronic Materials

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Abstract: The search for stable, lead-free, and optically efficient semiconductors remains a central challenge in the development of next-generation photovoltaic and optoelectronic devices. Antiperovskites, as structural inverses of conventional perovskites, offer a largely untapped chemical space with exceptional scope for electronic and optical tunability. Motivated by the absence of systematic studies on Sb-based antiperovskites, we present a comprehensive first-principles density functional theory investigation of five previously unexplored A_3SbX_3 compounds (A = Mg, Ca, Sr; X = F, I). Structural optimization confirms their stability in the cubic antiperovskite phase. Electronic structure calculations reveal that all studied compounds possess direct band gaps, a critical requirement for efficient light absorption and radiative recombination. The band gaps fall within the visible to ultraviolet range and can be effectively tuned through cation and anion substitution. Optical property analysis demonstrates strong absorption coefficients, pronounced dielectric response, and favorable refractive indices across the visible and UV spectral regions, highlighting their suitability for both solar photovoltaic absorbers and optoelectronic devices such as photodetectors and light-emitting components. Notably, iodide-based systems exhibit enhanced visible-light absorption, while fluoride-based compounds show wider band gaps advantageous for UV optoelectronics. This work establishes A_3SbX_3 antiperovskites as a new, unexplored class of direct-band-gap semiconductors and provides a theoretical foundation for their future experimental realization and device integration.

Efficient Solid State Symmetric Supercapacitor Based on CuO: Eu3+ Nanoparticles

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Abstract: Eu3+-doped CuO nanoparticles with varying dopant concentrations (0, 1, 2, and 3%) were synthesized via co-precipitation route and investigated as electrode materials for solid-state symmetric supercapacitors. X-ray diffraction confirmed the formation of phase-pure monoclinic CuO with slight lattice distortions upon Eu3+ incorporation, while SEM analysis revealed significant dopant-induced morphological evolution toward highly porous nanostructures. Electrochemical studies demonstrated enhanced charge storage performance for Eu-doped samples, with the CuO: Eu3+ (2%) electrode exhibiting the lowest charge-transfer resistance and superior pseudocapacitive behaviour. A solid-state symmetric supercapacitor fabricated using CuO: Eu3+ (2%) electrodes and a PVA/KOH gel electrolyte delivered a wide operating voltage of 1.35 V, achieving a maximum energy density of 47.23 Wh kg-1 at a power density of 674.87 W kg-1. The device also demonstrated excellent cycling stability with ~94% capacitance retention after 10,000 charge-discharge cycles and successfully powered a green LED. These results highlight Eu3+ doping as an effective strategy for improving the electrochemical performance of CuO-based solid-state supercapacitors.

Enhanced photovoltaic performance of Sb2S3 and Sb2Se3 double-absorber solar cell using first-principles, SCAPS-1D and machine-learning approaches

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Abstract: Antimony chalcogenides have earned significant attention as potential absorber materials owing to their suitable bandgap, high absorption coefficient and earth-abundance. In present work, we have performed a systematic multiscale investigation of Sb2S3 and Sb2Se3 using density functional theory(DFT), SCAPS-1D and a machine-learning(ML) framework. The DFT calculations were used to analyze the structural, electronic and optical properties of Sb2S3 and Sb2Se3. The bandgap values of 1.73 eV and 1.28 eV for Sb2S3 and Sb2Se3 respectively were estimated along with good optical absorption across the visible-UV region. The DFT derived material parameters were used as input in SCAPS-1D to design and simulate a heterojunction solar cell architecture FTO/ZnSe(ETL)/Sb2S3/Sb2Se3/CuSbS2(HTL)/Au. The effect of the key device parameters, including absorber layer thickness, defect density, radiative recombination coefficient, surface recombination velocity and operating temperature was systematically investigated. To further predict the optimized power conversion efficiency(PCE), the dataset for the machine learning algorithm were generated by using the three input parameters such as absorber thickness, bulk defect density(Nt) and shallow acceptor density(NA) and one output variable PCE in SCAPS-1D. We have used machine-learning models such as Support vector Regression, Random Forest, and XGBoost to find suitable ML model for optimized PCE prediction. Among the evaluated ML models, XGBoost exhibited superior predictive performance and achieved R2 values of 98.96% for Sb2S3 and 97.55% for Sb2Se3 with low root-mean-square error. Eventually, the estimated PCE of 19.06%, Voc of 1.07 V, Jsc of 20.74% and FF of 85.68% respectively were obtained for Sb2S3/Sb2Se3 double absorber heterojunction solar cells.

Fabrication and characterization of mixed halide CH3NH3PbI3-xClx perovskite solar cells processed in ambient air

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Abstract: In recent years, metal halide perovskite (MHPs) have garnered considerable interest as solution processable materials for photovoltaic applications. Their power conversion efficiency has shown a remarkable rise, from ~4 % to ~27% by 2024. MHPs demonstrate excellent properties, including high absorption coefficients (~105 cm^{-1}), adequate carrier mobilities, extended carrier lifetimes (>1 μs), impressive carrier diffusion lengths (up to ~1 μm), and tunable bandgaps (~ 1.3 to 2.3 eV). Mixed halide perovskite solar cells based on lead (Pb) materials are the subject of this study's manufacture and characterization processes. Various techniques, such as SEM for surface morphology, PXRD for thin film crystallization, and quantum efficiency, and I-V measurement systems for J-V and EQE characteristics, were used to characterize fundamental and electronic properties of these materials. A $CH_3NH_3PbI_{3-x}Cl_x$ n-i-p perovskite solar cell was fabricated in ambient air. A fill factor (FF) of 0.52, an open circuit voltage (Voc) of 0.88 V, a short circuit current density (Jsc) of 13.6 mA/cm^2, and an efficiency of 6.19% were all recorded by the optimized device.

High-Voltage Symmetric Supercapacitors Based on Polypyrrole/WS2 Nanocomposite Electrodes

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Abstract: The use of aqueous electrolytes in supercapacitors (SCs) is typically constrained by a narrow operating voltage window, which results in a low energy density and limits their practical applicability. To address this limitation, the incorporation of organic electrolytes offers a promising approach to achieve higher operating voltages while maintaining excellent energy and power densities. In this work, we report the synthesis of polypyrrole (PPy)/tungsten disulfide (WS2) nanoparticle (NP) nanocomposites via a facile in-situ route with varying WS2 NP loadings (5 and 10 wt%) to elucidate their influence on electrochemical performance for high-voltage symmetric SCs employing an organic electrolyte. The structural and morphological characteristics of the prepared materials were systematically analyzed using various analytical techniques. The PPy/WS2 nanocomposite electrode containing 5 wt% of WS2 NP exhibits the optimal performance, delivering a specific capacitance of 231.7 F g-1 at a scan rate of 5 mV s-1 in 1 M LiClO4/ (propylene carbonate: ethylene carbonate: ethyl acetate electrolyte) as an organic electrolyte. The assembled symmetric SC device achieved a high operating voltage of 2.4 V, corresponding to an energy density of 31.63 Wh kg-1 and a power density of 1200 W kg-1 at a current density of 1 A g-1. Furthermore, the device retained 85% of its initial capacitance after 3000 charge–discharge cycles, demonstrating excellent cycling stability and superior energy storage capability. These findings highlight the potential of PPy/WS2 nanocomposite-based electrodes in realizing next-generation high-voltage supercapacitors with enhanced energy and power performance.

Influence of Partial Titanium Substitution in Crystal Structure and Ion-Transfer Kinetics of $Na_{0.67}CoO_2$-Based Cathodes for Sodium-Ion Batteries

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Abstract: The widespread utilization of renewable energy sources has spurred the development of efficient energy storage devices, with rechargeable batteries emerging as a cornerstone technology. Sodium-ion batteries (NIBs) are recognized as a viable substitute for lithium-ion batteries in large-scale energy storage applications. Layered Na_xCoO_2 have attracted considerable attention as a promising cathode material. The quest for structural stability paired with strong electrochemical functionality continues to reshape the structural design of layered transition-metal oxide with strategies such as doping surface engineering. In this work, Ti-substituted $Na_{0.67}Co_{1-x}Ti_xO_2$ (x = 0.00,0.025,0.05,0.075,0.10) cathode materials were prepared via a solid-state synthesis route. The influence of Ti incorporation on phase evolution, crystallinity, and sodium-ion storage behavior was examined. Structural framework and phase composition analyses were carried out using X-ray diffraction. EIS techniques were used to analyse their charge-transfer characteristics and other electrochemical performance.

Integrated Experimental and SCAPS-1D Simulation Study of Electrodeposited CdTe Thin Films on FTO for Efficient CdTe/CdS Solar Cells

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Abstract: In this work, the synthesis and comprehensive characterization of CdTe thin films as absorber layers for CdTe/CdS solar cells deposited on fluorine-doped tin oxide (FTO) substrates by the electrodeposition (ED) technique are presented. CdTe/CdS thin-film solar cells have attracted significant global attention due to their high absorption coefficient, near-optimal band gap, and ability to achieve efficient energy conversion over a broad solar spectrum. The ED technique offers advantages such as low cost, simplicity, scalability, and suitability for large-area fabrication, making it an attractive approach for CdTe thin-film growth. CdTe thin films were deposited onto FTO glass substrates (75 mm × 25 mm × 1 mm), and their structural and optical properties were systematically investigated. X-ray diffraction (XRD) analysis confirmed the formation of a polycrystalline cubic phase CdTe structure. Optical characterization using UV–Vis spectroscopy revealed a direct optical band gap of approximately 1.5 eV, estimated from Tauc's plot, which is close to the optimal value for photovoltaic applications. Photoluminescence (PL) and Fourier transform infrared (FTIR) spectroscopy were employed to evaluate defect states and bonding characteristics of the deposited films, indicating good optical quality suitable for absorber layer applications. In addition to experimental analysis, numerical simulation of the CdTe/CdS solar cell device was performed using SCAPS-1D software to investigate the influence of absorber layer parameters on device performance. The modeled device structure demonstrated improved photovoltaic performance metrics. The combined experimental and simulation study provides valuable insight into the material properties and device optimization of electrodeposited CdTe thin films, contributing to the advancement of cost-effective and high-performance CdTe/CdS thin-film solar cells.

Interfacial-Driven Structural, Optical and Dielectric Enhancement in PVA/SiC–ZnO Hybrid Nanocomposite Films for Optoelectronic Applications

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Abstract: Hybrid polyvinyl alcohol (PVA) nanocomposite films reinforced with Silicon carbide (SiC) and Zinc oxide (ZnO) nanofillers (1–3 wt%) were successfully fabricated via a solution-casting technique to tailor their structural, optical and dielectric properties. X-ray diffraction analysis confirmed the effective incorporation of hexagonal ZnO and cubic SiC phases within the semi-crystalline PVA matrix, with the ZnO crystallite size increasing from 20.1 nm to 46.6 nm as the filler concentration increased which further validated by Rietveld refinement data. Optical microscopy revealed a relatively homogeneous dispersion of SiC–ZnO nanofillers and a modified surface morphology, indicative of strong polymer–filler interfacial coupling. Fourier-transform infrared spectroscopy further corroborated the presence of interfacial interactions between PVA chains and the embedded nanofillers. Notably, the optical band gap exhibited a pronounced reduction from 4.8 eV for pristine PVA to 2.8 eV at 3 wt% loading, attributed to defect-assisted electronic transitions and enhanced interfacial polarization. Concurrently, the refractive index increased from 1.71 to 2.06 at 600 nm, accompanied by a significant enhancement in optical conductivity, reaching 4.31×10^{8} S/cm. These findings highlight the effectiveness of SiC–ZnO hybrid fillers in engineering multifunctional PVA-based nanocomposites, making them promising candidates for advanced optoelectronic and photonic applications.

Investigation of structural and optical properties of Ho-doped CdO thin films using sol-gel spin coating method

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Abstract: In this study, the undoped and Ho-doped CdO thin films derived via the sol-gel spin coating method on a glass substrate are investigated for the first time. X-ray diffraction spectra revealed the cubic structure and preferred orientation of the films. Scanning electron microscopy showed the morphology of CdO thin films, including their cauliflower and granular features. To measure the optical band gap of CdO thin films, absorption spectra were employed. In the visible region, the optical analysis showed a significant decrease in the optical bandgap energy and an increase in transmittance with increasing Ho doping.

Liquid Substrate Assisted Self-Assembly Of 2D-Organic Small Molecules for High Performance Transistors

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Abstract: The future of electronics is increasingly envisioned around organic and molecular materials that enable flexible, lightweight, and low-cost devices beyond conventional inorganic systems. Molecular electronics based on organic small molecules (OSMs) represents a key step in this transition. With Chhattisgarh moving toward semiconductor manufacturing, integrating such emerging technologies is essential for establishing a competitive and forward-looking semiconductor ecosystem in India. This study focuses on spatial self-assembly and crystallisation dynamics of 2,7-dioctyl[1]benzothieno[3,2-b][1]benzothiophene (C8BTBT), a model OSM semiconductor, over a liquid substrate for molecular based electronics. Variation in vapour pressure, evaporation rate, and resulting drying velocity significantly influences crystallization behaviour, thin-film morphology, and charge transport. These effects were systematically examined using optical microscopy, atomic force microscopy (AFM), transmission electron microscopy (TEM), and field-effect transistor characterizations. Temperature dependent measurements were further performed to understand evolution of charge transport behaviour across different regions of the film. The study demonstrates a simple and scalable liquid–air interface strategy that requires minimal sophisticated infrastructure and draws inspiration from traditional hydroponic and liquid-surface processing techniques to fabricate high-performance organic field-effect transistors (OFETs). This approach makes the methodology particularly suitable for India's evolving semiconductor ecosystem. The work offers a practical and locally adaptable pathway toward high-performance molecular electronics, supporting the broader vision of establishing advanced electronic materials research and manufacturing capabilities in Chhattisgarh.

n-Type Doping of Single-Layer Graphene Using Chemical-Free Synthesized WO_3 Nanoparticles for High-Performance Flexible Supercapacitors

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Abstract: With its highly tunable electronic properties, doped graphene is a promising platform for next-generation electronic and photonic devices. Achieving selective and reliable n-type doping, together with controlled modulation of the Dirac point, is critical for the realization of high-performance graphene-based devices. Here, we report a simple and effective approach to modulate the electronic properties of single-layer graphene (SLG) using chemical free synthesized tungsten trioxide (WO3) nanoparticles and demonstrate its application for flexible supercapacitors. The n-type doping of SLG using WO3 nanoparticles are systematically investigated by Raman spectroscopy, electrical transport measurements, and photoelectron spectroscopy (PES) measurements. The supercapacitor performance of the WO3 doped graphene electrodes are evaluated using cyclic voltammetry and galvanostatic charge-discharge measurements, exhibiting excellent capacitive performance. Furthermore, the flexible symmetric supercapacitor device fabricated using WO3 doped graphene electrodes demonstrates outstanding performance while maintaining high flexibility and electrochemical stability under various bending angles. Our study demonstrates an efficient and robust charge transfer doping strategy for graphene and its application in supercapacitors.

Photophysical Investigation of Carbon Dot Induced Luminescence Enhancement in Lanthanide Molecular Complex

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Abstract: Luminescent lanthanide metal complexes have shown great potential in optical application. A wide emission range of color arises from different lanthanide metal complexes. However, the insufficient luminescence of lanthanide complexes remains a potential bottleneck. Luminescent complexes synthesized with organic ligands show luminescence due to "antenna effect". However, low fluorescent quantum yield is perceived, which is inadequate for practical applications. Herein, we have synthesized TbIII2(L)2(NO3)2(dmf)2 complex, using a ligand obtained by 1:1 condensation of salicylaldehyde and 2-(2-Aminoethoxy)ethanol, H2L. Luminescence study revealed pure green light emission from the TbIIIL-complex with the quantum yield (QY) of~ 3.37%. The fluorescent emission was further enhanced by combining TbIIIL with N, S-doped carbon dots (CDs), derived from sulphilinamide and citric acid. An almost six-fold increase in luminescence QY of 21% has been noticed. Photoluminescence enhancement of ten-fold was rationalized by the energy harvesting capacity of CDs with consecutive energy transfer to the excited level of luminescent TbIII metal centres. This photophysical interaction of CD→TbIIIL to enhance luminescence was unexplored earlier. Current study conveys a simple and easy strategy to improve the luminescence property of the lanthanide complexes, by incorporation of CDs, to be implemented for optical, sensing and anti-counterfeiting applications.

Physical and Optical absorption studies on 60B2O3-10WO3-(30-x)Bi2O3-xBaO glasses

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Abstract: This study investigates the physical and optical absorption properties of 60B2O3-10WO3 -(30-x)Bi2O3-xBaO glasses with composition (where x =0, 5, 10, 15, 20, 25, and 30 mol%) via the conventional melt-quenching technique. The amorphous nature of the prepared glass samples is confirmed by X-ray diffraction studies. Archimedes' principle is used for the estimation of the density of the present glass samples. The density of the present glass samples decreases with BaO substitution. The optical cut-off wavelength (λc) shifted to the shorter wavelength, whereas the optical energy band gap (Eopt) is increasing, and the Urbach energy (ΔE) is also increasing with the substitution of BaO content.

Structured Light beams for Securing Information

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Abstract: The use of a Gaussian beam is not adequate for many optical applications. Light that is shaped spatially and temporally for a purpose is referred to as Structured light. Such an optical field with a custom-shaped wavefront fundamentally shapes the energy distribution and momentum flow in light. Light with spatial inhomogeneity can bring important applications in optical security. Specifically, polarization engineered structured beams have gained significant importance in the optical field due to their unique topological properties, which exhibit a topologically protected structure. This offered exciting possibilities for advanced applications in information storage and optical communication. The present work demonstrates the generation, characterization and application of polarization engineered structured beams for high-dimensional optical cryptography to secure information for unauthorized access. Experimental and simulation results are presented that verify the feasibility of the proposed system.

Sustainable Microwave Synthesis of Ni-Substituted $ZnCo_2O_4$ Nanospheres for High-Performance Photocatalysis and Supercapacitors

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Abstract: In this work, a sustainable green microwave-assisted synthesis route is demonstrated for the fabrication of nickel-doped zinc cobaltate nanospheres ($ZnCo_{2-x}Ni_xO_4$; x = 0.0, 0.02, 0.06, and 0.1) aimed at dual applications in photocatalysis and electrochemical energy storage. The microwave-assisted method enables uniform Ni incorporation and controlled nanosphere morphology under rapid, energy-efficient conditions without the need for harsh reaction environments.

Among the investigated compositions, the Ni-ZCO-0.1 sample exhibited the highest photocatalytic performance, achieving 96% degradation of methylene blue dye within 60 min under visible-light irradiation, which can be attributed to enhanced light absorption and improved charge separation efficiency. Structural analyses using X-ray diffraction , confirmed the successful substitution of Ni ions into the spinel lattice, while HR-TEM and EDX elemental mapping revealed porous nanospheres with homogeneous elemental distribution.

Optical studies based on UV-Vis diffuse reflectance spectroscopy and Tauc analysis indicated a reduced and optimized band gap, facilitating efficient visible-light-driven photocatalytic activity. Electrochemical evaluation showed that the Ni-ZCO-0.1 electrode delivered a high specific capacitance of 380 F g^{-1} in 1 M KOH electrolyte at a current density of 1 A g^{-1}. Furthermore, electrochemical impedance spectroscopy revealed lower charge-transfer resistance and equivalent series resistance, indicating improved charge-transfer kinetics. The electrode also demonstrated excellent cycling stability, retaining 96% of its initial capacitance after 3000 charge–discharge cycles. Overall, this study establishes that a microwave-assisted green synthesis strategy is an effective approach for developing multifunctional spinel nanomaterials with strong potential for environmental remediation and high-performance energy storage applications.

Synthesis and Thermoluminescence study of Ca2ZnSi2O7:Ce3+Dy3+ phosphor: A high sensitive phosphor for low UV Dosimetry applications.

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Abstract: A series of Calcium zinc silicate (Ca2ZnSi2O7) phosphors codoped with Ce^{3+} and Dy3+. ions were successfully synthesized via the traditional solid-state reaction method. The structural integrity and phase purity of the prepared phosphors were confirmed using the XRD technique. This study focuses on the synergistic effect of codoping, specifically investigating how the incorporation of Ce^{3+} ions facilitates an energy transfer process that significantly enhances the thermoluminescence (TL) intensity compared to the singly doped counterparts. Thermoluminescence experiments were conducted across various dopant concentrations and UV irradiation durations to optimize the emission response. The peak shape method was employed to calculate essential kinetic parameters, including activation energy (E), order of kinetics (b), and the frequency factor (s), and providing insight into the trapping centers within the host lattice. in a marked increase in peak height and area. The results demonstrate that the Ca2ZnSi2O7:Ce3+Dy3+. phosphor exhibits excellent linearity and stability for UV exposure. These findings suggest that the energy transfer-enhanced phosphor is a highly effective candidate for low-dose UV dosimetry applications.

Synthesis, Structural and Luminescence Properties of Nd3+ Doped La2SiO5

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Abstract: In this study, Nd3+ doped La2SiO5 synthesized using a solid-state method and different characterization techniques used for the sample analysis. X-ray diffraction (XRD) identified the phase purity of the sample, revealing a hexagonal crystal structure in the P 63/m space group. Fourier transform infrared (FTIR) spectroscopy confirms the composition presence of the host lattice. Scanning electron microscopy (SEM) revealed that the sample particles exhibited a morphology similar to a cauliflower surface. Photoluminescence (PL) analysis studies showed that samples excited at 980 nm and emission peak observed at 545 nm. CIE color coordinates show an intense green color. Therefore, the synthesized La2SiO5:Nd3+ phosphor can be used in green LED applications and display devices.

Keywords:: - XRD, FTIR, SEM, PL, crystal structure, morphology.

The impact of high-speed CMEs on geomagnetic storm during ascending phase of solar cycle 25

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Abstract: High-speed CMEs create most moderate to severe geomagnetic storms. Their importance is particularly obvious during the ascending phase of Solar Cycle 25, characterized by increased explosion and CME–CME interactions. This study investigates the influence of the velocity of CMEs and associated SW parameters on the intensity of geomagnetic storms during the ascending phase of SC 25 (2019–2023). We collect data on CME and SW plasma properties including speed, density, and magnetic field from observations near Earth. We then connect them to geomagnetic reactions by using storms that are classified by the Dst index. Multiple regression and correlation studies measure how high-speed ejecta and halo CMEs change the strength of storms. While density fluctuations can change the length of storms and make them stronger during the main phase, a recent study for 2021–2022 shows that a unit increase in solar-plasma speed leads to an average Dst decrease of about −0.25 nT. According to studies of halo CMEs in SC 25 rising phase, geoeffective halo events happen far faster than regular CMEs. Most halos that are linked to X-flares are faster than 1000 km s^{-1}, and a small but important number of them cause strong storms (Dst < −100 nT). The results show that during the rising phase of SC 25, the strength of CMEs, the direction of the magnetic field, density structure, and interactions all work together to control the speed of geomagnetic storms. These things are also important for making good predictions about space weather.

The Role of Solar Wind Plasma Parameters and IMF Turbulence in Driving Forbush Decreases of cosmic rays intensity during the Rising Phase of Solar Cycle 25

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Abstract: This paper investigates the relationship between the Forbush decrease of cosmic rays and solar parameters such as the interplanetary magnetic field and solar wind plasma parameters. A sudden decrease in the intensity of cosmic rays is called the Forbush decrease. For this, we obtained data from the Moscow Neutron Monitor, including ≥3% magnitude fds during the rising phase of solar cycle 25, and IMF and solar wind plasma parameters from NASA OMNIweb (.gov). This paper shows that the Fds of CRI are directly correlated with the magnitude increase of IMFs and solar wind plasma parameters. We found a positive correlation between the magnitude of Fds and the magnitude of IMFs and the peak value of IMF, with correlation coefficients of 0.69 and 0.65, respectively. All these Fds have been found to be associated with disturbances in solar wind plasma parameters. The magnitude of Fds, the magnitude and peak value of the associated disturbance in solar wind plasma velocity are positively correlated with correlation coefficients of 0.63 and 0.58. The magnitudes of Fds, the magnitude and peak value of the associated disturbance in solar wind plasma temperature are positively correlated with correlation coefficients of 0.55 and 0.43. The magnitude of Fds. the magnitude and peak value of the associated disturbance in solar wind plasma density are positively correlated with 0.57and 0.53. By finding out the causes of FdS in this paper, we can understand the importance of these parameters in space weather forecasting.

Keywords: Forbush decreases (Fds), Coronal Mass Ejections (CMEs), Interplanetary magnetic fields (IMF), Solar Wind (SW), Solar Cycle (SC), Cosmic Rays (CR)

Magnetically Coupled Intergranular Interactions and Synergistic Effects on Oxygen Evolution Reaction in FerrimagneticAntiferromagnetic Hetero-nanostructures

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Abstract: Designing of ferrimagnetic (FM)–antiferromagnetic (AFM) heterostructured NiFe2O4/LaFeO3 (NL) can act as an efficient electrocatalyst due to magnetically coupled intergranular interactions and synergistic effects, which can be explored as facile descriptors for deciphering the intrinsic field-free OER performance in alkaline medium. Studying OER under field-free conditions allows us to assess the natural electronic and magnetic interactions at the heterojunction interface, providing a baseline understanding of how FM–AFM coupling influences charge transfer and catalytic activity without the effects of externally applied magnetic fields. Magnetic investigations reveal that the saturation magnetization (Ms) decreases with increasing LaFeO3 (LFO) loading. While pristine NiFe2O4 exhibits a high Ms of 41.126 emu/g and the N7L3 (30% LaFeO3) composite shows a significantly lower Ms of 28.873 emu/g, along with very low effective coercivity (~7 Oe) compared to all other synthesized samples. The N8L2 (20% LaFeO3) heterostructure exhibits the highest squareness ratio (0.11), indicative of a multidomain structure and comparatively stronger magnetically coupled intergranular magnetostatic interactions among all the synthesized composite materials. N8L2 heterostructure material exhibiting an overpotential of 378 mV at a current density of 10 mA/cm2 for oxygen evolution reaction (OER) with a Tafel slope of 86 mV dec−1 in 1 M KOH electrolyte solution. N8L2 exhibited 93.49% faradaic efficiency and long-term stability for OER performance. The alignment of non-volatile spins and modified Fe–O–Ni superexchange pathways at the heterojunction interface alters the electronic structure and magnetic properties, thereby contributing to enhanced OER performance for N8L2 heterostructure material, indicating strong potential for electrochemical energy conversion technologies.

Veterinary Science, Animal Husbandry and Dairy Technology

Antimicrobial Resistance and ESBL Gene Profiling of Escherichia coli Isolated from Zoo Environments in Chhattisgarh

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Abstract: Antimicrobial resistance (AMR) in wildlife-associated environments represents a growing One Health concern due to the potential transmission of resistant bacteria among animals, humans, and the environment. This study investigated the prevalence, antimicrobial resistance patterns, and extended-spectrum β-lactamase (ESBL) gene profiles of Escherichia coli isolated from air and dust samples collected from three zoos in Chhattisgarh—Maitri Bagh Zoo (MBZ), Kanan Pendari Zoo (KPZ), and Nandan Van Zoo Jungle Safari (NVZ). A total of 180 samples were processed using selective culture and biochemical methods, yielding 102 presumptive E. coli isolates, all of which were confirmed by 16S rRNA gene PCR. Antimicrobial susceptibility testing against 14 antibiotics showed complete sensitivity to aztreonam (100%) and high sensitivity to imipenem (96.07%), while high resistance was observed to amoxyclav (93.13%) and tetracycline (83.30%). Location-wise variation in resistance patterns was evident, with MBZ showing the highest resistance to amoxyclav (97.56%), KPZ to tetracycline (88.23%), and NVZ to amoxyclav (92.59%). The Multiple Antibiotic Resistance (MAR) index ranged from 0.07 to 0.57, with 96.07% of isolates exhibiting MAR values >0.2, indicating exposure to high-risk antibiotic environments. Phenotypic analysis identified ESBL production in 35.29% of isolates, with the highest prevalence in NVZ (48.14%). Molecular characterization confirmed ESBL genes in 22.54% of isolates, predominantly blaTEM, followed by blaSHV and blaCTXM. The study highlights a significant burden of multidrug-resistant and ESBL-producing E. coli in zoo environments, identifying air and dust as potential reservoirs for AMR dissemination. Strengthened biosecurity measures, environmental surveillance, and prudent antimicrobial use are essential to mitigate emerging One Health risks in wildlife conservation settings.

Comparative studies on efficacy of various NSAIDs for analgesic management of long bone fracture in canine patients

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Abstract: The present study was carried out in 18 clinical cases of long bone fractures in dogs presented to Teaching Veterinary Clinical Complex, Padmanabhpur, Durg; randomly divided into three groups (n=6) to evaluate peri-operative analgesic efficacy following orthopaedic interventions. Anaesthesia in all dogs was achieved using atropine (0.04 mg/kg IM), dexmedetomidine (10 µg/kg IV), butorphanol (0.02 mg/kg IV) and ketamine for induction and maintenance. Dogs of group A received meloxicam (0.2 mg/kg IM), group B received carprofen (4 mg/kg SC) and group C received tolfenamic acid (4 mg/kg IM), administered 30 minutes prior to preanaesthesia and continued once daily for five days. Pain was assessed using the University of Melbourne Pain Scale (UMPS) on days 0, 1, 3 and 5 post-operatively.

Sedation onset and anaesthetic induction times were comparable among groups. Surgical duration, anaesthetic duration, ketamine requirement and quality of anaesthesia scores showed no significant intergroup differences. Recovery parameters were slightly prolonged in Group B. Hematological evaluation revealed transient decrease in haemoglobin, PCV and TEC, with stress-related neutrophilia, lymphopenia and elevated cortisol levels. Biochemical alterations included mild increase in serum glucose, BUN, creatinine, ALT and AST during early intervals.

Post-operative pain scores declined significantly in all groups. Group B demonstrated consistently lower UMPS scores, while Group C showed no significant improvement between day 3 and 5. However, on day 5, groups A and B had significantly lower pain score than Group C. Hence, it can be concluded that carprofen provided comparatively superior analgesic efficacy in canine orthopaedic patients.

Diagnostic and prognostic significance of serum IL-31 and total IgE and their correlation with disease severity in canine atopic dermatitis

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Abstract: Atopic Dermatitis (AD) is a prevalent skin disorder affecting both humans and animals. As companion animals, dogs often share the same environment as their owners and naturally develop skin disorders that are clinically and immunologically similar to human AD. In recent years, the incidence of AD has notably increased in both species. Canine atopic dermatitis (CAD) is a genetically predisposed, inflammatory and pruritic allergic skin disease directed against environmental allergens. The dynamic of CAD is multifactorial and complex interactions between genetics and environment are hypothesized, as in human AD. Evidence suggested that interleukin-31 (IL-31) was a potent pruritogenic cytokine that played a key role in pruritic skin conditions in humans. The objective of the present study was to assess the serum levels of Interleukin-31 and total Immunoglobulin (Ig) E in dogs affected with atopic dermatitis. The serum IL-31 and total IgE assays were performed using canine-specific commercial kits based on the Sandwich ELISA technique supplied by FineTest®, China. The present study demonstrated a significant elevation of serum IL-31 and total IgE concentrations in dogs affected with AD, supporting their central role in the immuno-pathogenesis of CAD. Interleukin-31 (IL-31) showed a strong and significant positive correlation with pruritus Visual Analog Score (pVAS), highlighting its key role in pruritic mechanisms of CAD. The lack of a significant correlation between serum IgE levels and clinical indices indicates that IgE reflects atopic status rather than current disease severity.

Evaluation of LaSota and Clone 30 Vaccine Efficacy against Circulating Genotype of Virulent Newcastle Disease Virus of Chicken in Chhattisgarh state

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Abstract: The present study was undertaken to evaluate the efficacy of LaSota and Clone 30 vaccines against circulating Newcastle disease virus (NDV) genotypes in chickens of Chhattisgarh. Newcastle Disease (ND) outbreaks were investigated in commercial broiler farms of Chhattisgarh. Oropharyngeal swabs, cloacal swabs and pooled tissue samples were collected from birds showing clinical signs and lesions suggestive of ND. Samples were processed for NDV isolation and characterization in embryonated chicken eggs. Genotyping was carried out by partial F-gene sequencing and phylogenetic analysis. Three broiler farms were detected positive for NDV. Mean death time, disease severity and pathology revealed velogenic NDV pathotypes in all the three farms. One velogenic isolate (RBF4TS_2025) was characterized as genotype XIII. Efficacy of LaSota and Clone 30 vaccines was evaluated against NDV genotype XIII through a cross-protection study in chicks. Protective HI titers were achieved in both LaSota and Clone 30 vaccinated groups. However, LaSota immunized NDV challenged birds showed higher mortality (50%) and moderate to severe clinical signs. In contrast, Clone 30 vaccination resulted in reduced mortality (33%) and milder disease. Complete cessation of virus shedding was noted in chickens of LaSota as well as Clone 30 immunized birds by day 14 post NDV challenge. Overall, Clone 30 vaccine provided superior but incomplete protection indicating the need for genotype-matched vaccines for effective ND control.

Polymeric Nanoparticle-Encapsulated Ginsenoside-Rich Panax ginseng Extract: In Vitro and In Vivo Acaricidal Assessment in Cattle Infested with Rhipicephalus microplus

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Abstract: Infestation with Rhipicephalus microplus poses a major challenge to cattle health, causing anaemia, reduced productivity, and transmission of haemoprotozoan diseases. The present study evaluated the in vitro and in vivo acaricidal efficacy of polymeric nanoparticle-encapsulated ginsenoside-rich Panax ginseng extract in naturally infested cattle. Ginsenoside-rich extract was prepared using hydroalcoholic extraction and formulated into PLGA-based nanoparticles by the emulsion–solvent evaporation method. The optimized formulation demonstrated suitable particle size, high encapsulation efficiency, and controlled drug release. In vitro acaricidal activity was assessed using the Larval Packet Test and Adult Immersion Test, where the nanoparticle formulation exhibited significantly higher mortality compared to the crude extract. In vivo evaluation was conducted in tick-infested cattle divided into control, deltamethrin-treated, crude extract-treated, and nanoparticle-treated groups for 21 days. The nanoparticle-treated group showed the greatest reduction in tick counts. Haematological analysis revealed significant improvement in haemoglobin, packed cell volume, and erythrocyte counts, along with normalization of leukocyte levels. Biochemical parameters, including AST, ALT, urea, and creatinine, were restored toward normal values without signs of systemic toxicity. Overall, the polymeric nanoparticle formulation enhanced the bioefficacy of ginsenoside extract and demonstrated superior acaricidal activity and systemic recovery compared to crude extract. The findings suggest that nanoencapsulated phytoconstituents represent a promising, safe, and sustainable alternative for tick control in cattle.

Keywords: Ticks, infestation, drug, chemical, herbal

Isolation, Characterization and Therapeutic Potential of Bacteriophage against MDR Escherichia coli

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Abstract: The present study aimed to isolate, characterize and evaluate the therapeutic potential of lytic bacteriophages against multidrug-resistant (MDR) Escherichia coli. Bacteriophages were successfully isolated from sewage samples and purified using the Double Agar Layer method yielding clear, well-defined plaques ranging from 2 to 7 mm in diameter indicative of obligately lytic activity. Phage titers ranged from 3.8×10^3 to 5.2×10^3 PFU/mL with Luria Bertani agar identified as the most suitable medium for optimal plaque development and phage propagation.

Transmission electron microscopy revealed morphologically diverse structurally intact tailed bacteriophages belonging to the families Myoviridae, Siphoviridae, and Podoviridae distinguished by characteristic capsid sizes and tail architectures. These observations were confirmed by family specific PCR amplification of conserved genetic markers (gp23, RNA polymerase and BoRG1) confirming taxonomic identity at the family level. Host range analysis demonstrated strong to moderate lytic activity against MDR E. coli while no lysis was observed against Klebsiella pneumoniae and Staphylococcus aureus confirming strict host specificity.

Phenotypic stability studies showed that the isolated bacteriophages retained high lytic activity at physiologically relevant temperatures (4°C to 37°C) and under neutral to mildly alkaline pH conditions (pH 7 - 9) indicating suitability for therapeutic application. In vivo therapeutic evaluation using chicken embryo lethality and murine infection models demonstrated that bacteriophage treatment alone or in combination with Trimethoprim Sulphamethoxazole significantly reduced mortality, achieved rapid bacterial clearance and supported normal growth. The study establishes that the sewage derived bacteriophages as stable, host-specific and highly effective biological agents against MDR E. coli supporting their potential use as a safe alternative or adjunct to conventional antibiotic therapy.

Phenotypic Characterization of Indigenous Pig of Bastar Region of Chhattisgarh

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Abstract: The aim of study was to evaluate phenotypic traits of indigenous pigs of Bastar region of Chhattisgarh. The study was done at three districts: Narayanpur, Bastar and Dantewada. Body weight, body measurement, coat colour, snout length, bristle size, ear orientation, hoof placement and top line of 255 local pigs were evaluated. The body weight (Kg) at different stages (birth, 3 months, 6 months, 9 months, 1 year, and adult) for males was 0.44±0.06, 6.77±0.17, 12.02±0.37, 18.03±0.44, 24.49±0.44, and 43.53±1.04, respectively. For females, it was 0.35±0.03, 6.65±0.22, 11.95±0.36, 18±0.34, 24.32±0.67, and 43.46±1.42, respectively. The chest girth, body length, height at withers, neck girth, and snout length for males were 81.46±1.53 cm, 74.1±1.5 cm, 51.88±0.65 cm, 57.7±1.25 cm, and 27.01±0.82 cm, respectively, and for females, 77.02±1.7 cm, 74.38±1.28 cm, 51.81±0.83 cm, 54.28±1.17 cm, and 28.3±0.76 cm, respectively. No significant differences were found between males and females in body weight and body measurements, except for neck girth. The predominant coat color was black (81%), black with white patches (12%), and white (7%). The straight snout was 82%, while slightly concave snout was 18%. Erect horizontal ears 64% and upward erect ears were 36%. Medium-sized bristles were 90%, while short and long bristles were 7% and 3%, respectively. Full hoof placement was 75% while partial hoof placement was 25%. A concave top line was 58%, while 42% had a straight top line. Pig rearing is an important source of income for local tribes of Bastar and this breed can be improved through selection to enhance the financial conditions of these people.

Studies on Gross Morphology and Histology of Proventriculus and Small intestine in Trigonella foenum-graecum Seed Extract Supplemented Broiler Chicken.

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Abstract: Inclusion of herbal supplement in the diet should be encouraged to enhance the bird's performance, improve feed utilization, maintain health and alleviate adverse effects of environmental stress in view to achieve economic and environmentally broiler chickens. The present experiment was conducted on 54 healthy broiler birds of Ross AP strain irrespective of their sex procured from M/s Indian Agro and Food Industries Ltd., Corporate House, Village–Indamara, ABIS, Rajnandgaon (C.G.). Birds were divided into four groups (eighteen birds in each group) – control (Group I), standard group (Group II) and fenugreek Supplemented group (Group III). Six birds from each group were sacrificed at 14, 28 and 42 days of age to record the gross morphology and morphometrical parameters. The representative samples of proventriculus, duodenum, jejunum and ileum were collected and fixed in 10% buffered formalin for 24-48 hours. The fixed tissue samples were processed in alcohol-xylene sequence, embedded and blocked in paraffin wax at 58˚C-60˚C melting point. The sections of 3–5-micron thickness were cut and stained by Hematoxylin and Eosin (H&E) for study of normal histological structure.

Live body weight was highly significant in comparison to group I and nonsignificant in comparison to group II at forty-two days of age. Recorded gross morphometrical parameters were maximum in group III followed by group II and group I in all age and groups of broiler birds. Highly significant effects of herbal supplementation were seen on, weight and volume of small intestine, weight and width of proventriculus duodenum, jejunum and ileum at forty two days of age. Only length of duodenum was highly significantly affected by herbal supplementation in comparison to group II and group I. Whereas, in proventriculus, jejunum and ileum length was significant in comparison to group I.

Tilapia Fish Skin as a Bioactive Biological Scaffold for Enhanced Full-thickness Wound Healing in Rabbits: A Comparative Study

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Abstract: The skin is the largest organ of the body accounting for more than 10 percent of total body weight and functions as a protective barrier involved in thermoregulation immunity sensation and metabolism. In veterinary practice wounds such as incisions, lacerations, burns , ulcers and tissue loss are frequently encountered. This study evaluated the efficacy of tilapia fish skin compared with bovine collagen particles and conventional povidone iodine dressing in rabbits. Eighteen New Zealand White rabbits were randomly divided into three groups with six animals in each group and two deep skin wounds measuring 1.5 by 1.5 centimetres were surgically created on each animal. Group I received conventional dressing group II received bovine collagen particles and group III received tilapia fish skin bandage. Healing was assessed by gross and morphometric evaluation percentage wound contraction haematological and biochemical parameters connective tissue biomarkers including hydroxyproline and hexosamine histomorphology histochemistry and total viable count. Sterilized tilapia skin achieved 99.85 percent microbial reduction confirming antimicrobial efficacy. Clinically the tilapia group showed faster wound contraction, earlier granulation tissue formation reduced inflammation and superior cosmetic healing. Histology revealed increased fibroblast proliferation, enhanced angiogenesis and well-organized dense collagen fibers. Elevated hydroxyproline and hexosamine levels indicated enhanced collagen synthesis and extracellular matrix remodelling. Haematological and biochemical values remained within physiological limits confirming safety. Overall tilapia fish skin proved to be a safe, cost effective and superior biological dressing compared with collagen particles and conventional therapy.

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