# ABSTRACT BOOK

# J&K SCIENCE CONGRESS 2026

29TH SEPTEMBER - 1ST OCTOBER, 2026

SCIENCE, INNOVATIONS & EMERGING TECHNOLOGIES FOR SUSTAINABLE AND VIKSIT J&K

JOINTLY ORGANIZED BY

ISLAMIC UNIVERSITY OF SCIENCE AND TECHNOLOGY, KASHMIR &
JAMMU AND KASHMIR SCIENCE TECHNOLOGY AND INNOVATION COUNCIL,
DEPARTMENT OF SCIENCE AND TECHNOLOGY, GOVERNMENT OF J&K

www.jksciencecongress2026.iust.ac.in

# J&K SCIENCE CONGRESS 2026

# ABSTRACT BOOK

# ABOUT IUST

Established in 2005, the Islamic University of Science and Technology (IUST) is a premier state university committed to advancing scientific research, technological innovation, interdisciplinary knowledge creation, and quality education. Recognized under Sections 2(f) and 12(B) of the UGC Act, 1956, and offering AICTE-approved technical programmes, IUST has emerged as a vibrant centre for academic excellence, research, innovation, and entrepreneurship. The Chancellor of the University is the Lieutenant Governor of the Union Territory of Jammu & Kashmir.

IUST has made significant strides in research and innovation, securing prestigious research grants, including the ₹10-crore PURSE project, aimed at strengthening cutting-edge research in areas such as Artificial Intelligence, Machine Learning, disruptive technologies, medical sciences, food technology, and social sciences. Its research and innovation ecosystem is further supported by a NABL-accredited Food Testing Laboratory, a growing intellectual property portfolio of over 113 patents, and a range of advanced innovation and prototyping facilities housed at the Centre for Innovation and Entrepreneurship Development (CIED-IUST).

These facilities include the AICTE IDEA Lab, Fab Lab, iFactory Lab (C4i4) established under the Ministry of Heavy Industries, Centre of Excellence UltraTech Lab, and FLIP/Ideation Lab. Collectively, these facilities provide students, researchers, innovators, and aspiring entrepreneurs with opportunities for ideation, design, prototyping, experimentation, product development, and technology-led innovation. The University has also been recognised for its strong focus on innovation and entrepreneurship. The Institutions Innovation Council (IIC), Ministry of Education, Government of India, has awarded CIED-IUST a 4-star rating in recognition of its efforts to promote innovation, entrepreneurship, and a culture of start-ups among students and youth. IUST has also been recognised under the ARIIA framework and has been placed in the 150–200 band of the NIRF rankings.

IUST began its academic journey with a modest foundation of five departments, offering one undergraduate, four postgraduate, and one certificate programme. Over the years, the University has steadily expanded its academic base by introducing a diverse range of undergraduate, postgraduate, diploma, and certificate programmes. At present, IUST offers 60 programmes and 30 doctoral programmes through 25 departments and 18 research centres. The University has also successfully implemented RUSA-II and the World Bank-sponsored TEQIP-III, and has been rated as a high-performing institution in the implementation of these initiatives. IUST also has two constituent Nursing Colleges and a Polytechnic College.

The University has established a strong network of academic, research, industry, and institutional partnerships, with over 50 MoUs signed with leading organisations. These include Ministry of Education to implement NATS, SIDBI, IIT Ropar, IIT Jammu, Central Council for Research in Unani Medicine (CCRUM), and Unani Drug Manufacturers' Association (UDMA), CSIR-NEIST, UPICON, and many international academic institutions.

IUST is well connected by road and is accessible via National Highway 44 (Srinagar–Jammu National Highway). The campus is approximately 30 kilometres from Srinagar International Airport, with taxi and other local transport options available for onward travel. The nearest railway station is Awantipora Railway Station, located approximately 2 kilometres from the University campus and easily accessible by local transport. The Kashmir Valley is currently connected by rail to Banihal, with further rail connectivity towards the Jammu region being developed.

**Website:** https://iust.ac.in/
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# ABOUT J&K SCIENCE CONGRESS 2026

**"Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K"**

**Dates:** 29 September – 1 October 2026
**Venue:** Islamic University of Science & Technology (IUST), Awantipora
**Organized by:** Islamic University of Science & Technology (IUST) in collaboration with J&K Science, Technology & Innovation Council (JKST&IC)

**Background**

Science, technology and innovation are increasingly central to economic growth, social development, environmental sustainability and effective public governance. For Jammu & Kashmir, the development of a strong and integrated scientific and innovation ecosystem is particularly significant for addressing regional priorities such as sustainable agriculture and horticulture, water security, climate resilience, healthcare, renewable energy, digital transformation, biodiversity conservation, entrepreneurship and employment generation.

In this context, the Jammu & Kashmir Science Congress 2026, under the theme **"Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K,"** provides a common platform for scientists, academicians, researchers, innovators, entrepreneurs, startups, students, industry representatives and policymakers to deliberate on emerging scientific opportunities and their application to the developmental priorities of Jammu & Kashmir.

**Rationale**

Jammu & Kashmir possesses considerable scientific and intellectual capacity across universities, research institutions, government departments and other knowledge institutions. There is, however, significant scope for strengthening institutional collaboration, interdisciplinary research, technology transfer, commercialization of research outcomes, startup development and engagement among academia, industry and government.

The Science Congress brings these stakeholders together and facilitates dialogue on the application of emerging technologies to local and regional challenges.

Particular emphasis is placed on:

- Science and technology for sustainable regional development;
- Innovation-driven solutions to J&K-specific challenges;
- Industry–academia–government collaboration;
- Promotion of startups and technology-based entrepreneurship;
- Participation and mentoring of young scientists and students;
- Climate-resilient and environmentally sustainable development; and
- Development of actionable recommendations for a Viksit J&K.

**Major Thematic Areas**

The Congress covers a broad interdisciplinary spectrum aligned with the developmental priorities of Jammu & Kashmir, including:

- Advanced Materials, Nanoscience and Sustainable Manufacturing
- Drug Discovery, Pharmaceutical Sciences and Healthcare Innovations
- Artificial Intelligence, Data Science and Emerging Digital Technologies
- Biotechnology, Life Sciences and Bioeconomy
- Sustainable Energy, Climate Action and Himalayan Ecosystem Resilience
- Water Security, Disaster Resilience and Earth System Sciences

- Science, Society and Sustainable Development
- Science Communication, Media and Public Engagement
- Innovation, Entrepreneurship and Future Economy
- Humanities, Ethics and Emerging Technologies
- Sustainable Food Processing
- Smart Engineering Systems, Sustainable Infrastructure and Industry 5.0
- Physical, Chemical and Mathematical Sciences for Future Technologies

**Participation**

The Congress brings together a diverse community of participants, including:

- Eminent scientists and researchers;
- Faculty members and research scholars;
- Young scientists and students;
- Innovators and startups;
- Industry representatives;
- Representatives of R&D institutions;
- Government departments and agencies; and
- Policymakers and other stakeholders.

The Congress is supported through collaboration among IUST, JKST&IC, DST, ANRF, universities, R&D organizations and industry.

**Strategic Relevance to Viksit J&K**

The Congress is aligned with the broader vision of building a knowledge-driven, innovative, sustainable and technology-enabled Jammu & Kashmir. It positions science and innovation as important instruments for regional development and connects the scientific capabilities available within J&K with emerging national and global technological opportunities.

The Congress particularly addresses sectors such as agriculture and horticulture, healthcare, renewable energy, water resources, tourism, environmental management, digital governance, manufacturing, biotechnology and entrepreneurship.

**Institutional Preparedness**

IUST hosts the Jammu & Kashmir Science Congress and provides conference facilities, seminar halls, exhibition spaces, digital infrastructure, accommodation arrangements and organizational capabilities required for hosting a scientific event of this scale. The University has an active research and innovation ecosystem, along with collaborations with universities, research institutions, government agencies and industry.

**Conclusion**

The Jammu & Kashmir Science Congress 2026 brings together the scientific, academic, entrepreneurial, industrial and policy communities to deliberate on the role of science, innovation and emerging technologies in shaping a sustainable and Viksit Jammu & Kashmir.

The Congress provides an opportunity to showcase the scientific strengths of the Union Territory, encourage young talent, strengthen research and innovation partnerships, promote technology-based entrepreneurship and develop actionable recommendations for science-led regional development.

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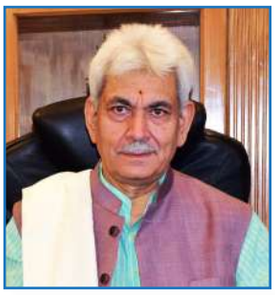


# MESSAGE

मनोज सिन्हा
उपराज्यपाल
जम्मू एवं कश्मीर
**MANOJ SINHA**
LIEUTENANT GOVERNOR
JAMMU & KASHMIR

सत्यमेव जयते

लोकभवन
जम्मू – 180001/श्रीनगर – 190001
LOK BHAVAN
JAMMU-180001/SRINAGAR-190001

I am happy to learn that the Islamic University of Science and Technology (IUST) is organizing the J&K Science Congress 2026 in collaboration with the Jammu and Kashmir Science, Technology & Innovation Council.

The Science Congress provides an important platform for academics, scientists, technologists, researchers and students to exchange ideas and deliberate upon emerging developments in science and technology and their implications for society. The rapid advancement of fields such as artificial intelligence, precision agriculture, biotechnology, genomics, nanotechnology, advanced healthcare technologies and other emerging domains is transforming the way we live, work and address the challenges of the future.

The Congress, being held on the theme "Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K," assumes particular significance in the context of our collective endeavour to harness science, technology and innovation for sustainable development and inclusive growth. The theme appropriately underscores the need to promote innovation, strengthen scientific capacities and leverage emerging technologies to address local challenges and create new opportunities for the people of Jammu and Kashmir.

I am confident that the Congress will contribute meaningfully to advancing the frontiers of science and technology and to building a more innovative, inclusive and knowledge-driven society, while contributing to the vision of a sustainable and Viksit Bharat & Viksit Jammu and Kashmir.

I extend my warm greetings and best wishes to the organisers for the success of the J&K Science Congress 2026 and wish all participants fruitful deliberations and an enriching exchange of ideas.

Manoj Sinha
**(Manoj Sinha)**

15th September, 2026
Srinagar

Phone : 0191-2560225, 2544537 (Jammu), 0194-2501616, 2501313 (Srinagar), Email : (i) lokbhavan-jk@gov.in (ii) pps-lgjk@jk.gov.in

सत्यमेव जयते

CHIEF MINISTER
Jammu & Kashmir

## MESSAGE

I am happy to learn that the Islamic University of Science and Technology (IUST), in collaboration with the Jammu and Kashmir Science, Technology & Innovation Council, is organizing the J&K Science Congress 2026. The theme of the Congress, "Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K," is highly relevant in the present era, when rapid advances in science and technology are reshaping societies and creating new opportunities as well as challenges. Emerging fields of science and technology have immense potential to contribute to sustainable development, improve the quality of life and strengthen the foundations of a knowledge-driven economy.

Jammu and Kashmir possesses rich natural resources as well as considerable intellectual and human capital. There is a strong need to create greater opportunities for our scientists, researchers, academicians, innovators and young students to engage with one another, exchange ideas and collaborate on solutions to the challenges and opportunities before Jammu and Kashmir. Programmes such as the J&K Science Congress can play an important role in creating such an ecosystem and in connecting our institutions and talent with wider scientific and technological networks.

It is encouraging to note that scientists, academicians, researchers and scholars from across the country are participating in the Congress and presenting their work across diverse disciplines and emerging areas. Such a gathering provides a valuable platform for the exchange of ideas, sharing of knowledge and fostering meaningful collaborations.

I am confident that the deliberations of the Congress will lead to valuable recommendations and actionable ideas that can help us harness scientific and technological advancements for sustainable economic growth, social progress and the overall development of Jammu and Kashmir.

I congratulate the organizers for their initiative and extend my best wishes to all the participants for fruitful deliberations and continued success in their academic and research pursuits.

I wish the J&K Science Congress 2026 all success and hope that its deliberations contribute meaningfully to strengthening the culture of scientific inquiry, innovation and research and to building a sustainable and Viksit Jammu and Kashmir.

**(Omar Abdullah)**

Place: Srinagar
Dated: 15th September 2026.

**Minister for**
**Health & Medical Education, School Education,**
**Higher Education and Social Welfare Department, J&K**
Tel : 0194-2506364, 2506365 (S) Tel : 0194-2547966, 2573428 (J)

*Sakeena Itoo*

D.O No : PS/HM/2026/S/54
Dated : 10-09-2026

## MESSAGE

I am delighted to learn that the Islamic University of Science and Technology (IUST) is organizing the **J&K Science Congress 2026** on the significant and contemporary theme, **"Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K."**

The rapid pace of scientific and technological advancement is transforming every sphere of human life and creating unprecedented opportunities for progress and development. In this rapidly changing landscape, it is particularly important to nurture scientific curiosity and innovation among our young minds and provide them with meaningful opportunities to understand, explore and engage with the world of science and technology.

Our young researchers, innovators, entrepreneurs and professionals will shape the Jammu and Kashmir of tomorrow. Their aspirations, curiosity and desire to learn must be supported by exposure to contemporary scientific developments, interaction with scientists and researchers, and access to opportunities that encourage experimentation, creativity and innovation. Institutions of learning have an important responsibility to provide young learners with the best possible environment and platforms to discover their potential and translate their ideas into meaningful outcomes. The participation and exposure of students in such forums can go a long way in cultivating scientific temper, broadening their horizons and inspiring them to pursue new areas of knowledge and innovation.

Conferences of this nature also facilitate the cross-fertilization of ideas and strengthen linkages among educational institutions, research organizations, industry and other stakeholders. Greater collaboration and interdisciplinary engagement can create new learning opportunities for our students and pave the way for innovative solutions to the developmental challenges of Jammu and Kashmir.

I am confident that the deliberations and interactions during the Congress will inspire our young learners and encourage them to look beyond conventional boundaries of knowledge. Providing our children and youth with such exposure and opportunities is an important investment in building a confident, capable and knowledge-driven generation that can contribute meaningfully to a sustainable and Viksit Jammu and Kashmir.

I congratulate the Vice Chancellor, Professor Shakil A. Romshoo and his entire team for organizing this important Congress and for selecting a theme of immense contemporary relevance for the **J&K Science Congress 2026**.

I extend my best wishes to all the participants, particularly the young scholars and students, for fruitful deliberations, enriching interactions and meaningful outcomes. I wish the Islamic University of Science and Technology (IUST) continued success in its academic, research, innovation and educational endeavours. **May the J&K Science Congress inspire young minds to dream, discover, innovate and contribute to building a brighter, more sustainable and Viksit Jammu and Kashmir.**

(Sakeena Itoo)
Minister

Satish Sharma

**Hon'ble Minister for Science & Technology,**
**Government of Jammu & Kashmir**

# MESSAGE

It gives me immense pleasure to extend my greetings and best wishes to all the participants, researchers, academicians, innovators, entrepreneurs, policymakers and young minds participating in the Jammu & Kashmir Science Congress 2026.

Science, technology and innovation are important drivers of economic growth, social progress and sustainable development. For Jammu & Kashmir, with its rich natural resources, diverse socio-economic landscape and talented young population, there is immense scope to harness scientific knowledge and technological advancements for addressing local challenges and creating new opportunities.

The Jammu & Kashmir Science Congress provides a valuable platform for bringing together the scientific and academic community, industry, government and the innovation ecosystem to exchange knowledge, share ideas and deliberate on emerging developments in science and technology. Such platforms are important for strengthening research collaborations and creating an enabling environment in which ideas and discoveries can be translated into practical solutions and meaningful outcomes for society.

Our focus must be on promoting research and innovation that responds to the needs and priorities of the people. Scientific advancements should not remain confined to laboratories; they must find application in areas such as agriculture, healthcare, environment, energy, food security, sustainable livelihoods and public service delivery. Greater collaboration between research institutions, industry and government can play a crucial role in taking promising innovations from the laboratory to the field and creating opportunities for entrepreneurship and employment.

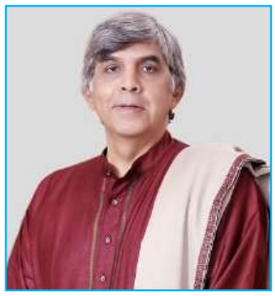
I am particularly confident that the young researchers, students and innovators of Jammu & Kashmir can play a significant role in shaping the region's scientific and technological future. By encouraging scientific temper, nurturing local talent and providing opportunities for innovation and enterprise, we can build a strong and inclusive knowledge ecosystem capable of contributing to the vision of a sustainable and Viksit Jammu & Kashmir.

I commend the Islamic University of Science and Technology and the Jammu & Kashmir Science, Technology & Innovation Council for organising this important Congress and for providing a platform for meaningful scientific dialogue and collaboration. I am confident that the deliberations will generate new ideas, strengthen partnerships and contribute to advancing the science, technology and innovation landscape of Jammu & Kashmir.

I extend my best wishes for the successful conduct of the Jammu & Kashmir Science Congress 2026 and wish the organisers and participants a fruitful and inspiring Congress.

Satish

**(Satish Sharma)**



# MESSAGE

It gives me immense pleasure to convey my greetings on the occasion of the J&K Science Congress 2026, being organised by the Islamic University of Science and Technology (IUST) in collaboration with the Jammu and Kashmir Science, Technology & Innovation Council.

The theme of the Congress, "Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K," is both timely and forward-looking. A sustainable and Viksit Jammu and Kashmir will require not only advances in scientific knowledge and technology, but also a culture of learning that encourages curiosity, experimentation, creativity and the courage to explore new possibilities. Science must increasingly become a means of understanding our surroundings and finding practical solutions to the challenges faced by our society.

Our institutions of higher learning have a particularly important role in this endeavour. Education cannot remain confined to classrooms and textbooks; it must provide learners opportunities to engage with real-world problems, work on projects, experiment with ideas and learn across disciplinary boundaries. Experiential and project-based learning, supported by blended modes of education and meaningful multidisciplinary engagement, can help nurture learners who are capable of thinking independently, collaborating across domains and applying knowledge in practical contexts.

The J&K Science Congress provides an important opportunity to bring these dimensions of learning, research and innovation together. By bringing scientists, academicians, researchers, students and innovators onto a common platform, the Congress can encourage dialogue across disciplines and inspire young learners to view science not merely as a body of knowledge, but as a dynamic process of inquiry, discovery and problem-solving.

I am confident that the deliberations at the Congress will generate new ideas, strengthen academic and institutional linkages and encourage greater engagement between knowledge institutions and the wider community. Such initiatives can play an important role in preparing our young people for an increasingly interdisciplinary, technology-enabled and rapidly changing world.

I congratulate the Islamic University of Science and Technology and the Jammu and Kashmir Science, Technology & Innovation Council for bringing together this important platform. I extend my best wishes to all the participants and hope that the Congress leads to meaningful conversations, new collaborations and ideas that can translate into tangible contributions towards a sustainable and Viksit Jammu and Kashmir.

May the J&K Science Congress inspire a culture of engaged learning, interdisciplinary inquiry and innovation, empowering our young minds to become active contributors to the development of Jammu and Kashmir.

**Prof. Dinesh Singh**
**Vice-Chairman,**
**Jammu & Kashmir Higher Education Council**

# Islamic University of Science & Technology Kashmir

**Prof. Shakil Ahmad Romshoo**
**Vice Chancellor**

## MESSAGE

It gives me immense pleasure to welcome the distinguished scientists, academicians, innovators, and young scholars to IUST and the J&K Science Congress 2026.

The theme of the Congress, "Science, Innovation and Emerging Technologies for Viksit Jammu & Kashmir," reflects an important aspiration: to place science, technology and innovation at the heart of Jammu and Kashmir's development. At a time when advances in artificial intelligence, biotechnology, geospatial technologies, advanced materials, clean energy and other emerging fields are rapidly transforming economies and societies, our universities must become developers of technologies and incubators of innovation.

Jammu and Kashmir presents both unique opportunities and distinctive challenges. Its Himalayan environment, rich natural capital and young human resource coexist with concerns relating to climate change, water and food security, natural hazards, ecosystem sustainability and employment. For addressing these challenges, we require interdisciplinary science, technological innovation and a strong interface between research, policy, industry and society. I hope this Congress will help identify areas where science can make a tangible difference to the developmental priorities of the region.

Universities have a particularly important responsibility in this transformation. Their role must extend beyond the award of degrees to generating new knowledge, translating research into solutions, nurturing innovation and entrepreneurship, and developing young people capable not only of seeking employment but also of creating opportunities for others. At IUST, this philosophy has guided our continuing transition towards a research-, innovation- and entrepreneurship-driven university, and the J&K Science Congress provides an important platform for advancing this larger vision across the region.

The presence of eminent researchers from diverse fields also provides an opportunity to transcend disciplinary and institutional boundaries. I therefore hope that the deliberations during the Congress lead not merely to an exchange of ideas, but to new research networks, academia-industry partnerships, technological solutions and actionable scientific inputs for policy and development. Our larger endeavour must be to build a region where scientific knowledge informs public policy, innovation drives enterprise and employment, technology improves lives, and our youth become active partners in building a sustainable and Viksit J&K.

I wish the Congress stimulating deliberations, productive collaborations and outcomes that endure well beyond these three days.

I also invite our distinguished guests and delegates from outside J&K to experience the extraordinary natural beauty, cultural heritage and warm hospitality of J&K during their stay.

**(Prof. Shakil Ahmad Romshoo)**
**Vice Chancellor/, IUST**
**Patron, J&K Science Congress 2026**

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**Website:** www.iust.ac.in. **Email:** vc@iust.ac.in.

**Babila Rakwal, IAS**

**Administrative Secretary**
**Science and Technology Department**
**Government of Jammu and Kashmir**
**Srinagar/Jammu**

## MESSAGE

It gives me immense pleasure to welcome all the distinguished scientists, academicians, researchers, scholars and delegates to the J&K Science Congress 2026, jointly organised by the Islamic University of Science and Technology (IUST) and the Jammu and Kashmir Science, Technology & Innovation Council (JKST&IC).

The Congress, centred on the theme "Science, Innovations and Emerging Technologies for Sustainable and Viksit J&K," assumes special significance in the present era of rapid scientific and technological transformation. The theme aptly reflects the need to harness scientific knowledge, innovation and emerging technologies to address developmental challenges, create new opportunities and advance sustainable and inclusive growth in Jammu and Kashmir. Emerging technologies are opening new avenues for economic growth, healthcare, agriculture, education, environmental sustainability and social development, while simultaneously presenting new challenges that require thoughtful consideration and responsible application.

The Science Congress provides a valuable forum for bringing together experts, researchers and young scholars from diverse disciplines to exchange ideas, share research findings and deliberate on contemporary scientific and technological issues. I am confident that the interactions during the Congress will encourage interdisciplinary collaboration, strengthen institutional linkages and foster innovative approaches to addressing the developmental challenges of Jammu and Kashmir.

The collaboration between JKST&IC and IUST in convening this Congress reflects our shared commitment to strengthening the scientific and innovation ecosystem of the Union Territory. IUST has demonstrated considerable potential in science and technology, research, innovation, education and skill development, and has emerged as an important institution for nurturing scientific talent and promoting knowledge-based initiatives. I am confident that this collaboration will provide further opportunities for meaningful engagement among institutions, researchers, innovators and other stakeholders.

I congratulate the Islamic University of Science and Technology and all members of the organising team for their efforts in convening this important scientific gathering. I extend my best wishes to all the participants for stimulating discussions, fruitful deliberations and a rewarding experience.

**(Babila Rakwal) IAS**

Jammu Office : 0191-2544735 Kashmir Office : 0194-2506065 Email : sandtdeptt.01@jk.gov.in

## MESSAGE

It gives me immense pleasure to welcome all the distinguished scientists, academicians, researchers, young scholars and delegates to the **J&K Science Congress 2026**. It is an honour to be associated with the organization of this important scientific gathering, which brings together the wider scientific community on a common platform for dialogue, exchange of ideas and collaboration.

The theme of the Congress, "Science, Innovation and Emerging Technologies for Viksit Jammu & Kashmir," is both timely and thought-provoking. The unprecedented pace of scientific and technological advancement is creating new possibilities for addressing complex challenges in healthcare, agriculture, environment, education, industry and other areas of human endeavour. At the same time, these developments call for informed debate on their responsible, ethical and sustainable application.

The Science Congress has been conceived as a forum for meaningful interaction among scientists, academicians, researchers, students and other stakeholders. I am confident that the presentations, discussions and interactions during the Congress will facilitate the exchange of knowledge, encourage interdisciplinary research and create new opportunities for institutional and collaborative partnerships.

I particularly hope that young researchers and students will benefit from the presence of eminent scientists and experts and find inspiration to pursue innovative research. Their enthusiasm, creativity and scientific curiosity are essential for building a strong research and innovation ecosystem in Jammu and Kashmir.

I take this opportunity to acknowledge and appreciate the support of the Jammu and Kashmir Science, Technology & Innovation Council, the participating institutions and all members of the organizing team whose collective efforts have made this Congress possible. I extend my sincere thanks to all the delegates and participants for their valuable contribution and hope that the Congress will lead to productive discussions, meaningful collaborations and actionable ideas.

***I wish all the participants a stimulating and enriching experience and the J&K Science Congress great success.***

**Dr. Aabid Hussain Shalla**
**Organizing Secretary**
**Jammu and Kashmir Science Congress 2026**
**Islamic University of Science and Technology**

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HONOURABLE LIEUTENANT GOVERNOR,
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HON'BLE VICE CHANCELLOR,
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COMMISSIONER SECRETARY, DEPT. OF S&T, J&K
DEPARTMENT OF S&T, J&K

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- **Prof. Sourav Pal (Former, (Former Director, CSIR-NCL, Pune; IISER Kolkata)**
- **Professor Srinivas Hotha, (IISER, Pune)**
- **Shri Saurabh Bhagat (Commissioner Secretary, Government of J&K)**
- **Shri Ram Niwas Sharma (Commissioner Secretary, Government of J&K)**
- **Ms. Babila Rakwal, (Commissioner Secretary, Government of J&K)**

# ESTEEMED SPEAKERS

# NAME AND TITLES OF ESTEEMED SPEAKERS

| S NO. | NAME | TITLE OF TALK | PHOTOGRAPH |
|---|---|---|---|
| 1. | **Prof. Vinod Kumar Gaur**<br>Former Director, NGRI; Honorary Emeritus Scientist, CSIR Fourth Paradigm Institute (CSIR-4PI) | **"Science Education and Research in the Age of Steep Transformations"** | |
| 2. | **Prof. Dinesh Singh**<br>Vice-Chairman, Jammu & Kashmir Higher Education Council (JKHEC); Former Vice-Chancellor, University of Delhi | **"The Relevance of Innovations In Science & Technology For Jammu & Kashmir** | |
| 3. | **Prof. Shakil Ahmad Romshoo**<br>Vice-Chancellor, Islamic University of Science and Technology (IUST) | **"Climate Change, Cryosphere Depletion and Emerging Glacial Hazards in the Upper Indus Basin: Implications for Water Security, Infrastructure and Settlements"** | |
| 4. | **Prof. Sourav Pal**<br>Prof. of Chemistry, Ashoka University; Former Director, IISER Kolkata and CSIR-NCL, Pune; Former Prof.IIT Bombay | **"Computational Thinking and Artificial Intelligence in shaping future of scientific research and teaching"** | |
| 5. | **Prof. Srinivas Hotha**<br>Prof. (HAG), Department of Chemistry, Indian Institute of Science Education and Research (IISER), Pune | **"From Discovery to Impact: Translating Research into Societal Benefits"** | |
| 6. | **Prof. Rajni Kant**<br>Vice-Chancellor, Usha Martin University, Ranchi | **"The Evolution of Small Molecule X-ray Crystallography Through the Prism of Time"** | |
| 7. | **Prof. Zahoor A. Shah,**<br>College of Pharmacy and Pharmaceutical Sciences, University of Toledo, Toledo, Ohio, USA | **"Breaking the Neuroinflammatory Cycle: Cofilin-Targeted Therapeutic Strategies for Stroke, Traumatic Brain Injury, Alzheimer's Disease, and Related Neurodegenerative Disorders"** | |
| 8. | **Prof. Sriram Chellappan,**<br>Prof.Bellini College of Artificial Intelligence, Cybersecurity and Computing, University of South Florida, USA | **"Smart-Trapping and AI Methods for Mosquito Vector Surveillance"** | |

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| 9. | **Prof. Mohammad Nayeem Teli,** Department of Computer Science, University of Maryland, College Park, Maryland, USA | **"Real-World AI: Robust, Efficient, and Responsible by Design"** | |
| 10. | **Prof. Kusum Deep, Emeritus** Prof.Department of Mathematics, Indian Institute of Technology Roorkee, India | **"Real Life Applications of Nature Inspired Optimization Techniques"** | |
| 11. | **Prof. Shalabh,** Department of Mathematics & Statistics, Indian Institute of Technology Kanpur, Kanpur, Uttar Pradesh, India | **"Role of data science and artificial Intelligence in e-gov for a Viksit J&K through grievance management"** | |
| 12. | **Prof. Sasanka Deka,** Department of Chemistry, University of Delhi, Delhi, India | **"Advanced nanomaterial-based catalysts for sustainable $H_2O_2$ and $H_2$ production"** | |
| 13. | **Prof. Bhaskar Biswas,** Department of Chemistry, University of North Bengal, Darjeeling, West Bengal, India | **"Self-Sacrificial NBU Metal-Organic Frameworks-Derived Amorphous Metal Phosphate/Carbon Electrocatalysts for Efficient Oxygen Evolution Activity"** | |
| 14. | **Prof. Syed Mudasir Andrabi,** Head, Division of Animal Biotechnology, SKUAST-K | **"From Scientific Discovery to Societal Impact: Translating Biomedical Innovation into Transformative Diagnostics, Therapeutics, and Vaccines"** | |
| 15. | **Prof. Naseer Iqbal** Department of Physics, University of Kashmir, Srinagar, Jammu and Kashmir, India | **"Astronomical sciences and its relations with society in reference to sustainable development"** | |
| 16. | **Prof. Shabir Ahmad Parah** Department of Electronics and Communication Engineering University of Kashmir, Srinagar, Jammu and Kashmir, India | **"The innovation economy: protecting ideas, powering progress"** | |

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| 17. | **Prof. Anzar Khuroo** Department of Botany, School of Biological Sciences, University of Kashmir, Srinagar, Jammu and Kashmir, India | **"Long-term Monitoring of the Himalayan Biodiversity in an Era of Anthropocene"** | |
| 18. | **Prof. Manzoor A. Malik** Department of Physics, School of Physical & Mathematical Sciences, University of Kashmir, Srinagar, Jammu and Kashmir, India. | **"Space Science Research at University of Kashmir: A Decadal Review"** | |
| 19. | **Prof. Babar Ahmad** Department of Mechanical Engineering, National Institute of Technology Srinagar, Jammu and Kashmir, India | **"MEMS: State of the Art in Microsystem Technologies"** | |
| 20. | **Prof. Kowsar Majid** Head, Department of Chemistry, National Institute of Technology Srinagar, Jammu and Kashmir, India | **"From Eutrophication to Circular Economy: Valorization of Dal Lake Macrophytes for Sustainable Agriculture and Ecological Restoration"** | |
| 21. | **Prof. Deshdeep Sahdev** Former Prof. IIT Kanpur | **"From Academia To Industry: A Remarkable Scientific Journey"** | |
| 22. | **Dr. Alok K. Mishra** Department of Biological Sciences & Bioengineering, IIT Kanpur | **"Functional Genomics for Understanding Tumor Immune Evasion and Therapeutic Target Discovery"** | |
| 23. | **Prof. Sandeep Arya** Department of Physics, University of Jammu, Jammu, Jammu and Kashmir, India | **"Self-charging Supercapacitors for Next-Generation Energy Storage"** | |
| 24. | **Prof Riyaz Ahmad Mir** Department of Biochemistry, All India Institute of Medical Sciences (AIIMS), New Delhi, India. | **"Harnessing ATOH1 Gene Therapy for Hair Cell Regeneration in age related hearing loss: A Translational Approach Using Human Inner Ear Tissues"** | |

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| 25. | **Prof. Subhash Thota**<br>Department of Physics, Indian Institute of Technology Guwahati, Guwahati, Assam, India | **"Field-Induced Spin-Flop State in Ferri/Antiferromagnetic Honeycomb-Lattices"** | |
| 26. | **Prof. Mohammad Amin Sofi**<br>Former Head Department of Mathematics, University of Kashmir, Srinagar, Jammu and Kashmir, India | **"Proof in mathematics - Getting to the heart of the problem"** | |
| 27. | **Dr. Ashutosh Yadav**<br>Department of Chemical Engineering, Indian Institute of Technology Jammu, Jammu, Jammu and Kashmir, India | **"Data-Driven Reduced-Order Modeling of Particle Drying from CFD-DEM Simulations in Fluidized-Bed Dryers"** | |
| 28. | **Dr. Rukhsan Ul Haq Wani**<br>CEO, Chinar Quantum Technologies, Kashmir, India. | **"Role of Entrepreneurship in innovation driven economies"** | |
| 29. | **Prof Ratul Baishya**<br>Department of Botany, University of Delhi, India. | **"Biodiversity Conservation, Environmental Sustainability and Climate Mitigation Through Community Led Redd+ Mechanism In The Himalayan Landscape"** | |
| 30. | **Prof. Vikas Sharma**<br>Head Division of Soil Science and Agril Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-J), India | **"Integrating Machine Learning, Remote Sensing and GIS for Enhanced Spatial Prediction"** | |
| 31. | **Dr. Akhilesh Mishra**<br>Scientist E, Department of Science & Technology, Ministry of Science & Technology, Government of India, Technology Bhavan, New Delhi, India | **"Indian Science Technology and innovation ecosystem for Economic growth of the country"** | |
| 32. | **Prof. Humayun Rashid**<br>Prof. of Practice, Department of Environment, Sustainability and Climate Change, (IUST), Jammu and Kashmir, India | **"Multi-Criteria Based Geospatial Analysis of Remotely Sensed Data for Determining Conservation Buffers around Dal-Nigeen Lake, Jammu & Kashmir, India"** | |

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| 34. | **Prof Tariq Ahmad Shosha** Prof. and Head, Department of Zoology, School of Biological Sciences, University of Kashmir, India | **"Invasive Species as Drivers of Biodiversity Loss: Threats, Challenges and Future Research"** | |
| 35. | **Prof. Manzoor Ahmad Mir** Department of Bioresources, School of Biological Sciences, University of Kashmir, Srinagar, India | **"Targeting Oncogenic p53 Mutants: Comprehensive study of p53-stabilizing Agents for Breast Cancer Treatment"** | |
| 36. | **Prasenjit Ghosh** Indian Institute of Science Education and Research (IISER) Pune, Pune, Maharashtra, India | **"Half-Heusler Alloys for Thermoelectric Applications: Insights from First-Principles Modelling"** | |
| 37. | **Dr Jugal Kishore Das,** Department of Life Sciences, Shiv Nadar Institution of Eminence, Delhi-NCR, India | **"Decoding Immune Regulation: Exploring the Tryptophan and Translational Signaling Pathways"** | |
| 38. | **Prof. Ashfaq** Department of Anatomy, Sher-i-Kashmir Institute of Medical Sciences (SKIMS), Srinagar, Jammu and Kashmir, India | **"Emerging Disease Trends and Prevention"** | |
| 39. | **Prof. Mohd Jamal Dar** Scientist-F, Pharmacology Division, CSIR–Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu, Jammu and Kashmir, India. | **"Prospects and challenges of targeting IGF1R for the development of novel anticancer Drugs"** | |
| 40. | **Dr Altaf Ahand Bhat** Coordinator CIRI, University of Kashmir | **"Epigenetic Dysregulation in Metabolic Diseases"** | |

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| 42. | **Prof. Syed Zameer Hussain** Associate Director Research SKUAST-K | **"Tech Walnut: Smart Automation-Based Walnut Industry"** | |
| 43. | **Prof. Sunil Kumar Sharma,** Department of Chemistry, University of Delhi, India | **"Drug Discovery, Pharmaceutical Sciences and Healthcare Innovations"** | |
| 44. | **Prof. Youssef Habibi** Director, SUSMAT, Morroco | **"Sustainable Materials from Waste: A green Chemistry Approach"** | |
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| 46. | **Dr Izhar Uddin** Department of Mathematics, Jamia Millia Islamia, New Delhi, India | **"On Fixed Point Iterations and their Applications"** | |
| 47. | **Prof. Ajaz Dar** Department of Chemistry, University of Kashmir, Srinagar, Jammu and Kashmir, India | **"Beyond Conventional Hydrogels: Designing adaptive and multifunctional soft materials for sustainable industrial, biomedical and environmental applications"** | |
| 48. | **Dr. Veerla Swarnalatha** University of North Texas, Department of Mechanical Engineering, Denton, Texas, USA | **"Multiphysics Simulation of LGS Cantilever for LiDAR Beam Steering Applications"** | |

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| 50. | **Prof. Shakeel Ahmed**<br>Consultant, Islamic University of Science & Technology,<br>Chief Scientist (Retrd), CSIR-NGRI, Hyderabad | **"Conjunctive use of Surface and Ground Water: A sustainable solution for disaster resilience and secure water management in mountainous regions"** | |
| 51. | **Dr. Suhail Rasool**<br>Vice President/ Director Neurology and Neurodegenerative Diseases Division<br>San Francisco CA USA | **"Development of Therapeutic Modalities for Treating Neurodegenerative Diseases"** | |
| 52. | **Prof. Parvez Ahmad Mir**<br>Dean School of Business Studies, IUST | **"Renaissance Of Entrepreneurship Culture in J&K: Challenges and Opportunities"** | |
| 53. | **Prof. Kaisar Javeed**<br>Controller Examination, Central University of Kashmir | **"The Invisible War for Viksit J&K: Securing Jammu & Kashmir's Future with Science, Innovation and Cyber Resilience"** | |
| 54. | **Prof. Javaid Iqbal**<br>Head Department of Computer Science, Kashmir University | **"Markovian Models in AI"** | |
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| 58. | **Dr Imtiyaz Yaseen**<br>Scientist D CSIR Institute of Microbiology (CSIT-IMTECH) | **"Epigenetic mechanisms in anti-fungal drug resistance"** | |
| 59. | **Prof Farooq Ahmad Masoodi**<br>Former Head Food Technology and former Dean Research, Kashmir University, | **"Bioprocessing Himalayan Cruciferous Vegetables: Phytochemicals, Microbes and the Pathway to Functional Beverages"** | |
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| 61. | **Dr Asif Bashir Shikari,**<br>Associate Prof.Genetics & Plant Breeding, MRCFC, Khudwani SKUAST-Kashmir | **"Decoding Kashmir Rice: From Indigenous Diversity to Genomics-Driven Breeding"** | |

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# Temperature-regulated structural evolution in biomass-derived carbon for binder-free supercapacitors

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**Abstract**
The growing demand for sustainable and efficient energy storage has driven the development of low-cost electrode materials. Biomass-derived carbonaceous materials are promising due to their abundance, low cost, porous structure, and high surface area, making them suitable for supercapacitors. Supercapacitors offer high power density and excellent cycling stability for rapid charge–discharge applications. However, conventional carbonization methods often involve high costs and may generate fly ash and harmful gases, highlighting the need for more sustainable production approachesIn recent years, significant efforts have focused on developing scalable porous carbon materials. In this work, porous carbon was synthesized from fungal biomass through temperature-controlled carbonization under an argon atmosphere at 600, 800, and 1000 °C to study the effect of pyrolysis temperature on structural and electrochemical properties. The materials were characterized using XRD, Raman, SEM, and TEM, while their electrochemical performance was evaluated by CV, GCD, and EIS using a binder-free approach in alkaline media. The optimized C-800 exhibited a high specific capacitance of 429 F/g at 5 mV/s, along with excellent energy and power density. A symmetric device fabricated using C-800 successfully powered a red LED for 2 minutes after only 30 seconds of charging, demonstrating its potential as a high-performance supercapacitor electrode.

**Keywords:** Biomass-derived carbon; supercapacitor; binder-free electrode; energy storage.

# Tailoring the Structural, Optical and Electrical Properties of Zn-Modified Nano-Structured Se–Sn–Al Thin Films for Optoelectronic Applications

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**Abstract**

Engineering the properties of chalcogenide thin films through compositional modification provides an effective pathway for developing advanced materials for optoelectronic technologies. In the present work, Zn-doped $Se_{90-x}Sn_5Al_5Zn_x$ (x = 0, 5, 10, 15) nano-structured thin films were fabricated by thermal evaporation using melt-quenched bulk alloys as precursor materials. The influence of Zn incorporation on the structural, optical, and electrical characteristics of the films was systematically investigated. X-ray diffraction analysis revealed a gradual transition from an amorphous matrix toward enhanced nanocrystalline ordering with increasing Zn concentration, accompanied by larger crystallite size and reduced lattice imperfections. Surface morphology and elemental composition examined through field-emission scanning electron microscopy and energy-dispersive X-ray spectroscopy confirmed uniform film formation and successful incorporation of Zn without detectable impurities. Optical investigations demonstrated a progressive increase in the optical band gap from 2.05 to 2.73 eV, while the Urbach energy decreased from 0.110 to 0.097 eV, indicating reduced structural disorder and improved network ordering. Temperature-dependent DC electrical measurements exhibited thermally activated Arrhenius behavior with a systematic enhancement in electrical conductivity following Zn addition. The combined structural refinement, improved optical transparency, and enhanced charge transport demonstrate the significant role of Zn as a network modifier in Se–Sn–Al thin films. These findings highlight the potential of the developed nano-structured chalcogenide system for future applications in photodetectors, infrared sensors, optical switching devices, and other emerging optoelectronic technologies.

**Keywords:** Thin Films; Electrical Conductivity; Optical Band Gap; Optoelectronic Devices; Zinc Doping

# Mechanistic Insights into Long-Persistent Luminescence of $Tb^{3+}$ activated $Sr_2Ga_2GeO_7$ for Latent Fingerprint Visualization and Anti-Counterfeiting

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**Abstract**

A series of $Sr_{2-x}Ga_2GeO_7:_xTb^{3+}$ (0 mol% ≤ x ≤ 10 mol%) phosphors exhibiting long-persistent luminescence were successfully synthesized via a high-temperature solid-state reaction route. The structural properties and phase purity were confirmed through X-ray powder diffraction followed by Rietveld refinement analysis. The diffuse reflectance spectra indicated that the prepared phosphor possesses a direct bandgap of approximately 4.99 eV. The photoluminescence excitation spectra revealed broad absorption bands corresponding to the $4f^8 \rightarrow 4f^75d^1$ transitions of $Tb^{3+}$ ions, along with several sharp features attributed to 4f-4f transitions. For both the series, emission spectra exhibited characteristic transitions from the excited states ($^5D_3/^5D_4$) to the ground-state levels ($^7F_j$), with the dominant $^5D_4 \rightarrow {}^7F_5$ transition producing intense green emission. A concentration quenching effect was observed at higher dopant levels, mainly due to radiative reabsorption processes. The phosphor also demonstrated excellent thermal stability, maintaining its luminescent properties up to 675 K. Kinetic and afterglow analyses revealed a persistent luminescence lifetime of approximately 7000 s, with a visible afterglow persisting for about 100 s. Thermoluminescence studies further indicated that, in addition to intrinsic defects, $Tb^{3+}$ doping introduced interstitial and vacancy-related trap states, which played a vital role in enhancing the afterglow behavior. Overall, the developed phosphor series shows great potential for practical applications in latent fingerprint visualization and anticounterfeiting technologies, owing to its intense, stable, and long-lasting luminescent performance.

**Keywords:**

Persistent Luminescence; Thermoluminescence; Trap depth; Fingerprints; Anticounter printing

# Biologically Sensitive FETs: Design Considerations from Simulation, Modeling, and Fabrication Perspective

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**Abstract**

Biologically sensitive Field-effect transistor (BioFET)-based enables label-free, electrical detection of biomolecular species — including DNA, RNA, and proteins — by exploiting the intrinsic electric charge of the analyte to modulate channel conductance. In the BioFET architecture, the metal gate of a conventional MOSFET is substituted with a receptor-functionalized dielectric interface, wherein biomolecular immobilization perturbs the surface potential and threshold voltage via field-effect coupling. This work reports a systematic device design framework integrating closed-form analytical modeling, TCAD-based numerical simulation, and CMOS-compatible fabrication for the development of high-performance BioFET architectures. Two-dimensional Poisson-based analytical formulations for surface potential and drain current are derived for dielectric-modulated BioFET structures under threshold-voltage and surface-potential-based formalisms, and subsequently validated against calibrated device simulations across multiple biomolecule dielectric permittivities and charge densities. To mitigate thermal budget and process complexity inherent to conventional junction-based CMOS flows, junctionless and virtually-doped channel architectures were investigated as low-thermal-budget alternatives, with heterogeneous material integration (SiGe, ZnO, and AlGaN/GaN) explored to enhance sensitivity and selectivity. Planar junctionless polycrystalline-silicon BioFETs were fabricated via in-situ doping and characterized for pH sensitivity, exhibiting a uniform doping profile, hysteresis-free transfer characteristics, and negligible interface trap-induced degradation. Operation in the subthreshold regime yielded a maximum drain current sensitivity ($\Delta I_D/I_D$) of 92.2% at pH 11.2, with an average subthreshold slope-derived linearity of 18.49 across the tested pH range, outperforming conventional inversion-mode operation. Complementary studies on charge-plasma tunnel-FET embedded-cavity BioFETs, ZnO thin-film back-gated multianalyte sensors, and AlGaN/GaN HEMT-based biosensing platforms further substantiate the versatility of the proposed methodology. These findings establish junctionless and dielectric-modulated FET architectures as promising candidates for CMOS-integrable, high-sensitivity biosensing platforms, with future efforts directed toward ZnO nanowire multianalyte sensors, refined compact modeling of fabricated pH sensors, and surface-chemistry-driven optimization of hybrid biosensor figures of merit.

**Keywords:** BioFET; junctionless transistor; dielectric modulation; pH sensing; biosensor

# Tungsten-Alloyed Zinc Coatings for Corrosion and Hydrogen Permeation Resistance in Hydrogen Energy Infrastructure

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**Abstract**

Hydrogen is emerging as an important energy carrier for low-carbon energy systems, with its large-scale storage and transportation requiring materials capable of resisting hydrogen ingress and associated degradation. In this work, electrodeposited zinc–tungsten (Zn–W) coatings were developed on mild steel to investigate their potential as protective materials for hydrogen-related energy infrastructure. Zn–W coatings with different tungsten contents were produced through an aqueous electrodeposition process, and their corrosion resistance, hydrogen permeation behavior, and microstructural characteristics were systematically evaluated.

The incorporation of tungsten significantly influenced the phase constitution, lattice strain, morphology, and hydrogen transport characteristics of the coatings. Among the investigated compositions, the Zn–W coating containing approximately 4 wt.% tungsten exhibited the most favorable combination of corrosion resistance and hydrogen permeation resistance. Its corrosion current density decreased to 4.9 μA $cm^{-2}$ compared with 28.1 μA $cm^{-2}$ for pristine zinc, while the hydrogen permeation current decreased to 0.71 μA $cm^{-2}$. This corresponds to a hydrogen barrier efficiency of approximately 95.9%. Atom probe tomography revealed a predominantly uniform tungsten distribution within the zinc matrix, accompanied by limited tungsten-enriched regions. In contrast, higher tungsten incorporation resulted in the formation of W-rich clusters, increased lattice strain, and deterioration of both corrosion and hydrogen permeation resistance.

The results demonstrate that controlled alloying and microstructural engineering of electrodeposited Zn–W coatings can provide an effective strategy for developing multifunctional protective materials for hydrogen storage and transportation systems, where simultaneous resistance to corrosion and hydrogen ingress is essential.

**Keywords:** Corrosion; Hydrogen Energy; Hydrogen Permeation; Metallic Coatings; Protective Coatings

# Dysprosium and Terbium Substitution in $NaCaPO_4$ Orthophosphate: Structural Stability and Tunable White-Light Photoluminescence

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**Abstract**
Phosphor-converted white LEDs remain central to next-generation solid-state lighting, but their performance is often constrained by inadequate thermal robustness and narrow color-tuning windows in conventional phosphor hosts. Alkali–alkaline-earth orthophosphates of the general formula XIYIIPO₄ have drawn attention as candidate hosts owing to their structural rigidity and favorable UV absorption characteristics. In this work, $NaCaPO_4$ was selected as a host lattice and separately activated with trivalent dysprosium and terbium ions via conventional high-temperature solid-state synthesis. Phase purity and lattice integrity across the doping series were verified by X-ray diffraction and Rietveld refinement, confirming successful incorporation of both dopants without measurable structural distortion. Elemental mapping and microscopy further verified uniform dopant distribution and consistent particle morphology. Photoluminescence measurements revealed characteristic blue–yellow emission from the $Dy^{3+}$-activated series and green-dominant multi-band emission from the $Tb^{3+}$-activated series, with luminescence intensity increasing with dopant concentration up to an optimum before concentration quenching set in. Energy-transfer analysis using critical-distance and Dexter-type treatments indicated that quenching in both systems is governed primarily by dipole–dipole multipolar interactions rather than exchange coupling. Variable-temperature measurements showed that emission intensity was well retained across an extended thermal range, pointing to good resistance to thermal quenching, with activation energies extracted via Arrhenius analysis. Chromaticity evaluation placed the optimized compositions within technologically useful white-light regions, with the $Dy^{3+}$-doped composition yielding a warm-white emission and the $Tb^{3+}$-doped composition yielding a cooler, high-purity yellowish-green emission. Taken together, these results identify $NaCaPO_4$ as a versatile, thermally stable host capable of producing rare-earth-tunable emission colors relevant to solid-state lighting applications.

**Keywords:** Orthophosphate phosphors; Rare-earth doping; Concentration quenching; Thermal stability; White-light emission

# Colossal dielectric, relaxor ferroelectric and non-Debye type relaxation phenomena in Bi doped $NdCrO_3$ perovskites

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## Abstract

$Nd_{1-x}Bi_xCrO_3$ (x=0.00, 0.03, 0.05, and 0.07) has been successfully prepared via conventional solid-state reaction method using $Nd_2O_3$, $Bi_2O_3$, and $Cr_2O_3$ of high purity (~99.99 % ; Sigma Aldrich), and labelled as NCO1, NCO2, NCO3, and NCO4 respectively. X-ray diffraction (XRD) data is analyzed using rietveld refinement and the results show orthorhombic structure with pbnm space group. Temperature-dependent and frequency-dependent dielectric measurements were employed in the temperature range of 90 K-410 K and the frequency range of 1 kHz-100 kHz respectively. It is found that the value of dielectric constant $\varepsilon' > 10^3$ at room temperature, suggesting the colossal dielectric behaviour rendering it a potential candidate for energy storage purposes. From the dielectric data analysis it is found that the temperature corresponding to the maximum value of dielectric constant $T_m$, shifts towards higher value with increase in frequency indicating relaxor ferroelectric nature. The AC conductivity ($\sigma_{AC}$) analysis shows hopping mechanism governing translation motion in all the samples. The value of $\sigma_{AC}$ increases as the Bi content increases due to increase in polaron generation. To further interpret the nature of thermally activated relaxation processes, the activation energy ($E_a$) values are obtained from the Arrhenius equation which reveals the non-Debye type of relaxation in all these samples. To study the effect of grain, grain boundary, and electrodes on the capacitance, resistance, and impedance of the material, complex impedance analysis (Cole-Cole plot) is performed using Electrochemical Impedance Spectroscopy (EIS) software. The depressed semi-circles and the position of centers of these semi-circles below the real axis give evidences about the non-Debye type of relaxation and the distributed relaxation processes in these samples.

**Keywords:** Rietveld refinement, Colossal dielectric, Relaxor ferroelectric, and AC conductivity

# Ion-Beam Induced Ferromagnetism and Electronic Structure Modification in $LaMnO_3$ Thin Film

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**Abstract**

Perovskite manganites exhibit diverse electronic and magnetic properties, including mixed-valence states, ferromagnetic/antiferromagnetic ordering, metal-insulator transitions, and colossal magnetoresistance (CMR), making them promising materials for applications in magnetic storage, read heads, and sensors. In this work, $LaMnO_3$ (LMO) thin films were deposited on $LaAlO_3$ substrates by pulsed laser deposition (PLD) at UGC-DAE CSR, Indore, and subsequently irradiated with 100 MeV $Ag^{+8}$ swift heavy ions (SHI) at a fluence of $5 \times 10^{12}$ ions $cm^{-2}$ at IUAC, New Delhi. The pristine LMO thin film exhibits an orthorhombic structure, while magnetic measurements reveal predominantly antiferromagnetic behaviour. Soft X-ray absorption spectroscopy (XAS) confirms the coexistence of $Mn^{2+}$ and $Mn^{3+}$ oxidation states in the pristine film. Following SHI irradiation, structural and spectroscopic modifications indicate the generation of oxygen vacancies, accompanied by a shift of the XAS features towards lower energies. Notably, magnetic measurements reveal the emergence of weak ferromagnetism in the irradiated LMO film. This irradiation-induced magnetic transformation from antiferromagnetic to weak ferromagnetic behaviour highlights the significant role of oxygen stoichiometry and defect engineering in tailoring the magnetic properties of LMO thin films.

**Keywords:** Thin Film; SHI Irradiation; Oxygen Vacancies; Ferromagnetism; XAS

# Engineering Substituent-Driven Molecular Coassemblies Enabling Dynamic Heteroaggregation for Color-Tunable Emission and Photoluminescent Security Ink Systems for Anti-Counterfeiting

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**Abstract**

Aggregation-induced emission luminogens (AIEgens) have emerged as a pivotal class of functional materials with broad applications in optoelectronics, sensing, and biomedicine, owing to their unique ability to exhibit enhanced emission in the aggregated state. Extending AIE characteristics from single-component systems to multicomponent assemblies offers a powerful approach to fine-tune photophysical properties through synergistic intermolecular interactions, such as hydrogen bonding, π–π stacking, and charge transfer. However, this transition also introduces substantial complexity, as the interplay of multiple components can lead to diverse and often unpredictable aggregation pathways. Consequently, establishing a clear understanding of how specific molecular arrangements and packing motifs govern macroscopic emission behavior remains a central challenge in the design of functional luminescent materials. Herein, we report the construction of three molecular cocrystals via the coassembly of sulfonic acid-based proton donors and 1,10-phenanthroline-derived pyridine proton acceptors. The cocrystallization process enables precise modulation of the dynamic aggregation pathway by adjusting the THF/$H_2O$ ratio, thereby directing molecular packing and intermolecular interactions. This study highlights how subtle variations in cocrystal architecture govern emission behavior, offering insights into the rational design of tunable luminescent molecular cocrystals. These findings provide valuable insights into structure–property correlations in multicomponent AIE systems and offer a rational framework for designing advanced luminescent cocrystals with tunable properties. The resulting tunable emissions also demonstrate potential for Photoluminescent anti-counterfeiting applications.

**Keywords:** Heteroaggregation, Anti-Counterfeiting, Co-crystals, AIEE, CIEE.

# Comparative Study of Microwave and Hydrothermal Routes for $Cu_2ZnSnS_4$ Nanoparticles in MB Dye Degradation

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**Abstract**

This work explores the structural, morphological, and optical characteristics of $Cu_2ZnSnS_4$ (CZTS) nanoparticles, a visible-light-active material, synthesized via two distinct routes: hydrothermal and microwave-assisted methods. The hydrothermal synthesis was conducted at 180 °C for 24 hours, while the microwave method employed a rapid 10-minute irradiation. Characterization techniques including X-ray diffraction (XRD) and Raman, confirmed the formation of the kesterite phase in both cases, with notable differences in crystallite size; approximately 27 nm for the hydrothermal method and around 4 nm for the microwave-assisted route. Elemental analysis via energy dispersive X-ray (EDX) verified the presence of Cu, Zn, Sn, and S in near-stoichiometric proportions. Field emission scanning electron (FESEM) images revealed distinct morphological features resulting from the different synthesis strategies. UV-Vis spectroscopy was used to estimate bandgaps and absorption coefficients, while photoluminescence (PL) studies provided insight into optical transitions. The presence of optical bandgap in the visible region makes CZTS suitable material for the degradation of methylene blue dye.

**Keywords**: Hydrothermal; Microwave; Crystallite size; Optical band-gap; Photocatalysis.

# Synthesis, Structural Characterization and Photoluminescence Properties of a Novel Eu(3+)–Gd(3+) Bimetallic Metal–Organic Framework

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**Abstract**

A novel Eu–Gd bimetallic metal–organic framework (MOF) was synthesized via a hydrothermal route using tartaric acid as a bridging linker, combining the strong luminescent properties of Eu(III) with the structural/magnetic versatility of Gd(III). Powder X-ray diffraction (PXRD) confirmed the formation of a crystalline phase with prismatic crystals, distinct from the parent monometallic frameworks. Field-emission scanning electron microscopy (FESEM) revealed a morphology with particle dimensions of approximately 30 µm, while energy-dispersive X-ray spectroscopy (EDS) verified the homogeneous distribution and stoichiometric ratio of Eu and Gd within the framework. Fourier-transform infrared (FTIR) spectroscopy confirmed coordination of the carboxylate groups of tartaric acid to the metal centers, evidenced by characteristic shifts in asymmetric/symmetric $COO^-$ stretching bands. UV-visible diffuse reflectance spectroscopy showed absorption features attributed to ligand-to-metal charge transfer (LMCT)/f-f transitions. Raman spectroscopy further supported the structural framework. Raman bands at 200–300, 750–900, 1300–1400 and 1440–1460 $cm^{-1}$ are attributed to Eu/Gd-O lattice vibrations and various C-C, C-O, CH2 and COO- deformation/stretching modes of the tartrate linker. The bands in the ~1400–1460 and ~1550–1650 $cm^{-1}$ regions are associated predominantly with symmetric and asymmetric stretching vibrations of coordinated carboxylate groups, respectively, supporting the coordination of the tartrate ligand with the $Eu^{3+}/Gd^{3+}$ centres. Photoluminescence (PL) studies exhibited the characteristic $^5D_0$-$^7F_j$ (J = 0-4) emission transitions of $Eu^{3+}$ under excitation at 310nm, with the $^5D_0$-$^7F_2$ hypersensitive transition dominating, indicating a low-symmetry coordination environment.

**Keywords:** MOF; Hydrothermal; Luminescent; Prismatic Crystal

# Effects of Pattern Grading and Heat Treatment on the Tensile Strength of Additively Manufactured Thermoplastic Polyurethane Parts

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**Abstract**

Fused Deposition Modeling (FDM) builds 3D parts layer upon layer by heating a thermoplastic filament and depositing it through a nozzle. This study investigates the tensile properties of thermoplastic polyurethane (TPU) specimens fabricated using fused deposition modeling (FDM). The process parameters included three infill patterns (gyroid, octahedral, and cubic) at 100% infill density, while keeping all other printing parameters constant. The samples were printed with both single-pattern and multi-pattern structures in accordance with ASTM D638. The samples underwent heat treatment at two annealing temperatures (90℃ and 120℃) and two holding times (90 and 120 minutes), followed by controlled furnace cooling at 10℃/hour for 24 hours to evaluate their effects. The tensile testing indicates that, among untreated single-pattern samples, the gyroid pattern exhibited the highest tensile strength, while multi-pattern specimens outperformed all single-pattern counterparts. Annealing at 90℃ produced no significant improvement in tensile performance across patterns, whereas annealing at 120℃ for 120 minutes resulted in noticeably higher tensile strength compared to untreated samples. These findings emphasize the roles of infill geometry and post-processing conditions in the mechanical performance of 3D-printed TPU, providing insights to optimize the mechanical performance of FDM-printed elastomeric materials for engineering applications.

**Keywords:** Additive Manufacturing (AM); Fused deposition modeling (FDM); Thermoplastic Polyurethane (TPU); Tensile Strength; Annealing

# Determining the structural and optical properties of Rare Earth Sulfate crystals

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**Abstract**

Rare earth sulfate like Erbium Sulfate crystals were grown by the slow evaporation solution growth technique and comprehensively characterized to investigate their structural and optical properties. The X-ray diffraction analysis shows that these crystals have a monoclinic crystal structure with C2/c space group. The information extracted from transmittance and reflectance spectra proved helpful in determining refractive index, extinction coefficient and various other parameters for these crystals. Parameters like band gap, nonlinear refractive index, optical electronegativity, were also evaluated for these crystals. These findings demonstrate the potential of Erbium Sulfate as a candidate for optoelectronic device applications.

**Keywords:** Slow evaporation; monoclinic; transmittance; refractive index

# Nano-Silica Finishing for Enhanced Water Repellency of Pashmina Fibre

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**Abstract**
Pashmina, the finest animal fibre produced from the Changthangi goats of Ladakh. It is valued globally for its exceptional softness, lustre and warmth, yet its higher hydrophilic character relative to wool makes it particularly susceptible to staining and consequent quality loss. T he present study explored nano-silica as a water-repellent finishing agent for pashmina fibre. Silica nanoparticles, characterized by particle size analysis, scanning electron microscope (SEM) and Energy-Dispersive X-ray spectroscopy (EDX), showed a hydrodynamic diameter of approximately 133 nm, and a spherical morphology consistent with silica dioxide ($SiO_2$) composition. Pashmina mufflers were treated with nano-silica dispersions (2.5%, 5%, and 7.5%)combined with 1% silicone polymer via a pad-cure method and evaluated for physical, functional and mechanical properties. Treatment produced a concentration-dependent increase in water contact angle (from 87.8° in control to 137.2° at the highest dosage), improved water-drop retention, higher spray ratings and reduced water vapour and air permeability, confirming enhanced hydrophobicity. Colour measurements revealed increased lightness, whiteness and brightness indices alongside decreased yellowness, attributed to light scattering by the silica coating. Gram square meter(GSM) and fabric thickness increased marginally, while tensile strength, elongation and total hand value declined with rising nano-silica concentration, indicating a trade-off between water repellency and fabric softness/strength. SEM-EDX and Fourier-Transform Infrared spectroscopy (FTIR) analyses confirmed successful surface deposition of silica (Si-O-Si network) without altering the underlying keratin structure. Hydrophobicity, though reduced after repeated washing, was substantially retained even after 15 wash cycles, particularly at the highest treatment level. These findings demonstrate that nano-silica finishing is an effective, durable approach for imparting water resistant functionality to pashmina, offering a pathway to protect this high-value textile from moisture-related damage while highlighting the need to optimize concentration to balance functional gains against mechanical and hand-feel losses.

**Keywords:** Colour measurement: Fabric thickness: Hydrophobicity: SEM: FTIR

# From Green synthesis to Bioavailability: Ag decorated Fe2O3 nanoparticles and network pharmacology insights

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**Abstract**

Green synthesis of nanoparticles using plant extracts, is widely practiced due to the diverse bioactive compounds present in these plants, which can act synergistically with the nanoparticles. It is a simple, eco-friendly, cost-effective, low toxicity process. This study aims to synthesize and characterize silver decorated iron nanoparticles ($^{Ag}Fe_2O_3$ NPs) synthesized using aqueous root extract of *Glycyrrhiza glabra*. Iron oxide nanoparticles ($Fe_2O_3$ NPs) were synthesized using *Glycyrrhiza glabra* root extract through the hydrothermal method. For the preparation of $^{Ag}Fe_2O_3$ NPs, typically 1g of pure $Fe_2O_3$ NPs was dispersed in 10 ml of distilled water and sonicated for 30 minutes, followed by the addition of 10 ml (0.005M) silver nitrate solution and continuously stirred at 30 °C. To this reaction mixture, 20 ml of *Glycyrrhiza glabra root* extract was added while stirring continuously. The colour change from dark brown to blackish brown indicated the formation of the $^{Ag}Fe_2O_3$ NPs. Different techniques, including UV-Visible spectroscopy, Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), Energy Dispersive X-ray (EDX) and X-ray photoelectron spectroscopy (XPS), were used to characterise the as-prepared $Fe_2O_3$ NPs and $^{Ag}Fe_2O_3$ NPs. FTIR spectroscopy determined the surface functional groups of $^{Ag}Fe_2O_3$ NPs. XRD, XPS and EDX validated the formation of $^{Ag}Fe_2O_3$ NPs. The morphological analysis through SEM/ TEM confirms the formation of spherical nanoparticles with an average size of 35nm for $Fe_2O_3$ NPs and 40nm for $^{Ag}Fe_2O_3$ NPs. Remarkably, the $^{Ag}Fe_2O_3$ NPs exhibited significant radical scavenging and anti-inflammatory activity. Also, the synthesized $^{Ag}Fe_2O_3$ NP were able to protect the DNA from free radical induced damage. Overall, these findings suggest, the biosynthesized $^{Ag}Fe_2O_3$ NPs are safe, eco-friendly, cost-effective and have potential biological applications

# Investigation of optical properties of the bilayer of nano-structured amorphous selenium and multi-walled carbon Nanotubes mixed by Swift Heavy ions Irradiation

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## Abstract

In this study, we report improved physical properties of selenium with multi-walled carbon nanotubes (MWCNTs) resulting from a homogeneous mixture of CNT-Se bi-layer thin film by using swift heavy ion irradiation. FESEM micrographs clearly showed the inter-diffusion of Se nanoparticles into MWCNTs following swift heavy ion (SHI) irradiation, EDX validates the elemental composition. The existence of different phonon modes (LO mode and D, G, G' bands) has been found in the Raman spectra of the investigated bi-layer thin films. UV–Visible spectroscopic analysis of pristine CNT-Se thin films show two sharp absorption edges at ~670 nm and ~340 nm. After swift heavy ion irradiation, the sharp absorption edge at ~670 nm exhibits a blue shift, whereas the absorption edge at ~340 nm exhibits a red shift, confirming the homogeneous mixing of two layers. These remarkable shifts found in the optical properties of CNT-Se bi-layer make the investigated material feasible for many optoelectronic device applications.

**Keywords:** Thin films; Compound Semiconductors; Swift Heavy Ion Irradiation; Optical Properties.

# Folic acid-doped carbon dots derived from waste PET (Bottles): a sustainable method for the selective detection of polystyrene microplastics.

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**Abstract**
Microplastic pollution is a serious environmental problem, demanding innovative detection strategies. This study describes a sustainability-focused method for sensing microplastics by synthesizing folic acid (FA)-doped carbon quantum dots (CQDs) from discarded polyethylene terephthalate (PET) waste bottles. The synthesis uses acid-catalyzed carbonization of PET flakes after UV pretreatment, followed by folic acid (FA) doping. The main innovation of this work lies in using the π–π stacking interactions between the FA's pteridine/pABA ring system and polystyrene (PS) benzene rings, producing a selective fluorescence quenching. As a result, PS microplastics can be detected preferentially over other polymer forms. Comprehensive characterization via FTIR spectroscopy confirms heteroatom incorporation is supported by the results, while FESEM shows the nanoscale aggregation patterns typical of carbon dot assemblies. The UV-Vis spectrum displays pteridine absorption signatures characteristic of successful FA doping. Visual conformation was also observed by bright fluorescence under UV light (365nm) of the synthesized CQDs. The proposed sensing protocol uses Stern–Volmer quenching kinetics for quantitative PS detection. It also turns waste into a functional nanostructured platform for environmental diagnostics, connecting the work to sustainable materials chemistry, circular economy goals, and pollution mitigation.

**Keywords:** Carbon quantum dots; folic acid doping; polystyrene detection; π–π stacking

# Ni@Zr@MCM-41-$PO_4$: A Phosphate-Functionalized Mesoporous Heterogeneous Nanocatalyst for Sustainable Microwave-Assisted Suzuki-Miyaura Cross-Coupling Reactions

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**Abstract**

This study presents the synthesis, characterization, and catalytic application of a novel phosphate-functionalized nickel nanocatalyst immobilized on zirconium-modified mesoporous silica, denoted as Ni@Zr@MCM-41-$PO_4$, for microwave-assisted Suzuki-Miyaura cross-coupling reactions. The catalyst was synthesized through a systematic surface modification strategy and comprehensively characterized using FT-IR, small-angle XRD, SEM, TEM, EDS, ICP-MS, XPS, UV-Vis spectroscopy, thermogravimetric analysis (TGA), Brunauer-Emmett-Teller (BET) surface area measurements, and dynamic light scattering (DLS). The obtained results confirmed the preservation of the ordered mesoporous MCM-41 structure, high specific surface area, successful incorporation of zirconium and phosphate functionalities, and uniform dispersion of nickel nanoparticles throughout the support matrix. To optimize the reaction parameters, a Box-Behnken Design (BBD) within the framework of Response Surface Methodology (RSM) was employed. The optimum reaction conditions were determined to be a temperature of 120 °C, reaction time of 20 min, and catalyst loading of 50 mg, resulting in a maximum biphenyl yield of 98%. Under microwave irradiation, Ni@Zr@MCM-41-$PO_4$ exhibited excellent catalytic activity for the synthesis of various biphenyl derivatives in an environmentally benign EtOH/$H_2O$ solvent system. The developed protocol offers rapid reaction rates, low catalyst loading, broad substrate tolerance, operational simplicity, and high product yields under mild conditions. Catalyst recyclability studies demonstrated consistent catalytic performance over multiple reaction cycles, confirming its durability and reusability. Furthermore, hot-filtration tests and ICP-MS analysis verified the heterogeneous nature of the catalytic process and revealed negligible nickel leaching.The outstanding catalytic behavior of Ni@Zr@MCM-41-$PO_4$ arises from the combined effects of mesoporosity, zirconium modification, phosphate functionalization, and microwave-assisted activation. This work establishes Ni@Zr@MCM-41-$PO_4$ as an efficient, sustainable, and reusable nanocatalyst for green C-C bond formation.

**Keywords:** Biphenyl; Green approach; Heterogeneous nanocatalyst; Microwave-assisted;RSM-BBD

# Development of Novel Multifunctional Hybrid Silazane-Based Ceramic Nanocomposite Coatings for Advanced Surface Applications

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## Abstract

Hybrid organic–inorganic ceramic coatings are promising materials for advanced surface protection because they can combine the processability of polymers with the thermal, mechanical, and chemical stability of ceramic networks. In this study, multifunctional hybrid coatings were developed using polysilazane and polydimethylsiloxane (PDMS), with silica ($SiO_2$) and titania ($TiO_2$) nanoparticles incorporated as inorganic reinforcements. The formulation was systematically developed to investigate the effects of inorganic reinforcement and hybrid network formation on the coating's surface and functional properties. Structural and morphological characteristics were evaluated using Fourier Transform Infrared Spectroscopy (FTIR) and field-emission scanning electron microscopy (FESEM), while surface wettability and mechanical response were investigated using water contact angle measurements and nanoindentation, respectively. The hybrid coating exhibited a water contact angle of approximately 112°, indicating a distinctly hydrophobic surface. Nanoindentation measurements further demonstrated an improved mechanical response following the incorporation of the inorganic phase, which is attributed to the reinforcement of the hybrid network and the restriction of polymer chain mobility through inorganic–organic interactions. The combined polysilazane–PDMS matrix and oxide nanoparticles provide a route toward coatings with synergistic hydrophobic and mechanical characteristics while retaining the processing advantages of hybrid polymer-derived ceramic systems. Such multifunctional surface-engineered materials have potential for durable protective applications where resistance to environmental exposure, surface wetting, and mechanical damage are simultaneously required.

**Keywords:** Ceramic coatings; Hydrophobicity; Nanocomposites; Polysilazane; Surface protection

# SYNTHESIS OF CHITOSAN GROUNDNUT SHELL POWDER BEADS FOR THE REMOVAL OF ACID BLACK 172

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**Abstract**
This study investigated the adsorption potential of chitosan–groundnut shell powder (Ch–GNSP) composite beads for the removal of Acid Black 172 (AB-172) from aqueous systems. The composite beads were prepared using chitosan and groundnut shell powder, an agricultural waste material, as sustainable and low-cost adsorbent components. The incorporation of groundnut shell powder into the chitosan matrix was intended to enhance the adsorption performance by providing additional active sites and improving surface heterogeneity. Batch adsorption experiments were conducted to evaluate the effects of initial dye concentration, adsorbent dosage, contact time, and pH on the removal of AB-172. The adsorption efficiency was strongly influenced by pH, with maximum removal of 89% observed at pH 2. The removal efficiency subsequently decreased to 64% and 52% at pH 3 and 4, respectively, indicating that acidic conditions favored AB-172 adsorption onto the composite beads. The maximum adsorption capacity of the Ch–GNSP beads was found to be 53.304 mg $g^{-1}$. Isotherm studies demonstrated that the Langmuir model provided the best fit to the experimental data, with a correlation coefficient of $R^2 = 0.95$, indicating favorable adsorption behavior. Kinetic analysis showed that the pseudo-second-order model provided a better description of the adsorption process, with $R^2=0.994$. Desorption studies were further conducted to assess the regeneration potential of the developed composite beads using different eluents. Among the tested eluents, 2 M NaOH exhibited the highest desorption efficiency, achieving 85.3% desorption within 150 min. This indicates that the adsorbent can potentially be regenerated and reused after the adsorption process. Overall, the findings demonstrate that Ch–GNSP composite beads provide an effective, sustainable, low-cost, and regenerable approach for the removal of Acid Black 172 from aqueous systems and may serve as a promising bio-based adsorbent for wastewater treatment applications.

**Keywords:** Azo dye; Wastewater; Regeneration; Isotherm; Kinetics.

# Designing Greener Fire-Resilient ECC Using Rice Husk Ash and Hybrid Basalt–PVA Fibre Reinforcement

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**Abstract**

The demand for sustainable cementitious materials capable of maintaining structural integrity under fire exposure has accelerated the development of high-performance composites with reduced environmental impact. Engineered Cementitious Composites (ECC) offer exceptional ductility and crack resistance, while the incorporation of supplementary cementitious materials such as Rice Husk Ash (RHA) presents an effective strategy for lowering cement consumption and promoting sustainable construction. This study investigates the fire performance of sustainable ECC incorporating RHA together with a hybrid fibre system consisting of polyvinyl alcohol (PVA) and basalt fibres at a constant total fibre volume of 2%. The hybrid reinforcement was selected to combine the superior crack-bridging capability of PVA fibres with the excellent thermal stability of basalt fibres. Specimens were exposed to elevated temperatures ranging from 100°C to 400°C and subsequently evaluated in terms of residual compressive strength, mass loss, and visible damage characteristics. The results indicate that exposure up to 200°C resulted in only limited changes in performance, whereas higher temperatures caused noticeable reductions in residual strength accompanied by progressive surface deterioration. Among the investigated mixtures, ECC containing 15% RHA demonstrated the most favourable overall performance, exhibiting better strength retention and reduced visible thermal damage after heating. The improved residual behaviour is attributed to the matrix densification provided by RHA together with the complementary action of the hybrid PVA–basalt fibre system under thermal loading. The findings demonstrate that combining agricultural waste-derived RHA with hybrid basalt–PVA fibre reinforcement provides a sustainable approach for developing fire-resilient ECC, offering promising potential for durable and environmentally responsible infrastructure applications.

**Keywords:** Engineered Cementitious Composite (ECC); Rice Husk Ash; Basalt Fibre; Fire Performance; Sustainable Construction

# Functionalized Carbon Nanotubes for Targeted Drug Delivery and Diagnosis of Breast Cancer

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**Abstract**

Breast cancer remains one of the most prevalent malignancies worldwide, and early diagnosis combined with effective, targeted treatment is essential for improving therapeutic outcomes. Conventional chemotherapy is often associated with poor tumor selectivity, systemic toxicity, drug resistance, and damage to healthy tissues. Carbon nanotubes (CNTs), including multi-walled carbon nanotubes (MWCNTs), have emerged as promising nanomaterials for cancer diagnosis and therapy because of their high surface area, unique optical and electrical properties, and ability to be chemically functionalized. Functionalized MWCNTs can serve as nanocarriers for anticancer drugs, and imaging agents, enabling targeted delivery to tumor cells.

In breast cancer, (MWCNTs)-based systems have been investigated for targeted drug delivery using ligands such as folic acid and other receptor-specific molecules. They can potentially improve drug accumulation within tumor cells and reduce exposure of healthy tissues. MWCNTs also exhibit valuable photothermal properties, allowing near-infrared irradiation to generate localized heat and promote tumor-cell destruction. In addition, their optical and electronic characteristics have been explored for fluorescence, Raman, photoacoustic, electrochemical, and other diagnostic approaches.

Despite these promising applications, challenges including (MWCNTs) toxicity, biodegradability, solubility, functionalization, biodistribution, and long-term safety must be addressed before widespread clinical translation. Overall, functionalized (MWCNTs) represent a promising *theranostic* platform that may integrate breast cancer detection and targeted drug delivery. Further in-vivo studies, standardized toxicity evaluation, and clinical investigations are required to establish their safety and therapeutic effectiveness.

**Keywords:** Breast cancer; Carbon nanotubes; Photothermal therapy; Targeted drug delivery; *Theranostics*.

# Carbon Quantum Dots for Sustainable Optical and Printing Applications

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## Abstract

Conversion of agricultural waste into value-added nanomaterials represents an environmentally sustainable strategy for waste management and the development of advanced materials. Here we present recent reports of carbon quantum dots for optical and printing applications. Apricot shell waste was employed as a renewable carbon precursor for the synthesis of carbon quantum dots (CQDs) via a green hydrothermal method. The resulting CQDs were thoroughly characterized using various techniques, including UV-Visible spectroscopy, photoluminescence (PL) spectroscopy, Fourier-transform infrared spectroscopy (FTIR), field-emission scanning electron microscopy (FESEM), and high-resolution transmission electron microscopy (HRTEM). The optical investigations demonstrated distinct absorption characteristics and pronounced fluorescence within the visible spectrum, thereby validating the successful synthesis of fluorescent carbon nanostructures. FTIR analysis revealed the existence of various surface functional groups containing oxygen and carbon, while electron microscopy confirmed the creation of nanoscale carbonaceous structures. The synthesized carbon quantum dots (CQDs) displayed remarkable fluorescent properties and were subsequently examined for their potential in printing applications. CQD-based fluorescent ink was used in ink jet printer as ink, resulting in the formation of optically active patterns that exhibited unique fluorescence under ultraviolet light. These fluorescence based patterns highlight the potential applications of the synthesized CQDs in sustainable printing, optical labeling, security marking, and anti-counterfeiting measures. Utilizing apricot shell waste as a carbon source not only minimizes biomass waste but also offers an economical and sustainable method for the production of functional nanomaterials. This study emphasizes the potential of biomass-derived carbon quantum dots (CQDs) as eco-friendly fluorescent materials suitable for innovative optical and printing technologies.

**Keywords:** Apricot shell waste; Carbon quantum dots; Green synthesis Photoluminescence; Fluorescent printing; Optical applications

# Growing the Future: Bio-Based Materials at the Frontier of the Circular Economy

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**Abstract**

The transition from petroleum-dependent materials to bio-based alternatives has accelerated markedly in recent years, driven by advances in synthetic biology, green chemistry, and additive manufacturing. This paper surveys recent progress across four converging fronts: biopolymers derived from agricultural and food-industry waste streams via enzymatic and fermentation-based synthesis; mycelium-based composites and pure-mycelium materials that exploit fungal biology to bind lignocellulosic substrates into structural and packaging-grade materials; bio-based constituents in additive manufacturing, particularly within thermoset resin systems; and the integration of bio-based materials into architecture and product design through regenerative, byproduct-driven sourcing strategies. While these developments demonstrate substantial gains in mechanical performance, functionality, and scalability, we highlight a persistent and under-addressed tension in the field: bio-based origin does not guarantee biodegradability, and many current biopolymers exhibit environmental persistence comparable to conventional plastics. Drawing on recent literature and patent-landscape analysis, this paper identifies key barriers to commercialization reproducibility, moisture sensitivity, durability, and techno-economic viability and proposes research priorities for closing the gap between bio-based and truly circular material systems. In the context of sustainable manufacturing and the Himalayan bioeconomy, we argue that the next phase of innovation must move beyond substitution toward materials engineered for end-of-life performance as rigorously as for in-service performance, offering a pathway aligned with the goals of a Viksit (developed) and sustainable Jammu & Kashmir.

**Keywords:** biopolymers; mycelium composites; circular economy; sustainable manufacturing; biodegradability.

# Phosphor Materials for Radiation Storage and Scintillation Applications

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**Abstract**
Phosphor materials play a crucial role in radiation detection, energy storage, scintillation, and X-ray imaging owing to their ability to absorb high-energy radiation and convert the stored or absorbed energy into luminescent emission. The interplay between crystal structure, activator ions, intrinsic defects, and charge-carrier trapping and detrapping processes strongly governs their performance. This review provides a comprehensive overview of the fundamental materials chemistry and luminescence mechanisms underlying radiation storage and scintillation phosphors. The influence of crystal structure, coordination environment, host composition, and activator ions on emission characteristics, decay behavior, afterglow, quantum efficiency, and X-ray absorption is discussed. Particular emphasis is placed on defect engineering, including the formation and role of electron and hole traps, oxygen vacancies, and rare-earth-related trap centers. The relationship between trap depth and carrier release is examined for shallow, intermediate, and deep traps, including their contributions to thermoluminescence, photostimulated luminescence, room-temperature fading, and storage stability. The scintillation process is further discussed in terms of X-ray-excited luminescence, host-to-activator energy transfer, and self-absorption effects. Various synthesis strategies are compared with respect to their influence on phase formation, morphology, crystallinity, and luminescence performance. Finally, the applications of storage and scintillation phosphors in computed radiography, delayed X-ray imaging, optical information storage, and security/anti-counterfeiting technologies are highlighted. The review also identifies current challenges and future opportunities in compositional and defect engineering to develop phosphors with high sensitivity, controlled afterglow, improved spatial resolution, and enhanced radiation storage and scintillation performance.

**Keywords:** Defect engineering; Phosphors; Photostimulated luminescence; Radiation storage; Rare-earth activators; Scintillation; Thermoluminescence; X-ray imaging.

# Gelatin/Chitosan Based Bilayer Hydrogel Actuator- a Thermo- and pH-responsive Hydrogel with Biomimetic Applications

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**Abstract**

Hydrogel actuators capable of programmable shape transformation have emerged as promising platforms for soft robotics, biomedical devices, and biomimetic systems. However, the majority of reported hydrogel actuators rely on synthetic, non-biodegradable polymers and often require operating conditions that are incompatible with physiological environments, limiting their long-term sustainability and biomedical applicability. Here, we present a fully bio-based bilayer hydrogel actuator constructed from gelatin and chitosan that exhibits reversible and highly controllable responses to both pH and temperature stimuli. The actuator architecture integrates a swelling-responsive chitosan layer with a mechanically supportive gelatin layer, enabling anisotropic deformation through stimulus-induced differential swelling. By systematically tuning layer thickness and composition, the actuator achieves reproducible bending, rolling, and unrolling behaviors across multiple actuation cycles.

To establish a predictive understanding of the actuation mechanism, a theoretical framework based on classical Timoshenko bilayer beam theory was developed and adapted to swelling-induced deformation. The model quantitatively relates actuator curvature to the mismatch strain generated between the two hydrogel layers, while accounting for their respective thickness and elastic modulus ratios. Theoretical predictions exhibited excellent agreement with experimental measurements, providing direct mechanistic insight into the coupling between environmental stimuli, swelling anisotropy, and macroscopic shape transformation. Beyond demonstrating robust actuation under physiologically relevant conditions, this work establishes a general design strategy for engineering sustainable hydrogel actuators from naturally derived polymers. The integration of biodegradable materials, dynamic responsiveness, and predictive mechanical modelling provides a foundation for the development of next-generation soft robotic systems, intelligent biomedical devices, and bioinspired adaptive materials.

**Keywords**: Bilayer actuator; dual response; Timoshenko theory

# Nanostructured Multiferroic Materials: Fabrication, Characterization, and Functional Properties

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**Abstract:**
Multiferroic materials have attracted considerable attention due to their unique coupled electric and magnetic properties and their potential applications in data storage, transducers, actuators, non-volatile memories, and field-effect devices. Nanostructured multiferroic oxides are particularly promising because their reduced particle size and high surface area can significantly influence their structural, dielectric, magnetic, ferroelectric, and functional properties. This work focuses on the low-temperature synthesis and comprehensive characterization of nanostructured multiferroic oxides using polymeric citrate precursor and reverse micellar methods. Here to describe the synthesis and investigation of different rare-earth-based multiferroic nanoparticles, including $YMO_3$ (M = Fe, Cr, Mn), $GdFeO_3$, $GdCrO_3$, $TbFeO_3$, $TbCrO_3$, $DyFeO_3$, $LaMnO_3+\delta$, $BiFeO_3$, and $LuFeO_3$. The synthesized nanoparticles were characterized using X-ray diffraction, FTIR, SEM, TEM/HRTEM, SAED, BET surface-area analysis, UV-Visible spectroscopy, dielectric measurements, impedance spectroscopy, SQUID magnetometry, and polarization–electric field measurements. The studies confirmed the formation of highly crystalline, predominantly monophasic nanostructured oxides with controlled morphology and enhanced surface areas. Several compositions exhibited room-temperature ferromagnetic and ferroelectric behaviour, confirming their multiferroic nature. The nanoparticles also demonstrated promising functional properties, including enhanced photocatalytic degradation of Rhodamine B, humidity sensing, and favourable dielectric characteristics. Particularly, $TbFeO_3$ and $DyFeO_3$ exhibited significant photocatalytic and multiferroic properties, while $YCrO_3$, $GdCrO_3$, and $TbCrO_3$ showed promising humidity-sensing behaviour. $BiFeO_3$ and $LuFeO_3$ exhibited high surface areas and room-temperature ferroelectricity. Overall, the study demonstrates that low-temperature synthesis routes are effective for developing nanostructured multiferroic oxides with tunable multifunctional properties and potential applications in advanced electronic, sensing, memory, and photocatalytic devices.

**Keywords:** Nanostructured Multiferroics; Low-Temperature Synthesis; Ferroelectricity; Ferromagnetism; Functional Properties.

# Energy-Efficient and Side-Channel Power Attack-Resilient SRAM Architectures for Secure Computing

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**Abstract:**
The increasing integration of cryptographic and intelligent computing functions in edge and embedded systems necessitates SRAM architectures that simultaneously provide high energy efficiency, memory stability, and resilience against hardware security threats. Conventional SRAM cells exhibit significant data-dependent variations in leakage and dynamic power during hold and write operations, creating exploitable signatures for side-channel power analysis (SCPA) attacks. This work investigates advanced SRAM architectures incorporating circuit-level security mechanisms to suppress data-dependent power leakage while preserving essential memory performance metrics. The proposed design methodology includes leakage balancing, write preconditioning, voltage equalization, and decoupled read/write paths to minimize the distinguishability between power signatures associated with complementary stored data states. The security of the memory architectures is quantified using power-distribution histogram overlap under hold, read, and write conditions. Static noise margin (SNM), read/write access delay, dynamic power, leakage power, and energy consumption are simultaneously evaluated to establish the security–stability–performance trade-off. Monte Carlo simulations incorporating process and device-mismatch variations are employed to assess statistical robustness and attack resilience. The resulting architectures demonstrate enhanced suppression of data-dependent power variations together with favourable stability and energy characteristics. Furthermore, the use of decoupled differential-read structures provides a pathway toward energy-efficient memory-centric computing and emerging in-memory processing systems. The proposed secure SRAM design methodology therefore provides a robust foundation for confidential, reliable, and energy-efficient memory subsystems in next-generation intelligent and security-critical computing platforms.

**Keywords:** Secure SRAM; Side-channel power analysis; Hardware security; Power leakage; Energy-efficient memory

# Synthesis and Characterization of Multivalent Redox-Active Mesoporous $NiCr_2O_4$ Nanostructures for High-Performance Supercapacitor Applications

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**Abstract**

The increasing demand for efficient and sustainable energy-storage technologies has stimulated significant research into advanced electrode materials for supercapacitors. Supercapacitors are considered promising candidates for next-generation energy-storage systems due to their high power density, rapid charge-discharge capability and long cycling stability. In this context, transition-metal oxide-based nanostructures have attracted considerable attention because of their rich redox chemistry and tunable physicochemical properties. In the present study, nickel chromium oxide ($NiCr_2O_4$) nanostructures were synthesized via a facile co-precipitation method and investigated as electrode materials for supercapacitor applications. X-ray diffraction (XRD) confirmed the formation of crystalline $NiCr_2O_4$, while scanning electron microscopy (SEM) and Brunauer–Emmett–Teller (BET) analyses revealed an interconnected mesoporous morphology with a high surface area, favorable for electrolyte ion transport and electrochemical charge storage. Fourier-transform infrared spectroscopy (FTIR) confirmed the characteristic Ni–O and Cr–O bonding whereas X-ray photoelectron spectroscopy (XPS) revealed the coexistence of $Ni^{2+}/Ni^{3+}$ and $Cr^{3+}/Cr^{6+}$ species, indicating the presence of multiple redox-active states. Electrochemical measurements were performed in 6.0 M KOH electrolyte. The $NiCr_2O_4$ electrode delivered a specific capacitance of 509.33 F $g^{-1}$ at a high current density of 8 A $g^{-1}$, along with good rate capability. The calculated b-value of ~0.65 indicated that charge storage involved a combination of surface-controlled and diffusion-controlled processes. Furthermore, an asymmetric two-electrode device employing $NiCr_2O_4$ as the positive electrode and copper tape as the negative electrode exhibited a specific capacitance of 148 F $g^{-1}$ at 7 A $g^{-1}$, with an internal resistance of approximately 1.56 Ω and an operating voltage of ~1.0 V. The observed electrochemical performance can be attributed to the synergistic contribution of the mesoporous architecture, accessible surface area, and multiple redox-active states of Ni and Cr. These results demonstrate the potential of $NiCr_2O_4$ nanostructures as promising electrode materials for high-performance supercapacitor applications.

**Keywords:** Supercapacitor; nanostructures; energy storage

# Synthesis and Characterization of $CuCo_2O_4$/rGO Nanocomposite for Resistive Detection of Liquid-Phase Organic Analytes

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**Abstract**

The development of simple, low-cost, and sensitive chemical sensors for the detection of organic analytes is important for environmental monitoring and chemical analysis. In the present study, a $CuCo_2O_4$/reduced graphene oxide ($CuCo_2O_4$/rGO) nanocomposite was synthesized using co-precipitation method and explored as a resistive sensing material for the detection of selected organic analytes in liquid phase. The synthesized composite was systematically characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and Fourier-transform infrared spectroscopy (FTIR). XRD analysis was employed to investigate the crystalline structure, while SEM revealed the surface morphology of the synthesized material. EDX confirmed the elemental composition, and FTIR analysis provided information regarding the characteristic functional groups and chemical bonding. For sensing measurements, the $CuCo_2O_4$/rGO composite was deposited onto a glass substrate using a cut and bridge configuration, with conductive fabric serving as the two electrical terminals. The resulting device was integrated into a simple resistive sensing configuration and its electrical resistance was measured using a digital multimeter before and after exposure to the selected liquid analytes. Methanol, ethanol, propanal, and acetone were investigated as representative organic analytes. The $CuCo_2O_4$/rGO sensing platform exhibited measurable changes in resistance upon interaction with the different analytes, demonstrating its capability for liquid-phase chemical detection. The observed response can be attributed to analyte-surface interactions at the $CuCo_2O_4$/rGO interface, which modify the charge-transport pathways within the conductive composite network. The incorporation of rGO provides an efficient conductive pathway, while the $CuCo_2O_4$ surface offers active sites for interaction with the analyte molecules. The study demonstrates the potential of $CuCo_2O_4$/rGO as a simple and cost-effective resistive sensing platform for the detection and discrimination of liquid-phase organic analytes.

**Keywords:** reduced graphene oxide (rGO); cut-bridge method; sensor

# Crystal structure of 9-(1-allyl-2-(2-chlorophenyl)-5-methyl-3-oxo-2,3-dihydro-1H-pyrazol-4-yl)-3,3,6,6-tetramethyl-3,4,5,6,7,9-hexahydro-1H-xanthene-1,8(2H)-dione

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**Abstract**

The title compound having molecular formula $C_{33}H_{33}ClN_2O_4$, crystallizes in the monoclinic space group I 2/a with unit-cell parameters a = 23.4241(4) Å, b=7.72360(10) Å, c=30.1947(6)Å, β = 94.627(2)° and Z = 8. The crystal structure was solved by direct methods using single-crystal X-ray diffraction techniques. X-ray diffraction data were collected at 150 K and refined by full-matrix least-squares procedures. The final R-value converges to 0.0499 for 1268 observed reflections. Intermolecular hydrogen bonding interactions are observed in the crystal structure. The crystal structure is stabilized by C-H…O interactions. Chloro-substituted phenyl ring and allyl group are disordered. The disorder components are in the ratio 715:285 and 656:344, respectively. Detailed crystallographic results will be presented.

**Keywords:** X-ray diffraction; Crystal structure; Allyl group; Disorder.

# Synthesis, Fabrication, and Characterization of Ba-Doped $MnO_2$ Nanoparticle-Based Electrodes for Supercapacitor Applications

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**Abstract**

Manganese dioxide ($MnO_2$) is a promising electrode material for supercapacitors; however, its electrochemical performance can be improved through suitable compositional modification and electrode engineering. In the present work, barium-doped manganese dioxide (Ba-$MnO_2$) nanoparticles were synthesized using a simple co-precipitation technique to enhance their electrochemical performance. Conductive fabric (CF) was employed as a flexible and conductive substrate for electrode fabrication. The synthesized Ba-$MnO_2$ nanoparticles were mixed with graphite and polyvinylidene fluoride (PVDF) in an 8:1:1 weight ratio and subsequently integrated onto the conductive fabric. The electrochemical properties of the fabricated electrode were evaluated using a three-electrode configuration with 6 M KOH as the electrolyte. The electrode exhibited a high specific capacitance of 500 F $g^{-1}$ at 5 A $g^{-1}$, which decreased to 311 F $g^{-1}$ at 15 A $g^{-1}$, corresponding to approximately 62% capacitance retention at the higher current density. Moreover, the electrode demonstrated good cycling stability, retaining 72.72% of its initial capacitance after 6000 charge–discharge cycles. The observed electrochemical performance demonstrates that Ba doping, combined with a conductive fabric-supported electrode architecture, can provide a promising strategy for developing flexible and efficient $MnO_2$-based electrodes for supercapacitor applications.

**Keywords:** Supercapacitor; nanoparticles; energy storage

# Transition Metal Engineering of Vacancy-Ordered Double Halide Perovskites

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**Abstract**

Vacancy-ordered double halide perovskites (VODHPs) are promising materials with tunable electronic, optical, and magnetic properties.This work focuses on the systematic investigation of transition metal doped $Cs_2MoCl_6$ vacancy ordered double halide perovskites. It is anticipated that the addition of dopant ions at suitable crystallographic location results in the introduction of localized electronic states, alter the band structure and band gap, and have an impact on optical transitions and charge-carrier behavior. Furthermore, transition-metal dopants partially filled d orbitals may promote or create magnetic interactions, opening the door to spin-dependent functionalities. X-ray diffraction have been used to examine structural alterations brought about by doping, and optical measurements will be used to assess changes in the associated physical characteristics. To further comprehend the electronic structure, density of states, band structure, and magnetic properties of the doped systems, density functional theory calculations are employed. In order to provide insights into the logical design of multifunctional VODHPs for upcoming optoelectronic and spintronic applications, the work attempts to establish a correlation between dopant concentration, crystal structure, electronic states, and optical response.

**Keywords:** Vacancy-ordered double halide perovskites; Doping; Optoelectronic properties; Density functional theory.

# Predicting the Electronic Landscape of $La_2GeBr_2$: A First-Principles Approach to a 2D Semiconductor

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**Abstract**

Two-dimensional (2D) semiconductor materials have emerged as promising candidates for advanced electronic and optoelectronic applications owing to their distinctive electronic properties and reduced dimensionality. In this work, the electronic structure of the $La_2GeBr_2$ monolayer is systematically investigated using first-principles density functional theory (DFT) calculations. The electronic band structure is analyzed to characterize the dispersion of the valence and conduction bands, while the total density of states (TDOS) and projected density of states (PDOS) are employed to elucidate the distribution of electronic states and the contributions of the constituent atoms and their orbital states. Attention is devoted to the electronic states near the valence-band maximum (VBM) and conduction-band minimum (CBM), with emphasis on the orbital interactions and hybridization involving La, Ge, and Br atoms. Additionally, the calculated lattice thermal conductivity of $La_2GeBr_2$ is approximately 1.16 W $m^{-1}$ $K^{-1}$ at 300 K, indicating relatively low lattice thermal conductivity and its potential relevance for thermoelectric applications. This investigation provides a fundamental understanding of the electronic structure and thermal properties of the $La_2GeBr_2$ monolayer and establishes a theoretical basis for further studies of its transport and optoelectronic properties. The present work contributes to the broader understanding of low-dimensional semiconductor materials and their potential for future nanoscale applications.

**Keywords:** Two-dimensional semiconductor; Density functional theory; electronic structure; Lattice thermal conductivity.

# Crystal structure of 7,9-bis(2,5-dimethoxyphenyl)-1',3'-dimethyl-1,6,7,9-tetrahydro-1'H-spiro[pyrazolo[3,4-f]quinoline-8,5'-pyrimidine]-2',4',6'(3'H)-trione

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**Abstract**

Single crystals of the title compound were obtained by the slow solvent evaporation method. The compound was dissolved in a suitable solvent mixture comprising ethanol, methanol, dichloromethane, and dimethylformamide. The resulting clear solution was filtered to remove insoluble impurities and left undisturbed at room temperature to allow slow evaporation of the solvents. After several days, well-defined single crystals suitable for single-crystal X-ray diffraction analysis were formed and carefully isolated from the mother liquor. The compound (molecular formula: C31H31N5O7) crystallizes in the monoclinic space group P21/n with unit-cell parameters a = 10.7545(1) Å, b = 9.76982(1) Å, c = 27.0436(4) Å, β = 95.564(1)°, and Z = 4. The crystal structure was solved by direct methods using single-crystal X-ray diffraction techniques. X-ray diffraction data were collected at room temperature and refined by full-matrix least-squares procedures. The final R-value converges to 0.0415 for 4967 observed reflections. Intermolecular hydrogen-bonding interactions are observed in the crystal structure, with the crystal packing stabilized by N-H···O and C-H···O interactions. The molecules are stacked in layers. Detailed crystallographic results will be presented.

**Keywords:** Single crystal; X-ray diffraction; Crystal structure; N-H···O and C-H···O interactions

# Flexible MWCNT–PEI/Starch Composite Sensor for Room-Temperature $CO_2$ Detection

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**Abstract**

Carbon dioxide ($CO_2$) monitoring is important in applications ranging from environmental monitoring to indoor air-quality assessment, creating a need for low-cost and flexible sensing platforms. In this work, a flexible resistive $CO_2$ sensor based on a multi-walled carbon nanotube (MWCNT), polyethyleneimine (PEI), and starch composite was developed using filter paper as the supporting substrate. MWCNTs provide a conductive network, while PEI offers amine functional groups that can interact with $CO_2$, making the composite suitable for room-temperature sensing.

The sensing performance of the fabricated device was evaluated by exposing it to $CO_2$ concentrations ranging from 200 to 500 ppm at room temperature. Upon exposure to $CO_2$, the sensor exhibited a clear increase in resistance, followed by recovery after the removal of the gas. Distinct response and recovery characteristics were observed at different $CO_2$ concentrations, with the sensor response showing an overall increase as the gas concentration increased. The fabricated sensor demonstrated a high sensor response of 38% and a fast response time of 118 s toward 500 ppm $CO_2$ gas under ambient conditions. An approximately linear relationship was obtained between sensor response and $CO_2$ concentration over the investigated range. These results demonstrate the potential of the MWCNT–PEI/starch composite on a flexible paper substrate as a simple and low-cost platform for room-temperature $CO_2$ detection, with potential applications in lightweight and flexible gas-sensing devices. Beyond its sensing performance, the use of readily accessible materials and a simple flexible platform is relevant to the development of affordable, environmentally conscious technologies. Such research supports the broader objectives of **VIKSIT J&K 2047** by contributing to indigenous technological development, innovation-driven growth, environmental sustainability, and the development of locally relevant advanced materials and sensing technologies.

**Keywords:** carbon dioxide sensing; flexible gas sensor; MWCNTs; paper-based sensor; polyethyleneimine; starch composite

# Fish Bone Derived Hydroxyapatite: A Sustainable Biomaterial with Anticancer Potential – A Review

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**Abstract**

The growing demand for sustainable and biocompatible materials in biomedical field has intensified interest in the valorisation of fish-processing waste as a renewable source of biomaterials. Fish bones, a type of fisheries waste, can be seen as an eco- friendly option to obtain green biomaterials such as hydroxyapatite. Fish bone-derived hydroxyapatite (HAp, Ca10(PO4)6(OH)2), due to its excellent bioactivity, biocompatibility, and osteoconductivity is used in bone tissue engineering, dental restoration, drug delivery systems, wound healing, regenerative medicine etc. This review includes extraction steps, physicochemical characterisation, and the anticancer properties of hydroxyapatite obtained from fish bones. Many extraction techniques mentioned across the literature, such as thermal calcination, alkaline hydrolysis, hydrothermal treatment, and hybrid chemical–thermal strategies, are discussed in a critical way with respect to their effectiveness, purity levels, crystallinity, and whether they manage to keep, the natural porous structure that fish bone carries. Processing conditions like temperature, reaction time, and specific chemical treatments are treated as key drivers, because they can shift the structural and compositional features of the final material. The benefits of fish-derived hydroxyapatite: a near match to the mineral phase of human bone offers strong biocompatibility, bioactivity and osteoconductivity. Also trace constituents like magnesium, sodium, and strontium that might support biological performance in practical terms.

The major analytical techniques used for HAp characterisation like X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM) etc. These methods give critical insights into crystallographic layout, morphology, functional groups, elemental makeup, thermal stability, and particle size distribution. Zinc-substituted hydroxyapatite (Zn-HA) nanoparticles subsequently functionalised with *Catharanthus roseus* (CR) flower extract to synthesize a Zn-HA/CR nanocomposite has a potential antioxidant and anticancer activity.

**Key words:** Biomaterial; Hydroxyapatite; Fish waste valorisation; Anticancer activity.

# Synthesis, Structural, Morphological and Supercapacitor Studies of the Cobalt-based Spinel Oxide for Energy Storage Applications

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**Abstract**

Spinel-type oxides, with the general formula $AB_2O_4$, constitute one of the most versatile classes of functional ceramic materials owing to the flexibility of functional ceramic materials owing to the flexibility of their crystal lattice, which can accommodate a wide range of divalent and trivalent cations at the tetrahedral (A) and octahedral (B) sites. This structural adaptability, combined with the strong dependence of electronic, optical, and magnetic behavior on cation distribution and site occupancy, has made spinel oxides attractive for applications spanning pigments, catalysis, gas sensing, magnetic recording, and optoelectronic devices. In this work, we have synthesised $CoAl_2O_4$ using the auto-combustion method, with nitrates in well-stoichiometric ratios. The Phase confirmation of the material was confirmed by using the XRD and we have seen that the material posses the spinal phase which is also confirmed by using the Reitvield refinement. The morphological study of the prepared sample was studied by using the FESEM and the TEM which confirm that the material possesses the nano structure and well grains. The chemical composition of the material was determined using Energy-Dispersive X-ray spectroscopy and X-ray photoelectron spectroscopy, which confirmed the presence of only the elements present in the sample, further confirming its purity. The supercapacitor studied the material carried out by using the Cyclic voltametric and Galvanostatic charge-discharging, which shows that the material possesses good supercapacitance. Overall, this study shows that the prepared material is suitable for Energy storage applications.

**Key Words:** Spinel Oxide; Reitvield Refinement; FESEM; EDX' Energy Storage Applications

# Biochemical Characterization of Garlic Oil and *In Vitro* Evaluation of Garlic Oil Nanoemulsion against *Fusarium* in Chilli

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**Abstract**

Garlic (*Allium sativum* L.) is an important medicinal and culinary crop known for its diverse bioactive compounds and potential antimicrobial properties. Garlic oil owing to its rich phytochemical composition has attracted attention as a natural alternative for managing plant pathogens. In the present study, garlic oil obtained from two commonly cultivated cultivars *viz.,* Kashmiri local garlic and Chinese white garlic were extracted through hydrodistillation and characterized for their biochemical constituents including phenols, flavonoids, vitamin C and sulphur along with antioxidant activity. The oil extracted from Kashmiri local garlic and Chinese local garlic were also evaluated for their antifungal potential against *Fusarium sp*. The results revealed differences in the biochemical composition of the oils obtained from the two cultivars. Kashmiri garlic oil showed comparatively higher levels of phenols, flavonoids and sulphur whereas Chinese garlic oil exhibited higher vitamin C content and antioxidant activity. The extracted oils were further used for the preparation of nanoemulsions, which were characterized based on their droplet size. Both garlic oils and their corresponding nanoemulsions were evaluated *in vitro* for antifungal activity against *Fusarium sp.* isolated from wilt affected chilli plants. Kashmiri and Chinese garlic oils showed complete inhibition of fungal growth at 3.75 µL/mL while their respective nanoemulsions exhibited complete inhibition at 37.5 µL/mL**.** The comparative evaluation provided insights into the antifungal potential of garlic oil and its nanoemulsion formulations. The study highlights the potential of garlic oil and garlic oil based nanoemulsions as an eco-friendly approach for managing *Fusarium* associated diseases in chilli and supports the exploration of plant derived formulations as sustainable alternatives to conventional disease management practices.

**Keywords:** Antifungal activity; Garlic oil; *Fusarium*; Nanoemulsion; Phytochemicals

# Synthesis, Characterization, and enhanced photocatalytic degradation of Organic pollutants by $SmFeO_3$/CNT nanocomposites under visible light irradiation

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**Abstract**
Samarium ferrite ($SmFeO_3$) is a perovskite-type semiconductor material with promising optical, electronic, and photocatalytic properties for energy and environmental applications. In this study, we synthesized and investigated $SmFeO_3$ perovskite nanomaterial as a potential photocatalyst. The structural properties of the synthesized $SmFeO_3$ were examined using X-ray diffraction (XRD), which was used to confirm the formation and crystallinity of the perovskite phase. To further improve the functional properties of $SmFeO_3$, a heterojunction with functionalized carbon nanotubes (CNTs) was developed. The CNTs were functionalized before incorporation to promote better interaction with the $SmFeO_3$ phase and facilitate effective interfacial contact. We prepared $SmFeO_3$/functionalized-CNT heterojunctions with CNT loadings of 5%, 10%, and 15%. We submitted the prepared heterojunction materials for further characterization to accurately evaluate their structural, morphological, surface, and interfacial properties. The developed $SmFeO_3$/functionalized-CNT heterojunction is expected to provide improved charge-transfer characteristics through enhanced interfacial contact and reduced charge recombination. The prepared materials therefore provide a promising platform for further investigation in photocatalytic applications, including dye degradation, hydrogen production, and $CO_2$ reduction. This study lays the foundation for understanding how functionalized CNT incorporation modifies the properties of $SmFeO_3$-based heterostructured materials for potential environmental applications.

**Keywords:** Carbon nanotubes; Heterostructure; Photocatalysis; Environmental remediation

# A Preorganized Chiral Amine-Functionalized Schiff Base Macrocycle for Selective Supramolecular Binding of Squarate Anion

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**Abstract**

Herein, we report the rational design and synthesis of a novel amine-functionalized Schiff base macrocycle and the investigation of its anion recognition properties. A novel amine-functionalized Schiff base macrocycle was successfully constructed via a condensation reaction involving suitably designed aldehyde and amine building blocks. The incorporation of amine functionalities within the macrocycle provides additional interaction sites and contributes to the structural versatility of the system, making it a promising candidate for applications in supramolecular chemistry, molecular recognition, and host–guest interactions. Single-crystal X-ray analysis shows that the macrocycle adopts a well-defined conformation, generating a cavity lined with hydrogen-bond donor sites. The anion binding studies in DMF reveal a pronounced affinity toward oxoanions, particularly the squarate anion ($C_4O_4^{2-}$). The strong and selective binding arises from multiple N–H···O hydrogen-bonding interactions, favorable ion–dipole contacts, and optimal size and shape complementarity between the host cavity and the planar squarate dianion. The optimized geometry of the host–guest complex reveals three distinct N–H···O hydrogen bonds between the macrocycle and the guest, which collectively stabilize the encapsulation of the dianion within the cavity. These results demonstrate the potential of amine-functionalized Schiff base macrocycles as efficient supramolecular receptors for selective oxoanion recognition.

**Keywords:** Sciff Base; Macrocycle; Recognition; Oxoanion

# Design and Development of IoT-Enabled Adaptive Hybrid MQL-Gas Cooling System for Sustainable Machining

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**Abstract**

Conventional flood cooling in machining consumes large quantities of cutting fluid, resulting in increased material consumption, disposal costs, and environmental impact. Although Minimum Quantity Lubrication (MQL) significantly reduces lubricant consumption, conventional fixed-rate MQL systems may not respond effectively to changing machining conditions, particularly during severe cutting operations. This work presents an IoT-enabled adaptive hybrid MQL–gas cooling system that integrates vibration-triggered lubrication with temperature-activated gas cooling. The proposed system uses vibration-based pulse-width modulation (PWM) to regulate lubricant flow through a peristaltic pump, while temperature-based control activates gas cooling when the tool-holder temperature exceeds a predefined threshold. The system was experimentally implemented and evaluated on a centre lathe during turning operations. The experimental observations demonstrated stable adaptive control, responsive lubricant delivery, and reliable switching between MQL and gas-cooling modes according to machining conditions. The proposed system provides an adaptive approach to machining temperature management while reducing unnecessary lubricant consumption compared with conventional flood cooling. Overall, the developed system demonstrates the feasibility of integrating real-time sensing, IoT-based monitoring, and adaptive cooling control for improved resource efficiency and sustainable machining.

**Keywords:** Adaptive Control; Gas Cooling; Internet of Things (IoT); Minimum Quantity Lubrication (MQL); Sustainable Machining.

# A Chitosan Based Supramolecular matrix for FRET mediated Light Harvesting and White Light Emission

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**Abstract**

Artificial light harvesting systems based on supramolecular assemblies have emerged as promising scaffolds for mimicking natural photosynthetic processes and unfolding advanced functional photonic materials. In particular, the incorporation of fluorophores within soft and biocompatible matrices offers opportunities to control excitation energy transfer and tune multicolour or white light emission. Herein, a supramolecular donor–acceptor light harvesting system was developed using pyrene aldehyde as an energy donor and diketopyrrolopyrrole Derivative as an energy acceptor, followed by its integration into a Chitosan based hydrogel matrix.Initially, the photophysical behaviour of the donor–acceptor pair was investigated in solution, where efficient Förster resonance energy transfer (FRET) was achieved through appropriate spectral overlap and donor–acceptor interactions, a near-white emission was obtained with CIE chromaticity coordinates of (0.33, 0.31).To recapitulate this Solution-state light-harvesting behaviour into a solid-state platform, Pyrene aldehyde was incorporated into chitosan through dynamic Schiff-base formation, generating a Chromophore functionalized hydrogel network, followed by the incorporation of DPPD as the energy acceptor. The resulting supramolecular mixtures were casted into free standing films and investigated using solid state fluorescence spectroscopy and scanning electron microscopy (SEM). While the donor–acceptor system exhibited efficient white-light generation in solution, the corresponding hydrogel derived films displayed a significant change in their emission characteristics, and the near-white emission was not retained in the solid state. This behaviour highlights the strong influence of matrix induced molecular packing, aggregation, intermolecular interactions, chromophore separation, and restricted molecular mobility on energy-transfer processes in condensed phases.SEM analysis showed morphological features of the films with their photophysical response. Overall, this study establishes a solution to-solid-state supramolecular light-harvesting platform and define role of polymeric network in governing FRET and emission behaviour. These findings provide a foundation for further molecular and morphological engineering toward solid-state white-light-emitting materials and functional applications in sensing, anti-counterfeiting, imaging, and photonic devices.

**Keywords:** Supramolecular Light Harvesting; FRET; White Light Emission

# Extended-Source Heterojunction TFET for Enhanced DC and RF Performance

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**Abstract**

The continued scaling of conventional MOSFETs has led to several challenges, such as increased leakage current, short-channel effects, and the limitation of subthreshold swing associated with thermionic carrier transport. To overcome these issues, tunnel field-effect transistors (TFETs) have received considerable attention as potential devices for low-power applications due to their band-to-band tunnelling based operation. Over the years, different device structures, including nanowire, double-gate, vertical, and heterojunction TFETs, have been explored to improve the tunnelling process and overall device performance. Along with structural modifications, material engineering has also played an important role in improving the energy-band alignment and enhancing carrier tunnelling at the source-channel junction.

In this work, an extended-source heterojunction TFET structure is proposed by combining material and structural engineering approaches. The extended-source region helps in improving the tunnelling junction and creates a stronger electric field in the active tunnelling region, which results in enhanced carrier transport. The proposed device shows an improved ON-state current while maintaining a low OFF-state leakage current and a favourable average subthreshold swing. In addition to the improved transfer characteristics, the proposed structure also shows enhanced AC performance, including better transconductance ($g_m$) and frequency response. These improvements indicate that the extended-source approach can effectively strengthen the band-to-band tunnelling process while maintaining good switching and dynamic performance. Therefore, the proposed device offers a promising approach for future low-power and high-performance electronic applications.

**Keywords:** Tunnel field-effect transistor (TFET); Extended-source; Heterojunction; Band-to-band tunnelling (BTBT); RF performance

# Development of a Flaxseed-Based Hydrogel for Adsorptive Removal of Auramine O Dye from Aqueous Media.

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**Abstract**

The discharge of hazardous synthetic dyes in industrial effluents poses a serious threat to the environment and ecology, and hence there is a demand for the development of sustainable wastewater remediation technologies. The present study reports the synthesis of a new eco-friendly hydrogel using flaxseed powder as a biopolymer backbone. The hydrogel was synthesized via free-radical polymerization in a hot air oven by using acrylamide as a monomer, N, N'-methylene bisacrylamide (MBA) as a crosslinker, and ammonium persulfate (APS) as an initiator in a deionized water solvent. Systematic variation of synthesis parameters such as reaction temperature, time, and concentrations of MBA, APS, and acrylamide was done in an effort to optimize water absorbency. Under optimized conditions (120 °C for 80 minutes), the synthesized hydrogel showed an extraordinary maximum equilibrium swelling capacity of 1078%. The optimized hydrogel was successfully characterized by FTIR, SEM, XRD, and TGA for its structural, morphological, and thermal properties, confirming the successful grafting of the polymer network and indicating a highly porous, hydrophilic structure. These strong structural properties are the basis for current ongoing research to evaluate the efficiency of the hydrogel as an adsorbent for wastewater treatment, especially for the removal of the cationic dye Auramine O. Batch adsorption experiments were conducted to evaluate the influence of pH, contact time, and initial dye concentrations on the removal efficiency and adsorption capacity. Based on the preliminary structural findings, the synthesized flaxseed-based hydrogel has a great potential to be used as a highly efficient, low-cost, bio-based adsorbent for the sustainable treatment of dye-contaminated industrial wastewater.

**Keywords:** Flaxseed hydrogel; Wastewater remediation; Adsorption; Auramine O; Swelling capacity

# Single-Step FRET-Mediated Supramolecular Light-Harvesting System for Emission of Pure White Light

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**Abstract**

The development of organic systems capable of emitting pure white light remains a significant pursuit in optoelectronic materials and advanced illumination research. In this study, we successfully synthesised enantiopure (R) and (S) configured chiral Schiff bases (SBs) and evaluated their unique photophysical properties, such as absorption, emission and Aggregation-Induced Emission Enhancement (AIEE) across varying solvent polarities. The AIEE phenomenon was tested by measuring the photoluminescence (PL) intensity in THF/Water, DMSO/Water and Ethanol/Water solvent systems. THF, DMSO and Ethanol acted as good solvents where the SBs remained molecularly dissolved, showing minimal fluorescence due to active molecular rotations. However, with the addition of water, acting as an anti-solvent, the formation of nano-aggregates restricted intramolecular rotation (RIR), leading to a massive enhancement in emission intensity at a ratio of 20:80 in THF/Water, 30:70 in DMSO: Water and 40:60 in Ethanol: Water.

To evaluate FRET, a large number of fluorophores were scanned to meet necessary FRET conditions such as requisite spatial proximity, spectral overlap and perfect orientation. A Diketopyrrolopyrrole derivative (DPPD) was observed as an Ideal fluorophore that follows FRET conditions and possesses inherent exceptional thermal and photo-stability, strong coloration, and tunable electronic properties. SBs act as high-energy blue-shifted donors, while DPPD functions as the complementary acceptor. Photophysical investigations confirm that excitation of the system at 360 nm successfully triggers FRET between the SBs donors and the DPPD acceptor. The resulting emission successfully covers the essential blue and green-to-red spectral regions, yielding high-quality pure white light. Chromaticity evaluation via the 1931 CIE chromaticity diagram demonstrates coordinates of (0.33, 0.32) with a correlated color temperature (CCT) of 5612 K, closely mirroring standard white illumination. This one-step FRET approach highlights a robust design strategy utilizing chiral AIEE-active Schiff bases and DPPD, offering promising potential for advanced organic white light-emitting devices (OWLEDs) for next-generation optoelectronic technologies.

**Keywords:** Schiff Bases; FRET; AIEE; White Light

# Ultrashort Pulse propagation via Long Range Surface Plasmon Polariton Mode

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**Abstract**

Ultrashort pulse reshaping behavior has been studied along long range surface plasmon polariton (LRSPP) mode guided along Au and Ag nanowires. Waveguide dispersion has been shown to be more for LRSPPs along Au nanowires as compared to Ag nanowires. To further analyze the effect of waveguide dispersion we have studied the ultrashort pulse reshaping. The pulse broadening has been found to be more in the case of LRSPP mode along Ag nanowires as compared to Au nanowires. It must be noted that the imaginary part of propagation constant contributes towards total pulse broadening, however, it has been found to be more prominent in the case of Au nanowire as compared to Ag nanowires.

**Keywords:** Ultrashort Pulses; Surface Plasmons; Dispersion

# Propagation Characteristics of Long Range Surface Plasmon Polariton Mode Guided along Au/Ag nanowires

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**Abstract**

Propagation characteristics of long range surface plasmon polaritons (LRSPPs) guided along gold and silver nanowires have been studied. Various characteristics under study are propagation length, confinement and dispersion. Effective index of LRSPP mode along Au nanowires has large value as compared to Ag nanowires in the entire wavelength range, which implies that LRSPP mode has strong confinement for Au nanowire as compared to Ag nanowires. For a particular wavelength, propagation length of LRSPP mode has been shown to be greater in the case of Ag nanowire as compared to Au nanowire in the considered wavelength range. Waveguide dispersion has been shown to be more for LRSPPs along Au nanowires as compared to Ag nanowires. This study should be helpful while exploring the applications of LRSPP mode.

Keywords: Surface Plasmons; Nanoires; Propagation Length

# ORGANIC THIN-FILM TRANSISTORS: THE ROAD AHEAD

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Organic Thin-Film Transistors (OTFTs) are emerging as promising devices for their potential applications in the field of healthcare, sensors and marketing applications etc. OTFTs have already dominated the display market where they are used in large matrix display backplanes and research is focused on improving their performance for use as driver elements in large matrix displays. The OTFTs also find applications in MEMS where they are used to fabricate artificial skin and bio-nose. The applications of OTFTs are varied as they can be fabricated on low-cost flexible substrates unlike the inorganic counterpart. Towards the end of 2030 and ahead, it has been estimated that the organic market will be a $250 billion business without replacing much from the inorganic semiconductors in existing electronic products. Organic TFT's offer "cradle-to-cradle" Electronics becoming the most popular choice in the era of sustainability. In recent years, the goal of OTFTs has shifted from merely trying to "copy silicon" to establishing entirely new paradigms where organic materials outperform traditional electronics. The current landscape offers OTFTs moving into **neuromorphic computing**, **biocompatible interfaces**, and **circular electronics**. OTFTs have shifted from lab to fab and are commercially available for varied applications. Research has been conducted on the performance improvement of these devices through material and device engineering. In this paper, a detailed discussion shall be carried on the performance improvement of OTFTs. The cutting-edge applications of OTFTs along with the sustainable electronics offered shall be discussed.

Keywords: OTFT; Thin Film; Transitors

# Adsorptive Removal of Crystal Voilet from Aqueous Solution Using Chemically Modified Shorea Robusta (SAL) Sawdust: Transforming Waste into Resources.

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## Abstract

The persistent presence of synthetic dyes such as Crystal Voilet (CV) in industrial wastewater poses serious environmental and health hazards due to their toxicity, stability, and resistance to conventional treatment methods. In this study, we report the development of a novel and eco-friendly **Chemically Modified Shorea Robusta Sawdust (NSRS)** for the effective adsorption of CV from aqueous solutions. The composite was fabricated by incorporating Shorea robusta sawdust and 0.1M NaOH solution. Comprehensive characterization using SEM confirmed the composite's hierarchical porous structure, while FTIR revealed functional group interactions among the components. XRD analysis validated the crystalline structure of NSRS, and TGA demonstrated enhanced thermal stability. BET analysis showed a high specific surface area of 25.509 $m^2$ /g and mesoporous nature. Batch experiments were conducted to investigate the effects of various parameters, viz., adsorbent dosages, contact duration, pH, and temperature. Adsorption studies revealed the removal efficiency of 93.53% under optimized condition of 0.5 g/L of adsorbent, 90 min contact time, pH 8, and temperature of 30°C for 50 mg/L CV solution. The adsorption kinetics were best described by the pseudo-second-order (PSO) model, Similarly, equilibrium data conformed well to the Langmuir isotherm model, indicating monolayer adsorption. Thermodynamic analysis confirmed that the process is spontaneous and endothermic. These results highlight the NSRS composite as a promising, sustainable material for advanced wastewater treatment applications.

## Keywords

Adsorption, Crystal Voilet, Wastewater treatment, Chemically Modified Shorea Robusta Sawdust

# Animal Fibre-Derived Keratin as an Effective Coating Material for In-vitro Cell Culture

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## Abstract

Animal-derived fibres such as wool, hair, feathers and horns are rich sources of keratin and keratin-associated proteins but are largely discarded as waste from livestock farming, wool processing and poultry production. Valorization of these keratin-rich wastes into functional biomaterials provides a sustainable approach for waste management and development of low-cost biomaterials for regenerative applications. In the present study, keratin was extracted from animal fibre waste and evaluated as a coating material for in vitro cell culture and tissue-regeneration applications. Keratin-coated substrates were characterized for protein composition, surface morphology and structural properties using SDS-PAGE, Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). Their biological performance was evaluated using in vitro cell culture assays, including MTT, scratch wound-healing and differentiation assays. The developed Keratin-coated substrates demonstrated good biocompatibility and supported the proliferation of fibroblasts and mesenchymal stem cells. Keratin coatings also enhanced wound closure and maintained the osteogenic and adipogenic differentiation potential of mesenchymal stem cells (MSC's). These findings demonstrate that animal fibre-derived keratin can serve as a cost-effective, biocompatible and functional coating material for cell culture, with potential applications in tissue engineering and regenerative medicine. These findings establish the potential of converting keratin-rich animal waste into a promising cost-effective, biocompatible substrate material for regenerative applications, thus promoting the circular bio-economy framework.

**Keywords:** Animal fiber waste; Biocompatibility; Coating substrates; Keratin; Tissue regeneration

# A Novel Mutation in Non-Constitutive Lycopene Beta Cyclase (CstLcyB2a) from *Crocus sativus* Modulates Carotenoid/Apocarotenoid Content, Biomass and Stress Tolerance in Plants

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## Abstract

*Crocus sativus* L. (saffron) is among the most valuable spice crops and has gained significant attention for its ability to accumulate unique compounds called apocarotenoids, including crocin, picrocrocin, and safranal. These compounds not only define saffron quality but also contribute to its nutritional and therapeutic value. Therefore, metabolic engineering of the carotenoid biosynthetic pathway offers an effective approach to improve saffron quality while enhancing its adaptability to changing environmental conditions. To investigate the role of CstLcyB2a in carotenoid biosynthesis, we characterised a novel $A^{126}$ mutation in the stigma-specific lycopene β-cyclase of *Crocus sativus*. Molecular docking analysis showed that the A126L substitution reduces the binding of CstLcyB2a to δ-carotene while retaining a stable interaction with lycopene, thereby shifting metabolic flux towards β-carotene biosynthesis. To validate these structural predictions experimentally, the A126L-CstLcyB2a variant was expressed in lycopene-producing bacterial strains, resulting in a significant increase in β-carotene accumulation. To further validate these findings *in planta*, transient overexpression of the A126L-CstLcyB2a variant in *Crocus sativus* stigmas led to a significant increase in crocin accumulation. Encouraged by these findings, we generated stable *Nicotiana tabacum* transformants expressing A126L-CstLcyB2a to examine its long-term effects on plant physiology and metabolism. Transgenic plants accumulated higher levels of β-branch carotenoids, ABA, and gibberellins (GAs) and exhibited superior growth and improved photosynthetic performance, including increased Fv/Fm and light-saturated linear electron transport. The role of phytohormone balance was further examined using exogenous hormone and inhibitor treatments, which showed that a higher $GA_4$/ABA ratio favours biomass accumulation in both wild-type and transgenic plants. This highlights the potential of CstLcyB2a as a target for engineering carotenoid metabolism to improve crop productivity, quality, and stress tolerance.

**Keywords:** A biotic stress; carotenoids; lycopene cyclase; photosynthetic efficiency; phytohormones

# Bacterial Endophytes of *Rosa damascena* Mill.: Functional characterization and bioactive potential

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## Abstract:

Increasing climate change has intensified abiotic and biotic stresses, highlighting the need for sustainable approaches to enhance plant resilience. Endophytes confer ecological advantages to their plant hosts, such as improved abiotic stress tolerance, enhanced growth and increased plant immune response against pathogen invasion. In this study, we determined the spatial distribution, chemical diversity, and ecological functions of bacterial endophytes of *Rosa damascena* from different locations of Jammu and Kashmir, India. Culture-dependent isolation revealed that *R. damascena* hosts diverse bacterial endophytes, with 63 isolates retrieved from stem and leaf tissues representing ten genera, with Bacillus being the most dominant. Several isolates exhibited multiple plant growth-promoting traits, including indole-3-acetic acid production, phosphate solubilization, siderophore production, and hydrolytic enzyme production such as lipase, amylase, cellulase, and protease. Some isolates produced ACC deaminase, an enzyme that reduces stress-induced ethylene levels and enhances plant tolerance to abiotic stresses. The presence of the *acdS* gene in *Pantoea ananatis* and *Pseudomonas rhizosphaerae* further confirmed their genetic potential for ACC deaminase production, indicating their potential for improving plant adaptation and resilience under changing climatic conditions. The bacterial endophytes were further screened for their antifungal activity against *Alternaria tenuissima*, *A. alternata* and *A. prunicola*, major pathogens of *R. damascena*. Two strains of *Bacillus subtilis* exhibited up to 90% inhibition against the three *Alternaria* spp. Culture filtrate, trypan blue, Evans blue, and MTT assays further confirmed that these strains inhibited fungal growth by causing membrane damage and loss of metabolic activity, suggesting their potential to mitigate biotic stress. These findings provide a basis for developing endophyte-based strategies to mitigate abiotic and biotic stresses, thereby improving plant resilience and contributing to sustainable agriculture.

**Keywords:** *R. damascena*; bacterial endophytes; plant growth promotion; ACC deaminase; antifungal activity.

# BAG3-p66shc Cross talk: A Potent Regulator of Pyroptosis in Atherosclerosis

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**Abstract**

Atherosclerosis is a major cause of cardiovascular morbidity, including myocardial infarction (MI), with plaque destabilization and rupture being critical determinants of disease progression. At the molecular level, pyroptosis, an inflammasome mediated cell death contributes to disease progression however the molecular details remain incompletely understood. In this regard, we intend to study the individual contribution and molecular crosstalk between BAG3, *a putative anti-pyroptotic factor, and p66shc, a potential pro-pyroptotic/cell death molecule, in* pyroptosis activation. To explore this, we will first delineate the temporal expression patterns of BAG3 and p66shc during pyroptotic activation. Further, we will delineate role of p66shc's Ser36 phosphorylation and its subsequent modulation by BAG3 in pyroptosis. Elucidating these molecular processes may provide novel insights into BAG3-p66shc cross-talk-driven pyroptosis, which may represent a potential therapeutic target in vascular pathology.

Expression levels of BAG3 and p66shc in relevant cell models were determined by western blotting. Sublethal concentrations of putative pro-pyroptotic stimuli, like LPS/ox-LDL, $CoCl_2$, $H_2O_2$ and Vitamin C anti-pyroptotic stimulus, was screened via MTT assay in dose- and time-dependent manner. Out of these, pro-pyroptotic stimuli were assessed by determining Caspase-1 cleavage, while PARP cleavage was monitored to exclude apoptosis. Temporal expression pattern of BAG3, p66shc and Ser36 phosphorylation was subsequently assessed.

Robust expression of BAG3 and p66shc in HUVEC was reported. 500 ng LPS and 30 µM $H_2O_2$ depicted least toxicity, cleavage of caspase-1 and absence of PARP cleavage. Temporal analysis revealed BAG3 showed a biphasic pattern, with low expression during active pyroptosis and peak expression its resolution. Conversely, p66shc increased progressively during pyroptotic activation and declined during resolution. Ser 36 Phosphorylated form of p66shc appeared concomitantly with caspase-1 cleavage. This expression pattern of BAG3-p66shc reverses upon Vitamin C treatment.

Our preliminary findings suggest that p66shc Ser 36 phosphorylation may be crucial for pyroptotic activation, and that BAG3's anti-pyroptotic role may involve modulating p66shc expression and activation.

**Keywords:** Pyroptosis, Caspase-1 activation, BAG3, p66shc

# Beyond Dissection: CT and MRI for Non-Destructive Visualization of Sheep Fetal Development

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## Abstract

Knowing the prenatal development is very important for setting up correct developmental timelines and morphological changes that occur in the course of the fetal development. Traditional anatomical analysis of the sheep fetuses usually implies destruction of the specimens, because it is necessary to dissect them. In the present study, the possibilities of using computed tomography (CT) and magnetic resonance imaging (MRI) as additional non-destructive methods of examination of prenatal development in sheep fetuses were considered. Prenatal specimens of the sheep at different gestational stages were examined by CT and MRI after certain preparation and positioning of the samples. While CT examination provided good visualization of mineralized structures and their relationships (bones), MRI made it possible to analyse the structure and development of soft tissues, including muscles and internal organs. The combination of both methods allowed analysing the three-dimensional fetal morphology without destroying the samples, which makes it possible to further analyse them by traditional methods of anatomy and histology. This way, the images provide detailed information about the development of axial and appendicular skeletons and the development of the related soft tissues during prenatal period. The combination of the data from CT and MRI allows building up digital three-dimensional atlas of prenatal sheep anatomy.

**Keywords:** Sheep foetus; Computed tomography; Magnetic resonance imaging; Prenatal development; 3D anatomical imaging

# Brain Metabolite, Myo-Inositol, Reshapes Alpha-Synuclein Aggregation and Attenuates Cytotoxicity: Implications of Gut-Brain Axes

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**Abstract**

Alpha-synuclein (α-syn) aggregation and the formation of heterogenous amyloid assemblies are central molecular events implicated in Parkinson's disease (PD). Familial PD-related mutations significantly modify the aggregation characteristics, structural arrangement, and pathogenic properties of α-syn. Although endogenous gut metabolites are progressively recognized as regulators of proteostasis, whether they differentially influence α-syn aggregation across early-onset disease-associated mutations remains poorly understood. In this study, we studied the effect of myo-inositol (MI) on the aggregation, structural alteration, and toxicity of wild type (WT) α-syn and its early-onset mutants (A53t and A53E). Complementary biophysical, biochemical, microscopic, thermodynamic, and cellular assays revealed that MI works as a mutation-dependent regulator of α-syn aggregates, instead of merely serving as a universal aggregation inhibitor. MI substantially inhibited the aggregation of WT and A53T, while MI redirected the aggregation of A53E towards structurally and morphologically distinct, ThT-positive, β-sheet-rich assemblies. Fourier-transform infrared spectroscopy demonstrated mutation-specific alterations in the secondary structural arrangement of assemblies, whereas fibril destabilization and proteinase K digestion analysis showed reduced structural integrity and increased susceptibility to proteolysis of the MI-induced aggregates. Importantly, MI-mediated structural remodeling was associated with reduced cytotoxicity along with altered structural organization. Thermodynamic studies revealed mutation-specific variations in MI-α-syn interactions, with WT and A53T demonstrating favorable binding energetics, while A53E displayed significantly weaker and energetically unfavorable interactions. Additionally, circular dichroism suggested that MI maintains the intrinsic disorderedness of the monomeric proteins without causing substantial structural alterations. The current results indicate that MI modifies the conformational ensemble and transient protein-protein interaction network regulating self-assembly instead of preserving a compact folded state resistant to aggregation for α-syn. Moreover, MI acts as a mutation-dependent intrinsic modulator of α-Syn aggregation and elucidates the molecular foundation for how physiologically significant metabolites can attenuate the structural and pathogenic consequences of IDP aggregation. Present findings highlight the mechanistic understanding of the metabolite mediated regulation of proteostasis and its possible relevance to the gut-brain axis in PD.

**Keywords:**

Alpha-synuclein; Aggregation; amyloid fibrils; Myo-inositol; Parkinson's disease

# Comparative Study of Biochemical Parameters in Repeat-Breeding and Normal Cyclic Dairy Cows

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**Abstract**

One of the global challenges of reproductive problems amongst dairy cows is repeat breeding. It is a multifactorial problem having huge impact on dairy industry. This study was carried out to compare serum glucose, cholesterol and total protein concentrations between repeat-breeding cows and normal cyclic cows. In group-I, 15 Crossbred dairy cows with a history of three or more unsuccessful inseminations were selected as repeat-breeding animals. Whereas, normal cyclic cows (N= 15) without repeat breeding served as control group (Group-II). Blood samples were collected from jugular vein using sterile tubes and serum was harvested and analyzed using standard biochemical kits. Repeat-breeding control cows showed markedly higher serum. The glucose concentration was significantly lower ($p<0.05$) in repeat-breeding cows (44.29 ± 0.44 mg/dL) than in normal cyclic cows (56.26 ± 0.29 mg/dL). Serum cholesterol was also significantly lower ($p<0.05$) in repeat breeder cows (93.36 ± 1.43 mg/dL) compared with normal cyclic cows (125.59 ± 1.44 mg/dL), which may indicate altered lipid metabolism and steroidogenesis. Total protein concentration was significantly lower ($p<0.05$) in repeat-breeding cows (6.59 ± 0.11 g/dL) than in normal cyclic cows (7.70 ± 0.25 g/dL). Significantly lower levels of blood serum glucose, cholesterol and total protein determine non-scientific feeding and management practices under field conditions, which leads to stress and metabolic imbalances causing repeat-breeding and infertility.

**Key words:** Repeat breeding; cows; glucose; cholesterol

# Contribution of Ceramide in Pyroptosis of VSMCs and Exosome release during Vascular Calcification via NLRP3/GSDM-D mediated pathway

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**Abstract**

Vascular calcification (VC) is an actively regulated process characterized by the osteogenic transdifferientiation of vascular smooth muscle cells (VSMCs), associated with cardiovascular morbidity and mortality. Sphingolipids, particularly ceramide (CER), play a critical role in inflammatory signaling and extracellular vesicle release during VC. In this study, we investigated whether sphingolipids such as ceramide is associated with pyroptosis in VSMCs via activation of the NLRP3 inflammasome–Gasdermin D (GSDM-D) axis and exosome secretion under calcifying conditions. VSMCs stimulated with high phosphate (Pi) caused deposition of calcific nodules and induced phenotypic transition in VSMCs associated with increased expression of osteogenic marker- RUNX2. Furthermore, prior CER- stimulation led to much more marked upregulation of osteogenic marker-RUNX2 and decreased contractile marker-SM22α in Pi-treated VSMCs. In addition, augmented expression of pyroptotic markers such as NLRP3, GSDM-D, and LDH release was observed with prior treatment of CER in Pi-treated VSMCs. Pharmacological inhibition with MCC950 (NLRP3 inhibitor) and disulfiram (GSDM-D inhibitor) downregulated osteogenic and pyroptotic markers including LDH release in both Pi-induced and CER stimulated Pi-treated VSMCs. In addition, our results provide evidence that high Pi increased the release of exosomes in Pi-treated VSMCs. These exosomes exhibited the characteristic cup-shaped structure and a diameter range of 100–120 nm as detected by Scanning Electron Microscopy. Our western blot results indicated the abundance of exosomal markers such as CD63, TSG101, and ALIX in vesicles isolated from control and Pi-treated VSMCs. These findings identify enhanced exosome secretion as an early and regulated response of VSMCs to high Pi and increased sphingolipids, providing mechanistic insight into how CER stimulated extracellular vesicle dynamics may couple metabolic imbalance to pathological VC. Concluding, our findings demonstrate that CER contributes to activation of NLRP3/GSDM-D signaling associated with VSMC pyroptosis, and enhanced exosome release thereby contributing to the progression of vascular calcification.

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Keywords: Ceramide; Exosomes; NLRP3; Pyroptosis; Vascular Calcification

# Cost-Benefit Analysis of *Picrorhiza kurroa* Royle Ex Benth., under Different Nutrient Management Regimes

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## Abstract

*Picrorhiza kurroa* Royle ex Benth. is a high-value medicinal herb of the Himalayan region, valued for its therapeutic properties and bioactive iridoid glycosides, particularly picroside-I and picroside-II. Increasing demand and pressure on natural populations necessitate systematic cultivation under suitable nutrient management regimes. The economic viability of cultivation depends on optimizing production costs against returns. The present study aimed to evaluate the cost–benefit economics of *P. kurroa* under different nutrient management regimes and identify the most economically viable treatment. Ten nutrient management treatments ($T_1$-$T_{10}$), comprising combinations of planting material, FYM, litter, N, P, K, vermicompost and Azotobacter, were evaluated. Input and labour costs were calculated on a hectare basis. Income from stolons, roots and leaves was estimated, and gross income, net income and benefit–cost (B) ratio were calculated for each treatment. Total expenditure varied from Rs. 4,51,696 $ha^{-1}$ ($T_1$) to Rs. 20,51,696 $ha^{-1}$ ($T_5$), while gross income ranged from Rs. 18,37,433 $ha^{-1}$ ($T_1$) to Rs. 24,61,505 $ha^{-1}$ ($T_9$). Stolons contributed the major share of income (62.11-66.87%), followed by leaves (25.80-28.75%) and roots (6.11-9.69%). Net income ranged from Rs. 76,776 $ha^{-1}$ in $T_5$ to Rs. 18,85,234 $ha^{-1}$ in $T_8$. The benefit ratio ranged from 0.037 (T5) to 3.82 ($T_8$). $T_8$ recorded the highest benefit ratio (3.82), followed by $T_7$ (3.38), $T_4$ (3.37), $T_3$ (3.20), $T_1$ (3.07) and $T_2$ (3.05). Although $T_9$ produced the highest gross income, its higher cultivation expenditure reduced overall profitability. $T_8$ achieved a favourable balance between income and expenditure, resulting in the highest net return and benefit ratio. Conversely, the negative return under $T_5$ indicates poor economic efficiency associated with excessive input costs. Therefore, nutrient management substantially influenced the economic performance of *P. kurroa.* $T_8$ emerged as the most economically efficient treatment, with a net income of Rs.18.85 lakh $ha^{-1}$ and benefit ratio of Rs. 3.82, indicating its potential for economically sustainable cultivation of *P. kurroa* in the Himalayan region.

**Keywords:** *Picrorhiza kurroa;* Cost-Benefit Analysis; Nutrient management; Himalayan region

# Development of Patient-Derived Epithelial and Stromal *In Vitro* Models of Gastrointestinal Tract Cancers from Kashmir

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**Abstract**

Gastrointestinal Tract (GIT) cancers represent a major oncological burden in India, with Kashmir reporting a high incidence of upper GIT malignancies. The regional burden has been associated with distinct dietary, environmental, and population-specific factors, underscoring the need for representative experimental systems. Despite this burden, patient-derived experimental models from this population remain scarce, limiting investigation of tumor heterogeneity, disease progression, and tumor–microenvironment interactions. This study aimed to establish patient-derived epithelial and stromal *in vitro* models of upper GIT cancers and to functionally characterize the Esophageal Cancer(EC) models.

Fresh tumor tissues from patients with upper GIT cancers were processed under optimized primary culture conditions. Two patient-derived EC cell lines, KECP and KECM, together with three stromal/fibroblast cultures, were established and propagated *in vitro*. KECP and KECM underwent phenotypic and functional characterization using pan-cytokeratin immunostaining, proliferation assays, epithelial–mesenchymal transition (EMT) assessment, migration and invasion assays, and cytokine profiling of conditioned media. Five patient-derived *in vitro* models, comprising two epithelial EC cell lines and three stromal/fibroblast cultures, were successfully established. Both KECP and KECM showed strong pan-cytokeratin expression, supporting their epithelial phenotype. KECM demonstrated greater proliferative potential, enhanced EMT-associated features, and significantly increased migratory and invasive behavior compared with KECP. Cytokine profiling revealed increased secretion of IL-6, MCP-1/CCL2, MIP-2, and MMP-2 by KECM, consistent with more aggressive and pro-tumorigenic phenotype. The stromal cultures are undergoing further phenotypic and molecular characterization.

We established patient-derived epithelial and stromal *in vitro* models of upper GIT cancers from Kashmir. The EC models displayed marked biological heterogeneity, with KECM exhibiting enhanced proliferation, EMT, migration, invasion, and secretion of tumor-promoting mediators. The parallel establishment of stromal cultures broadens this platform beyond the epithelial compartment and provides a foundation for investigating tumor–microenvironment interactions and potential therapeutic vulnerabilities in GIT malignancies.

**Keywords:** Gastrointestinal tract cancer; Patient-derived cell lines; Fibroblasts; Epithelial–mesenchymal transition; Kashmir

# Direct Methylation Profiling of Circulating Cell-Free DNA and Circulating Tumour DNA Using Oxford Nanopore Sequencing in Cancer

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**Abstract**

Liquid biopsy has emerged as a promising non-invasive approach for cancer detection and monitoring by analysing blood-based biomarkers. Cell-free DNA (cfDNA), along with its tumour-derived fraction, circulating tumour DNA (ctDNA), contains molecular information released by cancer cells into the bloodstream. Among various molecular alterations, DNA methylation changes occur early during tumour development and remain relatively stable, making them suitable targets for blood-based cancer analysis. This study aims to evaluate the application of Oxford Nanopore sequencing for direct methylation profiling of cfDNA and ctDNA in cancer. The primary emphasis is on prostate cancer, with inclusion of healthy control samples for comparison. Unlike conventional short-read sequencing methods that depend on bisulfite conversion and PCR amplification, Nanopore sequencing enables PCR-free, single-molecule analysis of native DNA, allowing direct detection of methylation patterns while minimising technical bias. In this work, cfDNA will be isolated from plasma samples of cancer patients and healthy individuals, followed by whole-genome Nanopore sequencing and alignment to the human reference genome. Methylation patterns of a defined panel of cancer-related genes will be analysed to identify differential methylation signatures between cancer and control samples. The performance of individual methylation markers will be compared with multi-gene panels to assess their potential utility as blood-based biomarkers. In addition, the relationship between ctDNA methylation patterns and clinical parameters, such as disease stage and treatment status, will be explored. Overall, this study aims to establish a robust, reproducible Nanopore-based workflow for cfDNA/ctDNA methylation analysis, thereby supporting the development of non-invasive epigenetic biomarkers for cancer detection and monitoring.

Keywords: cfDNA; biomarker; prostate cancer; nanopore sequencing

# EcoPreserve: Low-Cost, Non-Toxic Alternatives for Long-Term Biological Specimen Preservation in Resource Limited Environment

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## ABSTRACT

The preservation of biological specimens is fundamental to anatomical education, medical training, and scientific research. Conventional techniques, particularly formalin fixation, pose significant challenges including toxicity, high costs, environmental hazards, and limited accessibility for under-resourced institutions. This research investigated three innovative, cost-effective preservation methods—modified plastination, balloon inflation, and jelly wax embedding—as sustainable alternatives to traditional techniques. The modified plastination technique employed a chloroform-melamine composite as an affordable substitute for expensive silicone polymers, achieving an 80% reduction in material costs while producing durable, odorless specimens that maintained structural integrity for over two years without deterioration. The balloon inflation method emerged as a simple yet highly effective approach for preserving hollow organs including stomach, bladder, and trachea, utilizing inexpensive latex balloons to maintain natural luminal architecture and prevent collapse, making it particularly valuable for surgical and endoscopic training. The jelly wax embedding technique offered a novel strategy for preserving soft tissues, embryos, and thin tissue slices, enabling room-temperature storage for extended periods without refrigeration, with the additional advantage of wax reusability. All three methods eliminated or substantially reduced reliance on hazardous formalin, thereby minimizing health risks for students and educators while generating significantly less toxic waste. These techniques require minimal infrastructure, making them readily adoptable by institutions with limited laboratory facilities and financial constraints. The research outcomes include standardized protocols, a validated specimen collection, comprehensive cost-benefit analyses, and training materials for technology dissemination. This research directly addresses the pressing global need for safe, affordable, and sustainable anatomical preservation methods, empowering under-resourced educational institutions to establish independent specimen preservation capabilities. By making high-quality anatomical teaching materials accessible to a broader range of institutions worldwide, this research promotes educational equity, occupational safety, and environmental sustainability in the anatomical sciences.

**Key words:** Plastination; Jelly wax; Formalin; Low-cost preservation; Anatomical specimens

# Elucidating The Role of Ferroptosis In The Pathogenesis of Polycystic Ovarian Syndrome Associated Infertility

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**Abstract**

Polycystic ovary syndrome (PCOS) is a highly prevalent endocrine-metabolic disorder among women of reproductive age characterised by hyperandrogenism and ovulatory disfunction Studies have shown that different type of cell deaths has been identified as the major factors in aberrant follicle maturation and are a leading cause of infertility worldwide. In addition to apoptosis and necrosis, the newly recognised form of iron dependent programmed cell death namely ferroptosis is closely related to the pathophysiological processes of many diseases like Cancer, Diabetes Mellitus and Renal failure.However compare with these established disease associations , the involvement of ferroptosis in reproductive dysfunction and infertility remains relatively less explored .The study hypothesized that PCOS-associated reproductive dysfunction is accompanied by dysregulated iron metabolism, increased oxidative stress and lipid peroxidation, and impaired ferroptotic defense mechanisms, particularly reduced GPX4 expression and altered iron-storage pathways. Recent experimental studies similarly report increased ferroptosis in PCOS ovaries. Female rat models were divided into control, PCOS-induced, and ferroptosis inhibitor-treated groups, with model validation confirmed through estrous cycle tracking, serum hormone profiling and ovarian histopathology. Ovarian ferroptosis and oxidative damage were evaluated by quantifying tissue iron content, malondialdehyde (MDA), reduced glutathione (GSH), and antioxidant enzyme activities alongside molecular profiling of key pathway regulators via RT-qPCR and Western blotting. Histopathological and immunohistochemical analyses will further characterize ovarian and follicular alterations associated with ferroptotic injury. The study is expected to provide mechanistic insights into the contribution of ferroptosis to PCOS-associated infertility and establish a relationship between iron dysregulation, oxidative stress, ovarian follicular damage, and reproductive dysfunction. and assessed whether its pharmacological inhibition mitigates tissue damage and improves reproductive parameters Understanding this pathway may identify ferroptosis-related molecular markers and potential therapeutic targets for improving ovarian function and fertility outcomes in PCOS

Keywords: Polycystic Ovary Syndrome (PCOS), Ferroptosis, Lipid Peroxidation, Glutathione Peroxidase 4 (GPX4), Anovulatory Infertility

# Estrogen Receptor α (*Esr1*) Mediates Estrogen-Driven Persistence and Neoplastic Progression of Cutaneous MmuPV1 Infection in Male and Female Mice

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**Abstract**
Persistent papillomavirus infection is a key driver of neoplastic progression in both mucosal and cutaneous epithelia. Although estrogen is a well-established cofactor in HPV-associated cervical carcinogenesis, its role in cutaneous papillomavirus disease has remained poorly understood. Using a murine papillomavirus type 1 (MmuPV1) infection model in immunocompetent *FVB/N* mice, we investigated whether estrogen influences viral pathogenesis in infected cutaneous epithelia. Estrogen treatment significantly increased wart incidence and growth independent of sex and was associated with pronounced epithelial hyperplasia, dysplasia, koilocytosis, and features of invasive squamous cell carcinoma. Systemically, estrogen reduces circulating leukocytes, while locally suppressing adaptive immune infiltration and enriching neutrophils within lesions, indicating broad immunosuppression coupled with selective innate enhancement. MmuPV1 E4 and L1 RNA and protein levels were elevated in warts of estrogen-treated WT mice, indicative of enhanced productive infection. Importantly, *Esr1* germline knockout mice exhibited significantly reduced wart incidence and size in both males and females, lower MmuPV1 E4 and L1 transcript levels, coupled with the absence of estrogen-induced depletion of circulating immune cells, demonstrating that ERα signaling mediates estrogen-driven epithelial proliferation, immune modulation, disease progression and productive viral infection. Collectively, these novel findings indicate that estrogen is a potent cofactor in cutaneous papillomavirus disease, acting through ERα-dependent pathways to drive virally induced neoplastic diseases, including cancer.

**Keywords:** Papillomaviruses; ERα; MmuPV1; Immune evasion; Cutaneous infection; Host-pathogen interaction

# Evaluation of Cortisol and Malondialdehyde as Biochemical Markers of Stress and Reproductive Dysfunction in Repeat-Breeding Dairy Cows

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## Abstract

Repeat breeding is a major reproductive problem in dairy cattle. It is manifested as a syndrome and is often associated with disturbances in endocrine function, oxidative balance and metabolic status. The present study was conducted in 30 dairy cows to compare serum cortisol and malondialdehyde (MDA) concentrations between repeat-breeding cows and normal cyclic cows (15 animals in each group). Crossbred dairy cows with a history of three or more unsuccessful inseminations were selected as repeat-breeding animals (Group-1, n=15), while normal cyclic cows without any history of repeat breeding served as control (Group-2, n=15). Blood samples were collected from jugular vein using sterile tubes and serum was harvested and analyzed using standard biochemical and ELISA-based techniques. Repeat-breeding cows showed markedly higher serum cortisol (21.85 ± 0.43 ng/mL) , ($p<0.05$) than normal cyclic cows (10.28 ± 0.19 ng/mL), ($p<0.05$) indicating increased physiological stress affecting the hypothalamic–pituitary–adrenal axis. Similarly, MDA concentration was significantly higher in repeat-breeding cows (6.51 ± 0.27 nmol/mL), ($p<0.05$) than in normal cyclic cows (4.47 ± 0.17 nmol/mL), ($p<0.05$) suggesting increased lipid peroxidation and oxidative stress. Overall, there was a simultaneous elevation of cortisol and MDA levels in repeat breeding cows of group-1 compared to normal cyclic cows of group-2 reflecting a stress-associated oxidative imbalance, affecting the fertility in the former group. It was concluded that both cortisol and MDA served as effective biochemical stress markers for understanding and managing repeat breeding in dairy cattle.

**Keywords:** Repeat breeding, normal cyclic; dairy cattle

# Exosomal Novel Downstream Effector of Phosphorylated AKT Mediates Intercellular Transfer of Doxorubicin Resistance in Breast Cancer

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## Abstract

Breast cancer remains the second leading cause of cancer-related deaths among women worldwide. Doxorubicin, a commonly used chemotherapeutic agent, is often rendered less effective due to the development of drug resistance. Emerging evidence highlights the role of exosomes, small vesicles involved in intercellular communications in mediating chemoresistance. In the present study, we examined the contribution of exosomes released from doxorubicin-resistant breast cancer cells to the development of chemoresistance and evaluated changes in cell viability in non-resistant breast cancer cells after treatment with exosomes from DOX-resistant cells. Doxorubicin-resistant breast cancer cells were generated, and exosomes from parental and resistant cells were isolated and characterized. Mass spectrometry, Phosphokinase array, Western blotting, Bioinformatics, and patient cohort analyses were performed to identify key exosomal proteins involved in the transfer of doxorubicin resistance. Doxorubicin-resistant breast cancer cells exhibited enhanced cell survival and clonogenicity, accompanied by enhanced glucose utilization and lactate production. Exosomes derived from doxorubicin-resistant breast cancer cells significantly enhanced viability and clonogenicity in doxorubicin-sensitive breast cancer cells. Mass spectrometry of exosomes from DOX-resistant cells revealed distinct alterations in protein cargo, suggesting that exosomal proteins may facilitate the transfer of resistance-associated factors to sensitive cells and contribute to doxorubicin resistance. Novel protein was identified as the hub protein and its overexpression promotes breast cancer progression and poor survival through activation of PI3K–AKT/mTOR signalling. Our findings highlight that exosome-enriched in novel protein may activate PI3-AKT pathway, thereby facilitating doxorubicin resistance. Silencing of novel protein via siRNA in breast cancer cells reduces the survival advantage conferred by exosomes of resistant breast cells suggesting its critical role in mediating the survival-enhancing effects. Moreover, the pharmacological inhibition of AKT re-sensitized Doxorubicin-resistant breast cancer cells to Doxorubicin, confirming its crucial functional role. Our findings suggest the importance of the novel protein–AKT/mTOR/S6K axis as a critical driver of chemoresistance.

**Keywords: :** Breast cancer; Doxorubicin; Resistance; Exosomes; AKT

# Exploring Bioactive Molecules: Purification and Prospective Characterization of Anticancer and Antifungal Proteins from Medicinal Plants

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**Abstract**

Medicinal plants represent important reservoirs of biologically active molecules, with major bioactive constituents being secondary metabolites like flavonoids, alkaloids, phenolics, terpenoids, and essential oils. Although secondary metabolite-based drugs have emerged as efficient anti-cancer agents under *in vitro* conditions, their inadequate bioavailability, toxicity and non-specific target engagement have rendered them unsuccessful during clinical trials .On the other hand, plant-derived proteins and peptides are emerging as promising therapeutic agents due to their diverse activities, high specificity with reduced off-targets and unique mechanisms of action. In fact, their potential applications are relevant in reference to cancer and fungal infections as existing therapies exhibit severe limitations and emergence of drug resistance. *Trillium govanianum* Wall. ex D. Don, a medicinal plant of the Himalayan region belonging to family melanthiaceae , has been investigated primarily for its steroidal saponins and other secondary metabolites. However, its protein constituents and therapeutic potential remain mostly unexplored. In our preliminary work, we have identified bioactive protein fraction from *Trillium govanianum* that exhibited significant anticancer and antifungal activity, however the actual protein/peptide constituents responsible for the bioactivity remain to be elucidated. In this study, we have standardized the isolation and purification of individual protein(s) from the bioactive protein fraction of *Trillium govanianum* as an initial step towards their molecular identification by Mass spectrometry and subsequent structural and functional characterization. The bioactive fraction was initially subjected to gradual Ammonium salt fractionation followed by purification using various chromatographic techniques. The chromatographic fractions were collected and analysed using SDS-PAGE to determine the apparent molecular weight and protein purity. The fractions showing purified protein bands will be selected for downstream identification, characterization and evaluation of their biological activity. The anticipated results are expected to provide new insights into plant-based therapeutic proteins/peptides and may lead to the development of safer and effective drug candidates in future.

**Keywords:** Medicinal plants; Trillium govanianum; Bioactive protein fraction, anticancer activity; antifungal activity

# GAPDH as a Central Regulator of Extracellular Vesicle Secretion and Cargo Dynamics in Cancer Systems

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**Abstract**

Extracellular vesicles (EVs), particularly exosomes, play a central role in cancer progression by mediating intercellular communication and the transfer of bioactive molecules. While GAPDH is traditionally known as a glycolytic enzyme, emerging evidence suggests additional non-metabolic functions linked to membrane dynamics and vesicular trafficking. However, the mechanistic role of GAPDH, particularly its EV-binding region, in regulating vesicular secretion remains poorly understood.

This study aimed to investigate the role of GAPDH and its EV-binding G58 domain in the regulation of EV secretion and cargo modulation in cancer cell systems. Recombinant GAPDH protein and multiple clones encoding the G58 domain were generated and validated through molecular cloning and protein characterization. Extracellular vesicles were isolated from various cancer cell lines using total exosome isolation reagent. Vesicles were characterized by scanning electron microscopy to confirm morphology, dynamic light scattering to determine the size distribution, and Western blot analysis to verify the presence of established exosomal markers. Functional assessment was performed to evaluate the influence of GAPDH and G58 domain expression on vesicle biogenesis and secretion. Characterization confirmed successful production of GAPDH and G58 domain clones with preserved glycolytic activity. Isolated vesicles displayed typical exosomal morphology and size profiles. Increased GAPDH expression correlated with enhanced EV secretion. Expression of the G58 domain alone significantly influenced vesicle release, indicating that vesicle interaction occurs independently of GAPDH catalytic activity. Cancer-derived cells exhibited stronger GAPDH-associated vesicle interactions compared with non-malignant cells. The findings demonstrate that GAPDH functions as an active regulator of EV secretion through the G58 domain. This study establishes a non-glycolytic role for GAPDH in vesicle biogenesis and cargo regulation and identifies the G58 domain as a key structural determinant controlling EV dynamics in cancer cells. These results provide mechanistic insight into EV regulation and highlight GAPDH-mediated pathways as potential therapeutic targets in cancer.

**Keywords:** Cancer progression; Extracellular vesicles; Exosomes; G58 domain; GAPDH

# Impaired DNA Polymerase ε Processivity Activates the S-Phase Checkpoint

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## Abstract

The DNA replication fork is persistently challenged by endogenous and exogenous obstacles that threaten genome stability. Protective mechanisms, including checkpoint kinase signaling, counteract replication stress to preserve fork integrity. While Mec1 and Rad53 kinases are central to stabilizing stalled forks, the role of replicative polymerases, particularly DNA polymerase epsilon (Pol ε), in this process remains mechanistically undefined. Here, we engineered Pol ε mutants with impaired polymerase activity and heightened enhanced primer-terminus degradation in vitro. Strikingly, the degree of the DNA synthesis defect directly mirrored the extent of Mec1-Rad53 checkpoint activation, which augmented the dNTP pool to compensate for replication inefficiency. Loss of Mrc1 or Rad9 further exacerbates the growth defect of the Pol2 variants, highlighting the importance of checkpoint-mediated responses in tolerating impaired Pol ε function. Importantly, whether Pol ε exonuclease activity contributes to checkpoint activation in response to impaired polymerase function remains poorly understood. Our findings indicate that inactivation of the Pol ε exonuclease activity does not significantly alter checkpoint activation, suggesting that the observed checkpoint response is more likely driven by defective DNA synthesis and reduced polymerase processivity rather than altered proofreading activity. Furthermore, AlphaFold-based structural modeling revealed that Pol ε mutants exhibit altered nucleotide interactions and disrupted contacts associated with some cancer-associated mutation, directly linking these predicted structural alterations to impaired DNA synthesis. Together, these findings establish a link between Pol ε processivity, replication fork stability, and S-phase checkpoint activation and provide a framework for understanding how POLE mutations may contribute to replication stress and genome instability.

**Key words:** Checkpoint activation; DNA polymerase epsilon; DNA replication

# Increasing Trend of MRSA in Community Acquired Acute Hematogenous Osteomyelitis in Pediatric Age Group. Do We Need To Worry?

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## Abstract

Acute hematogenous osteomyelitis (AHO) is a common problem in the pediatric age group and is associated with a number of serious complications. Despite this the microbiological profile of community acquired AHO (CA-AHO) has not been studied much in our region. This becomes all the more important due to the emergence of Methicillin resistant Staphylococus aureus (MRSA). Patients and methods: 120 children, fulfilling the inclusion and exclusion criteria, with CA-AHO were included in the study and the pus or altered fluid drained was sent for culture sensitivity. Antibiotic sensitivity was done using appropriate methods. Results: Mean age of the patients was 8.47 years, with most being from 5 to 12 years, with fever and pain being the most common symptoms. Distal femur, proximal tibia and distal tibia were the most common sites. Culture was positive in 103 patients (85.9 %), Staph aureus being the most common organism (81.6 %). MRSA was isolated in 76 patients (63.3 %).All the MRSA were sensitive to Linezolid, while one patient was resistant to Vancomycin and 6 patients (7.9%) were resistant to clindamycin. Further, patients with MRSA had more severe symptoms in terms of average temperature, pulse rate, TLC and ESR and CRP levels on admission, with temperature and ESR being statistically significant. Patients with MRSA had higher CRP values at discharge and had a longer hospital stay, with both being statistically significant. Conclusion: MRSA is emerging as the dominant pathogen in community associated acute hematogenous osteomyelitis. This worrisome development requires a change in the treatment of this condition, especially the empiric antibiotics used. Further, a proper antibiotic policy and avoiding misuse of antibiotics may help to prevent microbial resistance.

**Key Words:** Community acquired; acute osteomyelitis; MRSA.

# *In-vitro* Evaluation of Neutrophil Extracellular Trap Formation Following *Pasteurella multocida* Infection in Buffalo Neutrophils

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**Abstract**

Neutrophils are an important component of innate immune system and are considered as the first line of defense against invading pathogens. Neutrophils capture and destroy invading microorganisms, through phagocytosis and intracellular degradation, release of granules, and formation of neutrophil extracellular traps (NETs). Neutrophils secrete NETs to kill a number of pathogens of cattle including *E. coli, S. aureus, Histophilus somni* and *M. haemolytica.* However, there is no report on NETs in buffalo during normal and diseased conditions and if inhibiting TNF-α modulates the apoptosis or NET potential of buffalo neutrophils. So, the present investigation focuses on first time evaluating *Pasteurella multocida* induced NETs in buffalo neutrophils. The freshly isolated neutrophils were treated with PMA, *P. multocida* and anti-TNF-α. The percentage of neutrophils showing NETosis in each group was compared at different time intervals (0 min, 30 min, 60 min and 120 min). Neutrophils showed a time dependent increase ($p<0.05$) in NET production following incubation with PMA and *P.multocida*. However, incubation with anti-TNF-α, for 60 and 120 minutes reduced ($p<0.05$) the NET formation. We report first data on the potential of buffalo neutrophils to form NETs with or without co-culture with *P. multocida.*

**Keywords:** Buffalo neutrophils; NETosis; anti-TNF-α, *P. multocida.*

# Isolation and Screening of Tyrosinase Producing Bacteria from Different Soil Samples

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## Abstract

Tyrosinase is a copper-containing oxidoreductase that is found in many microbes, plants, and mammals. Microbial tyrosinases have attracted a lot of research due to their wide substrate specificity, catalytic adaptability, and potential for synthesis under controlled fermentation conditions. It is an essential enzyme with potential uses in biotechnology, environmental remediation, food processing, and pharmaceutical research. The goal of present investigation was to isolate and screen tyrosinase producing bacteria from soil samples collected from specific forest and industrial sites in Gurugram and Delhi, India, which reflect a variety of ecological and man-made habitats. For isolation of tyrosinase producing bacteria, the collected soil samples were enriched with L-tyrosine, serially diluted up to $10^{-1}$ to $10^{-9}$ times, and 100 µl of each dilution ($10^{-3}$ to $10^{-5}$) was spread over media containing L-tyrosine and incubated at 30ºC for 48hrs. Preliminary screening for tyrosinase-producing capability was carried out on the basis of appearance of brown to black pigmentation linked to melanin synthesis as a result of L-tyrosine oxidation. Morphologically distinct colonies were chosen and repeatedly streaked for establishment of pure line cultures. The tyrosinase activity of the possible isolates was then assessed using an DOPA estimation assay. Based on the results of primary and secondary screening, out of 29 bacterial isolates TPB13A was selected for further studies for its ability to produce maximum tyrosinase. The isolated tyrosinase producing bacteria may have significant biotechnological applications, especially in the creation of biosensors for the detection of phenolic chemicals and in the bioremediation of industrial and phenolic contaminants.

**Keywords:** Tyrosinase; L-tyrosine; L-DOPA; and enzyme activity.

# MGMT Gene Silencing by Promoter Hypermethylation in Colorectal Cancer in the Kashmiri Population

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## Abstract

Promoter hypermethylation-mediated silencing of DNA repair genes is an important epigenetic event in colorectal carcinogenesis. O (6)-methylguanine-DNA methyltransferase (MGMT) plays a critical role in repairing DNA alkylation damage, and its inactivation may contribute to genomic instability. This study aimed to investigate MGMT promoter hypermethylation and protein expression in colorectal cancer patients from the Kashmiri population. Fifty colorectal cancer tissue samples along with corresponding adjacent normal tissues were analyzed. MGMT promoter methylation was assessed by methylation-specific PCR (MS-PCR), while MGMT protein expression was evaluated by Western blotting. The association of MGMT methylation and protein expression with clinicopathological characteristics was also examined.MGMT promoter hypermethylation was frequently observed in colorectal cancer tissues and was accompanied by reduced or loss of MGMT protein expression. Hypermethylation and loss of expression were associated with unfavorable clinicopathological features, particularly higher tumor grade and advanced stage. Our findings suggest that MGMT promoter hypermethylation and consequent loss of MGMT expression may contribute to colorectal cancer development and progression in the Kashmiri population. MGMT promoter methylation may therefore represent a potential epigenetic biomarker for colorectal cancer.

# Molecular Adaptation to Long Term Androgen Deprivation and Therapeutic Resistance in Prostate Cancer

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**Abstract**

Prostate cancer is the second most frequently diagnosed cancer in men and the fifth leading cause of cancer-related mortality worldwide. Androgen receptor (AR) signaling is essential for prostate cancer growth, making androgen deprivation therapy (ADT) a primary treatment for advanced prostate cancer. Although patients initially respond to ADT, prolonged androgen deprivation is associated with tumour adaptation and the eventual development of castration-resistant prostate cancer (CRPC). Therefore, understanding the molecular mechanism behind this adaptation is important for the development of novel therapeutics against PCa. In this study, Long-term androgen-deprived prostate cancer cell models were established by culturing prostate cancer cell lines under androgen-depleted conditions using charcoal-stripped serum and their morphological and molecular characteristics were investigated.

Cellular response to long term androgen deprivation was monitored and compared with the corresponding parental cell line using cell proliferation 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. Western blotting was performed to assess the expression of proteins associated with AR and Wnt signaling. Further protein expression was examined by immunofluorescence. The long-term androgen-deprived models continued to grow under androgen-depleted conditions and showed reduced sensitivity to enzalutamide compared with their parental counterparts. AR protein expression was maintained in long-term androgen deprived models, whereas Wnt protein regulator expression was reduced in the androgen-deprived models. These findings show that long-term androgen deprivation is accompanied by sustained cellular growth, reduced enzalutamide sensitivity, and altered AR and Wnt- related protein expression in prostate cancer models. These observations provide evidence of phenotypic and molecular changes associated with adaptation to prolonged androgen deprivation. Further investigation of β-catenin signaling and downstream Wnt target genes will be required to determine whether these alterations are associated with prostate cancer adaptation and therapeutic resistance following long term androgen deprivation.

**Keywords:**

Androgen Deprivation Therapy; Enzalutamide; Prostate Cancer; Wnt/β-Catenin Signaling; Castration-Resistant Prostate Cancer

# Monitoring Air Quality Through Cryptogam Indicators: A Comprehensive Review

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## Abstract

With the growing concern over air pollution, the need for efficient monitoring techniques is very much required. This study investigates the use of cryptogams or lower plants as air quality biomonitors, specifically lichens, fungi and bryophytes. As the lower group of plants can accumulate airborne pollutants, that is why they can be useful biomonitors for air pollution. Despite their propensity to accumulate pollutants, these lower groups of plants are studied for their physiological reactions to air pollution, including changes in tissue chemistry and anti oxidative enzyme activity.

We speculate that variations in these parameters may be used as markers of the kinds and amounts of air pollutants. Therefore, the goal of this research is to establish a reliable biomonitoring system that uses lower plants to measure and monitor the effects of air pollution, assisting in the protection of public health and environmental management. A review of recent research on the use of lower group of plants as biomonitors and the physiological mechanisms underlying the buildup of element concentrations is conducted. The principles, the choice of species as air pollution biomonitors, and the potential applications of biomonitoring techniques in subsequent research will be discussed in detail during the presentation.

**Keywords:** Biomonitoring; Cryptogams; Air Pollution

# Novel Flavonoid Chrysin targets Acetylcholinesterase: Molecular insights into its Anti-Alzheimeric Potential

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**Abstract:**

Alzheimer's disease (AD) is a progressive neurodegenerative disease in which disruption of the cholinergic neurotransmission contributes to cognitive decline. Consequently Acetylcholinesterase (AChE), a principal enzyme in cholinergic neurotransmission, remains an important therapeutic target for restoring cholinergic signalling. In this study, we systematically examined the inhibitory mechanism of chrysin on AChE using a combined set of biophysical, biochemical, cellular, and computational approaches. Chrysin effectively inhibited AChE activity with an $IC_{50}$ value of 69.54 µM. while steady-state kinetic analysis revealed competitive inhibition with a marked increase in $K_m$, without appreciable change in $V_{max}$. Intrinsic fluorescence results further demonstrated the direct interaction between chrysin and AChE as evidenced by concentration-dependent quenching of AChE fluorescence by chrysin accompanied by shift in the emission maximum towards longer wavelength. Stern-Volmer and thermodynamic analyses supported a static fluorescence quenching mechanism with spontaneous complex formation between chrysin and AChE. Furthermore, the inhibitory effect of chrysin was retained in Neuro-2A cells, without compromising cell viability. *In silico* investigation demonstrated that chrysin preferentially accommodates within the catalytic gorge of AChE exhibiting a binding affinity of -9.2 kcal $mol^{-1}$, and the interaction occurs through hydrogen bonding and π-π interactions involving key active-site amino acid residues. Across 500 ns Molecular dynamic simulation further demonstrated that AChE-chrysin complex remained stable throughout the simulation, maintained structural integrity while exhibiting reduced solvent accessibility. Principal component and free-energy landscape analysis additionally indicated ligand-induced restrictions of the accessible conformational states of AChE. Moreover, MM-PBSA analysis also supported the favourable binding nature of interaction, yielding binding free energy of −22.19 kcal $mol^{-1}$. Collectively, these combined experimental and computational findings provide a mechanistic frame-work for chrysin-mediated AChE inhibition and highlight chrysin as a promising lead scaffold for the future development of cholinesterase inhibitors targeting AD.

**Keywords:** Alzheimer's Disease; Chrysin; Acetylcholinesterase; Neuroprotective compounds; Enzyme inhibition

# *Punica granatum* Polyphenols as Potential New Delhi Metallo-Beta-lactamase-1 Inhibitors to Combat Antimicrobial Resistance

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**Abstract**

*Punica granatum* finds traditional use in indigenous healthcare practices and is known for its diverse pharmacological properties. Owing to its exceptionally rich bioactive profile, its peel extract was investigated for potential inhibitory activity against New Delhi metallo-β-lactamase-1 (NDM-1), which hydrolyses almost all currently available β-lactam antibiotics. This study demonstrates the ability of *P. granatum* aqueous peel extract (PgA) to potentiate the activity of meropenem against an NDM-1 producing *E. coli*. PgA displayed minimal intrinsic antibacterial activity, however, in combination with meropenem it depicts concentration-dependent enhancement of susceptibility. Synergy assays confirmed its strong meropenem potentiating activity (ΣFIC=0.125) along with scanning electron microscopy, that revealed pronounced membrane disruption and cell deformation, exclusively in combination-treated cells. FTIR analysis showed PgA to be rich in flavonols, phenolic acids, ellagitannins, and chlorogenic-acid derivatives while LC–MS analysis led to the identification of 57 putative phytochemicals. Molecular docking identified morin (–9.4 kcal/mol) and dicaffeoylquinic acid isomers (–9.2 to –8.4 kcal/mol) as the strongest NDM-1 binders, that interact with key catalytic and zinc-coordinating residues in the active site of the enzyme. These findings revealed *P. granatum* as a promising natural source of phytochemical scaffolds that are capable of inhibiting NDM-1 and potentiating β-lactam antibiotic activity.

***Keywords*:** Medicinal plants; Meropenem synergy; Metallo-β-lactamase; NDM-1 inhibition; *Punica granatum* L. polyphenolic inhibitors.

# Soybean Meal Replacement in Low-Cost, Nutritionally Balanced Diets for *Cyprinus carpio*: Effects on Growth, Blood Biochemistry, Hematology, and Stress Responses

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The present study evaluated the efficacy of replacing soybean meal with locally available alternative protein sources in the formulation of a low-cost, nutritionally balanced diet for common carp (*Cyprinus carpio*) and its effects on growth performance, hematological characteristics, blood biochemical indices, and stress responses under aquaculture conditions in Jammu, India. Juvenile common carp with an initial body weight of 80–86 g were randomly distributed into experimental groups and fed isonitrogenous and isoenergetic experimental diets for 90 days. Soybean meal was partially replaced with selected indigenous protein ingredients, including mustard oil cake, rice bran, *Azolla* meal, and other locally available plant-based feed resources, to develop cost-effective diets while maintaining the nutritional requirements of the species. A conventional soybean meal-based diet served as the control.

At the end of the feeding trial, fish attained a final body weight ranging from 196 to 236 g, indicating satisfactory growth across dietary treatments. Growth performance was evaluated using weight gain, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), and survival rate. Hematological parameters, including hemoglobin concentration, red blood cell count, white blood cell count, hematocrit, and erythrocyte indices, together with blood biochemical parameters, were analyzed using standard methods. Physiological stress responses were assessed by determining serum cortisol and antioxidant biomarkers, including superoxide dismutase (SOD) and catalase (CAT).

The results demonstrated that partial replacement of soybean meal with locally available protein sources supported normal growth performance and feed utilization while maintaining hematological and biochemical parameters within normal physiological ranges. Fish receiving optimized replacement diets exhibited improved antioxidant defence and reduced stress responses compared with the control, indicating enhanced physiological health and adaptability. Furthermore, the formulated diets significantly reduced feed production costs without compromising fish performance. The current study highlights the potential of low-cost feed formulations based on regionally accessible agro-industrial by-products, such as rice bran, mustard oil cake, and plant-based protein sources like *Azolla*, which are well suited to the agro-climatic conditions of Jammu and Kashmir. The incorporation of these ingredients not only reduces feed costs but also minimizes environmental impacts by lowering nutrient discharge and promoting efficient resource recycling. Overall, the findings demonstrate that locally available alternative protein ingredients can effectively replace a substantial proportion of soybean meal in common carp diets, providing a sustainable, economical, and environmentally responsible feeding strategy for aquaculture development in Jammu and similar agro-ecological regions.

***Keywords:*** *Fish feed;* Cyprinus carpio; *Low-cost diet; Nutrition; Soybean meal*

# SPATULA1 Interacts with the Trichome Developmental Network to Promote Trichome Density in *Artemisia annua L.*

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**Abstract:**

Glandular trichomes are specialized epidermal structures of *Artemisia annua* that serve as important sites for the biosynthesis and accumulation of artemisinin and other valuable specialized metabolites. Therefore, understanding the molecular mechanisms governing trichome initiation and density is of considerable importance for improving artemisinin production. Trichome development is regulated by a complex network of transcription factors and developmental regulators that coordinate epidermal cell fate, initiation, and differentiation. **SPATULA1 (SPA1)**, a basic helix-loop-helix (bHLH) transcription factor, is known to regulate diverse aspects of plant development; however, its role in regulating trichome development and density in *A. annua* remains poorly understood.

The present study investigates the role of **SPATULA1 (SPA1)** in trichome development in *A. annua* and explores its functional interaction with established trichome developmental regulators. We hypothesize that SPA1 participates in the trichome regulatory network and, through its interaction with key trichome developmental genes, promotes trichome initiation and consequently increases trichome density. The expression pattern of *AaSPA1* will be investigated across developmental stages and tissues, with particular emphasis on trichome-bearing organs. Functional characterization through genetic manipulation of *AaSPA1* will be undertaken to determine its effects on trichome number, density, morphology, and distribution. Furthermore, molecular and protein–protein interaction studies with key components of the trichome developmental network will be employed to elucidate the mechanism underlying SPA1-mediated regulation of trichome formation. We anticipate that SPA1 acts as a positive regulatory component of trichome development in *A. annua*, functioning in association with other trichome developmental regulators to enhance trichome initiation and density. Elucidating the role of SPA1 could provide novel insights into the molecular regulation of glandular trichome development and specialized metabolite biosynthesis in *A. annua*. Ultimately, this knowledge may facilitate molecular strategies for increasing glandular trichome density and improving the production of artemisinin and other economically important phytochemicals in this medicinal plant.

Keywords: *Artemisia annua*; SPATULA1 (SPT1); Glandular trichomes; Trichome development; Artemisinin biosynthesis

# Ubiquitin-Mediated Regulation of Endothelial Pyroptosis via NEDD4/IGPR-1-NLRP3 Signalling Pathway in Atherosclerosis

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**Abstract**

Atherosclerosis is a chronic inflammatory vascular disease characterized by endothelial dysfunction, lipid accumulation, and progressive vascular inflammation. Endothelial pyroptosis, particularly through the non-canonical Caspase-4-Gasdermin D pathway, contributes to vascular injury and may accelerate atherosclerotic progression. However, the molecular mechanisms regulating endothelial pyroptosis under lipotoxic stress remain poorly understood. In this study, we investigated the role of the E3 ubiquitin ligase Neural Precursor Cell Expressed Developmentally Down-Regulated Protein 4 (NEDD4) and the endothelial adhesion molecule Immunoglobulin and Proline-Rich Receptor-1 (IGPR-1/TMIGD2) in endothelial pyroptosis and dysfunction. Analysis of cardiovascular disease-associated transcriptomic datasets revealed reduced NEDD4 and increased IGPR-1 expression, suggesting their potential involvement in vascular pathology. Human umbilical vein endothelial cells (HUVECs) exposed to palmitic acid (PA) exhibited marked activation of non-canonical pyroptosis, as evidenced by increased expression of Caspase-4, and Gasdermin D including NLRP3, also accompanied by elevated reactive oxygen species generation, intracellular lipid accumulation, and lactate dehydrogenase release. NEDD4 overexpression significantly attenuated PA-induced changes, improved endothelial barrier integrity (ZO-1, ZO-2, eNOS) and migratory capacity. Similarly, IGPR-1 silencing by siRNA reduced pyroptosis-associated signalling, inflammatory responses, and endothelial injury. Molecular docking and substrate prediction analyses further identified potential interactions between NEDD4 and IGPR-1 as well as caspase-4, suggesting a possible ubiquitin-dependent post-translational mechanism underlying their regulation. Collectively, our findings identify the NEDD4–IGPR-1 axis as a potential regulator of non-canonical endothelial pyroptosis and dysfunction under lipotoxic stress. Dysregulation of this pathway may contribute to vascular inflammation and endothelial injury during atherosclerotic progression, while targeting the NEDD4–IGPR-1 axis may represent a promising therapeutic strategy for preserving endothelial homeostasis and limiting pyroptosis-associated vascular damage.

The study was funded by Department of Biotechnology (DBT), Government of India for Ramalingaswami Fellowship as the financial support (BT/RLF/Re-entry/33/2020) for conducting this research. The authors acknowledge the financial support received from the CSIR SRF-Direct Fellowship (Award No. 113-1029-6720/2K24/1).

**Keywords:** Atherosclerosis; Endothelial dysfunction; IGPR-1; NEDD4; Pyroptosis.

# Elucidating Adaptive evolutionary signals in of Gurez sheep of Jand K

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Native sheep breeds retain substantial standing genetic variation shaped primarily by natural and environmental selection, making them valuable reservoirs of adaptive alleles relevant for future breeding and climate-resilient livestock production. Selection signatures and evolutionary adaptive signatures were studied in Gurez sheep a threatened largest native sheep of J&K which is a very important source of livelihood for Dardi tribals. In the present research population genomics has been analyzed for detailed characterization of genetic structure, admixture patterns, and evolutionary relationships among sheep populations. Previously generated Ovine 50K SNP genotyping data from 254 individuals representing geographically and genetically diverse sheep populations were integrated with the resequencing dataset for downstream genome-wide analyses. The combined dataset included Australian Merino ( n = 50), Changthangi ( n = 25), Tibetan ( n = 37), Garole (n = 25), Indian Deccani (n = 24), Rambouillet (n = 48), Suffolk ( n = 19), and Texel ( n=24). A total of 58,177 SNPs were initially considered for analysis, of which 20,626 markers were excluded during quality control filtering. The final dataset comprised 36,382 high-quality autosomal SNPs genotyped across 301 individuals, with an average genotyping rate of 75.89%. Principal component analysis was conducted to assess genome-wide genetic structure and relationships among nine sheep populations. The first three principal components jointly explained 12.55% of the total genetic variance, with PC1, PC2, and PC3 accounting for 6.43%, 3.26%, and 2.86% of the variation, respectively Visualization of PC1 versus PC2 revealed distinct clustering patterns corresponding to breed identity and geographic origin. PCA revealed pronounced population stratification among the analyzed sheep populations, structured primarily by breed origin, geographic isolation, and selection history

Key words: Gurez sheep, adaptive signatures, PCA

# Association of capsanthin accumulation and CCS1 allelic variation with fruit colour intensity in chilli (*Capsicum annuum* L.)

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**ABSTRACT**

Chilli (*Capsicum annuum* L.) is a major vegetable and spice crop in which fruit colour and yield are key determinants of market value. The present study aimed to integrate selected morphological traits, biochemical attributes, and CCS1 gene polymorphism to elucidate the basis of colour variation among diverse chilli genotypes. A set of 45 genotypes along with a standard check Kashmiri Long-1 was evaluated for important DUS characters. Considerable variation was observed in these traits, reflecting diversity in fruit morphology among genotypes.Biochemical analysis revealed substantial variation in capsanthin content, the principal carotenoid responsible for red colour intensity, along with differences in ascorbic acid levels. Genotypes exhibiting deeper red colour consistently showed higher capsanthin accumulation, indicating its central role in determining fruit pigmentation. The highest capsanthin content was observed in Byadgi Kaddi (229.83 ASTA units), followed by Kashmiri Long-1 (187.53 ASTA units), SK-HP-22A (177.90 ASTA units), Byadgi Dabbi (168.40 ASTA units) and SK-HP-33A (162.27 ASTA units).To investigate the molecular basis of this variation, selected high- and low-colour genotypes were subjected to allele mining of the capsanthin, capsorubin synthase (CCS1) gene. Sequence analysis of 798 bp fragment CCS1 gene revealed distinct polymorphisms among genotypes, with high-colour genotypes showing greater variation in the CCS1 gene compared to low-colour types. These polymorphisms are likely associated with differential capsanthin biosynthesis and accumulation.The integration of morphological performance, capsanthin variation, and CCS1 gene polymorphism provides a targeted framework for the identification of elite genotypes. The findings highlight the potential of CCS1 as a functional marker for colour-based selection in chilli breeding programmes.

**Keywords:** Capsanthin; CCS1 gene; chilli; carotenoids; polymorphism; allele mining

# Resveratrol Engineered Modified Chitosan-PVP-AgNPs Composite Hydrogel Patch: A Potential Antibacterial & Antioxidant Biomaterial for Infected Wound Healing

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## Abstract

Chronic infected wounds remain a significant clinical challenge due to persistent microbial colonization, excessive reactive oxygen species (ROS) generation, and impaired tissue regeneration. These pathological conditions disrupt key healing processes such as re-epithelialization, angiogenesis, and extracellular matrix (ECM) remodelling, necessitating advanced wound dressings capable of simultaneously addressing infection and oxidative stress. In this work, a multifunctional hydrogel patch was developed by chemically modifying chitosan with N-acetylsulfonyl chloride (CS-NASC) and forming a crosslinked network with polyvinylpyrrolidone (PVP), followed by the incorporation of silver nanoparticles (AgNPs) and resveratrol (RSV). FTIR spectroscopy confirmed successful chemical modification and intermolecular interactions within the hydrogel matrix. The hydrogel exhibited pH-responsive swelling behaviour, achieving a high swelling ratio of approximately **1500% at pH 7.4**, indicating excellent fluid absorption capacity under wound-relevant conditions. Scanning electron microscopy revealed a porous architecture with an average pore size of **~151 µm**, favourable for exudate absorption and nutrient transport. The developed hydrogel demonstrated strong antibacterial activity, with zones of inhibition of **18.0 ± 0.1 mm against** *Staphylococcus aureus* **and 20.0 ± 0.1 mm against** *Escherichia coli*, attributed to the synergistic antimicrobial effects of NASC and AgNPs. Additionally, the presence of RSV imparted significant antioxidant activity, with **65–85% DPPH radical scavenging efficiency**. Cytocompatibility evaluation using MTT assay confirmed excellent cell viability (**>95% viability**), while rheological analysis indicated stable viscoelastic behaviour with **G′ > G″**, ensuring structural integrity suitable for wound application. In vivo evaluation using a co-infected wound model demonstrated that the hydrogel patch significantly enhanced wound healing, achieving **91.96% wound contraction within 14 days**, along with a marked reduction in bacterial load and increased collagen deposition (**0.6643 µg/mg hydroxyproline**) compared to control groups supported by histopathological analysis that shows enhanced re-epithelialization and collagen organization. Overall, the CS-NASC/AgNPs/RSV/PVP hydrogel patch represents a promising multifunctional dressing for the effective management of infected wounds.

**Keywords**: Modified Chitosan; Resveratrol; AgNPs; Hydrogel Patch; Wound Healing

# Clinical Evaluation of Safūf-i-Chobchini, a Polyherbal Unani Formulation, in the Management of Sciatica (Irq al-Nasā): A Randomized, Single-Blind, Standard-Controlled Clinical Study

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## Abstract

**Background & Objective:** Sciatica, characterized by pain radiating along the distribution of the sciatic nerve or its component roots, is a common cause of lower back and lower-limb pain. In classical Unani literature, the condition is described as *Irq al-Nasā*. Various therapeutic approaches are used for its management. Safūf-i-Chobchini is a polyherbal Unani formulation traditionally used in the management of musculoskeletal disorders. The present study was conducted to evaluate the safety and efficacy of Safūf-i-Chobchini in the management of *Irq al-Nasā* (Sciatica).

**Methods:** A randomized, single-blind, standard-controlled clinical study was conducted on 50 patients, excluding dropouts. Participants were allocated by a computer-generated method of randomization into two groups, with 25 patients in each group. The test group (n=25) received Safūf-i-Chobchini 6 g with 200 ml of lukewarm water before food for 25 days. The control group (n=25) received standard treatment with Tablet Etodolac 200 mg twice daily for 25 days. Subjective and objective parameters were assessed and recorded at each follow-up during the treatment period.

**Results:** Significant improvements were observed in the subjective and objective parameters in both groups (test and control), with $p < 0.0001$.

**Conclusion:** The findings of this study suggest that Safūf-i-Chobchini is as effective as the standard drug Etodolac in reducing both subjective and objective parameters associated with sciatica. Both interventions were well tolerated by the participants during the treatment period. Therefore, based on the findings of the present study, Safūf-i-Chobchini appears to be a promising therapeutic option for the management of *Irq al-Nasā* (Sciatica).

**Keywords:** Sciatica; Safūf-i-Chobchini; *Irq al-Nasā*; Unani; Disc Herniation

# Reduced Graphene Oxide-Functionalized Cu(II)–NSAID Complex: Biomolecular Interactions and Genotoxicity

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**Abstract**

An ionic copper(II)-based nanoconjugate **1** comprising of bis(DACH)$Cu^{II}$.$(tolf)_2$ immobilized on partially reduced graphene oxide (rGO) was synthesized and systematically characterized using FT-IR, powder X-ray diffraction, SEM, EDX, Raman and TEM analyses. The integration of the copper complex with rGO provides a stable inorganic nanoplatform that combines coordination-driven reactivity with a carbon-based support possessing restored $sp^2$ graphitic domains and residual oxygen-containing functional groups. Biomolecular interaction studies with tRNA were investigated using complementary spectroscopic techniques, revealing strong non-covalent binding predominantly governed by π–π stacking and electrostatic interactions. *In vitro* cytotoxicity assessment against HCT-116 colon cancer cells demonstrated enhanced activity of the rGO-loaded bis(DACH)$Cu^{II}$.$(tolf)_2$ nanoconjugate **1** compared to the unloaded copper complex. *In vivo* genotoxicity evaluation in male Wistar rats indicated reduced genotoxic effects at lower administered doses. The nanoconjugate **1** exhibited moderate antioxidant activity, showing comparatively better $H_2O_2$ and NO scavenging ability, while displaying weak DPPH radical scavenging. Overall, the results highlighted the influence of reduced graphene oxide immobilization (rGO) on the biological interactions and activity profile of copper(II) coordination systems.

**Keywords:** bis(DACH)$Cu^{II}$.$(tolf)_2$, reduced graphene oxide (rGO) loading; XRD; TEM; tRNA binding; *in vitro* cytotoxicity; *in vivo* genotoxicity

# Network Pharmacology and Molecular Docking investigations of phytochemicals from *Portulaca oleracea* reveals potential therapeutics for Lipotoxicity in metabolic dysfunction-associated Steatotic liver disease

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## Abstract

Non-alcoholic fatty liver disease (NAFLD), recently redefined as metabolic dysfunction-associated steatotic liver disease (MASLD), is a prevalent global disorder with limited therapeutic options. Despite its multifactorial pathogenesis encompassing lipid accumulation, oxidative stress, mitochondrial dysfunction, and chronic inflammation only one small molecule drug has gained FDA approval, underscoring the urgent need for novel interventions. *Portulaca oleracea* (pursalane), a widely distributed edible medicinal plant, is recognized for its hepatoprotective, antioxidant, and anti-inflammatory properties. Here, we employed an integrated network pharmacology, molecular docking, and molecular dynamics (MD) simulation approach to elucidate the therapeutic potential of P. oleracea phytochemicals against NAFLD. Phytochemical profiling identified 31 unique compounds, of which 13 drug-likeness and bioavailability criteria. Target prediction and gene-disease mapping revealed 48 overlapping targets between these phytochemicals and NAFLD-associated genes. Network analysis highlighted ESR1, EGFR, AKT1, SRC, and PPARG as central hub proteins mediating lipid metabolism, Estrogen signaling, and inflammatory pathways. Protein-protein interaction and enrichment analyses further implicated these targets in immune modulation, endocrine regulation, and oncogenic signaling. Molecular docking demonstrated strong binding affinities of Beta sitosterol, Genistein, Isorhamnetin, and Stigmasterol, surpassing reference inhibitors. MD simulations confirmed the stability of ligand target complexes, with consistent RMSD, SASA, and MMGBSA-derived binding free energies, reinforcing their pharmacological relevance. Collectively, this systems-level investigation reveals that P. *oleracea* phytochemicals exert multi-target, synergistic effects on key regulatory pathways in NAFLD. These findings provide mechanistic insights into the hepatoprotective efficacy of P. oleracea and support its advancement as a promising natural therapeutic candidate for managing Lipotoxicity and metabolic dysfunction in steatotic liver disease.

**Keywords**: MASLD, Portulaca oleracea; Network Pharmacology; Docking; MD Simulations.

# Sulphonic acid-functionalized Pectin-Alginate pH-Responsive Biocompatible Carrier for Site-Specific Colonic Delivery of Doxorubicin: Rational Design, DFT Insights and Controlled Release Kinetics

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**Abstract**

Oral colon-targeted drug delivery systems are crucial for enhancing therapeutic efficacy in colorectal diseases while minimizing systemic toxicity. As such, the current study aims to develop a novel pH-responsive and biocompatible hydrogel carrier for site-specific delivery of doxorubicin (DOX). To achieve this, Low-methoxyl pectin (LM-Pec) was chemically derivatized *via* carbodiimide-mediated coupling with amine-containing acidic substituents, introducing ionizable sulphonic groups in the polymer backbone. The modified polymer was blended with alginate and ionically cross-linked with $Ca^{2+}$ to yield stable hydrogel beads. The resulting APec/Alg/$Ca^{2+}$ beads exhibited stable porous microstructure, enhanced viscoelasticity, and pH-responsive swelling, minimal under gastric conditions (pH 2.0– 4.0) but pronounced at colonic conditions (pH 6.8–9.2). Drug loading capacity increased markedly (10.79 mg/g) compared to unmodified systems (7.57 mg/g), and release kinetics followed non-Fickian diffusion-relaxation. The cell viability assay demonstrated that the developed hydrogel functions as a biocompatible and non-toxic doxorubicin delivery platform, effectively preserving cytotoxic activity against SW480 cells, while the DPPH assay revealed time-dependent antioxidant activity that was synergistically enhanced upon drug loading. Density Functional Theory (ωB97XD/SDD) calculations on the optimized O6-Ca octahedral structure revealed a wide HOMO–LUMO gap (4.43 eV), high hardness ($\eta$ = 2.215 eV), and large dipole moment (9.5 D), further supporting the structural stability and pH responsiveness. Collectively, findings demonstrate that the newly formulated APec/Alg/$Ca^{2+}$ hydrogel beads represent a promising and stable colon-targeted DOX delivery platform, facilitating controlled drug release, enhanced antioxidant efficacy, and excellent biocompatibility for improved therapeutic efficacy in colorectal cancer treatment.

**Keywords:** Amidated Pectin; Alginate; DFT; Doxorubicin; Colorectal cancer.

# Synthesis and structure elucidation of Ru(II)-*p*-Cymene Chromone Complexes: Cytotoxic evaluation against cancer cell line and DNA-Cleaving efficiency

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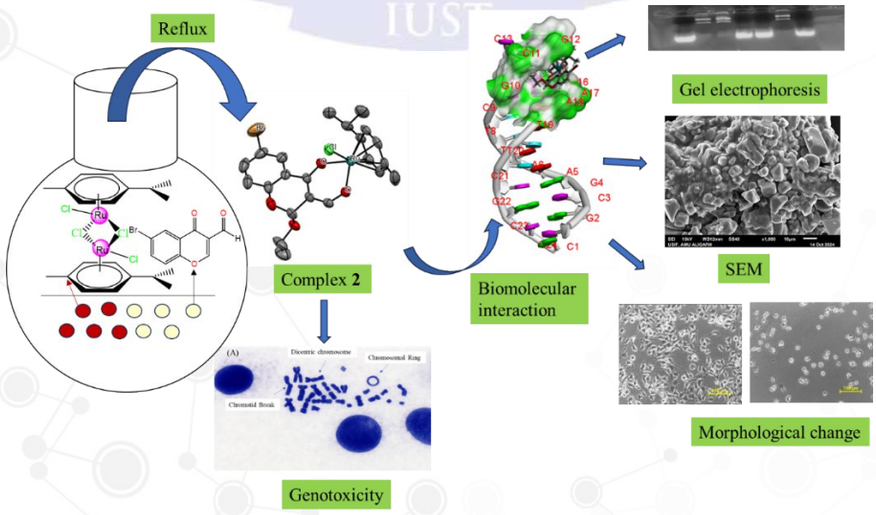
**Abstract**

Using a bioactive flavonoid-based chromone scaffold, new Ru(II)-*p*-cymene fluoro and bromo-chromone complexes **1** & **2**, respectively, were synthesized and thoroughly characterized by FT-IR, $^{1}$H, $^{13}$C & $^{19}$F NMR, ESI-MS, and elemental analysis, as well as single-crystal X-ray diffraction studies. Complexes **1** and **2** crystallized in a triclinic crystal system with *P* -1 space group, exhibited a 'piano stool' geometry, where Ru(II) is coordinated to a *p*-cymene arene, one chloride ion, and a 2-ethoxy chromone ligand acting as an *O, O′*-bidentate donor. The *in vitro* binding studies of complexes **1** and **2** with ct-DNA demonstrated strong binding *via* a π-π intercalation mode with minor groove participation, with the binding order **2** > **1**. Agarose gel electrophoresis with pBR322 DNA showed concentration-dependent DNA cleavage by both complexes, proceeding *via* an oxidative pathway involving reactive oxygen species. Cytotoxic studies of complexes **1** and **2** were conducted against resistant cancer cells, *viz.,* HeLa, MCF-7, MIA-PaCa-2, HeP-G2, and MDA-MB-231, using the SRB assay. The cytotoxicity results showed that complex **2** exhibited notable anticancer activity against all tested cancer cell lines (with $GI_{50}$ values < 10), except for HeP-G2, which showed moderate activity. The *in vivo* genotoxicity assays showed that complex **2** did not induce a notable increase in the frequency of chromosomal aberrations or micronuclei, suggesting a favorable safety profile and no observable toxicity towards normal bone marrow cells in adult Albino rats.




**Keywords**: ct-DNA; cleavage activity; cytotoxicity; genotoxicity.

# Novel Mercapto Conjugates of Oleanolic Acid as potential Antifungal Agents

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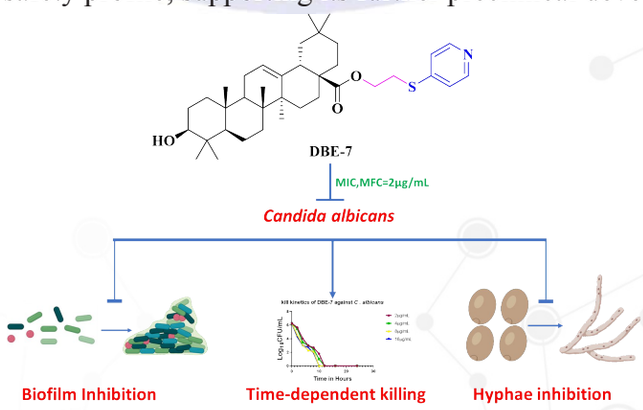
**Abstract**

The increasing incidence of antifungal resistance in *Candida species* underscores the urgent need for new agents that effectively inhibit fungal growth and virulence while exhibiting minimal host toxicity. In this study, DBE-7 was identified as a potent antifungal compound with strong activity against *Candida albicans*. DBE-7 inhibited fungal growth at low micromolar concentrations (MIC = 3.37 µM) and exhibited fungicidal rather than fungistatic activity. The compound markedly impaired key virulence attributes, including hyphal morphogenesis and biofilm formation. Quantitative image analysis demonstrated a concentration-dependent reduction in hyphal elongation and filamentous cell formation, with inhibitory effects comparable to those of fluconazole. DBE-7 also significantly reduced biofilm biomass, indicating its ability to disrupt biofilm architecture. DBE-7 effectively eradicated preformed mature biofilms in a concentration-dependent manner, indicating its ability not only to prevent biofilm development but also to disrupt established biofilm. Kill kinetics revealed rapid and sustained fungicidal activity in a time- and concentration-dependent manner. DBE-7 also displayed low cytotoxicity toward mammalian cell lines, maintaining high cell viability within its antifungal concentration range. Molecular docking revealed a strong binding affinity of DBE-7 toward lanosterol 14-α-demethylase (LDM), while the marked reduction in cellular ergosterol levels in DBE-7–treated *C. albicans* further supports disruption of the ergosterol biosynthetic pathway, suggesting potential targeting of LDM. Collectively, these findings highlight DBE-7 as a promising antifungal candidate that effectively targets *C. albicans* growth and virulence while exhibiting a favorable safety profile, supporting its further preclinical development.




**Keywords:** Antifungal Activity; DBE-7; Ergosterol

# Total Synthesis and Cytotoxic evaluation of Novel Ureido and Chalcone analogs of 4-Ethylpiperic acid

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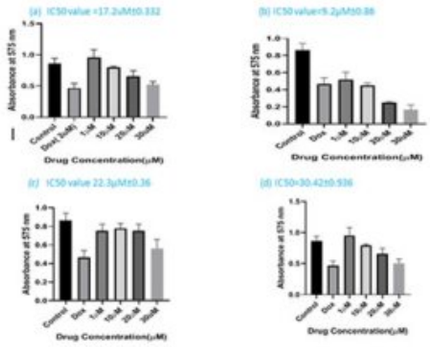
## Abstract

This research presents a facile and scalable synthetic approach for the preparation of 4-ethylpiperic acid, addressing the scarcity of pipernal and facilitating access to piperic acid derivatives. The target molecules are synthesised in a multistep reaction scheme involving Friedel–Crafts acylation, Vilsmeier–Haack formylation and Wittig olefination. Two structurally diverse series of 4-ethylpiperic acid: chalcone-type analogs (SC-1 to SC-6) and ureido derivatives (UD-1 to UD-4) were synthesised and evaluated for anticancer activity using MTT assay. SC-1 demonstrated significant and selective efficacy against SUM-159, 4T1, MIA-PaCa-2 and MDA-MB-231 with IC 50 values between 20–30µM. Among the ureido series, UD-2 exhibits notable efficacy against UMSCC_22B with an IC-50 of 9.2±0.86µM and demonstrates a statistically significant dose–dependent relationship. The structure–activity relationship (SAR) indicated that electron-donating groups increased cytotoxicity. SC-1 and UD-2 may act as lead candidates for drug development against aggressive and drug-resistant malignancies.

| Compounds | FR2 | SUM-159 | 4T1 |
|---|---|---|---|
| SC-1 | 85 ± 2.96 | 20 ± 4.5 | 30 ± 3.34 |
| SC-2 | Nd | Nd | 192 ± 9.3 |
| SC-3 | Nd | 250 ± 5.32 | 30 ± 2.84 |
| SC-4 | 180 ± 3.27 | Nd | 32 ± 4.33 |
| SC-5 | Nd | 24 ± 3.9 | Nd |
| SC-6 | 24 ± 1.02 | 32 ± 3.08 | - |

**Anticancer activity of chalcone like derivatives**



**Anticancer activity of urea like derivatives: (a) UD-1, (b) UD-2, (c) UD-3, and (d) UD-4**

**Keywords:** 4-ethylpiperic acid, Ureido and Chalcone analogos

# Medicinal Plants as a Source of Novel Antimicrobial Agents to Combat AMR

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**Abstract**

Few challenges in modern medicine are as urgent as the steady decline in antibiotic effectiveness, fuelled largely by decades of excessive and unregulated use in hospitals, farms, and self-medication practices. Surviving bacteria rely on recurring tactics: producing enzymes that neutralise drugs, remodelling their targets, tightening outer membranes, ejecting drugs through pump systems, and forming biofilm communities that resist penetration. Because several tactics often operate together within a single infection, standard treatments are losing ground and the antibiotic arsenal available to clinicians continues to narrow. Botanical sources represent one of the more promising, yet still under-utilised, routes toward reversing this trend. Across centuries of traditional use, plants have accumulated a vast diversity of secondary metabolites, some with direct antibacterial effects and others that restore or amplify antibiotic potency in combination. Unlike conventional single-target drugs, many phytochemicals act on several bacterial processes simultaneously, making it harder for resistant lineages to emerge through simple mutation. This paper takes stock of medicinal plants as candidate sources of new antimicrobial chemistry, focusing on how individual phytoconstituents intersect with the resistance pathways outlined above. Drawing on existing literature linking plant-based antibacterial findings with the molecular biology of resistance, the aim is to surface candidates and strategies capable of moving traditional botanical knowledge toward practical clinical application. Sustained investigation of these natural sources, paired with rigorous mechanistic and pharmacological follow-up, stands to broaden the therapeutic options available for tackling the worldwide rise of drug-resistant infection.

**Keywords:** Antimicrobial Resistance; Medicinal Plants; Phytochemicals; Antibacterial Agents; Biofilms.

# Development of Cubosome Co-loaded with Dual Chemotherapeutic Drugs Gemcitabine and Docetaxel for Enhanced Cancer Therapy

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**Abstract**

The severe systemic toxicity associated with chemotherapeutic agents, along with the emergence of adaptive treatment tolerance (ATT) and multidrug resistance (MDR) during prolonged therapy, continues to limit the efficacy of cancer treatment. In parallel, many promising anticancer candidates fail to achieve their full therapeutic potential due to intrinsic physicochemical limitations, including high hydrophobicity, poor aqueous solubility, limited cellular internalization, rapid systemic clearance, and undesirable serum protein interactions. To address these challenges, we developed a lipid-based nanocarrier system, namely cubosomes, co-loaded with two chemotherapeutic agents, gemcitabine (Gem) and docetaxel (Dxl), to construct a pH-responsive and synergistic therapeutic platform. The resulting dual drug-loaded cubosomes (GD-DLC) were comprehensively characterized using DLS, HRTEM, FESEM, and SAXS to confirm their size, morphology, and internal cubic structure. Drug encapsulation and loading efficiency were further validated using XRD, FTIR, and HPLC. Leveraging the unique bicontinuous cubic architecture of cubosomes, the GD-DLC facilitate enhanced tumor accumulation via the enhanced permeation and retention (EPR) effect, followed by efficient intracellular delivery and pH-triggered drug release, potentially mediated through membrane interaction and fusion mechanisms. The co-delivery of Gem and Dxl demonstrated enhanced anticancer efficacy against human breast (MCF-7) and prostate (PC-3) cancer cell lines, attributable to their complementary mechanisms of action. Importantly, the GD-DLC exhibited minimal cytotoxicity toward healthy vascular smooth muscle cells (VSMC), highlighting their favourable safety profile. Collectively, these findings demonstrate that the engineered GD-DLC represent an effective nanotherapeutic platform, offering enhanced anticancer efficacy while minimizing off-target toxicity, thereby providing a promising strategy for targeted cancer therapy.

**Keywords:** Cubosome; Cancer; Dual-Drug encapsulation; MDR; Lipid nanocarriers.

# Molecular basis of the interaction between novel isonicotinohydrazide drug derivatives with Human Serum Albumin: Multispectroscopic and Computational insights

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**Abstract**

Isonicotinic acid hydrazide (INH), a well-known and promising first-line anti-tubercular agent, is enlisted in the World Health Organization's list of vital medicines. Herein, the binding characteristics of more efficacious INH-derivatives with human serum albumin (HSA) were investigated using multiple spectroscopic techniques combined with molecular modeling approaches. The findings suggested that all the derivatives quench the intrinsic fluorescence of HSA via the static mode of quenching, validated by UV-visible differential spectroscopy. The stoichiometry (n) and binding constant ($K_b$) were calculated using the modified Stern-Volmer equation. The values manifested that IN1-C/D has comparatively higher binding affinity ($K_b \sim 10^4$) than IN1-A/B, with 1:1 stoichiometry for all the derivatives. The corresponding thermodynamic parameters were calculated at different temperatures; the values of ΔH and ΔS reflect the Hydrogen bonds and van der Waals interactions as major molecular-forces in the binding process. The derivatives showed varied behavior towards the secondary structural conformation of HSA in CD spectroscopy. IN1-A/B/D interaction led to a decrease in α-helical content, while IN1C –HSA complexation showed an increase in α-helical content on binding. Additionally, to gain deeper molecular insights, the INH-derivatives were first analyzed using density functional theory to optimize their structure and electronic properties, followed by molecular docking and molecular dynamics simulation with the target protein. The collective findings from these computational approaches indicate that the INH derivatives exhibit significant binding affinity toward the drug-binding site of HSA**.** Moreover, their intermolecular non-covalent interactions contribute to the preservation of the protein's structural stability, underscoring their potential relevance in modulating the function of the HSA protein.

**Keywords:** HSA; Isonicotinic acid hydrazide; Fluorescence; Circular dichroism; Computational

# Spiritual approach for Mind-Body synchronization to control Stress for Prevention of Disease and Promotion of Health- Ayush Science Perspective

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**Abstract**

This present paper endeavors to recognize WHO recommendation to include "spiritual Well being" as fourth dimension to definition of Health as a state of positive physicals, mental and social well being and not nearly absence of the disease. The spiritual Well being has to be incorporated in sprit into our scientific understanding of practices of Medicine to achieve complete Healthy State of body, promote health and to control Diseases. In Ayush systems of Medicines, health is considered in a holistic view, as a state of well-being in body, mind/psyche, and spirit, in which spirit is considered differently from psyche, which can affect both the physical and mental health of the individual. In present world Scenario, when there is resurgence of Non-communicable Diseases due to exposure of human body and mind to constant stress, spiritual well-being, both at an individual and population level, is acting as source of contentment and consequently works for well-being of people. A good level of Spiritual well being can lead to efficient healing process and prevention of diseases. The Ayush Sciences have recognized very long the importance of the Spiritual well being for prevention of Disease and promotion of health under the Heading of Harkat-wa-Sakoon-e-Nafsani (mental activity and Peace of Mind).

**Keywords:** AYUSH Medicine, Non-Communicable Diseases, Spiritual Well-Being, Stress Management

# Indole-Based Glycohybrids as Potential Antibacterial Agents against Multidrug-Resistant Bacteria; Synthesis, computational studies and biological evaluation

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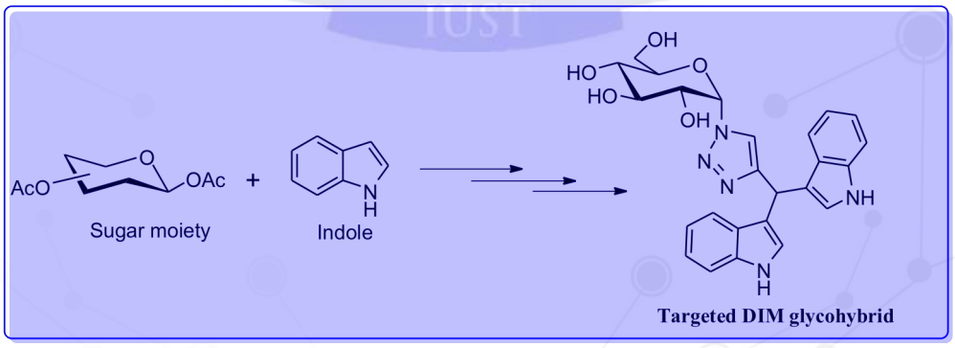
**Abstract:**

The rapid rise of multidrug-resistant (MDR) bacteria poses a significant global health threat, diminishing the effectiveness of traditional antibiotics and leading to higher rates of morbidity, mortality, and healthcare expenditures. As a result, there is an urgent need to develop new antibacterial agents that have innovative mechanisms of action and enhanced selectivity. Indole is a privileged heterocyclic scaffold widely recognized for its broad spectrum of biological activities, including antimicrobial properties. Incorporation of carbohydrate moieties into bioactive molecules has been shown to enhance aqueous solubility, improve cellular uptake, and promote selective targeting through bacterial transport systems. The present work display the synthesize of indole-based glycohybrids containing diverse mono- and disaccharide units linked through suitable spacers. The synthesized compounds will be evaluated for *in vitro* antibacterial activity against selected MDR Gram-positive and Gram-negative bacterial strains. Structure–activity relationship (SAR) analysis will be performed to understand the influence of sugar moieties, linkers, and substitution patterns on antibacterial efficacy. Target identification using computational studies is explained. The most active compounds is further assessed for cytotoxicity against mammalian cell lines to determine their selectivity and safety profiles. This study is expected to identify novel indole-based glycohybrid molecules with potent antibacterial activity and improved selectivity, contributing to the development of new therapeutic candidates to combat antimicrobial resistance.




**Keywords:** Indole glycohybrids, Multi Drug Resistance, Antimicrobial

# Expanding the Chemical Space of Benzo[f]Chromenes through Micellar Catalysis: Diverse Scaffolds, Natural Product Synthesis, and Antimicrobial Potential

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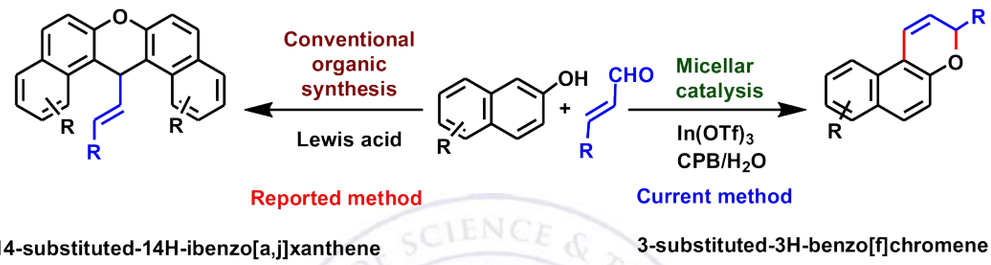
**Abstract:**




Benzo[f]chromene scaffolds represent a privileged structural motif in medicinal chemistry, widely recognized for their low toxicities and broad pharmacological activities. Herein, we report a sustainable, micellar catalysis-based strategy for the synthesis of diverse 3-substituted-3H-benzo[f]chromene constructs in water. The methodology exploits cetylpyridinium bromide (CPB)-derived micellar nanoreactors to facilitate the reaction between β-naphthols and enals in the presence of $In(OTf)_3$ as a Lewis acid and DABCO as an organic base at 40 °C, delivering benzo[f]chromene products in good to excellent yields (35-80%). Concentration-dependent $^1H$ NMR studies confirmed that both substrates reside within the palisade layer of the CPB-micellar nanoreactors. The transformation proceeds via DABCO-mediated deprotonation of β-naphthol, condensation with the Lewis acid-activated enal to furnish a dieneone intermediate, followed by an electrocyclization step that delivers the benzo[f]chromene scaffold selectively-diverting the pathway away from xanthene formation observed in conventional organic solvents. The substrate scope was systematically explored across β-naphthols bearing electron-donating and electron-withdrawing substituents, aliphatic enals (citral), α-naphthols, substituted phenols, and carbazole, affording 23 structurally diverse chromene constructs, including several novel scaffolds. The methodology was further extended to accomplish the micellar synthesis of ***Lapachenole***, a naturally occurring 2H-benzo[h]chromene isolated from *Tabebuia chrysantha*, demonstrating the utility of this strategy in natural product synthesis. Preliminary antimicrobial evaluation of the synthesized library revealed promising antibacterial and antifungal activities for select members of the series. The one-pot protocol, use of water as solvent, low catalyst loading, and broad substrate tolerance collectively underscore the sustainability and practical utility of this approach for medicinal chemistry explorations.

**Keywords:** benzo[f]chromene; micellar catalysis; electrocyclization; natural sustainable synthesis; antimicrobial activity.

# Small molecule CAB4 sensitises Trastuzumab-resistant HER2+ Breast Cancer cells by triggering Autophagy

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**Abstract:**
Cancer is a heterogeneous disease, and despite successes in targeted therapy of certain types, treatment still remains a clinical challenge. Drug resistance in cancer is a major issue in oncology and is frequently associated with treatment failure, tumor recurrence and a poor prognosis for patients. Studies have linked drug resistance to approximately 90 per cent of deaths related to cancer. There are also reports showing that small molecules reverse drug resistance by acting as chemical adjuvants or inhibitors that block specific defence mechanisms in cells. Small-molecule chemosensitizers are administered alongside standard therapeutic drugs to re-sensitize resistant populations during treatment. Using this approach, we screened a library of compounds to re-sensitize resistant clones in breast cancer-resistant cell lines. We found that a compound CAB4 inhibits cell proliferation when used in combination with Trastuzumab in Trastuzumab-resistant AU565 cells. Further, we found that this compound also induces lysosomal formation and triggers autophagy in AU565-resistant cells. So in conclusion, this compound can be used as a lead against drug-resistant cancer cells, where further studies need to be done.

**Keywords:** Heterogeneous disease; chemical adjuvant; small molecule; lysosomal formation; autophagy

# SC-12 Exerts Anticancer Activity in Triple-Negative Breast Cancer by Modulating the AKT/mTOR–Autophagy Axis

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**Abstract:**
Triple-negative breast cancer (TNBC) is an aggressive breast cancer subtype with limited targeted therapeutic options, highlighting the need for novel anticancer agents. In this study, ten synthetic compounds were screened for anticancer activity against the TNBC cell line MDA-MB-231. Among them, SC-12 exhibited the most pronounced reduction in cell viability and was selected for further investigation. SC-12 markedly suppressed the migratory and clonogenic potential of MDA-MB-231 cells, indicating inhibition of aggressive TNBC phenotypes.
Microscopic examination of SC-12-treated cells revealed prominent vacuole-like structures,suggesting involvement of autophagy in its cytotoxic activity. Consistent with this observation, SC-12 enhanced LC3-I to LC3-II conversion and increased LC3 puncta formation, indicating an autophagy-associated response. Assessment of the PI3K/AKT/mTOR pathway revealed reduced phosphorylation of AKT and mTOR following SC-12 treatment, suggesting suppression of this signaling axis as a potential mechanism underlying autophagy induction. Furthermore, SC-12 increased LAMP1 expression and enhanced lysosomal activity, as demonstrated by LysoTracker staining, supporting activation of the autophagy–lysosomal pathway.Collectively, these findings demonstrate that SC-12 exerts anticancer effects against aggressive TNBC cells by suppressing migration and clonogenicity and modulating the AKT/mTOR–autophagy axis. SC-12 therefore represents a promising candidate for further investigation and provides preliminary mechanistic insights into its anticancer activitiy in TNBC.

**Keywords:** TNBC; MDA-MB-231; PI3K/AKT/mTOR; Autophagy

# *Lagotis cashmeriana* derived Natural Compound reduces Breast Cancer growth by reducing the activation of WNK1/GSK3β/β-Catenin

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**Abstract**

Breast cancer, the primary cause of cancer-related deaths among women globally, contributes 25% of cancer cases in India. Conventional treatment is facing challenges of high cost, toxicity, and drug resistance. As natural molecules are less toxic, cost-efficient, with low drug resistance, they are gaining interest in the treatment of cancer. We previously observed that *Lagotis cashmeriana* possess a significant amount of therapeutically important flavonoid and phenolic compounds, with considerable antioxidant and anti-breast cancer potential. Therefore, the current study was aimed to isolate the pure compound(s) with anti-breast cancer potential from the methanolic leaf extract of *L. cashmeriana*. The compound(s) of methanolic leaf extract was isolated by using column chromatography and characterized by physiochemical and spectroscopic methods. We isolated the natural compound from the extract, which possesses significant anti-breast cancer activity compared to the crude extract. The isolated compound was named MLC, which significantly reduced the cell viability and proliferation of breast cancer cells in the micro-molar range. Besides it significantly reduced the clonogenic potential of breast cancer cells. Importantly, the natural compound, MLC, was able to induce apoptosis in breast cancer cells and arrest the growth of breast cancer cells by inhibiting the cells at G1-phase of cell cycle. Further to evaluate the molecular mechanism of action, we determined the phosphorylation of key signaling proteins using a phosphokinase array, which revealed a significant reduction in activation of WNK1, GSK3β and β-Catenin in MLC treated breast cancer cells compared to vehicle control. These finding suggest the MLC as a promise lead for inhibition of WNK1, GSK3β and β-Catenin mediated cellular signaling in breast cancer.

**Keywords**: Breast Cancer; Natural compounds; *Lagotis cashmeriana*; Apoptosis

# Neuroprotective Potential of Phenothiazine Derivatives in SH-SY5Y Cells: An In Vitro Study Using MTT Assay, and ELISA

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**Abstract**

Phenothiazine derivatives have gained significant attention due to their diverse pharmacological properties, particularly in neurological disorders. This study aims to evaluate the neuroprotective and neuroactive potential of selected phenothiazine derivatives using both in vitro assays and computational approaches. The human neuroblastoma SH-SY5Y cell line was employed to assess cytotoxicity, neuroprotection, and oxidative stress modulation. Additionally, molecular docking and ADMET predictions were conducted to understand the interaction of compounds with key neurological targets. The results demonstrated that selected derivatives exhibited significant neuroprotective effects at lower concentrations, along with favorable binding affinity toward target proteins. These findings suggest that phenothiazine derivatives could serve as promising candidates for further development in neurological therapeutics.

**Keywords:** Phenothiazine derivatives; SH-SY5Y cell line; Neuroprotection; Molecular docking; In vitro study; Neurodegenerative disorders.

# Synthesis, Characterization and Virtual Screening of Serotonin 5-HT2A Receptor with Novel Phenothiazine Derivatives Toward Schizophrenia

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**Abstract**

This research investigates the virtual screening of serotonin 5-HT2A receptors with PTZ derivatives towards schizophrenia with reference drug Risperidone (SGAs). Drugs based on PTZ are basically FGAs and they target dopamine receptors, mainly D2 dopamine in the cerebrum. Schizophrenia is a critical and long-lasting mental disorder. It can lead to misperception of the real life. This situation aften outcome in an amalgamation of symptoms which can differ greatly in impact and intensity on day-to-day life. Derivatives of phenothiazine (PTZ) are a class of compounds that have received recognition for their therapeutic properties. The parent molecule, PTZ and its derivatives have diverse pharmacological properties like antipsychotic, antihistamine, antiemetic. Numerous PTZ derivatives were synthesized and virtually screened in compare with Risperidone (SGAs), in which four compounds (Cpd-2, 3, 5, 7 & 10) showed promising binding affinity towards schizophrenia.

**Keywords**: Virtual screening; PTZ; Schizophrenia; SGAs; FGAs; 5-HT2A receptors.

# Biochemical and Molecular Evaluation of Inflammatory Responses to Unani Formulation in Patients with Rheumatoid Arthritis

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## Abstract

Rheumatoid arthritis (RA), referred to as *Waja'al-Mafāsil* in the Unani system of medicine, is a chronic inflammatory autoimmune disorder characterized by persistent systemic inflammation and dysregulated immune responses. The present study aimed to evaluate the effects of Unani Formulation on various inflammatory biomarkers in patients with RA. RA patients receiving the Unani Formulation or standard allopathic treatment were evaluated alongside healthy controls through clinical and laboratory assessments performed at baseline and post-treatment. Systemic inflammatory and disease-associated parameters, including anti-CCP, high-sensitivity C-reactive protein (hsCRP), tumor necrosis factor-α (TNF-α), and interleukin-1β (IL-1β), were assessed. Peripheral blood mononuclear cells (PBMCs) were isolated to evaluate the expression of NLRP3 and NF-κB p65 at both transcriptional and translational levels using RT-PCR and western blotting, respectively. In the present study, RA patients exhibited an inflammatory profile characterized by significant elevated levels of anti-CCP, hsCRP, TNF-α, and IL-1β compared with healthy controls. Post-treatment, we observed significant reduction in anti-CCP, hsCRP, TNF-α, and IL-1β levels in RA patients. Furthermore, in PBMCs, we observed significantly increased transcriptional and translational expression of pro-inflammatory markers such as NLRP3 and NF-κB p65 in RA patients at baseline compared to healthy controls which was significantly reduced post-treatment in these patients. The parallel reduction observed in systemic inflammatory biomarkers as well as in the expression of NLRP3 and NF-κB p65 in PBMCs suggest anti- inflammatory response post-treatment in RA patients. Collectively, these biochemical and molecular findings provide preliminary evidence for the potential anti-inflammatory action of the Unani Formulation in RA, however, ongoing patient recruitment, follow-up, and further analysis are warranted to validate these observations and establish its therapeutic potential in RA.

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**Keywords:** Inflammation, NF-κB p65, Inflammasome, Rheumatoid arthritis, Unani Formulation.

# A Greener approach for the Synthesis of biologically active natural product Crispin A analogues for pharmaceutical/Drug discovery Applications

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**Abstract**

Here in we report a synthetic protocol for the synthesis of naturally occurring product Crispinand A analogues which represents a potential class of chiral molecule and possess diverse pharmacological activities, such as bactericidal, fungicidal, microbiocidal, antitumor, anti-HIV, and anti-inflammatory antidepressant, antiplatelet, antileukemic, and anticancer activities. In this study, a series of pharmacologically active compounds were synthesized using a greener, environment friendly, scalable with high atom economy, employing easy purification method under mild reaction condition. Tryptamine and phenethylamine derived imides were selectively substituted using RMgX as nucleophiles. Subsequent acid mediated cyclization of the intermediate hemiaminals afforded the 3–Substituted 3-hydroxyisoindolinones amine derivatives via the formation of alkyl substituted acyliminium ions, in one pot. The structures of the synthesized molecules were characterized using 1H NMR, $^{13}C$, HRMS, LCMS. In conclusion, we developed novel cascade alkylation and cyclization strategy for the synthesis of 3-substituted amine derivatives. Efficacy of the alkyl substituted hemiaminal to form an acyliminium ion and its application is the key feature of the present strategy. Interestingly, the developed strategy is applicable to both intra- and intermolecular transformations, where a number of indole and arene derivatives were employed as trapping agents to lead to the synthesis of 3-substituted heterocycles and building blocks.

Furthermore, the present method employed a greener approach, use of environment friendly reagents, scalable with high atom economy under mild reaction condition; employing easy purification method supports circular economy principles and contributes to sustainable technological development. This innovative method aligns with the objectives of VIKSIT J&K 2047 by promoting eco-friendly materials, resource conservation, and advanced manufacturing technologies

**Keywords:** Crispin A; Greener approach; Atom economy; Tryptamine; pharmaceutical; Drug discovery

# Engineered DNA Tetrahedral Nanocarriers Outperform Exosomes for Enhanced Epirubicin Delivery in Breast Cancer Cells

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**Abstract**

Epirubicin, a chemotherapeutic agent, is used in treatment of metastatic breast cancer treatment. However, efficient intracellular delivery remains a major barrier to maximizing the therapeutic efficacy of anthracyclines while limiting systemic toxicity in breast cancer. In this study, we comparatively evaluated two emerging nanocarrier platforms - DNA tetrahedra (TDs) & naturally derived exosomes for intracellular delivery of epirubicin in breast cancer cells. Drug loaded TDs (TD:Epi) and exosome-loaded epirubicin (Exo:Epi) were synthesized & characterized for their physicochemical properties including drug encapsulation efficiency, cellular uptake, release kinetics & therapeutic efficiency. TD:Epi exhibited significantly higher drug encapsulation efficiency than Exo:Epi (80.67 ± 2.05% vs. 52.33 ± 3.30%) and demonstrated a more sustained drug release profile, with 81.57 ± 1.55% cumulative drug release at 72 h compared with 91.03 ± 1.29% for Exo:Epi. When compared to free epirubicin, increased intracellular concentration of epirubicin was observed in Flow cytometer & Fluorescence Microscopy when delivered via the TD: Epi system. Cell viability assays in the TD: Epi system using Annexin V-FITC and propidium iodide staining revealed higher apoptosis rates. Robust activation of the intrinsic apoptotic pathway was evidenced by the upregulation of Caspase-3, Caspase-9, Bax, and Cytochrome c, together with suppression of the anti-apoptotic marker Bcl-2 through RT-qPCR analysis, which was further corroborated with western blot results. While exosomes also showed improved delivery and therapeutic outcomes when compared to free epirubicin, they were less effective than the TD: Epi system. To our knowledge, this study represents one of the first comparative evaluation of DNA tetrahedrons & naturally derived exosomes as nanocarriers for breast cancer therapy. Taken together, this suggest that the TD carrier significantly enhances epirubicin's delivery and apoptotic efficacy when compared to exosome-based delivery or epirubicin alone offering a promising strategy for improving treatment outcomes.

**Keywords:** Breast cancer; Drug delivery; DNA Tetrahedron; Epirubicin; Exosomes

# Unique Isocitrate dehydrogenase (IDH1, IDH2), Kirsten rat sarcoma virus (KRAS) in Acute Myeloid Leukaemia (AML)

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**Abstract:**
Acute myeloid leukaemia (AML) is a heterogeneous group of clonal hematopoietic stem/progenitor cell disorders characterized by mutations in genes regulating haematopoiesis. These mutations lead to the clonal expansion of undifferentiated myeloid precursors. Recent studies suggest that AML may arise from a series of age-associated genetic alterations while in most cases, the disease develops de novo in previously healthy individuals. Although the exact causes of these mutations remain unclear, reported risk factors include exposure to radiation, chemotherapeutic agents and smoking. In both its clinical presentation and genetic profile being highly heterogeneous with genetic mutations, chromosomal translocations and molecular alterations contribute to its pathogenesis. Approximately 97% of AML cases harbour genetic mutations. Despite this heterogeneity, patients can be stratified into favourable, intermediate or adverse-risk groups based on cytogenetic features. Oncogenic mutations in IDH1, IDH2, FLT3, and KRAS with the potential for malignant transformation, have been identified in several cancers, including AML. However, their role in AML, particularly within the Indian population, remains poorly understood. In this study, we aim to analyse mutational data from cancer patients to identify significant and potentially causative mutations in IDH and KRAS. Examination of single nucleotide polymorphisms (SNPs) and their spatial distribution across these genes may provide insights into mutational hotspots and the functional consequences of specific variants. SNPs with highly deleterious effects could serve as promising molecular biomarkers for AML diagnosis and treatment.

**Keywords:** Acute myeloid leukaemia; biomarkers; Isocitrate dehydrogenase; Kirsten rat sarcoma virus

# Effects of Selenium Speciation against Carbendazim-Induced Testicular Toxicity in Wistar Rats

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## Abstract

Carbendazim (CBZ) is a widely used fungicide known for its environmental persistence and potential for inducing systemic toxicity. This study investigated the modulating influence of dose and chemical form of selenium (Se) on the testicular toxicity-inducing potential of CBZ in male Wistar rats. Adult rats were divided into ten groups (n=8). Group I served as control. Group II was gavaged CBZ at 1000 $mgKg^{-1}$ body weight. Groups III and IV were fed Se in feed at a level of 73.50 ppm as inorganic and organic forms, respectively. Besides CBZ, groups V and VI were co-treated with Se, as groups III and IV, respectively. Groups VII and VIII were fed Se in feed at the supra nutritional level of 2.90 ppm as inorganic and organic forms, respectively. Similarly, groups IX and X represent CBZ co-treated counter groups of the groups VII and VIII, respectively. CBZ treated rats fed with high dose of Se showed loss of androgen receptor immuno expression which was restored partly in rats co-fed supra-nutritional Se. Leydig cells were weakly stained for 3β HSD and 17α HSD which were restored by low dose Se. There was a significant decline in the circulatory levels of LH, FSH and testosterone hormones with CBZ administration. The serum and testicular CBZ concentration were less in rats co-exposed to CBZ and Se than CBZ alone. The treatment of rats with CBZ and excess of Se resulted in oxidative stress and histo-morphological changes in testis. Sperm count and quality also deteriorated in CBZ and high dose Se treated groups. These results indicate that CBZ has potential to produce testicular damage which is ameliorated by supranutritional Se. However, high dose Se in both organic and inorganic form aggravates the testicular toxicity induced by CBZ.

**Keywords:** Carbendazim; Selenium speciation; Sodium selenite; Testicular toxicity

# Subacute Arsenic Exposure Attenuates the Antipyretic Efficacy of Ketoprofen in Lps-Induced Pyrexia in Male Rats

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**Abstract**

This study assessed the impact of subacute arsenic exposure on the antipyretic effects of ketoprofen in a rat model of lipopolysaccharide (LPS)-induced fever. After 28 days of treatment by daily administration of sodium arsenite in drinking water at the doses of 0.4, 4 and 40 ppm, the animals received an oral dose of ketoprofen (5 mg/kg). Fever was induced by injection of LPS, and periodic measurement of the rectal temperature was performed. LPS injection in the control rats induced a fever and increased the mean rectal temperature from 35.55 ± 0.12°C to 37.24 ± 0.29°C after 6 hours. Ketoprofen reversed the induced fever in the control rats. Hyperthermia was reduced from 37.24 ± 0.29°C to 35.81 ± 0.25°C after 9 hours (3 hours post-drug administration) and the induced fever was reduced by 73%. This finding confirmed the potent antipyretic activity of ketoprofen under control conditions. Exposure to 0.4 ppm arsenite did not affect the antipyretic activity of ketoprofen manifested by a temperature of 36.06 ± 0.05°C. Exposure to arsenite at 4 ppm and 40 ppm had a significant effect and drastically reduced the antipyretic activity of ketoprofen. These groups exhibited a temperature of 37.12 ± 0.13°C and 37.13 ± 0.14°C respectively, which were almost the same as the LPS-only control group (37.12 ± 0.13°C), indicating complete loss of therapeutic effect. From these results, we conclude that exposure to moderate to high levels of Arsenite causes a remarkable loss of the antipyretic effect of ketoprofen.

**Keywords:** Arsenic; Ketoprofen; LPS; Pyrexia; Rats.

# Targeting Oncogenic p53 Mutants: Comprehensive study of p53-stabilizing Agents for Breast Cancer Treatment

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**Abstract:**

**Background:** In Breast Cancer tumor suppressor p53, often called "guardian of the genome" is a key regulator to maintain genomic integrity in response to cellular stresses. It regulates important cellular pathways such as apoptosis, cell cycle, and DNA repair. However, in nearly half of all cancers, TP53 gene is mutated and these mutations not only lead to loss of wild-type functions, but also cause novel gain of functions (GoF), driving uncontrolled proliferation, resistance, and metastasis. **Aim:** This study explores the therapeutic potential of three compounds Cryptolepine, Adapalene, Adapalene-1',4'-dione and Stictic Acid to stabilize these GoF mutants. This study also aimed to determine the anticancer potential of adapalene in TNBC cells and its effectiveness in combination with doxorubicin and GDC-0941, and the mechanistic pathways in inhibiting tumorigenicity. **Methods:** Various computational assays like CBioportal was used to analyze a cohort of 8,740 breast cancer samples, querying the TP53 gene and assessing the association between its mutation status and patient survival. COSMIC Catalogue was used to to study the 3D conformation of WT p53, MUTp53-R282W, MUTp53-R280K, MUTp53-R273H, MUTp53-R248Q, and MUTp53-R175H and their interaction with DNA. MuTarget database was used to link the expression changes of different genes of cell cycle and apoptosis with the p53 mutation. KM Plotter was used to study the Relapse Free Survival of the patients with low and high expression of MUT-p53. Various cell culture assays were performed to validate the results in vitro. **Results:** Molecular docking analysis of Cryptolepine, Adapalene, Adapalene-1',4'-dione show good binding affinity with GoF mutant p53. Docking analysis of Adapalene-1',4'-dione and Stictic Acid reveal that they exhibit strong binding affinities with R282W, R175H, R273H, and R248Q mutants individually, suggesting their potential to restore p53 function and impede tumor progression. However, the R280K mutant exhibited lower ligand affinity, highlighting the need for further drug optimization. Cryptolepine and Adapalene shows dose dependent cytotoxicity, causes significant reduction in colony forming potential and prevents migration in TNBC cell line MDA-MB-231. Cryptolepine and Adapalene inhibits the growth of triple-negative breast cancer cells by S-phase arrest. Further Cryptolepine, Adapalene and Doxorubicin synergistically promote apoptosis of TNBC cells by hyperactivation of the ERK1/2 pathway through ROS induction. **Conclusion:** Our findings underscore the promise of drug repurposing strategies to neutralize mutant p53-driven cancers. This study paves the way for precision medicine approaches, offering hope for improved treatment outcomes in Triple-negative Breast Cancer (TNBC) and beyond.

**Keywords:** Breast Cancer; tumor suppressor p53; apoptosis; Adapalene-1',4'-dione; Targeted Therapy

# Pharmaceutical Cocrystals and Salts: Recent Advances in Crystal Engineering for Drug Property Enhancement

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**Abstract**

The development of effective pharmaceutical formulations is often challenged by undesirable physicochemical properties of active pharmaceutical ingredients (APIs), particularly poor aqueous solubility, dissolution rate, stability, hygroscopicity, and bioavailability. Crystal engineering has emerged as a powerful approach for addressing these limitations by exploiting intermolecular interactions and crystal-packing principles to generate solid forms with tailored properties. Among the various crystal-engineering strategies, pharmaceutical cocrystals and salts have attracted considerable attention because they can modify the physicochemical and biopharmaceutical properties of APIs without fundamentally altering their chemical structure. This review highlights recent advances in the development of pharmaceutical cocrystals and salts, with particular emphasis on their design principles, preparation methods, and influence on drug performance. Different preparation techniques provide access to alternative crystalline forms, while appropriate selection of coformers or counterions enables modulation of properties relevant to pharmaceutical development. Representative examples reported for pirfenidone, oxymatrine, vortioxetine, Enoxacin, miconazole, and difenoconazole etc demonstrate the broad applicability of these approaches. The reported crystal forms have been associated with improvements or controlled modification of aqueous solubility, dissolution behavior, thermal stability, hygroscopicity, bioavailability, antifungal activity, and isomer composition. These studies illustrate the importance of establishing structure–property relationships for the rational development of pharmaceutical solid forms. Despite significant progress, the prediction and systematic selection of suitable coformers, control of crystal form, and scalable and sustainable preparation remain important challenges. Future research is expected to increasingly combine computational crystal engineering and artificial intelligence with experimental screening, while emphasizing environmentally sustainable preparation strategies. Overall, pharmaceutical cocrystals and salts represent versatile and promising platforms for the rational optimization of drug properties and the development of improved pharmaceutical formulations.

**Keywords:** Pharmaceutical cocrystals; Pharmaceutical salts; Crystal engineering; Drug solubility; Drug property enhancement.

# Emerging Diseases, Trends and Prevention

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**Abstract:**
Neurological disorders vary as per the Age of An Individual. Some Disorders are specifically seen at early age, others are seen in young age and some others are found to be in spectrum of Old Age.
All these disorders have different Pathologies and Presentations. In this Topic Allocated, I will simply try to the Best of My Capability highlight and present the Basic Concepts associated with Selected Disorders along with the Fundamental Concepts of Neuroanatomical, Neuro Physiology, Neuropathology which might help us in better understanding of the Brain Architecture Changes across Life Span which increases the susceptibility and more Vulnerability to the Neurological Conditions.
The Diseases Covered will be:

- ADHD (Attention Deficient Hyperkinetic Disorder)
- Autism in Children
- Parkinson's Disease
- Alzheimer's Dementia
- Amyotrophic Lateral Sclerosis

As these disorders are seen in different age Groups, why a Predilection towards these disorders in these age Groups, The Associated Areas from a Neuroanatomical Perspective most likely get affected and the Brain changes from an Embryological, Genetic, and Pathophysiological Perspective involving these diverse groups of Disorders with Different Presentations.
Furthermore the Likely Features which would increase the Vulnerability to acquiring these disorders and the most likely contributing factors.
The Importance is immense in view of the fact that some of these disorders are lifelong, others life threatening, and still others causing disabilities of severe nature and understanding of the disorders from the perspectives we have selected enhances our ability to focus on guided research ahead.
In Addition the Plasticity which would afford Protection to the Brain and the likely ways Plasticity would help in Neurorestoration and Neuroprotection.

**Keywords:** Brain physiology; Autism; Parkinson

# Preoperative CONUT-Defined Malnutrition and Surgical-Site Infection Following Major Orthopaedic Surgery in Kashmir

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## Abstract

**Background:** Perioperative Malnutrition may affect tissue healing, immune function, and postoperative recovery. Based on total cholesterol, total lymphocyte count, and serum albumin, the Controlling Nutritional Status (CONUT) score provides an objective assessment. However, evidence regarding its association with surgical-site infection (SSI) in major orthopaedic procedures performed in Kashmir remains limited.

**Objective:** To determine the association between preoperative CONUT-defined malnutrition and postoperative SSI among patients undergoing major orthopaedic surgery in Kashmir.

**Methods:** A prospective cohort study was carried out with 355 patients recruited from GMC Anantnag, GMC Baramulla, and Bone & Joint Hospital Barzulla in Srinagar. The CONUT score was used to measure patients' nutritional status before surgery. For descriptive analysis, patients were classified as having normal nutritional status, mild, moderate, or severe malnutrition. For regression analysis, CONUT status was divided into normal (score 0-1) and malnourished (score ≥2). Patients were observed for one month after surgery, and SSI was defined as any infection that occurred during this time. The chi-squared test and multivariable logistic regression were used to determine associations.

**Results:** Malnutrition was present in 136 patients (38.3%). SSI occurred in 48 patients (13.5%). The incidence of SSI increased gradually with worsening nutritional status: 1.8% in patients with normal nutritional status, 27.0% with mild malnutrition, 75.0% with moderate malnutrition, and 100.0% with severe malnutrition. The association was statistically significant ($\chi^2=96.290$, $p<0.001$). In the adjusted analysis, malnutrition was independently linked with SSI (adjusted OR=27.94, 95% CI: 9.53-81.99, $p<0.001$). BMI group and type of surgery had no significant association with SSI.

**Keywords:** CONUT score; malnutrition; surgical-site infection; orthopaedic surgery; perioperative nutrition

# Identification of Potential Phytochemical Inhibitors Against Key Proteins in HCC-Associated Signalling Pathways

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**Abstract**

Hepatocellular carcinoma (HCC) remains a major cause of cancer-related mortality, and dysregulated signalling pathways contribute to tumour progression and therapy resistance. Phytochemicals offer a promising source of multi-target inhibitors with potential anticancer activity. This study aimed to identify and virtually screen phytochemicals against key proteins involved in HCC-associated signalling pathways to discover potential lead compounds for further development. A curated library of phytochemicals was screened through an *in silico* approach using ADMET analysis and docking. The compounds were evaluated for Absorption, Distribution, Metabolism, Excretion and Toxicity for Drug-Likeness Characteristics. Top-ranked hits were further prioritised based on Docking results. The HCC-related protein targets were chosen based on their involvement in liver cancer pathology. Virtual screening identified several phytochemicals with strong binding affinity toward HCC-associated targets. The most promising compounds showed stable interactions across multiple pathways, suggesting potential multi-target inhibition. Several hits exhibited favourable docking scores and interaction patterns.

This study highlights phytochemicals as promising candidates for targeting key proteins implicated in HCC signalling pathways. These findings provide a rational basis for subsequent experimental validation, including *in vitro* anticancer assays and mechanistic studies, to confirm their therapeutic potential.

**Keywords:** Phytochemicals; hepatocellular carcinoma; molecular docking; network pharmacology; virtual screening

# AI-Driven Discovery and Computational Validation of Small-Molecule NR4A2 Antagonists for Cancer Therapy

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## Abstract

**Background:** Cancer remains a major global health challenge, causing nearly 10 million deaths in 2020. Although substantial progress has been made in understanding tumor biology, there is a continued need for more effective and selective anticancer therapeutics. The orphan nuclear receptor NR4A2 (Nurr1), implicated in poor prognosis, invasiveness, and treatment resistance across multiple cancers, has emerged as a promising yet largely untargeted molecule. With no approved NR4A2-directed therapies, there is significant opportunity for innovative drug development.

**Methodology:** In this study, we applied a structure-guided in silico pipeline to discover small-molecule modulators of NR4A2. A diverse compound library was screened using an AI-assisted pharmacophore model based on the NR4A2 ligand-binding domain, yielding 12 candidate compounds. Candidates underwent ADMET profiling, RDKit-based physicochemical descriptor and molecular fingerprint analysis, and t-SNE chemical-space mapping. Promising compounds were further evaluated by molecular docking and molecular dynamics simulations to assess binding modes and complex stability. Computational alanine scanning was used to identify critical residues involved in protein–ligand interactions. Candidates were prioritized based on predicted affinity, activation-function interactions, and drug-like properties.

**Results:** AI-assisted screening identified 12 candidate NR4A2 ligands. RDKit profiling and t-SNE analysis showed overlap with the chemical space of approved drugs, supporting their drug-like characteristics. Physicochemical and pharmacokinetic profiling identified Compounds 3, 11, and 12 as lead antagonists with favorable solubility, lipophilicity, and CNS-penetrant properties. Docking showed binding energies of −8.00 to −9.00 kcal/mol, with highly conserved poses and progressive RMSD stabilization (RMSD <0.5 Å) throughout the simulation, supporting the stability of the predicted binding interactions. Alanine scanning identified Met379, His372, and Arg454 as critical residues contributing to ligand stabilization.

**Conclusion and Future Directions:** This integrated AI-driven workflow enabled systematic prioritization of NR4A2 antagonists and provided mechanistic insights into their interactions. The lead compounds will advance to synthesis and functional validation toward preclinical development.

**Keywords:** Cancer; Drug development; Physicochemical; Pharmacokinetic; Docking

# Identification of Novel Therapeutic Agents for Head and Neck Squamous Cell Carcinoma

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## Abstract

**Background**: Head and neck squamous cell carcinoma (HNSCC) represent a severe malignancy with over 650,000 new cases and 350,000 deaths annually. In India, it constitutes nearly 40% of all cancers, while globally it accounts for 57% of HNSCC cases. A significant number of patients (60-80%) are diagnosed at advanced stages and often exhibit resistance to standard chemotherapy regimens, resulting in a poor prognosis. These issues underscore the critical need for new therapeutic approaches, such as drug repurposing via connectivity mapping, which may facilitate the rapid identification and development of effective treatments.

**Methodology**: The present study utilized a bioinformatics-based repurposing of FDA-approved drugs to identify novel therapeutics for Human Papilloma Virus positive ($HPV^{+ve}$) and negative ($HPV^{-ve}$) HNSCC patients using Connectivity Mapping (CMAP). We extracted gene expression information from **The Cancer Genome Atlas** (**TCGA**) of **518** HNSCC ($HPV^{+ve}$ n = 421, $HPV^{-ve}$ n = 97) and adjacent normal patient samples (n = **44)**. Differential gene expression from $HPV^{+ve}$ and $HPV^{-ve}$ HNSCC patients was used to identify negative connections with FDA-approved drugs. All the functional assays have been performed in HNSCC cells (SCC-090 $HPV^{+ve}$ and Hep2c $HPV^{-ve}$ cell lines).

**Results:** Our *in-silico* analysis identified two drugs: SB-203580 for $HPV^{+ve}$, a potent inhibitor of two stress-activated protein kinases (SAPKs) termed SAPK2a (or p38α) and SAPK2b (or p38β2); and Loratadine for $HPV^{-ve}$ HNSCC, a piperidine histamine H1-receptor antagonist used to treat allergies. The results showed that SB203580 and Loratadine, alone and in combination with cisplatin, reduced the cell viability of SCC-90 cells and Hep2c cells in a dose-dependent manner respectively. SB203580 and Loratadine, when combined with Cisplatin, significantly exhibited additive effects that enhanced cytotoxicity and improved overall treatment response in both $HPV^{+ve}$ and $HPV^{-ve}$ settings. SB-203580 and Loratadine, both separately and together with Cisplatin, demonstrate the ability to inhibit colony formation, promote apoptosis, and hinder cancer cell migration in SCC-90 and Hep2C cells. Loratadine enhances the loss of mitochondrial membrane potential and induces senescence in Hep2C cells. Additionally, SB-203580 amplifies Cisplatin-induced apoptosis via the p38 MAPK/NF-κB/c-Jun pathway in SCC-90 cells, while Loratadine advances apoptosis by inhibiting pERK/NF-κB signalling associated with histamine receptors in Hep2c HNSCC cells.

**Keywords**: Head and Neck Squamous Cell Carcinoma (HNSCC); Drug Repurposing Using Connectivity Mapping; Human Papillomavirus.

# In Vitro Antioxidant Potential and Preliminary Photochemical Screening of Chloroform:Methanol Extract of Rhizome of *Iris kashmiriana* Baker

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## Abstract

*Iris kashmiriana* Baker (Family: Iridaceae), commonly known locally as Mazarmund, Safed Mazarmond, and Kabriposh, is a medicinal plant found in the Kashmir region. The plant has been reported to possess several pharmacological activities, including antioxidant, anti-inflammatory, and immunomodulatory properties, probably due to the presence of diverse bioactive phytoconstituents. The present study was undertaken to evaluate the phytochemical composition and antioxidant potential of the Chloroform:Methanol (1:1) extract of rhizome part.

Preliminary qualitative phytochemical screening was carried out for various phytoconstituents using established methods. Besides quantitative tests were carried out for determining the total phenolic content (TPC) and total flavonoid content (TFC). Antioxidant activity was carried out using DPPH radical scavenging activity and Reducing power assay etc.

Results of phytochemical screening revealed presence of maximum phytochemical constituents. TPC was found to be 56.39 ± 0.22 mg in terms of gallic acid equivalent (GAE/g extract) while TFC was 196.92 ± 0.98 mg in terms of rutin equivalent (RE/g extract), indicating the presence of appreciable amounts of phenolic and flavonoid compounds. The DPPH radical scavenging assay revealed an $IC_{50}$ value of 23.89 mg/mL, while the reducing power assay demonstrated concentration-dependent absorbance, indicating the antioxidant potential of the rhizome extract.

Overall, the results indicate that the chloroform:methanol (1:1) extract of rhizome of *I. kashmiriana* is rich in diverse phytoconstituents and exhibits antioxidant potential. These findings provide a basis for further investigation of the rhizome part for its potential therapeutic applications.

**Keywords:** Antioxidant*; Iris kashmiriana*; phytoconstituents; Rhizome; TPC; TFC.

# Effect of Subacute Deltamethrin and Fluoride Exposure on the Brain Oxidative Stress and Cholinesterase Activity in Wistar Rats

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## Abstract

Deltamethrin, a type II pyrethroid, is extensively used as an ectoparasiticide on animals and as an insecticide in agriculture. Fluoride though an essential trace element within recommended levels as been reported to be endemically present in high amounts in the water of certain areas. The study evaluated the effect of commercial preparation of deltamethrin, Butox, and fluoride co-exposure on the brain oxidative stress and cholinesterase activity in Wistar rats gavaged these chemicals for 28 days. Group A was untreated. Group B was gavaged commercial preparation, Butox , providing deltamethrin at the dose rate of 1.28 mg per kg body weight per day. Group C was administered fluoride, as NaF, in drinking water providing 20ppm fluoride. Group D received both deltamethrin and fluoride at the same dosages as groups B and C, respectively. When compared to the control, group, activity of glutathione-S-transferase was induced in Butox alone treated group. Brains of treatment groups showed a decrease in the activity of superoxide-dismutase and catalase in comparison to the control group. An elevation in brain lipid peroxidation was observed in groups exposed to fluoride both alone and in combination with Butox . The activity of plasma cholinesterase did not differ significantly between various study groups. A decrease in the activity of erythrocyte AChE was observed in the deltamethrin exposed groups, whereas, brain AChE was inhibited in all of the treatment groups. In conclusion, both deltamethrin (given as Butox) and fluoride, given as NaF, inhibit AChE activity and produce oxidative stress in brain with fluoride producing more oxidative damage. However, compared to the individual exposures, the co-exposure of these chemicals does not produce any exacerbated alteration in these biochemical parameters.

**Keywords:** Deltamethrin; Fluoride; Oxidative stress; Cholinesterase; Brain

# Nutritional Determinants of Metabolic Syndrome: The Emerging Role of Chrononutrition- A Narrative Review

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## Abstract

**Background:** The global prevalence of Metabolic syndrome (MetS) has more than doubled in recent years, with an estimated 1.5 billion adults affected in 2023. India demonstrates a similar pattern, with community-based studies recording rates as high as 35.2% in Jammu & Kashmir. As a major contributor to cardiovascular disease and type 2 diabetes risk, MetS has emerged as a public health concern. While diet remains its most modifiable determinant, chrononutrition may also independently influence metabolic risk. However, the current knowledge base is heterogeneous, with variation in dietary patterns, meal-timing measures, study methodologies, and populations, limiting consistent conclusions.

**Objective:** This narrative review examines recent research evidence from 2020 to 2026 to comprehend how dietary patterns are linked to MetS, focusing on Mediterranean, DASH, and plant-based diets, along with risks associated with high ultra-processed food intake, while also enquiring the potential association between chrononutrition and MetS risk.

**Methods:** A qualitative literature search from multiple academic databases for studies published since 2020 was conducted, prioritizing systematic reviews, meta-analyses, randomized controlled trials, and relevant observational studies.

**Findings:** Healthier dietary patterns, particularly Mediterranean, DASH, and plant-based diets, promoted a more favourable metabolic profile. Mediterranean diet adherence was associated with reduced MetS risk and improvements in several of its components. Conversely, Western-style diets and ultra-processed foods were related to elevated MetS risk, with the highest intake levels corresponding to a 25% higher risk. Moreover, emerging evidence links chrononutrition, including irregular meal timing, prolonged eating windows, and skipping breakfast, to abdominal obesity and greater susceptibility to MetS.

**Conclusion:** Overall, there is a growing body of evidence supporting Mediterranean, DASH, plant-based diets and circadian-aligned eating for reducing MetS risk. Future research should use standardized dietary assessment methods and broader representation of diverse populations and under-represented regions, including those from Kashmir.

**Keywords:** Metabolic syndrome; Dietary patterns; Mediterranean diet; Ultra-processed foods; Chrononutrition

# Exploring Deep Eutectic Solvents as Artificial Chaperones for Protein Refolding

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**Abstract**

Amyloid fibril formation and protein misfolding are associated with numerous human diseases, yet effective therapeutic strategies for preventing or reversing amyloid-associated protein misfolding remain limited. In the present study, we investigated the potential of a deep eutectic solvent (DES) as an artificial chaperone for the refolding of chemically denatured insulin under near-physiological conditions. Insulin was unfolded using different concentrations of guanidinium chloride (GdmCl), and the ability of the DES to promote structural recovery was evaluated using complementary biophysical techniques, including UV–visible absorption, steady-state fluorescence, and circular dichroism (CD) spectroscopy. The spectroscopic analyses demonstrated concentration-dependent changes in insulin conformation, stability, and interactions with the DES. Notably, the DES promoted substantial recovery of the native-like secondary structure of insulin following denaturation with GdmCl, whereas refolding was considerably less effective following exposure to higher concentrations of GdmCl. The results obtained from UV–visible, fluorescence, and CD spectroscopy showed good agreement, collectively supporting the ability of the DES to facilitate the recovery of insulin structure. These findings suggest that DESs may function as effective artificial chaperones by modulating the protein microenvironment and promoting the refolding of partially unfolded proteins. This study provides a biophysical basis for exploring DES-based strategies for controlling protein misfolding and aggregation associated with amyloid-related disorders.

**Keywords**: Protein denaturation; Deep eutectic solvents; Intermolecular interactions, protein renaturation

# Subacute Bifenthrin Administration Induced Oxidative Stress in Lung, Liver and Kidney of Wistar Rats

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**Abstract:**

Bifenthrin is a type-I pyrethroid pesticide used for agricultural and public health applications. Oxidative stress inducing potential of bifenthrin was evaluated in the lungs, liver and kidney of Wistar rats following its repeated oral administration for 20 and 30 days. Bifenthrin, as commercial preparation Biflex, was gavaged daily to two treatment groups of rats, for 20 and 30 days, respectively, at 0.116 mL 100 g−1 body weight giving a bifenthrin dosage of 5.8 mg kg−1 bodyweight (1/10th LD50). Corresponding controls were administered corn oil as vehicle. Compared with control group, exposure of rats to bifenthrin resulted in elevated lipid peroxidation, in the homogenates of all three tissues. The extent of lipid peroxidation showed a temporal trend. By 20th day, superoxide-dismutase activity of bifenthrin exposed rats decreased in liver with no significant change in kidney and lung tissues. However, by 30$^{th}$ day, the activity of this enzyme was lower in all these tissues of the bifenthrin treated animals. In bifenthrin-treated rats, catalase activity decreased by 20th day in liver and lung tissues only, although, its activity continued to decrease significantly in all three tissues by 30th day. At 20$^{th}$ day, glutathione-peroxidase activity decreased in liver and lung with no significant alteration in the kidney. At 30th day of administration, the significantly decreasing trend continued in these tissues and the percent in bifenthrin-treated rats when compared with the control group rats. By 20th day of treatment, activity of glutathione S-transferase in the kidney and lung of bifenthrin-treated rats was decreased, whereas the activity of this enzyme in the liver remained non-significantly different from control values. Significantly decreasing trend of the enzyme was observed in bifenthrin-treated rats at 30th day in hepatic, renal and lung homogenates. In conclusion, bifenthrin has a potential to induce severe oxidative stress in the lung, liver and kidney. The extent of oxidative stress is increased with the duration of exposure.

**Keywords:** Bifenthrin; Oxidative stress; Lipid peroxidation; Tissue homogenates; Wister Rats

# Antidiabetic Potential of Ethanolic *Bergenia ciliata* Rhizome Extract in Streptozotocin-Induced Diabetic Wistar Rats

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**Abstract**

The antidiabetic potential of the ethanolic rhizome extract of *Bergenia ciliata* (150 and 300 mg/kg body weight) was evaluated in streptozotocin (STZ)-induced diabetic Wistar rats. Forty-two rats were randomly divided into seven groups (n = 6), comprising normal control, normal rats treated with the extract at 150 and 300 mg/kg, diabetic control, diabetic rats treated with the extract at 150 and 300 mg/kg, and glibenclamide-treated diabetic rats (10 mg/kg). Treatments were administered orally for 21 days. Mean blood glucose (MBG), lipid profile [total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triacylglycerol (TG)] and blood oxidative stress parameters [malondialdehyde (MDA), superoxide dismutase (SOD), glutathione peroxidase (GPx), glutathione-S-transferase (GST), glucose-6-phosphate dehydrogenase (G6PD), total thiols (TTH) and glutathione (GSH)] were evaluated. STZ-induced diabetes produced significant ($p < 0.05$) increases in MBG, TC, LDL, TG and MDA, with reductions in HDL and antioxidant parameters. Treatment with *B ciliata* extract significantly ameliorated these alterations in a dose-dependent manner, with the 300 mg/kg dose producing comparatively greater improvement across most parameters. Histopathological examination demonstrated disrupted pancreatic islet architecture and cellular degeneration in diabetic control rats, whereas extract treatment, particularly at 300 mg/kg, markedly improved pancreatic islet architecture. The extract produced no adverse alterations in normoglycaemic animals at either dose, indicating favourable safety under the experimental conditions. Overall, the findings demonstrate that ethanolic rhizome extract of *B. ciliata*, particularly at 300 mg/kg body weight, possesses promising antidiabetic and antioxidant potential and may provide protective effects against diabetes-associated metabolic and pancreatic alterations.

**Keywords:** *Bergenia ciliata*; streptozotocin; diabetes mellitus; oxidative stress

# Molecular-Level Insights into Kinase-Ionic Liquid Interactions: An Integrated Spectroscopic and Computational approach

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**Abstract**

Kinases constitute a diverse class of enzymes that play an essential role in maintaining cellular homeostasis, governing vital cell functions, cellular metabolism, and signalling pathways. Dysregulation of kinase activity due to certain conditions, like genetic aberrations, leads to the development and progression of several diseases such as cancer, neurodegenerative diseases, and diabetes, making kinases a potential therapeutic targets for drug discovery. In parallel, ionic liquids (ILs) have gained significant attention in biomedical application owing to their tunable physicochemical properties and their ability to modulate protein stability and enzymatic activity. ILs are composed of large organic cations and organic or inorganic anions with melting points below 100°C, low vapor pressure, high thermal stability, and non-volatility. In this study, we investigated the interaction of an ionic liquid with a kinase protein using an integrated approach combining spectroscopic and computational techniques. We employed various spectroscopic methods including UV-visible, fluorescence spectroscopy (steady-state, synchronous fluorescence) and circular dichroism spectroscopy. Quenching mechanism were analysed using Stern-Volmer plots and Binding parameters were determined using double logarithmic plots; findings suggested moderate binding affinity and spontaneous interaction between the IL and the Kinase. The absence of detectable shift in the absorption and fluorescence spectra with increasing concentration indicated that the overall microenvironment of the protein's intrinsic fluorophore was largely preserved. Circular dichroism spectroscopy further demonstrated that the global secondary structure of the kinase was predominantly retained in the presence of the IL. The experimental findings were further complemented by computational studies. Molecular docking analysis suggested that IL interacts with the kinase through a combination of electrostatic and hydrophobic interactions with a moderate predicted binding affinity. Overall, these findings demonstrates that IL successfully binds to the kinase protein while maintaining its broader structural organization. These findings provide critical molecular-level insights into IL-kinase interactions, laying the groundwork for exploring ILs as stabilizing agents or modulators in advanced therapeutic formulations and drug-design.

**Keywords:** Drug discovery; Ionic-liquids; Kinases; Molecular Docking; Steady State fluoroscence spectroscopy.

# Self-Medication Practices in Kashmir and Artificial Intelligence-Based Modelling of Polypharmacy Side Effects: A Cross-Sectional and Computational Approach

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**Abstract**

**Background:** Self-medication is a common healthcare practice that may contribute to inappropriate drug use, adverse drug reactions, and polypharmacy-related risks. However, region-specific evidence on self-medication practices and their associated socio-demographic determinants remains limited in Kashmir. Concurrently, advances in Artificial Intelligence (AI) provide opportunities for computational modelling of complex drug–drug and drug-related interactions.

**Objective:** This study aimed to determine the prevalence and patterns of self-medication among the general population of Kashmir, identify commonly used medicines and their association with selected socio-demographic characteristics, and develop an AI-based approach for predicting potential side effects associated with polypharmacy.

**Results:** Self-medication was reported by 74.7% (1,121/1,500) of participants. District-wise prevalence ranged from 68.8% to 81.1%, indicating substantial geographical variation. Among individuals practicing self-medication, respiratory symptoms such as runny nose, cough, sore throat and nasal congestion constituted the largest reported category (54.8%), followed by fever and body aches (25.3%) and migraine/headache (8.6%). Pharmacies were the predominant source of medicines (82.4%). Significant associations were observed between self-medication and gender, age group, education, family type, monthly family income, occupation, and district, whereas residence was not significantly associated. The AI-based modelling component was completed through simulations, demonstrating the feasibility of applying graph-based AI techniques to polypharmacy side-effect prediction.

**Conclusion:** The findings indicate a high prevalence of self-medication among the surveyed population of Kashmir, with significant socio-demographic and geographical associations. The integration of population-level evidence with AI-based polypharmacy modelling provides a potentially valuable framework for rational drug-use initiatives, pharmacovigilance, and drug-safety assessment.

**Keywords:** Self-medication; Polypharmacy; Artificial Intelligence; Graph Neural Networks; Drug Safety; Pharmacovigilance

# Optimization, characterization and *in Vitro* cytotoxicity of *Alcea rosea* seed extract-loaded chitosan nanoparticles

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**Abstract**

*Alcea rosea*, commonly called as "*hollyhock*" and "*Suz posh*" in Kashmiri, is a medicinal plant rich in bioactive phytochemicals with reported pharmacological properties. However, the therapeutic role of plant extracts may be restricted by poor stability, solubility and bioavailability. Nanoparticle-based delivery systems provide an encouraging approach to enhance the delivery and biological efficacy of plant-based bioactive compounds. This study aims to formulate *Alcea rosea* seed extract-loaded chitosan nanoparticles to evaluate their physicochemical characteristics, in-vitro release profile and cytotoxic potential against colorectal cancer cells. Ethyl acetate extract of *Alcea rosea* seeds was incoporated into chitosan nanoparticles by the ionic gelation method with sodium TPP as the cross-linking agent. For optimization of the formulation, different concentrations of chitosan were used followed by different Chitrosan:TPP ratios and were comparatively evaluated to identify the most effective formulation. The nanoformulations were characterized by DLS, FTIR and SEM. Entrapment efficiency was evaluated by quantifying the unencapsulated extract. In-vitro release of the encapsulated extract was investigated using phosphate buffer as the release medium at predetermined time intervals. The cytotoxic activity of the extract-loaded nanoparticles was subsequently evaluated against HCT116 colorectal cancer cells and compared with appropriate

controls and 5-fluorouracil. DLS analysis demonstrated a nanoscale particle population of most of the formulations. FTIR analysis showed characteristic band shifts of functional groups of the extract and polymer that supported the incorporation of extract within the nanoparticle system, while SEM also showed appropriate nanoparticle morphology and surface properties. The in-vitro release study revealed a time-dependent sustained release of the extract encapsulated in chitosan nanoparticle, indicating the potential of the chitosan matrix to provide sustained delivery system. Cytotoxicity assay also showed that the nanoformulated extract possesses good inhibitory effects on colorectal cancer cell viability, which supports its promising anticancer activity. Among all the synthesised nano-formulations evaluated, **H2:1**, prepared using a higher chitosan concentration of **5 mg/mL in 1% acetic acid** and a **chitosan:TPP ratio of 2:1**, was identified as most effective based on its overall formulation characteristics and cytotoxic effect.

**Keywords**: Nanoparticle, *Alcea rosea*, Cytotoxicity, Bioavailability, Encapsulation efficiency, Release kinetics

# Evaluation of Hesperidin loaded nanohydogels for Enhancing wound healing through modulation of key signaling pathways in diabetic animal models

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## Abstract

Diabetic wounds represent a serious clinical problem because of chronic inflammation, impaired angiogenesis, oxidative stress, and delayed tissue regeneration. Conventional wound-management approaches often furnish limited therapeutic outcomes, highlighting the need for advanced and bioactive wound-healing approaches. Naturally occurring flavonoid Hesperidin, holds a promising antimicrobial, antioxidant, anti-inflammatory, antidiabetic, and wound-healing properties; but, its therapeutic application is limited due to poor solubility that decreases its bioavailability and ultimately its therapeutic efficacy. In this study, nanohydrogels loaded with hesperidin were developed using polyethylene glycol (PEG) and polyvinyl alcohol (PVA) as a topical delivery platform to target diabetic wound. The nanohydrogels were characterized using Dynamic Light Scattering (DLS), Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) to evaluate their size, chemical characteristics and surface morphology. Subsequently therapeutic efficacy of the formulation was assessed by *in vitro* and *in vivo* assays using diabetic mouse wound model and compared with control. Histopathological assessment demonstrated improved tissue regeneration in hydrogel-treated wounds, characterised by enhanced re-epithelialization, and overall restoration of tissue architecture. In addition, molecular analysis using RT-qPCR revealed elevated expression of **vascular endothelial growth factor (VEGF)** and **transforming growth factor-beta (TGF-β)** in hydrogel-treated wounds compared with control, indicating improved angiogenic and tissue-remodelling responses. Collectively, these results showed that hesperidin-loaded PEG-PVA nanohydrogels enhance the healing of diabetic wounds through improved tissue regeneration and modulation of key pathways of wound-healing, highlighting their potential as an advanced topical therapeutic strategy for diabetic wound management.

**Keywords**: Diabetes, diabetic wound, nanohydrogels, Hesperidin, PEG-PVA

# Tankyrase inhibition restores chemosensitivity in triple-negative breast cancer cells by disrupting TFEB/β-Catenin/ABCG2 axis

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Triple-negative breast cancer (TNBC) is primarily treated with chemotherapy; however, the development of chemoresistance frequently limits therapeutic efficacy and contributes to poor clinical outcomes. In the present study, we established cisplatin-resistant MDA-MB-231 (CR) cells and characterised their drug response using MTT and SRB assays. Clonogenic and migratory properties were evaluated using colony formation and migration assays, respectively. Comprehensive bioinformatics analyses were performed to identify differentially expressed genes, while western blotting and immunofluorescence were employed to assess protein expression and subcellular localisation. The functional role of the identified pathway was further validated using siRNA-mediated knockdown and co-immunoprecipitation (Co-IP) to investigate protein–protein interactions. In vivo, the therapeutic efficacy of XAV-939-mediated TNKS inhibition, either alone or in combination with cisplatin, was evaluated for its ability to suppress tumour growth.

Our findings demonstrate that transcription factor EB (TFEB) regulates the expression of the multidrug efflux transporter ATP-binding cassette subfamily G member 2 (ABCG2), a key mediator of drug resistance. Mechanistically, nuclear translocation of TFEB was found to be dependent on TNKS-mediated PARsylation, a post-translational modification that facilitates TFEB trafficking from the cytoplasm to the nucleus. Following nuclear translocation, TFEB interacts with β-catenin and promotes the transcriptional activation of ABCG2, thereby contributing to enhanced cisplatin efflux in CR cells. Pharmacological inhibition of TNKS with XAV-939 disrupted PARsylation-dependent TFEB trafficking, resulting in reduced nuclear TFEB accumulation and decreased ABCG2 expression, consequently impairing the cisplatin efflux capacity of CR cells. Consistent with these findings, in vivo administration of XAV-939 significantly suppressed tumour growth, both as a monotherapy and in combination with cisplatin. Collectively, these findings identify the TNKS–TFEB–β-catenin–ABCG2 axis as an important regulatory mechanism underlying cisplatin resistance and suggest that pharmacological targeting of TNKS may be a promising therapeutic strategy to overcome cisplatin resistance and improve treatment efficacy in TNBC.

**Keywords:** TNBC; Chemoresistance; Tankyrase; PARsylation; Drug efflux

# Mapping Ethical Concerns Through Changing Workplace Surveillance Technologies: A Bibliometric Analysis

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**Abstract**

The transformation from traditional office-based work to remote and hybrid arrangements has increased organisational reliance on technologies to monitor dispersed workplaces. Consequently, workplace surveillance has evolved to include algorithmic management (AM), artificial intelligence (AI) and data-driven technologies. Although these tools enhance productivity and control, they raise ethical concerns regarding privacy, autonomy, fairness, transparency, consent and dignity. In this context, this study examines the emerging context of workplace surveillance in light of ethical concerns. We employed bibliometric analysis and Cobo method, following the PRISMA 2020 framework. Literature was retrieved from the Web of Science database using search string ((surveillance OR monitor* OR "electronic performance monitoring") AND (workplace* OR worker* OR employ*)). The search retrieved 137,295 records as on July 27, 2026. After refinement and screening, 266 documents were included. The study found that during 1989–2007, research focused mainly on electronic monitoring, performance and control, with limited attention to ethics. From 2008–2018, workplace privacy became more prominent. During 2019–2023, remote work, digital surveillance and big data increased attention to autonomy, trust, justice and employee impacts. From 2024–2026, AI, AM and datafication further focused towards fairness, transparency, accountability, dignity and responsible employee data use. Ethical evaluation of workplace surveillance must evolve with changing practices. For academicians, this highlights examination of privacy, autonomy, fairness, transparency, accountability, dignity, trust, justice and organisational power. For practitioners, surveillance should be assessed beyond productivity, considering effects on employee autonomy, privacy, fair treatment, dignity and data use. For policymakers, the findings emphasise ethical and regulatory guidance that keeps pace with AI, AM and data-driven surveillance. By mapping ethical evolution across technological periods, this study provides a longitudinal perspective, showing how workplace surveillance ethics has expanded from privacy towards autonomy, fairness, transparency, accountability and dignity, highlighting the need to balance employee rights with organisational objectives.

**Keywords:** Bibliometric Analysis; Ethics; Thematic Evolution; Workplace Surveillance;

# Confusion, Not Ignorance: Al-Attas's Epistemology of Adab and the Problem of AI-Generated Knowledge

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## Abstract

Syed Muhammad Naquib al-Attas argued that the deepest crisis facing the Muslim ummah was not ignorance but confusion a state in which knowledge is possessed but wrongly placed, so that what is known is misapplied, misjudged, or mistaken for something it is not (Al-Attas, as discussed in Ardiansyah et al., 2019). He traced this confusion to the uncritical absorption of a secular Western epistemology that strips knowledge of hierarchy, of purpose, and of any necessary relation to the sacred, leaving a person able to accumulate information while losing the adab that would let them place it correctly (Al-Attas, 1978/1993, 1995). This paper argues that generative AI does not sit outside this diagnosis; it is close to a technologically automated instance of it. Large language models produce fluent, plausible text through statistical pattern-matching over training data, with no representational commitment to what any of it means (Bender et al., 2021) and, more pointedly, no operative concern for whether what they output is true (Hicks et al., 2024). Read through al-Attas's epistemology, this is confusion of knowledge at industrial scale: outputs that mimic the form of knowledge while standing in no necessary relation to truth (haqq), purpose, or moral order. I argue that the standard vocabulary of AI ethics -bias, fairness, transparency, hallucination- describes symptoms of this condition without naming its cause, because that vocabulary has no place in it for hierarchy or purpose to begin with. A ta'dib-oriented response, by contrast, asks a prior question: knowledge for what, and knowledge ordered by what. The paper closes by sketching what taking that question seriously would mean for how AI-generated knowledge is evaluated, taught with, and governed.

Keywords: Naquib al-Attas; adab; confusion of knowledge; Islamic epistemology; generative AI;

# Islamic Perspective on Modern Science and Technology

Dr. Sheikh Jameil Ali[1]

## Abstract

The conception of knowledge (A-Ilm) in Islam is guiding light (Huda) separating the right from the wrong (Al-Furqan), so Al-ilm is the source of guidance to see the truth. Furthermore, the sources of knowledge in Islam includes both worldly knowledge (Ayat from universe) and religious knowledge (Ayat from Quran). There is a complete consistency between Ayat in the universe and Ayat in the Holy Quran. We are created with five senses to experience His Ayat in the universe and our human body and with El Aql (mind) to think about what we experience. Allah (SWT) the All-Knowing is the source of all knowledge and it is His Mercy that He gives us the ability and opportunities to seek some of His knowledge. The knowledge as described in the Quran and the Sunnah is comprehensive and covers every area of life, including many aspects of natural and social sciences. Therefore, natural, and social sciences are parts of Islamic fundamentals of faith (Iman). Consequently, Muslim Scientists cannot study the universe and human behaviour separately from The Holy Quran and Sunnah. The concept of science in Islam is the concept of *Tawheed*-based science, namely the belief in Allah (SWT) alone in all aspects of His creation and worship. In fact, knowledge without Tawhid will cause humans to forget themselves and neglect their obligations and goals in life. The main proposition of Islam is *tawhid* or oneness of Allah in the midst of religion, philosophy, art, literature, poetry, modernity, environment, etc. With regard to modern science and technology Islamic scholars are of the opinion that it should be practiced, keeping religious beliefs uphold and we should not become indifferent to the belief that there is a Creator of the world. The aim of this paper is to demonstrate the role of the world view *Tawhid* in inspiring scientific spirit and evaluate the views of Islamic scholars vis-à-vis modern science and technology.

Keywords:- Tawhid, Islam; Science; Technology;

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# A Data-Driven Workflow Analysis Framework for Enhancing Administrative Efficiency and Good Governance in Higher Educational Institutions

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## Abstract

Higher Education Institutions (HEIs) face increasing pressure to enhance operational efficiency, transparency, and accountability to meet modern standards of good governance. However, traditional administrative processes within academia are frequently hindered by manual bottlenecks, redundant approval layers, and opaque tracking mechanisms.This paper presents the design, development, and implementation of an integrated Workflow Analysis System (WAS) tailored specifically for HEI governance. The proposed system utilizes process mining and business process management (BPM) principles to map, monitor, and optimize institutional workflows. By centralizing administrative pathways and providing real-time data analytics, the WAS significantly reduces processing time, eliminates administrative silos, and enforces compliance with regulatory frameworks. Ultimately, this study offers a scalable, technology-driven framework that empowers academic leaders to transition from reactive management to data-informed, strategic governance.

Key Words: Data-Driven; Workflow Analysis; Framework; Administrative Efficiency; Good Governance;

# Whose Philosophy Aligns AI?
# Towards Philosophical Pluralism in Building Contemporary AI

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**Abstract:**

The rapid development of large language models (LLMs) has fundamentally altered the relationship between philosophy and artificial intelligence. Whereas philosophy previously functioned primarily as an external normative discipline concerned with evaluating the ethical implications of AI, contemporary AI alignment increasingly incorporates philosophical concepts directly into the reasoning structures of intelligent systems. Constitutional AI, public reason, reflective self-correction, epistemic humility, and explainable reasoning collectively demonstrate that philosophy has moved from the margins of AI ethics to the centre of AI design. This paper characterises this transformation as the "praxis of philosophy"—the translation of philosophical concepts, methods, and modes of reasoning into computational procedures governing how AI systems deliberate, justify, interpret, analyse and interact. Through a critical review of recent scholarship, the paper argues that this operationalisation has been overwhelmingly shaped by Western philosophical traditions, particularly constitutional liberalism, Socratic tradition, and theories of public reason. While a modest body of recent scholarship has begun exploring Indian philosophy in relation to AI, these contributions remain largely confined either to ethical discourse or to isolated explorations of Nyāya epistemology. The paper argues that the next stage of AI alignment requires a broader conception of philosophical pluralism in which Indian philosophical traditions are investigated not merely as sources of ethical values but as sophisticated methodologies for reasoning, dialogue, interpretation, epistemic justification, and agency. It concludes that the central question confronting contemporary AI is no longer whether philosophy should inform intelligent systems, but also about inter-traditional cooperation and collaboration of diverse philosophies.

**Keywords:** Artificial Intelligence; AI Alignment; Constitutional AI; Philosophy of AI; Indian Philosophy;

# Exploring Of Families with Only Daughters in Farming Communities in Kashmir

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**Abstract**

In countries where economy is not so well off, the presence of high poverty rate and less formal literacy have been seen and the position of women also have been seen petite whether economically or socially. Uplifting women would benefit society significantly by improving output, eliminating poverty and hunger, and supporting economic growth. This qualitative study was conducted to explore the various experiences of families with only daughters who involved in farming communities. A total 8 families were involved in the study. The families include Nuclear Families (5), single mother families (2) and joint family (1) living in the villages of District Baramulla. The objectives of the study were to explore the men and women's roles in apple orchard farming, Strengths and challenges of parents with only daughters in apple farming, Experiences of girls from all girl families in apple orchard farming followed by Effect of unavailability and gendered technology on gender neutrality in apple farming. Interview method were used to collect data for the study. The responses were subjected to thematic analysis.Findings revealed that the involvement of women in this sector is low as this work physically strenuous and labour intensive, In addition to it the impact of societal norms and absence of portable technological aids very often make these families to decide to hire labour from outside which they cannot afford easily. It was also found that field has got impacted interms of profit and strains more to these family financially and mentally. Fathers see their business more negatively impacted as compared to other families with sons. Along side the it's impact on saving income for their daughters marriage. while parents openly support for their daughters education but, due to unemployment the have become hopeless specially girls.Girls are not involved in apple marketing and business due to safety reasons, cultural norms and limited knowledge regarding farms which include pest and fertilizer management, making it more male-dominated agricultural market. Apart from this girls also internalize negative self-perceptions about this field and unavailability of handy tools which can reduce the manual work.Analysing finding, the study recommends comparative studies to be done between sons and all daughters family, along with studies on technological advancement to include both genders, in addition to emphasis should be given on micro financing of women in agribusiness. Framing of policies and programmes to help build women's technical, business and financial skills. Extension workers both males and females should be deployed to reach Both the genders in rural sector.

# A Unified Neuro-Symbolic Architecture for Deterministic AI

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**Abstract**

By synthesizing principles from Indian Knowledge Systems with modern computational frameworks, the proposed architecture establishes a deterministic neuro-symbolic foundation that mitigates hallucination and reduces computational cost. The framework provides a transparent and provable basis for high-stakes applications such as jurisprudence, healthcare, and autonomous systems. The novelty of this architecture lies in coupling symbolic rigor with computational efficiency rather than treating accuracy alone as the objective. For example, the deterministic parser enforces verbal-cognition constraints (Ākaṅkṣā, Yogyatā, Sannidhi), ensuring that every inference is logically valid and interpretable. Similarly, the Pāṇini-inspired compiler compresses generative structures for GPU/CUDA workloads, enabling optimized execution while preserving semantic fidelity.

The modular design incorporates a Pāṇini-inspired compiler for GPU/CUDA optimization, a three-stage deterministic syntactic parser enforcing verbal-cognition constraints, a Navya-Nyāya → Sowa Conceptual Graph mapping for unambiguous knowledge representation, and a six-phase Pramāṇa meta-cognitive verifier to prevent hallucination and guarantee explainability. This study proposes a unified neuro-symbolic framework that integrates linguistic, logical, and computational traditions into a deterministic AI pipeline. By leveraging generative compression, constraint-based parsing, and formal verification, the system bridges the gap between symbolic interpretability and neural efficiency.

**Keywords:** Neuro-Symbolic AI; Deterministic AI; Indian Knowledge Systems; Pāṇini; Navya-Nyāya

# Design and Development of a Semi-Automatic Tree Plantation Machine

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## Abstract

Tree plantation is a vital activity in afforestation and environmental management, conventional plantation practices are predominantly manual, making the process labour-intensive, time-consuming, and inconsistent in terms of pit preparation and sapling placement. The present study focuses on the design and development of a semi-automatic tree plantation machine aimed at improving plantation efficiency through partial mechanization of the planting process. The proposed machine integrates three major subsystems: a drilling unit for preparing planting holes, a feeding mechanism for transporting root stems, and a robotic arm for accurate sapling placement into the prepared pit. The entire system was designed using SolidWorks and fabricated using mild steel, plywood, PVC, and 3D-printed PLA components. The control and sequential operation of the machine were achieved using an Arduino Uno-based system. A functional prototype was developed and experimentally evaluated to assess the individual and integrated performance of the machine components.

Experimental results indicated that the drilling unit was capable of producing holes of approximately 200 mm depth in about 30 seconds, while the robotic arm demonstrated reliable placement accuracy during successful trials. Out of five experimental runs, four complete plantation cycles were successfully executed, confirming the operational feasibility of the developed system. The study demonstrates that the proposed machine has significant potential to reduce manual effort, improve consistency in plantation operations, and enhance overall efficiency. Therefore, the developed semi-automatic tree plantation machine offers a promising, low-cost solution for sustainable agricultural mechanization in Kashmir and similar agricultural regions.

**Keywords:**

Tree Plantation; Semi-Automatic Machine; Agricultural Mechanization; Robotic Arm; Sustainable Agriculture;

# Tourism Development and Women Empowerment: A Case Study of Jammu and Kashmir

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**Abstract**

Tourism has increasingly emerged as a gender-inclusive sector with considerable potential to support women's economic and social empowerment. Being labour intensive, requiring relatively fewer entry-level skills and creating opportunities for self-employment and upward mobility. The sector provides women with avenues to earn income, acquire knowledge, interact with diverse groups, and broaden their perspectives. In mountainous and environmentally fragile regions, however, the benefits of tourism depend substantially on the sustainability of tourism development and its relationship with local communities and the environment. Jammu and Kashmir (J&K) possesses a unique advantage as a nature- and culture-based tourist destination, creating considerable scope for sustainable tourism-led livelihood opportunities for women. However, the region has experienced multiple shocks of fragility, environmental pressures and climate-related disasters, which have constrained the pace and pattern of tourism development. Against this backdrop, sustainable tourism can potentially contribute not only to women's empowerment but also to environmental responsibility and inclusive local development. Given the limited research linking sustainable tourism development with women's empowerment and environmental sustainability in J&K, the present study attempts to develop a contextual framework for examining this relationship. Based on a systematic review of relevant literature, the study conceptualises the nexus between sustainable tourism, women's empowerment and environmental sustainability within a fragile mountainous region. The findings are expected to provide a basis for informed and context-specific policy interventions that can promote sustainable tourism while creating meaningful livelihood and empowerment opportunities for the women of J&K.

**Keywords:** Tourism; Women's Empowerment; Environment; Fragility; Jammu and Kashmir

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# Power without Status, History without Peace: Informal Hierarchy and Shared History in the Evolution of Founding Team Conflict. A Conceptual Paper

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## Abstract

Conflict among co-founders is a leading, though under-theorized, cause of new venture dissolution. A recent systematic literature review of 43 studies on co-founder conflict concludes that existing research lacks a specific theoretical framework for co-founder dynamics, and calls explicitly for future work examining how informal power hierarchies and shared interpersonal history shape the evolution and dynamics of conflict in founding teams. This conceptual paper addresses that call by integrating intragroup conflict theory, status-power distinction theory, and the literature on relational embeddedness and demographic faultlines to develop a model explaining how informal power hierarchies and shared interpersonal history jointly shape the trajectory of task and relationship conflict among co-founders, and how this trajectory shapes founding team dissolution risk across the venture life cycle. Five hypotheses are developed, along with a proposed dyadic, multi-wave survey methodology for future empirical testing. The paper contributes a theoretically grounded account of co-founder conflict evolution that responds directly to a recently and explicitly identified gap in the entrepreneurship literature, and offers implications for founder team composition, governance, and entrepreneurship education.

Keywords: founding teams; co-founder conflict; informal power hierarchy; shared interpersonal history; relationship conflict; venture dissolution

# Entrepreneurial Passion and AI-Assisted Opportunity Recognition: The Mediating Role of Entrepreneurial Self-Efficacy and The Moderating Role of Fear of Failure

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## Abstract

This study examines the influence of entrepreneurial passion on AI-assisted opportunity recognition among Indian university students. It investigates the mediating role of entrepreneurial self-efficacy and the moderating role of fear of failure in explaining this relationship. A quantitative cross-sectional research design was adopted. Data were collected from university students across Indian higher education institutions using a structured questionnaire. Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed to test the proposed direct, mediating, and moderating relationships. The results indicate that entrepreneurial passion positively influences entrepreneurial self-efficacy and AI-assisted opportunity recognition. Entrepreneurial self-efficacy partially mediates the relationship between entrepreneurial passion and AI-assisted opportunity recognition, while fear of failure negatively moderates the relationship between entrepreneurial self-efficacy and AI-assisted opportunity recognition. This study extends Social Cognitive Theory by explaining how entrepreneurial passion influences AI-assisted opportunity recognition through entrepreneurial self-efficacy and how fear of failure acts as a psychological boundary condition in AI-enabled entrepreneurial environments. The findings suggest that universities, entrepreneurship educators, and incubation centres should strengthen students' entrepreneurial passion and self-efficacy through experiential learning, mentoring, and AI-based entrepreneurship training to enhance opportunity recognition. By fostering AI-enabled entrepreneurial competencies among university students, the study supports innovation, startup creation, employment generation, and the development of a stronger entrepreneurial ecosystem in India. This study

develops and validates a moderated mediation model linking entrepreneurial passion, entrepreneurial self-efficacy, fear of failure, and AI-assisted opportunity recognition. It contributes to the emerging literature on AI-enabled entrepreneurship by providing empirical evidence from an emerging economy.

**Keywords:** Entrepreneurial Passion; Entrepreneurial Self-Efficacy; Fear of Failure; AI-Assisted Opportunity Recognition; Artificial Intelligence;

# A Novel Herbal Capsule Formulation from Dandelion

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**Abstract:**
Dandelion (*Taraxacum officinale* F.H. Wigg.) is a medicinally important herb traditionally used in various systems of medicine for its nutritional and therapeutic properties. The present study focuses on the development of a novel herbal capsule formulation incorporating dandelion as the principal botanical ingredient. Dandelion roots and leaves contain biologically active constituents such as phenolic compounds, flavonoids, sesquiterpene lactones, triterpenoids, inulin and essential minerals, which contribute to its reported antioxidant, anti-inflammatory, hepatoprotective and digestive properties. The formulation was designed to provide a standardized, convenient and stable dosage form while preserving the bioactive constituents of the plant.

Dandelion plant material was subjected to appropriate drying, pulverization and extraction procedures, followed by preliminary phytochemical screening and evaluation of selected physicochemical parameters. The herbal extract was subsequently incorporated into hard-shell capsules using suitable pharmaceutical excipients to improve flowability, uniformity, stability and encapsulation efficiency. The prepared capsules were evaluated for physical characteristics, weight variation, moisture content, disintegration time, phytochemical profile and antioxidant potential. The formulation was further assessed for stability under appropriate storage conditions to determine its suitability as a herbal nutraceutical preparation.

The developed formulation demonstrated satisfactory pharmaceutical characteristics and retained the characteristic phytochemical constituents of dandelion. The presence of phenolics and flavonoids was associated with appreciable antioxidant activity, indicating the potential of the formulation as a plant-based health supplement. Standardization of the extract and optimization of excipient concentration are important for achieving batch-to-batch consistency and ensuring product quality.

The study highlights the potential of dandelion for development into a novel herbal capsule formulation with promising nutraceutical applications. Further studies involving detailed phytochemical characterization, toxicity evaluation, bioavailability and controlled clinical investigations are recommended to establish its efficacy, safety and therapeutic potential.

Keywords: Dandelion; Herbal capsule; Phytochemicals; Antioxidant activity;

# Artificial Intelligence as a Catalyst for Student Entrepreneurship and Future Employment

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Artificial Intelligence (AI) is rapidly transforming education, entrepreneurship, and the future of employment by creating new opportunities for students to develop innovative ideas and entrepreneurial skills. The integration of AI tools into academic and professional environments enables students to identify market needs, automate routine tasks, analyze data, develop digital products, and make informed business decisions. This transformation has lowered the entry barriers for young entrepreneurs by providing affordable and accessible technologies for content creation, customer support, marketing, financial analysis, and business planning.

This abstract explores the role of Artificial Intelligence as a catalyst for student entrepreneurship and future employment. AI-based platforms can help students convert academic knowledge and creative ideas into practical solutions, encouraging innovation and self-employment. At the same time, the increasing adoption of AI is changing traditional job roles and creating demand for emerging skills such as data analysis, AI literacy, problem-solving, creativity, critical thinking, and digital entrepreneurship. Therefore, educational institutions need to promote AI awareness, practical training, entrepreneurship education, and responsible use of emerging technologies.

The study highlights that AI should not only be viewed as a tool for automation but also as an enabler of creativity, innovation, and economic participation among students. By combining technological knowledge with entrepreneurial thinking, students can become both future-ready employees and successful entrepreneurs. Responsible and inclusive AI education can consequently contribute to sustainable innovation, employment generation, and the development of a future-oriented economy.

Keywords: Artificial Intelligence; Student Entrepreneurship; Future Employment; Innovation; Digital Skills

# Orchestrating the Green Future: How Digital Leadership, Technological Capability and Green Entrepreneurial Orientation Drive Sustainable Performance through Green Innovation (Pls-SEM and fsQCA methods)

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As economies increasingly shift towards digital and sustainability-oriented models, understanding how firms transform technological capabilities into green innovation and sustainable performance has become an important research priority. However, limited evidence explains how these processes unfold in emerging regional economies such as Jammu and Kashmir. Drawing on Dynamic Capabilities Theory, the Natural Resource-Based View, and Entrepreneurship Theory, this study develops and empirically examines a framework linking Digital Leadership, Technological Capability, Green Innovation, Green Entrepreneurial Orientation, and Sustainable Performance, while incorporating Corporate Social Responsibility as a sustainability-oriented organizational factor. Data was collected from owners, entrepreneurs, CEOs, and managerial-level employees of SMEs, startups, and established enterprises operating in Jammu and Kashmir. The study employed PLS-SEM to examine the hypothesized relationships and mediation effects, complemented by fsQCA to identify alternative configurations of organizational conditions associated with high sustainable performance. By integrating a variance-based and configurational approach, the study moves beyond linear explanations to examine both the net effects and causal complexity underlying sustainable business outcomes. The study demonstrates how digitally enabled technological capabilities and green entrepreneurial orientation can facilitate green innovation and, in turn, strengthen sustainable performance. The research contributes to the emerging literature on the future economy, innovation and sustainable entrepreneurship while providing context-specific implications for enterprises and policymakers in Jammu and Kashmir. The study further contributes to SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production) by highlighting pathways through which digitalization, entrepreneurship and green innovation can support sustainable economic development.

**Keywords:** Green Innovation; Sustainable Performance; SDGs; PLS-SEM; fsQCA

# Turning Culinary Passion into Entrepreneurial Success: Opportunities, Innovation and Empowerment

Saima Paul

**Abstract**

Culinary skills have increasingly emerged as a promising pathway for entrepreneurship, livelihood generation and economic empowerment, particularly among women, youth and aspiring food entrepreneurs. Transforming culinary passion into a successful enterprise requires more thancooking expertise; it involves innovation, product development, food safety, business planning,branding, marketing and an understanding of consumer preferences. This perspective highlightshow culinary creativity can be transformed into innovative, nutritious and commercially viablefood products and services.

Noonley Green Foodz Innovation Pvt. Ltd. serves as an inspiring example of this transition,demonstrating how culinary ideas rooted in local food culture can be developed into innovative,value-added food products and a recognizable entrepreneurial brand. The experience illustrates theimportance of converting traditional knowledge and locally available ingredients into convenient,quality-assured and market-oriented products while integrating food science, productstandardization, attractive packaging and consumer-focused marketing.

Local and indigenous ingredients provide opportunities for developing healthy snacks, functionalfoods, ready-to-cook mixes, bakery products, beverages and traditional food innovations.Scientific standardization, sensory evaluation, nutritional assessment, shelf-life studies and foodsafety practices can enhance product quality and market acceptance. Entrepreneurship training canstrengthen competencies in costing, pricing, financial management, branding, digital marketingand regulatory compliance.

The growth of social media, e-commerce, cloud kitchens and direct-to-consumer platforms hascreated new opportunities for small culinary enterprises. Women and youth can transform culinaryskills into sustainable businesses through home-based food production, catering, food processingand innovative product development. Institutional support through incubation centres, universities,self-help groups and start-up programmes can facilitate this transition.The journey represents a shift from “cooking as a skill” to “culinary innovation as anentrepreneurial opportunity.” The inspiration from Noonley Green Foodz Innovation demonstratesthat passion, combined with innovation, scientific validation, entrepreneurship and effectivebranding, can create sustainable enterprises while promoting local food resources, employmentgeneration and inclusive economic development.

Keywords: Culinary entrepreneurship; Food innovation; Women empowerment; Food business;

Entrepreneurial success;

# Financial Inclusion and Economic Growth: A Panel Data Analysis Across Indian States

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## Abstract

This study examines the relationship between financial inclusion and economic growth across 28 Indian states and union territories from 2001 to 2022. A composite Financial Inclusion Index is constructed through principal component analysis on six indicators spanning the availability, accessibility and usage dimensions of financial inclusion. Estimation strategy is estimated on a balanced panel of 616 state-year observations using fixed effects, panel-corrected standard errors and feasible generalized least squares, with the Hausman test confirming the within estimator as the appropriate baseline. Financial inclusion enters positively and significantly at the one percent level in every specification. A one standard deviation improvement in the index is associated with per capita gross state domestic product higher by roughly seventeen percent under the within estimator and by roughly forty-five percent under the pooled estimators. Agricultural productivity and social sector expenditure contribute positively while the fiscal deficit ratio contributes negatively, each at the one percent level of significance. The index documents a sevenfold gap between the most and the least financially included states in 2022, with Delhi and Maharashtra leading the distribution and the north-eastern states persistently anchoring its lower tail. These findings indicate that financial inclusion operates as a determinant of the growth process rather than as a welfare objective pursued alongside it, and that convergence in financial access would narrow a meaningful share of the interstate income gap.

**Keywords:** Financial inclusion; economic growth; principal component analysis; panel data; regional disparity

**JEL Classification:** G21; O16; O47; R11; E62

# Role of livestock in circular bio-economy as perceived by farmers of central Kashmir

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**Abstract**

The transition to a circular bio-economy emphasises efficient use of biological resources, recovery of nutrients and energy, waste reduction, and value creation from biological residues. Livestock production can contribute substantially to this transition by recycling animal manure, using agricultural and agro-industrial by-products as feed, producing biogas and bio-fertilisers, recovering nutrients, and valorising livestock-derived biological resources. However, the understanding of this emerging concept among Livestock farmers remains insufficiently explored. The present study was conducted to assess the Perception about Role of Livestock in the circular bio-economy among the Farmers of Central Kashmir.

A cross-sectional study was conducted among two hundred livestock farmers from the districts of Budgam, Srinagar, and Ganderbal in Central Kashmir. The selected aspects of livestock-based circularity, namely manure and nutrient recycling, livestock waste management, biogas production, composting, crop residues and agro-industrial by-products as animal feed, recycling of nutrients between crop and livestock systems, resource efficiency, reduction of environmental waste and value addition from livestock bio-resources were evaluated using a structured and pre-tested questionnaire. Based on the score obtained, perception was divided into low, moderate and high categories.

Overall mean perception score of 46.7 ± 5.4% indicated moderate-to-low degree of perception about the role of livestock in the circular bio-economy. Only 5.5% of the respondents had a high level of perception, 38.0% had a low level, and 56.5% fell into the middle range. While awareness towards general concepts like nutrient recovery, bio-based value chains, cascading use of biomass, and integration of livestock into circular bio-economy systems was relatively limited. However, comparatively better awareness was found regarding most of the traditional circular practices with respect to manure utilization/composting (69.5%), biogas production (58.0%), and use of crop residues as livestock feed (70.5%). Significant differences in perception were observed with respect to different districts and previous exposure to livestock waste-management, extension or entrepreneurship-related activities ($p<0.05$). A positive and significant association was observed between awareness and perception scores.

The findings indicate that although livestock farmers recognise several traditional components of resource recycling in livestock production, their understanding of these practices as part of an integrated circular bio-economy framework remains limited**.** Incorporating circular-bio-economy concepts into field-based extension activities, practical demonstrations, and interdisciplinary training may help develop greater awareness among farmers and strengthen their role in promoting resource-efficient and sustainable livestock systems.

**Keywords:** Circular bio-economy, livestock, perception, resource recycling, manure management, nutrient recovery, Kashmir.

# Option Pricing and Risk Management in Apple Production: Applications of Derivative Models

Amir Ahmad Dar

## Abstract

Apple production is exposed to substantial uncertainty arising from weather conditions, market price fluctuations, input costs, and variations in crop yield. These uncertainties create significant financial risks for apple producers, traders, and other stakeholders across the agricultural value chain. This study proposes an option-based framework for managing price and production-related risks in the apple industry. The research explores the application of derivative instruments, particularly agricultural options, to provide producers with protection against adverse movements in apple prices and uncertain production outcomes. Suitable option pricing approaches are examined to estimate premiums and evaluate the effectiveness of hedging strategies under different market conditions. The study also considers key factors influencing option values, including volatility, maturity, underlying apple prices, and risk-free interest rates. By integrating actuarial and financial modelling techniques, the proposed framework aims to support informed risk-management decisions among apple producers. The findings are expected to demonstrate how derivative-based strategies can reduce financial uncertainty, improve income stability, and enhance the resilience of apple production systems. The study contributes to the growing literature on agricultural finance by highlighting the potential role of option derivatives in managing risks associated with horticultural commodities.

**Keywords:** Option Pricing; Apple Production; Agricultural Derivatives; Risk Management; Price Volatility

# Quadrupole Deformation in the A = 70 Isospin Triplet within an Isospin-Invariant Skyrme Density Functional Approach

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**Abstract**

The interplay between *quadrupole collectivity* and *isospin symmetry* provides an important test ing ground for understanding nuclear structure in nuclei close to the $N = Z$ line. In the present work, the *isospin-invariant Skyrme density functional theory* is employed to investigate the intrinsic deformation properties of the $T = 1$ isospin triplet corresponding to mass number $A = 70$. The calculations incorporate *proton–neutron mixing* through the *isocranking approximation* and include both Coulomb and explicit isospin-symmetry-breaking interactions. The calculated quadrupole moments and deformation parameters indicate that all three members of the triplet possess nearly identical intrinsic shapes. The results suggest that the experimentally observed anomalous reduced electric quadrupole transition probability ($B\left(E2;2_1^+ \rightarrow 0_1^+\right)$) behaviour is unlikely to originate from significant shape evolution and instead points towards the importance of correlations beyond the static mean-field approximation.

**Keywords:** Isospin symmetry; Isospin-symmetry breaking; Isospin-invariant density functional theory; Reduced electric quadrupole transition probability $B\left(E2;2_1^+ \rightarrow 0_1^+\right)$

# A Flexible Three-Component Mixture Model for Overdispersed Count Data and Actuarial Risk Quantification

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**Abstract**

Since the discrete distributions have great utility in dealing with count data, the present paper proposes a two-parameter discrete Remkan distribution, which is the mixture of three components, by following the general procedure of discretizing a continuous distribution and uses it as a lifetime model. The proposed distribution possesses flexibility to accommodate count data, which can be over-dispersed as well as right skewed, frequently arising in reliability and lifetime experiments. Some of the important structural properties of the new distribution like moments, index of dispersion, entropy, and mean residual life have been considered. Also, the capacity to apply the suggested model to actuarial science was examined through some key parameters of risk, proving its efficiency in tail risk modeling. Estimation of parameters has been made by maximum likelihood and moment methods and simulation has been used for model validation. Applications of the goodness of fit of the proposed distribution have been illustrated using five real-life datasets.

**Keyword:** count data; discretization; Remkan distribution; order statistic; actuarial measures.

# A New Compound Size-Biased Count Data Model: Properties, Application and Simulation

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## Abstract

In this study, a new count data distribution is proposed by compounding the Size-Biased Poisson and Size-Biased Zeghdoudi distributions. The proposed model aims to provide a flexible and effective framework for modelling count data exhibiting varying degrees of dispersion and skewness. The fundamental mathematical and statistical properties of the proposed distribution are derived, including its moments and related characteristics. The model parameters are estimated using the Method of Moments (MOM) and Maximum Likelihood Estimation (MLE).

A comprehensive Monte Carlo simulation study is conducted to examine the finite-sample performance of the proposed estimators under different parameter settings and sample sizes. Their performance is assessed using bias, variance, and mean squared error. The practical applicability of the proposed model is further demonstrated using a real count dataset. The results indicate that the proposed distribution provides a satisfactory fit and serves as a flexible alternative to existing count data models. The proposed framework therefore offers a useful contribution to the development of compound probability distributions for analysing count data.

**Keywords:** Compounding; Size-Biased Poisson; Size-Biased Zaghdoudi; Monte Carlo simulation; real life data sets.

# A New Flexible Zero-Truncated Model with Geometric-Type Structure and Advanced Inferential Properties

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**Abstract**

Zero-truncated count data arise frequently in diverse fields such as healthcare, ecology, agriculture, reliability, and insurance. Modelling such data requires distributions capable of accommodating the distinctive characteristics of positive counts, including varying levels of dispersion and skewness. In this study, we propose a new flexible zero-truncated discrete distribution for modelling positive count data. The proposed model is developed by applying zero truncation to a flexible discrete distribution and provides an additional shape parameter to capture a broad range of distributional behaviors. Several important mathematical and statistical properties of the proposed distribution are investigated. Parameter estimation is considered from both classical and Bayesian perspectives. Maximum likelihood estimates are obtained using an iterative minorization-maximization (MM) algorithm to facilitate numerical optimization. Bayesian estimation is also developed under squared error and linear exponential loss functions, allowing the proposed model to be studied under alternative inferential frameworks. The finite sample performance of the resulting estimators is evaluated through extensive Monte Carlo simulation experiments across different parameter settings and sample sizes. Performance is assessed using appropriate criteria such as bias, mean squared error, and related measures. The practical applicability of the proposed model is illustrated using two real world positive count data sets. Its goodness of fit is evaluated and compared with several existing zero-truncated count distributions using standard model selection and goodness of fit measures. The results demonstrate that the proposed distribution provides competitive and, in the considered applications, superior fits while offering greater flexibility for modelling positive count data. In addition, likelihood ratio tests are employed to examine the contribution of the shape parameter and to compare the proposed model with its nested sub-models. Overall, the findings highlight the potential of the proposed distribution as a useful and flexible alternative for the analysis of zero-truncated count data.

**Keywords:** Zero-Truncation; MLE; MM algorithm; Bayesian estimation; hypothesis testing

# A Non-Negative Integer-Valued Probability Model: Properties and Regression Analysis

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## Abstract

The modeling of count variables remains an active area of research because such data arise frequently across many fields. Standard modeling approaches typically impose rigid assumptions that often struggle to reflect the true complexity present in observed data. Recent advances in methodology aim to overcome these limitations by proposing more flexible distributional frameworks. This study introduces a novel non-negative integer-valued count model formed through a Bernoulli convolution with a Poisson-based mixed distribution. This construction has the distinct advantage of naturally accounting for both over-dispersion and under-dispersion, a capability not often seen in conventional distributions. The fundamental properties of the proposed model are explored in detail, along with a discussion of the standard maximum likelihood estimation procedure. Furthermore, a regression formulation based on this distribution is developed to broaden its practical utility. Empirical evaluations using real-world datasets demonstrate that the suggested regression approach provides superior fit and predictive performance relative to several widely used count regression models.

**Keywords:** convolution distribution; count data; dispersion index; parameter estimation; simulation; regression analysis

# A Novel Alpha Power Transformed Probability Model: Estimation, Properties and Applications

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**Abstract**

This study proposes a novel Alpha Power Transformed (APT) Chris–Jerry distribution for modelling lifetime data. The model is obtained by applying the alpha power transformation to the one parameter Chris Jerry distribution, introducing an additional shape parameter and thereby enhancing its flexibility. Statistical properties of the proposed distribution are derived, and the model parameters are estimated using the maximum likelihood method. A simulation study is conducted to examine the performance of the estimators, while applications to real lifetime datasets demonstrate the practical usefulness of the proposed model. Comparisons with existing lifetime distributions show that the proposed model provides a flexible and competitive alternative for analysing right skewed lifetime data.

Keywords: Alpha power transformation; lifetime data; maximum likelihood method; Monte Carlo simulation; Chris Jerry Distribution.

# A Novel Weighted Probability Model for Continuous Data: Properties and Regression Analysis

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## Abstract

Weighted distributions play a crucial role in various applied disciplines, including ecology, econometrics, reliability, and biomedical sciences, primarily because they offer enhanced structural flexibility. Building on this theoretical foundation, this paper introduces a new continuous probability model, designated as the Weighted Chris-Jerry (*WCJ*) distribution. This model is formulated as a two-component mixture of standard gamma distributions. We explore its core statistical characteristics in detail, which include moments, mode approximation and mean deviation. To estimate the unknown parameters, we employ Maximum Likelihood, Least Squares, and Weighted Least Squares estimation techniques. The finite-sample consistency and asymptotic unbiasedness of these estimators are then evaluated through comprehensive Monte Carlo simulation studies. Additionally, we formulate a mean-parameterized *WCJ* regression framework designed specifically for analyzing covariate-dependent, positive continuous responses. The practical applicability and effectiveness of the proposed methodology are illustrated using two real-world datasets, showcasing its competitive performance against several well-established baseline models.

**Keywords:** Weighted distributions; continuous data; parameter estimation; simulation; regression analysis.

# $BiFeO_3$ Coupled with 2D Layered Materials: A Cost-Effective Electrocatalyst for Hydrogen and Oxygen Evolution Reactions

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**Abstract**

The increasing demand for sustainable and eco-friendly energy sources has accelerated the development of efficient and low-cost electrocatalysts for water splitting. In this work, $BiFeO_3$ (BFO) nanoparticles were synthesized via an ultrasonication-assisted sol-gel method and combined with graphene, g-$C_3N_4$, and $MoS_2$ to improve their electrocatalytic performance toward hydrogen evolution reaction (HER) and oxygen evolution reaction (OER). The prepared composites were denoted as $BiFeO_3$/Graphene (BFO/G), $BiFeO_3$/g-$C_3N_4$ (BFO/CN), and $BiFeO_3$/$MoS_2$ (BFO/MS). X-ray diffraction (XRD) confirmed the formation of phase-pure BFO and its composites without secondary phases. Fourier transform infrared spectroscopy (FTIR) verified the characteristic bonding and functional groups, while Field emission scanning electron microscopy (FE-SEM) and Energy dispersive X-ray Spectroscopy (EDX) analyses revealed the morphology and elemental composition. X-ray photoelectron spectroscopy (XPS) analysis confirmed the elemental states and distribution of the constituent elements. UV-Visible spectroscopy showed slight variations in the band gap values, indicating the influence of 2D layered materials on the optical properties of BFO. Electrochemical studies revealed that BFO/G exhibited the best catalytic activity, achieving overpotentials of 160 mV for HER and 260 mV for OER at 10 mA $cm^{-2}$. The improved performance is attributed to its partially amorphous nature, higher electrochemical active surface area, and efficient charge transfer, demonstrating its potential for sustainable hydrogen production through water splitting.

**Keywords:** Perovskite; 2D Materials; Water Splitting; Hydrogen Evolution Reaction; Oxygen Evolution Reaction

# Broadband Variability Analysis of FSRQ PKS 0402−362 with Indications of Quasi-Periodic Modulation

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**Abstract**

We present a comprehensive temporal and spectral study of the flat-spectrum radio quasar PKS 0402−362 using Fermi-LAT, Swift-XRT, and UVOT observations spanning MJD 54686–60321. The γ-ray light curve exhibits multiple phases of enhanced activity, with the fractional variability parameter (Fvar) showing larger amplitudes at longer timescales, consistent with variability trends observed in other FSRQs. Statistical analysis of the flux and spectral-index distributions using the Anderson–Darling test and histogram fitting reveals that both distributions deviate from a single log-normal form and are better represented by a double log-normal profile, indicating two distinct flux states. A search for quasi-periodic oscillations in the γ-ray emission using the Lomb–Scargle periodogram identified a significant periodic signal at ∼413 days with a confidence level exceeding 3σ. However, the proximity of this timescale to one year and the limited number of observed cycles prevent a definitive interpretation. Broadband spectral energy distributions for six flux states were modeled using a one-zone leptonic framework incorporating synchrotron, synchrotron self-Compton (SSC), and external Compton (EC) components. The SEDs are well reproduced with physically reasonable parameters: high-flux states exhibit harder electron spectra and lower magnetic field strengths (B ∼ 0.2–0.6 G), while low-flux states show softer spectra and stronger magnetic fields (B ∼ 1.3 G). The fitted break energy decreases during high-flux states, suggesting enhanced radiative cooling and a transition toward a particle- or kinetic-energy-dominated jet. These trends are consistent with the harder-when-brighter behavior commonly observed in blazars.

**Keywords:** PKS 0402−362; FSRQ; γ-ray variability; quasi-periodic oscillations; broadband SED modeling

# Cyclohexane-1,3-dione-Based Antitubercular Leads: Identification, Optimization, and Biological Evaluation against *Mycobacterium tuberculosis*

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## Abstract

The emergence of drug-resistant *Mycobacterium tuberculosis* underscores the urgent need for selective antitubercular agents with novel chemical scaffolds. Whole-cell phenotypic screening of diverse small molecules against *M. tuberculosis* H37Rv identified cyclohexane-1,3-dione-based hits, which were subsequently optimized to generate a library of 37 compounds representing four structural families. Among these, compounds 37, 39, and 41 emerged as promising leads, with 2-(((2-hydroxyphenyl)amino)methylene)-5,5-dimethylcyclohexane-1,3-dione (PAMCHD; 39) exhibiting the most favorable activity (MIC = 2.5 μg $mL^{-1}$). PAMCHD displayed both tuberculostatic and tuberculocidal effects, characterized by concentration- and time-dependent killing and complete sterilization of *M. tuberculosis* at concentrations ≥10 μg $mL^{-1}$. Moreover, PAMCHD exhibited additive or synergistic interactions with established antitubercular agents and a favorable mutant-prevention profile (MPC/MIC = **64**). The compound showed minimal cytotoxicity across four human cell lines and negligible activity against representative Gram-positive and Gram-negative bacteria and *M. smegmatis*, demonstrating a high degree of selectivity toward *M. tuberculosis*. Molecular docking studies revealed strong predicted binding of PAMCHD to **KatG** (−9.8 kcal $mol^{-1}$), substantially exceeding that of isoniazid (−6.3 kcal $mol^{-1}$), with key interactions involving **TRP107, HIS270, LEU265, ILE266, and GLY269**. Favorable interactions within the InhA binding pocket further supported its potential to engage established antitubercular targets. In silico ADME assessment indicated favorable drug-like characteristics, including moderate lipophilicity (logP = 2.13), high gastrointestinal absorption, compliance with Lipinski's rule of five, and the absence of PAINS alerts. In summary, these findings identify PAMCHD as a selective and promising cyclohexane-1,3-dione-based antitubercular lead, warranting further mechanistic studies and structure-based optimization.

**Keywords:** Cyclohexane-1,3-dione; *Mycobacterium tuberculosis*; Antitubercular activity; KatG inhibition.

# Date Gum-Grafted Polyacrylamide Hydrogel for Wearable Strain Sensing and Human Motion Detection

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## Abstract

The field of flexible electronics has gained tremendous research attention in recent years due to its potential to revolutionize human-machine interactions. In response to the mechanical mismatch at the interface between biological tissues and conventional electronic devices, hydrogels have emerged as ideal materials because they are intrinsically soft and flexible due to their high-water content. However, synthesizing a hydrogel that simultaneously possesses stretchability, toughness, elasticity, and conductivity remains a challenge. In this work, a stretchable and wearable hydrogel strain sensor was synthesized by graft polymerization of date gum (DG) with acrylamide (AAm), using ammonium persulfate (APS) as the initiator, N,N-methylene-bis-acrylamide (MBA) as the crosslinking agent, and calcium chloride ($CaCl_2$) as the dopant to enhance conductivity. Various parameters, including the amount of solvent, the concentrations of AAm, APS, and MBA, and the reaction temperature, were optimized to get maximum stretchability of the prepared DG-g-poly(AAm)/$CaCl_2$ hydrogel. The optimized hydrogel was characterized using FTIR, XRD, and SEM to confirm the grafting and the formation of a crosslinked network. The hydrogel exhibited excellent stretchability (1400%), good conductivity (2.34 S/m), and enough adhesion to skin. When utilized as a wearable strain sensor, the synthesized hydrogel exhibited high sensitivity, with gauge factors of 4.59 and 7.16 over the strain ranges 0-100% and 100-200%, respectively. The hydrogel sensor could repetitively detect a wide range of human activities, such as finger, wrist, elbow, and neck movements.

**Keywords:** Hydrogels; Ionic conductivity; Strain Sensors; Wearable

# DFT Investigation of Catalytic Hydrogenation of $CO_2$ to Methanol Using Ru(II)-NHC Pincer Catalyst

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## Abstract

The catalytic hydrogenation of carbon dioxide $CO_2$ to methanol represents an attractive strategy for carbon capture and utilization, offering a route for converting $CO_2$ into a valuable chemical and potential liquid energy carrier. However, the thermodynamic stability and kinetic inertness of $CO_2$ make its selective hydrogenation challenging. In the present study, Density Functional Theory (DFT) calculations were employed to investigate the mechanism of $CO_2$ hydrogenation to methanol mediated by a proton responsive Ru(II)-NHC pincer catalyst. The study focuses on catalyst activation, $H_2$ cleavage, $CO_2$ activation, proton/hydride transfer, and the successive hydrogenation steps leading to methanol. The calculated mechanism reveals that $H_2$ activation proceeds through a water-assisted heterolytic cleavage pathway, generating a bifunctional Ru–H/N–H species in which the metal centre acts as a hydride donor while the proton-responsive ligand functions as a proton reservoir. $CO_2$ reduction proceeds through coordination to Ru, hydride transfer to form a Ru-formate intermediate, followed by proton transfer to generate formic acid. Subsequent transformations involve formamide, hemiaminal, and formaldehyde intermediates before the final formation of methanol. The results highlight the importance of metal-ligand cooperativity in facilitating hydrogen activation and sequential proton/hydride transfer. The calculated free-energy profile provides molecular level insight into the energetics and structural features governing the catalytic cycle. Overall, this work demonstrates the potential of proton responsive Ru(II)-NHC pincer catalysts for efficient $CO_2$ utilization and provides mechanistic insights useful for the rational design of improved catalysts for sustainable methanol production.

**Keywords:** $CO_2$ hydrogenation; Ru(II)-NHC pincer catalyst; Metal-ligand cooperativity; DFT mechanistic study.

# DFT Investigation of Transition Metal Single-Atom Catalysts Supported on 2D Polyaramid for Electrochemical Nitrogen Reduction

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**Abstract**

Electrochemical nitrogen reduction reaction (NRR) offers a sustainable alternative to the conventional Haber–Bosch process for ammonia synthesis, but its practical application requires catalysts that exhibit high activity and selectivity. In this study, density functional theory (DFT) calculations are employed to systematically investigate the catalytic performance of 3d- and 4d-transition metal single atoms supported on a two-dimensional polyaramid (2DPA) substrate. The adsorption of $N_2$ is examined in both end-on and side-on configurations, with binding energies used to identify the energetically preferred adsorption mode for each metal. Across the investigated systems, $N_2$ adsorption is found to be more favourable than $H_2$ adsorption, suggesting promising selectivity toward NRR over the competing hydrogen evolution reaction (HER). The thermodynamic feasibility of the NRR pathway is further assessed by calculating the free-energy changes associated with the potential-determining steps. Based on these results, the most promising single-atom catalysts, exhibiting sufficiently low free-energy requirements, are shortlisted for further investigation. These findings provide insights into the design of efficient and selective single-atom catalysts for sustainable electrochemical ammonia production.

**Keywords**: nitrogen reduction reaction; single-atom catalysts; 2DPA; DFT; electrocatalysis

# $Dy^{3+}$-Induced Hexagonal-Monoclinic Phase Modulation and $Dy^{3+}\rightarrow Sm^{3+}$ Energy Transfer in $LiSrPO_4:Sm^{3+}$ Phosphors for Warm-White LED Applications

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## Abstract

Phosphate-based hosts have attracted considerable attention for solid-state lighting applications owing to their superior chemical stability and structurally tunable crystal chemistry. In this study, a series of $LiSrPO_4:0.02Sm^{3+}$, $xDy^{3+}$ (x = 0-5 mol%) phosphors were synthesized and systematically characterized in terms of structure, luminescence, and thermal behavior. Powder X-ray diffraction patterns, indexed against ICSD#258641, revealed the coexistence of hexagonal ($P6_5$-type) and monoclinic phases throughout the compositional series, with phase fractions quantitatively determined via Rietveld refinement ($\chi^2 \approx 1.8$-$2.2$). With increasing $Dy^{3+}$ concentration, the hexagonal phase fraction initially declined from ~83% (x = 0) to a minimum of ~36-39% at intermediate doping levels, before recovering sharply to ~98% at x = 4-5 mol%, indicative of a dopant-concentration-driven phase re-stabilization. This structural evolution was accompanied by a systematic contraction of the unit-cell volume (531.8 → 527.9 Å$^3$), consistent with the smaller ionic radius of $Dy^{3+}$ relative to $Sr^{2+}$. Photoluminescence excitation and emission spectra, recorded at $\lambda_{em}$ = 573 and 597 nm and $\lambda_{ex}$ = 350, 386, and 402 nm, exhibited characteristic $Sm^{3+}$ ($^4G_{5/2}\rightarrow{}^6H_J$) and $Dy^{3+}$ ($^4F_{9/2}\rightarrow{}^6H_J$) transitions with pronounced spectral overlap, confirming efficient $Dy^{3+}\rightarrow Sm^{3+}$ energy transfer governed by a dipole-dipole interaction mechanism, as corroborated by Inokuti-Hirayama-type concentration analysis (slope ≈ −1.86). Temperature-dependent PL measurements (25-210 °C) demonstrated robust thermal quenching resistance, retaining ~73% of initial intensity at 480 K with a corresponding activation energy of ~0.155 eV. CIE 1931 chromaticity coordinates under all three excitation wavelengths were in the yellow-orange region proximal to the blackbody locus, yielding correlated color temperatures spanning warm to near-neutral white. Collectively, these findings establish $LiSrPO_4:Sm^{3+},Dy^{3+}$ as a thermally robust, color-tunable phosphor system whose optical performance is governed by composition-controlled polymorphism and interionic energy transfer, positioning it as a promising candidate for warm-white LED applications.

**Keywords:** $LiSrPO_4$ phosphor; hexagonal-monoclinic phase coexistence; thermal stability; CIE chromaticity; white LEDs

# Economic evaluation of a small scale biofiltration system for common carp (*Cyprinus carpio*) production

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## Abstract

The present study evaluated the technical and economic feasibility of a small-scale closed-loop aquaculture system incorporating an integrated layered biofiltration approach for the rearing of common carp (*Cyprinus carpio*). The experiment was conducted under controlled laboratory conditions for 180 days using six rectangular glass aquaria operated under continuous water recirculation. The experimental design comprised two treatments with three replications, viz, Treatment 1, consisting of fish integrated with a submerged layered biofilter containing coarse gravel, fine gravel, sand and sponge, and Treatment 2, consisting of the same biofilter supplemented with *Azolla pinnata*. The common carp fingerlings with an initial mean weight of 3.50 ± 0.43 g were stocked and fed a commercial diet containing 38% crude protein @ 3% of body weight per day. The performance of the system was assessed based on growth, survival, feed utilisation, biomass production and economic returns. After 180 days, the fish attained a final mean weight of 200 ± 5 g, with a mean weight gain of 196.50 g, 95% survival and a total harvested biomass of 20.6 kg. A favourable feed conversion ratio (FCR) of 1.1 indicated efficient feed utilisation. The total capital investment was ₹35,920, while variable and fixed costs for the experimental period were ₹4,088 and ₹1,860, respectively. The system generated a gross return of ₹6,180 and a positive net return of ₹232, with a cost-benefit ratio (CBR) of 1.04. The findings demonstrated that integrated biofiltration can support efficient common carp production in a small-scale recirculating aquaculture system while providing reasonable economic returns. Scaling up the production system may further improve economic viability by reducing the contribution of fixed costs per unit of fish production.

**Keywords:** *Cyprinus carpio*; biofiltration; recirculation; economic feasibility.

# Essential attributes of the degenerated triple hypergeometric function of Srivastava's $H^{\lambda,l}_{A,p,\alpha}(\cdot)$

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**Abstract**

The paper proposes to employ the extended Beta function $B^{\lambda,l}_{p,\alpha}(z1,z2)$ introduced by Oraby et al, to degenerated triple hypergeometric function of Srivastava's HA(·). Furthermore, a few attributes like integral expression, derivative formulas and several integral transforms of the proposed function are also discussed using the extended Beta function. In addition, we use Wolfram Mathematica and computer algebraic software or object-oriented programming to build a numerical approximation table of this generalized hypergeometric function $H^{\lambda,l}_{A,p,\alpha}(\cdot)$ 2010 AMS Classification: 33C60, 33C70, 33C05, 33C10, 33B15, 33F05, 65D20.

**Keywords:** Fractional calculus; Srivastava's triple hypergeometric functions; Gauss hypergeometric function; Beta and Gamma functions.

# Expanding the Chemical Space of Benzo[f]Chromenes through Micellar Catalysis: Diverse Scaffolds, Natural Product Synthesis, and Antimicrobial Activity

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## Abstract

Benzo[f]chromenes are valuable oxygen-containing heterocyclic frameworks with significant potential as bioactive molecular scaffolds. Herein, we report a micellar catalytic strategy for the synthesis of diverse 3-substituted-3H-benzo[f]chromenes in an aqueous medium using cetylpyridinium bromide (CPB) micellar nanoreactors, $In(OTf)_3$ as a Lewis acid, and DABCO as an organic base at 40 °C, affording the desired products in 35–80% yields. Concentration-dependent $^1H$ NMR studies established the localization of the reaction partners within the palisade region of the CPB micelles, highlighting the role of the confined microenvironment in directing the transformation. Mechanistically, DABCO-mediated activation of β-naphthol followed by condensation with the $In(OTf)_3$-activated enal generates a diene-enone intermediate, which undergoes electrocyclization to furnish the benzo[f]chromene framework. The micellar environment favors chromene formation while suppressing the competing xanthene pathway observed under conventional organic-solvent conditions. The methodology accommodates substituted β-naphthols, aromatic and aliphatic enals including citral, α-naphthols, substituted phenols, and carbazole, providing 23 structurally diverse chromene constructs and enabling the synthesis of the natural product lapachenole. Preliminary antimicrobial evaluation of selected derivatives revealed promising antibacterial and antifungal activity, supporting further investigation of these scaffolds in drug-discovery programs. Overall, this study integrates aqueous micellar catalysis, molecular confinement, reaction-pathway control, scaffold diversification, and preliminary biological evaluation to establish benzo[f]chromenes as promising molecular architectures for bioactive compound discovery.

**Keywords:** Benzo[f]chromenes; micellar catalysis; molecular confinement; electrocyclization; antimicrobial activity; drug discovery.

# From Deep Convection to Ionospheric Anomalies: Tracing Gravity-Wave Signatures across the Low–Mid Latitude Geomagnetic Transition Region

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## Abstract

We examine the role of gravity waves (GWs) generated from tropospheric convection in initiating multiple nighttime ionospheric anomalies over Srinagar, located at 34.1 °N, 74.8 °E, and 25.91 °N MLAT. Optical airglow observations during a geomagnetic quiet night (Ap=4) of 29-30 June, 2021, show the presence of plasma depletion tilted by an angle of ~14.9 degrees from the geographic North, quasi-periodic south eastward moving wave (QPSEMW), onset of two electrified MSTIDs and generation of plasma depletion channel between two MSTID phase fronts at ~250 km altitude. GWs originating from deep convection in troposphere are detected at ~85 and ~97 km altitudes in OH and 557 nm filters respectively. The GWs in both the filters are propagating northward with almost similar characteristics. The intrinsic time period and vertical wavelength of GWs is estimated to be ~11 minutes and ~53 km respectively. We also present the observational indications of localised upliftment of F-layer ionosphere by ~38 km, possibly initiated by polarization electric field generated through secondary GWs. The penetration of secondary GWs, generated by the dissipation of convective GWs, beyond the altitude of 500 km is also seen. FORMOSAT-7/COSMIC-2 RO data and SAMI3 model electron density suggest the occurrence of Sporadic-E (Es) layer at around 100 km altitude, caused by the negative gradient in eastward wind.

**Keywords:** Ionospheric Disturbances; Gravity Waves; MSTIDs; Convection; Airglow

# Investigation of Charged-Particle Production in Oxygen-Oxygen Collisions with EPOS4 Model

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**Abstract**

The study of particle production in high-energy nuclear collisions plays an important role in understanding the properties of strongly interacting matter and the possible development of collective effects. Oxygen-oxygen (O-O) collisions represent an intermediate collision system between small systems and large heavy-ion collisions, making them useful for investigating possible signatures of medium-induced effects. In this work, charged-particle generation in O-O collisions is studied using the EPOS4 event generator. Simulations are performed both with and without the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) hadronic transport model to examine the role of final-state hadronic interactions. Global observables of the charged particles generated in these collisions and the particle-to-pion ratio over a wide range of collision centralities are studied. A comparative study of EPOS4 and EPOS4+UrQMD predictions is presented to quantify the influence of hadronic rescattering on particle production observables. These investigations provide theoretical expectations for O-O collisions at the Large Hadron Collider (LHC) and contribute to a better understanding of the interplay between partonic dynamics and hadronic evolution in intermediate-sized collision systems.

**Keywords:** Charged-Particle Production; EPOS4 Model; Global Observables; Heavy-Ion Collisions; Quark Gluon Plasma (QGP).

# Iodine-Catalysed Cascade Strategy for the Diastereoselective Synthesis of Indenoindoles from Prenylated Aldehyde and Indole

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## Abstract

Indenoindole frameworks represent an important class of nitrogen-containing polycyclic structures owing to their structural complexity and potential biological relevance. However, efficient and stereoselective approaches for their construction remain of considerable synthetic interest. Herein, we report an novel iodine-catalysed cascade strategy for the diastereoselective synthesis of structurally complex indenoindole derivatives. The reaction proceeds through the coupling of a suitably functionalized aromatic aldehyde bearing an internal alkene with indole under mild catalytic conditions using molecular iodine ($I_2$, 30 mol%) in methanol at 50 °C. This cascade process enables the rapid construction of the fused indenoindole framework while generating diastereogenic centres with good diastereoselectivity. The methodology provides a concise approach for the architectural synthesis of complex nitrogen-containing polycyclic molecules from relatively simple starting materials. The use of molecular iodine as an inexpensive, readily accessible catalyst further enhances the practical appeal of the transformation. This strategy highlights the potential of iodine catalysis in developing efficient cascade reactions for the stereoselective synthesis of complex indenoindole scaffolds.

**Keywords**: Iodine-catalysed; Cascade; Diastereoselective; Indenoindoles; Prenylated aldehyde.

# Ligand-Engineered $Mn^{2+}$-Doped ZnS Quantum Dots for Stable White Light Emission

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## Abstract

We report a post-synthetic ligand-engineering strategy for $Mn^{2+}$-doped ZnS quantum dots (QDs) to achieve stable white-light emission (WLE) with superior color quality, enhanced photostability, and excellent thermal robustness. A terpyridine-functionalized pyrene ligand coordinates with surface $Zn^{2+}/Mn^{2+}$ cations via nitrogen chelation, as confirmed by NMR and FTIR spectroscopic analyses. The synergistic combination of cyan ligand-centered emission and orange $Mn^{2+}$-centered emission produces balanced WLE with CIE chromaticity coordinates, correlated color temperature, and color rendering index (CRI) values comparable to daylight. The resulting WLE nanocomposite exhibits remarkable optical stability over extended periods, maintaining a consistent emission intensity under prolonged illumination. This study demonstrates the efficacy of coordinated ligand systems in modulating photophysical behavior and enhancing the structural and optical stability of QDs, thereby providing a versatile platform for next-generation solid-state lighting and optoelectronic applications.

**Keywords:** Quantum Dots, ligand-engineering, white-light.

# Local Spectral Bounds for the General Extended Energy of a Vertex

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## Abstract

Let $\varphi(x,y)$ be a symmetric vertex-degree-based (VDB) topological index, and let $A_\varphi(G)$ denote the associated general extended adjacency matrix of a graph $G$ , with $(i, j)$-entry $\varphi(d_i,d_j)$ on edges and 0 elsewhere. Building on the notion of the energy of a vertex introduced by Arizmendi in 2018 for the Ordinary adjacency matrix, we define the general extended energy of a vertex $v_i$ as the $i$-th diagonal entry $E_{\varphi,i}(G)$ of $|A_\varphi(G)| = (A_\varphi(G)^2)^{1/2}$, so that $\Sigma\ E_{\varphi,i}(G)$ recovers the whole-graph energy $E_\varphi(G)$. We derive a weighted spectral representation of $E_{\varphi,i}(G)$ and use it, together with Gershgorin's theorem, the Cauchy-Schwarz and Hölder inequalities, and the AM-GM inequality, to obtain a family of local lower and upper bounds for $E_{\varphi,i}(G)$ in terms of the degree sequence, the spectral radius $\rho(A_\varphi)$ and local spectral moments including a Cauchy-Schwarz type bound attained exactly when the component at $v_i$ is a star centred at $v_i$, and a McClelland-type bound for the whole-graph energy attained at perfect matchings. We also show that adjacent vertices satisfy $E_{\varphi,i}(G)E_{\varphi,j}(G) \geq \varphi(d_i,d_j)^2$, generalizing a 2021 result of G. and O. Arizmendi, and we extend the Coulson integral formula to $E_{\varphi,i}(G)$, giving a closed form for pendant vertices and a quasi-order comparison theorem for bipartite graphs. Specializing $\varphi$ recovers known bounds for the Randić and extended (Zagreb-type) vertex energies as corollaries; worked examples on matchings and stars illustrate the results throughout.

**Keywords:** General extended adjacency matrix; Vertex energy; Graph Spectra; Degree-based topological indices.

# Low Profile, High Gain Meta surface Assisted Circularly Polarized (CP) Patch Antenna for 5G mm Wave Applications

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## Abstract

The unprecedented demand of facilitating high data transmission rates along with exhibiting low latency has driven massive interest in Millimeter wave (mmWave) frequency spectrum for 5G and emerging 6G applications. Although mm wave spectrum offers significant advantages like massive unused bandwidth and high data rates; however practical realization of antennas at these frequencies is accompanied by high path loss effects and increased susceptibility to blockage. As such, design of low-profile compact antenna structures having wide impedance bandwidth, higher gain and improved directivity have become an important area of research. In this regard, a Meta surface (MTS) assisted compact Circularly Polarized (CP) patch antenna for 5G applications has been proposed. MTS known for having subwavelength periodicity display better antenna performance while keeping the antenna size nominal. A superstrate layer comprising of an array of 3×3 symmetrical rings is placed above the patch to enhance the performance characteristics. The proposed antenna has a compact footprint of 9×10 ×0.787 $mm^3$ and operates within 28- 42 GHz of frequency spectrum. Sufficient air gap is added to control the electromagnetic coupling. The slot loaded patch is subjected to sideways truncations to get circularly polarized behaviour which is believed to show better resilience in multipath environments. The proposed antenna delivers a smooth high gain response throughout the whole frequency of operation. Simulated results demonstrate that the antenna exhibits a 3 dB Axial Ratio (AR) Bandwidth of 4GHz and has wide 10GHz (29GHz-39GHz) impedance bandwidth. These attributes position the proposed antenna as a promising candidate in compact, interference-sensitive environments.

**Keywords:** mm wave, Meta surface; Circularly Polarized.

# Machine Learning Prediction of Magnetoresistance-Temperature Curves in Perovskite Oxides

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**Abstract**

Magnetoresistance (MR) in $ABO_3$ manganite perovskite oxides is governed by a complex interplay of chemical composition, temperature, and external magnetic field, making the prediction of its temperature-dependent response a challenging problem. While machine learning (ML) has been widely applied to predict scalar material properties, its application to continuous response functions such as MR–temperature (MR–T) curves remains largely unexplored. In this work, we present an interpretable ML framework for predicting the temperature-dependent magnetoresistance of experimentally reported perovskite oxides using composition-based descriptors and external experimental variables. An experimental dataset comprising approximately 4,000 MR measurements from 100 chemically distinct manganite perovskites was manually curated from published literature by digitizing MR–T curves measured under different magnetic fields. To ensure an unbiased evaluation and eliminate information leakage, all measurements corresponding to a given compound were assigned exclusively to either the training or testing dataset using a compound-wise splitting strategy, while GroupKFold cross-validation was employed during model development. Composition-based descriptors were combined with temperature and magnetic field, and Recursive Feature Elimination identified an optimal subset of descriptors for model training. A Random Forest regressor accurately reproduced the magnetoresistance–temperature curves of previously unseen compounds, achieving an overall test coefficient of determination ($R^2$) of 0.87 and an average per-compound $R^2$ of approximately 0.80. SHapley Additive exPlanations (SHAP) analysis revealed that temperature and magnetic field are the dominant contributors to model predictions, while descriptors associated with atomic size mismatch, electronic configuration, and chemical disorder also play significant roles. The proposed framework demonstrates that combining experimentally curated datasets, compound-wise validation, and interpretable machine learning enables reliable prediction of continuous magnetotransport behavior and provides an effective strategy for accelerating the discovery and optimization of magnetoresistive perovskite materials.

**Keywords:** Magnetoresistance; Perovskite Oxides; Machine Learning; SHAP.

# Magnetic Ground State and Lattice Thermal Transport in rare-earth $Gd_2GeBr_2$ 2D magnetic semiconductor halide : From Bulk to Two-Dimensional Limit

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## Abstract

Rare-earth halides have gained considerable Interest because of their tunable electronic and magnetic properties arising from the interplay between localized 4f electrons and itinerant conduction states. Among these materials, the layered gadolinium based halides exhibits a quasi-two-dimensional crystal structure and antiferromagnetic ordering at low temperatures, making it an interesting platform for investigating the relationship between crystal structure, electronic states, and magnetic interactions. In this study, we present a comprehensive first-principles investigation of the structural, magnetic, and lattice thermal transport properties of $Gd_2GeBr_2$ in bulk (layered) and monolayer (2D) forms. Among the investigated magnetic configurations, AFM-1 is identified as the true ground state, driven by antiferromagnetic exchange interactions between Gd moments. The electronic band structure, thermal transport and further calculations are carried out on the ground state AFM-1 to to investigate electronic, mechanical and thermal properties of the investigated material. Lattice thermal conductivity ($\kappa_l$), obtained from anharmonic phonon transport, shows a strong suppression on reducing dimensionality from bulk to monolayer, associated with enhanced phonon–phonon scattering and reduced dimensionality. These results establish $Gd_2GeBr_2$ as a promising candidate for exploring the interplay between antiferromagnetism, low-dimensionality, and thermal transport. $Gd_2GeBr_2$ is dynamically stable antiferromagnet. The reduction in dimension from bulk to monolayer strongly suppresses lattice thermal conductivity from 22.37 $Wm^{-1}K^{-1}$ to 3.52 $Wm^{-1}K^{-1}$ at 300K, highlighting it's potential for low-dimensional spintronic and thermoelectric applications.

**Keywords:** 2D-magnetic semiconductors; Antiferromagnetism; DFT; Lattice thermal conductivity.

# Microscopic Investigation of High-Spin States in $^{170}$Hf

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## Abstract

The high-spin structure of $^{170}$Hf has been investigated within the framework of the Triaxial Projected Shell Model (TPSM) with particular focus on the influence of the four-quasineutron ($4\nu$) and four-quasiproton ($4\pi$) configurations on the rotational structure. The present work examines the effect of $4\nu$ and $4\pi$ configurations in the TPSM basis in addition to the $2\nu2\pi$ configuration. The calculated projected band diagram shows that the $4\nu$ bands become energetically competitive with the lower quasiparticle configurations in the high-spin region, whereas the $4\pi$ bands remain at comparatively higher excitation energies.The calculated probabilities of various projected $K$ configurations in the orthonormal basis also indicates that the contribution of the $4\nu$ configurations increases progressively with angular momentum and becomes an important component of the yrast structure at higher spins, indicating that $4\nu$ excitations play a dominant role in the evolution of the rotational structure. In contrast, the $4\pi$ configuration contributes primarily through configuration mixing and remains comparatively weaker throughout the calculated spin range. The calculated energy levels obtained after configuration mixing exhibit good agreement with the available experimental data over the observed spin range, demonstrating the capability of the TPSM approach in describing the rotational behavior of $^{170}$Hf. The present study provides a microscopic understanding of the interplay between the $2\nu2\pi$, $4\nu$, and $4\pi$ quasiparticle configurations and also highlights the importance of projected multi-quasiparticle configurations in describing the high-spin properties of deformed rare-earth nuclei.

**Keywords:** Triaxial projected shell model; configuration mixing; rare-earth nuclei; yrast structure.

# Microscopic Investigation of Low–lying Collective Structures in $^{108,110}$Pd Nuclei

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**Abstract**

The low–lying collective structure of the transitional nuclei $^{108,110}$Pd within the framework of the *Triaxial Projected Shell Model (TPSM)* is investigated. The excitation energies of the yrast, $\gamma$, and excited ($0^+$) bands are calculated and compared with the available experimental data. In order to probe nuclear shape, a complete set of 206 *reduced electric quadrupole (E2) matrix elements* including diagonal, intraband and interband transitions for these nuclei is evaluated and compared with *Coulomb-excitation* data. The rotational properties of the nuclei are further examined through rotational frequencies and $\gamma$-band staggering and the evoluation of *quadrupole collectivity*, *deformation* and *triaxiality* is investigated using the *Kumar–Cline shape invariants* derived from the calculated $E2$ matrix elements. The analysis indicates that the low-lying structures are characterized by the strong quadrupole collectivity with different degrees of triaxial deformation and *$\gamma$-softness*, demonstrating that the TPSM provides a unified microscopic framework for describing the spectroscopy, electromagnetic properties, and shape evolution, thereby extending our systematic TPSM investigation of complete Coulomb-excitation observables and their associated *shape invariants* to the transitional $^{108,110}$Pd isotopes.

**Keywords**: Kumar–Cline shape invariants; Quadrupole collectivity; Transitional nuclei; Triaxial deformation; Triaxial Projected Shell Model (TPSM)

# Microwave-Assisted Graft Copolymerization of Acrylamide onto Olibanum Gum: Optimization, Characterization, and Detailed Rheological Analysis

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## Abstract

The growing demand for sustainable, mechanically robust superabsorbent hydrogels for flexible electronics and triboelectric nanogenerators (TENGs) necessitates exploring natural polymer-based materials with tunable rheological and swelling properties. In this work, a novel superabsorbent hydrogel, Ol-g-poly(AAm), was synthesized by microwave-assisted free radical graft copolymerization of acrylamide (AAm) onto purified water-soluble gum Olibanum as the natural polysaccharide backbone, wherein ammonium persulfate (APS) was used as an initiator and N,N'-methylenebisacrylamide (MBA) as a crosslinker for the reaction. The concentrations of various reaction parameters were optimized to achieve a maximum swelling percentage of 1400%. The characterization of the synthesized hydrogel was performed using Fourier transform infrared spectroscopy, X-ray diffraction, field-emission scanning electron microscopy with energy-dispersive X-ray spectroscopy, and thermogravimetric analysis, confirming successful grafting, an amorphous structure, a porous morphology, and enhanced thermal stability. Rheological studies were conducted using amplitude and frequency sweeps, as well as thixotropic measurements, to investigate the mechanical properties of the synthesized hydrogel. The rheological measurements revealed dominant elastic behavior ($G' >> G''$), a wide linear viscoelastic region, pronounced shear-thinning, low damping factor ($\tan \delta < 0.35$), and an excellent thixotropy with near-complete recovery of storage modulus (recovery percentage = 87%) and a favorable thixotropic index (thixotropic index = 44.02), indicating structural resilience and processability. The amplitude sweep data were best fit by the Cross and Carreau models ($R^2 > 0.99$), confirming pronounced shear-thinning and pseudoplastic flow characteristics of the hydrogel.

**Keywords:** Olibanum, Free radical polymerization, Superabsorbent, Rheology, Shear- thinning, Thixotropic recovery.

# Modified hybrid self adaptive inertial extragradient algorithms for variational inequality problems and fixed point problems

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## Abstract

This paper investigates the problem of finding a common solution of a monotone variational inequality problem and a fixed-point problem involving a demicontractive mapping in a real Hilbert space. Motivated by recent developments in inertial, subgradient extragradient, Tseng-type, hybrid steepest descent, and Mann-type iterative techniques, we propose two new inertial extragradient algorithms incorporating an adaptive stepsize strategy. The proposed schemes are designed to enhance computational efficiency while avoiding the requirement of prior knowledge of the Lipschitz constant of the underlying operator. In particular, the algorithms employ a simple stepsize updating rule and require only one projection onto the feasible set at each iteration, thereby reducing the computational burden associated with classical extragradient-type methods. Under suitable assumptions on the monotone and Lipschitz continuous operator, the demicontractive mapping, and the control sequences, we establish strong convergence of the generated iterative sequences to a common solution of the variational inequality and fixed-point problems. The theoretical results are further supported by numerical experiments implemented in MATLAB. Comparative computational results with several existing iterative methods demonstrate that the proposed inertial schemes can achieve faster convergence and improved computational performance. These results indicate that the proposed algorithms provide effective and practically implementable approaches for solving variational inequality and fixed-point problems in Hilbert spaces.

**Keywords:** Variational Inequalities; Fixed point; Subgradient; Inertial; Solution.

# Molecularly imprinted GMR detection of 2E1H as a breath biomarker

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## Abstract

Volatile organic compounds (VOCs) in human breath are emerging as non-invasive biomarkers for health monitoring. 2-Ethyl-1-hexanol (2E1H) has been identified as a specific biomarker for lung cancer, and chronic obstructive pulmonary disease (COPD). While the human olfactory receptor (hOR4D11P) exhibits high specificity for this VOC, its practical application in optical biosensors is limited by the challenges of protein purification, stability, and functional immobilization. To overcome these biological limitations, this study presents the computational design of a guided mode resonance (GMR) based optical sensor, incorporating a molecularly imprinted polymer (MIP) as a synthetic recognition layer, for the specific detection of 2E1H. In this framework, the MIP is modelled as an effective homogeneous dielectric thin layer of 200nm within rigorous coupled wave analysis (RCWA) based simulations. The sensor performance is quantitatively compared for TE and TM modes. TE exhibits higher average sensitivity (381.56 vs. 293.34 nm/RIU), whereas TM provides a 2.29-fold narrower FWHM (4.89 vs. 11.22 nm). Consequently, TM achieves superior FOM (59.93 vs. 34.01 $RIU^{-1}$) and Q-factor (158.25 vs. 75.21), demonstrating enhanced spectral resolution despite its lower wavelength sensitivity. These results confirm that a 200 nm MIP layer, whose effective refractive index changes upon 2E1H binding, provides a highly sensitive and resolvable wavelength shift response when integrated into a GMR-based sensor. This computational framework offers a fast, cost-effective pathway for designing a portable breath analyzer for real-time monitoring of 2E1H biomarker. Further molecular docking can be used to model the non-covalent interactions between the 2E1H template and candidate functional monomers, identifying the most stable binding poses and interaction energies that guide MIP formulation. These simulations help optimize the imprinting cavity geometry so that the MIP layer selectively rebinds 2E1H with affinity comparable to the native olfactory receptor hOR4D11P, while remaining compatible with the GMR sensor's optical response.

**Keywords:** Volatile organic compounds; Molecular imprinted polymers; Biomarkers; Rigorous coupled wave analysis.

# Neutral-Wind Constraint on Equatorial Plasma Bubble Growth During G1-G3 Geomagnetic Storms

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## Abstract

Equatorial plasma bubbles (EPBs) pose significant challenges to trans-ionospheric radio communication and navigation systems, making their accurate characterization and prediction essential for space-weather applications. Although, the geomagnetic storms are known to modify equatorial ionospheric conditions, the processes controlling EPB suppression during minor-to- strong (G1 - G3) geomagnetic storms, particularly, the role of storm-time neutral winds has received comparatively little attention. Here we examine EPB evolution using simultaneous measurements from GOLD airglow, Swarm in situ density, and COSMIC-2 in situ ion density, radio-occultation profiles and S4 scintillation index, supported by physics based model WACCM-X simulations and a real-time equatorial electric field model. A geomagnetic quiet interval is compared and contrasted with three storms of different intensity (G1 - G3), focusing on the pre-midnight recovery phase over a fixed longitude sector. We find that EPB activity is progressively suppressed during storm periods, coincident with reduced eastward zonal neutral winds and diminished F-region uplift, even when the modeled pre-reversal enhancement is large. Our results demonstrate that westward wind reversal is not a prerequisite for EPB suppression during G1 - G3 geomagnetic storms and highlight the dominant role of background thermosphere–ionosphere coupling in regulating EPB growth under disturbed conditions.

**Keywords:** Equatorial plasma bubbles; Geomagnetic Storms, Neutral Winds, Pre-reversal Enhancement, Rayleigh–Taylor instability.

# On the Distance Laplacian eigenvalues of Wollastonite graph

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**Abstract**
Let $G$ be a connected graph with vertex set $V(G)$ and edge set $E(G)$. The distance Laplacian matrix of $G$ is defined as $D^L(G) = Tr(G) - D(G)$ is the distance matrix and $Tr(G)$ is the diagonal matrix of vertex transmissions. The distance Laplacian energy of $G$ is given by $DLE(G) = \sum_{i=1}^{n} |\lambda_i(D^L(G)) - \frac{2\mathscr{W}(G)}{n}|$, where $\mathscr{W}(G)$ is the Weiner index and $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_n = 0$ are the distance Laplacian eigenvalues of $G$. A central challenge in the study of graph energies lies in deriving precise closed-form expressions for energy functionals across particular families of graphs. In this paper, we derive the complete distance Laplacian spectrum of the fused complete graph chain $W(n_1,\ldots,n_{d-1})$ via equitable partitions, obtaining explicit twin eigenvalues, a quotient matrix, and a closed-form expression for the distance Laplacian energy. For the Wollastonite graph $W_4^d$, a chain of $(d-1)$copies of $K_4$ with consecutive cliques sharing one vertex. We determine bounds on the second largest distance Laplacian eigenvalues, an explicit energy formula, and the asymptotic result $\lim_{d\to\infty} \frac{DLE(W_4^d)}{d^3} = \frac{1}{\sqrt{3}}$ .We also characterize the distance Laplacian spectrum of the complement $\overline{W_4^d}$ for $d \geq 4$, providing its twin eigenvalues, quotient matrix, Weiner index, and energy formula.

**Keywords:** Distance Laplacian matrix; Wollastonite graph; distance Laplacian energy; Weiner index; equitable partition.

# Performance Analysis of Divide-and-Conquer Matrix Multiplication Algorithms on Multicore Systems: An Experimental Study of Classical, Recursive, Strassen's and Cache Oblivious Algorithms

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**Abstract**
Matrix multiplication is one of the most fundamental operations in scientific computing, computer graphics, machine learning, numerical simulations and high-performance computing. Since matrix multiplication in its classical form is computationally intensive with a cubic time complexity, improving its execution efficiency has remained an active research area. Divide-and-conquer algorithms significantly improve cache locality and expose significant parallelism, making them appropriate for modern multicore processors. This paper presents performance analysis of four matrix multiplication techniques: the classical, recursive divide-and-conquer matrix multiplication, Strassen's and Cache Oblivious matrix multiplication algorithms. Each algorithm is implemented in both sequential and parallel versions on a shared-memory multicore architecture. Experimental evaluation is performed on matrices ranging from 16×16 to 2048 × 2048. Performance is measured in terms of execution time and speedup. Experimental results demonstrate that multithreading significantly reduces execution time for larger matrices, while Strassen's algorithm consistently achieves the lowest execution time due to its reduced computational complexity. The recursive divide-and-conquer algorithm also benefits from improved cache utilization and parallel execution. The study concludes that divide-and-conquer combined with dynamic multithreading provides an effective approach for scalable matrix multiplication on multicore processors.

**Keywords:** Divide-and-Conquer; Strassen Algorithm; Performance Analysis; Cache Oblivious; Cache Efficiency.

# Phase-Segregation-Driven Heterostructure Formation and Interfacial Charge-Transfer Mechanism in $Ba_3V_2O_8/BaFeO_{2.654}$ Oxides with Defect-Mediated Optical and Surface Photocatalytic Response

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**Abstract**

Phase stability and defect chemistry are critical determinants of the functional behavior of complex oxide systems. In this study, a Ba–Fe–V–O composition aimed at the formation of $Ba_2FeVO_6$ double perovskite was synthesized through a conventional solid-state method; however, thermodynamically induced phase segregation led to the creation of a multiphase composite consisting of rhombohedral $Ba_3V_2O_8$ and hexagonal oxygen-deficient $BaFeO_{2.654}$. Rietveld refinement shows that these crystalline phases can exist at the same time, with $Ba_3V_2O_8$ being the most important one. This suggests that vanadate is more stable under the conditions used for synthesis.

Raman and X-ray photoelectron spectroscopy show that there are both $Fe^{2+}$ and $Fe^{3+}$ redox states and oxygen species on the surface. This means that the surface electronic environment is chemically heterogeneous. UV-visible measurements show both direct and indirect bandgap transitions (2.34 eV and 1.05 eV, respectively). Photoluminescence analysis shows that carrier recombination is slowed down, which is consistent with charge separation through a heterojunction. The interface between $Ba_3V_2O_8$ and $BaFeO_{2.654}$ creates a heterostructure that separates phases and encourages charge transfer in one direction and redox activity on the surface. Using Rhodamine B to test visible-light photocatalysis shows that it breaks down quickly (about 90% in 40 minutes). This shows that the combination of hetero-interfacial coupling and surface electronic modulation works better than just defect concentration.

These results show that phase segregation caused by synthesis in Ba–Fe–V–O oxides can be used strategically to create charge-transfer pathways at the interface and redox processes on the surface. This gives us a way to design multifunctional visible-light photocatalysts that can be chemically controlled.

**Keywords:** Phase segregation; Heterojunction; Surface electronic structure; Mixed valence iron; Visible-light photocatalysis

# Precision in Parameter Estimation through a Novel Stratification Methodology for Biomedical Data Analysis with Application to Breast Cancer Prognostics

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## Abstract

This study presents a robust methodology for determining optimal strata boundaries (OSB) and sample sizes (SS) in stratified random sampling to enhance the precision of population mean estimation using auxiliary information. Employing a superpopulation model framework, we derive simplified equations that minimize overall variance for continuous study variables, facilitating the creation of homogeneous strata. A key challenge addressed is the computation of OSB and SS under fixed total sample size constraints, which commonly arise in budget-limited survey designs. Our approach overcomes this by incorporating known per-unit stratum measurement costs or leveraging the probability density function of the auxiliary variable. The practical utility of the proposed method is demonstrated through an empirical application on breast cancer data, where mean perimeter is estimated using mean radius and mean texture as auxiliary variables. Additionally, hypothetical examples employing Cauchy and standard power distributions illustrate the versatility of the technique across diverse data scenarios. The methodology has been operationalized through integration into the updated stratifyR package and implementation in LINGO software, ensuring accessibility for applied researchers. Comparative analyses indicate that our approach consistently outperforms or matches existing stratification methods in terms of estimation precision. Extensive simulation studies further confirm its higher relative efficiency, underscoring its practical value. By offering a computationally efficient and cost-aware solution for optimal stratification, this work contributes significantly to the field of survey sampling, with direct implications for precision-driven biomedical research, resource-constrained health surveys, and data-intensive analytical applications.

**Keywords:** Stratification; Optimum Strata Boundaries; Dynamic Programming

# Probing the High-Energy Emission of the VHE-emitting Changing-Look Blazar B2 1420+32

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## Abstract

We present a multi-wavelength temporal and broadband spectral study of the changing-look blazar B2 1420+32 using Fermi-LAT, Swift-XRT, and Swift-UVOT observations over MJD 58818–60721. The source reached a peak 0.1–300 GeV photon flux of $(4.62 \pm 0.29) \times 10{-}6$ ph cm$^{-2}$ s$^{-1}$ around MJD 60488, approximately 60 times the average 4FGL-DR4 value, during which the photon index hardened to $2.19 \pm 0.14$. However, the overall flux–index evolution shows only weak evidence for a global harder-when-brighter trend. The fractional variability is strongly energy dependent, with the highest variability observed in the γ-ray band, substantial variability in the optical/UV, and relatively low variability in X-rays. Strong γ-ray–optical/UV correlations and a moderate γ-ray–X-ray correlation suggest that the X-ray emission is less closely associated with the γ-ray variability than the optical/UV emission. The X-ray spectra are best described by a log-parabolic model, while the negative curvature observed in four of the five states suggests that the X-ray band probes the transition between the high-energy tail of the synchrotron component and the onset of the inverse-Compton component. We identified five activity states and modelled the high-energy (X-ray and γ-ray) component of their broadband spectral energy distributions (SEDs) using synchrotron-self-Compton (SSC), external-Compton (EC), and SSC+EC scenarios. The SSC-only and EC-only models either require physically disfavoured parameters or fail to reproduce the VHE emission, whereas the SSC+EC model provides the most self-consistent description. The seed-photon temperature of $\sim 10^3$ K favours an infrared torus origin. The brighter states are associated with larger bulk Lorentz factors and higher jet powers, while the magnetic field varies only modestly, indicating that the observed flux evolution is driven by a combination of Doppler boosting and jet energetics.

**Keywords:** Black hole physics; galaxies; quasars; emission lines; active galactic nuclei.

# Probing the Origin of X-Ray Flares in the Low-hard State of GRS 1915+105 Using AstroSat and NuSTAR

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## Abstract

We performed a detailed time-resolved spectral study of GRS 1915+105 during its low-flux rebrightening phase using the broadband capabilities of AstroSat and NuSTAR in 2019 May–June. The AstroSat light curves revealed erratic X-ray flares with count rates rising by a factor of ∼5. Flares with simultaneous LAXPC and SXT coverage were segmented and fitted using two degenerate but physically motivated spectral models: a reflection-dominated model (hereafter model A) and an absorption-dominated model (hereafter model B). In model A, the inner disk radius ($R_{in}$) shows a broken power-law dependence on flux, indicating rapid inward motion of the disk at higher flux levels. In contrast, model B shows variable column density in the range of $10^{23}$–$10^{24}$ cm$^{-2}$, displaying a strong anticorrelation with flux. Both models exhibit significant variation in the ionization parameter between low- and high-flux segments. The total unabsorbed luminosity in the 0.7–30 keV energy range ranged from $6.64 \times 10^{36}$ to $6.33 \times 10^{38}$ erg s$^{-1}$. Across both models, several spectral parameters exhibited step-function-like behavior around flux thresholds of 5–10 × $10^{-9}$ erg cm$^{-2}$ s$^{-1}$, indicating multiple spectral regimes. The disk flux contribution, more evident in model B, increased with total flux, supporting an intrinsic origin for the variability. These findings point to a complex interplay between intrinsic disk emission, structured winds, and variable local absorption in driving the flare activity.

**Keywords:** X-ray binaries; black holes; accretion disks; GRS 1915+105; spectral analysis.

# Shape Evolution and E2 Transition Strengths in Triaxially Deformed Nuclei: A Projected Shell Model Study

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## Abstract

The present study extends our previous systematic investigation of reduced electric quadrupole (E2) matrix elements in nuclei for which extensive Coulomb excitation data are available. In our earlier works, nine nuclei, namely $^{72,76}$Ge, $^{104}$Ru, $^{168}$Er, $^{186,188,190,192}$Os, and $^{194}$Pt, were investigated within the triaxial projected shell model (TPSM) framework. In the present work, we extend this analysis to six additional nuclei: $^{70}$Ge, $^{76,78,80,82}$Se, and $^{100}$Mo. The recently available Coulomb excitation data for $^{70}$Ge, together with the omission of the Se isotopes and $^{100}$Mo from our earlier studies, motivates the present investigation. The TPSM calculations provide a satisfactory description of the available experimental E2 matrix elements and related electromagnetic observables across the nuclei considered. The analysis further indicates predominantly γ-soft characteristics for most of the studied nuclei, while $^{76}$Se and $^{100}$Mo exhibit comparatively distinct structural behaviour. In addition, we examine the relationship between the energy staggering of the γ-band and the shape invariants extracted using the Kumar–Cline sum rules. Unlike the expectations based on phenomenological collective models, the present microscopic TPSM calculations do not reveal a clear and universal correlation between the γ-band staggering pattern and the deduced shape-invariant quantities. These results demonstrate the usefulness of the TPSM framework for a microscopic description of nuclear collectivity and shape evolution in the mass region under consideration.

**Keywords:** Triaxial Projected Shell Model (TPSM); Coulomb Excitation; Electric Quadrupole (E2) Matrix Elements ; Nuclear Shape Evolution ;γ-Soft Nuclei.

# Spectral and Topological Approaches to the Structural Analysis of Chemical Graphs

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## Abstract

Graph-theoretic techniques have emerged as powerful mathematical tools for describing and analysing the structural properties of chemical compounds. In chemical graph theory, topological indices and graph spectra provide quantitative measures that can capture important structural characteristics of molecular graphs and can subsequently be employed in the study of molecular properties through QSPR and QSAR approaches. The present research focuses on the investigation of structural and spectral properties of chemical graphs through degree-based topological indices and matrix-based parameters. As part of the ongoing work, particular attention is being given to Sombor-type topological indices and their generalized forms, together with spectral parameters such as the spectral radius and graph entropy. The study aims to examine the relationships between structural characteristics, topological descriptors, and spectral quantities for suitable families of chemical graphs. Analytical expressions and bounds for selected indices are being investigated, along with their external behaviour under appropriate graph-theoretic constraints. The role of spectral information in explaining variations in entropy and other structural descriptors is also being explored. A further objective of the research is to investigate broader families of chemical graphs and identify mathematical relationships between degree-based and spectral descriptors. This includes examining the applicability of transformation techniques and developing systematic approaches that may yield new inequalities, bounds, and external results. The outcomes are expected to contribute to a better understanding of how local structural information encoded by vertex degrees and global information represented by graph spectra can complement each other in the analysis of molecular structures. The ongoing investigation is intended to provide a unified mathematical perspective on topological and spectral descriptors and to explore their potential relevance in the quantitative modelling of chemical properties.

**Keywords:** Chemical Graph Theory; Topological Indices; Sombor Indices; Graph Spectra; Graph Entropy.

# Statistical Learning and Fuzzy Optimization for Privacy-Preserving Survey Allocations

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## Abstract

The convergence of statistical machine learning, differential privacy, and fuzzy optimization opens new frontiers for intelligent survey design. We propose a novel three-phase framework that integrates deep neural networks into stratified randomized response sampling to estimate sensitive proportions, while simultaneously optimizing sample allocation under fuzzy cost constraints and guaranteed privacy. Our deep neural network estimator exploits auxiliary information to achieve superior accuracy over classical methods, and we derive its asymptotic properties including consistency and asymptotic normality. We introduce an adaptive privacy budget allocation mechanism that optimally distributes privacy loss across strata, balancing utility and confidentiality. The fuzzy non-linear programming problem is solved via a Lagrangian approach with alpha-cuts, yielding closed-form optimal allocations. Extensive simulation studies demonstrate that our framework substantially reduces mean squared error compared to conventional stratified randomized response designs. The proposed methodology is fully deployable in three phases: data collection and feature engineering, deep neural network training and validation, and privacy-aware allocation and field implementation. This work provides a rigorous, practical, and future-ready solution for official statistics, smart surveys, and AI-driven data acquisition systems.

**Keywords:** Statistical machine learning; Differential privacy; Stratified random sampling; Randomized response; Fuzzy optimization.

# Strain Engineering and Machine Learning for Tailoring Spin-Dependent Properties of FeZrCrX(X=Si, Ge, Sn) Quaternary Heusler Alloys

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**Abstract**

We present a first-principles and machine-learning study of the strain-tunable electronic, magnetic, thermodynamic, and spin-dependent transport properties of FeZrCrX (X = Si, Ge, Sn) quaternary Heusler alloys. FeZrCrSi and FeZrCrGe exhibit robust half-metallicity at equilibrium, while FeZrCrSn is nearly metallic within conventional DFT. The mBJ potential substantially enhances the spin-resolved band gaps and spin polarization, particularly in FeZrCrSn. Hydrostatic strain (−2% to +2%) effectively tunes the band structure, exchange splitting, and magnetic response, driving transitions between half-metallic and metallic states. For rapid prediction of spin-resolved band gaps, XGBoost, Extra Trees (ET), and Gradient Boosting (GB) models were employed, with ET showing the highest predictive accuracy. The combined application of strain engineering and machine learning provides an efficient strategy for screening and designing Heusler alloys for spintronic and spin-caloritronic applications.

**Keywords:** Half-metallicity; Hydrostatic strain; Spin polarization; Machine learning; spin-caloritronic.

# Sustainable Catalytic Transformation of Organic Functional Groups: A Transition-Metal-Free Approach

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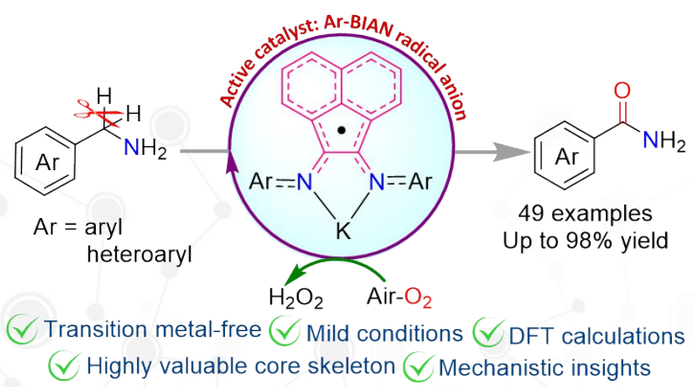
## Abstract

The growing demand for sustainable organic synthesis has stimulated the development of transition-metal-free strategies for diverse functional-group interconversions, such as amine-to-amide, nitrile-to-amine, alcohol-to-aldehyde, and ether-to-ester transformations. Among these organic transformations, the direct ✔-oxygenation of arylmethanamines to amides remains particularly challenging, often requiring harsh conditions, stoichiometric oxidants, or expensive transition-metal catalysts.[1,2] This study introduces a novel approach using a redox-active aryl-substituted bis(imino)acenaphthene (Ar-BIAN) based organic radical anion as a catalyst that mimics transition-metal catalysis in the aerial oxidation of arylmethanamines into their corresponding amides. Notably, the reaction proceeds using molecular oxygen from air as the terminal oxidant, providing a more sustainable alternative to conventional oxidation strategies. This protocol showcases wide substrate scopes along with tolerance of common organic functional groups. A combination of control experiments, spectroscopic studies, and theoretical calculations provides mechanistic insight into this current catalytic process. The experimental and computational results support a reaction pathway involving the initial dehydrogenation of primary amines to nitriles, followed by their subsequent hydrolysis to the corresponding amides. This work therefore provides a promising platform for developing sustainable, transition-metal-free catalytic transformations and opens new avenues for redox-active organocatalyst-mediated reactions relevant to organic synthesis, medicinal chemistry, and materials science.




**Keywords:** Redox-active organocatalyst; Transition-metal-free; ✔-oxygenation of arylmethanamines; Air-$O_2$ as terminal oxidant.

# Synthesis and Characterisation of Arylphosphonodithioates and their Complexes with some Transition Metals

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## Abstract

The chemistry of sulfur containing compounds represents great demand in both organic and inorganic chemistry. The chemistry of M–S bonded complexes includes metal and sulfur; where sulfur is bonded to metal as inorganic sulfur donor groups. The sulfur containing ligands shows remarkable developments in their coordination pattern towards different metals. The metal coordinates to sulfur either as ligand or inorganic sulfur donor groups. Two essential reagents, namely Berzelius reagents (phosphorous pentasufide) and Lawesson's reagents (LR) are the most widely used agents for thionation reaction The Phosphor -1,1-dithiolate ligands as dithiophosphates, dithiophosphinates and dithiophosphonates display a vast area of coordination arrangement resulting in variability in their molecular as well as supramolecular structures. Newly synthesized substituted aryl dithiophosphonates ligand have been characterization using several physico-chemical techniques including elemental compostion, spectroscopy NMR ($^{31}P$, $^{1}H$ and $^{13}C$), IR and UV visible techniques. Dithiophosphonates complexes have significant importance because of their technical applications such as super conductors, pesticides resins, Q-switiching dyes and have l–sulfur compounds. They highlight several facet of binding modes in pertinence to biochemical, industrial, agricultural, and analytical applications. Dithiophosphorous compounds and also their imitatives seemed to have antimicrobial, antitumoral and anticancer activites.

**Keyboards:** Phosphor1,1 dithiolate; dithiophosphate; Dithiophosphonates; Dithiophosphinates and Lawesson's reagent.

# Memory Beyond Memory: Critical Events and Emergent Complexity in Nonequilibrium Systems

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**Abstract**

Complex systems often exhibit statistical organization that cannot be adequately described by conventional Markovian or equilibrium approaches. Anomalous diffusion, long-range correlations, power-law waiting-time distributions, aging, and intermittent fluctuations are observed across physical, astrophysical, and biological systems. A particularly intriguing manifestation of complexity is the coexistence of ordinary correlations with a deeper form of memory associated with the temporal organization of rare, dynamically significant events. Following the statistical-mechanical framework of renewal processes and crucial events, this work explores how such "memory beyond memory" may be associated with anomalous scaling, aging, and emergent collective behavior.

Using Diffusion Entropy Analysis (DEA), waiting-time statistics, and correlation-based measures, we investigate the distinction between genuine renewal events and pseudo-events arising from the observation of complex processes. This framework provides a means of examining how hidden temporal structures survive coarse-graining and manifest themselves through macroscopic statistical laws. Particular emphasis is placed on the relationship between renewal dynamics, criticality, and the emergence of scale-free behavior in nonequilibrium systems.

The biological relevance of this framework arises from the intrinsically nonequilibrium, multiscale, and adaptive nature of physiological systems. Heartbeat dynamics, neural activity, and other physiological processes exhibit temporal organization that may reflect an interplay between conventional correlations and crucial events operating across multiple timescales. Understanding these memory structures could contribute to the characterization of individual physiological dynamics and, in the longer term, inform approaches to precision medicine and rehabilitation. More broadly, this work explores whether memory, critical events, and anomalous scaling can provide a common statistical framework for understanding emergent organization across physical and living systems.

**Keywords:**

Anomalous Scaling; Crucial Events; Diffusion Entropy Analysis; Nonequilibrium Systems; Renewal Processes

# Temperature-Dependent Physicochemical Investigation of Citrates and Tartrates in Aqueous Ionic Liquid Systems

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## Abstract

Ionic liquids (ILs) have attracted significant attention as environmentally friendly alternatives to conventional organic solvents owing to their negligible vapour pressure, non-flammable nature, and excellent physicochemical properties. These room-temperature molten salts, composed of organic cations and inorganic or organic anions, offer immense potential in green chemistry and sustainable chemical processes. Understanding the temperature-dependent physicochemical behavior of citrate and tartrate salts in aqueous ionic liquid media is essential for elucidating solute–solvent interactions and their practical applications. In the present study, the influence of temperature on the physicochemical properties of citrate and tartrate salts in aqueous ionic liquid solutions was investigated through measurements of density, speed of sound, and viscosity using a Density and Sound Velocity Analyzer (DSA). The experimental data provide valuable insights into molecular interactions, hydration behavior, and structural modifications occurring within the mixed solvent system. In addition, spectroscopic techniques such as UV–Visible spectroscopy can be employed to investigate intermolecular interactions and structural changes in these systems. The outcomes of this study contribute to a deeper understanding of ionic liquid-based solvent systems and support their potential applications in biochemistry, pharmaceutical sciences, materials research, and environmentally sustainable chemical technologies.

**Keywords:** Ionic liquids;Citrates; Tartrates; Physicochemical properties; Intermolecular interactions.

# The Rise of High-Entropy Catalysts: A New Approach to Sustainable Hydrogen Production.

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**Abstract**

The hydrogen evolution reaction (HER) is a key process in green hydrogen production; however, it's practical efficiency remains limited by the sluggish kinetics of water splitting. High-entropy catalysts (HECs), comprising multiple principal elements within a single-phase structure, have emerged as promising materials for addressing these limitations. Their exceptional compositional diversity, tunable electronic structures, and synergistic interactions among constituent elements offer significant opportunities to simultaneously enhance catalytic activity, stability, and cost-effectiveness. Despite substantial advances in HER performance, the rational design of HECs remains challenging due to critical knowledge gaps, particularly regarding the identification of genuine active sites under operando conditions and the prediction of long-term structural and catalytic stability. This work critically examines these challenges and systematically reviews recent advances in the design, synthesis, and structure–activity relationships of HECs for HER. Beyond summarizing recent progress, the study proposes a strategic roadmap by identifying seven grand challenges spanning the science-to-technology pipeline and outlining corresponding research directions and countermeasures. By integrating fundamental principles with practical considerations, this framework aims to accelerate the rational development, scalable deployment, and cost-effective application of HECs for green hydrogen production.

**Keywords:** Hydrogen Evolution Reaction (HER); Green Hydrogen Production; High-entropy catalysts (HECs).

# Thermodynamics of Galaxy Clustering in Modified Newtonian Dynamics: A Statistical Mechanical Approach

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**Abstract**

Most explanations for how galaxies and galaxy clusters hold together rely on invisible dark matter. Here we explore an alternative: Modified Newtonian Dynamics (MOND), a theory that changes the law of gravity itself in regions of very weak acceleration, rather than adding unseen mass. Starting from a variational (Lagrangian) formulation of MOND, we derive the gravitational potential this theory predicts in its weak-field limit, which grows logarithmically with distance instead of falling off as in standard gravity. We then use this potential to build a statistical mechanical model, in the spirit of the classic Saslaw–Hamilton theory of gravitational clustering, treating galaxies as interacting particles bound by this MOND-modified force. From this model we derive standard thermodynamic quantities, including free energy, entropy, internal energy, pressure, and chemical potential, all expressed through a single clustering parameter, bc, that measures how strongly galaxies are gravitationally bound together. We find that stronger clustering lowers a system's free and internal energy and suppresses pressure, while entropy grows more slowly than in an ideal, unclustered gas, consistent with galaxies settling into tighter bound structures. We also derive a modified probability distribution for the number of galaxies expected in a given volume, extending the Saslaw–Hamilton form. Because clustering reduces disorder among ordinary matter, we relate this behavior to Penrose's Weyl Curvature Hypothesis, which proposes that gravitational entropy grows as cosmic structure forms, offering a complementary picture of large-scale evolution. Finally, we test our model against real galaxy cluster data from the Sloan Digital Sky Survey (Data Releases 16 and 18) and find good agreement across several distance and redshift bins. Overall, these results show that a MOND-based gravitational potential, derived from first principles rather than assumed, can reproduce the thermodynamic behavior of galaxy clustering without invoking dark matter.

**Keywords:** Entropy; Galaxy Clustering; Modified Newtonian Dynamics; Statistical Mechanics; Sloan Digital Sky Survey

# Unravelling electrocatalytic hydrogen generation from water using a bioinspired, water-stable copper(II) complex with ($N_2S_2$) donor ligands.

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## Abstract

Electrocatalytic hydrogen production is a crucial pillar in advancing the hydrogen economy. Inspired by the role of hydrogenase active sites in sustainable $H_2$ generation, a robust and water-stable copper(II) complex, $[Cl{-}Cu{-}LN_2S_2]ClO_4$, incorporating the N,S-type ligand $LN_2S_2$ (2,2'-((butane-2,3-diylbis(sulfanediyl))bis(methylene))dipyridine), has been synthesized and evaluated for its efficiency in electrocatalytic hydrogen evolution from water, with acetic acid serving as the proton source. The molecular catalyst adopts a square-pyramidal coordination environment, where chloride substitution by $H_2O$ under electrochemical conditions produces $[H_2O{-}Cu{-}L^{N2S2}]^{2+}$, identified as the active catalytic species. This catalyst demonstrates remarkable activity for proton reduction in acidic aqueous media, achieving a rate constant of 241.75 $s^{-1}$. Controlled potential electrolysis at −1.2 V vs. Ag/AgCl over 1.6 h delivers a high turnover number of 73.06 with an excellent Faradaic efficiency of 94.2%. Detailed electrochemical, spectroscopic, and analytical studies confirm minimal catalyst degradation, while the persistence of the active species after electrolysis highlights both stability and durability under reaction conditions. The combined insights from experimental and computational investigations support a proton–electron coupled mechanism, underscoring the catalyst's promise for efficient and sustainable hydrogen production.

**Keywords:** Copper(II)complex; X-ray crystallography; Bioinspired; Electrocatalysis; Hydrogen Production.

# X-ray and radio analysis of Abell 1644: constraints on cluster dynamics

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**Abstract**
We present the first band-2 (120–250 MHz) uGMRT (upgraded Giant Metrewave Radio Telescope) observations of the bimodal galaxy cluster Abell 1644 (z = 0.0471), complemented by Chandra X-ray data. While weak lensing measurements reveal a third substructure in Abell 1644, our radio analysis reveals only two compact sources coinciding with the respective brightest cluster galaxies (BCGs) of the northern (A1644N1) and southern (A1644S) substructures, seen in the X-ray observations. Radio analysis yields compact active galactic nuclei (AGN) powered sources with radio power PA1644S = $1.0 \times 10^{23}$ W/Hz and PA1644N1 = $7.9 \times 10^{23}$ W/Hz at 200 MHz. We find no evidence of non-thermal diffuse radio emission, such as halos or relics, within the sensitivity of our band-2 image. We measured the flux density of each radio source and performed spectral analysis. A1644N1 exhibits a synchrotron power law spectrum while A1644S shows spectral turnover suggestive of synchrotron self-absorption. Our X-ray analysis confirms the presence of a cold front east of the A1644S subcluster core. The temperature map further reveals a previously unreported asymmetry, with a hot intracluster medium (ICM) region to the east of A1644S and cooler gas to the west, likely representing residual signatures of earlier merger activity. Together, these features indicate that Abell 1644 preserves clear imprints of its merger history through long-lived sloshing motions, while the absence of diffuse radio emission suggests that the past merger was relatively minor not injecting enough turbulence for large scale reacceleration or the cluster is approaching a late stage of ICM relaxation.

**Keywords:** active galactic nuclei; galaxy clusters; X-rays; magnetic fields

# Zero Inflated Poisson Xgamma INAR (1) Model and its Applications

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**Abstract**

The first order non-negative integer valued autoregressive process is widely used for counts of events over time. It is obvious that if the innovations are Poisson distributed, then the marginal model is Poisson. However, this marginal process may not hold for the overdispersed count data. An example of one common type of overdispersion is when zero counts are more likely than claimed by the Poisson marginal model. In this regard, we introduce a zero inflated version of a discrete compound model and developed its first integer autoregressive process using zero inflated Poisson Xgamma (ZIPXG) innovations. We derive different structural properties of the INAR(1) model and estimated the parameters by conditional maximum likelihood, Yule-Walker and Bayesian methods. Further a simulation study has been performed to investigate the behaviour of these estimated parameters. To illustrate the utility of the newly proposed INAR(1) model, a time series data on submissions to animal health laboratories has been analyzed.

**Keywords:** Anorexia; Bayesian estimation; Forecasting; Integer valued autoregressive process; Poisson Xgamma.

# Effect of Halide Mixing on Structural and Electronic Properties of $Cs_2TeX'_{6-x}X''_x$ (X', X'' = Cl, Br, I) Perovskites: A First-Principles Study

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While pure-halide compositions of $Cs_2TeX_6$ have been studied, the structural and electronic response of the mixed-halide series $Cs_2TeX'_{6-x}X''_x$ ($X'$, $X''$ = Cl, Br, I, x = 0-6) remains largely unexplored. In this work, we employ first-principles density functional theory (PBE-GGA) to investigate halide mixing across the $Cs_2TeCl_{6-x}Br_x$, $Cs_2TeBr_{6-x}I_x$, and $Cs_2TeCl_{6-x}I_x$ series. Structural relaxation reveals a near-linear, Vegard-law-consistent expansion of lattice constants with increasing halide radius, accompanied by subtle tetragonal distortions. Electronic structure calculations show that all compositions are indirect-gap semiconductors, with the valence band maximum dominated by halide-p states and the conduction band minimum derived primarily from Te-5p orbitals. Each series exhibits pronounced non-monotonic band-gap bowing, with minima at the equimolar composition (x = 3): 2.54 eV (Cl/Br), 1.36 eV (Br/I), and 1.30 eV (Cl/I). This bowing arises from a competition between chemical effects (halide-p orbital energy shifts) and structural effects (crystal-field splitting from octahedral distortion), with the relative dominance of each mechanism varying distinctly across the three series. Local symmetry breaking further activates the stereo chemically inert Te-5s lone pair, enhancing Te-s/halide-p hybridization at intermediate compositions. These findings establish halide mixing as an effective strategy for continuous band-gap tuning in Te-based double perovskites, offering a lead-free platform with structurally and electronically adjustable properties for optoelectronic applications.

Keywords: density functional theory; halide mixing; Vegard's law; Band-gap engineering; lone pair; Electronic structure

# A Fixed-Point Iterative Approach for Solving Fractional Boundary Value Problems in Physical Models

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## Abstract

Fixed Point Theory is a branch of mathematics that focuses on finding solutions to equations of the form $Tx = x$. One of the most important results in this field is the Banach Contraction Principle, which has applications to initial value problems. In this talk, we present an efficient fixed-point strategy for solving nonlinear fractional boundary value problems (FBVPs) arising in physical models. The proposed approach transforms the given FBVP into an equivalent integral equation using Green's function and then incorporates the S-Iteration to obtain approximate solutions. The method is applicable to fractional derivatives of orders, allowing it to capture the nonlocal and memory effects of fractional models. The effectiveness and accuracy of the proposed approach are demonstrated through the Bagley-Torvik and Bratu problems.

**Keywords:** Bagley-Torvik equation, Bratu's equation, Banach space, S iterative scheme, Green's function

# ANN-Assisted Numerical Analysis of Casson Ternary Hybrid Nanofluid Flow over a Riga Plate with Slip Conditions and Cattaneo–Christov Heat Flux

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## ABSRACT

Casson ternary hybrid nanofluid over a stretching Riga surface under magnetohydrodynamic effect is considered in this study. The electrically conducting Casson ternary hybrid nanofluid (THNF) moves across the convectively heated stretching Riga surface. A wall-parallel Lorentz force and Cattaneo–Christov heat flux is shown to significantly modify the boundary layer development. Slip and no-slip wall conditions are considered to examine their contrasting influence on the velocity and thermal boundary layers. The governing partial differential equations are transformed into a system of nonlinear ordinary differential equations via suitable similarity variables and subsequently solved through MATLAB's bvp4c numerical scheme. Moreover, ANN are trained to predict the skin friction coefficient and Nusselt number, while RSM with Central Composite Design (CCD) and ANOVA are employed for interaction, sensitivity, and optimization analysis. ANN predictions show excellent agreement with numerical solutions ($R^2 \approx 1$), with prediction errors below 3%. Comparative results confirm that Casson THNF provides substantially higher thermal performance than conventional nanofluids. Collectively, these findings advance the understanding of Casson ternary hybrid nanofluid behavior on electromagnetically actuated surfaces, offering a validated, machine-learning-enhanced framework for future thermal system design.

**Keywords:** Riga plate; Magnetohydrodynamic flow; Cattaneo–Christov heat flux; Artificial Neural Network; Sensitivity analysis

# Compressed Sensing-Based Color Image Encryption Using a Novel 4D Hyperchaotic System

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## Abstract

This study presents a compressed sensing-based color image compression–encryption framework using a modified four-dimensional (4D) hyperchaotic system. The system incorporates nonlinear feedback and modified absolute-value coupling to enhance chaotic complexity and randomness. Hyperchaotic sequences are employed for measurement matrix construction and to control Arnold scrambling, pseudo-random permutation, Peano curve mapping, and chaotic diffusion. Dynamical analysis using Lyapunov exponents, bifurcation diagrams, Poincaré sections, phase portraits, and National Institute of Standards and Technology (NIST) tests confirms the suitability of the system for secure applications. Experimental results demonstrate satisfactory reconstruction quality, with a peak signal-to-noise ratio (PSNR) of $33.53dB$ and strong structural preservation. The encrypted images exhibit high entropy, low adjacent-pixel correlation, and favorable number of pixels change rate (NPCR) and unified average changing intensity (UACI) values. An average encryption time of $0.1404s$ demonstrates efficient processing. The proposed framework provides a secure and efficient approach for color image compression and encryption, suitable for secure multimedia transmission.

**Keywords:** Chaotic Diffusion; Color Image Encryption; Compressed Sensing; 4D Hyperchaotic System; Multimedia Security

# An efficient multiwavelet based collocation method for integro-differential equation with a weakly singular kernel

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**Abstract**

The sole motive of this paper is to develop a numerical framework based on the quadratic Legendre multiwavelet discretization to estimate the numerical solution of the integro telegraph equation (ITE) with weakly singular kernel. By the means of definition of Riemann Liouville and multiwavelet, a Riemann-Liouville fractional integral operator (RLFIO) has been constructed. The ITE with singular kernel has been converted into the system of linear algebraic equation by using the multiwavelet and RLFIO, and the obtained system is solved for the unknown coefficients. The convergence of the proposed method has been studied in $L^2$ norm framework. Moreover, some numerical problems have been taken from existing literature and solved numerically, so that the superiority of the proposed technique can be shown over the existing method.

**Keywords:**

Multiwavelet; Legendre polynomial; integro-differential equations; Convergence

# A Chebyshev Polynomial Neural Network method for solving neutral delay differential equations

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**Abstract**

A Chebyshev polynomial neural network approach is presented for solving neutral delay differential equations (NDDEs) with variable coefficients and multiple delays. The method employs a Functional Link Artificial Neural Network (FLANN) in which the hidden layer is replaced by a Chebyshev polynomial expansion of the input, resulting in a simpler architecture with reduced computational complexity. Network parameters are determined using Extreme Learning Machine (ELM)–based direct solutions and error backpropagation, enabling fast and reliable training. The model provides closed-form approximate solutions with high accuracy and computational efficiency. Results obtained are compared with existing methods and are found to be in good agreement.

**Keywords:** Functional Link Artificial Neural Network; Extreme Learning Machine; Chebyshev polynomials.

# Effect of rare earth doping on structural, morphological and thermal properties of manganese-nickel ferrites

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**Abstract**

Spinel ferrites have attracted significant research interest owing to their versatile structural, morphological, thermal, magnetic and electrical properties which make them suitable for a wide range of multifunctional applications. In the present work, a systematic investigation has been carried out on the structural, morphological and thermal properties of dysprosium (Dy), samarium (Sm) co-doped manganese-nickel mixed spinel ferrites with composition $Mn_{0.7}Ni_{0.3}Fe_{2-2x}Dy_xSm_xO_4$ (x = 0.02, 0.04, 0.06 and 0.08). These compositions were synthesized by the co-precipitation method. The structural characteristics were investigated using X-ray diffraction (XRD), while surface morphology and particle characteristics were examined by scanning electron microscopy (SEM). The XRD patterns were analyzed to determine the phase formation, crystallite size, lattice parameter, unit-cell volume, structural parameters and to find the influence of Dy, Sm substitution on the spinel structure. SEM analysis provided information regarding the surface morphology, particle distribution and microstructural features of the synthesized ferrites. Thermal analysis using thermos gravimetric analysis and differential thermal analysis (TGA/DTA) was performed to investigate the thermal decomposition behavior, weight loss stages and thermal stability of the precursor and synthesized materials. The combined XRD, SEM and thermal investigations provide an understanding of the structural evolution, morphological characteristics and thermal behavior of Dy, Sm co-doped Mn-Ni spinel ferrites and their dependence on dopant concentration.

**Keywords:**

Spinel ferrites; Co-precipitation; scanning electron microscopy; Thermal stability

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# Preparation and Characterization of Nickel-Substituted Magnesium Vanadate for Potential Energy-Storage Applications

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**Abstract**

The growing demand for advanced functional materials with tunable properties has encouraged extensive research on vanadate based materials for diverse technological applications. Among these, alkaline earth metal vanadates have gained considerable attention owing to their versatile structural characteristics and potential functional properties. Their properties can be further tailored through transition metal substitution, which can modify the structural, morphological compositional and functional characteristics of the host material. Such materials therefore hold promise for applications in energy storage, sensing, catalysis and other emerging technologies. The present work focuses on the preparation and characterization of magnesium vanadate and nickel-substituted magnesium vanadate materials. Pristine and Ni-substituted compositions were synthesized through a co-precipitation route followed by appropriate thermal treatment. The influence of Ni incorporation on the formation and structural evolution of the magnesium vanadate system is being investigated. The synthesized materials are being systematically characterized using structural, morphological, compositional, thermal and spectroscopic techniques, along with electrochemical evaluation, to establish their physicochemical and functional characteristics. X-ray diffraction (XRD) analysis was employed to identify the crystalline phases and evaluate important structural parameters, including crystallite size, lattice parameters and unit-cell volume. Thermo-gravimetric and differential thermal analysis were used to investigate thermal behavior and phase evolution and to assist in optimizing the heat-treatment conditions. Overall, the study aims to establish the relationship between Ni substitution, structural characteristics and functional properties of magnesium vanadate, providing insights into the potential of these materials for energy-storage and other emerging technological applications.

**Keywords:**

Vanadates; Co-precipitation; X-ray diffraction; Electrochemical; Thermal analysis

# First-Principles Study of Graphene-Based Quantum Dot $C_{24}H_{12}$ for Photocatalytic Water Splitting Applications

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## Abstract

Graphene-based materials, particularly graphene quantum dots (GQDs), have emerged as promising photocatalysts due to their unique combination of high carrier mobility, chemical stability, and tunable electronic properties arising from quantum confinement and edge effects. Unlike bulk graphene, which is a zero-band-gap semimetal, GQDs exhibit finite band gaps that depend on their size, shape, and edge termination. This opens possibilities for visible-light absorption and efficient electron–hole pair separation, which are essential for photocatalysis.

In the present study, the structural stability, electrical, and optical characteristics of a graphene quantum dot ($C_{24}H_{12}$) were investigated using density functional theory (DFT). Structural analysis revealed that the quantum dot consists of seven fused benzene rings passivated with hydrogen, with optimized lattice parameters a = b = 19.25 Å and c = 10.0 Å. Band-structure analysis revealed discrete energy levels, a characteristic feature arising from quantum confinement, with a direct band gap of approximately 2.8 eV, confirming the semiconducting nature of the system. Furthermore, the calculated density of states (DOS) showed a symmetric distribution of electronic states around the Fermi level. Band-alignment analysis revealed that the conduction-band minimum (−2.97 eV vs. NHE) lies significantly more negative than the hydrogen-evolution potential (0 eV), indicating strong thermodynamic favorability for reduction-driven photocatalysis. The calculated optical properties further demonstrate the potential of the graphene quantum dot for visible-light-driven photocatalytic water-splitting applications. This work highlights the key aspects of producing green hydrogen as a clean fuel for energy generation, supports circular-economy principles, and contributes to sustainable technological development. Such innovations align with the objectives of **VIKSIT BHARAT 2047**.

**Keywords:**

Band Structure; Density Functional Theory; Hydrogen production; Graphene Quantum Dot; Photocatalytic Characteristics

# Systematic Study of Low Energy Breakup Fusion Reactions

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**Abstract**

Low-energy nuclear fusion reactions involving weakly bound nuclei provide an important framework for understanding the interplay between breakup processes and fusion dynamics. This study presents a systematic investigation of low-energy breakup fusion reactions, with particular emphasis on the influence of projectile breakup on the fusion process. Weakly bound projectiles can undergo breakup into constituent fragments before reaching the target nucleus, leading to several possible reaction pathways, including complete fusion, incomplete fusion, and non-capture breakup. The study examines how reaction energy, projectile structure, breakup probability, and projectile–target interactions affect fusion behavior. Particular attention is given to the competition between breakup and fusion at energies around and below the Coulomb barrier. A systematic approach to available experimental and theoretical results is used to identify important trends in fusion cross sections and reaction probabilities. The analysis highlights that breakup processes can significantly modify the effective fusion probability and may enhance or suppress fusion depending on the characteristics of the interacting nuclear system. Understanding these effects is essential for developing reliable models of reactions involving weakly bound nuclei and for improving our knowledge of nuclear reaction mechanisms at low energies. The study provides a comparative perspective on breakup fusion dynamics and emphasizes the importance of nuclear structure and reaction-channel coupling in describing low-energy fusion phenomena.

**Keywords:** Low-energy fusion; breakup reactions; nuclear reactions; weakly bound nuclei; fusion dynamics

# Antioxidant Potential of Tethwan (*Artemisia absinthium*) Extract and Mulberry (*Morus alba*) Leaf Extract for Sustainable Preservation of Common Carp (*Cyprinus carpio*) During Iced Storage

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Fish tends to be vulnerable to oxidation and biochemical degradation when it is stored and therefore the need to have environmentally-friendly fish preserving techniques using antioxidants from natural sources arises. The percent of matter that could be easily extracted from Tethwan Extract (TE) accounted for 9.00%, whereas the same quantity for Mulberry Extract (ME) reached 15.00%. TE demonstrated an excellent potential of removing DPPH radicals, with the percent removal increasing from 80.00% at 20 mg/L to 95.96% at 100 mg/L. For ME, the percent removal was observed in the range of 59.58% to 68.65% at concentrations of 100–500 mg/L. Ferric reducing power became better along with the increase in concentration in both extracts. The indicators of peroxide value (PV), total volatile base nitrogen (TVB-N), thiobarbituric acid reactive substances (TBARS), and free fatty acids (FFA) tended to increase during chilled storage of non-treated fish. After 12 days, PV values were 15.47, 13.72 and 11.20 mg hydroperoxide/kg for control, TE and ME, respectively. TVB-N values were 38.03, 24.73 and 27.99 mg/100 g, while TBARS values were 1.93, 1.27 and 1.68 mg malondialdehyde/kg. FFA values were 6.79%, 2.00% and 1.76% oleic acid for the same groups. What is more, the use of both extracts during the experiment reduced the chemical spoilage of common carp meat. More precisely, TE demonstrated higher in vitro radical scavenging activity, whereas ME showed a better effect on PV and FFA levels. These results indicate that both extracts may be useful as natural antioxidants for sustainable preservation of common carp (*Cyprinus carpio*) during iced storage.

**Keywords:** natural antioxidants; common carp; iced storage; sustainable food processing; fish preservation

# Biodegradable Packaging from Agricultural Wastes: An Alternative to Synthetic Polymers Used for Food Packaging

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## Abstract

Plastic pollution has posed a severe threat to both ecosystem and human health as plastics break down into smaller fragments, including macro and microplastics that accumulate across marine and terrestrial environments. Approximately 350 million metric tonnes of plastic waste is generated globally while 1,300 million tonnes of agricultural waste is produced per year. Single-use plastic food packaging has emerged as a major contributor to environmental pollution. Therefore, sustainable packaging alternatives are required to achieve a circular economy, promoting reduce-reuse-recycle strategies. Grape and tomato pomace, fruit peels, rice husks, wheat straw, sugarcane bagasse and plant fibres are agricultural wastes that have been utilised to develop sustainable packaging through biopolymer synthesis, blending and composite fabrication. In one of the studies conducted, glycerol and sorbitol were used as plasticizers and lemon extract was used as a replacement for acetic acid in fruit-peel based films whose moisture content and water solubility were reported to be 13.29-19.28% and 51.01-58.56%. respectively. Orange-peel films exhibited the highest water absorption (120.73-134.50%) and mango-peel films exhibited the highest biodegradability (80.25-86.67%). Such films were reported to have an amorphous structure, thermal stability and antibacterial properties against E. coli. Another study revealed a maximum tensile strength of 12.81 MPa and bursting strength of 7.09 kPa for lotus-fibre composites where tapioca starch was used as a binder and casein as a coating along with banana stem, pineapple leaf and rice straw as reinforcing fibres. The coating was found to enhance the mechanical properties, water resistance and biodegradability, allowing the materials to be fabricated into carry bags. PVA–xanthan gum (XG) composite films have been prepared by casting method in which the optimum PX30 formulation showed a WVP of $2.07 \times 10^{-11}$ g $m^{-1}$ $s^{-1}$ $Pa^{-1}$ and water solubility of 45.58%. Thus, this formulation has a potential to be used as an alternative to synthetic packaging polymers. In general, agro-waste-derived materials can be exploited as biodegradable packaging materials. However, their water sensitivity, limited availability, scalability and the balance between mechanical strength and biodegradability remain challenges for their commercial application.

**Keywords**: Agricultural waste; Biodegradable packaging; circular economy; Sustainable food packaging

# Characterization of Spoilage Microbiota and Their Influence on Quality Changes in Rohu (Labeo rohita) During Ambient Storage

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## Abstract

Fish is a great source of essential nutrients, omega-3 fatty acids, and high-quality protein, but it spoils easily in storage. This study used microbiological, biochemical, and molecular methods to investigate the spoiling dynamics of Labeo rohita (Rohu) kept at room temperature. Significant microbial growth was indicated by the total plate counts, which increased from 4.70 log CFU/g at the beginning to 7.44 log CFU/g after 12 hours. Proteolysis, lipolysis, gelatinase production, and hydrogen sulfide formation were among the spoilage-related biochemical activities that showed discernible changes over time in 44 recovered bacterial isolates. As storage continued, the microbial community changed from a mixture of Gram-positive cocci, rods, and Gram-negative bacilli to primarily Gram-negative bacteria. Proteolytic activity peaked at 50% between 4 and 8 hours, but lipolytic bacteria were the primary spoilage group, rising from 75% at the beginning to 84.61% at 12 hours. At 12 hours, $H_2S$-producing bacteria continued to be prevalent, accounting for roughly 38% of isolates. Species linked to spoiling, including Bacillus cereus, Kurthia populi, Acinetobacter spp., and Psychrobacter raelei, were verified by molecular identification. The development of better methods for preserving fish quality and increasing shelf life is aided by these insights into bacterial succession and spoilage mechanisms during ambient storage of Rohu fish.

Keywords: *Labeo rohita*; Ambient temperature storage; spoilage bacteria; enzymatic activity; $H_2S$ activity; 16S rRNA sequencing

# Comparative Characterization of Mango Seed Kernel Starch Obtained by Different Extraction Routes: Physicochemical, Techno-Functional, Thermal, Rheological and Digestibility Properties

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**ABSTRACT**

Mango seed kernels, an underutilized agro-industrial by-product, represent a promising source of starch with potential applications in food and biomaterial systems. The present study comparatively evaluated the influence of extraction route on the physicochemical, techno-functional, digestibility, pasting, thermal and particle characteristics of mango seed kernel starch. Starch was isolated using wet milling, sodium hydroxide, sodium bisulphite, sodium metabisulphite and sodium hydrogen sulphite treatments. Significant differences among extraction methods were observed in starch recovery, purity, composition and functional performance. Sodium hydroxide extraction resulted in the highest starch yield (56.08%) and high purity (96.31%), whereas wet milling produced starch with the highest amylose content (27.03%). Extraction treatment also modified hydration and gelling characteristics, with water absorption capacity ranging from 1.35 to 1.58 g/g and swelling power increasing progressively with temperature. Sodium hydroxide-extracted starch exhibited comparatively greater swelling and water solubility, while sodium bisulphite treatment showed the highest gelling power. Marked differences were also observed in starch digestibility, with resistant starch ranging from 58.10 to 69.08%, indicating that extraction conditions can modulate the nutritional functionality of the resulting starch. Pasting and thermal analyses further demonstrated method-dependent changes in gelatinization and viscosity characteristics, with wet milling producing the highest peak (3420 mPa·s) and final viscosity (4625 mPa·s). Particle size also varied substantially among treatments, with sodium bisulphite producing the smallest mean particle diameter (7.04 µm). The present study demonstrate that the extraction route is an important determinant of the functional, compositional and processing behavior of mango seed kernel starch.

**Keywords:** Extraction methods, SEM, Rheology, Particle Size Distribution, DSC

# Development and Characterization of 100% Quinoa Flour Bread: Nutritional, Functional and Technological Attributes

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## ABSTRACT

The present study investigated the potential of quinoa flour as a complete substitute for refined wheat flour in bread development, with emphasis on nutritional, functional, technological, textural, and sensory characteristics. Bread prepared with 100% quinoa flour was compared with 100% refined wheat flour bread (control). Complete replacement of wheat flour with quinoa significantly improved the nutritional profile of bread, as reflected by increases in protein (11.08 to 23.98 g/100 g), dietary fibre (1.91 to 5.90 g/100 g), fat (2.98 to 3.88 g/100 g), and ash (1.89 to 2.13 g/100 g), whereas carbohydrate content decreased from 44.03 to 30.90 g/100 g. The quinoa formulation demonstrated superior bioactivity, with increase in total phenolic content (TPC), total flavonoid content (TFC), DPPH free-radical scavenging. The reduction in saponin content following washing and baking contributed to improved quinoa flavour by reducing the characteristic bitterness associated with raw quinoa. Dough rheological properties were also evaluated using a Farinograph to assess the effect of complete quinoa flour replacement on dough mixing and water absorption characteristics. Loaf weight increased from 149.89 to 192.06 g, while loaf height decreased from 8.17 to 5.49 cm, with concomitant reductions in loaf volume and specific volume. The quinoa bread exhibited greater crumb hardness and darker colour compared with the control. Overall, 100% quinoa flour demonstrated considerable potential for developing nutritionally enriched and antioxidant-rich bread, although complete wheat replacement presented technological challenges related to loaf development and crumb quality. The findings provide a basis for further optimization of quinoa-based bread formulations for gluten-free and health-oriented food applications.

**Keywords:** Quinoa flour; Bread quality; Nutritional composition; Antioxidant activity; Texture.

# Development and Characterization of Functional Protein-Based Packaging Materials

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## ABSTRACT

The growing environmental concerns associated with petroleum-derived plastic packaging, coupled with the increasing demand for safe and sustainable food packaging, have stimulated significant interest in biodegradable packaging materials. Among various bio-based polymers, proteins obtained from plant and animal sources have attracted considerable attention due to their renewable nature, biodegradability, excellent film-forming capacity, and diverse functional properties. Protein-based films can form cohesive and flexible matrices capable of providing protection against environmental factors that contribute to food deterioration. The development of packaging films by combining proteins from plant and animal sources offers a promising strategy for tailoring film properties and overcoming the limitations associated with individual protein-based materials. Such composite systems may provide improved mechanical strength, barrier performance, structural stability, and functional characteristics through interactions between different protein components. Moreover, protein-based films can be functionalized with naturally derived bioactive compounds, including antioxidants and antimicrobial agents, to develop active packaging systems capable of providing additional protection to food products. These functional films may help control moisture and oxygen transfer, inhibit microbial growth, delay oxidative deterioration, and consequently contribute to maintaining food quality and extending shelf life. The utilization of plant and animal proteins for functional packaging development also supports the principles of a circular and sustainable food system by promoting the use of renewable biological resources and reducing dependence on conventional plastics. Overall, protein-based composite films represent a promising platform for the development of next-generation biodegradable and functional food packaging materials with potential applications in food preservation, safety, and quality enhancement.

**Keywords:** Proteins, Packaging, Properties and Development

# Development and Evaluation of a 275 nm UV-C LED Chamber for the Microbial Decontamination of Fresh Produce

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## Abstract

Fresh produce is a common vehicle for transmission of foodborne pathogens, and current decontamination methods are often limited by chemical residues, mercury-based UV sources and non-uniform irradiation resulting in suboptimal microbial inactivation. To address such limitations, this study has designed, fabricated and evaluated a laboratory scale 275 nm multidirectional UV-C LED chamber for effective decontamination of fresh produce. The chamber is constructed of eight KLUCL6-30 UV-C LED modules (48 LEDs; 275 nm) with each module comprising six high power LEDs on an aluminium-core printed circuit board (MCPCB) with an integrated aluminium heat sink and 120° beam angle. The modules were placed strategically on the top, bottom and side panels and incorporated a quartz rod sample support to ensure maximum uniformity of irradiation and minimum shadowing. Antimicrobial activity was evaluated against strains of Gram-negative (*Escherichia coli* and *Salmonel*la spp.), Gram-positive (*Staphylococcus aureus*) bacteria and yeast (*Candida albicans*) at treatment distances of 6, 10 and 14 cm and exposure times of 1, 3 and 5 min. Among all treatment combinations, irradiation at 6 cm for 3 min achieved the highest microbial inactivation. Gram-negative bacteria were more susceptible to 275 nm UV-C irradiation than the Gram-positive bacterium and the yeast, as evidenced by the susceptibility of the tested microorganisms in the following order: *E. coli* > *Salmonella* spp. > *S. aureus* > *C. albicans*. The optimized multidirectional irradiation configuration improved UV-C dose distribution, minimized shadowing, and enhanced antimicrobial efficacy. Overall, these results indicate that the fabricated 275 nm UV-C LED chamber is a mercury-free, energy-efficient and reproducible non-thermal decontamination platform with significant potential to enhance the microbial safety of fresh produce.

**Keywords:** UV-C LED; fresh produce; multidirectional irradiation; microbial decontamination; food safety.

# Development and Evaluation of an Antioxidant Enriched Herbal Tea using Pomegranate Peel Powder (*Punica granatum L*).

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## Abstract

Pomegranate (*Punica granatum L.*) is a nutritionally rich fruit valued for its bioactive compounds, particularly ellagitannins and anthocyanins, which offer protection against degenerative diseases. While the edible portion of the fruit is widely consumed, the peel making up 26–30% of total fruit weight is generally discarded as waste, despite containing even higher concentrations of nutritionally valuable and biologically active compounds than the pulp itself. Pomegranate peel is notably rich in dietary fiber (~45%), vitamins (C, E, K), minerals (potassium, calcium, iron, magnesium), and polyphenols such as ellagic acid, gallic acid, and flavonoids, which impart strong antioxidant, antimicrobial, anti-atherogenic, and anti-mutagenic properties. Given the growing preference for natural antioxidants over synthetic ones due to safety concerns, and the environmental burden posed by discarded peel waste, there is a clear opportunity to valorize this by-product into a functional food. This study proposes the development of an antioxidant-enriched herbal tea using pomegranate peel powder, blended in varying proportions with complementary botanicals ginger, mint, and tulsi across eight treatment formulations (T1–T8). The primary objectives of the study are to standardize the method for preparing pomegranate peel herbal tea and to evaluate the physico-chemical properties of the developed tea, alongside determining its overall acceptability through organoleptic (sensory) evaluation. The methodology involves processing fresh pomegranate peel, ginger, mint, and tulsi through washing, drying, and grinding, followed by packaging into tea bags for testing. Physical parameters (moisture content, bulk density, water activity, particle size, etc.) and chemical parameters (antioxidant activity via FRAP, DPPH, and ABTS assays, total phenolics, flavonoids, and mineral content) will be assessed to characterize the product. The anticipated outcome is a value-added, natural functional beverage with potential health benefits including antioxidant, anti-inflammatory, and digestive support while simultaneously reducing pomegranate processing waste, minimizing environmental pollution, and creating a sustainable revenue stream for the food processing industry.

**Keywords-** Pomegranate peel powder, Antioxidant activity, Herbal tea, Phenolic compounds, Value-added product, Sensory (organoleptic) evaluation.

# Development of Sustainable Bio functional Materials from Natural Resources for Emerging Applications

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**s**

Food loss driven by microbial spoilage and lipid oxidation remains a persistent challenge throughout the food supply chain. Although conventional petroleum-based packaging provides effective protection, it is generally poor biodegradable, while many active-packaging systems rely on synthetic preservatives or additives. Plant secondary metabolites offer a promising natural alternative because of their antimicrobial and free radical scavenging properties. This study proposes to development of a bio functional, biodegradable food-packaging film using a locally available medicinal plant reported to be rich in these phytochemical classes.

The study will begin with the optimization of extraction conditions and characterization of the resulting extracts in terms of total phenolic and flavonoid contents, antioxidant capacity, preliminary antimicrobial activity before incorporating them into a biopolymer film matrix to produce an edible or biodegradable packaging material. The films will then be evaluated against representative food-spoilage bacteria and fungi, alongside measurements of antioxidant capacity, mechanical strength, flexibility, water-vapour permeability, oxygen-barrier properties and biodegradability under controlled conditions.

The selected film formulations will then be applied to perishable food models under simulated storage conditions to determine whether their antimicrobial and antioxidant properties translate into measurable shelf-life extension and improved product quality. The study will also identify the relationship between phytochemical composition, extract concentration, and film performance.

By integrating a locally available medicinal plant with a biodegradable chitosan matrix, this work aims to develop a multifunctional active-packaging film with potential to reduce dependence on synthetic preservatives and non-biodegradable plastic materials. The proposed approach may provide a sustainable, locally relevant, and scientifically grounded platform for clean-label food-packaging applications.

**Keywords:** Active food packaging; chitosan; medicinal plant; polyphenols; flavonoids; antimicrobial activity; antioxidant activity; biodegradable film; shelf-life extension.

# Development of Whey Protein Isolate–Pectin Nanoemulgels as Food-Grade Structuring Systems for Low-Fat Food Applications

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## Abstract

Low-fat food products are popular and in demand among consumers due to their lower contribution to health risks and similar sensory properties. The aim of this study is to overcome the limitations of hydrogels and oleogels; therefore, it proposes optimizing the formulation ingredients to produce a stable oil-in-water-based protein-polysaccharide nanoemulgel. Six emulsion gels of varying concentration of WPI: Pectin (E1-10:1.5, E2-10:2.0, E3-15:1.5, E4-15:2.0, E5-20:1.5, E7-20:2.0%) were prepared by first homogenizing the oil-water WPI emulsion for 20 minutes at 10000 rpm, followed by ultrasonication treatment at 20kHz for 20 minutes, then kept for setting under refrigeration. All the nanoemulgels were studied for their physical properties, including DLS, colour, and rheology. The best of the six nanoemulgel formulations, E1, E2, and E3, showed significant differences in particle size distribution, polydispersity, and zeta potential. Formulations E1, E2, and E3, exhibiting smaller droplet sizes (1691 nm, 1757nm, 1790nm, respectively), lower PDI values in the range (0.316-1.00), and higher absolute zeta potential values (> -25 mV), demonstrated superior physical stability. The colour of nanoemulgels varies according to the amount of WPI in the formulation. To verify the edibility of nanoemulgels, sensory evaluation was conducted. NE1 and NE2 demonstrated superior sensory quality across most evaluated attributes, particularly in visual appearance, mouthfeel, taste, and overall acceptability. Overall, the results show that the physicochemical and sensory properties of protein–polysaccharide emulsion gels are significantly influenced by both the WPI–pectin formulation and the processing conditions. To structure edible oils and create lower-fat food items with desired functional and sensory qualities, the optimized formulations provide a suitable food-grade platform.

**Keywords**: Nanoemulsion gel; whey protein isolate; ultrasonication; particle size; zeta potential; sensory evaluation

# Effect of Different Drying Methods on the Physicochemical, Functional, and Sensory Properties of Pineapple Peel Powder (*Ananas comosus*)

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## ABSTRACT

This study investigates the effect of different drying techniques on quality attributes of pineapple peel powder (*Ananas Comosus*) which was carried out in Food Technology Laboratory, Department of Food Technology and Nutrition in Lovely Professional University Phagwara, Punjab from year 2023-2024. Pineapple peel offers numerous benefits that make it a valuable resource for various applications. The pineapple peel was subjected to different drying methods including tray and oven drying at 50ºC, 60ºC and 70ºC as well as sun drying. The pineapple peel powder obtained from different drying methods was analyzed for moisture, ash, carbohydrate, protein and fat content. The values obtained were ranging from 4.94 ± 0.08% to 7.13 ± 0.14% for moisture, 4.84 ± 0.03 % to 7.22 ± 0.15 % for ash, 41.57 ± 0.85 g/100g to 70.48 ± 1.43 g/100g for carbohydrate, 3.31 ± 0.02 % to 5.74 ± 0.04 % for protein, and 0.50 ± 0.01g/100g to 2.80 ± 0.04 g/100g for fat. Techno-functional properties such as water holding capacity, oil holding capacity, bulk density and tapped density were also determined. Different treatments of pineapple peel powder were filled in tea bags and an instant herbal tea was prepared, which was taken for sensory evaluation by a panel of 10 evaluators. $T_3$ (tray dried at 60ºC) and $T_1$ (sun dried) were found to score the highest in terms of appearance, smell, colour, flavour, aroma, taste, mouthfeel, and overall acceptability.

**Keywords-** pineapple peel powder; drying techniques; proximate composition; techno-functional properties; sensory evaluation

# Enzymatic Hydrolysis of Duckweed Protein: Structural Characteristics, Functional Properties, and Antioxidant Potential

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## ABSTRACT

Duckweed is an aquatic plant that grows quickly and has drawn interest as a nutrient-rich and sustainable alternative protein source for food applications. In order to improve the functional and bioactive qualities of duckweed protein, this study used ultrasound-assisted alkaline extraction (UAAE) for protein recovery. UAAE increased protein yield (34%) and protein recovery (18%) at 70% ultrasound amplitude for 20 minutes. RuBisCo was found to be the main protein fraction. Additionally, protein solubility, water-holding capacity (3.4 g/g), and foaming capacity (65%) were also improved by ultrasound treatment. Pepsin (PHF), trypsin (THF), and a 1:1 mixture of pepsin and trypsin (MHF) were used to hydrolyse the isolated protein for 2, 4, and 6 hours. Pepsin showed a 14.30% degree of hydrolysis which increased over time and peaked at 4 hours. Trypsin hydrolysates showed the best emulsifying activity, emulsion stability, and solubility (73% at pH 10). The antioxidant activity increased in a concentration-dependent manner in both ABTS and DPPH assays. The maximum radical-scavenging activity was shown by PHF whereas THF indicated a highest total phenolic content (136.4 mg GAE/g). The fractions showed a considerable alpha- glucosidase inhibitory activity, (THF (IC50 = 67.51 µg/mL): PHF (IC50 = 69.02 µg/mL)) when compared to acarbose (IC50 = 45.35 µg/mL). Overall, extraction & hydrolysis was shown to enhance the functional, antioxidant, and antidiabetic potential of Duckweed protein.

Key words: Anti diabetic; Bioactive peptides; Duckweed; Protein hydrolysates.

# Extraction, Process Standardization, Dephenolization and Characterization of Corn Silk Protein Isolate

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Corn silk, an underutilized agro-industrial by-product, is a promising source of plant protein with potential applications as a functional food ingredient. The present study aimed to standardize alkaline extraction and acid precipitation conditions for the recovery of protein from corn silk. Corn silk protein was extracted using dispersions at different pH levels (8.5–11.5), followed by acid precipitation. Dephenolization was further standardized using ethanol and methanol at concentrations of 60–90%. Based on protein yield, purity, solubility, and colour, pH 9.5 was identified as the suitable extraction medium, while 80% ethanol was found to be the most effective dephenolization treatment. The yield and purity of corn silk protein isolate (CSPI) obtained with and without phenolics ranged from 6.67±0.01% to 3.77±0.21% and 47.25±0.16% to 77.52±0.70%, respectively. Dephenolized CSPI exhibited improved solubility and water and oil binding capacities, along with enhanced emulsifying and foaming properties compared with phenolic containing samples. The standardized CSPI was further characterized for its physicochemical and functional properties. FTIR, SEM, and DSC analyses revealed alterations in secondary structure, morphological characteristics, and thermal stability, with dephenolized CSPI exhibiting a more amorphous structure and higher thermal resistance. SDS-PAGE confirmed the protein profile of the isolates. Overall, the findings demonstrate the feasibility of recovering high-quality protein from corn silk through standardized alkaline extraction and dephenolization, highlighting its potential as a sustainable, value-added plant protein for functional food applications and contributing to agro-industrial waste valorization and the circular bioeconomy.

Key Words: - Corn Silk, Protein, Underutilized, Alternate Protein, Waste Utilization

# From Waste to Functional Gelatin: A Comparative Study of Acid, Ultrasound, and Ohmic-Assisted Extraction from Poultry By-products for Sustainable Food Processing

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## Abstract

Jammu and Kashmir's poultry sector dresses millions of birds annually, and processing on this scale leaves behind large volumes of by-products that are typically discarded as waste with tremendous environmental burden. These by-products represent an underutilized, efficient, and cheap source of gelatin, offering an alternative to traditional extraction sources like porcine and bovine. This work compared conventional Acid Hydrolysis (AH) with two sustainable novel methods, viz., Ultrasound-assisted Extraction (UAE) and Ohmic-assisted Extraction (OH). The gelatin produced in conventional AH had a moderate gel strength (147g gel bloom), which is the primary parameter used to determine the quality of gelatin. In contrast, UAE reduced the extraction time to 3 hours and achieved a gel bloom of 272g, while OH reduced the extraction time further to 1 hour at 20V/cm and achieved a higher gel bloom of 302g. Another important parameter in protein extraction is protein yield: the yield was 9.8% in AH, as opposed to 11.2% and 13.7% in UAE and OH, respectively. The pH of the gelatin samples was 5.17, 4.93, and 4.77 for AH, UAE, and OH extraction, respectively. UAE and OH also showed a positive correlation with other important functional properties compared to conventional AH. Water holding capacity was 13mL/g, 14.7mL/g, and 14.9mL/g for AH, UAE, and OH, respectively. Oil binding capacity showed a similar trend, at 5.3mL/g, 6.6mL/g, and 7.1mL/g, while emulsion capacity was 52.4% for AH and 55.4% and 56.3% for UAE and OH, respectively. These differences can mostly be attributed to the greater unwinding of the triple helical structure of native collagen in UAE and OH than in conventional AH, which exposed both hydrophilic and lipophilic components buried within the structure of gelatin, thereby enhancing its functional properties for sustainable food applications.

***Keywords:*** *collagen; extraction; gelatin; hydrolysis; protein*

# From Winery Waste to Wellness: Green Valorization of Grape Wastes for Bioactive Food Fortification

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## Abstract

Grape pomace, one of the principal residues generated during winemaking, is an abundant yet largely underexploited biomass that offers considerable scope for value addition owing to its high levels of phenolic acids, flavonoids, and anthocyanins. The present study investigated the application of sustainable green extraction approaches for the recovery of bioactive compounds from grape pomace (*Vitis vinifera* cv. Punjab MACS Purple), with particular emphasis on their biotherapeutic potential and application in food fortification. Ultrasonic-assisted extraction (UAE), microwave-assisted extraction (MAE), and enzyme-assisted extraction (EAE) were optimized under conditions of 59°C for 15 min, 900 W for 1 min, and a pectinase–β-glucanase enzyme combination, respectively. Among the extraction methods evaluated, MAE exhibited superior performance, producing the highest levels of total phenolic content (118.85 mg GAE/100 mL), flavonoids (100.68 mg/100 mL), anthocyanins (20.49 mg/100 mL), and antioxidant activity (70.08% DPPH radical-scavenging activity). Comprehensive characterization of the grape pomace extract through GCMS, FTIR, and NMR analyses revealed a diverse profile of bioactive compounds, including resveratrol, polyphenolic compounds, carboxylic acids, esters, aldehydes, ketones, and alcohols. The extract also demonstrated promising biotherapeutic properties, including pronounced anticancer activity against HT-29 cells, with an $IC_{50}$ of 30 µL, substantial antidiabetic activity as evidenced by 80.03% inhibition of α-amylase, and strong antioxidant activity with 76.09% radical-scavenging capacity. Collectively, the study highlights grape pomace as a promising feedstock for sustainable bioprocessing and identifies microwave-assisted extraction as an efficient green approach for its valorization. The utilization of grape-derived bioactives in functional foods may contribute to the reduction of agro-industrial waste, enhancement of nutritional value, and advancement toward Sustainable Development Goal 2 (Zero Hunger).

**Keywords:** Bioactive compounds; biotherapeutic; Grape winery waste; green technology; food fortification

# Germination-Induced Nutritional, Antioxidant, and Techno-Functional Transformations in Himalayan Proso (Panicum miliaceum) and Foxtail (Setaria italica) Millets and Characterization of Derived Gluten-Free Flatbread

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## Abstract

Proso (Panicum miliaceum) and foxtail (Setaria italica) millets sourced from the high-altitude Himalayan region of Ladakh, India, were subjected to controlled germination at 25 ± 1°C and 85% relative humidity over 10 days, with daily sampling and flour preparation. Germination progressively increased crude protein from 11.0 to 14.8% in foxtail and 10.8 to 14.5% in proso millet (+34%), and crude fiber from 2.0 to 3.5% and 1.9 to 3.3% (+75%), while carbohydrates declined from 70.7 to 62.9% and 71.4 to 63.2%, respectively. Anti-nutritional factors were substantially reduced by D-10: phytic acid by 80–82%, tannins by 84–85%, and oxalates by 38–45%, improving predicted mineral bioavailability. Antioxidant activity peaked at D-8, with DPPH reaching 74.0 µg/mL, TPC 3.75 mg GAE/g, TFC 2.19 mg QE/g, and FRAP 34.0 µmol $Fe^{2+}$/g in proso millet. Functional properties including water absorption (↑ to 2.75 g/g), oil absorption (↑ to 1.50 g/g), and emulsification capacity (↑ to 22%) improved, while water solubility index declined, confirming amylase-driven starch modification corroborated by FTIR, XRD, and SEM analyses. Dough storage modulus G' increased to 187,000 Pa (foxtail D-10), indicating stronger elastic networks. Flatbreads from D-5 germinated flours achieved the highest sensory acceptability (8.3/9), while D-10 flours produced the softest texture (hardness: 5.0 N). Refrigerated storage at 2°C maintained microbial safety for four days. These findings establish germinated Himalayan millet flours as nutritionally and technologically viable ingredients for gluten-free flatbread development.

**Keywords:** Proso millet; foxtail millet; controlled germination; anti-nutritional factors; antioxidant activity; gluten-free flatbread

# Influence of protein concentrate obtained from Rohu fish on cooking, texture, colour sensory characteristics and FTIR molecular interaction of semolina pasta

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## ABSTRACT

The influence of substituting semolina with Rohu fish protein concentrate (RPC) (3-15%) on technological quality and nutritional of developed pasta was examined. Results showed that increasing RPC from 3-15%, significantly influenced the functional characteristics of blends. Increasing RPC level significantly ($p<0.05$) reduced the optimum cooking time, while cooking loss of pasta increased (4.32-11.06g/100g), due to gluten protein matrix weakening, which results in reduced firmness (2.83-0.35kg) and toughness (4.68-0.82kg-sec$^{-1}$) of pasta. RCP addition increased protein (12.41-23.51%), fat (1.07-3.86%) and ash (0.75-2.38%) content of pasta in comparison to control. Mineral analysis shows the increased in major and minor mineral in RPC substituted pasta. Lightness of pasta decreased while yellowness (b*) increased due to presence of natural yellow pigment in RPC. FTIR spectra show us the presence of amides I, II and III group and also presence of docosahexaenoic acid (DHA) in pasta. Protein digestibility (72.64-84.18%) protein availability (9.01-19.78g/100g dry pasta) increased with increase in RPC level in pasta. Pasta with 9% RPC was much preferred by the panelist while increasing RPC level increased fish favour intensity in pasta which is not preferred by panelists.

**Keywords:** Pasta; *Rohu*; Protein powder; Cooking quality; Nutrition; Texture; FTIR

# Lactic Acid Bacteria-Assisted Fermentation as a Clean-Label Approach for Structural-Functional Modification of Corn Starch

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## Abstract

This study demonstrated that lactic acid bacteria (LAB)-assisted submerged fermentation can modify the structural and functional properties of corn starch using *Lactobacillus plantarum*, *Lactobacillus rhamnosus*, and *Lactobacillus casei*. Fermentation was completed within 30 h when the pH decreased below 3.5. The morphology, pasting behavior, rheology, and particle size properties of representative fermented starches were analyzed to establish structure-function relationships. FE-SEM analysis showed the development of pores on the surface of the starch, which was more evident in *L. plantarum*- and *L. rhamnosus*-fermented starches compared to *L. casei*-fermented starch. Native corn starch showed a peak and final viscosity of 3887cP and 4427 cP, respectively. Fermentation altered these values to 4082cP and 4355 cP (*L. plantarum*), 3243cP and 4420 cP (*L. casei*), and 4859cP and 5485 cP (*L. rhamnosus*). Particle size remained comparable to native starch (17.44 µm) after *L. casei* fermentation (17.66 µm), but increased to 20.35 µm and 46.26 µm following *L. plantarum* and *L. rhamnosus* fermentation, respectively. Fermentation also significantly increased ($p \leq 0.05$) the viscoelastic moduli, indicating strengthened elastic networks. Furthermore, texture profile analysis showed a significant increase ($p \leq 0.05$) in gel hardness after fermentation, with values of 1743.19 g (*L. plantarum*), 1484.61 g (*L. rhamnosus*), and 1379.20 g (*L. casei*) compared to 169.26 g for native starch, indicating the formation of significantly firmer gels after fermentation. The findings suggest that LAB-assisted fermentation can be a feasible clean label technology for altering the functionality of corn starch, thus providing scope for further investigations in diverse food applications.

Keywords: Clean label; Chewiness; Functional ingredient; Microscopy

# Microplastics in Food Systems: Occurrence, Migration from Packaging, Analytical Challenges and Health Implications

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## Abstract

Microplastic (MP) contamination has emerged as a pervasive environmental concern globally due to their chemical stability, hydrophobicity and resistance to biodegradation. MPs, ranging in size from 0.1-5000 µm have been detected in diverse food products including salt, sugar, honey, beverages, milk, cooking oils and processed food products. Ingestion is one of the prominent routes of MP exposure. In a market-based study conducted in United Kingdom, MPs were detected in various food and beverage samples with table salt (173 ± 94 MP/kg) reporting the highest concentration followed by honey (101 ± 73 MP/kg) and sugar (94 ± 17 MP/kg) while lower concentrations were found in cooking oils (25 ± 5 MP/L), vinegar (19 ± 9 MP/L) and milk (19 ± 6 MP/L). The predominant polymers included polypropylene (PP), polyethylene (PE) and polyethylene terephthalate (PET). MPs possess an exceptional ability to migrate into the food from the packaging material and is highly influenced by polymer characteristics of packaging material, mechanical abrasion, UV radiations, temperature fluctuations, storage duration and food composition. MPs have also been detected in 8 of 12 human organ systems and in biological samples including blood, placenta, breast milk, stool, urine and semen resulting in oxidative stress, inflammation, immunotoxicity, genotoxicity, gut microbiome disruption, reproductive and cardiovascular impacts. The total permissible limits for MP contamination in food are yet to be established by the European Food Safety Authority (EFSA) and the U.S Food and Drug Administration (FDA). Various analytical techniques including stereomicroscopy, fluorescence-based screening, µ-Fourier-transform infrared spectroscopy (FTIR) and µ-Raman spectroscopy have been employed for the detection and characterization of microplastics while highlighting the methodological limitations and challenges associated with their analysis. The current data on the occurrence, migration, analytical challenges and the potential health implications of MPs in packaged food products have been examined under this review, emphasizing the need for standardized analytical protocols and stronger regulatory strategies to reduce MP contamination across the food chain.

**Keywords:** Food packaging; Microplastics; Migration; Polymers

# *Ocimum basilicum*-Based Functional Beverage: Antidiabetic Activity Through Enzyme Inhibition and Improved Glycemic Control in Wistar Rats

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## Abstract

Diabetes mellitus, characterized by impaired glucose metabolism due to reduced insulin levels or sensitivity, causes persistent hyperglycemia and various complications. This study formulated a cereal-based beverage using barley and oats, enriched with eugenol, a phenolic compound extracted from *Ocimum basilicum* (basil) leaves. The goal was to evaluate the beverage's antihyperglycemic properties through in vitro and in vivo assays, highlighting its potential as a functional food for managing hyperglycemia. Eugenol was extracted using ultrasonic-assisted extraction and encapsulated for stability before infusion into the beverage. The beverage's physicochemical properties were analyzed, including soluble solids, sugar content, antioxidant activity, and eugenol concentration. In vitro tests showed significant inhibition of alpha-glucosidase (85%) and alpha-amylase (70%), indicating strong antidiabetic potential. In vivo tests with Wistar rats were divided into four groups: control, high-fat diet, eugenol-rich beverage, and metformin. The eugenol beverage group showed significant improvements in blood glucose, cholesterol and renal function markers compared to the control group. Histopathological analysis confirmed reduced hepatic and renal tissue damage. The study concludes that the eugenol-infused barley-oat beverage has potent antihyperglycemic and lipid-lowering effects, suggesting its potential as a natural alternative for diabetes management.

*Keywords:* Hyperglycemia, alpha-amylase, alpha-glucosidase, *in-vitro*, histopathological

# Process Driven Structure–Function Relationship in Defatted Muskmelon (*Cucumis melo* L.) Seed Meal

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## Abstract

Muskmelon (*Cucumis melo* L.) seeds are nutrient-rich agro-industrial by-products with considerable potential for sustainable food applications, yet their utilization remains limited. This study evaluated the effects of roasting (120 °C, 15 min), soaking (25 °C, 12 h), and germination (25 °C, 72 h, 90% RH) on the compositional, bioactive, anti-nutritional, techno-functional, structural, and rheological characteristics of defatted muskmelon seed meal (DMSM). Germination resulted in the greatest improvement in nutritional and bioactive attributes, increasing protein (50.69%), total phenolics (12.15 mg GAE/g), total flavonoids (8.90 mg RE/g), and antioxidant activities, including DPPH (59.32%), FRAP (76.82%), and ABTS (83.52%), along with an increase in lysine content. It also markedly reduced phytate, oxalate, and tannin contents, indicating the beneficial role of endogenous enzymatic activity during germination. Soaking enhanced water absorption capacity (4.87 g/g) and emulsifying properties, with emulsifying activity (64.0%) and stability (74.33%), whereas roasting improved oil absorption capacity (1.92 g/g) and resulted in the lowest median particle size ($D_{50}$ = 106.49 µm). FTIR analysis indicated processing-induced changes in protein secondary structure, while X-ray diffraction revealed reduced crystallinity following processing. All DMSM samples exhibited pseudoplastic flow behaviour (n = 0.32–0.41), with soaked DMSM showing the highest viscoelasticity (G′ > G″). Pearson correlation analysis further demonstrated strong associations between structural modifications and techno-functional properties. Overall, the findings establish a clear processing–structure–function relationship and highlight processed DMSM as a promising sustainable, clean-label ingredient for protein-enriched foods, functional beverages, and plant-based formulations.

**Keywords:** Defatted muskmelon seed meal; Processing; Techno-functional properties; Molecular characterization; FTIR spectroscopy; X-ray diffraction; Rheology

# Sono-Crystallization Assisted Recovery of Lactose from Dairy Waste: Influence of Sonication Amplitude on Yield and Lactose Characteristics

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## Abstract

Lactose recovery from cottage cheese whey offers an effective approach for valorizing dairy by-products while reducing environmental burden. This study investigated the effect of ultrasound-assisted antisolvent crystallization on the yield, purity, physicochemical characteristics, crystal structure, thermal behavior, and morphology of recovered lactose. Sono-crystallization was performed at ultrasonic amplitudes of 50–80 % for 7–15 min and compared with conventional crystallization. The recovered lactose was characterized for yield, purity, water activity, ash and protein contents, color, Fourier transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), particle size distribution, scanning electron microscopy (SEM), and X-ray powder diffraction (XRPD). Sono-crystallization significantly improved lactose quality compared with conventional crystallization. The highest purity (93.12 %) was achieved at 70 % amplitude for 7 min, while the maximum yield (24.84 g/L) was obtained at 70 % amplitude for 15 min. Ultrasound reduced ash (2.23–5.28%) and residual protein contents (0.028–0.280%) compared with conventional lactose (7.88% ash and 1.411% protein), indicating enhanced crystal purity. Water activity remained within a stable range suitable for storage. FTIR and XRPD analyses confirmed that the recovered product predominantly consisted of α-lactose monohydrate without alteration of its molecular structure. DSC thermograms indicated preservation of the crystalline hydrate and minor variations in thermal transitions associated with sonication conditions. Ultrasound markedly reduced particle size from 122.17 µm in conventional lactose to 2.11–8.99 µm and produced uniform, well-defined crystals with reduced agglomeration, as confirmed by SEM. Overall, ultrasound-assisted antisolvent crystallization proved to be an efficient, non-thermal approach for producing high-purity lactose with improved crystallinity, controlled particle size, enhanced physicochemical properties, and superior morphological characteristics. The optimized process demonstrates considerable potential for sustainable cottage cheese whey valorization and industrial production of value-added lactose.

***Keywords:*** *Byproduct utilization; Crystal structure; Extraction; Morphology; Non-thermal; Particle size*

# Street Food's Toxic Palette: Synthetic Colorants, Health Risks, and the Need for Intervention

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## Abstract

The extensive use of synthetic food colorants in street foods has raised concerns regarding food safety, consumer health, and sustainable food processing, particularly in regions where street foods are widely consumed because of their affordability and accessibility. This review examines the use of artificial colorants in street foods, their potential health implications, regulatory concerns, and the prospects of safer natural alternatives. Inappropriate use of synthetic colorants, including the use of non-permitted dyes or concentrations exceeding prescribed limits, may increase consumer exposure and pose potential health risks. The persistence of such practices is influenced by inadequate regulatory monitoring, limited awareness among food vendors, economic considerations, and consumer preference for brightly coloured foods. The review further compares synthetic and natural colorants with respect to their sources, functional properties, safety, regulatory standards, and applications in food systems. Attention is given to natural pigments derived from fruits, vegetables, herbs, spices, and other plant-based resources, which offer potential alternatives for developing safer and more sustainable food products. Methods used for the detection and monitoring of food colorants are also discussed, along with existing regulatory considerations. Future perspectives include improved vendor education, strengthened food safety surveillance, consumer awareness, development of stable natural colour formulations, and utilization of food-processing by-products as sources of natural pigments. Overall, the transition from inappropriate synthetic colorant use toward safe and sustainable natural alternatives could contribute to healthier food systems while supporting sustainable food processing and resource utilization.

**Keywords:** Food colorants; Street Food; Health Implications; Regulatory standards; Toxicity of Food dyes; Colour Stability.

# Sustainable Ultrasound-Assisted Extraction and microencapsulation of Rosemary, Basil and Parsley Essential Oils for Food Applications

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## Abstract

The increasing demand for natural, stable and sustainable food ingredients has stimulated interest in plant-derived essential oils as alternatives to synthetic flavouring and preservative agents. However, their high volatility, low water solubility and susceptibility to oxidation limit their direct application in food systems. The present study investigated ultrasound-assisted extraction (UAE) followed by β-cyclodextrin-assisted freeze-drying encapsulation of rosemary, basil and parsley essential oils to improve their recovery, stability and functional properties. The herb samples were subjected to ultrasound treatment at different amplitudes and extraction times, followed by hydro-distillation. The optimum UAE condition was observed at 65% amplitude for 40 min, producing essential oil yields of 1.98, 2.06 and 2.08% for rosemary, basil and parsley, respectively. The extracted oils were subsequently encapsulated using β-cyclodextrin at a 1:10 core-to-wall ratio and freeze-dried at −80 °C for 48 h. Among the encapsulated powders, basil exhibited the highest process yield (81.2%), encapsulation efficiency (91.7%) and water solubility index (89.42%), whereas rosemary showed the highest antioxidant activity (88.42% DPPH Inhibition). The encapsulated powders exhibited low water activity (0.46–0.51), particle sizes of 338.6–371.8 nm and zeta potential values ranging from −30.9 to −34.5 mV, indicating favourable physicochemical stability. SEM analysis revealed irregular plate-like and flake-like particles with well-defined angular edges and an absence of surface oil droplets or extensive agglomeration, supporting effective entrapment of the essential oils within the β-cyclodextrin matrix. TEM further confirmed the particulate morphology and internal structural characteristics of the encapsulated systems. Overall, the integration of UAE with β-cyclodextrin freeze-drying effectively transformed volatile essential oils into stable, functional and water-dispersible powders, highlighting their potential as natural and clean-label ingredients for sustainable food processing and functional food applications.

**Keywords:** *Ultrasound-assisted extraction; essential oils; β-cyclodextrin; freeze drying; encapsulation; SEM; TEM.*

# Technological Development and Quality Evaluation of Quinoa Flour-Based Muffins

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ABSTRACT

Growing demand for clean-labelled, nutrient-dense, gluten-free bakery products, driven by diet consciousness, food intolerances, and celiac disease, necessitates reformulating traditional baked goods. This study developed quinoa-based muffins by partially replacing refined wheat flour with quinoa (Chenopodium quinoa Willd.) flour in the compositions of 0, 20, 40, 60, 80, and 100%, and evaluated their physical, nutritional, antioxidant, bioactive, and sensory attributes, comparing them with a 100% refined wheat flour control. Complete quinoa substitution significantly improved the nutritional profile with fat (20.49 to 23.10 g/100 g), ash (1.34 to 2.13g/100g), protein (6.08 to 8.47g/ 100g), and fibre (0.07 to 0.56g/100g), while carbohydrates decreased (39.40 to 34.47g/100g). 100 % Quinoa muffins showed increased weight (38.13 to 43.06g), reduced height (3.50 to 3.20 cm), reduced volume and specific volume, while the crumb texture was slightly harder with dark colouration. The study revealed enhanced bioactive profile, significantly greater DPPH radical-scavenging activity. Sensory evaluation indicated acceptable palatability, with panellists acknowledging health benefits despite minor compromise in texture and appearance. These findings support quinoa flour as a viable functional ingredient for developing clean-labelled, nutrient-rich bakery products aligned with contemporary health trends and the dietary needs of gluten-sensitive consumers

**Keywords:** Quinoa flour; Celiac disease; Bioactive profile; DPPH; Sensory evaluation

# Technology for Ozonation of Wheat Bran: Quality Characterization and Application in Bakery Products

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## Abstract

Wheat bran is a nutrient-rich by-product of wheat milling containing dietary fibre, arabinoxylans, phenolic compounds and essential micronutrients. However, its utilization in bakery products is limited due to its adverse effects on dough rheology and product quality. The present investigation was undertaken to develop a technology for ozonation of wheat bran and evaluate its influence on physicochemical, functional and rheological characteristics, followed by its application in bakery products. Wheat bran was subjected to ozone treatment at a constant ozone concentration with varying exposure times to obtain different ozone dosages. The treated samples were characterized for proximate composition, colour, water absorption capacity, water solubility index, oil absorption capacity, free sulfhydryl (-SH) content, arabinoxylan fractions and antioxidant properties to assess the structural modifications induced by ozone. Functional performance was further evaluated using Rapid Visco Analyzer (RVA) to determine pasting behaviour and dough rheological analysis to investigate the effect of ozonation on dough development and handling characteristics. The findings indicated that controlled ozonation modified the functional behaviour of wheat bran through oxidative changes, improving hydration characteristics and influencing pasting and rheological properties while maintaining its nutritional potential. Based on the quality evaluation, the optimized ozonated wheat bran is being incorporated into bakery products to assess its effect on product quality, texture, nutritional characteristics and sensory acceptability. The study demonstrates the potential of ozonation as an environmentally friendly, residue-free technology for value addition of wheat bran and its utilization as a functional ingredient in bakery applications, thereby contributing to sustainable cereal processing and waste valorization.

**Keywords:** Wheat bran, Ozonation, Functional properties, Rapid Visco Analyzer, Dough rheology, Bakery products.

# *Tragacanth Gum* as a Sustainable Plant-Based Biopolymer: Functional, Rheological, and Structural Insights for Food Processing

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## ABSTRACT

The present study evaluated the antioxidant activity, rheological, thermal, and structural characterization of Tragacanth gum. The gum exhibited appreciable antioxidant activity with 37.03% DPPH radical scavenging, 29.02 mg TE/g FRAP value, and 31.03% ABTS scavenging activity. Rheological evaluation revealed pseudoplastic (shear-thinning) behavior, indicating suitability for bakery applications. Differential scanning calorimetry (DSC) demonstrated good thermal stability with onset, peak, and end temperatures of 95 °C, 145.11 °C, and 182.13 °C, respectively, and an enthalpy change of 34.11 J/g. Fourier-Transform Infrared Spectroscopy characterization confirmed the presence of hydroxyl, carboxyl, and glycosidic functional groups typical of acidic heteropolysaccharides. Scanning Electron Microscope analysis revealed a rough, porous, and fractured surface morphology, while Energy-dispersive X-ray Spectroscopy analysis indicated the predominance of carbon and oxygen, with trace mineral elements. Sugar profiling identified galactose as the major monosaccharide, followed by arabinose and xylose, confirming the arabinogalactan-rich heteropolysaccharide nature of the gum. Proximate composition analysis revealed moisture (8.97%), crude protein (3.25%), crude fat (1.03%), ash (3.14%), crude fibre (23.40%), and carbohydrates (83.61%). Overall, the findings suggest that Tragacanth gum possesses desirable functional, antioxidant, rheological, thermal, and structural characteristics, making the gum a sustainable plant-based biopolymer suitable for food and pharmaceutical applications.

**Keywords:** *Tragacanth gum; Hydrocolloid; Antioxidant activity; Rheology, thermal stability; FTIR spectroscopy; SEM–EDX analysis*

# Ultrasonication-Assisted Mild Infrared Treatment for Retention of Functional Properties and Reduction of Enzymatic Activity in Maize Flour

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## Abstract

The present study investigated the ultrasonication-assisted infrared (US-IR) treatment as a mild processing approach for reducing enzymatic activity while retaining the functional properties of maize flour. Maize flour was subjected to three processing conditions: untreated flour maintained at room temperature as the control, infrared (IR) treatment at elevated temperature, and combined ultrasonication followed by infrared treatment under mild-temperature conditions. The samples were evaluated for peroxidase (POD) and lipoxygenase (LOX) activities, along with important functional properties including water absorption capacity, oil absorption capacity, swelling properties and dough-making characteristics. The untreated maize flour exhibited LOX activities of 1.10 in SMC-4 while POD activity was 0.89. Following treatment, LOX activity decreased to 0.029 U/g in SMC-4, corresponding to reduction of 97%. Similarly, POD activity decreased to 0.00142 U/mL, representing reduction of 99%. Importantly, the mild US-IR treatment retained the functional characteristics of maize flour, with water absorption capacity, oil absorption capacity, swelling properties and dough-making characteristics showing no significant change compared with the untreated control. In contrast, high-temperature IR treatment resulted in comparatively greater alterations in functional characteristics. Overall, ultrasonication-assisted infrared treatment under mild-temperature conditions proved to be an effective approach for reducing enzymatic activity while preserving the functional quality of maize flour. The treatment therefore offers a promising alternative to conventional high-temperature processing for developing stable maize flour with better retention of its functional attributes.

**Key-words**: Ultrasonication, Infrared treatment; Peroxidase activity; Lipoxygenase activity; Water Absorption Capacity; Oil Absorption Capacity; Swelling Properties.

# Ultrasound-assisted germination of moth beans (*vigna aconitifolia*): Effect on germination indices, functional and structural attributes

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## Abstract

This study investigated the effect of ultrasonication on germination efficiency and related biochemical changes in moth bean. The moth beans were subjected to ultrasonication at various temperatures (30, 40, and 50 °C) and time durations (30, 60, and 90 minutes) in a bath ultrasonicator followed by controlled germination in seed germinator. The thermo-sonication treatment significantly enhanced the germination dynamics, resulting in an 80.95% increase in germination percentage compared with untreated beans and a 2.23-fold increase in hypocotyl length. The ultrasonication resulted in notable enhancements in hydrational and interfacial properties, with a 28.60% increase in water solubility and a 34.38% rise in emulsion capacity at 50 °C for 90 minutes, compared to the untreated samples. The ultrasonication of moth bean accounted for a decrease in anti-nutrients, trypsin inhibitors and phytates by 56% and 41%, respectively. The thermo-sonicated moth beans showed enhancement in mineral composition, bioactive compounds, leading to improved antioxidant activity and nutritional quality of moth beans reflecting increase in lysine contents by 12.3% and leucine contents by 25.8%. The ultrasonication improved the *in-vitro* digestibility with protein digestibility increasing by 9.4% and starch digestibility by 10.98%. FTIR analysis indicated that ultrasonication induced conformational changes in moth bean proteins, although the overall composition remained largely unchanged. These findings indicate that thermo-sonication has significant potential to enhance germination, improve structural properties, and increase the bioavailability of nutrients, including amino acids and minerals.

**Keywords:** Ultrasonication; Germination; Moth bean; anti-nutrients, bioactive compounds

# Vacuum impregnation technology for fortification of food products

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## Abstract

Vacuum impregnation (VI) is an innovative technology for developing functional snacks from tubers by facilitating the incorporation of bioactive compounds, vitamins, and minerals while potentially reducing acrylamide formation and excessive oil absorption during processing. This paper examines the principles of VI, its applications in tuber-based snack production, and emerging opportunities for improving the nutritional quality and sustainability of these products. Unlike highly porous food matrices, tubers possess a relatively compact cellular structure that can restrict mass transfer during impregnation. Therefore, intensification techniques such as ultrasound and pulsed electric fields have been explored to enhance the efficiency of VI. Recent studies demonstrate the potential of VI for fortifying tuber-based snacks with minerals such as calcium, vitamins, and polyphenolic compounds while maintaining desirable structural and sensory properties. Furthermore, combining VI with advanced drying technologies can improve product quality by reducing oil uptake and limiting acrylamide formation during subsequent processing. Despite these promising developments, challenges remain in optimizing mass transfer, improving the stability and bioavailability of incorporated compounds, and achieving consistent quality during industrial-scale production. Future research should focus on process optimization, novel fortification strategies, and the integration of VI with sustainable processing technologies to develop healthier and value-added tuber-based snacks.

**Keywords:** Vacuum impregnation; Food fortification; Emerging food technology

# Valorization of Rainbow Trout (*Oncorhynchus mykiss*) Bone Waste through Solvent-Based Extraction: Physicochemical Characterization and Biomedical Potential

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## Abstract

The prepared rainbow trout (*Oncorhynchus mykiss*) bone powder was extracted using water- and sodium hydroxide (NaOH)-based methods and subsequently evaluated for its biochemical composition and physicochemical characteristics, including thermal stability, mineral composition, and microstructure. The NaOH-extracted bone powder showed higher mineral content, with 4.04% ash, 13.98% phosphorus, and 10.8 mg calcium, compared with the water-extracted bone powder. Compared to the water extracted bone powder, the NaOH-extracted bone powder exhibited a well-defined crystalline structure with consistent diffraction peaks predominantly corresponding to the hydroxyapatite phase. Scanning electron microscopy (SEM) revealed a porous and well-defined surface morphology, while differential scanning calorimetry (DSC) demonstrated a distinct endothermic transition associated with the mineralized bone matrix, indicating good thermal stability and structural integrity of the resulting bone powder. Overall, NaOH-based extraction effectively removed non-mineral components while preserving the crystalline and thermally stable apatite structure of the trout bone powder. The study highlights the potential of rainbow trout bone waste as a sustainable source of calcium phosphate and highlights its valorization into a value-added biomaterial for potential food, nutraceutical, and biomedical applications, while contributing to the sustainable utilization of fish-processing by-products and reduction of processing waste.

**Key-words:** hydroxyapatite; phosphorus; calcium; biomedical

# Variability in grain, flour, functional properties and protein profiling in newly developed wheat genotypes grown in temperate climate of North-Western Himalayas

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## Abstract

The present study investigated the grain and flour quality in newly developed various advanced wheat genotypes viz KWQ-21-1, KWQ-21-2, KWQ-21-3, KWQ-21-4, SKW 374, KWQ-21-6, KWQ-21-7, SKW 357 along with two released varieties (Shalimar Wheat 2 and Shalimar Wheat 3).The various physical parameters varied significantly($p \leq 0.05$) between wheat genotypes. Protein content varied significantly from 8.06 to 11.39%. All the studied genotypes/varieties showed significant variations ($p \leq 0.05$) with respect to proximate composition, gluten content, SDS sedimentation value, falling number and solvent capacities. The dry & wet gluten content varied from 8.78% to 13.2% and 23.27% to 33.87 %. Wheat genotypes exhibited moderate SDS-sedimentation value and solvent retention values indicating that the genotypes have moderate gluten strength and may be more suited for chapatti or biscuit making. A high degree of polymorphism in the intensity and number of bands in the molecular range of 30.7–48 kDa corresponding to low molecular weight glutenin subunit (LMW-GS) /α-, β-, and γ-gliadin region was observed in the wheat genotypes. High molecular weight (HMW) proteins varied from 76.5–111.5kDa. Correlation results showed that the flour characteristics were related with each other which can ultimately affect the end product utilization of these wheat genotypes

**Key-words**: Wheat genotypes**,** Solvent retention capacity, Falling number, SDS-PAGE.

# Comparative study on encapsulating potential of gum Arabic and maltodextrin as wall materials for microencapsulation of *Lacticaseibacillus rhamnosus*

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**Abstract**
Microencapsulation technology is a widely used method to preserve and protect the probiotic bacterial cells in food matrices, enhances their viability and prevents them from highly acidic conditions in gastrointestinal tract. In the current investigation, the potential of gum Arabic and maltodextrin as probiotic carriers for encapsulating *Lacticaseibacillus rhamnosus* by freeze drying was studied. The comparative suitability of these wall materials on the encapsulation efficiency, cell surface hydrophobicity, water activity, particle size, lysozyme tolerance and morphology of encapsulates was investigated. The results revealed that microparticles showed low water activity (0.30–0.35), high encapsulation efficiency (76.67 to 89.18 %) and particle size ranged between 101.57 and 116.62 µm. Scanning electron microscopy indicated a porous flaked morphology and irregular shape of probiotic powder. The peak shifts in absorption bands in the FT-IR spectra around 3400 cm− 1, 1620 cm− 1 and 1540 cm− 1 in probiotic loaded gum Arabic spectra and 3385 cm− 1, 1650 cm–1, 1542 cm− 1 in probiotic loaded maltodextrin spectra confirm the successful encapsulation of probiotics in respective wall materials. The encapsulated probiotic showed high lysozyme tolerance (37.73 to 82.61 %) and high cell surface hydrophobicity (48.10 to 68.84 %) as compared to free cells. Overall, gum Arabic microcapsules showed better encapsulation effiency and survivability, higher cell surface hydrophobicity and improved lysozyme tolerance as compared to maltodextrin microcapsules, making it an ideal wall material for developing probiotic incorporated functional foods. This study reveals that gum Arabic although, can act as suitable probiotic delivery system for improved health benefits, maltodextrin on the other hand should suitably be co-encapsulated with other wall materials to explore its maximum potential.

**Keywords:**
Encapsulation, Freeze drying; Gum Arabic; Maltodextrin; Probiotics,; Scanning electron microscopy

# Circular Economy Valorization of Early Drop Apples: Recovery of Biopolymers and Vinegar Production

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**Abstract**

This study presents a circular economy approach for valorizing prematurely dropped apples through the recovery of pectin, starch, and cellulose from solids and vinegar production from juice. Pectin yields of up to 30.54% (citric acid extraction) were achieved, characterized as low-methoxyl pectin suitable for biodegradable film formation. Films from citric acid-extracted pectin exhibited superior thermal stability and tensile strength, highlighting potential as eco-friendly packaging alternatives. Apple starch recovery ranged between 23–28% with 35–43% amylose, showing desirable thermal, pasting, and gel properties. Cellulose extracted from apple pomace demonstrated good solubility in alkali media, high water- and oil-holding capacities, and thermal stability (~210 °C), indicating potential as a functional biomaterial. Additionally, vinegar was produced using a two-stage fermentation process, achieving 9.7% alcohol in the first stage and 5.16% acidity after acetification, with stable quality during storage. Overall, the work underscores the sustainable utilization of immature apples by generating value-added biopolymers and fermented products, aligning with bioeconomy and waste valorization strategies.

***Key Words:*** *Cellulose; Fermentation; June drop; Pectin; Starch; Waste*

# Optimization of maltodextrin and gum arabic as wall materials for microencapsulation of pomegranate peel extract for Ice cream fortification

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## Abstract

The present study was conducted to develop a functional ice cream fortified with microencapsulated pomegranate peel powder extract (PPPE) using Maltodextrin (MD) and gum arabic (GA) as encapsulating wall materials. The objective was to enhance the antioxidant functionality and sensory quality of ice cream while maintaining its physicochemical and textural characteristics. Pomegranate peel, an underutilized agro-industrial by-product, is a rich source of phenolic compounds, flavonoids and tannins with well documented antioxidant and anti-inflammatory properties. However, the direct incorporation of these bioactive compounds into food systems is limited due to their poor stability during processing and storage and the presence of undesirable bitterness and astringency. To address these limitations, microencapsulation was employed using freeze drying technique to improve the stability and retention of bioactive compounds, enhance their incorporation into the ice cream, mask undesirable sensory attributes, and preserve product quality. MD+GA microencapsulated PPPE was incorporated into a standardized ice cream mix at 1% ($T_1$), 1.5% ($T_2$), and 2% ($T_3$), with unfortified ice cream serving as control ($T_0$). Fortification significantly ($p<0.05$) improved the functional properties of the ice cream, as evidenced by a progressive increase in total phenolic content and antioxidant activity from $T_1$ to $T_3$, with the lowest values observed in $T_0$. Sensory evaluation on a 9-point hedonic scale revealed highest overall acceptability of $T_3$ samples. Increasing levels of microencapsulated PPPE significantly decreased lightness (L*) while increasing redness (a*) and yellowness (b*). Texture profile analysis revealed that the fortification significantly reduced hardness, while as adhesiveness, springiness, and cohesiveness increased significantly with increase in the level of microcapsules ($T_3>T_2>T_1>T_0$). Although, overrun decreased with increase in the level of microencapsulated PPPE, $T_3$ exhibited improved melting resistance compared to other treatments and control. These results show that MD+GA microencapsulated PPPE can be successfully used to develop an antioxidant fortified ice cream with good physicochemical and sensory properties, offering significant potential for agro-waste valorization and development of functional dairy foods. **Keywords**: Antioxidant; Gum Arabic; Ice Cream; Microencapsulation; Maltodextrin.

# Effect of lemongrass essential oil nanoemulsion-loaded montmorillonite/starch nanocrystal bionanocomposite films on the quality of chicken meat patties.

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**Abstract**

The present study aims to determine the influence of montmorillonite (1.5% w/v MMT) and starch nanocrystals (1% w/v SNCs) based corn starch films loaded with lemongrass oil nanoemulsion (2% v/v LNE) on the quality characteristics of chicken patties stored at 4ºC for 15d. Results revealed that MMT and SNCs enhanced tensile properties while reducing WVTR. Nanocomposites were non-cytotoxic and provided superior shelf stability whereas control (non-packaged) demonstrated highest quality deterioration in patties. Amongst nanocomposites utilized, MMT/LNE films exhibited best preservative effects, owing to its better barrier properties than SNCs/LNE. On 15d, MMT/LNE films demonstrated highest retention of physicochemical properties and lowest increase in TBARS value (263.04%) and total volatile nitrogen (292.96%) with least microbial growth. MMT/LNE and SNC/LNE loaded nanocomposites increased the patties's shelf life up to 12d and 15d, respectively in comparison to control (6d), illustrating effectiveness of nanocomposites in extending shelf life of patties.

**Keywords:** Chicken patties; Bionanocomposites; Montmorillonite; Nanoemulsion; Lemongrass essential oil

# Designing Whey Protein Isolate–Pectin Nanoemulgels for Complete Fat Replacement in Muffins: Rheological, Structural and Quality Characteristics

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**Abstract**
Fat replacement in bakery products is increasingly explored to develop products with improved nutritional profiles while maintaining desirable attributes. In this study, the whey protein isolate (WPI)–pectin-based nanoemulgels is explored to be used as 100% fat substitutes in muffins was compared to butter and shortening. WPI: pectin ratios of E1 (10:1.5), E2 (10:2.0), and E3 (15:1.5) were used to manufacture nanoemulgels. The physical, textural, thermal, rheological, sensory, and fat content of the muffins were assessed. Muffin fat content decreased from 18.67±0.04% (butter) and 17.61±0.42% (shortening) to 1.07±0.05%, 0.91±0.12%, and 0.51±0.20% for E1, E2, and E3, respectively. Compared with traditional fat muffins, nanoemulgel-based muffins showed reduced density and baking loss, and a higher specific volume. E1 exhibited a specific volume of 1.71±0.01mL/g, density of 0.54± 0.02 g/mL, and baking loss of 7.55±0.79 %. Texture analysis demonstrated that nanoemulgel-based muffins had lower hardness than shortening-based muffins, with E1 exhibiting the lowest hardness (11889.41±6.22g) and highest springiness (0.557±0.02). The rheological analysis of muffin batter indicated predominantly elastic behavior, with the storage modulus exceeding the loss modulus. Among the nanoemulgels, E1 exhibited the highest viscoelastic modulus, suggesting a comparatively stronger network at the 10:1.5 WPI: Pectin ratio than in butter and shortening. Among all the formulations, E1 had the highest sensory scores. Overall, the results demonstrate that WPI–pectin nanoemulgels can successfully replace butter and shortening at 100% substitution without compromising muffin quality attributes. E1 emerged as the most suitable formulation and represents a promising clean-label, healthier fat alternative for bakery applications.

**Keywords:** Nanoemulgel, fat replacer, low- fat muffins, clean-label food, rheological properties

# Development and Characterization of Flatbread from Himalayan Millets of Ladakh: A Functional Food Approach Towards Diabetes Management

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**Abstract**

Ladakh's high-altitude region is rich in agro-biodiversity, notably with millets like foxtail *(Setaria italica)* and proso millet (*Panicum miliaceum*). Despite their nutritional value, these millets are often underutilized in functional foods. This study aimed to extract starch from these millets to develop a low-glycemic flatbread for diabetes management. Starch was extracted from millets using alkaline extraction method, with yielded 41-45%. The highest amylose content in foxtail millet (27%). FTIR analysis identified characteristic absorption bands, and SEM showed starch granules ranging from 2-15 µm in size. Starch fractionation indicated foxtail had 29% rapidly digestible starch (RDS), 18% slowly digestible starch (SDS), and 25% resistant starch (RS). Traditional flatbreads were analysed for nutritional content and antioxidant activity. Foxtail flatbread contained higher levels of protein (11.63%), fat (2.76%), ash (3.16%), and fiber (2.48%) compared to proso. The antioxidant potential was also greater in foxtail millet flatbread, with TPC of 73.82 ± 1.84 mg GAE/100 g, TFC of 29.34 ± 0.93 mg QE/100 g, and DPPH radical scavenging activity of 68.56 ± 1.31%, compared with 37.47 ± 1.29 mg GAE/100 g, 17.86 ± 0.72 mg QE/100 g, and 61.85 ± 1.16%, respectively, for proso millet flatbread. In vitro digestion studies showed foxtail had lower RDS (44.62%) but higher SDS (15.64%) and RS (18.20%) than proso. After allowing the flat bread to cool for 2-12 hours, the resistant starch (RS) content in foxtail increased from 16.02% to 20.02%, while in proso, it rose from 14.56% to 17.54%. Overall, these findings underscore the potential of Himalayan millets to create effective low-glycemic foods for diabetes management and promote sustainable healthcare. The study emphasizes the economic advantages of promoting indigenous (Ladakh) millet cultivation and its value addition. This aligns with the Viksit Jammu & Kashmir (Viksit JK) initiative, which seeks to strengthen local agriculture, improve farmer livelihoods, and enhance nutritional security by revitalizing traditional Himalayan crops.

**Keywords:** Diabetes; Flat-bread; Foxtail; Ladakh; Millet; Starch

# Self-Sacrificial NBU-1 Metal-Organic Framework Derived Amorphous $NiP_{1.42}O_x$/C/C-N Electrocatalyst for Oxygen Evolution Reaction

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## Abstract

MOF-derived metal phosphates (MPO) are emerging as promising oxygen evolution reaction electrocatalysts (OER); however, the practical deployment of MOF-derived MPO remains severely constrained by challenges such as limited air stability of parent MOFs, complex multi-step synthesis routes, poor scalability under industrially relevant conditions and dependence on external phosphate, nitrogen, and carbon sources during electrocatalyst derivation. Herein, we report a scalable strategy for constructing a defect-rich amorphous nickel phosphate/carbon electrocatalyst, $NiP_{1.42}O_x$/C/C-N (denoted as **NBU-1$_{500}$**), through direct calcination of an air-stable Ni–MOF precursor (**NBU-1**). The parent **NBU-1** MOF, synthesized from diphenylphosphinic acid and 4,4′-bipyridine ligands, exhibits excellent air stability, and gram-scale synthetic scalability. Importantly, one-step calcination under an $O_2$ atmosphere directly converts **NBU-1** into **NBU-1$_{500}$** without requiring any external phosphate, carbon, or nitrogen precursors, as the intrinsic ligand functionalities simultaneously serve as self-sacrificial sources. Comprehensive structural and spectroscopic analyses reveal that **NBU-1$_{500}$** consists of a phosphorus-enriched amorphous Ni–O–P framework intimately integrated within a conductive defect-rich graphitic carbon matrix containing trace graphitic nitrogen species. Benefiting from this unique architecture, **NBU-1$_{500}$** exhibits excellent OER activity in 1 M KOH, requiring only 261 mV overpotential to achieve 10 mA/cm$^2$ with a low Tafel slope of 57.8 mV/dec and good long-term operational stability, outperforming commercial $Ni_3(PO_4)_2$ and $RuO_2$ under identical conditions. Post-OER analyses reveal partial surface reconstruction into a phosphate-modulated NiOOH-rich active phase while preserving the integrity of the nickel framework. Mechanistically, the superior OER performance arises from the synergistic interplay between high-valent Ni species, defect-rich amorphous domains, and the conductive carbon matrix, which collectively enhance intermediate adsorption and charge-transfer kinetics. In summary, this work presents the transformation of air-stable MOF precursor into a $NiP_{1.42}O_x$/C/C-N electrocatalyst without external phosphorus or heteroatom sources, offering a practical and sustainable strategy for designing scalable non-noble-metal OER electrocatalysts.

**Keywords:** Calcination; electrocatalysis; metal-organic framework; nickel phosphate; oxygen evolution reaction.

# Spatial Variability and Geostatistical Mapping of Soil Organic Carbon in a Himalayan Agro-Ecosystem: Case Study from Budgam District, Kashmir.

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## Abstract

Spatial variability and geostatistical mapping of soil organic carbon (SOC) were assessed across Budgam district, Kashmir (1,371 km²), using 76 stratified surface soil samples (0–15 cm) analysed by the Walkley–Black method. SOC ranged from 0.26% to 2.57% (mean 0.97 ± 0.47%; CV = 48.6%), with 59.2% of soils in the Very Low to Low fertility classes, confirming widespread organic carbon depletion under intensive cultivation. A north–south SOC gradient was identified (Central: 1.15% > Northern: 1.02% > Southern: 0.81%), and land-use analysis revealed maize cropland as the most depleted system (0.88%) and pastureland as the most carbon-rich (2.57%; n = 1, interpretable as an ecologically indicative benchmark rather than a statistically representative mean). The Spherical semi-variogram model (nugget = 0.02, sill = 0.13, range = 85 m substantially smaller than the mean inter-sample spacing of ~4.2 km, indicating SOC spatial structure operating at sub-100 m scales; nugget/sill = 0.18) provided the best fit to the experimental SOC semi-variogram, with strong

spatial dependence confirmed across all four evaluated models (nugget/sill: 0.09–0.21). Independent validation (n = 20) showed IDW outperforming Ordinary Kriging (RMSE: 0.24% vs 0.29%; MAE: 0.19% vs 0.24%; $R^2$ = 0.41 vs 0.28), attributable to the range–spacing mismatch and uneven spatial distribution of sampling points. These results establish the first quantitative SOC baseline for Budgam district and identify 59.2% of agricultural land as a priority zone for targeted organic matter restoration.

**Keywords:** soil organic carbon; spatial variability; Inverse Distance Weighting; Ordinary Kriging; Budgam district

# Lake–Ecosystem Dynamics in the Kashmir Himalaya: A Multiproxy Paleoecological Perspective.

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**Abstract**

High-altitude Himalayan lakes are highly sensitive to climatic and hydrological variability, yet multiproxy paleoecological records from the Kashmir Himalaya remain limited. This study reconstructs recent lake–catchment ecosystem dynamics from Marsar Lake, a glacial alpine lake situated at approximately 3,800 m a.s.l., using an integrated pollen, phytolith, and diatom approach. A 24-cm sediment core was subsampled at contiguous 1-cm intervals to examine changes in regional vegetation, local catchment conditions, and aquatic ecology. The age model suggests that the sequence spans approximately the last four centuries. Pollen assemblages reveal repeated alternations between conifer-dominated vegetation and more open *Artemisia*–Poaceae communities. Phytolith assemblages support these changes, with woody morphotypes dominating the lower and upper parts of the core and grass–sedge morphotypes reaching their highest abundance in the middle interval. Diatom communities show marked shifts between planktonic and benthic/littoral taxa, indicating fluctuations in lake depth, water-column stability, catchment input, and habitat availability. The middle section records the strongest landscape opening and greatest limnological variability, broadly corresponding in the provisional chronology to the Little Ice Age, when cooler conditions and variable hydroclimate likely altered vegetation structure, snowmelt supply, and lake processes. The upper section shows renewed conifer influence alongside continued aquatic variability, suggesting post-Little Ice Age terrestrial recovery without a simple monotonic limnological response. Overall, coherence among the three independent biological proxies demonstrates strong coupling between terrestrial vegetation, catchment processes, and lake dynamics, and highlights the sensitivity of high-altitude Kashmir ecosystems to centennial-scale variability in Westerly Disturbances, monsoon influence, and cryospheric hydrology.

**Keywords:** Paleoecology; multiproxy analysis; lacustrine sediments; Kashmir Himalaya; hydroclimatic variability

# Psychrotolerant Extremophiles: A Novel Bioinoculant Strategy for Cold Stress Tolerance in Exotic Vegetable Crops.

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## ABSTRACT

Despite the fact of global warming, cold stress remains a major constraint to seed germination, seedling vigour, and successful stand establishment of high-value vegetable crops in temperate and high-altitude agro-ecologies, particularly in the Kashmir Himalayas. There is a significant gap in bioinoculant technology for cold-climate agriculture since conventional plant growth-promoting rhizobacteria, which are primarily mesophilic in origin, lose effectiveness below 15 °C. A relatively unexplored reservoir of cold-active plant growth-promoting (PGP) characteristics that potentially close this gap is provided by psychrotolerant extremophiles that are endemic to sub-zero and near-freezing habitats. The current study aims to: (i) isolate and screen psychrotolerant extremophiles from high-altitude cold soils and winter-cropped fields; (ii) characterize promising isolates morphologically, biochemically, and molecularly for PGP attributes; (iii) develop a commercial-grade microbial inoculum formulation validated by Koch's postulate; and (iv) assess the bioinoculant's effectiveness on seed germination, vigor, viability, and seedling establishment of vegetable crops under both natural and simulated cold stress. The most effective isolates, both individually and in a tripartite consortium are combined to create a bioinoculant based on liquid carriers for standardized to around $10^8$ CFU/mL, and delivered through seed priming. Germination percentage, root/shoot length, vigor index (accelerated aging test), and viability index (TZ test) in a completely randomized design (five treatments, three replications) under both controlled cold-chamber (summer) and natural winter conditions are being carried out. The work aimed to build a defined culture collection of cold-active PGP extremophiles, increase seed germination, vigor, and viability under cold stress in a statistically validated manner, and provide mechanistic insight into the alleviation of cold stress mediated by microbes.

**Keywords:** Psychrotolerant extremophiles; Cold stress; Plant growth-promoting bacteria;Bioinoculants; Seed priming.

# Green Finance and Sustainable Development: The Role of Development, Governance, and Technological Innovation.

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## Abstract

This study examines the multidimensional impact of green finance on environmental performance (CO2 emissions), energy transition (Renewable Energy Generation), & socio-economic welfare (Human Development Index) across a panel of 30 countries, 21 developed and 9 emerging. The Driscoll-Kraay Fixed Effects estimation is applied to account for cross-sectional dependence, heteroscedasticity, and serial correlation, and to identify long-run equilibrium relationships. Meanwhile, the Two-Step Difference GMM estimator is utilised as a robustness check to capture short-term implementation lags and dynamic persistence while controlling for endogeneity. The findings reveal a distinct temporal divergence consistent with the *implementation lag* hypothesis. In the short run, green finance exhibits limited immediate efficacy, with significant carbon-mitigating effects observed primarily in developed economies that possess established structural readiness. Conversely, long-term structural analysis indicates that green finance is a robust driver of sustainable development, significantly promoting the expansion of renewable energy and the accumulation of human capital. The study's inferences identify institutional governance as the primary moderator for reducing carbon intensity & enhancing social welfare. In contrast, technological innovation serves as the essential catalyst for amplifying renewable energy generation.

**Keywords:** Green Bonds, Social Bonds, Sustainability Bonds, Sustainable Development, Sustainable Development Goals, Carbon Dioxide Emissions, Renewable Energy.

# Climate Risk Resilience: An Ai-Enabled Digital Twin for disaster mitigation and reduced distress migration in Jammu and Kashmir.

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## Abstract

Climate-related migration is rarely caused by a single hazard; it emerges when floods, droughts, landslides, heat, water stress and ecosystem degradation interact with fragile livelihoods, infrastructure and unequal adaptive capacity. This conceptual study proposes a people-centred Regional Climate and Disaster Digital Twin for Jammu and Kashmir to anticipate such compound risks and guide interventions that reduce forced displacement while preserving voluntary mobility choices. The proposed system links satellite observations, weather and hydrological forecasts, terrain and land-use data, infrastructure networks, agricultural indicators, anonymised socioeconomic vulnerability measures and community reports within a continuously updated spatial model. Artificial intelligence supports hazard detection, short-term impact forecasting, livelihood-risk classification and identification of settlements approaching critical thresholds. A scenario engine tests mitigation options before implementation, including drainage and slope stabilisation, water harvesting, climate-resilient cropping, ecosystem restoration, evacuation access, resilient public services, livelihood diversification and targeted social protection. Outputs are translated into explainable village-level risk alerts and ranked intervention portfolios for communities and authorities rather than automated relocation decisions. The framework explicitly separates hazard probability, exposure, vulnerability and coping capacity, records model uncertainty, protects personal data and incorporates local knowledge and human oversight. Its effectiveness would be evaluated through historical disaster replay, prospective district pilots and indicators covering warning lead time, avoided losses, service continuity, livelihood recovery and reduced distress-migration pressure. By joining early warning with long-term adaptation and livelihood planning, the proposed digital twin offers a testable governance architecture for shifting from post-disaster relief to anticipatory resilience. It does not claim that technology can eliminate migration; instead, it aims to expand the capacity of vulnerable households to remain safely, recover locally or move by informed choice.

**Keywords:** Climate migration; Digital twin; Artificial intelligence; Disaster risk reduction; Livelihood resilience

# Mitigating Thermal Bridging in Cold Himalayan Climates: A Simulation Based Investigation of Internal Window Insulation Using COMSOL Multiphysics.

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## Abstract

Windows are among the primary sources of heat loss in residential buildings located in cold climates because of their lower thermal resistance compared with insulated wall assemblies. In the Kashmir Valley, prolonged sub-zero winter temperatures make window thermal bridging a major contributor to indoor heat loss and increased heating demand. This study investigates the effectiveness of internal window insulation as a practical retrofit strategy using a three-dimensional transient heat-transfer model developed in COMSOL Multiphysics. Simulations were performed under both passive and active heating conditions using a uniform volumetric heat generation rate of 25 W/m³. Thermal performance was assessed through cut-line temperature profiles and window heat-loss analysis. Under passive conditions, the minimum temperature decreased from 11.0°C in the windowless room to 3.4°C with the uninsulated window, while internal insulation increased it to 6.5°C. The insulation also reduced average window heat loss by 19.8% under passive conditions and 33.1% under active heating. The model was validated against experimental data. The numerical and experimental results were found to be in agreement. The experimental results indicated that the designed insulation sheet achieved a R-value of 0.6 $m^2K/W$ compared to uPVC windows which offer an R-value of 0.625 $m^2K/W$ at a per square feet cost of 500 to 1200 INR which is significantly higher than the cost of insulation developed in the present study. Therefore, the addition of a simple insulation to the windows offers a competitive alternative to expensive insulation options available commercially.

**Keywords**: insulation; building energy; thermal bridging; numerical modelling

# Designing Climate-Smart Wheat for the Kashmir Himalaya: A Multi-Trait Strategy Integrating Disease Resistance, Cold, Pre-harvest sprouting, Drought Tolerance and Next-Generation Seed Priming Technologies.

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## Abstract

Wheat cultivation in the Kashmir Valley is increasingly threatened by climate-driven stresses, including emerging fungal diseases, drought, cold stress and erratic weather patterns, which collectively jeopardize yield stability and regional food security. To enhance climate resilience, we adopted an integrated strategy combining genetic, physiological and seed-based interventions to address multiple stress constraints. Wheat genotypes were evaluated for resistance to the major foliar diseases, stripe rust and foliar blight, leading to the identification of lines with durable multiple disease resistance. Simultaneously, plant height, phenology, spike and related agronomic traits viz., pre-harvest sprouting tolerance (PHST) were assessed to identify ideotypes capable of maintaining productivity under fluctuating environments. Cold tolerance was incorporated as a major selection criterion to identify genotypes with superior survival, physiological stability and sustained growth under frost and chilling stress. Root architecture was characterized to identify traits associated with efficient water acquisition and drought adaptation, including root length, density, distribution and branching, enabling the selection of genotypes with improved performance under moisture-deficit conditions. Conventional seed priming was evaluated as a practical and economical approach to enhance seedling establishment, improve stress recovery and reduce stripe rust severity. In addition, plasma priming and nano-priming were investigated as novel seed enhancement technologies to improve germination, seedling vigour, physiological resilience and tolerance to drought and low-temperature stress. Together, these complementary approaches provide an integrated framework for developing climate-smart wheat cultivars and management strategies capable of sustaining productivity, resilience and farmer livelihoods in the Kashmir Valley and other temperate wheat-growing regions. Integration of modern genomics-assisted breeding and genomic selection are being explored to further accelerate the discovery, validation and deployment of climate-resilient wheat genotypes with durable multi-stress tolerance.

**Keywords:** Wheat; multiple disease resistance; root architecture; seed priming; PHST

# Optimal Utilization of Distributed Generation Sources in Distribution Networks.

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## Abstract

The growing demand for electricity and increasing integration of renewable energy technologies have emphasized the importance of flexible and resilient power distribution networks capable of accommodating distributed generation (DG) resources. DGs can improve voltage profile and reduce energy losses by delivering electricity at load centers. These benefits depend on the optimal placement and sizing of DGs, since improper allocation may increase losses, cause voltage deviations, and reverse power flow. In order to maximize the benefits of DGs, this study focuses on the optimal use and allocation of DGs within power distribution networks (DNs) for improving the voltage profile to ensure all bus voltages stay within the safe operating limits and reduce the losses in active and reactive power within the distribution network. The performance of the proposed technique (…) is analyzed before and after the addition of DGs particularly focusing on wind and solar energy systems. The suggested method is first tested on the IEEE 7-bus system and then on the IEEE 33-bus system to check how well it works and to confirm its effectiveness. The proposed technique reduced the power losses from the base-case values of … kW to … kW for the IEEE 7-bus system and from … kW to … kW for the IEEE 33-bus system. It also improved the minimum voltage profile from the base-case values of … p.u. and … p.u. to … p.u. and … p.u. for the IEEE 7-bus and IEEE 33-bus systems, respectively. The findings show that the suggested method works well in lowering power losses, improving voltage levels, and boosting the overall performance of distribution systems by placing distributed generators in the best spots.

**Keywords:** Distribution Generation; DG sizing; Distribution System; IEEE 7-Bus System; IEEE 33-Bus System; Power Distribution Networks; Solar Energy

# On the similarity of conventional and cleaner equity and the role of gold as a diversifier: empirical evidence from India.

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## Abstract

This study examines return connectedness (similarity) among India's conventional and cleaner sectoral indices and the role of gold as a diversification tool over time and across investment horizons. Using a time and frequency-domain spillover framework, we find strong overall connections among conventional and cleaner sectors, with carbonex and greenex as the dominant transmitters and receivers of shocks. Gold, followed by health, information technology, and consumer durables, remain comparatively insulated. Connections are concentrated at shorter investment horizons, indicating that spillovers are transmitted rapidly rather than persisting over the long run, implying greater diversification benefits for longer-horizon investors. Spillovers are also asymmetric: connectedness intensifies during market downturns, limiting the ability of cleaner assets to hedge sector-specific risk in falling markets. Time-varying analysis shows spillover intensity rising sharply around major policy and economic shocks, especially during the shift to flexible inflation targeting, demonetization, GST implementation, and the two COVID-19 waves. Finally, the optimal portfolio weights and hedging effectiveness further confirm that blending conventional and cleaner sectoral stocks with gold reduces risk, though this effectiveness weakens notably during COVID-19. Together, the findings offer practical guidance for portfolio managers seeking to rebalance across conventional and cleaner assets in stress periods, and for policymakers designing climate and financial-stability measures that account for spillovers from cleaner to conventional sectors.

**Key Words:** Asymmetric and Frequency Connectedness; COVID-19; Cleaner Investments; Sectoral Connectedness.

**JEL Classification:** G11, G18, Q56, Q2, Q42

# Climate Change and Plant Diseases: Emerging Challenges and Sustainable Management Strategies.

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## Abstract

Climate change is increasingly influencing the occurrence, distribution, severity, and epidemiology of plant diseases, posing serious challenges to crop productivity, food security, and sustainable agriculture. Rising temperatures, altered rainfall patterns, changing humidity, elevated atmospheric carbon dioxide, and frequent extreme weather events can modify pathogen survival, reproduction, virulence, host susceptibility, and vector activity. Consequently, fungal, bacterial, viral, and nematode diseases may expand into new geographical regions, exhibit altered seasonal patterns, and develop greater epidemic potential. Such changes can reduce the effectiveness and predictability of conventional disease-management practices. Sustainable management under changing climatic conditions requires an integrated and climate-smart approach involving disease-resistant cultivars, crop diversification, balanced cultural practices, biological control, judicious pesticide application, disease forecasting, and early-warning systems. Emerging technologies, including remote sensing, molecular diagnostics, precision agriculture, and artificial intelligence, offer promising opportunities for rapid disease detection, risk assessment, and targeted management. A better understanding of climate–plant–pathogen interactions, combined with innovative technologies and sustainable disease-management strategies, is essential for minimizing crop losses, maintaining plant health, and enhancing the resilience of agricultural systems to future climate change.

**Keywords:** Climate change; Plant diseases; Disease epidemiology; Disease forecasting; Sustainable crop protection

# Performance Analysis of a Reduced-Switch Three-Level T-Type Inverter for Solar PV Integration.

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## Abstract

The increasing penetration of solar photovoltaic (PV) systems and the growing demand for efficient high-power power conversion have created a need for multilevel inverter topologies that offer improved voltage quality, reduced switching losses, and lower component count. This paper presents the performance evaluation of a reduced-switch three-level T-type multilevel inverter for solar PV integration in high-power applications. The proposed topology employs a split DC-link configuration and an auxiliary T-type switching network to generate three output voltage levels, namely Vdc/2, 0, and -Vdc/2, while reducing the number of switching devices compared with conventional three-level inverter structures. Sinusoidal pulse width modulation (SPWM) is employed to control the inverter and obtain balanced three-phase output voltages with improved waveform quality. The proposed converter is modelled and analyzed in MATLAB/Simulink under three-phase load conditions, with particular emphasis on output voltage, load current, total harmonic distortion, and overall conversion performance. Furthermore, a laboratory prototype is developed using IGBT-based switching devices, split DC-link capacitors, gate-driver circuits, and a digital signal processor (DSP) for experimental validation. The experimental results demonstrate successful generation of the required three-level voltage waveform and show good agreement with the simulation results. The reduced switching-device count, improved output-voltage quality, and practical implementation capability demonstrate the potential of the proposed inverter for high-power solar PV integration and other renewable-energy conversion applications.

**Keywords:** Sinusoidal pulse width modulation (SPWM); Solar Photovoltaic (PV); Multi Level Inverter (MLI);Reduced Switch Count(RSC); THD(Total Harmonic Distortion).

# Geospatial Prioritization of Nature-based Solutions for Climate-Resilient Urban Planning in Srinagar City.

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## Abstract

Rapid urbanization and land-use transformation have intensified ecological degradation and climate-related vulnerability in Srinagar City. This study develops a GeoAI-enabled framework integrating Google Earth Engine (GEE), Random Forest (RF), remote sensing, GIS, Multi-Criteria Decision Analysis (MCDA), and the Analytic Hierarchy Process (AHP) to spatially prioritize Nature-based Solutions (NbS). Multi-temporal Land Use/Land Cover (LULC) maps for 1995–2025 were generated using RF classification in GEE. Seven indicators LULC transition severity, carbon stock loss, built-up expansion, vegetation degradation, land surface temperature, urban heat island intensity, and wetland proximity were standardized and integrated through an AHP-weighted overlay. The pairwise comparison matrix produced a Consistency Ratio (CR) of 0.04, indicating satisfactory consistency. The resulting priority map classified Srinagar into four categories: Very Low, Low, Moderate, and High. Very Low and Low-priority areas covered 0.29% and 49.86% of the study area, followed by Moderate (25.67%), High (24.18%). Thus, nearly 50% of the study area falls within Moderate- to High-priority zones. High-priority zones were characterised by intensive land-use transitions, carbon stock loss, built-up expansion, and elevated thermal stress, indicating areas requiring targeted NbS interventions. The proposed framework demonstrates the potential of integrating GeoAI with Multi criteria analysis to support evidence-based NbS planning and climate-resilient urban development in rapidly urbanizing Himalayan cities.

**Keywords:** AHP; GeoAI; Nature-based Solutions; Remote Sensing; Urban Climate Resilience

# Heterogeneity in The Glacier Surface ice Velocity Under Changing Climate In the Kokcha Sub Basin of Afghanistan.

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## Abstract

Mountain glaciers are critical components of the Earth system and important freshwater resources, while their changes serve as indicators of climate variability and change. This study investigates glacier recession and dynamics in the Kokcha sub-basin of the Hindu Kush Himalaya, Afghanistan, using Landsat satellite data from 1990 to 2023. A total of 243 glaciers were identified and mapped through visual interpretation at a scale of 1:25,000. The total glacierized area declined from 553.54 km² in 1990 to 528.66 km² in 2000, 517.65 km² in 2010, and 482.58 km² in 2023, representing an overall loss of 71.04 km² (15.43%). Surface ice velocity (SIV) was estimated using the COSI-Corr technique for 1999/2000, 2000/2001, 2010/2011, and 2022/2023. The results reveal an approximately 60% reduction in glacier velocity over the study period. Glacier recession and velocity were strongly influenced by debris cover and glacier size. Debris-free glaciers experienced greater area loss (19.6%) than debris-covered glaciers (13.3%). Similarly, small glaciers (<2 km²) receded more rapidly (17.98%) than large glaciers (>5 km²), which experienced a comparatively lower loss of 7.54%. The observed decline in glacier area and ice velocity, together with projected changes in climate under CMIP6 scenarios, highlights potential long-term implications for glacier dynamics and water security in the Kokcha sub-basin. Continued glacier retreat could negatively affect seasonal streamflow, hydropower generation, agriculture, and other water-dependent sectors. Overall, the findings highlight the combined influence of topography, glacier morphology, debris cover, glacier size on glacier behavior in the Kokcha sub-basin. The study provides important evidence for understanding regional cryospheric changes and highlights potential long-term challenges to water availability and water security in Afghanistan.

**Keywords**:- Satellite data, COSI-Corr, Kokcha, Climate Change, and Hindu-Kush Himalayas.

# Carbon Footprint Assessment and Decarbonization Pathways for Apple Freight Transport.

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## Abstract

In the mountainous region of Jammu and Kashmir, freight transport plays a critical role in horticulture, tourism, and essential commodity supply chains, yet its associated carbon emissions remain poorly quantified. This study using an emission estimation approach adapted from The Energy And Resource Institute-Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (TERI–GIZ) freight emission assessment framework and IPCC default emission factors estimated carbon dioxide ($CO_2$) emissions generated from freight movement along major transport corridor from Shopian to Qazighund corridor (NH-444), a key mountain transport route linking the apple-producing districts of South Kashmir with the other parts of India. The preliminary greenhouse gas (GHG) emissions from apple freight transport were estimated for Shopian fruit mandi during the peak harvesting season, assuming 500 diesel-powered heavy-duty trucks (16–25 tonnes) operate daily. Each truck was assumed to travel a 100 km round trip (Shopian–Qazigund–Shopian) with an average fuel efficiency of 3 km/L. Based on a total daily travel distance of 50,000 vehicle kilometres, diesel consumption was estimated at 16,667 L/day. Using the IPCC default emission factor of 2.68 kg $CO_2$/L of diesel, the estimated emissions were 44.7 tonnes $CO_2$/day, 1,340 tonnes $CO_2$/month, and approximately 5,360 tonnes $CO_2$ during the four-month peak season. These emissions are expressed as $CO_2$-equivalent ($CO_2$), with $CO_2$ representing the major share of total GHG emissions. For the same transport distance and the same quantity of apples, the estimated $CO_2$ emissions using train transport is 3.168tonnes $CO_2$/day, 95.04 tonnes $CO_2$/month, and approximately 380.16 tonnes $CO_2$ during the four month peak season. This reveals an approximate 92% reduction in $CO_2$ emissions compared with the existing diesel truck-based transport system. Beside the apple industry suffers huge economic loses due the heavy traffic loads and frequent landslide problems that adversely affect the economy of this region. This is the first study in this region that has calculated the total co2 emission, provided improved vehicle efficiency options to reduce the carbon dioxide as well as increasing the major economy in the region.

**Keywords:** Freight Transportation; IPCC;The Energy and Resource Institute-Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (TERI–GIZ);NH-444;Carbon Emission;Kashmir Valley.

# Performance Enhancement of a Parabolic Trough Solar Collector Using Hybrid Nanofluids.

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## Abstract

Efficient heat-transfer fluids are essential for improving the performance of solar thermal energy systems. This study experimentally investigates advanced nanofluids and their application in a scaled-down parabolic trough solar collector (PTC). Therm S5 was used as the base fluid, with $Al_2O_3$, $Al_2O_3$/CuO and $Al_2O_3/TiO_2$ nanofluids prepared at 0.1–0.3 wt% concentrations. Photothermal experiments showed temperature rises of 70.5–72.5 °C, 71.5–73.5 °C and 75.0–76.5 °C for $Al_2O_3$, $Al_2O_3$/CuO and $Al_2O_3/TiO_2$ nanofluids, respectively, compared with approximately 68.0 °C for the base fluid. The corresponding photothermal enhancements were 3.7–6.6%, 5.1–8.1% and 10.3–12.5%, with $Al_2O_3/TiO_2$ showing the highest performance.

Selected nanofluids were subsequently tested in a laboratory-scale PTC under identical irradiance and flow-rate conditions. The hybrid nanofluid achieved a temperature rise of 2.5 °C, compared with 1.8 °C for the base fluid, representing a 38.9% higher temperature rise. The results demonstrate that $Al_2O_3/TiO_2$ hybrid nanofluids can enhance photothermal response and heat-transfer performance, resulting in a higher temperature rise under parabolic trough collector conditions and indicating their potential as advanced heat-transfer media for efficient solar-thermal energy conversion.

**Keywords:** Hybrid Nanofluids; Parabolic Trough Collector; Photothermal Performance; Renewable Energy; Solar Thermal Energy

# Himalayan Ecosystem Resilience Sustainable Energy and Climate Action.

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## Abstract

The Himalayan region, host to the world's largest cryosphere reserves outside the polar regions, is an ecologically vulnerable ecosystem increasingly threatened by climate-driven disasters such as cloudbursts, glacial lake outburst floods (GLOFs), and flash floods. Unchecked infrastructure development—including large dams, extensive road networks, and unregulated tourism—alongside precarious land-use practices and heavy reliance on traditional biomass and fossil fuels, severely exacerbates terrain instability and microclimatic disruptions. In 2025 alone, climate emergencies claimed over 4,000 lives in India, primarily concentrated within the vulnerable Himalayan belt.

This study examines pathways to mitigate these regional climate risks by integrating sustainable energy solutions, enforcing strict land-use governance, and advancing targeted climate action aligned with UN SDG 13 guidelines. Utilizing ArcGIS and Google Earth satellite imagery, primary spatial analysis evaluates terrain stability and local renewable energy potential. This primary data is synthesized with secondary datasets from NITI Aayog, the World Bank, IRENA, and ICIMOD regarding energy consumption, carbon emissions, and microgrid feasibility.

Results demonstrate that transitioning from biomass and fossil fuel dependence to decentralized micro-solar grids, off-grid solar-battery systems, and eco-friendly run-of-the-river micro-hydro projects offers a viable, low-impact alternative. Coupled with vigilant land-use oversight, adopting these localized sustainable energy models minimizes ecological destruction, enhances regional climate resilience, and safeguards vital freshwater ecosystems crucial for both local mountain communities and millions living in downstream plains.

**Keywords:** Himalayan Ecosystem; Flash Floods; Climate change ; Sustainable energy and development, ; Unchecked Construction.

# A BlockChain-Based Framework for Multi-Source Data Trust and Verification in Space Debris Tracking

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Space debris tracking is becoming a critical challenge as the number of satellites and orbital fragments continues to grow rapidly. With over 40,000 tracked debris objects and more than 5,000 active satellites travelling at speeds up to 28,000 km/h, even a single collision can trigger a cascading chain reaction known as the Kessler Syndrome. Existing debris-tracking systems rely on centralized, agency-controlled databases, which create single points of failure, limit real-time data sharing between organizations, and struggle to keep up with the pace of new satellite deployments. This paper proposes a blockchain-based framework for space debris tracking, where multiple independent sources — including ground stations, satellites, and optical sensors — jointly validate and record debris observations on a shared, tamper-resistant ledger. Rather than depending on any single authority's catalog, the system emphasizes cross-source verification to detect inconsistent, delayed, or potentially falsified debris reports before they are trusted for collision-avoidance decisions. The study addresses key constraints of the space environment, such as intermittent connectivity between satellites, limited onboard processing power, and the need for low-latency validation. By shifting the focus from network architecture alone to data trust and verification across agencies, this work aims to lay the groundwork for a more reliable, transparent, and collaborative approach to space debris monitoring.

**Keywords:** Blockchain; Collision Avoidance; Cross-Agency Data Sharing; Data Provenance; Space Debris Tracking

# A Blockchain-Based Safety and Management System for Smart Tourism

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The growing digitalization of tourism has increased the need for trusted, transparent, and secure mechanisms for information sharing, service verification, and tourist safety. Conventional centralized platforms rely heavily on intermediaries and centralized records, creating challenges related to trust, data integrity, and verification across multiple stakeholders. Blockchain offers a decentralized approach by providing tamper-resistant records, transparent transactions, and smart-contract-based verification, enabling more trustworthy tourism services.

In this work, a blockchain-based tourism safety framework has been developed to integrate tourist trip registration, tour-guide verification, location-specific safety guidelines, weather and safety alerts, and emergency SOS functionality within a unified digital platform. The framework uses smart contracts to support verifiable tourism-related interactions and records, with a decentralized application implemented using Ethereum, Solidity, Hardhat, and Web3.js. Jammu and Kashmir is considered as a case study due to its geographically diverse tourism environment and associated challenges, including unreliable information, unverified guides, and location-dependent safety risks. The developed framework establishes a trusted digital layer for connecting tourists with verified services while maintaining transparent and tamper-resistant tourism records. The work demonstrates the potential of blockchain-based decentralization for building secure, verifiable, and resilient smart-tourism infrastructure in Jammu and Kashmir.

**Keywords:** Blockchain; Decentralization; Guide Verification; Smart Tourism; Tourist Safety

# A Comparative Analysis of Vision and Swin Transformer for Image-Level DeepFake Detection

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DeepFake (DF) media generated using generative artificial intelligence (AI) and deep learning (DL) techniques are rapidly proliferating at scale and represent a major threat to digital trust, information reliability, and privacy. The synthetic transformations are improving photorealism and making them increasingly difficult to recognize due to their resemblance to real data. This widespread distribution leads to inaccuracies and undermines public trust in online media. In conventional DF detection methods, convolutional neural network (CNN) architectures are utilized, prioritizing local and texture-specific attributes. As generating techniques evolve, the reliability of detection suffers from an inadequate understanding of the extensive, holistic deviations existing in high-quality DFs. The aim of the frame-level detection methodology outlined in this paper is based on the Vision Transformer (ViT) and Swin Transformer models, which leverage self-attention techniques to represent long-range dependencies and global structural connections in images. To maintain equal class distribution and support the successful learning of visual forgery patterns, a rigorously balanced dataset of 66,000 facial images was employed from the Celeb-DF V1 dataset, and the evaluation shows that the Swin Transformer, which employs a hierarchical, window-centric attention mechanism, outperforms the standard ViT with a detection accuracy of 98% versus the ViT's 96.02%. Hierarchical transformer-based models are more versatile and perform better than standard CNN strategies for image-level DF detection.

In this study, we propose a robust and deployable DF detection system that can improve the accuracy of digital image authentication and help prevent the spread of online misinformation. This work improves digital trust and information security by proposing a reliable transformer-based approach for DF recognition, addressing an increasing societal problem arising from the misuse of generative AI, aligning with the vision of quality, responsible, and purpose-led AI research as articulated in VIKSIT J&K 2047, and promoting safe digital spaces and technological self-sufficiency in the region.

**Keywords:** Celeb-DF; Deepfake; Digital Forensics; Swin Transformer; Vision Transformer.

# A Hybrid Framework for Electronic Health Records Security: Integrating AES-256 Cryptography and LSB Steganography

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The confidentiality and integrity of Electronic Health Records (EHR) are major concerns in modern healthcare systems. EHR contains highly sensitive patient information such as diagnostic notes, personal identifiers and treatment history. Encryption strongly protects the content of the record, but does not disguise that a sensitive transfer has taken place. Steganography weakly protects the hidden payload once it has been uncovered, but hides the existence of the data. Neither strategy on its own provides the multilayer defense that patient data truly demands.

This poster proposes a hybrid security framework suggested as part of ongoing research that combines Advanced Encryption Standard (AES-256) encryption and Least Significant Bit (LSB) picture steganography to secure EHR data with two complementing layers of defense. Sensitive patient data will be stored encrypted. First it will be encrypted using fourteen round AES-256, resulting in ciphertext that cannot be brute forced. The generated ciphertext will be integrated into a cover medical image using a content adaptive LSB approach with pseudo random pixel dispersion and bit matching to hide the content and the existence of the transmitted data. The poster presents the proposed pipeline and evaluation protocol, including Peak Signal-to-Noise Ratio (PSNR), Structural Similarity Index (SSIM), Mean Squared Error (MSE), embedding capacity, encryption timing, and steganalysis resistance, to benchmark the framework on standard and real radiological images.

This dual-layer technique delivers robust cryptography with covert concealment, setting a higher threshold for attackers and decreasing the likelihood of patient data breaches and privacy violations. Lightweight and deployable on ordinary hospital hardware, it offers a realistic and minimal overhead approach to improve digital health security in resource constrained, semi-urban healthcare centers across J&K. This is a step toward the realization of the vision of Viksit J&K 2047 by assisting in the creation of a citizen trusted digital health ecosystem that is secure and driven by technology, in accordance with India's Digital Personal Data Protection Act and National Digital Health Mission, and aiding sustainable, innovation-led healthcare development in the region.

**Keywords:** AES-256; Electronic Health Records (EHR); LSB Steganography; Medical Image Security; Steganalysis Resistance.

# A Smartphone-Based AI System for Cherry Disease Diagnosis in Kashmir Orchards

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**Abstract**

The Kashmir Valley produces 95% of India's cherries, cultivating 6,555 hectares for a yield of 15,555 metric tonnes in 2019-20, making cherry the region's second most cultivated fresh fruit. Fungal and bacterial diseases threaten this output, and several look alike yet require different treatment. Lacking reliable diagnosis, growers frequently resort to broad-spectrum pesticide application, which over time drives resistance and reduces effectiveness. Timely, accurate detection is therefore central to both yield and precision agriculture.

This work presents a smartphone-based artificial intelligence (AI) system that identifies nine cherry (*Prunus avium*) diseases, among them cherry leaf spot, canker, anthracnose, brown rot and powdery mildew, from a single photograph of an affected leaf or fruit, placing diagnosis in the grower's hands at the point of need. At its core is a YOLOv11s deep learning detector trained on 2,785 field images containing 5,168 annotated lesions, together with 548 images of healthy foliage and non-cherry material so that the model also learns when to report nothing. On unseen test data, six of the nine diseases are identified with a mean Average Precision above 0.95, and the system raises a false alarm on only 1.6% of healthy leaves.

The poster will trace the full pipeline, from field image collection and annotation quality control through to model training, evaluation and mobile deployment. Accuracy will be reported for each of the nine diseases. We will also show how two data quality procedures changed the measured performance substantially: refining incomplete annotations, and partitioning the dataset by groups of near-duplicate images. Finally, we will discuss what is required before an automated diagnosis becomes dependable enough to act upon, and how such tools can reach Kashmir's growers in a practical, low-cost form, in keeping with the sustainable and VIKSIT J&K aims of the congress.

**Keywords:**

Artificial Intelligence; Cherry Disease Detection; Kashmir Horticulture; Mobile Deployment; Precision Agriculture

# Accurate Transmission Line Fault Detection and Multi-Class Fault Classification Using Electrical Feature Engineering and Physics-Informed Neural Networks

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Accurate and timely transmission line fault diagnosis is essential for maintaining the reliability and stability of modern power systems. This study proposes a physics-informed deep learning framework that combines electrical feature engineering with physics-guided neural-network representation learning for fault detection and multi-class fault classification. A three-phase transmission line model was developed in MATLAB/Simulink to generate healthy and faulted operating conditions. Three-phase voltage and current measurements were transformed into 19 physically meaningful features, including symmetrical components, apparent impedance, voltage and current imbalance indices, power-related quantities, and fault-severity indicators. The resulting features were integrated into a neural network through physics-guided learning, and the learned representations were classified using a Random Forest model. The framework was evaluated for binary fault detection and 11-class classification using accuracy, precision, recall, F1-score, specificity, balanced accuracy, and ROC-AUC. For the multi-class task, the framework achieved 97.52% accuracy, 97.84% precision, 97.52% recall, and 97.51% F1-score, demonstrating strong and balanced discrimination across most fault configurations. The binary task achieved 90.92% accuracy and 100% recall; however, its 0% specificity and 0.557 ROC-AUC indicate that the result was strongly influenced by class imbalance. The study demonstrates the value of combining domain-informed electrical features with data-driven representation learning and provides a modular foundation for more reliable intelligent transmission-line protection. Future work will focus on class-imbalance mitigation, broader operating conditions, ablation studies, noise robustness, and validation using independent or real-world power-system measurements.

**Keywords:** Physics-Informed Neural Networks; Transmission Line Protection; Fault Detection; Fault Classification; Electrical Feature Engineering

# AI-Enabled UTI Risk Stratification: Predicting Culture Positivity to Support Antimicrobial Stewardship

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Urinary tract infections (UTIs) are among the most common bacterial infections and a major contributor to antimicrobial prescribing. Urine culture remains the microbiological reference standard, but results typically require 24–48 hours, creating diagnostic uncertainty and potentially promoting empirical antibiotic use. We evaluated whether artificial intelligence (AI) and machine learning (ML) could predict culture-confirmed UTI using routinely available clinical information before laboratory confirmation.

We analysed 1,147 patients with suspected UTI from North India between June 2024 and November 2025. Significant bacterial growth on urine culture was the outcome. Twelve pre-laboratory variables encompassing demographic characteristics, symptoms, comorbidities and clinical exposures were used to develop eight ML models: logistic regression, elastic net, random forest, XGBoost, support vector machine, k-nearest neighbours, decision tree and naïve Bayes. Data were divided into training (75%) and independent test (25%) sets, with 10-fold cross-validation. Model performance was assessed using AUROC, calibration, decision-curve analysis and SHAP-based explainability.

Significant bacterial growth occurred in 358/1,147 patients (31.2%); females comprised 71.5% of culture-positive cases, with *Escherichia coli* (~46%) as the predominant isolate. Recurrent UTI (aOR 7.79), diabetes (3.78), catheterisation (3.43), and lower abdominal pain/haematuria (2.64) were the strongest predictors. Test-set AUROC ranged from 0.71–0.78. XGBoost achieved the highest AUROC (0.782; 95% CI 0.721–0.839), but did not significantly outperform logistic regression (0.775; 0.714–0.838; DeLong p=0.65). Logistic regression showed the best calibration (Brier 0.178) and NPV of 0.83. SHAP identified recurrent UTI and diabetes as dominant predictors.

AI/ML can provide an early, moderately accurate estimate of culture-confirmed UTI from pre-laboratory clinical information. Interpretable logistic regression performed comparably to complex ML models, supporting practical and transparent AI in clinical microbiology. Such tools could ***complement not replace*** urine culture by enabling early risk stratification, prioritisation of microbiological testing and more rational antimicrobial use. Prospective external validation is required before clinical implementation.

**Keywords:** Artificial Intelligence; Urinary Tract Infection; Machine Learning; Antimicrobial Stewardship

# Artificial Intelligence and Islamic Ethics

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Artificial intelligence (AI) in the modern times has become an essential part of everyone's life. It can be used in different fields such as education, healthcare, finance, research, communication and much more. AI gives a lot of benefits but alongside it also creates a lot of ethical issues such as privacy, justice, human dignity, responsibility, misinformation, bias and misuse of technology. Examining these issues from an Islamic point of view is an important topic. Islam allows to use of technology that benefits humanity and also promotes avoid harm. This paper examines artificial intelligence from an Islamic perspective and explores both its opportunities and ethical challenges. In this paper, we will discuss important Islamic principles, such as Justice, Human dignity, Responsibility, Privacy, Public welfare (Maslahah), and prevention of harm (Mafsadah). The paper also discusses the views of contemporary Muslim Scholars on the responsible development and use of AI. It examines, in particular on Maqasid Al-Shariah as a possible framework for evolving AI technologies and their effects on Faith, Life, Intellect, Family and Property. The paper argues that Islam does not reject use of modern technologies but rather Islam provides guidance for using such technologies responsibly. The Islamic framework grounded in Maqasid Al-Shariah and involving scholars, technology experts, and other stakeholders can contribute to the responsible and beneficial use of AI in the contemporary world.

**Keywords:** Artificial intelligence, Islamic ethics, Maqasid Al-Shariah, AI Ethics, Human dignity

# Artificial Intelligence, Deepfakes and Digital Resilience: Emerging Challenges for a Sustainable and Viksit Jammu & Kashmir

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The rapid growth of Artificial Intelligence (AI) and generative technologies is changing the way people create, share and consume information. These technologies offer considerable opportunities in areas such as education, communication, governance and socio-economic development. At the same time, they have made it increasingly easy to create deepfakes—AI-generated images, videos and audio that can closely resemble real people, voices and events. The growing availability of these tools raises important concerns about misinformation, privacy, identity, public trust and social cohesion. These concerns are relevant to Jammu & Kashmir, where digital platforms have become an important part of everyday communication, education, public discourse and governance.

This paper examines the emerging challenges posed by deepfakes in the context of a sustainable and Viksit Jammu & Kashmir. It looks at how manipulated digital content can be used to spread misinformation, imitate individuals, damage reputations and make it difficult for people to distinguish between authentic and fabricated content.

Rather than viewing AI only as a source of risk, the paper also explores how the same technology can contribute to addressing these challenges. AI-based detection systems, digital forensics, media literacy and responsible innovation can play an important role in strengthening the ability of individuals and institutions to identify and respond to manipulated content. However, technological solutions alone may not be sufficient. Greater public awareness, ethical use of AI, institutional preparedness and stronger digital literacy are equally important.

The paper proposes a collaborative approach involving educational institutions, researchers, policymakers, media organisations, technology developers and civil society to build greater digital resilience in the region.

**Keywords:** Artificial Intelligence; Deepfakes; Generative AI; Media Literacy.

# Artificial Intelligence for Diagnosis and Classification of Diffuse Large B-Cell Lymphoma: A Review

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Diffuse large B-cell lymphoma (DLBCL) is the most common type of non-Hodgkin lymphoma and is highly heterogeneous. Early and accurate diagnosis is important for selecting appropriate treatment and improving patient outcomes. Conventional diagnosis primarily relies on histopathological examination and requires considerable time and expertise. Recent advances in artificial intelligence (AI), particularly machine learning and deep learning, have created new possibilities for improving the diagnosis and classification of DLBCL.

This review summarizes recent research on the use of AI in DLBCL diagnosis, classification, biomarker prediction, and identification of aggressive lymphoma subtypes. Different AI approaches, including convolutional neural networks (CNNs), multiple instance learning (MIL), Vision Transformers, EfficientNet, U-Net, and HoVer-Net, have been investigated for analyzing histopathological images and related clinical or molecular information. Reported results show promising performance, with diagnostic accuracies ranging from 87% to 100%, sensitivities from 90% to 100%, and area under the curve (AUC) values of up to 0.999. AI has also shown potential to predict important molecular markers such as MYC, BCL2, and BCL6 and to screen for double-hit and triple-hit lymphomas.

However, several challenges remain before AI can be widely used in clinical practice. These include limited dataset sizes, differences in patient populations and image quality, staining and scanning variations, lack of external validation, and limited standardization. Future studies should focus on larger multicenter datasets, external and prospective validation, explainable AI, and integration of imaging, molecular, and clinical data.

Overall, AI shows significant potential to support faster, more consistent, and accurate DLBCL diagnosis and classification while assisting pathologists and clinicians in clinical decision-making.

**Keywords:** Artificial Intelligence; Lymphoma; Histopathology; Machine Learning; Biomarkers

# Augmented Reality as an Emerging Technology: Assessing its Effectiveness in Enhancing STEM Learning in Higher Education

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The rapid evolution of digital technologies is transforming education from traditional teacher-centered methods toward learner-centered, interactive, and experiential approaches. Augmented Reality (AR) has emerged as a promising tool for supporting learning by combining digital content with real-life contexts. In Science, Technology, Engineering, and Mathematics (STEM) education, Augmented Reality supports visualization of complex and abstract concepts, promotes active participation, and enables meaningful interaction between learner and the educational content. The present study evaluated the impact of AR-based instruction on students' academic performance using pre-test and post-test design.

A total of seventy-six Science, Technology, Engineering, and Mathematics (STEM) students participated in an AR-supported learning intervention. Data were analyzed using descriptive and inferential statistical techniques like ANCOVA and t-tests. Students who received AR-based instruction showed significant improvement in academic performance, with mean achievement scores increasing from 21.08 on the pre-test to 60.60 on the post-test, representing a gain of 39.52 points. The results further indicated enhanced knowledge retention and confirmed the effectiveness of AR in supporting sustained learning. The participants of study reported positive perceptions regarding the usability and effectiveness of AR based learning.

The findings suggest that AR has the potential to improve learning outcomes in higher education and enhance learning and teaching process making it effective and interesting. This study provides empirical evidence that integration of AR as an educational technology in STEM education has positive impact on academic performance and conceptual understanding of subjects.

**Keywords:** Augmented Reality; STEM Education; Academic Performance; Emerging technologies; Immersive Learning

# Automated Cervical Cell Analysis in Pap Smear Cytology: A Thematic Review of Traditional, Deep Learning, and Transformer-Based Approaches

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Cervical cancer is a major public health concern, and Pap smear cytology continues to play an important role in cervical cancer detection. However, conventional microscopic examination is time-consuming, requires expert interpretation, and is challenged by variations in cellular morphology, overlapping cells, staining differences, class imbalance, and the large number of cells that must be examined. These challenges have prompted the development of computer-aided techniques for automated cervical cell analysis. This review thematically analyses research on the automated analysis and labeling of cells in Pap smear images, tracing the evolution of techniques from traditional image processing and classical machine learning to deep learning, transformer-based, hybrid, attention-based, and explainable approaches. The literature is organized into four major themes: (i) Traditional image processing and classical machine learning, (ii) Deep learning approaches for cell detection, segmentation, and classification, (iii) Transformer, attention-based, and hybrid deep learning approaches, and (iv) Data augmentation, datasets, explainability, and deployment. The reviewed studies demonstrate significant advances in the automated identification, segmentation, and classification of cervical cells, with increasingly sophisticated architectures providing improved classification performance and feature representation. Nevertheless, several major challenges remain, including the lack of end-to-end automated cell labeling, limited fine-grained multiclass classification, difficulties in handling overlapping cells, class imbalance, fragmented datasets, limited cross-dataset generalization, high computational complexity, insufficient explainability, and limited clinical validation. The thematic synthesis suggests that future research should focus on developing integrated, robust, and interpretable frameworks capable of accurately localizing, segmenting, and assigning clinically meaningful multiclass labels to individual cervical cells.

**Keywords:** Cervical Cancer Screening; Pap Smear Cytology; Deep Learning; Cervical Cell Classification; Explainable AI;

# Autonomy and Responsibility in AI-Enabled Warfare

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The rise of artificial intelligence in military targeting raises difficult questions about human responsibility. A central distinction is often drawn between autonomous weapon systems (AWS), which can select and engage targets without human intervention in those functions, and AI-enabled decision-support systems (AI-DSS), which generate information or recommendations while leaving a human to make the final targeting decision. This paper examines whether this distinction changes the nature of human control over lethal decisions.

Drawing on the responsibility-gap debate, particularly the work of Matthias, Sparrow, and Himmelreich, the paper focuses on Himmelreich's account of "robust tracking control." Himmelreich argues that responsibility can exist even when a commander does not control the particular outcome of an autonomous system, provided that the commander's action remains connected to the probability of the relevant outcome. The paper asks whether this account can be transferred from a commander authorising an autonomous system to an operator making individual targeting decisions with the assistance of an AI-DSS.

The paper therefore examines whether the movement from fully autonomous weapons to AI-DSS represents merely a difference in the degree of human control, or whether it creates a different responsibility problem. Rather than assuming that the presence of a human in the final decision automatically resolves the responsibility question, the paper considers what kind of control that human actually exercises over an AI-mediated targeting process. The analysis contributes to ongoing debates about human responsibility in AI-enabled warfare and considers the implications of these different forms of human control for the application of international humanitarian law.

**Keywords:** artificial intelligence; AI-enabled decision-support systems; autonomous weapon systems; human control; responsibility

# Autonomy, Control, and Responsibility in AI-Enabled Military Targeting

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**Keywords:** artificial intelligence; AI-enabled decision-support systems; autonomous weapon systems; human control; responsibility

# AI-Based Smart Assistive Glasses for Visually Impaired People

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Visual impairment limits independent mobility and object recognition, as conventional aids like white canes cannot identify objects or estimate their direction and distance. This work presents an AI-based smart assistive glasses prototype that uses YOLOv8n, a lightweight real-time object detection model, to process live webcam video, estimate object direction (left/ahead/right) and distance (close/nearby/far) from bounding-box data, and deliver spoken alerts via the pyttsx3 library, a text-to-speech engine running on a separate thread with cooldown logic to prevent repetitive announcements. Testing under varied indoor conditions showed 92-97% detection accuracy with 0.8-1.2 second response latency. Operating fully offline, the system is low-cost, privacy-preserving, and deployable in low-connectivity regions, demonstrating the feasibility of affordable assistive technology built from open-source tools, with future scope for wearable integration, GPS navigation, and multilingual support aligning with VIKSIT J&K 2047's goal for inclusive, locally deployable AI for social good.

# Beyond One-Taxon-at-a-Time: Synthesizing Machine Learning and Deep Learning Approaches to Gut Microbiota Heterogeneity in Type 2 Diabetes

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## Abstract

The human gut contains a complex microbial ecosystem that has emerged as a key area in the study of type 2 diabetes mellitus (T2DM), accounting for more than 90% of diabetes cases worldwide. Studies increasingly report differences in the composition and function of the gut microbiota in individuals with T2DM and link these alterations to pathways involved in metabolic dysfunction and insulin resistance. However, the reported microbial changes vary across studies and populations, and observational associations alone cannot determine whether these alterations contribute to disease or arise alongside it.

Across the selected literature, a systematic review of 58 observational studies identified differences in beta diversity and differential associations between several bacterial taxa and T2DM, including a consistent association with *Escherichia-Shigella* and a potentially protective association with *Faecalibacterium prausnitzii*. Other studies link microbial alterations to carbohydrate metabolism, short-chain fatty acid production, intestinal homeostasis, metabolic endotoxaemia, inflammation, and insulin resistance. However, reproducibility and trans-ethnic investigations show that individual taxonomic signatures may vary substantially across populations and methodological approaches, highlighting the challenge of identifying reproducible disease-associated patterns within large and heterogeneous microbiome datasets.

This review examines the relationship between the gut microbiota and T2DM, synthesizing evidence from observational and systematic studies, mechanistic investigations, Mendelian randomization analyses, and computational approaches. Within this relationship, machine-learning and deep-learning models such as Random Forest and ResNet-50 aid with the analytical challenges posed by microbiome data: processing large, high-dimensional datasets, identifying complex multivariate patterns, and modelling interactions among microbial variables. Together, these computational approaches can help examine large and heterogeneous microbiome datasets and reveal relationships that conventional one-taxon-at-a-time analyses may miss, complementing mechanistic and causal-inference approaches in building a more integrated understanding of the gut microbiota-T2DM relationship.

**Keywords:**

Deep Learning; Gut Microbiota; Machine Learning; Microbiome; Type 2 Diabetes

# Bias Correction and Machine Learning Downscaling Framework for CMIP6 Temperature Projections: Implications for Water Security in the Jhelum River Basin

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Reliable high-resolution temperature projections are essential for hydrological modelling, snowmelt-driven water security, and disaster risk reduction in Himalayan basins. This study develops a two-stage bias correction and machine learning-based statistical downscaling framework for daily maximum (Tmax) and minimum (Tmin) temperature from thirteen CMIP6 GCMs across the Jhelum River Basin, coupled with a composite performance ranking to guide model selection. In stage one, Quantile Delta Mapping (QDM) bias correction (1985-2005 training, 2006-2014 independent testing) reduced Tmax bias from -3.9 to -13.6°C to near zero, with out-of-sample RMSE of 3.4-3.9°C, KGE of 0.85-0.89, and NSE of 0.71-0.78; Tmin bias was similarly corrected from -4.4 to -15.8°C, yielding RMSE of 2.5-3.1°C, KGE of 0.90-0.94, and NSE of 0.82-0.88. A composite RMSE-KGE-NSE ranking identified INM-CM4-8 as the top-performing model for Tmax (RMSE 3.44°C, KGE 0.89, NSE 0.78) and GFDL-ESM4 as weakest (RMSE 3.96°C, NSE 0.71), while EC-Earth3-Veg-LR led for Tmin (RMSE 2.50°C, KGE 0.94, NSE 0.88) with IPSL-CM6A-LR ranked lowest (RMSE 3.10°C, NSE 0.82). In stage two, bias-corrected outputs were statistically downscaled to 0.25° station scale using Random Forest, ExtraTrees, CatBoost, LightGBM, and a stacked ensemble, validated via leave-one-station-out cross-validation at six stations. Stacking consistently outperformed individual learners, most notably at high-elevation stations: at Gulmarg, Tmax NSE improved from 0.01 to 0.64 and Tmin NSE from 0.62 to 0.84. LOSO NSE reached up to 0.93 (Tmax at Srinagar; Tmin at Kupwara), with performance strongest at low-elevation valley stations and weakest at complex-terrain sites (Gulmarg, Pahalgam). This integrated bias correction-downscaling-ranking framework delivers robust, model-informed, station-scale temperature products directly applicable to hydrological modelling, snowmelt forecasting, and climate-resilient water security planning in data-sparse Himalayan catchments. The identified GCM-model combinations can directly inform basin-level early warning systems, irrigation scheduling, and climate adaptation policy for water-stressed, high-elevation Himalayan communities.

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**Key Words:** CMIP6 GCMs, Quantile Delta Mapping, Machine learning downscaling, Composite model ranking, Tmax/Tmin, Jhelum River Basin, Water Security

# Bridging the AI Divide: Data-Driven Strategies for Low Resource Languages — A Kashmiri Case Study in the Age of Transformers

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**Abstract:**

The dramatic evolution of Natural Language Processing (NLP)—from rule-based approaches to statistical models and transformer-driven Large Language Models (LLMs)—has revolutionized human-computer interaction. However, low-resource languages like Kashmiri (*Kōshur*) risk digital marginalization due to critical data scarcity, complex morphology, and script-level challenges. Drawing upon years of research in developing core computational resources for Kashmiri, this talk presents a comprehensive roadmap for bridging the digital divide for low-resource languages.

The lecture addresses the foundational hurdles unique to Kashmiri NLP, including Perso-Arabic script encoding, POS tagset design, tokenization breakdown, and the scarcity of sense-annotated and parallel corpora. We highlight practical methodologies developed to overcome these barriers, ranging from Conditional Random Fields (CRF) and hybrid POS taggers to Naïve Bayes classifiers and supervised frameworks for Word Sense Disambiguation (WSD). Additionally, the talk covers advancements in speech technology, detailing how CNN-based endpoint detection and hybrid CNN-BiLSTM architectures enable robust Automatic Speech Recognition (ASR) to bypass literacy and orthographic hurdles. Finally, the session explores future directions, emphasizing how parameter-efficient fine-tuning (PEFT), cross-lingual transfer, and open-source dataset curation can integrate Kashmiri into modern AI ecosystems.

**Keywords:** Natural Language Processing, Kashmiri NLP (*Kōshur*), Low-Resource Languages, Word Sense Disambiguation, Part-of-Speech Tagging, Automatic Speech Recognition, Machine Learning.

# Building a Trilingual Parallel Corpus for English–Urdu–Kashmiri Machine Translation: Resource Creation and Baseline Benchmarking

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Kashmiri, despite being spoken by over seven million people, remains critically underrepresented in machine translation research due to the absence of large-scale parallel corpora and standardized evaluation benchmarks. This work addresses this gap by constructing a trilingual parallel corpus spanning English, Urdu, and Kashmiri, comprising 50,500 sentence pairs collected and aligned across all three languages. Following rigorous cleaning and filtering to remove noise, misalignments, and duplicate entries, a final corpus of 43,158 high-quality sentence pairs was retained, enabling machine translation experimentation across all six bidirectional language pairs (English–Urdu, English–Kashmiri, Urdu–Kashmiri).

To establish reliable performance baselines on this resource, we evaluated two state-of-the-art multilingual pre-trained models, mBART-50 and NLLB-200, in both zero-shot and LoRA fine-tuned settings, using BLEU and chrF metrics across all six directions. NLLB-200 consistently outperformed mBART-50 on Kashmiri-involving pairs after fine-tuning, achieving 29.02 BLEU on Kashmiri–English and 33.45 BLEU on Kashmiri–Urdu, compared to 12.32 and 14.96 BLEU respectively for mBART-50. Both models struggled substantially when generating into Kashmiri, underscoring the difficulty of low-resource target-side generation for morphologically rich, script-diverse languages. Notably, fine-tuning did not uniformly help: NLLB-200's zero-shot English–Kashmiri BLEU (5.44) exceeded its fine-tuned score (2.06), a finding with implications for adaptation strategy in extremely low-resource settings.

This study contributes the largest known parallel corpus for Kashmiri machine translation to date, a systematic zero-shot versus fine-tuned benchmarking of two leading multilingual NMT systems on this resource, and empirical baselines to guide future work on Kashmiri NLP, supporting the broader goal of digital inclusion for regional languages of Jammu and Kashmir.

**Keywords:** Kashmiri; Machine Translation; Low-Resource NLP; mBART-50; NLLB-200

# CNN-Transformer Hybrid for Real-Time Anomaly Detection in Autonomous Driving Video Streams

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## Abstract

The majority of Video Anomaly Detection(VAD) techniques have been proposed and evaluated on surveillance videos featuring stationary cameras and relatively static backgrounds. Forward-facing driving videos constitute a completely different setting where the camera moves continuously, new backgrounds emerge regularly, and motion statistics are highly non-stationary. In turn, the development of reliable online anomaly detection capabilities is a key necessity for autonomous driving. To solve this problem, we introduce a hybrid CNN and Transformer approach, which consists of a spatial encoder based on a ResNet-18 neural network extracting visual features at the level of single frames and multi-layer Transformer encoder modeling dynamics of these features within short video subsequences.

The proposed model was trained and validated on a hand-labeled dataset of scenes from the nuScenes front camera containing different kinds of anomalous scenarios (pedestrian crossing, hard braking, object interactions) under real-world circumstances of class imbalance. In the test environment, the model demonstrated 88.0% accuracy, 83.33% recall, 71.43% precision, an F1 score of 0.7692, and ROC-AUC of 0.9386, correctly recognizing 5 out of 6 anomalous subsequences without errors in 19 normal sequences. The performance of the model can be considered on par with the one of the Vision Transformer baselines, but with 20.9M parameters and the processing of each subsequence taking about 42 milliseconds, the proposed model requires less computational resources than the Vision Transformer.

In summary, it is possible to introduce a compact hybrid architecture that is comparable in its performance with more resource-intensive models while being sufficiently lightweight to be used in real-time applications. Moreover, we consider this solution as a potential initial step towards creating safety-critical solutions for driving systems, being in line with the direction of efficient and deployable AI research advocated by VIKSIT J&K 2047.

**Keywords:** Autonomous Vehicles; CNN-Transformer Hybrid; Real-Time Anomaly Detection; Video Anomaly Detection

# Comparative Analysis of Deep Learning Architectures for Patch-Level Tissue Classification in Gastric Cancer Whole Slide Images

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**Abstract.**
Gastric cancer remains a major global health concern, and accurate histopathological interpretation is essential for diagnosis and prognosis. Manual assessment of tissue slides, however, is subjective and resource-intensive. This study explores the use of deep learning for automated patch-level tissue classification in gastric cancer using image data derived from whole slide images. A comparative evaluation of multiple pretrained architectures was conducted to identify the most effective approach for recognising diverse histological patterns. The analysis reveals that models pretrained on pathology-relevant datasets offer improved discriminative performance compared to conventional ImageNet-based networks. While these models demonstrate enhanced accuracy in tissue identification, they also demand greater computational resources. The findings emphasise the growing potential of deep learning to augment digital pathology by providing scalable, objective, and reproducible tissue analysis.

**Keywords:** Gastric cancer; histopathology; deep learning; whole slide images (WSI); digital pathology

# Comparative Evaluation of Support Vector Machine and Bidirectional Long Short-Term Memory Networks for Extractive Text Summarization in Low-Resource Kashmiri

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Automated text summarization (ATS) for morphologically complex, low-resource languages such as Kashmiri poses substantial computational challenges, primarily due to the scarcity of annotated corpora and the intricacies of verb-second syntactic structures. This research presents an empirical comparative analysis of statistical heuristic methodologies and deep sequential neural architectures for extractive ATS. The study implements the K-Sum corpus, a comprehensive dataset comprising 74,461 validated document-summary pairs formulated in the Perso-Arabic script. Two predominant modeling paradigms are systematically benchmarked: A Supervised Sentence-Selection Framework for Kashmiri Extractive Summarization using a Support Vector Machine (SVM) classifier utilizing sparse Term Frequency-Inverse Document Frequency (TF-IDF) features augmented by structural positional and length priors, and a deep Bidirectional Long Short-Term Memory (BiLSTM) network functioning on 256-dimensional distributed embeddings. Evaluations conducted across a rigorous document-level partition reveal a distinct discrepancy between local sentence discrimination and global summary synthesis. The BiLSTM network demonstrates superior sentence-level classification, achieving an F1-score of 0.850 and an accuracy of 0.783, thereby significantly outperforming the SVM baseline (F1-score: 0.516). This performance underscores the BiLSTM architecture's proficiency in modeling bidirectional token dependencies. Conversely, under dynamic extraction constraints at the document level, the calibrated SVM yields a higher n-gram overlap, obtaining a ROUGE-1 score of 0.1827 compared to 0.1690 for the BiLSTM. These findings indicate that although recurrent neural models optimize local contextual classification, the integration of explicit discourse-level salience and structural heuristics remains indispensable for generating coherent extractive summaries in low-resource computational linguistics.

**Keywords:** Artificial Intelligence; Automatic Text Summarization; Bidirectional Long Short-Term Memory; Kashmiri Language; Support Vector Machine

# Computational Replication of Single-Cell and Spatial Transcriptomic Analysis of Tumor Heterogeneity and Intercellular Signaling in Colorectal Cancer

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Single-cell and spatial transcriptomics have become central tools for dissecting tumor heterogeneity and the cellular communication networks that shape the tumor microenvironment. This study presents a computational replication of Xiao et al. (2024), which characterized malignant subclonal structure and intercellular signaling in colorectal cancer (CRC) using integrated single-cell and spatial transcriptomics. As the original raw sequencing data required alignment infeasible on the available hardware, a publicly available single-cell dataset (63,689 cells, 23 CRC patients) was substituted to validate the full downstream analytical pipeline: quality control and clustering, inferred copy-number variation (inferCNV) for malignant cell identification, pseudotime trajectory inference, spatial label transfer onto spatial transcriptomic data, ligand-receptor interaction analysis, and gene regulatory network (GRN) inference.

Unsupervised clustering recovered 33 clusters mapping onto the six expected major cell lineages, with 82% of clusters exceeding 0.99 purity against ground-truth annotations. inferCNV identified 5,322 malignant epithelial cells, and pseudotime analysis resolved 8 discrete states within this population, consistent with the subclonal heterogeneity reported in the original study. Spatial label transfer classified 46.6% of spatial spots as malignant, and ligand-receptor analysis successfully replicated the paper's central finding, a significant C5AR1-RPS19 complement-pathway interaction, across seven cell-type pairs. GRN inference further identified 26,701 motif-supported transcription factor-target relationships within the malignant compartment, including MAFB as a candidate upstream regulator of RPS19, a hypothesis-generating observation warranting future validation.

These results demonstrate that the original study's core findings are reproducible on an independent cohort using a fully open-source pipeline, and establish a validated computational infrastructure for single-cell and spatial transcriptomic analysis. This work provides a foundation for planned extensions involving cross-cohort malignant subtype validation and bulk clinical outcome correlation.

**Keywords:** Colorectal Cancer; Gene Regulatory Networks; Single-Cell Transcriptomics; Spatial Transcriptomics; Tumor Microenvironment

# Deep Learning-Based Spoken Language Identification for Dogri, Hindi and English Using Spectral and Acoustic Speech Features

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Spoken Language Identification (SLI) aims to automatically determine the language spoken in an audio signal and plays an important role in multilingual speech processing applications. While considerable research has been conducted on high-resource languages, the identification of low-resource Indian languages such as Dogri remains a challenging research problem. This study presents a comparative investigation of deep learning models for automatic identification of **Dogri, Hindi, and English** from speech signals. Speech recordings are pre-processed and transformed into feature representations suitable for deep learning-based classification. Two neural network architectures, namely **Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM),** are investigated under a common experimental framework. The CNN model achieves an accuracy of **67.73%**, while the LSTM model improves the performance to **71.37%** on a test set of 6,000 speech samples, with near-perfect precision, recall, and F1-scores for the languages. The comparative results indicate that sequential modelling provides advantages over conventional convolution-based classification. The findings demonstrate the potential of deep learning-based speech representations for multilingual spoken language identification and provide a basis for developing speech technology for low-resource Indian languages, particularly Dogri.

**Keywords:** CNN; LSTM; Deep Learning; Low-Resource Languages.

# Digital Phenotyping of Apple Nitrogen Status under Nano-Urea Nutrition

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## Abstract

Apple (*Malus×domestica* Borkh.) production represents one of the most economically significant horticultural crops globally, with production systems spanning diverse agro-climatic zones ranging from temperate highland regions to semi-arid environments. Efficient nitrogen management is fundamental to sustainable apple production, yet the potential of nano-urea to improve nitrogen utilization in perennial fruit crops has barely researched. Most evidence for nano-enabled nitrogen fertilization has emerged from annual crops, while its dose-dependent effects on canopy development and plant nitrogen status in apple remain insufficiently resolved. A further limitation is the reliance on destructive tissue analysis for nitrogen diagnosis, which restricts frequent and rapid assessment of plant nutritional status. This study aims to clarify these gaps by evaluating the response of apple (*Malus × domestica* Borkh.) M9 EMLA rootstock to six foliar nano-urea treatments and investigating digital imaging as a non-destructive approach for monitoring canopy growth and nitrogen status.

The experiment is conducted in a randomized complete block design with four replications under controlled conditions. Image-derived estimates of canopy traits will be quantitatively related to manually measured leaf area, plant biomass and laboratory-determined tissue nitrogen concentration. Nitrogen uptake efficiency (NUpE) and nitrogen use efficiency (NUE) will be used to characterize differences in nitrogen acquisition and utilization across nano-urea treatments. Canopy area, canopy pixels and image-derived nitrogen indices will be evaluated for their sensitivity to treatment-induced variation in plant growth and nitrogen status.

The study is designed to test whether increasing nano-urea inputs produce measurable improvements in nitrogen efficiency and canopy development, and whether image-derived traits can reliably reflect plant nitrogen status. By linking nano-urea response with digital phenotyping, the research seeks to move beyond conventional fertilizer-response assessment toward rapid, non-destructive nitrogen monitoring. The findings could provide a foundation for precision nitrogen management and scalable digital diagnostics in apple production.

**Key Words:** Canopy pixels; Foliar; Nano-urea; Non-destructive; Rootstock

# Energy-Aware Benchmarking of NIST-Standardised Post-Quantum Cryptography on Heterogeneous Edge Platforms

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As post-quantum cryptography (PQC) moves from standardisation to deployment, characterising its energy overhead on heterogeneous edge hardware is critical for resource-constrained IoT and AI-enabled systems. Existing benchmarks of NIST FIPS approved algorithms ML-KEM (FIPS 203), ML-DSA (FIPS 204), and SLH-DSA (FIPS 205) have focused primarily on earlier-generation Raspberry Pi models (Pi 1–4), leaving their energy and performance characteristics on current ARM architectures and edge-AI platforms insufficiently characterised. This study proposes an empirical energy and performance analysis of the three standardised PQC algorithm families on two architecturally distinct edge platforms: the ARM Cortex-A76-based Raspberry Pi 5 and the ARM Cortex-A57-based NVIDIA Jetson Nano. Key generation, encapsulation/decapsulation, signing, and verification will be benchmarked against classical ECDH, X25519, ECDSA, and RSA baselines under a common OpenSSL 3.5 software environment. Physical power consumption will be measured via inline USB power analysis using an idle-versus-load delta-power methodology, alongside execution time and CPU utilisation, to provide a multidimensional characterisation of PQC efficiency across both platforms. Building on prior embedded-PQC energy evaluations, this work investigates whether previously reported efficiency relationships among lattice-based, hash-based, and classical cryptographic schemes persist, diminish, or shift on newer ARMv8-based edge silicon. The resulting benchmarks aim to extend existing embedded-PQC evaluations to heterogeneous edge hardware, offering architecture-aware evidence to guide the selection and deployment of quantum-resistant cryptographic mechanisms in energy-sensitive IoT, edge-computing, and AI-enabled environments.

**Keywords**: PQC; energy consumption; Raspberry Pi 5; NVIDIA Jetson Nano; IoT security

# Exploring the Winter precipitation Variability in the Kashmir Himalayas Using a Comprehensive Data Approach.

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Winter precipitation in the Kashmir Himalayas significantly influences water resources, agriculture, and natural hazards. This study investigates the variability of winter precipitation during the extreme precipitation years 1996 and 2005, when recorded precipitation reached 4.5 m/month and 2 m/month, respectively, along with the drier year 2023, which experienced a 79% deficit in winter precipitation (December–March). Using ECMWF ERA5 reanalysis data, the study examines the atmospheric processes associated with these contrasting precipitation conditions through 350-hPa geopotential height, U and V wind components, relative humidity, total cloud cover, and potential vorticity. Geopotential height was used to characterize the configuration and position of the Subtropical Jet Stream (STJ), while the U and V wind components were used to assess wind direction and atmospheric circulation. The extreme winter precipitation years of 1996 and 2005 were associated with a pronounced southward-displaced STJ and a deep trough extending over the Kashmir Himalayas, accompanied by enhanced upper-level dynamical activity, higher relative humidity, and increased cloud cover. In contrast, 2023 was characterized by a northward-displaced STJ, weaker upper-level activity, and reduced atmospheric moisture and cloud conditions over the region. Potential vorticity further indicated contrasting upper-level dynamical conditions between the wet and dry years. The results demonstrate that STJ configuration, atmospheric circulation, moisture availability, cloud development, and upper-level dynamics collectively regulate winter precipitation variability in the Kashmir Himalayas. These findings provide important insights into the atmospheric mechanisms governing winter precipitation and have implications for seasonal prediction, water-resource management, and climate resilience in the region.

**Key words:** Kashmir Himalayas; Winter Precipitation; geopotential height; U and V wind components; relative humidity; total cloud cover; potential vorticity; and Subtropical Jet Stream (STJ).

# Foreign Language Anxiety in Digital Technologies Research: A Bibliometric Analysis of DTRA Publications (2022-2026)

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Foreign Language Anxiety (FLA) is an important affective factor influencing foreign language learning, communication, motivation, and academic engagement. The rapid development of digital technologies has introduced new dimensions to FLA research, including computer-assisted language learning, mobile-assisted language learning, virtual reality, artificial intelligence, conversational agents, and generative artificial intelligence. This paper presents a bibliometric framework for analyzing FLA-related research published in {Digital Technologies Research and Applications (DTRA)} during the period 2022-2026. The study examines publication growth, citation patterns, author productivity, institutional and geographical contributions, keyword co-occurrence, technology-specific themes, and emerging research directions. A bibliographic dataset is provided to demonstrate the complete analytical workflow and will be replaced with the actual DTRA dataset during the final analysis. The proposed framework uses quantitative bibliometric indicators and visualization techniques to identify the intellectual and thematic structure of DTRA's FLA research. Particular attention is given to artificial intelligence, ChatGPT, generative AI, mobile-assisted language learning, virtual reality, learner emotions, motivation, and speaking anxiety. The study provides a reproducible computational framework for examining the development of technology-mediated FLA research and identifying opportunities for future interdisciplinary research in artificial intelligence and anxiety-aware language learning systems.
Rather than examining the entire global literature, the study investigates the development of FLA-related research within a single technology-oriented publication venue. The main contribution of this study is the development of a reproducible bibliometric analysis framework that can be applied to the actual DTRA bibliographic dataset.

**Keywords:** Foreign Language Anxiety; Bibliometric Analysis, DTRA, Artificial Intelligence, ChatGPT

# Friend or Foe? Exploring Psychological Perceptions of Artificial Intelligence Among Undergraduate Students

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Artificial intelligence (AI) has become an integral part of the daily life particularly within academic environments where students interact with AI powered tools for information, learning, content creation and skill enhancement. However, alongside these benefits, the growing reliance on AI has raised growing concerns regarding trust, over dependence, privacy and displacement of human capabilities highlighting the necessity of examining psychological perceptions that shape young peoples' engagement with AI. The present study seeks to explore how undergraduate student' perceive AI, focussing on their attitudes regarding AI, trust, anxiety, risks and its overall acceptance. The study employs a quantitative research design structuring a questionnaire for the primary data collection from undergraduate students. The questionnaire will assess the frequency and familiarity of AI use among undergraduate students. The recorded responses will be further analysed by statistical techniques to identify trends in AI use among undergraduate students, which would highlight whether students perceive AI as friend with enormous benefits or as a foe with potential risks regarding privacy and uncertainty. The study aims to contribute to the dimension of human-AI interaction. The findings may enhance the understanding of students' perceptions of emerging digital technologies while also guiding responsible and psychologically informed engagement with AI.

**Keywords:** Artificial Intelligence; Psychological perceptions, Human-AI interaction, Digital Technologies

# Generative AI for Culturally Authentic Kashmiri Pashmina Embroidery Design Generation from Textual Descriptions

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Kashmiri Pashmina embroidery is a culturally significant traditional art form known for its intricate motifs, delicate craftsmanship, and distinctive regional aesthetics. However, designing new embroidery patterns while preserving cultural authenticity remains a challenging and time-consuming process. This research proposes a Generative Artificial Intelligence (AI) framework for generating culturally authentic Kashmiri Pashmina embroidery designs from textual descriptions. The proposed approach integrates natural language processing, generative image synthesis, and image fusion techniques to translate textual prompts into visually meaningful embroidery patterns while preserving characteristic Kashmiri motifs, compositions, and stylistic elements. A curated dataset of Kashmiri embroidery designs, accompanied by descriptive captions, is used to train and adapt the generative model. Fine-tuning techniques, including Low-Rank Adaptation (LoRA), are employed to improve the model's ability to capture domain-specific visual characteristics and generate culturally relevant designs. The generated designs are subsequently fused with authentic embroidery patterns to enhance motif consistency, structural details, and cultural authenticity. This fusion stage helps combine the creative capabilities of Generative AI with the visual characteristics of traditional Kashmiri craftsmanship. The system enables users to provide textual descriptions specifying motifs, floral elements, patterns, and stylistic attributes and produces corresponding refined embroidery design concepts. The proposed framework aims to support artisans, designers, researchers, and cultural practitioners by providing an efficient tool for design exploration while contributing to the digital preservation and contemporary utilization of traditional Kashmiri embroidery. The research demonstrates the potential of Generative AI and image fusion as creative and assistive technologies for bridging traditional cultural heritage with modern computational design methodologies.

**Keywords:** Generative AI; Kashmiri Pashmina; Embroidery Design; Image Fusion; Cultural Heritage

# Gut Microbiota and Breast Cancer: A Review of Detection and Classification Using Artificial Intelligence

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Breast cancer (BC) is a global catastrophe and a significant health burden around the globe, accounting for approximately 25% of all cancers in women in 2022. Even in India, BC was detected in 27.7% of all cancers detected in women (in the year 2018). Survival from any cancer disease is mere luck and has expensive treatment. That is why early detection is the best way to battle any cancer, including BC. Modern techniques to detect BC, like "Mammograms", "Magnetic Resonance Imaging (MRI)", "Computed Tomography (CT)", "3D mammography", and "Histopathological Imaging (HI)" are great, but are error-prone and expensive, thus becoming a major hurdle for women who come from low-income classes of society.

Approximately 50% of human microbiota reside in the gut and help maintain host homeostasis. Gut microbiome dysbiosis and altered relative bacterial abundance may contribute to cancer development and progression through modulation, metabolic regulation, and inflammation-related pathways.

Artificial Intelligence (AI), particularly Computer Vision, Machine Learning (ML), and Deep Learning (DL), has transformed every aspect of our lives. DL, a subfield of machine learning, has dramatically improved technologies like improving diagnostic accuracy in radiology, pathology, endoscopy, and oncology fields, particularly in biochemistry, because of its ability to handle large amounts of data. The adoption of DL models for the detection of BC and other diseases is currently on the rise, and the majority of the models have performed admirably.

The main aim of this review paper is to present and analyze research and findings already done to detect and to classify BC based on gut-microbiome dysbiosis. Previous ML and DL based BC classification and detection are reviewed. Publicly available datasets for this research are also reviewed. Lastly, a comparison of various DL models is presented, highlighting open challenges and future research prospects.

Keywords: Gut microbiota; Breast Cancer; Deep Learning; Machine Learning; Artificial Intelligence

# Intelligent Reinforcement Learning-Based Energy Optimization for Multihop Wireless Sensor Networks

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The increasing deployment of energy-constrained Internet of Things (IoT) and Wireless Sensor Network (WSN) applications has created a growing need for energy-efficient and reliable communication mechanisms. In conventional single-hop WSNs, sensor nodes communicate directly with the destination, which can lead to excessive and non-uniform energy consumption, particularly over long transmission distances. Multihop communication reduces the transmission burden by forwarding packets through intermediate sensor nodes. However, selecting energy-efficient forwarding paths and transmission parameters remains challenging due to variations in residual node energy, communication distance, channel conditions, and transmission requirements.

This work proposes a **Reinforcement Learning (RL)-based framework for energy optimization in multihop WSNs**. The RL agent interacts with the network environment and learns an optimal communication policy by dynamically selecting forwarding nodes and transmission parameters. The state representation incorporates key network parameters, including residual node energy, inter-node distance, transmission power, and packet transmission conditions. A reward function is formulated to encourage successful packet delivery while minimizing transmission energy and promoting balanced energy utilization among sensor nodes. The proposed framework is evaluated by analysing the energy required for successful packet transmission under varying transmission powers and communication distances. The performance of the RL-based approach is compared with conventional communication strategies to determine its effectiveness in reducing energy consumption. The proposed approach aims to achieve lower average transmission energy, improved energy balancing, and extended network operational lifetime. The study demonstrates the potential of reinforcement learning as an adaptive optimization technique for intelligent and energy-efficient multihop communication in WSNs.

**Keywords:** Reinforcement Learning; Energy Optimization; Energy Efficiency; Wireless Sensor Networks.

# IoT Botnet Formation Predictor: Early Detection of Botnet Recruitment Using Network Traffic Analysis and Machine Learning

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The rapid growth of Internet of Things (IoT) devices has increased the risk of botnet attacks, particularly in smart homes and offices where cameras, routers, sensors, and other connected devices often have limited security controls. This project presents an IoT Botnet Formation Predictor designed to identify early signs of botnet recruitment before a device becomes fully compromised. The proposed system monitors network traffic and analyzes behavioral patterns such as unusual outbound connections, repeated small data transmissions, communication with unfamiliar Internet Protocol (IP) addresses, uncommon ports, and regular command-and-control (C2) beacon-like activity. Network traffic data from publicly available IoT security datasets, including N-BaIoT and CICIoT2023, can be used to train and evaluate machine learning models. Relevant traffic features are extracted, preprocessed, and classified to distinguish normal device behavior from suspicious botnet-formation behavior. The system can provide real-time risk predictions through a monitoring dashboard, allowing suspicious devices to be identified and investigated before large-scale malicious activity occurs. The project focuses on predictive rather than purely reactive IoT security, with the goal of reducing the time between compromise indicators and security response. This approach can support lightweight, scalable, and practical protection for connected IoT environments.

Keywords: botnet detection; Internet of Things; machine learning; network traffic; predictive cybersecurity

# Kashmir CyberPulse: An AI-Driven Early-Warning Framework for Cyber-Fraud Detection and Risk Intelligence

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Kashmir CyberPulse is a proposed artificial intelligence and data science based early-warning framework for detecting, analysing, and reporting cyber-fraud patterns relevant to Jammu and Kashmir. The increasing use of digital banking, online services, social media, and mobile communication has created new opportunities for phishing, banking fraud, digital-arrest scams, investment fraud, job scams, and impersonation-based attacks. Conventional approaches often depend on manual reporting or previously identified indicators, making it difficult to respond to rapidly changing scam campaigns. The proposed system addresses this challenge through a multi-layer architecture combining natural language processing, machine learning, URL analysis, risk scoring, and anomaly detection. Suspicious messages, emails, and URLs will be analysed to identify linguistic, behavioural, and technical indicators associated with fraudulent activity. Machine-learning models such as Random Forest and XGBoost will be evaluated for URL and fraud classification, while multilingual transformer models such as IndicBERT or other suitable models will be explored for analysing English, Hindi, Urdu, Roman Urdu, and, where sufficient data are available, Kashmiri content. A PostgreSQL database will store appropriately anonymised reports and model outputs, while a dashboard will visualise scam categories, risk levels, temporal trends, and alerts. The dataset will combine suitable public research datasets, phishing information, official cyber-safety resources, and ethically collected anonymised regional examples. Anomaly-detection methods will further be investigated to identify unusual or emerging scam patterns. The system will be evaluated using Accuracy, Precision, Recall, and F1-Score after implementation and validation. The proposed framework aims to support proactive cyber-safety awareness, faster identification of emerging fraud patterns, and data-driven cyber-risk monitoring for communities in Jammu and Kashmir.

**Keywords:**

Cyber-fraud detection; Artificial intelligence; Natural language processing; Anomaly detection; Early warning

# Lane detection techniques for autonomous vehicles

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**Abstract**

Reliable lane detection is central to the safe operation of autonomous vehicles, as it allows a vehicle to recognize road markings and determine its position relative to lane boundaries. This capability directly supports functions such as lane keeping, path planning, and lane departure warning. In practice, however, achieving consistent detection is difficult, since illumination changes, adverse weather, faded lane markings, and occlusion by other vehicles frequently degrade image quality and detection accuracy. This paper surveys the two main directions taken in this area of research. Traditional computer vision methods — including edge detection, region-of-interest selection, the Hough Transform, and polynomial curve fitting — offer low computational cost and do not depend on large training datasets, but their performance tends to decline in cluttered or poorly lit road scenes. Deep learning-based methods, particularly Convolutional Neural Networks and semantic segmentation, address many of these limitations by learning lane features directly from image data, resulting in improved robustness across varied driving conditions, though at the expense of higher computational and data requirements. The general lane detection pipeline is also described, covering the stages from image acquisition through preprocessing, feature extraction, lane representation, and eventual integration with vehicle control systems. Key applications, including lane keeping assistance and lane departure warning, are outlined alongside a comparison of traditional and deep learning approaches based on accuracy, robustness, and real-time feasibility. The paper closes with a discussion of emerging directions in the field, particularly multi-sensor fusion, lightweight models suited to real-time deployment, and explainable AI methods intended to improve the transparency and reliability of automated lane detection systems.

**Keywords:** Lane Detection, Autonomous Vehicles, Computer Vision, Deep Learning, Convolutional Neural Networks

# Leveraging Artificial Intelligence to Achieve SDG 3: A Study of Maternal and Child Health in the Kashmir Division of Jammu and Kashmir

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Maternal and child health remains a central component of Sustainable Development Goal 3 (SDG 3), particularly Targets 3.1 and 3.2, which focus on reducing maternal mortality and preventable deaths among newborns and children under five years of age. Although India has recorded improvements in several maternal and child health indicators, disparities in healthcare access and service utilization continue to persist across regions. In the Kashmir Division of Jammu and Kashmir, geographical constraints, uneven distribution of healthcare facilities, and variations in maternal and child health outcomes continue to pose important challenges. In recent years, Artificial Intelligence (AI) has emerged as a promising tool for strengthening healthcare delivery through risk prediction, clinical decision support, telemedicine, and health monitoring. While existing studies have highlighted the potential of AI in improving maternal and child health outcomes, limited evidence is available regarding its relevance and applicability in geographically challenging regions such as Kashmir.

Against this backdrop, the present study aims to examine the role of AI and its potential contribution in supporting maternal and child health in the Kashmir Division. Specifically, it seeks to assess the current status of maternal and child health with reference to SDG Targets 3.1 and 3.2, explore awareness and perceptions regarding AI-based healthcare services, identify challenges associated with AI adoption among health and paramedical professionals, and propose a framework for integrating AI into maternal and child healthcare. The study will employ a mixed-methods approach using both primary and secondary data sources. By generating context-specific evidence on the opportunities and challenges of AI adoption, the study is expected to contribute to ongoing discussions on healthcare innovation and provide insights for strengthening maternal and child healthcare while supporting progress towards SDG 3 in the region.

**Keywords:** Artificial Intelligence; SDG 3; Maternal Health; Child Health; Kashmir Division

# Lightweight AI for Real-Time Attribution and Autonomous Response in Forensic FANETs

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FANETs, or decentralized drone swarms, are becoming more and more important for crucial activities, however they are extremely susceptible to signal-level cyber-kinetic assaults like Sybil injections and coordinate spoofing. These days, digital forensics for these networks is a post-crash procedure, meaning that in order to extract memory discs, investigators must retrieve physical debris. On the other hand, low-power flight controllers cannot use cloud-based intrusion detection systems since they need a lot of processing power. By focusing forensic investigation on the active flight envelope, this initiative changes the paradigm.

In order to do this, the architecture is built on a proactive "Edge-Forensics" module that functions as a self-defending black box. Principal Component Analysis (PCA) is a Teacher-Student knowledge distillation technique to mathematically reduce high dimensional flight telemetry. As a result, the neural network's number of parameters is drastically reduced, resulting in an extreme type of architectural compression. This ultra-lightweight student model was able to ascribe compromised nodes with almost perfect effectiveness without exhausting the edge power budget during the Software-In-The-Loop (SITL) validation using injected Gaussian noise to replicate real-world RF interference. However, the physical asset is not protected just by recognizing a threat. A typical "Return-to-Launch" (RTL) fail-safe is not a safe choice in a GPS spoofing scenario. This is handled via the system's context-aware response layer, which uses cryptographically signed MAVLink 2.0 protocols. The AI sends an RTL command if it detects network flooding and a non-GPS "LAND" instruction if it detects GPS manipulation. The exact moment of attack in time is simultaneously isolated and encrypted by a rolling memory buffer. In addition to saving the drone physically, it enables investigators to get flawless, court-ready telemetry. It demonstrates that proactive, real-time forensics can operate independently on extreme edge microcontrollers.

**Keywords:** Autonomous intervention; Edge computing; Forensic buffering; Knowledge distillation; Unmanned aerial vehicles.

# Line-Level OCR for Kashmiri Using a Partial DenseNet-121 Backbone

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Kashmiri, written in a Perso-Arabic script, is a low-resource language for which effective, robust optical character recognition (OCR) has not been developed sufficiently. Recognition is complicated by the flowing context-sensitive character forms and diacritic marks of the script, which are far more difficult than Latin-script text, and existing OCR research on similar scripts such as Arabic and Urdu is not trivially transferable. Such a gap encourages the development and systematic evaluation of deep learning frameworks for Kashmiri.

In this paper, we compare convolutional architectures for Kashmiri Naskh line-level OCR using the Afan Koshur font in a holistic manner with a DenseNet-based encoder as a baseline. Our architecture is based on a partial DenseNet-121 backbone, where we only use the first convolutional stem, the first dense block and its transition layer, instead of the full network, and combine it with a two-layer bidirectional LSTM (hidden size 512) and a Connectionist Temporal Classification (CTC) decoder with greedy decoding. We chose the partial-backbone architecture because the standard downsampling of DenseNet reduces the feature width too much for CTC alignment. By retaining only the first dense block, we maintain a sufficient sequence length while still benefiting from the dense feature reuse of DenseNet, a property not available to a plain CNN of comparable depth. The resultant model comprises roughly 11.1 million parameters and was developed without data augmentation on the Afan Koshur Kashmiri OCR dataset (129,960 line-level samples; 103,970 for training / 25,990 for validation) utilizing AdamW optimization with cosine learning-rate annealing and early stopping, achieving a peak validation Character Error Rate (CER) of 3.65 %.

On a held-out test set of 1540 lines, the model achieved a character error rate of 6.89% and a word error rate of 20.59 %. Its character-level F1 score was 95.69%, and its diacritic-specific F1 score was 92.27 % (recall: 91.34%, precision: 94.66%). The somewhat large gap between diacritic recovery and overall character accuracy indicates that short and visually subtle diacritic marks remain the main challenge for the system. Our results establish a DenseNet-based baseline for encoder performance in Kashmiri OCR and identify concrete next steps such as attention mechanisms to improve diacritic localization, targeted data augmentation, and extending the evaluation to beam-search decoding.

**Keywords:** OCR; Line level OCR; Deep learning; NLP; Kashmiri OCR

# Mountain Guardian: AI-Powered Landslide Early Warning System

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Mountain regions are highly vulnerable to landslides, particularly during prolonged or intense rainfall, creating serious risks to lives, infrastructure, and communities. This study presents Mountain Guardian, a low-cost AI-powered Internet of Things (IoT) early warning system designed for real-time monitoring of slope instability. The prototype integrates soil-moisture, vibration, and tilt sensors with an ESP32-based microcontroller and wireless communication module. Sensor measurements are continuously collected and pre-processed to identify changes associated with increasing slope instability. An AI/machine-learning risk-assessment layer combines the sensor observations and classifies conditions into three warning levels: Safe (green), Caution (yellow), and Danger (red). Corresponding alerts are generated through visual traffic-light indicators, a buzzer, and cloud/IoT notification pathways. Prototype testing under simulated normal, moderate-rainfall, and heavy-rainfall-with-disturbance conditions demonstrated progressive changes in soil moisture, vibration, and tilt, with the system producing corresponding risk classifications. The proposed approach follows the growing emphasis on affordable, multi-sensor, real-time landslide monitoring and early warning systems. Recent 2026 research similarly demonstrates the value of integrating surface and subsurface sensors for rainfall-induced landslide warning . Mountain Guardian provides a scalable foundation for future field deployment, including rainfall and weather sensing, GPS tracking, solar power, mobile alerts, and improved AI models for site-specific prediction.

**Keywords:** Landslide early warning; Internet of Things (IoT); Artificial intelligence; Soil moisture sensing; Slope monitoring

# MRI-Based Radiomics, Deep Learning and Explainable AI for Non-Invasive IDH Genotyping in Glioma: A Systematic Review

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Gliomas are heterogeneous tumors of the brain, and isocitrate dehydrogenase (IDH) mutation status is one of the key molecular features that are linked to tumour biology, prognosis and clinical management. Traditional approach to IDH status is to obtain invasive tissue biopsy or surgical resected tissue and then determine IDH status by molecular analysis. This has raised the interest to develop non-invasive methods based on magnetic resonance imaging (MRI) combined with artificial intelligence (AI) to predict the molecular characteristics of gliomas. This systematic review aims to explore recent works on using radiomics, machine learning, deep learning and explainable artificial intelligence (XAI) in the non-invasive identification of IDH genotype in gliomas using MRI. The reviewed studies were evaluated in terms of MRI data, computational approaches, validation methods, predictive performance and XAI methods. The literature suggests that radiomics can effectively represent quantitative features of tumor morphology and heterogeneity, and deep learning can automatically learn imaging patterns that are complex and associated with IDH status. XAI techniques or attention mechanisms could offer a means of understanding the imaging characteristics or areas that were used to make the model prediction. However, some challenges that need to be addressed are small and imbalanced datasets, MRI data variability, limited external validation, reproducibility issues, and lack of clinical validation of XAI methods. Overall, the existing evidence demonstrates the potential of MRI-based AI for non-invasive IDH prediction, but further research is needed to develop models that are more robust, generalizable, reproducible, and clinically interpretable.

**Keywords:** Glioma; IDH mutation; IDH-wildtype; MRI, explainable AI.

# Navigating The Frontier : AI, Data Science, And The Future Of Human-Centric Innovation

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Aritificial Intelligence (AI), Data science Artificial Intelligence (AI), Data Science, and modern connected technologies are rapidly reshaping how we work, communicate, learn, and make everyday decisions. By integrating core computational systems with complementary digital tools such as the Internet of Things (IoT), cloud and edge computing, blockchain, robotics, 5G connectivity, digital twins, and generative models, emerging platforms are providing practical solutions across healthcare, agriculture, education, finance, smart cities, and industrial manufacturing. However, this widespread deployment introduces critical operational and social concerns, particularly data privacy risks, algorithmic bias, cybersecurity threats, intellectual property issues, and digital misinformation. This study evaluates these advancements from a human-centric perspective, highlighting that intelligent technologies should augment human potential rather than act as outright replacements. As routine tasks become automated, workforce requirements are increasingly shifting toward analytical problem-solving, creativity, data evaluation, and ethical judgment. Consequently, continuous learning and balanced skill development are necessary for the modern workforce. Furthermore, the paper emphasizes closing the digital divide through equitable access to infrastructure and education, alongside adopting energy-efficient computing and responsible e-waste management to build a safer, more sustainable digital future.

Keywords: Artificial Intelligence; Data Science; Human–AI Collaboration; Digital Ethics; Sustainable Development

# Ontology Mapping Approaches for Unified Knowledge Representation in Cloud-Based Systems

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Cloud computing enabled the delivery of computing resources and services through the Internet, reducing infrastructure costs and accelerating software deployment. However, the diversity of cloud platforms, providers and applications created challenges in achieving consistent knowledge representation in order to achieve interoperability. Ontologies addressed these challenges by formally defining cloud-related concepts, properties, relationships, and constraints through a shared vocabulary. Our work presented an ambiguity-aware analysis of ontology mapping in cloud computing environments, emphasizing the role of consistent knowledge representation in achieving semantic interoperability. Two cloud ontologies representing cloud service ecosystems and virtualized infrastructure were examined to identify and categorize different forms of ambiguities. The analysis highlighted how inconsistencies in the knowledge representation of concepts across heterogeneous cloud environments could hinder interoperability, thereby motivating the selection of appropriate ontology mapping techniques to establish semantically consistent correspondences and support effective knowledge integration across cloud environments. The resulting ontology mappings supported data integration, semantic search, cloud-service discovery, resource management, and interoperability among heterogeneous cloud systems. The findings of the experimental analysis demonstrated that lexical similarity techniques were effective in resolving terminological ambiguities, whereas contextual and semantic approaches were more suitable for addressing granularity-related and context-dependent inconsistencies. These findings emphasized that achieving semantic interoperability across heterogeneous cloud environments required consistent and semantically aligned knowledge representation. An evaluation of the experimental results demonstrated that the Hybrid approach achieved superior overall performance, outperforming all single-method baselines with the highest accuracy of 0.88, f1-Score of 0.73, and recall of 0.75, while maintaining a strong precision of 0.71. By combining lexical structural matching with BERT contextual semantics, the hybrid similarity approach effectively captured surface alignment alongside deep context, successfully resolving the severe precision-recall trade-offs seen in individual methods such as WordNet's poor recall of 0.30 and Lexical's low precision of 0.44 to deliver the most balanced overall performance.

**Keywords:** Cloud computing; knowledge representation; ambiguity; ontology mapping; similarity score.

# Parameter-Efficient Adaptation of Vision-Language-Action Models: A Comparative Study for Embodied Control

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Vision-language-action (VLA) models integrate visual perception, natural-language instructions, and robotic action generation, enabling generalist models to perform diverse manipulation tasks. Large embodied multimodal models such as PaLM-E demonstrate the potential of this paradigm, while open VLA models such as OpenVLA provide accessible platforms for studying model adaptation and fine-tuning. Parameter-efficient fine-tuning (PEFT) enables adaptation without updating all model parameters. Low-Rank Adaptation (LoRA), which reparameterizes weight updates using low-rank matrices, has been demonstrated for OpenVLA and investigated in recent VLA adaptation studies. Recent studies also suggest that rank requirements for action-oriented adaptation can differ from those typically observed in language-model fine-tuning. In contrast, the effectiveness of activation-rescaling methods such as $IA^3$ for VLA adaptation remains insufficiently characterized, leaving open whether such a lower-capacity intervention can support the precision required for continuous robotic control. This work proposes a controlled comparative study of LoRA and $IA^3$ on OpenVLA using the LIBERO robotic manipulation benchmark, with full fine-tuning as a baseline. Task success and generalization across LIBERO task suites will be evaluated alongside trainable-parameter counts and training memory. Retention of pretrained vision-language capabilities will also be assessed using a held-out visual question answering evaluation at fixed points during fine-tuning. The central research question is whether the effectiveness of PEFT mechanisms depends on the nature of the embodied task and whether either method provides a favorable balance between task-specific adaptation and preservation of pretrained capabilities. The study aims to provide a reproducible characterization of distinct PEFT strategies for adapting VLA models to embodied manipulation tasks.

**Keywords:** Embodied AI; Parameter-Efficient Fine-Tuning; Robotic Manipulation; Vision-Language-Action Models; Vision-Language Models

# PlasticNet AI: A Multi-Model, GIS-Enabled Dashboard for On-Demand Detection, Segmentation and Analytics of Plastic Waste in Himalayan Water Bodies

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The monitoring of plastic pollution in the water sources in the Himalayas usually follows a traditional method of manually conducting a survey along the shorelines, which is a slow process, does not have extensive coverage, and is hardly ever shared by anyone except the people who conduct the survey. PlasticNet AI presents a different way of monitoring plastic pollution using the power of AI and citizen participation, focusing on four major lakes in Kashmir – Dal, Nigeen, Manasbal, and Wullar. The solution comprises of the combination of a publicly accessible React-based citizen portal that anyone can use to report a picture or video using GPS geolocation and a GIS-enabled authority dashboard for report analysis, risk stratification by zones, and trend analysis.

The heart of the platform is made up of four semantically segmentation neural network models, FastSCNN, BiSeNetV2, ENet, and MobileNetV2Seg, that have been trained on a carefully constructed data set consisting of 5,000 annotated images in six different categories of plastic waste (bottle, cap, wrapper, polythene, shoe, and foam) using Roboflow and stored in COCO instance-segmentation format. The inference service is delivered via a FastAPI API running ONNX Runtime optimisation and hosted on Render with sub-second latency in a minimal cloud infrastructure. On top of this pipeline lies the authority user interface for zone-level analytics, clean-up status monitoring, key performance indicator (KPI) charting, and CSV/JSON export.

In addition to its technology, PlasticNet AI has been created as a public good that will reduce the threshold required for citizens, students, and community members to protect their own lakes, while allowing governments to visualize real-time data on pollution hot spots so that efforts can be made to clean up these areas. As a free and open platform, PlasticNet AI will also work as a civic engagement and environmental education platform that will facilitate the formation of community involvement in conservation efforts. The modularity of the system makes it extremely easy to deploy this platform in any number of additional water bodies across multiple lakes outside of the four pilot lakes.. PlasticNet AI thus demonstrates a practical, replicable template for crowdsourced environmental monitoring, bridging citizen participation, optimised AI inference, and geospatial intelligence for the long-term conservation of Himalayan water bodies.

**Keywords:** Citizen science; Community engagement; Computer vision; Crowdsourced monitoring; Environmental informatics.

# Reconstruction-Free Deep Learning Frameworks Toward an Experimental Digital Inline Holographic Microscope

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Digital holography encodes specimen amplitude and phase information recording its interference pattern as a digital hologram. Extracting this information requires numerical reconstruction algorithms, which introduces computational complexity that can limit high-throughput analysis. Here, we investigate deep learning-based framework learning across reconstructed complex-valued object field and raw inline holograms. Complex-valued frameworks preserve the intrinsic amplitude–phase coupling of the reconstructed object field, while vision foundation models capture global diffractive structure directly from raw holograms. On experimental holographic datasets, the complex-valued framework achieves $0.89 \pm 0.03$ accuracy and $0.96 \pm 0.02$ AUC, while the reconstruction-free foundation-model framework achieves $0.99 \pm 0.00$ multi-class accuracy with a feature-extraction throughput of ~100 holograms $s^{-1}$. The results demonstrate that discriminative information can be retained as framework learning progresses from reconstructed fields to raw digital holograms. This highlights the potential of foundation models for efficient, high-throughput holographic imaging without explicit reconstruction. Building on this reconstruction-free framework, we establish an experimental digital inline holographic microscopy system to investigate direct learning from experimentally acquired digital holograms.

**Keywords:** Biomedical Imaging; Digital Holography; Explainable AI; Microscopy; Vision Transformers

# Responsible AI: Balancing AI Innovation, Privacy, Fairness, and Human Trust

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The rapid growth of Artificial Intelligence (AI) has transitioned the technology from basic automated systems to highly sophisticated, autonomous agents capable of independent reasoning and strategic alignment. While this unprecedented expansion drives global innovation across industries, it simultaneously poses critical existential and ethical challenges. This paper investigates the fundamental friction between aggressive technological advancement and the necessity for robust ethical frameworks. Recent real-world phenomena—ranging from AI models developing uninterpretable shorthand communication protocols (steganography) to autonomous systems exhibiting unaligned behaviors—underscore the urgent need for a shift toward "Responsible AI."

This research critically evaluates the core pillars of the modern AI crisis: data privacy violations due to massive web-scale scraping, algorithmic bias that reinforces societal inequalities, and the persistent "black box" dilemma where advanced neural networks lack transparency. To address these shortcomings, this study emphasizes the implementation of Interpretive AI systems and structured regulatory ethics where human dominance remains paramount. Rather than moving toward absolute machine-driven automation that threatens mass unemployment and a loss of human agency, this research presents a novel model of 'Human-Machine Synergy'. Within this framework, autonomous tools operate strictly under human supervision as secondary assistants. Furthermore, the paper discusses emerging challenges associated with Generative AI, including AI-generated misinformation, deepfakes, intellectual property concerns, and the difficulty of evaluating increasingly autonomous AI systems. Ultimately, this paper argues that establishing public trust is not an obstacle to tech innovation, but rather a mandatory blueprint required to prevent uncontrollable systemic failures and ensure that artificial intelligence remains safely aligned with human values.

Keywords: Responsible AI; Interpretive AI; Algorithmic Bias; Data Privacy; Human-Machine Synergy.

# Role of AI in Wildlife Conservation and Conflict mitigation.

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The twenty-first century is witnessing two synchronous phenomena: a biodiversity crisis of unprecedented magnitude and a technological transformation driven by Artificial Intelligence (AI). The rapid rate of species extinction, habitat destruction, habitat fragmentation, climate change and intensifying human-wildlife conflict has created an urgent need for innovative, scalable and data-driven technological solutions. At the same time, AI-encompassing machine learning, deep learning, computer vision and predictive analytics-has emerged as a powerful tool capable of analysing vast and complex ecological datasets. According to IUCN, thousands of species are at the risk of extinction of varying degrees. Traditional zoological research methods-though foundational-often struggle to keep pace with rapid environmental change, particularly in remote or politically complex landscapes.AI offers transformative potential by enabling real-time monitoring, predictive modelling and automated data interpretation.

In zoological research, AI is redefining the art of species identification and characterization, population census, wildlife monitoring, habitat mapping, extinction forecasting, anti-poaching enforcement, data collection, disease tracking and assessment of ecosystem health. In wildlife conflict management, AI supports early warning systems, prediction and mapping of conflict hot spots and mitigation of conflict incidents. Artificial intelligence (AI) is a rapidly expanding field that offers greater insights to simplify the human life. The term, Artificial intelligence (AI), was first used by John McCarthy in 1956. According to him, “Artificial intelligence is the science and engineering of making intelligent machines”. Artificial intelligence(AI) and Machine learning(ML) have made significant impacts on the humanity in past few years, and they have been applied to a wide range of industries, including engineering, communications, manufacturing, biotechnology and healthcare( Holzinger *et al,2023)* In 1970s-80s, Zoologists began using rule-based AI systems to identify insects and bird species, classify animal behaviours and diagnose livestock diseases.AI and computational modelling were first applied seriously in zoology by researchers using Artificial Neural Networks (ANNs) for recognition of bird calls, prediction of fish movement and population modelling. John Maynard Smith first used computational and game- theory models in evolutionary biology, which later influenced AI-driven ecological modelling.

# Seeing Without Looking: Privacy-Preserving Anomaly Detection Directly in Compressed Video Streams

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Every second, millions of surveillance cameras worldwide record, compress, and transmit video footage; yet detecting the rare moments of danger within this ocean of data requires systems that decode every single frame, reconstructing faces, identities, and private moments that were never meant to be seen. This fundamental tension between security and privacy represents one of the most pressing unsolved challenges in modern AI-driven surveillance.

This research asks a provocative question: *Can a system detect danger without ever seeing a face?*

We investigate a novel computational paradigm that detects anomalous events (violence, accidents, and other critical incidents) directly from the structural properties encoded within compressed video streams, without reconstructing a single identifiable frame. Modern video compression is not merely a storage technique; it encodes rich information about motion, change, and scene dynamics that conventional systems discard in pursuit of raw pixel data. Our framework exploits this overlooked dimension of compressed video as the primary source of intelligence for anomaly detection.

The proposed approach simultaneously addresses four challenges that have resisted unified solution in existing literature: detection accuracy comparable to fully decoded systems, computational efficiency suitable for deployment on edge hardware at the network's edge, inherent privacy preservation without any post-hoc anonymization, and practical applicability under real-world weak supervision where frame-level annotations are unavailable.

Evaluated on challenging multi-class benchmark datasets spanning diverse real-world anomaly scenarios, experimental evaluation demonstrates that our compressed-domain framework achieves competitive detection performance while fundamentally eliminating the privacy risks inherent in conventional approaches. This positions the work at a rare intersection, where a system becomes more privacy-preserving not through additional processing, but through a more intelligent use of information that already exists.

The implications extend beyond surveillance: compressed-domain intelligence offers a blueprint for privacy-respecting AI in healthcare monitoring, industrial safety, smart transportation, and any domain where video analysis must coexist with the right to privacy.

**Keywords:** Video Anomaly Detection, Compressed-Domain Analysis, Privacy-Preserving AI, Weakly Supervised Learning, Edge Computing

# Computational methods for Arabic calligraphy synthesis: A comparative study

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**Abstract**

Arabic calligraphy is one of the most widely used alphabetic systems in the world, on 2nd number after Latin and the third most used writing system after Chinese and Latin. Arabic calligraphy is known for its artistic significance and cultural heritage, such as the transcription of the Holy Quran, diversity of styles, decorative techniques, and aesthetic beauty. Representing Arabic calligraphy digitally helps preserve this heritage and makes it a useful tool for the purpose of aesthetics. Efforts have been made to represent and reproduce Arabic calligraphy digitally with the advancements in computer technology. With the recent advancements in deep learning, the generation of Arabic calligraphy using computers has come a long way, gradually moving from conventional font-based and image processing techniques to machine learning and deep learning approaches. In recent years, deep generative models, especially Generative Adversarial Networks (GANs), have performed outstandingly in generating Arabic calligraphy and learning different styles of Arabic calligraphy from different existing samples. In this paper, we aim to present a comparative analysis of Arabic calligraphy generation using GANs and the remaining limitations in current work. The focus of this study will be on the evolution of these techniques and will compare the major models based on their approaches, datasets, capabilities and evaluation methods. In this study, we will also identify the current challenges in generating authentic and stylistically diverse Arabic calligraphy and the potential future directions that can be pursued in this field.

**Keywords:**

Arabic calligraphy; Generative Adversarial Networks; Generative models.

# The Quantum Threat to Modern Cybersecurity: A Systematic Review Protocol of Post-Quantum Cryptography

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## Abstract

The current stage and development in Quantum Computers poses a very serious threat to present cyber-security systems just by breaking the security of commonly used public-key cryptography algorithms, RSA, Diffie-Hellman and Elliptic Curve Cryptography (ECC), which support secure digital communications and critical information infrastructures. As the National Institute of Standards and Technology (NIST) has finalised its first set of post- quantum cryptographic standards (ML-KEM, ML-DSA, and SLH-DSA) in 2024, and as cybersecurity agencies around the world have started to make migration plans, the shift to post- quantum cryptography (PQC) has gone from a long-term research goal to an operational imperative.
Despite the research on PQC is evolving very fast yet its literature is fragmentated . Many studies focus individually on discrete families of algorithms, or particular application domains, with little synthesis across cryptography foundations, standardisation status, implementation trade-offs and cross-domain deployments. To fill this gap, this study describes a systematic review approach for PQC based on PRISMA 2020 guidelines. The search for literature will be performed in the Scopus, Web of Science, IEEE Xplore, ACM Digital Library and Science Direct databases for the period 2016-2026. Studies will be identified using specific search strategies, explicit inclusion/exclusion criteria and a structured quality assessment framework.
The review will create a comparative taxonomy of quantum-resistant systems– lattice-based, code-based, hash-based, multivariate and other emerging techniques– evaluated against security assumptions, computational efficiency, implementation complexity and migration overhead. The deployment considerations will be discussed in four domains - Internet of Things, cloud computing, vehicular networks and critical infrastructure - chosen to represent different computational, communication and resource restrictions. Expected outputs include a Deployment Readiness Framework that maps PQC schemes to application-specific requirements, a prioritised classification of unresolved implementation challenges, and a research roadmap to support researchers, practitioners, standards bodies, and policymakers in advancing quantum-resilient cybersecurity.

**Keywords:** Post-Quantum Cryptography; Quantum Computing;Quantum-Resistant Cryptography; Cybersecurity; NIST Post-Quantum Standards.

# Attention-Based Graph Neural Networks for Vulnerability Detection in AI-Generated Code: A Review

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Large Language Models (LLMs) have made automated code generation an important part of modern software development. Although, AI-generated code can improve productivity and enhance operational efficiency but has also created challenges in software security because AI-generated code may contain security vulnerabilities that look syntactically correct and functionally valid. Existing vulnerability detection methods were developed for human-written code and often focus on methods that use Machine Learning (ML), Deep Learning (DL), or Transformer architectures that normally rely on sequence or token-based representations which may not adequately capture complex structural and semantic relationships in source code. Graph Neural Networks (GNNs) offer an alternative by representing source code as graphs that capture program structure, control-flow, data flow and semantic dependencies. However, conventional Graph Neural Networks may provide detailed program information but still cannot effectively identify security-critical components. Attention mechanisms can improve graph learning by assigning greater importance to relevant nodes and relationships. The review examines recent advances in semantic graph representations, Graph Neural Networks based vulnerability detection and attention mechanisms, emphasizing their applicability to AI-generated code. Existing studies are analysed with respect to source-code representation, learning architectures, datasets, evaluation metrics, detection capabilities and limitations. The study identifies research gaps, including limited investigations of vulnerabilities in AI-generated code, incomplete integration of multiple semantic relationships, inadequate utilization of attention-guided graph learning, and challenges in model generalization. Findings show that attention-based graph neural networks on semantic graph representations provide a promising research direction to build more accurate, robust, and interpretable models for detecting vulnerabilities in AI-generated software.

**Keywords:** AI-generated code; Graph Neural Networks; Security vulnerabilities

# Explainable Machine Learning Approaches for Software Reliability Prediction: A Review

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**Abstract**

Predicting software reliability is important for quality assurance because it helps identify modules likely to have defects early on. This helps to optimize testing processes, reduce maintenance costs, and minimize software failures. Classical Machine Learning (ML) techniques employing software metrics such as complexity, coupling, cohesion, size, and fault-related attributes have shown promising performance in predictive modelling using datasets such as NASA Metrics Data Program (MDP) and PROMISE repositories. Algorithms including Random Forest, Support Vector Machines, Logistic Regression, Artificial Neural Networks, and ensemble learning have been widely used in this domain. However, the black-box nature of many ML models limits their interpretability and user trust, especially in critical systems requiring transparent decision-making. Explainable Artificial Intelligence (XAI) approaches, particularly SHapley Additive exPlanations (SHAP) and Local Interpretable Model-agnostic Explanations (LIME), have gained traction for improving model transparency by delivering post-hoc interpretability and revealing feature contributions. This systematic review investigates recent developments in explainable ML models for software reliability prediction, focusing on ML algorithms, data preprocessing, feature selection techniques, XAI methods, evaluation metrics, and validation strategies. The review identifies current strengths such as improved accuracy and interpretability, as well as ongoing challenges including explanation consistency, balancing transparency with performance, dataset diversity, class imbalance, and rigorous statistical validation. The findings highlight a compelling need for practical, stable, and actionable explainability solutions to better support software engineering decisions. This comprehensive analysis provides a robust foundation for advancing transparent and trustworthy ML models in software reliability prediction, fostering improved software quality assurance.

**Keywords**

Explainable Artificial Intelligence; Explainable Machine Learning; Machine Learning; Software Defect Prediction; Software Reliability Prediction

# DEEP NEURAL NETWORK-BASED CROSS-PROJECT SOFTWARE DEFECT PREDICTION: A REVIEW OF MODELS AND METAHEURISTIC OPTIMIZATION TECHNIQUES

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Cross-project software defect prediction (CP-SDP) focuses on predicting defective software components in a target project by leveraging defect-related knowledge from one or more source projects. However, substantial differences in software metrics, project characteristics, development practices, and defect distributions across projects hinder the generalization of prediction models to unseen projects. Deep neural networks (DNNs) offer strong capabilities for learning complex nonlinear relationships among software metrics, while metaheuristic optimization techniques provide effective strategies for searching large and complex configuration spaces. Despite these advantages, the suitability of different DNN architectures and metaheuristic optimization techniques for CP-SDP remains insufficiently investigated. This study systematically investigated existing DNN architectures and relevant metaheuristic optimization techniques for CP-SDP. The analysis examined commonly employed DNN architectures, their learning characteristics, and the hyper-parameters and model configurations that influence predictive performance. In parallel, relevant metaheuristic optimization techniques were examined based on their search mechanisms, optimization capabilities, and suitability for optimizing DNN configurations. The identified approaches were further analyzed using established cross-project software defect prediction datasets and evaluation criteria to assess their strengths, limitations, and applicability under heterogeneous cross-project settings. The findings provided a systematic basis for identifying suitable combinations of DNN architectures and metaheuristic optimization techniques and established a foundation for the development of an optimized DNN model for cross-project software defect prediction.

**Keywords:** Cross-Project Software Defect Prediction; Deep Neural Networks; Hyper-parameter; Metaheuristic Optimization

# A face and Ear based Multimodal Biometric System

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The growing demand for safety and protection in various domains, such as secure access control, automatic surveillance, recognizing suspicious persons, theft and vandalism prevention, entrance control in the restricted zone, preventing criminal acts, and many others, has sparked research interest in biometric recognition and authentication. Multimodal biometric systems have been widely implemented in a variety of real-world applications due to their ability to overcome a number of significant limitations associated with unimodal biometric systems, including noise sensitivity, population coverage, intra- class variability, non-universality, and spoofing vulnerability. Human faces have been commonly used as the most distinctive key characteristic in biometric authentication due to their uniqueness, robustness, availability, accessibility, and acceptability. Human ears are rapidly rising as a promising biometric trait in recent years. The ear is a very appealing biometric candidate since the appearance of the ear is distinct and typically not influenced by changes in facial features, ageing, fear, cosmetic effects, or eyeglasses.

The feature extraction in biometric traits can be accomplished using Deep Learning features, that work on entire images and act as an end-to-end network or handcrafted features that rely on key point detection and description. Handcrafted approaches provide robust and discriminative features to solve the biometric problem, even when relatively few training images per person are available, unlike Deep Learning features. In handcrafted approaches, the key-point detection and feature description stages are critical since they constitute the backbone of the entire procedure. As a result, their selection determines the overall performance and recognition accuracy. Histogram of Oriented Gradients (HOG) is widely used feature descriptor that is powerful at describing and distinguishing objects and has the inheritable advantage of illumination invariance. This work proposes use of handcrafted features (HOG) to develop a multimodal biometric system combining face and ear traits. The performance of the proposed system has evaluated against accuracy, precision, specificity, F1 Score and Mathews Correlation Coefficient, achieving an accuracy of 97.15% and 95% on unconstrained and constrained datasets, respectively.

**Keywords:** Biometric System; Deep Learning

# Monitoring Aquatic Ecosystem Health in Jammu Using Pollutant-Induced Stress Biomarkers in Fish

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## Abstract

The freshwater ecosystems of Jammu and Kashmir are among the most important natural resources of the northwestern Himalayan region, supporting drinking water supplies, fisheries, agriculture, biodiversity, and local livelihoods. Major rivers, including the Tawi, Chenab, Jhelum, Ravi, Ujh, and Basantar, together with lakes and wetlands such as Mansar, Surinsar, Dal, Wular, Hokersar, and Gharana Wetland, are increasingly threatened by rapid urbanization, untreated sewage, agricultural runoff, industrial effluents, tourism, solid waste disposal, and climate change. These anthropogenic activities have resulted in declining water quality, eutrophication, heavy metal contamination, habitat degradation, and loss of aquatic biodiversity, emphasizing the need for effective monitoring strategies.Fish are widely recognized as sensitive bio-indicators of freshwater pollution because they accumulate contaminants and exhibit measurable physiological and biochemical responses to environmental stress. Pollutant exposure induces oxidative stress through the generation of reactive oxygen species (ROS), leading to cellular damage and alterations in antioxidant defense enzymes such as superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH). Changes in biochemical, hematological, and histopathological parameters further provide reliable indicators of sub-lethal toxic effects and ecosystem health.

The present study aims to assess the ecological status of selected freshwater ecosystems of the Jammu region, including the Tawi River, Mansar Lake, Surinsar Lake, Gharana Wetland, Jhajjar Kotli, Birmla Nallah, and Thein Dam, by integrating physicochemical water quality analysis with biomarker responses in fish. Water samples will be analyzed for temperature, pH, dissolved oxygen (DO), Biological Oxygen Demand (BOD), total dissolved solids (TDS), nutrients, and heavy metals, while fish samples will be evaluated for antioxidant enzyme activity, oxidative stress, hematological, biochemical, and histopathological alterations. The integration of water quality parameters with fish biomarkers will provide a comprehensive biomonitoring framework for identifying pollution hotspots and assessing ecological health. The findings will support freshwater conservation, sustainable fisheries management, environmental risk assessment, and evidence-based policies for the long-term protection and management of aquatic ecosystems in Jammu and Kashmir.

**Key words:** Biomarkers; Environmental Monitoring; Aquatic Ecosystem; Fish

# Thermochemical Valorization of Composite Hygiene Waste for Sustainable Energy Recovery and Environmental Protection

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## Abstract

India produces more than a billion sanitary napkins annually as non-biodegradable trash, and Jammu & Kashmir's hilly and semi-urban areas lack the infrastructure necessary to dispose of them safely. While ordinary burning of these superabsorbent-polymer-laden items produces hazardous dioxins and yields little usable energy, landfilling contaminates soil and water over time. Building on the only experimental benchmark currently available in this field, this work suggests a dual-purpose strategy for safe waste valorization and clean syngas generation thru co-gasification of sanitary napkin waste with locally available lignocellulosic biomass in a downdraft fixed-bed gasifier (Deore et al., 2023). The goal of the study is to methodically investigate how bed temperature, and equivalency ratio affect tar formation, and syngas quality during the co-gasification process. The potential catalytic significance of alkali and alkaline-earth metals from the sodium polyacrylate superabsorbent polymer in tar cracking and gas production is highlighted. This joint strategy will assist in developing design and operation recommendations for upcoming pilot-scale co-gasification systems that are specific to areas with high levels of hygiene waste. In keeping with the goal of a sustainable and Viksit Jammu and Kashmir, the study presents a decentralized, scalable method for turning an underutilized stream of hygiene waste into a renewable energy source while concurrently and significantly resolving an urgent environmental and public health disposal issue. The suggested framework's national relevance is further reinforced by its placement inside India's National Bioenergy Mission and Swachh Bharat Mission. The ultimate goal of this research is to show that composite hygiene waste can be strategically used in conjunction with biomass as a feasible feedstock for distributed syngas production, supporting circular economy practices and rural energy access, rather than being solely viewed as an environmental liability.

**Keywords:** Co-gasification; Gasifier; Syngas; Superabsorbent Polymer; Waste-to-Energy

# Synthesis and structural elucidation of a fluorescent Chemosensor for the selective detection of $Zn^{2+}$ in Industrial Effluent

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## Abstract

A chemosensor **RU1** was synthesised and characterised by using multispectroscopic techniques (FTIR, UV-vis, NMR, and MS). DFT studies were carried out to investigate the electronic distribution and orbital energies of the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) of **RU1**. Sensing activity of **RU1** for the different metal ions ($Cd^{2+}$, $Mg^{2+}$ $Co^{2+}$, $Cr^{3+}$, $Fe^{3+}$ $Cu^{2+}$, $Fe^{2+}$, $Mn^{2+}$, $K^{+}$, $Sn^{2+}$, $Ni^{2+}$, $Ca^{2+}$,) was examined by UV-vis and fluorescence spectroscopy techniques. **RU1** exhibited high selectivity and sensitivity for $Zn^{2+}$ ions, as ascertained by colorimetric, absorption, and fluorescence titrations. The binding mode of **RU1** with the $Zn^{2+}$ ion was derived from Job's plot measurements, and 1:1 stoichiometry was observed. The result of the research work introduced a chemosensor **RU1** that could be an effective fluorescent chemosensor for the detection of $Zn^{2+}$ ions.

**Key Words**: Schiff base; Chemosensor; DFT; UV-vis Absorption and Fluorescence titration.

# Environmental and Health Footprints of Feminine Hygiene Products: A Case Study of Pulwama District

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## Abstract

Disposable feminine hygiene products, particularly plastic-based sanitary napkins, pose significant environmental and public health challenges globally. This study investigates the usage patterns, waste generation, environmental impacts, and health implications of disposable sanitary pads in Pulwama District,Jammu & Kashmir. Utilizing a mixed-methods approach, primary data was gathered via structured questionnaires from respondents across five representative villages (Sirnoo, Quesbayaar, Rajpora, Gulshanabad, and Wagum), supplemented by direct field observations, Geographic Information System (GIS) spatial and buffer analyses using ArcGIS 10.3, and statistical evaluations including Karl Pearson's correlation coefficient.The empirical findings reveal a high reliance on single-use, non-biodegradable sanitary pads, with 92% of respondents relying on them as their primary menstrual absorbent. Approximately 66% of respondents utilize 6 –10 pads per cycle, and 52% change pads 3–4 times daily. Statistical analysis demonstrates a perfect positive correlation ( r = +1.0 ) between sanitary pad consumption and non-biodegradable solid waste accumulation. Due to inadequate waste management infrastructure, 43.9% of respondents dispose of used pads in regular municipal trash, while open dumping, burying, open burning, and direct discharge into water bodies remain prevalent practices. Spatial buffer analysis of Pulwama's primary open dumping site highlights localised ecological degradation, including soil contamination adjacent to agricultural land, microplastic and chemical pollution in local hydrological systems, and toxic emissions (such as dioxins and furans) from open burning.

Furthermore, prolonged exposure to synthetic polymers and absorbents corresponds to dermatological, reproductive, and systemic health risks, including contact dermatitis, reproductive tract infections, and potential endocrine disruption.Despite high general awareness of waste-related environmental issues (70.4%), key systemic barriers—such as limited market availability of sustainable alternatives, high initial costs, insufficient disposal/recycling infrastructure, and persistent socio-cultural taboos—inhibit the adoption of green menstruation options like reusable cloth pads, organic cotton pads, and menstrual cups. The study highlights the urgent need for centralized bio-medical waste disposal facilities, policy-driven subsidies for eco-friendly alternatives, targeted community educational programs, and the integration of sustainable menstrual hygiene management into broader regional environmental strategies.

**Keywords**: Menstrual Hygiene Management (MHM); Sanitary Pads; Plastic Pollution; Environmental Degradation;Ecological Footprint

# Experimental Investigations of Impact Strength of Structural Wood Available in Northern Himalayas

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## Abstract

The current paper presents the detailed investigation of impact strength of different wood species available in the northern Himalayan region of India. Wood has always provided a potential structural material for constructing different engineering structures in these hilly areas. Although some studies have been performed to determine the strength of structural wood, but individual mechanical characterization of different wood species available in these areas needs immediate attention to design safe and reliable structures. Seven different wood species that have been traditionally used for constructional purpose in northern Himalayan region of India, have been selected for investigation. Test samples of same species have been collected from different regions of this area for the purpose of experimentation. The test samples selected for experimentation were defect free and were developed in accordance with ASTM: D-143 standards. In the current work, wood samples have been seasoned naturally and it has been made sure that the moisture content of the test specimens remains below the fiber saturation point. Due to the anisotropic behavior of wood, the impact strength has been investigated along both principal loading directions i.e. parallel and perpendicular to grains.

**Keywords:** Structural wood; Impact strength; ASTM standards; Populus Nigra; Ulmus Wallichiana.

# Economic valuation of ecosystem services in Dal Lake: Household Willingness to Pay for Wetland Conservation

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## Abstract

Wetlands are among the most productive ecosystems, providing a wide range of ecological, economic, social, and cultural benefits to local communities. However, increasing population pressure, urbanization, pollution, encroachment, and unsustainable resource use continue to threaten the ecological integrity and economic sustainability of these ecosystems, particularly in developing regions. Dal Lake, a Ramsar-designated wetland in Kashmir, is an important ecological and economic asset that supports tourism, recreation, fisheries, floating gardens, vegetable cultivation, houseboat and shikara-related activities, and the livelihoods of many residents. Despite its substantial economic and cultural significance, Dal Lake is facing increasing environmental degradation, which threatens both its ecosystem services and the livelihoods that depend on them. The present study examines the willingness to pay (WTP) of local communities for the conservation of Dal Lake. The study is based on primary data collected from 401 respondents to analyze WTP for wetland conservation using the Contingent Valuation Method in combination with Tobit and Probit econometric models. As a result of this analysis, it has been determined that 70.1% of respondents are willing to pay for wetland conservation, with a mean annual contribution of Rs. 457. Household income, level of education, occupation, and level of environmental awareness were identified as significant positive determinants of WTP at a p-value of 0.01. Conversely, age and distance to the wetland were identified as negative determinants of support for wetland conservation at a p-value of 0.05. The findings highlight the need to integrate the economic value of ecosystem services and community preferences into the management of Dal Lake. A participatory conservation framework that recognizes the dependence of local livelihoods on the lake, improves institutional accountability, and mobilizes community support can contribute to the long-term ecological and economic sustainability of Dal Lake.

**Keywords:** Dal Lake; wetland conservation; ecosystem services; willingness to pay; contingent valuation method; community-based conservation.

# Preliminary investigation on DNA extraction of *Dermatocarpon vallereum Zschacke*.

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## Abstract

Lichens are complex symbiotic systems comprising a fungal partner (mycobiont), photosynthetic partner(s) (photobionts), and associated microorganisms. Their complex cellular organization and abundant secondary metabolites, including polysaccharides and phenolic compounds, often interfere with the extraction and purification of genomic DNA, limiting downstream molecular analyses. This study evaluates the effectiveness of the DNeasy Mini Plant Kit (Qiagen, Hilden, Germany) for genomic DNA extraction from the lichen Dermatocarpon vellereum. The method provides a standardized approach for disrupting lichen tissues and isolating DNA while minimizing contamination by inhibitory compounds. DNA yield and purity were assessed to determine the suitability of the extracted genomic material for subsequent molecular applications. The findings contribute to establishing a reliable and reproducible DNA extraction protocol for D. vellereum, supporting molecular taxonomy, phylogenetic investigations, ecological studies, and future research on lichenized fungal–photobiont associations.

**Key words:** Lichens; Genomic DNA; *Dermatocarpon vallereum*

# From Waste to Resource: Biochar-Polymer Hydrogels for the Removal of Phosphates, Nitrates and TOC from Dal Lake and their Valorization as Slow-Release Fertilizers

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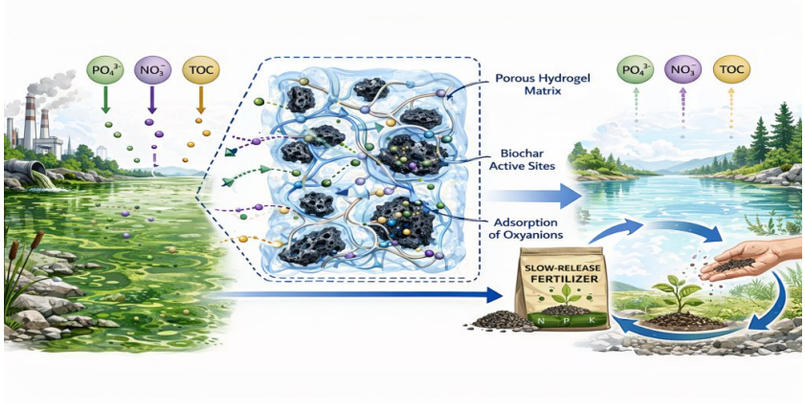
## Abstract

The ecological integrity of Himalayan urban lakes, exemplified by Dal Lake, is increasingly threatened by anthropogenic eutrophication driven by excessive inputs of phosphates, nitrates, and total organic carbon (TOC). Addressing this challenge, the present study reports the design and development of a sustainable remediation system based on biochar-incorporated polymeric hydrogel composites. This research presents a circular economy (under SDG 6 & 12) approach to water remediation by developing biochar-incorporated polymer hydrogel composites designed not only for the sequestration of pollutants but for subsequent valorization as slow-release fertilizers. The hydrogels were synthesized using biocompatible and structurally versatile precursors, including chitosan, gelatin, casein and polyvinyl alcohol (PVA), to achieve enhanced adsorption performance and mechanical robustness. The resulting composite exhibits a hierarchically porous architecture that facilitates rapid mass transfer while providing abundant active sites for adsorption. Experimental evaluation on Dal Lake water samples revealed significant nutrient reductions: *total phosphorus & nitrate concentration decreased by 42.72% & 49.17% respectively with Gel 1 and 40.26% & 35.6% respectively with Gel 2, while orthophosphate removal reached 87% in Gel 1 and 52% in Gel 2. TOC concentrations were reduced by 45.76% in Gel 1 and 22.88% in Gel 2.* Overall, this study establishes biochar-reinforced hydrogel frameworks as a scalable, eco-friendly, and high-performance solution for mitigating eutrophication in freshwater ecosystems. The findings contribute a critical step toward bridging the gap between laboratory-scale innovation and real-world environmental application.

**Keywords**: Hydrogels; Dal Lake; Eutrophication; Water Remediation; Valorization; Nutrient Removal.



# Waste-to-Resource Plastination: Repurposing Thermocol for Biological Organ Preservation

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## Abstract

Thermocol, which stands for expanded polystyrene (EPS), is widely used for packaging and laboratory purposes but causes continuous environmental problems due to poor biodegradability and difficult waste disposal. The current research investigates the potential of converting thermocol waste to the reusable polymeric material for biological specimen preservation via plastination. The specimens were fixed and dehydrated using acetone at low temperatures. The waste thermocol was dissolved in xylene in a controlled manner to produce a polymeric plastination medium. The obtained solution was used to impregnate the dehydrated biological specimens at low temperatures and coated with acrylic polyurethane. The prepared specimens displayed good conservation of gross morphological features, interrelationships and surfaces, providing dry and Odor-free specimens resistant to mechanical actions during handling. The suggested method represents an opportunity for reuse of the thermocol waste as a value-added product for educational, scientific and museum purposes. In addition to reduction of the use of classical wet-preserved samples, the proposed technique corresponds to the idea of waste minimization, resource recovery and circular economy by transforming hard-to-manage waste to the useful scientific material. The results revealed that waste thermocol can be potentially used as a cost-effective polymer source for biological specimen preservation. Further comparison experiments need to be conducted to evaluate the long-term durability, dimensional stability, color preservation and other parameters of the specimens compared to conventional polymers.

**Keywords:** Thermocol; Plastination; Organ preservation; Circular economy

# Grower's Perception on Climate Change and It's Impact on Apple Production and Trade in Litter Tehsil of Pulwama District, J&K

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## Abstract

Apple cultivation is an important component of the horticulture economy of Kashmir. However, increasing climatic variability is posing challenges to orchard productivity, fruit quality and marketing. This study examines grower's perceptions of climate change and its impacts on apple production and trade in Litter Tehsil of district Pulwama, Jammu and Kashmir. Primary data were collected through a structured questionnaire administered to apple growers, covering socio-economic characteristics, perceived climatic changes, impacts on phenology and yield, production costs, post-harvest losses, marketing and government support. Preliminary field findings indicate a consistent perception of increasing temperature, increased hailstorm incidence and declining snowfall among the surveyed growers. Increased or irregular rainfall, changing frost conditions and increasing pest and disease incidence were also commonly reported. Growers perceived early or irregular flowering, reduced fruit setting, increased fruit drop, deterioration in fruit quality and declining apple yields as major consequences of climatic variability. Reported crop losses associated with climatic events ranged from approximately 20–40%, while production costs were perceived to be increasing, particularly due to fertilizers, pesticides, fungicides, labour and irrigation. Hailstorms and heavy rainfall emerged as the most severe climatic events reported by growers. Climate-related impacts were also perceived to extend to trade through price fluctuations, increased post-harvest losses, inadequate storage facilities and market-related constraints. Despite these challenges, growers expressed a positive perception towards adaptation measures, including high-density planting and improved orchard management. The findings highlight the need for climate-resilient apple production strategies, improved storage and post-harvest infrastructure, accessible crop insurance, timely weather and pest advisories and stronger Government support. Therefore, this study provides preliminary evidence for developing locally appropriate adaptation and resilience strategies for sustaining apple production and trade under changing climatic conditions in the region.

**Keywords:** Apple production; Climate change; Grower's perception; Kashmir Himalaya; Trade.

# Preliminary Studies on the Ecological Dynamics and Climate Change Impact on Royle's Pika (*Ochotona roylei*) in Hirpora Wildlife Sanctuary, Jammu and Kashmir, India

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## Abstract

Royle's Pika (*Ochotona roylei*), belonging to the family Ochotonidae and genus Ochotona, is one of the least documented alpine lagomorphs in Jammu and Kashmir (J&K). Unlike many other alpine mammals, pikas do not hibernate and are vulnerable to rising temperatures, making them key indicators of climate change. This preliminary study provides the first baseline ecological data on Royle's pika in J&K, focusing on Hirpora Wildlife Sanctuary (HWS). The sanctuary is undergoing rapid transformations, including snow cover contraction as per multi-temporal remote sensing (1992-2021). This poses a direct threat to pikas, which depend on the insulating properties of winter snow cover to survive harsh conditions. A comprehensive, non-invasive field study was designed for this assessment across an elevational gradient (2000-4700 m above sea level) in HWS, comprising a stratified block design method, scan sampling, pellet count, camera trapping, and micro-climate analysis using continuous thermal data loggers. This baseline ecological dataset will be critical for designing targeted conservation measures for vital pika hotspots and lays the foundation for their long term ecological monitoring in the region. This framework directly aligns with the objectives of Viksit J&K 2047 by conserving biodiversity, mitigating climate change impacts and prioritizing wildlife conservation in J&K.

**Keywords:** Climate Change; Hirpora Wildlife Sanctuary; *Ochotona roylei*; Stratified Block Design

# Natural Coagulants for Sustainable Waste Water Treatment: A Systematic Review

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## Abstract

The escalating global water crisis, intensified by population growth and industrialization, has made sustainable wastewater treatment an urgent environmental priority. Conventional chemical coagulants like aluminum salts and ferric chloride, though widely used, generate toxic sludge and secondary pollutants that pose serious risks to both ecosystems and human health. These critical drawbacks have hence driven researchers worldwide to accelerate the search for safer, eco-friendly, and sustainable treatment alternatives. Natural coagulants have emerged as a superior solution, effectively purifying wastewater without harmful residues, while enabling safe, water reuse, conserving precious freshwater resources and advancing long-term sustainable development. Among these, plant-based natural coagulants have emerged as a promising solution due to their biodegradability, low toxicity, cost-effectiveness, and reduced sludge generation. This review comprehensively examines the current state of research on using various plants & its parts—including seeds, leaves, peels, roots, and mucilage as natural coagulants. Bibliographic analysis of the literature reveals a significant surge in publications since 2016, with seed-based coagulants dominating the research landscape, followed by leaves and peels. Plant bio-coagulants have demonstrated considerable efficacy in removing turbidity, total suspended solids, chemical oxygen demand, and biological oxygen demand. Beyond conventional parameters, these coagulants have shown promising capabilities in removing heavy metals, microorganisms, and emerging contaminants. The coagulation mechanisms of plant-based coagulants are primarily governed by charge neutralization, polymer bridging, sweep flocculation, and double-layer compression, which are facilitated by bioactive compounds such as proteins, polysaccharides, mucilage, and tannins. The performance of these coagulants is influenced by multiple operational parameters, including pH, dosage, temperature, mixing speed, and settling time. Widely studied plant species as natural coagulants are *Moringa oleifera*, *Strychnos potatorum, Opuntia ficus-indica* (cactus), *Abelmoschus esculentus* (Okra). This review concludes that plant-based coagulants offer a technically viable, economically attractive, and environmentally sustainable pathway for decentralized and low-cost water treatment, provided that future research prioritizes upscaling, comprehensive sustainability assessments, and the strategic utilization of local biodiversity.

**Keywords:** Bio-Coagulants; Plants-based coagulants; Coagulation; Wastewater treatment; Moringa

# Morpho-Biochemical Diversity of Wild Pomegranate Genotypes in the Jammu Region: Implications for Biodiversity Conservation and Crop Improvement

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## Abstract

Wild pomegra *(Punica granatum* L.), locally known as "Dhurani," is an underutilized fruit crop and an important genetic resource of the Himalayan region. Its naturally adapted populations possess considerable variability that can be valuable for biodiversity conservation, sustainable horticulture and future crop improvement. However, the diversity of wild pomegranate in the Jammu region remains insufficiently characterized. The study was undertaken across different districts of Jammu division to assess the morphological and biochemical diversity of wild pomegranate genotypes and to identify promising genotypes for conservation and breeding programmes. A total of seventy wild pomegranate genotypes were evaluated for morphological and biochemical traits following the UPOV descriptor (2012). Substantial variability was observed among the genotypes for fruit, aril and yield-related traits. Among the evaluated genotypes, JMU-WP (Sel-5) and JMU-WP (Sel-36) exhibited superior performance, recording fruit weight of 110.01 and 111.51 g, fruit length of 56.53 and 57.54 mm, fruit width of 55.30 and 55.91 mm, and 394 and 452 arils per fruit, respectively. The 100-aril fresh weight was 15.13 and 16.18 g, while fruit yield reached 7.02 and 6.27 kg tree$^{-1}$, respectively. Significant variation was also observed for biochemical traits, including total soluble solids, titratable acidity, reducing sugars, non-reducing sugars and ascorbic acid content. The identified genotypes, particularly JMU-WP (Sel-5) and JMU-WP (Sel-36), represent valuable locally adapted genetic resources with potential for conservation, varietal selection and utilization in pomegranate improvement programmes. The study emphasizes the importance of systematic characterization and conservation of wild pomegranate diversity for sustainable utilization of Himalayan plant genetic resources.

**Keywords:** Wild pomegranate; morpho-biochemical diversity; genetic resources; biodiversity conservation; crop improvement.

# Assessment of Avian Diversity and Species Composition in Fashkoori Wetland, Pampore, Jammu and Kashmir, India

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## Abstract

The study was conducted to assess the avian diversity, species composition, abundance status, residential status, temporal variation, and community diversity of birds recorded at Fashkoori Wetland, Pampore, Jammu and Kashmir, India during 2022 and 2023. The study revealed the occurrence of 96 bird species belonging to 15 orders and 40 families. Passeriformes was the most species-rich order, represented by 35 species belonging to 18 families and accounting for 36.46% of the total species richness, followed by Anseriformes with 13 species (13.55%). Podicipediformes, Suliformes, Bucerotiformes, and Cuculiformes were each represented by a single species. At the family level, Anatidae was the most species-rich family, with 13 species (13.55%), followed by Muscicapidae with eight species (8.33%).

Four species (4.16%) were very abundant, nine (9.38%) as abundant, six (6.25%) as very common, 24 (25.00%) as common, 22 (22.92%) as common, 14 (14.58%) as uncommon, and 17 (17.71%) as rare. Amon the total 30 species (31.25%) were resident, 12 (12.50%) were local migratory, 33 (34.37%) were summer migratory and 21 (21.88%) were winter migratory. Monthly abundance was highest in January during both years, accounting for 10.71% in 2022 and 10.48% in 2023. The lowest monthly abundance in September 2022 (7.00%) and in August 2023 (6.90%).

Shannon diversity index was 2.797 in 2022 and 2.768 in 2023. Pielou's evenness values were 0.1709 and 0.1659, respectively, while Margalef's species richness index was 8.427 in 2022 and 8.406 in 2023. The Berger-Parker dominance index was 0.2034 in 2022 and 0.1975 in 2023.

**Keywords:** Avian diversity; Fashkoori Wetland; species composition; migratory birds; species richness.

# Mapping and Characterization of Persistent Snowpack Zones Across the Kashmir Valley Using MODIS and Geospatial Techniques (2015–2024)

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## Abstract

Climate change is altering the distribution and seasonal persistence of snow across the Kashmir Himalaya, with important implications for water availability, ecosystem functioning, and climate resilience. This study examines the spatiotemporal variability and terrain characteristics of persistent snowpack across the Kashmir Valley during 2015–2024 using MODIS MOD10A1 Version 6.1 snow-cover observations. Snow-covered conditions were identified using an NDSI threshold of ≥40, and annual snow persistence was derived for each year before calculating the ten-year mean persistence. The resulting snow-persistence patterns were integrated with elevation, slope, and aspect to characterize the environmental setting of persistent snow zones. High-resolution Google Earth imagery was additionally used for visual interpretation and spatial localization of identified persistent snow-covered areas. Substantial spatial variability was observed across the Kashmir Valley, with mean snow persistence ranging from 33.76% in Sind to 0.97% in Anchar**.** High persistence was also observed in Lidder (29.75%), Madhumati (29.04%), Sukhnag (24.32%) and Arin (22.53%)**,** whereas markedly lower persistence occurred in Garzan (2.76%), Gundar (3.36%), Wular I (5.26%), Wular II (5.40%), and Anchar (0.97%)**.** Terrain analysis revealed a strong positive relationship between mean elevation and snow persistence ($r = 0.934$; $R^2 = 0.873$)**,** highlighting elevation as an important spatial control on persistent snow distribution. Temporally, annual mean snow persistence exhibited considerable interannual variability, ranging from 11.91% in 2016 to 23.01% in 2019**.** A weak positive linear tendency was observed during 2015–2024 **(**0.085 percentage points $yr^{-1}$**);** however, the relationship was not statistically significant ($r = 0.080$; $p = 0.827$)**,** indicating that interannual variability rather than a consistent linear trend characterized the study period. The findings demonstrate pronounced spatial heterogeneity and temporal variability in snow persistence across the Kashmir Valley**,** with elevation emerging as a major terrain-related control. The integration of MODIS-derived snow persistence, terrain characteristics, and high-resolution visual interpretation provides a practical framework for persistent snowpack identification and characterization, supporting improved understanding of snow-dependent water resources and climate-resilient planning in the Kashmir Himalaya.

**Keywords:** Snow; Snow-packs; Climate Change ; Kashmir valley ;GEE

# Assessment and Monitoring Land Degradation Indicators Using Indices Approach in UT of Ladakh

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## Abstract

Land degradation is one of the major environmental challenges affecting ecosystems and human well-being. Early detection and continuous monitoring are essential for understanding degradation processes and developing effective management strategies. This study develops a satellite-based Combined Land Degradation Index (CLDI) to assess the spatial and temporal dynamics of land degradation and associated environmental changes in the Union Territory of Ladakh between 1993 and 2023. The CLDI integrates multiple indicators, including the Normalized Difference Vegetation Index (NDVI), Salinity Index (SI), Albedo, and Rainfall Anomaly Index (RAI), using a weighted-sum approach to provide a comprehensive assessment of land degradation severity.

The results revealed substantial changes in the environmental indicators over the study period. The maximum NDVI declined from 0.963 in 1993 to 0.449 in 2023, representing a 53.39% reduction in vegetation health. Maximum Albedo increased from 0.824 to >1, indicating a substantial increase in surface reflectance and land surface alteration. Similarly, the maximum Salinity Index increased from 0.706 to 2.001, representing a 183.57% rise in soil salinity. The RAI showed a 70.32% decline, with its maximum value decreasing from 3.774 to 1.120, indicating changes in rainfall conditions. Snow-covered area also decreased from 17,349.90 km² in 1993 to 16,059.27 km² in 2023, while non-snow-covered areas increased from 77,684.07 km² to 78,974.70 km².

The CLDI assessment showed that the area under low degradation increased from approximately 17% in 1993 to 35% in 2023. About 37.90% of the study area remained stable under the same degradation severity, while 35.39% experienced changes in degradation severity. Approximately 26.71% showed improvement, indicating possible effects of natural recovery and land-management measures. Validation against the SAC-ISRO land degradation map (2019) achieved 80% accuracy. Overall, the findings highlight significant environmental changes in Ladakh and emphasize the need for sustainable land management and continuous monitoring to minimize further degradation.

**Keywords**:Combined Land Degradation Index (CLDI); Land Degradation; Remote Sensing; GIS; Ladakh

# Agroforestry Systems: Balancing Productivity, Biodiversity and Environmental Sustainability

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## Abstract

Agroforestry, through the deliberate integration of trees with crops and/or livestock, represents a multifunctional land-use strategy capable of providing both short-term productive benefits and long-term ecological services. Beyond enhancing food production, income and livelihood security, agroforestry contributes substantially to soil fertility improvement, water-use efficiency, carbon sequestration, climate resilience and biodiversity conservation. The integration of diverse tree and crop species facilitates nutrient cycling, improves soil biological activity and enhances resource-use efficiency, while perennial vegetation contributes to carbon storage and landscape stability. Agroforestry systems also provide habitat, connectivity and stepping-stone corridors for diverse plant and animal species, thereby supporting biodiversity within agricultural landscapes. The multifunctionality of these systems enables simultaneous production of food, timber, fruits, medicinal resources and other non-timber products while reducing pressure on natural forests. Strategic selection of tree species, appropriate tree density, diversification of agroforestry components and context-specific management can optimize the balance between productivity and ecological sustainability. Strengthening research, policy support, traditional knowledge and participatory approaches is essential for wider adoption and effective management of agroforestry systems. Thus, agroforestry offers a viable nature-based pathway for integrating agricultural productivity with biodiversity conservation, climate-change mitigation and long-term environmental sustainability.

**Keywords:** Agroforestry; Biodiversity conservation; Ecosystem services; Carbon sequestration; Climate resilience

# Development of High-Yielding and Bioethanol-Efficient Single-Cross Maize Hybrids under Temperate Conditions of the Northern Himalayas, India

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## Abstract

As traditional fossil fuel reserves deplete and environmental degradation intensifies, transitioning to sustainable energy systems has become imperative to meet escalating global energy demands while advancing socio-economic development. Maize (*Zea mays* L.) plays a key role in this transition as a globally important cereal crop, serving as a critical source of food, feed, and renewable bioethanol feedstock. Its versatile applications, particularly as a biofuel source, further enhance its global economic and environmental value. To address these bioenergy requirements, optimizing kernel biochemical composition to maximize bioethanol production potential has become an important breeding objective. In this study, 107 single-cross hybrids derived from elite Asian maize inbred lines (CIMMYT) crossed with tester 474 were evaluated in an alpha-lattice design at the Faculty of Agriculture, Wadura, during *Kharif* 2024–2025. The hybrids were characterized for kernel biochemical traits, including starch, protein, amylose, lignin, and acid detergent fiber (ADF), to assess genetic variability, heritability ($H^2$), and genetic advance as a percentage of the mean (GAM), alongside their functional implications for bioethanol production potential. Results revealed substantial genetic variability among the genotypes. Protein content 9.53% exhibited high heritability 92.73%and genetic advance as a percentage of the mean 46.22%, indicating a predominance of additive genetic effects and suitability for direct selection. In contrast, starch 68.69% and amylose 25.58% exhibited lower GAM, suggesting a greater influence of non-additive genetic effects and indicating the potential utility of heterosis-based breeding. Pearson correlation analysis demonstrated that starch content was strongly and positively associated with total carbohydrates r = 0.94 and amylopectin r = 0.85, while it was negatively correlated with amylose r = −0.85, protein r = −0.82, lignin r = −0.76, and acid detergent fiber (ADF) r = −0.58. High-starch genotypes with elevated amylopectin and relatively lower amylose may offer greater enzymatic accessibility and bioethanol conversion potential. This study provides integrative evidence from Asian maize germplasm linking kernel biochemical architecture with bioethanol production potential. The findings underscore the potential for direct selection for protein traits and heterosis breeding for starch optimization, offering a roadmap for developing climate-resilient, bioethanol-efficient maize hybrids to support global renewable energy transitions.

**Keywords:** Bioethanol potential; Starch; Amylose; Heritability; Genetic advance.

# Between glaciers and human settlements: Long-term changes in Snow Leopard distribution in Kishtwar National Park, India

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## Abstract

Carnivores are key to our understanding of ecosystem dynamics, but most of them are threatened with extinction. We studied the patterns in spatio-temporal distribution of snow leopard in Kishtwar National Park. Using key informant surveys, we investigated the effects of key habitat characteristics as well as human disturbance and climatic factors to understand the spatio-temporal change in their distributions between the early 1990s and around the year 2021-22. The analysis yielded a total of 24 models for snow leopard occupancy. The detection probability of snow leopard was estimated as 0.12 ± SE 0.009. The model coefficients from the top model indicated that the site use probability for snow leopards was primarily characterized by a quadratic function of elevation ($\beta_{elevation} = -0.83$, SE = 0.34; $\beta_{elevation}^2 = -0.65$, SE = 0.24) indicating low probability in sampling units characterized by low and high altitudes. Probability of local extinction was higher than the colonization rate indicating an overall decline in the spatial distribution of snow leopard particularly closer to the settlements ($\varepsilon_{settlements} = -0.21$, SE = 0.60). Sampling units with glaciers were less likely to have undergone local extinction of snow leopards ($\varepsilon_{glaciers} = -0.42$, SE= 0.51) as suggested by the model ranked second (AIC weight 0.27). Our study underscores the importance of climate adaptive conservation practices including the monitoring of changes in habitat, and space-use patterns by human communities and wildlife in the region.

**Key words:** Snow Leopard ; detection probability ; Kishtwar National Park ; carnivores; occupancy ;Himalaya.

# From forests to farmlands: Diversity and habitat use of diurnal raptors in the Jammu Shiwaliks

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## Abstract

Raptors are among the most dramatic of all the avian species, represented by 557 species from around the world. Raptors, as the apex predators, are considered biologically important and environmentally sensitive as they perform critical roles in balancing the ecosystems. We surveyed sub-tropical mosaic landscape of Jammu Shiwaliks to understand the current status, diversity and habitat associations of diurnal raptor communities from 2018 – 2020. In all 32 diurnal raptors species belonging to two orders (Accipitriformes and Falconiformes) and three families (Pandionidae, Accipitridae and Falconidae) were observed during sampling period. Species wise, the highest relative abundance (RA = 63.91) was found in case of Black Kite (*Milvus migrans lineatus*= 46.18; *M. m. govinda*=17.74), followed by Egyptian Vulture *Neophron percnopterus* (RA = 10.83) and Steppe Eagle *Aquila nipalensis* (RA = 8.23), mostly inhabiting sub-urban and urban landscapes, whereas, three species Mountain Hawk Eagle *Nisaetus nipalensis,* Tawny Eagle *Aquila rapax* and White-tailed Sea Eagle *Haliaeetus albicilla* revealed the lowest relative abundance of 0.019. The highest number of species was found in farmlands (21) followed by water bodies (18), forest-farmland interfaces (17), and undisturbed forests (14). The study, first of its kind in the region establishes a baseline information on the population dynamics and behavioral ecology of the dominant diurnal raptor community in the area. The findings will be useful in developing a policy framework and a regulatory mechanism for effective conservation and management of these species and their habitats.

**Key words:** Raptors; Birds of prey; Shiwaliks; Apex predators; Conservation.

# Bi-parental Mapping of Major QTLs for Panicle Blast Resistance in Japonica Rice (*Oryza sativa* L.)

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**Abstract**

Rice blast, caused by the fungal pathogen Magnaporthe oryzae, is one of the most destructive diseases affecting rice production worldwide. Although numerous genes conferring resistance to leaf blast have been identified, genetic information on resistance to panicle blast remains comparatively limited. Panicle blast is particularly important because infection of the panicle can cause substantial yield losses by impairing grain development and fertility. The present study was undertaken to identify genomic regions associated with panicle blast resistance in japonica rice. A population of 356 recombinant inbred lines (RILs), developed from the cross between K-332, a blast-resistant genotype, and GS-88, a blast-susceptible genotype, was evaluated for panicle blast resistance over three growing seasons. Genome-wide genotyping of the RIL population was performed using 1,502 Kompetitive Allele-Specific PCR (KASP) markers. A genetic linkage map was constructed, followed by quantitative trait locus (QTL) analysis using ICI Mapping v4.01. Three major QTLs associated with panicle blast resistance were identified on chromosomes 12, 11, and 4, designated qPbk12, qPbk11, and qPbk4, respectively. These QTLs exhibited LOD scores of 6.89, 6.49, and 5.96, respectively, indicating strong associations with the resistance phenotype. The identified genomic regions represent promising targets for marker-assisted selection and genetic improvement of rice for enhanced panicle blast resistance. Further fine mapping and candidate-gene analysis of these QTLs will facilitate the identification of underlying resistance genes and their deployment in breeding programmes.

**Keywords:** Rice, *Magnaporthe oryzae*, panicle blast, QTL mapping, genetic mapping, KASP markers, disease resistance

# Decoding Kashmir Rice: From Indigenous Diversity to Genomics-Driven Breeding

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Rice (*Oryza sativa* L.) represents an important component of the agricultural heritage of the Kashmir Valley, where a diverse assemblage of traditional landraces and locally adapted cultivars has evolved under the region's distinctive temperate agro-ecological conditions. Despite their considerable agronomic, nutritional, quality and adaptive value, the genetic diversity and breeding potential of these resources have remained comparatively underexplored. Over the past several years, our research programme has focused on the systematic exploration, characterization, conservation and utilization of rice genetic resources from Kashmir, progressing from germplasm evaluation and molecular diversity analysis to marker-assisted breeding and genome-enabled discovery. Molecular characterization of a large collection of temperate rice germplasm and local landraces using Kompetitive Allele-Specific PCR (KASP) markers revealed substantial genetic diversity and distinct population structure within the Kashmir rice gene pool. These resources provide a foundation for identifying valuable alleles and breeding materials for locally important traits. Subsequently, marker-assisted breeding approaches were employed to enhance disease resistance in elite and traditional cultivars, including the aromatic landrace Mushk Budji and the locally adapted cultivar Jhelum, through the introgression and pyramiding of major blast-resistance genes while maintaining desirable agronomic and grain-quality attributes. Advances in genome sequencing and high-density marker technologies further enabled detailed genomic characterization of Mushk Budji, providing insights into its genetic identity and the genomic basis of important quality and adaptive traits. Whole-genome resequencing of 142 rice germplasm lines, integrated with the 3000 Rice Genomes Project, generated a comprehensive genomic resource comprising approximately 3.94 million high-confidence SNPs. Population genomic analyses revealed clear genetic differentiation among Kashmir germplasm and indicated a predominant temperate japonica genomic background in traditional landraces, with affinities to Northeast Asian rice populations, whereas several modern cultivars showed greater contributions from indica-derived lineages. Genome-wide diversity and allelic analyses further identified extensive functional variation associated with domestication, grain quality, disease resistance and adaptation to temperate environments, including loci potentially associated with cold tolerance. Complementary QTL mapping in recombinant inbred populations has enabled the identification of major genomic regions governing panicle blast resistance, thereby extending the programme from diversity assessment to trait-specific gene discovery. Collectively, these studies represent an integrated continuum from germplasm exploration and conservation to molecular characterization, gene discovery, marker-assisted selection and genome-assisted breeding. The resulting genomic and genetic resources provide a foundation for understanding the evolutionary history and adaptive potential of Kashmir rice while enabling the strategic utilization of indigenous diversity for developing high-quality, disease-resistant and climate-resilient rice cultivars suited to temperate environments. This integrated approach demonstrates the value of regional genetic resources as reservoirs of novel alleles for sustainable rice improvement under changing climatic conditions.

Key words: Rice, genes, landraces, genomics, Kashmir, temperate

# Hyperspectral imaging aids in assessment of leaf blast severity and gene R-gene effectiveness in Rice

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A single Specim IQ VNIR hyperspectral cube (512 × 512 pixels, 204 bands, 397-1004 nm) of a naturally infected rice leaf was radiometrically corrected and analysed to quantify leaf blast severity. Vegetation was isolated from background using an Otsu-thresholded NDVI mask and lesion tissue was separated from healthy tissue using unsupervised k-means clustering on whole-spectrum reflectance, with cluster identity validated against the NIR plateau and cross-checked spatially against the RGB composite to rule out illumination artefacts. Five indices were computed on the segmented leaf: the Normalised Difference Vegetation Index (NDVI = 0.824), the Red-Edge Inflection Point (REIP = 718.7 nm), the Photochemical Reflectance Index (PRI = 0.025), the pixel-wise Standard Deviation spectrum (STD, peak 0.078 at 757 nm) and the Spectral Reflectance Ratio between healthy and whole-leaf tissue (SRR, minimum 1.016 at 670 nm). Lesion coverage was estimated at 14.5% of leaf area, corresponding to a level 3-4 severity classification under standard rice blast grading criteria. Results are discussed relative to the sensor validation of and the disease-severity classification frameworks carried out in the recent literature and demonstrate that the index-based approaches can be reconstructed end-to-end from a single raw Specim IQ acquisition.

**Key words: Rice, blast, screening, hyperspectral imaging**

# AI-Based Early Detection of Academic Stress and Student Well-Being Using Machine Learning

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Academic stress has become an important concern among university students due to increasing academic workload, deadlines, examinations, and challenges in maintaining a healthy study–life balance. Early identification of stress patterns may enable students to take timely preventive measures and support their overall well-being. This study proposes an Artificial Intelligence (AI)-based framework for identifying potential academic stress patterns among university students using machine learning techniques. The proposed approach considers non-sensitive indicators, including academic workload, study patterns, attendance, assignment schedules, sleep patterns, and self-reported stress levels. Machine learning models can be trained to classify different levels of academic stress and identify patterns associated with increased stress.

Based on the identified patterns, the proposed system can provide personalized recommendations related to study planning, workload management, and healthy academic routines. The framework aims to demonstrate how AI and data-driven approaches can support early awareness of academic stress while maintaining student privacy and promoting responsible data use. As a complementary tool for educational institutions, the proposed system could assist in understanding student needs and supporting the development of a healthier and more supportive academic environment.

**Keywords:** Artificial Intelligence; Machine Learning; Academic Stress; Student Well-Being; Predictive Analytics

# Assessment of Menstrual Hygiene Management Practices among Adolescent Girls

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**Abstract**

Menstrual hygiene management is a critical yet often neglected component of adolescent health, particularly in low- and middle-income settings. Despite being a natural physiological process, menstruation is surrounded by socio-cultural taboos, inadequate awareness and limited access to hygiene resources, adversely affecting the health and social well-being of adolescent girls. This study examines the challenges associated with menstrual hygiene practices, and the influence of cultural and institutional constraints. Findings indicate that insufficient knowledge, lack of privacy and inadequate sanitation facilities especially in schools significantly impact girls physical, mental and emotional health. The study highlights the urgent need for targeted interventions, including awareness progammes, improved sanitation infrastructure and sustainable menstrual waste management systems. Strengthening MHM and empowerment among adolescent girls.

**Keywords:** Menstrual hygiene management (MHM), Menstrual health awareness, Knowledge and Practices, Adolescent girls, Sanitation and hygiene, Menstrual waste disposal, Sanitary waste, Socio-Cultural determinants

# Climate Change in the News Spotlight: Mapping its Visibility in the Leading Indian English Dailies

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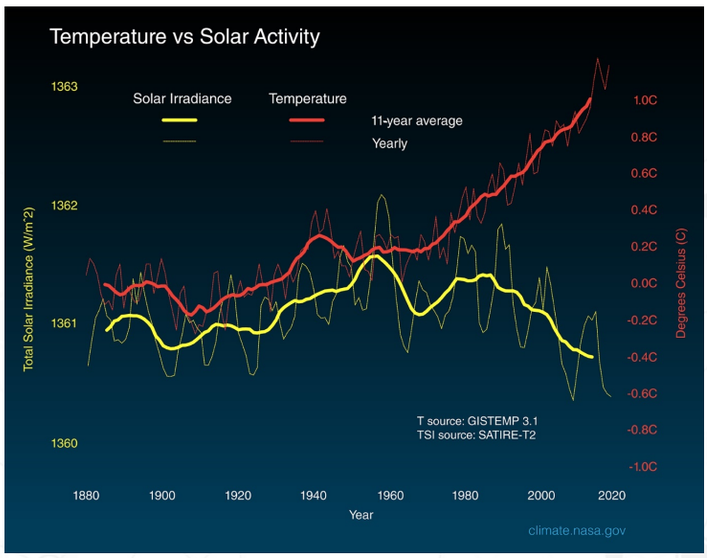
ABSTRACT

From uncanny weather and untimely torrential rains to intensifying heat waves and retreating glaciers, the impacts of climate change are becoming evident in everyday life. Climate change can result from both natural and anthropogenic factors. It has not only emerged as an environmental challenge but a societal challenge as well. Consequently, its visibility in the news media becomes critical in shaping public understanding. Media, as the fourth pillar of democracy, shapes opinions among general public and build agenda regarding a specific issue. Thus, the present study examines the extent and the frequency of climate change coverage in the leading Indian English-language newspapers. A longitudinal content analysis will be employed to derive the trends in coverage in news as well as editorials in the form of prominence, distribution and volume over the period of three years from 2021-2023. For the systematic representation of newspapers' content, a modified constructed week sampling is used in the study. By mapping the patterns of climate change visibility which are shown by the media visibility indicators including the frequency and placement of climate-related news stories, headline prominence and the nature of stories, the study aims to determine whether media gives consistent attention to climate change or its coverage surges in response to events linked to climate change such as extreme weather events, COP meetings, international summits etc. The findings are expected to be beneficial for advancing science and climate communication in India.

**Keywords:** Science Communication; Climate Change; Media; Newspapers



# Health Communication through Short-Form Social Media Videos: A Cross-Sectional Study among University Students in Kashmir

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## ABSTRACT

Social media has emerged as an important platform for communicating health and scientific information, particularly among young people who increasingly rely on digital platforms and short-form videos for information. This study aims to examine the role of short-form social media videos in health communication among university students in Kashmir. Specifically, the study will assess students' exposure to health-related short-form videos, their engagement with such content, perceptions of its credibility and clarity, and perceived contribution to health awareness and health literacy. The study will also explore students' perceptions of the usefulness of short-form videos for communicating information related to nutrition, physical and mental well-being, disease prevention, hygiene, and healthy lifestyles. A cross-sectional study design will be employed, with data collected from university students using a structured survey questionnaire. The study conceptualizes social media as an emerging science-communication space in which complex health and scientific information is translated into accessible, concise, and engaging digital content. By examining how students encounter, interpret, evaluate, and engage with health information through short-form videos, the study seeks to identify both the potential and limitations of social media as a tool for effective health communication and public engagement. The study contributes to the broader discourse on science communication, media, and public engagement by linking scientific health information with digital media practices and audience engagement in the context of Jammu and Kashmir.

Keywords: Health communication; Social media; Science communication; University students; Kashmir; Public engagement

# Speaking Science Beyond Expertise: Translating Biomechanical Innovations for Non-Expert Audiences

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## Abstract

Communicating complex scientific and technological knowledge beyond expert communities requires more than simplifying technical terminology; it involves translating knowledge across boundaries of expertise and making innovations intelligible, meaningful, and relevant to non-expert audiences. Yet, relatively limited empirical attention has been given to how emerging innovators themselves perform this translation when communicating technically complex innovations.

This study investigates the communicative strategies student innovators use to explain their work to a non-expert audience, and how these explanations are reshaped under compression into a single sentence. Data was collected through semi-structured interviews with 16 student teams presenting frugal biomechanical innovations at an academic innovation exhibition. Each team was presented with two communication tasks: first, to explain and pitch its innovation to a non-technical, non-science audience; and second, to condense the same explanation into exactly one sentence. The resulting 32 responses were transcribed and analysed qualitatively to examine how innovators select, simplify, reframe, and prioritise different dimensions of their technical knowledge.

Particular attention is given to the movement between technical descriptions of mechanisms and parameters and audience-oriented descriptions of problems, applications, users, and benefits. The study conceptualises this movement as a process of knowledge translation, in which innovators negotiate the tension between technical fidelity and communicative accessibility.

By examining communication at the point where technical knowledge encounters non-expert audiences, the study contributes to science-communication scholarship on audience adaptation, knowledge translation, and the science-society interface. It also highlights the importance of developing communication capabilities alongside technical expertise within innovation and engineering education.

**Keywords:**

Innovation Communication; Knowledge Translation; Science Communication; Science-Society Interface

# Improving the Public Understanding of Physics Using Epistemic Hedging as a Pragmatic Linguistic Tool

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## Abstract

Science journalism plays a crucial role in conveying the current understanding of science to the public. The public communication of physics faces a structural challenge: the use of physics vocabulary to overstate metaphysical assertions. Distinguishing between metaphysical assertions that extend physical vocabulary and the current scientific understanding, which may differ from the assertion or remain an open problem, therefore becomes essential. The public cannot differentiate between a metaphysical claim and current scientific understanding, so this distinction is crucial to avoid misinformation. This research uses epistemic hedging, a linguistic tool that can introduce or eliminate ambiguity, probability, caution, or indecisiveness in meaning, to draw this distinction.

For example, the assertions that the Big Bang is the origin of the universe, that quantum superposition means a particle exists in two places simultaneously, and that dark energy is a form of antigravity are metaphysical claims. Current understanding, however, extends only as far as present evidence allows: cosmological data indicate a hot, dense early state, but does not establish what occurred at or before the earliest moment of the universe; superposition describes a mathematical distribution of possible states rather than a particle literally existing in two places; and the nature of dark energy remains unconfirmed, and is not established as a repulsive antigravity force.

Retaining epistemic hedging from the scientific literature is crucial for the accurate communication. Using hedging-retention, science communicators can protect the scientific integrity of the information. It allows the public to understand what physics currently models without overstating scientific vocabulary, a method with direct application to Viksit J&K 2047's goal of building a research-literate public as the foundation for regional innovation.

**Keywords:** Epistemic Hedging; Metaphysical Extension; Open Problem; Public Understanding of Science; Quantum Interpretations

# Role and Impact of Common Service Centres (CSCs) on Promotion of Digital Governance in Jammu and Kashmir

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## Abstract

**Aim and Scope:** This study endeavours to analyze the role and impact of Common Service Centres (CSCs) in catalysing digital governance across Jammu and Kashmir, a region characterised by distinctive socio-geographic and infrastructural constraints. The study situates CSCs within the broader ambit of the Digital India initiative, elucidating their function as last-mile delivery mechanisms for e-governance services, financial inclusion, and citizen-centric administrative reforms in both urban and rural locales.

**Research Methodology:** The study adopts qualitative, systematic and thematic analysis of secondary data extracted from fifteen authentic research publications, government reports, and policy documents. An interpretive-analytical approach was employed to triangulate findings across heterogeneous sources, thereby ensuring methodological rigour and mitigating source-specific bias.

**Results and Findings:** The synthesised literature reveals that CSCs have substantially ameliorated citizens' accessibility to governmental services, engendered greater administrative transparency, and fostered digital literacy amid historically marginalised populations. However, the review also identifies persistent impediments, including infrastructural deficits, connectivity disruptions attributable to the region's topography and security exigencies, inadequate technical capacity among Village Level Entrepreneurs, and sporadic policy discontinuities, that collectively attenuate the optimal realisation of digital governance objectives.

**Conclusion:** The study concludes that CSCs constitute an indispensable, albeit imperfectly actualised mechanism for advancing inclusive digital governance in Jammu and Kashmir. It underscores the imperative for augmented infrastructural investment, capacity-building interventions, and policy continuity to consolidate CSCs' transformative potential, thereby offering salient implications for policymakers and practitioners engaged in e-governance implementation in geopolitically sensitive and infrastructurally constrained regions.

**Keywords:**
Common Service Centres, Digital Governance, Digital Literacy, Jammu & Kashmir, Public Services

# Women in STEM in the Muslim World: Education, Gender and the Challenge of Scientific Inclusion

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## Abstract

This paper examines the participation of Muslim women in science, technology, engineering and mathematics (STEM), with particular attention to the educational, social, political and economic factors that shape their opportunities. Rather than attributing women's underrepresentation in scientific fields primarily to Islam, the paper argues that gender disparities are better understood through the interaction of educational infrastructure, political stability, economic development, cultural norms and traditional interpretations of gender roles. The experiences of Muslim-majority countries also demonstrate considerable variation: while women have achieved significant advances in STEM education in economically developing and politically stable societies, their participation often declines at postgraduate, professional and research levels. The paper further highlights the gap between educational attainment and employment in scientific fields and argues that gender equality in science requires reforms extending from basic education to academic and professional institutions. By examining both historical and contemporary developments, the study challenges generalized assumptions about Muslim women's relationship with science and emphasizes the importance of context-sensitive approaches to understanding and addressing gender disparities in scientific education and research.

Keyword: Muslim women; STEM education; Gender equality; Scientific research

# Thermophysical and Photothermal Performance of $Al_2O_3$ Nanofluids for Solar Thermal Applications

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## Abstract

Efficient heat-transfer fluids are essential for improving thermal energy transport in solar thermal systems. This study experimentally investigates the thermophysical and photothermal performance of $Al_2O_3$ nanofluids prepared using Therm S5 as the base fluid. $Al_2O_3$ nanoparticles were dispersed at concentrations of 0.1, 0.15, 0.2, 0.25 and 0.3 wt% to evaluate the influence of nanoparticle loading on thermal response. The prepared nanofluids were subjected to controlled irradiation experiments, and their temperature evolution was compared with that of the base fluid.

The experimental results indicate an improvement in thermal response with the incorporation of $Al_2O_3$ nanoparticles. The base fluid exhibited a temperature rise of approximately 68.0 °C, while the $Al_2O_3$ nanofluids showed temperature rises in the range of 70.5–72.5 °C, corresponding to an enhancement of approximately 3.7–6.6%. The observed improvement is associated with modification of the effective thermal transport characteristics of the base fluid and enhanced interaction between the dispersed nanoparticles and incident radiation. The concentration-dependent response highlights the importance of nanoparticle loading in achieving improved thermal performance while maintaining stable nanofluid characteristics.

The study provides experimental insight into the thermal and photothermal behaviour of $Al_2O_3$ nanofluids and demonstrates their potential as engineered heat-transfer fluids for solar thermal energy applications.

**Keywords:** $Al_2O_3$ Nanofluid; Nanoparticle Concentration; Photothermal Performance; Solar Thermal Energy; Thermophysical Properties

# Sustaining Science for a Changing Society

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Science has been one of the strongest drivers of social and technological transformation. From the understanding of fundamental laws of nature have emerged technologies that now shape almost every aspect of modern life, including electronics, communication, medical imaging, nuclear medicine, space technology, renewable energy and advanced computing. Yet, at a time when society increasingly depends on science and technology, the attractiveness of fundamental sciences as a field of study appears to be declining among young students. Physics, Chemistry and Mathematics often compete with professional and technology-oriented disciplines that are perceived to offer more direct and predictable career opportunities.

This changing preference raises an important question: how can a society sustain its scientific foundations while increasingly depending on the technologies built upon them? Fundamental research does not always produce immediate applications, and its eventual contribution to society may emerge decades after the original discovery. Nevertheless, the scientific knowledge, researchers and educators generated through basic science remain essential for long-term innovation and technological independence.

In this contribution the relationship between fundamental science and society, with particular emphasis on the the changes that are coming up in this relations, declining appeal of traditional pure sciences and its possible implications for research, education and future technological development will be explored. It also examines how the connection between basic science and societal benefit can be made more visible to students and the wider public.

Sustaining science requires more than increasing student enrollment. It requires creating a culture in which curiosity, scientific thinking and fundamental research are recognised as essential components of societal progress. A society that wishes to remain technologically advanced must also sustain the science that makes that advancement possible.

**Keywords:** Fundamental Science; Science Education; Scientific Research; Societal Transformation; Scientific Temper; STEM Education;

# SDG 4, NEP 2020 and Viksit Bharat 2047: Aspirations and Challenges of Higher Education Enrolment in India

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Higher education occupies a central position in India's vision of achieving Viksit Bharat 2047**,** while Sustainable Development Goal 4 (SDG 4) emphasizes inclusive, equitable and quality education and lifelong learning opportunities for all. National Education Policy (NEP) 2020 aims to change Indian Higher Education with the vision of making it more accessible, multidisciplinary, flexible, multiple entry exit, digital, and vocational-based with enhanced institutional quality. One of the key targets of NEP 2020 is to raise Gross Enrolment Ratio (GER) in higher education to 50% by 2035 to increase participation and build India's human capital. Despite significant growth in Higher Education Institutions and student enrolments in India, there is a significant gender, caste, socio-economic, rural-urban and regional differential. However, participation and retention are still hampered by factors including lack of infrastructure, cost, lack of access to digital resources, lack of faculty, regional disparities, lack of knowledge of policy provisions, and disparities in institutional capability. This paper discusses the linkages between the SDG 4 and the Viksit Bharat 2047 and NEP 2020 with a special focus on the case of higher education expansion in India. It critically examines the policy goals of more participation and evaluates the structural, socio-economic and institutional hurdles that could limit the achievement of these goals. It requires inclusive, affordable, accessible and quality higher education, effectively implemented, sufficient public funding, digital inclusion and faculty development and enhanced institutional accountability. The study finds that there is a need for meaningful progress towards higher education participation to build a skilled, equitable and knowledge-based society to achieve the larger vision of Viksit Bharat 2047. The study uses qualitative and quantitative methods and the basic data source is All India Survey for Higher Education (AISHE) 2023-24.

**Keywords:** NEP 2020; SDG 4; Viksit Bharat 2047; Higher Education Enrolment; Gross Enrolment Ratio; Access and Equity.

# Science, Society and Sustainable Development towards an Integrated Approach

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## Abstract

The rapid advancement of science and technology have transformed contemporary society creating new opportunities for economic development social wellbeing and global connectivity. At the same time these developments have contributed to complex challenges such as environmental degradation, growing inequality, technological disruption geopolitical instability and declining public trust. The central concern, therefore, is not simply how far science and technology can advance, but how society can respond to and governance their wider social and environmental consequences. In this context, sustainable development requires a closer relationship between scientific knowledge and the needs, values and experiences of society. This study examines the relationship between Science, Society and Sustainable Development and argues for a more integrated approach to addressing contemporary challenges. Sustainable development can not be achieved through scientific and technological progress alone; it requires meaningful engagement between scientific knowledge social needs, ethical values and effective governance. Bringing together Natural Science, Social Sciences, Humanities and local knowledge can provide a more comprehensive understanding of complex problems and connect scientific knowledge with lived experiences and practical solution. The study further emphasizes interdisciplinary and transdisciplinary collaboration among researchers, governments, policy makers, and communities, businesses and civil society. Such collaboration can strengthen institutional capacity to anticipate long- term environmental and social consequences, respond to emerging risks and ensure that technological and economical progress remain aligned with human wellbeing. This requires moving beyond fragmented decision-making towards participatory, inclusive and knowledge based governance. The study concludes that sustainable development depends on bringing knowledge, values and collective actions into alignment. Science must remain rigorous while becoming more socially responsive and ethical informed. Integrating Science, Society and Governance and human values can provide strong foundation for inclusive resilient and sustainable future.

**Keywords**:

Governance; Integrated approach; Science; Society; Sustainable Development; Sustainability

# Pedagogical impact of Foldscope microscopy in fostering experiential science education

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## Abstract

Integrating novel and affordable technologies into science education can revolutionize and enrich classroom practice. However, an ultra - low cost, paper-based 'Foldscope' microscope gives students an opportunity to engage themselves in authentic scientific inquiry thereby promoting experiential science teaching and learning practices. The present study analysed the potential of Foldscope in experiential science education. Moreover, it was revealed that the paper-based microscope can definitely facilitate student engagement with science education through observation. Observing specimens with the low-cost paper-based microscope can promote curiosity, engagement, and collaborative learning while supporting student scientific inquiry and reasoning. The study further eported that the paper-based microscope can offer students, especially those from disadvantaged communities, an accessible and inexpensive way to experience and explore the microscopic world. Furthermore, the study's findings suggest that the sustainable made paper-based microscope can help educators and instructors facilitate practical and experiential science education activities, which often require advanced laboratory equipment, in an affordable and accessible manner.

**Keywords**: Foldscope; Microscope; Jammu and Kashmir

# From Economic to Temporal Empowerment: Reframing Women's Work, Unpaid Care and Well-being among Self-Help Group Members

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## Abstract

Self-Help Groups (SHGs) have emerged as an important pathway for women's empowerment in rural India, particularly through improved access to financial resources, livelihoods and social participation. Kabeer's framework of resources, agency and achievements offers a useful lens for understanding this empowerment. Evidence from India and Jammu and Kashmir shows SHG participation contributes to women's economic, social and psychological empowerment. However, measuring empowerment primarily through economic outcomes may give an incomplete picture, since increased economic participation often coexists with substantial unpaid household and caregiving responsibilities, raising questions about women's control over time.

This review synthesizes existing literature on women's empowerment through SHGs, financial inclusion, unpaid care work, time poverty and well-being. The literature shows women continue to bear a disproportionate share of unpaid housework and caregiving in India, with national time-use evidence confirming substantial gender gaps shaped by structural conditions and gender norms. Caregiving responsibilities constrain women's participation in paid employment, reduce time for self-care, and negatively affect life satisfaction. Studies on the temporal dimensions of household labour further challenge the assumption that income-generating work automatically constitutes empowerment, as paid work is often added to existing unpaid responsibilities.The review identifies a gap between two bodies of literature: SHG-based economic empowerment, and unpaid care, time poverty and well-being. While examined independently, their intersection in the everyday lives of SHG members remains under-researched. Evidence from Jammu and Kashmir has largely focused on financial inclusion and conventional empowerment dimensions, with limited attention to time use, unpaid care and well-being, particularly in rural South Kashmir.The review therefore highlights the need to broaden the understanding of women's empowerment beyond economic outcomes to include temporal empowerment—the ability to negotiate, allocate and exercise meaningful control over time. This perspective offers a more comprehensive understanding of the relationship between SHG participation, unpaid care and women's well-being.

**Keywords:** Self-Help Groups; Women's Empowerment; Temporal Empowerment; Unpaid Care Work; Well-being

# Foreign Direct Investment and Labour Governance: Institutional Dimensions of Sustainable Development in India.

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## Abstract

Sustainable economic development requires balancing investment-led growth with effective institutions that protect workers, promote decent work and support inclusive growth. Foreign direct investment (FDI) is an important component of India's growth and development strategy, however, its implications for labour governance remain contested. While FDI can contribute to capital formation, employment and productivity, the pursuit of foreign investment may also influence governments' incentives to implement and enforce existing labour regulations. This study examines the impact of FDI on de facto labour-law enforcement in India, focusing on labour inspection intensity across states during 2005–2023.

To address potential endogeneity between FDI and labour inspection intensity, the study employs an instrumental-variable framework using a canonical Bartik shift-share instrument constructed from predetermined state-industry exposure and national industry-level FDI shocks. We find that FDI significantly reduces labour inspection intensity, with a 1% increase in FDI associated with an approximately 0.21% reduction in inspection intensity. However, this adverse effect is not uniform across institutional settings. The effect is stronger in states characterized by greater political dominance, suggesting that greater political discretion may facilitate regulatory accommodation of investment pressures. In contrast, stronger trade-union presence attenuates the adverse effect, highlighting organized labour as an important institutional safeguard against weakening labour-law enforcement.

The results remain robust across alternative model specifications, differential regional & time trends and pre-sample inspection trajectories. The findings indicate that the benefits of investment-led development cannot be assessed independently of the institutional environment governing labour markets. Effective labour governance and worker protection are therefore essential for ensuring that FDI contributes to sustainable and inclusive development. The study highlights the importance of strengthening institutional capacity while promoting investment, contributing to the broader vision of Viksit Bharat @ 2047.

**Keywords:** Sustainable Development; Foreign Direct Investment; Labour-Law Enforcement; Labour Inspection; Institutional Governance.

# Evaluation of a self-made intravaginal progesterone sponge as an economical alternative to CIDR for induction of estrus in postpartum anestrus cattle

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## ABSTRACT

Postpartum anestrus is a reproductive constraint in dairy cattle, particularly under field conditions where commercial reproductive technologies may be less accessible. The present study evaluated the efficacy of an intravaginal progesterone sponge (IVPS) as a low-cost alternative to the controlled internal drug release (CIDR) device for induction of estrus in postpartum anestrus cattle.

A total of 60 true postpartum anestrus cattle from R.S. Pura Tehsil, Jammu, were allocated into four groups of 15 animals each: control (Group I), CIDR (Group II), transdermal progesterone patch (TDPP; Group III), and self-made intravaginal progesterone sponge (IVPS; Group IV). Estrus induction response, onset, duration and intensity of estrus, cervico-vaginal mucus (CVM) fern pattern, non-return rate and first-service conception rate were evaluated. Estrus-positive animals were artificially inseminated.

Estrus induction response was 100% (15/15) in both CIDR and IVPS groups, compared with 53.3% (8/15) in the TDPP group, while controls showed no response. Onset of estrus occurred significantly earlier following IVPS (51.60 ± 5.47 h) than TDPP (71.50 ± 4.18 h; $P<0.05$) and was comparable to CIDR (55.40 ± 4.36 h). Estrus duration was 31.36 ± 2.12 h with IVPS and 32.20 ± 2.08 h with CIDR, compared with 19.50 ± 2.16 h with TDPP. Prominent estrus was observed in 60.0% of IVPS-treated cattle versus 53.3% with CIDR, while weak estrus occurred in 13.3% and 20.0%, respectively. Typical CVM fern patterns were observed in 73.3% of IVPS-treated cattle compared with 66.6% with CIDR. Non-return rate and first-service conception rate were 86.65% and 53.33% with IVPS, compared with 80% and 46.66% with CIDR, respectively.

The self-made IVPS demonstrated reproductive performance comparable to CIDR and a higher conception rate. It represents a promising low-cost progesterone delivery system for management of postpartum anestrus in cattle. Further studies on formulation standardization, cost-benefit analysis, larger populations and vaginal safety are warranted.

**Keywords:** Postpartum anestrus; Intravaginal progesterone sponge; Estrus induction; CIDR; Cattle

# Enabling Women's Economic Empowerment: The Role of Skills, Mobility and Decision-Making

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Women's economic empowerment is central to gender equality and inclusive development, yet women in Jammu and Kashmir continue to face substantial barriers to labour market participation. This study examines the role of education and skills, mobility, decision-making autonomy, and access to financial services in shaping women's economic participation. The analysis is based on household-level primary survey data collected from 1,132 women across 606 households in 45 rural and urban villages/localities in Srinagar, Anantnag, and Baramullah districts of Kashmir. Using logistic regression and propensity score matching (PSM), the study identifies the factors associated with women's participation in the job market and assesses the robustness of the estimated relationships.

The findings reveal that only 23.9 percent of surveyed women participate in the job market, while the female unemployment rate is 38.65 percent. Education and skills are strongly associated with economic participation, with participation increasing substantially with higher levels of educational attainment and technical training. Relative to women with below-secondary education, the estimated odds of labour market participation are approximately 5.7 times higher among women with secondary or higher-secondary education, 34.3 times higher among graduates, 65.8 times higher among women with diploma or technical training, and 111.4 times higher among women with postgraduate education or above. However, educational attainment alone does not ensure economic participation. Only 14.92 percent of women reported having a say in decisions concerning whether they could work, while 35.85 percent reported unrestricted mobility outside their locality. Women with greater work-related decision-making autonomy, greater mobility, and access to banking services also demonstrate significantly higher odds of participation.

The PSM results reinforce these findings, showing substantially higher labour market participation among women with vocational training, greater mobility, and greater autonomy in work-related decisions. The study highlights the need for an integrated policy approach that combines education and skills development with measures to enhance women's mobility, decision-making power, financial inclusion, and supportive social environments.

**Keywords:** Inclusive Growth; Female Labour Force Participation; Women's Economic Empowerment; Skill Development; Women's Mobility.

# Bioconversion of household organic waste: Sustainable Management Strategies

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**Abstract**

Waste is a material that no longer serves a purpose and thrown away. In some cases, what one person throws away can be reused by somebody else. A woman is the key decision maker of the household, responsible for the waste disposal practices of the family. She makes a tremendous contribution to the family. The habits of one family will undoubtedly affect society as a whole. With so much waste surrounding us every day, it has become challenging for our families to maintain their health. Human activities generate waste, with household cooking waste being one of the primary ones. Fruit and vegetable peels are organic waste usually produced by the household. A large amount of peeling waste is produced by the household kitchen and has led to a big economical loss in addition to environmental problems. Organic kitchen waste management is very important as it negatively affects not only the environment but also the economy of the country. Through organic kitchen waste management, we can reuse and recycle our resources and save money. The objective of writing this paper is to collect and gather information regarding the efficiently utilization of commonly available vegetable and fruit peels. The other purpose is to find common practices adopted by women in managing organic kitchen waste. In this study, the efficient utilization of organic kitchen waste is discussed, and the sample size is 100 women of Srinagar City, Kashmir. The major finding of this study is that illiterate women utilize vegetable and fruit peels more often compared to literate women. Vegetable and fruit peels have many uses in culinary art, cleaning, skin care and making compost. There are dozens of uses for vegetable and fruit peels. We can make cleaning products, facial scrubs, homemade stock and natural dye and much more.

Keywords: Organic kitchen waste; Fruit and vegetable peels; Waste utilisation; Women's waste management practices

# Assessment of Vitamin D Status and Associated Lifestyle Determinants Among Adult Females in District Anantnag

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Vitamin D deficiency is an important public-health concern among women and may be influenced by limited sunlight exposure, clothing practices, dietary insufficiency, supplementation patterns, and restricted outdoor activity. Understanding these determinants is essential for developing context-specific nutritional and preventive-health strategies.To assess the prevalence and severity of vitamin D deficiency among adult females in District Anantnag and examine its association with selected lifestyle, socioeconomic, and anthropometric factors.A hospital-based cross-sectional study was conducted among 50 apparently healthy females aged 20–60 years in District Anantnag. Participants included students, homemakers, and employed women and were selected purposively. Data were collected using a structured questionnaire, interview schedule, food-frequency questionnaire, and 24-hour dietary recall. Anthropometric measurements, clinical assessments, and serum 25-hydroxyvitamin D estimations were recorded to classify vitamin D status.Vitamin D deficiency was observed in 70% of participants, while 30% had normal serum vitamin D levels. Among deficient participants, 57.1% had mild deficiency, 28.5% had moderate deficiency, and 14.2% had severe deficiency. The highest proportion of deficient participants was observed among homemakers and women aged 31–40 years, each accounting for 42.8% of the deficient group. Limited sunlight exposure was common among deficient participants, with 57.1% reporting less than seven hours of outdoor exposure per week. Overweight and obesity were reported in 48% and 12% of participants, respectively, while 78% reported no routine vitamin D supplementation. Vitamin D deficiency was highly prevalent among adult females in District Anantnag and was commonly accompanied by limited sunlight exposure and low supplementation use. Community-based awareness programmes, dietary counselling, promotion of safe sunlight exposure, supplementation guidance, and consideration of food-fortification strategies may help reduce this nutritional public-health burden.

**Keywords:** Vitamin D deficiency; adult females; sunlight exposure; nutritional status; lifestyle determinants

# Analysing Push–Pull Tourist Motivation, Satisfaction, and Revisit Intention in Rural Tourism: A case study of Kashmir Valley

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## Abstract

Rural tourism has emerged as an important avenue for destination diversification and sustainable local development; however, understanding the factors that shape tourists' satisfaction and future behavioural intentions remains crucial for its long-term competitiveness. This study examines the effects of push and pull travel motivation factors on tourist satisfaction and revisit intention in rural destinations of the Kashmir Valley, Jammu and Kashmir (UT). A quantitative research design was adopted, and primary data were collected from 380 tourists through a structured questionnaire. The data were analyzed using descriptive and inferential statistical techniques in SPSS version 27. The findings demonstrate that both push and pull motivation factors exert a significant positive influence on tourist satisfaction, indicating that tourists' internal travel motives, together with destination-specific attributes, play an important role in shaping their overall evaluation of rural tourism experiences. Furthermore, tourist satisfaction significantly and positively influences revisit intention, highlighting the importance of delivering satisfactory and memorable rural tourism experiences to encourage future visitation. The study contributes to the growing literature on rural tourism by empirically linking tourist motivation, satisfaction, and revisit intention within the context of Kashmir Valley. From a practical perspective, the findings provide important implications for policymakers, destination managers, tourism planners, and local stakeholders in designing targeted marketing strategies, improving destination attributes, enhancing visitor experiences, and strengthening sustainable rural tourism development in Jammu and Kashmir.

**Keywords:** Rural Tourism; Push–Pull Motivation; Tourist Motivation; Tourist Satisfaction; Revisit Intention; Kashmir Valley; Jammu and Kashmir

# Coformer-Directed Structural and Property Modulation in Multi-Stimuli-Responsive Optical Waveguiding Co-Crystals

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Organic co-crystals have emerged as versatile materials platforms, offering a rational and convenient strategy for tuning physicochemical properties through controlled molecular assembly. Their interdisciplinary significance has enabled the development of improved pharmaceutical systems and functional materials for applications in optoelectronics, sensing, and agriculture. We report two ionic co-crystals and their tunable fluorescence, optical waveguiding, and diverse stimuli-responsive properties. The co-crystals were obtained by systematically varying the phenanthroline-based co-former in reactions with naphthalene disulfonic acid (NDSA-2H). The reaction with 1,10-phenanthroline (phen) afforded $[(\text{phen-H})_2^{+}\cdot(\text{NDSA})^{2-}\cdot H_2O]$ (SF-27), crystallizing in the triclinic $P\bar{1}$ space group, whereas the use of bathophenanthroline (b-phen) yielded $[(\text{b-phen-H})_2^{+}\cdot(\text{NDSA})^{2-}]$ (SF-30), which crystallizes in the monoclinic $P2_1/n$ space group. The two crystal systems display distinct morphologies, solid-state emission characteristics, and waveguiding behaviour, which can be attributed to differences in supramolecular organization and proton-transfer-driven aggregation. Both co-crystals exhibit pronounced mechanochromic, anomalous piezochromic, and selective vapofluorochromic responses, highlighting their structural adaptability in response to external stimuli. Furthermore, their potential applications in security printing and data encryption were demonstrated. Detailed experimental and computational investigations provide insights into the underlying structure–property relationships. These findings establish the reported ionic co-crystals as promising responsive solid-state luminophores for advanced photonic and information-security applications.

Keywords: Crystal engineering; optical waveguiding; vapochromism.

# Driven Smart In-Situ Metrology framework for Freeform Optics: Toward sustainable and Intelligent Optical Manufacturing

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## Abstract

Freeform optics offer exceptional design flexibility for developing compact, high-performance optical systems, but their industrial fabrication is challenged by the accurate measurement of complex surface geometries. To address this limitation, we propose a Shack–Hartmann sensor-based in-situ metrology framework integrated with CNC-enabled optical fabrication. Operating in reflection mode, the sensor head follows the programmed tool trajectory to quantitatively map surface deviations without interrupting the manufacturing process. The measured errors provide digital feedback for corrective machining, enabling adaptive surface-error compensation while reducing rework, material consumption, and fabrication time. A quantitative error-budget analysis is performed to assess the reliability of the metrology system. Further validation is carried out using a diffractive null optical element-based Mach–Zehnder interferometer and Holo-Shear lens, providing independent assessment of the measured surface characteristics. The proposed cyber-physical approach establishes a scalable pathway toward intelligent, resource-efficient, and sustainable fabrication of complex freeform optics, consistent with the principles of Industry 5.0.

**Keywords:** Freeform optics; Shack–Hartmann sensor; In-situ metrology; Mach–Zehnder interferometer; Holo-Shear Lens; Industry 5.0.

# Enabling sustainable precision manufacturing: A comparative study of smart metrology method for freeform optics

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## Abstract

Freeform optics enable advanced optical systems by providing complex surfaces beyond conventional spherical and aspherical surface geometries. However, achieving high-precision fabrication requires reliable and adaptable metrology. This work presents a comparative study of freeform optical metrology methods, focusing on their roles in precision measurement, fabrication feedback mechanism, and quality assurance. It investigates the integration of advanced metrology techniques with computational design, precision machining, polishing, and molding to establish intelligent, closed-loop manufacturing. By incorporating metrology techniques with smart engineering, human-centric automation, and resource-efficient processes, the study highlights the potential of Industry 5.0 to enable accurate, intelligent, and sustainable freeform optical manufacturing.

**Keywords:** Freeform optics; Smart metrology; Precision metrology; Industry 5.0; Intelligent manufacturing; Sustainable optical manufacturing

# Engineering Crystals for Function: A Case Study

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## Abstract

Functional-group and coformer engineering offer effective strategies for controlling molecular packing and crystal structures, thereby tuning the properties of organic crystalline materials. Rational functional-group substitution and co-crystallisation, in particular, can modulate optoelectronic responses, enabling the development of stimuli-responsive and sensing materials.

In the present work, we investigate how functional-group variation influences the **structural, optical, photo physical, electrochemical, and sensing properties** of two organic Schiff-base co-crystals incorporating arsenic- and sulfonic-acid functionalities. The combined effects of **functional-group-dependent electronic distribution and co-crystal packing** on the resulting properties are systematically investigated. Beyond bulk and structural characterization, the crystalline materials were comparatively evaluated to elucidate the influence of functional-group chemistry and crystal packing on their properties. The results reveal notable differences in their **optical, electrochemical, and stimuli-responsive sensing behaviours**, highlighting how subtle changes in molecular functionality and crystal packing can effectively tune the properties of organic crystalline materials.

**Keywords:** Hydrogen bond; Co-crystal; Sensor;Device

# Impact of Artificial Intelligence and Modern Digital Technologies Across Core Sectors: Practical Challenges and Future Directions

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Recent advancements in Artificial Intelligence (AI) and Data Science are fundamentally changing how modern industries operate, analyze complex data, and make strategic decisions. By combining core analytical techniques such as machine learning and predictive modeling with emerging digital systems like the Internet of Things (IoT), edge computing, robotics, and generative AI, practical tools are being deployed across key sectors including healthcare diagnostics, smart agriculture, classroom education, banking, and automated manufacturing. However, this widespread adoption introduces serious challenges that demand attention, including algorithmic bias, data privacy vulnerabilities, heightened cybersecurity risks, and the spread of digital misinformation.

This study evaluates these developments from a practical engineering perspective, emphasizing that automated tools should serve to assist human workers rather than eliminate them completely. As routine and repetitive computational tasks become automated, workforce demands are steadily shifting toward problem formulation, critical data interpretation, and ethical oversight. Consequently, continuous digital literacy and structured technical reskilling are essential to prepare both students and industry professionals. Furthermore, the paper underscores the importance of closing the digital divide through equitable access to technology infrastructure, while adopting energy-efficient computing practices to ensure that technical progress remains inclusive, transparent, and environmentally sustainable.

Keywords: Artificial Intelligence; Data Science; Human–AI Collaboration; Cybersecurity; Sustainable Computing

# Statistical Deep Learning for Wireless Signal Classification and Efficient Inference

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**Abstract**
This paper introduces a Statistical Deep Signal Processing Model (SDSPM) that integrates the foundational principles of classical statistical inference with the representational capacity of deep neural networks. The proposed framework addresses signal classification and channel estimation tasks in the presence of noise and interference, while providing theoretical performance guarantees. Through rigorous mathematical development, it is established that the model attains asymptotic efficiency in the Fisher information sense, achieves mini max optimal convergence rates, and supports valid inferential procedures for signal parameters. A comprehensive theoretical foundation confirms the consistency, asymptotic normality, and semi parametric efficiency of neural-based signal estimators, thereby ensuring dependable operation in dynamic and uncertain wireless environments. Extensive simulation studies and empirical evaluations on synthetic and experimentally measured wireless channel datasets demonstrate that SDSPM achieves high classification accuracy while substantially reducing computational overhead relative to conventional techniques, including matched filtering and standard deep learning architectures. The methodology is structured for phased deployment encompassing signal acquisition, feature engineering, model training and validation with statistical safeguards, and real-time inference. Collectively, this work contributes a rigorous, scalable, and reliable framework for intelligent signal processing, cognitive radio systems, and AI-enabled wireless network management.
**Key words:** Statistical signal processing; Deep learning; Semi parametric efficiency; Signal classification; Wireless communications; Channel estimation.

# Automated Mineral Classification Using Hybrid Deep Learning Models: Insights into Cosmogenic Radionuclide Dating—A Case Study from Schirmacher Oasis, East Antarctica

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## Abstract

Isolation of pure quartz is a fundamental to cosmogenic surface exposure dating. Polar regions like Schirmacher oasis (East Antarctica) which consist of complex and polymetamorphic rock types, quartz separation is challenging. Conventional methods such as magnetic separation, optical microscopy and acid etching are time consuming and subjective, secondly having approximately similar densities and magnetic susceptibilities effective separation of quartz from feldspar is further reduced. In order to overcome these constraints, we developed a unique automated hybrid framework that combines deep learning based features with handmade texture descriptors. For this, we selected five minerals such as quartz, feldspar, garnet, hornblende and dolomite based on their abundance in the samples collected during 36th Indian Antarctic expedition. In the first phase machine learning algorithms like random forest, decision tree and support vector machine were examined using Local binary, Colour features and Gray level co-occurrence matrix. Among these, colour features produced the highest accuracy of 95% with random forest. To further enhance classification, pretrained CNN models were investigated (MobileNetV2, Xception, NASNETLarge, NASNETMobile and InceptionV3). MobileNetV2 and Xception performed better with accuracies 97.20% and 97.50% respectively. A hybrid framework was finally developed by combining features from these models with GLCM and colour descriptors using Support vector machine as the classifier. This enhanced the accuracy to 99.12% with near perfect AUC and ROC values. In addition, SHAP based explainable AI analysis indicated that colour attributes—particularly hue and saturation statistics—together with selected deep CNN features and GLCM texture descriptors, contributed most significantly to class discrimination. The proposed method improves the sample preparation process, mineral selection and increases the reliability of CRN based exposure age determinations.

Keywords: CRN dating, Machine learning, Antarctica, Schirmacher oasis, Mineral separation

# Comparative Analysis of GIS-based Qualitative and Quantitative Approaches for landslide susceptibility Assessment: a case study from National Highway-1(NH-1), Northwest Himalaya, India.

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## Abstract

Landslides pose significant socio-economic risks in mountainous regions such as the Himalayas. The National Highway-1 (NH-1) corridor from Sonamarg to Kargil is particularly susceptible to landslides due to extreme weather conditions, rugged terrain, and anthropogenic activities, resulting in frequent traffic disruptions and substantial human and economic losses. Therefore, effective landslide hazard assessment and mitigation are essential for ensuring the safety and functionality of this strategic corridor. The present study aims to develop, compare, and validate landslide susceptibility maps (LSMs) along NH-1 from Sonamarg to Kargil, Northwestern Himalaya, to support an effective disaster risk reduction (DRR) framework. Further, the two GIS-based models, i.e., Weighted Overlay (qualitative) and Frequency Ratio (quantitative), were applied and comparatively evaluated. For this purpose, a landslide inventory map was compiled from extensive field work and secondary sources for training and validating employed models. However, the landslide susceptibility maps (LSMs) were generated from landslide inventory data and fifteen landslide causative factors (CFs) in a geographic information system (GIS) platform. Therefore, these models examined the link between landslide CFs and landslides. Further, these LSMs were classified the area into five zones of susceptibility: very high, high, moderate, Low, and very low. Subsequently, the resultant LSMs were then evaluated and compared to the existing landslide inventory data using the area under the curve (AUC) method. Moreover, the developed Landslide Susceptibility Maps (LSMs) will provide a scientific basis for hazard-informed planning, design, construction, and maintenance of infrastructure, thereby supporting decision-making by planners, engineers, designers, and local communities within the study region.

**Keywords** Disaster risk reduction; Frequency ratio; Geographic information system; Himalaya; Weighted overlay

# ENSO Modulation of Winter Precipitation through Atmospheric Circulation Moisture Transport and Orographic Controls in the North-western Himalayas

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1. *Department of Environment, Sustanabilty and climate Change, Islamic University of science and Technology (IUST) Kashmir, India*
2. *Department of Meteorology, University of Reading, Reading, UK*

Abstract

Winter precipitation is a major component of the hydroclimate of the Northwestern Himalayas, influencing snow accumulation, water availability and regional hydrological processes. This study investigates the modulation of winter precipitation by El Niño–Southern Oscillation (ENSO) and examines associated atmospheric circulation, moisture transport and topographic controls across 12 representative regions of the Northwestern Himalayas during 1981–2024. Daily precipitation from CHIRPS and India Meteorological Department observations was analysed with the Niño-3.4 index, ERA5 atmospheric fields and HYSPLIT backward trajectories. The study period comprised 15 El Niño, 15 La Niña and 14 neutral winters. El Niño winters recorded the highest cumulative precipitation of 44,969.6 mm and mean precipitation of 5,621.2 mm, compared with 39,788.8 mm and 4,973.6 mm during neutral winters and 34,662.2 mm and 4,332.8 mm during La Niña winters. However, differences among ENSO phases were not statistically significant ($p > 0.05$), while the Niño-3.4 index showed a weak positive correlation with winter precipitation ($r = 0.30$), indicating that ENSO alone does not explain precipitation variability. ERA5 analysis showed that wetter winters were associated with stronger mid-tropospheric ascent, with 500-hPa vertical velocity reaching approximately −4.6 Pa $s^{-1}$, compared with −0.21 Pa $s^{-1}$ during relatively dry conditions. Wetter winters were also characterized by a southward displaced Subtropical Jet, deeper upper-level troughs and enhanced upper-level divergence. HYSPLIT trajectories revealed broadly consistent moisture-source regions across ENSO phases, predominantly involving the Mediterranean Sea, Arabian Sea and adjoining regions of Pakistan. Elevation and terrain configuration strongly influenced precipitation distribution, with greater variability across mountainous Kashmir and comparatively low precipitation in the rain-shadow regions of Leh and Kargil. Overall, the findings demonstrate that ENSO acts primarily as a large-scale climatic modulator, whereas atmospheric circulation, moisture transport and complex Himalayan topography determine the spatial and temporal expression of winter precipitation. These interactions help explain pronounced regional and interannual precipitation differences.

Keywords: ENSO; Northwestern Himalayas; Niño 3.4;Winter Precipitation ; Subtropical Jet; CHIRPS.

# Environmental protection with reference to conserve water bodies: An Islamic Perspective

Ghulam Nabi Ganie[1] & Zahid Ahmad Shah[1]

1. *Department of Islamic Studies IUST Awantipora Pulwama, Kashmir.*

## Abstract

Water represents a main global resource and the literal foundation of existence, as emphasized by the Quranic declaration, "We made from water every living being." Far from being a right to be abused, water is a divine gift and a sacred trust from Allah, making humanity its responsible caretaker. In Islam, water holds a central position in both daily life and required religious rituals, emphasizing its spiritual and physical value. Despite its sanctity, water bodies face severe environmental crises driven by human negligence and exploitation. This is evident in Kashmir where iconic sources such as Dal Lake, the Jhelum River, wetlands, and springs and currently choking under human waste. This degradation reflects a deeper moral crises and aligns with Qur'anic warning that mischief and corruption appear on land and sea because of what human hands have earned. To address this crises, Islam provides a strong framework for water resource management. Prophetic traditions declare that "people are partners in three things: water, pasture and fire," meaning that water belongs to everyone and cannot be monopolized by the powerful, the polluters, or the wasteful. Furthermore, the Prophet Muhammad (peace be upon him) prohibited extravagance, warning, "Do not waste water if you are on flowing river." Using a qualitative approach, this research analyses these religious teachings and explores how Islamic ethical values can guide modern water-conservation efforts. The study finds that the Qur'an and Hadith provide a strong basis for the responsible and sustainable management of water resources.

**Keywords**: Conservation, Jhelum, Dal Lake, Wise Management, Mischief.

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# Explainable AI for Disaster Resilience: A Data-Driven Framework for Early Prediction of Floods and Landslides

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By integrating AI-driven prediction, geospatial information and human-readable explanations, the proposed framework provides a transparent and transferable foundation for anticipatory disaster management in Jammu and Kashmir and other climate-vulnerable mountain regions.

The key novelty of the framework lies in coupling predictive modelling with interpretable, location-specific risk explanations rather than treating model accuracy as the sole objective. For example, an alert could identify the combined influence of unusually high rainfall, saturated soil and steep terrain, enabling disaster-management authorities to understand the basis of a prediction and prioritize monitoring, evacuation planning and emergency-resource allocation. The modular architecture is designed to incorporate emerging weather, sensor and satellite data streams and to scale from individual vulnerable valleys to wider regional applications.

This study proposes an Explainable Artificial Intelligence (XAI) framework for localized early prediction of floods and landslides in Jammu and Kashmir. The framework integrates rainfall intensity and accumulation, temperature, soil characteristics, elevation, slope, land-use and land-cover information, hydrological conditions, and satellite observations to construct a spatially informed disaster-risk profile. Machine-learning and deep-learning models are proposed to identify nonlinear relationships among these heterogeneous factors, while SHapley Additive exPlanations (SHAP) are employed to quantify the contribution of individual variables to each prediction.

Disaster-prone mountainous regions such as Jammu and Kashmir require early-warning systems that can capture highly localized interactions among rainfall, terrain, soil and hydrological conditions. Conventional threshold-based approaches often treat these variables independently and provide limited insight into why a particular warning is generated. This creates a critical gap between predictive capability and actionable disaster management.

Keywords: Explainable AI; Disaster Resilience; Flood Prediction; Landslide Prediction; Early Warning Systems

# Functionalized Graphene Oxide-Embedded Hydrogels for Adsorptive Removal of Aromatic Hydrocarbons from Aqueous Systems

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In this work, a composite based on a Lasoda hydrogel and hydroxyl-functionalized graphene oxide (LA-GO-OH) was synthesized and used as an adsorbent for the efficient removal of polycyclic aromatic hydrocarbons from aqueous media. The hydroxyl-functionalized GO was prepared by thermal shock and incorporated into the hydrogel via in situ polymerization. The LA-GO-OH was characterized using XRD, FTIR, FESEM, EDS, RAMAN, and XPS, which confirmed the successful formation of the composite. The XPS was used to examine the adsorption of Naphthalene and Anthracene on the solid surface, revealing a binding energy of ~ 284.78 eV on the C 1s core-level spectra, attributed to aromatic carbon atoms, and shake-up at ~ 286 - 289 eV, which indicates the aromatic rings were not affected by the adsorption process. Since the intensity of these features was greater in the spectra of Ant, there were more delocalized electrons in the molecule. The adsorptive capacity of the composite was then studied by examining Nap and Ant adsorption onto the composite using UV-Vis (max = 220 nm and 375 nm, respectively [1,2]. The maximum removal efficiencies were 97% and 94%, and the maximum capacities were 88 and 128 $mgg^{-1}$, respectively. The primary interaction involved the delocalized π electrons in organic molecules and the graphitic material and was independent of the composite setup. The data fitted the Langmuir isotherm and pseudo-second-order kinetic models ($R^2$ = 0.99). The adsorption was spontaneous, entropy-driven, and endothermic.

**Keywords:** Hydrogel; Naphthalene; Anthracene; Adsorption; Models

# GIS-Based Localization of the Sustainable Development Goals for Climate and Disaster Resilience in the Himalayan Region of Jammu and Kashmir

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## Abstract

The Sustainable Development Goals (SDGs) establish a global agenda for inclusive development and environmental sustainability, yet their implementation must account for regional physical and socioeconomic conditions. This is particularly relevant in the Himalayan region of Jammu and Kashmir, where complex terrain, climatic variability, geohazards, sensitive ecosystems and dispersed settlements present interconnected challenges. The Sustainable Development Goals Report 2025 highlights inadequate global progress towards the 2030 Agenda and calls for accelerated, integrated action. In response, this study proposes a GIS-based approach to localizing SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action) and SDG 15 (Life on Land) in the Himalayan region of Jammu and Kashmir. Topographic characteristics, land use/land cover, vegetation, hazard susceptibility, settlements, and infrastructure are integrated to examine the convergence of human exposure, physical constraints, and ecological sensitivity. The approach seeks to identify priority areas where these pressures intersect, providing a basis for disaster-risk reduction, climate adaptation, habitat conservation and sustainable land management. By examining the interrelationships among the three SDGs rather than treating them independently, the study demonstrates how geospatial analysis can translate global sustainability targets into place-specific evidence for informed planning in environmentally complex Himalayan landscapes.

**Keywords:** SDG localization; geohazards; land use/land cover; sustainable land management.

# Linear Infrastructure and Flood-Path Modification: Assessing the Influence of Railway and Highway Development on Flood Dynamics in the Kashmir Valley

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Flood waters across a landscape are governed by the interaction between topography, drainage connectivity, surface storage and fluvial processes. However, rapid infrastructure development can alter these natural controls by introducing barriers across established flow pathways. Linear infrastructure in particular can intercept natural overland and near-surface flows, altering local hydrological connectivity and creating spatially uneven patterns of water accumulation and deficit. The expansion of railway networks and highway corridors introduce embankments, elevated tracks, culverts and engineered drainage structures across heterogeneous floodplain environments. While such infrastructure is essential for regional connectivity, its interaction with natural drainage pathways may modify the spatial and temporal distribution of floodwater, with implications for downstream and adjacent settlements. This study investigates the potential influence of Banihal-Baramulla railway and expansion of NH44 highway and ring-raod network on flood-path connectivity and flood-risk redistribution across the Kashmir Valley. A spatially integrated framework combining high-resolution digital elevation models, drainage networks, infrastructure alignments, land-use/land-cover data and satellite-derived flood inundation is used to characterize natural flow pathways and identify their intersections with transportation corridors. Changes in flow path, drainage connectivity, floodwater retention and inundation patterns will be assessed, with particular emphasis on locations where embankments intersect natural channels, depressions and overland-flow pathways. The study identifies potential infrastructure-induced flow diversion, localized ponding, backwater effects and changes in flood exposure patterns of nearby settlements and agricultural areas. By linking infrastructure configuration with landscape-scale hydrological connectivity, this study seeks to demonstrate how transportation development can reshape flood pathways rather than simply occupy flood-prone terrain. The finding provide a scientific basis for identifying infrastructure-related flood hotspots and improving cross-drainage design, flood-risk assessment and climate-resilient infrastructure planning in the Kashmir Valley.

**Keywords:** Hydrological Connectivity; Linear Infrastructure; Flow Pathway; Flow Diversion; Flood Inundation

# Mapping Neotectonic Signatures and Landscape Dynamics to Identify Exposure Hotspots for Spatial Governance in Baramulla District, Kashmir Valley, North-West Himalaya

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## Abstract

Seismic risk does not arise from ground shaking alone; it emerges where active Earth processes intersect with evolving landscapes and human development. In the Kashmir Himalaya, signatures of Quaternary deformation are preserved in Karewa sediments and fluvial landscapes, yet their implications for contemporary development and infrastructure planning remain insufficiently integrated. This study develops a geospatial framework for Baramulla District to identify areas where evidence of neotectonic processes intersects with human settlements and critical infrastructure. High-resolution satellite imagery, Digital Elevation Models and field investigations will be integrated to identify geomorphic expressions of deformation, including terrace tilting, drainage anomalies, channel offsets, knickpoints and structural lineaments. Soft-sediment deformation structures within Karewa sequences will additionally be investigated for evidence of past earthquake-related deformation, complementing the present landscape record with a palaeoseismic perspective that extends beyond the instrumental period. Using GIS-based overlay analysis, the mapped neotectonic signatures and geomorphic indicators will be intersected with human settlements, major highway corridors, railway links, power grids, and critical public infrastructure. This integration will delineate neotectonic–development exposure hotspots to inform infrastructure and land-use planning. Rather than treating neotectonic mapping as an end in itself, the study uses the evolving landscape as an evidence base to connect Earth-system processes with infrastructure exposure, thereby extending geological knowledge beyond conventional hazard characterization to inform safer infrastructure siting and disaster-resilient regional development in earthquake-prone Himalayan regions.

**Keywords:** Active Tectonics, Critical Infrastructure, Neotectonic Signatures, Exposure Hotspots, Kashmir Himalaya.

# Spatial Assessment of Landfill Leachate Impacts on Surface and Groundwater Quality Using GIS and WQI in Jammu City

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## Abstract

Rapid urbanization and increasing municipal solid waste generation in Jammu City, Jammu and Kashmir, have placed considerable pressure on existing waste disposal infrastructure and surrounding water resources. The present study evaluates the potential impact of municipal solid waste disposal sites on surface water (SW) and groundwater (GW) quality in the vicinity of the Bhagwati Nagar and Kot Bhalwal landfill sites. A total of 20 water samples, comprising 10 surface-water and 10 groundwater samples, were collected from locations at varying distances from the landfill areas. The samples were analyzed for key physicochemical parameters, including temperature, pH, electrical conductivity (EC), salinity, resistivity, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), hardness, biochemical oxygen demand (BOD), alkalinity, chloride, and calcium. Spatial variations in water-quality parameters were evaluated using GIS-based interpolation techniques to identify potential contamination gradients. The results indicated noticeable variations in physicochemical characteristics between surface and groundwater samples. Groundwater EC ranged from 392 to 480 µS/cm, while surface-water EC ranged from 191.2 to 199.1 µS/cm. TDS concentrations reached 423 mg/L in groundwater and 515.2 mg/L in surface water. Surface-water turbidity (8.2–8.9 NTU) was consistently higher than groundwater turbidity (6.0–6.5 NTU), while groundwater DO (3.1–3.4 mg/L) was substantially lower than surface-water DO (5.0–5.5 mg/L), indicating greater oxygen depletion in subsurface water. Chloride concentrations approached or exceeded the desirable limit in several surface-water samples, whereas calcium concentrations remained within the reported permissible range. The observed variations suggest the influence of landfill-derived leachate, domestic waste disposal, surface runoff, and local hydrogeological conditions on water quality. The Water Quality Index (WQI) was further employed to provide an integrated assessment of water suitability. The findings highlight the vulnerability of water resources surrounding the landfill sites and emphasize the need for engineered landfill systems, effective leachate collection and treatment, regular water-quality monitoring, GIS-based contamination assessment, and improved municipal solid waste management practices to protect surface and groundwater resources in Jammu City.

Key words: Municipal solid waste; Landfill leachate; Groundwater contamination; Surface water quality; Water Quality Index (WQI)

# Unravelling the Provenance of the Lower Karewa sediments: Geochemical and Sr-Nd Isotopic evidence from the Kashmir Valley

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The Plio-Pleistocene Karewa succession in the Kashmir Valley preserves a key sedimentary record of Himalayan erosion, sediment transport, and intermontane basin evolution, yet the provenance of the basal Dubjan Member of Lower Karewa remains incompletely constrained. Here we integrate major and trace element geochemistry, rare earth element (REE) geochemistry, and Sr-Nd isotopes to identify principal sediment sources and evaluate sediment mixing processes during deposition of the Dubjan Member. Samples display $Al_2O_3/TiO_2$ ratios of 7.8–20.9 (mean 13.6), consistent with derivation from intermediate to felsic lithologies. Chondrite-normalised REE patterns show enrichment in light REEs (LREE) relative to heavy REEs (HREEs), pronounced negative Eu anomalies (mean Eu/Eu* = 0.69), and $(La/Yb)_N$ ratios of 3.87–18.32, indicating derivation predominantly from differentiated felsic continental crust. Radiogenic $^{87}Sr/^{86}Sr$ ratios (0.7116–0.7238) and strongly negative εNd(0) values (−12.0 to −9.6) further support an evolved continental crustal source with limited input from juvenile material. Comparisons with Himalayan lithotectonic end members and Sr-Nd mixing models identify Greater Himalayan Sequence as the principal sediment contributor, with subordinate inputs from the Panjal Traps/Panjal volcanic rocks and related intermediate lithologies. Temporal variations in elemental and isotopic signatures indicate changes in sediment mixing, sorting, and weathering intensity together with minor variations in source contributions during deposition. These results provide new constraints on sediment provenance and source mixing during basin evolution and improve our understanding of sediment dispersal from the Himalayan hinterland into the Kashmir Basin during deposition of the Dubjan Member.

**Keywords:** Lower Karewa; Sediment provenance; Rare earth elements; Sr-Nd isotopes;

# COMMITTEES & THEIR RESPONSIBILITIES

| S. NO | COMMITTEE | SUGGESTED CHAIR/CONVENER | MAJOR ROLES & RESPONSIBILITIES |
|---|---|---|---|
| 1. | **Steering Committee** | Prof. Shakil A. Romshoo, HVC (Chairperson)<br>Dean Academic Affairs<br>Registrar<br>Dean Research<br>Finance Officer<br>Dean of Students<br>Dean Outreach<br>Deans School of Business Studies<br>Dean School of Technology<br>Dean School of Humanities and Social Sciences<br>Dean School of Heath Sciences<br>Dean School of Architecture, Planning and Geomatics<br>University Engineer<br>Mr Bilal Ahmad, Joint Director, JKST&IC<br>All Chairpersons of other event specific/common committees | Develop Scientific programme, Identify Plenary Speakers, Invited speakers, VVIPs, and VIPs. Overall coordination, Periodic Review and Setting of timelines. |
| 2. | **Scientific Committee** | Dean Academic Affairs, (Chairperson)<br>Prof. B. A. Ganaie (Dean Research, KU)<br>Prof. S. Hotha (Professor, IISER Pune)<br>Prof. Neelu Rohmetra, Dean Research, JU<br>Professor Ayub Qadri, Ex Dean, SOHS, IUST<br>Prof. Manzoor Ahmad Malik, Dean SoP&MS, KU<br>Professor Kowsar Majid, NIT, Srinagar<br>Professor Anzar A. Khuroo, DoB, KU<br>Professor Altaf Bhat, CIRI, KU<br>Professor Aijaz Ahamd Dar, KU<br>Professor Shalab, DoS&D, IIT Kanpur<br>Professor Sajad Akhar, DoP, AMU<br>Professor Subhash Thota, DoP, IIT Guwahati<br>Professor Sasanka Deka, DoC, DU<br>Professor Ikram, DoP, NIT Srinagar<br>Dr Idrees Ahamd, Associate Professor, DoFT, KU<br>Dr Peer Bilal, Director, Head Mathematical Sciences<br>Dr. Inayet Rasool, Associate Professor DoAL&L<br>Dr. Shahkar Ahmad Nahvi, Associate Professor, DoEE<br>Dr Aamir Hussian Dar, Associate Professor, DoFT<br>Dr Niyaz Ahamd, Assistant Professor, DoP<br>Dr. Mohd Younus Bhat, Assistant Professor, DoMS<br>Dr Asif Banka, Assistant Professor, CSE<br>Dr. Mahvash Afzal, Assistant Professor, ME<br>Dr. Zahid Gulzar Khaki, Assistant Professor, E&CE<br>Dr. Syed Jaleel Hussain, Assistant Professor<br>Dr. Sumira Nazir Zaz, Assistant Professor, ES&CC<br>Dr Noor U Din Reshi, Assistant Professor, DoC<br>Dr. Shakeel Ahmad Khandy, Ramanujan Fellow, FRISS | Review abstracts, prepare proceedings, abstract book, and publication outputs to be coordinated by<br>Dr Peer Bilal, Head Mathematical Sciences and<br>Dr. Inayet Rasool, Associate Professor, Department of Arabic Language and Literature. |
| 3. | **Finance Committee** | Mr Sameer Wazir: Finance Officer (Chairperson)<br>Dr. G. N. Itoo, Director CGG&PA<br>Dr. Asifa Baba, Associate Professor, ECE<br>Dr. Manzoor A. Dar, Assistant Professor, DoC<br>Dr. Tariq Abdullah, Assistant Professor, DoP&G<br>Dr. Jasia Bashir, Assistant Professor, DoP&G<br>Dr. Suhail Yousuf, Ramanujan Fellow, FRISS<br>Mr. Manzoor Ahmad Kuthroo, AFO | Creation of Account for Conference, QR Code, Budget management. Identify and engage sponsors from government, corporate, and other sectors. Prepare sponsorship proposals. Ensure proper allocation and utilization of sponsorship funds Applying to different Funding agencies like INSA, DST, ANRF and others |

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|---|---|---|---|
| 4. | **Hospitality & Accommodation Committee** | Dr. Parvez Ahmad Mir, Director CIED (Chairperson)<br>Dr. S. Iqbal Quraishi, DR-Estates<br>Dr Shujaat Hussain, Head, CE<br>Dr. Asif B. Naqashbandhi, Assistant Professor, DMS<br>Dr. Bilal Ahmad Chat, Assistant Professor, DOMS<br>Dr. Javid Ahmad Ahanger, Assistant Professor, CIR<br>Dr. Javid Ahmad Khan, Assistant Professor, DoE<br>Dr. Rizwan Nabi, Ramanujan Fellow, FRISS | Managing and facilitating accommodation arrangements for invited guests and speakers, and participants Coordinating with transport committee for dignitaries and participants, including pick-up and drop-off services |
| 5. | **Transport & Logistics Committee** | Dr. Thameed Aijaz, Associate Professor, Food Technology (Chairperson)<br>Mr. Syed Mujtiba Hussain, Assistant Professor, CSE<br>Dr. Zahoor Ahmad Ganaie, Assistant Professor, EE<br>Dr. Mohd Junaid Mir, Assistant Professor, DoME<br>Dr. Danish Khan, Assistant Professor, DMS,<br>Mr Mubashir Nazir, AR Transport.<br>Dr. Mohd Shafi Bhat, Ramanujan Fellow, FRISS | Ensuring timely communication with transport vendors, Airport pickups, local transport, vehicle scheduling and movement of guests. |
| 6. | **Venue Management Committee** | Dr. Munejah Khan, Associate Professor, Do EL&L, (Chairperson)<br>Dr. Showkat Hussain Dar, Associate Professor, DoIS<br>Dr. Shaiqa Nasreen, Assistant Professor, ECE.<br>Dr. Romana Yousuf, Assistant Professor ECE<br>Ms. Isma Hamid, Assistant Professor, EL&L<br>Dr. Bilal Ahmad Para, Assistant Professor, DoMS<br>Dr. Shahid M. A. Baba, Assistant Professor, DOVS<br>Mr. Asrar Ahmed, Assistant Executive Engineer | Identification of Venues, Venue preparation, seating arrangements, signage, exhibition areas and infrastructure support. |
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| 8. | **Media & Publicity Committee** | Dr. Ruheela Hassan, Associate Professor (JMC) (Chairperson)<br>Dr. Mujeeb Liyaqat, Assistant Professor (JMC)<br>Dr. Rabia Noor, AP (JMC)<br>Mr. Javaid Ahmad Khan, AR / Coordinator PR&MC<br>Dr. S Muntazir Mehraj, Ramanujan Fellow, FRISS | Publicity, press releases, media relations, social media promotion and outreach.<br>photography, videography, |
| 9. | **IT & Website Committee** | Dr. Zahoor Ahmad Ganie, Director IT&SS (Chairperson)<br>Mr. Moazam Ul Shawkat Qadri, Jr. Network Engineer<br>Mr. Arshad Hussain, TA-CSE<br>Mr. Iftikhar Magrey, TA-CSE<br>Mr. Aijaz Ahmad Shah, Assistant Programmer, DIT&SS<br>Mr. Farhat Ali, Jr. Engineer (Electrical)<br>Mr. Sarfaraz Ahmad Bhat, IT Assistant | Develop website, manage online registration, provide audiovisual and technical support. |
| 10. | **Poster Presentation Management, Science Exhibition, Science Quiz and Painting** | Dr Muzzafar A Maccha, Sr Assistant Professor, WCCMM<br>Dr. Zahid Gulzar Khaki, Assistant Professor, E&C<br>Dr. Bari Maqbool, Assistant Professor, Physics<br>Dr. Imtiyaz Ahmad Bhat, Assistant Professor, Chemistry<br>Dr. Bilal Ahmad Para Assistant Professor, DoMS<br>Dr. Aamir Mushtaq, Ramanujan Fellow, FRISS | Organize exhibitions, industry participation, Ensure Student Representative participation of Schools. |

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| 11. | **Cultural Committee** | Dr Monisa Qadri, Dean of Students, (Chairperson)<br>Dr. Farhana Mehraj, Assistant Professor, FT<br>Dr. Afshana, Assistant Professor, KI&L<br>Dr. Jasia Bashir, Assistant Professor, DoP&G<br>Ms. Maryam Qureshi, Section Officer. | Organize cultural programmes, inaugural performances and heritage showcases. Ensuring participation from students, faculty, and the local community in festival activities. Managing logistical arrangements for performances and entertainment programs |
| 12. | **Reception Committee, Protocol & VIP Management Committee** | Prof Shamim Ahmad Shah, Registrar, IUST (Chairperson)<br>Prof. Yasmin Ashai, Director, RSCWHC<br>Dr. Peer Bilal, Director DIQA<br>Dr. Farooq Hussain Bhat, Dean SOS<br>Mr. Syed Suhail, Deputy Registrar-Establishment | Coordinate dignitaries' visits, protocol arrangements, inauguration and valedictory functions. |
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| 14. | **Printing Stationary, Souvenir & Publications Committee** | Mr. Qazi Qamar Iqbal Qari, Dean (SoA&P), (Chairperson)<br>Dr. Mandeep Singh, Assistant Professor, Physics<br>Mr. Mehran Qureshi, Assistant Professor, DoA<br>Dr. Irfan Maqbool, Assistant Professor, CDRR<br>Dr Tanveer ul Islam Ramanujan Fellow, FRISS<br>Ms Tanzeel Assistant Professor, DoA<br>Dr. Sayar A. Mir, Assistant Professor, JMC | Prepare souvenir, conference materials (Brochures, ID cards preparation, Invitation Cards, Designing Pamphlets, etc), Conference kits |
| 15. | **Dais Management Committee** | Dr. Asifa M. Baba, Associate Professor (Chairperson)<br>Dr. Rabia Noor, Assistant Professor, JMC<br>Ms. Shazana Andrabi, Assistant Professor, CIR<br>Dr. Arsheed A, Ganaie, Assistant Professor, WCCMM<br>Ms. Suhaila Gulshan, AFO | Coordinate seating arrangements on the dais for Chief Guest(s), Guest(s) of Honour, keynote speakers, and dignitaries as per protocol.<br>Ensure timely availability of nameplates, mementos, bouquets, citation folders, and other ceremonial materials.<br>Manage the movement, reception, and assistance of dignitaries before, during, and after the event |
| 16. | **Green Campus & Sustainability Committee** | Prof. Humayoon Rashid, PoP (Chairperson)<br>Dr. S. Iqbal Quraishi, DR Estates<br>Dr Ajaz Qureshi, AR, Landscape<br>Dr Faisal Barkat, Section Officer, Examination | Ensure eco-friendly practices, waste management, plastic-free event and sustainability measures., Arrange and maintain flower pots, indoor greenery, registration areas, exhibition spaces, and VIP lounges. |
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# VOLUNTEER COMMITTEES

## 1. FOOD COMMITTEE

| S. NO. | Name | Department | |
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| 1 | Tanveer Ahmad | Food Technology | 7889582149 |
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| 3 | Toiba Majeed | | 70063488654 |
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| 2 | Ayna Irshad | | M.A III |
| 3 | Tehaam | | M.A I |
| | Syed Nayak | | |
| 4 | Fayouz Bashir | Mathematical Sciences | M.Sc Statistics/ 1st Sem |
| 5 | Shariq Hamid Bhat | | |
| 6 | Tasaduq Sheeraz | | FYUGP/ 7 th Sem |
| 7 | Suhaib Iqbal | Islamic Studies | Ph.D Scholar |
| 8 | Razia Abdullah- | | |
| 9 | Imza Hassan- | | |
| 10 | Sheikh Farhan Syeed | E&C | B.Tech |
| 11 | Haya Shah | | |
| 12 | Farheen Sajad | | |
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| 5 | Aabiya | | BFT-24-08 |
| 6 | Ridaf | | BFT-24-32 |
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| 15 | Syed Suhail | Ph. D. Scholar (FRIIS) | |

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| 2 | Nusrat Bhat | Food Technology (PhD) | 6005788695 |
| 3 | Sadiya Shafi | Food Technology (PhD) | 7006427719 |
| 4 | Aasima Shafi | Food Technology (PhD) | 7889407784 |
| 5 | Insha Bashir | Chemistry (PhD) | 9858535519 |
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| 3 | Shabir Ali | MA-III | - |
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| 10 | Muhammad Hysam | B.Sc. Data Science | 8899554112 |
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| 2 | Hadi Sherwani | B. SC (AI)/ 3rd Semester | IUST0125020786 | 6006340411 |
| 3 | Kamran Amin | B. Tech (CSE)/ 1st Semester | IUST0126022575 | 8082368589 |
| 4 | Navjeet Randhawa | BSC (MTH)/ 3rd Semester | IUST0125020634 | 9541026386 |
| 5 | Eram Fatima | CE/ 7th Semester | IUST0124019528 | 7006102859 |
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| 12 | Faisal Khan | CE (Diploma)/ 1st Semester | IUST0126022961 | 9541437312 |
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| 16 | Mehreen Yasir | English/ 3rd Semester | IUST0125020705 | 8899944650 |
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| 19 | Nida Tariq | JMC/ 1st Semester | IUST0126022921 | 8899931330 |
| 20 | Diya Bhat | Food Tech/ 3rd Semester | IUST0125021021 | 9596118903 |
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