VALORIZATION 2026

INTERNATIONAL CONFERENCE ON SCIENCE & TECHNOLOGY INTEGRATION FOR CIRCULAR ECONOMY

29TH - 30TH JANUARY 2026

CONFERENCE PROCEEDINGS

BITS Pilani
Hyderabad Campus

BITS Pilani
TECHNOLOGY ENABLING CENTRE
DST Supported

BITS Pilani
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Institution's Innovation Council

BITS ENVIRONMENTAL SCIENCE & TECHNOLOGY
BEST LAB

Birla Institute of Technology and Science, Pilani
Pilani I Dubai I Goa I Hyderabad I Mumbai

Prof V Ramgopal Rao, Ph.D.,
Fellow of IEEE, TWAS, INAE, INSA, IASc, NASI
Vice-Chancellor & Senior Professor
Former Director (2016-2021), IIT Delhi
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Message from Vice Chancellor

It gives me immense pleasure to extend a warm welcome to all participants of VALORIZATION 2026: International Conference on Science & Technology Integration for Circular Economy, being organised at BITS Pilani, Hyderabad Campus.

Over the years, VALORIZATION has evolved into a meaningful platform for interdisciplinary deliberation, and the 2026 edition further strengthens this legacy by addressing some of the most pressing challenges of our time, such as resource depletion, waste accumulation, energy transition, and environmental sustainability.

The transition towards a circular economy necessitates the effective integration of science, technology, and policy. The conference theme aligns well with this vision, further emphasizing interdisciplinary convergence across biotechnology, engineering, and energy systems. This approach enables sustainable waste valorisation while enhancing climate resilience and promoting sustainable development.

I am confident that this event will provide a technically enriching and inclusive forum for academicians, researchers, industry professionals, and policymakers to exchange ideas, present pioneering research, and explore pathways for real-world implementation.

I commend the organizing committee for their dedication and vision in curating this important event, and extend my best wishes to all participants for a productive, engaging, and inspiring conference experience. Through collective deliberation and collaboration, this conference aims to make a meaningful contribution toward making our planet a better place to live.

Warm regards,

Ramgopal Rao

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Birla Institute of Technology & Science, Pilani
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Prof. D. Sriram
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Message from Director Incharge

It gives me great pleasure to extend a warm welcome to all delegates joining VALORIZATION 2026 at BITS Pilani, Hyderabad Campus. This conference brings together a community of researchers, innovators, and practitioners who are united by a common purpose: to rethink how science and technology can reshape our relationship with resources, energy, and the environment.

Rather than viewing waste as an endpoint, VALORIZATION 2026 emphasises transformation, integration, and intelligent design, where discarded materials become inputs for new processes, products, and value chains. The conference provides a platform to explore how fundamental research, advanced engineering, and data-driven technologies can converge to support circular systems that are both economically viable and environmentally responsible.

Throughout this conference, participants will engage in focused technical sessions, expert-led discussions, and interdisciplinary exchanges that span the biological, chemical, environmental, and engineering sciences. By bringing together diverse expertise and perspectives, VALORIZATION 2026 aims to stimulate new ways of thinking, challenge conventional boundaries, and foster research that yields scalable, real-world solutions.

I sincerely appreciate the efforts of the organizing committee for their commitment to building a forum that promotes rigorous scholarship, open dialogue, and meaningful collaboration. I hope that the interactions and ideas generated here will extend well beyond this event, seeding long-term partnerships and innovative initiatives that contribute to a more regenerative and sustainable future.

Warm regards,

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Birla Institute of Technology & Science, Pilani
Hyderabad Campus

Prof. P. Yogeeswari
Dean Administration
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Message from Dean Administration

Welcome to VALORIZATION 2026, a global forum that brings together researchers, innovators, and practitioners committed to redefining how science and technology can enable a circular and resource-resilient future.

VALORIZATION 2026 is designed as a meeting ground for ideas, evidence, and innovation. Over the course of this conference, participants will explore how advances in biological processes, energy systems, material recovery, and environmental engineering can be translated into scalable solutions for real-world sustainability challenges. More than a technical gathering, this conference represents a collective effort to move from isolated research outcomes toward integrated, systems-level impact.

At a time when societies are being called upon to balance development with ecological responsibility, platforms such as VALORIZATION 2026 play a crucial role. The discussions here are expected to extend beyond disciplinary boundaries, encouraging convergence between fundamental science, applied engineering, and policy-relevant perspectives. By doing so, the conference aims to nurture ideas that not only advance knowledge but also inform practice and innovation.

The strength of this conference lies in the diversity of its participants and the breadth of its themes. Contributions from multiple institutions, sectors, and research domains will enrich deliberations, enabling a multidimensional understanding of circular economy pathways and sustainable technologies. Such diversity is essential for building inclusive, forward-looking, and implementable solutions.

I commend the organising committee for their commitment to creating an engaging scientific program. I hope this conference will lay the foundation for long-term collaborations and inspire innovative research efforts that translate into meaningful contributions toward a sustainable and resilient future.

Sincerely,

Prof. P. Yogeeswari, M.Pharm, Ph.D.

भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
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डॉ. प्रतिष्ठा पाण्डेय
प्रमुख (अनुसंधान एवं विकास अवसंरचना प्रभाग)

MESSAGE

I am delighted to note that BITS Pilani, Hyderabad Campus, is organizing "VALORIZATION 2026: International Conference on Science and Technology Integration for Circular Economy." At a time when sustainable technologies and circular economy frameworks are redefining the future of resource management, this conference serves as a timely and important platform for scientific exchange and innovation.

The relevance of VALORIZATION 2026 is further strengthened by the advanced research ecosystem developed under national initiatives such as DST-SATHI-PURSE, led by the Department of Science and Technology (DST), Government of India. The integration of the Sophisticated Analytical & Technical Help Institutes (SATHI) program with PURSE has enabled the establishment of shared, professionally managed, advanced research facilities, supporting high-end analytics, advanced manufacturing, and translational research. Such infrastructure plays a pivotal role in empowering academia, research institutions, startups, and industry to pursue cutting-edge, solution-oriented research.

The conference encompasses emerging and impactful areas, including waste-to-energy technologies, advanced fuel cells, and sustainable energy management. The enthusiastic response and high-quality submissions received from researchers in India and abroad underscore the growing global emphasis on wealth-from-waste concepts and circular bioeconomy solutions.

VALORIZATION 2026 is envisioned as a vibrant platform to promote meaningful scientific dialogue and inspire new collaborations among researchers, academicians, and industry professionals. With its comprehensive technical program and participation of experts from reputed institutions, the conference is well-positioned to stimulate discussions on current adsvances and future research directions in sustainable science and engineering.

I extend my best wishes to the organizing committee for the successful conduct of VALORIZATION 2026 and commend their efforts in advancing interdisciplinary research and innovation through this initiative.

Pratishtha Pandey

(Dr. Pratishtha Pandey)

Birla Institute of Technology & Science, Pilani
Hyderabad Campus
Institution's Innovation Council (IIC)
Prof. Ruchi Jain Dey
Co-Convenor
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Message

The Institution's Innovation Council (IIC), BITS Pilani, Hyderabad Campus, is pleased to be associated with VALORIZATION 2026: International Conference on Science and Technology Integration for Circular Economy. The conference provides an enabling platform to examine how scientific research and technological advancements can be effectively translated into solutions addressing global challenges related to resource efficiency and environmental resilience. This initiative strongly aligns with the vision of the Ministry of Education's Innovation Cell (MIC) to foster robust, innovation-driven ecosystems within Higher Education Institutions and to facilitate the transformation of knowledge into impactful, real-world applications. Innovation today extends beyond ideation; it demands integration of science with technology, academia with industry, and research with societal needs. VALORIZATION 2026 exemplifies this integration by creating a platform where sustainable technologies, circular economy principles, and translational research converge. Such forums are essential for nurturing entrepreneurial thinking and enabling students and researchers to move from conceptual innovation to scalable applications.

The IIC is committed to cultivating a vibrant innovation ecosystem through structured programs in ideation, pre-incubation, prototyping, and mentorship. Platforms such as VALORIZATION 2026 support the development of a robust innovation ecosystem by facilitating awareness of evolving research landscapes, start-up opportunities, and industry-aligned innovation pathways. The themes of this conference align closely with national priorities and the objectives of the Atal Ranking of Institutions on Innovation Achievements. The deliberations and interactions fostered through this event are expected to inspire novel ideas, encourage start-up formation, and strengthen academia-industry linkages.

The IIC commends the organizing committee for their vision and dedication in curating a technically robust and innovation-oriented conference. We are confident that VALORIZATION 2026 will serve as a catalyst for creative thinking, collaborative research, and entrepreneurial action, particularly among young innovators and early-career researchers. We extend our best wishes for the successful conduct of VALORIZATION 2026 and hope that the ideas and partnerships emerging from this platform will contribute meaningfully to building a sustainable, innovation-led future.

Best regards,

Ruchi Jain Dey

Birla Institute of Technology & Science, Pilani
Hyderabad Campus
Prof. P. Sankar Ganesh, Ph.D., Professor of Biological Sciences
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Message from Convenor

It is my great pleasure to welcome you to VALORIZATION 2026: The International Conference on Science and Technology Integration for a Circular Economy, organized at BITS Pilani, Hyderabad Campus**.** VALORIZATION 2026 is envisioned as a platform where scientific rigour aligns with practical relevance, fostering dialogue across disciplines**,** including biological sciences, engineering, environmental studies, and emerging energy technologies. The technical sessions and invited lectures are structured to promote knowledge exchange, focused discussion, and interdisciplinary collaboration.

VALORIZATION 2026 has witnessed an overwhelming response from the research and professional community, reflected in over 150 registrations from research scholars, faculty, industry professionals, and policy makers representing diverse institutions across many Indian states and countries. The program is further strengthened by 10 invited lectures from distinguished experts spanning academia, national research laboratories, industry, and policy organizations. This geographic and institutional diversity underscores the growing global relevance of waste valorization, bioenergy, wastewater treatment, and circular bioeconomy research. The breadth of participation and thematic coverage reflects the growing emphasis on integrating scientific innovation with sustainable and scalable solutions.

A distinctive feature of this event is the post-conference workshop and field visit, designed to provide hands-on exposure to biomethanation systems, methane-to-hydrogen conversion, fuel cell technologies, and on-campus waste-to-energy facilities, thereby strengthening translational learning and research capacity.

I extend my sincere gratitude to the co-convenors, BITS Pilani's leadership, all invited speakers, session chairs, authors, and, most importantly, the participants for their valuable contributions. I also acknowledge the dedicated efforts of the organizing committee, faculty colleagues, research scholars, staff members, partners, and sponsors, whose commitment has been instrumental in the successful organization of VALORIZATION 2026.

I trust that this annual event will grow further in the years ahead to serve as a platform for national and international research on waste valorization and circular economy. I wish all delegates a thought-provoking and rewarding conference experience, and I hope that VALORIZATION 2026 will foster meaningful new collaborations and impactful research outcomes that support a sustainable and circular future.

Choicest regards

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VALORIZATION 2026

International Conference on Science & Technology Integration for Circular Economy

BITS Pilani
Hyderabad Campus

Program Schedule

DAY 1: Thursday 29th January 2026 Venue: Classroom No. F-101 Link: https://meet.google.com/vtw-gxdy-tjv		
10:00 – 10:30AM	**Inauguration**	
10:30 – 10:40AM	**Group Photo**	
10:40 – 11:00AM	**High Tea and Networking Session**	
Invited Lectures		
11:00 – 11:30AM	**Prof. Sai P. Katikaneni** **Adjunct Professor, Department of Chemical Engineering, BITS Pilani Dubai Campus, United Arab Emirates** ***Invited Lecture 1:*** *Methane to hydrogen and eFuels: Technologies and R&D challenges & opportunities*	
11:30AM – 12:00PM	**Mr. Vinod Kumar Mauriya** **Dy. General Manager, Project Engineering (Civil), National Thermal Power Corporation, Limited, Hyderabad.** ***Invited Lecture 2:*** *Restorative solution to toe-drain water collected at Ash-dyke of thermal power plants*	
Oral Presentations		
	Scientific Session: 1 **Theme: Circular Economy** **Venue: Classroom No. F-101** **Chair – Prof. Satyapaul A. Singh** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/vtw-gxdy-tjv**	**Scientific Session: 2** **Theme: Environment & Waste Management and Sustainable Development** **Venue: Classroom No. F-202** **Chair – Prof. Ankur Bhattacharjee** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/npe-xnmh-ryf**
12:00 – 12:10PM	**Arun Barathi S** **SRM University, AP** ***VAL01:*** *Efficient laccase production by Schizophyllum commune through process optimization in solid-state fermentation of lignocellulosic biomass*	**Anna Varghese, Bhuvaneswari Raman, Harsh Mittal** **BITS Pilani, Hyderabad Campus** ***VAL07:*** *Reimagining just transition of electronics economy: Thinking with Hyderabad's and Delhi's popular repair clusters*
12:10 – 12:20PM	**Arunika Srivastava** **BITS Pilani, Hyderabad Campus** ***VAL02:*** *Life cycle assessment of solar photovoltaic panels for the circular economy*	**Banoth Rajesh** **BITS Pilani, Hyderabad Campus** ***VAL08:*** *Experimental evaluation of fresh properties and buildability of 3D printed concrete*

12:20 – 12:30PM	**Chepyala Sahith** **Forest College & Research Institute, Siddipet** ***VAL03:*** *Selective lignin degradation of Eucalyptus and Bamboo residues through fungal consortium-based biological pretreatment*	**Dr. Lata Ramrakhiani** **CSIR - Central Glass & Ceramic Research Institute, Kolkata** ***VAL09:*** *Valorization of jute mill waste for treatment of electroplating effluent and sludge management as zinc micro-fertilizer*
12:30 – 12:40PM	**Dr. Anshu Priya** **Center of Innovative and Applied Bioprocessing, Punjab** ***VAL04:*** *Valorization of lignin waste for the production of eco-friendly lignosulfonate-based cement admixture for sustainable construction*	**Niha Nousheen** **Forest College and Research Institute, Siddipet** ***VAL10:*** *Fire and thermal performance of Melia dubia-Pleurotus ostreatus mycelium-based bio- composites for sustainable packaging and insulation applications*
12:40 – 12:50PM	**Hameeda Bee** **University College of Science, Osmania University, Hyderabad** ***VAL05:*** *Valorization of agro-industrial substrates for biosurfactant production*	**Rushikesh Tahakik** **MGM College of Agricultural Biotechnology, Maharashtra** ***VAL11:*** *Eco-friendly bio cement production using urease-producing Bacillus sp. for self-healing concrete applications*
12:50 – 01:00PM	**Keitumetse Ngaka** **BITS Pilani, Hyderabad Campus** ***VAL06:*** *The critical and unbiased assessment of composting*	**Saurabh Chandrakant Patankar** **BITS Pilani, K K Birla Goa Campus** ***VAL12:*** *Densification of lignocellulosic biomass using recyclable deep eutectic solvents*
Scientific Session: 3 **Theme: Anaerobic digestion/ Biomethanation/ Methane to Hydrogen** **Venue: Classroom No. F-203** **Chair – Prof. K. Supradeepan** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/dxq-ihat-iqf**		**Scientific Session: 4** **Theme: Wastewater Treatment** **Venue: Classroom No. F-106** **Chair – Prof. Chanchal Chakraborty** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/nht-qdjo-srd**
12:00 – 12:10PM	**Danavath Balu** **BITS Pilani, Hyderabad Campus** ***VAL13:*** *Evaluation of polyurethane free-standing films as hydrogen barrier for steel components in hydrogen infrastructure*	**Dr. Vidhi Bhatt** **Charotar University of Science and Technology, Gujarat** ***VAL19:*** *Photocatalytic degradation of glyphosate contaminated wastewater by WS2/ZnO nanohybrids*
12:10 – 12:20PM	**Madhava Surya S** **SRM University, AP** ***VAL14:*** *Fermentation strategies for efficient bioethanol Production: A bibliometric analysis*	**Harshavardhan M** **National Institute of Technology, Surathkal** ***VAL20:*** *Utilizing millet straw biochar for effective malachite green dye adsorption and application of RSM*
12:20 – 12:30PM	**Hemapriya S** **BITS Pilani, Hyderabad Campus** ***VAL15:*** *Hydrogel-mediated chemisorption of volatile fatty acids and concomitant biogas enhancement in high solids biomethanation*	**Rashmi Ranjan Mandal** **SRM University, AP** ***VAL21:*** *Integrated phytoremediation and biomass valorization of Eichhornia crassipes for sustainable arsenic and mercury removal*

12:30 – 12:40PM	**Dr. Addagatla Ravindar** **Osmania University, Hyderabad** ***VAL16:*** *Invitro method development for bioassay of fab antibody molecule*	**Ravindra Kulal** **BITS Pilani, Hyderabad Campus** ***VAL22:*** *Sustainable Inactivation of Antimicrobial Resistance in biopharmaceutical wastewater via non-thermal pulsed electric field electroporation*
12:40 – 12:50PM	**Balamanikandan R.** **BITS Pilani, Hyderabad Campus** ***VAL17:*** *Valorization of food waste via anaerobic bioprocessing: Carbon accounting and carbon credit potential*	**Venkatalakshmi Jakka** **Vignan's Foundation for Science, Technology & Research, Guntur** ***VAL23:*** *Eco-Friendly polyvinyl alcohol/ nanocellulose bio-composite film as sustainable adsorbent for Safranin-O and reactive red dyes*
12:50 – 01:00PM	**Dimple K** **BITS Pilani, Hyderabad Campus** ***VAL18:*** *Metabolic pathway integration in anaerobic digestion for circular waste valorization*	**Chaitanya Dhangar, Rudra Pratap Singh Shekhawat** **Amity University, Rajasthan** ***VAL24:*** *Review on low-cost bio waste derived adsorbents for wastewater treatment*
01:00 – 02:00PM	**Lunch Break**	
Invited Lectures **Venue: Classroom No. F-101** **Link: https://meet.google.com/vtw-gxdy-tjv**		
02:00 – 02:20PM	**Dr. Biju Philip** **La Trobe University, Melbourne, Victoria, Australia.** ***Invited Lecture 3:*** *Sustainable circular economy innovation: Bridging business, science, technology, and academic–industry collaboration*	
02:20 – 02:40PM	**Dr. Gangagni Rao A** **Senior Principal Scientist, CSIR-Indian Institute of Chemical Technology, Hyderabad** ***Invited Lecture 4:*** *Valorization of Organic Waste for the generation of Compressed Biogas (CBG) and Fermented Organic Manure (FOM)*	
02:40 -03:00PM	**Dr. M. Dwarakanath** **Chairman, State Environment Impact Assessment Authority, Puducherry** ***Invited Lecture 5:*** *Legislative, cultural principles infused in ancient India towards circular economy*	
Oral Presentations		
	Scientific Session: 5 **Theme: Circular Economy** **Venue: Classroom No. F-101** **Chair – Prof. Ankur Bhattacharjee** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/vtw-gxdy-tjv**	**Scientific Session: 6** **Theme: Environment & Waste Management and Sustainable Development** **Venue: Classroom No. F-201** **Chair – Prof. Satyapaul A. Singh** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/npe-xnmh-ryf**
03:00 – 03:10PM	**Palvi Andotra** **BRIC-National Agri-Food and Biomanufacturing Institute, Punjab** ***VAL25:*** *Enhanced photocatalytic oxidation of 5-Hydroxymethylfurfural to 2,5-Diformylfuran over modified TiO_2*	**Varshini R** **SRM University, AP** ***VAL31:*** *Waste is not a burden: Unlocking economic and climate benefits in cassava starch biorefineries*

03:10 – 03:20PM	**Sonal Ayakar** **BITS Pilani, K K Birla Goa Campus** ***VAL26:*** *Microbial consortia engineering and genome-guided enzyme discovery for lignocellulosic waste valorization*	**A. Thulasi** **K. S. Rangasamy College of Technology, Tamil Nadu** ***VAL32:*** *A green solution for waste management and the circular economy in KSR Institutions*
03:20 – 03:30PM	**Syamala Diwakaruni** **BITS Pilani, Hyderabad Campus** ***VAL27:*** *Circular economy strategies for sustainable management of municipal solid waste landfill leachate*	**Aliya Navas** **NICMAR University, Pune** ***VAL33:*** *Framework for organisational change while driving sustainability in the construction industry*
03:30 – 03:40PM	**AL Mushavir Rahman M** **Kalaignarkarunanidhi Institute of Technology, Tamil Nadu** ***VAL28:*** *Valorization of jackfruit (Artocarpus Heterophyllus) rind via solid state fermentation for antioxidant rich postbiotic-recovery*	**Aman Kumar Bhonsle** **CSIR-Indian Institute of Petroleum, Dehradun** ***VAL34:*** *Utilization of used cooking oil into bio-based value-added products*
03:40 – 03:50PM	**Anushree Pant** **Dr. B.R. Ambedkar National Institute of Technology, Punjab** ***VAL29:*** *Biochemical characterization and molecular evaluation of Aspergillus flavus LP1 lipase for eco-friendly detergent applications*	**Amogh Kale, Sujal Balapure** **MIT Art, Design & Technology University, Pune** ***VAL35:*** *Green synthesized silver nanoparticles from Moringa oleifera integrated into chitosan gelatin films for sustainable food packaging applications*
03:50 – 04:00PM	**Aryasree M** **Central University of Kerala, Kerala** ***VAL30:*** *Valorization of cashew processing waste for sustainable lignin extraction and applications using deep eutectic solvents*	**Apoorva K. V.** **National Institute of Technology, Surathkal** ***VAL36:*** *Operational assessment of ward-level urban groundwater stress and seasonal recovery for sustainable development in a coastal city*
Scientific Session: 7 **Theme: Anaerobic digestion/ Biomethanation/ Methane to Hydrogen** **Venue: Classroom No. F-204** **Chair – Prof. K. Supradeepan** **BITS Pilani Hyderabad Campus** **Link: https://meet.google.com/dxq-ihat-iqf**		**Scientific Session: 8** **Theme: Wastewater Treatment** **Venue: Classroom No. F-106** **Chair – Prof. Lavanya Suresh** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/qvb-crob-ram**
03:00 – 03:10PM	**Mihir Acharya** **CSIR -IICT, Hyderabad** ***VAL37:*** *Hydrodynamic cavitation–driven disintegration of lignocellulosic agri-residues: From lab-scale optimization to pilot-scale validation for enhanced anaerobic digestion*	**Supriya Jena** **Kalinga Institute of Industrial Technology, Bhubaneswar, Odisha** ***VAL43:*** *Sustainable remediation of fluoride-contaminated groundwater using activated sludge: Experimental validation, mechanistic understanding, and modeling*
03:10 – 03:20PM	**Pallavi Vadla** **BITS Pilani, Hyderabad Campus** ***VAL38:*** *Performance evaluation and industrial-scale demonstration of thermophilic anaerobic co-digestion for renewable energy production*	**Prema Malali** **KLE Technological University, Hubballi** ***VAL44:*** *Assessment of surface water quality for sustainable domestic use: A case study of Tolankere lake.*
03:20 – 03:30PM	**Sibin V Mathew** **BITS Pilani, Hyderabad Campus** ***VAL39:*** *Numerical investigation of two-phase mixing in an anaerobic digester*	**Gobinda Chandra Mahapatra** **KIIT School of Chemical Engineering, Bhubaneswar** ***VAL45:*** *Solar-driven Fe/ZnO photocatalyst for sustainable water disinfection*

03:30 – 03:40PM	**Sandhya Gupta** **BITS Pilani, Hyderabad Campus** ***VAL40:*** *Role and fate of microplastics as substrata during anaerobic digestion: Biofilm formation, microbial community dynamics, and polymer alterations*	**Dr. V. Saravanan** **Annamalai University, Tamil Nadu** ***VAL46:*** *Photocatalytic treatment of dairy industry wastewater: Process optimization and performance evaluation using response surface methodology*
03:40 – 03:50PM	**Ritik Kumar Yadav** **Amity University Rajasthan** ***VAL41:*** *Bio-methanation of municipal waste in India: Decentralized circular economy analysis*	**G. Satish Kumar** **Vellore Institute of Technology, Vellore** ***VAL47:*** *Effect of redox-active and redox-inactive metal doping in magnetite spinel on catalytic wet peroxide oxidation of sulfamethoxazole*
03:50 – 04:00PM	**Pitta Abhishek** **Gandhi Institute of Technology and Management, Visakhapatnam** ***VAL42:*** *Development of sequential nano-enrichment of inoculum for dark fermentation-driven biohydrogen and volatile fatty acid production*	**Taksheel Jain** **Work Integrated Learning Program, BITS Pilani** ***VAL48:*** *Sustainable and Green Wastewater Treatment Methodologies*
04:00 – 04:15PM	**High Tea and Networking Session**	
Oral Presentations		
	Scientific Session: 9 **Theme: Circular Economy** **Venue: Classroom No. F-101** **Chair – Prof. Ankur Bhattacharjee** **BITS Pilani Hyderabad Campus** **Link: https://meet.google.com/vtw-gxdy-tjv**	**Scientific Session: 10** **Theme: Environment & Waste Management and Sustainable Development** **Venue: Classroom No. F-201** **Chair – Prof. Lavanya Suresh** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/npe-xnmh-ryf**
04:15 – 04:25PM	**Bhuvaneshwari G** **Guru Nanak College, Chennai** ***VAL49:*** *Fabrication, characterization and application of a sustainable eggshell bio-composite for slow release of TSP*	**Dharani S, Dr. N. Muthulakshmi Andal** **PSGR Krishnammal College for Women, Coimbatore** ***VAL55:*** *Extirpation and infusion of spent POP's in corrosion alleviation as inhibitors*
04:25 – 04:35PM	**Bragadish Iyer** **Charotar University of Science & Technology, Gujarat** ***VAL50:*** *Sustainable valorization of paper waste into bio-based adhesives for circular economy applications*	**Dr. Abir Sarbajna** **Vellore Institute of Technology, Vellore** ***VAL56:*** *Metal-directed structural divergence governing cytotoxic and antimicrobial activity in multinuclear quinoline complexes*
04:35 – 04:45PM	**Dildivya, Kalaivani E** **KalaignarKarunanidhi Institute of Technology, Tamil Nadu** ***VAL51:*** *Biodiesel production from Animal waste fat using fe_2O_3-ZrO_2 nanomagnetic catalyst*	**Dr. Vikash** **Government Post Graduate College, Uttarkashi** ***VAL57:*** *Sustainable keratin extraction from wool cortical cells for tissue engineering applications*
04:45 – 04:55PM	**Dr Palashpriya Das** **Guru Nanak Institute of Pharmaceutical Science & Technology,**	**Mohamed Tharik. A** **Vellore Institute of Technology, Vellore** ***VAL58:*** *Integrated assessment of seasonal climate*

	waste fat using fe_2O_3-ZrO_2 nanomagnetic catalyst	
04:45 – 04:55PM	**Dr Palashpriya Das** **Guru Nanak Institute of Pharmaceutical Science & Technology, West Bengal** ***VAL52:*** *Valorization of floral waste and slaughterhouse remains via microbial fermentation for biosurfactant production & environmental remediation*	**Mohamed Tharik. A** **Vellore Institute of Technology, Vellore** ***VAL58:*** *Integrated assessment of seasonal climate variability, surface energy balance, and drought dynamics in a rain-fed semi-arid region of south India*
04:55 – 05:05PM	**Gundlapalli Manaswini** **Vellore Institute of Technology, Vellore** ***VAL53:*** *Waste valorization for sustainable bioplastics: Microbial production of Polyhydroxyalkanoates (PHAs) in a circular bioeconomy*	**P. Revathi Prasanna** **Acharya Nagarjuna University, Guntur** ***VAL59:*** *Sustainable Development Goals globalization and health equity towards sustainable development*
05:05 – 05:15PM	**Imran Ahmad** **Durban University of Technology, Durban** ***VAL54:*** *High-rate algal ponds for wastewater valorization in a circular economy*	**Nivedhini M** **Anna University, Chennai** ***VAL60:*** *GIS-Based planning framework for recyclable waste management: A conceptual case study towards circular economy*
Scientific Session: 11 **Theme: Anaerobic digestion/ Biomethanation/ Methane to Hydrogen** **Venue: Classroom No. F-204** **Chair – Prof. K. Supradeepan** **BITS Pilani Hyderabad Campus** **Link: https://meet.google.com/dxq-ihat-iqf**		**Scientific Session: 12** **Theme: Wastewater Treatment** **Venue: Classroom No. F-106** **Chair – Prof. Chanchal Chakraborty** **BITS Pilani, Hyderabad Campus** **Link: https://meet.google.com/qvb-crob-ram**
04:15 – 04:25PM	**Sri Himaja Pamu** **BITS Pilani, Hyderabad Campus** ***VAL61:*** *Harnessing sunlight for photocatalytic hydrogen evolution via band engineered $LaNiO_3$-$LaVO_4$ heterostructures*	**Krishika Aneja** **IISER, Mohali** ***VAL67:*** *A metal-tolerant mesophilic laccase from Achromobacter sp.: Molecular identification, biochemical characterization and dye decolorization*
04:25 – 04:35PM	**Sridhar Babu Gaddala** **CSIR-IICT, Hyderabad** ***VAL62:*** *CFD-guided design of a hydrodynamic cavitator for enhanced biomethane production from rice straw*	**M. Nanthini** **Coimbatore Institute of Engineering and Technology, Coimbatore** ***VAL68:*** *Nano-activated carbon composites for removal of emerging contaminants in wastewater*
04:35 – 04:45PM	**Urvi Milind Dixit** **BITS Pilani, Hyderabad Campus** ***VAL63:*** *Valorization of marine macroalgae biomass via sequential protein recovery and anaerobic digestion for circular bioenergy*	**Mahek Vadalia** **Atmiya University, Rajkot, Gujarat** ***VAL69:*** *Combinatorial approach for efficient dye degradation using green tea extract and Streptomyces rochei MMAD5.*
04:45 – 04:55PM	**Dr. Johnravindar Daviraj** **PSG Institute of Advanced Studies, Coimbatore** ***VAL64:*** *Impact of biochar addition on VFA degradation and methane production during food waste sludge co-digestion*	**Monisha M** **Vellore Institute of Technology, Vellore** ***VAL70:*** *Advanced treatment approaches for the removal of Per- and polyfluoroalkyl substances (PFAS) in wastewater.*
04:55 – 05:05PM	**Dr. Sreetama Ghosh** **Vellore Institute of Technology, Vellore** ***VAL65:*** *From CO_2 to hydrocarbons: A*	**P Udaya Chandrika** **Gandhi Institute of Technology & Management, Visakhapatnam**

	methanol-mediated route using bifunctional catalysts	***VAL71:*** *Enhanced azo and basic dye degradation using inorganic and organic nanoparticle-encapsulated aerobic consortia*
05:05 – 05:15PM	**Drishti Wacchani** **Amity University, Rajasthan** ***VAL66:*** *Bio-methanation of municipal waste in India: Decentralized circular economy analysis*	**Preeti** **ICAR- Central Soil Salinity Research Institute (Karnal), Haryana** ***VAL72:*** *Impact of different RSC neutralized water irrigation on soil properties under vegetable production*

Poster Presentations
Venue: LTC-Foyer
Chair – Prof. P. Sankar Ganesh
BITS Pilani, Hyderabad Campus
Time: 12:00 – 4:00PM

Ayushi Kumari, Advaith Roy
BITS Pilani, Hyderabad Campus
VAL73: *Comparative analysis of biological treatment systems for Pulsed Electric Field-pretreated biopharmaceutical effluent*

Balamanikandan R, Tanaya Pol, Nithila S, Shriya K, Bhargavi Ambatkar
BITS Pilani, Hyderabad Campus
VAL74: *Synergistic effects of substrate composition and electrode potential on voltage-assisted anaerobic digestion*

Dhanushkumar Annadhurai, Lithisri Saravanan, Mahasree Mohan
K. S. Rangasamy College of Technology, Tamil Nadu.
VAL75: *Rapid composting of solid waste: An eco-friendly solution for affordable organic manure*

Kirti Jyoti, Sonam Rani
National Institute of Technology Durgapur, West Bengal
VAL76: *Aerobic deterioration of waste biomass using bacterial consortia for biobutanol production: An overview*

Murali Krishnan B, Balaji Prithiviraj P, Jyothish Krishna K B
SRM Institute of Science and Technology, Tamil Nadu
VAL77: *Circular valorization of soybean processing residues into functional lipopeptide biosurfactants for sustainable food systems*

Sneha S, Ashwina T Shankar, Pradhanyaa S
SRM Institute of Science and Technology, Tamil Nadu
VAL78: *Bioconversion of agro-industrial protein by-products into high-value functional food and feed ingredients*

Sutharsanan V, Mugunthan J Y, Chirag Malik
SRM Institute of Science and Technology, Tamil Nadu
VAL79: *Development and performance evaluation of glycolipid-based biosurfactants for industrial detergent formulations*

End of Day 1

DAY 2: Friday 30th January 2026
Venue: Classroom No. F-101
Link: https://meet.google.com/vtw-gxdy-tjv

10:00 – 10:20AM	**Mr. Kiran KK** **Managing Director, Kaashyap Envergy Infrastructure Private Limited, Hyderabad** ***Invited Lecture 6:*** *Applications of Artificial Intelligence and Machine Learning in Anaerobic Digestion*
10:20 – 10:40AM	**Prof. Nicky Eshtiaghi** **Chemical Engineering, School of Engineering, RMIT University, Melbourne, Australia.** ***Invited Lecture 7:*** *Sludge Rheology Role in Sustainable Treatment of Wastewater Sludge*

10:40 – 11:00AM	**High Tea and Networking Session**	
Oral Presentations		
	Scientific Session: 13 **Theme: Circular Economy** **Venue: Classroom No. F-101** **Chair – Prof. Lavanya Suresh** **BITS Pilani Hyderabad Campus** **Link: https://meet.google.com/vtw-gxdy-tjv**	**Scientific Session: 14** **Theme: Environment & Waste Management and Sustainable Development** **Venue: Classroom No. F-205** **Chair – Prof. Chanchal Chakraborty** **BITS Pilani Hyderabad Campus** **Link: https://meet.google.com/npe-xnmh-ryf**
11:00 – 11:10AM	**Dr Jampala Annie Modestra** **CSIR-NEERI, Hyderabad** ***VAL80:*** *Tailored microbiome-driven upcycling of plastic waste to value-added bioproducts: Sustainable bioprocessing towards a circular bioeconomy*	**Sahana R & Kavin Prakash T** **KalaignarKarunanidhi Institute of Technology, Tamil Nadu** ***VAL86:*** *Starch-based biodegradable film reinforced with natural fibers for sustainable food packaging*
11:10 – 11:20PM	**Jeya Preethi** **Bharathiar University, Tamil Nadu** ***VAL81:*** *Circular bioeconomy potential of mushroom biomass valorization for medicinal bioactive production: An integrated life cycle and techno-economic perspective*	**Saniya P, Loukya D** **KalaignarKarunanidhi Institute of Technology, Tamil Nadu** ***VAL87:*** *Biochar-Phase Change Material (PCM) hybrid for passive thermal regulation and environmental sustainability*
11:20 – 11:30AM	**Jiji M** **Indian Institute of Technology, Palakkad** ***VAL82:*** *PET glycolysis catalyzed by acid-base bifunctional metal oxyhydroxides*	**Sanjay S** **KalaignarKarunanidhi Institute of Technology, Tamil Nadu** ***VAL88:*** *Smart Waste Segregation System*
11:30 – 11:40AM	**Kaviraj R** **Central University of Kerala, Kerala** ***VAL83:*** *Enhanced bioethanol production from sugarcane leaves through ionic liquid, Dimethylbutylammonium hydrogen sulfate pretreatment*	**Sanket Chawke** **NICMAR University, Pune** ***VAL89:*** *Assessment of impact on air quality index from manufacturing industries in Gujarat using GIS*
11:40 – 11:50AM	**Kevanshi M. Dave** **Gujarat University, Ahmedabad** ***VAL84:*** *From waste streams to bioplastics: Circular bioeconomy-based PHA production*	**Swati B. Khunt** **Atmiya University, Rajkot** ***VAL90:*** *Microbial carbon circularity: Engineering CO_2-fixing autotrophic microbes for sustainable industrial biomanufacturing*
11:50AM – 12:00PM	**Kingston. S** **Sathyabama Institute of Science and Technology, Chennai** ***VAL85:*** *Grafting effect of polystyrene blend with epoxy resin on the properties of the resulting paint formulation*	**Vani G Viswam** **Vel Tech Rangarajan Dr Sagunthala R&D Institute of Science and Technology, Chennai** ***VAL91:*** *Valorization of underexplored northeast Indian plant resources into sustainable surfactant systems for cosmetic applications*

Scientific Session: 15 Theme: Anaerobic digestion/ Biomethanation/ Methane to Hydrogen Venue: Classroom No. F-208 Chair – Prof. P. Sankar Ganesh BITS Pilani Hyderabad Campus Link: https://meet.google.com/dxq-ihat-iqf		Scientific Session: 16 Theme: Wastewater Treatment Venue: Classroom No. G-108 Chair – Prof. Abhradeep Majumder BITS Pilani Hyderabad Campus Link: https://meet.google.com/nht-qdjo-srd
11:00 – 11:10AM	**Jijnasha Bal** **College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Rajasthan** ***VAL92:*** *Green hydrogen as a cornerstone of decarbonization: Processes & Prospects*	**Dr. Pratibha V. Bakre** **Government College of Arts, Science & Commerce, Goa** ***VAL98:*** *Biopolymer based hydrogels for sustainable removal of water pollutants*
11:10 – 11:20AM	**Gantala Sarva Sai Nikhilesh** **BITS Pilani, Hyderabad Campus** ***VAL93:*** *Electrode assisted biomethanation of food waste under high organic loading*	**Sakshi Dange** **Vellore Institute of Technology, Vellore** ***VAL99:*** *Machine learning–assisted GIS analysis of groundwater contamination for irrigation suitability in Katpadi block*
11:20 – 11:30AM	**Pavithra Pari** **BITS Pilani, Hyderabad Campus** ***VAL94:*** *Hydrothermal and partial wet oxidation pretreatment of food organics and garden organics for enhanced biogas production*	**Sattam Mandal** **Vignan's Foundation for Science, Technology & Research, Andhra Pradesh** ***VAL100:*** *Membrane filtration for microplastic removal: A comprehensive review of wastewater treatment technologies, performance, and mechanisms*
11:30 – 11:40AM	**Vanshikha Gupta** **Defence Research and Development Establishment (DRDE), Gwalior** ***VAL95:*** *Development and characterization of anaerobic microbial inoculum for anaerobic digestion of synthetic night soil and microbial community dynamics revealed by metagenomics*	**Vikram Hiren Raval, Riddhi M Kathrotiya** **Gujarat University, Ahmedabad, Gujarat** ***VAL101:*** *Valorization of agricultural wastes for cost-effective removal of acid azo dyes from wastewater*
11:40 – 11:50AM	**Varshashree R** **Vel Tech Rangarajan Dr Sagunthala R&D Institute of Science & Technology, Chennai** ***VAL96:*** *Synthesis of Ch-TiO_2-Fe_3O_4 nanoparticles and conjugated with phycocyanin extracted from Arthrospira platensis for Lactobacillus spp. separation*	**Mathu Metha K** **KPR Institute of Engineering and Technology, Tamil Nadu** ***VAL102:*** *An Investigation of antimicrobial activity of biomolecule metal oxide nanoparticles*
11:50AM – 12:00PM	**Tushar Singh** **G.B. Pant University of Agriculture & Technology, Uttarakhand** ***VAL97:*** *Enhanced biomass hydrolysis using recombinant cellulase produced by Penicillium funiculosum*	**Sunil Sahu** **National Institute of Technology, Raipur*** ***VAL103:*** *Scale-up performance of Microbial Electrolysis Cells (MECs) for sustainable biohydrogen production and wastewater valorization*

Scientific Session: 17 Theme: Circular Economy Venue: Classroom No. F-101 Chair – Prof. Satyapaul A. Singh BITS Pilani Hyderabad Campus Link: https://meet.google.com/vtw-gxdy-tjv		Scientific Session: 18 Theme: Energy Management/ Membrane Fuel Cells Venue: Classroom No. F-207 Chair – Prof. Ankur Bhattacharjee BITS Pilani Hyderabad Campus Link: https://meet.google.com/dxq-ihat-iqf
12:00 – 12:10PM	**Lata Pawar** **BRIC - National Agri-Food & Biomanufacturing Institute, Mohali** ***VAL104:*** Advanced *biocatalyst for the green conversion of 5-hydroxymethyl furfural to a biopolymer precursor 2,5-furandicarboxylic acid*	**Anup Kumar Pradhan** **BITS Pilani Hyderabad Campus** ***VAL110:*** *Metal-free electrocatalyst for improved oxygen electrocatalysis towards solid state flexible zinc-air battery*
12:10 – 12:20PM	**M. Lavanya** **Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science & Technology, Chennai** ***VAL105:*** *Valorization of finger millet husk an agro-residue for sustainable aquafeed development in Clarias gariepinus*	**Birudu Sarika** **Indian Institute of Petroleum & Energy (IIPE), Anakapalli** ***VAL111:*** *Investigation of pyrolysis behavior and kinetics of de-oiled cashew nutshell using kinetic models*
12:20 – 12:30PM	**Patel Rutu H.** **Shree Ramkrishna Institute of Computer Education and Applied Sciences, Sarvajanik University, Surat** ***VAL106:*** *Synergistic biological pretreatment of substrate and lignocellulolytic enzyme production by fungal consortium for valorization of wheat straw to levulinic acid*	**Kandi Mounika** **BITS Pilani, Hyderabad Campus** ***VAL112:*** *Machine learning enabled forecasting of energy allocation in fuel cell integrated grid connected local energy system*
12:30 – 12:40PM	**Pooja G, Mathiyazhagan R** **KalaignarKarunanidhi Institute of Technology, Tamil Nadu** ***VAL107:*** *Production of bioethanol using agricultural wastes*	**Aparna I** **National Institute of Construction Management and Research, Pune** ***VAL113:*** *Wind analysis for rooftop solar PV at NICMAR University, Pune*
12:40 – 12:50PM	**Rajesh Cheduri** **SRM University, AP** ***VAL108:*** *Valorization of secondary resource materials from E-waste*	**Dr. Aswin Sriram G, Dr. Vijayalakshmi Ramalingam, Sandya Rajan, Sai Manaswini J** **Sri Sivasubramaniya Nadar College of Engineering, Chennai** ***VAL114:*** *Thermochemical conversion of Africana sp. biomass towards feedstock fuel*
12:50 – 01:00PM	**Ruksana S** **Central University of Kerala, Kerala** ***VAL109:*** *Pectin extraction from cashew apple bagasse: Extraction methods and valorization*	**Dr. K. Sivagami** **Vellore Institute of Technology, Vellore,** ***VAL115:*** *Performance, emission, and combustion analysis of different waste oil blends in a diesel engine*
01:00 – 02:00PM	**Lunch Break**	

Scientific Session: 19 Theme: Circular Economy Venue: Classroom No. F-202 Chair – Prof. Chanchal Chakraborty BITS Pilani, Hyderabad Campus Link: https://meet.google.com/npe-xnmh-ryf		Scientific Session: 20 Theme: Energy Management/ Membrane Fuel Cells Venue: Classroom No. G-106 Chair – Prof. P. Sankar Ganesh BITS Pilani, Hyderabad Campus Link: https://meet.google.com/nht-qdjo-srd
12:00 – 12:10PM	**Shrestha Mondal** **Vellore Institute of Technology, TN** ***VAL116:*** *Next-generation biodiesel production from non-edible oilseed feedstocks*	**V.S. Shanthini** **Vellore Institute of Technology, TN** ***VAL121:*** *Sustainable biodiesel production from used rice bran oil: Catalyst development and characterization*
12:10 – 12:20PM	**Sonali Biswas** **Vellore Institute of Technology, TN** ***VAL117:*** *Microalgae cultivation in wastewater as a dual strategy for biodiesel production and nutrient remediation*	**Kumar Gaurav** **Amity University Haryana, Gurugram** ***VAL122:*** *Simultaneous wastewater treatment and power generation via microbial fuel cells*
12:20 – 12:30PM	**Suha Rahman P K** **Central University of Kerala, Kerala** ***VAL118:*** *Improved delignification and fermentable sugar recovery from spent Cymbopogon biomass using γ -Valerolactone/ $Fecl_3$ pretreatment*	**Narender Kumar** **National Institute of Technology, Hamirpur** ***VAL123:*** *Eco-friendly recovery and graphene valorization of spent lithium-ion batteries for next generation energy storage*
12:30 – 12:40PM	**Susovan Patra** **Vidyasagar University, West Bengal** ***VAL119:*** *Valorization of chicken slaughterhouse waste into enriched biofertilizer through bacterial fermentation*	**R. Kaviya, Dr. P. Kanchana** **PSGR Krishnammal College for Women, Coimbatore** ***VAL124:*** *Crystallographic and theoretical design of a Co (II) complex for enhanced energy storage, efficient catalysis, and selective L-Cysteine fluorescent sensing*
12:40 – 12:50PM	**Dr. K. Kiruthika** **K. S. Rangasamy College of Technology, Tamil Nadu** ***VAL120:*** *Deep Learning-Based Smart Waste Disposal Approach for Smart Recycling in Circular Economy Systems*	**Maddipatla Naga Sai Karthik** **BITS Pilani, Hyderabad Campus** ***VAL125:*** *Valorization of anaerobic digestate for enhanced biomass production in Chlorella sorokiniana: A circular economy approach*
01:00 – 02:00PM	**Lunch**	
Invited Lectures **Venue: Classroom No. F-101** **Link: https://meet.google.com/vtw-gxdy-tjv**		
02:00 – 02:30PM	**Dr. Atun Roy Choudhury** **Technical Head-Unison i3x Pvt. Ltd., Hyderabad** ***Invited Lecture 8:*** ***Global Shortcomings in Handling and Management of Organic Sludge and Associated Hazards: A Comprehensive Assessment***	
02:30 – 03:00PM	**Dr. Hélène Carrère** **Director of Research, INRAE, University of Montpellier, Laboratory of Environmental Technology, Narbonne, FRANCE.** ***Invited Lecture 9:*** ***Which Pretreatments for Anaerobic Digestion Process?***	

03:00 – 03:30PM	**Prof. Ashish A Prabhu** **Assistant Professor, Department of Biotechnology, National Institute of Technology, Warangal** ***Invited Lecture 10: Valorization of Water Hyacinth for Xylitol and Lipid Accumulation using Meyerozyma Guilliermondii***
03:30 – 04:00PM	**High Tea and Networking Session**
04:00 – 5:00PM	**VALEDICTORY SESSION**
End of Day 2	
DAY 3: Saturday 31st January 2026 Venue: Classroom No. F-101	
Post-Conference Workshop	

10:00 – 10:30AM	**Introductory Session**	**F-101**
10:30 – 10:50AM	**Biomethanation of Organic Waste** **Prof. P. Sankar Ganesh**	**BITS Environmental Science & Technology (BEST) Laboratory** A-Block
10:50 – 11:10AM	**Conversion of Biogas to Electricity** **Prof. K. Supradeepan**	**Computing Lab** W-Block
11:10 – 11:30AM	**Conversion of Methane to Hydrogen** **Prof. Satyapaul A. Singh**	**Colloids and Interfaces Laboratory** D-Block
11:30AM – 12:10PM	**Hydrogen-fed Membrane Fuel Cells** **Prof. Chanchal Chakraborty** **Power Demand Response Management** **Prof. Ankur Bhattacharjee**	**DST-PURSE Lab** A-Block
12:10 – 01:00PM	**Field visit to On-campus Biomethanation Plant** **Prof. P. Sankar Ganesh**	**Sewage Treatment Plant**
01:00PM	**End of Workshop and Lunch**	

Partners & Sponsors

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2	**Mr. Vinod Kumar Mauriya** Dy. General Manager, Project Engineering (Civil), National Thermal Power Corporation, Limited, Hyderabad. ***Invited Lecture 2:*** *Restorative solution to toe-drain water collected at Ash-dyke of thermal power plants*	3
3	**Dr. Biju Philip** La Trobe University, Melbourne, Victoria, Australia. ***Invited Lecture 3:*** *Sustainable circular economy innovation: Bridging business, science, technology, and academic–industry collaboration*	5
4	**Dr. Gangagni Rao A** Senior Principal Scientist, CSIR-Indian Institute of Chemical Technology, Hyderabad ***Invited Lecture 4:*** *Valorization of Organic Waste for the generation of Compressed Biogas (CBG) and Fermented Organic Manure (FOM)*	7
5	**Dr. M. Dwarakanath** Chairman, State Environment Impact Assessment Authority, Puducherry ***Invited Lecture 5:*** *Legislative, cultural principles infused in ancient India towards circular economy*	9
6	**Mr. Kiran KK** Managing Director, Kaashyap Envergy Infrastructure Private Limited, Hyderabad ***Invited Lecture 6:*** *Applications of Artificial Intelligence and Machine Learning in Anaerobic Digestion*	11
7	**Prof. Nicky Eshtiaghi** Chemical Engineering, School of Engineering, RMIT University, Melbourne, Australia. ***Invited Lecture 7:*** *Sludge Rheology Role in Sustainable Treatment of Wastewater Sludge*	13
8	**Dr. Atun Roy Choudhury** Technical Head-Unison i3x Pvt. Ltd., Hyderabad ***Invited Lecture 8:*** *Global Shortcomings in Handling and Management of Organic Sludge and Associated Hazards: A Comprehensive Assessment*	15

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9	**Dr. Hélène Carrère** Director of Research, INRAE, University of Montpellier, Laboratory of Environmental Technology, Narbonne, FRANCE. ***Invited Lecture 9:*** *Which Pretreatments for Anaerobic Digestion Process?*	17
10	**Prof. Ashish A Prabhu** Assistant Professor, Department of Biotechnology, National Institute of Technology, Warangal Invited Lecture 10: Valorization of Water Hyacinth for Xylitol and Lipid Accumulation using Meyerozyma Guilliermondii	19

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VAL02	**Arunika Srivastava** **BITS Pilani, Hyderabad Campus** *Life Cycle Assessment of Solar Photovoltaic Panels for the Circular Economy*	22
VAL03	**Chepyala Sahith** **Forest College and Research Institute, Sri Konda Laxman Telangana Horticultural University, Telangana.** *Selective lignin degradation of Eucalyptus and Bamboo residues through fungal consortium-based biological pretreatment*	23
VAL04	**Dr. Anshu Priya** **Center of Innovative and Applied Bioprocessing (CIAB)** *Valorization of Lignin Waste for the Production of Eco-friendly Lignosulfonate-Based Cement Admixture For Sustainable Construction*	24
VAL05	**Hameeda Bee** **University College of Science, Osmania University, Hyderabad** *Valorization of agro-industrial substrates for biosurfactant production*	26
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Methane to Hydrogen and eFuels: Technologies and R&D Challenges & Opportunities

Dr. Sai P. Katikaneni

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Abstract

Decarbonizing energy and industrial systems to meet global net-zero targets and India's 2070 commitment requires scalable, low-carbon pathways to produce clean hydrogen and synthetic fuels (eFuels). Methane, derived from diverse sources such as landfill gas, wastewater treatment plants, biogas, and natural gas, represents a strategic feedstock for enabling a circular carbon economy when coupled with advanced conversion technologies and carbon management. This invited talk provides an overview on methane-to-hydrogen and eFuels pathways, focusing on technology integration and R&D challenges and opportunities.

The presentation begins with an overview of clean fuels hydrogen and eFuels such as eMethanol and eJet fuels and their role in transport, power, industry, and hard-to-abate sectors including steel, cement, and sustainable aviation fuels. The current global status and Indian policy landscape are discussed, with emphasis on the National Green Hydrogen Mission, emerging clean energy targets, and enabling frameworks for low-carbon fuels.

Two representative technology pathways are analyzed. The first case focuses on methane-rich fuels from landfill gas, wastewater treatment plants, and biogas, where methane and co-produced CO_2 are converted into carbon-neutral syngas using conventional and emerging routes such as catalytic reforming, tri-reforming, and electrochemical processes. Key technical challenges related to feedstock variability, catalyst durability, energy efficiency, and system integration are highlighted, along with opportunities for coupling syngas with direct air capture–derived CO_2 for downstream eFuel synthesis.

The second case examines methane pyrolysis as a CO_2-free route to hydrogen production, powered by renewable electricity and yielding solid, high-value carbon. The influence of reactor concepts, operating conditions, and process design on hydrogen yield and carbon morphology is discussed, with focus on advanced carbon products such as carbon

nanotubes and carbon nanofibers. A high-level techno-economic comparison with steam methane reforming is presented, including breakeven analysis on electricity cost and carbon co-product value required to achieve target hydrogen costs of \$2–3/kg H_2.

The talk concludes with a comparative perspective on methane-derived hydrogen and eFuels pathways and outlines critical R&D gaps, scale-up challenges, and integration opportunities. Methane-to-hydrogen and eFuels technologies are positioned as key enablers for a circular carbon economy, linking waste-derived carbon, clean energy, and advanced materials to support India's long-term decarbonization goals.

Bio Sketch

Currently, Dr. Katikaneni is working as Adjunct Professor, Department of Chemical Engineering, BITS Pilani, Dubai Campus and as Advisory Director, Ingenero Inc, Houston, USA. Dr. Katikaneni is accomplished Senior Research Consultant, Scientist, Hydrogen & Fuel Cells Strategist and Clean Energy Subject Matter Expert with 30+ year's industrial experience (Aramco and FuelCell Energy) in delivering industrial R&D, commercialization & new technologies initiation to commercialization in emerging new fuels such as blue, green & turquoise hydrogen production, hydrogen carriers & hydrogen supply chain technologies, strategic planning, development of fuel cells, electrolyzers, CCUS, e-Fuels, Sustainable aviation fuels, direct air capture, renewable integration, circular carbon economy, fuel processing, catalytic membrane reactors, catalysis, downstream oil & gas and refinery technologies. Dr. Katikaneni has 60+ granted and pending patent applications, more than 80+ high impact journal publications and conference proceedings, Guest Editor: 3 Journal Books; Invited talks: 20; h-index: 24; Citations: 2700+; Organized 10 international conferences and workshops through American Chemical Society (ACS) in H_2 and fuel cells

Restorative Solution to Toe-Drain Water Collected at Ash-Dyke Of Thermal Power Plants

Mr. Vinod Kumar Mauriya

National Thermal Power Corporation, Limited, Hyderabad.

Abstract

In general, coal-ash generated from thermal plants is disposed in the ash-dyke lagoons by wet-disposal method requiring considerable amount of water. A typical 660MW plant annually uses about 16MCM of water, out of that about 8% is used in coal-ash handling operations. From the total water discharged in ash-dyke lagoon, decanted surface water (about 80%) is taken back to ash handling system through recirculation system, however about 20% as sub-surface water gets trapped in deposited ash in ash-dyke lagoon and subsequently released to toe-drain of peripheral ash-dyke. Considering present environmental requirements, now the water received in toe-drain from ash-dyke is necessarily to be collected and taken back for reuse which otherwise was earlier discharged in nearby natural-drains. For reuse of toe-drain water, based on ground topography of ash-pond area, one option is to direct tap-off from toe-drain of ash-dyke at right locations and connect to one or two sumps for pumping back in the re-circulation system of ash handling operations. However, in case the existing ground topography does not permit feasibility of direct tap-off, then an additional peripheral-drain of RCC or brick masonry is to be constructed with suitable connection to toe-drain at right locations. This peripheral-drain would be routed to one or two pump-house(s) depending on the length of peripheral-drain. The sump/pump-house for collection of toe-drain water will be rightly located at the points of lowest ground levels as per ground topography along the toe-drain/ peripheral-drain. Each pump-house will cater to the water from a defined length of toe-drain and accordingly quantity of water to be handled at each pump-house is decided. The adopted restorative solution to toe-drain water has facilitated recycling and reuse of toe-drain water back to the thermal plant in ash handling operations, thereby reducing water consumption in thermal plants.

Keywords: *Industrial water; coal-ash; ash-dyke; toe-drain water; reuse; re-circulation.*

Bio Sketch

Sh. Vinod Kr Mauriya after completing B.Tech(Civil) did M.Tech (Geotech Engg.) from IIT Delhi in year 2002, joined NTPC Ltd in 2004 and has been contributing significantly in various areas of geotechnical engineering from last 21 years. He did MBA in Operations Management in 2010. He is a certified Project Management Associate (IPMA-D) from PMCI (2010). He has also done "Harvard manage mentor" certification course on general management from Harvard University. He has played a key role in planning, engineering and execution of various components of NTPC's first Mega Hydro project (Koldam) in Bilaspur district of Himachal Pradesh. He has been instrumental in planning, engineering and design of all kind of ash disposal systems for 25 thermal plants of NTPC, first thermal plant of THDC (Khurja STPP) and many other organisations like UPRVNL, MPPGCL etc. He has taken various initiatives in NTPC to implement various new technologies like use of Geo-composites, Geogrid, Geocell, Geobag, Geotextiles, HDPE liner protection and introduction of use of Sea-sand and Bottom-ash as filter material. He is an active member of various knowledge sharing platforms in NTPC and is involved in Ash dyke design, Ash mound design and system design of coal Mine voids for NTPC and many other organisations. He has published more than 50 technical papers in National/International conferences and journals. His technical ability and innovative approach have resulted in significant contribution in the area of geotechnical and geo-environmental engineering.

Sustainable Circular Economy Innovation: Bridging Business, Science, Technology, and Academic–Industry Collaboration

Dr. Biju Philip

La Trobe Business School, Melbourne, Victoria, Australia.

Abstract

La Trobe University, explores the intersection of business strategy, sustainability, and circular economy innovation. In this lecture, he highlights the critical role of academic–industry collaboration and business school leadership in translating circular economy research into scalable solutions, particularly in emerging economies.

The transition to a Circular Economy is not solely a technological challenge; its success depends on how scientific and technological innovations are integrated, governed, and scaled across value chains to deliver measurable sustainability and societal impact. This lecture frames Circular Economy implementation through a value-chain perspective, emphasising the need for interdisciplinary academic and industry collaboration to translate research and innovation into practical, system-level outcomes.

Drawing on examples from La Trobe University, Melbourne, Australia, and BITS Pilani, Hyderabad Campus, India, the lecture examines the challenges of moving circular technologies from pilot projects to scalable solutions, highlighting the fragmentation that often impedes adoption. It demonstrates the importance of coordinated approaches across academic disciplines and cross-sector partnerships in driving circular value creation, sustainability, and social impact.

The lecture also underscores the evolving role of business schools as catalysts for circular transformation. Through Circular Economy literacy, curriculum innovation, executive education, and research and industry engagement, business schools can equip future leaders and managers to design and manage sustainable value chains and foster innovations that scale. By bridging science, technology, and business practice, this lecture provides actionable insights for researchers, educators, and practitioners seeking to

accelerate Circular Economy innovation through collaborative and interdisciplinary approaches.

Bio Sketch

Dr Biju Philip is an academic at La Trobe Business School, holding a PhD in Management and master's degrees in commerce, accounting, and university teaching. He brings over two decades of experience across higher education, industry, and the not-for-profit sector. An award-winning lecturer, he received the La Trobe Business School Teaching Award in 2025 and the Dean's Commendation for Teaching Excellence in 2018. His work focuses on strategic operations management and innovation in higher education teaching, with a strong emphasis on translating research into practice. He teaches master's-
level management subjects and is leading the development of a new subject, Circular Economy in Practice, which integrates industry engagement, applied problem-solving, and sustainability-oriented innovation. He collaborates extensively with academic and industry partners internationally to support circular economy transitions. A Fellow Certified Practising Accountant, Dr Philip serves with CPA Australia's Environment, Social and Governance Centre of Excellence, contributing expertise in governance and sustainability.

Valorization of Organic Waste for the generation of Compressed biogas (CBG) and Fermented organic Manure (FOM)

Dr. Gangagni Rao Anupoju

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Abstract

India is one of the fastest-growing economies in the world, with rapidly increasing energy demand and a high dependence on imported fossil fuels, accounting for nearly 77% of crude oil and about 50% of natural gas requirements. Valorization of organic waste for the production of Compressed Biogas (CBG) and Fermented Organic Manure (FOM) presents a sustainable and circular bioeconomy solution. CBG exhibits calorific value and combustion characteristics comparable to compressed natural gas (CNG), enabling its utilization as a renewable automotive fuel, while FOM serves as a nutrient-rich soil amendment that enhances soil health and agricultural productivity.

To promote CBG deployment, the Government of India launched the Sustainable Alternative Towards Affordable Transportation (SATAT) initiative in 2018, targeting the establishment of 5,000 CBG plants with an annual production capacity of 15 million metric tonnes (MMT) of CBG and 50 MMT of bio-manure. As of early 2026, approximately 132 CBG plants are operational in India, producing around 920 tonnes per day of CBG, indicating measurable progress but also a significant gap from national targets. Challenges related to feedstock availability, technology selection, economic viability, limited awareness, and competition from alternative fuels continue to hinder the programme. To encourage investment, the Government of India provides central financial assistance of up to ₹4 crore per 4.8 TPD plant for entrepreneurs establishing CBG facilities.

The successful implementation of CBG projects depends on efficient bioreactor performance, robust biogas upgrading systems, and integrated plant design covering feedstock logistics, process optimization, operation and maintenance, product quality assurance, and sustainable management of residues and by-products. Advancing organic

waste valorisation for CBG and FOM production can strengthen rural economies, enhance resource circularity, reduce environmental impacts, and contribute significantly to India's clean energy transition.

Keywords: *CBG, FOM; Bioreactor; Biogas; SATAT.*

Bio Sketch

Dr. A. Gangagni Rao is a distinguished environmental engineer renowned for his translational research in waste-to-energy and anaerobic digestion technologies. He earned his B.Tech in Chemical Engineering from A.U. College of Engineering (1988), M.Tech from IIT Delhi (1990), Ph.D. in Environmental Biotechnology from JNTU Hyderabad (2007), and postdoctoral training in Biofuels from University College Cork, Ireland (2008).

Dr. Rao is a pioneer of indigenous high-rate biomethanation technologies in India, notably the Anaerobic Gas Lift Reactor (AGR), with nearly 40 biogas plants deployed nationwide. His work spans solid waste, agricultural biomass, effluents, and gaseous emissions, leading to innovations such as UASB indigenization, accelerated anaerobic composting, dry anaerobic digestion systems, bi-phasic solid-state digesters, biofilters, and Bio-SAC-based effluent treatment. His contributions gained national recognition, including mention of the Bowenpally Biogas Plant by the Hon'ble Prime Minister in Mann Ki Baat (2021).

With 7 patents, over 80 Q1/Q2 journal publications, 28 book chapters, and an h-index of 25, Dr. Rao has also served as advisor to several national and international organizations and as a member of key expert committees under MNRE, PSA–GoI, and State Pollution Control Boards.

A recipient of numerous national and international awards, he is a Fellow of the Royal Society of Chemistry (UK), Fellow of BRSI, IIChE, Institution of Engineers, and Telangana Academy of Sciences, and has been honored with prestigious awards including the Sir M. Visvesvaraya Award, VASVIK Award, and Indian Green Energy Award for outstanding contributions to renewable energy and waste management.

Legislative, Cultural principles infused in Ancient India towards Circular economy

Dr. M. Dwarakanath

Chairman, State Environmental Impact Assessment Authority, SEIAA, Government of Pondicherry.

Abstract

Indians had indigenous knowledge derived from deep understandings, practices, skill sets, and long interactions that they had with the Nature, its various aspects and phenomenon's. In earlier years, the life activities at every step was intertwined with Nature and not looked in isolation. The principles of mitigation and adaptation were infused in the population through the day to day life style. The traditional knowledge had been passed on to next Generations by way of seeing, observation, training and Practice. The beauty of understanding of the traditional knowledge is reflected in the approaches adopted in accordance to the local conditions, affordability, sustainable options with the locally available materials.

The knowledge system ranged from Agricultural practices, Integrated pest management, crop rotation, Compost making, food grains preservation, Up cycling and repurposing of clothes, ecofriendly transportation, usage of eco- friendly day to day materials which are degradable, traditional water storage structures both underground and over the ground etc. the list is endless.

It may be appreciated that these practices focused on a number of Circular Economy concepts namely, durability, degradability, local availability, recycling , reuse and waste elimination, ensuring resources remained in use, embodying a sustainable lifestyle etc. Indian Spiritual Practices irrespective of the Religion had preached about conservation, preservation of natural resources, worshipping of plants, animals and sustainable use of our resources.

Indian Legislations had infused Circular Economy principles much before the Western World started using the terminology. Indian Constitution, is one of the earliest Constitution in the World, which has provisions for Protection of Environment and has provisions for

the State to make Endeavour for protection and improvement of the environment, for safeguarding the forest and wild life. It further defines and cast upon duty of every citizen of India - 'to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures'. The legislations formulated, be it on Water, Air or on Environment through various Acts, Rules and notifications aimed at Treatment, recycling, reuse of treated waste water, air and various types waste and recycling, reuse or recovery of materials etc. Such cultural, social, religious beliefs and practices with the backing of legislative frame work had existed in India and the Circular economy Principles were adopted by the Nation in a big way taking Giant steps towards the same.

Keywords: *Circular Economy, Indian Traditional Knowledge, Constitution of India, Legislations on Environment, Social and cultural Practices, recycling, material recovery, reuse.*

Bio Sketch

Presently, serving as Chairman, State Environmental Impact Assessment Authority,(SEIAA), Government of Pondicherry.
Served for more than 30 yrs with R&D Institutions, Delhi & Puducherry Government Departments.
Served as Director, DSTE & Member Secretary, Puducherry Pollution Control Committee.
Serving as Visiting Professor in four Universities/ Colleges in the last 5 years.
Served as a former expert member twice in R&D Committee of MOEF&CC, GOI.
Served with NEERI, NSI, WAPCOS (I) Ltd earlier.
Executed more than 15 major projects funded by WB, GOI Ministries.
Visited several countries for training programs.
Actively Involved in Training/ Lectures for Faculties and Students in various Orientation, Madan Mohan Malviya Mission Training Programs, FDPs, Refreshers Program & Regular curriculum on Environment, Pollution control, Sustainability, Climate Change related topics.
Motivational Speaker & Soft Skill Trainer as well

Applications of Artificial Intelligence and Machine Learning in Anaerobic Digestion

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Abstract

Anaerobic digestion (AD) is a vital technology for achieving sustainable waste management and renewable energy generation through biogas production. However, the inherent complexity of AD processes arising from variable feedstock composition, nonlinear process dynamics, and sensitive microbial interactions poses challenges in achieving stable and optimized performance. Traditional modelling and control methods often fall short in accurately representing these complex relationships. In recent years, artificial intelligence (AI) and machine learning (ML) have emerged as promising tools to overcome these limitations and improve the efficiency and reliability of anaerobic digestion systems. This review presents an overview of the applications of AI and ML in anaerobic digestion, focusing on their use in biogas and methane yield prediction, process monitoring, fault detection, and optimization of operational parameters such as organic loading rate, hydraulic retention time, temperature, and pH. Commonly applied techniques, including artificial neural networks, support vector machines, random forest models, decision trees, gradient boosting regression, deep learning, hybrid modelling approaches, etc., are discussed in terms of their predictive capability and practical relevance. Furthermore, the review addresses key challenges associated with data availability, model interpretability, scalability, and industrial implementation.

Keywords *Anaerobic digestion; Artificial intelligence; Machine learning; Biogas; Process optimization*

Bio Sketch

A graduate Engineer from NIT Warangal (1988-92 Batch); and an Innovator; Kiran

- Kiran KK is based out of Hyderabad and Kuala Lumpur, and he has constructed more than 50 full scale Biogas projects on turnkey basis in India and abroad.
- Kiran KK owns 2 Joint patents with Indian Institute of Technology: Hyderabad in the fields of environment and renewable energy. The patented technologies are implemented as full scale commercial projects after successfully crossing TRL-9 level.
- Kiran KK has constructed way back in 2015; a 2.2 MW Capacity Power plant based on Palm oil mill effluent on BOO Basis which is the First ever such plant for the country of Malaysia.
- Kiran KK has constructed Biogas plants on rare type of feedstock such as
- wastewater coming out of Marigold Flower processing units.
- Kiran KK has constructed First ever CBG plant based on Process condensate
- generated in Ethanol Plant
- Kiran KK is presently constructing first ever CBG plant integrated with a Grain
- based Ethanol Plant
- Kiran KK has successfully developed prototypes under UAY (Uchchatar Avishkar Yojana) and IMPRINT (Impacting Research Innovation and Technology) both are Pradhan Mantri Yojana; Government of India
- Kiran KK has Published more than 10 Research papers in High Impact Journals

Sludge rheology role in sustainable treatment of wastewater sludge

Prof. Nicky Eshtiaghi

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Abstract

Clean water is one of the most essential requirements for human health, environmental sustainability, and economic development. Sludge rheology plays a significant role in the sustainable treatment of wastewater sludge. By understanding and controlling the flow behavior and deformation of sludge, treatment plants can optimize their processes, reduce maintenance cost, improve resource recovery, and reduce the environmental impact of sludge management. Sludge rheology has a significant impact on the performance of pumps, anaerobic digesters, dewaterability equipment, mixers, and heat exchangers.

A large portion of the total energy consumption in any sludge treatment plants is used for pumping sludge within the treatment processes. The efficient operation of sludge pumps requires an accurate calculation of friction losses for which sludge rheological parameters is an important parameter. Rheological parameters change as composition changes due to season, origin and treatment process. A validated pressure drops calculation toolkit was developed with up to 10% errors against actual data collected both at industrial scale and a pilot plant of sludge pumping system in a range of solid concentrations of sludge.

Anaerobic digesters are used to treat sludge and produce biogas. The rheology of the sludge can affect the digestion process, as it can impact the ability of microorganisms to break down the organic matter in the sludge. Sludge with high viscosity may have a lower biodegradability, resulting in a longer retention time within the digester, which can increase the size and cost of the digester. Additionally, the rheology of the sludge can impact the efficiency of the mixing within the digester, affecting the biogas production and overall treatment performance. Experimental results indicated that higher volatile solids destruction leads to increased difficulty to flow and dewater.

Incorporating sludge rheology knowledge into the design, operation, and optimization of treatment processes can ultimately lead to more sustainable sludge management practices, where resource recovery is maximized, energy consumption is minimized, and environmental impacts are reduced.

Bio Sketch

Nicky Eshtiaghi is a Professor of Chemical Engineering at RMIT University, an Engineers Australia (EA) Fellow and Chartered Engineer, a Fellow of the Higher Education Academy (FHEA, UK), the Past President of Australian Society of Rheology and an Editor in Chemical Engineering Research and Design Journal (Q1, Elsevier). With a consultative, evidence-based approach, a feature of Nicky's leadership roles over the past decade has been her focus on bringing together multiple partners from industries, governments, and the university sector, to set-up and deliver large research programs. She leads Sustainable Waste Processing Laboratories which investigates the flow behaviour of solid residue (sludge) from wastewater treatment plants with the aim of optimizing the energy efficiency of processes in sludge treatment lines. She has extensive research experience in process optimisation, biomass conversion to added value product including hydrochar, and biogas, anaerobic digestion, and removal of microplastic from water as well as recycling critical mineral from spent batteries. She is the recipient of several prestigious awards including IChemE Australasia Awards- Research Project Excellence Award, 2015 Engineers Australia's Victorian Professional Engineer of the Year for engineering competence, leadership skills, creativity, innovation, and conspicuous service to industry, the profession and society, Australia's Most Innovative Engineer recognition in 2020 (Engineers Australia), the 2017 Australian Awards for University Teaching (AAUT) and IChemE Morton Medal in 2021 for outstanding contribution to students learning and a game changer educator.

Global Shortcomings in Handling and Management of Organic Sludge and Associated Hazards: A Comprehensive Assessment

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Abstract

The prominent sources of organic sludge include domestic and certain industrial wastewater treatment plants, such as those in the food processing and paper and pulp industries, and many organic sludge is generated from anaerobic digesters and faecal sludge treatment plants. The global generation of organic sludge has surpassed an alarming 100 million tons per annum, with sewage sludge alone contributing about half of this amount. However, the absence of effective handling and management methods has ineffective handling and management methods have made treatment and resource recovery a persistent challenge. This has led to a continued reliance on outdated technologies such as landfilling, deep burial, co-composting, etc. Typically, the treatment costs for these methods range from $50 to $100 per ton. While inexpensive, these processes are primitive, have a large footprint, and provide negligible environmental benefits. Moreover, the high moisture content and pathogenic and organic loads significantly increase the risk of secondary pollution. Therefore, there is a pressing need for a comprehensive treatment scheme that addresses these shortcomings and effectively valorises waste streams. Existing literature suggests that the fundamental characteristics of most types of sludge remain similar, making it feasible to explore advanced hybrid biological treatment schemes capable of handling variations and shock loads. Further, the techno-economic feasibility and sustainability of these advanced methods can be assessed using tools such as life cycle assessment to enable informed decision-making.

Keywords: *Environmental Sustainability, Life Cycle Assessment, Organic Sludge, Resource* Recovery, Sludge Treatment

Bio Sketch

Dr. Atun Roy Choudhury is an Environmental Engineer with a PhD from BITS Pilani and currently serves as Technical Head at Unison i3x. He has held key roles across leading organizations including IL&FS Environment, Ramky Enviro Engineers Ltd., Banka Bio, Shrushti Group, and Cube Bio. His core expertise includes waste management, waste valorization, air pollution control, water, and sanitation systems.

He has authored over 60 publications in reputed international journals, books, and scientific magazines and serves as an Editor and Reviewer for leading publishers such as Nature, Oxford Academic, Elsevier, Springer, PLOS, etc. His expert views have been featured in national newspapers and magazines, and he is a frequent speaker at national and international forums, including TEDx.

Dr. Choudhury is a recipient of the UGC Gold Medal and holds certifications as an Environmental Lead Auditor. His patented work on waste valorization has received recognition from the United Nations, the Government of India under the KAPILA scheme, and the India Book of Records. He has also been featured in the Oxford World Book of Researchers. He continues to contribute to sustainable environmental solutions through the integration of research, industry practice, and innovation.

Which pretreatments for anaerobic digestion process ?

Dr. Helene CARRERE

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Abstract

Anaerobic digestion is a key process for ecological transition as it combines the treatment of organic waste and the production of renewable energy and of organic fertilizer. After the development of sewage sludge anaerobic digestion, biogas agricultural sector and collective biogas plants are facing an important development in France and in Europe. This presentation proposes an overview of pretreatments that can be applied to the anaerobic digestion of solid waste for which hydrolysis is the rate limiting step. The main objectives of pretreatments are generally the increase of methane production and/or the increase of waste degradation rate. First, principle of anaerobic digestion will be reminded and pros and cons of pretreatment will be discussed. Then, the anaerobic digestion limitations of main solid feedstocks are discussed, introducing some strategic guidelines for their pretreatment. In particular, the main pretreatment technologies applied at full scale will be reviewed for sewage sludge, animal byproducts and fatty waste, food waste and organic fraction of municipal solid waste, and lignocellulosic biomass. Finally, few new research topics on pretreatments will be introduced

Bio Sketch

Dr Hélène Carrère is an INRAE research director (equivalent to full research professor). She received her PhD in Process Engineering in 1993 from National Polytechnic Institute of Toulouse, France. She joined INRAE in 1994 to work on separation processes in Microbiology and Food Process Engineering unit in Grignon. She moved to Laboratory of Environmental Biotechnology in Narbonne in 2001 where her research focuses on the concept of environmental biorefinery. In particular, she is recognised for her studies on the development of physico-chemical or biological pretreatments to improve the performance of anaerobic digestion and dark fermentation for the recovery of resources from various feedstocks (e.g. sewage sludge, lignocellulosic biomass, manure, food waste, etc.). She has supervised or co-supervised 30 PhD, 34 master students, 8 Post-docs, 8 Visiting Scholars, and 7 contractual research engineers. She has co-authored more than150 scientific papers and 15 book chapters. Among a total of around 200 oral and poster presentations, she has delivered more than 30 international or national invited conferences. Her Web of Science H-index is 57 (> 12,000 citations) and Google Scholar H-index is 70 (> 20,000 citations). In 2018, she was listed in top 1% most cited authors in cross field category (Clarivate Analytics). She is serving as Associate Editor for Waste Management Journal since 2018 and for Bioresource Technology since 2024.

Valorization Of Water Hyacinth For Xylitol And Lipid Accumulation Using *Meyerozyma Guilliermondii*

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Abstract

Biofuels are low carbon emission, sustainable and eco-friendly fuels produced from organic matter that significantly combat fossil fuel-associated challenges such as energy shortage, environmental pollution and climate change. Xylitol is a pentose sugar alcohol with a significant antiplaque effect since it cannot be fermented. Furthermore, Xylitol is approved by the FDA as an essential low-calorie artificial sweetener in many products, such as chewing gums, mouth rinsers, and sugar-free tablets. In the current study, lipid and xylitol-producing strains were isolated from the soil sample, and the sequencing results showed that the isolated strain was *Meyerozyma guilliermondii*. Further, alkali-treated water hyacinth was used to produce the cocktail enzyme (cellulase 1.2 U/ml and xylanase 16.1 U/ml) using *Aspergillus terreus* with solid-state fermentation. The hydrolysis of water hyacinth using the cocktail enzyme resulted in 10 g/L of glucose and 30 g/L xylose. The hydrolysate was used for the fermentation using *Meyerozyma guilliermondii*. The fermentation has resulted in an 80% conversion of xylose to xylitol and accumulated 20% lipid dry cell weight. This work displays the potential of harnessing second-generation feedstock to produce value-added products such as lipid and xylitol, showing the circular bioeconomy.

Bio Sketch

Dr. Ashish Prabhu received his bachelor's degree in Biotechnology from Visvesvaraya Technological University and a Master's in Industrial Biotechnology from Manipal Institute of Technology, India. During his master's, he worked as a project assistant at Central Food Technological Research Institute in Mysore, India. Ashish obtained his PhD (Biochemical Engineering) 2018 from the Department of Biosciences and Bioengineering, Indian Institute of Technology, Guwahati. His doctoral research primarily focused on engineering methylotrophic yeast Pichia pastoris to produce human interferon-gamma. Subsequently, he also worked on engineering other GRAS (Generally Regarded as Safe) organisms such as Bacillus, K. lactis and E.coli for producing therapeutic proteins/Enzymes. Post PhD, he joined Tata Institute of Genetics and Society, Bangalore, India, where he worked on producing malarial antigens and Single chain antibodies in E.coli and Insect cell lines. Later he joined as a Research Fellow in Metabolic Engineering, Centre for Climate and Environmental Protection in Cranfield University and also in Imperial college london, United Kingdom. Where he worked on the engineering of oleaginous yeast Yarrowia lipolytica for the production of value-added products such as xylitol and succinic acid using renewable carbon sources such as sugarcane bagasse hydrolysate, food waste and crude glycerol. He is an assistant professor at the Department of Biotechnology, National Institute of Technology Warangal. He has published 50 publications and 12 book chapters in national and international journals. He also serves as an editor and reviewer in many international journals.

VAL01

Efficient Laccase Production by *Schizophyllum commune* through Process Optimization in Solid-State Fermentation of Lignocellulosic Biomass

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Abstract

The urgent need to decarbonize energy systems has positioned lignocellulosic biofuels as a key component of future sustainable energy portfolios; however, biomass recalcitrance caused by lignin remains a major technological barrier. Enzyme-based pretreatment strategies are increasingly preferred over harsh chemical methods due to their selectivity and environmental compatibility. Among ligninolytic enzymes, laccase (EC 1.10.3.2), a multicopper oxidase, plays a crucial role in lignin depolymerization by oxidizing phenolic and non-phenolic lignin units using molecular oxygen as the terminal electron acceptor, thereby improving cellulose accessibility. In this study, a laccase-producing *Schizophyllum commune* strain was isolated from natural habitats, screened, and exploited for efficient laccase production under solid-state fermentation using lignocellulosic biomass as a low-cost substrate. Laccase production by *S. commune* is often constrained by substrate heterogeneity and solid-state fermentation limitations such as moisture control, oxygen diffusion, and complex parameter interactions. To overcome these bottlenecks, nine key physicochemical and nutritional parameters were systematically optimized to enhance crude laccase yield and functional efficiency. Under optimized conditions, crude laccase activity reached 500–700 IU/mL. The produced enzyme demonstrated effective biomass delignification, which was conclusively validated through X-ray diffraction, Fourier-transform infrared, and Raman spectroscopic analyses, confirming significant structural and compositional modifications in the treated lignocellulosic biomass.

Keywords: *Laccase production, Solid-state fermentation, Lignocellulosic biomass delignification.*

VAL02

Life Cycle Assessment of Solar Photovoltaic Panels for the Circular Economy

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Abstract

Life Cycle Assessment (LCA) is the process of assessing the environmental impact of products and processes, from 'cradle-to-grave', considering the crucial stages of the entire product lifecycle. In recent times, India has pronounced a strong commitment towards establishing large-scale solar photovoltaic (Solar-PV) farms as a major shift towards renewable energy sources and reducing fossil fuel consumption to reduce the environmental pollution burden. Solar PV panels are manufactured through a technologically advanced process, and at each stage of their life cycle, namely, material extraction, manufacturing, shipping, consumption, and disposal, they are involved with the consumption of material, energy, and the release of solid, liquid, and gaseous residues into the environment. It is essential to study the carbon dioxide equivalent of cumulative environmental pollution through LCA to find possible ways of reducing the same. The present study aims to conduct a systematic LCA of Solar-PV panels through methods involving the use of open-source software, readily available datasets, and the ISO 14040 standard. It was found that the Solar-PV panel associated electricity production was associated with water wastage, marine life and terrestrial life affliction, and mineral source depletion. For a 1 kWh solar panel, the LCA showed that the pollution assessed included water consumption of 0.000407481 DALYs, marine ecosystem damage of 2.47793E-06 species.yr, and mineral resource scarcity of USD13 (ReCiPe2016 method) units of 0.489753337. The LCA was found to yield suitable solution options as well. Recycling of crucial elements within the Solar-PV panel makes it possible to reduce mineral scarcity as well as water usage.

VAL03

Selective lignin degradation of Eucalyptus and Bamboo residues through fungal consortium-based biological pretreatment

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Abstract

The efficient utilization of lignocellulosic forest biomass is a critical component of circular bioeconomy strategies aimed at reducing waste and promoting sustainable industrial processes. This study investigates the potential of white-rot fungal consortia for the biological valorization of lignocellulosic substrates, focusing on eucalyptus and bamboo as representative forest-based residues. Three ligninolytic fungi such as *Trametes versicolor*, *Ganoderma lucidum*, and *Schizophyllum commune* were evaluated individually and as a consortium for their ability to selectively degrade lignin while preserving cellulose fractions, thereby enhancing biomass processability. The fungal treatments were assessed through qualitative and quantitative analyses, including weight loss measurements, ligninolytic enzyme activity profiling, and Fourier Transform Infrared (FTIR) spectroscopy. Consortium-based treatments demonstrated significantly higher lignin degradation efficiency compared to monocultures, indicating synergistic interactions between fungal species. FTIR spectral analysis revealed a marked reduction in lignin-associated functional groups, confirming selective delignification of the substrates. Enhanced enzyme production of laccase, lignin peroxidase, and manganese peroxidase, further supported the effectiveness of biological pretreatment. The findings highlight the advantages of fungal consortium-mediated biomass processing as an eco-friendly alternative to conventional chemical pretreatments, which are often energy-intensive and environmentally detrimental. By converting forest biomass residues into biologically modified substrates with improved downstream applicability, this approach contributes to waste minimization, resource efficiency, and sustainable material utilization.

Keywords: *Biological valorization; Circular bioeconomy; Delignification; Lignocellulose; White-rot fungi*

VAL04

Valorization of Lignin Waste for the Production of Eco-friendly Lignosulfonate-Based Cement Admixture For Sustainable Construction

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Abstract

The research work involves the synthesis of lignin-based cement admixture, lignosulfonate, from waste lignin, sodium sulfite, and formaldehyde. The development involves the transformation of waste lignin into water-soluble lignosulfonates with application in construction sector. The synthesis method aims at the incorporation of sulfonate group functionalities onto the lignin backbone through sulfonation and hydroxymethylation reactions under controlled alkaline and thermal conditions. The product exhibits 100% solubility in deionised water at neutral pH at room temperature. The synthesized lignosulfonate was then characterized using an elemental analyzer, which demonstrates the content of carbon, hydrogen, nitrogen, sulfur, and an increased sulfur content compared to the pristine lignin, validating the sulfonation process. Further, the FTIR peaks in lignosulfonate exhibited the signature adsorption bands corresponding to the functional groups introduced during the sulfonation reaction. The presence of a band at ~621 cm^{-1}, which is in the 600–640 cm^{-1} range, corresponds to the symmetric S=O stretching, which is the signature peak that confirms the incorporation of sulfonic groups into the lignin structure, validating successful sulfonation. Asymmetric S=O stretching in the 1030–1080 cm^{-1} range, specifically at ~1041 cm^{-1} and C-O stretching at ~1120 cm^{-1}, suggests bonding of sulfonate groups to lignin. The thermal stability graph of lignosulfonate exhibited a multistep degradation, which is typical of sulfonated lignin derivatives. The sample was thermally stable up to around 150°C, which makes it suitable for moderate-temperature cement hydration processes. The X-ray diffraction (XRD) analysis of the synthesized lignosulfonate-based cement admixture displayed an amorphous–semi-crystalline structure, which is typical of lignin-derived sulfonated materials. The synthesised

lignosulfonate-based cement admixture demonstrated superplasticizing ability with a significant reduction in water requirement, while maintaining better dispersion, flowability, and workability in the flow table and vicat needle compared to the commercial lignosulfonate and the control mix. The work bridges the gap between waste valorization and sustainable construction, with lignosulfonate offering a dual benefit of waste to resource conversion and green construction material, opening new avenues for biomanufacturing-driven construction.

Keywords: *Lignin valorization, Biomanufacturing, Lignosulfonate-based cement admixture, Sustainable construction*

VAL05

Valorization of agro-industrial substrates for biosurfactant production

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Abstract

Microbial surfactants produced by microorganisms (bacteria, yeast, fungi) have emerged as alternatives to surface active agents due to their low toxicity, biodegradability, multi functionalities under extreme temperature, pH conditions. Microbial surfactants are classified as glycolipids, lipopeptides, lipoproteins, polymeric surfactants. In addition, they can be produced from renewable sources with aspect of sustainable economics and can be the focus to meet the sustainable development goals (SDGs). Biosurfactants are eco-compatible molecules of 21st century and there is increase in demand with CAGR of 6 .1% from 2021 to 2030. In recent past, work on biosurfactants as emerging biomolecules has geared up due to their bio and interfacial activity, which is also dependent on the structure and composition of each with unique applications in field of agriculture, food, environment and pharmaceuticals. At the Plant Probiotic and Biosurfactant Lab (P2BL), we work on production of microbial surfactants from plant growth promoting bacteria (*Pseudomonas aeruginosa DR1*, *Bacillus velezensis MS20*, *Bacillus mojavensis RHPR20*, *Stenotrophomonas maltophila GHG9* and yeast (*Pichia occidentalis MHY5*, *Hanseniaspora guilliermondii MHY3*, *Hanseniaspora pseudoguilliermondii MHY7*, *Hanseniaspora opuntiae MHY8*) which have been identified by molecular methods. Production of these microbial surfactants have been explored using oil cakes, mango kernel seed oil, fruit wastes and spent mushroom wastes. Quantification of biosurfactant produced was done by gravimetric method and analysis was done by TLC, FTIR. Further application based studies were done against the phytopathogens with the produced biosurfactant. The results of the same will be presented.

Keywords: *Bacteria, yeast, Biosurfactants, substrates, antifungal*

VAL06

The critical and unbiased assessment of composting

Keitumetse Ngaka and P. Sankar Ganesh*

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Abstract

Composting is widely promoted as a sustainable and cost-effective strategy for managing organic wastes, improving soil quality, and reducing reliance on landfilling and incineration. Despite its long history and broad application, composting outcomes are highly variable and context-dependent, necessitating a critical and unbiased evaluation of its environmental, technical, and socio-economic performance. This assessment examines composting from multiple perspectives, including process efficiency, greenhouse gas emissions, nutrient conservation, pathogen and contaminant control, and end-product quality. While composting offers clear benefits such as organic matter stabilization, nutrient recycling, and waste volume reduction, it also presents notable limitations, including nitrogen losses, odor generation, inconsistent maturity, microplastic accumulation, and challenges in quality assurance. Operational constraints, such as feedstock heterogeneity, moisture and aeration control, and scale-specific management requirements, further influence process reliability. Moreover, the sustainability of composting is closely linked to the efficiency of source segregation, regulatory frameworks, and market demand for compost products. By synthesizing both advantages and drawbacks, this critical and unbiased assessment highlights that composting is neither a universal solution nor an inherently low-impact technology, but rather a process whose effectiveness depends on careful design, monitoring, and integration within broader waste management systems. The study underscores the need for standardized quality criteria, improved process control, and transparent life-cycle evaluations to ensure composting delivers genuine environmental and agronomic benefits.

Keywords: *Organic waste; Composting; Waste management; Cost–benefit analysis; Environmental sustainability*

VAL07

Reimagining Just Transition of Electronics Economy: Thinking with Hyderabad's and Delhi's popular repair clusters

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Abstract

The Indian electronics economy has invited significant policy interventions in the last few years that have attempted to institute a sustainability agenda into the sector besides investments for economic growth and livelihood. This paper examines these interventions around sustainable e-waste management and the promotion of the circular economy through a grounding in the practices of vibrant and growing electronic-repair clusters in Hyderabad and Delhi. Based on ethnographic fieldwork and in-depth interviews with the technicians in these clusters, we raise questions around gradual exclusion of the practices and concerns of urban popular repair clusters by the recent policy interventions. In particular, we point to exclusionary tendencies in terms of a select corporate actors and producers of the electronic goods participating in the policy process, alongside the sidelining of the urban majority. Our fieldwork shows this majority electronics economy as embedded in local urban processes which allow for sustainable value creation as well as enable the circular flow of valuable materials and waste-streams across different city spaces and national and transnational economic circuits. On these grounds, we argue for centering of the popular repair clusters for reimagining the just transition of the electronics economy. This would allow for strengthening the ongoing processes of urbanization which have created livelihood opportunities for majority populations and could potentially enable negotiation with exploitative processes enabling the circularity of discarded streams across uneven geographies within cities and across national and transnational economic circuits. This presentation would thus present the emerging perspective of the team comparing the value-circuits and

governance networks of electronic-waste across Hyderabad and Delhi and invite a discussion with the broader academic audience interested in the just transition of the electronics sector.

Keywords: *Popular Economies, Informal Sector, electronics economy, Repair, Circular Economy*

VAL08

Experimental Evaluation of Fresh Properties and Buildability of 3D Printed Concrete

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Abstract

Conventional concrete construction methods are often constrained by intensive formwork requirements, high labor dependency, material waste, and limited geometric freedom, which collectively reduce construction efficiency and sustainability. Rapid urbanization and the need for customized, resource-efficient infrastructure exacerbate these issues. Emerging digital building technologies require early-age rheology and structural build-up control, which cast-in-place processes lack. Thus, innovative building methods are needed that reduce environmental impacts while maintaining fresh-state performance and structural stability. This paper examines the fresh-state properties and buildability characteristics of 3D printed concrete (3DPC) through a comprehensive experimental program. The initial setting behavior of cement pastes and mortar mixtures was evaluated using ultrasonic pulse velocity (UPV) measurements and penetration resistance tests to capture early-age structural evolution. The shear strength development of mortar mixtures, a key parameter governing layer stability and interlayer bonding, was assessed using both penetration-based methods and a vane shear apparatus. Workability quantified through flow table tests, while buildability was evaluated using shape retention tests and the slug test to determine the material's ability to sustain its own weight without excessive deformation or collapse. Overall, the study demonstrates that a balanced combination of workability, setting time, and shear strength is essential for achieving printable and stable 3DPC mixtures. The results highlight the effectiveness of simple, non-destructive, and practical test methods for characterizing fresh-state behavior relevant to additive manufacturing in the construction industry. Furthermore, the incorporation of supplementary cementitious materials (SCMs) supports improved rheological control and reduced cement content, contributing to lower embodied carbon and promoting circular

economy principles. The findings confirm that optimized fresh-state properties of 3DPC can enhance construction efficiency, reduce material waste, and offer a more sustainable alternative to conventional construction practices.

Keywords: *3D printed concrete (3DPC), Supplementary cementitious materials (SCM), UPV, Slug test, Fresh properties.*

VAL09

Valorization of jute mill waste for treatment of electroplating effluent and sludge management as zinc micro-fertilizer

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Abstract

Jute industry fibrous wastes are commonly known as jute caddies that have been discarded in open landfills at huge quantities. These fibrous wastes were used for development of biochar for heavy metals remediation from metal bearing wastewater as recycle prospective. Metal-bearing effluents generated from industrial sectors like electroplating, super alloys production, batteries, ceramics, mining and metal processing and discharged directly into natural waters that could constitute high-risk for ecosystem. In present investigation, chemically activated biochar from jute mill waste as adsorbents were developed for removal and recovery of heavy metal contaminants from electroplating effluent. The treatment effects of synthetic and electroplating wastewater using developed biochar revealed >96% removal of Zn(II), Cu(II), Ni(II), Co(II), Cd(II) and Pb(II). The biochar showed maximum Zn(II) adsorption capacity of 526.32 mgg^{-1}. The biochar was characterized and adsorption mechanism elucidated using BET, zeta potential, FESEM-EDX, FTIR, XPS, XRF, ICP-AES, techniques. Zn(II) binding was achieved by ion exchange, complexation with functional groups, electrostatic interactions, adsorption and micro-precipitation. Functional groups were involved in the order of amino> phosphate> hydroxyl> carbonyl> Sulfhydryl> carboxyl which were confirmed as significant decreased in adsorption after chemical modification. The negative zeta-potential of biochar influenced Zn(II) adsorption by electrostatic interactions. Reductions in the K, Na, Ca and Mg content indicated ion-exchange mechanism. Evaluation of data regarding presence of Zn(II)-laden biochar mixed with soil revealed a positive influence on *Cicer arietnium* seed germination, plant growth parameters, protein and chlorophyll a and b content. There were no changes in the antioxidant enzymes activities, superoxide dismutase (SOD) and catalase (CAT)

between the plants grown in control soil and different Zn(II)-laden biochar mixed soil, suggesting that 15% of the Zn(II)-laden biochar could not be excess condition of zinc. Combining these practices can manage jute waste, metal-bearing effluent treatment, micro-fertilizer application and soil productivity improvement at low cost, environmental safe and fruitful manner.

Keywords: *Waste derived adsorbent, Jute caddies biochar, Heavy metals, soil amendment, metal loaded adsorbent management*

VAL10

Fire and Thermal Performance of Melia dubia-Pleurotus ostreatus Mycelium-Based Bio- Composites for Sustainable Packaging and Insulation Applications

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Abstract

The widespread use of non-biodegradable, petroleum-based materials such as expanded polystyrene and polymeric foams in packaging and fire-sensitive construction applications has resulted in persistent environmental and safety challenges. These materials contribute significantly to solid-waste accumulation and microplastic pollution and exhibit rapid ignition and flame propagation, posing serious fire hazards. Within the framework of the circular economy, sustainable development, and integrated waste management, there is an urgent need for alternative materials that are both biodegradable and fire-aware. This study evaluates mycelium-based bio-composites as a sustainable alternative to conventional packaging and insulation materials, with particular emphasis on fire and thermal performance. Industrial woody residues of Melia dubia, commonly treated as low-value forestry waste, were utilised as lignocellulosic substrates and biologically bound using the white-rot fungus Pleurotus ostreatus. Composite panels were produced through controlled mycelial colonisation, followed by oven drying to terminate fungal activity and hot-press densification at 145 °C and 21 kg cm^{-2} to enhance structural consolidation. Fire performance was evaluated using a rate of burning test, which showed that Melia dubia-Pleurotus ostreatus bio-composites burned significantly more slowly than conventional packaging and foam materials. Even after 450 seconds of exposure, the composites exhibited only about 70% mass loss, indicating reduced flame spread and improved resistance to combustion. This behaviour is attributed to the formation of a stable char layer during thermal exposure, which acts as an insulating barrier that limits heat transfer and suppresses the release of combustible

volatiles. Thermogravimetric analysis (TGA) further supported the enhanced fire performance of the developed bio-composites. The materials displayed multi-stage thermal degradation behaviour and retained a significant residual char fraction without complete mass loss up to 600 °C. The presence of chitin and polysaccharide-rich fungal biomass within the lignocellulosic matrix contributed to char formation and improved thermal stability. The results demonstrate that Melia dubia-Pleurotus ostreatus mycelium-based bio-composites outperform conventional packaging materials in terms of fire behaviour while simultaneously valorising industrial woody waste. These findings highlight their strong potential as biodegradable, fire-aware alternatives for packaging and non-structural construction applications, supporting circular bio-economy strategies and environmentally responsible waste management.

Keywords: *Mycelium Bio-Composites; Fire performance, Thermogravimetric analysis; Melia dubia; Pleurotus ostreatus.*

VAL11

Eco-Friendly Bio cement Production using Urease-Producing *Bacillus* sp. for Self-Healing Concrete Applications

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Abstract

Bio cementation refers to the formation of particle-binding materials through microbial activity, primarily via Microbially Induced Carbonate Precipitation (MICP), in which microbial metabolism facilitates calcium carbonate precipitation in the presence of calcium ions. In the present study, urea-rich field soil was screened to isolate potential urease-producing bacteria for biocement production. Based on morphological and biochemical characterization using *Bergey's Manual of Determinative Bacteriology*, the isolate was identified as *Bacillus* sp. The biocementation potential of the isolated strain was evaluated, and the resulting biocement was characterized using microscopic observations and Fourier Transform Infrared (FTIR) analysis. Mechanical and durability-related properties of bacterial-modified cement cubes were assessed in terms of water absorption, compressive strength, and crack-healing efficiency. Results demonstrated that bacterial incorporation significantly reduced water absorption compared to control and standard cement cubes, while compressive strength showed a notable increase. The maximum healable crack width observed in *Bacillus* sp.-treated concrete ranged from 0.3 to 0.4 mm, compared to 0.2–0.3 mm in standard concrete and only 0.1–0.2 mm in control specimens. These findings indicate that *Bacillus* sp.-based bacterial concrete is effective for crack remediation in concrete structures. However, cracks exceeding 0.5 mm were not efficiently healed, corroborating earlier reports. Although the study highlights improvements in strength and crack-healing performance, further investigations are required to assess long-term durability, performance under marine environments, and cost-effectiveness before large-scale application in construction practices.

Keywords: *Bio cementation, Microbially Induced Carbonate Precipitation (MICP), Urease-producing bacteria, Bacillus sp., Bacterial concrete, Biocement production.*

VAL12

Densification of lignocellulosic biomass using recyclable deep eutectic solvents

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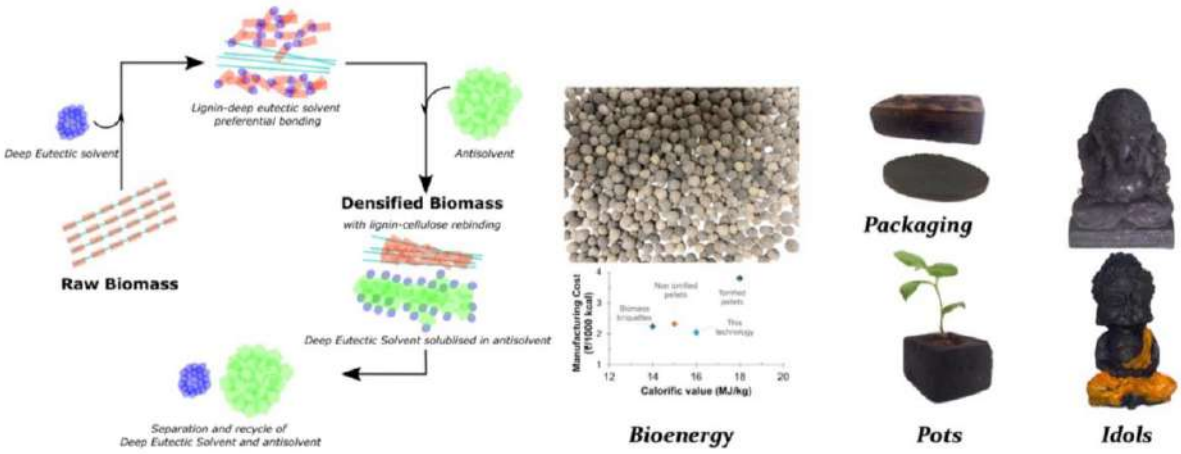
Abstract

The major hurdle in effective utilization of agricultural or horticultural waste is the logistics associated with the low-density material. This work describes a new process to increase the density of lignocellulosic biomass by 170% using deep eutectic solvents. The deep eutectic solvent selectively removes the lignin from the lignocellulosic biomass after which the cellulose chains collapse on each other after removal of lignin due to lack of hydrogen bonding. An antisolvent is added to the mixture which selectively solubilizes the deep eutectic solvent. The lignin then rebinds on the surface of the collapsed cellulose to yield a densified lignocellulosic material that can be put into a desirable shape. The deep eutectic solvent and the antisolvent can be separated by crystallization and recycled. The densified biomass can be used to make pellets for co-combustion with coal in fluidized bed reactor, make biodegradable idols or rigid packaging materials. This technology was patented and scaled up to 2 MTPD by GreenShift Energy Pvt Ltd incubated at BITS Pilani.



Keywords: *Lignocellulosic biomass, Waste management, Deep eutectic solvents, Bioeconomy*

VAL 13

Evaluation of Polyurethane Free-Standing Films as Hydrogen Barrier for Steel Components in Hydrogen Infrastructure

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Abstract

Hydrogen embrittlement (HE) poses a significant threat to the durability and safe operation of steel components used in hydrogen infrastructure, particularly under high-pressure environments. This study presents the fabrication, characterization, and hydrogen barrier evaluation of polyurethane (PU) free-standing nanocomposite films incorporated with 2 wt.% titanium dioxide (TiO_2) nanoparticles. The films were prepared using a sacrificial poly (sodium 4-styrenesulfonate) (PSS) layer deposited from an aqueous medium, followed by PU deposition via spray coating and subsequent delamination through PSS dissolution, enabling the formation of defect-free free-standing films with thicknesses of 18 µm, 26 µm, and 35 µm. Field-emission scanning electron microscopy confirmed smooth, uniform surfaces and homogeneous TiO_2 dispersion within the PU matrix. The chemical integrity and successful incorporation of TiO_2 were verified using UV-Vis and Fourier transform infrared spectroscopy. Differential scanning calorimetry revealed a crystallinity of approximately 17.16%, which contributes to reduced hydrogen diffusion, while X-ray diffraction confirmed the coexistence of amorphous PU and crystalline anatase TiO_2 phases. Hydrogen gas transport behavior was investigated using a differential pressure method. The intrinsic hydrogen permeability showed negligible dependence on film thickness, with values of 26.85, 24.23, and 20.42 Barrer for the 18 µm, 26 µm, and 35 µm films, respectively. In contrast, hydrogen permeation rate and flux exhibited a strong thickness dependence, decreasing with increasing film thickness due to the extended diffusion path. The spray coating process adopted in this work is cost-effective, scalable, and industrially viable, making it suitable for large-area applications. Overall, the systematic evaluation demonstrates that PU-TiO_2 free-standing films exhibit effective

hydrogen barrier performance and hold strong potential as protective layers for mitigating hydrogen embrittlement in steel components used in hydrogen infrastructure.
Keywords: *Hydrogen embrittlement, Polyurethane-titanium dioxide, Free standing film, Film characterizations, Hydrogen gas transport, Hydrogen barrier.*

VAL14

Fermentation Strategies for Efficient Bioethanol Production: A Bibliometric Analysis

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Abstract

Bioethanol is a key renewable biofuel for reducing dependence on fossil fuels and mitigating greenhouse gas emissions. Fermentation strategies play a crucial role in determining the efficiency, yield, and economic feasibility of bioethanol production from biomass. In this present study, a bibliometric analysis is proposed to identify research trends, Knowledge gaps, future directions, and key challenges related to the production of bioethanol from agricultural waste. Bibliometric data were retrieved from established scholarly search engines and databases such as Scopus, Web of Science, and Google scholar to ensure the comprehensive coverage of relevant literature. The collected data were analyzed using bibliometric tools including VOSviewer, Bibliometrix, and CiteSpace. Vosviewer was employed to visualize keyword co-occurrence and collaboration networks, Bibliometrix was used to visualize assess publication trends, leading journals, and thematic evolution, while CiteSpace helped to identify influential references and emerging research fronts. The analysis indicates that simultaneous saccharification and fermentation (SSF) is most extensively investigated strategy due to its operational simplicity and industrial relevance. In contrast, simultaneous saccharification and co-fermentation (SSCF), Consolidated bioprocessing (CBP), and continuous fermentation approaches have received comparatively less attention, mainly because of technical and process related challenges. Recent research trends highlight increasing interest in process efficiency. This bibliometric study provides a comparative overview of the evolution of fermentation strategies in bioethanol research and identifies potential directions for future research aimed at improving sustainable bioethanol production.

Keywords: *Bioethanol, Fermentation strategies, Bibliometric analysis*

VAL15

Hydrogel-Mediated Chemisorption of Volatile Fatty Acids and Concomitant Biogas Enhancement in High-Solids Biomethanation

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Abstract

High-solid food waste (HSFW) biomethanation offers a sustainable route for treating organic waste at elevated loading rates. However, the performance is constrained by the accumulation of volatile fatty acids (VFAs), which induce pH instability and inhibit methanogenesis. In this study, a hydrogel-assisted chemisorption mechanism was incorporated to enable simultaneous VFA regulation and pH stabilization during HSFW biomethanation. Hydrogel beads were synthesized using alginate-chitosan incorporated with ammonium acetate to enhance selective interaction with protonated carboxylic acids. Batch adsorption experiments demonstrated selective removal of VFAs with C_2-C_6 (25-52%), while alcohols exhibited minimal uptake (1-3%), confirming a chemisorption-driven and functionally selective mechanism. Adsorption was maximized under acidic conditions (pH ~4), with capacities reaching 35.61 mg/g for acetic acid and 33.12 mg/g for butyric acid. Hydrogel dose optimization identified 40 g/L as the most effective and economical loading, beyond which no significant improvement was observed. The hydrogel retained ~50% of its adsorption capacity after four regeneration cycles. The hydrogel system was integrated into the leachate collection chamber of a leach-bed reactor operated under high organic loading (240-260 g VS/L). Hydrogel addition on Day 16 resulted in the VFA reductions of 48% (acetic), 58% (propionic), 49% (butyric), 28% (valeric), and 34% (caproic). Consequently, cumulative biogas production increased from 0.24 to 0.31 m^3 kg/VS, corresponding to a 29% enhancement over the control. Overall, the incorporation of hydrogel enhances the stability of high-solids biomethanation through effective VFA regulation, while enabling resource recovery consistent with the circular bioeconomy.

Keywords: *Food Waste; Alginate; Leach Bed Reactor; Acetic Acid; Organic Load.*

VAL16

Invitro Method Development For Bioassay Of Fab Antibody Molecule

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Abstract

Bioassay is a scientific experiment or technique, employed to determine the effect of a substance on a certain type of living matter. With the drug industry's expanding emphasis on biologics; the need for robust cell-based assays has grown at all stages of development. The development of bioassays requires a deep understanding of mechanisms of action of the biomolecule under study. Vascular endothelial growth factor (VEGF) which expressed on endothelial cells is one of the key regulators of tumor neoangiogenesis. Targeting VEGF signaling may represent a new therapeutic option in the treatment of age related macular degeneration. A humanized FAB antibody neutralizes the bioactive forms of VEGF, in turn inhibits the neovascularisation. Current study focused in determination of bioassay protocol for the estimation of drug potency in relative to standard.

Keywords: *Vascular endothelial growth factor, fragment of antibody, age related macular degeneration, Phosphate buffer saline*

VAL17

Valorization of Food Waste via Anaerobic Bioprocessing: Carbon Accounting and Carbon Credit Potential

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Abstract

The transition from linear to a circular economy demands integrated solutions that simultaneously address waste management, renewable energy generation, and greenhouse gas (GHG) mitigation. We optimised the anaerobic system for the biogas production from high-organic-load food waste. The setup delivered enhanced energy recovery alongside a significant drop in COD, demonstrating both treatment efficacy and energy valorization. Life Cycle Assessment was conducted to quantify net GHG reductions by accounting for all relevant process inputs and outputs. The estimated methane emission reduction equates to certifiable carbon credits under the carbon market framework, making anaerobic systems financially viable tools for mitigating climate change. The study highlights the dual advantages of anaerobic bioprocessing, which simultaneously advances renewable gas production and contributes to carbon neutrality within industrial and urban ecosystems. Amalgamating carbon accounting into process design allows decentralised waste-to-energy systems to be effectively aligned with carbon credit trading, thereby contributing to national and global Net-Zero targets. This article gives an eclectic framework for the circular valorization of food waste through anaerobic bioprocessing, systematically linking biogas production with carbon accounting and carbon credit potential.

Keywords: *Anaerobic bioprocessing, circular economy, waste-to-energy, waste valorization, GHG mitigation.*

VAL18

Metabolic Pathway Integration in Anaerobic Digestion for Circular Waste Valorisation

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Abstract

Anaerobic digestion (AD) is increasingly viewed as a circular bio factory rather than a waste treatment process, where the integration of microbial metabolic pathways governs resource recovery outcomes. This work reframes anaerobic digestion as a dynamic network of carbon and electron redistribution, in which hydrolytic, acidogenic, acetogenic, and methanogenic pathways function as controllable metabolic modules rather than sequential steps of AD. Hydrolysis regulates substrate flux into the system, while acidogenesis establishes volatile fatty acid pools that act as branching nodes directing carbon either toward energy recovery or intermediate accumulation. Acetogenesis represents a critical thermodynamic checkpoint, constrained by hydrogen partial pressure and syntrophic electron exchange, thereby coupling pathway stability to the reactor's microenvironment. Methanogenesis, via acetoclastic and hydrogenotrophic routes, determines the efficiency of carbon closure into methane, while incomplete mineralisation preserves nutrient value within the digestate. By mapping pathway bottlenecks and electron flow constraints to circular economy outputs, this framework identifies metabolic leverage points for steering anaerobic digestion toward enhanced methane yields, improved nutrient recycling, or platform chemical production. Such a pathway-centric perspective enables the rational design of anaerobic digestion systems as flexible waste-to-resource technologies within circular bioeconomy strategies.

Keywords: *Anaerobic digestion; Metabolic pathways; Syntrophic interactions; Methanogenesis; Circular bioeconomy; Waste valorisation.*

VAL19

Photocatalytic Degradation of Glyphosate Contaminated Wastewater By Ws2 /Zno Nanohybrids

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Abstract

Heterogeneous photocatalysis is an efficient advanced oxidation process for the removal of trace organic pollutants from aquatic environments. In this study, WS_2/ZnO nanohybrids were investigated as a photocatalyst for the degradation of glyphosate under UV irradiation. Atomically thin WS_2 nanosheets were synthesized via liquid phase exfoliation, followed by decoration with ZnO nanoparticles using a microwave-assisted solvothermal method. Structural and compositional characterization by XRD and XPS confirmed the successful formation of WS_2/ZnO nanohybrids, while elemental mapping indicated uniform distribution of W, S, Zn, and O. SEM and HR-TEM analyses revealed well-dispersed ZnO nanoparticles on few-layer WS_2 nanosheets, with SAED patterns indicating a single crystalline nature. Photocatalytic experiments were conducted using simulated glyphosate effluent, and degradation was monitored spectrophotometrically. Liberation of inorganic phosphate confirmed glyphosate mineralisation. The WS_2/ZnO nanohybrids achieved a degradation efficiency of 73 ± 0.1%, demonstrating their potential as an effective photocatalyst for pesticide remediation.

Keywords: *Glyphosate, Photocatalysis, Degradation, Wastewater treatment, Nanohybrids*

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VAL20

Utilizing millet straw biochar for effective malachite green dye adsorption and application of RSM

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Abstract

Remediation of synthetic dyes using biochar derived from agricultural residues offer a sustainable low cost, and efficient process. Applying Response Surface Methodology (RSM) in remediation process, enables prediction and optimization while revealing the interactions between different parameters. In this work, the adsorptive performance of Malachite green dye using biochar derived from millet straw biomass, which is an agricultural waste, is evaluated. Experimental design is done using Box-Behnken design in response surface methodology (RSM-BBD), while response prediction and optimization were achieved using the corresponding RSM regression model. The influence of five parameters such as pyrolysis temperature, holding time, dye pH, dye concentration and adsorbent dosage on the adsorption process were studied. According to the experimental design, biochar is synthesized through pyrolysis at 300, 500 and 700 °C with varying holding time (1, 2 and 3 hour) and its properties were investigated using characterisation techniques. Based on the study, a percentage of removal greater than 99% was achieved for biochar prepared at 500 and 700 °C. RSM model demonstrated an R^2 value of 0.89 and it is validated by Analysis of Variance (ANOVA). These findings highlight the promise of millet straw biochar as a sustainable adsorbent and demonstrate the effectiveness of RSM as a tool for optimization and prediction in dye- contaminated wastewater treatment.

Keywords: *Adsorption, Malachite green dye, Millet straw biochar, Response surface methodology.*

VAL21

Integrated phytoremediation and biomass valorization of *Eichhornia crassipes* for sustainable arsenic and mercury removal

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Abstract

Phytoremediation using *Eichhornia crassipes* was assessed as a sustainable strategy for the removal and stabilization of arsenic (As) and mercury (Hg) from contaminated aquatic systems, followed by the conversion of harvested biomass into biochar to enhance long-term metal immobilization. The study assessed plant performance under two different contamination levels (1 and 5 mg L^{-1}) to understand concentration-dependent responses. At the lower concentration, *E. crassipes* achieved high removal efficiencies, arrive at 93% As and 87% Hg reduction within 30 days. However, the removal decreased significantly at 5 mg L^{-1}, with efficiencies dropping to 76% for As and 52% for Hg, indicating physiological limitations and reduced uptake capacity under higher metal stress. Morphological and spectroscopic study revealed significant structural alterations in plant tissues and showed the accumulation of As and Hg within cellular sections, validating the plant's role as an effective accumulator species. To ensure safe post-harvest handling and prevent secondary contamination, the metal-enriched biomass was subjected to pyrolysis. The resulting biochar showed strong retention of both metals, attributed to its carbonaceous structure and enhanced binding sites formed during thermal transformation. This stable biochar demonstrated clear potential for long-term immobilization and reduced metal mobility. Overall, the integrated process combining phytoremediation with biomass valorization offers an eco-friendly, cost-effective, and circular approach for mitigating toxic metal contamination in water bodies. The outcomes highlight the double benefit of pollutant removal and the production of a value-added material, improving the applicability of *E. crassipes* in sustainable environmental management.

Keywords: *Phytoremediation; Biochar; Removal efficiency; Valorization; Relative Growth Rate; Eichhornia crassipes*

VAL22

Sustainable Inactivation of Antimicrobial Resistance in Biopharmaceutical Wastewater via Non-Thermal Pulsed Electric Field Electroporation

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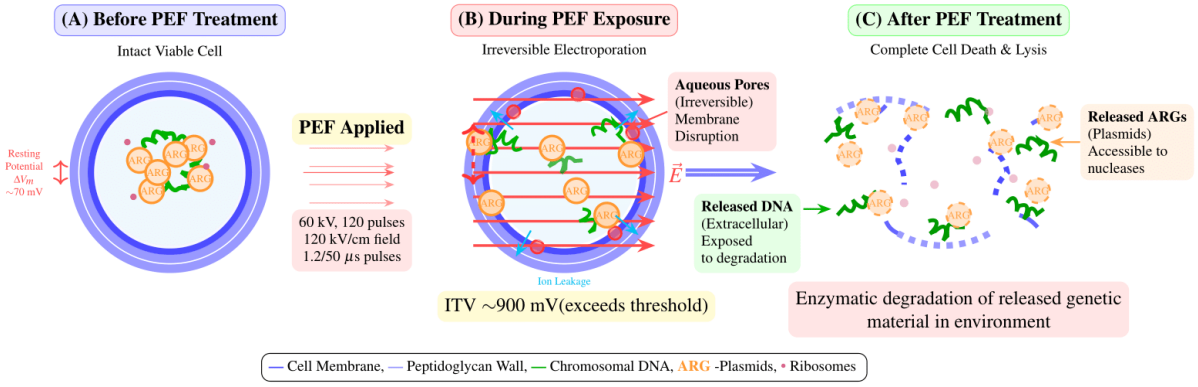
Abstract

Within the circular economy framework, sustainable management of industrial by-products is crucial for reducing environmental risks and minimizing resource depletion [1,2]. The biopharmaceutical industry generates substantial volumes of biopharmaceutical fermentation wastewater (BFW) that contains live pathogens and antibiotic resistance genes (ARGs). Untreated discharge promotes the spread of antimicrobial resistance (AMR) via vertical and horizontal gene transfer [3]. Current industrial pre-treatments, alkali dosing followed by moist heat sterilization at 121°C, are increasingly incompatible with sustainable development goals due to heavy chemical reliance, fossil fuel consumption, and high carbon footprints [4]. Furthermore, traditional techniques require pressurized heat-kill tanks and continuous thermal monitoring, raising operational complexity. To address these challenges, Pulsed Electric Field (PEF) technology presents a promising, energy-efficient, non-thermal alternative. This process applies ultra-short, high-intensity electrical pulses to a liquid medium, inducing a transmembrane voltage exceeding the ~900 mV critical threshold [5,6]. This triggers irreversible electroporation and complete cell lysis, releasing chromosomal DNA and ARG-carrying plasmids into the extracellular environment. Once released, these genetic materials become highly accessible to environmental nucleases, ensuring enzymatic degradation and preventing the further dissemination of AMR [7,8]. Laboratory-scale evaluations (120 pulses at 120 kV/cm; 1.2/50 µs pulses) demonstrate complete microbial inactivation, validated via flow cytometry and spread plate enumeration. Furthermore, theoretical cost analysis suggests that PEF is 80% cheaper than traditional steam sterilization. By eliminating steam-based infrastructure and drastically reducing operational expenses, this integrated PEF approach

provides a robust, source-level solution that aligns biopharmaceutical manufacturing with modern circular economy principles and global sustainable industrial practices [9,10].

Keywords: *Antimicrobial-resistant, Irreversible electroporation, Membrane breakdown, Sustainability, Wastewater treatment.*

Graphical Abstract:



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VAL23

Eco-Friendly Polyvinyl Alcohol/Nanocellulose Bio-Composite Film as Sustainable Adsorbent for Safranin-O and Reactive Red Dyes

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Abstract

Water pollution is a major environmental issue caused by industrial and domestic discharges. Adsorption is a widely accepted, cost-effective, and sustainable method for removing contaminants such as dyes, heavy metals, and pharmaceutical residues from wastewater. The use of biopolymeric adsorbents enhances environmental sustainability due to their biodegradability, abundance, and low cost. Incorporation of nanofillers improves the mechanical and thermal properties of biopolymers, increasing their practical applicability. Among available biopolymers, cellulose stands out as a promising material for nanocomposite development, offering significant potential for the design of eco-friendly and sustainable materials for water purification. In this study, nanocellulose (NC) was isolated from sweet lime peel waste through acid–alkali treatment followed by ultrasonication and characterized using FTIR, XRD, TGA, SEM, and TEM. The obtained NC was employed as a reinforcement in a polyvinyl alcohol (PVA) matrix to fabricate a bio-composite film via a simple solution casting method. The synthesized PVA/NC film was evaluated for dye removal from water. Batch adsorption studies showed over 90% removal of Safranin-O at 10 ppm using a 150 mg adsorbent dose at room temperature within 80 min, while Reactive Red exhibited approximately 80% adsorption at pH 4 under similar conditions. Comparative studies with cellulose and PVA revealed the superior adsorption performance of the PVA/NC composite, demonstrating its potential as an effective and sustainable adsorbent for wastewater treatment.

Keywords: *Sweet lime peel waste; Nanocellulose; Bio-composite film; Wastewater treatment; Dye adsorption; Safranin-O; Reactive Red.*

VAL24

Review on Low-Cost Bio Waste Derived Adsorbents for Wastewater Treatment

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Abstract

Wastewater produced from industrial and domestic activities carries harmful pollutants such as synthetic dye and heavy metals create serious environmental and health concerns. To overcome this issue, proper wastewater treatment required for protecting water resources. Various conventional treatment techniques such as chemical precipitation, ion exchange, adsorption, ultrafiltration are being employed for wastewater treatment. Adsorption found to be most commonly applicable due to its ease of operation, cost-effectiveness, simple design, less energy requirement, diverse applications and recycling potential. Adsorption utilizes natural and synthetic adsorbents for the treatment of wastewater such as zeolite, bone char, agricultural waste, activated charcoal and many more. This paper reviewed about the removal of water-soluble pollutants released from industries and their treatment techniques specially focusing on biomass-derived adsorbents. Further, this paper focusses towards challenges in the available techniques by describing the detailed information about the physical and chemical composition of various biomass and its effect on adsorption capacity.

Keywords: *Wastewater, Adsorption, Adsorbents, Techniques*

VAL25

Enhanced Photocatalytic Oxidation of 5-Hydroxymethylfurfural to 2,5-Diformylfuran over Thermally Reduced TiO_2

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Abstract

Biomass is a highly abundant and renewable source of natural organic carbon and can be transformed into various valuable compounds. Photocatalytic conversion of biomass-derived 5-hydroxymethylfurfural (HMF) to value-added 2,5-diformylfuran (DFF) is an environmentally friendly process. DFF is useful for manufacturing various compounds, including pharmaceuticals and antifungal medications. In this work, the photocatalytic activity of TiO_2, reduced TiO_2 (TiO_2_R) catalysts was compared for the selective oxidation of 5-hydroxymethylfurfural (HMF) into 2,5-diformyfuran (DFF). The results reveal that modified (TiO_2_R) shows the best catalytic performance, achieving 62.0 % HMF conversion along with 49.0 % yield of DFF in 30 min reaction time. HMF conversion with TiO_2_R is almost twice that of the untreated TiO_2 catalyst, due to the reduction of TiO_2, which leads to the generation of oxygen vacancies (V_o). V_o manipulates the band structure of semiconductors and also acts as an active site for catalytic reactions. Here, we have investigated how reduction treatment influences V_o and the reaction pathway for the selective oxidation of HMF to DFF. The modified catalyst is characterized by X-ray powder diffraction (XRD), N_2-sorption analysis, scanning electron microscope (SEM), Raman, NH_3-TPD, CO_2-TPD, O_2-TPD, XPS, and UV-DRS to understand the effect of reduction on the activity of TiO_2.

Keywords: *Biomass, photocatalysis, HMF, DFF, oxygen vacancies.*

VAL26

Microbial Consortia Engineering and Genome-Guided Enzyme Discovery for Lignocellulosic Waste Valorization

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Abstract

Valorization of lignocellulosic wastes is still limited by the recalcitrant architecture of cellulose, hemicellulose, and lignin, which limits efficient biomass-to-value conversion. To address this challenge, we mined various environmental samples for diverse enzyme chemistries capable of driving efficient depolymerization of biomass (carbohydrates). In this study, eighty-six bacterial strains were isolated from soil, manure, decaying wood, cow dung, and waste effluent. Synergistic interactions among the isolated strains were systematically evaluated to rationally assemble microbial consortia with enhanced lignocellulolytic performance. Our consortium, MC31 (Cellulomonas uda and Pseudomonas citronellolis) and MC29 (Cellulomonas uda and Pseudomonas jinjuensis), yielded 46% and 44% degradation of rice husk biomass, respectively. Six-day studies showed cumulative degradation up to 71%, with citric acid as the primary end-product. Soluble sugar concentrations ranged 269-1051 mg/L, and total cellulase activity 0.018–0.037 IU. Under optimized conditions for MC31 (5% w/v substrate, 10% v/v inoculum, 48 h aerobic incubation), rice straw hydrolysis resulted in a 3.78- fold increase in soluble sugar release, accompanied by a 1.21-fold enhancement in overall biomass degradation. Despite these advances, polymer-to-monomer conversion remains kinetically constrained, as released sugars are rapidly consumed by the microbes for growth, limiting downstream product recovery. To address this limit, whole-genome sequencing was undertaken to identify genes coding for cellulolytic enzymes. A genome-wide analysis using dbCAN3 revealed an extensive number of genes encoding lignocellulolytic enzymes. Pseudomonas citronellolis encoded more than 30 open reading frames, including three endoglucanases, one exoglucanase, five β-glucosidases, 19 hemicellulases, 12 auxiliary lignin-modifying enzymes, and multiple carbohydrate-binding modules, alongside multiple glycosyltransferases. In contrast, Cellulomonas uda showed a cellulase-enriched profile with two endoglucanases, three exoglucanases, two β- glucosidases, and seven

hemicellulases. Collectively, these findings support an enzyme- centric strategy focused on heterologous expression of complementary lignocellulolytic enzymes, providing a robust framework for the development of scalable and controllable lignocellulosic biorefineries.

VAL27

Circular Economy Strategies for Sustainable Management of Municipal Solid Waste Landfill Leachate

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Abstract

Due to an increase in population and lifestyle changes, the global Municipal Solid Waste (MSW) is expected to reach 2590 million metric tons by 2030. Approximately 30% of global waste is disposed of in MSW landfills. Various biochemical changes occurring in such landfills result in the generation of a dark-coloured, unpleasant liquid known as landfill leachate (LL). Several types of organic and inorganic compounds, as well as gases such as methane, are dissolved in LL and will be released into the ecosystem if left untreated. Biological methods provide highly effective alternatives to conventional LL physicochemical treatment methods. Specifically, a sustainable treatment approach coupled with resource recovery is offered by anaerobic digestion (AD) of LL. In this investigation, two sustainable biological LL treatment methods are discussed that not only remediate inherent pollutants but also recover valuable resources, such as biogas and biofertilizer, thus enabling a circular economy (CE). The first method was based on an innovative and patented two-stage integrated aerobic-anaerobic (IAAN®) reactor system. Aerobic pretreatment of LL with an activated sludge process (ASP) inoculum using the Simultaneous Nitrification and Anammox Denitrification (SNAD) process effectively reduced the inhibitory ammoniacal nitrogen (AN) concentration. When this pretreated biodegradable LL was fed to the intelligently stirred thermophilic anaerobic reactors (iSTAR®), biogas production was enhanced 1.06 times. The technique was proven highly effective, yielding significant reductions in key pollutants: 88% for ammoniacal nitrogen, 69% for BOD, and 62% for COD. The second treatment method is anaerobic co-digestion (AnCoD) of LL with faecal sludge (FS). The FS is defined as the partially digested, concentrated, and hazardous aqueous semisolid material that accumulates over time in

septic tanks. Co-digestion of substrate at a mixing ratio of 70% LL and 30% FS in stirred tank reactors (STRs) was investigated under both mesophilic (30°C) and thermophilic (50°C) conditions. The thermophilic reactor achieved superior performance, yielding a biogas yield of 1.28 m^3/KgVS removed, 80% COD reduction, and 64% VS reduction compared to the mesophilic reactor's yield of 0.92 m^3/Kg VS removed, a 71% COD reduction, and a 46% VS reduction. Both the IAAN® and AnCoD reactor systems provide robust, sustainable alternatives for LL treatment, reducing contaminants. By converting waste into valuable byproducts, such as biogas (bioenergy) and digestates (biofertilizer), these processes provide transformative solutions, driving the transition towards a CE.

Keywords: *Landfill Leachate, Anaerobic Co-digestion, Two-Stage Reactor, Faecal Sludge, Biogas Yield, Ammoniacal Nitrogen, Resource Recovery, Circular Economy.*

VAL28

Valorisation of Jackfruit (*Artocarpus Heterophyllus*) Rind via Solid State Fermentation For Antioxidant Rich Postbiotic-Recovery

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Abstract

Artocarpus heterophyllus, one of the most abundant fruits in India, despite its abundance, the utilisation is limited, and post-harvest losses are substantial, with nearly one-third of the produce being underutilised. This study addresses the challenge of agro-industrial waste by exploring the valorisation of *Artocarpus heterophyllus* rind into a functional, antioxidant-rich ingredient using Solid-State Fermentation (SSF). The powdered rind and rags were fermented under SSF with *Lactobacillus* sp. and *Aspergillus niger* separately, followed by incubation at varying temperatures for three days. SSF with *Lactobacillus* sp. resulted in higher Total Phenolic Content, whereas *Aspergillus niger* fermentation demonstrated superior free radical scavenging activity, indicating qualitative differences in antioxidant functionality despite lower phenolic levels. These findings confirm that microbial SSF enhances bioactive recovery through distinct metabolic mechanisms. The study establishes SSF as a practical and sustainable waste-to-wealth strategy for jackfruit rind valorisation, with potential for postbiotic recovery and functional ingredient development. This foundational work provides a platform for future optimisation and mechanistic investigations in the areas of waste to wealth.

Keywords: *Jackfruit Rind, Waste Valorisation, Postbiotics, Antioxidants, Solid-State Fermentation*

VAL29

Biochemical characterization and molecular evaluation of *Aspergillus flavus* LP1 lipase for eco-friendly detergent applications

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Abstract

Lipases offer a sustainable alternative to conventional chemicals in detergent formulations, enabling efficient cleaning while reducing environmental impact. In this study, a fungal lipase from *A. flavus* LP1 was semi-purified and evaluated for its potential as a functional and cost-effective detergent additive. The enzyme was characterized for biochemical and physicochemical properties, including stability across temperature (20-70 °C), pH (6-11), metal ions (Ca^{2+}, Mg^{2+}, and Na^{+}), inhibitors (Zn^{2+}, Fe^{2+}, and Mn^{2+}), surfactants (Tween 20, Tween 80, and Triton X-100), and commercial detergents. Application studies demonstrated that incorporating the lipase (242.5 U) into detergent (1% w/v, v/v) provided comparable cleaning performance to higher detergent concentrations (10% w/v, v/v), thereby allowing a tenfold (90% decrease) reduction in overall detergent usage and synthetic chemical load. Fourier Transform Infrared Spectroscopy (FTIR) supported the enzyme-mediated degradation of lipid-based stains. In addition, molecular docking revealed, strong binding affinity of lipase towards lipid-based ligands, triolein, linoleic acid and ricinoleic acid. The findings highlight the potential of lipase-supplemented detergents as an eco-friendly, economical, and sustainable alternative to conventional formulations, with promising implications for green cleaning technologies.

Keywords: *Lipase; Aspergillus flavus; molecular docking; enzymes; eco-friendly; enzymatic detergents*

VAL30

Valorisation of cashew processing waste for sustainable lignin extraction and applications using deep eutectic solvents

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Abstract

Lignocellulosic biomass derived from agricultural residues is an important renewable feedstock for sustainable biorefinery and circular bioeconomy applications. Cashew processing waste (CPW) is an underutilized agro-industrial residue that despite its abundance and high lignin content, requires effective valorization strategies. Lignin-based biorefineries have gained significant attention due to its wide applications in functional materials, antioxidants, and environmental remediation. This study focuses on the extraction of lignin from CPW using deep eutectic solvents (DESs) as a green and sustainable pretreatment approach. The lignocellulosic composition of the destarched CPW was determined to be 23.85% cellulose, 17.01% hemicellulose, and 33.94% lignin, confirming its suitability for lignin-focused valorization. Various DES combinations were evaluated, among which choline chloride:oxalic acid (ChCl:OA) exhibited the highest extraction efficiency. A maximum lignin recovery of 20.0% was achieved using ChCl:OA in a 1:1 molar ratio at 6% biomass loading, 90°C, and 2 h incubation. Structural characterization using Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) confirmed effective disruption of the lignocellulosic matrix during DES pretreatment, while FTIR analysis of the recovered lignin showed characteristic functional groups, indicating minimal structural alteration during extraction. The extracted lignin exhibited strong antioxidant activity with an IC_{50} value of 4.69 µg. High cationic dye adsorption efficiency, achieving 94.2% removal of Safranine-O, was also observed for the extracted lignin. Thus, the DES-assisted lignin extraction adopted in this study points to be an environmentally benign strategy. In brief, the findings of this study confirm CPW as a promising feedstock for lignin-based biorefineries, supporting circular bioeconomy and sustainable waste management.

Keywords: *Agriresidues, Cashew processing waste, Lignin extraction, Deep eutectic solvents, Antioxidant activity, Dye adsorption*

VAL31

Waste Is Not a Burden: Unlocking Economic and Climate Benefits in Cassava Starch Biorefineries

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Abstract

Conventional cassava starch processing is energy-intensive and produces large amounts of waste, posing challenges to long-term industrial sustainability. In this study, Techno-Economic Analysis (TEA) and Life Cycle Assessment (LCA) were used to compare a Business-as-Usual (BAU) process with four waste valorisation scenarios. Among them, the fully integrated biorefinery scenario (S4), which converts all processing residues into animal feed, fungal protein, algal fish feed, and biogas, emerged as the most promising option. Although S4 requires the highest Total Capital Investment ($14.57 million), it delivers the best economic performance, with an annual net profit of $5.2 million, a high Internal Rate of Return (IRR) of 296.88%, and a short payback period of 2.8 years, compared to 4.44 years for the BAU scenario. From an environmental perspective, S4 achieves a net-negative Global Warming Potential of −433.8 kg CO_2eq per tonne of cassava root, while the BAU process emits 154.26 kg CO_2eq per tonne. In addition, S4 provides substantial land-use savings (−475.95 m^2a crop eq) by replacing conventional protein and feed products. However, the integrated pathways also involve trade-offs, particularly higher water consumption (64.3 m^3 per tonne of root) and increased marine ecotoxicity. Uncertainty analysis using Monte Carlo simulations showed good result reliability, with coefficients of variance below 30%. The study demonstrates that the alternative scenarios offer a viable and climate-positive pathway for cassava starch industries by combining economic profitability with sustainable resource recovery.

Keywords: *Cassava, Biorefinery, Life cycle assessment, Techno-economic analysis, Sustainability*

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VAL32

A Green Solution For Waste Management and The Circular Economy in KSR Institutions

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Abstract

The enormity of energy crisis has multifold dramatically over the past decades. A number of developing countries are keen on using energy from non – conventional sources such as solar energy, geothermal energy, biomass etc. The content of this paper gives a concise study of fuel biotechnology starting with a broad review of aspect of utilization of biofuels & their physical principles. In recent years, there has been worldwide recognition of the fact that fossil fuels are inherently limited in quantity and highly polluting. Based on this aspect the biogas technology, which is simple, safe, cost effective, eco-friendly and can be further developed to reach each & every household of this country. This paper deals with the aspect of producing useful energy source from food waste and human excreta produced at K.S.R. Institutions ladies' hostel. The human excreta collected from the ladies' hostel and the food waste are to be brought to a common place and that both are used in production of bio - gas. This bio – gas produced can be effectively used for domestic purposes especially in kitchens. Thus, the paper deals with three main aspects.

- Producing energy from waste.
- Disposal of waste scientifically.
- Production of cost-effective energy resource.
- To obtain valuable source as methane for laboratory purposes or kitchen uses or lighting of streetlamps.
- To reduce usage of fossil fuel in the campus.

By using this method, the cost of fuels can be reduced. This requires only a small amount of

installation charges, but it can serve a large number of people. Hence an alternative source of energy which serves large mass with relatively less expenditure can be found. This also makes our environment clean and healthy. The remains of excrete from biogas plant can be utilized as manures for crops.

Keywords: *Waste Management, Energy Production, Biogas Production, Circular Economy and Ecofriendly.*

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VAL23

Framework for Organisational Change While Driving Sustainability in the Construction Industry

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Abstract

The Construction industry is a major factor in greenhouse gas emissions globally. It faces serious challenges while integrating sustainable practices, mainly due to complex Organisational barriers that exist in the industry. This study concentrates on the critical research gap in structured change management frameworks shaped for sustainability adoption within the construction sector. The ultimate objectives of this study are to identify key organisational challenges and to develop a substantial framework to facilitate this transition. The research involves a comprehensive literature study and data collected through open-ended interviews with industry professionals and a survey across three construction sectors, such as Infrastructure, Real estate and Concrete batching plants. In this mixed methodology approach, the data analysis supported by survey responses evaluated on a Likert scale showcased the prevalent barriers, including high upfront costs, resistance to change, knowledge gap among stakeholders, lack of measurement tools and weak regulatory incentives. This study proposes a Change management framework designed to tackle these obstacles. The framework highlights strategic training interventions, stakeholder collaboration, and the integration of sustainability metrics into the processes. The research contributes an applicable model to guide construction organisations in guiding the structural and operational shift necessary for a sustained sustainability integration, thereby aligning environmental goals with long term business operability.

Keywords: *Organisational Barriers, Sustainable Construction, Change Management Framework*

VAL34

Utilization of used cooking oil into bio-based value-added products

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Abstract

The growing energy demand and environmental concerns have created an urgent need for research into clean and renewable energy sources. Biofuels and bio-based chemicals offer potential solutions; however, high production costs and low yields remain significant challenges. India produces an estimated 11–15 lakh tons of oil from traditional and non-edible feedstocks; however, edible oils are limited due to concerns over food security. Therefore, non-edible oils and Used Cooking Oil (UCO) provide promising alternatives for biofuels and bio-based chemicals. UCO can be directly used as fuel in boilers and furnaces or converted into biodiesel, green solvents, greases, plasticizers, biosurfactants, and Biolubricants. Despite its potential, UCO utilization is still limited, with only a fraction of the 25 million metric tons consumed annually being recovered. Initiatives like FSSAI's RUCO mission aim to streamline UCO collection for biodiesel and value-added chemicals. This current work gives a comprehensive review of exploring UCO potential, its conversion into bio-based chemicals, and performing life cycle and economic assessments of the products.

Keyword: *Biodiesel; Biosurfactant; UCO; Economics; Feedstocks*

VAL35

Green-synthesized silver nanoparticles from *Moringa oleifera* integrated into chitosan gelatin films for sustainable food packaging applications

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Abstract

Increasing demands related to the environmentally friendly properties of petroleum-based plastic materials have encouraged researchers to explore eco-friendly and biodegradable materials that can replace food packaging materials and biomedical materials. This study introduces multifacated biodegradable composite materials, designed to incorporate green-synthesized silver nanoparticles (AgNPs) into a chitosan (CH) and gelatin (GE) biopolymer. In this experiment, silver nanoparticles were successfully synthesized using leaf extract, a biological medium that acts naturally as a reductant and stabilizing agent. Characterization procedures on silver nanoparticles include UV Visible spectroscopy, Fourier Transform Infrared Spectroscopy, dynamic light scattering, and scanning electron microscopy. The addition of AgNPs greatly enhanced the physicochemical characteristics of the composite films in terms of opacity, UV protection, and water resistance. The antibacterial activity results using E. coli and S. aureus showed a strong concentration-dependent inhibitory effect. The film with the highest inhibitory activity among the tested films was BCGF4 with an inhibitory zone diameter of 11.2 to 12.1 mm. To validate the experimental results, in silico molecular docking analyses were carried out using MOE 2019.0102. The prominent quality of Moringa oleifera's active compounds, quercetin 3-O-malonylglucoside, illustrated a strong binding affinity to the bacterial DNA Gyrase B (PDB ID: 1JIJ) target, achieving the maximum dock affinity of -8.98 kcal/mol and establishing strong hydrogen bonding bridges with essential catalytic residues of Asp177 and Tyr36. The application research showed that the prepared films could extend the shelf life of carrots up to 15 days effectively. In addition, the evaluation of cytotoxicity, as well as the soil burial biodegradation test, confirmed the biocompatibility, bioactivity, and

environmental friendliness of the prepared films. In conclusion, the CH–GE–AgNP films could serve as an efficient sustainable material to replace the plastics.

Keywords: *Chitosan; Gelatin; Green synthesis; Silver nanoparticles; Food packaging*

VAL36

Operational Assessment of Ward-Level Urban Groundwater Stress and Seasonal Recovery for Sustainable Development in a Coastal City

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Abstract

Rapid urban expansion in coastal cities is intensifying pressure on groundwater resources, posing significant challenges to sustainable development. This research presents a ward-level assessment of urban growth and groundwater stress in Mangaluru City Corporation, India, integrating remotely sensed built-up mapping and long-term groundwater level observations. Built-up areas for the period 2004–2022 were mapped using a Random Forest classification of multi-temporal Landsat imagery, achieving a high accuracy (F1 score > 0.89). Groundwater stress was evaluated using pre-monsoon groundwater levels, while post-monsoon levels were used to assess seasonal recovery and residual stress. Spatial interpolation and zonal analysis were employed to derive ward-scale indicators. Results indicate that 85% of wards experienced high pre-monsoon groundwater stress in 2022, increasing to 93% by 2030 under trend-based projections, with a mean projected deepening of 1.76 m. Post-monsoon analysis reveals limited seasonal recovery, with high residual stress persisting in most wards and further deterioration projected by 2030. The findings highlight the inability of seasonal recharge to offset increasing urban-driven abstraction, demonstrating the importance of ward-scale diagnostics for guiding sustainable urban groundwater management and development planning in rapidly urbanizing coastal regions.

Keywords: *Urban groundwater stress, Seasonal groundwater recovery, Ward-level assessment, Sustainable development, Remote sensing and GIS, and Coastal urbanization.*

VAL37

Hydrodynamic Cavitation–Driven Disintegration of Lignocellulosic Agri-Residues: From Lab-Scale Optimization to Pilot-Scale Validation for Enhanced Anaerobic Digestion

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Abstract

The recalcitrant lignin-carbohydrate matrix of lignocellulosic biomass severely hinders anaerobic digestion of rice straw. Conventional pretreatments, despite partial efficacy, suffer high energy demands, chemical inputs, and scalability limitations. In this study, rotational hydrodynamic cavitation (HC) was investigated as a pretreatment strategy, both independently and in conjunction with a mild alkaline (1% NaOH) system, to enhance biogas generation from rice straw in a 1 L bench-scale anaerobic digester (0.7 L working volume). The untreated substrate produced 6,560 mL cumulative biogas (Cumulative Biogas yield: 104.06 mL g^{-1} dry biomass) with 39.18% methane content, whereas HC + NaOH pretreatment increased cumulative biogas production to 11,080 mL (Cumulative Biogas yield: 162.65 mL g^{-1} dry biomass), with methane concentration elevated to 50.82%. This enhancement was corroborated by a marked increase in soluble COD (5,600 mg L^{-1} post-HC + NaOH, compared to 1,920 mg L^{-1} for raw biomass), demonstrating significant solubilization of organic constituents. Structural characterization revealed a reduction in Kalson lignin from 18.7% (raw biomass) to 13.5% (HC + NaOH), indicating effective delignification and disruption of lignin–cellulose–hemicellulose linkages. The synergistic effects of cavitation-induced shear forces and alkaline treatment markedly enhanced substrate disintegration, reduced particle size, and improved digestibility, thereby promoting elevated microbial activity and methane yield. These results underscore the promise of hydrodynamic cavitation (HC)-assisted pretreatment specially under alkaline conditions as a scalable, energy- efficient, and environmentally compatible method for

valorizing lignocellulosic feedstocks into superior biogas, in accord with circular bioeconomy tenets.

Keywords: *Hydrodynamic Cavitation, Lignocellulosic Biomass, Anaerobic Digestion*

VAL38

Performance Evaluation and Industrial-Scale Demonstration of Thermophilic Anaerobic Co-Digestion for Renewable Energy Production

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Abstract

Anaerobic digestion is a proven and sustainable technology for converting organic wastes into renewable energy. However, its efficiency is often limited by suboptimal substrate composition and operating temperature. This study investigated the anaerobic co-digestion of food waste (FW) and sewage sludge (SS) with the objective of optimising substrate mixing ratios, enhancing biogas production, and demonstrating process scalability from laboratory to industrial scale, with integrated electricity generation. Lab-scale anaerobic co-digestion experiments were conducted using FW and SS at different mixing ratios (100:0, 75:25, 50:50, 25:75, and 0:100) under thermophilic (55 °C) conditions over a 30-day digestion period. The optimal thermophilic ratio of 75 FW:25 SS achieved the highest biogas yields of 0.55 m3 kg^{-1} VS, representing a 1.9-fold improvement over mono-digestion of food waste. Correspondingly, maximum volatile solids and COD reductions of 49.96% and 70.32%, respectively, were recorded. Carbon and nitrogen mass balance analyses confirmed stable process performance, with approximately 65% of input carbon recovered in biogas. Microbial community analysis using 16S rRNA gene sequencing revealed distinct temperature-driven shifts, with thermophilic reactors enriched in hydrolytic and acidogenic genera, such as Pseudomonas and Serratia, which support accelerated organic matter degradation and enhanced methane formation. Insights from lab-scale optimization enabled the successful scale-up to a 12 m3 thermophilic anaerobic digester operated at 55 °C with a daily feed of 300 kg and a hydraulic retention time of 30 days. At steady state, the industrial reactor consistently produced 28-30 m3 /day of biogas, with an approximate methane content of 55%. After upgrading, the biogas was utilised in

an internal combustion engine to generate 52.1-56.1 kWh/day of electricity, exceeding the plant's internal energy demand and demonstrating reliable energy recovery. This study establishes thermophilic co-digestion of FW and SS as a robust and scalable waste-to-energy strategy with strong potential for decentralised renewable power generation.

Keywords: *Substrate optimization, Anaerobic co-digestion, Biogas production, Industrial-scale, and Circular economy*

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VAL39

Numerical Investigation of Two-Phase Mixing in an Anaerobic Digester

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Abstract

Anaerobic digestion is a controlled process that converts organic waste into biogas without oxygen. The process occurs in an anaerobic digester, which consists of a tank and an impeller [1]. The organic waste slurry is mixed with microorganisms within the tank, and the chemical reactions generate biogas. Mixing of the slurry in the tank influences the anaerobic digestion process as it improves the uniform distribution of microorganisms in the slurry [2]. The factors affecting mixing include the geometry and positioning of the impeller, tank dimensions, and the viscosity of the slurry. The flow induced by the impeller interacts with the walls of the tank and generates highly turbulent flows. Visualization and analysis of these complex flows using experimental methods are challenging and costly. Computational Fluid Dynamics (CFD) is an effective and economic tool for visualizing flow patterns and analyzing velocity components within the digester. This study presents CFD simulations of a stirred tank with varying impeller speeds. The system geometry includes a cylindrical tank partially filled with water and stirred by a Rushton impeller. The study discusses the variation in the free surface between air and water, the power consumption of the impeller, and the velocity profiles.

Keywords: *Anaerobic digestion, CFD, stirred tank, Rushton impeller*

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VAL40

Role and Fate of Microplastics as Substrata During Anaerobic Digestion: Biofilm Formation, Microbial Community Dynamics, and Polymer Alterations

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Abstract

Microplastics (MPs) present in sewage sludge, particularly nylon-6 (PA6), are increasingly recognized not as inert contaminants but as active substrates for microbial colonization, forming distinct "plastisphere" communities under anaerobic conditions. During anaerobic digestion (AD), these MPs are introduced with sewage sludge (SS) and may dynamically interact with microbial processes. This study investigated the fate and functional role of PA6 MPs during 30-day mesophilic (37 °C) batch anaerobic digestion of SS. MPs were added at environmentally relevant concentrations ranging from 200 to 2000 particles kg^{-1} total solids (TS), and digester performance, as well as MP-associated physicochemical changes, were systematically evaluated. Digestion stability was monitored alongside detailed characterization of MP surface and polymer properties using scanning electron microscopy (SEM), confocal laser scanning microscopy (CLSM), Fourier-transform infrared spectroscopy (FTIR), and differential scanning calorimetry/thermogravimetric analysis (DSC/TGA). Results revealed pronounced biofilm development on PA6 MPs, forming heterogeneous plastisphere microstructures distinct from surrounding sludge flocs. MP mass increased significantly ($p < 0.05$), attributable to biofilm accumulation. Polymer analysis indicated a 17.4% reduction in crystallinity (from 32.8% to 27.1%), suggesting structural reorganization of PA6 during digestion, while FTIR spectra showed no significant change in carbonyl index, indicating negligible oxidative degradation. SEM imaging further revealed surface roughening and microcrack formation, indicating predominantly physical polymer alteration. Process performance exhibited a clear dose-dependent response. At a low MP dose (200 particles kg^{-1} TS), specific biogas production (0.87 m^3 kg^{-1} VS d^{-1}) exceeded that of the control (0.30 m^3 kg^{-1} VS d^{-1}), indicating a

stimulatory effect. At a moderate MP concentration (600 particles kg^{-1} TS), biogas production decreased to 0.68 m^3 kg^{-1} VS d^{-1}. Further increases in MP loading led to marked inhibition, with biogas production declining to 0.23 m^3 kg^{-1} VS d^{-1} at 1200 particles kg^{-1} TS, accompanied by a substantial reduction in solids degradation. At the highest MP concentration (2000 particles kg^{-1} TS), biogas production was suppressed by approximately 90% relative to the low-dose condition, nearly inhibiting the digestion process. Overall, these findings demonstrate that PA6 MPs function as dynamic ecological niches within anaerobic digesters, exerting dose-dependent effects on digestion performance with important implications for digester operation and biosolids management.

Keywords: *Microplastics; Plastisphere; Anaerobic digestion; Biogas production; Dose-dependent effects; Biofilm formation*

Acknowledgement: *The author acknowledges the Department of Science & Technology, Government of India, for financial support, vide reference no. DST/WISE-PhD/LS/2024/48 under the WISE Fellowship for PhD programme to carry out this work.*

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VAL41

Bio-methanation of municipal waste in India: Decentralized circular economy analysis

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Abstract

India with the largest population in world and due to rapid urbanization and rising consumption patterns produces 62 million tonnes of municipal solid waste (MSW) annually, out of which 40–60 % is decomposable organic matter. This waste disposed off in open dumps results in various Green House Gas emissions causing climate change, land pollution, foul odors, health hazards to human beings and other risks and challenges. These challenges highlight the need for decentralized and resource-oriented waste treatment solutions. Anaerobic digestion of decomposable organic matter provides an opportunity to produce biogas which can be upgraded to compressed methane to replace fossil fuels. The biogas thus produced can be used directly for electricity generation and direct cooking fuel, or it can even be purified and compressed into compressed biogas to serve as a vehicle or cooking fuel. This paper examines bio-methanation of municipal waste in India as a decentralized circular economy approach, focusing on city-level initiatives that convert organic waste into Bio-CNG and organic manure. The paper evaluates environmental benefits, operational challenges, and the role of decentralized bio-methanation in strengthening circular economy implementation in India's urban waste management systems.

Keywords: *Bio-methanation, bio-CNG, municipal solid waste, waste management, circular economy*

VAL42

Development of sequential nano-enrichment of inoculum for dark fermentation-driven biohydrogen and volatile fatty acid production

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Abstract

Dark fermentative biohydrogen (H_2) production is limited by poor substrate utilization, microbial instability, and competition from hydrogen-consuming populations. In this study, date-derived nanoparticles (2-42 nm) were synthesized via acid hydrolysis coupled with ultrasonication and employed in a multi-stage inoculum enrichment strategy. A seawater-derived native inoculum was sequentially subjected to heat-shock treatment (HSM), nanoparticle-assisted enrichment to form a nano-augmented inoculum (NEI), and targeted bioaugmentation by standard microorganisms to develop a nano-enriched superior consortium (NEM) with enhanced stress tolerance and functional resilience. Illumina MiSeq 16S rRNA sequencing revealed pronounced microbial restructuring during the enrichment process. The native inoculum was dominated by lactic acid bacteria and *Bacteroides*, whereas HSM selectively enriched *Firmicutes* (45-50%), particularly *Clostridia*, and suppressed methanogens and hydrogen-consuming bacteria. NEI was predominantly composed of *Pseudomonas* (62.2%) and *Alcaligenes* (13.7%), whereas NEM exhibited a balanced community dominated by *Pseudomonadota* (45-50%) and Bacillota (30-32%), with *Sphingomonadales, Desulfovibrionales*, and *Terriglobiales* as key functional groups. Process performance improved significantly with nano-assisted enrichment. Maximum volatile fatty acid (VFA) concentrations of 13.5, 78.2, and 55.6 g L^{-1} were achieved for HSM, NEI, and NEM, respectively, with COD removals up to 96%. The enrichment of hydrolytic and acidogenic taxa, including *Pseudomonas*, *Clostridium*, and *Oscillibacter*, facilitated stable substrate conversion under saline and thermally stressed conditions. Overall, nanoparticle-driven microbial engineering enables the development of resilient consortia for enhanced biohydrogen and VFA

production, offering a robust strategy for sustainable food waste valorization within a circular bioeconomy framework.

Keywords: *Dark fermentation, Organic nanoparticles, Inoculum enrichment, Bioaugmentation, Hydrogen production, Volatile fatty acids.*

VAL43

Sustainable Remediation of Fluoride-Contaminated Groundwater Using Activated Sludge: Experimental Validation, Mechanistic Understanding, and Modeling

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Abstract:

Responsible consumption and production require innovative strategies that simultaneously address industrial waste generation and water contamination. In India, the Bureau of Indian Standards and WHO recommend a maximum permissible fluoride limit of 1.5 mg/L in drinking water, yet studies have documented groundwater fluoride levels as high as 5.9 mg/L in Rajasthan and exceeding 8 mg/L in some districts, far above safe limits and leading to widespread dental and skeletal fluorosis in rural communities. This study aims to develop a circular and sustainable water treatment approach by valorizing Al/Si-rich industrial sludge as an efficient adsorbent for fluoride removal, supporting circular resource systems and inclusive access to safe water. Industrial sludge was thermally activated at 550 °C to enhance surface properties and employed in ultrasound-assisted batch adsorption. Ultrasonication was used as a technological enabler to improve particle dispersion and mass transfer. Adsorption performance was evaluated through kinetic, isotherm, and thermodynamic analyses, and environmental safety was assessed using cytotoxicity testing. Fluoride adsorption followed the Langmuir isotherm and pseudo-second-order kinetics, indicating monolayer chemisorption. Thermodynamic parameters confirmed a spontaneous and endothermic process. Ultrasound application significantly enhanced adsorption efficiency by reducing agglomeration and diffusion resistance. Cytotoxicity results demonstrated high cell viability, confirming the safety of treated water. By transforming industrial sludge into a value-added adsorbent, this study demonstrates circular synergies between waste management and sustainable water treatment. The approach advances SDG-12 by promoting responsible resource utilization, waste

valorization, and environmentally sound production practices, offering a scalable pathway for inclusive and sustainable water purification.

Keywords: *Circular economy, Industrial sludge valorization, Fluoride removal, Ultrasound-assisted adsorption, Sustainable water treatment.*

VAL44

Assessment of Surface Water Quality for Sustainable Domestic Use: A Case Study of Tolanakere Lake

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Abstract

Rapid urbanisation and population growth have significantly degraded surface water bodies, reducing their suitability for domestic and emergency water supply. Urban lakes are increasingly affected by anthropogenic activities, leading to deteriorating water quality and ecological imbalance. This study presents a sustainable assessment of surface water quality and proposes improvement measures for Tolankere Lake, a major freshwater lake in Hubli– Dharwad city, Karnataka, India. Water samples were collected weekly over a period of seven weeks from five representative locations within the lake, including the inlet, central, treated, and outlet points. Physicochemical parameters such as pH, turbidity, electrical conductivity, total dissolved solids (TDS), dissolved oxygen (DO), alkalinity, acidity, and hardness were analyzed and compared with Indian drinking water standards (IS:10500–2012 and IS:3025). The results indicate that most parameters were within permissible limits; however, turbidity consistently exceeded acceptable values, and dissolved oxygen showed spatial variability, indicating the need for appropriate treatment and continuous monitoring. Sustainable treatment options such as coagulation–sedimentation followed by rapid sand filtration and slow sand filtration were identified as suitable solutions to improve water quality with minimal environmental impact. An estimation of lake water availability revealed that Tolankere Lake can supply approximately 16 days of domestic water demand for Hubli city during emergency conditions. The study contributes to Sustainable Development Goals SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), highlighting the role of urban lake management in sustainable and circular water systems.

Keyword: *Surface Water Quality; Urban Lake Management; Sustainable Water Treatment*

VAL45

Solar-Driven Fe/ZnO Photocatalyst for Sustainable Water Disinfection

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Abstract

Achieving responsible consumption and production under SDG 12 requires sustainable water treatment technologies. Conventional disinfection relies on chemical additives and external energy, resulting in secondary pollution and inefficient resource utilization. Solar-driven photocatalysis with earth-abundant materials offers a low-energy, circular, and environmentally responsible alternative. This study develops a low-cost, solar-active Fe/ZnO photocatalyst for efficient bacterial disinfection and organic contaminant degradation, promoting resource-efficient water treatment aligned with SDG 12. Fe-doped ZnO nanoparticles were synthesized via co-precipitation and characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and UV-Vis spectroscopy. The photocatalytic activity was optimized by varying the catalyst dosage, pH, temperature, and irradiation time. Disinfection was tested against *Escherichia coli* (a Gram-negative bacterium). ROS scavenger studies identified the dominant species responsible for bacterial inactivation. Iron doping enhanced visible-light absorption and suppressed electron–hole recombination, increasing ROS generation. Complete bacterial inactivation was achieved at very low catalyst concentrations with short solar exposure. Scavenger experiments confirmed hydrogen peroxide (H_2O_2) as the primary ROS causing bacterial membrane damage. The photocatalyst also effectively degraded organic contaminants without chemical disinfectants. The Fe/ZnO photocatalyst demonstrates a sustainable, energy-efficient, and circular approach to water disinfection. By minimizing chemical use, harnessing solar energy, and enhancing material efficiency, this work supports SDG 12 and highlights the potential of photocatalytic systems for responsible water consumption and decentralized water treatment.

Keywords: *Photocatalytic disinfection, Fe/ZnO, solar irradiation, SDG 12, sustainable water treatment*

VAL46

Photocatalytic Treatment of Dairy Industry Wastewater: Process Optimization and Performance Evaluation Using Response Surface Methodology

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Abstract

The present study investigates the performance of a TiO_2-based photocatalytic reactor for the treatment of dairy industry wastewater, focusing on the reduction of chemical oxygen demand (COD), biochemical oxygen demand (BOD), total dissolved solids (TDS), and total suspended solids (TSS). Photocatalytic oxidation was employed as an advanced treatment process to enhance the degradation of organic and inorganic contaminants present in the wastewater. Process optimization was carried out using Response Surface Methodology (RSM) to evaluate the combined effects of space time, air flow rate, operating temperature, UV irradiation intensity, and TiO_2 catalyst dosage on treatment efficiency. The optimized operating conditions were identified as a space time of 10.06 min, air flow rate of 10.06 L/min, temperature of 60.12 °C, UV intensity of 62.3 lux, and TiO_2 concentration of 3.15 mg/L. Under these conditions, maximum removal efficiencies of 69.89% for COD and 68.49% for BOD were achieved. Significant reductions in TDS and TSS were also observed, indicating effective mineralization and suspended solids removal through photocatalytic reactions. The findings confirm that photocatalytic treatment, when operated under optimized conditions, offers a reliable and efficient approach for improving the quality of dairy wastewater. Overall, this study highlights the potential of photocatalytic reactor systems as an advanced and sustainable treatment technology for dairy industry effluents.

Keywords: *Photocatalytic reactor; Dairy wastewater; TiO_2 photocatalysis; Response Surface Methodology; Advanced oxidation process*

VAL 47

Effect of Redox-Active and Redox-Inactive Metal Doping in Magnetite Spinel on Catalytic Wet Peroxide Oxidation of Sulfamethoxazole

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Abstract

Magnetite (Fe_3O_4), Manganese (Mn) and Aluminium (Al) substituted magnetite spinel nanoparticles ($Fe(FeMn)_2O_4$, $Fe(FeAl)_2O_4$) were synthesized using a simple co-precipitation method. The synthesized nanoparticles were subsequently coated with a carbon matrix (to avoid nanoparticle agglomeration) and evaluated as heterogeneous Fenton catalysts for the catalytic wet peroxide oxidation of sulfamethoxazole (SMX) antibiotic. XPS analysis revealed a positive shift in the Fe^{3+} binding energies in $Fe(FeMn)_2O_4$@C and $Fe(FeAl)_2O_4$@C, indicating an increased electropositive character of $Fe^{3+(\delta^+)}$. Incorporation of Mn and Al into the Fe_3O_4 lattice markedly enhanced the catalytic performance compared to Fe_3O_4@C, which indicates both $Mn^{2+}$and Al^{3+} ions enhanced the production of reactive oxygen species (•OH and HOO•). In addition, the graphene layer in the carbon matrix, enriched with π-electrons, facilitated rapid electron transfer between the oxidant and the spinel nanoparticles led to high SMX mineralization. Under optimized reaction conditions, $Fe(FeMn)_2O_4$@C significantly enhanced the reaction kinetics, with an observed rate constant (k_{obs}) of 0.04 min^{-1}, which is four times higher than that of Fe_3O_4@C (k_{obs} = 0.01 min^{-1}). Remarkably, $Fe(FeAl)_2O_4$@C catalyst demonstrated superior catalytic activity, with the k_{obs} of 0.11min^{-1}, about three times higher than $Fe(FeMn)_2O_4$@C. This improvement in reaction kinetics correlates well with the mineralization efficiency, reaching 60%, 50%, and 18% for $Fe(FeAl)_2O_4$@C, $Fe(FeMn)_2O_4$@C, and Fe_3O_4@C, respectively, within 60 minutes. At higher pH, $Fe(FeAl)_2O_4$@C selectively decomposed H_2O_2 to produce (•OH and HOO•) whereas, $Fe(FeMn)_2O_4$@C favoured non-selective decomposition of H_2O_2 to O_2 and H_2O. This study underscores the significance of polarizing Fe electrons in the magnetite spinel by doping with the redox-inactive metal Al, which possesses Lewis acid character, to accelerate the challenging reduction of Fe^{3+} in the redox

cycle. Aluminum, being redox-inactive, is identified as a more effective dopant for polarizing Fe electrons in the magnetite spinel compared to the redox-active metal Mn.

Keywords: Al and Mn doped magnetite, Antibiotic degradation, Advanced Oxidation Process, Redox cycle.

VAL48

Sustainable and Green Wastewater Treatment Methodology

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Abstract

Wastewater nowadays is a societal problem rather than a natural per say as due to this untreated water not been treated well and the harmful contaminants it is getting exposed too due to this it is been leading to water scarcity, water pollution and environmental degradation as well as these are challenges industries all around the world are facing making it a global shortage of water also due to immense population growth and massive industrialization all over the world water depleting natural and green water sources like sea, oceans, lakes, rivers, canals, wells etc. on a regular basis in 2025 almost more than 72% of wastewater is untreated across urban and rural areas of the country in this case study model we'll be studying structured and methodological approach summarizing treatment technologies using green wastewater sources primarily how wastewater has been treated with Micro – algae and Macro - algae in removing contaminants from suspended solids, organic matter to emerging of deleterious pollutants which would help residents of complexes, general public to reuse the treated water again and again via recycled water reaching their homes through this treatment, disinfection, filtration units also we'd be looking at different case examples through this case study models who all have implemented wastewater treatment through micro – algae across different industries across globe also we'd be looking how it is effective as compared to Conventional wastewater treatment methods of WTP, STP, ETP etc.

Keywords: *Microalgae, Macro–algae, Water treatment plant, Sewage treatment plant, Effluent treatment plant.*

VAL49

Fabrication, Characterization and Application of a sustainable eggshell bio-composite for slow release of Triple super phosphate

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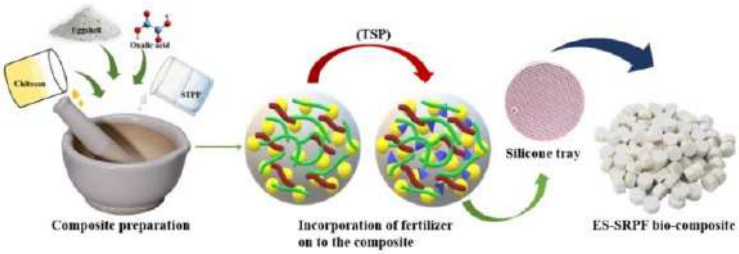
Abstract

This study investigates the fabrication of biowaste, bio-degradable and bio-compactable material from food industry waste, eggshell and marine waste chitosan, to prepare a novel slow-release phosphate fertilizer (ES-SRPF). The prepared ES-SRPF exhibited significant water holding capacity, retention capacity, swelling ratio and equilibrium water content, which would assist the maintenance of water levels in soil. The prepared slow-release phosphate fertilizer was characterized by various analytical techniques such as Fourier transform infrared (FT-IR), Powder X-ray diffraction, thermogravimetric analysis, scanning electron microscopy, energy-dispersive X-ray spectroscopy and Brunauer-Emmett-Teller (BET) methods. Nutrient release study was conducted using glass column in both water and soil which verified that the ES-SRPF fertilizer exhibits an excellent release behaviour as followed by CEN standard. Agricultural application of ES-SRPF showed enhanced plant growth of cucumber to attain as an environment-friendly fertilizer in modern agriculture. Thus, the bio-composite has served as a sustainable carrier for the slow release of ES-SRPF, which supports the SDG -2, zero hunger and SDG-12, responsible consumption and production.

Keywords: *Eggshell, SRF, TSP, Chitosan, and Pot experiment.*



VAL50

Sustainable Valorization of Paper Waste into Bio-Based Adhesives for Circular Economy Applications

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Abstract

The growing demand for sustainable materials and effective paper waste management has led to interest in bio-based adhesives. The present study investigates the production of adhesive exopolysaccharides (EPS) using paper waste as a low-cost substrate through solid-state fermentation (SSF). The key objective was to prepare moulded blocks of the paper waste bonded through in situ produced adhesive EPS towards production of light weighted construction materials. Two bacterial isolates (P1 and B1) were cultivated under SSF conditions (at 37 °C, 7 days) using paper waste (2.0 to 5.0 g), in EPS production medium. Maximum EPS yield of 5.0 mg/ g paper substrate was obtained using 5.0 g paper waste. A mixed substrate system incorporating paper waste and eucalyptus leaves (1:1) further supported effective EPS synthesis. The recovered EPS exhibited strong adhesive properties, enabling the formation of stable moulded blocks, indicating its suitability as a natural binder for lightweight particleboard applications. Plackett–Burman statistical analysis identified K_2HPO_4, NaCl, sucrose, and temperature as significant positive factors influencing EPS production ($p < 0.05$). This work highlights a sustainable approach for converting paper waste into value-added adhesive biopolymers with industrial potential.

Keywords: *Paper waste valorization; Exopolysaccharides; Solid-state fermentation; Bio-based adhesives; Circular economy*

VAL51

Biodiesel Production from Animal Fat Waste using Magnetic Nano Catalyst (Fe_2O_3 – Zro_2)

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Abstract

The growing global interest in sustainable and eco-friendly fuels has intensified the quest for alternative energy sources to substitute conventional fossil fuels. This research utilized beef fat, a readily available by-product from slaughterhouses, as an inexpensive non-edible lipid source for biodiesel generation. A Fe_2O_3–ZrO_2 nanomagnetic catalyst was developed through processes of co-precipitation, coating, and calcination, and it was characterized using FTIR, SEM, XRD, and PSA to verify its functional groups, surface morphology, crystalline structure, and particle size distribution. A high yield of 93.7% was achieved in the extraction of beef fat oil, and GC–MS analysis indicated a composition abundant in C16–C18 fatty acids, which is ideal for transesterification. The low free fatty acid (FFA) value of 0.51% confirmed that it was suitable for base-catalyzed reactions without the need for pretreatment. The created nanocatalyst displayed significant magnetic properties, nanoscale crystallinity (~30 nm), and a consistent particle distribution (~177 nm), facilitating easy recovery and reusability. Biodiesel was successfully produced via transesterification using methanol and the Fe_2O_3–ZrO_2 catalyst, followed by purification to adhere to ASTM D6751 fuel standards. The findings indicate that utilizing beef fat together with a reusable nanomagnetic catalyst presents an effective and sustainable method for high-quality biodiesel production, aligning with principles of a circular economy and waste valorization.

Keywords: *Animal fat waste; Transesterification; Nanomagnetic catalyst; Fourier Transform Infrared Spectroscopy; Gas Chromatography-Mass Spectrometry; Response Surface Methodology.*

VAL52

Valorization of Floral Waste and Slaughterhouse Remains via Microbial Fermentation for Biosurfactant Production and Environmental Remediation

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Abstract

The present study describes valorization of floral waste and slaughterhouse remains through production of microbial surfactants for potential applications in environmental remediation. A nutrient rich medium composed of floral waste and minced slaughterhouse remains was used for fermentation by a biosurfactant producing bacterium isolated from slaughterhouse wastewater. This bacterial isolate was screened through emulsification index (E_{24}), oil spreading and drop collapse assays. In order to optimize the yield of the biosurfactant, fermentation parameters, including substrate ratio, pH, temperature and incubation time were optimized. The biosurfactant extracted from the culture was checked for its ability to reduce surface tension of water followed by determination of its critical micelle concentration, and stability under varied pH, temperature and salinity conditions. The test biosurfactant was also evaluated for its environmental remediation potential through determination of oil emulsification, hydrocarbon displacement and adsorption of heavy metal, thereby demonstrating its potential for efficient removal of pollutants. The present study thereby not only presents a unique approach of dual waste valorization but also generation of value-added products like biosurfactants, which further displays ability to promote environmental remediation. Through this study, cost effective sustainable production of biosurfactant was achieved and it was done through utilizing such wastes which are hugely generated nowadays and add to the burden of organic wastes. The results generated in this study paved the path for combining wastes of diverse categories and channelizing them into generation of functional products with a plethora of application potentials. This further helps in devising green solutions for waste management in line with SDG 12 (responsible consumption & production).

Keywords: *Biosurfactant, Floral Waste, Slaughterhouse Remains, Fermentation, Bioremediation, Waste Valorization*

VAL53

Waste Valorization for Sustainable Bioplastics: Microbial Production of Polyhydroxyalkanoates (PHAs) in a Circular Bioeconomy

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Abstract

Plastic pollution and increasing pressure on natural resources have intensified the global demand for sustainable materials aligned with circular economy principles. Conventional petroleum-based plastics persist in the environment and contribute significantly to ecological degradation. In this context, Polyhydroxyalkanoates (PHAs) have emerged as a promising class of biodegradable and biocompatible biopolymers synthesized by a wide range of microorganisms as intracellular carbon and energy storage compounds. Owing to their renewable origin, complete biodegradability, and thermoplastic properties, PHAs are increasingly recognized as viable alternatives to conventional plastics across multiple application sectors. The valorization of waste and low-cost biomass substrates for microbial PHA production offers a sustainable pathway for integrating bioplastic manufacturing into a circular bioeconomy framework. Agricultural residues, industrial by-products, and organic waste streams can serve as economical carbon sources, addressing one of the principal challenges limiting PHA commercialization. Substrate costs alone account for nearly 50% of total production expenses, and their replacement with waste-derived feedstocks significantly enhances economic feasibility. Moreover, the incorporation of waste valorization strategies into microbial fermentation processes contributes to waste reduction, resource recovery, and improved environmental performance. Despite these advantages, large-scale deployment of PHAs remains constrained by challenges associated with feedstock variability, fermentation efficiency, downstream processing complexity, and overall production economics. Variations in waste composition can affect microbial metabolism and polymer yield, while recovery and purification steps often remain energy-intensive. Recent advances in microbial strain development, metabolic engineering, process optimization, and environmentally benign

extraction technologies are progressively addressing these limitations, improving yield, scalability, and cost-effectiveness. By coupling biodegradable polymer production with waste-to-resource strategies, PHAs represent a sustainable material solution capable of mitigating plastic pollution while advancing circular economy and waste valorization objectives.

Keywords: *Waste Valorization; Polyhydroxyalkanoates (PHAs); Circular Economy; Biodegradable Bioplastics; Microbial Fermentation; Biomass Waste*

VAL54

High-Rate Algal Ponds for Wastewater Valorization in a Circular Economy

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Abstract

High-rate algal ponds are shallow, sunlight-driven raceway systems that integrate wastewater treatment with biomass production through tightly coupled algal-bacterial processes. In these systems, microalgae are the primary source of dissolved oxygen, supporting aerobic heterotrophic bacteria in degrading organic matter while simultaneously assimilating inorganic carbon, nitrogen, and phosphorus into algal biomass. Typical HRAPs operate at water depths of 0.2 to 0.4 m with continuous paddle-wheel mixing, maintaining surface velocities of 0.15 to 0.30 m s^{-1} to ensure uniform circulation, prevent biomass settling, and maximise light exposure across the photic zone. The shallow geometry and extended light path enable high areal photosynthetic fluxes, resulting in daytime dissolved oxygen concentrations frequently exceeding 15 to 20 mg L^{-1} under favourable irradiance. This photosynthetic oxygenation can partially or fully replace mechanical aeration, reducing energy demand by up to 60-80 per cent compared to conventional activated sludge systems. Nutrient removal in HRAPs is achieved through a combination of biological assimilation, pH-induced ammonia volatilisation and phosphate precipitation, and bacteria-mediated nitrification and denitrification. Under optimised hydraulic retention times of 3 to 8 days, reported removal efficiencies typically range from 70 to 95 per cent for nitrogen and phosphorus and above 90 per cent for total suspended solids. Paddle-wheel-driven hydrodynamics and raceway geometry play a critical role in regulating oxygen transfer, light utilisation efficiency, and algal-bacterial contact. Recent advances focus on optimising channel width, length-to-width ratios, and mixing intensity to minimise night-time oxygen deficits while maximising biomass productivity. In addition to effective wastewater polishing, harvested algal biomass offers pathways for valorization into bioenergy, biofertilizers, and soil amendments, positioning HRAPs as a robust and low-cost platform for circular bioeconomy-oriented wastewater treatment.

Keywords: *High-rate algal ponds; Wastewater treatment; Paddle wheel mixing; Algal bacterial consortia, Biomass production*

VAL55

Extirpation and Infusion of Spent POP's in Corrosion Alleviation as Inhibitors

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Abstract

PFOA (Per Fluoro Octanoic Acid), widely declared class of POPs (Persistent Organic Pollutant), a stable, toxic and non-biodegradable compound, is primarily discharged from chrome plating industries, electronics / non – stick pans (Teflon), polishes and wax products. Even, minute intake of this noxious compound, lead to cardiovascular and reproductive problems. The present study aims at adsorbing these anions under laboratory conditions, employing two plant-based litter materials, CRP (*Coleus rotundifolius* Pellets) and MCP (*Magnolia champacca* Pod shells), after subjecting the latter to chemical modification (TCRP, TMCP). Experimental verification of Batch mode involved the optimization of operating conditions: 9 mg/L initial PFOA concentration; 4 mg TCRP / 5 mg TMCP dose; 12 mins contact time for maximum PFOA sequestration. Native and PFOA laden TCRP and TMCP were characterized using SEM/EDAX, FTIR and TG/DTA to determine the variations in surface morphologies, elemental composition, functional groups and stability/ decomposition. TCRP registered a marginal increase in PFOA removal (96%) against TMCP (91%). Hence, the bulk nature of TCRP was quantified by extending to column set up. Continuous column analysis aimed at fixing sorbent dose, sorbate initial concentration and flow rate, to yield maximum scavenging ability of TCRP. TCRP from the exhausted column was collected and involved as precursor in preparing corrosion inhibitor by adding suitable binders. The anti-corrosive behaviour of the prepared sample was tested at different dose and time intervals of coating on aluminium plates. The anti-rusting efficacies in acid and saline environs of these attributes were methodically verified by Weight Loss measurements, Impedance Spectra and Tafel Polarization Plots. The better inhibiting efficiency was envisaged in acidic conditions. The made observations confirm the sorption efficacy of chosen materials and notable anti-corrosive property of TCRP.

Keywords: *PFOA, litter materials, adsorption, batch, column, corrosion inhibitio*

VAL56

Metal-directed structural divergence governing cytotoxic and antimicrobial activity in multinuclear quinoline complexes

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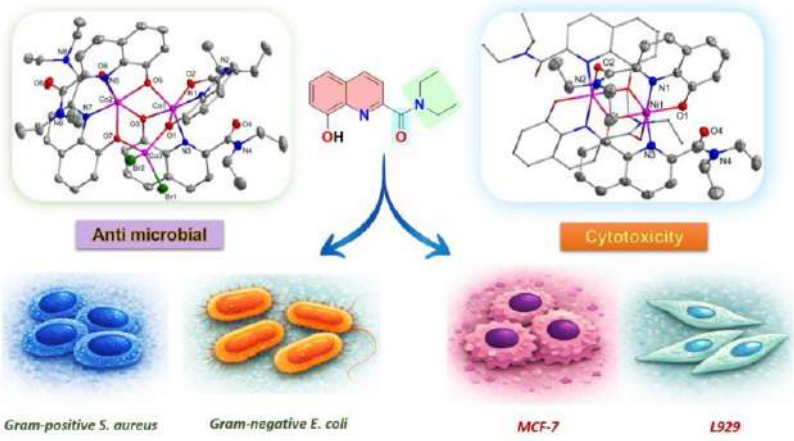
Abstract

A quinoline functionalized ligand LH afforded trinuclear cobalt complex 1 and a dinuclear nickel complex 2 upon metalation. Single-crystal X-ray diffraction revealed distinct coordination architectures despite an identical ligand framework. 1 incorporated terminal bromide ligands in a higher nuclearity assembly and showed strong antimicrobial activity towards both Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) strains. In contrast, 2 adopted a compact, halide-free structure and exhibited cytotoxic properties towards human breast cancer cell line (MCF7) and mice fibroblast cell line (L929). These results indicate that metal-directed coordination architecture results in divergent biological outcomes.



VAL57

Sustainable Keratin Extraction from Wool Cortical Cells for Tissue Engineering Applications

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Abstract

Keratin is a biopolymer essential for developing biomaterials for biomedical and industrial applications. Common keratin extraction methods employ organic solvents, detergents, and energy-intensive processes for removing lipids from the wool surface, which reduces the purity of the extracted keratin. In this study, rabbit wool was disintegrated by *B. altitudinis* VK-1120 in the basal salt medium. The cortical cells from wool were isolated with a maximum yield of 61.43% ± 2.02% at a wool concentration of 3.5% (w/v) at 37 °C and pH 8.0. The cortical cells contained an average length of 93.50 ± 5.11 µm and an average diameter of 3.93 ± 0.36 µm. This approach effectively eliminates surface lipids and cuticle proteins, making it appropriate for keratin extraction. Keratin was extracted from cortical cells using the sulfitolysis method. The resulting keratin was analyzed with FT-IR and XRD, which confirmed the presence of its characteristic chemical groups. Secondary structure analysis showed both α-helix and β-sheet formations. The molecular weight of the extracted keratin ranged from 35 to 63 kDa, displaying two distinct protein bands. Thermal stability, as evaluated by DSC and TGA, confirmed the higher stability of cortical cells compared to keratin. Moreover, the isolated keratin showed biocompatibility with fibroblast cells. This approach offers a sustainable method for extracting pure keratin from wool cortex for use in the preparation of biomaterials.

Keywords: Cortical cells, Keratinase, Sustainable approach, Intermediate filaments

VAL 58

Integrated Assessment of Seasonal Climate Variability, Surface Energy Balance, and Drought Dynamics in a Rain-Fed Semi-Arid Region of South India

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Abstract

Understanding the evolving interactions between climate variability, surface energy balance, and drought dynamics is critical for enhancing drought resilience in rain-fed agro-ecological systems. This study presents a comprehensive assessment of long-term seasonal hydro-climatic and radiative changes in the Pudukkottai district of Tamil Nadu, India, using historical observations and future projections spanning 1980–2100. Seasonal variations in temperature, precipitation, relative humidity, cloud cover, downward shortwave radiation (DSR), surface albedo, and potential evapotranspiration (PET) were analysed alongside multiple standardized drought indices, including the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), and Reconnaissance Drought Index (RDI). Results indicate a persistent warming trend across all seasons, with the strongest temperature increases observed during summer. Monsoon precipitation exhibits a pronounced intensification toward the end of the century, while winter rainfall shows a consistent decline, signalling increased dry-season stress. Concurrent increases in atmospheric humidity and cloud cover contribute to a systematic reduction in DSR and surface albedo, reflecting a coupled land–atmosphere response and a progressive shift in the regional surface energy balance. Despite declining solar radiation, PET increases substantially across all seasons, driven primarily by rising temperatures and enhanced atmospheric demand. Drought analysis reveals a divergence between precipitation-based and energy-based indices. While SPI suggests a transition toward wetter conditions in the future due to increased monsoon rainfall, SPEI and RDI indicate sustained drought stress, particularly during summer, highlighting the dominant role of temperature-driven evapotranspiration. These findings demonstrate a transition from precipitation-limited to energy-limited drought regimes under climate change. The study underscores the

necessity of integrating hydro-climatic and radiative processes in drought assessment frameworks to accurately evaluate regional vulnerability and inform climate-resilient water and land-use planning.

Keywords: *Climate change, Seasonal drought, Surface energy balance, Potential evapotranspiration, Radiative forcing, land-use planning*

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VAL59

Globalization and Health Equity towards Sustainable Development

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Abstract

The implementation of sustainable systems is an essential requirement in modernmanufacturing, in order to minimize environmental and health concerns and conserve energyand natural resources. Health according to the World Health Organization, is a state of complete physical, mental and social well-being and not merely the absence of disease and infirimity. Health can be promoted by encouraging healtful activities, such as a regular physical exercise and adequate sleep and by reducing or avoiding unealthful activities or situations, such as smoking or excessive stress. Environment Sanitation protects public health by maintaining hygienic environment and preventing the spread of disease, it is often called as the Social and Preventive Medicine OR Community Medicine.Three global phenomena need to be considered in the discussion about globalization, health equity and sustainable development.Three global phenomena need to be considered in the discussion about globalization, health equity and sustainable development.Globalization is a key context for the study of social determinants of health (SDH).This article discusses globalization and its health challenges from a vantage of political science, emphasizing increased global flows (of pathogens, information, trade, finance, and people) as driving, and driven by, global market integration.

Keywords: *World Health Organization, well-being, infirimity, globalization, Preventive Medicine, Social determinants of health, global market integration, Environment Sanitation.*

VAL 60

GIS-Based Planning Framework for Recyclable Waste Management: A Conceptual Case Study towards Circular Economy

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Abstract

Waste generation has increased significantly as a result of rapid urbanization and population growth, putting strain on the environment and waste management systems, especially in developing nations. Conventional waste management techniques are frequently disjointed, with little integration of data, spatial information, and planning tools. This leads to poor adoption of circular economy principles and ineffective decision-making. Integrated, data-driven strategies that promote resource efficiency and sustainable planning are needed to address these issues. A conceptual case study of a digital decision-support framework intended to aid in waste management and environmental planning is presented in this study. In order to facilitate visualization, system-level analysis, and well-informed decision making, the suggested framework incorporates secondary waste-related data, spatial information, and fundamental analytical tools. The methodology entails gathering data on waste generation and composition, geography, and demographics, followed by waste flow analysis, gap analysis, and conceptual scenario assessment. Visualization using charts and spatial representations supports interpretation of system performance and the identification of priority intervention areas. The framework's decision-support outputs offer planning insights on resource recovery, recycling, waste reduction, and segregation. By identifying high waste-generating zones, dominant waste fractions, and system inefficiencies, the framework facilitates targeted interventions aimed at reducing waste sent to landfills and improving recycling efficiency. By encouraging resource recovery from organic and recyclable waste streams, the approach highlights circular economy principles. The novelty of this study lies in its integrated and planning-oriented methodology, which combines data analysis, spatial understanding, and decision support within a single conceptual framework. Designed to operate using secondary data, the framework is adaptable to data-limited and resource-

constrained urban contexts. The study highlights the potential role of digital decision-support systems in strengthening environmental and waste management planning and supporting the transition from linear waste management practices towards more sustainable and circular systems.

VAL 61

Harnessing Sunlight for Photocatalytic Hydrogen Evolution via Band-Engineered LaNiO3 -LaVO4 Heterostructures

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Abstract

With the growing focus on sustainable and efficient hydrogen production, photocatalytic water splitting has become a promising approach. In the present study, we developed a LaNiO3-LaVO4 heterostructure composite to improve solar-light-driven photocatalytic activity for hydrogen generation. The catalysts were synthesized using the sol-gel method, which allowed for precise control over their composition and structure. Their properties were analyzed using X-ray Diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), Ultraviolet Photoelectron Spectroscopy (UPS), Scanning Electron Microscopy (SEM), Diffuse Reflectance Spectroscopy (DRS), Photoluminescence Spectroscopy (PL), and Time-Correlated Single Photon Counting (TCSPC). Photocatalytic testing under simulated solar irradiation revealed a 60% enhancement in hydrogen evolution activity, achieving a yield of 1232 µmol/g for the LaNiO3-LaVO4 heterostructure, compared to the performance of the pristine catalysts. This enhancement is attributed to synergistic interfacial interactions and improved charge carrier separation facilitated by the heterostructure. These results show the potential of LaNiO3-LaVO4 heterostructures as effective photocatalysts for solar-driven hydrogen production and emphasize the importance of band engineering and heterostructure design in sustainable energy technologies.

Keywords: *Band engineering; heterojunction photocatalyst; green hydrogen; light harvesting*

VAL 62

CFD-Guided Design of a Hydrodynamic Cavitator for Enhanced Biomethane Production from Rice Straw

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Abstract

Rice straw is an abundant lignocellulosic biomass with high potential for renewable biomethane production; however, its compact fibrous structure limits biodegradability during anaerobic digestion. This study presents a CFD-based design and evaluation of a hydrodynamic cavitation pretreatment system to improve rice straw digestibility and biomethane yield. Computational fluid dynamics (CFD) was used as a guiding tool to design and optimize the cavitator for effective cavitation intensity and improved energy efficiency. The CFD-guided cavitation system was experimentally validated, showing clear physical and structural modification of rice straw after pretreatment, including increased surface roughness and porosity. Experimental results demonstrated improved substrate availability, reflected by an increase in specific surface area and pore volume of cavitated biomass. Biomethane potential tests showed a ~36% increase in biogas yield and a ~23% improvement in methane content compared to untreated rice straw, while maintaining the same retention time. These improvements indicate accelerated hydrolysis and enhanced anaerobic digestion performance. Overall, the study confirms that CFD-assisted hydrodynamic cavitator design enables efficient biomass pretreatment and offers a scalable, energy-efficient strategy for enhancing biomethane production from agricultural residues, supporting sustainable waste-to-energy applications.

Keywords: *Hydrodynamic cavitation, Computational fluid dynamics (CFD), Rice straw pretreatment, Biomethane production, Anaerobic digestion*

VAL63

Valorization of Marine Macroalgae Biomass via Sequential Protein Recovery and Anaerobic Digestion for Circular Bioenergy

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Abstract

Marine macroalgae are a promising biorefinery feedstock due to their high productivity and diverse biochemical composition, particularly proteins. However, after protein extraction, the remaining macroalgal residue is often considered a low-value by-product, limiting overall biomass utilisation and compromising process sustainability. This study evaluated the feasibility of valorizing protein-extracted marine macroalgal biomass through anaerobic digestion (AD) as a downstream energy recovery route, supporting an integrated circular biorefinery concept. Batch AD experiments were conducted over 30 days to investigate biodegradability, organic matter conversion, nutrient transformation, and biogas generation from the protein-extracted substrate. The protein-extracted macroalgal biomass demonstrated substantial anaerobic biodegradation, achieving 56% total solids reduction and 61% volatile solids reduction, indicating effective mineralization of residual organic matter. A 40% decrease in chemical oxygen demand further confirmed efficient conversion of soluble and particulate organics during digestion. Nutrient dynamics showed enhanced nitrogen transformation, with total Kjeldahl nitrogen reduced by 56% and ammonia reduced by 74%, suggesting improved microbial assimilation and mineralization pathways under anaerobic conditions. Phosphate reduction was also observed, reflecting nutrient redistribution during digestion and potential retention within the digestate. Biogas production trends confirmed successful bioenergy recovery from the protein-extracted macroalgal residue, supporting its suitability as a substrate for methane-rich biogas generation. The improved digestion performance is likely associated with the protein extraction process serving as a pretreatment step, enhancing substrate solubilization and microbial accessibility by partially disrupting macroalgal structural components. These results demonstrate that protein-extracted macroalgal residues remain highly digestible and can be effectively converted into renewable energy via AD,

strengthening the sustainability and resource efficiency of macroalgae-based circular biorefineries.

Keywords: *Marine macroalgae, nutrient transformation, biogas production, and resource recovery.*

VAL64

Impact of Biochar addition on VFA degradation and methane production during food waste sludge co-digestion

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Abstract

Food waste (FW) and sewage sludge (SS) are generated at an increasing rate globally due to increased urbanization. The present study evaluates the feasibility of biochar supplements on the performance of anaerobic co-digestion and food waste/sludge at different total solids (TS) content (2.5%, 5.0% and 7.5%). The underlying mechanisms of biochar enhance TS anaerobic co-digestion of FW/sludge co-digestion were investigated with a focus on volatile fatty acids (VFA) degradation, methane yield, and microbial community. The results showed that the addition of biochar significantly increased the cumulative methane production by 21.3%, 24.5%, and 33% at TS content of 2.5%, 5.0%, and 7.5%, respectively, compared with the control without biochar. Optimal solid content was found to be 5.0%, which produced accumulative methane yields of up to 340.47 ±0.81mL/gVSadd significantly promoted VFA degradation, especially in butyric and propionic acid concentrations. The large methane yield of biochar amended treatments was correlated to the high organic removal, efficient degradation of volatile fatty acid and volatile solids, significant promotion of direct interspecies electron transfer activity, and the growth of methanogens. The biochar surface area offered substantial support for direct interspecies electron transfer (DIET) activity, and biofilm-mediated growth of methanogens i.e. Methanosarcina, Methanosata, and Methanobrevibacter, dominated in archaeal community in three reactors, and the relative abundance of the biochar addition group showed an increasing trend with increasing total solid content. The biochar-enriched digestate improved the seed germination index, C/N ratio, and bioavailability of plant micronutrients, i.e., N, P, and K, as well as reducing ammonium content, conducive to land application.

Keywords: *Anaerobic co-digestion, Food waste, biochar, direct interspecies electron transfer.*

VAL65

From CO_2 to Hydrocarbons: A Methanol-Mediated Route Using Bifunctional Catalysts

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Abstract

The catalytic hydrogenation of carbon dioxide to fuels and chemicals is a promising route for mitigating emissions while producing sustainable energy carriers. Among the available pathways, methanol-mediated CO2 conversion offers an integrated approach where methanol acts as a key intermediate for hydrocarbon formation. However, the coupled reaction network involving methanol synthesis, hydrocarbon formation, and side reactions such as reverse water gas shift (RWGS) remains insufficiently understood, limiting rational process and reactor design.1,2. In this work, direct CO2 hydrogenation to hydrocarbons was investigated over a bifunctional In2O3/HZSM-5 catalyst through a combination of systematic experiments and kinetic modeling. The In2O3 catalyzes methanol formation from CO23, while the acidic HZSM-5 zeolite promotes subsequent conversion of methanol to hydrocarbons via the methanol-to-hydrocarbon pathway. Fixed-bed reactor experiments were conducted across a wide range of temperatures, pressures, feed compositions and space velocities. A comprehensive kinetic model was developed by coupling a Langmuir-Hinshelwood-Hougen-Watson (LHHW) kinetic for methanol synthesis with a lumped kinetic scheme for hydrocarbon formation.4 The bifunctional system exhibited strong suppression of RWGS compared to the standalone methanol synthesis catalyst, leading to a pronounced reduction in CO formation and enhanced hydrocarbon yields.5 More than 99 % of the intermediate methanol was converted under most operating conditions. The kinetic model successfully captured experimental trends in CO2 conversion, product selectivity and hydrocarbon distribution. Overall, this work provides a validated kinetic framework for understanding and predicting methanol-mediated CO2 hydrogenation to hydrocarbons. The insights gained are expected to support

catalyst design, reactor optimization and the development of efficient carbon utilization technologies for sustainable fuel production.

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VAL67

A Metal-Tolerant Mesophilic Laccase from *Achromobacter sp.*: Molecular Identification, Biochemical Characterization, and Dye Decolorization

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Abstract

Laccases are multicopper oxidases recognized for their ability to oxidize a wide range of phenolic and aromatic substrates, positioning them as environmentally benign alternatives to conventional chemical oxidants. In this study, a laccase-producing Achromobacter species was isolated from a natural source and molecularly identified through 16S rRNA gene sequencing. Optimization of culture conditions demonstrated that maximum biomass formation and extracellular laccase production occurred within 24 h of incubation. The enzyme exhibited optimal catalytic activity at 40 °C and pH 5.0 and maintained over 85% of its residual activity in the presence of various metal ions at concentrations up to 10 mM, indicating pronounced metal tolerance and operational stability. Partial purification of the enzyme revealed two prominent protein bands of approximately 50 kDa and 200 kDa on SDS-PAGE, suggesting the presence of multiple laccase isoforms. Enzymatic activity was further confirmed by guaiacol oxidation on native PAGE. Furthermore, the laccase demonstrated efficient decolorization of dyes belonging to different chemical classes, highlighting its functional versatility. Collectively, these findings suggest that Achromobacter-derived laccase represents a stable and efficient biocatalyst with significant potential for industrial enzyme applications and environmental bioremediation.

Keywords: *Bacterial laccase; Achromobacter species; metal tolerance; enzyme characterization; dye decolorization; bioremediation*

VAL68

Nano-Activated Carbon composites for removal of emerging contaminants in Wastewater

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Abstract

The growing contamination of water resources by organic pollutants necessitates the development of efficient, sustainable, and low-cost adsorbents. In this study, nanoporous activated carbon was synthesized from plant-based pod waste of Senna auriculata and systematically characterized to evaluate its suitability for wastewater treatment applications. The physicochemical properties of the prepared adsorbent were investigated using Brunauer–Emmett–Teller (BET) surface area analysis, Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX). The results revealed a high specific surface area with a well-developed micro- and mesoporous structure, along with the presence of oxygen-containing functional groups on the carbon surface. Batch adsorption experiments were performed to assess the effects of contact time, initial pollutant concentration, pH, and temperature. The enhanced adsorption performance is attributed to the synergistic effects of porous structure and surface functional groups facilitating electrostatic interactions and diffusion of pollutant molecules. Overall, the findings highlight the potential of the synthesized nanoporous activated carbon as an effective adsorbent for environmental remediation.

Keywords: *Nasnoporous Activated carbon, Adsorption, Sustainable, Bio waste*

VAL69

Combinatorial approach for efficient dye degradation using Green tea extract and *Streptomyces rochei* MMAD5

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Abstract

Synthetic or man-made dyes are widely used in various industries like textile, leather, paper, cosmetics, and also food industries due to their two significant properties like stability and vibrant coloration. However, their resistance to conventional wastewater treatment processes have raised environmental concerns. Thus, there is a need to find alternative treatments that are effective in removing dyes from large volumes of effluents and are low in cost. The present study involves the combinatorial approach using actinomycetes and green tea for efficient Congo red, an azo dye degradation. For this, the actinomycetes were isolated and identified as Streptomyces rochei MMAD5 from the soils of Jetpur, near industrial area which is contaminated with various dyes. Dye degradation ability was checked using UV–Visible spectrophotometer. Green tea waste extract was prepared by boiling, filtering and centrifuging to assesses its potential for its dye degradation. The combinatorial study using both Streptomyces rochei MMAD5 and green tea extract was carried out and was found to degrade the dye effectively, rather than using both individually. The synergistic effect was observed which demonstrates that upon integration of microbes with plant, it enhances the efficiency of azo dye degradation or bioremediation. This study highlights a sustainable waste-valorization approach, wherein ecofriendly waste is transformed into a resource which is value-added for bioremediation. The synergistic integration of such strategies supports circular economy and contributes to achieving various sustainable development goals.

Keywords: *Dye degradation, Green tea extract, Streptomyces rochei MMAD5, Congo red dye.*

VAL70

Advanced Treatment Approaches for the removal of Per- and polyfluoroalkyl substances (PFAS) in wastewater

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Abstract

Emerging contaminants like Per and Polyfluoroalkyl substances (PFAS) are persistent and highly mobile pollutants in the environment. Widely detected in various environmental matrices (soil, water, and air) and increasingly detected in industrial and municipal wastewater, raising serious environmental and public health concerns. Due to their presence of a strong C-F bond, which makes them resistant to biological degradation, traditional wastewater treatment techniques are typically ineffective in eliminating PFAS, resulting in their continued discharge into aquatic habitats. However, current improvements in treatment methods aim to enhance PFAS removal efficiency and destruction from wastewater systems. Due to the presence of a strong C-F bond in PFAS, which makes them resistant to biological degradation, traditional wastewater treatment techniques are typically ineffective in eliminating PFAS, resulting in their continued discharge into aquatic habitats. Furthermore, current improvements in treatment methods aim to enhance PFAS removal efficiency and destruction from wastewater systems. Advanced non-destructive technologies, including granular activated carbon, nanofiltration, and reverse osmosis, have demonstrated significant removal efficiency, especially for long-chain PFAS. However, these technologies mostly concentrate PFAS in secondary waste streams, creating challenges in regeneration, disposal, and long-term sustainability. To overcome these limitations, destructive technologies such as electrochemical oxidation, plasma treatment, photocatalysis, and sonolysis are being investigated for PFAS defluorination and mineralisation. The presentation will also discuss the challenges in performance of these systems in realistic wastewater

circumstances, focusing on the impact of co-contaminants, energy consumption, and operational complexity. Hybrid treatment techniques that combine separation and destructive techniques are proposed as possible methods for improving overall treatment efficiency while addressing concentrate management difficulties. This presentation also discusses future options for scalable, low-energy, and cost-effective PFAS treatment approaches.

Keywords: *Per and Polyfluoroalkyl substances; wastewater treatment techniques; nanofiltration; reverse osmosis; electrochemical oxidation.*

VAL71

Enhanced Azo and Basic Dye Degradation Using Inorganic and Organic Nanoparticle-Encapsulated Aerobic Consortia

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Abstract

Nanoparticle-mediated dye degradation has emerged as an effective wastewater treatment strategy due to its high surface reactivity and ability to enhance both catalytic and biological removal processes. Although recent advances demonstrate efficient degradation of recalcitrant dyes, the practical application of free nanoparticles remains limited by aggregation and weak interactions with microbial systems. In this study, inorganic iron-based and organic date-derived nanoparticles were synthesized and integrated with a pre-enriched aerobic dye-degrading bacterial consortium to improve nano-bio stability and degradation efficiency. Inorganic iron nanoparticles ($FeCl_3$-based) were prepared via heat treatment followed by ultrasonication, yielding particle sizes of 2-4 nm. In contrast, organic nanoparticles were synthesized using magnetic stirring and ultrasonication, producing particles of ~42 nm. Both nanoparticle types were encapsulated with the microbial consortium to ensure stable association. Dye degradation experiments were conducted using Congo Red, Methyl Orange, Methylene Blue, and Crystal Violet at concentrations ranging from 50 to 500 ppm. The control system showed negligible dye removal, whereas reactors containing only inorganic or organic nanoparticles achieved moderate degradation. Encapsulated inorganic nanoparticles demonstrated superior performance toward azo dyes, achieving 89% removal of Congo Red (200 ppm) within 48 hours and 71% removal of Methyl Orange (50 ppm) in 72 hours. In contrast, organic nanoparticles were more effective for basic dyes, degrading 65% Methylene Blue (200 ppm) within 24 h and 66% Crystal Violet (100 ppm) within 48 h. SEM analysis confirmed uniform nanoparticle distribution and effective bacterial attachment, indicating stable nano-bio interactions. Overall, the complementary performance of inorganic and organic

nanoparticles highlights nano-encapsulated microbial systems as a robust and sustainable strategy for efficient dye wastewater treatment.

Keywords: *Dye wastewater treatment, Organic nanoparticles, Aerobic bacterial consortium, Nano-bio hybrid system, Recalcitrant dyes, Encapsulation*

VAL72

Impact of different RSC neutralized water irrigation on soil properties under vegetable production

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Abstract

An experiment under tomato (Lycopersicon esculentum) crop was carried out at Research Farm, ICAR–Central Soil Salinity Research Institute, Karnal during Rabi, 2023-24, to assess the impact of irrigation with RSC water and neutralization of alkalinity of water with different reclamation agents. In this experiment, nine treatments were laid out in factorial RBD with three replications. Results showed that, irrespective of treatments, irrigation with neutralized water [acid neutralizer (AN), liquid S (LS) and sulphur reaction product (CSRP)] significantly decreased the soil pH, calcium carbonate (CaCO3), NH4OAc-K, exchangeable sodium percentage (ESP), concentration of saturation paste extract carbonates and bicarbonates, sodium absorption ratio (SAR) and parameters like carbonate and bicarbonate to chloride sulphate ratio and sodium to chloride sulphate ratio, however, soil EC, exchangeable bases, exchangeable sodium ratio (ESR), and CaCl2-S, followed the decreasing trend. Whereas irrigation with BAW, RSC and neutralized water showed similar Walkley-Black organic carbon, KMnO4–N and Olsen P. Due to improved soil physico- chemical properties tomato fruit yield was also significantly improved. Based on the results of this study, it can be concluded that new formulations acid neutralizer (AN), liquid S (LS) and sulphur reaction product (CSRP) are the prominent ameliorant can be used as neutralization of alkalinity of irrigation water for high value crops.

Keywords: *Tomato, alkali water, neutralised water and physico-chemical properties*

VAL73

Comparative Analysis of Biological Treatment Systems for Pulsed Electric Field -Pretreated Biopharmaceutical Effluent

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Abstract

Global biopharmaceutical production has reached unprecedented scales, with antibiotic consumption exceeding 40 billion doses annually and vaccine production expanding rapidly to address the healthcare demands of a growing global population [1]. This intensive manufacturing generates substantial volumes of biopharmaceutical fermentation wastewater (BFW), an inevitable by-product of complex multi-stage processes including fermentation, extraction, and purification [8]. BFW contains viable microorganisms and antibiotic residues, creating intense selection pressure that drives antimicrobial resistance (AMR) development. If discharged untreated, these resistant microbes can transfer resistance genes to environmental bacteria through vertical and horizontal gene transfer mechanisms, exacerbating the global AMR crisis recognized by WHO as a critical health threat [1]. Therefore, effective BFW treatment before environmental discharge is imperative. Conventionally, BFW undergoes moist heat sterilization at 121°C for 30-35 minutes. At industrial scales, this requires steam generated by boilers fueled with Piped Natural Gas (PNG), resulting in substantial CO_2 emissions and significant operational costs, a burden that undermines sustainability goals in pharmaceutical manufacturing [8]. Alternative technologies that reduce both environmental impact and economic costs are urgently needed. Pulsed Electric Field (PEF) technology offers a promising energy-efficient alternative for microbial inactivation [4]. PEF applies high-voltage pulses that generate electric fields across microbial cell membranes, inducing transmembrane potential increases. When this potential exceeds the critical threshold of approximately 900 mV, irreversible electroporation occurs, causing cell lysis and microbial inactivation without thermal energy requirements. Preliminary laboratory-scale investigations demonstrate

that 500 mL BFW samples treated with PEF at 120 kV/cm achieve effective microbial reduction. Following PEF pretreatment, the effluent was subjected to further remediation using two biological treatment systems to reduce residual organic and inorganic contaminants. This study comparatively evaluates the integration of PEF pretreatment with Moving Bed Biofilm Reactor (MBBR) [5] and Activated Sludge Process (ASP) [6] for comprehensive pollutant removal, AMR mitigation, and water quality enhancement. Comparative analysis revealed that MBBR demonstrated superior treatment efficiency compared to ASP.

Keywords: *Activated Sludge Process, Antimicrobial resistance, Moist heat sterilization, Moving Bed Biofilm Reactor, Piped Natural Gas*

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VAL74

Synergistic effects of Substrate Composition and Electrode Potential on Voltage-Assisted Anaerobic Digestion

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Abstract

Anaerobic digestion is a widely applied biological process for the stabilization of organic waste and the recovery of renewable energy. Despite its advantages, the efficiency of digestion is frequently constrained by limitations in interspecies electron transfer within complex microbial consortia. These limitations become particularly pronounced under high organic loading conditions, where excessive substrate availability disrupts microbial electron flow and syntrophic interactions, leading to volatile fatty acid (VFA) accumulation, pH decline, redox imbalance and process instability. The challenge increases during the co-digestion of mixed substrates such as carbohydrates, proteins and lipids, as each substrate class follows distinct biochemical degradation pathways and imposes different electron transfer demands on the microbial community. Under such conditions, inefficient VFA conversion affects acetogenesis and methanogenesis, highlighting the critical need for improved regulation of electron transfer and intermediate utilization to maintain stability under high organic loading. Voltage-assisted anaerobic digestion has emerged as a promising strategy to overcome these limitations by introducing an alternative, electrode-mediated electron transfer pathway. The application of an external voltage enhances microbial redox interactions and promotes more efficient VFA utilization, thereby improving process stability under stressed conditions. In this study, a laboratory-scale batch anaerobic digestion system was operated under voltage-assisted conditions to investigate the interactions of different substrate classes. Synthetic substrates representing carbohydrates, proteins, and lipids were prepared at varying concentrations and evaluated under both electrode-assisted and control setups. Cyclic voltammetry was employed to identify a safe operating voltage range, while substrate degradation kinetics and VFA profiles were monitored over time. The results demonstrated that optimized applied

voltage results in enhanced VFA utilization and improved process stability, particularly under high organic loading conditions. These findings provide a practical framework for optimizing voltage-assisted anaerobic digestion systems treating mixed substrates and contribute to the development of more robust and efficient anaerobic digestion processes.

Keywords: *Anaerobic digestion, voltage-assisted digestion, substrate optimization.*

VAL75

Rapid Composting of Solid Waste: An Eco-Friendly Solution for Affordable Organic Manure

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Abstract

Rapid composting technology has received considerable attention during recent years because of its scientific credibility and financial viability in organic waste treatment and soil fertility amendment. Rapid composting technology not only relieves the pressure on municipal landfill sites, but it is also an effective tool for farmers to obtain inexpensive and nutrient-rich organic manure for prosperous crop cultivation. In this light, this research work endeavored to transform different kinds of organic wastes such as flower waste, corn husk, plantain waste, tea powder waste, and vegetable waste into high-quality organic manure using an optimized aerobic rapid composting technique. To achieve various treatment combinations such as T1 through T9 with changing proportions of different kinds of organic waste and cow dung using bulking, all samples were placed in grow bags of 18 × 18 cm with periodic turning to facilitate sufficient aeration and microbial action. Compost samples were obtained at 15-day intervals up to a total of 75 days with analysis of samples to evaluate the maturity status of various samples, different physicochemical parameters were analyzed, including moisture content, pH, electrical conductivity, total organic carbon, nitrogen, phosphorus, potassium, and organic matter. The experimental results showed that T4, T5, T6, and T7 have an ideal composition level with substantially increased content of NPK and an ideal C/N ratio varying from 3.84:1 to 17.32:1, ensuring effective decomposition of organic matter. Based on this experimental work, rapid composting can become a cost-effective and efficient tool in preparing high-quality organic manure with parallel reduction in solid organic waste.

Keywords: *Organic fertilizers, Degradable, Flower waste, Plantain waste, Compost.*

VAL76

Aerobic Deterioration of waste biomass using bacterial consortia for biobutanol production: An overview

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Abstract

Utilizing bacterial consortia for the aerobic deterioration of waste biomass is an economical and environmentally friendly method of producing biobutanol. This study highlights the benefits of mixed microbial cultures over conventional single-strain systems, including their increased ability to withstand fermentation inhibitors and break down complicated lignocellulosic substrates. The metabolic pathways affecting butanol production, substrate pretreatment procedures, and consortia design are important factors. Through interactions between several bacterial species and synergistic enzyme release, aerobic consortia exhibit better substrate utilization efficiency. In the present review, novel methods of strain selection, culture optimization and process factors that improve fermentation kinetics and butanol production have been discussed. The efficiency of bioconversion increases substantially while hazardous byproducts are reduced when aerobic degradation is coupled with thermochemical and enzymatic pretreatment Additionally, this review explores the environmental benefits, economic feasibility, and process scalability of biobutanol as a biofuel alternative. Future aspects include metabolic engineering of consortium members, real-time process monitoring, and integration with biorefinery concepts for comprehensive waste valorization as a potential approach to the circular bioeconomy and energy sustainability.

Keywords: *Waste Valorization; Lignocellulosic biomass; Circular bioeconomy; Biofuel; Bioconversion.*

VAL77

Circular Valorization of Soybean Processing Residues into Functional Lipopeptide Biosurfactants for Sustainable Food Systems

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Abstract

The valorization of agro-industrial by-products into high-value, food-grade biomolecules constitutes a cornerstone of sustainable and circular food systems. Soybean processing industries generate large volumes of protein-rich residual streams that remain substantially underexploited despite their considerable nutritional and functional potential. In the present study, soybean hydrolysate obtained from industrial soybean by-products was systematically valorized as a renewable and sustainable nitrogen source for the microbial production of lipopeptide biosurfactants by Bacillus amyloliquefaciens, targeting food-related applications. Biosurfactant production was optimized using a one-factor-at-a-time experimental strategy to elucidate the effects of key process parameters, including incubation time, substrate concentration, pH, and inoculum size, on lipopeptide biosynthesis. Under optimized cultivation conditions, maximal biosurfactant production was achieved after 96 h of incubation, resulting in pronounced surface tension reduction and enhanced oil dispersion capacity, thereby demonstrating strong emulsifying efficiency suitable for food formulations. The lipopeptides produced exhibited significant antimicrobial activity against selected foodborne pathogens, underscoring their potential application as natural food preservatives. Furthermore, favorable critical micelle concentration, antioxidant activity, and solubilization characteristics highlight the multifunctional nature of these biosurfactants within complex food matrices. Collectively, this study establishes a robust valorization pathway for converting soybean-derived industrial by-products into functional lipopeptide biosurfactants, directly supporting Sustainable Development Goal 12 (Responsible Consumption and Production) through waste minimization and the development of sustainable food ingredients. The findings

reinforce the promise of B. amyloliquefaciens-derived lipopeptides as environmentally benign, bio-based alternatives to conventional synthetic emulsifiers and preservatives in the food industry.

Keywords: *Agro-industrial valorization, Lipopeptide biosurfactants, Soybean hydrolysate, Natural antimicrobial agents, Sustainable food systems*

VAL78

Bioconversion of Agro-Industrial Protein By-Products into High-Value Functional Food and Feed Ingredients

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Abstract

Agro-industrial oilseed meals, such as soybean and cottonseed meal, are abundant and protein-rich by-products with considerable potential for value addition. However, their utilization in food and feed systems has remained limited due to inconsistent functional properties and restricted application versatility. In this study, soybean and cottonseed meals were enzymatically valorised into functional protein hydrolysates using food-grade proteases as a sustainable and mild bioprocessing approach. Controlled enzymatic hydrolysis was employed to tailor the degree of hydrolysis, enhance protein solubility, and improve functional properties while minimising processing severity and nutritional losses. The resulting protein hydrolysates were comprehensively characterised in terms of degree of hydrolysis, amino acid composition, and functional properties, including emulsifying activity, foaming capacity, water and oil holding capacity, and solubility across a wide pH range. Process optimization was carried out to identify hydrolysis conditions that maximized functional performance and process efficiency while maintaining scalability and industrial relevance. The optimized hydrolysates demonstrated improved functional attributes and showed strong potential as high-value, sustainable protein ingredients for food and feed applications. Overall, this work supports circular bioeconomy strategies by enabling the resource-efficient valorisation of agro-industrial residues into application-ready protein products, contributing to the United Nations Sustainable Development Goals, particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production).

Keywords: *Valorisation, Hydrolysates, Byproducts, Circular Bioprocessing, Bioactive peptides.*

VAL79

Development and Performance Evaluation of Glycolipid-Based Biosurfactants for Industrial Detergent Formulations

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Abstract

Industrial detergents predominantly rely on chemically synthesized surfactants that are associated with environmental persistence, occupational health risks, and adverse ecological impacts. Prolonged exposure to these surfactants may cause skin irritation and respiratory issues among workers, while their release into aquatic environments contributes to bioaccumulation. In response to these concerns, the development of eco-friendly industrial detergent formulations using glycolipid biosurfactants as primary or co-surfactants. Glycolipid biosurfactants are produced using Pseudomonas fluorescens and Starmerella bombicola, which are known producers of rhamnolipid and sophorolipid biosurfactants, respectively. The effect of media composition on biosurfactant production is studied to understand the influence of nutrients on yield and functional properties. Multiple liquid detergent formulations are developed by incorporating biosurfactants with non-ionic and amphoteric surfactants, builders, enzymes, and functional additives. The formulated detergents are evaluated for key physicochemical and performance parameters. The results indicate that the formulations exhibit mildly alkaline pH values suitable for detergent applications and active matter content in the range of approximately 8–10%. A significant reduction in surface tension is observed with increasing concentration, suggesting effective surfactant activity and low apparent critical micelle concentration (CMC). The formulations also demonstrate good oil dispersion efficiency, with dispersion increasing proportionally with concentration. Foaming studies show controlled foam generation and high foam stability under agitation, indicating resistance to foam collapse under simulated washing conditions. Overall, the results demonstrate that glycolipid biosurfactant-based detergent formulations can achieve effective cleaning

performance while offering improved environmental compatibility. This work highlights the potential of biosurfactants as sustainable alternatives to conventional synthetic surfactants for household and industrial detergent applications.

Keywords: *Industrial detergent, glycolipid biosurfactant, rhamnolipid, sophorolipid, cleaning performance*

VAL80

Tailored microbiome-driven upcycling of plastic waste to value-added bioproducts: Sustainable bioprocessing towards a circular bioeconomy

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Abstract

Polyethylene terephthalate (PET), a widely used polymer in daily human activities, is predominantly recycled through mechanical processes. However, biological routes, particularly microbial and enzymatic approaches, have emerged as sustainable alternatives that enable PET depolymerization into its monomers, terephthalic acid (TPA) and ethylene glycol (EG), followed by their conversion into value-added products. Effective implementation of these biocatalytic pathways requires selective enrichment of microbial communities capable of PET degradation and monomer utilization. In this study, a mixed anaerobic bacterial inoculum was used as the parent community. Heat pretreatment (HT) was applied to suppress methanogenic populations and enrich acidogenic bacteria, while untreated inoculum (UT) served as a control. A total of twelve experimental conditions were evaluated using PET, TPA, and EG as substrates, both with and without glucose as a co-substrate, under HT and UT conditions. Reactor performance was monitored through periodic assessment of substrate degradation, pH variation, total volatile fatty acid (VFA) production, metabolite profiles, and gas generation. Structural integrity and functional groups of PET, TPA, and EG were characterized using Fourier Transform Infrared (FT-IR) spectroscopy. The presence of glucose as a co-substrate significantly influenced metabolic profiles. EG supplemented with glucose resulted in a diverse VFA profile dominated by acetic, butyric, and propionic acids, whereas TPA with glucose primarily yielded acetic acid. Biogas production was observed predominantly in systems supplemented with glucose alongside PET or its monomers. EG and TPA alone exhibited minimal gas production, indicating that further optimization of pH and operational conditions may enhance biogas yields. Results provide valuable insights into the development of anaerobic microbial consortia for PET depolymerization and valorization, emphasizing the importance of

inoculum pretreatment and co-substrate supplementation in optimizing anaerobic biotransformation processes.

Keywords: *Carboxylic acids, Biogas, Plastic upcycling, Co-metabolism, Bioeconomy.*

VAL81

Circular Bioeconomy Potential of Mushroom Biomass Valorization for Medicinal Bioactive Production: An Integrated Life Cycle and Techno-Economic Perspective

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Abstract

Mushrooms are increasingly recognized as sustainable bioresources capable of supporting circular bioeconomy and sustainable production–consumption systems. Their ability to convert low-value agro-residues into nutrient-rich biomass and bioactive compounds positions mushroom cultivation as a low-input, high-efficiency biological system. Beyond food applications, mushroom biomass represents a promising feedstock for the production of medicinal bioactives such as polysaccharides, phenolics, and other functional metabolites. However, the environmental and economic feasibility of valorizing mushroom biomass for medicinal applications has not been comprehensively evaluated using integrated sustainability assessment frameworks. This study presents an integrated life cycle assessment (LCA) and techno-economic analysis (TEA) of circular mushroom biomass valorization pathways for medicinal bioactive production. A cradle-to-gate system boundary was applied, encompassing mushroom biomass sourcing, drying, green extraction of medicinal bioactives, and valorization of residual biomass through circular reuse options. Environmental performance was assessed in terms of carbon footprint, energy demand, and water use, while economic feasibility was evaluated through cost structure analysis, unit production cost, and sensitivity assessment.The results highlight that circular integration significantly reduces environmental impacts by improving resource efficiency and minimizing waste generation compared to linear processing pathways. Techno-economic results indicate that extraction yield, energy consumption, and solvent recovery efficiency are key drivers influencing overall process viability. The integrated LCA–TEA framework enables identification of sustainability and cost hotspots, providing actionable insights for process optimization. Overall, this work demonstrates the

potential of mushroom biomass valorization as a viable circular bioeconomy strategy for sustainable medicinal bioactive production and offers a decision-support framework for researchers, industry stakeholders, and policymakers.

Keywords: *Mushroom biomass; Circular bioeconomy; Life cycle assessment; Techno-economic analysis; Medicinal bioactives; Sustainable production and consumption; Agro-waste valorization*

VAL82

PET glycolysis catalyzed by acid-base bifunctional metal oxyhydroxides

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Abstract

Polyethylene terephthalate (PET) is one of the largest produced plastics in the world. Extensive use in food packages, biomedical accessories, and textiles has kept the global demand for PET soaring for several decades now. Out of more than 70 million tons of PET produced every year, nearly 90% is not chemically recycled. Due to its high chemical stability, PET waste does not undergo degradation for a long time but causes hazardous pollution to aquatic and terrestrial ecosystems. There is a need to develop efficient, low-cost, eco-friendly methods to depolymerize PET waste into industrially useful bulk chemicals. In the present work, we have explored the ability of metal oxyhydroxides of the general formula M'O(OH) or MM'O(OH) (where M and M' are transition metals from 3d, 4d or 5d series) with abundant acid-base bifunctional surface hydroxyl groups to depolymerize PET to bis(2-hydroxyethyl) terephthalate (BHET) and ethylene glycol. We have synthesized various monometallic oxyhydroxides, zinc-containing bimetallic oxyhydroxides, and a trimetallic oxyhydroxide. We achieved a maximum PET conversion of 85% with the trimetallic oxyhydroxide.

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VAL83

Enhanced bioethanol production from sugarcane leaves through ionic liquid, Dimethylbutylammonium hydrogen sulfate pretreatment

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Abstract

Sugarcane is a major tropical and subtropical crop, generating a large amount of straw and bagasse as leftover residues, which can lead to waste management issues. Sugarcane leaves are rich in cellulose and hemicellulose, making them suitable source for bioethanol production. Destarched alcohol insoluble residue (AIR) of post-harvest cane leaves was prepared and used for the current study. The compositional analysis of untreated biomass showed 51.2% cellulose, 26.8% hemicellulose, and 18.9% lignin. HPLC quantification of ester-linked cell wall-bound hydroxycinnamates was carried out. p-coumaric acid (9.6 mg/g) was found to be the predominant one, followed by ferulic acid (5.2 mg/g). The effect of dimethylbutylammonium hydrogen sulfate [DMBA][HSO4] pretreatment on cane leaves was evaluated based on delignification. 80% [DMBA][HSO4], 10% biomass loading at 150 °C for 45 min, yielding 81.3% delignification and 80.6% hemicellulose dissolution was found as the optimum pretreatment condition. Structural changes in biomass after pretreatment were analysed using FT-IR and XRD, showing a significant reduction in hemicellulose, lignin, and cellulose crystallinity. Surface morphological characterization of pretreated biomass using FESEM showed extensive disruption on cell wall surface. Pretreated biomass showed enhanced saccharification (86.3%) compared to untreated (15.8%). Co-fermentation of enzymatic hydrolysate using Saccharomyces cerevisiae MTCC 36 and Pichia stipitis NCIM 3498 resulted in a maximum ethanol yield of 349.9 mg/g pretreated biomass (95.5% of theoretical conversion) at 18 h. These findings indicated that [DMBA][HSO4] is a cost-effective ionic liquid for the efficient pretreatment of post-harvest cane leaves. The pretreated biomass can be utilized as a promising bioethanol feedstock, aligning well with the circular economy approach.

Keywords: *sugarcane leaves, ionic liquid, pretreatment, saccharification, bioethanol*

VAL84

From Waste Streams to Bioplastics: Circular Bioeconomy-Based PHA Production

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Abstract

The rising environmental burden of petrochemical plastics necessitates sustainable alternatives aligned with circular economy practices. This study presents a waste-valorization strategy to produce polyhydroxyalkanoates (PHA) using an indigenous Bacillus licheniformis S-3 isolated from sewage water. Diverse agro-industrial residues—including molasses, bagasse, fruit peels, crop straw, husks, and oilseed by-products—were hydrolysed and employed as low-cost carbon sources, enabling efficient microbial growth and PHA accumulation. Extracted biopolymers were processed into biodegradable films, demonstrating the conversion of agricultural waste into high-value materials. Comprehensive thermal and structural analyses [Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and 1H/ C13 Nuclear Magnetic Resonance (NMR)] confirmed the formation of semi-crystalline PHB suitable for bioplastic applications. This work underscores the potential of integrating microbial bioprocessing with waste valorization to achieve resource efficiency, reduce plastic dependency, and advance circular bioeconomy strategies.

Keywords: *Agro-industrial waste, Bioplastics, Circular economy, PHA, Sustainable development*

VAL85

Grafting Effect of Polystyrene Blend with Epoxy Resin on the Properties of the Resulting Paint Formulation

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Abstract

Waste polystyrene (PS), particularly expanded polystyrene (EPS), poses significant environmental challenges due to poor degradability and limited recyclability. In this study, more than 50 formulation trials were conducted to evaluate the conversion of EPS into functional coating and binder systems through solvent dissolution, epoxy modification, and grafting. Initial dissolution trials using 1–10 g EPS in 5–30 mL of aromatic and polar solvents achieved complete dissolution; however, early coatings failed adhesion and drying tests. Epoxy-modified systems containing 20–80 g epoxy resin and 7–40 g hardener showed improved film formation but still failed cross-cut adhesion in several cases. Grafting modification using maleic anhydride (0.1–1.0 g) initiated by benzoyl peroxide (0.1–0.6 g) significantly enhanced interfacial compatibility. Optimized grafted PS formulations, combined with epoxy resin and additives such as nano-silica (0.1–0.3 g), successfully passed 3 mm cross-cut adhesion tests after curing at 60–110 °C. FTIR analysis confirmed grafting through the appearance of polar carbonyl bands (~1720 cm^{-1}) alongside characteristic PS peaks at 3025, 2920–2850, and 1600 cm^{-1}. XRD results indicated retention of the amorphous PS structure, while SEM revealed improved coating uniformity and adhesion. The results demonstrate that MAH–BPO grafting is a key strategy for transforming EPS waste into adhesion-stable, value-added coating materials suitable for sustainable recycling applications.

Keywords: *Expanded polystyrene waste; Polystyrene recycling; Maleic anhydride grafting; Epoxy-modified coatings; FTIR analysis; Cross-cut adhesion test; Circular economy*

VAL86

Starch-Based Biodegradable Film Reinforced with Natural Fibers for Sustainable Food Packaging

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Abstract

The growing concern about plastic pollution has sped up the search for biodegradable alternatives in food packaging. Starch, which is a naturally abundant and renewable biopolymer, has great film-forming ability. However, it has poor mechanical strength and is sensitive to moisture. This study looks at developing a starch-based biodegradable film reinforced with natural fibers to improve its properties. Natural fibres like banana fiber, jute fiber, and rice husk fiber are added to starch to increase tensile strength, flexibility, and barrier properties. We evaluate the films for mechanical performance, water absorption, and biodegradability. The results show that adding fiber significantly boosts the durability of starch films while keeping them biodegradable. The proposed material offers a sustainable and low-cost alternative to traditional plastic packaging, especially for short-life food items. Using agricultural waste fibres also helps reduce waste and promotes environmental sustainability. This study shows the potential of starch–fiber biocomposites as eco-friendly packaging materials and supports moving towards circular economy practices.

VAL87

Biochar-Phase Change Material (PCN) Hybrid for Passive Thermal Regulation and Environmental Sustainability

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Abstract

Climate change and rising energy demands have intensified the need for sustainable, low-energy thermal management solutions. Passive thermal regulation using environmentally friendly materials is gaining significant attention as an alternative to energy-intensive cooling and heating systems. This study explores the potential of a Biochar–Phase Change Material (PCM) hybrid system for passive thermal regulation applications. Biochar, a carbon-rich material derived from agricultural waste, possesses high porosity, thermal stability, and carbon sequestration ability. Phase Change Materials are capable of absorbing and releasing latent heat during phase transitions, thereby maintaining stable temperatures. By integrating biochar with PCMs, a hybrid material can be developed that enhances heat storage efficiency while reducing PCM leakage and improving mechanical stability. The proposed system focuses on material characterization, thermal performance evaluation, and environmental impact assessment. The hybrid material demonstrates improved thermal energy storage capacity, reduced temperature fluctuations, and enhanced sustainability compared to conventional materials. Additionally, the use of agricultural waste–derived biochar contributes to waste valorization and carbon footprint reduction. This work highlights the feasibility of biochar–PCM hybrids as a cost-effective, eco-friendly solution for passive thermal regulation in buildings, packaging, and agricultural storage systems. The study opens new avenues for sustainable material design without the use of biological agents or complex optimization techniques.

VAL88

Smart Waste Segregation System

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Abstract

The Smart Waste Segregation System using ESP8266 aims to automate waste classification and monitoring through the integration of sensors and IoT technology. The system classifies waste into metallic, organic, recyclable, and non-recyclable categories using sensors such as IR sensors for object detection, metal sensors for metallic waste identification, and moisture sensors for waste characterization. The ESP8266 microcontroller processes sensor data and controls relay- and motor-based mechanisms, including DC motors and servo motors, to direct waste into appropriate bins, while also transmitting real-time data to a cloud-based IoT platform such as ThingSpeak or Blynk for monitoring and alerts. An ultrasonic sensor is employed to monitor bin fill levels and provide notifications when bins are full, ensuring timely waste collection and maintenance. The system operates on a regulated 5 V power supply, ensuring energy efficiency and continuous operation. The prototype demonstrates over 90% segregation accuracy, offering advantages such as fully automated operation, cost-effectiveness, scalability, improved hygiene, and reduced manual contact. While the system is dependent on Wi-Fi connectivity and limited to specific waste categories, future enhancements include solar-powered operation, data analytics for municipal waste management, and integration with smart city infrastructure. Overall, the Smart Waste Segregation System provides an efficient, affordable, and scalable solution for automated waste handling, supporting sustainable waste management practices and contributing to Sustainable Development Goals 11 and 12.

VAL89

Assessment of Impact on Air Quality Index from Manufacturing Industries in Gujarat using GIS

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Abstract

In India, the major cause of air pollution is industrial emissions which contribute nearly 17%. of the total greenhouse gas emissions and Gujarat alone contributes 16 % of these emissions a good target considering its 38,445 registered factories and industrial belts. Within Gujarat, Ankleshwar is a large industrial hub, and the area is estimated to be 1,600 hectares and has more than 1,200 industrial plants. chemical, pharmaceutical, engineering industries. The level of air quality in these areas is Air Quality Index (AQI) register in the orange and red zones quite often, which means that the air quality is dangerous and requires further research into the involved causes and chemicals. Although many studies have conducted a general evaluation of the industrial effects on air quality, there is a gap in critical determination. quantification and spatial mapping of various gaseous emissions - hydrogen sulphide (H2S), and others. ammonia, amines, aldehydes, and ketones- in the production of the production process through high level of field. geographic information systems (GIS). This study fills this deficiency by. using factory level analysers and GIS mapping to directly measure and analyze major pollutants in. The industrial areas of Ankleshwar as well as the major field data collection on the hotspots of emissions, receptor-sensitive areas, and housing districts near large factories. The methodology assimilates spatial digitalization of the industrial wards of Ankleshwar, sampling. strategic sampling points depending on the direction of wind, and sophisticated volatile organic. real time gas analysis based on compound (VOC) detection technology. Sources of secondary data such as the Gujarat Pollution Control Board, IMD, complement on-ground measurements to give a supplement. interdisciplinary viewpoint. The anticipated results are that the statistically significant differences between AQI and can be identified. the difference in pollutant levels in industrial and residential areas with

emphasis on the role of site-specific emissions of manufacturing. The analysis value is shown by proving the existence of the two pollutants. Were dispersion patterns and the effectiveness of spatial mapping and quantitative gas detection of urban air. quality assessment. These will help in specific interventions on emission reduction. provide control over industrial air pollutions in Gujarat.

***Keywords**: Air Quality Index, GIS mapping, Ankleshwar, Industrial emissions, Manufacturing Pollutants, Hydrogen Sulphide, Ammonia, Spatial Analysis*

VAL90

Microbial Carbon Circularity: Engineering CO_2-Fixing Autotrophic Microbes for Sustainable Industrial Biomanufacturing

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Abstract

The escalating crisis of anthropogenic climate forcing necessitates a fundamental transition from linear industrial models to a circular bioeconomy. While conventional Carbon Capture and Storage (CCS) technologies are hindered by significant energetic penalties and high operational costs, microbial carbon sequestration offers a transformative, biocatalytic alternative. This research explores the frontier of "Microbial Carbon Circularity," a framework wherein industrial CO_2 is not merely sequestered but actively valorized into high-value metabolites through the metabolic prowess of autotrophic microorganisms. Central to this study is the comparative analysis of diverse carbon fixation architectures, including the reductive pentose phosphate (Calvin) cycle and the energetically efficient Wood-Ljungdahl pathway (WLP) found in acetogenic and cyanobacterial species. By leveraging the latest advancements in synthetic biology—specifically CRISPR-Cas-mediated precision genome editing and 'omics-driven metabolic flux analysis—this work delineates strategies to engineer "microbial cell factories." These engineered strains are designed to optimize carbon assimilation rates and redirect metabolic flux toward the biosynthesis of sustainable biofuels, biodegradable polymers (such as Polyhydroxyalkanoates), and specialty organic acids. Furthermore, the presentation evaluates the technical hurdles of gas-liquid mass transfer and the scalability of gas fermentation systems, drawing insights from current global industrial pioneers like LanzaTech and local initiatives by the Indian Oil Corporation. By integrating biological innovation with industrial biomanufacturing, this research underscores a viable pathway toward achieving net-zero emissions and establishing a resilient, carbon-neutral industrial ecosystem.

Keywords: *Microbial Carbon Circularity, Autotrophic Bioconversion, Metabolic Engineering, Synthetic Biology, Wood-Ljungdahl Pathway, Sustainable Biomanufacturing.*

VAL91

Valorization of Underexplored Northeast Indian Plant Resources into Sustainable Surfactant Systems for Cosmetic Applications

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Abstract

The growing emphasis on environmentally responsible and dermal-compatible products has intensified the search for sustainable alternatives to synthetic surfactants. This study explores the development and optimization of saponin-rich plant-derived surfactant systems from five underexplored plant species native to Northeast India: Albizia lucidior, Albizia chinensis, Acacia auriculiformis, Acacia pennata, and Gymnocladus assamicus, highlighting the valorization of renewable bioresources within a circular economy framework. Hydrothermal extracts were characterized using UV-Vis spectroscopy, FTIR analysis, and foam performance evaluation. Surface activity was assessed through Ross-Miles foam stability testing and critical micelle concentration (CMC) measurements, where several extracts demonstrated enhanced foaming behavior and stability comparable to or exceeding that of sodium lauryl sulfate (SLS). A Taguchi L8 orthogonal array design was employed to optimize multi-plant extract combinations, with contact angle minimization selected as the primary response to improve wetting performance. The optimized formulation consisting of ACB, AAP, AAL, and APB achieved a contact angle of 74.00, closely matching the predicted value of 72.80, with high statistical reliability (R^2 = 99.7%). Beyond its physicochemical performance, the optimized bio-surfactant system exhibited notable antibacterial activity against Staphylococcus aureus, confirming its relevance for cosmetic hygiene applications. The antioxidant potential, evaluated through the DPPH radical scavenging assay, indicated an effective free-radical scavenging capacity. Application studies on hair substrates further demonstrated superior wettability, yielding contact angles of 73.30 on virgin hair and 47.60 on bleached hair. Overall, this work demonstrates

the sustainable conversion of plant-based resources into multifunctional, biodegradable natural surfactant systems, supporting environmental sustainability, circular economy principles, and the development of green cosmetic and personal care formulations.

Keywords: *Saponins, Surfactants, Wetting Behavior, Cosmetic Applications, Northeast India, Circular Economy, Sustainable Development, Green Chemistry*

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VAL92

Green Hydrogen as a Cornerstone of Decarbonization: Processes and Prospects

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Abstract

Green hydrogen, produced via the electrolysis of water powered by renewable energy sources, is increasingly recognized as a pivotal technology for achieving deep decarbonization across multiple sectors. The production process is anchored in three main electrolyzer technologies, alkaline, proton exchange membrane (PEM), and solid oxide electrolyzers, each offering distinct trade-offs in efficiency, scalability, and cost. Current research trends emphasize coupling electrolysis with solar, wind, and hybrid renewable systems to ensure stable, carbon-neutral hydrogen generation. Advances in materials science, such as improved catalysts and membranes, are driving efficiency gains, while digital optimization and smart grid integration enhance operational flexibility. At the same time, large-scale demonstration projects and policy-driven investments are accelerating cost reductions, with gigawatt-scale electrolyzer deployments projected to achieve parity with fossil-based hydrogen within the next decade. Despite this momentum, challenges remain high capital expenditure, water resource constraints in arid regions, and the complexities of hydrogen storage, transport, and distribution. Nevertheless, green hydrogen is increasingly positioned as a viable solution for decarbonizing hard-to-abate industries such as steel,cement, and chemicals, as well as enabling clean fuels for aviation, shipping, and long-haul transport. Future pathways point toward international hydrogen trade networks, integration with carbon capture technologies, and the development of hydrogen hubs that link production, storage, and end-use applications. These abstract underscores the transformative potential of green hydrogen production while highlighting the need for continued innovation, supportive policy frameworks, and global collaboration to realize its role in a sustainable energy future.

Keywords: *Green hydrogen; Electrolysis; Alkaline electrolyzer; Proton exchange membrane (PEM) electrolyzer; Solid oxide electrolyzer (SOEC); Renewable energy integration*

VAL93

Electrode-Assisted Biomethanation of Food Waste under High Organic Loading

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Abstract

Food waste biomethanation is a well-established biological process for converting organic waste into methane-rich biogas. However, operation at high organic loads (COD ≈ 260 g/L) often results in rapid acidification, accumulation of volatile fatty acids (VFAs), pH decline, and subsequent inhibition of methanogenic activity. To address these limitations, electrode-assisted biomethanation offers a promising approach by stimulating electron transfer processes that enhance VFA utilization, support methanogenic pathways, and improve system buffering against pH failure. This study systematically evaluates the performance of electrode-assisted biomethanation of high-organic load food waste under multiple operational configurations, including direct substrate digestion, substrate dilution, pH adjustment, and a combined dilution-pH control strategy. Reactors were operated using graphite and copper-coated graphite as anode and cathode, respectively, under an applied potential of 0.7 V, and performance was assessed in terms of COD removal, VS reduction, pH stability, and biogas production. The results demonstrate that the electrode-assisted system treating the direct substrate with electrodes achieved the highest biogas yield of 0.33 m^3 CH_4/kg VS and a VS reduction of 50%, indicating effective mitigation of acidification without the need for extensive dilution or chemical buffering. In contrast, diluted and pH-adjusted systems showed comparatively lower methane yields due to reduced substrate availability or altered microbial kinetics. Overall, this study confirms that electrode-assisted biomethanation is a viable and robust strategy for stabilizing high-organic-load food waste digestion, enhancing energy recovery, and advancing sustainable waste-to-energy solutions within a circular economy framework.

Keywords: *Electrode Assisted Biomethanation; Electron Transfer; Food Waste; High Organic Load; Waste-to-Energy*

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VAL94

Hydrothermal and Partial Wet Oxidation Pretreatment of Food Organics and Garden Organics for Enhanced Biogas Production

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Abstract

Food Organics and Garden Organics (FOGO) constitute the organic fraction collected through green bin systems recently implemented across Australia. These bins are primarily intended for household organic waste and are collected weekly. However, due to the rapid biodegradation of food waste, the collected material is often dominated by garden waste and other lignocellulosic fractions by the time of collection. Composting is currently the predominant treatment option for FOGO; nevertheless, it faces challenges such as large land requirements, odour issues, and greenhouse gas emissions. Thermal and pressure-based pretreatment methods for lignocellulosic biomass have been widely investigated, yet their specific impacts on heterogeneous FOGO waste streams remain insufficiently explored. This study aims to identify optimal pretreatment conditions for hydrothermal and partial wet oxidation processes to enhance biogas production from FOGO. Pretreatment experiments were conducted over a temperature range of 150-220 °C, with residence times of 10-60 minutes, and at varying oxygen levels. The effects of pretreatment were evaluated using key physicochemical and biochemical parameters, including pH, total solids, volatile solids, volatile fatty acids, total glucose, total amino acids, lipid and protein content. The results demonstrated that hydrothermal pretreatment in the absence of oxygen yielded the highest methane production, indicating that oxidative conditions may adversely affect methanogenic potential. Further investigations are required to assess process scalability, energy balance, and the feasibility of large-scale implementation.

Keywords: *Lignin, Pretreatment, Food Organics and Garden Organics, High Pressure, High Temperature.*

VAL95

Development and Characterization of Anaerobic Microbial Inoculum for Anaerobic digestion of Synthetic Night Soil and Microbial Community Dynamics Revealed by Metagenomics

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Abstract

Anaerobic digestion (AD) is a microbially mediated process, wherein methanogenic efficiency is dictated by the structure and function of syntrophic microbial consortia. This study presents development of anaerobic microbial inocula (AMI) from cattle dung (CD) for anaerobic degradation of synthetic night soil (SNS) and a strategy to enhance specific methanogenic activity (SMA) of AMI employing sodium acetate (SA) and sodium formate (SF). Physicochemical characterization revealed progressive reductions, indicating accelerated microbial conversion of both dissolved and particulate organics. Specific methanogenic activity (SMA) assays demonstrated that all AMIs achieved values within the optimal range for methanogenic enrichment; with AMI CD+SA+SF BF significantly outperformed control and single-substrate AMIs, achieving peak methane production (970.7 ± 27.6 NmL) and SMA (0.1242 g CH_4-COD/g VSS/d). To validate biodegradation efficiency, AMI CD+SA+SF BF was compared with the AMI CD BF (control) in a semi-continuous four-chamber biodigester treating SNS. The test digester achieved consistently higher COD removal (>90%) and was approximately 5–7% higher than in control digester throughout the digestion period. Shotgun metagenomic sequencing revealed a distinct shift in microbial community structure from fecal-associated taxa in raw CD to specialized methanogens, syntrophic fermenters, and fermentative yeasts in AMI and AD sludge. SA and /or SF inclusion promoted the coexistence of acetoclastic (Methanothrix soehngenii) and hydrogenotrophic (Methanospirillum hungatei, Methanoregula formicica) archaea, alongside syntrophic fermenters (Syntrophomonas wolfei). Diversity indices, cordination analyses (PCoA, NMDS), and co-occurrence networks highlighted enhanced ecological complexity and metabolic cooperation.

Functional annotation via COG analyses provided analysis of metabolic pathways, cellular processes and signalling pathways. These findings substantiate that all strategies yielded functional AMIs. Substrate-specific enrichment not only augments inoculum efficacy but also steers microbial community succession toward functionally specialized, methane-producing consortia. The developed AMI offers a scalable, biosafe, and field-deployable solution for improving AD of fecal wastes in decentralized sanitation systems.

Keywords: *Anaerobic digestion, Anaerobic microbial inoculum, Specific methanogenic activity, Microbial community dynamics*

VAL96

Synthesis of Ch-TiO_2-Fe_3O_4 nanoparticles and conjugated with phycocyanin extracted from Arthrospira platensis for *Lactobacillus spp.* separation

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Abstract

Many industries face challenges in maintaining microbial cultures during repeated batch fermentation. Therefore, an effective strategy is required to retain cells. In this study, we focused on developing a novel protein-conjugated magnetic nanoparticle system to enhance the retainment of Lactobacillus spp. Chitosan-coated, phycocyanin-encapsulated TiO_2-doped Fe_3O_4 nanoparticles (Pc-Ch-TiO_2-Fe_3O_4 NPs) were synthesized for promoting cell adhesion. Magnetic iron oxide nanoparticles were prepared using a co-precipitation method, phycocyanin was extracted & purified from spirulina and characterized by FE-SEM, EDX, XRD, FTIR, XPS, and VSM analyses. The particle size was determined to be 44 - 45 nm using the Debye–Scherrer equation. VSM analysis indicated a magnetic saturation of 80 emu/mg. When 0.4 g/L of nanoparticles were applied with an external magnetic field, a cell separation efficiency of 71% was achieved, which was further validated through fluorescence microscopy FE-SEM. The retained cells along with the nanoparticles were subsequently used as inoculum to sustain biomass, cell dry weight, substrate utilization, lactic acid production, and pH across repeated batch fermentations. The experimental data were fitted to the Contois kinetic model for performance evaluation.

Keywords: *Fe3O4 nanoparticles, Phycocyanin extraction, protein crosslink, Cell separation, Contois model.*

VAL97

Enhanced Biomass Hydrolysis Using Recombinant Cellulase Produced by Penicillium funiculosum

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Abstract

This study explores the production of recombinant cellulase enzymes using an engineered strain of Penicillium funiculosum, focusing on optimizing biomass hydrolysis for second-generation biofuel applications. The research employs media optimization to enhance cellulase and β-glucosidase enzyme production, leveraging modifications that exclude trace elements to mitigate inhibitory effects. Comparative fermentation analyses in a 20L bioreactor assessed the cellulose utilization dynamics and the enzymatic yield under varied conditions. The findings indicated significant improvements in enzyme activity, with the highest productivity observed in modified media formulations. The purification of β-glucosidase using a Ni-NTA system yielded high-purity enzymes with increased specific activity, suitable for synergistic applications with cellulase. Biomass hydrolysis trials using a cocktail of these enzymes demonstrated superior lignocellulose degradation efficiency and higher glucose release than commercial enzyme formulations. The optimized enzymatic cocktail exhibited resilience to inhibitory byproducts, enhancing the hydrolysis of pre-treated rice straw. This research contributes to cost-effective, scalable strategies for lignocellulosic biomass conversion by integrating process optimization with high-efficiency enzyme systems. These advancements support the development of sustainable biofuel production technologies, aligning with global energy security and environmental sustainability goals.

Keywords: *Cellulase, Biomass hydrolysis, β-glucosidase, Second-generation biofuels*

VAL98

Biopolymer-Based Hydrogels for sustainable removal of water pollutants

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Abstract

Water pollution is a vital environmental issue owing to the fast growth of chemical industries and the discharge of industrial pollutants into the water system. Textiles, paper mills, and biomedical industries use different dyes, such as crystal violet, methylene blue, methyl orange, congo red, etc., with complex organic structures, which are difficult to degrade and cause substantial mutagenic and carcinogenic injury to human life. Hence, elimination of these dyes from water bodies is necessary in order to protect our natural water resources. Adsorption is known to be a versatile technique of removing such waste materials from water bodies. Natural biopolymers and biopolymer-based hydrogels, produced by renewable resources, are considered greener, sustainable, and eco-friendly materials and have garnered much scientific attention recently, owing to their outstanding structural features, abundant availability, nontoxicity, ease of modification, biocompatibility, and promising potentials. In the present study, the removal efficiency of two commonly known dyes, Methylene Blue (MB) and Congo Red (CR), is studied using biopolymer-based hydrogels as an efficient adsorbent under different experimental conditions, such as contact time, adsorbent dosage, and initial concentration of the adsorbate. Two plant-based biopolymers, viz., starch and pectin, were used for synthesizing hydrogel material, which was further modified with beetroot and Clitoria ternatea flower extract, and were compared for their adsorption efficiency. Comprehensive characterization studies were undertaken to evaluate the structural, chemical, and physical properties of the synthesized hydrogels. Swelling studies and antioxidant activity were carried out to further understand the properties in detail.

Keywords: Biopolymer; Hydrogels; Adsorption; Methylene Blue; Congo red

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Machine Learning–Assisted GIS Analysis of Groundwater Contamination for Irrigation Suitability in Katpadi Block

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Abstract

The Katpadi block basin has been severely affected by groundwater quality pollution due to industrial effluents, agricultural drainage water, and rapid urbanisation. This research evaluates the quality of the groundwater from 148 samples through the use of physicochemical tests, GIS mapping, and WQI. Correlation and cluster analysis found TDS, nitrate and turbidity as the key parameters causing pollution. The study also assesses the suitability of the groundwater for irrigation through other parameters developed as SAR (Sodium Adsorption Ratio), Na% (Sodium Percentage), and AI (Aggressive Index). The results also demonstrate that a fairly large proportion of the samples are labelled unsuitable or doubtful for use in agriculture. The high sodium and salinity indices suggest a strong potential for soil structural damage and reduced fertility, which may compromise agricultural sustainability in the long term. ANFIS was used for advanced modeling of WQI, with training and testing correlation coefficients of 92.72% and 89.46%, respectively. The study emphasises the importance of preventing pollution, safe water supply, and the proper usage as well as management of groundwater, essential in eliminating various diseases borne by unsafe water and functioning as a basis for the advancement of SDG 6, which talks of clean water. This research aligns GIS with computational intelligence techniques that offer rich information to policymakers and other stakeholders for the safe and efficient use of groundwater in the Katpadi block and other regions.

Keywords: *Adaptive Neuro-Fuzzy Inference System, Circular Soil Management, Groundwater Quality, Water Quality Index, Irrigation Indices, Sustainable Development Goals*

VAL100

Membrane Filtration for Micro-plastic Removal: A Comprehensive Review of Wastewater Treatment Technologies, Performance, and Mechanisms

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Abstract

Micro-plastic (MP) pollution is a growing global concern, with wastewater treatment plants (WWTPs) being a significant point of discharge into aquatic environments. Although conventional primary and secondary treatment processes can remove a significant fraction of MPs, fine particles smaller than 20 µm often remain in treated effluents. The membrane filtration as an effective tertiary treatment technology for MP removal, with a particular focus on the emerging use of ceramic membranes. Ceramic membranes offer advantages such as high chemical and mechanical stability, longer lifespans, and reduced fouling propensity compared to polymeric membranes. Laboratory studies demonstrate that ceramic micro-filtration and ultra-filtration can achieve MP removal efficiencies exceeding 72–99%, contributing to overall removal rates of over 96% when combined with conventional processes. This review critically examines the performance of membrane-based technologies for MP removal in WWTPs, with a particular emphasis on ceramic membranes, and discusses key challenges such as fouling behavior, cleaning strategies, and scalability. The current progress and future research directions are highlighted to support the development of efficient and sustainable membrane-based solutions for microplastic mitigation.

Keywords*: Microplastics; Wastewater treatment; Membrane filtration; Ceramic membranes*

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VAL101

Valorization of Agricultural Wastes for Cost-Effective Removal of Acid Azo Dyes from Wastewater

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Abstract

The extensive use of synthetic azo dyes in textile industries presents a major challenge to the environment due to their stability, toxicity, and resistance to conventional treatment systems. This study explores the potential of 15 economically viable agro-waste substrates as natural biosorbents for the decolorization of textile dyes. Locally available residues—sugarcane bagasse, molasses, corn husk, rice husk, wheat straw, wheat bran, groundnut oil cake, mustard oil cake, carrot peel, beetroot peel, garlic peel, banana peel, orange peel, potato starch, potato peel were pre-processed and screened against selected acid azo dyes (metal complex dyes), including Acid Yellow-137, Acid Red-182, Acid Blue-193, and Acid Brown-452. Each agro-waste was evaluated for its dye removal efficiency under controlled laboratory conditions. The results show variable decolorization performance among the waste types. The attributes include differences in surface area, porosity, lignocellulosic content, and functional chemistry. Lignocellulosic materials such as sugarcane bagasse, rice husk, and wheat straw showed the highest % decolorization, frequently outperforming peel-based wastes. While the soft-textured vegetable and fruit peels were found to be moderately effective with limited binding sites. Overall, several agro residues achieved significant (>45%) dye removal during initial screening, highlighting their potential implication as a low-cost alternative for wastewater treatment. With a promising application, this study paves the way for further optimization, activation, reduced particle size, and multiple waste blending methods as a suggestive option.

Keywords: *Decolorization, Lignocellulosic materials, Agro-waste, Wastewater, Valorization*

VAL102

An Investigation of Antimicrobial Activity of Biomolecule Assisted Metal Oxide Nanoparticles

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Abstract

The biosynthetically prepared metal oxide nanoparticles, which function effectively as antimicrobial agents, are used to lessen the harmful effects that are posed by microorganisms that have become antibiotic-resistant and kept spreading ever more on a vast scale of environments. The increasing adversity in the biomedical field necessitates the development of materials that fulfill biomedical requirements, and biosynthesized nanoparticles have received significant attention, as they offer substantial benefits by being biocompatible—the critical parameter in need. This review explores on assorted metal oxide nanoparticles synthesis methods assisted with biomolecules, including doped metal oxides and their nanocomposites, and also investigates their physicochemical properties, factors affecting antimicrobial efficacy, and potential to replace conventional antibiotics. The main objective is to provide a comprehensive overview of biomolecule-assisted metal oxide nanoparticles as effective and sustainable antimicrobial agents.

Keywords: *Metal oxide nanoparticles; antibiotic resistance; biological synthesis; antimicrobial activity; biomolecules*

VAL103

Scale-Up Performance of Microbial Electrolysis Cells (MECs) for Sustainable Biohydrogen Production and Wastewater Valorization

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Abstract

Microbial electrolysis cells (MECs) offer a sustainable pathway for coupling wastewater treatment with renewable hydrogen production under mild operating conditions. In this study, the scale-up performance of MECs was experimentally evaluated using a representative organic-rich wastewater source characterized by near-neutral pH (7.2–7.6), elevated chemical oxygen demand (COD: 470–625 mg/L), high suspended solids (410–610 mg/L), low dissolved oxygen (2.3–3.2 mg/L), and ambient temperature conditions (28–30 °C). Dual-chamber MECs were operated at lab scale (100 mL) and pilot scale (1 L) using carbon-based electrodes and an externally applied voltage of 0.8 V. In the 100 mL MEC, hydrogen production monitored using an MQ-8 gas sensor reached peak concentrations of approximately 1,530 ppm, accompanied by a COD removal efficiency of ~68% over the operational cycle. Upon scale-up to the 1 L MEC, hydrogen accumulation increased significantly, reaching peak concentrations of approximately 3,245 ppm, while COD removal improved to ~82%, indicating enhanced electron recovery and bioelectrochemical conversion efficiency. The pilot-scale reactor also exhibited greater operational stability and sustained hydrogen signals compared to the lab-scale system. These results demonstrate that scaling MECs positively influences both biohydrogen production and wastewater treatment efficiency. The findings highlight the potential of MEC technology as a scalable and energy-efficient platform for wastewater valorization and sustainable hydrogen recovery, supporting circular economy and low-carbon energy transition goals.

Keywords: *Microbial electrolysis cells (MECs); Biohydrogen production; Electroactive bacteria; Wastewater treatment; Anode biofilm; Reactor scale-up; Bioelectrochemical sys*

VAL104

Advance biocatalyst for the green conversion of 5-hydroxymethyl furfural to a biopolymer precursor 2,5-furandicarboxylic acid

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2,5-furandicarboxylic acid (FDCA) is a bio-derived compound which serves as a building block of Polyethylene furandicarboxylate (PEF) for the synthesis of bioplastics. 5-hydroxymethylfurfural oxidase (HMFO) are the promising biocatalysts for the oxidation of 5-hydroxymethylfurfural (HMF) to FDCA through three oxidation steps. The substrate could be fructose and other C6 sugars present in lignocellulosic biomass, providing an eco-friendly and sustainable route for the production of FDCA, an essential monomer for biopolymer development. The newly identified HMFO enzyme was heterologous expressed in E. coli and the recombinant protein was purified and characterized. The catalytic function of new@HMFO was authenticated for oxidation of HMF to FDCA. new@HMFO oxidized HMF resulting in a 99% yield of FDCA within 24 h. The secondary structure composition of new@HMFO was analysed. The optimal enzymatic activity of the recombinant protein was observed at pH 8.0 and temperature 30°C. The kinetic parameters of new@HMFO for the substrate HMF, FFCA, DFF and vanillyl alcohol were also determined. The Km values for HMF, FFCA, DFF and vanillyl alcohol were 2.252 mM, 5.551 mM, 2.503 mM and 1.589 Mm respectively.

Keywords: *Biopolymers, 2,5-furandicarboxylic acid (FDCA), Polyethylene furandicarboxylate (PEF).*

VAL105

Valorisation of Finger Millet Husk an Agro-Residue for Sustainable Aquafeed Development in Clarias gariepinus

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Abstract

The feed formulation with plant-based ingredients influences the body composition and optimal fish growth. Finger millet hush (ragi husk), an underutilised agro byproduct, represents a promising plant-based protein source for sustainable aquafeed formulations, either as a partial replacement or in combination with conventional fishmeal protein. A 45-day feeding trial was conducted using juvenile fish with an initial mean body weight of 4.02 ± 0.98 g (three replicates). Fish fed the Finger millet husk-based diet exhibited the highest specific growth rate (SGR) of 2.76 ± 0.04% and achieved a significant weight gain of 10.73 ± 0.8 g compared to the control diet. Additionally, the formulated diet demonstrated an improved feed conversion ratio (FCR) of 1.05, indicating superior feed efficiency. Based on growth performance, nutrient assimilation efficiency, and overall fish health indicators, the results suggest that dietary inclusion of finger millet husk at an optimal level of 25% significantly enhances both growth efficiency and health status, highlighting its potential as a cost-effective and sustainable functional ingredient in aquaculture feed formulations.

Keywords: *Finger millet husk, fish feed, fish growth performance, sustainable aquaculture, Protein*

VAL106

Synergistic biological pretreatment of substrate and lignocellulolytic enzyme production by fungal consortium for valorization of wheat straw to levulinic acid

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Abstract

Inspired by natural coexistence of fungi as primary wood degraders, the current study ventures to harness the enzyme production capabilities of fungi, to valorize the recalcitrant agricultural residues. In the present study, cultivation of compatible fungal consortium of ascomycete (*Trichoderma lentiforme* HR 27) and basidiomycete (*Ganoderma casuarinicola* HR 31) fungi was carried out under SSF. Further, to achieve the higher enzyme production single-factorial optimization was carried out which resulted in 5.99, 5.18, 1.13, 2.57, 4.97, and 2.68-fold increase in endoglucanase, exoglucanase, β-glucosidase, mannanase, xylanase, and laccase production, respectively, using wheat straw as substrate, on fourth day of fermentation. Optimized Asther's medium includes, 1.5g/L Tween 80 as surfactant and 0.5mM $CuSO_4$ as inducer in with initial pH of 3.5. Subsequently, statistical optimization was performed of all medium components , whose results also revealed Tween 80 (2.5g/L), $CuSO_4$ (0.5mM) and initial medium pH of 3.5 as significant parameters for enhanced lignocellulolytic enzyme production. Compared to unoptimized media, statistically optimized media resulted in 18.05, 8.50, 2.44, 6.71, 6.87, and 3.58-fold increase in endoglucanase, exoglucanase, β-glucosidase, mannanase, xylanase, and laccase production, respectively. Comparative study of compositional analysis of substrate obtained after extracting crude enzyme under optimized and unoptimized conditions was also performed. It was observed that 31.7% of delignification with exposure of 43.25% cellulose and 24.85% hemicellulose occurred in substrate obtained after single-factorial optimization studies. However, wheat straw obtained after statistical optimization studies showed further increase in delignification (37.95%) and consequent exposure of cellulose (44.20%) and hemicellulose (25.8%) content. In subsequent step, the biologically

pretreated wheat straw was subjected to enzymatic hydrolysis by crude lignocellulolytic enzyme cocktail, resulting in formation of sugar rich hydrolysate. Further, upon acid-catalyzed conversion of hydrolysate levulinic acid production was obtained. Thus, this research exemplifies robust strategy for achieving circular economy and zero-waste approach towards sustainable development by converting agricultural residues into industrially benefited compounds.

Keywords: - *Fungal consortium, optimization, enzyme cocktail, waste valorization, levulinic acid*

VAL107

Production of Bioethanol using agricultural wastes

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Abstract

The wastes segregated from agricultural lands can be put to good use by using it as a substrate for biofuel production like ethanol etc. Bioethanol from agricultural waste can be produced by the procedures like pretreatment, enzymatic hydrolysis, fermentation, and recovery steps with major feedstocks including straw, sugarcane bagasse, and corn cobs as they are a rich source of nutrients for the growing microbes. Recalcitrant lignin, enzyme and logistics costs, inhibitor formation are all various limitations which limits scale-up. Advances in pretreatment chemistry, low-cost enzyme production, enzymatic and chemical methods combination and biorefinery integration show promise in future aspects. We aim to investigate the most yield producing process and understand the effects of various methods like combining weak acid hydrolysis with enzymatic saccharification impact the final yield of the bioethanol and theuse of genetically enhanced micro-organisms rather than conventional microbes which are prone to damage by external factors caused by treatment changes.

VAL108

Valorisation of Secondary Resource Materials from E-waste

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The rapid advancement of electronic technologies and the reduction in product life cycles have led to a substantial increase in electronic waste generation worldwide, with printed circuit boards (PCBs) representing one of the most resource-intensive fractions. PCBs are generated from a wide range of discarded electronic devices, including mobile phones, computers, and consumer electronics, and contain significant quantities of critical and valuable metals embedded within complex multilayer structures. Despite their relatively small contribution by weight to total electronic waste, PCBs possess metal concentrations that often exceed those of primary mineral ores, highlighting their importance as a secondary resource. This work reviews the sources and generation of PCB waste and emphasises its potential for sustainable metal recovery within a circular economy framework. The structural characteristics and heterogeneous composition of PCBs that influence recycling strategies are discussed. Particular attention is given to hydrometallurgical processing as an effective and adaptable approach for metal extraction from PCB waste. Hydrometallurgical methods offer advantages such as improved selectivity, lower energy consumption, and reduced environmental impact compared to conventional high-temperature routes. This study highlights recent developments and challenges associated with hydrometallurgical recovery of critical and valuable metals from PCB waste, including pretreatment requirements, leaching behaviour, and downstream separation processes. Overall, the study underscores the role of PCB waste valorisation in resource conservation and sustainable e-waste management.

Keywords: *Printed circuit boards, electronic waste, hydrometallurgy, resource recovery, circular economy*

VAL109

Pectin Extraction from Cashew Apple Bagasse: Extraction Methods and Valorization

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Abstract

Pectin is widely used in the food and pharmaceutical sectors, and its recovery from agricultural waste using efficient, eco-friendly, cost-effective methods contributes towards circular bioeconomy. Cashew apple bagasse (CAB) is an abundant by-product of the cashew processing industry and is often underexploited for its various applications. In the present study, a comparative evaluation of pectin extraction from cashew apple bagasse using conventional acid and deep eutectic solvents (DESs) was carried out. In conventional methods, both mineral and organic acids were attempted. Various DES systems were prepared for pectin extraction by combining different hydrogen bond donors and acceptors. Among the synthesized DESs, ChCl-urea (molar ratio 1:2) extraction at 800C for 2h was found to yield the highest pectin (6%). The structural characteristics of the extracted pectin analyzed by FTIR confirmed the characteristic functional groups of pectin. ChCl-urea extracted pectin showed a smooth surface, compared to acid extracted pectin in FESEM analysis. ChCl-urea extracted pectin was examined for bioplastic production in this study. The utilization of CAB as a feedstock for value-added biopolymers can contribute to waste minimisation, resource efficiency, and sustainable material production. CAB was also found to contain 23.85% cellulose and 18.5% hemicellulose, indicating its potential as a suitable feedstock for bioethanol production. In brief, the adoption of green solvent systems such as DESs offers an environmentally benign extraction process for pectin and its transition to high-value products.

Keywords: *Agriresidues, Cashew apple bagasse, Pectin, Deep eutectic solvents, Waste management*

VAL110

Metal-Free Electrocatalyst for Improved Oxygen Electrocatalysis Towards Solid-State Flexible Zinc-Air Batteries

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Abstract

Rechargeable Zn-air batteries (ZABs) offer high energy density and environment-friendliness but require durable, nonprecious bifunctional catalysts for oxygen reduction reaction (ORR) and oxygen evolution reaction (OER) to enhance oxygen electrocatalysis, improving reaction kinetics and performance in practical applications. Herein, a unique metal-free throne-like hierarchical ternary electrocatalyst containing graphitic carbon nitrides-polypyrrole on carbon nanorod (g-C3N4-PPy@CNR) is synthesized by depositing g-C3N4-PPy on the surface of a metal-organic framework-derived carbon nanorod. g-C3N4-PPy@CNR catalyst exhibits outstanding ORR and OER in alkaline media with a low potential gap of 0.63 V, more efficient than commercial catalysts like the mixture of Platinum on Carbon (Pt-C) and ruthenium dioxide (RuO2). Moreover, the g-C3N4-PPy@CNR catalyst is utilized to assemble the ZABs with solution and solid-state electrolytes. The ZAB comprised of g-C3N4-PPy@CNR cathode reveals a high energy density of 620 Wh/kg, a specific capacity of 541.2 mAh/g with an open circuit potential of 1.39 V. Assembled solid-state ZAB outperforms the commercial Pt-C and RuO2-based ZAB with impressive energy density, capacity, and high charge-discharge stability and is used efficiently as the energy sources for green hydrogen generation through overall water splitting, light emitting diode (LED) panel and wearable electronics.

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VAL111

Investigation of pyrolysis behavior and kinetics of de-oiled cashew nutshell using kinetic models

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Abstract

The valorization of agro-industrial residues into value added products (like bio-oil, biochar, etc.) using thermochemical process is gaining a significant attention in the last few decades. De-oiled cashew nutshell, an abundant agro-industrial waste generated after oil extraction, is largely underutilized and commonly treated as a disposal burden. This feedstock can be a promising feedstock option for pyrolysis due to its high carbon content and availability. In this work, pyrolysis behavior and kinetic parameters of De-oiled cashew nut shell were analysed using thermogravimetric analysis. Further, the study was performed under various heating rates and temperature. The ultimate analysis of De-oiled cashew nut shell was carried out for chemical composition (e.g., moisture content, fixed carbon, volatile matter and ash content), whereas proximate study was conducted to analyse the elemental compositions (carbon, hydrogen, nitrogen, sulphur and oxygen). Model-free isoconversional kinetic methods, including Kissinger–Akahira–Sunose (KAS) and Flynn–Wall–Ozawa (FWO) approaches, were employed to estimate the apparent activation energy as a function of conversion. The obtained kinetic parameters offer valuable insights for optimizing pyrolysis conditions and promoting sustainable value added product recovery from agro-industrial residues.

Keywords: *Pyrolysis, De-oiled cashew nutshell, Bio oil, Sustainability, Kinetic study*

VAL112

Machine Learning Enabled Forecasting of Energy Allocation in Fuel Cell Integrated Grid Connected Local Energy System

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Abstract

With the increasing integration of fuel cell systems in modern distribution networks, accurate prediction of shared power between PEMFCs and the utility grid has become essential for ensuring stable operation, efficient energy utilization, and reduced grid dependency. This work presents a machine learning-based predictive framework for accurately estimating the shared power between a proton exchange membrane fuel cell (PEMFC) system and the AC distribution grid operating under dynamically varying load conditions. A diverse set of supervised learning algorithms, including XGBoost, Random Forest, Extra Trees, Gradient Boosting, AdaBoost, K-Nearest Neighbours (KNN), Support Vector Machines (SVM), and Linear Regression, is systematically analyzed under fluctuating load profiles to identify robust predictors for PEMFC-grid power-sharing behavior. The models are trained and validated using experimentally obtained real-time data from a 1 kW PEMFC and AC distribution grid-connected system, and their predictive performance is evaluated using standard regression metrics such as the coefficient of determination (R^2), mean absolute error (MAE), and root mean square error (RMSE). The comparative analysis reveals that the AdaBoost algorithm most effectively captures the nonlinear characteristics and transient variations of shared power dynamics, resulting in superior prediction accuracy across a wide range of operating conditions. Integration of the optimized predictive model within the energy management system enables adaptive and intelligent power-sharing decisions, improves coordination between the PEMFC and the utility grid, reduces dependence on grid power, and enhances overall operational efficiency and system reliability under continuously varying load conditions.

Keywords: *Proton exchange membrane fuel cell (PEMFC), Machine learning (ML), Energy management, power-sharing, AC (alternating current) distribution grid.*

VAL113

Wind Analysis for Rooftop Solar PV at NICMAR University, Pune

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Abstract

The increasing adoption of solar PV systems in urban environments demands the assessment of site-specific climatic factors that influence system performance and structural safety, which are significantly influenced by local wind conditions. This study investigates the influence of wind patterns on the feasibility of different tilt angles for a rooftop solar PV system at NICMAR University, Pune to evaluate the wind characteristics and their impact on solar PV systems. Hourly wind speed and wind direction data for the year 2025 were obtained from the NASA POWER database and analysed using Python-based wind rose visualization to identify dominant wind directions and prevailing wind speed ranges. The wind characteristics were integrated with tilt-dependent PV energy simulations for three rooftop configurations (4°, 10°, and 18°). A feasibility framework was incorporated and normalized energy output, wind obstruction index, and overall suitability index were developed to evaluate the optimal tilt angle. The results indicated that the higher tilt angles can marginally increase annual energy generation and lead to increased aerodynamic exposure and wind-induced obstruction. This study highlights the importance of integrating wind rose analysis with tilt optimization to achieve reliable and site-specific performance assessment of rooftop solar PV systems.

Keywords: *Rooftop solar photovoltaic (PV) system, wind–PV interaction, NASA POWER data*

VAL114

Thermochemical Conversion of Africana sp. Biomass towards Feedstock Fuel

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Abstract

Thermochemical conversion of lignocellulosic biomass offers a viable pathway for sustainable energy generation, provided the feedstock exhibits favourable thermal and kinetic characteristics. In this study, the pyrolytic degradation behaviour and reaction kinetics of Kigelia africana fibre were systematically investigated using thermogravimetric analysis. Experiments were conducted over a temperature range of 35–600 °C under inert conditions at heating rates of 5, 10, and 20 °C min^{-1} to elucidate the multi-stage degradation profile of the biomass. Distinct mass loss regions corresponding to moisture release, active devolatilization, and char formation were identified, reflecting the inherent lignocellulosic composition of the fibre. The kinetics was investigated using different models like Kissinger-Akahira-Sunose (KAS), Flynn – Ozawa – Wall (FOW) and Broido's plot. The average Ea values determined by KAS, FOW methods were 12.01 and 7.805 kJ/mol respectively. Coats – Redfern method was utilized to determine the pre-exponential factors and the reaction order of the pyrolysis. The HHV of Kigelia africana was 17.23 MJ/kg, suggested as a potential bio-feedstock energy source. The estimated activation energy values indicate moderate thermal reactivity and predictable degradation behaviour. Proximate and ultimate analyses revealed a volatile-rich composition with favourable elemental ratios, supporting efficient thermochemical conversion. The higher heating value of the fibre further substantiates its energy potential. Microscopic examination using field emission scanning electron microscopy confirmed a fibrous and heterogeneous morphology, influencing heat transfer and devolatilization dynamics. Overall, the results demonstrate that Kigelia africana fibre possesses suitable thermal stability, kinetic feasibility, and energy characteristics, establishing its potential as a promising bio-feedstock for pyrolysis-based energy applications.

Keywords: *Kigelia africana; Thermogravimetric analysis; Pyrolysis; Reaction kinetics; Activation energy; Bio-feedstock fuel*

VAL115

Performance, Emission, And Combustion Analysis of Different Waste Oil Blends in a Diesel Engine

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Abstract

In Today's world, the demand for alternate fuels is increasing rapidly for various applications, this study aims to identify the potential of different waste oil blends as an alternative fuel for diesel engines. In this investigation, Different oil blends were prepared and compared to commercial diesel. The experiment was designed to investigate the properties of engine characteristics for different oil blends and diesel. The optimum operating conditions were achieved using oil blends as a fuel source for diesel engines. The oil blends properties, performance, combustion, and emission analysis of the diesel engine. The waste oil blends were mixed in a ratio of 10%, 25% and 50% with diesel and the engine trials were done. The physicochemical properties of various oil blends were measured and compared with those of diesel. The Performance, Emission, and Combustion characteristics of oil blends and Diesel were studied through experiments, The Experimental studies of Performance, emission, and combustion characteristics were carried out in a single-cylinder four-stroke diesel engine under various engine loads. Emission analysis shows an increase in CO, HC, and other oxides of nitrogen above 25% blending of waste oils and diesel combination. Combustion analysis results in a slight increase in the Heat release rate and the Cylinder pressure. This is due to the presence of unsaturated carbons in the oil blends. In general, the study confirms the viability of different waste oil blends as a sustainable alternative to diesel fuel, and a measure of energy diversification. Further research needs to be conducted on long-term engine life, optimal blend ratio, and the use of emissions control technology before its widely accepted for field applications. Future studies will aim to optimize process conditions, enhance combustion efficiency, and perform pilot-scale scale-up tests to confirm the same. Hydrogenation of all different oil

blends can be done and compared to diesel. Emission control technologies and fuel upgrading methods has been developed to improve feasibility and sustainability.

Keywords: *Performance; Emission; Combustion; Diesel Engine; waste*

VAL116

Next-Generation Biodiesel Production from Non-Edible Oilseed Feedstocks

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Abstract

The growing depletion of fossil fuel resources and increasing environmental concerns have intensified the global search for sustainable and cleaner energy alternatives. Biodiesel has emerged as a promising renewable fuel, particularly when derived from non-edible oilseeds that do not compete with food supplies. Non-edible seeds offer advantages such as wide availability, low cost, and minimal impact on food security, making them attractive feedstocks for biodiesel production. In the present work, oils extracted from selected non-edible seeds were converted into biodiesel through transesterification, and critical process parameters—including catalyst concentration, reaction temperature, and oil-to-alcohol molar ratio—were optimized to achieve maximum yield. The produced biodiesel was evaluated for key physicochemical and fuel properties such as viscosity, calorific value, and emission characteristics, and the results were compared with conventional diesel fuel standards. The outcomes reveal that biodiesel obtained from non-edible seed oils meets essential quality specifications and exhibits reduced harmful emissions relative to petroleum diesel. The findings demonstrate the compatibility of non-edible seed biodiesel with existing diesel engines without requiring major modifications. Overall, the work emphasizes the potential of non-food biomass resources in enhancing energy security and reducing environmental impacts, while providing useful insights for scaling up biodiesel technologies in regions with abundant non-edible oilseed availability.

Keywords: *Biodiesel; Non-edible seeds; Catalyst; Feedstocks; Transesterification; Renewable fuel*

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VAL117

Microalgae Cultivation in Wastewater as a Dual Strategy for Biodiesel Production and Nutrient Remediation

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Abstract

The desire for sustainable energy has increased interest in microalgae as a biodiesel source. Microalgae, unlike conventional oilseed crops, grow quickly, have high lipid content, and can use non-arable land and non-potable water. Microalgae in wastewater can reduce production costs and improve sustainability. Wastewater delivers nitrogen and phosphate, minimizing the demand for synthetic fertilizers, and biofuel generation at a low cost while remediating wastewater. Wastewater-resistant microalgae strains are grown under optimum circumstances to increase biomass and lipid output. By using nutrient-rich industrial and municipal effluents, microalgae can produce biofuel and remove pollutants, solving energy and environmental issues. The study examines how wastewater composition affects algal biomass growth, lipid accumulation, and biochemistry. Optimization of culture factors including light intensity, pH, and retention time is also examined to maximize lipid productivity with minimal generation time. Wastewater-grown microalgae produce high lipid yields while minimizing nutrient loads, suggesting they could be a sustainable biodiesel source. Integrating wastewater treatment with microalgal biofuel production can cut costs, boost energy efficiency, and support circular bioeconomy models.

Keywords: *Microalgae; Biodiesel; Wastewater treatment; Transesterification; Lipid production; Biofuels*

VAL118

Improved Delignification and Fermentable Sugar Recovery From Spent Cymbopogon Biomass Using λ-Valerolactone/ $FeCl_3$ Pretreatment

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Abstract

The recalcitrant nature of lignocellulosic biomass poses a significant challenge in efficient fractionation of biomass, with delignification being a critical step in bioethanol production. In the present study, native and Cymbopogon spent biomass were initially subjected to compositional and structural analyses to evaluate for changes occurring during the distillation process. There was no difference in cellulose, hemicellulose, and lignin contents, in the spent biomass, highlighting its potential as a feedstock for bioethanol. The residual biomass was composed of 46.4% cellulose, 28.3% hemicellulose, and 20.5% lignin. This study further investigates the removal of lignin from residual biomass through pretreatment using FeCl3-catalysed γ-valerolactone (GVL)/water system. Pretreatment parameters including GVL/ water ratio, catalyst concentration, reaction time, temperature, biomass loading were optimized using one variable at a time (OVAT) method. The highest delignification (74.1%) was obtained at pretreatment using 60:40 GVL/water, 90mM FeCl3 at 130˚C, 6% biomass loading for 3h. Under these conditions, 92.9% hemicellulose dissolution was also observed. Drastic structural changs in the biomass after pretreatment were observed by SEM, XRD and FTIR analysis, confirming the efficient delignification and hemicellulose dissolution. Furthermore, enzymatic hydrolysis of the pretreated biomass resulted in an enhanced fermentable sugar yield of 661.6 mg/g pretreated biomass, indicating its potential as a feedstock for enhanced bioethanol production.

Keywords: *Cymbopogon, γ-valerolactone, Pretreatment, Delignification, Bioethanol*

VAL119

Valorization of Chicken Slaughterhouse Waste into enriched biofertilizer through bacterial fermentation

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Abstract

The present investigation aimed to exploit potential keratinolytic and proteolytic bacteria to degrade the whole poultry slaughterhouse waste (skin-feather - blood mixture), followed by utilization of fermented meal into enriched biofertilizer. A keratinolytic (SKK1) and a proteolytic (SKP 1) bacterium were isolated from the soil, and after RSM-based optimization, their enzymatic activities reached up to 380 U/ ml and 251 U/ml, respectively. Fermentator led to a fermentation rate of around 68.35 %, and 71.89 % of the keratin and protein content of raw slaughterhouse waste were converted into an amino acid-enriched composite. The undigested residual uses are mixed with the sawdust and cow dung in a 2:1:1 proportion in order to produce nitrogen-enriched vermicompost. Nitrogen, carbon, phosphorus, potassium, magnesium, sodium, and calcium content of the final product was analyzed, and the mineral composition was found in suitable ranges for plant growth promotion. This innovative approach not only contributes to waste valorization but also supports the principles of a circular bioeconomy and eco-friendly farming practices.

Keywords: *Polutry & Slaughterhouse waste, Keratinolytic, Proteolytic, Vermicompost, biofertilizer*

VAL120

Deep Learning-Based Smart Waste Disposal Approach for Smart Recycling in Circular Economy Systems

Dr. K. Kiruthika

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Abstract

Effective waste segregation is a fundamental prerequisite for increasing the efficiency of the recycling process and creating a sustainable environmental management system within a circular economy background. Currently, established segregation methods are entirely dependent on human involvement and judgment or machine-based methodologies drawn from established principles. These methods have proven to be inefficient and impractical, mainly due to the growing and variable amounts of solid waste management volumes.

This study aims to come up with a framework of intelligent waste segregation system using deep learning technology. This system makes use of the concept of computer vision to help sort waste efficiently. This method of sorting utilizes the function of the Convolutional Neural Network (CNN). Transfer learning method will be integrated to the system to ensure that the convergence of the system is hastened accordingly. Data augmentation method integrated to the system to address the problem of class imbalance. This addresses the problem of illumination variation and the backgrounds of the objects.

The applicability of the projected framework for deployment in various environments is ensured, thereby allowing integration with smart waste collection systems and recycling machines. The performance of the deployed model is verified through common performance evaluation criteria, accuracy, precision, recall, F1 score and benchmark datasets. The analysis reveals that superior performance and better ability to generalize the outcome are achieved through deep learning-based models compared to traditional machine learning models.

Other than waste classification itself, data analysis is also utilized in the assessment of segregation efficiency based on classification and trends of performance. There is also the

increased precision of segregating waste to their sources, which reduces contaminants in recyclable waste material in efficient recycling processes.

The current study, in general, points to the potential benefits of using a deep learning–based waste segregation approach to meet sustainability goals more effectively. The proposed system enables correct segregation at the source, thus assisting in the reuse and recycling of waste materials and embracing the concepts of the circular economy. The framework further extends the base for including IoT-based sensing, real-time monitoring, and intelligent infrastructures for waste management.

Keywords: *Deep Learning, Intelligent Waste Segregation, Computer Vision, Smart Recycling, Circular Economy*

VAL121

Sustainable Biodiesel Production from Used Rice Bran Oil: Catalyst Development and Characterization

Shanthini VS [a], Chitra D [b], Ganesh Moorthy I [b], *

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Abstract

The valorization of waste-derived feedstocks into renewable fuels offers a sustainable solution to current energy and environmental challenges. This study investigates biodiesel production from used rice bran oil (URBO) employing a CaO-based heterogeneous catalyst, with emphasis on catalyst characterization and fuel quality evaluation. The CaO catalyst was synthesized via calcination at 800 °C and systematically characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transform infrared spectroscopy (FTIR). XRD analysis confirmed the formation of highly crystalline cubic CaO, with characteristic diffraction peaks at 2θ values of 32.2°, 37.4°, and 53.9°, indicating high phase purity. SEM images revealed a porous and agglomerated morphology with irregular particles, providing enhanced surface accessibility for catalytic reactions. FTIR spectra exhibited prominent absorption bands around 3640 cm^{-1} and 1415 cm^{-1}, corresponding to surface hydroxyl groups and strong O^{2-} basic sites essential for transesterification activity. Transesterification of URBO with methanol was carried out under controlled reaction conditions. The produced biodiesel was purified and evaluated for key physicochemical properties. The density and kinematic viscosity were measured as 878 kg m^{-3} and 4.6 mm^2 s^{-1} at 40 °C, respectively, while the flash point was recorded as 168 °C. A significant reduction in acid value from 6.2 mg KOH g^{-1} in the raw oil to 0.48 mg KOH g^{-1} in the biodiesel indicated effective conversion. All measured fuel properties complied with ASTM D6751 and EN 14214 standards. Post-reaction characterization of the spent catalyst showed minimal structural degradation, demonstrating good stability and reusability. The findings highlight the potential of CaO-based heterogeneous catalysts for the sustainable valorization of waste rice bran oil into high-quality biodiesel.

Keywords: *Used rice bran oil, Biodiesel production, Heterogeneous catalyst, Transesterification, Catalyst characterization.*

VAL122

Simultaneous Wastewater Treatment and Power Generation via Microbial Fuel Cells

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Abstract

The emphasis on sustainable and low-cost energy sources is central to overcoming energy scarcity and climate change challenges. Microbial fuel cells (MFCs) provide a sustainable and innovative pathway for energy production via fuel cell technology. Fuel cell technologies have gained recognition as effective clean energy solutions capable of contributing to energy security, economic advancement, and environmental protection. Microbial fuel cells (MFCs) function as bio-electrochemical devices that convert the chemical energy of substrates into electrical energy via microbial catalysis, involving the extraction of electrons and protons during oxidation. Electrons are transferred from the anode to the cathode via an external circuit, whereas protons diffuse through the proton exchange membrane that divides the anodic and cathodic compartments. The rich organic and inorganic content of wastewater makes power generation via MFCs an economically feasible solution for minimizing environmental pollution. A two-chamber microbial fuel cell was analyzed in this work to assess its power output and its potential to reduce chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total dissolved solids (TDS). Therefore, the MFC proved to be an effective and eco-friendly approach for both wastewater remediation and electricity production.

Keywords: *Microbial Fuel Cell (MFC), Wastewater treatment, Sustainable Energy, Waste-to-Energy, Power generation*

VAL123

Eco-Friendly Recovery and Valorisation of Spent Lithium-Ion Batteries for Next Generation Energy Storage

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Abstract

The increasing use of lithium-ion batteries in electric vehicles and portable electronics has intensified concerns about resource depletion and environmental impact. Conventional recycling methods are energy-intensive and generate secondary pollution, highlighting the need for sustainable alternatives. This work proposes an integrated framework for eco-friendly recovery and valorisation of spent lithium-ion batteries. Critical metals including lithium, cobalt, nickel, and manganese will be extracted using bioadsorbents, green solvents, and deep eutectic solvents. In parallel, waste anode carbon will be transformed into graphene nanostructures and employed in the fabrication of high-performance supercapacitors designed for ultra-fast charging and regenerative braking. Recycled materials will also be incorporated into sodium-ion and solid-state battery prototypes, with validation through advanced electrochemical testing and predictive simulations such as density functional theory, molecular dynamics, and machine learning. Sustainability will be assessed through life cycle and techno-economic analyses, aligned with extended producer responsibility and green credit frameworks. The expected outcomes include scalable recovery processes, graphene-based energy devices, and a circular economy pathway for next-generation energy storage systems.

Keywords: *Battery recycling, Graphene supercapacitors, Sodium-ion batteries, Circular economy, Sustainability assessment*

VAL124

Crystallographic and Theoretical Design of a Co(II) Complex for Enhanced Energy Storage, Efficient Catalysis, and Selective L-Cysteine Fluorescent Sensing

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Abstract

A novel divalent cobalt(II) complex with molecular formula [CoC9H11N3O7] was synthesized in aqueous solution. The structure and composition of the complex were confirmed through a combination of techniques, including elemental analysis, FT-IR spectroscopy, UV–vis spectroscopy, ^{1}H NMR spectroscopy, mass spectrometry, thermogravimetric and differential thermal analysis (TG-DTA), and single-crystal X-ray diffraction (SCXRD). Crystallographic studies revealed that the complex crystallizes in the monoclinic Cc space group and adopts a distorted octahedral geometry around the Co(II) ion, with two independent molecules present in the asymmetric unit. The electronic properties and reactivity of the complex were investigated using Density Functional Theory (DFT) by examining the frontier molecular orbital (FMO) energies and the associated energy gap. Hirshfeld surface analysis and energy framework calculations were carried out to elucidate the intermolecular interactions and quantify the interaction energies that contribute to the structural stabilization of the complex. Electrochemical evaluation of Co(II) complex in a three-electrode setup with 3 M KOH as the electrolyte demonstrated superior supercapacitive behavior, achieving a specific capacitance of 372 F g^{-1} at a current density of 1 A g^{-1}, along with an energy density of 107.2 Wh kg^{-1} and a power density of 2.5 kW kg^{-1}. Additionally, the complex exhibited excellent catalytic activity for the reduction of picric acid (PA), achieving 94% degradation within 32 minutes. The complex also showed promising sensing capabilities for L-cysteine (L-Cys) detection, where it demonstrated selective fluorescence quenching in the concentration range of 10–100 µM. These findings highlight the multifunctional nature of CoPDMCZ for energy storage, environmental remediation, and biochemical sensing applications.

Keywords: *Cobalt(II) complex, structural analysis, energy storage, picric acid reduction, fluorescence sensing.*

VAL125

Valorization of anaerobic digestate for enhanced biomass production in *Chlorella sorokiniana*: a circular economy approach

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Abstract

Microalgae are fascinating systems that can be employed in a variety of ways to create biorefineries that operate on a circular economy concept. One significant strategy is resource recovery via mixotrophic growth in organic wastes. Cultivation of microalgae in nutrient-rich digestate obtained from anaerobic digestion of food waste offers a sustainable waste management solution while also contributing to the bioeconomy by producing value-added products that can be used in a range of applications.[1] The objective of the present study is to enhance the biomass productivity which can act as the substrate for other processes that can generate green energy, simultaneously addressing the current environmental issues.[2] One of the key goals of this strategy is to optimize process parameters to increase biomass productivity. Activated carbon-based clarification of the digestate was performed in order to facilitate mixotrophic growth of Chlorella sorokiniana. The clarification process achieved 98.53% reduction in OD at 680 nm. The C/N ratio, pH, inoculum percentage, temperature, and nutritional balance were optimized for enhanced microalgal productivity. Maximum biomass yield and productivity of 2.9 g L-1 and 0.34 g L-1 d-1 was obtained at the following conditions where the C/N ratio was maintained at 5.5, pH at 6, Temperature at 250C, and Inoculum percentage at 10% respectively. Further experiments were designed using L9 orthogonal array of Taguchi method to understand the interactions between different process parameters. The present study will help in the conversion of organic waste, which is otherwise considered as a risk to the environment, into value-added products.

Keywords: *Algae; Anaerobic digestate; Bio economy; Biomass; Process optimization*

References:
[1] Chong, C. C., Cheng, Y. W., Ishak, S., Lam, M. K., Lim, J. W., Tan, I. S., Show, P. L., & Lee, K. T. (2022). Anaerobic digestate as a low-cost nutrient source for sustainable microalgae cultivation: A way forward through waste valorization approach. In Science of the Total Environment (Vol. 803). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2021.150070
[2] Zuliani, L., Frison, N., Jelic, A., Fatone, F., Bolzonella, D., & Ballottari, M. (2016). Microalgae cultivation on anaerobic digestate of municipalwastewater, sewage sludge and agro-waste. International Journal of Molecular Sciences, 17(10). https://doi.org/10.3390/ijms17101692

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Creating Infrastructures in the Realm of Environment & Energy

Kiran KK

Managing Director

Kiran KK, a veteran in the environment and energy sectors, has over 31 years of experience. He is a graduate of NIT Warangal and has held significant roles in Reva Enviro, Ecoboard Industries, GMR Group, and Ramky Group. Kiran has also served on the Boards of MM Enviro Projects and Rahyals Group. He co-developed two patents in collaboration with IIT Hyderabad and has published over 10 research papers in prestigious journals.

Technologies Developed

- HRCM (High Rate Complete Mix) Anaerobic Digester
- EGSB (Expanded Granular Sludge Bed) Anaerobic Digester
- IITH-Kaashyap-ABT (Algal Bacterial Tower)
- IITH-Kaashyap-n SBR (Novel Sequential Bio Reactor)
- IITH-Kaashyap-CBME (Continuous Bi-Polar Mode Electrocoagulation)

Technical Collaboration

- Indian Institute of Technology - Hyderabad
- Indian Institute of Chemical Technology; Hyderabad
- Department of Atomic Energy; Govt of India
- BITS PILANI - Hyderabad
- Indian Institute of Technology; Roorkee
- IIIT Hyderabad - Indian Institute of Information Technology, Hyderabad

Achievements and Milestones

- Joint Research Patent: Kaashyap Envergy Infrastructure Pvt. Ltd. and IIT Hyderabad's collaboration in wastewater treatment innovation.
- Nisargruna Biogas Plant Technology License: Signed on 27-10-2020.

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• Kaashyap Envergy Reactors: Innovative high-rate bio-meThanization reactors designed for enhanced biogas production and higher methane-rich biogas output.

• Energy & Water Solutions: Kaashyap Envergy provides cutting-edge solutions to capture energy and generate crystal-clear water from high-strength organic wastewater in industries such as sugar, distillery, starch, and palm oil mills.

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Gadag, Karnataka

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Shiraguppi Sugar Works Ltd
Kagwad, Karnataka

Biogas capture from Sugar factory effluent.

Green & Smart Sdn Bhd
Kualalumpur, Malaysia

Malaysia's first-ever tank-based Anaerobic Digester system for Palm Oil Mill effluent under the FIT program.

Synthite Industries Ltd - Harihar, Karnataka

Hybrid CSTR Technology-based anaerobic digester for Marigold flower processing effluent.

NSL Krishnaveni Sugars Ltd
Kothakota, Telangana

First Ever Distillery condensate treatment plant based on following four technologies:

- Anaerobic Digester based on EGSB
- IITH-Kaashyap-ABT(Algal Bacterial Tower)
- IITH-Kaashyap-n SBR(Novel SBR Technology)
- IITH-Kaashyap-CBME(Continuous Bi-Polar Mode Electro-coagulation Technology

BioCNG / CBG (Compressed Biogas) Projects under execution

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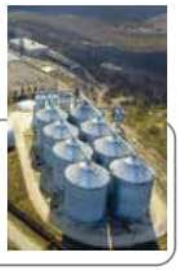
- CNSL Sugars Ltd ; Koppa Unit ; Karnataka
- S E Agro Private Limited ; Rajahmundry
- REPA BVS Bio-energies Private Limited; Hyderabad



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- Monitoring Anaerobic Digester operations 24/7 using AI and ML to optimize Biogas and BioCNG production.

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Your decision today shapes the impact you create tomorrow. Stand with us now to deliver a cleaner, greener future. Today, adopting sustainable choices may feel challenging, but over time, they become powerful habits that help every individual contribute to a healthier planet.

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NOTHING SHOULD GO WASTE ,REIMAGINING WASTE
Together with technology, we can forge a partnership for zero waste to reclaim nature.

Who We Are

Pure Planet is a WasTech startup committed to transforming global waste management through human-led, technology-driven solutions. This is more than an organisation; it is a movement for conscious, sustainable living. The belief is that waste is purpose in disguise and that every individual has a role in shaping a sustainable planet.

Our Vision

We envision a world where every individual recognises their responsibility toward waste and sees it as a valuable resource. By fostering awareness and collective action, we aim to build a truly circular, sustainable future that protects the planet for generations to come.

Our Mission

Our Mission is transforming waste management through innovation and human-led technology and empowering communities and businesses to adopt responsible waste practices and accelerate the circular economy.

Our Circular Economy Approach

Collection & Segregation at Source

- Dry Waste (Recyclable)
  - Process
    - Recover/ Reuse/ Recycle
- Wet Waste
  - Process at site
    - Waste to Energy

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EcoIntel Bin

Our Solution

Comprehensive WasTech Offerings

Smart Seggregation

AI-powered EcoIntel bins that automatically identify, sort, and compact waste to improve recycling efficiency and support sustainable waste management operations effectively.

iSTAR

Patented thermophilic anaerobic digestion technology that processes hazardous waste efficiently and generates methane-rich bio-gas for renewable energy and sustainability use.

Biostabilisation Plant

Convert biogas byproducts into FCO-standard compost and soil amendments.

Consultancy for Waste

Expert consultancy and solutions for all types of waste, including special waste streams

Carbon & Green Credit

Services that assist organisations in generating carbon credits and participating in reforestation-based green credit programs to improve environmental sustainability performance.

CSR goals & ESG disclosures

Enabling industries to meet Environmental, Social, and Governance (ESG) compliance with transparency and accountability.

Why Pure Planet?

- ✓ **Human-led Tech**
  Scalable & modular AI, SCADA, IoT solutions designed for India
- ✓ **Tailored Solutions**
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- ✓ **Measurable Impact**
  Real-time tracking, analytics, and carbon footprint calculations.
- ✓ **End-to-End Service**
  From collection to resource recovery—complete ecosystem.
- ✓ **R&D for environmental solutions**
  We learn about the waste. Every waste is unique. We quantify the waste to redefine urban sustainability.
- ✓ **Social Impact**
  Environmental justice, livelihood creation, and community engagement

We are a solution for your innovation

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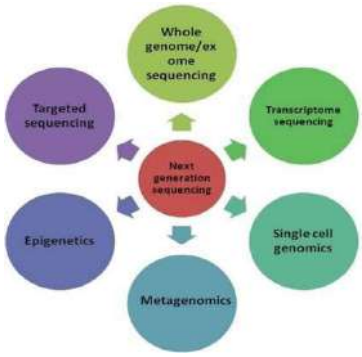
"Delivering Genomic Insights Through Cutting-Edge Sequencing Technologies"

Allele Tech Private Limited is an innovation-driven biotechnology enterprise delivering advanced genomic and molecular solutions. The company operates at the intersection of precision science and modern technology, offering specialized expertise in Next Generation Sequencing (NGS), molecular diagnostics, bioinformatics, and genetic research. Supported by robust infrastructure and a highly skilled scientific team, Allele Tech contributes to progress in personalized healthcare, agricultural genomics, and environmental biotechnology.

At Allele Tech we provide a comprehensive portfolio of services designed to support the requirements of academic institutions, research laboratories, healthcare organizations, and industry partners. These services include whole-genome and targeted sequencing, transcriptome (RNA-seq) analysis, microbiome profiling, and customized bioinformatics workflows. With a strong emphasis on data accuracy, reproducibility, and timely delivery, Allele Tech is recognized for its quality-driven approach and collaborative mindset, making it a reliable partner in advancing scientific research and translational outcomes.



Guided by a commitment to harness the potential of genomic science, Allele Tech strives to translate advanced research into meaningful real-world solutions. Through strong collaborative partnerships and the delivery of reliable, high-quality data and analytical insights, the company supports researchers and innovators in driving progress across genomics and biotechnology, contributing to the development of impactful and sustainable scientific advancements.

Our Services

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  Pac Bio
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- dNTPs
- Nucleic Acid Extraction Kits
- NGS Library Kits
- Custom Oligo synthesis

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PROJECT

BIOREACTOR

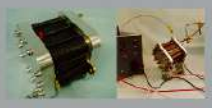
The bioreactor vessel: This is the main body of the bioreactor, where the cells are grown. It's typically made of stainless steel for durability and sterility. In the image, it appears to be cylindrical with a flat bottom.

Agitator : This is a motor-driven paddle or impeller that mixes the culture broth inside the vessel. It ensures good aeration and prevents cell settling. The image shows the agitator shaft coming out of the top of the vessel, but the impeller itself is not visible.

Sparger : This is a pipe or tube that introduces gas (usually air or oxygen) into the culture broth. It can be seen at the bottom of the vessel in the image.

pH probe: : This is a sensor that measures the acidity or alkalinity of the culture broth. It is also usually inserted into a thermowell in the vessel wall. The image does not show a pH probe, but it may be located on the back side of the vessel.

PRODUCT



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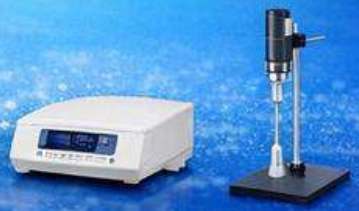

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