



Microbes, bioconversion technologies, and sustainable environment: targeting for food processing waste utilization

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The accumulation of food waste materials generated from the food-based industries and crop harvesting has led to the consideration of extracting high-value products to offset the cost of treatment and disposal. Food waste is regarded as a renewable source for the production of bioenergy and platform bio-chemicals (Kurniawan et al. 2024; Bains et al. 2024). Thus, in recent years, significant emphasis has been paid to the development of modern and novel technologies for food waste recycling, which have several characteristics such as being fast, clean, sustainable, cost-effective, and environmentally friendly (Verma et al. 2024; Rajak et al., 2024). In an era where sustainable development is no longer optional but essential, the challenge of managing food processing waste has gained global attention. With the growing concerns over environmental degradation, resource scarcity, and increasing food demand, the integration of innovative biological tools into waste management has become a strategic priority. This special issue, “Microbes, Bioconversion Technologies and Sustainable Environment: Targeting Food Processing Waste Utilization,” brings to light cutting-edge research and emerging approaches aimed at transforming waste liabilities into value-added assets through microbiological and biotechnological interventions.

Biological degradation has become an increasingly popular alternative for the treatment of agricultural, industrial, and organic wastes for both economic and ecological reasons. In these circumstances, agricultural food wastes could be integrated by clean technologies or be returned as an organic substrate to the soil as valuable materials, with minimum risk to environmental factors and ecosystems (Sarangi et al. 2024a, b). Microorganisms play a pivotal role in nature’s recycling system. Their metabolic diversity and adaptability make them ideal agents for the conversion of organic residues into biofuels, enzymes, bioplastics, organic acids, and other industrially relevant products. The scientific contributions featured in this issue explore the vast potential of microbial communities and engineered consortia in driving bioconversion processes, offering sustainable alternatives to conventional waste disposal practices. Bioconversion technologies, underpinned by advancements in microbial genomics, metabolic engineering, and process optimization, offer promising solutions for addressing food industry waste. These technologies not only help in reducing environmental pollution but also contribute to circular bioeconomy models by recovering valuable compounds from waste streams. Through anaerobic digestion, solid-state fermentation, composting, and other microbial processes, researchers are developing efficient pathways for turning agro-industrial residues into usable commodities. Thus, the circular economy concept is important in the food waste sector, and the transition from waste to resources can be achieved by reframing wasted food and by-products as valuable resources, increasing investment in food loss and waste reduction, and integrating food loss and waste more broadly in the sustainable development goal (SDG) agenda. Aspects related to the different environmental approaches, microbial conversion technologies, fuel technologies, chemical and bioprocess design, environmental technologies, waste valorization, energy recovery, and novel biocatalysts for food waste utilization towards value addition will be covered in this special issue.

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This compilation of studies emphasizes interdisciplinary collaboration—spanning microbiology, environmental science, food technology, and biochemical engineering—to devise integrative strategies for sustainable waste valorization. The authors present experimental insights and review evolving concepts that could reshape industrial practices, policy frameworks, and environmental sustainability goals. This issue showed a collection of articles focusing on microbial technologies for the conversion of food processing wastes into a diverse variety of value-added compounds with industrial relevance in the context of the clean environment. The issue also included comprehensive coverage of current advances in a variety of fields, including biofuels, biochemicals, bioprocess engineering, microbiology, chemical catalysis, biocatalysis, environmental engineering, and fine chemicals production technologies.

The guest editors express their gratitude to the Editor-in-Chief of the ESPR journal, the editorial assistant, and the supporting staff for providing the opportunity to curate this special issue. We also encompass our sincere thanks to all the contributors and reviewers whose efforts have been instrumental in making this publication possible. It is our hope that the articles in this special issue will stimulate further research and innovation in this significant field around the globe among scientific communities. By harnessing the power of microbes and bioconversion strategies, we edge closer to a future where food production and environmental stewardship progress hand in hand.

Declarations

Competing interests Authors declare that there is no competing interests.

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(Biotech Research Society of India, Society for Biotechnologists of India, Association of Microbiologists of India, Indian Science Congress Association, and Forum of Scientists, Engineers & Technologists). He has published many books in the field of biomass conversion and value addition by Elsevier, Springer, and CRC Press.



Sanjukta Subudhi Sanjukta Subudhi is working as Associate Director and Senior Fellow at TERI, India. She leads the microbial biofuel and biochemical research group at TERI. Research explorations of her group span the domain of microbial production of clean fuel (bio-hydrogen bio-methane, bio-butanol, bioethanol, biojet fuel, from 1st, and next-generation feed stocks) and green biochemicals (2,3 butane diol, lactic acid, value-added volatile fatty acid, lipase, bio-flocculant, carotenoids, PUFA, and pre- and probiotics). Her in-depth research contributions are recognized in the form of 62 high impact factor peer-reviewed international journal publications, 4 patents, 1 position paper, 1 white paper, 4 book chapters, and over 100 international conferences (> 1771 citations, h-index, 22, I10 index, 37).

She has established *Tata Chemicals Ltd (TCL)–TERI Centre of Excellence at TERI*, as the lead project coordinator. This centre aims at demonstrating bioprocesses for integrated production of biochemicals and biofuels, in a cost-effective manner through the employment of a circular bioeconomy approach.

She is the Bioeconomy expert member of Indian Federation of Green Energy (IFGE) and is a task force expert in Environmental biotechnology and Bioenergy domain (DBT-BioCARE, Ministry of Science and Technology, Govt. of India). Dr Subudhi is the member

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