

# **SUSTAINABLE FOOD INNOVATIONS:**

## **PRODUCT DEVELOPMENT, PACKAGING, AND WASTE VALORIZATION**

**Innovations in Sustainable Food Processing,  
Functional Foods and Smart Technologies**

*Edited by*

**Kamlesh Prasad, PhD  
Shubhra Shekhar, M. Tech.  
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**Sant Longowal Institute of Engineering and Technology,  
Longowal – 148106, Sangrur, Punjab, INDIA**

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## *About the Editor*

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### **Kamlesh Prasad, PhD**

Prof. Kamlesh Prasad is a distinguished academician, researcher, and food technologist with extensive experience in teaching, research, academics, administration, and scholarly publishing. He is currently serving as Professor in the Department of Food Engineering and Technology at Sant Longowal Institute of Engineering and Technology (SLIET), Longowal, Punjab, India. In addition to his academic responsibilities, he has served as Head of the Department (Food Engineering and Technology), Coordinator of the Internal Quality Assurance Cell (IQAC), Chairman of the Rajbhasha Hindi Cell, and Public Grievance Officer (PGO) of the institute. He is also the Chairman of the Conference on Future Innovations, Food Allergies, and Traditional Foods (FIFATF-2025 and FIFATF-2026).

Prof. Prasad obtained his postgraduate degree in Food Technology from the CSIR-CFTRI, Mysore. He subsequently earned his doctoral degree in Food Technology from GBPUA&T, Pant Nagar. His major areas of specialisation include fruit and vegetable processing, non-destructive quality evaluation of foods, image analysis, food process optimisation, nanotechnology applications in food systems, engineering properties of biological materials, innovative food processing technologies, and traditional foods to combat hidden hunger.

Prof. Prasad has authored and co-authored more than 200 research papers published in reputable national and international journals and conference proceedings. He has also authored several books, edited scholarly volumes, and contributed chapters to books published by leading national and international publishers. His publications have served as valuable references for researchers, students, and professionals in food science, food engineering, and postharvest technology. Also associated with several prestigious professional societies and scientific organisations, including the ASABE, IFT, AFST(I), NSI, USI, IEEE, and other national and international professional bodies. In addition to his research accomplishments, Prof. Prasad has actively contributed to academic leadership, curriculum development, student mentoring, and research capacity building.

This edited book is being published as part of the conference proceedings, reflecting his commitment to advancing research and disseminating knowledge in these critical domains.

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Mr Shubhra Shekhar is a PhD candidate in the School of Chemical Engineering at the University of New South Wales (UNSW), Sydney, Australia. He is currently a member of the Faculty Board, holds higher-degree research student positions in engineering, has served as President of the Chemical Engineering Research Society (CERS), and is a member of the AGSE Industry PhD cohort, actively engaging with both industry and academic partners. His research focuses on non-destructive sensing and advanced characterisation methods to improve quality assurance and process understanding in modern food systems. His work brings together principles from chemical engineering, computer science, and data-driven modelling to develop innovative approaches for analysing complex food products and their behaviour.

He is a GATE achiever and has completed an M. Tech. (Food Process Engineering) from NIT, Rourkela. He received the Best Student Award from the Association of Food Scientists and Technologists, India (AFSTI), Mysuru, in 2021 and ranked top in the deemed-to-be university at graduation. He was also the All-India Topper (Elite) and received a Silver Medal for the NPTEL Course conducted by IIT Kharagpur. Got an appreciation letter from Nestle India Ltd., Moga, for his contributions in the form of recommendations. Won several prizes in academics, co-curricular and extracurricular activities. Received letters of appreciation for his contributions to several events and activities. He has successfully delegated his responsibilities as the in-charge of the Society of Food Technocrats (SOFT), the Photography Club (SVIESA), and numerous other professional committees and events. He has industrial exposure with Mondelez India Foods Private Limited, Baddi, HP; Mrs Bector's Food Specialities Limited, Greater Noida, UP; and Nestle India Limited, Moga, Punjab. He is a widely travelled person and has visited countries including Australia, Switzerland, Italy, France, Vatican City, Belgium, the Netherlands, Germany, the Czech Republic, Austria, Hungary, Singapore, Thailand, and Hong Kong. His work is published as articles in books, journals, and conference proceedings of international repute.

## **Harish Kumar Sharma, PhD**

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# Preface

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It gives us immense pleasure to present ***Sustainable Food Innovations: Product Development, Packaging, and Waste Valorization***, an edited volume bringing together the research contributions addressing important contemporary challenges and opportunities in sustainable food processing, food product development, packaging, and resource valorization.

The food sector increasingly needs to meet growing demand for nutritious, safe, affordable, high-quality foods while using natural resources efficiently and reducing food and agricultural waste. Sustainable food innovation therefore requires approaches that integrate product development, nutritional improvement, efficient processing, waste reduction, value addition, and environmentally responsible packaging.

The book comprises fourteen chapters covering diverse themes. These include food applications for addressing celiac disease, techno-economic evaluation of wheat bran for fibre-rich food products, rice straw for sustainable packaging, utilization of underexplored banana species, food allergen reduction using cold plasma, and the nutritional and functional potential of tangerine peel waste.

Several chapters emphasize the valorization of underutilized crops and food resources. The volume includes studies on Tardi (*Dioscorea bellophylla*) starch, amla cultivars, multi-millet formulations, bitter gourd, jute leaves, asparagus bean flour, dietary-fibre recovery, and bioactive compounds from stinging nettle. These contributions show the potential of diverse plant resources and food-processing residues as sources of nutrients, functional ingredients, bioactive compounds, and value-added food products.

The book also highlights sustainable packaging and innovative processing technologies. Converting rice straw into packaging materials offers a way to create value from agricultural residue, while starch-based antimicrobial films show the potential of renewable materials for functional packaging applications. Other contributions address cold plasma treatment, drying technologies, extraction processes, and hydrothermal recovery of dietary fibre.

An important feature of this volume is its multidisciplinary approach, bringing together perspectives from food technology, food engineering, agricultural sciences, nutrition, biotechnology, materials science, and related disciplines.

We hope that “*Sustainable Food Innovations: Product Development, Packaging, and Waste Valorization*” will serve as a useful reference for researchers, academicians, postgraduate and doctoral students, food technologists, engineers, industry professionals, and other stakeholders.

We sincerely thank all the authors, reviewers, institutions, colleagues, students, and supporters whose contributions have made this volume possible.

*K. Prasad, S. Shekhar, and H. K. Sharma (Editors)*

# Acknowledgement

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The publication of *Sustainable Food Innovations: Product Development, Packaging, and Waste Valorization* has been made possible through the collective efforts, cooperation, and support of numerous individuals and institutions. As editors, we sincerely acknowledge everyone who contributed to preparing and completing this volume.

First, we express our heartfelt gratitude to all the contributing authors for sharing their research findings, knowledge, and expertise. The fourteen chapters covering sustainable food product development, agricultural and food-waste valorization, sustainable packaging, functional ingredients, food allergen management, processing technologies, nutritional enhancement, dietary-fibre recovery, and bioactive compounds form the foundation of this book.

We sincerely thank the reviewers and subject experts for their valuable time, critical evaluation, and constructive suggestions. Their scholarly inputs have helped improve the quality, scientific content, and presentation of the chapters.

We gratefully acknowledge Sant Longowal Institute of Engineering and Technology (SLIET), Longowal, for providing the institutional support and academic environment necessary for this scholarly initiative. We particularly appreciate the support of all FIFATF-2025 sponsors in bringing this edited volume to publication.

We also acknowledge the valuable contribution of the Department of Food Engineering and Technology, SLIET, Longowal, whose academic and research environment continues to encourage innovation and knowledge dissemination in food engineering and technology.

We extend our sincere thanks to the collaborating institutions and academic partners whose researchers contributed to this volume. We particularly acknowledge the association of researchers from national and international institutions.

We thank our research scholars, students, faculty members, colleagues, collaborators, and well-wishers for their valuable support, encouragement, and academic contributions. We also appreciate the efforts of all those who assisted with manuscript preparation, editing, compilation, formatting, proofreading, correspondence, and publication. Special thanks to my scholars, Gunjan Thakur and Sunil Kumar, for their efforts in shaping this book in its present form.

Finally, we express our heartfelt gratitude to our families and friends for their patience, encouragement, and continued support throughout the preparation of this book. Thanks are also extended to the administrations of the institute and the Ministry of Food Processing Industry for their support.

We sincerely hope that this volume will contribute to advancing research and innovation in sustainable food product development, resource-efficient processing, sustainable packaging, agricultural and food-waste valorization, nutritional enhancement, and the development of environmentally and economically sustainable food systems.

*K. Prasad, S. Shekhar, and H. K. Sharma (Editors)*

# Significance of the Edible Banana Species of Mizoram: Research Status and Prospects

Lalmangaihi  and Himjyoti Dutta 

**Abstract.** The Indian state of Mizoram is in a special geographical position, sharing two international boundaries with Myanmar and Bangladesh. Currently, prospective trade routes and tourism have necessitated urgent technological upgradation towards commercialization of the locally grown produce of this forest-clad state. Mizoram's natural conditions support a wide diversity of banana and plantain species that have played a key role in ensuring the health, nutritional, and economic security of local tribal populations. Till date, fourteen banana species belonging to *Musa* L. and *Ensete* Bruce ex Horan. species have been formally identified and reported from the state. Latest improvements in technological know-how have enabled the local small-scale processors to commercialize value-added products in packaged or ready-to-serve forms. However, the traditional practices of consuming the edible pseudostem, flowers, and inflorescence have yet to be scientifically explored, given recent global research and developments in other banana-producing zones in India and worldwide. Local ethno-medicinal knowledge systems also suggest using banana fruits to treat anaemia, hypertension, diarrhoea, burns, wounds, and stomach ulcers, and pseudostem juice for kidney problems. In addition, the stem layers and leaves have several other traditional uses, such as packaging material for fermented and aquatic foods, water-resistant roofing, and biodegradable cutlery. This paper briefly reviews the current research status and future opportunities for research on Mizoram's banana resource.

**KEYWORDS:** Tribal knowledge, Organic, Product development, Technology upscaling, Antioxidant

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## 1. Introduction

Banana (*Musa species*), as an important cash crop, is one of the most widely grown tropical fruits worldwide (Das et al., 2025; Prasad et al., 2022). India is the largest producer, followed by China and Indonesia. The state of Mizoram, often referred to as the “Land of the Highlanders”, lies between 21°58’-24°35’N latitude and 92°16’-93°29’E longitude, and shares international borders with Myanmar and Bangladesh. According to the Indian State of Forest Report (2021), Mizoram has the highest forest coverage among the Northeast states, with approximately 84.53% of its geographical area under forest cover. The region with transitioning zones of lowland and highland is also unique since the landmasses of the southern and northern hemispheres meet in this area, leading to increased species diversity (Singh, 2010). A significant proportion of the local ‘Mizo’ population of Mizoram is dependent on forest resources for livelihood, making it the second largest source of subsistence in the state (Sati and Vangchhia, 2016). Mizoram's natural climatic and ecological conditions produce a wide variety of banana and plantain species. While several wild banana fruits are considered inedible, many have long been consumed and cultivated. These have traditionally met locals' nutritional needs. Today, banana cultivation and sales in local markets (Fig. 1) are a notable source of economic security for many Mizo people. However, scientific documentation of banana species and types grown in Mizoram has been limited. Fourteen banana species belonging to *Musa* L. and *Ensete* Bruce ex. Horan species have been formally identified and reported (Lalfakzuala et al., 2015; Lalrinfela and Thangjam, 2012).

## 2. Traditional Uses of Edible Banana in Mizoram

The Mizo tribe have a rich cultural heritage associated with the utilization of banana in their daily lives. Bananas are not only a staple food in different cuisines, but are also believed to have many medicinal properties. Although these practices have been followed for generations, many nutritional and therapeutic claims have been only recently received scientific attention (Lalfakzuala et al., 2015). Local food processors have developed value-added products from different parts of the plant in packaged or instantly consumable forms. Ripe fruits are either consumed fresh or fermented into wines and probiotic drinks, while unripe fruits are processed into ready-to-eat snacks,

product and process innovations remain unstandardized. Evidence-based studies on processing parameters, shelf-life extension, packaging improvements, and sensory and quality evaluation are needed. Utilization of banana pseudostem, including fiber extraction, biodegradable packaging and eco-textiles has also gained global attention but remains underexplored in Mizoram. Agronomic evaluation of local banana landraces would support crop improvement and conservation strategies, as well as the potential for GI-tag registration for unique types.

## 6. Conclusion

Banana is an essential biological and cultural resource in Mizoram, supporting nutrition, traditional medicine and rural livelihoods. Although fourteen species of *Musa* and *Ensete* have been identified, scientific research on their nutritional and antinutritional value, phytochemical properties, and processing potential remains limited. Different plant parts, such as the pseudostem, flowers, and inflorescence, widely used in Mizo cuisine remain underexplored. Strengthening interdisciplinary research, integrating traditional knowledge with scientific evidence, and promoting technology-driven value addition remain essential to unlock the full potential of Mizoram's banana resources and enhance economic resilience for local communities.

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# SUSTAINABLE FOOD INNOVATIONS:

## PRODUCT DEVELOPMENT, PACKAGING, AND WASTE VALORIZATION

### Innovations in Sustainable Food Processing, Functional Foods and Smart Technologies

This book presents recent research and innovative applications in sustainable food product development, packaging and waste valorization. It explores the utilization of biodegradable crops, food processing by-products and agricultural residues, development of functional and specialized food products, sustainable packaging materials, and emerging processing technologies. The chapters highlight multidisciplinary approaches integrating food science, food engineering, nutrition, biotechnology and materials science for resource-efficient, environmentally sustainable and value-added food systems. The volume serves as a useful reference for researchers, academics, students, industry professionals and Policymakers working towards innovations in sustainable food processing, functional foods and smart technologies.

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