

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

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.

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Preface

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

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)

An Approach to Combat Celiac Disease through Food Applications

Neerja, Shubhra Shekhar , Kaushal Kishor Prasad , and Kamlesh Prasad 

Abstract. Celiac disease (CD) is a prevalent autoimmune condition that affects a significant portion of the population, resulting in an immune reaction to gluten that damages the small intestine and triggers a range of symptoms. It manifests in various ways, including gastrointestinal issues like chronic diarrhea and abdominal discomfort, as well as extraintestinal symptoms such as dermatitis herpetiformis. The primary treatment for CD is strict adherence to a gluten-free diet (GFD), which has become increasingly popular among those without the disease due to perceived health benefits. This shift has driven growth in the gluten-free product market, improving dietary options for those with CD. Effective management of CD requires addressing nutritional imbalances and preventing associated complications like osteoporosis and cancer. Progress in gluten-free ingredient development and food technology plays a crucial role in enhancing the nutritional quality of these diets and supporting overall well-being. Continued research and innovation are essential to advance care and improve quality of life for individuals with CD.

Keywords: Celiac disease, Celiac sprue, Gluten-sensitive enteropathy, Wheat, Allergy, Symptoms.

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1. Introduction

Celiac disease (CD) is a chronic autoimmune condition that affects approximately 2% of the global population, with a higher incidence among women (Yilmaz and Polat, 2023). It can occur at any age and presents with a wide variety of symptoms, ranging from gastrointestinal disturbances to extraintestinal issues. Although wheat or wheat bran contains ample amounts of fiber (Saini et al., 2023a; Saini et al., 2023b; Saini et al., 2024, 2025a, b) but the disease is triggered by the ingestion of gluten, a protein found in wheat, barley, and rye, which causes an abnormal immune response in genetically predisposed individuals (Prasad et al., 2007; Prasad et al., 2010a; Prasad et al., 2010b). This immune response results in chronic inflammation and damage to the lining of the small intestine (Gaba et al., 2024; Jafari et al., 2024). Central to CD pathophysiology is gliadin, a component of gluten, which increases intestinal permeability. This process is aggravated by the enzyme transglutaminase, which deaminates gluten into glutamic acid, further exacerbating the inflammatory response (Alzahrani, 2024). Historically, CD diagnoses were often delayed until patients, typically older individuals, exhibited severe malabsorption symptoms such as weight loss, diarrhea, or steatorrhea. Children with GI symptoms and growth issues were sometimes diagnosed earlier (Rossi et al., 2024). The cornerstone of managing CD is strict adherence to a gluten-free diet (GFD), which must be maintained for life to prevent disease progression and alleviate symptoms (Zhang et al., 2022). The rise in popularity of GFDs has been driven in part by the “health halo” effect, the belief that GF products are inherently healthier. This trend extends beyond individuals with CD to those without gluten sensitivity who adopt a GFD for perceived health benefits (Papagianni et al., 2024). The expansion of the GF food market has played a significant role in supporting those with gluten-related disorders (Capriles et al., 2023).

1.1 Symptoms

Celiac disease manifests through a wide range of symptoms, both gastrointestinal and extra-intestinal (Table 1; Fig. 1). Gastrointestinal symptoms are frequently observed and include chronic diarrhea, abdominal pain, bloating, and unintended weight loss, reflecting the disease’s impact on nutrient absorption (Ludvigsson and Murray, 2019). Children may particularly suffer from growth retardation due to malabsorption (Gessaroli

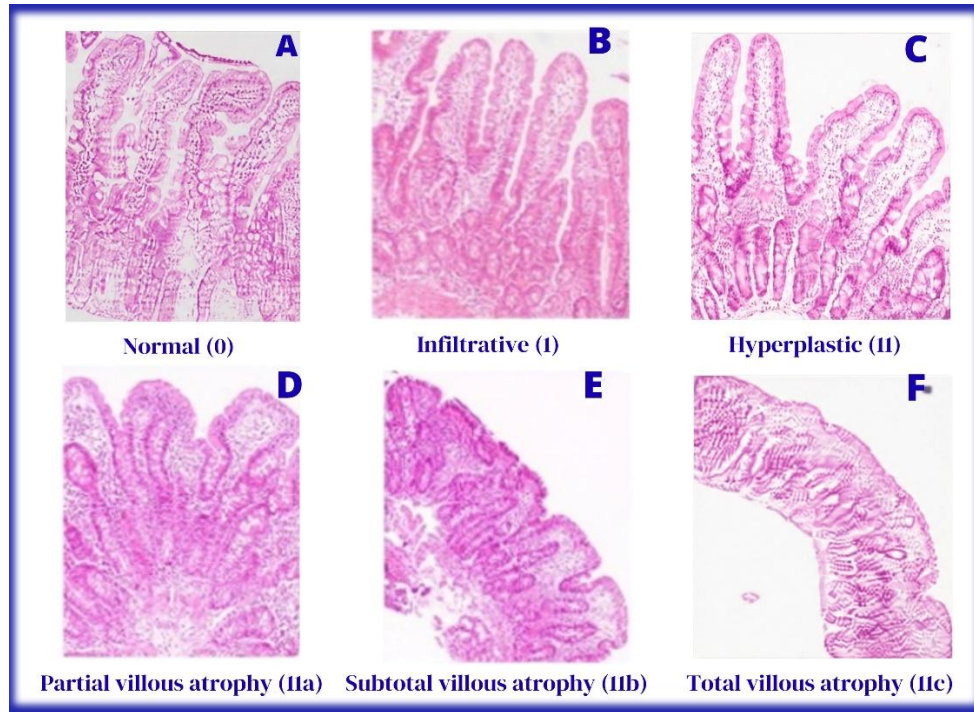


Fig. 2 Modified Marsh Oburhuber classification of Celiac disease.

and market appeal of these products. This approach will be crucial for expanding the market and improving dietary options for individuals with gluten sensitivities and CD (Escudero-Hernández et al., 2015).

5. Conclusion

Celiac disease (CD) remains a complex autoimmune condition with diverse manifestations, making diagnosis and management challenging. The disease is triggered by an adverse immune reaction to gluten, causing damage to the small intestine and leading to a variety of gastrointestinal and extra-intestinal symptoms. The variability in symptom presentation complicates diagnosis and underscores the need for more reliable, accessible diagnostic tools. The cornerstone of treatment is a lifelong adherence to a GFD, which is crucial for alleviating symptoms and preventing long-term complications. Although GFDs are widely advocated, greater awareness of the disease is needed to avoid misunderstandings and ensure effective management. The growing market for GF products has expanded the range of options available, improving quality of life for individuals with CD. Innovations in GF product development, including alternative flours and advanced processing techniques, have improved both nutritional value and sensory appeal. However, these advancements also bring challenges related to the nutritional adequacy and cost of GF foods. Moreover, ongoing research is essential to address complications such as refractory CD and related conditions, including nutrient deficiencies and the risk of malignancies. In essence, while significant progress has been made in understanding and managing CD, continued research and innovation are imperative. Advances in diagnostic methods, dietary interventions, and GF food technologies are crucial for improving patient outcomes. By addressing the challenges and leveraging new developments, the quality of life for individuals with CD can be substantially enhanced, providing a clearer path toward effective management and improved health.

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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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