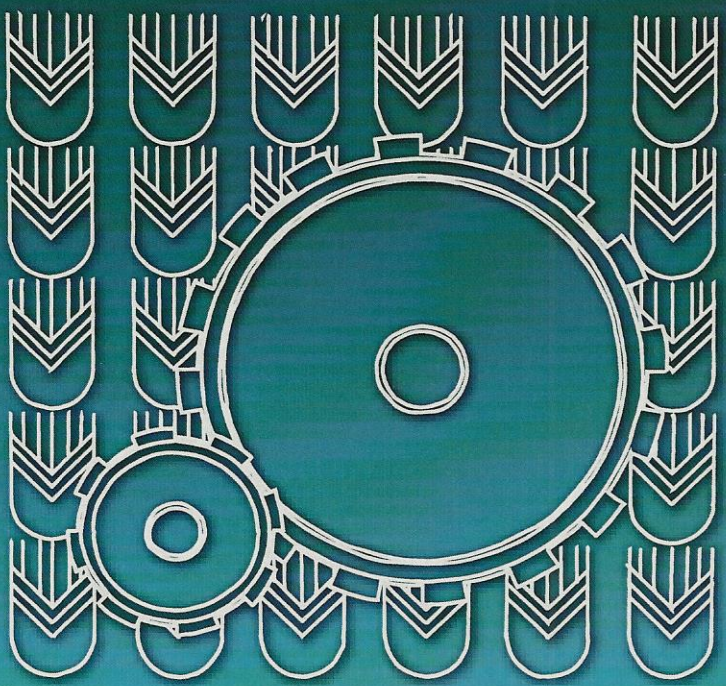
Contemporary Food Engineering Series

Da-Wen Sun, Series Editor

Engineering Aspects of Cereal and Cereal-Based Products



Edited by
Raquel de Pinho Ferreira Guiné
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Food Science & Technology

Engineering Aspects of Cereal and Cereal-Based Products

Cereal food engineering has become increasingly important in the food industry over the years, as it plays a key role in developing new food products and improved manufacturing processes. **Engineering Aspects of Cereal and Cereal-Based Products** focuses on the recent growth in cereal technology and baked foods science, reviewing the latest updates in technological developments in agricultural cultivation and processing for cereal scientists, food engineers, and students.

Cereals include a vast number of biochemical entities, very diverse in composition and properties, as well as technological abilities. The text discusses cereal production, which varies according to cultural practices, type of cereal, cultivar, and region. It also addresses transportation, storage, and cereal quality—important at every phase from harvest to production. Chapters cover technological operations such as wet and dry milling and extrusion, and they address particular processing operations that are subject to improvements, including bread and confectionary baking.

The text also examines malting, rice processing, breakfast cereals, and pasta. In addition, it explores new trends in cereal-based products and the effects of processing on nutritional and functional properties of cereal products. This book discusses the basic elements of cereal technology, from production to transformation, including the most important processing operations in cereal technology, with emphasis on the engineering aspects.

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Engineering Aspects of Cereal and Cereal-Based Products

Contemporary Food Engineering

Series Editor

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Series Preface

Contemporary Food Engineering

Food engineering is the multidisciplinary field of applied physical sciences combined with the knowledge of product properties. Food engineers provide the technological knowledge transfer essential to the cost-effective production and commercialization of food products and services. In particular, food engineers develop and design processes and equipment to convert raw agricultural materials and ingredients into safe, convenient, and nutritious consumer food products. However, food engineering topics are continuously undergoing changes to meet diverse consumer demands, and the subject is being rapidly developed to reflect market needs.

In the development of food engineering, one of the many challenges is to employ modern tools and knowledge, such as computational materials science and nanotechnology, to develop new products and processes. Simultaneously, improving food quality, safety, and security continues to be a critical issue in food engineering study. New packaging materials and techniques are being developed to provide more protection to foods, and novel preservation technologies are emerging to enhance food security and defense. Additionally, process control and automation regularly appear among the top priorities identified in food engineering. Advanced monitoring and control systems are developed to facilitate automation and flexible food manufacturing. Furthermore, energy saving and minimization of environmental problems continue to be important food engineering issues, and significant progress is being made in waste management, efficient utilization of energy, and reduction of effluents and emissions in food production.

The *Contemporary Food Engineering Series*, consisting of edited books, attempts to address some of the recent developments in food engineering. The series covers advances in classical unit operations in engineering applied to food manufacturing as well as such topics as progress in the transport and storage of liquid and solid foods; heating, chilling, and freezing of foods; mass transfer in foods; chemical and biochemical aspects of food engineering and the use of kinetic analysis; dehydration, thermal processing, nonthermal processing, extrusion, liquid food concentration, membrane processes, and applications of membranes in food processing; shelf-life and electronic indicators in inventory management; sustainable technologies in food processing; and packaging, cleaning, and sanitation. These books are aimed at professional food scientists, academics researching food engineering problems, and graduate-level students.

The editors of these books are leading engineers and scientists from many parts of the world. All the editors were asked to present their books to address the market's need and pinpoint the cutting-edge technologies in food engineering.

All the contributions have been written by internationally renowned experts who have both academic and professional credentials. All the authors have attempted to

provide critical, comprehensive, and readily accessible information on the art and science of a relevant topic in each chapter, with reference lists for further information. Therefore, each book can serve as an essential reference source to students and researchers in universities and research institutions.

Da-Wen Sun
Series Editor

Preface

The cereal technology and baked foods industry is a major scientific and technological area, one that is in constant development and is of crucial importance for today's food industry and nutrition.

The field of cereal science and engineering is very wide, and further developments have been achieved in the last few years, whose effects will be decisive in today's cereal products technologies. This book intends to give an updated contribution to provide food science professionals and students the most recent information available.

Cereals include a vast number of biochemical entities, very diverse in composition and properties, as well as technological abilities. Their production varies according to the type of cereal, cultivar, or place of growing, as well as cultural practices. Their quality is of the utmost importance, not only at harvest, but also mostly after storage, when they are used for transformation. Technological operations such as milling, either wet or dry, and extrusion have been important in the past and are still a main area of concern in cereal technology. Some particular processing operations, like bread or confectionary baking, are subject to improvements nowadays, and the nutritional and functional properties of cereal products are more and more important from the consumer's point of view. For these reasons, all the aspects referred to, as well as others, are included in the present book, showing some recent advances in the cereal technology and baked foods science.

Raquel de Pinho Ferreira Guiné
Paula Maria dos Reis Correia

Series Editor

Professor Da-Wen Sun, PhD, is a world authority on food engineering research and education; he is a member of the Royal Irish Academy, which is the highest academic honor in Ireland; he is also a member of Academia Europaea (The Academy of Europe) and a fellow of International Academy of Food Science and Technology. His main research activities include cooling, drying, and refrigeration processes and systems; quality and safety of food products; bioprocess simulation and optimization; and computer vision and spectral imaging technologies.

In particular, his many scholarly works have become standard reference materials for researchers in the areas of computer vision, computational fluid dynamics modeling, vacuum cooling, etc. Results of his work have been published in more than 600 papers, including over 250 peer-reviewed journal papers (Web of Science h-index = 41; Google Scholar h-index = 47). He has also edited 13 authoritative books. According to Thomson Reuters's *Essential Science Indicators*^{SM} updated as of July 1, 2010, based on data derived over a period of ten years and four months (January 1, 2000–April 30, 2010) from the ISI Web of Science, a total of 2554 scientists are among the top 1% of the most cited scientists in the category of agriculture sciences, and Professor Sun is listed at the top with a ranking of 31.

Dr. Sun received his first class BSc honors and his MSc in mechanical engineering, and his PhD in chemical engineering in China before working at various universities in Europe. He became the first Chinese national to be permanently employed in an Irish university when he was appointed a college lecturer at the National University of Ireland, Dublin (University College Dublin [UCD]), in 1995. He was then continuously promoted in the shortest possible time to the position of senior lecturer, associate professor, and full professor. Dr. Sun is now a professor of food and biosystems engineering and director of the Food Refrigeration and Computerized Food Technology Research Group at UCD.

As a leading educator in food engineering, Dr. Sun has contributed significantly to the field of food engineering. He has guided many PhD students who have made their own contributions to the industry and academia. He has also, on a regular basis, given lectures on the advances in food engineering at international academic institutions and delivered keynote speeches at international conferences. As a recognized authority in food engineering, Dr. Sun has been conferred adjunct/visiting/consulting professorships by over ten top universities in China, including Zhejiang University, Shanghai Jiaotong University, Harbin Institute of Technology, China Agricultural University, South China University of Technology, and Jiangnan University. In recognition of his significant contribution to food engineering worldwide, and for his outstanding leadership in the field, the International Commission of Agricultural and Biosystems Engineering (CIGR) awarded him the CIGR Merit Award in 2000

and again in 2006; the UK-based Institution of Mechanical Engineers named him Food Engineer of the Year 2004; in 2008, he was awarded the CIGR Recognition Award in recognition of his distinguished achievements as the top 1% of agricultural engineering scientists around the world; in 2007, he was presented with the only AFST(I) Fellow Award in that year by the Association of Food Scientists and Technologists (India); in 2010, he was presented with the CIGR Fellow Award (the title of "Fellow" is the highest honor in CIGR and is conferred upon individuals who have made sustained, outstanding contributions worldwide); and in 2013, he was awarded by the International Association of Food Protection (IAFP) with the Frozen Food Foundation Freezing Research Award for his preeminence and outstanding contributions in research that impact food safety attributes of freezing.

Dr. Sun is a fellow of the Institution of Agricultural Engineers and a fellow of Engineers Ireland (the Institution of Engineers of Ireland). He has also received numerous awards for teaching and research excellence, including the President's Research Fellowship, and has received the President's Research Award from UCD on two occasions. He is also the editor in chief of *Food and Bioprocess Technology—An International Journal* (Springer) (2011 Impact Factor = 3.703, ranked at the fourth position among 128 ISI-listed food science and technology journals); series editor of the Contemporary Food Engineering Series (CRC Press/Taylor & Francis Group); former editor of *Journal of Food Engineering* (Elsevier); and an Editorial Board Member for a number of international journals including *Journal of Food Process Engineering*, *Sensing and Instrumentation for Food Quality and Safety*, *Polish Journal of Food and Nutritional Sciences*, *etc.* Dr. Sun is also a chartered engineer.

On May 28, 2010, he was awarded membership to the Royal Irish Academy (RIA), which is the highest honor that can be attained by scholars and scientists working in Ireland. At the 51st CIGR General Assembly held during the CIGR World Congress in Québec City, Canada, in June 2010, he was elected as incoming president of CIGR and will become CIGR president in 2013 to 2014. The term of the presidency is six years—two years each for serving as incoming president, president, and past president. On September 20, 2011, he was elected to Academia Europaea (The Academy of Europe), which is functioning as European Academy of Humanities, Letters and Sciences and is one of the most prestigious academies in the world; election to the Academia Europaea represents the highest academic distinction.

Editors

Raquel de Pinho Ferreira Guiné has a license in Chemical Engineering, MSc in Engineering Science specializing in industrial engineering, and a PhD in Chemical Engineering specializing in Unit Operations and Transfer Phenomena, all at the Faculty of Sciences, Coimbra University, Coimbra, Portugal. She is a coordinator–professor at the CI&DETS Research Center and Food Engineering Department, Polytechnic Institute of Viseu, Portugal.

Paula Maria dos Reis Correia has a license in Agro-Industrial Engineering, MSc in Food Science and Technology, and a PhD in Food Engineering, all at the Institute of Agronomy, Technical University of Lisbon, Lisboa, Portugal. She is an adjunct professor at the CI&DETS Research Center and Food Engineering Department, Polytechnic Institute of Viseu, Portugal.

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