BAKERY PRODUCTS SCIENCE AND TECHNOLOGY

SECOND EDITION

Editor: Weibiao Zhou

Administrative Editor: Y. H. Hui

Associate Editors: I. De Leyn, M. A. Pagani, C. M. Rosell, J. D. Selman, N. Therdthai

WILEY Blackwell

Bakery Products Science and Technology

Bakery Products Science and Technology

Second Edition

Editor

Weibiao Zhou

Food Science and Technology Programme, c/o Department of Chemistry,
National University of Singapore, Singapore

Administrative Editor

Y. H. Hui

Science Technology System, West Sacramento, California, USA

Associate Editors

I. De Leyn

Faculty of Bioscience Engineering, Department of Applied Biosciences, Ghent University, Ghent, Belgium

M. A. Pagani

Department of Food, Environmental and Nutritional Sciences (DeFENS),
Università degli Studi di Milano, Milan, Italy

C. M. Rosell

Food Science Department, Instituto de Agroquímica y Tecnología de Alimentos,
Consejo Superior de Investigaciones Científicas, Paterna, Spain

J. D. Selman

Fossatello Group, Carnforth, Lancashire, UK

N. Therdthai

Department of Product Development, Faculty of Agro-Industry, Kasetsart University,
Bangkok, Thailand

WILEY Blackwell

Registered Office
John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Offices
9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
111 River Street, Hoboken, NJ 07030-5774, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

Library of Congress Cataloging-in-Publication Data

Bakery products science and technology / [compiled by] Dr Weibiao Zhou and Y H Hui. – Second edition.
pages cm
Includes bibliographical references and index.
ISBN 978-1-119-96715-6 (cloth)
1. Baking. 2. Baked products. I. Zhou, Weibiao. II. Hui, Y. H. (Yiu H.)
TX763.B325 2014
641.81′5–dc23
2013048365

A catalogue record for this book is available from the British Library.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Cover image: Fresh Bread © iStock/ Chelnok
Cover design by Andy Meaden

Set in 10/12pt Times Ten by SPi Publisher Services, Pondicherry, India

1 2014

Contents

Preface to the Second Edition

Bakery products, especially bread, have a long history and they form an important part of the diets of humans around the globe. Bakery products are not only popular in traditional markets such as Europe, but they are also gaining popularity in emerging markets. For example, Euromonitor International recently reported that China's market for industrial baked goods was valued at US$25.4bn for 2013, up from US$19.6bn in 2012.

Meanwhile, today's consumers are increasingly conscious of health issues, so producing high-quality bakery products presents both a challenge and an opportunity. While there is no dispute that bakery products contain a high amount of carbohydrate and some may also contain gluten and high levels of fat and sugar, they can also be a source of wholesome food and balanced nutrients. Producing new types of bakery products or reformulating existing ones to increase their nutritional value or raise their nutritional profile is likely to remain a trend for the foreseeable future.

Since the publication of the first edition of this book in early 2006, progress in the science and technology of baking and bakery products has done much to address these and other challenges. Therefore, the second edition provides a timely update and expansion to the previous edition. The book consists of 42 chapters that are grouped into 7 parts:

1. Introduction to baking and bakery products;
2. Characterization and properties of important types of flours for bakery products, including those from wheat, rye, rice, barley, maize, sorghum, millet, and other grains;
3. Major baking ingredients such as water, yeast and other leavening agents, ascorbic acid and other redox agents, sugar and sweeteners, lipids, egg, dairy ingredients, enzymes, and other functional additives;
4. Science and technology of bakery production with dedicated chapters on mixing and dough making, fermentation, baking, and packaging. Also included are shelf-life prediction, process optimization and control, and sensory and nutritional attributes of bakery products. Specific issues such as rheology, browning, and functional bakery products are also covered;
5. Manufacturing of a variety of bread products including yeast bread, sourdough, frozen dough, par-baked bread, and steamed bread, as well as their quality control issues;
6. Other selected bakery products such as cakes, biscuits, pastries, pretzels, bakery products from unconventional flours, and dietetic bakery products; and
7. An overview of specialty bakery products from around the world as well as an in-depth analysis of bakery products from selected countries including China, Italy, Mexico, and Turkey.

Despite every intention to provide a comprehensive reference book on baking science and technology, we appreciate that it is not possible to claim that this book represents complete coverage. Nevertheless, we hope it serves as an essential reference on the latest knowledge and technologies for professionals in the baking industry, academia and government bodies, as well as for undergraduate and postgraduate students in their study and research related to baking and bakery products.

We thank the contributors, all respected professionals from industry, government, and academia, for sharing their experience and expertise in their particular fields. The 65 authors are from 21 countries and have a diversity of expertise and background that cover the whole spectrum of the science, technology, and engineering of baking and bakery products.

We also express our sincere thanks to the five associate editors who are domain experts from five countries, for their dedication to producing a book of the highest quality possible, and the editorial and production teams at Wiley Blackwell for their efforts, advice, and professionalism.

We truly wish that you enjoy the book and find its contents informative and beneficial to your work, research, or study.

Weibiao Zhou and Y.H. Hui

Contributors

Victoria Kristina Ananingsih
Food Technology Department,
Soegijapranata Catholic University,
Central Java, Indonesia

Lidia Ballester-Tomás
Department of Biotechnology,
Instituto de Agroquímica y Tecnología
de Alimentos,
Consejo Superior de Investigaciones Científicas,
Paterna, Spain

Luis A. Bello-Perez
Centro de Desarrollo de Productos Bióticos del
Instituto Politécnico Nacional,
Yautepec, Morelos, México

Francesco Bonomi
Department of Food, Environmental and
Nutritional Sciences (DeFENS),
Università degli Studi di Milano,
Milan, Italy

Gabriella Bottega
Department of Food, Environmental and
Nutritional Sciences (DeFENS), Università degli
Studi di Milano,
Milan, Italy

Ana Isabel Bourbon
Centre of Biological Engineering,
Universidade do Minho,
Braga, Portugal

Inês Castro
Castro,
Pinto & Costa, Lda,
Maia, Portugal

Stanley P. Cauvain
BakeTran,
Witney, Oxford, UK

Miguel Ângelo Cerqueira
Centre of Biological Engineering,
Universidade do Minho,
Braga, Portugal

Selena Chan
Christchurch Polytechnic Institute of Technology,
Christchurch, New Zealand

Xiao Dong Chen
Department of Chemical and Biochemical Engineering,
College of Chemistry and Chemical Engineering,
Xiamen University,
Xiamen, China

Peter Chung Chieh
Department of Chemistry,
University of Waterloo,
Waterloo,
Ontario, Canada

Nyuk Ling Chin
Department of Process and Food Engineering,
Faculty of Engineering,
Universiti Putra Malaysia,
Serdang, Selangor, Malaysia

Concha Collar
Food Science Department,
Instituto de Agroquímica y Tecnología de Alimentos,
Consejo Superior de Investigaciones Científicas,
Paterna, Spain

Frank D. Conforti
Department of Human Nutrition, Foods, and Exercise,
Virginia Tech,
Blacksburg, Virginia, USA

I. De Leyn
Faculty of Bioscience Engineering,
Department of Applied Biosciences,
Ghent University,
Ghent, Belgium

Pasquale Ferranti
Dipartimento di Scienza degli Alimenti,
Università di Napoli "Federico II",
Portici, Italy

Pamela C. Flores-Silva
Centro de Desarrollo de Productos Bióticos del
Instituto Politécnico Nacional, Yautepec,
Morelos, México

Virginia Giannou
Laboratory of Food Chemistry and Technology,
School of Chemical Engineering,
National Technical University of Athens,
Athens, Greece

Avi Goldstein
Department of Food Science,
University of Guelph,
Guelph, Ontario, Canada

Manuel Gómez
College of Agricultural Engineering,
University of Valladolid,
Palencia, Spain

Noël Haegens
Classo Foods, Vrasene, Belgium

Raija-Liisa Heiniö
VTT Technical Research Centre of Finland,
Food Biotechnology/Flavour Design,
Finland

M. S. Hemalatha
Department of Biochemistry and Nutrition,
CSIR–Central Food Technological Research
Institute, Mysore, India

Sidi Huang
Grain Growers Limited,
North Ryde, New South Wales,
Australia

Y. H. Hui
Science Technology System,
West Sacramento,
California, USA

Gözde İnan
Abant Izzet Baysal University,
Faculty of Arts and Sciences,
Department of Biology,
Bolu, Turkey

Kati Katina
University of Helsinki, Finland

Hyunsook Kim
Department of Physiology,
College of Veterinary Medicine,
Konkuk University,
South Korea

Vassilios Kiosseoglou
Laboratory of Food Chemistry and Technology,
School of Chemistry,
Aristotle University of Thessaloniki,
Thessaloniki, Greece

Dimitra Lebesi
Laboratory of Food Chemistry and Technology,
School of Chemical Engineering,
National Technical University of Athens,
Athens, Greece

Kim Little
Campden BRI, Chipping Campden,
Gloucestershire, UK

Shao Quan Liu
Food Science and Technology Programme,
c/o Department of Chemistry,
National University of Singapore,
Singapore

Tiphaine Lucas
IRSTEA Food Process Engineering Research Unit,
Rennes Cedex,
France

Mara Lucisano
Department of Food, Environmental and Nutritional
Sciences (DeFENS), Università degli Studi di Milano,
Milan, Italy

Gianfranco Mamone
Istituto di Scienze dell' Alimentazione – CNR,
Avellino, Italy

Alejandro Marangoni
Department of Food Science,
University of Guelph, Guelph, Ontario,
Canada

Manuela Mariotti
Department of Food, Enviromental and Nutritional
Sciences (DeFENS), Università degli Studi di Milano
Milan, Italy

Alessandra Marti
Department of Food, Environmental and Nutritional
Sciences (DeFENS), Università degli Studi di Milano,
Milan, Italy

Peter J. Martin
School of Chemical Engineering and Analytical
Science, The University of Manchester,
Manchester, UK

N. N. Misra
School of Food Science and Environmental Health,
Dublin Institute of Technology, Dublin, Ireland

Bonastre Oliete Mayorga
Regional Centre of Animal Selection and
Reproduction, Valdepeñas, Spain

Perla Osorio-Diaz
Centro de Desarrollo de Productos Bióticos del
Instituto Politécnico Nacional,
Yautepec, Morelos, Mexico

M. A. Pagani
Department of Food, Environmental and Nutritional
Sciences (DeFENS),
Università degli Studi di Milano,
Milan, Italy

Adamantini Paraskevopoulou
Laboratory of Food Chemistry and Technology,
School of Chemistry,
Aristotle University of Thessaloniki,
Thessaloniki, Greece

Daniel Pinto
Castro, Pinto & Costa, Lda,
Maia, Portugal

Kaisa Poutanen
VTT Technical Research Centre of Finland,
Finland

U. J. S. Prasada Rao
Department of Biochemistry and Nutrition,
CSIR–Central Food Technological Research
Institute,
Mysore, India

José Antonio Prieto
Department of Biotechnology,
Instituto de Agroquímica y Tecnología de Alimentos,
Consejo Superior de Investigaciones Científicas,
Paterna, Spain

Emmanuel Purlis
Centro de Investigación y Desarrollo en Criotecnología de Alimentos (CIDCA – CONICET La Plata), Facultad de Ciencias Exactas, UNLP, La Plata, Argentina

Francisca Rández-Gil
Department of Biotechnology, Instituto de Agroquímica y Tecnología de Alimentos, Consejo Superior de Investigaciones Científicas, Paterna, Spain

C. M. Rosell
Food Science Department, Instituto de Agroquímica y Tecnología de Alimentos, Consejo Superior de Investigaciones Científicas, Paterna, Spain

Sarabjit S. Sahi
Campden BRI, Chipping Campden, Gloucestershire, UK

Maria E. Sanchez-Pardo
Escuela Nacional de Ciencias Biológicas del Instituto Politécnico Nacional, México, D.F.

Koushik Seetharaman
Department of Food Science, University of Guelph, Guelph, Ontario, Canada

J. D. Selman
Fossatello Group, Carnforth, Lancashire, UK

N. Therdthai
Department of Product Development, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand

Brijesh K. Tiwari
Department of Food Biosciences, Teagasc Food Research Centre, Dublin, Ireland

Gary Tucker
Campden BRI, Chipping Campden, Gloucestershire, UK

Constantina Tzia
Laboratory of Food Chemistry and Technology, School of Chemical Engineering, National Technical University of Athens, Athens, Greece

Rubi G. Utrilla-Coello
Centro de Desarrollo de Productos Bióticos del Instituto Politécnico Nacional, Yautepec, Morelos, México

Antonio Vicente
Centre of Biological Engineering, Universidade do Minho, Braga, Portugal

Wallace H. Yokoyama
USDA, ARS, Western Regional Research Center, Albany, California, USA

Seyhun Yurdugül
Abant Izzet Baysal University, Faculty of Arts and Sciences, Department of Biology, Bolu, Turkey

Lu Zhang
Department of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen, China

Weibiao Zhou
Food Science and Technology Programme, c/o Department of Chemistry, National University of Singapore, Singapore

Part 1

Introduction

1

Introduction to Baking and Bakery Products

Weibiao Zhou[1], N. Therdthai[2], and Y. H. Hui[3]
[1]Food Science and Technology Programme, c/o Department of Chemistry, National University of Singapore, Singapore
[2]Department of Product Development, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand
[3]Science Technology System, West Sacramento, California, USA

Bakery Products Science and Technology, Second Edition. Edited by W. Zhou, Y. H. Hui, I. De Leyn, M. A. Pagani, C. M. Rosell, J. D. Selman, and N. Therdthai.

Introduction

Bakery products, particularly bread, have a long history of development. Evidence from the most recent archaeological discovery indicates that baking practice may have started as early as 23 000 years ago (i.e. ~21,000 BC) during the Paleolithic Period (Piperno and others 2004). At that time, people discovered wheat and learnt to mix wheat grain meal with water and bake it on stones heated by fire. This gave birth to the first flat bread made by humans. During the period of 2600–3000 BC, yeast was used by ancient Egyptians to make fermented bread. Due to the high cost of milling, whole wheat and whole grain bread was generally consumed. White bread was also available, but limited only to groups of rich people. Since the 1900s, white bread has become common for everyone. Today, bakery products range in complexity from consisting of the simple ingredients of a plain pastry to the numerous components that make up a cake. The evolving of bakery products from the original plain and simple forms to the modern varieties with specific attributes and functionalities using sophisticated manufacturing technologies has been going hand-in-hand with the progress in many related fields of science and technology. For today's professionals, keeping abreast of the advanced knowledge in bakery products' science and technology is critical to continuously improve the productivity of current practice, identify the most important areas to direct limited research and development resources, and launch new competitive products into the market, as well as to predict future trends in the industry.

This chapter highlights the topics covered in this book using selected material from each chapter. Table 1.1 serves as a frame of reference for the discipline.

Flours

Wheat flour

Wheat is the most versatile cereal due to the capacity of its storage proteins to interact and develop the gluten network, which forms the basic framework of many bakery products. Because there is a deep crease in the kernel, flour is extracted by a sequence of breaking, sieving, and size-reducing processes, known as the milling process. This process makes it possible to contemporaneously separate the bran and germ regions and to break the endosperm cells into a very fine product, suitable for rapid hydration and gluten development. Milling yield and flour refinement are closely related both to the milling conditions and the variety of wheat used. The latter highly influences the technological performance of the flour (measured by several instrument tests) and bread characteristics. As well as refined flours, increasing attention is being given to whole wheat flours that include the bran and germ fractions, which are presently considered to be by-products despite their richness in several bioactive compounds.

Wheat flour chemistry

The biochemistry of the main components of wheat flour (proteins, carbohydrates, and lipids) are presented and discussed with a focus on those properties relevant to the baking industry. As well as considering the composition and structure

Table 1.1 Baking science and technology: a composite picture[a]

- **Materials of Baking Products**
- Ingredients from wheat
  - Wheat flour milling
  - Other wheat products
- Ingredients from other grains
  - Rye
  - Rice
  - Barley
  - Sorghum
  - Corn
  - Oat
  - Millet
  - Soy
- Yeast and chemical leavening
- Yeast
- Chemical leavening agents
  - Acids
  - Baking powder
- Ascorbic acid and redox agents
- Fats and oils
  - Fat and oil processing
  - Types of fat and oil
    - Butter
    - Margarine
    - Shortening
    - Vegetable oils
  - Fat's role in bakery products
  - Yeast-raised products
  - Laminated products
  - Cakes
    - Cookies and crackers
    - Dough fat
    - Filling fat
    - Spray oil
    - Coating fat
- Sweeteners
  - Nutritive sweeteners
    - Sucrose (regular refined sugars)
    - Invert sugar
    - Fondant
    - Brown sugar
    - Molasses
    - Fructose
    - Starch hydrolysates
    - Honey
    - Malt syrup
  - Alternative sweeteners
    - Sugar alcohols
    - High intensity sweeteners
  - Nutritional profiles
  - Browning
  - Functional products
  - Rheology
- Dairy products
  - Fresh liquid milk
  - Cream
  - Fermented milk products
  - Evaporated and condensed milk
  - Whey products
  - Cheese
- Eggs
- Fruits and nuts
    - Fruits
    - Nuts
- Chocolate and cocoa
- Salt, spices, and flavorings
    - Salt
    - Spices
    - Flavoring
- Water
- Production of Bread and Yeast-Leavened
  - Bakery Foods
  - Types of yeast products
    - Lean dough products
    - Rich dough products
    - Rolled-in yeast dough products
    - Special dough products
- Steps in yeast dough production
- Types of dough-making processes
  - Straight dough method
  - Sponge-and-dough method
  - Chorleywood bread process
  - Sourdoughs
- Production of soft wheat products
  - Crackers
  - Cookies
    - Commercially made cookies
    - Handmade cookies
      - Dough mixing methods
      - Types and make up methods
  - Cakes
    - Types of cakes
    - Cake formula balancing
    - Methods of mixing
    - Baking
  - Pastries
- Shelf-life and Packaging of Bakery Products
  - The mechanism of staling
  - Anti-staling additives
  - Packaging technologies
- Additional Topics
  - Sensory profiles
  - Quality control
  - Computer technology, optimization and automation
- World specialty products

[a]Some of the listings in this table are inspired by Lai and Lin (2006).

of each of the major macromolecules in flour, particular attention is paid to the interactions among the various flour components and to their modification in the various phases of baking-related processes. The role of water transfer issues is also considered, along with its modulation by flour components or by added ingredients.

Rye flour

Rye (*Secale cereale* L.) is a traditional raw material for baking in northern and eastern Europe. The flavor and structure of rye bread are quite different from those of wheat bread, and vary depending on flour type, other raw materials and ingredients, dough making process, baking conditions, and time, as well as the size and shape of the bread. Generally consumed as whole grain products, rye offers a good source of dietary fiber, phenolic compounds, vitamins, trace elements, and minerals. Rye bread has also been shown to have beneficial physiological effects, especially for glucose metabolism and satiation. Expanding research data strengthen the position of rye grain as an important raw material for healthy foods, and the potential for developing novel products is growing with the knowledge about its transformations during milling and baking processes.

Rice flour

Rice is one of the most consumed cereals, mainly as milled rice. However, several different value-added rice products have been developed prompted by the unique nutritive properties of this grain. Among all the processed rice-based products that are being launched, bakery products have received special attention. Nowadays, more people are attracted to wheat-free foods because of health concerns or to avoid wheat in the diet. The chapter on rice gives a brief description of rice production and reviews the physicochemical characteristics of rice flours and their use in baking.

Barley, corn, sorghum, and other cereal grains

Developing countries with diets based on coarse grains continue to derive 70–80% of total food calories from maize, sorghum, and/or millet. In developed countries, the concept of using South American, African, and Asian traditional non-wheat cereals and ethnic grains as a template for wheat, wheat-free, and gluten-free based foods, matches the interest in westernized countries for exotic foods with their previously unappreciated extra nutritional value. Chapter 6 gives an update on the traditional and new uses in baking of major coarse grains worldwide. Special emphasis is placed on the challenges and opportunities of using maize, barley, oat, sorghum, and millet in composite breads. The evolution of the production, consumption, share of calories, and categories of use of individual coarse grains is revised, and the diversity of ethnicl goods and bakery products from coarse grains across the continents is presented. An overview of the advances in coarse grain-based baked goods based on scientific and technological progress and on their health-promoting effects is provided.

Baking ingredients

Water

The importance of water as a baking ingredient is overshadowed by its overwhelming abundance. The role of water in baking science is perhaps not fully appreciated by most of us, but all master bakers know that water plays a major role in the art and science of baking. The amount of water controls the quality, texture, taste, odor, volume, flavor, and the mouthfeel of bakery products. The art of baking involves using the optimum amount of quality water.

Nearly all foods contain water, while it is the major component in many foods. Even dry foods contain some water. If the baking process does not call for water as an ingredient, water is still involved, because it is present in some of the ingredients. Water reacts with the baking ingredients and evaporates when heated. Chapter 7 explores many facets of water with an emphasis on its role in baking.

Yeast

Saccharomyces cerevisiae has been used in the production of fermented cereal-based products since ancient times. Its domestication and large-scale propagation were key factors in the development of the modern baking industry. Here, the authors review how the long association of *S. cerevisiae* with bakers and yeast producers has affected its makeup and genetic characteristics. They also look into how the yeast industry has achieved the low-cost transformation of abundant feedstock, such as molasses, in to cell biomass of high technological quality, and how genetic improvement approaches could address the demands of consumers and producers of strains with optimized or novel properties. Finally, they discuss the possibility of using non-conventional yeast species as alternatives to industrial *S. cerevisiae* strains.

Chemical leavening agents

Leavening agents including yeast, other microorganisms, and chemical leaveners are important for their gas producing ability to give volume and crumb structure to a baked product. Chemical leaveners are interesting for their almost immediate action when applied in a recipe. The production of carbon dioxide is responsible for the fermentation/expansion of a dough or batter and is important for crumb structure. Crumb structure is the result of a certain "lightness" that is important for the properties such as volume, shape, flavor development, tenderness, and brittleness of a baked product.

Carbon dioxide is produced by yeast, other microorganisms (sourdough), and chemical leaveners. Each leavening agent has a specific characteristic that makes it suitable for use in some products. Each leavening agent also has its limitations. The working mechanism of chemical leaveners and acidulants are discussed in Chapter 9.

While carbon dioxide is the most important factor for leavening, other gases (ammonia gas), water as steam, and incorporated air (added during the mixing process) also play a role in the expansion of baked goods.

Chemical leaveners are a group of leavening agents, mostly inorganic salts, which when added to dough, either singly or in combination, react to produce gases. Carbon dioxide is the main leavening gas and is produced by either decomposition, where ammonium bicarbonate produces ammonia, water, and carbon dioxide in the presence of water, or by the reaction of an acidic salt and sodium bicarbonate in the presence of moisture and heat to form a salt, water, and carbon dioxide.

Ascorbic acid and redox agents

Ascorbic acid is commonly used as an improver in the baking industry and in some countries it is the only oxidation improver allowed. Other dough improvers include potassium bromate and azodicarbonamide to oxidize and sodium metabisulfite and L-cysteine to reduce gluten-forming proteins. The key change affected by such materials is the sulfhydral/disulfide reaction which plays an important role in the rheological properties of bakery systems. In Chapter 10, the effects of these materials are reviewed in brief. Enzymes are now used to replace or support the action of the traditional redox materials and the effects of selected enzymes in the production of bakery products is described.

Sugars and sweeteners

Sweeteners are important ingredients in bakery products. As well as providing a sweet taste, they also affect the fermentability, appearance, flavor, color, structure, and texture of the finished products. There are many choices of sweeteners available, and the type chosen depends on the degree of sweetness needed, its functions in the dough or batters, and the desired appearance or texture of the baked product. Marketing and regulatory issues must also be checked carefully, as they can vary in different countries. Sucrose is one of the most important nutritive sweeteners used domestically and in the food industry. However, as a response to public interest in low-calorie products, there has recently been a growing interest in sucrose substitutes. This is a huge challenge, due to the detectable losses in appearance, texture, flavor, and mouthfeel of the final food caused by sucrose reduction or substitution.

Fats and fat replacers

Chapter 12 focuses on the properties and functions of lipids as ingredients in food applications. Lipids may play a variety of roles in food systems depending on their application. Differences in the crystallization of fats may yield networks with altered macroscopic properties. Firstly, this chapter discusses the role of food lipids in various common baked-product matrices. The relationships between the microstructure and the macroscopic properties of lipid networks are then discussed, focusing on the roles of crystallization, polymorphism, rheological properties, microstructure, and processing conditions. Finally, strategies for the replacement of fats in baked products for the purpose of improving human health are discussed.

Eggs

Chicken egg is a multifunctional food material used in the preparation of many foods (salad dressings, meringue, cakes, and so on). Its multifunctional role originates from the differing properties of the albumen and the yolk fractions, which are made up of protein constituents that differ in molecular size and structural flexibility. Egg constituents in food products may function as foaming, emulsifying, and/or gel network agents, thus contributing to the development of their unique sensory and rheological characteristics. In baked products, especially cakes, egg functional constituents contribute to product structure development and physical stability, with the extent of this contribution depending on the product type and the presence of other functional ingredients.

Dairy ingredients

Chapter 14 describes the effect of adding dairy ingredients to gluten-containing and gluten-free bakery products. The addition of dairy ingredients improves the nutritional quality of bakery products but alters the rheological behavior of dough and batters and the quality of bread, cakes, and biscuits. Furthermore, some dairy ingredients are used as substitutes for bakery ingredients such as eggs and fats. The behavior of dairy ingredients in bakery products depends on their composition, changes during the production process, and on their interaction with other components. The chapter describes the characteristics of milk and the changes that occur during the production of concentrated, dried, and fermented milks, cream, cheese, whey, and casein and whey protein concentrates. This is followed by a description of the role of dairy ingredients in bakery products.

Enzymes

Chemical additives are often used to obtain improved bakery products. As enzymes are natural and safe, food industries prefer to use enzymes as alternatives to synthetic chemicals. The enzyme-catalyzed reactions are substrate specific and take place under mild conditions. Different enzymes such as amylases, proteases, peroxidases, glucose oxidase, xylanase, laccase, lipase, and transglutaminase are used to improve dough and bread quality. Use of these enzymes in non-bread, wheat-based products is also increasing. A basic knowledge of enzymes is required for them to be used efficiently as ingredients. Also, enzymes should be sourced from a safe organism and be free of toxins. In Chapter 15, basic aspects of enzyme properties, some of the important enzymes used in the baking industry and their effect on flour constituents in improving functionality, and the use of enzymes in improving the functionality of some non-bread, wheat-based products are discussed.

Other functional additives

Functional additives have been used in the bakery sector for almost a century. Today the selection of emulsifiers, a wide range of enzymes, and oxidizing and reducing agents has been extended because of the evolution of bakery equipment and processing and because of an increased understanding of the complex mechanisms of their interactions with different constituents of flour and dough. The various additives are developed to compensate for variations in the processing characteristics of flours. They improve the machinability of dough, simplify the process, improve the quality of baked goods, and extend their shelf-life. Chapter 16 discusses oxidizing and reducing agents, vital gluten, emulsifiers, and also briefly mentions enzymes.

Baking science and technology

Mixing, dough making and dough make-up

It cannot be stressed enough that mixing is the most important stage of the entire baking process. If it is not done properly, it is not possible to correct it later. Therefore discipline is required. It is not easy to repeat exactly the same process every 12 or 15 minutes; however, it is necessary and of the utmost importance. Someone who wants to be proud of the quality of the product he has made must also be proud of the fact that he is capable of repeating the same process over and over again – and that is a real challenge. In Chapter 17, the factors that influence mixing are discussed: calculating the temperature of water, different kneading machines, the head and tail effect, and so on.

Fermentation and proofing

Fermentation in baking is mainly due to yeast and lactic acid bacteria. Their metabolic activities are responsible for the quality of the dough and hence for much of the quality of the final bakery products. Mechanisms during fermentation mainly include generation of carbon dioxide gas (promoting dough expansion), lactic acid (contributing to dough acidity), acetic acid (acting as antifungal compound), exopolysaccharides (involving dough viscosity properties), volatile compounds (acting as flavoring agents), and amino acids (involved as precursors of flavoring compounds). In addition, fermentation may cause some change in starch digestibility and the availability of minerals and vitamins. Consistent fermentation can be easier to achieve using starter cultures. To monitor the kinetics of dough expansion during fermentation, non-destructive testing has been developed using digital video cameras, magnetic resonance microscopy, X-ray tomography, and acoustic waves.

Baking

During baking, heat and mass transfer takes place in the dough simultaneously and interdependently, and involves four major changes:

1. Gases are vaporized as the temperature increases: the gas cell increases in volume provided that the cell wall retains gases and is deformable.
2. Starch gelatinizes as temperature increases to an extent depending on the local availability of water; proteins coagulate. These changes limit the dough extensibility.
3. The initial structure with closed gas cells separated by dough walls is transformed into a porous structure with interconnected pores, known as the dough–crumb transition.
4. Under the action of high temperatures at the boundaries, water vaporizes in the oven atmosphere. Depending on the product thickness, but also on baking conditions, this supports the formation of a dry, hard crust in the case of dessert or bread dough, and may also lead to complete drying in the case of biscuits and cookies.

These different changes do not occur sequentially but overlap and they are discussed in detail in Chapter 19.

Packaging and shelf-life prediction

Bakery products are popular and appealing due to their nutritional, sensory, and textural characteristics. However, these qualities can start to deteriorate immediately after baking leading to staleness, loss of moisture and flavor, and a limited shelf-life. Therefore, research has focused on the development of advanced packaging and preservation technologies and techniques for bakery products. Inherent overall product quality, as well as environmental storage conditions, influence the characteristics of bakery products and hence affect their acceptance. Thus, packaging materials, methods, and conditions for different bakery products, as well as the methodology for estimating and predicting their shelf-life, have been investigated.

Process optimization and control

Chapter 21 describes how the processing of baked products involves a sequence of processing stages that starts with mixing and ends with cooling. A structured process optimization study must consider all stages as linked because changes to any one processing stage will affect the other stages as a result of the interactions between stages. For example, increasing the proofing temperature will change the gas cell expansion of bread dough and also affect the baking process because of the changes this imposes on heat and mass transfer. Additional difficulties in optimizing the bread making process are the timings from the start of mixing to the end of baking and how to ensure that changes made to one stage are not compromised by another. These difficulties pose interesting challenges for the subject of process optimization.

Sensory attributes

The flavor of a cereal product is formed by a combination of the volatile and phenolic compounds, amino acids and peptides, sugars, and fatty acids, and their relative amounts significantly influence the perceived flavor. The flavor of native grain is mild, but by bioprocessing, such as sourdough fermentation, germination, and enzymatic treatment, or by extrusion or milling fractionation, the cereal product flavor can be modified as desired. In addition to containing fiber and bioactive compounds, whole-grain products that are beneficial to health must be tasty so they are attractive to the consumer.

Nutritional attributes

Wheat bread has been an important source of caloric energy and protein for the people of many continents for thousands of years and continues to be so. Bread, particularly white wheat bread, has recently been implicated as contributing to the chronic diseases associated with obesity, although in its whole grain forms it may also ameliorate these conditions. Chapter 23 focuses on the physiological impact of bread composition and processing on obesity, diabetes, and cardiovascular diseases. Recent research has suggested that chronic low-grade inflammation, due to the passage of intestinal bacterial fragments into the body, is a cause of chronic obesity-related diseases and perhaps initiates obesity itself. Cellulose, arabinoxylans, phenolic substances associated with fiber, resistant starch, amylose content, and processing affect digestibility, rate of absorption, intestinal tight barrier function, bile acid excretion, fat excretion, blood cholesterol, blood glucose, blood insulin, and insulin resistance.

Browning

Bakery products have typical quality features that are diverse and depend on the particular product and its country or region of origin (for example, there are regional variations of the same product). Surface color is an important sensory attribute particularly associated with appearance, aroma, taste, and with the overall quality of bakery products. It has a significant effect on consumer judgment as color influences the anticipated oral and olfactory sensations because of the memory of previous eating experiences.

Therefore, surface color plays a key role in the acceptance of the product by consumers, and it is often used to determine the end point of the baking process.

The formation of color in bakery products occurs during the baking stage (unless colored ingredients or colorants are being used), which is the scope of discussion in Chapter 24. This phenomenon is widely known as browning and is the result of non-enzymatic chemical reactions – the Maillard reaction and caramelization – that produce colored compounds during baking. The Maillard reaction takes place where reducing sugars and amino acids, proteins, and/or other nitrogen-containing compounds are heated together, while caramelization describes a complex group of reactions that occur due to direct heating of carbohydrates, in particular sucrose and reducing sugars. Because of the type of reactants and products involved in the Maillard reaction and caramelization, the importance of browning development is not only related to sensory aspects but also to nutritional properties. From this angle, the Maillard reaction impairs the content and bioavailability of amino acids and proteins, and it may be related to the formation of harmful compounds such as acrylamide and hydroxymethylfurfural (HMF). On the other hand, some reaction products are associated with positive nutritional properties such as antioxidant activity.

Functional bakery products

Consumers' demand for healthier food products that prevent nutrition-related diseases and improve physical and mental well-being has led to the accelerated growth of the functional foods market. Nowadays, the bakery industry seeks to improve the health attributes of their products using functional ingredients. The major areas of development involving functional foods are gastrointestinal health and immunity, prevention of cardiovascular diseases and cancer, weight control, insulin sensitivity and control of diabetes, and mental and physical performance.

Fibers, flavors, vitamins, minerals, bioactive compounds, prebiotics, and probiotics are some of the compounds used most frequently to add value to food products. These topics are explored in Chapter 25.

Rheology of bread and other bakery products

Chapter 26 introduces rheological terms useful for food scientists and technologists in understanding the rheological properties of bakery products that correlate with baking performance. The properties related to the deformation of bread dough and the flow of cake batters are characterized to obtain parameters either through fundamental approaches involving large or small deformation testing or through empirical approaches using standard test methods. The physical transformations of dough and batters that occur during mixing because of the forces and deformations arising from the mechanical actions of mixing are described. Rheological parameters from different measurement approaches are analyzed and compared. The chapter highlights the problems of differing and mismatched test ranges and speeds, as dough characteristics are highly dependent on the stresses, strains, and strain rates applied.

Bread

Bread manufacture

Bread is a major food item for many people across the world. Varieties of bread, particularly as functional foods, have been developed to serve the needs of the consumer. Nonetheless, for almost all bread varieties, the bread manufacturing process mainly consists of mixing, fermentation and proofing, sheeting, molding, baking, cooling, and, if required, slicing. Each of the steps plays a unique role in the development of dough and bread towards the quality of the final product; therefore they all need to be carefully operated within a prescribed range. Advanced process control and automation systems should also be designed and implemented for bread manufacturing.

Quality control

Bread quality is very much an individual perception, and is therefore a contentious issue. Quality means different things to different people, and no two people share the same opinion about a particular type of bread. However, cereal scientists and technologists are able to identify certain characteristics for each style of bread and to determine the attributes that add to quality and those that detract from it. In Chapter 28 the issue of bread quality is tackled from the European prospective, and the factors that are considered to be important in the range of bread types that are popularly consumed in the United Kingdom and the rest of Europe are examined.

Appearance is the first visual assessment of a loaf, and key factors include the volume (size) of the bread as well as the color – particularly that of the crust – and the shape of the loaf. The quality issues considered to be important differ for each style of bread. For example, a key factor for sandwich-type bread would be the uniform distribution of small-sized bubbles, which gives the bread crumb its characteristic appearance and the physical strength to allow butter to be spread over the surface. For French baguettes, it is the crisp, flavorful crust that contributes most to eating quality, paired with an open and irregular crumb. For these two bread types, the production methods are essentially the same; the process must create the appropriate number and sizes of gas bubbles in the dough and ensure that they survive during subsequent processing. The process of creating and controlling bubble structure therefore makes a fundamental contribution to bread quality, and this chapter deals with the key mechanisms of structure control available to the baker, as well details on the choice of ingredients, formulations, equipment, and processing methods that affect the quality of the final product.

Sourdough

Sourdough is a mixture of cereal flour and water fermented with lactic acid bacteria (LAB) with or without yeasts, and includes traditional sourdoughs and fermented cereal foods. The growth of LAB acidifies the dough and imparts a sour taste and odor, while yeast fermentation contributes to the aroma and leavening. Sourdough fermentation improves texture, enhances nutritional status, and extends the shelf-life of baked products and fermented cereal foods. LAB cultures adapt to the acidic environment of sourdoughs by developing acid-resistant mechanisms associated with arginine catabolism, glutamate decarboxylation, and exopolysaccharide formation, as well as through thiol accumulation and beneficial interactions with the yeasts. Cereal is a suitable matrix for developing functional foods by fermentation with probiotics, biofortification, and glutamate bioconversion to bioactive γ-aminobutyric acid.

Frozen dough and par-baked bread

In Chapter 30, frozen dough and par-baked definitions and technologies are discussed. Particular emphasis is paid to dough gas retention properties and the roles of yeast in frozen and refrigerated dough. The principles of formulation and production for frozen, pre-proved frozen and refrigerated dough are identified and discussed. The manufacture of par-baked products is considered.

When a product is baked, sold, and consumed locally within 24–48 h of production, changes to the product quality are limited. However, if the product is to retain its edibility for longer, then strategies which extend its shelf-life are required. An alternative to shelf-life extension strategies is to use technology to interrupt the standard industrial bread processes and use the intermediates for bake-off production at local sites such as village bakeries, railway and petrol stations, and retail baking environments. Freezing and par-baking represent the two most common means of achieving such aims. However, a major challenge for the primary manufacturer of frozen dough and par-baked products is that the ultimate product is only determined at final bake-off, when the conditions and practices used are not usually within the primary manufacturer's control.

Steamed bread

Chinese steamed bread is widely known as 'eastern bread' and has been consumed in its various forms for more than 1700 years. Although it originated in China, its popularity has spread to Japan, Korea, and Southeast Asia. Steamed bread is the staple food in the wheat growing areas of northern China. It may be consumed at all meals and is usually eaten hot. Dough for Chinese steamed bread is made from fermented wheat flour or blends of wheat and other grain flours. The product is cooked by steaming in a steamer. The most common types of steamed breads are either round or roughly cylindrical in shape with a white, smooth, shiny skin devoid of crust. Texture varies from dense to open and the flavor is dependent upon local tastes.

Like European bread, where one piece of bread dough can be used to make different forms of products such as pan bread, rolls, and buns, the same piece of steamed bread dough can be used to make different forms of steamed products such as steamed bread, steamed buns, and steamed twisted rolls. Steamed products can be made with and without fillings.

Traditionally, steamed bread is made at home by hand. Today, in cities, almost all steamed bread, buns, and rolls are made in small factories. These modern factories use mechanical mixing, sheeting, and even rounding. Therefore, in Chapter 31, all topics on steamed products refer to products made using mechanical processing.

Traditional and specialty products

Cakes

For centuries cake-making has changed very little. The 16th century Spice Cake, the 18th century Nun's Cake, even the rich Pound Cake of the colonial days required long hours of labor. Old "receipts" read:

> …take a half a peck of fine wheat-flour … three pounds of refined sugar … dry them by the fire … take four pounds of butter, beat it with a cool hand, then beat thirty-five eggs, etc.

Later recipes called for smaller amounts, but the method of mixing was essentially the same.

There are a variety of cake products with a broad range of formulations. Ingredients, such as flour, have improved through processing; therefore, cakes contain higher levels of shortening, sugar, eggs, and milk. The modern cake is characterized by a sweet taste, short and tender texture, and pleasant flavors and aromas. Chapter 32 presents current science and technology in the manufacture of cakes.

Biscuits

The word biscuit is derived from the Latin *panis biscotis* meaning twice cooked bread. This is because the original process consisted of baking the biscuits in a hot oven and then drying in a cool oven. Biscuit has two meanings: (i) small round bread leavened with baking powder or soda, and (ii) any of the various small flat sweet cakes. 'Biscuits' is the original British word used to include small baked products (usually flat) based on wheat flour with various inclusions of fat, sugar, and other ingredients. The name 'biscuit' is synonymous with 'cookie' but the former is more comprehensive in meaning in the United Kingdom and Indian sub-continent and the latter in the United States. Wafer biscuits represent a special type of baked product because they are formed between a pair of hot plates and not on a baking band or wire as are most other types. Today, biscuits are a part of snacks, luxury gifts, dietary products, infant foods, and also come with the addition of many expensive ingredients, such as chocolate and cream. In general, biscuits are recognized as those products that are cereal based and baked to a moisture content of less than 5%. The cereal component is variously enriched with two major ingredients, fat and sugar. The ingredients and manufacture details for biscuits are discussed in Chapter 33.

Pastries

The origin of puff pastry and Danish pastry is thought to be the Turkish *baklava*. Baklava is a rich, sweet pastry made of layers of phyllo pastry filled with chopped nuts and sweetened with syrup or honey. It is characteristic of the cuisines of the former Ottoman Empire. Phyllo dough is a paper-thin sheet of unleavened flour dough used for making pastries. By adding yeast to the dough, puff pastry becomes Danish pastry.

In Scandinavia and in Denmark in particular, the term *Danish* pastry is not used. In these countries bakers talk about *wienerbrot* which literally means "bread from Vienna". In French, the term used for Danish pastry is *viennoiserie*, again referring to Vienna as the origin of these products. In Austria itself it is called *plunder*.

It is generally thought that the croissant originated in France. While traditionally ascribed to the French painter and cook Claude Gelée who lived in the 17th century (the story goes that Gelée was making a type of very buttery bread for his sick father and the process of rolling the butter into the bread dough created a croissant-like finished product), the origin of the croissant lies in Vienna. The shape of the croissant is a crescent moon and was first made by the bakers of Vienna during the 1683 siege of their beloved city by the Ottoman Empire. They made a *plundergebäck* in the shape of a crescent moon to betray the position of the Ottoman army. Years later when the French queen Marie-Antoinette (1755–1793) visited Vienna, she fell in love with the product in the shape of a half moon or *lune croissant* in French, hence the name *croissant* in French.

It is important to understand that all these types of products (puff pastry, croissant, Danish pastry) are made by creating alternating layers of dough and fat by folding and rolling the dough. Chapter 34 explores the world of European pastries.

Pretzels

Hard pretzels were introduced to the United States in the 1860s at Lititz, Pennsylvania and have since become a very popular snack food. Pretzel is said to have had its origin when a 12th century monk rewarded children who recited their prayers properly. The crossed center of the pretzel form, legend has it, represented the folded hands of prayer. Pretzels are acknowledged as a healthy snack and are gaining popularity around the world.

Since the 1980s, significant advances have been made in automating pretzel production. Considerable improvements have been made to the equipment used in plants including high-speed mixers, pretzel dough cutter systems, automated pretzel forming machines, and pretzel ovens. Several patents have also been granted for new methods in hard pretzel manufacturing. Chapter 35 describes traditional and new methods in the production of pretzels.

Bakery products of unconventional flours

Unconventional flours from fruits, legumes, and tubers are used in the elaboration of bakery products, replacing different amounts of wheat flour, or in products without wheat flour such as gluten-free products. Unconventional flours are used in bakery products so that ingredients such as dietary fiber and bioactive compounds that are not available in wheat or maize flours are included. This can lower the consumption of digestible carbohydrates that increase the glucose level in the blood, and could therefore have health benefits. Bakery products normally contain a high amount of starch that becomes digestible due to the cooking process. The combination of wheat or maize flours with ingredients rich in dietary fiber, such as unripe fruit and legume flours, decreases starch digestibility. Additionally, fruits like unripe banana present a high level of resistant starch. Results obtained in the studies so far have shown a higher amount of resistant starch, dietary fiber, and bioactive compounds in bakery products with added unconventional flours from unripe fruits and legumes; additionally, the glycemic response of these bakery products was lower than the control samples. The use of unconventional flours is an alternative to produce functional bakery products.

Dietetic bakery products

Increased consumer income, improved consumer understanding of nutrition, and enhanced consumer expectations are changing attitudes to the role of diet in the lifestyle of individuals. Global health systems in developed and developing countries have begun to shift emphasis from dealing with infectious disease to managing the challenges presented by increases in mortality caused by chronic diseases including cardiovascular diseases, diabetes, and cancer . Therefore, in recent years, assessing the health consequences of food consumption habits has emerged as an important topic of inquiry.

Bakery products may be usefully adapted to increase healthier eating options for consumers. "We are what we eat" is an apt adage adopted by some consumers to inform their dietary choices. It is therefore important for bakers to also be conversant with the range of consumer preferences and dietary needs characterizing the present bakery products market.

In Chapter 37, bakery products that cater for the special dietary needs of consumers are introduced. The following dietary market opportunities are discussed:

- food intolerances (specifically gluten and lactose intolerance and allergy to eggs),
- bakery products that contribute to a healthier lifestyle (low-fat, low-sugar, and high-fiber products),
- bakery products required for specialized diet requirements (consumers with diabetes),
- bakery products for special religious diet requirements (Kosher and Halal),
- bakery products suitable for lifestyle choices (sports nutrition, vegetarianism, and veganism), and
- bakery products suitable for various demographics of consumers (children, women, and seniors).

Each section includes a discussion on the challenges that each dietary requirement will present to the baker or bakery technologist.

Examples of world bakery products

World specialties

The list of speciality bakery products, especially bread, in the world is endless and it would be impossible to describe all of them. Suffice to say that if there are five bakers in a town, there will be five different kinds of bread. This is because the secret of bread making does not only lie in the recipe but also in the way the product is actually made. The discussion in Chapter 38 is limited to a number of products (and their production methods) that are distinct and well-known throughout the world, with some emphasis on Belgium.

Bakery products in China

It is unquestionable that China is a gourmet food paradise. Among countless delicacies in China, the delicate traditional baked foods are significant and play a very important role as either staple food or non-staple food. Wheat was cultivated in China about 5000 years ago. At first, the grains were eaten raw, but soon the art of grinding it into flour was learned. Even though wheat is a staple food grain in the West, the Chinese have developed many more ways to prepare it. This very wide variety of Chinese grain products, and their level of sophistication, is due to the many different methods of preparation and cooking that have been developed, including frying, deep frying, baking, steaming, and boiling. Dishes can be sweet, salty, soft, hard, crispy, spongy or flaky.

Italian bakery products

In Italy, popular tradition has led to the creation of different types of baked goods, both sweet and savory, whose origins come from the broad diversification over the centuries of crops cultivated in the different pedoclimatic conditions of the Italian peninsula and with the use of different fermentation procedures, including the sourdough process. A classification of Italian baked products based on different criteria – percentage of sugar in the formulation, texture, specific volume, and moisture content – is proposed Chapter 40. The process cards of the most popular products are presented after a brief description of the different steps of the bread baking process. The products taken into consideration are different kinds of bread, produced from common wheat flour or remilled semolina by straight dough or sourdough fermentation, Neapolitan pizza, festivity cakes such as *panettone, pandoro* and *colomba*, and other traditional products of the different Italian regions.

Mexican bakery products

Mexico is probably the country that has the highest number of types of bread (around 1600) in the world. The Mexican bread industry can be considered as artisanal because small factories, including those inside supermarkets, produce fresh bread that is consumed immediately. Bread is also sold in baskets by people walking in the street or riding on bicycles. Mexican bread can be divided into two main kinds: salty and sweet. Salty bread is named "pan de labranza" with names such as "bolillo", "telera", "birote", "frances", and this kind of bread is the most consumed. There is a wide variety of sweet bread that is consumed during breakfast and dinner. There are diverse kinds of bread such as "pan de muerto" and "rosca de reyes" that are prepared for festivals or special dates. The industry of Mexican bread and the types of products is a creativity that continues from generation to generation.

Bakery products in Turkey

Turkish cuisine is full of some amazing food components with which to spoil your taste buds. However, no matter where you go in Turkey and whatever it is that you eat, you will find one thing to be a constant part of the meals, and that is bread. Turkish bread is consumed not only for breakfast, but also with all meals at all times of the day. This is why almost every household either bakes its own bread or sends its dough to a communal bakery. Bread baking is such an integral part of the Turkish lifestyle that every household must have its own baker who is an expert at making the bread. The foundation of Turkish food is, if anything, dough made of wheat flour. The original white bread that is used in Turkey is called ekmek and flat bread is known as pide. There are other types of bread such as simit, with sesame seeds, and manti that has much in common with ravioli. There is a whole family of foods that are made out of these types of bread and are categorized under the name borek. These varieties of bread are eaten for breakfast as well as for snacks and they also accompany most of the daily meals. These versatile pieces of bread can be sliced, filled, fried, baked, toasted, grilled, and prepared in many inventive ways. The Muslims of the Ottoman period believed bread to be one of the earliest forms of cuisine dating back to the time of the Prophet Adam, and bread is still held as one of the simplest and most honorable foods to eat. Taking their inspiration from this very basic food, they make bread a big part of their daily lives. Some would argue that there is no bread on Earth that tastes like Turkish bread, and you have to eat it to realize how good it actually is.

References

Lai HM, Lin TC. 2006. Bakery products: Science and technology. In: Hui Y H and others, editors. Bakery products: Science and technology. 1st ed. Ames, IA: Blackwell Publishing. Chapter 1.

Piperno DR, Weiss E, Holst I, Nadel D. 2004. Processing of wild cereal grains in the Upper Palaeolithic revealed by starch grain analysis. Nature 430:670–3.