

VOLUME 2

ADVANCES IN FOOD SCIENCE AND NUTRITION

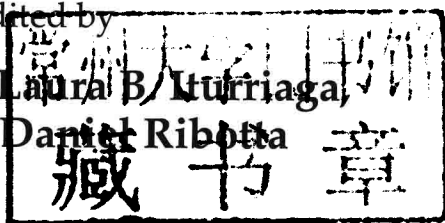
EDITED BY

Visakh P.M., Laura B. Iturriaga,
and Pablo Daniel Ribotta

Advances in Food Science and Nutrition

Edited by

Visakh. P. M, Laura B. Iturriaga,
and Pablo Daniel Ribotta



WILEY

Copyright © 2014 by Scrivener Publishing LLC. All rights reserved.

Co-published by John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts.

Published simultaneously in Canada.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

For more information about Scrivener products please visit www.scrivenerpublishing.com.

Cover design by Russell Richardson

Library of Congress Cataloging-in-Publication Data:

ISBN 978-1-118-13709-3

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Advances in Food Science and Nutrition

Scrivener Publishing
100 Cummings Center, Suite 541J
Beverly, MA 01915-6106

Publishers at Scrivener
Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

Preface

Advances in Food Science and Nutrition summarizes many of the recent technical research accomplishments in the areas of potato production, composition and starch processing; milk and different types of milk products; processing and preservation of meat, poultry and seafood; food ingredients; fruits and fruit processing; antioxidant activity of phytochemicals and their method of analysis; indispensable tools in food science and nutrition; transformations of food flavor due to elaboration of industrial processing; new trends in sensory characterization of food products, and; ultrasound applications in food technology. As the title indicates, the book emphasizes various aspects of the advances in food science and nutrition and their different applications for the food sciences and scientific community. It is written in a systematic and comprehensive manner and all recent advances are discussed in detail. It is very important to mention that till now, there have not been many books published on this topic.

In this sense, the content of this book is unique. It presents up-to-date records on major findings and observations in the field, and is intended to serve as a “one stop” reference resource for related important research accomplishments. The various chapters of the book are contributed by prominent researchers from industry, academia and government/private research laboratories around the world. Therefore, it will be a very valuable reference source for university and college faculties, professionals, post-doctoral research fellows, senior graduate students, food science technologists and researchers from R&D laboratories working in the area of food science and nutrition.

The first chapter on food chemistry and technology is an overview of the contents of the book. This chapter is essential for beginners since it provides a thorough understanding of the basics of food science.

Chapter 2 discusses potatoes and their production, composition and starch processing. The chemical composition of potatoes is explained along with the effects that cultivar, location, growth, fertilizer applications, maturity at harvest, and storage conditions have on them. A survey on milk and different types of milk products, their processing and preservation are covered in Chapter 3. Among the other topics discussed by the authors are milk production and quality.

Chapter 4 discusses processing and preservation of meat, poultry and seafood. Numerous topics are explored by the authors such as food quality characteristics; deterioration and microbial contamination; physical and chemical methods of preservation; preliminary processes; control of moisture and temperature; radiation and other technologies; various methods and compounds; microbiological contributions to meat; hurdle combinations of methods, and; atmosphere inside packaging.

Useful terminology and definitions are found in Chapter 5 on food ingredients. Also covered are food additives, novel and natural plant-based ingredients, and properties and applications of plant-derived ingredients. Chapter 6 discusses fruits and fruit processing. Included in the many subtopics are the effects of low temperature on fruits; modified and controlled atmosphere storage; modified atmosphere packaging; edible coatings; factors affecting fruit conservation methods; traditional preservation methods, and; modern preservation methods with minimal processing.

The authors of Chapter 7 on antioxidant activity of phytochemicals and their method of analysis address the importance of antioxidants in human health. Also addressed are natural antioxidants; methods used to measure total antioxidant activity; problems in comparing various methods of antioxidant activity and discrepancies over their measurement, and; methods for antioxidant phytochemical analysis.

Chapter 8 on indispensable tools in food science and nutrition is a thorough discussion enhanced by many reviews in recent research works. Topics are presented on food safety from farm to plate; foodborne pathogens; probiotics in food; the pros and cons of genetically modified (GM) foods; bioavailability of nutrients, and; food safety regulations.

The important topic of transformations of food flavor due to elaboration of industrial processing is covered in Chapter 9. Topics discussed are aroma compounds; chemical reactions that contribute

food flavor; the Maillard reaction; formation of flavor compounds in the Maillard reaction and kinetics and factors influencing it; flavor from lipids; flavors formed via fermentation, and; special processes used in the industrial production of flavor. Chapter 10 discusses new trends in sensory characterization of food products. Explained in the various topics are descriptive analysis; methodologies based on specific attributes; methodologies that provide a verbal description of the products; methods based on the comparison with references, and; comparison of the methodologies.

The effect of food processing on bioactive compounds is presented in Chapter 11. The author includes many of the recent advances related to the topics of bioactive compounds; reactive oxygen species; antioxidant defenses against reactive oxygen (RO); bioactive compounds and natural antioxidants; processing of foods containing bioactive components; effect of postharvest handling methods and shelf life determination; methods for the determination of antioxidants; methods for measuring the oxidation of an oil or food sample; techniques involving bioactive compound determination, and; high performance liquid chromatography (HPLC).

Advancements in storage technologies for fresh fruits are presented in Chapter 12. Different techniques for food storage are discussed such as methylcyclopropene (1-MCP) based storage technology; palladium-based ethylene adsorbers; ultra low oxygen (ULO) storage technology; dynamic controlled atmosphere (DCA) storage technology; microcontrolled atmosphere (MCA) and bulk modified atmosphere packaging (MAP) technologies; nitric oxide based technology, and; biosensors.

The final chapter is on ultrasound applications in food technology. The equipment used in the applications, combined processes and effects on safety and quality parameters are discussed. Some of the specific topics are ultrasound application in equipment design for improving processing efficiency; food preservation applications; enzymes and microorganisms, and; ultrasound effects on food quality attributes.

Finally, the editors would like to express their sincere gratitude to all the contributors of this book, who were an excellent support throughout the successful completion of this venture. We are grateful to them for the commitment and the sincerity they have shown towards their contribution to the book. Without their enthusiasm and support, the compilation of a book series could not have been possible. We would like to thank all the reviewers who have taken

their valuable time to make critical comments on each chapter. We also thank the publisher Wiley-Scrivener for recognizing the demand for such a book, for realizing the increasing importance of the area of food science and nutrition, and for starting a new project in which not many other publishers are yet involved.

Visakh. P. M
Laura B.Iturriaga
Pablo Daniel Ribotta

Contents

Preface	xiii
1 Recent Advances in Food Science and Nutrition: State of Art, New Challenges and Opportunities	1
<i>Visakh. P.M., Laura B. Iturriaga and Pablo Daniel Ribotta</i>	
1.1 Potato Production, Composition and Starch Processing	2
1.2 Milk and Different Types of Milk Products	4
1.3 Processing and Preservation of Meat, Poultry and Seafood	5
1.4 Food Ingredients	7
1.5 Fruits and Fruit Processing	7
1.6 Antioxidant Activity of Phytochemicals and Their Method of Analysis	9
1.7 Indispensable Tools in Food Science and Nutrition	10
1.8 Transformation of Food Flavours Due to Industrial Processing Elaboration	11
1.9 New Trends in Sensory Characterization of Food Products	12
1.10 Effect of Food Processing on Bioactive Compounds	13
1.11 Recent Advances in Storage Technologies for Fresh Fruits	14
1.12 Ultrasound Applications in Food Technology	16
References	17

2	Potato: Production, Composition and Starch Processing	23
	<i>Narpinder Singh, Amritpal Kaur, Khetan Shevkani and Rajarathnam Ezekiel</i>	
2.1	Introduction	24
2.2	Composition	24
2.3	Starch Production	34
2.4	Starch Properties	36
	References	41
3	Milk and Different Types of Milk Products	49
	<i>Yantyati Widyastuti and Andi Febrisiantosa</i>	
3.1	Introduction	49
3.2	Milk Production and Quality	51
3.3.1	Effect of Animal Diet on Milk Productivity	51
3.2.2	Organic Milk	56
3.3	Types of Milk Products	56
3.3.1	Liquid Milk as Beverage	57
3.3.2	Cream	59
3.3.3	Butter	59
3.3.4	Ice Cream	60
3.3.5	Fermented Milk Product	62
3.4	Conclusion	65
	References	65
4	Processing and Preservation of Meat, Poultry and Seafood	69
	<i>Elisabete M.C. Alexandre, Cristina L.M. Silva and Teresa R.S. Brandão</i>	
4.1	Introduction	70
4.2	Food Quality Characteristics	71
4.3	Deterioration and Microbial Contamination	73
4.4	Physical Methods of Preservation	74
4.4.1	Preliminary Processes	74
4.4.2	Water Spray-Washings	76
4.4.3	Control of Temperature	77
4.4.4	Control of Moisture	81
4.4.5	Radiation Technologies	82
4.4.6	Other Technologies	87

4.5	Chemical Methods of Preservation	89
4.5.1	Curing	89
4.5.2	Smoking	90
4.5.3	Other Methods/Compounds	91
4.6	Microbiological Contributions to Meat Preservation	93
4.6.1	Competition	93
4.6.2	Fermentation	94
4.6.3	Bacteriocins	94
4.7	Hurdle Combinations of Methods	95
4.8	Atmosphere Inside Package	95
	Acknowledgments	96
	References	96
5	Food Ingredients	105
	<i>Dongxiao Sun-Waterhouse</i>	
5.1	Introduction	106
5.2	Useful Terminology and Definitions	107
5.3	Food Additives	109
5.4	Novel and Natural Plant-Based Ingredients	113
5.5	Properties and Applications of Plant-Derived Ingredients	120
5.6	Conclusion and Future Prospects	125
	References	126
6	Fruits and Fruit Processing	133
	<i>Ariel R. Fontana and Romina P. Monasterio</i>	
6.1	Introduction	133
6.2	Fruits	136
6.2.1	Low Temperature	136
6.2.2	Modified and Controlled Atmosphere Storage	137
6.2.3	Modified Atmosphere Packaging	140
6.2.4	Edible Coatings	141
6.3	Fruit Processing	142
6.3.1	Factors Affecting Fruit Conservation Method	143
6.3.2	Traditional Preservation Methods	144
6.3.3	Modern Preservation Methods with Minimal Processing	146
	References	150

7 Antioxidant Activity of Phytochemicals and Their Method of Analysis	153
<i>Ashish Rawson, Ankit Patras, B. Dave Oomah, Rocio Campos-Vega and Mohammad B. Hossain</i>	
7.1 Introduction	154
7.2 Importance of Antioxidants in Human Health (Their Mechanism of Action)	155
7.3 Natural Antioxidants	158
7.3.1 Sources of Natural Antioxidants	158
7.3.2 Uses of Natural Antioxidants	160
7.4 Overview of Methods Used to Measure Total Antioxidant Activity	163
7.4.1 Measurement of Antioxidant Activity	165
7.4.2 Assays Involving a Biological Substrate	165
7.4.3 Assays Involving a Non-Biological Substrate	166
7.5 Problems in Comparing Various Methods of Antioxidant Activity and Discrepancies over Their Measurement	188
7.6 Methods for Antioxidant Phytochemical Analysis	191
7.6.1 Spectrophotometer	191
7.6.2 High Performance Liquid Chromatography (HPLC)	191
7.6.3 Liquid Chromatography–Mass Spectrometry (LC–MS)	214
7.6.4 Liquid Chromatography–Nuclear Magnetic Resonance (LC–NMR)	215
7.7 Concluding Remarks	237
References	238
8 Indispensable Tools in Food Science and Nutrition	257
<i>Sneha P. Bhatia</i>	
8.1 Introduction: Food Safety – From Farm to the Dinner Plate	257
8.2 Foodborne Pathogens	259
8.3 Probiotics in Food	264
8.4 Genetically Modified (GM) Foods – Friends or Foe?	270
8.5 Bioavailability of Nutrients	273

8.6	Food Safety Regulations	275
8.7	Conclusion	276
	References	276
9	Transformations of Food Flavor Due to Industrially Processing of Elaboration	279
	<i>Romina P. Monasterio</i>	
9.1	Introduction	280
9.2	Aroma Compounds	292
9.3	Chemical Reactions that Contribute to Food Flavor	292
9.3.1	Maillard Reaction	293
9.3.2	Flavor from Lipids	298
9.3.3	Flavors Formed via Fermentation	302
9.4	Special Industrial Process and Flavor	309
9.5	Industrial Production of Flavor	312
9.6	Summary	315
	References	315
10	New Trends in Sensory Characterization of Food Products	321
	<i>Gastón Ares and Ana Giménez</i>	
10.1	Introduction	321
10.1.1	Sensory Characterization	321
10.1.2	Descriptive Analysis	322
10.2	New Trends in Sensory Characterization of Food Products	325
10.2.1	Overview	325
10.2.2	Methodologies Based on Specific Attributes	327
10.2.3	Methodologies that Provide a Verbal Description of the Products	332
10.2.4	Holistic Methodologies	338
10.2.5	Methods Based on the Comparison with References	345
10.2.6	Comparison of the Methodologies	348
10.3	Conclusions and Recommendations	352
	References	354

11 Effect of Food Processing on Bioactive Compounds	361
<i>Sarana Sommano</i>	
11.1 Bioactive Compounds	362
11.1.1 Reactive Oxygen Species (ROS)	362
11.1.2 Antioxidant Defenses Against ROS	363
11.1.3 Bioactive Compounds or Natural Antioxidants	364
11.1.4 Other Significant Bioactive Compounds	371
11.2 Processing of Foods Containing Bioactive Components	372
11.2.1 Effect of Postharvest Handling Methods and Shelf Life Determination	372
11.2.2 Effect of Processing	373
11.2.3 Effects of Storage	377
11.3 Methods for the Determination of Antioxidants	378
11.3.1 Measuring Antioxidant Activity	378
11.3.2 Radical-Scavenging Methods	378
11.3.3 Methods for Measuring the Oxidation of an Oil or Food Sample	380
11.3.4 Techniques Involving Bioactive Compound Determination	383
References	385
 12 Recent Advances in Storage Technologies for Fresh Fruits	 391
<i>Sukhvinder P. Singh and Leon A. Terry</i>	
12.1 Introduction	392
12.2 1-Methylcyclopropene (1-MCP) Based Storage Technology	393
12.3 Palladium Based Ethylene Adsorbers	394
12.4 Ultra Low Oxygen (ULO) Storage Technology	397
12.5 Dynamic Controlled Atmosphere (DCA) Storage Technology	398
12.6 Microcontrolled Atmosphere (MCA) and Bulk Modified Atmosphere Packaging (MAP) Technologies	400

12.7 Nitric Oxide Based Technology	401
12.8 Biosensors	403
12.9 Conclusions	405
References	406
13 Ultrasound Applications in Food Technology: Equipment, Combined Processes and Effects on Safety and Quality Parameters	413
<i>Rui M.S. Cruz, Igor Khmelinskii and Margarida C. Vieira</i>	
13.1 Introduction	414
13.2 Equipment Design	416
13.3 Ultrasound Application for Improving Processing Efficiency	420
13.4 Food Preservation Applications	424
13.4.1 Enzymes	424
13.4.2 Microorganisms	424
13.5 Ultrasound Effects on Food Quality Attributes	430
13.6 Conclusions	432
References	432
Index	445

Recent Advances in Food Science and Nutrition: State of Art, New Challenges and Opportunities

Visakh. P.M.^{1,2,*}, Laura B. Iturriaga³ and Pablo Daniel Ribotta⁴

¹*Centre for Nanoscience and Nanotechnology, Mahatma Gandhi University, Kottayam, Kerala, India*

²*School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, India*

³*Institute of Chemical Sciences, Faculty of Agronomy, National University of Santiago del Estero, Santiago del Estero, Argentina*

⁴*Department of Science and Technology, National University of Córdoba, Córdoba, Argentina*

Abstract

This chapter presents a brief account on various topics concerning food science and nutrition. Also presented are different parameters within food science and nutrition such as potato production, composition and starch processing; milk and different types of milk products; processing and preservation of meat, poultry and seafood; food ingredients; fruits and fruit processing; antioxidant activity of phytochemicals and their method of analysis; indispensable tools in food science and nutrition; transformations of food flavour due to elaborative industrial processing; trends in sensory characterization of food products; effects of food processing on bioactive compounds; recent advances in storage technologies for fresh fruits and; ultrasound applications in food technology, etc. Also discussed are recent technical research accomplishments in the area that have immense structural possibilities for chemical and mechanical

*Corresponding author: visagam143@gmail.com

Visakh. P. M, Laura B. Iturriaga and Pablo Daniel Ribotta (eds.) *Advances in Food Science and Nutrition*, (1–22) 2014 © Scrivener Publishing LLC