## Woodhead Publishing Series in Food Science, Technology and Nutrition

# Poultry Quality Evaluation

Quality Attributes and Consumer Values

Edited by

Massimiliano Petracci

University of Bologna, Bologna, Italy

Cécile Berri

URA, INRA, Nouzilly, France



Woodhead Publishing is an imprint of Elsevier The Officers' Mess Business Centre, Royston Road, Duxford, CB22 4QH, United Kingdom 50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States The Boulevard, Langford Lane, Kidlington, OX5 1GB, United Kingdom

Copyright © 2017 Elsevier Ltd. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

#### Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

#### **British Library Cataloguing-in-Publication Data**

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

#### Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-0-08-100763-1 (print) ISBN: 978-0-08-100769-3 (online)

For information on all Woodhead Publishing publications visit our website at https://www.elsevier.com/books-and-journals



Publisher: Andre G. Wolff
Acquisition Editor: Nina Bandeira
Editorial Project Manager: Karen R. Miller
Production Project Manager: Julie-Ann Stansfield

Cover Designer: Christian Bilbow

Typeset by MPS Limited, Chennai, India

### **Contents**

List of Preface	f Contributors ce	xiii xv			
1.	Dynamics and Patterns of Global Poultry-Meat Production Hans-Wilhelm Windhorst				
	<ul> <li>1.1 Introduction</li> <li>1.2 The Dynamics of Global Poultry-Meat Production Between 1994 and 2014</li> <li>1.3 The Patterns of Poultry-Meat Production in the Country Development Groups in 2014</li> <li>1.4 The Leading Poultry-Meat-Producing Companies—An Overview</li> <li>1.5 A Projection of the Development of Poultry-Meat Production and Consumption Between 2014 and 2024</li> <li>1.6 Projected Surplus and Deficit of Poultry Meat on Continent and Country Levels in 2024</li> <li>1.7 Summary and Perspectives</li> <li>References</li> <li>Further Reading</li> </ul>	1 5 11 15 22 24 25 25			
Betv	to I at is New in Our Understanding of the Association ween Muscle Structure and the Basic Eating Alities of Cooked Meat?	n			
2.	Myogenesis Muscle Growth and Structure  Daniel Clark and Rachel Harding				
	<ul> <li>2.1 Introduction</li> <li>2.2 Muscle Structure</li> <li>2.3 Muscle Contraction</li> <li>2.4 Fiber Type</li> <li>2.5 Embryonic Origin of Muscle</li> <li>2.6 Posthatch Muscle Growth</li> </ul>	29 29 31 32 33 36			

#### vi Contents

	2.7	, ,	enic Regulatory Factors in Muscle Growth	37			
	2.8	_	ation of Muscle Growth	38			
	2.9		ellular Matrix Regulation of Muscle Growth	40			
	2.10		urface Proteoglycans: Mediators of ECM Signaling	42			
	2.11	Growt	fect of Growth Selection on Myogenesis and Muscle	43			
	Refe	rences		44			
3.	Mus	Muscle Metabolism and Meat Quality Abnormalities					
	Mass	imiliand	o Petracci, Francesca Soglia and Cécile Berri				
	3.1	Introdu	ction	51			
	3.2	Postmo	rtem Muscle Metabolism-Related Abnormalities	53			
	3.3	Muscle-	Growth-Related Abnormalities	59			
		3.3.1 [	Deep Pectoral Myopathy	59			
			Emerging Muscle Abnormalities	61			
		Conclus		70			
	Refe	rences		70			
4.	Dev	elopm	ents in Our Understanding				
••		of Water-Holding Capacity					
		Bowke					
	4.1			77			
	4.1		uction  ods for Massuring WHC	77 78			
	4.2		ods for Measuring WHC Gravimetric Methods				
			External Mechanical Force Methods	78 79			
				79 79			
			Cooking Methods Other Methods	79 79			
	4.3			80			
	4.3 4.4		•				
	4.5		oution and Types of Water Within Muscle	82 83			
	4.5	4.5.1	Bound Water	84			
			Immobilized Water	85			
			Free Water	85			
	4.6		lying Mechanisms That Influence WHC	85			
	7.0		Net Charge Effects	86			
			Steric Effects	87			
			Protein Denaturation	89			
			Protein Degradation	91			
	4.7		oultry Meat	92			
	4.8		e Fiber Type Differences	92			
	4.9		nortem Factors	93			
	1.5		Feed Withdrawal	94			
			Preslaughter Activities	94			
			Environmental Conditions	95			
			z	,,			

		Contents	vii
	4.10 Postmortem Factors		97
	4.10.1 Stunning		97
	4.10.2 Electrical Stimulation		98
	4.10.3 Carcass Chilling		99
	4.10.4 Deboning		101
	4.10.5 Postmortem Time and Storage		101
	4.11 Summary		103
	References		103
5.	Methods for Measuring Meat Texture		
	Amit Morey and Casey M. Owens		
	5.1 Meat Tenderness		115
	5.1.1 Warner—Bratzler Shear Force Analys	sis	117
	5.1.2 Allo-Kramer Shear Force Analysis		122
	5.1.3 Texture Profile Analysis		124
	5.1.4 Meullenet—Owens Razor Shear (MC	ORS)	
	and Blunt MORS		125
	5.1.5 Sensory Evaluation		128
	5.2 Cooking Method 5.3 Future Needs		129
	References		<ul><li>129</li><li>129</li></ul>
	Further Reading		132
6.	Poultry Meat Color and Oxidation		
	Rafael Carvalho, Massami Shimokomaki		
	and Mario Estévez		
	6.1 Introduction		133
	6.2 Poultry Oxidation: Biochemical Basis		134
	6.3 Color of Poultry: Biochemical Basis	_	137
	6.4 Oxidative Damage and Discoloration of Po	oultry	139
	6.4.1 Oxidation of Poultry	1	139
	6.4.2 Impact of Oxidation on Poultry Qua	•	<ul><li>142</li><li>144</li></ul>
	<ul><li>6.4.3 Color Defects and Discoloration of F</li><li>6.5 Antioxidant Protection of Poultry: Future</li></ul>	-outry	144
	Perspectives		146
	6.5.1 Antemortem Strategies		146
	6.5.2 Packaging Strategies		148
	6.5.3 Formulation Strategies		149
	6.6 Conclusion		150
	References		150

7.	Current Challenges in Poultry Meat Safety Frederique Pasquali, Alessandra De Cesare, Marine Meunier, Muriel Guyard, Katell Rivoal, Marianne Chemaly and						
	7.1 7.2	ardo Manfreda Introduction Update on Traditional and Emerging Biological Hazards	159				
		in Poultry and Poultry Meat	160				
	7.3	Challenges Targeting Live Poultry	163				
		7.3.1 Application of the Metagenomic Approach to Promote the Gut Health	163				
		7.3.2 The Challenge of Reduction of Antimicrobial Resistance	100				
		in Poultry Production	166				
		7.3.3 The Challenge to Control <i>Campylobacter</i> in Live Poultry	172				
	7.4	0 0 0 7	174				
		7.4.1 Control Strategies for <i>Campylobacter</i> at the Level	4-				
		of Meat Processing	174				
		7.4.2 Definition of Food Safety Criteria for <i>Campylobacter</i> in Poultry Meat	178				
	7.5	Future Trends	181				
		References 18					
		her Reading	195				
Me	w To	echniques for Measuring/Predicting/Producin Quality, and How They Help Us Minimize ility in Eating Quality and/or Maximize Value					
8.	Genetics and Genomics for Improving Poultry Meat						
	Qu	ality					
	Elisa	abeth Le Bihan-Duval and Cécile Berri					
	8.1	Introduction	199				
	8.2	Evidence of a Genetic Variability of Meat Quality in Chicken	200				
		8.2.1 Selection for Growth and Muscle Development:					
		Impact on Muscle Fiber Characteristics	200				
		8.2.2 Between Line Variability of Muscle Postmortem	200				
		Metabolism and Subsequent Meat Quality	202				
		8.2.3 Estimation of Genetic Parameters of Meat Quality Traits	20 <sup>2</sup> 205				
	8.3	8.2.4 Experimental Selection for Meat Quality Functional and Positional Genomics to Unravel Meat Quality	200				
	0.5	Traits Determinism	208				
		8.3.1 Transcriptomic Approach (Microarray, RNAseq)	209				
		8.3.2 QTL and eQTL Detection	212				
	8.4	Conclusion	216				
	Dofe	arancas	216				

9.	Proteomics and Metabolomics in Relation to Meat Quality Francesco Capozzi, Alessia Trimigno and Pasquale Ferranti					
	9.1	Introduction to Proteomics and Metabolomics  9.1.1 Definition of Proteomics and Metabolomics  9.1.2 Main Platforms Employed  9.1.3 Proteomics and Metabolomics in the Investigation of Meat Quality				
		9.1.4 C rences her Readi	Conclusions and Future Applications	240 242 245		
10.		Vibrational Spectroscopy for Quality Assessment of Meat				
	Ana M. Herrero, Pedro C. Hernandez, Francisco Jiménez-Colmenero and Claudia RC. Perez					
	10.1	Introdu	ıction	247		
	10.2		ral Characteristics of Proteins, Lipids, and Water			
			nined by Vibrational Spectroscopy	248		
		10.2.1		248		
		10.2.2	Spectral Analysis of Complex Biological Systems	249		
		10.2.3	· ·	251		
	10.3		Application of Vibrational Spectroscopy for Meat Quality			
		Assessn		260		
			Vibrational Spectroscopy and Sensory Analysis Vibrational Spectroscopy and Physicochemical Methods	261 262		
		10.3.3	Vibrational Spectroscopy and Microbiological Analysis	262		
		10.3.4	Vibrational Spectroscopy and Authentication	267		
	10.4	_	,	268		
	Acknowledgments					
		rences		268		
Par	t III					
The Per	Cu cept		Qualities of Consumer and Public What Is Sustainable, Ethical, Desirabl	le,		
11.	Poultry Meat Nutritive Value and Human Health					
	Alessandra Bordoni and Francesca Danesi					
	11.1 11.2	Introdu Protein		279 280		

#### **x** Contents

12.

References

11.5 11.6 11.7 11.8 Refer	Lipids Energy Iron Other Minerals Vitamins and Other Essential Nutrients Future Perspectives: Poultry Meat as a Functional Food rences ner Reading	281 282 282 284 285 286 288 290	
	edient Addition and Impacts on Quality, Healt	h <i>,</i>	
and	Consumer Acceptance		
Shai	Barbut		
12.1	Introduction	291	
12.2	Salt	292	
	12.2.1 Sodium Chloride	292	
	12.2.2 Sodium Nitrite and Sodium Nitrate	294	
	12.2.3 Phosphates	295	
	12.2.4 Sodium Ascorbate and Sodium		
	Erythorbate	296	
12.3	Water	296	
12.4	Spices, Sweeteners, and Flavor Enhancers	297	
	12.4.1 Spices	297	
	12.4.2 Sweeteners and Browning Agents	299	
	12.4.3 Flavor Enhancers	300	
12.5	Acids and Acidulants	300	
12.6	Binders	300	
12.7	Fillers	301	
12.8	Gums	302	
	12.8.1 Carrageenan	302	
	12.8.2 Alginate	302	
12.0	12.8.3 Xanthan Gum	303	
12.9	Batter and Breading Ingredients	303	
	12.9.1 Predusting 12.9.2 Battering	303 304	
	12.9.3 Breading	305	
12.10	ĕ	307	
12.10		308	
12.12	1	308	
12.13			
12.14		309 309	

310

13.	Consumer Attitudes to Poultry Meat: A Comparative Study of the UK and China					
	Patrio	Patricia Parrott and Keith Walley				
	13.1 13.2	Case Country A: United Kingdom	313 314			
		13.2.1 An Introduction to the UK	314			
		13.2.2 The Poultry Industry in the UK	315			
	13.3	13.2.3 The Market for Poultry Meat in the UK  Case Country B: China	316 317			
	13.3	13.3.1 An Introduction to China	317			
		13.3.2 The Poultry Industry in China	319			
		13.3.3 The Market for Poultry Meat in China	320			
	13.4	,	322			
		13.4.1 Consumption and Purchase of Poultry Meat	322			
		13.4.2 Purchase Factors	326			
	13.5	Conclusion	331			
		owledgments	332			
	Refe	rences	332			
		duction) re Castellini and Alessandro Dal Bosco				
	14.1	Introduction	225			
	14.1 14.2		335			
	17.2	(Welfare and Adaptation)	336			
	14.3	Management of Poultry Pasture	338			
		14.3.1 Pasture Rotation	339			
		14.3.2 Control Disease Outbreaks and Parasites	339			
		14.3.3 Prevention of the Risk of Predation	340			
		14.3.4 Intake of Pasture and (Alternative) Poultry Feed	340			
	14.4	Housing Systems (Movable or Stationary)	342			
	14.5	Sustainability of Pasture-Based Poultry Rearing Systems	342			
	14.6	Social Benefits and Main Economical Constraints	345			
	14.7	Nutritional Characteristics of Poultry Meat Reared Under Alternative Systems	346			
	14.8	Conclusion	351			
		rences	352			
		ner Reading	357			
Index	(		359			