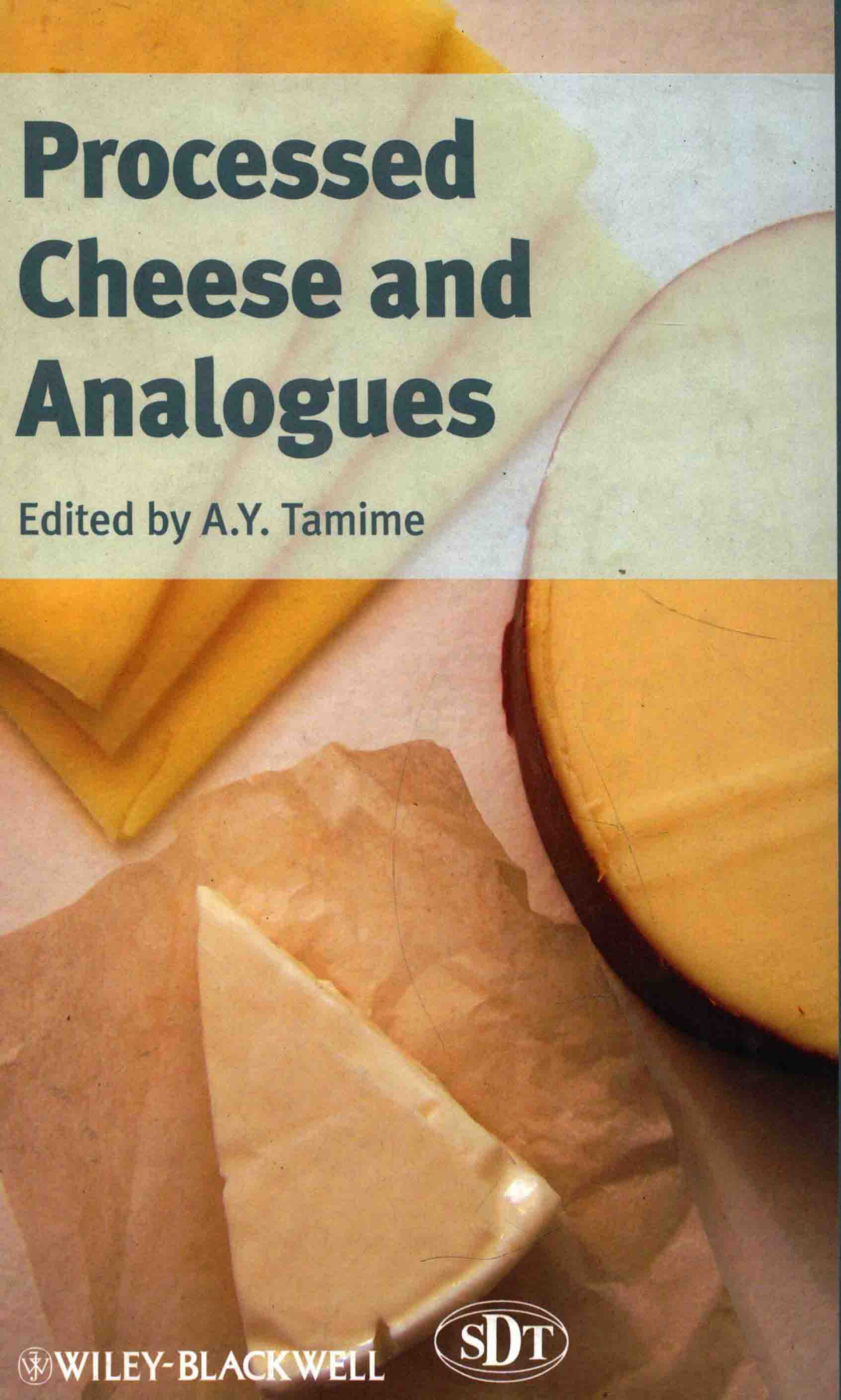
# Processed Cheese and Analogues

Edited by A.Y. Tamime



SOCIETY OF DAIRY TECHNOLOGY

WILEY-BLACKWELL

SDT

# Processed Cheese and Analogues

Edited by

A.Y. Tamime
Consultant in Dairy Science and Technology
Ayr, UK



WILEY-BLACKWELL
A John Wiley & Sons, Ltd., Publication

SDT

This edition first published 2011 © 2011 by Blackwell Publishing Ltd.

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing program has been merged with Wiley's global Scientific, Technical and Medical business to form 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
2121 State Avenue, Ames, Iowa 50014-8300, 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*

Processed cheese and analogues / edited by A.Y. Tamime.
p. cm. – (Society of Dairy Technology series)
Includes bibliographical references and index.
ISBN 978-1-4051-8642-1 (hardcover : alk. paper) 1. Processed cheese. I. Tamime, A.Y.
SF272.5.P76 2011
637'.358 – dc22

2010052430

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

This book is published in the following electronic formats: ePDF [9781444341829]; Wiley Online Library [9781444341850]; ePub [9781444341836]; Mobi [9781444341843]

Set in 10/12.5pt Times by Laserwords Private Limited, Chennai, India
Printed and bound in Malaysia by Vivar Printing Sdn Bhd

1 2011

# Processed Cheese and Analogues

*The Society of Dairy Technology (SDT) has joined with Wiley-Blackwell to produce a series of technical dairy-related handbooks providing an invaluable resource for all those involved in the dairy industry, from practitioners to technologists, working in both traditional and modern large-scale dairy operations. For information regarding the SDT, please contact Maurice Walton, Executive Director, Society of Dairy Technology, PO Box 12, Appleby in Westmorland, CA16 6YJ, UK. email: execdirector@sdt.org*

Other volumes in the Society of Dairy Technology book series:

Probiotic Dairy Products (ISBN 978 1 4051 2124 8)
Fermented Milks (ISBN 978 0 6320 6458 8)
Brined Cheeses (ISBN 978 1 4051 2460 7)
Structure of Dairy Products (ISBN 978 1 4051 2975 6)
Cleaning-in-Place (ISBN 978 1 4051 5503 8)
Milk Processing and Quality Management (ISBN 978 1 4051 4530 5)
Dairy Fats and Related Products (ISBN 978 1 4051 5090 3)
Dairy Powders and Concentrated Products (ISBN 978 1 4051 5764 3)
Technology of Cheesemaking, 2nd edition (ISBN 978 1 4051 8298 0)

# Preface to the Technical Series

For more than 60 years, the Society of Dairy Technology (SDT) has sought to provide education and training in the dairy field, disseminating knowledge and fostering personal development through symposia, conferences, residential courses, publications, and its journal, the *International Journal of Dairy Technology* (previously published as the *Journal of the Society of Dairy Technology*).

In recent years, there have been significant advances in our understanding of milk systems, probably the most complex natural food available to humans. At the same time, improvements in process technology have been accompanied by massive changes in the scale of many milk processing operations, and the manufacture a wide range of dairy and other related products.

The Society has embarked on a project with Wiley-Blackwell to produce a Technical Series of dairy-related books to provide an invaluable source of information for practising dairy scientists and technologists, covering the range from small enterprises to modern large-scale operations. This tenth volume in this series, on *Processed Cheese and Analogues*, provides a timely and comprehensive update of the principles and practices involved in the production of these products, from raw materials and processing technology to assurance of the quality of the final product. Processed cheese and its analogues have found many uses in both domestic consumption and in the catering and fast food sectors, providing functional properties beyond those that can normally be achieved with traditional cheeses.

Andrew Wilbey
Chairman of the Publications Committee, SDT

# Preface

There is a wide range of processed cheese products, i.e. natural products made from blending different cheeses to form a range of solid and spreadable products, and cheese analogues (made not from cheese, but from dairy and non-dairy ingredients) available to the food market worldwide. Some of these products are extensively used in the fast food/catering chains (e.g. as 'shredded' cheeses), and are of increasing economic value in the industrialised and developing countries.

The purpose of this book, which is written by a team of international scientists, is to review the latest scientific developments in this field. The authors, who are all specialists in these products, have been chosen from around the world. The scientific aspects reviewed in this publication include (a) the functionality of ingredients, including the natural cheeses, emulsifying salts, stabilisers, flavourings and colourings, (b) the interactions between natural cheese and processing conditions in developing the rheology and final texture of the product, (c) current processing equipment and manufacturing practices, (d) the current statutory regulations (national and international) of these products because an appreciable percentage of the internationally traded 'natural' cheese includes processed cheese varieties and (e) quality assurance of processed cheese (in terms of chemical, physical and microbiological properties and sensory profiling) to ensure the safety of the product for the consumer.

Some key scientific aspects of processed cheese manufacture can be manipulated to control and maintain the consistency and quality of the final product, and coverage of this topic has produced some overlap with those sections dealing with, for example, the interaction of emulsifying salts with natural cheese components. I have felt justified in allowing this overlap because it emphasises the prime importance of the ingredients used during the preparation of the cheese blend including the effects of processing on the quality and consistency of processed cheese for the end-user.

There is no doubt that the book will have an international recognition by dairy technologists, students, researchers and processors, and will become an important component of the Technical Series promoted by the Society of Dairy Technology.

A.Y. Tamime

# Contributors

**Editor**

**Dr A.Y. Tamime**
24 Queens Terrace
Ayr KA7 1DX
UK
Tel. +44 (0)1292 265498
Fax +44 (0)1292 265498
Mobile +44 (0)7980 278950
E-mail: adnan@tamime.fsnet.co.uk

**Contributors**

**Dr M.A.E. Auty**
Teagasc Food Research Centre
Moorepark
Fermoy
Co. Cork
Ireland
Tel. +353 25 42442
Fax +353 25 42340
E-mail: mark.auty@teagasc.ie

**Professor E.M. Buys**
Department of Food Science
University of Pretoria
Lynnwood Road
Pretoria 0002
South Africa
Tel. +27 12 420 3209
Fax +27 12 420 2839
E-mail: elna.buys@up.ac.za

**Mr S. Dixon**
215 Moss Bank Road
St Helens
Merseyside WA11 7NS
UK
Tel. +1 507 775 7070
Fax +1 507 775 7878
Mobile +1 507 254 2338
E-mail: stevedixon51@yahoo.co.uk and
steved@meadowingredients.com

**Dr J. Domagala**
University of Agriculture
Animal Products Technology Department
30–149 Krakow
Balicka 122
Poland
Tel. +48 12 662 4803
Fax +48 12 662 4810
E-mail: rtdomaga@cyf-kr.edu.pl

**Dr K.J. Domig**
Department of Food Science
and Technology
BOKU – University of Natural Resources
and Life Sciences
Muthgasse 18
A-1190 Vienna
Austria
Tel. ++0043 (0)1 47654 6750
Fax ++0043 (0)1 47654 6751
E-mail: konrad.domig@boku.ac.at

**Dr E. Duggan**
Food and Health Institute
UCD Agriculture and Food Science
Centre
University College Dublin
Belfield
Dublin 4

Ireland
Tel. +353 1 7167675
Fax +353 1 7161147
E-mail: elaine.duggan@ucd.ie

**Dr K. Dürrschmid**
Department of Food Science
and Technology
BOKU – University of Natural Resources
and Life Sciences
Muthgasse 18
A-1190 Vienna
Austria
Tel. +43 (0)1 36006 6295
Fax +43 (0)1 36006 6293
E-mail: klaus.duerrschmid@boku.ac.at

**Dr T.P. Guinee**
Dairy Products Research Centre
Teagasc
Moorepark
Fermoy
Co. Cork
Ireland
Tel. +353 25 42204
Fax +35325 42340
E-mail: Tim.Guinee@teagasc.ie

**Dr M. Hickey**
Derryreigh
Creggane
Charleville
Co. Cork
Ireland
Tel. +353 (0)63 89392
E-mail: mfhickey@oceanfree.net

**Dr A. Hill**
University of Guelph
Department of Food Science
Guelph
Ontario N1G 2W1
Canada
Tel. +1 (0)519 824 4120 extension 53875
Fax +1 (0)519 824 6631
E-mail: arhill@uoguelph.ca

**Mr S. Kaliappan**
Frito-Lay R&D
7701 Legacy Drive
Plano, TX 75024-4099
USA
Tel. +1 (0)972-334-4951
Fax +1 (0)972-334-2329
E-mail: siva.kaliappan@pepsico.com

**Professor W. Kneifel**
Department of Food Science and
Technology
BOKU – University of Natural Resources
and Life Sciences
Muthgasse 18
A-1190 Vienna
Austria
Tel. +43 (0)1 36006 6290
Fax +43 (0)1 36006 6266
E-mail: wolfgang.kneifel@boku.ac.at

**Professor J.A. Lucey**
University of Wisconsin-Madison
Department of Food Science
1605 Linden Drive
Madison, WI 53706-1565
USA
Tel. +1 (608) 265 1195
Fax +1 (608) 262 6872
E-mail: jalucey@facstaff.wisc.edu

**Dr A. Maurer-Rothmann**
Management Business Line Dairy
Business Unit Food
BK Giulini
Ladenburg
Germany
Tel. +49 (0)6203 77 148
Fax +49 (0)6203 77 185
E-mail: andrea.maurer@bk-giulini.com

**Dr L. Metzger**
Alfred Chair in Dairy Education
Dairy Science Department
South Dakota State University
Box 2104 Dairy-Microbiology Building

Brookings, SD 57007
USA
Tel. +1 (0)605-688-5477
Fax +1 (0)605-688-6276
E-mail: Lloyd.Metzger@sdstate.edu

**Dr J.F. Mostert**
Food Safety and Human Nutrition
ARC-Animal Production Institute
Private Bag X2
Irene 0062
South Africa
Tel. +27-12-672-9296
Fax +27-12-665-1551
E-mail: ferdie.mostert@telkomsa.net

**Professor D.D. Muir**
DD Muir Consultants
26 Pennyvenie Way
Girdle Toll
Irvine KA11 1QQ
UK
Tel. +44 (0)1294 213137
E-mail: Donald@ddmuir.com

**Professor M. Nogueira de Oliveira**
Universidade de São Paulo
Departamento de Tecnologia
Bioquimico-Farmacêutica
Avenue Prof. Lineu Prestes 580,
Bloco 16
Sao Paulo 05508-900
Brazil
Tel. +55 (0)11 3091 3690
Fax +55 (0)11 3815 6386
E-mail: monolive@usp.br

**Dr N. Noronha**
Food and Health Institute
UCD Agriculture and Food Science
Centre
University College Dublin
Belfield
Dublin 4
Ireland
Tel. +353 1 7167675
Fax +353 1 7161147
E-mail: nessa.noronha@ucd.ie

**Professor E.D. O'Riordan**
UCD Agriculture and Food Science
Centre
University College Dublin
Belfield
Dublin 4
Ireland
Tel. +353 1 7167016
Fax +353 1 7161147
E-mail: dolores.oriordan@ucd.ie

**Professor G. Osthoff**
Department of Microbial Biochemical
and Food Biotechnology
University of the Free State
PO Box 339
Bloemfontein 9300
South Africa
Tel: +27 (0)51 4012216
Fax +27 (0)51 4019335
E-mail: OsthoffG.SCI@ufs.ac.za

**Mr M. O'Sullivan**
Food and Health Institute
UCD Agriculture and Food Science
Centre
University College Dublin
Belfield
Dublin 4
Ireland
Tel. +353 1 7167158
Fax +353 1 7161147
E-mail: michael.osullivan@ucd.ie

**Mr E. Slabber**
Dairybelle
PO Box 744
Bloemfontein 9300
South Africa
Tel. +27 (0)51 4114426
Mobile +27 (0)825619092
Fax +27 (0)51 4301450
E-mail: Ernest.Slabber@Dairybelle.co.za

**Dr A. Smith**
University of Guelph
Analytical Microscopy
Department of Food Science
Guelph
Ontario N1G 2W1
Canada
Tel. +1 (0) 519 824-4120 ext. 52112
Fax +1 (0) 519 824-6631
E-mail: smitha@uoguelph.ca

**Professor Z. Ustunol**
Michigan State University
Department of Food Science and Human Nutrition
2105 S. Anthony Hall
East Lansing, MI 48824
USA
Tel +1 517 355 7713 extension 184
Fax +1 517 353 1676
E-mail: ustunol@anr.msu.edu

**Dr M. Wszolek**
University of Agriculture
Animal Products Technology Department
30–149 Krakow
Balicka 122
Poland
Tel. +48 12 662 4788
Fax +48 12 662 4810
E-mail: monika@cyberia.pl

# Contents

*A colour plate section appears between pages 302 and 303*