

Methods in
Molecular Biology 1592

Springer Protocols



Jing Lin
Marcos Alcocer *Editors*

Food Allergens

Methods and Protocols

 Humana Press

METHODS IN MOLECULAR BIOLOGY

Series Editor

John M. Walker

School of Life and Medical Sciences

University of Hertfordshire

Hatfield, Hertfordshire, AL10 9AB, UK

For further volumes:

<http://www.springer.com/series/7651>

Food Allergens

Methods and Protocols

Edited by

Jing Lin

*Bioinformatics Institute, A*STAR, Singapore; Institute of High Performance Computing, A*STAR, Singapore; Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

Marcos Alcocer

School of Biosciences, University of Nottingham, Sutton Bonington Campus, Leicestershire, UK

Editors

Jing Lin
Bioinformatics Institute
A*STAR
Singapore
Institute of High Performance Computing
A*STAR
Singapore
Pediatric Allergy and Immunology
Icahn School of Medicine at Mount Sinai
New York, NY, USA

Marcos Alcocer
School of Biosciences
University of Nottingham
Sutton Bonington Campus
Leicestershire, UK

ISSN 1064-3745 ISSN 1940-6029 (electronic)
Methods in Molecular Biology
ISBN 978-1-4939-6923-4 ISBN 978-1-4939-6925-8 (cBook)
DOI 10.1007/978-1-4939-6925-8

Library of Congress Control Number: 2017936062

© Springer Science+Business Media LLC 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Humana Press imprint is published by Springer Nature
The registered company is Springer Science+Business Media LLC
The registered company address is: 233 Spring Street, New York, NY 10013, U.S.A.

Preface

Food allergies, which are abnormal immune responses to food proteins (known as food allergens), have become a major public health problem due to their increasing prevalence, life-threatening potential, and enormous medical and economic impact. So far, the most common food allergens are described in few food products such as cow's milk, eggs, tree nuts, peanuts, soy, wheat, fish, and shellfish. With the recent advances in genomics, molecular biology, and immunology techniques, a complex network of interactions and cross-reactivities becomes apparent. While improved versions of traditional methods (e.g., ELISA) are still widely applied in many laboratories for food allergen studies and allergy diagnostics, novel techniques (e.g., microarray, flow cytometry, mass spectrometry) have led to new methods in the food allergy field.

Food Allergens: Methods and Protocols provides a collection of methodologies for both basic research and clinical diagnosis/treatment relevant to food allergens, including food allergen production, purification, characterization, detection, and quantification, together with bioinformatics approaches applied to modern food allergen studies. In addition, current developments and future trends in food allergen-related laboratory techniques are also covered.

Chapter 1 is an introductory overview chapter describing commonly used methods for food allergen production, detection, and epitope mapping. The remaining 19 chapters are divided into four parts:

Part I, Food Allergen Purification and Production, provides methods of producing recombinant food allergens in bacterial and yeast expression systems, the two most commonly used system for protein production, and the chromatographic methods in protein purification.

Part II, Food Allergen Discovery, Detection, and Quantification, can be classified into three types of methods including DNA-based methods, protein-based methods (e.g., Western blotting, ELISA), and cell-based methods (e.g., basophil activation assay). Many of these methods are also useful for food diagnostics.

Part III, Allergenic Epitope Mapping, comprises experimental methods used for mapping of B-cell epitopes (IgE epitopes) or T-cell epitopes, in silico epitope prediction method, and an overview of bioinformatics resources/tools in epitope/allergen prediction.

Part IV, Methods Currently Being Developed and Future Development, deals mainly with the new concepts of allergenicity as an outcome of protein and food matrix interaction. The particular search for NKT bioactive lipids is described as well as a review on the novel techniques in development for food allergen detection.

Over the past decades, the development of new innovations and technologies has led to great improvements in many aspects of food allergen studies (e.g., reproducibility, sensitivity, specificity, and high throughput capacity). These methods greatly facilitate identification, characterization, and quantification of food allergen and are slowly leading to a better understanding of food allergic diseases and their diagnosis and pointing toward specific therapeutics. We have tried to include in this book a set of important protocols highly relevant to food allergens studies. We hope that the protocols provided here would be valu-

able resources not only to immunologists, biochemists, molecular biologists, and medical doctors/students working in the food allergy area but also useful for the food industry, legislators, food standard agencies, allergologists, pediatricians, and clinicians/biologists working in the general field of allergic diseases and immunology.

We would like to take this opportunity to express our gratitude to all the authors for sharing their valuable expertise through the contribution of detailed protocols and notes for this book. We also want to thank Professor John Walker and the editorial staff of Springer for continuous assistance and encouragement.

Singapore
Sutton Bonington, Leicestershire, UK

Jing Lin
Marcos Alcocer

Contents

<i>Preface</i>	<i>v</i>
<i>Contributors</i>	<i>ix</i>
1 Overview of the Commonly Used Methods for Food Allergens	1
<i>Jing Lin and Marcos Alcocer</i>	
PART I FOOD ALLERGEN PURIFICATION AND PRODUCTION	
2 Allergen Extraction and Purification from Natural Products: Main Chromatographic Techniques.	13
<i>Barbara Cases, Carlos Pastor-Vargas, and Marina Perez-Gordo</i>	
3 Recombinant Allergen Production in <i>E. coli</i>	23
<i>Changqi Liu, LeAnna N. Willison, and Shridhar K. Sathe</i>	
4 Recombinant Allergens Production in Yeast	47
<i>Maria Neophytou and Marcos Alcocer</i>	
PART II FOOD ALLERGEN DISCOVERY, DETECTION, AND QUANTIFICATION	
5 2D-Electrophoresis and Immunoblotting in Food Allergy	59
<i>Galina Grishina, Luda Bardina, and Alexander Grishin</i>	
6 Two-Dimensional Electrophoresis and Identification by Mass Spectrometry	71
<i>Fernando de la Cuesta, Gloria Alvarez-Llamas, and Maria G. Barderas</i>	
7 Enzyme-Linked Immunosorbent Assay (ELISA)	79
<i>George N. Konstantinou</i>	
8 Detection of Food Allergens by Taqman Real-Time PCR Methodology	95
<i>Aina García, Raquel Madrid, Teresa García, Rosario Martín, and Isabel González</i>	
9 Detection of Food Allergens by Phage-Displayed Produced Antibodies	109
<i>Raquel Madrid, Silvia de la Cruz, Aina García, Rosario Martín, Isabel González, and Teresa García</i>	
10 Protein Microarray-Based IgE Immunoassay for Allergy Diagnosis	129
<i>Nuzul N. Jambari, XiaoWei Wang, and Marcos Alcocer</i>	
11 Basophil Degranulation Assay	139
<i>Madhan Masilamani, Mohanapriya Kamalakannan, and Hugh A. Sampson</i>	
12 Use of Humanized RS-ATL8 Reporter System for Detection of Allergen-Specific IgE Sensitization in Human Food Allergy.	147
<i>Eman Ali Ali, Ryosuke Nakamura, and Franco H. Falcone</i>	

PART III ALLERGENIC EPITOPE MAPPING

- 13 Assessment of IgE Reactivity of β -Casein by Western Blotting
After Digestion with Simulated Gastric Fluid. 165
Sara Benedé, Rosina López-Fandiño, and Elena Molina
- 14 IgE Epitope Mapping Using Peptide Microarray Immunoassay 177
Jing Lin and Hugh A. Sampson
- 15 T-Cell Proliferation Assay: Determination of Immunodominant T-Cell
Epitopes of Food Allergens 189
Madhan Masilamani, Mariona Pascal, and Hugh A. Sampson
- 16 Tetramer-Guided Epitope Mapping: A Rapid Approach
to Identify HLA-Restricted T-Cell Epitopes from Composite Allergens 199
Luis L. Diego Archila and William W. Kwok
- 17 T-Cell Epitope Prediction 211
George N. Konstantinou
- 18 An Overview of Bioinformatics Tools and Resources in Allergy 223
Zhiyan Fu and Jing Lin

PART IV METHODS CURRENTLY BEING DEVELOPED AND FUTURE DEVELOPMENT

- 19 The Use of a Semi-Automated System to Measure Mouse
Natural Killer T (NKT) Cell Activation by Lipid-Loaded Dendritic Cells. 249
Ashfaq Ghumra and Marcos Alcocer
- 20 Recent Advances in the Detection of Allergens in Foods 263
*Silvia de la Cruz, Inés López-Calleja, Rosario Martín, Isabel González,
Marcos Alcocer, and Teresa García*
- Index* 297

Contributors

MARCOS ALCOCER • *School of Biosciences, University of Nottingham, Sutton Bonington Campus, Leicestershire, UK*

EMAN ALI ALI • *Division of Molecular Therapeutics and Formulation, School of Pharmacy, University of Nottingham, Nottingham, UK*

GLORIA ALVAREZ-LLAMAS • *Laboratorio de Inmunoalergia y Proteomica, Departamento de Inmunologia, IIS-Fundacion Jimenez Diaz, Madrid, Spain*

LUIS L. DIEGO ARCHILA • *Benaroya Research Institute at Virginia Mason, Seattle, WA, USA*

MARIA G. BARDERAS • *Department of Vascular Physiopathology, Hospital Nacional de Paraplégicos, Toledo, Spain*

LUDA BARDINA • *Elliot and Roslyn Jaffe Food Allergy Institute, Division of Allergy and Immunology, Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

SARA BENEDÉ • *Instituto de Investigación en Ciencias de la Alimentación (CIAL, CSIC-UAM), Madrid, Spain; Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

BARBARA CASES • *Research and Development Department, Inmunotek S.L., Madrid, Spain*

SILVIA DE LA CRUZ • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*

FERNANDO DE LA CUESTA • *Centre for Cardiovascular Science, Queen's Medical Research Institute, University of Edinburgh, Edinburgh, UK*

FRANCO H. FALCONE • *Division of Molecular Therapeutics and Formulation, School of Pharmacy, University of Nottingham, Nottingham, UK*

ZHIYAN FU • *Genome Institute of Singapore, A*STAR, Singapore*

AINA GARCÍA • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*

TERESA GARCÍA • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*

ASHFAQ GHUMRA • *School of Biosciences, University of Nottingham, Sutton Bonington, Loughborough, UK*

ISABEL GONZÁLEZ • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*

ALEXANDER GRISHIN • *Elliot and Roslyn Jaffe Food Allergy Institute, Division of Allergy and Immunology, Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

GALINA GRISHINA • *Elliot and Roslyn Jaffe Food Allergy Institute, Division of Allergy and Immunology, Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

NUZUL N. JAMBARI • *Department of Food Sciences, Faculty of Food Sciences and Technology, University of Putra Malaysia, Serdang, Selangor, Malaysia*

MOHANAPRIYA KAMALAKANNAN • *Division of Allergy and Immunology, Department of Pediatrics, The Jaffe Food Allergy Institute, Icahn School of Medicine at Mount Sinai, New York, NY, USA*

- GEORGE N. KONSTANTINOU • *Department of Allergy and Clinical Immunology, General Military Training Hospital, Thessaloniki, Greece; Division of Allergy and Immunology, Jaffe Food Allergy Institute, Icahn School of Medicine at Mount Sinai, New York, NY, USA*
- WILLIAM W. KWOK • *Benaroya Research Institute at Virginia Mason, Seattle, WA, USA; Department of Medicine, University of Washington, Seattle, WA, USA*
- JING LIN • *Bioinformatics Institute, A*STAR, Singapore; Institute of High Performance Computing, A*STAR, Singapore; Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, NY, USA*
- CHANGQI LIU • *School of Exercise and Nutritional Sciences, San Diego State University, San Diego, CA, USA*
- INÉS LÓPEZ-CALLEJA • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*
- ROSINA LÓPEZ-FANDIÑO • *Instituto de Investigación en Ciencias de la Alimentación (CIAL, CSIC-UAM), Madrid, Spain*
- RAQUEL MADRID • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*
- ROSARIO MARTÍN • *Departamento de Nutrición, Bromatología y Tecnología de los Alimentos, Facultad de Veterinaria, Universidad Complutense de Madrid, Madrid, Spain*
- MADHAN MASILAMANI • *Division of Allergy and Immunology, Department of Pediatrics, The Jaffe Food Allergy Institute, Icahn School of Medicine at Mount Sinai, New York, NY, USA; Immunology Institute and The Mindich Child Health and Development Institute, Mount Sinai School of Medicine, New York, NY, USA*
- ELENA MOLINA • *Instituto de Investigación en Ciencias de la Alimentación (CIAL, CSIC-UAM), Madrid, Spain*
- RYOSUKE NAKAMURA • *Division of Medicinal Safety Science, National Institute of Health Sciences, Setagaya-ku, Tokyo, Japan*
- MARIA NEOPHYTOU • *School of Biosciences, University of Nottingham, Sutton Bonington, Loughborough, UK*
- MARIONA PASCAL • *Immunology Department, CDB, Hospital Clinic de Barcelona, Universitat de Barcelona, Barcelona, Spain*
- CARLOS PASTOR-VARGAS • *Department of Immunology, IIS Fundación Jiménez Díaz-UAM, Madrid, Spain*
- MARINA PEREZ-GORDO • *Institute for Applied Molecular Medicine (IMMA), School of Medicine, Universidad CEU San Pablo, Madrid, Spain*
- HUGH A. SAMPSON • *Pediatric Allergy and Immunology, Icahn School of Medicine at Mount Sinai, New York, NY, USA; The Jaffe Food Allergy Institute, Icahn School of Medicine at Mount Sinai, New York, NY, USA*
- SHRIDHAR K. SATHE • *Department of Nutrition, Food and Exercise Sciences, Florida State University, Tallahassee, FL, USA*
- XIAOWEI WANG • *School of Biosciences, University of Nottingham, Sutton Bonington, UK*
- LEANNA N. WILLISON • *School of Science, Mathematics and Computing, Albany State University, Albany, GA, USA*