Methods of Analysis for Functional Foods and Nutraceuticals

EDITED BY

W. Jeffrey Hurst
Series Preface

The Functional Foods and Nutraceuticals Series was developed to offer food, nutrition, and health practitioners a comprehensive treatment of the emerging science and technology of functional foods and nutraceuticals shown to play a role in preventing or delaying the onset of diseases, especially chronic diseases. Books in the series cover a wide range of developments in chemistry, biochemistry, pharmacology, epidemiology, and engineering of products from plants and animal sources; results of animal and clinical trials; and regulatory, standardization, and quality control issues.

This volume, *Methods of Analysis for Functional Foods and Nutraceuticals*, edited by W. Jeffrey Hurst, presents advanced methods of analysis for carotenoids, phytoestrogens, chlorophylls, anthocyanins, amino acids, fatty acids, flavonoids, water-soluble vitamins, and carbohydrates. Dr. Hurst has assembled a stellar list of international contributors in the forefront of analysis of phytochemicals.

It is hoped that the effort will be useful to food, nutrition, and health practitioners and to students and researchers in industry, government, and university laboratories.

G. Mazza

*Series Editor*
Preface

A book on the analysis of functional foods should first define “functional foods.” Unfortunately, there are numerous definitions currently being used, which can result in substantial confusion. For the purposes of this book, functional foods are defined as foods that are similar in appearance to or may be conventional foods that are consumed as part of a usual diet and are demonstrated to have some physiological benefits and/or reduce the risk of diseases beyond basic nutritional functions. In some of the chapters in this book, you will notice that the author has chosen to provide his or her own perspective on this terminology, reflecting the diversity seen by authors from around the globe.

This volume is the fourth in the Functional Foods and Nutraceuticals Series. It is not a general food analysis book, since there are presently a sufficient number of those in print. It was developed to concentrate on the analytical aspects of functional foods, with a focus on a number of compound classes. You will notice that there are subjects that have not been included, for a variety of reasons. For example, we have made a conscious decision not to include a chapter on added botanicals, since that topic has been included in the second book in this series, *Herbs, Botanicals and Teas*, edited by G. Mazza and D. Oomah and would have been superfluous to this offering. Each chapter in this book focuses on a particular compound class rather than a food type, since this will allow an analyst the opportunity to see the determination of a particular compound in a variety of food matrixes rather than be limited to a single matrix. The author of each chapter has provided an overview of the particular topic with information on a variety of methods to allow for the determination of members of that compound class in food matrixes. Additionally, each chapter, while important to the overall theme of the book, was written to be able to stand independently from the others.

The nine chapters were carefully chosen so that each reflects an important area of interest and research in functional foods. The book includes a chapter on phytoestrogen analysis, which is of increasing interest to the scientific and medical community, especially with respect to the soy isoflavones and their impact on women’s health. There are few resources on the analysis of these compounds. Two chapters discuss the analysis of vitamins, with one focusing on water-soluble vitamins and the other focusing on carotenoids and provitamin A. The determination of vitamins in food has been of interest for decades, and these chapters provide an update on methods along with an emphasis on functional foods. Fatty acid analysis is always a timely topic in any food analysis book, and in our case we have chosen to concentrate on ω3 fatty acids and conjugated linoleic acid (CLA), since both of these topics are gaining in importance with respect to positive health effects from their consumption. Amino acid analysis was selected for inclusion because these compounds are critical to the makeup of many functional foods. There are chapters
on flavonoids and anthocyanins, both of which are the subject of intense interest and increasing research; on an almost daily basis one can read the scientific and popular press and find an article about some member of these classes, ranging from blueberries to tea, coffee, and cocoa. Moreover, analytical information on these compounds tends to be published not only in mainstream journals, but also in more niche journals not available to all researchers. A chapter on chlorophyll analysis might initially seem out of place here, but in the literature we see an expanding number of citations and, as the authors of the chapter indicate, a growing interest in health effects. The final chapter concentrates on carbohydrates and other electrochemically active components. While there is continued interest in the determination of simple carbohydrates, there is scant information on some of the complex carbohydrates. Additionally, this chapter discusses the application of this technology for the determination of other classes of compounds, such as sulfur compounds, that are of interest in functional foods.

The information included in this volume is timely and appropriate for a large audience, which can include practicing analysts and researchers, those in management interested in this topic, and food science faculty and students. In addition to providing the information noted above, each chapter includes references for further reading.

I thank all who have been involved in this project for their continued interest and support, with the biggest thanks to my wife, Deborah, for her support when I agreed to work on “another book.”

W. Jeffrey Hurst
Contributors

**Lan Dao**
Western Regional Research Center
Agricultural Research Service
U.S. Department of Agriculture
Albany, California
ltl@pw.usda.gov

**Gary Dobson**
Scottish Crop Research Institute
Invergowrie, Dundee DD2 5DA
Scotland, United Kingdom
gdobso@scri.sari.ac.uk

**Miguel Ángel Fernández-Muiño**
Área de Nutrición y Bromatología
Departamento de Biotecnología y Ciencia de los Alimentos
Universidad de Burgos
Burgos, Spain
mafernan@ubu.es

**Dámaso Hornero-Méndez**
Grupo de Química y Bioquímica de Pigmentos
Departamento de Biotecnología de Alimentos
Instituto de la Grasa, CSIC
Sevilla, Spain
hornero@cica.es

**Manuel Jarén-Galán**
Grupo de Química y Bioquímica de Pigmentos
Departamento de Biotecnología de Alimentos
Instituto de la Grasa, CSIC
Sevilla, Spain
majaren@cica.es

**Lourdes Gallardo-Guerrero**
Grupo de Química y Bioquímica de Pigmentos
Departamento de Biotecnología de Alimentos
Instituto de la Grasa, CSIC
Sevilla, Spain
lgallar@cica.es

**Beatriz Gandul-Rojas**
Instituto de la Grasa, CSIC
Sevilla, Spain
bgandul@cica.es

**William R. LaCourse**
Department of Chemistry and Biochemistry
University of Maryland–Baltimore County
Baltimore, Maryland
lacourse@umbc.edu

**Larry R. Massom**
Woodson-Tenet Laboratory
A Division of Eurofins Scientific
Memphis, Tennessee
LarryMassom@yahoo.com
M. Isabel Mínguez-Mosquera
Grupo de Química y Bioquímica
de Pigmentos
Departamento de Biotecnología
de Alimentos
Instituto de la Grasa, CSIC
Sevilla, Spain
minguez@cica.es

María Teresa Sancho-Ortiz
Área de Nutrición y Bromatología
Departamento de Biotecnología y
Ciencia de los Alimentos
Universidad de Burgos
Burgos, Spain
mtsancho@ubu.es

B. Dave Oomah
Agriculture and Agri-Food Canada
Pacific Agri-Food Research Centre
Summerland, British Columbia, Canada
oomahd@em.agr.ca

Gowsala Sivam
Baystr University
Kenmore, Washington
gowsalas@bastyr.edu

Antonio Pérez-Gálvez
Grupo de Química y Bioquímica
de Pigmentos
Departamento de Biotecnología
de Alimentos
Instituto de la Grasa, CSIC
Sevilla, Spain
aperez@cica.es

Gary Takeoka
Western Regional Research Center
Agricultural Research Service
U.S. Department of Agriculture
Albany, California
grt@pw.usda.gov

Suresh Ralapati
The University of New Mexico
Health Sciences Center
Department of OB/GYN
Albuquerque, New Mexico
ralapati@msn.com

Felicidad Valls-García
Área de Nutrición y Bromatología
Departamento de Biotecnología y
Ciencia de los Alimentos
Universidad de Burgos
Burgos, Spain
fvalls@ubu.es

©2002 CRC Press LLC
Table of Contents

Chapter 1
Phytoestrogens
B. Dave Oomah

Chapter 2
Analysis of Fatty Acids in Functional Foods with Emphasis on ω3 Fatty Acids and Conjugated Linoleic Acid
Gary Dobson

Chapter 3
Carotenoids and Provitamin A in Functional Foods
M. Isabel Mínguez-Mosquera, Dámaso Hornero-Méndez, and Antonio Pérez-Gálvez

Chapter 4
Chlorophylls
M. Isabel Mínguez-Mosquera, Beatriz Gandul-Rojas, Lourdes Gallardo-Guerrero, and Manuel Jarén-Galán

Chapter 5
Anthocyanins
Gary Takeoka and Lan Dao

Chapter 6
Amino Acid Analysis
Larry R. Massom

Chapter 7
Water-Soluble Vitamins
Miguel Ángel Fernández-Muiño, María Teresa Sancho-Ortiz, and Felicidad Valls-García

Chapter 8
Carbohydrates and Other Electrochemically Active Compounds
Suresh Ralapati and William R. LaCourse

Chapter 9
Analysis of Flavonoids
Gowsala Sivam