

Food Chemistry

Second Edition

Editors

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Springer

H.-D. Belitz · W. Grosch

Food Chemistry

Translation from the Fourth German Edition
by M.M. Burghagen, D. Hadziyev, P. Hessel, S. Jordan
and C. Sprinz

Second Edition with 460 Figures and 531 Tables



Springer

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ISBN 3-540-64692-2 2nd Ed. (soft cover) Springer-Verlag Berlin Heidelberg New York

ISBN 3-540-64704-X 2nd Ed. (hard cover) Springer-Verlag Berlin Heidelberg New York

ISBN 3-540-15043-9 1st Ed. Springer-Verlag Berlin Heidelberg New York

Library of Congress Cataloging-in-Publication Data

Belitz, H.-D., (Hans-Dieter)

[Lehrbuch der Lebensmittelchemie. English]

Food chemistry / H.-D. Belitz, W. Grosch. – 2nd ed. / translation from the fourth German edition

by M. Burghagen ... [et al.]

Includes bibliographical references and index.

ISBN 3-540-64704-X (hard). – ISBN 3-540-64692-2 (soft)

1. Food-Analysis. I. Grosch, W. (Werner) II. Title.

TX545.B3513 1999 664'.07-dc21 99-10777

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Printed in Germany

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Cover design: de'blik, Berlin

Typesetting: Fotosatz-Service Köhler GmbH, 97084 Würzburg

Production: ProduServ GmbH, Verlagsservice, Berlin

SPIN: 10680543 (soft) 10685705 (hard) 52/3020 – 5 4 3 2 1 0 – Printed on acid-free paper

In Memoriam
Joseph Schormüller (1903–1974)
Professor of Food Chemistry at the
Technische Universität Berlin

Preface to the Second English Edition

The second edition of “Food Chemistry” is a translation of the fourth German edition of this textbook. The text has been corrected only in a few places, e. g., most of the production data are presented for the year 1996.

The preparation of this edition was greatly delayed due to the deaths of Professor Dr. H.-D. Belitz in March 1993 and of Professor Dr. D. Hadziyev, who translated the first edition, in July 1995. H.-D. Belitz worked on the preparation of the second edition.

Dr. Margaret Burghagen translated most of the extensive changes incorporated into this new edition and revised the entire text. I am greatly indebted to her for her excellent work. It was a pleasure to work with her.

I gratefully acknowledge the help of my colleagues who made valuable criticisms and contributed to the improvement of the text. I particularly thank Dr. M. C. Kühn, Holland.

I would also like to thank Mrs. R. Jauker for assistance in completing the manuscript and for proofreading and my son B. Grosch for assistance in preparing the index.

Garching, January 1999

W. Grosch

Preface to the First English Edition

The two German editions of the “Lehrbuch für Lebensmittelchemie” were so well accepted not only as a university textbook, but also as a first comprehensive source of information for people in science, industry, official food control and administration, that the publishing house, Springer-Verlag (Heidelberg), decided to edit an English version.

The first English edition is actually the second German edition which was revised for this purpose.

We are specially thankful to our colleague Prof. Dr. D. Hadziyev for the translation of the book.

Garching, December 1986

H.-D. Belitz, W. Grosch

Preface to the Fourth German Edition

For the fourth edition, all the chapters have been carefully revised and updated. Furthermore, one chapter and various sections have been added and others have been reworked. Some of the changes that have been made are:

- The relationships between the water content and reactivity of food have been presented in terms of the kinetics of phase transitions.
- The formation of mutagenic compounds from amino acids by thermal reactions has been discussed in greater detail.
- Technologically important properties of proteins, such as the formation of foams, gels and emulsions, have been summarized.
- The chapter on enzymes contains revised sections on the relationships between structure and catalytic activity and on the temperature dependency of the reaction rate.
- In the chapter on carbohydrates, the *Maillard* reaction and the section on starch have been discussed in greater detail and a section on halodeoxy sugars has been added.
- The chapter on aroma substances and the sections on the aroma substances of individual foods have been completely revised.
- The chapter on food additives has been modified to include new sweeteners (suosan, guanidines, alitame, sucralose) and a more detailed presentation of emulsifiers.
- Dioxins have been included in the chapter on food contamination.
- The chapters on individual foods contain more detailed presentations of analysis (meat, fats, fruit), various constituents (cereal proteins, legume proteins, proteinase inhibitors, phenolic compounds) and of some technical processes (micelle and gel formation in the case of milk and baking process and ageing of baked products).
- A short chapter on drinking water, mineral and table water has been added.
- The references included in each chapter have been updated.

We would like to thank all our readers who have helped us with their constructive criticism in the preparation of this manuscript. For the completion and proofreading of the manuscript, we are indebted to Mrs. R. Berger, Mrs. Ch. Hoffmann, Mrs. I. Hofmeier, Mrs. G. Nominacher-Ullrich and Mrs. K. Wüst. We are very grateful to Springer Verlag for their consideration of our wishes and for the pleasant cooperation.

Garching, June 1992

H.-D. Belitz, W. Grosch

Preface to the First German Edition

The very rapid development of food chemistry and technology over the last two decades, which is due to a remarkable increase in the analytical and manufacturing possibilities, makes the complete lack of a comprehensive, teaching or reference text particularly noticeable. It is hoped that this textbook of food chemistry will help to fill this gap. In writing this volume we were able to draw on our experience from the lectures which we have given, covering various scientific subjects, over the past fifteen years at the Technical University of Munich.

Since a separate treatment of the important food constituents (proteins, lipids, carbohydrates, flavor compounds, etc.) and of the important food groups (milk, meat, eggs, cereals, fruits, vegetables, etc.) has proved successful in our lectures, the subject matter is also organized in the same way in this book.

Compounds which are found only in particular foods are discussed where they play a distinctive role while food additives and contaminants are treated in their own chapters. The physical and chemical properties of the important constituents of foods are discussed in detail where these form the basis for understanding either the reactions which occur, or can be expected to occur, during the production, processing, storage and handling of foods or the methods used in analyzing them. An attempt has also been made to clarify the relationship between the structure and properties at the level of individual food constituents and at the level of the whole food system.

The book focuses on the chemistry of foodstuffs and does not consider national or international food regulations. We have also omitted a broader discussion of aspects related to the nutritional value, the processing and the toxicology of foods. All of these are an essential part of the training of a food chemist but, because of the extent of the subject matter and the consequent specialization, must today be the subject of separate books. Nevertheless, for all important foods we have included brief discussions of manufacturing processes and their parameters since these are closely related to the chemical reactions occurring in foods.

Commodity and production data of importance to food chemists are mainly given in tabular form. Each chapter includes some references which are not intended to form an exhaustive list. No preference or judgement should be inferred from the choice of references; they are given simply to encourage further reading. Additional literature of a more general nature is given at the end of the book.

This book is primarily aimed both at students of food and general chemistry but also at those students of other disciplines who are required or choose to study food chemistry as a supplementary subject. We also hope that this comprehensive text will prove useful to both food chemists and chemists who have completed their formal education.

We thank sincerely Mrs. A. Mödl (food chemist), Mrs. R. Berger, Mrs. I. Hofmeier, Mrs. E. Hortig, Mrs. F. Lynen and Mrs. K. Wüst for their help during the preparation of the manuscript and its proofreading. We are very grateful to Springer Verlag for their consideration of our wishes and for the agreeable cooperation.

Garching, July 1982

H.-D. Belitz, W. Grosch

Introduction

Foods are materials which, in their naturally occurring, processed or cooked forms, are consumed by humans as nourishment and for enjoyment.

The terms “nourishment” and “enjoyment” introduce two important properties of foods: the nutritional value and the hedonic value. The former is relatively easy to quantify since all the important nutrients are known and their effects are defined. Furthermore, there are only a limited number of nutrients. Defining the hedonic value of a food is more difficult because such a definition must take into account all those properties of a food, such as visual appeal, smell, taste and texture, which interact with the senses. These properties can be influenced by a large number of compounds which in part have not even been identified. Besides their nutritional and hedonic values, foods are increasingly being judged according to properties which determine their handling. Thus, the term “convenience foods”. An obvious additional requirement of a food is that it be free from toxic materials.

Food chemistry is involved not only in elucidating the composition of the raw materials and end-products, but also with the changes which occur in food during its production, processing, storage and cooking. The highly complex nature of food results in a multitude of desired and undesired reactions which are controlled by a variety of parameters. To gain a meaningful insight into these reactions, it is necessary to break up the food into model systems. Thus, starting from compositional analyses (detection, isolation and structural characterization of food constituents), the reactions of a single constituent or of a simple mixture can be followed. Subsequently, an investigation of a food in which an individual reaction dominates can be made. Inherently, such a study starts with a given compound and is thus not restricted to any one food or group of foods. Such general studies of reactions involving food constituents are supplemented by special investigations which focus on chemical processes in individual foods. Research of this kind, is from the very beginning, closely associated with economic and technological aspects and contributes, by understanding the basics of the chemical processes occurring in foods, both to resolving specific technical problems and to process optimization.

A comprehensive evaluation of foods requires that analytical techniques keep pace with the available technology. As a result a major objective in food chemistry is concerned with the application and continual development of analytical methods. This aspect is particularly important when following possible contamination of foods with substances which may involve a health risk. Thus, there are close links with environmental problems.

Food chemistry research is aimed at establishing objective standards by which the criteria mentioned above – nutritional value, hedonic value, absence of toxic compounds and convenience – can be evaluated. These are a prerequisite for the industrial production of high quality food in bulk amounts.

This brief outline thus indicates that food chemistry, unlike other branches of chemistry which are concerned either with particular classes of compounds or with particular methods, is a subject which, both in terms of the actual chemistry and the methods involved, has a very broad field to cover.

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