

H.-D. Belitz · W. Grosch

Food Chemistry



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Translation from the second German Edition
by D. Hadziyev

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Professor Dr.-Ing. H.-D. Belitz

Professor Dr.-Ing. W. Grosch

Institut für Lebensmittelchemie der Technischen Universität München
and Deutsche Forschungsanstalt für Lebensmittelchemie, München
Lichtenbergstraße 4
D-8046 Garching, FRG

Translator:

Professor Dr. D. Hadziyev

Department of Food Science

University of Alberta

Edmonton, Alberta, Canada

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

Preface to the First English Edition

The two German editions of the "Lehrbuch für Lebensmittelchemie" were so well accepted not only as an 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 Second German Edition

Appreciative critiques and rapid sales have indicated that the first edition of our books has been well received by many readers.

A second print run was dictated therefore, earlier than expected, so that in this second edition we have concentrated on correcting errors and updating statistical data. Nevertheless, we have done our best to adapt the text to include the most important, recent developments and, where appropriate, the references have also been brought up to date. With respect to the latter it is important to emphasize that a textbook should, apart from discussing the state of the art, provide an incentive for more intensive study.

Our thanks are due to all readers who have assisted us in preparing this second edition by pointing out errors and proofreading by their constructive criticism. For the preparation of the manuscript and we are indebted to Mrs. A. Mödel (food chemist), Mrs. R. Berger, Mrs. J. Hahn, Mrs. I. Hofmeier, Mrs. H. Troesch and Mrs. K. Wuest. Once again, we would like to acknowledge the pleasant cooperation of our publishers.

Garching, September 1984

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, due to a remarkable augmentation to the analytical and manufacturing possibilities, make 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 last 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 foods. 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 and no preference or judgement should be inferred from the choice of references; they are given simply to encourage further reading. Additional literature of 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 subsidiary subject. We also hope that this comprehensive text will prove useful to both food chemists and chemists generally 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

Foreword of the Translator

Providing basic and applied information on the state of knowledge within food science and technology is a constant challenge. This translation presents an intellectually digested overview of the ever provoking field of food chemistry.

The translation is a textbook in the German sense which means it is both a textbook and a reference. It is a handbook in the North American sense, which means a comprehensive, one volume reference. Also, it exemplifies how to write a chemically oriented text without excessive repetition of basic disciplines and food processing, and showing that many food science disciplines are mature enough to be dealt with separately. On the basis of the revised second German edition, the book was additionally revised, upgraded and supplemented with English references all in a joint pursuit to develop an English edition.

Often being asked why I embarked on a "linguistic exercise" rather than writing my own book, the answer is intimately connected with the way humane deal with knowledge. If it is good, our duty is to remove its language barrier and let it be disseminated. Furthermore there were other attributes.

The authors are my personal friends. One is administrator of the Institute of Food Chemistry, Technical University Munich, where both are wonderful teachers and scientists. They are highly regarded by the scientific community for their work on the extent and mechanism of lipid oxidation, carotenoid cooxidation, and for the field of proteinase enzymes and their natural inhibitors in cereals and vegetables. Also, the correlation of sensory properties of peptides and other compounds with their structures and/or extent of protein hydrolysis is a highlight of their research. The authors reliably recount the vast heritage and progress in food chemistry in post-war Germany. Admittedly, the latter developed separately rather than closely interrelated with other countries. Hence, the translation reflects this process and sheds light on the present status of their teaching within their University degree programs.

The translation aims to serve the needs of senior undergraduate and graduate students and to serve as a handbook for teaching staff and graduates employed by baking, brewing, dairy, meat and other food industries, Agriculture and Government agencies. This is especially so since it meets the revised minimum curriculum standards set by the Institute of Food Technologists.

The translation generally follows the American style and spelling (odor or flavor rather than odour or flavour) and for compound nomenclature follows the recommendations of the Merck Index, tenth edition, with some exceptions (e. g. an "e" in flavine, but not in riboflavin, or often prolamines rather than exclusively prolamin).

It is a pleasure to acknowledge the commendable cooperation of the authors, and the skill and assistance of Leonard Steele and Judy Nuss. Also valuable was the release from active teaching, administrative and extension work by being granted a study leave – special thanks are due to my Department of Food Science and the Faculty of Agriculture and Forestry.

Edmonton, December 1986

D. Hadziyev

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 enjoyment 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 enjoyment value of a food is more difficult because such a definition must take account of 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. As well as for its nutritional and enjoyment values food is increasingly being judged according to properties which determine its value in use. 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 dissolve the food into model systems. Thus, starting from compositional analyses (detection, isolation and structural characterisation of food constituents), the reactions of a single constituent or of a simple mixture are 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 so that a major part of food chemistry is concerned with the application and continual development of analytical methods. This aspect is particularly important with respect to 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 scales by which the criteria mentioned above – nutritional value, enjoyment value, absence of toxic compounds and convenience – can be evaluated. These are a prerequisite for the production of high quality food in sufficient quantity.

The brief outline given here makes clear 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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