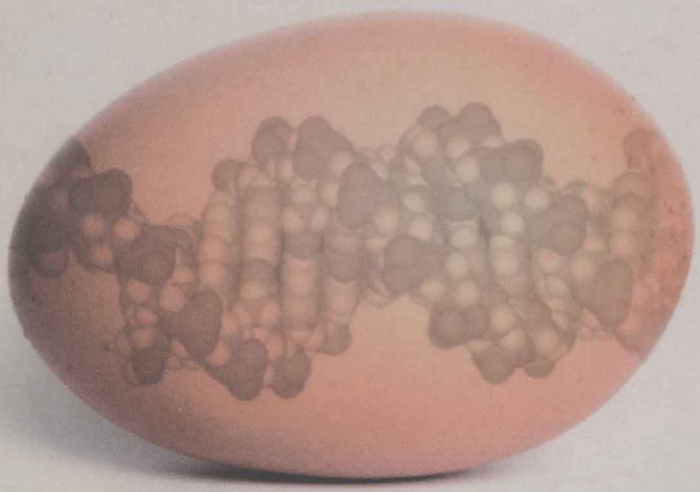
Edited by **Geoffrey Campbell-Platt**

Food Science and Technology



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Food Science and Technology

Edited by

Geoffrey Campbell-Platt

Professor Emeritus of Food Technology, University of Reading
President of IUFoST 2008–2010

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Contents

Introduction

Geoffrey Campbell-Platt

Food science and technology is the understanding and application of science to satisfy the needs of society for sustainable food quality, safety and security.

At several universities worldwide, degree programmes in food science and technology have been developed in the past half-century. This followed the lead of the University of Strathclyde (then the Royal College of Science and Technology) in Glasgow, Scotland, under the leadership of the first Professor of Food Science, who also became President of the International Union of Food Science and Technology (IUFoST), the late John Hawthorn.

The aim of these courses has been to provide food science and technology graduates with the ability, through multidisciplinary studies, to understand and integrate the scientific disciplines relevant to food. They would then be able to extend their knowledge and understanding of food through a scientific approach, and to be able to apply and communicate that knowledge to meet the needs of society, industry and the consumer for sustainable food quality, safety and security of supply.

1.1 Food science and technology course elements

Students studying food science and technology in higher education need to have undertaken courses in the basic scientific disciplines of chemistry, biology, mathematics, statistics and physics. These are developed in food science and technology degree programmes through course elements in Food Chemistry, Food Analysis, Food Biochemistry, Food Biotechnology, Food Microbiology, Numerical Procedures and Food Physics. These are all covered by chapters in this book, followed by chapters covering Food Processing, Food Engineering and Packaging. Further courses are required in Nutrition, Sensory Evaluation, Statistical Techniques, and Quality Assurance and Legislation. Regulatory Toxicology and Food Safety is addressed, as is Food Business Management. Other course elements in Food Marketing and Product Development are included, together with chapters on Information Technology, and Communication and Transferable Skills.

Food science and technology are science-based courses, requiring a good grounding in science and the use of laboratory and pilot-plant facilities, to reinforce the theoretical knowledge acquired. As well as acquiring practical laboratory and observation skills, laboratory experiments need to be written up, developing important reporting and interpretation skills. Universities therefore require up-to-date facilities for chemical, microbiological laboratory exercises, and processing pilot-plant facilities for teaching the principles of unit processing and engineering operations, as well as sufficient well-qualified staff to teach the range of disciplines covered in this book.

1.2 Evolution of the book

The book has evolved from a working group of the Committee of University Professors of Food Science and Technology (CUPFST), United Kingdom, who

sought to agree a framework of common course elements for the various food science and technology courses established in the UK. Newer universities advised that each course element should be based on outcomes, which should be achieved on successful completion, and it is these outcome headings that have largely been used as subject headings in each chapter of this book. This approach is popular internationally and is used by professional institutes such as the Institute of Food Science and Technology (IFST) in the UK, and the book has evolved in consultation with the recommended Education Standards for Food Science of the Institute of Food Technologists (IFT) in the USA.

The IFT recognises food science as the discipline in which engineering, biological and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public. Food technology is recognised as the application of food science to the selection, preservation, processing, packaging, distribution and use of safe, nutritious and wholesome food. In short, it could be said that the food scientist analyses and takes apart food materials, whilst the food technologist puts all that knowledge into use in producing safe, desired food products. In practice, as recognised throughout the world, the terms are often used interchangeably, and practising food scientists and technologists have to both understand the nature of food materials and produce safe, nutritious food products.

It is understood, and desirable, that the various food science and technology courses offered will vary, reflecting particular research interests and expertise, in different institutions, and students will want to develop their own interests through specific module choices or individual research projects. However, the purpose of establishing the core competencies, reflected in the chapters of this book, is to recognise what a food science or food technology graduate can be expected to achieve as a minimum, so that employers and regulators know what to expect of a qualified graduate, who could then expect, after suitable relevant experience, to become a member of a professional body, such as IFT or IFST, or a Chartered Scientist.

1.3 Food safety assurance

In our increasingly interdependent globalised world, food safety is an implied term in the 'food purchasing or food service' consumer contract, which often appears to be addressed publicly only when something goes wrong. In fact, food control agencies and food retailers require processors and manufacturers to apply Hazard Analysis Critical Control Points (HACCP) to all their processes. This, combined with good practices, such as Good Manufacturing Practice (GMP), and traceability, build quality and safety assurance into the food chain, which is inherently better with the very large number of food items produced and eaten frequently, and when individual item or destructive testing can only give a limited picture of the total production. Both HACCP and GMP require good teamwork by all involved in food processing, and it is the multidisciplinary-trained food scientist or technologist who usually is called upon to lead and guide these operations.

In our modern world where food ethics are to the fore, in terms of sustainable production practices, care of our environment, fair-trade, packaging recycling and climate-change concerns, food scientists and technologists will have an increasing role to play, in keeping abreast of these issues and the science that can be applied to help address them. Food scientists, to be successful, already need good interpersonal, communication and presentation skills, which may be learned through example, mentoring and practice in as many different situations as possible; in the future, these skills promise to be in even greater demand, as scientists engage with increasingly demanding members of the public.

1.4 The International Union of Food Science and Technology (IUFoST)

IUFoST is the international body representing some 65 member countries and some 200,000 food scientists and technologists worldwide. IUFoST organises World Congresses of Food Science and Technology in different locations around the world, normally every 2 years, at which the latest research and ideas are shared, and the opportunity is provided for young food scientists to present papers and posters and to interact with established world experts. Higher education in food science and technology has been of great interest for several years, with many developing countries looking for guidance in establishing courses in the subject, or to align them more closely with others, to help graduates move more successfully between countries and regions. IUFoST is

also helping the development of Distance Education, where people are in employment and not able to attend normal university courses. IUFoST therefore sees the publication of this book as an important part of its contribution to helping internationally in sharing knowledge and good practice.

IUFoST has also established the International Academy of Food Science and Technology (IAFoST), to which eminent food scientists can be elected by peer review, and are designated as Fellows of IAFoST. The Fellows have acted as lead authors and advisers in the increasing range of authoritative Scientific Information Bulletins published by IUFoST, through its Scientific Council, which help summarise key food issues to a wider audience.

1.5 The book

In writing this book, we have been honoured to have the 20 chapters written by 30 eminent authors, from 10 different countries. All authors are experts in their respective fields, and together represent 15 of the world's leading universities in food science and technology, as well as four leading international organisations. We are particularly honoured that several of the authors are distinguished Fellows of IAFoST, so helping directly to inspire younger potential food scientists and technologists through this textbook for students.

It is therefore hoped that this book is adopted widely, providing tutors and students with the basic content of the core components of food science and technology degrees, while providing guidance through references to further knowledge and for more advanced study. If this work provides the opportunity to help students worldwide in sharing a common ideal while developing their own interests and expertise, the original aim of Professor John Hawthorn in developing this vital subject, so essential for all of us, from Scotland to a worldwide discipline, will have been achieved.

Supplementary material is available at www.wiley.com/go/campbellplatt

Food chemistry

Richard A. Frazier

Key points

- Carbohydrate chemistry: structures, properties and reactions of major monosaccharides, oligosaccharides and polysaccharides in foods.
- Proteins: chemistry of the amino acids and their role in protein structure, a description of the major forces that stabilize protein structure and how they are disrupted during protein denaturation.
- Lipids: structure and nomenclature, polymorphism of triglycerides, oil and fat processing (hydrogenation and interesterification), and lipid oxidation.
- Chemistry of minor components in foods: permitted additives, vitamins and minerals.
- Role of water in foods: water activity, its determination and the importance for microbial growth, chemical reactivity and food texture.
- Physical chemistry of dispersed systems: solutions, lyophilic and lyophobic dispersions, colloidal interactions and the DLVO theory, foams and emulsions.
- Chemical aspects of organoleptic properties of foods.

2.1 Introduction

Food chemistry is a fascinating branch of applied science that combines most of the sub-disciplines of traditional chemistry (organic, inorganic and physical chemistry) together with elements of biochemistry and human physiology. Food chemists attempt to define the composition and properties of food, and understand the chemical changes undergone during production, storage and consumption, and how these might be controlled. Foods are fundamentally biological substances and are highly variable and complex; therefore, food chemistry is a constantly evolving and expanding field of knowledge that underpins other areas of food science and technology. This chapter cannot hope to encompass all of the intricacies and details of food chemistry, but instead attempts to provide an overview of the fundamental areas that constitute this important area of science. To delve deeper, the reader is encouraged to refer to one or more of the excellent texts relating to food chemistry that are listed as further reading at the end of this chapter.

2.2 Carbohydrates

Carbohydrate is the collective name for polyhydroxyaldehydes and polyhydroxyketones, and these