Recent Advances in FOOD SCIENCE

Volume 1
COMMODITIES

Edited by
J. Hawthorn
&
J. Muil Leitch

RECENT ADVANCES IN FOOD SCIENCE

Papers read at the Residential Summer Course
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VOLUME ONE

COMMODITIES

Edited by

Professor JOHN HAWTHORN,
B.Sc., Ph.D., A.R.C.S.T., F.R.I.C.

Head of Department of Food Science

and

JAS. MUIL LEITCH, B.Sc., F.R.I.C.

Senior Lecturer in Food Science

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PREFACE

In 1948 and 1951, short courses in Food Science were offered by the Low Temperature Research Station at Cambridge and the papers presented were later edited for publication* by Bate-Smith and Morris. These courses had two important results. They stimulated interest in the organization of the rapidly-growing but amorphous mass of scientific and technological information on foodstuffs, and they effectively introduced the term 'Food Science' as an acceptable title for this body of knowledge.

It seemed appropriate to choose 1960 as the year for a re-appraisal of this subject. Considerable progress had taken place during the preceding decade. Additionally the subject had been brought to public notice by the centenary of the 1860 Food and Drugs Act (U.K.) and the hundred and fiftieth anniversary of the publication of Appert's work on the preservation of food in sealed containers. Because of its teaching school and its residential facilities, the Royal College of Science and Technology was chosen as a meeting place, and through the generosity of the Office of the Science Adviser to the North Atlantic Treaty Organization, funds were placed at the disposal of the organizing committee which enabled invitations to be extended to food scientists from overseas. In all, fifteen countries were represented in addition to the United Kingdom.

In planning the lecture programme, the organizing committee decided at the outset to exclude nutritional considerations from the programme. The decision was regretted even as it was made, but it was essential to reduce the volume of material to manageable proportions. In spite of this simplification selection presented our greatest problems, and the compromise solution was this attempt to describe the more important salients. It is inevitable that the coverage is incomplete and that the presentation follows more the pattern of a course than would have been the case had these volumes been produced for their own sake. Nevertheless, it is our belief that the over-all pattern gives a not inaccurate impression of the field of investigation in this rapidly-growing subject.

The papers recorded in these volumes are the work of some fifty contributors, and the editors have interpreted their function as a duty to preserve the style and approach of individual contributors rather than to attempt a contrived uniformity.

E. C. Bate-Smith
J. Hawthorn
G. A. Reay

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* *Food Science: A Symposium.* Cambridge University Press, 1951.

FOREWORD

DAVID LOWE, C.B.E.

Deputy Chairman Agricultural Research Council
Member Food Research Advisory Committee

IT GAVE me great pleasure to be present at the Residential Course on Recent Advances in Food Science. I was able to attend a few lectures in each part and I found them most interesting and stimulating. In addition, I met many old friends and, I hope, made some new ones.

The A.R.C first assumed over-all responsibility for food research* in July, 1959, although some items of food have been included in the programmes of certain research institutes for many years. While all the efforts of agriculture are channelled towards the production of food (and, of course, such by-products as wool and hides) farmers usually handed their produce over at the 'farm gate' or the auction market. This was also accepted by many as the dividing line for research. The removal of this dividing line, or barrier, and the opening of the gate, must be of great benefit to agriculture.

As I said at the dinner marking the end of the course, 'In all research it is essential to have maximum known history'. While we can start our investigations today with animals of known genetical history—even with identical twins (most useful tools)—and while we know a lot about the effects of their environment, their nutrition, health, conversion ratios, etc., it is equally important to know how they are handled from the moment they leave the farm to the time of slaughter with some special emphasis on their condition immediately before slaughter. To meet this need, as a temporary measure we are developing a small outstation at Cherry Hinton near Cambridge, where we have available that most important requirement, a commercial abbatoir. All this is essential to knowledge and for research in meat quality.

We also want to follow our fruits along the road from blossom to the following spring when they are taken from store at Ditton. We must have the maximum information from the farm and orchard to help explain variations in keeping quality, and to supplement our attack on storage problems. Again with vegetables there is much still to do. Canning, quick-freezing, hydrocooling, pre-packing—all those present problems and are complicated by the great variety of strains and the effect on them of different soils, climate, nutrition and methods of cultivation. With both of these commodities we must continue to keep a strict watch on the after-effects following the application of insecticides and fungicides, not only for possible residual effects on or in the produce but also in the soil.

* That is agriculturally produced food. Research on the preservation of fish for food still remains in the control of the Department of Scientific and Industrial Research. Food trade research associations are also assisted by D.S.I.R.

At the dinner I quoted from the annual report of the A.R.C. for the year 1958–9 :

'In deciding on the problems to be solved, the Council is anxious to build up for food research a similar relationship with the Ministry of Agriculture, Fisheries and Food, and the Department of Agriculture for Scotland to that which has worked well in agriculture. To that end the Minister of Agriculture and the Secretary of State for Scotland have recently set up a Food Research Advisory Committee to advise on food problems requiring investigation or research which should be undertaken with the aid of public funds and to make recommendations as to the priority to be accorded on such problems.

'The importance has been previously stressed of considering the production, handling, storage, packaging and processing of food as links in one continuous chain of operations, the final objective of which is to provide the nation with food of the highest quality at the lowest economic price. The Council has therefore always in mind the need to integrate research on production with that on the intermediate steps involved in the passage of food from the farm to the dinner table. This is equally true whether the production is on our own farms or those overseas. To this end the Council is keeping in touch with research on production throughout the Commonwealth and, where possible, in other countries from which our food comes.'

No research exceeds in importance that in food. As I have indicated, it is our duty to integrate it, and, if necessary, to expand it to meet the priorities which the Minister's advisory committee present to us.

LIST OF CONTRIBUTORS

William Bennett Adam, M.A., F.R.I.C.
Director of Research
The Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping Campden, Gloucestershire, England

Edgar Charles Bate-Smith, M.SC., PH.D., M.INST.R., F.L.S.
Director
Low Temperature Research Station, Cambridge, England

James Reginald Bendall, B.A.(CANTAB).
Low Temperature Research Station, Cambridge, England

John Adam Blain, B.SC., PH.D., A.R.I.C.
Lecturer in Biochemistry
Department of Applied Microbiology and Biology, The Royal College of Science and Technology, Glasgow C.1, Scotland

Harold Burton, B.ENG., M.SC., A.M.I.E.E.
Research Engineer
National Institute for Research in Dairying, Shinfield, Reading, England

Norman Chamberlain, B.SC., PH.D., F.R.I.C., M.I.BIOL.
Head of the Member Services Division
British Baking Industries Research Association, Chorleywood, Hertfordshire, England

John J. Connell, B.SC., PH.D.
Principal Scientific Officer
Department of Scientific and Industrial Research, Torry Research Station, Aberdeen, Scotland

Robert J. M. Crawford, B.SC., PH.D., N.D.A., N.D.D.
Senior Lecturer
Department of Dairying, West of Scotland Agricultural College, Auchincruive, Ayr, Scotland

John Charles Dakin, B.SC., A.I.BIOL.
Research Officer
British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey, England

John J. Devlin, F.INST.B.B.
Technical Manager
Simon–AMF Ltd., Cheadle Heath, Stockport, Cheshire, England

Ronald B. Duckworth, B.SC., PH.D.
Lecturer in Food Science
Department of Food Science, The Royal College of Science and Technology, Glasgow W.2, Scotland

Gordon Cowan Eddie, B.SC., A.R.C.S.T., A.M.I.MECH.E., M.I.MAR.E., M.INST.R.
Principal Scientific Officer
I/C Engineering Research and Development, Department of Scientific and Industrial Research, Torry Research Station, Aberdeen, Scotland

John Carter Fidler, O.B.E., B.SC., PH.D.(DUNELM), PH.D.(CANTAB.), M.INST.R.
Senior Principal Scientific Officer
Ditton Laboratory (Agricultural Research Council), Larkfield, Kent, England

Nathan Fisher, B.SC., PH.D.
Senior Scientific Officer
British Baking Industries Research Association, Chorleywood, Hertfordshire, England

James Collins Forrest, B.SC., A.M.I.MECH.E.
Development Engineer
Corn Products International, 717 Fifth Avenue, New York 22, U.S.A.

*William Findlay Geddes, PH.D.
Professor and Head of the Department of Agricultural Biochemistry
University of Minnesota, St. Paul 1, Minnesota, U.S.A.

Thomas Gibson Gillespy, B.SC., PH.D., A.R.C.S.
Senior Bacteriologist
The Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping Campden, Gloucestershire, England

Evelyn Graham Beaujohn Gooding, M.A., M.I.BIOL.
Technical Adviser
Corn Products Co., New York, N.Y., U.S.A.
Formerly Officer in Charge,
(Senior Principal Scientific Officer)
Ministry of Agriculture, Fisheries and Food Research Establishment, Aberdeen, Scotland

John Hawthorn, B.SC., PH.D., A.R.C.S.T., F.R.I.C.
Professor of Food Science
Department of Food Science, The Royal College of Science and Technology, Glasgow C.1, Scotland

Matthew Edward Highlands, A.B., S.M., PH.D.
Head of Department of Food Science
Maine Agricultural Experiment Station, University of Maine, Orono, Maine, U.S.A.

Thomas Widdowfield Houston, B.SC., M.I.BIOL.
Senior Scientific Officer
Food Science and Atomic Energy Division, Ministry of Agriculture, Fisheries and Food, Great Westminster House, London S.W.1, England

James W. Howie, M.D., M.R.C.P., F.R.F.P.S.
Professor of Bacteriology
Head of University Department of Bacteriology, The Western Infirmary, Glasgow, Scotland

Joseph Harry Hulse, B.SC.TECH., A.M.C.T.
Deputy Director of Research
Maple Leaf Mills Limited, 43 Junction Road, Toronto 9, Ontario, Canada

Maurice Ingram, M.A., PH.D.(CANTAB.)
Deputy Director
Low Temperature Research Station, Downing Street, Cambridge, England

Derek James Jayne-Williams, B.SC., M.SC., PH.D.
Research Bacteriologist
National Institute for Research in Dairying, University of Reading, Shinfield, Reading, England

*Dr. Geddes died on 7th January, 1961

Gisela Jellinek, DR. RER. NAT., DIPL. CHEM.
Heidelberg, Mozartstr. 15, West Germany
Formerly Research Assistant
Institut für Ernährungswissenschaft der Justus Liebig-Universitat Giessen, Giessen, West Germany

Charles Robert Jones, PH.D., B.SC., F.R.I.C.
Assistant Director of Research
The Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans, Hertfordshire, England

Karl Bryce Jones, PH.D., B.SC., A.R.C.S., F.R.I.C.
Principal Scientific Officer
Food Science and Atomic Energy Division, Ministry of Agriculture, Fisheries and Food, Great Westminster House, London S.W.1, England

Noel Rees Jones, M.SC., PH.D.
Principal Scientific Officer
Department of Scientific and Industrial Research, Torry Research Station, Aberdeen, Scotland

Norman R. Knowles, PH.D., M.SC., B.SC.
Director of Scientific and Technical Division
British Egg Marketing Board, Wingate House, 93-107 Shaftesbury Avenue, London W.1, England

Derek Gordon Land, B.SC., PH.D., A.R.I.C.
Senior Scientific Officer
Low Temperature Research Station, Anstey Hall Annex, Trumpington, Cambridge, England
Formerly Ministry of Agriculture, Fisheries and Food Experimental Establishment, Aberdeen, Scotland

Ralston Andrew Lawrie, B.SC., PH.D.(CANTAB.), F.R.I.C.
Principal Scientific Officer
Low Temperature Research Station, Downing Street, Cambridge, England

Colin H. Lea, D.SC., SC.D.(CANTAB.), F.R.I.C.
Senior Principal Research Officer
Low Temperature Research Station (Agricultural Research Council), Cambridge, England

Robert Malcolm Love, B.SC., PH.D.
Principal Scientific Officer
Department of Scientific and Individual Research, Torry Research Station, Aberdeen, Scotland

John Arnold Lovern, PH.D., D.SC., F.R.I.C., F.R.S.E.
Senior Principal Scientific Officer
Department of Scientific and Industrial Research, Torry Research Station, Aberdeen, Scotland

Norman A. Matheson, B.SC., PH.D.
Department of Protein and Liquid Chemistry, Rowett Research Institute, Bucksburn, Aberdeen, Scotland

Joseph Meyrath, D.TECH.SC. (ZURICH)
Senior Lecturer in Applied Microbiology
Department of Applied Microbiology and Biology, The Royal College of Science and Technology, Glasgow C.1, Scotland

Ernest O. Morris, B.SC., PH.D., M.I.BIOL.
Professor of Applied Microbiology
Department of Applied Microbiology and Biology, The Royal College of Science and Technology, Glasgow C.1, Scotland

Emil M. Mrak, B.S., M.S., PH.D.
Chancellor; Professor of Food Technology
Food Technologist in Experimental Station, University of California, Davis, California, U.S.A.

Mamie Olliver, M.SC., F.R.I.C.
Chief Research Chemist
Connaught Food Products Ltd., Section of Schweppes Research Laboratories, Hendon, London N.W.9, England

James Pace, B.SC., PH.D.
Research Association of British Flour Mills, Cereals Research Station, Old London Road, St. Albans, Hertfordshire, England

Robert William Pomeroy, M.A., PH.D., DIP.AGRIC.SCI.
Principal Scientific Officer
University of Cambridge and Agricultural Research Council, School of Agriculture, Downing Street, Cambridge, England

Isaac Arthur Preece, PH.D., M.SC., D.SC., F.R.I.C., M.U.BIOL., F.R.S.I.
Professor of Brewing and Applied Biochemistry
Editor of the Journal of the Institute of Brewing
Heriot-Watt College, Edinburgh, Scotland

Bennet B. Rae, M.A., B.SC., PH.D., F.R.S.E.
Assistant Director
Marine Laboratory (Department of Agriculture and Fisheries for Scotland), Aberdeen, Scotland

Richard Kenneth Sanders, M.A.
Head of Research Department
The Metal Box Co. Ltd., Kendals Avenue, Westfields Road, Acton, London W.3, England

James Garden Sharp, M.A., B.SC., PH.D.
Principal Scientific Officer
University of Cambridge and Agricultural Research Council, Low Temperature Research Station, Cambridge, England

James Mackay Shewan, B.SC., PH.D., F.R.I.C., F.R.S.E., M.INST.BIOL.
Senior Principal Scientific Officer
Department of Scientific and Industrial Research, Torry Research Station, Aberdeen, Scotland

James Andrew Buchan Smith, C.B.E., D.SC., F.R.S.E.
Director
The Hannah Dairy Research Institute, Ayr, Scotland

Cyril Tyler, D.SC., PH.D., F.R.I.C.
Professor
Department of Physiological Chemistry, The University of Reading, Reading, England

Thomas Andrewes Uthwatt, B.A., A.M.I.MECH.E., A.M.I.E.E.
Director of Research
Mather & Platt Limited, Park Works, Manchester 10, England

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SECTION ONE

INTRODUCTORY PAPERS

FOOD SCIENCE AS A DISCIPLINE

E. C. BATE-SMITH

THE FIRST Summer Course in Food Science—which appears to have been the first ever course in this subject—was held at the Low Temperature Research Station, Cambridge, in 1948. The Low Temperature Station, which is concerned purely with research and has no teaching responsibilities, was at the time* one of three laboratories which comprised the Food Investigation Organization of the Department of Scientific and Industrial Research. The other two laboratories were Torry Research Station, Aberdeen, responsible for work on fish, and Ditton Laboratory, Maidstone, Kent, responsible for most of the work on fresh fruits and vegetables. The commodities dealt with at the Low Temperature Station were meat, bacon, eggs, poultry, and in some degree fruits and vegetables. Dr Franklin Kidd was Director of Food Investigation with a separate headquarters office in Cambridge.

Originally, the Food Investigation Board was set up to deal with the problems of spoilage in refrigerated cargoes of meat and fruit. Until the outbreak of war in 1939 its activities and experience were fairly limited both by the exclusion of such important commodities as cereals and dairy products from its field of interest as well as by its restriction to refrigeration as a method of preservation (except for a short period of activity in canning). Under wartime conditions, however, circumstances abruptly changed. All the refrigerated shipping space was needed for hard frozen, 'telescoped' cargoes, and attention was turned to dehydration and compaction as a means of saving weight and volume of all manner of imported foodstuffs. Out of this experience was born a realization of the broad principles which governed the behaviour of foods in general subjected to the diverse storage and processing treatments which were currently employed, or might conceivably be employed in the future. These principles comprise, essentially, the subject matter of food science.

I am going to try and analyse our reasons for making a distinction between food science and food technology. In considering this question during the last few weeks I came to the conclusion that the best way to express my own feelings about where the distinction lay was that science is concerned with *understanding* whilst technology is concerned with *exploiting*. Both use knowledge—the same knowledge—but that knowledge is used in a different way in the two categories of organization. To my surprise, and gratification, on opening the current number of *Nature*, I found in the presidential address by Sir George Thomson to the British Association on the subject of 'The Two

* In July 1959 the Low Temperature Station and Ditton were transferred to the Agricultural Research Council, Torry remaining in D.S.I.R. The office of Director of Food Investigation has been abolished.

Aspects of Science' precisely this same distinction drawn. In the course of this address he remarked : 'The best way to make advances in technology, whether on the medical or the engineering side, turns out to be to understand the principles. This is quite a recent discovery—indeed it has probably only recently become true'. So far as I am myself concerned, it is indeed a recent discovery, and by virtue of its being an independent one of my own, I have no doubt whatever as to its truth !

In the English language we are fortunate in having two root sources to draw upon for most of our needs of expression, and these can often convey different shades of meaning. As a complement to the Anglo-Saxon 'understanding' we have the Latin derivative 'comprehending'—often used synonymously—but the second has also a usage in the sense of 'all-including'. I do not think a science can support a claim to provide an understanding of its subject unless that understanding is founded on the 'comprehension' of that subject in the second sense. Our experiences of the war left us with an acute appreciation of the shortcomings of food science especially in some particular directions, and it has been my effort in the intervening years to make good some of these deficiencies. So much depends, in such complicated materials as foods, on the behaviour of complex chemical molecules—mucoproteins, lipoproteins, phospholipids, lignin, tannins, and so on—that, by virtue of their complexity, are less studied and less known than the simpler, more amenable substances. We ourselves, and others, have made great progress in our knowledge of these substances during the last ten years. But there are many areas, quite properly and necessarily comprehended within food science, which are receiving too little attention, if, indeed, any at all. One especially I must mention, and that is the area of subjective assessment : the evaluation of those properties of foods which determine its appeal to the consumer. Much is being contributed to our knowledge in detail in relation to particular articles of food in particular circumstances, but little to our understanding of the principles which should govern the methodology of assessment. Dr Kidd, in his introductory lecture to the first summer course, did not neglect to point out that we cannot leave out the consumer and his needs when we consider the food he consumes, and in this sense nutrition also forms a part of food science. But the science of nutrition extends a long way beyond the boundaries of what we consider to represent food science ; the two sciences can be regarded as distinct areas but having much common ground between them.

It is, of course, just as impossible to draw a definite boundary between food science and food technology : the two are complementary. Food science is necessary to fertilize food technology, and food technology is equally necessary—I am tempted to say—to manure food science ! It is as essential for the food scientist to operate on the factory floor from time to time as for the food technologist to go into the factory with a thorough understanding of food science.

The Emergence of Food Science as a Discipline

In the intervening years, food science has come to be accepted as a subject area for teaching. In this country the first degree course with food science

as an honours subject has been instituted in Glasgow by the University, to which the Royal College of Science and Technology is affiliated, and others are to follow. It is interesting to see how, in analogous fields of activity, professionalization has been achieved. It is fair to consider, for instance, medicine and engineering, which Sir George Thomson mentioned in his presidential address, but of these medicine is perhaps the closer to our own case, being similarly concerned with the intimate well-being of the human individual, and another closely analogous science is that of agriculture, concerned as it is with the same biological principles and many of the same biological problems. In all these instances an essential step between the art and craft and the discipline is the introduction of organized teaching : first of the art and craft, and later of the science. In the case of medicine, for instance, it was the physician who first achieved professional recognition, and it was physic which was first of the medical sciences to become a teaching subject in the universities and in which a degree could be obtained. In this country doctorates in medicine were first conferred only by the universities of Oxford and Cambridge, and it is interesting to consider, as Dr Raven has recently done*, how much the physical sciences owe to the discipline of 'physick' as taught in these places.

However, the 'professionalization' of medicine took place not through the qualification of a degree, but by the granting of a Royal Charter to the College of Physicians in London in 1518. The apothecaries obtained a charter in 1616, and the surgeons a charter in 1745. The legal requirement of a qualification in order to practice came with the Apothecaries Act of 1815, which for a time put the apothecaries in a powerful position, but the Medical Act of 1888 determined the present state of affairs, where degrees of recognized universities, the conjoint qualification of the Royal Colleges of Surgeons and Physicians, and the Licentiate of the School of Apothecaries all entitle the holder to enrolment with the General Medical Council, which is itself a Government-appointed body. Thus professionalization in the medical sciences took place through the incorporation of its elements into their respective Colleges and Societies, and not merely by the organization of the science as a subject for teaching.

The essential feature of this emergence of medicine as a profession is not so much the element of privilege conferred on its members, but the discipline required of them in regard to its practice. It is this discipline which gives the profession the authority it undoubtedly commands.

It seems to me that we have reached a point in the emergence of food science where there is a need for some form of incorporation, for the exercize not only of the discipline of the mind, which is provided by organized teaching, but for the exercize of a discipline of practice, so as to create a body of authority in regard to those many questions of public interest for which the food scientist is, in some degree at least, responsible—questions, for instance, of quality, wholesomeness and safety. There does, in fact, seem to be a case for the formation of an institution which will give visible shape to the existence of food science as a discipline, whose scope and content we have attempted to cover and define in organizing the present course.

* Raven, C. E. 'Science, Medicine and Morals', 1959 (London : Hodder and Stoughton)

TEACHING AND RESEARCH IN FOOD SCIENCE

E. M. MRAK

AMERICAN food scientists have profited greatly by the fine contributions of British food scientists. The advanced thinking and approach of these gentlemen have had a profound influence on our scientists in the field of food research and teaching. I assure you that I have experienced at first hand many of the dramatic changes that have taken place in the United States during the past 30 years. I have experienced teaching in the art and science of wine making and in just the plain art of jam making. The latter involved the amount of sugar, time, temperature, and other factors involved in good jam making. On the other hand, not a word was devoted to heat penetration, browning reaction, chemical changes, rheological properties, or even consumer acceptance. Nevertheless this was the way in which the teaching of food technology started in the United States and this was the type of thinking that was prevalent until some of the earlier work of British scientists showed quite clearly that there could be, and needed to be, another aspect to teaching and research in food technology. It is true that it took some time to bring about changes in the United States and only in recent years have we seen a marked increase in thinking about the more fundamental aspects of food technology. I for one am grateful for the contributions and influence that our counterparts in Britain have had on food science teaching and research in the United States.

The reference to studies in the art I can assure you referred to studies in one of our great universities. When early in my career I had the opportunity to see some of the papers that came out from the Low Temperature Research Station, from Aberdeen, from Long Ashton, and elsewhere, I looked upon them with awe for I was aware that these places did not have the tremendous food production resources behind them that we had and still have in California. Your advanced type of work and forward thinking, therefore, set the stage for us to free ourselves from the 'pressure' of the farmers, processors, and even members of the legislature to do 'good, practical research and teaching'. At that time there was no realization of the need to stockpile what is considered by some to be useless information, but which might later prove to be 'useful useless' information. In other words, there was no building of a savings account of information that might be used later.

The agricultural experiment stations in the United States naturally had a great influence on the type of teaching and research. The early trends in these organizations, which have contributed so much to our agriculture, were heavily burdened with this practical point of view. It is needless to say that the reorientation of this type of thinking could not, and did not, take place overnight. I am sorry to say that industry saw the need for fundamental food science before the great majority of our experimental stations and