



DEVELOPMENTS IN FOOD SCIENCE 29

# FOOD SCIENCE AND HUMAN NUTRITION

*Edited by*

GEORGE CHARALAMBOUS



ELSEVIER

Amsterdam - London - New York - Tokyo 1992

DEVELOPMENTS IN FOOD SCIENCE 29

**FOOD SCIENCE  
AND HUMAN  
NUTRITION**

## DEVELOPMENTS IN FOOD SCIENCE

- Volume 1 J.G. Heathcote and J.R. Hibbert  
Aflatoxins: Chemical and Biological Aspects
- Volume 2 H. Chiba, M. Fujimaki, K. Iwai, H. Mitsuda and Y. Morita (Editors)  
Proceedings of the Fifth International Congress of Food Science and Technology
- Volume 3 I.D. Morton and A.J. MacLeod (Editors)  
Food Flavours  
Part A. Introduction  
Part B. The Flavour of Beverages  
Part C. The Flavour of Fruits
- Volume 4 Y. Ueno (Editor)  
Trichothecenes: Chemical, Biological and Toxicological Aspects
- Volume 5 J. Holas and J. Kratochvil (Editors)  
Progress in Cereal Chemistry and Technology. Proceedings of the VIIth World Cereal and Bread Congress, Prague, 28 June-2 July 1982
- Volume 6 I. Kiss  
Testing Methods in Food Microbiology
- Volume 7 H. Kurata and Y. Ueno (Editors)  
Toxicogenic Fungi: their Toxins and Health Hazard. Proceedings of the Mycotoxin Symposium, Tokyo, 30 August-3 September 1983
- Volume 8 V. Betina (Editor)  
Mycotoxins: Production, Isolation, Separation and Purification
- Volume 9 J. Holló (Editor)  
Food Industries and the Environment. Proceedings of the International Symposium, Budapest, Hungary, 9-11 September 1982
- Volume 10 J. Adda (Editor)  
Progress in Flavour Research 1984. Proceedings of the 4th Weurman Flavour Research Symposium, Dourdan, France, 9-11 May 1984
- Volume 11 J. Holló (Editor)  
Fat Science 1983. Proceedings of the 16th International Society for Fat Research Congress, Budapest, Hungary, 4-7 October 1983
- Volume 12 G. Charalambous (Editor)  
The Shelf Life of Foods and Beverages. Proceedings of the 4th International Flavor Conference, Rhodes, Greece, 23-26 July 1985
- Volume 13 M. Fujimaki, M. Namiki and H. Kato (Editors)  
Amino-Carbonyl Reactions in Food and Biological Systems. Proceedings of the 3rd International Symposium on the Maillard Reaction, Susuno, Shizuoka, Japan, 1-5 July 1985
- Volume 14 J. Škoda and H. Škodova  
Molecular Genetics. An Outline for Food Chemists and Biotechnologists
- Volume 15 D.E. Kramer and J. Liston (Editors)  
Seafood Quality Determination. Proceedings of the International Symposium, Anchorage, Alaska, U.S.A., 10-14 November 1986
- Volume 16 R.C. Baker, P. Wong Hahn and K.R. Robbins  
Fundamentals of New Food Product Development
- Volume 17 G. Charalambous (Editor)  
Frontiers of Flavor. Proceedings of the 5th International Flavor Conference, Porto Karras, Chalkidiki, Greece, 1-3 July 1987
- Volume 18 B.M. Lawrence, B.D. Mookherjee and B.J. Willis (Editors)  
Flavors and Fragrances: A World Perspective. Proceedings of the 10th International Congress of Essential Oils, Fragrances and Flavors, Washington, DC, U.S.A., 16-20 November 1986
- Volume 19 G. Charalambous and G. Doxastakis (Editors)  
Food Emulsifiers: Chemistry, Technology, Functional Properties and Applications
- Volume 20 B.W. Berry and K.F. Leddy  
Meat Freezing. A Source Book

- Volume 21 J. Davidek, J. Velišek and J. Pokorný (Editors)  
Chemical Changes during Food Processing
- Volume 22 V. Kyzlink  
Principles of Food Preservation
- Volume 23 H. Niewiadomski  
Rapeseed. Chemistry and Technology
- Volume 24 G. Charalambous (Editor)  
Flavors and Off-Flavors '89. Proceedings of the 6th International Flavor Conference,  
Rethymnon, Crete, Greece, 5-7 July 1989
- Volume 25 R. Rouseff (Editor)  
Bitterness in Foods and Beverages
- Volume 26 J. Chelkowski (Editor)  
Cereal Grain. Mycotoxins, Fungi and Quality in Drying and Storage
- Volume 27 M. Verzele and D. De Keukeleire  
Chemistry and Analysis of Hop and Beer Bitter Acids
- Volume 28 G. Charalambous (Editor)  
Off-Flavors in Foods and Beverages
- Volume 29 G. Charalambous (Editor)  
Food Science and Human Nutrition

## PREFACE

As Burns phrased it, the best laid schemes, etc., and plans for the Seventh International Conference scheduled for June 1991 at Samos did gang agley because of the uncertainties of the then political situation.

Frustrated would-be participants dubbed the aborted Conference "notional", "mirage", "now-you-see-it, now-you-don't". They all lobbied the Organizers for publication of their current research reports at this point in time, pledging other up-to-date papers and chapters for a rescheduled Conference in 1992.

This series of meetings, going back to 1977, has always attempted to bring together active researchers from all parts of the world for a relaxed discussion of their research results and technological interests, resulting in a timely publication of a compilation of up-to-date working documents.

In view of this, the Conference Organizers and the Publishers decided to include in this volume the sixty-odd papers that would have been presented at Samos in 1991. Their authors include both some founding fathers (and mothers) of these fourteen-year-old meetings and some new blood. We would particularly like to welcome newcomers from Egypt, Turkey, Brazil, Singapore - all educated in Europe and/or North America and now successfully conducting research in their own countries.

We wish to thank the Publishers for their forbearance and all contributors to this "mirage" Conference for up-to-date reports on their current research in Food Science and Human Nutrition.

The Seventh International Conference on Recent Developments in Food Science and Human Nutrition has been rescheduled for June 24-26, 1992 at Pythagorion, Samos Island in Greece, and its Proceedings will again be published by Elsevier.

The Editor

## LIST OF CONTRIBUTORS

*Numbers in parentheses indicate where contributions begin*

- N.S. ABU FOUL (43) Omar El-Mokhtar Street, El Remal, 54-163 Gaza Palestine
- E. AKOCHI-K. (131) Food Science and Agricultural Chemistry Department,  
McGill University, P.O. Box 187, Macdonald Campus, Ste-Anne de Bellevue,  
Québec, Canada H9X 1C0
- K. AKRIDA-DEMERTZI (475) Department of Chemistry, University of Ioannina,  
P.O. Box 1186, GR-45 110 Ioannina, Greece
- I. ALLI (131) Food Science and Agricultural Chemistry Department,  
McGill University, P.O. Box 187, Macdonald Campus, Ste-Anne de Bellevue,  
Québec, Canada H9X 1C0
- E. ALONSO (437) Departamento de Química Agrícola, Geología y Geoquímica,  
Universidad Autónoma de Madrid, E-28049 Madrid, Spain
- I. ALPERDEN (491) Department of Nutrition and Food Technology, TÜBITAK, P.O. Box 21,  
41470 Gebze-Kocaeli, Turkey
- G. ANGELOUSIS (175) Department of Food Technology, School of Food Technology and  
Nutrition, T.E.I. of Athens, St. Spyridon Street, Egaleo, GR-122 10 Athens, Greece
- D. APOSTOLOPOULOS (257) Kraft General Foods, General Foods U.S.A., Packaging  
Evaluation Center, South Broadway, Tarrytown, NY 10591, U.S.A.
- N. ARBELOT (75) Laboratoire AM3, URA 1411, Faculté des Sciences de Saint Jérôme,  
Avenue Escadrille Normandie-Niemen, Case 561, F-13397 Marseille Cedex 13, France
- P. AZARIO (75) Laboratoire AM3, URA 1411, Faculté des Sciences de Saint Jérôme,  
Avenue Escadrille Normandie-Niemen, Case 561, F-13397 Marseille Cedex 13, France
- A.S. BA-JABER (761) Department of Food Science, King Saud University, Riyadh,  
Saudi Arabia
- M.E. BAILEY (783) Department of Food Science and Nutrition, University of Missouri-  
Columbia, Agriculture 21, Columbia, MO 65211, U.S.A.
- R. BARONE (75) Laboratoire AM3, URA 1411, Faculté des Sciences de Saint Jérôme,  
Avenue Escadrille Normandie-Niemen, Case 561, F-13397 Marseille Cedex 13, France
- H. BEL-HAJ (526) Department of Food Science and Human Nutrition, Colorado  
State University, Fort Collins, CO 80523, U.S.A.

- A. BELANGER (141) Agriculture Canada, Station de Recherches, St-Jean-sur-Richelieu, Québec, Canada J2S 8E3
- J.M.R. BELANGER (141) Agriculture Canada, Food Research Centre, St. Hyacinthe, Québec, Canada J2S 8E3
- B. BLACH (543) Colorado Cereals, Yuma, CO 80759, U.S.A.
- M. BOURZEIX (437) Station Expérimentale de Pech Rouge-Narbonne, INRA, Bd. General de Gaulle, F-11100 Narbonne, France
- R.J. BRADDOCK (571) IFAS, Citrus Research and Education Center, University of Florida, Lake Alfred, FL 33850, U.S.A.
- P. BRUNERIE (163, 351) Centre de Recherche Pernod-Ricard, 120 Av. du Marechal Foch, F-94015 Créteil, France
- M.D. CABEZUDO (451) Instituto de Fermentaciones Industriales (CSIC), Juan de la Cierva 3, E-28006 Madrid, Spain
- K.R. CADWALLADER (571), Department of Food Science, Louisiana State University, Baton Rouge, LA 70803, U.S.A.
- M.L. CAVALCANTE (643) Departamento de Nutrição, Universidade Federal de Pernambuco, 50379 Recife, PE, Brazil
- J.L. CAVALLO (651) General Foods U.S.A., 250 North Street, White Plains, NY 10625, U.S.A.
- M. CHANON (75) Laboratoire AM3, URA 1411, Faculté des Sciences de Saint Jérôme, Avenue Escadrille Normandie-Niemen, Case 561, F-13397 Marseille Cedex 13, France
- S. CHEVRIER (427) Cervac-Est, 1 Allée Chaptal, F-54630 Richardmenil, France
- R.L. COLTON (341) BRAMCAFE International Ltd, 101 Tanglewood Drive, Lansdale, PA 19446, U.S.A.
- K.L. CRIPPEN (183, 211) Southern Regional Research Center, U.S. Department of Agriculture, Agricultural Research Service, 1100 Robert E. Lee Blvd, New Orleans, LA 70124, U.S.A.
- J. CROUZET (99) Génie Biologique et Sciences des Aliments, Institut des Sciences de l'Ingénieur de Montpellier, Université de Montpellier II - Sciences et Techniques du Languedoc, F-34095 Montpellier Cedex 05, France
- H. DAUN (287, 303) Department of Food Science and the Center for Advanced Food Technology, Cook College, Rutgers University, P.O. Box 231, New Brunswick, NJ 08903, U.S.A.

- P.G. DEMERTZIS (277, 287, 303, 313, 321) Laboratory of Food Chemistry, University of Ioannina, GR-451 10 Ioannina, Greece
- L.F. DI CESARE (249) I.V.T.P.A., via Venezian 26, I-20133 Milano, Italy
- S.J.B. DUFF (1) Energy, Mines and Resources Canada, Alternative Energy Division, Rm. 744, 580 Booth St., Ottawa, Ontario, Canada K1A 0E4
- L. DWYER (723) Department of Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- R.J. EVANS (27) KALSEC Inc., 3713 West Main St., Kalamazoo, MI 49007, U.S.A.
- J.D. FLOROS (499) Department of Food Science, Purdue University, 1160 Smith Hall, West Lafayette, IN 47907, U.S.A.
- H.-J. FU (347) Hangzhou Tea Processing Research Institute of the Ministry of Commerce, Hangzhou, Zhejiang, People's Republic of China
- N. GIANNONITS-ARGYRIADIS (175) VIORYL, Kato Kifissia, GR-145 64 Athens, Greece
- S.G. GILBERT (287, 303) Department of Food Science and the Center for Advanced Food Technology, Cook College, Rutgers University, P.O. Box 231, New Brunswick, NJ 08903, U.S.A.
- A.E. GROSSER (123) Department of Chemistry, McGill University, 801 Sherbrooke St. West, Montreal, PQ, Canada H3A 2K6
- A.A. GUILLOU (499) Department of Food Science, Purdue University, 1160 Smith Hall, West Lafayette, IN 47907, U.S.A.
- W.F. GUO (347) Hangzhou Tea Processing Research Institute of the Ministry of Commerce, Hangzhou, Zhejiang, People's Republic of China
- R.A. GUTHEIL (783) Department of Food Science and Nutrition, University of Missouri-Columbia, Columbia, MO 65211, U.S.A.
- J.E. HARDWICK (595) Center for Crops Utilization Research, Iowa State University, Ames, IA 50011, U.S.A.
- A. HOFFMANN (351) Gerstel GmbH, Aktienstrasse 232-234, D-4330 Mülheim a/d Ruhr, Germany
- D.G. HOLM (537) San Luis Valley Research Center, Colorado State University, Center, CO 80759, U.S.A.

- W.G. HUGHES (145) Department of Horticulture, Colorado State University, Fort Collins, CO 80523, U.S.A.
- T.IIDA (153) Department of Industrial Chemistry, College of Engineering, Nihon University, Koriyama, Fukushima-ken 963, Japan
- T. ISHIKAWA (153) Department of Industrial Chemistry, College of Engineering, Nihon University, Koriyama, Fukushima-ken 963, Japan
- L. IZQUIERDO (451) Instituto de Agroquímica y Tecnología de Alimentos (CSIC), Jaime Roig 11, E-46019 Valencia, Spain
- L.A. JOHNSON (595) Center for Crops Utilization Research, Iowa State University, Ames, IA 50011, U.S.A.
- J.P. JOLY (427) Laboratoire de Chimie Organique 3, URA 486, B.P. 239, F-54506 Vandoeuvre Cedex, France
- P.J. KALAOUZIS (321) Laboratory of Food Chemistry, Department of Chemistry, University of Ioannina, GR-451 10 Ioannina, Greece
- M. KARAKUŞ (491) Department of Nutrition and Food Technology, TÜBİTAK, P.O. Box 21, 41470 Gebze-Koacaeli, Turkey
- V. KARATHANOS (329) Food Science Department and Center for Advanced Technology, Rutgers University, New Brunswick, NJ 08903, U.S.A.
- S.KECK (351) Irish Distillers Group, Bow Street, Smithfield, Dublin 7, Republic of Ireland
- S. KERMASHA (131) Food Science and Agricultural Chemistry Department, McGill University, P.O. Box 187, Macdonald Campus, Ste-Anne de Bellevue, Québec, Canada H9X 1C0
- A.A. KHAN (679) Applied Research Inc., P.O. Box 1486, Hawthorne, CA 90250, U.S.A.
- M. KIKUCHI (153, 469) Department of Industrial Chemistry, College of Engineering, Nihon University, Koriyama, Fukushima-ken 963, Japan
- C.H. KIM (515, 519) Department of Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- M.E. KOMAITIS (175) Department of Agricultural Industries, Agricultural University of Athens, Iera Odos 75, Votanikos, GR-118 55 Athens, Greece
- M.G. KONTOMINAS ( 277) Laboratory of Food Chemistry, Department of Chemistry, University of Ioannina, GR-451 10 Ioannina, Greece

- A.A. KOUTINAS (475) Department of Chemistry, University of Patras, GR-261 10 Patras, Greece
- V. KOVAC (437) Faculty of Technology, University of Novi Sad, 21000 Novi Sad, Yugoslavia
- M. LAGOUDAKI (313) Laboratory of Food Chemistry, Department of Chemistry, University of Ioannina, GR-451 10 Ioannina, Greece
- M.L. LAW (565) Department of Lioscience and Biotechnology, University of Strathclyde, 131 Albion Street, Glasgow G1 1SD, Scotland, U.K.
- C.L. LEDERER (371, 403) Sensory Science Laboratory, Department of Food Science and Technology, Wiegand Hall, Oregon State University, Corvallis, OR 97336, U.S.A.
- L.M. LIBBEY (371, 403) Agricultural Chemistry Department, Oregon State University, Corvallis, OR 97331, U.S.A.
- K. LORENZ (551) Department of Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- N.V. LOVEGREN (183, 211) Southern Regional Research Center, U.S. Department of Agriculture, Agricultural Research Service, 1100 Robert E. Lee Blvd, New Orleans, LA 70124, U.S.A.
- S.-J. LUO (347) Hangzhou Tea Processing Research Institute of the Ministry of Commerce, Hangzhou, Zhejiang, People's Republic of China
- K. MacNAMARA (351) Irish Distillers Group, Bow Street, Smithfield, Dublin 7, Republic of Ireland
- M.R. McDANIEL (371, 403) Sensory Science Laboratory, Department of Food Science and Technology, Oregon State University, Corvallis, OR 97336, U.S.A.
- J.A. MAGA (145, 149, 515, 519, 526, 531, 537, 543, 551, 723, 761) Department of Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- P. MAHESHWARI (595) Department of Food Science and Human Nutrition, Iowa State University, Ames, IA 50011, U.S.A.
- E.L. MAIA (633) Departamento de Ciencia de Alimentos, Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, C.P. 6121, 13081 Campinas, SP, Brazil
- S.N. MAROUSIS (329) Central Engineering, Procter and Gamble Co., Cincinnati, OH 45232, U.S.A.
- A.M. MARTIN (229, 239) Food Science Program, Department of Biochemistry, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X9

- P.J. MARTIN-ALVAREZ (451) Instituto de Fermentaciones Industriales (CSIC),  
Juan de la Cierva 3, E-28006 Madrid, Spain
- T. MATSUMOTO (153) Department of Industrial Chemistry, College of Engineering,  
Nihon University, Koriyama, Fukushima-ken 963, Japan
- P. MAUGEAIS (163) Université du Havre, B.P. 540, Le Havre Cedex, France
- P. METZGER (75) Laboratoire de Chimie Moléculaire, URA 1411, Faculté des Sciences  
de Saint Jérôme, Avenue Escadrille Normandie-Niemen, Case 561,  
F-13397 Marseille Cedex 13, France
- D.B. MIN (617) Department of Food Science and Technology, The Ohio State University,  
2121 Fyffe Road, Columbus, OH 43210, U.S.A.
- B.S. MISTRY (617) Department of Food Science and Technology, The Ohio State University,  
2121 Fyffe Road, Columbus, OH 43210, U.S.A.
- Y.G. MOHARRAM (43) Food Science and Technology Department, Faculty of Agriculture,  
Alexandria University, Alexandria, Egypt
- L. MOJOVIC (585) Biochemistry Engineering Department, Faculty of Technology  
and Metallurgy, P.O. Box 494, 11001 Belgrade, Yugoslavia
- M. MOLL (427) Cervac-Est, 1 Allée Chaptal, F-54630 Richardmenil, France
- N. MOLL (427) Laboratoire de Chimie Organique 3, URA 486, B.P. 239,  
F-54506 Vandoeuvre Cedex, France
- P.A. MURPHY (595) Department of Food Science and Human Nutrition, Iowa  
State University, Ames, IA 50011, U.S.A.
- W.D. MURRAY (1) Science and Technology Division, Library of Parliament, Ottawa,  
Ontario, Canada K1A 0A9
- G.B. NICKERSON (371, 403) Agricultural Chemistry Department, Oregon State  
University, Corvallis, OR 97336, U.S.A.
- Ž.L. NIKOLOV (595) Department of Food Science and Human Nutrition,  
Iowa State University, Ames, IA 50011, U.S.A.
- Y. NODA (469) Department of Industrial Chemistry, College of Engineering,  
Nihon University, Koriyama, Fukushima-ken 963, Japan
- J.R.J. PARÉ (141) Environment Canada, R.R.E.T.C., Ottawa, Ontario, Canada K1A 0H3

- D.R. PATTON (731) Procter and Gamble Co., Miami Valley Laboratories, Cincinnati, OH 45239, U.S.A.
- R. PEREZ (451) Instituto de Agroquímica y Tecnología de Alimentos (CSIC), Jaime Roig 11, E-46019 Valencia, Spain
- J.R. PIGGOTT (565) Department of Bioscience and Biotechnology, University of Strathclyde, 131 Albion Street, Glasgow G1 1SD, Scotland, U.K.
- N. RAMARATHNAM (141) Agriculture Canada, Food Research Centre, St. Hyacinthe, Quebec, Canada J2S 8E3
- R.A. RENQUIST (531) Orchard Mesa Research Center, Colorado State University, Grand Junction, CO 81503, U.S.A.
- E. REVILLA (437) Departamento de Química Agrícola, Geología y Geoquímica, Universidad Autónoma de Madrid, E-28049 Madrid, Spain
- V. REYNE (99) Génie Biologique et Sciences des Aliments, Institut des Sciences de l'Ingenieur de Montpellier, Université de Montpellier II - Sciences et Techniques du Languedoc, F-34095 Montpellier Cedex 05, France
- G.S. REYNHOUT (27) KALSEC Inc., 3713 West Main Street, Kalamazoo, MI 49007, U.S.A.
- K.A. RIGANAKOS (277) Laboratory of Food Chemistry, Department of Chemistry, University of Ioannina, GR-451 10 Ioannina, Greece
- M. RIVA (249) D.I.S.T.A.M., Sezione Tecnologie Alimentari, Università di Milano, via Celoria 2, I-20133 Milano, Italy
- G.P. RIZZI (731) Procter and Gamble Co., Miami Valley Laboratories, Cincinnati, OH 45239, U.S.A.
- D.B. RODRIGUEZ-AMAYA (633, 643) Departamento de Ciencia de Alimentos, Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, C.P. 6121, 13081 Campinas, SP, Brazil
- A.J. ST. ANGELO (711) Southern Regional Research Center, U.S. Department of Agriculture, New Orleans, LA 70124, U.S.A.
- F.Z. SALEEB (651) General Foods U.S.A., 250 North Street, White Plains, NY 10625, U.S.A.
- C. SALLES (99) Laboratoire de Recherches sur les Arômes, INRA, 17 rue Sully, F-21034 Dijon Cedex, France
- M.D. SALVADOR (451) Facultad de Ciencias Químicas, Paseo de la Universidad 4, E-13071 Ciudad Real, Spain
- N.B. SANCHEZ (371, 403) CIATI - Bartolomé Mitre y 20 de Junio, (8336) Villa Regina - Rio Negro, Argentina

- T.H. SANDERS (183, 211) National Peanut Research Laboratory, U.S. Department of Agriculture, Agricultural Research Service, 1011 Forrester Drive S.E., Dawson, GA 31742, U.S.A.
- G.D. SARAVACOS (329) Food Science Department and Center for Advanced Food Technology, Rutgers University, New Brunswick, NJ 08903, U.S.A.
- A. SCHIRALDI (249) D.I.S.T.A.M., Sezione Tecnologie Alimentari, Università di Milano, via Celoria 2, I-20133 Milano, Italy
- G.R. SCHMIDT (723, 761) Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523, U.S.A.
- S. SETO (153) Department of Industrial Chemistry, College of Engineering, Nihon University, Koriyama, Fukushima-ken 963, Japan
- S. SHILER-MARINKOVITZ (585) Biochemistry Engineering Department, Faculty of Technology and Metallurgy, P.O. Box 494, 1101 Belgrade, Yugoslavia
- J.N. SOFOS (743, 761) Departments of Animal Sciences and Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- A.M. SPANIER (695) Food Flavor Quality - Meat Program, U.S. Department of Agriculture, Agricultural Research Service, Southern Regional Research Center, 1100 Robert E. Lee Blvd, New Orleans, LA 70124, U.S.A.
- C.K. SQUIRE (145) Department of Food Science and Human Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- A.R. STEIMLE (731) Procter and Gamble Co., Miami Valley Laboratories, Cincinnati, OH 45239, U.S.A.
- N.G. STOFOROS (665) National Food Processors Association, 6363 Clark Avenue, Dublin, CA 94568, U.S.A.
- T. TAMURA (153) Department of Industrial Chemistry, College of Science and Technology, Nihon University, Kanda-ku, Tokyo 101, Japan
- K. VAN EVEREN (551) Department of Food Science and Nutrition, Colorado State University, Fort Collins, CO 80523, U.S.A.
- J.R. VERCELLOTTI (183, 211, 711) Southern Regional Research Center, U.S. Department of Agriculture, Agricultural Research Service, 1100 Robert E. Lee Blvd, New Orleans, LA 70124, U.S.A.
- G. VERNIN (75) Laboratoire de Chimie Moléculaire, URA 1411, Faculté des Sciences de Saint Jérôme, Avenue Escadrille Normandie-Niemen, Case 561, F-13397 Marseille Cedex 13, France

S. VIDAL (651) General Foods U.S.A., 250 North Street, White Plains, NY 10625, U.S.A.

H. WETHERILT (15) Department of Nutrition and Food Technology, TÜBİTAK,  
P.O. Box 21, 41470 Gebze-Kocaeli, Turkey

L.F.M. YONG (115) Aroma Biotech Pte Ltd, 6 Shenton Way, #29-01 DBS Building,  
Singapore 0106, Republic of Singapore

## CONTENTS

Preface .....	vii
List of Contributors .....	xv
Developments of a Microbially Catalyzed Oxidation System .....	1
S.J.B. DUFF and W.D. MURRAY	
Evaluation of <i>Unica</i> Species as Potential Sources of Important Nutrients .....	15
H. WETHERILT	
Alternates to Synthetic Antioxidants .....	27
R.J. EVANS and G.S. REYNHOUT	
Utilization of Cottonseed Protein in Preparing New Edible Food Products .....	43
Y.G. MOHARRAM and N.S. ABU-FOUL	
Computer-Aided Organic Synthesis Applied to the Study of Formation of Aroma Compounds. Thermal Degradation of Diallyl Disulfide .....	75
G. VERNIN, J. METZGER, P. AZARIO, R. BARONE, M. ARBELOT and M. CHANON	
Formation of Aroma by Hydrolysis of Glycosidically Bound Components .....	99
V. REYNE, C. SALLES and J. CROUZET	
The Effect of Carbon and Nitrogen Sources on the Growth and Aroma Production of <i>Penicillium italicum</i> .....	115
L.F.M. YONG	
The Computer Simulation of the Chemical Kinetics of Flavor Compounds in Heated Foods .....	123
A.E. GROSSER	
Flavor Compounds in Maple Syrup .....	131
I. ALLI, E. AKOCHI-K and S. KERMASHA	
A Rapid Method for Monitoring Food Volatiles .....	141
J.R.J. PARE, J.M.R. BELANGER, A. BELANGER and N. RAMARATHNAM	
Bramble Dried Leaf Volatiles .....	145
J.A. MAGA, C.K. SQUIRE and H.G. HUGHES	
Influence of Variety and Location of Growth on Resulting Bramble Dried Leaf Volatiles .....	149
J.A. MAGA, C.K. SQUIRE and H.G. HUGHES	
Steam Volatile Constituents from Seeds of <i>Momordica charantia</i> L. ....	153
M. KIKUCHI, T. ISHIKAWA, T. IIDA, S. SETO, T. TAMURA and T. MATSUMOTO	

Comparison of Volatile Components in Two Naranjilla Fruit ( <i>Solanum quitoense</i> Lam.) Pulp from Different Origins .....	163
P. BRUNERIE and P. MAUGEAIS	
Analysis of the Volatile Constituents of a Special Type of White Bread .....	175
M.E. KOMAITIS, G. ANGELOUSIS and N. GIANNONITS-ARGYRIADIS	
Defining Roasted Peanut Flavor Quality. Part I. Correlation of GC Volatiles with Roast Color as an Estimate of Quality .....	183
J.R. VERCELLOTTI, K.L. CRIPPEN, N.V. LOVEGREN and T.H. SANDERS	
Defining Roasted Peanut Flavor Quality. Part II. Correlation of GC Volatiles and Sensory Flavor Attributes .....	211
K.L. CRIPPEN, J.R. VERCELLOTTI, N.V. LOVEGREN and T.H. SANDERS	
Growth Response of the Mushroom <i>Agaricus campestris</i> to Nitrogen Sources when Cultivated in Submerged Fermentation .....	229
A.M. MARTIN	
Study of the Growth and Biomass Composition of the Edible Mushroom <i>Pleurotus ostreatus</i> .....	239
A.M. MARTIN	
Improved Retention of Mushroom Flavor in Microwave-Hot Air Drying .....	249
L.F. DI CESARE, M. RIVA and A. SCHIRALDI	
Study of the Interaction between Polyvinyl Chloride and Vinyl Chloride Monomer using Inverse Gas Chromatography - Thermodynamic and Structural Considerations .....	257
D. APOSTOLOPOULOS	
Inverse Gas Chromatographic Study of Moisture Sorption by Wheat and Soy Flour and the Effect of Specific Heat Treatment on their Sorption Behavior .....	277
K.A. RIGANAKOS, P.G. DEMERTZIS and M.G. KONTOMINAS	
Application of a Modified I.G.C. Method in the Study of the Water Sorptional Behavior of Selected Proteins. I. Lysozyme-Water Interactions .....	287
P.G. DEMERTZIS, S.G. GILBERT and H. DAUN	
Application of a Modified I.G.C. Method in the Study of the Water Sorptional Behavior of Selected Proteins. II. Gliadin-Water Interactions .....	303
P.G. DEMERTZIS, S.G. GILBERT and H. DAUN	
Water Sorption Hysteresis in Potato Starch and Egg Albumin .....	313
M. LAGOUDAKI and P.G. DEMERTZIS	
Study of Water Vapor Diffusion Through Plastic Packaging Materials Using Inverse Gas Chromatography .....	321
P.J. KALAOUZIS and P.G. DEMERTZIS	