Highlights: Fats for the Future II

Fats for the Future II, an international conference sponsored by the Royal Society of New Zealand and organized by the Oils and Fats Specialist Group of the New Zealand Institute of Chemistry, was held Feb. 12-17, 1989, at the University of Auckland in New Zealand. Laurence Eyres of the New Zealand Dairy Board headed the organizing committee, with R.C. Cambie of the Department of Chemistry, University of Auckland, serving as cochairman. Kenneth K. Carroll of the University of Western Ontario's Department of Biochemistry wrote the following article summarizing highlights of the conference.

The first Fats for the Future conference on oils and fats, chaired by the late Stan Brooker, was held in Auckland, New Zealand, in 1983; that successful conference led Dr. Brooker to suggest that a follow-up conference be held in 1989. The resulting scientific program attracted over 225 registrants from more than a dozen countries, including many members of AOCS. The scientific program covered topics ranging from basic academic research to industrial applications. There also were poster presentations and commercial exhibits. Social functions provided opportunities for informal conversation, and there was a well-organized program for accompanying persons. Many registrants visited scientific establishments and toured New Zealand during pre- and post-conference tours.

The conference began on Sunday, Feb. 12, with registration and an opening mixer. The official opening on Monday morning included welcomes from conference chairman Laurence Eyres; Philip Warren, deputy mayor of Auckland; A.D. Campbell, I.U.P.A.C. representative for New Zealand; T. Hatherton, president of the Royal Society of New Zealand; and L.H. Princen, director of the U.S. Department of Agriculture's (USDA) Northern Regional Research Laboratory at Peoria, Illinois, representing AOCS.

The first plenary lecture, by F.D. Gunstone of the University of St. Andrews, Scotland, was on "Oils and Fats—Past, Present and Future." Gunstone briefly reviewed world trade in edible fats and oils. He noted reasons for a rising demand for edible oils: to satisfy the needs of growing populations, to increase sources of energy for undernourished people, and to satisfy a variety of applications in the oleochemical industry. Meeting this demand can be facilitated by developing new crops and by modifying existing crops to achieve higher oil content, higher yields and greater resistance to disease, Gunstone said.

Recent innovations include the development of low erucic rapeseed oil and high oleic sunflowerseed oil, and commercialization of jojoba as a source of liquid wax esters. Gunstone also noted increasing interest in fish oils (as sources of long-chain n-3 polyunsaturated fatty acids); in evening primrose, borage and black current oils (as sources of gamma linolenic acid); and in meadowfoam (as a source of C_{20} and C_{22} fatty acids). Finally, Gunstone touched on the tremendous diversity in the structure of fatty acids—over 1,000 of which have been identified—and the large number of isomeric glycerides, which could amount to more than 8,000 combinations for glycerides containing 20 different fatty acids. Recent advances in lipid methodology have enhanced the lipid chemist's analytical capabilities; analyses that required weeks of intensive effort in the days when Gunstone worked as a student in Professor Hilditch's Liverpool laboratory now can be done in a matter of hours.

The nutritional aspect of lipids was a major theme for the first two days of the conference. Sir John Scott of the University of Auckland discussed dietary fat in relation to heart disease and referred to instances in which he felt expert dogma had inhibited progress and fostered controversy. M.I. Gurr, nutrition consultant of the Milk Marketing Board in England, spoke on "Dairy Fats: Nutritional Nasties or Dietary Delights?" He said the trend toward low-fat dairy products in the United Kingdom (U.K.) was promoted by health concerns but not all of these concerns are necessarily valid. Discussing ways in which the dairy industry might respond to health concerns, he said it is impractical to achieve a substantial reduction in the fat content of milk produced by cows; however, the fatty acid composition could be modified by dietary means to increase the proportion of monounsaturated to saturated fatty acids, and biotechnology might be used to alter the fatty acid composition of cow's milk to be more like that of human milk.

J.R. Sabine of Waite Research Institute, Adelaide, Australia, discussed the basis for determining optimal levels of fat in the diet (for provision of energy, essential fatty acids and vitamins), in the body (total and regional—as energy storage, as insulation, for aesthetics) and in the blood (atherosclerosis, role of specific lipids). R. Beaglehole of the Department of Community Health, University of Auckland, discussed diet and serum cholesterol, with specific reference to coronary heart disease in New Zealand. He emphasized that a population approach is needed to lower the level of serum cholesterol in order to reduce the risk of coronary heart disease, and gave 5 mmol/L as a reasonable goal. He favored a dietary approach and cited the high costs of drug treatment.

R.G. Ackman of the Technical University of Nova Scotia, Halifax, Nova Scotia, spoke about possible beneficial properties of fish oils and concentrates. These are largely attributed to the n-3 polyunsaturated fatty acids—eicosapentaenoic (EPA) and docosahexaenoic (DHA)—but consideration should

also be given to the effects of docasapentaenoic acid (DPA) which is present in appreciable amounts in some fish oils, Ackman said. The positional distribution of these fatty acids can vary depending on the source. For example, DHA is predominantly in the 2-position in fish oils and in the 3-position in lipids from marine mammals. It may not be possible to predict the biological properties of such materials from fatty acid analysis alone. Analysis of commercial fish oil capsules in Ackman's laboratory has shown they generally contain about 80% of the claimed amounts of EPA and DHA. This could be related to the formation, during preparation and storage, of polymers that would not be measured in the analysis.

D.L. Topping of the Division of Human Nutrition, CSIRO, Adelaide, discussed mechanisms by which dietary fish oils reduce plasma triacylglycerols. Fish oils accelerate oxidation and inhibit biosynthesis of fatty acids, thus decreasing secretion of very low-density lipoproteins by the liver, he said; they also tend to raise plasma glucose levels and are contraindicated in diabetes. Low-density lipoproteins (LDL) are not decreased by fish oils, probably because of the down-regulation of LDL receptors in the liver which is dependent on other factors, notably dietary fiber, Topping said. He pointed out that studies showed LDL receptor activity is suppressed by wheat bran but potentiated by rice bran or oat bran. A.R. Leeds of the Department of Food and Nutritional Science, King's College, London, discussed the lipid-lowering effects of soluble dietary fiber from sources such as oats and rye and described studies with bread containing guar gum. It is evident that the effects of dietary fat on plasma lipid levels can be modified by dietary fiber.

Several talks were devoted to the effects of specific types of dietary lipids. V.K. Babayan of the New England Deaconess Hospital, Boston, described the nutritional characteristics of triacylglycerols containing medium-chain fatty acids: these fatty acids are rapidly cleared from the circulation and oxidized, do not require carnitine for oxidation, and are not elongated to longer-chain saturated fatty acids in the body. Babayan also described the preparation of structured triacylglycerols containing medium-chain fatty acids designed to provide the most desirable nutritional properties.

F.H. Mattson of the Department of Medicine, University of California, San Diego, described the preparation and properties of sucrose polyester, which has the culinary, organoleptic and physical properties of triacylglycerols but is neither digested nor absorbed. Tests have shown no evidence of toxicity, and a petition to use this material (known as SPE or olestra) in shortenings and frying oils has been filed with the U.S. Food and Drug Administration and with Health and Welfare, Canada.

D.F. Horrobin of the Efamol Research Institute, Guildford, England, discussed the biological effects of evening primrose oil. These are thought to be due to gamma linolenic acid (GLA), an essential fatty acid formed from linoleic acid by Δ6 desaturation. The Δ6 desaturase is not present in skin; its activity in other tissues can be impaired by disease conditions such as diabetes. Horrobin said there is evidence that evening primrose oil is effective in the treatment of conditions such as atopic eczema and diabetic retinopathy. However, Horrobin stressed, the biological properties of a GLA-containing oil cannot be predicted from its fatty acid composition alone, since black current and borage seed oils, which have a higher content of GLA, were found to be less effective than evening primrose oil. It was suggested that the positional distribution of fatty acids also may be a factor. R.A. Gibson of the Department of Pediatrics, Flinders Medical Centre, Adelaide, reported that evening primrose oil significantly improved lichenification in children with atopic eczema when given before, but not when given after, safflower oil in a double-blind crossover trial.

Several papers were presented on dietary fat and cancer. B.C. Baguley of the Cancer Research Laboratory, University of Auckland, reviewed the basic concepts of carcinogenesis, including a discussion of initiation, promotion, oncogenes, growth factors, effects of gene loss and effects of environmental factors. K.K. Carroll of the Department of Biochemistry, University of Western Ontario, London, Canada, described epidemiological and experimental data linking dietary fat to cancer, particularly breast and colon cancer. Several recent case-control and prospective studies have raised doubts about the significance of dietary fat in carcinogenesis, but other researchers have suggested that the reported studies may not be capable of detecting even strong associations because of methodological problems and the smaller differences between test groups in such studies relative to intercountry comparisons. Controlled clinical trials, although expensive, may be needed to provide a definitive answer.

David Kritchevsky of the Wistar Institute of Anatomy and Biology, Philadelphia, was unable to attend the conference; however, John Birkbeck of the University of Auckland and chairman of the New Zealand Nutrition Foundation read Kritchevsky's paper on cancer and caloric restriction. Early studies showing that cancer growth can be retarded in animals by caloric restriction have been confirmed by recent studies with better defined diets and more carefully controlled conditions. These studies and experiments involving treadmill exercise have clearly shown that energy balance has important effects on carcinogenesis in experimental animals. The session on cancer also included a group discussion on dietary lipids and cancer focusing on observations relating to cancer in New Zealand and on possible future directions for researchers.

Plenary lectures on several other topics were held during the first two days. Tseuneo Yamane of Nagoya University, Nagoya, Japan, described experiments on enzymatic interconversions of glyc-

erophospholipids catalyzed by phospholipase D, immobilized on amphiphilic gel beads. Phospholipase D from various sources was used and conditions were varied to optimize the conversions and to minimize the formation of phosphatidic acid as a by-product. Colin Ratledge of the University of Hull, Hull, U.K., surveyed current research in the microbial production of fats and oils. Microorganisms offer the advantages of rapid growth, utilization of a wide variety of substrates, ease of mutation, and production of a varied spectrum of fats and oils, he said. Oleaginous yeasts can accumulate over 70% lipid, which tends to have a high content of monoenoic fatty acids, but may contain appreciable amounts of 18:2 fatty acids. Strategies are being developed to produce a fat high in stearic acid that might be used as a cocoa butter substitute. These include use of sterculic acid to inhibit desaturation of stearic acid or use of a strain lacking Δ9 desaturase. Industrial processes are also being developed to produce gamma linolenic acid, using species of Murorales fungi.

Charmian O'Connor of the Department of Chemistry, University of Auckland, presented a lecture on the properties and function of a lipase in human milk that is stimulated by bile acids. Besides acting as a lipase to catalyze the hydrolysis of triacylglycerols, it can serve as a synthetase to catalyze the formation of retinyl palmitate from retinol and palmitic acid. The enzyme is a glycoprotein with a molecular weight in the range of 75,000 to 100,000 daltons.

Other sessions during the first two days dealt with marine lipids, phospholipids, processing and commercial technology. J.M. Ryder of the Fish Technology Section, Division of Horticulture and Processing, CSIR, Auckland, reported that astaxanthin esters account for over 98% of the orange pigment in the oil of the orange roughy. This carotenoid could perhaps be fed to farmed salmon to impart the desired pink color to their flesh. Denis Body of the Biotechnology Division, DSIR, Palmerston North, New Zealand, described the effects of diets containing either orange roughy or snapper on the lipid composition of rat liver and heart tissues. The oil of orange roughy (*Hoplostetus atlanticus*) consists almost entirely of wax esters, whereas that of snapper (*Chrysophrys auratus*) contains mainly glycerol-based lipids.

Peter Nichols and John Volkman of the Division of Oceanography, CSIRO, Hobart, Tasmania, discussed methods to provide adequate amounts of omega-3 polyunsaturated fatty acids in the diets of fish or other marine or estuarine animals in the form of rotifers and microalgae. Murray Skeaff of the University of Otaga, Dunedin, New Zealand, described studies carried out in collaboration with Bruce Holub at the University of Guelph, Guelph, Ontario, on the effects of dietary fish oil (MaxEPA) on inositol phospholipids in human platelets. Yoshima Yamano described some of the physicochemical properties of phospholipids from soybean and egg yolk and the effects of hydrogenation and treatment with phospholipase A on these properties.

The processing and commercial technology session featured papers by J. Bogdanor of W.R. Grace (N.Z.) Ltd., Wellington, on modified caustic refining; A. Tirtiaux of S.A. Fractionnement Tirtiaux, Fleurus, Belgium, on dry fractionation technology; and R. Ariaansz of Engelhard Ltd. U.S.A. on absorptive bleaching of fats and oils.

Wednesday's program included three plenary lectures on product development and marketing. Speaker Laurence Eyres said new products are more likely to succeed if they are an improvement over existing products and if there is a continuing demand for such products. Eyres discussed changes affecting the dairy industry, such as the use of low-fat milk and polyunsaturated margarines. Current interest in oils high in monounsaturated fatty acids might stimulate the development of products from avocado oil, which contains about 75% monounsaturates and 8% linoleate. Currently, edible fat/oil use in New Zealand is distributed approximately as follows: spreads—40%, baked goods—17%, confectionery—12%, liquid oils—6%, ice cream—5%, biscuits and cookies—3%, snack foods—2%, and salad dressings—1%.

K.G. Berger, a consultant from London, England, discussed problems and opportunities in the market development of fats and oils, about 90% of which are used for food. Factors that determine which fats and oils are used include: availability, price, traditional eating habits, marketing and development of new products. Those showing the greatest growth in recent years are palm, rapeseed, soybean and sunflowerseed oils, Berger said.

L.H. Princen of USDA's Northern Regional Research Center described the commercialization of several new industrial specialty crops. These include jojoba, which contains 50% oil of which 50% is wax esters; crambe, which contains a high concentration of erucic acid in the 1- and 3- positions of triacylglycerols; meadowfoam, the lipids of which contain 95% C_{20} and C_{22} fatty acids; lesquerella, being developed as a source of hydroxy fatty acids; cuphea seed oils, sources of short- to medium-chain fatty acids ranging from C_8 to C_{14}; and fennel, a source of petroselenic acid which can be cleaved to yield lauric acid and adipic acid. K. Coupland of Croda Industrial Ltd., Hull, U.K., described a recent survey of plants in England, mainly in Oxfordshire, as potential sources of fats and oils. The use of erucamide to confer slipperiness to plastics was discussed, as well as the possibility of using erucic acid to prevent tissue accumulation of C_{26} fatty acid associated with an adrenoleukodystrophy in children.

Marvin Bagby of USDA's Northern Regional Research Center described the use of soybean oil in the U.S. for industrial purposes, 60% of which is for epoxidized coatings. A development program is being conducted to modify soybean oil for use as a replacement for imported oils such as tung, rapeseed, palm kernel and coconut. This involves enzymatic ap-

AOCS members attending the Fats for the Future II conference in New Zealand earlier this year pose together during a break. The conference drew participants from more than a dozen countries.

proaches to isomerization and conjugation, and nonenzymatic approaches for addition, substitution, esterification and acetoxylation. Other studies are concerned with the growth of microorganisms on soybean oil and the bioconversion of oleic acid to 10-hydroxystearic acid, 10-ketostearic acid and ricinoleic acid for industrial use.

J.P. Clark of Henkel Corp., La-Grange, Illinois, described experiments in which tocopherols were added to various fats and oils to determine the amounts that would provide maximum stability. The addition of tocopherols to vegetable oils increased stability somewhat but soon reached a plateau. With animal fats, there was a much greater increase in stability before a plateau was reached. In the case of menhaden fish oil, 600 parts per million (ppm) of tocopherol were required to reach a plateau. No prooxidant effects of added tocopherol were observed, even at concentrations of more than 1,000 ppm.

Other presentations were by J. Davies, CSIR, Lower Hutt, New Zealand, on "The Whey To Make Cocoa Butter" and by Douglas Rankin of the Wool Research Organization of New Zealand at Christchurch on "Factors Affecting Levels of Calcium in New Zealand Wool Greases."

A concurrent session on deodorizer and distillation technology featured the following speakers and topics: H.M. Myers of H.L.S. Ltd., Petah Tikvah, Israel, physical refining and process automation in edible oil technology; P.A. Wells of the University of New South Wales, Sydney, Australia, supercritical fluid extraction of triacylglycerols; A. Craig of Flavourtech Pty, Griffith, Australia, a low-temperature multistage stripping device for removal and recovery of flavors from oils; and Brian Crawford of the University of Technology, Broadway, N.S.W., Australia, fractionation of fish oil esters with a falling film evaporator. A paper by P. Sjoberg of Alfa-Laval Ford Engineering AB, Sweden, on a thin-film technique for deodorization of edible fats and oils was presented by Brian Fitzpatrick of Alfa-Laval, Australia.

The Thursday morning session was devoted to palm and palm kernel oils. The opening plenary lecture on "Recent Developments in the Malaysian Palm Oil Industry" was given by A.S.H. Ong, director of the Palm Oil Research Institute of Malaysia (PORIM), who discussed the characteristics of palm oil, the technology involved in its production, its use for various food and nonfood purposes, and future prospects for the industry. PORIM's G.F. de Wit reviewed palm oil's nutritional properties, with particular reference to the effects on blood cholesterol levels, thrombosis and experimental carcinogenesis. He concluded that palm oil is a safe and nutritive edible oil.

J.S. Charnock, CSIRO, Adelaide, described long-term feeding experiments with rats in which palm oil was compared with a saturated animal fat and a polyunsaturated vegetable oil. The effects of palm oil on experimentally induced cardiac arrhythmias were intermediate to those of the other two dietary fats. Measurement of prostacyclin and thromboxane production by rats on the different diets did not provide a clear explanation of the effects on cardiac arrythmia. In other presentations, F.D. Gunstone discussed the chemistry of palm and palm kernel oils; B.K. Tan of Lam Soon (M) Bhd., Malaysia, described novel fractions of palm oil and palm kernel oil produced by fractionation and other modification processes; Y.K. Teah and Nor Aini Idris of PORIM discussed the use of palm oil for frying and specialty fats and for shortenings and margarines, respectively; and K.G. Berger considered the use of palm oil products as replacements for dairy fat.

An afternoon session was devoted to dairy lipids. The plenary lecture by R.E. Timms, a consultant from Swinderby, Lincolnshire, U.K., dealt with the use of milk fat modified by fractionation, hydrogenation, interesterification and blending with other fats and oils

in confectionery fats, shortenings, and spreads. Modification of dairy fats for diverse food uses was discussed by R. Norris, D. Illingworth and A.K.H. MacGibbon of the New Zealand Dairy Research Institute; D.S. Munro of Bay Milk Products Ltd., Edgecombe, New Zealand; and Alicja Pedersen of Gerstenberg & Agger A/S, Copenhagen, Denmark.

The nutritional and chemical aspects of dietary lipids were the themes of a concurrent session. R. Yodice of SVO Enterprises, Wickliffe, Ohio, spoke on the nutritional properties and stability of high oleic sunflowerseed oil. D.C.K. Roberts of the Human Nutrition Research Unit, University of Sydney, described the fatty acid composition of adipose tissue taken from a group of over 250 Australians and discussed the findings in relation to age, gender, sampling site and diet. A.J. Sinclair, Department of Applied Biology, Royal Melbourne Institute of Technology, Melbourne, discussed experiments carried out in collaboration with Kerin O'Dea of Deakin University, Geelong, Australia. These studies were concerned with the effects on plasma lipid and lipoprotein levels in human volunteers of very low fat diets (< 7% of energy) containing varying amounts and types of C_{20} and C_{22} polyunsaturated fatty acids and a vegetarian diet lacking these fatty acids.

The final session speaker was F.B. Shorland, Victoria University, Wellington, New Zealand. Shorland is the acknowledged father of lipid research in New Zealand and has maintained an active interest in the field during his retirement. His discussion of the unfolding role of fats in nutrition spanned more than 40 years of research. L. Hartman, who spoke the following day, worked with Shorland for many years at the Fats Research Laboratory in Wellington and returned from Rio de Janeiro for the first time in 20 years to participate in the conference. Hartman described the modernization of methods for analysis of oils and fats, such as saponification number, monoglyceride content, and hydroxyl value, indicating that progress in developing simple and reliable methods can be achieved in countries where there is a relative lack of research resources and sophisticated equipment.

The program for the meeting's last day focused on chromatography and the analysis of lipids. Discussing applications of the Iatroscan to lipid research, R.G. Ackman indicated it is highly sensitive but requires calibration; saturated compounds are best for this purpose because of their stability during storage. J.K. Volkman described the analysis of lipids of marine sediments in relation to organic geochemistry. Major sources of these lipids include microalgae, bacteria and animals. Lipids from land plants provide an index of terrestrial input. The sediments also may contain petroleum-derived products from storm water drains, oil spillages and natural oil seepage. Capillary gas chromatography and computerized capillary gas chromatography-mass spectrometry were used to separate and identify lipids such as hydrocarbons, fatty acids, sterols and ketones from these sediments. Most compounds can be identified by these and other methods, such as thin-layer chromatography with flame ionization detection, and by derivatization and hydrogenation of the compounds.

W.W. Christie of the Hannah Research Institute, Ayr, Scotland, described other useful techniques for the analysis of lipids. Picolinyl ester derivatives of fatty acids can be separated readily on capillary columns coated with nonpolar stationary phases, and they give distinctive mass spectra useful in characterizing the fatty acids. Separation of lipids by reversed-phase HPLC and of fatty acid methyl esters by silver ion HPLC prior to preparation of the picolinyl esters makes it possible to identify many minor components.

J.D. Craske, who directed the Central Research Department of Unilever Australia Pty. Ltd. in Sydney until his recent retirement, discussed the application of accurate analysis to control edible oil production. He stressed the need for speed, accuracy and reliability to make such analyses effective. Other analytical topics and speakers were: D.R. Body, the lipid composition of roe from some New Zealand fish; C.R. Johnston, also of DSIR, Palmerston North, chromatographic analysis of ruminant fats; D.L. Pearce of the Department of Chemical and Process Engineering, University of Canterbury, Christchurch, a new sampling technique for supercritical fluid extract solubility; and R.K. Richardson of the N.Z. Dairy Research Institute, Palmerston North, fatty acid analysis of milk fat and milk fat blends by gas chromatography.

Speakers and topics in a concurrent session on lipids in baking technology were: P.J. Barnes of High Wycombe, Bucks, U.K., cereal lipids in baking; Jorgen Madsen, Grindsted Products A/S, Denmark, use of emulsifiers in low fat foods; Ralph Crabtree, United Milk Tasmania Ltd., Davenport, Tasmania, trends in the use of oils and fats in the Australian baking industry; R.N. Robertson of Macphie Foods Ltd., Stonehaven, Kincardineshire, Scotland, innovative uses of fats and oils; and Nobuya Matsui of Niijima Gakuen Women's Jr. College, Takasaki City, Japan, use of oil and emulsifiers in different types of cakes in Japan.

One feature of the final conference session was the presentation of the Stanley G. Brooker Memorial Prize to R.D. Wilson of the New Zealand Dairy Research Institute, Palmerston North, for his paper, "Flavor Volatiles from New Zealand Milk Fat." This prize, in memory of Dr. Brooker, was awarded for the most innovative and stimulating paper by a lipid scientist under the age of 32.

The plenary lectures are to be published by Ellis Horwood Ltd., Chichester, West Sussex, England. Manuscripts submitted by others who gave oral presentations at the conference were bound in looseleaf form and made available to registrants at the conference.