Key trends in fats

Will dry fractionation and interesterification replace hydrogenation? How should fat and oils be identified on food labels? What will be the future demand for specialty oils? These were among questions addressed at the “Fats and Oils in the Nineties” conference, held March 23–26 in Fredericia, Denmark.

Topics ranged from new or improved processing technologies to current issues in foods and nutrition and prospective markets for new and specialty oils. The conference attracted 105 registrants from 20 countries, and was organized by the International Food Science Center (IFSC) in Lystrup, Denmark.

Challenges in food uses

Frank Gunstone, professor in the department of chemistry at the University of St. Andrews in Scotland, discussed challenges in the food use of oils and fats. Of the total world production of vegetable oils, approximately 80% is consumed as food, 6% is consumed in animal feed, and 14% is used by the oleochemical industry, he said.

To be successful in food applications, oils and fats must have the desired chemical and physical properties, including appropriate melting behavior, Gunstone said. Chemical composition affects nutritional aspects of the fats.

"Since the mixtures provided by nature do not always have exactly the desired properties, they may have to be modified to give improved behavior," Gunstone said.

Kolding, Denmark, was among sites visited by conference participants, who toured a thirteenth century castle in the town.
and oils in 1990s spotlighted at Danish conference

Processing allows manufacturers to alter physical and chemical properties for specific food applications. Techniques used include one or more of the following: blending, fractionation, hydrogenation, and interesterification. Additives, such as emulsifying agents and antioxidants, confer physical and chemical stability on the fat systems, he said.

Gunstone said that if new nonfood uses for oils and fats (and their derivatives) are to be found, all reactive sites of these molecules must be exploited. The acyl group and the double bonds are the reactive sites on which oils and fats manipulation traditionally has occurred; there are still no useful reactions of the saturated parts of the alkyl chain that can be exploited, he said.

Important reactions at the unsaturated sites on the fatty acid chain include hydrogenation, epoxidation, dimerization, and oxidation.

Chemical reactions carried out at fatty acid acyl sites have been widely used by the oleochemical industry, for example, to produce surfactants. Major starting materials for such products are the C12 oils from coconut and palm kernel; C16 and C18 oils from tallow, palm and palm stearin; and C19 oils from high-erucic rapeseed. Primary products include fatty acids, methyl esters, alcohols, amines and amides, and glycerol. From these, secondary products may be derived.

Gunstone predicted that production of these oleochemicals will increase, with Asia becoming an ever more important source of oleochemicals at the expense of Western European producers.

The fat substitute olestra, or octaacyl sucrose, is an example of a secondary product made by the acylation of sucrose with methyl esters. Fatty alcohols, another secondary product, are seeing increased use because of their positive ecological and toxicological properties, he reported.

**Interchangeability**


Economists and commercial managers often think that fats and oils are mostly interchangeable, he said.

"In my experience in the food industry, I have learned to be very wary of this concept, and to subject oils or blends to considerable testing programs to define the extent of interchangeability," he said.

Interchangeability can involve many characteristics, including chemical composition, physical and nutritional properties, functionality in food products, technical modifications, price, and availability.

"Chemical composition and physical properties are very closely interlinked," Berger said.

The difference between solids and liquids (physical properties) is attributable to the proportions of saturated and unsaturated fatty acids (chemical properties). Unsaturated fatty acids are more reactive and thus more sensitive to oxidation. Oils differ also in the flavor which they impart to foods.

Because a natural fat is a mixture of many different triglycerides containing different fatty acids, defining its physical properties is difficult, Berger said. Solid fats all have different behaviors, he said, and knowing the solid fat content (SFC) at a range of temperatures is useful for predicting behavior.

Functional properties of fats are often largely determined by their SFC at a specific temperature or in a defined range, Berger said. For example, cocoa butter has a high solids content at 20–25°C, making it hard and brittle, but it melts completely at body temperature, so that no residues are left in the mouth. Margarines, which are produced by blending different fat fractions, can be made more or less spreadable at refrigerator temperatures by altering the fats chosen for the blend.

Edible oils are truly interchangeable only in the contribution they make to the energy content of the diet, Berger said: all fats provide 9 kcal/gram. Other nutritional properties, such as sterol content and fatty acid composition, vary considerably among the oils.

"Thus, although from most technical aspects the liquid oils are very interchangeable, nutritional considerations make them less so," he said.

Berger predicted that current nutritional studies will help define the dietary effects of saturated, monounsaturated, and polyunsaturated fatty acids. There is also interest in the dietary effects of unhydrogenated fish oil—and an awareness of trans fatty acids, he reported.

Technology has had a tremendous impact on the interchangeability of fats and oils, he said. Fractionation, for example, can be used on beef tallow to yield stearine, oleo, and beef oil fractions. The particular properties of these fractions can be varied by using different crystallizing temperatures.
“Fractionation by various techniques is a very important process today. For example, over three million tons of palm oil are fractionated per year in Malaysia alone,” he said.

A shortage of solid fats, caused by a tremendous increase in production of liquid oils, led to the use of hydrogenation, which has become “an almost universal technology,” Berger said. Using hydrogenation, a variety of solid fats can be produced from any starting material. Hydrogenated palm olein, palm kernel oil, and palm kernel stearin can be the basis of commercial confectionery fats.

“These examples show how a high degree of interchangeability can be obtained by combining well known processes,” Berger said.

Interesterification creates triaturated and therefore raises the melting point of a fat such as beef tallow or palm oil without the use of hydrogenation. The process raises the solids content and modifies polymorphic behavior toward stable, small crystals, he reported.

“If you couple fractionation with interesterification, you can do almost anything,” Berger said. “We don’t necessarily want to do away with hydrogenation, but it does require a lot of electricity. In India, there’s almost a strategic need to get away from hydrogenation because of limited electricity.”

Leo Lips, of Unichema International, agreed that fractionation is becoming a more prevalent technology than in the past, a trend he attributed to the increasing amount of palm oil in the market. However, he stressed that hydrogenation would continue to be very important to the industry.

Table 1
Evaluation of food products containing fish oils

<table>
<thead>
<tr>
<th>Food category</th>
<th>Food</th>
<th>Taste panel evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spreads and pastes</td>
<td>fish spread</td>
<td>acceptable</td>
</tr>
<tr>
<td></td>
<td>cheese spread</td>
<td>good</td>
</tr>
<tr>
<td></td>
<td>peanut butter</td>
<td>acceptable</td>
</tr>
<tr>
<td>Margarine</td>
<td>margarine</td>
<td>good</td>
</tr>
<tr>
<td>Salad dressing</td>
<td>salad cream</td>
<td>acceptable</td>
</tr>
<tr>
<td></td>
<td>mayonnaise</td>
<td>production problems</td>
</tr>
<tr>
<td></td>
<td>coleslaw</td>
<td>poor</td>
</tr>
<tr>
<td>Dairy product</td>
<td>yogurts</td>
<td>poor</td>
</tr>
<tr>
<td>Oils and oil blends</td>
<td>french dressing</td>
<td>good</td>
</tr>
<tr>
<td></td>
<td>canned fish</td>
<td>good</td>
</tr>
<tr>
<td>Smoked/spiced foods</td>
<td>salami</td>
<td>good</td>
</tr>
<tr>
<td></td>
<td>pork sausages</td>
<td>good</td>
</tr>
</tbody>
</table>

* Foods produced at Leatherhead Food RA; products evaluated by taste panels elsewhere in United Kingdom or in Denmark.

“However, present day technology enables a high degree of interchangeability to be achieved, provided that costs of the additional processes required can be justified.”

In a later session, participants discussed advantages and disadvantages of fat modification technologies. A dramatic reduction in hydrogenation was predicted by one participant, citing controversy over health effects of trans fatty acids. Other participants agreed that the industry was moving away from hydrogenation, but were more cautious.

Leo Lips, of Unichema International, agreed that fractionation is becoming a more prevalent technology than in the past, a trend he attributed to the increasing amount of palm oil in the market. However, he stressed that hydrogenation would continue to be very important to the industry.

Handling oils and fats

Bergen also spoke on problems and solutions in the handling of oils and fats. Many problems arise from the reactivity, particularly at the double bonds and in the ester link of the fatty acids with glycerol, he said. Oxidation and hydrolysis reactions give rise to off-flavors.

“The human palate is very discriminating,” Berger said. “When as few as 1 in 1,000 double bonds in a food oil has reacted with oxygen, it is already too late.”

Oxidation can involve free radicals and appears to need traces of metals as catalysts, Berger said. Once started, oxidation proceeds as autocatalytic chain reactions. Traces of metals in an oil greatly affect oil stability, he said.

For example, 0.05 ppm (parts per million) of copper is enough to halve stability. Copper contamination often is caused by equipment used to sample oil in bulk tankers, Berger said.

Light also can induce oxidation, Berger said. The chemical pathway of light-induced oxidation is not inhibited by antioxidants, and most cooking oils are packaged in clear containers, increasing oil vulnerability to light-induced oxidation.

Much of the oxygen exposure of oils occurs because of poor handling, Berger said. The bleaching process, which is carried out under vacuum, removes much of the oxygen, and high vacuum deodorization also reduces oxygen content—but pumping oils into storage tanks may reintroduce oxygen.

Bergen offered specific guidelines to guard against rancidity. He suggested using the lowest practical storage and process temperatures, reducing air exposure, minimizing interaction with catalytic metals, and keeping storage to a minimum and cleanliness to a maximum. He also suggested that tanks and pipelines be designed so that they can be drained completely when emptied to reduce the chance of residual product contaminating fresh oils.

Bergen suggested that processors maximize retention of an oil’s natural antioxidants. He predicted that the use of synthetic antioxidants would lessen in the future because consumers are viewing them with increasing disfavor. Although natural antioxidants are more expensive, he suggested that manufacturers test natural antioxidants in products to be prepared for what he sees as a certain trend.

Transport is a risky time for oil
quality. There is risk of aeration, contamination, and overheating at every transfer point in the transportation chain, Berger said. Around the world, 20-25 million tons of oils and fats are transported in bulk each year, he reported.

Berger presented data on the quality changes of several oils before and after transport. Use of nitrogen as an inert gas cover in tanks appeared to reduce peroxide value and free fatty acid content in a 20-day shipment of refined palm olein, he said. Cargo contamination is less a problem now that international standards have been implemented for transport and storage of oils and fats, he reported.

Unintended enzymatic and chemical hydrolysis also may lower oil quality. Enzymatic hydrolysis, the more common form, can be caused by enzymes present in microflora in oil. Lipases can survive heat treatment, Berger said, and can be reactivated in the oil under certain conditions. A high standard of plant hygiene when processing oil may help reduce enzymes, he said.

**Processing and analysis**

Alternative processing methods were the subject of several presentations. Alain Tirtiaux said that dry multiple fractionation can be a low-cost modification process. Tirtiaux is managing director at Tirtiaux s.a. Fractionnement in Fleurus, Belgium, a manufacturer of fractionation equipment. Approximately 10% of world production of fats and oils is fractionated, the largest portion being from palm oil, he said. Thomas Willner spoke on the use of dry fractionation to produce cocoa butter replacers. Willner is with Krupp Maschinenteknik GmbH in Hamburg, Germany. Cocoa butter replacers are particularly of interest in countries permitting unlimited use of cocoa butter substitutes in chocolate products, he said. Manufacturers can replace the relatively expensive cocoa butter with comparable fat fractions from less expensive base materials. Willner reported on the processes used to produce pressure-resistant fat crystals for use in confectioneries.

Nigel Langley, research and development manager at Croda Universal Ltd., in Hull, England, spoke on the use of adsorption chromatography, or “super refining,” to modify natural oils. Langley described a commercial scale chromatography technique developed to purify natural oils by removing color bodies, hydroperoxides, and odor; the method is similar to preparative chromatography but lower in cost. Super-refined oils offer advantages to formulators in cosmetics and pharmaceuticals, including reduced color, less odor, and greater stability, he said.

This chromatography technique does not alter the chemical structure of the oil, is carried out at low temperatures, and does not harm sensitive substrates such as polyunsaturated fatty acids, Langley said. The process also lowers peroxide value, with its implications for oil stability, he said.

Chemical methods for modifying oils were addressed by Lips, of Unichema. He focused on hydrogenation techniques and choosing catalysts to confer selectivity on the reaction. The selectivity of the catalyst determines the effect of hydrogenation on double bonds and the degree of cis and trans isomerization. One-third of all fats are hydrogenated before final end-use, he reported.

Alasdair Macrae, of Unilever Research in Bedford, U.K., spoke on enzymatic methods for modifying oils. Using recombinant DNA has allowed enzyme manufacturers to produce lipases more efficiently and at lower costs than previously, he said. Macrae cited several advantages of enzyme-catalyzed processes over conventional chemical and physical processes, including the mild reaction conditions under which enzymic processes are operated, the reaction specificity of enzymic catalysis, and the consumer perception that these reactions are “natural.” The specificity of lipases allows the generation of both new products and products which are difficult to obtain by conventional methods, he said.

A good area for future research is in discovering lipases with unusual specificities, Macrae said. Potential applications of this technology include development of cocoa butter equivalents, confectionery fats, hardstocks, human milk fat substitutes, and nutritional fats, he said.

J.W.J. Gielen, research and development manager at Unichema International in The Netherlands, spoke on oils for the oleochemical industry and second generation fatty acids. Of the 80 million metric tons (MMT) of oils and fats produced, only 10 MMT tons are used in the chemical industry, and of that, 3.7 MMT tons in oleochemicals, Gielen said. Fatty acids and alcohols are the major products for use in detergents, polymers, and lubricants. Only 1% of the European market for lubricants is supplied by oleochemical-derived products, he said. However, the 1990s will bring stricter performance and environmental requirements for lubricants, he predicted, making vegetable-derived products more attractive for this market.

Second-generation fatty acids rep-
represent a potential new outlet for agricul-tural overproduction, Gielen said. Although he wasn’t certain that new products were in demand, he said that the chemical industry needs additional supplies and substitutions as well as security of supply. The industry also needs improved quality and ease of production, unique fatty acids, and new functionalities, he said. New industrial oilseed crops such as meadowfoam, vernonia, euphorbia, and lesquerella could be developed for greater use, Gielen said, but he was doubtful about their economic viability in the market. He predicted that crambe would be the first alternative oilseed crop available on the market.

Gielen listed several constraints on development of new raw materials: (a) current raw materials are well-established crops, (b) new oil crops are high-risk, and (c) glycerine would be produced by use of these new materials, affecting glycerine markets. Market demand will be vital to establishing these crops, he said.

Improvements in analytical methods are equally important to the fats and oils industry. Edward G. Perkins, of the Department of Food Science at the University of Illinois in Urbana, Illinois, spoke on modern analytical methodology for evaluation of fats and oils. Perkins reported that the trend toward laboratory computerization has led to systems to efficiently manage information through data bases and automatic data recording. Perkins discussed basic analytical tests used in analysis of edible fat products, as well as recent modifications to the basic tests.

"Rapid introduction of new analytical instrumentation to accomplish many of the tests common in the industry has resulted in a confusing situation," he said.

Perkins explained that many of the adaptations to AOCS official methods, using state-of-the-art instruments, have not undergone the rigorous testing procedures used to verify official methods.

"Accuracy and reproducibility of these techniques must be worked out...to determine if the "new" method can substitute for the older one," he said.

Barry Jones, of Oxford Analytical Instruments in the U.K., spoke on use of NMR (nuclear magnetic resonance) for SFC (solid fat content) measurements. After an introduction to the technology of nuclear magnetic resonance measurement, Jones discussed the advantages and disadvantages of different NMR techniques. Pulse NMR measures the energy emitted from a sample as it decays; the time constant and shape of the curve yield information about the sample, including the content of solid fat in the sample. NMR can be applied to SFC via indirect or direct methods, he said.

Nutrition issues
Nutrition issues generated much discussion. Stuart Barlow, of the International Association of Fish Meal Manufacturers (IAFMM), spoke on new uses and challenges for fish oil (Table 1). Most of the fish oils currently being used in foods are in margarines, Barlow said. Although fish oils only account for 2% of world production of fats and oils, he suggested that niche markets exist for this oil.

The challenge is to increase consumers' intake of ω-3 fatty acids, Barlow said. Enthusiasm for the ω-3 fatty acids originated with studies of Greenland Eskimos. The Eskimos have been shown to have much lower rates of myocardial infarction than Danish populations. Studies in other populations have suggested that dietary fish oil is related to a decrease in coronary disease.

Barlow reported that fish oil concentrate is being developed by several pharmaceutical companies for use in specific diseases. The encapsulated fish oils are high in eicosahexaenoic acid and docosahexaenoic acid, and are being used to treat heart and inflammatory diseases.

“Our interest as an industry has been in the diet. We believe that in normal life there is a marginal deficiency of ω-3,” Barlow said. To increase consumption of these fats, the association has experimented with developing food products that contain ω-3 fatty acids. IAFMM produced a number of products using fish oil and evaluated taste and performance of these products. The questions, Barlow said, were: Can we make a refined and deodorized fish oil? Can we put it into foods? Will it taste good? The results were positive (see Table 1). Two fish oil-containing margarines are commercially available in Denmark, but are small in volume, he reported.

The dietary implications of essential fatty acids and polyunsaturated fatty acids in oils were discussed by Vincent Ziboh, from the University of California at Davis. Ziboh reviewed the metabolic pathways by which polyunsaturated fatty acids are manufactured in the body. Since the essential polyunsaturated fatty acids cannot be synthesized in the body, inexpensive sources must be sought for future human consumption, he said. He cautioned that a proper balance between the ω-3 and ω-6 fatty acids must be maintained in the human diet; oxidative damage in industrial processes and hydrogenation should be minimized, he said.

In a discussion session, the question was raised about whether trans fatty acids should be included in labeling declarations as saturated or monounsaturated fatty acids. Kanes Rajah, of Ernest George Limited, said that a conflict exists between the perceived nutritional disadvantage of trans fatty acids and the functional advantage of trans fatty acids; hydrogenation adds value to some oils, he said, even as it adds trans fatty acids. Rajah predicted that the conflict would be unresolved for another 20 years.

Kurt Berger, often an advisor for the Palm Oil Institute of Malaysia, offered an opinion that current evidence is not sufficient to establish the safety of dietary trans fatty acids.

Franz Timmermann, of Chem. Fabrik Grunau GmbH, predicted that medium chain triglycerides will be “an important specialty” in the food industry. Because they contain only saturated fatty acids, commercially...
produced medium chain triglycerides are extremely stable. A physiological advantage of MCTs is that they are metabolized like carbohydrates rather than oils and fats.

"Whereas the transport of long-chain fatty acids takes place in the lymphatic system, medium chain fatty acids are transported by the portal vein directly to the liver. Whereas normal oils and fats are stored in the adipose tissue, medium chain fatty acids are oxidized almost totally in the liver," he said.

Timmermann reported that preliminary data also has demonstrated that MCTs can help lower serum cholesterol levels.

**New and specialty oils**

"New and Specialty Oils" were the topic of several lectures at the conference. Gunstone spoke on new vegetable oils. Minor oil crops exist for which new uses are being found, he said, and other new crops under investigation are expected to be of future commercial interest. These specialty oils are produced in low volumes, primarily for markets in the United States and Europe. Some are used because of their distinctive flavors; others are used in cosmetics, toiletries, and pharmaceuticals.

Agriculture needs new crops, Gunstone said, but unless a new crop has a specific property, such as γ-linolenic acid, it must compete with oils already available in bulk quantities. Even if a new crop can be easily grown, harvested, processed, and marketed, the separate handling of the crop may add prohibitive costs to the product. A new crop must quickly become available in high yields and at low cost. Gunstone said that demand for the new oil must be market-led.

"There is an interest in new crops which produce high concentrations of a single acid such as lauric, oleic, erucic, or petroselinic acid, and for fatty acids with additional functional groups," he said. Gunstone reported that biotechnology techniques can modify rapeseed to produce seeds high in lauric acid by altering the synthesis pathway that normally leads to production of palmitic acid. Another source for lauric oils is petroselinic acid, an isomer of oleic acid that yields lauric acid upon ozonolysis. Cuphea, currently a wild plant, produces seed oils dominant in the medium chain fatty acids.

Oleic acid, important in the oleochemical industry, can be inexpensively obtained from tall oil, tallow, and palm oil. However, a number of minor seed crops are rich in oleic acid, the most significant of which is *Euphorbia lathyris*, with 84% oleic acid in a seed containing 50% oil, he reported. The recently developed high oleic sunflower varieties have 81% oleic acid. Other sources rich in oleic acid include jessenia palm, olive, high oleic safflower, almond, macadamia, and rape oils. Not all of these are available commercially, but selective enrichment for oleic acid could make several of these more attractive sources, he said.

Petroselinic acid has potential for the cosmetic and pharmaceutical industry, but specific uses are not yet developed. Gunstone reported that attempts are being made in Europe to develop coriander as a useful oil crop. Coriander contains 80% petroselinic acid in its oil. Gunstone reported that varieties of *Umbelliferae* are rich in petroselinic acid; many already are cultivated for other purposes, he said, and could be developed for optimal oil yield.

Higher monoene fatty acids, such as erucic acid, are available from industrial rapeseed oil. Work is underway to raise the content of erucic acid to 70% or more in the high erucic acid rapeseed and in other crops such as cramble, honesty, nasturtium, and mustard, Gunstone said. Jojoba oil is also rich in monoene fatty acids and has been developed to some extent, he said.

Linseed and γ-linolenic acid (GLA) oils are sources of C18 polyunsaturated fatty acids. Linseed oil use for industrial applications has declined, but the seed oil is getting attention. Plant breeders have introduced a variety of linseed, "linola," which yields oil that is low in linolenic acid but high in linoleic acid. This variety is expected to be introduced as a commercial crop in Australia in 1992, in Canada in 1993, and in Europe in 1994, he reported. This crop was developed in just over 10 years, he said, demonstrating that it probably is easier to modify existing crops than to attempt to tame and modify wild plant species.

Gunstone reported a "small but growing and thriving industry" investigating oils containing high amounts of GLA; seed oils containing this fatty acid include evening primrose oil, borage, and blackcurrant oils. Commercial extraction is limited to evening primrose oil at this time. Some microbiological lipids also contain GLA; products have been developed in Japan and the United Kingdom based on these lipids. GLA is thought to be beneficial in treating a variety of disorders including multiple sclerosis, arthritis, and atopic eczema, he said.

The topic of microbiological-derived oils was addressed in more depth by Colin Ratledge, from the Department of Applied Biology at the University of Hull, United Kingdom.

"Because of the increased rate of costs in biotechnology, versus flat rates in agriculture, microorganisms are out of court for anything other than the very specialized source of oils," Ratledge said.

All microorganisms contain lipids, he said, but few accumulate lipids to an extent that they could be considered as potential sources. Cellular lipid content of 50–80% of dry weight has been found. Cultivation of such microorganisms is no problem—commercial fermentation technology already exists for production of materials such as amino acids and antibiotics.

"If you can identify a manipulatable organism, anything is possible," Ratledge said.

**Proceedings available**

A proceedings of the "Oils and Fats in the Nineties" conference is available for 500 Danish krona (approximately $80), plus postage. Please contact Elsebeth Bisbo, International Food Science Centre A/S, PO Box 44, Sonderskovvej 7, DK-8520 Lystrup, Denmark (fax: 45-86 22 99 96).
Commercial production of microbial lipids offers a number of advantages, he said. The organisms are grown under controlled conditions, resulting in very uniform product and year-round production. Unlike agriculture, the process does not need crop protection chemicals which must be removed later in the refining process.

"Microbial products are therefore the equivalent of 'organically grown' and as such should command a premium price," he said.

Cetus Company in the United States has used bacteria to produce wax monoesters similar to jojoba and sperm whale oil, although large-scale production has not occurred. When polyhydroxybutyrate is produced by bacteria, it constitutes up to 80% of the cell mass; it is recovered by removing the rest of the cell rather than by extraction from the cell. This material is used in biodegradable plastics.

Ratledge said that 20 species of yeast have been identified which will produce over 50% of mass as fats. One such yeast produces a high amount of stearic acid and has been examined for potential as a cocoa butter substitute. Mutations to the yeast have yielded mutants which produce up to 50% of total lipid as stearic acid.

"The range of fatty acids produced by molds is much more extensive than yeasts," Ratledge said. GLA and ω-3 and ω-6 polyunsaturated fatty acids are produced in high amounts by certain molds. Processes for commercial production of GLA exist in the United Kingdom and in Japan, he said.

Algae are also potential sources of oils and fats, Ratledge said. Martek Corp. in the United States produces such a "designer oil," including one with 35% docosahexaenonic acid (DHA). Ratledge said that the processes for growing algae in large-scale fermenters is very expensive, but that work continues on these sources despite the cost and lack of clear economic feasibility. Impediments to the development of single-cell oils are numerous, he said. For microbial oils to find a place in the fats and oils market, they must provide lipids that are expensive to produce by other methods or are unique to the microorganisms.

"Microorganisms always will be the expensive source of fats and oils, but it is a technology to be reckoned with," Ratledge said. "All that remains is for the entrepreneur to identify: which lipid and which microorganism."

Vijai K.S. Shukla spoke on unconventional and exotic specialty oils. The International Food Science Centre, a research organization directed by Shukla, is screening new oil-yielding plant species for potential industrial and food applications. Conference participants had an opportunity to visit the IFSC facility. Shukla reported that four palms native to South America are potential new sources for lauric and palmitic acids, particularly the species Attalea colenda and Jessenia batata.

He also reported that oil from the papaya seed contains 74% oleic acid and has a similar triglyceride pattern as olive oil. Cannon ball oil is a major source of linoleic acid, Shukla said. The seeds of this species contain 51% oil, of which 86% is linoleic acid. Manioc seed was found to yield oil which was 70% linoleic acid; the triglyceride pattern of this oil is similar to sunflower oil, he reported. Several seed oils contain high amounts of linolenic acids. Borage seed oil contains higher amounts of GLA (20–25%) than evening primrose oil (8–10%), the usual source for this fatty acid. High amounts of α-linolenic acid are found in whortleberry (28%) and mountain cranberry (36%), Shukla said. Blackcurrant oil has been found to contain equal amounts of both α- and γ-linolenic acids, 13–15% each.

In examining oils for use as confectionery fats, Shukla said that fats containing monounsaturated, symmetrical triglycerides are the better substitutes for cocoa butter. Mango kernel oil is useful for confectionery because its total amount of monounsaturated triglycerides is 66%. Several species of Shorea, Dipterocarpaceae, native to Malaysia, contain over 94% monounsaturated triglycerides. Other special oils investigated by IFSC include Jack fruit seed, mchune, nere seed, coral, karanja, and macadamia nut.

"The plant kingdom globally provides us with a large variety of unexploited oils and fats which could be developed commercially in order to balance the deficit emerging in developing countries," Shukla said.

The conference were supported by Eastman Chemicals, Nestlé Research, Novo Nordisk, PGE Canada, Toms Factories, and Unilever Research.

This multi-article report on the "Fats and Oils in the Nineties" conference was prepared by INFORM newswriter Karen Dotson.
Oil demand forecast to rise 32% during decade

World demand for oils and fats will rise by 32%, or 25 million metric tons (MMT), by the end of the century, to around 105 million metric tons annual disappearance, Sigfried Mielke, founder of the Oil World market newsletter, told attendees at the Fredericia conference.

“Risk means that every year oil millers and manufacturers worldwide will have to produce an average 2.5 MMT more oils and fats during this decade,” Mielke said. Disappearance in 1990 totaled 80.4 MMT.

Most of this increased disappearance will be met by increases in soy, sunflower, rape, palm, and palm kernel oils, as these are the only oils whose production growth rates match the 3% average annual rate of demand growth, he said. Other fats and oils with below-average growth are mainly by-products whose output depends on demand for the main products, he said.

Since the early 1970s, palm and palm kernel oils have become growth leaders for the whole field of fats and oils, driven by “unparalleled” profitability and by attractive price differentials, Mielke said.

“In 1990 the palm and palm kernel share of total world disappearance of oils and fats reached 15.3% compared with only 8.7% ten years before. This was by far the biggest market share gain registered in the past decade in the field of oils and fats,” he said.

GATT a key factor

The future of these growth oils absolutely depends on the outcome of the GATT negotiations, Mielke said. Speaking at the end of March, he said he was assuming that the GATT would be concluded within one to three months. The proposed cuts in European subsidies would drop European grain prices toward world market levels, making them more competitive with oil meals as an energy source in livestock feed, he said. If the EC agricultural reform is implemented as proposed, use of oil meals for livestock products could decline by 15%, lowering demand for soybean meal and as a consequence decreasing oil output, Mielke predicted.

“Thus, if GATT succeeds, the soybean oil share of world disappearance of the 17 oils and fats is set to decline further. It may fall to 19% by the year 2000,” he said. Share of palm and palm kernel oils will rise to 21%, and rape and sunflower oils combined to 21%.

“The palm complex will get the lion’s share of the growth in world disappearance of oils and fats,” Mielke said. “It is best suited to cover the oil supply gap created by the expected sharp decline in EC soybean meal usage because the meal share of the total yield is the lowest and the oil share the highest of all oilseed/fruit complexes.”

Production of palm and palm kernel oils will exceed that of soybean oil by the turn of the century, he predicted. Rapeseed oil should experience the next largest demand growth to fill any gap created by a slower increase in soybean oil production. Sunflower oil will be the third beneficiary, he said.

“Apart from lauric oils, the prospects for the remainder of this year are for further price rises because of an unusually tight supply situation. For the remainder of the 1990s we expect the prices for oils and fats to average higher than in the second half of the 1980s, if the GATT round is concluded successfully,” Mielke said.

Mielke said the basic factors that determine the long-term trend of world oils and fats production and consumption are population, per capita income, prices, and technological developments.

Population

Population growth is the driving force behind consumption, Mielke said. He predicted that, despite a slight decline in growth rate, global population will increase by approximately one billion persons during the 1990s, to reach 6.3 billion by the year 2000.

All of the increase will occur in the less-developed countries, he said. Population growth doubled world disappearance of the 17 major oils and fats from 25 years ago; during the five years ending in 1992, global population growth accounted for an average annual increase in disappearance of 1.2 MMT, he reported.

The other factor in total disappearance is an increase in per capita disappearance, Mielke said. Although this growth depends on uncertain factors, such as income, government policy, foreign exchange, and for some countries, credit availability, Mielke predicted per capita consumption will

![Graph showing oil demand forecast to rise 32% during decade](https://example.com/graph.png)
Mielke predicted that lessened world dependence on oilseed production in the northern hemisphere and the trend toward generally more market-oriented oilseed production programs in the United States and Europe should prevent exceptionally high prices for over two years, and should keep the general price level lower than in the mid-1970s.

Exchange rates, foreign exchange reserves and credits will also affect consumption, he said. These have been important factors affecting consumption since 1990 in the former East Bloc, and will continue to be important for many countries which are short on foreign exchange.

Other developments
Finally, Mielke reported that scientific, environmental, and dietary developments have exerted important, if opposite, influences on per capita disappearance in many countries. He reported an increasing use of fats and oils for oleochemicals and feed. Another negative influence on consumption is the tendency of nutritionists to urge people in developed nations to eat less fat.

"This has begun to influence per capita disappearance especially in the developed countries, where it is already very high. However, where the per capita disappearance for nonfood uses is increasing sharply, so that total per capita use keeps rising," he said.

Mielke predicted that per capita disappearance of fats and oils will continue to rise in the next 10-15 years, but that the rate of growth will fall to or slightly under 5% for the five years ending 1997. He attributed this decline to the severe economic crisis in the former Soviet states are not expected until 1993 or later, Mielke said.
Too much labeling termed ‘a danger’

“Taking into consideration all the labeling requirements (existing and future) on foodstuffs in general, there is a clear danger of overlabeling and overcommunication,” Ivan Hodac warned attendees at the “Oils and Fats in the Nineties” conference.

Hodac is secretary general of the International Federation of Margarine Association (IFMA) and the Association of the Margarine Industries of the EC Countries (IMACE). He spoke at the conference on oils and fats labeling in the European Community (EC).

“If the food industry will not raise its voice very strongly as soon as possible, the labeling burden imposed on it by very often uncoordinated and doubtful legislative efforts both at the EC and Member States level might have serious consequences for its business,” he said.

“It is of a crucial importance that labeling provisions are harmonized at the Community level in order not to create barriers to trade. It is extremely important also that labeling requirements do not impose an unnecessary financial burden on the food industry.

“At the end of the day, it will be the consumer who will pay the price.”

Nutrition labeling could be the next and most important development in food labeling, Hodac said. Under a 1990 EC regulation, nutrition labeling is not required unless a nutrition claim appears on the label, but, he said, in view of the developments in the United States, it would not be surprising if nutrition labeling became obligatory in the future. As U.S. regulatory agencies are completing new food labeling regulations, the EC is in the process of establishing its own labeling regulations.

Current EC labeling regulations are voluntary, but Hodac predicted that mandatory regulations would be adopted soon. He stated that quantitative declaration of ingredients and labeling of recyclable packaging (including specific information on types of plastic and means of disposal) probably will be required. Other labeling requirements are under debate.

An agreement has not been reached on EC regulation of health claims and product descriptors, Hodac said. However, it has been decided that a community wide ruling on claims is not necessary for the implementation of the “single market” at the end of 1992, he said. Definite regulations for claims should be laid down, Hodac said, but he doubted that such regulations would be put into effect. Food labeling proposals are due at the end of 1992, he said.

U.S. labeling regulations are extremely important to the EC, Hodac said, because the regulations will be compulsory when they take effect (now scheduled for May 1993). Descriptors such as “low fat,” “fat free,” and “low cholesterol” are defined differently under U.S. and EC regulations. For example, the EC regulations allow a “low fat” claim for a product in which a 50% reduction in fat from the level in the reference product has been obtained; a reduced-fat table spread could still contain 40 g fat/100 g and use the “low fat” claim. Under U.S. regulations, a claim of “low fat” will be permitted only if the product has no more than 3 g fat/100 g. Furthermore, cholesterol claims are not being harmonized in the EC, Hodac reported, whereas U.S. regulations have specific guidelines for cholesterol claims.

“This is going to cause lots of problems for us,” Hodac said. “The EC will establish descriptor terms, but I am in favor of descriptors for categories of food products rather than across all foods.”

Serving size will be another contentious issue, he said. U.S. regulations require that nutrient content information on food sold in the United States be presented as amount per serving size, which must be in standard household (nonmetric) units; in Europe such information is uniformly presented as g/100 g.

A proposed EC Labeling Directive under consideration requires certain information to appear on the food label, including a declaration of ingredients. This declaration is the most “troublesome” portion of that legislation for the fats and oils industry, Hodac said, because the directive permits individual member countries to issue stricter ingredient labeling requirements for fats and oils. France and Belgium intend to require that oils and fats be labeled with the specific source of all fats and oils. This would provide a nontariff barrier to intra-EC trade, Hodac said, because manufacturers would have to change packaging to match requirements in the country where the product is to be sold; furthermore, it is not possible to accurately and quantitatively determine the components in a mixture of fats and oils, he said. Hodac expected this provision in the directive to be amended.

Environmental labeling is becoming an important issue in the EC, he reported, citing a proliferation of different country systems for labeling product packages. An EC proposal on harmonized package labeling is being prepared, he said, but “the big question is when it would happen. In any case, it would again increase the quantity of information the manufacturer will be requested to put on the label.”

“Different kinds of dots and marks are growing like mushrooms without any coordination from the EC authorities,” he said.