

Companies in Canada have introduced a number of nonhydrogenated soft margarines that incorporate palm and/or palm kernel oil for hardening.



Tools: hydrogenation, interesterification

Hydrogenation and interesterification are among the tools the industry uses to give fats and oils desired functionality for specific products.

Approximately one-third of all edible fats and oils in the world are hydrogenated, while approximately 10% are fractionated or interesterified, according to data from Unichema International that was presented at the Fourth Latin American Congress held in 1992. Interesterification currently has limited application in the United States. However, interest is growing in whether interesterification can be used to lower *trans* fatty acid isomers in food products.

Unresolved nutritional questions concerning *trans* fatty acids are prompting companies in the United States and Canada to consider options other than hydrogenation to modify oils. Meanwhile, increasing palm oil production in Latin America may increase use of interesterification in that region.

Currently, formulators can raise the melting point and solid fat content of fats by (a) hydrogenating oils to different degrees of hardness or (b) interesterifying a liquid oil with a more saturated oil. The U.S. industry uses hydrogenation predominantly. In Europe, companies use interesterification for a wider variety of products, including margarines.

This article was written by Barbara Fitch Haumann, senior editor/writer for INFORM.

Hydrogenation is a chemical process for adding hydrogen to unsaturated triglyceride esters. Interesterification is a rearrangement of the fatty esters on the glycerol molecule. Some in the industry see an advantage in using both.

"It's best to use them together," according to Alan R. McCurdy, a professor at the University of Saskatchewan in Canada. To do this, formulators fully hydrogenate an oil and interesterify it with a nonhydro-

generated fat or oil to get a particular melting characteristic.

"Hydrogenation and interesterification sometimes are used together to get products with specific highly desired functionalities," according to Robert Hastert, president of Hastech Corp. However, when both are used, "You add cost," Hastert pointed out. "The improvement in functionality must be desirable enough to offset the higher price required for the product."

Hastert and Kenneth F. Carlson, president of RBD Technologies, predicted there will be more use of interesterification in the United States and modifications to the hydrogenation process for such products as margarines because of interest to reduce *trans* fatty acid in products.

"Awareness concerning possible nutritional implications of *trans* fatty acids is bringing increased interest in alternatives to our current way to hydrogenate," Carlson said. "For instance, people in the industry are working on ideas to make the hydrogenation process smoother, using gentler designs to more evenly distribute the hydrogen in the oil. Companies also are experimenting with catalysts to lower *trans* content. In addition, companies are trying to find alternate feedstocks by exploring the use of interesterification."

Formulation criteria

Formulation changes during the past 30 years have concentrated on making margarine products less saturated.

Margarine-type products today are not hydrogenated to the same extent as in the past and contain more liquid oils, resulting in fewer saturates in the final products. However, this has led to more *trans* isomers in the products.

Average ranges of *trans* fatty acid content of margarines are 11–30% in the United States, 11–39% in the United Kingdom, 7–32% in Western Europe and 7–32% in Eastern Europe, according to data published by consultant Kurt Berger in the March/April 1993 issue of *Lipid Technology*. A recent article on "Properties of Margarines Available in the U.S. Market" by M. Kohiyama and colleagues provided detailed analysis of 93 margarines and spreads available in the U.S. market. The article, published in the March 1994 issue of the *Journal of the Japan Oil Chemists' Society (Yukagaku)*, includes *trans* and *cis* data.

Feedstocks for formulated products range from soybean and canola oils, which are high in polyunsaturated fatty acids, to coconut and palm stearin, which are highly saturated, with coconut oil being approximately 90% saturated fatty acids.

"What you do to make the products depends on the performance you want and what feedstocks you have available at an affordable price," according to Hastert.

Fats exist in three crystal forms: α , β' and β . β' is the preferred crystal form for most margarines and shortenings because it produces a smooth texture and an enhanced creaming perfor-

mance. The β crystal is desirable for fluid or pumpable shortenings for frying and breadmaking.

Hardness of a fat often is measured by its melting point. However, for a fat or fat blend to be plastic, it must consist of both solid and liquid phases. The ratio of these two phases at different temperatures is measured and expressed as Solid Fat Content (SFC) or Solid Fat Index (SFI). The results are similar, but the methodology is different.

The common practice for preparing U.S. margarines is direct blending. Table spreads are usually a blend of one or more partially hydrogenated basestocks with an unhardened oil or with a blend of two or more hydrogenated oils. Stick margarines can be divided into soft stick and hard stick. Virtually all hard stick margarines are hydrogenated, and soft stick margarines and soft tub spreads are a blend of liquid oil and hard basestock. Fluid shortenings are flowable suspensions of solid fat in liquid oil, and the liquid oil phase may or may not be partially hydrogenated.

The selection of oils available domestically often influences what techniques will be used. For instance, hydrogenation is widely used in the United States due to the availability of such oils as soybean. In countries where palm and coconut oils are more available, interesterification is more apt to be used.

Hard fats such as palm kernel and palm oils are readily available in trop-

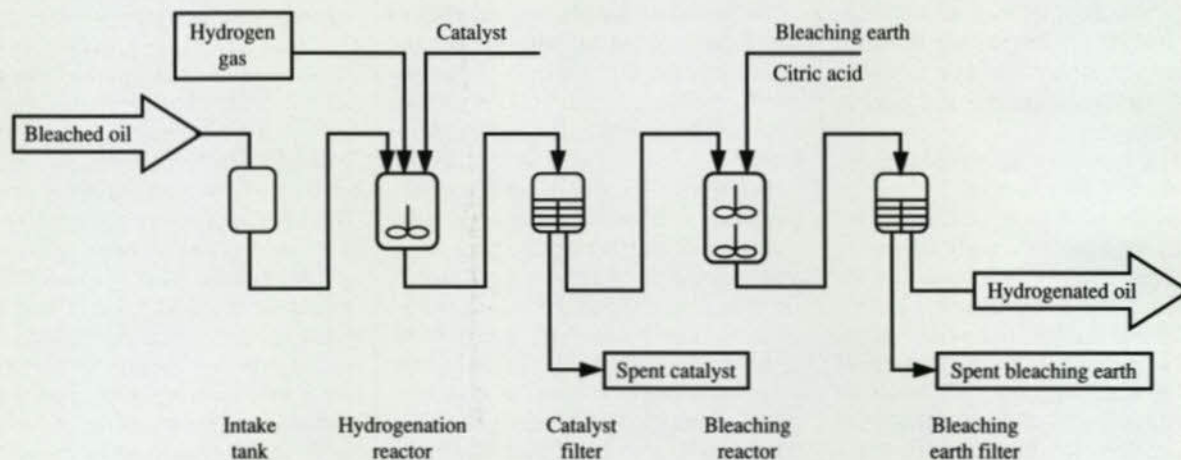


Figure 1. Hydrogenation process

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ical regions. Palm oil can be fractionated into palm stearin (harder fraction) and palm olein (softer fraction). Palm oil also can be hydrogenated. Other hard fat choices are lard or tallow. However, with the trend away from animal fat usage in products, lard and tallow are not generally chosen in North America.

"So often the best formulations are some of this feedstock and some of that," Hastert said. The practice of using palm oil in some U.S. formulations, however, was curtailed after an antitropical oils campaign launched during the 1980s. As a result, formulators began substituting hydrogenated cottonseed oil for palm in shortenings where β' characteristics are needed for functionality.

"It didn't make sense for technical or nutritional reasons," Hastert said, noting that the tropical oils controversy never became an issue in Europe. "Palm oil will begin to be used again in the United States, but it will take a long time to recover from this pseudoscience," he added.

However, because palm oil crystallizes somewhat more slowly than cottonseed hard fat, switching to palm oil might require slowing down or modifying existing production lines.

Hydrogenation

Liquid-phase hydrogenation of vegetable oils was developed by Wilhelm Normann in the early 1900s. The purpose is to change the molecular composition and structure of an oil.

Hydrogenation is done generally to increase the hardness of an oil. The result is improved oxidative stability and functionality for use in margines, solid cooking fats and baking shortenings.

During the reaction, hydrogen gas is intimately mixed with the oil in the presence of a catalyst (Figure 1). After hydrogenation, the catalyst is filtered out. The oil is bleached with adsorbent clays, and residual traces of nickel are chelated with citric acid. Temperature, hydrogen pressure, type and amount of catalyst, and agitation affect the hydrogenation reaction. In commercial practice, for economic reasons, companies seek to use the least amount of

catalyst required to achieve the effect they want.

A partially hydrogenated oil will have different properties, depending on whether hydrogenation was performed selectively or nonselectively. Simply stated, selective hydrogenation

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tion is a steering of the reactions toward a step-by-step reduction of linolenic acid to linoleic acid, and linoleic to oleic acid, stopping short of stearic acid. In nonselective hydrogenation, more linolenic and linoleic acids go directly to stearic acid.

"Wherever possible, manufacturers aim more toward higher activity for higher turnaround, which is nonselective," according to David R. Erickson, a consultant based in St. Louis, Missouri.

Isomerization occurs during hydrogenation, with many of the *cis* double bonds migrating along the fatty acid chain. Some of the *cis* double bonds are then converted to the *trans* configuration. The *trans* fatty acids have higher melting points than the *cis* fatty acids, and many *cis* isomers have elevated melting points compared to the original *cis* fatty acids that were present in the oil.

High reaction temperatures pro-

mote formation of *trans* isomers. High concentration of hydrogen gas results in low selectivity and low isomer content, while low concentration of hydrogen gas results in high selectivity and high *trans* isomer content. Other conditions, such as catalyst activity, catalyst selectivity and agitator speed, also are factors.

Most commercial hydrogenation plants use batch slurry reactor equipment and supported nickel catalysts. The reaction is carried out at 150–225°C, with hydrogen gas pressure ranging from 0.5–4 atmospheres (5–50 psig). Continuous systems would have desirable attributes, but have not achieved significant commercial use at this point.

A review paper by Jonas Edvardsson and Said Irandoust, published in the March 1994 issue of the *Journal of the American Oil Chemists' Society*, discusses reactors used for hydrogenating edible oils.

Recent advances

Work continues on improving the hydrogenation process.

One aspect has been research to decrease the amount of degradation products and *trans* isomers produced.

Associate professor Peter N. Pintauro and his graduate students at Tulane University, for instance, have developed a low-temperature electrocatalytic process for hydrogenating edible oils that results in less *trans* isomer formation.

In this electrocatalytic reaction scheme, atomic hydrogen is produced on an active Raney nickel powder cathode surface by the electrochemical reduction of water molecules from the electrolytic solution. Adsorbed hydrogen reacts with the oil's triglycerides to form hydrogenated product. The operation does not require high temperatures or pressures.

The electro-hydrogenated oil has higher stearic acid content and lower *trans* isomers than oil produced via traditional hydrogenation. Pintauro and his students have reported. Pintauro has sent samples of the resulting oil to the U.S. Department of Agriculture.

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ture's National Center for Agricultural Utilization Research (NCAUR) for odor and flavor stability analyses.

"Preliminary sensory evaluations show this oil has less characteristic hydrogenated odor/flavor than conventionally hydrogenated oils," according to NCAUR's Kathleen Warner, explaining, "Thus, this product may be good not only because it has lower *trans* content but also because it has less characteristic hydrogenated flavor."

Pintauro has obtained a patent on the process, and Tulane University is actively seeking industrial collaboration in the hopes that the process can be commercialized. Original funding for the research came from the U.S. Department of Energy (DOE). Currently, the project is funded in part by the state of Louisiana as well as DOE and Lou Ana Foods Inc.

"If and when it will be commercialized will depend on funding and company interest," Pintauro said, noting that processing costs based on current reactor designs are somewhat higher than traditional hydrogenation methods.

Other research to improve hydrogenation performance has centered, in part, on new generations of catalysts, designed to improve activity and selectivity while maintaining good filterability. This has included increasing the pore size and decreasing the particle size of the catalysts.

"To a certain extent, the level of *trans* isomers (created) can be controlled by selecting adequate hardening conditions, particularly reaction temperature and catalyst. Low levels of *trans* are obtained if hydrogenation is performed at low temperature using fresh catalyst, while re-use of catalyst, high reaction temperature and, in particular, a sulfur-promoted catalyst will increase *trans* isomer formation and steepness of the solid line," Leo Lips of Unichema International said in a presentation at the Fourth Latin American Congress in Argentina in 1992.

In other work, Peter H. Berben and colleagues at Engelhard De Meern B.V., De Meern, The Netherlands,

have investigated which reaction conditions and catalyst systems would produce the fewest *trans* isomers during hydrogenation in a batch reactor.

Nickel catalysts and precious metal catalysts were used at various temper-

"Precious metal catalysts open the possibility of hydrogenating under a wider range of operating conditions."

—Okonek

atures and hydrogen pressures. By changing the reaction conditions, they lowered the amount of *trans* isomers formed with nickel catalysts by 30–40%, without considerably increasing the amount of saturates. They also found that platinum catalysts hardly produced any *trans* isomers, but the amount of saturates increased dramatically. Addition of ammonium as a reaction modifier brought the amount of saturates formed back to normal levels.

"Whether ammonia or other modifiers may be used in food products or to produce food products is another question, however," Berben pointed out.

"The thrust of our research is to explore alternative catalysts for lowering *trans*," according to Douglas Okonek, product technology manager for Engelhard Corp. "Precious metal catalysts open the possibility of hydrogenating under a wider range of operating conditions." Nickel catalysts must be used at temperatures above 130–140°C. "Precious metal catalysts

are very interesting since these catalysts are already active at much lower temperatures," Berben said, noting that in the Engelhard studies, precious metal catalysts were used at 60°C.

Meanwhile, J.B. Rivers Jr., president of RIMECO Inc. based in Oklahoma City, believes the current hydrogenation process needs to be revised.

"We need to adopt a continuous, ubiquitous process," Rivers said. His company has designed a reactor that is compartmentalized to help control the following factors along each step of hydrogenation: hydrogen concentration in solution, catalyst strength and concentration, temperature, uniform shear on all incremental volumes of the mixture, and pressure.

"As the finished oil quality is the object of the process, the ideal reactor must have the capability of stopping the reaction at the desired degree of unsaturation," Rivers said, explaining, "With the highly reactive small grain oils, it is desirable to reduce the polyunsaturates to monounsaturates without creating saturates or *trans* isomers."

His company's process is controlled with a patented oil quality monitor designed to give near-instantaneous results for iodine value, solid fat index and melting point to regulate the process at several steps along its progression.

Rivers is seeking funding through the U.S. Department of Commerce's Advanced Technology Program to build a prototype of his system. "It is a question of money, time and support to build a continuous plant," Rivers said, noting he has approached large oil processing companies as well as equipment manufacturers but has yet to get support for the project.

"There is interest in the idea, but there is reluctance in the food industry to invest in making changes," he said.

Interesterification

Unlike hydrogenation, interesterification neither affects the degree of saturation nor causes isomerization of the fatty acid double bond. Thus, it does not change the fatty acid profile of the starting material. Instead, it rearranges

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the fatty acids on the glycerol molecule.

Interesterification can be carried out at significantly lower temperatures than hydrogenation, depending on the type of catalyst used. Temperatures for interesterification can range from 240°C down to 0°C. The most commonly used catalyst is sodium methylate.

Some interesterification catalysts regroup the fatty acids randomly. Specific enzymic catalysts, however, can be used to rearrange fatty acids on selected positions of the triglyceride only. In either situation, the oil's melting profile is changed. In most applications, interesterification is used to generate steeper melting blends. Nutritional functionality, particularly absorption characteristics, also can be altered by interesterification.

Random interesterification, the predominant form used, changes the crystal form of an oil or blend to produce desired solid fat content curves or to produce blends with high levels of polyunsaturated fatty acids. A 1969 West German patent, for instance, was granted for a zero *trans* product produced by interesterifying 30% palm oil, 30% palm stearin and 40% palm kernel oil and by blending 27.5% of the interesterified fat with 72.5% of polyunsaturated vegetable oils.

Intesterification involves oil pretreatment, reaction with a catalyst and deactivation of the catalyst. The process usually uses a batch reactor with an agitator, and includes heating and cooling, sparging and vacuum steps. Figure 2 depicts a typical batch interesterification vessel.

The effect on melting and solidification properties ultimately depends on the type and mixture of the starting materials, according to Michael D. Erickson, senior research scientist at Kraft Food Ingredients (KFI), in a chapter on interesterification prepared for the *Handbook of Soy Oil Processing and Utilization*, 2nd Edition, to be published later this year.

Chemical interesterification also can be directed. Known as the Eckey Process, directed interesterification

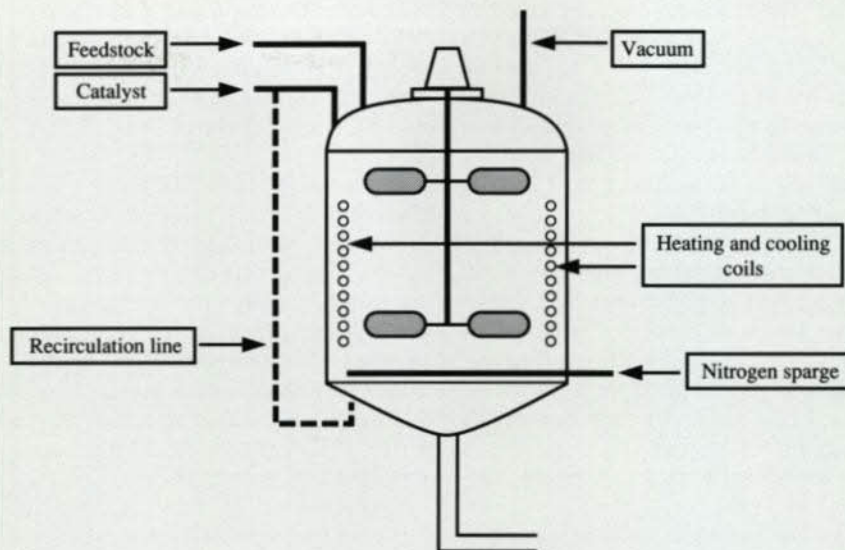


Figure 2. Typical batch interesterification vessel

produces the desired array of triglycerides through temperature manipulation. The reaction is conducted at lower temperatures than random interesterification. "The triglycerides solidify because their melting point is above the reaction temperature," Erickson wrote, noting, "This provides the opportunity to selectively fractionate a mixture to obtain desired functional properties."

Intesterification was a significant modification process before animal fats were displaced by vegetable oils in products, he added.

Forty years ago, researchers at Swift & Co. in the United States developed interesterification to modify lard to function as a shortening for such baked goods as cake. After the discovery by Karl Mattil, Frank Norris and colleagues, Swift installed this process at its plants during the 1950s. It then began interesterifying its Swift'ning household lard-based shortening.

Today, with less use of animal fats in foods, industry experts said they know of no U.S. companies using interesterification to produce margarine and shortening feedstocks. The primary, and limited, use of interesterification in the United States is to produce high-value specialty fats, such as cocoa butter substitutes and confectionery fats.

Outside the United States, interesterification is used to produce specialty fats as well as hardened fats without *trans* fatty acids. For instance, Unilever's Becel margarine, an interesterified margarine, is available in Canada and continental Europe.

To make Becel, hard fractions of palm and palm kernel oil are interesterified and blended with liquid oil. The hard fraction represents approximately 12–15% of the formula. Currently, Becel has approximately 10–15% of the Canadian margarine market.

In India and Pakistan, consumers use vanaspati, a shortening based on hydrogenated vegetable oil. However, vanaspati of satisfactory consistency and no *trans* acids can be made using interesterification, according to Berger in the March/April 1993 issue of *Lipid Technology*. He noted that S. Majumdar and D.K. Bhattacharya have obtained products of satisfactory consistency by interesterifying palm stearin with a variety of vegetable oils. M.S.A. Kheiri and co-workers also have prepared similar products on a larger scale.

Intesterification drawbacks

Intesterification is not preferred by the U.S. industry for a number of reasons.

For one, it is not a very clean pro-

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cess. "The reactions are very sensitive to moisture," according to NCAUR's Gary List. He said that if the sodium methoxide catalyst reacts with moisture in the air, "you get saponification, not interesterification." The resulting soap has to be washed out of the oil, resulting in oil loss.

"You don't end up with a 100% triglyceride, but you also get small amounts of diglycerides and sometimes traces of monoglycerides. This means the oil yield from interesterification is not as good as hydrogenation," List said. Another concern is using a fresh catalyst.

"Intesterification is a messy reaction," List said.

David Erickson, who at one time worked for Swift, agreed that interesterification is not as versatile as hydrogenation. "If interesterification

were an economical and versatile process, industry would have switched over to it many, many years ago when the first concerns over *trans* were voiced," he pointed out.

Enzymatic interesterification

Chemical interesterification, however, is not the only route for this process. Also gaining scrutiny is enzymatic interesterification, now used commercially to produce high value-added products, such as structured triglycerides for confectionery use.

Unilever Research scientists in the United Kingdom developed and patented a process to make cocoa butter equivalents (CBEs) by specific enzyme interesterification of high-oleic sunflower oil and a palm oil fraction. These enzymatic CBEs have been tested extensively in chocolate

recipes and are completely interchangeable with cocoa butter, according to Loders Croklaan B.V. researchers.

During 1993, Loders Croklaan put an enzymic interesterification plant on line in Wormerveer, The Netherlands, to produce fats for confectionery use.

Oil modification by lipases is performed under virtually anhydrous conditions, at temperatures up to 70°C, according to Paul Quinlan and Stephen Moore of the Colworth Laboratory, Unilever Research, United Kingdom, in an article in the May 1993 issue of *INFORM*.

Intesterification using random lipases produces fat compositions similar to those obtainable from standard chemical methods. An advantage is that these lipases generally are perceived as "natural" alternatives to chemical techniques.

Current applications of lipases, however, center around exploitation of the *sn*-1,3 fatty acid specificity of most commercially available enzymes, which allows the manufacture of specific triglycerides in high yield. Such triglycerides can improve organoleptic properties, such as reducing waxiness and imparting cool melting, and can reduce the total saturated fat content of a product. Also, Quinlan and Moore wrote, low levels can improve the processing or storage properties of products, reducing bloom in confectionery products.

"In these applications, the major advantages of enzymic interesterification over existing chemical technologies lie in the range of specificities available in lipases and the greater degree of control in reactions," they wrote.

Unilever scientists also have developed a novel triglyceride via enzymatic interesterification and based on vegetable fats to closely mimic the fatty acid distribution in human milk fat. "This triglyceride can only be made with the use of a 1,3-specific lipase, by reacting tripalmitin with unsaturated fatty acids," according to Quinlan and Moore. This product currently is under commercial development for use in infant formula under the trade name Betapol.



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Interesterification research

Research on interesterifying fats and oils continues as the industry contemplates possible changes in product formulations.

Engelhard laboratories, for instance, are working on alternate catalysts to the widely used homogeneous catalyst, sodium methylate, for chemical interesterification.

Meanwhile, at NCAUR, List and colleagues have randomly interesterified liquid vegetable oils through chemical interesterification using hydrogenated soybean and cottonseed hardstocks. This has resulted in blends of liquid (80%) and solid triglycerides (20%) with plasticity curves similar to commercial tub margarine oils prepared by blending hydrogenated hardstocks. They also have shown that blending an interesterified basestock with additional liquid oil results in a product with plasticity and melting point suitable for shortening formulations.

List originally conducted interesterification trials during the 1970s to create zero *trans* fats as a result of concerns that dietary *trans* fatty acids might be linked to atherosclerosis. Although those trials were successful, the work was dropped. Prompting revival of this research were advances in genetic engineering that promise future availability of soybean lines with altered fatty acid composition, including increased saturated fatty acid content, according to List.

"A lot of these products may end up in margarines in the future," he said.

The goal of this latest work has been to build a database characterizing the structures, including the solid fat indices and melting points, resulting from interesterifying liquid oils with hydrogenated hardstocks. In the future, high palmitic or high stearic soybean oil might substitute for the fully hydrogenated hardstocks, List said.

At the University of Lund, H.M.A. Mohamed and colleagues have conducted studies to produce margarine fat without *trans* fatty acids by enzymatic interesterification of cottonseed oil and fully hydrogenated soybean oil.

"Exploitation of the varying specificities of different lipases permits production of a variety of desirable glyceride mixtures that are unobtainable using conventional chemical interesterification processes," they wrote in the November 1993 issue of *Fett Wissenschaft Technologie*. They

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—deMan

noted that chemical interesterification had been used to produce zero-*trans* margarines in previous studies.

The Lund researchers said interesterification of fats always causes diglyceride formation, "as diglycerides are intermediates in the reaction. The high content of diglycerides is expected to delay crystallization and lower the solid fat content of the interesterified fat." However, they noted, L. Hernqvist and K. Anjou have used diglycerides to stabilize the β' polymorph in margarine containing hydrogenated rapeseed and soybean oils. "Thus the presence of diglycerides produced in the enzymatic reaction can be an advantage in the commercial production of margarine fat stock," they wrote.

A disadvantage was 4–6% free fatty acid content, which must be removed from interesterified fat stocks to be used in margarine. "How-

ever, the amounts of free fatty acids formed when a lipase is used the first time are higher than those formed on repeated use or after the initial stabilization period in a continuous column process. Free fatty acid formation can also be decreased by operating at lower temperatures or by drying the enzyme preparation and substrate feedstock before use," they wrote.

In a follow-up article published in the February 1994 issue of *Fett Wissenschaft Technologie*, Mohamed and K. Larsson, also at the University of Lund, summarized findings concerning crystallization behavior and functional properties of cottonseed oil interesterified with fully hydrogenated soybean oil by lipases. "The most striking effect was an increase in the relative stability of the β' -crystal form by interesterification, indicating possibilities for margarine production without *trans* fatty acids," they wrote.

At the University of Saskatchewan, McCurdy also has made margarine stock using fully hydrogenated palm stearin as well as high erucic acid rapeseed stearine via enzymatic interesterification.

Meanwhile, at the University of Guelph, John deMan and France Cho have carried out chemical interesterification and enzymatic interesterification using hydrogenated canola oil and palm stearin. Some of their findings with chemical interesterification were published in the *Journal of Food Lipids* during 1993. Other findings with enzymatic interesterification are slated to be published in *ELAEIS*.

"There is an increasing tendency to produce margarines with higher levels of unhydrogenated oils. This means that the crystal network has to hold large amounts of liquid oil," deMan said.

Cho and deMan have used partial chemical interesterification to produce soft margarine formulations with low *trans* content containing 50–70% liquid oil. They selected blends of liquid canola oil as well as hydrogenated canola oil and palm stearin for their experiments. "You need to make sure the hard components are interesterified to the consistency you need, and then add the liquid oils," deMan said, adding, "I don't see any drawbacks. If

Fat modification to be discussed

Industry representatives said the issue of fat modification will continue to be of great interest to companies. One opportunity for discussing it will be a workshop entitled "Developing and Processing Vegetable Oils for Human Nutrition," to be held Oct. 2-3, 1994, in Winnipeg, Canada. The Canadian Section of the American Oil Chemists' Society is organizing the workshop.

Hastert, Mag and McCurdy will be among the speakers. Topics will include the physiological effects of dietary *trans* isomers and saturated fatty acids, as well as hydrogenation and interesterification. For more details on the workshop, contact W.W. Riley Jr., Canola Council of Canada, 400-167 Lombard Ave., Winnipeg, Manitoba R3B 0T6, Canada (fax: 204-942-1841).

you can hydrogenate, you can inter-esterify."

deMan also has looked at the performance of enzymatic interesterification. Its chief advantage over chemical interesterification is one can direct the fatty acids to specific positions. However, disadvantages are that it generates some free fatty acids and partial glycerides, and it also is more expensive.

In India, interesterification of blends of fully hydrogenated rice bran oil and rice bran oil has produced plastic fats suitable for zero-*trans* margarines, according to Ajit Joshi, in an article in the April-June 1993 issue of *The Journal of the Oil Technologists' Association of India*.

"This type of margarine made from interesterified products does not have *trans* isomers, and a large amount of liquid oil can be incorporated in them," Joshi wrote.

The *trans* dilemma

Industry representatives agreed that the controversy over *trans* fatty acids in the diet has forced companies to consider making changes. However, at least in Canada, it is hydrogenation that is under attack, according to Theodore Mag of T. Mag/Associates, Consulting.

"Here in Canada, marketing departments have determined the word 'hydrogenated' should be avoided. Consumers don't understand that fully hydrogenated means there are no *trans* fatty acids. They believe that anything

hydrogenated is bad for them. Companies want to be able to get away from any mention of hydrogenated fat on product labels," Mag said, noting that as in the United States, labels in Canada must state whether the oil has been hydrogenated.

The large companies, except Unilever-owned Thomas J. Lipton, Mag said, "seem to be sitting and waiting." Several smaller companies in Canada, however, have introduced nonhydrogenated soft margarines that use fractionated palm and/or palm kernel oil in the formula for hardening. These include Nuvel marketed by Thibault, Mirage Crystal from Mirage Margarina Ltd. and nonhydrogenated margarine from J.E. Bergeron & Fils.

CanAmera Foods is supplying oil blends and the actual formulations for these companies. "They asked us to come up with formulations using unhydrogenated oils," according to George Clenzos, quality assurance manager for CanAmera Foods.

The Nuvel product contains 60% canola, 27% soybean and 13% modified palm oil. The Mirage Crystal contains 51% canola, 34% soybean and 15% modified palm oil. Bergeron's nonhydrogenated margarine, which is mainly canola oil but also contains 2% palm kernel oil and modified palm oil, is the cheapest formulation.

Ault Foods, meanwhile, has developed a nonhydrogenated soft margarine now marketed by its Lactantia section under the name Olivina. This

also uses an oil blend provided by CanAmera. Olivina is a more expensive product because it contains refined olive oil, high-oleic sunflower oil, regular sunflower oil and canola oil as well as palm and palm kernel oil.

Other soft margarines marketed as nonhydrogenated in Canada include President's Choice from Loblaw, Golden Gate and Fleischmann's.

Products deviating from the Becel formulation, which uses larger amounts of palm kernel oil, may not be equal in quality, Mag said. "If you cut down palm kernel in the formulation, you cut quality as well," he said.

The *trans* issue, Mag and Hastert agreed, is far from resolved.

"Currently, if you want a product with a certain functionality, you have to interesterify or hydrogenate or you use a natural saturated fat such as palm or coconut oil. Then the question is, do you want a saturated fat or a fat with *trans* isomers?" Hastert pointed out.

"There is some indication that *trans* have some harmful effects, but not as harmful as saturated fat. Measuring the long-term health effects is very difficult. People, however, like things black or white. They like to ask, 'Is this good for me or bad for me?' The old standby answer of moderation is probably what's best. It's probably not which fat you eat but how much fat," Hastert said.

KFI's Michael Erickson noted that pursuing low-*trans* technology "has limited long-term potential. The general public will recognize the word 'hydrogenated' as being the source of yet another perceived health risk. For other-than-liquid applications, and if tropical fats are not an option, co-interesterified blends of liquid oil and fully hardened oil are the only practical alternative. However, labeling laws require that hydrogenated oil be declared even though a product like this contains no *trans* fatty acids—or at least not nutritionally significant amounts. This makes crop technology the only remaining alternative for achieving a domestic nonhydrogenated fat." ■