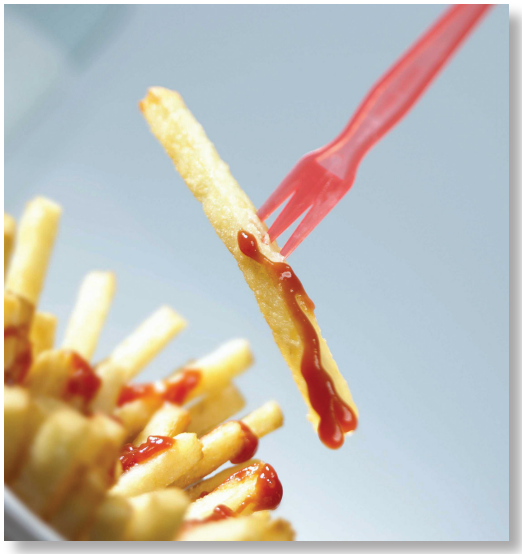
by Donald E. Pszczola

Future Strategies for **Fat Replacement**

Just the fats, ma'am. That would probably be the catch-phrase for *Dragnet*'s Sergeant Joe Friday if he worked as a food formulator in the early 1990s. Back then, all his efforts would have been concentrated on getting a certain element off the streets—or in this case, to put it more accurately, getting the negatively perceived fat out of the formula.

While fats were being removed—in that sense the good sergeant was very successful in his dogged pursuits—they were also being replaced with a number of ingredients that were not necessarily able to reproduce the same functionality characteristics that fats provided. Consequently—and I can be a witness to this, being a fledgling "cub" editor for *Food Technology* at the time—many of the resulting low-fat foods introduced were lacking in the desired texture or mouthfeel. As their sales fell to the wayside, they were dismissed as first-generation products.

Well, almost 20 years have now past, and Sergeant Friday has since retired, although I hear he's now a classroom instructor teaching young food formulators lessons he had learned through trial and error on the streets or in the kitchens. And fortunately lessons have been learned which I think are reflected in today's fat-replacement strategies.



***Food formulators** are looking at a variety of ways to replace certain fats—for example, partially hydrogenated vegetable oils—without compromising their functionality.*
Photo courtesy of Nutrinova

One example of an established ingredient that you might quickly recognize is *Olean* brand olestra, the no-fat cooking oil approved by the Food and Drug Administration in 1996. Recently, its manufacturer, P&G Food Ingredients, Cincinnati, Ohio (phone 513-983-3175, www.pg.com), launched its redesigned *Olean* website, which offers updated information about the fat replacer and its benefits, and includes copies of various studies and testimonials from manufacturers that use the ingredient.

Compared to the way fat replacers used to be promoted—as a 'one-size-fits-all' solution— ***today they are more likely to be customized to fit a specific application.***

Before discussing these strategies, however, let's first look at how things have changed over the years.

Traditionally, fats were replaced with starches, gums, proteins, fiber-based ingredients, and other fats. As will be seen in this article, there are no new magic bullets—rather, these ingredients are still being used in fat replacement, although they have evolved, benefiting from advancements in technology, new functionality improvements, and increased understanding of their potential heath implications.

Compared to the way fat replacers used to be promoted—as a "one-size-fits-all" solution—today they are more likely to be customized to fit a specific application. For example, a cookie would require one type of strategy, while products such as ice creams, potato chips, French fries, and salad dressings would require others to achieve the functionality of their full-fat counterparts. How food formulators find the right fat replacer requires scientific knowledge and precision, as

Fat Replacement continued...

well as—what else—trial and error.

The adoption of an ingredient system approach obviously helped in their labors. Much like the direction that sweeteners have taken in today's formulating, fat replacers seem to be working best as part of system that combines other ingredients, including different fat replacers. Furthermore, as food formulators rediscover texture (see the January 2006 *Ingredients* section), that may also have a positive influence on strategies involving fat replacement, spurring new textures or textural improvements in the development of foods that have been reduced in fat.

Another difference when comparing strategies is that many of today's fat replacers have been developed in response to FDA's mandate that *trans* fatty acid content of foods be included on nutrition labels as of January 1, 2006. Hence, *trans* fats are being replaced with no *trans* fats. This, of course, was not the case 20 years ago when consumers were told that vegetable oils, because they are relatively low in saturated fats, were healthy for them.

Also, back then, fat replacers were promoted as replacing fat—without making too many distinctions between the different kinds of fat and their connotations. The reason that these low-fat products were being developed…well, that went without saying—fat wasn't good for you and should be eliminated with extreme prejudice. That implicit message was probably more fueled by concerns related to heart disease rather than weight management. In fact, ironically during those days there was no mention of an obesity epidemic or even an approaching one.

To show how things have dramatically changed, an article published in the *Chicago Tribune* on May 17, 2006, pointed out that much more attention is now being spent on how fats differ, and that some fats, such as monounsaturated and polyunsaturated, have a healthy effect. The article, which focused in particular on the health benefits of omega-3s, strongly supported the idea that certain fats should be replaced with more beneficial fats, and that consumers need to move beyond previous conceptions of fat.

Today, marketing is also taking different approaches when dealing with fat-replaced products, as demonstrated by these examples.

At the 2006 FMI show, Frito-Lay highlighted with some fanfare its new line of snack chips, *Lay's Sensations*, made with pure sunflower oil. The product has lower saturated fat per serving (1 g or less when compared to potato chips cooked in other types of oils and 0 g of *trans* fats. The chips, available in *Lime & Cracked Black Pepper* and *Sweet Chili & Sour Cream*, demonstrate how unique seasoning combinations can provide low-fat snacks with a new dimension. This sophisticated pairing of health with new and different flavor experiences would not have been seen in product development 20 years ago, and Frito-Lay clearly wanted to create a "sensation" at the FMI show.

A different marketing approach, according to a *Crain's Chicago Business* article (May 6, 2006), may have been taken by Kraft Foods Inc. when it recently introduced its *trans*-fat-free *Oreos*. The article maintained that the rollout was a subdued one, similar to the conservative approach that Kellogg took when it removed its *trans* fats from products such as *Pop-Tarts* and *Cheese-It* crackers. The lack of promotion may be due to a concern that consumers may react negatively if they learn that their favorite icons were tampered with.

And a number of other fat-replacement strategies and their marketing approaches could be seen at the 2006 National Restaurant, Hotel-Motel Show. The event featured the latest restaurant trends and innovations, including, not surprisingly, the latest

Fat Replacement continued...

developments in the area of fat replacement, especially the ongoing search for substitutes for partially hydrogenated oils.

So, when it comes to fat replacement, where are we at?

Well, in the late 1990s when the fat-replacement craze showed signs of diminishing (something new was appearing on the horizon, nutraceuticals) some food pundits announced that fat replacement was dead. Others argued more wisely that with the end of the first-generation products, new and improved versions would follow. Like other ingredients, fat replacers would continue their evolution, shaped by a variety of considerations, including labeling ones. We certainly saw that with the issue of *trans* fats.

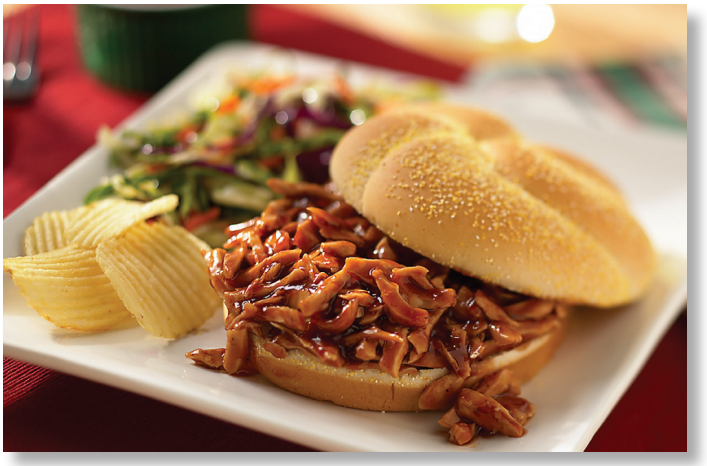
Today we're dealing with an obesity epidemic, which by different reports, is a global one. This increasing problem is complicated, especially in terms of individual responsibility, and shows no signs of abating in the near future. In response, the food industry has developed a number of different strategies toward replacing certain fats. This article will look at some of these different ways.

Enzymes of interest...erification

Enzymatic interesterification makes it possible to produce shortenings and margarines that are free of *trans* fatty acids but have similar handling, melting, and baking properties to those produced using traditional methods. The resulting product—for example, a confectionery fat or a bakery shortening—can then be used to decrease *trans*-fat content without compromising functionality.

Archer Daniels Midland allied with Danish enzyme manufacturer Novozymes A/S to develop the technology, which uses enzymes to alter fatty-acid structures instead of employing chemicals or partial hydrogenation. (The catalyst in the process is a 1,3-specific lipase called *Lipozyme®TL IM*, which rearranges the fatty acids in the 1 and 3 positions, but the fatty acid in position 2 is unchanged.)

Fully hydrogenated vegetable oils and liquid oils are blended and enzymes are used to modify these oils to provide desired melting characteristics for functional applications. Furthermore, these products can be easily customized to meet customer-specified



Foods ranging from shredded pork empanadas to gourmet cookies *can reduce their* trans *fatty acid content by a line of oils and fats produced via an enzymatic interesterification process.*
Photo courtesy of ADM

Fat Replacement continued...

A fiber-based ingredient *derived from citrus pulp serves as an effective moisture management tool in food applications where fat has been reduced.*
Photo courtesy of Fiberstar Inc.

performance characteristics.

The resulting enzyme-interesterified products are part of the *NovaLipid*™ portfolio available from ADM, Decatur, Ill. (phone 800-637-5866, www.admworld.com). This portfolio consists of system-specific oils and fats providing formulators with zero- and low-*trans* fat alternatives for the food and nutrition industries. Other products featured include naturally stable oils, tropical oils, and blended oils.

At the 2006 IFT Food Expo®, this line of oils and shortenings will be showcased in a variety of food applications such as gourmet cookies, shredded pork empanadas, and vegetarian chicken wings. The oils and shortenings are said to have an extremely low taste profile.

In addition to this technology, ADM will be highlighting its *Enova* oil, manufactured through a patented process which converts soy and canola oils into an oil rich in diglycerides. The body metabolizes the light-tasting oil differently than conventional cooking oils so that less is stored in the body as fat.

"Fiberizing" fat replacement?

In the 2006 February *Ingredients* section, "Fiber Gets a New Image," a number of fiber-based ingredients were showcased to demonstrate their versatility and expanding value in the area of functionality. One innovative example, an ingredient derived from citrus pulp, serves as an effective moisture management tool in a variety of food applications where fat has been reduced.

Marketed under the name *Citri-Fi*, the fiber-based ingredient is offered by Fiberstar Inc., Willmar, Minn. (phone 320-231-1829, www.fiberstar.net). By tightly binding water or oil within its fiber matrices, the ingredient can enhance product quality and sensory characteristics. In fact, according to the manufacturer, studies have shown that there were no differences between products containing a fat reduction of 50% and full-fat versions.

Because of the ingredient's properties, formulators can reduce saturated fats, *trans* fats, and calories in a wide array of food products. And the proof of that is in the pudding. Or, in this case, the burrito. At the 2006 IFT Food Expo, Fiberstar will be making available for sampling a number of food products made with the fiber. These include burritos and other meat products, cookies, and coleslaw. Attendees will be able to compare these fiber-containing products with their full-fat versions.

In order to be effectively used in such a wide range of applications, the ingredient comes in different types—with each one developed to meet the needs of that specific application. Two new products will be launched at the show.

Citri-Fi 100 M40 is a new micro-grind product that has been specifically designed for use in processed meat and meat analogs. The ingredient functions as a moisture- or fat-binding agent, and can replace up to 30% of the saturated fat content while maintaining or improving the taste and texture of the product compared to the full-fat control.

Citri-Fi 300 FG is a new combina-

tion product that has been specially designed for binding oil in cookie applications where shortening is replaced. This ingredient is said to be highly effective in adding tightly bound moisture to baked products to improve moistness and shelf life.

Literature will also be available describing how a specific *Citri-Fi* product can meet the functionality needs of that application. For example, in cole slaw, *Citri-Fi 200 FG* can be added at 0.25–1% to reduce free water separation. It binds the water and oil while maintaining a similar mouthfeel and consistency.

High-fiber ingredient "trims" fat

A derivative of whole oats and barley, *Calorie-Trim* (or *C-Trim*) is the latest fat replacer developed by George E. Inglett, a chemist with the U.S. Dept. of Agriculture's Agricultural Research Service. Over the years, he and his fellow scientists, based at the National Center for Agricultural Utilization Research in Peoria, Ill., have created a whole series of "Trim" products, including *Oatrim*, *Z-Trim*, *Nu-Trim*, *Soy-Trim*, and *Rice-Trim*, with the different technologies then being licensed to private companies.

For example, don't get your C's and Z's mixed up. One of Inglett's inventions, *Z-Trim*, is a zero-calorie fat-substitute gel made from corn and wheat, and is now produced by FiberGel Technologies, Mundelein, Ill. (phone 847-549-6002, www.ztrim.com), which owns the worldwide rights to the ingredient for all fields of use. The ingredient can substantially reduce *trans* and saturated fats, making meat products juicier and lowering fat calories by 25–50% in most foods without affecting taste or texture.

This new addition (the one that starts with the letter "C") contains between 2.5–3.5 calories/gram, and can mimic some of the functionality properties of fat. However, in addition to its suitability as a fat replacer, it can provide the benefits of beta-glucan, a soluble fiber which studies have shown can help regulate blood glucose and lower LDL cholesterol. This ingredient, compared to products made with the earlier technologies, reportedly has a higher content of beta-glucan—containing 20–50% soluble fiber which is 5–10 times greater than that of rolled oats, oat flour, and oatmeal.

Derived from whole oats and barley, the high-fiber fat replacer is formulated as a white, odorless powder having virtually no taste, and can be used in a wide range of food products, including yogurt, chocolate, smoothies, baked goods, peanut butter spreads, and trail mixes. ARS food technologists testing the ingredient have found that the amount of fat that can be replaced without compromising the taste or texture of the product varies, depending on the formulation.

For example, sugar cookies made with 5 –10% *C-Trim* produced the best results, while at higher concentrations—around 30%—the cookies became hard and difficult to chew. In peanut butter spreads, a satisfactory product could be formulated with about 15% of the fat substituted with the ingredient. In yogurt products, the ingredient did not interfere with the fermentation process by the cultures. Chocolate products may also benefit by the inclusion of the ingredient. According to Inglett, "In one test, we're replacing some of the cocoa butter in dark chocolate with *C-Trim*, which really cuts down on the fat and calories."

ARS has licensed the ingredient to FutureCeuticals,

Fat Replacement continued...

Momence, Ill. (phone 815-472-6853, www.futureceuticals.com), a processor of nutraceutical and functional food ingredients. The high-fiber fat replacer was featured in the March 2006 issue of *Agricultural Research* magazine (www.ars.usda.gov/is/AR/archive/mar06) as part of the latest research findings on obesity.

Reaching new "lows" in low-linolenic oils

At the 2006 IFT Food Expo, the United Soybean Board, Seattle, Wash. (phone 206-270-4522, www.talksoy.com), will be serving kettle chips along with ice-cold beer. What is of particular interest here is that the kettle chips have been fried in low-linolenic oil and contain no *trans* fat.

Over recent months, there have been several developments in the area of soy-based low-linolenic oils and the potential they offer as *trans* fat solutions and health alternatives. These enhanced oils do not require hydrogenation, but perform similarly to partially hydrogenated oils. In addition, these oils are said not to oxidize as much as traditional soybean oils when exposed to high-heat applications like deep fat frying.

At a press conference in late 2005, Qualisoy, Seattle, Wash. (phone 206-270-4634, www.Qualisoy.com), a collaborative effort among the soybean industry to help market the availability of trait-enhanced soybeans and soybean oil, discussed several of these developments, their benefits, and what lies in the future for these alternative oils with reduced linolenic fatty acids.

These oils, for example, have greatly improved flavor stability over non-hydrogenated vegetable oils and rival the flavor stability of lightly hydrogenated oil. Applications that do not require a high level of oxidative stability due to high-heat processing will benefit from the inclusion of low-linolenic soybean oil. Flavor stability and shelf life of the product will exceed that of non-hydrogenated oil.

The next step in enhanced functionality will be soybean oil that has improved oxidative stability along with superior flavor stability. Several research programs are developing a soybean with increased levels of oleic fatty acid along with

Soy-based low-linolenic oils *do not require hydrogenation but perform similarly to partially hydrogenated oils.*
Photo courtesy of United Soybean Board

Fat Replacement continued...

reduced linolenic fatty acid. (See sidebar on page 83 for a report on high-oleic oils, the subject of a Formal Lecture presented at the 2006 IFT Annual Meeting.)

Qualisoy recently established its own seal of authority, which it unveiled at the press conference. This seal will appear on products marketed by Qualisoy that meet certain standards for trait-enhanced soybeans: a maximum linolenic acid content of 3% (normally 7% occurs in soybeans), a minimum oleic acid content of 50%, and a maximum saturated fatty acids content of 7%. Meeting these standards are several low-linolenic soy oils that are currently available in the marketplace, including *Advantage LL*® from Cargill; *Vistive*™ from Archer Daniels Midland, Ag Processing, Cenex Harvest States, and Zeeland Farms; and *Nutrium* from Bunge and DuPont.

Another new oil that would meet this criteria is *Asoyia*™ *Ultra Low Lin Soybean Oil*, developed at Iowa State University and available from Asoyia, LLC, Winfield, Iowa (phone 319-257-3400, www.asoyia.com). Processed from 1% ultra-low-linolenic soybeans, the oil is free of all *trans* fatty acids, is low in saturated fat, and offers a superior cooking performance with fryer life up to double that of conventional soybean oils. Its linolenic acid content—reportedly the lowest available—eliminates the need for hydrogenation without increasing saturated fat or adversely affecting taste. According to Vivian Jennings, CEO of the company, more than 12 million lb of the oil will be marketed to the U.S. foodservice industry and overseas, with current customers including food processors, restaurants, and university and hospital foodservice.

In December 2005, Kellogg Co. announced that it would reformulate a number of its food products, using Qualisoy-approved low-linolenic soybean oil as a way of eliminating *trans* fat. The company will reportedly use a variety processed from *Vistive* low-linolenic soybeans, as well as *Nutrium* low-linolenic soybean oil.

"Food company commitments such as Kellogg's help illustrate the necessary volume that is needed to satisfy the marketplace," said United Soybean Director Kent Gronlie. "Right now, consumer demand for heart-healthy oil is changing our entire industry and to keep our share of the edible oil market here in the U.S., we'll have to embrace that change."

System reduces use of shortening

Shortening with enhanced functionality for use in bakery applications can be produced by a system, *Cryo-Crystalliser*™, from the BOC Group, Inc., Murray Hill, N.J. (phone 908-508-4074, www.boc.com). Tests have demonstrated that reduction of up to 30% in total shortening use in a formula can be achieved, as a result of this process, with no observed loss in product quality.

The patented system contacts atomized liquid fats and oils with liquid nitrogen to instantaneously produce fat crystals with a unique morphology. These sub-micron fat crystals in stable beta-conformation, called "Mighty MicroCrystals," are then combined with oils in various proportions to produce liquid or plastic shortening, which can be customized to customers' requirements.

The resulting shortening contains a large number of these fat crystals which provide certain baked products with the necessary functionality. »»

Furthermore, because of shortening reduction, total fat content of a baked product can be reduced and the total amount of saturated fat in the formulation will not increase. In addition, the product can be made *trans* free if the base fat and oils used are themselves non-hydrogenated or *trans* free.

Sensory analysis compared the performance of palm/canola shortening made by the system with that of a conventional shortening in a cookie formulation. Total shortening use level was varied at 100% and 70% of the standard. The cookies were evaluated for a number of properties, including dough handling, texture, thickness and weight, and percent of moisture.

According to the company, the "cryo crystallized" shortening, at the reduced level of 70%, made a cookie with a better-eating quality. The cookie, described as crunchy with easy break down in mouth, was said to be better than the control, suggesting that the system could achieve a measurable impact on functionality while reducing fat content.

Providing starch solutions

The incorporation of starch has played an important role in fat replacement, with many textural solutions being starch based. Derived from a variety of different sources including corn, rice, potato, wheat, and tapioca, starch can function as a fat mimetic, at least partially replacing the sensory properties that are diminished when fat is taken out of a product.

The 2006 April *Ingredients* section focused on starches and their expanding uses. As was discussed in that article, this increasing application has been fueled by a number of ongoing starch innovations—for example, resistant starches that behave physiologically like fiber and native starches that function like their modified versions, to name a couple. These developments, because of their functionality and potential health benefits, will provide formulators with additional fat-replacement solutions.

Resistant starches, in particular, should be mentioned here as they are especially in the spotlight these days. As a starch, these ingredients bring important functionality properties—they can be used as a bulking agent in fat replacement applications, as well as offer clean flavor and low impact on appearance. Furthermore, they bring a number of health benefits associated with fiber-based ingredients to the formulation.

Sources of starches are also being increasingly promoted in fat replacement. For example,

rice starches, because they have a tiny granule size, neutral taste, and a soft and creamy mouthfeel, may be used as a milkfat replacer for low-fat ice cream products.

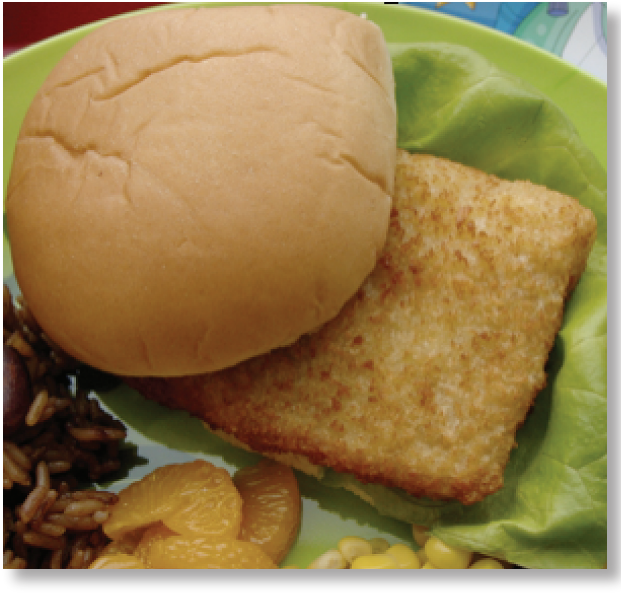
Keeps moisture in, fat out

A novel process utilizing proteins extracted from animal muscle tissue reduces fat content by 50–80% in deep-fried foods such as meat, poultry, seafood, and other products. The protein concentrate applied by the technique establishes a physical barrier that prevents water molecules from evaporating during the deep-frying process, resulting in products having increased moisture content with less frying oil absorbed.

The "fat-blocking" method was developed by Proteus Industries, Gloucester, Mass. (phone 978-675-9140, www.proteusindustries.com), and was one of the emerging ingredient developments described in the July 2005 *Ingredients* section. A separation technology is used to isolate soluble proteins, which are then concentrated by an ultrafiltration membrane. The mix of proteins and liquid may be incorporated into a batter mix or applied by spraying the surface of a substrate prior to deep frying or by dipping the product after it has been breaded.

According to company founder and chief scientist Stephen D. Kelleher, independent test results showed that recent production of 90,000 lb of par-fried frozen fish portions made by the process and prepared for the U.S. military was well within the range of established low-fat standards.

Kelleher announced the findings at the School Lunch



A novel process utilizing proteins *reduces fat content in deep-fried foods such as meat, poultry, and seafoods.*

Photo courtesy of Proteus Industries

Fat Replacement continued...

Association's Child Nutrition Conference. The conference focused on helping operators and industry leaders build relationships while working to boost student participation in school lunch programs and create a healthier lunch program. Proteus, in conjunction with Good Harbor Fillet Co., has used the process to successfully lower the fat in school lunch items such as fish sticks.

In addition to decreasing fat absorption, which leads to potential health benefits, the process can improve the overall quality of the deep-fried product, as discussed in the October 2005 *Ingredients* section's update on the innovative directions that batters and breadings are taking in today's marketplace. Because the process locks in moisture and decreases fat absorption, fried coatings stay crisper and avoid the risk of softening or sogginess after cooking. Finished products have a clean flavor, a moist substrate, and a crunchier coating with an appealing appearance. Also, the protein concentrate functions at a low pH level, which creates an environment hostile to bacteria and increases the product's shelf life.

The process, which took about four years to develop, has been applied to seafood items, but can be extended to chicken, pork, beef, and other breaded foods. Furthermore, Kelleher noted that in laboratory conditions, some applications using the process achieved a 90% fat reduction. As such, it is possible that fried food products can be formulated with even lower fat levels. Proteus has licensed its technology to several food processors, and with the expansion of the technology to include other products, the opportunities for future licensing of the method grows.

Whipping fat-replacement problems

Like starches mentioned earlier, food gums have played an important role in formulating low-fat products. Some of their functionality benefits have included thickening, protein stabilization, moisture retention, and mouthfeel—all important properties when trying to develop a low-fat product without compromising taste and texture.

Creating a low-fat dairy cream can be a particularly daunting task. Dairy cream is an emulsion of fat dispersed in an aqueous phase containing proteins such as whey and casein. The whipping characteristics of a cream are dependent on the formation of a fat globule network that supports foam formation during the whipping process. As a result, low-fat creams are less able to support foam formation, and good whipped cream texture is difficult to achieve.

To meet the challenge of making a better low-fat dairy whipping cream, Aqualon, a business unit of Hercules Inc., Wilmington, Del. (phone 302-995-3180, www.aqualon.com), has developed *AeroWhip™ 620* and *640 Whip-Optimized Solutions*. These cellulose-based ingredients allow for the formulation of reduced-fat whipping cream with excellent aeration properties, firm foam structure, improved body and mouthfeel, syneresis control,

Fat Replacement continued...

and superior stability. In addition, very-low-fat whipping creams, of less than 25% fat, may be made with good foam properties.

Studies conducted by the company have looked at the microstructure of low-fat dairy whipped cream in the presence of emulsifiers, carrageenan, and surface-active stabilizers such as hydroxypropylcellulose (HPC). The interaction of emulsifiers and stabilizers with the fat globule network in pasteurized and UHT processed dairy creams were then studied and evaluated.

Results showed that the whipping properties of low-fat dairy creams are improved by greater than 50% in the presence of HPC and emulsifiers. These improvements are due in part to the surface activity of these ingredients and the increased viscous modulus of the resulting cream. HPC is largely present in the aqueous phase of low-fat cream, forming a bi-continuous network with proteins and dispersed fat. The cream containing HPC is more viscous, leading to improved whipped cream properties, even at low-fat contents. Furthermore, particle size agglomeration is prevented over time in the presence of HPC.

Method rapidly measures oil components

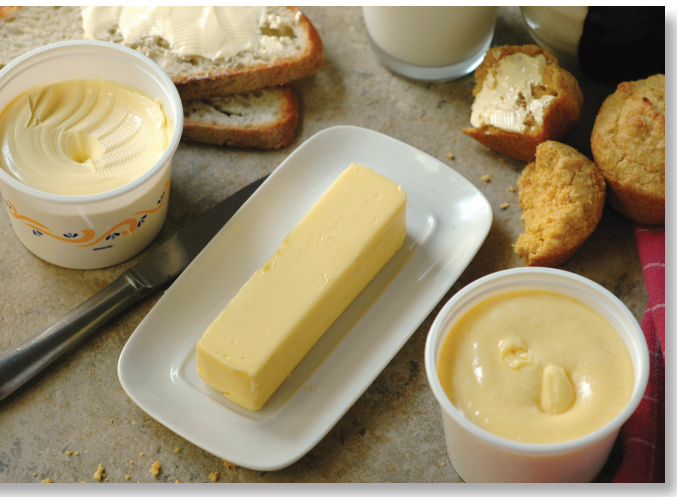
University of Arkansas researchers have found a way to rapidly characterize the components of edible oils. By using mass spectrometry techniques, they are able to reduce analysis time from days to minutes—a time reduction which will help the food industry better analyze oils and which may prove beneficial when formulating with different fats and oils.

"It's important to characterize fats so that people know what they're eating," said Jackson O. Lay, Director of the University of Arkansas Mass Spectrometry Facility. He noted that traditional methods of measuring the components of edible oils involve a time-consuming process which transforms the original oil into a different product—one in which the diglycerides and triglycerides cannot be distinguished.

"The two types of fat are metabolized differently, and diglycerides may be beneficial to human health," explained Lay. "So knowing the ratio of diglycerides to triglycerides may turn out to be of interest to nutrition researchers."

The researchers developed a direct method for characterizing edible oils, using matrix-assisted

Fat Replacement continued...



Emulsifier systems *help improve the stability and functionality of low-fat table margarines and spreads.*
Photo courtesy of Stepan Co.

laser desorption/ionization mass spectrometry (MALDI-MS). With this technique, they dissolved the oils in hexane, mixed them with another liquid, and then measured the spectra to determine the mass of the different components of the oil. They can then sort out the fatty acids of different weights.

For this experiment, the researchers used oils derived from soybeans, sunflower, corn, canola, olive, and peanut, as well as hydrogenated vegetable oil, shortening, butter, and lard. When they compared the results of MALDI-MS to other characterization methods, they found agreement within 4% of research literature values and within 7% of values on package labels, which could be due to rounding in nutrition labels.

This rapid method for characterization can lead to other findings. Given its speed, it lends itself to a large statistical analysis. Food scientists could look at seasonal variations in oils, or determine what happens when oil begins to decompose.

Emulsifier systems bring stability

According to Frost & Sullivan, a global growth consulting company, the U.S. food emulsifier markets earned revenues of $504.9 million in 2005 and an estimated $668 million in 2006. In particular, the rise in demand for low-fat foods is presenting numerous opportunities for participants in these markets.

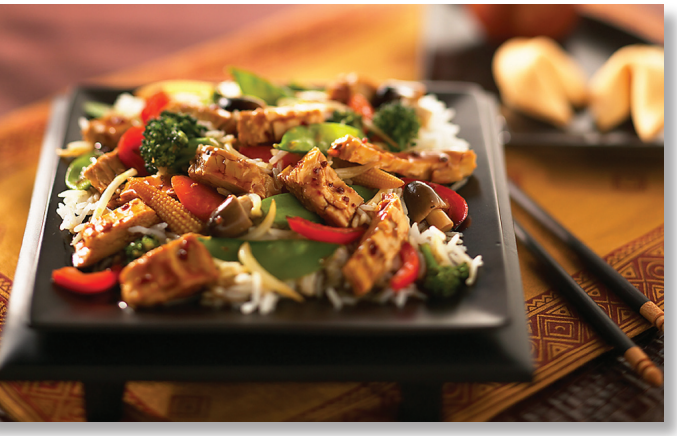
In addition to performing their basic functions, emulsifiers and emulsifier blends can act as low-fat substitutes and stabilizers, creating products that are low in fat or *trans* fats without compromising their quality. The fact that many of these blends can be custom made to suit the requirements of food companies only increases their future value in the area of fat replacement.

Here are examples of food emulsifiers that have low-fat applications:

• *Drewpol PGPR*, a polyglycerol polyricinoleic acid from Stepan Co., Maywood, N.J. (phone 201-712-7642, www.stepan.com), is Generally Recognized As Safe for use as an emulsifier in margarine, low-fat margarine, spreads, creamers, and dairy analogs. The ingredient is said to be produced through an "in situ" polymerization process that yields very low color, and presents superior emulsification and dispersion relative to conventional polyglycerol esters. Low-fat table margarines and spreads incorporating the emulsifier demonstrate improved stability, are easier to spread, and exhibit a reduction in splatter when used for frying.

• Low-fat ice creams can be created by stabilizer systems, *Grindsted® IcePro*, available from Danisco USA, Inc., New Century, Kansas (phone 913-764-8100, www.danisco.com). The systems are blends of emulsifiers and hydrocolloid gums that are used to manipulate

Fat Replacement continued...



Blends of fats and oils can be modified *to give them additional health and functionality benefits. An enhanced oil for stir-frying, for example, could be produced.*
Photo courtesy of ADM

ice crystal size, allowing manufacturers to reduce fat and solids.

At the 2006 IFT Annual Meeting + Food Expo, a New Products & Technologies presentation (68-4) will describe the technology for ice crystal control in ice cream and frozen desserts. Danisco has found that certain combinations of propylene glycol monostearate (PGMS) and monoglycercides and diglycerides significantly reduce the size of ice crystals in ice creams even after heat shock.

The technology maintains small ice crystals throughout distribution and shelf life of the product without the necessity of changing equipment or processing parameters.

Finding a way to reduce fat in hot dogs

How whey proteins can help make hot dogs of varying fat levels more appealing from a functionality perspective will be the subject a presentation given at the 2006 IFT Annual Meeting + Food Expo. The presentation, entitled "Utilizing Whey Proteins in Regular, Reduced-Fat, and Fat-Free Hot Dogs," is sponsored by Dairy Management Inc., Rosemont, Ill. (phone 800-248-8829, www.innovatewithdairy.com).

Speakers from Proliant Meat Ingredients and DMI will report on the latest findings of a research project that studied the addition of whey protein concentrate and whey protein isolate in hot dogs where fat was partially or totally replaced, comparing them to full-fat versions. It was found that these whey ingredients can help increase the cook yield, reduce syneresis, improve texture and emulsifying capabilities, and enhance organoleptic characteristics.

The presentation will be held on Tuesday, 9:20 a.m., during the meeting. DMI experts will also be

Fat Replacement continued...

Session highlights **high-oleic oils**

High-oleic, *trans*-free oils and the benefits they offer food processors are the focus of Formal Lecture 42, held Monday, June 26, 2:30 p.m. to 5:30 p.m., at the 2006 IFT Annual Meeting + Food Expo®. An alternative to traditional hydrogenated and saturated fatty acid cooking oils, these naturally stable high-oleic oils deliver a superior frying performance and a more attractive nutritional profile.

These enhanced, high-oleic oils are said to have a longer fry life than traditional cooking oils and do not interfere with the food's natural taste. Each type of high-oleic oil has functional properties suited to different applications. Frying and baking applications in both the industrial and foodservice segments take advantage of the enhanced stability of these high-oleic oils.

The availability of high-oleic oils depends on plant breeding and identity preservation by oil producers and processors. Manufacturers are now accomplishing this, and significant quantities of these oils are available for large-scale uses, as well as smaller foodservice businesses. Furthermore, since these oils are virtually *trans*-fat free, their availability will help food processors meet the new U.S. Dietary Guidelines, which became effective in January 2006.

The session will include the following presentations:

• The technology behind modified, *trans*-free oil production will be discussed by Brent Zacharias, Oil & Traits Marketing Manager, Dow AgroSciences LLC, Indianapolis, Ind. The company's *Natreon* high-stability oil, produced from a new generation of canola and sunflower varieties, demonstrates longer fry life than current partially hydrogenated oils. French fries cooked in the high-oleic oil have more than an 80% reduction in *trans* and saturated fat content than those cooked in partially hydrogenated soybean oil. Because of its high oxidative stability and functionality characteristics, it can replace partially hydrogenated oils in frying and snack food applications and extend shelf life. The company is increasing its production of this oil by 35% in North America this year and plans to double volume in 2007.

• Health trends and public policy implications of *trans*-free oils will be covered by Patricia Kearney, President and CEO of PMK Associates, Inc., Alexandria, Va., a strategic marketing and communications firm that specializes in food and nutrition, agriculture, public health, and environmental issues.

• The frying performance and food quality of high-oleic oils will be examined by Roman Przybylski, University of Lethbridge, Dept. of Chemistry and Biochemistry, Alberta, Canada. He will discuss the results of a study that found that high-oleic oils demonstrated a much better performance during rotational frying of French fries, chicken, and fish strips than standard oils and hydrogenated frying shortening.

• The use of *trans*-fat-free shortenings in bakery products as a viable alternative to hydrogenated products will be described by Frank Orthoefer, FTO Food Technology LLC, Germantown, Tenn. The flakiness and tenderness of pies and cookies are due to the functionality that oils and shortenings provide. Most shortenings, however, are a major source of *trans* fatty acids, as they are formulated with partially hydrogenated oils to impart and meet the performance and stability requirements necessary for a satisfactory bakery product. With mandatory labeling, alternative formulas are desired. High-stability alternative oils may provide a substitute for hydrogenated oils. If solid or plastic shortenings are required, combinations of fully hydrogenated hard fats with modified oils are viable alternatives. The functionality, nutritional, and labeling benefits of using simple blends and interesterified mixes to produce all-purpose *trans*-free shortenings will be covered.

• Composition and characteristics of various modified oils will be presented by Monoj Gupta, MG Edible Oil Consulting International, Richardson, Tex. Oils that will be covered include high-oleic and low-linolenic canola oil, high-oleic sunflower oil, mid-oleic sunflower oil, and low-linolenic soybean oil.

• The results of a human study comparing mid-oleic sunflower oil and olive oil on cardiovascular disease risk factors will be reported by Penny Kris-Etherton, Professor, Dept. of Nutritional Sciences, Pennsylvania State University. The study indicates that polyunsaturated fatty acids (PUFA) are important for cholesterol lowering, and strategies for replacing saturated fatty acids should not markedly decrease PUFA content of the human diet.

Today's soybean oils *are offering enhanced functionality and health benefits. For example, soybeans are being developed with increased levels of oleic fatty acids and reduced levels of linolenic fatty acids.*
Photo courtesy of United Soybean Board

Fat Replacement continued...

on hand to discuss the functionality benefits of whey proteins in a variety of other applications.

Encapsulating healthier alternatives

Studies have shown that oils rich in omega-3 fatty acids offer a variety of health benefits such as reducing the risk of coronary heart disease, improving conditions associated with older age, and ensuring the developmental health of newborns. However, because these fatty acids are prone to oxidation, their inclusion into foods can cause off flavors—a problem which food and ingredient companies have to solve if they are to take full advantage of the marketing opportunities that these healthy oils present, especially as alternatives to more traditional fats and oils.

For example, *Powder-loc*™ from Ocean Nutrition Canada Ltd., Dartmouth, Nova Scotia, Canada (phone 902-480-3200, www.ocean-nutrition.com), is a process that microencapsulates fish oil in a multi-shell gelatin matrix with a protective outer shell surrounding it. This creates double protection for the oil from both oxidation and the stress of food processing, including high temperatures that occur during pasteurization. The resulting ingredient powder, *Meg-3*®, has been successfully commercialized in breads, milk, yogurt, tortillas, orange juice, nutrition bars, and confectionery products, such as candy chews.

A stabilized omega oil powder, *OmegaDry® 1510*, is a gamma-cyclodextrin inclusion complex of menhaden fish oil available from Wacker Chemical Corp., Adrian, Mich. (phone 517-264-8671, www.wacker.com). In this product, the omega-3s are protected by the cavity of the cyclodextrin and highly stabilized against oxidation and temperature.

The company also developed a new method using cyclodextrins for hardening fats and oils without changing their nutritional profile or increasing their overall level of saturated fats.

Blending new alternatives

This article has discussed a number of fat replacement alternatives, many of them based on proteins, starches, gums, and healthy fats and oils. But this broadening range of ingredients may still only be the tip of the iceberg, especially when considering the potential health and functionality benefits that blending traditionally processed fats and oils can provide in a formulation. These products can be custom formulated to provide a variety of melt profiles for frying, baking, confectionery, and margarine applications, as well as meet *trans*-free, lower-calorie, and weight management needs.

Let's look at some possible examples of components that could be blended to create novel fat systems for use in future food formulations:

Neobee® M-5 Medium Chain Triglycerides from Stepan Company, Maywood, N.J. (phone 201-712-7642, www.stepan.com), is celebrating its 50th birthday. First commercialized as an energy source for patients with fat malabsorption, MCTs may be used as a functional ingredient in beverages, confections, snack foods, sports nutrition bars and shakes, and healthy oils. The range of MCTs and structured lipids are free of *trans* fatty acids, provide special metabolic properties, and offer excellent solvency, oxidative stability, and organoleptic properties. Studies support their role in satiety and weight management as well as normal blood glucose levels.

New ingredients such as *Clarinol CLA* from Lipid Nutrition, a division of Loders Croklaan, Channahon, Ill. (phone 800-621-4710, www.croklaan.com), can be used to formulate products that have body-composition benefits. Studies have shown that conjugated linoleic acid (CLA) can reduce body fat and increase lean muscle mass, while enhancing immune function, cardiovascular health, and normal blood glucose levels.

Flaxseed oil, *HiOmega®*, is an excellent source of essential fatty acids, including omega-3s, omega-6s, and omega-9s. The ingredient, available from Polar Foods, Inc., Winter Springs, Fla. (phone 407-677-6664) is said to contain a minimum 70% omega 3s—at least 30% higher than other flax seed oils in the marketplace. Research shows that these fatty acids work to regulate cardiovascular, circulatory, immune, and nervous systems.

Imagine these or other ingredients mentioned in this article blended together so that they provide additional functionality and health benefits. Also, consider incorporating into this mix other ingredients such as antioxidants, fiber, and nutrients, and new possibilities can be created, along with other exciting ones on the horizon.

New technologies can also be used to help further this development along. For example, this article earlier discussed enzyme interesterfication, which modified blends of fats and oils to give them desired melt characteristics. And researchers are always busy developing new ways to analyze the components of oils, enhance their traits, and study their performance in frying and other applications.

With these different developments working together, approaches to fat replacement will continue to evolve. And that's a fat! I mean fact. **FT**

Next month's Ingredients *section will provide its annual installment of emerging ingredients and the roles they play in functionality, health, convenience, and overall reformulation.*

Donald E. Pszczola,
Senior Associate Editor
• depszczola@ift.org

www.ift.org

Members Only: Read more about fats and oils online at *www.ift.org*. Type in the keyword in our search box in the upper left side of our home page.