WEIGHING TRANS FAT STAND-INS

Exchanging heart-taxing fats makes **PROCESSED FOODS** healthier

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WHEN THE FOOD & DRUG Administration moved to ban the use of partially hydrogenated oils in foods last month, health advocates cheered. These oils contain artificial trans fats, which increase risk of coronary heart disease. FDA predicts such a ban could prevent up to 20,000 heart attacks and 7,000 deaths each year.

But those who remember switching from butter to trans-fat-containing margarine in the 1980s may be feeling some déjà vu. After all, trans fats gained wide usage in the food industry because of health concerns about saturated fats like those in butter. So it's natural to wonder—what fats are replacing trans fats, and are they any healthier?

"Trans fats confer the greatest health risk. Anything they're replaced with is going to be better," answers Penny M. Kris-Etherton, a professor of nutrition at Pennsylvania State University. Trans fats raise so-called bad, or low-density lipoprotein, cholesterol and lower the high-density lipoprotein (HDL) kind, its better counterpart. To weigh the relative risk of trans fat alternatives, it helps to look back at why the food industry started using these fats in the first place.

Partial hydrogenation of oils, introduced to our food supply with Crisco shortening in the early 1900s, offers two benefits to food manufacturers. It keeps cheap liquid oils like soybean oil from going rancid, and it can harden these oils so they can be used in baked goods, shortenings, and frostings. These qualities can be traced back to changes in these oils' fatty acids, where naturally cis-configured double bonds switch to trans during partial hydrogenation.

Many food manufacturers and restaurant chains swapped out trans fats after FDA required labeling of the fats in 2006, responding to health concerns and pressure by nonprofit groups such as the Center for Science in the Public Interest (CSPI). But trans fats are still found in some brands of microwave popcorn and ready-to-bake cookies and biscuits, as well as packaged frosting and baked goods. And although many snack foods are listed as having 0 grams of trans fat, they can still contain up to 0.5 g of trans fats per serving if partially hydrogenated oil is listed as an ingredient.

To get the advantages of trans fats in fried foods and packaged snacks without the heart-straining damage, food manufacturers are using a variety of alternatives. For liquid oils, the options include natural and modified vegetable and tropical oils. Where a solid fat is needed, oil blends or modifications such as fractionation, full hydrogenation, and interesterification are available.

THE MOST PROFOUND health benefits come when vegetable oils with high unsaturated fat content are used as substitutes, says Walter C. Willett, a professor of epidemiology and nutrition at Harvard School of Public Health. Making such a switch has been relatively simple for fried food makers and large restaurant chains, according to Michael F. Jacobson, executive director of CSPI. For example, McDonald's cooks its french fries in a blend of soybean and canola oils. Many small restaurants, he says, still use partially hydrogenated oils. Such oils are cheaper to use because they don't spoil as quickly as natural vegetable oils.

To extend frying and shelf life, Dow, DuPont, and Monsanto have used breeding or genetic modification to develop so-called high-oleic soybean, canola, and sunflower oils (C&EN, March 12, 2012, page 30). They are low in polyunsaturated fatty acids, which keeps them from going rancid, and enriched in monounsaturated oleic acid. The high oleic acid content makes these oils substantially more healthful than trans fats. They are less beneficial than their natural counterparts, however, because of their reduced levels of α-linolenic acid, a polyunsaturated omega-3 fatty acid, according to Harvard School of Public Health's website.

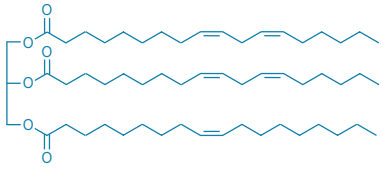
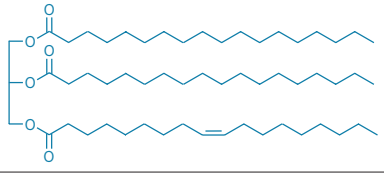
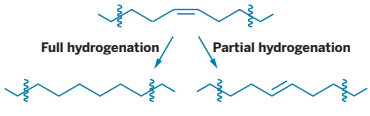
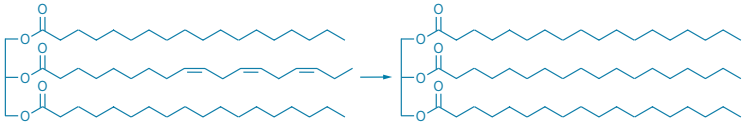
But liquid vegetable oils can't be used in store-bought snack foods such as cookies and cakes, says Sarah Berry, a nutritional scientist at King's College London, because the fats must be solid at room temperature. Making these foods enjoyable requires

THE REPLACEMENTS Food makers are swapping out unhealthy trans fats with a variety of alternative fats.

ALTERNATIVE	FOOD EXAMPLE
Liquid vegetable oils (olive, canola, soybean, sunflower, safflower, cottonseed, corn)	
High-oleic oils (modified soybean, canola, sunflower)	
Tropical oils (palm, coconut)	
Fractionated oils	
Animal fats (butter, lard, tallow)	
Fully hydrogenated soybean and palm oils	
Interesterified oils	

SOURCES: Harvard School of Public Health; FDA Dietary Guidelines for Americans, 2010

ISTOCKPHOTO (SHORTENING); SHUTTERSTOCK (REST)

HEALTH GAIN WHEN REPLACING TRANS FATS	CHEMICAL STRUCTURE
Large, especially for oils high in monounsaturated and polyunsaturated fats.	**A common triglyceride** in sunflower oil contains polyunsaturated linoleic acid (top) and monounsaturated oleic acid (bottom) units. 
Modest to large; high monounsaturated fat content is beneficial, but lower polyunsaturated omega-3 fatty acid content removes some benefit.	**Typical triglyceride structure** of sunflower oil (above) is modified to increase oleic acid and decrease linoleic acid content.
Modest; researchers recommend limiting in diet because of saturated fat content.	
Small to modest, as fractions used in processed foods may be high in saturated fat.	
Small; researchers recommend limiting in diet because of high saturated fat content.	**Representative triglyceride in animal fat** (tallow) contains saturated stearic acid (top) and unsaturated oleic acid (bottom) units. 
Small; these fats have neutral effects on heart disease risk but are saturated.	**Full hydrogenation removes double bonds** in an unsaturated fat to create a saturated fat without forming trans fats. Partial hydrogenation produces trans fats. 
Unresolved	**In one example of interesterification,** an unsaturated linolenic acid chain is replaced with stearic acid to form a saturated triglyceride. 

FOOD REGULATION

Industry Wonders What Ingredients Will Be Next

The Food & Drug Administration's move last month to revoke the "generally recognized as safe" (GRAS) status of partially hydrogenated oils in foods worries some experts in the food industry. They believe that FDA will use the approach to regulate other ingredients, such as sodium and caffeine. Partially hydrogenated oils are the biggest dietary source of artificial trans fats, which have been shown to raise levels of "bad" cholesterol and have no known health benefits.

The approach "is easier and potentially faster," than FDA's traditional process of regulating a food ingredient, says Mitchell Cheeseman, a former official in FDA's food program and currently a managing director at the law firm Steptoe & Johnson. The traditional process is lengthy and involves writing warning letters and demonstrating potential harm to human health, he notes.

When a substance is deemed GRAS, it is not subject to premarket review and approval by FDA. GRAS status is based on scientific data and information about intended use that are evaluated by experts. A company or other entity can determine a substance to be GRAS. Hundreds of food ingredients are considered GRAS on the basis of industry self-determinations. FDA's move to crack down on partially hydrogenated oils is, in part, the agency's attempt to demonstrate that it has a tool that can be used to deal with other GRAS ingredients, Cheeseman says.

Advocacy groups, such as the Pew Charitable Trusts and the Natural Resources Defense Council, are increasingly questioning the safety of GRAS food ingredients. These groups are calling on Congress to pass legislation that would eliminate the GRAS status for all food substances.

Intense scrutiny of FDA's GRAS program dates back to 2010 when the Government Accountability Office, the investigative arm of Congress, raised questions about FDA's inability to require industry to submit information about GRAS determinations. Because of this ongoing pressure, "we expect FDA will continue to aggressively target food ingredients marketed based on GRAS self-determinations," Cheeseman says.

Authority given to FDA under the Food Safety Modernization Act, which was signed into law in January 2011, makes it easier for the agency to access safety information related to GRAS determinations. As FDA begins to implement that law, "it's more important than ever," Cheeseman warns, for independent GRAS determinations to be credible and as solid as possible.—BRITT ERICKSON

"We expect FDA will continue to ... target food ingredients."

raising the melting point of the oils to achieve a melt-in-your-mouth sensation.

Ideal replacements from this standpoint are cocoa and shea butter, which have "the wonderful mouthfeel of very good chocolate," but they're usually too expensive to be used in processed foods, Berry says. So scientists have devised a range of more economical strategies for hardening oils.

These include using saturated tropical oils such as palm and coconut oil or mixing them with vegetable oils. Because palm oil is semisolid at room temperature, fractionation is often used to isolate portions with a higher melting point such as palm stearin, which is rich in saturated fatty acids. Willett says that tropical oils may be slightly healthier than other options for hardened oils; coconut oil raises HDL cholesterol.

Beyond mixing oils, food scientists use several chemical transformations to harden liquid vegetable oils. Full hydrogenation solidifies oils without producing trans fats. The process removes the double bond in an unsaturated fat, converting it to a saturated fat and raising its melting point. Fully hydrogenated soybean oil is an improvement over trans fats: It has neutral effects on cardiovascular disease risk, Berry says, as it doesn't affect the ratio of total to HDL cholesterol, a main metric for assessing risk.

IN ANOTHER HARDENING method, interesterification, catalysts or enzymes shuffle around the fatty acids in triglycerides, the main component of oils and fats. Most liquid vegetable oils have an unsaturated fatty acid at the middle position of the triglyceride, whereas hard animal fats often have a saturated fatty acid there. Through interesterification, palm oil can be modified to put a saturated fatty acid in the middle position. The result is "a fat similar to cocoa butter but at a fraction of the price," Berry says. "I think they will be increasingly used by the food industry."

The jury is still out on the health impacts of interesterified fats. A 2007 study found that they negatively affect insulin sensitivity, a risk factor for heart disease (*Nutr. Metab.* 2007, DOI: 10.1186/1743-7075-4-3). Willett says, however, that the study tested unrealistically high levels of the modified fats. In contrast, a small study by Berry and colleagues found no adverse effects (*Am. J. Clin. Nutr.* **2007,** *85,* 1486).

"I don't think we have evidence that interesterified oils increase heart disease risk, but we should keep use of these and saturated fats low and use natural liquid oils as much as possible," Willett says.

New approaches for solidifying fats are on the horizon. Recently, George John and colleagues at City College of New York made molecules composed of fatty acids bound to a sugar alcohol. When they are mixed with a vegetable oil, the molecules assemble into a gel-like structure, hardening the oil (*J. Agric. Food Chem.* 2013, DOI: 10.1021/jf401987a). John says various food makers have shown interest in the method.

Despite the health gains of kicking out trans fats, many processed foods contain unhealthy amounts of salt and added sugars as well as fats, Kris-Etherton cautions. "There are probably certain foods people shouldn't be eating, like frosted donuts," she says, whether they are trans fat free or not. ■