Robert M. Kerr Food & Agricultural Products Center

FOOD TECHNOLOGY FACT SHEET

Adding Value to OKLAHOMA

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Low Trans Fat and Trans-Free Fat Update

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In previous fact sheets (FAPC-133 *Trans* Fats, Health and Nutritional Labeling of Foods and FAPC-134 Formulating Food Products with Low *Trans* Fats) health effects of *trans* fats and the U.S. Food and Drug Administration (FDA) labeling rule regarding foods containing *trans* fats were discussed. Since then, a number of new low *trans* and *trans*-free fat alternatives have been developed by the edible oil industry. This fact sheet will highlight some of these products. While reading this fact sheet, it is important to keep in mind that "no *trans*" and "zero *trans*" claims on food packages refer to 0.5 g or less *trans* fat per serving. The serving size is defined as 1 tablespoon or about 12 g.

Today, there is a significant body of scientific evidence indicating that *trans* fatty acids increase low density lipoprotein (LDL) (bad cholesterol) and decrease high density lipoprotein levels (HDL) (good cholesterol). Vegetable oils do not contain significant amount of *trans* fatty acids. Small amount of *trans* fats or *trans* fatty acid-containing fats/oils, naturally occur in meats and dairy products. Concerns over the adverse effects of *trans* fats are not for the ones naturally present in foods but for the ones formed during hydrogenation of vegetable oils.

The fatty acid composition of fats and oils (Table 1) determines their oxidative stability. Oils containing highly unsaturated fatty acids (i.e. polyunsaturated fatty acids such as linolenic, linoleic, eicosapentaenoic-EPA and docosahexaenoic acids-DHA) are prone to rapid oxidation. The majority of plant oils do not contain a significant amount of EPA and DHA. However, traditional soybean and canola varieties have substantial amounts of linolenic acid, which makes them unsuitable for some food applications such as deep fat frying. The degradation products of unsaturated fatty acids can results in strong off-flavors and have adverse health effects. Oils with lower levels of linolenic acid have dramatically improved flavor profiles.

Hydrogenation reduces the number of double bonds or unsaturation in unsaturated fatty acids. There are two main reasons for hydrogenating vegetable oils. These are 1) to increase oil stability by reducing the tendency to oxidize, thereby, extend shelf life and fry life and (2 to change the physical characteristics for easier handling and consistency for improved functionality such as aeration, mouth feel and texture. Formation of *trans* fatty acids during the hydrogenation process limits their use for improving oxidative stability and functionality of highly unsaturated oils.

Today, there are a number of no *trans* and low *trans* edible oil and fat options that are suitable for high temperature applications. There are also no or low *trans* products that are high in solid fat content and suitable for baking applications. These products can be broadly classified as follows:

1) Trait-enhanced vegetable oils
2) Oil/fat blends
3) Interesterified fats
4) Fats and oils naturally high in saturated fatty acids

1) Trait-Enhanced Vegetable Oils

Oxidative stability of oils decreases with increasing unsaturation or the number of double bonds on the fatty acids that make up the oil. For example, oleic acid (one double bond) is 10 times more stable than linoleic acid (two double bonds) and 20 times more stable than linolenic acid (three double bonds). Therefore, decreasing linolenic acid content of an oil while increasing oleic acid improves its oxidative stability. Unfortunately, presence of healthy polyunsaturated fatty acids such as linolenic and linoleic acids in the oil reduces its oxidative stability making them unsuitable for high temperature cooking applications. For example, regular soybean oil is rich in polyunsaturates; hence, regular soybean is not recommended for frying applications.

Trait-enhanced vegetable oils are developed by using traditional breeding methods and biotechnology tools to create oilseeds that yield oils with desired functionality and oxidative stability. QUALISOY™ (www.qualisoy.com/) is a "collaborative effort in the soybean industry to help market the development and availability of healthier soybeans and soy oil, reduce environmental impacts of livestock production through improved soybean meal and improve the global competitiveness of the U.S. soybean industry." Through the Qualisoy program, numerous trait-enhanced soybeans have been developed by breeders to have reduced levels of polyunsaturates. Today, low linolenic soybeans (less than 3 percent linolenic acid) are available in the market (www.cargillfoods.com/na/en/products/oils-shortenings/Products/index.jsp, www.adm.com/en-US/products/food/oils/Pages/default.aspx, www.bungenorthamerica.com/products/categories/60-trans-fat-free-frying-oils and some other edible oil producers). High oleic sunflower, canola, soybean and peanut oils are also available as relatively stable no *trans* oils.

2) Oil/Fat Blends

In the food industry it is very common to use oil and fat blends for lowering *trans* fat and saturated fatty acid contents, improving flavor profile and extending shelf life of the products. Canola, cottonseed and soybean oil blends with other oils and fats, partially and fully hydrogenated fats, are very common. There are companies such as Archer Daniels Midland Co. (ADM) that provide custom oil and fat blends formulated for specific food applications.

3) Interesterified Oils

Chemical and/or enzymatic interesterification is used for improving the physical and functional properties of fats and oils by redistribution of fatty acid within the oil chemical structure. It is usually done by reacting highly saturated fats (i.e. palm oil, palm stearin, fully hydrogenated vegetable oils) with liquid edible oils to produce fats with intermediate characteristics. The difference between the oil and fat blends discussed in section 2 of this article and the interesterified fats is oil blends are made by physical mixing of various oils and fats while interesterified fats are produced through chemical or enzymatic reactions, which do not produce *trans* fats. Enzyme reactions are carried out under mild conditions and allow a better control over the final product properties as compared to chemical interesterification. For example ADM produces Novalipid™ line of products (www.adm.com/en-US/products/food/oils/Pages/Interesterified.aspx) that are produced by enzymatic interesterification.

4) Fats and Oils Naturally Rich in Saturated Fatty Acids

Fats and oils rich in saturated fats were widely used in food products until they were replaced with hydrogenated fats in late 1980s. Animal fats including butter, palm, palm kernel and coconut are some of the fats that are rich in saturated fats (Table 1). Keep in mind most of the saturated fats tend to increase cholesterol levels, and nutritional guidelines recommend consumers reduce consumption of both *trans* and saturated fats.

However, there are scientific studies indicating stearic acid, a saturated fatty acid found in vegetable oils and animal fats, does not raise plasma cholesterol levels. Oilseed breeders are working on development of seeds that produce oils rich in stearic acid. Coco butter is naturally rich in stearic acid.

Another alternative for formulating no *trans* food products is to use emulsified oils and non-fat ingredients. Emulsifiers prepared with unhydrogenated and unsaturated oils mimicking the performance of shortening are good *trans*-fat alternatives. A new microsaturation process, which blends unsaturated oils with oils rich in saturated medium chain fatty acids, has been claimed to produce a dense mixture of fats that can be used as a *trans*-fat alternative (http://microlipids.com/microlipids/biofuels-and-food-prices/).

Margarines, spreads and shortenings are traditionally structured by blending a solid fat with a liquid oil to attain desired texture, melting profile and crystalline properties. A new emerging technology produces products, oil organogel, that have the potential to replace *trans* fat in food products. Similar to margarines and shortenings, oil organogels are structured fats except they do not contain *trans* fats. Oil organogels have been prepared using different types of food-grade structuring compounds such as emulsifiers, saturated fatty acids, long-chain fatty alcohols and natural waxes.

Table 1. Fatty acid composition of oilseeds (%, w/w basis).

Oil Source	Saturated	Mono-unsaturated	Poly-unsaturated	Linoleic Acid	Linolenic Acid
Normal Soybean	14.4	23.3	57.9	51.0	6.8
Normal Canola	7.1	58.9	29.6	20.3	9.3
High Oleic Canola	6.5	72.0	17.1	14.3	2.6
Normal Sunflower	10.3	19.5	65.7	65.7	0.0
Mid Oleic Sunflower	9.0	57.3	29.0	28.7	<0.1
High Oleic Sunflower	9.7	83.6	3.8	3.6	0.2
Corn	12.9	27.6	54.7	53.2	1.2
Peanut	16.9	46.2	32.0	32.0	0.0
Cottonseed	25.9	17.8	51.9	51.5	0.2
Palm	49.3	37.0	9.3	9.1	0.2
Palm Kernel	81.5	11.4	1.6	1.6	0.0
Coconut	86.5	5.8	1.8	1.8	0.0