Trans Fats: Dr. J. S. Pai

Many bakery products use fats that are solid. These bakery fats yield products with highly desirable properties for examples, cakes and doughnuts are very spongy and soft, biscuits are crunchy, cookies are crumbly etc. These products were earlier produced by animal fats like lard or butter etc. However, these animal fats became expensive and less available and so a new fat was available in the early part of last century that was cheaper and also had properties similar to animal fats or sometimes even better.

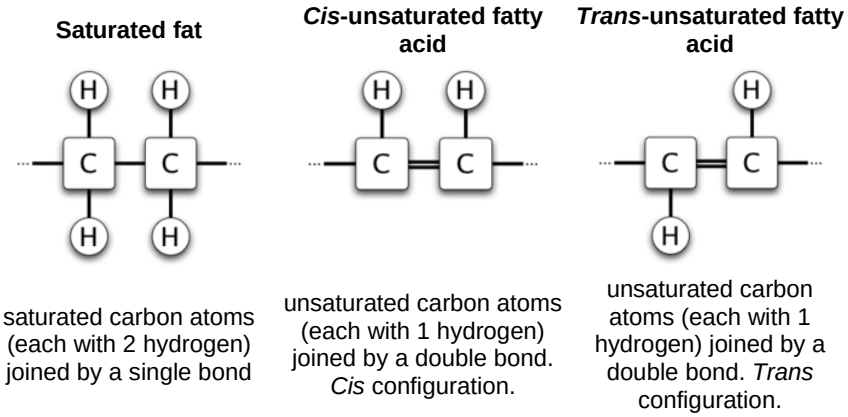
Vegetable oils are liquid at room temperature and are not very suitable for many bakery products. The fatty acids present are mostly unsaturated making them liquid. Liquid fats do not produce cakes and doughnuts that are spongy and light. Also liquid oils with more unsaturated fatty acids are more prone to oxidation and rancidity. German chemist Normann produced more solid fats from liquid oils by hydrogenating them i.e. by adding hydrogen into their double bonds using metal catalysts. During the process, trans fatty acids formed that helped making the fat more solid. This made them more stable towards rancidity and gave better properties. Thus cheaper oils could be converted into more valuable solid fats and used in bakery products.

During the last decade, the health implications of trans fats were highlighted. Harvard School of Public Health estimated that between 30,000 and 100,000 deaths due to cardiac arrests were attributable to trans fats in the US. There were many studies that followed to confirm the dangers of trans fats to human health and strict regulations started right from declaration on label the trans fat contents to outright banning in some countries the manufacture and sale of products containing trans fats.

Chemistry of trans fats

Fats are triglycerides or esters of glycerol and fatty acids. Fatty acids are either saturated or unsaturated based on number of hydrocarbon atoms in the fatty acid part. Each carbon atom carrying two hydrogen atoms except the end carbon that carries three. When less than the maximum number of hydrogen atoms is present, fatty acids are called unsaturated. In monounsaturated, two hydrogen atoms are less (one on each of adjacent carbons) giving one double bond, while in polyunsaturated, 4 or more hydrogen are less giving two or more double bonds. When a double bond is present, each carbon in the double bond will carry one hydrogen atom. In nature, hydrogen atoms of a double bond will orient on same side of the bond (cis), whereas, while industrial hydrogenation is being carried out, large number of hydrogen atoms in double bonds orient on either side of the bond i.e. trans configuration, so these fatty acids are called trans fatty acids and fats containing them are called trans fats.

During hydrogenation especially at high temperature and with certain metal catalysts, the formation of trans fatty acids is more pronounced as some of the unsaturated bonds are getting saturated by hydrogen. When all the unsaturated bonds are converted to saturated, there is no cis or trans. These two configurations are only seen in unsaturated fatty acids. Thus trans fatty acids are present only in partially hydrogenated fats.



Trans fats have certain advantages also. Unsaturated fatty acids with cis-type double bond is not linear but is bent at the point of unsaturation. This lowers the melting point giving them liquid property. With saturated fatty acids, the configuration of molecule is linear so molecules can nicely stack up giving them solid properties. Trans fatty acid also is somewhat linear because of orientation of hydrogen atoms on either side of the bond, so they also behave more like saturated fatty acids and give solid properties to fat. Thus in spite of being unsaturated, these fats are solid and are quite useful in bakery products.

Applications in Food Products

The animal fats were not keeping up with demands when hydrogenated vegetable oils were developed. These were also very cost effective compared to animal fats or semi-solid fats of plant origin like palm kernel oil. There are certain sects of vegetarians that would not consume certain or all animal fats so the fat derived from vegetable oil with properties of animal fats would be quite useful under these circumstances too.

The understanding of process of hydrogenation developed further. The properties of hydrogenated fat with respect to the food product quality in which it was used were studied and that led to further improvements in the hydrogenation process. Specialised fats were developed with specific applications in bakery products. Soon the products like cakes, pastries, doughnuts, and other bakery

products were produced with sensory properties especially the textural properties that were far superior to those possible using animal fats.

The hydrogenated fats were also more stable than vegetable oils to oxidative rancidity. This was another advantage so many fried products were produced using hydrogenated fats as they would resist deterioration. Another advantage was also in fried products. Foods fried in these fats were less greasy or oily because after frying when food cools down, fat solidifies and appears less oily.

Another advantage is that products formulated using hydrogenated fats such as margarine can be easy to use when taken from refrigerator. Butter is quite hard when just taken from fridge but margarine can be designed to be easily spreadable even when just taken from fridge.
Thus with several advantages the hydrogenated vegetable oils production and consumption became quite high until the adverse effects of these were beginning to appear. Because of their health risks several countries have either restricted consumption of trans fats in processed foods or made it mandatory to declare their content in foods.

Trans Fat Containing Foods

Some trans fat occurs naturally. Milk from the ruminant animals (cattle, sheep etc.) contains a type of trans fat at a level of 2 to 5% of total fat. Natural trans fats have conjugated linoleic acid and vaccenic acid that originate from the rumen of these animals. The naturally occurring trans fatty acids do not seem to have effect on lowering of HDL cholesterol. Their content in milk fat is quite low. Their contributions to the CVD risk if any seem to be insignificant. Hence most countries have only enacted legislation to control the intake of industrially produced trans fats.

Most baked goods may contain significant amounts of trans fats. Some of the foods along with their trans fat and saturated fat contents are given below as per the FDA Consumer magazine published by US FDA in 2003 & 2004.

Product	Serving Size	Total Fat g	Sat. Fat g	Trans Fat g	Sat.+Trans Fat g
French Fried Potatoes (Fast Food)	Medium (147 g)	27	7	8	15
Margarine, stick	1 tbsp	11	2	3	5
Margarine, tub	1 tbsp	7	1	0.5	1.5
Shortening	1 tbsp	13	3.5	4	7.5
Potato Chips	Small bag (42.5 g)	11	2	3	5
Doughnut	1	18	4.5	5	9.5
Cookies (Cream Filled)	3 (30 g)	6	1	2	3
Candy Bar	1 (40 g)	10	4	3	7
Cake, pound	1 slice (80 g)	16	3.5	4.5	8

A National Diet and Nutrition Survey carried out in UK in 2000/01 indicated that significant amounts of trans fat in UK diets came from cereal products (biscuits, buns, cakes, pastries etc.), meat products (burgers, kebabs, meat pies etc.), fat spreads (margarines & spreads), potato and savoury snacks (chips & other snacks). Many manufacturers have since reformulated their products and claim to have much less or no trans fats in their products.

Nutrition and Health Significance

Metabolic studies have shown trans fats to have adverse effects on blood cholesterol levels. They not only increase LDL (bad) cholesterol but also decrease HDL (good) cholesterol. This combined undesirable effect on the ratio of LDL/HDL is almost double that of saturated fats. Thus the effect of trans fats on coronary heat disease is worse than the saturated fats.

Some studies have shown that C-reactive protein, another indicator of risk of heart disease, is elevated sizeably increasing the risk substantially due to high consumption of trans fats. Trans fats have also been associated with increased risk of coronary heart disease in epidemiologic studies.

There are many other studies continuing to gauge the effect of trans fats on cancer, diabetes, obesity, liver dysfunction and infertility although some preliminary results indicate adverse effects.

Animal fats and milk contain small amounts of trans fatty acids. These have been shown to behave differently than the industrially produced synthetic trans fatty acids. Two fatty acids are predominantly found as natural trans fatty acids namely vaccenic acid and conjugated linoleic acid (CLA). Vaccenic acid has been shown in a recent study to lower LDL cholesterol in rats. CLA has been shown to have anti-cancer properties although there are some other undesirable side-effects like lowering insulin sensitivity. These need to be studied further before any recommendations are made with their respect.

Regulation of Trans Fats in Foods

Australian government wants to pursue policy of reducing trans fats from fast foods. Canada requires that food labels list the amount of trans fat on food labels. It is trying to reduce the intake of trans fats. City of Calgary banned trans fats from restaurants and fast food chains. Denmark became the first country to introduce laws to strictly regulate sale of trans fat containing foods. It has restricted fats and oils to have not more than 2% trans fats, effectively restricting partially hydrogenated oils. Switzerland followed Denmark in banning trans fats. UK encouraged self regulation by industry. Sainsbury became first UK major retailer to ban all trans fat from their own brand foods.

US FDA did not approve nutrient content claims such as “trans fat free” or “low in trans fat” as they could not determine safe daily intake that could be taken. However, they made it mandatory to declare trans fat content on labels, allowing contents less than 0.5g per serving to be declared as 0g on food label unlike other countries. FDA also defines trans fats as containing one or more trans linkages that are not in conjugated system. Thus naturally occurring trans fatty acid like conjugated linoleic acid is not considered as trans for label purpose whereas the industrially produced trans fatty acids are considered.

New York city has barred restaurants from using frying and spreading fats containing artificial trans fats above 0.5g per serving from July 1, 2007 and gave one year for compliance. Many other cities in the US are also putting similar restrictions.

Indian government has notified amendment to PFA to include the declaration of trans fat content of certain foods. There are many challenges in front of Indian food industry.

Effects in Industry

Manufacturers have started producing low trans fat bakery fats and shortening. One company has reformulated it using solid saturated palm oil mixed with soybean oil and sunflower oil. This blend gives similar properties of original shortening but zero gram trans fat per tablespoon compared to original 1.5g per tablespoon. Others have started marketing product line of non-hydrogenated oils, margarines and shortenings made from various oils.

Some major food chains have chosen to remove or reduce trans fats in their products. Many fast food chains have reduced or eliminated trans fats from their products including fried chicken, French fries etc.

Major reformulation challenge is avoiding simple substitution of trans fat with saturated fats that might have properties to make better looking products but may still have adverse health effects although not as bad as trans fats.

USDA scientists have shown that altering conditions of hydrogenation will have an effect on extent of trans fat formation. Instead of standard process being carried out at a pressure of 20 psi, they used 200 psi to lower the trans fat content from about 40% to about 17% in soybean oil.

Future

Scientists are ingenious and developed fats from vegetable sources to produce food products that surpassed the ones prepared using animal fats. Given some time they will come up with solutions to avoid use of trans fats in these foods as these have been proven harmful. Use of newer sources, newer processes of preparing fats and food products, using different or newer ingredients, they will produce the desirable properties in foods like cakes, doughnuts, other bakery products and fried foods. Until then people may have to watch their trans fat intake.

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