

Trans fat

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Abstract

The primary dietary source for *trans*-fats is processed food from “partially hydrogenated oils.” In November 2013, the U.S. Food and Drug Administration (FDA) made a preliminary determination that partially hydrogenated oils and it considered as no longer generally Recognized as Safe (GRAS) in human food. Before 1990, very little attention was known about how *trans*- fat can harm your health. In the 1990, research began identifying the adverse health effects of *trans*-fats. Based on these findings, FDA instituted labeling regulations for *trans*-fat and consumption has decreased in the US in recent decades, however some individuals may consume high levels of *trans*-fats based on their food choices.

Trans-fats are easy to use, inexpensive to produce and last a long time action. *Trans*-fats give foods a desirable taste and texture. Many restaurants and fast-food outlets use *trans*-fats to deep-fry foods because oils with *trans*-fats can be used many times in commercial fryers. Several countries (Denmark, Switzerland, and Canada) and jurisdictions (California, New York City, Baltimore, and Montgomery County, MD) have reduced or restricted the use of *trans*- fats in food service establishments.

Trans- fats raise your bad low density lipoprotein (LDL) - cholesterol levels and lower your good high density lipoprotein (HDL) - cholesterol levels. Eating *trans*-fats increases your risk of developing heart disease and stroke. It’s also associated with a higher risk of developing type two-diabetes.

Trans- fats can be found in many foods, including fried foods like doughnuts, and baked goods including cakes, pie crusts, biscuits, frozen pizza, cookies, crackers, and stick margarines and other spreads. Look for trans fat on the ingredient list on food packages. You can determine the amount of *trans*- fats in a particular packaged food by looking at the Nutrition Facts panel. However, products can be listed as “0 grams of *trans* fats” if they contain 0 grams to less than 0.5 grams of *trans*- fat per serving. You can also spot *trans*- fats by reading ingredient lists and looking for the ingredients referred to as “partially hydrogenated oils. Small amounts of *trans*- fats occur naturally in some meat and dairy products, including beef, lamb and butter fat.

The American Heart Association recommends cutting back on foods containing partially hydrogenated vegetable oils to reduce *trans*-fat in your diet and preparing lean meats and poultry without added saturated and trans-fat. Read the Nutrition Facts panel

on foods you buy at the store and, when eating out, ask what kind of oil foods are cooked in. Replace the *trans*-fats in your diet with mono-unsaturated or poly-unsaturated fats. The American Heart Association recommends that adults who would benefit from lowering LDL cholesterol reduce their intake of *trans*-fat and limit their consumption of saturated fat to 5 to 6% of total calories.

Here are some ways to achieve that: 1. Eat a dietary pattern that emphasizes fruits, vegetables, whole grains, low-fat dairy products, poultry, fish and nuts. Also limit red meat and sugary foods and beverages. 2. Naturally oils are occurring in unhydrogenated vegetable oils like canola, safflower, sunflower and olive oil, must used. 3. Look for processed foods made with unhydrogenated oil rather than partially hydrogenated or hydrogenated vegetable oils or saturated fat. 4. Use soft margarine as a substitute for butter, and choose soft margarines (liquid or tub varieties) over harder stick forms. Look for “0 g *trans*-fat” on the Nutrition Facts label and no hydrogenated oils in the ingredients list. 5. Doughnuts, cookies, crackers, muffins, pies and cakes are examples of foods that may contain *trans*-fat. Limit how frequently you eat them. 6. Limit commercially fried foods and baked goods made with shortening or partially hydrogenated vegetable oils. Not only are these foods very high in fat, but that fat is also likely to be *trans*-fat.

Key words: *trans* fat, phospholipids, triglyceride, cholesterol.

Review of Literatures

Hardened fat is final product start as experiments by Nobel laureate Paul Sabatier worked in the late 1890s to develop the chemistry of hydrogenation, which enabled the margarine, oil hydrogenation, and synthetic methanol industries (**Nobel Lectures, 1912**). Whereas Sabatier considered hydrogenation of only vapors, the German chemist Wilhelm Normann showed in 1901 that liquid oils could be hydrogenated, and patented the process in 1902. During the years 1905–1910, Normann built a fat-hardening facility in the Herford company. At the same time, the invention was extended to a large-scale plant in Warrington, England, at *Joseph Crosfield & Sons, Limited*. It took only two years until the hardened fat could be successfully produced in the plant in Warrington, commencing production in the autumn of 1909. The initial year's production totalled nearly 3,000 tones. In 1909, Procter & Gamble acquired the US rights to the Normann patent; in 1911, they began marketing the first hydrogenated shortening, Crisco (composed largely of partially hydrogenated cottonseed oil). Further success came from the marketing technique of giving away free cookbooks in which every recipe called for Crisco (**Patterson, 1998**). Normann's hydrogenation

process made it possible to stabilize affordable whale oil or fish oil for human consumption, a practice kept secret to avoid consumer distaste.

Prior to 1910, dietary fats consisted primarily of butter fat, beef tallow, and lard. During Napoleon's reign in France in the early 19th century, a type of margarine was invented to feed the troops using tallow and buttermilk; it did not gain acceptance in the U.S. In the early 20th century, soybeans began to be imported into the U.S. as a source of protein; soybean oil was a by-product. What to do with that oil became an issue. At the same time, there was not enough butter fat available for consumers. The method of hydrogenating fat and turning a liquid fat into a solid one had been discovered, and now the ingredients (soybeans) and the "need" (shortage of butter) were there. Later, the means for storage, the refrigerator, was a factor in trans-fat development. The fat industry found that hydrogenated fats provided some special features to margarines, which allowed margarine, unlike butter, to be taken out of the refrigerator and immediately spread on bread. By some minor changes to the chemical composition of hydrogenated fat, such hydrogenated fat was found to provide superior baking properties compared to lard. Margarine made from hydrogenated soybean oil began to replace butter fat. Hydrogenated fat such as Crisco and Spry, sold in England, began to replace butter and lard in the baking of bread, pies, cookies, and cakes in 1920 (**Shurtleff et al., 1980**). In the 1940s, Catherine Kousmine researched the effects of trans fats on cancer.

Production of hydrogenated fats increased steadily until the 1960s, as processed vegetable fats replaced animal fats in the US and other Western countries. At first, the argument was a financial one due to lower costs; advocates also said that the unsaturated trans-fats of margarine were healthier than the saturated fats of butter (**Kummerow, 2008**).

Some meat and dairy products contain small amounts of naturally occurring trans fat. But most trans fat is formed through an industrial process that adds hydrogen to vegetable oil, which causes the oil to become solid at room temperature. This partially hydrogenated oil is less likely to spoil, so foods made with it have a longer shelf life. Some restaurants use partially hydrogenated vegetable oil in their deep fryers, because it doesn't have to be changed as often as do other oils (**Casimir et al., 2002**).

What is meant by trans-fats: In most naturally occurring unsaturated fatty acids, the hydrogen atoms are on the same side of the double bonds of the carbon chain (*cis* configuration — from the Latin, meaning "on the same side"). However, partial hydrogenation reconfigures most of the double bonds that do not become chemically saturated, twisting them so that the hydrogen atoms end up on different sides of the chain (**Dijkstra et al., 2008**). This type of configuration is called *trans*, from the Latin, meaning "across". The trans configuration is the lower energy form, and is favored when

catalytically equilibrated as a side reaction in hydrogenation. The same molecule, containing the same number of atoms, with a double bond in the same location, can be either a *trans* or a *cis* fatty acid depending on the configuration of the double bond. For example, oleic acid and elaidic acid are both unsaturated fatty acids with the chemical formula $C_{18}H_{34}O_2$ (Hill and Doris, 2007). They both have a double bond located midway along the carbon chain. It is the configuration of this bond that sets them apart. The configuration has implications for the physical-chemical properties of the molecule. The *trans* configuration is straighter, while the *cis* configuration is noticeably (EFSA, 2010).

Hydrogenation of an unsaturated fatty acid: refers to the addition of hydrogen atoms to the acid, causing double bonds to become single ones, as carbon atoms acquire new hydrogen partners (to maintain four bonds per carbon atom). Full hydrogenation results in a molecule containing the maximum amount of hydrogen (in other words, the conversion of an unsaturated fatty acid into a saturated one). Partial hydrogenation results in the addition of hydrogen atoms at some of the empty positions, with a corresponding reduction in the number of double bonds. Typical commercial hydrogenation is partial in order to obtain amalleable mixture of fats that is solid at room temperature, but melts upon baking (or consumption). In food production, the goal is not to simply change the configuration of double bonds, while maintaining the same ratios of hydrogen to carbon. Instead, the goal is to decrease the number of double bonds and increase the amount of hydrogen in the fatty acid. This changes the consistency of the fatty acid and makes it less prone to rancidity (in which free radicals attack double bonds). Production of *trans*-fatty acids is therefore an undesirable side effect of partial hydrogenation. Catalytic partial hydrogenation necessarily produces *trans*-fats, because of the reaction mechanism. In the first reaction step, one hydrogen is added, with the other, coordinatively unsaturated, carbon being attached to the catalyst. The second step is the addition of hydrogen to the remaining carbon, producing a saturated fatty acid. The first step is reversible, such that the hydrogen is re-adsorbed on the catalyst and the double bond is re-formed. The intermediate compound was with only one-hydrogen added contains no double bond and can freely rotate. Thus, the double bond can re-form as either *cis* or *trans*, of which *trans* is favored, regardless the starting material. Complete hydrogenation also hydrogenates any produced *trans* fats to give saturated fats (Bassett et al., 2010).

What are Trans-fats: *Trans* fats, or *trans*-unsaturated fatty acids, *trans* fatty acids, are a type of unsaturated fats that are uncommon in nature but became commonly produced industrially. A fatty acid is characterized as either *saturated* or *unsaturated* based on the presence of double bonds in its structure. If

the molecule contains no double bonds, it is said to be saturated; otherwise, it is unsaturated to some degree (Thomas, 2002). Only unsaturated fats can be *trans* or *cis* fat, since only a double bond can be locked to these orientations. Saturated fatty acids are never called *trans fats* because they have no double bonds. Therefore, all their bonds are freely rotatable (IUPAC, 2009). Other types of fatty acids, such as crepenynic acid, are contains a triple bond, are rare and of no nutritional significance (Ashok, et al., 2009). Carbon atoms are tetravalent, forming four covalent bonds with other atoms, whereas hydrogen atoms bond with only one other atom. In saturated fatty acids, each carbon atom (besides the last) is connected to its two neighbor carbon atoms as well as two hydrogen atoms. In unsaturated fatty acids, the carbon atoms that are missing a hydrogen atom are joined by double bonds rather than single bonds so that each carbon atom participates in four bonds (Gatto, et al., 2003). In chemical terms, *trans fat* is a fat (lipid) molecule that contains one or more double bonds in *trans* geometric configuration. A double bond may exhibit one of two possible configurations, *trans* or *cis*. In *trans* configuration, the carbon chain extends from opposite sides of the double bond, whereas, in *cis* configuration, the carbon chain extends from the same side of the double bond. The *trans* molecule is a straighter molecule. The *cis* molecule is bent (Spencelayh,2007).

1. Saturated fatty acid (e.g. Stearic acid): Stearic acid is a saturated fatty acid found in animal fats and is the intended product in full hydrogenation. Stearic acid is neither *cis* nor *trans* because it has no carbon-carbon double bonds.
2. Cis (Oleic acid): Oleic acid is a *cis* unsaturated fatty acid making up 55–80% of olive oil (Alonso et al,1999).
3. Trans (Elaidic acid): Elaidic acid is the principal *trans* unsaturated fatty acid often found in partially hydrogenated vegetable oils (Udo Erasmus, 2007). The *trans* fatty acid, elaidic acid has different chemical and physical properties, owing to the slightly different bond configuration. It has a much higher melting point, 45 °C, than oleic acid, 13.4 °C, due to the ability of the *trans* molecules to pack more tightly, forming a solid that is more difficult to break apart. This notably means that it is a solid at human body temperatures.

How are Source of trans fat:

1. In vitro productions: In food production, liquid *cis*-unsaturated fats such as vegetable oils are hydrogenated to produce saturated fats, which have more desirable physical properties, e.g. they melt at a desirable temperature (30–40 °C). Partial hydrogenation of the unsaturated fat converts some of the *cis* double bonds into *trans* double bonds by an isomerization reaction with the catalyst used for the hydrogenation, which yields a *trans* fat (Maria et al., 2006). Animal-based fats

were once the only *trans* fats consumed, but by far the largest amount of *trans* fat consumed today is created by the processed food industry as a side effect of partially hydrogenating unsaturated plant fats (generally vegetable oils). These partially hydrogenated fats have displaced natural solid fats and liquid oils in many areas, the most notable ones being in the fast food, snack food, fried food, and baked goods industries (Maria et al., 2006). Partially hydrogenated oils have been used in food for many reasons. Hydrogenation increases product shelf life and decreases refrigeration requirements. Many baked foods require semi-solid fats to suspend solids at room temperature; partially hydrogenated oils have the right consistency to replace animal fats such as butter and lard at lower cost. They are also an inexpensive alternative to other semi-solid oils such as palm oil. Up to 45% of the total fat in those foods containing artificial *trans* fats formed by partially hydrogenating plant fats may be *trans* fat (Maria et al., 2006). Baking shortenings, in general, contain 30% *trans* fats compared to their total fats, whereas animal fats from ruminants such as butter contain up to 4%. Margarine not reformulated to reduce *trans* fats may contain up to 15% *trans* fat by weight.

2. In vivo productions: Fats contain long hydrocarbon chains, which can either be unsaturated, i.e. have double bonds, or saturated, i.e. have no double bonds. In nature, unsaturated fatty acids generally have *cis* as opposed to *trans* configurations. A type of *trans* fat occurs naturally in the milk and body fat of ruminants (such as cattle and sheep) at a level of 2–5% of total fat (Maria et al., 2006). Natural *trans*-fats, which include conjugated linoleic acid (CLA) and vaccenic acid, originate in the rumen of these animals. CLA has two double bonds, one in the *cis* configuration and one in *trans*, which makes it simultaneously a *cis*- and a *trans*-fatty acid. It has been established that *trans* fats in human milk fluctuate with maternal consumption of *trans* fat, and that the amount of *trans* fats in the bloodstream of breastfed infants fluctuates with the amounts found in their milk. Reported percentages of *trans* fats (compared to total fats) in human milk range from 1% in Spain, 2% in France, 4% in Germany, and 7% in Canada and the United States (Hunter, 2005).

What are the difference between natural and artificial *trans* fat: Most artificial *trans* fats are chemically different from natural *trans* fats. Two Canadian studies (Wang and Spencer, 2008). have shown that the natural *trans* fat vaccenic acid, found in beef and dairy products, could actually be beneficial compared to hydrogenated vegetable shortening, or a mixture of pork lard and soy fat, by lowering total and LDL and triglyceride levels (Wang et al., 2010). A study by the US Department of Agriculture showed that vaccenic acid raises both HDL and LDL cholesterol, whereas

industrial *trans* fats only raise LDL without any beneficial effect on HDL (**Bassett et al., 2010**).

What are the adverse effect of trans-Fat:

1. Although *trans* fats are edible, consumption of *trans* fats has shown to increase the risk of coronary heart disease in part by raising levels of the lipoprotein LDL (so-called "bad cholesterol"), lowering levels of the lipoprotein HDL ("good cholesterol"), increasing triglycerides in the bloodstream and promoting systemic inflammation (**Mensink, and Katan,1990**). Trans fat has been shown to consistently be associated, in an intake-dependent way, with increased risk of coronary heart disease, a leading cause of death in Western nations (**Oh, et al., 2005**).
2. In light of recognized evidence and scientific agreement, nutritional authorities consider all *trans* fats as equally harmful for health (**UK Scientific Advisory Committee on Nutrition., 2007**) and recommend that consumption of *trans* fats be reduced to trace amounts (**Ascherio et al.,2006 and EFSA, 2010**).
3. In fact, by the 1980s, fats of animal origin had become one of the greatest concerns of dieticians. Activists, such as Phil Sokolof, who took out full page ads in major newspapers, attacked the use of beef tallow in McDonald's french fries and urged fast-food companies to switch to vegetable oils. The result was an almost overnight switch by most fast-food outlets to switch to trans-fats (**Booyens et al., 1988**).
4. Studies in the early 1990s, however, brought renewed scrutiny and confirmation of the negative health impact of trans-fats (**Mensink; et al., 2003**).
5. In 1994, it was estimated that trans-fats caused 20,000 deaths annually in the US from heart disease.
6. Mandatory food labeling for *trans* fats was introduced in several countries. Campaigns were launched by activists to bring attention to the issue and change the practices of food manufacturers (**Willett and Ascherio.,1995**).
7. In January 2007, faced with the prospect of an outright ban on the sale of their product, Crisco was reformulated to meet the United States Food and Drug Administration definition of "zero grams trans fats per serving" (that is less than one gram per tablespoon, or up to 7% by weight; or less than 0.5 grams per serving size) (**FDA , 2005; Regulation: 21 CFR 101.9 (c) (2) (ii)**,

- 2007 and Newswise, 2008**) by boosting the saturation and then diluting the resulting solid fat with unsaturated vegetable oils.
8. A University of Guelph research group has found a way to mix oils (such as olive, soybean, and canola), water, monoglycerides, and fatty acids to form a "cooking fat" that acts the same way as trans and saturated fats (**Shockman,2007**).
 9. In 2013, the United States Food and Drug Administration (FDA) issued a preliminary determination that partially hydrogenated oils (which contain *trans* fats) are not "generally recognized as safe", which was expected to lead to a ban on industrially produced *trans* fats from the American diet.
 10. On 16 June 2015, the FDA finalized its determination that trans-fats are not generally recognized as safe, and set a three-year time limit for their removal from all processed foods. In other countries, there are legal limits to *trans*-fat content. *Trans*-fats levels can be reduced or eliminated using saturated fats such as lard, palm oil or fully hydrogenated fats, or by using inter-esterified fat. Other alternative formulations can also allow unsaturated fats to be used to replace saturated or partially hydrogenated fats. Hydrogenated oil is not a synonym for *trans*-fat complete hydrogenation removes all unsaturated fats.
 11. The National Academy of Sciences (NAS) advises the United States and Canadian governments on nutritional science for use in public policy and product labeling programs. Their 2002 *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids* (**Food and nutrition board, institute of medicine of the national academies, 2005**) contains their findings and recommendations regarding consumption of trans fat.

How decreasing the trans-fat in food: Researchers at the United States Department of Agriculture have investigated whether hydrogenation can be achieved without the side effect of trans-fat production. They varied the pressure under which the chemical reaction was conducted (applying 1400 kPa (200 psi) of pressure to soybean oil in a 2-liter vessel while heating it to between 140 °C and 170 °C. The standard 140 kPa (20 psi) process of hydrogenation produces a product of about 40% trans fatty acid by weight, compared to about 17% using the high-pressure method. Blended with un-hydrogenated liquid soybean oil, the high-pressure-processed oil produced margarine containing 5 to 6% trans-fat. Based on current U.S. labeling requirements, the manufacturer could claim the product was free of trans-fat (**Taylor and Francis,**

2007). The level of trans-fat may also be altered by modification of the temperature and the length of time during hydrogenation.

How Trans-fat detected: Trans fat levels may be measured. Measurement techniques include chromatography (by silver ion chromatography on thin layer chromatography plates, or small high-performance liquid chromatography columns of silica gel with bonded phenylsulfonic acid groups whose hydrogen atoms have been exchanged for silver ions). The role of silver lies in its ability to form complexes with unsaturated compounds. Gas chromatography and mid-infrared spectroscopy are other methods in use.

Concentrations of trans fat in some food: Trans fat contents in various food, ranked in g per 100 gm (Eller et al., 2005):

food type	trans-fat content	food type	trans-fat content
Shortenings	10 to 33g	Margarine/spreads	3 to 26 g
Breads/cake products	0.1 to 10 g	Cookies and crackers	1 to 8 g
Salty snacks	0 to 4 g	Cake frostings and sweets	0.1 to 7g

Trans-fat and food today: Reaction scheme: By far the largest amount of *trans*-fat consumed today is created by the processed food industry as a side effect of partially catalytic hydrogenation of unsaturated plant fats (generally vegetable oils) with *cis* carbon-carbon double bonds (Baer, 2010). These partially hydrogenated fats have displaced natural solid fats and liquid oils in many areas, the most notable ones being in the fast food, snack food, fried food, and baked goods industries (Hu, 2010).

What are the advances of trans-fat: Trans fats are used in shortenings for deep-frying in restaurants, as they can be used for longer than most conventional oils before becoming rancid. In the early 21st century, non-hydrogenated vegetable oils that have life spans exceeding that of the frying shortenings became available (Innis et al., 1999). As fast-food chains routinely use different fats in different locations, trans-fat levels in fast food can have large variations. For example, an analysis of samples of McDonald's French fries collected in 2004 and 2005 found that fries served in New York City contained twice as much trans-fat as in Hungary, and 28 times as much as in Denmark. At KFC, the pattern was reversed with Hungary's product containing twice the trans-fat of the New York product. Even within the US there was variation, with fries in New York containing 30% more trans-fat than those from Atlanta (NYC Board of Health, 2006).

Nutritional guidelines: Their recommendations are based on two key facts.

1. First, "trans fatty acids are not essential and provide no known benefit to human health", whether of animal or plant origin (**IMNA, 2005**).
2. Second, while both saturated and trans fats increase levels of LDL, trans fats also lower levels of HDL;**(IMNA, 2005)** thus increasing the risk of coronary heart disease. The NAS is concerned "that dietary trans fatty acids are more deleterious with respect to coronary heart disease than saturated fatty acids";**(IMNA,2005)**. This analysis is supported by a 2006 New England Journal of Medicine (NEJM) scientific review that states "from a nutritional standpoint, the consumption of trans-fatty acids results in considerable potential harm but no apparent benefit."**(Mozaffarian, et al., 2006)**. Because of these facts and concerns, the NAS has concluded there is no safe level of trans-fat consumption. There is no adequate level, recommended daily amount or tolerable upper limit for-trans fats. This is because any incremental increase in trans fat intake increases the risk of coronary heart disease (**IMNA, 2005**). Despite this concern, the NAS dietary recommendations have not recommended the elimination of trans-fat from the diet. This is because trans-fat is naturally present in many animal foods in trace quantities, and therefore its removal from ordinary diets might introduce undesirable side effects and nutritional imbalances if proper nutritional planning is not undertaken. The NAS has, therefore, "recommended that trans-fatty acid consumption be as low as possible while consuming a nutritionally adequate diet"**(Mozaffarian et al., 2003)**. Like the NAS, the World Health Organization (WHO) has tried to balance public health goals with a practical level of trans-fat consumption, recommending in 2003 that trans-fats be limited to less than 1% of overall energy intake. The US National Dairy Council (US-NDC) has asserted that the trans fats present in animal foods are of a different type than those in partially hydrogenated oils, and do not appear to exhibit the same negative effects (**IMNA, 2005**). While a recent scientific review agrees with the conclusion (stating that "the sum of the current evidence suggests that the Public health implications of consuming trans fats from ruminant products are relatively limited"), it cautions that this may be due to the low consumption of trans fats from animal sources compared to artificial ones (**IMNA, 2005**).
3. More recent inquiry (independent of the dairy industry) has found in a 2008 Dutch meta-analysis that all trans fats, regardless of natural or

artificial origin equally raise LDL and lower HDL levels (*NDC, 2007*). Other studies though have shown different results when it comes to animal based trans-fats like conjugated linoleic acid (CLA). Although CLA is known for its anticancer properties, researchers have also found that the cis-9, trans-11 form of CLA can reduce the risk for cardiovascular disease and help fight inflammation (**Tricon, et al., 2004 and Brouwer et al., 2010**).

Health risks:

1. Partially hydrogenated vegetable oils have been an increasingly significant part of the human diet for about 100 years (in particular, since the later half of the 20th century and where more processed foods are consumed (**Zulet et al., 2004**), and some deleterious effects of trans-fat consumption are scientifically accepted, forming the basis of the health guidelines (**Koletzko and Decsi, 1997**).
2. The exact biochemical methods by which trans-fats produce specific health problems are a topic of continuing research. One theory is that the human lipase enzyme works only on the cis configuration and cannot metabolize a trans-fat although this theory has been overturned by the recognition that trans-fat is metabolized but competitively inhibits the metabolism of other fatty acids (**Valenzuel and Morgado, 1999**).
3. Intake of dietary trans-fat perturbs the body's ability to metabolize essential fatty acids (EFAs including Omega 3) leading to changes in the phospholipid fatty acid composition in the aorta, the main artery of the heart, thereby increasing risk of coronary heart disease (**Booyens et al., 1988**). While the mechanisms through which trans-fats contribute to coronary heart disease are fairly well understood, the mechanism for trans-fat's effect on diabetes is still under investigation.
4. Trans fatty acids may impair the metabolism of long-chain polyunsaturated fatty acids (LCPUFAs), but maternal pregnancy trans-fatty acid intake has been inversely associated with LCPUFAs levels in infants at birth thought to underlie the positive association between breast feeding and intelligence (**Kummerow et al., 2004**). High intake of trans-fatty acids can lead to many health problems throughout one's life. Trans-fat is abundant in fast food restaurants (**Siri-Tarino, et al. 2010**). It is consumed in greater quantities by people who do not have access to a diet consisting of fewer hydrogenated fats, or who often consume fast food. A diet high in trans fats can contribute to obesity, high blood pressure, and a

greater risk for heart disease. Trans fat has also been implicated in the development of Type 2 diabetes (**Mena et al., 2013**).

5. Coronary heart disease: The primary health risk identified for trans fat consumption is an elevated risk of coronary heart disease (CHD)(**Ulf Riserus 2006 and Zaloga et al., 2006**). In this study, Hu and colleagues analyzed data from 900 coronary events from the study's population during 14 years of follow up. They determined that a nurse's CHD risk roughly doubled (relative risk of 1.93, CI: 1.43 to 2.61) for each 2% increase in trans fat calories consumed (instead of carbohydrate calories) (**Ascherio, et al., 1996**). By contrast, for each 5% increase in saturated fat calories (instead of carbohydrate calories) there was a 17% increase in risk (relative risk of 1.17, CI: 0.97 to 1.41) (**Mozaffarian et al., 2006**). Hu also reports on the benefits of reducing trans-fat consumption. Replacing 2% of food energy from trans-fat with non-trans unsaturated fats more than halves the risk of CHD (53%) (**Mozaffarian et al., 2006**). Another study considered deaths due to CHD, with consumption of trans-fats being linked to an increase in mortality, and consumption of polyunsaturated fats being linked to a decrease in mortality (**Hu et al., 1997**).
6. Alzheimer's Disease: A study published in Archives of Neurology in February 2003 suggested that the intake of both trans fats and saturated fats promote the development of Alzheimer disease (**Morris, et al., 2003 and Lopez-Garcia, et al., 2005**).
7. Cancer: There is no scientific consensus that consumption of trans-fats significantly increases cancer risks across the board. The American Cancer Society states that a relationship between trans-fats and cancer "has not been determined (**Granholt, et al., 2008**).
8. Diabetes: There is a growing concern that the risk of type 2 diabetes increases with trans-fat consumption (**Trans Fat Task Force, 2006**). However, consensus has not been reached. For example, one study found that risk is higher for those in the highest quartile of trans-fat consumption (**Chajès et al., 2008**). Another study has found no diabetes risk once other factors such as total fat intake and BMI were accounted for (**Hu et al., 2001**).
9. Obesity: Research indicates that trans-fat may increase weight gain and abdominal fat, despite a similar caloric intake (**Van Dam et al., 2002**). A 6-year experiment revealed that monkeys fed a trans-fat diet gained 7.2%

of their body weight, as compared to 1.8% for monkeys on a mono-unsaturated fat diet (**Kavanagh et al., 2007**). Although obesity is frequently linked to trans-fat in the popular media (**Kavanagh et al., 2007**). this is generally in the context of eating too many calories; there is not a strong scientific consensus connecting trans-fat and obesity, although the 6-year experiment did find such a link, concluding that "under controlled feeding conditions, long-term TFA consumption was an independent factor in weight gain (**McNamara et al.,2007**). TFAs enhanced intra-abdominal deposition of fat, even in the absence of caloric excess, and were associated with insulin resistance, with evidence that there is impaired post-insulin receptor binding signal transduction (**Kavanagh et al., 2007**).

10. *Liver dysfunction*: Trans-fats are metabolized differently by the liver than other fats and interfere with liver cell function (**Thompson, 2006**).
11. Infertility in women: One 2007 study found,"Each 2% increase in the intake of energy from trans unsaturated fats, as opposed to that from carbohydrates, was associated with a 73% greater risk of ovulatory infertility(**Chavarro Jorge et al., 2007**).
12. Major depressive disorder: Spanish researchers analyzed the diets of 12,059 people over six years and found those who ate the most trans fats had a 48 per cent higher risk of depression than those who did not eat trans fats (**Phivilay, et al.,2009**).
13. Behavioral irritability and aggression: a 2012 observational analysis of subjects of an earlier study found a strong relation between dietary trans-fat acids and self-reported behavioral aggression and irritability, suggesting but not establishing causality (**Beatrice et al. 2012**).
14. *Diminished memory*: In a 2015 article, researchers re-analyzing results from the 1999-2005, UCSD Stat in Study argue that "greater dietary trans-fatty acid consumption is linked to worse word memory in adults during years of high productivity, adults age <45"(**Shari, 2011 and Golomb et al., 2015**).

How the Countries deals with trans-fat:

The international trade in food is standardized in the <u>Codex</u>	<ul style="list-style-type: none"> ○ Hydrogenated oils and fats come under the scope of Codex Stan 19 ("CODEX STAN 1999). ○ Non-dairy fat spreads are covered by Codex Stan 256-2007(CODEX STAN 2007). ○ In the Codex Alimentarius, trans-fat to be labelled as such is defined as the geometrical isomers of monounsaturated and polyunsaturated fatty acids having non-conjugated [interrupted by at least one methylene group (-CH₂-)] carbon-carbon double bonds in
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<u>Alimentarius.</u>	the trans configuration. This definition excludes specifically the trans-fats (vaccenic acid and conjugated linoleic acid) that are present especially in human milk, dairy products, and beef.
Argentina	<ul style="list-style-type: none"> • Since August 2006 food products should be labeled with the amount of trans- fat in them (CODEX STAN 2007). • Since 2010 vegetable oils and fats directly sold to consumers must only contain 2% of trans-fat over total fat and other food must contain less than 5% of their total fat. • Starting on December 10, 2014, Argentina has on effect a total ban on food with trans fat, a move that could save the government more than US\$100 million a year on healthcare ("Se acerca el fin de las grasas trans para los alimentos argentinos". La Nacion. ,2014).
Australia	<ul style="list-style-type: none"> ○ The Australian federal government has indicated that it wants to pursue actively a policy of reducing trans-fats from fast foods. The former federal assistant health minister, Christopher Pyne, asked fast food outlets to reduce their trans-fat usage. A draft plan was proposed, with a September 2007 timetable, in order to reduce reliance on trans-fats and saturated fats. ○ Currently, Australia's food labeling laws do not require trans-fats to be shown separately from the total fat content. However, margarine in Australia has been mostly free of trans-fat since 1996(Fast food outlets asked to cut down trans fat usage, 2007).
Austria	<ul style="list-style-type: none"> • Trans fat content limited to 4% of total fat, 2% on products that contain more than 20% fat (Peter et al., 2004).
Brazil	<ul style="list-style-type: none"> ○ Resolution 360 of 23 December 2003 by the Brazilian ministry of health required for the first time in the country that the amount of trans-fat to be specified in labels of food products. ○ On 31 July 2006, such labelling of trans-fat contents became mandatory. ○ In 2007 the ministry established a target to reduce the total amount of trans-fat in any industrialized food sold in Brazil to a maximum of 2% by the end of 2010 (BMG., 2013).
Canada	<ul style="list-style-type: none"> • In November 2004, an opposition day motion seeking a ban similar to Denmark's was introduced by Jack Layton of the New Democratic Party, and passed through the House of Commons by an overwhelming 193–73 vote. Like all Commons motions, it served as an expression of the views of the House but was not binding on the government and has no force under the law. • Since December 2005, <u>Health Canada</u> has required that food labels list the amount of trans-fat in the nutrition facts section for most foods. Products with less than 0.2 grams of trans-fat per serving may be labeled as free of trans fats. These labelling allowances are not widely known, but as an awareness of them develops, controversy over truthful labelling is growing. In Canada, trans-fat quantities on labels include naturally occurring trans-fats from animal sources (CRFSA, 2007). • In June 2006, a task force co-chaired by Health Canada and the <u>Heart and Stroke Foundation of Canada</u> recommended a limit of 5% trans fat (of total fat) in all products sold to consumers in Canada (2% for tub margarines and spreads). The amount was selected such that "most of the industrially produced trans-fats would be removed from the Canadian diet, and about half of the remaining trans-fat intake would be of naturally

	<p>occurring trans fats". This recommendation has been endorsed by the <u>Canadian Restaurant and Foodservices Association</u> and Food & Consumer Products of Canada has congratulated the task force on the report, (CFIA, 2007) although it did not recommend delaying implementation to 2010 as they had previously advocated.</p> <ul style="list-style-type: none"> • Ten months after submitting their report the <u>Heart and Stroke Foundation of Canada</u> and Toronto <u>Public Health</u> issued a plea to the government of Canada: "to act immediately on the task force's recommendations and to eliminate harmful trans fat from Canada's food supply (Food & Consumer Products of Canada, 2006). • On 20 June 2007, the federal government announced its intention to regulate trans-fats to the June 2006 standard unless the food industry voluntarily complied with these limits within two years. • On 1 January 2008, <u>Calgary</u> became the first city in Canada to reduce trans fats from restaurants and fast food chains. Trans fats present in <u>cooking oils</u> may not exceed 2% of the total fat content (CRFSA, 2007). • However, the replacement of local health regions with the Alberta Health Services Board in 2009 has temporarily eliminated all enforcement of the law. • Effective 30 September 2009, British Columbia became the first province in Canada to mandate the June 2006 recommendation in provincially regulated food (BCMHL, 2009).
Denmark	<ul style="list-style-type: none"> ○ Denmark became the first country to introduce laws strictly regulating the sale of many foods containing trans-fats (Nasser, et al., 2011). ○ In March 2003, a move that effectively bans partially hydrogenated oils. The limit is 2% of fats and oils destined for human consumption (Stender and Dyerberg, 2004). This restriction is on the <i>ingredients</i> rather than the final products. This regulatory approach has made Denmark the only country in which it is possible to eat "far less" than 1 g of industrially produced trans fats daily, even with a diet including prepared foods (News - Medical. Net , 2013). ○ It is hypothesized that the Danish government's efforts to decrease trans fat intake from 6 g to 1 g per day over 20 years is related to a 50% decrease in deaths from ischemic heart disease (Stender, et al., 2006).
Israel	<ul style="list-style-type: none"> • Since 2014, It is obligatory to mark food products with more than 2% (by weight) fat. The nutritional facts must contain the amount of trans-fats (N/A, 2010).
Sweden	<ul style="list-style-type: none"> ○ Parliament has given the government a mandate in 2011 to submit without delay a law prohibiting the use of industrially produced trans-fats in foods.
Switzerland	<ul style="list-style-type: none"> • <u>Switzerland</u> followed Denmark's trans fats ban, and implemented its own beginning in April 2008.
European Union	<ul style="list-style-type: none"> ○ In 2004, the <u>European Food Safety Authority</u> produced a scientific opinion on trans fatty acids, surmising that "higher intakes of TFA may increase risk for coronary heart disease" (The Independent, 2008). ○ In <u>Belgium</u>, the <u>Conseil Supérieur de la Santé</u> has published in 2012 a science-policy advisory report on industrially produced trans-fatty acids that focuses on the general population. It also provides specific information and recommendations regarding the nutritional requirements for dietary fats as well as amendments to the food legislation. The council recommends to Belgian authorities a contraignant legislation for the

	<p>interdiction of more than 2 g of trans fatty acids / 100 g of fat in food products. Unfortunately, since this report there is no action in this way by legislative authorities (EFSA-Q-2003-022 (2008)).</p>
<p>United Kingdom</p>	<ul style="list-style-type: none"> • In October 2005, the <u>Food Standards Agency</u> (FSA) asked for better labelling in the UK (Gray, 2006). • In the edition of 29 July 2006 of the <u>British Medical Journal</u>, an editorial also called for better labeling (BBC, 2006). • In January 2007, the British Retail Consortium announced that major UK retailers, including <u>Asda</u>, <u>Boots</u>, <u>Co-op</u>, <u>Iceland</u>, <u>Marks and Spencer</u>, <u>Sainsbury's</u>, <u>Tesco</u> and <u>Waitrose</u> intended to cease adding trans fatty acids to their own products by the end of 2007. • <u>Sainsbury's</u> became the first UK major retailer to ban all trans fat from all their <u>own brand</u> foods. • On 13 December 2007, the <u>Food Standards Agency</u> issued news releases stating that voluntary measures to reduce trans fats in food had already resulted in safe levels of consumer intake (Food Standards Agency, 2007). • On 15 April 2010, a <u>British Medical Journal</u> editorial called for trans fats to be "virtually eliminated in the United Kingdom by next year" (Dariush and Stampfer, 2010). • The June 2010 <u>National Institute for Health and Clinical Excellence</u> (NICE) report <i>Prevention of cardiovascular disease</i> declared that 40,000 cardiovascular disease deaths in 2006 were "mostly preventable". • To achieve this, NICE offered 24 recommendations including product labelling, public education, protecting under-16s from marketing of unhealthy foods, promoting exercise and physically active travel, and even reforming the <u>Common Agricultural Policy</u> to reduce production of unhealthy foods. Fast-food outlets were mentioned as a risk factor, with (in 2007) 170 g of <u>McDonald's</u> fries and 160 g nuggets containing 6 to 8 g of trans fats, conferring a substantially increased risk of coronary heart disease death. NICE made three specific recommendations for diet: <ol style="list-style-type: none"> 1. Reduction of dietary salt to 3 g per day by 2025. 2. Halving consumption of a saturated fat. 3. Eliminating the use of industrially produced trans fatty acids in food. However, the recommendations were greeted unhappily by the food industry, which stated that it was already voluntarily dropping the trans-fat levels to below the WHO recommendations of a maximum of 2 per cent. • Rejecting an outright ban, the Health Secretary <u>Andrew Lansley</u> launched on 15 March 2012 a voluntary pledge to remove artificial trans-fats by the end of the year. Asda, Pizza Hut, Burger King, Tesco, Unilever and United Biscuits are some of 73 businesses who have agreed to do so. Lansley and his special Adviser Bill Morgan previously worked for firms with interests in the food industry and some journalists have alleged that this results in a conflict of interest (Paul Lincoln, 2015). • Many health professionals are not happy with the voluntary nature of the deal. Simon Capewell, Professor of Clinical Epidemiology at the University of Liverpool, felt that justifying intake on the basis of average figures was unsuitable since some members of the community could considerably exceed this (McClenaghan, 2013).

United States	<ul style="list-style-type: none">○ Poster from New York City's board of health encouraging consumers to limit trans fat consumption Before 2006, consumers in the United States could not directly determine the presence (or quantity) of trans fats in food products. This information could only be inferred from the ingredient list, notably from the partially hydrogenated ingredients.○ In 2010, according to the FDA, the average American consumed 5.8 grams of trans-fat per day (2.6% of energy intake (Hogg, 2011). Mono-glycerides and di-glycerides are not considered fats by the FDA, despite their nearly equal calorie per weight contribution during actual ingestion. Critically important is the apparent fact that trans fatty acids that are part of mono- and diglycerides are not required to be listed on the ingredients label as making contributions to calorie count or trans fatty acid content (Misko, 2003).○ On 11 July 2003, the <u>Food and Drug Administration</u> (FDA) issued a regulation requiring manufacturers to list trans-fat on the Nutrition Facts panel of foods and some dietary supplements.^{[33][34]} The new labeling rule became mandatory across the board, even for companies that petitioned for extensions, on 1 January 2008. However, unlike in many other countries, trans fat levels of less than 0.5 grams per serving can be listed as 0 grams trans fat on the food label.○ According to a study published in the Journal of Public Policy & Marketing, without an interpretive footnote or further information on recommended daily value, many consumers do not know how to interpret the meaning of trans-fat content on the Nutrition Facts panel. In fact, without specific prior knowledge about trans-fat and its negative health effects, consumers, including those at risk for heart disease, may misinterpret nutrient information provided on the panel.○ The FDA did not approve nutrient content claims such as "trans fat free" or "low trans fat", as they could not determine a "recommended daily value". Nevertheless, the agency is planning a consumer study to evaluate the consumer understanding of such claims and perhaps consider a regulation allowing their use on packaged foods (<i>FSA, 2007</i>). However, there is no requirement to list trans fats on institutional food packaging; thus bulk purchasers such as schools, hospitals, jails and cafeterias are unable to evaluate the trans fat content of commercial food items. The FDA defines trans-fats as containing one or more <i>trans</i> linkage that are not in a <u>conjugated system</u>. This is an important distinction, as it distinguishes non-conjugated synthetic trans-fats from naturally occurring fatty acids with conjugated trans double bonds, such as <u>conjugated linoleic acid</u>.○ Critics of the plan, including FDA advisor Dr. Carlos Camargo, have expressed concern that the 0.5 gram per serving threshold is too high to refer to a food as free of trans-fat. This is because a person eating many servings of a product, or eating multiple products over the course of the day may still consume a significant amount of trans-fat. Despite this, the FDA estimates that by 2009, trans fat labeling will have prevented from 600 to 1,200 cases of coronary heart disease and 250 to 500 deaths each year. This benefit is expected to result from consumers choosing alternative foods lower in trans-fats as well as manufacturers reducing the amount of trans-fats in their products.○ The <u>American Medical Association</u> supports any state and federal efforts to ban the use of artificial trans-fats in U.S. restaurants and bakeries. The <u>American Public Health Association</u> adopted a new policy statement regarding trans-fats in 2007. These new
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	<p>guidelines, entitled <i>Restricting Trans Fatty Acids in the Food Supply</i>, recommend that the government require nutrition facts labeling of trans fats on all commercial food products. They also urge federal, state, and local governments to ban and monitor use of trans fats in restaurants. Furthermore, the APHA recommends barring the sales and availability of foods containing significant amounts of trans fat in public facilities including universities, prisons, and day care facilities etc.</p> <ul style="list-style-type: none"> ○ On 7 November 2013, the FDA issued a preliminary determination that trans fats are not "<u>generally recognized as safe</u>", which was widely seen as a precursor to a reclassification of trans fats as a "food additive," meaning they could not be used in foods without specific regulatory authorization. This would have the effect of virtually eliminating trans fats from the US food supply (FDA, 2003). ○ The ruling was formally enacted on 16 June 2015, requiring that within three years, all food prepared in the United States must not include trans fats, unless approved by the FDA (Lopez, et al., 2013).
<p>State and local regulation in the United States</p>	<ul style="list-style-type: none"> • The state of California and some US cities are acting to reduce consumption of trans-fats. • In May 2005, <u>Tiburon</u>, California, became the first American city where in all restaurants voluntarily cook with trans-fat free oils. • <u>Montgomery County</u>, Maryland approved a ban on partially hydrogenated oils, becoming the first county in the nation to restrict trans-fats (Spivack, et al., 2007). • New York City embarked on a campaign in 2005 to reduce consumption of trans-fats, noting that heart disease is the primary cause of resident deaths. This has included a Public education campaign and a request to restaurant owners to eliminate trans-fat from their offerings voluntarily. Finding that the voluntary program was not successful, New York City's Board of Health in 2006 solicited public comments on a proposal to ban artificial trans fats in restaurants. The board voted to ban trans fat in restaurant food on 5 December 2006. New York was the first large US city to strictly limit trans fats in restaurants. Restaurants were barred from using most frying and spreading fats containing artificial trans fats above 0.5 g per serving (Davey,2006). • On 1 July 2007, and were supposed to have met the same target in all of their foods by 1 July 2008. The <u>Philadelphia</u> City Council voted unanimously to pass a ban on 8 February 2007, which was signed into law on 15 February 2007, by Mayor <u>John F. Street</u>. By 1 September 2007, eateries must cease frying food in trans-fats. A year later, trans fat must not be used as an ingredient in commercial kitchens. The law does not apply to prepackaged foods sold in the city. On 10 October 2007, the Philadelphia City Council approved the use of trans-fats by small bakeries throughout the city. • Nassau County, a suburban county on Long Island, New York, banned trans fats in restaurants effective 1 April 2008. Bakeries were granted an extension until 1 April 2011. • <u>Albany County</u> of New York passed a ban on trans fats. The ban was adopted after a unanimous vote by the county legislature on 14 May 2007. The decision was made after New York City's decision, but no plan has been put into place. • Legislators received a letter from Rick J. Sampson, president and CEO of the New York State Restaurant Association, calling on them to "delay any action on this issue until the

<p>full impact of the New York City ban is known."</p> <ul style="list-style-type: none">• San Francisco officially asked its restaurants to stop using trans fat in January 2008. The voluntary program will grant a city decal to restaurants that comply and apply for the decal (Boston Globe, 2007). Legislators say the next step will be a mandatory ban.• Chicago also considered a ban on oils containing trans fats for large chain restaurants, and finally settled on a partial ban on oils and posting requirements for fast food restaurants.• On 19 December 2006, <u>Massachusetts</u> state representative <u>Peter Koutoujian</u> filed the first state level legislation that would ban restaurants from preparing foods with trans-fats. The statewide legislation has not yet passed. However, the city of <u>Boston</u> did ban the sale of foods containing artificial trans fats at more than 0.5 grams per serving, which is similar to the New York City regulation; there are some exceptions for clearly labeled packaged foods and charitable <u>bake sales</u>.• <u>Maryland</u> and <u>Vermont</u> were considering statewide bans of trans fats as of March 2007.• <u>King County, Washington</u> passed a ban on artificial trans fats effective 1 February 2009.• On 25 July 2008, California became the first state to ban trans fats in restaurants effective 1 January 2010. California restaurants are prohibited from using oil, shortening, and margarine containing artificial trans fats in spreads or for frying, with the exception of deep frying doughnuts (Sondag, 2008). As of 1 January 2011, doughnuts and other baked goods have been prohibited from containing artificial trans fats. Packaged foods are not covered by the ban and can legally contain trans fats.• In 2007, the American Heart Association launched its "Face the Fats" campaign to help educate the public about the negative effects of trans fats, and bring it into the large picture
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Oils reach in Trans fat: Palm oil, a natural oil extracted from the fruit of oil palm trees that is semi-solid at room temperature (15–25 degrees Celsius), is increasingly being used as an alternative to partially hydrogenated fats in baking and processed food applications (**Food Navigator, 2009**).

Three years 2015–2018 phaseout:

- 1 In 2013, the FDA planned to phase out the use of trans fats in all foods, considering that there is no safe amount of trans fats that should be consumed.
- 2 In June 17, 2015, the FDA issued a final determination that there is no consensus that industrially-produced trans fatty acids are generally recognized as safe for any use in human food. Trans-fat must be removed from prepared foods within three years by June 2018. The FDA estimates the ban will cost the food industry \$6.2 billion over 20 years as the industry reformulates products and substitutes new ingredients for trans fat. The benefits are estimated at \$140 billion over 20 years mainly from lower health care spending. Food companies can petition the FDA for

approval of specific uses of partially hydrogenated oils if the companies submit data proving the oils' use is safe (**Edney, 2015**).

History of decreasing trans fat in fast food:

- 1.** The J.M. Smucker Company, American manufacturer of Crisco (the original partially hydrogenated vegetable shortening), in 2004 released a new formulation made from solid saturated palm oil cut with soybean oil and sunflower oil (**NIHCE, 2010**). This blend yielded an equivalent shortening much like the previous partially hydrogenated Crisco, and was labelled zero grams of trans fat per 1 tablespoon serving (as compared with 1.5 grams per tablespoon of original Crisco) (**Crisco, 2007**).
- 2.** As of 24 January 2007, Smucker claims that all Crisco shortening products in the US have been reformulated to contain less than one gram of trans fat per serving while keeping saturated fat content less than butter (**FCPC, 2007**). The separately marketed trans fat free version introduced in 2004 was discontinued.
- 3.** Agribusiness giant Bunge Limited, through their Bunge Oils division, are now producing and marketing an *NT* product line of non-hydrogenated oils, margarines and shortenings, made from corn, canola, and soy oils (**FDA., 2013**).
- 4.** Since 2003, Lodars Croklaan, a wholly owned subsidiary of Malaysia's IOI Group has been providing trans fat free bakery and confectionery fats, made from palm oil, for giant food companies in the United States to make margarine trans fat free (**urner, 2006**).
- 5.** Some major food chains have chosen to remove or reduce trans fats in their products. In some cases these changes have been voluntary. In other cases, however, food vendors have been targeted by legal action that has generated a lot of media attention. In May 2003, BanTransFats.com Inc., a U.S. non-profit corporation, filed a lawsuit against the food manufacturer Kraft Foods in an attempt to force Kraft to remove trans fats from the Oreo cookie. The lawsuit was withdrawn when Kraft agreed to work on ways to find a substitute for the trans fat in the Oreo. In November 2006, Arby's announced that by May 2007, it would be eliminating trans fat from its French fries and reducing it in other products.
- 6.** Similarly, in 2006, the Center for Science in the Public Interests sued KFC over its use of trans fats in fried foods. Concerning their class action complaint, KFC reviewed alternative oil options, saying

"there are a number of factors to consider including maintaining KFC's unique taste and flavor of Colonel Sanders' Original Recipe". On 30 October 2006, KFC announced that it will replace the partially hydrogenated soybean oil it currently uses with a zero trans fat low linoleic soybean oil in all restaurants in the US by April 2007, although its biscuits will still contain trans fats (**KFC, 2007**). Despite the US-specific nature of the lawsuit, KFC is making changes outside of the US as well; in Canada, KFC's brand owner is switching to trans fat free Canadian canola oil by early 2007. Wendy's announced in June 2006 plans to eliminate trans fats from 6,300 restaurants in the United States and Canada, starting in August 2006.^[190] In November 2006, Taco Bell made a similar announcement, promising to remove trans fat from many of their menu items by switching to canola oil. By April 2007, 15 Taco Bell menu items were completely free of trans fat. In January 2007, McDonald's announced they will start phasing out the trans fat in their fries after years of testing and several delays. This can be partially attributed to New York's recent ban, with the company stating they would not be selling a unique oil just for New York customers but would implement a nationwide change. Chick-fil-A's menu is trans fat free as of 9 October 2007.

- 7.** In response to a May 2007 lawsuit from the Center for Science in the Public Interest, Burger King announced that its 7,100 US restaurants would begin their switch to a menu containing zero grams of trans fat oil by the year 2008.^[193]
- 8.** The Walt Disney Company announced that they will begin getting rid of trans fats in meals at US theme parks by the end of 2007, and will stop the inclusion of trans fats in licensed or promotional products by 2008 (**Walt Disney Company, 2007**)
- 9.** Although IHOP restaurants pledged in a 2007 press release to eliminate transfat from their food, the nutrition information on the company website for the Summer/Fall 2015 Core Menu shows that they still have a considerable amount of transfat in their food, including 4.5 grams in their "mega monster cheeseburger".
- 10.** The Girl Scouts of the USA announced in November 2006 that all of their cookies contain less than 0.5 g trans fats per serving, thus meeting or exceeding the FDA guidelines for the "zero trans fat" designation.

11. Health Canada's monitoring program, which tracks the changing amounts of TFA and SFA in fast and prepared foods shows considerable progress in TFA reduction by some industrial users while others lag behind. In many cases, SFAs are being substituted for the TFAs (**CBC, 2007**).

Trans fat in your food: The manufactured form of trans fat, known as partially hydrogenated oil, is found in a variety of food products, including: 1. Baked goods. Most cakes, cookies, pie crusts and crackers contain shortening, which is usually made from partially hydrogenated vegetable oil. Ready-made frosting is another source of trans fat. 2. Snacks. Potato, corn and tortilla chips often contain trans fat. And while popcorn can be a healthy snack, many types of packaged or microwave popcorn use trans fat to help cook or flavor the popcorn. 3. Fried food. Foods that require deep frying—french fries, doughnuts and fried chicken — can contain trans fat from the oil used in the cooking process. 4. Refrigerator dough. Products such as canned biscuits and cinnamon rolls often contain trans fat, as do frozen pizza crusts. 5. Creamer and margarine. Nondairy coffee creamer and stick margarines also may contain partially hydrogenated vegetable oils (**Kerkstra, et al., 2007**).

Reading food labels: In the United States if a food has less than 0.5 grams of trans-fat in a serving, the food label can read 0 grams trans-fat. This hidden trans-fat can add up quickly, especially if you eat several servings of multiple foods containing less than 0.5 grams a serving. When you check the food label for trans fat, also check the food's ingredient list for partially hydrogenated vegetable oil, which indicates that the food contains some trans fat, even if the amount is below 0.5 grams.

What should you eat? Don't think a food that is free of trans-fat is automatically good for you. Food manufacturers have begun substituting other ingredients for trans-fat. Some of these ingredients, such as tropical oils, coconut, palm kernel and palm oils, contain a lot of saturated fat. Saturated fat raises your LDL cholesterol. In a healthy diet, 25 to 35 percent of your total daily calories can come from fat, but saturated fat should account for less than 10 percent of your total daily calories. Monounsaturated fat, found in olive, peanut and canola oils are a healthier option than is saturated fat. Nuts, fish and other foods containing unsaturated omega-3 fatty acids are other good choices of foods with monounsaturated fats (**Jakobsen, et al., 2010**).

What foods have trans fat? These foods often have trans-fat. You will need to read the Nutrition Facts table to know for sure: 1. Deep fried foods (spring rolls, chicken nuggets, frozen hash browns, French fries). 2. Ready to eat frozen foods (quiche,

burritos, pizza, pizza pockets, French fries, egg rolls, veggie and beef patties).3. Hard (stick) margarine and shortening. 4. Commercially baked goods (donuts, Danishes, cakes, pies). 5. Convenience foods (icing, puff pastry, taco shells, pie crusts, cake mixes).6. Toaster pastries (waffles, pancakes, breakfast sandwiches). 7. Oriental noodles. 8. Snack puddings. 9. Liquid coffee whiteners. 10. Packaged salty snacks (microwave popcorn, chips, crackers). 11. Packaged sweet snacks (cookies, granola bars) (L'Abbé,et al., 2009).

Trans fat, news and Public perception: A cross-sectional study was conducted in Regina, Saskatchewan in February 2009 at 3 different grocery stores located in 3 different regions that had the same median income before taxes of around \$30,000. Research scientist Ali Bell and research associate Dufton Lewis wanted to find out how much the public knows about trans fatty acids and how it feels about it. Of the 211 respondents to the study, most were women who purchased most of the food for their household. When asked how they decide what food to buy, the most important factors were price, nutritional value, and need. When looking at the nutritional facts, however, they indicated that they looked at the ingredients, and neglected to pay attention to the amount of trans-fat. This means that trans fat is not on their minds unless they are specifically told of it.

When asked if they ever heard about trans-fat?	98% said, "Yes
It was unhealthy or healthy?	only 27% said that unhealthy
They only knew a little about trans-fats.	79% have been more educated
Were more likely to view trans-fat as a major health concern?	Respondents aged 41–60
When asked if they would stop buying their favorite snacks if they knew it contained trans fat?	most said they would continue purchasing it, especially the younger respondents
The respondents that called trans-fat a major concern,	56% of them still wouldn't change their diet to non-trans fat snacks.

This is because taste and food gratification take precedence over perceived risk to health. "The consumption of trans fats and the associated increased risk of CHD is a public health concern regardless of age and socioeconomic status" (Brouwer, et al., 2010).

What to look for on the label: 1. Food manufacturers must list how much trans-fat is in their foods on the Nutrition Facts table. Because of this, many food

manufacturers have changed their recipes. A large number of packaged foods are now reduced in trans-fat or are trans-fat free. 2. Look at the number of grams of trans-fat in the Nutrition Facts table. Choose products with the lowest amount. 3. Look at the % DV beside saturated fat on the Nutrition Facts table. Choose products with 10% DV or lower for saturated fat (this number is actually for the total of saturated and trans-fat). The lower the number the better. Foods with a 5% DV or lower are considered low in fat (*McCaffrey, 2007*). 4. Check the ingredient list: avoid eating foods made with hydrogenated or partially hydrogenated oil and shortening. 5. Look for words such as “free of trans fatty acids”, “reduced in trans fatty acids” and “lower in trans fatty acids” (**IMNA,2005**):.

WHERE TO FIND GOOD FATS: 1. Plant-based oils, like the kind you find in I Can't Believe It's Not Butter. 2. Olive, canola, and sesame oils. 3. Avocados 4. Nuts (like almonds, pistachios and walnuts). 5. Fish (like salmon and sardines). 6. Soybeans (*MFMER, 2015*).

Conclusions

Based on the a review of the scientific evidence, the FDA no longer recognizes trans fat that comes from partially hydrogenated oils as GRAS (generally recognized as safe). The ban doesn't affect the small amounts of natural trans-fats found in beef, lamb, and full-fat dairy products. On June 16, 2015, the FDA took action that will significantly reduce the use of Partially Hydrogenated Oils (PHOs), the major source of artificial *trans*-fats in the food supply. Companies have three years (from 2015) to phase out artificial trans-fats from their products. Food makers once used artificial trans-fats to enhance the flavor, texture, and shelf life of processed foods. You might have seen those trans-fats listed as "partially hydrogenated oils. This action is expected to reduce coronary heart disease and prevent thousands of fatal heart attacks each year in the United States. The FDA has set a compliance date of three years. This will allow companies to either reformulate products without PHOs and/or petition the FDA to permit specific uses of PHOs. Many companies have already been working to remove PHOs from processed foods and the FDA anticipates that many may eliminate them ahead of the three-year compliance date. It's important to note that *trans*-fat will not be completely gone from foods because it occurs *naturally* in small amounts in meat and dairy products, and is present at very low levels in other edible oils. The FDA encourages consumers seeking to reduce *trans*-fat intake to check a food's ingredient list to determine whether or not it contains PHOs. Currently, even foods labeled with “0” grams *trans*-fat may contain small amounts (less than one-half a gram per serving) of PHOs. Selecting foods with even small amounts of *trans*-fat can up to a significant intake over time.

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