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TRANS FATS: THE WORST TYPE OF FAT

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ABSTRACT

Trans fatty acids, are a form of unsaturated fats having at least one double bond in their chemical structure. Trans fats (artificial) are now notorious as the worst fat in the food industry. Trans fats get generated when oils are only partially hydrogenated to generate semi-solid oils. This change may seem small, but it totally changes the fat's physical properties. Hydrogenation increases the shelf life, texture and flavour stability of foods. In the past, experts believed trans fats were healthier than saturated fats like butter. Yet recently researchers identified that this man-made fats are associated with many severe health problems. It has drastic effects on the body in comparison to even saturated fats and have arisen as the newest bad boy to the food industry. Several studies pointed out that trans fats consumption is a modifiable dietary risk factor for heart diseases, metabolic dysfunction, diabetes mellitus, endothelial dysfunction. It adversely affects lipid levels, causes systemic inflammation, increases body weight, visceral adiposity, insulin resistance and adversely affects multiple cell types including hepatocytes, adipocytes and macrophages. Though trans fats have been on their way out, many popular products still contain trans fats. Search for an alternative is the need of the hour and efforts should be taken by stakeholders to make the public aware of this worst fat.

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INTRODUCTION

Trans Fatty Acids (TFA) are a class of fatty acids which contain one or more double bonds in the trans configuration. Recently, the implication of TFA to public health has received increasing attention. Trans fats are formed when hydrogen is added to the chemical structure of vegetable oils. Addition of hydrogen makes the fat more shelf-stable and therefore the food made using it will also have a better shelf life. This helps in preventing food from easily spoiling when kept unrefrigerated. They can withstand repeated heating and this process of hydrogenation turns liquid oil into a solid. This allows easier transportation and provides scope for wider uses. Partial hydrogenation, that is, the process of adding hydrogen to oil, creates a semi-solid fat that helps to prevent foods from melting at room temperature and is much cheaper than butter or lard. Trans fats take much longer to go rancid than traditional fats and therefore is the favourite frying oil in restaurants. Trans fats used in frying are also more durable (Severson, 2003) than other types of oils and have a neutral taste. Trans fats have no nutritional value. Man made trans fats are the fats that the food manufactures loves, but our arteries and hearts don't. Several studies reveal the dangers of trans fats.

Trans Fatty Acids (TFA) found in Partially-Hydrogenated Vegetable Oils (PHVO) increases Coronary Heart Disease risk factors to a greater extent than what was thought earlier (ICMR, 2010). The American Heart Association and WHO recommend limiting TFA consumption to less than 1 percent of overall energy intake while the National Academy of Sciences recommends reducing TFA consumption to zero if possible(Bartoo, 2013). In 2013November, the USDA made the welcome, belated determination that partially hydrogenated oils (primary source of trans fats) can no longer be "generally regarded as safe" (Scientific American, 2016). There are no identified nutritional benefits of trans fatty acids and clear metabolic consequences exist. Therefore judicious public policy would dictate that the consumption be minimized and that information on the trans fats content of foods be available to consumers (Ascherio and Willett, 1997).To promote public health, several local and state governments in the United States have banned the usage of artificial trans fats in restaurants (Resnik, 2010).

TFA are unsaturated fatty acids. But...

Trans fatty acids are a form of unsaturated fats. Unlike saturated fats, (no double bonds) unsaturated fats contain at least one double bond in their structure. This double bond can be in the "cis" or "trans" configuration based on the

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position of hydrogen atoms around the double bond. The “cis” configuration means hydrogen atoms on “same side” of double bond and it is the common structure in nature. “Trans” is latin for “on the opposite side.” Saturated fats have hydrogen atoms on opposite sides of double bond, which can lead to many health problems.

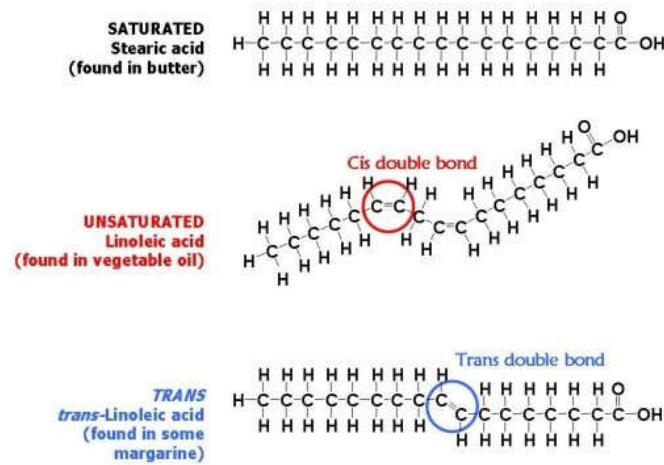


Figure 1. Structure of Saturated, Unsaturated (cis) and Trans fatty acids

Sources of Trans Fats in diet

Trans fatty acids in the diet come from two main sources (Srilakshmi, 2014).

- **Natural sources:** Trans fats are produced in the gut of ruminants by bacterial fermentation. Trans fats occur naturally in fats and meats of ruminant animals like beef, lamb and mutton and dairy products like cheese and cream, but at much smaller concentrations. Such natural trans fats are also known as Ruminant Trans fats (rTFA).
- **Industrial Trans fats (iTFA):** Most trans fats are formed through an industrial process (iTFA) that adds hydrogen to vegetable oils, and the oil gets converted to solid at room temperature. Trans fats may also be produced when vegetable oils are heated for frying foods at very high temperatures. A study by Li *et al* (2013) shows that the cis to trans isomerization may occur at 150 °C. To avoid the risk of trans fatty acid (TFA) intake in daily foods, the heating temperature should be kept under 150 °C.

Discovery and development of Industrial Trans fats

German chemist Wilhelm Normann in 1901 discovered the process of partial hydrogenation of oils. This hydrogenation converts inexpensive liquid vegetable oils into semi solid shortenings and creates trans fats in this way. They add hydrogen atoms to unsaturated fats by adding hydrogen gas through vegetable oil in the presence of nickel catalyst. The inventors of partial hydrogenation received the Nobel Prize in 1912 (Scientific American, 2016). Partially hydrogenated oils don't spoil as easily as non-hydrogenated fats. Therefore hydrogenated fats were attractive to food makers and industries. Over the last few decades, partially hydrogenated oils became a mainstay in popular snacks, commercially baked food items, and margarines. Before the discovery of partial hydrogenation, the only trans fat that humans consumed came

from ruminants. Many food manufacturers started using artificial trans fats in food products during the 1980s to reduce the saturated fat content of food. This is because the medical consensus at that time was that saturated fats are very unhealthy. Now it is clear that trans fats are much worse for the human heart than saturated fats; some saturated fats are good for health; and moderate amounts of cholesterol in the diet are essential to health (Severson, 2003). When saturated fat was identified as a contributor to high cholesterol, companies such as McDonald's switched from saturated fats like beef tallow to hydrogenated vegetable oil for frying. At the time, switching from butter or lard (both of which contain high saturated fat) to a product made from healthy vegetable oil seemed to make sense. It took decades for scientists to realize how deadly trans fats could be.

Hydrogenation

Trans fats are created by pumping hydrogen into vegetable oils. This changes the chemical structure of the oil, turning liquid oil into a solid one. This process involves high pressure, hydrogen gas and a metal catalyst like nickel. This hydrogenation of vegetable oils alters the geometric structure of the polyunsaturated fatty acids from natural ‘cis’ to ‘trans’ form. Only cis forms can serve as essential fatty acids to be incorporated in cell structure. When fats are completely hydrogenated, they have the maximum possible hydrogen atoms bound to them, and the liquid oil become solid. But when oils are only partially hydrogenated to generate semi-solid oils, trans fats are created.

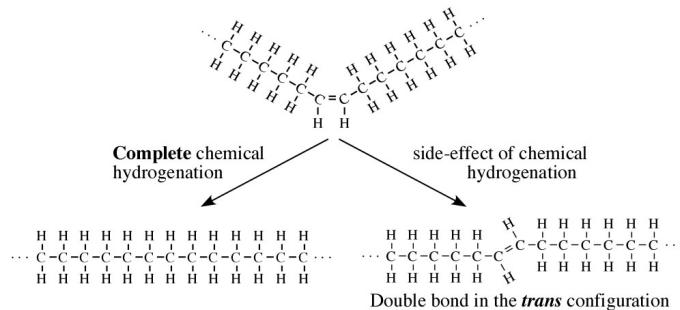


Figure 2. Hydrogenation

Concern has existed that the process of partial hydrogenation may have adverse consequences because natural essential fatty acids are destroyed and it inhibit the enzymatic desaturation of linoleic and linolenic acid (Ascherio and Willett, 1997).

Foods that contain Manufactured Trans Fats

The manufactured form of TFA, Partially Hydrogenated Vegetable Oil (PHVO), is found in a variety of food products. Food and Drug Administration once estimated that about 95 percent of prepared cookies, 80 percent of frozen breakfast products and all crackers contained trans fat.

- **Baked foods:** Cakes, biscuits, pies, crackers and cookies contain shortening, which is usually partially hydrogenated oil.
- **Fried food:** Foods that require deep frying like french fries, doughnuts and fried chicken — usually contain trans fat from the oil used for cooking process.
- **Snacks:** Potato, corn and tortilla chips often contain trans fat.

- **Refrigerator dough:** Products such as frozen meat are loaded with hydrogenated oils or trans fat, as do frozen pizza crusts, ready-to-use frostings and frozen pies.
- **Creamer and margarine:** Nondairy coffee creamer and most of the margarines contain partially hydrogenated vegetable oils.
- **Microwave popcorn:** Popcorn can be a healthy snack. But one will be consuming the harmful buttered and flavoured popcorns, yet which contain lots of trans fats which are added to enhance its flavours.
- **Fat spreads and margarines:** Many people have been using margarine, believing it is a healthier substitute to the butter. But margarine is hydrogenated vegetable oil and contain trans fats, although reformulation has led to significant reductions in recent years (Poojara, 2013).

Dangers of Trans Fats

Concern about TFAs increasing the risk of coronary disease has existed for many decades (Ascherio *et al*, 1994). Contrary to prevailing dietary advice, recent researches found no excess cardiac risk associated with intake of saturated fat. In contrast, research suggests that industrial trans fats may increase the risk of coronary heart disease (Science daily, 2015) and are more worsen than all other fats. Even in 1981, a group of Welsh researchers speculated that TFA might be linked with heart disease (Thomas *et al*, 1981). Harvard study by Willett *et al*, (1993) strongly supported the hypothesis that intake of trans fats contributed to the risk of heart attack. The study also concluded that replacing just 2 percent of energy from trans fat with healthy unsaturated fat could decrease the risk of coronary heart disease by about one-third. The increased risk of heart diseases has been associated with the intake of total TFA, as well as foods known to contain major sources of iTFA, such as margarine, cakes, and cookies. (Sun *et al*, 2007 and Lemaitre *et al*, 2002). A high LDL cholesterol level in combination with a low HDL cholesterol level increases the risk of heart disease. Thus trans fatty acids turn out to be even more atherogenic than saturated fats like myristic acid (Ascherio *et al*, 1994 and Neubauer *et al*, 2006). Katan *et al*, (1995) also pointed out that diets high in trans fats can lead to obesity, high blood pressure, increased levels of LDL and Triglyceride, decreased level of HDL, and thereby increasing the risk of heart disease. Lichtenstein *et al*, (2003) in his studies revealed that TFA consumption increased Lipoprotein-a levels and are associated with increased CHD risk. In a case control study by (Sun *et al*, 2007), the estimated dietary TFA consumption was strongly correlated with erythrocyte TFA levels and higher total erythrocyte TFA content was associated with higher CHD risk. Mozaffarian *et al* (2009) also observed adverse lipid effects like increase in LDL- cholesterol, decrease in HDL-cholesterol, increased total/HDL-C ratio. He also explains its proinflammatory effects like increased tumor necrosis factor- α activity and endothelial dysfunction. Trans fats are believed to damage the inner lining of the blood vessels or the endothelium. Another study at Harvard School of Public Health indicates that eliminating trans fats from the food supply could prevent up to 1 in 5 heart attacks and related mortality in U.S (Mozaffarian, 2006).

Mozaffarian *et al* (2004) reported that TFA intake is positively associated with markers of systemic inflammation, interleukin 6 (IL-6) and C-reactive protein (CRP) in women with higher body mass index. It also promotes the activity of the immune system which is associated with cardiovascular

diseases, diabetes, and other chronic conditions. (Micha and Mozaffarian, 2009). From looking at the evidence, it seems very clear that trans fats are an important driver of inflammation, which can potentially lead to all sorts of diseases. Eating trans fat promotes obesity and resistance to insulin, both are precursor to diabetes. Lefevre *et al*. (2005) observed higher insulin in postprandial state and C-peptide concentrations after TFA meal, compared with the MUFA meal. Experimental studies in animals by Axen *et al*. (2003) also suggest that TFA consumption induces insulin resistance. Hu *et al*. (2001) and Souza *et al* (2015) also suggest that TFA consumption was significantly associated with diabetes incidents.

The association of trans fat consumption with diabetes risk was most evident among overweight or obese individuals or people with lower levels of physical activity (Salmeron *et al*, 2001). Ibrahim *et al*. (2005) demonstrated that feeding rats a diet with 3%E TFA had raised fasting insulin levels compared with control. This increase was larger than for a diet with 10%E from SFA. Natarajan *et al*. (2005) studied that rats consuming 10%E TFA had low insulin-stimulated glucose transport compared with a diet with 10%E from SFA. The above studies suggest that TFA induce insulin resistance, even compared to SFA. Tsai *et al* (2005) observed in his studies that TFA intake has been associated with incidence of cholelithiasis and Chavarro *et al*, (2007) found association of TFA with an ovulatory infertility. Both these conditions are associated with insulin resistance. Long-term prospective observational studies (Koh-Banerjee *et al*, 2003) suggest that TFA consumption promotes weight gain, particularly accumulation of abdominal fat. TFAs enhanced intra-abdominal deposition of fat, even in the absence of excess calorie, and leading to insulin resistance (Kavanagh *et al*, 2007). Trans fat also disturbs the normal healthy endothelium of blood vessels. According to Thompson *et al* (2008) there is weak evidence for association between trans-FA and breast or colorectal cancer. Recent studies pointed out that high trans-fat intake may lead to Alzheimer's disease, breast and prostate cancer, liver dysfunction, infertility, Type 2 diabetes and even depression (Lichtenstein *et al*, 2003 and Thompson *et al* 2008). That is why many doctors considered trans fats to be the worst type of fat you can eat. But additional investigation is required to elucidate the potential effects of TFA consumption on each of these disease outcomes.

Natural Trans Fats: good or bad?

Contrary to popular opinion, all trans fats are not bad. Muzaffarian *et al* (2009) had the opinion that in the amounts consumed in actual diets rTFA is not a major contributor to CHD risk. Although data from experimental models suggest that rTFA has benefits over risk of CVD and cancer, further research is needed to determine the effects in humans. Conjugated Linoleic acid (VLA) and trans Vaccinic acid (VA), two natural animal fats found in dairy and beef products reduce risk factors associated with heart disease, diabetes and obesity(Field *et al*, 2009). Existing data from human studies do not consistently support the conclusions from experimental studies (Gebauer, *et al*, 2016). Milk contains trans fat components with beneficial properties, like Conjugated Linoleic Acid (CLA). Milk fat is the richest natural source of CLA, an average of 4.5mg/g of fat (Nagpal *et al*, 2007). There is increasing interest towards the health benefits of CLA such as ant carcinogenic, antiatherogenic, antidiabetic and

immunomodulatory effects (Belury, 2002; Kathirvelan and Tyagi, 2011). There have been few Animal studies that have shown protective effects of CLA on prostate cancer (Gebauer, et al., 2016) In ruminants CLA originates during biodegradation of linoleic acid. Vaccenicacid is another naturally occurring trans-fatty acid found in the ruminant fats and in dairy products such as milk, yogurt and butter. Vaccenic acid is the only dietary precursor of the *cis*-9, *trans*-11 conjugated linoleic acid (CLA), which has been associated with various health benefits. Other than the benefits obtained through CLA, the benefits of vaccenic acid itself in reducing cancer risk are not clear. Epidemiological studies have produced contradictory results. A case control study by Aro et al (2000) found an inverse association of serum VA and breast cancer among postmenopausal women. But Shannon et al (2007) observed a direct association of VA in breast cancer risk.

Shopping Tips

Even if the nutrition label says there's zero trans fat, that doesn't necessarily mean it has no trans fats. A product claiming zero trans fat may actually contain up to a half gram. Brands are allowed to round down to zero if the product has less than half a gram. So check the ingredient label for "vegetable shortening" or "hydrogenated" or "partially hydrogenated oils". The major but hidden source of trans fats are the industrially made partially hydrogenated vegetable oils. Search for an alternative product without such words, especially if the product is something you eat regularly. To estimate the trans fat content in a product add together the saturated, monounsaturated and polyunsaturated fat. If the total is less than the "total fat" number, the rest is possibly trans fat. Of course, many food products come without labels, such as food sold in bakeries, restaurants, cafeterias and schools. Since consumers cannot be certain whether these unlabeled food contain trans fats, they cannot make the choice to avoid trans fat-laden foods. There are many states and cities considering laws to eliminate trans fats in foods. So be intelligent while shopping to avoid the worst type of fat. In order to avoid these bedstraws fats, the best thing you can do is avoid processed foods and fast food from your diet. It is better to choose real butter (though saturated) instead of margarine; and olive oil or coconut oil instead of harmful, but in smaller amounts. Buy fresh meat and then refrigerate it at home. Making homemade meals and snacks instead of fast foods are the best way to remove trans fats. We can choose the type of fat and the amount of fat in home recipes.

Smart steps by the Food Industry

Big improvements have been found in recent years, although trans fats are still present in many processed foods. Consumption of trans fats has reduced significantly in recent years. Yet, current intake is quite high enough to cause ill health. Many food makers have recognized that consumers, who are aware of this, would avoid products containing trans fat. Fearing losses, several companies have found ways to make their brands without trans fats or partially hydrogenated oils. Even some margarines have been almost trans fat-free for several years. Most chip makers have now started using trans-free oils for making chips and other fried snacks. Frozen food makers have introduced frozen fried chicken products without trans fat. Several major restaurant chains have reformulated their products to reduce trans fats.

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