# Trans Fatty Acids: Chemistry, Health risk association, Global and Indian regulations- A review

**Dr. Gargee Yadav**
Associate Professor
Department of Chemistry
S.N.Sen B.V.P.G.College, Kanpur, India

***Abstract :*** Trans fatty acids in foods have been a subject of concern from the day they have been identified as a potent health risk factor linked with cardiac diseases.

Industrially produced trans fats are an important ingredient in snack food, baked foods, and fried foods. Manufacturers often use them as they don't turn rancid as easily as non-hydrogenated fats. They can withstand repeated heating without breaking down, and the process can turn a liquid oil into a solid, which can be easily transported. It was also much less expensive than many solid animal fats. These characteristics were attractive to food makers, and partially hydrogenated oils became a mainstay in commercial baked goods like packaged pastries and cookies, other snack foods, and in fast-food restaurant deep fryers. Moreover, it's consumption increased since the 1960s when the food industry began replacing animal fats with partially hydrogenated oils following public health recommendations to reduce the intake of saturated fats, such as those contained in butter.

Recent research has shown that it promotes inflammation, an overactivity of the immune system that has been implicated in heart disease, stroke, diabetes, and other chronic conditions.

Elimination of industrially produced trans fats from the global food supply has been identified as one of the priority targets of WHO's strategic plan.

***IndexTerms* - trans-fatty acids, partially hydrogenated vegetable oils, Heart diseases WHO's strategic plan**

## INTRODUCTION

Prior to 1950s butter was the main fat ingredient, but with the research related to the negative health impacts of saturated fatty acids, partially hydrogenated oils became a popular replacement for saturated acids (butter). They were cheaper than fats.

Trans Fatty acids are unsaturated fatty acids that contain one or more unconjugated double bond in the trans configuration [1].

The term trans fats is used to describe triglycerides that are rich in trans fatty acids. Although some trans fatty acids are produced during fermentation in the rumen of ruminant animals, most trans fatty acids are generated during industrial processing through partial hydrogenation of vegetable oils rich in Polyunsaturated Fatty Acids (PUFAs).
Poly unsaturated fatty acids are susceptible to attack by oxygen molecules because their points of unsaturation render them vulnerable in this regard [2].

When oxygen molecules attack these points of unsaturation the modified fatty acid becomes oxidized. The oxidation of fatty acids makes the oil rancid and gives the food prepared with it an unappetizing taste [3]

As oils can undergo oxidation when stored in open containers, they must be stored in airtight containers and possibly be refrigerated to minimize damage from oxidation. Partial Hydrogenation offers a solution to this problem. An unsaturated fat can be made into a saturated fat via hydrogenation reactions.

The amount of trans fatty acids in partially hydrogenated vegetable oils can be as high as 60%, with different isoforms of trans-octadecenoic acid (trans 18:1) accounting for 80–90% of the total trans fatty acid content [4]

Foods containing these industrially produced artificial trans fatty acids carry several benefits including improved texture, better taste, and enhanced shelf life, but at the same time they promote inflammation, ER stress, and cholesterol synthesis [5].

## SOURCES OF TRANS FATS

There are two main sources for trans fats: natural sources (in the dairy products and meat of ruminants such as cows and sheep) and industrially produced sources (partially hydrogenated oils) [6].

Natural trans fats are formed by bacteria in the stomachs of cattle, sheep, and goats. Beef, lamb, and dairy products contain naturally occurring trans fats. Other types of meat, such as poultry, fish, and pork, also contain a small amount trans fats [4].

On the other hand, artificial trans fats are mainly formed during hydrogenation, a process in which hydrogen is added to vegetable oil to form a semisolid product known as partially hydrogenated oil

Trans fats are present in commercial baked goods, such as cakes, cookies, pastries, Microwave popcorn, Frozen pizza, Refrigerated dough, such as biscuits and rolls. Fried foods, including French fries, doughnuts, and fried chicken.[8].

**CHEMISTRY OF TRANS FATS**

Saturated fats are solid at room temperature due to their molecular shape.
They have a chain like structure which allows them to stack very well forming a solid at room temperature. Unsaturated fats are not linear due to double bonded carbons which results in a different molecular shape because the sp2 carbons are trigonal planar, not tetrahedral (sp3 carbons) as the carbons are in saturated fats. This change in structure will cause the fat molecules to not stack very well resulting in fats that are liquid at room temperature. Butter is mostly saturated fat, that's why it's solid at room temperature. Olive Oil is liquid at room temperature, thus it's an unsaturated fat.
Vegetable oils are commonly referred to as "polyunsaturated" i.e. there are several double bonds present. Vegetable oils may be converted from liquids to solids by the hydrogenation reaction.
Hydrogenation of vegetable oils is carried out by passing out hydrogen gas (H2) into the heated oil in the presence of 'powdered nickel as catalyst'. It is an addition reaction [9].

Complete hydrogenation creates a product containing only saturated fats, which typically has a solid and waxy consistency that is not appropriate for cooking, baking, or eating. Thus, only partial hydrogenation of vegetable oils is done. Partially hydrogenated fats have improved taste, shelf life, slightly increased melting point, so that it is solid at room temperature, also they impart the desired texture and crispness to baked and fried foods. In addition to this, processed vegetable oils are cheaper than fats obtained from animal sources, making them a popular choice for the food industry [10].

A major health concern during the hydrogenation process is the production of trans fats. Trans fats are the result of a side reaction with the catalyst of the hydrogenation process. An unsaturated fat which is normally found as a cis isomer converts to a trans isomer of the unsaturated fat.
Although trans fatty acids are chemically "monounsaturated" or "polyunsaturated," they are nutritionally different from the cis monounsaturated or polyunsaturated fatty acids.
The major negative factor associated with trans fats is that it tends to raise "bad" LDL- cholesterol and lower "good" HDL-cholesterol.

**NEED FOR ELIMINATION FROM DIETARY INTAKE**

1993 Harvard study strongly supported the hypothesis that intake of partially hydrogenated vegetable oils contributed to the risk of having a heart attack. [11]

Trans fat consumption increased LDL cholesterol and reduced HDL cholesterol [12].

They have been found to diminish mental performance. Relationship between Trans-fat intake and depression risk was observed. There is growing evidence for a possible role of Trans fat in the development of Alzheimer´s disease and cognitive decline with age [13].

Trans fats intake has also been associated with an increased risk for other noncommunicable diseases (NCDs) and related conditions such as ovarian cancer, infertility, endometriosis, Alzheimer's disease, diabetes, and obesity.

Replacing trans fats with unsaturated fatty acids decreases the risk of heart disease.

Research has already found that earlier bans on the use of trans fats in New York State public eateries are associated with a drop in heart attacks and strokes [14].

**GLOBAL REGULATIONS**

Elimination of industrially produced trans fats from the global food supply has been identified as one of the priority targets of WHO's strategic plan.
California was the first state to pass legislation phasing out trans fats from restaurants and baked goods by 2010 and 2011, respectively.
Substantial progress has been made in the last ten years to remove iTFA from the global food supply and will protect 3.5 billion people from this toxic substance. Despite these efforts, much remains to be done, with over 100 countries yet to act.
Although there is no safe level of trans fat consumption, the World Health Organization recommends that total trans-fat intake does not exceed 1% of total energy intake, which translates to less than 2.2 g per day for a 2,000-calorie diet.
Since all people, in all countries, must be protected from the risks of trans fat consumption, the World Health Organization has called for global elimination of industrial trans-fat by 2023 with the REPLACE initiative [15].

REPLACE provides six strategic actions to ensure the prompt, complete, and sustained elimination of industrially produced trans fats from the food supply:

1. Review dietary sources of industrially produced trans fats and the landscape for required policy change.
2. Promote the replacement of industrially produced trans fats with healthier fats and oils.
3. Legislate or enact regulatory actions to eliminate industrially produced trans fats.
4. Assess and monitor trans fats content in the food supply and changes in trans-fat consumption in the population.
5. Create awareness of the negative health impact of trans fats among policy makers, producers, suppliers, and the public.
6. Enforce compliance of policies and regulations.

In year 2020, WHO announced a certification scheme to recognize countries that achieve the elimination of industrially produced trans-fatty acids.

## INDIAN REGULATIONS

Trans fats in India are often found in "vanaspati," a partially hydrogenated oil often used as a low-cost alternative in food preparation. [16]

Bakery products, like Biscuit, cake, rusk etc.
Fried foods, such as bhatura, poori, pakora, bhujiya, namkeens etc.
Small amounts of trans fats are also formed when the same cooking oil is used for repeated frying; not only at commercial outlets but even at household levels [17]

In India, the Food Safety and Standards Authority of India (Fssai) passed a policy in November 2018 reducing the current permissible limit of trans fats in oils/fats in food products from 5% to 2% by year 2022 and protecting an additional 1.4 billion people from the harmful effects of consumption of trans fats [18].

In Asia, only India and Thailand have implemented best-practice trans-fat policies.

## CONCLUSION

Eliminating trans fats is key to protecting health and saving lives. Removing them completely from processed foods could prevent thousands of heart attacks and deaths each year, lessening the burden on health systems as well.

Eliminating trans fatty acids is achievable by combined approaches.

The developing nations need to mandate restrictions on trans fats and legally impose limits on the amount that can be contained in packaged food.

Government should formulate policies so that food manufacturers ensure trans fats being replaced with healthier fats – polyunsaturated (healthiest) or monounsaturated fats and oils.

Furthermore, since the rules may not cover foods without labels—such as those sold in bakeries, cafeterias, schools, and restaurants—consumers couldn't easily choose to avoid potentially trans-fat-laden foods in these eatables. For this educational efforts and local bans will create awareness among masses to avoid the use and consumption of such products.

Governments, the food industry, academia and civil society should work in tandem to make food systems healthier for future generations, by eliminating industrially produced trans fats.

## REFERENCES

**[1]. https://www.sciencedirect.com/topics/medicine-and-dentistry/trans-fatty-acid**
**[2]. Frankel, E.N., Lipid Oxidation, ed. E.N. Frankel. Vol. 10. 2005, Bridgewater, UK: The Oily Press**
**[3]. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/rancidity**

**[4]. Kuhnt K, Baehr M, Rohrer C, Jahreis G. Trans fatty acid isomers and the trans-9/trans-11 index in fat containing foods. Eur J Lipid Sci Technol. 2011;113:1281–92**

**[5]. Filip S, Vidrih R. Trans Fatty Acids and Human Health. InTech; 2012. 43–64.**

**[6]. Musavi A, Tekin A, Erinç H. Formulation of trans-free margarines using hydrogenated and interesterified palm olein. J Oil Palm Res 2011;23:1153-8.**
**[7]. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5579633/**

**[8]. https://www.fsai.ie/faq/trans_fatty_acids.html**

**[9]. https://chem.libretexts.org/Bookshelves/Biological_Chemistry/Supplemental_Modules_(Biological_Chemistry)/Lipids/Fatty_Acids/Hydrogenation_of_Unsaturated_Fats_and_Trans_Fat**

**[10]. https://www.fsai.ie/faq/trans_fatty_acids.html**

**[11]. Willett WC, Stampfer MJ, Manson JE, Colditz GA, Speizer FE, Rosner BA, Hennekens CH, Sampson LA. Intake of trans fatty acids and risk of coronary heart disease among women. The Lancet. 1993 Mar 6;341(8845):581-5.**

**[12] Mensink RP, Katan MB. Effect of dietary trans fatty acids on high-density and low-density lipoprotein cholesterol levels in healthy subjects. New England Journal of Medicine. 1990 Aug 16;323(7):439-45.**

**[13]. https://pubmed.ncbi.nlm.nih.gov/27215959/**

**[14].Brandt EJ, Myerson R, Perraillon MC, Polonsky TS. Hospital admissions for myocardial infarction and stroke before and after the trans-fatty acid restrictions in New York. JAMA cardiology. 2017 Jun 1;2(6):627-34.**

**[15]. Nishida C, Uauy R. WHO scientific update on health consequences of trans fatty acids: Introduction. Eur J Clin Nutr 2009;63 Suppl 2:S1-4.**

**[16]. Dorni C, Sharma P, Saikia G, Longvah T. Fatty acid profile of edible oils and fats consumed in India. Food chemistry. 2018 Jan 1;238:9-15**

**[17]. https://eatrightindia.gov.in/trans-fat-free-india.jsp**

**[18]. https://www.thehindubusinessline.com/news/national/fssai-launches-new-campaign-to-eliminate-trans-fats**