REVIEW

TRANS FATS- A REVIEW

T.MONICA JYOTHI*, DR.SUDHA PARIMALA

Department of Pharmaceutical Analysis and Quality Assurance, RBVRR Womens College Of Pharmacy, Osmania University, Barkathpura, Hyderabad, Telangana, India.

Submitted on: 04.04.2016; Revised on: 25.04.2016; Accepted on: 03.05.2016

ABSTRACT:

Usually fats have cis configuration(naturally occurring fats),but in the food production, liquid cis-unsaturated fats such as vegetable oil are partial hydrogenated which converts some of the cis form into trans form by an isomerization reaction with the catalyst used for the hydrogenation, which yields a trans fat. These straight molecules (trans fat molecules) are able to stack more closely against one another, making the substance more solid and stable. Due to busy schedules many are preferring readymade foods like fast foods, chocolates. wafers, popcorn, french fries, KFC foods, pastries, cakes, margarine, vanaspathi, pizza, burgers, ice creams, cookies, pies, breads, French fries, doughnuts, potato chips etc are rich in trans fat. A coronary heart disease is the major health risk. Others Diseases are cancer, obesity, infertility in women, diminished memory, Alzheimer's disease, diabetes, liver dysfunction, major depressive disorders, behavioral irritability and aggression, Damage arteries. Trans fat decreases the HDL cholesterol and increases LDL cholesterol. It can be easily determined by Various Analytical Techniques. While it's impossible to completely avoid all trans fats due to their presence in nature, it is advisable to cut them out of your diet as much as possible, and the best place to start is avoiding all foods with the phrase "partially hydrogenated/Shortening" anywhere in the ingredients list.

KEYWORDS: Partially Hydrogenated, Coronary Heart Diseases, FTIR-ATR

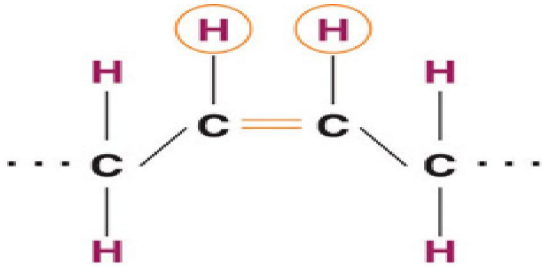
Corresponding Author: T.Monica Jyothi
E-mail : monicajyothi777@gmail.com

Indian Research Journal of Pharmacy and Science; 9(2016) 540-548
Journal Home Page: https://www.irjps.in

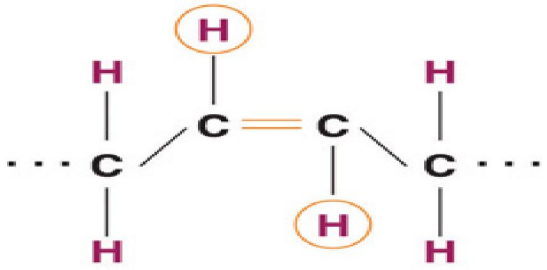
INTRODUCTION:

Trans fats are mono- or polyunsaturated fats in which one or more of the double bonds is in a trans configuration[1].Naturally occurring trans fats– or ruminant trans-fatty acids are produced by the gut bacteria of ruminant animals and found in small amounts in the food products from these animals (for example, the meat and milk products from cattle, sheep and goats)[2].The trans fatty acid content of industrially hydrogenated fats varies widely and may account for up to 60% of the fatty acid content, whereas the trans fatty acid content of beef and dairy products is considerably lower and accounts for 2%–5% of the fatty acid content. Processed foods and oils provide approximately 80% of trans fats in the diet, compared to 20% that occur naturally in food from animal sources[3].

Cis fatty acid (bent)



Trans fatty acid (straighter)



MECHANISM OF TRANS FATS FORMATION:

Fatty acids are generally classified as saturated, monounsaturated or polyunsaturated, and properties of fats depend on the fatty acids composing them. Within an unsaturated fatty acid molecule, one of two configuration forms can occur around one double bond. The cis form has the two parts of the carbon chain bent towards each other, and the trans form has the two parts almost linear, similar to saturated fatty acids. Linear molecules can pack together closely in a given space, and give the substance a higher melting point, while bent molecules cannot pack together easily, so that fats of these molecules have a lower melting point[4]. By adjustment of the hydrogenation reaction parameters, such as catalyst concentration, hydrogen pressure, temperature, and agitation, the production of trans double bonds can be modulated. For example, maximum formation of TFA isomers is achieved at low hydrogen pressures (100 to 200kilopascal [kPa]), high temperatures (200°C to 215°C),and a catalyst concentration of 0.005% nickel/oil. Whereas lower formation of TFA isomers (but higher conversion of the double bonds to saturated bonds) is achieved at higher hydrogen pressures (300 kPa), lower temperatures (165°C to 180°C), and slightly higher catalyst concentrations (0.008% nickel/oil)[5].

HOW TO AVOID TRANS FATS IN FOOD PRODUCTS:

Use the Nutrition Facts Label as your tool for reducing trans fat in your diet.

- Keep Trans fat consumption as low as possible by limiting foods that contain trans fats formed during food processing. Trans fat has no percent Daily Value (%DV), so use the amount of grams (g) as your guide.

- Look for partially hydrogenated oils, a source of trans fat, on the ingredient list on a food package. Note: The Nutrition Facts label can state 0 grams of trans fat if the food product contains less than 0.5 grams of trans fat per serving. Thus, if a product contains partially hydrogenated oils, then it might contain small amounts of trans fat even if the label says 0 grams of trans fat.
- Choose lean cuts of meat and skinless poultry.
- Switch from stick margarine to soft margarine (liquid, tub, or spray).
- Limit packaged snack foods and commercially prepared (ready-made) baked goods.
- Substitute fat-free (skim) or low-fat (1%) milk and milk products (such as yogurt and cheese) or fortified soy beverages for full-fat (whole) milk and milk products.
- Get plenty of foods that are naturally low in fat and high in dietary fiber, such as whole grains, beans, peas, fruits, and vegetables.
- Cook and bake with liquid oils (like canola or olive oil) instead of solid fats (like shortening, butter, or lard).
- Try baking, steaming, grilling, or broiling. These cooking methods do not add extra fat.

When eating out, remember to ask which fats are being used to make the food you're ordering. You can also ask to see nutrition information, which is available in many fast food and chain restaurants, and choose a lower fat option[6].

SOURCES:

They originate from various sources:

1. Bacterial transformation of unsaturated fatty acids in the rumen of ruminant animals.

2. Industrial hydrogenation (used to produce semi-liquid and solid fats that can be used for the production of foods such as margarine, shortenings and biscuits).

3. Deodorisation (a necessary step in refining) of unsaturated vegetable oils (or occasionally fish oils) high in polyunsaturated fatty acids.

4. Heating and frying of oils at too high temperatures (> 220°C). These modifications are time-dependent with about 5% of isomerization of n-3 18:3 after 2 hours and 25% after 12 hours of heating[7].

Table I: Sources of Fats [8][9][10]

SOURCE	AMOUNT OF TRANS FAT
FRENCH FRIES	MEDIUM(8gms)
DOUGHNUTS	ONE DOUGHNUT(5gms)
POUND CAKE	ONE SLICE(4.5gms)
SHORTENING	ONE TABLESPOON(4gms)
CANDY BAR	ONE BAR(3 gms)
MARGARINE	ONE TABLESPOON(3 gms)
POTATO CHIPS	SMALL BAG(3 gms)
COOKIES(CREAM FILLED)	2 to 3 gms
BISCUITS	3.5 gms
MICROWAVE POPCORN	5 gms
SANDWITCH	2 gms
FROZEN PIZZA	1 gm per slice
PIE AND PIECRUST	1 -4 gms
PILLSBURY FROZEN POT PIE CRUST DOUGH	15 gms
FRIED CHICKEN	1 gm
ICE CREAM	0.5 gms
BURGER	3.5 gms
CRACKERS	0.5 gms
MEAT STICKS	1-2 gms
PASTRIES	4.5 gms
FROZEN DINNERS	0.5 gms

SWEET ROLLS	0.5 gms
ASIAN CRUNCHY NOODLES	1.5 gms per ½-cup serving
CANNED CHILI	0.5-1 gm
PACKAGED PUDDING	1 gm

HEALTH RISKS

The exact biochemical methods by which trans fats produce specific health problems are a topic of continuing research. 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. They increase the risk of cardiovascular disease more than any other macronutrient including saturated fat, through multiple mechanisms including adverse effects on lipids, endothelial function and inflammation. They are readily incorporated into cell structures such as cell membranes and the Golgi apparatus, resulting in unintended effects on multiple biological pathways[11].

CORONARY HEART DISEASE

The primary health risk identified for trans fat consumption is an elevated risk of coronary heart disease(CHD)[11].Trans fats increase LDL cholesterol and reduce HDL cholesterol, they result in an exaggerated increased risk of coronary heart disease[12]. A 1994 study estimated that over 30,000 cardiac deaths per year in the United States are attributable to the consumption of trans fats. By 2006 upper estimates of 100,000 deaths were suggested. A comprehensive review of studies of trans fats published in 2006 in the New England Journal of Medicine reports a strong and reliable connection between trans fat consumption and CHD, concluding that "On a per-calorie basis, trans fats appear to increase the risk of CHD more than any other macronutrient, conferring a substantially increased risk at low levels of consumption (1 to 3% of total energy intake)". 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.There are two accepted tests that measure an individual's risk for coronary heart disease, both blood tests. The first considers ratios of two types of cholesterol, the other the amount of a cell-signaling cytokine called C-reactive protein. The ratio test is more accepted, while the cytokine test may be more powerful but is still being studied. The effect of trans fat consumption has been documented on each as follows:

Cholesterol ratio:

Trans fatty acids increased the plasma ratio of total to HDL cholesterol nearly twofold compared with saturated fats.This ratio compares the levels of LDL to HDL. Trans fat behaves like saturated fat by raising the level of LDL, but, unlike saturated fat, it has the additional effect of decreasing levels of HDL. The net increase in LDL/HDL ratio with trans fat is approximately double that due to saturated fat.(Higher ratios are worse.) One randomized crossover study published in 2003 comparing the effect of eating a meal on blood lipids of (relatively) cis and trans fat rich meals showed that cholesteryl

ester transfer (CET) was 28% higher after the trans meal than after the cis meal and that lipoprotein concentrations were enriched in apolipoprotein after the trans meals[11].

C-reactive protein (CRP):

A study of over 700 nurses showed that those in the highest quartile of trans fat consumption had blood levels of CRP that were 73% higher than those in the lowest quartile. The stiffer and harder fats are,the more they clog up your arteries.Trans fat do the same thing in our bodies that bacon grease does to kitchen sinks.Over time,they can "clog the pipes" that feed the heart and brain,which can lead to heart attack or stroke risk[11].

OTHER HEALTH RISKS

In general, there is much less scientific consensus asserting that eating trans fat specifically increases the risk of other chronic health problems[11]:

ALZHEIMER'S DISEASE

Several lines of evidence support the theory that an elevated blood cholesterol level is related to the development of Alzheimer's disease. In experimental models, animals fed high-fat and high-cholesterol diets exhibited impaired learning and memory performance compared with animals on control diets and also demonstrated more A-beta deposition in the brain, greater loss of neurons, and other Alzheimer's disease-related neuropathology. One study of 444 Finnish men found that an elevated blood cholesterol level (> 6.5 mmol/L) in midlife was associated with 3 times the risk of developing Alzheimer's disease in late life. High intake of saturated fat doubled the risk of Alzheimer's disease, and even moderate intake of trans fat increased the risk by 2 to 3 times[13].

CANCER

A study found that eating a lot of trans fats may increase breast cancer risk. Of the 25,000 European women who participated in the study, women who had the highest levels of trans fats in their blood were about twice as likely as women with the lowest trans fat levels to develop breast cancer[14]. Those who did not use NSAIDs were at a 50% greater risk of developing colon cancer when they consumed high levels of trans-fatty acids. Women who were estrogen negative, i.e., postmenopausal not taking hormone replace therapy, had a twofold increase in risk from high levels of trans-fatty acids in the diet, while women who were estrogen positive did not experience an increased risk of colon cancer, regardless of level of trans-fatty acids consumed[15].

DIABETES

The relationship between trans fats and diabetes risk is not completely clear. A large study of over 80,000 women found that those who consumed the most trans fats had a 40% higher risk of diabetes. However, two other similar studies didn't find any relationship between trans fat intake and diabetes. Several controlled trials in humans have also looked at trans fats and important diabetes risk factors, such as insulin resistance and blood sugar levels. Unfortunately, the results have been inconsistent some studies appear to show harm, while others show no effect. That being said, several animal studies have found found that large amounts of trans fats lead to negative effects on insulin and glucose function. Most notable was a 6 year study on monkeys which found that a high trans fat diet caused insulin resistance, abdominal obesity (belly fat) and elevated fructosamine, a marker of high blood sugar[16].

OBESITY

The six-year study tracked the health changes of 51 male vervet monkeys that were split into two groups and fed identical diets, but with one difference: One group got 8 percent of its calories from trans fats, while the other group received those calories from healthy monounsaturated fats, such as olive oil. By the end of the study, the monkeys fed the trans fats had increased their body weight by 7.2 percent versus the other group, which only experienced a 1.8 percent increase. However, the most telling difference between the two groups was easy to see: The trans fat monkeys had grown large bellies, while the other group had not. Researchers said the weight gain was surprising, since neither group had been fed enough calories to gain weight -- especially not the 30 percent increase in abdominal fat that the trans fat group experienced. In addition, the researchers found that the trans fats not only caused excess visceral fat;

they actually caused fat from other parts of the body to be redistributed to the belly. Researchers concluded that, calorie for calorie, consuming trans fats leads to greater weight gain, especially in the belly area[17].

LIVER DYSFUNCTION

Trans fats are metabolized differently by the liver than other fats and interfere with delta 6 desaturase. Delta 6 desaturase is an enzyme involved in converting essential fatty acids to arachidonic acid and prostaglandins, both of which are important to the functioning of cells[8]. Scientists at Cincinnati Children's Hospital Medical Center have discovered that a diet with high levels of fructose, sucrose, and of trans fats not only increases obesity but also leads to significant fatty liver disease with scar tissue. The study was conducted in mice, some of which were fed a normal diet of rodent chow and some a 16-week diet of fructose and sucrose-enriched drinking water and trans-fat solids. Their liver tissue was then analyzed for fat content, scar tissue formation (fibrosis), and the biological mechanism of damage. This was done by measuring reactive oxygen stress, inflammatory cell type and plasma levels of oxidative stress markers, which are known to play important roles in the development of obesity-related liver disease and its progression to end-stage liver disease. he investigators found that mice fed the normal calorie chow diet remained lean and did not have fatty liver disease. Mice fed high calorie diets (trans-fat alone or a combination of trans-fat and high fructose) became obese and had fatty liver disease[18].

INFERTILITY IN WOMEN

Researchers at the Harvard School of Public Health found that women with Ovulation-related fertility problems tended to eat more trans fats than fertile women. Obtaining just 2% of total calories from trans fats instead of healthier monounsaturated fats was associated with a doubled risk for this type of infertility. In addition, each 2% increase in trans fat consumption as a replacement for carbohydrates brought a 73% greater risk of ovulation-related infertility, after adjusting for other known and suspected infertility risk factors, according to the study[19].Pharmacologic activation of the peroxisome proliferator-activated receptor gamma (PPAR-gamma) improves ovulatory function in women with polycystic ovary syndrome, and specific dietary fatty acids can affect PPAR-gamma activity[20].Eating trans fats have an effect on the body by interfering with a cell receptor involved in inflammation, glucose metabolism and insulin sensitivity. Insulin sensitivity and poor glucose metabolism are the same factors that affect the fertility of women who have polycystic ovary syndrome[21].

MAJOR DEPRESSIVE DISORDER

Consumption of trans-unsaturated fatty acids (TFAs or trans-fats) has been linked to a significantly increased risk for depression[22].In a study conducted in Spain, patients without a history of depression who consumed diets high in trans fats experienced a nearly 50% increase in major depressive disorder[23].

BEHAVIORAL IRRITABILITY AND AGGRESSION

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[11].The study of nearly 1,000 men and women provides the first evidence linking dietary trans fatty acids with adverse behaviors that impacted others, ranging from impatience to overt aggression[24].Dietary trans fatty acids inhibit production of omega-3 fatty acids, which experimentally have been shown to reduce aggression[25].

DIMINISHED MEMORY

Trans fat consumption is adversely linked to memory sharpness in young to middle-aged men[26].Researchers evaluated data from 1,018 men and women who were asked to complete a dietary survey and memory test involving word recall. On average, men aged 45 and younger recalled 86 words; however, for each additional gram of trans fats consumed daily, performance dropped by 0.76 words. This translates to an expected 12 fewer words recalled by young men with dietary trans fatty acid intake levels matching the highest observed in the

study, compared to otherwise similar men consuming no trans fats[27].

EVALUATION OF TRANS FATS

Analytical methods have been introduced to analyze *trans* fat content in foods including infrared (IR) spectroscopy, gas chromatography (GC), Fourier transform-infrared (FT-IR) spectroscopy, reverses-phase silver ion high performance liquid chromatography, and silver nitrate thin layer chromatography. Currently, FT-IR spectroscopy and GC are mostly used methods[28].The GC method widely used requires some complicated procedures such as separation extraction of the sample and esterification, and thus requires considerable time and cost. The American Organization of Analytical Chemists (AOAC) formulate method AOAC 2000.10 by using infrared spectroscopy and ATR to evaluate the trans-fat content[29].

CONCLUSION

There are no known nutritional benefits of trans fatty acids and clear adverse metabolic consequences exist, prudent public policy would dictate that their consumption be minimized and that information on the trans fatty acid content of foods be available to consumers. There is no physiological requirement for Trans fats-they have no intrinsic health value above their caloric value-and therefore their intake should be as low as possible. While it's impossible to completely avoid all trans fats due to their presence in nature, it is advisable to cut them out of your diet as much as possible, and the best place to start is avoiding all foods with the phrase "partially hydrogenated/Shortening" anywhere in the ingredients list.

REFERENCES

1.http://www.perkinelmer.com/CMSResources/Images/44-152585PRD_TRANS_FAT.pdf

2.World Health organization.regional office for Europe,Eliminating trans fats in Europe,A policy brief,

http://www.euro.who.int/__data/assets/pdf_file/0010/288442/Eliminating-trans-fats-in-Europe-A-policy-brief.pdf?ua=1

3. Vandana Dhaka,Neelam Gulia,Kulveer Singh Ahlawat and Bhupender Singh Khatkar, Trans fats—

sources, health risks and alternative approach - A review, J Food Sci Technol. 2011 Oct; 48(5): 534–541.

4. Masanori Semma,Trans fatty acids:properties,Benefits and Risks,Journal of health science

5. MARIA TERESA TARRAGO-TRANI, PhD; KATHERINE M. PHILLIPS, PhD; LINDA E. LEMAR, MS; JOANNE M. HOLDEN, MS,New and Existing Oils and Fats Used inProducts with ReducedTrans-Fatty Acid Content, journal of the AMERICAN DIETETIC ASSOCIATION

6.FOOD FACTS from the U.S.Food and Drug Administration,Talking about Trans fats:what you need to do, http://www.fda.gov/downloads/Food/IngredientsPackagingLabeling/UCM239579.pdf

7. European Food Safety Authority (EFSA),Parma, Italy, Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, transfatty acids, and cholesterolEFSAPanel on Dietetic Products, Nutrition, and Allergies (NDA),

8. http://www.slideshare.net/lindy23/trans-fat

9.Kristin Kirkpatrick, MS, RD, LD,July 10,2015,Avoid These 10 Foods Full of Trans Fats,Cleveland Clinic,healthessentials

10.TIME INC.NETWORK,Health,The 22 Worst Foods for Trans Fat

11. https://en.wikipedia.org/wiki/Trans_fat

12.Yolanda Smith,BPharm,Trans Fat Nutritional Guidelines,NEWS MEDICAL LIFE SCIENCES & MEDICINE

13. Martha Clare Morris, ScD, Diet and Alzheimer's Disease: What the Evidence Shows

14. Breast Cancer Risk Factors,BREAST CANCER.ORG,LOWER YOUR RISK

15. Slattery ML,Benson J,Ma KN,Schafffer D,Potter JD, Trans-fatty acids and colon cancer, 2001;39(2):170-5.,NCBI

16. Joe Leech, Dietitian ,Why Are Trans Fats Bad For You? The Disturbing Truth,AUTHORITY NUTRITION,An Evidence Based Approach

17. Thursday, January 11, 2007 by: Jessica Fraser, Animal study links yet another health problem with trans fats: an increase in stubborn belly fat,NATURAL NEWS

18. High levels of Fructose, Trans Fats Lead to Significant Liver Disease, Says Study, Monday, June 28, 2010,Cincinnati Children's, Newsroom

18.Salynn Boyles,WebMD Health News,Reviewed by Louise Chang,MD, Trans Fats May Increase Infertility, Trans fats are strongly linked to heart disease. New research suggests they may also increase a woman's risk of infertility.

19.Chavarro JE,Rich-Edwards JW,Rosner BA,Willett WC, Dietary fatty acid intakes and the risk of ovulatory infertility, 2007 Jan;85(1):231-7.

20.Hethir Rodriguez C.H., C.M.T, Trans Fats May Increase Infertiliy Issues,NATURAL INFERTILITY INFO

21. Deborah Brauser, January 28, 2011, Trans-Fats Linked to Increased Depression Risk,Medscape

22.Kelth Veronese,Trans Fats and the chemistry of evil

23.Debra Kain,More Trans Fat Consumption Linked to Greater Agression,UC San Diego News Center

25.Beatrice A. Golomb,Marcella A. Evans,Halbert L. White, Joel E. Dimsdale,Trans Fat Consumption and Aggression,PLOS|ONE

26.American Heart Association, Trans Fat Consumption is Linked to Diminished Memory in Working-aged Adults,American Heart Association Meeting Report Abstract 15572, November 18, 2014

27.Science News, University of California, San Diego Health Sciences, June 17, 2015, Dietary trans fat linked to worse memory

28.Juhee Song, Joohyeok Park, Jinyeong Jung, Chankyu Lee, Seo Yeoung Gim, HyeJung Ka, BoRa Yi, Mi-Ja Kim, Cho-il Kim and JaeHwan Lee,Analysis of Trans Fat in Edible Oils With Cooking Process, Toxicol Res. 2015 Sep; 31(3): 307–312,NCBI

29. Quantitative Analysis of Trans-fats in Food Products Using an FT/IR-ATR Method,JASCO,Application Note, No. 050-AT-0215

CONFLICT OF INTEREST REPORTED: NIL; SOURCE OF FUNDING: NONE REPORTED