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Review Article

Industrial trans-fat: a cause of concern for Indian population

Rakesh Kumar, Nawin Jai Vignesh K.*, Anbuselvi, Anudharani, Angeeth

Department of Community Medicine, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamil Nadu, India

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***Correspondence:**
Dr. Nawin Jai Vignesh K.,
E-mail: nawinvignesh1995@gmail.com

ABSTRACT

The trans-fats are a form of unsaturated fatty acids which contain one or more unconjugated double bonds in the trans-configuration. Trans-fat is found in natural sources such as dairy products and meat but the quantity of trans-fatty acid in natural sources is meagre. Most commonly they are found in industrial food products like bakery products, cookies and snacks. Several studies have identified increased industrial trans-fat consumption as harmful to human health. The major effects are on the cardiovascular system and central nervous system. To reduce the trans-fatty acid consumption, the global and national organizations have proposed various approach and strategies like WHO 'Replace' action plan strategy, implementation of trade policies and guidelines, work-site intervention strategies, improvements in hydrogenation technology, labeling of food products, behavioural change communication for population. Trans-fatty acid consumption is a modifiable risk factor. Planning and implementation of government policies and guidelines for reduction of trans-fatty acid levels in food product can have a significant impact. But behavioural change among general population is the key to reduce trans-fatty acid consumption.

Keywords: Trans-fatty acid, India, Diet

INTRODUCTION

The trans-fats are a form of unsaturated fatty acids which contain one or more unconjugated double bonds in the trans configuration.[1] In simple words, trans-fatty acids are unsaturated fatty acids with trans configuration and separated double bonds.[2] Any food can contain two types of dietary fats. They are saturated fatty acids and unsaturated fatty acids which includes trans-fatty acids. Of the major concern are industrially produced trans-fatty acids, which lead to grave consequences on health.

The Government of India in the Food safety and Standard Act, 2011 (2nd amendment) has defined 'Industrial trans-fatty acids' as 'all the geometrical isomers of monounsaturated and polyunsaturated fatty acids having non-conjugated, interrupted by at least one methylene group, carbon-carbon double bonds in the trans configuration. It excludes trans-fatty acids from dairy, meat, fish and their products'.[3]

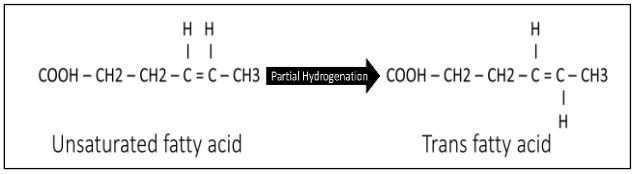

Figure 1: Partial Hydrogenation of unsaturated fatty acid to trans fatty acid.

METHODS

The data related to trans-fat sources and estimation were obtained through a series of steps, allowing for maximum coverage countries of both western and eastern nations but predominantly concentrating on Indian standards and data. This comprised a search of peer-reviewed and gray

literature published till March 2022. Electronic databases such as Directory of Open Access Journals (DOAJ), Google scholar, and National Library of Medicine (NLM) were used for searching relevant articles. The search keywords that were commonly used were trans-fat, trans-fatty acids, dietary fat (s), processed food (s) and baked food (s).

HISTORY AND SOURCES OF TRANS-FAT

The process of hydrogenation of oil was discovered in 1903 by German chemist Wilhelm Normann and the first use of trans-fatty acids in food was in 1911 by Procter and Gamble Company for Crisco vegetable shortening.[4] Until late 1990, the use of trans-fat usage was significantly high in western nations and several studies have investigated the trans-fat content of various food items. Trans-fat is found in natural sources such as in animal products such as dairy products, meat, fish, chicken, beef fat etc. produced by ruminant bacteria which isomerizes and can convert the double bonds to trans configuration. But the quantity of trans-fatty acid in natural sources is meagre. Most commonly they are found in industrial food products like bakery products, cookies, crackers, snacks, candies, desserts and shortenings etc.[2] A study conducted in Thailand found Bakery products, i.e.; puffs, pies, and deep-fried doughnuts, that used partially hydrogenated oil (PHOs) as the main source of trans-fatty acid (TFAs) and contained 3-5% TFAs.[5]

Some popular trans-fatty acids-containing foods in India are fried foods, street foods, packaged foods, baked foods such as biscuits and pastries and sweets like jalebi. Most of these foods use vanaspati and it is the main source of trans-fatty acids in India. Based on the vanaspati used for cooking, the maximum consumption of it can be up to 20 grams per person per day.[3] But these same foods can also be prepared free of trans-fatty acids by using alternative sources like groundnut oil, sunflower oil, safflower oil and olive oil. Food processing and cooking methods such as food baking, stir-frying, pan-frying, and deep frying at high temperatures have been thought to increase the trans-fatty acid content of food. However, Song et al in their study found only stir-frying increased trans-fatty acid content whereas pan-frying, baking and frying procedures did not make any change.[2] Naturally, vegetable oils are good dietary sources of monounsaturated and polyunsaturated fatty acids which are good for health. But when vegetable oil is hydrogenated, the amount of trans-fatty acids in partially hydrogenated vegetable oils can be as high as sixty per cent, with different isoforms of trans-octadecenoic acid accounting for eighty to ninety per cent of total trans-fatty acid content.

DETECTION AND ESTIMATION OF TRANS-FATTY ACID

Several analytical methods and survey tools have been developed for direct and indirect estimation of trans-fatty acids in foods.[6] 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 are the direct methods. Among them, attenuated total reflection-Fourier-transform infrared (ATR-FTIR) spectroscopy and gas chromatography with flame ionization detection (GC-FID) are the most commonly used methods due to their high accuracy, sensitivity, and speed of trans-fatty acid determination.[2,5] Indirect methods such as diet surveys using food frequency questionnaires e.g. Fred Hutchinson food frequency questionnaire have also been used in several studies to estimate trans-fatty acid content.[7] Some studies have also used crude indirect measures such as the quality of diet to indicate harmful fat in the diet. For example, a Brazilian study highlighted the cut-off value of 45% for SoFAS foods (solid fat and added sugars) to total energy intake, to classify low-quality diets.[8]

EFFECTS OF TRANS-FATTY ACID

Several studies have identified increased industrial trans-fat consumption as harmful to human health. The major effects are on the cardiovascular system and central nervous system.

Effect on the cardiovascular system

Trans-fatty acid consumption is a significant risk factor for non-communicable diseases in general and cardiovascular diseases in particular.[9] The major risk factor for subclinical atherosclerosis is higher habitual intakes of saturated and trans-fatty acids.[7] Industrial TFAs in particular have been associated with deleterious cardiovascular effects. In contrast, ruminant trans-fatty acids (rTFAs) may have a cardioprotective role within the heart.[10] Trans-fatty acid intake has been associated with a variety of deleterious cardiovascular complications like coronary heart disease and sudden death from cardiac causes.[11] Following the intake of trans-fatty acids, the increase in high levels of serum cholesterol, particularly low-density lipoprotein (LDL) and the decrease in high-density lipoprotein (HDL) count increase the risk of atherosclerosis. Trans-fatty acids decrease the beneficial HDL resulting in a decreased LDL/HDL ratio. According to 2017 estimates, every year more than 1.5 million deaths in India are attributed to coronary heart disease, of which nearly five per cent are due to trans-fatty acids intake.[12] Trans-fatty acids are also associated with cardiac arrhythmias or sudden cardiac arrest. The mechanism behind this is it affects the membrane structures and alters the enzymatic pathways, which may induce cardiac arrhythmia and death.[13]

Obesity and diabetes mellitus

A person with a normal amount of calorie intake and more amount of trans-fatty acids intake may possess an increased risk of overweight and central obesity. A high fatty diet is a well-known risk factor for the development of type two diabetes mellitus.[14] According to a study, the

incidence of type two diabetes mellitus can be lowered by forty per cent if the oils were consumed in their original form.[15]

Non-alcoholic fatty liver diseases

No proven evidence is available to indicate the risk of fatty liver disease among humans due to trans-fatty acid intake. But in a study where a mouse was fed with trans-fatty acids and a high fructose corn syrup (HFCs) equivalent for 16 weeks, the mouse developed hepatic histopathological and metabolic abnormalities that characterize non-alcoholic steatohepatitis (NASH).[10,16] These findings are significant and indicate the need for further research on the epidemic of NASH.

Effects on brain and nervous system

Trans-fatty acid also affects the brain. Daily intake of TFA was significantly associated with memory loss in younger adults.[7] Trans-fatty acid increases anxiety-like behaviour via alterations in proinflammatory and anti-inflammatory cytokine levels and GR expression in limbic brain regions.[17] Higher intake of trans-fatty acid is also associated with brain stroke. Higher intake of trans-fatty acid was associated with higher incidence of ischemic stroke independent of major lifestyle/dietary factors in a large cohort study among postmenopausal women. Further, the adverse effect of trans-fatty acid intake on ischemic stroke may be attenuated by aspirin use.[18]

GLOBAL EFFORT AND GOALS FOR TRANS-FATTY ACID REDUCTION

Many global and national level efforts have been taken to reduce the consumption of trans-fatty acid intake. But, the food industries are continuing to use trans-fatty acids, because of their cheap cost, the long shelf life of trans-fatty acid foods, improved taste and texture of food. The WHO has recommended trans-fatty acid intake of 1 per cent of total energy intake.[9] To achieve this goal, the WHO proposed the 'Replace' action package of 2018 which aims to eliminate industrially-produced trans-fatty acid in the global food supply by 2023.[9]

REDUCTION OF TRANS-FAT INTAKE

Some of the strategies to reduce the trans-fatty acid content in food are as follows- (a) the WHO Replace action plan strategy; (b) implementation of trade policies and guidelines; (c) work-site intervention strategies; (d) improvements in hydrogenation technology; (e) labeling of food products; and (f) behavioural change communication for population.

The WHO 'Replace' strategy

The WHO has recommended a 'Replace' action plan for the successful elimination of industrial trans-fatty acid by 2023.[19] The 'Replace' action plan includes the following six action strategies- (a) review dietary sources of industrially-produced trans-fatty acid and the landscape for required policy change; (b) promote the replacement of industrially-produced trans-fatty acid with healthier fats and oils; (c) legislate or enact regulatory actions to eliminate industrially-produced trans-fatty acid; (d) assess and monitor trans-fatty acid content in the food supply and changes in trans-fatty acid consumption in the population; (e) create awareness of the negative health impact of trans-fatty acid among policy-makers, producers, suppliers, and the public; and (f) enforce compliance with policies and regulations.[19]

Implementation of trade policies and guidelines

Trade dynamics and public health considerations within powerful countries may help to promote anti-trans-fat regulation globally but may not be sufficient and are ethically questionable.[9]

Worksite intervention strategies

Denmark was the first country in the world to regulate the content of artificial trans-fatty acid in certain ingredients in food products and was successful in eliminating artificial trans-fatty acid food supply. Denmark's food policy to restrict the content of artificial trans-fatty acid in certain ingredients in its food supply achieved a reduction in CVD mortality rates by about 14.2 deaths per 1,00,000 people per year.[20]

However, a study conducted in fast-food restaurants in the United States found little evidence of consistency with dietary guidance to reduce intakes of sodium and saturated fat during the 14 years of a policy of product reformulation.[21]

The Indian government had recently amended the food safety and standard act to set the limit for industrial trans-fatty acid in food products. According to amendments, food products with industrial trans-fatty acid levels shall not be more than 2% by mass of the total oils/fats present in the food products in which edible oils and fats are used as an ingredient, on and from 01st January 2022.[3]

IMPROVEMENTS IN HYDROGENATION TECHNOLOGY

To achieve the lower TFA limits in India, the industry would need to enhance current hydrogenation technology, employ blends of vegetable oils with lower unsaturation, and use fractions high in solids generated from natural oils in order to attain the lower TFA limitations in Indian vanaspati, bakery fats, and shortenings (palm, palm kernel, coconut). TFA should be one of the quality indicators for refined vegetable oils. It is perhaps necessary to generate a database on TFA content in refined oils, and if the database shows high TFA, modifications in the deodorization step have to be considered to ensure that TFA is within the specified limits. The edible oil industry needs support and

investment to develop, set up and operate alternative technologies (enzymatic inter-esterification).[22] Alongside this, it is necessary to evaluate the long-term nutritional and health effects of fats and oils obtained through these new technologies.

LABELING OF FOOD PRODUCTS

To give consumers a choice the nutrient label of appropriate size and on front of food labels on fats/oils and processed foods should give contents of trans-fatty acids and saturated-fatty acids level separately.

Nutrition label disclosure on food packets provides consumers with the alternate safe natural vegetable oil free from trans-fatty acid by creating demand and mass commutations and individual counselling to dissuade them from consuming trans-fatty acid.

BEHAVIOUR CHANGE COMMUNICATION FOR THE GENERAL POPULATION

The importance of using alternative oil sources which are natural vegetable oils and fats soft at room temperature for hard fats should be emphasized. In the Indian Food Based Dietary Guidelines (FBDG), information for TFA has to be included. Alongside, key messages on the negative health effects of TFA and information on products which contain TFA should be prepared.[23]

CONCLUSION

Trans-fatty acid consumption is a modifiable risk factor. Planning and implementation of government policies and guidelines for reduction of trans-fatty acid levels in food product can have a significant impact. But behavioural change among general population is the key to reduce trans-fatty acid consumption.

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