

The Implications of Trans-fatty acids Consumption on Health and Nutritional Status

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Abstract: *Trans-fatty acids have the presence of one or more double bonds in the trans configuration instead of the usual cis configuration. They were introduced to the food system more than 50 years. Trans-fats are preferred items by food industry as they impart firmness to margarines and plasticity as well as emulsion stability to shortenings. There have been many studies that showed that the consumption of trans-fatty acids can cause many chronic health problems. Results from studies have clarified the direct association of trans-fatty acids with cardiovascular diseases, breast cancer, pregnancy complications, premature delivery, colon cancer, diabetes, obesity and allergy. Based upon these findings, trans-fatty acids intake should be eliminated from diet and new technology of hydrogenation of oils should be developed which in order to produce zero trans-fatty acids and maintaining the desirable properties contributed by trans-fatty acids to the hydrogenated oils. This review is intended to be a wakeup call to the public and the health authority in Syria about the dangers of consumption of products containing trans-fatty acids on health and nutritional status. Unfortunately, the consumption hit high levels due to the cheap value of trans-fat in the Syrian markets. Presently in Syria there is no system to monitor and regulate the amount of trans-fats in processed foods and hence a stringent food law is immediately required.*

Keywords: *Trans-fatty acids, Hydrogenation. Low density lipoproteins, CVD, CHD*

INTRODUCTION

Consumption of fat over 30 % of daily calorie requirements usually leads to increase both saturated fat and calorie intakes. Trans-fatty acids consumption can cause lipid profile changes by increasing levels of low density lipoproteins (LDL), triglycerides and to reduces good cholesterol or high density lipoproteins (HDL) and it also increase insulin levels. Trans-fatty acids are defined as unsaturated fatty acids that contain at least one double bond in the trans configuration [1]. They are produced during industrial partial hydrogenation of vegetable oil, a process widely used at commercial level to produce solid fats. The Trans-fatty acids content of partially hydrogenated vegetable oils depends on the variables of the hydrogenation process i.e. time, catalyst, temperature, and hydrogen pressure; the types and proportions of oils and composition of monounsaturated fatty acids

(MUFA) and poly unsaturated fatty acids (PUFA)[2]. Sources of trans-fatty acids Dietary fatty acids with trans double bonds come primarily from Industrial sources i.e. by partial hydrogenation of edible oils containing unsaturated fatty acids to saturated fats and secondly from bacterial transformation of unsaturated fatty acids in the rumen of ruminants. Ruminant and industrial fats contain the same trans-fatty acids isomers, but the proportions differ[3]. Vaccenic acid and elaidic acid are the primary dietary trans-fatty acids. The major animal trans-fatty acids is Vaccenic acid (18:1, trans-11) , whereas elaidic acid (18:1, trans-9) is the main trans-fatty acids isomer in industrial hydrogenation process[4,5]. The trans-fatty acids acid content of industrially hydrogenated fats varies widely and may account for up to 60% of the fatty acid content, whereas the trans-fatty acids acid content of beef and dairy products is considerably lower and accounts for 2%–5% of the fatty acid content [6]. Processed foods and oils provide approximately 80% of trans-fatty acids in the diet, compared to 20% that occur naturally in food from animal sources. The major dietary sources of trans-fatty acids are all snacks such as cakes, cookies, crackers, margarine, fried foods, potato chips, microwavable popcorn, shortening and animal products[7]. In order to reduce the intake of trans-fats, people should limit their consumption of foods which contained processed sources of trans-fatty acids. Dietary intake of fat should come from polyunsaturated and monounsaturated fatty acids. Plant sources of poly unsaturated fatty acids are vegetable oils, including soybean oil, corn oil, canola oil, walnuts, flaxseed and safflower oil. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are omega3 fatty acids that are found mainly in fatty fish. Sources of monounsaturated fatty acids include olive oil, canola oil, high oleic safflower oil, and sunflower oil and nuts[8].

Trans-fatty acids are not formed during frying process. Tsuzuki(2010) has reported that an ordinary frying process using unhydrogenated oils has little impact on total fatty acids intake from edible oils[9]. No trans-fatty acids were formed in unhydrogenated and hydrogenated soybean oil during heating at 160, 180 or 200 °C for 24 h, implying that trans-fatty acids acid can only be formed under drastic heating conditions i.e. heating the oil at high temperatures or reusing the oil many times[10].

HEALTH RISKS OF TRANS-FATTY ACIDS

A low intake of fats and oils (less than amount corresponding to 20% of daily calorie intake) increases the risk of inadequate intakes of vitamin E and of essential fatty acids and may contribute to unfavorable changes in HDL and triglycerides. Following risks are reported to be associated with the intake of trans-fatty acids on human health.

Cardiovascular diseases and trans-fats

Epidemiological studies that have been carried out for many years have shown that populations consuming diets high in saturated fatty acids show relatively high levels of serum cholesterol and carry a high prevalence of coronary heart disease [11,12,13]. Based on the evidence of these studies, it is generally accepted that high levels of serum cholesterol, particularly LDL, promote the development of atherosclerosis or coronary heart disease. Mensink and Katan (1990) suggested that trans-fatty acids increased LDL and decreased the good cholesterol HDL resulting in a less desirable LDL/HDL ratio [4]. Invariably, it established that trans-fatty acids could be worse than the saturated fatty acids. The concept has become widely accepted that lowering LDL cholesterol by any means will reduce the risk of coronary heart disease [14]. It has been estimated that dietary trans-fatty acids from partially hydrogenated oils may be responsible for 30,000–100,000 premature coronary deaths per year in the United States. Trans-fatty acids acid has unique effects on serum lipid levels. Mozaffarian et al. (2006) reported that saturated fat and Trans-fatty acids had similar effects on LDL on a calorie for—calorie basis [15]. However, when compared with either saturated or unsaturated fat, trans-fatty acids reduced HDL and increased the ratio of total cholesterol to HDL. Consumption of trans-fatty acids also increased serum triglyceride and lipoprotein levels and reduced LDL particle size in controlled trials indicating higher risk of coronary heart disease. These adverse effects of trans-fatty acids have been confirmed by subsequent metabolic studies [16,17,18,19]. Williams et al. (1998) established an association between trans-fatty acids and incidence of non-fatal myocardial infarction from coronary heart disease [20]. Relative risk for cardiovascular disease was increased by 27% as a result of consumption of trans-fatty acids [21]. Although it is established that trans-fatty acids increase LDL levels and decrease HDL levels (markers of coronary heart disease), little is known about the mechanisms by which trans-fatty acids actually work at the cellular level. It is unknown what levels of trans-fatty acids are clinically significant and it is not clear how Trans-fatty acids are associated with cardiac arrhythmias or sudden cardiac arrest. It was hypothesized that Trans-fatty acids affect membrane structure, thus altering enzymatic pathways that may subsequently induce cardiac arrhythmias and sudden death. Moreover observational studies by Mozaffarian

et al. (2009) showed that a higher CHD risk is related to trans-fatty acids from food industries sources. Because animal fat contains low levels of fatty acids (<6%), the amounts of animal trans-fatty acids consumed are low in most countries (generally <1 energy%). In the amounts actually consumed, animal trans-fatty acids are not a contributor to CHD risk [22,23].

Cancers and trans-fats

There is conflicting evidence concerning the possible role of trans-fatty acids in breast cancer. Kohlmeier et al. (1997) investigated the relationship between trans-fatty acids and postmenopausal breast cancer in European populations differing greatly in their dietary fat intakes [24]. The adipose concentration of trans-fatty acids showed a positive association with breast cancer, not attributable to differences in age, body mass index, exogenous hormone use, or socio-economic status. These findings suggested an association of adipose stores of trans-fatty acids with postmenopausal breast cancer in European women, but require confirmation in other populations, with concomitant consideration of the potential roles of dietary saturated and monounsaturated fats. The analysis of trans and cis fatty acids levels in blood serum of women showed that breast cancer risk increased with the increase in trans-fatty acids acid level, reflecting processed food consumption. It was reported that women with elevated serum levels of trans-fatty acids acid have double the risk of developing breast cancer as compared to women with the lower levels [25].

Colon cancer Slattery et al. (2001) reported that the men and women above age of 67 years those did not use non steroidal anti-inflammatory drugs (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. not taking hormone replace therapy after menopause, 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. It has been hypothesized that trans-fatty acids could increase risk of cancer through alteration of immune response, cell wall integrity, and prostaglandin synthesis [26,27].

Pregnancy

It was previously assumed that trans-fatty acids do not cross the placenta; therefore the fetus is protected against trans-fatty acids [28]. However, recent studies have shown that trans-fatty acids cross to the fetus, as they were found in the same levels in the blood of newborn infants as in that of mothers [28,29]. Long Chain Poly Unsaturated Fatty Acids (LCPUFAs) which are important for both growth and the development of vision and the central nervous system in fetus are decreased after consuming trans-fatty acids [30]. Elias

and Innis (2001) showed that trans-fatty acids acid levels including conjugated linoleic acid (CLA) in the umbilical blood of neonates reflected the mother's levels of trans-fatty acids in the blood and thus the mother's trans-fatty acids acid intake[31]. The pregnancy period was also found to be shorter in mothers with higher trans-fatty acids acid level in the infant's blood while trans-fatty acids appear to shorten it. Omega 3 fatty acids inhibit the contraction in uterine cells by virtue of an effect on the ion channels of these cells, thus prolonging pregnancy[32]. Trans-fatty acids may have the opposite effect. Mother's intake of trans-fatty acids is negatively associated with levels of polyunsaturated fatty acids in the blood of newborn infants, it is advisable to minimize the intake of trans-fatty acids during pregnancy [33]. There is also an association between a high intake of trans-fatty acids and the risk of preeclampsia [34]. It was noticed that women who developed preeclampsia had approximately 30% higher trans-fatty acids acid levels in red blood cells than women who did not develop this disorder[35].

Interference with essential fatty acids

Essential fatty acids (EFA) are essential for the development of the nervous system and vision. High intakes of trans-fatty acids have been shown to influence the metabolism of omega 3 acids. New-born infants, and especially if premature, show borderline deficiency in EFA, and their trans-fatty acids intake from the mother's milk is related to her trans-fatty acids intake[36].

Diabetes and trans-fats

Studies showed that the risk of the development of type-II diabetes was associated with trans-fatty acids acid intake [37]. Intake of industrially produced trans-fatty acids in the USA is on average 3% energy, a reduction in trans-fatty acids acid intake of 2% energy could reduce the incidence of type-II diabetes by 40% if the fats containing the trans-fatty acids. Studies carried out at showed that both saturated fatty acids (SFA) (5 g/100 g,10% energy) and trans-fatty acid (3% energy)increased insulin resistance (decreased insulin sensitivity).However, the effects of trans-fatty acid were greater than SFA in increasing insulin resistance. Increasing dietary linoleic acid did not prevent trans-fatty acids induced increase in insulin resistance; it becomes necessary to reduce the absolute intake of trans-fatty acids [38].

Weight gain and trans-fats

Trans-fatty acids may increase weight and abdominal fat deposits. A Swedish study indicated that certain conjugated linoleic acid isomers that are present only in very low levels in animal fat increase the insulin resistance of men with abdominal obesity [39]. In another study revealed that monkeys fed on a trans-fatty acids diet gained 7.2% of their bodyweight, as

compared to 1.8% for monkeys on a monounsaturated fat diet [40,41].

Other effects of trans-fatty acids consumption may include asthma, allergic cold and asthmatic eczema in children aged 13–14 years. A positive association was found between the intake of trans-fatty acids and these diseases .Such an association was not observed for the intake of monounsaturated and polyunsaturated fatty acids [42].

CONCLUSION

Trans-fatty acids have several beneficial aspects for processed foods due to their characteristic structures. These very characteristic structures, in turn, have been suspected to be harmful. Trans-fats consumption is on the rise all over the world including Syria due to cheap value compared with healthy fats. Trans-fats and their products containing trans-fatty acids are considered a major health threat. They can alter metabolic process in the body leading to serious health issues associated with the possibility of the development of several health problems, including CVD, obesity, diabetes mellitus, breast and colon cancers. In children, trans-fats are responsible for poor fetal and infant neurodevelopment and growth, in addition to allergy and skin problems.

RECOMMENDATIONS

- 1- Increase consumer awareness of the health implications of Trans-fatty acids consumption
- 2- Food manufacturers should find technological alternatives to reduce or eliminate trans-fatty acids in their products. Such as modification of the hydrogenation process Hydrogenation i.e. saturating some double bonds and converting others to the trans configuration is a common technique to provide firmness and plasticity to shortenings, thus, enabling the production of solid and semi solid fats.
- 3- Modifying the conditions of hydrogenation (e.g. pressure, temperature, and catalyst) affects the FA composition of the resulting oil, including the amount of trans-fatty acid formed, and properties such as melting point and solid fat content of the oil. Modification of the hydrogenation process can be used to prepare low-trans baking shortenings. Low or zero-trans baking fats may have increased levels of stearic acid from the hydrogenation of α -linolenic, linoleic, and oleic acids, and also significant levels of palmitic acid for functionality.
- 4- Use of interesterification to rearrange the distribution of the fatty acids and to modify the melting and crystallization behavior of the fat
- 5- Labeling of trans-fatty acids which requires that the Nutrition Facts panel list the amount of trans-fatty acids in a serving of food if a serving contains 0.5 g or more of trans-fatty acids

- 6- It's recommended to fix a limit of not more than 10% trans- fatty acids in partially hydrogenated vegetable oils.
- 7- Higher taxes should be imposed on tran-fats imports.
- 8- Consumers should be educated about how to minimize the intake of trans-fatty acids.
- 9- Consumers should learn to recognize and avoid products containing trans-fatty acids.
- 10- Restaurants and food manufacturers should use alternative fats in food production and preparation
- 11- Local, state, and national government agencies should aid these efforts by enforcing legislation that limit trans-fatty acids use.

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