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The Trans Fatty Acid Content of Snacks Offered in Kermanshah

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ABSTRACT

Consumption of foods containing Trans Fatty Acids (TFAs) may have effects on the plasma lipoprotein profile to increase LDL and decrease HDL level which may lead to coronary heart disease, atherosclerosis, diabetes, fetal growth disorder, and increase the probability of cancer. Because of insufficient documents related to the TFA content of Iranian foods, this study aimed to examine TFA content of cakes, confectionaries, and snacks in markets. A cross-sectional study was designed and food samples were collected from all different zones of Kermanshah city in Western Iran. Fatty acids were extracted using the Folch method and methylated by the AOCS method. Fatty acids separated using gas chromatograph with a flame ionization detector and a 100 m × 0.25-mm inside diameter silica column. The highest amount of TFAs was found in coffee mate, biscuits, and cakes that contained 6.95%–13.94% of total fatty acids. Confectionaries showed 1.24%–3.38% TFAs. Palmitic and stearic acid were the most abundant saturated fatty acids found in analyzed foods. Coffee mate and chocolates presented the greatest amount of saturated fatty acids among foods. This study confirmed that Iranian snack foods contain high TFA levels due to use of hydrogenated fat by food processing companies. According to the adverse health effect of TFAs they need to be minimized or eliminated from foods, we strongly recommend that hydrogenated fat should replace with other safe, edible oils, with minimal content of TFAs.

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Introduction

The prevalence of chronic, non-communicable diseases has a strong and direct correlation with lifestyle, particularly diet and fat intake [1]. The effects of dietary fats on health, in addition to lipids status, are depending on the type of fatty acid contents of foods [2]. Fatty acids in the diet generally consist of two main groups, saturated and unsaturated fatty acids. In unsaturated fatty acids, the dual band of carbon atoms may be in cis or trans forms. Naturally, the unsaturated fatty acids are in cis form.

Trans fatty acids (TFAs) are produced in industrial hydrogenation of edible oils, microbial changes in unsaturated fatty acids in the body of cud-chewing animals, heating, frying in temperatures above 180°C, and deodorant of edible oils, the most important of which is industrial hydrogenation [3-5]. By industrial hydrogenation, Elaidic acid (trans isomers of oleic acid) is produced, which is a major trans fatty acid in foods [6-8]. The main sources of trans fats are hydrogenated oils and fats such as solid and semi-solid oils, margarines and vegetable shortenings, cookies, crackers, snacks, fried foods, sweets, fried potato, soup powder, and other fast foods [9,10]. Different types of trans fatty acid isomers have different effects on health. Industrial sources of trans fatty acids is directly proportional to the risk of coronary heart disease [11] and may increase in LDL-C, and decrease in HDL-C (the only fat that does not raise HDL [9]). Increasing ratio of TC/HDL-C, concentration of fat, weight gain, and impairing arterial dilation which may also depends on nitric oxide [12-18]. The TFAs that are produced by partial hydrogenation of edible oils, unlike TFAs from ruminants, has damaging effects on serum lipids, inflammation, and endothelial function [19].

Researchers consider the power of TFAs in coronary disease even more than saturated fats and carbohydrates [20]. The daily consumption of 4–5 grams of TFAs will increase the risk of coronary artery disease by 25% [11] and will cause stimulation of inflammatory mediators implicated in heart disease and increases in CRP, non-consolidation, increased risk of atherosclerosis plaque rupture, and increased insulin resistance [21-24]. High consumption of TFAs may increase the risk of diabetes type II, sudden death, and increases in allergic diseases [25]. Replacing 10% of the energy from cis with trans fatty acids significantly increases insulin resistance [26-29]. There is reports on direct relationship between the concentrations of TFAs in adipose tissue and breast cancer in post-menopausal women [30]. The important point is that TFAs can cross the human placenta and can be excreted in breast milk. High consumption of TFAs during pregnancy has negative effects on the growth of human embryos [31]. Given the deleterious effects of TFAs, the Food and Drug Administration (FDA) of America suggests that the energy intake by TFAs should be reduced to less than 1% of total energy intake [32]. Also in 2003, a law was issued considering the necessity of using trans fatty acid labeling on food packages, which is now actually used in some developed countries [33]. This issue is not carried out in some developing countries, including Iran, which could be due to insufficient information on TFAs contents of foods. Thus the need for a comprehensive study in this area is evident. The purpose of this study was to determine the amount of TFAs in snack foods offered in the city of Kermanshah.

Materials and Methods

A cross-sectional study was conducted in 2011 in Kermanshah. 267 food samples were randomly selected from 13 types of the most common consumed snacks in the market and were assessed for levels of TFAs. At least 150 g of each sample from 10 brands of biscuits, rice bread, date bread, and chocolate, 7 brands of cake and crisps, 5 brands of local traditional sweets (shortcake, Baklava, Zoolbia, Bamieh, traditional local confectionary), 3 brands of donuts, and 2 brands of coffee mate was purchased. The packaged samples must be intact and without any damages, and had enough time to be analyzed within two days before the expiry date. To increase the reliability of the data, the sampling was carried out at different months of year and different zones of the city. The city of Kermanshah was divided into five regions, the stores identified, and samples were provided evenly from all parts of the city. After grinding and homogenizing, sufficient amount of sample was used to extract lipids. Fat and oil content of collected samples were extracted using the Folch method [34]. The derivation was conducted by AOCS method using 0.5 M methanol, NaOH, and 14% BF3. After salting out using a saturated solution of sodium chloride, the obtained solution was dried by nitrogen gas in a 40 ºC Bain-Marie, and then 100µl hexane was added and 1µl of prepared solution was injected

into the calibrated GC [35]. Varian gas chromatography system model CP-3800 equipped with flame ionization detector and CP-Sil 88 capillary column with 100 m length and 0.25 mm inside diameter was used for identification and determination of fatty acids. The split of the device was set to 1 to 100, and the temperature of the injection environments and the detector was set respectively to 270 ºC and 300 ºC, respectively. The column temperature was programmed to allow sufficient time for the extraction of all fatty acids from the column. The nitrogen gas with 99.8% purity and the flow speed of 2 ml/min was used as the carrier gas. A proportion of unsaturated to saturated fatty acids have also been studied, because the UK Department of Health recommended that the proportion should be at least 45% to ensure that the product has enough utility of ingestion [36]. To determine the profile of fatty acid, the percentages of total fatty acids in the samples were calculated from the different brands of thirteen different types of food. Descriptive statistics was used to statistical analysis the amount of fatty acids and t-test was used to compare between samples. The SPSS software version 16.0 was used for calculations and $P < 0.05$ was considered statistically significant.

Results

Elaidic trans fatty acid Oleic acid ($C_{18:1t}$) was found in most snack foods (**Fig.1**). Coffee mate contained the highest amount of $C_{18:1t}$, which was about 14% of total fatty acids in the product. After coffee mate, biscuits were second in containing the highest levels of TFAs. In addition to Elaidic acid, this product also contained Erucic acid ($C_{22:1t}$). Among the foods, zoolbia (a traditional sweet) was the only product that contained no TFAs. Based on the amount of TFAs, the analyzed foods can be classified into three main categories ($P < 0.05$). Zoolbia, Bamieh, potato chips, chocolate, rice bread, date bread, and Baklava are in the first category that contains less than 2% trans fatty acids. Donuts and shortcake are in the second category with a range of 3%–6% TFAs. Cakes, biscuits, and coffee mate, due to the highest amounts of TFAs (7%–14%), were in the third group. Saturated fatty acids (SFA) of biscuits were also higher than other products. Chocolate was in the next place of higher amounts of SFA, and Zoolbia showed the lowest amount of SFA (**Table 1**).

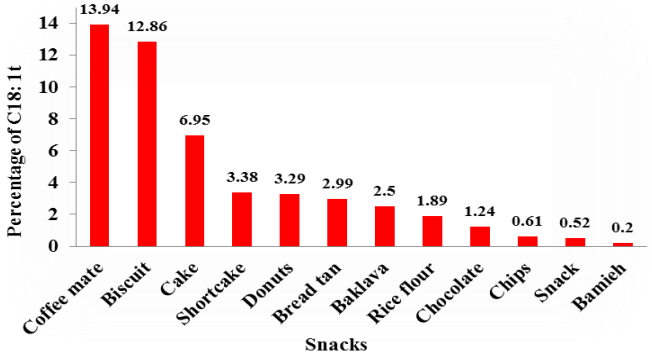

Figure 1: Percentage of TFAs were present in snacks

Table 1: Percentage of Saturated fatty acids were present in snacks in Kermanshah

Sample	Lauric acid	Myristi acid	Palmitic acid	Stearic acid	Arachidic acid	Behenic acid
Cake	0.1±0.2	0.8±0.4	21.9±5	2.7±2.27	0.03±0.09	ND
snack	0.2±0.2	1.1±0.4	36.2±8.8	4.6±1.1	0.04±0.09	0.03±0
Chocolate	8.5±12.9	7.3±9.6	25.4±4.2	24.8±11.6	0.3±0.4	ND
Bread tan	0.05±0.07	0.7±0.2	38.3±2.9	6.9±2.8	ND	ND
Rice bread	0.3±0.5	0.9±0.3	39.7±3.3	6.8±1.4	ND	ND
Biscuit	0.05±0.07	0.6±0.1	29±8.9	8.5±2.7	0.03±0.09	ND
Coffee mate	18.7±3.2	14.7±0.8	15.4±3.8	24.6±7.8	0.1±0.2	ND
Donuts	0.05±0.04	0.6±0.2	25.9±8.01	5.03±1.1	ND	ND
Bamieh	ND	1.1±1.04	17.3±7.3	4.3±1.1	ND	ND
Zoolbia	ND	0.7±0.1	16.1±8.6	4.4±0.3	0.01±0.03	0.04±0.1
Baklava	ND	0.6±0.1	23.4±8.8	5.7±3.4	ND	ND
Shortcake	0.07±0.07	1.1±0.7	40.0±2.9	7.2±2.1	ND	ND
Chips	0.08±0.06	0.8±0.1	37.8±3.5	4.2±0.3	0.04±0.1	ND

Table 2: Percentage of Polyunsaturated fatty acids were present in snack foods in Kermanshah (2011)

Sample	Palmitoleic acid	Oleic acid	Linoleic acid	Eicosenoic acid	α-Linolenic acid	Dihomo-γ-linolenic acid
Cake	0.2±0.2	30.2±4.6	28.2±10.3	2.2±1.8	0.7±1.1	0.08±0.1
Snack	0.07±0.07	38.7±6.5	16.4±11.9	0.08±0.1	0.9±1.7	ND
Chocolate	0.08±0.1	25.7±10.2	5.4±5.8	ND	0.2±0.6	ND
Bread tan	ND	39.4±1.7	10.6±2.9	0.03±0	0.1±0.2	ND
Rice bread	0.4±1.3	37.9±1.7	10.8±2.2	0.09±0	0.1±0.2	ND
Biscuit	0.04±0.07	33.2±6.1	13.09±9.05	0.3±0.8	0.4±0.4	ND
Coffee mate	ND	8.06±7.8	2.5±0.8	ND	0.09±0.1	0.98±1.39
Donuts	0.26±0	33.8±2	27.8±6.8	1.6±2.1	0.6±0.5	0.07±0
Bamieh	ND	28.4±7.2	44.1±12.3	2.6±2.5	2.2±2.0	ND
Zoolbia	ND	26.7±7.6	46.4±14.3	3.9±2.8	ND	ND
Baklava	ND	29.6±5.2	34.1±15.3	0.02±0	2.6±1.8	ND
Shortcake	ND	36.2±2.2	10.8±2.3	ND	0.1±0.1	ND
Chrisps	0.02±0.04	41.7±1.0	13.5±4.4	0.4±0.5	0.1±0.1	ND

Stearic (C_{18}) and palmitic acids (C_{16}) contained the highest amount of saturated fatty acids. The highest amount of Palmitoleic acid ($C_{16:1}$) was found in rice bread, oleic acid in chips, linoleic acid and Eicosenoic acid ($C_{20:1}$) in Zoolbia, α-linolenic acid in baklava, and Dihomo-γ-linolenic ($C_{20:3}$) acid in coffee mate. In **Table 2** showed unsaturated fatty acids contents of foods. The ratio of PUFA/SFA in the analysed samples of chocolate and biscuits only applies to one single sample, and others were so greatly different from the standard. In all cases of rice bread, date bread, and shortcake, the proportion was less than 0.45. PUFA/SFA in some samples of snack was higher and in some cases was lower than the recommended limit. The ratio of PUFA/SFA in most of cake samples was at an acceptable level. Crisp was higher than 0.45. Due to the high amount of saturated fatty acids, the ratio of PUFA/SFA in coffee mate was more than 10-fold lower from the recommended level (0.04 vs. 0.45).

Discussion

The study findings indicate that coffee mate contained very high level of TFAs as well as SFAs, which may have an adverse effect on cardiovascular diseases and cancer. A study conducted in Costa Rica by Bailin et al. reported that amount of trans fatty acid in non-dairy coffee mate was 33.72%, and the amount of SFA was more than 30% [37].

The amount of TFAs in our study was less than the Costa Rica study, while the amount of the SFA in coffee mate used in Iran are two-fold more than the Costa Rica samples. High concentrations of TFA and SFA may be induced by hydrogenated coconut oils and palm corn oil during processing of coffee mate. As we know that 100 g of palm corn oil contains 81.5 g SFAs and 100 g coconut oil contains 86.5 g SFAs [38]. TFAs in biscuits was generally higher than the samples in other studies from New Zealand [39], Spain [40], Argentina [41], America [42], and lower than the samples from Brazil [36] and Canada [43]. Biscuits is a popular, widely used snack food, and was the only sample that contained TFAs. SFA in Iranian biscuits was higher than the Brazilian sample [36] and lower than the samples tested in New Zealand [39] and Spain [40]. Research on biscuits in Canada [43] and Spain [40] showed a higher amount of PUFA and MUFA than in our study. The main reason for these differences can be using different extraction methods of fatty acids or using less SFA for biscuit production in other countries. It is necessary to reduce industrial TFAs in order to minimize health risks [44]. Consumption of TFAs in advanced industrial countries is declining; however, it is likely that consumption of foods with higher TFAs may put the population at risk for CHD disease [45]. Cakes after biscuits showed the highest amounts of TFAs. As cake and biscuit normally given as an early complementary feeding, high

quality of raw materials needs to be carefully selected for their production. According to the results, the trans fatty acids in analyzed cake samples in this study was more than studies in Canada [43] and Australia [3], and less than Spanish studies [40]. TFAs in Iranian cakes were more than cakes in Switzerland [3] and New Zealand [39]. It can be so risky for public health because biscuits and cakes that contain high levels of TFA are the most widely used among many age groups in society, especially children and adolescents. Recently published data indicates the increasing influence of fatty acid types on coronary artery disease rather than the amount of them; this fact has been shown in several epidemiological studies [14,45,46].

Donuts samples examined in this study contain more TFA and SFA than the Canadian samples [43]. High differences in the amount of TFAs in tested donuts from this study with the samples in Australia and Canada could be related to the type of fats, temperature, and technique used in the production process.

Presence of harmful saturated fatty acids in chocolate is more important than any other snack because it is one of the most popular sweets among population. The amount of TFA in chocolates examined in this study was more than the same sample examined in Switzerland [3] and New Zealand [39], and lower than Canadian chocolate [43]. Excess amounts of SFA in Iranian chocolate compared to samples from New Zealand [39] and Canada [43] may affected by using different fats in the production of chocolate which, may cause problems in the long-term for Iranian consumers. The amount of Oleic acid ($C_{18:1t}$)in chips in the current study showed the same results with that of Fernandez San Juan's study in Spain [40,47]. The analyzed crisps had less TFAs than Australia [48] and Canada [43], and more than the Argentinean studies [41]. Studies show that TFA in products containing high amounts of TFA, such as crisps, need to be removed or reduced [49], but it should be noted that this reduction in trans fatty acids does not lead to increased amounts of SFA. In the Netherlands, TFA of McDonald's chips have been reduced to less than 4% and held SFA to at least 24% [50], which can be considered a success in preventing chronic diseases. One of the most popular snacks in childhood and adolescence is cheese snake, and based on the results, has more TFA than cheese snakes from Spain [40] and less TFA than Chee Toz (snack brand in Argentina) [41]. TFAs have strong biological effects and can increase the prevalence of overweight, obesity diabetes type II, and coronary artery disease [51]. Consumption of low quality food during early childhood may increase the risk of complications in adulthood.

The differences in the amount of trans fatty acids in different types of foods may be because of using hydrogenated or non-hydrogenated but combined oils in food processing. The hydrogenation process of oils is not the same all over the world. The difference in TFAs content of foods could partly be due to different fatty acid extraction methods that use Soxhlet methods or solvents such as benzene and cyclohexane and petrolatum for the extraction. The amount of trans fatty acids in hydrogenated oils varies in different conditions such as temperature, pressure, and catalyst amount [36]. The reason for using this type of oil can be a lower cost than liquid oils, as well as better formation of foods, and also that most people preferred to use the hydrogenated oils for a better taste food product.

Conclusion

This study shows that significant amounts of fatty acids can be absorbed into our body by consumption of snack foods. TFAs in Iranian tested foods, especially in cakes, biscuits and coffee mate, was very high due to the use of hydrogenated oils in the preparation of these products. The production of hydrogenated oils should be limited. It is suggested that the presence of labels containing the exact amount of all fatty acids, especially TFAs, on food products should be mandatory by the state government. In addition, it is necessary to increase public nutritional knowledge on the quality and safety of food consumption.

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