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A Comparison of Fatty Acid Profiles in Highly Demanded Traditional and Fast Foods in Isfahan, Iran

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ABSTRACT

Background: High consumption of fatty acids is known as a dietary risk factor for cardiovascular diseases. The aim of study was to survey of fatty acid profiles in the traditional/fast foods commonly consumed in Iran. **Methods:** Gas chromatography was used in the present study to determine the composition of fatty acids in 40 most popular traditional/fast foods consumed in Isfahan, Iran. The food samples were collected from 19 restaurants. **Results:** In all the tested samples, palmitic acid was at the highest level of saturated fatty acids (SFAs) ($P < 0.05$). Although in both groups of foods, the levels of trans fatty acids (TFAs) were above 2% in 30% of examined foods, the higher amounts of TFAs were found in traditional foods ($P < 0.05$). The results show that traditional foods contain higher levels of SFAs and TFAs than fast foods. **Conclusions:** The alarming findings of the present study should compel the relevant authorities in Iran to adopt and implement appropriate policies that systematically and continually control the types of food prepared and served in restaurants in order to minimize the intake of SFAs and TFAs.

Keywords: *Fatty acids; Fast foods; Traditional foods; Iran*

Introduction

According to the health data published by the World Health Organization (WHO), non-communicable diseases (NCDs) will cause more than three quarters of global deaths by the year 2030. Internationally, cardiovascular diseases (CVDs) were responsible for 31% or 17.5 million deaths in 2011, and the estimates indicate that this number could rise to 23.3 million by the year 2030 (World Health Organization, 2015). Because of the destructive role of high fat intake in causing CVDs, its reduction has been a major recommendation of nutrition and health specialists over the past few decades. In fact, CVDs are considered to be among the leading causes of deaths globally (Ghazavi *et al.*, 2020) . Several studies have recently shown that in triggering CVDs, the type of fat is much more important than the amount of fat consumed (Ghazavi *et al.*, 2020). Among fatty acids, saturated and trans fatty acids (SFAs

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and TFAs) lead to the increase of low-density lipoprotein (LDL) and reduction of high-density lipoprotein (HDL) levels (Sacks *et al.*, 2017). With the exception of stearic acid, other SFAs lead to an increase in serum cholesterol levels (Nazari *et al.*, 2012). However, according to published reports, TFAs contributes twice as much as SFAs to the growth of total cholesterol (Polley *et al.*, 2018). Over-consumption of SFAs and TFAs increases the risk of several diseases (Sacks *et al.*, 2017). Severe frying, prolonged cooking, and using hydrogenated oils in restaurants lead to the production of TFAs in prepared foods. These processes are considered as major causes of TFAs in human diets in many countries (Abramovič *et al.*, 2018). Considering the importance of fatty acids as a major risk factor in NCDs, various investigations have been conducted in different countries to measure the composition of fatty acids in biscuits and wafers (Costa *et al.*, 2016), potato chips (Roe *et al.*, 2013), bakery products (Ansorena *et al.*, 2013) and margarine and shortening (Abramovič *et al.*, 2018). Although few reports are available on fatty acid contents in some Iranian foods (Pasdar *et al.*, 2013) and traditional sweets (Ghazavi *et al.*, 2020), there is lack of information on the amounts of these compositions in some popular foods. Iran is a vast country with a population of 80 million undergoing an epidemiologic transition, in which the load of communicable diseases gradually reduces, while, based on the evidence, the rate of NCDs is on the rise. The socioeconomic developments and the successful implementation of primary health care programs in recent decades have led to general health improvements and reduced child and maternal mortality rates. A notable revolution has also occurred in preventing communicable diseases. Nevertheless, NCDs have persisted as a great health problem in Iran. In 2013, 236000 deaths occurred in Iran due to NCDs, and the country has witnessed a rise of 14.5% in the number of such deaths during the past two decades (World Health Organization, 2015). Traditional foods constitute the main part of Iranian diet and are considered to be distinct from other types of food due to their unique qualities and the cultural and ethnic identities they represent. In Iran, the consumption of traditional as well as fast foods is increasing. The rise in the rates of NCDs around the world and also in Iran can be attributed to the changes of lifestyle and dietary pattern among different peoples (Esfandiari *et al.*, 2019). In a previous study on the traditional sweets distributed in the city of Isfahan (Iran), TFAs with an average share of 1.6±0.3% in total fat content (range of 0.04±0.001 to 7.9±1.1%) were detected in all the examined samples. More than half of the samples had less than 2% TFAs in total fat, which has been set as a limit by Iran's Health Organization (Ghazavi *et al.*, 2020). Considering the popularity of traditional and fast foods in Iranian diet and the significant effects of fatty acids in such foods on public health, this investigation has been conducted to measure the amounts of SFAs and TFAs in these foods by means of gas chromatography. This is the first comprehensive survey of fatty acid profiles in the traditional/fast foods commonly consumed in Iran.

Materials and Methods

Study setting: In this cross-sectional study, traditional and fast food samples (20 samples from each category) were selected from 19 restaurants located in two districts of the city of Isfahan, Iran. Based on the volume of purchase in most restaurants, the selected foods were considered as highly popular. The ingredients of the traditional Iranian food samples selected for this study are presented in **Table 1**. These foods are totally prepared through frying or prolonged cooking. Most of the fast food samples were taken from the menus given out to customers in the selected restaurants. The names of the selected fast foods are listed in **Table 2**. The experiments were performed in duplicates.

Measurements: Fat extraction from the samples and fatty acid methylation procedures were performed using the official Association of Official Analytical Chemists (AOAC) method

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(Horwitz, 2012). A 100g portion of each sample was weighed and homogenized. An n-hexane solvent was used for oil extraction. The mixture of n-hexane and methanol potassium was added to the composition. The solution was placed in water bath (50-55°C) and mixed 3 times for 5 min to make it ready for injection. The chemical and standard fatty acid solutions used in the study were obtained from Merck Company, Germany. The fatty acids in food samples were detected and identified by means of a gas chromatography device (Yangi Model 6500, Korea) equipped with a BPX-70 column (60 m × 0.25 mm × 0.2 µm), flame ionization detector at a temperature of 280°C and a Hamilton syringe with a capacity of 10 µl. Hydrogen with 60 psi pressure, 99.9% purity, and 2 ml/min flow was used as the carrier gas, with the split of the device adjusted at 1/100. The initial temperature of the column was set to 110°C, which, after 10 min, was raised to 210°C at a rate of 5°C/min. A calibration curve was plotted for each fatty acid. Finally, the retention times, peak area percentages, and injected samples were determined using a chromatography data stations software program (YL-Clarity).

Data analysis: The data related to fatty acid profiles were presented in the format of mean ± standard deviation (SD). The ANOVA-test was applied to compare the average quantities of different fatty acids in traditional and fast food samples at 95% confidence level. The Software Package of Social Sciences (SPSS21, IBM, Armonk, NY, USA) was used to perform data analysis.

Results

Table 2 shows SFA contents in traditional Iranian foods and fast foods. The highest amounts of SFAs measured in traditional foods belonged to Ghormeh sabzi stew (76.83 ± 0.66%) and chicken stew (72.63 ± 2.95%). The highest quantities of SFAs in the fast food category were found in vegetable pizza (53.12 ± 2.97%) followed by cheese burger (45.49 ± 0.36%); which were considered to be significant compared to all the surveyed food samples ($P < 0.05$). Among the traditional foods, barley soup, Adasi (Persian lentil soup), barbecued chicken, and milk soup had the lowest SFA levels (range of 8.27 ± 0.78 to 29.98 ± 1.62%). Similarly, fast food samples, such as fried mushrooms, special corn and "corn with mushroom and cheese" contained less than 20% SFAs in total fat. The total SFA contents of traditional and fast food samples were 44.18% and 32.48%, respectively. Among traditional foods, the majority of the tested samples (60%) contained 20-50% SFAs, 30% contained more than 50% SFAs and 10% contained less than 20% SFAs in total fat. However, in the fast food category, the majority of the samples (80%) contained 20-50% SFAs, 5% contained more than 50% SFA and 15% contained less than 20% SFAs in total fat. Palmitic acid was found in all the tested traditional food samples. Palmitic acid, stearic acid, and arachidic acid were measured in all the examined fast food samples. In general, palmitic acid and stearic acid were the dominant SFAs in traditional foods and fast foods, respectively. Based on the SFA results related to traditional foods, all types of fatty acids were present in Halim (wheat and lamb porridge) eggplant Halim (Persian eggplant and lentil dish), and Kaleh Pache (head and legs of sheep). In the fast food group, all types of fatty acids were found in cheese burger, mushroom burger, "hamburger with mushroom and cheese", special snack, "snack with meat and mushroom", Sambusa, special pizza, and vegetable pizza.

The TFAs contents of the studied food groups are summarized in **Table 3**. The total contents of TFAs in traditional and fast food groups were 0.85 ± 0.15% and 0.98 ± 0.08%, respectively. Furthermore, in 8 of the 40 foods listed in Table 3, the TFA levels were higher than 2%. Based on the TFA results, palmitoleic acid was dominant in both groups of examined foods. The overall amounts of TFAs are illustrated in **Figure 1**. As can be seen, biryani, Kubideh kebab (an Iranian meat kabab made from ground lamb or beef), Abgoosht (meat broth), eggplant Halim, Kaleh

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pache, and Halim in the group of traditional foods and mushroom burger, hamburger, cheese burger, double burger, "hamburger with mushrooms and cheese" and "snack with meat and mushrooms" in the fast food category have more than 2% TFA (the permissible limit of TFA for food products in Iran). Besides, the lowest total amount of TFA was found in Fesenjan stew (0.22% in total fat) from the traditional food group and to a lesser extent in Fried chicken nugget (0.5% in total fat) from the fast food category.

Table 1. Description of ingredients of different Iranian traditional foods

Sampels	Ingredients
Kashk and eggplant	Fried eggplant, kashk, fried onion, garlic, mint, oil, walnut, salt, black pepper and turmeric
Eggplant Halim	Rice, eggplant, kashk, fried onion, lentil, lamb, saffron, mint, oil, walnut, salt, black pepper, turmeric and cinnamon
Halim	Wheat, onion, lamb, meat, butter, cinnamon and salt
Adasi	Lentil, onion, potatoe, water, oil, salt, pepper and turmeric
Lentil Halim	Meat, rice, kashk, fried onion, lentil, mint, oil, walnut, saffron, salt and black pepper
Abgoosht	Meat with fat, pea, bean, onion, tomato sauce, tomato, potato, salt, black pepper and turmeric
Kaleh pache	Kaleh pache of lamb, pea, water, oil, salt, black pepper and turmeric
Barbecue chicken	Chicken, onion, butter, lemon, saffron, olive oil, salt, black pepper and ginger
Kubideh kebab	Minced meat with fat, onion, saffron, black pepper and salt
Biryani	meat, onion, mint, oil, bread, salt, black pepper, turmeric and cinnamon
Kofteh Tabrizi	Minced meat with fat, cotyledon, rice, egg, onion, vegetable, tomato sauce, olive oil, salt, black pepper and turmeric
Chicken Tah-Chin	Rice, chicken breast, yogurt, egg, onion, oil, saffron, salt, black pepper, turmeric and cinnamon
Chicken stew	Chicken thigh or breast, carrot, plum, onion, oil, tomato sauce, fried potato, salt, black pepper and turmeric
Fesenjan stew	Chicken breast, powdered walnut, onion, pomegranate sauce, sugar, saffron, salt, oil, black pepper and turmeric
Gheymeh stew	Meat, cotyledon, tomato sauce, onion, cinnamon, lemon, oil, fried potato, saffron, salt, black pepper and turmeric
Ghormeh sabzi stew	Meat, bean, vegetable, lemon, oil, salt, black pepper and turmeric
Sholeghalamkar ash	Pea, bean, lentil, rice, wheat, meat, tarragon, onion, mint, salt, oil, black pepper and cinnamon
Reshteh ashe	Pea, bean, lentil, oil, spinach, parsley, dill, coriander, turmeric, noodle, garlic, peppermint, onion, salt, black pepper and kashk
Barley soup	Onion, carrot, chicken breast, parsley, barley, tomato sauce, oil, salt, black pepper and turmeric
Milk soup	Onion, carrot, chicken breast, parsley, barley, milk, cream, mushroom, oil, salt, black pepper and turmeric

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Table 2. Mean (± SD) of saturated fatty acids (%) in traditional and fast foods.

Traditional foods	C12:0	C14:0	C15:0	C16:0	C17:0	C18:0	C20:0	ΣSFA
Kashk and eggplant	ND	3.91±0.00	0.65±0.02	23.20±0.01	0.19±0.00	5.69±0.01	0.49±0.00	34.13±0.04
Eggplant Halim	0.39±0.56	6.47±0.33	0.67±0.17	32.92±1.25	0.51±0.11	8.27±0.22	0.57±0.05	49.80±2.69
Halim	0.35±0.38	4.25±0.41	0.44±0.47	27.16±4.76	0.38±0.35	5.48±1.41	0.27±0.09	38.33±7.87
Adasi	ND	ND	ND	8.00±0.10	ND	1.08±0.03	ND	9.08±0.14
Lentil Halim	0.18±042	0.69±0.11	ND	24.41±0.47	0.13±0.01	4.33±0.24	0.40±0.13	30.14±1.38
Abgoosht	ND	12.72±0.13	1.69±0.28	31.47±0.55	2.86±0.56	12.67±0.42	ND	61.41±1.94
Kaleh pache	0.96±0.07	3.64±0.09	0.22±0.01	19.78±0.71	0.97±0.00	9.01±0.33	0.41±0.02	34.99±1.23
Barbecue chicken	0.27±0.09	1.40±0.01	0.51±0.04	19.04±0.11	0.24±0.00	6.05±0.01	ND	27.51±0.26
Kubideh kebab	ND	3.05±0.78	0.33±0.01	23.35±0.64	2.67±0.03	13.18±0.31	ND	42.58±1.77
Biryani	ND	5.37±0.61	ND	34.51±0.09	0.43±0.00	32.32±0.06	ND	72.01±0.15
Kofteh tabrizi	ND	ND	1.62±0.01	13.93±0.05	0.38±0.02	24.23±3.42	ND	40.16±3.5
Chicken tah-Chin	ND	2.83±0.00	1.11±0.03	24.98±0.03	3.28±0.01	40.84±0.14	ND	68.04±0.21
Chicken stew	1.30±0.83	8.64±0.58	0.14±0.01	29.16±0.23	0.40±0.00	32.37±1.30	ND	72.63±2.95
Fesenjan stew	ND	ND	7.16±0.04	0.07±0.05	30.24±0.02	ND	ND	37.47±0.11
Gheymeh stew	ND	0.51±0.08	1.31±0.52	31.11±0.08	ND	38.19±0.18	ND	72.12±0.86
Ghormeh sabzi stew	ND	ND	3.23±0.01	35.46±0.30	0.44±0.00	37.70±0.35	ND	76.83±0.66
Sholeghalamkar ash	ND	ND	ND	13.87±0.02	0.09±0.00	25.84±0.16	ND	39.8±0.18
Rashteh ash	ND	ND	ND	14.37±0.03	0.12±0.00	25.03±0.18	ND	39.52±0.21
Barley soup	ND	0.73±0.14	ND	7.54±0.21	ND	ND	ND	8.27±0.78
Milk soup	ND	3.34±0.81	0.07±0.02	19.82±0.66	ND	6.32±0.13	0.43±0.00	29.98±1.62
Total	0.14±0.11	2.42±0.17	0.95±0.08	21.83±0.56	2.16±0.05	16.18±0.41	0.12±0.01	44.18±1.34
Fast foods	C12:0	C14:0	C15:0	C16:0	C17:0	C18:0	C20:0	ΣSFA
Fried potato	ND	0.67±0.00	0.32±0.13	27.58±0.00	0.11±0.00	4.38±0.01	0.44±0.05	33.5±0.19
Fried potato with mushroom and cheese	ND	1.74±0.01	0.33±0.08	32.49±0.29	0.24±0.14	3.93±0.08	0.19±0.05	38.92±0.65
Hamburger	ND	ND	ND	25.95±7.09	0.65±0.01	8.02±0.04	0.29±0.20	34.91±7.34
Double burger	ND	2.42±0.02	0.66±0.00	19.40±0.08	1.81±0.14	11.56±0.01	0.21±0.00	36.06±0.25
Cheese burger	0.90±0.01	4.55±0.02	0.59±0.00	31.21±0.06	0.73±0.25	7.41±0.01	0.10±0.01	45.49±0.36
Mushroom burger	0.17±0.06	2.69±0.01	0.39±0.01	28.0±0.14	0.63±0.04	7.56±0.06	0.15±0.00	39.59±0.32
Hamburger with mushroom and cheese	1.41±0.67	3.92±1.71	0.57±0.26	29.63±1.84	0.89±0.34	7.43±0.37	0.15±0.01	44±5.2
Pirozhki[a]	ND	0.38±0.00	ND	17.95±0.04	0.10±0.03	4.17±0.00	0.39±0.00	22.99±0.07
Hot dog	ND	0.74±0.30	0.18±0.06	21.33±1.06	0.51±0.32	8.85±2.79	0.26±0.04	31.87±4.57

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Table 2. Mean (± SD) of saturated fatty acids (%) in traditional and fast foods.

Special corn[b]	ND	ND	ND	13.47±0.04	0.15±0.05	4.16±0.06	0.40±0.00	18.18±0.15
Corn with mushroom and cheese	ND	0.40±0.01	0.06±0.02	13.03±0.23	0.12±0.00	4.19±0.13	0.45±0.08	18.25±0.47
Special snack[c]	0.27±0.00	1.07±0.01	0.11±0.00	21.79±0.11	0.16±0.03	5.21±0.04	0.42±0.00	29.03±0.19
Snack with meat and mushroom	0.23±0.08	1.67±0.21	0.23±0.09	24.50±0.38	0.24±0.06	6.16±0.09	0.24±0.02	33.27±0.93
Sambusa[d]	0.21±0.06	0.68±0.00	0.04±0.00	27.26±0.04	0.10±0.00	4.17±0.08	0.43±0.00	32.89±0.18
Falafel[e]	ND	1.23±0.57	ND	28.52±0.32	0.14±0.06	3.59±0.03	0.32±0.00	33.8±0.98
Special pizza	0.61±0.00	2.34±0.01	0.25±0.00	22.03±0.02	0.18±0.00	4.83±0.01	0.15±0.06	30.39±0.10
Vegetable pizza	2.35±0.00	8.11±0.01	0.92±0.01	33.53±2.85	0.51±0.08	7.44±0.01	0.26±0.01	53.12±2.97
Fried chicken thigh	0.99±0.62	0.11±0.01	ND	18.22±0.95	0.11±0.00	5.53±0.43	0.11±0.01	25.07±2.02
Fried chicken nugget	ND	0.55±0.06	ND	20.23±0.36	ND	5.33±0.00	0.27±0.09	26.38±0.51
Fried mushroom	0.36±0.00	ND	ND	11.60±0.01	0.10±0.04	5.44±0.01	0.52±0.01	18.02±0.07
Total	0.37±0.07	1.66±0.14	0.23±0.03	23.38±0.79	0.37±0.07	5.96±0.21	0.28±0.03	32.48±1.34

C12:0: Lauric acid; C14:0: Myristic acid; C15:0: Pentadecanoic acid; C16:0: Palmitic acid; C17:0: Margaric acid; C18:0: Stearic acid; C20:0: Arachidic acid; ND: Not Detected, P value <0.05; [a]: Pirozhki ingredients: Mince meat, onion, mushroom, bell pepper, tomato paste, Pirozhki dough, pizza cheese, garlic powder, turmeric, salt and black pepper; [b]: Special corn ingredients: Sweet corn, butter, thyme, lemon juice, mayonnaise sauce, salt and pepper; [c]: Special snack ingredients: Toast bread, ham, cheddar cheese, tomato paste and mayonnaise sauce; [d]: Sambose ingredients: Potato, onion, coriander, parsley, lavash bread, turmeric, mincemeat, salt and black pepper; [e]: Falafel ingredients: Pea, parsley, onion, garlic, black pepper, salt, cumin, coriander, turmeric and oil.

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Table 3. Mean (± SD) of trans fatty acids (%) in traditional and fast foods.

Traditional foods	C14:1t	C16:1t	C18:1t	C18:2t	C18:2(all-t-9.12)	C18:3t
Kashk and eggplant	ND	0.08±0.06	ND	0.74±0.21	ND	0.34±0.00
Eggplant halim	0.23±0.09	0.14±0.04	ND	0.74±0.18	1.46±0.75	0.25±0.08
Halim	0.40±0.11	0.21±0.23	ND	1.32±0.52	0.28±0.13	0.05±0.35
Adasi	ND	0.10±0.02	ND	ND	0.24±0.04	ND
Lentil halim	ND	0.06±0.03	ND	ND	0.20±0.00	ND
Abgoosht	1.46±0.02	2.37±1.37	0.85±0.08	1.24±0.08	1.17±1.14	ND
Kaleh pache	0.17±0.01	0.63±0.25	ND	ND	1.67±0.31	ND
Barbecue chicken	0.08±0.04	0.21±0.01	0.41±0.04	0.68±0.22	ND	0.33±0.09
kubideh kebab	1.15±0.03	5.39±0.73	ND	1.92±0.74	ND	ND
Biryani	1.37±0.08	5.45±0.01	ND	1.69±0.05	ND	0.75±0.21
Kofteh tabrizi	ND	0.38±0.01	ND	0.46±0.04	ND	0.37±0.00
Chicken tah-Chin	ND	0.19±0.01	ND	0.82±0.02	ND	0.70±0.00
Chicken stew	ND	0.41±0.01	ND	0.55±0.04	ND	ND
Fesenjan stew	ND	0.14±0.06	ND	ND	ND	0.08±0.00
Gheymeh stew	ND	ND	ND	0.29±0.04	ND	ND
Ghormeh sabzi stew	0.23±0.06	0.34±0.08	ND	0.31±0.25	ND	0.30±0.00
Sholeghalamkar ash	ND	ND	ND	0.18±0.01	ND	0.42±0.00
Rashteh ash	ND	0.03±0.01	ND	0.30±0.00	ND	0.41±0.04
Barley soup	ND	0.39±0.06	ND	0.34±0.02	ND	0.42±0.11
Milk soup	ND	0.65±0.04	ND	0.38±0.57	ND	0.46±0.00
Total	0.25±0.01	0.85±0.15	0.06±0.006	0.59±0.14	0.25±0.06	0.24±0.04
Fast foods	C14:1t	C16:1t	C18:1t	C18:2t	C18:2(all-t-9.12)	C18:3t
Fried potatoe	ND	0.07±0.00	0.16±0.06	ND	ND	0.42±0.05
Fried potatoe with mushroom and cheese	0.08±0.04	0.08±0.01	ND	0.20±0.04	ND	0.32±0.03
Hamburger	ND	4.35±0.13	ND	0.96±0.86	ND	0.36±0.11
Double burger	0.55±0.21	3.04±0.04	ND	ND	1.20±0.28	ND
Cheese burger	0.19±0.04	3.35±0.11	ND	1.37±0.23	ND	0.20±0.02
Mushroom burger	0.17±0.01	4.40±0.04	ND	1.31±0.06	ND	0.26±0.11
Hamburger with mushroom and cheese	0.21±0.06	2.12±0.87	ND	0.88±0.47	ND	0.23±0.07
Pirozhki	ND	0.09±0.01	ND	0.22±0.01	0.41±0.01	ND
Hot dog	0.27±0.10	0.23±0.11	ND	0.59±0.01	ND	0.32±0.01
Special corn	ND	0.08±0.06	ND	0.09±0.06	ND	0.35±0.00
Corn with mushroom and cheese	ND	0.04±0.01	ND	0.73±0.13	ND	0.40±0.05
Special snack	ND	0.08±0.01	ND	0.67±0.01	ND	0.44±0.01
Snack with meat and mushroom	0.11±0.06	1.54±0.08	ND	0.55±0.11	0.46±0.11	0.41±0.15
Sambusa	ND	0.06±0.01	ND	0.40±0.04	ND	0.39±0.01
Falafel	ND	0.03±0.01	ND	0.34±0.05	ND	0.50±0.14
Special pizza	0.08±0.01	0.18±0.01	ND	0.29±0.01	ND	0.22±0.01
Vegetable pizza	0.23±0.01	0.22±0.08	ND	0.87±0.01	ND	ND
Fried chicken thigh	ND	0.25±0.06	ND	0.21±0.00	ND	0.26±0.06
Fried chicken nugget	ND	0.17±0.00	ND	ND	0.33±0.11	ND
Fried mushroom	ND	0.85±0.02	ND	0.14±0.01	ND	0.44±0.02
Total	0.09±0.02	0.98±0.08	0.008±0.03	0.94±0.1	0.09±0.02	0.27±0.04

C14:1t: Myristoleic acid; C16:1t: Palmitelaidic acid; C18:1t: Elaidic acid; C18:2t: Linolelaidic acid; C18:2(all-t-9.12): Linolelaidic acid; C18:3t: Octadecatrinoic acid; t : trans, ND: Not Detected, P value <0.05.

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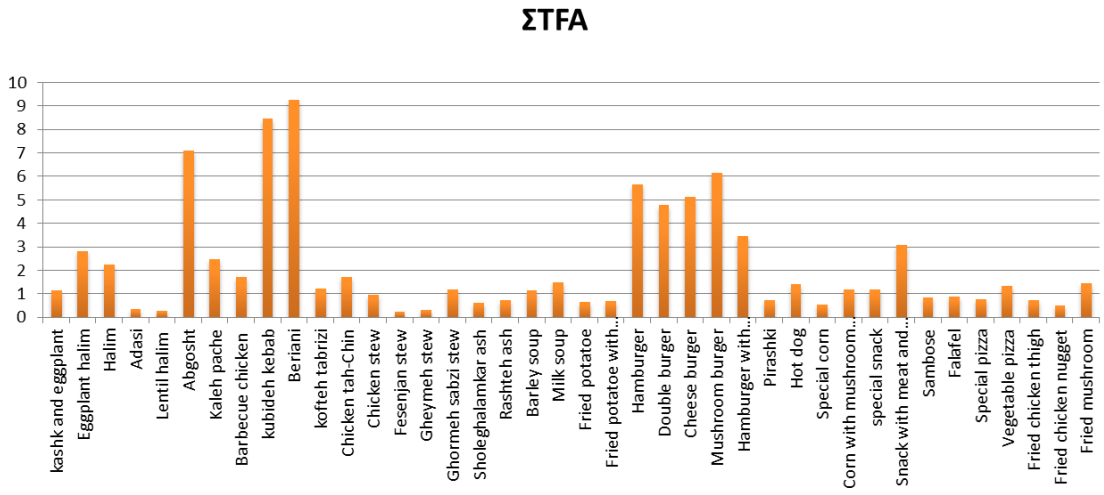

Figure 1. Comparison of total amount of trans fatty acids (%) in traditional and fast foods.

Discussion

According to published reports, one of the major risk factors for CVDs in humans is a combination of fatty acids and, especially, elevated amounts of SFA found in their diets (Sacks *et al.*, 2017). Based on the results of this study (**Table 2**), the average total SFAs in traditional foods (44.18±1.34%) is 1.36 times that of fast foods (32.48±1.34%). The highest levels of total SFAs were found in Ghormeh Sabzi stew, chicken stew, Gheime stew, and biryani among the traditional foods and in vegetable pizza, cheese burger, "hamburger with mushrooms and cheese" and mushroom burger in the fast food group; which can be alarming, considering the high popularity and consumption of these foods.

The daily SFA intake should be less than 10% of the overall daily intake of energy (Kuna and Achinna, 2013). However, findings have revealed that the total SFA levels in all the tested samples from both food groups are higher than the limit recommended by the WHO except in Adasi (9.08±0.14%) and barley soup (8.27±0.78%).

The way traditional foods are prepared has changed over time, which can include overuse of hydrogenated oils, deep frying of vegetables and meats, prolonged cooking of some foods, or even the use of unnecessary ingredients during cooking (Abdolahi *et al.*, 2015). Among the mentioned factors, the use of hydrogenated oils in traditional foods because of their cheapness compared to liquid oils is one of the main reasons for the high level of SFA compared to fast foods. As the results of this study showed the highest levels of total SFAs were found in Ghormeh Sabzi stew and chicken stew among the two group foods. Hydrogenated oil may also be used more than other foods in Ghormeh Sabzi stew during frying onions and meat and, and in chicken stew fried onions and chicken to create a more delicious taste.

Adasi, with lentil as its main ingredient, is a delicious and nutritious type of soup in Iranian cuisine. This food is served warm in breakfast and sometimes, along with bread, as a light lunch or dinner. Lentil is a member of the legume family and a very good source of cholesterol-lowering fiber. Not only do lentils help lower cholesterol, but also control blood sugar related disorders, since their high fiber content prevents blood sugar level from rising too rapidly after a meal. Lentils also contain moderate to high amounts of seven important minerals, B-vitamins, and protein, all with virtually no fat (Mahmoudi and Maleki, 2004). Barley soup, as an appetizer or light dinner, is also a popular and common food in Iran. As its name implies, its main ingredients are barley along with vegetables, such as carrots, parsley, and coriander. Barley soup has high fiber content and also lower levels of SFA compared to

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the common meals served in restaurants (Abdolahi *et al.*, 2015).

Dietary fiber is generally accepted as a beneficial factor in controlling and preventing diabetes. Barley is a great source of soluble and insoluble dietary fibers, which are effective in lowering blood cholesterol and reducing the risk of heart diseases. Barley is a smart choice for those concerned about type-2 diabetes, because it is high in a specific type of soluble fiber called beta glucans. In fact, barley has more beta glucans fiber than any other grains. Beta glucans have been shown to lower glucose absorption and help control the glycemic index (Zeng *et al.*, 2018).

As can be seen from the results of this study in Table 2, palmitic, stearic, and myristic acids are SFAs with the highest levels in both food groups tested. Among SFAs, stearic acid has a neutralizing effect on LDL cholesterol, whereas lauric, myristic, and palmitic acids raise serum cholesterol levels. It has also been shown that the presence of lauric and myristic acids has a more significant effect on the development of CVDs than the overall amount of SFAs (Briggs *et al.*, 2017). Furthermore, stearic acid reduces the level of LDL in blood plasma, but has no effect on the level of HDL.

According to the findings of this study, among the fatty acids found in different food samples, palmitic acid is the dominant SFAs, which heightens the risk of type-2 diabetes. Therefore, diabetic patients are encouraged to consume more PUFAs than SFAs in order to properly control the lipid factors in their blood serum (Sacks *et al.*, 2017).

The amounts of SFA detected in the present study were very similar to those obtained by the other study (Milićević *et al.*, 2014). The highest level of palmitic acid was found by Milicevic *et al.* study in chicken thighs and breasts (Milićević *et al.*, 2014). Pasdar reported the amount of SFAs to be 38.16% of total fat in examined foods, such as barbecued morsels, fried shrimp, fried chicken, chicken nuggets, burgers, sausages, cold cuts, Falafel, rib barbecue, fillet barbecue, Kubideh kebab, barbecued chicken, and pizza (Pasdar *et al.*, 2013). Vučić reported the highest level of palmitic acid in Serbian margarines among all SFAs (Vučić *et al.*, 2015). Furthermore, in a study conducted by Albuquerque et al., the highest levels of SFAs were found in fast foods, cereal products, nuts, snacks, cookies, biscuits and wafers, potato and its products, bakery products, and sauces (Albuquerque *et al.*, 2018).

TFA intake may vary according to dietary habits and different contents of TFAs in processed foods across the globe (Salimon *et al.*, 2017). TFAs has been found in 33% of hydrogenated oils, 1.6–16.1% of dairy products, 2% of traditional sweets and up to 36.1% of some snacks, such as cakes (Bhardwaj *et al.*, 2016, Ghazavi *et al.*, 2020, Pérez-Farinós *et al.*, 2016). Studies have shown that a 2% increase in the TFA intake could raise the risk of CVDs by 23%. A recent study has also found that a 39% reduction of CVDs can be achieved in Iran by replacing TFAs with unsaturated fatty acids (Nazari *et al.*, 2012). Due to the heightened concerns about the effects of TFAs on health, some countries have established new standards on the maximum permitted levels of TFAs in foods. Denmark was the first country in the European community to set an upper limit of 2% TFAs in food. In Canada and the United States, the recommended TFA intake was 4–12% of total fat intake. But today, the recommended amount of TFA intake is 0.6–2% of the total daily energy consumption (Trattner *et al.*, 2015). In Iran, the allowable amount of TFAs in total fat has been set to 2% (Ghazavi *et al.*, 2020).

In the group of traditional foods, the levels of TFAs in biryani were significantly higher than those of other samples, followed by Kubideh kebab and Abgoosht (**Figure 1**). In the fast food category, mushroom burger, hamburger and cheese burger had higher levels of TFAs. Biryani is a famous Iranian dish which is native to Isfahan, a central province in Iran. This food has been acknowledged around the world and is popular among Iranians. Biryani is made of red meat and liver. So in spite of its high protein

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content, it also has a significant amount of cholesterol. Therefore, its consumption is not recommended for patients suffering from CVDs or hyperlipidemia (Abdolahi *et al.*, 2015).

In both tested food groups, 30% of the samples contained more than 2% TFAs. The results also indicate that Fesenjan stew has the lowest amount of TFAs in the 40 examined samples. Walnuts are one of the main ingredients of Fesenjan stew (Table 1). Studies have shown that edible nuts are rich in unsaturated fatty acids (oleic acid and linoleic acid) and free of any TFAs (Poggetti et al., 2018). Among the examined fast foods, it is reasonable to assume that burgers contain the highest amounts of TFAs, because of using oils at high temperatures to cook them. According to a study in the United Kingdom (Roe *et al.*, 2013), the TFA levels in processed foods were found to be in the range of 0.04–2.40%, with the highest levels in fish fried in butter and in French fries. The results of this study were in line with these findings. A recent study by Costa *et al.* (2016) reported the highest level of TFAs (3.42%) in biscuits, wafers and cookies among the food products in Portuguese markets. In another study carried out in Slovenia, found TFA levels of 0.11–6.37% in margarine and 0.05–11.16% in shortening (Abramovič *et al.*, 2018).

The TFA levels measured in this study were much higher than those found in the UK and Portugal (Costa *et al.*, 2016, Roe *et al.*, 2013) but lower than those obtained by Abramovič (only for shortening) (Abramovič *et al.*, 2018).

To enable consumers to choose healthy foods, the food producers in Iran have been required, since 2015, to affix traffic light labels on their products that show the status of risk factors (e.g., TFAs) for NCDs (Esfandiari *et al.*, 2019). In view of the high amounts of TFAs found in the examined foods in this study, it seems that such labels should attract the attention of the general public to choose more appropriate foods. The discrepancies between the results of the current study and other studies could be due to the sampling design, the difference between the numbers of samples, the types of oil used, and different cooking temperatures.

Conclusion

The profiles of fatty acid compositions in the most common traditional and fast foods consumed in Iran are presented. The findings of this study reveal that of the two examined food categories, the highest levels of SFAs and TFAs belong to traditional foods. This can be attributed to the use of solid hydrogenated oils in many restaurants to prepare foods. It may be necessary to indicate the amounts of SFAs and TFAs, as risk factors of CVDs, by traffic light labels on foods prepared and served in restaurants. On the other hand, the vegetables and legumes used in some foods are rich in fiber and, along with certain dietary groups, such as nuts, are suitable for the prevention of CVDs and should probably be an important part of a healthy diet and lifestyle. In this regard, it is recommended to have traffic light labeling on restaurant foods, in order to discourage the consumption of foods with high levels of SFAs and TFAs and encourage the intake of healthier foods.

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Authors' contributions

We declare that all the authors were active in this manuscript. Madani RS, Sami M and Esfandiari Z were research designer. Kermani S and Karamian E collected the data. All authors read and approved the final manuscript.

Conflict of interests

There is no conflict of interests.

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