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Original Article

Fatty acid composition of commercially available Iranian edible oils

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Abstract

BACKGROUND: Trans-fatty acids (TFAs), unsaturated fats with at least one double bond in the Trans configuration, are industrially formed in large quantities when vegetable oils are partially hydrogenated. This study was undertaken to quantify the amounts of the common fatty acids in several commercial oils marketing in Iran.

METHODS: The most consumed commercially available brands of vegetable oils were randomly selected from products available in supermarkets. A 10g sample was drawn from each mixed sample and prepared for fatty acid analysis by gas chromatography (GC).

RESULTS: Palmitic acid (C16:0) and stearic acid (C18:0) jointly constituted 21% of total fatty acids in partially hydrogenated vegetable oils (PHVOs). More than one third of total fatty acids in Iranian PHVOs were Trans fats. TFAs constituted almost 1% and 3% of total fatty acids in Iranian cooking and frying oils. This study showed higher contents of TFAs in Iranian commercially available hydrogenated vegetable oils. Statistical Package for Social Sciences was used for all statistical analyses.

CONCLUSIONS: Although several studies reported multiple adverse effects of TFAs on human health, limited information is available about total fatty acid composition, particularly TFAs, in Iranian edible oils. Our findings indicated higher content of TFAs in Iranian commercially available PHVOs.

KEYWORDS: Fatty Acids, Vegetable Oils, Trans Fats.

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Trans-fatty acids (TFAs), unsaturated fats with at least one double bond in the trans configuration, are industrially formed in large quantities when vegetable oils are partially hydrogenated. TFAs are also available in naturally occurring foodstuffs like dairy products and meats. Dietary intakes of TFAs have been indicated to affect risk of several conditions such as cardiovascular disease (CVD), insulin resistance, increased levels of blood lipids, inflammation, and endothelial dysfunction.[1]

TFAs from partially hydrogenated vegetable oils (PHVOs) account for 2% to 3% of total energy intake in US populations.[2] In Iran, TFAs accounts for 33% of all fatty acids in PHVOs, representing 4.2% of all calories consumed by Iranians, approximately twice as high as the US population and much higher than many European people. Such a high dietary intake can be partly explained by governmental subsidization of these products, which continued until most recently. Previous investigations estimated that 8% to 39% of CVD events among Iranians might be prevented by elimination of TFAs in PHVOs. These figures might be even greater because that study just considered in home consumption of PHVOs.[3]

Due to the multiple adverse effects of manufactured TFA, in 2003 the Danish Gov-

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ernment stated that industrially produced TFA should be limited to 2% of the total fat in a food.[4] Although dietary intakes of TFAs impose a great burden to Iranian health care system, little data is available regarding TFAs contents of Iranian vegetable oils. To determine if the significant association of vegetable oils with different diseases is mediated through TFA content of these products, knowing the amount of TFAs in these products is crucial. The present study was, therefore, undertaken to quantify the amounts of the common fatty acids exist in several commercial oils marketing in Iran, with particular attention to TFAs.

Methods

Three kinds of oils are marketing in Iran including: PHVOs, cooking oils (non-hydrogenated vegetable oils) and frying oils. Several brands are available with six being most reputed: Ladan (PHVO, cooking), Ghoo (PHVO, cooking), Bahar (cooking, frying), Ghonche (frying), Varamin (PHVO), Tordsorkh (frying). To have a representative sample of oils marketing in the city, we initially asked some selected supermarkets about the brands people buy. The same assessment was also done in a randomly selected group of people. We identified that the mentioned brands are the most selling oils in Isfahan city. Each brand was randomly selected three times from products available in supermarkets. To provide a homogeneous sample of each brand, 70 grams of oil from each sample was taken and mixed with each other. Finally a 10g sample was drawn from each mixed sample and prepared for fatty acid analysis.

Total lipids were extracted with chloroform: methanol (2:1 v/v) using the Folch technique.[5] Samples of the lipid extract were taken and the fatty acid components converted to their respective methyl esters. Methyl-esterification of samples was done by the BF_3-MeOH method.[6] Then, the fatty acid methyl esters were quantified using a Younglin capillary gas chromatography equipped with flame ionization detectors and column of TR-CN100 (60 m, 0.25 mm inside diameter, 20 μm film thickness). Conditions of work were as follows: injection temperature: 240° C, detector temperature: 250° C, initial temperature: 90° C, initial time: 5 min, 150° C for 10 min, 200° C for 15 min and final temperature: 240° C for 20 min. Helium used as the carrying gas, with a pressure of 20 psi and a split ratio of 20:1. For each sample, methyl ester was prepared three times.

Statistical Methods

Statistical Package for Social Sciences was used for all statistical analyses. All findings have been reported as means and standard deviations. Analysis of variance was used for comparing the fatty acid compositions of different vegetable oils. P values considered significant at < 0.05.

Results

Fatty acid compositions of different oils marketing in Iran are provided in table 1. The most common SFAs in Iranian PHVOs are palmitic acid (C16:0) and stearic acid (C18:0) that jointly constitute 21% of total fatty acids in these products. The same fatty acids are also found in greater amounts in cooking and frying oils. However, total SFA content of cooking oils is almost half the amount in PHVOs and frying oils (9.4% vs. 22.4% and 18.9%, respectively, $p < 0.01$). Palmitic acid (C16:0) content of frying oils was higher than PHVOs and cooking oils (14.8% vs. 10.7% and 6.1%, respectively, $p < 0.01$), while stearic acid in PHVOs (C18:0) was higher than in cooking and frying oils (10.3% vs. 3.2% and 3.5%, respectively, $p < 0.01$).

Table 1, also presents total and individual TFA content of different oils. More than one third of total fatty acids in Iranian PHVOs are Trans fats with elaidic acid (C18:1 9t) being the most common one. Other TFAs found in limited amounts in this product. TFAs constitute almost 1% and 3% of total fatty acids in Iranian cooking and frying oils. The most common TFA in frying oils was linolelaidic acid (C18:2, 9t 12t). PHVOs had greater amounts of elaidic acid (C18:1 9t), petroselaidic acid (C18:1 6t) and trans-13-octadecenoic acid (C18:1 13t)

Table 1. Fatty acid content (%) of different oils marketing in Iran

	Hydrogenated oils (n = 9)	Cooking oils (n = 9)	Frying oils (n = 9)	P value
C4:0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	-
C8:0	0.0 ± 0.0	0.0 ± 0.0	0.01 ± 0.03	0.3
C10:0	0.004 ± 0.007	0.0 ± 0.0	0.0 ± 0.0	0.03
C12:0	0.4 ± 0.009	0.01 ± 0.01	0.0 ± 0.0	< 0.01
C14:0	0.7 ± 0.3	0.06 ± 0.07	0.6 ± 0.1	< 0.01
C16:0	10.7 ± 5.23	6.1 ± 2.11	14.8 ± 2.15	< 0.01
C17:0	0.1 ± 0.1	0.005 ± 0.007	0.01 ± 0.01	< 0.01
C18:0	10.3 ± 2.57	3.2 ± 0.7	3.5 ± 1.2	< 0.01
C16:1 t	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	-
C18:1 6t	1.9 ± 1.95	0.0 ± 0.0	0.0 ± 0.0	< 0.01
C18:1 9t	32.1 ± 4.98	0.1 ± 0.1	0.2 ± 0.23	< 0.01
C18:1 11t	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	-
C18:1 13t	0.04 ± 0.07	0.0 ± 0.0	0.0 ± 0.0	0.04
C18:2 9t,12t	1.5 ± 0.57	0.8 ± 0.3	2.4 ± 0.9	< 0.01
C16:1	0.4 ± 0.71	0.7 ± 0.65	0.5 ± 0.83	0.65
C18:1 9c	26.5 ± 2.30	41.7 ± 10.9	40.2 ± 3.65	< 0.01
C18:2	7.3 ± 2.67	37.5 ± 12.50	28.4 ± 2.20	< 0.01
CLA	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	_
C18:3	0.7 ± 0.25	3.4 ± 2.38	3.1 ± 0.58	< 0.01
Total SFA	22.4 ± 3.52	9.4 ± 1.79	18.9 ± 1.98	< 0.01
Total TFA	35.2 ± 4.81	0.9 ± 0.29	2.6 ± 0.75	< 0.01
Total cis-unsaturated fatty acids	34.9 ± 1.19	83.4 ± 2.06	72.3 ± 3.42	< 0.01

(c = cis) (t = trans)

C4:0 (Butyric acid); C8:0 (Caprylic acid); C10:0 (Capric acid); C12:0 (Lauric acid); C14:0 (Myristic acid); C16:0 (Palmitic acid); C17:0 (Heptadecanoic acid); C18:0 (Stearic acid); C16:1 t (Palmitelaidic acid); C18:1 9t (Elaidic acid); C18:1 6t (Petroselaidic acid); C18:1 11t (trans-vaccinic acid); C18:1 13t (trans 13-octadecenoic acid); C18:2-9t 12t (Linolelaidic acid); C16:1 (Palmitoleic acid); C18:1 9c (Oleic acid); C18:2 (Linoleic acid); C18:2-c9t 11c or C18:2 10t 12c (Conjugated linoleic acid (CLA)); C18:3 (Linolenic acid).

compared to cooking and frying oils, while frying oils were of great content of linolelaidic acid (C18:2 9t 12t) compared to other oils.

Total cis-unsaturated fatty acid content of PHVOs was 35% with oleic acid (C18:1 9c) being the most common fatty acid in these products. Linoleic acid (C18:2) constituted 7% of total fatty acids in PHVOs. As expected, the greatest percent of total fatty acids was cis-unsaturated fats with 83% for cooking oils and 72% for frying oils. Again as in PHVOs, the most common fatty acid in both cooking and frying oils was oleic acid (C18:1 9c) followed by linoleic acid (C18:2). Comparing different oils, most cis-unsaturated fatty acids were found in greater amounts in cooking and frying oils as compared with PHVOs.

Discussion

Our findings showed that TFAs in Iranian commercially available oils are in the range of 0.9 to 35.2%, the highest amount found in PHVOs. Although several studies reported multiple adverse effects of TFAs on human health, limited information is available about total fatty acid composition, particularly TFAs, in Iranian edible oils. A previous study by Bahrami et al [7] indicated that commercially available Iranian PHVOs contain 59.1% of their total fatty acids as TFAs or SFAs. The corresponding figure in our study was 57.6%. Another study showed that TFA content of the most commonly consumed PHVOs in Iran were in the range of 23% to 36%.[8] In India, Trans fat content of PHVOs used for cooking and preparing commercially fried, processed, bakery

and street foods was reported to be almost 40%.[9]

The effects of trans fats on the cardiovascular system seem to be isomer-specific. Recent data suggested no harmful effects of naturally accruing Trans fats in dairy products on cardiovascular health. The amount of C18:1 11-trans isomer, a Trans fatty acids found in dairy products, in all samples of our study was zero. Harmful effects of trans-C18:2 isomers and trans-C18:1 isomers may be stronger than palmitoleic acid (trans-C16:1).[10] In the current study, the highest amount of trans-C18:2 isomers were 2.4% (in frying oils) and the highest amount of trans-C18:1 isomers was 34.0% (in PHVOs).

As compared with other countries, commercially available Iranian frying oils contain lower amounts of TFAs. The frying oil used in the food industry in the majority of European countries contains almost 10% TFA and those in the US and Peru contain 23% and 24% TFAs, respectively [4]; while the TFAs content of frying oils in the current study was 2.6%. In France, commercially used frying oil contains 3% alpha-linolenic acid (ALA).[11] In our study ALAs of frying oils was 3.1%. In Iran, due to the lower consumption of fish and seafood-derived n-3 fatty acids, plant sources (vegetable oils) of this fatty acid (ALA) are of great importance for reducing the risk of CVD. Our study indicated that the SFAs content of both PHVOs and frying oils were high, which was expected because these oils had undergone some extent of hydrogenation. Although frying oils are apparently liquid, manufactures use the process of hydrogenation to prolong their stability to some extent. In Iran, fast food consumption is increasing in high levels which are sources of trans fats.[12]

Some points need to be considered in the interpretation of our findings. First, budgetary limitations in our study did not allow accurate determination of all fatty acids (e.g. myristelaidic acid trans-C14:1) in the commercially available oils. Second, the main aim of the study was measurement of TFAs, not the whole individual fatty acids in vegetable oils. Third, the type of fatty acids existing in different kinds of non-hydrogenated oils is dependent upon the plant from which the oil is extracted. For instance, the fatty acid composition of soy non-hydrogenated oil is quite different than that of corn-based non-hydrogenated oil. We couldn't analyze different oils to report their fatty acid composition separately and future studies should take this point into account.

Conlusions

In conclusion, our findings indicated higher content of TFAs in Iranian commercially available PHVOs. Future studies must focus on estimating total dietary intakes of TFAs among Iranian population and then determining the possible effects of human health.

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Conflict of Interests

Authors have no conflict of interests.

Authors' Contributions

SA had substantial contributions to conception and design and interpretation of data and writing the manuscript. NS had substantial contributions to conception and design .BN and SS carried out the biochemical analysis. LA and AE had contributions to data analysis.
All authors have read and approved the content of final manuscript.

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