Trans FA and Solid Fat Contents of Margarines Marketed in Turkey

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ABSTRACT: *Trans* FA (TFA), solid fat contents (SFC), and slip melting points of 12 different tub and stick margarines marketed in Turkey were examined in this study. No *trans* isomers were found in four margarines, which suggests they were formulated from interesterified or blended fats and oils. The products with no TFA generally had more short-chain saturated FA, which suggests coconut oil-based oil components. TFA content of the other 10 products varied from 7.7 to 37.8%. Compared to the products formulated in North America, Turkish margarines contain more TFA and have higher SFC.

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KEY WORDS: Margarine, solid fat content, *trans* fatty acid.

Margarine is a butterlike product obtained from edible fats and oils. Hardening techniques such as hydrogenation, interesterification, and fractionation are used in the preparation of its hard-stock to increase the solids content and to improve the resistivity to thermal and atmospheric oxidation and the plasticity of the products (1–3).

Hydrogenation is a process that reduces the relative unsaturation of the oils and promotes geometric and positional isomerization (4). Formation of *trans* isomers affects the physical and chemical properties of the final products, as *trans* isomers have higher melting points and greater stability than *cis* ones (5). However, several published reports have indicated that *trans* FA (TFA) have adverse effects on serum cholesterol, TAG levels, and coronary heart disease (6–10). Therefore, there is concern about the consumption of products having high TFA, and efforts are being undertaken to produce zero-*trans* products by alternative techniques to partial hydrogenation. Interesterification does not alter the FA profiles of the blends but rearranges the FA over TAG according to random distribution (5,11,12).

Melting behaviors of the finished products over a range of temperatures determine the consistency, plasticity, and crystallization properties of margarines. They are largely a function of the solid glyceride contents of the fats at those temperatures (13). Solid fat content (SFC) is therefore analyzed to indicate the crystallization tendency and finished product quality (14). The preparation of the base-stock is mainly dependent on the SFC values of the fats used in the formulations.

This paper reveals the TFA and melting behaviors of the margarines available in Turkish markets.

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MATERIALS AND METHODS

Standards and reagents. A mix of 37 FAME including some isomers was supplied by Supelco (Bellefonte, PA); all chemicals were reagent grade.

Samples. Twelve different vegetable oil-based margarine samples were purchased from supermarkets and coded with a number. Margarines were transferred to glass beakers and placed in an oven to break the emulsions. After centrifugation, oils were freed from water by dehydrating with anhydrous sodium sulfate and then were dried under vacuum.

Preparation of FAME. FA were converted into their methyl esters according to AOCS official Method Ce 2-66 (15).

GC analyses of FAME. FA and *trans*-isomers were determined by using a Shimadzu 17A gas chromatograph (Shimadzu Co., Kyoto, Japan) equipped with an FID. Analyses were performed with an SP2560 column (100 m × 0.25 mm i.d. × 0.20 µm film thickness) (Supelco). The initial temperature of 140°C was maintained for 5 min, raised to 240°C at a rate of 4°C/min, and kept at 240°C for 10 min. The split ratio was 1:100, and the carrier gas was helium. The injector and detector temperatures were 230 and 240°C, respectively.

SFC. SFC of the samples was measured by low-resolution pulsed NMR using Maran SFC (Resonance Instrument Ltd. Witney, United Kingdom) according to AOCS Official Method Cd 16b-93 (16). Measurements were carried out at 10, 21.1, and 33.3°C. A constant resonance frequency of 20 MHz was used with an *f*-factor of 1.626, which was determined by measuring a set of predefined artificial standards that were designed to replicate approximately 0, 30, and 70%. The direct method at 40°C operating temperature was used for the measurements.

Slip melting point (SMP). SMP was analyzed in triplicate according to the AOCS Official Method Cc 3-25 (17).

RESULTS AND DISCUSSION

FA play an important role in human diet. The percentages of n-3 and n-6 FA that are recommended in the diet are 0.5 and 3% of calories, respectively (18), whereas it is recommended to reduce TFA levels because of their adverse effect on health.

Table 1 shows the FA compositions, SFC, and SMP of the margarines. Included are data for 2 tub and 10 stick products. TFA contents of tub products were 0.0 and 7.7% of the total FA content, whereas stick products ranged from 17.8 to 37.8%. A survey of the composition and properties of a number of soft (tub) and stick margarines marketed in the United

TABLE 1
FA Compositions, Solid Fat Contents (SFC), and Slip Melting Points (SMP) of the Margarines

	FA (wt%)															SFC (%)°C			
Product	8:0	10:0	12:0	14:0	16:0	18:0	18:1[a] *trans*	18:1[a] *cis*	18:2[a] *trans*	18:2[a] *cis*	18:3	≥20:0	Total SFA above 14:0	Total TFA	TFA + SFA above 14:0	10 °C	21.1 °C	33.3 °C	SMP (°C)
Tub																			
1	0.4	0.3	4.0	1.6	11.8	7.3	—	33.0	—	37.5	3.9	0.2	19.4	—	19.4	12.2	7.3	1.8	31.5
2	—	—	0.1	0.5	21.3	5.6	7.7	41.2	—	19.1	4.3	—	26.9	7.7	34.6	29.6	14.8	3.1	32.5
Stick																			
3	1.1	1.3	16.9	5.8	31.3	7.5	—	18.2	—	17.2	0.9	—	38.7	—	38.7	46.5	25.7	5.9	35.5
4	1.1	1.0	13.3	4.9	26.2	7.3	—	23.2	—	23.0	—	—	33.4	—	33.4	40.6	23.0	5.2	36.0
5	1.1	1.0	11.4	4.8	24.8	8.7	—	17.7	—	28.4	2.1	0.1	33.6	—	33.6	42.4	23.4	5.1	35.5
6	0.9	0.8	9.3	3.7	22.1	5.7	19.4	23.5	1.7	11.7	0.3	1.1	28.5	21.1	49.7	47.3	25.8	4.4	36.5
7	tr	tr	0.5	0.7	20.4	7.6	31.3	18.7	3.2	15.9	1.0	0.6	28.7	34.5	63.2	59.1	35.8	7.2	34.5
8	tr	tr	0.5	0.8	16.3	8.1	31.0	17.1	6.8	17.1	1.4	0.5	24.9	37.8	62.7	54.6	33.4	6.7	37.0
9	—	tr	0.3	0.6	20.4	7.7	31.9	21.3	0.8	16.0	0.5	0.4	28.4	32.7	61.1	56.5	32.2	5.4	34.5
10	—	—	0.3	0.8	24.9	6.6	23.4	32.0	1.1	10.8	0.8	0.3	31.7	24.5	56.1	56.7	29.8	4.5	36.0
11	—	—	0.3	0.7	22.5	9.4	15.6	26.5	5.5	17.8	1.6	0.3	32.1	21.1	53.2	50.1	27.8	4.8	34.5
12	—	—	0.2	0.6	22.2	8.5	16.2	38.9	1.8	9.2	2.5	0.2	30.8	18.0	48.8	50.0	22.0	5.1	34.5

[a]Total *trans* or *cis* isomers of the relevant FA. TFA, *trans* FA; SFA, saturated FA; tr, trace.

States indicated that the TFA content of soft (tub) products ranged from 2.6 to 14.6% of the total FA content, whereas the stick products ranged from 3.2 to 25.8% (19). As shown from the comparison, there is an agreement between TFA contents of Turkish and North American tub margarines, whereas TFA levels of Turkish stick margarines are considerably higher.

According to Table 1, four of the margarines had no *trans* isomers and are called zero-*trans* margarines (ZTM). On the other hand, there was only one margarine brand containing no *trans* acid in Turkish markets in 1994 (20). Compared with *trans*-containing margarines, ZTM contained more short-chain saturated FA, mainly lauric and myristic acids, which had an atherogenic potential (21) and relatively high linoleic acid within the range of 17.2 and 37.5%. These data suggest that ZTM were formulated from interesterified or blended fats and oils such as coconut oil-based oils, sunflower oils, or corn oils.

The samples in this research were vegetable oil-based margarines. Hence, the elevated stearic acid contents (5.6–9.4%) suggest that interesterified or partially hydrogenated basestocks high in stearic acid were blended with liquid oils to achieve the desired SFC. In addition, high levels of palmitic acid in the margarines indicated that palm oil was a major source of the blends. The data shown in Table 1 also suggest that tub products were formulated with approximately 50% unhydrogenated soybean or canola oil, as their linolenic acid contents were about 4%.

The SFC values of tub margarines were 12.2 and 29.6% at 10°C, 7.3 and 14.8% at 21.1°C, and 1.8 and 3.1% at 33.3°C, whereas those of stick margarines ranged from 40.6–59.1% at 10°C, 22.0–35.8% at 21.1°C, and 4.4–7.2% at 33.3°C. When compared to the U.S. products (19,22), of the two tub products, only one (sample 1) had SFC values within the SFC range of the American soft (tub) margarines, whereas another one (sample 2) showed melting behaviors similar to the U.S. stick products. However, 10 stick products had significantly higher SFC values than the U.S. stick margarines, which may have resulted from the higher saturated and TFA contents of the Turkish stick products. Saturated FA (SFA: $C_{16:0} + C_{18:0}$) contents of the U.S. stick products ranged between 17.9 and 25.2% (19), whereas those in Turkish stick products ranged from 28.48 to 38.74%. The highest SFC values were obtained for sample 7, which probably resulted from the highest total TFA + SFA (63.2%) content.

The SMP of *trans*-free margarines having higher palmitic acid contents were identical to those of the other stick products, even though SFA contents of ZTM were considerably lower than the total TFA + SFA contents of the others. Moreover, the SMP of sample 1 is 31.5°C, although it has the lowest SFA (19.4%). From these data, it is apparent that *trans*-free products (ZTM) were formulated by interesterification as melting points of common vegetable oils increase after interesterification (23), i.e., since the SUS (saturated-unsaturated-saturated)-type glycerides predominate in natural oils and melt at a lower temperature than their unsymmetrical counterparts formed during interesterification (22).

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