

Determination of FA Composition and Total *Trans* FA of Turkish Margarines by Capillary GLC

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ABSTRACT: In this research, FA composition and total *trans* FA contents of 16 different brands of margarine (8 hard-type and 8 soft-type) sold in Turkey were determined by capillary GLC method. According to the results, the contents of saturated FA, monounsaturated FA, and PUFA were within the ranges of 23.9–32.3, 44.0–61.9, and 14.2–24.1%, respectively, in hard-type margarines, and 27.0–39.9, 21.0–40.9, and 32.0–53.7%, respectively, in soft-type margarines. Hard-type margarines contained total *trans* FA concentrations of 20.1–34.3%, whereas soft-type margarines contained less than 8.9% total *trans* FA. C_{18:1} *trans* acid content was within the range of 18.5–29.8% in hard-type margarines, and it was significantly higher than the range in soft margarines (0.7–8.1%). C_{18:1} *trans* acid was the major *trans* FA in all margarines, and C_{18:3} *trans* acid concentrations were less than 0.2%.

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KEY WORDS: Capillary gas–liquid chromatography, margarine, *trans* FA, Turkish origin.

Trans FA, which are created by the partial hydrogenation of liquid vegetable oils in the manufacturing of margarine and vegetable shortening, increase serum levels of LDL cholesterol and decrease those of HDL cholesterol (1,2). The adverse effects of the *trans* FA on the ratio of total cholesterol to HDL cholesterol are twice that of saturated FA (3). Some epidemiological studies have also found a positive association between levels of *trans* FA intake and risk of cardiovascular disease (4,5). Owing to these concerns, the Food and Agriculture Organization and the World Health Organization recommended in 1994 that fats for human consumption contain less than 4% of the total fat as *trans* and urged the food industry to reduce the presence of *trans* fats in their products to these levels (6).

Vegetable oil production was approximately 1.45 million tons per year between 1995 and 2000 in Turkey. About 30% of this production was used by the margarine industry. Total margarine production was 550 million kg, and consumption was 430 million kg per year. These results indicate that margarines have an important role in the consumption of vegetable oil in Turkey. Vegetable oil consumption is approxi-

mately 15.9 kg/person/year, and 6.3 kg of this value is from margarines (7).

This paper presents the FA composition and total *trans* FA contents of Turkish margarines determined by capillary GLC. The *trans* isomers of the samples were evaluated in relation to health.

EXPERIMENTAL PROCEDURES

Sample selection. Seven different margarine companies are present in Turkey. Of these, five are major producers. Margarines produced by these companies are sold in all regions of Turkey. The five leading margarine companies produce 23 different brands (10 soft and 13 hard) of margarines. Of these, the top 16 best-selling brands (8 soft and 8 hard), which represented 85% of the market share, were selected for analysis and then purchased locally. Each brand was coded with a number (1, 2, 3, ...), and margarine samples were taken four times over a 4-mon period. FAME standards (99% purity) were purchased from Nu-Chek-Prep Inc. (Elysian, MN).

Analysis. Each sample was homogenized and dehydrated with sodium sulfate, and the FA present were converted to methyl esters.

Preparation of FAME. FAME were prepared from the margarines after alkaline hydrolysis, followed by methylation in methanol with 12.5% BF₃ as catalyst. The final concentration of the FAME was approximately 7 mg/mL in heptane (8).

Capillary GLC. Analyses of the FAME by capillary GLC were carried out on a Hewlett-Packard 6890 chromatograph, equipped with an FID on a split injector (Chrompack, Middleburg, The Netherlands). A fused-silica capillary column (Chrompack) was used for the FAME analysis; CPTM-Sil 88, 50 m × 0.25 mm i.d., 0.2 μm film. GLC operating conditions were: temperature program of 130°C for 5 min, rising to 177°C at a rate of 2°C/min. Other GLC conditions were: injector temperature, 250°C; detector temperature, 250°C; carrier gas, helium at a flow rate of 1 mL/min.

RESULTS AND DISCUSSION

FA composition and *trans* FA of Turkish margarines are given in Tables 1 and 2.

The sum of monounsaturated FA in hard-type margarines

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TABLE 1
FA Compositions and *Trans* FA of Turkish Hard-Type Margarines^a

FA	Sample code							
	1	2	3	4	5	6	7	8
8:0	— ^b	—	0.1	—	—	—	—	—
10:0	—	—	0.1	—	0.1	—	—	—
12:0	0.1	0.3	2.1	0.4	0.5	0.3	0.2	0.2
14:0	0.3	0.5	1.2	0.6	0.6	0.5	0.6	0.5
16:0	15.8	17.1	19.9	18.6	19.5	18.7	21.4	21.5
16:1	0.2	0.4	0.2	0.4	0.4	0.4	0.5	0.4
18:0	8.6	5.3	8.2	5.8	6.2	6.2	5.9	7.3
18:1 <i>trans</i>	23.9	29.8	18.5	27.1	24.5	28.5	24.3	18.5
18:1 <i>cis</i>	33.7	31.1	25.2	31.2	24.7	20.9	22.3	36.1
18:2 <i>trans</i>	3.2	4.4	2.0	4.3	2.9	3.3	3.6	1.6
18:2 <i>cis</i>	12.7	8.5	20.6	8.5	18.5	19.9	19.9	11.7
18:3 <i>trans</i>	—	0.1	—	0.1	0.1	—	—	—
18:3 <i>cis</i>	0.3	0.3	1.0	0.2	1.1	0.3	0.3	1.4
20:0	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.3
20:1	0.1	0.6	0.1	0.6	0.1	0.1	0.1	0.2
20:2	0.4	0.9	0.1	1.3	0.2	0.3	0.3	0.1
22:0	0.4	0.3	0.3	0.6	0.3	0.3	0.2	0.2
Total saturated	25.5	23.9	32.3	26.3	27.5	26.3	28.7	30.0
Total monounsaturated	57.9	61.9	44.0	59.3	49.7	49.9	47.2	55.2
Total polyunsaturated	16.6	14.2	23.7	14.4	22.8	23.8	24.1	14.8
Total <i>trans</i>	27.1	34.3	20.5	31.5	27.5	31.8	27.9	20.1
Total unsaturated	74.5	76.1	67.7	73.7	72.5	73.7	71.3	70.0
Total saturated/total unsaturated	0.34	0.31	0.48	0.36	0.38	0.36	0.40	0.43

^aEach value is an average of four determinations and expressed as wt% of total FAME.^b—, not detected.**TABLE 2**
FA Compositions and *Trans* FA of Turkish Soft-Type Margarines^a

FA	Sample code							
	1	2	3	4	5	6	7	8
8:0	0.2	0.3	— ^b	0.3	0.4	—	0.1	0.2
10:0	0.3	0.4	—	0.3	0.4	—	0.1	0.2
12:0	4.7	6.1	0.1	5.3	6.6	0.2	2.4	3.5
14:0	2.2	2.7	0.2	2.5	2.8	0.5	1.1	2.0
16:0	23.7	18.5	19.5	24.3	19.7	19.7	10.7	23.9
16:1	0.3	0.3	0.2	0.3	0.3	0.2	0.1	0.4
18:0	6.2	6.8	6.2	6.7	5.8	6.0	8.3	8.2
18:1 <i>trans</i>	1.4	5.2	7.2	1.2	3.6	8.1	0.7	3.3
18:1 <i>cis</i>	22.4	19.3	28.8	22.6	21.6	32.4	21.7	17.3
18:2 <i>trans</i>	0.4	0.6	1.5	0.3	0.4	0.8	0.1	0.6
18:2 <i>cis</i>	35.2	38.2	34.3	33.7	37.2	30.1	52.5	39.6
18:3 <i>trans</i>	0.1	—	0.2	0.1	—	—	—	—
18:3 <i>cis</i>	2.2	0.5	0.3	1.8	0.4	1.0	1.1	0.3
20:0	0.3	0.4	0.5	0.3	0.3	0.3	0.4	0.3
20:1	0.1	0.1	0.3	0.1	0.1	0.2	0.1	—
20:2	—	0.1	0.2	—	—	0.1	—	—
22:0	0.3	0.5	0.5	0.2	0.4	0.4	0.6	0.2
Total saturated	37.9	35.7	27.0	39.9	36.4	27.1	23.7	38.5
Total monounsaturated	24.2	24.9	36.5	24.2	25.6	40.9	22.6	21.0
Total polyunsaturated	37.9	39.4	36.5	35.9	38.0	32.0	53.7	40.5
Total <i>trans</i>	1.9	5.8	8.9	1.6	4.0	8.9	0.8	3.9
Total unsaturated	62.1	64.3	73.0	60.1	63.6	72.9	76.3	61.5
Total saturated/total unsaturated	0.61	0.56	0.37	0.66	0.57	0.37	0.31	0.63

^aEach value is an average of four determinations and expressed as wt% of total FAME.^b—, not detected.

(average 53.1%; range 44.0–61.9%) exceeded that in soft-type margarines (average 27.5%; range 21.0–40.9%). However, soft-type margarines had higher PUFA contents than hard-type margarines. EFA are included in the PUFA group, so the PUFA contents are of major importance for the biological and nutritional value of these products. PUFA contents in soft-type margarines ranged between 32.0 and 53.7% (average 39.2%), whereas hard-type margarines contained less than 24.1% (average 19.3%) PUFA. The mean PUFA values for Turkish soft-type margarines (39.2%) are comparable to recent margarine results for Bulgaria (36.3%) and Netherlands (42.5%) (both of them produced from vegetable oils) (9). However, margarines from Austria (produced from vegetable oils and fats) reportedly had PUFA values (18.3%) similar to Turkish hard-type margarines (9).

The hard-type margarines, as generally expected, had higher total *trans* FA contents (average 27.6%; range 20.1–34.3%) than the soft margarines (average 4.5%; range 0.8–8.9%). As expected, C_{18:1} *trans* acid was the major *trans* group in all the margarines prepared from partially hydrogenated vegetable oils, ranging from 18.5 to 29.8% (average 24.4%) in hard-type margarines. These values were higher than the values 0.7–8.1% (average 3.8%) determined in soft margarines. C_{18:2} *trans* acid content of the hard-type margarines ranged from 1.6 to 4.4% (average 3.2%), whereas that of soft-type margarines was less than 1.5% (average 0.6%). C_{18:3} *trans* acid content was less than 0.2% in all margarines. Turkish margarines contain vegetable oils that have been partially hydrogenated, resulting in the formation of variable amounts of *trans* isomers. Besides, some hard-type margarines are still made with highly hydrogenated fats.

The mean total *trans* FA value of 27.6% for Turkish hard-type margarines is high relative to recent margarine data for products of Australia (13.1%) (10), Denmark (3.0%) (11), France (3.8%) (12), and Greece (10%) (13). In addition, margarines from Canada (23.6%) (14), the United States (22.6%) (15), and Austria (21.3%) (16) have total *trans* FA levels similar to those found in Turkish hard-type margarines. However, Turkish soft margarines have low total *trans* FA contents, but the amount of saturated FA in them is undesirably higher (average 33.3%) than Turkish hard-type margarines (average 27.6%). We may see an increase in demand for Turkish hard-type margarines with greatly reduced *trans* isomer content because of questions raised about the biological utilization and effects of *trans* FA. Margarines for this type of product could be made by interesterification.

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