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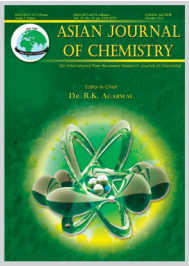

Assessment of *Trans* Fatty Acid and Conjugated Linoleic Acid Content of Turkish Commercial Ice Creams

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In this study, 27 commercial ice creams belonging to 4 different brands sold in Turkey were analyzed for their fatty acid composition, with relevance on their *trans* fatty acid and conjugated linoleic acid content. 16:0 palmitic acid was major fatty acid in all samples, except for cacao and chocolate ice creams. Other predominant fatty acids were 12:0 lauric acid, 18:0 stearic acid and 18:1 ω9 oleic acid. Saturated fatty acids occurred in the largest proportions in all samples followed by monounsaturated fatty acids and polyunsaturated fatty acids. The total percentages of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids ranged between 61.56-80.99, 13.30-30.86 and 3.68-8.02 %, respectively. *Trans* fatty acids and conjugated linoleic acid contents in ice cream samples were between 0.71-2.66 and 0.17-0.91 %, respectively. The results of this research have demonstrated that *trans* fatty acid and conjugated linoleic acid contents of ice creams obtained in Turkey are favorable levels when compared to many countries.

Key Words: *Trans* fatty acids, Conjugated linoleic acid, Ice cream, Turkey.

INTRODUCTION

Milk is known as the most necessary food for life in infant. Milk and dairy products have formed an integral element of human diet since the earliest domestication animals. Milk has a high nutrient density and thus contributes significantly to the daily intake of several nutrients. It contains many constituents including proteins, fats, carbohydrates, vitamins and minerals. Dairy products are an important source of calcium. The calcium plays a significant role in building bone. In addition, it may affect the serum lipoprotein profile. It provided as a food supplement and found to increase serum HDL cholesterol concentrations[1] and decrease serum total cholesterol[2] and LDL cholesterol concentrations[3].

Ice cream is a dairy product, is a complex food colloid that consists of air bubbles, fat globules, ice crystals and an unfrozen serum phase[4]. It is a frozen dessert that is delicious, nutritious and relatively cheap. It is made from dairy products such as cream combined with flavourings and sweeteners such as sugar[5]. Ice creams are food products that show great potential for use as vehicles for probiotic cultures, with the advantage of being foods consumed by all age groups[6]. Milk fat is important to ice cream due to it increases the richness of flavour in ice cream, produces a smooth characteristic texture by lubricating the palate, helps to give body to the ice cream and contributes good melting properties[7]. Milk fat gives ice cream its distinctive richness and characteristic smooth texture. Fat and fat structure development in ice cream and related frozen dairy dessert are critical for optimal structure and physical properties, stability, flavor and texture[4]. The use of both milk and vegetable fat as a fat source for ice cream formulations is widespread in the world. A typical ice cream contains 10 % fat from milk, cream or vegetable sources, 10 % nonfat milk solids which are mainly proteins from milk or whey powders and 15 % sweeteners[8]. Some chronical diseases such as cardiovascular disease are linked to type of fatty acids in the diet[9]. *Trans* fatty acids (TFAs) occur naturally in dairy products and fats of ruminants as a result of bacterial biohydrogenation. In addition, *trans* fatty acid are industrially formed by partial hydrogenation of unsaturated fatty acids from vegetable and marine oils[10]. Industrial and ruminant *trans* fatty acid have a different isomer profile, with *trans* vaccenic acid (18:1t11) usually being the predominant isomer in ruminant fat[11,12] while *trans*-18:1 isomers of partially hydrogenated oils[13]. Industrial *trans* fatty acid intake is associated with increased risk of coronary heart disease[14]. *Trans* fatty acids have been shown to raise low density lipoprotein (LDL) cholesterol and lower high density lipoprotein (HDL) cholesterol levels[15]. In contrast to *trans* fatty acids, conjugated linoleic acid (CLA) that has positive effects on health has received considerable interest since the discovery

of the its effects. Some of these beneficial effects are decrease in incidence of carcinogenesis[16,17], atherosclerosis[18] and body fat[19]. The 9c, 11t isomer of conjugated linoleic acid that is known as rumenic acid is natural *trans* fats and originate mainly from biohydrogenation of linoleic acid by fermentative bacteria in ruminants and by endogenous synthesis from vaccenic acid by Δ^9 desaturase[20]. The higher vaccenic acid level becomes, the more conjugated linoleic acid content increases because conjugated linoleic acid is synthesized from vaccenic acid. Ice cream which is high conjugated linoleic acid content have been shown that is used of the milk fat as main source of fat. The objective of our study was determine fatty acid composition, *trans* fatty acid and conjugated linoleic acid content of Turkish commercial ice creams.

EXPERIMENTAL

Sample collection: Ice cream samples belonging to four brands (a total of 27 samples) that were commonly consumed in Turkey were collected from super markets. These samples were categorized as flavored with cacao (n = 4), pistachio (n = 4), chocolate (n = 4), almond (n = 3), vanilla (n = 4), maras (n = 4) and kaymak (n = 4). Maras and kaymak ice creams are the traditional Turkish ice cream types.

Fatty acid analysis: The fat of the ice cream samples were extracted by the Folch, Lees & Sloane Stanley method[21]. Fatty acid methyl esters were performed according to AOCS[22]. Approximately 200 mg sample was weighed accurately into glass centrifuge vial. Then 2.0 mL hexane was added, followed by 0.1 mL of 2N methanolic KOH. The vial was then closed and shaken well for 30 s, centrifuged and 2 drops of the upper layer removed and diluted with 2 mL hexane. The fatty acid methyl esters were analyzed on a HP (Hewlett Packard) Agilent 6890N model gas chromatograph (GC), equipped with a flame ionization detector (FID) and fitted with a HP-88 capillary column (100 m, 0.25 mm ID and 0.2 μm). Chromatographic conditions were performed according to Ledoux *et al.*[23] method modified as follows: Injector and detector temperatures were 250 and 280 ºC, respectively. The oven was programmed at 60 ºC initial temperature and 1 min initial time. Thereafter the temperature increased 20 ºC/min to 190 ºC held for 1 h then increased at 1 ºC/min to 220 ºC and held for 10 min at 220 ºC. Carrier gas was helium (1 mL/min). Identification of fatty acids and *trans* isomers were carried out by comparing sample FAME peak relative retention times with those obtained for Alltech standards. Linoleic acid conjugated methyl ester (mixture of *cis*-and *trans*-9,11- and -10,12-octadecadienoic acid methyl esters, catalog number O5632) was purchased from Sigma-Aldrich (St. Louis, MO, USA). Results were expressed as FID response area relative percentages. Each reported result is the average value of three GC analyses. The results are offered as mean ± SD.

RESULTS AND DISCUSSION

Table-1 shows the mean of fatty acid composition expressed in g/100 g total fatty acids and the percentages of saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs) and total *trans* fatty acid and conjugated linoleic acid content in ice cream samples. Ice cream must have a minimum fat content of 10 % in many legal jurisdictions. Premium ice creams generally have a fat content of 14-18 %. The best source of milk fat in ice cream for high quality flavor is fresh cream[24]. Ice creams should be contained to 2-12 % milk fat according to the legal limits established by Turkish Food Codex. Dairy fat contains a high proportion of saturated fatty acids. In our study, saturated fatty acids contents were found to be higher than those of monounsaturated fatty acids and polyunsaturated fatty acids in all ice cream samples. Saturated fatty acids were determined as 80.99, 65.21, 75.30, 61.56, 69.71, 67.72 and 62.46 %in ice creams flavored with cacao, pistachio, chocolate, almond, vanilla, maras and kaymak, respectively. This value was found as 50.2-66.1 % in Korea[25], 35.88-91.67 % in Poland[26], 40.2 % in Spain[27] and 65.96 % in Costa Rica[28]. Saturated fatty acids, as compared to unsaturated fatty acids, may increase the incidences of atherogenicity[29]. The main saturated fatty acid found in all analyzed samples was 12:0 lauric acid, 14:0 miristic acid, 16:0 palmitic acid, 18:0 stearic acid, while the main monounsaturated and polyunsaturated fatty acids were oleic acid 18:1c9 oleic acid and 18:2ω6 linoleic acid, respectively. Monounsaturated fatty acids ranged from 13.30-30.86 % and oleic acid was identified as the most abundant monounsaturated fatty acid in ice cream samples. Similar results were observed by Seckin *et al.*[30], who determined that oleic acid was predominant monounsaturated fatty acid and ranged from 23.12-32.78 g/100 g total fatty acid in some dairy products in Turkey. Monounsaturated fatty acid of ice creams sold in Spain-studied by Griguol *et al.*[31] was found 21.1 %. Linoleic acid was the primary polyunsaturated fatty acid in all samples. The ratio of this fatty acid varied between 2.45-7.16 %. The highest level of linoleic acid as shown in Table-1 is in ice cream flavoured with pistachio. Similarly, Zegerska and Borejszo[26] observed that the linoleic acid ratio ranged from 1.60-6.62. In our study, in all samples the 18:1t11 vaccenic acid represented the largest *trans* fatty acid isomer followed by 18:1t9 elaidic acid, 18:2t9t12 and 18:2t9c12. The amount of vaccenic acid was found 0.59-2.34 %. 18:1t11 can be transformed to 18:2c9t11-conjugated linoleic acid[32] and beneficial effects have been reported for these isomers. The total *trans* fatty acid content ranged from 0.71-2.66 %. Richter *et al.*[33] found that in ice cream, total *trans* fatty acid content was 5.14 % of total fatty acids. Dairy products are the major dietary source of conjugated linoleic acid. Homogenized whole milk contains about 5 mg conjugated linoleic acid/g of fat[34]. In Turkey, conjugated linoleic acid contents of some commercial milks were determined as 0.961-1.020 %[35]. In present study, 18:2c9t11 rumenic acid which is the main conjugated linoleic acid isomer was found 0.13-0.85 %. The total conjugated linoleic acid content varied between 0.19-0.91 %. Conjugated linoleic acid contents of ice creams flavored with maras and kaymak were shown to be higher than other ice cream groups.

This study has shown that fatty acids compositions of ice creams have a desirable characteristic in the human diet when their levels of *trans* fatty acid and conjugated linoleic acid contents are considered. Our results showed that the fatty acid composition of Turkish ice creams was higher in conjugated linoleic acid and lower in *trans* fatty acid than those of other countries.

TABLE-1
THE MEAN VALUE OF FATTY ACID COMPOSITION AND TFA AND CLA CONTENT ANALYZED ICE CREAMS IN DIFFERENT CATEGORIZE (g %/100 g FATTY ACID)*

Fatty acids	Cacao	Pistachio	Chocolate	Almond	Vanilla	Maras	Kaymak
C 4:0	2.05 ± 2.83**	0.22 ± 0.20	1.09 ± 2.31	0.86 ± 1.19	1.32 ± 3.13	3.03 ± 7.41	2.05 ± 3.99
C 6:0	0.39 ± 0.07	0.39 ± 0.38	0.40 ± 0.23	0.38 ± 0.32	0.45 ± 0.12	0.99 ± 1.40	1.00 ± 0.81
C 8:0	4.83 ± 0.63	2.70 ± 4.44	3.63 ± 1.96	0.76 ± 0.63	1.69 ± 4.04	0.78 ± 1.15	0.79 ± 0.29
C 10:0	4.01 ± 0.45	2.48 ± 3.40	3.16 ± 1.31	0.99 ± 0.29	1.68 ± 2.80	1.65 ± 2.30	1.60 ± 0.93
C 11:0	0.02 ± 0.01	0.04 ± 0.10	0.03 ± 0.04	0.06 ± 0.08	0.06 ± 0.06	0.16 ± 0.27	0.15 ± 0.13
C 12:0	35.43 ± 4.44	17.97 ± 34.64	27.02 ± 13.97	5.04 ± 5.97	9.23 ± 22.63	2.94 ± 5.84	2.74 ± 1.29
C 13:0	0.04 ± 0.01	0.04 ± 0.04	0.04 ± 0.06	0.05 ± 0.05	0.06 ± 0.05	0.11 ± 0.12	0.11 ± 0.12
C 14:0	13.38 ± 1.32	8.18 ± 10.35	10.48 ± 3.23	4.06 ± 1.22	5.76 ± 6.92	7.76 ± 10.34	7.24 ± 4.97
C 15:0	0.02 ± 0.01	0.04 ± 0.07	0.03 ± 0.06	0.10 ± 0.10	0.09 ± 0.09	0.32 ± 1.02	0.34 ± 0.43
C 16:0	13.55 ± 2.89	20.55 ± 12.56	16.79 ± 5.88	23.95 ± 3.01	25.40 ± 5.48	30.89 ± 12.1	28.89 ± 8.87
C 17:0	0.05 ± 0.01	0.16 ± 0.24	0.11 ± 0.15	0.29 ± 0.16	0.26 ± 0.25	0.49 ± 0.48	0.42 ± 0.32
C 18:0	7.11 ± 1.11	12.28 ± 13.24	12.41 ± 9.33	24.90 ± 1.87	23.56 ± 19.00	18.35 ± 25.4	16.95 ± 9.78
C 19:0	0.03 ± 0.01	0.04 ± 0.04	0.05 ± 0.03	0.05 ± 0.04	0.05 ± 0.04	0.11 ± 0.22	0.10 ± 0.11
C 20:0	0.01 ± 0.01	0.06 ± 0.23	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.03	0.04 ± 0.07	0.02 ± 0.03
C 21:0	0.03 ± 0.03	0.03 ± 0.05	0.02 ± 0.04	0.03 ± 0.07	0.03 ± 0.02	0.04 ± 0.08	0.04 ± 0.03
C 22:0	0.04 ± 0.02	0.03 ± 0.03	0.02 ± 0.03	0.02 ± 0.03	0.05 ± 0.06	0.05 ± 0.18	0.03 ± 0.04
ΣSFA* **	**80.99 ± 15.20**	**65.21 ± 15.14**	**75.30 ± 3.01**	**61.56 ± 1.79**	**69.71 ± 5.20**	**67.72 ± 6.71**	**62.46 ± 39.06**
C 14:1 ω5	0.05 ± 0.01	0.18 ± 0.20	0.10 ± 0.10	0.29 ± 0.16	0.27 ± 0.13	0.83 ± 0.53	0.81 ± 0.29
C 15:1 ω5	0.01 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	0.02 ± 0.01	0.06 ± 0.16	0.05 ± 0.05
C 16:1 ω7	0.08 ± 0.03	0.38 ± 0.37	0.22 ± 0.22	0.65 ± 0.26	0.55 ± 0.30	1.37 ± 0.87	1.31 ± 0.51
C 17:1 ω8	0.02 ± 0.01	0.07 ± 0.08	0.03 ± 0.02	0.08 ± 0.03	0.07 ± 0.03	0.18 ± 0.13	0.18 ± 0.07
C18:1 c9	12.92 ± 1.60	24.13 ± 10.87	17.02 ± 2.55	29.39 ± 1.83	22.71 ± 5.04	22.02 ± 5.66	27.04 ± 6.31
C18:1 c11	0.18 ± 0.06	0.17 ± 0.17	0.26 ± 0.08	0.41 ± 0.04	0.21 ± 0.14	0.24 ± 0.28	0.22 ± 0.09
C 20:1 ω9	0.02 ± 0.02	0.03 ± 0.02	0.02 ± 0.01	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.02	0.03 ± 0.02
C 22:1 ω9	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.04	0.02 ± 0.02	0.02 ± 0.01	0.03 ± 0.05	0.02 ± 0.01
ΣMUFA* **	**13.30 ± 3.32**	**24.99 ± 22.22**	**17.68 ± 5.89**	**30.86 ± 2.13**	**23.87 ± 5.61**	**24.75 ± 4.42**	**29.65 ± 13.29**
C 18:2 ω6	3.13 ± 2.72	7.16 ± 4.29	3.60 ± 1.85	4.61 ± 0.49	3.80 ± 1.17	2.45 ± 0.95	4.14 ± 1.93
C 18:3 ω6	0.15 ± 0.09	0.31 ± 0.28	0.33 ± 0.13	0.70 ± 0.03	0.60 ± 0.27	0.35 ± 0.46	0.31 ± 0.23
C 18:3 ω3	0.12 ± 0.10	0.19 ± 0.10	0.19 ± 0.13	0.18 ± 0.12	0.30 ± 0.04	0.28 ± 0.04	0.26 ± 0.02
C 20:2 ω6	0.02 ± 0.02	0.02 ± 0.01	0.02 ± 0.02	0.03 ± 0.02	0.03 ± 0.01	0.04 ± 0.03	0.04 ± 0.02
C 20:3 ω6	0.02 ± 0.03	0.03 ± 0.02	0.03 ± 0.03	0.08 ± 0.08	0.03 ± 0.01	0.05 ± 0.05	0.07 ± 0.06
C 20:3 ω3	0.02 ± 0.03	0.03 ± 0.03	0.03 ± 0.03	0.05 ± 0.02	0.06 ± 0.03	0.15 ± 0.16	0.10 ± 0.06
C 20:4 ω6	0.02 ± 0.03	0.02 ± 0.01	0.02 ± 0.02	0.02 ± 0.01	0.03 ± 0.02	0.05 ± 0.09	0.05 ± 0.03
C 20:5 ω3	0.03 ± 0.08	0.03 ± 0.04	0.03 ± 0.03	0.03 ± 0.02	0.04 ± 0.01	0.05 ± 0.09	0.04 ± 0.02
C 22:2 ω6	0.02 ± 0.04	0.03 ± 0.02	0.03 ± 0.04	0.03 ± 0.04	0.05 ± 0.02	0.05 ± 0.09	0.03 ± 0.01
C 22:3 ω3	0.04 ± 0.06	0.05 ± 0.03	0.04 ± 0.03	0.04 ± 0.02	0.11 ± 0.08	0.14 ± 0.35	0.10 ± 0.08
C 22:4 ω6	0.02 ± 0.02	0.02 ± 0.01	0.05 ± 0.04	0.03 ± 0.02	0.05 ± 0.02	0.09 ± 0.16	0.06 ± 0.01
C 22:5 ω6	0.03 ± 0.03	0.06 ± 0.07	0.09 ± 0.07	0.17 ± 0.01	0.16 ± 0.08	0.09 ± 0.20	0.10 ± 0.07
C 22:5 ω3	0.03 ± 0.04	0.03 ± 0.01	0.03 ± 0.03	0.04 ± 0.01	0.05 ± 0.01	0.10 ± 0.12	0.07 ± 0.02
C 22:6 ω3	0.03 ± 0.03	0.04 ± 0.01	0.04 ± 0.03	0.06 ± 0.06	0.08 ± 0.04	0.07 ± 0.06	0.07 ± 0.04
ΣPUFA* **	**3.68 ± 4.59**	**8.02 ± 4.43**	**4.53 ± 1.93**	**6.07 ± 0.55**	**5.39 ± 0.94**	**3.95 ± 1.11**	**5.40 ± 1.95**
C18:1 t9	0.03 ± 0.03	0.04 ± 0.03	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.01	0.11 ± 0.22	0.06 ± 0.05
C 18:1 t11	1.80 ± 1.81	1.28 ± 1.53	2.22 ± 2.11	1.07 ± 0.35	0.59 ± 0.35	2.34 ± 3.12	1.41 ± 0.64
C 18:2 t9 t12	0.03 ± 0.02	0.10 ± 0.17	0.05 ± 0.03	0.05 ± 0.02	0.05 ± 0.03	0.12 ± 0.11	0.10 ± 0.04
C 18:2 t9 c12	0.04 ± 0.03	0.04 ± 0.02	0.06 ± 0.02	0.04 ± 0.02	0.05 ± 0.02	0.09 ± 0.08	0.09 ± 0.05
ΣTFA* **	**1.90 ± 1.89**	**1.46 ± 1.53**	**2.35 ± 2.13**	**1.18 ± 0.32**	**0.71 ± 0.39**	**2.66 ± 3.16**	**1.66 ± 0.72**
CLA (18:2 c9 t11)	0.15 ± 0.06	0.32 ± 0.30	0.13 ± 0.04	0.33 ± 0.09	0.32 ± 0.06	0.85 ± 0.42	0.81 ± 0.35
CLA (18:2 t10 c12)	0.02 ± 0.01	0.01 ± 0.00	0.02 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	0.03 ± 0.05	0.02 ± 0.01
CLA (18:2 c11 t13)	0.02 ± 0.01	0.01 ± 0.00	0.02 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.04	0.02 ± 0.01
ΣCLA* **	**0.19 ± 0.14**	**0.34 ± 0.30**	**0.17 ± 0.06**	**0.37 ± 0.09**	**0.35 ± 0.06**	**0.91 ± 0.42**	**0.85 ± 0.36**

*Average of three lots analyzed. **Values reported are means ± SD. ***SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid, PUFA: Polyunsaturated fatty acid, TFA: Trans fatty acid. CLA: Conjugated linoleic acid.

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