POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES
Pol. J. Food Nutr. Sci. 2005, Vol. 14/55, No 1, pp. 71–74

FATTY ACID COMPOSITION OF ICE CREAMS INCLUDING *TRANS* ISOMERS

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Key words: ice creams, fatty acids, *trans* isomers

The fatty acid composition of fat extracted from 20 types of ice creams available on the Polish market was analyzed by gas chromatography with a 100 m long capillary CP Sil 88 column. The results indicate that a very high content of *trans* fatty acids (about 24% of total fatty acids) occurred only in one type of ice creams. The *trans* C18:1 content of 19 tested ice creams ranged from 0.12 to 4.21%. The *cis*/*trans* and *trans*/*cis* C18:2 isomers were present in the amounts from 0 to 0.82%. The 18 of the ice creams tested were characterised by very high levels of lauric acid (in the range of 41.86 to 48.28%) and myristic acid (in the range of 15.06 to 17.78% of total fatty acids). The fatty acid composition indicated that only one type of the ice creams examined was produced with the use of milk fat.

INTRODUCTION

Many reports indicate the association of dietary intake of fat and fatty acids with the occurrence of some civilisation diseases like coronary heart disease, obesity or some kinds of cancer. According to many studies, some saturated fatty acids and especially some *trans* fatty acids (TFA) have adverse impact on human health. It has been shown that TFA increases total cholesterol, LDL cholesterol, lipoprotein a [Lp(a)] level and decrease HDL cholesterol [Mensink & Katan, 1990; Willett *et al.*, 1993; Katan *et al.*, 1995; Ascherio *et al.*, 1999]. A positive association between the intake of TFA and prevalence of childhood asthma and allergies was also found [Weiland *et al.*, 1999].

Ice creams are a group of food products being very popular among children. Therefore, though ice creams are not a major source of dietary fat, there is a need for providing information on their fatty acid profile. There are limited data on the fatty acid composition of ice creams in Poland. Daniewski *et al.* [1998] examined one type and Żegarska & Borejszo [2001] – 10 types of ice creams.

In this work we have estimated the contents of fatty acids, including *trans* acids, of twenty types of marketed ice creams.

MATERIAL AND METHODS

Material. Twenty types of ice creams were purchased from the local retail stores during in the period of January/February 2002. The ice creams were produced by six different producers.

Analytical methods. Fat extraction from the ice creams was carried out by the Folch's method [Folch *et al.*, 1957]. Fatty acid methyl esters of the fat were prepared, according to the IDF method [1999], as follows: 50 mg of fat was weighed into a test tube and dissolved in 2.5 mL of hexane. An aliquot (0.1 mL) of 2 mol/L methanolic KOH solution was added. The tube was capped and vigorously shaken for 1 min and allowed to stand for 5 min. Then, 0.25 g of solid $NaHSO_4$ was added and the sample was centrifuged for 3 min at room temperature. An aliquot from the clear supernatant was taken for GLC analysis.

The fatty acid composition was determined by GLC on a Hewllett-Packard 6890 chromatograph (Palo Alto, CA) with a flame ionization detector. The following conditions were used: a fused silica capillary column coated with cyanopropyl polysiloxane (CP Sil 88, 100 m, 0.25 mm ID, 0.20 μm film thickness, Chrompack, Middelburg, The Netherlands); the column temperature: 60°C (1 min) up to 180°C at Δt=5°C/min; the injector and detector temperatures: 225 and 250°C, respectively; flow of carrier gas (helium): 0.8 mL/min; split ratio: 1:100; injected sample: 1 μL. The identification of fatty acids was based on retention times of standards (Sigma Chemical Co., St. Louis, MO) and literature data [Duchateau *et al.*, 1996; Ulberth & Henninger, 1994].

For the samples with above 1% *trans* C18:1 isomers, the Ag-TLC/GLC method was used to separate all positional isomers of *trans* C18:1. The fatty acid methyl esters were separated on glass plates coated with a layer of silica gel containing 10% $AgNO_3$. The plates were developed with petroleum ether/diethyl ether (90:10, v/v) and visualised with dichlorofluorescein solution. The *trans*-monoene fraction was eluated from the plates together with the saturated fraction with diethyl ether. After evaporation of ether, the methyl esters were dissolved in hexane and used for GLC analyses under the same chromatographic conditions as total fatty acid methyl esters, but without split (splitless).

All samples were analysed in duplicate and mean values were reported. The repeatability of fatty acid contents

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determined by the analytical method used was characterised by the coefficient of variation lower than 3%. The results for the fatty acid content were given in weight percentage.

RESULTS AND DISCUSSION

The fatty acid composition presented in Table 1 shows that the 18 types of tested ice creams had a high level of lauric acid, ranging from 41.86 to 48.28%, and of myristic acid – from 15.06 to 17.78% of total fatty acids. Only two types of ice creams contained a small amount of these acids (sample 1 and 16). A very high level of lauric and myristic acids may indicate the use of coconut oil in the manufacture of these ice creams. It appears that the use of this oil is now a common manufacturing practice in Poland. Also our earlier study [Żegarska & Borejszo, 2001] indicated that among 10 types of ice creams, seven types contained a very high level of lauric and myristic acids.

The ice creams that contained a high level of lauric and myristic acid had small amounts of *trans* C18:1 acids, ranging from 0.12% to 2.11%. The sample 16 contained 4.21% of *trans* C18:1 acids. Only one type of the ice creams (sample 1) had very high *trans* C18:1 acid concentration (23.26%). High levels of *trans* C18:1, *i.e.* 11.3 and 19.4%, were determined in two types of ice creams in an earlier study [Żegarska & Borejszo, 2001].

A very high level of *trans* isomers, in the range of 12.7–45.1% of total fatty acids, was found in 10 different Brazilian ice creams [Kawashima & Soares, 1993].

A wide range of the *trans* isomers in ice creams has been noted in European countries. Ice creams from 14 countries were analyzed by Aro *et al.* [1998]. The samples included both products with milk fat and products with vegetable fat. Half the samples with vegetable fat contained high levels of *trans* fatty acids (18–31%) and the other half demonstrated low concentrations of these acids (0.2–1.8% of total fatty acids). The range of *trans* fatty acids in the ice cream with milk fat was 2.63–6.07%. The mean *trans* fatty acid value of 2.5% was reported by San Juan [2000] for 30 samples of Spanish ice creams.

The distribution of the positional *trans* C18:1 isomers (Table 2) may indicate that milk fat was used only in the production of one type of the ice creams tested (sample 16). Milk fat displays a characteristic profile of positional *trans* C18:1 isomers with the highest level of *trans* vaccenic acid (*trans* 11 C18:1) [Żegarska *et al.*, 1996; Precht & Molkentin, 2000]. The sample 16 also contained high amounts of butyric acid (2.27%), palmitic acid (28.06%) and conjugated linoleic acid (0.86%) (Table 1). The high proportion of *trans* 6 to *trans* 10 isomers in the samples 1, 11 and 13 indicates the incorporation of partially-hydrogenated oil to these ice creams.

TABLE 2. Proportion of positional *trans* 18:1 isomers in some ice cream fats (percentage of total *trans*-18:1 acids).

Trans-18:1 isomers	Sample			
	1	11	13	16
t 4 + *t* 5	1.0	1.9	1.7	1.5
t 6 – *t* 8	25.5	20.1	10.7	5.4
t 9	17.4	17.4	19.2	4.0
t 10	17.4	14.5	23.2	6.1
t 11	13.1	14.0	20.1	56.1
t 12	12.9	9.9	10.7	4.2
t 13	6.9	10.1	8.5	10.3
t 14	2.6	7.2	4.0	3.2
t 15	1.3	1.9	1.0	3.8
t 16	1.8	2.9	1.0	5.3

TABLE 1. Fatty acid composition of ice cream fats (percentage of total fatty acids).

Sample	4:0	6:0	8:0	10:0	12:0	14:0	16:0	18:0	18:1*t*	18:1*c*	18:2 *c,t/t,c*	18:2 *c,c*	18:3 *c,c,c*	18:2 *conj*	Others
1	0.00	0.19	2.10	1.64	11.31	4.24	13.43	5.02	23.26	28.49	0.56	5.74	2.51	0.06	1.47
2	0.12	0.78	8.50	6.34	45.19	16.99	10.00	5.56	0.39	4.80	0.00	1.09	0.06	0.03	0.15
3	0.04	0.80	8.89	6.67	46.34	16.40	9.77	5.15	0.17	4.39	0.00	1.19	0.03	0.00	0.17
4	0.02	0.74	8.59	6.53	46.12	16.56	9.98	3.64	0.22	5.89	0.01	1.53	0.05	0.00	0.14
5	0.04	0.80	9.09	7.11	48.28	16.39	8.41	2.90	0.16	5.41	0.00	1.27	0.04	0.00	0.11
6	0.00	0.75	8.83	6.72	47.30	16.10	8.71	2.53	0.87	6.24	0.00	1.69	0.14	0.01	0.13
7	0.03	0.69	7.99	6.21	45.76	16.76	9.92	5.48	1.00	4.83	0.01	1.07	0.08	0.01	0.16
8	0.00	0.76	8.95	6.75	47.12	16.21	8.70	4.53	0.42	5.18	0.00	1.31	0.04	0.00	0.06
9	0.06	0.74	8.49	6.62	46.47	16.54	9.38	4.51	0.18	5.41	0.02	1.38	0.04	0.00	0.18
10	0.05	0.53	6.05	4.80	41.95	15.06	10.92	6.20	0.87	10.87	0.07	2.08	0.16	0.03	0.38
11	0.02	0.52	6.62	5.44	42.67	17.25	11.56	5.81	1.82	6.68	0.00	1.42	0.05	0.02	0.13
12	0.00	0.64	7.84	6.18	45.12	16.90	9.96	5.54	0.84	5.51	0.06	1.24	0.03	0.00	0.16
13	0.03	0.70	8.27	6.27	44.40	15.44	9.03	3.57	2.11	7.61	0.29	2.07	0.10	0.00	0.13
14	0.12	0.75	7.41	5.78	41.86	16.51	12.13	5.88	0.68	6.90	0.19	1.42	0.12	0.05	0.22
15	0.03	0.67	7.96	6.24	45.78	16.96	9.97	5.40	0.65	4.75	0.01	1.10	0.04	0.01	0.43
16	2.27	1.68	1.10	2.34	2.86	9.53	28.06	12.48	4.21	22.85	0.82	2.27	0.86	0.86	7.81
17	0.00	0.44	6.46	5.63	44.76	17.71	10.70	7.35	0.21	5.14	0.05	1.35	0.06	0.00	0.17
18	0.00	0.39	6.15	5.53	44.72	17.78	11.80	7.36	0.12	4.86	0.00	1.16	0.01	0.00	0.14
19	0.08	0.61	7.27	5.87	44.01	17.17	11.21	4.63	0.18	6.95	0.00	1.67	0.05	0.02	0.30
20	0.04	0.55	7.11	5.84	45.04	17.61	11.16	6.52	0.20	4.67	0.00	1.07	0.03	0.03	0.13

Abbreviations: 18:1 *t* – *trans* 18:1; 18:1 *c* – *cis* 18:1; 18:2 *c,t/t,c* – *cis,trans/trans,cis* 18:2; 18:2 *c,c* – linoleic acid; 18:3 *c,c,c* – α-linolenic acid; 18:2 conj. – conjugated linoleic acid (CLA)

The fat of the ice creams contained *trans* (*c*/*t* and *t*/*c*) C18:2 isomers at the level of 0.00–0.82 % (Table 1). The highest content of *trans* C18:2 isomers was found in the sample with milk fat. According to Precht & Molkentin [2000], milk fat contains *c*/*t* and *t*/*c* isomers of C18:2 in the range of 0.11 to 1.41%.

Table 3 shows the fat content and the fatty acids of ice creams grouped in respect of nutritional significance. The fat content of the majority of ice creams was in the range of 5 to 10%, but two types had 14% and four – 2.5% fat content. The ice creams had a very high proportion of the sum of lauric, myristic and palmitic acids. According to the recent studies [Kris-Etherton *et al.*, 2000], the hypercholesterolemic effect of saturated FA is largely due to lauric, myristic, and palmitic acids. The total level of these acids in the fat of the examined ice creams ranged from 28.98% to 73.81%. Sixteen of the twenty samples contained more than 70% of these acids. A proportion of monoenoic fatty acids was in the range of 4.56 (sample 3) to 29.89% (sample 16, with milk fat). Only sample 1 had 52.23% of monoenoic acids, but nearly half of these acids were *trans* C18:1 isomers. The polyenoic fatty acid content of the ice creams was very low. The 16 samples had less than 2% of the polyenoic acids. The ratio of linoleic to α-linolenic acid was in the range from 2 to 116. This ratio in the diet should be between 5:1 and 10:1 [FAO Food and Nutrition Paper, 1994]. Linoleic acid is the major *n*-6 fatty acid, and α-linolenic acid is the major *n*-3 fatty acid. It has been confirmed that a decreased intake of *n*-6 and an increased intake of *n*-3 polyenoic fatty acids can improve the health status [Simopoulos, 2002].

CONCLUSIONS

The results obtained indicate that the majority of ice creams available on the Polish market are characterised by a low content of *trans* fatty acids. The fat of these ice creams is rich in saturated fatty acids, especially lauric and myristic acids because of the use of coconut oil in their production.

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TABLE 3. Fat content of ice creams and content of selected fatty acids of ice cream fats (percentage of total fatty acids).

Sample	Fat* (%)	Σ12:0–16:0[a]	SFA	MFA	PFA	Total *trans* FA	18:2/18:3[b]
1	14.0	28.98	38.51	52.23	9.28	23.82	2
2	8.5	72.18	93.63	5.19	1.18	0.39	18
3	8.5	72.51	94.23	4.56	1.22	0.17	40
4	8.5	72.66	92.30	6.11	1.59	0.23	31
5	14.0	73.08	93.12	5.57	1.31	0.16	32
6	6.5	72.11	91.05	7.11	1.84	0.87	12
7	2.5	72.44	92.98	5.84	1.17	1.01	13
8	8.5	72.03	93.05	5.60	1.35	0.42	33
9	8.5	72.39	92.97	5.59	1.44	0.20	34
10	5.0	67.93	85.87	11.79	2.34	0.94	13
11	2.5	71.48	89.96	8.56	1.49	1.82	28
12	10.0	71.98	92.33	6.35	1.33	0.90	41
13	8.5	68.89	87.81	9.74	2.46	2.40	21
14	8.5	70.50	90.63	7.58	1.78	0.87	12
15	8.5	72.71	93.32	5.51	1.16	0.66	27
16	8.5	40.45	65.30	29.89	4.81	5.03	3
17	2.5	73.17	93.19	5.35	1.46	0.26	22
18	8.0	74.30	93.87	4.98	1.16	0.12	116
19	7.9	72.39	91.06	7.19	1.75	0.18	33
20	2.5	73.81	94.01	4.86	1.13	0.20	36

* – from the labels; [a] – 12:0 + 14:0 + 16:0; SFA – saturated fatty acids; MFA – monoenoic fatty acids; PFA – polyenoic fatty acids; [b] – ratio of linoleic to α-linolenic acid

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Received January 2004. Revision received March and accepted November 2004.

SKŁAD KWASÓW TŁUSZCZOWYCH LODÓW, Z UWZGLĘDNIENIEM ZAWARTOŚCI IZOMERÓW *TRANS*

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Skład kwasów tłuszczowych tłuszczu wydzielonego z 20 rodzajów lodów dostępnych na polskim rynku oznaczano metodą chromatografii gazowej przy zastosowaniu 100 m kolumny kapilarnej (CP Sil 88).

Przeprowadzone badania wykazały, że jeden rodzaj lodów charakteryzował się wysoką zawartością nienasyconych kwasów tłuszczowych o konfiguracji *trans* (ok. 24% ogólnego składu kwasów tłuszczowych). Zawartość izomerów *trans* kwasu C18:1 w tłuszczu 19 rodzajów badanych lodów mieściła się w zakresie od 0,12 do 4,21% (tab. 1). Izomery *cis*/*trans* i *trans*/*cis* kwasu C18:2 były obecne w ilości od 0 do 0,82%. W 18 rodzajach stwierdzono wysoki udział kwasu laurynowego (41,86 do 48,28%) i mirystynowego (15,06 do 17,78% ogólnego składu kwasów tłuszczowych). Skład kwasów tłuszczowych wskazuje, że tylko jeden rodzaj badanych lodów wyprodukowany został z udziałem tłuszczu mlekowego.