

FATTY ACID COMPOSITION, INCLUDING TRANS ISOMERS, IN FATS OF MILK DESSERTS*Beata Paszczyk, Zbigniew Borejszo, Magdalena Majewska**Chair of Commodity Science and Food Analysis, University of Warmia and Mazury in Olsztyn, Poland*Key words: milk desserts, fatty acids, *trans* isomers, CLA

The aim of this study was to assess the composition of fatty acids, including unsaturated fatty acids in *trans* configuration, in different types of milk desserts purchased at the local market in Olsztyn. Determinations were performed with the GC method, with the application of an HP 6890 gas chromatograph equipped with a flame ionization detector (FID) and a 100 m long capillary column with CP Sil 88 phase.

The desserts analysed were characterised by different contents of fat, ranging from 2.0 to 12.9%. Contents of particular groups of fatty acids were as follows: higher saturated fatty acids – from 58.76 to 69.77%, monounsaturated fatty acids – from 18.03 to 28.83%, polyunsaturated fatty acids – from 2.25 to 3.98%, and volatile fatty acids – from 6.57 to 10.18% of total fatty acids in the desserts fat.

Fat isolated from all analysed desserts was confirmed to contain *trans* isomers of C18:1 acid, *cis,trans* and *trans,cis* isomers of C18:2 acid as well as *cis-9, trans-11* isomers of CLA.

INTRODUCTION

The domestic market offers a broad range of dairy products such as yoghurts, acidophilous milks, kefir, buttermilks, homogenized cream cheeses and desserts. These products are consumed not only by adults but also by small children, hence they should be characterised by a good quality and by a beneficial composition of fatty acids which are important body constituents. Milk desserts should be healthy, safe and should supply as much health-promoting compounds as possible as they are indispensable for the growth and development of a young organism.

Dairy products are produced mainly from cow's milk. The quantitative composition of milk fat is subject to changes as affected by a variety of factors, *e.g.* the feeding of cows, the breed of cows, individual characteristics, lactation period, climatic conditions, age *etc.* The fatty acids composition in milk fat is, however, affected to the greatest extent by the feeding of cows. Milk fat from the period of pasture feeding is characterised by higher concentrations of C18 acids, mainly C18:1, and substantially lower contents of palmitic and myristic acids in comparison to that from the period of winter feeding [Jaworski, 1978; Staniewski, 2000; Jansen, 2002]. According to a study by Staniewski [2000], the total content of saturated fatty acids in milk fat isolated from butter obtained from stall feeding accounted for 60.19%, that of volatile fatty acids – for 9.64%, that of monoenoic fatty acids – for 27.18%, and that of polyenoic ones – for 2.99%. On the other hand, in butter fat originating from milk collected during pasture feeding saturated fatty acids constituted 54.71%, volatile fatty acids – 9.43%, monoenoic fatty acids – 31.33%, and

polyenoic fatty acids – 4.53% of the total fatty acids. Milk fat originating from pasture feeding is additionally characterised by almost 2-fold higher content of *trans* isomers. According to investigations by Żegarska *et al.* [1996, 2006], the mean total content of *trans* isomers of C18:1 acid in the period of winter feeding may fluctuate between 1.26 and 2.16%, whereas in the period of summer feeding between 3.57 and 6.87%. In turn, the content of *trans* isomers of C18:2 acid may range from 0.29 to 0.61% in milk fat from the winter feeding, and from 0.65 to 1.19% in milk fat from the summer feeding [Żegarska *et al.*, 2006]. As shown by Precht & Molkenin [1997], the mean total content of *trans* isomers of C18:1 acid oscillated from 3.28 to 6.75% (mean value: 5.08%) in milk fat from pasture feeding, from 2.71 to 4.95% (mean value: 3.8%) in milk fat from a transitory period, and from 1.29 to 4.21% (mean value: 2.65%) in milk fat from the winter feeding.

Milk and dairy products are an important source of *trans* isomers in a human diet. Ample surveys conducted by, among others, Fritsche & Steinhart [1997], Aro *et al.* [1998], Daniewski *et al.* [1998], Paszczyk *et al.* [2006], and Żegarska *et al.* [2005, 2008] have indicated that the content of *trans* isomers of C18:1 and C18:2 acids in fats isolated from dairy products may vary. Contents of *trans* isomers of C18:1 acid may range from 0.49 to 4.69% in cheeses (the exception was "Rokpol" cheese analysed by Daniewski *et al.* [1998] in which their content reached 10.05%), and from 0.46 to 4.22% in yoghurts, from 1.95 to 2.91% in bioyoghurts, from 1.18 to 4.16% in kefir, from 1.12 to 4.08% in acidophilous milk, and from 0.12 to 23.82% in ice creams. In turn, *trans* isomers of C18:2 acid in dairy products could be in the range of 0.11 to 1.17% in cheeses, from 0.35 to 0.82% in yoghurts,

from 0.39 to 0.86% in kefir, and from 0.35 to 0.85% in acidophilous milk. Such a large variation in the content of *trans* isomers in fat extracted from dairy products may be affected by a variety of factors, such as: production technology, type and composition of additives applied, and – to the greatest extent – by the quality and fatty acids profile of milk they are made of. In some cases, the higher content of these isomers in a product could be due to the fact that in the production process some producers use saturated plant oils, which is hardly ever declared on products' labels. Taking the above into consideration, dairy products available on the local market may be characterised by significant quantities of *trans* isomers of unsaturated fatty acids. Ample studies conducted with humans and animals have indicated some of these isomers to exert an unfavourable influence on the body. *Trans* isomers have been implicated to increase the level of LDL cholesterol and to decrease the level of HDL cholesterol [Mensink & Katan, 1990; Zock & Katan, 1992; de Roos *et al.*, 2001], as well as to inhibit the activity of delta 6-desaturase [Gurr, 1983, Precht & Molckentin, 1995], and finally contribute to atherosclerosis [Stachowska *et al.*, 2002] and ischaemic heart disease [Willett *et al.*, 1993].

Milk fat is additionally a rich source of conjugated dienes of linoleic acid (CLA) in a human diet. These compounds have been claimed to exhibit some biological activity favourable to human health. The most active isomer in that group is *cis-9, trans-11* CLA. Ample surveys have shown that this acid possesses antioxidative [Parodi, 1999], antiatherosclerotic [Lee *et al.*, 1994] and anticarcinogenic [Pariza, 1991; Parodi, 1997] properties. The content of *cis-9, trans-11* CLA in milk fat originating from pasture feeding of cows has been reported to range from 0.22 to 0.52%, and that in milk fat from the winter feeding – from 0.65 to 1.69% of the total fatty acids in milk fat [Żegarska *et al.*, 1996, 2006].

The available literature lacks reports on the quality of milk desserts. Whilst, the intake of those products in Poland as well as their availability on the Polish market and flavour diversity are very high. For this reason, the aim of this study was to determine the composition of fatty acids, including *trans* isomers of unsaturated fatty acids, in fat extracted from milk desserts purchased on the local market in Olsztyn.

MATERIAL AND METHODS

Material

Material to be analysed were various desserts: vanilla-flavoured milk desserts, creamy-flavoured milk desserts with and without the addition of whipped cream, creamy desserts with the addition of cocoa and nuts, creamy-flavoured creams, and blancmange creams (puddings). In total, 17 various types of desserts originating from 8 different producers were analysed in the study. Taking into account the composition of the products analysed as well as additives that could, to some extent, modify the composition and concentrations of fatty acids in the finished product, the desserts were divided into three groups presented in Table 1.

All products analysed were purchased at retail shops in Olsztyn, in February 2007. Each dessert was analysed during its shelf life.

TABLE 1. Analysed groups of desserts.

Group of products	Number	Description
I	1	Desserts produced from pasteurized milk with the addition of cream or whey
	2	
	3	
	4	
	5	
	6	
	7	
II	8	Desserts produced from milk and cream, with the addition of nuts and cocoa
	9	
	10	
	11	
	12	
III	13	Desserts produced from milk and cream, with the addition of saturated lipids
	14	
	15	
	16	
	17	

Analytical methods

Fat extraction from the analysed products was performed with the Folch's method [Christie, 1973].

Methyl esters of fatty acids were prepared according to the IDF method using a methanol solution of KOH [IDF Standard 182: 1999].

Separation of methyl esters of fatty acids of the isolated fat was conducted with the gas chromatography (GC) method using a Hewlett Packard 6890 chromatograph with a flame-ionization detector (FID).

Determinations were carried out under the following conditions: capillary column – 100 m x 0.25 mm i.d. (Chromopack), film thickness – 0.20 µm, stationary phase – CP Sil 88, column temperature: 60°C (1 min) – 180°C, $t=5^{\circ}\text{C}/\text{min}$; the injector and detector temperatures: 225 and 250°C, respectively; carrier gas: helium, flow rate: 0.8 cm³/min, split 100:1, and the volume of injected sample: 1 µL.

Peaks of individual fatty acids were identified by comparing their retention times with those of methyl esters of reference fat with known fatty acids profile. For identification of positional *trans* isomers of C18:1, use was made of the standards of methyl esters of those isomers (Sigma) and literature data [Wolf, 1994, Precht & Molckentin, 1996]. In turn, the *trans* isomers of C18:2 acid (*cis,trans* and *trans,cis*) were identified with the use of a mixture of standards of C18:2 isomers (Supelco) and literature data [Henninger & Ulberth, 1994], whilst *cis-9, trans-11* CLA – with a mixture of CLA methyl esters (Sigma) and literature data [Roach *et al.*, 2002].

All measurements were performed in duplicate.

RESULTS AND DISCUSSION

Fat content of the analysed groups of desserts and contents of particular groups of fatty acids in the fat were com-

piled in Table 2. The mean contents of the groups of fatty acids and standard deviations calculated for the analysed groups of desserts were presented in Figure 1.

Diversity of recipes, raw material composition and additives contributed to differences in fat content of the analysed desserts available on the market (Table 2). The differences were observed both between and within the groups of desserts. The highest differentiation in fat content was noted in desserts produced from milk with the addition of sweet cream or whey (products of group I). Fat content of those products ranged from 2.0% (product no. 6 and 7) to 8.4% (product no. 3), with the mean content accounting for 3.90% (Table 2, Figure 1). The highest content of fat and the lowest differentiation within the group were reported for milk desserts with the addition of cocoa and nuts (group II). In products of that group, fat content ranged from 8.9% (product no. 10) to 12.9% (product no. 9), with the mean value accounting for 10.36%. In desserts containing milk fat and saturated lipids (group III) the content of fat was ranging from 3.4% (product no. 17) to 8.6% (product no. 14), with the mean content accounting for 6.26% (Table 2, Figure 1).

The results obtained indicate that in the total composition of fatty acids in fat extracted from all analysed milk desserts, the predominating fatty acids were the higher saturated ones (C12-C18), (Table 2, Figure 1). The total content of those acids in products from group I oscillated from 60.22% (product no. 7) to 67.23% (product no. 1), with the mean value accounting for 63.26%. A lower con-

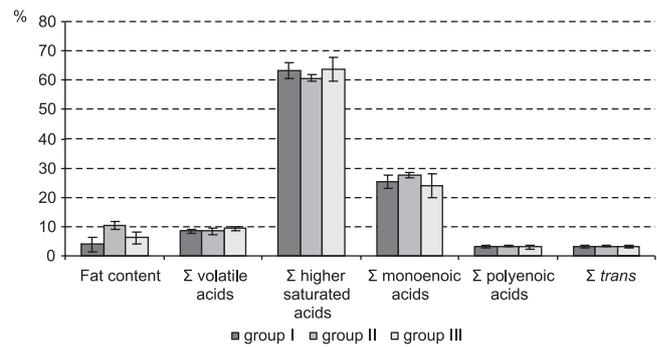


FIGURE 1. The mean contents (\pm SD) of fat and particular groups of fatty acids in the total fatty acids composition of fat isolated from the analysed groups of dairy desserts.

tent of saturated fatty acids was noted for milk desserts with the addition of cocoa and nuts (group II). The total content of these acids in this group of products ranged from 59.33% (product no. 11) to 62.18% (product no. 10), with the mean content of 60.69%. In desserts containing apart from milk fat also the saturated lipids (group III), the concentration of saturated fatty acids ranged from 58.76% (product no. 16) to 69.77% (product no. 17), with the mean value accounting for 63.85%. In most of the products analysed, amongst the saturated fatty acids the highest concentrations were noted for: palmitic (C16) and stearic (C18) acid, *i.e.* from 24.0% to 35.42% and from 7.89% to 11.29%, respectively, of the total fatty acids composition. Within this group

TABLE 2. Fat content in the analysed groups of dairy desserts and the composition of particular groups of fatty acids (% in the total fatty acids composition).

Group of products	Number	Fat content* (%)	Σ volatile acids (C4-C10)	Σ higher saturated acids (C12-C18)	Σ monoenoic acids	Σ polyenoic acids	Σ trans isomers
I	1	5.5	8.20	67.23	22.05	2.53	2.66
	2	3.9	8.28	64.86	24.15	2.72	2.86
	3	8.4	9.16	63.41	24.67	2.77	3.17
	4	3.0	8.45	64.91	24.00	2.65	2.83
	5	2.5	8.87	61.09	26.84	3.21	3.36
	6	2.0	7.28	61.12	28.14	3.46	3.69
	7	2.0	8.76	60.22	27.50	3.52	3.66
Mean \pm SD		3.90 \pm 2.34	8.43 \pm 0.61	63.26 \pm 2.57	25.34 \pm 2.21	2.98 \pm 0.41	3.18 \pm 0.41
II	8	10.0	8.71	60.13	27.92	3.26	3.28
	9	12.9	9.45	61.80	25.74	3.02	3.46
	10	8.9	6.57	62.19	27.98	3.27	2.93
	11	10.0	8.99	59.33	27.69	3.98	3.44
	12	10.0	8.60	59.99	28.06	3.35	3.46
Mean \pm SD		10.36 \pm 1.50	8.46 \pm 1.11	60.69 \pm 1.24	27.48 \pm 0.98	3.38 \pm 0.36	3.31 \pm 0.23
III	13	5.3	10.18	65.41	21.90	2.51	3.08
	14	8.6	9.38	63.26	24.50	2.86	3.38
	15	8.0	8.55	62.06	25.60	3.79	2.59
	16	6.0	8.90	58.76	28.83	3.50	3.51
	17	3.4	9.96	69.77	18.03	2.25	2.51
Mean \pm SD		6.26 \pm 2.10	9.39 \pm 0.69	63.85 \pm 4.09	23.77 \pm 4.06	2.98 \pm 0.65	3.01 \pm 0.45

*- value declared on the products' package.

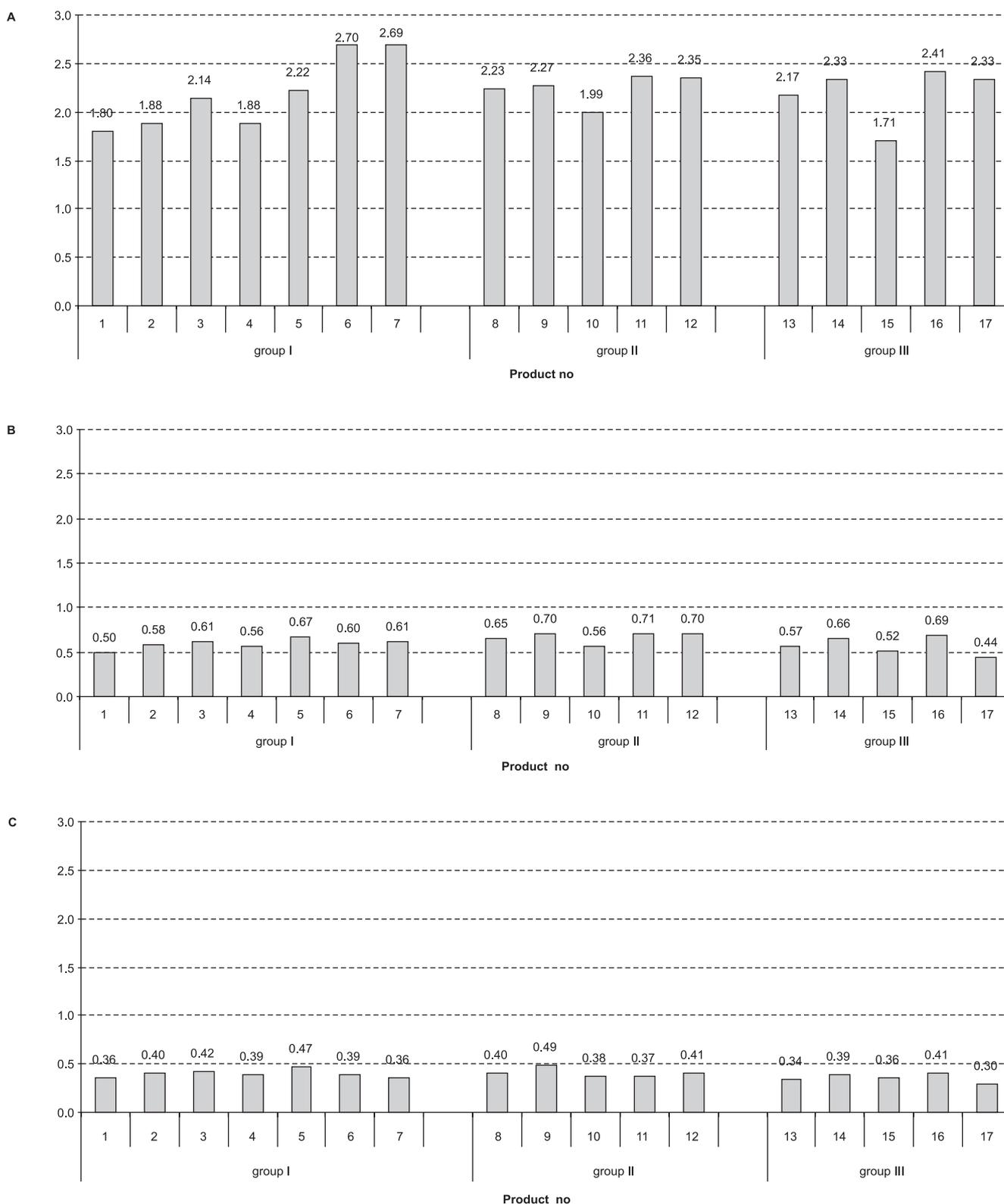


FIGURE 2. The content of *trans* C18:1(A), *trans* C18:2(B) and *cis*-9, *trans*-11 CLA (C) in the total fatty acids composition of fat isolated from the analysed dairy desserts.

of fatty acids, the greatest differences were observed for the content of lauric acid (C12). Its concentration in fat extracted from 13 analysed desserts fluctuated between 3.04% and 4.07%. In turn, in fat of the other four products, *i.e.* no.

13, 14, 15 and 17, it was substantially higher and ranged from 6.89% to 19.03% of the total fatty acids composition. The content of myristic acid (C14) ranged from 9.49% to 13.65%. From the nutritional point of view, the high con-

centration of saturated fatty acids has an adverse impact on human health. The saturated fatty acids, mainly lauric (12:0) and myristic (14:0) acids, have been implicated to increase the level of LDL cholesterol in blood serum and to contribute to the ischemic heart disease [Ziemiański, 2001].

In fat extracted from the products originating from group I, the content of monoenoic fatty acids ranged from 22.05% (product no. 1) to 28.14% (product no. 6), with the mean value of 25.34%, whereas in fat from the products of group II it fluctuated between 25.74% (product no. 9) to 28.06% (product no. 12), with the mean content of 27.48% (Table 2, Figure 1). The lowest mean content of monoenoic fatty acids was noted in milk desserts produced with addition of saturated lipids (group III). The percentage of monoenoic acids in fat isolated from desserts belonging to this group ranged from 18.03% (product no. 17) to 28.83% (product no. 16), with the mean content accounting for 23.77%. In fat of all the analysed desserts, the monoenoic fatty acids were mainly represented by oleic acid, which constituted from 13.7% to 22.31% of the total fatty acids composition of those desserts.

The mean content of short-chain fatty acids (C4 to C10) in fat isolated from the analysed milk desserts from group I and II was at a similar level (Table 2, Figure 1). In fat extracted from desserts belonging to group I, the total content of these acids oscillated from 7.28% to 9.16%, whereas in fat isolated from desserts of group II it ranged from 6.57% to 9.45%. The mean content of volatile fatty acids (9.39%) was slightly higher in the products with the addition of saturated lipids (group III). In this group of desserts, the short-chain fatty acids constituted from 8.55% up to 10.18% of the total fatty acids (Table 2).

The milk desserts analysed were characterised by a low content of polyenoic fatty acids. Their content in products containing only the milk fat (group I) was within the range of 2.53% (product no. 1) to 3.52% (product no. 7), with the mean content of 2.98% of the total fatty acids composition of fat in desserts under study (Table 2, Figure 1). In desserts with the addition of saturated lipids, the mean content of these acids was at a similar level (2.98%). In all analysed desserts with the addition of cocoa and nuts (group II), the content of polyenoic fatty acids exceeded 3%, ranging from 3.02% (product no. 9) to 3.98% (product no. 11), with the mean value accounting for 3.38%. In fat isolated from all desserts of that group of products, the predominating fatty acids were linoleic (C18:2) and linolenic (C18:3) acids.

The mean contents of particular groups of acids in the total fatty acids composition in fat isolated from the desserts analysed approximate contents of fatty acids in fat extracted from milk collected in the period of winter feeding of cows [Staniewski, 2000; Jaworski, 1978]. The addition of other fats (hydrogenates ones) or additives (cocoa, nuts) caused minor fluctuations in the total fatty acids composition of fat in these products.

Fat extracted from all the analysed desserts was found to contain *trans* isomers of C18:1 acid, *cis,trans* and *trans,cis* isomers of C18:2 acid as well as *cis*-9, *trans*-11 isomers of CLA.

In the group of *trans* isomers occurring in fat isolated from all analysed desserts the highest concentration was reported for *trans* C18:1 acid. The total content of these isomers in the total fatty acids composition in fat isolated from products belonging to group I ranged from 1.80% (product no. 1) to 2.70% (product no. 6), (Figure 2A). The addition of cocoa, nuts or saturated lipids did not evoke any significant changes in contents of *trans* isomers of C18:1 in the finished product. In desserts with the addition of cocoa and nuts (group II), the concentration of these isomers fluctuated between 1.99% (product no. 10) and 2.36% (product no. 11), whereas in the desserts produced with addition of saturated lipids – between 1.71% (product no. 15) and 2.41% (product no. 16), (Figure 2A). In the available literature there is sparse information on the determination of *trans* isomers of fatty acids in desserts. Only Daniewski *et al.* [1998] were analysing the quality of two desserts: a cottage cheese dessert with fruits and a chocolate dessert “Kubuś”. The content of *trans* isomers of C18:1 acid in products examined by those authors was similar to that determined in milk desserts analysed in our study.

The content of *trans* isomers of C18:2 acid (*cis,trans* and *trans,cis*) in the total fatty acids composition in fat extracted from desserts no. 1 to 7 (group I) was within the range of 0.50% (product no. 1) to 0.67% (product no. 5). In fat isolated from the other desserts it was at a similar level, *i.e.*: in the desserts with the addition of cocoa and nuts (products 8 to 12) it ranged from 0.56% (product no. 10) to 0.71% (product no. 11), whereas in desserts no. 13 to 17 it ranged from 0.44% (product no. 17) to 0.69% (product no. 16), (Figure 2B).

In the total fatty acids composition of fat isolated from desserts originating from group I, the content of *cis*-9, *trans*-11 CLA isomer constituted from 0.36 to 0.47% (Figure 2C). Desserts with the addition of cocoa, nuts or saturated lipids were found to contain *cis*-9, *trans*-11 acid at a similar level. The content of CLA isomer in the desserts with the addition of cocoa and nuts ranged from 0.37% (product no. 11) to 0.49% (product no. 9), whilst in fat extracted from the desserts containing saturated lipids – from 0.30% (product no. 17) to 0.41% (product no. 16), (Figure 2C).

CONCLUSIONS

1. In fat isolated from the milk desserts the content of higher saturated fatty acids ranged from 58.76% to 69.77%, that of monoenoic fatty acids from 18.03% to 28.83%, that of polyenoic fatty acids from 2.25% to 3.98%, and that of volatile fatty acids from 6.57% to 10.18%.

2. The total contents of *trans* C18:1, *trans* C18:2 and *cis*-9, *trans*-11 CLA isomers in the total fatty acids composition of fat isolated from the analysed groups of dessert were at a similar level.

3. The composition of fatty acids as well as isomers of fatty acids were found to be affected to the greatest extent by the quality of raw material used for the production of desserts. The addition of other fats caused only minor fluctuations in the composition of fatty acids and in the content of *trans* isomers occurring in the products analysed.

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