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COMPOSITION OF FATTY ACIDS IN SELECTED SORTS OF BISCUITS, OFFERED FOR CHILDREN

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The fatty acid (FA) composition, especially total trans-fatty acids (TFA) content in 12 assortments of biscuits offered for children, produced by four different companies, were determined by gas chromatography. Total fat content of the biscuit samples ranged from 2.2 to 22.8 g/100 g of product. The major FAs were palmitic C16:0, oleic C18:1, and linoleic C18:2 acids. Depending on the biscuit type, the total saturated fatty acids (SFA) content was between 14.8% and 60%, total monoenoic FA (MUFA) 32.4% and 57.5%, and polyenoic FA (PUFA) 5.8% and 26.8%. The results of the examination of total FA composition of samples have shown a very large variation in the content of TFA in the biscuits produced by different plants. The total FA content ranged from 0.5 to 8.8%. The levels of TFA in studied biscuits offered for children were relatively low by comparison with products from other countries. According to the regulatory approach Danish Veterinary and Food Administration (2003), the levels of TFA in examined samples did not exceed the limited value of 2 g/100 g of product. Furthermore, these contents of TFA are conforming to the requirements under European Union Food Law.

Keywords: biscuits offered for children, fatty acid composition, trans-fatty acids, food composition

There is increasing interest in the effects of TFA and PUFA on human health and in the sources of these acids in the diet. In confectionary products, the source of TFA is predominantly either milk/butter used in the formulation or hydrogenated vegetable fat. Milk fat contains 2–5% of acids of several trans-FA. These acids are generated in the rumen of ruminants by biohydrogenation of unsaturated FA or by partial hydrogenation of PUFA in vegetable oils. The quantitative composition of the TFA fraction in milk fat differs from that in partially hydrogenated oils. Vaccenic acid (C18:1 11t), a trans-FA present predominantly in milk fat up to about 80% of the total trans-FA, may be desaturated in the organism to the conjugated linoleic acid (CLA) which has numerous beneficial biological effects (Yacoob et al., 2006). On the other hand, the TFA in partially hydrogenated vegetable oils increase the risk of coronary heart disease (CHD). TFA ingestion increases LDL and total cholesterol levels and decreases that of HDL cholesterol. Furthermore, TFA increase triacylglycerols and lipoproteins in blood which are also strong predictors of CHD (Forycki, 2010). Gerberding (2009) reported that TFA had a greater effect than SFA on increasing the risk of cardiovascular diseases. It is evident that natural trans fats are metabolized differently from hydrogenated trans fats. For example, trans-FA in hydrogenated soybean oil inhibited the metabolic conversion of linoleic to arachidonic acid, whereas vaccenic acid did not (Kummerow et al., 2004).

The demand of consumers for supplying adequate amounts and proportions of PUFA in their diet can rather not be satisfied by increasing the contents of PUFA-rich fats in confectionary products. This is because the shortenings used in the formulations for these products are generally not rich sources of PUFA. Furthermore, increasing the contents of PUFA in biscuits would aggravate the sensory and health-related problems caused by lipid oxidation.

The estimation of TFA intake is difficult because it depends on the method used, e.g. dietary recalls. Lowest estimates of TFA intake are obtained from dietary recalls (Larqué et al., 2001). In industrialized countries, the consumption of TFA is rather high, averaging 2–8 g/day (Hulshof et al., 1999) but has been decreasing over the recent decades. The current TFA consumption amounts to 3–6 g/day in the U.S., United Kingdom, and Germany, 1.2–6.7 g/day in Greece and 1.7–4.1 g/day in Iceland (Wagner et al., 2000). The reasons for that decrease are modifications in technological processes, i.e. the use of plant oils and only partially hydrogenated plant cooking oils for frying. Nevertheless, a high consumption of products fried in hydrogenated fats or frequent attending of fast food restaurants results in an increased consumption of TFA in certain groups and the same applies to younger population, especially children, who consume chocolate spreads containing 0.6–8.9% TFA (Wagner et al., 2000). Moreover, children prefer to consume products containing high levels of TFA: chocolate bars, microwave popcorn, or cookies (Leth et al., 2006). Studies in Canada showed that even preschool children aged 1.5–5 years are exposed to TFA. Mean intake of TFA in Canada by children in early childhood was 4.8 g/day, representing 1.8% of the total energy intake (Innis, 2006). Baked food, especially cookies, are widely consumed by teenagers resulting in an exposure to TFA in amounts high enough to have adverse health effects on blood lipids and inflammatory markers in adults. Enig (1995) reported that in 1993, the intake of TFA by American teenagers exceeded 30 g/day. In Poland, many types of confectionery products for children are manufactured and, thus, biscuits have become one of the major sources of dietary fat. Many reports on fatty acid composition of confectionery products have been recently published, but published data on fat quality in products for children are scarce (Daglioglu et al., 2000).

In this study, we present the fatty acid composition with special emphasis on total *trans* fatty acid contents in several types of biscuits for children.

1.1. Materials

The study was conducted on 12 sorts of biscuits (manufactured in 2009), representative of four Polish confectionery manufacturers. Each manufacturer was assigned letter code (A, B, C, D), and different biscuit sorts were numbered. The following types of biscuits were analysed: containing milk chocolate, butter flavour, sugar, or corn. They were examined before their shelf-lives expired. Confectionery wrapping was one of the criteria of selecting the product as it influenced noticing them by children and evoked positive emotions.

1.2. Methods

Sample preparation. Lipids were extracted from the analysed products by the Folch's method (Folch et al., 1957). FA methyl esters (FAMEs) were prepared according to A.O.A.C.-IUPAC method by alkaline hydrolysis of the fat, followed by methylation in 0.5 M methanol with BF_3 as catalyst. FAMEs were extracted into 4 ml hexane (A.O.A.C.-IUPAC, 2000).

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The total FA composition was determined by HR-GC in a GC Agilent 6890 gas chromatograph equipped with capillary column 100 m×0.25 mm×0.2 µm Rtx 2330, (Restek Corp., USA), flame ionization detector, and split/splitless injector. Hydrogen carrier flow was 1 ml min^{-1}. Injector and detector temperatures were 250 °C, the oven temperature was programmed from 155 °C for 45 min, and then to 210 °C at 1.5 °C min^{-1}. The final temperature was maintained for 50 min, and the total time was 90 min. For identification of FA, Standard Supelco 37 Component FAME Mix No 47885-U (Sigma Aldrich, Poland) as well as an in-house mixture of vegetable hydrogenated oils containing trans isomers was used. The results were expressed in a form of percentage participation in the total amount of methyl esters.

1.3. Statistical analysis

All analyses were conducted in three replicates. The data were reported as means ± standard deviation (SD). All SD were within 3% of the reported mean values. Analysis of variance (ANOVA) and the post-hoc Tukey's test were used to assess the between-mean differences using the Statistica 9 PL (StatSoft, Inc. 2010) software.

2. Results and discussion

The total fat content in samples was expressed as relative to 100 g of the product (Fig. 1). Fat contents varied significantly ($P<0.05$) due to the use of different recipes by the manufacturers and depended on the amount of fat used in the formulations of biscuits. The examined biscuits contained from 2.2 (product C-3) to 22.8 g (product D-2) fat/100 g of product, as well as different proportions of unsaturated and saturated fatty acids. In 9 out of 12 products, fat content did not exceed 15%. Thus, fat content in the studied cookies created for children was markedly lower compared to that in other confectionery (for all consumers) which ranged from 11 to 35% (Paszczyk et al., 2007). Considering the fact that obesity among children steadily increases and affects as much as 18% of Polish population aged 13–15 years (Zawodniak-Szałapska et al., 2007), putting on the market confectionery of relatively low fat content is a rational move.

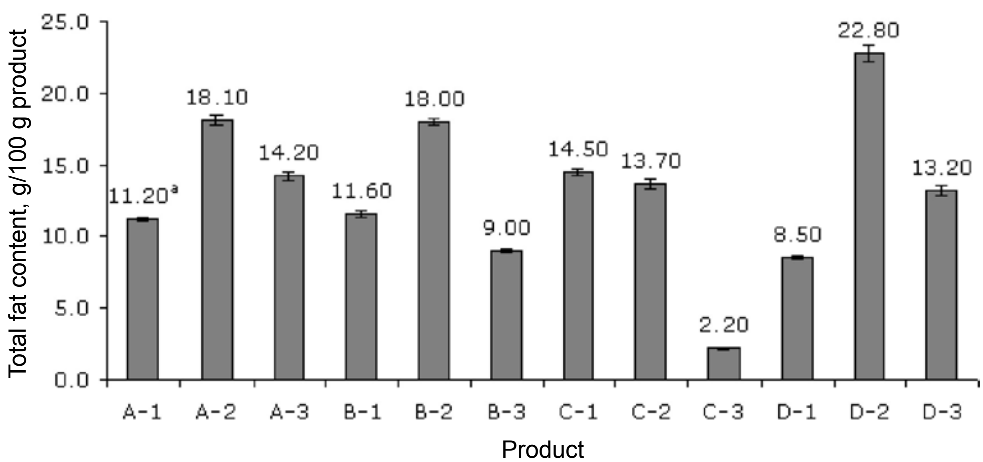

Fig. 1. Total fat content in studied biscuits (g/100 g of product). [a]Values are expressed as means ±SD of 3 independent assays

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Total amounts of unsaturated (MUFA, PUFA) and saturated FA (SFA) in biscuits produced by four different Polish companies are given in Table 1; in all examined samples of cookies the SFA and monoenoic FA predominated. The levels of SFA ranged from about 32 to 60%, except for one type of biscuit (B-3) that contained only about 15% of SFA. The significantly (P<0.05) lower level of SFA in biscuit B-3 may be indicative of almost only vegetable oils being used. According to the report of Van Erp-Baart and co-workers (1998) on the *TRANSFAIR* project (1995–1996), Belgian, English, and Spanish cookies, offered for all consumers, contained a higher average proportion of SFA (83–90%) due, probably, to the use of coconut oil (39, 44 and 45% C12:0, respectively). Moreover, butter cookies in The Netherlands were typically real butter cookies, whereas the German butter cookies had other types of fat in addition to butter because the TFA content was low (1.6%). Similar contents of SFA like in this study were assayed in Italian, Greek, and French cookies (47.0–56.5% SFA) (Van Erp-baart et al., 1998), but in Turkish (Petit beurre) biscuits as well as in Brazilian cracker biscuits the content of SFA was lower, ranging 33.8–47.9% and 16.9–39.2%, respectively (Daglioglu et al., 2000; Martin et al., 2005). Lower contents of SFA (7.5–30%) characterized also Polish cookies offered for all consumers in 2000 year (Żegarska & Borejszo, 2001), as well as biscuits on Spanish market in 1995–1998 (25.2% SFA) (Fernandez San Juan, 2000). Regarding the data of cookies for children analysed in the present study, biscuits for children had higher content of SFA than Turkish cookies named "Baby" offered for children, SFA content in the latter ranging from 35.2 to 48.2% (Daglioglu et al., 2000).

Table 1. Content of SFA, MUFA and PUFA in the analysed biscuits (% of total FA)[a]

Product	SFA[d]	MUFA[e]	PUFA[f]	TFA[g]
A-1[b]	49.2±0.38a[c]	35.6±0.69a	11.6±0.29a	3.4±0.08a
A-2	60.0±0.66b	32.4±0.58b	6.7±0.086b	1.35±0.03b
A-3	32.1±0.56c	47.6±0.55c	19.2±0.051c	1.3±0.03b
B-1	49.9±1.03a	37.7±0.49d	11.9±0.11a	1.0±0.07c
B-2	58.1±0.58d	33.3±0.42b	7.1±0.089b,d	1.05±0.03c
B-3	14.8±0.27e	57.5±0.85e	26.8±0.61e	0.5±0.01d
C-1	36.0±0.77f	42.5±0.64f	19.8±0.52c	0.72±0.01e
C-2	35.6±0.67f	42.7±0.59f	19.8±0.49c	0.62±0.01d,e
C-3	40.8±0.38g	38.4±0.45d	17.4±0.36f	1.29±0.01b
D-1	58.1±0.68d	33.0±0.64b	5.8±0.12b	3.2±0.06f
D-2	42.1±0.41g	36.7±0.51d,a	8.1±0.14d	8.78±0.12g
D-3	34.3±0.64f	42.7±0.52f	17.0±0.38f	5.65±0.08h

[a] Values are expressed as means ±SD of 3 independent assays; [b] A, B, C, D: biscuits manufacturers; Arabic numerals at letter – different sorts of biscuits; [c] values denoted in columns with the same letters are not significantly different (P<0.05); [d] SFA: saturated fatty acids; [e] MUFA: monounsaturated fatty acids; [f] PUFA: polyunsaturated fatty acids; [g] TFA: trans fatty acids

In samples analysed in this study, palmitic C16:0 and stearic acids C18:0 were determined to be predominant saturated FA. Their amounts ranged from about 10 to 41% and from 3 to 22%, respectively. In cookies and biscuits offered on European market in 1995–1996

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(*TRANSFAIR* project) the content of stearic acid C18:0 was comparable and ranged from 4.0 to 18.4% (Van Erp-Baart et al., 1998). Spanish biscuits contained, on average, 25.2% of C16:0 and 12.0% C18:0 (Fernandez San Juan, 2000). In New Zealand, the content of palmitic acid C16:0 in biscuits was comparable to our data and ranged from 16.1 to 38.3% but the content of stearic acid C18:0 was much lower and amounted to 0–0.3% (Lake et al., 1996). In biscuits recommended for children (Daglioglu et al., 2000) the main SFAs were also palmitic C16:0 and stearic C18:0 acids, but their content did not vary as much as in this study and ranged 21.0–37.9% and 5.6–8.4%, respectively.

Our biscuits for children contained also short-chain FA C6:0–C10:0 which indicated the presence of milk fat. Caproic acid C6:0 (0.17%) was found only in three samples: B-2, D-1, and D-2 in significantly ($P<0.05$) different amounts (0.07–0.17%). Moreover, in 5 samples: B-1, B-2, C-3, D-1, and D-2, only caprylic acid C8:0 was detected (0.10–0.43%; Table 2), its content in Turkish biscuits offered for children being slightly higher (0.2–0.8%) (Daglioglu et al., 2000). Capric acid C10:0 was found in all samples in smaller amounts (0.05–0.40%) than in Spanish biscuits offered for all consumers (2.3%) (Fernandez San Juan, 2000) but comparable to those reported by Daglioglu and co-workers (2000) (0.2–0.7%).

However, a comparison with the available literature regarding the content of short-chain C6:0–C10:0 FA is difficult because milk fat is not as often used in biscuits as palm, rapeseed or coconut oils. For example, short-chain C6:0–C10:0 fatty acids were not detected in Brazilian biscuits (Martin et al., 2005) and in New Zealand biscuits and cakes (Lake et al., 1996).

Other atherogenic SFAs beside palmitic acid, are lauric C12:0 and myristic C14:0 acids (Gropper et al., 2009). In the biscuits for children, the content of lauric acid C12:0 ranged from 0.14 to 3.1% and was lower compared to Spanish biscuits (11.8%) and cookies investigated in the *TRANSFAIR* project, in which the content of lauric acid was really high (39–45%). Similarly variable but lower amount of C12:0 acid (0.3–6.0%) was found in Turkish biscuits for children (Daglioglu et al., 2000).

Myristic acid C14:0 content in our biscuits (0.57–2.2%) was higher than in New Zealand (0.1–1.0%), Brazilian (0.1–1.47%) or Turkish biscuits (0.6–1.0%) offered for all consumers (Lake et al., 1996; Martin et al., 2005) but similar to Turkish biscuits offered for children (0.9–2.9%) (Daglioglu et al., 2000).

The majority of unsaturated FA were MUFA. Other authors reported that the reduced level of PUFA (especially linolenic acid, C18:3) and an increased content of MUFA (e.g. mainly oleic acid, C18:1 9c) provided higher oil stability. That is why the resulting product could be used whenever food required high cooking or frying temperatures (Auld et al., 1992).

However, from the point of view of nutrition physiology, PUFA are the most important FA for the proper metabolism in humans. The lowest content of total MUFA (32.4%) was observed in sample A-2 which contained the highest amount of total SFA (60%). The highest content of MUFA (57.5%) was in the sample B-3 with the lowest level of SFA (14.8%). Significant differences ($P<0.05$) in MUFA contents are shown in Table 1. The major MUFA was oleic acid (C18:1 9c), its contents averaging 31.7–52.8%. Generally, cookies offered for all consumers, studied by other researchers, contained less oleic acid, e.g. 1.9–5.4% in New Zealand biscuits (Lake et al., 1996), 28% in Spanish biscuits (Fernandez San Juan, 2000) or 33.6–36.8% in Brazilian cracker biscuits (Martin et al., 2005). Also, biscuits offered for children in Turkey contained less oleic acid (23.5–36.1%) than Polish products for children (Daglioglu et al., 2000).

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Table 2. Fatty acid composition of studied biscuits [a]

Fatty acids (%)	Product					
	A-1 [b]	A-2	A-3	B-1	B-2	B-3
C6:0	ND[d]	ND	ND	ND	0.17±0.004	ND
C8:0	ND	ND	ND	0.20±0.005	0.39±0.007	ND
C10:0	0.17±0.005a[c]	0.38±0.008b	0.15±0.004c	0.40±0.008d	0.06±0.001e	0.11±0.002f
C12:0	0.35±0.008a	0.53±0.011 a,b	0.24±0.006 a,c	1.5±0.032e	0.55±0.01a	0.14±0.003 b,c,d
C14:0	1.5±0.035a	1.9±0.052b	1.9±0.049b	1.5±0.043a	1.8±0.047b	0.57±0.015c
C15:0	0.10±0.003a	0.18±0.004b	0.10±0.002a	0.10±0.002a	0.17±0.004c	0.09±0.002d
C16:0	41.2±0.58a	33.9±0.45b	20.8±0.54c	39.9±0.62a	40.0±0.52a	10.1±0.23d
C17:0	0.12±0.003	0.23±0.005	0.12±0.003	0.12±0.003	0.22±0.003	–
C18:0	5.4±0.061a	22.2±0.59b	8.3±0.097c	5.4±0.074a	20.1±0.47d	3.2±0.081e
C20:0	0.35±0.007a	0.75±0.017	0.48±0.012c	0.35±0.008a	0.69±0.014d	0.53±0.014e
C14:1c	ND	ND	ND	ND	0.14±0.004	ND
C16:1c	0.20±0.006a	0.37±0.007b	0.46±0.013c	0.20±0.004a	0.42±0.007c,d	0.69±0.011e
C18:1 9c	31.8±0.58a	31.3±0.67a	44.6±0.52b	36.1±0.41c	31.8±0.43a	52.8±0.85d
C18:1 11c	0.82±0.019a	0.55±0.014b	2.0±0.057c	1.0±0.021d	0.89±0.023a,d	3.1±0.079e
C18:1t all	2.6±0.071a	0.95±0.019b	0.80±0.014c	0.20±0.005d	0.81±0.017c	0.10±0.002d
C20:1c	0.12±0.003a	0.14±0.002a	0.59±0.013b	0.35±0.009c	0.09±0.002d	0.89±0.016e
C18:2 n6	11.3±0.31a	6.3±0.12b	14.9±0.28c	11.8±0.25a	6.7±0.14b	19.4±0.31d
C18:2tt	0.42±0.009a	0.20±0.004b	0.10±0.002c	0.40±0.009d	0.22±0.004e	0.20±0.005b
C18:2ct	0.40±0.008a	0.20±0.002b	0.10±0.002c	0.40±0.009a	0.10±0.002c	0.20±0.004b
C18:3 n3	0.35±0.005a	0.36±0.006a	4.3±0.071b	0.12±0.003c	0.33±0.005a,c	7.5±0.091d

Fatty acids (%)	Product					
	C-1	C-2	C-3	D-1	D-2	D-3
C6:0	ND	ND	ND	0.07±0.001	0.10±0.002	ND
C8:0	ND	ND	0.43±0.009	0.10±0.003	0.29±0.007	ND
C10:0	0.14±0.002c	0.14±0.003c	0.39±0.009g	0.20±0.005h	0.05±0.001e	0.12±0.002f
C12:0	0.31±0.005 a,d	0.31±0.005 a,d	3.1±0.073f	0.33±0.006 a,d	0.49±0.012a,d	0.17±0.003 b,d
C14:0	1.2±0.029d	1.2±0.024d	1.8±0.039b	1.3±0.031d	2.2±0.043e	0.79±0.021f
C15:0	0.08±0.001e	ND	0.10±0.002a	0.22±0.004f	0.25±0.005g	ND
C16:0	30.1±0.41e	30.1±0.52e	27.8±0.43f	33.0±0.59b,g	32.0±0.61g	28.8±0.57e,f
C17:0	0.27±0.006	ND	ND	0.20±0.006	ND	0.28±0.0051
C18:0	3.2±0.079e	3.2±0.085e	6.0±0.15f	21.9±0.58b	5.8±0.13a,f	3.3±0.069e
C20:0	0.63±0.011f	0.63±0.014f	1.1±0.029g	0.74±0.022b	0.94±0.027h	0.79±0.019i
C14:1c	ND	ND	ND	ND	ND	ND
C16:1c	ND	0.27±0.005f	2.4±0.046g	0.33±0.005b	0.42±0.006d	ND
C18:1 9c	40.0±0.85e	40.0±0.71e	34.0±0.53f	31.7±0.57a	34.1±0.62f	39.5±0.81e
C18:1 11c	2.0±0.039c	2.0±0.045c	1.6±0.031f	0.83±0.018a	1.8±0.042g	2.5±0.059h
C18:1t	0.20±0.005d	0.10±0.002d	0.89±0.004b	2.8± 0.041e	8.2±0.11f	5.2±0.087g
C20:1c	0.55±0.012f	0.55±0.015f	0.40±0.007g	0.13±0.003a	0.38±0.009c	0.72±0.013h
C18:2tt	0.27±0.005f	0.27±0.005f	0.20±0.004b	0.18±0.004g	0.21±0.004 b,e	0.22±0.005e
C18:2ct	0.25±0,004d	0.25±0.005d	0.20±0.005b	0.18±0.005e	0.37±0.009f	0.21±0.005g
C18:3 n3	3.4±0.046e	3.4±0.057e	0.91±0.021f	0.35±0.008a	0.63±0.014g	4.1±0.089b

[a] Results expressed as percentage of total fatty acid methyl esters. Values are expressed as means ±SD of 3 independent assays; [b] A, B, C, D: biscuits manufacturers; arabic numerals at letter – different sorts of biscuits;

[c] values denoted in columns with the same letters are not significantly different ($P<0.05$); [d] ND: not detected

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The total cis-PUFA content in biscuits for children ranged from about 5.8% to 26.8% and in 8 out of 12 analysed samples exceeded 10%. That content was higher than in New Zealand (3.0–11.0%) (Lake et al., 1996), Spanish (8.9% on average) (Fernandez San Juan, 2000) or Polish biscuits (4.6–10.8%) (Paszczyk et al., 2007) offered for all consumers, but similar to the high and diverse content of PUFA in Brazilian biscuits (9.74–33.6%) (Martin et al., 2005). Because essential fatty acids (EFA) are included in this group, the PUFA content is very important for the biological and nutritional value of biscuits. EFA in cookies were represented by linoleic (C18:2 9c 12c) and α-linolenic (C18:2 9c 12c 15c) acids. The content of linoleic acid ranged from 5.4 to 19.4% and was significantly higher in samples A-3 and B-3 ($P<0.05$) and comparable to samples C-1, C-2, and C-3. The content of α-linolenic acid (C18:3 9c 12c 15c) ranged from 0.12 to 7.5%; that acid, belonging to the omega-3 family, markedly increases the nutritional value of fats. However, the three unsaturated double bonds being unstable restrict its application in bakery fats.

All examined biscuits contained TFA (Fig. 2), its total content ranging from 0.5 to 8.8%. The highest levels of TFA were found in samples D-1, D-2, D-3, and A-1. Other biscuits had lower contents of TFA (0.5–1.4%). Pfalzgraf and co-workers (1994) reported that TFA contents in German cakes ranged from 0 to 15.5% and Daglioglu and co-workers (2000) reported for Turkish biscuits (offered for all consumers and also for children) TFA ranging 1.0–30.5%. Van Erp-baart and co-workers (1998) reported the lowest TFA content in cookies/biscuits from Italy and Spain and highest in those from Norway and Iceland. Ratnayake and co-workers (1993) found the total TFA contents up to about 39% in Canadian bakery products. According to Lake and co-workers (1996), the levels of TFA in New Zealand sweet biscuits (1.9%) were relatively low compared to U.S. and Canadian products. They stated that the “hard” baking margarines with high levels of hydrogenated fats found in North America were not extensively used in processed foods in New Zealand. Moreover, the levels of TFA in New Zealand foods are similar to those reported for Australian products. For this reason, the intake of TFA in New Zealand probably resembles the estimates for Australia (Noakes & Nestel, 1994). Also, high level of TFA was assayed in Brazilian crackers (up to 31%) (Martin et al., 2005).

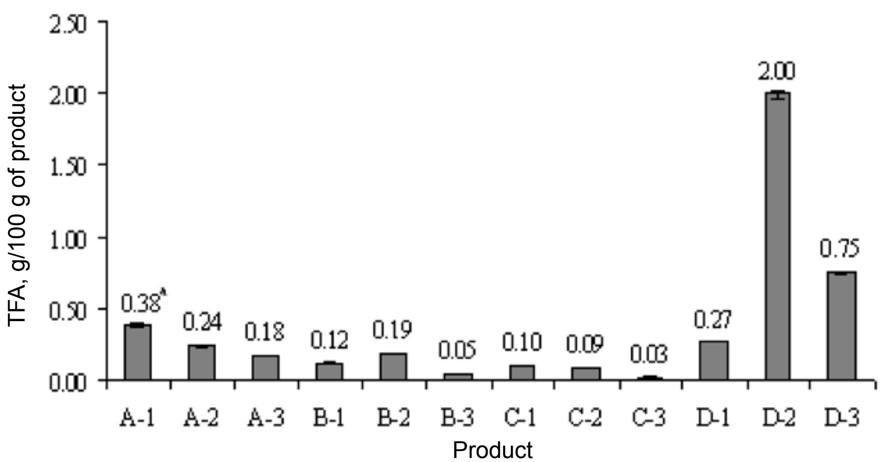

Fig. 2. Content of total trans fatty acids (g/100 g of product) in the studied biscuits. [a] Values are expressed as means ±SD of 3 independent assays

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Partially hydrogenated vegetable oils are the main source of TFA in the diet. They contain a reduced bond angle compared to the cis-isomers, which causes higher melting points. The major trans-isomers found in partially hydrogenated vegetable oils and ruminant fats are the trans C18:1 monoenoic FA, while PUFA are found only in trace amounts (Sanders, 1988).

The trans C18:1 content of the examined biscuits for children varied from 0.1 to 8.2% of the total FA. Similar data were reported by Żegarska and Borejszo (2001) who found the trans C18:1 content in the majority of cakes to range from about 1.5 to 8.3%. The results for trans C18:1 in Turkish biscuits (0.7 to 29.1%) are considerably higher than those in this study, the trans C18:1 being the predominant trans-isomer found in all Turkish biscuits types (Daglioglu et al., 2000). Enig and co-workers (1983) reported the trans C18:1 content in the American cakes to amount to up to about 21%. Also, for Brazilian crackers and Spanish biscuits high contents of trans C 18:1 (8.8–28.3%) (Martin et al., 2005) and 28.0% (Fernandez San Juan, 2000), respectively, were reported.

The fat of the examined biscuits contained also cis-trans C18:2 isomer (0.1–0.4%) and trans-trans C18:2 in the same range. The trans C18:2 isomers determined by Daglioglu and co-workers (2000) in all samples of Turkish biscuits ranged from 0.3 to 3.1%. Previous studies showed that trans-trans C18:2 isomers had markedly adverse effects on human health due to inhibition of the Δ6 desaturase, thus interfering with the biosynthesis of long chain PUFA (Precht & Molkentin, 1995). For that reason, Canada imposed the regulation that TFA content in margarines must be kept below 1% of the total FA (Ratnayake & Pelletier, 1992).

Data presented here show the levels of TFA in studied biscuits offered for children to be relatively low compared to those in products from other countries. According to the regulatory approach (Danish Veterinary and Food Administration, 2003), the levels of TFA in examined samples did not exceed the limit of 2 g/100 g of product (Fig. 2). Furthermore, these contents of TFA are consistent with the European Union Food Law.

3. Conclusions

Nine out of 12 brands of biscuits for children contained less than 15 g fat /100 g of product, which is satisfactory, considering problems with overweight in children. The GC analysis showed a quite high variability of the FA composition which was caused by the diversity of fat sources. Generally, SFA and MUFA dominated in the biscuits. High contents of palmitic and oleic acids may suggest the use of palm oils in shortening manufacture. In 5 brands of biscuits, also coconut or milk fat were probably used as suggested by the presence of short-chain SFA. In 5 analysed samples the PUFA content of approximately 20% and significant presence of α-linolenic acid simultaneously, suggested the addition of rapeseed oil. The contents of trans-isomers in the examined biscuits were relatively low: 0.03–2.0 g/100 g of product, and were lower compared to those in cookies and biscuits offered for all consumers in other countries.

Taking into account the fact that the intake of TFA negatively affects health and development of children, the manufactures of these products further ought to reduce the TFA content in food, having in mind that such products are offered also for children. That recommendation may be feasible with the advances in food technology. An improvement of fat hydrogenation process by modifying temperature, pressure, time, and raw materials,

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might decrease the content of undesirable trans-fatty acids in food products. Furthermore, in order to decrease the TFA intake, the information required for nutritional labelling of foods ought to include TFA content; that recommendation is currently being implemented in the United States and Europe.

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