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Fatty Acid Composition of Butter Originated from North-Eastern Region of Poland

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The study investigated the fatty acid composition (fatty acids, FA) of 19 samples of butter originating from the north–eastern region of Poland throughout the year. The annual variability was observed in the FA composition of butter. A higher content of short and medium chain saturated FA (SCFA) was determined in the samples from the winter season (12.6–13.4%) and lower one in the summer samples (11.2–12.1%). The major FA of the saturated long chain acids (LCFA) of butter were: palmitic C16:0: (25.7–34.6%) and myristic C14:0: (9.7–11.9%), their higher contents were found in the samples from the winter and early-spring production. Butters produced in the summer period were characterised by a higher content of oleic acid C18:1 9c (20.6–23.1%) belonging to monounsaturated FA (MUFA) as compared to the samples produced in the winter and spring (18.3–21.4%). Contents of FA belonging to polyunsaturated fatty acids (PUFA) were: 1.0–1.5% for linoleic C18:2 9c 12c (LA) and linolenic acids C18:3 9c 12c 15c (ALA), which were subjected to seasonal variation in the range of 0.1–1.0%. The content of predominant *trans* isomer in ruminant fats, *i.e.* vaccenic acid C18: 1 11t (VA), resulting from "biohydrogentaion" of the PUFA (LA and ALA) in the rumen, has been strictly connected with the season of production: a higher content of VA was determined in butter samples from the summer and autumn (1.9–3.8%) and lower one in the samples produced in the winter and spring (0.8–1.3%). Similarly, seasonal variation was also observed in the content of conjugated linoleic acid C18: 2 9c11t (CLA). Its significant content – 580 mg CLA /100g of product on average – was determined in butter samples produced in the summer and autumn season in the north-eastern region of Poland.

INTRODUCTION

Butter is a traditional product obtained exclusively form cow milk as a result of the so-called "cream churning". Owing to lipids composition it is classified as a complexed fat. Apart from triacylglycerols it contains phospholipids, tocopherols and carotenoids [Jensen, 2002]. Butter is characterised by an extraordinarily rich fatty acids composition. The study of Jensen *et al.* [1991] reported the presence of over 400 various fatty acids with a diversified number of carbon atoms, *i.e.* from 4 to 26. Some of them are characterised by specific biological and nutritional properties, important from the human health point of view, such as *e.g.* butyric acid C4:0 or conjugated dienes of linoleic acid – CLA. It is worth emphasising that milk fat belongs to scarce dietary sources of butyric acid, a potential inhibitor of cancer cells proliferation [Watkins *et al.,* 1999]. Likewise, next to meat of ruminant animals, butter is a product with a substantial content of CLA and vaccenic acid C18:1 11t, both exhibiting documented biological activity [Pariza, 2004; Wahle *et al.,* 2004; Field *et al.,* 2009]. For these reasons it is essential to explore the composition of butter, being a potential source of health-promoting fatty acids.

Milk fat composition shows variability due to genetic, physiological and environmental factors. The environmental factors are associated with varying climatic conditions, seasonal changes of feed quality and its availability, as well as biological calendar [Jaworski & Kuncewicz, 2008].

Owing to nutritional needs of milk cattle (ruminants), whose basic feed is all mash diet, the region of production is one of the most important factors determining the composition of milk [Ledoux *et al.,* 2005]. The region of north–eastern Poland is commonly called "Green Lungs of Poland". It is characterised by vast areas of grasslands and a lower level of industrialisation in comparison to the other regions of Poland.

The aim of this study was to investigate fatty acids composition (FA), including conjugated dienes of linoleic acid (CLA), of 19 butter samples (in an annual cycle) originating from the north–eastern Poland.

MATERIAL AND METHODS

The experimental material consisted of 19 samples of butter from the provinces of the north–eastern Poland: Mazovia, Podlachia, Lublin, Pomerania, Warmia and Masuria. The samples were collected in the years 2008–2009 and their characteristics (geographical origin) was depicted in Table 1. The extraction and determination of fat content of butter samples was performed using the Rose-Gottlieb

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method according to AOAC No. 905.02 [AOAC, 2000]. The analyses were conducted in triplicate.

Methyl esters of fatty acids (FAME) were prepared by transmethylation of fat samples using a mixture of concentrated H_2SO_4 (95%) and methanol according to AOCS Official Method Ce 2–66 [AOCS, 2000]. Fatty acids composition was determined by gas chromatography (GC) according to the Polish Standard [PN-EN ISO 5508], using an Agilent 6890N chromatograph with split/splitless injector, FID detector, Rtx 2330 Restek capillary column with a stationary phase of high polarity: 100 m in length, 0.25 mm in diameter, with film thickness of 0.1 μm, at column temperature: initial 120°C, final 210°C, and time of analysis: 120 min.

The standard of milk fat CRM 164 (Community Bureau of Reference, EU, Brussels, Belgium) and Supelco 37 No:47885-U standard (Sigma Aldrich) were applied for fatty acids identification. The results were expressed as percentage of the sum of resolved methyl esters. The CLA content was calculated using the internal standard method with docosanoic acid C22:0 as an internal standard. The CLA content in mg/g of fat was calculated according to the formula proposed by Prandini *et al.* [2007]. Then, the CLA values were calculated per 100 g of product.

The statistical analysis was conducted in order to verify the significance of differences in contents of individual fatty acids in butter samples from different production periods using one-way analysis of variance (ANOVA) and Tukey's test. The calculations were performed at a significance level of $p<0.05$ with Statistica 9 PL software (StatSoft, Inc. 2010).

RESULTS AND DISCUSSION

Fat content of butter samples ranged from 82.03 to 83.10% (Table 1). The samples analysed were characterised by fat content typical of Extra butter according to the Polish Standard PN-A-86155. A typical GC chromatogram of butter and identification of FA as FAME is depicted in Figure 1. The FA composition of all 19 analysed samples in the annual cycle was presented in Table 2. Table 3 reports seasonal changes of FA composition of the butter samples.

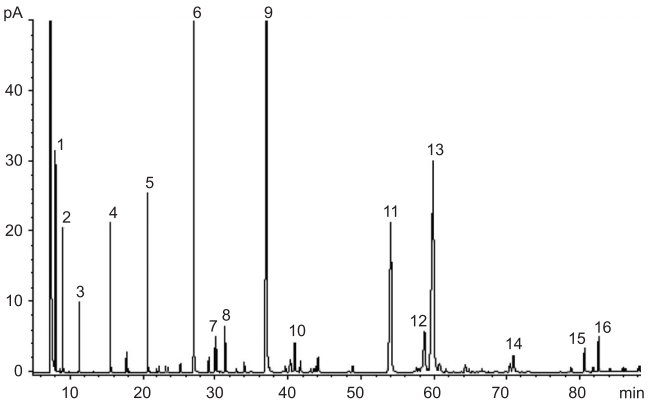

FIGURE 1. Separation of fatty acids of butter from the summer production period (sample 8 – Grajewo, Podlaskie) by GC. Capilary Column RTx 23330 (Restek Corp., USA) "split/splitless" injection: sample 1.40% in hexane in 1 μL, column temperature: initial temp. 155°C, time 45 min, next gradient at the rate 1.5°C/min, final temp. 210°C, time 50 min; hydrogen flow rate constant, 0.8 mL/min. Identification: 1. C4:0–2.5%; 2. C6:0–2.2%; 3. C8:0–1.3%; 4. C10:0–2.8%; 5. C12:0–3.2%; 6. C14:0––10.7%; 7. C14:1–1.0%; 8. C15:0–1.2%; 9. C16:0–28.3%; 10. C16:1––1.5%; 11. C18:0–11.8%; 12. C18:1 11t-2.8%; 13. C18:1 9c-22.1%; 14. C18:2 9c12c-1.2%; 15. C18:3 9c12c15c-0.7%; 16. C18:2 9c11t-0.8%.

Short- and medium-chain saturated fatty acids (SCFA) represented by C4:0 to C12:0 acids are valuable constituents of milk fat, since in a human body they are entirely utilised as an energy source and thus do not cause obesity. Antifungal, antibacterial and antiatherosclerotic properties are attributed to those fatty acids as well [Przybojewska & Rafalski, 2003; Watkins *et al.,* 1999]. In the samples analysed there were identified five acids belonging to SCFA: C4:0 – butyric, C6:0 – caproic, C8:0 – caprylic, C10:0 – capric, and C12:0 – lauric acid (Figure 1). The statistically significant differences ($p<0.05$) were noted between the total content of SCFA in butter samples depending on the production season (Table 3). Higher contents of SCFA

TABLE 1. Characteristics of butter samples.

Sample No.	Date of production	Province	Fat (%)	S.D.
1	03.03.2009	Starogard Gdański[1] Pomorskie[2]	82.10	0.28
2	17.03.2008	Wolanów[1] Mazowieckie[2]	82.05	0.21
3	27.04.2009	Ostrołęka[1] Mazowieckie[2]	82.07	0.18
4	30.05.2008	Ciechanów[1] Mazowieckie[2]	82.03	0.16
5	15.06.2009	Wysokie Mazowieckie[1] Mazowieckie[2]	82.12	0.14
6	28.06.2008	Ciechanów[1] Mazowieckie[2]	82.06	0.21
7	11.07.2008	Ciechanów[1] Mazowieckie[2]	82.10	0.16
8	15.07.2009	Grajewo[1] Podlaskie[2]	83.10	0.28
9	27.07.2009	Grajewo[1] Podlaskie[2]	83.08	0.11
10	05.09.2008	Olecko[1] Warmińsko-mazurskie[2]	82.15	0.22
11	08.09.2008	Radzyń Podlaski[1] Lubelskie[2]	82.12	0.20
12	09.09.2009	Sokółka[1] Podlaskie[2]	82.15	0.14
13	02.10.2008	Radzyń Podlaski[1] Lubelskie[2]	82.10	0.28
14	18.10.2009	Nowy Dwór Gdański[1] Pomorskie[2]	82.08	0.17
15	20.11.2009	Ciechanów[1] Mazowieckie[2]	82.06	0.14
16	07.01.2009	Bielsk Podlaski[1] Podlaskie[2]	82.05	0.16
17	03.02.2008	Kosów Lacki[1] Mazowieckie[2]	82.04	0.11
18	24.02.2009	Ciechanów[1] Mazowieckie[2]	82.04	0.18
19	27.02.2008	Wysokie Mazowieckie[1] Mazowieckie[2]	82.08	0.17

[1] place (city) of production, [2] province in Poland.

(12.6–13.4%) were determined in the winter samples and those originating from early spring (March). The summer samples and the ones produced in September were characterised by lower contents of SCFA, *i.e.* 9.6–12.1% (Table 2). Similarly, the higher contents of SCFA in winter samples were found by Ledoux *et al.* [2005].

A significant variation in SCFA contents in the annual cycle was particularly evident in the case of lauric acid C12:0, whose content ranged from 2.5% in the autumn samples to 3.8% in the winter samples. The samples from the winter season were characterised by higher contents of butyric acid (2.7–2.9%), however the differences were not statistically significant ($p<0.05$) in comparison to those noted for the other three seasons (Table 3). A similar tendency was found by Lindmark-Mansson *et al.* [2003], who noted the lowest content of C12:0 fatty acid in autumn (September) – 3.6%, and a higher one – 4.0% in the winter samples (December). It could be noticed that the seasonal variations were the same as those in the present study, however, the values assayed were higher.

A characteristic feature of animal fat, including milk fat, is a considerable content of long chain saturated fatty acids (LCFA). In this study the following LCFA were identified: C14:0 – myristic; C15:0 – pentadecanoic; C16:0 – palmitic, and C18:0 – stearic acid (Figure 1). Likewise in previous studies [Ledoux *et al*., 2005], higher contents of LCFA were found in the samples from winter and spring months. It must be underlined that significantly higher ($p<0.05$) contents of LCFA were characteristic of the samples from the winter production season (Table 3). It applied to both individual FA and total LCFA contents. Due to the increasing phenomenon of milk fat adulteration with admixtures of fat of plant origin, the knowledge of FA composition of milk fat, including contents of FA being typical of this fat, is of the outmost significance these days. The content of myristic acid – C14:0 may serve as an indicator of the "originality" of milk fat composition [Stołyhwo & Rutkowska, 2007]. In the analysed samples, the content of C14:0 acid ranged from 9.7 to 12.0%. Its lower content was found in the summer samples and these from the season of early autumn (September). Similar trends were observed in the content of palmitic acid C16:0, which was observed to diminish from 34.6% to 33.4% in the winter samples and from 30.8% to 28.3% in the summer samples (Table 2). The knowledge of the contents of the above-mentioned acids belonging to LCFA is also important from the technological perspective, for they determine traits associated with consistency [Jensen, 2002].

TABLE 2. Fatty acids composition expressed as % of total fatty acids in butter samples, given as means.

Fatty acids	Sample no.																		
	Spring				Summer					Autumn						Winter			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Short- and middle-chain saturated																			
C4:0 butyric	2.8	2.5	2.6	2.2	2.9	2.4	2.4	2.5	2.9	2.6	2.4	2.4	2.2	2.4	2.5	2.8	2.7	2.7	2.9
C6:0 caproic	2.2	2.0	2.0	1.9	2.1	1.9	2.0	2.2	2.1	1.9	1.9	1.6	1.7	1.8	1.9	2.2	2.0	2.2	2.3
C8:0 caprylic	1.4	1.3	1.2	1.3	1.3	1.2	1.3	1.3	1.3	1.2	1.1	1.0	1.1	1.1	1.2	1.4	1.3	1.4	1.4
C10:0 capric	3.1	3.0	2.8	2.9	2.7	2.6	2.9	2.8	2.7	2.5	2.4	2.1	2.5	2.5	2.9	3.1	3.0	3.3	3.1
C12:0 lauric	3.6	3.6	3.5	3.6	3.1	3.1	3.4	3.2	3.1	2.9	2.9	2.5	3.1	3.0	3.7	3.6	3.6	3.8	3.6
∑ SCFA	13.1	12.4	12.1	11.9	12.1	11.2	12.0	12.0	12.1	11.1	10.7	9.6	10.6	10.8	12.2	13.1	12.6	13.4	13.3
Long-chain saturated																			
C14:0 myristic	11.6	11.8	11.5	11.2	10.5	10.6	11.4	10.7	10.5	10.1	10.5	9.7	10.6	10.3	12.0	11.9	11.9	11.9	11.8
C15:0 pentadecanoic	1.2	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.3	1.2	1.1	1.3	1.2
C16:0 palmitic	34.5	34.2	32.0	30.4	28.7	29.8	30.8	28.3	28.9	25.7	31.2	27.4	30.5	29.1	34.5	34.3	33.8	33.4	34.6
C18:0 stearic	8.4	9.0	9.5	10.3	11.5	10.7	9.9	11.8	11.7	12.1	10.2	11.4	10.6	10.4	8.6	9.3	9.7	8.6	8.9
∑ LCFA	55.7	56.3	54.2	53.1	51.8	52.4	53.3	51.9	52.3	49.2	53.0	49.6	52.8	51.0	56.3	56.3	56.4	55.2	56.6
Monounsaturated																			
C14:1 tetradecenoic	1.1	1.2	1.2	1.0	1.0	1.0	1.1	1.0	1.2	1.0	1.1	0.9	1.1	1.1	1.3	1.3	1.1	1.2	1.2
C16:1 palmitoleic	1.7	1.7	1.6	1.6	1.5	1.6	1.6	1.5	1.5	1.2	1.7	1.3	1.7	1.6	1.9	1.7	1.6	1.8	1.7
∑ *trans* isomers of C18:1	1.7	1.6	1.7	2.7	2.9	3.1	2.3	3.3	2.8	4.5	2.5	5.1	2.7	3.4	1.9	1.7	1.7	1.6	1.6
C18:1 11t vaccenic	1.0	1.1	1.2	2.1	2.6	2.4	2.5	2.8	2.5	3.8	1.9	3.2	1.9	2.8	1.3	1.2	1.0	1.1	0.8
C18:1 9c oleic	18.4	18.9	20.0	21.4	23.1	22.1	20.6	22.1	22.6	21.8	22.1	24.2	22.1	21.9	18.5	18.9	19.2	18.5	18.3
∑ MUFA	23.9	24.5	24.1	28.8	31.1	30.2	28.1	30.7	30.6	32.3	29.3	34.7	29.5	30.8	24.9	24.8	24.6	24.2	23.6
Polyunsaturated																			
C18:2 9c12c linoleic	1.4	1.2	1.3	1.2	1.4	1.5	1.1	1.2	1.5	1.1	1.3	1.5	1.3	1.3	1.1	1.0	1.2	1.3	1.1
C18:3 9c12c15c linolenic	0.1	0.3	0.4	0.5	0.5	0.6	0.5	0.7	0.6	1.0	0.5	0.8	0.5	0.6	0.4	0.4	0.4	0.4	0.3
C18:2 9c11t CLA	0.3	0.3	0.4	0.6	0.8	0.7	0.5	0.8	0.8	1.3	0.7	1.0	0.8	0.7	0.3	0.3	0.3	0.3	0.3
∑ PUFA	1.8	1.8	2.1	2.3	2.7	2.8	2.1	2.7	2.9	3.4	2.5	3.3	2.6	2.6	1.8	1.7	1.9	2.0	1.8

TABLE 3. Seasonal variations of the fatty acid composition of butter (%) given as mean±S.D.

Fatty Acids	Season				Differences
	Spring n=4	Summer n=5	Autumn n=6	Winter n=4	
Short- and middle-chain saturated					
C4:0 butyric	2.53±0.217	2.620.259	2.42±0.133	2.78±0.083	ns
C6:0 caproic	2.03^{ab}±0.109	2.06^{a}±0.114	1.80^{b}±0.126	2.18^{a}±0.109	*
C8:0 caprylic	1.30^{a}±0.071	1.28^{a}±0.045	1.12^{b}±0.075	1.38^{a}±0.043	*
C10:0 capric	2.95^{ac}±0.112	2.74^{ab}±0.114	2.48^{b}±0.256	3.13^{ac}±0.109	*
C12:0 lauric	3.58^{a}±0.043	3.18^{ab}±0.130	3.02^{b}±0.392	3.65^{ac}±0.087	*
Σ SCFA	12.38^{ac}±0.455	11.88^{ab}±0.383	10.83^{b}±0.841	13.10^{c}±0.308	*
Long-chain saturated					
C14:0 myristic	11.53^{ab}±0.217	10.74^{a}±0.378	10.53^{a}±0.787	11.88^{b}±0.043	*
C15:0 pentadecanoic	1.23±0.043	1.22±0.045	1.18±0.075	1.20±0.071	ns
C16:0 palmitic	32.78^{ab}±1.677	29.30^{a}±1.002	29.73^{a}±3.085	34.03^{b}±0.460	*
C18:0 stearic	9.30^{ab}±0.696	11.12^{a}±0.807	10.55^{ab}±1.190	9.13^{b}±0.415	*
Σ LCFA	54.83^{ab}±1.256	52.34^{a}±0.594	51.98^{a}±2.635	56.13^{b}±0.545	*
Monounsaturated					
C14:1 tetradecenoic	1.13±0.083	1.06±0.089	1.08±0.133	1.20±0.071	ns
C16:1 palmitoleic	1.65±0.050	1.54±0.055	1.57±0.266	1.70±0.071	ns
Σ trans isomers of C18:1	1.93^{ab}±0.449	2.88^{ab}±0.377	3.35^{a}±1.236	1.65^{b}±0.050	*
C18:1 11t vaccenic	1.35^{ab}±0.439	2.56^{a}±0.152	2.48^{a}±0.941	1.03^{b}±0.148	*
C18:1 9c oleic	19.68^{ab}±1.152	22.10^{a}±0.935	21.77^{a}±1.835	18.73^{b}±0.349	*
Σ MUFA	25.33^{a}±2.018	30.14^{b}±1.184	30.25^{b}±3.298	24.30^{a}±0.458	*
Polyunsaturated					
C18:2 9c12c linoleic	1.28±0.083	1.34±0.182	1.27±0.151	1.15±0.112	ns
C18:3 9c12c15c linolenic	0.33^{a}±0.148	0.58^{ab}±0.084	0.63^{b}±0.225	0.38^{ab}±0.043	*
C18:2 9c11t CLA	0.40^{ab}±0.122	0.72^{ab}±0.130	0.80^{a}±0.335	0.30^{b}±0.000	*
Σ PUFA	2.00^{ab}±0.212	2.64^{ab}±0.313	2.70^{a}±0.587	1.85^{b}±0.112	*

S.D. - standard deviation. ns - not significant, * - significant differences between season of production (ANOVA with Tukey's post-hoc test): $p<0.05$. Values denoted in lines with the same letters are not statistically different at $p<0.05$.

Unlike changes, as compared to the above mentioned two acids, were observed in the content of stearic acid C18:0, being the final product of biohydrogenation of unsaturated FA in the rumen of ruminants [Collomb *et al.,* 2006]. Its higher content ranging from 9.9% to 12.1% was found in butter samples originating from the summer and early autumn production (July-September). In turn, in the samples from winter and spring periods its contents were lower and amounted to 8.4–10.3% (Table 2). With reference to literature data it can be noticed that similarly higher contents of this fatty acid in summer butter samples (German and French) were determined by Wolff [1995] and Ledoux *et al.* [2005]. On the other hand, Lock & Garnsworthy [2003] noted the highest content in autumn months, and the lowest content of C18:0 acid in summer milk samples originating from Holstein-Friesian cows (United Kingdom). These discrepancies in the content of stearic acid could have been affected by the climatic differences and the resultant vegetative season of plants in the countries of the continent (Poland, Germany and France), and the island ones (the United Kingdom).

Monounsaturated fatty acids (MUFA) were represented by the following acids: C14:1 – tetradecenoic, C16:1 – palmitoleic, C18:1 9c – oleic and C18:1 11t – vaccenic (Figure 1). The statistical analysis revealed significant differences ($p<0.05$) in the total fatty acids content of MUFA group in the annual cycle between two seasons: summer-autumn and winter-spring (Table 3). A higher content of oleic acid C18:1 9c was found in the samples from summer and autumn production (18.5–24.2%), and lower one in these from winter and spring periods (18.3–21.4%) (Table 2). Similarly, a higher content of C18:1 9c acid was noted in summer samples of butter investigated by Ledoux *et al.* [2005] as well as in sour cream samples (June–September) analysed by Żegarska *et al.* [2006]. It is also worthy of notice that the higher content of this acid was observed during periods in which dairy cattle could graze on pastures. It is known that pasture grazing is the main source of monounsaturated FA in milk fat [Jensen, 2002; Kelly *et al.,* 1998], hence their increased content in the above-mentioned periods.

Among MUFA, worthy of special emphasis is vaccenic acid C18:1 11t (VA) due to its antiatherogenic properties as well capability to inhibit cancer cells proliferation in colon and other organs [Field *et al*., 2009]. The content of VA in butter samples was similar in the summer and autumn season of production, whereas significantly different

($p<0.05$) in the winter period (Table 3). The content of VA in the analysed samples ranged from 0.8 to 1.2% in the winter season and from 1.3 to 3.8% in the samples from summer and autumn period (Table 2). The similarly higher content of VA during summer and autumn periods and much lower during the winter period were noted in sour cream samples by Żegarska *et. al.* [2006] and in milk fat samples from Holstein- Friesian cows in the United Kingdom by Lock & Garnsworthy [2003]. When analysing samples of French butter, Ledoux *et al.* [2005] demonstrated the total content of *trans* isomers C18:1 4t-12t to range from 1.7% (winter samples) to 2.5% (summer samples), which was less than in the Polish samples from the same periods (1.6–3.3%). Interestingly, two samples from the autumn period were found to contain as much as 4.5 and 5.1% of total C18:1 *trans* isomers. Among 19 butter samples analysed in our study, the highest content of VA was noted in two samples originating from Warmia and Masuria province (Olecko) – 3.8% and Podlachia province (Sokółka) – 3.2% (Table 2). It can be assumed that such a high content of VA was associated with better access of cattle to "green feed" in those regions. Analysing the results obtained for VA contents of butter samples in the annual cycle, an increase was observed in this acid content during late spring transition period (samples 4 and 5). Most likely this phenomenon is due to an increased content of unsaturated fatty acids: linoleic and linolenic acids, being substrates for VA synthesis, that are provided through pasture grazing of dairy cattle in that period [Ferlay *et al.,* 2006; Nałęcz-Tarwacka & Grodzki, 2005]. Similar results confirming the intensity of biohydrogenation of unsaturated FA during the so-called transition period (May) were also obtained by Nałęcz-Tarwacka & Grodzki [2005], who determined FA composition of milk fat of Holstein-Friesian cows and observed an increased content of VA along with pasture feeding.

Polyunsaturated fatty acids (PUFA) of milk fat were represented by linoleic acid C18:2 9c12c and linolenic acid C18:3 9c12c15c belonging to the *n*-6 and *n*-3 families, respectively. The content of linoleic acid C18:2 9c12c ranged from 1.0% to 1.5% and was not subject to any statistically significant ($p<0.05$) seasonal variations. This is likely to be due to various feeding systems of cows bred in the studied region. In 7 samples originating from the summer and autumn production an increased content of C18:2 9c12c acid (1.3–1.5%) was observed, which confirms findings of Nałęcz-Tarwacka & Grodzki [2005], who revealed that the increased share of pasture grazing can increase the content of C18:2 9c12c and total PUFA in milk fat. However, it should also be taken into consideration that the composition of all mash feed is a very effective factor increasing the content of PUFA in milk. This phenomenon was confirmed in earlier studies by White *et al.* [2001], who demonstrated a higher content of linoleic acid in milk from cows fed in the stall (2.5%) than in the pasture system (1.8%).

The content of linolenic acid C18:3 9c12c15c in the analysed butter samples ranged from 0.1% to 1.0%. A considerably lower content of this acid was observed in the early spring and winter periods (0.1–0.4%), whereas during the summer and early autumn periods it was not lower than 0.5% (Table 2), and comparable to findings reported by Żegarska *et al.* [2006] for sour cream.

Conjugated dienes of linoleic acid (CLA) are a group of positional isomers and stereoisomers of linoleic acid C18:2 9c 12c containing in their molecules the arrangement of conjugated bonds, and the most promising component of milk fat. The interest in that group of compounds was initiated by a team of researchers led by Michael Pariza in 1979, who were first to find factors inhibiting mutagenesis in *Salmonella tiphimurium* bacteria in beef meat [Pariza *et al.,* 1979]. Further studies of the above-mentioned team as well as of other authors have demonstrated a number of health-promoting activities of CLA, *e.g.* as a factor inhibiting carcinogenesis process or displaying antiatherogenic properties [Mougios *et al.,* 2001; Pariza, 2004; Wahle *et al.,* 2004]. In milk fat its main representative is C18:2 9c11t isomer, constituting 75 to 90% of total CLA content [Wahle *et al.,* 2004]. The C18:2 9c11t isomer was also determined in the present study. Its content in the analysed butter samples varied depending on the season. The lowest contents of CLA (0.3–0.4%) were noted in the winter, early spring and November samples, when the animals had no access to green feed. Then, from May to October its content was observed to from 0.5 to 1.3% (Table 2). The statistical analysis confirmed differences ($p<0.05$) in CLA content between butter samples originating from the winter and autumn periods (Table 3). Similar trends in the CLA content in the annual cycle were observed by Żegarska *et al.* [2006] for sour cream samples, with the exception of the summer season when they reported a slightly higher mean CLA content, *i.e*. 1.40%. In the presented study a similar value (1.3%) was determined only in the sample originating from the Warmia-Masuria province (Olecko). Alike seasonal variability in CLA of milk fat was observed by Lock & Garnsworthy [2003], who determined a higher content of CLA (0.6–1.7%) than in the presented study. The reason of those differences is a much longer period of grazing in the United Kingdom than in Poland. The accurate calculation of CLA content by internal standard method and calculation per 100 g of product (Figure 2) enabled a comparison of the results obtained with the results of other published studies. The analysed butter samples from the north-eastern Poland region were characterised by the following CLA content per 100 g of product: winter and spring season – app. 245 mg (May – transition period 490 mg), summer season – 410–665 mg, and autumn season – 247–1068 mg (Figure 2). Comparing the results with reference data it should be pointed out that CLA content in butters from the winter and spring season was lower than that determined by Ledoux *et al.* [2005], who reported 340–790 mg CLA in butters originating from various regions of France. In turn, the CLA content in the summer and autumn samples was similar to that determined by Ledoux *et al.* [2005] in the summer season (440–910 mg). These observations were confirmed by the studies of Collomb & Bülher [2000], who revealed the content of CLA in milk fat from Switzerland (mountain country) to range from 700 to 1550 mg CLA/100 g of fat. The study of FA composition was conducted on 19 samples of butter. A sig-

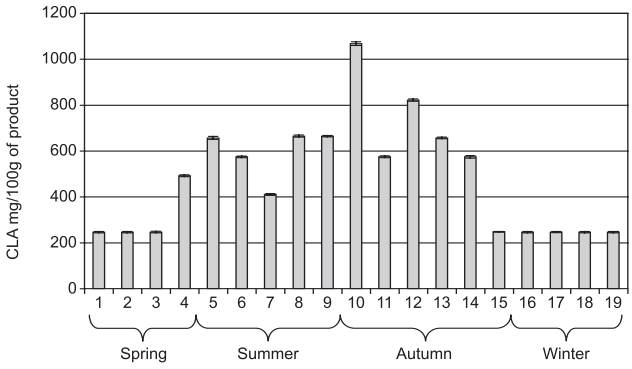

FIGURE 2. CLA content (mg/100 g of product) of butter samples.

nificantly higher number of samples from individual provinces of that region would enable differentiation of regional differences between them. The authors intend to conduct such analyses in the nearest future. However, it should be underlined that butter samples originating from the production periods of summer and autumn were characterised by a high CLA content – app. 580 mg/100 g of product.

CONCLUSIONS

Changes were noted in FA composition of butter from the north-eastern region of Poland in annual cycle, namely:

- butter samples originating from winter and early spring season were characterised by a higher content of saturated FA, both the SCFA as well as palmitic C16:0 and myristic C14:0 acids belonging to LCFA,
- butter samples from summer and autumn periods were characterised by: higher contents of stearic acid C18:0 and unsaturated fatty acids belonging to MUFA and PUFA, mainly by higher contents of FA typical of milk fat: vaccenic acid C18:1 11t and CLA C18:2 9c 11t.

The mean content of health-promoting CLA isomer – C18:2 9c11t in the analysed butter samples originating from the north--eastern region of Poland accounted for 246 in the winter samples and for 580 mg CLA /100 g of product in the autumn and summer samples.

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