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FATTY ACID PROFILE OF MILK FAT IN THE LOCAL DAIRY PRODUCTS FROM NORTH-EASTERN POLAND

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Key words: fatty acids, milk fat, local dairy products.

Abstract

The aim of this study was to determine the fatty acid profile of cheese and tvorog milk fat obtained from the local producers from the region of north-eastern Poland. The material consisted of tvorog and cheese samples made from cow, goat and sheep's milk. Methyl esters of fatty acids in milk fat was prepared with the use of IDF Standard 1999 and was performed by the gas chromatography method. Differences were found in the percentage share of each fatty acid group depending on the type of milk from which the cheese was produced. It may be concluded that local tvorog and cheese made from goat's, sheep's and cow's milk from north-eastern Poland may be a valuable source of short- and medium-chain fatty acids as well as CLA.

PROFIL KWASÓW TŁUSZCZOWYCH W TŁUSZCZU MLEKOWYM LOKALNYCH PRODUKTÓW MLECZARSKICH PÓŁNOCNO-WSCHODNIEJ POLSKI

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Słowa kluczowe: kwasy tłuszczowe, tłuszcz mlekowy, lokalne produkty mleczarskie.

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Abstrakt

Celem badań było określenie profilu kwasów tłuszczowych tłuszczu sera i twarogu uzyskanych od lokalnych producentów z regionu północno-wschodniej Polski. Materiał badawczy stanowiły próbki sera i twarogu wykonane z mleka krowiego, koziego i owczego. Estry metylowe kwasów tłuszczowych w tłuszczu mleka przygotowano z zastosowaniem metody IDF Standard 1999 oraz przeprowadzono metodą chromatografii gazowej. Stwierdzono różnice w procentowym udziale poszczególnych grup kwasów tłuszczowych w zależności od rodzaju mleka, z którego wytworzono ser. Można stwierdzić, że lokalne twarogi i sery z koziego, owczego i krowiego mleka z północno-wschodniej Polski mogą być cennym źródłem zarówno krótkich i średnich łańcuchów kwasów tłuszczowych, jak i CLA.

Introduction

Nowadays, consumers are searching for the products that offer them some unique sensory properties and nutritional quality, standing out from the products available on the market (RADZYMIŃSKA et al. 2008). Among such products one can count those made by the local producers of raw materials coming from the region. The notion "local" should be understood as an area located in a proximity to a target consumer and availability on a local market, which in turn creates a specific relation between a producer and a consumer. Consumers are being urged to support local farmers, sustain the regional food supply, and consume a healthier diet through the purchase of local foods directly from producers and the production of seasonally- and geographically-appropriate foods that have been grown and raised at home or in the local community garden. Indeed, the "turn to quality" discourse has become an integral component of local food consumption (WINTER 2003).

Quality control, and related to this evaluation of the authenticity of the products manufactured by the local producers, in this case, is particularly important. Important factors in determining the quality of local dairy products such as milk, butter and cheese are lipids and fatty acids. A unique characteristic of milk fat is the presence of the short chain fatty acids, which are a source of readily available energy. The most important are essential fatty acid (C18:2, C18:3), which serve a number of significant functions, including structural and bioregulation functions (PIETRZAK-FIEĆKO et al. 2007). Recently, intensive research has also been conducted on trans fatty acids and conjugated linoleic acids (CLA) in sheep and goats milk and milk products, because of the beneficial effects of CLA isomers on human health and the putative negative effects of trans isomers (SCINTU and PIREDDA 2007).

It is characteristic for the local dairy production to use the raw materials from a variety of animals including sheep and goat. However, goat's or sheep's milk and its products (including cottage and ripening cheese), despite their

popularity in the European countries, have just started to be recognized in Poland (DMYTRÓW et al. 2010).

Therefore, the objective of the study was to determine the fatty acid profile in cheese and tvorog milk fat obtained from the local producers and local raw materials from the region of north-eastern Poland.

Material and Methods

Selection of samples of local dairy products

The selection of samples of cottage and ripening cheese for analysis of fatty acid profile was performed in the first half of 2011 based on the database created by the Chair of Commodity Science and Food Analysis, University of Warmia and Mazury in Olsztyn. The database was created based on numerous individual interviews aimed at collecting information on local products made from goat's, cow's and sheep's milk currently manufactured in agrotourist farms and small and medium-sized local plants.

This database included basic information on manufacturers, general description of their products, origin of raw materials, sale points or details that might influence purchase of raw materials. The study included exclusively the products which were made of raw material of local origin. In the presented study, all dairy products were obtained in the same season and, therefore, seasonal variations were not expected.

Samples

The research material consisted 11 samples of tvorog (7 samples of tvorog from cow's milk and 4 from goat's milk) and 14 samples of cheese made from cow goat and sheep's milk (8 samples cheese made from cow milk, 4 from goat milk and 2 from sheep milk).

Analytical conditions

Fat from tvorog and cheese were separated by the Schmid-Bądzyński--Ratzlaff method, following a description provided by PRZYSŁAWSKI (2009). The method is based on the release of fat from proteins using hydrochloric acid, followed by extraction with organic solvents: ethyl ether, petroleum ether.

After the fat was extracted, the fatty acid profile was determined in it by the IDF Standard method (1999). Methyl esters of fatty acids were obtained:

solvent and KOH in methanol was added to a weight amount of fat. $NaHSO_4$ was then added and the result was centrifuged. The methyl esters obtained in the process were analysed.

Separation of the examined compounds was performed by gas chromatography using gas chromatographer: HP 6890; flame ionization detector (FID); capillary column with a length – 100 m, inside diameter of 0.25 mm; temperature: detector – 250°C, dispenser – 230°C and column – 60C (1 min) to 180°C (Δt 5°C/min); carrier gas – helium, flow rate – 1.5 cm^3/min, split 50:1.

The identification of fatty acids was carried out on the basis of their retention time in relation to the retention time of standards of fatty acid methyl esters. For this purpose, a mixture of 37 standards of Supelco 37 Component FAME Mix. For the calculation of the percentage share of fatty acids the Chemostation computer program was used. Descriptive analysis was used to calculate means and standard deviation.

Results and Discusion

Both in tvorog and ripening cheese the differences in the content of saturated (SFA) and unsaturated fatty acids were detected depending on the type of milk used to manufacture the products (Table 1, Table 2). The composition of fatty acids in dairy products varies considerably according to environmental factors, farming practice, and genetic and physiological factors related to animals (COLLOMB et al. 2006, LEDOUX et al. 2005).

The content of SFA in total fat in the samples of tested tvorog was on average 70% with a slightly higher content in the products made of goat's milk. In the case of ripening cheese made of goat's and sheep's milk the content of SFA was by over 4% lower than in the products made of cow's milk. The main SFA found in fat extracted from the products made of cow's, goat's and sheep's milk included C16:0, C18:0 and C14:0 acids, similarly to the data presented by other authors (NEUPANEY et al. 2003).

Presence of short- and medium-chain fatty acids (SCFA) is typical of milk: the series of acids from C4:0 to C12:0 has been recognized as milk fat component with properties beneficial to health (WHIGHAM et al. 2000). The significantly high content of SCFA was detected in the samples of fat extracted from goat tvorog (21.60% in total fat) and goat rennet cheese (20.34% in total fat). In the products made of cow's milk the average content of SCFA was 14.67% in total fat in tvorog made of cow's milk and 15.23% for ripening cheese made of cow's milk. RUTKOWSKA et al. (2009) reported a significantly lower content of SCFA in fat of cheese that originated from the dairy plants in the northern, eastern and central Poland, especially in fat extracted from goat

Table 1

Fatty acid composition and *trans* fatty acid content of analysed tvorogs (mean ± standard deviation)

Fatty acids (g/100g of fat)	Tvorog made from cow milk (n = 7)	Tvorog made from goat milk (n = 4)
C4:0	3.56 ± 0.28	2.57 ± 0.14
C6:0	2.40 ± 0.09	2.58 ± 0.22
C8:0	1.53 ± 0.04	2.89 ± 0.39
C10:0	3.36 ± 0.15	9.47 ± 1.45
C11:0	0.07 ± 0.01	0.10 ± 0.01
C12:0	3.75 ± 0.26	3.99 ± 0.66
C13:0izo	0.08 ± 0.02	0.02 ± 0.01
C13:0	0.21 ± 0.02	0.16 ± 0.01
C14:0izo	0.13 ± 0.02	0.10 ± 0.01
C14:0	11.26 ± 0.29	10.07 ± 0.55
C15:0izo	0.30 ± 0.03	0.24 ± 0.04
C15:0aizo	0.60 ± 0.05	0.43 ± 0.04
C15:0	1.27 ± 0.07	0.84 ± 0.57
C16:0izo	0.29 ± 0.13	0.29 ± 0.02
C16:0	28.20 ± 1.88	25.82 ± 1.27
C17:0	0.66 ± 0.29	0.61 ± 0.41
C18:0	11.25 ± 0.87	11.47 ± 2.61
C19:0	0.20 ± 0.02	0.19 ± 0.03
Σ **SFA**[a]	**69.09 ± 4.52**	**71.83 ± 8.42**
C10:1	0.32 ± 0.02	0.20 ± 0.04
C12:1	0.04 ± 0.01	0.03 ± 0.01
C14:1	0.91 ± 0.07	0.35 ± 0.46
C16:1	0.87 ± 0.57	0.38 ± 0.26
C17:1	0.12 ± 0.14	0.14 ± 0.17
C18:1 c9	20.49 ± 0.84	19.94 ± 1.57
C18:1c11	0.66 ± 0.09	0.52 ± 0.06
C18:1c12	0.18 ± 0.03	0.19 ± 0.08
C18:1c13	0.11 ± 0.02	0.06 ± 0.02
C20:1	0.10 ± 0.04	0.05 ± 0.02
Σ **MUFA**[b]	**23.80 ± 1.82**	**21.86 ± 2.67**
C18:2	1.41 ± 0.30	1.95 ± 0.55
C18:3	0.57 ± 0.21	0.40 ± 0.14
CLA*c*	0.71 ± 0.37	0.54 ± 0.14
Σ **PUFA**[d]	**2.68 ± 0.88**	**2.89 ± 0.82**
t6+t9	0.44 ± 0.03	0.43 ± 0.07
t10+t11	2.44 ± 0.90	1.65 ± 0.40
t12	0.28 ± 0.04	0.25 ± 0.05
t16	0.38 ± 0.06	0.29 ± 0.03
t13c9	0.21 ± 0.03	0.20 ± 0.03
t12c9	0.21 ± 0.02	0.23 ± 0.05
t9c12	0.04 ± 0.01	0.03 ± 0.01
t11c15	0.27 ± 0.07	0.13 ± 0.05
Σ **TFA**[e]	**4.27 ± 1.16**	**3.19 ± 0.67**

Explanations: [a]SFA – saturated fatty acid; [b]MUFA – monounsaturated fatty acid; [c]CLA – conjugated linoleic acid; [d]PUFA – polyunsaturated fatty acid; [e]TFA – trans fatty acid

Table 2

Fatty acid composition and *trans* fatty acid content of analysed cheeses (mean ± standard deviation)

Fatty acids	Cheese made from cow milk (n = 8)	Cheese made from goat milk (n = 4)	Cheese made from sheep milk (n = 2)
1	2	3	4
C4:0	3.27 ± 0.91	2.48 ± 0.35	3.17 ± 0.52
C6:0	2.31 ± 0.61	2.42 ± 0.15	2.41 ± 0.12
C8:0	1.68 ± 0.71	2.60 ± 0.24	1.98 ± 0.08
C10:0	4.03 ± 2.74	8.45 ± 1.33	5.61 ± 0.36
C11:0	0.07 ± 0.04	0.13 ± 0.03	0.13 ± 0.05
C12:0	3.87 ± 0.64	4.26 ± 1.59	4.54 ± 1.09
C13:0izo	0.07 ± 0.03	0.04 ± 0.03	0.07 ± 0.04
C13:0	0.19 ± 0.05	0.19 ± 0.04	0.23 ± 0.06
C14:0izo	0.10 ± 0.07	0.10 ± 0.01	0.13 ± 0.04
C14:0	8.35 ± 5.23	10.66 ± 0.93	11.83 ± 1.78
C15:0izo	0.27 ± 0.08	0.23 ± 0.05	0.31 ± 0.11
C15:0aizo	0.52 ± 0.14	0.41 ± 0.07	0.63 ± 0.12
C15:0	1.18 ± 0.30	1.19 ± 0.15	1.39 ± 0.04
C16:0izo	0.32 ± 0.08	0.27 ± 0.03	0.35 ± 0.06
C16:0	30.89 ± 3.23	26.12 ± 1.61	28.28 ± 4.90
C17:0	0.49 ± 0.41	0.77 ± 0.12	0.39 ± 0.55
C18:0	9.84 ± 1.57	11.54 ± 3.33	10.16 ± 1.94
C19:0	0.19 ± 0.03	0.20 ± 0.03	0.28 ± 0.05
C20:0	0.19 ± 0.06	0.27 ± 0.09	0.21 ± 0.07
Σ SFA[a]	**67.82 ± 16.93**	**72.31 ± 10.18**	**72.04 ± 11.99**
C10:1	0.29 ± 0.09	0.22 ± 0.06	0.22 ± 0.07
C12:1	0.04 ± 03.01	0.03 ± 0.01	0.03 ± 0.01
C14:1	0.82 ± 0.36	0.15 ± 0.07	0.15 ± 0.16
C16:1	0.98 ± 0.62	0.60 ± 0.20	0.60 ± 0.08
C17:1	0.19 ± 0.13	0.27 ± 0.02	0.27 ± 0.04
C18:1 c9	21.66 ± 6.11	20.32 ± 2.79	20.32 ± 5.02
C18:1 c11	0.69 ± 0.27	0.48 ± 0.11	0.48 ± 0.18
C18:1 c12	0.23 ± 0.13	0.17 ± 0.08	0.17 ± 0.08
C18:1 c13	0.09 ± 0.02	0.05 ± 0.01	0.05 ± 0.04
C20:1	0.14 ± 0.07	0.03 ± 0.03	0.03 ± 0.01
Σ MUFA[b]	**25.13 ± 7.81**	**22.31 ± 3.37**	**22.31 ± 5.68**
C18:2	2.12 ± 1.40	1.65 ± 0.34	1.36 ± 0.10
C18:3	0.50 ± 0.18	0.45 ± 0.15	0.53 ± 0.09
CLAc	0.60 ± 0.35	0.46 ± 0.18	0.72 ± 0.17
Σ PUFA[d]	**3.22 ± 1.93**	**2.56 ± 0.67**	**2.61 ± 0.36**
t16	0.31 ± 0.07	0.32 ± 0.04	0.45 ± 0.11

cont. table 2

1	2	3	4
t13c9	0.19 ± 0.05	0.21 ± 0.06	0.32 ± 0.13
t12c9	0.24 ± 0.06	0.22 ± 0.06	0.27 ± 0.06
t9c12	0.06 ± 0.07	0.03 ± 0.01	0.06 ± 0.01
t11c15	0.19 ± 0.12	0.17 ± 0.08	0.51 ± 0.09
t6+t9	0.53 ± 0.33	0.38 ± 0.04	0.49 ± 0.11
t10+t11	1.96 ± 0.93	1.28 ± 0.55	3.72 ± 0.42
t12	0.36 ± 0.31	0.21 ± 0.05	0.35 ± 0.12
Σ TFA[e]	**3.83 ± 1.95**	**2.81 ± 0.89**	**6.16 ± 1.07**

Explanations: [a]SFA – saturated fatty acid; [b]MUFA – monounsaturated fatty acid; [c]CLA – conjugated linoleic acid; [d]PUFA – polyunsaturated fatty acid; [e]TFA – trans fatty acid

cheese. The results confirm the statement proposed by ALONSO et al. (1999) who assumed that dairy products made of goat's milk had a high content of two fatty acids, i.e. C8:0 and C10:0, in comparison with the products made from cow's milk. This phenomenon was detected in both cottage and ripening cheese.

It was demonstrated that the content of monounsaturated fatty acids (MUFA) in fat of tvorog made of cow's milk was app. 23.80% and was slightly higher than in the products made of goat's milk. A similar tendency, i.e. higher content of this group of fatty acids in total fat in the products made of cow's milk (25.13%), was reported for ripening cheese (Table 1, Table 2).

Among unsaturated fatty acids, polyunsaturated fatty acids (PUFA) play an important role because of their physiological functions. C18:2 was the most prevalent and constituted from 1.36% (in sheep rennet cheese) to 2.12% (in cow rennet cheese) in total fatty acids depending on raw material and type of products (Table 2).

CLAs which are found primarily in food derived from ruminants, such as dairy products and beef, which represent a mixture of positional and geometric isomers of linoleic acid (18:2 cis-9, cis- 12) which contain conjugated double bonds. Data from experimental studies suggests several biological activities of CLA, such as anti-carcinogenic properties, alteration of blood levels of cholesterol and modulation of the immune system (PARIZA et al. 2001, WHIGHAM et al. 2000).

Tvorogs, made of goat's milk, had a higher content of PUFA as compared to the products made of cow's milk. However, this relation was reversed for CLA (Table 1). Among the samples of tvorog made of cow's and goat's milk tested for the composition of fatty acids, the highest content of CLA, i.e. 1.3%, was detected in tvorog made of cow's milk. In dairy products manufactured with cow's milk, the content of CLA was more diversified with the lowest value of

0.20% of total fatty acids in one of the samples. In the case of goat cheese, the content of CLA was on a more comparable level – reaching on average 0.54% of total acids. White cheese produced in Bulgaria from goat's milk contained only 0.5% CLA (MICHAJLOVA 2007). In the fat of fresh sheep cheese, the content of CLA is much higher, i.e. approximately 1.7% (NUDDA et al. 2005). Among the tested types and varieties of cheese, the content of CLA was highest in Italian Pecorino sheep cheese amounting to 0.8 mg per 100 g of fat (PRANDINI et al. 2007). Other Italian varieties of sheep cheese contained even higher amounts of CLA – ranging from 1.0 to 2.5% of total acids (CABIDDU et al. 2006).

The highest content of CLA was detected in fat of ripening cheese made of sheep's milk (on average over 0.72% of total fat), whereas in other cases the proportion of CLA in the profile of fatty acids was lower: 0.60% in fat of cow cheese and 0.46% in fat of goat cheese. The studies conducted by BARAN et al. (2011) also demonstrated a higher content of CLA in the total profile of fatty acids in ripening sheep cheese in comparison with its content in cheese made of goat's milk and from a mixture of goat's and sheep's milk (Table 2).

There is a growing interest in geometric isomers of unsaturated fatty acids in trans-configuration (TFA) found in milk fat because of their harmful impact on human health (JUTTELSTAD 2004). TFA present in milk and meat derived from ruminants constitute from 1% to 8% of total fatty acids. The content of TFA in milk fat changes with season, with higher contents reported in summer when animals graze and a lower amount is detected in winter when they are fed with feedstuffs (FELKNER-POŹNIAKOWSKA et al. 2012).

In the tested group of products, significantly higher content of TFA, i.e. over 6%, was detected in ripening cheese made of sheep's milk, while the lowest content was found in cottage and ripening cheese made of goat's milk in which it did not exceed 3% of total fatty acids (Table 1, Table 2).

Conclusions

Today's consumers are looking for natural, traditional food processed as little as possible which has specific sensory features and documented quality. With reference to the present studies, it may be concluded that local tvorog and cheese made from goat's, sheep's and cow's milk from north-eastern Poland may be a valuable source of short- and medium-chain fatty acids as well as CLA.

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