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FATTY ACID PROFILE AND MINERALS CONTENT IN MILK FROM COWS OF VARIOUS BREEDS OVER SPRING-SUMMER FEEDING PERIOD

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The paper focused on the evaluation of a fatty acid profile and mineral component contents in milk obtained from cows of 5 breeds maintained in Poland. The studies covered 147 milk samples collected from cows of Polish Holstein-Friesian black-white (42) and red-white (26) varieties, Simental (31), Whitebacks (15) and Polish Red (33). Milk was sampled at the spring-summer season when dietary units included green forage. It was found that the milk gained from the cows of 3 breeds (in that two native), *i.e.* Whitebacks, Polish Red and Simental, had the fatty acid ratio most beneficial for human nutrition. Significantly higher proved to be a conjugated linoleic acid (CLA) level. The milk also contained more essential macro- (K, Ca, Na, Mg) and some microelements (Zn, Fe). A vital effect (beside the breed) was likely to have a feeding system of animals supplied mainly with pasture fodder.

INTRODUCTION

Milk and its products are indispensable in human nutrition. A high nutritive value of milk results from its complex chemical composition, forms of the components enabling the efficient digestion, absorption and assimilation as well as their appropriate proportions [Żelazna & Popielarska, 2003].

The main energy component of milk is fat that proves to be the most readily digestible fat of animal origin. It is due to a relatively high percentage (14%) of short- and medium chained fatty acids that are fully used as energy fuel, among others in the muscles, liver, kidneys, thrombocytes and the nervous system. Thus, these acids do not contribute to any adiposity [Żelazna & Popielarska, 2003; Reklewska *et al.*, 2003]. Milk fat comprises mono- and polyunsaturated fatty acids, some of them are recognized to exert a beneficial impact on human health. A conjugated linoleic acid (CLA) still arises an increasing interest owing to its confirmed activity of an anticancer, immunomodelling, antioxidative and antiatherogenic nature [Przybojewska & Rafalski, 2003].

In milk fat there are long-chained saturated fatty acids originating from the tissue reserves processing or nutrients absorbed in the small intestine of a cow [Pisulewski *et al.*, 2001]. Reklewski *et al.* [2002] claims that these acids induce hyper cholesterolemia, that is growth of total cholesterol and its LDL fraction.

Milk is a valuable source of mineral components that play various functions in human organism. They constitute building matter for bones, teeth, skin and hair (Ca, P, Mg), participate in the metabolic processes (Fe, Zn, Cu). Moreover, they are of key importance in the water-electrolyte balance and acid-base equilibrium maintenance (Na, K, Cl), as well as perform a regulatory function in the body (Se, Mn, Mo, Cr) [Hathcock, 1997; Śmigielska *et al.*, 2005; Żelazna & Popielarska, 2003].

Most of the research made in this field so far has focused mainly on the assessment of the effect of various diets of cows on the nutritive value of milk. However, research papers [Barłowska *et al.*, 2005; Grega *et al.*, 1998; Grega *et al.*, 2000b] analysing the impact of a cow breed on milk nutrient contents, inlcuding a fatty acid level, are sparse.

The objective of the present study was to evaluate fatty acid profile and mineral elements content in milk gained from cows of five breeds maintained in two regions of Poland.

MATERIAL AND METHODS

The investigations were conducted on 147 samples of milk collected over the spring-summer season from cows of five breeds, namely Polish Holstein-Friesian black-white (42) and red-white variety (26), Simental (31), Whitebacks (15) and Polish Red (33). The cows of the Simental breed, Polish HF red-white and Polish Red variety were maintained at the mountain regions, *i.e.* in the Eastern and Cen-

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tral Beskid. Pasture fodder constituted the basic bulky feed for these animals. The Whitebacks' diet was similar and the cows were kept at small farms on the Polesie region, where milk production appeared to be extensive. The cows of the Polish HF breed black-white variety came from the farms in the Lubelszczyzna region characterised by the intensive milk production. The basic feeding system therein included silages (maize silage and hay-silage), while green forage made only a slight supplement. The fatty acids of milk were determined according to a modified method of Atwal *et al.* [1990], whereas the saponification and fat estrification –using Matyka's method [1976]. A fatty acid content was established on a gas chromatograph Varian CG 3900 equipped with a flame ionization detector (FID). Percentage of each fatty acid content was calculated applying Star GS Workstation ver. 5.5. software. In order to determine the contents of mineral components and trace elements, the material was subjected to wet digestion in a mixture of HNO_3 and $HClO_4$ according to the AOAC 986.15 standard [2000]. The levels of Ca, Mg, Na, K, Zn, Fe, Mn and Cu were recorded using flame AAS technique applying a "Solar 939" spectrometer (Unicom).

The results obtained were analysed statistically with StatSoft Inc. STATISTICA ver.6 on the grounds of one factor variance analysis, providing the mean values and standard deviation. Significance of differences was determined with the Fisher's test (LSD).

RESULTS AND DISCUSSION

Table 1 presents fatty acid levels in milk of cows of the breeds analysed. The highest saturated fatty acid content was recorded in milk of cows Polish Holstein Friesian (PHF) breed black-white variety (68.35%) and red-white (67.83%). An equally high content of these fatty acids was indicated in a native cattle breed, that is Whitebacks (67.24%). The lowest content of this acid group was observed in milk of Simental cows. A specific property of milk fat is the presence of short- and medium chained fatty acids that constitute a readily available energy source and are not deposited in human adipose tissue as opposed to the long chained fatty acids [Żelazna & Popielarska, 2003]. The highest level of these acids was shown in milk obtained from Whitebacks (22.83%) that also had the lowest content of long chained acids (43.27%) so harmful for human nutrition. The lowest percentage of these acids was detected in milk of cows of Polish Red breed (15.81%). Milk of red-white cows had the highest content of long chained saturated acids (51.27%). Similar tendencies in SCFA and MCFA contents were found by Grega *et al.* [1998, 2000a] who reported their higher contents in milk of cows of Holstein-Friesian and Black-and-White breed compared to milk from Polish Red and Simental breeds. Jaworski *et al.* [1997] holds that milk fat from cows of Black-and-White pedigree was characterised by a significantly higher content of long chained saturated fatty acids than that from the Polish Red cows' milk.

Taking into account human nutrition, an unsaturated fatty acid content in milk, predominantly polyenoic fatty acids is essential for the appropriate development and functioning of organism. Our own studies revealed that the highest UFA content, including PUFA, was detected in milk of cows of two breeds, *i.e.* Simental (36.29%; 3.62%, respectively) and Polish Red (35.67%; 4.21%, respectively). Whereas, significantly ($p \leq 0.01$) lowest content of unsaturated fatty acids, including PUFA, was recorded in milk of black-white cows – 31.16% and 2.78%, respectively.

Most of the research performed [Nałęcz-Tarwacka & Grodzki, 2005; Pisulewski *et al.*, 2001; Reklewska *et al.*, 2003] point to nutrition as a factor influencing the content of polyunsaturated fatty acids in milk. It was proved that the cows fed green forage produced milk with an increased content of these acids. In our investigations, the differences in the content of these acids may be partly relative to the differentiated nutrition of the analysed breeds of cows. The animals with the highest PUFA level confirmed, that is Simental and Polish Red, were maintained on farms situated in the Bieszczady and Beskidy regions, the area of natural pasture predominance.

The greatest attention (regarding a broad spectrum of pro-health activity) has been paid to the main C-18:2 cis-9 trans-11 isomer, commonly referred to as CLA [Pisulewski *et al.*, 2001; Przebojewska & Rafalski, 2003; Reklewska *et al.*, 2003]. This term comprises a whole group of linoleic acid isomers. The most abundant source of this isomer appears to be milk products. The present studies revealed that the highest content of this acid was recorded in milk of two native cattle breeds, *i.e.* in Polish Red (0.94%) and Whitebacks (0.80%) (Table 1). A substantially lower level of this acid was determined in milk obtained from Polish Hol-

TABLE 1. Fatty acid profile in milk from cows of different breeds.

Breed	n		Fatty acids (%)						
			SFA	SCFA+MCFA	LCFA	UFA	MUFA	PUFA	CLA
Polish Holstein-Friesian black-white variety	42	$\bar{x}$	68.35^{B}	20.39^{B}	48.26^{B}	31.16^{A}	28.37^{A}	2.78^{A}	0.63^{A}
		SD	4.32	3.39	2.79	3.95	3.74	0.58	0.27
Polish Holstein-Friesian red-white variety	26	$\bar{x}$	67.83^{B}	16.96^{A}	51.27^{C}	31.51^{A}	28.23^{A}	3.28^{B}	0.52^{A}
		SD	3.89	4.06	2.77	4.60	4.31	0.73	0.13
Simental	31	$\bar{x}$	62.85^{A}	16.66^{A}	46.33^{AB}	36.29^{B}	32.66^{C}	3.62^{B}	0.73^{A}
		SD	3.78	3.13	3.02	3.72	3.54	0.71	0.19
Whitebacks	15	$\bar{x}$	67.24^{B}	22.83^{C}	43.27^{A}	32.25^{A}	28.89^{A}	3.08^{AB}	0.80^{B}
		SD	4.42	3.51	3.61	3.71	3.41^{B}	0.33	0.22
Polish Red	33	$\bar{x}$	64.31^{AB}	15.81^{A}	48.36^{B}	35.67^{B}	31.46^{B}	4.21^{C}	0.94^{B}
		SD	3.26	2.63	1.82	3.24	4.04	0.74	0.21

A, B, C – differences between the breeds; A, B, C – differences significant at $p \leq 0.01$.

TABLE 2. Content of macro- and microelements in milk of cows of different breeds

Breed	n		Content of mineral components (mg/L)							
			K	Ca	Na	Mg	Zn	Cu	Fe	Mn
Polish Holstein-Friesian black-white variety	42	$\bar{x}$	764.7^{A}	942.2	374.7^{AB}	62.8^{A}	3.40^{A}	0.06^{B}	0.20^{A}	0.09^{C}
		SD	136.7	102.2	112.3	13.8	1.57	0.49	1.43	0.64
Polish Holstein-Friesian red-white variety	26	$\bar{x}$	1050.7^{B}	955.8	321.3^{A}	69.7^{A}	4.61^{AB}	0.09^{C}	0.25^{A}	0.03^{A}
		SD	243.1	128.7	72.3	34.4	1.09	0.56	1.05	0.17
Simental	31	$\bar{x}$	1131.8^{BC}	1009.3	432.1^{BC}	126.5^{B}	5.21^{B}	0.03^{A}	0.54^{B}	0.02^{A}
		SD	177.7	147.9	128.6	27.4	2.64	0.17	2.92	0.13
Whitebacks	15	$\bar{x}$	1206.5^{C}	976.6	452.9^{C}	128.3^{B}	5.47^{B}	0.10^{C}	0.16^{A}	0.01^{A}
		SD	350.7	258.7	208.9	28.6	2.18	0.40	0.61	0.07
Polish Red	33	$\bar{x}$	1192.8^{C}	980.8	420.3^{BC}	71.0^{A}	5.23^{B}	0.06^{B}	0.63^{B}	0.06^{B}
		SD	150.9	127.2	117.9	11.4	2.53	0.27	2.87	0.25

A, B, C – differences between the breeds; A, B, C – differences significant at $p \leq 0.01$.

stein-Friesian cows of both varieties: black – 0.63% and red-white – 0.52%. Our previous studies [Barłowska *et al.*, 2005] conducted on three breeds demonstrated that milk of Black- and Red-White cows had a lower level of CLA compared to milk of Simental. Therefore, it may be indicated that (besides the genetic conditioning) an equally important factor determining a significantly higher CLA content in milk of cows of the above-mentioned breeds proves to be pasture feeding. This assumption has been confirmed by the investigations conducted by Reklewska *et al.* [2003].

Milk and its products constitute a rich source of the mineral components that satisfy, to a great extent, men's demand for calcium, phosphorus, potassium, magnesium and sodium [Śmigielska *et al.*, 2005].

The present authors' own investigations have not demonstrated an explicit impact of a breed on macro- and microelement content of milk. It should be emphasized, however, that the milk gained from the cows of Polish Red, Simental and Whitebacks breeds contained slightly more K, Ca, Na, Mg and Zn and in some cases the differences proved statistically significant (Table 2). Feeding may have had some influence as well. As it was mentioned before, the cows of this breed were kept on farms where green forage was the main feed. Litwińczuk *et al.* [2005], evaluating milk from the black-white cows from the Lubelszczyzna region and from the Bieszczady (with Simental breed predominance), found a higher content of these elements in the milk obtained from cows from the Bieszczady region. A mean content of each mineral in the milk of cows from this region reached: K – 1310.2 mg/L; Ca – 908.5 mg/L; Na – 398.9 mg/L; and Mg – 133.5 mg/L, respectively. According to the research by Zapletal & Bonczar [1993], the content of these elements in the milk purchased near Kraków was at a similar level. While estimating calcium level in milk from cows of four breeds, namely black-white, red-white, Polish Red, Grega *et al.* [2000b] detected the highest content of this element in milk from Simental cows (138.25±7.62 mg%), whereas the lowest one in that from the black-white cows (108.61±4.77 mg%).

Milk is considered a poor source of iron. Its highest content ($p=0.01$) was detected in milk of cows maintained at the mountain region, that is Simental (0.54 mg/L) and Polish Red (0.63 mg/L). Górska & Oprządek [2004], studying the milk of cows from the Southern Polesie, observed that the content of iron fluctuated from 0.42 up to 0.45 mg/kg subject to a season.

CONCLUSION

Summing up, the milk gained from the cows of three breeds (including two native cattle), *i.e.* Whitebacks, Polish Red and Simental, showed the most favourable for human nutrition ratios of the fatty acids. This milk had a significantly elevated content of conjugated linoleic acid (CLA) and more essential macroelements (K, Ca, Na and Mg) and some microelements (Zn, Fe). It is likely that, beside the breed, a vital impact was exerted by a nutrition system of these animals fed mainly pasture fodder.

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PROFIL KWASÓW TŁUSZCZOWYCH I ZAWARTOŚĆ SKŁADNIKÓW MINERALNYCH W MLEKU KRÓW RÓŻNYCH RAS Z OKRESU ŻYWIENIA WIOSENNO-LETNIEGO

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Celem pracy była ocena profilu kwasów tłuszczowych oraz zawartości składników mineralnych w mleku pozyskiwanym od krów 5 ras utrzymywanych w Polsce. Badaniami objęto 147 prób mleka pobranego od krów polski holsztyno-fryz odmiany czarno-białej (42) i odmiany czerwono-białej (26), simental (31), białogrzbiet (15) i polska czerwona (33). Mleko pobierano w okresie wiosenno-letnim, kiedy w skład dawek pokarmowych wchodziła zielonka pastwiskowa. Wykazano, że mleko pozyskiwane od krów trzech ras (w tym dwóch rodzimych), tj. białogrzbiet, polskiej czerwonej i simentalerów miało najbardziej korzystne z punktu widzenia żywienia człowieka proporcje kwasów tłuszczowych. Istotnie wyższy był w nim również udział sprzężonego kwasu linolowego (CLA). Mleko to zawierało także więcej podstawowych makro (K, Ca, Na, Mg) i niektórych mikroelementów (Zn, Fe). Znaczący wpływ na to (obok rasy) miał prawdopodobnie stosowany systemem żywienia tych zwierząt, w którym podstawę stanowiła zielonka pastwiskowa.