Effect of mare's breed on the fatty acid composition of milk fat

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ABSTRACT: Gas chromatography and IDF Standard method (1999) were used to analyze the fatty acid composition of milk fat of mares originating from the following breeds: 10 of Wielkopolska breed, 10 Konik Polski Horses, and 9 Polish Cold-blooded Horses. Eighty-seven mare's milk samples were collected in the years 2000–2002. Unsaturated fatty acids were shown to prevail in the milk fat of mares of Wielkopolska breed (61.32%) and of Konik Polski mares (52.58%) whereas saturated acids prevailed in the milk fat of Cold Blooded mares (54.95%). The study revealed that the fatty acid composition of the investigated groups of mares was breed-specific. Of course, the impact of other uncontrolled factors such as nutrition is not excluded, either.

Keywords: fatty acids; mare's milk; breed

In the life of a foal, mare's milk is the most valuable food source, barely replaceable with any other product. Milk of this origin has also been used in human nutrition (Drogoul et al., 1992). Mongolians inhabiting steppes of Central Asia are known to consume a variety of mare's milk based products as well as to be perfect in their acquisition. Those products are used, among others, in the sanatorium treatment of tuberculosis, chronic gastric ulcer disease, scurvy, dysentery, and other chronic diseases (Solaroli et al., 1993). The biological and nutritive value of milk originating from mammals is most of all a species specific trait that has been well recognised in respect of a number of macroelements. For instance, among many mammal species, mare's milk has been reported to raise a considerable interest due to its resemblance to human milk in its chemical composition (Pordąb, 1997). The gross composition of mare's milk differs from cow's milk in its nutritional value (Hanuš et al., 2008). Cow's milk has a higher content of fat and different fatty acid composition compared to mare's milk (Pešek et al., 2005). Mare's milk has a low content of fat but the composition of fatty acids and concentration of lactose is similar to that of human milk. On the other hand, mare's milk has a lower concentration of proteins and mineral salts than cow's milk (Jahreis et al., 1999; Malacarne et al., 2002). In Italy, mare's milk was considered as a possible substitute for cow's milk for allergic children (Curadi et al., 2001).

Accounting for a relatively long period of lactation, considerable milk yield and e.g. the resemblance of nitrogen compounds of mare's milk to those present in human milk, mare's milk can be considered as a raw material for the production of formulae substituting natural food of infants (Caspo et al., 1995; Smoczyński and Tomczyński, 1982).

On the contrary, as the breeding industry faces a growing need for searching and preparing supplements to be used in foal feeding (Tomczyński et al., 1983), cognitive studies of factors determining the chemical composition of milk are becoming increasingly important. The results of such studies are not only of cognitive significance but also of practical applicability.

Some authors (Kulisa, 1977) reported that the breed does not affect the milk composition, while other researchers reported a significant effect of breed (Boulot, 1987; Webb and Casey, 1995; Tsiplakou et al., 2006; Gołębiewski and Brzozowski, 2008).

The study is aimed at determining the fatty acid composition of milk fat of mares as affected by the breed of horses kept in the region of north-eastern Poland as potential material to produce dietetic products for infant feeding.

MATERIAL AND METHODS

The experiment was carried out on three groups of horses of different breeds. The nutrition of mares was similar in research groups. The composition of feed ration comprised oats, hay and pasture grass. The observations covered 9 Polish Cold Blooded mares, 10 mares of Konik Polski, and 10 mares of Wielkopolski Horse. Eighty-seven hand milked milk samples were collected in the years 2000–2002, in 6- month intervals within a single lactation to account for its initial, on course, and final stages. Analyses were carried out on selected mares in different stage of lactation (initial, middle and terminal). The samples were obtained by hand milking. Before milking, foals were separated from their mothers for 2 hours and placed in an adjoining box to maintain visual contact. During milking, to increase milk secretion, foals were allowed back to the dam's box, taking precautions not to let them suck the milk. After a thorough mixing, ca 250 ml sample was taken from the milk collected and fixed with hydrogen peroxide at a dose of ca 1 ml per volume of milk taken. Until analysed, the milk samples were stored in a freezer at a temperature of –21°C.

The fat content of milk was determined by the extraction method of Rose-Gottlieb (PN-57-A-86104). The fatty acid composition was estimated after the acids were transformed into methyl esters according to the IDF Standard 1999. The composition was then analyzed with an HP 6890 gas chromatograph, on a Supelcowex capillary column (30 m × 0.32 mm i.d.) under the following conditions: flame-ionization detector, gas-helium as a carrier at a flow rate of 1.20 cm^3/min, separation temperatures: column from 60°C (1 min) to 175° at a gradient of 8°C/min, detector – 250°C and a sample injector with 100:1 division – 225°C. Peaks were identified based on a comparative analysis with retention times of the standards of fatty acid methyl esters with the known composition.

Quantitative calculations were carried out using Chemostation software. The results are given as arithmetic mean and standard deviation. The software Statistica 8 PL was used for data analysis. Data from the experiment were analyzed by analysis of variance (ANOVA). Duncan's test was used to compare the differences at a significance level $P = 0.05$ and $P = 0.01$.

RESULTS AND DISCUSSION

Table 1 presents the percentage composition of saturated fatty acids of milk fat from sampled mares. The milk fat of Polish Cold-blooded mares had higher concentrations of $C_{8:0}$ (3.88%), $C_{10:0}$ (8.34%), $C_{12:0}$ (9.16%) and $C_{14:0}$ (8.70%) acids as compared to Wielkopolska and Konik Polski breeds.

$C_{6:0}$ acid was detected only in trace amounts in eight milk samples originating from mares of Wielkopolska and Konik Polski breeds.

Similar results of the volatile fatty acids from $C_{6:0}$ to C_{10} and trace amounts of the $C_{6:0}$ acid were reported by other authors (Jaworski et al., 1982). It has been confirmed that a low concentration of $C_{6:0}$ acid is a typical trait of milk fat from non-ruminant animals, compared to that of ruminants that have a considerable concentration of this acid.

High concentrations of $C_{8:0}$ acid and $C_{10:0}$ acid in the milk fat of mares were also observed by other authors (Jaworski et al., 1982; Malacarne et al., 2002). According to Jaworski et al. (1982), the levels of $C_{8:0}$ (3.1% to 4.5%) and $C_{10:0}$ acids (5.2 to 10.2%) in mare's milk are similar to those found in goat's milk fat. Compared to human milk, mare's milk has 11 and 4 times higher levels of $C_{8:0}$ and $C_{10:0}$ acids, respectively (Malacarne et al., 2002).

The analysis of saturated fatty acids (from $C_{13:0}$ to $C_{16:iso}$) demonstrated a significantly higher ($P = 0.01$) concentration of $C_{13:0}$ acid in the milk fat of mares of Wielkopolska breed compared to the other two breeds.

Table 1. Saturated fatty acid composition (%) of milk fat of mares originating from different breeds

Fatty acid	Wielkopolski Horse		Konik Polski		Polish Cold-blooded Horse	
	mean	SD	mean	SD	mean	SD
C_6	trace amount		trace amount		trace amount	
C_8	2.05^{aA}	0.74	2.97^{bAB}	1.21	3.88^{cB}	1.35
C_{10}	4.07^{aA}	1.41	5.52^{aA}	2.84	8.34^{bB}	2.76
C_{12}	4.98^{aA}	1.80	5.96^{aA}	2.89	9.16^{bB}	2.19
C_{13}	0.25^{aA}	0.36	0.08^{bB}	0.09	0.08^{bB}	0.08
$C_{14\ iso}$	0.01^{aA}	0.04	0.03^{aA}	0.04	0.02^{aA}	0.04
C_{14}	5.25^{aA}	1.72	6.53^{bA}	1.99	8.70^{cB}	1.98
C_{15}	0.76^{aA}	0.88	0.94^{aA}	0.88	0.63^{aA}	0.36
$C_{16\ iso}$	0.22^{aA}	0.34	0.19^{aA}	0.08	0.15^{aA}	0.11
C_{16}	19.64^{aA}	3.79	23.42^{bB}	2.73	22.64^{bB}	4.37
C_{17}	0.50^{abAB}	0.42	0.59^{aA}	0.21	0.35^{bB}	0.20
C_{18}	0.98^{aA}	0.29	1.14^{aA}	0.45	1.00^{aA}	0.23

^{a,b,c}statistically significant differences at a significance level $P = 0.05$
^{A,B,C}statistically significant differences at a significance level $P = 0.01$
SD = standard deviation

A higher concentration of $C_{16:iso}$ acid (0.22%) was reported for the mares of Wielkopolski Horse, Konik Polski – 0.19%; Polish Cold-blooded horse – 0.15%. $C_{16:0}$ acid was found to prevail among higher saturated acids (from $C_{16:0}$ to $C_{18:0}$) and its concentration accounted for 23.42% in milk fat of Konik Polski mares, 22.64% in milk fat of Polish Cold-blooded mares, and 19.64% in milk fat of Wielkopolski Horse mares. It should be emphasized that the milk of Konik Polski mares was charac-

Table 2. Unsaturated fatty acid composition (%) of milk fat of mares originating from different breeds

Fatty acid	Wielkopolski Horse		Konik Polski		Polish Cold-blooded Horse	
	mean	SD	mean	SD	mean	SD
$C_{10:1}$	1.31^{aA}	0.51	1.23^{aA}	0.66	1.70^{bA}	0.49
$C_{12:1}$	0.23^{aAB}	0.16	0.14^{bA}	0.12	0.34^{cB}	0.15
$C_{14:1}$	0.57^{aA}	0.25	0.58^{aA}	0.18	0.73^{bA}	0.22
$C_{16:1}$	5.01^{aA}	1.38	7.26^{bB}	3.30	4.86^{aA}	1.30
$C_{17:1}$	0.05^{abAB}	0.15	0.13^{aA}	0.19	0.00^{bB}	0.01
$C_{18:1}$	18.01^{aA}	5.21	23.96^{bB}	6.36	14.47^{cA}	3.05
$C_{18:2}$	15.86^{aA}	8.90	5.93^{aB}	1.69	12.72^{bA}	7.36
$C_{18:3}$	20.28^{aA}	10.15	13.35^{bB}	6.15	10.20^{bB}	2.51

^{a,b,c}statistically significant differences at a significance level $P = 0.05$
^{A,B,C}statistically significant differences at a significance level $P = 0.01$
SD = standard deviation

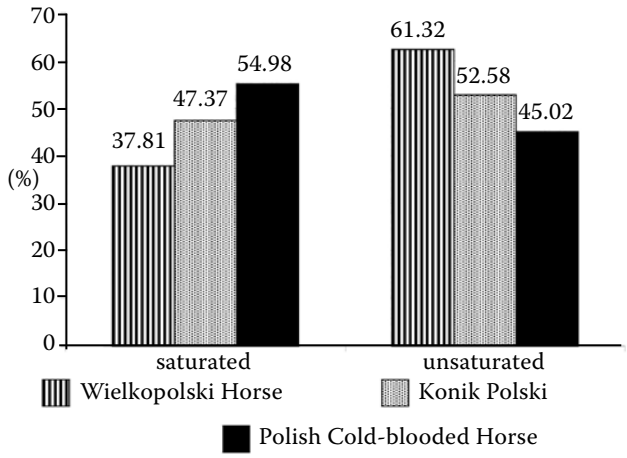

Figure 1. Total saturated and unsaturated fatty acids in mare milk fat of mares from different breeds

terised by the levels of six acids ($C_{14:iso}$, $C_{15:0}$, $C_{16:0}$, $C_{17:0}$ and $C_{18:0}$) whose concentrations were higher than in the milk of Wielkopolski Horse and Polish Cold-blooded mares. Similarly high levels of $C_{16:0}$ acid (23.1%) in mare's milk were found by Jaworski et al. (Jaworski et al., 1982).

The composition of unsaturated fatty acids in the milk fat of examined mares is presented in Table 2. In the group of monounsaturated fatty acids, $C_{18:1}$ was found to prevail. The highest concentration of this acid was noted in the milk fat of Konik Polski mares and was statistically different ($P = 0.01$) from that reported for the other breeds. $C_{18:2}$ (15.86%) and $C_{18:3}$ (20.28%) in Wielkopolski mares were higher than in the milk of Konik Polski and Polish Cold-blooded mares.

The investigations into fatty acid composition carried out by Jaworski (1982) and Kulisa (1998) demonstrated that $C_{18:2}$ and $C_{18:3}$ acids prevailed among the unsaturated fatty acids and that their concentrations were several times higher compared to those reported for the fat of cow's milk (Jaworski et al., 1982). In addition, a high concentration of $C_{18:1}$ acid was observed, which – as postulated by Kulisa (1998) – is a typical trait of mares' milk (Kulisa, 1998).

Figure 1 illustrates total saturated and unsaturated fatty acids in the milk fat of mares from different breeds. The total sum of saturated fatty acids differed in milk samples of the studied breeds. The lowest concentration of these acids was found in the milk of mares of Wielkopolska breed (37.81%) whereas the highest concentration was found in milk samples of Polish Cold-blooded mares (54.95%). The total sum of unsaturated fatty acids also showed differences between the breeds analyzed. The highest levels of unsaturated fatty acids were observed in the milk fat of Wielkopolski Horse mares (61.32%) whereas the lowest were in the milk fat of Polish Cold-blooded mares (45.02%).

The mean total sum of saturated fatty acids in mare's milk is similar to the values confirmed in human milk. On the contrary, cow's milk contains a higher quantity of saturated fatty acids. According to Malacarne et al. (2002) mare's milk was characterized by the level of 55.8%, human milk 54.8% and cow's milk by 68.0% of saturated fatty acids. Pešek et al. (2006) reported that the mean saturated fatty acid content in cow's milk fat of Czech Pied cattle was 64.71% in the range of 57.71%–71.67%.

The total sum of unsaturated fatty acids accounted for 44.2% in mare's milk, 45.2% in human milk and 32.0% in cow's milk (Malacarne et al., 2002).

The reported analysis of the fatty acid composition of milk fat from mares of different breeds demonstrated differences in the concentrations of some fatty acids, both in saturated and unsaturated ones. The milk of Wielkopolski Horse mares was characterized by the prevalence of unsaturated fatty acids, whereas the samples originating from Konik Polski mares had a predominance of saturated fatty acids. The latter were also found to prevail in the milk fat of Polish Cold-blooded mares. The fatty acid composition of the mare groups examined was observed to be breed-specific. Despite the need for further studies on the composition of mare's milk in dependence on the mare breed, it may be interesting to use mare's milk from a selected breed to prepare dietetic products for infant feeding.

REFERENCES

Boulot S. (1987): L'ingestion chez la jument. Etude de quelques facteurs de variation au cours du cycle gestion-lactation. Implications, nutritionelles et metaboliques. ENSA Rennes, France.

Caspo J., Stefler J., Martin T.G., Makray S., Caspo-Kiss Zs. (1995): Composition of mares' colostrum and milk. Fat content, fatty acid composition and vitamin content. International Dairy Journal, 5, 393–402.

Curadi M.C., Giampietro P.G., Lucenti P., Orlandi M. (2001): Use of mare milk in pediatric allergology. In: Proceeding of the Associazione Scientifica di Produzione Animale XIV Congress, Firenze, Italy, 14, 647–649.

Drogoul C., Prevost H., Maubois J.L. (1992): Le lait de juments un produit, une filičre ŕ développer? Quoi de neuf

en matičre d'études de recherches sur le cheval? 18čme Journées d'Etude, Cereopa, Paris, France, 37–51.

Gołębiewski M., Brzozowski P. (2008): Comparison of dairy performance of Montbeliarde and Black-White cows housed in the same environmental conditions. Annals of Animal Science, 8, 3–11.

Hanuš O., Vegricht J., Frelich J., Macek A., Bjelka M., Louda F., Janů L. (2008): Analysis of raw cow milk quality according to free fatty acid contents in the Czech Republic. Czech Journal of Animal Science, 53, 17–30.

IDF Standard (1999): Milk fat: Preparation of fatty acid methyl esters. 182.

Jahreis G., Fritsche J., Möckel P., Schöne F., Möller U., Steinhart H. (1999): The potential anticarcinogenic conjugated linoleic acid, *cis*-9, *trans*-11 C18:2, in milk of different species: cow, goat, ewe, sow, mare, woman. Nutrition Research, 19, 1541–1549.

Jaworski J,, Jaworska H,, Tomczyński R,, Smoczyński S. (1982): Fatty acid composition in mare milk in period of lactation. Zeszyt Naukowy ART. Olsztyn Technologia Żywności, 17, 85–94. (in Polish)

Kulisa M. (1977): The composition of mare's milk in three horse breeds with reference to N-acetylneuraminic acid. Acta Agraria et Silvestria. Seria Zootechnica, 27, 25–37.

Kulisa M. (1998): The content of selected amino-acids and fatty acids in mare's milk from arabic, małopolski, hucarski breeds. Roczniki Naukowe Zootechniki, 4, 79–8. (in Polish)

Malacarne M., Martuzzi F., Summer A., Mariani P. (2002): Protein and fat composition of mare's milk: some nutritional remarks with reference to human and cow's milk. International Dairy Journal, 12, 869–877.

Pešek M., Špička J., Samková E. (2005): Comparison of fatty acids composition in milk fat of Czech Pied cattle and Holstein cattle. Czech Journal of Animal Science, 50, 122–28.

Pešek M., Samková E., Špička J. (2006): Fatty acids and composition of their important groups in milk fat of Czech Pied cattle. Czech Journal of Animal Science, 51, 181–188.

Pordąb Z. (1997): Lipids in modified milk for infant. Przemysł Spożywczy, 8, 33–35. (in Polish)

Smoczyński S., Tomczyński R. (1982): A study of chemical composition of mare milk. I. Chemical composition of mare milk in first ten days of lactation. Zeszyt Naukowy ART Olsztyn Technologia Żywności, 17, 77–84. (in Polish)

Solaroli G., Pagliarini E., Peri C. (1993): Compositional and nutritional quality of mares' milk. Italian Journal of Food Science, 1, 3–10.

Tomczyński R., Smoczyński S., Suska G. (1983): Chemical composition of mare milk in depend on lactation period and age of animals. Przegląd Naukowy Literatury Zootechnicznej, 28, 118–126. (in Polish)

Tsiplakou E., Mountzouris K.C., Zervas G. (2006): The effect of breed, stage of lactation and parity on sheep milk fat CLA content under the same feeding practices. Livestock Science, 105, 162–167.

Webb E.C., Casey N.H. (1995): Genetic differences in fatty acid composition of subcutaneous adipose tissue in Dorper and SA Mutton Merino wethers at different live weights. Small Ruminant Research, 18, 81–88.

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