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Changes in physico-chemical characteristics, somatic cell count and fatty acid profile of Brown Short-haired goat milk during lactation*

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The main aim of this study was to evaluate the effect of the lactation stage (SL) on the fatty acids (FA) profile of raw milk of Brown Short-haired goats reared under organic regime. An integral part of the study was also to assess the effect of the SL on the physico-chemical characteristics and somatic cell count (SCC) of milk. Milk records and samplings of each goat were carried out seven times from April to October. SL had a significant effect on contents of almost all monitored physico-chemical properties, somatic cell counts (SCC) and FA of milk and also on average daily milk yield (DMY). DMY gradually decreased with advanced lactation (from 3.44 to 1.44 litre), whereas the content of total solids (TS) increased in the course of lactation (from 10.9 to 14.0%). Also the content of milk fat (F) increased in the course of lactation (from 3.2 to 4.7%). Contents of total protein (TP) and casein (C) were relatively high in early lactation, decreased as lactation peaked and increased towards to late lactation (3.7% of TP and 2.6% of C). Titratable acidity (TA) gradually increased from 90th day (6.2°SH) to the end of lactation (8.5°SH), while positive correlations with TS, F, TP,

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C and lactose were found. SCC increased as lactation advanced, moreover, a positive correlation among SCC and TA and TS was found. The SL had a significant effect on all FA groups. PUFA gradually decreased towards to late lactation, which was caused mainly by the content of linoleic acid. Similarly, the presence of linolenic acid and PUFA/SFA ratio showed a decreasing tendency with advanced lactation. Also the CLA content was the lowest at the end of lactation. PUFA n-6/n-3 ratio increased in mid lactation (7.8) and thereafter decreased towards to late lactation (3.5). In our opinion, a less favourable presence of particular groups of FA in late lactation was related with a decrease in pasture quality under organic conditions.

KEY WORDS: goat / organic farming / lactation stage / milk properties /milk fat quality

In the last decade goat rearing in the Czech Republic (CR) undergone a substantial population increase. Current development of goat farming is mainly influenced by the higher consumer interest in goat milk products because of their natural, organic image and perceived health effects. Moreover, the goat milk is also increasingly used as an alternative to the cows milk because of its chemical composition, digestibility and low allergenicity. Goat milk is in the CR used mainly for cheese-making, whereas, on some farms it is also processed into various fermented milk products [Kuchtík *et al*. 2013].

Brown Short-haired (BSH) goat breed was obtained by crossing of indigenous spotted and brown goats with imported bucks of German Brown goat. This breed is currently included among European animal genetic resources. Due to its adaptability to unfavourable climatic conditions these goats are primarily kept in submoutainous and mountainous areas. Typical of this breed are also good milk yields, milk quality, and high prolificacy [Sedláčková and Kuchtík 2002].

Production and quality of dairy goat milk are affected by various factors such as nutrition, breed, lactation stage, parity, environment, season, and udder health status [Park *et al*. 2007]. Regarding basic chemical composition, the goat milk is quite similar to the cow milk. Nevertheless, goat milk has a more alkaline pH, as compared to cow milk and therefore is more suitable for consumers suffering from stomach acid imbalance.

The somatic cell count (SCC) of milk represents a sensitive marker for udder health and is considered to be a useful parameter to evaluate the relationship between intramammary infection and changes in milk characteristics [Raynal-Ljutovac *et al.* 2007]. In this respect, it is important to point out that the lactation stage (SL) is the most important non-infectious factor associated with SCC level [Raynal-Ljutovac *et al.* 2007]. In general, goat milk contains a higher SCC level than cow milk due to an apocrine secretory process of goats. Leitner *et al.* [2004] give a normal SCC level in goat´s milk as 210 000 to 1 120 000 cells/ml.

The fatty acid (FA) composition of goat milk is markedly different from that of cow milk, since goat milk fat is rich in short-chain FA (SCFA), e.g. caproic (C6:0), caprylic (C8:0) and capric (C10:0) as well as in medium-chain FA, e.g. lauric (C12:0). Short-chain FA comprise 15−18% out of the total FA in goat milk but only 5−9% in cow milk [Amigo and Fontecha 2011]. The most important factor affecting the FA profile of goat milk is nutrition [Pajor *et al.* 2009, Renna *et al.* 2012], whereas other

important effects are the season [Kondyli *et al.* 2012], lactation stage [Eknćs *et al.* 2006] and breed [Talpur *et al.* 2009].

The main aim of our study was to evaluate the effect of lactation stage on the FA profile of raw milk of Brown Short-haired goats kept under organic regime. An integral part of this study was also to assess the effect of lactation stage on the physico-chemical characteristics and SCC of milk.

Material and methods

The study was carried out on an organic farm "Kozí dvorek", located in the Vysočina region of the Czech Republic (an altitude of 520 m above sea level; an average annual temperature of 6.6°C; annual precipitation of 670 mm). Nine goats of Brown Short-haired breed were involved in the study. All goats were in the second lactation and delivered twins. Weaning of kids took place at the age of 45 to 50 days. After weaning all goats were machine-milked twice a day. During lactation, the daily feed ration of does consisted of permanent pasture (*ad libitum),* meadow hay *(ad libitum),* organic rolled oats (0.5 kg/doe), organic feed mixture for milking goats (VK DRCMAN, Czech Republic; 0.5 kg/doe), and organic mineral lick (*ad libitum).* During the experiment, all goats were kept in one flock under identical conditions without any discernible differences in nutrition or management. All goats were under permanent veterinary supervision.

Milk recording and sampling of each goat were carried out seven times within the whole experimental period (from April to October). Milk records were carried out from morning milking (6 am.) and evening milking (6 pm.), with an accuracy of 0.01 l. Milk samples were taken only from morning milking. Individual milk samples were cooled to 5-8°C and transported to the specialized milk laboratory at Mendel University in Brno and to the private Laboratory for Milk Analysis in Brno – Tuřany (Bohemian-Moravian Association of Breeders, a.s.).

Total solids (TS) content was determined gravimetrically by drying at 102°C to constant weight. Fat (F) content was determined by Gerber's acidobutyrometric method. Total protein (TP) and casein contents were determined using a PRO-MILK apparatus (Danish Co. Foss Electric). Lactose (L) content was determined polarimetrically. Active acidity (pH) was measured with the pH-meter WTW 95 with the electrode WTW SenTix 97. Titratable acidity (TA) was determined by titration using the Soxhlet–Henkel method. SCC was determined with fluoroopto-electronic apparatus BENTLEY 2500.

Milk (30 ml) was centrifuged at 4 000 rpm for 15 minutes. Samples of milk fat were stored frozen until fatty acids analyses. Extracted milk fat (50-60 mg) was dissolved in isooctane and homogenised in sonication bath. After the addition of CH_3ONa, the mixture was heated under the reflux condenser. In the first phase, the lipids reacted with CH_3ONa. In the alkaline environment, ester bonds in lipid compounds were well and quickly destructed and FA were released in the form of methyl esters. After the addition

of BF_3, the rest of CH_3ONa was neutralised and any remaining free FA were esterified in the acidic environment. Isooctane was added to the hot mixture of reagents, followed by saturated water solution of NaCl and fatty acid methyl esters (FAMEs) were shortly and intensively shaken out to get to the isooctane phase. After the separation of the organic and water phases the FAMEs were analysed using a gas chromatograph HP 4890 (Hewlett-Packard) with capillary column DB-23 (60m×0.25mm×0.25μm). The following temperature program was used: 100°C * 3min * 10°C/min * 170°C * 0min * 4°C/min * 230°C * 8min * 5°C/min * 250°C * 15min. Injector and detector temperature was 270°C and 280°C, respectively. The injection volume was 2 μl and nitrogen was used as the carrier gas. FAMEs were detected with the flame ionization detector. Final chromatograms were processed with CSW station program (version 1.7, Data Apex). Standard of the fatty acids mixture was SUPELCO 37 component FAME mix, cat. No. 47885-U + Linoleic acid conjugated methyl ester, cat. No. O5632. The content of individual FA was expressed as a percentage of the total sum of all detected FA.

Statistical analyses were performed using STATISTICA CZ version 10. Values of SCC were transformed to natural logarithm prior to statistical analysis. ANOVA analysis was used to study the differences in the physico-chemical properties, somatic cell count, and FA composition of raw milk in the course of lactation. When the analysis of variance showed significant differences within the lactation stage, Sheffe's test was used. Pearson's correlation was carried out to asses a level of the correlation coefficient among particular variables of physico-chemical properties and somatic cell count in milk. The differences were considered significant if $P<0.05$.

Results and discussion

As expected, the stage of lactation (SL) had a significant effect on contents of all monitored basic components of milk and daily milk yield (Tab. 1). These findings correspond with data published by Kondyli *et al.* [2007], Vacca *et al.* [2010] and Mestawet *et al.* [2012].

Concerning daily milk yield (DMY), the gradual decrease was probably affected mainly by the deterioration of the pasture quality in advanced lactation. By contrast, Vacca *et al.* [2010] and Mestawet *et al.* [2012] showed that the peak of DMY occurs in the mid lactation, while lower values of DMY were found in the early and late lactation stages. From both of these studies it appears that when DMY increases, the fat and protein contents decrease and *vice versa*. Daily milk yield of BSH goats in this experiment was relatively high compared to values published by Strzałkowska *et al.* [2009], Vacca *et al.* [2010] and Mestawet *et al.* [2012] for the various goat breeds reared on conventional farms. Also the total length of lactation in our experiment was considerably longer than that of the above mentioned authors.

On the contrary, within the similar lactation period Kuchtík and Sedláčková [2003] found a higher DMY in White Short-haired goats reared on conventional farm as compared to goats in our study.

In dairy goats, because of their seasonal lactation, it is relatively usual that contents of TS, TP and F are high in early lactation, decrease as lactation peaks and increase again when milk volume decreases towards the late lactation [Zeng *et al.* 1997, Kuchtík and Sedláčková 2003, Fekadu *et al.* 2005]. These trends were also confirmed in our study. Contents of TS, TP and F of milk in BSH goats during lactation were similar to those reported by Antunac *et al.* [2001] in Alpine and Saanen goats but, on the other hand, lower than those shown by Aganga *et al.* [2002], Kuchtík and Sedláčková [2003], Vacca *et al.* [2010] and Matutinovic *et al.* [2011], whereas in all above stated studies goats were reared in conventional farms. The above mentioned differences in DMY and milk composition depend mainly on nutrition and also on a particular breed, since specific genetic structures may result in different morphological traits and production parameters. Moreover, specific husbandry conditions also may play an important role. A significantly negative correlation was found between DMY and contents of TS, TP, F and casein in all cases (Tab. 2), which is in accordance with the data published by Vacca *et al.* [2010].

With the exception of the first sampling, the L content in the course of the lactation was the most constant component of all monitored milk components, confirming its role as an osmotic regulator and a compensator for variations in all other components. The relatively balanced content of L in goat milk during lactation was reported also by Kuchtík and Sedláčková [2003] and Eknćs *et al.* [2009]. By contrast, Kondyli *et al.* [2007], Strzałkowska *et al.* [2010] and

Table 1. Mean values of physico-chemical properties and SCC of goat milk in the course of lactation

Trait	Day of lactation							range	SEM	P
	62	90	125	161	188	224	258			
DMY (l)	3.44^{A}	3.12^{A}	3.04^{ACa}	2.38^{BCb}	2.22^{B}	2.03^{BD}	1.44^{D}	0.80-4.50	0.104	**
TS (%)	10.88^{A}	11.61^{BCa}	11.40^{AB}	11.57^{BCa}	11.81^{BC}	12.22^{Cb}	14.03^{D}	10.51-15.05	0.132	**
Fat (%)	3.20^{Aa}	3.29^{A}	3.45^{A}	3.56^{ABa}	3.66^{ABb}	3.97^{Bb}	4.67^{C}	2.99-5.46	0.070	**
Total protein (%)	2.99^{Aa}	2.69^{Bb}	2.76^{ABbc}	2.73^{B}	2.92^{ABac}	2.70^{Bb}	3.72^{C}	2.36-4.00	0.048	**
Casein (%)	2.23^{Aa}	2.05^{A}	2.10^{A}	2.03^{Ab}	2.17^{A}	2.06^{A}	2.59^{B}	1.80-2.80	0.028	**
Lactose (%)	3.83^{A}	4.77^{B}	4.32^{C}	4.42^{BC}	4.33^{C}	4.61^{BC}	4.58^{BC}	3.44-4.98	0.043	**
pH	6.73	6.72	6.73	6.72	6.70	6.63	6.73	5.70-6.94	0.018	NS
TA (°SH)	6.21^{Aa}	6.16^{Aa}	6.37^{A}	6.76^{A}	7.18^{ABb}	7.96^{BC}	8.49^{C}	4.77-9.12	0.141	**
SCC ($x10^3$/ml)	253^{a}	373	360	416	559	745	759^{b}	73-1352	46.2	*

$^{aA...}$Means within a row bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.
SEM – standard error of the mean; **$P<0.01$; *$P<0.05$; NS = non-significant.
SCC – somatic cell count; DMY – daily milk yield; TS – total solids; TA – titratable acidity.

Table 2. Pearson´s correlation coefficients between DMY, physico-chemical properties and SCC in goat milk

Trait	DMY	TS	Fat	TP	Casein	Lactose	pH	TA	SCC
DMY	1.00	-0.65**	-0.70**	-0.40**	-0.30*	-0.28*	0.03	-0.39**	-0.19
TS		1.00	0.93**	0.77**	0.71**	0.52**	0.1	0.68**	0.35**
Fat			1.00	0.66**	0.60**	0.34**	0.04	0.65**	0.26*
TP				1.00	0.95**	0.01	0.13	0.49**	0.35**
Casein					1.00	-0.01	0.13	0.44**	0.32*
Lactose						1.00	0.11	0.34**	0.18
pH							1.00	-0.16	-0.05
TA								1.00	0.43**
SCC									1.00

**P<0.01; *P<0.05.
DMY – daily milk yield; TS – total solids; TP – total protein; TA – titrable acidity; SCC – somatic cell count.

Vacca *et al.* [2010] recorded a decreasing trend of L content with advanced lactation. A correlation between the DMY and L content was significantly negative, whereas a correlation between contents of L and F was significantly positive (Tab. 2), as also reported by Zeng *et al.* [1997] and Kuchtík and Sedláčková [2003].

As for the effect of the SL on milk acidity, only a significant effect on TA was confirmed. The TA values gradually increased from day 90 to the end of the lactation, which is in line with results published by Antunac *et al.* [2001] and Kuchtík and Sedláčková [2003]. Titratable acidity plays a fundamental role in all phases of milk coagulation and also influences the rate of syneresis and determines the suitability of milk for cheese making [De Marchi *et al.* 2009], whereas the value of TA is quite affected by a protein content, as is apparent from the studies conducted by Kuchtík and Sedláčková [2003] and Strzałkowska *et al.* [2009]. In contrast, the higher TP content, the higher TA and *vice versa*. This trend was also confirmed in our study which resulted in a positive correlation between TA and TP (Tab. 2). A correlation between TA and pH was negative (P>0.05), in agreement with findings reported by Kuchtík and Sedláčková [2003], however in this case this correlation was found to be significant.

Values of pH in our experiment did not differ during lactation and the pH was not significantly correlated to any of the milk indicators measured**.** This agrees with the results published by Kondyli *et al.* [2012], while Aganga *et al.* [2002] found pH values which were significantly higher at the end of lactation compared to early lactation stages. Agnihotri and Rajkumar [2007] reported that pH gradually increases from the beginning of lactation and thereafter decreases with an advanced lactation stage. In general, the pH is an important parameter which affects the physico-chemical stability of casein micelles and milk behaviour in rennet coagulation and cheese making [Pirisi *et al.* 2007]. According to Vacca *et al.* [2010] the pH value could also be considered as a warning alarm for problems in feeding or an inflammation of the mammary gland.

All goats in this study were under permanent veterinary supervision and no clinical signs of mastitis were observed. This fact was reflected in the relatively low mean values of SCC that ranged from $253x10^3$ to $759x10^3$ per ml with respect to the lactation stage (Tab. 1). The limit of $1x10^6$ SCC/ml, which is the threshold fixed for

goat milk by the US Food and Drug Administration [Paape *et al.* 2007] was exceeded in our study only with a few individual samples. By the way, in EU there is no fixed limit for SCC in goat milk. Somatic cell counts in the present study significantly increased as lactation advanced, what is considered normal in seasonal dairy herds [Fekadu *et al.* 2005]. Moreover, Raynal-Ljutovac *et al.* [2007] reported that the late stage of lactation is the most important non-infectious factor causing a higher SCC level, in line with our findings. The correlations between SCC and TP and TA were highly significantly positive (Tab. 2). In our opinion, the high positive correlation between the SCC and TA was caused by the decrease in DMY and increase in TP at the end of lactation.

The fatty acid profile of goats´ milk during lactation is presented in Table 3. The results of the present study showed that the lactation stage had a significant effect on all determined FA, in agreement with results published by Eknćs *et al.* [2006] and Talpur *et al.* [2008]. Nudda *et al.* [2003] observed a significant effect of SL on C18:0, C18:1, C18:2, C18:3 and C18:2/9,11/ contents, while Güler *et al.* [2007] confirmed this effect for C10:0, C12:0, C14:0, C16:0, C18:0, C18:1 and C18:2. The LS had also significant effect on all evaluated groups of FA, consistent with findings reported by Tsiplakou *et al.* [2006] and Atasoglu *et al.* [2009].

As for individual FA in present study, the highest levels were found out in contents of C10:0, C14:0, C16:0, C18:0, and C18:1n9c, which is consistent with findings reported by Tsiplakou *et al.* [2006] and D'Urso *et al.* [2008], while as expected, the SFA group made up the most frequent group of total FA. Žan *et al.* [2006] claim that the SFA can constitute up to 75 % of total FA, mainly due to high contents of C16:0 and C18:0. In our study the proportion of SFA showed no long-term trend in its variation, which is in accordance with the data published by D'Urso *et al.* [2008] and Tudisco *et al.* [2010]. By contrast, Strzałkowska *et al.* [2009] and Ataţođlu *et al.* [2009] found out that the SFA percentage significantly decreased during lactation. The SFA content in our study ranged from 66.4 to 76.4 %. This range is considerably higher than SFA presence reported by D'Urso *et al.* [2008] and Tudisco *et al.* [2010], what was in our study mainly associated with the higher presence of C16:0 and C18:0. An important characteristic of small ruminant milk fat is a high content of short and medium-long chain FA, especially in goat´s milk fat [Chilliard *et al.* 2007]. In our study, the total content of C4:0 - C10:0 varied from 12.6% (day 188) to 15.2% (day 125), whereas it is possible to see an increasing trend in the content of C4:0 – C8:0 up to day 161 of lactation and its subsequent gradual decline at the end of lactation. Moreover, Chilliard *et al.* [2007] stated that the content of C6:0 – C10:0 is in goat milk twice higher that in the cow milk.

In general, the contents of C12:0, C14:0, C16:0, C14:1, and C16:1 of milk in our experiment showed similar trends, while these contents increased with advanced lactation, except for the day 161 and 188 of lactation. A completely opposite trend was observed in contents of C18:0, C18:1n9t, C18:2n6t, and C18:2/9,11/. According to most studies, proportion of MUFA in the total FA goat´s milk content can vary from 15 to 30%, however, the intrinsic content of oleic acid (C18:1n9c) is the main

Table 3. Fatty acid profile of goat milk in the course of lactation (% of total measured FA)

Trait	Day of lactation									P
	62	90	125	161	188	224	258	range	SEM	
C4:0	1.41^{AB}	1.46^{A}	1.38^{AB}	1.47^{A}	1.33^{AB}	1.24^{BC}	1.08^{C}	0.96-1.59	0.021	**
C6:0	1.98^{A}	1.98^{A}	1.98^{A}	1.92^{A}	1.80^{AB}	1.80^{AB}	1.57^{B}	1.46-2.33	0.027	**
C8:0	2.39^{ab}	2.36^{ab}	2.48^{a}	2.20^{ab}	2.14^{ab}	2.27^{ab}	1.98^{b}	1.45-2.87	0.036	*
C10:0	7.95^{AB}	7.92^{AB}	9.32^{A}	7.04^{B}	7.33^{B}	9.31^{A}	8.07^{AB}	4.15-11.09	0.154	**
C12:0	3.32^{AB}	3.35^{AB}	4.73^{AC}	2.97^{B}	3.49^{AB}	5.98^{C}	5.67^{C}	1.89-10.44	0.190	**
C14:0	8.84^{A}	9.04^{Aa}	11.01^{BCb}	8.08^{A}	9.26^{AB}	12.61^{C}	12.56^{C}	6.82-16.24	0.260	**
C15:0	1.05^{A}	1.21^{AB}	1.62^{B}	0.86^{A}	1.03^{A}	1.24^{AB}	1.29^{AB}	0.69-2.89	0.015	**
C16:0	27.14^{A}	28.25^{ABa}	32.40^{BCb}	25.54^{A}	27.67^{A}	34.31^{C}	32.42^{BCb}	21.31-39.26	0.042	**
C18:0	14.37^{ABa}	13.59^{AB}	9.84^{ACb}	15.97^{B}	13.86^{ABa}	7.46^{C}	8.07^{C}	3.48-21.82	0.496	**
C20:0	0.28^{a}	0.33^{A}	0.23^{BC}	0.30^{AB}	0.30^{AB}	0.19^{Cb}	0.28^{a}	0.11-0.47	0.041	**
C14:1n5c	0.10^{A}	0.12^{A}	0.21^{AB}	0.12^{A}	0.18^{A}	0.32^{BC}	0.38^{C}	0.07-0.54	0.483	**
C16:1n7c	0.49^{A}	0.57^{AB}	0.89^{BC}	0.59^{AB}	0.76^{ABDa}	1.10^{CDb}	1.20^{C}	0.42-1.73	0.041	**
C18:1n9t	0.99^{ADa}	0.79^{ABD}	0.47^{BC}	1.05^{D}	0.66^{ACb}	0.39^{C}	0.48^{BC}	0.28-1.58	0.499	**
C18:1n9c	22.19^{AB}	23.33^{ABa}	19.30^{A}	26.67^{B}	26.16^{B}	18.51^{Ab}	22.36^{AB}	12.09-35.14	0.021	**
C18:2n6t	0.54^{A}	0.38^{B}	0.21^{C}	0.54^{A}	0.32^{BCa}	0.19^{C}	0.19^{Cb}	0.08-0.64	0.161	**
C18:2n6c	4.95^{A}	3.89^{AB}	3.14^{BCa}	3.21^{BCa}	2.70^{BC}	2.18^{C}	1.69^{Cb}	1.41-6.20	0.049	**
C18:2(9,11)	0.53^{AB}	0.44^{AB}	0.33^{ABa}	0.85^{Ab}	0.61^{AB}	0.43^{AB}	0.17^{B}	0.11-1.78	0.041	**
C18:2(10,12)	0.04^{A}	0.01^{B}	0.01^{B}	0.02^{AB}	0.01^{B}	0.01^{B}	0.00^{B}	0.00-0.08	0.002	**
C18:3n3c	1.43^{A}	0.96^{B}	0.46^{C}	0.58^{C}	0.40^{C}	0.46^{C}	0.54^{C}	0.30-2.02	0.008	**
ΣSFA	68.73^{AC}	69.50^{AC}	74.99^{B}	66.36^{A}	68.21^{ACa}	76.41^{B}	72.99^{BCb}	59.11-80.39	0.548	**
ΣMUFA	23.78^{ABac}	24.82^{ABa}	20.87^{A}	28.44^{Bb}	27.76^{B}	20.33^{Ac}	24.43^{AB}	14.68-31.45	0.490	**
ΣPUFA	7.49^{Aa}	5.68^{ABb}	4.15^{BC}	5.20^{B}	4.03^{BCc}	3.26^{C}	2.58^{C}	2.23-8.91	0.224	**
ΣUFA	31.27^{AD}	30.50^{AD}	25.01^{BC}	33.64^{A}	31.79^{ADa}	23.59^{BC}	27.01^{CDb}	18.42-40.89	0.548	**
ΣPUFAn-3	1.43^{A}	0.96^{B}	0.46^{C}	0.58^{C}	0.40^{C}	0.46^{C}	0.54^{C}	0.26-2.02	0.049	**
ΣPUFAn-6	5.49^{A}	4.28^{AB}	3.35^{BDac}	3.75^{BCa}	3.01^{BD}	2.37^{CDbc}	1.87^{Db}	1.57-6.79	0.172	**
PUFAn-6/n-3	3.94^{A}	4.76^{AB}	7.33^{C}	6.82^{BC}	7.80^{Ca}	5.59^{ABCb}	3.48^{Ac}	2.38-10.05	0.273	**
CLA	0.57^{AB}	0.45^{AB}	0.33^{ABa}	0.88^{Ab}	0.62^{AB}	0.43^{AB}	0.17^{B}	0.11-1.83	0.042	**

[aA...] Means within a row bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.
SEM – standard error of the mean; **$P<0.01$; *$P<0.05$.

determining factor. This was shown also in our study, as the MUFA presence was relatively variable due to a variation in the content of C18:1n9c. The contents of MUFA in this study ranged from 20.33 to 28.44%, which is a markedly wider range than that found by Talpur *et al.* [2008] and Tudisco *et al.* [2010]. Moreover, the contents of MUFA, more precisely C18:1n9c, were in the above-mentioned studies also lower than in our investigations.

The PUFA group is important because of its favourable effect on human health. In general, the PUFA content in goats´ milk is relatively low, but it can be elevated by supplements of plant oils or oilseeds into feed [Cieslak *et al.* 2010]. However D´Urso *et al.* [2008] and Tudisco *et al.* [2010] stated that PUFA content of milk fat is relatively very variable during lactation, while this variability is mainly related to a variation in FA profile of the pasture. In our study, the PUFA contents up to mid-lactation were also relatively very variable, but thereafter they gradually decreased towards to late lactation. This was related mainly to the reduction in linoleic acid (C18:2n6) content. By contrast, Strzałkowska *et al.* [2009] showed the opposite trend.

The C18:2n6c content is very low in goat´s milk [Park et al. 2007]. However, since C18:2n6c is important for human health, its content in milk fat can be markedly increased by the supplementation of the feed by large amounts of encapsulated safflower or encapsulated rapeseed, sunflower, soybean or cotton seed oil [Chilliard *et al.* 2000]. Tudisco *et al.* [2010] also stated markedly higher presence of C18:2n6c in organic farming (2.77%) than in conventional farming (2.07%). In our assessment, the content of C18:2n6c decreased from 4.95 to 1.69% with advanced lactation. By contrast Talpur *et al.* [2008] found its increase in late lactation and Eknćs *et al.* [2006] found its fluctuation during lactation, with the highest value in the mid-lactation**.**

Like linoleic acid, the linolenic acid (C18:3n3c) is also nutritionally very important for human health. Its content in goats´ milk is also relatively low, whereas its increase can be achieved by a similar manner to that of C18:2n6c. In our experiment, the highest presence of C18:3n3c was found at the beginning of the lactation while this fact was probably affected by the best pasture quality in that period. Thereafter the presence of C18:3n3c markedly decreased till the day 125 of lactation and subsequently it showed relatively balanced content, what is in accordance with results published by Ataţođlu *et al.* [2009]. By contrast Tsiplakou *et al.* [2006] reported gradual increasing of C18:3n3c during lactation.

Food products from ruminants are a major dietary source of conjugated linoleic acid (CLA) for humans. The total CLA content in milk fat of goats is lower than that of milk fat of sheep and cows [Park *et al.* 2007]. It appears that the CLA content in milk is mainly influenced by nutrition. In our study, the significant increase in CLA content (0.88 %) became on day 161 of lactation, while its significant lowest content (0.17 %) occurred thereafter at the end of lactation. In our opinion, relatively high CLA presences in early lactation and in the summer are again a consequence of sufficient intake of the high quality pasture in that period, which is in line with findings published by Talpur *et al.* [2008]. In contrast D'Urso *et al.* [2008] and Tudisco *et al.* [2010]

reported that the CLA content gradually increased with advanced lactation. Besides, Tsiplakou *et al.* [2006] and Atasoglu *et al.* [2009] did not find out a significant effect of the SL on CLA content.

The minimum P/S (PUFA/SFA) ratio set for the human nutrition is 0.45 [Simopoulos 2004]. P/S ratio in our study showed a gradually decreasing trend during lactation (from 0.11 to 0.03). Values of P/S ratio in our assessment, with exception of the end of lactation, are similar to those published by Tsiplakou *et al.* [2006], Atasoglu *et al.* [2009], Tudisco *et al.* [2010], and Delgado-Pertińez *et al.* [2013]. Markedly lower P/S ratio in goat milk was reported by Talpur *et al.* [2008], whereas those authors stated that a higher P/S ratio occurs in sheep, cow and buffalo milk as compared to goat milk. Concerning trends of P/S ratio in goats´ milk in the course of lactation, most studies revealed only its low variability. However, its gradual increase with advanced lactation was found out by Strzałkowska *et al.* [2009].

The value of the PUFA n-6/n-3 (n-6/n-3) ratio in the present study increased in mid lactation and thereafter decreased in late lactation. These values in our assessment were relatively close to the recommended range of 4-5 published by Ralph [2000]. Values of n-6/n-3 in our study are similar to those recorded by Pajor *et al.* [2009], Ceballos *et al.* [2009] and Delgado-Pertińez *et al.* [2013] in goat milk. Moreover, Ceballos *et al.* [2009] stated in cows´ milk a markedly higher level of n-6/n-3, specifically 10.49. Concerning FA profile in milk, it is important to point out that the majority of above stated studies was carried out under conventional farming.

In conclusion it can be stated that although the Brown Short-haired breed is included among local breeds and currently is also included among European animal genetic resources, its milk yield and milk quality is entirely comparable to high-yielding dairy breeds. The results of our study also suggest that this breed is suitable for rearing in the organic system. In line with Vacca *et al*. [2010], we have to notice that the results of our study extend the knowledge about the local goat breeds and their use under organic regime.

Our results show that the stage of lactation had a significant effect on the contents of almost all monitored physico-chemical properties, SCC and FA of milk in the Brown Short-haired breed. The most important changes in milk composition and FA profile occurred in the last third of lactation, when e.g. considerably increased the contents of fat and protein. In this lactation stage, also the significant decrease in PUFA n-6 and CLA contents were found, probably due to the deterioration of pasture quality. However, relatively high DMY and favourable level of SCC were recorded in this period.

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