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EFFECT OF CHOSEN FACTORS ON MILK YIELD, BASIC COMPOSITION AND SOMATIC CELL COUNT OF ORGANIC MILK OF BROWN SHORT-HAIRED GOATS

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Abstract

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Effect of stage of lactation (SL), parity (PA), litter size (LS) and month of kidding (MK) on daily milk yield, basic composition and somatic cell count of organic goat milk were evaluated using 32 goats of Brown short-haired breed which were reared on an organic farm in Olešenka. Goats were on the 1st (n = 15), 2nd (n = 10) and 3rd (n = 7) lactation; 15 of them gave birth to singles and 17 to twins. Kidding occurred in January (n = 5), February (n = 13) and March (n = 8). During the experiment all goats were reared on permanent pasture, in one flock and under the identical conditions. The PA had a significant effect on all monitored parameters; also the SL had a significant effect on all monitored parameters except SCC. Systematic factors LS and MK had a significant effect only on DMY and SCC; on the other hand, these factors had no significant effect on basic milk composition. The milk fat was the most variable component of the milk. On the other hand the lactose content was during lactation very well-balanced. SCCs were relatively low which indicates good health status of mammary gland. The highest DMY, SCC and contents of basic milk components, except lactose, were found in goats on PA2. The higher DMY was expected in goats with twins compared to goats with singles, but the opposite trend proved to be true.

organic milk, dairy goats, milk yield, composition, somatic cells

Goats were the first to be domesticated by early humans as farm livestock about 10,000 years ago and these animals were developed around the world into hundreds of different breeds (Hatziminaoglou and Boyazoglu, 2004; Park and Haenlein, 2006). In the Czech Republic (CR) the goat husbandry has generally been ranked among a minority group in the animal production. However, last ten years can be considered as the renewal of this breeding in our country, whilst its development was above all registered within the organic production. By the way, the number of goats has increased since 2006 by 61.5% and the current number app2roaches 23,300 heads (Bucek *et al.*, 2011), while in 2011 was approximately a quarter of goats reared on organic farms. The most widespread breeds in CR are White short-haired goat and Brown short-haired goat.

Goat's milk composition is very similar to cow's milk, making it a relatively widely used for subsequent processing (consume goat milk, cheese, yoghurts, fermented milk products etc.). On the other hand, this milk is relatively very often used as an alternative to cow milk because of its digestibility and low allergenicity (Mowlem, 2005). In any case, goat milk is very popular among the consumers because of its natural and organic image. Consumption of goat milk has not been a traditional in the Czech Republic; currently its consumption is only 0.1 liters per inhabitant per year. On the other hand, nowadays the value of goat milk in human

nutrition is growing up (Hanuš *et al.*, 2008 and Bucek *et al.*, 2011). The chemical composition of goat milk and its production are affected by various factors, mainly by nutrition, breed, stage of lactation, parity, environment, season and udder health status (Boayzoglu and Morand-Fehr, 2001; Park *et al.*, 2007).

For goat milk is typical "goat smell" or "goaty" rancid taste which is caused by the short-chain fatty acids (FA), these make up approximately 25% of all free FA in goat milk. Under unfavorable condition goat milk is subjected to lipolysis in which these FA are liberated (Soryal *et al.*, 2005; Park and Guo, 2006). Compared to cow milk, goat milk is richer in vitamins and minerals (Carnicella *et al.*, 2008). Goat milk proteins are similar to the major cow milk proteins in their general classification, but they differ in genetic polymorphism (Haenlein, 2004). The fat globules in goat milk are characterized by a smaller diameter than those of cow milk and probably this is one of the reasons for its easier and quicker digestion (Park *et al.*, 2007).

The somatic cell count (SCC) is a major indicator of the health status of mammary gland. Mastitis is the most frequent disease in dairy herds and is the main source of economic loss in milk production. Goat milk contains naturally higher SCC than cow milk due to the apocrine secretory process of goats (Park and Guo, 2006), while Leitner *et al.*, (2004) reported as normal SCC between 210,000 and 1,120,000 cells/ml. However, as opposed to dairy cows, for which the European Union (Council Regulation No. 853/2004) established the limit to be at 400,000 cells/ml, goat milk limit is not established.

The main aim of our study was to evaluate the effect of chosen factors (stage of lactation, parity, litter size and month of kidding) on milk yield, basic composition and SCC of organic milk of Brown short-haired goat.

MATERIAL AND METHODS

The study was carried out on an organic farm in Olešenka during 2011. The farm is situated in the Vysočina region at an altitude of 520m above sea level with an average annual temperature of 6.6 °C and annual precipitation of 670mm. The experiment involved 32 goats of Brown short-haired breed, while in terms of parity 15 goats were on the first lactation (PA1), 10 goats on the second lactation (PA2) and 7 goats on the third lactation (PA3). With regard to litter size there were 15 goats which gave birth to singles (LS1) and 17 goats gave birth to twins (LS2). The kidding occurred in January (n = 5), February (n = 13) and March (n = 8). The weaning of kids was carried out at the age of kids from 45 to 50 days. After the weaning all does began to be machine milked twice a day.

Before parturition the daily feed ration of goats consisted of meadow hay *(ad libitum)*, haylage *(ad libitum)*, organic mineral lick *(ad libitum)* and fodder beet (1 kg/head). During the lactation the daily feed ration of goats consisted of permanent pasture (*ad libitum*), meadow hay *(ad libitum)*, organic oat (0.5kg/head), organic feed mixture for milking goats (VK DRCMAN/CR, 0.5kg/head) and organic mineral lick *(ad libitum.)*. During the experiment, all goats were reared in one flock under identical conditions without any discernible differences in nutrition or management.

Milk records and samplings for each goat were carried out seven times in the period from April to October. Milk records were carried out during the morning and evening milking (6 am, 6 pm), whereas, sampling was done only in the morning. The obtained data was subsequently recalculated using linear interpolation to the average 50th, 85th, 120th, 155th, 190th, 225th and 260th day of lactation.

Individual milk samples were cooled to 5–8 °C and transported in a thermo-box to a 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.). As part of the laboratory analysis, the following determinations of milk composition were carried out: total solids (TS), fat (F), total protein (TP), casein (C) and lactose (L) contents. The evaluation of daily milk yield (DMY) and somatic cell count (SCC) was also an integral part of this study. Milk yield was determined from the whole day with an accuracy of 0.01l.

TS content (%) was determined gravimetrically; by over drying at 102 °C to constant weight (Czech technical Standard ISO No. 6731, 1998). F content (%) was determined by Gerber's acidobutyrometric method (Czech Technical Standard ISO No. 2446, 2001). TP and C contents (%) were determined using a PRO-MILK apparatus (manufactured by the Danish Co. Foss Electric; Czech Technical Standard No. 570530, 1974). L content (%) was determined polarimetrically (Czech Technical Standard No. 570530, 1974). SCC was determined using fluoro-opto-electronic apparatus BENTLEY 2500 (Czech Technical Standard EN ISO No. 13366-2, 2007).

A statistical analysis was carried out using the mathematical-statistical package STATISTICA version 9.0. The following mathematical model was used:

$$Y_{ijklm} = \mu + SL_i + PA_j + LS_k + MK_l + e_{ijklm},$$

where Y_{ijklm} is the experimental observation, μ the general mean, SL_i the fixed effect of ith stage of lactation ($i = 1, \ldots 7$), PA_j the fixed effect of jth parity ($j = 1, 2$ *and* 3), LS_k the fixed effect of kth litter size ($k = 1$ *and* 2), MK_l the fixed effect of lth month of kidding ($l = 1, 2$ *and* 3) *and* e_{ijklm} is random residual error. Tukey's HSD test was used to determination the statistically significant differences. The differences were considered significant if $P < 0.05$.

RESULTS AND DISCUSSION

The stage of lactation (SL) (Tab. I) had a significant ($P \leq 0.01$) effect on daily milk yield (DMY) and

contents of fat (F), total protein (TP) and casein (C). This factor also significantly ($P \leq 0.05$) affected contents of total solids (TS) and lactose (L). These findings correspond with data published by Zeng *et al.* (1997), Kuchtík and Sedláčková (2003), Kondyli *et al.* (2007), Mestawet *et al.* (2012) and Pajor *et al.* (2012). On the other hand, the SL had not a significant effect on somatic cell count (SCC), which is in line with data published by Borges *et al.* (2004). However, Fekadu *et al.* (2005) and Vacca *et al.* (2010) did not found a significant effect of SL on SCC.

DMY decreased from the beginning till the end of lactation, similar trend has been reported by Zeng and Escobar (1995), Kuchtík and Sedláčková (2003), Keskin *et al.* (2004) and Strzałkowska *et al.* (2010). On the contrary, according to Vacca *et al.* (2010) and Mestawet *et al.* (2012), the peak of DMY occurred in the mid lactation, while the lower values were found in the early and late lactation stage. In our opinion, the gradually decreasing DMY was affected by the deteriorating quality of pasture.

In dairy goats, because of their seasonal lactation, it is usual that contents of TS, TP and F are high in early lactation, decrease as lactation peaks and increase when milk volume decreases towards late lactation (Zeng *et al.*, 1997; Fekadu *et al.*, 2005 and Soryal *et al.*, 2005). Also Strzałkowska *et al.* (2010) and Mestawet *et al.* (2012) reported, that in the early and late lactation stage the contents of TS, TP and C are significantly higher than in the mid lactation stage. This observation follows the normal lactation curve of dairy goats. In contrast, under this study was found that the contents of TS, TP and C were relatively stable between the 50th and 190th day of lactation, however subsequently greatly increased till the end of lactation. In our opinion, the substantial increase in contents of TS, TP and C from 190th day to the end of lactation was affected by the decreasing DMY. The same trends have been reported also by Kuchtík and Sedláčková (2003). However, Aganga *et al.* (2002) found, that the contents of TS, TP a C increased since the beginning of the lactation.

The values of F content during lactation in our experiment were the most variable compared to the other parameters. However, it is necessary to complete that from 190th day of lactation till the end of lactation its values had a gradual increasing trend. On the other hand, Vacca *et al.* (2010) in Sarda goat breed and Přidalová *et al.* (2008) in goat bulk milk samples recorded increasing trend of F content from the beginning till the end of lactation. However, Kuchtík and Sedláčková (2003) found in White short-haired goats a relatively stable content of F between 35th and 163th day of lactation, followed by its increasing up to the end of lactation period. Completely different trend found Guo *et al.* (2001), Strzałkowska *et al.* (2010) and Mestawet *et al.* (2012), because in their studies the lowest F content was found in the mid lactation stage.

The L content in the course of lactation was relatively the most constant of all components of milk, except 50th (4.22 %) and 225th (4.60 %) day of lactation, confirming its role as an osmotic regulator and a compensator for variations in all other components. Similar well-balanced trend, except the 100th day of lactation, has been reported by Zeng and Escobar (1995) and Kuchtík and Sedláčková (2003). Přidalová *et al.* (2008) also found that L content is well-balanced till September; however, since this month till the end of the lactation above mentioned authors reported significant decrease of this parameter. On the other hand, Kondyli *et al.* (2007) and Vacca *et al.* (2010) observed a decreasing trend of L content during lactation, whilst Prasad *et al.* (2005) and Mestawet *et al.* (2012) mentioned that L content was high in the early lactation and lowest in the late lactation stage.

According to Fekadu *et al.* (2005), SCCs increase significantly as lactation advanced, which is considered normal in seasonal dairy goat herds. In our experiment the SCC ranged from 511.10^3 to 1006.10^3/ml, while from 120th day till the end of lactation the gradual increase of this parameter was found. On the other hand, Zeng and Escobar (1996) and Vacca *et al.* (2010) reported a significant increase of SCC only in the period from spring till the summer. In conclusion of this part it is necessary to complete that the SCC during lactation in our experiment were markedly lower in comparison with Zeng and Escobar (1995) and Přidalová *et al.* (2008), whilst according to Zeng and Escobar (1995) dairy goats with healthy udders may produce milk with $> 1.0.10^6$ cells/ml, particularly in late lactation.

The parity (PA) had a significant effect on all parameters of goat milk, which is in line with results published by Zumbo *et al.* (2004), Carnicella *et al.* (2008) and Strzałkowska *et al.* (2010). On the other hand, Zeng and Escobar (1995) states that parity did not affected contents of basic milk component and SCC.

In our study the goats on PA1 had the lowest DMY, while goats on PA2 and PA3 had a similar milk yield which is consistent with finding by Zeng and Escobar (1995). However, the goats on PA2 had a significantly higher content of TS, F, TP, C and SCC in milk compared to goats on PA1 and PA3. On the contrary, Strzałkowska *et al.* (2010) found the highest DMY, as well as the contents of TS, F, TP and C in goats on the first lactation. The same scenario, except DMY, has been reported by Zumbo *et al.* (2004), whereas the above mentioned authors determined the highest DMY in goat on PA3.

The L content was the highest in goats on PA1 (4.49 %), whilst on the PA2 and PA3 were found the same contents of this parameter. On the contrary, Carnicella *et al.* (2008) observed statistically higher L content in goats on PA1 and PA2 (4.7 %) compared to PA3 (4.6 %). Furthermore, Strzałkowska *et al.* (2010) reported the highest L content in goats on PA2 (4.55 %) and Zumbo *et al.* (2004) in goats on PA1 (4.70 %) and PA3 (4.71 %). Under our study, the goats

I: *Effect of stage of lactation, parity, litter size and month of kidding on milk yield, composition and somatic cell count in goat milk*

	Milk Yield (l/day)			Total solids (%)			Fat (%)			Total protein (%)			Casein (%)			Lactose (%)			SCC (10^3/ml)		
	L.S.M.	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**	**L.S.M.**	**S.E.M.**	**Sign.**
STAGE OF LACTATION		**			*			**			**			**			*			NS	
50. day	2.81	0.195	A	11.39	0.205	a	3.21	0.137	ABC	2.82	0.051	A	2.09	0.036	A	4.22	0.086	a	750	341	
85. day	2.56	0.211	AB	10.76	0.129	b	2.85	0.107	AC	2.69	0.029	A	2.03	0.020	A	4.51	0.045	bd	599	169	
120. day	2.56	0.129	AB	10.61	0.108	b	2.75	0.105	A	2.82	0.035	A	2.07	0.023	A	4.36	0.016	c	511	129	
155. day	2.18	0.103	B	11.10	0.152	ab	3.36	0.145	BE	2.79	0.032	A	2.05	0.021	A	4.38	0.020	ce	632	121	
190. day	1.76	0.107	C	11.38	0.126	a	3.34	0.116	CE	2.85	0.036	A	2.11	0.027	A	4.46	0.034	bc	657	125	
225. day	1.50	0.104	C	12.21	0.251	c	3.96	0.168	D	3.02	0.091	B	2.22	0.055	B	4.60	0.032	d	878	132	
260. day	1.29	0.103	C	13.20	0.215	d	4.46	0.154	D	3.56	0.070	C	2.54	0.045	C	4.53	0.040	bde	1006	175	
PARITY		**			**			**			*			*			*			*	
PA1	1.61	0.061	A	11.27	0.128	A	3.22	0.092	A	2.91	0.039	a	2.12	0.025	a	4.49	0.020	a	504	46	a
PA2	2.50	0.106	B	11.77	0.143	B	3.62	0.105	B	2.93	0.047	a	2.17	0.029	b	4.40	0.040	b	963	170	b
PA3	2.51	0.153	B	11.19	0.160	A	3.24	0.128	A	2.85	0.045	b	2.12	0.029	a	4.40	0.032	b	676	101	ab
LITTER SIZE		*			NS			NS			NS			NS			NS			*	
Singles	2.22	0.093	a	11.37	0.125		3.31	0.094		2.90	0.037		2.14	0.023		4.43	0.026		527	53	a
Twins	2.04	0.089	b	11.47	0.113		3.41	0.082		2.90	0.035		2.14	0.022		4.44	0.025		850	114	b
MONTH OF KIDDING		**			NS			NS			NS			NS			NS			*	
January	2.24	0.139	A	11.49	0.222		3.38	0.162		2.92	0.058		2.16	0.035		4.43	0.044		403	103	a
February	2.46	0.106	A	11.49	0.110		3.47	0.085		2.88	0.036		2.13	0.023		4.40	0.030		978	131	b
March	1.66	0.068	B	11.31	0.147		3.23	0.105		2.92	0.045		2.14	0.029		4.49	0.022		519	53	a
AVERAGE/WHOLE LACTATION	**2.13**	**0.065**		**11.42**	**0.084**		**3.36**	**0.062**		**2.90**	**0.025**		**2.14**	**0.016**		**4.44**	**0.018**		**701**	**67**	

ABCDE: within the columns, values with different letters are significantly different at $P \leq 0.01$, **: statistically highly significant ($P \leq 0.01$); abcde: within the columns,values with different letters are significantly different at $P \leq 0.05$, *: statistically significant ($P \leq 0.05$); NS: statistically non-significant

of PA2 had a significantly higher SCC contrary to the goats on PA1 and PA3, which is in line with data published by Zumbo *et al.* (2004).

Litter size (LS) had a signicifant ($P \leq 0.05$) effect only on DMY, which is in line with results published by Zumbo *et al.* (2004) and Carnicella *et al.* (2008), and on SCC, which corresponds with finding by Zumbo *et al.* (2004). With regard to DMY, it was expected that the goats with twins will have higher DMY compared to goats with singles. Zumbo *et al.* (2004) also found out the higher DMY in multiple kidding goats, while above mentioned authors stated that the higher milk yield in multiple kidding goats could be explained by the effect of the greater quantity of placental hormones produced during pregnancy and by suckling kids. However, in our experiment the higher DMY was found in goats with singles. Zumbo *et al.* (2004) also reported a significant effect of LS on L content, while in their experiment the goats with a singles had a higher content of L compared to our result. As far as the SCC the goats with a singles had in our study statistically lower its count against goat with twins, which is in agreement with results published by Zumbo *et al.* (2004).

Month of kidding had a significant effect on DMY and SCC; on the other hand, this factor did not affect any of the monitored components of milk. Goats which gave birth in January and February had significantly higher DMY compared to goats which gave birth in March. In our opinion, higher DMY in goats which gave birth in January and February could have been caused by stable feed ration in winter. In conclusion of this part it is necessary to complete that significantly higher SCC was observed in goats which gave birth in January.

CONCLUSIONS

The stage of lactation had a significant effect on all monitored parameters except somatic cell count (SCC). The parity had a significant effect on all monitored parameters. The litter size and month of kidding had a significant effect only on daily milk yield (DMY) and SCC. As far as the particular basic components of milk, the milk fat was the most variable component. On the other hand, the lactose content was during lactation very well-balanced. SCCs were relatively low, except the 260th day of lactation, which indicates good health status of mammary gland. The highest DMY, SCC and contents of basic milk components, except lactose, were found in goats on PA2. It was expected the higher DMY in goats with twins compared to goats with singles, but it was found out the opposite trend.

SUMMARY

Evaluation of effect of chosen factor (stage of lactation, parity, litter size and month of kidding) on daily milk yield, basic composition (contents of total solids, fat, total protein, casein and lactose) and somatic cell count of organic goat milk was carried out on an organic farm in Olešenka during the year 2011. Thirtytwo goats of Brown short-haired breed were involved in the experiment, while 15 goats were on the first lactation (PA1), 10 goats on the second (PA2) and 7 goats on the third lactation (PA3). With regard to litter size, 15 goats gave birth to singles and 17 to twins, while the kidding occurred in January (n = 5), February (n = 13) and March (n = 8). The weaning was carried out at the age of kids from 45 to 50 days, after that all goats began to be machine milked twice a day. During the lactation, the daily feed ration of goats consisted of permanent pasture (*ad libitum*), meadow hay *(ad libitum)*, organic oat (0.5 kg/head), organic feed mixture for milking goats (VK DRCMAN/CZE, 0.5kg/head) and organic mineral lick (*ad libitum*). The milk records and samplings for each goat were carried out seven times in the period from April to October. The milk analysis were carried out using standard methods. The stage of lactation had a significant effect on all monitored parameters except somatic cell count (SCC) and the parity had a significant effect on all monitored parameters. On the other hand, systematic factors of litter size and month of kidding had a significant effect only on daily milk yield (DMY) and SCC. With regard to the particular basic components of milk, the milk fat was the most variable component; on the other hand, the lactose content was during lactation very well-balanced. SCCs were relatively low, except the 260th day of lactation, which indicates good health status of mammary gland. The highest DMY, SCC and contents of basic milk components, except lactose, were found in goats on PA2. It was expected the higher DMY in goats with twins compared to goats with singles, but under the study it was found out the opposite trend.

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