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SOMATIC CELL COUNTS AND TOTAL BACTERIAL COUNTS IN GOAT MILK

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Summary

The main aim of our study was to evaluate the somatic cell count (SCC) and the total bacterial count (TBC) in the raw goat's milk immediately after milking. The study was carried out in seven goats of the Brown Short-haired (BSH) breed during the whole lactation. An integral part of our study was to evaluate the effect of the stage of lactation (SL) on the daily milk yield (DMY), basic milk components (contents of fat, total protein and lactose), and pH of milk and relationships between all monitored indicators. All monitored goats were in the second lactation and throughout the study, all these goats were clinically healthy. Individual milk recording and sampling of each goat were carried out on the mean 64, 109, 146, 181 and 218 day of lactation. During milk recording and sampling all monitored goats were milked by hand. During lactation, the mean values of Log SCC ranged from 3.68 to 7.16 and the mean values of Log TBC from 5.30 to 9.49, whilst the SL had a significant ($p \leq 0.01$) influence on both of these indicators. Both the Log SCC and the Log TBC had a significant ($p \leq 0.01$) correlation only with the content of lactose, whilst both of these correlation were negative. However, the correlation between the Log SCC and the Log TBC was significanly ($p \leq 0.05$) positive. Regarding the effect of the SL on all other monitored traits, this factor had a significant ($p \leq 0.01$) effect on the DMY and contents of all basic milk components. Nevertheless, the SL had no significant effect on pH. Despite the fact that the SL had a significant ($p \leq 0.01$) effect on the fat and protein contents, in general it can be stated that their contents were quite variable. On the other hand the contents of lactose gradually decreased during lactation. In conclusion, it can be stated that the results of our study suggest that the content of lactose may be a good predictor of both the SCC and the TBC and that when the SCCs increase the TBCs also increase and vice versa.

Keywords: goat milk, somatic cell count, total bacterial count, basic milk components, pH, hand milking

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Introduction

Many studies show that the SCC in goat milk compared to their counts in cow milk, due to apocrine milk secretion process in goats, are generally higher and show higher variability. The SCC also represents a sensitive marker for udder health and is considered to be a useful parameter to evaluate the relationship between intramammary infection (IMI) and changes in milk characteristics (*Raynal-Ljutovac et al*. 2007). The SCCs are also affected by non-infectious factors, when according to *Jiménez-Granado et al*. (2014) the most important these actors are fraction of milking, stage of lactation and number of lactation, whilst according to *Paape et al*. (2001), the SCCs in clinically healthy goats range from 270,000 to 2,000,000/mL. However**,** in the EU, there is no legal limit for this indicator in goat milk.

The TBC is used to evaluate the bacteriological quality of milk, while this quality trait is mainly affected by milking method, hygiene of milking equipment and storage tanks, hygiene of milkers and environment in the milking parlor. However, according to *Contreras et al*. (2003) a high prevalence of IMI also contribute to an increase in bacterial counts. According to Delgado-*Pertiñez et al.* (2003) the TBCs in bulk samples range from 10^3 to 10^6 Colony Forming Units (cfu)/mL. In conclusion to the above it must be added that the EU determines for small ruminants the limits for the TBC in bulk milk, in contrast to SCC, when these limits are: $1{,}500 \times 10^3$ cfu/mL in milk subjected to heat treatment and 500×10^3 cfu/mL for milk not subjected to heat treatment.

The main aim of our study was to evaluate the SCC and the TBC in the raw milk of Brown Short-haired goats during lactation and their relationships to selected milk traits. An integral part of our study was to evaluate the effect of the stage of lactation (SL) on all monitored indicators.

Material and methods

The study was carried out on a organic goat dairy farm located on the territory of the PLA Beskydy in Czech Republic. Experimental procedures and animal care conditions followed the recommendation of European Union directive 86/609/EEC and were approved by Expert Commission for Ensuring the Welfare of Experimental Animals of Mendel University in Brno.

Seven goats of Brown short-haired breed (BSH) in the second lactation were involved in the study, while this breed is currently included among European animal genetic resources. At the beginning of the study and during the whole lactation all monitored goats were clinically healthy. The kidding occurred from 29th January to 2nd February and the weaning of kids was carried out at their average age of 55 days. After weaning all monitored goats began to be machine milked twice a day. During the study, the daily feed ration of goats consisted of pasture (*ad libitum*), meadow hay (*ad libitum*), concentrate mixture (1 kg/doe) and mineral lick (*ad libitum*). During our study, all goats were kept in one flock under identical conditions without any discernible differences in their nutrition or management.

Individual milk recording and sampling of each goat were carried out on the mean 64, 109, 146, 181 and 218 day of lactation. As mentioned above, after weaning all monitored goats began to be machine milked twice a day. However in the days when milk recording and sampling were carried out, all monitored goats were milked by hand. Milk yield recording was carried out in the morning milking (7 a.m.) and in the evening milking (7 p.m.), while milk samples were taken only from morning milking. (first milk was discarded). 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.). All monitored goats were dried off within fourteen days after the last recording and sampling.

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The SCC was determined using fluoroopto-electronic apparatus BENTLEY 2500 (Czech State Standard EN ISO No. 13366-2). The TBC was determined according to CSN EN ISO 4833-1 (560083). (Microbiology of the food chain – Horizontal method for the enumeration of microorganisms. Part 1: Colony count at 30 degrees C by the pour plate technique. The DMY (in g) was recorded as total yield of morning plus evening milking. Fat (F) content (in %) was determined by Gerber's acidobutyrometric method (Czech Technical Standard ISO No. 2446). Total protein (TP) content (in %) was determined according to the Czech Technical Standard EN ISO 8968-1 using a Kjeltec (Foss Electric, Denmark). Lactose (L) content (in %) was determined polarimetrically (Czech Technical Standard No. 570530). The pH of milk was measured with the pH-meter WTW 95 with the probe WTW SenTix 97.

Before performing statistical analysis, the SCCs and TBCs were transformed into logarithmic form to normalize their frequency distribution. The software Statistica 14 was used to perform the statistical analysis (StatSoft CR s.r.o., Prague, Czech Republic). Data was analysed via analysis of variance procedure, one-way ANOVA (post hoc analysis using the Tukey test). The effects of the SL were included in ANOVA model. The differences between means were considered statistically significant at $p \leq 0.05$ and $p \leq 0.01$. Pearson correlation coefficients were calculated for all measured traits via Statistica 14 software (*$_{\equiv}$ $p \leq 0.05$; ** $_{\equiv}$ $p \leq 0.01$).

Results and discussion

The SL (*Table 1*) had a significant ($p \leq 0.01$) effect on the Log SCC which is in line with *Kuchtík et al*. (2015) and *Margatho et al*. (2018). However, in contrast, *Králíčková et al*. (2013) and *Kuchtík et al*. (2021) did not find the effect of this factor on this indicator. Quite a number of studies show that the Log SCC gradually increases depending on the day of lactation. However, in our study the mean values of Log SCC were quite variable. Specifically, in the first two samplings the values of this indicator were relatively low, but in the third sampling there was an unexpected significant ($p \leq 0.01$) increase of the Log SCC (from 3.68 to 7.13). Subsequently, an insignificant decrease in Log SCC was registered, but a slight increase of this indicator (from 6.62 to 7.16) was detected again during the last sampling. However, these changes had no effect on the health status of all monitored goats.

***Table 1*: Mean values of all monitored indicators during lactation**

Indicator	Mean day of lactation					Range of individual samples	Overall mean	**SEM**	P
	64 (A)	109 (B)	146 (C)	181 (D)	218 (E)				
Log SCC	4.81^{CdE}	3.68^{CDE}	7.13^{AB}	6.62^{aB}	7.16^{AB}	1.61-8.06	5.88	**0.3021**	**
Log TBC	5.70^{DE}	5.30^{DE}	6.47^{DE}	9.49^{ABC}	8.98^{ABC}	4.08-12.82	7.19	**0.3609**	**
DMY (g)	2000^{d}	2814^{E}	2407	2871^{aE}	1600^{BD}	800-3500	2339	**121.7879**	**
Fat (%)	3.02^{E}	3.32^{e}	3.16^{E}	2.68^{E}	4.21^{AbCD}	2.15-5.44	3.28	**0.1191**	**
TP (%)	2.74^{BE}	3.17^{ACd}	2.65^{BE}	2.88^{bE}	3.38^{ACD}	2.51-3.96	2.96	**0.0560**	**
Lactose (%)	4.76^{CD}	4.56^{d}	4.37^{A}	4.25^{Ab}	4.48	4.10-4.98	4.48	**0.0430**	**
pH	6.56	6.62	6.57	6.55	6.71	6.47-7.01	6.60	**0.0204**	N.S.

DMY = daily milk yield; TP = total protein; a,b,d,e - $p \leq 0.05$ *; A,B,C,D,E - $p \leq 0.01$**; N.S.: not significant

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The SL also had a significant ($p \leq 0.01$) effect on the Log TBC, which is in line with the result published by *Margatho et al*. (2018). In contrast, *Paschino et al*. (2020) and *Kuchtík et al*. (2021) did not find a significant influence of this factor on this indicator. Relatively low values of the Log TBC were found, in contrast to the Log SCC, until the third sampling, i.e. until the middle of lactation. Subsequently, however, in the case of the two last samplings, significantly ($p \leq 0.01$) higher values of this indicator (9.49 and 8.98) were found compared to the first three samplings. This fact, in our opinion, was mainly influenced by the human factor (change of the milker), because a significant increase of the Log TBC, as in the case of Log SCC, was not reflected both in the health status of the goats and in significant changes in milk indicators. This fact is also confirmed by the correlations between Log SCC and Log TBC on the one hand and the contents of the F and TP on the other hand, when all these correlations, see *Table 2*, were insignificant. However, the correlation between the Log SCC and the L content and the Log TBC and the content of L were in both cases significantly ($p \leq 0.01$) negative which to some extent suggests, that the decrease of the L content may be a good prerequisite for increasing both Log SCC and Log TBC. As for the correlation between the Log SCC and the Log TBC, this was significantly ($p \leq 0.05$) positive, which to some extent suggests that when the SCCs increase the TBCs also increase and vice versa. At the end of this part, it should be added that the correlations both between Log SCC and pH and between Log TBC and pH were insignificant in both cases, which is a bit surprising because quite a lot of studies show that significant changes in both Log SCC and Log TBC have a significant effect on pH.

***Table 2:* Correlation coefficients between all monitored indicators**

Indicator	Log SCC	Log TBC	DMY	Fat	TP	Lactose	pH
LogSCC	1.00	0.38*	-0.16	0.07	-0.10	-0.42**	0.16
Log TBC		1.00	-0.14	0.14	0.20	-0.48**	0.14
DMY			1.00	-0.50**	-0.23	-0.08	-0.37*
Fat				1.00	0.64**	0.04	0.26
TP					1.00	-0.05	0.43**
Lactose						1.00	0.02
pH							1.00

DMY = daily milk yield; TP = total protein;* - $p \leq 0.05$; ** - $p \leq 0.01$.

Many studies also show that the F and TP contents gradually increase during lactation and the DMY gradually decreases, while the SL usually has a significant effect on all these indicators. In the present study the SL had a significant ($p \leq 0.01$) influence on all these indicators, which is in line with *Králíčková et al.* (2013) and *Paschino et al.* (2020). However, in the present study the DMY had an unexpectedly increasing level from the first to the fourth sampling. In contrast, the contents of F and TP had relatively highly variable values in this period, when especially the contents of TP were relatively very low in the third and fourth sampling. This fact, in our opinion, was mainly influenced by the relatively high DMY. In conclusion to this part, however, it must be stated that within the last sampling there was a significant ($p \leq 0.01$) decrease in the DMY and a significant ($p \leq 0.01$) increase in the contents of F and TP.

As for the content of L, its content gradually decreased during lactation and the SL had a significant ($p \leq 0.01$) influence on this indicator, which is in accordance with the data published by

Králíčková et al. (2013) and *Vacca et al*. (2018). In conclusion, it is still necessary to state that the content of L was not lower than 4% in any of the individual samples, which according to some studies is the limit for IMI.

Conclusions

The stage of lactation had a significant influence on all monitored indicators, with the exception of pH. Both the Log SCC and the Log TBC had a significant correlation only with the content of lactose, whilst both of these correlation were negative. However, the correlation between the Log SCC and the Log TBC was significantly positive. Despite the fact that the SL had a significant influence on the contents of fat and total protein, in general it can be stated that their contents were during lactation quite variable. On the other hand the contents of lactose gradually decreased during lactation. In conclusion, it can be stated that the results of our study suggest that the decrease of lactose content may be a good prerequisite for increasing both Log SCC and Log TBC.

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