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SOMATIC CELL COUNT AND MILK YIELD LOSSES IN GOATS

Oto Hanuš[1], Petr Roubal[1], Josef Kučera[2,3], Marcela Klimešová[1], Radoslava Jedelská[1], Jaroslav Kopecký[1]

[1]Dairy Research Institute, s.r.o., Ke Dvoru 12a, 160 00 Prague 6, Czech Republic
[2]Department of Animal Breeding, Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[3]Czech–Moravia Breeders Corporation a.s., Benešovská 123, 252 09 Hradištko, Czech Republic

Abstract

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This work is aimed at prediction and quantification of goat milk yield (MY, kg) losses by the somatic cell count (SCC, $10^3.ml^{-1}$) in milk recording. The goal is to support the prevention of milk secretion disorders, milk yield and quality. During two years there were evaluated composition and properties of individual milk samples (n = 1 173). There were included animals of brown short-haired (BSH) breed and BSH × white short-haired in one flock. The linear and nonlinear regression, interpolation, extrapolation, approximation and qualified estimation were used for milk losses prediction along the SCC. The relevant values of the SCC arithmetic and geometric mean and median and MY arithmetic mean were: 1,400 $10^3.ml^{-1}$ (with high variability of 128 %), 745 and 747 $10^3.ml^{-1}$; 2.94 kg/day. The relationship between fat and crude protein had a correlation coefficient of 0.395, $P < 0.001$. There were stated the correlations between SCC and: lactose –0.416, $P < 0.001$; solids non fat –0.25, $P < 0.001$; MY –0.135, $P < 0.01$. The relationship between SCC and MY was negative along months, 6 cases out of 7 and significant in March and May ($P < 0.05$ and $P < 0.01$). For instance predicted MY for SCC intervals 1–1.999, 2–2.999, 3–3.999, 4–4.999, 5–5.999, 6–6.999 and ≥ 7 thousands $10^3.ml^{-1}$ may be 3.99, 3.77, 3.6 , 3.46, 3.33, 3.23 and 3.13 kg in 3rd month etc. The corresponding MY losses by SCC are evident from this trend. The result use is focused on the original dairy goat farm and use elsewhere is possible in farms with similar SCC, goat milk yield and rearing system.

Keywords: individual goat milk, lactation, fat, crude protein, lactose monohydrate, milk secretion disorders, milk recording

INTRODUCTION

The milk secretion disorders (MSDs, mastitis) affect the mammary glands of mammal females. These are an important factor in the milk quality and yield (MY). MSDs are usually the result of technological mistakes in animal husbandry and are often of infectious origin. The somatic cell count (SCC) is a relevant indicator of the presence of subclinical and clinical mastitis. Bulk and in particular individual SCCs in small ruminants show significantly higher values (averages often from 500 to 1,000 $10^3.ml^{-1}$) and also variability than in cows (Wilson *et al.*, 1992; Droke *et al.*, 1993; Gajdůšek *et al.*, 1996; Kuchtík and Sedláčková, 2003; Contreras *et al.*, 2007, Morand-Fehr *et al.*, 2007, Paape *et al.*, 2007, Pirisi *et al.*, 2007, Raynal-Ljutovac *et al.*, 2007; Genčurová *et al.*, 2008; Hanuš *et al.*, 2008; Granado *et al.*, 2014; Kuchtík *et al.*, 2015). This is also true for healthy mammary glands or in environmentally friendly organic flocks (Králíčková *et al.*, 2013). This fact is also influenced by the higher frequency of goats and sheep breeds. In addition, in small ruminants and especially in goats the SCC limits are not so clear (Kuchtík *et al.*, 2015). It is also valid in relation to milk yield (MY) from which SCC and MY level the mammary gland is possible to suspect of being infected as compared to cows (Ali and Shook, 1980; Reneau *et al.*, 1983, 1988; Wiggans and Shook, 1987; Ryan, 1992;

Jones and Bailey, 2009; Salfer *et al.*, 2015). It is clear, however, that not only in cows but also in sheep and goats (Kuchtík *et al.*, 2015), the significantly high SCCs are associated with an increased likelihood of a pathogenic infection of the mammary gland, that is, with the occurrence of MSDs. In the case of small ruminants so far, due to more variable factors, the directly related losses of milk yield by SCC are not yet well known (Wilson *et al.*, 1992; Shearer and Harris, 1992, 2003; Escobar, 1999; Barrón-Bravo *et al.*, 2013; Pleguezuelos *et al.*, 2015) as it is in cows (Reneau *et al.*, 1983, 1988; Jones *et al.*, 1984; Reneau, 1986; Crist *et al.*, 1997; Jones and Bailey, 2009). Therefore, the aim of this work was to quantify the estimates of goat milk losses according to individual SCCs in the flock under the Czech Republic conditions where dairy goat farming today is not a completely traditional and widespread branch of livestock production as it would be needed not only with regard to the possible health benefits of goat milk but also to previous times.

MATERIAL AND METHODS

Flock of dairy goats and individual samples in milk recording

A flock of dairy goats (120 animals) and sheep is kept in a beer-grain area: – altitude of 270 m; – annual rainfall 550 mm. Breed structure of flock: – majority representation of brown shorthair (BSH); – BSH hybrids with white shorthair goat and minor with Nubian goat. Feeding characteristics: – in the summer, all-day grazing on the clover-grass pasture with addition of grass silage (from 2 to 2.5 kg per head and a day), grass hay *ad libitum* and grain concentrates (from 0.8 to 1 kg per head and day); – in winter, 4 kg of clover–grass silage per head and day, grass hay *ad libitum* and grain concentrates (1.2 kg per head and day). The goats are milked in the milking parlor into pipeline. The individual goat milk samples (IMSs) were: – taken monthly during regular milk recording (MR) for 2 years; – treated with DF Control Microtabs (0.03 % of bronopol) tableted preservative; – transported under cold conditions (<8 °C) to the laboratory and analyzed.

Milk sample analyses

Milk samples were analyzed in the accredited (CSC EN ISO/IEC 17025) laboratory (LRM Buštěhrad, ČMSCH a.s. Hradištko) on the somatic cell count (SCC, $10^3.ml^{-1}$) through the Somacount flow cytometer (Bentley Instruments, Chaska, USA). These instruments were regularly calibrated on the so-called reference (CSN EN ISO 13366–1 (57 0531); CSN EN ISO 13366–2) direct microscopic method (Hanuš *et al.*, 2009, 2011). Further analyzes for contents of fat (F, g/100g = %), crude protein (CP, g/100g = %), lactose (L, g/100g = %, monohydrate) and solids non fat (SNF, g/100g = %) were performed (CSN 57 0536) via Bentley Infrared Analyzer (IR) (Bentley Instruments, Chaska, USA). The total solids content (TS, g/100g = %) was calculated as the sum of SNF and F in %. These instruments were regularly calibrated on the so-called reference methods (CSN 57 0530): – extraction and gravimetric method according to Röse-Gottlieb for F (CSN EN ISO 1211); – mineralization, distillation and titration method according to Kjeldahl for CP (CSN 57 0530); – enzymatic method for lactose (IDF 79B: 1991); – gravimetric method for TS with F reduction for SNF (drying at 102 °C – CSN ISO 6731). The specific IR calibration for goat milk (Hanuš *et al.*, 2009) was performed twice per lactation (year).

Statistic data evaluation

It was necessary to expect the absence of normal frequency distribution of SCC data (Janů *et al.*, 2007; Hanuš *et al.*, 2008, 2010; Genčurová *et al.*, 2008) and to calculate with the lognormal frequency distribution of the values. Therefore, the logarithmic (log_{10}) data transformation (Ali and Shook, 1980; Shook, 1982; Raubertas and Shook, 1982; Reneau *et al.*, 1983, 1988; Reneau, 1986; Wiggans and Shook, 1987) was used. This also allowed expression of the geometric mean (xg). Statistical evaluation was performed using MS Excel (Microsoft, Redmond, USA).

The milk yield (MY, kg) of goat and the lactation order (1st and 2nd and others) from MR was added. There were calculated the milk energy coefficients (F/CP, fat/crude protein and F/L, fat/lactose) as well (Manzenreiter *et al.*, 2013). The calculation of the basic statistical characteristics (Tab. I; n number of cases, x arithmetic mean, sd standard deviation, xg geometric mean, vx variation coefficient, minimum, maximum and m median) was performed separately along years (2014 and 2015) and in total. An unpaired t-test of the significance of the mean difference between calendar years was performed. Similarly, the statistical evaluation along calendar months (years in total and separately) and also unpaired t-test always between the first and last month of lactation was performed. The data file was also similarly processed according to the order of the lactation (1st, 2nd and the other) by years and in total. The linear and nonlinear regressions between MY and milk indicators were calculated in the total file. The MY loss along SCC for the total data file was calculated selectively from the results of linear and nonlinear regressions in lactation months according to the determination coefficients of relation between SCC (log SCC) and MY. The MY for x, m or xg was calculated by SCC intervals. To estimate the milk losses (MY losses) according to SCC growth there were used; – the linear and nonlinear regressions; interpolation; extrapolation; approximation; qualified guess.

I: *Total statistical evaluation of the goat milk indicator data set of individual samples in milk recording (2014 and 2015)*

IN/PA	MY	F	CP	L	SNF	TS	F/CP	F/L	SCC	log SCC
unit	kg	%	%	%	%	%	ratio	ratio	$10^3.ml^{-1}$	-
n	1,193	1,193	1,193	1,193	1,193	1,193	1,193	1,193	1,173	1,173
x	2.94	3.35	3.01	4.5	8.13	11.48	1.11	0.74	1,400	2.8719
xg	-	-	-	-	-	-	-	-	745	-
sd	1.15	1.03	0.34	0.26	0.47	1.29	0.32	0.24	1,789	0.5085
vx (%)	39.0	30.7	11.3	5.9	5.8	11.2	29.2	31.9	128	-
min	0.6	1.41	2.12	2.03	6.33	8.17	0.49	0.31	8	0.9031
max	7.0	12.89	5.77	5.36	11.5	20.06	5.42	3.29	9,999	4.0
m	2.8	3.2	2.98	4.5	8.12	11.35	1.07	0.72	747	2.8733

IN/PA indicator/parameter; MY milk yield; F fat content; CP crude protein content; L lactose monohydrate content; SNF solids non fat content; TS total solids content; F/CP coefficient fat/crude protein; F/L coefficient fat/lactose; SCC somatic cell count; log SCC logarithmus (log_{10}) for SCC; n number of cases; x arithmetic mean; xg geometric mean; sd standard deviation; vx variation coefficient (%); min minimum; max maximum; m median.

RESULTS AND DISCUSSION

Basic statistical evaluation of goat milk data file

Overall statistical evaluation is shown in Tab. I. The average values of milk indicators (n = from 1,173 to 1,193) and their variability are consistent with our earlier results for goat milk (Genčurová *at al.*, 2008; Hanuš *et al.*, 2008). Similarly, the lower lactose mean is in agreement as compared to cow milk (Genčurová *at al.*, 2008; Hanuš *et al.*, 2010). The arithmetic mean of the original SCC data (1,400 $10^3.ml^{-1}$) showed a high variability of 128%. This variability value indirectly confirms the assumption of absence of normal data frequency distribution. This fact corresponds to the other mean SCC values xg 745 $10^3.ml^{-1}$ and m 747 $10^3.ml^{-1}$. This is also consistent with the results of several authors (Gajdůšek *et al.*, 1996; Kuchtík and Sedláčková, 2003; Paape *et al.*, 2007; Park *et al.*, 2007; Pirisi *et al.*, 2007; Raynal-Ljutovac *et al.*, 2007; Přidalová *et al.*, 2009; Kuchtík *et al.*, 2015). However, mean values of goat SCC are clearly higher than these mentioned by Persson *et al.* (2014) for healthy mammary glands during lactation from the beginning (m 137 $10^3.ml^{-1}$) to the end (449 $10^3.ml^{-1}$). Milk yield, fat content and energy coefficients (F/CP and F/L) showed variability of about 30% and other component variables from 6 to 11%.

Significant differences in milk parameters (MY $P < 0.001$, F $P < 0.01$, L $P < 0.001$, SNF $P < 0.001$, TS $P < 0.001$ and F/CP $P < 0.05$) were recorded (Tab. II) between 2014 (n = 535) and 2015 (n = 638 – 658). This is explainable in view of the practical changes in the flock (its turnover and enlargement) from year to year.

In addition, the evaluation of milk indicator differences between 1st and 2nd and other goat lactations (Tab. III) was performed. Here the significant differences in milk indicators were recorded for: MY $P < 0.001$, 1st lactation lower (2.17 < 3.15 kg, it is 45.2%, n = 256 and 937); SCC $P < 0.001$, 1st lactation lower (xg 560 < 801 $10^3.ml^{-1}$, it is 43.0%, n = 241 and 932). This mentioned fact is essential for the methodical procedure of estimation of milk yield losses in MR in goats by SCC. The differences in other milk indicators (F, CP, L, SNF, TS, F/CP and F/L) were insignificant ($P > 0.05$). For 2nd and higher goat lactation as compared to 1st there was (Tab. III): F slightly higher (3.35 > 3.33%); CP slightly lower (3.01 < 3.02%); L slightly higher (4.50 > 4.49%); SNF equal (8.13%); TS slightly higher (11.48 > 11.46%); F/CP slightly higher (1.11 > 1.1); F/L slightly lower (0.71 < 0.75).

Evaluation of regression relationships between goat milk indicators

The evaluated regression relations between the milk indicators (Tab. IV) showed some interesting points. A significant correlation between SCC and L (–0,416, $P < 0.001$, n = 1,173; Fig. 1) was confirmed in line with our previous results. Under these conditions 17.3% in the L variability is explainable by SCC variability and vice versa. That is a relatively high number about the biologic-pathological issue. In individual goat milk samples a correlation relationship between L and log SCC –0.46 ($P < 0.01$) was previously found which is very similar to the relevant findings in cow milk (Hanuš *et al.*, 2008, 2010). This means the explanation of up to 21.2% in L variability through SCC variability and vice versa. The relationship between L and SCC in cows is therefore almost always negative and ranges usually from –0.25 to –0.6 (depending on the type of sample, MY and herd health status). This is logical in view of the fact that SCC is a partial mastitis indicator. Mastitis pathogenic infection can reduce the mammary gland secretory epithelium where lactose is synthesized as a specific milk component. The significant relationship between log SCC and SNF (–0.25, $P < 0.001$, n = 1,173; Tab. IV; Fig. 2) has similar basis regarding L. However, here are only 6.3% of SNF variations that can be explained by SCC variations and vice versa. Correlation –0.25 has the same value as the previously found

II: *Significance of differences between years for milk indicators of individual goat samples in milk recording (2014–2015)*

IN/PA	MY	F	CP	L	SNF	TS	F/CP	F/L	SCC	log SCC
unit	**kg**	**%**	**%**	**%**	**%**	**%**	**ratio**	**ratio**	**10^3.ml^{-1}**	**-**
n 2014	535	535	535	535	535	535	535	535	535	535
x	2.42	3.26	3.0	4.45	8.07	11.34	1.09	0.73	1,372	2.8908
xg	-	-	-	-	-	-	-	-	778	-
sd	0.86	1.0	0.35	0.21	0.41	1.2	0.31	0.24	1,723	0.4819
vx (%)	35.4	30.7	11.6	4.8	5.1	10.6	28.1	33.0	126	-
n 2015	658	658	658	658	658	658	658	658	638	638
x	3.37	3.42	3.02	4.54	8.18	11.59	1.13	0.75	1,423	2.8561
xg	-	-	-	-	-	-	-	-	718	-
sd	1.18	1.04	0.33	0.29	0.5	1.34	0.34	0.23	1,843	0.5297
vx (%)	35.0	30.5	11.0	6.5	6.2	11.6	29.8	30.9	130	-
t	15.58	2.68	1.01	5.93	4.06	3.35	2.12	1.45	0.49	1.16
sig	***	**	ns	***	***	***	*	ns	ns	ns

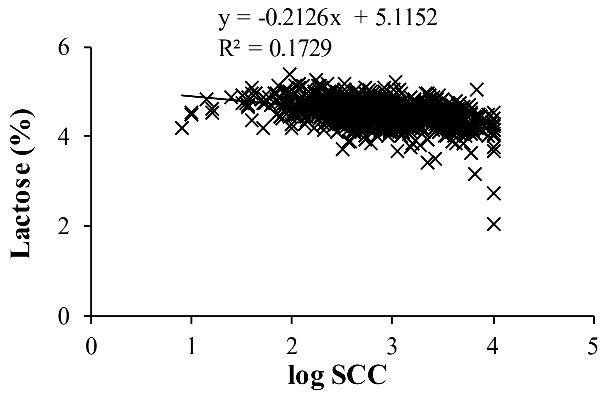
IN/PA indicator/parameter; MY milk yield; F fat content; CP crude protein content; L lactose monohydrate content; SNF solids non fat content; TS total solids content; F/CP coefficient fat/crude protein; F/L coefficient fat/lactose; SCC somatic cell count; log SCC logarithmus (log_{10}) for SCC; n number of cases; x arithmetic mean; xg geometric mean; sd standard deviation; vx variation coefficient (%); t t–test value; sig difference significance: * = P ≤ 0.05; ** = P ≤ 0.01; *** = P ≤ 0.001; ns = P > 0.05.

III: *Significance of differences between lactations (1st, 2nd and others) for milk indicators of individual goat samples in milk recording (2014 and 2015)*

IN/PA	MY	F	CP	L	SNF	TS	F/CP	F/L	SCC	log SCC
unit	**kg**	**%**	**%**	**%**	**%**	**%**	**ratio**	**ratio**	**10^3.ml^{-1}**	**-**
n 1st	256	256	256	256	256	256	256	256	241	241
x	2.17	3.33	3.02	4.49	8.13	11.46	1.1	0.75	898	2.7482
xg	-	-	-	-	-	-	-	-	560	-
sd	0.75	1.09	0.32	0.25	0.43	1.27	0.34	0.28	1,281	0.412
vx (%)	34.3	32.8	10.7	5.5	5.2	11.0	31.1	37.1	143	-
n 2nd a. o.	937	937	937	937	937	937	937	937	932	932
x	3.15	3.35	3.01	4.5	8.13	11.48	1.11	0.74	1,530	2.9039
xg	-	-	-	-	-	-	-	-	801	-
sd	1.15	1.01	0.34	0.27	0.48	1.3	0.32	0.22	1,877	0.5261
vx (%)	36.4	30.1	11.4	6.0	5.9	11.3	28.7	30.3	123	-
t	12.92	0.28	0.42	0.54	0	0.22	0.44	0.6	4.93	4.26
sig	***	ns	ns	ns	ns	ns	ns	ns	***	***

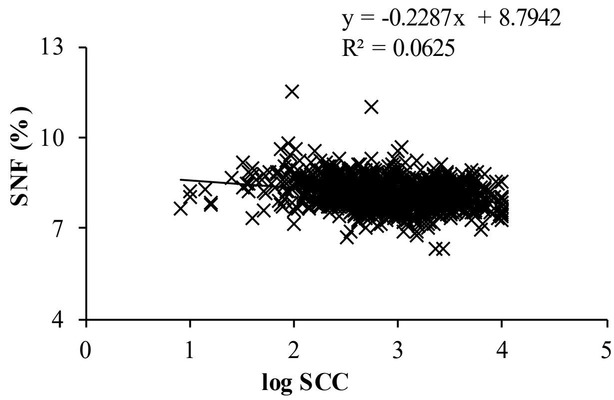
IN/PA indicator/parameter; MY milk yield; F fat content; CP crude protein content; L lactose monohydrate content; SNF solids non fat content; TS total solids content; F/CP coefficient fat/crude protein; F/L coefficient fat/lactose; SCC somatic cell count; log SCC logarithmus (log_{10}) for SCC; n number of cases; x arithmetic mean; xg geometric mean; sd standard deviation; vx variation coefficient (%); t t-test value; sig difference significance: * = P ≤ 0.05; ** = P ≤ 0.01; *** = P ≤ 0.001; ns = P > 0.05.

correlation index result for the same milk indicators in individual goat milk samples (Hanuš *et al.*, 2008). The relative stability of this relationship in the stocks of goat flocks is confirmed in this way. These relations of SCC, L and SNF are also confirmed by Leitner *et al.* (2004 a, b) and Robertson and Muller (2005). The lactose content is usually positively correlated to the MY height and it is not only because of the lactation stage and therefore along the lactation curve but also because of the physiology of milk secretion and ejection and regulation of intra-udder osmotic pressure. This fact was also used and taken into account in the design of advisory programs for the prevention of milk secretion disorders. In this work, however, the MY × L relationship was expressed only by a low positive correlation coefficient of 0.054 (n = 1,193, Tab. IV). Similarly, the correlation between log SCC and MY (–0.135, P < 0.01, n = 1,173; Tab. IV) is also important from methodical point of view. Here, nevertheless, only 1.8% in the MY variability is explainable by the SCC variability and vice versa. The highest values of these nonlinear negative relationships were found in March in 2nd and 3rd



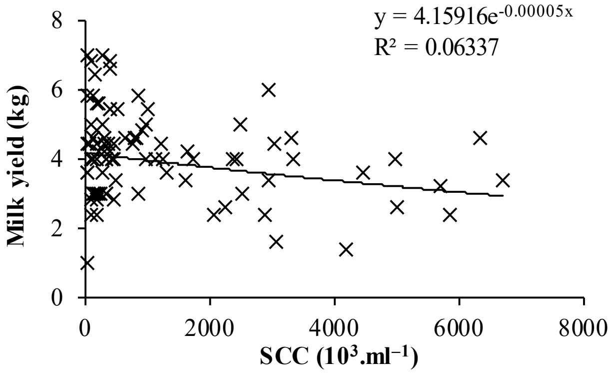
r = –0.416; P < 0.001; n = 1,173

1: *Relationship between somatic cell count (log SCC, in 10³.ml⁻¹) and lactose content (L, in %) in individual goat milk samples in milk recording*



r = –0.25; P < 0.001; n = 1,173

2: *Relationship between somatic cell count (log SCC, in 10³.ml⁻¹) and solids non fat content (SNF, in %) in individual goat milk samples in milk recording*



r = 0.252; P < 0.05; n = 96

3: *Nonlinear relationship between somatic cell count (SCC, in 10³.ml⁻¹) and milk yield (MY, in kg) in individual goat milk samples in milk recording in March and in 2nd–3rd lactation month*

month of lactation: correlation index 0.252, P < 0.05, n = 96; (Fig. 3); 0.266, P < 0.05, n = 96 (Tab. IV). Here 7.1% in MY variability is explained by variability in SCC and vice versa. However, this relationship confirms MY loss with SCC increasing in goats by its significance similarly to cows (Ali and Shook, 1980; Shook, 1982; Raubertas and Shook, 1982; Reneau *et al.*, 1983, 1988; Reneau, 1986; Casey and Maughan, 1987; Wiggans and Shook, 1987; Ryan, 1992; Crist *et al.*, 1997; Leitner *et al.*, 2004 a, b, 2008; Jones and Bailey, 2009; Looper, 2012; Salfer *et al.*, 2015). Thus, the right to predict MY losses according to SCC increasing in regular MR in goats is confirmed as also regardig results by Barrón-Bravo *et al.* (2013) and Pleguezuelos *et al.*, (2015).

The log SCC × L correlation is therefore of a methodical significance for the further procedure of estimation of goat MY losses according to the SCC in MR as well as the important log SCC × MY relation. The MY was significantly (P < 0.01) related only to SCC, CP and the F/CP coefficient in sequence according to the tightness of relevant relation. Further relationships of goat MY to other monitored milk indicators in MR were insignificant (P > 0.05, Tab. IV). From other relations the F × CP relation (0,395, P < 0,001, n = 1,193; Tab. IV; Fig. 4) is remarkable. This is mainly influenced by the similar dynamics of lactation curves of both indicators with higher values at the beginning of lactation, a decrease in the middle part and a slight increase in lactation end, similarly to cows. Here, 15.6% of CP variations are explainable by F variations and vice versa.

Quantified models of prediction of goat milk losses according to SCC

The MY results were divided by the SCC intervals and the months of lactation (Tab. V). The SCC intervals are consistent with the typical distribution of SCC data in the goats according to the results of this work and literary sources (Wilson *et al.*, 1992; Droke *et al.*, 1993; Gajdůšek *et al.*, 1996; Kuchtík and Sedláčková, 2003; Contreras *et al.*, 2007; Morand-Fehr *et al.*, 2007; Paape *et al.*, 2007; Pirisi *et al.*, 2007; Raynal-Ljutovac *et al.*, 2007; Genčurová *et al.*, 2008; Hanuš *et al.*, 2008; Granado *et al.*, 2014; Kuchtík *et al.*, 2015). The equations for the MY loss estimates (Tab. VI) were calculated from the MY results in months according to the SCC intervals (Tab. V). It was confirmed here that the more convincing results of the monitored SCC × MY relationship are provided by total evaluation (Tab. V) rather than separately according to lactation as it is usual in cows (Reneau *et al.*, 1983, 1988; Jones

IV: *Correlation coefficients of linear regression relationships between goat milk indicators for individual samples in whole dataset (2014 and 2015, n = from 1,173 to 1,193)*

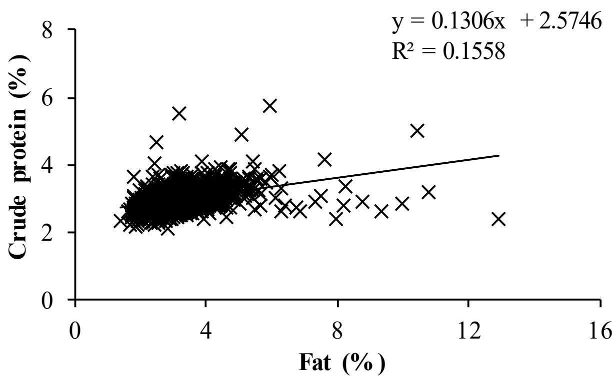
IN	MY	F	CP	L	SNF	TS	F/CP	F/L	SCC	log SCC
MY			−0.1				0.092		−0.125	−0.135
F	*0.048*		**0.395**	0.203	**0.401**	**0.943**	**0.921**	**0.959**		−0.08
CP				0.189	**0.833**	**0.617**		**0.378**	*0.079*	
L	*0.054*				**0.702**	**0.417**	0.14		**−0.396**	**−0.416**
SNF	*−0.042*					**0.683**	0.102	**0.251**	−0.164	**−0.25**
TS	*0.022*						**0.771**	**0.856**		−0.154
F/CP			*0.032*					**0.883**		*−0.06*
F/L	*0.022*			*−0.042*					0.123	
SCC		*0.02*				*−0.042*	*0.007*			
log SCC			*−0.024*					*0.017*		

IN milk indicator; MY milk yield; F fat content; CP crude protein content; L lactose monohydrate content; SNF solids non fat content; TS total solids content; F/CP coefficient fat/crude protein; F/L coefficient fat/lactose; SCC somatic cell count; log SCC logarithmus ($\log_{10}$) for SCC; n number of cases; significance: P ≤ 0.05 above the diagonal the italic letters; P ≤ 0.01 above the diagonal, normal letters style; P ≤ 0.001 above the diagonal, the bold letters; P > 0.05 under the diagonal, the italic letters.

V: *Goat milk yield (in kg) along calendar (lactation (−1)) month of milk recording (MR) according to classes of somatic cell count (SCC), in total (2014 and 2015, 1^{st}, 2^{nd} and other lactations)*

M/Cl	2^{nd}	3^{rd}	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}
A	3.39±0.81/53	4.21±1.36/39	2.78±0.91/37	3.45±1.22/40	2.72±0.86/31	2.49±0.89/24	2.19±0.72/17
B	3.62±0.82/19	4.41±1.1/19	3.24±0.89/42	3.22±1.28/62	2.78±0.97/52	2.6±0.93/44	2.0±0.69/23
C	3.0±1.23/6	4.53±0.76/9	3.05±1.04/45	3.52±1.42/50	2.8±1.01/47	2.51±0.95/41	2.07±0.77/27
D	2.88±1.51/5	4.13±0.6/8	3.22±1.12/34	3.07±0.97/41	2.97±1.23/41	2.62±1.0/51	2.05±0.67/24
E	2.6/1	3.64±1.24/9	3.27±0.86/17	2.89±1.2/11	2.93±1.08/21	2.67±0.83/20	2.11±0.61/13
F	2.85±0.1/4	3.32±1.11/12	2.82±1.06/32	2.67±1.2/17	2.98±0.98/36	2.33±0.83/39	1.64±0.56/10

(x±sd/n = arithmetic mean±standard deviation/number of cases; M = month; Cl = SCC class: A = to 300; B = from 301 to 600; C = from 601 to 1,000; D = from 1,001 to 2,000; E = from 2,001 to 3,000; F = over 3,000 $10^3.ml^{-1}$)



r = 0.395; P < 0.001; n = 1,193

4: *Relationship between fat (F, in %) and crude protein content (CP, in %) in individual goat milk samples in milk recording*

VI: *Predicted goat milk yield (MY, in kg) according to somatic cell count (SCC, in 10^3.ml^{-1}) in individual samples in milk recording along seasonal (lactation (–1)) months*

month	**Axis x for SCC (ths)**	**equation**	**m**	**xg**	**x**	**1.5**	**2.5**	**3.5**	**4.5**	**5.5**	**6.5**	**7.5 ths**
	SCC interval (ths)					**1–1.999**	**2–2.999**	**3–3.999**	**4–4.999**	**5–5.999**	**6–6.999**	**≥ 7 ths**
	relation: x × y		**MY (y)**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**	**y**
2nd	SCC × MY	Lin	3.39	3.39	3.34	3.14	2.94	2.74	2.54	2.34	2.14	1.94
2nd	log SCC × MY	Lin	3.35	3.35	3.27	3.17	3.11	3.08	3.06	3.04	3.02	3.0
2nd	SCC × MY	Pol 2nd	3.4	3.4	3.34	3.12	2.92	2.74	2.58	2.44	2.32	2.22
2nd	log SCC × MY	Pol 2nd	3.44	3.44	3.35	3.1	2.93	2.8	2.69	2.6	2.52	2.45
3rd	SCC × MY	Lin	4.26	4.24	4.11	4.04	3.84	3.64	3.44	3.24	3.04	2.84
3rd	log SCC × MY	Lin	4.14	4.11	3.95	3.91	3.82	3.76	3.71	3.68	3.65	3.62
3rd	SCC × MY	Pol 2nd	4.27	4.24	4.06	3.97	3.74	3.55	3.41	3.3	3.23	3.2
3rd	log SCC × MY	Pol 2nd	4.32	4.29	4.08	3.99	3.77	3.6	3.46	3.33	3.23	3.13
4th	SCC × MY	Lin	3.08	3.08	3.05	3.05	3.0	2.95	2.9	2.85	2.8	2.75
4th	log SCC × MY	Lin	3.05	3.05	3.05	3.05	3.04	3.04	3.04	3.04	3.04	3.04
4th	log SCC × MY	Pol 2nd	3.18	3.18	3.15	3.15	3.06	2.97	2.89	2.81	2.74	2.68
5th	SCC × MY	Lin	3.29	3.28	3.19	3.12	2.92	2.72	2.52	2.32	2.12	1.92
5th	log SCC × MY	Lin	3.25	3.24	3.16	3.11	3.03	2.97	2.93	2.89	2.86	2.84
5th	SCC × MY	Pol 2nd	3.31	3.31	3.25	3.2	3.04	2.87	2.67	2.46	2.22	1.97
5th	log SCC × MY	Pol 2nd	3.33	3.32	3.2	3.13	2.95	2.81	2.69	2.6	2.51	2.43
6th	SCC × MY	Lin	2.83	2.83	2.85	2.85	2.89	2.93	2.97	3.01	3.05	3.09
6th	SCC × MY	Pol 2nd	2.83	2.83	2.86	2.85	2.9	2.95	2.99	3.03	3.07	3.1
7th	SCC × MY	Lin	2.56	2.56	2.53	2.54	2.5	2.46	2.42	2.38	2.34	2.3
7th	log SCC × MY	Lin	2.53	2.53	2.52	2.53	2.52	2.51	2.51	2.51	2.51	2.5
7th	SCC × MY	Pol 2nd	2.51	2.51	2.48	2.5	2.46	2.4	2.32	2.22	2.1	1.96
7th	log SCC × MY	Pol 2nd	2.6	2.6	2.56	2.58	2.53	2.49	2.45	2.41	2.38	2.35
8th	SCC × MY	Lin	2.06	2.06	2.02	1.99	1.89	1.79	1.69	1.59	1.49	1.39
8th	log SCC × MY	Lin	2.04	2.04	2.01	2.0	1.96	1.94	1.92	1.91	1.9	1.89
8th	SCC × MY	Pol 3rd	2.06	2.06	2.06	2.05	1.98	1.75	1.22	0.28	–1.19	–3.31
8th	log SCC × MY	Pol 2nd	2.11	2.12	2.07	2.04	1.92	1.82	1.72	1.64	1.57	1.5

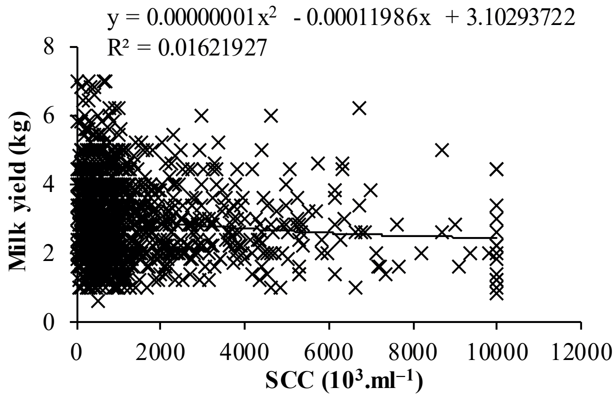
(median (m); geometric mean (xg); arithmetic mean (x); thousands (ths); linear (Lin); nonlinear, polynomial (Pol)) and Bailey, 2009; Penry, 2012; Salfer *et al.*, 2015). This was subsequently respected. According to the reached results the goat MY does not respond so sensitively by its decrease with SCC growth as in cows (Reneau *et al.*, 1983, 1988). Surprisingly, the mean goat MY was, along months, mostly lower in the first SCC interval (up to 300 10^3.ml^{-1}), higher and stabilized at mid-range SCC intervals and lower up to the last two SCC intervals. It means markedly lower from SCCs higher than 2,000 10^3.ml^{-1} (Tab. V). For this reason, the nonlinear regression was also introduced for further assessment and estimation of the MY losses according to SCC.

The higher probability of lower sensitivity (or smaller decrease) of goat MY to SCC changes (increase) can also be assumed according to the review given by Kuchtík *et al.* (2015). The main factors influencing SCC in goat milk are summarized by Granado *et al.* (2014). As a result, SCCs in goat milk are primarily influenced by infectious and non-infectious factors. Non-infectious factors are then divided by the authors into internal and external. They include into internal factors for example between-milking interval, milking rate, lactation stage, lactation number, breed and so on. They include into external factors for instance milking type, feeding, stress, season, production system etc. The goat milk SCCs can be significantly affected by the health state of the mammary gland (Contreras *et al.*, 2007). Paape *et al.* (2001) reported the SCC mean in milk of healthy goats ranging from 270,000 to 2,000,000/ml. There are substantially higher SCCs in the range from 659,000 to 4,213,000/ml in goats with mastitis. Leitner *et al.* (2004 a, b) found in healthy goats a mean SCC of 417,000/ml whereas in goats with mastitis 1,750,000/ml. Silanikove *et al.* (2010) introduced the SCC in milk of healthy goats about 300,000/ml. Leitner *et al.* (2008) assume about up to 25% of goats in the flock the occurrence of subclinical bacterial infection (SBI) when SCCs are less than 840,000/ml in bulk milk samples. With SCC ranging from 840,000 to 1,200,000/ml there is possible to assume the SBI occurrence for up to 50% of the goat in the flock. If SCCs range from 1,600,000 to 3,500,000/ml the SBI may be present up to 75% of goats. Goat milk with a SCC > 3,500,000/ml is not recommended for purchase for high occurrence probability of pathogen microorganisms and toxins.

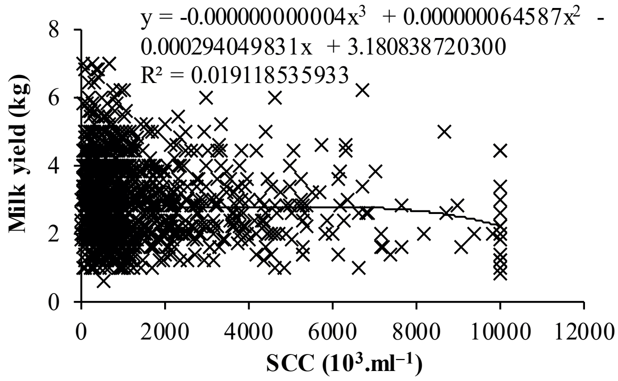
From the linear regression assessment performed among the selected milk indicators by month of lactation (MR calendar) it is clear that the relationship between SCC and MY is mostly negative along the months, 6 cases out of 7 for SCCs and for log SCC except June. However, this relationship was statistically significant only in March and May ($P < 0.05$ and $P < 0.01$). This was also the reason for linking of nonlinear evaluation. The use of polynomials brought slightly more significant relationships between SCC and MY in goats by months and only slightly higher determination coefficients. Despite that, there is possible to do a quantification of MY loss along individual goat SCCs according to relevant equations (with the highest R^2, though insignificant) mostly from second higher (SCC) half of such relationship. Although less intensively than in cows also in goats the MY reduction is associated with subclinical mastitis occurrence and high SCC (Shearer and Harris, 2003). The differences in response of mentioned relationship may be based on differences in milk secretion between cows and goats (predominantly merocrine and predominantly apocrine (Escobar, 1999)). A significant correlation index (0.298, 0.163 and 0.21, for SCC; $P < 0.05$ and $P < 0.01$; 3rd polynomial order) was found between SCC and MY at 3 months (March, April and May) of 7 (from 2nd to 8th). In the tightest variant of relationship there 8.9% of variations in MY can be explained by SCC variability and vice versa. A polynomial calculation of the relationship was performed for the total data file. The tightness of relationship expression (correlation, coefficient and index) increased slightly from −0.135 (log SCC, $P < 0.01$) to 0.138 (SCC, $P < 0.01$; Fig. 5). Still just 1.9% of the MY variability is explicable by SCC variability. However, the trend of curves is clearly consistent with the pathological (mastitis) effect. The higher suitability of polynomials for the estimation of MY losses by SCC in goats is so obvious.

Predicted MY (or MY loss, in kg) was calculated based on selected SCC mean values (m, xg and x in 10^3.ml^{-1}) which were relevant to data file of the given equation. The same was done according to the imaginatively increased SCC values in a serie of SCC intervals. This was done (Tab. VI) for individual months according to selected equations. Equations were selected by a qualified estimate: linear or nonlinear; for SCC or log SCC × MY. E.g. predicted MY for SCC intervals 1–1,999, 2–2,999, 3–3,999, 4–4,999, 5–5,999, 6–6,999 and ≥ 7,000 10^3.ml^{-1} may be 3.99, 3.77, 3.6, 3.46, 3.33, 3.23 and 3.13 kg in 3rd month (Pol 2nd) and so on. The corresponding MY losses according to SCC are apparent from the trend. The relatively lower loss values result from the calculated values of goat MY losses according to the SCC increase (according to the degree of milk secretion disorder or subclinical mastitis) in the MR during the season (lactation period). These MY losses are lower in corresponding SCC at their lower levels than in cows (Reneau, 1986; Escobar, 1999; Shearer and Harris, 2003; Penry, 2012). At higher SCC levels the relative MY losses can be comparable. Pleguezuelos *et al.* (2015) mentioned the percentages estimated in losses of MY for SCC levels (in milion SCC/ml) as follows: 1; 2; 3; > 7. These corresponding MY losses were as follows: 11.4; 19.5; 24.2; 35.7%. Such results are in quite good accordance with our findings.

Similar, however slightly higher, were our findings also in view of the results of Barrón-Bravo *et al.* (2013), which reported for higher SCC the MY losses in values of 12.9%, 29.1% and 15.4% for three different breeds of goats.



r = 0.127; P < 0.01; n = 1,173



r = 0.138; P < 0.01; n = 1,173

5: *Polynomial (2nd and 3rd order) relationship between somatic cell count (SCC, in $10^3.ml^{-1}$) and milk yield (MY, in kg) in individual goat milk samples in milk recording in total for whole lactation (year)*

CONCLUSION

The calculated predicted absolute goat milk losses at the upper SCC intervals can be further relativized (%) to the appropriate central values (probably a pathological condition not yet burdened) of month MY for practical use. This use is focused on the original dairy goat farm, use elsewhere is possible in farms with similar SCC, goat milk yield and rearing system. The results are useful for promotion of animal health and prevention of milk secretion disorders, goat milk yield and quality and operational safety of their breeders. There is a realistic possibility to construct similar prediction programs for predictions of milk losses according to mastitis and its SCC indicator and for prevention of milk secretion diosrders in goats such as in cows.

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REFERENCES

ALI, A. K. A. and SHOOK, G. E. 1980. An optimum transformation for somatic cells concentration in milk. *Journal of Dairy Science*, 63(3): 487–490.

BARRÓN-BRAVO, O. G., GUTIÉRREZ-CHÁVEZ, A. J., ÁNGEL-SAHAGÚN, C. A., MONTALDO, H. H., SHEPARD, L. and VALENCIA-POSADAS, M. 2013. Losses in milk yield, fat and protein contents according to different levels of somatic cell count in dairy goats. *Small Ruminant Research*, 113: 421–431.

CASEY, R. H. and MAUGHAN, R. D. 1987. Mastitis and its control. *Western Australian Department of Agriculture Bulletin 4126*.

CONTRERAS, A., SIERRA, D., SANCHEZ, A., CORRALES, J. C., MARCOC, J. C., PAAPE, M. J. and GONZALO, C. 2007. Mastitis in small ruminants. *Small Ruminant Research*, 68(1–2): 145–153.

CRIST, W. L., HARMON, R. J., O'LEARY, J. and MCALLISTER, A. J. 1997. *Mastitis and its control*. Publication ASC-140. Cooperative Extension Service, University of Kentucky, College of Agriculture.

CNI. 1999. *Determination of milk composition by mid-infrared analyzer* [in Czech: *Stanovení složení mléka infračerveným absorpčním analyzátorem*]. CSN 57 0536. Prague: Czech Normalization Institute.

CNI. 1973. *Methods for testing of milk and milk products* [in Czech: *Metody zkoušení mléka a tekutých mléčných výrobků*]. CSN 57 0530. Prague: Czech Normalization Institute.

CNI. 2011. *Milk – Fat content determination – Gravimetric method (Reference method)* [in Czech: *Mléko – Stanovení obsahu tuku – Vážková metoda (Referenční metoda)*]. CSN EN ISO 1211 (570534). Prague: Czech Normalization Institute.

CNI. 2012. *Milk, cream and condensed unsweetened milk – Total dry matter content determination (Reference method)* [in Czech: *Mléko, smetana a zahuštěné neslazené mléko – Stanovení obsahu celkové sušiny (Referenční metoda)*]. CSN ISO 6731 (570535). Prague: Czech Normalization Institute.

CNI. 2005. *Conformity assessment – General requirements for the competence of testing and calibration laboratories* [in Czech: *Posuzování shody – Všeobecné požadavky na způsobilost zkušebních a kalibračních laboratoří*]. CSN EN ISO/IEC 17025. Prague: Czech Normalization Institute.

CNI. 1998. *Milk – Somatic cell count determination – Part 1: Microscopy method*. [in Czech: *Mléko – Stanovení počtu somatických buněk – Část 1: Mikroskopická metoda (Referenční metoda)*]. CSN EN ISO 13366–1 (57 0531). Prague: Czech Normalization Institute.

CNI. 2007. *Milk – Somatic cell count determination – Part 2: Manual for fluoro–opto–electronic instrument operation* [in Czech: *Mléko – Stanovení počtu somatických buněk – Část 2: Metoda elektronického počítání částic*]. CSN EN ISO 13366–2 (57 0531). Prague: Czech Normalization Institute.

DROKE, E. A., PAAPE, M. J. and DICARLO, A. L. 1993. Prevalence of high somatic cell counts in bulk tank goat milk. *Journal of Dairy Science*, 76(4): 1035–1039.

ESCOBAR, E. N. 1999. Somatic cells in goat milk. In: *Proc. 14th Ann. Goat Field Day*. Langston, OK: Langston University.

GAJDŮŠEK, S., JELÍNEK, P. and HAMPL, A. 1996. Somatic cell counts in goat milk and their relation to milk composition and properties. *Živočišná Výroba / Czech Journal of Animal Science*, 41: 25–31.

GENČUROVÁ, V., HANUŠ, O., HULOVÁ, I., VYLETĚLOVÁ, M. and JEDELSKÁ, R. 2008. The differences of selected indicators of raw milk composition and properties between small ruminants and cows in the Czech Republic. *Výzkum v chovu skotu / Cattle Research*, 50(183): 10–19.

GRANADO, R. J., RODRIGUEZ, M. S., ARCE, C., and ESTEVEZ, V. R. 2014. Factors affecting somatic cell count in dairy goats: a review. *Spanish Journal of Agricultural Research*, 12(1): 133–150.

HANUŠ, O., GENČUROVÁ, V., VYLETĚLOVÁ, M., LANDOVÁ, H., KOPECKÝ, J. and JEDELSKÁ, R. 2008. The effect of goat udder health on composition and properties of raw milk. *Folia Veterinaria*, 52(3–4): 149–154.

HANUŠ, O., GENČUROVÁ, V., YONG, T., KUČERA, J., ŠTOLC, L., JEDELSKÁ, R., KOPECKÝ, J. 2009. Reference and indirect instrumental determination of basic milk composition and somatic cell count in various species of mammals. *Scientia Agriculturae Bohemica*, 40(4): 196–203.

HANUŠ, O., HRONEK, M., HYŠPLER, R., YONG, T., TICHÁ, A., FIKROVÁ, P., HANUŠOVÁ, K., SOJKOVÁ, K., KOPECKÝ, J. and JEDELSKÁ, R. 2010. Relationship between somatic cell count and lactose content in milk of various species of mammals. (In Czech) *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 58(2): 87–100.

HANUŠ, O., SOJKOVÁ, K., HANUŠOVÁ, K., SAMKOVÁ, E., HRONEK, M., HYŠPLER, R., KOPECKÝ, J., JEDELSKÁ, R. 2011. An experimental comparison of methods for somatic cell count determination in milk of various species of mammals. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, LIX(1): 67–82.

IDF 79B. 1991. *Dried Milk, Dried Ice – Mixes and Processed Cheese, Determination of Lactose Content, Enzymatic Methods*. International IDF Standard 79B:1991. International Dairy Federation.

JANŮ, L., HANUŠ, O., BAUMGARTNER, C., MACEK, A. and JEDELSKÁ, R. 2007. The analysis of state, dynamics and properties of raw cow milk quality indicators in the Czech Republic. *Acta Fytotechnica et Zootechnica*, 10(3): 74–85.

JONES, G. M. and BAILEY, T. L. 2009. *Understanding the basics of mastitis*. Virginia Cooperative Extension Publication No. 404–233. Virginia State University.

JONES, G. M., PEARSON, R. E., CLABAUGH, G. A. and HEALD, C. W. 1984. Relationships between somatic cell counts and milk production. *Journal of Dairy Science*, 67(8): 1823–1831.

KRÁLÍČKOVÁ, Š., KUCHTÍK, J., FILIPČÍK, R., LUŽOVÁ, T. and ŠUSTOVÁ, K. 2013. Effect of chosen factors on milk yield, basic composition and somatic cell count of organic milk of Brown short-haired goats. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61(1): 99–105.

KUCHTÍK, J., ŠUSTOVÁ K., KALHOTKA, L. and PAVLATA, L. 2015. Total bacteria count (TBC) and somatic cell count (SCC) in goat milk and their relationship [in Czech: Celkový počet mikroorganismů a počet somatických buněk v kozím mléce a jejich korelace]. *Mlékařské Listy*, 152: XIX–XXVI.

KUCHTÍK, J. and SEDLÁČKOVÁ, H. 2003. Composition and properties of milk in white short-haired goats on the third lactation. *Czech Journal of Animal Science*, 48(12): 540–550.

MORAND-FEHR, P., FEDELE, V., DECANDIA, M. and LE FRILEUX, Y. 2007. Influence of farming and feeding systems on composition and quality of goat and sheep milk. *Small Ruminant Research*, 68: 20–34.

LEITNER, G., MERIN, U., GLICKMAN, A., WEISBLIT, L., KRIFUCKS, O., SHWIMMER, A. and SARAN, A. 2004 a. Factors influencing milk quantity and quality in Assaf sheep and goat crossbreds. *South Africa Journal of Animal Science*, 34(5): 162–164.

LEITNER, G., MERIN, U. and SILANIKOVE, N. 2004 b. Changes in milk composition as affected by subclinical mastitis in goats. *Journal of Dairy Science*, 87(6): 1719–1726.

LEITNER, G., SILANIKOVE, N. and MERIN, U. 2008. Estimate of milk and curd yield loss of sheep and goats with intrammamary infection and its relation to somatic cell count. *Small Ruminant Research*, 74(1–3): 221–225.

LOOPER, M. 2012. *Factors affecting milk composition of lactating cows*. FSA4014. Agriculture and Natural Resources, Department of Agriculture Research and Extension, University of Arkansas System.

MANZENREITER, H., FÜRST-WALTL, B., EGGER-DANNER, C. and ZOLLITSCH, W. 2013. Zur Eignung des Gehalts an Milchinhaltsstoffen als Ketoseindikator. In: *LFZ Raumberg-Gumpenstein des BMLFUW, 40*. Viehwirtschaftliche Fachtagung – Ökonomik, Proteinversorgung, Grundfutterqualität, Grundfutterkonservierung, Mutterkuhhaltung, Forschungsergebnisse LFZ. pp. 9–19.

PAAPE, M. J., WIGGANS, G. R., BANNERMAN, D. D., THOMAS, D. L., SANDERS, A. H., CONTRERAS, H., MORONI, P. and MILLER, R. H. 2007. Monitoring goat and sheep milk somatic cell counts. *Small Ruminant Research*, 68: 114–125.

PARK, Y. V., JUAREZ, M., RAMOS, M. and HAENLEIN, G. F. W. 2007. Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research*, 68(1–2): 88–113.

PENRY, J. F. 2012. Mastitis Focus: a core part of the mastitis control toolkit. In: *Proceedings of the New Zealand Milk Quality Conference*. pp. 7.04.1–7.04.5.

PERSSON, Y., LARSEN, T. and NYMAN, A. K. 2014. Variation in udder health indicators at different stages oflactation in goats with no udder infection. *Small Ruminant Research*, 116(1): 51–56.

PIRISI, A., LAURET, A. and DUBEUF, J. P. 2007. Basic and incentive payments for goat and sheep milk in relation to quality. *Small Ruminant Research*, 68(1): 167–178.

PLEGUEZUELOS, F. J., DE LA FUENTE, L. F. and GONZALO, C. 2015. Variation in milk yield, contents and incomes according to somatic cell count in a large dairy goat population. *Journal of Advances in Dairy Research*, 3:145.

PŘIDALOVÁ, H., JANŠTOVÁ, B., CUPÁKOVÁ, Š., DRAČKOVÁ, M., NAVRÁTILOVÁ, P. and VORLOVÁ L. 2009. Somatic cell count in goat milk. *Folia Veterinaria*, 53(2), 2: 101–105.

RAUBERTAS, J. and SHOOK, G. 1982. Relationship between lactation measures of SCC and milk yield. *Journal of Dairy Science*, 65: 419–425.

RAYNAL-LJUTOVAC, K., PIRISI, A., CRÉMOUX, R. and GONZALO, C. 2007. Somatic cells of goat and sheep milk: Analytical, sanitary, productive and technological aspects. *Small Ruminant Research*, 68: 126–144.

RENEAU, J. K. 1986. Effective use of dairy herd improvement somatic cell counts in mastitis control. *Journal of Dairy Science*, 69: 1708–1720.

RENEAU, J. K., APPLEMAN, R. D., STEUERNAGEL, G. R. and MUDGE, J. W. 1983, 1988. *Somatic cell count. An effective tool in controlling mastitis*. AG–FO–0447. Agricultural Extension Service, University of Minnesota.

ROBERTSON, N. H. and MULLER, C. J. C. 2005. Somatic cell count in goat's milk as an indication of mastitis. *South African Journal of Animal Science*, 6(1): 1–7.

RYAN, D. P. 1993. Cell count interpretation. *IDF, Mastitis Newsletter*, 134(18): 12–15.

SALFER, L. et al. 2015. *Learning about dairy*. Updated from the publication Learning About Dairy NCR593. University of Minnesota Extension.

SHEARER, J. K. and HARRIS, B., JR. 1992, 2003. *Mastitis in Dairy Goats*. IFAS Extension, University of Florida, DS 85.

SHOOK, G. E. 1982. Approaches to summarizing somatic cell count which improve interpretability. In*: Proceedings 21st Annu. Mtg. National Mastitis Council*. Louisville, KY. Arlington, VA: Natl. Mastitis Counc. Inc.,

SILANIKOVE, N., LEITNER, G., MERIN, U. and PROSSER, C. G. 2010. Recent advances in exploiting goat's milk: quality, safety and production aspects. *Small Ruminant Research*, 89(2–3): 110–124.

WIGGANS, G. and SHOOK, G. 1987. A lactation measure of somatic cell count. *Journal of Dairy Science*, 70(12): 2666–2672.

WILSON, D. J., STEWART, K. N. and SEARS, P. M. 1992. Effects on goat somatic cell counts of intramammary infection, stage of lactation and season. *Journal of Dairy Science*, 75(Suppl.1)(163): (Abstr.) P54.

Contact information

Oto Hanuš: hanus.oto@seznam.cz
Petr Roubal: roubal@milcom-as.cz
Josef Kučera: kucera@cmsch.cz
Marcela Klimešová: marcela.vyletelova@seznam.cz
Radoslava Jedelská: radka.jedelska@seznam.cz
Jaroslav Kopecký: jaroslav.kopecky@email.cz