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SOMATIC CELL COUNT IN MILK OF INDIVIDUAL LACAUNE EWES UNDER PRACTICAL CONDITIONS IN SLOVAKIA: POSSIBLE EFFECT ON MILK YIELD AND ITS COMPOSITION

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ABSTRACT
The aim of this study was to describe the health status of udder through analysis of somati cell count (SCC) in milk of Lacaune breed. The study was conducted at five Slovak farms. Milk yield recordings and milk samples were taken from March till August by certificated organisation for milk recording, where also milk analysis on SCC was processed. In total 1192 samples were analysed. Milk samples were divided into the five categories on the basis of SCC: SCC <0.2 × 106, between 0.2 – 0.4 × 10^6, 0.4 – 0.6 × 10^6, 0.6 – 1 × 10^6 and >10^6 cells.mL^{-1}. Animals were divided into seven stages of lactation (first: 30-60 days of lactation and then each following 30 days a further group of lactation stage was considered). The Mixed model with Scheffe's analysis as a post hoc test was used. SCC on farm 3 was highest (5.80 ±0.04 log SCC mL^{-1}) as compared with others farms (p <0.05). Significant effect of farms on milk yield demonstrates different level of farm management. Between farm 1 and 3 the differences in milk yield per milking is more than double. Frequency of distribution of milk samples was 53.36%, 13.93%, 6.29%, 7.21% and 19.21% for different categories respectively. In category >10^6 cells.mL^{-1} the highest percentage was on farm 4 (33.57%) and lowest on farm 2 (8.06%) though more representative percentage was on farm 5 (12.05%) due to larger number of animals. The negative effect of high SCC on milk yield was observed in all farms. Data also revealed that main part of individual milk samples had SCC below 0.6 × 10^6 cells.mL^{-1} which could be an important argument for future legislative establishment of limits for SCC in ewe's milk.

Keywords: Lacaune; somatic cell counts; milk yield

INTRODUCTION
Sheep milk production is currently the main breeding aim of many agricultural farms and privately-employed farmers in many countries. Milk plays thus a crucial role in the economy of cooperatives and farms. In Slovakia there is effort to increase the milk production by the importing dairy breeds especially Lacaune or use them to improve milk yield of traditionally bred sheep. Increasing of milk yield could by potential a risk for udder health especially if high producing breed is bred in less breeding systems. Recently on the basis of somatic cell counts in milk we showed higher percentage of health problems of udder in Lacaune or its crossing with Tsigai and Improved Valachian as compared with pure mentioned ones raised under to same conditions **(Idriss et al., 2015)**.

At present the somatic cell count (SCC) is considered to be a basis for abnormal milk control programs for cows, goats and sheep **(Bergonier-Berthelot, 2003; Zajac et al., 2016)**. Higher number of SCC reduced milk production and negatively affects other variables (lactose) and positive fat and protein contents **(Olechnowicz et al., 2009; Rupp et al., 2003)**. In spite of negative effect of SCC on milk production, in dairy ewes there is not legislative duty to analyse raw milk of ewes for SCC for the market purposes as it is in dairy cow well established. The trade with milk and milk product could be thus possible influenced by milk quality related to consumers' demands **(Kubicová and Dobák, 2012)**.

Individual SCC (SCC) is a useful predictor of infected gland, though there is no accepted threshold that can permit to differentiate between "healthy" and "infected" udders in dairy ewes **(Berthelot et al., 2006)**. Last mentioned authors reported the udder as healthy if individual SCC is lower than 0.5 × 10^6 cells.mL^{-1}, and infected if at least two individual SCC were higher than 1 or 1.2 × 10^6 cells.mL^{-1}, while at the flock level, if SCC exceeded 0.65 × 10^6 cells.mL^{-1}, they indicated up to 15% occurrence of mastitis. Recently in Tsigai ewes under practical conditions only 13% of ewes had over 0.6 × 10^6 cells.mL^{-1} **(Vršková et al., 2015)**. In another study with uninfected Valle del Belice ewes, 83.7% of the milk samples were below 0.5 × 10^6 cells.mL^{-1} and only 2.6%

samples had SCC above 1×10^6 cells.mL^{-1} **(Riggio et al., 2013)**. On the base of field study the **Pengov (2001)** considered the threshold of 0.25×10^6 cells.mL^{-1} beyond the assessment of udder health of ewes.

Increasing numbers of Lacaune in dairy practice is a good way for farmer to increase the milk production but on the other side it is important to evaluate the efficiency of implementation of this breed into dairy practice. One of the most important information is udder health. The hypothesis of the work was that SCC negatively influences milk yield and its compstition. Further hypothesis was that SCC differs among farms. Therefore the aim of the study was to describe the actual health status of udder through analysis of milk on SCC in Lacaune under practical conditions and possible effect on milk yield and its composition.

MATERIAL AND METHODOLOGY

The study was performed in five ewes dairy farms in Slovakia in 2016. In all farms there was only Lacaune breed in their first to fourth lactations. Animals were machine milked two times a day. Because of missing values of age the parity effect was not studied. Before weaning the lambs, the ewes were fed in stable with hay and grass or alfalfa/clover silage. At the end of April and beginning on May the animals were on pasture additionaly fed with concentrate intake in parlour during milking.

Milk yield recording and milk samples were taken during the period from March till August depending on the selected farm by certificated organisation for milk recording (Plemenárske služby, š. p. SR Bratislava). In Table 1 there are numbers of milk samples from different farms and period of sampling. In total 1192 samples were collected and analysed. Milk samples from each udder were transported to the certificated Central laboratory of Plemenárske služby š.p. Bratislava for milk analysis on SCC and milk composition (fat, protein, lactose).

Statistical methods

For statistical evaluation the ewes were divided into the five groups on the basis of their individual SCC in milk: SCC $<0.2 \times 10^6$ cells.mL^{-1}, SCC between $0.2 – 0.4 \times 10^6$ cells.mL^{-1}, SCC between $0.4 – 0.6 \times 10^6$ cells.mL^{-1}, SCC between $0.6 – 1 \times 10^6$ cells.mL^{-1}, SCC $> 10^6$ cells.mL^{-1}. Also the effect of farms was involved into statistical evaluation (FARM). On the basis of date of lambing there was a possibility to divided animals into seven stages of lactation (first: 30-60 days of lactation and then each following 30 days a further group of lactation stage was considered) (STAGE).The statistical model using SAS **(Mixed procedure; SAS/STAT 9.1, 2002-2003)**. can be written in the following form (1):

(1)

$$y_{ijkl} = \mu + FARM_i + HEALTH\ (FARM)_j + STAGE_k + u_l + e_{ijkl},$$

where y_{ijkl} = the measurements for milk yield, fat, protein, lactose and logSCC; μ = overall mean; $FARM_i$ = the fixed effects of five farms; HEALTH $(FARM)_j$ = fixed effect of health (five SCC categories) within five farms; $STAGE_k$ = fixed effect of stage of lactation (seven stages of lactation); u_l =random effect of ewe, $u_l \sim N(0, \sigma c2)$ and e_{ijkl} = random error, assuming $e_{ijkl} \sim N(0, I\ \sigma^2_e)$. Data are presented as LSmeans (Least squares means) ±standard error per milking.

RESULTS AND DISCUSSION

Basic statistic data of measured parameters were: milk yield 856 ±11.76 mL, fat 6.41 ±0.05%, protein 5.96 ±0.02%, lactose 4.62 ±0.01% and logx SCC 4.4 ±0.01 cells.mL^{-1}. The effect of farm on milk yield and its composition are presented in Table 2. LS Means of all parameters significantly were different among farms. The highest milk yield was found out on third farm (900.09 ±22.73 mL) and lowest on farm first (439.92 ±41.05 mL, p <0.05). The fat content was significantly lowest on farm second (4.69 ±0.19%) as compared with others farms (p <0.05). Significantly highest content of proteins was measured on fourth farm (6.44 ±0.07%) as compared with others farms (p <0.05). Lactose content, though significant among farms, was numerically similar. On third farm there was highest SCC (5.80 ±0.04 logSCC mL^{-1}) as compared with others farms

Table 1 Numbers of experimental ewes on farms in each month.

	March	April	May	June	July	August	Total
First		13	26	31	31	31	132
Second			62				62
Third	42	57	59	62		63	283
Fourtn		33	32	30	31		126
Fifth			261			328	589
Total	**42**	**103**	**440**	**123**	**62**	**422**	**1192**

Table 2. The effect of farm on milk yield and ith composition and on somatic cell counts.

Farm	Milk yield		Milk composition (%)						logSCC	
	mL		Fat		Protein		Lactose		cells.mL^{-1}	
	LS means	Std. Error	LS means	Std. Error	LS means	Std. Error	LS means	Std. Error	LS means	Std. Error
First	439.92^a	41.05	6.77^a	0.16	5.83^a	0.08	4.51^{ab}	0.04	5.50^a	0.06
second	565.97^a	50.15	4.69^b	0.19	5.92^a	0.09	4.61	0.04	5.39^{ad}	0.09
Third	900.09^b	22.73	6.41^a	0.09	6.00^a	0.04	4.64^c	0.02	5.80^c	0.04
Fourth	787.54^{bc}	37.44	6.87^{ac}	0.14	6.44^b	0.07	4.65	0.03	5.64^{bd}	0.06
Fifth	767.57^c	25.28	6.84^c	0.10	6.05^a	0.05	4.52^b	0.02	5.27^{cd}	0.04

Note: ^{a,b,c} LS Means in the same column with different letters are different (p <0.05).

Table 3 The effect of somatic cell counts on milk yield and its composition within different farms.

Farm		**SCC categories, x.10^3 cells.mL^{-1}**									
		<200		**200 – 400**		**400 – 600**		**600 – 1000**		**>1000**	
First	Milk yield (mL)	543.53	42.30	465.33	69.96	430.52	119.66	396.05		364.16	65.28
	Fat (%)	6.36	0.16	7.26	0.27	6.79	0.46	6.81	0.46	6.60	0.25
	Protein (%)	5.56	0.05	5.77	0.13	5.84	0.22	6.15	0.22	5.94	0.12
	Lactose (%)	4.60	0.04	4.55	0.06	4.62	0.10	4.52	0.10	4.29	0.06
Second	Milk yield (mL)	863.70	58.92	476.71	101.03	597.65	112.34	628.99	112.97	262.80	141.57
	Fat (%)	3.90	0.23	4.72	0.39	4.73	0.43	4.98	0.43	5.12	0.54
	Protein (%)	5.81	0.11	5.94	0.19	5.73	0.22	5.94	0.21	6.17	0.26
	Lactose (%)	4.86	0.05	4.71	0.09	4.68	0.10	4.51	0.10	4.27	0.12
Third	Milk yield (mL)	1030.02	32.68	855.30	45.94	843.72	71.39	875.93	56.96	895.99	31.46
	Fat (%)	5.93	0.13	6.62	0.18	6.67	0.27	6.23	0.22	6.58	0.12
	Protein (%)	5.86	0.06	6.4	0.08	6.09	0.13	6.06	0.10	5.99	0.06
	Lactose (%)	4.82^{a}	0.03	4.71	0.04	4.66	0.06	4.62	0.05	4.41^{b}	0.03
Fourth	Milk yield (mL)	817.56	48.24	887.16	68.08	692.18	91.93	794.52	112.26	746.27	63.12
	Fat (%)	6.65	0.19	6.81	0.26	7.19	0.35	6.47	0.43	7.26	0.24
	Protein (%)	6.14	0.09	6.38	0.13	6.68	0.17	6.26	0.21	6.72	0.12
	Lactose (%)	4.62	0.05	4.65	0.06	4.62	0.08	4.75	0.10	4.59	0.05
Fifth	Milk yield (mL)	852.24	21.57	795.92	44.08	809.40	64.64	754.33	59.13	625.96	42.40
	Fat (%)	6.62	0.08	6.71	0.17	6.90	0.25	7.4	0.23	6.90	0.16
	Protein (%)	5.96	0.04	5.92	0.08	6.09	0.12	6.10	0.11	6.17	0.08
	Lactose (%)	4.62	0.02	4.56	0.04	4.45	0.06	4.55	0.05	4.43	0.04

Note: ^{a,b} LSmeans in the same line with different letters are different (p <0.05).

Table 4 The effect of stage of lactation on millk yield, milk compositon and SCC.

Stage of lactation	**Milk yield** mL		**Milk composition (%)** Fat		Protein		Lactose		**SCC SCC** cells.mL^{-1}	
30 – 60 days	962.09^{a}	49.33	5.28^{a}	0.18	5.25^{a}	0.09	4.87^{a}	0.04	5.51	0.10
60 – 90 days	1038.39^{a}	21.2	5.12^{a}	0.08	5.44^{a}	0.04	4.78^{ac}	0.02	5.54	0.04
90 – 120 days	844.82^{b}	27.53	5.81^{c}	0.11	5.72^{b}	0.05	4.69^{bc}	0.02	5.47	0.05
120 – 150 days	637.08^{d}	31.34	6.52^{d}	0.12	6.00^{c}	0.06	4.57^{d}	0.03	5.44	0.06
150 – 180 days	524.37^{c}	23.63	7.35^{b}	0.09	6.59^{d}	0.04	4.43^{ef}	0.02	5.46	0.05
180 – 210 days	460.41^{cd}	42.29	6.83^{bd}	0.16	6.60^{d}	0.08	4.49^{df}	0.04	5.56	0.08
>210 days	378.36^{d}	54.98	7.3^{bd}	0.21	6.63^{d}	0.10	4.27^{e}	0.05	5.66	0.11

Note: $^{a,b,c, d, e,f}$ LS means in the same column with different letters are different (p <0.05).

(p <0.05). Significant effect of farms on milk yield demonstrates different level of farm management. Between first and third farm the differences in milk yield per milking is more than double. In our previous studies **(Mačuhová et al. 2012; Tančin et al. 2011)** the milk yield of LC was comparable to first or second farm. **Oravcova et al. (2006)** published from data obtained in our practical conditions daily milk yield 1.053 ±0.475 kg in Lacaune breed. Fat content in milk with exception of second farm (unusually very low) and protein content were similar to data published by **Rovai et al. (2015)**. In another study of **Oravcova et al. (2007)** 6.97 ±1.514% fat and 5.62 ±0.692% protein for Lacaune was found out.

The effect of SCC on milk yield and its composition within each involved farm is presented in Table 3. The numerically negative effect of high SCC on milk yield was observed almost in all farms. Especially in the farm third and fourth, with higher number of animals, there was seen high numerical decrease of milk yield between group SCC $<0.2 \times 10^6$ cells.mL^{-1} and SCC $>10^6$ cells.mL^{-1}. We found out also numerical reduction of milk production in ewes with high SCC **(Vršková et al., 2015)**, though it is shownon large number of ewes the significant reduction of milk yield with high SCC in milk was found out in Manchega ewes **(Adrias et al., 2012)**, in Churra ewes **(Gonzalo et al., 2002)** and in line 05 dairy ewes

Table 5 Frequency of distribution (%) of milk samples in different SCC categories.

	Somatic cell counts, categories x.10^3 cells.mL^{-1}				
Farm	<200	200 – 400	400 – 600	600 – 1000	>1000
First	47.73	18.18	5.30	6.06	22.73
Second	50.00	16.13	12.90	12.90	8.06
Third	32.86	15.90	7.07	10.60	33.57
Fourth	39.68	20.63	11.11	6.35	22.22
Fifth	67.74	10.36	4.41	5.43	12.05
Total	**53.36**	**13.93**	**6.29**	**7.21**	**19.21**

Note: ^{a,b,c} LS Means in the same column with different letters are different (p <0.05).

(Olechnowicz et al., 2009). Significant negative effect of high SCC on lactose content was calculated only in fourth farm though the lactose content numerically decreased in all farms with increasing SCC. SCC did not influence protein and fat content as published by **Rovai et al. (2015)**. In our study with Tsigai ewes **(Vršková et al., 2015)** and in other work **(Olechnowicz et al., 2009)** there was found out significant increase of fat, protein and lactose content with increasing SCC in milk**.** Though not significant in this study we also confirm the decrease of lactose with high SCC in milk.

The stage of lactation significantly influenced all parameters except SCC (Table 4). Milk yield, fat and protein content affected by stage of lactation are in agreement with data **Oravcova et al. (2006, 2007, 2015)**. Though not significant effect of stage of lactation (p <0.065) we found out the higest values at the begining and at the end of lactaion indicating the most critical periods for udder health. In healthy ewes **Arias et al. (2012)** found significant increase of SCC during lactation but if they analysed the data in ewes with high SCC at beginning of lactation the SCC during lactation decreased.

Frequency of distribution of individual milk samples in different SCC categories is presented in Table 5. In the SCC category below 0.2×10^6 cells.mL^{-1} was categorised 53.36 % of individual samples and in category over 10^6 cells.mL^{-1} were almost 19.21% samples. In both mentioned categories there was seen clear effect of farm. The highest percentage of samples in SCC category below 0.2×10^6 cells.mL^{-1} was found out in fifth farm (67.74%) and lowest on fourth farm (32.86%). In category over 10^6 cells.mL^{-1} the highest percentage on fourth farm (33.57%) and lowest on second farm (8.06%) though more representative low percentage was on fifth farm (12.05%) due to larger number of animals (Table 1). In our study with different breeds the LC had lowest percentage of samples in low SCC categories and was similar to fourth farm **(Idriss et al., 2015)**. Very high difference in the milk samples distribution in SCC categories indicates different level of effective breeding of LC breed under Slovakian practical conditions. Another factors negatively influence SCC in milk is high milk production **(Tančin et al., 2016)** as see in Table 5 at third farm. Therefore farmers aiming the increase milk yield should beware of possible increase of risk for mastitis. On the other side the percentage of samples in the category over 10^6 cells.mL^{-1} is relative low (except farm third) which indicate that high SCC in ewe's milk is not probably physiological trait and deserve more attention to preventive mastitis programs implemented in dairy sheep practice. Therefore more study is needed to find out relationship between high SCC in milk and presence of microorganisms in udder.

CONCLUSION

The results of this study indicated that the SCC of individual milk samples could be important factor contributing to more effective management of the breeding systems. Data also revealed that main part of individual milk samples had SCC below 0.6×10^6 cells.mL^{-1} which could be an important argument for future legislative establishment of limits for SCC in ewe's milk.

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