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Original Paper

The impact of somatic cell count on milk yield and composition

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The aim of this work was to clarify impact of somatic cell count (SCC) on milk yield and its composition. The experiment was realized on one dairy farm with Tsigai breed. Totally 252 milk samples from 84 ewes (on their first and second lactation) were analysed. Milk samples within regular test recording day from the whole udder were collected during lactation in April, June and July. On the basis of SCC the samples were divided into the SCC groups: first <200 × 10^3 cells/ml; second ≥200 <400 × 10^3 cells/ml; third ≥400 <600 × 10^3 cells/ml; fourth ≥600 <1,000 × 10^3 cells/ml; fifth ≥1,000 × 10^3 cells/ml to see the effect of SCC at the level of regular milk recording test day. The same SCC groups were used for distribution of the lactation means of somatic cell score (SCS) for evaluation of the effect of SCC at the level of whole lactation. Total milk yield per lactation was affected SCS per lactation ($P = 0.0089$). In each month of sampling we observed decrease content of lactose at the level of test day ($P < 0.001$) and at the level of lactation ($P = 0.001$) with increase of SCC. The increase content of protein we detected with increase of SCC at the level of test days ($P = 0.0281$) and decline per lactation ($P = 0.0452$). In content of fat we did not find out change in relation with increase of SCC in regular milk recording test days and per lactation also. The analyses suggest that SCC negatively impact on milk yield and milk composition and SCC should be in high attention of dairy practice.

Keywords: somatic cell count, milk yield, milk composition

1 Introduction

Mastitis mainly health problem of udder of dairy animals affecting economy of milk production and its quality and hygienic safety (Leitner et al., 2008; Tvarožková et al., 2019, review). This disease causes high economic looses due to decline milk yield and change milk composition (Oravcová et al., 2018; Paschino et al., 2019). Mastitis decreased milk yield up to 25% (Cuccuru et al., 2011). Also our previous study showed negative effect of somatic cells counts (SCC) on milk yield and its composition (Margetín et al., 2013; Baranovič et al., 2018; Tančin et al., 2017a).

In general mastitis and especially subclinical mastitis is accompanied by increase of SCC (Pengov, 2001). SCC are in generally accepted as indicator of health of mammary gland. Surprisingly in ewe's milk there is not determined physiological limit of SCC for detection of healthy udders as it is well acceptated in dairy cows. Many studies evaluated possible limit of SCC with different values. The limit of SCC >500 × 10^3 cells/ml was determined by Sutera et al. (2018) as indicator in relation to change in milk quality. In another study SCC 300 × 10^3 cells/ml was considered as ideal value for the diagnosis of subclinical mastitis (Arias et al., 2012). In one of our studies was observed the highest number of ewes with SCC <400 × 10^3 cells/ml (Tvarožková et al., 2018).

Thus the optimal set limit for SCC could be proposed at the level with minimal negative effect on milk yield and its composition. Therefore, the aim of the work was to clarify the effect of different levels of SCC on milk yield and its composition at the level of test day and also at the level of whole lactation.

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2 Material and methods

2.1 Milk samples collection

The experiment was performed in one dairy farm of eastern Slovakia. On this farm was kept Tsigai breed. Ewes were in their first and second lactation. Hand milking was performed two times a day. The samples were collected as part of milk recording service once a month during evening milking. The samples were taken in April, June and July during 2019 from the same 84 animals. Overall were collected 252 milk samples.

2.2 Laboratory analysis

Milk samples from whole udder were transported to the certificated Central laboratory of Breeding services of the Slovak Republic (Plemenárske služby š.p. SR Bratislava) and subsequently analysed for milk composition and SCC.

2.3 Statistic analysis

For the evaluation of the impact of SCC at the level of regular milk recording test day the milk samples (252 samples) were divided on the basis of SCC into the SCC groups: first group $<200 \times 10^3$ cells/ml; second $\geq 200 < 400 \times 10^3$ cells/ml; third $\geq 400 < 600 \times 10^3$ cells/ml; fourth $\geq 600 < 1{,}000 \times 10^3$ cells/ml; fifth $\geq 1{,}000 \times 10^3$ cells/ml.

For evaluation of the impact of SCC at the level of whole lactation, the individual SCC at each regular milk recording test day were transformed into somatic cell score (SCS) according formula (Lusis et al., 2010): $SCS = LOG_2(SCC/100{,}000) + 3$. From the obtained data the mean SCS per lactation for each ewe was calculated according: mean = (April_SCS + June_SCS + July_SCS)/3. Obtained means of SCS (84 ewes) were again transformed into SCC to distribute of ewes into above mentioned SCC groups. For calculation of whole milk production during lactation (min. 110 days) the formula from milk recording recommendation was used (PSSR, 2012). Data were statistically evaluated by SAS® software (SAS Studio 3.8, 2018). The used general linear model (PROC GLM) can be written as follows:

At test day level:

$$y_{ij} = \mu + \text{SCCGROUP}_i + \text{MONTH}_j + u_m + e_{ij}$$

where:
y_{ij} – measurements for observed variables; m – overall mean; SCCGROUP_i – fixed effects of SCC GROUP; MONTH_j – fixed effect of MONTH (April, Juni, July); u_m – random effect of ewes, $up \sim N(0, \sigma u\ 2)$; e_{ij} = random error, assuming $e_{ij} \sim N(0, I\ \sigma 2\ e)$

At whole lactation level:

$$y_{ij} = \mu + \text{SCCGROUP}_i + e_i$$

where:
y_i – measurements for observed variables; m – overall mean; SCCGROUP_i – fixed effects of SCC GROUP; e_i – random error, assuming $e_i \sim N(0, I\ \sigma 2\ e)$

3 Results and discussion

At the level of regular milk recording test days we did not find out significant impact SCC on milk yield, but was observed numerically decline in milk yield (290.8 ±7.19 ml, 260.5 ±10.19 ml resp.) in relation with increase of SCC (SCC $<200 \times 10^3$ cells/ml, SCC $\geq 1{,}000 \times 10^3$ cells/ml resp.). Tančin et al. (2017a) detected reduced milk yield in milk with high SCC. With the advancing stage of lactation we detected decline of milk yield during observed months ($P < 0.001$) (Table 1). The stage of lactation had the impact on the decrease of milk yield in study published by Oravcová et al. (2020).In content of fat we did not find out change regarding to the SCC groups. Similarly Vivar-Quintana et al. (2006) did not record significantly effect of SCC on fat in milk. During lactation period we recorded the increase of fat ($P < 0.001$) (Table 1). Tančin et al. (2017b) reported the increase milk fat with advancing lactation. SCC group had statistical significant effect on content of protein ($P = 0.0281$). We observed significant increase in content of protein in SCC group with SCC $\geq 1{,}000 \times 10^3$ cells/ml (6.3 ±0.08%) compared to group with SCC $<200 \times 10^3$ cells/ml (5.9 ±0.06%) ($P = 0.0452$). In ewe's milk with SCC over 1 000 $\times 10^3$ cells/ml Albenzio et al. (2004) observed higher content of total

protein. The effect of month on change content of protein was observed (P <0.001) (Table 1). In study realized by Kuchtík et al. (2017) there was detected higher level content of protein in late lactation in compared with early lactation. In observed months we found out significant decrease content of lactose in SCC group with SCC ≥1,000 × 10^3 cells/ml (4.4 ±0.04%) in compared to SCC group with low SCC <200 × 10^3 cells/ml (4.8 ±0.03%) and SCC group with SCC ≥200 <400 × 10^3 cells/ml (4.7 ±0.03%) (P <0.001). Lower lactose content in milk with high SCC was recorded in study published by Baranovič et al. (2018). Also we detected significant impact of months of observation on decline content of lactose (P <0.001) (Table 1).

Table 1 Statistical significance of factors as SCC group and month on the evaluated variables

Variable	Milk yield (ml)	Fat (%)	Protein (%)	Lactose (%)
Factor	*Pr* > *F*	*Pr* > *F*	*Pr* > *F*	*Pr* > *F*
SCC group	0.2034	0.6144	0.0281	<0.001
Month	<0.001	<0.001	<0.001	<0.001

SCC group – first group <200 × 10^3 cells/ml; second group ≥200 <400 × 10^3 cells/ml; third group ≥400 <600 × 10^3 cells/ml; fourth group ≥600 <1,000 × 10^3 cells/ml; fifth ≥1,000 × 103 cells/ml, Month: April, Juni, July

At the whole lactation level the total milk yield per lactation was significant affected by SCC (P = 0.0089) but without significance among means (76.01 ±4.6 l, 78.4 ±2.3 l, 61.2 ±7.0 l, 62.5 ±6.3 l, 66.5 ±3.7 l in SCC groups respectively). SCC had the impact on content of fat (P = 0.0337), protein (P = 0.0452) and lactose (P = 0.001) (Table 2). But we did not find significance among SCC groups in content of fat (6.9 ±0.4 kg, 7 ±0.2 kg, 5.8 ±0.6 kg, 5.6 ±0.6 kg, 6.1 ±03 kg in SCC groups resp.) and protein (4.5 ±0.3 kg, 4.6 ±0.1 kg, 3.8 ±0.4 kg, 3.7 ±0.4 kg, 4.2 ±0.2 kg in SCC groups resp.). We observed significant impact of SCC on decline of lactose per lactation in SCC group with SCC ≥1,000 × 10^3 cells/ml (2.9 ±0.2 kg) in compared to SCC group with SCC ≥200 <400 × 10^3 cells/ml (3.8 ±0.1 kg) (P = 0.01).The decrease content of lactose was observed in the study of Tančin et al. (2017b).

Table 2 Statistical significance of factor as SCC group on the evaluated variabless

Variable	Milk yield (ml)	Fat (%)	Protein (%)	Lactose (%)
Factor	*Pr* > *F*	*Pr* > *F*	*Pr* > *F*	*Pr* > *F*
SCC group	0.0089	0.0337	0.0452	0.001

For SCC groups see table 1

4 Conclusions

One of the main reasons why farmers should pay increased attention to SCC they are the changes in the milk yield and its composition that occur as a result of subclinical mastitis. The measure of SCC, milk yield and its composition routinely during recording test day could improve detection of subclinical mastitis in dairy practice.

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