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Connection of somatic cell count and milk yield as well as composition in dairy ewes

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Abstract

The aim of this study was to determine the effect of somatic cell count (SCC) on milk yield and composition using a threshold value of $250 \cdot 10^3$ cells/ml in dairy ewes of line 05. A total of 1 512 milk samples from udder halves were collected throughout milking periods at monthly intervals. In the present study milk composition (from halves of the udder) and daily milk yield (from udders) was examined in terms of SCC in ewe milk in three groups: from both halves of the udder below $250 \cdot 10^3$ cells/ml, from one halves of the udder below $250 \cdot 10^3$ cells/ml and from second half udder above $250 \cdot 10^3$ cells/ml and from both halves of the udder above $250 \cdot 10^3$ cells/ml.

Milk yield from udders, somatic cell count in milk samples from udder halves and milk composition depended on the level of SCC recorded for halves of the udder. Somatic cell counts in milk from one or both halves of udders exceeding $250 \cdot 10^3$ cells/ ml resulted in a statistically significant ($P<0.01$) decrease in daily milk production of ewes, by approx. 15.89 and 30.22%, respectively. The analysis of variance showed also a significant effect of parity and stage of lactation of ewes on somatic cell count (log SCC) and milk composition from udder halves below $250 \cdot 10^3$ cells/ml.

Keywords: dairy ewes, somatic cell count, milk yield, milk components

Zusammenfassung

Zusammenhang zwischen somatischer Zellzahl, Milchleistung und Milchzusammensetzung bei Milchschafen

Es wurden die Zusammenhänge zwischen der somatischen Zellzahl (SCC) bei einem Grenzwert von $250 \cdot 10^3$ Zellen/ml, der Milchleistung und Milchzusammensetzung bei Kreuzungsmuttern aus Ostfriesischen Milchschafen und Polnischen Merino untersucht. Für die Beurteilung von Menge und Zusammensetzung standen aus monatlichen Probennahmen 1 512 Proben zur Verfügung. Abhängig von der Zahl somatischer Zellen wurden drei Gruppen gebildet (I – aus beiden Euterhälften <250, II – aus einer Euterhälfte >250 und der zweiten <250, III – aus beiden Euterhälften $>250 \cdot 10^3$ Zellen/ml). Sowohl bei der Milchmenge als auch der -Zusammensetzung bestanden zwischen den SCC Gruppen signifikante Unterschiede. Lag die SCC Zahl über $250 \cdot 10^3$ (II bzw. III) fand sich eine geringere Milchleistung von 15,98 bzw. 30,22%. Die Varianzanalyse wies auch

Zusammenhänge zwischen der Zellzahl und dem Laktationsstadium hinsichtlich der Milchzusammensetzung nach.

Schlüsselwörter: Milchschaf, Anzahl somatischer Zellen, Milchleistung, Milchzusammensetzung

Introduction

Breed, flock, parity, stage of lactation, type of birth, estrus, as well as diurnal, monthly and seasonal variations of somatic cell counts (SCC) contribute significantly to changes of SCC in milk of dairy sheep (GONZÀLEZ-RODRIGUEZ *et al.* 1995, FAHR *et al.* 2001, GONZALO *et al.* 2002, SCHULZ *et al.* 2004, Kukowivs *et al.* 2006, WÓJTOWSKI *et al.* 2006, RAYNAL-LJUTOVAC *et al.* 2007). However, BIANCHI *et al.* (2004) observed a significant increase of fat concentration in milk from infected udder halves in the Sarda breed. In relation to the effect of SCC on the percentage content of protein in ewe milk, many authors are of the opinion that a high level of SCC is related to a higher protein content in milk than a low SCC level (DIAZ *et al.* 1996, NUDDA *et al.* 2003, ALBENZIO *et al.* 2004, BIANCHI *et al.* 2004). In turn, other authors reported lower percentage content of protein at a high SCC (JAEGGI *et al.* 2003). PIRISI *et al.* (2000) and ALBENZIO *et al.* (2005) indicated non-significant differences in protein contents at high and low levels of SCC in ewe milk.

In dairy sheep physiological and pathological thresholds of SCC are 0.25 to $1.0 \cdot 10^6$ cells/ml (GONZÁLEZ-RODRIGUEZ *et al.* 1995, EL-SAIED *et al.* 1999, PENGOV 2001, ARIZNABARRETA *et al.* 2002). Some studies point to values between 250 and $300 \cdot 10^3$ cells/ml as the most satisfactory discrimination thresholds between healthy and infected udders (GONZÁLES-RODRIGUEZ *et al.* 1995, PENGOV 2001, TIETZE *et al.* 2001, ARIZNABARRETA *et al.* 2002, WÓJTOWSKI *et al.* 2006).

The aim of this study was to determine the effect of somatic cell count on milk yield and composition using a threshold value of $250 \cdot 10^3$ cells/ml in dairy ewes of line 05.

Material and methods

The investigations were carried out in the years 2000-2002 at the Złotniki Experimental Farm belonging to the August Cieszkowski Agricultural University of Poznań. Experimental material consisted of dairy ewes line 05 (East-Friesian sheep 13/16 and Polish Merino 3/16). Ewes were machine milked for the period of 16 weeks in two calendar seasons: spring-summer (III-VI) and summer-autumn (VII-IX). Ewes with clinically healthy udders were milked two months after lambing (60 ± 22 days). Total in the years 2000-2002 examined 756 ewes. Milking performance of ewes was examined at monthly intervals and the yield of the udder was determined in ml from both morning and evening milking. At each milk recording before morning milking, after fore stripping, washing and drying of the teats, approx. 50 ml of milk were collected from the udder halves in order to determine the percentage content of fat, total protein and lactose, as well as somatic cell counts (SCC). The basic milk composition was evaluated using a MilkoScan testing machine, while SCC – using a Fossomatic 90 apparatus.

Results received presented in this study for 3 groups of ewes in dependence from somatic cell counts in milk from udder halves. The first group of ewes has SCC in milk from left and right halves of the udder below $250 \cdot 10^3$ cells/ml. Second group of ewes has SCC in milk from one halves of the udder below $250 \cdot 10^3$ cells/ml and from second half udder above $250 \cdot 10^3$ cells/ml. Third group of ewe‹s has SCC in milk from left and right halves of the udder above $250 \cdot 10^3$ cells/ml.

The SCC value was transformed to a common logarithm (log SCC) in order to obtain the distribution close to normal (ALI and SHOOK 1980). The data were subjected to an analysis of variance, using the GLM procedure of the SAS software package (2000). The following linear models were applied in the calculations:

$$Y_{ijk} = \mu + A_i + B_{ij} + C_{ijk} + e_{ijk} \quad (1)$$

where Y_{ijk} is the daily production of milk of the udder at milk recording (ml), somatic cell counts (log SCC), fat, protein and lactose contents (%) in milk from half udder, μ is the grand mean, A_i is the effect of parity, B_{ij} is the effect of type of birth of ewes, C_{ijk} is the effect of stage of lactation, and e_{ijk} is the effect of random error.

Results and discussion

The mean daily milk yield was 956.51 ml. The mean log SCC was 5.19 and the mean percentage content of fat, protein and lactose in milk was 5.45, 6.12, and 4.92, respectively. The means for milk yield, log SCC, fat, protein and lactose contents were similar to those recorded for other dairy sheep breeds (EL-SAIED *et al.* 1998, FAHR *et al.* 2001, SCHULZ *et al.* 2004, RIGGIO *et al.* 2007).

Results for mean daily milk yield and somatic cell counts in milk (log SCC) depending on SCC from udder halves are given in Table 1. The results show that SCC had a significant effect on daily milk production of ewes. Somatic cell counts in milk from one or both halves of udders above $250 \cdot 10^3$ cells/ml had a statistically significant effect on a decrease in daily milk production of ewes, by about 15.89 and 30.22 %, respectively. The stage of lactation of ewes was statistically different ($P<0.01$) in milk production in all groups of sheep, but parity only in the third groups (SCC in milk from both udder halves above $250 \cdot 10^3$ cells/ml). Numerous studies indicate a relationship between an increase in SCC and a decrease in milk yield. EL-SAIED *et al.* (1999) and FAHR *et al.* (2001) found a negative phenotypic correlation of SCC with milk yield (–0.16) for 2 379 ewes belonging to 10 flocks of the Spanish Churra breed. Similar results were reported by GONZALO *et al.* (1994) for ewes of that breed and by PELLEGRINI *et al.* (1997) for Lacune ewes. OTHOMANE *et al.* (2002) for ewes in eight Churra dairy flocks found a decrease of milk yield related to an increase in SCC.

Changes in milk composition depending on the level SCC from the udder half are presented in Table 2. The results show that SCC in milk below and above $250 \cdot 10^3$ cells/ml had a significant effect on milk composition. An increase of somatic cell counts in milk from udder halves above $250 \cdot 10^3$ cells/ml resulted in a significant increase of fat and protein content at a simultaneous significant decrease in lactose content.

Table 1
Means of milk yield and somatic cell counts (log SCC) depending on SCC from the udder half
Die durchschnittliche Milchleistung und die Zahl der somatischen Zellen (log SCC) abhängig von SCC aus den Euterhälften

Group of sheep	n	Milk Production/d, ml		Effect *P*					
				Parity		Type of birth		Stage of lactation	
1	399	1 092.44[a]		ns		ns		**	
2	193	918.83[b]		ns		**		**	
3	164	762.34[c]		*		ns		**	
		Somatic cells count in milk from udder half, log SCC							
		Left	Right	Left	Right	Left	Right	Left	Right
1	399	4.70[a]	4.67[a]	**	*	ns	ns	*	**
2	193	5.30[b]	5.66[b]	*	*	ns	ns	ns	ns
3	164	6.12[c]	6.05[c]	ns	*	*	ns	ns	ns

Group 1 SCC in milk from left and right halves of the udder below $250 \cdot 10^3$ cells/ml, Group 2 SCC in milk from one halves of the udder below $250 \cdot 10^3$ cells/ml and from second half udder above $250 \cdot 10^3$ cells/ml, Group 3 SCC in milk from left and right halves of the udder above $250 \cdot 10^3$ cells/ml, [a,b,c] means in the same column followed by different letters are different at $P<0.01$. *$P<0.05$, **$P<0.01$, ns not significant

Table 2
Changes in milk composition depending on SCC from the udder half
Die Veränderungen der Milchzusammensetzung in Abhängigkeit von SCC aus den Euterhälften

Group of sheep	n	Milk composition		Effect *P*					
				Parity		Type of birth		Stage of lactation	
		Left	Right	Left	Right	Left	Right	Left	Right
Fat content in milk from the udder half, %									
1	399	4.98[a]	5.10[a]	**	**	ns	ns	**	**
2	193	5.22[ac]	5.57[b]	**	*	ns	ns	**	**
3	164	6.38[b]	6.66[c]	ns	ns	ns	ns	**	**
Protein content in milk from the udder half, %									
1	399	5.94[a]	5.95[a]	ns	ns	ns	ns	**	**
2	193	6.11[ac]	6.17[b]	ns	ns	ns	ns	**	**
3	164	6.56[b]	6.50[c]	*	*	ns	ns	**	**
Lactose content in milk from the udder half, %									
1	399	5.14[a]	5.14[a]	**	**	*	ns	**	**
2	193	4.93[b]	4.89[b]	ns	ns	ns	ns	**	**
3	164	4.27[c]	4.49[c]	*	ns	**	ns	**	**

Group 1 SCC in milk from left and right halves of the udder below $250 \cdot 10^3$ cells/ml, Group 2 SCC in milk from one halves of the udder below $250 \cdot 10^3$ cells/ml and from second half udder above $250 \cdot 10^3$ cells/ml, Group 3 SCC in milk from left and right halves of the udder above $250 \cdot 10^3$ cells/ml, [a,b,c]Means in the same column followed by different letters are different at $P<0.01$. *$P<0.05$, **$P<0.01$, ns not significant

The increase in SCC results from the transfer of white blood cells from blood to milk (PIRISI *et al.*, 2000). This increase is related to changes in milk composition, which may have two main explanations: injury of udder cells which reduces the synthesis of milk constituents in the udder (e.g. lactose), and changes in permeability of membranes and interstitial spaces, that increase the passage of components from blood to milk (SCHULTZ 1977).

The stage of lactation in ewes in all groups had a significant effect on milk composition ($P<0.01$). The type of birth of ewes in all groups did not have a significant effect on fat, protein and lactose content ($P<0.01$) in milk from both halves of the udder

(except for lactose content in milk from left udder halves in the first and third groups of ewes). Parity had a significant effect on fat content in milk in the first and second groups of ewes, but on protein content only in the third group of ewes. Parity had a significant effect on lactose content in milk from both udder halves in the first group of ewes (SCC in milk from both udder halves below $250 \cdot 10^3$ cells/ml).

Several authors showed that SCC did not affect fat content of ewe milk (PIRISI *et al.* 2000). In contrast, BIANCHI *et al.* (2004) observed a significant decrease of milk fat content in milk of infected ewes. Fat and protein contents in milk were not influenced by SCC and both increased with the advancement of lactation (ALBENZIO *et al.* 2005). EL-SAIED *et al.* (1999), NUDDA *et al.* (2003), ALBENZIO *et al.* (2004) and BIANCHI *et al.* (2004) reported that ewe milk with a high SCC contains more total protein than milk with a low SCC. In contrast, JAEGGI *et al.* (2003) found that the total protein content was lowest in milk with the highest SCC levels. PIRISI *et al.* (2000) and ALBENZIO *et al.* (2004) showed no significant differences between protein content of milk with high or low SCCs. The pH value increased and lactose concentration decreased with an increase in SCC of ewe milk (PIRISI *et al.* 2000, NUDDA *et al.* 2003, VIVAR-QUINTANA *et al.* 2006).

It is concluded that in milk of dairy ewes of line 05 fat and protein contents increased and lactose concentration decreased with an increase of SCC above $250 \cdot 10^3$ cells/ml. Milk yield from udders, somatic cells count in milk samples from udder halves and milk composition depended on the level of SCC recorded in milk from halves of the udder. Somatic cell counts in milk from one or both udder halves exceeding $250 \cdot 10^3$ cells/ml resulted in a statistically significant ($P<0.01$) decrease in daily milk production of ewes, by about 15.89 and 30.22 %, respectively.

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