Variation of somatic cell count (SCC) of dairy cattle in conditions of Mediterranean region in Croatia

P. Mijić[1], V. Gantner[1], T. Bobić[1] & K. Kuterovac[2]

[1]Faculty of Agriculture, J.J. Strossmayer University in Osijek, Trg Svetog Trojstva 3, 31000 Osijek, Croatia
[2]Agrokor d.d., Trg D. Petrovića 3, 10 000 Zagreb, Croatia

Abstract

With the aim of analysis the variability of somatic cell count (SCC) of dairy cattle in conditions of Mediterranean region in Croatia, 217,509 test-day records, collected from January 2005 until April 2010, were extracted from HPA (Croatian Agricultural Agency) database. Milk recording in Croatia occurs according to the AT4 milk recording method. Somatic cell count (SCC) in milk samples taken from each lactating cow was analyzed using the Fossomatic 5000 (Foss Electric, Hillerød, Denmark). Determined values of SCC were natural log-transformed (LSCC). The test-day records with SCC value above 200,000 cells/ml (LSCC > 2.301) as well as the test-day records recorded after the 500th lactation day were deleted from the dataset. According to the parity, cows were divided into three classes, that is heifers, cows in second lactation and cows in third and higher lactations. From total number of cows 64.76% belonged to the Simmental breed, while 35.24% were Holsteins. According to the test date, four measuring season subgroups were created. Cows were also divided in two calving season subgroups regarding the calving date.

The temperature and the relative humidity in stable were also recorded at each milk recording. Significant rise of average daily temperature, as expected, was observed from January till July. During summer season besides high temperatures, increased relative humidity produce stress microclimatic condition for dairy cows.

For estimation of LSCC variability due to measuring season effect with particular regard to parity and breed fixed – effect model that take into account the effects of lactation stage, calving and measuring season was used. The significance of differences between the means of the LSCC within the measuring season classes in regard to parity classes and animals' breed was tested with Scheffe test. For the statistical analysis as well as for the figures drowing the SAS/STAT package was used (SAS Institute Inc., 2000).

Increasing trend of LSCC in summer and autumn season was noticed in both analysed breeds regardless the parity class. Regarding the measuring months, in both, Simmental and Holstein heifers, highest value of LSCC was measured in October and November, while, in cows in second as well as in third and higher lactations, the highest values of LSCC were noticed during September, October and November. Regarding the parity class the highest values of LSCC were obtained in both breeds in third and higher lactations. In all cows, regardless the breed and parity, the highest value of LSCC was determined during autumn period, while the lowest value occurred in spring season. In order to control and reduce the level of mastitis in a herd, udder health must be monitored. Somatic cell count measurements provide to breeders the opportunity to monitor and evaluate udder health.

Keywords: somatic cell count (SCC), dairy cattle, Mediterranean region

Introduction

The profitability of dairy farm could be considerably affected by mastitis prevalence in the herd. Blosser (1979) noted that mastitis is worldwide recognized as one of the most costly diseases of dairy cows. Major deficits caused by mastitis occurs through: 1) decreased milk production; 2) discard of milk that contained antibiotics or was of abnormal composition; 3) cost of veterinary services to treat acute and chronic mastitis; 4) cost of drugs purchased by dairymen for intra mammary infusion; 5) cost of increased labor to care for mastitic cows; 6) decreased sale value of cows sold for dairy purposes; 7) increased herd replacement costs when cows were culled because of mastitis; 8) decreased reproductive performance; 9) premium losses due to milk quality reduction (Dobbins, 1977; Schrick et al. 2001).

The somatic cell count (SCC) could be used as tool for udder health evaluation. The infection status of the udder is the main effect that influences SCC (Campbell, 2010). Other effects, genetics and environmental such as lactation number, stage of lactation, estrus, exercise, heat stress, stray voltage and day-to-day variation may all be related to small SCC changes (Harmon, 1994; Green et al., 2006). These factors may significantly affect the SCC only if the cow has an intra mammary infection, while if mammary gland is uninfected, these factors will not have notable effect on SCC (Barry, 2002).

An uninfected udder will typically have a SCC less than 100,000 cells/ml. Smith et al. (2001) quoted that when the SCC is in interval from 100,000 to 199,999 cells/ml, the presence of infection can only be ruled out by bacteriological testing. A SCC of 200,000 cells/ml or more is a clear signal that an infection 1) is occurring, 2) has occurred recently or 3) the mammary gland is still recovering from an infection, which may take days, weeks or longer (Shultz, 1977). Typically, the more severe the infection, the higher the SCC will be.

The aim of this research was to determine variation in somatic cell count (SCC) of healthy dairy cattle in environmental conditions of Mediterranean region in Croatia.

Material and methods

With the aim of analysis the variability of somatic cell count (SCC) of dairy cattle in conditions of Mediterranean region in Croatia, 217,509 test-day records, collected from January 2005 until April 2010, were extracted from HPA (Croatian Agricultural Agency) database. Milk recording in Croatia occurs according to the alternative milk recording method every four weeks when, depending of the particularly farm, the HPA control assistant (A) or the farmer (B) measures morning or evening milk yield, notes initial time of control milking and initial time of previous milking, and, for analysis of milk composition and somatic cell count (SCC), takes milk sample from each lactating cow. Somatic cell count (SCC) was analyzed using the Fossomatic 5000 (Foss Electric, Hillerød, Denmark). Determined values of SCC were natural log-transformed (LSCC). The test-day records with SCC value above 200,000 cells/ml (LSCC > 2.301) as well as the test-day records recorded after the 500^{th} lactation day were deleted from the dataset.

According to the parity, cows were divided into three classes, that is heifers (P_1), cows in second lactation (P_2) and cows in third and higher lactations (P_3). From total number of cows 64.76% belonged to the Simmental breed, while 35.24% were Holsteins. Variability of analyzed trait according to cows' breed and parity class is shown in table 1.

Table 1. Description of analysed trait, LSCC (n = 217,509).

Parity classes	Simmental			Holstein		
	mean	stddev	CV	mean	stddev	CV
P_1	1.636	0.384	23.488	1.654	0.398	24.089
P_2	1.710	0.398	23.253	1.722	0.384	22.310
P_3	1.755	0.389	22.143	1.763	0.381	21.625
∑	1.729	0.392	22.672	1.746	0.385	22.037

According to the test date, four measuring season subgroups were created (S_1 – spring – including the period from April till June; S_2 – summer – including the period from July till September; S_3 – autumn – including the period from October till December; and S_4 – winter – including the period from January till March). Cows were divided in two calving season subgroups regarding the calving date (C_1 and C_2 that include animals calved in spring/summer and autumn/winter season).

The temperature and the relative humidity in stable were recorded at each milking. Distribution of average daily temperature and average relative humidity according to months of measuring is shown on figure 1. Significant rise of average daily temperature, as expected, was observed from January till July. During summer season besides high temperatures, increased relative humidity produce stress microclimatic condition for dairy cows. Berman et al. (1985) suggested that the upper limit of ambient temperatures at which Holstein cattle may maintain a stable body temperature is 25 to 26°C, and that above 25°C practices should be instituted to minimize the rise in body temperature.

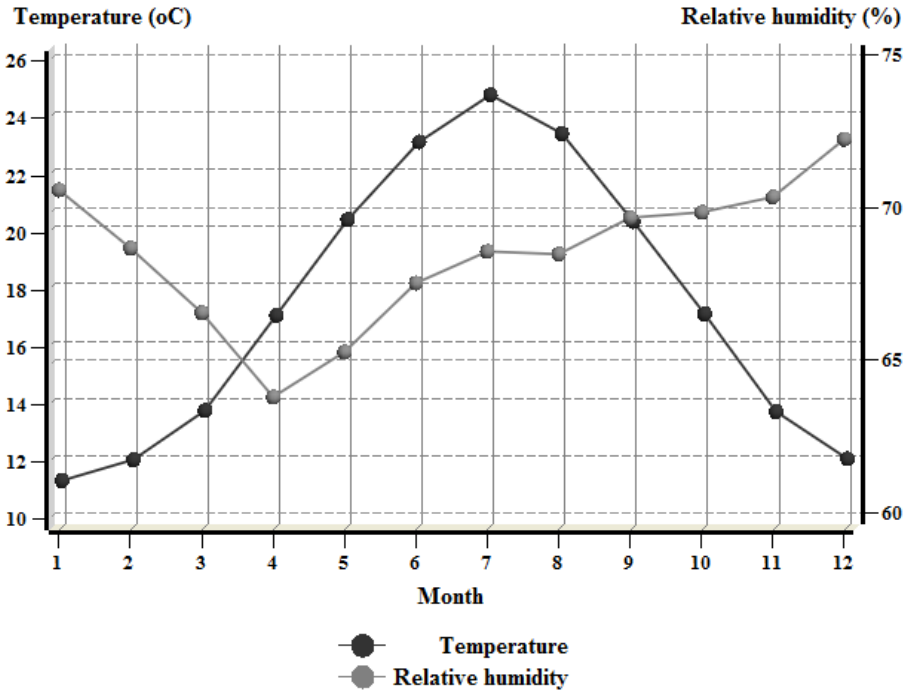

Figure 1. Average measured temperature and relative humidity in stable according to months.

For estimation of LSCC variability due to measuring season effect with particular regard to parity and breed following fixed – effect model was used:

$$y_{ijkl} = \mu + b_1(d/305) + b_2(d/305)^2 + b_3 \ln(305/d) + b_4 \ln^2(305/d) + C_j + S_k + e_{ijkl} \qquad (1)$$

where:

y_{ijk} = predicted daily LSCC,
μ = intercept.
$b_{1,2,3,4}$ = regression coefficients of Ali and Schaeffer lactation curve (1987),
d = lactation stage (days),
C_i = effect of calving season (i = 1 – spring/summer; 2 – autumn/winter),
S_j = effect of measuring season (j = 1 – spring; 2 – summer; 3 – autumn; 4 – winter),
e_{ijk} = residual.

The significance of differences between the means of the LSCC within the measuring season classes in regard to parity classes and animals' breed was tested with Scheffe test. For the statistical analysis as well as for the figures drowing the SAS/STAT package was used (SAS Institute Inc., 2000).

Results and discussion

Variations of LSCC due to measuring months by parity classes for Simmental breed are shown on figure 2. The smallest number of LSCC, during all measuring months, was determined in heifers. The determined LSCC value varied in interval from 1.59 to 1.68 depending of the month of measurement. Significantly higher values, in interval from 1.67 to 1.75, were determined in cows in second lactation. The highest value of LSCC were obtained in cows in third and higher lactations (LSCC = [1.73, 1.78]). In all cows, increasing trend of LSCC in summer and autumn season was noticed. Regarding the measuring months, in heifers highest value of LSCC was measured in October and November, while, in cows in second as well as in third and higher lactations, the highest values of LSCC were noticed during September, October and November.

Smith et al. (2009), in study of somatic cell count benchmark, determined increase of SCCS (somatic cell count score) in dairy cattle in the months of July, August, September and October while the lowest values occurred during the winter and spring months. The highest value of LSCC was determined in September for all analyzed U.S. regions (Northeast, Midwest, Midsouth, and South). Same authors also determined statistically significant difference in SCCS between lactations (1^{st}, 2^{nd} and 3^{rd}+) with lowest value in first and highest value in cows in third and higher lactations.

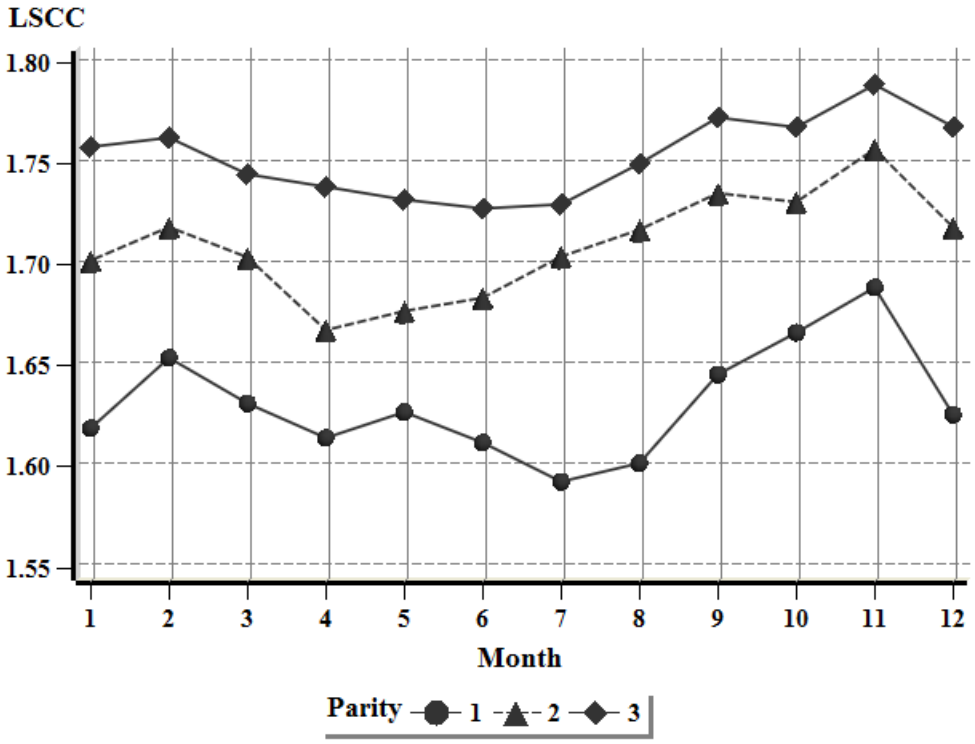

Figure 2. Variations of LSCC due to measuring months by parity classes for Simmental breed.

Figure 3 show trends in monthly LSCC according to the parity classes for Holstein cows. Similarly as in Simmental cows, in all Holsteins, increasing trend of LSCC during summer and autumn season was noticed. The highest values of LSCC in interval from 1.73 to 1.80 were obtained in cows in third and higher lactations. Significantly lower values were determined in cows in second lactation (LSCC = [1.66, 1.77]). In Holstein heifers, until July, variation in LSCC was similar to one observed in Simmentals. Significantly higher LSCC value determined during August, September, October and November in Holsteins comparing to the Simmentals.

Regarding the measuring months, in Holstein heifers highest value of LSCC was measured in October and November, while, in cows in second as well as in third and higher lactations, the highest values of LSCC were noticed during September, October and November. Green et al. (2006) determined increase in the total somatic cells produced between May and September compared with October and March.

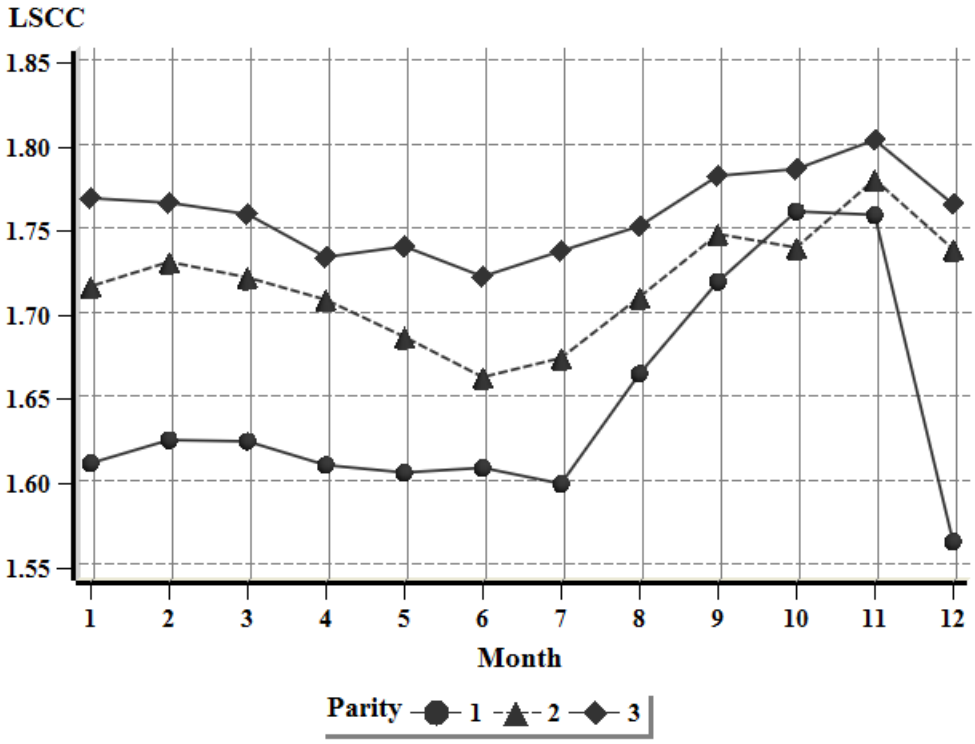

Figure 3. Variations of LSCC due to measuring months by parity classes for Holstein breed.

Least square means of LSCC per seasons in relation to parity classes are shown in table 3. Highly significantly ($P < 0.01$) higher value of LSCC in autumn in comparison to other seasons was determined in Simmental heifers. In Simmentals in 2nd lactation highest value of LSCC was determined in autumn, slightly lower during summer, and significantly lower in winter and spring season. In cows in 3rd+ highly significant ($P < 0.01$) differences were observed between all seasons, with highest value noticed during autumn season. In all cows, regardless the breed and parity, the highest value of LSCC was determined during autumn period, while the lowest value occurred in spring season.

Table 2. Least square means of LSCC for seasons in relation to parity classes and breed.

Measuring season	Simmental/Parity			Holstein/Parity		
	P_1	P_2	P_3	P_1	P_2	P_3
Spring	1.618^{A}	1.673^{A}	1.729^{A}	1.614^{A}	1.685^{A}	1.728^{A}
Summer	1.620^{A}	1.718^{BC}	1.743^{B}	1.673^{B}	1.701^{AC}	1.754^{B}
Autumn	1.659^{B}	1.735^{B}	1.766^{C}	1.701^{B}	1.757^{B}	1.789^{C}
Winter	1.622^{A}	1.708^{C}	1.760^{D}	1.618^{A}	1.724^{BC}	1.770^{B}

*the values, within parity classes, marked with the same letter are not significantly different ($P > 0.01$)

Highly significantly ($P < 0.05$) increase of SCC from 4.1×10^5 in the spring to 8.6×10^5 in the summer was observed by Bouraoui et al. (2002). Negative effects of heat stress on SCC

through impaired mammary defense mechanisms was also noticed by Collier (1982) and Du Perez et al. (1990).

Conclusion

During the conducted research increasing trend of LSCC in summer and autumn season was noticed in both analysed breeds regardless the parity class. Regarding the measuring months, in both, Simmental and Holstein heifers, highest value of LSCC was measured in October and November, while, in cows in second as well as in third and higher lactations, the highest values of LSCC were noticed during September, October and November. Regarding the parity class the highest values of LSCC were obtained in Holstein and Simmental cows in third and higher lactations. In all cows, regardless the breed and parity, the highest value of LSCC was determined during autumn period, while the lowest value occurred in spring season.

Udder health must be monitored in order to control and reduce the level of mastitis in a herd. Somatic cell count measurements provide to breeders the opportunity to monitor and evaluate udder health.

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