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**Izvorni znanstveni članak**
**Original scientific paper**

# OSCILLATION OF SOMATIC CELL COUNT IN MILK OF RECORDED COWS IN SLOVENIA IN YEARS 1997-2007

**M. Klopčič, J. Osterc, M. Klinkon**

**Abstract**

Oscillation of somatic cell count (SCC) in milk of recorded cows was studied in Slovenia for the period 1997 to 2007. Measurements of 5,267,264 test days were taken predominantly of Simmental (42.4 %), followed by Black and White (37.7 %) and Brown breed (19.9 %). The analysis showed substantial seasonal differences in milk yield and in milk composition. Breeders are faced with problems of low milk quality and frequent mastitis in summer months. It has been concluded that the average SCC was the highest in Black and White cows ($404x10^3$/ml milk) and the lowest in Simmental cows ($288x10^3$/ml milk). Since 1996 SCC has been considered one of the criteria for milk price determination, therefore it has been reduced and health status of udder improved in recent years. Both are the result of better herd management and wider knowledge that breeders achieved. The average SCC dropped from 431 thousand in 1996 to 331 thousand cells/ml milk in 2007. Lower SCC was noticed also on family farms compared to the former large scale farming enterprises. Monthly recording analysis proved that 10.1 % cows had more than 400 thousand SCC/ml milk, and 84.9% cows up to 250 thousand SCC/ml milk at recording. During the trial period milk yield/milking day increased and fat, as well as protein content improved.

**Key words:** dairy cows / milk yield / milk recording / somatic cell count

## *Introduction*

Milk production is an important feature of animal production in Slovenia owing to the fact that two thirds of agricultural lands are grasslands. Therefore cattle breeding is the most appropriate for maintenance of cultural landscape. Milk and milk products represent also the most important parts of agricultural market in the EU.

Economic milk production demands high milk yield per cow, milk with high nutritive value and of best hygienic quality produced by healthy cows. Milk components could be a good indicator of poor food supply and ineffective

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management of herd shown as health and reproduction problems and low hygienic quality of milk.Thus it is important to know the interactions so as to produce quality milk and healthy cows. The breeder can manage the herd effectively if he monitors each cow along with the whole herd. Health and nutritional disorders lead to lower production rate and diseases and reproduction defects. Highly productive cows often get mastitis and consequently higher somatic cell count. Breeders that produce milk intensively and depend on quality market milk production want to monitor the health conditions of udder of each cow. Certain milk components are of great help, especially lactose content and somatic cell count. The objective of the present paper is to indicate oscillations in milk contents and in milk quality of recorded cows in eleven-year-long period and to find out changes in milk content depending on somatic cell count in milk of recorded cows of different breeds and various regions of Slovenia.

In Slovenia milk quality of market milk is under control. Besides milk fat and protein content milk quality depends also on micro-organism count (MOC) and somatic cell count (SCC). Above traits significantly affect the purchase price of milk. Milk content is important information on animal supply with energy and proteins and on health conditions, primarily of udder. Udder inflammation causes higher SCC in milk and changes in basic milk content. Milk lactose content drops, composition and quality of milk proteins change, the relations among minerals (sodium, potassium, chlorine) are changed as well (Klinkon, 2000; Klopčič, 2006). Above changes in milk contribute to lower technological value of milk (Zorko, 1992). Thus breeders' economic conditions worsen with lower quality of milk, lower production rate and health care expenses caused by mastitis. Hence breeders decide to exclude cows with frequent mastitis from the herd, thus the length of cows' life shorten on one hand and their production costs augment on the other (Osterc and Klopčič, 1998; Brade, 2001).

SCC determination in cows is the right way to discover subclinical mastitis in dairy cows (Blowey, 1995). SCC is affected by physiological effects like lactation period (Deluyker et al., 1993), consecutive lactation and age of cow respectively (Jones et al., 1984), breed of dairy cows (Pogačar, 1998; Reents, 1997), production system (Klopčič, 2002), disturbances in food supply (Ferčej, 1995) and some metabolic defects (ketosis, acidosis, parturient paresis) along with infectious and claw diseases (Schukken et al., 1992; Pengov & Zadnik, 1993).

Milk recording in cows should be carried out every month to ensure systematic and effective breeding. The recording results show to breeders and to

experts new ways for better management of herds. The aims of milk recording is not only to find out milk yield and reproduction traits but also to find out hygienic quality of produced milk and health conditions of animals. Consequently the breeder can balance the diet in accordance with good production and quality of milk (Klopčič, 1995; Ferčej, 2002).

*Material and methods*

In Slovenia the reference A4 method was used in milk recording until year 2004, which means that cows were recorded once a month at both milking (ICAR, 2007). Since March 2004 the AT4 method has been applied, which means that a controller is present at one milking only on alternate basis: one month at evening milking and the next month at morning milking.

Statistical procedure and analyses are based on the results of monthly milk recording that was carried out on Slovenian farms and state enterprises in the period from 1997 to 2007. Besides milk yield and milk content, a special attention was paid to the oscillation of somatic cell count in some cows. Collected data were processed by SAS/STAT (SAS Institute Inc., 2005) at the Centre for Expert Work in Animal Breeding by Biotechnical Faculty, Zootechnical Department. The results of milk recording are the property of Ministry of Agriculture, Forestry and Food.

Milk traits of recorded cows were estimated using the statistical parameters and phenotypic correlations for the studied milk traits. SCC was divided into 5 classes depending on cell count. We calculated mean values for other milk content regarding the SCC class:

| | |
|---|---|
| SCC 1 | up to100,000 cell/ml milk |
| SCC 2 | 100,001 to 250,000 cell/ml milk |
| SCC 3 | 250,001 to 400,000 cell/ml milk |
| SCC 4 | 400,001 to 600,000 cell/ml milk |
| SCC 5 | above 600,000 cell/ml milk |

*Results*

Table 1 shows mean values for milk traits of milk recorded cows in Slovenia in the period from 1997 to 2007 and a tendency to produce better basic milk contents (milk fat and proteins) and udder health estimated by SCC. The average milk fat content of recorded cows increased from 1997 and reached the highest content in 2001 (4.26%). Milk protein content increased since 1997

reaching the highest content in 2000 to 2002 (3.40 %). Milk lactose content changed less in the last ten years. The lowest content (4.58 %) was noticed in 1998 and in 2006 and the highest (4.63 %) in 2002 and 2003. The average milk urea content ranged from 19.89 to 28.58 mg/dl in the years 2005 and 2001. The average SCC in milk was the highest (402 thousand/ml) in 1997 and the lowest (331 thousand/ml) in 2007. Average SCC oscillated in the studied period with a tendency to decrease showing that udder health conditions improved as a result of more effective herd management and breeders' awareness.

Table 1. – MEAN VALUE ( $\bar{x}$ ) AND STANDARD DEVIATION (SD) OF MILK YIELD AND MILK CONTENT OF RECORDED COWS ON FARMS IN SLOVENIA IN DIFFERENT YEARS

| Year | No. | Milk, kg | Fat, % | Protein, % | Lactose, % | SCC x $10^3$/ml | Urea, mg/dl |
|---|---|---|---|---|---|---|---|
| 1997 | 186,509 | 17.76±6.71 | 4.10±0.76 | 3.27±0.38 | 4.62±0.27 | 402±929 | - |
| 1998 | 415,836 | 17.10±6.68 | 4.19±0.75 | 3.34±0.37 | 4.58±0.28 | 367±788 | - |
| 1999 | 436,424 | 17.64±6.93 | 4.21±0.75 | 3.39±0.38 | 4.60±0.26 | 356±763 | - |
| 2000 | 458,891 | 18.19±7.16 | 4.18±0.75 | 3.40±0.39 | 4.61±0.24 | 347±751 | 23.31 ± 9.04 |
| 2001 | 476,247 | 18.61±7.17 | 4.26±0.76 | 3.40±0.39 | 4.59±0.24 | 360±757 | 28.58±10.09 |
| 2002 | 508,820 | 18.76±7.12 | 4.23±0.76 | 3.40±0.39 | 4.63±0.25 | 355±762 | 28.56±10.32 |
| 2003 | 517,552 | 19.04±7.17 | 4.25±0.78 | 3.39±0.38 | 4.63±0.25 | 359±773 | 24.32 ± 9.23 |
| 2004 | 546,115 | 18.85±7.06 | 4.22±0.69 | 3.37±0.37 | 4.62±0.25 | 344±740 | 22.17 ± 9.75 |
| 2005 | 566,637 | 19.15±7.03 | 4.18±0.65 | 3.33±0.35 | 4.62±0.25 | 349±749 | 19.89 ± 9.54 |
| 2006 | 558,290 | 19.67±7.12 | 4.12±0.65 | 3.29±0.35 | 4.58±0.24 | 353±759 | 21.19 ± 8.91 |
| 2007 | 558,864 | 20.30±7.31 | 4.12±0.66 | 3.31±0.36 | 4.60±0.23 | 331±734 | 19.94 ± 9.03 |
| All | 5,267,264 | 18.78±7.13 | 4.19±0.72 | 3.36±0.38 | 4.61±0.25 | 349±755 | 21.99 ± 9.79 |

Figure 1. – SOMATIC CELL COUNT PER MONTH AND PER YEAR – MILK RECORDING RESULTS

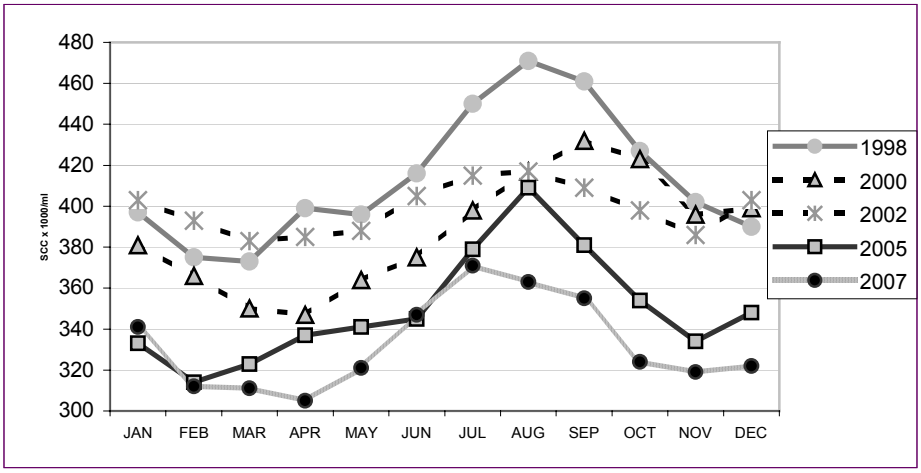


Figure 1 presents the average SCC by months in the years 1998 to 2007. As it can be noticed SCC dropped every year of the studied period except during summer months when SCC increased. The worst SCC appeared in 1998. In the further years milk quality improved also in summer months hence no significant increase in SCC was noticed in comparison with the years 1998 and 1999.

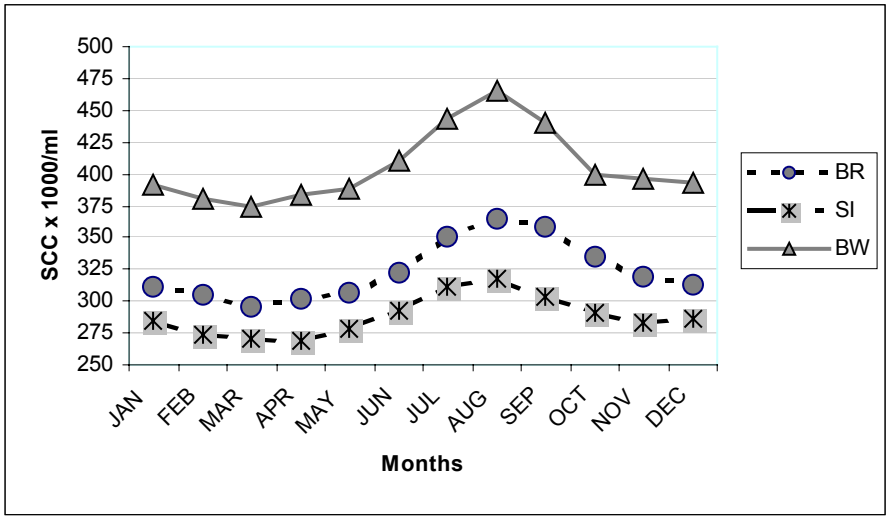
Table 2 displays the average milk content and SCC in different regions. Significant differences are noticed among regions by SCC oscillations from $295x10^3$/ml in the region of Kranj and $407x10^3$/ml in the region of Novo mesto. Similar oscillations were noticed in other milk contents. Among regions significant differences were found in breed composition of recorded cows and in systems and conditions of farming.

Table 2. – MEAN VALUE ( $\bar{x}$ ) AND STANDARD DEVIATION (SD) OF MILK YIELD AND MILK CONTENT OF RECORDED COWS IN SLOVENIA IN DIFFERENT REGIONS IN YEARS 1997 - 2007

| Region | No. | Milk, kg | Fat, % | Protein, % | Lactose, % | SCC x $10^3$/ml |
|---|---|---|---|---|---|---|
| Mur. Sobota | 682,435 | 15.80±5.78 | 4.41±0.71 | 3.37±0.38 | 4.59±0.25 | 330±718 |
| Ptuj | 1,112,674 | 18.07±7.18 | 4.18±0.72 | 3.35±0.38 | 4.55±0.24 | 351±723 |
| Celje | 951,147 | 18.85±6.62 | 4.13±0.73 | 3.37±0.36 | 4.60±0.23 | 297±619 |
| Kranj | 615,387 | 21.60±7.71 | 4.17±0.69 | 3.33±0.37 | 4.62±0.25 | 295±652 |
| Ljubljana | 1,058,337 | 19.54±7.34 | 4.16±0.71 | 3.37±0.37 | 4.65±0.24 | 386±807 |
| Nova Gorica | 336,609 | 17.86±6.50 | 4.07±0.74 | 3.30±0.37 | 4.65±0.29 | 365±878 |
| Novo mesto | 510,675 | 19.85±7.03 | 4.22±0.70 | 3.38±0.38 | 4.63±0.24 | 407±833 |
| **All** | 5,267,264 | 18.78±7.13 | 4.19±0.72 | 3.36±0.38 | 4.61±0.25 | 349±755 |

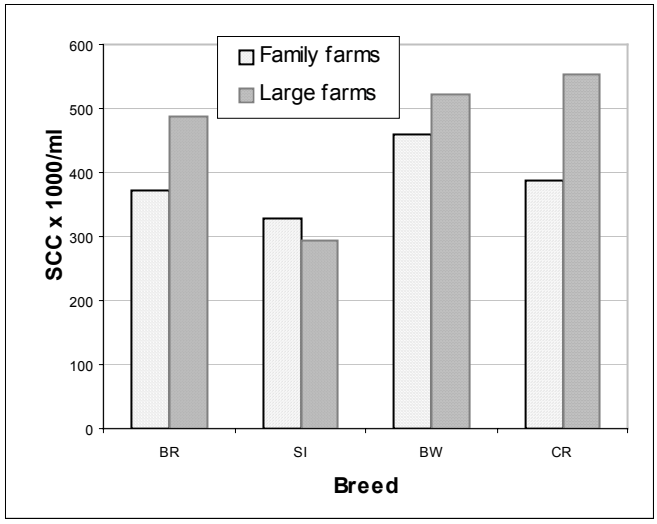
Figure 2 presents SCC differences between breeds during the year. Referring to picture the highest SCC was found in Black-and-White cows (BW) and the lowest in Simmental cows (SI) all the year long. All three breeds had higher SCC in summer. In summer farmers have a lot of troubles with SCC in milk purchased by dairies due to high temperatures, high relative moisture, insects and storms that are frequent in summer in Slovenia. In summer the frequency of acute and covered mastitis is higher thus information on milk recording results and SCC in cows are very important and useful for our farmers.

Figure 2. – SOMATIC CELL COUNT PER MONTH AND PER BREED – MILK RECORDING RESULTS




Further on the differences in SCC per farm herds and former large scale farming enterprises are shown (Fig. 3).

Figure 3. – SOMATIC CELL COUNT PER BREED AND PER OWNER – MILK RECORDING RESULTS



They differ in herd size (family farm herds have 15.8 cows on average, herds on former large scale farming enterprises have 175 cows on average), breed composition and management system. Black-and-White cows prevail on former large scale farming enterprises while Simmental breed is the most frequent on family farms followed by Black-and-White and Brown breed cows. In all breeds except the Simmental one the SCC was lower in herds from family farms than in herds from enterprises. On the large farms the number of Simmental and Brown cows is very small.

Table 3. – MEAN VALUE ( $\overline{x}$ ) AND STANDARD DEVIATION (SD) OF MILK YIELD AND MILK CONTENT OF RECORDED COWS DEPEND ON CLASS OF SCC

| | Milk yield and components depend on somatic cell count (SCC) | | | | |
|---|---|---|---|---|---|
| Parameter | SCC 1* | SCC 2* | SCC 3* | SCC 4* | SCC 5* |
| No. | 3,811,473 | 663,030 | 261,936 | 170,964 | 359,861 |
| Milk, kg | 18.70 ± 7.08 | 19.33 ± 7.11 | 18.71 ± 7.24 | 18.63 ± 7.35 | 18.80 ± 7.43 |
| Fat, % | 4.19 ± 0.72 | 4.19 ± 0.70 | 4.21 ± 0.71 | 4.21 ± 0.72 | 4.22 ± 0.76 |
| Protein, % | 3.34 ± 0.37 | 3.38 ± 0.37 | 3.41 ± 0.38 | 3.41 ± 0.39 | 3.41 ± 0.40 |
| Lactose, % | 4.64 ± 0.23 | 4.60 ± 0.23 | 4.55 ± 0.25 | 4.51 ± 0.26 | 4.44 ± 0.29 |
| Urea, mg/dl | 22.19 ± 9.72 | 22.41 ± 9.85 | 22.12 ± 9.89 | 21.71 ± 9.88 | 19.88 ± 9.66 |

SCC 1* = up to 100,000 somatic cell/ml milk
SCC 2* = 100,001 to 250,000 somatic cell/ml milk
SCC 3* = 250,001 to 400,000 somatic cell/ml milk
SCC 4* = 400,001 to 600,000 somatic cell/ml milk
SCC 5* = over 600,000 somatic cell/ml milk

Table 3 shows the average milk content considering the SCC. The shown results indicate that milk fat content and milk protein content increased with higher SCC. Nevertheless, it should be stressed that the protein quality changed and worsened in relation to higher SCC although milk protein content is higher in mastitis infected cows but such milk contains less quality proteins because the content of blood protein increases (Brade, 2001). The average milk lactose content decreases with increased SCC. Milk containing less than 100,000 cell/ml contained 4.64 % lactose that decreased to reach the lowest content (4.44 %) in milk with the average SCC above 600 thousand cell/ml.

*Conclusions*

Based on monthly milk recording results we analyzed data on milk yield and composition of controlled cows of Brown, Simmental and Black-and-White breed in Slovenia for the period from 1997 to 2007. The statistical analysis of the collected data on milk recording pointed out as follows:

- Average milk gain in milk recording cows increases every year regardless the breed.
- Milk fat content and protein content remain on the same level with the exception of summer months when they are lower but are higher in autumn and winter. Simmental breed cows produce best milk regarding milk content but no differences were found between the other two breeds as well.
- Milk lactose content changes only slightly during the year or in the whole period. The lowest milk lactose content was found in Black-and-White cows and the highest in Simmental cows.
- SCC is lower every year consequently to better management on farms and higher level of knowledge of breeders. The highest SCC was found during summer as a result of unpleasant breeding conditions (high temperatures, moisture, insects, nutrition, food intake, etc.). Black-and-White cows from the large enterprises were the most stricken.
- Milk components and milk quality change as SCC changes. Various SCC classes differ significantly especially in lactose content that decreases when SCC increases. On the contrary, milk protein content increases when SCC increases although proteins of lower quality prevail.
- Breeders have most of milk quality problems and udder infections in late spring and in summer months. New efforts and knowledge will contribute to better milk gain in the critical period when there is a lot of seasonal work on farms and production conditions are most unfavorable.

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**OSCILACIJA U BROJU SOMATSKIH STANICA KOD KONTROLIRANIH KRAVA U SLOVENIJI U RAZDOBLJU 1997-2007**

**Sažetak**

Oscilacija u broju somatskih stanica (SCC) kod kontroliranih krava proučavana je u Sloveniji u razdoblju od 1997. do 2007. godine. Tijekom 5.267.264 test dana mjerenja su obavljana pretežno za simentalsku (42,4%), zatim za crno-bijelu (37,7%) i smeđu pasminu (19,9%). Analiza je pokazala znatne sezonske razlike u mliječnosti i sastavu mlijeka. Uzgajivači se suočavaju s problemom loše kakvoće mlijeka i čestom pojavom mastitisa u ljetnim mjesecima. Utvrđeno je da je prosječan SCC najviši kod crno-bijelih krava ($404x10^3$/ml mlijeka), a najmanji kod simentalskih krava ($288x10^3$/ml mlijeka). Počev od 1996. godine, broj somatskih stanica smatra se jednim od kriterija za utvrđivanje cijene mlijeka. Zahvaljujući boljem upravljanju stadom i proširivanju znanja uzgajivača, SCC je zadnjih godina smanjen, a stanje zdravlja vimena je poboljšano. Prosječan SCC smanjio se od 431.000 stanica/ml mlijeka u 1996. godini na 331.000 stanica/ml mlijeka u 2007. godini. Primjećeno je, također, da je SCC niži na obiteljskim farmama nego na bivšim velikim gospodarstvima. Analiza mjesečne kontrole pokazala je da je 10,1% krava imalo više od 400.000 SCC/ml mlijeka, a 84,9% krava do 250.000 SCC/ml mlijeka u vrijeme kontrole. Tijekom probnog razdoblja mliječnost po mliječnom danu se povećala, a mliječna mast i sadržaj proteina su se poboljšali.

**Ključne reči:** mliječne krave / mliječnost / mliječna kontrola / broj somatskih stanica

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