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The influence of the season on the chemical composition and the somatic cell count of bulk tank cow's milk

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ABSTRACT

The aim of our research was to establish the influence of the season on the chemical composition of bulk tank cow's milk and the somatic cell count in it. The bulk tank cow's milk samples were collected daily during a period of one year. When the milk was brought to the dairy in special tanks, before pouring bulk tank milk, samples were taken that we marked as «tours». Milk samples were taken in three tours from the tanks every seven days, and 144 tours were processed in total. Comparing chemical indicators of milk quality, milk fat levels were significantly higher in the winter and the autumn ($P<0.05$) in comparison to the periods of spring and summer. Protein levels significantly differed between the seasons ($P>0.05$), and the highest levels were registered during the winter. Lactose level was significantly higher during the winter and the spring ($P<0.05$), and the NFDM (non fat dry matter) was significantly lower in the summer, in comparison to the other seasons ($P<0.05$). Determining the somatic cell count (SCC) in the bulk tank cow's milk samples, we established that during the winter the somatic cell count was significantly higher in comparison to the other seasons ($P<0.05$). However, we did not determine significant, high or positive correlations between the chemical composition of the milk and the somatic cell count in either of the seasons. Based on the results of our research, we concluded that the season has an influence on the somatic cell count and the chemical composition of fresh cow's milk, but not on the correlations between them.

Key words: cow, milk, chemical composition, somatic cell count, season

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Introduction

The hygienic quality main indicators for fresh cow's milk are the total number of microorganisms and the somatic cell count (SCC) (ČAČIĆ et al., 2003). Chemical composition and hygiene quality is of the greatest importance in public health, processing technology and the quality of milk products. Unwanted ingredients in the milk, before, during and after milking, and all the factors that harm the milk, are always marked as alterations in milk quality (HAVRANEK and RUPIĆ, 1996). Milk composition can be very variable, and it depends on numerous of factors such as: the breed and health of the animals, the lactation period, the manner and type of nutrition, the season, the manner of milking (manual or automatic), as well as the age and the number of lactation, and finally on the individual itself (age, body mass, moving, etc.) (TRATNIK, 1998).

Milk fat was the only milk ingredient measured for milk payment, but nowadays the payment criteria also include protein quantities, total microorganism count and somatic cell count in 1 mL, with compulsory determination of freshness. Somatic cell count in the milk has been the subject of research and in paper publication since 1910 (BAGADI, 1977).

The somatic cell count in the milk is closely connected to dairy gland inflammation, so the somatic cell count is acknowledged as an international standard in milk quality (HARMON, 2001). With the increase of somatic cell count above 400.000/mL, the milk is altered, and the consequences are manifested in lower secretion, alterations in chemical composition and the physical, bacteriologic and technologic characteristics of the milk (ANTUNAC et al., 1997). The somatic cell count in the milk samples of healthy cows that do not have mastitis is usually lower than 200.000/mL, while most cows have somatic cell count lower than 100.000/mL (RIŽNAR, 1981; HARMON, 2001; RUEGG, 2003). In infected quarters more than 90% of somatic cells are neutrophiles, and a somatic cell count higher than 200.000/mL is a mastitis indicator (RUEGG, 2003).

During bacterial infection, microorganisms are multiplied in the dairy gland, which leads to toxin and enzyme production that stimulates the release of inflammation mediators in that tissue. Under the influence of inflammation mediators, leukocyte migration to the damaged tissue begins. The mass of polymorphonuclear leukocytes passes between the secretion of epithelial cells of the dairy gland and goes to the alveole lumen, increasing the somatic cell count in the dairy gland secretion. The strength of inflammation, and the number of the attracted cells depend on the causing agent, the lactation period, the immune status of the animal, and genetic factors, as well as the nutritive condition of the animal (BENIĆ, 2004). Besides, irregular automatic milking also causes increased somatic cell count influences (CERGOLJ et al., 1998). The organism reacts with a defense mechanism against irritating agents with an increased somatic cell count, especially polimorphonuclear leukocytes (90%), so their increased number in any

of the udder quarters shows disturbed secretion (NG-KWAI HANG et al., 1984; RENEAU, 1986; HARMON, 1994; TOPOLKO and BENIĆ, 1997; ANTUNAC et al., 1997). KISHK et al. (1999) say that there is a strong correlation between somatic cell count, milk production and fertility.

The aim of our study was to establish the influence of the season on the chemical composition and the somatic cell count in bulk tank cow's milk.

Materials and methods

The milk was taken from the lactofreeze at milk collection centres and was driven in the tanks to the dairy, and after that chilled to +4 ºC in the lactofreeze. The tank delivered milk to the dairy in a period of three hours. At arrival in the dairy, before pouring the milk, a bulk tank milk sample was taken from the tank and marked as «the tour». In this research we took three tours every seven days in a period of one year. With that, we took 36 tours in each season of the year. We had a total of 144 tours. The first tour included 17 lactofreezes. The second included 24 lactofreezes, while the third tour included a total of 4 lactofreezes. After the tour collections, we undertook the following chemical analysis: determination of milk fats, proteins, no fat dry matter and the quantity of milk sugar (lactose).

Sample preparations of fresh raw milk for chemical analysis. For the tests, milk samples were warmed in a bottle in a water bath or microwave oven at approximately 40 ºC / not over 45 ºC/, after that were stirred and poured, so that the melted milk fat could emulgate. After that, the sample was chilled to 15 to 20 ºC. Everything had to be done without foam in the sample. Milk fat, proteins, lactose and no fat dry matter were determined in the infrared measuring device Milkoscan 133 B (Denmark). The measuring device prints the results after every measuring. The results are shown as percentages.

Determination of somatic cell count. Somatic cell count was determined with by the citoflow method, using the instrument Foosomatic 90 (it counts 90 samples). The principle of the device is the coloration of the nucleus with ethide bromide color that has an affinity for DNA. After the filtration, the sample travels through the measurement tube, and in the exit from the measurement tube, colored nucleus fluoresce in the beam of infrared light. Light impulses are recorded in the device, and the result is read on the screen and written with the printer.

Statistical analysis. All the results of the research were processed using ANOVA (StatSoft, Statistics, version 7.1.) statistical method and Tukey tests of post-hoc analysis. Results with $P<0.05$ were considered statistically significant.

Results

Table 1. Chemical indicators of milk quality in different seasons (n = 144)

Season	Milk fat in 100 g	Proteins in 100 g	Lactose in 100 g	NFDM in 100 g
Winter	4.47 ± 0.02[a]	3.54 ± 0.01[a]	4.57 ± 0.01[a]	8.83 ± 0.02[a]
Spring	4.30 ± 0.02[b]	3.44 ± 0.01[b]	4.54 ± 0.01[a]	8.71 ± 0.02[b]
Summer	4.28 ± 0.01[b]	3.34 ± 0.01[c]	4.49 ± 0.01[b]	8.57 ± 0.01[c]
Autumn	4.52 ± 0.03[a]	3.48 ± 0.01[b]	4.48 ± 0.01[b]	8.70 ± 0.01[b]

Values with different superscripts in the same column differ significantly (P<0.05)

In Fig. 1, the results of the somatic cell count in the milk are shown, in terms of the season.

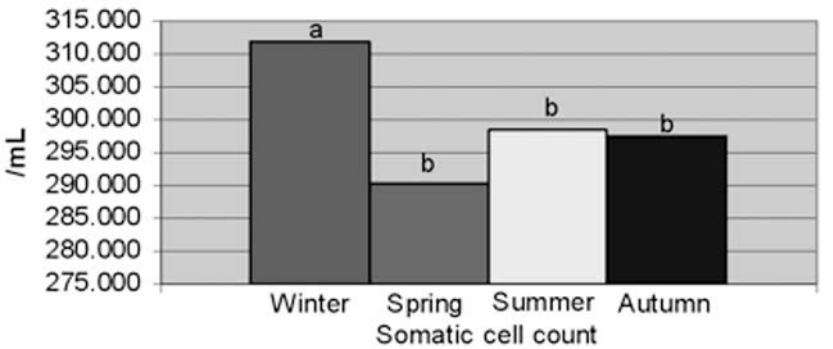

Fig. 1. The somatic cell count in the bulk tank milk samples in different seasons Values with different superscripts in the same column differ significantly (P<0.05)

Table 2. Correlations between chemical indicators of milk quality and the somatic cell count during the winter

Winter	Somatic cell count	Milk fat	Proteins	Lactose	NFDM
Somatic cell count	1.00	0.00	- 0.08	- 0.17	- 0.17
Milk fat	0.00	1.00	0.33	- 0.26	0.18
Proteins	- 0.08	0.33	1.00	- 0.17	0.52
Lactose	- 0.17	- 0.26	- 0.17	1.00	0.37
NFDM	- 0.17	0.18	0.52	0.37	1.00

Table 3. Correlations between chemical indicators of milk quality and the somatic cell count during the spring

Spring	Somatic cell count	Milk fat	Proteins	Lactose	NFDM
Somatic cell count	1.00	- 0.06	0.04	- 0.11	- 0.03
Milk fat	- 0.06	1.00	0.53	0.01	0.40
Proteins	0.04	0.53	1.00	0.11	0.81
Lactose	- 0.11	0.01	0.11	1.00	0.68
NFDM	- 0.03	0.40	0.81	0.68	1.00

Table 4. Correlations between chemical indicators of milk quality and the somatic cell count during the summer

Summer	Somatic cell count	Milk fat	Proteins	Lactose	NFDM
Somatic cell count	1.00	- 0.01	- 0.28	- 0.03	- 0.35
Milk fat	- 0.01	1.00	0.61	- 0.29	0.29
Proteins	- 0.28	0.61	1.00	- 0.11	0.81
Lactose	- 0.03	- 0.29	- 0.11	1.00	0.34
NFDM	- 0.35	0.29	0.81	0.34	1.00

Table 5. Correlations between chemical indicators of milk quality and the somatic cell count during the autumn

Autumn	Somatic cell count	Milk fat	Proteins	Lactose	NFDM
Somatic cell count	1.00	0.39	- 0.08	0.12	0.05
Milk fat	0.39	1.00	- 0.05	0.13	0.10
Proteins	- 0.08	- 0.05	1.00	- 0.53	0.53
Lactose	0.12	0.13	- 0.53	1.00	0.21
NFDM	0.05	0.10	0.53	0.21	1.00

In the Table 1. collective results of the chemical tests are shown, considering season. From shown results, it can be seen that the highest average of milk fat is in the autumn 4,52 g, and the lowest in the summer 4.28 g in 100 g. Considering protein and lactose levels, as well as the NFDM, their quanitities were the highest in the winter, (3.54; 4.57; 8.83 g in 100 g). The lowest protein levels and NFDM were established in the summer period (3.34; 8.57 g in 100 g), and lactose levels in the autumn 4.48 g in 100 g.

In Tables 2, 3, 4 and 5 the correlations are shown between the chemical indicators of milk quality and the somatic cell count, in terms of the season.

Discussion

The obtained results of the chemical indicators in milk quality show that the milk value is a collection of all the components of its composition. Milk fat was previously the only milk ingredient measured in milk payment, but as a payment criteria protein quantities, total microorganisms number and somatic cell count in 1 mL are now also included, with compulsory determination of freshness (ANTUNAC et al., 1997). The main ingredients of milk are water, milk fat, proteins and lactose. Milk composition can be very variable, and it depends on the numerous of factors such as: breed and the health condition of the animals, lactation period, manner and the type of nutrition, season, manner of milking (manual or automatic), as well as the age and the number of lactation, and finally on the individual itself (age, body mass, moving, etc.) (WOLFSON and SUMNER, 1993). Considering the statements by these authors and researching the influence of the season on the chemical parameters in the bulk tank milk samples , we concluded that the season has a significant effect on the chemical composition of fresh cow milk. Contrary to this, HAVRANEK and RUPIĆ (1996), ANTUNAC et al. (1997) and TRATNIK (1998), on the basis of their research, concluded that the season has no influence on the chemical composition of the milk. Bacterial infection of the dairy gland represents the main source of somatic cell count increase in milk, and the total count in 1 mL is an internationally accepted parameter in the evaluation of udder health status. With the increase of the somatic cell count above 400.000/mL, the milk is altered, and the consequences are manifested in lower secretion, alterations in chemical composition and physical, bacteriologic and technologic characteristics of the milk (ANTUNAC et al., 1997). In our research we confirmed the statements by these authors, we did not find alterations in chemical and physical composition, bacteriologic and technologic characteristics of milk, since the somatic cell count was not over 400.000 somatic cells per mL. Besides, the results of the chemical indicators in the bulk tank milk obtained in our research match the standards from the Rulebook of fresh milk quality (OG RoC. 102/2000.). BENIĆ (2004) stated that the individual milk fractions, daily variations in the somatic cell count, the interval between regular milking, the period and the number of lactations, the influence of stress, season and the manner of milking should also be taken into consideration in the interpretation of the results of somatic cell count, but there is no evidence that these indicators significantly influence the increase of somatic cell count over 200.000/mL in milk from healthy udders (HARMON, 1994).

COLEMAN and MOSS (1989) showed that the highest SCC in Holstein cows (412.000/ml) is in May and June, and the lowest is in July and August (132.000/ml). These authors suggest that the season does not affect the SCC in Holstein cows. This is not in accordance with the results of our research, since we established that the season has a significant influence on the somatic cell count in the milk. SCHULTZ et al. (1990) researched the

influence of the season, the age and the number of lactations on SCC. Considering the age, authors said that in the cows of six years of age or more, the SCC is the lowest from November to February, and the highest is from July to August, while in three year old cows it is the other way around. Considering the number of lactations, the SCC was the highest during the first lactation in May, in the second during February, and in the third and later lactations in December. The same authors also researched the influence of the month when parturition occurred on SCC and proved that in cows in their first and second lactation, the SCC was the lowest if the parturition occurred in the period from August to November. In cows that were in their 3rd or later lactation, the lowest SCC was when the parturition occurred in the period from April to September. These results are in accordance with our results, since we also established that the season has a significant influence on the somatic cell count in the milk.

We concluded that the season has a significant influence on the somatic cell count in milk and the milk composition. However, we did not establish alterations in chemical and physical composition, or the bacteriologic and technologic characteristics of the bulk tank milk samples, which was expected, since the somatic cell count was not over 400.000 somatic cells per 1 mL.

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DOBRANIĆ, V., B. NJARI, M. SAMARDŽIJA, B. MIOKOVIĆ, R. RESANOVIĆ: Utjecaj sezone na kemijski sastav mlijeka i broj somatskih stanica. Vet. arhiv 78, 235-242, 2008.

SAŽETAK

Cilj istraživanja bio je utvrditi utječe li godišnje doba na kemijski sastav mlijeka i broj somatskih stanica u njemu. Mlijeko je tijekom godine dana sakupljano svaki dan. Pri dolasku mlijeka u mljekaru posebnim cisternama prije istakanja uzimani su uzorci. Uzorci mlijeka uzimani su iz cisterne svakih sedam dana od tri dopremljene količine. Ukupno je bilo obrađeno 144 dopremljenih količina. Usporedbom kemijskih pokazatelja kakvoće mlijeka razina masti bila je značajno veća zimi i u jesen ($P<0,05$) u odnosu na proljeće i ljeto. Vrijednosti proteina značajno su se razlikovale među godišnjim dobima ($P>0,05$), a najviša razina zabilježena je zimi. Razina laktoze bila je značajno veća zimi i u proljeće ($P<0,05$), a vrijednosti BST-a bile su značajno niže ljeti u odnosu na druga godišnja doba ($P<0,05$). Određujući broj somatskih stanica u mlijeku zimi je zabilježen značajno veći ($P<0,05$) broj somatskih stanica u odnosu na ostala godišnja doba. Međutim, nisu ustanovljene značajne, jake i pozitivne korelacije između pokazatelja kemijskoga sastava mlijeka i broja somatskih stanica ni u jednomu godišnjemu dobu. Na osnovi rezultata zaključeno je da godišnje doba utječe na broj somatskih stanica i na kemijski sastav mlijeka, ali ne i na korelacije između njih.

Ključne riječi: kravlje mlijeko, kemijski sastav, somatske stanice, godišnje doba