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EFFECT OF SOMATIC CELL COUNT ON THE AMOUNT OF DAILY MILK YIELD AND CHEMICAL COMPOSITION OF MILK FROM COWS KEPT IN THE REGION OF SOUTHERN PODLASIE

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Abstract. The effect of somatic cell count on the amount of daily milk yield and chemical composition of milk from 662 cows kept on 25 farms located in the region of southern Podlasie was analysed. A total of 5061 milk samples were evaluated. They were divided into four classes corresponding to the content of somatic cells in 1 ml of milk: <200,000; 201,000–400,000; 401,000–1,000,000; >1,000,000. It was found that, with an increase in the somatic cell count in 1 ml of milk, there was an increase in milk protein content from 3.36% to 3.54% and milk fat content from 4.02% to 4.16%, whereas the content of casein and dry matter in milk decreased from 2.56% to 2.45% and from 13.13% to 12.98%, respectively. Moreover, the percentage of casein in milk protein decreased from 76.2% to 69.2%. Also, milk yield was reduced, and the calculated losses in the milk yield resulting from an increase in the SCC were 10.6 to 17.3%.

Keywords: chemical composition, cows, milk, SCC

INTRODUCTION

Mastitis is the most frequent and most expensive disease occurring in the husbandry and breeding of dairy cows. Milk somatic cell count is the most commonly applied evaluation indicator of the health state of the mammary gland of a cow during lactation [Harmon 1994, Pillai et al. 2001, Smith et al. 2001]. It is assumed that somatic cell count in the milk of healthy cow does not exceed 100,000 in 1 ml. In the case of acute infection, SCC can reach even between ten and twenty million [Harmon 1994, Czupa 1998, Danków 2000]. According to Malinowski and Kłosowska [2000], a threshold determining the borderline between health and disease is 200,000 cell elements in 1 ml of milk. Although somatic cell count in cow's milk is associated mainly with the health state of the udder, it has been proved that also other factors such as: breed, age, lactation period, season, hygiene of

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cows, affect this trait [Dorynek et al. 2002, Antkowiak et al. 2003, Sawa et al. 2007, Bogucki et al. 2010]. Marketed and processed milk cannot contain more than 400,000 somatic cells in 1 ml [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 18 sierpnia 2004 r. DzU nr 188, poz. 1946 z późn. zm.].

An inflammatory condition of the udder results in decreased milk yield and changes in its chemical composition, physical properties and hygienic quality [Kisza et al. 1981, Sender and Bassalik-Chabielska 1984, Kurek 1995, De Vliegher et al. 2005, Hagnestam et al. 2007]. These changes lead to the decreased nutritional and technological value of milk. According to Kroll et al. [1996], such milk has reduced thermal stability, which sometimes excludes its pasteurization or sterilization and has very low capability of coagulation under the influence of rennet. Moreover, the decrease in the content of dry matter in milk results in the worse output of finished products [Kisza et al. 1981, Janicki 1996].

The aim of the study was the evaluation of the effect of somatic cell count on the milk yield and its content of fat, protein, casein and dry matter.

MATERIAL AND METHODS

The research was conducted between 2007 and 2008 on 662 Polish Holstein-Friesian cows kept on 25 farms located in the region of southern Podlasie and included in the milk recording. On all farms cows were kept under the barn-and-pasture system. Data concerning somatic cell count, daily milk yield and content of fat, protein and dry matter in milk were obtained from the results of test milkings. A total of 5061 milk samples were evaluated. Moreover, from cows under study, 440 milk samples were collected, in which the content of casein (%) was determined with the Walker's method [PN-86/A-86122]. Assays were performed for single cows in days in which test milking was carried out.

The research material was divided into four classes corresponding to the content of somatic cells in 1 ml of milk: <200,000; 201,000–400,000; 401,000–1,000,000; >1,000,000. The effect of the level of somatic cells on the daily milk yield and chemical composition of milk was evaluated using one-way analysis of variance. The significance of differences between the means was estimated with Tukey's test. The correlation coefficients between lnSCC (natural logarithm of SCC) and the analysed properties of milk were also calculated.

RESULTS AND DISCUSSION

In the studied population of cows only 60.4% produced milk containing less than 200,000 somatic cells in 1 ml, whereas milk from approx. ¼ of cows contained over 400,000 somatic cells in 1 ml (Table 1). A highly significant effect of somatic cell count on the daily milk yield and content of protein, fat and dry matter in milk and significant influence on the casein content were found (Table 1 and 2). The highest daily milk yield (22.6 kg) was recorded in a group of cows in which the level of somatic cells in 1 ml of

milk did not exceed 200,000, whereas the lowest daily milk yield (18.7 kg) was characteristic of cows producing milk with the highest level of somatic cells (>1,000,000 · ml^{-1}) (Table 1). A similar tendency to the decreased daily milk yield with increasing amount of cell elements in milk has also been found by Coulon et al. [2002], Sawa and Piwczyński [2002], Guliński et al. [2003], Neja [2003], Piwczyński [2003], Górska [2004], De Vliegher et al. [2005], Hagnestam et al. [2007]. De Vliegher et al. [2005] analysed the decrease in the milk yield of cows in the first lactation and found that, during the first 45 days of its duration, cows produced, on average, 24 kg milk daily, if SCC was less than 50,000 in 1 ml of milk, whereas if SCC was >1,000,000 the average milk yield per cow decreased to 21.5 kg. Guliński et al. [2003] recorded a decrease in the daily milk yield from 22.5 kg for the SCC ≤ 100,000 · ml^{-1} to 19.1 kg for SCC >400,000 · ml^{-1}. Coulon et al. [2002] and Hagnestam et al. [2007], report that even after the abatement of mastitis the milk yield is never as high as it was before the occurrence of mastitis.

The losses in milk yield calculated in the present study and resulting from the increase in the somatic cell count from 200,000 to 400,000 in 1 ml of milk were 10.6% and the losses caused by an increase in SCC over 1 million amounted to 17.3%. It should be emphasized that the losses in milk production concerned approx. 40% of cows under study, in which SCC in milk was over 200,000 · ml^{-1} (Table 1). In the study by Piwczyński [2003] the losses in the milk production with an increase in SCC from 200,000 to more than 1 million in 1 ml in the first, second and third lactation were 11.5%, 14.2% and 17.7%, respectively.

With an increase in somatic cell count in milk from 200,000/ml to >1,000,000 · ml^{-1}, the milk protein content increased from 3.36% to 3.54% (Table 2). A highly significant effect of somatic cell count on the percentage content of protein has also been proved by Sawa et al. [2000], Sawa and Piwczyński [2002], Neja [2003], Górska [2004] and Stanek et al. [2004]. Czaplicka et al. [1993] recorded an increase in the percentage content of protein with increasing severity of an inflammatory condition in each of the 10 lactation months. In the fourth and eighth month of lactation the difference in the milk protein content between healthy cows and those with acute symptoms of mastitis amounted to even 0.24%. Also Wielgosz-Groth and Groth [2003] found higher milk protein content in the milk from infected udders compared to milk from cows with healthy udder (3.43 and 3.16%, respectively). However, Jóźwik et al. [2004] and Ziemiński et al. [2004] did not prove any effect of SCC on the percentage content of milk protein.

The casein content in milk of the highest cytological quality (<200,000 somatic cells/ml) was the highest and equalled 2.56% after which it decreased to 2.52% in the milk in which SCC ranged from 200,000 to 1,000,000 · ml^{-1}. The lowest amount of casein (2.45%) was recorded in milk with more than 1,000,000 somatic cells. The percentage of casein in the milk protein also decreased from 76.2% in milk in which SCC was the lowest (<200,000) to 69.2% in the milk with the highest SCC (>1,000,000). A significant effect (P≤0.05) of the health state of udders on the amount of casein in milk was observed by Wielgosz-Groth and Groth [2003]. The percentage content of this constituent decreased from 2.62 for milk from healthy cows to 2.34 for milk from udders with inflammatory condition. A decrease in the casein content in milk resulting from mastitis is also indicated by such authors as Czupa [1998] and Kroll et al. [1996].

Table 1. Daily milk yield (kg) depending on somatic cells count
Tabela 1. Dzienny udój mleka (kg) w zależności od poziomu komórek somatycznych

SCC in milk, thousand · ml^{-1} LKS w mleku, tys. · ml^{-1}	Number and percentage of cows depending on SCC Liczba (n) i % krów wg klas poziomu LKS w mleku		Daily milk yield, kg Dzienny udój, kg		Percentage of losses % strat
	n	%	$\overline{x}$	sd	22.6 = 100%
< 200	3093	60.4	22.6^{A}	8.8	0
200–400	807	14.7	20.2^{B}	8.3	10.6
401–1000	694	16.1	19.6^{B}	8.8	13.3
> 1000	467	8.8	18.7^{C}	8.8	17.3
Total – Razem	5061	100	21.8	8.9	13.7

A, B, C – means with different letters differ significantly at P≤0.01.
A, B, C – średnie oznaczone różnymi literami różnią się istotnie przy P≤0,01.

Table 2. Milk composition depending on somatic cells count
Tabela 2. Skład chemiczny mleka krów w zależności od poziomu komórek somatycznych

SCC in milk, thousand · ml^{-1} LKS w mleku, tys. · ml^{-1}	Protein, % Białko, %		Casein, % Kazeina, %		% casein in protein % kazeiny w białku	Fat, % Tłuszcz, %		Protein to fat ratio Stosunek białka do tłuszczu		Dry matter, % Sucha masa, %	
	$\overline{x}$	sd	$\overline{x}$	sd		$\overline{x}$	sd	$\overline{x}$	sd	$\overline{x}$	sd
< 200	3.36^{A}	0.42	2.56^{b}	0.47	76.2	4.02^{A}	0.84	0.86	0.19	13.13^{A}	1.05
200–400	3.48^{B}	0.48	2.52^{b}	0.52	72.4	4.14^{AB}	0.89	0.86	0.18	13.12^{A}	1.10
401–1000	3.47^{CB}	0.50	2.52^{b}	0.45	72.6	4.15^{B}	0.87	0.88	0.20	13.01^{B}	1.09
> 1000	3.54^{C}	0.47	2.45^{a}	0.38	69.2	4.16^{B}	0.88	0.87	0.20	12.98^{B}	1.10
Average Średnio	3.41	0.45	2.52	0.46	73.9	4.07	0.86	0.87	0.19	13.03	1.07

A, B, C, a, b – means in columns with different letters differ significantly: capital letters at P≤0.01, small letters at P≤0.05.
A, B, C, a, b – średnie w kolumnach oznaczone różnymi literami różnią się istotnie: duże litery przy P≤0,01, małe litery przy P≤0,05.

The lowest milk fat content (4.02%) was recorded in the class of milk with the lowest amount of cell elements, whereas for milk in which SCC was >1,000,000 in 1 ml, percentage content of milk fat increased to 4.16 (Table 2). Most authors [Czaplicka et al. 1993, Sawa et al. 2000, Czerniewicz et al. 2001, Turki et al. 2001, Guliński et al. 2003, Stanek et al. 2004] found an increase in the percentage content of milk fat with increasing SCC. Guliński et al. [2003] observed an increase in the mean fat content in 1 ml of milk from 3.79% for milk containing less than 100,000 somatic cells to 4.18% in milk in which SCC exceeded 400,000. Also in the study by Czerniewicz et al. [2001], the milk fat content in the milk of ill cows in the first and second lactation was always higher than that in the milk of their healthy age mates. However, Piwczyński [2003] did not find any effect of SCC on the milk fat content.

The dry matter content in milk decreased with increasing SCC. Its highest amount (13.13%) was characteristic of milk from cows of the best cytological quality (<200,000 somatic cells in 1 ml), whereas the milk with the highest SCC in 1 ml (>1,000,000) had the lowest amount of dry matter (12.98%) (Table 2). Mroczkowski et al. [1999] and Górska [2004] also observed a decrease in the dry matter content resulting from an increase in SCC in the milk from 400,000 to 1,000,000 · ml^{-1} (from 12.85 to 12.60 and from 13.39% to 13.06%, respectively). However, Turki et al. [2001] and Wielgosz-Groth and Groth [2003] did not record any effect of SCC on the dry matter content in milk.

The ratio of protein to fat in the milk with different somatic cell count remained at a similar level of 0.86 – 0.88. The differences between individual SCC classes were very small and non-significant (Table 2).

There were very low but statistically significant (P≤0.05) correlation coefficients between lnSCC and daily milk yield (r = –0.11) as well as content of fat (r = 0.05) and protein (r = 0.06) in milk (Table 3). Negative correlation coefficients between SCC and milk yield were also obtained by other authors [Sawa and Piwczyński 2002, Neja 2003, Carlen et al. 2004, Januś and Borkowska 2004, Juozaitiene et al. 2004, Stanek et al. 2004] and the values they recorded ranged from r = –0.03 to r = –0.39.

Table 3. Correlation coefficients (r) between ln SCC and milk yield, ln SCC and composition of milk

Tabela 3. Współczynniki korelacji (r) pomiędzy ln LKS a wydajnością i składem mleka

Specification Wyszczególnienie	r
Daily milk yield, kg Dzienny udój, kg	–0.11^{x}
Fat, % Tłuszcz, %	0.05^{x}
Protein, % Białko, %	0.06^{x}
Casein, % Kazeina, %	–0.04
Solids, % Sucha masa, %	0.01
Protein to fat ratio Stosunek białka do tłuszczu	–0.01

A, B, C, a, b – means in columns with different letters differ significantly: capital letters at P≤0.01, small letters at P≤0.05.

A, B, C, a, b – średnie w kolumnach oznaczone różnymi literami różnią się istotnie: duże litery przy P≤0,01, małe litery przy P≤0,05.

Positive, although very low but significant correlation coefficients between SCC and milk fat content were also obtained by Sawa and Piwczyński [2002] and Stanek et al. [2004]. They ranged between r = 0.066 to r = 0.08. The negative correlation coefficients for these traits ranging from r = –0.03 to r = –0.28 were reported by Carlen et al. [2004], Januś and Borkowska [2004] and Juozaitiene et al. [2004].

A positive relationship between SCC and milk protein content has been confirmed by most authors [Lindmark-Mänsson et al. 2000, Sawa and Piwczyński 2002, Neja 2003, Januś and Borkowska 2004]; however, the values of correlation coefficients reported by various authors differ (from 0.09 to 0.374).

CONCLUSIONS

It was found that, with an increase in the somatic cell count in 1 ml of milk from 200,000 to >1,000,000, the content of milk protein and fat also increased, whereas the content of casein and dry matter in milk as well as the proportion of casein in milk protein decreased. A decrease in milk yield was also observed and the calculated losses in the milk yield resulting from an increase in SCC ranged from 10.6 to 17.3%.

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WPŁYW LICZBY KOMÓREK SOMATYCZNYCH NA WIELKOŚĆ DZIENNEGO UDOJU I SKŁAD CHEMICZNY MLEKA KRÓW UTRZYMYWANYCH W REGIONIE POŁUDNIOWEGO PODLASIA

Streszczenie. Analizowano wpływ poziomu komórek somatycznych na wielkość dziennego udoju i skład chemiczny mleka 662 krów utrzymywanych w 25 gospodarstwach w regionie południowego Podlasia. Łącznie oceniono 5061 prób mleka, które podzielono na cztery klasy odpowiadające określonej zawartości komórek somatycznych w 1 ml mleka: <200 tys., 201–400 tys., 401–1000 tys. i >1000 tys. Stwierdzono, że wraz ze wzrostem liczby komórek somatycznych w 1 ml mleka z 200 do >1000 tys. wzrosła zawartość białka z 3,36% do 3,54% i tłuszczu z 4,02% do 4,16%, natomiast obniżyła się zawartość kazeiny z 2,56% do 2,45% i suchej masy w mleku z 13,13% do 12,98%. Ponadto zmniejszył się udział kazeiny w białku mleka z 76,2% do 69,2%. Zmniejszyła się także wydajność mleka, a obliczone straty w wydajności mleka na skutek wzrostu LKS wynosiły od 10,6 do 17,3%.

Słowa kluczowe: krowy, LKS, mleko, skład chemiczny

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