

## The influence of somatic cell count in milk on reproductive traits and production of Black-and-White cows

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### ABSTRACT

The aim of this study was to estimate the relationships between somatic cell count in milk, reproduction traits and milk production of cows of the Black-and-White breed. The research was carried out on 412 herds of the active Black-and-White cattle population in Lithuania. Data on cows in the first three lactations during the period between 1998 and 2003 were used. Milk yield increased but lactation duration decreased with the increasing lactation number. The effect of lactation numbers on milk yield and dry period, as well as on calving interval, was found to be statistically significant ( $P < 0.001$ ). Insemination number, service period and calving interval decreased with the increasing lactation number. The best milk production and reproductive performance was obtained in the third lactation. The increase of SCC (from 100 000/mL to 800 000/mL and over) increased the number of inseminations per conception of Black-and-White cows (from 133.1 to 144.6%), service period (from 55.5 to 77.9%) and calving interval (from 11.6 to 17.7%) in the first three lactations. Correlation between the SCC  $\log_2$  and milk yield was significantly negative ( $r = -0.35$ ,  $P < 0.01$ ). Statistically significant ( $P < 0.01$ ) positive correlations ranging from 0.36 to 0.44 were found between the SCC  $\log_2$  and the investigated reproductive traits.

**Key words:** cows, somatic cell count, reproductive traits, milk lactation number, correlation

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### Introduction

Mastitis is one of the most costly and common diseases affecting dairy cows throughout the world. The economic impact of mastitis on dairy herds is related to reduced milk production, reduced milk quality, with increases in SCC (somatic cell count), increased milk costs due to the treatment and discarded milk, and increased risk of culling (DEGRAVES and FETROW, 1993).

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Milk SCC is identified as an accurate, indirect method to predict mastitis in dairy cattle. In milk of healthy cows, SCC does not reach 100 000/mL. A cow is considered to be sick with subclinical mastitis when the SCC in the total amount of milk increases to more than 200 000/mL.

Milk yield loss due to SCC was found to vary considerably depending on the level of SCC (PHILIPSSON et al., 1995; SENDER et al., 1998; KOLDEWEIJ et al., 1999; RUPP and BOICHARD, 2000).

In addition to the negative impact on milk yield and its components, mastitis was reported to have a detrimental effect on reproductive performance in lactating dairy cows (MOORE et al., 1991). The negative relationship of somatic cell count with traits of reproduction was estimated by MOORE et al. (1991), BARKER et al. (1998), and SCHRICK et al. (2001).

The aim of this study was to estimate the relationship between SCC in milk, reproduction traits and milk production, of the Lithuanian Black-and-White breed.

### **Materials and methods**

The research was carried out on 412 herds of the active population of Lithuanian Black-and-White cattle during the period between 1998 and 2003. The cows under investigation had genes of the Holstein breed (from 50 to 87.5%).

The following reproductive traits were studied: calving age, number of inseminations per conception, service period, dry period, and calving interval.

Data consisting of test day records, including SCC of cows in the first three lactations (up to 12 control milkings per cow to the 320<sup>th</sup> day of lactation), were selected for estimation. Data on the whole lactation were used for analysis of milk yield. The milk recording data of all cows, which had calved, were used for the investigations.

For the analysis of the influence of the SCC on the reproductive traits of Black-and-White cows, the average of test-day data SCC per lactation was used.

In this study, coefficients of correlation between SCC and reproductive traits and milk production in Black-and-White cows were investigated. The test-day SCC was log transformed to base 2 for the estimation of correlation.

The relationships of SCC and reproductive traits and milk yield were investigated in cows raised in herds registered by Black-and-White Cattle Breeders' Association.

The research was also carried out at the Center of Country Business Development and Information and at the Laboratory of Establishment of Animal Breeding Value and Biometry at the Lithuanian Veterinary Academy, where the PostgreSQL database for data manipulation and analysis in the LINUX operating system was created.

Statistical analyses were carried out using "R 1.8.1" package (<http://www.r-project.org>).

## Results

According to the data, average milk yield of 21,125 Black-and-White cows was 5179 kg (4.29% fat and 3.34% protein) in the first lactation, 5672 kg (4.31% fat and 3.38% protein) of 18,214 cows in the second lactation, 6001 kg (4.28% fat and 3.33% protein) of 12,183 cows in the third lactation (Table 1).

Table 1. Production and reproductive traits of Black-and-White cows

Trait	1 <sup>st</sup> lactation	2 <sup>nd</sup> lactation	3 <sup>rd</sup> lactation	P		
				Lactation		
				1-2	2-3	1-3
Milk yield, kg	5179 ± 20.42	5672 ± 18.91	6001 ± 29.88	<0.001	<0.001	<0.001
Lactation duration, days	311.1 ± 0.89	313.3 ± 1.01	309.9 ± 0.95	>0.1	<0.01	>0.1
Calving age, months	28.4 ± 0.06	41.3 ± 0.04	53.8 ± 0.04	<0.001	<0.001	<0.001
Insemination times for a pregnancy	1.67 ± 0.01	1.58 ± 0.01	1.42 ± 0.01	<0.001	<0.001	<0.001
Calving interval, days	377.9 ± 1.12	376.7 ± 0.97	369.2 ± 0.95	>0.1	<0.001	<0.001
Service-period after calving, days	114.1 ± 0.54	106.6 ± 0.70	92.6 ± 0.68	<0.001	<0.001	<0.001
Dry period, days	66.8 ± 0.89	63.4 ± 0.66	59.3 ± 0.51	<0.01	<0.001	<0.001

The data analysis of cows in different lactations showed age at the first calving to be 28.4 ± 0.06, at the second calving - 41.3 ± 0.04, and at the third calving - 53.8 ± 0.04 months.

We studied the number of inseminations for pregnancy. The number of inseminations before first calving was 1.67 ± 0.01, before the second - 1.58 ± 0.01 and before the third - 1.42 ± 0.01 times.

According to the results of the study, the shortest calving interval (369.2 ± 0.95 days) was estimated after the third lactation, the longest - between the first and second calving - (377.9 ± 1.12 days).

The service-period from calving to conception of cows varied depending on their age: the longest was in the first lactation (114.1 ± 0.54 days), whereas in the second it was shorter (106.6 ± 0.70 days), and in the third lactation it was the shortest (92.6 ± 0.68 days).

The results of the dry period showed the longest dry period in the first lactation ( $66.8 \pm 0.89$  days) and the shortest - in the third lactation - ( $59.3 \pm 0.51$  days).

According to the results, milk yield increased in general, but lactation duration decreased with the increasing lactation number. The effect of the lactation number on milk yield and dry period, as well as on calving interval, was found to be statistically significant ( $P < 0.001$ ).

The insemination number, service period and calving interval decreased with the increasing lactation number. The best milk and reproductive performances were obtained in the third lactation.

This study was carried out to investigate the effect of SCC on reproduction. The research showed differences between levels of SCC and reproduction of cows. Cows in a higher class for SCC showed the worst traits of reproduction. The results of reproduction data in cows of Black-and-White breed depending on SCC in milk are shown in Table 2.

The influence of calving age on SCC level was found to be statistically not significant. The effects of insemination times on pregnancy, service-period after calving and calving interval were statistically significant ( $P < 0.001$ ).

According to the results of the study, the increase of SCC from 100 000/mL to 800 000/mL and over increased the number of inseminations per conception of Black-and-White cows in the first lactation from  $1.22 \pm 0.03$  to  $2.98 \pm 0.04$  (1.76 or 144.6%), in the second lactation from  $1.24 \pm 0.04$  to  $2.89 \pm 0.04$  (1.65 or 133.1%), in the third lactation from  $1.29 \pm 0.06$  to  $3.01 \pm 0.04$  (1.72 or 133.3%); the service period in days increased from  $74.2 \pm 3.21$  to  $130.1 \pm 2.85$  (55.9 or 75.3%) in the first lactation, from  $84.3 \pm 3.01$  to  $129.4 \pm 1.08$  (45.1 or 55.5%) in the second lactation and from  $74.3 \pm 2.15$  to  $132.2 \pm 1.74$  (57.9 or 77.9%) in the third lactation. The calving interval according to lactation number increased in the first lactation from  $360 \pm 2.14$  to  $402 \pm 1.73$  days (42 or 11.6%), in the second lactation from  $365 \pm 1.02$  to  $416 \pm 2.11$  days (51 or 13.9%), in the third lactation from  $362 \pm 1.13$  to  $426 \pm 1.63$  days (64 or 17.7%).

The results of correlations between SCC, reproductive traits and milk yield of cows are shown in Tables 3-4

The research revealed the negative impact of SCC on milk yield of Black and White cows. Correlation between the SCC and milk yield in the herds of Black-and-White cattle was significantly negative ( $r = -0.35$ ,  $P < 0.01$ ).

Statistically significant ( $P < 0.01$ ) positive correlations, ranging from 0.36 to 0.44, were found between the SCC and the investigated reproductive traits (service period, calving interval, dry period and insemination index).

After investigating the reproductive traits, the highest correlations were observed between the service period and the calving interval (0.95,  $P < 0.01$ ). The number of inseminations per conception was highly correlated with the service period and the calving interval (0.68 and 0.53, respectively). Both the lactation duration and the dry period were highly correlated with the service period and calving interval.

Table 2. Influence of SCC on cow reproduction traits

Class of SCC*10 <sup>3</sup> /mL	Insemination times for a pregnancy			Service-period after calving, days			Calving interval, days		
	Lactation								
	1	2	3	1	2	3	1	2	3
<100	1.22 ± 0.03	1.24 ± 0.04	1.29 ± 0.06	74.2 ± 3.21	84.3 ± 3.01	74.3 ± 2.15	360 ± 2.14	365 ± 1.02	362 ± 1.13
101 - 200	1.46 ± 0.04	1.33 ± 0.04	1.56 ± 0.03	70.9 ± 1.22	90.9 ± 1.88	82.8 ± 2.43	362 ± 1.05	376 ± 1.21	363 ± 1.72
201 - 400	1.70 ± 0.06	1.78 ± 0.05	1.80 ± 0.04	97.8 ± 2.07	97.8 ± 2.24	87.9 ± 1.77	379 ± 0.99	378 ± 2.52	389 ± 2.01
401 - 600	2.04 ± 0.02	2.12 ± 0.03	2.34 ± 0.05	125.5 ± 3.33	127.2 ± 1.73	116.7 ± 2.06	387 ± 0.87	383 ± 2.00	401 ± 1.07
601 - 800	2.71 ± 0.01	2.61 ± 0.05	2.81 ± 0.03	126.8 ± 2.19	126.8 ± 0.99	120.9 ± 1.87	394 ± 1.34	404 ± 1.84	409 ± 2.11
>800	2.98 ± 0.04	2.89 ± 0.04	3.01 ± 0.04	130.1 ± 2.85	129.4 ± 1.08	132.2 ± 1.74	402 ± 1.73	416 ± 2.11	426 ± 1.63

Table 3. Correlation between SCC and reproduction traits and milk production of cows

Trait	SCC	P
Insemination index	0.44	<0.01
Service period, day	0.36	<0.01
Calving interval, days	0.38	<0.01
Dry period, days	0.40	<0.01
Lactation duration, days	0.07	<0.05
Milk yield, kg	-0.35	<0.01

Table 4. Correlation coefficients between reproduction traits and their statistical significance

Reproduction trait	Insemination index	Service period, days	Calving interval, days	Dry period, days	Lactation duration, days	Calving age, months
Insemination index	*	0.68	0.53	0.07	0.21	0.28
Service period, days	<0.01	*	0.95	0.64	0.62	0.42
Calving interval, days	<0.01	<0.01	*	0.70	0.66	0.19
Dry period, days	<0.05	<0.01	<0.01	*	0.59	0.06
Lactation duration, days	<0.01	<0.01	<0.01	<0.01	*	0.31
Calving age, months	<0.01	<0.01	<0.01	<0.05	<0.01	*

## **Discussion**

Profitable and efficient milk production depends upon cost-effective management of dairy herds. Diseases and reproductive efficiency affect milk yields and culling decisions, which ultimately impact on the profitability of dairy farms (DEGRAVES and FETROW, 1993).

Mastitis is one of the most common diseases affecting dairy cows and accounts for major economic losses to the dairy industry (GRÖHN et al., 1998; RAJALA et al., 1999).

CULLOR (1990), MOORE et al. (1991) concluded that a coliform mastitis infection, whether early or late in lactation, may negatively affect reproductive function because of gram-negative endotoxin and various cell mediators on endocrine function.

BARKER et al. (1998) studied the effects of clinical mastitis in early lactation on the reproductive performance of Jersey cows. Clinical mastitis affected reproductive performance of dairy cows and timing in lactation. Mastitis decreased pregnancy rate and increased the incidence of abortions in cows.

Efficient reproductive performance is essential for the maintenance of consistently high levels of milk production. Herds with a high prevalence of mastitis may experience a lower reproductive efficiency. Reduced reproductive performance due to mastitis may be related to an extension of the interval from calving to the first postpartum AI, reduced pregnancy to insemination, prolonged days open, and an increased late embryonic mortality after pregnancy diagnosis. Reproductive losses in lactating dairy cows have increased in recent years, and these losses appear to be multifactorial. Decrease in conception rate appears to be associated with higher milk production and an incidence of health disorders early postpartum (GRÖHN and RAJALA-SCHULTZ, 2000; LUCY, 2001).

As measures of fertility for lactating dairy cows, such as conception rate and pregnancy maintenance decline, more attention and efforts to prevent diseases that might decrease reproductive efficiency need to be assigned (GRÖHN and RAJALA-SCHULTZ, 2000; LUCY, 2001). Prevention of mastitis caused by environmental pathogens should focus on reduction of new intramammary infections during the dry period and early lactation (SMITH and HOGAN, 1993).

Determination of somatic cell count is used in many countries to improve mastitis resistance. The results of this study support the findings of similar studies, regarding a negative relationship between level of SCC in milk, milk yield and reproductive performance of cows.

## **Conclusion**

The research showed a negative impact of SCC on milk yield of Lithuanian Black-and-White cows. Correlation between the SCC  $\log_2$  and milk yield was significantly negative ( $r = -0.35$ ,  $P < 0.01$ ).

Milk yield increased, but lactation duration decreased with the increasing lactation number. The effect of the lactation number on milk yield and dry period, as well as on calving interval, was found to be statistically significant ( $P < 0.001$ ).

The insemination number, service period and calving interval decreased with the increasing lactation number after the second lactation. The best milk production and cow reproductive performance were obtained in the third lactation.

The increase of SCC (from 100 000/mL to 800 000/mL and over) increased the number of inseminations per conception of Black-and-White cows in the first three lactations (from 133.1 to 144.6%); service period (from 55.5 to 77.9%), and calving interval (from 11.6 to 17.7%). Statistically significant ( $P < 0.01$ ) positive correlations, ranging from 0.36 to 0.44, were found between the SCC  $\log_2$  and the service period, calving interval, dry period and insemination index.

According to the results of the study, mastitis had a negative impact on milk production and reproductive traits of cows.

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**JUOZAITIENE, V., A. JUOZAITIS: Utjecaj broja somatskih stanica u mlijeku na reprodukcijska obilježja i proizvodnost crno-bijelih krava. *Vet. arhiv* 75, 407-414, 2005.**

**SAŽETAK**

Cilj istraživanja bio je utvrditi povezanost između broja somatskih stanica (SCC) u mlijeku, reprodukcijskih obilježja i proizvodnje mlijeka u krava crno bijele pasmine. Istraživanje je provedeno na 412 stada crno-bijelih krava u Litvi. Rabljeni su podaci o prve tri laktacije krava u razdoblju između 1998. i 2003. Proizvodnja mlijeka se povećavala, a trajanje laktacije skraćivalo s porastom rednog broja laktacije. Utjecaj rednog broja laktacije na proizvodnju mlijeka i razdoblje zasušenja te na međutelidbeno razdoblje bio je statistički značajan ( $P < 0,001$ ). Broj osjemenjivanja je opadao, a trajanje servisnog i međutelidbenog razdoblja bilo je kraće s porastom rednog broja laktacije. Najbolja proizvodnja mlijeka i reprodukcijska sposobnost ostvarene su u trećoj laktaciji. Povećanje SCC (od 100 000/mL na 800 000/mL i više) pratilo je u prve tri laktacije i povećanje broja osjemenjivanja po koncepciji crno-bijelih krava (od 133,1 do 144,6%), produljenje servisnog razdoblja (od 55,5 do 77,9%) te produljenje međutelidbenog razdoblja (od 11,6 do 17,7%). Korelacija između SCC  $\log_2$  i proizvodnje mlijeka bila je statistički značajno negativna ( $r = -0,35$ ,  $P < 0,01$ ). Statistički značajno ( $P < 0,01$ ) pozitivna korelacija, u rasponu od 0,36 do 0,44 utvrđena je između SCC  $\log_2$  i istraženih reprodukcijskih obilježja.

**Cljučne riječi:** krave, broj somatskih stanica, reprodukcijska obilježja, redni broj laktacije, korelacija

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