

GENETIC PARAMETERS OF MILKING TRAITS AND SCC IN MILK

PARAMETRII GENETICI AI SCC ȘI PRINCIPALELOR CARACTERISTICI ALE LAPTELUI

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The aim of work was to determine genetic parameters for number of somatic cells (SCC) in the cow milk. Research took place on the sample of 247 cows of three different breeds. Genetic parameters were estimated by linear mixed model. It is found that heritability for SCC is 0.014 and genetic correlations with milking traits are small negative to small positive. Results show that decrease of SCC can be accomplished, by optimization of environmental factors, and selection for this characteristic must be done by sophisticated mathematic-statistical methods.

Key words: genetic parameters, milk, cows, somatic cells

Introduction

Breeding aim in selection of dairy cattle is improvement of all economically important traits. Situation in the market is changing with lower or higher speed and depending on these changes the breeding aim changes, too.

Traits which today enter into breeding aim of dairy cattle in the international level (*Interbull, 2007*) are as follows:

1. production – includes production of milk, fat and protein,
2. conformation – follows itself from August 1999
3. longevity – follows itself from November, 2004
4. calving – follows itself from February 2005. That trait includes easiness of calving, direct and maternal
5. fertility of cows – follows itself from February 2007
6. udder health – follows itself from May 2005. Under the udder health it is considered:
 - number of somatic cells in the cows milk,
 - appearance of clinical mastitis.

From all mentioned traits, except the production traits, special attention is turned to health of the udder. Udder health is of exceptional economic importance, because it directly influences on the quality and by that also to milk price, and from the other side it influences to longevity.

Mastitis represents the inflammation of mammary gland as a whole, with its parts for production, accumulation and secretion of milk (Boboš, 2005). Symptoms of inflammation may have subclinical form (subclinical mastitis) and clinical form (clinical mastitis). Subclinical mastitis may be discovered by laboratory check up only (CMT), or on the basis of lower milk production of the individual quarters. Subclinical mastitis may develop into clinical one, and may be treated spontaneously also. In this phase exists small inflammation of mammary gland, milk and mammary quarters appear normally. Frequency of subclinical mastitis is 2 to 20 times larger than that of clinical mastitis. With clinical mastitis, secretion of milk is abnormal, in lumps and flaked. Clots are agglomeration of tissue residues, leukocytes and proteins. These clots block the milk channels and prevent the disposal of liquids from alveoli, and in such way the tympany of the udder appears. Udder may be red, hard, hot and painful.

With subclinical and clinical mastitis mammary gland produces large number of defensive factors of which the significant role have polymorphonuclear leukocytes, lymphocytes and macrophages, designated as somatic cells. Number of somatic cells depends on species, causes and stage of infection. Increased number of somatic cells in milk appears as a consequence of lesions on the mammary gland, and selection to diminish mastitis may be done indirectly through selection for diminishing the number of somatic cells (Haas *et al.*, 2007). If the number of somatic cells in 1 ml of bulk milk does not exceed 300,000/ml and clinical health state of mammary gland is good, it must be considered that still 10 to 15% of quarters show the signs of subclinical mastitis (Boboš, 2005).

Increased number of somatic cells in milk affects on the price of cost of raw milk in that sense because the buyers wish milk containing less than 400,000 somatic cells in 1 ml milk.

Experiments have shown that the number of somatic cells in the cows' milk is genetically predisposed. Heritability for that trait is about 0.12 (Da, Y. *at al.*, 1992).

Because of all cited it is necessary to carry out selection of bulls for number of somatic cells on the basis of number of somatic cells in the milk of daughters. However, that is not an easy task because heritability for number of somatic cells in milk, for instance in Japan (Interbull, 2007) is 0.082, in Denmark 0.15 (found in first lactation cows) then in South Africa is 0.062, in Italy 0.080 (found in third lactation cows). A good example distinguishes oneself Israel where heritability for number of somatic cells in milk amounts 0.43 (found in fifth lactation cows).

Materials and Methods

Aiming to get data about the number of somatic cells, sampling of milk has been carried out at individual agricultural producers. In investigation were included 247 cows of Holstein-Friesian breed, Simmental breed and Red Holstein cows.

Before sampling, data concerning the cows have been collected such as CS (ID) number of cows, date of birth, parity, date of last calving and CS or tattoo of sire.

Sampling was carried out two times (at morning and evening milking) when the amount of milk was measured. By means of metal ladle having a volume of 20 ml, equal amounts of milk have been weight out for sample, so that collective sample in the plastic bottle has a volume of 40 ml. That was done on farms with stationary or semi-stationary milking machines. On farms with milk and vacuum line for sampling weighting of amount of milk waycator was used.

Collected samples have been brought to laboratory of Dairy “Subotica” for analysis. Here was carried out percentage of milk fat and protein and number of somatic cells. Data obtained were processed at the Faculty of Agriculture in Novi Sad, so that they were obtained by number of lactation, amount of milk, fat and protein according to cow on the milking day, for 305 days and for complete lactation.

Except the number of somatic cells (SCC) average value and variability, as well as genetic parameters have been estimated also for milk yield (MILK YIELD, kg), milk fat content (MILK FAT, %), protein content (PROTEIN, %), yield of milk fat (MILK FAT YIELD, kg) and protein (PROTEIN YIELD, kg).

Average value and variability of traits examined were estimated by the software package STATISTICA. Genetic parameters were estimated by applying the software LSMLMW (Harvey, 1990) by the method of interclass correlation. Mathematical – statistical model that was used for estimation of genetic parameters was:

$$Y_{ijklmno} = \mu + O_i + F_j + Gt_k + S_l + Gr_m + L_n + e_{ijklmno}$$

where are:

Y – phenotypic value of the traits observed

μ - general average value

O – random effect of sire

F – fixed effect of farm

Gt – fixed effect of year of calving

S – fixed effect of season of calving

Gr – fixed effect of year of birth

L – fixed effect of lactation order number

e – other uncontrolled effects (random error)

Results and Discussions

Average values and variability of all traits examined were observed according to breeds. Phenotypic parameters of traits for Holstein-Friesian breed are presented in the Table 1.

Average value of SCC in total of 174 breeding females of Holstein-Friesian breed amounted 321828, which satisfies maximum allowed value for purchase of milk of 400000 somatic cells in 1 ml milk. However, SD of 32969 and the maximum level of 999000 somatic cells/ml of milk points that in the population there are animals which do not satisfy the standards.

Table 1

Average production and variability of traits examined for Holstein-Friesian breed

TRAITS	<i>n</i>	\bar{x}	$S\bar{x}$	<i>SD</i>	<i>min</i>	<i>max</i>
SCC	174	321828	24993	32969	8000	999000
MILK YIELD (KG)	174	7894	168	2216	3304	15577
MILK FAT (%)	174	3.74	0.053	0.696	2.88	4.87
PROTEIN (%)	174	3.13	0.019	0.247	2.60	3.77
MILK FAT YIELD (KG)	174	295.6	7.7	101.8	125.6	602.8
PROTEIN YIELD (KG)	174	243.5	4.2	55.9	105.7	425.3

Milk of breeding females of Simmental breed (Table 2), also contained, on average, satisfactory number of somatic cells and it amounted 312629 per milliliter milk, with large variability. SD amounted 32149, minimum value 9000 and maximum 999000 per ml of milk. Lower average SCC in milk of cows of Simmental breed in relation to Holstein-Friesian breed, as well as some lower phenotypic variability, may be explained by higher resistance of this breed to unpleasant environmental factors, and therefore also with healthier udder in this breed.

Table 2

Average production and variability of traits examined for Simmental breed

TRAITS	<i>n</i>	\bar{x}	$S\bar{x}$	<i>SD</i>	<i>min</i>	<i>max</i>
SCC	35	312629	54343	32149	9000	999000
MILK YIELD (KG)	35	6646	354	2094	3948	12503
MILK FAT (%)	35	3.82	0.09	0.52	2.07	4.83
PROTEIN (%)	35	3.28	0.04	0.21	2.99	3.66
MILK FAT YIELD (KG)	35	254.3	15.3	90.7	111.6	507.0
PROTEIN YIELD (KG)	35	215.3	10.1	59.7	140.5	381.7

The lowest average number of somatic cells, 297973, was found in Red Holstein breed (Table 3). In this breed, also, was found the lowest variability of that trait. SD amounted 29495, minimum value 14000 and maximum 999000.

In the EU countries for milk containing up to 200000 somatic cells in ml, producer obtains premium of 3 – 5% of the regular price. For milk containing from 250000 – 400000 somatic cells in ml, he obtains 5 – 10% less from normal price of milk, and for milk containing more than 400000 somatic cells in ml, he gets 40% only in relation to normal milk price. If in Serbia farmers would appreciate that standard, it would be necessary, besides adequate equipment for milking, to maintain constant hygiene of udder, which is achieved by construction of buildings for animals with suitable beds.

Table 3

Average production and variability of traits examined for Red Holstein breed

TRAITS	<i>n</i>	\bar{x}	$S\bar{x}$	<i>SD</i>	<i>min</i>	<i>max</i>
SCC	38	297973	47848	29495	14000	999000
MILK YIELD (KG)	38	7349	267	1650	4219	12515
MILK FAT (%)	38	3.63	0.10	0.62	2.24	4.72
PROTEIN (%)	38	3.12	0.04	0.22	2.58	3.56
MILK FAT YIELD (KG)	38	269.4	14.1	86.7	123.2	555.7
PROTEIN YIELD (KG)	38	228.2	7.7	47.3	119.4	356.7

Table 4

Heritability on diagonal, genetic correlation above and phenotypic correlation below diagonal for traits examined

TRAITS	SCC	MILK YIELD KG	MILK FAT %	PROTEIN %	MILK FAT YIELD KG	PROTEIN YIELD KG
SCC	0.014	-0.066	-0.022	0.030	-0.005	-0.043
MILK YIELD (KG)	-0.235	0.218	-0.624	-0.913	0.805	0.986
MILK FAT (%)	0.128	-0.276	0.087	0.287	-0.099	-0.735
PROTEIN (%)	0.194	-0.706	0.523	0.234	-0.99	-0.852
MILK FAT YIELD (KG)	-0.144	0.811	0.290	-0.401	0.551	0.654
PROTEIN YIELD (KG)	-0.201	0.958	-0.139	-0.486	0.852	0.333

Besides hygiene, it is necessary to carry out selection of animals, and specially bulls with good genetic predisposition for lower number of somatic cells in milk.

For SCC, heritability amounted 0.014 which is some value from the average for that trait, which according to citation of *Da, Y. and al., (1992)* amounts 0.12. Established heritability also was lower from the value presented by Interbull organization for member countries, of which the lowest value was found in the South Africa, where it amounts 0.062, and the highest in Israel where it was 0.43.

Lower value of heritability may be caused by established high phenotypic variability. Optimization of environmental factors would increase heritability value and enable more efficient selection of breeding females and males for that trait.

Genetic correlation between SCC and traits of milk yield were low and amounted -0.066 for milk yield, -0.022 for butterfat content, 0.030 for protein content, -0.005 for butterfat yield and -0.043 for protein yield. Although genetic correlations between SCC and milk production traits are low, still, negative correlation point to facts that by increasing the SCC values of the traits cited decrease. That is one reason more because is necessary to work on decreasing the number of somatic cells in cow's milk.

Conclusions

By investigation, in all three breeds examined, SCC satisfied standards as of our country as well as of the EU. However high phenotypic variability indicate that is necessary to work on optimization of environmental factors. From one side, it is necessary to do, due to elimination of large number of somatic cells in all animals. From the other side, decrease of phenotypic variability, would contribute to increase of heritability and efficiency of selection for that trait.

Low heritability also indicates that the selection for that trait must be carried out by applying sophisticated mathematical – statistical models, such as different derivatives of Animal Model.

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