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ENVIRONMENTAL EFFECTS AND HERITABILITY ESTIMATION FOR MILK TRAITS AT TEST-DAYS IN THE SLOVENIAN BROWN, SIMMENTAL AND BLACK-AND-WHITE CATTLE POPULATION

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Abstract

Milk trait records from 13138 cows of all three breeds in Slovenia were observed. The data consists of 89860 measurements in the year 1996. The cows were daughters of 381 bulls. The statistical model considers the effects of herd, season of calving, consecutive lactation and lactation stage for at least 6 measurements within the lactation. All the environmental effects were statistically significant for all traits and breeds. The following heritabilities were estimated: h^2_m - for individual measurements, h^2_c - for lactation and w - repeatability coefficient for milk yield, fat, protein and lactose content at milk recording. h^2_m for milk yield was between 0.11 for Black-and-White and 0.21 for the Brown breed; for fat and protein content the estimated value was 0.11 for the Brown and 0.22 for Simmental breed, and 0.22 for fat content and 0.20 for protein content for the Black-and-White. h^2_m for lactose content was between 0.18 for the Brown breed and 0.36 for the Black-and-White. h^2_c was higher than h^2_m for all traits and was the highest for milk yield in Brown breed (0.65) and the lowest for Black-and-White (0.20). For the other traits Black-and-white had the highest values. The highest repeatability coefficients were for milk yield (0.59-0.71) followed by the lactose content (0.30-0.43) and protein and fat content (0.13-0.41).

Key words: dairy cattle, selection, milk traits, heritability

Introduction

About 65000 cows are included into production record according to the A4 method (ICAR; 1995), which represent about one third of cow population in

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Slovenia. The cows are of various breeds, about one half of them are Simmental, one fourht is Brown and one fourht is Black-and-White. Since 1984 data have been collected in a new modern way, which means monthly collection and processing of data, and is called AP control. The control has been enlarged every year but there are only one third of the recorded cows in the control. Data from other recorded cows are not stored. Only lactation conclusions are calculated. AP data enabled to investigate heritability estimations on the base of monthly measurements.

In Slovenia each breed has its own selection programme that enables the increase of income of cattle production in certain conditions and production branches.Regarding the production branch only those animals are chosen that can give the highest income in a combined way of production (Brown and Simmental breeds) or in milk production (Black-and-White breed). Owing to the National Selection Programme the new generation of bulls and cows is better that the previous one. Annual genetic improvement has been even among 10 and 80 kg of milk per cow (Pogačar, 1996). The improvement depends on the programme, population, seleciton, heritability estimations of milk traits and exactness of breeding value estimation.

The objective of our research was to estimate heritabilities on the base of daily records and without environmental effects in order to estimate breeding value of bulls and cows on the base of daily records and not only on lactation production in future. The generation interval will be shortened and the exactness of breeding value estimation will increase as well as selection improvement (Swalve, 1995).

Materials and Methods

Milk trait records from Brown, Simmental and Black-and-White cows were observed in the investigation. There were 13.138 cows tested. Data on milk traits for the year 1996, which meant 89.860 measurements, were considered. The statistical package SAS was used for statistical analysis. The effects of herd, season of calving, consecutive lactation and lactation stage were considered by the statistical analysis. The effects of herd, season of calving, consecutive lactation and lactation stage were considered by the statistical model for at least six measurements within one lactation.

Statistical model:

$$Y_{ijklmn} = \mu + H_i + V_j + K_{jk} + L_l + S_{lm} + e_{ijklmn}$$

μ - mean value
H_i - farm and season of calving (i= 1...347)
V_j - sire
Brown breed: j = 1 ... 141
Simmental breed: j = 1 ... 133
Black-and-White breed: j = 1 ... 107
K_{jk} - cow (sire)
Brown breed: k = 1 ... 2906
Simmental breed: k = 1 ... 1240
Black-and-White breed: k = 1 ... 8992
L_l - lactation (l = 1 .... 7)
S_{lm} - lactation stage (lactations)
(m = 1 .....12)
e_{ijklmn} - random effect

The following heritabilities were estimated: h^2_m – for individual measurements, h^2_c for lactation and repeatability coefficient w for milk yield, fat, protein and lactose contents at regular monthly milk records.

Heritability estimation for individual measurements (h^2_m) was calculated using the following model:

$$h^2_m = \frac{4 \times s^2_{sire}}{s^2_{sire} + s^2_{residue} + s^2_{cow\ (sire)}}$$

For heritability estimatin (h^2_c) for lactation the following model was used:

$$h^2_c = \frac{4 \times s^2_{sire}}{s^2_{residue} + s^2_{sire}}$$

The repeatability coefficient was calculated using the following equation:

$$w = \frac{s^2_{cow\ (sire)}}{s^2_{cow\ (sire)} + s^2_{residue}}$$

Results

In 1996 13138 cows were checked every month. Cows were daughters of 381 bulls. During the investigation 89860 measurements were obtained, 72%

of which were form Black-and-White cows, 19% from Brown cows and 9% from Simmental cows.

Table 1 - NUMBER OF COWS AND MEASUREMENTS PER BREED

Breed	No. of cows.	No. of measurements	No. of fathers
Brown	2.906	16.900	141
Simmental	1.240	8.548	133
Black-and-White	8.992	64.412	107
Total	13.138	89.860	381

The effects of environment were statistically significant for all milk traits and all breeds.

Data obtained by measurements and analyses of variance were used for heritability estimations for each measurement (h^2_m) and heritability estimations for lactation (h^2_c). Table 2 displays heritability estimations for each measurement of milk yield, and fat, protein and lactose content for all cows.

Table 2 - HERITABILITY ESTIMATIONS (h^2_m) FOR EACH MEASUREMENT

Breed	Milk, kg	Fat, %	Protein, %	Lactose, %
Brown	0.21	0.11	0.11	0.18
Simmetanl	0.17	0.11	0.11	0.2
Black-and-White	0.11	0.22	0.20	0.36

The highest h^2_m for milk yield was noticed in Brown cows and the lowest in Black-and-White cows and vice versa for contents of milk. The highest h^2_m for the contents of fat, protein and lactose were noticed in Black-and-White cows while there were no differences between Simmental and Brown cows.

Table 3 shows heritability estimations for lactation, all cows and all milk traits were considered.

Table 3 - HERITABILITY ESTIMATIONS (h^2_c) FOR LACTATION

Breed	Milk, kg	Fat, %	Protein, %	Lactose, %
Brown	0.65	0.14	0.20	0.25
Simmental	0.51	0.15	0.18	0.35
Black-and-White	0.20	0.30	0.30	0.59

Heritability estimations for lactation are higher than heritability estimations for each measurement. The highest h^2_c for milk yield was noticed in Brown cows and the lowest in Black-and-White cows. h^2_c for milk content was the highest in Black-and-White cows and the lowest in Brown cows. Simmental cows have a bit higher h^2_c than Brown cows.

Repeatability coefficients for the measured milk traits were calculated for all breeds. Table 4 displays repeatability coefficients for milk yield and milk content in all breeds.

Table 4 - REPEATABILITY COEFFICIENT (w) FOR MEASURED TRAITS

Breed	Milk, kg	Fat, %	Protein, %	Lactosee, %
Brown	0.71	0.23	0.13	0.30
Simmental	0.69	0.25	0.41	0.40
Black-and-White	0.59	0.29	0.36	0.43

The highest repeatability coefficient for milk yield was recognised in Brown cows (0.71), followed by Simmental (0.69) and Black-and-White cows (0.59). The highest repeatability coefficient for fat content was noticed in Black-and-White cows (0.29) and the lowest in Brown cows (0.23). The highest repeatability coefficient for protein content was estimated in Simmental cows (0.41), a bit lower in Black-and-White cows (0.36) and the lowest in Brown breed (0.13). The same values were estimated for lactose content only that the repeatability coefficient for lactose content was higher than for fat and protein contents (between 0.30 in Brown cows and 0.43 in Black-and-White cows).

Conclusions

1. Heritability estimations (h^2_m) for each measurement were the lowest for milk yield and the highest for the content of lactose (contents ranged between 0.11 for milk yield and 0.36 for lactose content) in Black-and-White cows. In Simmental cows the values for the contents of fat and protein (0.11) were the lowest and the highest for the content of lactose (0.22). In Brown cows the value of milk yield was the highest (0.21) while the values of fat and protein content were equal to simmental cows.
2. Values of heritability estimations (h^2_c) for lactation were higher but proportions among the studies traits were similar to the values for h^2_m.
3. Repeatability coefficients (w) did not consider the effects of fattening, season of calving, sequence of lactation and lactation stage that were

statistically highly significant for all traits and breeds. Estimated repeatability coefficients (w) were the highest for milk yield (among 0.6 and 0.7) while for the milk content were among 0.23 and 0.40.

4. Results showed that if environmental effects were eliminated and heritability estimations evaluated on daily milk production basis we could begin to estimate the breeding value on day records and repeating daily measurements. The success of selectin and exactness of estimation of breeding value as well as selection improvement will be assured.

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PROCJENJIVANJE DJELOVANJA OKOLINE I NASLJEDNOSTI NA OSOBINE MLIJEKA NA DANE TESTIRANJA POPULACIJE SLOVENSKOG SMEĐEG, SIMENTALSKOG I CRNO-ŠAROG GOVEDA

Sažetak

Razmatrane su zabilježene osobine mlijeka 13138 krava svih triju pasmina u Sloveniji. Podaci se sastoje od 89860 mjerenja obavljenih 1996. godine. Krave su kćeri 381 bika. Statistički model uzima u obzir djelovanje stada, godišnjeg doba telenja, uzastopne laktacije i stupnja laktacije za najmanje 6 mjerenja unutar laktacije. Svako djelovanje okoline bilo je statistički signifikantno za sve osobine i pasmine. Izračunavane su ove nasljednosti: h^2_m - za pojedinačna mjerenja, h^2_c - za laktaciju i w - koeficijent ponavljanja za prinos mlijeka, sadržaj masnoće, bjelančevina i laktoze prilikom mjerenja mlijeka. h^2_m za prinos mlijeka bio je između 0.11 za crno-šaru i 0.21 za smeđu pasminu, procijenjena vrijednost za sadržaj masnoće i bjelančevina bila je 0.11 za smeđe i 0.22 za simentalsku pasminu, te 0.22 za sadržaj masnoće i 0.20 sadržaj bjelančevina za crno-šaru. h^2_m za sadržaj laktoze bio je između 0.18 za smeđu pasminu i 0.36 za crno-šaru. h^2_c bio je viši od h^2_m za sve osobine a najviši za prinos mlijeka u smeđe pasmine (0.65) i najnižiu u crno-šaru (0.20). Za druge osobine crno-bijela pasmina imala je najviše vrijednosti. Najviši koeficijenti ponovljivosti bili su za prinos mlijeka (0.59 - 0.71), zatim sadržaj laktoze (0.30 - 0.43), te bjelančevina i sadržaja masnoće (0.13–0.41).

Ključne riječi: mliječno govedo, selekcija, osobine mlijeka, nasljednost

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