Genetic Parameters of Conformation Traits in Brown, Simmental and Holstein Breed Calves in Slovenia

Betka LOGAR [1] (✉)
Miran ŠTEPEC [2]
Klemen POTOČNIK [2]

Summary

Conformation traits of Brown, Simmental and Holstein breed calves were studied to estimate the genetic and environmental parameters using data from two classification systems. Calves were classified in the period 2000 – 2010 between the age of one to 51 days. Beside the chest girth as a measurement in cm five traits were scored. At the beginning, the traits such as muscularity, form, body depth, body length and width were scored on the scale from 1 to 3 or 1 to 9 while in the year 2008 the system of classification changed to scores from 1 to 5 for all traits. Due to high variability of the data their thorough cleaning and homogenisation was required. Uni- and bivariate analyses using animal model methodology were performed. The effects of technician by year of classification, classification age class, birth season in months by years were treated as fixed and the herd by year of classification and additive genetic effect as random. Heritability estimates for data from the new classification system are rather higher (0.05-0.29) than those from the old system. Genetic correlations between estimates of two classification systems are very high, i. e. in a range from 0.74 to 0.97, which indicates a strong genetic relationship between the old and the new system of classification. The only exceptions were form and body depth in Simmental breed. In the chest girth the estimates of heritability from 0.16 to 0.27 were obtained.

Key words

cattle, conformation traits in calves, genetic parameters, classification systems

[1] Agricultural Institute of Slovenia, Animal Science Department,
Hacquetova ulica 17, 1000 Ljubljana, Slovenia
✉ e-mail: betka.logar@kis.si
[2] University of Ljubljana, Biotechnical Faculty, Zootechnical Department,
Groblje 3, 1230 Domžale, Slovenia

Received: June 1, 2011 | Accepted: June 30, 2011

Aim

In the Slovenian breeding scheme the so-called 'Biological Test' includes monitoring of genetic defects in calves, monitoring of calving ease and classification of calf conformation traits. The test has started after the year 1990. At the beginning, approximately 150 calves, ancestors of a particular breading bull, were classified by a classifier. Later on, the test was broadened to the whole population in a pedigree recording scheme and the classification was done by technicians together with pedigree recording.

The aim of the study was to estimate the genetic and environmental parameters in conformation traits of Brown, Simmental and Holstein breed calves in Slovenia using data from two classification systems.

Material and methods

The conformation trait records and pedigree information was extracted from the database of Slovenian Cattle Recording Scheme (Logar et al., 2005) for Brown, Simmental and Holstein breed calves classified at the age of one to 51 days in the period 2000 – 2010. Six traits were studied. At the beginning of the test the traits such as muscularity, form, body depth, body length and width were classified on the scale from 1 to 3 or 1 to 9 (Table 1), then, in the year 2008, the system of classification was made uniform for all those traits and changed to estimates from 1 to 5, while the system of measuring of chest girth (in cm) did not change during that period. Data was edited applying standard deviations by technician and year of classification as main criteria. The records of particular technician within year of classification and out of defined standard deviations range (from 0.4 to 1.6 for the estimates from 1 to 9, from 0.1 to 0.4 for the estimates from 1 to 3 and from 0.2 to 0.8 for the estimates from 1 to 5) were removed from the data set. Then, if the frequency of particular measurement (65, 70, 75, 80, 85, 90 cm) was higher than 30% by a certain technician in a year, data for this technician and year was excluded from further analyses. At least 20 classifications in at least three different herds per year were required for a technician. More than half of the data was excluded during data cleaning. After the cleaning, the data was additionally homogenised by technician within classification year. Descriptive statistics of the data by breeds and classification system are shown in Table 1. The highest number of observations is recorded in Simmental breed. As a result of data cleaning the number of observations differs within breed and system of classification. With a smaller exception of muscularity and form estimated in the old system there is no big difference in the statistics within particular trait.

For the chest girth univariate analysis was used while for the traits with two scales of scores bivariate analyses were performed. Observations from the old system were treated as a first trait and those from the new system as a second trait. The genetic correlation between the traits was used as measurement of genetic relationship between the estimation systems within trait. Data structure and available pedigree allowed animal model. Pedigree included data on five generations of ancestors. Genetic parameters were estimated using residual maximum likelihood (REML) as applied in VCE-6 (Kovač et al., 2002). The following animal model was used:

$$y_{tijklm} = \mu_t + T_{ti} + A_{tj} + S_{tk} + h_{tl} + a_{tm} + e_{tijklm} \quad [1]$$

where

y_{tijklm} = conformation trait record of calf m born in herd l in season k classified in age class j by classifier i;
μ_t = overall mean of trait t (t = 1, 2);
T_{ti} = fixed effect of classifier i (by year of classification) for trait t;
A_{tj} = fixed effect of age at classification class j for trait t (i = 1,…6);
S_{tk} = fixed effect of birth season k (in months by years) for trait t;
h_{tl} = random effect of herd l by year of classification for trait t;
a_{tm} = random additive genetic effect of animal m for trait t;
e_{tijklm} = random residual effect for trait t.

Heritability for trait t (t = 1, 2) was calculated as proportion of direct additive genetic variance to the total variance.

Results and discussion

In Brown breed (Table 2) higher estimates of heritability were obtained on data from the new classification system (0.05 – 0.15) than those from the old system (0.02 – 0.14). The highest enlargement was in body length (from 0.03 to 0.13). Heritability estimate for form did not change with classification system; however form was the trait with the highest heritability among classified traits already in the old classification system. Genetic correlations between estimates from the old and the new system

Table 1. Number of records (N), means and standard deviations (SD) by breeds and classification system

Trait	Brown breed			Simmental breed			Holstein breed		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Muscularity (1-9)	52.869	5.74	1.07	250.879	6.02	1.07	97.040	5.62	1.22
Muscularity (1-5)	16.161	3.20	0.67	115.057	3.34	0.66	58.730	3.19	0.65
Form (1-9)	53.810	5.87	1.06	258.634	6.19	1.06	104.413	6.01	1.12
Form (1-5)	18.349	3.34	0.64	121.108	3.41	0.65	57.291	3.32	0.62
Body depth (1-3)	31.116	2.03	0.31	139.695	2.08	0.36	64.763	2.03	0.34
Body depth (1-5)	17.935	3.21	0.65	116.898	3.30	0.68	58.949	3.20	0.65
Width (1-3)	23.052	2.01	0.31	115.297	2.09	0.36	61.867	2.01	0.32
Width (1-5)	17.539	3.11	0.65	112.375	3.32	0.66	54.957	3.14	0.63
Body length (1-3)	18.390	2.06	0.33	116.115	2.11	0.38	39.007	2.12	0.40
Body length (1-5)	16.430	3.50	0.68	106.064	3.53	0.72	51.855	3.49	0.68
Chest girth (cm)	65.593	81.10	6.61	396.618	83.85	6.59	169.335	80.69	5.88

of classification in Brown breed were rather high, in the range from 0.78 to 0.97, which indicated a strong genetic relationship. The estimates of heritability on data from the new classification system in Simmental breed (Table 3) were higher than in Brown breed, from 0.24 to 0.29. In Simmental high heritability estimates were obtained for form (0.41), but genetic correlation between estimates of form from two classification systems is unexpectedly low. The reason for that could be in age at classification, while in the recent years more and more calves have been classified during the first days after birth when form is difficult to classify and that could result in unexpected estimates of paramters. The estimate of genetic correlation for body depth is low, which could be a consequence of optimization problems at the estimation. Likewise in Simmental breed genetic correlations for muscularity, body length and width are high (0.81 – 0.91). The enlargement of heritability estimates with the new classification system in Holstein (Table 4) did not follow other two breeds. The estimates were from 0.03 to 0.09 in the old system and from 0.07 to 0.11 in the new one. On data from the new classification system the highest heritability (0.11) was estimated for muscularity. For form higher heritability was estimated for data from the old classification system. As in Simmental the reason could be in the classification difficulties in the first days after birth. Genetic correlations between the estimates from both classification systems were rather high in Holstein too, from 0.74 to 0.89.

Generally, in all three breeds, Brown, Simmental and Holstein heritability estimates (Table 2, Table 3, Table 4) on data from the new classification system are higher (0.05-0.29) than those from the old system (0.01-0.20). In the chest girth, which is the only trait without a change of observation system, the heritability estimates from 0.16 in Holstein to 0.27 in Simmental breed were obtained. Heritabilities used in October national evaluation of breeding values for classified conformation traits in calves (Center za strokovno delo, 2011) are from 0.01 to 0.07 and in chest girth from 0.09 to 0.20, which is much lower than in this study. In our study better estimates of heritability were obtained also with data cleansing. In the national genetic evaluation the data from both classification systems within trait was transformed to one scale. High genetic correlations between estimates from the old and the new system of classification in our study indicated a strong genetic relationship between the estimates from old and new system of classification. That indicated a suitability of univariate model in analyse of conformation traits in calves, as well.

The proportion of total variability caused by herd effect (heard*year) was rather low, i. e. from 2 to 10%, which is quite uncommon in cattle breeding studies. The reason could be in the fact that calves were classified soon after birth, which reduced herd variance. The highest proportion of herd variance was in chest girth (10 to 11%) while the major part of variability remained unexplained.

From the new, uniform system of classification, higher estimates of genetic parameters were obtained in this study. On the base of genetic and environmental parameters obtained a positive impact on the selection in conformation traits in calves with higher genetic gain could be expected. For classification of traits difficult to classify in first days after birth shifting of classification in later period could be appropriate.

Table 2. Proportions of variance components and genetic correlations for conformation traits in Brown calves

Trait	Range	Heritability	Genetic correlation	Herd*year	Residual
Muscularity	1-5	0.152	0.783	0.038	0.810
	1-9	0.132		0.057	0.810
Form	1-5	0.143	0.801	0.036	0.820
	1-9	0.143		0.066	0.790
Body depth	1-5	0.053	0.968	0.043	0.904
	1-3	0.024		0.022	0.955
Body length	1-5	0.129	0.896	0.032	0.840
	1-3	0.034		0.017	0.949
Width	1-5	0.115	0.786	0.040	0.845
	1-3	0.048		0.027	0.925
Chest girth	cm	0.253		0.102	0.645

Table 3. Proportions of variance components and genetic correlations for conformation traits in Simmental calves

Trait	Range	Heritability	Genetic correlation	Herd*year	Residual
Muscularity	1-5	0.270	0.808	0.042	0.687
	1-9	0.196		0.057	0.746
Form	1-5	0.408	0.093	0.071	0.521
	1-9	0.313		0.027	0.660
Body depth*	1-5	0.244	0.207	0.037	0.719
	1-3	0.013		0.026	0.961
Body length	1-5	0.285	0.913	0.039	0.676
	1-3	0.063		0.029	0.909
Width	1-5	0.242	0.878	0.037	0.720
	1-3	0.049		0.024	0.927
Chest girth	cm	0.271		0.093	0.636

* Optimization finished with status 3

Table 4. Proportions of variance components and genetic correlations for conformation traits in Holstein calves

Trait	Range	Heritability	Genetic correlation	Herd*year	Residual
Muscularity	1-5	0.114	0.786	0.050	0.835
	1-9	0.087		0.079	0.834
Form	1-5	0.074	0.739	0.057	0.870
	1-9	0.107		0.073	0.820
Body depth	1-5	0.068	0.736	0.046	0.887
	1-3	0.029		0.019	0.951
Body length	1-5	0.099	0.892	0.047	0.854
	1-3	0.030		0.024	0.946
Width	1-5	0.102	0.860	0.045	0.853
	1-3	0.032		0.034	0.934
Chest girth	cm	0.160		0.110	0.731

There is no information about comparable test in foreign populations while the estimation of conformation traits performed later, in primiparous cows is spread worldwide (Interbull Centre, 2011). Because the classification of conformation trait in calves and primiparous cows have been recorded routinely, further studies of connection between conformation traits in calves and primiparous cows in the Slovenian population will be possible.

Analysis of calf conformation traits also showed that a large amount of data were out of expected range. Our suggestion is to pay more attention to monitoring of technicians in the future work.

Conclusions

An improvement of genetic parameters for conformation traits in the calves of Brown, Simmental, and Holstein breeds classified by two classification systems in Slovenia was attained in the current study, which promises higher genetic gain in the selection of those traits. Classification of conformation trait in calves and primiparous cows have been recorded routinely, therefore further studies of connection between conformation traits in calves and primiparous cows in the Slovenian population are feasible.

References

Center za strokovno delo. 2011. Redni obračun PV za Oceno telet - april 2011. http://www.bfro-uni-lj.si/zoo/org/centre/gov/zunanjost/oct/1102/_main.html

Interbull Centre. 2011. Interbull routine genetic evaluation for conformation traits April 2011. http://www-interbull.slu.se/conform/framesida-conf.htm

Kovač M., Groeneveld E., García-Cortés L.A. 2002. VCE-5, a package for the estimation of dispersion parameters. In: Proceedings of the 7th World Congress on Genetics Applied to Livestock Production, August 19-23, 2002, Montpellier, France. Session 18. CD-ROM communication No. 28–06

Logar B., Podgoršek P., Jeretina J., Ivanovič B., Perpar T. 2005. Online-available milk-recording data for efficient support of farm management. In: Knowladge transfer in cattle husbandry. Publication-European Association for Animal Production. Wageningen, Wageningen Academic Publishers: 227-230

---

acs76_51