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Population genetic evaluation of weaning weight of different beef cattle breeds

KülönbözŖ húsmarhafajták választási súlyának populációgenetikai értékelése

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ABSTRACT

Population genetic analysis was performed on data from 42,695 purebred beef calves from seven breeds born from 1981 to 2005 in Hungary. Animal model were used for the estimations. Sire, herd, age of dam at calving, birth year, season of birth and sex of calf had significant effects on 205-day calf weaning weight for each breed. Direct heritability value estimates were 0.18 to 0.61, the maternal heritability values from 0.07 to 0.38, and the total heritability values were between 0.09 and 0.35. The direct-maternal genetic correlations were high and negative for all the breeds varying from -0.63 to -0.88.

Keywords: seven breeds, direct-, maternal-, total heritability, direct-maternal genetic correlations

ÖSZEFOGLALÁS

A munka során hét fajtába tartozó, 1981 és 2005 között született, összesen 42 659 fajtatiszta borjú választási eredményét értékeltük Magyarországon. A populációgenetikai elemzés Animal Modellel történt. Az tapasztaltuk, hogy az apa, a tenyészet, az anya borjazás kori életkora, a születési év, a születési évszak és a borjú ivara szignifikánsan befolyásolta a 205-napos választási súlyt. E teljesítménymutató direkt örökölhetŖsége (h^2d) 0,18 és 0,61 között, anyai örökölhetŖsége (h^2m) 0,07 és 0,38 között, teljes örökölhetŖsége (h^2T) 0,09 és 0,35 között változott. A korrelácó a direkt és anyai hatás között szoros, negatív volt és -0,63 - -0,88 között alakult fajtától függŖen.

Kulcsszavak: hét fajta, direkt-, anyai-, teljes örökölhetŖség-, direk-anyai genetikai korreláció

INTRODUCTION

Weaning weight in beef cattle is a trait of major economic importance because the weaned calf is the end product and total output of the cow-calf unit. There are numerous studies that have examined weaning weight of different beef breeds and the influence of environmental and genetic effects *(Minyard and Dinkel, 1965; Sellers et al., 1970; Pell and Thayne, 1978; Gregory et al., 1979; Meyer, 1994; Cundiff et al,. 1998; Szabó et al., 2006; Vergara et al., 2009)*.

While a number of these authors have reported heritability values for weaning weight including data for the maternal effect, according to *Meyer (1994) and Vergara et al., (2009)* further research is required to separate the direct and maternal genetic components for better estimation of genetic values in beef cattle populations.

The primary aim of this study, using data from pure bred cattle populations in Hungary, was to evaluate environmental and genetic effects on weaning weight. Also, direct and maternal heritabilityôs, together with direct-maternal genetic correlations, were estimated.

MATERIAL AND METHODS

Population genetic analysis was performed on data from 42,695 purebred beef calves from seven breeds, Hungarian Grey, Limousin, Hereford, Angus, Charolais, Hungarian Simmental and Blonde d' Aquitaine, born between 1981 and 2005 in Hungary. Performance and complete pedigree data were recorded by the breed associations. The number of calf records can be seen in Table 1.

Table 1. Summary of data used for genetic evaluation

	Breed						
	HG	HS	AA	HE	CH	BD	LI
Period of records	1984-2004	1981-2003	1989-2002	1990-2002	1990-2005	1993-2005	1992-2005
Number of herds	9	2	1	2	12	2	3
of calves	5720	7032	2451	5109	13087	3250	6046
of sires	182	232	63	119	146	27	55
of dams	2638	2057	933	1954	6168	1173	1838
of paternal grand sire	35	17	13	18	44	3	8
of maternal grand sires	104	114	19	55	101	20	34
of paternal grand dams	50	24	31	32	69	4	16
of maternal grand dams	702		119	234	990	429	558

HG = Hungarian Grey; HS = Hungarian Simmental; AA = Angus; HE = Hereford; CH = Charolais; BD = Blonde dôAquitaine; LI = Limousin

The beef herds from which the data originated were all on different farms. Cows were mated using both artificial insemination and natural service to produce straightbred calves. The majority (70-75 %) of calvings took place in spring, 10-15 % of calvings were in winter, 5-10 % were in summer, and 4-8 % were in autumn. The calves remained with their dams on pasture, and were creep-fed corn and wheat (30-50 kg/calf) for the last two months of the nursing period. The calves were weighed on the day of birth and at weaning. Weaning weights and corresponding ages were recorded between 150 and 240 days age. Calf weaning weight was adjusted to 205 days of age by linear interpolation from birth weight, weaning weight and age.

The 205-day weaning weights were analysed using animal model. The software used to evaluate the environmental and genetic effects, and to estimate genetic parameters and breeding values was Harveyõs (1990) *Least Squares Maximum Likelihood,* and *Derivative Free Restricted Maximum Likelihood* (DFREML) *Computer Program* (Meyer, 1998), and the *Multitrate Derivative Free Restricted Maximum Likelihood* (MTDFREML) program developed by Boldman *et al.* (1993).

The animal model was:

$\hat{R} = X_b + Z_u + W_m + S_{pe} + e$

where:

$\hat{R}$ = vector of observation (trait); b = vector of fixed effects (herd, age of dam at calving, year, season and sex); u = vector of random effect (animal); m = vector of maternal genetic effect; pe = vector of maternal permanent environmental effect; e = vector of random residual effect; X = matrix of fixed effects; Z = matrix of random effects; W = matrix of maternal genetic effect; S = matrix of maternal permanent environmental effect

RESULTS AND DISCUSSION

Sire, herd (except for Blonde d'Aquitaine), age of dam at calving, birth year, season and sex of calf all had significant effects (PÒ0.05) on 205-day weaning weight of calves in each breed (Table 2). These findings correspond to the results of others reported in the literature *(Minyard and Dinkel, 1965; Sellers et al., 1970; Pell and Thayne, 1978; Gregory et al., 1979; Cundiff et al., 1998; Szabó et al., 2006)* who also found significant effects of one or more of the factors mentioned on weaning performance.

The breed mean 205-day weaning weight varied from 191 to 242 kg, with standard deviations of 30 to 41 kg. The coefficient of variation values were below 20% for all breeds.

The variance components and heritability value estimates obtained from the animal model are shown in Table 3.

The direct breed heritability (h^2_d) values ranged 0.18-0.61 across the breeds. These values are slightly higher than those reported by *Meyer (1994)*. Also, they are higher than obtained by *Splan et al. (2002)* who found value 0.14. Maternal heritability value (h^2_m) estimates are lower (0.07-0.38) than the direct heritability, and are similar to the finding of *Mohuiddin (1993)* who reported that the maternal heritability value of weaning weight tended to be lower than the direct heritability value. This result indicates a greater genetic influence of the calf than its dam for the trait. The opposite result was found by *Splan et al. (2002)* whose estimate of maternal heritability was slightly greater (0.19) than the estimate for direct heritability (0.14). The total heritability values (h^2_T) were between 0.09 and 0.35 which are similar to the values obtained by *Meyer (1994) and Vergara et al. (2009)*.

Table 2. Significance of the effects of various factors on 205-day weight of calves

	Breed						
Source of variance	HG	HS	AA	HE	CH	BD	LI
Sire	****	****	****	****	****	****	****
Herd	****	**	-[1]	**	****	NS	****
Age of cows at calving	****	****	****	****	****	****	****
Birth year	****	****	****	****	****	****	****
Birth season	****	****	****	****	****	****	****
Sex	****	****	****	****	****	****	****

HG = Hungarian Grey; HS = Hungarian Simmental; AA = Angus; HE = Hereford; CH = Charolais; BD = Blonde dőAquitaine; LI = Limousin
** = P<0.05; *** = P<0.01; **** = P<0.001
[1]Only one herd

The direct-maternal genetic correlations (r_{dm}) were high (-0,52 to -0,88) and negative for all breeds. Similar results have been reported by *Meyer (1992, 1997)* and by *Koots et al. (1999)* who also found strong negative direct-maternal genetic correlations. Several estimates of direct-maternal correlation reported by *Mohuiddin (1993)* were negative, although they ranged from -0,78 to 0.25. Also, similarly negative, but a somewhat lower correlations were reported by *Splan et al. (2002)* (r_{dm}= -0.18) and *Vergara et al. (2009)*, while *Sullivan et al. (1999)* assumed a zero correlation.

A difference in the genetic correlation between direct and maternal components of gain from birth to weaning can have several practical consequences. Negative estimates of direct-maternal genetic covariance have been reported for many beef cattle breeds are now included in national genetic evaluations of many breed associations *(Splan et al., 2002)*.

Table 3. Estimated variance and covariance components and heritability values of 205-day weight of calves

Genetic parameters	Breed						
	HG	HS	AA	HE	CH	BD	LI
Overall mean value, kg	191	236	212	204	227	242	203
ů$^{2}_{p}$ phenotypic variance	631	1250	980	1189	1515	1265	871
ů$^{2}_{d}$ additive direct genetic variance	384	461	173	224	892	697	302
ů$^{2}_{e}$ residual variance	262	768	755	875	626	434	533
ů$^{2}_{pe}$ maternal permanent environmental effect	42	69	0	80	30	30	72
e^2 the ratio of the residual variance to the phenotypic Variance	0.41	0.61	0.77	0.74	0.41	0.34	0.55
ů$^{2}_{m}$ maternal genetic variance	162	89	128	130	569	410	229
ů$_{dm}$ direct-maternal genetic covariance	-219	-137	-77	-120	-602	-307	-165
c^2 the ratio of the maternal permanent environmental variance to the phenotypic Variance	0.07	0.06	0.00	0.07	0.02	0.02	0.07
h^2_d direct heritability	0.61	0.37	0.18	0.19	0.59	0.55	0.31
h^2_m maternal heritability	0.26	0.07	0.13	0.11	0.38	0.32	0.24
$h^2_m+c^2$	0.33	0.13	0.13	0.18	0.40	0.32	0.31
h^2_T total heritability	0.22	0.24	0.12	0.09	0.18	0.35	0.19
r_{dm} direct-maternal genetic correlation	-0.88	-0.68	-0.52	-0.70	-0.84	-0.57	-0.63

HG = Hungarian Grey; HS = Hungarian Simmental; AA = Angus;
HE = Hereford; CH = Charolais; BD = Blonde dôAquitaine;
LI = Limousin

CONCLUSION

Variance components, heritability values, and direct-maternal genetic correlations of 205-day weaning weight were similar for purebred populations of different beef cattle breeds in Hungary, generally corresponding to the results reported by several authors.

These estimates can help to improve the genetic evaluation programmes of different beef cattle breeds in the country.

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