Genetic Study of Birth Weight and Weaning Weight in Najdi Calves

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Abstract: In this study data on birth weight and weaning weight of Najdi calves, collected from 1989-2004 by Najdi cattle Research Station, located in Khuzestan province were analyzed. Mean and standard deviation of birth weight and weaning weight were 18.08±3.17 and 49.56±13.10, respectively. Based on appropriate model, direct and maternal heritability for birth weight and weaning weight were estimated 0.37, 0.08, 0.11 and 0.09, respectively. Correlation between direct and maternal effect were 0.56 and -0.16 for birth weight and weaning weight. Genetic, phenotypic and environmental correlations between two traits were estimated as 0.50, 0.64 and 0.44. Mean inbreeding coefficient was 0.78% with maximum level of 25%. The regression coefficients of birth weight and weaning weight on inbreeding coefficient were -0.182 and -0.0627 kg, respectively. The results of this study showed that the mean inbreeding level of population was low and the effect of inbreeding coefficient on these traits was not significant.

Key words: Najdi cattle, heritability, growth traits, maternal effect and inbreeding

INTRODUCTION

Birth weight and initial growth of calf, especially in suckling period, are affected not only by direct additive genetic but also by maternal additive genetic and maternal permanent environmental effects (milking and mothering ability). Therefore, particularly if there is a negative correlation between direct and maternal genetic effects, both effects should be taken into account in selection processes to achieve optimum genetic progress. Koch *et al.* (1994), using Australian Herford cattle data, reported heritability estimates for direct and maternal genetic effects and correlation between these 2 genetic effects for weaning weight to be 0.16, 0.17 and -0.28, respectively. In study of tropical cattle, Mackinnon *et al.* (1991) obtained direct heritability estimate of 0.16 for birth weight and 0.13 for weaning weight, fitting an animal model including maternal effects. They also suggested direct-maternal genetic correlations of 0.01 and 0 for birth weight and weaning weight, respectively. In study of American Herford cattle by DeMattos *et al.* (2000) estimates of direct and maternal heritability for birth weight were 0.24 and 0.16. They found negative genetic correlation between direct and maternal additive genetic effects for birth weight as -0.42. Those estimates for Canadian Herford cattle were 0.20, 0.16 and -0.35 in the same study. Most evidence also indicates that inbreeding adversely affects the growth and vitality of animals. Therefore, estimates of inbreeding effects are needed to adjust records of individual animals in order to increase the accuracy of the selection of breeding animals and to facilitate the analysis of data. The present study was conducted to determine the levels of inbreeding and study the effect of inbreeding on birth weight and weaning weight of Najdi calves, born in Najdi cattle Research Station, located in Khuzestan province in Iran. Then, the effect of maternal additive genetic and maternal permanent environmental effect on mentioned traits were studied, using different models to investigate the influence of these effects on genetic parameter estimates.

MATERIALS AND METHODS

Data in this study were obtained from the Najdi cattle Research Station of Khuzestan province in Iran. Two traits were considered: Birth Weight (BW) and Weaning Weight (WW). The calves were born from 1989-2004. Fixed effects, considered in analysis were birth year, birth season, sex of calf and dam parity. Variance components and genetic parameters were estimated for birth weight and weaning weight, based on 6 different animal models by including or ignoring genetic maternal and maternal permanent environmental effects, applying the derivative-free restricted Maximum likelihood package of Meyer (2000).

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The 6 different animal models fitted were:

$$M1) \ y = Xb + Z_1a + e$$

$$M2) \ y = Xb + Z_1a + Wpe + e$$

$$M3) \ y = Xb + Z_1a + Z_2m + e, \ cov_{am} = 0$$

$$M4) \ y = Xb + Z_1a + Z_2m + e, \ cov_{am} \neq 0$$

$$M7) \ y = Xb + Z_1a + Z_2m + Wpe + e, \ cov_{am} = 0$$

$$M8) \ y = Xb + Z_1a + Z_2m + Wpe + e, \ cov_{am} \neq 0$$

where:

y = Vector of observations
b = Vector of fixed effects (birth year, birth season, sex of calf, dam parity class)
X = Matrix that associates b with y
α = Vector of breeding values for direct additive genetic effects
Z_1 = Matrix that associates a with y
m = Vector of breeding values for maternal genetic effects
Z_2 = Matrix that associates m with y
pe = Vector of permanent environmental effect due to dams
W = Matrix that associates pe with y and
e = Vector of random residual effects

In all cases in analysis of weaning weight trait, age of calves at weaning, was considered as covariate. Likelihood ratio test were used in order to determine the most effective model for each trait. The coefficient of inbreeding of the individuals and average level of population inbreeding were calculated using Pedigree software (Sargolzaei *et al.*, 2006) from available pedigree records of animals. The impact of inbreeding on calves birth weight and weaning weight was studied by including inbreeding as a covariate in the model.

RESULTS AND DISCUSSION

Records of 1250 male and female calves were analyzed. The average birth weight and weaning weight of the calves were 18.08±3.17 and 42.6±13.10 kg, respectively. All fixed effects in model were significant. The average of birth weight and weaning weight were 19.70 and 53.67 kg in males and were 17.87 and 48.82 kg in females, respectively.
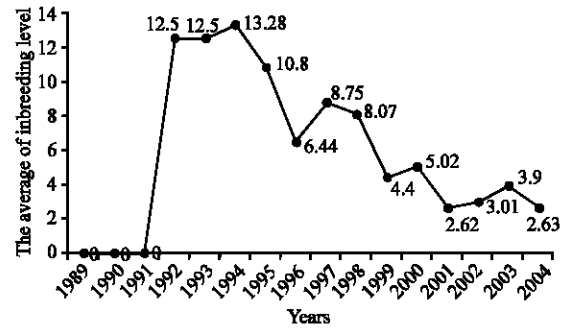

Fig. 1: The evolution of the inbreeding level from 1989-2004

Inbreeding: The average inbreeding coefficient in this particular population was 0.78% with the maximum level of 25%. The evolution of the inbreeding level from 1989-2004 is presented in Fig. 1, shows a trend of reduction of inbreeding coefficient during studied years.

In total population, there were 186 inbred animals with the average inbreeding of 5.60%, which is much more than the average of inbreeding of total population. Also, the average of inbreeding for male and female calves was estimated of 0.75 and 1.02, repectively. Regression coefficient of birth weight on percent of inbreeding was computed as -0.0627, indicated that birth weight is depressed as 62.7 g/each percent of inbreeding. The same coefficient was found for weaning weight as -0.182. Ferraz *et al.* (2000) reported the average inbreeding level of SantaGertrudis herd to be 0.0395, using 10 generation records. Swiger *et al.* (1961), in the study of inbreeding effects on beef cattle performance, reported that increased inbreeding level caused to reduce growth rate and feed consumption in calves. Burgess *et al.* (1954) also showed that inbreeding had significant effects on weaning weight of Herford calves. Hays and Brinks (1980) reported a depressing effect of increased inbreeding on weight, height and weight to height ratio in beef cattle. Rollins *et al.* (1949) indicated that the magnitude of the inbreeding effect varied with age and characteristic in Jersey cattle and weight was most affected. They reported that at 6 months of age, an increase of 1% in inbreeding caused a decrease of 0.47 % in mean weight, 0.15% in mean heart girth and 0.16% in mean height. Inbreeding appeared to affect the prenatal and post natal rate of growth as the inbred animals were smaller at birth and grew more slowly than the other animals. However, in the study of Herfored cattle by Alexander and Bogart (1961), no evidence of an effect of inbreeding of the calf on birth weight, post weaning rate of gains or feed

economy during performance test was found. The lack of significance of the degree of inbreeding depression on rate of gain and feed economy indicate that either selection has been effective in offsetting inbreeding depression or that these traits are not subject to such inbreeding depression. The average inbreeding level of our studied population was low and the results of analysis showed that the inbreeding depression for birth weight and weaning weight was not significant.

Genetic parameters: Direct heritability of birth weight was varied between 0.37-0.63 for birth weight and 0.11-0.24 for weaning weight, using different models. Estimates of variance components and genetic parameters for birth and weaning weight are shown in Table 1 and 2.

Birth weight: Moderate to high direct heritabilities (0.37-0.63) and low maternal heritabilities (0.11-0.24) were estimated for birth weight. The estimate of heritability which was 0.63 for birth weight in model No.1, reduced in model No. 3 by including maternal genetic as 2nd random effect. Waldron *et al.* (1993) showed that models not accounting for maternal genetic effects could yield substantially higher estimates of heritability. The similar result obtained with model No. 4, considering direct and maternal additive genetic effects. In this study, direct genetic effect is higher than maternal genetic effect for birth weight and weaning weight. Similar results have

been found in study of native Korean cattle by Lee *et al.* (2000), in study of Austrian beef cattle by Meyer *et al.* (1993) and in study of Japanese Black cattle by Aziz *et al.* (2005). Plasse *et al.* (2002) and Ferraz *et al.* (2000) obtained estimates of direct heritability for birth weight of SantaGertrudis and Brahman cattle to be 0.16 and 0.33, respectively. In current study, estimated genetic correlation between direct and maternal genetic effects was positive and 0.56 for birth weight, based on model No. 4. Including corresponding covariance between direct and maternal effects in model No. 4 reduced direct and maternal heritability, compared to model No. 3. Consequently, because of having high LogL, model No. 4 is suggested as appropriate model to estimate genetic parameters in our study. Based on suggested model, direct and maternal heritability estimates for birth weight were found to be 0.37 and 0.08. From an analysis of Austrian beef cattle birth weight, Gutierrez *et al.* (2007) reported maternal heritability of 0.10 for birth weight and Sarmiento and Garcia (2007) found estimate of maternal heritability for birth weight to be 0.06 in Columbian Romosinuani herd. Albuquerque (2001) also reported direct and maternal heritability for birth weight of Zebo cattle of 0.28 and 0.01, respectively. But, Kriese *et al.* (1991), working with SantaGertrudis cattle, obtained estimates of direct and maternal heritability to be 0.34 and 0.26 with negative correlation between two additive genetic effects and Aziz *et al.* (2005) reported direct and maternal heritability for birth weight in Japanese Black calves to be 0.38 and 0.48, respectively.

Weaning weight: For weaning weight, by considering maternal genetic and environmental affects (models No. 2, 3, 4, 7 and 8) logarithm of likelihood ratio increased. But, including covariance between direct and maternal genetic effects in model No. 4 did not cause any difference. Therefore, model No. 4 is suggested as proper model for weaning weight because of high LogL and insignificant different with model No. 7 and 8. The analysis of weaning

Table 1: Variances and genetic parameters of Najdi calves birth weight based on different models

Birth weight	M1	M3	M4
σ^2_a	4.91	3.69	2.90
σ^2_m	-	1.15	0.61
σ^2_e	2.90	2.95	3.44
σ^2_{pe}	-	-	-
σ^2_p	7.81	7.80	7.70
h^2	0.63±0.05	0.47±0.08	0.37±0.11
m^2	-	0.15	0.08
pe^2	-	-	-
r_{am}	-	-	0.56
Log L	-1788.5587	-1780.5086	-1779.9411

Table 2: Variances and genetic parameters of Najdi calves weaning weight based on different models

Weaning weight	M1	M2	M3	M4	M7	M8
σ^2_a	23.52	15.84	11.68	13.28	11.72	13.06
σ^2_m	-	-	9.13	10.51	7.94	9.32
σ^2_e	80.23	80.36	82.87	81.88	82.58	81.80
σ^2_{pe}	-	7.51	-	-	1.28	1.10
σ^2_p	103.75	103.72	103.68	103.79	103.54	103.64
h^2	0.24±0.06	0.15±0.06	0.11±0.06	0.13±0.06	0.11±0.06	0.13±0.06
m^2	-	-	0.09	0.10	0.08	0.09
pe^2	-	0.07	-	-	0.01	0.01
r_{am}	-	-	-	-0.16	-	-0.15
Log L	-3487.2333	-3483.2857	-3481.6071	-3481.5597	-3481.5634	-3481.5294

weight, based on appropriate model, results in a direct heritability estimate of 0.11 and a maternal heritability estimate of 0.09. Marquez *et al.* (2004) reported direct heritability for weaning weight in crossbred Mexican beef cattle as 0.2. But Plasse *et al.* (2002) in the study of Brahman calves weaning weight, reported relative heritability due to direct genetic effects (h2) of 0.14 with relative heritability due to maternal genetic effects (m2) of 0.13 and Ferraz *et al.* (2000) reported corresponding parameters as 0.30 and 0.10, using SantaGertrudis records. The direct-maternal genetic correlation was -0.16 and -0.15 for weaning weight based on model No.4 and 8, respectively. Sarmiento and Garcia (2007) reported estimates of r_{am} in Columbian cattle of -0.34, but Elzo *et al.* (1998) estimated correlation between these 2 genetic effects of 0.23 for weaning weight. The negative direct-maternal genetic correlation indicated that there is an antagonism between direct genetic and maternal genetic effects for weaning weight analysis (Ferraz *et al.*, 2000). Therefore, considering this correlation in selection program can be significant. Similar results about this negative correlation observed in the study of Santa Gertrudis and other Brahman crossbred calves in America by Kriese *et al.* (1991). Generally, results of this study show that ignoring maternal genetic and environmental effects in analysis model caused to overestimate direct heritability for studied trait. Consequently, considering this correlation can be effective in selection programs.

Genetic, phenotypic and environmental correlations between birth weight and weaning weight were 0.50 and -0.64 and 0.44, respectively. Ferraz *et al.* (2000) also, reported genetic correlation between these traits as 0.43 in male group, 0.3 in female group and 0.40 in both groups. However, Jung *et al.* (2004) estimated direct genetic correlation for birth weight and weaning weight as 0.50 for German Holstein calves. The high positive correlation between these two traits indicated that there are many genes which affect 2 traits simultaneously, as selection based on one trait caused to positive response for another trait.

CONCLUSION

In general, due to the contribution of maternal effects to the phenotypic variance analyzed traits, those effects should be taken into account in genetic evaluations for birth weight and weaning weight. Because of negative genetic correlation between direct and maternal effects for weaning weight trait, methods of selection accounting for both direct and maternal genetic effects would result in greater economic selection response than selection based only on direct genetic effect. Also, the results of this study showed that the mean inbreeding level of studied population was low and the effect of inbreeding coefficient on these traits was not significant for birth weight and weaning weight.

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