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Genetic Parameter Estimates for Lamb Weight at Post-Weaning in Zandi Sheep, Using Single-Trait Animal Models

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Abstract: The aim of the present study was to estimate variance components and genetic parameters for post-weaning growth traits of 2634 Zandi lambs from 202 sires and 1093 dams for 6 Month Weight (6MW) of 1893 lambs from 188 sires and 816 dams for 9 Month Weight (9MW) and of 1115 lambs from 156 sires and 514 dams for Yearling Weight (YW). Data and pedigree information used in this study were collected from Khojir Research Station (Tehran-Iran) during 1993-2008. Genetic parameters were carried out by Restricted Maximum Likelihood (REML) method, under six different single-trait animal models. Log likelihood ratio test indicated the most appropriate model for 6MW should included direct additive genetic effects as well as maternal permanent environmental effects whilst the most appropriate model for 9MW and YW had only the direct additive genetic effects. The effects of lamb's sex, dam's age and birth year were highly significant on all three traits ($p<0.01$) but birth type was only significant effect on 6 MW ($p<0.05$) and was no significant effect on 9MW and YW ($p>0.05$). Average weights were 27.55±0.09, 32.67±0.11 and 34.92±0.16 kg for 6MW, 9MW and YW, respectively. Estimates of direct heritability (h^2) were 0.132, 0.134 and 0.133 for 6MW, 9MW and YW, respectively. The estimate of maternal permanent environmental variance as a proportion of phenotypic variance (c^2) was 0.056 for 6MW.

Key words: Zandi sheep, 6MW, 9MW, YW, environmental effects, direct heritability

INTRODUCTION

The genetic characterization of local breeds is of paramount importance not only for conservation purposes but also for the definition of breeding objectives and breeding programmes.

The Zandi sheep are fat tailed breed, medium-sized (mature weight range is 45-50 kg) and indigenous to the Tehran and Markazi Provinces which rearing in Khojir Research Station of Tehran, Iran. In these sheep, the main purpose is lamb and mutton production.

Post-weaning traits are important in terms breeding. At the post-weaning period the role of maternal effects tends to decline (Snyman *et al*., 1995) thus animal performance is a more realistic indication of expression of genes with direct additive effects on body weight.

To determine optimal breeding strategies to increase the efficiency of sheep production, knowledge of genetic parameters for weight traits at various ages is needed. Information on genetic parameters for post-weaning growth traits of Zandi breed is sparse and only a few attempts have been made to estimate genetic parameters in this breed. Hence, chief target of the present investigation was to estimation of genetic parameters for post-weaning growth traits in Zandi sheep.

MATERIALS AND METHODS

In order to study on lamb weight at post-weaning in Zandi sheep, information are applied that was collected during 1993-2008 (16 years) from Khojir Research Station of Tehran. In this station, Maiden ewes were exposed to rams at about 18 months of age and kept in the flock until death or the apparent infertility. Rams were used for 3 or 4 breeding years and kept separated from ewes except in the mating season. In the mating season (commenced in August) each group of the ewes (detected in estrus) was allotted to one fertile ram in a separate mating pen. At birth, lambs were weighed, tagged, sexed and identified to their parents. Birth date was also recorded. During the suckling period, lambs were kept indoors and allowed to nurse their mothers twice a day. The suckling stage lasted for 90 days on average. Animals were kept on natural pasture during the spring, summer and autumn seasons and indoors during the winter. The structure of data used in the study is shown

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in Table 1. The SAS (2003) statistical package and the method of unequal subclass analysis of variance was used to test the significance of the fixed effects of type of birth in 2 categories (single and twin), year of birth in 16 categories (1993-2008), lamb's sex in 2 categories (male and female) and age of dam in 7 categories (2, 3, 4, 5, 6, 7 and 8 years old) and age of lamb at 6, 9 and 12 months of age (days) as a covariate for 6MW, 9MW and YW, respectively. The interactions between fixed effects were not significant and therefore taken out of account.

Variance and covariance components and genetic parameters were estimated using the DFREML3.1 program (Meyer, 2000) by fitting 6 single-trait animal models. The analysis of variance showed that fixed effects of year of birth, lamb's sex and age of dam were significant for all three traits. Consequently, those effects were included in all six models for those traits. But the effect of birth type was only significant effect on 6MW and was included in models for 6MW. A simplex algorithm is used to search for variance components to minimize the function, -2 log Likelihood (L). Convergence was assumed when the variance of the function values (-2 log L) of the simplex was $<10^{-8}$. A log likelihood ratio test was used to choose the most suitable random effects model for each trait. The reduction in -2 log L when a random effect was added to the model was calculated. If this reduction was greater than the value of the chi-square distribution with one degree of freedom ($p<0.05$), the additional random effect fitted was considered significant. When log likelihoods did not differ significantly ($p>0.05$), the model that had the fewer number of parameters was selected as the most appropriate. These models were:

Model 1: $y = Xb + Z_1a + e$

Model 2: $y = Xb + Z_1a + Z_3c + e$

Model 3: $y = Xb + Z_1a + Z_2m + e \quad Cov(a,m) = 0$

Model 4: $y = Xb + Z_1a + Z_2m + e \quad Cov(a,m) = A_{\sigma am}$

Model 5: $y = Xb + Z_1a + Z_2m + Z_3c + e \quad Cov(a,m) = 0$

Model 6: $y = Xb + Z_1a + Z_2m + Z_3c + e \quad Cov(a,m) = A_{\sigma am}$

where, y is a vector of records on the different traits; b, a, m, c and e are vectors of fixed effects, direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and the residual effects, respectively. X, Z_1, Z_2 and Z_3 are corresponding design matrices associating the fixed effects, direct additive genetic effects, maternal additive genetic effects and maternal permanent environmental effects to vector of y.

It is assumed that direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and residual effects to be normally distributed with mean 0 and variance $A\sigma^2_a$, $A\sigma^2_m$, $Id\sigma^2_c$ and In σ^2_e, respectively. That σ^2_a, σ^2_m, σ^2_c and σ^2_e are direct additive genetic variance, maternal additive genetic variance, maternal permanent environmental variance and residual variance, respectively. A is the additive numerator relationship matrix, I_d and In are identity matrices that have order equal to the number of dams and number of records, respectively and σ_{am} denotes the covariance between direct additive genetic and maternal additive genetic effects.

Table 1: Description of data set

Character	6MW[a]	9MW[a]	YW[a]
Number of records	2634.00	1893.00	1115.00
Number of sire	202.00	188.00	156.00
Number of dams	1093.00	816.00	514.00
Number of dam with own records	667.00	484.00	197.00
Average number of progeny per dam	2.41	2.32	2.17
Mean (kg)	27.55	32.67	34.92
S.D (kg)	4.76	4.68	5.45
C.V (%)	15.87	10.99	12.82

[a]6MW: 6-month weight, 9MW: 9 Month Weight, YW: Yearling Weight, SD: Standard Deviation and CV: Coefficient of Variation

RESULTS AND DISCUSSION

The Least squares means and standard errors for mentioned traits are shown in Table 2. In the study on lamb weight at post-weaning in Zandi sheep the effects of lamb's sex, dam's age and birth year were highly significant on 6MW, 9MW and YW ($p<0.01$) but type of birth was only significant effect on 6MW ($p<0.05$) and was no significant effect on 9MW and YW ($p>0.05$). For 6MW, 9MW and YW amount of body weight in male lambs were heavier than female ones that can be explained in part by differences between male and female in endocrine system. The lambs produced by dams of 2 years old have lower weight than other lambs. Differences in nursing and maternal behavior of dam probably are reasons for significant influenced by age of

Table 2: Least squares means and standard error for post-weaning growth traits

	Traits[a]		
Fix effects	6MW (kg)	9MW (kg)	YW (kg)
Lamb's sex	**	**	**
Male	$28.54^{a}\pm0.12$	$33.72^{a}\pm0.14$	$36.29^{a}\pm0.18$
Female	$26.38^{b}\pm0.13$	$31.312^{b}\pm0.16$	$33.18^{b}\pm0.27$
Birth type	*	NS	NS
Single	$27.64^{a}\pm0.10$	$32.73^{a}\pm0.11$	$34.94^{a}\pm0.17$
Twin	$26.96^{b}\pm0.24$	$32.17^{a}\pm0.35$	$34.73^{a}\pm0.46$
Dam's age (Year)	**	**	**
2	$26.79^{c}\pm0.17$	$32.06^{b}\pm0.18$	$34.04^{b}\pm0.35$
3	$27.40^{bc}\pm0.20$	$32.60^{a}\pm0.24$	$34.79^{ab}\pm0.35$
4	$27.90^{ab}\pm0.22$	$33.01^{a}\pm0.27$	$35.10^{a}\pm0.41$
5	$27.85^{ab}\pm0.24$	$33.09^{a}\pm0.30$	$35.28^{a}\pm0.40$
6	$28.23^{ab}\pm0.30$	$33.20^{a}\pm0.36$	$35.58^{a}\pm0.31$
7	$28.40^{a}\pm0.36$	$33.10^{a}\pm0.33$	-
8	$28.23^{ab}\pm0.45$	-	-
Birth year	**	**	**

Within column, within each factor, least square means with different superscripts are different at $p<0.01$; [a]For trait abbreviations see footnote of Table 1; *: $p<0.05$; ** $p<0.01$; NS: Non Significant

Table 3: Log likelihood values with the most appropriate model in bold for post-weaning traits

	Traits[a]		
Models	6MW	9MW	YW
1	-3800.33	-2994.82	-2429.77
2	-3797.65	-2994.44	-2429.18
3	-3812.21	-3004.78	-2440.31
4	-3811.26	-3006.28	-2429.71
5	-3812.16	-3004.78	-2440.19
6	-3811.24	-3008.34	-2431.94

[a]For trait abbreviations see footnote of Table 1

Table 4: Variance components and genetic parameters estimated by DFREML using single-trait analysis

Traits[a]	Fitted model	σ^2_a	σ^2_c	σ^2_e	σ^2_p	h^2_d±SE	c^2±SE
6MW	2	2.618	1.107	16.129	19.855	0.132±0.038	0.056±0.023
9MW	1	1.810	-	11.738	13.548	0.134±0.038	-
YW	1	2.719	-	17.692	20.411	0.133±0.046	-

σ^2_a: direct additive genetic variance; σ^2_c: maternal permanent environmental variance; σ^2_e: residual variance; σ^2_p: phenotypic variance; h^2_d: direct heritability; c^2: ratio of maternal permanent environmental effect, SE.: Standard Error; [a]For trait abbreviations see footnote of Table 1

dam on post-weaning traits in current study. Differences in management, food availability, condition of climate probably are reasons for significant effects of year. Singe lambs burn at 6 month weight were heavier than twin lambs whilst differences of between single and twin lambs were no significant for 9MW and YW. Bahreini *et al.* (2007) reported that birth year, lamb's sex, dam's age are significant sources of variation on 6MW, 9MW and YW in Kermani sheep which is in concordance with the results.

The log likelihood values under 6 different single-trait models with the most appropriate model (bold) determined using log likelihood ratio tests are shown in Table 3 and Heritability estimates based on the most appropriate model for growth traits are shown in Table 4. The most appropriate model for 6MW should included direct additive genetic effects as well as maternal permanent environmental effects but the most appropriate model for 9MW and YW had only the direct additive genetic effects. The estimation of h^2 for 6MW was 0.132 which the range of direct heritability estimates for 6MW in literature vary substantially from 0.09 (Bahreini *et al.*, 2007) to 0.51 (Gizaw *et al.*, 2007). The results in the present study were nearly in concordance with those of 0.153 reported by Lavvaf *et al.* (2007) in Moghani sheep, very lower of 0.51 reported by Miraei-Ashtiani *et al.* (2007) in Sangsari sheep and higher than those of 0.08 reported by Bahreini *et al.* (2007) in Kermani sheep. The estimate of c^2 was 0.056 for 6MW and similar to those reported by Refik *et al.* (2009) in Turkish Merino sheep. Current estimations revealed that for weight at 6 month the role of maternal effects tends to decline. Similar to the finding, Maniatis and Pollott (2002) in their study on Suffolk breed reported that maternal influence never completely disappeared after weaning and these effects might persist into the post-weaning growth period.

The estimate of h^2 for 9MW in this study (0.134) was relatively low in concordance with those of 0.13 reported by Bahreini *et al.* (2007) in Kermani sheep and within range of those reported in the literature by other researchers from 0.08 (Miraei-Ashtiani *et al.*, 2007) to 0.59 (Snyman *et al.*, 1995).

Estimate of h^2 for YW in the present study (0.133) was nearly in concordance with those of 0.14 reported by Bahreini *et al.* (2007) and lower than those of 0.33 reported by Abegaz *et al.* (2005) but within range of those reported by other researchers from 0.10 (Miraei-Ashtiani *et al.*, 2007) to 0.58 (Snyman *et al.*, 1995).

CONCLUSION

However, the results are closer to those reported by other researchers but low direct heritability estimates for mentioned traits in the current study may be due to the low nutritional level, poor quality of the pasture at the Khojir Research Station and harsh climate conditions especially at post weaning period, suggest that this environment is not favorable for expression of genetic potential of Zandi lambs. Also, maternal effects did not disappeared until 6 months of age due to a carry-over effect after weaning. Thus, selection for 6MW is required to be taken into account direct additive genetic effects as well as maternal permanent environmental effects.

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