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Estimation of Genetic and Environmental Parameters Affected Pre-Weaning Traits of Arabi Lambs

H. Roshanfekr, M. Mamouei, K. Mohammadi and E. Rahmatnejad
Department of Animal Science, Faculty of Animal and Food Science,
Agricultural and Natural Resources Ramin (Khuzestan) University, Ahvaz, Iran

Abstract: In this study, the data of Birth Weight (BW), Weaning Weight (WW) and Average Daily Gain from birth to weaning (ADG) of Arabi lambs were used to estimate of environmental effects, heritability, phenotypic and genetic correlations among these traits. The parameters were estimated using derivative free restricted maximum likelihood methods by excluding or including maternal genetic or maternal permanent environmental effects to optimize the model for each trait. Influencing factors such as type of birth, year of birth, lamb's sex and age of dam were investigated as the fixed effects for models. The results showed that year of birth, type of birth, lamb's sex and age of dam were highly significant sources of variation on mentioned traits ($p<0.001$). On the basis of log likelihood ratio test results, model 1 which included direct genetic effects only was determined to be the most appropriate model for above traits. Direct genetic heritability of BW, WW and DG were 0.12±0.07, 0.10±0.07 and 0.10±0.08, respectively. Phenotypic and genetic correlations between BW-WW, BW-ADG and WW-ADG were 0.23 and 0.49, 0.12 and 0.43 and 0.67 and 0.89, respectively.

Key words: Arabi lamb, genetic parameters, environmental effects, growth traits, heritability, phenotypic correlation

INTRODUCTION

The Arabi sheep is among the indigenous breeds raised in southwestern region of Iran. This breed is usually black, pied or white with a black head. The males are horned and the females are hornless (polled). To determine optimal breeding strategies to increase the efficiency of sheep production, knowledge of genetic parameters for weight traits at various ages and also the genetic relationships between the traits is needed. Various environmental effects on lamb growth have previously been studied in several investigations on other breeds (Neser *et al*., 2001; Lavvaf *et al*., 2007; Ghafouri *et al*., 2008).

By far, the most important environmental effects are year, sex, type of birth, age of dam and age of lambs at weighing. Importance of these effects on pre-weaning traits has reported by several researchers (Eltawil *et al*., 1970; Notter *et al*., 1975; Jorgenson *et al*., 1993). Usually, male lambs in comparison to female lambs have higher at BW, WW and ADG. Also, twin born lambs compared to single born lambs have lighter at BW, WW and ADG (Bourfia and Touchberry, 1993; Bennett *et al*., 1991).

The objective of this study was to estimation of genetic and environmental parameters affected pre-weaning traits of Arabi lambs. In addition, the correlations between mentoined traits were estimated.

MATERIALS AND METHODS

Data: The data used in the present study were collected from the Animal Science Research Station of Agricultural and Natural Resources Ramin University in Khuzestan province of Iran during 2003 and 2004. Three traits were considered: Birth Weight (BW), Weaning Weight (WW) and Average Daily Gain from birth to weaning (ADG) also for these traits used 710, 611 and 611 records of Arabi lamb, respectively. In general, animals were managed following semi-moving. In the other hand, sheep fed in site of station from late December to mid February and remain the year reared on natural pasture. The mating period began from early August to early October and continued as controlled. Lambing was from early January and continued until early February. Lambs kept by mother at all the time of 1st month and use of mother's milk twice daily at 2nd and 3rd month. The lambs were weaned at about 90±5 days old. Lambs fed from 15 days old in addition to mother's milk by complementary feed containing 45% barley, 5% corn, 10% cottonseed meal,

Corresponding Author: K. Mohammadi, Department of Animal Science, Faculty of Animal and Food Science, Agricultural and Natural Resources Ramin (Khuzestan) University, Ahvaz, Iran

19% bran, 17% of sugar beet pulp, 2% alfalfa powder, 1% bone powder, 0.5% salt, 0.1% multi vitamin and 0.4% antibiotic. Male and female lambs separated after weaning and females were with the main herd at pasture. Considering the variable being weaning age, WW based on 90 days old using the following formula was correct (Notter *et al*., 1975):

$$WWc = \frac{(WW - BW) \times 90}{WA} + BW$$

Where:

WW_C = Corrected Weaning Weight on 90 days old
WA = Weaning Age

Statistical analysis: Firstly, the SAS statistical package (SAS, 2003) and the method of unequal subclass analysis of variance were used to test the significance of the fixed effects. A linear model was used to identify fixed effects on variation of lamb weight at birth and weaning:

$$y_{ijklmn} = \mu + Y_i + A_j + S_k + T_l + e_{ijklmn}$$

Where:

y = Records on the traits
μ = Mean
Y_i = Effect of birth year in two class (2003 and 2004)
A_j = Effect of dam age at lambing in five class (2-6 years old)
S_k = Effect of lamb's sex in two class (male and female)
T_l = Effect of birth type in two class (single and twin)
e_{ijklmn} = Residual effects

Genetic parameters were estimated by Restricted Maximum Likelihood procedures (REML) using a derivative free algorithm fitting an animal model (DFREML3.1; Meyer). 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 logL) of the simplex was $<10^{-8}$. A log likelihood ratio test was used to choose the most suitable random effects model for each trait (Meyer, 1992). The reduction in -2 logL 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. To ensure that a global maximum was reached, several other rounds of iterations were used using results from the previous round as starting values. When estimates did not change, convergence was confirmed. Six different animal models to assess the importance of different effects were fitted for each trait: Model 1 was a model with direct genetic effects as the only random effect other than residuals:

$$y = Xb + Z_1a + e \quad (1)$$

In Model 2 we included a random effect of maternal permanent environmental:

$$y = Xb + Z_1a + Z_3c + e \quad (2)$$

Model 3 allowed for a maternal genetic effect to those of Model 1:

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

Model 4 was the same as model 3 but a non-zero correlation was assumed between direct and maternal genetic random effects.

$$y = Xb + Z_1a + Z_2m + e \quad Cov(a, m) = A\sigma_{am} \quad (4)$$

Models 5 and 6 included both maternal permanent environmental and maternal genetic effects but allowing a genetic correlation between direct and maternal genetic random effects only for model 6:

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

$$y = Xb + Z_1a + Z_2m + Z_3c + e \quad Cov(a, m) = A\sigma_{am} \quad (6)$$

Where, y is a vector of records on the different traits; b, a, m, c and e are vectors of fixed effects, direct genetic effects, maternal genetic effects, maternal permanent environmental effects and the residual effects, respectively. X, Z_{1-3} are corresponding design matrices associating the fixed effects, direct genetic effects, maternal genetic effects and maternal permanent environmental effects to vector of y. It is assumed that direct genetic effects, maternal genetic effects, maternal permanent environmental effects and residual effects to be normally distributed with mean 0 and variance $A\sigma^2_a$, $A\sigma^2_m$, $I_d\sigma^2_c$ and $I_n\sigma^2_e$, respectively. That σ^2_a, σ^2_m, σ^2_c and σ^2_e are direct genetic variance, maternal genetic variance, maternal permanent environmental variance and residual variance, respectively. A is the additive numerator relationship matrix, I_d and I_n 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 genetic and maternal genetic effects.

Genetic and phenotypic correlations were estimated using multivariate analysis. The fixed effects included in the multivariate animal models were those in univariate analyses. Estimates of univariate analyses were used to obtain starting values for multivariate analyses. If the value of -2 log likelihood variance in the Simplex function $<10^{-8}$; it was assumed convergence had been achieved.

RESULTS AND DISCUSSION

Analysis of variance and least squares mean and standard error for traits and prediction of environmental effects on these traits have shown in Table 1 and 2. The weights at BW, WW and ADG of male lambs represented 8, 9 and 10%, respectively were heavier than of those of female lambs. Differences in sexual chromosomes, probably in the position of genes related to growth, physiological characteristics, difference in endocrinal system (type and measure of hormone secretion especially sexual hormones) lead to difference in animal growth. In relation to endocrinal system, estrogen hormone has a limited effect on the growth of long bones in females. Type of birth were significant ($p<0.01$) on BW, WW and ADG. Competence between twins to feed with their dam's milk causes them to receive less milk than singles. Therefore, it is a good reason that singles are heavier than twins when weaning. In a study on Kermani sheep (Rashidi *et al*., 2008) observed that single lambs weighed 1.14 kg for BW, 2.66 kg for WW and 0.011 kg for ADG more than lambs born as twins. The effect of birth year on body weight traits of Arabi sheep was significant ($p<0.01$). Climate and environmental changes have effect on dam's environment and feeding in the last weeks of pregnancy and milk production and the quality and quantity of pasture forages which also affect the provision of food and other requirements for animals. The lambs produced by dams of 4-6 years old have more weight than lambs born from young ewes. It can be related to higher capacity of milking in association with 4-6 years old ewes in comparison to younger ones. The results of this experiment in agreement with reports by other researchers (Notter *et al*., 1975; Eltawil *et al*., 1970; Stobart *et al*., 1986; Boujenans *et al*., 1992) but contrast to Farid *et al*. (1976).

The log likelihood values under six different single-trait models with the most appropriate model (in bold) determined using log likelihood ratio tests regarding early growth traits of Arabi lambs are shown in Table 3 and heritability estimates based on the most appropriate model for growth traits are shown in Table 4.

Based on the log likelihood ratio test results and the number of parameters included in the models, model 1 was considered to be the most appropriate model for BW, WW and ADG traits.

Estimate of direct heritability for BW in the current study (0.12) was closer to those reported by Neser *et al.* (2001) in Dorper sheep and Bahreini *et al*. (2007) in Kermani sheep. This value was lower than those obtained

Table 1: Variance analysis of environmental effects on pre-weaning growth traits of Arabi lambs

	BW		WW		ADG	
SOV	DF	MS	DF	MS	DF	MS
Age of dam	4	8.32**	4	62.29[ns]	4	0.0059[NS]
Type of birth	1	119.81**	1	860.48**	1	0.1012**
Sex	1	12.76**	1	697.88**	1	0.0911**
Year of birth	1	11.38**	1	354.33**	1	0.0390**
Born weight	-	-	1	901.52**	1	0.0280**
Error	702	0.35	602	25.31	602	0.0029
CV	-	12.31	-	18.77	-	21.7800
R^2	-	0.49	-	0.31	-	0.2400

** = significant in 0.01 ($p<0.01$), NS = Non Significant, BW = Born Weight, WW = Weaning Weight, ADG = Daily Gain from birth to 90 days old, SOV = Source of Variation, DF = Degree of Freedom, MS = Mean of Squares, CV = Coefficient of Variation, R^2 = Coefficient of correlation

Table 2: Least squares means and standard error for pre-weaning growth traits in Arabi lambs

Class	Subclass	No.	BW (kg)	No.	WW (kg)	DG (g)
Age of dam (year)	2	127	3.26±0.06[c]	111	24.70±0.56[b]	231.53±6.20[b]
	3	164	3.66±0.06[b]	117	25.27±0.56[ab]	237.79±6.17[ab]
	4	179	3.79±0.05[ab]	163	25.78±0.42[ab]	243.53±4.68[ab]
	5	154	3.78±0.05[ab]	143	26.05±0.44[a]	251.97±4.90[a]
	6	86	3.88±0.06[a]	77	25.62±0.59[ab]	241.64±6.53[ab]
Type of birth	Single	460	4.12±0.03[a]	411	26.24±0.28[a]	256.73±3.12[a]
	Twin	250	3.55±0.04[b]	200	24.52±0.46[b]	222.85±5.12[b]
Sex	Male	369	3.92±0.03[a]	317	26.71±0.32[a]	250.80±3.55[a]
	Female	341	3.63±0.04[b]	294	24.46±0.30[b]	228.79±3.78[b]
Birth year	2003	364	3.81±0.04[a]	319	26.43±0.32[a]	250.77±3.61[a]
	2004	346	3.53±.040[b]	292	24.92±0.35[b]	237.77±3.89[b]

[a,b]Means in each class with different superscripts are significant different ($p<0.05$)

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

	Traits[a]		
Model	BW	WW	ADG
1	6230.13	-3624.14	2386.73
2	6227.82	-3633.67	2384.59
3	6226.19	-3628.52	2383.16
4	6228.75	-3627.83	2382.74
5	6228.34	-3629.32	2383.05
6	6227.91	-3628.81	2384.13

[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_e	σ^2_p	h^2_d±SE
BWT	1	0.46	3.36	3.82	0.12±0.07
WWT	1	1.63	14.67	16.30	0.10±0.07
ADG	1	0.18	1.64	1.82	0.10±0.08

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

Table 5: Correlations between traits (1 and 2) resulted from two- trait DFREML with appropriate models

Trait 1	Trait 2	r_d	r_p
BW	WW	0.49	0.23
BW	ADG	0.43	0.12
WW	ADG	0.89	0.67

r_d: direct genetic correlation between direct effects of traits 1 and 2; r_p: phenotypic correlations between traits 1and 2; for trait abbreviations see footnote of Table

by Hanford in Rambouillet sheep and Miraei-Ashtiani *et al*. (2007) in Sangsari sheep whose estimates were 0.27 and 0.33, respectively. But it was higher than those obtained by Maria and van Vleck (1993), El-Falidi *et al*. (2000), Bahreini *et al*. (2007) and Rashidi *et al*. (2008).

Estimate of direct heritability for WW (0.10) in the optimum model was lower than the estimates in Dorper sheep by Neser *et al*. (2001) and in Lori sheep by Lavvaf and Noshary (2008) but higher than the value reported by Lavvaf *et al*. (2007). However, it was in accordance with the estimates reported by Ozcan *et al*. (2005).

The direct heritability estimate for ADG was 0.10. Estimates reported by Lavvaf *et al*. (2007) in Miraei-Ashtiani *et al*. (2007) in Sangsari sheep were lower than the estimate but estimate reported by Dugoma *et al*. (2002) in Tygerhoek Merino sheep was higher than the the result.

The results of two-trait analyses under the most appropriate model are shown in Table 5. Genetic correlations estimates were positive, moderate to high and varied from 0.43-0.89.

The genetic correlation estimate between BW-WW, BW-ADG and WW-ADG were 0.49, 0.43 and 0.89, respectively. Also, the phenotypic correlation estimate between BW-WW, BW-ADG and WW-ADG were 0.23, 0.12 and 0.67, respectively. In general, these results were within the range reported by other researchers (Miraei-Ashtiani *et al*., 2007; Rashidi *et al*., 2008).

CONCLUSION

The findings of the present study confirmed the importance of fixed factors such as type of birth, year of birth, lamb's sex and age of dam at lambing in Arabi sheep which should be fitted in the animal models. Also, the genetic parameters estimated for growth traits indicate that there is genetic variation among the animals that can be utilized for genetic change in these traits by selection in Arabi sheep raised under their specific harsh environmental conditions. Moreover, the present findings shown that birth weight an important economic trait that has very effect on many traits related with it in lamb.

REFERENCES

Bahreini, B.M.R., F.E. Shahroudi and L.D. van Vleck, 2007. Estimates of genetic parameters for growth traits in Kermani sheep. J. Anim. Breed. Genet., 5: 296-301.

Bennett, G.L., A.H. Johnson and A.H. Carter, 1991. Genetic and environmental effects on carcass characteristics of Southdown x Romney lambs: II. Genetic and phenotypic variation. J. Anim. Sci., 65: 1864-1874.

Boujenans, I., G.E. Bradford, Y.M. Berger and A. Chikhi, 1992. Genetic and environmental effects on growth to 1 year and viability of lambs from a crossbreeding study of D, MAN and Sardi breeds. J. Anim. Sci., 69: 3989-3998.

Bourfia, M. and R.W. Touchberry, 1993. Diallel cross of three Moroccan breeds of sheep: I. Lamb growth and carcass traits. J. Anim. Sci., 71: 870-881.

Dugoma, G., S.J. Schoeman, S.W.P. Cloete and G.F. Jordaan, 2002. Genetic parameter estimate of early growth traits in the Tygerhoek Merino flock. South Afr. J. Anim. Sci., 32: 66-75.

El-Falidi, M., C. Michaux, J. Detilleux and P.L. Leroy, 2000. Genetic parameter for growth traits of the Moroccan Timhadit breed of sheep. Small Ruminant Res., 37: 203-208.

Eltawil, E.A., L.N. Hazel, G.M. Sidwell and C.E. Terrill, 1970. Evaluation of environmental factor. Affecting birth, weaning and yearling traits in Navajo sheep. J. Anim. Sci., 31: 823-827.

Farid, A. and M. Makarechian and N. Sefidbakht, 1976. Crossbreeding of Iranian fat-tailed sheep: I-Preweaning growth performance of Karakul, Mehraban. Naeini and their reciprocal crosses. Iran. J. Agric. Res., 4: 69-79.

Ghafouri, K.F., M., Eskandarinasab and A. Hassanabadi, 2008. Estimation of genetic parameters for lamb weight at various ages in Mehraban sheep. Ital. J. Anim. Sci., 7: 95-103.

Jorgenson, J.N., P.H. Petersen and K. Raving, 1993. Environmental factors influencing lamb growth in six Danish sheep breeds. Anim. Breed. Abst., 61: 4912-4912.

Lavvaf, A. and A. Noshary, 2008. Estimation of genetic parameters and environmental factors on early growth traits for lori breed sheep using single trait animal model. Pak. J. Biol. Sci., 11: 74-79.

Lavvaf, A., A. Noshary and A. Keshtkaran, 2007. Environmental and genetic effects on early growth traits in Moghani sheep breeds. Pak. J. Biol. Sci., 10: 2595-2598.

Maria, G.A. and L.D. van Vleck, 1993. Estimates of variances due to direct and maternal effects for growth traits of Romano sheep. J. Anim. Sci., 71: 845-849.

Meyer, K., 1992. Variance components due to direct and maternal effects for growth traits of Australian beef cattle. Livest. Prod. Sci., 31: 179-204.

Miraei-Ashtiani, S.R., S.A.R. Seyedalian and M.M. Shahrbabak, 2007. Variance components and heritabilities for body weight traits in Sangsari sheep, using univariate and multivariate animal models. Small Rumin. Res., 73: 109-114.

Neser, F.W.C., G.J. Erasmus and J.B. van Wyk, 2001. Genetic parameter estimates for pre- and post-weaning weight traits in Dorper sheep. Small. Ruminant Res., 40: 197-202.

Notter, D.R., L.A. Swiger and W.R. Harvey, 1975. Adjustment factors for 90-day lamb weight. J. Anim. Sci., 40: 383-391.

Ozcan, M., B. Ekiz, A. Yilmaz and A. Ceyhan, 2005. Genetic parameter estimates for lamb growth traits and greasy fleece weight at first shearing in Turkish Merino Sheep. Small Rumin. Res., 56: 215-222.

Rashidi, A., M.S. Mokhtari, A.S. Jahanshahi and M.R.M. Abadi, 2008. Genetic parameter estimates of pre-weaning growth traits in Kermani sheep. Small Rumin. Res., 74: 165-171.

SAS., 2003. User's Guide Statistics. Version 9.1. SAS Institute, Inc., Cary, N.C..

Stobart, R.H., J.M. Bassett, T.C. Cartwright and R.L. Blackwell, 1986. An analysis of body weights and maturing patterns in western range ewes. J. Anim. Sci., 63: 729-740.