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INTRODUCING THE SUITABLE MODEL FOR ANALYSIS OF THE LAMB BODY WEIGHT USING LOG LIKELIHOOD RATIO TEST

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ABSTRACT

The objectives of this study were to introduce the most suitable animal model for analysis of body weights at birth (BW), one month (SW1), two month (SW2), three month (SW3), four month (SW4), five month (SW5) and six month (SW6) of ages. Data from 3952 lambs born from 142 sires and 1182 dams, collected from 1992 to 2003 were used. Nine animal models were considered that differed in the (co)variance components. All traits were analyzed with DFREML software package by AI-REML algorithm. A Log likelihood ratio test was used to choose the most suitable animal models for each trait. The addition of maternal permanent environmental effect (c) with maternal genetic effect (m) already fitted did not increase -2 log L value significantly for SW5 and SW6. Maternal additive genetic effect increased significantly -2 log L of model ($p<0.01$), but this effect together with maternal permanent and temporary environmental effect (t) did not improved -2 log L. Therefore, when maternal permanent and temporary environmental effects are in models, maternal genetic effect can be ignore for all traits. The model including direct additive (a), maternal permanent and maternal temporary environmental effects was determined to be the most suitable model for BW, SW1, SW2 and SW5. The most suitable model for SW3 and SW4 traits was model 2 (including a and c). For SW6, model 3 (including a and m) was the best model.

INTRODUCTION

In order to defining the breeding objectives and strategies for Baluchi sheep, genetic parameters of the important economic traits such as body weight in different ages is required. Growth traits, specially in young ages are influenced by direct additive genetic, maternal additive genetic and maternal permanent environmental effects (Snyman et al 1995; Torshizi et al,1996; Yazdi et al 1997; Duguma et al, 2002; Maniatis and Pollott, 2002; Matika et al, 2003). In multiple birth animals such as sheep, in addition to maternal permanent environmental effects, maternal environmental effects can be derived from factors specific to one litter of a dam (maternal temporary environmental or litter effect). Therefore, estimates of genetic parameters using animal model includes only direct additive genetic effect is biased (Snyman et al, 1995; Duguma et al.2002; Matika et al,2003)

Genetic parameters have been estimated for body weights in different ages in Baluchi sheep. Direct and maternal heritability of birth weight (0.125,0.11), weaning weight (0.067,0.099) and body weight in 6 months of the age (0.109,0.047) were estimated (Khalili et al, 2002). Yazdi et al (1997) were also estimated direct and maternal heritability of birth weight (0.14,0.02), weaning weight (0.019,0.03), body weight in 6 months of age (0.23,0.02) and yearling weight (0.32,0.02) .In these researches, maternal temporary environmental effect has not been included in animal model. Therefore, the objective of present study was the estimation of (co) variance components and genetic parameters for the body weights in birth, 1, 2, 3, 4, 5 and 6 months of age in Baluchi lamb breed using different univariate animal models and introducing the most suitable animal model for analysis of lamb body weights.

MATERIAL AND METHODS

Data. Data from 3952 lambs born from 142 sires and 1182 dams, collected from 1992 to 2003 were used to estimate the genetic parameters. Because the birth dates and the age of the lambs in recording were different, the body weights in 1, 2, 3, 4, 5 and 6 months of the age were calculated by multiplying the average daily gain between two ages in related intervals (as day) and adding to body weight in previous age. Seven production traits namely body weights at birth (BW), one month (SW1), two month (SW2), three month (SW3), four month (SW4), five month (SW5) and six month (SW6) of ages were considered .

Statistical models. Nine animal models were considered that differed in the (co)variance components fitted as shown in table 1. Fixed effects in these models were the lamb sex, birth type, age of the dam and birth year. Direct additive genetic, maternal additive genetic, maternal permanent environmental and maternal temporary environmental effects were considered as random effects. Estimates of (co)variance components, and log likelihood values, were obtained using derivative-free REML procedures fitting a single-trait animal model. All traits were analyzed with DFREML software package by AI-REML algorithm. The convergence criterion for estimation of (co)variance components was 10^{-8} .

Table 1: (Co)variance components fitted in mixed models

Model	(Co)variances fitted[A]
1	$\sigma^2_e + \sigma^2_a$
2	$\sigma^2_e + \sigma^2_a + \sigma^2_c$
3	$\sigma^2_e + \sigma^2_a + \sigma^2_m$
4	$\sigma^2_e + \sigma^2_a + \sigma^2_m + \sigma_{am}$
7	$\sigma^2_e + \sigma^2_a + \sigma^2_m + \sigma^2_c$
8	$\sigma^2_e + \sigma^2_a + \sigma^2_m + \sigma^2_c + \sigma_{am}$
9	$\sigma^2_e + \sigma^2_a + \sigma^2_c + \sigma^2_t$
10	$\sigma^2_e + \sigma^2_a + \sigma^2_m + \sigma^2_c + \sigma^2_t$
11	$\sigma^2_e + \sigma^2_a + \sigma^2_m + \sigma^2_c + \sigma^2_t + \sigma_{am}$

[A] σ^2_e: residual variance, σ^2_a: direct additive variance, σ^2_c: maternal permanent environmental variance, σ^2_m: maternal additive variance, σ^2_t: maternal temporary environmental variance, σ_{am}: direct-maternal additive covariance

A log Likelihood ratio test was used to choose the most suitable animal models for each trait (Dobson,1991). An overall "best" model was defined as that with the largest log likelihood value and that included the set of random effects that, in general, were significant. When -2 time the difference between the log likelihood was greater than a critical value from a chi square distribution with one degree of freedom, the additional random factor was concluded to have had a significant effect. When log likelihood did not differ significantly, the model, which had fewer parameters was chosen to be the most appropriate.

RESULTS AND DISCUSSION

The results for the models comparisons using likelihood ratio test for maternal genetic, maternal permanent environment, maternal temporary environment and direct-maternal additive genetic covariance for all weight traits are presented in table 2. Data in table 2 are two times the difference between log likelihood of full and reduced models. Results indicated that model 11 had maximum log likelihood for all traits. For SW3, SW4 and SW6, although log likelihood of model 11 was greater than model 8, but the difference between two models were not significant(P>0.05).

Fitting maternal permanent environmental effect (models 2) improved the -2 log L significantly, compared to a model fitting only direct genetic effect (model 1) for all weight traits. The addition of maternal permanent environmental effect with maternal genetic effect already fitted did not increase -2 log L value significantly for SW5 and SW6. Therefore, maternal additive genetic effect in model reduced the importance of maternal permanent environmental effects for SW5 and SW6 (model 3 vs model 7).

Maternal additive genetic effect increased significantly -2 log L of model 3 as compared with model 1 (p<0.01), but this effect together with maternal permanent (model 2 vs model 7) and temporary (model 9 vs model10) environmental effect did not improved -2 log L. Therefore, when maternal permanent and temporary environmental effects are in models (model 2 vs model 7 and model 9 vs model 10), maternal genetic effect can be ignore for all traits.

Table 2- Log likelihood Values (-2Δlog L)[A] from the fit of animal models to field data on all body weight traits.

Random factor	Compared models	BW	SW1	SW2	SW3	SW4	SW5	SW6
σ^2_c	M1 vs M2	51.06^{**}	32^{**}	34.8^{**}	22.2^{**}	14.8^{**}	11^{**}	9.4^{**}
	M3 vs M7	10.08^{**}	10.6^{**}	14.2^{**}	5^{*}	7^{**}	1.4^{ns}	1.4^{ns}
σ^2_m	M1 vs M3	45.62^{**}	21.6^{**}	21^{**}	17.2^{*}	8^{**}	10.6^{**}	8.2^{**}
	M2 vs M7	3.7^{ns}	0.2^{ns}	0^{ns}	*	0^{ns}	1^{ns}	0.2^{ns}
	M9 vs M10	3.62^{ns}	0.4^{ns}	0^{ns}	0^{ns}	0^{ns}	1.2^{ns}	0.2^{ns}
					0^{ns}			
σ^2_t	M2 vs M9	16.12^{**}	63^{**}	34.2^{**}	3^{ns}	1.6^{ns}	9.4^{**}	2.4^{ns}
	M7 vs M10	16.04^{**}	63.2^{**}	34^{**}	3^{ns}	1.6^{ns}	9.6^{**}	2.4^{ns}
	M8 vs M11	16.4^{**}	61.6^{**}	34.2^{**}	3.4^{ns}	3^{ns}	9.2^{**}	2.8^{ns}
σ_{am}	M3 vs M4	1.26^{ns}	1.2^{ns}	0.4^{ns}	2^{ns}	4^{*}	5.4^{*}	1^{ns}
	M7 vs M8	1^{ns}	1.6^{ns}	0.6^{ns}	1.2^{ns}	0.8^{ns}	3.6^{ns}	0.2^{ns}
	M10 vs M11	1.36^{ns}	3.2^{ns}	0.6^{ns}	1.6^{ns}	0.6^{ns}	3.2^{ns}	0.6^{ns}

[A] -2 Δlog L : -2(log L full model- log L reduced model)

** p<0.01, * p<0.05 and ^{ns} is non significant

Comparison of model 2 vs model 9, model 7 vs model 10 and model 8 vs model 11 showed that models with maternal temporary environmental effect for BW, SW1, SW2 and SW5 resulted in significantly better -2 log L than models that ignored this effect, but it was not significant ($p>0.05$) for SW3, SW4 and SW6. Models including maternal temporary environmental effect (models 9, 10 and 11) had high log L values and the differences between these models were not significant ($p>0.05$). So, model 9, which has fewer parameters than other litter effect models, was determined to be the most suitable model for BW, SW1, SW2 and SW5. The most suitable model for SW3 and SW4 traits was model 2. For SW6, model 3 was the best model. It is expected that after weaning and with increasing the age of lambs, influence of maternal temporary environmental effect is reduced. Then, the results for SW5 can not be explained. The addition of direct-maternal genetic covariance in models 4, 8 and 11 with maternal effect already fitted did not increase -2 log L values significantly for all body weight traits , but, the difference between models 3 and 4 were significant for SW4 and SW5 ($p<0.05$).

CONCLUSION

In order to unbiased estimation of direct heritability, maternal effects (genetic and temporary and permanent environmental) should be considered in models fitted specially in early body weights. Therefore, the presence of maternal temporary environmental effect in animal models were needed for body weight traits especially before wearing.

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