African Journal of Biotechnology Vol. 11(8), pp. 2119-2123, 26 January, 2012
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.3114

Full Length Research Paper

Estimation of genetic parameters for body weights of Kurdish sheep in various ages using multivariate animal models

Borhan Shokrollahi* and Masoud Zandieh

Department of Animal Science, School of Agriculture, Sanandaj Branch, Islamic Azad University, Kurdistan, Iran.

Accepted 23 December, 2011

Genetic parameters and (co)variance components were estimated by restricted maximum likelihood (REML) procedure, using animal models of kind 1, 2, 3, 4, 5 and 6, for body weight in birth, three, six, nine and 12 months of age in a Kurdish sheep flock. Direct and maternal breeding values were estimated using the best linear unbiased prediction (BLUP) by DF-REML software. The data used in the present study was obtained from one research flock of Kurdistan Kurdish sheep, including 2476 animals, during the period of 1993 to 2003 (11 years). The log L estimated for all of the six models of this study showed that model 6 was the most appropriate for the analysis of data. Direct heritability values for the traits of this study based on the model 6 (best model) were 0.161, 0.233, 0.260, 0.091, and 0.122, for body weight in birth, three, six, nine and 12 months of age, respectively. Furthermore, maternal heritability (m^2) based on the model were 0.238, 0.023, 0.014, 0.005, 0.004, for body weight in birth, three, six, nine and 12 months of age, respectively. Correlation between direct and maternal additive genetic values for body weight in birth, three, six, nine and 12 months of age were 0.0351, 0.5911, 0.7427, 0.7968 and 0.5735, respectively. Direct additive genetic correlations between birth weight and body weight performance at later ages were positive and relatively high, ranging from 0.31 to 0.67, and they were positive and high between weaning and later weights and six month with yearling weight, ranging from 0.54 to 0.79.

Key words: Genetic parameters, (co)variance components, body weights, Kurdish sheep.

INTRODUCTION

Most of Iranian sheep are fat-tailed, carpet wool and native breeds. Kurdish sheep are indigenous to the Kurdistan province of Iran. This breed is also reared in other areas of Iran (North Khorasan, Kermanshah and Ilam). They are mainly reared in rural areas of Kurdistan. The important features of this breed are being susceptible animals for fattening, good growth rate and high compatibility with the semiarid climate. The color of the animal is white with black or brown head and face and black or brown spots in hands and legs. This breed is highly valued for their meat and wool production. It is essential to have knowledge of genetic parameters for weight traits at different ages and also the genetic relationships between the traits to formulate optimum breeding strategies for improved production. The effects of various environmental factors on lamb growth have previously been studied in several investigations on other breeds (Jorgensen et al., 1993; Yazdi et al., 1997). By far, the most important environmental factors are year, sex, type of birth, age of dam, and age of lambs at weighing. Many random factors can influence the growth of lambs. These factors consisted of direct genetic effects, maternal genetic effects and environmental factors, which affect both the lamb and its dam. Studies of various sheep breeds have shown that both direct and maternal

*Corresponding author. E-mail: Borhansh@Iausdj.ac.ir or Borhansh@yahoo.com. Tel: +98 0871 3289424 or +98 918 871 6920; Fax: +98 871 3288677.

Abbreviations: BW, Birth weight; **WW,** weaning weight; **6MW,** six months weight; **9MW,** nine months weight; **YW,** yearling weight.

Table 1. Characteristics of the data structure for body weights of Kurdish sheep.

Character	BW	WW	6MW	9MW	YW
Number of records	2245	2193	1947	1576	1059
Mean (Kg)	3.69	19.45	25.32	26.74	29.47
Standard deviation (Kg)	0.47	3.22	3.95	5.21	4.12
Coefficient of variation (%)	12.73	16.55	15.60	16.97	13.98

BW, Birth weight; WW, weaning weight; 6MW, 6 month weight; 9MW, 9 month weight; YW, yearling weight.

genetic effects are important for lamb growth (Maria et al., 1993; Tosh and Kemp 1994; Nasholm and Danell 1996; Yazdi et al., 1997). Hence, to achieve optimum genetic progress in a selection program both the direct and maternal components should be taken into account (Meyer, 1992; Maria et al., 1993). The present investigation was undertaken to estimate genetic parameters and the variances and covariances for lamb weights at different ages. In addition, the correlations between the traits were estimated.

MATERIALS AND METHODS

This study was carried out using data of a herd under supervision of Agriculture-Jahad Organization of Kurdistan in Bijar. Bijar city is located at 125 km from the center of Kurdistan province (Sanandaj). These areas have good weather and suitable pastures in some seasons. Average annual rainfall is 252 mm in Bijar. The data used in the present study were collected from 1993 to 2003. The traits were birth weight (BW), weaning weight (WW), six months weight (6MW), nine months weight (9MW) and yearling weight (YW).

In general, animals were managed following conventional practices. Natural pasture is the main source of feed. The quantity and quality of the pasture vary considerably during the year. In spring and summer, quantity and quality of the pasture is good and animals are grass-fed in pasture. In fall, the quantity and quality of the pasture decreases and supplemental feeding has to be provided especially at the time of flushing and in winter animals are penned in closed position with manual feeding. The mating period began between late summer (August) and early autumn (September). Lambing was in February and March and lambs were weaned until about three months of age.

Records were prepared to analysis using EXCEL 97 software. During the preparation process, abnormal data were removed and thrown. The pedigree and data files were prepared according to several single-trait analyses.

The general linear model (GLM) was used to investigate the effect of fixed factors on the traits using SAS 9 software. First analysis was conducted by putting all fixed factors in the model. After, factors that did not have significant effect on different traits were removed and finally traits were analyzed by model having significant factor.

A covariate variable (weaning age) was used to remove bias due to different age at post weaning. Weaning age as covariate variable was used for estimation of variance components for WW, 6MW, 9MW and YW, too. Variance and covariance components, genetic parameters, breeding values, correlation between direct and maternal additive genetic effects, phenotypic, and environmental residues effects were estimated using the DF-REML program by fitting six single-trait animal models. Univariate analyses for each trait and data set were carried out considering six different models to assess the importance of maternal effects:

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

Model 2: $Y = Xb + Z_1a + Z_2c + e$

Model 3: $Y = Xb + Z_1a + Z_3m + e$ $\quad Cov(a,m) = 0$

Model 4: $Y = Xb + Z_1a + Z_3m + e$ $\quad Cov(a,m) = A\sigma_{am}$

Model 5: $Y = Xb + Z_1a + Z_2c + Z_3m + e$ $\quad Cov(a,m) = 0$

Model 6: $Y = Xb + Z_1a + Z_2c + Z_3m + e$ $\quad Cov(a,m) = A\sigma_{am}$

Where, *Y* is vector of observations, *b,* vector of fixed, a, vector of random animal effects, *m,* vector of maternal genetic effects, *c,* vector of maternal environmental effects, *e,* vector of random residual effects, and *X*, Z_1, Z_2, Z_3 are incidence matrices relating records to fixed, random animal effects, maternal environmental effects and maternal genetic effects, respectively. Assumption for matrices of variance and covariance including random effects were:

$V(a) = \sigma^2_a$, $V(m) = A\,\sigma^2_m$, $V(c) = I\,\sigma^2_c$, $V(e) = I\,\sigma^2_e$ and $Cov(a, m) = A\,\sigma_{am}$

Where, I is an identity matrix and σ^2_a, σ^2_m, σ^2_c and σ^2_e are additive

Table 2. Estimates of variance components and genetic parameters for body weights.

Trait	Model	σ^2_a	σ^2_c	σ^2_m	σ_{am}	σ^2_e	σ^2_p	h^2_a	C^2	M^2	r_{am}
BW	1	0.1597				0.2189	0.3786	0.4218			
	4	0.0546		0.0923	0.0047	0.2151	0.3667	0.1488		0.2517	0.0662
	6	0.0586	0.0116	0.0865	0.0025	0.2051	0.3643	0.1608	0.0318	0.2374	0.0351
WW	1	3.5412				8.3141	11.855	0.2987			
	4	2.3291		0.8745	0.5739	7.8576	11.653	0.2001		0.0751	0.4623
	6	2.7652	0.0748	0.2785	0.5187	8.1942	11.831	0.2337	0.0063	0.0235	0.5911
MW6	1	5.3452				9.4080	14.753	0.3623			
	4	3.6843		0.2894	0.7357	9.8804	14.589	0.2544		0.0198	0.7124
	6	3.7694	0.4863	0.2157	0.6697	9.3482	14.489	0.2601	0.0335	0.0148	0.7427
MW9	1	3.9861				19.139	23.125	0.1723			
	4	1.5643		1.1857	0.4264	19.721	22.897	0.0683		0.0517	0.3130
	6	2.0654	1.2476	0.1032	0.3679	19.005	22.789	0.0906	0.0547	0.0045	0.7968
YW	1	5.0736				15.305	20.379	0.2489			
	4	4.4762		0.3987	0.3564	15.233	20.465	0.2187		0.0194	0.2679
	6	2.4894	0.2615	0.0843	0.2627	15.284	20.371	0.1222	0.0128	0.0041	0.5735

σ^2_a, Additive genetic variance; σ^2_c, maternal environmental variance; σ^2_m, maternal genetic variance; σ_{am}, direct-maternal genetic covariance; σ^2_e, residual variance; σ^2_p, phenotypic variance; h^2_a, direct heritability; C^2, σ^2_c/σ^2_p; M^2, maternal heritability; r_{am}, direct-maternal genetic correlation.

direct, additive maternal, maternal permanent environmental and residual variances, respectively. The direct maternal correlation (r_{am}) was computed as the ratio of the estimates of direct maternal covariance (σ_{am}) to the product of the square roots of estimates of σ^2_a and σ^2_m (Willham, 1972). A simplex algorithm is used to search for variance components to minimize the function, –2log likelihood (L). Convergence was assumed when the variance of the function values (–2logL) of the simplex was less than 10^{-8}. For all models, a restart was performed after a first convergence to verify that convergence was not at a local minimum. A log likelihood ratio test was used to select the most suitable random effects model for each trait. The reduction in –2logL was calculated by adding a random effect to the model. The additional random effect fitted was considered significant if this reduction was greater than the value of the chi-square distribution with one degree of freedom ($p < 0.05$). 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.

RESULTS AND DISCUSSION

The data structure and means, standard deviations and coefficient of variation are presented in Table 1. The mean values for the different traits are smaller than those of the studies of other breeds (Yazdi et al., 1997), probably due to the more extensive conditions under which the herd was maintained. In Kurdistan, herds are maintained in pastures about nine month of the year. The birth weight has less coefficient of variation than other traits, which is an indication of the smaller effect of environment on birth weight than on the other traits. LSM analysis for fixed effects showed that age of dam, year of lambing, sex of lamb and type of birth had significant effect on BW ($p < 0.01$). Age of dam, sex of lamb, year of lambing, type of birth and weaning age (covariate variable) had significant effect on WW ($p < 0.01$). Age of dam, sex of lamb, year of lambing and weaning age (covariate variable) had significant effect on 6MW, 9MW and YW ($p < 0.01$). Therefore, the effects of significant fixed factors were considered in analysis of different weights by models. In other studies, the effects of these environmental factors were also important on body development of lambs (Jorgensen et al., 1993; Yazdi et al., 1997; Bahreini Behzadi et al., 2007).

Estimates of variance components and genetic parameters are given in Table 2. In model 1, estimates for h^2_a and σ^2_a were higher in comparison with the other models caused by ignorance of maternal effects. Addition of maternal genetic and environmental effects in models 4 and 6 decreased the estimates of both σ^2_a and h^2_a compared with Model 1. Meyer (1992) suggested that models not considering maternal genetic effects could result in substantially higher estimates of additive direct genetic variance and higher estimates of h^2_a. If maternal effects are exist but not considered, the estimate of additive genetic variance will include at least part of the maternal variance. Therefore, estimates of direct heritability will reduce when maternal effects are existed. Model 6 (including an additive maternal effect) yielded smaller estimates of σ^2_a and h^2_a than models 1 and 4. Maternal

Table 3. Estimates of direct genetic, maternal genetic, maternal environment, residual and phenotypic correlations between various weights from two-trait analyses.

Trait 1	Trait 2	r_a	r_m	r_c	r_e	r_p
BW	WW	0.6701	0.5641	0.3251	0.2436	0.3854
BW	6MW	0.3842	0.3972	0.1835	0.1768	0.3276
BW	9MW	0.3158	0.4238	0.4762	0.2139	0.3542
BW	YW	0.3624	0.4509	0.4145	0.2688	0.3349
WW	6MW	0.7953	0.7414	0.7168	0.4369	0.7237
WW	9MW	0.5908	0.6953	0.1124	0.3952	0.6421
WW	YW	0.6145	0.7166	0.4217	0.4027	0.5832
6MW	9MW	0.5773	0.6481	0.3349	0.5039	0.6041
6MW	YW	0.5439	0.7602	0.2174	0.5371	0.5928
9MW	YW	0.4812	0.6741	0.6242	0.4928	0.6376

r_a, Direct genetic correlation; $r_{m,}$ maternal genetic correlation; r_c, maternal environment correlation; r_e, residual correlation; r_p, phenotypic correlation.

heritability was reduced with age which confirms the findings of Notter (1997) and Yazdi (1997) which observed that maternal effects are important in young animals but diminish with age. It was determined that maternal genetic effects were more important than the permanent maternal environmental effect of the dam for these traits in Kurdish sheep. Results on the basis of log likelihood test and number of used parameter show that model 6 was the most appropriate model for all traits. Estimates of genetic parameters for lamb weights at different ages are presented in literature. Heritability estimates is very different in these studies. Reported heritability estimates for BW were 0.01 to 0.39, and for WW were 0.06 to 0.39, depending on the model used and breed of lamb. Direct heritabilities for body weights had a tendency to increase with age measured, because estimates of direct additive genetic variance component increased faster than the environmental variance components. Tendency for estimates of direct heritability to increase with age measured has also been reported in several studies (Bahreini Behzadi et al., 2007). Direct heritabilities estimates in this study are within the range of other published studies (Bahreini Behzadi et al., 2007; Gamasaee et al 2010; Jafaroghli 2010, Gowane 2010). Estimates of maternal heritability are tended to diminish from birth to yearling weight. Maternal genetic effects expressed during gestation and lactation had been expected to have a declining effect on weight as lambs became older. Maternal heritability reduced with age, which confirms Robison (1981) suggestion, that maternal effect in mammals are important in young animals but diminish with age. Maternal heritability estimates of BW and WW in this study were higher than values reported by Snyman et al. (1995), Yazdi et al. (1997), Ligda et al. (2000), and Jafaroghli et al. (2010) Gamasaee et al. (2010) and lower than values reported by Gowane et al. (2010) for several sheep breeds. The high estimates of maternal heritability for 9MW and YW were unexpected because at these ages individuals do not depend on their mother and their weights should reflect only the direct effect of the genes on growth except for carry over maternal effects from before weaning (El Fadili et al., 2000). In general, the trend of increasing direct heritabilities and decreasing maternal heritabilities with age in Kurdish sheep are similar to the average trends reported for other breeds. The direct and maternal heritability estimates for lamb body weights found in the present study are within the range of those reported in literature. Estimates for direct genetic correlations between body weights in different ages ranged from 0.31 for BW and 9MW to 0.79 for WW and 6MW (Table 3). In this study, estimate of genetic correlation of BW and YW was moderate.

The genetic correlation of WWT with post weaning weights were high to moderate (WW to 6MW = 0.79, WW to 9MW = 0.59, and WW to YW = 0.61). The genetic correlations between other weight traits (6MW to YW) were also moderate (positive) ranging from 0.48 for 9MW to YW to 0.57 for 6MW to 9MW. The genetic correlation estimate of 0.67 for BW to WW was higher than the estimate of 0.56 by Hanford et al. (2002) in Columbia sheep, 0.52 by Hanford et al. (2003) in Targhee sheep and 0.45 by Gowane et al. (2010) in Bharat Merino sheep. High genetic correlation between body weight traits suggests that many of the genetic factors that influence body weight at weaning to adult stage were the same. On the basis of the high genetic correlation of 6MW with 9MW and 12WT, it can be concluded that animals with above average 6WT would tend to be above average in genetic merit for 9MW and YW. Estimates of maternal genetic correlation (r_m) were moderate to high and positive (0.39 for BW to 6MW to 0.76 for 6MW to YW) among growth traits. The positive maternal genetic correlations of birth weight with later weights indicate that maternal effects on the later weights are partly originating from the prenatal period. The results with higher maternal heritability for birth weight than for all later weights also support this conclusion. All genetic correlations among growth traits of Kurdish lambs were positive, indicating that selection for any of the traits should result in positive genetic change in the other traits. Estimates of maternal permanent environmental correlation (r_c) were low to high (0.11 for WW to YW to 0.71 for WW to 6MW) among growth traits. The estimate of r_c between birth and weaning weight was 0.32, which was lower than the estimate by Hanford et al. (2002) for Columbia sheep (0.46) and Gowane et al. (2010) for Malpura sheep. The estimates for phenotypic correlation between different body weight traits were positive and medium to large and were similar to the residual correlation estimates for the respective traits.

REFERENCES

Bahreini Behzadi MR, Shahroudi FE, Van Vleck LD (2007). Estimates of genetic parameters for growth traits in Kermani sheep. J. Anim. Breed. Genet. 124: 296-301.

El Fadili M, Michaux C, Detilleux J, Leroy PL (2000). Genetic parameters for growth traits of the Moroccan Timahdit breed of sheep. Small. Rumin. Res. 37: 203-208.

Gamasaee VA, Hafezian SH, Ahmadi A, Baneh H, Farhadi A, Mohamadi A (2010). Estimation of genetic parameters for body weight at different ages in Mehraban sheep. Afr. J. Biotech. 9(32): 5218-5223.

Gowane GR, Chopra A, Prakash V, Arora AL (2010). Estimates of (co)variance components and genetic parameters for body weights and first greasy fleece weight in Malpura sheep. Liv. Sci. 131: 94-101.

Gowane, GR, Chopra A, Prince LLL, Paswan C, Arora AL (2010). Estimates of (co)variance components and genetic parameters for body weights and first greasy fleece weight in Bharat Merino sheep. Animal, 4(3): 425-431.

Hanford KJ, Van Vleck LD, Snowder GD (2002). Estimates of genetic parameters and genetic change for reproduction, weight and wool characteristics of Columbia sheep. J. Anim. Sci. 80: 3086-3098.

Hanford KJ, Van Vleck LD, Snowder GD (2003). Estimates of genetic parameters and genetic change for reproduction, weight and wool characteristics of Targhee sheep. J. Anim. Sci. 81: 630-640.

Jafaroghli M, Rashidi A, Mokhtari MS, Shadparvar AA (2010). (Co)Variance components and genetic parameter estimates for growth traits in Moghani sheep. Small Rumin. Res. 91: 170-177.

Jorgensen JN, Henning-Petersen P, Ranvig H (1993). Environmental factors influencing lamb growth in six Danish sheep breeds. Acta. Agric. Scand., Sect. A, Animal. Sci. 43: 16-22.

Ligda CH, Gabriilidis G, Papadopoulos Th, Georgoudis A (2000). Investigation of direct and maternal genetic effects on birth and weaning weight of Chios lambs. Livest. Prod. Sci. 67: 75-80.

Maria GA, Boldman KG, Van Vleck LD (1993). Estimates of variances due to direct and maternal effects for growth traits of Romanov 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.

Nasholm A, Danell O (1996). Genetic relationships of lamb weight maternal ability and mature ewe weight in Swedish Finewool sheep. J. Anim. Sci. 74: 329-339.

Notter DR (1997). Genetic parameters for growth traits in Suffolk and Polypay sheep. Livest. Prod. Sci. 55: 205-213.

Robison OW (1981). The influence of maternal effects on the efficiency of selection; a review. Livest. Prod. Sci. 8: 121-137.

Snyman MA, Erasmus GJ, Van Wyk JB, Oliver JJ (1995). Direct and maternal co-variance components and heritability estimates for body weight at different ages and fleece traits in Afrino Sheep. Livest. Prod. Sci. 44: 229-235.

Tosh JJ, Kemp RA (1994) Estimation of variance components for lamb weights in three sheep populations. J. Anim. Sci. 72: 1184-1190.

Willham RL (1972). The role of maternal effects in animal breeding: III. Biometrical aspects of maternal effects in animals. J. Anim. Sci. 35: 1288-1293.

Yazdi MH, Engström G, Nasholm A, Johansson K, Jorjani H, Liljedahl LE (1997). Genetic parameters for lamb weight at different ages and wool production in Baluchi sheep. Anim. Sci. 65: 224-255.