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Genetic and Non-Genetic Parameter Estimates for Growth Traits in Turkish Merino Lambs

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Abstract: Genetic and non-genetic influences on the body weights of 8429 Turkish Merino lambs sired by 292 rams over 1992-2006 were evaluated. Traits analyzed were Birth Weight (BW), 3 Months Weight (3 MW), 6 Months Weight (6 MW), 12 Months Weight (12 MW), Pre-weaning Daily Gain (PRDG) and Post-weaning Daily Gain (PSDG). REML estimates of variance and covariance components were obtained by using animal models in which the fixed effects of year of lambing, sex, birth type and age of dam and random animal direct and the maternal genetic effects were included. Average weights were 4.31±0.02, 32.4±0.36 45.1±0.43, 53.4±0.55 kg; 315±4 and 76±2 g for BW, 3 MW, 6 MW, 12 MW, PRDG and PSDG, respectively. All environmental factors were statistically significant, except age of dam for PSDG. Estimates of direct and maternal heritabilities were 0.14, 0.16; 0.29, 0.03; 0.31, 0.05; 0.38, 0.09; 0.29, 0.03 and 0.49, 0.10 for BW, 3 MW, 6 MW, 12 MW, PRDG and PSDG, respectively. Genetic and phenotypic correlations among traits were statistically significant and favorable. In general, heritability estimates are moderate and hence, genetic progress can be achieved through mass selection.

Key words: Turkish Merino sheep, genetic and phenotypic parameters, growth traits, daily gain, sex, random animal

INTRODUCTION

German Mutton Merino sheep were imported into Turkey in the 1930s to improve the growth performance and fleece quality of indigenous sheep breeds. The Turkish Merino sheep were obtained by crossbreeding German Mutton Merino with indigenous Kivircik sheep at Karacabey state farm and with indigenous white Karaman sheep at central Anatolian state farm (Yalcin, 1986). Turkish Merino sheep is a dual purpose breed (meat and wool production).

Profitability of sheep for meat production depends to a large extent on the body weights of the lambs and therefore, selection objectives should include these traits. Knowledge of genetic parameters is crucial for genetic evaluation and designing breeding schemes. Numerous studies have estimated genetic and phenotypic parameters for growth traits in sheep (Bosso *et al*., 2007; Miraei-Ashtiani *et al*., 2007; Vatankhah *et al*., 2008; Ajoy *et al*., 2006; Dixit *et al*., 2001; El Fadili *et al*., 2000; Maxa *et al*., 2007; Hanford *et al*., 2006; Hanford *et al*., 2003; El-Fadili and Leroy, 2001; Jurado *et al*., 1994).

Growth traits of farm animals are determined not only by an animal's genetic potential for growth but also by maternal genetic and permanent and temporary environmental effects. Hence, to achieve optimum genetic progress in a selection programme, both direct and maternal genetic components should be taken into account, especially if there is not an antagonistic relationship between them (Meyer, 1992).

The purpose of this study was to estimate direct and maternal genetic parameters among lamb weights and daily gain at different ages in Turkish Merino sheep. Such parameters are important in designing breeding strategies for the Turkish Merino sheep population.

MATERIALS AND METHODS

Animals and management: Data and pedigree information for Turkish Merino (Karacabey Merino) sheep used in this study were collected at the Marmara Animal Breeding Research Institute. The data were on 8429 Turkish Merino sheep from 2478 ewes sired by 292 rams and born in a period of 15 years (1992-2006).

Flock size was 550-600 breeding ewes and 20-25 rams per year. Traits considered were body weights at different age of lambs. The numbers of records for each age group are shown in Table 1. The difference in the number of the records available for each trait was primarily because of death or lack of that particular record. Most of the ram lambs were sold or distributed to farmers at weaning.

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Table 1: Least-squares means (±SE) for growth traits of Turkish merino sheep[a]

	Body weight (kg)				Daily gain (g)	
Variables	BW	3 MW	6 MW	12 MW	PRDG (0-3 months)	PSDG (3-12 months)
Number of records	8429	4898	3009	2419	4898	2381
Number of sires	292	185	147	134	185	133
Number of dams	2478	1514	1189	1141	1514	1131
Flock mean±SE	4.31±0.02	32.4±0.36	45.1±0.43	53.4±0.55	313±4	76±2
Year of lambing	**	**	**	**	**	**
Sex of lamb						
Female	4.16±0.02b	30.5±0.37b	41.9±0.45b	49.5±0.57b	293±4.1b	67±2.23b
Male	4.45±0.02a	34.4±0.38a	48.3±0.46a	57.4±0.58a	333±4.1a	85±2.27a
Type of birth						
Single	5.21±0.01a	35.8±0.18a	47.9±0.23a	55.5±0.25a	343±1.9a	72±1.03b
Twin	4.38±0.01b	31.7±0.14b	45.1±0.18b	53.6±0.23b	304±1.6b	81±0.91a
Triplet	3.34±0.07c	29.9±1.06b	42.4±1.26c	51.2±1.61c	292±1.4b	74±6.32ab
Age of ewe						
≤2	3.91±0.02d	30.1±0.42d	43.5±0.51d	51.8±0.64c	282±4.7c	75±2.58a
3	4.26±0.02c	32.2±0.41c	45.5±0.51bc	52.7±0.62b	306±4.5b	78±2.46a
4	4.36±0.02b	33.1±0.42ab	46.1±0.50a	54.8±0.62a	317±4.6a	77±2.47a
5	4.41±0.02ab	33.9±0.43a	46.9±0.54a	54.3±0.66a	329±4.7a	75±2.63a
6	4.47±0.03a	33.4±0.47ab	45.9±0.58ab	54.7±0.72a	326±5.1a	76±2.85a
>7	4.44±0.03ab	31.1±0.49bc	42.9±0.61cd	52.0±0.73bc	319±4.1ab	71±2.95a

[a]Means with similar letters within a column do not differ from one another at $p \leq 0.05$, ** $p \leq 0.01$; ns: $p > 0.05$

Ewes were first bred at an average age of 18 months. Hand mating was applied once a year between the 15th of June and 30th of July and continued for 40-45 days. Rams were selected based on mature weight. Dams were only culled for infertility. Rams were used in the flock for 2 or 3 consecutive years. Ewes were grazed on green pasture during lambing and suckling periods. During the rest of the time, they were fed on dry pasture and cereal crops residues. During the mating period and 5-10 days after lambing ewes were kept indoors and fed a ration composed of cereals, straw, hay, mineral and vitamins.

All lambs were weighed and ear tagged within 12 h of birth. The lambs were kept together with their dams in individual boxes for the first 3 days after birth. Then a flock composed of suckling lambs and their dams was formed. All lambs in the flock were weaned on the same day at approximately 90 days of age. The 3, 6 and 12 month weights of lambs were adjusted to 90, 180 and 365 days of age, respectively. The traits analyzed were birth weight, 3, 6 and 12-month weights, pre-weaning (from birth to 3 months of age) and post-weaning (from 3 month of age to 12 months of age) daily gains.

Statistical analyses: Least-squares procedures based on mixed model methodology (Harvey, 1990) were used to analyze data on growth traits. Fixed effects due to year of lambing, sex of lamb, type of birth and age of ewe at lambing were included in the general statistical model.

Genetic parameters were estimated by Restricted Maximum Likelihood (REML) method using DFREML 3.0 programme (Meyer, 1998). The maximum of the log-likelihood value was found by the simplex method. Convergence was considered to be reached when, the variance of function values in the simplex method was <10-8. The genetic and non-genetic effects for each of the weights and growth traits were analyzed by using the animal model. Direct and maternal heritabilities and covariance between direct and maternal effects were initially estimated using single trait analysis. Then genetic and phenotypic correlations among all traits were estimated by using two-trait analysis.

RESULTS AND DISCUSSION

Environmental effects: The least-squares means and their Standard Errors (SE) for growth traits by sex of lamb, type of birth and age of dam are presented in Table 1. Year of lambing, sex of lamb, type of birth and age of dam were significant ($p \leq 0.01$) on body weight and daily gain of lambs. On the other hand, the age of lamb had no significant effect on post-weaning daily gain. Variation observed in feed availability may have contributed to the significant year effect. The male lambs were 6-16% heavier than female lambs. Single born lambs were also significantly ($p \leq 0.01$) heavier than twin and triplet born lambs by 19 and 61% (BW), 13 and 20% (3 MW), 6 and 12% (6 MW), 4 and 8% (12 MW) and 13 and 17% (PRDG), respectively. However, twin and triplet born lambs grew faster (12-3%) than single born lambs during the PSDG period. This could be explained by compensation growth when taking into account the natural feed restriction during the weaning period because of the limitation in the sucked milk by twins. These results are in agreement with those reported in literature for Turkish Merino

Table 2: Direct heritability (h^2_d)±SE[a], maternal heritability (h^2_m)±SE[a], genetic correlation between direct and maternal effects[a], genetic correlations±SE[b] and phenotypic correlations[c] among growth traits in Turkish Merino lambs[d]

Traits	BW	3 MW	6 MW	12 MW	PRDG	PSDG
BW	0.14±0.02a 0.16±0.01b -0.37c	0.16	0.13	0.15	-0.01	0.03
3 MW	0.48±0.05	0.29±0.01a 0.03±0.01b -0.94c	0.72	0.26	0.99	-0.44
6 MW	0.40±0.06	0.95±0.01	0.31±0.03a 0.05±0.01b -0.95c	0.75	0.71	0.25
12 MW	0.38±0.05	0.56±0.04	0.97±0.01	0.38±0.04a 0.09±0.02b -0.98c	0.23	0.77
PRDG	-0.99±22.29	0.99±0.01	0.94±0.01	0.52±0.04	0.29±0.02a 0.03±0.01b 0.35c	-0.46
PSDG	0.08±0.05	-0.78±0.02	0.57±0.05	0.93±0.01	-0.81±0.02	0.49±0.03a 0.10±0.02b -0.99c

[a]a: Values h^2_d; b: Values h^2_m; c: Values r_{dm}, [b]Values given below the diagonal; Values given above the diagonal; h^2_d = Direct genetic heritability; h^2_m = Maternal genetic heritability; r_{dm} = Direct-maternal genetic correlation

(Ozcan *et al*., 2005), Bharat Merino (Dixit *et al*., 2001), Rambouillet (Bromley *et al*., 2000), Dohne Merino (Cloete *et al*., 1998), Dala (Larsgard and Olesen, 1998) and Afrino (Snyman *et al*., 1995).

The heavier body weight of male lambs may be due to variation in their endocrine profile and in their culling level practiced at different ages. Lower body weight of twins and triplet lambs may be due to limited uterine space and inadequate availability of nutrients during pregnancy and competition between the twins for limited quantity of milk available from the dam. The physiological compensatory mechanism may have played its role in influencing the faster growth rate to overcome the handicap during the pre-weaning period for achieving the physical and physiological maturity at the same time. It was body weight rather than age of dam, which played a greater role in influencing lamb weights (Dixit *et al*., 2001).

Heritabilities: Estimates of genetic and phenotypic correlations, direct and maternal heritabilities and their standard errors are shown in Table 2. Direct heritabilities were 0.14±0.02 (BW), 0.29±0.01 (3 MW), 0.31±0.03 (6 MW), 0.38±0.04 (12 MW), 0.29±0.02 (PRDG) and 0.49±0.03 (PSDG). Maternal heritabilities were 0.16±0.01, 0.03±0.01, 0.05±0.01, 0.09±0.02, 0.03±0.01 and 0.10±0.02 for BW, 3 MW, 6 MW and 12 MW, PRDG and PSDG, respectively. In general, direct heritabilities (h^2_d) were medium to high and maternal heritabilities (h^2_m) were low (Table 2). The h2d estimates for BW were within the range of values were reported by Yazdi *et al.* (1997) in Baluchi (0.14), Tosh and Kemp (1994) in Polled Dorset (0.20). The estimates were higher than Cloete *et al.* (1998) in Dohne Merino (0.04) and lower than Snyman *et al.* (1997) in Afrino (0.22), Bromley *et al.* (2000) in Rambouillet (0.19). Direct heritability estimate for 3 MW was similar to that reported by Analla *et al.* (1997) in Segurena (0.28) and for 6 MW was lower than Wuliji *et al.* (2001) in Merino (0.44). Direct heritability estimates for 12 MW were similar to the estimates reported by Lee *et al.* (2002) in Merino (0.38), by Brown *et al.* (2002) in Merino (0.33) and by Clarke *et al.* (2003) in Merino (0.35). The direct heritabilities for PRDG and PSDG were higher than the one reported by Hagger (1998) in Swiss W Alpine. The higher estimates of direct heritability by age of weights in the current study are in agreement with other estimates from the study, Yazdi *et al.* (1997) and Duguma *et al.* (2002). A tendency for estimates of direct heritability to increase with age was also found by Mavrogenis *et al.* (1980). The higher estimates in heritability for morphological characters during ontogeny are generally associated with declining maternal effects with age (Rutledge *et al*., 1972).

Maternal heritability (h2m) estimates for body weights suggest that additive maternal effects are important. The maternal heritability for BW (0.16) is similar to that reported by Cloete *et al.* (2002) in Dormer (0.16). The estimates of maternal heritability for 3 MW were within the range of those reported by Rao and Notter (2000) in Suffolk, Maria *et al.* (1993) in Romanov, Al-Shorepy and Notter (1998) in composite breed, Analla and Serradilla (1998) in Merino. The estimate of h2m for 6MW is similar to that reported by Wuliji *et al.* (2001) in Merino (0.08). The maternal heritability estimate is also similar to the result reported by Wuliji *et al.* (2001) in Merino (0.09), but higher than Al-Shorepy and Notter (1998) in a composite breed (0.05) and Yazdi *et al.* (1997) in Baluchi (0.02). The maternal heritability estimate for PRDG is similar to those reported by Hagger (1998) in Swiss W Alpine (0.04). The maternal heritability estimate for PSDG was higher than the estimate given by Yazdi *et al.* (1997) in Baluchi (0.01).

Genetic and phenotypic correlations: Genetic correlation (r_{dm}) estimated for direct additive and additive maternal effects were generally high and negative in direction except for PRDG.

Negative correlations between direct and maternal effects can be due to environmental and management circumstances. Meyer *et al*. (1993) pointed out that large negative estimates of r_{dm} are usually induced by environmental and management circumstances. In some cases, it could be a problem in partitioning the direct and the maternal variation correctly.

The ram for BW (-0.37) in this study was in agreement with those reported by Tosh and Kemp (1994) in Pollet Dorset (-0.35) and Van Wyk *et al*. (1993) in Dormer (-0.35). The ram for 3, 6 and 12 MW were between -0.94 and -0.98 and similar to those reported by Maria *et al*. (1993) in Romano sheep breed (-0.98) and El Fadili *et al*. (2000) in Moroccan Timahdit (-0.97). The estimates of r_{dm} for PRDG and PSDG were similar to the values reported by Yazdi *et al*. (1997) for Baluchi sheep and by Maria *et al*. (1993) for Romanov sheep. Direct and maternal effects could be covered by the environmental circumstances, especially when field data are analyzed (Robison, 1972).

The estimates for phenotypic correlations varied from -0.01 to 0.99. The highest phenotypic correlation was observed between 3 MW and PRDG (0.99), while the lowest was between BW and PRDG (-0.01).

The phenotypic correlations given by Dixit *et al*. (2001) for BW and PSDG (0.03); BW and 12 MW (0.19); PRDG and 3 MW (0.98), 3 MW and 6 MW (0.69), 6 MW and PRDG (0.63); 6 MW and PSDG (0.24), 12 MW and PSDG (0.79) in the Bharat sheep breed were similar to those estimated in the present study. Phenotypic correlations estimated for PSDG-PRDG (0.10) and PRDG-3 MW (0.19) by Dixit *et al*. (2001) were higher and in negative direction. The phenotypic correlation coefficient for BW and 3 MW (0.40) presented by Bosso *et al*. (2007) is higher, while the one for BW and PSDG (0.06) is similar and the remaining estimates are lower than the coefficients for the present study. The phenotypic correlation between BW and 3 MW (0.49) for Moroccan Timahdit sheep breed given by El-Fadili *et al*. (2000) was higher than the estimate. At the same time Maria *et al*. (1993) found higher estimates of phenotypic correlation for BW-3 MW (0.58) and BW-PRDG (0.37) in Romanov sheep breed.

Genetic correlation estimates varied from -0.78 to 0.99 and were 0.48, 0.95, 0.97, 0.99, 0.94, 0.52, 0.93 for BW-3 MW, 3-6 MW, 12-6 MW, 3 and 6 MW-PRDG, 12 and 12 MW-PSDG, respectively. They were high and in positive directions. However, the correlation between BW and PSDG has low and positive value (0.08).

Genetic correlations between PRDG-3MG and PSDG-12 MW for the Bharat sheep breed were reported by Dixit *et al*. (2001) to be 0.97 and 0.95, respectively. Genetic correlation between 3 MW and PRDG estimated for the Turkish Merino sheep by Ozcan *et al*. (2005) was close to unity. High and positive genetic correlation between 3 MW and PRDG (0.99) is similar to the correlation estimated for Tygerhoek Merino (Duguma *et al*., 2002). This means that both traits are genetically related and selection can be based on only one of these two traits. Genetic correlation between BW and 3 MW (0.12) given by Maria *et al*. (1993) for Romanov sheep is higher while, the coefficient (0.49) for the same traits in Moroccan Timahdit sheep reported by El-Fadili *et al*. (2000).

The estimates of genetic and phenotypic correlations, which have higher value than 0.90 for some traits showed no antagonisms among the body weights. These estimates are similar to the correlation coefficients reported for Moroccan Timahdit sheep breed by El-Fadili *et al*. (2000).

CONCLUSION

Any negative genetic correlation was not practiced between the traits concerning body weights of lambs. So, it may be possible to decide that there had not been any serious genetic antagonism between the traits to prevent correlated response to selection practices.

Consequently, an effective breeding plan could be designed with respect to the traits considered in this research. It would be reasonable to develop a selection program for increasing body weights if, we take the current management practices into the consideration in the region and a moderate genetic progress can be achieved through selection.

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