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Estimates of genetic parameters of early growth traits of barki sheep of Egypt

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ABSTRACT

The present study was carried out to estimate genetic parameters for birth weight (BW), weaning weight (WW) and average daily gain (ADG) in Barki sheep. The data set used in the present study were records of 1176 lambs, progenies of 83 sires and 690 dams, collected during 1994 to 2001 from the Barki sheep flock raised at Maryout research station, 35 km west of Alexandria, Egypt. The statistical analysis was carried out using restricted maximum likelihood (MTDFREML) methods. Four for model of animal models program including or ignoring maternal genetic and permanent environmental effects were fitted for the studied traits. These models included sex, year of birth and dam's age as fixed effects in addition to animal, sires and dams as random effects. Direct heritability obtained from Model 3, included only maternal additive effects, was estimated at 0.11 for BW, 0.15 for WW and 0.13 for ADG. Maternal heritability estimates for BW, WW and ADG were 0.11, 0.04 and 0.02, respectively. Correlation coefficients between direct additive and maternal genetic effects were high and negative ranged from – 0.97 to 0.99. Results indicated that in addition to additive direct genetic effect, additive maternal genetic effects need to be considered when carrying out genetic evaluations of early growth traits for improving growth performance in Barki sheep.

Keywords: Barki lambs, growth, direct heritability, maternal heritability, and genetic correlation

INTRODUCTION

The growth traits are important factors influencing the profitability in any meat producing enterprises. Rapid growth during the early stage of animal life could compensate some of the rearing costs and resulted in a higher net profit for the farmer. Body weights and growth rates during the pre-weaning stage are often considered as an early indicator of the following growth and economic benefit (Handford *et al.,* 2006). Birth weight and early growth rate of the animal are determined not only by the animal genetic potential but also by maternal and environmental factors (Mandal et al*.,* 2006). Many studies on various sheep breeds have shown that direct-, maternal-genetic influences and permanent maternal environmental effects are important for lamb growth, consequently they have to be considered in the breeding programs (Yazdi *et al.,* 1997; El Fadili *et al.,* 2000; Al-Shorepy, 2001; Mohammadi *et al.,* 2010).Therefore, in order to provide accurate estimates of genetic parameters which are essential for developing selection breeding scheme for Barki sheep which dominates the north western desert of Egypt with a population of 470,000 heads (11% of total Egyptian sheep population) and known to be well adapted to the harsh desert conditions and scarce vegetation (El-Wakil *et al.,* 2008), the present study was designed to estimate some genetic parameters for lamb's body weights and daily gain from birth until weaning for Barki lambs taking into consideration direct-,maternal- genetic and permanent maternal environmental effects.

MATERIALS AND METHODS

Data of the present study and its corresponding pedigree were attained from the accumulated records of the Barki sheep flock from 1994 to 2001 available at the Desert Research Centre of Egypt. Barki sheep flock is maintained at Maryout Research Station, 35 km west of Alexandria, where mating season takes place around July and lambing starts around December each year. Ewes were often first mated at approximately 16-18 months of age. Mating groups of 20-25 ewes with one ram were assigned during the mating season. At birth, lambs were ear-tagged and kept with their mother's to suckle and weighed within 24 hours after birth and at biweekly intervals thereafter until weaning. Detailed feeding and flock management was described by El-Wakil *et al,* (2009).

The present study dealt with records of birth weight (BW), weaning weight at 120 day (WW) and daily gain from birth to weaning (ADG). BW was kept as recorded while WW was adjusted to body weights at 120 days. The adjustments for individual body weights to the age of 120 days was done by interpolation between the data of the two successive ages assuming linear growth function during the short intervals. ADG between birth and weaning was calculated as the difference between weaning weight and birth weight divided by the age at weaning in days. Records on 1176 lambs descended from 83 rams and 690 ewes were included in the analysis. The characteristics of the data structure for BW, WW and ADG are shown in Table1.

Table 1. Description of data used in the analysis

	BW	WW	ADG
Number of animals	1176	1047	1047
Number of sires	83	83	83
Number of dams	690	615	615
Mean	3.56	19.29	131.02g
Standard deviation (SD)	0.70	4.16	32.93
Coefficient of variation (CV %)	19.86	21.61	25.13

BW = birth weight, WW= weaning weight, ADG= average daily gain from birth to weaning .

Statistical methods

General Linear Model producers of Statistical Analysis Systems (SAS, 2002) were used to test the significance of the fixed effects. Sex, age of dam and year of birth were found to be significant for the studied traits, so they were included in the model. SAS (2002) also used to generate the initial values required to run the animal model.

Variance components and genetic parameters were estimated using MTDFREML (Boldman *et al.*, 1995). Univariate analysis for each trait was performed considering four different animal models to assess the direct, maternal genetic and maternal permanent environmental effects. All models included the same fixed effects mentioned earlier and considering the animal, sire and dam as random effects. The following four animal models were employed to estimate genetic parameters:

Model1: $y=Xb+Z_1a+e$	
Model2: $y=Xb+Z_1a+Z_3c+e$	
Model3: $y=Xb+Z_1a+Z_2m+e$	$Cov(a,m)=A\sigma_{am}$
Model4: $y=Xb+Z_1a+Z_2m+Z_3c+e$	$Cov(a, m) = A\sigma_{am}$

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. The covariance structure for the model was:

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

Where, I_n and I_e are identity matrices of order equal to the number of dams and number of records, respectively. σ^2_a, σ^2_m, σ^2_c and σ^2_e are direct additive genetic variance, maternal genetic variance, maternal permanent environmental variance and residual variance, respectively, and $\sigma_{a,m}$ is direct-maternal genetic covariance. *A* is the additive numerator of the relationship matrix. The genetic correlation between direct-maternal genetic effects, direct heritability (h^2_d) and maternal heritability (h^2_m) were calculated from (co) variance components.

RESULTS AND DISCUSSION

Table 1 showed that averages of birth weight (BW), weaning weight (WW) and average daily gain (ADG) were 3.56 kg, 19.29 kg and 131.02 g, respectively. The present estimates appeared to be close to that reported earlier in the same flock for BW and WW (3.45 kg, 19.9 kg, respectively, Bedier *et al.,* 1995) and ADG (122.33 gm, Fahmy et al*.,* 1969).

Estimates of genetic parameters using single-trait analysis for the studied animal models are presented in Table 2. Ignoring maternal genetic and permanent environmental effects (Model 1), resulted in larger estimates for σ^2_a and h^2_d compared with other models in BW, WW and ADG. The addition of the maternal environmental effect (Model 2) and maternal genetic effects (Model 3) reduced the estimates of both σ^2_a and h^2_d compared with Model 1 in the studied traits. Meyer (1992) showed that models not accounting for maternal genetic effects could result in substantially higher estimates of additive direct genetic variance and therefore, higher estimates of h^2_d. If maternal effects are present but not considered, the estimate of additive genetic variance will include at least part of the maternal variance. Therefore, estimates of direct heritability will decrease when maternal effects are included. Model 3, which included additive maternal genetic effect, yield smaller estimates of $\sigma^2_a$and h^2_d than did Models 1 and 2. The additive maternal genetic effect was determined to be more important than the permanent maternal environmental influence of the dam for BW, WW and ADG in Barki sheep.

Table2.Estimates of (co) variance components for birth weight (BW), weaning weight (WW) and average daily gain(ADG) from birth to weaning using different animal models in Barki lambs.

σ^2_a=direct additive variance, σ^2_m= maternal additive variance, σ_{am}= direct-maternal covariance, σ^2_c= permanent environmental variance, σ^2_e= residual variance, σ^2_{p} = total phenotypic variance, h^2_d = direct heritability, h^2_m = maternal heritability, c^2 = ratio of permanent environmental variance to total variance.

For the estimates of BW, WW and ADG in the present study, h^2_d were computed and found to be ranging from 0.11 to 0.14 after maternal effects was taken into account. In contrast, failure to take account of these effects gave estimates ranging from 0.17 to 0.33. This indicates the extent to which estimates of h^2_d can be biased if maternal effects, either genetic or environmental, are ignored using an animal model. The $h^2_d$of BW in particular was halved when all or any of the maternal effects were fitted compared to that estimate obtained with Model 1 (h^2_d = 0.33). Snyman *et al.* (1995) reported that ignoring maternal effects, if these effects have a significant influence, leads to the overestimation of direct as well as total heritability.

In the present study, the h^2_m estimates were lower than the h^2_d estimates for both WW and ADG. In general, the values for h^2_d in the present study varied from low to medium and were influenced by the model fitted (Table 2).

Heritability estimates of h^2_d and h^2_m reported by several authors ranged from 0.03 to 0.53 and from 0.02 to 0.45 for BW and from 0.04 to 0.39 and from 0.01 to 0.038 for WW and from 0.010 to 0.20 and from 0.07 to 0.16 for ADG, respectively depending on the model used and the breed of lamb (Behzadi et al*.,* 2007; Mohammadi and Edriss, 2007; Ghafouri-kesbi and Eskandarinasab, 2008; Mohammedi *et al.,* 2010; Shokrollahi and Baneh, 2012 and Mokhtari *et al.,* 2012).

The maternal permanent environmental effect (c^2) ranged from 0.13 to 0.21 and from 0.01 to 0.06 for BW and ADG, respectively, and was found to be 0.11 for WW (Table 2). That seemed to be close to that reported elsewhere (Ligda et al., 2000; Kalantar and Torshizi, 2002; Duguma *et al.,* 2002 and Mohammadi and Edriss, 2007). Edriss *et al* (2002) reported an estimate of 0.07 for the permanent effect of the dam in BW. They attributed this value to the influence of the uterus and the effect of multiple births. Relatively large c^2estimate for BW most likely reflected differences in rearing abilities of dams that might be influenced by environmental fluctuations between years or her birth status.

Estimates of correlations between direct and maternal genetic effects (r_{am}) for BW and WW attained in table 2 seemed to be higher than that previously reported ranged from -0.64 to 0.89 and from 0.16 to 0.91 for BW and WW, respectively**.** In this respect, Hassen et al (2003) with Awassi sheep reported that correlations between direct and maternal genetic effects (r_{am}) for BW, WW and ADG were -0.23,-0.57 and -0.74, respectively.

CONCLUSION

Heritability estimates of early growth traits derived from the different models ranged from low to moderate. It seems that ignoring genetic and environmental maternal effects lead to an overestimation of the h^2 estimates. Likewise, exclusion of maternal permanent environmental effects of the dam resulted in overestimation of h^2_m estimates, particularly for BW. Thus, direct and maternal effects need to be considered when carrying out genetic evaluations of early growth traits. Similarly, genetic and environmental maternal effects on WW should not be ignored because they could mask the true genetic potential of lambs. That might be of help to breeders in order to plan appropriate breeding programs for improving growth performance in Barki sheep.

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تقدير المعالم الوراثية لصفات النمو المبكرة فى الأغنام البرقى فى مصر

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استهدفت الدراسة تقدير المعالم الوراثية لوزن الميلاد و وزن الفطام ومتوسط معدل النمو من الميلاد وحتى الفطام فى الأغنام البرقى. استخدمت الدراسة سجلات قطيع الأغنام البرقى لعدد ١١٧٦ من الحملان وهم أبناء لعدد ٨٣ كبش و ٦٩٠ نعجة خلال الفترة من عام ١٩٩٤ حتى ٢٠٠١ حيث كان القطيع يربى فى محطة بحوث مريوط الواقعة على مسافة ٣٥ كيلومتر غرب الأسكندرية.تم إجراء التحليل الأحصائى للبيانات المتاحة باستخدام أربعة نماذج من برنامج نموذج الحيوان تختلف فيما بينها فى احتوائها أو عدم احتوائها على التأثير الوراثى الأمى، التأثير الأمى البيئي الدائم، كما تضمنت هذه النماذج بعض التأثيرات الثابتة (الجنس، سنة الميلاد، عمر الأم) والتأثيرات العشوائية (الحيوان، الكبش، النعجة).

تم تقدير المكافئات الوراثية المباشرة من النموذج الثالث والذى يتضمن التأثيرات الوراثية التجمعية الأمية بمقدار 0.11 لوزن الميلاد، 0.15 لوزن الفطام ، 0.13 لمتوسط معدل النمو من الميلاد للفطام. كما تم تقدير المكافئ الوراثى الأمى لوزن الميلاد، و وزن الفطام ومتوسط معدل النمو من الميلاد وحتى الفطام بمقدار 0.11 و 0.04 و 0.02 على الترتيب. كما كانت تقديرات معاملات الارتباط بين التأثيرات الوراثية المباشرة والتأثيرات الوراثية الأمية عالية وسالبة. كما أوضحت النتائج أهمية الأخذ فى الاعتبار كل من التأثيرات الوراثية التجمعية المباشرة و التاثيرات الوراثية التجمعية الأمية عند إجراء التقييم الوراثى لصفات النمو المبكرة لتحسين أداء الأغنام البرقى.

قام بتحكيم البحث

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