

EVALUATION OF DIRECT AND MATERNAL (CO) VARIANCE COMPONENTS AND HERITABILITIES FOR SOME BODY WEIGHTS AND GROWTH TRAITS IN BARKI SHEEP

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ABSTRACT

The present study was conducted to investigate the importance of maternal effects on some body weights and growth traits in Barki sheep. Body weight records and pedigree information of 3189 lambs progenies of 186 sires were taken from the Barki sheep flock of the Desert Research Centre maintained at two research stations; Ras Elhekma (from 1963 to 1972) and Maryout (from 1973 to 2004). The present study dealt with body weights at birth, *BW*, weaning, 120 days, *WW* and yearling, 360 days, *YW* as well as average daily gain from birth to weaning, *DGBW* and from weaning to yearling, *DGWY*. (Co) variance components and the corresponding genetic parameters were estimated by fitting a series of six animal models using the MTDFREML program. These models included the significant fixed effects together with the animal, sire and dam as random effects. Such models were fitted for each studied trait and differed in ignoring or including various random effects. Log-likelihood ratio tests were conducted to determine the most suitable model for the studied traits.

Results indicated that the animal model which includes only direct genetic effect was the most appropriate one. Direct heritability estimates ranged from 0.10 to 0.36 for *BW*, 0.13 to 0.30 for *WW*, 0.07 to 0.23 for *YW*, 0.13 to 0.26 for *DGBW* and 0.08 to 0.10 for *DGWY*. The corresponding values for maternal heritability ranged from 0.18 to 0.20, 0.12 to 0.19, 0.12 to 0.19, 0.10 to 0.17 and 0.01 to 0.07, respectively. It is obvious that maternal influences were generally higher for *BW*, *WW* and *YW* than the respective direct ones. The direct and maternal environmental components tended to increase as age advanced from birth to yearling. The correlation between direct and maternal genetic effect ranged from 0.07 to 0.35 for the studied traits except for *DGWY* (-0.72). Although total direct components has a major contribution (82%) to the phenotypic variance, total maternal components controls the remainder of about 20% and being relatively constant at that level to the yearling stage which imply the importance of maternal influences on growth traits of Barki sheep. The impact of maternal effects on *BW* appeared to be mainly genetic and tended to decline as age advanced. The current investigation advocates that selection process should account for both direct and maternal genetic effects to increase the accuracy of genetic evaluation and enhance the genetic gain for growth traits in Barki sheep.

INTRODUCTION

Barki sheep is one of the indigenous breeds of Egypt, known to be well adapted to the dry, harsh conditions and scarce vegetation of the north western desert. They are fat-tailed and while it is a dual-purpose sheep (meat and wool), they are mostly kept for their mutton production. For faster genetic improvement and increasing the efficiency of the prevailing production system, accurate genetic parameters for economically important traits are prerequisite. An effective breeding plan can only be devised after thorough knowledge has

been obtained about the inheritance of economically important traits estimated from sheep dominated in such prevailing conditions. Recently, several investigations indicated considerable maternal effects on body weight and growth traits in sheep (Maria *et al.*, 1993; Snyman *et al.*, 1995; Gowane *et al.*, 2010; Rashidi *et al.*, 2011) and these effects being important in the expression of animal performance. Maternal effects occur when an offspring's phenotype is influenced by that of its mother, it may be caused by genes that a

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mother is carrying as well as by the environment she experiences (Robison, 1981). Maternal effects arise from mother's ability to produce the milk needed for growth of the lambs in addition to her general maternal behavior (Rashidi, 2012; David *et al.*, 2013). When growth traits are included in the breeding goal, both direct and maternal genetic effects should be taken into account together with their correlations in order to achieve optimum genetic progress (Ligda *et al.*, 2000; Ghafouri-Kesbi and Baneh, 2012). Recent development in statistical methods has simplified the partitioning of variance components into direct and maternal effects which can be included in animal model analyses (Meyer, 1998). The importance of maternal effects on growth parameters together with its implications on the genetic improvement program has not been fully investigated in Barki sheep. Therefore, the objective of the present study is to investigate the importance of maternal effects on some body weights and growth traits through fitting different animal models including both genetic maternal and environmental effects to estimate genetic parameters, particularly the maternal ones in order to help formulating an optimum breeding program for improving Barki sheep.

MATERIALS AND METHODS

Data

Body weight records and pedigree information of Barki sheep were originated from the sheep flock of the Desert Research Centre maintained at two research stations; Ras Elhekma (from 1963 to 1972) and Maryout (from 1973 to 2004). Management of the flock was almost the same where ewes were often first mated at approximately 16 months of age. The breeding season usually carried out once a year in June – July to start lambing in October – November. At birth, lambs were weighed to assign birth weight, then body weights were recorded at biweekly intervals till weaning followed by monthly intervals till the animal removed from the flock. Shearing took place

once a year during April- May. Feeding of the flock depends mainly on grazing at Ras Elhekma while rely on cut and carry at Maryout research station. Detailed flock management was described by El-Wakil *et al.* (2009).

The present study dealt with body weights at birth, *BW*; weaning, 120 days, *WW* and yearling, 360 days, *YW*. Average daily gain was also calculated from birth to weaning, *DGBW* and from weaning to yearling, *DGWY*. *BW* was kept as recorded while *WW* and *YW* were linearly adjusted to body weights at 120 and 360 days, respectively. The adjustments for individual body weights to different ages were made by interpolation between the data of two successive ages assuming linear growth function during the short intervals. *DGBW* was calculated as the difference between birth and weaning body weights divided by the number of days from birth till weaning. *DGWY* was calculated as the difference between weaning and yearling body weights divided by exact number of days from weaning up to 360 days. Editing of the original data was done to remove the few numbers of twinning from the data set together with those animals that had missing identifications. After editing, the data set consisted of 3189 records of lambs which were progenies of 186 sires. Characteristics of the data structure are summarised in table (1).

Table (1). Characteristics of the data structure for the studied traits

	No of records	Mean (kg)	S.E. (kg)	C.V. (%)
No. of animals	3189			
No. of sires	186			
No of dams	1748			
BW	3189	3.54	0.01	17.92
W120	2780	17.51	0.08	24.01
W360	1717	31.56	0.17	22.90
DGBW	2780	0.116	0.64	29.02
DGWY	1717	0.055	0.55	41.31

Statistical Analysis

Preliminary analyses were performed, using the general linear model (GLM) procedure of SAS (SAS, 2004), to determine

the significance of the fixed effects to be included in the final model for the studied traits. The significant fixed effects in the analytical model were lamb gender, year of birth, dam age and location. Then, these fixed effects were included as seen in the following model and comparisons among subclass means were carried out following Tukey test (SAS, 2004).

$$Y_{ijklm} = \mu + G_i + L_j + R_{k(j)} + A_l + E_{ijklm} \quad (1)$$

Where, Y_{ijklm} is the observation for each studied trait of m^{th} animal of i^{th} gender, j^{th} location and k^{th} year within location and l^{th} age of dam; μ is the overall mean; G_i is the fixed effect of gender (1=male and 2=female); L_j is the fixed effect of location (1= Ras Elhekma and 2= Maryout); $R_{k(j)}$ is the fixed effect of year of birth within location (Ras Elhekma from 1963 to 1972 and Maryout from 1973 to 2004); A_l is the fixed effect of age of dam (2,3,4 and 5 years and more); E_{ijklm} is the random residual error assuming to be NID (0, σ^2_e). These fixed effects were found to be significant for the studied traits, hence they were included in the model.

(Co) variance components and the corresponding genetic parameters were estimated by fitting a series of six animal models using the MTDFREML program (Boldman *et al.*, 1995). All models included the same fixed effects mentioned earlier and considering the animal, sire and dam as random effects. These models were fitted for each studied trait to assess the importance of maternal effects and differed in ignoring or including various random effects and also with and without covariance between animal effects as follows:

Model 1: $y = Xb + Z_a a + e$

Model 2: $y = Xb + Z_a a + Z_c c + e$

Model 3: $y = Xb + Z_a a + Z_m m + e$
where $\text{Cov}(a, m) = 0$

Model 4: $y = Xb + Z_a a + Z_m m + e$
where $\text{Cov}(a, m) = A\sigma_{am}$

Model 5: $y = Xb + Z_a a + Z_m m + Z_c c + e$
where $\text{Cov}(a, m) = 0$

Model 6: $y = Xb + Z_a a + Z_m m + Z_c c + e$
where $\text{Cov}(a, m) = A\sigma_{am}$

where y is a vector of observations on the studied trait; 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 (direct permanent environmental) effects, respectively. X , Z_a , Z_m and Z_c are incidence matrices relating observations to the fixed effects, direct additive genetic effects, maternal additive genetic effects and maternal permanent environmental effects, respectively. It was assumed that direct additive genetic, maternal additive genetic, maternal permanent environmental and direct permanent environmental effects to be normally distributed with mean of zero and variance of $A\sigma_a^2$, $A\sigma_m^2$, $I_d\sigma_c^2$ and $I_n\sigma_e^2$, respectively; where, σ_a^2 , σ_m^2 , σ_c^2 and σ_e^2 are direct additive genetic variance, maternal additive genetic variance, maternal permanent environmental variance and the direct permanent environmental variance, respectively. "A" is the additive numerator relationship matrix, while I_d , I_l and I_n are identity matrices with dimensions equal to the number of the dams and number of records, respectively. Moreover, σ_{am} refers to the covariance between direct additive genetic and maternal additive genetic effects.

(Co) variance components were also employed to estimate direct (h^2_d) and maternal heritabilities (h^2_m). Depending on the model, variance ratios were computed as additive direct heritability ($h^2_d = \sigma_a^2 / \sigma_p^2$), where σ_p^2 is the phenotypic variance, additive maternal heritability ($h^2_m = \sigma_m^2 / \sigma_p^2$) and the ratio of maternal permanent environmental variance to the phenotypic variance ($c^2 = \sigma_c^2 / \sigma_p^2$). The direct-maternal genetic correlation ($r_{a,m}$) was computed as the ratio of the direct-maternal genetic covariance ($\sigma_{a,m}$) to the product of the square roots of σ_a^2 and σ_m^2 . Error variance was estimated directly from the residual sums of squares. Among the above mentioned six models, the most appropriate model for each trait was selected based on likelihood ratio tests, Log L (Meyer, 2000). The higher the Log L. value the more appropriate the model.

RESULTS AND DISCUSSION

Direct and maternal (co) variance components for the studied traits are presented in table (2) together with their corresponding heritabilities. It appeared that estimates of

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genetic parameters for the studied traits are model dependent and greatly influenced by the statistical model used in the analysis (Ligda *et al.*, 2000; Ghafouri-Kesbi and Eskandarinasab, 2008; Shokrollahi and Baneh, 2012). The most suitable model for each trait was determined based on Log L values. Model 1 had consistently the highest Log L values whereas slight differences have been existed among the corresponding values of the other models. Therefore, the simple animal model (Model 1) which containing the direct additive genetic effect as the sole random effect appeared to sufficiently explain the variation in the data while no improvements have been occurred in its Log L value as a result of introducing maternal effects. On the other hand, the addition of maternal effects, either genetic or environmental (Models 2-6), seemed to affect the estimated h^2_d and other genetic parameters which reveal the importance of maternal influence in determining genetic parameters for the studied traits in Barki sheep.

Direct additive genetic variance (σ^2_a) and heritabilities (h^2_d)

Model 1, which ignored maternal effects, resulted in higher estimates of σ^2_a and h^2_d than did the other models (Table 2). Estimates of h^2_d ranged from 0.11 to 0.36 (*BW*), 0.13 to 0.30 (*WW*), 0.07 to 0.23 (*YW*), 0.13 to 0.26 (*DGBW*) and 0.08 to 0.10 (*DGWY*). Based on the appropriate models previously determined (Model 1), the corresponding values for σ^2_a were 0.13, 3.85, 7.41, 215.89 and 27.20, respectively. Direct additive effects in *BW*, *WW* and *YW* obtained from the appropriate models are of importance as evident from the estimates of their corresponding moderate h^2_d which indicate that genetic progress for growth traits in Barki sheep is possible by mass selection. Selection for *DGBW* would be more effective than *DGWY*.

Table (2) showed that estimates of h^2_d were substantially higher when maternal effects, either genetic or environmental, were ignored from Model 1. Fitting maternal permanent environmental variance (σ^2_c) in Model 2 reduced

the estimates of σ^2_a and h^2_d compared to Model 1, while inclusion of maternal genetic effects (Models 3- 6) showed further reduction in both σ^2_a and h^2_d , for which there is negligible differences in h^2_d of the other models within each trait. That trend occurred for all studied traits except for *DGWY* which exhibited higher estimates of σ^2_a and h^2_d in those models included either or both maternal effects together with the direct-maternal covariance. Similar findings were reported elsewhere (Ligda *et al.*, 2000; Maniatis and Pollott, 2003).

The literature showed substantial variation for genetic parameters obtained from various studies which probably attributed to breeds employed, environmental rearing conditions, level and quality of management and nutrition, fitted models used as well as the parameter definition and calculating methods. Furthermore, results obtained from the animal model using univariate analysis are different from those attained from multivariate analysis. Thus, it appears difficult to compare current results with results from the literature.

Maternal additive genetic variance (σ^2_m) and maternal heritabilities (h^2_m)

Estimates of σ^2_m and h^2_m appeared to be dependent on the models from which they were originated (Models 3-6). Estimates of σ^2_m for *BW*, *WW*, *YW*, *DGBW* and *DGWY* ranged from 0.06 to 0.07, 1.51 to 2.41, 3.98 to 6.06, 83.21 to 136.71 and 4.61 to 21.16, respectively. The respective values for h^2_m showed slight differences within each trait and ranged from 0.18 to 0.20, 0.12 to 0.19, 0.12 to 0.19, 0.10 to 0.17 and 0.01 to 0.07, respectively. Estimates of h^2_m for *BW* and *YW* were slightly low in the models without direct-maternal covariance, whereas the opposite pattern occurred for *WW*, *DGBW* and *DGWY* which is probably associated with the negative covariance between direct and maternal genetic effect. These results exhibited reasonable maternal genetic variability in this flock which could be used to select for mothering ability to genetically improve growth traits in Barki sheep.

Table (2). (Co) variance components and genetic parameters for body weights at birth (BW), weaning (WW) and yearling (YW) as well as average daily gain from birth to weaning (DGBW) and from weaning to yearling (DGWY) estimated from various animal models.

Traits	Models	σ^2_a	σ^2_m	σ_{am}	σ^2_e	σ^2_c	σ^2_p	h^2_d	h^2_m	c^2	r_{am}	Log L
BW	1	0.13	-	-	0.24	-	0.37	0.36	-	-	-	9.36
	2	0.05	-	-	0.24	0.07	0.36	0.14	-	0.19	-	-38.74
	3	0.04	0.07	-	0.25	-	0.36	0.11	0.20	-	-	-52.17
	4	0.04	0.06	0.01	0.25	-	0.36	0.11	0.18	-	0.22	-52.54
	5	0.04	0.07	-	0.25	0.00	0.36	0.11	0.20	0.00	-	-52.17
	6	0.04	0.06	0.01	0.25	0.00	0.36	0.11	0.18	0.00	0.22	-52.54
WW	1	3.85	-	-	9.08	-	12.94	0.30	-	-	-	9803.68
	2	2.25	-	-	8.36	2.16	12.78	0.18	-	0.17	-	9768.38
	3	1.62	2.20	-	8.87	-	12.69	0.13	0.17	-	-	9762.23
	4	1.70	2.41	-0.24	8.83	-	12.69	0.13	0.19	-	-0.12	9762.05
	5	1.70	1.51	-	8.64	0.86	12.71	0.13	0.12	0.07	-	9759.96
	6	1.74	1.63	-0.12	8.62	0.84	12.71	0.14	0.13	0.07	-0.07	9759.91
WY	1	7.41	-	-	25.46	-	32.87	0.23	-	-	-	7655.77
	2	4.25	-	-	22.56	5.70	32.50	0.13	-	0.18	-	7633.40
	3	2.29	6.06	-	23.96	-	32.31	0.07	0.19	-	-	7625.03
	4	2.11	5.44	0.64	24.12	-	32.31	0.07	0.17	-	0.19	7624.92
	5	2.43	5.21	-	23.63	1.05	32.31	0.08	0.16	0.03	-	7624.74
	6	2.15	3.98	1.03	23.78	1.36	32.30	0.07	0.12	0.04	0.35	7624.46
DGBW	1	215.89	-	-	605.78	-	821.67	0.26	-	-	-	21233.22
	2	137.79	-	-	562.54	114.09	814.42	0.17	-	0.14	-	21208.93
	3	102.67	115.96	-	591.13	-	809.76	0.13	0.14	-	-	21203.65
	4	109.74	136.71	-23.28	586.44	-	809.61	0.14	0.17	-	-0.19	21203.23
	5	106.30	83.21	-	578.45	42.75	810.71	0.13	0.10	0.05	-	21202.21
	6	111.52	99.67	-16.70	575.68	40.30	810.47	0.14	0.12	0.05	-0.16	21201.98
DGWY	1	27.20	-	-	291.61	-	318.81	0.09	-	-	-	11406.41
	2	25.24	-	-	288.23	5.18	318.65	0.08	-	0.16	-	11406.21
	3	24.52	4.61	-	289.56	-	318.68	0.08	0.01	-	-	11406.16
	4	31.50	21.16	-18.62	284.74	-	318.77	0.10	0.07	-	-0.72	11405.00
	5	24.49	4.61	-	289.48	0.03	318.60	0.08	0.01	0.00	-	11406.16
	6	31.51	21.04	-18.57	284.71	0.13	318.82	0.10	0.07	0.00	-0.72	11405.00

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, r_{am} = correlation of additive genetic effect and maternal genetic effect and Log L= log likelihood. The most appropriate models according to log likelihood are in bold.

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The importance of maternal effects are demonstrated to be substantial in young animals and tend to diminish with age (Ligda *et al.*, 2000; Gowane *et al.*, 2010; Senemari *et al.*, 2011). However, it is remarkable that maternal influences tended to sustain throughout the first year of Barki sheep despite the slight reduction in σ_m^2 and h_m^2 from *BW* to *WW* to *YW* (Tables 2 and 3). It is demonstrated that the effect of maternal influences was performed after weaning until nine months of age (Rashidi, 2012) and still present for body weight at 12 months of age (Safari and Fogarty, 2003; Snyman, 2012).

Table (2) revealed that h_m^2 estimates were generally higher for *BW*, *WW* and *YW* than the corresponding estimates of h_d^2 while the opposite trend occurred in *DGWY* with some discrepancies in *DGBW*. Maternal heritability was more important for *DGBW* than *DGWY*. Several investigators reported higher h_m^2 than h_d^2 (Senemari *et al.*, 2011; Thiruvankadan *et al.*, 2011) while others indicated the opposite trend (Rashidi, 2012; Shokrollahi and Baneh, 2012). The higher estimates of h_m^2 than h_d^2 exhibited in table (2) probably indicates that it may be worthwhile to use aggregate breeding values (direct and maternal) for accurate design of a breeding program for Barki sheep since both genotype of the lamb and genotype of the dam had an influence on these body weights. That suggestion is consistent with Assan *et al.* (2011).

Direct (σ_d^2) and maternal (σ_c^2) permanent environmental variances

Table (2) indicated that σ_e^2 and σ_c^2 tended to increase as age increased from birth to weaning to yearling. For all traits, σ_c^2 and c^2 exhibited the highest estimate in the presence of direct additive genetic effect (Model 2) whereas addition of maternal genetic effects in the model reduced c^2 estimates to reach negligible values (Models 5 and 6). For *WW*, *YW* and *DGBW*, ignoring c^2 (Models 3 and 4) let a large amount of this variance allocated mainly for σ_m^2 and resulted in higher estimate of h_m^2 . Thus, estimation of c^2 is necessary to obtain accurate estimates of h_m^2 . Similar findings were reported elsewhere (Snyman *et al.*, 1995; Ligda *et al.*, 2000).

Since it has all (co) variance components, the full model (Model 6) was utilized to calculate the percentages of direct additive ($\sigma_a^2\%$), maternal additive ($\sigma_m^2\%$), maternal permanent environmental (c^2), direct permanent environmental ($\sigma_e^2\%$) variance components as well as direct maternal covariance component ($\sigma_{am}\%$) from the phenotypic variance (σ_p^2) together with total maternal (TMC) and total direct components (TDC) for the studied traits (Table 3). Although TDC has a major contribution (82%) to the phenotypic variance, TMC controls the remainder of about 20% and being relatively constant at that level to the yearling stage. Keeping in mind that genetic improvement program is a long term process; such observed contribution of 20% for maternal effects cannot be neglected as it is likely to be enlarged in the long run. That would imply the importance of maternal effects on growth traits of Barki sheep which may be taken into consideration in any selection program on this breed. In the same context, the impact of maternal effects on *BW* appeared to be mainly genetic since $\sigma_m^2\%$ reached its maximum level with no variance due to maternal permanent environmental effects ($c^2=0$). The contribution of c^2 increased for *WW* and *YW*. A possible interpretation could be that maternal influences at birth are entirely genetic where lambs being dependent on their mothers, whereas weaned lambs depend on themselves and affected to some extent by genetic and/or environmental portions of the maternal effects up to the yearling stage. Presumably, maternal effects at the moment of birth might reflect the differences in the quality and capacity of the uterine space for fetal growth as well as other maternal behaviors whereas suckling and feeding level, weather conditions, disease and other environmental factors could be accounted for from birth onwards. Similar findings were reported elsewhere (Maria *et al.*, 1993; Ghafouri-Kesbi and Baneh, 2012; Gowane *et al.*, 2010). On the other hand, several investigators have proven positive association between maternal genetic effects and milk produced by ewes (Rashidi, 2012; David *et al.*, 2013). In case of Barki sheep, milk production is often not sufficient to rear one single lamb.

Regarding the present results which indicated that maternal effects extended for the whole first year, it is likely that maternal influence in this breed probably reflects an adaptive mechanism of mothering ability through which the mother provide more care for her offspring to stand against the harsh environmental conditions of the desert.

Table (3) revealed that $\sigma_e^2\%$ were much higher than the respective values of c^2 at all ages. While $\sigma_a^2\%$, $\sigma_m^2\%$ and c^2 tend to decrease

from weaning to yearling stages; $\sigma_e^2\%$ shows a gradual increase after weaning till yearling stage which probably associated with a reduction of $\sigma_a^2\%$ and consequently for h^2_d as observed in table (2). It is worthwhile mentioned that this flock is usually subjected to interrupted feed shortage for prolonged periods throughout the year and even before mating and lambing seasons which resulted in poor milk production by the ewes in addition to creating large environmental variation particularly at later

Table (3). Percentages of (co) variance components (*in brackets*) and total maternal (TMC) and total direct (TDC) component for the studied traits estimated from the full model (Model 6)

Trait	σ_a^2	σ_m^2	σ_{am}	σ_e^2	σ_c^2	σ_p^2	TMC	TDC
BW	0.04 (0.11)	0.06 (0.17)	0.01 (0.03)	0.25 (0.69)	0.00 (0.00)	0.36	0.19	0.82
WW	1.74 (0.14)	1.63 (0.13)	-0.12 (0.00)	8.62 (0.68)	0.84 (0.07)	12.71	0.20	0.82
YW	2.15 (0.07)	3.98 (0.12)	1.03 (0.03)	23.78 (0.74)	1.36 (0.04)	32.30	0.18	0.83
DGBW	111.52 (0.14)	99.67 (0.12)	-16.70 (0.00)	575.68 (0.71)	40.30 (0.05)	810.47	0.17	0.85
DGWY	31.51 (0.10)	21.04 (0.07)	-18.57 (0.00)	284.71 (0.89)	0.13 (0.00)	318.82	0.07	0.99

σ_a^2 = direct additive variance, σ_m^2 = maternal additive variance, σ_{am} = direct maternal covariance, σ_c^2 = maternal permanent environmental variance, σ_e^2 = direct permanent environmental variance, σ_p^2 = phenotypic variance, TMC= $\sigma_m^2 + 0.5 \sigma_{am} + \sigma_c^2$ and TDC= $\sigma_a^2 + 0.5 \sigma_{am} + \sigma_e^2$. Negative (co) variance components were regarded as zeros.

stages after weaning. That might explain the tendency for h^2_d to slightly decline as age advanced towards weaning and yearling stages. Such findings are in consistent with other investigators (Ghafouri-Kesbi and Eskandarinasab, 2008; Senemari *et al.*, 2011).

Correlation of additive genetic effect and maternal genetic effect (r_{am})

Table (2) indicated that estimates of r_{am} ranged from 0.07 to 0.35 for the studied traits while showed much higher and negative estimates for *DGWY* (-0.72). Direct maternal covariances (σ_{am}) as well as r_{am} estimates were positive for *BW* and *YW* and being negative for other traits with slight differences between Model 4 and Model 6. These results revealed that in addition to additive direct effect, maternal influences, either genetic and/or environmental,

are important and must be considered when estimating genetic parameters for growth traits in Barki sheep. In this context, the positive correlation between direct and maternal genetic effects may account for increasing lamb birth weight and possible lambing difficulties. On the other hand, the negative r_{am} obtained suggests the need to develop separate sire and dam lines to maximize genetic progress for these traits. Similar suggestion was reached in Rambouillet, Targhee and Columbia lambs (Burfening and Kress, 1993).

It is notable that accurate estimate of maternal effects is dependent on key pedigree relationships and data structure. Large data with many relationship between relatives related to the mother is necessary to allow for effective separation of maternal genetic components (Maniatis and Pollott, 2003). The current study

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was planned to investigate the importance of maternal effects on growth parameters in Barki sheep. It is thought that such interesting topic needs to be thoroughly investigated; therefore the full set of data available at Desert Research Centre from 1963 to 2004 was employed in order to produce reliable estimates for genetic parameters, particularly the maternal ones.

CONCLUSION

The current investigation revealed that while total direct components has a major contribution of 82% to the phenotypic variance in body weights, maternal effects, both genetic and environmental, have controlled the remainder of about 20% and being persisted up to the yearling stage. The importance of maternal effects in Barki sheep is obvious as a result of the obtained moderate estimates of maternal heritabilities together with its impact on the estimation of genetic parameters. Moreover, negative correlations between direct and maternal genetic effects in some traits indicated different rankings of individuals when the maternal contribution is omitted in the evaluation procedure, hence maternal effects could mask true genetic potential of lambs. Therefore, in order to obtain reliable estimates of genetic parameters for body weights and to increase the accuracy of genetic evaluation, the present study advocate that selection process accounting for both direct and maternal genetic effects would enhance the genetic gain for growth traits in Barki sheep than selection based only on direct genetic effects.

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الملخص العربي

تقييم مكونات التباين والتغاير المباشرة والأمية والمكافئات الوراثية لبعض أوزان الجسم وصفات النمو في الأغنام البرقى

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عند عمر سنة، 0.13 to 0.26 لمعدل النمو من الميلاد وحتى الفطام، 0.08 to 0.10 لمعدل النمو من الفطام وحتى عمر سنة. كما تراوحت المكافئات الوراثية الأمية ما بين 0.18 to 0.20 لوزن الميلاد، 0.12 to 0.19 لوزن الفطام، 0.12 to 0.19 للوزن عند عمر سنة، 0.10 to 0.17 لمعدل النمو من الميلاد وحتى الفطام، 0.01 to 0.07 لمعدل النمو من الفطام وحتى عمر سنة. وكان من الواضح أن المكافئات الوراثية الأمية أعلى من مثيلاتها المباشرة لأوزان الميلاد والفطام وعند عمر سنة. زادت مكونات التباين البيئية المباشرة والأمية بزيادة العمر من الميلاد وحتى عمر سنة. تراوحت معاملات الارتباط الوراثية ما بين التأثيرات المباشرة والأمية ما بين 0.07 to 0.35 للمكافئات المدروسة ما عدا معدل النمو من الفطام وحتى عمر سنة (-0.72). أوضحت الدراسة أن مكونات التباين المباشرة الكلية تمثل 82% من التباين الكلى وتمثل مكونات التباين الأمية الكلية حوالي 20% ونظرا هذه النسبة ثابتة تقريبا حتى عمر سنة مما يوضح أهمية التأثيرات الأمية على صفات النمو في الأغنام البرقى. التأثيرات الأمية على وزن الميلاد كانت أساسا وراثية وتناقصت بتقدم العمر. أوصت الدراسة بضرورة أن يتضمن البرنامج الانتخابي كلا من التأثيرات الوراثية المباشرة والأمية لزيادة دقة التقييم الوراثي وزيادة العائد الوراثي لصفات النمو في الأغنام البرقى.

أجريت هذه الدراسة للتعرف على أهمية التأثيرات الأمية على بعض أوزان الجسم وصفات النمو في الأغنام البرقى. استخدمت في هذه الدراسة سجلات النسب و أوزان الجسم لعدد 3189 حمل أبناء لعدد 186 كبش المتحصل عليها من قطيع الأغنام البرقى التابع لمركز بحوث الصحراء في كلا من محطة بحوث رأس الحكمة (منذ عام 1963 حتى 1972) ومحطة بحوث مريوط (منذ عام 1973 حتى 2004). الصفات المدروسة هي وزن الميلاد، وزن الفطام عند 120 يوم، الوزن عند عمر سنة، 360 يوم بالإضافة إلى متوسط معدل النمو من الميلاد وحتى الفطام وكذلك من الفطام وحتى عمر سنة. باستخدام برنامج (MTDFREML) تم تقدير مكونات التباين والتغاير والمعالم الوراثية لكل الصفات المدروسة من خلال عدد ستة نماذج الحيوان الإحصائية التي تضمنت التأثيرات الثابتة الهامة علاوة على التأثيرات العشوائية وهي الحيوان والكباش والنعاج، وقد اختلفت هذه النماذج فيما بينها من حيث احتوائها أو عدم احتوائها على هذه التأثيرات العشوائية. وتم استخدام Log likelihood ratio test لتحديد أفضل هذه النماذج لكل الصفات المدروسة. أوضحت النتائج أن نموذج الحيوان الذي يتضمن التأثيرات الوراثية المباشرة هو أفضل النماذج التي تم دراستها. تراوحت المكافئات الوراثية المباشرة ما بين 0.10 to 0.36 لوزن الميلاد، 0.13 to 0.30 لوزن الفطام، 0.07 to 0.23 للوزن