GENETIC ANALYSIS OF PRE-WEANING GROWTH TRAITS OF BARKI AND RAHMANI LAMBS

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SUMMARY

Data relevant to 704 Barki and 732 Rahmani lambs born at Alexandria University Experimental Station between 1991-2014 were utilized in this investigation to estimate genetic parameters, breeding values and genetic trends of birth weight (BW), weaning weight (WW) and average daily gain (ADG). The fixed effects of season and year of birth, sex of lamb, type of birth and parity on the considered traits were also studied.

The least squares analysis with unequal subclass numbers showed that the overall means of BW, WW and ADG of Barki lambs were 3.69 kg, 20.53 kg and 139.7 g, respectively, the corresponding values for Rahmani lambs were 3.54 kg, 20.09 kg and 137.8 g, respectively. The analysis also indicated that fixed factors effects on all studied traits of both breeds were generally significant (P<0.01or P<0.05) except for the effects of year of birth on BW and parity on WW and ADG of Barki lambs were not significant.

Genetic parameters and breeding values for the studied traits were estimated using the Wombat programme fitting Multiveriate Animal Models. Estimates of the direct heritability (h^2_a) were 0.186, 0.078 and 0.073 for BW, WW and ADG of Barki lambs, respectively. The corresponding values for Rahmani lambs were 0.285, 0.130 and 0.121, respectively. Estimates of the maternal heritability (h^2_m) were 0.121, 0.099 and 0.103 for BW, WW and ADG of Barki lambs, respectively. The respective values for Rahmani lambs were 0.097, 0.040 and 0.033, respectively. Estimates of the fraction of variance due to maternal permanent environmental effects (C^2) were 0.024, 0.022 and 0.016 for BW, WW and ADG of Barki lambs, respectively. The corresponding values for Rahmani lambs were 0.094, 0.039 and 0.033, respectively. Maternal effects were considerable portion of variation for early growth traits of both breeds.

All correlations were positive and significant (P<0.01). The genetic corrletions were extermely high, being 0.993, 0.991 and 1.000 between BW and WW, between BW and ADG and between WW and ADG of Barki lambs, respectively. The corresponding values for Rahmani lambs were 0.685, 0.677 and 1.000. The maternal genetic correlations were high to extremely high being of 0.775, 0.753 and 0.999 between BW and WW, between BW and ADG and between WW and ADG of Barki lambs, respectively. The respective values for Rahmani lambs were 0.984, 0.988 and 1.000, respectively. The maternal permanent environmental correlations among growth traits of both breeds were extremely high ranged from 0.926 to 0.997. The phenotypic correlations were moderate since they varied from 0.395 to 0.479 between BW and each of WW and ADG of both breeds, and were extremely high being 0.994 and 0.996 between WW and ADG of Barki and Rahmani lambs, respectively. High and positive genetic correlations among lamb's growth traits of both breeds showed that improvement of one trait by selection would cause positive progress in the others.

The breeding values for BW, WW and ADG of Barki rams ranged between -0.227 and 0.333 kg, between -1.666 and 2.444 kg and between -11.60 and 17.00 g, respectively. The corresponding values for Rahmani rams were between -0.475 and 0.241 kg, between -3.995 and 2.983 kg and between -27.21 and 20.57g. The genetic trends estimated by the regression of rams breeding values on time were positive but not significant for all traits of both breeds except for BW of Rahmani lambs which was significant (P<0.05). The results in general showed the need for designing an effective selection programme to improve growth traits of lambs of both breeds.

Keywords: Pre-weaning growth, genetic parameters, breeding values, genetic trends, Barki, Rahmani, lambs

INTRODUCTION

Lambs are the most profitable outcome of any sheep flock in Egypt. Early growth traits of lamb are of particular interest for the profitability in any sheep producing enterprise (Selvaggi *et al*. 2011, Javed *et al.* 2013, Mohammadi *et al*. 2013, Mokhatri *et al.* 2013, Rashidi 2013, , Jannune *et al.* 2015, AL-Bial *et al.* 2016 and Eteqadi *et al*. 2016). Growth traits of lambs are quantitative in nature and are influenced by lamb's genetic potential for growth, maternal genetic and permanent environmental effects and temporary environmental effects (Mostafa *et al*. 2011, Rashidi 2013, Mohammadi *et al*. 2013, Akthar *et al.* 2014, Jalil-Sarghale *et al*. 2014, Mohammadi *et al*. 2015, Aguiree *et al.* 2016, Aksoy *et al*. 2016, Bayeriyar and Hadi 2016, Eteqadi *et al*. 2016 and Taghi *et al*. 2016).

Knowledge of genetic and phenotypic parameters is important for determination of the optimal breeding strategies for the genetic improvement of the lambs' growth traits (Selvaggi *et al*. 2011, Jafari *et* *al*. 2012, Shokrollahi and Zandieh 2012, Javed *et al*. 2013, Mohammadi *et al*. 2013, Mokhatri *et al*. 2013, Rashidi 2013, Jalil-Sarghale *et al*. 2014, Al-Samarai *et al*. 2015, Aguirre *et al*. 2016, AL-Bial *et al*. 2016, Bayeriyar and Hadi 2016and Jawasreh *et al*. 2018). An accurate prediction of breeding value of growth traits of lambs is an integral part of most genetic improvement breeding programmes (Javed *et al*. 2013, Akthar *et al.* 2014, Roshanfekr 2014, Ahmadpanah *et al.* 2016, Eteqadi *et al*. 2016, Baneh and Ahmadpanah 2018, Yadav*et al.* 2018 and Sallam *et al.* 2019). Genetic trends for early growth traits of lambs of different sheep breeds have been indicated by several investigations (Mostafa *et al*. 2011, Hossein-Zadeh 2012, Javed *et al*. 2013, Roshanfekr 2014, Aguirre *et al*. 2016, Ahmadpanah *et al*. 2016, Eteqadi *et al*. 2016, Mallick *et al*. 2016, Baneh and Ahmadpanah 2018, Jawasreh *et al*. 2018, Yadav *et al.* 2018 and Sallam *et al.* 2019).

The objective of this investigation was to estimate genetic parameters, breeding values and genetic trends of birth and weaning weights and pre-weaning average daily gain of Barki and Rahmani lambs in an experimental flock of sheep.

MATERIALS AND METHODS

Data:

Data used in this investigation were from the records of the sheep flock of the Experimental Station, Faculty of Agriculture, Alexandria University. The records covered the period from 1991 to 2014 and were relevant to 704 and 732 Barki and Rahmani lambs presenting 20 and 21 rams and 205 and 214 ewes, respectively. Basic statistics and distribution of the data are show in Table 1.

Table 1: Basic statistics and distribution of the data for the studied traits of Barki and Rahmani lambs.

Items	Barki			Rahmani		
	BW	WW	ADG	BW	WW	ADG
Mean , (kg or g)	3.69[a]	20.53[a]	139.7[a]	3.54[b]	20.09[a]	137.8[a]
SD, (kg)	0.60	4.64	37.00	0.59	4.27	33.82
C.V (%)	16.28	22.95	26.62	16.76	22.00	25.23
No. of records	704	636	636	732	629	629
No. of sires	20	20	20	21	21	21
No. of dams	205	197	197	214	195	195
No. of ram lambs	363	331	331	358	304	304
No. of ewe lambs	341	305	305	374	325	325
No. single lambs	633	570	570	478	416	416
No. twin lambs	71	66	66	254	213	213

BW: birth weight, WW: weaning weight, ADG: average daily gain.
Means of each trait with the same letter are not significantly different (P>0.05).

Animals were housed in semi closed pens, fed on *Berseem* (*Trifolium alexandrinum*) during winter and spring and on stubble and *Berseem* hay and/ or fodder sorghum (*Sorghum bicolor)* during summer and autumn. Supplementary concentrate ration of about 0.25 kg / head was offered daily along the year.

The flock was managed for all year round lambing. Females were first mated at about 18 months of age. Rams and ewes were selected as yearlings based on visual appraisal for type and size rather than on a pre-set intensive selection programme. Once the ewe entered the breeding flock, there is no chance for culling until the end of its productive life.

Statistical procedures:

Least squares of GLM procedure (SAS 2008) were utilize to test the significance of the fixed effects of season of birth (4 seasons), year of birth (8 periods), sex (male and female), type of birth (single and twin) and parity (8 parities) on birth weight (BW), weaning weight (WW) and average daily gain (ADG) from birth to weaning of lambs. Months of birth were classified by season into autumn births between September and November, winter births between December and February, spring births between March and May and summer births between June and August. Years of birth from 1991-2014 were classified to eight periods (1= 1991-1993, 2= 1994 - 1996, 3=1997 - 1999, 4= 2000 – 2002, 5= 2003-2005, 6= 2006-2008, 7= 2009-2011 and 8= 2012-2014). Parity was between 1 and 7 or over. Each breed data were analyzed separately. The statistical model fitted was:

$\mathbf{Y_{ijklmn}=\mu + A_i + B_j + C_k + D_l + P_m + e_{ijklmn}}$ where,

$\mathbf{Y_{ijklmn}}$: either BW, WW or ADG; $\boldsymbol{\mu}$: an underlying constant specific to each trait; A_i: the fixed effect of i^{th} season of birth(i=1,2,3 and 4); $\mathbf{B_j}$: the fixed effect of j^{th} year of birth (j=1,2,3……8); $\mathbf{C_k}$: the fixed effect of k^{th} sex(k=1 and 2); $\mathbf{D_l}$: the fixed effect of l^{th} type of birth (l=1 and 2); P_m: the fixed effect of m^{th} parity (m=1,2,37) and $\mathbf{e_{ijklmn}}$: random residual assumed to be independent normally distributed with mean zero and variance σ_e^2 .

Variance components, genetic parameters and breeding values were estimated using the Wombat programme (Meyer 2006) fitting multivariate animal model. The assumed model was:

$y = Xb + Z_a a + Z_m m + Z_c c + e$

where y is a n × 1 vector of observations for each trait; b, a, m, c and e are vectors of fixed effects (season of birth, year of birth, sex and type of birth and parity), direct additive genetic effects, maternal additive genetic effects, maternal permanent environmental effects and the residual effects, respectively; X, Za, Zm, Zc are the incidence matrices of fixed effects, direct additive genetic effects, maternal genetic effects and maternal permanent environmental effects; A is the numerator relationship matrix between animals; and σ_{am} is the covariance between additive direct and maternal genetic effects. The (co)variance structure for the model was:

$V(a) = A\sigma^2_a$, $V(m) = A\ \sigma^2_m$, $V(c) = I_P\ \sigma^2_c$, $V(e) = I_R\ \sigma^2_e$ and Cov (a, m) = 0

where I_P and I_R are identity matrices with orders equal to the number of dams and the number of lambs, respectively and σ^2_a, σ^2_m, σ^2_c, and σ^2_e are direct additive genetic variance, maternal additive genetic variance, maternal permanent environmental variance, and residual variance, respectively. Estimates of heritability (h^2_a), maternal heritability (h^2_m) and permanent maternal environmental effects (c^2) were calculated as ratios of estimates of σ^2_a, σ^2_m, and σ^2_c, respectively, to the phenotypic variance (σ^2_p).

The genetic trends for the studied traits were computed as the regression coefficients of rams breeding values on their year of birth.

RESULTS AND DISCUSSION

The current means of BW, WW and ADG of Barki lambs were 3.69kg, 20.53 kg and 139.7g, respectively. The corresponding values for Rahmani lambs were 3.54 kg, 20.09 kg and 137.8 g, respectively, (Table 1). The present means were higher than those (3.56 kg, 19.29 kg and 131.02 g, respectively) of BW, WW and ADG of Barki lambs depicted by Gad and El-Wakil (2013), and those (3.42 kg, 19.49 kg and 135.00 g, respectively) of Rahmani lambs depicted by Abbas *et al.* (2010) on other experimental flocks of sheep in Egypt.

Fixed effects:

Table 2 shows the results of analysis of variance for fixed effects on all studied traits. The fixed effects on all studied traits of both breeds were generally significant (P<0.01or P<0.05) except for the effects of year of birth on BW and parity on WW and ADG of Barki lambs that were insignificant. Similar significant fixed effects on BW, WW and ADG of lambs of various sheep breeds have been well depicted in the literature (Selvaggi *et al.* 2011, Jafari *et al.* 2012, Mohammadi *et al.* 2013, Mokhatri *et al.* 2013, Jalil-Sarghale *et al.* 2014, Rahimi *et al.* 2014, Al-Samarai *et al.* 2015, Aguiree *et al.* 2016, AL-Bial *et al.* 2016, Taghi *et al.*, 2016, Tohidi *et al.*2016, Marufa *et al.*, 2017 and Jawasreh *et al.*, 2018).

Table 2: Mean squares (MS) and level of significance ((P<) for factors affecting studied traits of Barki and Rahmani lambs.

Source of variation	Barki					Rahmani			
	df*	MS (P<)	BW	WW	ADG	MS (P<)	BW	WW	ADG
Season of birth	3	MS	1.1052	218.3	15187.5	MS	1.7497	87.13	6342.7
		(P<)	0.0278	0.0001	0.0001	(P<)	0.0020	0.0041	0.0014
Year of birth	7	MS	0.6526	339.2	24252.3	MS	1.5113	375.3	26487.2
		(P<)	0.0836	0.0001	0.0001	(P<)	0.0001	0.0001	0.0001
Sex of lamb	1	MS	8.4796	556.6	29685.2	MS	4.9514	225.5	12981.4
		(P<)	0.0001	0.0001	0.0001	(P<)	0.0002	0.0007	0.0011
Type of birth	1	MS	50.072	1421.7	64205.6	MS	57.699	1114.2	51403.7
		(P<)	0.0001	0.0001	0.0001	(P<)	0.0001	0.0001	0.0001
Parity	6	MS	4.4481	44.71	1996.5	MS	4.4875	55.61	2690.7
		(P<)	0.0001	0.0620	0.1946	(P<)	0.0001	0.0097	0.0392
Error		MS	0.3616	22.21	1380.6	MS	0.3514	19.54	1208.9
			(685)	(617)	(617)		(713)	(610)	(610)

BW: birth weight, WW: weaning weight, ADG: average daily gain.
Not significant (P>0.05); Significant (P< 0.05)
Figures within parentheses are the degrees of freedom (df) of the error term.

Genetic and phenotypic parameters:

Variance components and heritabilities:

Estimates of all components of variance (σ^2_a, σ^2_m, σ^2_c, σ^2_e and σ^2_p), direct and maternal heritabilities (h^2_a and h^2_m) and fraction of variance due to maternal permanent environmental effects (c^2) for BW, WW and ADG of Barki and Rahmani lambs are found in Table 3. Estimates of σ^2_a and h^2_a for all studied traits were higher for Rahmani than Barki lambs. An adverse trend was observed for σ^2_m and h^2_m for all traits. The estimates of h^2_a were higher than h^2_m for BW of both breeds. The estimates of h^2_a were relatively lower than h^2_m for WW and ADG in Barki lambs. Whereas, the estimates of h^2_a were higher than h^2_m for WW and ADG in Rahmani lambs. The estimates of σ^2_c and c^2 were higher for Rahmani than Barki lambs for all traits. Estimate of σ^2_e of BW was slightly higher for Barki than Rahmani lambs. An opposite trend was observed for WW and ADG. Estimates of σ^2_p for BW were equal for both breeds and for WW and ADG were higher for Rahmani than Barki lambs.

Table 3. Variance components and heritabilities for the studied traits of Barki and Rahmani lambs

Item	Barki			Rahmani		
	BW	WW	ADG	BW	WW	ADG
σ^2_a	0.078	4.30	208.26	0.118	8.07	378.17
σ^2_m	0.050	5.52	294.17	0.040	2.50	102.58
σ^2_c	0.010	1.23	46.23	0.039	2.39	104.38
σ^2_e	0.281	44.46	2301.58	0.217	49.11	2536.71
σ^2_p	0.421	55.52	2850.26	0.414	62.08	3121.85
$h^2_a \pm$ SE	0.186(0.115)	0.078(0.096)	0.073(0.092)	0.285(0.140)	0.130(0.086)	0.121(0.083)
$h^2_m \pm$ SE	0.121(0.085)	0.099(0.070)	0.103(0.069)	0.097(0.092)	0.040(0.072)	0.033(0.069)
$c^2 \pm$ SE	0.024(0.061)	0.022(0.059)	0.016(0.058)	0.094(0.067)	0.039(0.059)	0.033(0.056)

BW: birth weight, WW: weaning weight, ADG: average daily gain.
σ^2_c: maternal permanent environmental variance, c^2: portion of maternal permanent environmental effects.

The current estimates of h^2_a were 0.186, 0.078 and 0.073 for BW, WW and ADG of Barki lambs, respectively. The corresponding values for Rahmani lambs were 0.285, 0.130 and 0.121 (Table 3). The current low to moderate h^2_a values could be attributed to the low level of nutrition and the differences in managing practices at the sheep experimental station, causing large environmental variations. Jalil-Sarghale *et al.* (2014) reported low h^2_aestimates of 0.06, 0.12 and 0.08 for BW, WW and ADG of Baluchi sheep, respectively in Iran. Also, low h^2_a estimates of 0.124 and 0.169 for BW and WW of Zandi sheep, respectively in Iran were indicated by Taghi *et al.* (2016). Moderate h^2_a estimates of 0.22, 0.20 and 0.38 for BW, WW and ADG of Santa Ines sheep, respectively In Brazil were depicted by Aguiree *et al.* (2016). Moderate to high h^2_a estimates of 0.19, 0.43 and 0.30 for BW, WW and ADG, respectively of White Boni sheep, respectively in Yemen were found by AL-Bial *et al.* (2016). Moderate to high h^2_a estimates from six models ranged from 0.24 to 0.44 for BW and from 0.27 to 0.40 for WW of Karayaka lambs in Turkey were also depicted by Aksoy *et al.* (2016). In India, Mallick *et al.* (2017) documented h^2_a estimates of 0.29 and 0.16 for BW and WW of Bharat Merino sheep, respectively. In Iran, Baneh and Ahmadpanah (2018) reported moderate h^2_a estimates of 0.285 and 0.371 for BW and WW of Ghezel sheep, respectively. Jawasreh *et al.* (2018) obtained h^2_a estimates of 0.30, 0.19 and 0.19 for BW, WW and ADG of Awassi sheep, respectively in Jordan. Sallam *et al.* (2019) depicted low h^2_a estimates of 0.07, 0.15 and 0.16 for BW, WW and ADG of Barki lambs, respectively in another experimental flock in Egypt. The low h^2_a estimates for growth traits of both breeds except for BW of Rahmani lambs indicate that direct genetic effects represent a little portion of the variances in these traits. Hence, slow genetic progress would be obtained by direct selection for these traits.

The present estimates of h^2_m were 0.121, 0.099 and 0.103 for BW, WW and ADG of Barki lambs, respectively. The corresponding values for Rahmani lambs were 0.097, 0.040 and 0.033 (Table 3). The estimates of h^2_m for all studied traits were higher for Barki than Rahmani lambs. Maternal additive effects constitute a considerable part of variation for BW of both breeds and for WW and ADG of Barki lambs only. Similarly, low h^2_mestimates of 0.09, 0.04 and 0.03 for BW, WW and ADG of Baluchi sheep, respectively were reported by Jalil-Sarghale *et al.* (2014). Aguiree *et al.* (2016) also depicted low h^2_m estimates of 0.14, 0.13 and 0.10 for BW, WW and ADG of Santa Ines sheep, respectively. Aksoy *et al.* (2016) obtained h^2_mestimates ranged from 0.15 to 0.22 for BW and from 0.04 to 0.14 for WW of Karayaka lambs, respectively. Low h^2_m estimates of 0.121 and 0.071 for BW and WW of Zandi sheep, respectively were reported by Taghi *et al.* (2016). Baneh and Ahmadpanah (2018) found low h^2_m estimates of 0.113 and 0.031 for BW and WW of Ghezel sheep, respectively. Sallam *et al.* (2019) depicted low h^2_m estimates of 0.06, 0.06 and 0.10 for BW, WW and ADG of Barki lambs, respectively. The h^2_m estimates obtained in this study for body weights of both breeds decreased with advanced in ages. This trend has also been reported in other studies on various sheep breeds (Jalil-Sarghale *et al.* 2014, Mohammadi *et al.*, 2015, Taghi *et al.*, 2016 and Baneh and Ahmadpanah 2018).

Estimates of the portion of variation due to maternal permanent environmental effects (c^2) were 0.024, 0.022 and 0.016 for BW, WW and ADG of Barki lambs, respectively. The respective values for Rahmani lambs were 0.094, 0.039 and 0.033 (Table 3). Estimates of c^2 were very low for all studied traits of both breeds except that for BW of Rahmani lambs which was considerable (0.094). Differences in estimates of c^2 for BW of lambs of both breeds could be attributed to uterine capacity as well as, multiple births. Similarly, Jalil-Sarghale *et al.* (2014) reported low c^2 values of 0.09, 0.08 and 0.07 for BW, WW and ADG of Baluchi sheep, respectively. Also, Aksoy *et al.* (2016) obtained c^2 ranging from 0.010 to 0.098 for BW and from 0.060 to 0.093 for WW of Karayaka lambs. Moreover, Sallam *et al.* (2019) depicted low c^2 estimates of 0.09, 0.06 and 0.06 for BW, WW and ADG of Barki lambs, respectively. Contradictory, Aguiree *et al.* (2016) reported high c^2 estimates of 0.57, 0.60 and 0.48 for BW, WW and ADG of Santa Ines sheep, respectively.

Both maternal effects (h^2_m and c^2) were 0.145, 0.121 and 0.119 of variations in BW, WW and ADG of Barki lambs. The respective values for Rahmani lambs were 0.191, 0.079 and 0.066 (Table 3). Similarly, several studies on sheep showed that maternal effects represent a crucial portion of variation in early growth traits of lambs (Mostafa *et al.* 2011, Moktari *et al.* 2013, Rashidi 2013, Mohammadi *et al*. 2013, Akthar *et al.* 2014, Jannoune *et al*. 2015, Aguiree *et al.* 2016, Taghi *et al*., 2016, Baneh and Ahmadpanah 2018, Sallam *et al*. 2019). Therefore, the maternal effects should be considered in the analytical model to achieve more accurate genetic evaluation for early growth traits of lambs.

Genetic and phenotypic correlations:

Table (4) shows that all correlations (r_g, r_m, r_c and r_p) among growth traits of Barki and and Rahmani lambs were positive and significant (P< 0.01).

Table 4: Correlation coefficients among the studied traitsof Barki and Rahmani lambs.

Item	Barki			Rahmani		
	BW&WW	BW&ADG	WW&ADG	BW&WW	BW& ADG	WW&ADG
r_g±SE	0.993** (0.318)	0.991** (0.351)	1.000** (0.007)	0.685** (0.276)	0.677** (0.298)	1.000** (0.003)
r_m±SE	0.775** (0.239)	0.753** (0.257)	0.999** (0.004)	0.984** (0.543)	0.988** (0.685)	1.000** (0.013)
r_c±SE	0.926** (0.340)	0.949** (0.490)	0.997** (0.500)	0.992** (0.484)	0.981** (0.578)	0.997** (0.010)
r_p±SE	0.448** (0.039)	0.395** (0.041)	0.994** (0.001)	0.479** (0.039)	0.432** (0.041)	0.996** (0.001)

BW:birth weight, WW: weaning weight and ADG: average daily gain.
r_c: maternal permanent environmental correlation. **: Highly significant (P< 0.01)

The direct genetic correlations (r_g) between BW and each of WW and ADG were high close to unity for Barki lambs and were moderately high for Rahmani. The correlations between WW and ADG of Barki and Rahmani lambs were equal to unity (Table 4). Hence, selection for any of growth traits could cause genetic progress in the others. The current r_g valuesshowed that there is high degree of direct genetic resemblance among the growth traits of Barki lambs in comparison with Rahmani. Jalil-Sarghale*et al*. (2014) depicted moderate to high r_g values of 0.72, 0.52 and 0.85 between BW and WW, between BW and ADG and between WW and ADG of Baluchi lambs, respectively. Low to moderate r_g values of 0.685, 0.221 and 0.687 between BW and WW, between BW and ADG and between WW and ADG of White Boni Sheep, respectively were reported by AL-Bial*et al.* (2016).Significant (P<0.01) and positive r_g value of 1.00 between BW and WW of Bharat Merino sheep was found by Mallick *et al*. (2017). Jawasreh *et al.* (2018) depicted significant (P< 0.01) and moderate positive r_g values of 0.63, 0.62 and 0.67 between BW and WW, between BW and ADG and between WW and ADG of Awassi sheep, respectively. Sallam*et al.* (2019) obtained moderate to high $r_g$values of 0.40, 0.50 and 0.92 between BW and WW, between BW and ADG and between WW and ADG of Barki lambs, respectively. The genetic correlation between two traits is properly due to the pleiotropic effects of genes on both traits. Therefore, genetic correlations are necessary for determination of the optimal breeding strategies required for genetic progress of the lambs' growth traits.

Maternal genetic correlations (r_m) among growth traits of Barki lambs were high to extremely high close to unity (Table 4). Similarly, the r_m values among growth traits of Rahmani were high to extremely high close to unity (Table 4). In view of the current r_m values, there is high degree of maternal genetic resemblance among the growth trait of Rahmani lambs in comparison with Barki. Also, there is good evidence that maternal effects on WW and ADG are partly originating from the prenatal period. Jalil-Sarghale *et al.* (2014) obtained moderate to high r_m values of 0.67, 0.54 and 0.87 between BW and WW, between BW and ADG and between WW and ADG of Baluchi lambs, respectively.

All maternal permanent environmental correlations (r_c) among growth traits of both breeds were extremely high close to unity. The correlations indicated high degree of resemblance among the growth trait of both Barki and Rahmani lambs in their response to the permanent environmental effects. Jafari *et al.* (2012) found r_c values of 0.44, 0.31 and 0.95 between BW and WW, between BW and ADG and between WW and ADG of Makuie lambs, respectively in Iran. Shokrollahi and Zandieh (2012) and Rashidi (2013) depicted low r_c values of 0.35 and 0.21 between BW and WW of Kurdish sheep and Black sheep in Iran, respectively. Mokhtari *et al.* (2013) found r_c values of 0.27, 0.72 and 0.64 between BW and WW, between BW and ADG and between WW and ADG of Arman lambs in Iran, respectively.

The phenotypic correlations (r_p) among the studied growth traits of Barki and Rahmani lambs ranged from 0.395 to 0.996 (Table 4). Jalil-Sarghale *et al.* (2014) depicted low to high r_p values of 0.40, 0.25 and 0.88 between BW and WW, between BW and ADG and between WW and ADG of Baluchi lambs. AL-Bial *et al.* (2016) obtained low r_p values of 0.331, 0.210 and 0.431 between BW and WW, between BW and ADG and between WW and ADG of White Boni Sheep, respectively. Mallick *et al.* (2017) found significant (P< 0.01) and moderate r_p value of 0.37

between BW and WW of Bharat Merino sheep. Jawasreh *et al*. (2018) reported significant (P<0.01) moderate to high r_p values of 0.48, 0.48 and 0.85 between BW and WW, BW and ADG and between WW and ADG of Awassi sheep, respectively. Sallam *et al*. (2019) obtained low to high r_p estimates of 0.28, 0.12 and 0.88 between BW and WW, between BW and ADG and between WW and ADG of Barki lambs, respectively. The phenotypic correlation could be attributed to genetic effects that are in common for the two traits, as well as environmental effects that affect both traits.

Table 5. Estimated breeding values (EBV) for the studied traits of Barki and Rahmani rams

Trait	Barki EBV			Rahmani EBV		
	Min.	Max.	Range	Min.	Max.	Range
BW (kg)	-0.227	0.333	0.560	-0.475	0.241	0.716
WW (kg)	-1.666	2.444	4.110	-3.995	2.983	6.978
ADG (g)	-11.60	17.00	28.60	-27.21	20.57	47.78

BW:birth weight, WW: weaning weight, ADG: average daily gain.

Estimated breeding values (EBV):

The estimated breeding value (EBV) is an estimate of the genetic potential of the animal expressed relative to the population average. The EBV for BW, WW and ADG of rams of both breeds are presented in Table (5). The ranges of EBV for all traits were higher for Rahmani rams than Barki. In view of the obtained EBV, there is good evidence that rams of both breeds had never been neither evaluated nor selected. Consequently, a considerable rate of genetic improvement in early growth traits of lamb could be achieved through selection of rams. Javed *et al*. (2013) reported that the EBV for BW and WW varied from -0.25 to 0.27 and from -0.99 to 1.30 kg, respectively of Lohi lambs in Pakistan. Al-Samarai *et al*. (2015) indicated that the EBV ranged between -0.325 and 0.255, between -1.142 and 1.284 and between -0.103 and 0.053 kg for BW, WW and ADG of Awasi rams, respectively. Yadav *et al*. (2018) found that the EBV varied between -0.07 and 0.18 kg and between 4.69 and 4.75 kg for BW and WW of Munjal rams, respectively.

E- Genetic trends:

Table (6) shows that regression coefficients (b) of estimated breeding values of rams on time were positive but insignificant for all traits of both breeds except for BW of Rahmani lambs that was significant (P<0.05). This might be attributed to lack of or ineffective selection of rams and to the changes occurred in the feeding regimes and management practices across the years. Hossein-Zadeh (2012) obtained significant (P<0.05) genetic trends of 1.63 and 69.2g/year for BW and WW of Moghani sheep in Iran, respectively. Aguiree *et al*. (2016) reported slightly negative genetic trend of -0.001 kg/year for BW and positive genetic trend of 0.04 kg/year for WW of Santa Ines sheep. Ahmadpanah *et al*. (2016) depicted significant (P<0.01) and positive direct genetic trends of 0.93and 43.74g/year for BW and WW of Iranian-Black sheep, respectively. Eteqadi *et al*. (2016) found significant (P<0.001) positive direct genetic trends of 0.51 and 5.56 g/year for BW and WW of sheep in Iran, respectively. Mallick *et al*. (2016) reported significant (P< 0.01) positive genetic trends of 0.005kg/year for BW and non-significant positive of 0.0008 kg/year for WW of Bharat Merino in India. Baneh and Ahmadpanah (2018) reported significant positive direct genetic trends of 2.34 and 46.20 g/year for BW and WW of Ghezel sheep in Turkey, respectively. On the contrary, Jawasreh *et al*. (2018) obtained significant (P< 0.01) negative genetic trends of -0.0005, −0.006, and −0.0001 kg/year for BW, WW and ADG of Awassi sheep in Jordan, respectively. Yadav *et al*. (2018) depicted negative genetic trends of -0.09, and -0.25 and -0.0001 kg/year for BW and WW of Munjal sheep, respectively. Sallam *et al*. (2019) obtained genetic trends of 2, 180 and 2 g/year for BW, WW and ADG of Barki lambs, respectively.

Table 6. Regression coefficients (b ±) of estimated breeding values of rams on birth year for growth traits of Barki and Rahmani breeds.

Trait	Barki	Rahmani
	b ± SE	b ± SE
Birth weight (kg)	$0.008^{NS} \pm 0.008$	$0.015^{*} \pm 0.007$
Weaning weight (kg)	$0.057^{NS} \pm 0.058$	$0.143^{NS} \pm 0.075$
Average daily gain (g)	$0.396^{NS} \pm 0.403$	$0.978^{NS} \pm 0.517$

NS: Not significant (P>0.05), *: Significant (P< 0.05)

CONCLUSIONS

The low direct genetic variations in WW and ADG of Barki and Rahmani lambs indicated that improvement of these traits by selection would result in slow genetic changes.The maternal effects were considerable portion of variation in early growth traits of lambs of both breeds. The high and positive genetic correlations among lambs' growth traits indicated that improvement of any trait by selection would cause positive changes in the others. The wide range of rams breeding values for BW, WW and ADG in both breeds was probably due to the absence of selection or planned matings since the rams had never been neither evaluated nor selected. Consequently, a considerable rate of genetic improvement in lamb growth traits could be obtained by selection of rams based on their breeding values. The results in general showed the need for designing an effective selection programme to improve growth traits of lambs in both breeds.

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التحليل الوراثي لصفات النمو قبل الفطام للحملان البرقى والرحمانى

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استخدم في هذا البحث بيانات سجلات لحملان عددها ٧٠٤ برقى و٧٣٢ رحماني مولودة في محطة بحوث كلية الزراعة جامعة الإسكندرية خلال الفترة من ١٩٩١-٢٠١٤م. وذلك لتقدير المعايير الوراثية، القيم التربوية والاتجاهات الوراثية لصفات وزن الميلاد، وزن الفطام ومعدل النمو اليومي من الميلاد حتي الفطام للحملان. وأيضاً دراسة تأثير كل من موسم الميلاد، سنة الميلاد، الجنس، نوع الميلاد وترتيب موسم الميلاد على الصفات موضع البحث.

تم تحليل البيانات بطريقة الحد الأدنى للمربعات باستخدام برنامج الـ SAS. أوضحت النتائج أن المتوسط العام كان ٣.٦٩ كجم لوزن الميلاد، ٢٠.٥٣ كجم لوزن الفطام و١٣٩.٧ جم لمعدل النمو اليومي للحملان البرقي وكان ٣.٥٤ كجم، ٢٠.٠٩ كجم و١٣٧.٨ جم لنفس الصفات على الترتيب للحملان الرحماني. كما أوضحت النتائج أن تأثيرات موسم الميلاد، سنة الميلاد، الجنس، نوع الميلاد وترتيب موسم الميلاد كانت معنوية (P< 0.05 أو P<0.01) على الصفات موضع البحث فيما عدا تأثير سنة الميلاد على وزن الميلاد للحملان البرقي وتأثير ترتيب موسم الميلاد على كل من وزن الفطام ومعدل النمو اليومي لنفس السلالة كانت غير معنوية.

تم تحليل البيانات بواسطة نموذج الحيوان Multivariate Animal Model بإستخدام برنامج Wombat وذلك باستخدام نموذج تضمن التأثير الوراثي للحيوان، التأثير الوراثي الأمي، التاثير الأمي البيئي المستديم والتأثير المتبقي كتأثيرات عشوائية كما تضمن تأثيرات العوامل الثابتة موضع البحث. كانت تقديرات المكافيء الوراثي االمباشر٠.١٨٦، ٠.٠٧٨ و٠.٠٧ لوزن الميلاد، وزن الفطام ومعدل النمو اليومي على الترتيب للحملان البرقي وكانت ٠.٢٨٥، ٠.١٣٠ و٠.١٢١ لنفس الصفات على الترتيب للحملان الرحماني. كانت تقديرات المكافيء الوراثي الأمي ٠.١٢١، ٠.٠٩٩ و٠.١٠٣ لوزن الميلاد، وزن الفطام ومعدل النمو اليومي على الترتيب للحملان البرقي وكانت ٠.٠٩٧، ٠.٠٤٠ و ٠.٠٣٣ لنفس الصفات على الترتيب للحملان الرحماني. ويتضح أن تقديرات المكافيء الوراثي المباشر للصفات الثلاث أعلي في الرحماني عنها في البرقي بينما كانت تقديرات المكافيء الوراثي الأمي أعلى في البرقي عنها في الرحماني. تقديرات نسبة التباين نتيجة للتأثير الأمي البيئي المستديم كانت ٠.٠٢٤، ٠.٠٢٢ و٠.٠١٦ لوزن الميلاد، وزن الفطام ومعدل النمو اليومي على الترتيب للحملان البرقي وكانت ٠.٠٩٤، ٠.٠٣٩ و٠.٠٣٣ بالنسبة للصفات السابقة على التوالي للحملان الرحماني. وكانت التقديرات للصفات الثلاث أعلي في الرحماني عنها في البرقي. يتضح أن التأثيرات الأمية تعتبر جزءَا هاماً من التباين المظهري للصفات موضع البحث في السلالتين. لذا بنبغي وجود هذه التأثيرات في نموذج التحليل الاحصائي عند إجراء التحليل الوراثي لصفات النمو قبل القطام في القطيع موضع البحث.

كانت تقديرات التلازم الوراثي المباشر في سلالة البرقي ٠.٩٩٣، ٠.٩٩١، ١.٠٠٠ بين وزن الميلاد وكلاً من وزن الفطام ومعدل النمو اليومي وبين وزن الفطام ومعدل النمو اليومي على التوالي، بينما كانت هذه القيم في سلالة الرحماني ٠.٦٨٥، ٠.٦٧٧ ، ١.٠٠٠ لنفس الصفات. كانت تقديرات التلازم الوراثي الأمي في سلالة البرقي ٠.٧٧٥، ٠.٧٥٣، ٠.٩٩٩ بين وزن الميلاد وكلاً من وزن الفطام ومعدل النمو اليومي وبين

وزن الفطام و معدل النمو اليومي على التوالي، بينما كانت هذه القيم في سلالة الرحماني ٠.٩٨٤، ٠.٩٨٨ ، ١.٠٠٠ لنفس الصفات. كانت تقديرات التلازم الأمي البيئي المستديم موجبة مرتفعة جداَ وتراوحت بين ٠.٩٢٦ و ٠.٩٩٧ في السلالتين. وكانت تقديرات التلازم المظهري موجبة متوسطة وتراوحت بين ٠.٣٩٥ و ٠.٤٧٩ بين وزن الميلاد وكل من وزن الفطام ومعدل النمو اليومي في كلتا السلالتين، بينما كانت موجبة مرتفعة جداَ بين وزن الفطام ومعدل النمو اليومي (٠.٩٩٤) في البرقي و (٠.٩٩٦) في الرحماني.

تراوحت تقديرات القيم التربوية للكباش بين -٠.٢٢٧- ٠.٣٣٣ كجم، -١.٦٦٦- ٢.٤٤٤ كجم وبين -١١.٦٠-١٧.٠٠ جم لوزن الميلاد، وزن الفطام ومعدل النمو اليومي علي الترتيب للحملان البرقي وتراوحت بين -٠.٤٧٥-٠.٢٤١ كجم، -٣.٩٩٥-٢.٩٨٣ كجم وبين -٢٧.٢١-٢٠.٥٧ جم بالنسبة للصفات السابقة على الترتيب للحملان الرحماني. ويلاحظ أن هناك مدى واسع نسبياَ للقيم التربوية للكباش الرحماني مقارنة بالبرقي بالنسبة لكل الصفات.

حُسبت قيم الاتجاهات الوراثية عن طريق معاملات اعتماد القيم التربوية للكباش على السنوات وكانت غير معنوية موجبة لكل الصفات في السلالتين فيما عدا صفة وزن الميلاد للرحماني حيث كانت معنوية ($P< 0.05$) موجبة. وبالتالي لم يوجد تحسين وراثي محدد بالنسبة لكل الصفات وذلك لغياب الانتخاب الفعال للأباء. توضح نتائج هذا البحث بصفة عامة أن هناك ضرورة حتمية لتصميم برنامج انتخاب فعال لتحسين صفات النمو للحملان في كلتا السلالتين في هذا القطيع موضع البحث.