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GENETIC AND PHENOTYPIC PARAMETERS OF BIRTH, WEANING AND YEARLING BODY WEIGHTS OF BARKI SHEEP RAISED IN THE NORTH WESTERN COAST OF EGYPT

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SUMMARY

The present study investigated environmental factors affecting birth (BW), weaning (WW) and yearling body weights (YW) and estimated the heritabilities and genetic correlations of these traits in a Barki sheep flock maintained in the north western coast of Egypt. Body weight data of 1046 animals (542 females and 504 males) progenies of 163 sires and 557 dams obtained from 1963 to 2005 were used. Data were analyzed using a model composed of location, year of birth within location, sex of lamb and age of dam. Moreover, heritabilities as well as genetic and phenotypic correlations were estimated using multiple traits animal model.

Barki males had significantly heavier body weights than females at birth (3.64 kg vs 3.46 kg), weaning (19.56 kg vs 18.44 kg) and at 12-month of age (32.05 kg and 30.02 kg). Year of birth within location showed highly significant effects on the studied body weights. Furthermore, age of dam revealed highly significant effect on birth weight, where older dams tend to produce heavier lambs than those of younger ones. These results clearly indicate that corrections for the studied environmental effects are necessary to increase accuracy of direct selection for BW, WW and YW.

Heritability for weaning weight was found to be higher (0.41) than BW (0.32) and YW (0.30). Therefore, selection based on WW would probably be more effective compared with BW or YW. Hence, heavier body weights at weaning are worth to be considered in the Barki sheep flock if the improvement of mutton production is the objective.

Keywords: Body weight, heritability, genetic correlations, Barki sheep, Egypt

INTRODUCTION

Improving the productive efficiency and particularly for mutton is the main objective towards the improvement of the local Barki sheep maintained in the north western coast (NWC) of Egypt. The breeding strategy to achieve such goal has been going on for so many years in the Barki sheep flock of the Desert Research Centre in the NWC. Barki is one of the main local sheep breeds of Egypt dominating in the

NWC and known to be well adapted to the desert and harsh prevailing conditions as well as shortage of feed.

Genetic improvement for reproduction, lamb growth and fleece traits are usually considered as major goals for sheep production (Dickerson, 1978). Lamb growth traits are of significant importance for mutton production. Birth weight, weaning weight and yearling weight could probably indicate the growth features at three main stages in the animal life. These traits could also be taken as selection criteria to enhance the potentiality of mutton production in Barki sheep. Thus, estimating heritabilities and genetic correlations between these traits is of interest. However, these traits could be affected by various environmental factors that mask genetic differences when comparing animals (Kennedy, 1992). These factors must be corrected for to elucidate genetic differences between animals in order to increase the efficiency of selection procedures.

The present study aimed to investigate the environmental factors affecting birth, weaning and yearling body weights in Barki sheep and estimating the heritabilities and genetic correlations of these traits, since this information is prerequisite for designing any breeding programs.

MATERIALS AND METHODS

Data

The data used in the present study were collected from the Barki sheep flock raised at Ras ElHekma (RHRS), from 1963 to 1972, and Maryut Research Stations (MRS), from 1973 to 2005, belonging to the Desert Research Centre. RHRS is located 400 kilometers west of Alexandria while MRS is located 35 kilometers west of Alexandria. In 1972, sheep flock at RHRS moved to MRS.

Flock Management

Flock management in RHRS and MRS was almost the same where natural mating was practiced once a year (around July) and lambing started around December each year. The main difference between RHRS and MRS is natural grazing which was commonly used in the first one while indoor feeding with little grazing was practiced in the second station. At birth, lambs were ear-tagged, weighed and allowed to suckle their dams until weaning at 3-4 months of age. After weaning, animals were fed concentrate mixture of 0.5 to 1.0 kg / head / day according to their physiological status, in addition to *ad-libitum* of Berseem (*Trifolium alexandrinum*) hay. The concentrate mixture consisted of 50% cotton seed cake, 18% wheat bran, 15% yellow maize, 11% rice polish, 3% molasses, 2% limestone and 1% salt. Fresh water was made available for the flock once a day. Body weights were recorded just before morning feeding at biweekly intervals starting from birth till weaning and at monthly intervals afterwards until the animal removed from the flock.

Data processing

Body weight data obtained from the Barki sheep flock of the Desert Research Centre was utilized from 1963 to 2005. Adjustments for individual body weights to different ages in the original data were carried out by intrapolation between the data of two successive ages; growth during the short intervals was assumed to be linear. Twin lambs were found to be very infrequent in the data, thus they were excluded from the original data. Consequently, a total of 1046 animals (542 females and 504 males) progenies of 163 sires and 557 dams were included in the analyses.

Statistical model

Data on birth weight (BW), weaning weight (WW) and yearling weight (YW) of lambs were analyzed using SAS (1998) to study the effect of location (L), year of birth within location (Y/L), sex of lamb (S) and age of dam at lambing (A). The statistical model was as follows:

$$\mathbf{W_{ijklm} = u + L_i + Y_{i(j)} + S_k + A_l + e_{ijklm}} \qquad \textbf{(1)}$$

Where :

W_{ijklm} = the record of BW, WW or YW measured on mth lamb born in ith location at jth year of birth within ith location of kth sex of lamb and lth age of dam,

u = the overall mean,

L_i = the fixed effect of ith location where i= 1(RHRS) and 2(MRS),

$Y_{i(j)}$ = the fixed effect of jth year of birth within ith location (from year 1963 up to 1972 for location 1 and from year 1973 up to 2005 for location 2),

S_k = the fixed effect of the kth sex (k=1 for female and 2 for males),

A_l = the fixed effect of lth age of dam (l = 2,3,4 and 5 years and more),

e_{ijklm} = random error assumed to be NID (0, σ^2_e).

The analysis of variance for the fixed model was performed using GLM procedure of SAS (1998). Moreover, genetic parameters for birth weight, weaning and yearling weights of 1046 records from 542 females and 504 males were estimated. Multiple trait animal model (MTDFREML) proposed by Boldman *et al*. (1993) was used to estimate the heritability, genetic and phenotypic parameters for BW, WW and YW. The same fixed effects of model (1) were included in this analysis beside the animal, sire and dam as random effects. The following linear model was used:

$$\mathbf{Y = X\beta + Z_a a + e} \qquad \textbf{(2)}$$

Where:

Y = is N vector of observations of BW, WW or YW,

X= is the incidence matrix for fixed effects mentioned previously in model (1),

β = is the vector including the overall mean and the same fixed effects as those stated in model (1),

Z_a= is the incidence matrix for random effects,

a = is the vector of direct genetic effect of the animal; and

e = is a vector of random residuals normally and independently distributed with zero mean and variance σ^2_e I.

The variance-covariance structure for the model is as follows:

$$\begin{bmatrix} V \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ e_1 \\ e_2 \\ e_3 \end{bmatrix} = \begin{bmatrix} A\sigma^2 a_1 & \sigma a1 a2 & \sigma a1 a3 & & 0 & \\ \sigma a_2 a_1 & A\sigma^2 a_2 & \sigma a 2 a 3 & & & \\ \sigma a_3 a_1 & \text{ó2 a2 a3} & A\sigma^2 a_3 & & & \\ & & & In_1\sigma^2 e_1 & \sigma e_1 e_2 & \sigma e_1 e_3 \\ & 0 & & \sigma e_2 e_1 & In_2\sigma^2 e_2 & \sigma e_2 e_3 \\ & & & \sigma e_3 e_1 & \sigma e_3 e_2 & In_3\sigma^2 e_3 \end{bmatrix}$$

where:

A is the numerator relationship matrix,

$\sigma^2 a_1, \sigma^2 a_2$ and $\sigma^2 a_3$ Are the direct genetic variance(s) for BW, WW and YW,

$\sigma a1a2, \sigma a1a3 and \sigma a2a3$ Are the direct genetic covariance(s) between traits,

$\sigma^2 e_1$, $\sigma^2 e_2$ and $\sigma^2 e_3$ Are the error variance(s) for studied traits,

$\sigma e1e2, \sigma e1e3 and \sigma e2e3$ Are the error covariance(s) between traits.

RESULTS AND DISCUSSION

The present study estimated the overall average body weight for Barki sheep as 3.46 kg at birth, 14.46 kg at weaning and 23.82 kg at 12-month of age (Table 1). Maryut research station showed slightly heavier lambs at birth while had significantly heavier animals at weaning and yearling stages compared with Ras ElHekma research station. Tables (1 and 2) also indicated that males are often significantly heavier than females at birth, weaning and yearling stages. Moreover, age of dam showed highly significant effect on birth weight (BW) whereas no significant effects existed on weaning (WW) and yearling weights (YW).

In the same flock, Mokhtar *et al*. (1991) estimated average birth weights for males (3.69 kg) and females (3.49 kg), average weaning weight for males (18.61 kg) and females (17.37 kg) as well as average yearling weight for males (33.18 kg) and females (30.65 kg). Later, Ahmed *et al*. (1992) showed estimates of 2.92 kg, 14.1 and 28.7 kg for the averages of body weights at birth, weaning and yearling, respectively. Moreover, Bedier *et al*. (1995) found that average birth weight, weaning weight and yearling weight for Barki sheep in the same flock were 3.45 kg, 19.9 kg and 32.7 kg, respectively.

Table 1. LSMEAN±SE for birth (BW), weaning (WW) and yearling (YW) body weights (in kg) in both sexes in Barki sheep

Factors		Birth weight	Weaning weight	Yearling weight
Location				
	RHRS	3.42± 0.04	12.30± 0.52	21.32±0.82
	MRS	3.48± 0.03	16.61±0.37	26.31±0.59
Sex				
	Male	3.55±0.03	15.03±0.40	24.98±0.63
	Female	3.34±0.03	13.88±0.38	22.64±0.61
Age of dam				
	2	3.22± 0.04[a]	14.17± 0.56[a]	23.70± 0.89[a]
	3	3.49± 0.04[b]	15.00± 0.53[a]	24.84 ±0.84[a]
	4	3.49± 0.05[c]	13.93± 0.61[a]	22.31± 0.96[a]
	5	3.59± 0.03[d]	14.73± 0.46[a]	24.41± 0.73[a]

RHRS= Ras ElHekma Research Station; MRS= Maryout Research Station.

Different a, b and c superscript letters, in each column, indicated significant differences between means at P<0.05.

Table 2. Analysis of variance for birth (BW), weaning (WW) and yearling (YW) body weights in Barki sheep

Source	DF	Mean Squares		
		Birth weight	Weaning weight	Yearling weight
Location	1	0.58	2881.28**	3863.85**
Year/ location	25	1.73**	728.39**	1789.75**
Sex	1	13.31**	420.37**	1737.75**
Age of dam	3	6.22**	55.10	267.79
Residual	1261	0.35	63.29	158.23
Total	1291			
R-square		0.16	0.23	0.21
c.v.		16.91	48.78	48.34

** Significant at P<0.01

The present estimates appeared to be comparable with the corresponding estimates of some local sheep breeds, the Ossimi where average birth weight was found to be ranged from 3.32 to 3.48 kg (Aboul-Naga and Mansour,1991; Mousa *et al*.,1994) as well as weaning and yearling weights averaging 12.3 kg and 34.0 kg, respectively according to Aboul-Naga and Mansour (1991). On the other hand, for Awassi sheep, Mousa *et al*. (1994) estimated average birth weight and weaning weight as 3.32 kg and 12.2 kg, respectively.

Tables (1 and 2) indicated that while Barki males had significantly heavier body weights than Barki females, differences between sexes increased as age advanced from birth to weaning up till yearling. The coefficient of variation appeared to be much higher at weaning and yearling compared with that at birth as many factors seemed to be involved in the variations of body weights at later stages compared with those involved at lambing.

In Barki sheep, some local breeds and other coarse wool breeds, many authors indicated the significance of the sex of lamb effect where males were found to be generally heavier than females in Barki sheep (Mokhtar *et al*., 1991; Ahmed *et al*., 1992; Bedier *et al*., 1995), Rahmani (Aziz and Abdelsalam,1993; Abdel-Aziz,1994), Awassi (Ghoneim *et al*., 1982) and Yemeni Dhamari sheep (Al-bar *et al*., 2002).

As expected, location and year of birth within locations generally showed highly significant effects on body weights at birth, weaning and yearling stages. Fluctuations in some environmental factors prevailed; in particularly quality and quantity of the available feed stuff could be an explanation. Moreover, the effect of locations could be looked at a combination of some genetic and environmental factors affecting animal performance. Year of birth showed significant effect on body weights in Barki (Ahmed *et al*., 1992; Bedier *et al*., 1995), Rahmani (Aziz and Abdelsalam,1993), Awassi (Kassab,1975) and Yemeni Dhamari sheep (Al-bar *et al*., 2002). Figures (1 and 2) indicated that while body weights generally tend to increase, more fluctuations in WW and YW compared with BW appeared for so many years with no clear trends despite the breeding plan implemented in this flock. Probably the management of this flock as well as the effectiveness of the breeding plan has to be considered in order to proceed with the improvement of mutton production in this flock.

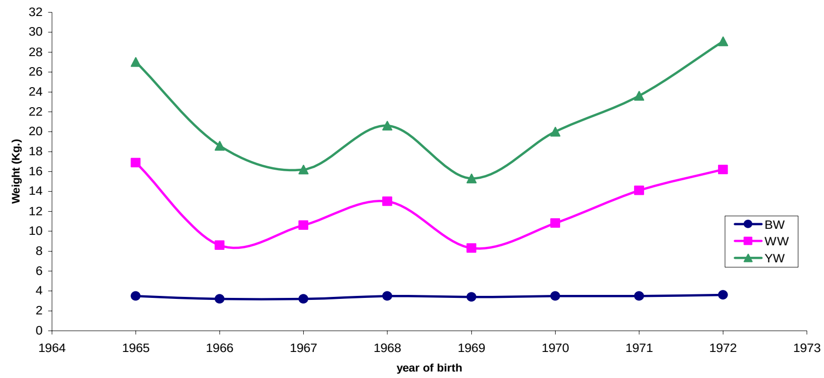

Fig.(1). The relationships between year of birth and body weights at birth (BW),weaning (WW) and yearling (YW) at Ras ElHekma research station.

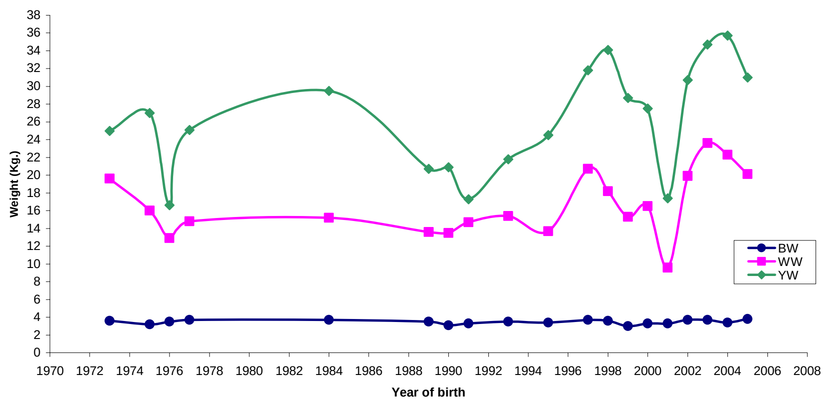

Fig. (2). The relationships between year of birth and body weights at birth (BW), weaning (WW) and yearling (YW) at Maryut research station.

Age of dam showed a highly significant effect on birth weight but not on weaning and yearling weights, where older dams tend to produce heavier lambs than those of younger dams in Barki sheep (Tables 1 and 2). This result might indicate that birth weight of the lamb would depend almost entirely on the performance of his dam. As the lamb gets older he would be capable to express his own performance. Similar findings were reported for Barki sheep (Mokhtar *et al*., 1991; Ahmed *et al*., 1992), Rahmani sheep (Abdel-Aziz,1994; Aziz and Abdelsalam,1993), Awassi sheep (Ghoneim *et al*., 1982) and Yemeni Dhamari sheep (Al-bar *et al*., 2002).

The aforementioned results clearly indicate the significance of some environmental factors such as location, year of birth within location, sex and age of dam on the studied body weights. Thus, corrections for these environmental effects are necessary to increase accuracy of direct selection for birth, weaning and yearling weights in Barki sheep. Improving and controlling the environmental factors could help genetic factors to show their effects on animal body weights. Thus, improvement of growth performance in Barki sheep could be attained if reasonable levels of flock management as well as selection pressure are maintained.

Table (3) shows that weaning weight has higher heritability (0.41) than birth (0.32) and yearling weights (0.30). Moreover, weaning weight was found to have higher genetic correlations with yearling weight (0.92) than that of birth weight (0.74). The present heritability estimates are comparable with other estimates obtained elsewhere. The heritabilities of birth weight was found to be ranged between 0.25 and 0.81in Barki lambs (Guirgis *et al*., 1982; Abdel-Aziz, 2000) and 0.66 in Rahmani lambs (Abdel-Aziz, 2000). The corresponding estimates for weaning weight were found to be ranged between 0.21 to 0.27 in Barki sheep (Guirgis *et al*.,1982; Abdel-Aziz, 2000), between 0.26 to 0.28 in Rahmani (Abdel-Aziz,2000; Shaat *et al*., 2004), 0.24 in Ossimi (Shaat *et al*., 2004). Moreover, Guirgis *et al*., (1982) estimated the heritability of yearling weight as 0.28 in Barki sheep. On the other hand, Abdel-Aziz (2000) reported the genetic correlations between birth weight and weaning weight as 0.36 while the phenotypic correlation estimate was found to be 0.27 in Barki lambs. The corresponding values for Rahmani sheep were 0.72 and 0.38 for the genetic and phenotypic correlations, respectively.

Table 3. Heritabilites (on diagonal) an genetic correlations (below diagonal) for birth (BW), weaning (WW) and yearling (YW) body weights in Barki sheep

Trait	BW	WW	YW
BW	0.32		
WW	0.74	0.41	
YW	0.74	0.92	0.30

Selection based on weaning weight might be more effective for its higher heritability compared with birth and yearling weights. It is fortunate to rely on weaning weight in selection program since heavier body weights at weaning are worth to be considered in the flock if the improvement of mutton production is the objective. Practically, sheep breeders usually evaluate their lambs after weaning either by selling them or keeping them for breeding purposes. It would also be of advantage to find out that heavier weaning weight would be associated with more increase in yearling weight than that of birth weight. The increase in yearling weight would meet the breeder and consumer preferability while reducing birth weight would avoid dyscostia.

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المعالم الوراثية والمظهرية لأوزان الجسم عند الميلاد والفطام وعمر سنة فى الأغنام البرقي المرباة فى الساحل الشمالى الغربى فى مصر

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أجريت هذه الدراسة للتعرف على العوامل البيئية التى تؤثر فى فى أوزان الميلاد والفطام والوزن عند عمر سنة علاوة على تقدير المكافئ الوراثى والارتباطات الوراثية لهذه الصفات بهدف تحسين انتاج اللحوم فى قطيع من الأغنام البرقى فى الساحل الشمالى الغربى من جمهورية مصر العربية. استخدمت فى هذه الدراسة بيانات أوزان الجسم لعدد 1046 حيوان (542 أنثى و 504 ذكر) أبناء 163 كبش و 557 نعجة تم الحصول عليها من سجلات القطيع فى المدة ما بين عامى 1963 الى 2005. اشتمل النموذج الاحصائى على الموقع، سنة الميلاد داخل الموقع ، جنس المولود وعمر الأم. كما تم تقدير المكافئ الوراثى والارتباطات الوراثية والمظهرية لهذه الصفات باستخدام نموذج الحيوان متعدد الصفات.

أوضحت النتائج أن ذكور الأغنام البرقى كانت معنويا أثقل وزنا من الاناث عند الميلاد (3.55 كجم & 3.34 كجم) و عند الفطام (15.03 كجم & 13.88كجم) وعند عمر سنة (24.98 كجم & 22.64 كجم). وكان لسنة الميلاد داخل الموقع تأثير معنوى على مستوى 1% على الأوزان المدروسة نتيجة اختلاف العوامل البيئية السائدة. كما كان تأثير عمر الأم معنويا على وزن الجسم عند الميلاد حيث أعطت الأمهات الكبيرة فى العمر أوزانا أثقل من تلك الصغيرة. تؤكد هذه النتائج ضرورة التصحيح لتلك العوامل البيئية لزيادة الكفاءة فى الانتخاب لأوزان الجسم.

أوضحت النتائج أن المكافئ الوراثى لوزن الفطام (0.41) كان أعلى منه لوزن الميلاد (0.32) وللوزن عند عمر سنة (0.30). لهذا فان الانتخاب لوزن الفطام قد يكون أكثر كفاءة من ذلك الذى يعتمد على وزن الميلاد أو الوزن عند عمر سنة ومن ثم فان انتخاب الحيوانات الأثقل وزنا عند الفطام يجب أن يؤخذ فى الاعتبار لتحسين صفات النمو فى قطيع الأغنام البرقى.