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GENETIC AND NON-GENETIC VARIABILITY OF WOOL PRODUCTION IN THE EGYPTIAN BARKI SHEEP

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ABSTRACT

Barki sheep Flock of 937 sheep maintained at Mariout Research Station, close to Alexandria during three years were used in this study. Flock management was similar to commercial conditions in this area. Least squar means of annual greasy fleece weight of Barki sheep was 1.84 ± 0.06 kg. Annual greasy fleece weight highly significant decreased with advanced age. Year of shearing significantly affected annual greasy fleece weight . The kemp fibers content significantly affected annual greasy fleece weight, where fleeces with few Kemp fibres had the heaviest weight followed, by medium and the lightest were the abundant Kemp fibres content. The annual skirting's weight tended to decrease with advanced age where the heaviest skirtings were produced from one year. Females produced significantly heavier skirtings than males. While, year of shearing affected annual skirting's weight ($P<0.01$). Staple structure and Kemp class had no effect on annual skirting's weight or percentage. Although single born and twins produced similar weight of skirting. Annual fleece wool weight ($P<0.01$) decreased with advanced age. Furthermore, Kemp score and year of shearing affected annual fleece wool weight significantly and highly significantly, respectively. Heritability estimates of greasy fleece weight, fleece Kemp score and skirting's weight were 0.55, 0.39 and 0.25, respectively. Genotypic correlation coefficients among some fleece traits of Barki sheep were studied.

Keywords: Barki sheep, Greasy fleece weight, Heritability and non genetic factors

INTRODUCTION

Sheep play an active role in meat and wool production in Egypt. However, its wool consider the second important raw material for making fabric after linen. However, Barki sheep wool evaluated as course wool type with high variability traits (Guirgis, 1973) and Hamada (1981) Neverless Greasy fleece weight is considered one of the important quantitative measure for wool production, which contributes to determine the economic value of sheep breeds. In the same time, It is consider as the most common way for wool marketing. The greasy fleece weight obtained from individual animal immediately after shearing will be includes the wool fiber output as well as the associated impurities, (the endogenous type as wool grease, suint, urine and feces contaminants and the exogenous type as dirt and vegetable matter).

It is well known that clip preparation, as the first step prior to processing, would promote marketing of wool, hence better prices and income for wool producers. Raw wool specification serves as a link between the wool production and wool processing sectors (Hansford, 1997). Traditionally, wool was sold by auction, but there has been a steady decline in the proportion of wool sold by this way. Many farmers now choose to sell wool directly to private buyers and end-users. Farmers are keen to develop relationships with processors so they can receive information from end-users and adjust their wool specifications to market requirements.

These systems involve the selection of animals based on the subjective assessment of several sheep and wool traits. In the same time breeders using these systems also often maintain pedigree and objectively measured performance information. To successfully incorporate these traits into a combined genetic evaluation, it is important to have knowledge of the genetic and environmental relationships between these traits. This study examines some factors affecting wool production of Egyptian Barki Sheep and the phenotypic and genetic relationships among the subjectively assessed wool traits.

MATERIALS AND METHODS

Barki sheep Flock (937 animals) maintained at Mariout Research Station close to Alexandria were studied during three years. Flock management was similar to commercial flocks maintained in this area. Sheep grazed Egyptian clover (Berseem; Trifolium alexandrinum) in addition to crop residues whenever available. A concentrate mixture (14%CP and 60%TDN) of 0.5 kg / head / day was given. The concentrate mixture consisted of 50% undecorticated cotton seed cake, 18% wheat bran, 15% yellow corn, 11% rice polish, 3% molasses, and 2% limestone and 1% common salt. During summer months, the animals received Berseem hay ad libitum. Drinking clean tap water was provided ad libitum twice daily. The yearly mating season usually starts in June and lambing occurs at November. Lambs are allowed to suckle their dams for about three months. Shearing occurs once a year, often in May. Yearlings are usually shorn at approximately 18 months of age. Ewes are allowed to stay in yards after coming back from grazing fields and they are kept indoors at night. Greasy fleece weight and the weight of its components, skirting and fleece wool, are estimated immediately after shearing. Animals where grading and divided into six groups. Fleeces were separated into skirting & fleece wool. Representing samples from fleece wool of each group were taken for the study of physical wool characteristics.

The system applied in this study was to class Barki wool according to staple structure and Kemp content into six grades as follows:

Staple structure / **Kemp score**	**Open**	**Dense**
Few or no Kemp	Group 1 (OK1)	Group 2 (DK1)
Medium Kemp	Group 3 (OK2)	Group 4 (DK2)
Plentiful Kemp	Group 5 (OK3)	Group 6 (DK3)

Generalized linear model procedure on SAS (1995) was conducted on greasy fleece weight, and its components, namely skirting and fleece wool as well as their percentages out of the weight of the fleece. Furthermore, the fleece wool was divided into back and sides lines. The analysis was conducted on the above mentioned traits using the following model.

$$Y_{ijklmno} = \mu + Y_i + S_j + A_k + T_l + K_m + B_n + e_{ijklmn}$$

Where: $Y_{ijklmno}$ = is the observation of interest;
μ = is the overall mean.
Y_i = is the i^{th} year (1= 2002, 2 = 2003, 3= 2004).
S_j = is the j^{th} sex ,(1= male, 2 = female).
A_k = the effect of k*th* age of animals (1,2,3,4,5).
T_l = the effect of t*th* staple structure (l=1,2).
K_m = the effect of m*th* Kemp score (m=1,2,3).
B_n = the effect of n*th* body positions (n=1,2,3,4.5,6) where 1= wither, 2=back, 3= hip, 4= shoulder, 5= mid-side and 6= breech.
Bo = the effect of n*th* Type of birth (o=1,2).
$e_{ijklmno}$ = the random error effect.

Simple correlation coefficients were calculated between each two parameters, on the raw materials only. Means between different groups were tested by Duncan test.

The genetic parameters were estimated by derivative free REML with a simplex algorithm using the Multiple Trait Derivative Free Restricted Maximum Likelihood (MTDFREML) programs of Boldman et al. (1995). A minimum of three restarts was used to ensure convergence to the same solution. Starting values for iteration were derived from literatures for the initial run. For subsequent runs, previous solutions were used as starting values. No changes were seen in (co)variance components after the second cold restart (Crews and Franke, 1998).

Animal model was used to obtain variance components, descriptive statistics and breeding values with Best Linear Unbiased Prediction (BLUP) methodology. BLUP has become the most widely accepted method for genetic evaluation of livestock (Morde, 1996). Henderson (1988) recommended that mixed model methodology give Best Linear Unbiased Prediction for genetic values.

The heritability was estimated as four times the ratio of sire (31 sire) observational components to total phenotypic variance (summation of sire and residual variance components) if δ2s is the sire components and δ2e the residual component.

The heritability estimated as:

$$h^2 = 4\delta^2S / (\delta^2S + \delta^2e)$$

Where, δ2S= is the sire component of variance, δ2e = is the error component of variance.

Genetic correlations are computed by dividing the family covariance component estimate between the two traits by the geometric mean of the two family variance component estimates, i.e.

$$rG(a, a') = \delta ss` / \delta s \delta s`$$

Where (rG (a,a`) )is the genetic correlation between a and a' traits, (δ ss`) is the covariance estimate between the two traits, (δs) and (δs`) is the geometric mean of the two family variance.

RESULTS AND DISCUSSIONS

Quantitative wool characteristics

Greasy fleece weight

Least squares mean of annual greasy fleece weight of Barki sheep was 1.84 ± 0.06 kg (Table 1). This estimate was similar to that reported by Azzam (1999) and very close to that obtained by Marai (1975) on the same breed. The present estimate was lower than those reported in Barki sheep by Gadallah (2001). Furthermore, the annual greasy fleece weight of Barki sheep decreased highly significant with advanced age (Table 1), where the heaviest fleeces produced at one year and the lightest fleeces at five years old.

These results disagreed with those reported by Ahmed, *et al,* (1992), Ibrahim, *et al*, (1993) and Ahtash (1998) who reported that age had no significant effect on greasy fleece weight in Akkaraman, Awassi, Barbary, Barki, and Ossimi sheep. On the other hand, Kassab and Karam, (1961) found that greasy fleece weight of Barki sheep increased until 3 years of age, while Guirgis and Galal (1972), Ganai and Pandey (1995), working on different breeds of sheep, found that greasy fleece weight tended to increase with advancement of age up to 2 - 4 years of age, which after it declined. When the time of lambing and the time of shearing were considered, it could be concluded that the first shearing occurred when animals aged from 14 to 16 months of age. This mean that the first clip represented growth of 14 – 16 months and might be adjusted to 12 months growth. The relatively heaviest annual fleeces were obtained from two years animals at the second shearing (Table 1). Azzam (1999) obtained similar results in Barki sheep.

Whereas males produced heavier fleeces (1.87 ± 0.06 kg) than females (1.83 ± 0.02 kg), differences were not significant. These results were in agreement with those reported by Azzam (1999). However, Guirgis (1980), on Barki sheep did not found significant effect on greasy fleece weight. On the other hand, Gadallah (2001) found that sex of animal affected annual greasy fleece weight of Barki sheep ($P<0.01$).

Table (1) shows that year of shearing significantly affected annual greasy fleece weight of Barki sheep ($P<0.01$), where year 2002 had the heaviest fleeces and the lightest fleeces were those of year 2003. Many investigators encountered significant differences in greasy fleece weight of sheep due to year of shearing (Arora *et al*., 1999 and Gadallah, 2001). The annual differences in the average fleece weight might reflect feeding, health, weather fluctuations and other environmental factors affecting the animals differently from year to the other. Furthermore , Brown *et al*, (1966) reported that within a flock, the main reasons for differences in fleece weights among years were due to differences in fibre volume and fibre diameter. Guirgis (1973) reported that the effect of year on the Barki greasy fleece weight might be due to differences in the amount and quality of edible vegetation. On the other hand, Guirgis (1980) found that year had no significant effect on fleece weight of Merino, Barki and their crosses.

Animals with open staple structure produced heavier fleeces (1.93 ± 0.03 kg) than those of dense staple structure (1.74 ± 0.03 kg), however differences were not significant (Table 1) . Kemp fibres content affected significantly annual greasy fleece weight of Barki sheep (P<0.01), where fleeces with few Kemp fibres had the heaviest weight (1.96 ± 0.04 kg) followed by medium content (1.81 ± 0.03 kg) and the lightest fleeces were that of abundant Kemp fibres content (1.74 ± 0.04 kg). Type of birth had no effect on annual greasy fleece weight of Barki sheep.

Least squares means of annual skirting's weight and percentages of Barki sheep were 0.65 ± 0.03 kg and 35.60 %, respectively (Table 1). The skirting percentage was in accordance with Guirgis (1973) as 36.8%. Also, Gadallah (2001) as skirting weight and percentage (0.86 kg and 33.77). On the other hand a higher estimate of skirting was reported by Hassan (1985), on the same breed, as 44%. A lower estimate of skirtings was reported by Lupton, *et al*, (1992), on Ramboillet ewes, as 17%. Kott, *et al*, (1992) on Targhee ewes as 13.2%.

Annual skirting's weight of Barki sheep tended to decrease non-significantly with advanced age where the heaviest were from one year and the lightest was that of five years old (Table 1). With respect to skirtings percentage, it tended to decrease non significantly with advanced age until three years old and tended to increase after that.

Females produced significantly heavier skirtings (0.65 ± 0.01 kg) than males (0.58 ± 0.03 kg). The skirtings percentage also of female had significantly higher values (35.78 ± 0.43) than males (Table 1). These results were in agreement with Gadallah (2001) who reported that sex of animals affected the amount and percentage of skirtings and fleece wool of Barki sheep (P< 0.01).

Year of shearing affected annual skirtings and weight percentage (P<0.05), where year 2004 (Table 1) had the heaviest skirtings (0.68 ± 0.02 kg) followed by year 2002 and 2003 (0.65 ± 0.02 and 0.62 ± 0.02 kg). However, in year 2003 the heaviest percentage of skirtings (37.13 ± 0.67%) followed by year 2004 (35.95 ± 0.85%) and the lightest were in year 2002 (32.44 ± 0.58%). Gadallah (2001) observed that year of shearing affected (P < 0.01) amount and percentage of skirtings and that of fleece wool of Barki sheep. Table 1 shows that the staple structure and Kemp class had no effect on annual skirtings weight or percentage of Barki sheep. Although single born and twins produced similar weight of skirtings, which meant that type of birth had no effect on annual skirtings weight or percentage of Barki sheep. Numbers of observations were differ according traits under study.

Table (1): Least-squares means ± standard error of Greasy fleece weight and Skirtings

	No.	Greasy fleece weight	No.	Skirtings weight	Skirtings percentage
Total mean		**1.84 ± 0.06**		**0.65 ± 0.03**	**35.60**
Age of animal (year)		**		*	NS
1	299	2.01 ± 0.03[ab]	298	0.73 ± 0.02[a]	35.94 ± 0.68[a]
2	109	1.93 ± 0.06[a]	109	0.65 ± 0.03[ab]	33.17 ± 0.98[a]
3	80	1.76 ± 0.06[a]	80	0.59 ± 0.03[b]	33.87 ± 1.09[a]
4	64	1.59 ± 0.08[ab]	64	0.58 ± 0.03[b]	35.925 ± 1.31[a]
5	60	1.55 ± 0.06[b]	58	0.54 ± 0.03[c]	35.21 ± 1.39[a]
Sex of animal:		NS		*	**
Male	98	1.87 ± 0.06[a]	98	0.58 ± 0.03[a]	30.53 ± 1.05[a]
Female	657	1.83 ± 0.02[a]	560	0.65 ± 0.01[b]	35.78 ± 0.43[b]
Year of shearing:		**		*	*
2002	280	1.98 ± 0.03[a]	274	0.65 ± 0.02[ab]	32.44 ± 0.58[a]
2003	274	1.66 ± 0.03[b]	274	0.62 ± 0.02[a]	37.13 ± 0.67[b]
2004	201	1.87 ± 0.04[b]	200	0.68 ± 0.02[b]	35.95 ± 0.85[b]
Staple structure:		NS		NS	NS
Open	379	1.93 ± 0.03[a]	377	0.68 ± 0.02[a]	35.44 ± 0.56[a]
Dense	376	1.74 ± 0.03[a]	371	0.61 ± 0.02[a]	34.75 ± 0.58[a]
Kemp score:		**		NS	NS
Few	191	1.96 ± 0.04[a]	191	0.68 ± 0.02[a]	34.18 ± 0.74[a]
Medium	404	1.81 ± 0.03[ab]	404	0.64 ± 0.02[a]	35.07 ± 0.56[a]
Abundant	160	1.74 ± 0.04[b]	155	0.63 ± 0.02[a]	36.30 ± 0.94[a]
Type of birth:		NS		NS	NS
Single	554	1.87 ± 0.03[a]	551	0.66 ± 0.01[a]	35.18 ± 0.47[a]
Twins	37	1.84 ± 0.10[a]	37	0.66 ± 0.05[a]	35.71 ± 1.77[a]

*** = Significant at P<0.05, ** = Significant at P<0.01 and NS = not significant.**
Means within columns followed by the same superscript are not significantly different.

Fleece wool weight and percentage

Least squares means of annual fleece wool weight and percentage of Barki sheep was 1.19 ±0.05 kg and 64.40% (Table 2). This estimate of fleece wool percentage was in accordance with that obtained by Guirgis (1973), working on the same breed, as 63.2%. Also, Gadallah (2001) obtained value of 1.66 kg represented 66.23%. was considered. However , a lower estimate was found by Hassan (1985), working on the same breed, as 56%, meanwhile, a higher estimate was recorded by Lupton, *et al,* (1992), working on Ramboillet ewes, as 83%.

Annual fleece wool weight of Barki sheep decreased highly significantly with advanced age where the heaviest fleece wool estimates were produced at one and two years (1.28 ± 0.03 kg) and (1.28 ± 0.05 kg), and the lightest weight was at five years old (0.98 ± 0.05 kg). With respect to fleece wool percentage, it could be observed that males had highly significant value (69.47 ± 1.05) than that of females (64.22 ± 0.43). Meanwhile age of animals had no significant effect on fleece wool weight. Gadallah (2001) reported that sex of animals affected the amount and percentage of fleece wool of Barki sheep (P<0.01), where males had higher amounts and percentages of fleece wool than females (Table 2).

Table (2): Least-squares means ± standard error of Fleece wool weight and percentage

	No.	Fleece wool weight	Fleece wool percentage
μ		**1.19 ± 0.05**	**64.40**
Age of animal (year)		**	NS
1	298	1.28 ± 0.03 [a]	64.06 ± 0.68 [a]
2	109	1.28 ± 0.05 [a]	66.83 ± 0.68 [a]
3	80	1.17 ± 0.05 [a]	66.13 ± 0.68 [a]
4	64	1.01 ± 0.05 [b]	64.075 ± 1.09 [a]
5	58	0.98 ± 0.05 [b]	64.79 ± 1.39 [a]
Sex of animal:		NS	**
Male	98	1.29 ± 0.04 [a]	69.47 ± 1.05 [a]
Female	560	1.17 ± 0.02 [a]	64.22 ± 0.43 [b]
Year of shearing:		**	*
2002	274	1.33 ± 0.03 [a]	67.56 ± 0.58 [a]
2003	274	1.04 ± 0.02 [b]	62.87 ± 0.67 [b]
2004	200	1.20 ± 0.03 [c]	64.05 ± 0.85 [b]
Staple structure:		NS	NS
Open	377	1.25 ± 0.02 [a]	64.56 ± 0.56 [a]
Dense	371	1.13 ± 0.02 [a]	65.25 ± 0.56 [a]
Kemp score:		*	NS
Few	191	1.28 ± 0.03 [a]	65.82 ± 0.74 [a]
Medium	404	1.17 ± 0.02 [b]	64.93 ± 0.74 [a]
Abundant	155	1.11 ± 0.03 [c]	63.70 ± 0.94 [a]
Type of birth:		NS	NS
Single	551	1.21 ± 0.02 [a]	34.82 ± 0.47 [a]
Twins	37	1.18 ± 0.08 [a]	64.79 ± 1.77 [a]

*** = Significant at P<0.05, ** = Significant at P<0.01 and NS = not significant.**
Means within columns followed by the same superscript are not significantly different.

Year of shearing (Table 2) affected annual fleece wool weight of Barki sheep (P<0.01), where year 2002 had the heaviest fleece wool (1.33 ± 0.03 kg) followed by year 2004 and the lightest was year 2003 (1.04 ± 0.02 kg). With respect to fleece wool percentage, it could be seen similar significant (P< 0.05) trend. Gadallah (2001) observed that year of shearing affected (P < 0.01) percentage of fleece wool of Barki sheep (P<0.01), while the effect on amount of fleece wool was not significant. With regard to staple structure,Table (2) shows that animals with open staple structure produced higher weight and lower percentage of fleece wool compared with dense staple structure. However, differences were not significant. Table (3) shows that Kemp score significantly affected annual fleece wool weight of Barki sheep (P<0.05), where fleeces with few Kemp fibres had the heaviest weight (1.28 ± 0.03 kg) followed by medium content (1.17 ± 0.02 kg) and the lowest were those of abundant Kemp fibres content (1.11 ± 0.03 kg). It could be observed that there was no significant effect in fleece wool percentage due to Kemp fibres content (Table 2). However, results showed that fleece wool percentage tended to decrease as Kemp fibres increased. Furthermore, single born animals produced slightly higher weight and percentage of fleece wool than twins without significant differences.

Qualitative wool characteristics
Kemp score

Least square means of Kemp score of Barki wool was 2.11 ± 0.03 (Table 3) which might mean that Barki wool had few Kemp fibres. Similar estimate (2.00) was reported by Helal (2004) who observed in Barki sheep at Ras Sudr Research Station in Southern Sinai, Egypt. Also Ahtash (1998) recorded Kemp score in wool of Libyan Barbary sheep as 2.03. Azzam (1999) obtained nearly similar values in the same breed as 2.06. Guirgis (1980) and Guirgis, *et al,* (1982) reported lower Kemp score, in the same breed as 1.61 and 1.56, respectively. El-Gabbas (1993 and 1994) found that the average Kemp score ranged from 1.84 to 2.09 in Barki sheep of the same flocks rose along the north western coastal belt of Egypt. El-Gabbas (1999) too assessed Kemp scores as 2.09, 1.45, 2.23, 1.97 and 1.31 for Barki, Farafra, Ossimi, Saidi and Rahmani breeds, respectively. Furthermore, Kemp score tended to decrease significantly with advanced age (Table 3). The respective decreased noticed at 6, 5, 1, 2, 4 and 3 years , where the highest Kemp score was observed in wool of animals aged six years (2.19 ± 0.07) and the lowest at three years old (2.07 ± 0.04). Azzam (1999) showed that sequence of shearing (related to age) had a highly significant effect on Kemp score ($P<0.01$). However, El-Gabbas (1999) found no difference between first and second shearing season in different local breeds. Saddick (1988), working with Ossimi sheep, reported that no particular trend was detected for the effect of age on Kemp fibres percentage. Meanwhile, differences between males and females were not significant. Table (3) showed that year of shearing affected Kemp score of Barki wool ($P<0.01$), where year 2002 had the lowest (1.90 ± 0.102) and the highest was at year 2004 (2.02 ± 0.104). Moreover, Barki sheep of dense structure had significantly higher value of Kemp score (2.18 ± 0.02) than that of open structure (2.05 ± 0.02).

Body positions affected Kemp score of Barki wool ($P<0.01$), where shoulder position had the lowest (1.99 ± 0.03) followed by breech and mid-side positions (2.03 ± 0.03 and 2.03 ± 0.03, respectively), withers position (2.17 ± 0.03) and the highest value was that of the back and hip positions as 2.24 ± 0.03 and 2.23 ± 0.03, respectively. In spite of differences were significant, the differences among dorsal positions or lateral positions were not significant. The presented results showed that all of the three dorsal positions were higher than those of the lateral. This might mean that Kemp score tended to take a lateral-dorsal trend. These results were in agreement with those reported by Guirgis (1973), on Barki sheep, who found an antero-posterior trend and lateral- dorsal trend. Guirgis (1980) reported that the main Kemp production was on the dorsal line of the fleece with maximum value on the back and hip (1.61) and a minimum on shoulder position (0.36). El-Gabbas (1993) reported that dorsal positions appeared to produce more Kemp than those of the lateral and there was also an antero posterior trend. He showed that the body positions were significantly affected Kemp score. Similar findings were reported by Al-Betar (2000). Helal (2004) observed that body position significantly affected Kemp score where back position had higher Kemp score (2.51) than that of mid-side position (1.75).

Table (3): Least-squares means ± standard errors of Qualitative wool characteristics

Factors \ Traits	No.	Kemp score	Cotting level	Coat depth (cm)	Fleece openness score
μ	541	2.11 ± 0.03	1.96 ± 0.02	6.38 ± 0.06	2.00 ± 0.02
Age (year)		*	*	**	**
1	146	2.13 ± 0.02 [bc]	2.14 ± 0.02 [a]	6.30 ± 0.04 [a]	2.06 ± 0.02 [a]
2	138	2.08 ± 0.03 [c]	1.91 ± 0.02 [bc]	6.75 ± 0.05 [b]	1.87 ± 0.02 [b]
3	104	2.07 ± 0.04 [ac]	1.95 ± 0.03 [b]	6.66 ± 0.06 [b]	1.92 ± 0.03 [bc]
4	63	2.07 ± 0.04 [ac]	1.85 ± 0.03 [c]	6.04 ± 0.08 [c]	2.00 ± 0.03 [ac]
5	55	2.18 ± 0.04 [b]	1.95 ± 0.03 [b]	5.71 ± 0.07 [d]	2.02 ± 0.03 [a]
6	35	2.19 ± 0.07 [b]	2.10 ± 0.05 [a]	5.38 ± 0.11 [e]	2.11 ± 0.05 [a]
Sex		NS	**	**	**
Male	74	2.09 ± 0.11 [a]	1.69 ± 0.07 [a]	6.55 ± 0.14 [a]	1.69 ± 0.06 [a]
Female	467	2.12 ± 0.07 [a]	2.01 ± 0.04 [b]	5.95 ± 0.09 [b]	2.16 ± 0.04 [b]
Year		*	**	**	**
2002	166	2.12 ± 0.10 [ab]	1.63 ± 0.06 [a]	5.55 ± 0.14 [a]	1.97 ± 0.04 [a]
2003	197	2.14 ± 0.08 [a]	1.92 ± 0.05 [b]	6.95 ± 0.11 [b]	1.91 ± 0.04 [b]
2004	178	2.08 ± 0.10 [b]	2.35 ± 0.06 [c]	6.33 ± 0.14 [c]	2.11 ± 0.06 [c]
Staple structure		**	**	**	**
Open	74	2.05 ± 0.02 [a]	1.82 ± 0.02 [a]	6.61 ± 0.03 [a]	1.91 ± 0.01 [a]
Dense	467	2.18 ± 0.02 [b]	2.12 ± 0.02 [b]	5.95 ± 0.03 [b]	2.10 ± 0.01 [b]

*** = Significant at P<0.05, ** = Significant at P<0.01 and NS = not significant.**
Means within columns followed by the same superscript are not significantly different.

Cotting level

Least square means of cotting score of Barki wool was 1.96 ± 0.02 (Table 3) which might mean that Barki wool had significantly (P< 0.05) a somewhat low cotting level. Guirgis *et al,* (2001) reported that two thirds of the fleeces, in some breeds of Egyptian sheep, have medium to high levels of cotting at shearing. Table (3) showed that age of animals significantly affected cotting score; that animals aged one year produced fleeces with the highest value (2.14 ± 0.02) followed by six (2.10 ± 0.05), five (1.95 ± 0.03),(1.95 ± 0.03), (1.91 ± 0.02) and the lowest value was that of four years old (1.85 ± 0.03). So, it could be concluded that no particular trend was detected for the effect of age on cotting level. However, Table (3) showed that Barki females produced wool with (P < 0.05) higher cotting score (2.01 ± 0.04) than males (1.69 ± 0.07). This might be due to the physiological status of females as gestation, lambing and lactating which would result in some degree of effect on fibre shedding. Year of shearing had a highly significant effect on cotting score of Barki wool to show the highest value of cotting level in year 2004 (2.35 ± 0.06) followed by year 2003 (1.92 ± 0.05) and the lowest value in year 2003 (1.63 ± 0.06). This might be mainly due to differences in nutrition level which resulted from differences in rainfall and vegetation. Guirgis et al.,(2001) reported that drought, as a frequently occurring phenomenon in semi-arid regions, would contribute to tenderness and fibre breakage. In Britain, as different condition cotting in wool is regarded as being more prevalent in rainy seasons (Ryder and Stephenson 1968). In addition, D’Arcy (1979) found that wool cotting is often a result of a serious set-back such as starvation or sickness that causes fibres to break or shed. Also, under warm moist conditions and when the wool is not well nourished rubbing causes the fibres to move. He added that identifies the conditions most prone to cotted wool production as: when lush feed follows drought, in old sheep, with sheep of poor condition, strong-woolled sheep on poor country. However Ryder and Stephenson (1968) claim that one of the benefits of improved pasture nutrition of wool sheep is the greater value of wool lacking faults such as breaks and cotting.

Barki sheep of dense structure had higher value of cotting score (2.12 ± 0.02) than that of open structure (1.82 ± 0.02). The difference was highly significant (Table 3). This might mean that sheep of open structure were more adapted with hot conditions regions where it was thought that animals of less cotted fleeces could loss more heat to the environment. Body position had a highly significant effect on cotting score . It could be observed that the highest value of cotting level was that of breech position (2.14 ± 0.03) followed by mid-side and shoulder positions (2.02 ± 0.03 and 2.01 ± 0.03, respectively), withers position (1.90 ± 0.03), back position (1.87 ± 0.03) and the lowest value was in hip position (1.85 ± 0.03). However, differences among dorsal positions and those between shoulder and mid-side positions were not significant. It could be noticed that cotting score tended to take dorso lateral trend where all positions of lateral line exceeded those of the dorsal line. This might be due to less fibre diameter and more staple crimp frequency on lateral line wool compared with that of dorsal one. Khan (1966), on Merino wool, reported that finer wool felted more readily than coarser wool and wool with sinusoidal crimps felted more readily than wools with helical crimp. British luster long wools found to be much greater mean of fibre diameter than Merino wools, it has helical crimping and are prone to cotting (Ryder and Gabra-Sanders 1984). They added from their studies that cotted and normal wool of British Blackface, Cheviot, Swaledale and Border Leicester sheep; that no evidence that mean fibre diameter, the number of cuticle scale edges, fibre crimp wavelength or the number of shed fibres were differ between normal and cotted wool. They observed too in cotted wool there was a greater number of loops in which one fibre encircled at least one other fibre.

Coat depth

Least squares mean of coat depth of Barki wool was 6.38 ± 0.06 cm. (Table 3). Age of animal affected significantly coat depth of Barki wool. The animals aged two years produced fleeces with the highest coat depth (6.75 ± 0.05 cm.) followed by three years of age (6.66 ± 0.06 cm.), one year (6.30 ± 0.04), four years (6.04 ± 0.08 cm.), five years (5.71 ± 0.07 cm.) and the lowest value was that of six years old (5.38 ± 0.11 cm.). The obtained results, in Karadi sheep (Ghoneim, *et al*, 1974), in Arabi sheep (Ibrahim and Gharib 1979), in Merino, Suffolk, Barki, Rahmany and their crosses and in Ossimi, Rahmany and their crosses. (El-Qobati, 1990) indicated that staple length tended to increase gradually as age advanced and the differences were statistically highly significant. The study of Vessely *et al*, (1965), working on

Romnelet, Canadian Corriedale, Rambouillets, encountered a significant effect of age on the staple length, where the youngest ewes produced the longest staples. However, Bigham, *et al* (1978) reported that staple length increased up to 3 or 4 years of age and declined at 5 years of age in Romney, Coopworth, Perendale, Cheviot and Dorset-Romney sheep. On the other hand, Sharafeldin (1965), and Kishore, *et al,* (1982) reported that age of animal had no significant effect on the staple length of wool.

Table (3): continued

Traits / Factors	Kemp score	Cotting level (Score)	Coat depth (cm.)	Fleece openness score
Body positions	**	**	**	**
Withers	2.17 ± 0.03 [a] (689)	1.90 ± 0.03 [a] (681)	6.21 ± 0.06 [a] (679)	1.88 ± 0.03 [a] (684)
Back	2.24 ± 0.03 [a] (689)	1.87 ± 0.03 [a] (683)	6.37 ± 0.06 [bc] (681)	2.13 ± 0.02 [b] (685)
Hip	2.23 ± 0.03 [a] (689)	1.85 ± 0.03 [a] (683)	6.44 ± 0.06 [c] (680)	2.15 ± 0.02 [b] (685)
Shoulder	1.99 ± 0.03 [b] (689)	2.01 ± 0.03 [b] (688)	6.17 ± 0.06 [a] (685)	1.97 ± 0.02 [c] (686)
Mid-side	2.03 ± 0.03 [b] (689)	2.02 ± 0.03 [b] (688)	6.26 ± 0.06 [ab] (685)	1.97 ± 0.02 [c] (686)
Breech	2.03 ± 0.03 [b] (689)	2.14 ± 0.03 [c] (687)	6.28 ± 0.06 [ab] (685)	1.89 ± 0.02 [a] (686)

**** = Significant at P<0.01. Means within columns followed by the same superscript are not significantly different.**

Moreover, males produced wool with higher coat depth (6.55 ± 0.14 cm.) than females (5.95 ± 0.09 cm.), the difference was highly significant. This might be due to the challenges facing females such as physiological status; gestation, lambing and lactating. These results were in agreement with those reported by Azzam (1982) on Barki sheep ; Ibrahim and Gharib (1979) on Arabi sheep who reported that males produced longer staples than females. However, many investigators found that females tended to produce longer staples than males Awad, *et al*, 1969 on Merino, Barki and their crosses; Marai, 1973 on Texel sheep and Guirgis, *et a,l* (1978) on Awassi and Karadi sheep. On the other hand, sex was shown to have no significant effect on staple length, (Guirgis, 1980), in Merino, Barki and their crosses, (Taneja, *et al*, 1991), in Magra sheep . The higher value of coat depth of males compared with that of females might be also due to the lower mean of ram's age compared with ewe's age where the rate of replacement of rams was lower than that of ewes. The rate of culling was higher in rams than that of ewes.

Furthermore, year of shearing had a highly significant effect on coat depth of Barki wool (Table 4). The highest value of coat depth was in year 2003 (6.95 ± 0.11 cm), followed by year 2004 (6.33 ± 0.14 cm) and the lowest value was in year 2002 (5.55 ± 0.14 cm). This might be due to differences in nutrition level as a result of differences in rainfall and vegetation. These results were in agreement with those obtained by Guirgis *et al*, (1982) on Barki, Lewer *et al*, (1983) on Perendale ewes and Magid and Zaied (1992) on

Barbary sheep. On the other hand, Aboul-Naga (1970), working on Merino, Ossimi and Barki sheep, found that differences in staple length due to year effect were not significant.

Table (3) showed that Barki sheep of dense structure had shorter staples (5.95 ± 0.03) than open structure (5.95 ± 0.03 cm.). The difference was highly significant. Meanwhile, body position had highly significant effect on coat depth of Barki wool. The highest was that of hip position (6.44 ± 0.06 cm.) followed by back position (6.37 ± 0.06 cm.), breech position (6.28 ± 0.06 cm.), mid-side position (6.26 ± 0.06 cm.), withers position (6.21 ± 0.06 cm) and the lowest value was that of shoulder position (6.17 ± 0.06 cm.). It could be observed that the three dorsal line positions were deeper than those of lateral line positions. Differences were highly significant except among withers, shoulder, mid-side and breech, as well as between back and between back, mid-side and breech positions. Guirgis (1973), on Barki sheep also found that differences among body positions were highly significant. He found that mean values of staple length were 7.02, 6.78, 6.00, 12.59 and 13.30 on the withers, back, hip, mid-side and breech, respectively. Aboul-Heif (1974) found that staples on the withers position were significantly longer than those obtained from the back or mid-side positions. Saddick (1993) found that Ossimi sheep exhibited wide variations among the different positions over their body. He also reported that the staples on the hip position were the longest among the all positions over the body. On the other hand, Al-Betar (2000), on Barki, Rahmany and Baladi sheep, found that there was a slight dorso-ventral gradient in staple length where dorsal positions had longer staples than those of the lateral ones with significant differences. He also observed an antero-posterior gradient in staple length where the anterior positions had longer staples than those of the posterior. Similar findings were reported on Barki wool by Gadallah (2001) who found that class B (wool obtained from the back line of fleece wool) had slightly longer staples than those of class S wool obtained from sides line of fleece wool). However, the differences were not significant.

Fleece openness

Least squares means of openness score of Barki fleeces was 2.00 ± 0.02 (Table 3) which might mean that Barki wool had a lowest medium degree of easiness to open the fleece. Age of animal had a highly significant effect on fleece openness of Barki sheep. Animals aged two years had the easiest degree to open the fleece (1.87 ± 0.02) followed by three years (1.92 ± 0.03), four years (2.00 ± 0.03), five years (2.02 ± 0.03), one year (2.06 ± 0.02) and the highest value (hardest degree to open) was that of six years old (2.11 ± 0.05). This mean that easiness to open the fleece tended to decrease with advanced age. This might be related to cotting level which partially had the similar trend. Furthermore, Barki males tended to produce fleeces more easy to open (1.69 ± 0.06) than those of females (2.16 ± 0.04). The difference was highly significant. This might be due to the lower mean of ram's age compared with ewe's age where the rate of replacement of rams was lower than that of ewes. The rate of culling was higher in rams than that of ewes. Meanwhile, year of shearing had a highly significant effect on fleece openness of Barki sheep. It could be observed that the highest value of openness (more hard) was that year 2004 (2.11 ± 0.06) followed by year 2002 (1.97 ± 0.04) and the lowest value (easiest openness) was that of year 2003 (1.91 ± 0.04). Dense structure had higher value of openness (2.10 ± 0.01) than that of open structure (1.91 ± 0.01). The difference was highly significant. That might mean that dense structure fleeces' harder to open the fleece than that of open structure fleeces . Table (3) showed that body position had a highly significant effect on openness of Barki fleece. It could be seen that the highest value of openness (i.e. more hard to open) was that of back and hip positions (2.16 ± 0.02 and 2.15 ± 0.02, respectively) followed by mid-side and shoulder positions (1.97 ± 0.02, and 1.97 ± 0.02, respectively) and the lowest values were that of withers and breech positions (1.88 ± 0.03 and 1.89 ± 0.02, respectively). It could be observed that the dorsal line positions were hard to open than that of lateral line positions except that of withers where shoulder was harder to open than withers. Differences were highly significant except that between positions withers and breech, between back and hip and between shoulder and mid-side positions.

Heritability estimates

Least square means of heritability estimate of greasy fleece weight was 0.55 (Table 4). This estimate might mean that greasy fleece weight appeared to have highly heritable value in this flock of Barki sheep. High heritability estimates were recorded by Kadry *et al* (1980) and Davis and Kinghorn (1986) on Barki and Merino sheep (0.84 & 0.55, respectively). However, low heritability estimates were obtained by Aboul-Naga & Afifi (1977) in Rahmani sheep(0.19), by Blair, *et al*, (1985) in New-Zealand sheep(0.16). The moderate heritability estimates of greasy fleece weight were obtained in different breeds of sheep by Ghoneim, *et al*, (1974) in Awassi(0.36); Aboul-Naga and Afifi, 1977 and El-Kimary, *et al*, 1985 (0.34 and 0.37 respectively) in Barki sheep..

Table (4): Heritability estimates of some Barki fleece characteristics.

Traits	Heritability (h^2)
Greasy fleece weight	0.55
Belly wool cover	0.39
Kemp score	0.39
Skirting's weight	0.25
Fleece wool weight	0.20
Coat depth	0.19
Cutting level	0.15
Fleece openness	0.11

Percentage of belly wool cover and fleece Kemp score showed similar heritability estimates ($h^2 = 0.39$). The high heritability of belly wool and fleece Kemp score in Barki lead to conclude that any improvement in belly wool cover will be obtained by genetic as well as environmental improvement on the basis of highly significant effect of year, sex and age on belly wool cover. The present of h^2 was close to that reported by Guirgis *et al* (1982), in Barki sheep as 0.43. In the same trend El-Gabbas (1993) reported that the genetic factors might have a major role in controlling Kemp score to give importance for selection programs as indicated by highly significant animal effect.

Least square means of heritability estimate of skirting and fleece wool weights were 0.25 and 0.20 respectively (Table 4). These traits estimates appeared to have moderate heritability in this flock of Barki sheep. However, Least squares mean of heritability estimate of Fleece openness , Cotting level and Coat depth were 0.11, 0.15 and 0.19 respectively (Table 3). This mean that the environment play active role in the performance of these traits. The heritability estimate of staple length (0.20) was similar to that found by Kadry (1971), in Barki sheep. Lower estimates obtained (0.16) by Guirgis, *et al,* (1982), in Barki sheep, 0.17 by Gajbhiye and Johar (1987) in Megra sheep, (010) by Taneja, *et al*, (1991), Megra sheep. Higher estimates of heritability (0.24) were reported by Madson & Chapman (1960), in Rambouillet sheep, (0.26) by Kadry *et al*, (1980) in Barki sheep, (0.40) by Lewer *et al,* (1983) in Perendale sheep, 0.55 by Cardellino, *et al*, (1998) in Polwarth sheep. Thus, heritability estimate of staple length ranged from 0.10 to 0.72.

Genetic correlations

Genotypic correlation coefficients between some fleece traits of Barki sheep were presented in Table (5). Fleece openness showed low positive correlation values with cutting level, Kemp score, belly wool cover and skirting weight and lower negative with coat depth and highly significant value with Greasy fleece weight (r=0.72) and Fleece wool weight (r= 1.00). Cutting levels significantly positive correlated with all examined traits except with kemp score which was negative.

Kemp score showed significant low negative genetic correlation with all examined traits except with belly wool cover which was positive.

Coat depth showed significantly positive values of genetic correlations with all examined traits. Belly wool cover showed medium positive values of genetic correlation with all examined traits.

Table (5): Genetic correlations between some Barki fleece traits

Traits	Cotting level	Kemp score	Coat depth	Belly wool cover	Greasy fleece weight	Skirting's weight	Fleece wool weight
Fleece openness	0.02 NS	0.20 *	-0.12 NS	0.07 NS	0.72***	0.02 NS	1.00**
Cotting level		-0.45**	0.89 **	0.21*	1.00**	1.00**	1.00**
Kemp score			-0.04 NS	0.13 NS	-0.44**	-0.25*	-0.62**
Coat depth				0.53**	0.56**	0.59**	0.32*
Belly wool cover					0.30*	0.46**	0.38*

*** = Significant at P<0.05, ** = Significant at P<0.01 and NS = not significant.**

Generally, the Barki fleece characteristics affected by some genetic and environmental factors.The greasy fleece weight, Kemp score and belly wool cover consider as high heritable traits; however, degree of openness, cotting score and coat depth as medium to low heritable traits. This had to the effective way for improvement by selection for the high heritable genetic traits of improving the environmental conditions for the medium and low heritable traits. Furthermore, fleeces of open structure with no Kemp would be selected for better quality of the fleece, and welfare of the animals. In addition for more effective; sorting Barki fleece wool may be done on the basis of staple structure (open, dense) and Kemp score (no Kemp, medium Kemp and plentiful Kemp). Thus six classes will be developed (open structure with no Kemp, open structure with medium Kemp, open structure with plentiful Kemp, dense structure with no Kemp, dense structure with medium Kemp and dense structure with plentiful Kemp).

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الإختلافات الوراثية وغير الوراثية لإنتاج الصوف فى أغنام البرقى المصرية

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استخدم فى هذه الدراسة عدد ٩٣٧ حيوان من أغنام البرقى بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء حيث استمرت الدراسة مدة ثلاث سنوات وكانت ظروف الرعاية مماثلة لتلك المتبعة فى القطعان التجارية لهذه المنطقة.

كان متوسط أقل المربعات لوزن الجزة السنوى هو ١,٨٤ ± ٠,٠٦ كجم فى المتوسط وتناقص وزن الجزة الخام السنوى بدرجة عالية المعنوية بتقدم العمر وكذلك كان لسنة الجز تأثير معنوى على وزن الجزة الخام، وجد أن محتوى الألياف من الكمب يؤثر معنويا على وزن الجزة الخام حيث أن الجزات القليلة المحتوى من الياف الكمب كان لها أعلى الأوزان وتليها المتوسطة المحتوى من الياف الكمب ، وأخف الأوزان كانت تلك الغزيرة المحتوى من الياف الكمب.

كانت أوزان الشوائب تميل للتناقص بتقدم العمر حيث كانت أثقلها وزنا للحيوانات عمر عام ثم عامان. وأنتجت الإناث وزن أثقل معنويا لوزن الشوائب عن الذكور، وكان تأثير سنة الجز على وزن الشوائب معنويا ($P<0.01$).

لم يكن لتركيب الجزة ودرجة الكمب تأثير على وزن الشوائب أو نسبتها وكانت أوزان الشوائب متماثلة للولادات الفردية والزوجية، وتناقص وزن الجزة السنوى معنويا بتقدم العمر وكذلك أثرت درجة الكمب وسنة الجز على وزن الجزة.

قدر المكافئ الوراثى لوزن الجزة ودرجة الكمب ووزن الشوائب بـ ٠,٥٥ ، ٠,٣٩ ، ٠,٢٥ .على التوالى. كما قدرت أيضا معاملات الإرتباط الوراثية فيما بين صفات الجزة لأغنام البرقى.