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THE RESPONSE OF SOME FACTORS AND NUTRITIONAL STRESSES ON OBJECTIVE AND SUBJECTIVE WOOL TRAITS OF SOME EGYPTIAN BREEDS OF SHEEP

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SUMMARY

The present study was designed to determine the effect of some factors on subjective and objective wool traits. More emphasis were paid to impose some nutritional stresses on wool while growing and investigating their effects on fibre diameter variability and wool tenderness which are regarded as serious faults affecting the monetary value as well as the processing performance of the Egyptian wool.

Three local coarse wool breeds were included in the present study: Barki, Rahmany and Baladi. These breeds were allocated in three feeding regimes; maintenance (M), productive (P) and fluctuated (F) groups. The experiment was run for one full year where M group kept on maintenance diet throughout, P group was given 1.6 from the maintenance requirement while F group started with the maintenance and was shifted each three months between productive and maintenance requirements. Animals in each breed group were divided according to their sex and then allocated randomly into three feeding regimes. One-year wool sample was taken from six body positions on the right hand side. Wool samples were used to study the subjective as well as some objective wool traits. Results indicated that breed and feeding regime had significant effects on most studied traits. Barki sheep had higher bulk, resilience and staple strength compared with the other two breeds whereas Baladi breed indicated more fibre diameter variability along the fibres. The later was found to be more pronounced in F group compared with M and P groups. Also, the effects of sex and body position were presented and discussed. Results were discussed from the management, breeding and processing points of views to elucidate the possibility of producing appropriate wool for the carpet industry.

***Keywords:** Subjective and objective wool traits, Egyptian sheep, feeding regimes, breed, sex, wool sample position, and type of fibre*

INTRODUCTION

The wide variability of wool was attributed to genotype as well as to various physiological and environmental factors. Nutrition is considered to be the most important environmental factor affecting wool traits.

In Egypt, indigenous pasture species are perennials or annuals. They usually have a season of rapid growth followed by a dry season characterized by deficiency of feed value to the sheep. Moreover, commercial farms could also be exposed to many periods of fluctuation in requirements and supplement diets. In this regard the effect of instability of nutritional regimes affects the diameter of fibres resulting in tender regions along wool fibres and affecting their processing performance and the quality of the end products. Therefore, the present study was designed to determine the effect of some factors on subjective and objective wool traits. More emphasis were paid to impose some nutritional stresses on wool while growing and investigating their effects on fibre diameter variability and wool tenderness which are regarded as a serious fault affecting the monetary value as well as the processing performance of the Egyptian wool.

MATERIALS AND METHODS

The present study was carried out at experimental station of Alexandria university during 1998 and 1999. Data collected were obtained from yearling ewes of three local breeds; Barki (12), Rahmany (11) and Baladi (4) sheep. These breeds are generally characterized by fat tail and coarse fleeces (Galal, 1985).

The experimental animals were kept in closed pens all the day. Concentrates were offered once daily and followed by roughages. Maiden ewes were not bred during the study. Animals in each breed group were divided into sub-groups according to their sex. Each breed and sex sub-group was then allocated randomly into three nutritional regimes; maintenance, productive (approximately 1.6* maintenance) and fluctuated. The maintenance and productive regimes were continued throughout the year while the fluctuated group started with maintenance and turned between productive and maintenance at intervals of 92 days.

Animals fed in 4 periods of 92 days. The feed stuff available in each period was the same for all groups. These four periods were as follow: In the first period, animals were fed on Berseem (*Trifolium alexandrinum*) straw and commercial pellets covering 100% of crude protein requirements. In the second period, Berseem and commercial pellets diet covered 70% of the daily requirements. In the third period, animals were fed on Berseem and commercial pelleted diet for 42 days to cover 70% of the daily requirements, followed by 50 day-feeding on rice straw and the commercial pelleted diet to cover 100% of crude protein requirements. The fourth period comprised feeding on Sorghum (*Sorghum vulgaris var saccartum*) and the commercial pelleted diet to cover 70% of the daily requirements. Chemical compositions of diets were analyzed (A.O.A.C., 1990) and diets were formulated (Kearl, 1982) to cover the nutritional requirements of sheep. Body weight of each animal was recorded at the beginning and at biweekly intervals throughout the experimental period. The statistical analysis indicated no significant difference in the initial weight of sheep fed under three different feeding regimes.

One-year wool samples were obtained at the beginning and the end of the experiment from six body positions, three on the dorsal positions (Wither (Wth), Back (Bk) and Rump (Rp)) and three on the lateral ones (Shoulder (Sh), Mid-side (Ms) and Britch (Br)). Wool samples were obtained by using fine scissors as close as possible to the skin surface forming a square of approximately 10 x 10 cm from each position. The dimensions of these squares were recorded for each animal, position and sampling occasion to calculate the area shorn. Greasy wool sample taken from the area shorn was also weighted and the greasy wool production per unit area (GWA) was then calculated for each animal, position and occasion (El-Gabbas, 1993a). Ten staples were taken from each greasy sample and used for measuring fibre diameter (FD) (El-Gabbas, 1998), staple length (STL), staple crimp (CR) and staple strength (SS) and point of break (POB) according to El-Gabbas, *et al.* (1999a). The greasy sample was scoured to estimate clean scoured yield (Chapman, 1960), clean wool per unit area (CWA) (El-Gabbas, 1993a), loose wool bulk (BUL) and resilience (RES) (Bedford *et al.*, 1977). Wool samples taken from animals were subjectively assessed to determine greasy colour grade (GCG), luster grade (LG), handle grade (HG), bulk grade (BLG) and kemp score (KS) (EL-Gabbas, 1993).

The statistical computer package of SAS (1995) was used to analyze the data of the present study. Analysis of variance was performed to examine the differences due to the studied sources of variations. Comparisons among means within each group were tested using Duncan's New Multiple Range Test. The statistical model included the effects of feeding treatment, sex, breed and position. Preliminary analyses indicated the importance of these main effects as well as the interactions of treatment with both breed and sex. Thus, they were included in the model.

RESULTS AND DISSCUSION

A- Objective wool characteristics

Comparisons among wool yield percentages of the breeds (Table 1) showed that Barki and Baladi sheep had more YLD compared with Rahmany sheep. These differences were highly significant. These results are in agreement with the findings of Azzam (1982), Ali (1997) and Abd El-Maguid (2000). These differences found in YLD might due to management system. The present results showed that there was no sex difference in YLD%. These result are in accordance with those obtained by Ragab and Ghoneim (1961) and Satava *et al.* (1985). Position of sample had a highly significant effect on YLD%. Dorsal positions had higher YLD% compared with those of lateral positions. The later exposed more to the non-wool contaminants compared with dorsal positions. El-Gabbas (1986) and Thornberry and Atkins (1984) reached the same conclusions. Maintenance feeding group indicated higher YLD% compared with the other two treatments. That probably due to lower yolk production in this group, a result that agrees with Daly and Carter (1955).

Breed differences in GWA and CWA showed the same trend regarding the breed, treatment, sex and positions. Breed differences were found to be highly significant where Baladi sheep had higher GWA and CWA compared with the other two breeds. The amplitude of wool growth cycle seems to vary considerably amongst breeds, which reflects the importance of genetic factors. The results also showed that sex had insignificant effect on CWA and GWA (gm/cm2). Position had highly significant effect on GWA and CWA. A dorso-venteral gradient was observed in which dorsal positions had higher CWA than lateral ones. Differences in blood supply to various body positions might act to determine the capacity for follicle population and resulted in such variations among body positions (El-Gabbas, 1993a). Sheep kept on productive diet indicated heavier CWA than maintenance and fluctuated ones. The CWA of productive feeding group were heavier than both maintenance and fluctuated feeding groups. The effect of feeding regime was highly significant on CWA (g/cm2). The highly significant interaction of breed X treatment for CWA indicated that Baladi sheep had the heaviest wool when kept on maintenance diet (Table 1). The results indicated highly significant breed effect on STL. Baladi breed had significantly longer STL followed by Rahmany and Barki sheep (Table 1). Longer STL in Baladi sheep might be due to lower crimp compared with the other two breeds. Significant breed differences in STL were also reported by Ali (1997), El-Gabbas (1999), Abd El-Maguid (2000) and Helal (2000). Females tended to have significantly longer STL than males. The significant differences among regions in STL over the body indicated slight dorso-ventral gradient in STL where dorsal positions had longer staples than lateral ones. An antero-posterior gradient also existed in which STL tended to be longer on the anterior parts of the body. The wool samples represented annual pattern of staples growth, it appeared that fluctuated feeding group had the shortest STL, while the longest staples were observed in group fed the maintenance and productive diets. Barki and Rahmany wool in productive group appeared to have longer staples while Baladi wool showed the longest staples when fed on maintenance. These results are in accordance with the findings of Thompson and Hynd (1998) and Masters *et al.* (1998).

Table 1. Least squares means and standard errors for greasy wool per unit area (GWA), clean wool per unit area (CWA) and clean scoured yield (YLD), Staple length (STL) and Staple crimp (CR) according to breed, feeding treatment, sex and position

Traits / Factor	No.	YLD (%)	GWA (g/cm^2)	CWA (g/cm^2)	STL (cm)	CR (/cm)
Overall mean	162	50.257 ± 0.41	0.379 ± 0.01	0.185 ± 0.01	10.70 ± 0.17	0.81 ± 0.01
Breeds (B)		**	**	**	**	NS
Barki	72	52.37 ± 0.64 ^{a}	0.32 ± 0.01 ^{c}	0.162 ± 0.01 ^{b}	9.98 ± 0.26 ^{b}	0.80 ± 0.02 ^{a}
Rahmany	66	47.38 ± 0.65 ^{b}	0.40 ± 0.01 ^{b}	0.182 ± 0.01 ^{b}	10.78 ± 0.27 ^{b}	0.82 ± 0.02 ^{a}
Baladi	24	52.31 ± 1.14 ^{a}	0.47 ± 0.02 ^{a}	0.246 ± 0.01 ^{a}	12.92 ± 0.47 ^{a}	0.73 ± 0.03 ^{a}
Treatments (T)		**	**	**	**	NS
Maintenance	48	56.159 ± 0.90 ^{a}	0.36 ± 0.02 ^{b}	0.20 ± 0.01 ^{b}	12.49 ± 0.37 ^{a}	0.811 ± 0.03 ^{a}
productive	60	49.432 ± 0.72 ^{b}	0.44 ± 0.02 ^{a}	0.22 ± 0.01 ^{a}	11.23 ± 0.29 ^{a}	0.807 ± 0.02 ^{a}
fluctuated	54	46.472 ± 0.89 ^{c}	0.38 ± 0.02 ^{a}	0.17 ± 0.01 ^{b}	9.97 ± 0.36 ^{b}	0.737 ± 0.03 ^{a}
Sex (S)		NS	NS	NS	NS	**
Males	72	49.76 ± 0.68 ^{a}	0.41 ± 0.01 ^{a}	0.194 ± 0.01 ^{a}	10.94 ± 0.28 ^{a}	0.69 ± 0.02 ^{b}
Females	90	51.61 ± 0.66 ^{a}	0.39 ± 0.01 ^{a}	0.199 ± 0.01 ^{a}	11.52 ± 0.27 ^{a}	0.88 ± 0.02 ^{a}
Positions (P)		**	**	**	*	**
shoulder	27	45.30 ± 1.05 ^{b}	0.37 ± 0.02 ^{bc}	0.17 ± 0.01 ^{cd}	11.65 ± 0.43 ^{ab}	0.90 ± 0.03 ^{a}
Mid-side	27	45.10 ± 1.05 ^{b}	0.36 ± 0.02 ^{c}	0.16 ± 0.01 ^{d}	10.94 ± 0.43 ^{ab}	0.84 ± 0.03 ^{ab}
Britch	27	38.18 ± 1.05 ^{c}	0.54 ± 0.02 ^{a}	0.20 ± 0.01 ^{bc}	10.37 ± 0.43 ^{b}	0.75 ± 0.03 ^{cd}
Wither	27	58.97 ± 1.05 ^{a}	0.42 ± 0.02 ^{b}	0.24 ± 0.01 ^{a}	12.12 ± 0.43 ^{a}	0.78 ± 0.03 ^{bc}
Back	27	59.53 ± 1.05 ^{a}	0.35 ± 0.02 ^{c}	0.21 ± 0.01 ^{ab}	11.41 ± 0.43 ^{ab}	0.76 ± 0.03 ^{bcd}
Rump	27	57.04 ± 1.05 ^{a}	0.35 ± 0.02 ^{bc}	0.20 ± 0.01 ^{bc}	10.90 ± 0.43 ^{ab}	0.69 ± 0.03 ^{d}
T × B		NS	NS	**	**	*
T × S		NS	NS	NS	NS	*

^{a,b,c,d}Within a column in each classification, means followed by the same superscript are not significantly different.
*P<0.05. ** P<0.01. NS: not significant

Breed and Feeding system had insignificant effect on CR. However, the significant feeding system X breed interaction found on right side revealed that maintenance group had higher CR in Barki and Baladi sheep while productive group showed higher CR in Rahmany sheep. Wool fibres of females contained significantly larger number of staple crimps than that in males. There is significant sex X feeding treatment interaction in which males showed the highest CR in the fluctuated group while females indicated the corresponding value when kept on maintenance diet. As the crimp frequency usually taken as indication for fineness, thus, female wool is finer than male ones. This received support from table (2) as the female wool appeared to have lower fibre diameter than males. Results also showed that the body positions had a highly significant effect on CR which showed a definite dorsal-lateral gradient where larger number of crimps were found in lateral positions than that in dorsal one. Moreover, there is also an antero-posterior gradient in which CR decreases from front to rear position on the dorsal and ventral lines.

Table 2. Least squares means and standard errors for Fibre diameter along fibre ($FD^{along\ fibre}$), along staple ($FD^{along\ stl}$) and their coefficient of variation (CV%).

Traits Factor	No.	($FD^{along\ fibre}$) (μm)	CV (%)	No.	($FD^{along\ stl}$) (μm)	CV (%)
Overall mean	836	33.00 ± 0.24	16.38 ± 0.10	540	27.03 ± 0.18	39.42 ± 0.33
Breeds (B)		**			**	
Barki	372	34.39 ± 0.41^a	16.52 ± 0.17^a	240	27.05 ± 0.29^a	43.77 ± 0.53^a
Rahmany	341	29.93 ± 0.42^b	15.75 ± 0.18^b	220	26.43 ± 0.28^a	36.77 ± 0.52^b
Baladi	123	36.85 ± 0.81^c	17.94 ± 0.34^c	80	28.60 ± 0.57^b	37.55 ± 1.06^b
Treatments (T)		**			**	
Maintenance	247	32.13 ± 0.53^a	15.48 ± 0.22^a	160	25.75 ± 0.38^a	36.98 ± 0.70^a
productive	310	36.78 ± 0.47^b	15.75 ± 0.19^a	200	29.20 ± 0.34^b	38.43 ± 0.63^b
fluctuated	279	32.26 ± 0.47^a	18.98 ± 0.20^b	180	27.14 ± 0.33^c	42.68 ± 0.62^c
Sex (S)		*			*	
Males	371	34.41 ± 0.39^a	16.15 ± 0.16^a	240	27.87 ± 0.28^a	41.92 ± 0.52^a
Females	465	33.03 ± 0.51^b	17.32 ± 0.22^b	300	26.85 ± 0.36^b	36.81 ± 0.68^b
Positions (P)		NS			**	
Mid-side	405	33.96 ± 0.42^a	16.45 ± 0.18^a	270	27.91 ± 0.30^a	37.36 ± 0.57^a
Back	341	33.49 ± 0.44^a	17.03 ± 0.18^b	270	26.82 ± 0.30^b	41.36 ± 0.57^b
Fibre types (TP)		**				
Fine	405	29.50 ± 0.48^a	16.66 ± 0.20^a			
Coarse	431	37.95 ± 0.41^b	16.81 ± 0.17^a			
B × P, B × S, P × S		**			NS	
T× B, T × S		**			**	
T×P		NS			NS	
T×TP, TP× B, TP × P		**			_	
TP × S		NS			_	

[a,b,c]Within a column in each classification, means followed by the same superscript are not significantly different.
*P<0.05. ** P<0.01. NS: not significant

The differences in FD among breeds were found to be highly significant (Table 2). Baladi wool had higher FD than the other two breeds. However, Barki sheep had higher within sample variation in terms of CV% compared with both Baladi and Rahmany breeds respectively. Similar results were obtained (Elsherbiny, *et al.*, 1979; Ali, 1997; El-Gabbas, 1998; Azzam, 1999 and Abd Al-Maguid, 2000). The results illustrated that Barki breed had higher CV% for FD along staple than both Rahmany and Baladi sheep, being 10.83, 8.08 and 8.83% respectively. Single fibre analysis was done to describe the subsequent changes in single fibre properties. The results indicated that Baladi sheep had coarser FD along the fibre followed by Barki and Rahmany breed. These differences in FD were statistically highly significant (Table 2). Within type of fibres (fine or coarse) the previous trends were also observed in both FD and CV% of FD along fibre. This might explain the highly significant effect of type of fibre X breed interaction for these traits. Table (2) indicated that males produced significantly coarser fibres than females. The effect of sex on fibre diameter was reported by Snyman *et al.* (1995); Wani *et al.* (1995) and Martinez *et al.* (1997). However, Azzam (1999) found insignificant effect of sex on fibre diameter. There was a highly significant interaction between breed and sex in FD along fibre. The Barki males had finer fibres than females while the males of both Rahmany and Baladi sheep produced coarser fibres compared with females. The differences in FD and its variability were found to be highly significant between mid-side and back.. The back position had finer fibres with higher variability than mid-side. Furthermore, the CV% of FD along staple was higher on the back than mid-side. Single fibre analysis showed insignificant differences between the two positions in FD. However, the back position had higher CV% of FD along fibre than mid-side position. The interaction between position and type of fibres was found to be highly significant. The fine fibres had lower diameter with lower variability in the back position whilst the coarse fibres had wider diameter with higher variability in the back sample than mid-side one. The interactions between position and either breed or sex for FD were highly significant. Higher FD was recorded in mid-side position for Barki and Rahmany breeds and in back for Baladi breed. Also, the males produced finer fibres in the back while females had finer fibres in the mid-side position. The diameter measurements were the finest in maintenance group, while the coarsest was in the productive group while the fluctuated group was in between. These differences were highly significant (Table 2). In addition, there were highly significant interactions between breed, sex and feeding treatment regime. Higher FD was estimated in both maintenance and fluctuated feeding groups for Baladi breed and for productive group in Barki breed. Moreover, the males had coarser fibres under productive and fluctuated feeding systems while females showed coarser diameter in group of maintenance diet.

The variability of FD along fibres and staples was higher in fluctuated feeding regime than productive and maintenance feeding regimes. These were in agreement with Hansford (1992), Peterson *et al.* (1998), Masters *et al.* (1998) and Thompson and Hynd (1998). There were highly significant interactions between type of fibres, sex, breed of sheep and nutritional regime. Baladi breed had coarser diameter along fibre in maintenance and fluctuated regimes while that was found for Barki in the productive regime. The males produced coarser fibres under productive and fluctuated regimes but it had finer fibres in maintenance regime. Also, the maintenance group had finest FD within both fine and coarse fibre types while the productive group produced the coarsest diameter in both types of fibre.

Table 3 illustrated that Barki breed had the highest values of both BUL and RES followed by Baladi and Rahmany sheep. The differences between them were highly significant. These results are in accordance with El-Gabbas (1999) and Abd El-Maguid (2000). Position and sex of sheep showed insignificant effect on BUL, while position had highly significant effect and sex had insignificant effect on RES. Wool on dorsal line had higher RES and BUL than lateral one. This might be attributed to the harshness which was higher in dorsal than lateral line. The interaction between sex and feeding regime in BUL was highly significant. Higher BUL was obtained from wools of females on maintenance and productive diets while male wool showed higher value in the fluctuated group. The maintenance feeding group was higher in BUL than fluctuated and productive groups. The differences due to nutritional regimes were highly significant. The interactions between nutritional regime and breed of sheep were highly significant for BUL. Wool samples from Barki and Rahmany breeds had more bulk and resilience under maintenance feeding while Baladi breed had the highest estimate of BUL and RES under fluctuated feeding.

Table 3. Least squares means and standard errors for the qualitative wool traits of bulk (BUL), resilience (RES), staple strength (SS) and point of break (POB) according to different factors studied.

Traits Factor	No.	BUL (cm^3/g)	RES (cm^3/g)	SS (N/Ktex)	POB (%)
Overall mean	162	26.571 ± 0.18	8.706 ± 0.13	19.69 ± 0.58	41.63 ± 0.65
Breeds (B)		**	**	**	NS
Barki	72	29.38 ± 0.23 [a]	9.70 ± 0.12 [a]	21.77 ± 0.93 [a]	40.98 ± 1.00 [a]
Rahmany	66	23.95 ± 0.24 [c]	7.75 ± 0.13 [c]	18.60 ± 0.95 [b]	41.47 ± 1.02 [a]
Baladi	24	26.14 ± 0.42 [b]	8.61 ± 0.22 [b]	16.75 ± 1.66 [b]	43.81 ± 1.78 [a]
Treatments (T)		**	**	NS	**
Maintenance	48	26.92 ± 0.33 [a]	9.00 ± 0.17 [a]	20.39 ± 1.31 [a]	39.01 ± 1.41 [b]
Productive	60	25.92 ± 0.26 [b]	8.34 ± 0.14 [b]	19.91 ± 1.05 [a]	40.34 ± 1.12 [b]
Fluctuated	54	26.63 ± 0.33 [b]	8.73 ± 0.17 [b]	16.82 ± 1.29 [a]	46.91 ± 1.39 [a]
Sex (S)		NS	NS	NS	NS
Males	72	26.63 ± 0.25 [a]	8.77 ± 0.13 [a]	19.15 ± 0.99 [a]	42.34 ± 1.07 [a]
Females	90	26.35 ± 0.24 [a]	8.67 ± 0.13 [a]	18.93 ± 0.96 [a]	41.34 ± 1.04 [a]
Positions (P)		NS	**	**	NS
Shoulder	27	26.18 ± 0.39 [a]	8.45 ± 0.20 [b]	17.85 ± 1.53 [bc]	45.19 ± 1.64 [a]
Mid-side	27	26.46 ± 0.39 [a]	8.43 ± 0.20 [b]	15.96 ± 1.53 [c]	39.61 ± 1.64 [a]
Britch	27	26.52 ± 0.39 [a]	8.29 ± 0.20 [b]	13.57 ± 1.53 [c]	39.78 ± 1.64 [a]
Wither	27	26.74 ± 0.39 [a]	9.04 ± 0.20 [a]	21.12 ± 1.53 [ab]	44.33 ± 1.64 [a]
Back	27	26.54 ± 0.39 [a]	9.05 ± 0.20 [a]	21.68 ± 1.53 [ab]	41.76 ± 1.64 [a]
Rump	27	26.47 ± 0.39 [a]	8.85 ± 0.20 [ab]	24.06 ± 1.53 [a]	41.85 ± 1.64 [a]
T × B		**	NS	**	**
T × S		**	NS	NS	NS

[a,b,c]Within a column in each classification, means followed by the same superscript are not significantly different.
** P<0.01. NS: not significant

Table (3) indicated that Barki wool had higher SS than both Rahmany and Baladi wool. The present results are in parallel with El-Gabbas (1999). However, higher estimates were reported by Azzam (1999). From the present results, it could be noticed that the differences in SS and POB between sexes were statistically insignificant (Azzam, 1999). Table 3 showed a distinct dorso-ventral gradient in SS where dorsal line had more soundness and the staple break slightly further from the top with less extensible fibres compared with lateral samples. Highly significant position effect on staple strength and insignificant effect on POB were presented in the same table. The nutritional regime had significant effect on POB but that on SS was insignificant. However, the maintenance and productive feeding groups had higher SS and the break point was closer to the top of staple than fluctuated ones. That might be attributed to higher variability in FD for the latter ones. These were close in agreement with findings of Thompson and Hynd (1998), Peterson *et al.* (1998) and Masters *et al.* (1998). A break in the middle of the staple gives a shorter hauteur in the top than if the staples break towards their end. The interaction between nutritional regime and breed of sheep was highly significant for both SS and POB. The staples of productive feeding regime were more sound within Barki and Baladi while Rahmany breed had staples with more soundness in maintenance feeding regime. Also, the staples of Barki and Rahmany breeds under productive feeding regimes tended to break at a point closest to the top whilst that was occurred in Baladi under maintenance diet.

B- Subjective wool characteristics

Table (4) showed that Baladi wool samples had pronounced yellowness compared with Barki samples. The effect of breed on each of GCG and LG was found to be insignificant. This is in agreement with El-Gabbas (1999) and Abd El-Maguid (2000). The females tend to have significantly higher degree of whiteness and more lustrous wool than males (Azzam 1999). The GCG of dorsal positions had whiter wool compared with the lateral ones. These differences in GCG among body positions were highly significant. While, the effect on LG was insignificant. The maintenance feeding group had whiter samples and higher lustre grade than fluctuated and productive groups. Differences in GCG and LG due to feeding treatment were highly significant, probably as a result of more skin secretions (yolk) in productive and fluctuated feeding groups compared with maintenance one, which could be indicated from the yield percentage data in table (1). Significant interaction between feeding treatment and sex was estimated in the same table. The females tended to have more lustrous wool than males in maintenance and fluctuated feeding groups while the opposite trend was obtained for productive group.

Table 4: Least squares means and standard errors for subjective wool traits as affected by some factors

Traits Factors	No.	GCG	No.	LG	KS	HG	BLG
Overall mean	90	2.13 ± 0.03	162	2.96 ± 0.02	2.00 ± 0.04	2.32 ± 0.03	2.34 ± 0.04
Breeds (B)		NS		NS	**	**	**
Barki	72	2.15 ± 0.04 ^{a}	72	2.95 ± 0.04 ^{a}	2.07 ± 0.07 ^{a}	2.61 ± 0.05 ^{a}	2.94 ± 0.06 ^{a}
Rahmany			66	2.91 ± 0.04 ^{a}	2.09 ± 0.07 ^{a}	2.13 ± 0.05 ^{b}	1.76 ± 0.06 ^{c}
Baladi	18	1.97 ± 0.08 ^{a}	24	3.01 ± 0.07 ^{a}	1.56 ± 0.13 ^{b}	2.13 ± 0.09 ^{b}	2.17 ± 0.10 ^{b}
Treatments (T)		**		**	**	**	**
Maintenance	30	2.40 ± 0.07 ^{a}	48	3.04 ± 0.06 ^{a}	1.48 ± 0.10 ^{b}	2.74 ± 0.07 ^{a}	2.64 ± 0.08 ^{a}
productive	30	1.72 ± 0.07 ^{b}	60	2.99 ± 0.05 ^{ab}	2.05 ± 0.08 ^{a}	1.98 ± 0.05 ^{b}	2.15 ± 0.07 ^{b}
fluctuated	30	2.04 ± 0.07 ^{c}	54	2.84 ± 0.06 ^{b}	2.19 ± 0.10 ^{a}	2.15 ± 0.07 ^{b}	2.09 ± 0.08 ^{c}
Sex (S)		*		**	**		**
Males	36	1.97 ± 0.05 ^{a}	72	2.85 ± 0.04 ^{b}	2.11 ± 0.08 ^{a}	2.23 ± 0.05 ^{a}	2.12 ± 0.06 ^{b}
Females	54	2.15 ± 0.06 ^{b}	90	3.06 ± 0.04 ^{a}	1.71 ± 0.07 ^{b}	2.36 ± 0.05 ^{a}	2.46 ± 0.06 ^{a}
Positions (P)		**		NS	**	**	**
shoulder	15	1.63 ± 0.08 ^{c}	27	2.96 ± 0.07 ^{a}	1.53 ± 0.12 ^{c}	2.33 ± 0.08 ^{a}	2.07 ± 0.09 ^{b}
Mid-side	15	1.73 ± 0.08 ^{c}	27	2.93 ± 0.07 ^{a}	1.76 ± 0.12 ^{bc}	2.39 ± 0.08 ^{a}	2.14 ± 0.09 ^{b}
Britch	15	1.66 ± 0.08 ^{c}	27	2.94 ± 0.07 ^{a}	1.91 ± 0.12 ^{ab}	2.04 ± 0.08 ^{b}	1.91 ± 0.09 ^{b}
Wither	15	2.33 ± 0.08 ^{b}	27	2.96 ± 0.07 ^{a}	1.99 ± 0.12 ^{ab}	2.32 ± 0.08 ^{a}	2.50 ± 0.09 ^{a}
Back	15	2.43 ± 0.08 ^{ab}	27	2.98 ± 0.07 ^{a}	2.11 ± 0.12 ^{ab}	2.44 ± 0.08 ^{a}	2.66 ± 0.09 ^{a}
Rump	15	2.56 ± 0.08 ^{a}	27	2.96 ± 0.07 ^{a}	2.16 ± 0.12 ^{a}	2.24 ± 0.08 ^{ab}	2.46 ± 0.09 ^{a}
T × B		NS		NS	**	**	**
T × S		NS		**	**	**	NS

^{a,b,c} Within a column in each classification, means followed the same superscript are not significantly different., GCG = Greasy color grade, LG = Lustre grade, KS = Kemp score, HG = Handle grade and BLG = Bulk grade.
*P<0.05. ** P<0.01. NS: not significant

The average of kemp score was higher in Barki, followed by Rahmany and Baladi wool. The differences due to breed were highly significant. The genetic factors might have a major role in controlling kemp score to give importance to selection programs. The present estimates are close to those previously reported for KS in Barki wool (El-Gabbas, 1993; Azzam, 1999 and Abd Al-Maguid, 2000). The results also indicated that males produced more kempy fibres than females. These differences were highly significant. The present results agreed with the finding of Azzam (1999). Results showed that dorsal positions produce more kemp than lateral ones. Moreover, there was a trend for KS to increase towards the posterior positions in both lateral and dorsal lines. Body position had highly significant effect on kemp score. This is in accordance with findings of and El-Gabbas (1993). The fleece content of kemp was moderate for fluctuated and productive feeding groups, while they had more kemp compared with maintenance group. Differences in kemp score due to feeding treatment were highly significant. The interaction between feeding treatment and both breed and sex were highly significant. The highest KS was found for Barki sheep in the fluctuated feeding group and for Rahmany in the maintenance and productive feeding groups. On the other hand, males produced more kemp in all feeding treatment groups expect in productive one. The kemp fibres tend to lie on the outside of the yarn and causes harsh handle and give a paler shade with dyeing. However, kemp fibres lead to excessive fibre loss particularly in carpet manufacture resulting in break and wastage during carding and spinning.

Barki sheep had a higher HG and BLG than Baladi and Rahmany breed. These differences were highly significant. The present assessment of HG and BLG were almost similar to that obtained by EL-Gabbas (1999). The results also showed that the differences in HG due to sex were not significant. However, females seemed to be slightly softer than male samples. This probably matched with higher crimp fibre and lower diameter in female wool. The interaction between sex and feeding treatment was highly significant. The females seemed to be softer than male samples in productive and fluctuated feeding groups. However, sex had highly significant effect on BLG. Female wool had higher BLG compared with males. The high BLG of female samples could be attributed to higher crimp frequency. High bulky wools often have higher crimp frequency than low bulk wools (Elliott and Clare, 1981). The dorsal positions had slightly softer and more bulky wool than lateral ones. Moreover, wool tended to be softer in the anterior parts of the body. The body positions had highly significant effect on HG and BLG. These results were close to those obtained by El-Gabbas (1993). The maintenance feeding treatment tended to have harsher wool and higher BLG compared with fluctuated and productive groups. This could be matched with higher both fineness and yield percentage in the maintenance group. Feeding treatments in the present study had highly significant effect on HG and BLG. The results also illustrated highly significant interactions between feeding treatment and breed for HG and BLG. Sheep subjected to maintenance diet showed softer wool except in Baladi breed while productive feeding group showed harsher wool except in Rahmany breed. Moreover, all breeds fed on maintenance diet had higher BLG except Baladi sheep in which feeding on fluctuated diet had the highest estimate. The results of BLG appeared to be closely related with the BUL measurement results. This would be useful in using the subjective bulk assessment in wool grading for carpet industry.

Finaly, the several sources of variation in FD, CR, POB together with a greater knowledge of the properties of this wool and requirements of industry, will enable the grower to make more soundly based decisions regarding management and breeding.

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