Egyptian J. Desert Res., 57, No.2, 403-428 (2007)

BRIEF SKIN STRUCTURE AND SOME COAT CHARACTERISTICS OF SHEEP BREEDS IN HALAYEB, SHALATEEN AND ABOU RAMAD TRIANGLE, IN TWO SEASONS

Abdou, A. S.; H. H. Swelim*; N. A. El-Sayed and N. S. Badawy
Animal Production Division, Desert Research Center, El-Matariya, Cairo, Egypt.
*Faculty of Science-Ain Shams University, Cairo, Egypt.

The present study was undertaken to investigate the effect of two seasons of the year, summer and winter, on the morphology and structure of the different skin components of three sheep breeds; Kanzi, Maneit and Aboudeleik. The study was carried out on thirty adult ewes in Hederbah valley, Halayeb and Shalateen Research Station, belonging to Desert Research Center. The station lies at 1400 km to the south east of Cairo.

Sheep skin consists mainly of epidermis and dermis. The epidermis composed of stratified squamous keratinized epithelium and its thickness differed significantly according to different breeds.

The dermis consists of connective tissue which is divided into an upper papillary layer and a lower reticular layer. An opposite trend to that exhibited by the dermal average thickness was observed in relation to coarseness.

The histological measurements taken for the sweat glands showed that there were significant differences between the three breeds and that the size increased significantly in summer season in comparison with winter season.

Secondary to primary follicle ratio (S/P ratio) was affected significantly by both breed and season.

The structure of the wool follicle in the sheep skin revealed that it consisted of outer root sheath and inner root sheath which could be divided into Henle's layer, Huxley's layer and cuticle.

There was an increase in the external and internal diameters of both primary and secondary follicles from summer to winter. While follicle wall thickness showed a noticeable decrease in summer irrespective of follicle types.

Generally, seasons affected fibre diameter where the highest diameter was found in summer. The relative width of the medulla increased with increasing fibre diameter.

The coat fibres in the three breeds were of bimodal structure consisting of outer and under coats. The outer coat percentage in the fleece increased significantly in summer season.

The kemp and A type fibres were found to have higher percentages than those of type B and C in the outer coat of different breed fleeces at different seasons for all body positions studied.

Aboudeleik breed had the highest percentage of the under coat fibres. Whereas, the dorsal body positions had greater amounts of the under coat fibres than those of the lateral positions. In all breed groups there was a significant increase in the under coat fibre length from summer to winter. The number of crimps/cm in the under coat fibres was significantly higher in winter season.

Keywords: Sheep skin, Wool follicles, Sweat glands, Histology, Coat composition.

The Halayeb, Shalateen and Abou-Ramad triangle region southeastern portion of Egypt has a vital and strategic importance to the country. It is characterized by a broad biodiversity of both plant and animal resources. The income of most of inhabitants in the triangle depends basically on raising, trading and marketing of animals, mainly camels, goats and sheep. Attention has been recently directed towards improving and developing the animal resources in this triangle region.

Unfortunately, little information is available with regard to the phenotypic and productive performance of sheep, camels and goats in this region. Therefore, classification and identification of animals are critically needed in order to raise the social life and income of inhabitants.

The integument of an animal is the protective cover of its body, and the medium through which the animal is in continuous contact with its surroundings. The role played by the skin in the adaptation of the animal to its environment is manifested through the various modifications of this important tissue and its structure in various species living in different habitats. The different types of hair coat in mammals are examples of these modifications.

The coat is an important structure which affects the response of animals to their surrounding environment. The changes in coat components of animals as well as seasonal changes could be of ecological significance (Hayman and Nay, 1961).

About half of the sheep population in the triangle region have a hair cover and the fleece structure consisting of outer-coat of kemp and coarse fibres and an under-coat of fine crimpy fibres (Guirgis and El-Ganaieny, 1998).

The study of the skin in the different sheep breeds in the area would have economic implications, in that it would establish the basic scientific data to assess wool production, quality and quantity.

The objective of this study is to investigate the histological structure of the skin and its different components and some coat characteristics of the different sheep breeds in the region of the Halayeb, Shalateen and Abou-Ramad triangle. Emphasis was placed on the qualitative and quantitative comparisons of some elements in the skin and the coat that are related to wool production and physiological adaptation. This would likely help in planning specific strategies for development of animal production in the triangle region.

MATERIALS AND METHODS

The experimental work of this study was carried out in 2001 in Shalateen Research Station, belonging to the Desert Research Center, Ministry of Agriculture and Land Reclamation, Egypt. The station is located in Hederbah valley, Red Sea Governorate.

The station lies at 1400 Km to south east of Cairo (Latitude 22° 00' and 23° 30' N and Longitude (34° 30' and 35° 00' E). The study was carried out on thirty ewes aged two years of three local sheep breeds (Kanzi, Maneit, and Aboudeleik).

Wool and skin samples were collected twice from ten animals each of the three local breeds. The first collection was in July (2001) that represented the mid summer season where the air temperature was 39.9 °C and the relative humidity was 39.4%. The second collection was 6 months later during January (2002) that represented the mid winter season where the air temperature was 25 °C and the relative humidity was 80.2 %.

The skin samples were carefully taken from the mid side position of each animal by means of a curved scissors and flattened on foam then fixed in calcium formol for about 24 hours (Barker, 1958), washed and left for 24 hours in distilled water and preserved in 70% ethanol. Dehydration was accomplished by transferring the samples into ascending series of ethanol (30 minutes in each of 70%, 80% and 90% ethanol, and finally two changes each for 15 minutes in absolute ethanol). Clearing was achieved by keeping samples in benzene for 30 minutes. Impregnation was carried out in paraffin wax. From paraffin blocks transverse and perpendicular sections of 6-8 microns in thickness were prepared

For general histological observations, sections were stained with Haematoxylin and Eosin stain (Drury and Wallington, 1980). Suitable sections from each sample were selected to study the wool follicle distribution and the ratio of secondary to primary follicles (S/P ratio) was calculated. An image analyzer (LEICAQ500MC) with lenses 10/0.847 and 40/0.65 was used for the quantitative histological studies including the external and internal diameters of the wool follicles. Then the follicle wall thickness was calculated. The wall thickness of the sweat gland was also measured. The wool fibre diameters and medulla thickness were measured by the 10/0.847 lens of the image analyzer. Vertical sections were used to measure the thickness of different skin layers, which included the epidermis and dermis.

Wool samples were taken from six positions in each animal (three dorsal, Wither, Back and Hip, and three laterals, Shoulder, Midside and Britch). All samples were tested for fibre type ratio according to the method followed by (Guirgis, 1973). The samples (not less than 200 fibres each) were sorted into outer and under coat. Outer coat fibres were classified into 4 types, kemp, A, B and C fibre types as reported by El-Ganaieny (1996). The average fibre lengths of both outer and under coats were measured. The number of crimps per cm was counted in the fine fibres of the under coat.

Data were statistically analyzed according to SAS (1995) using general linear model (GLM) followed by Duncan's multiple range test to examine the significance of differences between means.

RESULTS AND DISCUSSION

The skin of sheep appeared to consist of two main layers, a thin outer layer, epidermis, and a thicker inner layer, dermis (Fig. 1). Wool grows from small structures in the skin known as follicles, and these together with their associated glands (sweat and sebaceous glands) and errector muscles, were enveloped by the dermis

There was a general tendency for the skin to vary in thickness according to the coarseness of the fleece, being thickest in the Maneit (Fig.1) which possessed the coarsest fleeces.

Epidermis

The thickness of the epidermis was also roughly associated with the coarseness of the fleece it was thickest in the Maneit and Aboudeleik breeds (26.6 and 27.8μm) (Table 1).

Fig. (1). Vertical section of the skin of Maneit breed showing its average total thickness. (Hx. E., x 40).

Table (1). Mean thickness of the epidermis, dermis, sweat glands (µm ± SE) and secondary to primary follicles ratio (S/P ratio) in the skin of different sheep breeds at different seasons.

	Season \ Breed	Kanzi	Maneit	Aboudeleik	Overall mean
Epidermis	Summer	24.8 ± 0.8	23.1 ± 1.2	26.4 ± 1.2	24.8 [a]
	Winter	22.0 ± 0.8	30.0 ± 1.2	29.2 ± 1.2	25.8 [a]
	Overall mean	23.4 [b]	26.6 [a]	27.8 [a]	
Dermis	Summer	618.7±22.3	707.6±15.0	926.2± 0.5	715.0 [a]
	Winter	654.0±38.6	734.2±24.9	745.5±28.8	722.7 [a]
	Overall mean	627.5 [c]	714.7 [b]	830.6 [a]	
Sweat gland	Summer	10.6±0.1	8.3 ± 0.2	8.0 ± 0.1	9.3 [a]
	Winter	9.6 ± 0.1	8.5 ± 0.2	6.2 ± 0.1	8.5 [b]
	Overall mean	10.0 [a]	8.4 [b]	7.172 [c]	
S/P ratio	Summer	2.4 ± 0.1	2.7 ± 0.1	3.1 ± 0.1	2.7 [b]
	Winter	2.9 ± 0.1	3.4 ± 0.1	3.6 ± 0.1	3.4 [a]
	Overall mean	2.5 [c]	2.9 [b]	3.4 [a]	

Values followed by different letters are statistically different ($p<0.05$).

The differences in the epidermal thickness between breeds might be due to differences in the thickness of the two main layers constituting it, stratum Malpighii and stratum corneum, as demonstrated by Mahgoub *et al.* (1974). Also, Diomidova (1961) studied the structure of the epidermis in different breed groups which did not differ except in the number of cell layers in forming the stratum Malpighii, which seemed to be generally related to its thickness.

Dermis

The dermis or corium could be conveniently divided into two layers, an upper papillary layer and a lower reticular layer (Fig. 2).

The average thickness of the dermal layer in the skin differed from one breed to another as it was thickest (830.6µm) in Aboudeleik (Table 1).

The thickness of the dermal layer in this breed is greater by about 13.9 and 24.4 % than that of both Maneit and Kanzi breeds respectively. The difference might be due to the greater thickness of the wool-producing zone, the papillary layer, in Aboudeleik breed.

However, a trend may be observed (Table 1) which was opposite to that exhibited by the average thickness in relation to coarseness. The average thickness of the dermal layer was different significantly among breed groups, while the difference in different seasons was statistically nonsignificant.

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Fig. (2). Vertical section of sheep skin showing the different dermal layers and their components. errector pili muscle (EPM); papillary layer (P); reticular layer (R); sebaceous gland (SbG); sweat gland (SwG); wool follicle (WF). (Hx. E., x 100).

Sweat glands

The overall mean of the sweat gland thickness was significantly higher in summer than in winter (9.3 and 8.5 µm respectively).

Table (1) and figure (3) showed that the overall mean of sweat gland thickness was the highest in Kanzi breed, followed in a decreasing order by Maneit and Aboudeleik breeds with significant differences (10.0, 8.384 and 7.2 µm respectively).

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Fig. (3). Transverse section of the sweat gland of Kanzi breed skin showing its thickness in summer. (Hx. E., x 400).

Wool follicle types

Two main types, primary and secondary follicles were distinguished. The primaries were the largest (Fig. 4) arranged in groups in the skin (often three primaries in each group). The secondaries were more numerous and lay to one side of the primaries. This was in agreement with the general pattern in sheep as reported by Carter (1955).

The fundamental differences that distinguished the skin follicles were that the primaries had a sweat gland and an erector pili muscle, whereas the secondaries had neither of these. However, both types possessed sebaceous glands (Figs. 5 and 6).

Fig. (4). Vertical section of sheep skin showing its detailed structure. Dermis (D); epidermis (Ep); errector pili muscle (EPM); primary follicles (Pr); sebaceous gland (SbG); secondary follicles (Sc); sweat gland (SwG). (Hx. E., x 100).

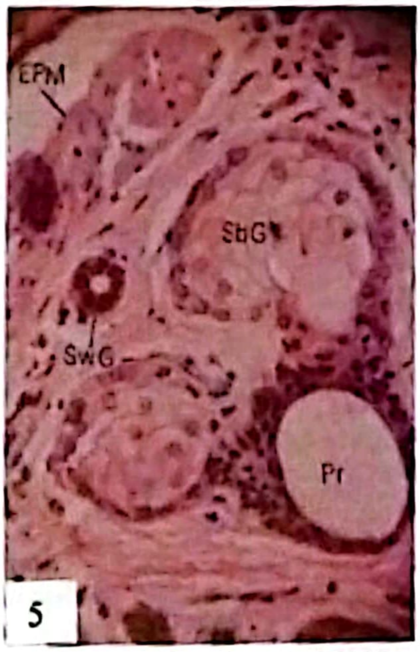

Fig. (5). Transverse section of sheep skin showing a primary follicle and its associated structures. errector pili muscle (EPM); primary follicle (Pr); sebaceous gland (SbG); sweat gland (SwG). (Hx. E., x 400).

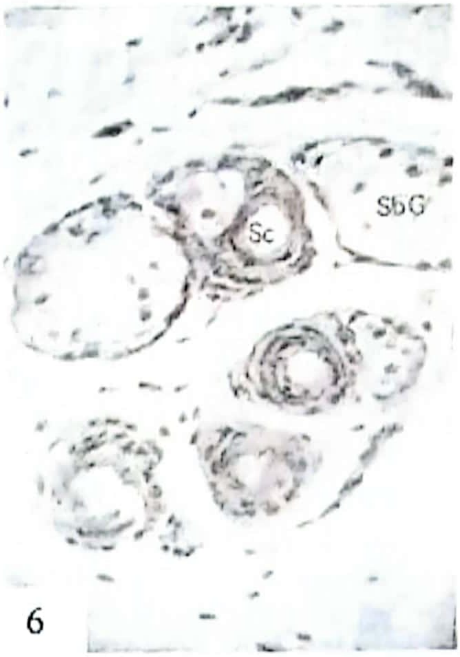

Fig. (6). Transverse section of sheep skin showing a secondary follicle (Sc) and the sebaceous gland (SbG) associated with it. (Hx. E., x 400).

Secondary to primary follicle ratio (S/P ratio)

The S/P ratio is defined as the number of secondary follicles to each primary follicle. The overall mean of S/P ratio increased significantly from summer to winter by the values from 2.7 to 3.4 (Table 1). This may be associated with follicle activity in which catagen phase (the stages of decreased S/P ratio), the follicle regresses, fibre growth stops and the brush end is formed (Speedy, 1992). Hekal (2001) explained the changes in mean S/P ratio between different seasons in Baladi goat in view of some secondary follicles that would become inactive especially at the stages of decreased S/P ratio. These follicles were receded towards the epidermal surface of the skin forming fibres with brush ends and producing dormant dermal papillae. The histological sections showed that some follicles might be at to shallow in depth to be included in S/P ratio estimate.

The highest mean value of S/P ratio was noticed in Aboudeleik breed (3.1±0.1), that is probably of adaptive significance for this breed . (Mahgoub and Bugis (1985) reported that the relatively higher density of secondary follicles, which produce finer hair or wool, in the coat of Harri sheep made this breed having higher S/P ratio than that of Najdi breed and attributed it to a probably adaptive response from this breed which was developed in the relatively colder climate of Hijaz mountains. Champion and Robards (2000) reported that Merinos have a higher S/P ratio than the Australasian carpet wool breeds.

Generally, the decrease in S/P ratio observed across the different breed groups may be due to a deficiency in the number of initiated and/ or matured secondary follicles during pre-natal and early postnatal life of lambs born and raised under severe desert conditions found in Halayeb, Shalateen and Abou-Ramad triangle. Also, adverse nutrition has been shown to cause a permanent decrease of secondary follicle population and S/P ratio (Schinckel and Short, 1961).

The low S/P ratio of the tropical and subtropical breeds might indicate the sparse, less dense and coarse coat, which might be suitable for animals in a hot environment. In the present study S/P ratio was calculated to show that the performance and activity of the wool follicles coincide with the adaptation of the animals from different breeds to the surrounding environmental conditions.

Structure of the wool follicle

The wool follicle appeared to consist of an external connective tissue sheath (the dermal root sheath) derived from the dermis and an internal root sheath derived from the epidermis (Fig.7). The dermal root sheath is composed of three layers, the outer and inner layers and the glassy membrane. The epidermal root sheath could be distinguished into inner and outer components. The outer component and the outer root sheath possessed a single row of tall cells that were directly in relation to the glassy membrane. The inner root sheath consisted of three distinct layers: Henle's layer, Huxley's layer and the cuticle and they appeared arranged concentrically from outside to inside (Fig. 8).

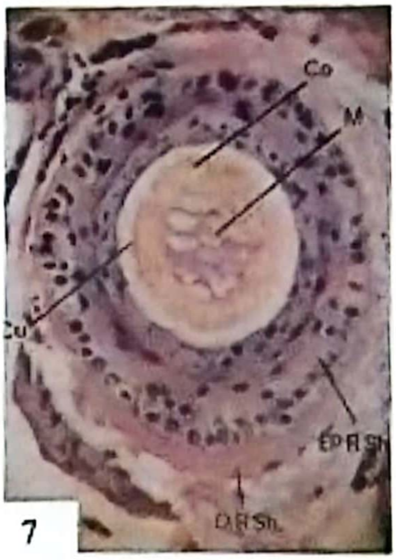

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Fig. (7). Transverse section of a primary follicle of sheep skin showing its dermal root sheath (D R Sh), epidermal root sheath (Ep R Sh) and different wool fibre layers. Cu, fibre cuticle; Co, cortex; M, medulla. (Hx. E., X 400).

Table (2). Mean external and internal diameters and wall thickness of both primary and secondary wool follicles (µm ± SE) in the skin of different sheep breeds at different seasons.

	Follicle type	Season \ Breed	Kanzi	Maneit	Aboudeleik	Overall mean
External diameter	Primary follicle	Summer	143.4 ± 2.6	149.2 ± 3.8	121.1 ± 4.2	140.2^{b}
		Winter	144.1 ± 4.8	143.1 ± 5.4	164.8 ± 4.6	151.9^{a}
		Overall mean	143.8^{a}	147.2^{a}	140.8^{a}	143.8^{a}
	Secondary follicle	Summer	52.9 ± 0.5	42.3 ± 0.6	412 ± 0.6	46.4^{b}
		Winter	49.8 ± 0.9	54.5 ± 0.9	52.2 ± 0.6	52.3^{a}
		Overall mean	52.2^{a}	46.3^{b}	46.9^{b}	
Internal diameter	Primary follicle	Summer	90.7 ± 2.1	105.9 ± 3.1	812 ± 3.4	92.8^{a}
		Winter	86.8 ± 3.9	94.3 ± 4.4	111.1 ± 3.7	97.9^{a}
		Overall mean	89.8^{b}	102.1^{a}	95.1^{b}	
	Secondary follicle	Summer	20.8 ± 0.2	16.8 ± 0.3	18.4 ± 0.3	18.8^{b}
		Winter	19.8 ± 0.4	21.4 ± 0.4	19.6 ± 0.3	20.1^{a}
		Overall mean	20.6^{a}	18.3^{c}	18.9^{b}	
Wall thickness	Primary follicle	Summer	52.7 ± 1.2	43.2 ± 1.7	39.1 ± 1.9	47.433^{b}
		Winter	58.1 ± 2.1	48.8 ± 2.4	53.7 ± 2.1	53.891^{a}
		Overall mean	53.9^{a}	45.0^{b}	45.6^{b}	
	Secondary follicle	Summer	32.2 ± 0.4	25.4 ± 0.5	23.3 ± 0.5	27.5^{b}
		Winter	30.0 ± 0.7	33.1 ± 0.7	32.7 ± 0.5	32.2^{a}
		Overall mean	31.6^{a}	27.9^{b}	27.9^{b}	

Values followed by different letters are statistically different ($p<0.05$).

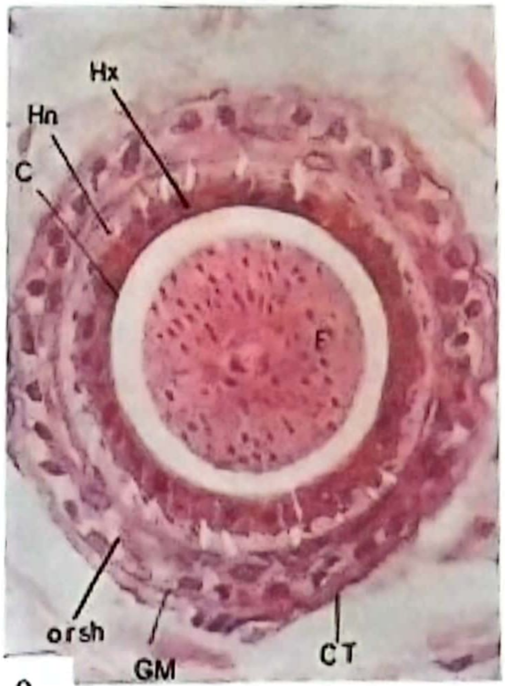

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Fig. (8). Transverse section of a primary follicle of sheep skin showing different layers of wool follicle and the wool fibre. connective tissue sheath (CT); outer root sheath (ORSh); follicle cuticle (C); Henle's layer (Hn); Huxley's layer (Hx); Glassy membrane (Gm). (Hx. E., X 400).

Follicle dimensions

Table (2) showed that the overall mean external diameter of the primary wool follicles, increased from 140.2µm in summer to 151.9µm in winter season ($p<0.05$) and the smallest overall mean of external diameter of the primary wool follicles was represented by Aboudeleik breed (140.7µm).

Whereas in secondary follicles, Kanzi breed showed the highest value (52.2µm) and differed significantly from the Maneit and Aboudeleik breeds which recorded the diameter values of 46.3 and 46.9µm, respectively (Table 2). External diameter was also significantly ($p<0.05$) higher in winter (52.3µm) than in summer (46.4µm).

On the other hand, internal diameter of primary wool follicles, in Maneit breed had the highest value (102.1 µm) which differed ($P<0.05$) from Aboudeleik (95.1) and Kanzi (89.8 µm) breeds (Table 2).

The results represented in table (2) showed that the highest internal diameter of the secondary wool follicles was in the Kanzi breed (20.6µm), while the lowest diameter was recorded in Maneit breed (18.3 µm) while Aboudeleik breed recorded an intermediate diameter (18.9 µm). The seasonal changes were associated with a significant increase in the internal diameter of the secondary follicles from summer to winter by the values (from 18.8 to 20.1 µm) as recorded in (Table 2).

Table (2) showed that Kanzi breed possessed larger wall thickness (53.9µm) than the Aboudeleik and Maneit breeds (45.6 and 45.0µm, respectively). In all breed groups, wall thickness of primary follicles which was influenced by seasonal changes and showed a significant increase in winter (53.9µm) than in summer (47.4µm) (Table 2).

In case of secondary follicles, the wall thickness was also affected significantly ($P<0.05$) by breed and season as shown in table (2).

The average values of external and internal follicle diameters and the follicle wall thickness showed the same trend among different breed groups. Aboudeleik breed exhibited the lowest values and the highest belonged to the Maneit breed. This trend corresponds more or less closely to that of average fibre diameter. It is also clear that all follicle dimensions were positively correlated with each other and with fibre diameter.

A more obvious and higher positive correlation seems to exist between average diameter of secondary follicle and its fibre than between average diameter of primary follicle and its fibre. In the latter case, the difference in the level at which follicle diameters were measured probably caused this discrepancy.

The dimensional relation within a follicle may be fundamentally connected with the type of fleece produced (Burns and Clarkson, 1949). Therefore, the large primary follicles produce coarser fibres than thin follicles (secondaries) that produce fine fibres. This may explain the more uniform change in external and internal diameters of secondary follicles than that of primary ones.

From another point of view, the fluctuations in the follicle diameter may be attributed to the changes in follicle activity during development of the wool fibres, thus the size of the follicle or its various parts may vary throughout its life (Burns, 1966).

A significant change occurred in the external and internal diameters of both follicle types during different seasons in all breed groups used in this study and this may be due to different rates of cell division associated with seasonal variations in climate as explained previously by El-Ganaieny and Abdou (1999). The follicle wall thickness of the primary and secondary follicles in all breed groups had the highest value in winter season which accompanied thickening in Huxley's layer of the inner root sheath and this was acclaimed by Priestley and Rudall (1965) and Priestley (1967). They also stated that the seasonal variation affects the direction of the matrix production. In winter, the Huxley's layer becomes thick due to the proliferation of the cells in the fibre matrix towards its production rather than towards the growth in fibre thickness, these results in the production of thin fibre. In summer, the fibre matrix directs its activity to the fibre formation so the fibre becomes thick in its diameter and the Huxley's layer returns to its normal thickness, consequently the follicle wall thickness decreases.

Wool fibres

Wool fibres could be divided into many categories according to their diameter and existence of a hollow center known as the medulla. The fibre types were fine, hair or coarse and kemp.

The wool fibres were composed of a thin outer layer (the cuticle) that surrounded the cortex, which in turn surrounded a central medulla (Fig 7). The cortex formed the bulk of the fibre substance, and the cuticle provided a covering surface. In the kemp and coarse fibres there was a large central core (the medulla) that contained apparently empty spaces filled with gases probably air.

Medulla

The medulla is an important characteristic structure in sheep fleeces because of its association with hairiness. Generally, the greatest primary fibre medullation was exhibited by the Maneit breed, reaching an average of 61.3%. Aboudeleik breed had lowest medullation percentage in primary fibres, while the Kanzi breed represented an intermediate medulla percentage (Table 3). This result is in harmony with those obtained on fibre diameter of the different breeds in the present study. The mean fibre medulla thickness in the winter season was 82.5% of that in summer. The higher degree of medullated fibres was encountered in summer coat. Moreover, the highly medullated fibres, the kemp fibres, showed a significant increase in summer season, and it is believed that high degree of medullation in the coat fibres helped in reduction of external heat load (Benjamin, 1985). In the present work, Maneit breed, had the coarsest fibres, and the percentage of medulla in its fibres in winter represented 76.6% of that in summer. While, in case of Kanzi and Aboudeleik breeds the fibre medulla in winter represented 81.6 and 92.5% that of summer season, respectively. It was clear that during winter months, there was a reduction in the number of fibres having continuous medulla. This might possibly assist in a decrease of an outward flow of heat through the wool coat during winter months (Benjamin, 1985). Also the thicker shorter medullated fibres in summer months would enhance air movement at skin surface resulting in a good opportunity for moisture evaporation and consequent transmission of heat from the skin as explained by Govindiah and Nagaroenkar (1983) in Indian cattle.

Table (3). Mean fibre diameters of both primary and secondary wool follicles and medulla thickness in the primary fibres (µm ± SE) in the skin of different sheep breeds at different seasons.

Follicle type	Breed / Season	Kanzi	Maneit	Aboudeleik	Overall mean
Primary follicle	Summer	82.5 ± 2.0	99.4 ± 2.9	107.3 ± 3.6	96.4 ^{a}
	Winter	81.5 ± 3.7	88.5 ± 4.1	79.5 ± 3.2	83.1 ^{b}
	Overall mean	82.3 ^{b}	95.8 ^{a}	91.9 ^{a}	
Secondary follicle	Summer	16.5 ± 0.2	16.8 ± 0.2	18.4 ± 0.3	17.1 ^{b}
	Winter	19.8 ± 0.40	21.4 ± 0.4	19.6 ± 0.3	20.1 ^{a}
	Overall mean	17.3 ^{c}	18.3 ^{b}	18.9 ^{a}	
Medulla	Summer	49.5 ± 2.6	66.5 ± 3.8	41.2 ± 4.6	52.4 ^{a}
	Winter	40.7 ± 4.8	50.9 ± 5.4	38.1 ± 4.2	43.2 ^{b}
	Overall mean	47.5 ^{b}	61.3 ^{a}	39.5 ^{c}	

Values followed by different letters are statistically different ($p<0.05$).

The medulla thickness was affected significantly ($P<0.001$) by the breed (Table 3). The hairy fleece, represented by Maneit breed, had the thickest medulla (61.3µm) than the other two breeds, Kanzi and Aboudeleik (47.5 and 39.5), respectively. This was in agreement with El-Sherbiny and Markotic (1974) who showed highly significant breed effects on the medulla thickness when they studied Barki, Ossimi, Rahmany and Merino sheep. Guirgis *et al.* (1978) also observed that the breed had a significant effect on medullation in two Iraqi coarse wool breeds and their reciprocal crosses.

The seasonal and nutritional effects on medullation of both coarse and fine fibres were recognized in Halayeb, Shalateen and Abou-Ramad triangle which have a higher ambient temperature and scarce nutrition. Scobie *et al.* (1998) found that the high protein diets increased the proportion of medullation to 5.6 vs. 3.8 for low protein diets ($P<0.01$). Also the same authors concluded that the proportion of medullation in Romney wool could vary independently from average fibre diameter.

Fibre diameter

The activity of the wool follicle culminates in the production of the fibre. Fibre diameter is the most important character affecting spinning count and the economic value of wool. The present study indicated that the effect of breed on the fineness of wool was highly significant (Table 3). In Kanzi breed fibre diameter was lesser than in the other two breeds. The Maneit breed, on the other hand, could be classed as a hairy sheep since it is close to hair characteristics in average primary and secondary fibre diameters.

Peterson *et al.* (1998) found that the variation in diameter along fibres was 24% ($P<0.05$) greater in the coarse wool sheep than in the fine wool sheep.

Measurements of the diameter of primary fibres in the present study indicated that the Maneit breed had the highest mean value (95.8 μm) followed by Aboudeleik and Kanzi breeds (92 and 82μm) respectively. These values were less than that reported by Mahgoub (1979) in Sudanese sheep (138 microns). Also, the Indian hair-type sheep have an average primary fibre diameter of 117 microns (Krishnarao *et al.*, 1960). Mahgoub and Bugis (1985) found that mean fibre diameter was 83.3μm in Najdi sheep.

On the other hand, the secondary wool fibres differed significantly in their mean diameters in breed groups of the present study (Table 3). They were relatively thin (17.3, 18.3, and 19μm) in Kanzi, Maneit and Aboudeleik breeds as compared to the Indian hair-type sheep which had an average secondary hair fibre thickness ranging from 22.3 to 32.0μm (Krishnarao *et al.*, 1960). Also, Sudanese desert sheep had relatively thick secondary fibres, with average thickness of 25μm, (Mahgoub, 1979). On the other hand, Mahgoub and Bugis (1985) reported an average diameter in Najdi and Harri sheep of 16.6 and 17.7μm, respectively. It is worthy to mention that the effect of nutrition in one season can affect wool production in the next. Rowe *et al.* (1989) working on young Merino sheep observed a carry-over effect of supplementary feeding during summer and autumn on wool growth during the following winter.

Relating the fibre diameter to the follicle diameter, it is interesting to point out that strains with larger follicles had the thicker fibres and vice versa. The present results indicated that, in the three breeds studied, there was a relationship between the internal diameters of primary wool follicles and the diameters of its fibres. The Maneit breed, which had the largest internal follicle diameter, had the largest primary fibre diameter. The diameter of the primary wool fibres was 91.6 % from that of the internal diameter of primary wool follicles in Kanzi breed, and was 93.8% in Maneit breed while it was 96.7 in Aboudeleik breed. It is obvious that the larger follicles have greater precursor materials greater number of cells and larger bulbs as illustrated by Schinckel (1961).

It seems that the suitable conditions that prevail during a season of the year always favour the increase of fibre diameter of wool growing during such season. The histological measurements revealed that wool diameter reaches its maximum in summer and narrowed again in winter. It has been shown that the primary fibres diameter in Kanzi breed tended to decrease during the winter months to about 98.7% of that found in summer and to 88.9% in Maneit breed and to about 74.1% in Aboudeleik breed.

Schlink *et al.* (1996) illustrated that there is a highly significant impact of season upon fibre diameter with maximum and minimum values in spring and autumn, respectively in grazing Merino wethers. Summer fibre diameters are 1.3 to 1.7 times greater than in winter, in Romney, Perendale and Scottish Blackface (Dick and Sumner, 1997).

Coat fibre types

In the three breeds of sheep, the coat fibres were of bimodal structure, consisting of two main types. The first is the outer coat, which contained kemp and coarse fibres that were highly medullated and act as camouflage to hide animals from predatory animals on range and forests. The second is the under coat, which contained fine and crimpy fibres and is known to play an important role in thermoregulation especially during cold conditions.

The average percentage of fine, coarse and kemp fibres in the three breed groups was (44.2, 38.9 and 19.9); (47.6, 26.6 and 25.7) and (54.2, 37.2 and 8.6%) in Kanzi, Maneit and Aboudeleik breeds respectively. Guirgis (1973) and Guirgis *et al.* (1978) found that the percentage of true wool, coarse and kemp fibres were (60.41, 35.1, 4.4); (57.1, 43.6, 0.1) and (34.8, 63.4, 0.9) in Barki, Awassi and Karadi breed.

The present findings indicated that body position had an effect on the percentage of the fine fibres but had no effect on kemp and coarse fibres (Table 4). However, the lateral positions recorded the higher percentage of kemp fibres than the dorsal ones (66.9 vs. 31.8), (81.5 vs.58.2) and (13.6 vs.11.1) in Kanzi, Maneit and Aboudeleik breeds respectively. The same trend was observed in both fibre types A and B for lateral and dorsal lines in Aboudeleik breed (46.6 vs. 45.6) while the opposite case was detected in Kanzi and Maneit breeds (23.9 vs. 29.4 and 22.5 vs. 31.8), respectively. On the other hand, the fibres from type C recorded higher percentage in the lateral line than that of dorsal line in Kanzi breed (1.7 vs.1.2). While in the Maneit breed percentage of fibre type C was greater in the dorsal line than in the lateral one (3.1% vs.0.1%). In case of Aboudeleik breed the dorsal line had a percentage of 4.7 from C fibre type while the lateral line had no fibres from this type.

Table (4). Mean percentage ± SE of both coat and fibre types in the fleece of different sheep breeds at different body positions.

Fibre type	Breed / Position	Kanzi	Maneit	Aboudeleik	Overall mean
Outer coat	Wither	31.1 ± 7.5	30.8 ± 6.6	33.5 ± 9.8	33.7 ^{d}
	Back	41.7 ± 7.5	49.7 ± 6.6	33.2 ± 9.8	43.5 ^{cd}
	Hip	54.0 ± 7.5	54.2 ± 6.6	53.3 ± 9.8	51.6 ^{bc}
	Shoulder	61.7 ± 7.5	56.7 ± 6.6	55.2 ± 9.8	57.3 ^{ab}
	Midside	58.7 ± 7.5	63.3 ± 6.6	44.7 ± 9.8	60.3 ^{ab}
	Britch	71.8 ± 7.5	63.9 ± 6.6	52.1 ± 9.8	66.2 ^{a}
	Overall mean	55.8 ^{a}	52.3 ^{ab}	45.8 ^{b}	
Kemp	Wither	3.0 ± 5.3	13.8 ± 4.7	0.2 ± 6.9	9.3 ^{b}
	Back	15.1 ± 5.3	20.8 ± 4.7	2.6 ± 6.9	17.1 ^{ab}
	Hip	13.6 ± 5.3	23.6 ± 4.7	8.3 ± 6.9	18.3 ^{a}
	Shoulder	12.8 ± 5.3	24.7 ± 4.7	4.8 ± 6.9	17.3 ^{ab}
	Midside	24.4 ± 5.3	28.2 ± 4.7	5.2 ± 6.9	24.2 ^{a}
	Britch	29.7 ± 5.3	28.5 ± 4.7	3.5 ± 6.9	25.4 ^{a}
	Overall mean	16.9 ^{b}	25.7 ^{a}	8.6 ^{c}	
A	Wither	17.9± 6.5	9.4 ± 5.7	16.3 ± 8.6	14.7 ^{b}
	Back	14.7 ± 6.5	14.7 ± 5.7	13.2 ± 8.6	15.5 ^{b}
	Hip	30.1 ± 6.5	16.5 ± 5.7	26.4 ± 8.6	21.5 ^{ab}
	Shoulder	38.6 ± 6.5	22.4 ± 5.7	32.1 ± 8.6	29.1 ^{a}
	Midside	26.3 ± 6.5	30.1 ± 5.7	18.7 ± 8.6	26.9 ^{a}
	Britch	32.4 ± 6.5	25.7 ± 5.7	32.7 ± 8.6	30.7 ^{a}
	Overall mean	28.8 ^{a}	18.3 ^{b}	22.6 ^{ab}	
B	Wither	8.7 ± 4.1	6.9 ± 3.7	14.8 ± 5.4	8.6 ^{a}
	Back	11.7 ± 4.1	13.9 ± 3.7	14.8 ± 5.4	9.9 ^{a}
	Hip	9.0 ± 4.1	10.9 ± 3.7	15.9 ± 5.4	10.1 ^{a}
	Shoulder	8.6 ± 4.1	8.9 ± 3.7	14.9 ± 5.4	9.6 ^{a}
	Midside	7.5 ± 4.1	4.8 ± 3.7	18.3 ± 5.4	8.4 ^{a}
	Britch	7.8 ± 4.1	8.7 ± 3.7	13.4 ± 5.4	8.8 ^{a}
	Overall mean	9.1 ^{ab}	7.6 ^{b}	12.5 ^{a}	
C	Wither	0.0	0.0	2.1 ± 1.2	2.1 ^{a}
	Back	0.0	0.0	2.6 ± 1.2	2.6 ^{a}
	Hip	1.2 ± 0.9	3.1 ± 0.8	0.0	2.2 ^{a}
	Shoulder	1.7 ± 0.9	0.6 ± 0.8	0.0	1.1 ^{b}
	Midside	0.0	0.0	0.0	0.0
	Britch	0.0	0.0	0.0	0.0
	Overall mean	0.9 ^{b}	0.8 ^{b}	2.1 ^{a}	
Under coat	Wither	68.9 ± 7.5	69.1 ± 6.6	66.5 ± 9.8	66.3 ^{a}
	Back	58.3 ± 7.5	50.3 ± 6.6	66.8 ± 9.8	56.5 ^{ab}
	Hip	46.0 ± 7.5	45.8 ± 6.6	46.7 ± 9.8	48.3 ^{bc}
	Shoulder	38.3 ± 7.5	43.3 ± 6.6	44.8 ± 9.8	42.7 ^{cd}
	Midside	41.3 ± 7.5	36.7 ± 6.6	55.3 ± 9.8	39.7 ^{cd}
	Britch	28.2 ± 7.5	36.0 ± 6.6	47.9 ± 9.8	33.8 ^{d}
	Overall mean	44.2 ^{b}	47.6 ^{ab}	54.2 ^{a}	

Values followed by different letters are statistically different ($p<0.05$).

In all the three breed groups, the dorsal parts of the body (Table 4) showed the highest percentages of the fine fibres which constituted the under coat. These values tended to decrease towards the lateral parts. The opposite was noticed in the percentages of the fibres, which constitute the outer coat. Guirgis *et al.* (1992) recorded variability in different coat characteristics in the different body positions of the one humped camel. Also, Hekal (2001) reported a significant effect of body position on the Baladi goat fibre type percentage.

The distribution of the outer coat fibres varied between hairy and woolly fleeces, where the hairy coats as in Kanzi and Maneit breeds contained higher values of kemp and A fibres (very coarse and medullated) than the woolly coats as in Aboudeleik breed (Table 4). The mean outer coat percentage was (55.8, 52.3 and 45.8%) in Kanzi, Maneit and Aboudeleik, respectively, while the percentage of kemp and A fibres were (16.9, 25.7 and 8.6%) and (28.8, 18.3 and 22.6%), respectively in the three breeds. This might be attributed to the nature of outer coat as being highly medullated and sparse thus assisting heat dissipation from the body in the prevailing hot conditions.

The opposite was observed in the under coat fibre percentages, whereas the mean value of the fine fibres (54.2%) was found in Aboudeleik breed which could be described as the finest breed in the triangle region. While the under coat fibre values were 47.6% and 44.2%, respectively in Maneit and Kanzi breeds as representing breeds with hairy fleeces (Table 4). These results might indicate that the under coat besides its biological function could be used when clipped in local woolly products. Guirgis and El-Ganaieny (1998) recorded that the percentage of under coat in hairy and woolly fleeces in sheep raised in Halayeb and Shalateen triangle was 37.5±4.1 and 49.7±4.0, respectively.

Sheep could adapt themselves to seasonal changes by controlling the character of the wool coat and develop a suitable coat for different climates. The activity of the wool follicles represented by resting and activity and the fibres produced are involved in this process. However, it is a relatively slow operation and the animal requires advanced warning for seasonal changes. Monthly changes in temperatures could give signal of approaching hot or cold season but these are erratic in comparison with day length. Therefore, photoperiod has been considered to be of important role in controlling the character of the coat by modifying neuro-secretory rhythms via the pineal gland, which would ultimately affect the initiation of hair growth (Lynch and Russel, 1990).

The proportion of various fibre types appeared to vary considerably according to season as the latter showed effect in all traits studied (Table 5). The percentage of the outer coat was higher in summer and tended to decrease in winter, while, the percentage of the under coat showed the opposite trend. It is obvious from table (5) that the mean percentage of kemp fibres was higher in summer than in winter (20.3 and 15.5). Also, the mean percentage of coarse fibres (A, B and C) showed the same trend where it was 34.5% in summer and 31.8% in winter. There was a relatively greater increase in the percentage of the kemp and coarse fibres with a corresponding decrease in the fine fibres in summer season. These might be of biological effect in thermoregulation, where such changes parallel the increase in ambient temperature. The presence of denser winter under coat than that of summer increase the insulating efficiency of the fleece providing an efficient system of heat conservation during the cold season and the under coat would act as an insulator against potential transfer of body heat to cold environment. This was in agreement with the findings of Guirgis *et al.* (1992) in camels. The change in climatic condition from summer to winter might affect regeneration of secondary follicles but not primary ones (El-Gabbas, 1993). Also, Ryder (1978) reported seasonal variations in the proportion of inactive follicles in different seasons. McGregor (2002) showed that the annual clean alpaca fibre growth was affected to a great extent by seasonal nutritional conditions than the annual wool growth (decline of 33 vs. 17%).

The average outer coat fibres length ranged between 2.61 and 1.84cm for both winter and summer seasons (Table 6). On the other hand, the average fibre length in the under coat ranged between 1.4 cm with 4.5 crimps/cm and 1.6cm with 5.2 crimps/cm in summer and winter seasons, respectively. The crimp number/cm in summer and winter was 4.4±0.2 and 4.6±0.1), (5.0±0.1 and 5.7±0.1) and (4.1±0.2 and 5.1±0.2) in Kanzi, Maneit and Aboudeleik breeds respectively.

From the previous results, it is clear that the crimp number/cm showed an increase in winter than in summer season in all breed groups. Thus increasing insulating capacity through holding more of the still layer of air to decrease the body heat loss under cold conditions as an adaptation mechanism. Batabyal and Singh (1983) found that the crimp number/cm was 4.0, 5.9 and 6.4 in autumn and 3.7, 6.0 and 6.2 in spring for three genetically different groups, and the effect of season was highly significant. It was observed from table (6) that the Maneit breed had a significantly greater mean number of fibre crimps (5.3) than the other two breeds Kanzi and Aboudeleik (4.5 and 4.6) although the latter produced finer wool under semi-arid condition of Egypt. Therefore, it can be said that type of breed had a highly significant effect on the number of crimps/cm. Guirgis and El-Ganaieny (1998) reported that the number of crimps/cm was (3.3±0.2) in the hairy fleeces and (2.9±0.1) in the woolly fleeces. Abd El-Maguid (2000) found that the average number of crimps/2cm in fine and coarse fibres in Barki and Ossimi breeds was 5.9, 2.2, 2.6 and 1.4, respectively, and the breed had highly significant effect on crimps.

Table (5). Mean length ± SE of the outer coat fibre types, under coat and its number of crimps/cm in the fleece of different sheep breeds at different body positions.

Fibre type	Breed / Position	Kanzi	Maneit	Aboudeleik	Overall mean
Kemp	Wither	3.3 ± 0.3	2.6 ± 0.2	2.9 ± 0.4	2.4^{ab}
	Back	2.7 ± 0.2	2.4 ± 0.2	3.0 ± 0.4	2.4^{abc}
	Hip	2.9 ± 0.2	2.7 ± 0.2	3.2 ± 0.3	2.6^{ab}
	Shoulder	2.4 ± 0.3	2.0 ± 0.2	2.1 ± 0.3	2.0^{c}
	Midside	2.6 ± 0.2	2.4 ± 0.2	2.3 ± 0.3	2.3^{bc}
	Britch	3.2 ± 0.2	2.4 ± 0.2	3.1 ± 0.3	2.7^{a}
	Overall mean	2.8^{a}	2.2^{b}	2.3^{b}	
A	Wither	2.5 ± 0.2	2.1 ± 0.2	2.4 ± 0.2	2.2^{bc}
	Back	2.7 ± 0.2	2.5 ± 0.2	2.9 ± 0.2	2.6^{ab}
	Hip	2.7 ± 0.2	2.5 ± 0.2	2.8 ± 0.2	2.5^{ab}
	Shoulder	2.5 ± 0.2	2.2 ± 0.2	2.1 ± 0.2	2.1^{c}
	Midside	2.5 ± 0.2	2.3 ± 0.2	2.4 ± 0.2	2.3^{bc}
	Britch	2.9 ± 0.2	2.7 ± 0.2	3.5 ± 0.2	2.7^{a}
	Overall mean	2.4^{ab}	2.3^{b}	2.6^{a}	
B	Wither	1.7 ± 0.2	1.8 ± 0.2	2.2 ± 0.2	1.8^{c}
	Back	2.0 ± 0.2	2.5 ± 0.2	2.4 ± 0.2	2.2^{ab}
	Hip	1.9 ± 0.2	2.3 ± 0.2	2.4 ± 0.2	2.1^{abc}
	Shoulder	1.5 ± 0.2	2.1 ± 0.2	1.8 ± 0.3	1.8^{c}
	Midside	1.7 ± 0.2	2.1 ± 0.2	2.4 ± 0.2	1.9^{bc}
	Britch	2.3 ± 0.2	2.8 ± 0.2	3.1 ± 0.2	2.3^{a}
	Overall mean	1.8^{b}	2.0^{b}	2.4^{a}	
C	Wither	-	-	1.7 ± 0.3	1.7^{a}
	Back	-	-	1.7 ± 0.3	1.7^{a}
	Hip	1.3 ± 0.3	1.5 ± 0.2	-	1.4^{a}
	Shoulder	1.8 ± 0.3	0.5 ± 0.6	-	1.1^{a}
	Midside	-	-	-	-
	Britch	-	-	-	-
	Overall mean	1.4^{a}	1.5^{a}	1.6^{a}	
Under coat	Wither	1.7 ± 0.1	1.6 ± 0.1	1.9 ± 0.2	1.7^{a}
	Back	1.7 ± 0.1	1.5 ± 0.1	1.9 ± 0.2	1.6^{a}
	Hip	1.8 ± 0.1	1.4 ± 0.1	1.7 ± 0.2	1.5^{ab}
	Shoulder	1.4 ± 0.1	1.1 ± 0.1	1.3 ± 0.2	1.2^{c}
	Midside	1.4 ± 0.1	1.3 ± 0.1	1.7 ± 0.2	1.4^{bc}
	Britch	1.5 ± 0.1	1.2 ± 0.1	1.5 ± 0.2	1.4^{bc}
	Overall mean	1.5^{b}	1.4^{b}	1.7^{a}	
Crimps/cm	Wither	4.2 ± 0.3	5.0 ± 0.2	4.2 ± 0.4	4.6^{c}
	Back	3.9 ± 0.3	4.9 ± 0.2	4.6 ± 0.3	4.6^{c}
	Hip	4.4 ± 0.3	4.9 ± 0.2	4.6 ± 0.4	4.8^{bc}
	Shoulder	4.8 ± 0.3	5.9 ± 0.3	4.4 ± 0.4	5.2^{ab}
	Midside	4.8 ± 0.3	5.6 ± 0.3	5.1 ± 0.4	5.4^{a}
	Britch	4.8 ± 0.3	5.5 ± 0.3	4.5 ± 0.4	5.0^{abc}
	Overall mean	4.5^{b}	5.4^{a}	4.6^{b}	

Values followed by different letters are statistically different ($p<0.05$).

The present study recorded an average fibre length of 1.6cm with 4.5 crimps/cm in Kanzi breed, 1.4 cm with 5.3 crimps/cm in Maneit breed and 1.7 cm with 4.6 crimps/cm in Aboudeleik breed (Table, 6). El-Ganaieny (1999) reported average fibre length of 1.9 cm with 2.7 crimps/cm in goats in winter season. While Hekal (2001) recorded average fibre length of 1.1 cm with 3.6 crimps/cm in Baladi goats.

Table (6). Mean percentage ± SE of the outer coat fibre types and under coat in the fleece of different sheep breeds at different seasons.

Fibre type	Breed / Position	Kanzi	Maneit	Aboudeleik	Overall mean
Outer coat	Summer	61.5 ± 3.2	50.2 ± 3.2	53.6 ± 4.7	54.8 [a]
	Winter	44.8 ± 5.2	56.1 ± 4.4	37.13 ± 5.8	47.3 [b]
	Overall mean	53.1 [a]	53.1 [ab]	45.3 [b]	
Kemp	Summer	15.2 ± 2.3	29.7 ± 2.3	9.1 ± 3.4	20.3 [a]
	Winter	17.7 ± 3.7	16.9 ± 3.1	0.8 ± 4.1	15.5 [b]
	Overall mean	16.4 [b]	23.3 [a]	4.1 [c]	
A	Summer	32.8 ± 2.8	14.0 ± 2.8	23.9 ± 4.1	23.1 [a]
	Winter	20.6 ± 4.6	25.6 ±3.8	22.6 ±5.1	23.1 [a]
	Overall mean	26.7 [a]	19.8 [b]	23.2 [ab]	
B	Summer	12.2 ± 1.8	5.4 ± 1.8	16.7 ± 2.6	9.7 [a]
	Winter	5.6 ± 2.9	12.7 ± 2.4	14. ± 3.2	8.4 [a]
	Overall mean	8.9 [ab]	9.0 [b]	15.4 [a]	
C	Summer	1.3 ± 0.4	1.1 ± 0.4	3.9 ± 0.6	1.6 [a]
	Winter	1.0 ± 0.7	0.9 ± 0.5	1.3 ± 0.7	0.2 [b]
	Overall mean	1.1 [b]	0.9 [b]	2.6 [a]	
Under coat	Summer	38.5 ± 3.2	49.8 ± 3.2	46.4 ± 4.7	45.1 [b]
	Winter	55.2 ± 5.2	43.9 ± 4.4	62.9 ± 5.8	52.7 [a]
	Overall mean	44.2 [b]	47.6 [ab]	54.2 [a]	

Values followed by different letters are statistically different ($p<0.05$).

It is obvious from the current study that in all breed groups the britch position had the longest fibres from kemp, A and B types (Table 7). On the other hand, the dorsal line positions showed the longest under coat fibres. In Kanzi and Aboudeleik breeds the wool grown on the midside position was more crimpy than that in the other positions, while in Maneit breed the shoulder position had the same trend. It could be seen from the present results that the crimpiness was affected significantly by the body positions. Dzabirski *et al.* (1998) observed significant differences in number of crimps/cm between samples from shoulder and thigh and from thigh and last rib in Merinolandschaft breed in the Republic of Macedonia. Al-Betar

(2000) also showed that, body positions had a highly significant effect on the number of crimps/cm, whereas, a larger number of crimps/cm was found in lateral positions than in dorsal ones.

Table (7). Mean length ± SE of the outer coat fibre types, under coat and its number of crimps/cm in the fleece of different sheep breeds at different body positions.

Fibre type	Breed / Position	Kanzi	Maneit	Aboudeleik	Overall mean
Kemp	Summer	2.1 ± 0.1	1.9 ± 0.1	2.2 ± 0.1	2.0 [b]
	Winter	3.6 ± 0.1	2.9 ± 0.1	3.3 ± 0.3	3.2 [a]
	Overall mean	2.9 [a]	2.4 [b]	2.8 [b]	
A	Summer	2.0 ± 0.1	1.9 ± 0.1	2.1 ± 0.1	1.9 [b]
	Winter	3.3 ± 0.13	2.9 ± 0.1	3.3 ± 0.1	3.1 [a]
	Overall mean	2.6 [ab]	2.4 [b]	2.7 [a]	
B	Summer	1.8 ± 0.9	1.7 ± 0.1	1.9 ± 0.1	1.8 [b]
	Winter	1.9 ± 0.2	2.9 ± 0.1	2.9 ± 0.1	2.6 [a]
	Overall mean	1.9 [b]	2.3 [b]	2.4 [a]	
C	Summer	1.5 ± 0.1	1.7 ± 0.1	1.6 ± 0.1	1.5 [a]
	Winter	1.3 ± 0.1	1.5 ± 0.1	1.4 ± 0.04	1.4 [a]
	Overall mean	1.4 [a]	1.6 [a]	1.5 [a]	
Under coat	Summer	1.3 ± 0.1	1.3 ± 0.1	1.6 ± 0.1	1.4 [b]
	Winter	1.8 ± 0.1	1.4 ± 0.1	1.8 ± 0.1	1.6 [a]
	Overall mean	1.6 [b]	1.4 [b]	1.7 [a]	
Crimps/cm	Summer	4.4 ± 0.2	4.9 ± 0.2	4.1 ± 0.2	4.5 [b]
	Winter	4.6 ± 0.1	5.7 ± 0.1	5.1 ± 0.2	5.1 [a]
	Overall mean	4.5 [b]	5.3 [a]	4.6 [b]	

Values followed by different letters are statistically different ($p<0.05$).

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Received: 18/09/2006
Accepted: 10/03/2007

تركيب موجز للجلد وبعض خصائص الغطاء في سلالات أغنام منطقة مثلث حلايب وشلاتين وأبورماد خلال فصلين من العام.

عائشة سيد عبده[1]، حمدي حامد سويلم[2]، نبيل عبد العظيم السيد[1]، نجلاء سالم بدوي[1]
١-شعبة الإنتاج الحيواني والدواجن - مركز بحوث الصحراء - المطرية - القاهرة - مصر
٢- كلية العلوم - جامعة عين شمس - القاهرة - مصر

أجريت الدراسة لفحص تأثير الظروف المناخيه المختلفة لموسمي الصيف والشتاء علي شكل وتركيب المكونات المختلفة لجلد الأغنام من سلالات الكانزي والمنائيت وأبو دليك. استخدم في الدراسة عدد ٣٠ من النعاج الناضجة بوادي حدربة بمحطة بحوث حلايب وشلاتين التابعة لمركز بحوث الصحراء علي بعد ١٤٠٠كم جنوب شرق القاهرة.

يتكون جلد الأغنام بصفة أساسية من طبقتي البشره والأدمة. وتتكون طبقة البشرة من الخلايا الطلائية والتى تختلف معنويا طبقا للاختلاف بين السلالات. اما الادمه فتتكون من النسيج الضام وتنقسم إلي طبقة حلمية علوية وطبقا شبكية سفلية حيث تظهر اتجاة معاكس في السمك بالعلاقة مع خشونة الالياف.

أظهرت القياسات الهستولوجيا ان هناك اختلاف معنوي في سمك الغدد العرقية بين السلالات المختلفة كما انة يزداد في موسم الصيف بالمقارنة مع موسم الشتاء. كما بينت الدراسة ان نسبة البصيلات الثانوية الي الأولية S/P ratio قد تأثرت معنويا بالتغيرات في كل السلالات وكذلك في مواسم السنه المختلفة.

أوضحت الدراسة ان بصيلات الصوف في جلد الأغنام تتكون من جدار الجذر الخارجي وجدار الجذر الداخلي والذي ينقسم بدورة الي طبقة هنلى وطبقة هاكسلي وكذلك طبقة الجليد. كما ان هناك زيادة في الاقطار الخارجية والداخلية لكل من بصيلات الصوف الاولية والثانوية في فصل الصيف عنة في فصل الشتاء . بينما كان هناك نقص ملحوظ في جدار كلا نوعي البصيلات في فصل الصيف.

أوضحت الدراسة ان التغير في فصول السنة قد أثر بصفة واضحة علي أقطار الألياف حيث اظهر فصل الصيف اكبر سمك للألياف وقد وجد ان هناك ارتباط بين زيادة قطر الألياف مع زيادة سمك النخاع داخلها. كما أظهرت الدراسة أن الغطاء الصوفي للأغنام الممثلة للسلالات الثلاثة ينقسم الى نوعين رئيسيين غطاء داخلي وخارجي. وقد وجد ان النسبة المئوية للغطاء الخارجي تزداد بصورة معنوية في فصل الصيف كما تختلف باختلاف سلالات الأغنام. كما وجد ان هناك زيادة ملحوظة في الألياف عالية النخاع من نوع A والكمب في الغطاء الخارجي لجميع السلالات في المواسم المختلفة وكذلك علي كل مناطق الجسم المدروسة. وتزداد النسبة المئوية للغطاء الداخلي على مناطق الجسم الظهرية عنها علي المناطق الجانبية كما أظهرت الأغنام من سلالة ابو دليك اعلي نسبة من الغطاء الداخلي. وقد أظهرت الياف الغطاء الداخلي زيادة في الطول وكذلك في عدد التموجات في السنتيمتر في موسم الشتاء.