

A COMPARATIVE TOPOGRAPHICAL AND HISTOLOGICAL STUDY OF HAIR AND HAIR FOLLICLES OF SHAMI GOAT AND BLACK GOATS IN THE MOSUL PROVINCE.

A. N. Abduljawaad, Alhaaik A.G. and M. H. Abdulraheem

Department of Anatomy and Histology College Veterinary Medicine/University of Mosul, Iraq

Key word: Skin, Hair follicles, Shami goat.

Corresponding Author: alhaaik_ag@yahoo.com

ABSTRACT

This study was conducted to prepare a database about hair follicles of Shami goat skin and to compare it with that of Black goat. To achieve this goal, a comparative topographic histological study of 10 areas of Shami goat skin and similar areas of the Black goat skin was performed. Samples of 10 male animals (5) Shami goats and (5) Black goats used in this study were clinically healthy, 1-2 years old . Hair follicles in most studied areas were of the composite type of primary and secondary hair follicles in both animals except for the ventral surface area of the tail where primary follicles were present only. The length of hair follicles in Black goats of all studied areas was longer than that of Shami goats. However, the depth of hair follicles in skin of Shami goats was significantly lower than that of Black goats, indicating that the angle of hair follicles in Shami goats is greater than those of Black goats. The follicles in Black goats were larger than those of Shami goats, indicating that the Shami goats hair was softer than that of Black goats. Shami goats hair had softness more than that of Black goat' hair. This softness is attributed to the increases the ratio of secondary hair follicles to primary hair follicles in Shami goats in most studied areas compared with those in Black goats. The follicular arrangement was studied in both species, however, the triangular arrangement of the follicles was predominant in both animals except for the ventral area of the tail, where the trio follicular arrangement appeared only in the Shami goats and did not appear in the Black goats where they spread uniformly and not in groups.

INTRODUCTION

The skin is the organ that surrounds the body, protects the organs under it from mechanical and physiological external effects (1). As well as it helps in regulation of body temperature, excretes sweat and sebum, and reflects the general body condition (2). The skin of goat also is a source of hair, which is used in different textiles and depends on the quality of the hair produced, and this is of economic importance (3).

There have been many studies dealing with different aspects of different animal skins. The study conducted by (4) who investigate the histomorphometrical features of skin of one-humped camel , in the same manner

(5,6) examined the topography and morphometry of basic components in different areas of the skin of Black goats.

In spite of presence of many studies about the skin of different farm animals in Iraq (7, 8, 9, 10 and 11) but there was no standard histological studies of the hair and follicles of the Shami goat skin. Most of the available Shami goat research is related to milk production and fertility (12, 13, and 14). Therefore, this research aimed to provide a basic knowledge base for hair and hair follicles, including a histological and morphometrical study of different areas of Shami goat skin compared to corresponding areas in Black goats.

MATERIALS AND METHODS

Skins of 10 healthy male animals (5) Shami goats and (5) Black goats aged between (, 1-2 years) were used in this study, samples were taken immediately after slaughter, and were collected in the autumn. Ten different areas of each animal's skin were selected for study (frontal area, the medial surface of forelimb, The lateral surface of the forelimb, the anterior abdomen region, the anterior back, the middle back region, the medial surface of the hind limb, the lateral surface of the hind limb, the ventral surface of the tail and the dorsal surface of the tail).

Neutral buffered formalin solution was used to fix the samples for at least 72 hours, followed by routine histological processing methods , using increasing concentrations of ethyl alcohol starting from (80%, 90%, 100%) for dehydration and chloroform was used as clearing agent.

The samples were passed with melted paraffin wax with a melting point (58-60 °C). The samples of each region were divided into two groups, the first group was oriented horizontally and the second set vertically within the wax blocks. The wax blocks were cut by a rotary microtome to get 5-7 µm histological sections . Hematoxylin and eosin stain was used for histological study and microscopic measurements (15), while the Masson's Trichrome stain was used for differentiation between muscle fibers and connective tissue fibers (16). The histological sections were photographed as well as micromorphometric parameters were measured using the color USB 2.0 digital image camera (Scope Image 9.0- China) which was provided with image processing software. The software of camera was calibrated to all lenses of Microscope-Olympus-CX31 by aid of 0.01mm stage micrometer (ESM-11 / Japan).

The micromorphometric measurements were done for all vertical and horizontal sections of selected areas of skin in both species and the parameters included the followings: length and depth of primary follicles, length of secondary follicles, diameter of each of primary and secondary follicles.

Statistical analysis:

Computer package (Sigma plot V12.0 / SYSTAT software) was used to conduct the histomorphometrical analysis. Data were presented as means $\pm$ SE (standard error) and were analyzed using t- test with significant level set on $P < 0.05$.

RESULTS

The study showed that the hair of both Shami goats and Black goats consists of two types of hair. The primary coarse hair composed of three layers, from the outside to the inside cuticle, the cortex, and the medulla (Fig. 1) and extends deep in the dermis (Fig. 3), accompanied by the sweat glands, sebaceous glands, arrector pilli muscle (Fig. 2). The secondary hair composed of two layers, the cuticle and cortex without the medulla (Fig. 3) which is located more superficially than the primary one, and not accompanied by sweat glands and arrector pilli muscle. It is accompanied by some sebaceous glands.

The hair follicles are structures that originated from the skin epidermis and extend deep in the dermis. The hair follicle consists of an inner layer and an outer layer that encapsulates the hair root, the inner layer called the internal root sheath, it can be distinguished in the lower two thirds of the hair follicle before the opening of the sebaceous gland.

The internal root sheath consists of three concentric layers, from the outside to the inside which are Henle's layer, or the so-called pale epithelial layer, consisting of a single row of keratinized columnar cells its longitudinal axis extend toward the length of the hair follicle. These cells appear cuboidal in the cross section which facing the inner surface of the outer sheath, followed by a Huxley's layer or a granular epithelial layer, this layer consists of one to three rows of irregular keratinized cells and contains an abundance of the trichohyaline granules and then followed by cuticle's layer of the internal root sheath which consists of keratinized and interstitial cells like cuticle of hair, except that its free edges are directed in the opposite direction. The outer sheath of the root consists from several layers of cells similar to the basal cells which represents the continuity of the basal and spinal layers of the epidermis but without a corneal layer. The thickness of the outer sheath decreases towards the hair follicle, where the follicle cells responsible for the formation of hair itself.

Our study showed that there was a clear difference between the lengths of primary hair follicles in Shami goats and had the longest hair follicle in the middle back region (Fig. 3). The average length was 2182.35 μm while the shortest hair length was in the ventral surface of the tail (Fig.4) where it reached 1065.56 μm from (Fig. 13) the results showed that the primary hair follicles in the dorsal areas and the lateral surfaces of the limbs were longer than those in the ventral regions and the medial surfaces of the limbs of both Shami

and Black goats. However, the mean length of follicles in all studied areas in Black goats was higher than the corresponding areas in Shami goats (Fig. 13)

It is worth mentioning that the depth of hair follicles in Shami goat was significantly less than the depth of follicles in all studied areas of Black goat, indicating that the angle of hair follicles in Shami goat was larger than in Black goats, so hair and hair follicle is relatively parallel to the skin surface in Shami goat than them in Black goats (Fig. 15).

The primary follicles of Shami and Black goats differed in according to different areas (Table 1). Primary hair follicles of Shami goat ranged from 92.95 to 171.16 μm while primary hair follicles in Black goats ranged between 94.29-182.7 μm . This indicates that diameters of hair originated from follicles in Shami goats were lower than those in Black goats. The results showed that the primary follicles in the dorsal areas and the lateral surfaces of the forelimbs and hind limbs were larger than those in the ventral areas and medial surfaces of the front and back limbs (Table 1).

The study showed that the mean length and diameter of secondary follicles in Black goats were higher than in Shami goats for all studied areas (Table 1), (Fig. 14) therefore the primary and secondary hair follicles in Black goats were larger than in the Shami goats, and this indicates that the hair of the Shami goats is more soft than that of the Black goats.

The study showed that hair follicles in most studied areas were from complex type and consisting of a single primary follicle with a number of secondary follicles except the area of the ventral surface of the tail was simple because of the lack of secondary follicles in this area for both species and this result was not mentioned in Any of the previous research (Fig. 5). Secondary follicles were opened to primary follicle at the site of opening of the sebaceous glands (Fig. 6), to be later the compound follicle.

Arrangements of hair follicles

The study showed that hair follicles in both species were not randomly distributed in the skin, but rather in the form of solitary, doublet and trio groups (Fig. 7, 8). Some quaternary and quintile groups may exist (Fig. 9, 10) but the trio arranged was common in all studied areas (table 2). Whatever these follicles are organized linearly in most regions (Fig. 7).

The solitary and doublet arrangement is predominant in Black goats skin compared to Shami goats for most regions, while the trio arrangement may predominate slightly in Shami goats compared to Black goats and in most of the studied areas. The quaternary arrangement was found in most areas of the Shami goat skin, this arrangement was not observed in the skin of the anterior surface of the front and back of the Black goat skin. The quintile arrangement appeared in the frontal area, the dorsal areas and the lateral surfaces of the front and back limbs of both animals (Table 2).

Our study showed a significant difference in follicular regulation in the area of the ventral surface of the tail between the two animals. The trio and doublet follicular arrangement, as well as the solitary arrangement of the Shami goats, were shown in the Black goats and for the same region only in the solitary arrangement (Fig. 11, 12) (tab.2).

DISCUSSION

The results of our study revealed two types of hair in the skin of both Shami goats and local Black goat, the coarse hair produced by primary hair follicles and consists of cuticle, cortex and medulla and the follicle of this hair extends deeply in the dermis and may reach the subcutaneous layer (18) accompanied by sebaceous glands and sweat glands and the arrector pili muscle of the hair.

Whereas the soft hair produced by secondary hair follicles, which consists of cuticle and cortex and does not contain medulla. These follicles do not accompanied by sweat glands or the muscle of the hair follicle. They are accompanied by some sebaceous glands. This is consistent with what is mentioned in (19) in pets and (20) in Arabian camel. The results of the study showed a difference in the lengths of hair follicles according to the different regions of the skin, as confirmed by (4) in one – humped camel. Generally, the length of primary and secondary hair follicles in the front and back areas and the lateral surface of the limbs were greater than the abdominal and medial surfaces of the limbs. This is consistent with the reference to (5) in Black goats. This may be due to a positive relationship between the thickness of the dermis and the length of the hair follicles. Comparative results showed that the mean length of primary and secondary follicles in all studied areas of Black goats was longer than the corresponding areas in Shami goats. No research was available to justify this finding and may be attributed to genetic causes.

It was also found that the depth of primary hair follicles in Shami goats was significantly lower than the depth of the follicles in the Black goats and if we take into consideration the absence of significant difference in the length of hair follicles in both animals, this indicates that the angle of Orientation of primary hair follicles in Shami goat higher than in Black goats. This leads to the fact that the hair of the Shami goats is relatively parallel to the surface of the skin compared to the Black goats, which may give a smooth appearance to the hair of the Shami goats.

The diameters of primary and secondary follicles of Shami goats and Black goats varied according to different areas of study and this is similar to that in one-humped camel (4). Our study showed that the hair follicles emitted from primary and secondary follicles of Shami goats are lower than in Black goats. This gives the hair of the Shami goats a much smoother and more beautiful appearance than the Black goats. Hair follicles in most studied areas in both species were composed of complex follicles consisting of one primary follicle and a number of secondary follicles.

Secondary follicles are usually opened on primary hair follicles. In some cases, small numbers of secondary follicles are opened directly on the surface near the primary follicle. This is consistent with what was mentioned by (6) in goat. The area of the ventral surface of the tail in both species was characterized by the presence of simple primary follicles due to the absence of secondary follicles in the ventral surface of the tail. The phenomenon that indicates that these follicles are primary follicles which is accompanied by sweat gland duct.

The results of the study showed that the compound hair follicles in both animals and for most areas of the study were not distributed randomly, but in groups and each group consists of primary and secondary follicles, which was mentioned by (20) in Arabic camels. Primary follicles are organized in a linear or semi-oblique pattern. The central primary follicle has been shown to be slightly larger than the primary peripheral follicles, which is confirmed by (2) in animals with complex follicles.

Our study showed that the trio arrangement of the follicles was predominant in both animals. This arrangement was described by (21) in Bengali goats and (22) in local Awassi sheep. However, it was slightly predominant in Shami goats rather than in Black goats, as well as, doublet and quaternary groups were also found at a lower rate, and only a few quintile groups were observed and in both species.

There was also an obvious difference in the follicular arrangement in the area of the ventral surface of the tail between the Shami goats and the Black goats. The arrangement of the follicular groups appeared in the Shami goats only, whereas the primary follicles in the Black goats of the same region were spread uniformly and not in groups, it has been attributed to genetic causes.

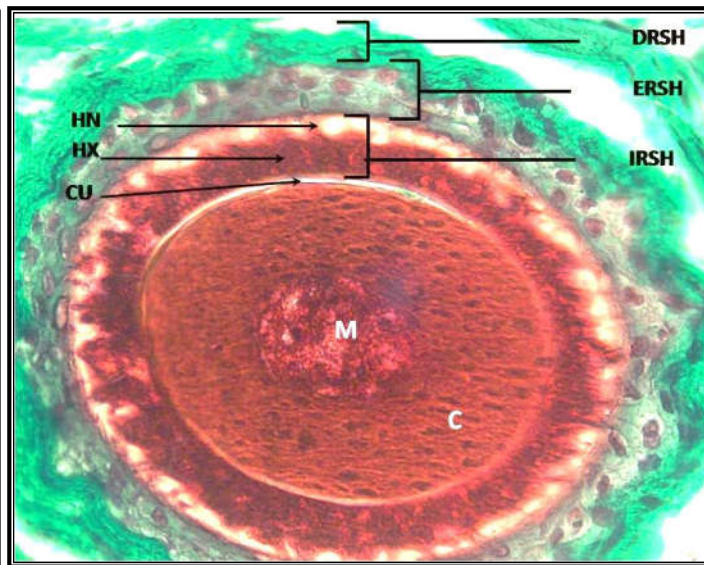
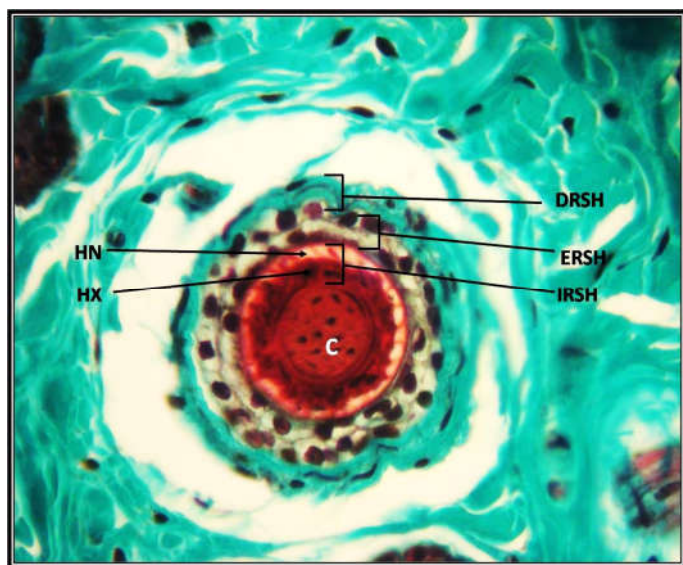


Fig (2). A horizontal histological section of the skin of the anterior back area in the Shami goats. Notice the cross section of the secondary hair. Cortex(C)and internal sheath IRSH with Henle (HN)and Huxley

Fig. (1). A horizontal histological section of the skin of the ventral surface area of the tail in the Shami goats. Note the primary hair layers of, medulla(M), cortex (c), cuticle (CU) , internal root sheath (IRSH) , Henle layer

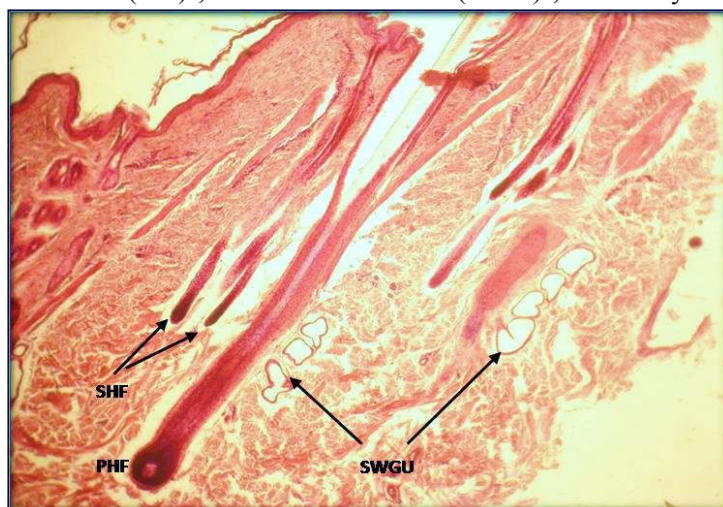
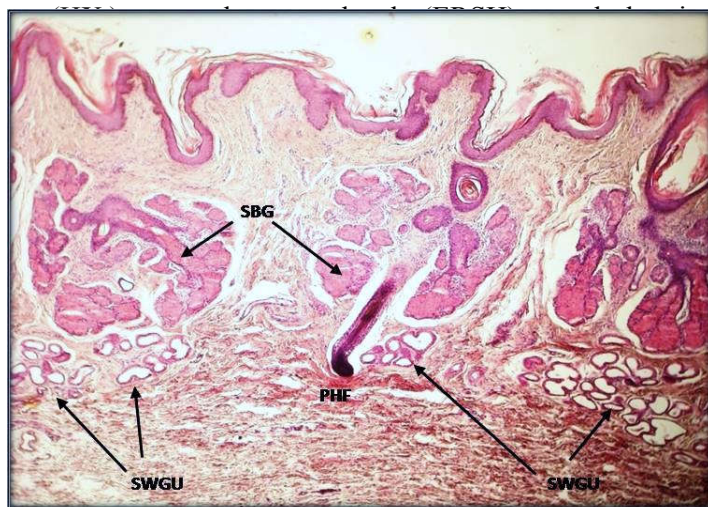


Fig (4). Vertical histological section of the skin of the ventral surface area of the tail in Shami goats. Note the short length of primary hair follicles and the lack of extension in the dermis with the presence of the units of sweat gland SWGU and sebaceous glands SBG associated with primary follicles. (H&E stain, 370X).

Fig (3). Vertical histological section of the skin of the middle back area in the Shami goat. Note the length of primary hair follicle PHF and its extension in the dermis and the less extension of secondary hair follicles SHF with the presence of secretory units of the sweat gland SWGU. (H&E stain, 370X).



Fig . (6). Horizontal histological section of the skin of the lateral surface area of the hind limb in local black goats. Note the opening of the secondary hair follicle SHF on the primary follicle PHR and note the presence of the SBG associated with the primary hair follicle. (H&E stain, 370X).

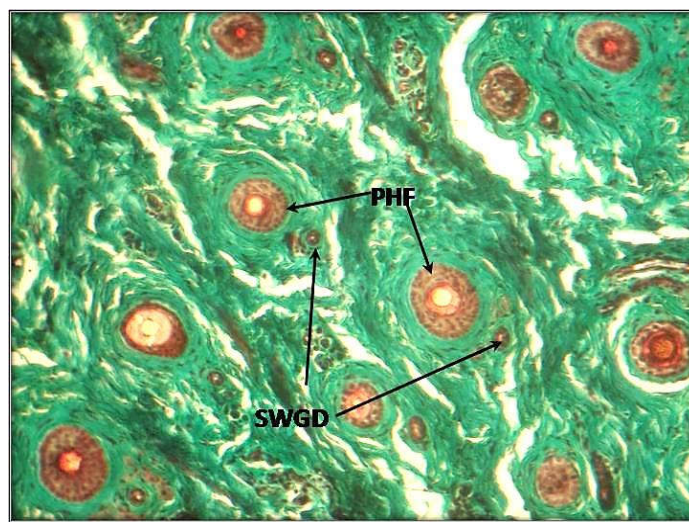


Fig (5). A horizontal histological section of the skin of the ventral surface area of the tail in the Shami goats. Note the absence of secondary follicles and the accompaniment of a sweat gland duct SWGD for each primary hair follicle PHF. (Masson's Trichrome stain, 165X).



Fig (8). A horizontal section of the skin of the anterior back area in the Shami goats. Note the solitary arrangement, the existence of the sweat gland duct SWD, the sebaceous glands SG and the secondary hair follicle SHF, the arrector pili muscle APM. (Masson's Trichrome stain, 115X).

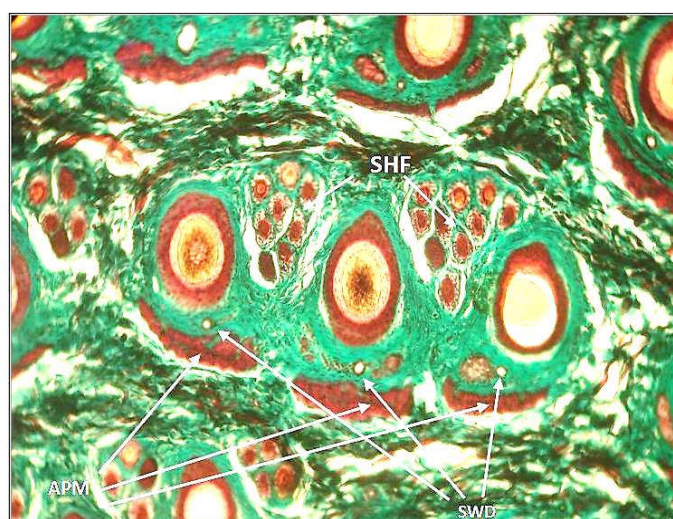


Fig (7). Horizontal histological section of the skin of the middle back area in the Shami goats. Note the trio arrangement of the follicles, the linear pattern of the primary follicles, the secondary follicles SHF, sweat gland duct SWD and arrector pili muscle APM (Masson's Trichrome stain, 90X).



Fig . (10). A horizontal section of the skin of the dorsal surface of the tail in the Shami goat at the mid-third level of the dermis. Note the quintile arrangement of primary follicles and note secondary follicle occupy the **Ectal side** while the sweat gland duct and the sebaceous gland and the arrector pili muscle occupy the opposite side **Ental side**. (Masson's Trichrome stain,

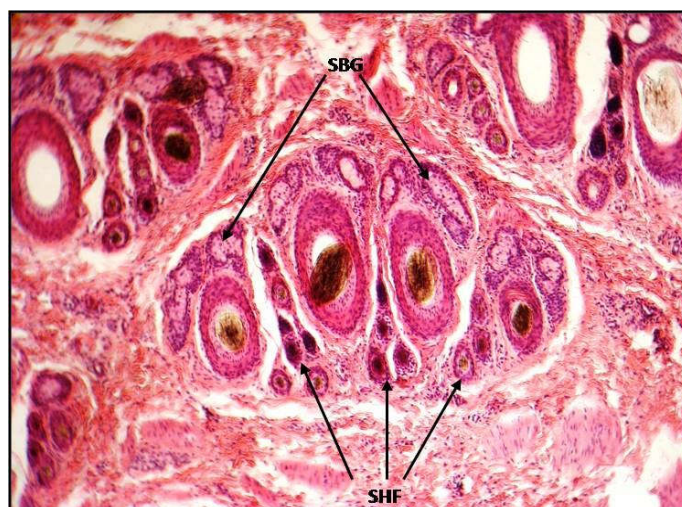


Fig (9). A horizontal section of the skin of the anterior back area in the Shami goats. Note the quaternary arrangement with the presence of sebaceous glands SBG associated with primary follicles and secondary hair follicles (SHF). (H&E stain, 90X).



Fig (12). A horizontal section of the skin of the ventral surface area of the tail in the black goat. Note the mono arrangement of primary hair follicles without secondary follicles. (H&Estain, 90X).

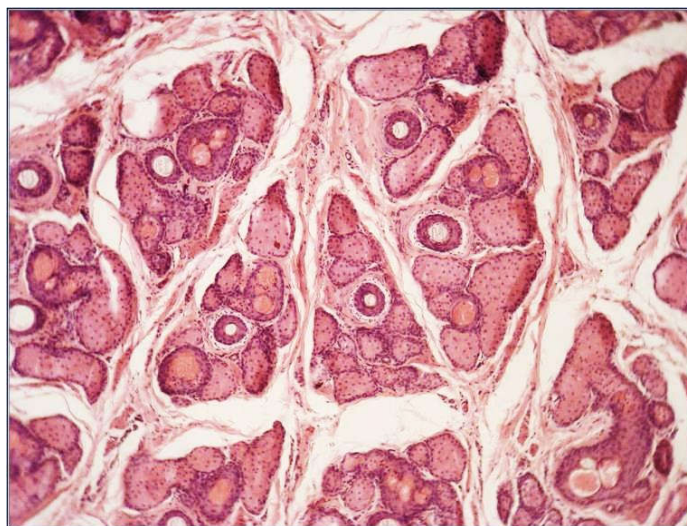


Fig (11). A horizontal section of the skin of the ventral surface area of the tail in the Shami goats. Note the regularity of primary follicles in groups as observed by the absence of secondary follicles. (H&E stain, 90X).

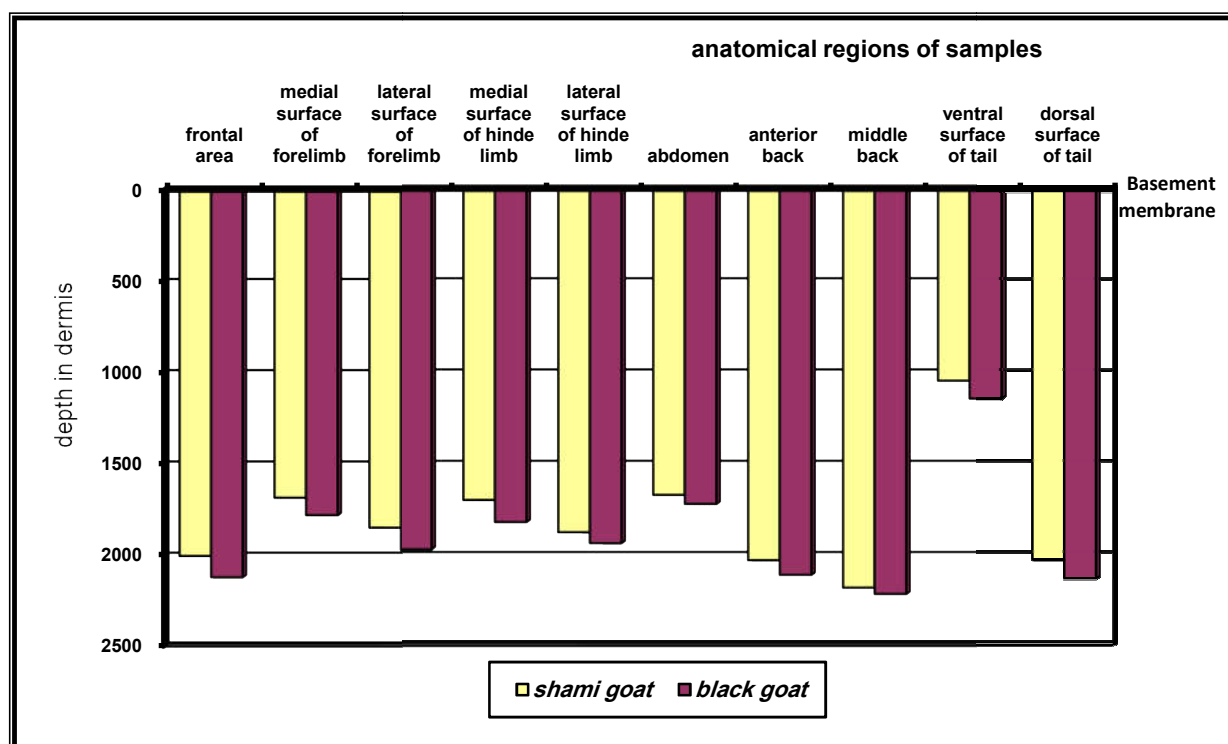


Fig. (13) show the lengths of primary hair follicles in depth of dermis for all studied skin regions of Shami goat and Black goat / μm

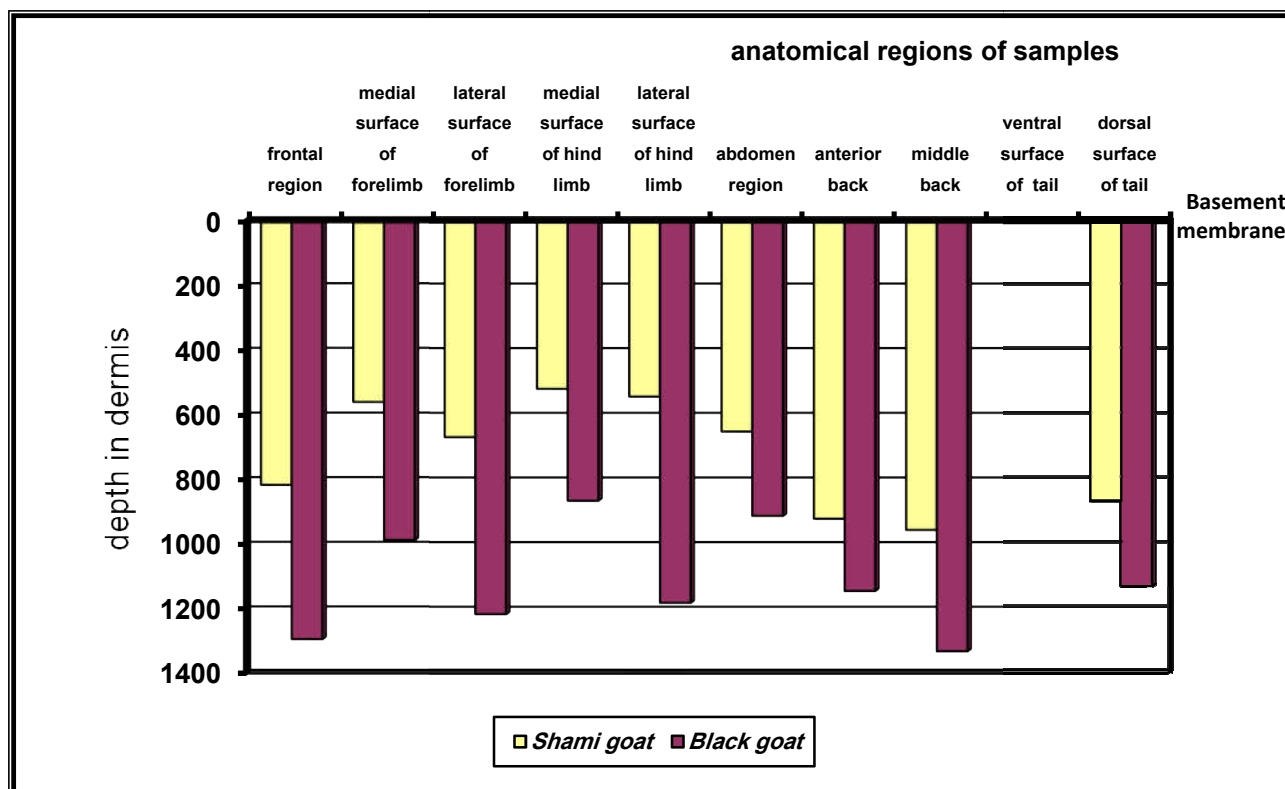


Fig. (14) Show the lengths of secondary hair follicles in depth of dermis for all studied skin regions of Shami goat and Black goat / μm

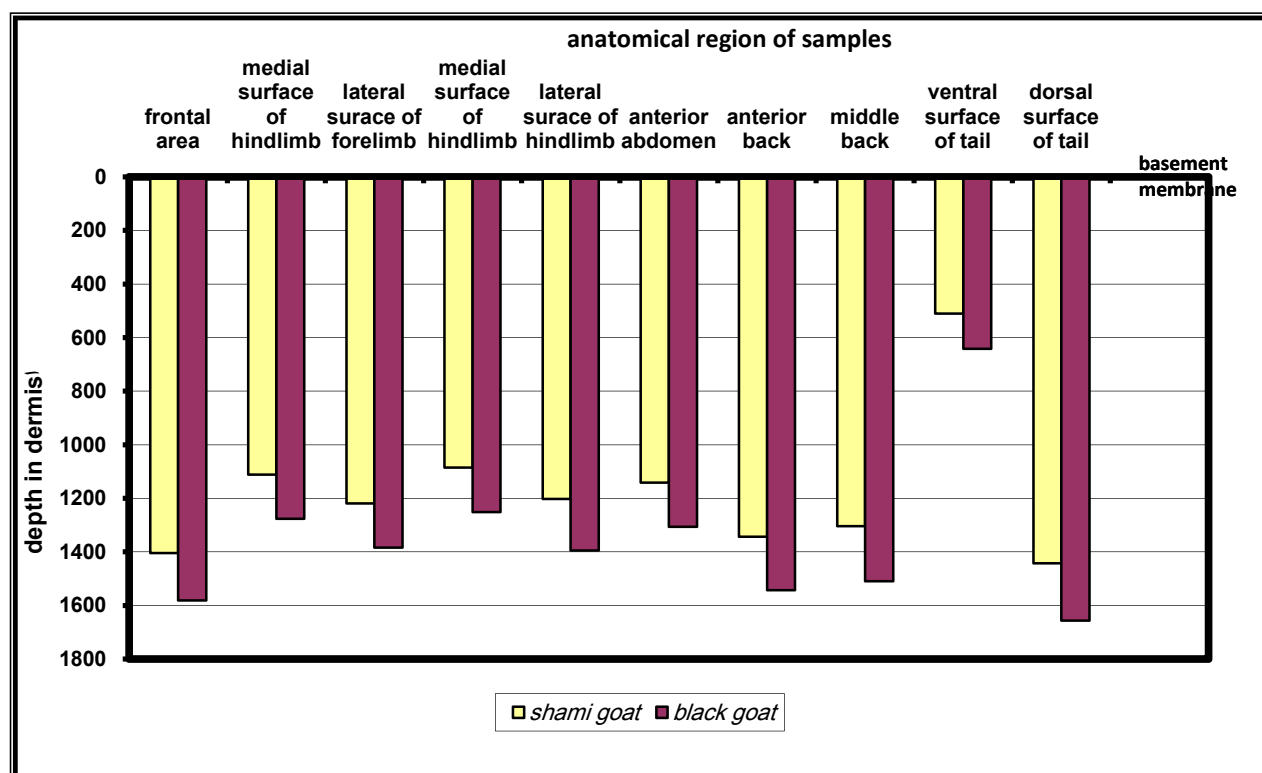


Fig. (15) Show the depth of primary hair follicle inside the dermis in all studies skin regions in Shami goat and Black goat/ μm .

Table (1) show the mean diameter of primary and secondary hair follicles at level of sebaceous glands for all studied skin regions of Shami goat and Black goat / μm

Anatomical regions of samples	Frontal region		Medial surface of fore limb		lateral surface of fore limb		Medial surface of hind limb		lateral surface of hind limb		Abdomen region		Anterior back		Middle back		Ventral surface of tail		Dorsal surface of tail	
	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat	Shami goat	Black goat
Primary follicles diameter	161.39 ± 3.45	178.27 ± 2.65	131.78 ± 3.98	143.49 ± 3.09	154.93 ± 4.21	162.44 4.85	142.99 ± 3.53	153.31 ± 4.81	158.67 ± 5.75	165.81 ± 4.95	128.7 ± 3.87	146.2 ± 4.32	A 171.16 ± 5.35	175.85 ± 6.21	163.2 ± 4.10	175.27 ± 5.19	B *92.95 ± 2.65	B *93.29 ± 2.43	164.85 ± 5.22	A 180.7 ± 6.51
secondary follicles diameter	45.99 ± 0.67	51.25 ± 0.49	43.6 ± 1.66	48.75 ± 1.39	44.6 ± 2.11	50.32 ± 1.76	43.24 ± 0.98	B- 46.66 ± 1.22	*46.61 ± 1.83	*50.72 ± 2.37	42.16 ± 0.54	47.89 ± 0.98	*48.5 ± 0.25	*51.71 ± 0.39	A- *49.5 ± 1.02	A- *52.14 ± 2.82	-----	-----	*47.66 ± 2.07	*51.87 ± 1.48

*Mean there is a significant difference between two species of animals at $p \leq 0.05$

A* refers to the largest primary follicle diameter in both species

B* refers to the smallest primary follicle diameter in both species

A* refers to the largest secondary follicle diameter in both species.

B* refers to the smallest secondary follicle diameter in both species

Table (2) show the percentage% of follicular arrangement in different skin regions in Shami goat and Black goat.

Anatomical regions of samples	Frontal region		Medial surface of forelimb		Lateral surface of forelimb		Medial surface of hind limb		Lateral surface of hind limb		Abdomen		Anterior back		Middle back		Ventral surface of tail		Dorsal surface of tail	
	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat	Sham goat	Black goat
Solitary Arrange.	10%	12%	13%	16%	7%	2%	10%	17%	2%	7%	14%	17%	7%	7%	4%	7%	42%	100%	4%	4%
Doublet Arrange.	13%	14%	19%	22%	12%	13%	19%	22%	11%	14%	22%	26%	7%	8%	2%	7%	32%	---	2%	4%
Trio Arrange.	60%	58%	70%	29%	72%	70%	72%	71%	77%	77%	70%	21%	78%	74%	70%	73%	27%	---	71%	72%
Quaternary Arrange.	12%	12%	8%	---	12%	18%	7%	---	8%	8%	4%	7%	13%	7%	10%	8%	---	---	17%	17%
Quintile Arrange.	5%	4%	---	---	4%	4%	---	---	7%	7%	---	---	7%	2%	7%	2%	---	---	9%	10%

ABSTRACT

1. Mohammed, A. ; Rabo, J. S. and Ibrahim, A. A. (1995) . Reaction of skin to suture materials in Borno white goats . Small Ruminant Research ., 16 : 191-194 .
2. Dellmann, H. D. and Brown, E.S. (1976) . Textbook of Veterinary Histology . 1thed . Lea and Fiebigar, USA, pp :459-463 .
3. Keskin, M. ; Biçer, O. and Gül, S. (2007) . Some Cashmere Characteristics of German Fawn × Hair Goat (B1) Crossbreds and Shami (Damascus) Goats of the Eastern Mediterranean Region., Turk. J. Vet. Anim. Sci., 31 :203-206 .
4. Abdul-Raheem, M. H.; AL-Hety, M. S. and Ahmed, N. S. (1999) Histological and morphological study of the skin of the one humped Camel (CamelusDromedarius) . Iraq J. Vet. Sci.; 12 : 1-11 .
5. Sultan, G. A. (2007) .Comparative Histological , Morphological and topographical study of the skin of the local males Black Goat . M. S. C. Thesis , Mosul university.
6. Abdul Raheem, M. H. and AL-Hety, M. S. (1997). Histological and morphological study of the skin of the Black goat . Iraq J. Vet. Sci., 10 : 59-71 .
7. Ibrahim, R. Sh.; Hussein, A. A, and Jabbar, A. I. (2017). Comparative microscopically study of the skin in local and wild rabbits. Kufa.J. Vet. Med. Sci., 8(1) : 151- 156.

8. Al-Umeri, S.K.W. and Al-Mamoori, N.A.M.(2016). Comparative histological and histochemical study of flank region skin, in camel, cow and buffalo. *Al-Qadisiya J. Vet. Med. Sci.*, 15(2): 102-107.
9. Obeyes, A.K. (2016). Histological study for skin of Horse. *Tikrit J. pu. Sci.*, 21(1) :31-35.
10. Abdul-Rahman, F. Y.; Asofi, M. K. and Al-Ekaby, A. K. (2006). Study on some productive characters of goats (Local , Shami and Shami x Local) . *IPA. J. Agric.*,34(2): 30-36.
11. AL-Saigh, M. N. R. (1999). A study of some body measurements and hair physical characteristic of Black Iraqi Local goats. *The Veterinarian.*;2:45-56.
12. Alsheikh, S. M. (2013). Influence of age and live body weight on daily milk yield of Zaraibi and Shami goats in Sinai, Egypt. *Annals of Agricultural sciences.*; 58(1):1-3.
13. Keskin, M; Avşar. Y.K.; Biçer, O. and Güler, M. B.(2004). Comparative study on the milk yield and milk composition of two different goat Genotypes under the climate of the eastern Mediterranean. *Turk.J.Vet.Anim. Sci.*, 28:531-536.
14. Güney, O. ; Torum, O. ; Özuyanik, O and Darcan, N. (2006) . Milk production, reproduction and growth performances of Damascus goats under NorthernCyprus conditions . *Small ruminant Research .*, 65 : 176-179 .
15. Luna, L. G. (1968) . *Manual of histological staining methods . 3rd ed .* , M.C. McGram-Hill Book Company , pp : 34,35,79,80 .
16. Culling, C.F.A. ; Allison, R.T. and Barr, W.T. (1985) . *Cellular pathology technique 4thed .* Butterworth ., pp:16 , 167 .
17. Petri, A. and Watson, P. (1999). *Statistics for veterinary and animal science.* Blackwell Publishing Co. Oxford, pp: 95-99.
18. Tortora, G. J. and Grabowski, S. R. (2000). *Principles of Anatomy and Physiology.* John Wiley & Sons . USA.
19. Samuelson, D. A. (2007). *Textbook of veterinary Histology.* Saunders. China.
20. Hekal, S.A. (2014). Histological study of the skin and leather characteristics in two types of Arabian camels (camelusdormedarius). *J. Amer sci.*, 10 (9): 41-47.
21. Barikhan, M.A. and Talukdar, A.H. (1977). Follicle population in Balck Bengal goats . *J. Agric. Sci. Camb.*, 88: 251-252.
22. Hadi, M.A.; Mehanna, N.H. and Al-Bedairi, A.W. (2014) Skin histological study in local breed sheep (*Ovisovis*). *Al-Qadisiya J. Vet. Med. Sci.*, 14(1): 14-19.