

## Histological, Morphometrical and Topographical Study of Sebaceous and Sweat Glands in the Skin of Local Black Males Goat

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### Abstract

The aim of this study was to add more information in the field of knowledge regarding the skin structures of a local black goat. topographical, histological and morphometrical studies were carried out in twelve certain different areas of the skin using twenty healthy adult male goats in the autumn season. Hematoxylin and Eosin stain and Masson's Trichrome stain were used for all samples. Results; that the sebaceous glands are composed of clusters of pale staining epithelial cells that located within the dermis and accompanied all primary and some of the secondary follicles. depending on skin area, the sebaceous glands were large in the skin of muzzle, scrotum, abdomen, the medial surface of the limbs and the abdominal surface of the ear. while their sizes are decreased in the skin of tail, lateral surfaces of limbs and dorsal aspect of ear skin. The size of sebaceous glands were inversely proportional to the hair density. The sweat glands except in the skin tail were apical secretion type, while their levels within the beneath of dermis and their density were varied according to the skin area. the skin of muzzle, tail, dorsal surface of the ear had high glandular density followed by the skin of cranial and middle back in addition to lateral surfaces of limbs. Less glandular density was found in the abdominal surface of ear, abdomen, medial surfaces of limbs and scrotum. In addition to the apocrine sweat glands, serous tubular acinus compound glands in the muzzle skin which extended widely beneath of dermis to subdermal layer. these glands were entirely serious excretion units with the main excretory channel that opens directly on the surface of the skin and had no relation with hair follicles.

**Keywords:** Histology, skin, Domestic animals, Glands

دراسة نسيجية وشكلية قياسية وطبغرافية للغدد الزهمية والعرقية في جلد ذكور الماعز الأسود المحلي

### الخلاصة

هدف البحث إلى إجراء دراسة شاملة لتوفير قاعدة معلومات أساسية لمكونات جلد الماعز الأسود المحلي، ولغرض الوصول إلى هذا الهدف فقد تم إجراء دراسات نسيجية وشكلية قياسية وطبغرافية مقارنة لاثنتي عشرة منطقة من جلد الماعز الأسود المحلي واستعمل لهذا الغرض جلد 20 حيواناً ذكراً بالغاً سليماً صحياً وتم اخذ النماذج في فصل الخريف. بينت الدراسة ان الغدد الزهمية رافقت جميع الجريبات الابتدائية وبعض الجريبات الثانوية، كما اختلفت احجام الغدد الزهمية باختلاف المناطق الجلدية فقد كانت الغدد الزهمية كبيرة الحجم في مناطق الخطم والصفن والبطن والسطح الأنسي للقوائم الأمامية والخلفية والسطح البطني للأذن وقل حجمها في مناطق الذيل والسطح الوحشي للقائمة الأمامية والخلفية، ومنطقة الظهر والسطح الظهرى للأذن ومن هذا يستدل على ان حجم الغدد الزهمية يتناسب عكسياً مع الكثافة الشعرية. كانت الغدد العرقية في كل المناطق المدروسة باستثناء جلد الخطم من نوع الغدد العرقية القمية الأفرز كما اختلف مستوى ظهور الغدد العرقية ومستوى انتهائها داخل الأدمة باختلاف المناطق المدروسة، كما اختلفت الكثافة الغدية باختلاف المناطق فقد احتوت مناطق الخطم والذيل والسطح الظهرى للأذن على كثافة غدية عالية يليها الظهر الأمامي والظهر الوسطي، السطح الوحشي للقائمة الأمامية والخلفية اما المناطق الأقل كثافة فكانت جلد السطح البطني للأذن وجلد البطن، السطح الأنسي للقوائم الأمامية والخلفية والصفن. اضافة الى الغدد القمية الأفرز، فقد ظهر في أدمة جلد الخطم غدد مصليية نيببية عنبية مركبة شغلت مساحة واسعة امتدت من الجزء السفلي للأدمة إلى طبقة تحت الأدمة وتتألف هذه الغدد من وحدات افرازية مصليية بالكامل وقناة اخراجية رئيسة تفتح على سطح الجلد مباشرة ولا علاقة لها بالجريبات الشعرية.

## Introduction

The skin is the protective cover of the body and plays an important role in protecting the body from external influences on the one hand and temperature control and humidity on the other hand (1). The skin consists of two main layers, the epidermis and the dermis separated by the basal membrane. The epidermis is composed of keratinized stratified squamous epithelium, its cells pass through stages of division, migration, differentiation and keratinization until it reaches the surface layer, as it becomes a dead cell that is constantly dislodged from the surface of the skin to be replaced by new keratinized cells, so the epidermis is a model of renewed tissue in the body (2). In most parts of the body, the dermis contains hair follicles, sweat and sebaceous glands, and the quality, size and numbers of these components vary according to animal types and skin areas in a single animal.

(3). The stated that hair follicles and sweat glands differ in size, depth and density in the different cow breeds. (4). Deference in the histological composition between some areas of the skin in single-hump camels

There are many studies on the histological structure of the skin and its accessories in humans (5). Although there are histological studies of the skin of local animals, it was a limited area of the skin (6). Due to the importance of local black goats and the relationship of the skin and hair to the general health condition of the body where hair loss, the appearance of crusts and the spread of external parasites are not due to skin diseases, but withdrew diseases that affect the body in general as well as economic importance (7). And due to the lack of coherent and comparable studies in this direction, as all previous researches has been limited to obtaining descriptive information and the amount of

preparations of the histological sections for unspecified or undeclared anatomical areas. Current study is designed to add comprehensive information to the knowledge field regarding to the types of skin glands and their distribution in different areas of the body in local black goat.

## Materials and methods

The research samples (skin) were taken from local black goat males aged 1-2 years immediately after they were slaughtered and the animals were selected from Mosul slaughter house, there were clinically healthy especially their skin.

All samples were taken in the autumn season only to avoid changes that may occur on the skin in different seasons (8). The areas of skin to be studied have been colored with marker before slaughter. After slaughter, the hair is removed from the target areas, four -six samples were taken from each area using punch set.

which is known for the diameter and the following anatomical positions: (front back, middle back, abdomen, tail, lateral surface of the forelimb, the medial surface of the forelimb, the scrotum, the lateral surface of the hind limb, the medial surface of the hind limb, the muzzle and the dorsal and ventral surfaces of the ear) .

The samples were immobilized in Alcoholic Bouin's solution for 48 hours. Then the samples were transferred to 4% phenol for 24 hours to reduce the hardness of the keratinocyte on the skin.

Samples were treated with ethyle alcohol of escalating concentration for the purpose of dehydration, starting from 50% concentration in several passes until the yellow color of the fixative was removed, then to 70% concentration for 24 hours, then 90%

concentration in two passes every 3 hours pass, then 100% concentration also in two passes at a rate of 3 Hours per pass.

Cedar wood oil was used at a rate of one pass for 24 hours for the purpose of clearing. Then the samples were transferred to Benzen for half an hour (9). And then the samples were passed in pure melting point paraffin wax, 58 ° C - 60 ° C , Four passes and one hour was allocated for each pass in an electric oven at 60 ° C. Some samples were placed in molten wax subjected to negative pressure by using a vacuum pump type C7960 in order to facilitate the penetration of the wax into the samples (10). with a rate of 4 passes, and 1 hour was allocated for each pass. Then the samples were poured into clearly marked wax molds (9). And half of the samples were immersed in a vertical position inside the wax, and the other half was immersed in a horizontal position to identify all skin structures and infer their measurements. Models were cut using a rotary microtome to obtain tissue slices of 5-8µm thickness and fixed on glass slides with a light layer of Egg albumin or so-called Mayer's adhesive (10).The following tissue stains were used to show the different tissue structures :

1- Delafield's Hematoxylin and Eosin stain to determine the general histological structure of the skin as a prelude to taking microscopic measurements (10).

2- Masson's Trichrome stain to differentiate between colloidal and muscle fibers in the skin (9).

The standard morphometrical study was carried out under a light microscope using the ocular micrometer and the stage micrometer with known measurement and extracting the micrometer value for each objective lens. The microscopic standard value was calculated for all the objective lenses of the microscope and was as

Table 1. Demonstrates the use of the micrometer value for models measured with different objective lenses of an optical microscope

The objective lens power	The microscopic standard value
4	34.4
10	13.3
40	3.3

Demonstrates the use of the micrometer value for models measured with different objective lenses of an optical microscope (Table No. 1), as each of the following variables were measured:

- 1- Depth of the sweat glands and measurements of their components.
- 2- The location of the sebaceous gland opening on the primary and secondary hair follicle and its distance from the basement membrane of the epidermis.
- 3- Dimensions of the sebaceous glands.

To ensure the accuracy of the microscopic measurements, they were compared with the standardization method for the Visopan (Reichert, Austria Nr. 366 F15). (Table No. 2)

Table .2 The accuracy of the microscopic measurements,

Objective lens power	Magnification power	The microscopic standard value
4/0.10	50	20
10/0.25	125	8
16/0.32	200	5
40/0.65	500	2
63/0.80	800	1.2
100/1.25	1250	0.8

The extraction of the microscopy value of the measured models with the Visopan objective lens is shown as found in the instrument manual itself.

The glandular density was calculated by counting the glandular units of adenomeres per unit area as follows:

Glandular density: the horizontal sections were chosen according to the type of glands, for the sebaceous gland density: the site was chosen slightly down from the place where the sebaceous ducts open to the hair follicles, as for the sweat glands, the site was chosen below the start of the sweat ducts.

The microscopic field area was calculated by calculating the diameter of the microscopic field in the objective lens that was examined, and the surface area of the microscopic field was extracted using the usual engineering method.

The study aimed to find glandular density per unit area in different skin areas.

The tissue sections were photographed using a digital camera and an optical microscope (Reichert, Neovar) with an adapter.

The magnification force was calculated by taking a microscopic image of the microscope ruler measuring 2 mm with information on the divisions, as each division is equivalent to 10 micrometers (E-Leitz, GmbH. Wetzlar) and with the same objective lens used for the slide to be photographed, and then calculating the magnification force with the microscopic ruler image for each object lens Relative to the size of the known scale ruler according to the following equation:

The data for the study were analyzed using the one way analysis of variance and the Duncan test to determine the statistical differences between the different areas of skin (11). The significant differences were studied in all tests at a significant level of  $P < 0.001$ .

## Results and discussion

### Sebaceous Glands

The results of our study showed that the sebaceous glands in all studied areas were simple vesicular, branched and filled with sebaceous cells with varying degrees of maturity. The cubic basal cells are based on the basement membrane and were small in size, flat with dark nuclei. While the following cells towards the center of the vesicle were large, ribbed, with pale nuclei and light-colored cytoplasm (Fig. 1) and this is consistent with that mentioned in American goats by (12) and in laboratory animals (13) and in man (14).

The sebaceous glands accompany the primary

hair follicles and in all the studied areas, as they showed that they connect to the follicle through a short channel lined with a squamous stratified epithelium called the pilosebaceous canal, which was indicated in some areas of goat skin by( 15). In skin areas (the back, armpit and inguinal) of the one humped camel (4).

While... all areas of the Egyptian buffalo skin except the nasolabial region are free of these glands (16) as confirmed in previous studies, that the skin covering the foot pad, hooves, claws and horns is free from sebaceous glands in various animals (17, 18). Researchers are pointed out that there are no sebaceous glands in the nasal surface of small ruminants and the nasolabial surface of large ruminants (19), but there are very large, single-formed sebaceous glands that open on a solitary hair follicle above the skin of the tail it is 3-9 cm from the base of the tail in the dog and the cat and its importance lies in giving shine to hair in this area. their function is pointed out that the majority of secondary follicles in the skin of the back are not associated with sebaceous glands but some secondary follicles in the skin of the abdomen are associated with sebaceous glands as well as in the skin of the scrotum and this is consistent with the results of our study where sebaceous glands accompany some secondary follicles . However, their numbers were low in the dermis of the back, tail and lateral surfaces of the forelimbs and hind limbs and ear surfaces .

Sebaceous glands are classified as holocrine secretion, where the sebum resulting from the complete decomposition of sebaceous cells moves to the skin surface through the follicle in most skin areas and this is confirmed in various animals (19) and in sheep and goats (18) while the researchers pointed out that they sometimes open directly on the surface of the skin in the lip of bovine and also in humans(20) . Some sebaceous glands are directly opened on the surface of the skin (21). Our results indicated

that the sebaceous glands in the ventral surface of the ear open directly to the surface of the skin.

However the sebaceous glands of cows, sheep and goats as well as in mice are influential to some substances that are part of the secretion and therefore the sebum does not consist of necrosis of sebaceous cells only(22) . Based on this, the sebaceous gland is not considered a fully excretory gland.

On the other hand, sebaceous glands appeared in the histological preparations due to the melting of fatty elements during the transactions with chemicals such as alcohol and xylene, and this is confirmed in Iraqi Mammals (23) .

The histological examination of the vertical sections prepared from the different anatomical regions revealed the presence of unilateral sebaceous glands in the back skin and the lateral surfaces of the forelimbs and hind limbs (Fig. 1). But they were multi-lobed in the medial surface of the forelimbs and hind limbs, scrotum and abdomen (Fig. 2). Research carried out on the skin of several types of Mammals (24), on the skin of Iraqi goats (15) and on human skin (14) , indicates a difference in the size and shape of the gland in different skin areas. This is consistent with the results of this study of the difference in the level of appearance of the sebaceous glands and the level of their termination inside the dermis in the different areas studied and as shown in (Table No. 3). That the extension of sebaceous glands in the depth of the dermis varied by different areas where the glands filled a great depth from the level of (398.60-463.80) micrometers starting from the basal membrane for the glands accompanying the primary follicle and in the skin of the medial surface of the forelimb and hind limb and the skin of the abdomen and muzzle, finally skin of scrotum. While the sebaceous glands accompanying the

secondary follicles in the same areas mentioned above were occupied a greater depth also. Where the glands began to appear from the level (321.20-372.40) micrometers from the basement membrane, while distance of extension of the sebaceous glands accompanying the primary follicle was lower in the skin of the back, tail, lateral surfaces of the forelimb and hind limb and the skin of the ear , in the level of (270.20 - 376.80) micrometers . The gland accompanying secondary follicle is slightly deep and for the same areas from level (177.40-227.00) micrometer in the intradermal layer .

Since the sebaceous glands were irregular in shape whereas their sizes, longitudinal and transverse axes through through were measured and the average dimensions of the sebaceous glands were deduced from each area of the skin as they showed a clear difference of their sizes in( Table No. 4). The highest size was observed in the skin of the muzzle , scrotum , skin of the medial surfaces of the limbs and then the skin of the abdomen and the scrotum skin. But in small proportions compared to the normal size of the sebaceous gland associated with the primary follicles and for the same areas mentioned (Fig. 3 and Fig. 4). This was, confirmed the researchers pointed out that the sebaceous glands are large in the skin of the scrotum then the abdomen and less than that in the size of the back skin of domestic goats .(15)

The results of the research showed that the sebaceous glands may accompany some secondary follicles in the studied areas (Fig. 5). However, they differ in size compared to the glands associated with the primary follicles, also differs in the degree of their extension into the dermis, The researchers have stated (4), when studying the skin of the single hump camel, that the sebaceous glands were large in size in the skin of the inguinal area and less than

that in the skin of the armpit. They also stated that the ratio of sebaceous glands to hair follicles varied as the ratio of sebaceous glands to the primary hair follicles (1:1) while the ratio of sebaceous glands to secondary follicles varied according to skin areas where the ratio was high (23:1) in the groin area, while the ratio decreased to (7: 1) in the armpit area .(15)

#### Sweat Glands

The results of our study showed that the sweat glands in all studied areas except for the muzzle, were apocrine type. They were simple cystic or tubular glands consisting of an almost straight . These glands had thin duct these glands had a sinuous or coiled secretory portion larger in diameter and hollow than the duct. The gland duct appeared for all studied regions is consisted of two layers of low-lying cubic epithelial cells with a centrally located nucleus. Its channels open on the primary hair follicles. This was consistent with what indicated in different animals (19) .The same researchers pointed out that the nasal plate (Planum nasali) in small ruminants such as sheep and goats and nasolabiali oral plate (Nasolabiali) for large ruminants such as cows are free of apical sweat glands secretion, While our results in the area of the muzzle showed the presence of some apical sweat glands secretion, whose secretory units are located below small number of hair follicles with a large number of eccrine glands, These glands occupied large areas extending from the lower part of the dermis to the subdermal layer. And their channels are opened directly on the skin. This difference may be due to the area, where the mucocutaneous junction surrounding the nostrils. Nostrils may not contain hair follicles or apical secretion sweat glands. While the area of our study extended to the upper part of the upper lip and the area between the nostrils of the presence of apical secretion glands in the muzzle of small ruminants are not available. However, the

presence of eccrine glands in the free or sparse area of the hair helps to moisturize the skin epidermis, as confirmed by in sheep and goats (18) . The secretory units of the sweat glands appeared completely serous and open on small interstitial channels, which in turn open on larger channels lined with vertical or high cubic cells with basal outlines and These cells had spherical nuclei are located near the cavity, giving them a similar shape to the striated channels found in the main salivary glands. Many researchers have indicated the presence of striated channels in the main salivary glands(19, 21) . But no studies are available on the presence of striated channels in the sweat glands of the goat muzzle, whether domestic or foreign, In the present study these channels are opened on larger channels that connect to each other to form the main excretory channel that opens directly on the surface skin. these channels are lined with squamous epithelium. This was confirmed in histological section of skin of cow muzzle (25).

Apical sweat glands are present in most parts of the skin of farm animals (18). But in humans they are limited to specific areas of the skin, and it was reported that human skin contains three million apical sweat glands secretion over certain areas (21). The results of our study showed that the apical secretion sweat glands are simple tubular or cystic glands consisting of a nearly straight thin channel and a coiled secretory part larger in diameter .These results were consistent with previous study of goat skin (26) and in awassi sheep skin (27) and also in certain skin areas of local goat(15). The horizontal sections at sweat gland opening showed that the diameters of the channels appeared different according to the studied areas, it was the largest diameter in the skin of the scrotum as its diameter reached (19.80  $\mu\text{m}$ ) which was confirmed in previous study of the skin of the single hump camel (4). And in bovine skin, it was pointed that the channel

diameter are varies in different skin areas (3).

However, in the present study the ducts of the sweat glands were less diameter in the skin of the dorsal surface of the ear, its diameter reached (15.67) $\mu\text{m}$ , according to (Table No. 5). The gland duct follows almost straight paths for all the studied areas. This channel penetrates the primary hair follicle just before it opens to the surface and opens at the neck of the primary hair follicle above the sebaceous gland (Fig. 6). and this is what was confirmed in Iraqi goats ( 15). But these channels may open directly on the surface, as indicated in American goats (12).

The number of sweat gland ducts differed in the unit area, as our results showed that the number of channels is identical to the number of primary and simple follicles ( Table No. 5). Which indicates that each primary or simple follicle opens with one sweat gland (Fig. 7). These data is confirmed in American goats (12) and in different animals (19). Another report showed that the increase in the number of channels in the skin of the Egyptian buffalo indicates a high glandular density in the female buffalo was (224 /  $\text{cm}^2$ ) in the armpit and forehead whereas the lowest glandular density was (118/ $\text{cm}^2$ ) in skin of the mammary gland. While in male buffalo had the highest glandular density (325/ $\text{cm}^2$ ) in the forehead and the lowest density (268/ $\text{cm}^2$ ) at the horn base (28) .

The second part of the gland, was the secretory part, it consists of a secretory end piece that has a wide cavity and lined with cubic cells of varying height. Accordingly, the secretory units can be divided into three functional stages. Small nuclei, the second type appeared lined with tall cuboid cells, their cavities small in size.The third type lined with tall columnar cells with bleb like cytoplasmic protrusions. These types appeared spread in the dermis of the studied areas, but all the secretory units of

the same gland were of one type, and this difference is due to their functional activity. The myoepithelial cells appeared between the secretory cells and the basement membrane and have spindle shaped nuclei (Fig. 8). These results were consistent with the findings of researchers in cows (29) and in the skin of a single hump camel (30). The appearance of the sweat glands and the level of their termination inside the dermis in the different areas studied, are shown in (Table No. 6) . The secretory unit was an irregular in shape and had sinuous tube. The size of each secretory unit was measured through their longitudinal and transverse axes and their average dimensions was carried out for each skin area. The results showed differences among these studied areas as shown in( Table No. 7). Large number of sections of the secretory units in the unit area indicates the length and degree of wrapping of the secretory unit. The dermis of the skin of the medial surface of the forelimb was one of the least dense regions of these units (Fig. 9). While the dermis of the skin of the muzzle and the tail was one of the densest areas of these units, as it occupied large areas within the dermis (Fig.10). The numbers of these secretory units per unit area varied in the different areas studied according to(Table No.7). Small numbers of secretory units were observed in the skin of the muzzle and scrotum where as they were found to accompany giant hair follicles. It should be noted that the presence of giant apical sweat glands were accompanied the giant follicular glands in the areas of the muzzle and scrotum, and the presence of such giant glands were noted by the researchers in different breeds of cows and for certain areas of the body (31).

Our study in the skin of the goat's muzzle

showed the presence of two types of sweat glands, which were apical and apocrine sweat glands. The apical sweat glands secretion consist of the secretory unit that takes on a convoluted tubular shape and these units are located near or below the hair follicles. They are characterized by their small size compared to the other studied areas (Fig.11). Their channel extends to the hair follicle near the opening to the cuticle. The apocrine sweat glands, were complex blueberry tubular glands. They occupied a large area extending from the lower part of the dermis to the hypodermal layer.

These glands were consisted of lobules in different shapes and sizes and are separated from each other by trabecular of connective tissue. The core of each lobule is composed of serous secretory units open into small interstitial channels that in turn open to larger channels that are lined with high columnar or cubic cells with an acidic stain. These cells are rested on the basal membrane and had globular nuclei. This gives them a shape similar to the striated channels that found in some salivary glands (Fig. 11).

These channels opened in larger one than them that connect with each other to form channels between the lobules and the main excretory duct. The later opened directly to the surface of the skin. The main canal is lined with a squamous stratified epithelium. It is believed that there is an inverse relationship between hair density and the size of the secretory unit. The thick hairy tail skin contained small secretory units, and this corresponds to what was indicated in the Iraqi goats and for specific areas of the body (15).



Table 3. The density location of the sebaceous glands accompanying the primary and secondary follicles and their extension within the dermis in vertical sections of the different areas of local black goat skin using the micrometer unit( $\mu\text{m}$ )

Anatomical sites for sampling of skin	Accompanying secondary follicles			Accompanying primary follicles		
	The beginning of the appearance of the sebaceous glands, starting from the basement membrane	The end of the sebaceous glands inside the dermis, starting from the basement membrane	extend sebaceous glands deep into the dermis	The beginning of the appearance of the sebaceous glands, starting from the basement membrane	The end of the sebaceous glands inside the dermis, starting from the basement membrane	extend sebaceous glands deep into the dermis
Front back	257.20 $\pm$ 51.91	740.40 $\pm$ 10.06	213.20 $\pm$ 48.42	442.20 $\pm$ 39.13	819.00 $\pm$ 14.91	376.80 $\pm$ 47.13
Middle back	252.00 $\pm$ 21.82	478.80 $\pm$ 17.55	226.80 $\pm$ 29.45	<sup>A</sup> 476.20 $\pm$ 19.49	836.40 $\pm$ 32.16	360.20 $\pm$ 39.43
Abdomen	228.00 $\pm$ 6.20	<sup>A</sup> -600.40 $\pm$ 25.64	<sup>A</sup> -372.40 $\pm$ 27.15	410.00 $\pm$ 35.67	<sup>A*</sup> 872.20 $\pm$ 39.85	462.20 $\pm$ 4.81
Tail	252.20 $\pm$ 18.56	429.60 $\pm$ 17.32	<sup>B</sup> -177.40 $\pm$ 16.81	473.20 $\pm$ 54.21	832.20 $\pm$ 20.25	359.00 $\pm$ 43.62
lateral surface of the forelimb	285.00 $\pm$ 50.01	512.00 $\pm$ 19.73	227.00 $\pm$ 42.99	470.20 $\pm$ 48.58	827.40 $\pm$ 18.86	357.20 $\pm$ 31.97
Medial surface of the forelimb	202.00 $\pm$ 25.91	541.40 $\pm$ 26.39	339.40 $\pm$ 7.30	317.20 $\pm$ 50.68	715.80 $\pm$ 26.08	398.60 $\pm$ 42.62
Scrotum	233.20 $\pm$ 25.84	587.40 $\pm$ 14.08	354.20 $\pm$ 19.34	371.40 $\pm$ 62.34	835.20 $\pm$ 32.63	<sup>A**</sup> 463.80 $\pm$ 79.09
lateral surface of the hind limb	<sup>A*</sup> 303.40 $\pm$ 18.77	530.00 $\pm$ 31.63	226.60 $\pm$ 21.33	475.20 $\pm$ 20.32	828.20 $\pm$ 19.34	353.00 $\pm$ 33.00
Medial surface of the hind limb	189.00 $\pm$ 22.83	510.20 $\pm$ 19.04	321.20 $\pm$ 9.36	301.00 $\pm$ 24.68	734.00 $\pm$ 24.42	433.00 $\pm$ 39.01
Muzzle	<sup>B*</sup> 150.00 $\pm$ 31.97	478.80 $\pm$ 14.85	328.80 $\pm$ 21.55	259.40 $\pm$ 22.96	665.20 $\pm$ 21.08	405.80 $\pm$ 41.30
Dorsal surface of the ear	111.40 $\pm$ 15.96	<sup>B</sup> -304.40 $\pm$ 20.08	193.00 $\pm$ 13.76	262.20 $\pm$ 13.70	532.40 $\pm$ 25.02	<sup>B**</sup> 270.20 $\pm$ 31.95
Ventral surface of the ear	-----	-----	-----	<sup>B</sup> 55.20 $\pm$ 7.66	<sup>B*</sup> 329.40 $\pm$ 21.49	274.20 $\pm$ 27.83

A laterally represents the highest dimension of the onset of the sebaceous glands associated with the primary follicles, starting from the basement membrane at a P <0.001 level. B laterally represents the lowest dimension of the onset of the sebaceous glands associated with primary follicles, starting from the basement membrane at a P <0.001 level. \* A laterally represents the highest dimension of the end of the sebaceous glands accompanying the primary follicles starting from the basement membrane at a probability P <0.001. B \* laterally represents the lowest dimension of the end of the sebaceous glands accompanying the primary follicles starting from the basement membrane at a probability level P <0.001. \*\* A laterally represents the highest expansion rate of primary follicle-associated sebaceous glands deep into the dermis at a P <0.001 level. \*\* B laterally represents the lowest extension rate of primary follicle-associated sebaceous glands deep into the dermis at a P <0.001 level. A \* - laterally, represents the highest dimension of the onset of the sebaceous glands associated with secondary follicles, starting from the basement membrane at a P <0.001 level. B \* - horizontally, represents the lowest dimension of the onset of the sebaceous glands associated with secondary follicles, starting from the basement membrane at a P <0.001 level. A- laterally, it represents the highest dimension of the end-onset of the sebaceous glands associated with secondary follicles, starting from the basement membrane at a P <0.001 level. B- Horizontally, it represents the lowest dimension of the end of the appearance of the sebaceous glands associated with secondary follicles, starting from the basement membrane at a P <0.001 level. A- - laterally represents the highest rate of extension of the sebaceous glands associated with secondary follicles deep into the dermis at a P <0.001 level. B- - laterally, it represents the lowest expansion rate of secondary follicle-associated sebaceous glands deep into the dermis at a P <0.001 level. All numbers inside the table are the mean $\pm$ standard deviation.

Table 4. The average dimensions of the sebaceous glands associated with the primary and secondary follicles of the different areas of the local black goat skin using a micrometer( $\mu\text{m}$ )

Anatomical sites for sampling of skin	The average dimensions of the sebaceous glands associated with the secondary follicles, the longitudinal axis x the transverse axis	The average dimensions of the sebaceous glands associated with the primary follicles, the longitudinal axis x the transverse axis
Front back	65.00 $\pm$ 5.74 X 36.40 $\pm$ 3.91	230.40 $\pm$ 12.01 X 39.40 $\pm$ 5.63
Middle back	69.00 $\pm$ 6.67 X 31.40 $\pm$ 2.40	214.00 $\pm$ 11.70 X 40.00 $\pm$ 6.59
Abdomen	98.00 $\pm$ 7.00 X 43.00 $\pm$ 4.18	242.60 $\pm$ 7.30 X 45.40 $\pm$ 6.30
Tail	73.20 $\pm$ 4.65 X 36.20 $\pm$ 4.81	<sup>B</sup> 190.00 $\pm$ 7.17 X 33.00 $\pm$ 5.38
lateral surface of the forelimb	<sup>B*</sup> 59.20 $\pm$ 6.61 X 31.20 $\pm$ 2.58	198.20 $\pm$ 12.67 X 41.00 $\pm$ 4.74
Medial surface of the forelimb	79.00 $\pm$ 6.36 X 42.2 $\pm$ 4.20	242.20 $\pm$ 6.97 X 52.00 $\pm$ 6.67
Scrotum	<sup>A*</sup> 105.0 $\pm$ 8.74 X 47.00 $\pm$ 4.35	247.00 $\pm$ 5.24 X 65.20 $\pm$ 6.09
lateral surface of the hind limb	63.00 $\pm$ 3.53 X 29.20 $\pm$ 6.94	216.20 $\pm$ 11.73 X 38.40 $\pm$ 4.82
Medial surface of the hind limb	78.20 $\pm$ 5.35 X 45.20 $\pm$ 5.11	240.20 $\pm$ 3.56 X 51.20 $\pm$ 6.68
Muzzle	115.00 $\pm$ 7.77 X 41.60 $\pm$ 3.64	<sup>A</sup> 254.20 $\pm$ 5.07 X 65.00 $\pm$ 5.61
Dorsal surface of the ear	82.00 $\pm$ 5.38 X 33.80 $\pm$ 5.16	140.80 $\pm$ 7.59 X 48.40 $\pm$ 4.82
Ventral surface of the ear	-----	151.80 $\pm$ 11.60 X 65.00 $\pm$ 4.84

A laterally, the mean of the sebaceous gland dimensions associated with the primary follicles at a probability level  $P < 0.001$ .

B horizontally represents the lowest mean of sebaceous gland dimensions associated with primary follicles at a probability level  $P < 0.001$ .

\* A horizontally, represents the highest mean of sebaceous gland dimensions associated with secondary follicles at a probability  $P < 0.001$ .

\* B horizontally, represents the lowest mean of the dimensions of the sebaceous gland associated with secondary follicles at a probability level  $P < 0.001$ .

All numbers inside the table are  $\pm$  standard deviation rates.

Table 5. The average diameter of the apical sweat gland ducts shows the diameter in micrometers and the glandular density in millimeter square units for the different areas of the local black goat skin

Anatomical sites for sampling of skin	Glandular density of apical sweat glands secretion in square millimeters	Apical sweat duct diameter of excretion in $\mu\text{m}$
Front back	$4.64 \pm 0.41$	$16.83 \pm 0.94$
Middle back	$4.14 \pm 0.72$	$17.09 \pm 0.83$
Abdomen	$3.10 \pm 0.45$	$19.47 \pm 0.90$
Tail	$10.00 \pm 0.60$	$16.50 \pm 0.67$
lateral surface of the forelimb	$4.40 \pm 0.31$	$16.45 \pm 0.65$
Medial surface of the forelimb	$2.94 \pm 0.37$	$18.98 \pm 1.41$
Scrotum	$3.72 \pm 0.58$	<sup>A</sup> $19.80 \pm 0.89$
lateral surface of the hind limb	$4.82 \pm 0.30$	$16.79 \pm 0.88$
Medial surface of the hind limb	$3.54 \pm 0.36$	$18.15 \pm 0.75$
Muzzle	<sup>A*</sup> $18.52 \pm 2.29$	$16.01 \pm 0.81$
Dorsal surface of the ear	$8.38 \pm 0.66$	<sup>B</sup> $15.67 \pm 0.66$
Ventral surface of the ear	<sup>B*</sup> $2.92 \pm 0.46$	$17.32 \pm 1.13$

A laterally represents the highest rate of apical excretory duct diameter at a probability level  $P < 0.001$ .

B laterally represents the lowest rate of apical excretory duct diameter at a probability level  $P < 0.001$ .

\* A laterally represents the highest glandular density of apical sweat glands at a probability level  $P < 0.001$ .

\* B laterally represents the lowest glandular density of apical sweat glands secretion at a probability level  $P < 0.001$ .

All numbers inside the table are  $\pm$  standard deviation rates.

Table 6. The density of the secretory units of the apical sweat glands and its extension within the dermis in vertical sections of the different areas of the local black goat skin using the micrometer unit( $\mu\text{m}$ )

Anatomical sites for sampling of skin	sweat glands extend deep into the dermis	The end of the secretory units of the sweat glands, starting from the basement membrane	The beginning of the emergence of sweat gland units, starting from the basement membrane
Front back	373.40 $\pm$ 66.04	1795.40 $\pm$ 53.21	1422.00 $\pm$ 31.52
Middle back	357.60 $\pm$ 67.73	1754.00 $\pm$ 43.62	1396.40 $\pm$ 48.63
Abdomen	417.80 $\pm$ 32.62	1415.00 $\pm$ 41.13	997.20 $\pm$ 28.35
Tail	266.00 $\pm$ 40.40	1927.80 $\pm$ 49.34	1661.80 $\pm$ 79.68
lateral surface of the forelimb	331.60 $\pm$ 40.16	1662.00 $\pm$ 51.89	1330.40 $\pm$ 53.95
Medial surface of the forelimb	399.00 $\pm$ 31.23	1330.00 $\pm$ 102.74	931.00 $\pm$ 83.20
Scrotum	<sup>A</sup> 532.00 $\pm$ 38.58	1463.00 $\pm$ 53.69	931.00 $\pm$ 49.59
lateral surface of the hind limb	348.20 $\pm$ 50.47	1703.40 $\pm$ 33.20	1355.20 $\pm$ 73.39
Medial surface of the hind limb	399.00 $\pm$ 33.95	1355.40 $\pm$ 65.89	956.40 $\pm$ 56.22
Muzzle	395.80 $\pm$ 35.70	1126.80 $\pm$ 44.89	731.00 $\pm$ 45.04
Dorsal surface of the ear	<sup>B</sup> 199.60 $\pm$ 10.76	531.80 $\pm$ 47.10	332.20 $\pm$ 51.64
Ventral surface of the ear	206.00 $\pm$ 34.40	465.00 $\pm$ 51.31	259.00 $\pm$ 20.95

A laterally represents the highest magnitude of sweat gland extension deep in the dermis at a P <0.001 probability level.

B laterally represents the minimum amount of sweat gland extension deep in the dermis at a P <0.001 level.

All numbers inside the table are  $\pm$  standard deviation rates.

Table 7. The number of secretory units of the apical sweat glands in square millimeter unit and its dimensions in the micrometer unit for the different areas of the local black goat skin

Anatomical sites for sampling of skin	The average of the apocrine unit dimensions, the longitudinal axis x the transverse axis	The number of secretory units per unit area mm <sup>2</sup>
Front back	215.20 ± 18.88 X 106.00 ± 21.19	8.10 ± 0.57
Middle back	233.80 ± 20.32 X 106.00 ± 19.64	7.88 ± 0.58
Abdomen	344.80 ± 35.15 X 158.20 ± 15.73	5.26 ± 0.19
Tail	158.00 ± 11.13 X 65.80 ± 10.56	14.82 ± 0.92
lateral surface of the forelimb	203.60 ± 26.53 X 90.80 ± 13.27	7.00 ± 0.57
Medial surface of the forelimb	356.60 ± 54.13 X 133.20 ± 26.05	<sup>B</sup> 4.60 ± 0.57
Scrotum	<sup>A*</sup> 350.40 ± 32.81 X 158.20 ± 11.58	6.08 ± 0.56
lateral surface of the hind limb	211.20 ± 19.03 X 106.00 ± 12.20	6.56 ± 0.53
Medial surface of the hind limb	339.20 ± 61.30 X 132.80 ± 25.39	4.76 ± 0.47
Muzzle	<sup>B*</sup> 133.20 ± 24.71 X 50.60 ± 9.99	<sup>A</sup> 16.28 ± 0.60
Dorsal surface of the ear	172.00 ± 10.65 X 91.40 ± 8.87	7.58 ± 0.85
Ventral surface of the ear	158.20 ± 8.34 X 65.80 ± 8.58	5.18 ± 0.58

A horizontally represents the highest rate of secretory units at a probability level P < 0.001

B Horizontally, represents the lowest mean of the number of secretory units at a probability level P < 0.001

\* A horizontally represents the highest mean of the secretory unit dimensions at a probability level P < 0.001

\* B horizontally represents the lowest mean of the dimensions of the secretory unit at a probability level P < 0.001

All numbers inside the table are standard deviation rates A horizontally represents the highest rate of secretory units at a probability level P < 0.001. All numbers inside the table are ± standard deviation rates.

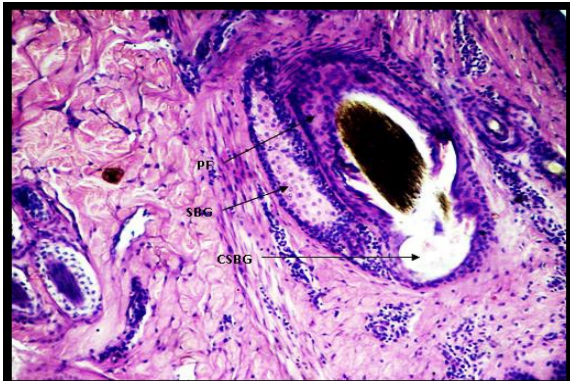


Fig. (1). A vertical section of the middle back skin. Notice the sebaceous gland SBG Single-lobe opening by the sebaceous channel CSBG on the primary follicle PF. (Hematoxylin and Eosin stain, X145).

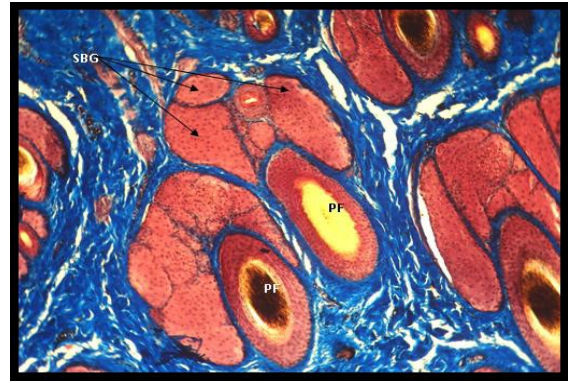


Fig. (2). A vertical section of the skin of the abdominal region. Showing the sebaceous gland SBG multi-lobed with primary follicle PF (Masson's Trichrome stain, X145).

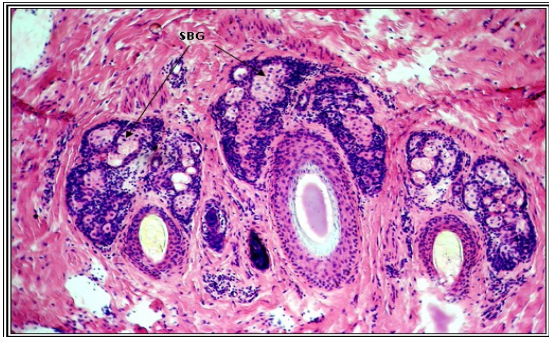


Fig. (3). A vertical section of the skin of the medial surface of the forelimb . Showing the normal size of the sebaceous gland SBG accompanying the primary follicle (Hematoxylin and Eosin stain, X 90).

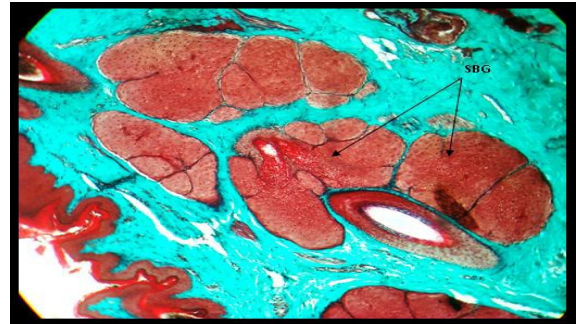


Fig.(4). A vertical section of the skin of the medial surface of the forelimb . Note the large sebaceous gland SBG and its duct that associated primary follicle (Masson's Trichrome stain)

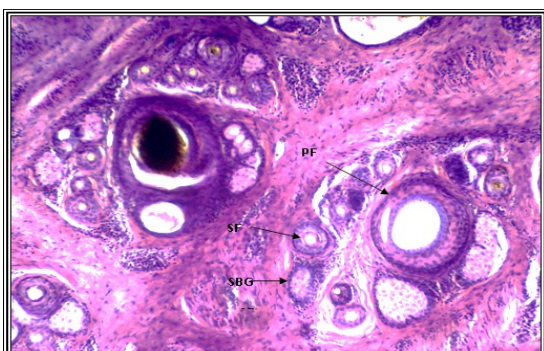


Fig.(5). A vertical section of middle back skin . Showing sebaceous glands SBG associated with secondary follicles SF with the presence of sebaceous gland associated with primary follicle PF (Hematoxylin and eosin stained, X 145)

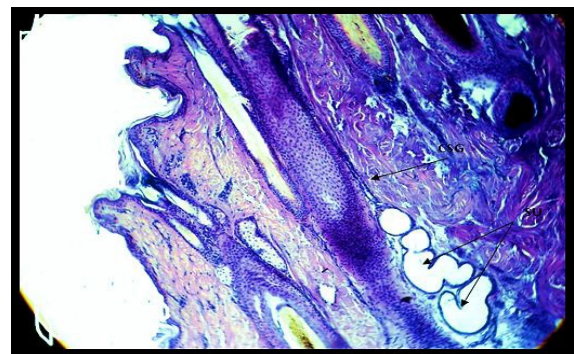


Fig.(6). A vertical section of the skin of the lateral surface of the hind limb. Showing the cystic secretory units SU and their connection to a straight channel CSG parallel to Primary hair follicle PF (Hematoxylin and eosin stain, X75).

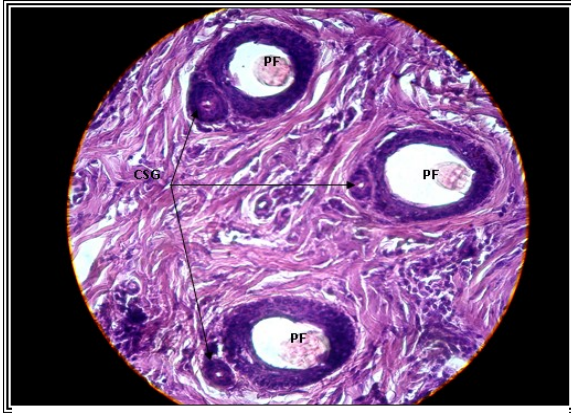


Fig.(7). Horizontal section of the skin of the muzzle in the upper third of the dermis. Showing the apical sweat gland ducts CSG accompanying all primary follicles PF (Hematoxylin and Eosin stain, X240).

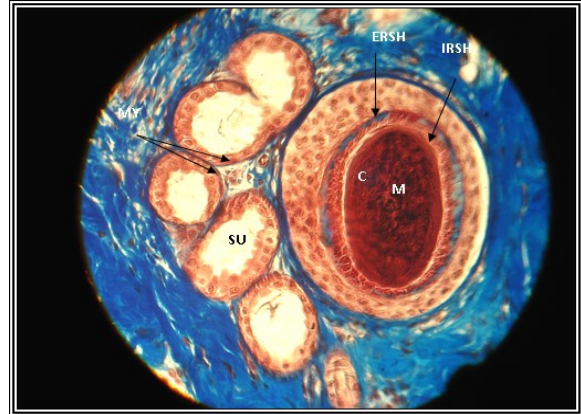


Fig.(8). A horizontal section taken from the lower third of the epidermis of the lateral surface of the forelimb . Showing the medulla M, the cortex C , the inner root sheath IRSH, and the outer root sheath ERSH of hair with the presence of the secretory units SU of the apical sweat glands and the presence of muscle epithelial cells MY. (Masson's Trichrome stain, X 240).



Fig.(9). Horizontal section of the skin of the medial surface of the forelimb in the lower third of the dermis. Note that the secretory unit SU is large but less numbered around the Primary follicle PF. (Masson's Trichrome stain, X 90).



Fig.(10). Horizontal section of the skin of the tail region in the lower third of the dermis. Showing the smaller size of the secretory unit SU with an increased number around the primary follicle (PF) (Masson's Trichrome stain , X 90)

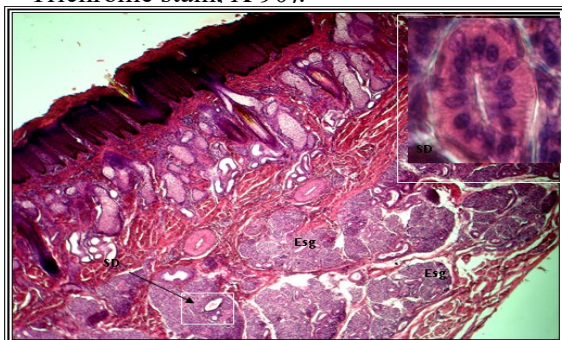


Fig.(11). Vertical section of the skin of the muzzle . Showing sweat glands Esg with their secretion in the lower third of the dermis and subdermal layer, the observed striated channel SD . (Hematoxylin and Eosin stain, X 46)

### Conclusions

The size of the sebaceous gland is inversely proportional to the hair density.

Difference in density and their extension of the sebaceous and sweat glands within the dermis in vertical sections of the different areas of local black goat skin.

The sweat glands were of apical apocrine type in all studied areas where primary follicles were associated with the presence of apocrine glands in the skin of the muzzle only.

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