



## Gross Morphometrical and Histomorphometrical Studies on Skin of Goat (*Capra hircus*)

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**How to cite this paper:** Mainde, U., Banubakode, S., Nandeshwar, N., & Charjan, R. (2020). **Biometrical and Histomorphometrical Studies on Skin of Goat (*Capra hircus*)**. *International Journal of Livestock Research*, 10(10), 181-187.

doi: <http://dx.doi.org/10.5455/ijlr.20200708021001>

**Received** : Jul 08, 2020  
**Accepted** : Aug 02, 2020  
**Published** : Oct 31, 2020

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### Abstract

*The present study was conducted on the skin samples of 220 goats of either sex, 20 samples each from different body regions namely dorsal neck, lateral neck, ventral neck, dorsal thorax, lateral thorax, ventral thorax, dorsal abdomen, lateral abdomen, ventral abdomen, lateral thigh and medial thigh to study the age wise gross morphometrical and histomorphometrical changes in the skin. The animals were divided into two groups, viz. six to twelve months of age (Gr I) and above one year age (Gr II). The skin samples of goats were collected from healthy animals irrespective of sex from Nagpur Municipal Corporation Slaughter house immediately after natural death. The present study confirmed that the dermal papillae were less developed in ventral neck region in Gr I and Gr II. There was no significant difference in thickness of papillary layer between lateral thigh and medial thigh region. Thickness of reticular layer was maximum in dorsal neck region, while it was minimum in medial thigh region. Depth of primary hair follicle was maximum in dorsal neck region and minimum in medial thigh region. Diameter of primary hair follicle was maximum in dorsal neck region in Gr I and Gr II, while it was minimum in medial thigh region in Gr I and lateral thigh region in Gr II. Depth of sweat gland was maximum in dorsal neck region and minimum in medial thigh region. Significant increase in depth of sweat gland with advancement of age was noted in both the age groups. Depth of sebaceous gland was maximum in dorsal neck region and minimum in medial thigh region. The present study would form a baseline data on the gross morphometry and histomorphometry of various parts of skin of goat which would be helpful in future research prospective.*

**Keywords:** Goat, Gross Morphometry, Histomorphometry, Skin

## Introduction

The skin is the largest organ in mammalian body and constitutes about 8.5 per cent of live body weight (Mainde *et al.*, 2019a). The skin of goat is often used for making gloves and boots. It is a versatile organ, which is extremely important for protection, perception, water regulation and wound healing (Razvi, 2015, Mainde *et al.*, 2018 and Mainde *et al.*, 2019b). The skin of goat is considered extremely durable used by the tannery industry to make rugs and carpet binding. Skin is generally thicker on the dorsal and extensor surfaces than on the ventral and flexor surfaces. Further, it is thicker in male animals. The capacity of the skin to move and stretch depends on its thickness, the number of folds, intrinsic elasticity and firmness of fixation by the tela subcutanea and age of individual (Montagna, 1956). The thickness of skin varies on the basis of species, breed, age, sex and body regions in domestic animals (Bal, 1977). The literature on the gross morphometry and histomorphometry of skin of goat is scanty and therefore, the present study was undertaken to develop a baseline data for future research perspectives.

## Materials and Methods

The skin samples of goats were collected from healthy animals irrespective of sex from slaughter house of Nagpur Municipal Corporation and also from animals after natural death. A total of 220 samples, 20 each from different body regions namely dorsal neck, lateral neck, ventral neck, dorsal thorax, lateral thorax, ventral thorax, dorsal abdomen, lateral abdomen, ventral abdomen, lateral thigh and medial thigh were used in the present study. The animals were divided into two groups, viz. six to twelve months of age (Gr I) and above one-year age (Gr II). The samples of skin were collected in ice box and brought to the laboratory. Thereafter skin was washed and cleaned by removing hairs using shaving blade and cut into pieces of 4 – 6 mm size. The gross morphometrical measurements were taken with the help of digital vernier's calliper. Then the samples were fixed in 10 per cent Neutral buffered formalin and processed for routine histological examination by paraffin embedding method (Singh and Sulochana, 1996). The histomorphometrical study of various parts of skin was carried out from the sections stained with Haematoxylin and Eosin. Further, the recorded biometrical and histomorphometrical data were subjected to standard statistical procedures recommended by Snedecor and Cochran (1994).

## Results and Discussion

### Gross Morphometry

The gross skin thickness was found more in Gr II as compared to Gr I in almost all the regions of the body under present study (Table 1). This age wise increase in thickness of the skin with the advancement of age may be attributed to the age wise development of different components of the skin in adult animals. The skin thickness was more in the dorsal part of body regions than the ventral part. Similarly, the thickness of skin on the lateral part of body was more than the medial part.

**Table 1:** Mean and SE of total skin thickness (mm) of Gr I and Gr II in different body regions in goat

Regions	Gr I	Gr II	P value
Dorsal Neck	1.872 ± 0.036	2.885 ± 0.177	<0.0001
Lateral Neck	1.740 ± 0.040	2.590 ± 0.148	<0.0001
Ventral Neck	1.622 ± 0.050	2.337 ± 0.145	0.0002
Dorsal Thorax	1.776 ± 0.039	2.717 ± 0.165	<0.0001
Lateral Thorax	1.498 ± 0.020	2.082 ± 0.168	0.0029
Ventral Thorax	1.403 ± 0.039	1.965 ± 0.097	<0.0001
Dorsal Abdomen	1.603 ± 0.043	2.499 ± 0.170	<0.0001
Lateral Abdomen	1.371 ± 0.031	1.916 ± 0.110	0.0002
Ventral Abdomen	1.174 ± 0.028	1.361 ± 0.017	<0.0001
Lateral Thigh	0.994 ± 0.019	1.636 ± 0.135	0.0002
Medial Thigh	0.892 ± 0.008	1.347 ± 0.093	0.0001

*P value <0.05 is significant and >0.05 is non-significant*

During the present study, it was found that the skin thickness was maximum on the dorsal neck region (1.872 ±

0.036 mm,  $2.885 \pm 0.177$  mm) and minimum on the medial thigh region ( $0.892 \pm 0.008$  mm,  $1.347 \pm 0.093$  mm) in Gr I and Gr II, respectively. There was significant increase in average thickness of skin with the advancement of age of the animal. In agreement with the findings of the present study, Purushotham (2010) in sheep and Razvi (2014) in goat reported that the skin thickness was maximums on dorsal neck region, while it was minimum in ventral neck region. Similar findings were also reported by Aslan *et al.* (2004) in the skin of cattle. The maximum thickness noted in the dorsal and lateral regions of the body during present study may be correlated to the more exposure of dorsal and lateral part of body to the sunlight in horizontal animals. However, in contrast with the findings of the present study, Sharma and Bharadwaj (1993) in Yak reported that the thickness of skin was maximum in ventral neck region. This variation in the observation regarding maximum thickness in the ventral neck region may be due to variation in species and climatic conditions such as high altitude.

### Histomorphometry

Microscopically, thickness of epidermis was decreased from dorsal to ventral region and lateral thigh to medial thigh region (Table 2). Epidermis was thickest in dorsal neck ( $19.05 \pm 0.58$   $\mu$ m,  $24.01 \pm 0.48$   $\mu$ m) and thinnest in ventral abdomen region ( $8.93 \pm 0.38$   $\mu$ m,  $17.66 \pm 0.54$   $\mu$ m) in Gr I and Gr II respectively. This finding of the present study was in accordance with the observations reported by Ahmad *et al.* (2010) in sheep. This decrease in the thickness of epidermis from dorsal to ventral surface and lateral to medial surface might be attributed to the fact that ventral and medial surfaces of the skin are more easily exposed to the friction than the dorsal and lateral surfaces of skin.

**Table 2.** Mean and SE of thickness of epidermis ( $\mu$ m) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P Value
Dorsal Neck	$19.05 \pm 0.58$	$24.01 \pm 0.48$	<0.0001
Lateral Neck	$15.21 \pm 0.44$	$19.10 \pm 0.38$	<0.0001
Ventral Neck	$12.03 \pm 0.31$	$18.53 \pm 0.73$	<0.0001
Dorsal Thorax	$17.36 \pm 0.36$	$21.94 \pm 0.54$	<0.0001
Lateral Thorax	$13.80 \pm 0.33$	$19.64 \pm 0.60$	<0.0001
Ventral Thorax	$12.61 \pm 0.28$	$17.85 \pm 0.41$	<0.0001
Dorsal Abdomen	$13.83 \pm 0.43$	$19.68 \pm 0.52$	<0.0001
Lateral Abdomen	$10.86 \pm 0.48$	$18.15 \pm 0.61$	<0.0001
Ventral Abdomen	$8.93 \pm 0.38$	$17.66 \pm 0.54$	<0.0001
Lateral Thigh	$18.41 \pm 1.12$	$20.70 \pm 1.20$	0.1809 (NS)
Medial Thigh	$16.64 \pm 0.84$	$18.34 \pm 1.10$	0.2374 (NS)

*P* value <0.05 is significant and >0.05 is non-significant

**Table 3:** Mean and SE of thickness of dermis ( $\mu$ m) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P value
Dorsal Neck	$2123 \pm 37.35$	$2476 \pm 45.07$	<0.0001
Lateral Neck	$1694 \pm 34.75$	$1875 \pm 39.73$	0.0029
Ventral Neck	$1487 \pm 33.67$	$1780 \pm 42.84$	<0.0001
Dorsal Thorax	$1664 \pm 34.72$	$2177 \pm 76.59$	<0.0001
Lateral Thorax	$1386 \pm 34.52$	$1768 \pm 71.41$	<0.0001
Ventral Thorax	$1189 \pm 33.18$	$1526 \pm 71.59$	0.0005
Dorsal Abdomen	$1419 \pm 33.74$	$1974 \pm 45.93$	<0.0001
Lateral Abdomen	$1282 \pm 37.52$	$1726 \pm 44.75$	<0.0001
Ventral Abdomen	$1086 \pm 37.44$	$1511 \pm 52.49$	<0.0001
Lateral Thigh	$1131 \pm 49.07$	$1385 \pm 9.67$	<0.0001
Medial Thigh	$1061 \pm 37.64$	$1089 \pm 48.38$	0.655 (NS)

*P* value <0.05 is significant and >0.05 is non-significant

The thickness of the dermis was found to be increased from Gr I to Gr II in all regions of the body under study. The dermal thickness was more in dorsal region than lateral and ventral regions. The lateral thigh region was thicker

than medial thigh region (Table 3). The thickness of dermis was maximum in dorsal neck region and minimum in medial thigh region. Similar observations were reported by Montagna (1956) in human skin and Sar and Calhoun (1966) in skin of American goat. The thickness of papillary layer was maximum in dorsal neck region, while it was minimum in medial thigh region in Gr I and Gr II (Table 4). The thickness of reticular layer was more as compared to papillary layer in all the body regions (Table 5). The thickness of reticular layer was maximum in dorsal neck region, while it was minimum in medial thigh region.

**Table 4:** Mean and SE of thickness of papillary layer ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P value
Dorsal Neck	919.353 $\pm$ 23.64	1197.9 $\pm$ 25.79	<0.0001
Lateral Neck	727.169 $\pm$ 13.01	911.7 $\pm$ 13.20	<0.0001
Ventral Neck	621.337 $\pm$ 10.85	776.39 $\pm$ 15.55	<0.0001
Dorsal Thorax	769.422 $\pm$ 18.39	1026.6 $\pm$ 14.58	<0.0001
Lateral Thorax	623.645 $\pm$ 9.64	866.29 $\pm$ 11.36	<0.0001
Ventral Thorax	448.406 $\pm$ 9.37	665.83 $\pm$ 16.65	<0.0001
Dorsal Abdomen	553.901 $\pm$ 11.50	885.33 $\pm$ 10.10	<0.0001
Lateral Abdomen	539.922 $\pm$ 10.99	717.8 $\pm$ 18.50	<0.0001
Ventral Abdomen	416.992 $\pm$ 8.80	600.41 $\pm$ 16.10	<0.0001
Lateral Thigh	447.752 $\pm$ 25.21	402.18 $\pm$ 24.44	0.2107
Medial Thigh	407.756 $\pm$ 20.94	370.79 $\pm$ 22.05	0.2398

*P* value <0.05 is significant and >0.05 is non-significant

**Table 5:** Mean and SE of thickness of reticular layer ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P value
Dorsal Neck	1484.185 $\pm$ 23.92	1815.8 $\pm$ 51.15	<0.0001
Lateral Neck	1324.475 $\pm$ 17.73	1578.7 $\pm$ 32.39	<0.0001
Ventral Neck	1196.907 $\pm$ 20.96	1435.9 $\pm$ 23.35	<0.0001
Dorsal Thorax	1407.898 $\pm$ 16.40	1668.50 $\pm$ 32.85	<0.0001
Lateral Thorax	1029.622 $\pm$ 18.02	1350.6 $\pm$ 61.95	<0.0001
Ventral Thorax	917.489 $\pm$ 17.53	1128.8 $\pm$ 22.15	<0.0001
Dorsal Abdomen	1129.702 $\pm$ 14.00	1348.1 $\pm$ 26.69	<0.0001
Lateral Abdomen	948.355 $\pm$ 1.151	1202.1 $\pm$ 44.58	<0.0001
Ventral Abdomen	861.01 $\pm$ 12.77	947.35 $\pm$ 54.29	0.1390 (NS)
Lateral Thigh	748.833 $\pm$ 38.17	799.19 $\pm$ 29.94	0.3129 (NS)
Medial Thigh	724.833 $\pm$ 28.17	763.88 $\pm$ 26.35	0.3248 (NS)

*P* value <0.05 is significant and >0.05 is non-significant

**Table 6:** Mean and SE of depth of primary hair follicle ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P value
Dorsal Neck	717.512 $\pm$ 27.87	1120.3 $\pm$ 74.07	<0.0001
Lateral Neck	581.517 $\pm$ 23.53	885.45 $\pm$ 60.68	0.0002
Ventral Neck	533.701 $\pm$ 18.38	749.3 $\pm$ 30.31	<0.0001
Dorsal Thorax	585.541 $\pm$ 35.91	993.53 $\pm$ 35.41	<0.0001
Lateral Thorax	453.231 $\pm$ 33.19	856.25 $\pm$ 41.03	<0.0001
Ventral Thorax	384.892 $\pm$ 19.89	724.64 $\pm$ 29.48	<0.0001
Dorsal Abdomen	624.752 $\pm$ 40.67	974.32 $\pm$ 38.83	<0.0001
Lateral Abdomen	587.829 $\pm$ 31.76	888.21 $\pm$ 40.24	<0.0001
Ventral Abdomen	351.149 $\pm$ 15.68	502.31 $\pm$ 27.18	0.0001
Lateral Thigh	590.204 $\pm$ 45.58	361.82 $\pm$ 19.81	0.0002
Medial Thigh	296.877 $\pm$ 20.21	334.81 $\pm$ 18.78	0.1861 (NS)

*P* value <0.05 is significant and >0.05 is non-significant

The depth of primary hair follicle increased with the advancement of age. The depth of primary hair follicle was maximum in dorsal neck region and minimum in medial thigh region in Gr I as well as Gr II (Table 6). The diameter of primary hair follicle was maximum in dorsal neck region in Gr I and Gr II, while diameter of primary hair follicle was minimum in medial thigh region in Gr I and lateral thigh region in Gr II (Table 7).

**Table 7:** Mean and SE of diameter of primary hair follicle ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P value
Dorsal Neck	164.443 $\pm$ 2.48	195.15 $\pm$ 5.71	0.0001
Lateral Neck	147.523 $\pm$ 2.54	183.05 $\pm$ 6.27	<0.0001
Ventral Neck	137.73 $\pm$ 2.71	188.04 $\pm$ 5.96	<0.0001
Dorsal Thorax	158.696 $\pm$ 2.93	187.03 $\pm$ 5.80	0.0004
Lateral Thorax	138.254 $\pm$ 3.61	185.98 $\pm$ 2.26	<0.0001
Ventral Thorax	131.753 $\pm$ 3.52	154.68 $\pm$ 3.66	0.0003
Dorsal Abdomen	151.68 $\pm$ 3.25	183.14 $\pm$ 6.10	0.0002
Lateral Abdomen	144.624 $\pm$ 3.25	168.41 $\pm$ 5.13	0.001
Ventral Abdomen	115.61 $\pm$ 3.90	155.8 $\pm$ 5.62	<0.0001
Lateral Thigh	85.276 $\pm$ 5.21	114.28 $\pm$ 3.49	0.0002
Medial Thigh	64.461 $\pm$ 1.89	117.2 $\pm$ 7.10	<0.0001

*P* value <0.05 is significant and >0.05 is non-significant

**Table 8:** Mean and SE of depth of sweat gland ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	
Dorsal Neck	1061.30 $\pm$ 20.91	1751 $\pm$ 45.18	<0.0001
Lateral Neck	445.04 $\pm$ 11.62	1254 $\pm$ 81.12	<0.0001
Ventral Neck	404.84 $\pm$ 10.76	954.3 $\pm$ 84.45	<0.0001
Dorsal Thorax	913.01 $\pm$ 19.46	1520 $\pm$ 82.17	<0.0001
Lateral Thorax	523.86 $\pm$ 18.63	1119 $\pm$ 82.32	<0.0001
Ventral Thorax	366.66 $\pm$ 11.66	869.15 $\pm$ 82.78	<0.0001
Dorsal Abdomen	738.11 $\pm$ 20.11	1377.85 $\pm$ 89.84	<0.0001
Lateral Abdomen	544.93 $\pm$ 15.91	1096.95 $\pm$ 81.26	<0.0001
Ventral Abdomen	391.04 $\pm$ 17.01	897.242 $\pm$ 81.65	<0.0001
Lateral Thigh	494.92 $\pm$ 19.03	493.067 $\pm$ 34.70	0.9633 (NS)
Medial Thigh	460.62 $\pm$ 11.70	416.148 $\pm$ 29.93	0.1834 (NS)

*P* value <0.05 is significant and >0.05 is non-significant

The depth of sweat gland was maximum in dorsal neck region in Gr I as well as Gr II when compared with other regions (Table 8). Similarly, it was noted that there was significant increase in depth of sweat gland with advancement of age from Gr I to Gr II. It was also found that the minimum depth of sweat gland was recorded in medial thigh region in both the groups. This regional variation in the depth of sweat gland may be attributed to the fact that skin over the dorsal part is thicker than the medial part. Moreover, the dorsal part of body is exposed to the sunlight and has more number of hair follicle than the medial part. The depth of sebaceous gland was maximum in dorsal neck region and minimum in medial thigh region in Gr I as well as Gr II (Table 9). Although there was no significant difference in the depth of sebaceous gland in almost all the regions with the advancement of age, but there was gradual increase in the depth of sebaceous gland from Gr I to Gr II. The above observations were contradictory to the findings of Sathapathy *et al.* (2017) in zebra.

**Table 9:** Mean and SE of depth of sebaceous gland ( $\mu\text{m}$ ) of Gr I and Gr II in different body regions in goat

Regions	Gr. I	Gr. II	P Value
Dorsal Neck	606.26 $\pm$ 12.64	834.791 $\pm$ 74.04	0.0012
Lateral Neck	480.855 $\pm$ 13.44	697.774 $\pm$ 23.97	<0.0001
Ventral Neck	408.145 $\pm$ 14.02	556.235 $\pm$ 22.73	<0.0001
Dorsal Thorax	517.076 $\pm$ 12.80	784.439 $\pm$ 13.79	<0.0001
Lateral Thorax	455.579 $\pm$ 12.43	546.636 $\pm$ 29.31	0.0054
Ventral Thorax	384.86 $\pm$ 12.21	394.757 $\pm$ 6.21	0.4792 NS
Dorsal Abdomen	457.113 $\pm$ 12.82	685.981 $\pm$ 18.12	<0.0001
Lateral Abdomen	425.536 $\pm$ 12.51	528.671 $\pm$ 5.37	<0.0001
Ventral Abdomen	363.321 $\pm$ 12.03	437.05 $\pm$ 16.82	0.0022
Lateral Thigh	222.963 $\pm$ 11.15	228.764 $\pm$ 6.96	0.6643 NS
Medial Thigh	215.964 $\pm$ 9.33	222.314 $\pm$ 9.70	0.6429 NS

*P* value <0.05 is significant and >0.05 is non-significant

## Conclusion

The total skin thickness, thickness of epidermis and dermis, thickness of papillary and reticular layers of dermis, depth and diameter of primary hair follicle, depth of sweat and sebaceous glands revealed characteristic age wise variations in goat. The present study would form a baseline data on the gross morphometry and histomorphometry of skin of goat which would be helpful in future research prospective.

## Conflict of Interests

There is no conflict of interest.

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