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# Histomorphology of sweat glands in different breeds of dogs#

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**Abstract**

*This study examined the histomorphology of sweat glands across various dog breeds, focusing on their structural characteristics and adaptations to environmental needs. Skin samples from 48 dogs representing indigenous and seven breeds (German Shepherd, Labrador Retriever, Dachshund, Beagle, Doberman Pinscher, German Spitz and Pug) were collected from the ventral abdominal region. Using standard histological techniques, histology and the size and distribution of sweat glands were analysed. The results revealed significant variations in gland size and number among different breeds. Breeds like the German Spitz, German Shepherd and Dachshund had the largest sweat gland diameters, suggesting a better capacity for thermoregulation. In contrast, the Pug, Doberman Pinscher and Labrador Retriever had fewer and smaller glands. Dachshund stood out for possessing both the highest number and large-sized glands, while German Spitz had fewer but larger glands, compensating for the lesser number. The types of sweat glands predominating in ventral abdominal regions in dogs were apocrine glands. It was concluded that significant differences existed in the number and size of the sweat glands among different breeds which play a key role in thermoregulation.*

**Keywords***: Sweat glands, dogs, breed comparison*

The skin is the largest organ in mammals, playing a crucial role in protecting against environmental challenges, regulating body temperature and facilitating sensory perception. Sweat glands vary in number, size and distribution across species and within breeds. Understanding these variations is critical in explaining differences in skin moisture and cooling efficiency among breeds and adaptability to heat stress. Previous studies have documented the distribution of sweat glands in various domestic and wild species, emphasising how gland morphology reflects adaptive strategies (Raghav *et al.*, 2021). However, comprehensive research focusing on the comparative histomorphology of sweat glands across different dog breeds is limited. This study aimed to fill this gap by examining the histological structure of sweat glands in seven dog breeds and indigenous dogs. This study also focused to compare the number and diameter of sweat glands in various dog breeds. The results will help to create personalized treatment approaches for skin disorders in various breeds of dogs.

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## Materials and methods

The study was conducted on the skin of 48 dogs including indigenous and seven breeds *viz.,* German Shepherd, Labrador Retriever, Dachshund, Beagle, Doberman Pinscher, German Spitz and Pug, with six animals from each breed. Skin samples were collected from the ventral abdominal region of dead animals and processed as per standard procedures. Samples were fixed in 10 per cent neutral buffered formalin and for specific staining procedures, the samples were also fixed in 10 per cent formol alcohol, processed and cut to a thickness of 4-5 µm for histological examination. Hematoxylin and eosin staining (Luna, 1968) was done for conducting the routine histological studies. Gomori's aldehyde fuchsin method (Luna, 1968) was done for demonstrating collagen and elastic fibres. McManus method for glycogen (PAS) (Singh and Sulochana, 1996) was done to see the presence of glycogen and Toluidine blue method to demonstrate the presence of mast cells (Singh and Sulochana, 1996).

The number and diameter of sweat glands were measured using a calibrated ocular micrometer. Data were analysed statistically using SPSS version 24.0

## Results and discussion

Sweat glands were located both in the deeper dermis and in the superficial part of subcutaneous tissue. Sweat glands were seen parallel and lateral to the hair follicles as well as on the ventral and deeper part of the root of the hair. According to Raghav *et al.* (2021), the sweat glands of dogs were associated with hair follicle. In this study, both hair follicle associated superficial sweat glands and those located in the deeper dermis were also noticed. The mean diameters of the secretory end piece of sweat glands as well as the number of sweat glands per low power field of microscope are given in table 1.

The diameter of sweat glands varied significantly across the breeds. It was noticed that among the breeds under study, German Spitz (93.93 µm), German Shepherd (88.40 µm) and Dachshund (76.46 µm) possessed sweat glands with largest diameters. Indigenous (47.28 µm) dogs, Beagle (30.44 µm) and Pug (33.05 µm) also showed relatively large sweat glands. Doberman Pinscher (25.76 µm) and Labrador Retriever (25.53 µm) showed smaller diameter for sweat gland acini. The diameter of sweat glands of Dachshund was similar to the reported diameter of sweat glands of dogs as 75.33±2.67 µm (Raghav *et al.,* 2021). These variations may affect the efficiency of thermoregulation in different breeds, with larger glands potentially producing more sweat for cooling.

Significant differences were noted in the number and distribution of sweat glands among different dog breeds. The Dachshund showed the highest number of sweat glands (7.50±0.43) per low power field of microscope, followed by German Spitz and Beagle. In contrast, the Pug had the fewest sweat glands (1.16±0.17) and smaller diameter for the glands, suggesting less skin moisture. Mohammed *et al.* (2022) documented that the sweat glands were few in buffalo, cow, goat and dog, but numerous and deeply located glands were seen in the dermis of sheep. Bell and Montagna (1972) reported that sweat glands were numerous in the digital pads of dogs and were surrounded by nerves. Sathapathy *et al.* (2017) and Lucy *et al.* (2023) reported that the sweat glands were absent in the skin of zebra and rabbits, respectively except for the perineal glands in rabbit.

Relating the diameter of sweat glands with their number in the given breeds revealed that Dachshund had the largest number of sweat glands (7.50±0.43) and relatively large gland diameter (76.46±4.50 µm) suggesting a better capacity for thermoregulation.

German Spitz possessed a moderate number of sweat glands (5.00±1.65), the gland diameters were the largest (93.93±6.86 µm), which suggests a good thermoregulatory mechanism with larger glands even though fewer in number. German Shepherd possesssed

**Table 1**. Parameters of sweat glands of different breeds of dogs, µm

| Breed | Number of sweat glands (Mean±SE) | Diameter of sweat glands (Mean ±SE) |
|---|---|---|
| Beagle | $4.50^{a,b}$ ±0.62 | $30.44^{b,c}$ ±4.34 |
| Dachshund | $7.50^{a}$ ±0.43 | $76.46^{a}$ ±4.50 |
| Doberman Pinscher | $3.00^{b}$ ±0.26 | $25.76^{c}$ ±1.99 |
| German Spitz | $5.00^{a}$ ±1.65 | $93.93^{a}$ ±6.86 |
| Labrador Retriever | $1.83^{b,c}$ ±3.31 | $25.53^{c}$ ±3.56 |
| German Shepherd | $2.83^{b,c}$ ±0.48 | $88.40^{a,b,c}$ ±14.53 |
| Pug | $1.16^{c}$ ±0.17 | $33.05^{b,c}$ ±3.29 |
| Indigenous | $2.33^{b,c}$ ±0.33 | $47.28^{b}$ ±4.21 |
| F value | 8.815 | 19.824 |
| P value | <0.001 | <0.001 |

Means having same superscript are not significantly different at 0.05 level.

relatively few sweat glands (2.83±0.48), the gland diameters were quite large (88.40±14.53 µm), which may compensate for the lower number by producing more sweat per gland.

Beagle had a moderate number of sweat glands (4.50±0.62) but comparatively smaller diameter (30.44±4.34 µm). Doberman Pinscher had fewer sweat glands (3.00±0.26) and small gland diameters (25.76±1.99 µm). Labrador Retriever had very few sweat glands (1.83±3.31) with small diameters (25.53±3.56 µm), suggesting less capacity for thermoregulation. Pug had the fewest sweat glands (1.16±0.17), with smaller diameter for glands (33.05±3.29 µm), indicating limited sweat production. Indigenous had a moderate number of sweat glands (2.33±0.33) and medium sized glands (47.28±4.21 µm), indicating a good thermoregulatory mechanism. In short, Dachshund and German Spitz possessed more number and larger diameter of sweat glands with better capacity for thermoregulation, while breeds like Pug and Labrador Retriever had fewer and smaller glands, indicating a lesser capacity.

The sweat glands observed in the ventral abdominal region in all the breeds under study were predominantly of apocrine type. Obayes (2016) reported that sweat glands in horse were simple tubular structures lined with simple cuboidal epithelium and their alveoli were surrounded by myoepithelial cells. Two types of sweat glands were identified in horse such as apocrine glands, which were associated with hair follicles and eccrine glands, which opened directly onto surface of the skin. In large white Yorkshire pigs, apocrine sweat glands with wider secretory end pieces lined by simple columnar epithelium were noticed in the snout and dorsal nasal regions while in the regions of neck and abdomen, the sweat glands were of eccrine type (Sumena *et al*., 2010).

The apocrine sweat glands in all these breeds of dogs were lined by simple cuboidal to columnar epithelium. Height of the cells varied depending on the stage of secretion. During secretion, the cells showed bud like apical projections, the apical blebs. The excretion of their secretion took place as these blebs got detached from the apex of each cell (Fig. 1).

1. Dermis
2. Secretory end piece of sweat gland
3. Apical bleb
4. Myoepithelial cell
5. Capillary

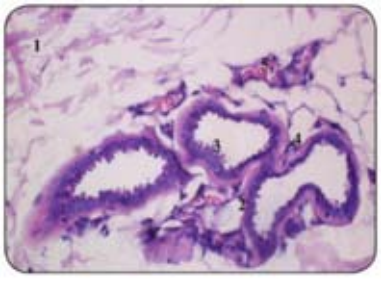


**Fig.1** C.S. of sweat glands in the ventral abdomen region of indigenous dog. H&E. x 400

Myoepithelial cells formed a distinct layer between the epithelium and the basal lamina (Fig. 2). These cells possessed elongated nucleus. Some of the lumen of the secretory unit showed secretory material and the lining epithelium was flattened. The secretions of sweat glands contained viscous oily substance and showed positive reaction to oil red O method for fats (Fig. 3). This secretion also gave a positive reaction to glycogen and mucins (Fig. 4). Rajani *et al.* (2020) reported that the Bengal tiger and golden jackal displayed apical blebs on the lining cells of sweat glands, suggesting apocrine type activity, which might be involved in the production of fat and pheromones.

1. Dermis
2. Secretory end piece of sweat gland
3. Apical bleb
4. Myoepithelial cell

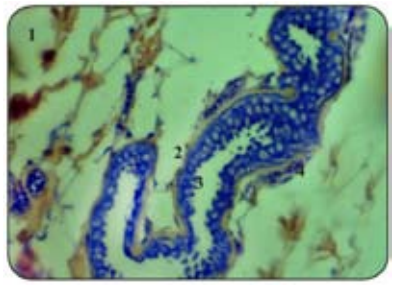


**Fig.2** C.S. of sweat gland duct in the ventral abdomen region of indigenous dog. PTAH. x 400

1. Dermis
2. Secretory end piece of sweat gland
3. Hair follicle
4. Sebaceous gland

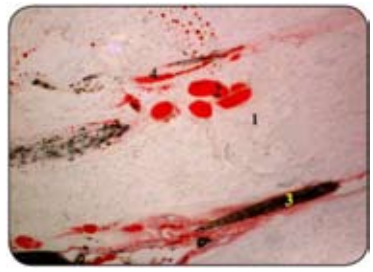


**Fig. 3** Section of the dermis of the ventral abdomen region Doberman Pinscher showing the sweat glands and sebaceous glands. Oil red O in propylene glycol method x 100

1. Secretory end piece of sweat gland
2. Adipose tissue

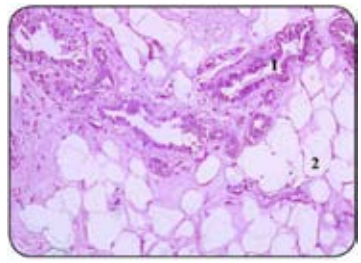
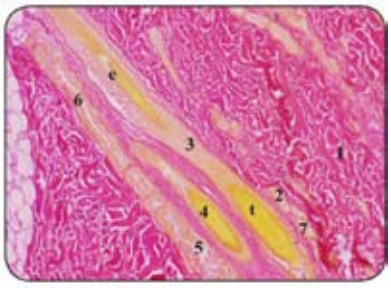


**Fig. 4** C.S. of sweat gland duct in the ventral abdomen region of indigenous dog. PTAH.x 400

The duct of the apocrine sweat gland coursed parallel to the wall of the hair follicle, toward the epidermis and opened into the upper portion of the hair follicle above the opening of the sebaceous gland (Fig. 5). The duct was composed of stratified cuboidal cells and showed a narrow lumen. The nuclei of these cells were spherical in shape. Ahmad *et al.* (2011) reported that in Malabari red sheep, the sweat glands were located at the junction of papillary and reticular layers of dermis, associated with the primary




1. Dermis
2. Sebaceous gland
3. L.S. of primary hair follicle showing exogen (e) and telogen (t)
4. Secondary follicle
5. Sweat gland
6. Duct of sweat gland
7. Sebaceous gland

**Fig. 5** L.S. of hair follicles in the ventral abdomen region of Labrador Retriever. McManus method for glycogen (PAS).x 200

hair follicle and rarely associated with the secondary hair follicles. Ducts of these glands passed out through the outer root sheath of the hair follicle and were lined by two layers of squamous cells with narrow lumen.

Results of this study will provide new insights into breed-specific variations in sweat gland structure and function in dogs. Such information could help to identify underlying factors influencing skin health and disorders, ultimately improving targeted treatments and advancing research on skin-related conditions across various dog breeds.

## Conclusion

The study investigated the number and diameter of sweat glands in various dog breeds to compare the capacity of thermoregulation. Breeds like German Spitz, German Shepherd and Dachshund had the largest diameter for sweat glands, suggesting better cooling efficiency, while the Pug and Labrador Retriever had smaller and fewer glands, indicating less capacity for sweat-based thermoregulation. The Dachshund had both the highest number and large-sized glands, showing efficient thermoregulatory mechanism. The findings highlighted significant variations in sweat gland characteristics across breeds, with larger glands potentially compensating for lower numbers, to regulate body temperature.

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