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Histomorphometric characterization of sweat glands in indigenous pig

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Abstract
Pig farming in India is still un-organized venture and about 70% of the pig population is reared under traditional system and Pigs are the chief converter of row feed into good source of human food. The pig shows anatomical and physiological similarities with human, which leads its role in biomedical research. The sweat glands has role in thermoregulation of the body. This study was conducted on twelve indigenous male i.e. six piglets up to two months of age and six adults above six months of age. The skin samples of various body regions were collected after slaughter of animals. The histological slides were prepared by the routine histological procedure of the tissue pieces of skin. The apocrine and eccrine types of sweat glands were observed in the reticular layer of the dermis. The eccrine sweat glands found only in snout region while apocrine was observed in rest of the body regions under study. The apocrine glands were saccular and convoluted tubular with longer and larger diameter than eccrine. The secretary units of apocrine glands were lined by cuboidal cells, while secretary units of eccrine glands were lined by clear and dark cells. The excretory ducts of apocrine glands opened at the base of the hair follicle, while that of eccrine glands opened through rete peg on the surface of skin. The secretory acini of both the type of glands were surrounded by spindle shaped myoepithelial cells. The values for the length, diameter and number of sweat gland were various in different body region and increased with advancement of the age of the animals. The average values for the micrometrical observations were higher in the dorsal abdominal region as compared with other body region in both the piglet and adult groups.

Keywords: Histomorphometry, skin, sweat glands, pig

Introduction
Pig farming in India is still un-organized venture and 70% of the pig population is reared under traditional system using locally available grains, vegetables, agricultural by-products and kitchen waste. The pig population contributes around 2.01% of the livestock population in India (19th Livestock Census of India, 2012) [1]. Among the total pig population of India, the indigenous pig population is about 76%. The pig shows anatomical and physiological similarities with human, which leads pigs, a good model in various human research (Meurens *et al*., 2012) [8]. There has been a role of pig in various biomedical research *viz*., blood supply in the dermis, histology of skin and its structures, protein and lipid compositions in layers of skin (Debeer, *et al*., 2013) [5], allergic contact dermatitis and organ transplantation etc. The thickness of the skin is depends on layers of skin, hair-coat properties and bulk of sweat and sebaceous glands. The sweat glands has role in thermoregulation of the body. The size of sweat gland and it's depth in dermis has an effect on the rate of heat transfer from an animal to the environment. The sweat glands thus are very important in the normal physiology of the pig (Collier and Gebremedhin, 2015) [3].

Material and Methods
The present study was conducted on twelve indigenous male pigs. These pigs were divided into two groups according to their ages viz., Group A (Piglet up to 2 months of age) and Group B (Adult pigs above 6 months of age). The skin samples were collected from various body regions i.e., thigh, dorsal abdomen (lumbar region on last rib), lateral abdomen, ventral abdomen, upper jaw (facial tuberosity), lower jaw (angle of mandible), snout and chin regions. The samples were collected immediately after the slaughter of animals from local market of Parbhani district and fixed in 10% neutral buffer formalin. The 5 mm thick skin tissues of various regions were processed for routine histological procedure, which included dehydration in ascending grades of ethanol, cleared in xylene and embedded in paraffin wax.

The tissue paraffin were blocks prepared and sectioned at 3 to 5 µm thickness and glass slides were prepared. These prepared slides were stained with Harris haemotoxyline (Mukharjee, 1992) [11] and eosin stain.

Result and discussion

The skin of pig microscopically comprised of three main layers from outer to inner viz., epidermis, dermis and hypodermis, which were observed in all the eight body regions under experimental study in both the age groups. The dermis was composed of connective tissue fibres and cells, sweat and sebaceous glands, arrector pilli muscles, blood vessels, nerves, hair follicles. Papillary and reticular layers of the dermis were observed in all the regions of both the groups (Renaudeau *et al.*, 2006) [12]. The sweat glands were found in the reticular layer of the dermis, which may extended into hypodermis. In the present study, the sweat glands were observed in two main types viz., apocrine and eccrine in both age groups. The apocrine glands were found in all body regions except snout in which eccrine type was observed. Montagna and Yun (1964**)** [10] reported the presence of apocrine glands mainly in hairy skin and eccrine type of glands in skin of snout region of female pig. The apocrine glands were saccular and convoluted tubular with coiled secretory portions. Trautmann and Fiebiger (1957) [15] reported glomi form type of secretory tubule were present in the pig and mentioned that it could be attributed to the angle of sectioned. The secretory units of these glands were long and had larger diameter than eccrine glands. These glands were extended into hypodermis and hence, surrounded by subcutaneous fat of hypodermis. These observations were in occurrence with Sumena *et al.* (2010) [14]. The lining cells of the secretary units were cuboidal and composed of eosinophilic cytoplasm with large prominent nucleus. These glands showed apical secretory caps projecting into the lumen of acinus. The apical portion of cell cytoplasm was found in the secretion in lumen of acinus. The excretory duct of apocrine gland opened at the base of the hair follicle. This duct was located close to the secretory portion of gland. Similar findings were recorded by David (1932) [4] in pig. The secretory ducts of glands were convoluted as well as straight with small lumen, which was lined by double layer of cuboidal epithelium. The spindle shaped myoepithelial cells with elongated nucleus were observed around the secretory acini in all body regions in both the groups whereas the myoepithelial cells were not observed around the excretory ducts of apocrine glands in both the groups.

The eccrine type of sweat glands was observed in dermis of snout in both the age groups. The secretory acini were convoluted tube shaped found in deeper part of dermis and in subcutaneous tissue of hypodermis. The secretory units were looked large lobules of various size and it was surrounded by connective tissue septa. Schummer *et al.*, (1981) [13] described that eccrine sweat glands were mainly found in regions which had few or no hairs and they produced a watery secretion in domestic animals. The size of the secretory acini was smaller than that of apocrine type. The acinar lining cells were of two types i.e, clear cells and dark cells. The clear cells were cuboidal shaped with clear cytoplasm and rounded nucleus at the centre and rested on basement membrane. The dark cells were seen towards luminal part of secretory acini and were filled with granules. Urmacher (1990) [16] mentioned that the dark cells of eccrine sweat glands in human permitted the reabsorption of sodium, potassium and chloride ions. The secretory acini were surrounded by myoepithelial cells in this type also. The convoluted portion of the excretory duct of the eccrine sweat gland was observed near the secretory unit. The dermal portion of duct was straight, while epidermal part was somewhat spiral and duct opened through rete peg on the surface of skin. The epidermal portion of duct showed keratohyline granules in the cytoplasm of lining cells. Bothe the types of the glands were concerned with thermoregulation of the body. In contrast, Ingram and Weaver (1969) [6] reported that the absence of eccrine glands in porcine skin and lesser ability of porcine skin to evaporate cutaneous moisture in comparison to other animals. The eccrine sweat glands were found in snout region and deeply located as compared to apocrine sweat glands of rest of the body regions of both age groups under study. The length and diameter of eccrine gland located in snout region of piglet was 56.61±1.14 and 27.85±0.89 µm while in adult group it was 66.63±1.56 and 33.28±0.65µm respectively. The maximum depth of sweat gland in piglet (2314.77±30.96 µm) and adult group (4285.29±17.20 µm) was observed in snout region of the body. The average number of sweat gland per cm^2 was ranged from 38.66 ± 3.65 to 42.50 ± 5.05 in piglet and while it was ranged from 40.00 ± 3.77 to 42.50 ± 4.61 in adult pig in all the body regions studied. The significantly higher number of sweat glands (per cm^2) was found in snout region of piglet (182.50 ± 7.10) and adult pig (252.16±7.21) as compared with other body regions under study. All the parameters of sweat gland studied in present experiment showed decreased trend from dorsal to ventral portion of the body, while, anterio-posterior body region comparison trend revealed maximum values in lateral abdomen in both age groups of pig. Similar observations were made by Schummer *et al.* (1981) [13] in pigs and Sumena *et al.*, (2010) [14] in pig. Renaudeau *et al.*, (2006**)** [12] observed significantly higher density of sweat glands in Caribbean (32.0 per mm^2) than European (25.4 per mm^2) growing pigs. Khiao *et al*., (2019) [7] mentioned that number of sweat glands per /cm^2 was 15.7±1.1 and 16.2±3.40 in human and pig abdomen, respectively. These values indicated that the number of the sweat glands per cm^2 in human and pig were almost similar.

Conclusion

In the present study, two types of sweat glands viz., apocrine and eccrine were found in the reticular layer of the dermis. The eccrine glands were observed only in snout region while apocrine glands were found in all other body regions under study. The apocrine glands were saccular, convoluted tubular with longer and larger diameter of secretroy units. The secretary units showed cuboidal with eosinophilic cytoplasm and large. The excretory ducts of these glands opened at the base of the hair follicles. The secretory acini were surrounded by spindle shaped myoepithelial cells. The secretory acini of eccrine sweat glands were convoluted tube shaped observed in deeper part of dermis and extended up to hypodermis. The secretory acini were lined by clear cells and dark cells. The clear cells were cuboidal shaped with rounded nucleus at the centre and rested on basement membrane. The dark cells were observed towards luminal part of secretory acini and were filled with granules. The secretory acini were surrounded by myoepithelial cells in this type also. The excretory ducts of the eccrine sweat gland opened through rete peg on the surface of skin. The morphometrical values for the length, diameter and number of sweat gland were found higher in adult group and piglet. The average values for the

micrometrical observations were higher in the dorsal abdominal region as compared with other body region in both the piglet and adult groups.

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Table 1: Micrometrical observations of Sweat gland in various body regions (n=6) of Piglet age group

Sr. No.	Regions	Length (µm)		Diameter (µm)		Depth(µm)	
		Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range
1	Thigh	86.15^{a}±3.77	70.43-98.47	62.00^{a}±1.25	59.17-65.75	1274.31^{e}±37.45	1111.17-1359.95
2	Dorsal abdomen	90.68^{a}±4.42	77.65-105. 2	65.96^{a}±5.43	48.65-84.16	2021.92^{b}±16.38	1948.11-2061.2
3	Lateral abdomen	87.88^{a}±4.90	67-99.91	63.59^{a}±5.96	40.76-79.45	1583.20^{c}±37.65	1436.22-1688.85
4	Ventral abdomen	85.69^{a}±4.92	64.39-98.62	61.58^{a}±4.87	51.28-78.9	1278.85^{e}±24.79	1220.62-1376.98
5	Upper jaw	85.90^{a}±3.05	79.93-99.94	61.96^{a}±6.19	33.81-73.64	1446.61^{d}±20.39	1391.39-1528.15
6	Lower jaw	86.26^{a}±3.40	76.09-99.94	62.16^{a}±6.01	35.01-73.64	1476.72^{d}±29.40	1408.8-1591.39
7	Snout	56.61^{b}±1.14	53.48-60.3	27.85^{b}±0.89	25.47-31.5	2314.77^{a}±30.96	2216.47-2399.8
8	Chin	85.85^{a}±4.88	64.14-98.62	59.53^{a}±4.37	47.34-76.02	1138.00^{f}±38.00	1066.58-1323.07

Different superscripts shows significant difference in the column (between the different region)

Table 2: Micrometrical observations of Sweat gland in various body regions (n=6) of adult group

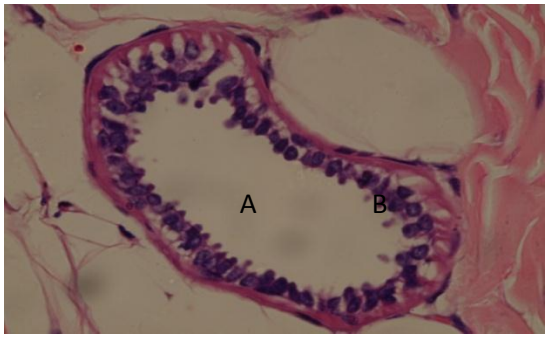
Sr. No.	Regions	Length (µm)		Diameter (µm)		Depth (µm)	
		Mean± SE	Range	Mean ± SE	Range	Mean± SE	Range
1	Thigh	100.85^{a}±3.32	92.31-113.98	70.87^{a}±1.81	63.32-76.65	2073.42^{f}±21.89	2003.65-2133.2
2	Dorsal abdomen	107.20^{a}±3.89	92.65-120.31	76.10^{a}±3.37	66.66-86.65	2872.60^{b}±27.74	2809.83-2983.17
3	Lateral abdomen	103.98^{a}±1.51	99.65-109.98	72.87^{a}±4.64	50.61-79.99	2422.05^{c}±25.04	2319.84-2483.17
4	Ventral abdomen	99.64^{a}±3.06	89.98-111.28	68.32^{a}±4.69	53.32-79.99	2275.97^{d}±18.04	2239.86-2349.89
5	Upper jaw	98.98^{a}±7.68	76.65-131.65	68.87^{a}±2.68	59.95-79.99	2167.65^{e}±27.16	2109.88-2273.2
6	Lower jaw	99.98^{a}±4.89	78.65-109.98	69.20^{a}±3.29	58.65-79.99	2119.15^{ef}±34.14	2016.87-2239.87
7	Snout	66.63^{b}±1.56	61.35-70.87	33.28^{b}±0.65	30.8-35.19	4285.29^{a}±17.20	4243.09-4346.42
8	Chin	95.20^{a}±4.69	83.98-116.64	67.76^{a}±4.36	53.32-79.98	2109.89^{ef}±17.64	2037.9-2161.88

Different superscripts shows significant difference in the column (between the different region)

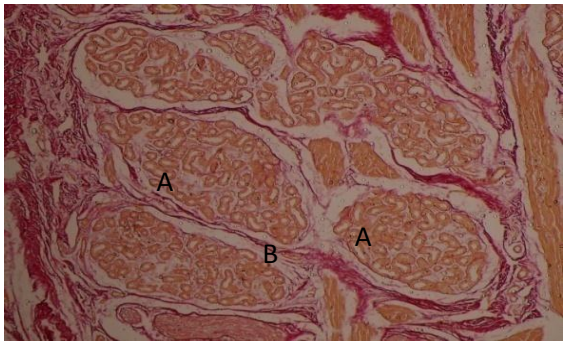
Table 3: Number of sweat gland per cm^2 in different body regions (n=6)

Sr. No.	Regions	Piglet		Adult pig	
		Mean ± SE	Range	Mean ± SE	Range
1	Thigh	39.83^{b}±4.62	30-60	41.33^{b}±4.32	30-53
2	Dorsal abdomen	42.50^{b}±5.05	30-60	42.50^{b}±4.61	30-60
3	Lateral abdomen	40.00^{b}±3.77	30-53	41.33^{b}±4.32	30-53
4	Ventral abdomen	42.33^{b}±5.73	30-60	42.33^{b}±4.70	30-60
5	Upper jaw	38.66^{b}±3.65	30-53	40.00^{b}±3.77	30-53
6	Lower jaw	38.66^{b}±4.91	30-60	40.00^{b}±3.77	30-53
7	Snout	182.50^{a}±7.10	151-196	252.16^{a}±7.21	227-272
8	Chin	41.16^{b}±3.31	30-53	41.16^{b}±3.31	30-53

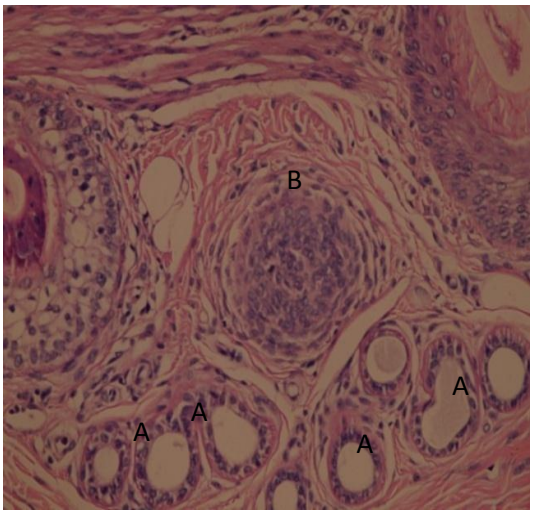
Different superscripts shows significant difference in the column (between the different region)



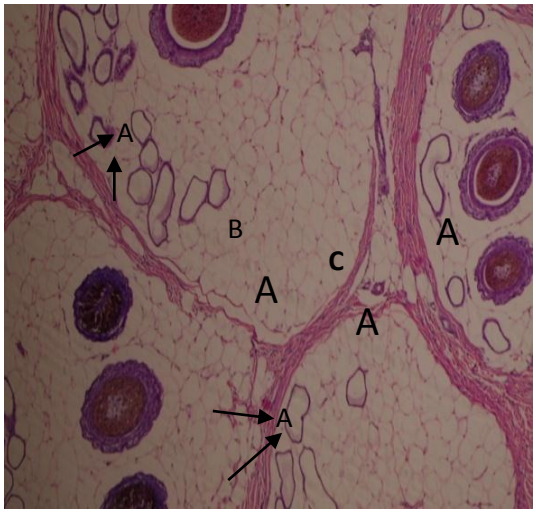
Photomicrograph of skin of upper jaw in adult showing A. Apocrine gland B. Basement membrane (H E x 1000)



Photomicrograph of skin of snout region in piglet showing A. Eccrine gland B. Septa. (VAN X 100)



Photomicrograph of skin of dorsal abdomen of adult pig showing A. Apocrine gland B. collagen fibers (H E x400)



Photomicrograph of skin of ventral abdomen adult pig showing A. Apocrine gland B. adipocytes C. collagen fibers (H E x 40)

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