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Microanatomical observations of hair in domestic animals: A comparative study

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Abstract

Microscopic observations of guard hairs collected from three different regions *viz.*, inter scapular, lumbar and croup regions of the different domestic animals *viz.*, cattle, buffalo, sheep, goat, horse and dog was carried out. Hair is an epidermal outgrowth which was made up of an outer cuticle, middle cortex and inner medulla in all the species. The cortex was non-cellular and the medulla was cellular made up of cornified cells in all species except dog. In cattle, buffalo and goat the scaling pattern was imbricate with no protrusions from hair shaft. Whereas, in dog, the scales were not prominent. 50 per cent of total diameter of the hair was made up of medulla. Medullary index of domestic animal hair ranged from 0.30 to 0.75. Within each species, the mean diameter of shaft portion of hair varied in different regions. Among the domestic animals, horse had the least medullary index of 0.30 and sheep and goat had the maximum medullary index of 0.75.

Keywords: Microscopic observations, guard hairs, domestic animals

1. Introduction

As hair is a structure found exclusively in mammals, Oken named the mammalia as Trichozoa (hair animals) and Bonnet named them as Pilifera (hair bearers) [1]. Hair is a thread-like outgrowth of the epidermis that forms the animal coat. Among the domestic animals hair is present in different degrees in different parts of the body. Ranging from a thick coat in most part of the body while remain hairless in certain parts of the body. The most important function of hair in mammals is to form insulation to serve thermoregulation. The differing colours in hair coats between different species and within species serve purposes of camouflage, and of sexual recognition and attraction among the member of the species. Large inter-individual variation reflects breed specific differences [2]. Microscopically hair is composed of cuticle, medulla, cortex and pigment granules. The distribution and arrangement of these shows variations between the hairs in different parts of the body. Every domestic animal species has its own characteristic hair pattern [3]. In mammals, four main types of hair were described of which guard hair is the most important in differentiation between various animal species [4, 5]. Hence, the present study is designed to compare the microscopic features of guard hairs in cattle, buffalo, sheep, goat, horse, and dog.

2. Materials and Methods

2.1 Sample collection

Dorsal guard hairs from three different places such as inter scapular region (R1), lumbar region (R2) and croup region (R3) were collected from the adult, live cattle, buffalo, sheep, goat, horse, and dog. Strands of samples were collected from six animals in each species. Collected samples were stored in polythene bags for further examination.

In the present study, on microscopic examination, various parameters such as the shape of the hair bulb, degree and pattern of pigmentation, scaling pattern was observed in different regions of the body (R1, R2 and R3). Hair sample of domestic animal species was divided into three portions such as root (r), mid shaft (s) and tip (t).

For microscopic examination whole mount of hair samples of different species was prepared [6]. Hair strands from six animals in each species were collected from three different regions. The microscopic features were observed in root, mid shaft and tip of the hair were recorded. For calculation of mean diameter, mid shaft portion alone was used. Cuticular scale patterns of guard hairs from different regions were observed by preparation of scale casts on a thin layer

of clear nail polish [7]. The clear nail polish was streaked on a clean, grease free glass slide. Then the hair sample was stuck on the slide and allowed for 1-2 min or until the nail polish dried off. After that, the hair sample was removed from the slide to get the scaling pattern which was observed under microscope.

Microscopic images were captured using Leica microscope (CH9435 Heer brugg). Micrometric observations were made by using Leica application suit (LAS V-4). Micrometric observations such as width of whole hair and width of medulla were measured. Medullary index was calculated using a formula [6].

Medullary Index = Maximum diameter of medulla / Maximum diameter of hair

Measurements were taken at the mid shaft of the hair. The data and measurements of all specimens were recorded and analysed by using SPSS software to calculate mean and standard deviation.

3. Results and Discussion

In the present study, hair was made up of three layers, namely cuticle, cortex and medulla in all the domestic animal species. Cuticle was made up of flattened cornified cells. Free edge of the cells showed variations among the domestic animals that resulted in various scaling pattern in each species. The cortex was located deep to the cuticle, non-cellular and composed of keratin. The medulla constituted the innermost part of the hair, consisted of pigments. Medulla was prominent in all the domestic animal species in the study. In the present study, except dog the medulla was composed of multicellular cornified cells as reported by Marinis and Asprea [8]. Since, the hair samples were collected from the hairy breed of sheep, the medulla was prominent in contrast to woolly breed wherein the medulla was absent [9].

In cattle, hairs from R1 appeared as bulb-like structures with no pigmentation. Shaft and tip portions showed uniform pigmentation and degree of pigmentation reduced towards the tip. A similar observation was made in R2 and R3 samples. The pigments were black in colour. Scaling pattern was found to be imbricate throughout the length of hair. Scales were prominent in R1 and R2 hairs and less prominent in R3 hairs. The medullary structure continued into root area and traces of follicular tissue was also observed [10] (Fig1a).

In buffalo, root was club shaped with no pigmentation in the root of hair collected from R1, R2 and R3 regions. Compared

to Cattle, though the cuticular scale pattern was continuous but not so prominent (Fig1b). Though uniform pigmentation was observed as in cattle, the colour of the pigment was brown [11].

In sheep, root was conical with lack of pigments in root of hair from R1, R2 and R3 regions. Unlike Buffalo, the cuticle was more prominent, medulla showed uniform distribution of black pigments. Degree of pigmentation was found to be lesser towards the tip (Fig1c). This is in contrast to the findings of Paluzzi [12] who observed a discontinuous pattern of medulla in sheep.

In goat, the root appeared as wider funnel-like structure without pigments in all the three regions (R1, R2 and R3). Cuticle was prominent, medulla showed black pigmentation throughout the hair (Fig1d). However, the degree of pigmentation was found to be more in mid shaft portion. Medulla occupied the almost entire width of the hair shaft as reported by Sato *et al.* [13].

In horse, root was bulb-like conical expansion in hairs from R1, R2, and R3 region. Cuticle was less prominent, whereas, cortex was more prominent structure than the medulla. Medulla showed more pigmentation in mid shaft and became fragmental or broken and absent towards the tip (Fig1e). This is in accordance with the findings of Marinis and Asprea, [8].

In dog, hair follicle was club shaped. Dense pigmentation was seen in the root. Pigmentation could be seen till the tip of the hair (Fig1f). Medulla was not prominent structure, amorphous as reported by Muller [14] and Robertson [15].

3.1 Scaling pattern

Cuticular scale patterns were considered as characteristic to species and subspecies which can be used in the identification [16]. In the present study, guard hairs collected from cattle, buffalo, goat showed imbricate scaling pattern with no protrusions from hair shaft. A similar observation was made by Kapil verma and Bhawana Joshi [16], Sato *et al.* [13] in goat and Partin [11], in Buffalo. Scaling pattern was not so prominent in dogs as per Muller [14] and Robertson [15].

Position of scales was observed as transversal in position and showed smooth scale margin. The scales were located at regular distance in all the domestic animals except dog. A similar observation was made in domestic ungulates by Marinis and Asprea [8] (Fig 2).

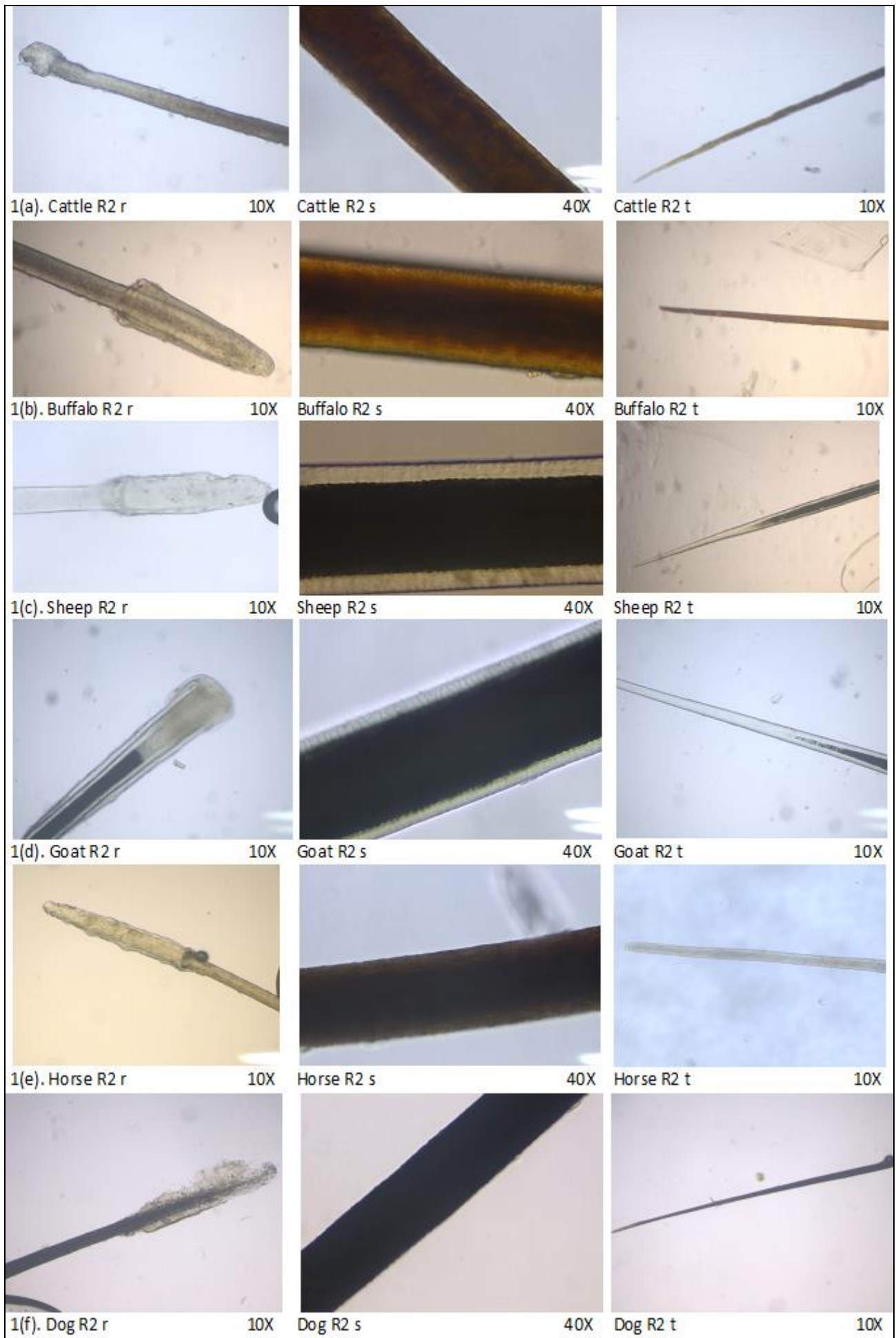


Fig 1: Photomicrograph of guard hair from lumbar region of different domestic animals r- root s- shaft, t- tip.

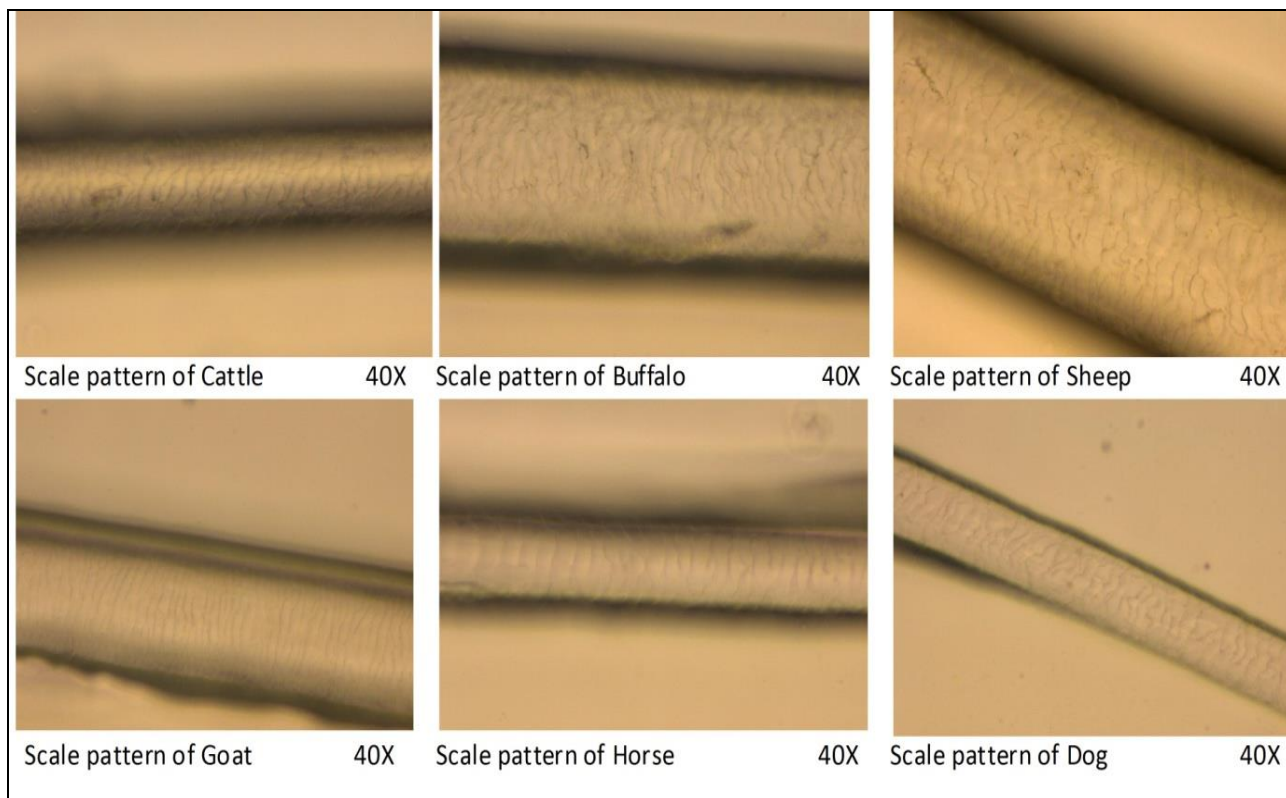


Fig 2: Photomicrograph showing the scale pattern of different domestic animals.

3.2 Medullary index

In the present study, in all domestic animal species 50 per cent of the total diameter of the hair was made up of medulla as reported by Saferstein ^[17]. Mean diameter of the hair and

mean diameter of medulla of hair from R1, R2 and R3 regions in all domestic animal species was given in Table-1 and 2. Medullary index of guard hair in different domestic animals in different regions was given in Table-3.

Table 1: Mean diameter of mid shaft portion of guard hair from interscapular (R1), lumbar (R2) and croup (R3) regions in different domestic animal species

Species	Region	Mean	SE
Cattle	R1	94.12	0.52
	R2	91.18	0.93
	R3	82.86	0.91
Buffalo	R1	135.22	1.44
	R2	114.27	0.68
	R3	141.11	0.46
Sheep	R1	161.40	0.90
	R2	194.45	0.35
	R3	145.80	1.02
Goat	R1	122.50	0.37
	R2	141.10	0.86
	R3	75.13	1.62
Horse	R1	82.95	0.40
	R2	60.32	0.89
	R3	72.71	0.52
Dog	R1	96.21	0.32
	R2	94.36	1.11
	R3	88.81	0.98

Table 2: Mean diameter of the medulla of guard hair

Species	Region	Mean	SE
Cattle	R1	59.161	0.83
	R2	42.965	1.31
	R3	41.21	0.53
Buffalo	R1	104.50	1.01
	R2	75.382	0.61
	R3	90.887	0.42
Sheep	R1	115.37	0.89
	R2	157.16	0.68
	R3	106.82	0.31
Goat	R1	97.08	0.55
	R2	107.54	0.83
	R3	52.24	0.57
Horse	R1	57.79	0.74
	R2	18.92	0.24
	R3	8.14	0.47

Medullary index was calculated using the formula in guard hairs collected from different regions of the body (R1, R2 and R3) and was shown in Table-3.

Table 3: Medullary index of guard hairs

Species	Region	Medullary index
Cattle	R1	0.628
	R2	0.471
	R3	0.496
Buffalo	R1	0.772
	R2	0.659
	R3	0.645
Sheep	R1	0.714
	R2	0.808
	R3	0.740
Goat	R1	0.792
	R2	0.762
	R3	0.695
Horse	R1	0.471
	R2	0.313
	R3	0.111
Dog	R1,R2,R3	-

In cattle, there was no much difference in the medullary index of R2 and R3 which is 0.471 and 0.496. Whereas, R1 showed 0.628. In buffalo, there was no much variation between the regions which ranged from 0.645 to 0.772. The medullary index of sheep and goat also didn't show much variation. It ranged between 0.695 to 0.808 in sheep and goat respectively. In horse, there was a drastic difference between the three regions. The medullary index of R3 was 0.111 (lowest) and medullary index of R1 was 0.471(highest).

In the present study, it was observed that the medullary index of domestic animal hair ranged from 0.30 to 0.75. Among the domestic animals horse had the least medullary index of 0.30 and sheep and goat had the maximum medullary index of 0.75. Except, horse the medullary index of the domestic animals was found to be more than 0.50. A similar observation was made by Narayan Reddy ^[18] and Krishnan Vij ^[19].

4. Conclusion

It is concluded that among the domestic animal species studied mean diameter of the guard hair varied between the three regions under study. Total diameter is least in horse and more in sheep. With regard to medullary diameter horse had least medullary diameter and sheep had more diameter. Also, horse had least medullary index among the domestic animal species studied. The above interspecies variations in

microscopic features of guard hairs might be used as a useful feature in species differentiation.

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