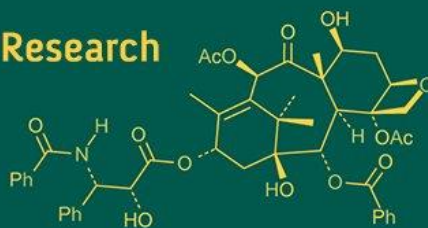
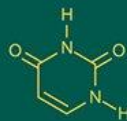
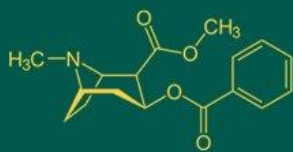


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Pushpendra Rawat

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

SK Gupta

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

Yogita Pandey

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

BP Shukla

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

N Shrivastava

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

Alka Suman

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

Corresponding Author:**SK Gupta**

Department of Veterinary
Anatomy and Histology, College
of Veterinary Science and A.H.,
Nanaji Deshmukh Veterinary
Science University, Jabalpur,
Madhya Pradesh, India

Trichological analysis on hair of malvi cattle

Pushpendra Rawat, SK Gupta, Yogita Pandey, BP Shukla, N Shrivastava and Alka Suman

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Abstract

For trichological analysis guard hair from back, neck, umbilical and tail regions of malvi cattle were collected. The colour, shape and band pattern of hair was examined to know the gross profile of hair. The cuticular impressions were prepared in a thin gelatin layer on a clean glass slide for assessment of cuticular scale pattern. For medullary configuration observation hair specimen was prepared with xylene. The physical characteristic of hair like colour, shape and band pattern showed huge variation in the same individual from region to region. The hair of malvi cattle were cylindrical in all body regions. Microscopically the hair was composed of cuticle, cortex and medulla from outer to inner side. The cuticular scales were in the form of regular waves with crenate scale margin in all body regions. The medulla of hair in all body regions of present study was continuous but 2-3 fragments were present towards tip. The medullary composition was unicellular with a typical cloisonne pattern in all the body regions. The margin of the medulla was scalloped type in all body region but few fringed were also present in back region. The medullary index of hair varied from 0.50 to 0.60.

Keywords: Trichological, hair, cuticle, medulla, malvi, cattle

Introduction

Hair is the characteristic threadlike outgrowths of the outer layer of the skin that form an animal's coat. The morphological characteristics of hair vary from species to species. These features are an important tool for identification of animal species. The mammalian hair fibers represent an interesting biological material which can be easily sampled, collected and transported as well as resist putrefaction and remain for very long periods of time so could provide long-term information. The study was conducted on hair of malvi breed of cattle with the objectives of gross, microscopic and scanning electron microscopic examination.

Materials and Methods

The study was carried out in the Department of Veterinary Anatomy and Histology, College of Veterinary Science and Animal Husbandry, Mhow, Nanaji Deshmukh Veterinary Science University, Jabalpur (M.P.). For present study six guard hairs from each body region (back, neck, umbilical and tail regions) from six adult and apparently healthy Malvi breed of cattle irrespective of sex were collected from the Livestock Farm Complex of College and nearby private livestock farms of Indore region.

To know the gross profile the colour, shape and band pattern of hair was examined. For assessment of cuticular scale pattern of hair, the cuticular impressions were prepared in a thin gelatin layer on a clean glass slide and examined under the light microscope to know the detail structure of hair cuticle of animals. For medullary configuration study each hair specimen was cleaned and cleared with xylene then mounted on microscopic slide in a drop of DPX for light microscopic observations. After preparation of histological slides of hair the numerical measurement in micron for both cortex and medulla width were taken using an ocular micrometer. For scanning electron microscopic examination, the hair sample was fixed in 3% glutaraldehyde buffered with 0.1M phosphate buffer at room temperature and carried to Department of Metallurgical Engineering and Materials Science, IIT Indore (M.P.) for detailed hair cuticular observations.

Results and Discussion

Hair was composed of three layers of cells, that is, the keratinized cuticle making up the

outer layer, the cortex forming the middle layer and the medulla resulting in the inner layer. These three layers form the hair structure patterns used in identification of species. The present trichological analysis on guard hair of Malvi cattle was done to study its gross, microscopic, micrometrical and scanning electron characterization with an aim of species and breed identification.

Gross Examination of Hair: Colour, shape and band pattern of hair was examined by naked eye. The physical characteristics of hair like colour, band pattern and hair profile showed huge variations in the same individual from region to region in the animal species. So, these features of hair could not be considered as an important tool for species identification from hair. These findings were in accordance with the observations of Sarkar *et al.* (2011) ^[11], who mentioned that the coat of mammalian species varies with season, habitat and sex of the individuals.

In present study, the hair colour was observed at different region. Hair colour depends on the pigments present in the hair and on the other physical properties that affect how light is transmitted through the hair. Hair colour is a useful feature in the hair comparison process. Within an individual, hair colour showed a degree of variation. However, the degree of variation within an individual species is less than the variation among different species individuals. The hair of Malvi cattle showed white and black colour in back, neck and tail region, but the umbilical region showed white coloured hair. No colour bands were found, it showed curved hair profile at all the body regions except tail. The hair of tail region were slightly wavy. In agreement with the findings of present study Koppikar and Sabnis (1976) ^[5] reported curved hair profile and high variation in hair colour in cattle.

The length of hair measured at different body regions was variable. The texture of hair included in this investigation varied from fine to coarse. Shape of hair was identical with its shaft configuration of hair. It was studied by feeling the hair between thumb and index finger. The same was reported by Kushwah (2024) ^[7] in wild herbivores and wild carnivores. In present study, the hairs of malvi cattle were cylindrical in all body regions. Kushwah (2024) ^[7] reported flat configuration in hairs of sambar and black deer and cylindrical configuration in the hair of deer and Nilgai. No band pattern was seen in any body region of Malvi cattle, However, Kushwah (2024) ^[7] reported band pattern in the hair of tail region of sambar and back region of deer.

Microscopic Examination of Hair

Cuticular scale pattern: In Malvi cattle the cuticular scales of hair in all the body regions were positioned transversely. These cuticular scales were arranged in the form of regular waves of imbricate patterns in all body regions (Figs. 1-4). The same was reported in cow by Ahmed *et al.* (2018) ^[11] and Yasser *et al.* (2018) ^[17]. However Mukherjee *et al.* (2016) ^[9] reported that domestic cow has irregular waves with crenate scale margins and Lungu *et al.* (2007) ^[8] reported flattened and deep imbricated scale at an oblique angle. Verma and Joshi (2012) ^[15] reported imbricate scale patterns without protrusion in the shaft of jersey cow.

The scale margin was crenate in all body regions of present study (Figs. 1-4). In agreement with the present study the crenate margin in cow were also reported by Ahmed *et al.* (2018) ^[11], Yasser *et al.* (2018) ^[17] and Mukherjee *et al.*

(2016) ^[9]. Crenate margin were also observed in goat, camel, horse and donkey by Ahmed *et al.* (2018) ^[11] and in horse, black buck and barking deer by Bhosale *et al.* (2019) ^[12]. Smooth margin were reported in sheep (Yasser *et al.*, 2018) ^[17], goat (Das *et al.*, 2018) ^[13], zebra and black buck (Yadav *et al.*, 2018) ^[16].

In present study cuticular scale were arranged closely in all body regions (Figs.1-4). While, Ahmed *et al.* (2018) ^[11] and Sarma *et al.* (2021) ^[12] reported intermediate scale distance in cow. Number of scales per row were 1 to 2 in back, neck and umbilical region but in tail region these were 2 to 3. Similarly, Bhosale *et al.* (2019) ^[12] reported that cow hair has maximum 3 number of scale count. Bhosale *et al.* (2019) ^[12] also reported that horse hair has maximum 2 number of scale count but elephant, barking deer, black buck and chinkara hair has maximum 3 number of scale count

Medullary configurations: It was observed that the medulla was absent at the tip of hair in all body regions. The medulla tapers from the proximal part of hair towards the tip of hair. The medulla was composed of closely packed, shrunken cells, but unlike cortex they were clearly visible. In concordance with the findings of Krause and Cultr (1975) ^[6] these cells and the air filled spaces between the intercellular connections, were responsible for the specific characteristic of the medulla.

The medulla of hair in all body regions (back, neck, umbilical and tail) in present study was continuous but 2-3 fragments were present towards tip. The medullary composition was unicellular with a typical cloisonne pattern in all the body regions (Figs. 5-8). Ahmed *et al.* (2018) ^[11] in cow reported that medulla was continuous, occupying more than half of the hair shaft, and no pigments were seen in the cortex. Senthilkumar *et al.* (2018) ^[13] in cow reported that the medullary structure continued into root area and traces of follicular tissue was also observed. Mukherjee *et al.* (2016) ^[9] in cow reported that the medulla of domestic cow appear dark and continuous. Verma and Joshi (2012) ^[15] in jersey cow reported continuous, amorphous or vacuolated medulla without mosaic pattern. Ahmed *et al.* (2018) ^[11] and Senthilkumar *et al.* (2018) ^[13] reported fragmented/discontinuous medulla in sheep. Ahmed *et al.* (2018) ^[11] in goat, camel, horse and donkey and Senthilkumar *et al.* (2018) ^[13] in goat reported continuous medulla. Das *et al.* (2018) ^[13] in Assam hill goat reported that the medulla was continuous and vacuolated. Senthilkumar *et al.* (2018) ^[13] also reported fragmented medulla in horse.

The margin of the medulla was scalloped type in all body region but few fringed were also present in back region (Figs. 5-8). However, Mukherjee *et al.* (2016) ^[9] reported that the medulla of domestic cow has straight margin. The margin of the medulla reported by Ahmed *et al.* (2018) ^[11] and Mukherjee *et al.* (2016) ^[9] was smooth in sheep, camel and donkey whereas it was serrated in goat. Ahmed *et al.* (2018) ^[11] and Senthilkumar *et al.* (2018) ^[13] also reported serrated margin in horse.

Micrometrical features of hair: The hair shaft diameter, showed variations throughout the length, therefore the diameter/width of the hair was measured at mid of the shaft. The medullary index was calculated by dividing the average width of medulla with the average diameter of hair. In present study the medullary index of hair varied from 0.50 to 0.60.

In malvi cattle the average length and width of the hair in back, neck, umbilical and tail regions were 13.18 ± 0.31 mm & 75.60 ± 2.42 μ m; 16.45 ± 0.36 mm & 59.41 ± 2.40 μ m; 15.68 ± 0.23 mm & 59.41 ± 1.96 μ m and 30.76 ± 0.33 mm & 71.54 ± 3.58 μ m, respectively. However SenthilKumar *et al.* (2018) [13] reported hair width in scapular region, lumbar region and croup region as 94.12 ± 0.52 μ m, 94.18 ± 0.93 μ m and 82.86 ± 0.91 μ m in cattle, 161.40 ± 0.90 μ m, 194.45 ± 0.35 μ m and 145.80 ± 1.02 μ m in sheep, 122.50 ± 0.37 μ m, 141.10 ± 0.86 μ m and 75.13 ± 1.62 μ m in goat and 82.95 ± 0.40 μ m, 60.32 ± 0.89 μ m and 72.71 ± 0.52 μ m in horse, respectively. Yadav *et al.* (2018) [16] reported that hair width in black buck, sambar deer and zebra were 23.53 ± 0.86 μ m, 27.75 ± 0.65 μ m and 32.75 ± 5.55 μ m, respectively.

Average thickness of one side cortex and diameter of medulla in the hair of back, neck, umbilical and tail regions were 15.12 ± 0.42 μ m & 45.36 ± 1.22 μ m; 13.07 ± 0.31 μ m & 33.26 ± 1.10 μ m; 14.85 ± 0.52 μ m & 29.71 ± 0.93 μ m; 14.31 ± 0.73 μ m & 42.92 ± 2.01 μ m, respectively. SenthilKumar *et al.* (2018) [13] reported diameter of medulla in scapular region, lumbar region and croup region as 59.16 ± 0.83 μ m, 42.96 ± 1.31 μ m and 42.21 ± 0.53 μ m in cattle, 115.37 ± 0.89 μ m, 157.16 ± 0.68 μ m and 106.82 ± 0.31 μ m in sheep, 97.08 ± 0.55 μ m, 107.54 ± 0.83 μ m and 52.24 ± 0.57 μ m in goat and 57.79 ± 0.74 μ m, 18.92 ± 0.24 μ m and 8.14 ± 0.47 μ m in horse, respectively.

The medullary index of hair in malvi cattle varied from 0.50 to 0.60. It was 0.60, 0.56, 0.50 and 0.60 in back, neck, umbilical and tail regions, respectively. SenthilKumar *et al.* (2018) [13] reported medullary index in scapular region, lumbar region and croup region as 0.62, 0.47 and 0.49 in cattle, 0.71, 0.80 and 0.74 in sheep, 0.79, 0.76 and 0.69 in goat and 0.47, 0.31 and 0.11 in horse, respectively.

Scanning Electron Microscopic Examination of Hair:

The hair samples of all the body regions under study were subjected for Scanning Electron Microscopy (SEM). The middle part of guard here were considered for SEM as a representative. The cuticular scales of guard hair were observed at 500X, 1000X, 2500X, 5000X magnification under scanning electron microscope. The scanning electron microscopic findings of the present study revealed that the cuticular scales of guard hair showed free cuticular scale margins, directed towards the tip or distal part of the hair shaft. These findings were in concurrence with the observations of Rajaram and Menon (1986) [10] in porcupine. In malvi cattle the cuticular scale of hair in all the body regions (back, neck, umbilical and tail regions) of present study were positioned transversely. These cuticular scale were arranged in the form of regular waves of imbricate patterns and having close scale margin in all body regions. The free margin of scale was convex thin and irregular in all the body regions (Figs. 9-16). The observations of the present study regarding transversely arranged cuticular scale was in agreement with the findings of Verma *et al.* (2016) [14] in spotted deer. Kamalakannan (2017) [4] stated that the in nilgai cuticular scale patterns was in the form of regular wave with smooth margins and had near scale distance.

Numbers of scale per row were 1 to 2 in back, neck and umbilical regions but in tail region these were 2 to 3 (Figs. 9-16). Similarly Bhosale *et al.* (2019) [2] reported that cow

hair has maximum 3 number of scale count. Bhosale *et al.* (2019) [2] also reported that horse hair has maximum 2 number of scale count and elephant, barking deer, black buck, chinkara hair has maximum 3 number of scale count. The maximum distance between two scale (height of scale) in back, neck, umbilical and tail region was 7.84 ± 0.05 μ m, 8.04 ± 0.06 μ m, 8.22 ± 0.05 μ m and 7.80 ± 0.06 μ m respectively. The width of the scale in back, neck, umbilical and tail region was 50.40 ± 2.27 μ m, 39.60 ± 1.75 μ m, 39.94 ± 1.77 μ m, 28.56 ± 1.52 μ m, respectively (Figs. 9-16). From the present research findings it is concluded that the physical characteristic of hair like colour, shape and band pattern showed huge variation in the same individual from region to region in the animal species. Differences were recorded in the cuticular pattern and medullary pattern of the hairs. The combination of gross and microscopic characteristics of hair might be important and useful for identification of mammalian hairs.

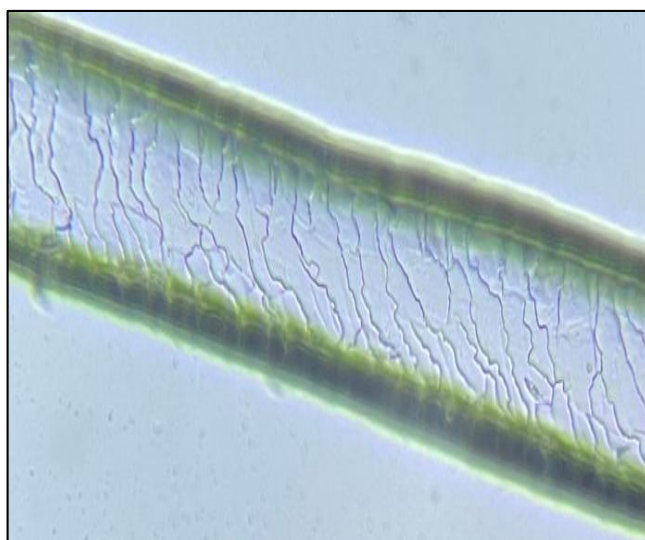


Fig 1: Cuticular scale patterns in hair of back region in malvi cattle showing, transversal scales in regular wavy pattern with crenate margin. (X 400)

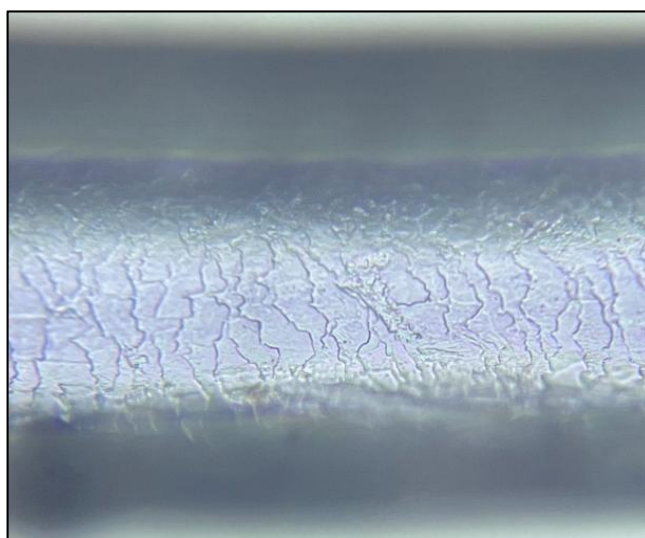


Fig 2: Cuticular scale patterns in hair of neck region in malvi cattle showing, transversal scales in regular wavy pattern with crenate margin. (X 400)



Fig 3: Cuticular scale patterns in hair of umbilical region in malvi cattle showing, transversal scales in regular wavy pattern with crenate margin. (X 400)



Fig 4: Cuticular scale patterns in hair of tail region in malvi cattle showing, transversal scales in regular wavy pattern with crenate margin. (X 400)

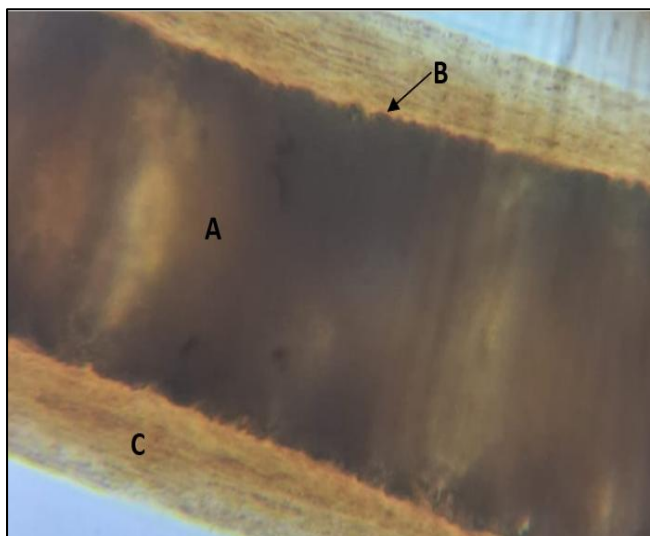


Fig 5: Hair of back region of malvi cattle showing
A- Medulla having cloisonne pattern
B- Scalloped margin
C- Thick cortex (X 1000)

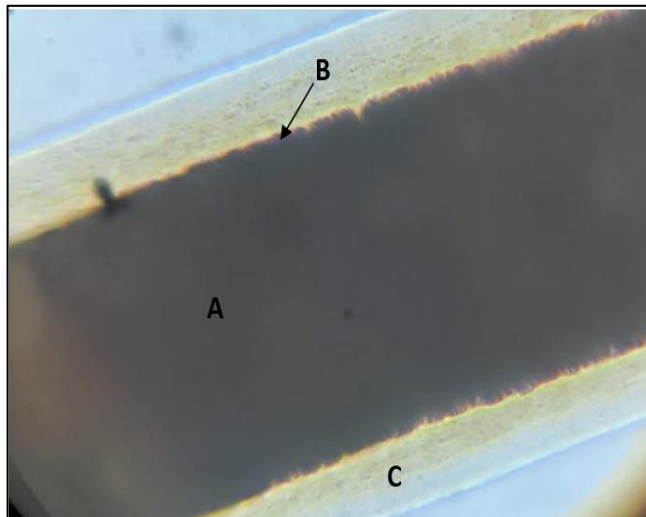


Fig 6: Hair of neck region of malvi cattle showing
A- Medulla having cloisonne pattern
B- Scalloped margin
C- Thick cortex (X 1000)

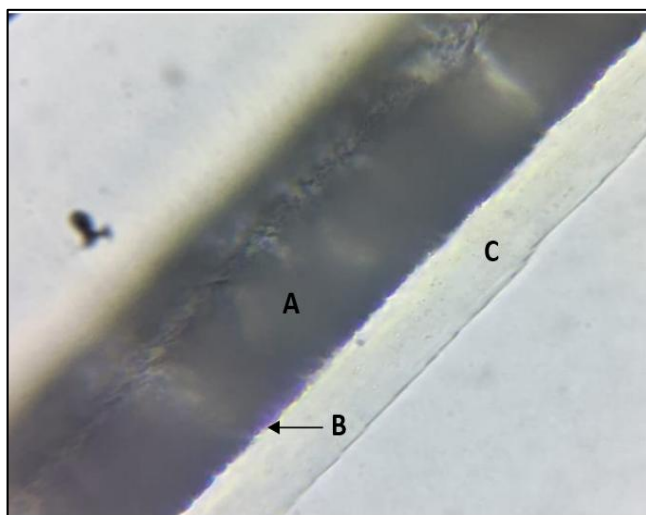


Fig 7: Hair of umbilical region of malvi cattle showing
A- Medulla having cloisonne pattern
B- Scalloped margin
C- Thick cortex (X 1000)

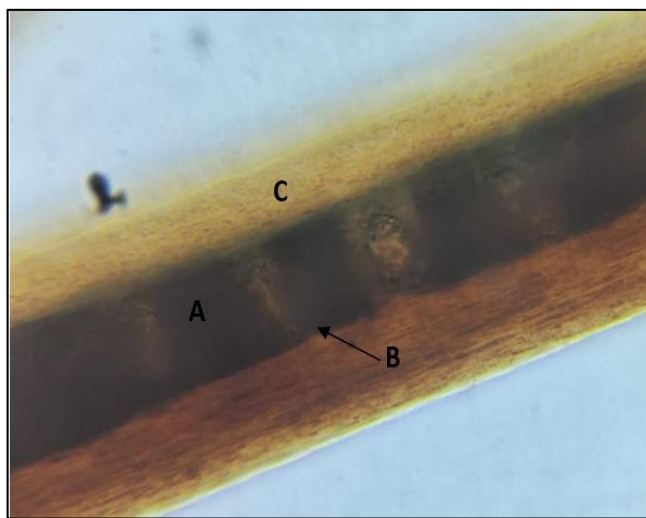


Fig 8: Hair of tail region of malvi cattle showing
A- Medulla having cloisonne pattern
B- Scalloped margin
C- Thick cortex (X 1000)

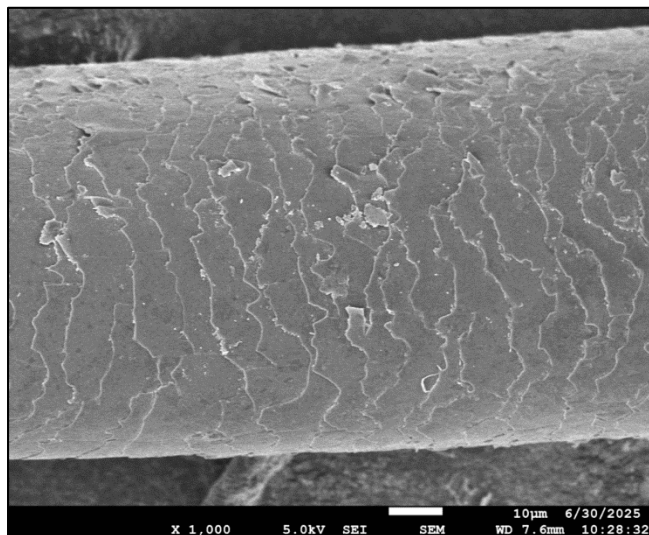


Fig 9: Cuticular scale patterns of hair in back region of malvi cattle under SEM at X 1000

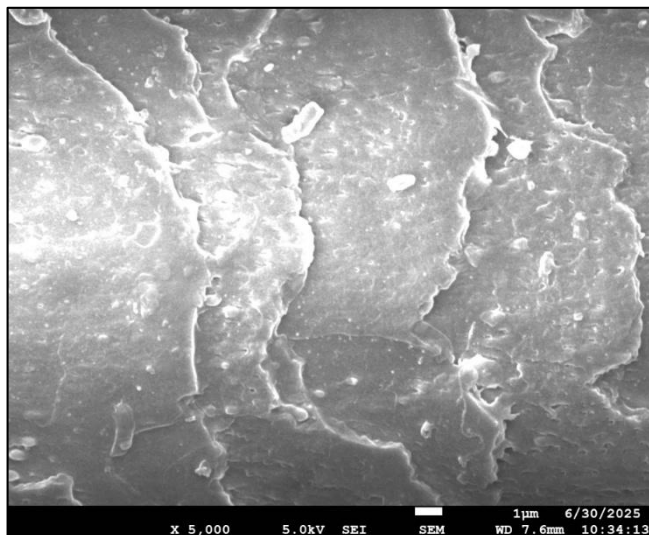


Fig 12: Cuticular scale patterns of hair in neck region of malvi cattle under SEM at X 5000

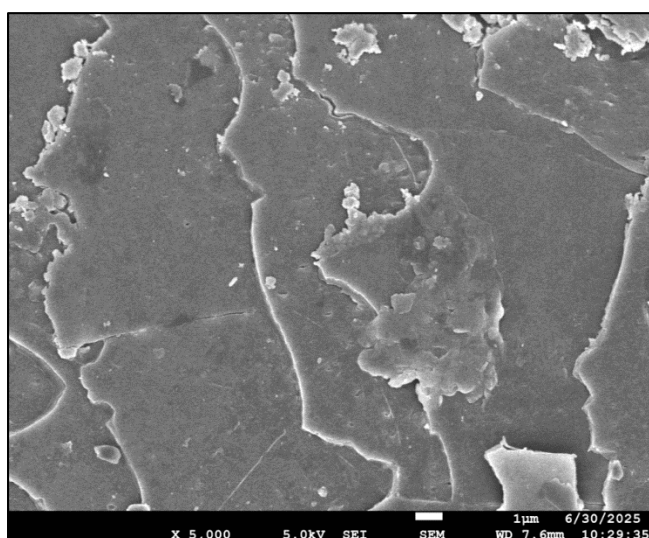


Fig 10: Cuticular scale patterns of hair in back region of malvi cattle under SEM at X 5000

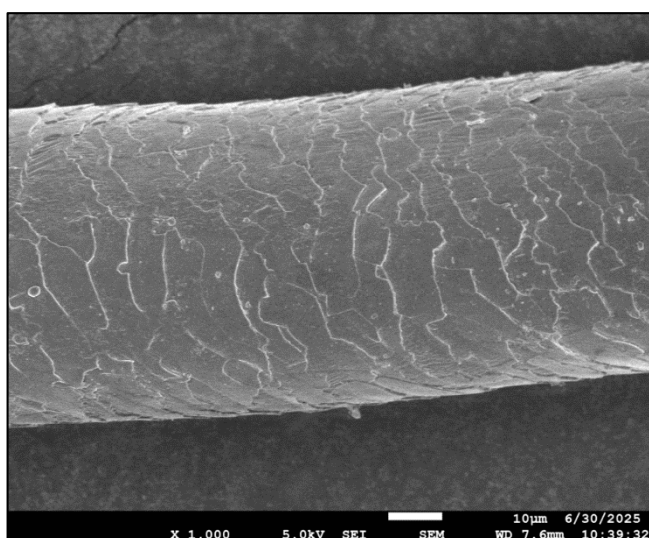


Fig 13: Cuticular scale patterns of hair in umbilic region of malvi cattle under SEM at X 1000

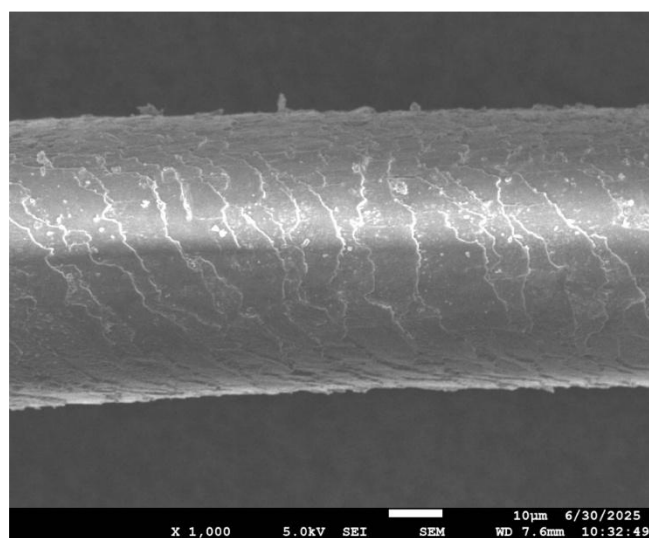


Fig 11: Cuticular scale patterns of hair in neck region of malvi cattle under SEM at X 1000

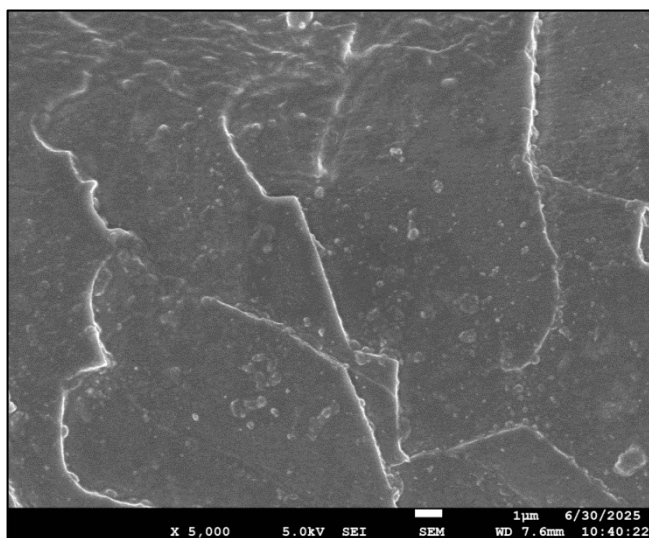


Fig 14: Cuticular scale patterns of hair in umbilical region of malvi cattle under SEM at X 5000

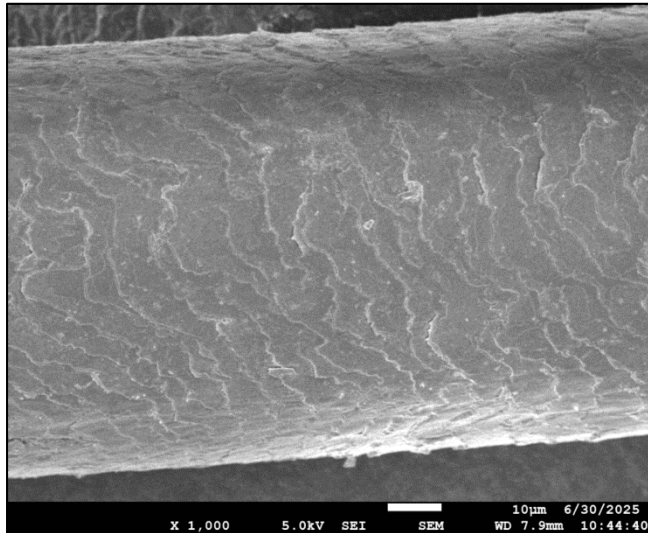


Fig 15: Cuticular scale patterns of hair in tail region of malvi cattle under SEM at X 1000

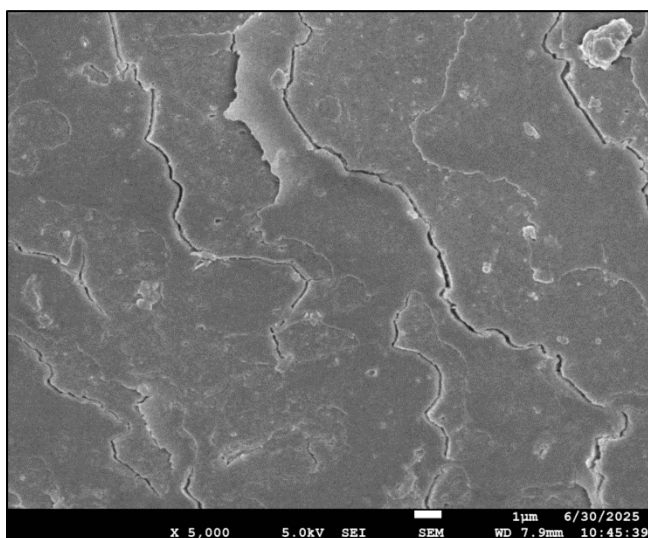


Fig 16: Cuticular scale patterns of hair in tail region of malvi cattle under SEM at X 5000

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