

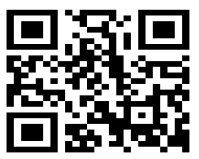
Characterization and grading of Black Bengal goat skin based on coat color

A.K.M.Baharul Islam Talukder¹, Fouzia Akhter², Sanjit Chandra Barman^{3*}

¹Upazila Livestock Officer, Bangladesh National Zoo, Dhaka, Department of Livestock Services, Ministry of Fisheries & Livestock, The government of Bangladesh, Dhaka, Bangladesh

²Senior Horticulturist, Department of Agricultural Extension, Ministry of Agriculture, The government of Bangladesh, Dhaka, Bangladesh

³Department of Environmental Science, Bangladesh Agricultural University, Mymensingh, Bangladesh



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Abstract: The research was conducted to study physical parameters and histological structural patterns based on the coat color of Black Bengal goat skins. Five hundred skins were randomly selected, measured using scientific instruments and the Haematoxylin-Eosin staining method was used for histological study. Black coat color skin was found the highest (58%), the mean weight, length and width of Black Bengal goat skin were 998.80 gm, 29.24 and 20.91 cm, respectively but there were no significant differences among the groups. The mean thickness of the skin was 1.97, 1.43 and 1.96 mm in butt, bell and shoulder region, respectively and significantly different between the groups in all categories. All slaughtered goats were flayed using "Muchki" (Hoisting and fisting) method. The average flay cut length, depth, mechanical and parasitic damages were 20.2 mm, 1.50 mm, 6.11 and 1.50 %, respectively. No significant difference ($p>0.05$) was found in inedible fleshing by-products, but significant differences ($p<0.05$) were found in trimming by-products production and salt required for curing. Salted skins were preserved for an average of 3.5 days. Hair follicles, sebaceous glands and erector pili muscles, collagen fibers and fiber bundles were more regular in butt region than shoulder and belly regions in black, brown, white and mixed coat color of Black Bengal goat skins..

Keywords: Black Bengal goat skin, coat color, physical characteristics of skin, histological structure of skin, skin quality.

Introduction:

Goats, a vital livestock component, have been reared in Bangladesh from the time of human settlement. Goat population in Asia contributes nearly 63.6% of the total world's livestock and in Bangladesh it contributes about 7% of the total Asia population [1]. The average number of goats per household is 2.3 and landless, small and medium farmers mostly rear them. Bangladesh's total number of goats is 30.33 million; about 90% are Black Bengal [2]. Black Bengal goats remain the main breed throughout the country for its recognition by the farmers as a prolific breed, easy to handle, high adaptability to stressful environmental conditions and different nutritional regimes, and comparatively more resistant to common diseases [3]. Goats are used primarily for meat production, but their skin is a valuable by-product [4]. It ranks second in terms of meat, milk and skin production, representing a significant amount among the total contribution of livestock in Bangladesh [2]. About 284 million pounds of meat from goats is used for human consumption. About 84 million pounds of leather is produced from goatskin annually, which helps earn foreign exchange. The rearing of goats requires low capital investment, acts as insurance against crop failure, and provides alternative sources of livelihood to the farmers year-round [5]. The government of Bangladesh has started a national program in 2002

on poverty alleviation, self-employment, food supply and increase skin export through goat rearing [6].

The skin is the body's biggest and most significant biological system, serving as a barrier between the body's exterior and interior environments [7]. The skin acts as a barrier, preventing electrolytes and macromolecules from being desiccated and leaving the body [8]. There is already a substantial domestic leather industry in Bangladesh, mostly export-oriented [9]. The leather includes some ready-made garments, although that aspect is confined mainly to a small export-trade in "Italian-made" garments for the US market [10]. This is the fast-growing leather products sector [11]. Presently Bangladesh produces between 2-3% percent of the world's leather market [12]. Most of the livestock base for this production is domestic, comprising 1.8 percent of the world's cattle stock and 3.7 percent of the goat stock. The hides and skins have a good international reputation [3]. Goat skins cover about 9 % of world's leather production. Even though the size of 0.2 -0.9 sq m and a thickness of 1 - 2 mm are similar to sheep skins, the structure of goat skins is very much firmer. Therefore goat skins are suitable for articles that demand distinct physical properties, e.g. shoes, garments, protective clothing, lining and leather goods [13].

Furthermore, major portion (over 92%) of the hides, skins and leathers available in our country is downgraded and rejected by various defects e.g. ante-mortem (i.e. goad marks scratches, parasitic lesions, etc.), post-mortem (i.e. poor pattern flay cuts, faulty scratches) and industrial defects [14].

Moreover, there are wide variations in Black Bengal goat skin coat color. It is essential to grade the products for smooth marketing of skins in home and abroad which require a standard gradation of skins. For characterization and grading of Black Bengal goat skins and establishment of better export-oriented leather industry in Bangladesh, it is necessary to collect the information related to skin weight, size, thickness, flaying, damage and defects, fleshing and trimming by-products, curing and anatomical structure based on coat color. The present research aims to estimate the availability of different coat colors of Black Bengal goat skins in Mymensingh, Bangladesh, by considering characterization and grading factors.

Materials and Methods

The present research was conducted on data collection from various physical measurements i.e., weight, size, thickness, flaying, damage and defects, fleshing and trimming by-products, curing procedure and histological structure i.e. grain layer and collagen fiber bundles in shoulder, bell and butt regions of black, mixed, brown and white coat color Black Bengal goat skins. Data were collected with a five hundred randomly selected Black Bengal goat skins at "Chamra ghodam (godown deals with raw hides and skins)" of Mymensingh, Bangladesh.

Data collection

Data were collected from July 27 to September 27, 2017 and the histological study was performed at mid-September to mid-October, 2017. Five hundred randomly selected black, mixed, brown and white coat color Black Bengal goat skins were used for the data collection on various parameters like coat color, sex, weight, skin size, length, width, thickness, shoulder, butt, belly. Data were collected using various scientific instruments i.e., Stater Spring Balance (Model 235, Japan) for weight measurement, measuring tape, thickness Gauge, magnifying glass, and weighing balance.

Coat color, weight and size of skin

The skins were divided into four groups i.e., white, brown (Fig. 3.2), black (Fig. 3.3) and mixed (Fig. 3.4) by eye estimation and the sex was determined by observing its external genitalia (scrotum, prepuce and teat). Weight of individual skin was measured by using the "Stater Spring Balance (Model 235, Japan)". Different skin size was determined by measuring its length and width using the measuring tape in cm. The length was accounted for by measuring the distance from the lower throat cut to the root of the tail (Fig. 3.6) and width was accounted by measuring the distance from the midway points between the fore and hind shank.

Thickness of skin

Thickness from three regions, namely shoulder, butt and belly of individual skins was measured with a dial Thickness Gauge (Model SM-112, Teclock Corporation, Japan) and then was recorded.

Flaying of skin

The butchers flayed the skins using a well-known technique named as "Muchki" (Hoisting and fisting) method. They usually used traditional available knives in this method.

Fleshing and trimming by-products of skin

After collection of skin, it was spread on a clean floor. Using knives, godown workers were done fleshing and trimming by-products (all sharp, irregular flaps on the edge of the hide and all excessively long shanks). Then fleshing i.e. removal of excessive meat and fat and trimming (edible and inedible) by-products i.e. all sharps, irregular flaps on the edge of the skin, horns, ears, the shanks below the knee and hock joints and that part of the tail which is more than 0.2032 meter from the junction of the tail with the skin were collected, weighed out separately and then recorded.

Curing of skin

The method of curing, amount of salt used in that curing and days of keeping the salted skins were recorded. The Aratder used wet salting curing on the green skin. After receiving the skin, the excessive meat, fat and all sharps, irregular flaps on the edge of the skin were removed. The skin was allowed to wash in a clean water bath. Then the skin was suspended on an equal level hanging on bamboo for drained off excessive water. After the water is draining off, the skin was spread on a clean floor and the flesh side was rubbed with common salt following a thumb rule of 500 to 800 gm salt for each skin depending on skin area and weight. The salted skin was then stored in stack, placing flesh side up, with other cured skins usually for a week.

Statistical Analysis

All the data were analyzed by the statistical method using analysis of variance for a 2x3 factorial experiment in Completely Randomized Design (CRD). With Duncan's new Multiple Range Test (DMRT), Mean values were tested for the difference using MSTATC.

Results and Discussion

Coat color and sex of skin

It was found that 9%, 9%, 58%, and 24% skins were white, brown, black, and mixed. The findings were represented that black is the highest (58%), then mixed (24%) and the lowest were brown (9%) and white (9%) together (Figure 1).

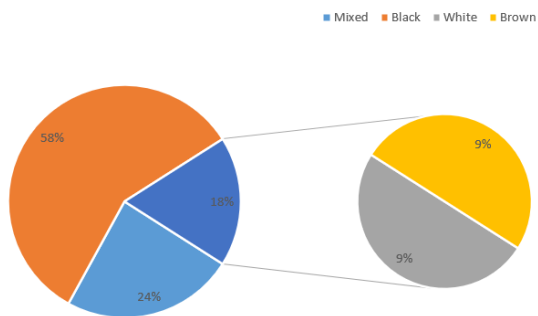


Figure 1. Distribution based on coat color

Moreover, according to sex, skins were categorized into eight different groups such as white male, brown male, black male, mixed male, white female, brown female, black female and mixed female, which included 21, 20, 116, 61, 26, 27, 166 and 63 numbers of skins respectively. It was found that 56.4% and 43.6% of skins were from female and male goats, respectively. Figure 2 illustrates that black females were the highest (166), and brown males were the lowest (20) in number.

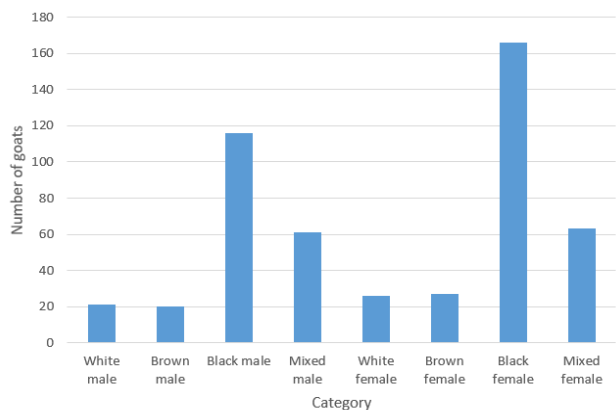


Figure 2. Distribution based on sex

Weight and size of skin

The weight of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were showed in Table 1. The average weight was highest in mixed males and lowest in white females, and the values were not significant ($p>0.05$) among the different coat color of Black Bengal goatskin [15]. The weight always depends on size and thickness of the skin. In the present study, the highest weight found in the mixed male group was justified because of the highest size and thickness of the mixed male skins.

Moreover, the length and width of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were showed in Table 1. The average length and width were highest in mixed males and the average length and width were found lowest in brown females and brown males, respectively. The values of both length and width were not significant ($p>0.05$) among the different coat color of Black Bengal goat skin. The size of the skins mostly depends on the size and shape of the animals. And the size of the animal depends on its genetic merits, nutrition, management, environment, diseases and damages, etc. [16]. Irrespective of age and sex, mixed color skin was found superior in size based on coat color.

Table 1. Length (cm) and width (cm) of Black Bengal goat skin based on coat color

| Category | Number (n) | Skin size | | | |
|--------------|------------|-------------------------|-----------------------|------------------------|-----------------------|
| | | Length (cm) (Mean ± SD) | Level of significance | Width (cm) (Mean ± SD) | Level of significance |
| White male | 21 | 29.33 ± 1.35 | | 20.76 ± 1.37 | |
| Brown male | 20 | 29.10 ± 1.21 | | 20.70 ± 1.26 | |
| Black male | 116 | 29.25 ± 1.30 | | 20.84 ± 1.18 | |
| Mixed male | 61 | 29.52 ± 1.40 | NS | 21.09 ± 1.14 | NS |
| White female | 26 | 29.15 ± 1.19 | | 21.03 ± 0.87 | |
| Brown female | 27 | 28.92 ± 1.24 | | 20.92 ± 1.14 | |
| Black female | 166 | 29.19 ± 1.27 | | 20.88 ± 1.14 | |
| Mixed female | 63 | 29.20 ± 1.35 | | 20.93 ± 1.22 | |

Note: NS means Not significant ($p>0.05$)

Thickness of skin

The thickness of butt, belly and shoulder of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were showed in Table 2. The average thickness of butt, belly and shoulder regions was highest in black, brown, and brown males, respectively, and was lowest in white females in all Black Bengal goat skin regions [4]. The thickness of skins in

different regions among the coat colors was significant ($p < 0.05$). In this study, male goatskin thickness was higher than female, possibly due to the genetic potentialities of the animals. It was also observed that the skin thickness increases with weight advancement. Considering the four different coat colors, the thickness of Bengal goatskin was 1.69 mm, which compared favorably well with the values obtained by other researchers for goatskin (Sar and Calhoun, 1966; Khan, 1970; Samad, 1994).

Table 2. Thickness (mm) of Black Bengal goat skin based on coat color

| Category | Number (n) | Thickness | | | | | |
|--------------|------------|----------------------|----|-----------------------|----|--------------------------|----|
| | | Butt (Mean \pm SD) | LS | Belly (Mean \pm SD) | LS | Shoulder (Mean \pm SD) | LS |
| White male | 21 | 1.99 \pm 0.13 | | 1.42 \pm 0.11 | | 1.69 \pm 0.11 | |
| Brown male | 20 | 2.00 \pm 0.14 | | 1.47 \pm 0.13 | | 1.73 \pm 0.11 | |
| Black male | 116 | 2.03 \pm 0.16 | | 1.46 \pm 0.14 | | 1.71 \pm 0.13 | |
| Mixed male | 61 | 1.97 \pm 0.16 | ** | | * | | * |
| White female | 26 | | | | | | |
| Brown female | 27 | | | | | | |
| Black female | 166 | | | | | | |
| Mixed female | 63 | | | | | | |

Note: L.S. = Level of significance **Significant at 0.01 level ($p > 0.01$) *Significant at 0.05 level ($p > 0.05$)

Moreover, the thickness close to the values of Bengal goat skin as recorded in the present study was nearer to the figures of 2.020 mm and 1.86 mm, respectively. It was also evident that the skin of the Bengal goat appeared to be thinner than the skin of the common American goat. This variation in skin thickness may be due to the variation of breed and the difference in the climatic conditions in which these two breeds originated. In the present study, the thickness was trended to be the highest in butt, intermediate in shoulder and the lowest in belly regions irrespective of age, sex, and coat color of the goats. In this respect Black Bengal goat skins were found similar skin thickness as those of goat skin from other parts of the world [17].

Flaying of skin

According to the shape and size of the skin and comments of butchers and workers of the godown, it was found that many scholars slaughtered all the animals or Halal method and skins were flayed using "Muchki" (Hoisting and fisting) method. They usually used traditional equipment (knives).

Table 3. Mechanical damage (%), parasitic damage (%), flay cut length (mm) and depth (mm) of Black Bengal goat skin based on coat color

| Category | Number (n) | Mechanical damage (%) | Parasitic damage (%) | Average flay cuts (mm) | |
|--------------|------------|-----------------------|----------------------|------------------------|-------|
| | | | | length | depth |
| White male | 21 | 9.52 | 14.28 | 22.5 | 1.5 |
| Brown male | 20 | 5 | 5 | 20 | 1.5 |
| Black male | 116 | 4.31 | 3.44 | 19.64 | 1.7 |
| Mixed male | 61 | 3.27 | 4.91 | 22.5 | 1.45 |
| White female | 26 | 7.69 | 11.53 | 17.5 | 1.45 |
| Brown female | 27 | 7.40 | 3.70 | 20.0 | 1.40 |
| Black female | 166 | 5.42 | 4.81 | 17.2 | 1.61 |
| Mixed female | 63 | 6.34 | 4.76 | 21.2 | 1.40 |

Damages and defects of skin

The average flays cut length, flay cut depth, mechanical and parasitic damage of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were showed in Table 3. Irrespective of age and sex, it was observed that white goats carried the highest mechanical and parasitic damage due to their low skin thickness and poor hair pattern. Black males are less affected by mechanical and parasitic damages due to their high skin thickness. It was also found that in white skin, ante-mortem defects are higher [18]. Damage caused before slaughter includes lesions from external ectoparasites like ticks and mites; scarring caused by fences, the horns of other goats, vaccination and bruising from trucking [19]. Besides coat color, season, breed, housing, nutrition, housing, and management influence skin damage and defects. Therefore, it is necessary to investigate the other factors affecting defects and damage of goatskin [20].

Fleshing and trimming by-products of skin

It was found that no edible fleshing and trimming by-products were produced at the trimming of skins but meant inedible fleshing and trimming by-production of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were showed in Table 4. Irrespective of age, it was found that mixed color skin produced the highest fleshing and trimming by-products due to it's higher weight, length and width and white females produced the lowest fleshing and trimming by-products because of it's lower weight, length and width [21]. The differences in the case of fleshing by-products of different coat color were not significant ($p>0.05$), whereas significant differences ($p<0.05$) were found in trimming by-products productions of different coat colors of Black Bengal goatskin.

Table 4. Fleshing and trimming by-products of Black Bengal goat skin based on coat color

| Category | Number | Fleshing(gm) (Mean \pm SD) | L.S. | Trimming by-products (Mean \pm SD) | L.S. |
|--------------|--------|---------------------------------|------|--------------------------------------|------|
| White male | 21 | 7.61 \pm 2.20 | | 25.47 \pm 3.84 | |
| Brown male | 20 | 7.55 \pm 1.85 | | 24.00 \pm 4.76 | |
| Black male | 116 | 7.89 \pm 2.18 | | 24.23 \pm 4.67 | |
| Mixed male | 61 | 8.21 \pm 2.15 | NS | 26.62 \pm 4.55 | * |
| White female | 26 | 6.92 \pm 2.00 | | 21.57 \pm 4.59 | |
| Brown female | 27 | 7.18 \pm 1.92 | | 22.59 \pm 4.47 | |
| Black female | 166 | 7.77 \pm 2.10 | | 24.16 \pm 4.60 | |
| Mixed female | 63 | 7.778 \pm 2.18 | | 22.79 \pm 4.79 | |

Note: L.S. = Level of significance NS Non significant ($p>0.05$) significant at 0.05 level ($p<0.05$)

Curing of skin

Irrespective of age and sex, 100% goatskins were cured using the wet salting method. The mean amount of curing salt of white male, brown male, black male, mixed male, white female, brown female, black female and mixed female Black Bengal goat skins were shown in Table 5. The amount of curing salt in wet salting method was found highest in brown male and lowest in white female. Irrespective of age, it was seen that the highest amount of curing salt was required in brown male as it's thickness was maximum out of other color categories. Moreover, there was a low significant difference ($p<0.05$) in curing salt use at Black Bengal goatskin coat colors.

Table 5. Amount of salt (gm) used in curing procedure of skin

| Category | Number (n) | Amount of salt (gm) (Mean \pm SD) | Level of significance |
|--------------|------------|--|--------------------------|
| White male | 21 | 624.238 \pm 72.29 | |
| Brown male | 20 | 692.500 \pm 76.56 | |
| Black male | 116 | 672.845 \pm 80.59 | |
| Mixed male | 61 | 670.492 \pm 76.58 | * |
| White female | 26 | 625.000 \pm 76.49 | |
| Brown female | 27 | 629.630 \pm 86.89 | |
| Black female | 166 | 672.289 \pm 82.85 | |
| Mixed female | 63 | 659.524 \pm 79.24 | |

Note: *Significant at 0.05 level ($p<0.05$)

The present research found that only on Tuesday cured goat skins were delivered at the tanneries in Dhaka from Mymensingh Chamragodham each week. Hence a week-round salted skins were preserved at the godown. So averagely, the skins were preserved for 3.5 days.

Conclusion

In the research, among the four coat color categories black was the highest (58%), then mixed (24%) and the lowest were brown (9%) and white (9%) together. The mean skin weight of Black Bengal goat was 998.80 gm where mixed male skin carries the highest mean weight (1019.67 gm) and there has no significant ($p>0.05$) difference in skin weight of different coat color. The mean length and width of Bengal goat skin were 29.23 and 20.90 cm, respectively. The highest mean length and width were 29.52 and 21.09 cm in mixed male but there was no significant ($p>0.05$) difference in length and width of different categories of skins. The mean thickness of Black Bengal goatskin in butt, belly and shoulder regions were 1.97, 1.43 and 1.69 mm respectively. Irrespective of age, sex and region, the mean thickness of Bengal goatskin was 1.69 mm. Moreover, the thickness was higher in butt (1.97 mm), intermediate in the shoulder (1.69 mm), and then in belly (1.43 mm) for all categories of skins. In belly and shoulder regions, the thickness was highly significant ($p<0.01$) difference whereas in butt region, it was low significant ($p<0.05$) difference. All slaughtered animals were flayed using "Muchki" (Hoisting and fisting) method. The average flays cut length, flay cut depth, mechanical and parasitic damage was 2.02 cm, 1.50 mm, 6.11% and 1.50 %, respectively in Black Bengal goatskin. All the skin was cured using the wet salting method and an averagely 665.50 gm salt was used for each skin. There had a low significant difference ($p<0.05$) in curing salt requirement. Salted skins were preserved for an average 3.5 days. It may be concluded that coat color has significant differences in skin thickness, inedible trimming by-products, defects and damages and salt required for curing that influences the leather industry in Bangladesh. The sebaceous glands were more minor in size, less in number and regularly distributed in collagen fibers in all categories of Black Bengal goat skins. Irrespective of age, the collagen fibers and the fiber bundles in the reticular layer of the dermis were relatively fuller, firmer and larger and were arranged in well-defined bundles.

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