

## Research Article

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

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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, and 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 was 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 the butt, bell, and shoulder regions, respectively, and significantly different between the groups in all categories. All slaughtered goats were flayed using the "Muchki" (Hoisting and fisting) method. The average flay cut length, depth, and 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, erector pili muscles, collagen fibers, and fiber bundles were more regular in the butt region than shoulder and belly regions in the black, brown, white, and mixed coat color of Black Bengal goat skins.

## Introduction

Goats, a vital livestock component, have been reared in Bangladesh from the time of human settlement. The 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 of their 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 of 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 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 the 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 at home and abroad which requires a standard gradation of skins. For characterization and grading of Black Bengal goat skins and the 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 collected 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 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 from mid-September to mid-October, 2017. Five hundred randomly selected black, mixed, brown, and white coat colors Black Bengal goat skins were used for the data collection on various parameters like coat color, sex, weight, skin size, length, width, thickness, shoulder, and 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, black, mixed by eye estimation, and the sex was determined by observing its external genitalia (scrotum, prepuce, and teat). The weight of individual skin was measured by using the “Stater Spring Balance (Model 235, Japan)”. Different skin size was determined by measuring their 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 and width was accounted for by measuring the distance from the midway points between the fore and hind shank.

### Thickness of skin

Thickness from three regions, namely the shoulder, butt, and belly of individual skins was measured with a dial Thickness Gauge (Model SM-112, Tetlock 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 traditionally available knives in this method.

### Fleshing and trimming by-products of skin

After the 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 Order used wet salting curing on the green skin. After receiving the skin, the excessive meat, fat, and all sharps, and 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 the 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% of skins were white, brown, black, and mixed. The findings represented that black is the highest (58%), then mixed (24%) and the lowest were brown (9%) and white (9%) together (Figure 1).

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.

### 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 shown 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 colors of Black Bengal goatskin [15]. The weight always depends on the 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 a 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 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 colors 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, damages, etc. [16]. Irrespective of age and sex, mixed color skin was found superior in size based on coat color.

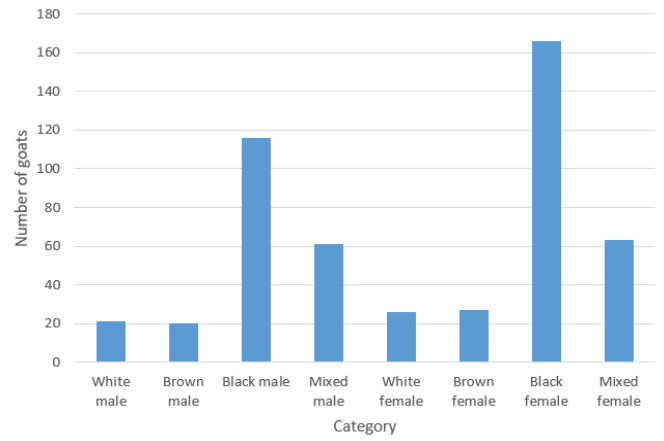


Figure 2: Distribution based on sex.

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 the butt, belly, and shoulder of a white male, brown male, black male, mixed male, white female, brown female, black female, and mixed female Black Bengal goat skins was shown 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).

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

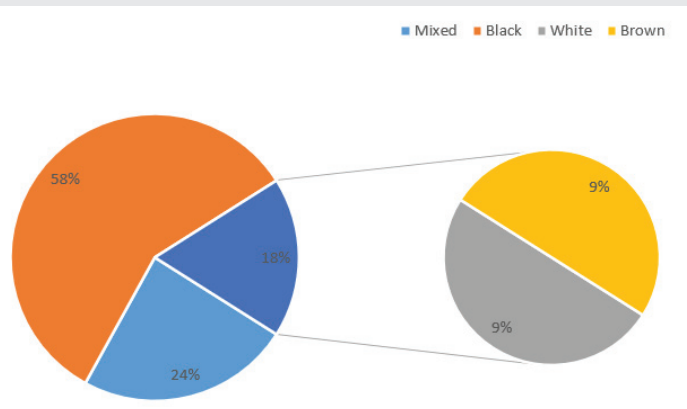


Figure 1: Distribution based on coat color.



the butt, intermediate in the 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 the “Muchki” (Hoisting and fisting) method. They usually used traditional equipment (knives).

### 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 shown 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, antemortem 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 to 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 a 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 4. Irrespective of age, it was found that mixed color skin produced the highest fleshing and trimming by-products due to its higher weight, length, and width and white females produced the lowest fleshing and trimming by-products because of their lower weight, length, and width [21]. The differences in the case of fleshing by-products of different coat colors 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.

### Curing of skin

Irrespective of age and sex, 100% of goatskins were cured using the wet salting method. The mean amount of curing salt of a white male, brown male, black male, mixed male, white female, brown female, black female, and mixed female Black Bengal goat skins was shown in Table 5. The amount of curing salt in the wet salting method was found highest in brown males and lowest in white females. Irrespective of age, it was seen that the highest amount of curing salt was required in brown males as its thickness was maximum out of other color

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

Category	Number (n)	Thickness					
		Butt (Mean ± SD)	LS	Belly (Mean ± SD)	LS	Shoulder (Mean ± SD)	LS
White male	21	1.99 ± 0.13		1.42±0.11		1.69 ± 0.11	
Brown male	20	2.00 ± 0.14		1.47 ± 0.13		1.73 ± 0.11	
Black male	116	2.03 ± 0.16		1.46 ± 0.14		1.71 ± 0.13	
Mixed male	61	1.97 ± 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 ( $p > 0.05$ ).

**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

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

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

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

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

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

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





categories. Moreover, there was a low significant difference ( $p < 0.05$ ) in curing salt use at Black Bengal goatskin coat colors.

The present research found that only on Tuesday cured goat skins were delivered to 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 brown (9%), and white (9%) together. The mean skin weight of the Black Bengal goat was 998.80 gm whereas 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 colors. 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 males 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 the 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 the butt (1.97 mm), intermediate in the shoulder (1.69 mm), and then in the belly (1.43 mm) for all categories of skins. In the belly and shoulder regions, the thickness was highly significant ( $p < 0.01$ ) difference whereas in the butt region, it was a low significant ( $p < 0.05$ ) difference. All slaughtered animals were flayed using the “Muchki” (Hoisting and fisting) method. The average flays cut length, flay cut depth, and 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 average of 665.50 gm of 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 of 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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