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Research Article

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Superficial muscles of black Bengal goat (*Capra hircus*): An especial emphasis on goat meat cut

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A B S T R A C T

Goat meat has created new opportunities both in domestic and export markets in Bangladesh for value addition to the meat supply chain. Meat cuts of goats are often seen in the supermarkets in the different city corporation markets throughout the country. This study aims to explore the superficial muscle anatomy of the Black Bengal goat (BBG) and propose a framework for anatomically informed ideal meat cuts using adult BBG (n=10). The goats were collected from nearby local market of Bangladesh agricultural University (BAU), Mymensingh, and sacrificed (pentobarbital sodium @ 20 mg/kg body weight, i/m followed by bled to death giving incision on the right common carotid artery) then fixed using 10% formalin infusion. After careful removal of the skin, the anatomically classified body regions (head, neck, thorax, abdomen, forelimb, and hindlimb) were mapped according to the popular meat cuts available in supermarkets. The whole body was divided and categorized as nine meat cuts, namely neck (neck chops), shoulder (Forequarter, rack/chop), rib (rack, cutlets), loin (loin chop, tenderloin), leg (leg steak), hind-shank (shank, drumstick), flank, breast, and foreshank (shank, drumstick). The superficial and mostly contributing muscles to the specific cut were observed considering the origin, various parts, prominent characteristics, insertion, and gross appearance with their associated structure. Anatomical knowledge from this research will primarily help butchers to obtain optimum meat cuts, as well as anatomists, students of veterinary medicine, and related research personnel.

INTRODUCTION

Goat farming plays a pivotal role in the agricultural economy of Bangladesh, particularly in rural and semi-urban areas where smallholder farmers rely on livestock for income, nutrition, and livelihood security. The Black Bengal goat (BBG) stands out as the most dominant (representing over 90% of the national goat population) and socio-economically significant among the various goat breeds reared in the country (Siddik *et al*., 2019). The consumption of goat meat is the most popular and special socio-cultural prestige since it has no religious taboos like beef (Chowdhury and Faruque, 2004). Goat meat locally known as chevon is highly prioritized due to tenderness, appealing flavor, and low-fat content, making it a preferred protein source across all socioeconomic groups (Siddik *et al*., 2019; Chowdhury *et al*., 2019).

Moreover, the growing demand for high-quality goat meat both in domestic and export markets has created new opportunities for value addition to the meat supply chain. The halal meat industry has shown increasing interest in Bangladeshi goat meat due to its flavor profile and lean composition (Siddik *et al*., 2019). Now a days meat cuts of meat animals (cattle and goat) are often seen in the supermarket like Shopnow, MinaBazar etc. in the different city corporation markets of Bangladesh. To capitalize on this potential, it is imperative to align traditional practices with

scientific knowledge, especially in the areas of carcass processing and meat standardization.

Despite its popularity among Bangladeshi meat consumers, scientific understanding of the BBG's anatomical and physiological properties remains limited, especially in terms of meat production and processing. Traditional slaughtering procedures in Bangladesh are mostly informal and dependent on family history rather than anatomical precision (Kamali *et al.*, 2021; Apu *et al.*, 2025). As a result, meat cuts are often inconsistent, leading to suboptimal carcass utilization and reduced commercial value.

In contrast, muscle anatomy based consistent meat-cutting techniques can considerably boost meat quality, consumer pleasure, and market competitiveness, both domestically and globally (Dey *et al.*, 2019).

The superficial musculature of meat animal is a critical determinant of meat yield and quality. For goats, superficial muscles such as the longissimus dorsi, biceps femoris, semimembranosus, and gluteus medius contribute significantly to the most valuable meat cuts. However, there is a dearth of anatomical studies that can enhance cut quality resulting in an increased meat yield.

This study aims to bridge that gap by examining the superficial muscle anatomy of the BBG and proposing a framework for anatomically informed meat cuts. By doing so, it seeks to enhance the efficiency of meat processing, improve product consistency, and support the livelihoods of rural butchers and farmers. The findings are expected to contribute to the broader goals of food security, rural development, and livestock sector modernization in Bangladesh.

MATERIALS AND METHOD

This study was conducted to examine the superficial musculature of the Black Bengal goat (*Capra hircus*) with special emphasis on meat-cut. The research was carried out at the Department of Anatomy and Histology, Faculty of Veterinary Science, Bangladesh Agricultural University (BAU), Mymensingh, between January 2022 to June 2024.

Ethical Considerations

All procedures involving animals were conducted in accordance with the ethical guidelines of the Bangladesh Agricultural University Animal Ethics Committee (Approval No. BAU-AEC-2025-03).

Selection of Animals

A total of 10 (ten) apparently healthy adult male (n=3) and female (n=3) Black Bengal goats (*Capra hircus*) 1.5 and 2 years (body weight ranging from 14-20 kg) were used for the present study. The goats were sourced from local livestock markets in the Mymensingh districts, where the breed is commonly reared under semi-intensive systems. Selection criteria included uniformity in body weight, absence of visible deformities, and a history of routine vaccination and deworming.

Sacrifice and Dissection

All goats were sacrificed using pentobarbital sodium @ 20 mg/kg body weight (I/m) followed by bled to death giving incision on the right common carotid artery. Circulatory blood form all the internal organs were flashed out using normal saline through the opening of a common carotid artery. Immediately after proper bleeding, four BBG (2 male and 2 female) the skin was removed very carefully keeping the subcutaneous fat fascia intact with the help of scalpel, scissors and forceps. Another of two BBG, an adequate amount of 10% formalin was injected for well preservation of the whole animal (n=2) using the same route. Followed by formalin injections, the animals were placed on the dissecting table for 24 hours to ensure optimum fixation. Then, the skin was removed very carefully keeping the subcutaneous fat fascia intact with the help of scalpel, scissors and forceps.

Anatomical Mapping

Removing the skin, the superficial muscles from the different regions of the whole body and areas different meat cuts were carefully examined and surgically isolated, transected and studied following origin and insertion (Figs. 1 and 2). After careful dissection of the skin and superficial fascia, the anatomically divided body region was compared with the topographic location of each meat cut obtained for meat industry (Figure 2). Photographs were taken during dissection.

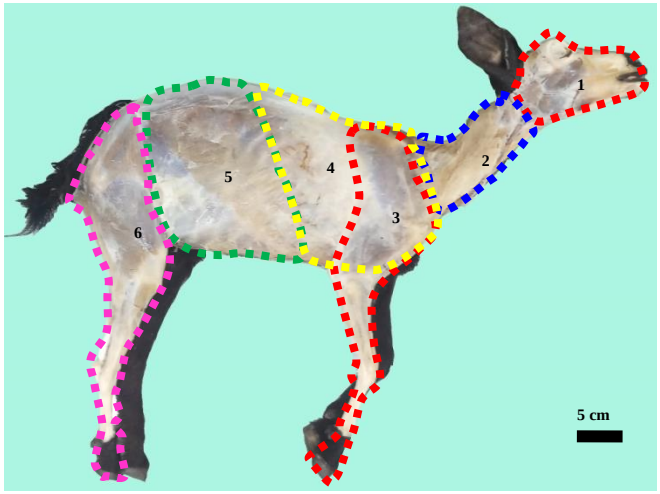

Figure 1: Different anatomical regions of the body emphasize superficial muscles in goat (right lateral view). 1. Head region, 2. Neck region, 3. Fore limb region, 4. Thoracic region, 5. Abdomen region, 6. Hind limb.

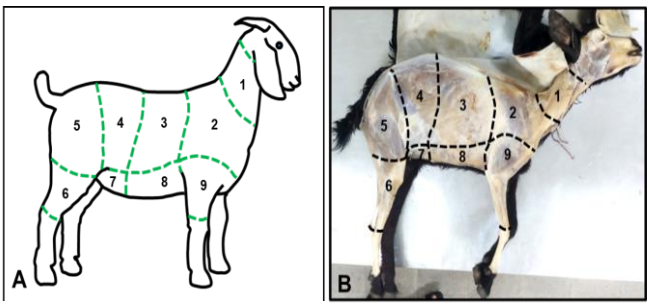

Figure 2A: Schematic diagram showing main goat meat cut areas of the body in goat. B. Main meat cuts areas of the body based on superficial muscles in goat (right lateral view). 1. Neck (neck chops), 2. Shoulder (Forequarter, rack/chop), 3. Rib (Rack, Cutlets) 4. Lion (Loin chop, Tenderloin), 5. Leg (Leg steak), 6. Hind shank (Shank, Drumstick), 7. Flank, 8. Brest and 9. Fore shank (Shank, Drumstick).

Photograph and Imaging Processing

Photographs were taken during dissection with a digital camera (DS-Fi1, Nikon, Tokyo, Japan). Adjustment of photographs for contrast, brightness and sharpness, layout, and lettering were performed in Adobe Photoshop 7.0J and Adobe Illustrator 10.0J.

RESULTS

This research was focused on categorizing the regional superficial muscles of goat which are involved to yield a particular meat cut. Based on the popular meat cut name, muscles involved in the meat cut have been described as follows:

Superficial muscles involved obtaining a neck chop

Anatomically, the muscles of the neck can be described as two groups namely muscles of the lateral cervical group and muscles of the ventral cervical group (Figures 3,4A). The prior knowledge of those muscles constitutes the lateral and ventral cervical of the neck is important for the neck chop cut. The brief description and characteristics of those muscles are as follows.

Brachiocephalicus: It is a long and flat muscle placed diagonally at the side of the neck. It has two parts, namely dorsal and ventral. The dorsal part originates from the occipital bone and ligamentum nuchae, whereas ventral part originates from temporal bone, wings of the atlas and mandible. However, both the dorsal and ventral parts unite and insert to the cranial border of the musculo-spiral groove of humerus (Figure 3).

Sterno-mandibulari: It is a long fleshy band of muscle which terminates by some tendinous fibers upon the ventral borders of the ramus of the mandible. It originates caudally attached with the manubrium of the sternum and the first costal cartilage and inserts on the ventral border of the mandible and zygomatic arch.

Sternothyrohyoideus: It was seen on the ventral surface of the trachea. Originates from the cartilage of the manubrium of the sternum and inserts on the lateral surface of the thyroid cartilage of the larynx.

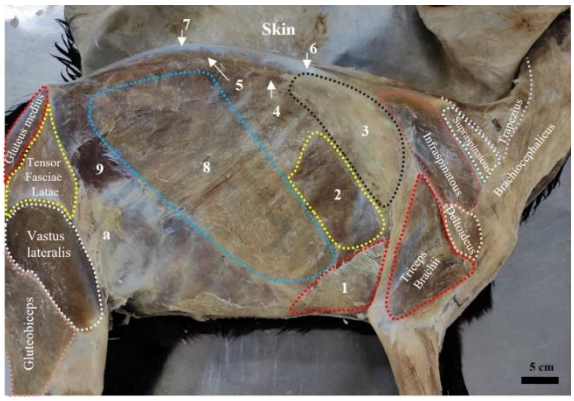

Figure 3: Superficial muscles of thorax and abdomen in goat (Right lateral view). 1. Pectoralis ascendens, 2. Serratus ventralis, 3. Latissimus dorsi, 4. Serratus dorsalis caudalis 5. Iliocostalis, 6. Longissimus thoracis, 7. Longissimus lumborum., 8. Obliquus externus abdominis, 9. Obliquus internus abdominis, a. Aponeurosis

Superficial muscles involved obtaining a cut from Shoulder (Forequarter, rack/chop)

Anatomically, shoulder region belongs to the first segment of the forelimb of goat, Shoulder regions contribute to obtaining a forequarter rack or chop cut from goat which includes the muscles of scapula and arm. Brief description of these muscles is as follows.

Supraspinatus muscle: This is a flat muscle, occupies the fossa of the scapula. It originates from the supraspinous fossa, the spine and the ventral part of the cartilage of the scapula and inserts on the cranial portion of both proximal tubercles of the humerus (the lesser and greater tubercles) (Figures 3 and 4A).

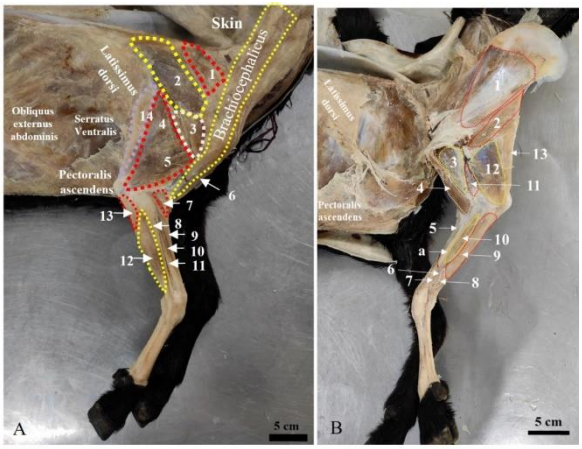

Figure 4: Superficial muscles of forelimb in goat.

A. Right lateral view. 1. Supraspinatus, 2. Infraspinatus, 3. Deltoideus, 4. Long head of triceps brachii, 5. Lateral head of triceps brachii, 6. Subclavius, 7. Brachialis, 8. Extensor digitorum lateralis, 9. Extensor carpi radialis, 10. Extensor digiti III, 11. Extensor digitorum communis, 12, Ulnaris lateralis, 13. Ulnar head of flexor digitorum profundus and 14. Tensor fasciae antebrachia. B. Medial view: 1. Subscapularis 2. Teres major 3. Coracobrachialis 4. Biceps brachii 5. Extensor carpi radialis 6. Deep head of flexor digitorum superficialis 7. Flexor digitorum profundus 8. Superficial head of flexor digitorum superficialis 9. Flexor carpi ulnaris 10. Flexor carpi radialis 11. Medial head of triceps brachii 12. Long head of triceps brachii 13. Tensor fasciae antebrachia, a. Radius.

Infraspinatus muscle: This muscle originated from the infraspinous fossa, spine of the scapula and scapular cartilage and inserted on the medial surface, caudal part of the greater tubercle of the humerus. The large, flat, superficial cartilaginous tendon inserts on the cranial portion of the greater tubercle, while the small deep, fleshy insertion is on the caudal aspect of the greater tubercle in the goat (Figures 3 and 4A).

Subscapular muscle: The subscapularis is a muscle on the medial surface which occupies the subscapular fossa of the scapula medially. It originated from the scapular cartilage and inserted on the lesser tubercle of the humerus (Figure 4B).

Teres major muscle: The teres major muscle originated from the caudal border and adjoining caudal angle of the scapula, as well as the subscapularis and inserted on the teres

tuberosity of the humerus, where it relates to the terminal tendon of the latissimus dorsi (Figure 4B).

Teres minor muscle: It contributes very little.

Triceps brachii: Triceps brachii is the major extensor muscle of the elbow, fills the angle between the caudal border of the scapula and humerus. It is composed of three heads, namely long (Figures 4A-B), lateral (Figure 4A), and medial head (Figure 4B). The long head arises from the caudal border of the scapula (Figures 4A-B) whereas the lateral head arises from the deltoid tuberosity and the curved rough line of the humerus (Figure 4A). The long head inserted on the lateral and caudal parts of the olecranon. The lateral head on the lateral surface of the olecranon and the tendon of the long head.

Biceps brachii: It originated from the supraglenoid tubercle of the scapula and inserted on the radial tuberosity, the medial collateral ligament of the elbow joint, a small tendon passing medially to join the pronator teres and the antebrachial fascia (Figure 4B).

Latissimus dorsi: It is a very thin and wide muscle spread across the dorsolateral aspect of the thorax. It originates from the lumbar and dorsal spines and inserts at the tuberosity of the humerus by blending with the tendons of the teres major (Figure 3).

Trapezius: It is thin and triangular muscle. It has two parts, namely cervical and thoracic. It originates from the supraspinous processes from the level of the 12th thoracic vertebra to atlas inserts on the scapular spine and fascia of shoulder and the arm (Figure 3).

Deltoideus: The acromion of the scapula, the spine of the scapula by means of the aponeurotic covering of the infraspinatus, and the caudal border of the scapula. Originated from the deltoid tuberosity inserted into the fascia covering the triceps brachii (Figure 4A).

Tensor fasciae antebrachia: It is a slender muscle, extending from the caudal angle of the scapula to the medial side of the olecranon. It originates from triceps brachii. It is terminated by a narrow, flat tendon on the medial surface of the olecranon and the antebrachial facia (Figure 4A).

Superficial muscles involved obtaining a cut from Rib (Rack, Cutlets)

The meat cut from the ribs and associated muscles of goat constitutes the goat rack or cutlets. The contributory muscles are as follows.

Longissimus thoracis: This muscle is a part of longissimus dorsi; connects the lumbar region to the ribs and thoracic vertebra. It originated from the dorsal surface of the sacrum, iliac crest, spinous and transverse processes of the lumbar vertebrae. Inserted on the transverse process of the thoracic vertebrae and dorsal aspect of the ribs (Figure 3).

Inter-costales muscles: It consists of two muscles: externi and interni for the intercostal spaces between the ribs (Figure 3).

Serratus muscles: The serratus muscles are two types, namely dorsalis and ventralis.

The serratus ventralis is a large, fan-shaped muscle on the lateral surface of the neck and thorax which originates from the transverse processes of the last four or five cervical vertebrae whereas inserts on a large triangular area on the cranial dorsal part of the costal surface of the scapula by an extensive subscapular attachment (Figure 3).

The dorsalis muscles are two, namely cranial and caudal. Originates from the areas of the dorsolateral aspect of the thoracic wall. Inserts on the cranial and lateral border of the 6 to 9th ribs (Figure 3).

Superficial muscles involved obtaining a cut from Loin (Loin chop, Tenderloin)

The longissimus thoracis et lumborum: It occupies the angle formed by the spines of the thoracic and lumbar vertebrae and the ribs and lumbar transverse processes. Originates from the crest and cranioventral surface of the ilium, the sacral spines, the lumbar and thoracic spines and the supraspinous ligament. Inserts on the transverse processes of the lumbar, thoracic and last three or four cervical vertebrae, as well as the spines of the last three or four cervical vertebrae (Figure 3).

Psoas muscles: It consists of two muscles namely, psoas major and minor.

Obliquus externus abdominis muscle: It is an extensive, broad and irregularly triangular muscle of the abdomen which originates from the caudal border and lateral surface of the last eight ribs and fascia over the intercostal muscles. It begun at the ventral part of the fifth intercostal space and ends on the last rib dorsal to its middle. It is inserted by means of the aponeurotic tissue to the coxal tuber, prepubic tendon and linea alba (Figures 3 and 5).

Obliquus internus abdominis muscle: It is also broad muscle located just beneath the obliquus externus abdominis. Originating from the coxal tuber and the deep lumbar fascia at the lateral border of the longissimus lumborum inserts on the caudal border of the last rib, the prepubic tendon and the linea alba (Figures 3 and 5).

Superficial muscles involved obtaining a cut from Leg (leg steak)

Muscles contributing to constitute the leg steak cut of goat meat are as follows.

Semimembranosus: This is a long, thick, fleshy muscle which lies on the caudal aspect of the rump. Originates from the ventral surface of the ischiatic tuber and the ischium. Inserts on the larger proximal insertion into the medial epicondyle of the femur (Figures 5A).

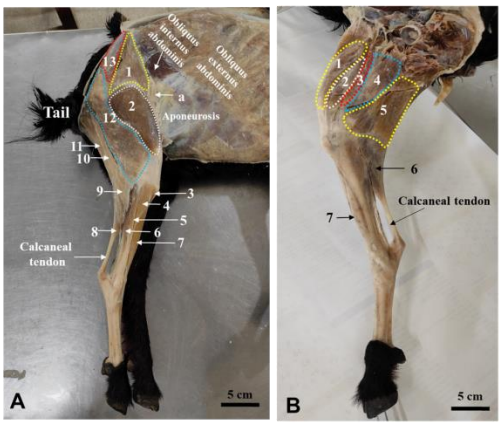

Figure 5: Superficial muscles of hind limb in goat. **A. Right lateral: 1**. Tensor fasciae latae, 2. Vastus lateralis, 3. Tibialis cranialis, 4. Fibularis longus, 5. Extensor digitorum lateralis,

6. Flexor digitorum profundus, 7. Fibularis tertius, 8. Flexor digitorum superficialis, 9. Gastrocnameus, 10. Semitendinosus, 11. Semimembranosus, 12. Gluteobiceps, 13. Gluteus medius, a. Sub-iliac Lymphnode. **B. Medial View**: 1. Rectus femoris 2. Vastus medialis 3. Sartorius 4. pectineus 5. Gracilis 6. Gastrocnemius 7. Fibularis tertius

Semitendinosus: It is a long, fleshy, fusiform muscle, lying on the caudolateral aspect of the rump very closely attached to the semimembranosus muscle. Originates from the caudoventral surface of the ischiatic tuber and the gluteo-biceps and inserts on the calcaneal tuber and into the crural fascia (Figure 5A).

Biceps femoris and adductor: Small muscle contributes a little

Gastrocnemius: It is a large, fleshy muscle composed of a medial and lateral head of nearly equal size. The lateral and medial head originated from the lateral supra-condyloid tuberosity, the cranial border of the lateral epicondyle of the femur and distal most portions of the medial supra-condyloid tuberosity as well as the medial epicondyle of the femur respectively. Inserts by very strong, combined tendons to the calcaneal tuber (Figure 5A).

Quadriceps femoris also contribute obtaining the cut. A fleshly muscle has four parts, vastus lateralis, rectus femoris, vastus medialis, and vastus intermedius.

Superficial muscles involved obtaining a cut from Hind-shank (Shank, Drumstick)

The muscles that contribute to forming the cut for hind-shank are categorized into two major groups as extensor and flexor group of muscles as follows

Fibularis tertius: It is superficial, fusiform muscle originated by a strong, round tendon from the extensor fossa of the femur in common with the extensor digitorum longus. Inserted on the tendon of insertion bifurcates to both a medial and lateral tendon (Figure 5B).

Tibialis cranialis: It is the deepest among the extensor muscle group. It is a thin muscle lying on the craniolateral side of the tibia (lateral to the cranial border of the tibia). Caudally originates from the lateral surface of the tibial tuberosity, the cranial border of the tibia and the proximal portion of the body of the tibia. Laterally, it originates from the lateral condyle of the tibia and vestigial head of the fibula. Inserted on the first tarsal bone and the fused second and third tarsal bones, as well as the large metatarsal bone (Figure 5B).

The flexor digitorum profundus: It is a complex muscle composed of three heads and lying on the caudolateral surface of the tibia. Originates from the caudal edge of the lateral condyle of the tibia, the caudolateral surface of the tibia, caudal border of the head of the fibula and the interosseous ligament. Inserted on the flexor tubercle of the distal phalanges of the third and fourth digits (Figure 5A).

Superficial muscles involved obtaining a cut from flank

The muscles involved in flank cut (Figure 3) are as follows

a) Part of external (superficial, fibers directed ventrad and caudad) and internal (deep, fibers are directed ventrad, craniad and mediad) oblique muscles.
b) Rectus abdominis muscle, straight muscles run eighter side of the linea alba from the xiphod cartilage to prepubic tendon.
c) Transverse abdominis muscle, fiber directed transversely and originated from the first five lumbar transverse processes and inserted into the linea alba

Superficial muscles involved obtaining a cut from pectoral region (breast cut)

The muscle involved in breast cut is pectoral muscles (Figure 3) and associated costal cartilage, connective tissues and fat.

a) Superficial pectoral muscles were widely extensive.
b) Deep pectoral muscles

Superficial muscles involved obtaining a cut from foreshank (Shank, Drumstick)

It lies on the lateral surface of the leg, between the remainder of the extensor group and the flexors of the limb. Originates from the lateral collateral ligament, lateral condyle of the tibia and vestigial head of the fibula. Inserts on the base and dorsal surface of the middle phalanx of the fourth (lateral) digit (Figure 4A).

Extensor carpi radialis: The largest muscle of the extensor group. Originates from the lateral epicondyloid crest of the humerus, radial fossa and intermuscular septum between this muscle and the extensor digitorum communis. Terminates as a broad and flat tendon of the metacarpal tuberosity (Figure 4A).

Extensor digitorum communis: The lateral and medial belly arises from the radial fossa, lateral epicondyle of the humerus, the fascia over the elbow joint, and radial fossa, lateral epicondyle of the humerus respectively. Inserted on the extensor process of the distal phalanges of the third and fourth digits (Figure 4A).

Ulnaris lateralis: Originates from the lateral epicondyle of the humerus. Inserted on the lateral surface and proximal border of the accessory carpal bone, the smaller, thin carpal cranial tendon passes over the accessory bone to insert into the lateral surface of the proximal end or base of the large metacarpal bone (Figure 4A).

Ulnar head of the flexor digitorum profundus: Originated from the medial, caudal and lateral surfaces of the proximal end of the ulna. Inserted on the flexor tubercle of the distal phalanx of the third and fourth digits (Figure 4A).

The flexor digitorum superficialis: It is divided into two bellies, superficial and deep terminating on tendons at the distal part of the forearm. Originates from the medial epicondyle of the humerus. Inserts on the proximal extremity of the surface of the middle phalanx of the third and fourth digits (Figure 4B).

DISCUSSION

Goats are the earliest domesticated animals among the ruminants and traditional source of animal protein (Hwang *et al.*, 2019). Nowadys, goat meat has achieved a good source of earnings in tropical and developing countries due to comfortably manageable, tasty, and tender quality of meat (van Wyk *et al.*, 2021; Hwang *et al.*, 2019; Park, 1990). Additionally, goat meat is also used as traditional medicine in some countries like Korea (Hwang *et al.*, 2019). However,

the significant increased demand as a meat and economic source has exposed the field and opportunity for meat industry in developing country like Bangladesh. As goat meat quality traits are directly influenced by the anatomical location of the muscles (Hwang *et al.*, 2019), the knowledge of superficial muscles can boost the way to achieve a good quality meat cut. Moreover, the anatomical location of superficial muscles in the Black Bengal goat plays a pivotal role in determining the quality and value of specific meat cuts. In contrary, the concept of anatomical knowledge of goat muscles can contribute to yield goat meat cut is yet to report. Additionally, the butcher house practices are mostly ancient and traditional in Bangladesh. Topographic knowledge of muscles is very important to obtain a good cut and the ultimate consumer satisfaction. Because superficial muscles are more accessible and less involved with the bone or connective tissue attachment. They are often preferred for retail cuts due to their ease of separation and desirable texture (Ali *et al.*, 2021). On the other hand, the distribution and size of these muscles across different anatomical regions such as the loin, leg, shoulder, and breast directly influence the tenderness, juiciness, and flavor profile of the resulting meat cuts (Leng *et al.*, 2024). Muscles located in areas subjected to less physical activity, such as the loin, typically yield more tender and palatable cuts, making them highly sought after in both local and commercial markets. In contrast, superficial muscles from more active regions, like the shoulder or leg, may be less tender but are valued for their robust flavor and suitability for slow-cooking methods (Ali *et al.*, 2021). The anatomical mapping of these muscles is therefore essential for optimizing carcass utilization, ensuring that each cut is directed toward its most appropriate culinary use (Amin *et al.*, 2000; Ali *et al.*, 2021). Furthermore, understanding the precise location of superficial muscles aids butchers and processors in standardizing meat cuts, which is crucial for maintaining consistency in quality and meeting consumer expectations (Amin *et al.*, 2000). This anatomical knowledge also supports the development of value-added products and can inform breeding and management practices aimed at enhancing the yield of premium cuts (Long *et al.*, 2025; Leng *et al.*, 2024). In the context of the Black Bengal goat, renowned for its adaptability and meat quality, strategic utilization of superficial muscle location can maximize economic returns and promote sustainable meat production practices (Amin *et al.*, 2000; Ali *et al.*, 2021).

CONCLUSIONS

In summary, the anatomical location of superficial muscles is a key determinant in the classification, quality, and marketability of meat cuts from the Black Bengal goat, underscoring the importance of detailed anatomical studies for the advancement of the goat meat industry.

The knowledge of butchers from markets is very shallow in terms of meat cutting. The research findings will help achieve more precise cuts, maximizing yield and reducing waste. It will guide butchers, and automated systems adapt to differences in carcass size, fat distribution, and muscle structure, leading to consistent product quality and efficient processing.

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Conflicts of interest

There is no conflict of interest among the authors.

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