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Anatomical and Histological Features in Muscles of Wild Boar (*Sus scrofa*) from Timor Island

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ABSTRACT

The anatomical features and histology of wild boars serve as two parameters for assessing the quality of wild boar meat. This study aimed to identify the anatomical and histological characteristics of wild boar muscles (*Sus scrofa*) from Timor Island, with potential benefits for the community and veterinary students. The research samples were the longissimus dorsi and biceps femoris muscles from three wild boars slaughtered in the laboratory. Muscle samples were prepared for anatomical observations. Muscle samples were anatomically observed, fixed in 10% alcohol, and then prepared for histological analysis using Hematoxylin and Eosin (HE) staining. The anatomical observation indicated that the boar's muscles exhibited a blackish-red coloration. The longissimus dorsi muscles had a chewy consistency, while the biceps femoris muscles were also chewy, displaying slight density and the distinctive aroma of fresh meat. Histological images indicated that muscle fibers appeared polygonal in shape in transverse sections, while elongated in longitudinal sections. Some fasciculi composed of muscle fibers exhibited multiple nuclei located at their peripheries. Between the muscle fibers, round fat cells with a nucleus were surrounded by three types of connective tissue. The histological characteristics of wild boar exhibit similarities to those of the Timor pig, Sumatran Ongole cattle, and Bali cattle.

Keywords: anatomy, Wild boar, Histology, Muscle

ABSTRAK

Gambaran anatomi dan histologi babi hutan merupakan dua parameter yang dapat digunakan untuk menentukan kualitas dari daging babi hutan. Tujuan dari penelitian ini adalah untuk mengetahui gambaran anatomi dan histologi otot babi hutan (*Sus scrofa*) asal Pulau Timor yang dapat bermanfaat bagi masyarakat dan mahasiswa kedokteran hewan. Sampel penelitian yang digunakan adalah otot longissimus dorsi dan bicep femoris dari tiga ekor babi hutan. Sampel otot kemudian diamati secara anatomi dan histologi. Sampel otot yang telah diamati secara anatomi kemudian difiksasi menggunakan formalin 10%, dilanjutkan dengan pembuatan preparat histologi serta pewarnaan Hematoksilin-Eosin (HE). Gambaran anatomi yang diamati menunjukkan bahwa otot babi hutan berwarna merah kehitaman, dengan konsistensi otot *longissimus dorsi* yang kenyal, sedangkan otot *biceps femoris* memiliki konsistensi kenyal, sedikit padat, dan berbau khas daging segar. Gambaran histologi menunjukan pada potongan transversal serabut otot akan terlihat berbentuk poligonal dan pada potongan longitudinal serabut otot akan terlihat memanjang. Terdapat beberapa fasikulus yang dibentuk oleh serabut otot juga memiliki inti banyak di tepinya. Terdapat sel lemak diantara serabut otot yang berbentuk bulat, inti sel lemak dan tiga jaringan ikat. Dapat disimpulkan bahwa gambaran histologi babi hutan memiliki kemiripan dengan babi timor, sapi sumba ongole, dan sapi bali.

Kata kunci: Anatomi, Babi Hutan, Histologi, Otot

INTRODUCTION

Wild boars in tropical areas are nocturnal animals, indicating their activity primarily occurs at night. Wild boars are sometimes active during the day, with peak activity in the late afternoon and early evening. Wild boars frequently engage in foraging activities, utilizing trails established by other large mammals (Winarno & Harianto, 2018).

Omnivorous animals, such as pigs, consume both plant-based and animal-based foods (Supriadi, 2014). Wild boars (*Sus scrofa*) inhabit nearly all islands in Indonesia. Wild boars (*Sus scrofa*) inhabit various environments, including semi-deserts, temperate forests, grasslands, and tropical forests.

Wild boars are wild animals often hunted by local communities. Their popularity stems from their unique flavor, tender meat, and low fat content (65.28%) (Rompis & Komansilan, 2014). Meat comprises various components, including muscle, connective tissue, and fat. Additionally, it comprises other elements, including bones, blood vessels, and nerve tissue. Meat refers to the portion of an animal's body composed of muscles that have undergone biochemical and biophysical transformations following slaughter or butchering. (Melania Br Tarigan *et al*., 2020).

Meat offers numerous advantages and is classified as one of the nine staple foods in Indonesia, leading to a variety of meat-based processed products. Meat typically comprises water, protein, fat, carbohydrates, and vitamins. The nutritional composition of meat differs based on its origin (Zahra *et al.,* 2023).

The increasing demand for wild boar meat (*Sus scrofa*) in East Nusa Tenggara (NTT) has resulted in a surge in pork sales. Given the prevalence of disease outbreaks in pigs, consumers need to understand how to identify safe pork for consumption physically. One important factor to consider when selecting meat for consumption is its tenderness. The tenderness of meat is determined by its primary components: muscle and connective tissue. Meat consists of connective tissue composed of cylindrical muscle fibers with highly variable diameters (Suwiti et al., 2015). Muscle tissue is categorized into three types according to histological features, anatomical location, and neural regulation: skeletal muscle, cardiac muscle, and smooth muscle (Wangko, 2014). This study aimed to identify the anatomical features associated with color, odor, and consistency that may benefit the public and the histological characteristics that can enhance understanding in related disciplines.

MATERIALS AND METHODS

Preparation of Tools and Materials

The equipment utilized included necropsy surgical instruments (surgical knife, surgical scissors), an embedding station, measuring cups, a hot plate, an incubator, tissue cassettes, a light microscope, a digital microscope, a fixation board, a ruler, sample pots, razor blades, a rotary microtome, and a water bath. The materials utilized included cover glass, masks, 10% formalin, distilled water, xylol, alcohol (70%, 80%, 90%, 100%), hematoxylin solution, eosin solution, paraffin, label paper, plastic trays, gloves, object glasses, and tissue.

Sample Preparation

Three wild boars were obtained from Camplong Forest. The wild boars were hunted and then slaughtered by exsanguination of the jugular vein and common carotid artery in the neck. Muscle samples were collected from the Longissimus dorsi in the back and the Biceps femoris in the hind legs. The Biceps femoris muscle, which plays a role in knee flexion and hip extension, is more active in movement than the Longissimus dorsi muscle, which primarily functions in maintaining posture. All methods used in this study were approved by the Research Ethics Committee, Faculty of Veterinary Medicine, Airlangga University (Certificate No. 1. KEH 087.06.2024). The samples were cut and placed in sample pots containing 10% formalin fixation solution measuring 3 cm^3. A total of six muscle samples were collected. The sample pots were then labeled according to the name of the muscle.

Observation

Two observations were made: anatomical and histological. Anatomical observation, including color, odor, and consistency, was conducted prior to placing the samples in the sample box. Histological observations were performed following the preparation of slides and staining with Hematoxylin and Eosin. Histological images were analyzed with a light microscope and a QBC® FM microscope, utilizing magnifications of 4x, 10x, and 40x.

Data Analysis

The research data were analyzed using descriptive methods and presented as figures.

RESULTS

Anatomical Description

Anatomical observations of the Longissimus dorsi (LD) and Biceps femoris (BF) muscles indicated that both muscles exhibited a dark red coloration. The LD muscle exhibited a soft consistency, whereas the BF muscle displayed a soft consistency with a slightly firm texture and a fresh meat odor (Figure 1). Anatomical observations were performed following the collection of muscle samples.

The LD muscle was situated on the back, while the BF muscle was found on the hind legs of wild boars. The muscles were observable by skinning the back and hind legs of a wild boar.

The dark red hue of wild boar (*Sus scrofa*) meat may result from heightened physical activity. The LD and BF muscles maintained their firmness and did not release water or become mushy upon pressure application. They emit a fresh meat aroma, lacking any signs of rot or sourness.

Histological description

The histological examination of wild boar muscle from Timor Island, as depicted in the transverse section (Figure 2), reveals that the muscle is composed of multiple fascicles. Fascicles, also known as bundles, consist of collections of muscle fibers. Each fascicle is separated by connective tissue. The

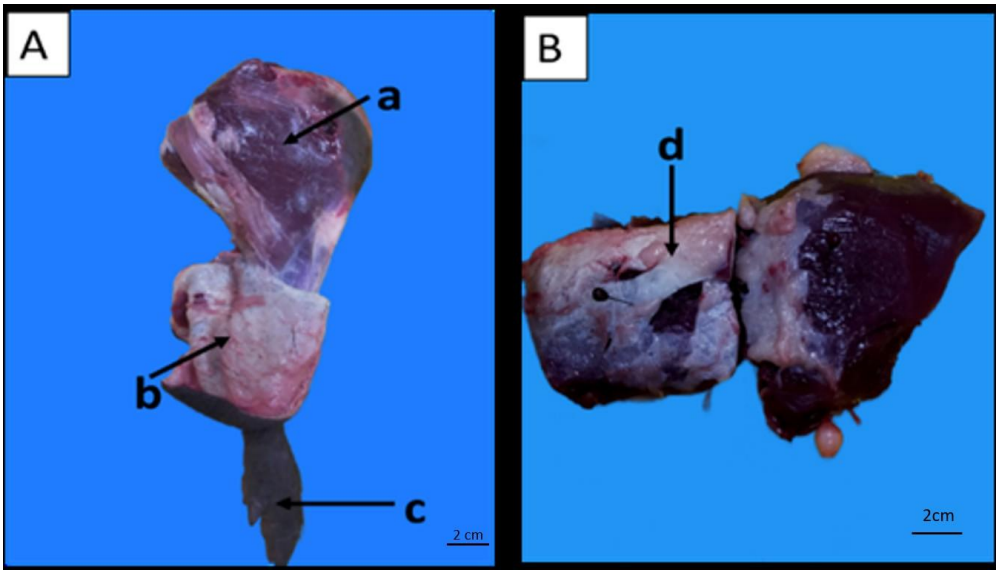

Figure 1. Macroscopic description of wild boar (*Sus scrofa*) muscle from Timor Island. A. Hind leg and B. *Longissimus dorsi* muscle. a. *Biceps femoris* muscle, b. skin, c. hind leg, d. fascia.

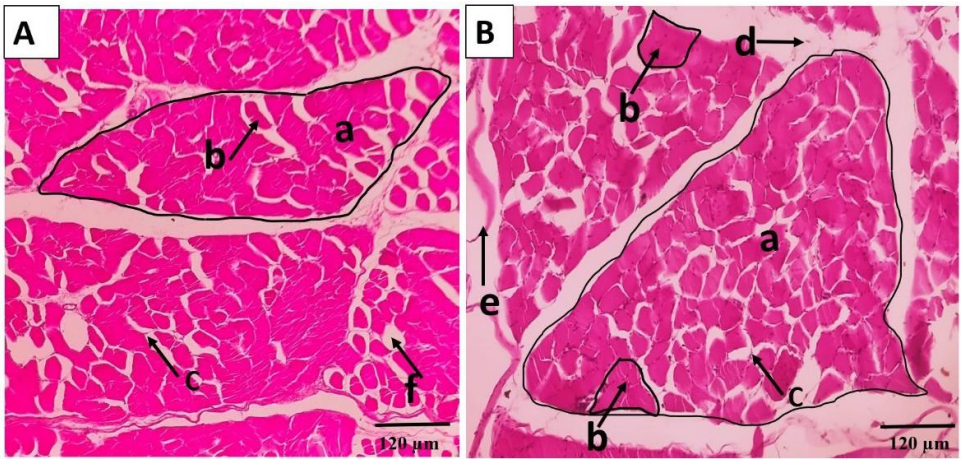

Figure 2 Microscopic image of Wild Boar Muscle (*Sus scrofa*) from Timor Island, transverse section. Figure A. Longissimus dorsi muscle and Figure B. Biceps femoris muscle. a. fascicle, b. muscle fiber, c. endomysium connective tissue, d. perimysium connective tissue, e. epimysium connective tissue, f. fat cell. (HE 10X).

muscle fibers in the fascicle contain cell nuclei located at the periphery, along with connective tissue. Muscle fibers are polygonal-shaped cells characterized by multiple nuclei located at their peripheries. There are several types of connective tissue in muscle histology, distinguished by their location (Figure 2): endomysium, which surrounds muscle fibers; perimysium, which surrounds and separates each fascicle; and epimysium, which surrounds the muscle.

Observations from the longitudinal section indicate that the histological structure of muscle fibers is characterized by their elongated shape, featuring numerous oval-shaped cell nuclei positioned along the peripheries of the muscle fibers (Figure 4). Based on histological observations, the BF muscle has denser fibers than the LD at 10X magnification.

Round adipocytes were observed in the LD muscle (Figure 3), with the nuclei located at the periphery. Adipocytes were identified interspersed among muscle fibers. Numerous adipocytes were identified in the LD muscle but were absent in the BF muscle.

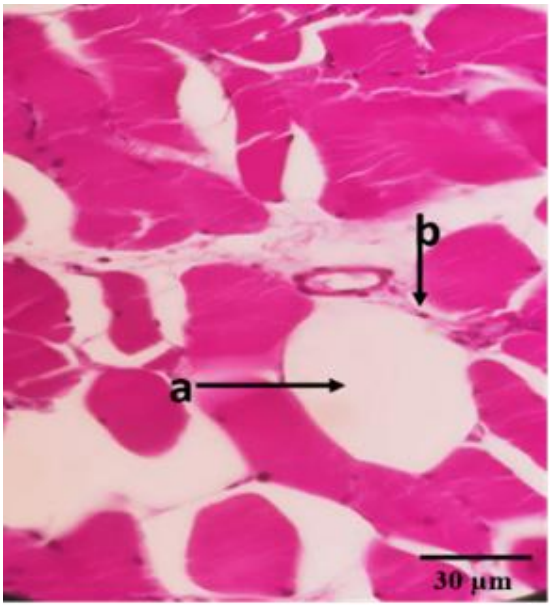

Figure 3. Microscopic Image of Fat Cells in Wild Boar (*Sus scrofa*) Muscle from Timor Island. Transverse section of the Longissimus dorsi muscle. a. fat cells and b. fat cell nuclei. (HE 40X).

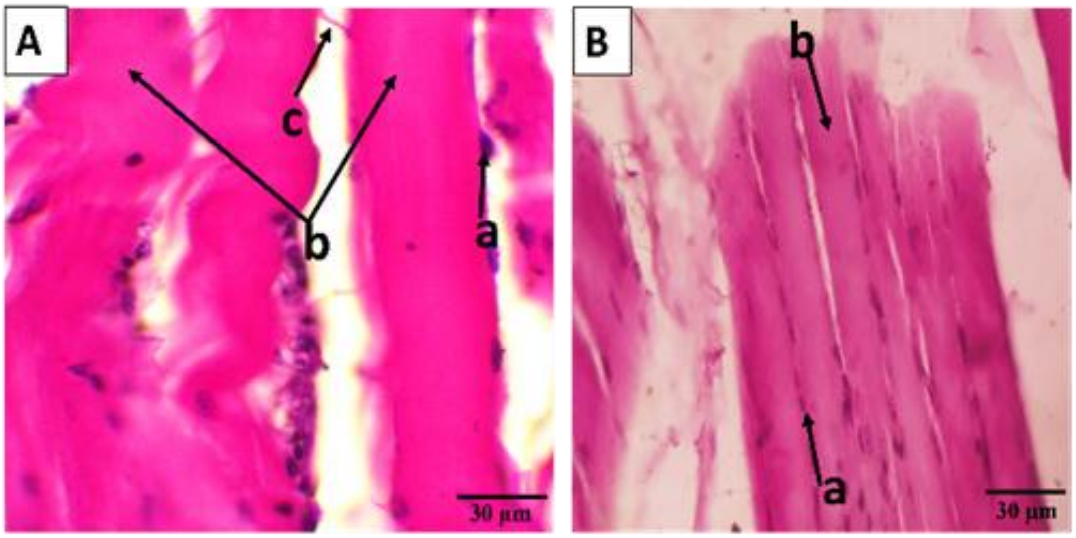

Figure 4. Microscopic image of muscle fibers from wild boars (*Sus scrofa*) from Timo Island, longitudinal section. A. Longissimus dorsi muscle, magnification 40X, and B. Biceps femoris muscle, magnification 10X. a. cell nucleus, b. muscle fiber, c. connective tissue. (HE).

DISCUSSION

Anatomical Description

The LD and BF muscles exhibited a blackish-red coloration. The observed color may result from the elevated activity levels of wild boars engaged in foraging and wallowing (Table 1). The findings are consistent with the study by Muttaqien et al. (2018) on wild boars in Aceh Besar, which indicated that active, uncaged wild boar muscles exhibit elevated myoglobin levels, leading to a red coloration. Nelwan et al. (2016) identify two types of skeletal muscle fibers: type 1 and type 2. Type 1 muscle fibers exhibit a red coloration due to the presence of myoglobin and mitochondria, which facilitate sustained contraction. Type 2 muscle fibers are characterized by a lighter appearance due to the absence of myoglobin and a limited quantity of mitochondria. High-quality meat is characterized by a red color, a shiny surface, the absence of a pale appearance, no sour or rotten odor, a firm consistency, and moisture retention (Naibaho et al., 2013).

Observations of the consistency of LD and BF muscles (Table 1) indicated that LD muscles exhibited a soft consistency, whereas BF muscles displayed a soft consistency with a slightly firmer texture. Upon pressing both muscles, no soft tissues or water-releasing muscles were observed. This study is consistent with the findings of Arimbhawa et al. (2022), which indicated that Bali pork exhibits a tender consistency. Connective tissue is one of the factors influencing consistency. With advancing age in animals, there is an increase in the formation of connective tissue. Connective tissue is more prevalent in older animals (Sihombing et al., 2020). In beef that has lost freshness, characteristics such as elevated moisture content and a pale coloration are noted (Prabowo et al., 2021).

The LD and BF muscles exhibited a fresh meat odor, lacking any signs of rot or sourness. Meat from animals under specific conditions may produce an unpleasant odor, resembling that of rotting flesh. Hasrul et al. (2015) state that meat subjected to rapid microbial growth will experience a degradation of its protein content. Moist conditions in meat lead to a decline in quality, as the high water content promotes microbial decay. This study is consistent with the findings of Adnyana et al. (2023), which indicate that fresh meat or red meat emits a fresh blood odor, whereas spoiled meat lacks this characteristic odor. Dangur et al. (2020) state that fresh meat possesses a distinct fresh meat aroma.

Histological description

The results of this study are in line with the research by Muttaqien *et al*. (2018) on wild boars from Aceh Besar, which found muscle fibers with many cell nuclei at the edges. Histologically, the meat consists of small muscle fibers arranged in bundles surrounded by connective tissue (Safitri et al., 2018; Suwiti, 2008). A collection of muscle fibers forms several fascicles surrounded by connective tissue. Connective tissue in muscles fills the gaps between muscle fibers, separates one fascicle from another, and covers the entire muscle tissue (Amtiran et al., 2021). Suwiti et al. (2015) describe the endomysium as a fine connective tissue characterized by a reticular and capillary structure, while the perimysium is identified as a dense connective tissue rich in collagen. The epimysium is also classified as a dense connective tissue.

The histological structure of muscle fibers in longitudinal sections appears elongated, featuring numerous oval-shaped cell nuclei positioned at the peripheries. This structure aligns with the findings of Penga et al. (2022) regarding Timor pigs and Amtiran

Table 1. Physical examination of the longissimus dorsi and biceps femoris muscles of wild boars (*Sus scrofa*) from Timor Island.

Sampel otot	Kriteria penelitian	Jumlah sampel		
		Babi 1	Babi 2	Babi 3
Otot LD	Warna	Merah kehitaman	Merah kehitaman	Merah kehitaman
	Konsistensi	Kenyal	Kenyal	Kenyal
	Bau	Daging segar (darah segar)	Daging segar (darah segar)	Daging segar (darah segar)
Otot BF	Warna	Merah kehitaman	Merah kehitaman	Merah kehitaman
	Konsistensi	Kenyal dengan sedikit padat	Kenyal dengan sedikit padat	Kenyal dengan sedikit padat
	Bau	Daging segar (darah segar)	Daging segar (darah segar)	Daging segar (darah segar)

et al. (2021) concerning Sumba Ongol cattle.

Histological observations indicate that the BF muscle exhibits denser fibers compared to the LD at 10X magnification. The density of muscle fibers is attributed to the minimal presence of intramuscular fat. Intramuscular fat is prevalent in the meat (Figure 5). These results are consistent with the study by Penga et al. (2022) on Timor pigs. According to Suwiti et al. (2015), intramuscular fat influences the tenderness and flavor of meat and provides spacing between muscle fibers. Myofibrils, which affect variations in muscle fiber thickness, are composed of contractile muscle proteins that create thick and thin myofilaments. These filaments are arranged in parallel and alternating patterns, resulting in a striated appearance in muscle fibers. Thin myofilaments are composed of actin, troponin, and tropomyosin proteins, which initiate muscle contraction. Meanwhile, thick myofilaments are composed of myosin proteins, which function in breaking down adenosine triphosphate (ATP) into adenosine diphosphate (ADP) to provide energy during muscle contraction (Listrat et al., 2016).

The intramuscular fat cells located between muscle fibers are characterized by their round and oval shapes, exhibiting a hollow center with the cell nucleus positioned at the periphery (Figure 3). These results are consistent with the findings of Suwiti *et al*. (2015), who reported that fat cells are round and oval, with large cell sizes consisting of a fat cell nucleus at the edge and very thin cytoplasm. Intramuscular fat was present in the LD muscles, but absent in the BF muscles of wild boars from Timor Island. The absence of fat cells in BF muscles resulted in a dense histological appearance of BF muscles. The dense BF muscle may be due to the location of the BF muscle in the hind legs of wild boars. The movement of the hind legs can influence the fat content in that region. A low-fat diet is significant as it results in no energy reserves stored as fat.

CONCLUSION

The longissimus dorsi and biceps femoris muscles exhibited a dark red coloration. The longissimus dorsi muscle exhibited a soft consistency, whereas the biceps femoris muscle presented a soft consistency accompanied by a slightly firm texture and a fresh blood odor. Histological analysis revealed that the longissimus dorsi and biceps femoris muscles consisted of fascicles containing muscle fibers characterized by multiple nuclei located at the periphery, along with adipocytes and their nuclei. Three types of connective tissue were present: the endomysium encasing individual muscle fibers, the perimysium surrounding each fascicle, and the epimysium enveloping the entire muscle. The muscle fibers of the biceps femoris exhibited greater density than those of the longissimus dorsi.

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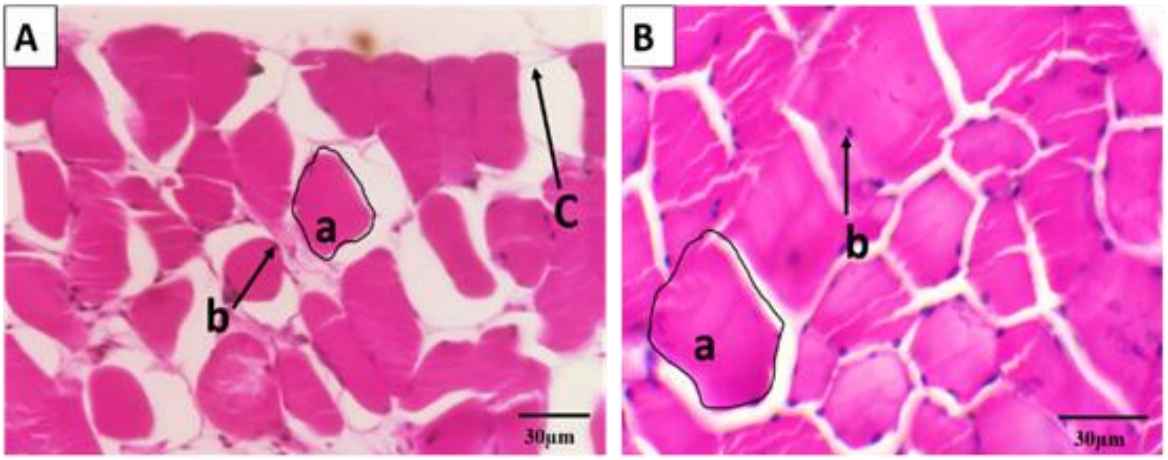

Figure 5. Microscopic image of muscle fibers from wild boars (*Sus scrofa*) from Timor Island, transverse section. A. Longissimus dorsi muscle and B. Biceps femoris muscle. Black lines: a. muscle fibers, b. cell nucleus, c. endomysium, connective tissue. (HE 40X).

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