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Myofiber Characteristics of Different Cuts of Qinghai Yak Beef and Their Effects on Meat Quality

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Abstract

This study aimed to investigate the myofiber characteristics of different cuts of Qinghai yak beef and their correlation with meat quality. Six cuts of yak beef, namely tenderloin, knuckle, shank, chuck, striploin, and neck, were analyzed for their myofiber properties using frozen sectioning and ATPase histochemical staining, and the correlation between these characteristics and meat quality attributes including meat color, pH, cooking loss, fat content, shear force, and texture profile analysis (TPA) was assessed. Results indicated that muscle location significantly affected the proportions of type I, IIA, and IIB myofibers ($P < 0.05$), which were closely related to beef quality. In terms of myofiber diameter, chuck exhibited the lowest type I diameter, whereas neck had a significantly higher type I diameter compared to other cuts ($P < 0.05$). Analysis of myofiber area also revealed significant differences in the area of the same myofiber type across different cuts ($P < 0.05$). Furthermore, other meat quality indicators such as fat content, cooking loss, meat color, and chewiness varied significantly among cuts ($P < 0.05$), while pH values did not differ significantly. These findings demonstrate that muscle location has a significant impact on yak beef quality and that a strong correlation exists between myofiber characteristics and beef quality.

Keywords: Yak; myofiber characteristics; quality; correlation.

1.Introduction

Qinghai yak is a dominant livestock species in the pastoral areas of China's Qinghai-Tibet Plateau, renowned for its robust vitality and adaptation to harsh, frigid climates(Shah et al., 2023). Compared to international research, studies in China primarily focus on yak breeds, wild yak conservation, yak meat texture, and strategies for expanding yak populations and production. Yak

meat is highly nutritious, characterized by lower fat content compared to common beef, and rich in various mineral elements and compounds (Li et al., 2023).

With the improvement of contemporary living standards, yak meat has become an indispensable component of the dining table. The quality of yak meat remains a subject of ongoing discussion. Myofibers, the fundamental structural units of yak meat, consist mainly of the sarcolemma, intramuscular collagen, cell organelles, myoglobin, myosin, actin, tropomyosin, and troponin(Ayaz et al., 2024). The type, area, and diameter of myofibers are influenced by various factors, leading to diverse muscle states. Studies have indicated a correlation between myofiber type composition and meat quality attributes such as tenderness, color difference, water-holding capacity, and pH(Holloway & Wu, 2019; Peng et al., 2022). However, the relationship between myofiber type and meat quality remains a topic of considerable debate. Factors such as animal breed, age, activity level, nutrition, and various control parameters can determine myofiber type composition. Breed plays a decisive role in myofiber type, as demonstrated in studies on poultry (Park et al., 2024), swine (Ismail & Joo, 2017; Li et al., 2019), and sheep(Talebi et al., 2022). Sun(Sun et al., 2022)conducted a comparative analysis of myofiber characteristics between Xinjiang Brown cattle and Angus cattle, revealing that Xinjiang Brown cattle have a smaller myofiber cross-sectional area (CSA) and that their meat quality is related to muscle location. Additionally, even within the same muscle, differences exist in myofiber type between superficial and deep layers. Deep muscles, primarily responsible for maintaining and supporting the body, exhibit a higher density of type I fibers per unit area compared to superficial muscles, which are mainly involved in rapid movement(Gallo et al., 2006; Morgan & Proske, 1984; Schiaffino & Reggiani, 2011).

To further determine the optimal meat cuts with superior quality and palatability, this study utilized yak beef from Haiyan Prefecture, Qinghai Province, as the raw material. ATPase histochemical staining was employed, leveraging the differential pH sensitivity of ATPase activity to classify myofibers into type I (red fibers), type IIA (intermediate fibers), and type IIB (white fibers). Six muscle locations—shoulder, striploin, tenderloin, chuck, knuckle, and neck—were stained and observed using an upright fluorescence microscope to analyze Qinghai yak myofiber types. Software was used to process and calculate fiber area and diameter, enabling the analysis of Qinghai yak myofiber characteristics and their correlation with different yak beef cuts. Simultaneously, meat color, pH, cooking loss, fat content, texture profile analysis (TPA), and shear force were measured for the different beef cuts. The correlation between beef quality and myofiber characteristics was then analyzed. This study aims to provide a theoretical basis and data support for the development and application of precision processing techniques for Qinghai yak, thereby enhancing its market value.

2. lab proc

2.1 Experimental Materials

Three 5-year-old Haiyan yaks with consistent weight and similar body condition scores were selected. Slaughter was conducted according to the "Operating Procedures for Cattle Slaughter" (GB/19477-2004). Six specific muscle locations were excised from each yak carcass: shoulder, striploin, chuck, knuckle, and neck. 50 minutes post-slaughter, 60g samples from each location were wrapped in aluminum foil, rapidly cooled in liquid nitrogen, and transported back to the laboratory for storage at -80°C in an ultra-low temperature freezer for ATPase enzyme staining. Additionally, 200g muscle samples from each location were collected for the determination of other meat quality indicators.

2.2.1 Frozen Sectioning

The cryostat was pre-cooled for 12 hours. Meat samples were removed from the ultra-low temperature freezer and placed in a -20°C freezer for 20 minutes, followed by a 4°C refrigerator for 20 minutes, and then allowed to stand at room temperature for 15 minutes. After thawing, the meat samples were cut perpendicular to the muscle fiber direction into 5mm × 5mm × 5mm pieces. The cryostat was set to a thickness of 1mm and a temperature of -20°C. Samples were placed on the specimen holder, embedded in embedding medium, and frozen on a quick-freeze platform for 15 minutes. The specimen holder was then clamped onto the microtome head. The handwheel was rotated clockwise once, and the section was gently brushed onto a glass slide.

2.2.2 ATPase Histochemical Staining

ATPase staining was performed with slight modifications to the method described by Man Weixiang [8]. Slides with adhered samples were air-dried at room temperature for 30 minutes before staining. The procedure was as follows: slides were rinsed 2-3 times with Tris buffer, incubated in alkaline pre-incubation solution for 10 minutes, rinsed 2-3 times with Tris buffer (1 minute each), and then incubated in the incubation solution (10ml ATPase working solution with 0.3g disodium adenosine triphosphate dissolved, pH 9.4-9.5) at 37°C for 2 hours. The working solution was removed, and the slides were rinsed with 1% calcium chloride solution for 3 minutes. After removing the calcium chloride solution, the slides were placed in 2% cobalt chloride solution for 3 minutes, rinsed with alkaline buffer for 2 minutes, rinsed with distilled water for 3 minutes (5 minutes each), developed with ammonium sulfide solution for approximately 1 minute, rinsed with tap water for 3 minutes, dehydrated with ethanol and xylene for 2 minutes (to achieve transparency), and finally covered with neutral resin and a coverslip. The slides were then placed in a slide box for microscopic examination.

2.2.3 pH Measurement

The pH meter was calibrated using pH 4.01 and pH 7.01 calibration solutions. The calibrated pH meter was inserted into the meat samples for measurement. The pH value of each meat sample

was determined as the average of three parallel measurements.

2.2.4 Color Difference Measurement

The L*, a*, and b* values of each meat location were measured using a colorimeter. Three measurements were taken for each location, and the average value was recorded.

2.2.5 Fat Content Determination

The crude fat content of the samples was determined using the acid hydrolysis method according to the national standard GB 5009.6-2016.

2.2.6 Cooking Loss Determination

Meat samples were weighed and recorded as W1. The samples were sealed in cooking bags and cooked in an 80°C water bath until the center temperature reached 70°C. The bags were opened, the surface moisture was wiped off, and the samples were cooled. The weight after cooking was recorded as W2. Cooking loss was calculated using the formula:

$$\text{CL（\%）} = \frac{Wa - Wb}{Wa} \times 100\%$$

2.2.7 Texture Profile Analysis (TPA)

Meat samples were sealed in plastic bags and cooked in an 80°C water bath until the center temperature reached 70°C. The samples were then removed and allowed to cool naturally to room temperature (20°C). Cubes of 1.0cm × 1.0cm × 1.0cm were cut along the muscle fiber direction. A CT3 texture analyzer with a TA-AACC36 probe was used to measure hardness, springiness, cohesiveness, and chewiness. The pre-test speed was 2mm/s, the test speed was 1mm/s, and the post-test speed was 5mm/s. Three replicates were performed, and the average value was recorded.

2.2.8 Water Holding Capacity (Pressure Method)

Water holding capacity was determined using the pressure method according to NY/T 1333-2007 [10], "Determination of Meat Quality in Livestock and Poultry."

2.4 Data Processing and Statistical Analysis

Myofiber types were observed using an upright fluorescence microscope. Images were captured using a digital imaging system, and myofiber diameter and area were measured using image analysis software. Data was processed using Microsoft Excel, and significant difference analysis

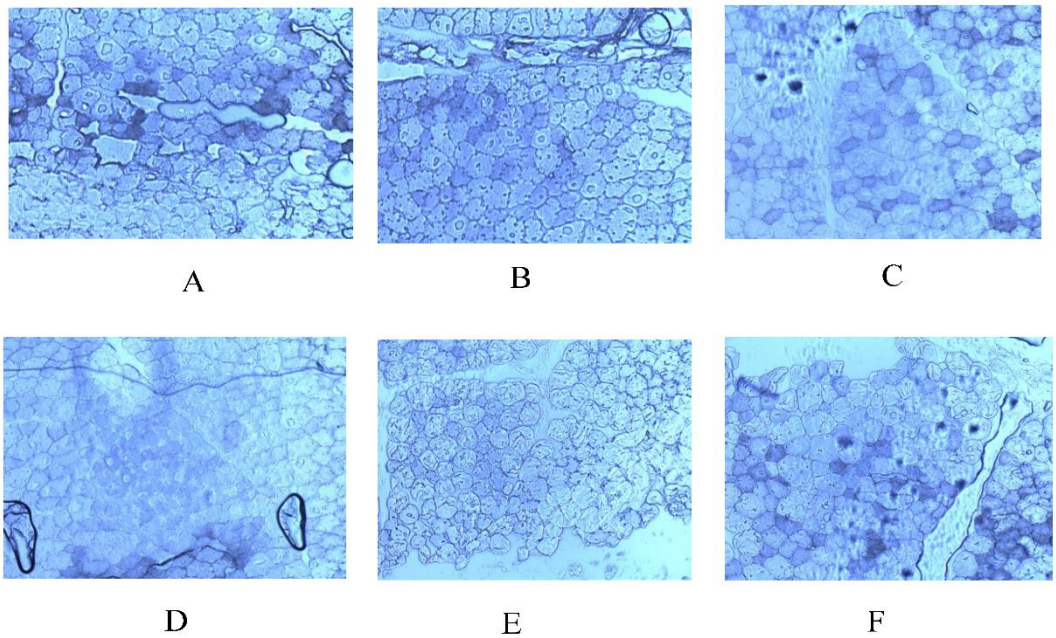
was performed using SPSS 20.0. Results are expressed as mean ± standard deviation.

3. Results and Discussion

3.1 Myofiber Characteristics of Different Yak Beef Cuts

The ATPase staining results for different yak beef cuts are shown in Figure 1. All six cuts—chuck, tenderloin, striploin, neck, and knuckle—were composed of type I, type IIA, and type IIB fibers. Using the ATPase staining method, normal skeletal muscle fibers appeared uniformly sized and circular. The diameter, area, and proportion of different myofiber types varied considerably. The myofiber characteristics of different yak beef cuts are presented in the table below. The results indicate that muscle location had a significant effect on the proportions of type I, type IIA, and type IIB myofibers ($P < 0.05$). Notably, the neck cut exhibited a significantly larger diameter of type I fibers compared to other cuts ($P < 0.05$), while the chuck cut had the smallest type I fiber diameter. The shoulder cut had a significantly larger diameter of type IIA fibers than other cuts ($P < 0.05$), and the chuck cut had the smallest. The knuckle cut exhibited a significantly larger diameter of type IIB fibers compared to other cuts ($P < 0.05$), while the neck cut had the lowest proportion of type IIB fibers. Significant differences were observed in the area of the same myofiber type across different cuts ($P < 0.05$). Among the six cuts, the neck cut had the largest type I fiber area, and the chuck cut had the smallest. The shoulder cut had the largest type IIA fiber area. The chuck cut had the largest type IIB fiber area, and the neck cut had the smallest.

Figure 1: ATPase enzyme histochemical staining micrographs of different muscle locations. A, Knuckle; B, Neck; C, Shoulder; D, Tenderloin; E, Chuck; F, Striploin



	Myofiber Diameter (μm)			Myofiber Area (×100 μm²)		
	I	IIA	IIB	I	IIA	IIB
Chuck	76.70±1.86Bb	65.16±2.83Cc	70.84±1.13Ab	66.37±7.08Cd	39.57±2.88Bc	72.09±1.58Aa
Knuckle	92.46±9.15ABa	86.26±6.59Bb	87.45±3.87a	78.69±5.05BCcd	67.17±5.04Bb	52.7±2.41Cb
Tenderloin	108.63±2.94Aa	76.15±1.19BCbc	78.08±2.47ab	86.9±3.20ABCbcd	45.59±0.06Bbc	56.60±3.91ABb
Striploin	104.29±3.56ABa	86.29±3.23Bb	72.70±5.84Bb	95.57±7.06ABCabc	99.80±4.01Aa	47.84±1.31BCbc
Neck	109.20±3.87Aa	80.42±4.26BCb	69.80±4.96a	114.03±3.88Aa	51.93±1.27Bbc	39.03±3.36Cc
Shoulder	110.80±1.78Aa	110.80±1.78Aa	73.445±3.92Cd	105.96±5.87ABab	103.75±3.55Aa	60.80±1.17ABab

Note: Within rows, different lowercase superscript letters indicate significant differences (P< 0.05); within columns, different uppercase superscript letters indicate significant differences (P< 0.05).

3.2 Differences in Meat Quality Among Different Cuts

3.2.1 Variations in pH Values of Yak Meat from Different Cuts

The pH value of yak meat is an important indicator reflecting the rate and extent of glycolysis. It is primarily influenced by the accumulation of lactic acid, which is produced during the fermentation of glucose in the meat. This pH level directly affects meat palatability, tenderness, cooking loss, and shelf life, and it also exhibits significant correlations with water-holding capacity and meat color . Therefore, pH is a crucial marker for assessing the freshness of yak

meat. The pH of the meat (the final pH measured 24 hours after slaughtering) ranges from 5.4 to 5.8, while the pH of Qinghai yaks is around 5.2 to 5.7(Hamoen et al., 2013). The acidic nature of yak meat post-slaughter results from the cessation of blood and oxygen supply, which interrupts normal metabolic processes. Consequently, under the influence of glycolytic enzymes, glycogen undergoes anaerobic decomposition, converting into glucose, which is then transformed into lactic acid. As lactic acid accumulates to a certain threshold, the activity of glycolytic enzymes diminishes, while inorganic phosphorylase activity increases significantly. This promotes the breakdown of adenosine triphosphate, releasing orthophosphate. The combination of lactic acid and orthophosphate creates an acidic medium, hence the lower pH in fresh meat post-slaughter (Wang et al., 2025; Yang et al., 2021). Figure 2 illustrates the comparative pH values of different cuts of yak meat, demonstrating significant differences ($P < 0.05$) among the various cuts. The tenderloin exhibits the highest pH, with significant differences observed when compared to the foreleg and hind leg. The striploin, due to the increased lactic acid production during muscle activity, displays a slightly lower pH than other cuts.

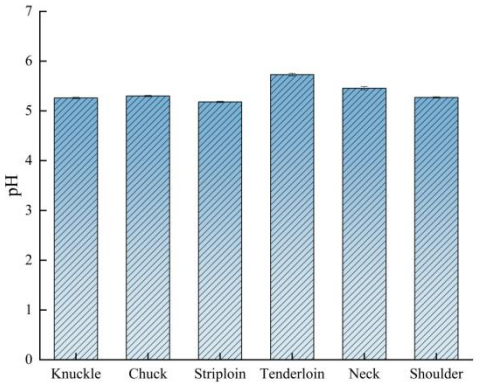


Figure 2 comparison of the pH value of yak beef in different parts

3.2.2 Differences in Meat Color Among Different Cuts of Yak Meat

Meat color is a decisive factor directly influencing consumer purchasing decisions. The L* value primarily represents meat brightness; a higher L* value indicates better gloss. The a* value represents redness; a higher a* value indicates a redder meat color. The b* value represents yellowness; a higher b* value indicates a greater degree of yellowness. Significant differences were observed in the L* values of different cuts of Qinghai yak meat($P < 0.05$), with a significant difference noted between the tenderloin and striploin. Among all cuts, the knuckle exhibited the highest brightness, while the striploin showed the lowest. Significant differences were also observed in the a* values ($P \leq 0.01$), with the shoulder having the highest redness and the neck having the lowest. No significant differences were found in the b* values ($P > 0.05$). The chuck displayed the highest yellowness, and the tenderloin showed the lowest.

Table 2 comparison of meat color of different parts of yak in qinghai province

Cut	L*	a*	b*
Tenderloin	46.75±0.58ab	13.22±2.0.73a	7.99± 0.91a
Chuck	43.37 ±0.51bc	14.52±0.81ab	11.34 ±1.83a
Knuckle	50.14 ±1.22a	10.75 ±0.37ab	9.53±0.87a
Shoulder	47.30 ±1.06ab	14.85 ±0.49a	8.80±0.32a
Neck	43.70 ±0.19bc	10.71 ±0.58cd	11.62 ±0.93a
Striploin	40.37 ±1.06c	12.03±0.12bc	10.58 ±1.98a

3.2.3 Differences in Fat Content Among Different Cuts

Fat serves as a crucial nutrient for heat and energy production(Ratnayake & Galli, 2009). Once absorbed, the majority of fat is transported to the liver via the bloodstream, with a smaller portion stored subcutaneously to maintain normal body temperature. Fat plays a vital role in meat quality(Everaert et al., 2022).The flavor compounds in meat are primarily generated through the oxidation of fatty acids, directly influencing flavor(Dinh et al., 2021; Fu et al., 2022). Fat content is influenced by external factors, including regional variations and feeding conditions, as well as by the growth environment and geographic location. Consequently, yaks raised in different regions exhibit varying fat content in their meat. The differences in fat distribution across various meat cuts indicate variations in fat content. Meat fat consists of three components: subcutaneous fat, intramuscular fat, and intermuscular fat. Typically, yak meat contains less than 3.5% fat. As depicted in the figure, there are significant differences ($P < 0.05$) in fat content among different cuts of Qinghai yak meat. The chuck exhibits the highest fat content, while the striploin contains the least.

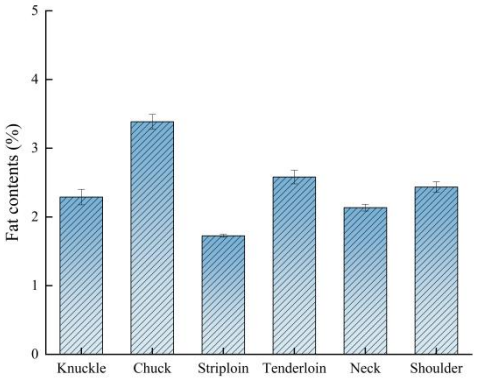


Figure 3 fat content of yak in different parts

3.2.4 Differences in Cooking Loss Among Different Cuts of Yak Meat

Cooking loss refers to the reduction in mass of a meat sample during the cooking process, primarily due to moisture loss. As observed in the figure, the cooking loss of Qinghai yak meat generally ranges from 17% to 26%. Research indicates that the cooking loss of yak meat is typically maintained above 30%, which is lower than that of yellow cattle. Comparisons of cooking loss among different cuts of Qinghai yak meat revealed significant differences ($P < 0.05$). A higher cooking loss corresponds to a lower cooked meat yield. The figure shows that the chuck exhibited the lowest cooking loss, indicating the highest cooked meat yield for this cut. Conversely, the tenderloin showed the lowest cooked meat yield.

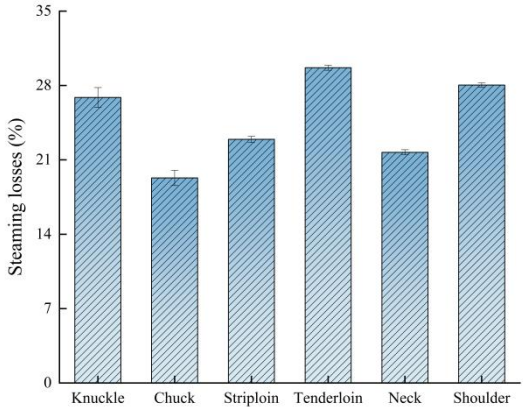


Figure 4 cooking loss of yak meat in different parts

3.2.5 Comparison of Shear Force and Texture Profile Analysis (TPA) Among Different Cuts

Texture Profile Analysis (TPA) provides direct insights into meat quality characteristics(Liu et al., 2025). Shear force, specifically, indicates meat tenderness; a lower shear force value signifies greater tenderness. Significant differences in shear force were observed among different cuts of Qinghai yak meat ($P < 0.05$). The chuck exhibited the highest shear force value, while the shoulder had the lowest.

The TPA results are presented in Table3. No significant differences ($P > 0.05$) were found in hardness, springiness, or cohesiveness among the different cuts. The shoulder displayed the highest hardness, and the tenderloin and striploin showed the lowest, with a difference of approximately 13N between the two. Springiness refers to the ability of meat to recover its original shape after deformation by an external force (Piette et al., 2004). Beef, rich in protein, forms a network structure with its hydration layer that resists external forces; this resistance is defined as meat springiness. In other words, a higher protein content correlates with greater springiness. Springiness is also related to water content, increasing with higher water content (De Huidobro et al., 2003). The shoulder had the highest springiness, indicating a higher protein content and potentially greater water holding capacity in this cut. Cohesiveness represents the

internal bonding strength of food, maintaining its integrity during mastication (Cheng & Sun, 2008; Pearce et al., 2011). It has been shown that the higher the cohesion, the finer the meat product is when chewed and the better its texture(Juárez et al., 2012). The cohesiveness of different cuts of Qinghai yak meat was generally around 0.6. Chewiness, which correlates with hardness, springiness, and cohesiveness, represents the work required to masticate solid food to a swallowable state and is numerically equal to the product of these three parameters(De Huidobro et al., 2005; Xie & Grossmann, 2025). Significant differences ($P < 0.05$) in chewiness were observed among different cuts of Qinghai yak meat. The shoulder exhibited the highest chewiness, suggesting better overall palatability.

Table 3 comparison of shear force and texture of different parts

Cut	Shear Force / N	Hardness / N	Springiness / mm	Cohesiveness	Chewiness / mJ
Knuckle	23.15±9.09a	15.80±3.76a	2.89 ±0.19a	0.60±0.04a	27.94±8.88a
Shoulder	21.31±3.27a	26.99±6.50b	3.49 ±0.23b	0.61±0.14a	36.25±0.92a
Chuck	27.77±2.19a	17.79±6.52a	3.02 ±0.33a	0.50±0.09a	23.87±5.63a
Neck	25.84±5.27a	19.27±1.36ab	2.84 ±0.14a	0.61±0.12a	32.89±8.38a
Striploin	21.76±0.67a	13.21±1.89a	2.88 ±0.14a	0.60±0.03a	23.54±4.26a
Tenderloin	21.40±6.25a	14.64±1.35a	2.79 ±0.09a	0.61±0.02a	22.69±3.30a

3.3 Correlation Analysis Between Muscle Fiber Characteristics and Beef Quality

The correlation analysis results between muscle fiber characteristics and beef quality are presented in Table 4. The muscle fiber type of yak meat has a significant impact on its quality. The diameter and area of Type IIB muscle fibers showed a significant positive correlation with L* values ($P < 0.05$). The a* values were significantly negatively correlated with the diameter and area of both Type I and Type IIA muscle fibers ($P < 0.01$). The b* values were significantly negatively correlated with the diameter and area of Type IIA muscle fibers ($P < 0.01$), and significantly negatively correlated with the diameter and area of Type I and Type IIB muscle fibers ($P < 0.05$). The pH value showed a significant positive correlation with the diameter of Type I muscle fibers ($P < 0.05$) and a highly significant positive correlation with the area of Type I muscle fibers ($P < 0.01$). Cooking loss showed a highly significant positive correlation with both the diameter and area of Type I muscle fibers ($P < 0.05$). Shear force values were highly significantly positively correlated with the diameter and area of Type I muscle fibers ($P < 0.01$).

Hardness showed a significant positive correlation with the diameter and area of Type I, Type IIA, and Type IIB muscle fibers ($P < 0.05$). Springiness showed no significant correlation with the diameter and area of Type I and Type IIA muscle fibers. Cohesiveness showed a significant negative correlation with the diameter and area of Type IIA and Type IIB muscle fibers ($P < 0.05$). Chewiness showed a significant positive correlation with the area of Type IIB muscle fibers ($P < 0.05$).

Table 4 correlation between muscle fiber and yak meat quality

	Muscle Fiber Diameter			Muscle Fiber Area		
	I	IIA	IIB	I	IIA	
L*	0.224	0.320	0.406*	0.132	0.344	0.428*
a*	-0.577**	-0.534**	-0.485*	-0.580**	-0.533**	-0.399
b*	-0.492*	-0.566**	-0.504*	-0.428*	-0.580**	-0.477*
pH	0.472*	0.493*	0.601**	0.722**	0.505*	0.541**
Cooking Loss	0.655**	0.408*	0.674**	0.537**	0.437*	0.777**
Shear Force	0.546**	0.468*	0.627**	0.621**	0.488*	0.625*
Hardness	0.400*	0.358*	0.493*	0.408*	0.392*	0.501*
Springiness	-0.097	-0.136	0.142	0.057	-0.086	0.226
Cohesiveness	-0.333	-0.482*	-0.494*	-0.394	-0.448*	-0.486*
Chewiness	0.091	0.081	0.394	0.207	0.122	0.484*

Note: '*' indicates a significant correlation at the 0.05 level (two-tailed), and '**' indicates a significant correlation at the 0.01 level (two-tailed).

4.Discussion

The anatomical location and functional characteristics of muscles are known to directly influence their fiber type composition, which in turn governs the organism's adaptation to specific physiological demands(Bartoň et al., 2014). This study focuses on the yak, a unique livestock species endemic to the Qinghai-Tibetan Plateau. Prolonged exposure to extreme environmental conditions, including hypoxia and cold temperatures characteristic of this region, may have led to the evolution of distinct muscle adaptive traits in this species.

Utilizing ATPase histochemical staining, our analysis revealed significant variations in muscle

fiber type distribution across different anatomical locations within yak meat. This heterogeneity is likely associated with the specific functional requirements of each muscle cut. Notably, all six yak muscle locations examined in this investigation contained Type I, Type IIA, and Type IIB fibers. Among these, the longissimus dorsi (LD, representing the outer loin cut) exhibited the highest proportion of Type I fibers, while the shoulder muscle displayed the highest proportion of Type IIB fibers. This profile presents a marked contrast to conventional cattle breeds. Previous studies on common cattle indicate that the LD typically comprises approximately 30% Type I, 18% Type IIA, and 52% Type IIX fibers, with Type IIB fibers being rarely detected (Schiaffino & Reggiani, 2011). The identification of Type IIB fibers in the yak LD is particularly noteworthy, suggesting that its dorsal musculature may possess enhanced rapid contractile capabilities. This difference in fiber type composition could potentially exert considerable influence on meat quality attributes, such as tenderness and water holding capacity.

Morphologically, the examined muscle cuts displayed significant differences not only in fiber type proportions but also in fiber diameter and cross-sectional area. Across all analyzed locations, muscle fiber diameter consistently followed the pattern: Type I > Type IIB > Type IIA. Furthermore, the diameters of both Type I and Type IIA fibers were significantly greater in the shoulder muscle compared to other cuts. This morphological disparity may correlate with muscle metabolic characteristics; the typically larger diameter of Type I fibers aligns with their high mitochondrial density and reliance on oxidative metabolism, consistent with established theoretical models.

It is crucial to recognize the species-specific nature of muscle fiber composition in yaks. For instance, Type IIB fibers can account for up to 55% of the LD muscle in pigs (Listrat et al., 2016), while significant interspecies and interbreed heterogeneity in fiber proportions exists among sheep and goats (Şirin et al., 2017). The distinct fiber distribution pattern observed in yaks likely reflects adaptations related to their locomotion patterns and energy metabolism strategies developed in response to the challenging high-altitude environment.

Concerning meat quality characteristics, our findings align well with the correlation between myoglobin content and meat color proposed by Joo(Joo et al., 2013). The higher proportion of Type I fibers (known to contain high concentrations of myoglobin) in the shoulder samples corresponded positively with significantly elevated a* values (redness index). This provides further supporting evidence for the mechanistic link between muscle fiber typology and meat color quality. Additionally, variations observed in pH, cooking loss, and fat content among the different muscle cuts likely arise from differences in intrinsic factors, such as metabolic enzyme activity and connective tissue content, which are themselves influenced by the relative proportions of different fiber types. Notably, the regionally specific distribution of Type IIB fibers revealed in this study may offer a novel perspective for understanding the unique textural properties of yak meat, including observed variations in shear force values.

Yak longissimus dorsi (LD) muscle shows Type IIB fibers, a finding different from common cattle. This may be due to genetic or high-altitude adaptation differences. Further studies using transcriptomics can explore the molecular mechanisms of yak muscle fiber differentiation, especially hypoxia responses. Quantitative models linking muscle fiber traits to meat quality will improve yak meat grading and aid in developing specialty meat products.

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