BF-1824
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RESEARCH ARTICLE **Indian Journal of Animal Research**

Comparison of Production Performance, Slaughtering Performance and Meat Quality of Qinghai Plateau-Type Yaks of Different Months of Age

Fa-Jie Gou[1,2],Yin-Cang Han[1,2],Yong-Gang Sun[1,2],Suo-Nan DuoJie[3],
Wei-Qin Ding[1,2],Sheng-Wei Jin[1,2],Ya-Qian Liu[1,2]

10.18805/IJAR.BF-1824

ABSTRACT

Background: Research and development in animal husbandry is receiving increasing attention as society continues to develop and as consumer awareness of the nutritional value of livestock products, information about their sources and the importance of production systems and environmental impacts increases. In this context, research on the production performance, slaughtering performance and meat quality of Qinghai plateau-type yak, as a rare and important livestock resource, has become essential and the market demand for high-quality yak meat products has increased significantly.

Methods: 10 yaks of 3, 4 and 5 months of age were selected at the same feeding level and 3 yaks of different months of age were randomly selected for slaughtering to determine the routine performance and meat quality and to evaluate them.

Result: The results showed that the pH of Qinghai Plateau-type yak meat differed significantly (P<0.05) among yaks of different ages. There was a significant difference in the ash content of the longest dorsal muscle of yaks with increasing months of age (P<0.05) and the water content of yak meat at 5 months of age decreased significantly (P<0.05). The difference in arm triceps muscle was more significant (P<0.05) in yaks of different months of age. There was no significant difference (P>0.05) in drip loss rate and moisture content of other parts of different months of age.

Key words: Meat quality, Nutritional quality, Production performance, Slaughter performance, Yak.

INTRODUCTION

The Tibetan Plateau is rich in biological and cultural diversity and due to the harsh climatic environment, the availability of rangeland is highly variable, with sparse and poor-quality vegetation. For example, in terms of dry matter, winter biomass in the Tibetan Plateau region averages 750 kg/hm and crude protein content is 6.2% (Jing *et al*., 2022). As a native herbivore living at an altitude of 3000 m~5000 m, the yak is highly adaptable to the unique ecological environment of the plateau and is known as the “Boat of the Plateau”(Bai, *et al*., 2023).

The quality of yak meat is not only affected by the feeding method, feed nutrition level and environment, but is also closely related to the growth stage of yaks (Li *et al*. 2018). In general, the average beef cow is usually slaughtered and marketed during a 12 to 24-month intensive holding period. However, due to the uniqueness of the yak’s living environment, which is different from that of ordinary beef cattle, its age at slaughter lacks a uniform standard and can vary from less than 2 years old to more than 10 years old (Edwards-Callaway, 2020). This age difference directly affects the quality of yak meat (Hu *et al*., 2021). It was shown that there were some differences in slaughter performance and meat quality of Red River Yellow cattle at different months of age (Yu *et al*., 2022). In an analysis of meat quality of Charolais heifers of various months of age, At a slaughter monthly age of 26 months, increasing carcass weight affects neither meat traits nor normal characteristics (Ellies-Oury *et al*., 2017). Increasing carcass weight at a slaughter month age of 36 months resulted in decreased muscle shear and a concomitant decrease in total collagen content (Li *et al.,* 2018). It was found that the slaughtering performance and meat quality of Penang Rivermale buffaloes changed significantly with age. Meat yield and carcass yield, on the other hand, increased gradually with age and were 34.58%~38.59% and 62.95%~75.34%, respectively.

In response to the diversified and individualized demands for beef in the current market, this experiment took

[1]Academy of Animal Science and Veterinary Medicine, Qinghai University, Xining, 810 016, China.

[2]Key Laboratory of Plateau Livestock Genetic Resources Protection and Innovative Utilization of Qinghai Provincial, Xining, 810 016, China.

[3]Animal Husbandry and Veterinary Station of Mole Town, Qilian County, Haibei Tibetan Autonomous Prefecture, Qinghai Province, 810 400, China.

Corresponding Author: Yin-Cang Han, Academy of Animal Science and Veterinary Medicine, Qinghai University, Xining, 810 016, China. Email: hyc-99101121@163.com

How to cite this article: Fa-Jie, G., Yin-Cang, H.,Yong-Gang, S., Suo-Nan, D.J., Wei-Qin, D., Sheng-Wei, J. and Ya-Qian, L. (2024). Comparison of Production Performance, Slaughtering Performance and Meat Quality of Qinghai Plateau-Type Yaks of Different Months of Age. Indian Journal of Animal Research. doi: 10.18805/IJAR.BF-1824.

Submitted: 10-06-2024 **Accepted:** 10-08-2024 **Online:** 02-09-2024

Qinghai plateau-type yaks as the research object. By analyzing the production and slaughtering performance of yaks of different months of age, the meat quality of yaks of different months of age was comprehensively evaluated. Physiological indexes, conventional nutrients and amino acid fractions were also comprehensively evaluated to evaluate the quality of yaks of Qinghai plateau-type to provide scientific bases for their production practice.

MATERIALS AND METHODS

Place and time of the work

The entire work was carried out during March 2023 to August 2023 at Bianma Meilong Palm Cooperative conducted in Qilian County, Haibei Tibetan Autonomous Prefecture, Qinghai Province. Its post-testing and experimental process was completed in the College of Animal Husbandry and Veterinary Science of Qinghai University.

Test animals

In the preliminary stage of this experiment, 30 newborn plateau-type yaks of similar weight and good health condition were selected from Meilong Palm Cooperative in Qilian County, Haibei Tibetan Autonomous Prefecture, Qinghai Province, China and were equally divided into three groups of 10 yaks each and after being given the same feeding conditions to be reared, three yaks were randomly slaughtered at each of the 3-month, 4-month and 5-month feeding periods, respectively, taking into consideration of the animal's welfare.

Determination of production performance and slaughter performance

All yaks were fed and watered normally before slaughter, fasted for 24 h and watered for 2 h before slaughter. Determination of pre-slaughter weight.

Measurement of meat quality

The determination of pH and meat color was referred to the Determination of Livestock and Poultry Meat Quality (NY/T1333-2007) (In Chinese) and the shear force was referred to the Determination of Meat Tenderness Shear Force Determination Method (NY/T1180-2006) (In Chinese) for the determination.

Statistics and analysis of data

Preliminary recording and processing of data was carried out using Excel software and then the data was statistically analyzed using the one-way ANOVA test in the SPSS 27.0 statistical software. The data were expressed as mean ± standard deviation. $P<0.05$ indicates a significant difference and $P<0.01$ indicates a highly significant difference.

RESULTS AND DISCUSSION

Analysis of growth performance and slaughter performance indexes of Qinghai plateau-type yaks at different months of age

As shown in Table 1, the weight of yaks was significantly different at different ages ($P<0.05$); and all the indexes of

Table 1: Determination of production performance and slaughtering performance of Qinghai Plateau-type yaks at different months of age.

Age in months	Pre-slaughter live mass/kg	Carcassmass /kg	Head mass/kg	Tare mass/kg	Bone mass/kg	Net meat weight/kg	Hoof mass/kg	Slaughter rate/%	Net meat rate/%
3	25.00±2.50^{c}	12.50±1.50^{b}	2.93±0.10^{b}	2.70±0.35^{b}	5.68±1.32^{b}	6.93±0.65^{b}	1.70±0.20	49.93±1.00	27.97±0.35
4	37.00±0.50^{b}	17.42±0.85^{b}	2.72±0.018^{b}	2.67±0.07^{b}	5.32±0.28^{b}	11.66±2.38^{b}	1.50±0.10	47.00±1.73	28.10±1.60
5	57.33±3.40^{a}	28.15±2.52^{a}	4.25±0.1^{a}	5.05±0.30^{a}	10.72±0.63^{a}	19.43±3.48^{a}	1.83±0.18	48.93±2.15	29.23±1.53
P-Value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.117	0.180	0.179

their slaughtering performance increased gradually with the age of the month and the carcass weights of the 3- and 4-month-old carcasses were significantly different from the carcass weights of 5-month-old carcasses (P<0.01); There were significant differences in head mass, skin mass and bone mass of yaks at 3, 4 and 5 months of age (P<0.05). The skin quality of 4-month-old yaks was highly significantly different from that of 3-month-old and 5-month-old yaks (P<0.01). There was a highly significant difference in net meat weights of 4-month-old yaks (P<0.01).

As shown in Table 2, there was a highly significant difference in the kidney mass of yaks at the ages of 3, 4 and 5 months (P<0.01); the significant difference in heart mass of 4-month-old yaks (P<0.05); The spleen mass and liver mass of 3 and 4-month-old yaks differed significantly (P<0.05), 5-month-old yaks did not have significant differences in spleen mass (P>0.05); 4-month-old yaks had a significantly different lung mass was significantly different (P<0.05) relative to those of 3- and 5-month-old yaks.

Analysis of conventional nutrients and micronutrient contents in different parts of Qinghai Plateau-type yaks at different months of age

As shown in Table 3, the nutrient composition and micronutrient content of the longest dorsal muscle of yaks varied greatly among different months of age (P<0.05); Water content in the longest dorsal muscle of 3 and 4-month-old yaks was significantly different from that of 5-month-old yaks (P<0.05); the difference in ash content was extremely significant between the ash content of 3-month-old and 5-month-old yaks as compared to that of 4-month-old yaks (P<0.01); and the contents of Znhad a significant difference at the age of 5 months (P<0.05).

As shown in Table 4, in the brachial triceps muscle of yaks, the differences in nutrient and micronutrient contents were slight with the increase in months of age. There were no significant differences in the contents of moisture, crude protein, ash and crude fat with the increase in months of age (P>0.05);P levels were significantly different in 3-month-old and 5-month-old yaks (P<0.05), with a highly significant difference in 5-month-old yaks (P<0.01). Ca, Cu, Fe and Zn contents were not significantly different with increasing age of months (P>0.05).

Analysis of meat quality traits in different parts of qinghai plateau-type yaks at different months of age

As shown in Table 5, in the longest dorsal muscle of yaks, the drip loss rate was significantly different in 3-month-old and 4-month-old yaks (P<0.05); The pH values of the most extended dorsal muscles of 4-month-old yaks were significantly different (P<0.05) relative to those of 3- and 5-month-old yaks. In meat color, the b* value of yaks of 4 months of age had a highly significant difference compared with that of 3-month-old and 5-month-old yaks (P<0.01); and the L* value of 3-month-old and 4-month-old yaks compared with that of 5-month-old yaks had a highly significant difference (P<0.01). The color a* and b* values of the arm triceps muscles of yaks of different ages were not significantly different (P>0.05); the L* values of the arm triceps muscles of yaks at the age of 5 months were significantly lower than those of the arm triceps muscles of yaks at the age of 3 months and 4 months (P<0.05). The b* values of the biceps femoris muscle of 5-month-old yaks were significantly lower than b* values of the biceps femoris muscle of 3-month-old and 4-month-old yaks (P<0.05).

Differences in amino acid composition and content of qinghai plateau-type yaks of different monthly ages

Table 6 shows that 19 standard amino acids, including 7 essential amino acids and 6 fresh flavor amino acids, were detected in Qinghai Plateau-type yak meat of different ages. Among them, the yak of the 3, 4 and 5months groups had significantly higher in the meat of yak of the 3 and 4months again content of GLU and HYP than that of the 5months age(P<0.05). With increasing age, the contents of essential amino acids and fresh flavor amino acids were higher in 3-month-old and 4-month-old yak meat than in 5-month-old yak meat. The contents of non-essential amino acids were significantly higher in 3-month-old yak meat than in 5-month-old yak meat and did not differ significantly from those in 4-month-old yak meat (P>0.05). The content of essential amino acids was significantly higher in 3-month-old yak meat than in 5-month-old yak meat but was less different from that in 4-month-old yak meat (P>0.05).

Analysis of growth performance and slaughter performance indexes of qinghai plateau-type yaks of different months of age

Body weight is an important phenotypic trait in livestock selection and breeding, while slaughter performance is an important indicator for evaluating their production performance (Hu *et al*., 2021). In this experiment, it was found that there were significant differences in body weight, carcass weight, net meat weight, as well as head mass and skin mass of Qinghai Plateau-type yaks at different stages of age and the magnitude of their variations was also large, mainly in 3-month-old and 4-month-old yaks. Diler Aet (Diler *et al*., 2023) It was shown that pre-slaughter live weight, carcass weight and shear strength of Holstein bulls differed

Table 2: Determination of organ weights of Qinghai Plateau-type yaks of different months of age.

Age in months	Heart mass/kg	Kidney mass/kg	Spleen mass/kg	Liver mass/kg	Lung mass/kg
3	0.32±0.02^{b}	0.23±0.03^{c}	0.04±0.017^{c}	0.55±0.05^{c}	0.70±0.05^{b}
4	0.37±0.03^{ab}	0.29±0.01^{b}	0.09±0.001^{b}	0.69±0.01^{b}	0.67±0.08^{b}
5	0.50±0.1^{a}	0.58±0.02^{a}	0.18±0.025^{a}	1.25±0.1^{a}	1.10±0.1^{a}
P-Value	0.026	<0.01	<0.01	<0.01	<0.01

Table 3: Contents of conventional nutrients and micronutrients in the longest dorsal muscle of Qinghai Plateau-type yaks of different months of age.

Age in	Mass fraction/%				Content/(mg-kg^{-1})				
months	moisture content	crude protein	ash	crude fat	Ca	P	Cu	Fe	Zn
3	77.61±1.23^{a}	18.53±2.46	0.91±0.02^{b}	3.48±0.73	27.80±1.03	1892.25±101.97	0.71±0.03	19.52±3.59	23.55±0.42^{a}
4	77.57±0.21^{a}	19.68±0.02	1.32±0.05^{a}	2.36±1.12	30.19±1.76	2014.64±51.87	0.69±0.02	19.72±0.94	22.05±0.68^{b}
5	73.74±0.07^{b}	20.09±1.12	0.82±0.07^{b}	3.38±0.03	31.03±0.59	1992.68±7.69	0.68±0.02	18.00±0.69	23.45±0.14^{ab}
P-Value	0.020	0.630	0.004	0.396	0.153	0.288	0.474	0.718	0.083

Table 4: Conventional nutrients and micronutrient contents in the arm triceps muscle of Qinghai plateau-type yaks at different months of age.

Age in	Mass fraction/%				Content/(mg-kg^{-1})				
months	moisture content	crude protein	ash	crude fat	Ca	P	Cu	Fe	Zn
3	76.91±1.12	18.89±1.06	1.23±0.21^{a}	3.36±0.54	25.69±0.72	1884.29±21.32^{b}	0.67±0.04	17.64±2.54	23.38±2.15
4	77.16±0.58	18.66±1.36	0.75±0.01^{b}	3.45±0.97	28.21±1.04	2034.02±2.29^{a}	0.67±0.01	18.21±0.14	22.11±1.26
5	74.89±1.02	19.35±0.82	0.85±0.03^{ab}	4.88±0.97	27.77±1.01	1919.45±37.82^{b}	0.65±0.01	19.14±1.21	22.99±0.31
P-Value	0.163	0.826	0.057	0.278	0.138	0.019	0.621	0.682	0.700

significantly among months of age. The present experimental study showed that for yaks, all the indexes of slaughter performance showed a trend of gradual increase with increasing age, which is consistent with the results of the above study. Ustuner Het (Ustuner *et al*., 2020) The results of the study showed that the growth rate of imported Simmental cattle varied greatly among different months of age and it was found that the growth rate of 3~12 month old Simmental cattle was significantly faster than that of 12~24 month old yaks. The present experimental study showed that three and four months of age carcasses had significant differences in body weights and 3, 4 and 5 months of age yaks had significant differences in head, hide and bone mass, which varied considerably with the increase in months of age. Moreover, the skin quality of 4-month-old yaks was highly significantly different from that of 3-month-old and 5-month-old yaks, suggesting that the rapid increase in the skin quality of yaks, as livestock in the cold regions of the high plateau, better adapts them to the local environment. Wang Yet (Wang *et al*., 2020) The study showed that by comparing the growth performance, carcass characteristics and meat quality of yellow, Simmental and yak cattle at different months of age, it was found that Simmental cattle had higher growth performance and carcass characteristics; higher meat protein content in yellow and yak cattle.

Analysis of conventional nutrient composition and trace element content of qinghai plateau-type yak meat of different months of age

Yak meat known as the ″crown of beef″, is a semi-wild natural green food, rich in protein and amino acids, as well as carotene, calcium, phosphorus and other trace elements, low-fat content, high calories, to enhance the body's resistance to disease, cellular vitality and organ function have a significant role (Wen *et al*., 2020). Yak meat is characterized by high protein, low fat, low calorie and rich in various amino acids (Peng Shuai, 2019). It is elastic in the mouth and has a more flavorful meat taste (Li *et al*., 2023). Nogo yet (Nogoy *et al*., 2022) The study's results showed that the fat content of grass-fed beef averaged 8.10%, the fat content of the longest dorsal muscle averaged 20.27% and the protein content of the longest dorsal muscle averaged 26.82%. The present experimental study showed that the average fat content and the average protein content of the longest dorsal muscle of 3, 4 and 5 month-old yaks were lower than those of grass-fed cattle, suggesting that there are some differences in the nutrient content of yak and beef meat, which may be related to their environments as well as their roles. With Corino, (Corino *et al*., 2022) There were also some differences in the reported protein content of Charolais beef cattle. In Orquera-Arguero, (Orquera-Arguero *et al*., 2023) the results of the study, it was found that the protein content in Holstein beef was lower at 12 months of age than at 15 months of age and 18 months of age, which was contrary to the results of the content in yak meat of different months of age, which might be related to the lesser variability of the age of yak cows in terms of month and also depended on the yak meat's inherent low-fat content may also depend on the low-fat content of yak meat itself.

Analysis of meat quality of Qinghai plateau-type yak meat of different months of age

Different breeds, sexes and ages all have important effects on the meat production performance and meat quality of

Table 5: Meat quality characteristics of the longest dorsal muscle, triceps brachii muscle and biceps femoris muscle of Qinghai Plateau-type yaks at different months of age.

position	Meat quality traits	3	4	5	*P*-Value
LD	Drip loss rate/%	1.85±0.21^{b}	5.95±0.25^{ab}	8.84±0.36^{a}	0.031
	Shear force/kg	49.48±0.28	59.27±0.34	61.11±0.76	0.119
	pH	6.59±0.31^{a}	6.37±0.07^{a}	5.74±0.01^{b}	0.003
	a*	18.54±1.28	17.14±0.38	18.12±0.29	0.162
	b*	10.25±0.57^{a}	10.20±0.32^{a}	8.18±0.96^{b}	0.014
	L*	44.20±2.32^{a}	41.70±0.51^{a}	36.84±1.57^{b}	0.004
AT	Drip loss rate/%	1.47±0.31^{b}	1.89±0.36^{b}	5.81±0.74^{a}	0.030
	Shear force/kg	47.83±0.67	46.77±0.95	45.44±0.56	0.686
	pH	6.47±0.33^{a}	6.48±0.16^{a}	5.68±0.20^{b}	0.012
	a*	18.39±0.87	18.79±0.88	19.15±2.41	0.341
	b*	9.71±0.91	9.80±1.34	8.27±0.45	0.476
	L*	37.29±2.51^{ab}	38.97±0.51^{a}	35.14±0.27^{b}	0.052
BF	Drip loss rate/%	2.04±0.04^{b}	7.31±0.24^{a}	7.25±0.34^{a}	0.040
	Shear force/kg	52.60±0.25	49.54±0.27	52.48±0.83	0.943
	pH	6.33±0.05^{a}	6.47±0.22^{a}	5.70±0.08^{b}	<0.01
	a*	16.91±1.30	15.00±0.23	17.56±2.60	0.233
	b*	8.86±0.16^{a}	8.47±0.75^{a}	6.25±1.24^{b}	0.018
	L*	36.98±1.93	35.51±0.99	37.03±2.17	0.630

Note: LD(Longissimus dorsi muscle); AT(Triceps brachii); BF(Biceps femoris).

cattle (Prajwal *et al*., 2019). The results showed that there were significant differences in quality, pH, shear and drip loss rate of beef at all ages. Moisture in conventional nutrients can reflect the tenderness of meat products to some extent, but indicators such as drip loss rate and shear force are more direct (Karaca and Arik, 2016). In this study, the shear force became larger with increasing age in months, with the best tenderness at 3 months of age with minimum shear force and maximum shear force at 5 months of age, which is consistent with the fact that Vsanteet (VSante, 2001) The results of the study the older the cow, the greater the shear force and the less consistent the tenderness of the meat. It is amply demonstrated that age is one of the most important factors affecting beef and therefore extra care should be taken in the production of cattle as well as in the kidding process. pH can directly reflect the intensity of glycogenolysis, but also one of the most important indicators for evaluating the quality of beef and has a certain effect on the tenderness, palatability, meat color and flavor of the meat (Sullivan 2011). In the present study, the dorsal longest muscle pH values of 4-month-old yaks were significantly different relative to those of 3 and 5-month-old yaks. The pH values of the muscles in the three sites of the longest dorsal muscle, the biceps femoris and the triceps brachii were acidic, which is in line with the results of Ramoset (Ramos *et al*. 2022) The results of the study of pH values in different parts of muscles of Nellore cattle were consistent.

Beef color is the first impression people have of the purchased beef. In the normal range of variation, it does not affect the nutritional value of the meat. However, sensory judgment and purchasing decisions play an essential role in the decision and are, therefore, important indicators of the quality of beef (Modzelewska-Kapitu³a M, 2021). Beef color is related to animal breed, sex, age and nutritional status. It refers to the apparent phenomenon of a series of physiological and biochemical changes in beef(Orquera-Arguero *et al*. 2023). From the analysis of the results, it can be seen that there is a tendency for the degree of redness to increase and the degree of yellowness to decrease with the age of the month, but the degree of brightness also tends to vary with the age of the month, depending on the part; this is consistent with the fact that (Saleem Usman Muhammad, 2019). The results of studies such as:

Analysis of amino acid composition and content of qinghai Plateau-type yak meat at different monthly ages:

It has been found that GLU and ASP have a direct correlation with meat quality and freshness of muscle and that GLU has a contributing effect on improving intelligence; Glutamine and ASP are both necessary in the body for the metabolism of proteins and sugars and both substances reduce blood ammonia in the body, thus acting as organ protectors (Li *et al*., 2023). In addition, Lys can be involved in the oxidation of fatty acids together with Metand, which is well known to promote animal growth and improve the nervous system (Duah *et al*., 2023). This study found that the amino acids ASP, GLU and Lys were more abundant in the muscles of all Qinghai Plateau-type yaks. In addition, the FAO/WHO

Table 6: Differences in amino acid composition and content of Qinghai Plateau-type yaks at different months of age(mg/g).

Composition of amino acid	Content of amino acid			
	3	4	5	*P*-Value
ASP#	8.47±7.3	8.30±7.36	3.56±3.47	0.338
GLU#	13.77±8.64^{a}	13.28±9.5^{a}	4.95±4.19^{b}	0.041
HYP	0.44±0.26^{a}	0.36±0.22^{ab}	0.17±0.13^{b}	0.011
Asn	/	/	/	/
Ser	0.19±0.29	0.15±0.21	0.01±0.03	0.316
Arg	2.01±1.95	1.64±1.73	0.87±1.05	0.479
Gly#	0.55±0.41	0.51±0.43	0.27±0.38	0.44
Thr*	0.94±0.98	0.88±0.91	0.26±0.44	0.243
Pro	5.08±2.17	4.97±2.69	3.7±2.78	0.595
Ala#	5.87±3.96	5.21±4.33	3.09±2.81	0.43
Val*	4.73±2.6	4.63±2.89	2.91±2.57	0.443
Met*	0.92±0.75	0.96±0.93	0.58±0.68	0.654
Cys-Cys	0.02±0.00	0.02±0.00	0.03±0.04	0.379
Ile*	5.21±2.74	5.14±3.01	3.41±2.79	0.479
Leu*	8.92±4.97	8.97±5.61	5.48±4.71	0.419
His	/	/	/	/
Phe*#	2.17±1.24	2.16±1.39	1.33±1.25	0.456
Lys*	39.77±24.19	39.18±25.99	23.28±20.17	0.410
Tyr#	2.12±2.59	1.69±2.1	0.46±0.67	0.340

Note: * is an essential amino acid and # is an umami amino acid. Different lowercase letters in peer data indicate significant differences between groups (P<0.05).

standard defines the ideal protein pattern as 40% essential amino acids/total amino acids and 40% essential amino acids/non-essential amino acids, respectively. In this experiment, the essential amino acids/total amino acids and essential amino acids/non-essential amino acids of all muscle parts of yaks were higher than the FAO/WHO standard, indicating that Qinghai Plateau-type yak meat contains amino acid species in line with human nutritional requirements and is a high-quality, high-grade beef. Ge Fet (Ge *et al*., 2023) The study results showed that the highest content of the essential amino acid Lys, followed by Leu and the lowest by Met was found in the Chinese native cattle breed Yunling cattle. GLU had the highest content among the non-essential amino acids, followed by ASP. This is consistent with the fact that the difference in the content of essential and non-essential amino acids in yak beef is slight and the difference in non-essential amino acids between yak and Yunling beef may be related to their breeds and ages.

CONCLUSION

With the increase of age in months, 4-month-old yaks had the fastest growth rate and their carcass weight, tare weight and net meat weight were significantly different from those of 3-month-old and 5-month-old yaks. Drip loss rate and pH for meat quality traits differed significantly in 4-month-old yaks.GLU and HYP content in 3- and 4-month-old yak meat was significantly higher than in 5-month-old yaks. This study can provide a theoretical basis for the management of yak breeding and also provide a reference for further optimization of breeding strategies and improvement of yak quality.

Conflict of interest

The authors declare no conflict of interest.

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