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Comparison of slaughter performances and meat qualities of Honghe yellow cattle at different ages

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ABSTRACT - We examined differences in slaughter performance and meat quality of Honghe yellow cattle of different ages. We randomly selected nine Honghe bulls for slaughter at 12 (12M), 36 (36M), and 60 (60M) months of age. There were significant differences in antemortem live weight, carcass weight, and net weight among the three groups, all of which increased with age. Backfat thickness in 36M (4.77±0.25 mm) and 60M (5.50±0.50 mm) was significantly higher than in 12M (3.00±0.00 mm), and the loin-eye area in 60M (68.02±16.02) was higher than in 12M (27.01±1.89). There was no significant difference in the pH value of the month-old group. Compared with 12M (29.33±4.93%) and 60M (23.87±5.08%), the cooking loss of meat in 36M (36.50±5.07%) was significantly higher; meanwhile, a* value was also the highest in 36M (22.39±1.34), the protein and fat content of muscle in 12M was lower, while the content of meat in 60M was lower. There was no significant difference in muscle ash, Ca, and P contents; the total amino acid and essential amino acid contents of 36M were higher than those of 12M and 60M, and the unsaturated fatty acids of meat in 12M were higher than those in 36M and 60M. The change of age has a certain influence on the slaughter performance and meat quality of Honghe yellow cattle.

Keywords: amino acids, fatty acids, nutritional composition, slaughter performance

1. Introduction

Honghe yellow cattle are a beef breed raised for generations in Honghe Prefecture, Yunnan province, and are an important part of the breeding industry in the region. They are a local genetic resource for both service and meat, originally listed in the Records of Livestock and Poultry Breeds of Honghe Hani and Yi Autonomous Prefecture in 1981 (Huang and Wang, 2015). Honghe Prefecture is situated in the Ailao Mountain chain in the mountainous southwestern Yunnan-Guizhou Plateau in China, and the cattle are able to tolerate grazing coarse fodder on steep slopes. The animals have gentle temperament, strong disease resistance, and good adaptability, as well as good meat quality and high amino acid content.

At slaughter, age is a crucial factor affecting performance and meat quality (Lundesjö Ahnström et al., 2012; Marti et al., 2013; Awan et al., 2014; Soji and Muchenje, 2016; Li et al., 2018). Optimized slaughter age can yield tenderer and fresher beef, of greater economic value. Other factors such as breed (Bonny et al., 2016; Flowers et al., 2018), sex (Mueller et al., 2019; Schiavon et al., 2019), feeding method (Braghieri et al., 2013; Turner et al., 2015; Moran et al., 2017), and fodder (Duckett et al., 2013; Avilés et al., 2015) also affect meat quality. In the United States, consumers prefer grass-fed beef, which is considered healthier and has less impact on the environment than grain-fed beef. Because of its environmentally friendlier and healthier image, grass-fed beef is becoming increasingly popular (Boogaard et al., 2011) and can play a key role in consumer acceptance (Musto et al., 2016). Honghe yellow cattle meet this description due to their active hillside grazing habits yielding low carcass fat content, high lean meat content, tender meat quality, and rich flavor. However, age-based slaughter performance and meat quality are not well studied in Honghe yellow cattle. We examined how slaughter performance, meat quality, and amino and fatty acid contents varied based on age at slaughter.

2. Material and Methods

2.1. Ethics committee number

This study was carried out in accordance with the recommendation of the local Institutional Animal Care and Use Committee (approval No.: YNAU20180020), and complied with the guidelines of the institutional administrative committee and ethics committee of laboratory animals.

2.2. Location of the experiment

This experiment was performed in Honghe Prefecture, Yunnan Province, China (103 longitude and 23 latitude).

2.3. Determination of slaughter performance

Honghe yellow cattle were randomly selected for slaughter at 12, 36, and 60 months of age to form groups 12M, 36M, and 60M, respectively, with three individuals per group, and a total of nine experimental Honghe yellow cattle. We measured their antemortem live weight after fasting for 24 h. After slaughter, we measured postmortem carcass weight after bloodletting, peeling, and removing the head, hooves, tail, and viscera. Slaughter rate, net weight, and meat to bone ratio were calculated. The cross section of the *longissimus dorsi* muscle from the 12th to 13th intercostal space of each bull was drawn using transparent sulfuric acid paper, and the loin-eye area was measured using a planimeter. Backfat thickness from the 12th to 13th intercostal space was measured using a fat-measuring meter.

2.4. Determination of meat quality

Forty-five minutes after slaughter, a pH-STAR carcass muscle pH meter was used to measure the pH of the intercostal *longissimus dorsi* muscle from the 12th to 13th intercostal space of the left carcass. We sampled the intercostal *longissimus dorsi* muscle and used a CHROMA METER CR-400 to measure the luminance (L*), redness (a*), and yellowness (b*) values. Shear force, cooking loss, and water loss rate were also measured. Each indicator was measured three times.

2.5. Determination of nutritional composition, amino acids, and fatty acids

Moisture was determined by drying under ambient pressure, the result was necessary to reach constant weight. Then, samples were ground using a blender and dry ice to obtain a homogenous powder. Ether extract was obtained by diethyl ether extraction in Soxhlet extractor. Crude protein content was determined using the Kjeldahl apparatus, and protein was computed using a fixed conversion factor of 6.25 g of protein/g of N. Ash content was determined by incineration (550±20 °C) in a muffle furnace. The microwave was programmed as follows: 250 watts for 5 min, 630 watts for 5 min, 500 watts for 20 min, and 0 watts for 15 min. Digested samples were transferred to 25 mL volumetric flasks and diluted with deionized water. The concentrations of calcium and phosphorus were then measured by

ICP-OES. The dorsal longest muscle at the 12th to 13th intercostal space was removed immediately after slaughter, and visible fat, muscle bonds, and surface connective tissues were removed. The muscle sample was then stored in a freezer at −20 °C. We took 0.2 g of sample in a 2 mL grinding tube and ground it at 60 Hz for 5 min; then, we transferred the ground sample to a 10-mL glass centrifuge tube, added 2 mL of methanol and 4 mL of chloroform, at 25 °C, 180 rpm/min, shaking for 20 min, added 2 mL of deionized water and an appropriate amount of Na_2SO_4, and vortexed it for 2 min. Next, it was centrifuged at 1000 rpm/min for 10 min, and the supernatant was transferred into a new centrifuge tube and blowdried with N_2. We added 1 mL of n-hexane, 25 μL (10.337 mg/mL) C19:0 internal standard, and vortexed it for 2 min. Then, we added 1 mL of 0.4 mol/L KOH/methanol and vortexed it for 1 min and reacted at 37°C for 30 min. Next, we centrifuged it at 2000 rpm/min for 5 min, and took the supernatant in an injection vial for examination. The test instrument was the 7890B-5977B Gas Chromatography-mass spectrometer (GC-MS) (Shanghai Minxin Biotechnology Co, Ltd), the specification and field of chromatographic column were DB-5 (30 m × 0.25 mm × 0.25 μm). The injection volume was 1 μL, the injection temperature 270 °C, the split ratio was controlled at 20: 1; helium (99.999%) was used as the carrier gas, and the flow rate was 1 mL/min. The column temperature was 70 °C for 5 min, 25 °C/min to 200 °C, 2 °C/min to 240 °C for 10 min; the interface temperature was controlled to 280 °C, and the ion source temperature was 230 °C; the temperature of the quadrupole was 150 °C, and the full scan mode was used for scanning. Data was extracted from the GC/MS data under Agilent data software data analysis and sorted according to the NIST database. The *longissimus dorsi* muscle was dried at 65 °C, and after defatting, the content of each amino acid was determined using an automatic amino acid analyzer (S-433D, Sykam, Germany).

2.6. Data processing and analysis

The test data were preliminarily sorted using Excel 2007 and then subjected to one-way analysis of variance (ANOVA) in general linear model using SPSS9.1 software. Duncan's multiple range comparison was used for multiple comparisons.

3. Results

3.1. Slaughter performance

As the age increased, live weight, carcass weight, and net weight of Honghe yellow cattle also increased (Table 1): live weight of 60M (235.17 kg) > 36M (189.17 kg) > 12M (108.5 kg), carcass weight of 60M (111.05 kg) > 36M (85.73 kg) > 12M (48.00 kg), and net weight of 60M (86.02 kg) > 36M (64.65 kg) >

Table 1 - Slaughter performance measurement of Honghe yellow cattle at different ages[1]

	Group			P
	12M	36M	60M	
Live weight (kg)	108.50±10.39C	189.17±21.35B	235.17±6.53A	0.001
Carcass weight (kg)	48.00±3.28C	85.73±17.81B	111.05±8.89A	0.002
Net weight (kg)	33.36±2.63C	64.65±15.70B	86.02±9.02A	0.001
Bone weight (kg)	14.64±0.72c	21.08±2.14b	25.47±0.29a	0.047
Backfat thickness (mm)	3.00±0.00B	4.77±0.25A	5.50±0.50A	0.007
Loin-eye area (cm^2)	27.01±1.89B	45.29±11.91AB	68.02±16.02A	0.010
Muscle fiber diameter (μm)	48.25±2.00c	53.67±2.66b	65.14±3.69a	0.039
Slaughter rate (%)	44.33±1.84	45.33±3.33	47.33±2.44	0.678
Net meat rate (%)	30.64±0.89b	34.00±4.94ab	36.33±2.78a	0.015
Carcass meat yield (%)	69.33±0.93b	75.00±1.40a	77.00±2.71a	0.043
Meat to bone ratio (%)	227.67±14.59b	306.00±13.59a	338.00±10.88a	0.048

[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.
In the same row, values with different lowercase letters mean significant difference (P<0.05), and values with different uppercase letters mean extremely significant difference (P<0.01).

12M (33.36 kg). There were significant differences among the three groups (P<0.01). Bone weight in 36M and 60M were 21.08 and 25.47 kg, respectively, higher than in 12M (P<0.05). Slaughter rate and meat to bone ratio increased by 1.00 and 3.00% and 78.33 and 32.00%, respectively. Slaughter rate was between 44 and 47% and increased with age. There were significant differences in backfat thickness among the three groups (P<0.01) [groups 60M (5.50 mm) and 36M (4.77 mm) > 12M (3.00 mm)], and the loin-eye area in 60M was higher (41.01 cm^2) than in 12M (P<0.01). Carcass meat yield in 60M was higher (7.67%) than in 12M (P<0.05). Muscle fiber diameter increased significantly with age among the three groups (P<0.05): 60M (65.14 μm) and 36M (53.67 μm) > 12M (48.25 μm).

3.2. Meat quality

There were no significant differences in water loss, shear force, or pH among the three groups (P>0.05; Table 2). Muscle pH ranged between 6.64 and 6.74. The cooking loss of 12M, 36M, and 60M were 29.33, 36.50, and 23.87%. There was significant difference in cooking loss between 36M and 60M (P<0.05). L* and a* values were, respectively, in the range of 28.4-34.43 and 18.76-22.39. L* in 12M was significantly higher 6.03 than in 60M (P<0.05), and a* in 36M was significantly higher than in 12M and 60M (P<0.05). There was no significant difference in b* among the three groups (P>0.05).

The moisture range was in the range of 72.46-74.89%, which decreased with age. Ash, Ca, and P contents were not significant (P>0.05), and crude protein content ranged between 80.39 and 83.95% (DM), intramuscular fat content ranged between 3.40 and 3.89% (DM) (Table 3), but did not differ significantly among the three groups (P>0.05), they were in the normal range.

Table 2 - Quality measurement results of Honghe yellow cattle at different ages[1] (fresh meat samples)

	Group			P
	12M	36M	60M	
pH 45min	6.64±0.10	6.65±0.17	6.74±0.03	0.495
Water loss rate (%)	38.58±1.09	36.83±1.25	38.25±0.75	0.870
Shear force (N)	34.89±1.57	38.32±2.01	45.28±1.36	0.554
Cooking loss (%)	29.33±4.93ab	36.50±5.07a	23.87±5.08b	0.017
L*	34.43±1.56a	30.23±3.59ab	28.40±2.56b	0.018
a*	19.36±0.72b	22.39±1.34a	18.76±1.29b	0.017
b*	5.15±0.35	5.76±0.82	4.96±2.03	0.246

[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.
L* - luminance; a* - redness; b* - yellowness.
In the same row, values with different letters mean significant difference (P<0.05).

Table 3 - Nutritional results (%) of Honghe yellow cattle at different ages[1]

	Group			P
	12M	36M	60M	
Moisture	74.89±0.75	73.23±0.99	72.46±0.75	0.293
Ash (DM)	4.80±0.04	4.78±0.12	3.99±0.12	0.298
Crude protein (DM)	83.95±0.62	80.39±3.67	83.66±0.57	0.651
Intramuscular fat (DM)	3.50±0.48	3.40±1.11	3.89±0.40	0.887
Ca (DM)	0.06±0.01	0.07±0.03	0.08±0.01	0.938
P (DM)	3.74±0.03	3.90±0.11	4.03±0.17	0.370

DM - dry matter.
[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.

3.3. Amino and fatty acids

There was no significant difference in amino acid content among the three groups (P>0.05), although total amino acid content was the highest at 36 months of age, 24.72 g/100 g. Glutamic acid content was the highest, followed by aspartic acid, lysine, leucine, and arginine (Table 4). There was no significant difference in functional amino acid content among the three groups (P>0.05). Total and essential amino acid contents in 36M were higher than in 12M and 60M, but not significantly so (Table 5). The n-6:n-3 ratio of 36M was 3.86, lower than in 12M (4.32) and 60M (4.11). The cis-11-eicosenoic acid content (C20:1) in 12M was significantly higher than in 60M (P<0.05). However, there was no significant difference in other fatty acids among the three groups (P>0.05; Table 6).

Table 4 - Amino acid (AA) composition and content in fresh meat of Honghe yellow cattle at different ages[1] (g/100 g)

Amino acid	Group			P
	12M	36M	60M	
Essential AA				
Thr	1.10±0.07	1.18±0.28	1.03±0.02	0.085
Vla	1.21±0.07	1.29±0.31	1.12±0.03	0.672
Met	0.60±0.04	0.67±0.14	0.58±0.02	0.438
Ile	1.17±0.08	1.25±0.29	1.17±0.11	0.744
Leu	1.94±0.14	2.09±0.51	1.57±0.45	0.314
Phe	0.95±0.07	1.01±0.26	0.88±0.02	0.769
Lys	2.03±0.11	2.17±0.59	1.90±0.03	0.930
Non-essential AA				
Asp*	2.22±0.15	2.38±0.58	2.08±0.05	0.284
Ser	0.94±0.06	1.01±0.25	0.88±0.02	0.594
Glu*	3.87±0.30	4.17±1.00	3.65±0.08	0.678
Gly*	1.12±0.11	1.13±0.31	1.03±0.09	0.926
Ala*	1.43±0.10	1.50±0.37	1.32±0.05	0.763
Cys	0.24±0.02	0.26±0.07	0.22±0.01	0.285
Tyr	0.85±0.06	0.91±0.22	0.79±0.01	0.714
His	1.01±0.04	1.12±0.33	0.93±0.05	0.558
Arg*	1.53±0.10	1.62±0.39	1.40±0.05	0.813
Pro	0.95±0.08	0.97±0.25	0.88±0.04	0.601

[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.
* Umami amino acid.

Table 5 - Functional amino acid (AA) content in fresh meat of Honghe yellow cattle at different ages[1]

	Group			P
	12M	36M	60M	
Total AA (g/100 g)	23.15±1.50	24.72±6.14	21.44±0.80	0.801
Essential AA (g/100 g)	8.99±0.57	9.66±2.37	8.26±0.41	0.751
Non-essential AA (g/100 g)	14.17±0.95	15.06±3.77	13.18±0.43	0.775
Essential AA/total AA (%)	38.83±0.44	39.10±0.25	38.52±0.74	0.077
Essential/non-essential AA (%)	63.48±1.19	64.22±0.68	62.67±1.95	0.079
Umami AA	6.08±0.45	6.55±1.58	5.73±0.13	0.869
Umami AA/total AA (%)	26.26±0.30	26.52±0.18	26.74±0.40	0.352
Sweet fresh AA	5.54±0.39	5.78±1.46	5.13±0.22	0.578
Sweet fresh AA/total AA (%)	23.94±0.65	23.37±0.12	23.95±0.28	0.126
Bitter AA	11.29±0.69	12.13±3.03	10.35±0.47	0.742
Bitter AA/total AA (%)	48.75±0.52	49.06±0.18	48.28±0.51	0.154

[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.

Table 6 - Fatty acid content (g/100 g) in fresh meat of Honghe yellow cattle at different ages[1]

Fatty acid	Group			P
	12M	36M	60M	
C6:0	0.0001±0.0001	0.0001±0.0000	0.0001±0.0000	0.341
C8:0	0.0001±0.0001	0.0001±0.0001	0.0001±0.0000	0.545
C10:0	0.0001±0.0001	0.0002±0.0004	0.0001±0.0002	0.372
C11:0	0.0001±0.0001	0.0001±0.0001	0.0001±0.0000	0.328
C12:0	0.0003±0.0002	0.0006±0.0006	0.0004±0.0004	0.863
C13:0	0.0001±0.0001	0.0001±0.0001	0.0001±0.0001	0.372
C14:0	0.0055±0.0039	0.0145±0.0090	0.0111±0.0062	0.607
C14:1n5	0.0007±0.0005	0.0018±0.0020	0.0012±0.0015	0.628
C15:0	0.0024±0.0008	0.0056±0.0061	0.004±0.0046	0.609
C16:0	0.0673±0.0175	0.1279±0.1164	0.108±0.0184	0.894
C16:1n7	0.0068±0.0021	0.0164±0.0174	0.0104±0.0100	0.422
C17:0	0.0053±0.0017	0.0118±0.0137	0.0094±0.0112	0.543
C17:1	0.0033±0.0008	0.0051±0.0044	0.0037±0.0029	0.435
C18:0	0.0794±0.0326	0.1653±0.1777	0.1217±0.1238	0.478
C18:1n9c	0.0886±0.0245	0.1931±0.1948	0.1373±0.1218	0.518
C18:2n6c	0.0626±0.0117	0.0567±0.0199	0.0471±0.0199	0.690
C18:3n3	0.0161±0.0031	0.0123±0.0048	0.0110±0.0052	0.786
C20:0	0.0018±0.0009	0.0043±0.0044	0.0027±0.0028	0.758
C20:1	0.0008±0.0001a	0.0005±0.0006ab	0.0003±0.0005b	0.041
C20:2	0.0007±0.0005	0.0006±0.0003	0.0008±0.0004	0.683
C20:3	0.0033±0.0007	0.0039±0.0017	0.0027±0.0011	0.360
C21:0	0.0005±0.0002	0.0009±0.0006	0.0006±0.0004	0.808
C20:4n6	0.0257±0.0041	0.0211±0.0089	0.0178±0.0077	0.430
C20:3n3	0.0003±0.0001	0.0002±0.0001	0.0002±0.0001	0.429
C20:5n3	0.0054±0.0009	0.0064±0.0027	0.0047±0.0023	0.198
C22:0	0.0006±0.0003	0.0012±0.0010	0.0007±0.0006	0.752
C22:1n9	0.0002±0.0001	0.0002±0.0001	0.0002±0.0000	0.334
C23:0	0.0005±0.0003	0.0008±0.0005	0.0005±0.0003	0.490
C24:0	0.0007±0.0003	0.0007±0.0005	0.0005±0.0004	0.569
C22:6n3	0.0008±0.0002	0.0011±0.0005	0.001±0.00050	0.081
C24:1	0.0030±0.0011	0.0028±0.0016	0.0019±0.0012	0.562
∑SFA	0.1646±0.0213	0.2827±0.0254	0.2599±0.0045	0.802
∑UFA	0.2177±0.0147	0.3039±0.0345	0.2679±0.0065	0.799
∑MUFA	0.1444±0.0015	0.3690±0.0211	0.4642±0.0372	0.833
∑PUFA	0.1103±0.0135	0.1611±0.0132	0.1517±0.0025	0.890
∑n-3 PUFA	0.0146±0.0031	0.0165±0.0024	0.0140±0.0014	0.934
∑n-6 PUFA	0.0633±0.0014	0.0638±0.0035	0.0576±0.0024	0.911
SFA:UFA (%)	0.7560±0.1008	0.9302±0.0053	0.9701±0.0040	0.054
PUFA:SFA (%)	0.6702±0.0034	0.5702±0.0040	0.5836±0.0055	0.882
MUFA:PUFA (%)	1.3096±0.0081	2.2905±0.0246	3.0600±0.1010	0.083
n-6:n-3 PUFA (%)	4.3200±0.0068	3.8667±0.0129	4.1140±0.0303	0.895

[1] Honghe bulls at 12 (12M), 36 (36M), and 60 (60M) months of age.
SFA - saturated fatty acids; UFA - unsaturated fatty acids; MUFA - monounsaturated fatty acids; PUFA - polyunsaturated fatty acids; n-6:n-3 - omega-6:omega-3 fatty acids ratio.
In the same row, values with different letters mean significant difference (P<0.05).

4. Discussion

Factors such as age (Li et al., 2018), breed (Taussat et al., 2019), and sex (Marenčić et al., 2018) of livestock can affect slaughter performance. The slaughter rate of 36-month-old Honghe yellow cattle was similar to adult Dengchuan cattle (46.4%) and adult Wenshan cattle (44.9%) (National Animal and Poultry Genetic Resources Committee, 2011), but lower than adult Luxi cattle (55.3%) and adult Jiaxian red cattle (59.4%) (Liu 2015; Shi et al., 2019). In Honghe yellow cattle slaughtered at 36 months of age, backfat thickness was higher than in adult Sinan yellow cattle (2.00 mm), and loin-eye area muscle area was greater than in adult Diqing yellow cattle (38.5 cm^2) (National Animal and Poultry Genetic Resources Committee, 2011; Zhang et al., 2016). In Yanbian yellow cattle, loin-eye area was significantly greater at 36 months than at 24 months of age ($P<0.05$), and backfat thickness also significantly increased ($P<0.01$) (Wu et al., 2015). Loin-eye area and backfat thickness similarly increased with age in our study. There were significant differences in the slaughter performance of Honghe yellow cattle at different months of age.

Muscle pH was higher in the early postmortem period compared with 24 h after slaughter (5.8-6.0). Muscle shear force of Honghe yellow cattle were similar to past findings (Ellies-Oury et al., 2017). All sensory traits (tenderness, flavor, juiciness, and overall liking) declined as shear force and age increased and as intramuscular fat percentage decreased. In Qinchuan cattle younger than 30 months, meat shear force increased with total collagen and muscle fiber diameter; after 30 months of age, shear force increase was related to the thermal solubility and non-reducing covalent cross-linking content of collagen (Lu, 2013).

Honghe yellow cattle L* and a* values were higher than measured for adult Leiqiong yellow cattle (31.85 and 12.84, respectively) (Luo et al., 2020). Breed, sex, age, nutrition, and ambient temperature may affect meat color (Giuffrida-Mendoza et al., 2015): the greater the age of the Honghe yellow cattle, the lower the a* value. Meat color is determined by the proportions of ferric myoglobin (bright red), myoglobin (dark red), and metmyoglobin (gray, brown) in the muscle. Among these, myoglobin content is a prominent factor affecting meat color (Pacheco et al., 2015). Purplish-red myoglobin is oxygenated to bright red, which symbolizes the freshness of meat, and is subsequently oxidized to produce brown methemoglobin, which leads to darkening.

Crude protein content in Honghe yellow cattle was higher than in Jinjiang yellow cattle (20.93%), Ji'an yellow cattle (21.03%), or Guangfeng yellow cattle (21.07%), which are local breeds in Jiangxi Province (Lan et al., 2011). This shows that Honghe yellow cattle are a good source of meat protein. Meanwhile, their intramuscular fat ranged between 0.88 and 1.07% (accounted for the total nutrient content), lower than in Brahman bulls aged 1-24 months under grazing conditions (1.36-1.95%) (Giuffrida-Mendoza et al., 2015).

Glutamate and aspartic acid contents in muscle tissue of Honghe yellow cattle were the highest, while the content of cysteine was the lowest (24.72 g/100 g). The rich glutamic acid and aspartic acid make the beef of Honghe yellow cattle have delicious flavor and important physiological effect (Wong et al., 2011). Glutamic acid content was the highest, followed by lysine, leucine, and arginine in the study of amino acid content in packaged beef from the United States (Wu et al., 2016). According to the requirements of FAO/WHO, the ideal protein pattern, EAA/NEAA in high-quality protein, should be above 0.60, and the EAA/NEAA of the three groups in this experiment were all higher than 0.60, which belongs to the meat with high nutritional value.

Among tallow fatty acids, the main saturated fatty acids are myristic, palmitic, and stearic acids. Palmitic acid content has the greatest effect on meat, and is negatively correlated with juiciness. We found that at 60M, palmitic acid content was higher than at 12M or 36M, indicating that juiciness decreased with age. Fatty acids also play a pivotal role in the tenderness, flavor, and taste of meat. Fatty acids, especially unsaturated fatty acids (UFA), are the major source for the generation of volatile compounds.

In meat nutritional profiles, high ratios of omega-6:omega-3 fatty acids (n-6:n-3) and polyunsaturated:monounsaturated fatty acid (PUFA:MUFA) are desirable (Jiménez-Colmenero et al., 2010). Based on previous studies, n-3 fatty acids are the most beneficial to heart health among all fatty acids and can reduce the incidence of cancer (Kalstad et al., 2021). Regular consumption of foods rich in n-3 fatty acids can prevent hypertension, depression, and Alzheimer's disease, as well as promote brain development (Del Gobbo et al., 2016).

Numerous experimental results have shown that the n-3 PUFA content in grass-fed beef is higher than in grain-fed beef (Dilzer and Park, 2012; Duckett et al., 2013), which is of benefit in minimizing hypercholesterolemia and lipoprotein esters in humans (Litwińczuk et al., 2015). This indicates that the meat quality of 36-month-old Honghe yellow cattle was more conducive to human health. Furthermore, the inclusion of lipid fodder in cattle diets can increase the beef content of beneficial fatty acids. Addition of dietary crude glycerol resulted in a 6.08% increase in unsaturated fatty acids in the meat of 22-month-old Nellore bulls (Castagnino et al., 2018). Based on this, future research should examine whether dietary lipid supplementation to Honghe yellow cattle can improve meat quality and taste according to human nutritional needs.

5. Conclusions

The slaughter performance of Honghe yellow cattle increases with the increase of months of age. As a whole, the meat color is bright, and the contents of amino acids and fatty acids and contents of glutamic acid, aspartic acid, and lysine are high. In general, the slaughter performance and meat quality of Honghe yellow cattle at 36 months of age are better.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: Y. Yu and J. Leng. Formal analysis: Y. Yu and S. Wang. Investigation: S. Wang and Q. Lu. Methodology: Q. Lu and Y. Tao. Project administration: B. Fu, P. Li and R. Yang. Resources: J. Leng. Writing-review & editing: J. Leng.

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