

Slaughter Performance, Muscle Quality and Nutritional Composition of Duoluo Goats in Sichuan Province

Mingliang ZHOU¹, Shan WU², Qian PANG¹, Basangzhuoma², Minghua CHEN¹, Hualong FU², Jinbin MAO², Pinggui YANG^{1*}

1. Sichuan Academy of Grassland Sciences, Chengdu 611731, China; 2. Animal Husbandry Station of Ganzi Tibetan Autonomous Prefecture, Kangding 626000, China

Abstract [**Objectives**] This study was conducted to understand the biological characteristics of Duoluo goats. [**Methods**] With male and female Duoluo goats as the research object, related performance indexes were determined and analyzed after slaughter. [**Results**] The weights of one-year-old male and female Duoluo goats before slaughter were (25.68 ± 2.37) and (24.51 ± 1.97) kg, respectively; the dressing percentages were (43.55 ± 3.24) % and (43.84 ± 3.42) %, respectively; and the net meat percentages were (33.02 ± 2.32) % and (34.19 ± 2.46) %, respectively. (2) The cooked meat rates of male and female Duoluo goats were (65.49 ± 1.42) % and (65.36 ± 1.55) %, respectively; the shearing force was (5.48 ± 1.24) and (5.65 ± 1.02) N, respectively; and the loin-eye muscle areas were (8.95 ± 1.72) and (8.82 ± 1.15) cm², respectively. (3) The protein contents of male and female Duoluo goats were (20.07 ± 0.42) and (19.47 ± 1.22) g/100 g, respectively; and the fat contents were (1.30 ± 0.80) % and (2.92 ± 0.55) %, respectively; and the cholesterol contents were (71.76 ± 11.47) and (74.83 ± 2.68) mg/100 g, respectively; (4) The Ca contents of male and female Duoluo goats were (69.53 ± 10.89) and (63.00 ± 4.56) mg/kg, respectively; the Fe contents were (16.73 ± 1.83) and (14.77 ± 0.58) mg/kg, respectively; and the Zn contents were (38.47 ± 3.68) and (31.83 ± 2.22) mg/kg, respectively. (5) In the muscles of male and female Duoluo goats, the contents of essential amino acids were (7.44 ± 0.24) and (7.26 ± 0.41) g/100 g, respectively; the contents of non-essential amino acids were (11.81 ± 0.33) and (11.42 ± 0.67) g/100 g, respectively; and the contents of flavor amino acids were (8.79 ± 0.27) and (8.42 ± 0.57) g/100 g, respectively. [**Conclusions**] This study lays a foundation for the excavation and utilization of the resource, Duoluo goats.

Key words Duoluo goat; Slaughter; Muscle quality; Amino acid

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Jiulong County is located in the northeast of the Yalong River, east of Hengduan Mountains, with a latitude of $28^{\circ}19' - 29^{\circ}20'N$ and longitude of $101^{\circ}7' - 102^{\circ}10'E$. It has a subtropical climate, with an average annual temperature of $8.9^{\circ}C$, a highest temperature of $31.7^{\circ}C$, a lowest temperature of $-15.6^{\circ}C$, and an active accumulated temperature $\geq 10^{\circ}C$ ranging from 2 000 to 5 000 $^{\circ}C$. The frost free period is 162–288 d, and the sunshine hours are 1 920 h. The dry and rainy seasons are distinct. The period from May to September is the rainy season, and that from November to April of the following year is the snowy season. Jiulong County is drought in winter and spring, and the rainfall is 760–1 300 mm. The grassland area of the county is 334 400.17 hm², accounting for 49.38% of the total area of the county, and the available grassland area is 291 666.81 hm², accounting for 87.23% of the grassland area. The vegetations include forage grasses in Poaceae, Cyperaceae, Asteraceae, Rosaceae, and Leguminosae and various shrubs, mainly consisting of corn, rice, wheat, potato, and legumes.

The central producing area of Duoluo goats is located in

Duoluo Township, Jiulong County, Ganzi Tibetan Autonomous Prefecture, Sichuan Province, and more than 10 towns of the county are distributed with Duoluo goats, which are also distributed in Kangding City and Luding County. The goats in this population are mainly black in head and neck and white in body, and also have pure black, all white, tan and other fur colors. They are suitable for the natural ecological environment of the alpine valleys in the Yalong River basin and are raised in a natural grazing way. Since 2016, the Animal Husbandry Station of Ganzi Tibetan Autonomous Prefecture and Sichuan Academy of Grassland Sciences have jointly excavated the resource population of Duoluo goats, and obtained information on the distribution, population characteristics, growth and development, slaughter performance and muscle quality of Duoluo goats. In this study, the slaughter performance, muscle quality, muscle nutritional components, minerals and amino acids of one-year-old Duoluo goat population were investigated, laying a foundation for further excavation and industrial development of Duoluo goats.

Material and Methods

Experimental animals

Taking Duoluo goats in Jiulong County, Ganzi Tibetan Autonomous Prefecture, Sichuan Province as the research object, 15 male and 15 female goats that met the appearance characteristics of Duoluo goat, a total of 30 goats, were selected. The feeding method was natural grazing.

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Mingliang ZHOU (1976–), male, P. R. China, associate researcher, PhD, devoted to research about excavation and utilization of sheep genetic resources.

* Corresponding author.

Slaughtering and trait determination

The goats were transported to the slaughterhouse 24 h before slaughter, and the supply of forage was stopped 12 h before slaughter, and the supply of water was stopped 2 h before slaughter. The indexes of body weight, body length, body height, chest circumference and body height were measured before slaughter.

The goats were slaughtered by bloodletting of cervical artery. After peeling, removing the head and hooves, internal organs were taken out, and the head weight, hoof weight, skin weight, skin area and weights of heart, liver, spleen, lung and kidney were measured. The contents of rumen, reticulum, omasum and abomasum were discarded, and the weights were measured. The contents of large intestine and small intestine were discarded, and the weights were measured. The carcasses were weighed, hung upside down naturally, and cut in half, and the left carcass was deboned to determine its bone weight and net weight.

In the 12th-13th intercostal space of the right half-carcass, the shape of the loin-eye muscle was described with tracing paper, and the area of the drawn shape, that is, the loin-eye muscle area, was calculated by squares. After slaughter, about 45 min later, the pH value of the cross section of the loin-eye muscle was measured with a pH meter; a CM-700d colorimeter was used to measure the *L* value of brightness, the *a* value of red and green, and the *b* value of yellow and blue at the cross section of muscle; and about 100 g of the longissimus dorsi muscle was taken and measured for its weight, and then cooked in a water bath for 30 min, and after taking out and cooling for about 15 min, it was weighed to calculate the cooked meat rate; Cooked meat rate (%) = (Weight after cooking/Weight before cooking) × 100%. Next, the meat sample for the determination of cooked meat rate was sampled by a sampler of tenderness meter CL-ML3 for the determination of the tenderness of the longissimus dorsi muscle.

A 500 – 1 000 g of sample was taken from the longissimus dorsi muscle or its mixture with triceps brachii and biceps femoris, and excess adipose tissue was removed. It was put in a sealed bag, which was then labeled, and sent to the analysis and testing center of Sichuan Academy of Agricultural Sciences to determine

the contents of nutritional components, mineral elements, heavy metal elements, amino acids and cholesterol in muscle tissue.

Amino acid scoring

According to the human essential amino acid balance model revised by FAO/WHO (Food and Agriculture Organization of the United Nations and World Health Organization), the amino acids of Duoluo goats were scored, that is, Amino acid score (AAS) = Content of tested amino acid / (Content of the same amino acid in the FAO/WHO model) × 100%.

Data analysis

Excel was used for data sorting and preliminary analysis, and SPSS 22.0 was used for *T*-test for comparison between male and female goats. The results were expressed as mean ± standard deviation ($\bar{x} \pm s$).

Results and Analysis

Slaughtering performance

As can be seen from Table 1, the weights of one-year-old male and female Duoluo goats before slaughter were (25.68 ± 2.37) and (24.51 ± 1.97) kg, respectively; the body lengths were (77.35 ± 4.41) and (76.24 ± 4.55) cm, respectively; the body heights were (58.46 ± 4.21) and (57.49 ± 3.14) cm, respectively; the chest circumferences were (71.09 ± 3.42) and (70.05 ± 2.31) cm, respectively. There were no significant differences in body weight, body length, body height and chest circumference between male and female goats ($P > 0.05$).

As shown in Table 2, the dressing percentages of one-year-old Duoluo goats were (43.55 ± 3.24) % and (43.84 ± 3.42) %, respectively; the net meat percentages were (33.02 ± 2.32) % and (34.19 ± 2.46) %, respectively; and the meat percentages of carcass were (75.85 ± 5.46) % and (77.95 ± 4.36) %, respectively. There were no significant differences in carcass weight, net meat weight, bone weight, dressing percentage, net meat percentage, meat percentage of carcass and bone-meat ratio between male and female goats ($P > 0.05$). The by-products of slaughtered one-year-old Duoluo goats are shown in Table 3.

Table 1 Weight and measurement of one-year-old Duoluo goats before slaughter

Gender	Number	Body weight//kg	Body length//cm	Body height//cm	Chest circumference//cm
♂	15	25.68 ± 2.37	77.35 ± 4.41	58.46 ± 4.21	71.09 ± 3.42
♀	15	24.51 ± 1.97	76.24 ± 4.55	57.49 ± 3.14	70.05 ± 2.31
<i>P</i> value		0.651	0.305	0.507	0.246

Muscle quality of Duoluo goats

As can be seen from Table 4, the pH_{45 min} values in the muscles of male and female Duoluo goats were (6.15 ± 0.17) and (6.21 ± 0.15), respectively; the loin-eye muscle areas were (8.95 ± 1.72) and (8.82 ± 1.15) cm², respectively; the shearing force was (5.48 ± 1.24) and (5.65 ± 1.02) N, respectively; and the cooked meat rates were (65.49 ± 1.42) % and (65.36 ± 1.55) %, respectively. There were no significant differences in

pH_{45 min}, loin-eye muscle area, shear force and cooked meat rate between male and female goats ($P > 0.05$). In the colorimeter, the *L* value representing the brightness of muscle was (47.47 ± 1.53) and (47.65 ± 1.38) for male and female goats, respectively; the *a* value representing red and green was (4.33 ± 0.75) and (3.95 ± 1.09), respectively; and the *b* value representing yellow and blue was (6.66 ± 1.11) and (6.46 ± 0.81), respectively. There were no significant differences in *L*, *a* and *b* between male and female

goats ($P > 0.05$).

Contents of nutritional components, minerals, cholesterol and heavy metals in muscles

As shown in Table 5, the water contents in muscles of male and female Duoluo goats were (77.53 ± 0.38) % and (76.37 ± 0.99) %, respectively; the protein contents were (20.07 ± 0.42) g/100g and (19.47 ± 1.22) g/100 g, respectively; and the fat contents were (1.30 ± 0.80) % and (2.92 ± 0.55) % respectively. The contents of water, dry matter, ash and protein in muscles were not significantly different between male and female goats, while the fat content of female goats was significantly higher than that of male goats.

Table 2 Slaughter performance of Duoluo goats

Trait	♂	♀	<i>P</i> value
Carcass weight//kg	11.18 ± 1.42	10.75 ± 1.13	0.357
Net meat weight//kg	8.48 ± 1.02	8.38 ± 0.65	0.442
Bone weight//kg	2.43 ± 0.62	2.34 ± 0.45	0.345
Dressing percentage//%	43.55 ± 3.24	43.84 ± 3.42	0.601
Net meat percentage//%	33.02 ± 2.32	34.19 ± 2.46	0.246
Meat percentage of carcass//%	75.85 ± 5.46	77.95 ± 4.38	0.419
Bone-meat ratio	1 : 3.49	1 : 3.58	0.337

Sample size: 15 males and 15 females.

As can be seen from Table 6, the cholesterol contents in the muscles of male and female Duoluo goats were (71.76 ± 11.47) and (74.83 ± 2.68) mg/100 g, respectively; the Ca contents were (69.53 ± 10.89) and (63.00 ± 4.56) mg/kg, respectively; and the Mg contents were (232.00 ± 9.60) and (221.66 ± 3.79) mg/kg, respectively; the Fe contents were (16.73 ± 1.83) and (14.77 ± 0.58) mg/kg, respectively; and the Zn contents were (38.47 ± 3.68) and (31.83 ± 2.22) mg/kg, respectively. There

Table 5 Nutritional components in muscles of Duoluo goats

Gender	Sample number	Moisture//%	Dry matter//%	Ash//%	Protein//g/100g	Fat//%
Male goat	10	77.53 ± 0.38	22.47 ± 0.38	1.07 ± 0.04	20.07 ± 0.42	1.30 ± 0.80
Female goat	10	76.37 ± 0.99	22.63 ± 0.99	1.02 ± 0.03	19.47 ± 1.22	2.92 ± 0.55
<i>P</i> value		0.128	0.128	0.155	0.466	0.044

Table 6 Contents of mineral elements and cholesterol

Category	♂	♀	<i>P</i> value
P//%	0.19 ± 0.010	0.18 ± 0.006	0.374
K//%	0.24 ± 0.02	0.27 ± 0.02	0.140
Na//%	0.06 ± 0.003	0.05 ± 0.006	0.349
Se//mg/kg	0.02 ± 0.001	0.01 ± 0.008	0.087
Ca//mg/kg	69.53 ± 10.89	63.00 ± 4.56	0.392
Mg//mg/kg	232.00 ± 9.64	221.66 ± 3.79	0.159
Fe//mg/kg	16.73 ± 1.83	14.77 ± 0.58	0.152
Zn//mg/kg	38.47 ± 3.68	31.83 ± 2.22	0.056
Cholesterol//mg/100 g	71.76 ± 11.47	74.83 ± 2.68	0.675

Amino acid contents of Duoluo goats

According to Table 8, 18 kinds of amino acids, 8 kinds of essential amino acids and 10 kinds of non-essential amino acids were detected in the muscles of male and female Duoluo goats. In the muscles of male and female Duoluo goats, the contents of essential

were no significant differences in the contents of mineral elements such as P, K, Na, Se, Ca, Mg, Fe and Zn and that of cholesterol in muscles between male and female goats. The contents of heavy metals are shown in Table 7. The contents of Pb and Cr in muscles were relatively low, while the contents of Mg, As, Hg, Ca and Cu were not detected.

Table 3 By-products from slaughter of Duoluo goats

Trait	♂	♀	<i>P</i> value
Head weight//kg	2.33 ± 0.25	1.95 ± 0.11	0.042
Hoof weight//kg	0.83 ± 0.12	0.64 ± 0.05	0.037
Skin weight//kg	2.19 ± 0.31	1.72 ± 0.14	0.008
Skin area//m ²	0.49 ± 0.06	0.43 ± 0.06	0.249
Heart weight//g	123.64 ± 13.25	109.43 ± 10.31	0.127
Liver weight//g	531.50 ± 44.55	494.03 ± 24.08	0.543
Spleen weight//g	50.48 ± 8.74	45.75 ± 10.21	0.442
Lung weight//g	340.61 ± 20.34	320.73 ± 15.57	0.542
Kidney weight//g	93.43 ± 4.77	88.39 ± 5.24	0.354
Net weight of stomach//kg	1.19 ± 0.12	1.35 ± 0.13	0.057
Net weight of intestine//kg	1.22 ± 0.14	1.28 ± 0.13	0.084

Sample size: 15 males and 15 females.

Table 4 Muscle quality of one-year-old Duoluo goats

Traits	♂	♀	<i>P</i> value
Loin-eye muscle area//cm ²	8.95 ± 1.72	8.82 ± 1.15	0.957
pH _{45min}	6.15 ± 0.17	6.21 ± 0.15	0.753
Shearing force//N	5.48 ± 1.24	5.65 ± 1.02	0.867
Cooked meat rate//%	65.49 ± 1.42	65.36 ± 1.55	0.895
L	47.47 ± 1.53	47.65 ± 1.38	0.756
a	4.33 ± 0.75	3.95 ± 1.09	0.476
b	6.66 ± 1.11	6.46 ± 0.81	0.649

Sample size: 15 males and 15 females.

Table 7 Contents of heavy metal elements

Category	♂	♀	<i>P</i> value
Pb	0.020 ± 0.007	0.020 ± 0.005	0.761
Cr	0.028 ± 0.007	0.028 ± 0.007	0.912
Cd	Not detected	Not detected	
As	Not detected	Not detected	
Hg	Not detected	Not detected	
Cu	Not detected	Not detected	
Mn	Not detected	Not detected	

When the content of a heavy metal element was lower than a certain value, the instrument couldn't detect its content, and the value was 1.0 mg/kg for Mn, 1.0 mg/kg for Cu, 0.001 mg/kg for Cd, 0.003 mg/kg for Hg and 0.01 mg/kg for As.

amino acids were (7.44 ± 0.24) and (7.26 ± 0.41) g/100 g, respectively, accounting for (38.75 ± 0.25) % and (38.84 ± 0.12) % of the total amino acids, respectively, and the contents of non-essential amino acids were (11.81 ± 0.33) and (11.42 ± 0.67) g/100 g, respectively, accounting for (61.53 ± 0.24) % and (61.52 ± 0.10) %

of the total amino acids. The total amino acid contents of male and female goats were (19.20 ± 0.53) and (18.57 ± 1.10) g/100 g, respectively, and their EAA/NEAA values were (62.98 ± 0.60) and (63.13 ± 0.19), respectively, and their EAA/TAA values were (38.75 ± 0.25) % and (38.84 ± 0.12) %, respectively.

Flavor amino acids are directly related to the flavor of muscles, and consist of five kinds of amino acids, such as glutamic acid, alanine, glycine, arginine and aspartic acid. The flavor amino acids in muscles of male and female Duoluo goats were (8.79 ± 0.27) and (8.42 ± 0.57) g/100 g, respectively, accounting for (45.76 ± 0.37) % and (45.32 ± 0.69) % of total amino acids.

According to the FAO/WHO model, the amino acids such as

lysine, leucine, isoleucine, valine, threonine, methionine + cystine and phenylalanine + tyrosine in muscles of Duoluo goats were scored. The score of leucine was the highest, with the values of (172.32 ± 1.81) % and (174.68 ± 1.06) % for male and female goats, respectively, and the score of methionine + cystine was the lowest, with the values of (88.29 ± 1.03) % and (97.05 ± 10.88) %, respectively. Amino acids such as lysine, leucine, isoleucine, threonine and phenylalanine + tyrosine were all higher than the ideal model of FAO/WHO, while valine and methionine + cystine were lower than the ideal model of FAO/WHO, as shown in Table 9.

Table 8 Amino acid contents in muscles of one-year-old Duoluo goats

Amino acid type	δ		η	
	Content//g/100 g	Percentage in total amino acids//%	Content//g/100 g	Percentage in total amino acids//%
Essential amino acid (EAA)	7.44 ± 0.24	38.75 ± 0.25	7.26 ± 0.41	38.84 ± 0.12
Lysine (Lys)	1.82 ± 0.07	9.48 ± 0.10	1.78 ± 0.10	9.61 ± 0.06
Leucine (Leu)	1.64 ± 0.05	8.56 ± 0.01	1.59 ± 0.09	8.57 ± 0.05
Isoleucine (Ile)	0.86 ± 0.03	4.50 ± 0.06	0.83 ± 0.05	4.47 ± 0.01
Phenylalanine (Phe)	0.74 ± 0.02	3.87 ± 0.01	0.72 ± 0.04	3.86 ± 0.02
Valine (Val)	0.94 ± 0.03	4.90 ± 0.05	0.90 ± 0.06	4.86 ± 0.06
Threonine (Thr)	0.89 ± 0.03	4.62 ± 0.04	0.86 ± 0.05	4.62 ± 0.04
Methionine (Met)	0.54 ± 0.02	2.83 ± 0.03	0.53 ± 0.03	2.85 ± 0.01
Tryptophan (Try)	0.07 ± 0.01	0.28 ± 0.03	0.05 ± 0.01	0.28 ± 0.02
Non-essential amino acid (NEAA)	11.81 ± 0.33	61.53 ± 0.24	11.42 ± 0.67	61.52 ± 0.10
Tyrosine (Tyr)	0.69 ± 0.02	3.61 ± 0.04	0.67 ± 0.03	3.63 ± 0.08
Alanine (Ala)	1.24 ± 0.04	6.48 ± 0.11	1.16 ± 0.10	6.26 ± 0.25
Glycine (Gly)	0.95 ± 0.03	4.95 ± 0.18	0.86 ± 0.08	4.63 ± 0.24
Aspartic acid (Asp)	1.92 ± 0.08	10.01 ± 0.15	1.85 ± 0.11	9.96 ± 0.03
Glutamic acid (Glu)	3.39 ± 0.11	17.64 ± 0.13	3.28 ± 0.21	17.65 ± 0.17
Arginine (Arg)	1.28 ± 0.04	6.68 ± 0.08	1.27 ± 0.07	6.82 ± 0.09
Serine (Ser)	0.81 ± 0.03	4.24 ± 0.04	0.78 ± 0.05	4.18 ± 0.03
Cystine (Cys)	0.05 ± 0.01	0.26 ± 0.04	0.10 ± 0.02	0.54 ± 0.07
Histidine (His)	0.75 ± 0.05	3.94 ± 0.21	0.79 ± 0.06	4.24 ± 0.37
Proline (Pro)	0.66 ± 0.02	3.43 ± 0.15	0.62 ± 0.06	3.32 ± 0.15
Flavor amino acids (FAAs)	8.79 ± 0.27	45.76 ± 0.37	8.42 ± 0.57	45.32 ± 0.69
Total amino acids (TAAs)	19.20 ± 0.53	100	18.57 ± 1.10	100
EAA/NEAA		62.98 ± 0.60		63.13 ± 0.19
EAA/TAA		38.75 ± 0.25		38.84 ± 0.12

Table 9 Amino acid scores of one-year-old Duoluo goats

Amino acid type	AA//g/100 g		FAO/WHO model	AAS//%	
	δ	η		δ	η
Lys	9.48 ± 0.10	9.61 ± 0.06	5.50	172.32 ± 1.81	174.68 ± 1.06
Leu	8.56 ± 0.01	8.57 ± 0.05	7.00	122.27 ± 0.17	122.37 ± 0.78
Ile	4.50 ± 0.06	4.47 ± 0.01	4.00	112.42 ± 1.41	111.76 ± 0.37
Val	4.90 ± 0.05	4.86 ± 0.06	5.00	97.91 ± 1.04	97.28 ± 1.14
Thr	4.62 ± 0.04	4.62 ± 0.04	4.00	115.43 ± 1.03	115.38 ± 1.04
Met + Cys	3.09 ± 0.04	3.40 ± 0.38	3.50	88.29 ± 1.03	97.05 ± 10.88
Phe + Tyr	7.48 ± 0.04	7.49 ± 0.10	6.00	124.71 ± 0.65	124.82 ± 1.67

Conclusions and Discussion

Body weight is an index to measure the important characteristics of livestock and poultry breeds. The body weights of one-year-old male and female Duoluo goats before slaughter were (25.68 ± 2.37) and (24.51 ± 1.97) kg, respectively. Due to long-term adaptation to the harsh environment and grazing methods in high-altitude areas, the slaughter weights of one-year-old male and female goats are lower than those of Chengdu Ma goats $(30.50, 30.25 \text{ kg})^{[1]}$, southern Sichuan black goats (Zigong type: $31.20, 30.50 \text{ kg}$; Jiang'an type: $32.35, 25.14 \text{ kg})^{[1]}$, Chuanzhong black goats (Jintang type: $41.54, 37.70 \text{ kg}$; Lezhi type: 43.04 and $37.29 \text{ kg})^{[1]}$, Beichuan white goats $(32.60 \text{ kg}, 26.00 \text{ kg})^{[1]}$, Banjiao goats (Sichuan Wanyuan, $39.50, 24.80 \text{ kg})^{[1]}$ and other breeds or populations, relatively close to those of Jianchang black goats $(24.14, 21.60 \text{ kg})^{[1]}$, Chuandong white goats $(23.35, 22.57 \text{ kg})^{[1]}$, Xinjiang goats $(22.6, 22.9 \text{ kg})^{[1]}$, Tibet goats $(24.0, 22.2 \text{ kg})^{[1]}$ and other breeds or populations, and higher than those of Baiyu black goats (Baiyu County, $17.4, 13.4 \text{ kg})^{[1]}$, Yangtze River Delta white goats $(21.2, 14.2 \text{ kg})^{[1]}$, Tibet goats (Danba County, $14.33 \text{ kg}, 12.50 \text{ kg})^{[2]}$, and Tibet goats (plateau type: $20.85, 15.83 \text{ kg}$; valley type: $20.42, 13.75 \text{ kg})^{[3]}$. Therefore, Duoluo goats belong to medium-sized meat goat breeds.

Cholesterol is a kind of lipid substance widely existing in animals, which is involved in the formation of cell membrane, the synthesis of bile acid and the synthesis of vitamin D and steroid hormones. If cholesterol intake is too high, it is easy to cause diseases such as atherosclerosis and venous thrombosis. Therefore, foods whose cholesterol content is lower than 100 mg in 100 g of food are generally called low-cholesterol foods, foods with a cholesterol content of 100–200 mg are referred to as moderate-cholesterol foods, and foods with a cholesterol content of 200–300 mg are referred to as high-cholesterol foods^[4]. In this study, the cholesterol contents of male and female Duoluo goats were (71.76 ± 11.47) and (74.83 ± 2.68) mg/100 g, respectively, which are consistent with those in muscles of Tibet goats^[4], Danba yellow goats^[4], Youzhou black goats^[5], Banjiao goats and other breeds or populations^[6]. The cholesterol content in 100 g of muscle was lower than 100 mg, so the meat of Duoluo goats belongs to low-cholesterol foods.

According to definition of protein's ideal model by FAO/WHO, the amino acid composition of protein with good quality should meet EAA/TAA higher than 40% and EAA/NEAA higher

than 60%, and if the amino acid composition ratio of protein in a food is similar to that of human protein, then this food can be regarded as having rich nutritional value. Otherwise, no matter how high its amino acid content is, it cannot be called a nutritious food^[7]. The EAA/NEAA values of male and female Duoluo goats were (62.98 ± 0.60) and (63.13 ± 0.19) , respectively, and the EAA/TAA values were $(38.75 \pm 0.25) \%$ and $(38.84 \pm 0.12) \%$, respectively. The EAA/TAA values were higher than 60%, while the EAA/NEAA values were close to 40%. The contents of essential amino acids in male and female goats were $(7.44 \pm 0.24) \text{ g}/100 \text{ g}$ and $(7.26 \pm 0.41) \text{ g}/100 \text{ g}$ respectively, accounting for $(38.75 \pm 0.25) \%$ and $(38.84 \pm 0.12) \%$ of the total amino acids, and the contents of nonessential amino acids were (11.81 ± 0.33) and $(11.42 \pm 0.67) \text{ g}/100 \text{ g}$, respectively, accounting for $(61.53 \pm 0.24) \%$ and $(61.52 \pm 0.10) \%$ of the total amino acids. Therefore, the mutton of Duoluo goats is considered as a kind of nutritious food.

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