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Comparison of meat nutritions and flavor between Chinese Yanbian yellow cattle and Simmental cattle

Mingbo Li[1]

[1]College of Integration Science, Yanbian University, Engineering Research Center of North-East Cold Region Beef Cattle Science Technology Innovation, Ministry of Education

mingboli128@163.com

Abstract. This research explored the difference between Chinese Yanbian yellow Beef and Simmental Beef in nutrients, meat quality and flavor, aimed at providing a basis for the development of Chinese Yanbian yellow cattle resources. Eight Chinese Yanbian yellow cattle and eight Simmental cattle were selected in this experiment. All the experimental cattle were fenced to 30 months of age under the same feeding conditions and slaughtered to determine the quality and flavor substance content of beef. The results showed that the contents of crude protein, ether extract and various amino acids in Chinese Yanbian yellow beef were significantly higher than those in Simmental beef ($P<0.05$). The shear force of Chinese Yanbian yellow beef was significantly lower than that of Simmental beef ($P<0.05$). The results of Gas chromatography-mass spectrometry (GC-MS) also showed that the kinds of flavor substances in Chinese Yanbian yellow beef were more than those in Simmental beef. In conclusion, the nutritional level and flavor of Chinese Yanbian yellow beef are better than those of Simmental beef. In conclusion, the nutritional level and flavor of Chinese Yanbian yellow beef are better than those of Simmental beef.

Keywords: Chinese Yanbian yellow cattle, simmental cattle, meat quality,nutrition content, flavor.

1. Introduction

With the improvement of people's living standards, people's requirements for food quality are constantly improving. Beef is prized for being high in protein, low in fat and rich in a variety of healthy vitamins and minerals[1]. However, to breed high-quality beef cattle is the result of years of continuous research by researchers.

Chinese Yanbian yellow cattle is one of the top five largest breeds of cattle in China[2]. Yanbian yellow cattle is an excellent breed after long-term natural and artificial selection. Simmental cattle, originated in central Europe as a triple-purpose breed selected for draught, meat, and dairy production, and are known today for their fast growth and beef yields[3]. At present, the analysis and research on meat quality characteristics, beef nutrition level and flavor substances between Yanbian cattle and Simmental cattle have not been reported. Therefore, this experiment was conducted to compare the differences in meat quality characteristics, nutrient levels and flavor substances between Yanbian yellow cattle and Simmental cattle under the same feeding conditions, and to provide a reference for the

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development and utilization of Yanbian yellow cattle germplasm resources and the production and development of high-quality beef.

2. Materials and Methods

2.1. Animals and sampling

Eight healthy 17-month-old Chinese Yanbian yellow cattle and Simmental fenced cattle were selected, with an average body weight of (395.42±10.84) kg and (541.61±19.25) kg. All the cows were fed under the same feeding conditions. The pre-experiment lasted for 10 days and the experiment lasted for 410 days, a total of 420 days. In order to meet the nutritional needs of cattle growth, feeding was carried out in three different growth stages: early fattening (17~19), middle fattening (20~24) and late fattening (25~30). According to the recommended nutritional values in China's Cattle Feeding Standards (NY/T 815-2004), corn was used as concentrate and straw and corn straw as roughage. Dietary composition and nutrient levels were shown in Table 1.During the experiment, the cattles were fed at 7:00 and 18:00 every day, and were fed in separate pens, fed freely, drank water and ventilated. Cattle were also fasted for 24 hours before being slaughtered. After slaughter, about 6 kg of meat was taken from each cow's hind leg, and part of the meat was stored at -80℃ for flavor and amino acid measurement.

Table 1. Composition and nutrient levels of experimental diets (DRY matter basis).

Ingredients	Age（month）		
	17~19	20~24	25~30
raw material,%			
3918 Mixed feed	22	18	13
corn	28	37	43
Corn stover	25	23	22
straw	25	22	22
total	100	100	100
Nutrition level			
Crude fiber,%	14.76	15.05	14.2
Crude ash,%	5.81	5.85	5.82
Crude protein,%	10.67	9.88	9.75
calcium,%	0.39	0.35	0.21
phosphorus,%	0.21	0.24	0.28

Note: 1. 3918 mixed feed is a concentrate: water 14%, crude protein 35.05%, crude fiber 15%, ash 20%, calcium 2.69%, phosphorus 1.0%.

2.2. Meat color

After slaughter, the hind leg meat was taken back to the laboratory and the brightness value (L*), red value (A*) and yellow value (B*) of the beef were determined by a chromaticity meter (CR-400S, Konica Minolta, Japan).

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2.3. Shear force test

According to NY/T1180-2006(determination of meat tenderness and shear force), put the cut meat sample into a thermostatic water bath at 80℃, take out the sample when the meat center temperature reaches 70℃, cool to room temperature, and take the meat column three times along the muscle fiber direction with a sampler with a diameter of 1.27cm. The measurement was carried out on a textural instrument (TA-XT Plus, SMS, UK) and the unit was expressed in Newtons (N).

2.4. Proximal analysis

Moisture, protein, lipid and ash 0were assayed accordingto the AOAC methods (1995).

2.5. Amino acid

2 g of lyophilized meat powder was homogenized with 45 mL of water for 1 min, then centrifuged at 0℃ for 10 000 r/min for 20 min. After filtration, a 50 mL 4% trichloroacetic acid (TCA) solution was added to the filtrate, placed at 37℃ for 30 min, and then the supernatant was put through a 0.4 m organic filter membrane. Finally, the contents of 18 kinds of amino acids were determined by an amino acid automatic analyzer (L-8900, Hitachi, Japan).

2.6. Flavor

Extraction of volatile flavor substances: Headspace solid phase microextraction (SPME) was adopted for extraction.Put the samples frozen at -20℃ into the refrigerator at 4℃ for 3 h. After returning to room temperature, weigh 2 g of the beef sample in a headspace bottle and balance the gas for 15 min.Fiber heads (50/30um DVB/ CAR/ PDMS, Supelco, USA) were extracted by the sand bath at 60℃ for 30 min, and then detected by GC-MS (QP2010 Plus, Shimadzu, Japan).

GC conditions: DB-5MS capillary column (30 m×0.25 mm×0.25 μm);The inlet temperature is 250℃, the injection mode is non-shunt, the carrier gas is helium (He), the column flow rate is 1 mL/min, the purge flow rate is 3.0 mL/min, and the shunt ratio is 50:1. Heating procedure:The initial temperature was 40℃, kept for 10 min, then increased to 200℃ at 5℃/min, and then to 280℃ at 20℃/min, kept for 5 min.

MS conditions: lectron impact (EI) temperature of 200℃, interface temperature of 280℃, solvent delay time 2 min, electron energy 70 eV, scanning mass range M/Z 40 ~ 550.

The compounds were searched by NIST08 and NIST08s spectral libraries for qualitative analysis[4-6]. Compounds with a qualitative match > 80. The relative contents of each compound were calculated by the peak area normalization method.

3. Statistical analysis

Excel and SPSS24.0 software were adopted to perform statistical analysis on the experimental data. Finally, it was expressed as mean ± standard deviation. T test was used for comparison between the two groups, and $P<0.05$ was considered a significant difference.

4. Results and Discussion

4.1. Comparison of meat quality characteristics between Chinese Yanbian Yellow cattle and Simmental cattle

Table 2 shows the results of the routine nutrient composition determination of yanbian cattle and Simmental cattle. The crude protein content of Yanbian yellow beef and Simmental beef was 22.97% and 20.80%, and the crude fat content was 7.84% and 1.78%, respectively, with significant differences ($P<0.05$). There were no significant differences in moisture and ash content between Yanbian beef and Simmental beef ($P > 0.05$). There was no significant difference in pH between Yanbian yellow beef and Simmental beef ($P>0.05$). As can be seen from the table, the brightness value of Yanbian yellow beef was significantly lower than that of Simmental beef ($P<0.05$), and there was no significant difference

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between the two breeds of cattle in redness value (P>0.05). The yellowness value of Yanbian yellow beef was significantly lower than that of Simmental beef (P<0.05). The shear force of Yanbian yellow beef was significantly lower than that of Simmental beef (P<0.05).

Table 2. Routine nutrition components of Yanbian cattle and Simmental cattle hind leg meat.

Items		Yanbian Yellow	Simmental
Protein (%)		22.97 ±0.54[a]	20.80 ±0.78[b]
Fat (%)		2.84 ±0.26[a]	1.78 ±0.46[b]
Ash (%)		1.20 ±0.43	1.70 ±0.17
Moisture (%)		72.46±0.21	73.24±0.51
pH24h		6.14±0.02	6.09±0.05
Meat color	L	25.55±0.87[b]	35.08±1.05[a]
	a	12.41±0.65[b]	15.41±0.76[a]
	b	2.30±1.14[b]	5.19±0.84[a]
Shear force (N)		50.33±2.33[b]	80.00±3.63[a]

Note: No letters in the shoulder label of the same data indicated no significant difference (P>0.05), while different letters indicated significant difference (P<0.05).

Intramuscular fat is a key factor affecting meat quality, and the higher the content of intramuscular fat, the better the flavor of meat[7]. Intramuscular fat deposition is very important for the sensory quality, flavor and processing characteristics of animal meat. In this study, the fat content of Yanbian yellow beef was significantly higher than that of Simmental beef. The amount of oxymyoglobin, myoglobin and oxymyoglobin in muscle determines the color of the muscle, and the less brightness and yellowness, the more redness, the better the quality of the meat. The results of this experiment showed that the brightness and yellowness of Yanbian yellow beef are obviously lower than those of Simmental beef, but the redness value is not very ideal. This may be due to the gradual oxidation of myoglobin to ferric iron with prolonged storage after slaughter, which reduces the redness value. Yanbian yellow beef is generally better in color than Simmental beef, which is more attractive to consumers. However, the shear force of Yanbian yellow beef is significantly lower than that of Simmental beef, indicating that Yanbian yellow beef is more tender, easier for consumers to chew, and has good palatability. Compared with Simmental beef, Yanbian yellow beef has better quality and has the potential to be high-quality beef.

4.2. Comparison of amino acids composition between Chinese Yanbian Yellow cattle and Simmental cattle

According to Table 3, the contents of 9 amino acids including threonine, glutamate and proline in Yanbian yellow beef were significantly higher than those in Simtal beef (P<0.05). The glycine content of Simental beef was significantly higher than that of Yanbian yellow beef (P<0.05). Meanwhile, the contents of total amino acids and essential amino acids in Yanbian yellow beef were significantly higher than those in Simmental beef (P<0.05). The total content of umami amino acids in Yanbian yellow beef was significantly higher than that in Simmental beef (P<0.05).

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Table 3. Amino acid contents of Yanbian yellow cattle and Simmental beef (%).

Items	Yanbian Yellow	Simmental
Thr	4.01 ±0.01[a]	3.49 ±0.01[b]
Val	4.36 ±0.02	3.84 ±0.02
Met	2.19 ±0.01[a]	1.85 ±0.01[b]
Lle	3.65 ±0.02	3.10 ±0.01
Leu	6.52 ±0.02	6.10 ±0.03
Phe	3.53 ±0.01	3.19 ±0.03
Lye	6.71 ±0.01[a]	5.77 ±0.02[b]
Trp	0.96 ±0.00	0.86 ±0.01
His	2.22 ±0.01	1.87 ±0.02
Arg	5.79 ±0.05	5.10±0.04
Asp	7.09 ±0.01[a]	6.28 ±0.01[b]
Ser	1.49 ±0.02[a]	0.12 ±0.04[b]
Glu	12.40 ±0.03[a]	7.38 ±0.03[b]
Gly	7.55 ±0.01[b]	10.36 ±0.04[a]
Ala	7.44 ±0.02	7.73 ±0.01
Cys	0.79 ±0.01	0.52 ±0.02
Pro	1.55 ±0.04[a]	0.49 ±0.01[b]
Tyr	3.92 ±0.02[a]	0.21 ±0.02[b]
EAA	31.92 ±0.05[a]	28.20 ±0.13[b]
NEAA	50.23 ±0.07[a]	40.04 ±0.11[b]
FAA	19.49 ±0.04[a]	13.66 ±0.03[b]
TAA	82.16 ±0.09[a]	68.24 ±0.08[b]

The amino acid content in meat is also an important index to evaluate the nutritional value of meat and an important factor affecting the quality of meat. Amino acids can also be divided into umami, sweet and bitter amino acids according to their effect on flavor. Umami amino acids mainly include glutamate, aspartic acid, glycine, alanine and proline[8-10]. This research shows that Yanbian yellow cattle and Simmental bracket contain beneficial to human body essential amino acid in the meat, there are eight kinds of amino acids is significantly higher than in Yanbian yellow beef simmental, two categories of below Simmental beef, including glycine was significantly lower than simmental, glycine belongs to a kind of tasty amino acids, but the delicate flavors of the Yanbian yellow cattle amino acid total content was significantly higher than that of simmental, Therefore, it is proved theoretically that Yanbian yellow beef has better amino acid content and composition and better flavor.

4.3. Comparison of Volatile flavor substance composition between Chinese Yanbian Yellow cattle and Simmental cattle

According to Table 4, there were differences in the number and types of volatile flavor compounds between Yanbian yellow beef and Simental beef. A total of 33 effective compounds were extracted from the two kinds of beef, and a total of 13 compounds were extracted, including 2 alcohols, 1 aldehyde, 2 esters and 8 alkanes.

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Table 4. Content of flavor substances in Yanbian beef and Simmental beef.

Items	Retention time /min	CAS No.	Compound name	Yanbian Yellow	Simmental
ketone,%	32.992	22198-51-2	1-（4- ethoxy -2- Hydroxythyl）-1- Octadecanone	0.993±0.39	-
	32.675	3879-26-3	Allyl acetoacetate	0.851±0.35	-
alcohol,%	16.875	3391-86-4	1-Octen-3-OL	1.040±0.61	-
	19.058	104-76-7	2-Ethylhexanol	2.470±1.15	-
	20.817	111-87-5	1-Octanol	0.281±0.09	1.256±0.68
	24.475	143-08-8	1-Nonanol	1.473±0.49	-
	33.458	112-53-8	1-Dodecanol	11.918±2.48[a]	3.062±1.22[b]
aldehyde,%	17.9	124-13-0	Octyl aldehyde	-	0.892±0.47
	22.067	124-19-6	1-NONANAL	1.416±0.67	-
	25.608	112-31-2	Decyl aldehyde	0.517±0.08	-
	31.692	112-54-9	Dodecyl aldehyde	0.873±0.37[a]	3.062±1.22[b]
	36.942	629-80-1	Hexadecanal	0.840±0.77	-
ester,%	38.75	10522-34-6	Propanoic acid, 2-methyl-, nonyl ester	2.216±0.67	2.902±0.32
	36.317	6846-50-0	2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	2.191±0.88	1.870±0.01
olefin,%	23.483	13151-10-5	1-Octene, 6-methyl-	3.669±1.72	-
	21.425	13151-29-6	1-Decene, 4-methyl-	1.367±0.69	-

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Table 5. Content of flavor substances in Yanbian beef and Simmental beef(continued).

Items	Retention time /min	CAS No.	Compound name	Yanbian Yellow	Simmental
	35.275	17312-62-8	Decane, 5-propyl-	0.790±0.11	-
	30.7	3891-98-3	Dodecane,2,6,10-trimethyl-	0.637±0.43	-
	31.408	629-59-4	Tetradecane	1.144±0.67	1.093±0.07
	35.417	25117-32-2	Tetradecane, 5-methyl-	-	1.136±0.24
	34.108	629-62-9	n-Pentadecane	1.533±0.27	-
	35.908	2882-96-4	Pentadecane, 3-methyl-	0.981±0.52	0.954±0.03
	36.642	544-76-3	n-Hexadecane	2.634±1.67	1.218±0.16
	37.767	3892-00-0	Pentadecane,2,6,10-trimethyl-	2.911±0.27	2.361±0.86
alkanes,%	39.108	1921-70-6	Pentadecane,2,6,10,14-tetramethyl-	1.564±1.3	1.610±0.18
	40.667	6418-44-6	Heptadecane, 3-methyl-	-	0.832±0.01
	41.45	638-36-8	Hexadecane,2,6,10,14-tetramethyl-	1.172±0.77	2.090±0.51
	41.317	593-45-3	Octadecane	1.557±0.01	1.770±0.37
	39.042	112-95-8	Eicosane	0.868±0.95	-
	24.408	1002-43-3	Undecane, 3-methyl-	0.490±0.23	-
	27.717	62185-53-9	Nonane, 5-(2-methylpropyl)-	0.475±0.01	-
	44.442	629-92-5	Nonadecane	1.108±0.74	1.007±0.20
	42.75	6561-44-0	Octadecane, 3-methyl-	-	0.781±0.29

Most alcohols have special flavors, such as 1-octene-3-ol with mushroom flavor, 2-ethyl-1-hexanol; Isooctanol has a sweet flavor, octanol has a lemon flavor, and nonanol has a grassy flavor[11-12]. Other aldehydes also have a variety of flavors, such as octanal has a fruity flavor, nonanal has a fatty flavor, and decanal has a sweet flavor. There are many kinds of hydrocarbon compounds in this study, but they have little effect on the flavor of beef. The types of volatile flavor substances and alcohols and aldehydes with special flavor in Yanbian yellow beef were significantly more than those in Simmental beef. It can be argued that Yanbian yellow beef had more diversified volatile flavor substances and better flavor.

5. Conclusion

This experiment was conducted to compare the differences of meat quality characteristics, nutrient levels and flavor substances between Yanbian yellow cattle and Simmental cattle under the same feeding conditions, and to develop and utilize the germplasm resources of Yanbian yellow cattle.It can be concluded that Yanbian yellow beef had good quality and rich amino acid content, among which the content of umami amino acid was high. There are more kinds of flavor substances, and the comprehensive evaluation result is obviously better than that of Simmental beef, which is an excellent breed for producing high-quality beef. Therefore, the protection, development and utilization of Chinese Yanbian yellow cattle resources should be further strengthened. At present, this study only analyzed the nutrient level and flavor substance content of the two cattle from the apparent point of view, with limited

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detection indexes. Therefore, the meat quality differences of the two beef cattle should be further analyzed from multiple perspectives in the future, especially the comparison at the molecular level.

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