The Effect of Process Parameters on Stewed Beef

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Abstract. To explore the application of stewing technique on the qualities and yields of stewed beef, the effect of process parameters, including solid-liquid ratio, time and temperature on the contents of major compounds, sensory ratings, color, PTA textural attributes and products yields were analyzed. The higher qualities was obtained when beef was stewed at 95\textdegree C, 150 min with solid-liquid ration 1:2.0, including high content of amino nitrogen and water-soluble protein, medium content of Nacl, high assessment about color and PTA texture, as well as the best sense.

Keywords: stewing process, stewed beef, qualities, producing yield.

1. Introduction
Sauce braised meat products are a kind of traditional meat products that are widely circulated and eaten in my country. They refer to leisure cooked meat products made by cooking meat or edible by-products in brine prepared with salt, soy sauce and spices. They have a rich variety and flavor. Variety and other characteristics [1]. During the cooking process, the seasoning and spice ingredients in the brine enter the meat product in the form of penetration and diffusion. At the same time, the product's own nutrients undergo denaturation, degradation, dissolution and other changes under heat treatment, and react with exogenous flavor substances. Form the unique flavor of the product [2,3,4,5]. The production and processing evaluation indicators of meat products mainly include the food quality indicators of the product itself, such as color, flavor, texture, water-soluble component content, and product yield. Therefore, the sensory properties of meat products are related to the heating process and the water-soluble accompanying heating. The changes in protein content and the chemical reactions involved in flavor are related to [6, 7, 8]. Reasonable cooking technology can improve the sensory characteristics of meat products, stabilize the shape and color of meat products, and form unique flavors and flavors [9].

The main proteins of meat are sarcoplasmic protein, myofibrin, fibrin, myosin actin, etc. The heat denaturation temperature is different, and it is distributed between 50-80 degrees Celsius. In recent years, researchers have studied the thermal changes of beef [10], chicken [11], pork [12], goose [13], camel [14], turkey [15] and Microwave [16], high pressure [17], ohmic heating [10] and other technical means coordinated processing effect [18]. After heat treatment, the microstructure of the muscle fibers and connective tissue membranes of the meat changes, and the collagen appears to
undergo denaturation and contraction, which affects the cooking loss, color and texture parameters of the meat [6, 10, 12].

Braising is a key step in the production process of braised beef. During the braising process, the braised beef is gradually heated from the outside to the inside, accompanied by a chemical reaction of flavor. There have been reports on the effect of marinating process parameters on the quality of marinated chicken legs and developed a quantitative marinating technology [19], but there are few reports on the beef marinating process. This article attempts to start from the main ingredients, sensory quality, chromaticity, texture characteristics and yield rate, and discuss the influence of braising process parameters on the quality of braised beef, in order to provide a reference for the production and processing of braised beef.

2. Materials and Methods

2.1. Experimental Materials

2.1.1. Experimental materials. Beef: Fresh beef hind legs, 18-month-old Luxi cattle, raised and slaughtered in Muyuan cattle farm in Qingyuan City, Guangdong. Pepper, onion, parsley, carrot: all purchased from Panlong Market, Haizhu District, Guangzhou; table salt: produced by Guangdong Salt Industry Group; Erguotou: produced by Beijing Niulanshan Winery

2.1.2. Experimental reagent. Sodium hydroxide, potassium dichromate, formaldehyde, sodium chloride, glacial acetic acid, and silver nitrate are all analytical grades. Coomassie Brilliant Blue G-250 is a biochemical reagent, all provided by Sinopharm Chemical Reagent Co., Ltd.

2.1.3. Laboratory apparatus. WSG-S colorimeter (Shanghai Physical Optical Instrument Factory), TA-XTPlus texture analyzer (Texture Technologies Corp., UK), UV-2550 ultraviolet-visible spectrophotometer (Shimadzu, China).

2.2. Sample Preparation

2.2.1. Raw material pretreatment. Wash and drain the beef and cut into 10cm squares. Wash parsley, onion, and carrots, drain them, and twist them into juice.

2.2.2. Dry pickled. Weigh a certain amount of beef cubes, onion juice, parsley juice, carrot juice, peppercorns, salt and Erguotou, mix them evenly, seal them with plastic wrap, marinate at 0-5 ℃ for 24h, and turn the raw materials every 4h. Times. The mass percentage of the marinade preparation is based on the mass of beef.

2.2.3. Beef cold water effluent. Add cold water 2.0 times the quality of the beef to the marinated beef. After boiling over a high fire, keep it slightly boiling for a certain period of time. Remove and quickly cool to room temperature with running water to wash away the blood on the surface and drain the surface water.

2.2.4. Marinade making. Marinade formula: stock 10kg, dried chili 100g, Chinese pepper 20g, star anise 50g, cinnamon 50g, tangerine peel 50g, bay leaf 40g, white pepper seed 20g, coriander seed 20g, cumin 20g, grass fruit 10g, white korea 10g, grass korea 10g, Luo Han Guo 10g, clove 10g, Erguotou 50g, rose wine 50g, fish sauce 100g, soybean paste 100g, bean paste 100g, salt 100g, monosodium glutamate 100g, white sugar 50g.

Fragrant chicken fat formula: fresh chicken celiac fat 1000g, parsley 200g, coriander 100g, dried chives 100g.
Fresh chicken abdominal fat is condensed into chicken fat. Add parsley, cilantro and dried chives, and fry into fragrant chicken fat. The old hen is chopped into 3cm square pieces, and the pork tube bones are chopped into 5cm long sections, drained with cold water, clean the blood on the surface, drain and sauté with fragrant chicken oil. Stir-fry the dried soybeans with fragrant chicken sauce. Add 500g of old hen, 200g of pork tube bones, 100g of dried soybeans, and 50g of ginger slices to 10kg of water, boil on high fire, keep a slight boil on low fire for 5 hours, and filter out the residue in the soup.

Wash the spices, drain the water, sauté with chicken fat and wrap them in gauze. Chop the bean paste and stir-fry with the soy bean paste in chicken sauce until fragrant. Put the spice bag, fried bean paste and soybean paste into the broth, boil on high heat, and keep slightly boiling for 3 hours. Take out the spice bag, strain off the marinade residue, boil over high heat, add Erguotou, rose wine, fish sauce, salt, monosodium glutamate and white sugar, and stir well.

2.2.5. Beef Marinated. Put the buffed beef into a certain proportion of marinade, heat it to a certain temperature on a high fire, and keep it warm for a certain time on a low fire. Remove the beef immediately after the high heat is quickly boiled and drain the surface marinade.

2.3. Physical and chemical analysis
Amino nitrogen content: neutral formaldehyde titration method \[20\]; water-soluble protein content: Coomassie Brilliant Blue G-250 colorimetric method \[20\]; NaCl content: silver nitrate titration method \[21\], the above indicators take 3 parallel arithmetic average value. Chromaticity: Colorimeter test method \[22\]. Texture characteristics: texture analyzer analysis method, the sample is cut into 30mm squares perpendicular to the direction of the muscle fiber to see the square test \[22\] “-” means the direction of the force is opposite to the direction of the probe drop; the above indicators are the arithmetic average of 5 parallels value.

2.4. Yield rate determination
Drain the marinated beef with the surface soup, and weigh the whole batch of samples while it is hot. Take the arithmetic average of 3 parallels.
Stewed beef yield rate (%) = marinated beef quality / raw material quality × 100

2.5. Sensory assessment
7 people (4 females and 3 males, aged 20 to 35) who have undergone food sensory evaluation training constitute an evaluation group to evaluate the sensory quality of braised beef while it is hot (Table 1). Remove the highest and lowest scores, and take the arithmetic average of the scores of the other 5 people.

| Senses index | Points | 1 | 3 | 5 |
|--------------|--------|---|---|---|
| Color aroma taste | Gray-black, matt | Dark red, uneven, dark gloss | Flesh red, uniform, coordinated and shiny |
|               | Fishy smell | Beef aroma is weak | Strong and pure beef aroma |
|               | Heavy or light salty, no umami | Heavy or light salty, lack of umami | Savory taste, obvious umami, harmonious |
| Aftertaste taste | No aftertaste or strong taste | Insufficient or uncoordinated | Soft and long |
| Taste        | Hard or no bite | Too old or weak | Refreshing and biting |
2.6. Data processing and analysis
The arithmetic mean and standard deviation of the experimental data were processed by Excel software, and Duncan analysis was processed by DPS 7.05 software.

3. Results and Analysis

3.1. The effect of the ratio of material to juice on the quality and yield of braised beef

| Juice ratio (w/w) | Amino nitrogen (%) | Water soluble Protein (%) | NaCl (%) | Sensory score | Yield rate (%) |
|-------------------|--------------------|---------------------------|----------|---------------|----------------|
|                   |                    |                           |          | Color         | Aroma          | Taste       | Afters Taste | Taste | Total |               |
| 1:1.0             | 0.33±0.01 a        | 5.64±0.04 a               | 1.81±0.01 a | 4.2±1.1 a    | 4.2±1.1 a      | 4.2±1.1 a  | 4.2±1.1 a   | 21.0±4.7 a | 68.9±0.5 a |
| 1:1.5             | 0.33±0.01 a        | 5.61±0.04 a               | 1.79±0.01 a | 4.6±0.9 a    | 4.6±0.9 a      | 4.6±0.9 a  | 4.6±0.9 a   | 23.0±4.7 a | 68.7±0.5 ab |
| 1:2.0             | 0.33±0.01 a        | 5.59±0.05 a               | 1.78±0.01 a | 4.6±0.9 a    | 4.6±0.9 a      | 4.6±0.9 a  | 4.6±0.9 a   | 23.0±4.7 a | 68.7±0.5 ab |
| 1:2.5             | 0.32±0.01 a        | 5.54±0.03 a               | 1.78±0.01 a | 4.6±0.9 a    | 4.6±0.9 a      | 4.6±0.9 a  | 4.6±0.9 a   | 23.0±4.7 a | 68.4±0.5 bc |
| 1:3.0             | 0.32±0.01 a        | 5.49±0.04 a               | 1.79±0.01 a | 4.6±0.9 a    | 4.2±1.1 a      | 4.2±1.1 a  | 4.2±1.1 a   | 21.4±5.0 a | 68.0±0.5 c  |

Marinate at 95°C for 150 minutes; different superscript letters in the same column indicate significant differences (p<0.05).

Marinade is the sauce and heat transfer medium for marinating marinated products. During the marinating process, the colored components in the marinade gradually adhere to the surface of the marinated product, and the aroma and taste substances gradually diffuse into the product to promote the formation of the color, aroma and taste of the product. At the same time, with the help of the heat transfer effect of the marinade, Make the product mature. During beef marinade processing, with the gradual decrease in the ratio of feed (the amount of beef marinade per unit mass increases), the amino nitrogen content, water-soluble protein content and NaCl content in the marinated beef slowly decrease (p>0.05), and the yield rate Then it decreased significantly (p<0.05) (Table 2).

When the juice ratio is greater than or equal to 1:1.5, reduce the juice ratio during marinating beef, and the sensory score of the marinated beef is slightly improved (p>0.05); when 1:2.5≤juice ratio≤1:1.5, the juice is further reduced. The sensory scores of braised beef remain unchanged; when the ratio of material to juice is ≤1:2.5, continue to reduce the ratio of sauces, and the color and aroma scores of braised beef remain unchanged. The scores of taste, aftertaste, taste and sensory scores are slightly Decrease (p>0.05) (Table 2).
3.2. The effect of the ratio of material to juice on the color and texture characteristics of braised beef

Table 3 Color and TPA textural attributes of beef braised at different ratio of beef to spices-soup

| Juice ratio (w/w) | Chroma | Shear force (kg) | Hardness (kg) | Rupture strength (g) | Viscosity (g·s) | Elasticity (mm) | Cohesion (g·mm) |
|------------------|--------|-----------------|---------------|---------------------|----------------|----------------|---------------|
|                  | L*     | a*             | b*            |                     |                |                |               |
| 1:1.0            | 71.59±0.1 | 4.95±0.1 | 5.67±0.0 | 3.04±0.0 | 9.3±0.6 | 63.8±3.0 | 0.65±0.0 | 0.44±0.0 |
|                  | 3d     | 1a             | 7a            | 7a                  |                |                |               |
| 1:1.5            | 72.96±0.0 | 4.63±0.1 | 5.22±0.1 | 2.84±0.1 | 9.1±0.5 | 58.3±1.8 | 0.58±0.0 | 0.41±0.0 |
|                  | 8b     | 2b             | 6b            | 1a                  |                |                |               |
| 1:2.0            | 73.25±0.2 | 4.34±0.0 | 4.52±0.1 | 2.79±0.1 | 3.19±0.1 | 8.5±0.7 | 0.50±0.0 | 0.37±0.0 |
|                  | 0c     | 8c             | 1c            | 4c                  |                |                |               |
| 1:2.5            | 73.42±0.1 | 4.15±0.0 | 4.22±0.0 | 2.57±0.1 | 2.96±0.0 | 7.7±0.5 | 0.48±0.0 | 0.36±0.0 |
|                  | 3c     | 9d             |               | 4d                  |                |                |               |
| 1:3.0            | 72.60±0.1 | 3.91±0.1 | 3.89±0.1 | 2.47±0.1 | 2.86±0.1 | 6.6±0.5 | 0.48±0.0 | 0.35±0.0 |
|                  | 1c     | 2d             | 3e            | 2c                  |                |                |               |

The marinating conditions are the same as those in Table 2; the different superscript letters in the same column indicate significant differences (p<0.05).

During the beef marinating operation, with the gradual decrease of the juice ratio, the L* of the marinated beef first (when the juice ratio ≥1:2.0) is significantly increased (p<0.05) and then (when the juice ratio ≤1:2.5) is significant Decrease (p<0.05), a* and b* gradually decreased significantly (p<0.05) (Table 3).

When beef is marinated, with the gradual decrease in the ratio of juice, the shearing force, hardness, elasticity and cohesiveness of the marinated beef decrease slowly (p>0.05), and the breaking strength first (when the ratio of material to juice is ≥1:2.0) decreases slowly ( After p>0.05) (when the ratio of material to juice is ≤1:2.0), the viscosity is significantly reduced (p<0.05), and the viscosity value is gradually reduced (p<0.05) (Table 3).

Because the marinade has the dual functions of seasoning and heat transfer, it reduces the ratio of beef marinade (increasing the amount of beef marinade per unit mass), and the rate of color, aroma, and taste substance concentration gradient decline in the marinade slows down; More color, aroma, and taste components diffuse into the beef; meanwhile, more water-soluble components in the beef are lost to the marinade. For this reason, the content of protein and fat in the stewed beef is reduced, the yield rate is reduced, and the color, texture properties and sensory scores are first improved and then deteriorated. When the juice ratio is 1:2.0, the content of amino nitrogen and water-soluble protein in braised beef is higher, the content of NaCl is moderate, and the color and texture characteristics are better. Therefore, the ratio of beef to juice when marinated is 1:2.0 should.

3.3. The effect of marinating temperature on the quality and yield of marinated beef

Increasing the temperature of beef marinating processing, the content of amino nitrogen and water-soluble protein in the marinated beef decreased slowly (p>0.05), and the yield rate gradually decreased significantly (p<0.05) (table 4). When the marinating temperature is ≤95°C, increase the beef marinating temperature, the color score of the marinated beef remains unchanged, the aroma, taste, aftertaste, and mouthfeel scores slightly increase (p>0.05), and the total sensory score increases significantly (p<0.05); When the marinating temperature is ≥95°C, continue to increase the beef marinating temperature, the color, aroma, and taste of the marinated beef will slightly decrease (p>0.05), the taste and aftertaste scores will remain unchanged, and the total sensory score will be significantly reduced ( p<0.05) (Table 4).

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### Table 4 Qualities and producing yields of beef braised at different temperature (%)

| Marinating temperature (°C) | Amino nitrogen (%) | Water soluble protein (%) | NaCl(%) | Color | Aroma | Taste | Aftertaste | Taste | Total score | Yield rate (%) |
|-----------------------------|--------------------|--------------------------|--------|-------|------|-------|------------|-------|-------------|----------------|
| 80                          | 0.32±0.01          | 5.69±0.02                | 1.79±0 | 4.6±0 | 3.8±0.1 | 3.4±0 | 3.4±0.9 | 3.0±0 | 18.2±1.4 | 18.2±1.4       |
| 85                          | 0.33±0.01          | 5.65±0.01                | 1.77±0 | 4.6±0 | 4.2±1.1 | 4.2±1.1 | 3.4±0.9 | 3.0±0 | 20.6±3.8 | 20.6±3.8       |
| 90                          | 0.33±0.01          | 5.61±0.01                | 1.80±0 | 4.6±0 | 4.6±0.9 | 4.6±0.9 | 4.2±1.1 | 1.8±0 | 22.6±3.8 | 22.6±3.8       |
| 95                          | 0.33±0.01          | 5.57±0.01                | 1.78±0 | 4.6±0 | 4.6±0.9 | 4.6±0.9 | 4.6±0.9 | 1.8±0 | 23.0±3.8 | 23.0±3.8       |
| 100                         | 0.31±0.01          | 5.49±0.01                | 1.82±0 | 4.6±0 | 4.6±0.9 | 4.6±0.9 | 4.6±0.9 | 1.8±0 | 21.0±3.8 | 21.0±3.8       |

The ratio of material to juice is 1:2.0 and marinated for 150 minutes; the different superscript letters in the same column indicate significant difference (p<0.05).

### Table 5 Color and TPA textural attributes of beef braised at different temperature

| Marinating temperature (°C) | Chroma | Textural properties |
|-----------------------------|--------|---------------------|
|                            | L*     | a*                  | b*                 | Shear force (kg) | Hardness (kg) | Rupture strength (g) | Viscosity (g·s) | Elasticity (mm) | Cohesion (g·mm) |
| 80                          | 73.8±0.13a | 5.6±0.16a | 6.71±0.017a | 3.74±0.12a | 4.39±0.14a | 12.4±0.7a | 111.3±6.71a | 0.76±0.1a | 0.79±0.04a |
| 85                          | 73.5±0.09b | 5.03±0.17b | 6.05±0.25b | 3.45±0.12a | 4.02±0.21a | 11.1±0.6ab | 77.3±3.6d | 0.70±0.0a | 0.70±0.05a |
| 90                          | 73.3±0.12b | 4.66±0.09c | 5.20±0.17c | 3.09±0.17a | 3.64±0.09a | 9.8±0.5abc | 61.2±4.0c | 0.57±0.0a | 0.56±0.05a |
| 95                          | 73.0±0.25c | 4.30±0.13d | 4.60±0.19d | 2.78±0.23a | 3.25±0.15a | 8.7±0.3bc | 52.3±2.5b | 0.48±0.0a | 0.42±0.04a |
| 100                         | 72.0±0.15d | 4.02±0.15e | 4.35±0.12d | 2.33±0.14a | 2.88±0.11a | 6.9±0.5c | 35.4±3.5a | 0.38±0.0a | 0.28±0.04a |

The marinating conditions are the same as those in Table 4; the different superscript letters in the same column indicate significant differences (p<0.05).

3.4. The effect of marinating temperature on the color and texture characteristics of marinated beef

During the beef marinating process, with the increase of the marinating temperature, the L*, a*, and b* of the marinated beef gradually decreased significantly (p<0.05). Increasing the temperature of beef marinating processing, the shear force, hardness, elasticity, and cohesiveness of marinated beef decreased slowly (p>0.05), and the rupture strength and viscosity values gradually decreased significantly (p<0.05) (Table 5).
The diffusion rate of the substance and the rate of chemical reaction both increase with the increase of temperature. Increase the temperature of beef marinating. During the marinating process, the thermal hydrolysis rate of protein and other macromolecular substances in beef, the dissolution rate of amino nitrogen, water-soluble protein, and the emission rate of volatile components are all accelerated. Protein is the main structural component of muscle fiber. Due to the denaturation and hydrolysis of protein, the mechanical strength of beef muscle fiber gradually decreases. As a result, the content, color and texture characteristics of amino nitrogen and water-soluble protein in braised beef decreased with the increase of beef braising temperature, and the sensory scores increased first and then decreased. When the marinating temperature is 95℃, the content of amino nitrogen and water-soluble protein in the marinated beef is higher, the NaCl content is moderate, the color and texture characteristics are better, and the sensory score is the highest, that is, the suitable temperature for beef marinating is 95℃.

3.5. The effect of marinating time on the quality and yield of marinated beef

| Marinating time (min) | Amino nitrogen(%) | Water soluble protein(%) | NaCl(%) | Sensory score | Yield rate (%) |
|-----------------------|-------------------|--------------------------|---------|---------------|----------------|
|                       | Color             | Aroma                    | Taste   | Aftertaste    | Taste | Total | Yield rate (%) |
| 60                    | 0.33±0.0          | 5.67±0.1                 | 1.74±0.1| 3.8±1         | 3.4±0.1 | 3.8±1 | 3.0±0.0 | 2.2±1.0 | 16.2±2.4 | 76.5±0.9 |
|                       | 1<sup>a</sup>     | 1<sup>a</sup>            | 9<sup>a</sup> | 1<sup>a</sup> | 1<sup>b</sup> | 7<sup>d</sup> | 6<sup>c</sup> |
| 90                    | 0.32±0.0          | 5.63±0.1                 | 1.76±0.1| 4.2±1         | 3.8±1 | 3.8±1 | 3.4±0.9 | 3.0±1 | 18.2±1 | 73.5±0.9 |
|                       | 1<sup>a</sup>     | 5<sup>a</sup>           | 2<sup>a</sup> | 1<sup>a</sup> | 1<sup>a</sup> | 4<sup>b</sup> | 1<sup>c</sup> | 5<sup>b</sup> |
| 120                   | 0.33±0.0          | 5.59±0.1                 | 1.77±0.1| 4.6±0         | 4.2±1 | 4.6±0 | 4.2±1.1 | 3.8±1 | 21.4±1 | 71.0±0.9 |
|                       | 1<sup>b</sup>     | 1<sup>a</sup>            | 9<sup>a</sup> | 1<sup>a</sup> | 1<sup>a</sup> | 1<sup>b</sup> | 7<sup>b</sup> | 5<sup>c</sup> |
| 150                   | 0.33±0.0          | 5.57±0.1                 | 1.78±0.1| 4.6±0         | 4.6±0 | 4.6±0 | 4.6±0.9 | 4.6±0 | 23.0±1 | 69.4±0.9 |
|                       | 2<sup>a</sup>     | 9<sup>a</sup>           | 9<sup>a</sup> | 9<sup>a</sup> | 9<sup>a</sup> | 9<sup>a</sup> | 4<sup>a</sup> | 6<sup>d</sup> |
| 180                   | 0.33±0.0          | 5.48±0.1                 | 1.79±0.1| 4.2±1         | 4.6±0 | 4.2±1 | 4.2±1.1 | 4.2±1 | 21.4±1 | 68.1±0.9 |
|                       | 1<sup>a</sup>     | 0<sup>a</sup>            | 1<sup>a</sup> | 9<sup>a</sup> | 1<sup>a</sup> | 1<sup>a</sup> | 1<sup>b</sup> | 5<sup>c</sup> |

The ratio of material to juice was 1:2 and marinated at 95℃; different superscript letters in the same column indicated significant differences (p<0.05).

Extend the processing time of beef marinade, the content of amino nitrogen in marinated beef is basically unchanged, the content of water-soluble protein decreases slowly (p>0.05), the content of NaCl slightly increases (p >0.05), and the yield rate gradually decreases (p<0.05) (Table 6).

When the marinating time is less than or equal to 150min, extend the beef marinating processing time, and the color, aroma, taste, and aftertaste scores of marinated beef will gradually increase (p>0.05), and the total score of taste score and sensory score will increase significantly (p<0.05). When the marinating time is ≥150min, continue to extend the beef marinating processing time, the color, taste, aftertaste, and mouthfeel of the marinated beef will slightly decrease (p>0.05), the aroma score will remain unchanged, and the total sensory score will be significantly reduced (p<0.05) (Table 6).

3.6. The effect of marinating time on the color and texture characteristics of marinated beef

The marinating conditions are the same as those in Table 6; the different superscript letters in the same column indicate significant differences (p<0.05).

Extending the time of beef marinating and processing, the L* of marinated beef changed significantly (p<0.05), while a* and b* fluctuated slightly (p>0.05). Extending the processing time of beef marinating, the shearing force, hardness, elasticity and cohesiveness of marinated beef
gradually decreased (p>0.05), and the fracture strength and viscosity value decreased significantly (p<0.05) (Table 7).

### Table 7 Color and TPA textural attributes of beef braised for different time (%)

| Marinating temperature (°C) | Chroma | Textural properties |
|-------------------------------|--------|---------------------|
|                              | $L^*$  | $a^*$  | $b^*$  | Shear force (kg) | Hardness (kg) | Rupture strength (g) | Viscosity (g·s) | Elasticity (mm) | Cohesion (g·mm) |
| 60                            | 73.32±1.09$^a$ | 4.27±0.09$^b$ | 4.78±0.17$^a$ | 4.66±0.07$^a$ | 5.21±0.09$^a$ | 17.0±0.07$^a$ | $^-$ | $^-$ | 0.75±0.04$^a$ | 0.65±0.03$^a$ |
| 90                            | 72.10±0.57$^c$ | 4.32±0.08$^a$ | 4.46±0.21$^a$ | 3.45±0.06$^a$ | 3.84±0.11$^a$ | 12.6±0.08$^b$ | $^-$ | $^-$ | 0.64±0.05$^a$ | 0.53±0.04$^a$ |
| 120                           | 73.63±0.44$^a$ | 4.56±0.14$^a$ | 4.89±0.05$^a$ | 2.88±0.09$^a$ | 3.26±0.08$^a$ | 9.5±0.05$^c$ | $^-$ | $^-$ | 0.56±0.03$^a$ | 0.44±0.03$^a$ |
| 150                           | 73.15±0.87$^{ab}$ | 4.17±0.06$^a$ | 4.53±0.13$^a$ | 2.75±0.12$^a$ | 3.09±0.07$^a$ | 8.6±0.3$^c$ | $^-$ | $^-$ | 0.50±0.07$^a$ | 0.38±0.03$^a$ |
| 180                           | 72.44±0.31$^{bc}$ | 4.35±0.07$^a$ | 4.65±0.21$^a$ | 2.66±0.09$^a$ | 2.83±0.05$^a$ | 8.4±0.06$^c$ | $^-$ | $^-$ | 0.43±0.04$^a$ | 0.33±0.04$^a$ |

During the beef marinating process, the proteins and lipids in the beef are gradually hydrolyzed under the action of heat, and the hydrolyzed products are continuously precipitated in the marinade. The colored substances in the marinade are gradually deposited and attached to the surface of the beef, showing a taste and aroma. The ingredients gradually diffuse into the beef. Extending the time of beef marinating and processing, the amount and degree of hydrolysis of protein and lipid in beef are increased, and more flavor and aroma components diffuse into the beef. Due to the hydrolysis of structural components such as protein, the mechanical strength of beef muscle fibers gradually decreases. Due to the combined effect of the above changes, the content of amino nitrogen in braised beef remains basically unchanged, the content of water-soluble protein continues to decrease, the content of NaCl gradually increases, the chromaticity value continues to fluctuate, the texture characteristic value gradually decreases, and the sensory score increases first and then reduce.

When the beef marinated processing time is 150min, the content of amino nitrogen and water-soluble protein in the marinated beef is higher, the NaCl content is moderate, the color and texture characteristics are better, and the sensory score is the highest. Therefore, the appropriate time for beef marinating processing is 150min.

### 4. Conclusions

When the juice ratio is greater than or equal to 1:1.5, reduce the juice ratio during marinating beef, and the sensory score of the marinated beef is slightly improved (p>0.05); when 1:2.5≤juice ratio≤1:1.5, the juice is further reduced The sensory scores of braised beef remain unchanged; when the ratio of material to juice is ≤1:2.5, continue to reduce the ratio of sauces, and the color and aroma scores of braised beef remain unchanged. The scores of taste, aftertaste, taste and sensory scores are slightlyslightly Decrease (p>0.05) (Table 2).

When the ratio of material to juice is 1:2.0, the marinating temperature is 95°C, and the marinating time is 150min, the content of amino nitrogen and water-soluble protein in the marinated
beef is higher, the content of NaCl is moderate, the color and texture characteristics are better, and the sensory score is highest.

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