WEP Warwick Evans Publishing

International Journal of Agriculture and Food Sciences Research

ISSN: 3006-7685 (Print), ISSN: 3006-3736 (Online) | Volume 1, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijafsr.v1n1.10
Journal homepage: https://wepub.org/index.php/IJAFSR/index

Effect of injection compound rolling process and curdlan gel on water retention of sauced beef

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ABSTRACT

Research background and significance: Under the current development trend in the field of global food science and technology, consumers' requirements for food safety, nutritional value and sensory quality are increasing, prompting the innovation of food processing and preservation technology to become the core of the industry development. In the production of traditional food spiced beef, how to ensure the yield and quality of spiced beef is the focus of the spiced beef market. By adding edible glue can gain weight, thereby improving the yield, but previous studies have shown that carrageenan, seaweed extract and so on seriously affect the sensory quality of marinated beef, especially causing its juice oozing, colloidal attachments oozing and so on. Research content: Through the systematic study of the application of curdlan gel in the processing of brine injection spiced beef, the specific effects of curdlan gel on the water retention and sensory quality of spiced beef were discussed in this study. (1) Sensory optimization injection rolling composite curing process. The experiment was carried out with beef tendinous meat and a series of auxiliary materials, using fine processes and methods, including saline injection, rolling salting, cooking treatment, etc., and then conducting sensory evaluation. (2) Compare the quality difference of curdlan gel 1 and 2. Determination of gel strength and optimization of water retention of stewed beef were carried out. Single factor ANOVA test was used to determine the optimal dosage of curdlan gel. The results showed that the water retention of beef with brine injection could be enhanced significantly when the dosage was 2%, respectively. Under the optimal process conditions, the sensory score of brined beef was 85.4 points. Through this study, important scientific and technological findings were obtained, which did not mean that the higher the concentration of curdlan gel, the better the water retention, on the contrary, the higher the concentration of its water retention would be affected but would decrease. This research not only expands the application range of curdlan gel in the food industry, but also provides new technical solutions and theoretical support for the innovation and development of meat processing technology, and meets the needs of consumers for high-quality meat products.

KEYWORDS

Curdlan gel; Spiced beef; Loss; Process preparation; Sensory score; Water retention

1. INTRODUCTION

In the current global food science and technology field, with the increasing requirements of consumers for food safety, nutritional value and sensory quality, the innovation of food processing and preservation technology has become the key to the development of the industry [1]. Especially in the meat processing industry, how to effectively improve the sensory quality of meat, extend the

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shelf life and reduce processing losses on the basis of ensuring food safety has become a common concern of scientific researchers and industry. Among many food additives, curdlan gel has attracted more and more attention in the food industry because of its unique properties derived from microorganisms and its advantages of natural, safe and renewable [2].

Curdlan gel, this microbial exopypolysaccharides not only has good thickening and water holding capacity, but also can form gels and films, which make it show excellent application potential in meat processing. For example, curdlan gel can improve the water loss during processing by enhancing the water retention ability of meat, thereby reducing cooking loss, improving the tenderness and juiciness of meat, and enhancing consumers' eating experience [3]. In addition, the gel properties of curdlan gel help to improve the structure and stability of meat products, so that meat products maintain better shape and texture during the shelf life.

For the specific scenario of brined beef processing, brining is a commonly used method to enhance the texture and flavor of the meat, but common problems in the process include the loss of moisture and flavor components. The addition of curdlan gel is not only expected to effectively reduce these losses and enhance the flavor locking ability of meat, but may also improve the overall processing performance and final quality of meat through its unique physical and chemical properties [4]. Therefore, this study was devoted to exploring the specific effects of adding curdlan gel to brine injection on water retention, protein stability and sensory quality during the processing of spiced beef, in order to provide new technical solutions and theoretical support for meat processing industry.

Through the systematic research on the application of curdlan gel in the processing of brine injection-brine beef, it can not only expand the application range of curdlan gel in the food industry, but also help to promote the innovation and development of meat processing technology to meet the needs of consumers for high-quality meat products.

2. MATERIALS AND METHODS

2.1. Experimental Materials

Beef shank meat: Select beef shank meat with similar quality and clear texture to ensure the accuracy of the experimental results.

Accessories (All accessories are purchased from the market to ensure their freshness and quality):

Salt: Used as a basic seasoning to enhance the flavor of meat.

White sugar: Adjust the sweetness of meat, balance the taste.

Star anise, ginger, orange peel, cinnamon, cilantro leaves: These spices together form the basic aroma of the brine and increase the aroma of the meat.

Light soy sauce, dark soy sauce, cooking wine, chicken essence.

Other materials:

curdlan gel No. 1 and curdlan gel No. 2 (the content of glue No. 1 is greater than that of glue No. 2): Provided by Shandong Cuoyuan Ekang Biotechnology Co., LTD., as the key materials of this study, to explore their effects on the processing loss of brine injectable beef.

Cooking bag: purchased in the market, used to package beef for cooking treatment, to maintain the moisture and nutrition of the meat.

2.2. Experimental Instruments

Table 2-1. Main instruments and devices

Instrument	model	manufacturer
Electronic analytical balance	AL104	Mettler Toledo Instruments LTD
Centrifugal machine	SR-800	Changzhou Surui Instrument Co., LTD
Laboratory water bath	DRHH-s6	Shanghai Cheng Jie Instrument Equipment Co., LTD
Vacuum-packed bag	30cm×20cm	Foshan Hongchen Packaging Materials Co., LTD
Vacuum sealing safety machine	QH-66	Zhejiang Qunhai electronic Technology Co., LTD
refrigerator	BCD-471WDCD	Haier Group
Cooking boiler	Ws-z50	Venus Factory
Mini magnetic stirrer	M-SCL	Hangzhou Qiwei Instrument Co., LTD
Vacuum pickling machine	KA-6189A	Shenzhen Ruifeng Electric Appliance Co., LTD
Texture analyzer	Pius	SMS
Saline injection machine	not have	not have

2.3. Methods

2.3.1. Processing technology of brine injection brined beef

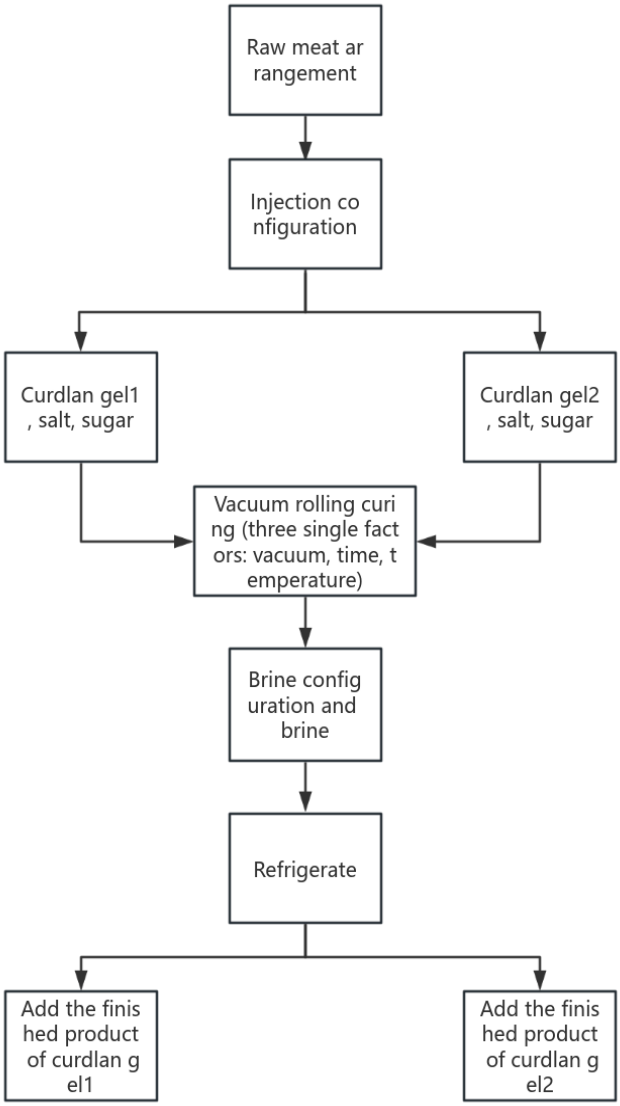

Figure 2-2. Process flow chart of brined beef for brine injection

2.3.2. Basic formula

The basic formula for brined beef is a carefully designed seasoning solution designed to enhance the flavor, tenderness and juiciness of beef through brined technology [5]. This method not only improves the taste of the meat, but also helps the meat retain water during processing, thus reducing loss. The following is a typical brine injectable beef base recipe, covering the main seasonings and spices:

Injection configuration:

Salt: basic seasoning, help meat taste, while playing a certain role in anti-corrosion; White sugar: balance the salty taste of salt, increase the taste level of meat; curdlan gel: Increases taste and reduces water loss.

Brine formula:

Light soy sauce (soy sauce): to increase the color and flavor of meat; Cooking wine: to enhance the smell, to help reconcile the taste of various seasonings; Dark soy sauce; Chicken essence: Used for freshening.

Brine cooking kit:

Star anise: provides a strong aroma and is a common choice for marinade spices. Ginger: to enhance the smell of fish, increase the flavor of meat. Orange peel: With a unique aroma, can increase the depth of the flavor of meat. Cinnamon: Adds a warm aroma and enhances the overall flavor layer. Leaf: Provides a refreshing aroma that balances the strong flavors of other spices.

2.3.3. Preparation method

Raw meat treatment: Remove the fascia of beef tendon meat and trim it to about 50 grams per piece.

Injection configuration: Mix salt, white granulated sugar and curdlan gel in appropriate proportions and dissolve them in cold water.

Saline injection: The injection is injected into the beef using a saline injection machine and evenly distributed.

Spice preparation: Prepare the spices such as star anise, ginger, tangerine peel, cinnamon peel and cilantro leaves, crush them with gauze.

Brine cooking: bring water to boil, add light soy sauce, dark soy sauce, chicken essence, cooking wine, green onion and prepared material package to the boiling water, boil the pot and then low heat for 1.5 h to make brine. The cooking pot should be closed with a lid during the brine boiling process. The marinated beef is first boiled in boiling water for 15 minutes, and then the water temperature is controlled by 90-95℃ for more than 60 minutes.

Remove from the pan and refrigerate: After marinating, gently remove the beef to the rack with chopsticks to avoid falling apart. It is first cooled at room temperature, and then pushed into the meat drying room at 0-4℃ for 12 hours.

2.4. Determination Of Gel Strength Of Curdlan Gel

2.4.1. Experimental methods

Take 0.3g sample in 15mL water, stir with magnetic stirrers at the speed of 1600/mim for 5min, then transfer the suspension to 18mm×180mm test tube, aerate under vacuum for 3min, and then quickly put the test tube into boiling water bath for 10min, and cool it in cold water for 30min. Remove the gel from the test tube, remove a section of 10mm gel from the bottom 20mm and 30mm, and determine it with a gel meter or texture meter. Do two parallel experiments to form a control.

2.4.2. Gel strength determination method

Gel strength was calculated from the recorded load-time (f-t) curve. Gel strength is measured in w, the value is expressed in grams per square centimeter (g/cm^2), calculated according to formula (1):

$$w = \frac{f}{0.196} \quad (1)$$

Where: f--the reading of the inflection point at which the curve drops sharply when the gel breaks in the load-time (F-T) curve, in grams (g);

0.196-The value of the cross-sectional area of the cylindrical probe in square centimeters (cm^2).

2.5. Determination Of Preparation Technology Of Brined Beef For Injection

2.5.1. Single factor determination of brined beef for brine injection

In the process of studying the optimization of brine injection brine beef processing technology, the first focus was on the influence of rolling kneading process parameters, including vacuum degree,

rolling time and rolling temperature, on the tenderness quality of beef [6]. By systematically changing the roiling vacuum degree (0.3, 0.4, 0.5, 0.6, 0.7MPa), roiling time (0.5h, 1h, 1.5h, 2h, 2.5h) and roiling temperature (3℃, 6℃, 9℃, 12℃, 15℃), this study aims to explore the specific effects of each parameter on beef tenderness. Thus the optimum combination of rolling and kneading process is determined. A series of single-factor experiments were designed to evaluate changes in beef tenderness under various conditions, in order to reveal the improvement effect of beef tenderness quality under optimal rolling and kneading conditions [7].

2.5.2. Orthogonal experimental design of brined beef injection

Based on the single factor test results in 2.5.1, the orthogonal experimental design method was adopted to comprehensively investigate the influence of factors such as roiling vacuum, roiling time and roiling temperature in the research on the processing technology of brine-infused beef, aiming to reduce the number of experiments effectively and ensure the obtaining of representative and scientific conclusions through systematic experimental design [8]. In this study, orthogonal experiments were carried out on the three main factors, and the specific factor levels were shown in Table 2-3.

Table 2-3. Orthogonal experimental factor levels

Level	A: Degree of rolling vacuum (MPa)	B: Rolling time(h)	C: Kneading temperature(℃)
1	0.4	1.5	3
2	0.5	2	6
3	0.6	2.5	9

2.5.3. Sensory evaluation method of brined beef for saline injection

The sensory scores were used as the criteria for determining the best sensory scores of brine-injected beef. Eight sensory assessors were randomly selected from different populations to objectively evaluate three aspects of brine-injected beef: appearance, texture, aroma, tenderness [9] and juiciness [10], as shown in Table 2-4.

Table 2-4. Scoring criteria of sensory evaluation

Sensory attribute	Standard for evaluation	Score range
appearance	- Bright flesh, smooth surface without foreign bodies	15-20
	- Slightly darker flesh, smoother surface	10-15
	- The flesh is dull, the surface is not smooth and foreign objects	Below 10
character	- Tight flesh, good elasticity, good feel	15-20
	- The flesh is tight and elastic	10-15
	- Loose meat, poor elasticity	Below 10
fragrance	- Rich aroma, delicious meat, no odor	15-20
	- Strong aroma, fresh meat taste, slight odor	10-15
	- Poor aroma, meat taste is not fresh, there is an obvious odor	Below 10
tenderness	- melts in the mouth, tender and easy to chew	15-20
	- Easy to chew with average tenderness	10-15
	- Difficult to chew, hard meat	Below 10
succulence	- Rich juice and moist taste	15-20
	- Medium juice, moist taste	10-15
	- Little juice, dry taste	Below 10

2.6. Water Retention Experiment Of Brined Beef By Saline Injection

2.6.1. Selection of water-retaining additives

When braised beef is injected with brine, curdlan gel can be added to it, thus reducing the loss of the product during processing and making the taste softer [11]. In this experiment, the different dosage of two different curdlan gel adhesives were compared, and the dosage ofcurdlan gel No. 1 was 0.5%, 1%, 1.5%, 2% and 2.5%. The addition of curdlan gel No. 2 is 0.5%, 1%, 1.5%, 2%, 2.5%. The optimal addition amount was selected through the experimental results.

2.6.2. Determination method of water retention

(1) Determination of cooking loss rate

Weigh the beef gravy before and after boiling, and calculate the cooking loss rate according to equation (2) [12].

$$cooking\ loss\ rate(\%) = \frac{m1-m2}{m1} \times 100\% \quad (2)$$

Where: m1--the weight of the Patty before cooking, g

m2--Weight of the meatloaf after cooking, g

(2) Determination of centrifugal loss rate

Accurately weigh the sample of about 3 g and record it as n1; Put it into a 20 mL centrifuge tube and centrifuge it at 3000 ×g for 15 min. After taking it out, weigh it as n2 and calculate the centrifugal loss rate according to the formula [13]:

$$centrifugal\ loss\ rate(\%) = \frac{n1-n2}{n1} \times 100\% \quad (3)$$

2.6.3. Optimization of water retention of spiced beef with brine injection

The water retention of brined beef was optimized by means of significance analysis. The effects of different addition amounts of curdlan gel 1 and curdlan gel 2 on water retention were respectively compared [14]. Single factor ANOVA test in spass software was used for analysis, and the factor levels are shown in Table 2-3 and 2-4.

Table 2-5. Analytical test factors for curdlan gel No. 1

Curdlan gel No. 1 dosage(%)	Cooking loss rate(%)	Centrifugal loss rate(%)
0	44.5	2.86
0	45.37	2.08
0	52.42	2.96
0.5	45.65	2.6
0.5	46.75	2.01
0.5	48.55	2.46
1	44.61	1.8
1	42.98	1.53
1	48.1	1.55
1.5	40.74	1.63
1.5	43.88	1.76
1.5	43.96	1.74
2	40.92	0.91
2	38.71	1.38
2	39.17	0.85
2.5	42.63	1.32
2.5	41.19	1.28
2.5	41.81	0.79

Table 2-6. Analytical test factors of curdlan gel No. 2

Curdlan gel No. 2 dosage(%)	Cooking loss rate(%)	Centrifugal loss rate(%)
0	44.57	2.97
0	48.9	3
0	42.28	2.18
0.5	42.09	2.35
0.5	46.2	1.46
0.5	44.91	1.95
1	40.91	1.58
1	47.35	1.28
1	41.22	1.59
1.5	40.2	1.19
1.5	42.12	0.95
1.5	40.11	1.6
2	37.44	1.1
2	39.08	0.86
2	36.45	0.99
2.5	37.37	1.21
2.5	40.43	0.94
2.5	37.47	1.27

3. RESULT ANALYSIS

3.1. Analysis Of Gel Strength Test Results

Table 3-1. Gel strength of Curdlan gel No. 1

	N/g	Jelly strength g/cm2
curdlan gel 1	252.12	1286.33
curdlan gel 1	232	1183.67
curdlan gel 1	232.39	1185.66
Mean value	238.84	1218.57

Table 3-2. Gel strength of Curdlan gel No. 2

	N/g	Jelly strength g/cm2
curdlan gel 2	196.97	1004.95
curdlan gel 2	171.06	872.76
curdlan gel 2	131.89	672.91
Mean value	166.64	850.2

By comparing Table 3-1 and Table 3-2, it can be seen that the gel strength of curdlan gel No. 1 is 1218.57g/cm2, and that of curdlan gel No.2 is 850.2g/cm2. The gel strength of 1 and 2 is different, but the gel strength of 1 is stronger.

3.2. Analysis Of Single Factor Test Results Of Brined Beef Injection Process

3.2.1. Determination of rolling vacuum degree

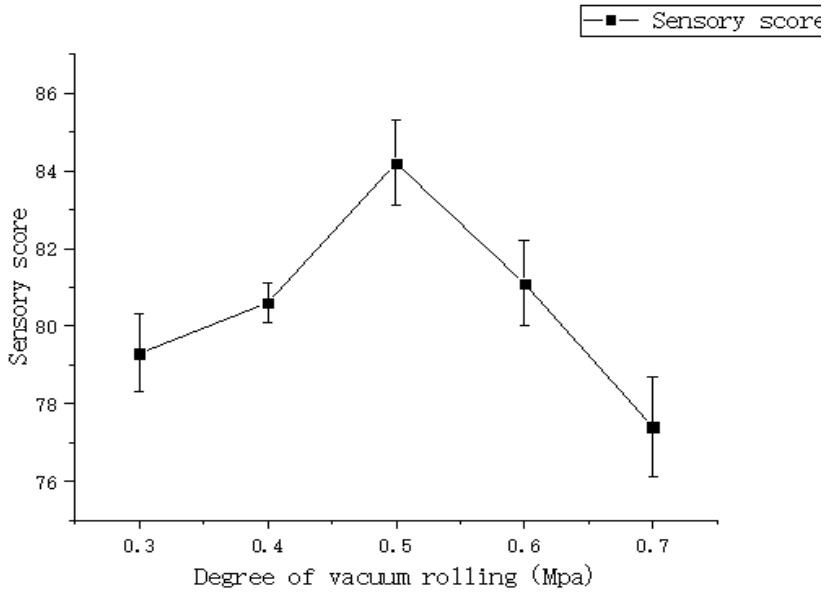

Figure 3-3. Effect of the space of rolling fungi on sensory scores

As can be seen from Figure 3-3, the sensory score is the highest when the vacuum degree of roll kneading is 0.5Mpa, and the roll kneading effect is better when the vacuum degree is 0.4Mpa-0.6Mpa. 0.5Mpa was selected for follow-up test.

3.2.2. Determination of rolling time

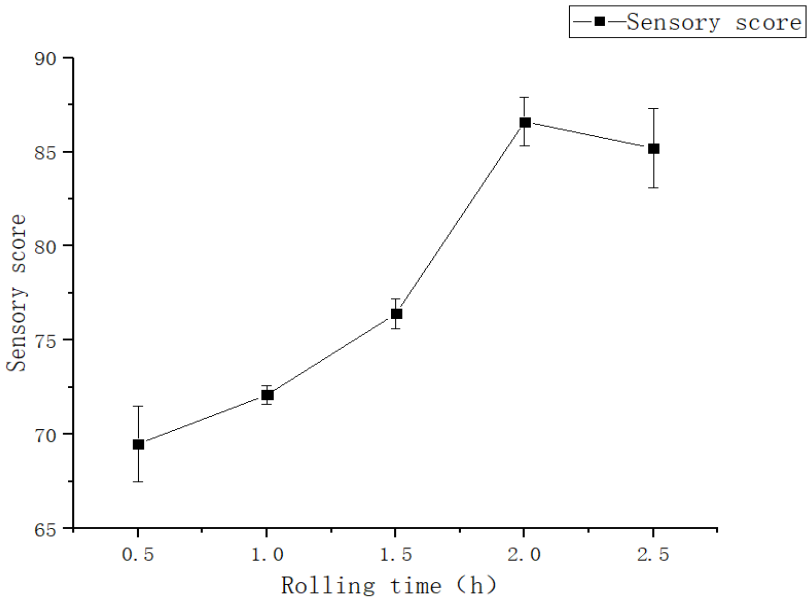

Figure 3-4. Influence of rolling time on sensory scores

As can be seen from Figure 3-4, when the vacuum degree of rolling is maintained at a certain level, with the increase of rolling time, the sensory evaluation first rises and then shows a downward trend. When the rolling time was 2h, the sensory score reached the maximum (86.6 points). In addition, the rolling time is between 1.5h and 2.5h, and the quality of spiced beef is better. Therefore, 2h was selected for the follow-up experiment.

3.2.3. Determination of rolling temperature

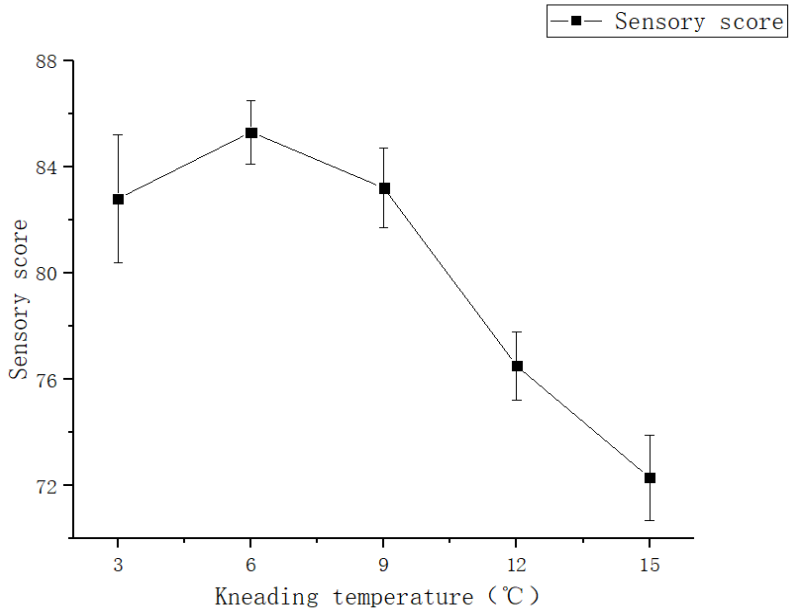

Figure 3-5. Influence of kneading temperature on sensory scores

As can be seen from Figure 3-5, sensory evaluation first increases and then decreases with the increase of rolling temperature. When the kneading temperature is 6℃, the sensory score is the maximum, and the kneading temperature is the best between 3℃ and 9℃.

3.3. Orthogonal Experiment Results Of Brined Beef Injection

Based on the results of the single factor test, orthogonal tests were conducted for the corresponding ranges of the three single factors, and the results and range analysis were shown in Table 3-6.

Table 3-6. Orthogonal experiment results

Test number	Element			Sensory score
	A.Degree of rolling vacuum/(Mpa)	B.Rolling time/(h)	C.Kneading temperature/(℃)	
1	1	1	1	76.75
2	1	2	2	82.75
3	1	3	3	83.75
4	2	1	2	80.88
5	2	2	3	81.13
6	2	3	1	82.25
7	3	1	3	77.75
8	3	2	1	84.36
9	3	3	2	85
K1	243.25	235.38	243.36	
K2	244.26	248.24	248.63	
K3	247.11	251	242.63	
k1	81.000	78.377	81.037	
k2	81.420	82.747	82.887	
k2	82.370	83.667	80.887	
R	1.333	5.290	2.000	

It can be seen from the analysis of orthogonal test results in Table 3-6 that the order of influence of each factor on sensory score of spiced beef is B > C > A. Specifically, the relationship between the level values of each factor is shown as follows: the level value relationship of factor A (roiling vacuum degree) is A3 > A2 > A1; the level value relationship of factor B (roiling time) is B3 > B2 > B1; the level value relationship of factor C (roiling temperature) is C2 > C1 > C3. Through comprehensive k value analysis and direct comparison, the optimal combination can be obtained as A3B3C2. Further analysis showed that the kneading time (B factor) had the greatest influence on the sensory score of spined beef, followed by the kneading temperature (C factor), and finally the kneading vacuum degree (A factor). This analysis result suggests that in the preparation process of stewed beef, the optimization of rolling time is the most critical factor, followed by the adjustment of rolling temperature, while the influence of rolling vacuum degree is relatively small [15]. According to this, it can be determined that the best preparation process of stewed beef is as follows: adjusting the roller kneading vacuum to the highest level (corresponding to A3), selecting the longest rolling time (corresponding to B3), and adjusting the roller kneading temperature to the medium high level (corresponding to C2). Validation tests based on this optimal process configuration showed that the sensory score of the stewed beef reached 85.4 points, which validated the effectiveness of the selected optimal combination and identified the significant impact of the preparation process on improving the sensory quality of the product. In summary, through a detailed analysis of the orthogonal test results in Table 3-4, we not only revealed the specific influence of the three factors of roading vacuum, roading time and roading temperature on the sensory score of stewed beef and their optimization direction, but also successfully determined the best roading preparation process. Under the conditions of the highest roller vacuum, the longest roller time and the medium high roller temperature, this process can effectively improve the sensory evaluation of braised beef tendon, thus providing an important technical basis for the preparation of high quality braised beef.

3.4. Experimental Results Of Water Retention Of Brined Beef By Saline Injection

3.4.1. Influence of the addition amount of curdlan gel on water retention of brined beef by brine injection

Table 3-7. Influence of the amount of curdlan gel added on the water retention of brined beef

curdlan gel 1 (2) dosage(%)	No. 1 cooking loss rate(%)	No. 2 cooking loss rate(%)	Centrifugal loss rate No. 1(%)	Centrifugal loss rate No. 2(%)
0	47.43 ± 4.34^{a}	$47.43 \pm 4.34a$	2.63 ± 0.48^{a}	2.63 ± 0.48^{a}
0.5	$46.98 \pm 1.46^{ab*}$	$44.4 \pm 2.1^{ab*}$	$2.36 \pm 0.31^{a*}$	$1.92 \pm 0.45^{b*}$
1	$45.23 \pm 2.62^{abc*}$	$43.16 \pm 3.63^{abc*}$	$1.63 \pm 0.15^{bc*}$	$1.48 \pm 0.18^{bc*}$
1.5	$42.86 \pm 1.84^{bcd*}$	$40.81 \pm 1.14^{bcd*}$	$1.71 \pm 0.07^{b*}$	$1.25 \pm 0.33^{c*}$
2	$39.6 \pm 1.17^{cd*}$	$37.66 \pm 1.33^{d*}$	1.05 ± 0.29^{d}	0.98 ± 0.12^{c}
2.5	$41.88 \pm 0.72^{d*}$	$38.42 \pm 1.74^{cd*}$	1.13 ± 0.3^{cd}	1.14 ± 0.18^{c}

Note: Data are expressed as mean ± standard deviation. a to d in the same column of letters, the same means the difference is not significant ($p > 0.05$), different means the difference is significant ($p < 0.05$). A * indicates a significant difference between two types in a row [16].

Cooking loss and centrifugal loss are important indexes to determine the water retention of spiced beef. As can be seen from Table 3-7, compared with the blank group without the addition of curdlan gel, the cooking loss and centrifugal loss rates of spiced beef were significantly decreased with the increase of the addition amount of curdlan gel 1 ($p < 0.05$), when the addition amount of curdlan gel 1 was

At 2%-2.5%, the changes of cooking loss and centrifugal loss were not significant ($p > 0.05$), and the cooking loss and centrifugal loss were the lowest at 2%, which were 39.6% and 1.05%, respectively.

Therefore, the addition of 2% curdlan gel 1 can significantly enhance the water retention of brined beef to some extent. Compared with the control group, the cooking loss and centrifugal loss rates of brined beef were significantly decreased with the increase of the addition level of curdlan gel 2 ($p < 0.05$). When the addition level of curdlan gel 2 was 1.5% to 2.5%, the changes of cooking loss and centrifugal loss of brined beef were not significant ($p > 0.05$). However, the cooking loss rate and centrifugal loss rate remained at the lowest value when the addition amount of curdlan gel was 2%, which were 37.66% and 0.98%, respectively. Therefore, the addition of 2% curdlan gel 2 can also optimize the water retention of brined beef.

3.4.2. Comparison of cooking loss and centrifugal loss of the addition amount of curdlan gel 1 and 2

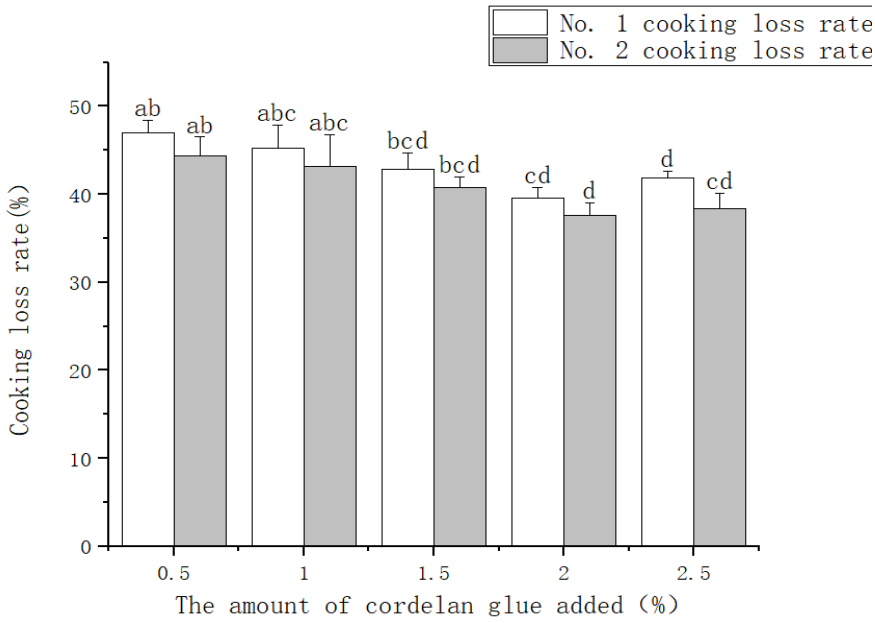

Figure 3-8. Cooking loss of curdlan gel 1 and 2

As can be seen from Fig. 3-8, the cooking loss of curdlan gel no. 2 is always less than that of glue No. 1 under any addition amount.

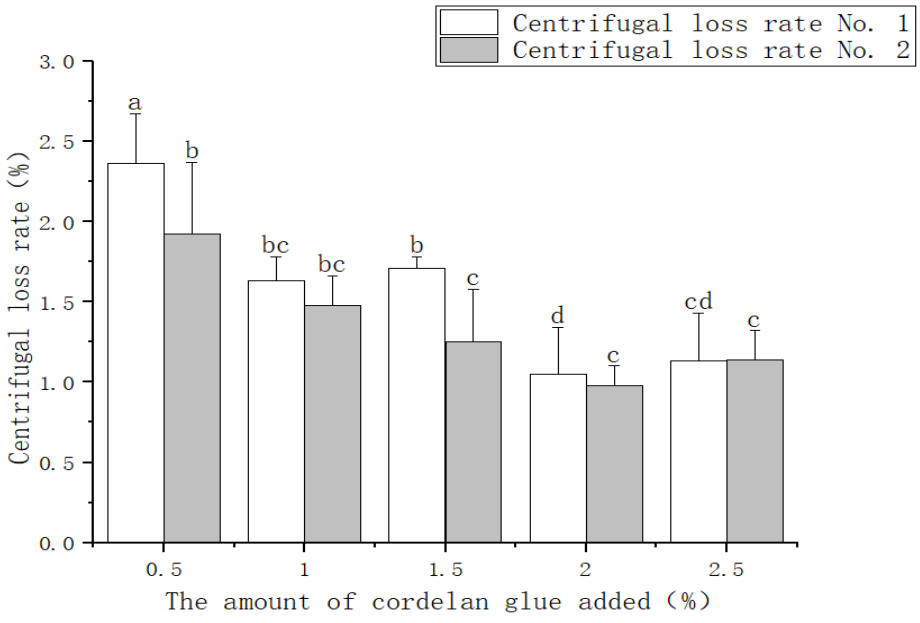

Figure 3-9. Centrifugal loss of curdlan gel 1 and 2

As can be seen from Figure 3-9, with the increase of the amount of No. 1 and No. 2 Codelan glue, the centrifugal loss rate showed a trend of decrease. Number 2; Centrifugal losses are lower compared to number 1.

It can be seen from the above two figures that under the process of brine injection of stewed beef, the water retention of stewed beef by curdlan gel No. 2 is better than that of curdlan gel No. 1.

4. CONCLUSION

In this paper, the effect of curdlan gel on the water retention of stewed beef was studied on the basis of brine injection of stewed beef. According to GB 28304-2012 gel strength measurement method, the gel strength of two different Kerderan adhesives was determined by texture analyzer. The effects of kneading vacuum, kneading time and kneading temperature on sensory evaluation of brined beef were investigated by single factor experiment. ANOVA test was used to determine the optimal water retention of additives on brined beef and the parameters were obtained.

After measuring the gel strength of curdlan gel 1 is 1218.57g/cm2, and the gel strength of curdlan gel 2 is 850.2g/cm2, it can be known that the gel strength of 1 and 2 is different, and the gel strength of 1 glue is greater than that of 2 glue. Through the single factor experiment, it was concluded that the optimal process conditions were as follows: roller vacuum of 0.6Mpa, roller kneading time of 2.5h, and roller kneading temperature of 6℃. The sensory score of the prepared brined beef was 85.4 points. Through the single factor ANOVA test, it is concluded that when the water retention of brine-injected beef is optimal, the addition amount of Kedelanjiao 1 is 2%, and the cooking loss rate of brine-injected beef is 39.6% and the centrifugal loss rate is 1.05%: The cooking loss rate and centrifugal loss rate of brined beef were 37.66% and 0.98% when the dosage of curdlan gel 2 was 2%. It can be seen that the water retention of curdlan gel 2 is better than that of No. 1, but the concentration and gel strength of curdlan gel 1 are much higher than that of No. 2. Therefore, important findings have been obtained. The high concentration of curdlan gel means that its gel strength is stronger, but it does not mean that it has strong water retention. On the contrary, when the concentration is too high, the water retention will be affected and the water retention will be reduced [17].

THANK YOU SPEECH

When I put down my paper, my mood was not relaxed. My thoughts and emotions came like a flood, hitting my tired heart, and I had mixed feelings at this time. College time is fleeting, more than ten years of student career will wave goodbye. The bits and pieces along the way are played back in my heart like images at this moment, whether happy, sad, harvest or frustration, they are so precious and warm.

On the occasion of the completion of this thesis, I would like to thank all the teachers and classmates who helped me in the process of my graduation design. First of all, I would like to thank my graduation project instructor for his congratulations to associate Professor. His rigorous academic attitude, his work style of excellence, and his tireless noble ethics in teaching have given me great inspiration. I found time to review and revise my thesis in my busy teaching work, and gave me patient guidance from the thesis proposal to the completion of the entire literary theory. Secondly, I would like to thank my classmates and friends, who have helped me solve many problems and put forward many valuable suggestions for my design.

ACKNOWLEDGMENTS

R & D Plan Zibo City Integration Program (2021SNPT0007), National Modern Agricultural Technology System in China (CARS-37), the Central Guide Local Science and Technology

Development Fund Project of Shandong Province (YDZX2022122), the key research and development Program (Rural Revitalization of scientific and technological innovation boost action plan of Shandong Province (2023TZXD046), Key technology research and development for high-quality cattle tallow green deep processing, sgyhx2023-56, Research and Development and Demonstration of Key Technologies for Processing and Application of Prefabricated Compound Condiments, Shandong Province Technology Innovation Leading Plan (Central Government's Guiding Funds for Local Scientific and Technological Development), YDZX2023088.

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