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Optimization of the Preparation Process of Marinated Beef Tendons and The Development of Low-fat Kederan Rubber Tendon Beef Patties

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Abstract: This paper aims to develop a special snack hoof tendon beef patty based on two kinds of local characteristic ingredients, beef tendon and beef. To explore the preparation process of beef tendon and the water retention capacity of beef tendon products, the orthogonal experimental analysis method was used to explore the influence of three single factors on the sensory of the prepared beef tendon, and the three single factors of beef tendon addition, curtai gum addition and salt addition were used to explore the optimization of the water retention of beef tendon beef tendon, and finally the optimal preparation conditions were obtained. The experimental results showed that the optimal preparation conditions were as follows: the marinating temperature was 120°C, the marinating time was 90min, and the simmering time was 5h.The content of beef tendon was 21.153%, the content of cadran gum was 2.154g and the content of salt was 1.498%, and the prepared product had the lowest cooking loss rate of 5.951% and the lowest centrifugal loss rate of 10.155%, so that the beef tendon beef patty achieved better water retention.

Keywords: Beef trotters; Hoof tendons; Beef patties; Process preparation; Sensory score; Water retention.

1. Preface

Cow's hoof tendon is a lumpy tendon in the sole part of the cow's foot[1],Beef tendons are highly nutritious and mainly composed of collagen and elastin, and the texture of beef tendons is similar to that of sea cucumber and has a rich taste,It is a commonly used ingredient in some dishes[2],Cow hooves have the nutritional characteristics of high protein, cholesterol-free, high calcium, and low fat[3],In addition, eating hoof tendons can also slow down the aging of the skin, which is very effective for beauty and anti-wrinkle[4].

There is an increasing demand for high-quality meat products with high nutritional value and low cost[5].Beef is one of the most important meats in the world[6]， Because of its low cholesterol, high protein, rich nutrition and other characteristics, it is gradually loved by consumers [7]. According to statistics, as of 2019, the total market value of the global beef industry was about $320 billion, and it is expected to reach $480 billion by 2027, with a compound annual growth rate of 48%. In China, beef is very popular, and consumers are very concerned about quality, health and safety. With the development of the economy and the improvement of people's living standards, consumers' demand for high-quality and safe beef continues to grow.The market size is still growing steadily, and it is expected to reach 1.7 trillion yuan by 2025.

Beef conditioning meat products, also known as prefabricated beef products, are based on beef as the main raw material. Conditioned meat products are a kind of nutrition and hygiene that can be eaten directly or after simple cooking treatment with the development of social economy and the improvement of people's living standards, and the pace of life is gradually accelerated, which can be eaten directly or after simple cooking treatment, which is convenient to eat, diverse, and its production and consumption have grown rapidly, becoming one of the main meat products of China's urban population[8],Among them, meatloaf is one of the most popular ready-to-eat meat products because of its very satisfying taste[9].With the progress of science and technology and the continuous development of cooking technology, people pay more attention to nutrition and health, and the production of meatloaf pays more attention to taste and quality.The beef patty studied in this experiment is a round cake-shaped meat product made from beef tendon and beef through the processes of grinding, chopping and molding.

2. Materials and Methods

2.1. Experimental materials

Ingredients: shoofed muscles, beef tendons, Excipients: salt, white sugar, black pepper, Sichuan pepper, star anise, ginger, tangerine peel, cinnamon, bay leaf, light soy sauce, cooking wine, hot pot base, All are commercially available; Kederan gum, provided by Shandong Cuiyuan Yikang Biotechnology Co., Ltd.; Retort pouches, purchased from the market.

2.2. Experimental instruments

Table 1-1. Major instruments and equipment

instrument	Model	factory
Electronic analytical balances	AL104	METTLER TOLEDO Instruments Ltd
centrifuge	Model SR-800	Changzhou Surui Instrument Co., Ltd
Meat grinder	SY6A	Guangdong Zhongshan letgoo Liguo Company
Vacuum-packed bags	30cm×20cm type	Foshan Hongchen Packaging Materials Co., Ltd
Vacuum sealing safety machine	QH-66 type	Zhejiang Qunhai Electronic Technology Co., Ltd
Refrigerator	BCD-471WDCD type	Haier Group
Cooker	WS-Z50 type	Venus Factory

2.3. Method

2.3.1. The processing technology of the hoof tendon beef patty

Cow hoof tendons thawed → Cleaning and disposal → Pre-cooked→ Brine preparation (braised beef tendons) → Simmer → finished product → Sensory determination

↓

Chop

↘

Beef is thawed and processed →Mincing→Stirring →Stir to combine → Pressed molding→ finished product → detect

↑

Accessories

2.3.2. Base formula

Braised beef tendon formula: Ginger, salt, sugar, cooking wine, light soy sauce, tangerine peel, cinnamon, star anise, Sichuan pepper, black pepper, bay leaves, hot pot base.

Beef patty recipe: Butter, salt, codlan gum, ground black pepper.

2.3.3. Key points of hoof tendon beef patty operation

Marinating: The beef tendons are cleaned and marinated before being added to the beef patty.From Pic 2- 1 Compared with picture 2-2, it can be seen in Figure 2-1 that the beef tendon that has not been marinated is directly added to the beef patty, the color of the beef tendon is whitish and the beef patty is not integral, the shape of the beef tendon in Figure 2-2 is round, and the beef tendon added to the beef patty is transparent and beautiful, which clearly reflects that the beef tendon is marinated and then added to the beef patty to present the effect of the beef tendon beef patty, so that the beef tendon can be better integrated into the beef patty, so that the beef patty tastes chewy and rich in taste[10].

Figure 2-1. Beef pie chart before modification

Figure 2-2. Modified beef pie chart

Chopping and mixing: By comparing Figure 2-1 and Figure 2-2, it can be clearly observed that the improved beef patty is more beautiful, so in the early process of making the beef patty, the beef must be chopped and mixed after grinding, and the beef chop and mix into minced meat, the beef patty made by chopping and mixing is not only easy to form and plays an important role in water retention, but also makes the hoof tendon beef patty taste more delicate and delicious.

2.4. Determination of the preparation process of marinated beef hoof tendons

2.4.1. Single-factor determination of marinated beef hoof tendons

Three variables, brine temperature, brine time, and simmering time, were selected for a single factor experiment, and eight evaluators with sensory evaluation ability were selected to score the braised beef hoof tendons according to the sensory scoring criteria in Table 2-2.

2.4.1.1 Marinating temperature

Five samples were weighed, and the total amount of each sample was 100 g, and the brine temperature was 80°C, 90°C, 100°C, 110°C, and 120°C. Sensory evaluation is carried out to select the optimal brine temperature for follow-up testing.

2.4.1.2 Marinating time

Five samples were weighed, the total amount of each sample was 100 g, and the marinating time was 30 min, 50 min, 70 min, 90 min and 110 min. Organoleptic evaluation was carried out to select the best marinating time for follow-up testing.

2.4.1.3 Simmering time

Five samples were weighed, the total amount of each sample was 100 g, and the simmering time was 2h, 3h, 4h, 5h, and 6h. Organoleptic evaluation was carried out to select the best simmering time for follow-up tests.

2.4.2. Orthogonal experimental design of braised cow hoof tendons

Based on the results of single factor test in 2.4.1, the L9(34) orthogonal experimental design was carried out on these three single factors, and the specific factor levels are shown in Table 2-1.

Table 2-1. Orthogonal experimental factor level

level	A: Marinating temperature (℃)	B: Marinating time (min)	C: Simmering time (h)
1	100	70	3
2	110	90	4
3	120	110	5

2.4.3. Sensory evaluation method of braised cow hoof tendons

Taking the sensory score as the criterion for determining the best braised beef tendon process, 8 sensory evaluators were randomly selected from different groups of people to objectively evaluate the three aspects of braised beef tendon: Organizational status[11]、flavor[12]、The specific scores of taste and chewiness are shown in Table 2-2.

Table 2-2. Sensory evaluation scoring criteria

project	Total scores/points	Grading Criteria
Organizational status	30	Tissue softness is moderate for 20~30 points; 10~20 points for slightly hard or soft tissue; The tissue is hard or soft and rotten for 0~10 points
flavor	30	Maintain the unique taste, good taste, and saltiness of beef hoof tendons for 20~30 points; Maintain the unique taste of beef hoof tendons, good taste, and moderate saltiness for 10~20 points; Basically, there is no unique taste of beef tendons, too salty or too light for 0~10 points
Chewiness	40	The hardness is suitable, and the chewiness is 30~40 points; The hardness is moderate, and the chewiness is less than 10~20 points; Too hard or too soft, difficult to chew or no chew is 0~10 points

2.5. Water retention experiment of beef patty

2.5.1. Selection of water-retaining additives

When making the hoof tendon beef patty, add certain accessories to make the hoof tendon beef patty retain water[13]The effect is good, and the taste is Q elastic.In this experiment, through the addition of cow tendons, the amount of cadran gum and the amount of salt, such as the addition amount of cow tendons is 5%, 10%, 15%, 20% and 25%, the addition amount of cadran gum is 0.5g, 1g, 1.5g, 2g, 2.5g, salt added is 1%、1.5%、2%、2.5%、3%The optimal addition amount was selected through the experimental results. At the same time, the optimal water retention capacity was found by comparing the experimental results of a single additive through the compound experiment of the three additives[14]the amount of addition.

2.5.2. Optimization of the water retention of the hoof tendon beef patty

The response surface method was used to optimize the water retention of hoof tendon beef patty[15].The influencing factors were the addition of beef tendon (X1), the addition of codiran gum (X2) and the addition of salt (X3), and the response values were cooking loss rate (Y1) and centrifugal loss rate (Y2).The Box-Behnken in Design-Expert 13 was used to design the response surface experiment, and the factor levels are shown in Table 2-3.

Table 2-3. Response surface analysis, test factor coding and level table

factor	Encoded values		
	-1	0	1
AOx tendon addition/%	15	20	25
BThe amount of codlan glue added/g	1.5	2	2.5
CSalt addition/%	1	1.5	2

2.5.3. Method for measuring water retention

2.5.3.1 Determination of cooking loss rate

The mass of the meatloaf is weighed before and after cooking, and the cooking loss rate is calculated according to equation (1)[16].

$$Cooking\ loss\ rate(\%) = \frac{m1-m2}{m1} \times 100 \qquad (1)$$

During the ceremony: m1——The quality of the patty before steaming, g

m2——The quality of the meatloaf after steaming, g

2.5.3.2 Determination of centrifugal loss rate

Accurately weigh about 3 g of the sample, denote it as w1, wrap the sample in dry filter paper and put it into a 20 mL centrifuge tube, centrifuge at 3000×g for 15 min, remove the filter paper immediately, then weigh it as w2, and calculate the centrifugal loss rate according to the formula[17]:

$$Centrifugal\ loss\ rate(\%) = \frac{w1-w2}{w1} \times 100 \qquad (2)$$

3. Results & Analysis

3.1. Analysis of single factor test results of preparation process of marinated beef hoof tendons

3.1.1. Determination of the marinating temperature

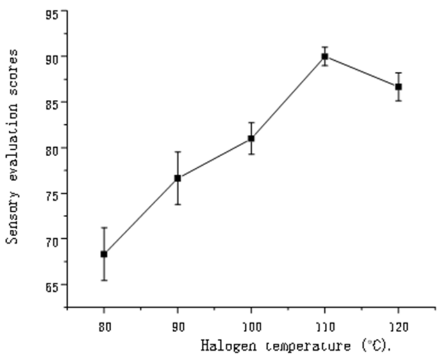

Figure 3-1. Effect of halogen temperature on sensory scores

As can be seen from Figure 3-1, when the marinating temperature is 110°C, the sensory evaluation is the highest, which is 91.9, which is significantly higher than the other values. Select this brine temperature for the following tests.

3.1.2. Determination of the marinating time

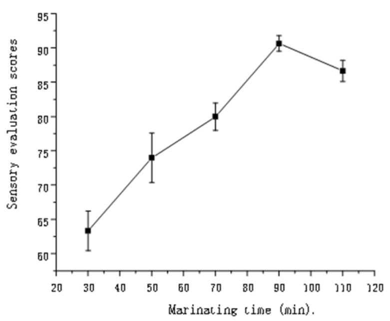

Figure 3-2. Effect of marinating time on sensory scores

As can be seen from Figure 3-2, when the marinating temperature remains unchanged, the sensory evaluation value first increases and then decreases with the gradual increase of the marinating time. At the marinating time of 90 min, the sensory evaluation value reached the maximum. Through the analysis, it was found that there was an optimal value for the effect of increasing the marinating time on the sensory evaluation, that is, at 90 min, the sensory evaluation of beef hoof tendon was the highest. The marinating time was better between 80 min and 100 min, and the tissue of the cow hoof tendon was moderately soft, and the taste and chewiness were better. The brine time was selected to be 90 min for the following tests.

3.1.3. Determination of the simmering time

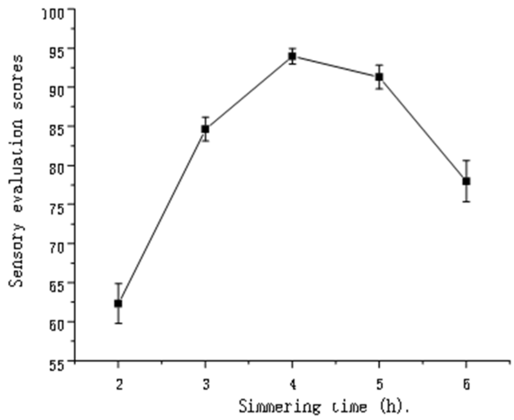

Figure 3-3. Effect of simmering time on sensory scores

As can be seen from Figure 3, the sensory evaluation first increased and then decreased with the increase of simmering time. When the simmering time was 4 h, the sensory score of beef tendon was the highest, and the simmering time was better between 3 h and 5 h. At this time, the tissue of the cow's hoof tendon is soft and moderate, and the taste and chewiness are good, if the simmering time is increased, the chewiness of the cow's hoof tendon will be too soft.

3.2. Orthogonal experimental results of marinated beef hoof tendons

Based on the results of the single variate test, the orthogonal test was performed on the corresponding range of the three single factors, and the results and range analysis are shown in Table 3-4.

The orthogonal test results in Table 1 show that the order of action of each factor is C> A> B. The relationship between the level values of each factor is as follows: A3 > A2 > A1;B2 > B3 > B1;C3 > C2 > C1, the optimal combination is A3B2C3 based on the k-value and the intuitive comparison. The order of influence of each factor on the braised beef tendon can be evaluated, and the stewing time is the most important one on the braised beef tendon, while the braised temperature and simmering time decrease in order.Therefore, it can be concluded that the optimal preparation process of braised beef hoof tendon is as follows: the marinating temperature is 120°C, the marinating time is 90 min, and the simmering time is 5 h,Based on this preparation process, a validation test was carried out again, and a sensory score of 84.5 was achieved under this preparation process.

Table 3-4. Orthogonal experimental results

Test number	factor			Sensory scores
	A control temperature/(°C)	B Halogen time/(min)	C Simmering time/(min)	
1	1	1	1	73
2	1	2	2	81.6
3	1	3	3	81.3
4	2	1	2	80.4
5	2	2	3	84.8
6	2	3	1	80.9
7	3	1	3	84.1
8	3	2	1	82
9	3	3	2	83.9
K1	235.9	237.5	235.9	
K2	246.1	248.4	245.9	
K3	250	246.1	250.2	
k1	78.633	79.167	78.633	
k2	82.333	82.800	81.967	
k3	83.333	82.033	83.400	
R	4.700	3.633	4.767	

3.3. The results of a single factor experiment on the water retention capacity of hoof tendon beef patty

3.3.1. Determination of the amount of beef tendon added

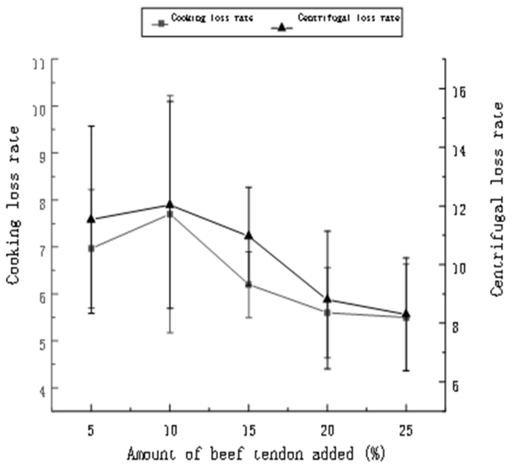

Figure 3-5. Effect of beef tendon addition on water retention of beef tendon beef patty

From the picture, it can be concluded that the addition of beef tendons in beef patties is relatively good when the amount of beef tendons is 20%, and the water retention of beef tendons is relatively better when 25% beef tendons are added than when 20% beef tendons are added. However, the price of beef tendons is relatively expensive, and considering the economy, adding 20% beef tendons to beef patties is the most modest.

3.3.2. Determination of the amount of gum added

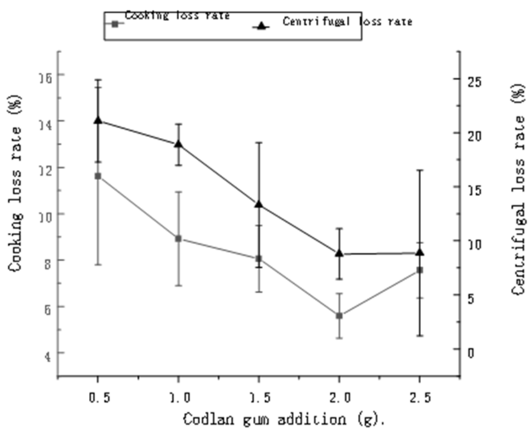

Figure 3-6. Effect of the amount of cordian gum on the water retention of beef patty

It can be seen from Figure 2 that when the addition amount of codlan gum is between 0.5 g and 2.0 g, the cooking loss rate of hoof tendon beef patty further decreases, and the centrifugal loss rate shows a decreasing trend. When the addition amount of codlan gum was between 2.0 g and 2.5 g, the cooking loss rate increased slowly, and the centrifugal loss rate showed an upward trend. At 2.0 g, the lowest cooking loss rate of 5.6% and the lowest centrifugal loss rate of 8.8% were achieved. Overall, the addition of 2.0 g of Coderan gum had a better water retention effect.

3.3.3. Determination of the amount of salt added

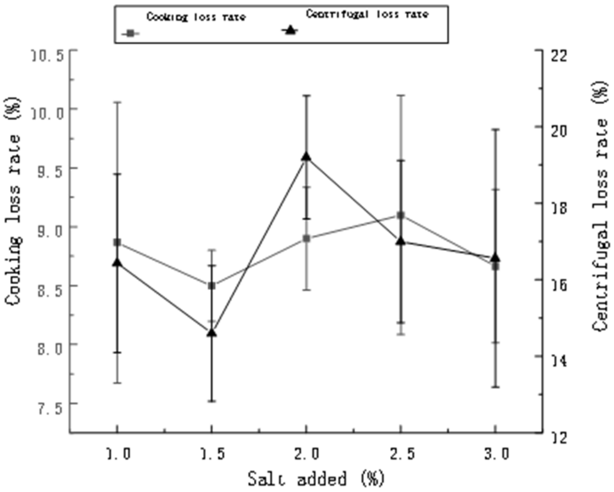

Figure 3-7. Effect of salt addition on the water retention of beef patties with hoof tendons

It can be seen from Figure 3 that when the amount of salt is between 1% and 1.5%, the cooking loss rate of hoof tendon beef patty further decreases, and the centrifugal loss rate shows a downward trend.When the amount of salt added was between 1.5% and 2%, the cooking loss rate increased, and the centrifugal loss rate showed an upward trend. The highest centrifugal loss was achieved at 2% salt and 2.5% at 2.5%. Therefore, under certain conditions, the amount of salt is 1.5%, and the water retention is better.

3.4. Optimization of the water retention of the hoof tendon beef patty

3.4.1. Results of response surface test of hoof tendon beef patty

Based on the results of the single factor test, the design-Expert 13 software was used to carry out the compound test on three additives: the addition of cow tendon, the addition of cadrel gum and the addition of salt[18],Based on the cooking loss rate and centrifugal loss rate, the Box-Behnken design combination was used to optimize the water retention of the hoof tendon beef patty. The experimental design scheme and data results are shown in Table 3-8, and the data in Table 3-8 were analyzed for variance, and the results are shown in Table 3-9 and Table 3-10.

Table 3-8. Box-Behnken trial design and results

Standard serial number	Experiment serial number	A Ox tendon addition/%	B Codlan gum addition amount/g	C salt addition amount/%.	Cooking loss rate/%.	Centrifugal loss rate/%
1	3	15	1.5	1.5	10	16.2
2	12	25	1.5	1.5	9.8	15.2
3	8	15	2.5	1.5	8.4	16.1
4	11	25	2.5	1.5	7.8	11.7
5	2	15	2	1	9.2	13.3
6	16	25	2	1	8.9	11
7	5	15	2	2	9.7	13.9
8	10	25	2	2	8	12.4
9	4	20	1.5	1	9.4	14.3
10	15	20	2.5	1	7.8	12.1
11	14	20	1.5	2	9.7	14.6
12	7	20	2.5	2	7	12.7
13	9	20	2	1.5	6.2	10.3
14	17	20	2	1.5	6	10.5
15	6	20	2	1.5	5.9	11.1
16	1	20	2	1.5	6.1	10.3
17	13	20	2	1.5	6.5	10

According to the test data in Table 7, the multiple regression equation was fitted, and the fitting formula for the addition of beef tendon (A), the addition of cadran gum (B) and the addition of salt (C) with the cooking loss rate was as follows: $Y1=6.14-0.3500A-0.9875B-0.1125C-0.1000AB-0.3500AC-0.2750BC+1.67A^2+1.19B^2+1.14C^2$.

According to the test data in Table 7, the multiple regression equation was fitted, and the centrifugal loss rate was used to fit the amount of beef tendon (A), the amount of cadran gum (B) and the amount of salt (C) as follows: $Y2=10.44-1.15A-0.9625B+0.3625C-0.8500AB+0.2000AC+0.0750BC+1.79A^2+2.57B^2+0.4175C^2$.

Table 3-9. Response surface test results and analysis of variance

Source of variance	Sum of squares	degree of freedom	mean square	F-number	P-value	Distinctiveness
model	35.52	9	3.95	60.78	<0.0001	**
A	0.9800	1	0.9800	15.09	0.0060	**
B	7.80	1	7.80	120.15	<0.0001	**
C	0.1013	1	0.1013	1.56	0.2519	
AB	0.0400	1	0.0400	0.6161	0.4583	
AC	0.4900	1	0.4900	7.55	0.0286	*
BC	0.3025	1	0.3025	4.66	0.0678	
A2	11.71	1	11.71	180.32	<0.0001	**
B2	5.99	1	5.99	92.22	<0.0001	**
C2	5.50	1	5.50	84.65	<0.0001	**
Residuals	0.4545	7	0.0649			
Out-of-the-way items	0.2425	3	0.0808	1.53	0.3376	
Pure error	0.2120	4	0.0530			
sum	35.97	16				
$R^2=0.9874$	$R^2Adj=0.9711$	$R^2Pred=0.8829$				
Adeq precision	20.9665					

Note: "*" indicates significant impact (P<0.05) and "**" indicates extremely significant impact (P<0.01).

As can be seen from Table 7-1, in the case of model F=60.78, p<0.0001 indicates that the model is highly significant. When the coefficient of determination $R^2=0.9874$ and the correction coefficient $R^2Adj=0.9711$, this indicates that there is a good agreement between the measured and predicted values of the cooking loss rate, indicating that the regression equation can correctly analyze and predict the cooking loss rate.In this model, the primary terms A, B and the secondary terms A^2, B^2 and C^2 all reached extremely significant levels, and the secondary term AC also showed a significant effect, indicating that the addition amount of beef tendon and the addition of cadre gum had a significant effect on the cooking loss rate of beef tendon beef patty. The F-values of the three factors were 15.09, 120.15 and 1.56, respectively, indicating that the influence of the three factors on the cooking loss rate was B>A>C. The secondary items A^2, B^2 and C^2 had extremely significant effects on the cooking loss rate (P<0.01).

Table 3-10. Response surface test results and analysis of variance

Source of variance	Sum of squares	degree of freedom	mean square	F-number	P-value	Distinctiveness
model	67.40	9	7.49	44.64	<0.0001	**
A	10.58	1	10.58	63.06	<0.0001	**
B	7.41	1	7.41	44.17	0.0003	**
C	1.05	1	1.05	6.27	0.0408	*
AB	2.89	1	2.89	17.22	0.0043	**
AC	0.1600	1	0.1600	0.9536	0.3613	
BC	0.0225	1	0.0225	0.1341	0.7250	
A^2	13.53	1	13.53	80.63	<0.0001	**
B^2	27.76	1	27.76	165.43	<0.0001	**
C^2	0.7339	1	0.7339	4.37	0.0748	
Residuals	1.17	7	0.1678			
Out-of-the-way items	0.5025	3	0.1675	0.9970	0.4800	
Pure error	0.6720	4	0.1680			
sum	68.58	16				
$R^2=0.9829$	$R^2Adj=0.9609$	$R^2Pred=0.8674$				
Adeq precision	17.8968					

Note: "*" indicates significant impact (P<0.05) and "**" indicates extremely significant impact (P<0.01).

As can be seen from Table 3-10, in the case of model F=44.64, p<0.001 indicates that the model is highly significant. When the misfit term F=0.9970, p=0.4800>0.05, it means that the model is not significant. When the coefficient of determination R^2=0.9829 and the correction coefficient R^2Adj=0.9609, this indicates that there is a good agreement between the measured and predicted values of the centrifugal loss rate, indicating that the obtained regression equation can correctly analyze and predict the centrifugal loss rate. In this model, the primary terms A, B and the secondary terms AB, A^2 and B^2 all reached extremely significant levels, and the primary term C also showed significant results, indicating that the amount of beef tendon addition, the amount of cadran gum and the amount of salt added in the experiment had a significant effect on the centrifugal loss rate of the beef patty. The F-values of the three factors were 63.06, 44.17 and 6.27, respectively, indicating that the influence of the three factors on the cooking loss rate was B>A>C. Among them, the addition amount of Kederan gum had the greatest effect on the cooking loss rate of beef tendon patty, followed by the addition of beef tendon, and the least effect was the amount of salt. The analysis of variance showed that the interaction term AB had a very significant effect on the response surface, while AC and BC had no significant effect, which indicated that there was an interaction effect between factors A and B, but there was no interaction effect between factors A and C, B and C. The results showed that there was a synergistic effect between the addition of beef tendon and the addition of cadran gum on the beef patty, but there was no synergistic effect between the addition of beef tendon and the amount of salt, and the addition of cadano gum and the amount of salt.

3.4.2. Analysis and optimization of response surface diagram of hoof tendon beef patty

In order to study the effects of various interaction conditions on the cooking loss rate and centrifugal loss rate of hoof tendon beef patty, the regression equation was calculated by Design-Expert13 software.Figures 3-1 to 3-6 show the 3D response surface and contour plots of the interaction conditions to better illustrate the effect of each variable on the response value. The design-expert13 program was used to optimize the regression equation to determine the optimal dosage of the three stabilizers to achieve the highest stability coefficient and the lowest centrifugal sedimentation rate: 21.152% beef tendon addition, 2.153 g cadrel glue addition and 1.498% salt addition. Under these conditions, the cooking loss rate and centrifugal loss rate of hoof tendon beef patty were predicted, which were 5.951% and 10.155%, respectively.

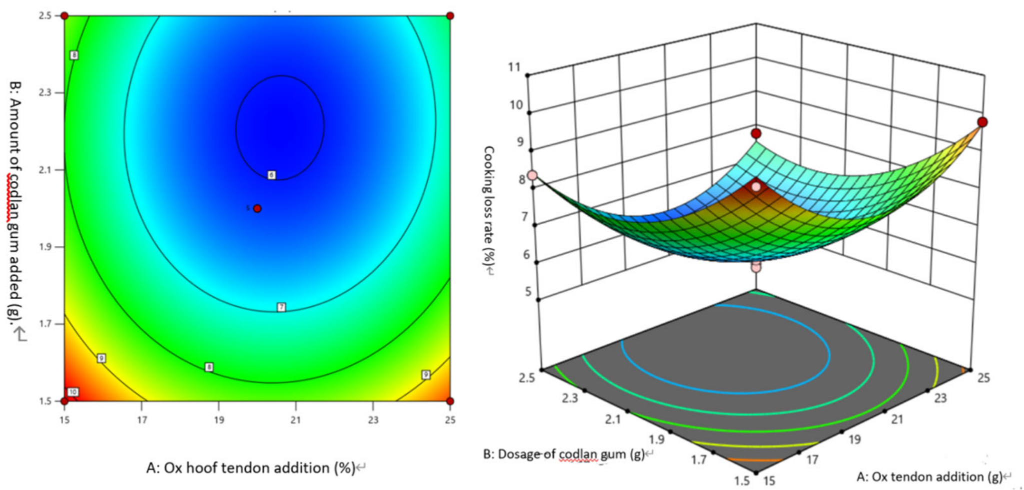

Figure 3-1. Contour plot and response surface diagram of the amount of cow tendon and the amount of cadran gum added to the cooking loss rate

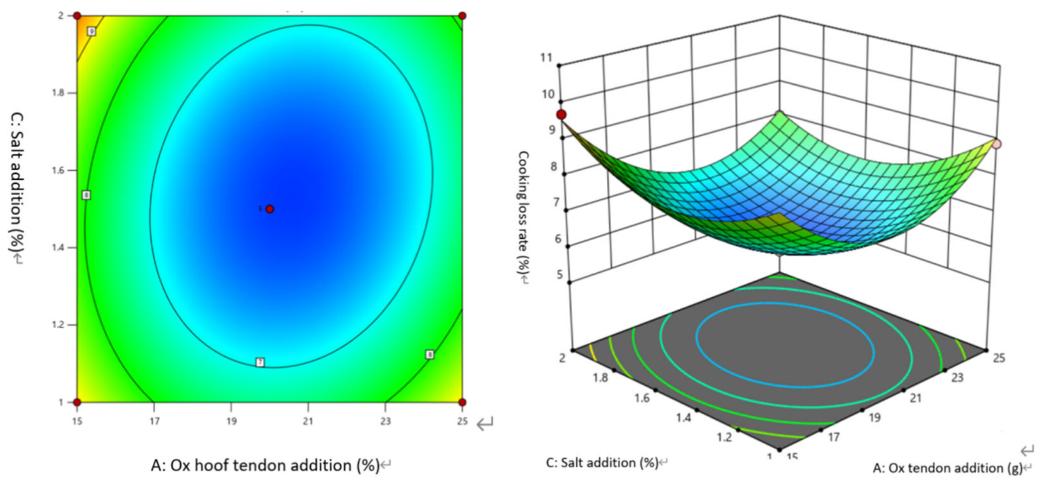

Figure 3-2. Contour plot and response surface diagram of the amount of beef tendon and salt added to the cooking loss rate

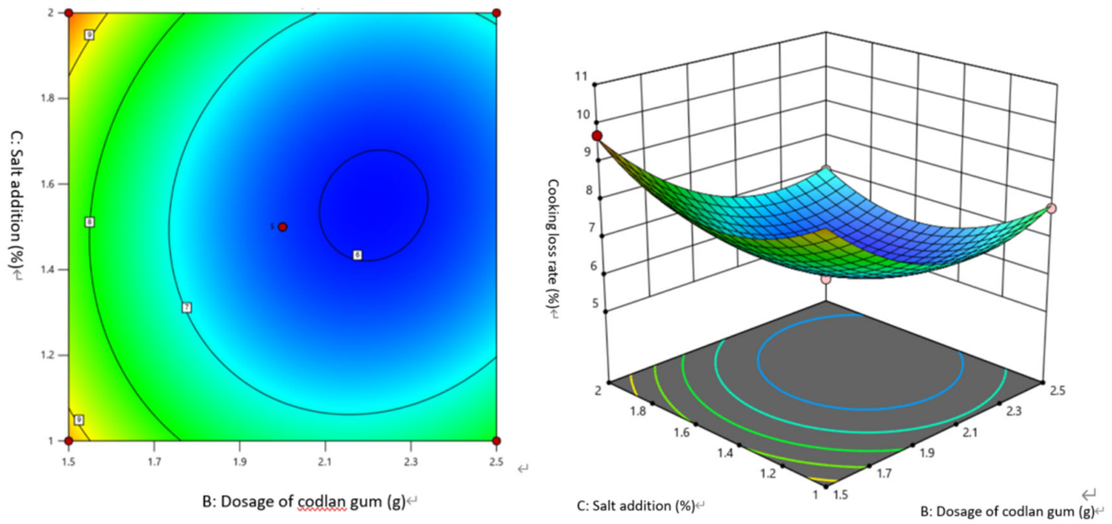

Figure 3-3. Contour plot and response surface diagram of the amount of codlan glue added and salt added to the cooking loss rate

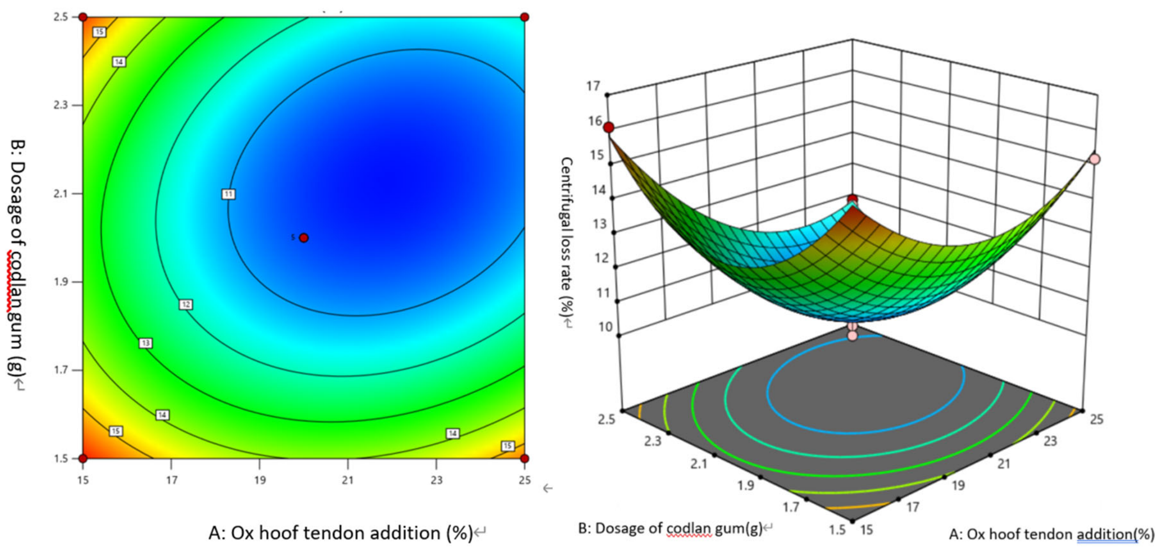

Figure 3-4. Contour plot and response surface diagram of the amount of cow hoof tendon and the amount of cordian gum added to the centrifugal loss rate

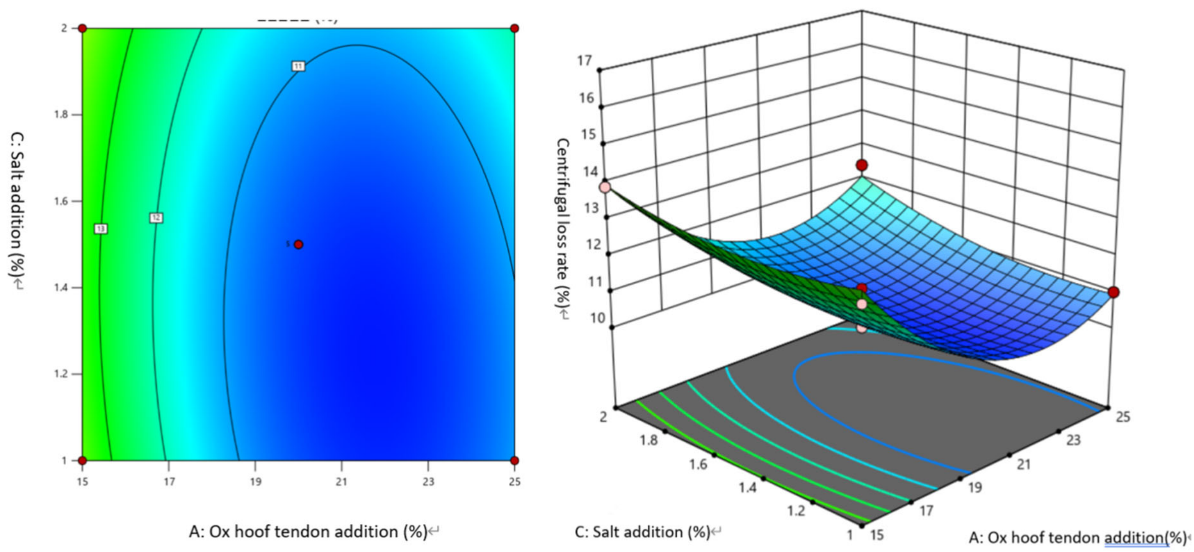

Figure 3-5. Contour plot and response surface plot of the amount of tendon addition and salt addition on the centrifugal loss rate

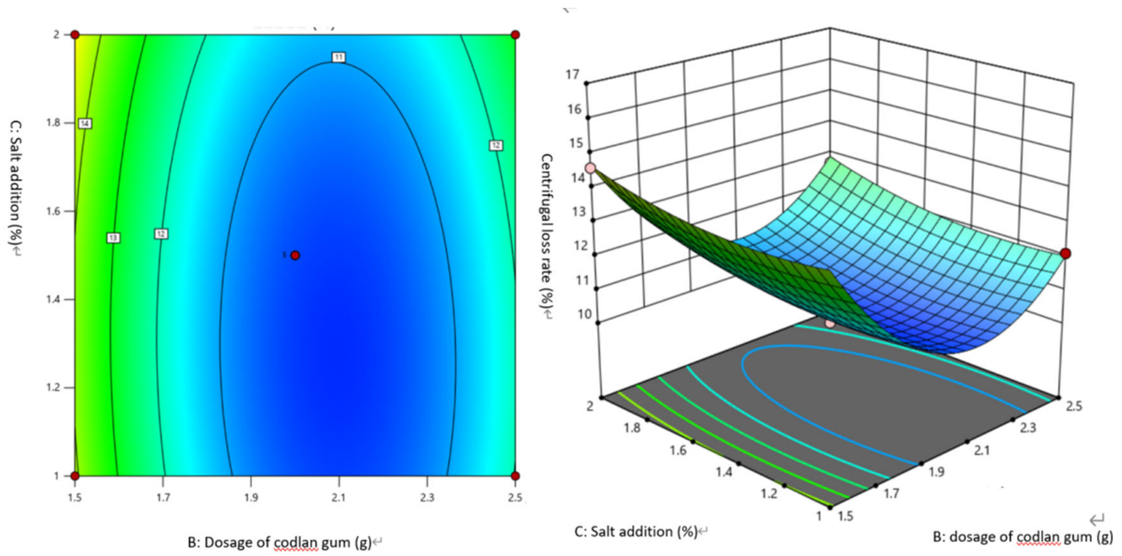

Figure 3-6. Contour plot and response surface plot of the amount of glue added and salt added to the centrifugal loss rate

3.4.3. Validate the experiment

The parameters were optimized and analyzed by using the response surface software[19], The optimal addition amount of water retention was 21.153% for cow tendon and 2.154 g for cadran gum The salt addition was 1.498%, and the cooking loss rate of hoof tendon beef patty was 5.951%, and the centrifugal loss rate was 10.155%. In order to test the reliability of the proposed method, the above optimization conditions were verified. After the three sets of parallel experiments, the average cooking loss rate of the obtained product samples was 6.291%, and the average centrifugal loss rate was 8.314%. This illustrates the accuracy and reliability of this model, as well as the feasibility of this model in practical applications.

4. Conclusion

In this project, beef and beef tendons are used as raw materials, and beef tendons are marinated and cut into pieces for later use, and beef is treated with fascia, diced, and ground for later use. In this experiment, the effects of marinating temperature, marinating time and simmering time on the sensory evaluation of marinated beef tendon were investigated by single factor experiment, and the optimal water retention of the addition on the beef tendon was determined by response surface optimization experiment, and the optimal parameters for making the beef tendon were finally determined.

Through the single factor test, the optimal conditions for the preparation process of marinated beef tendons were as follows: the marinating temperature was 120 °C, the marinating time was 90 min, and the simmering time was 5 h, and the sensory score of the prepared marinated beef tendons reached 84.5. Through the response surface optimization test, the optimal addition amount of water retention of hoof tendon beef patty was as follows:The addition amount of beef hoof tendon was 21.153%, and the addition amount of Kederan gum was 2154g, the salt addition is 1.498%, and the prepared product has the highest water retention, that is, the lowest cooking loss rate of 5.951% and the lowest centrifugal loss rate of 10.155%.The repeated test under these conditions showed that the cooking loss rate was 6.291% and the centrifugal loss rate was 8.314%, which was not much different from the theoretical merit predicted by the model. Therefore, the optimization process of this model can provide a reference for the water retention of hoof tendon beef patty.

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