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Research on the Process Optimization and Water Retention of Curdlan Gel Emulsified Sausage

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ABSTRACT

In the production of emulsified sausage, 0.4%, 0.6%, 1%, 1.4% and 1.6% can be added to the curdlan gel No. 1 and No. 2, respectivelyIn order to improve the water retention of beef emulsified sausage, the effect of different amounts of curdlan gel on the cooking loss of beef emulsified sausage was explored. Curdlan gum is a class of gel polysaccharides produced by microorganisms, which can improve the water retention and firmness of products at a relatively low cost. It is widely used in the food industry and can greatly improve the taste, appearance and texture of products. In this experiment, curdlan gel was added to emulsified beef sausages, and the effects of curdlan gel on the water retention of emulsified beef sausages were studied by the indicators of cooking loss rate and centrifugal loss rate, and the process was optimized by single factor experiment and orthogonal test. The experimental results showed that the optimal process for preparing emulsified sausage was as follows: marinating time 120 min, chopping and mixing water 10%, and cooking time 45 min. The best sensory score of 86.7 was obtained for the preparation of emulsified sausage by this process. The addition of curdlan gel 1 and 2 could significantly reduce the cooking loss of beef emulsified sausage ($P<0.05$) and improve the water retention of emulsified sausage. The lowest cooking loss rate of 15.5% and 6.53% were found to be 15.5% and 6.53% respectively when 1.4% was added, and the lowest cooking loss rate was 13.82% and 3.7% for 1.4% and 3.7% respectively. The optimal addition amount of 2 is 1.4%, and according to the comparative analysis of curdlan gel No. 1 and No. 2, the water retention of curdlan gel No. 2 is higher than that of curdlan gel No. 1, which provides a certain reference for enterprises to produce beef emulsified sausage.

KEYWORDS

Emulsified sausage, curdlan gel, orthogonal test, water retention, difference analysis.

1. INTRODUCTION

With the development of the food industry, emulsified sausage has gradually become a food that people often eat, and beef emulsified sausage is delicious and rich in nutritional value, becoming an important source of human nutrition. Due to the moderate protein denaturation during processing, the meat quality is firm and elastic, which can maintain the original nutrients and inherent flavor to the greatest extent[1]. Emulsified sausage is a kind of ready-to-eat food, which uses livestock and poultry meat as raw materials, is processed through chopping, chopping, pickling and other processes, fully fills the raw materials into the casing, and finally enters the process of cooking or roasting to form a class of intestinal products with uniform emulsification. In the production process, how to ensure the quality and taste of emulsified sausage is the focus of the market, so the study of improving the taste

quality of emulsified sausage has also become one of the hot spots of today's research, usually pork and chicken as raw materials, less beef as raw materials, beef is expensive, if the taste quality is not good, it will cause sales to decline, and the cost will also increase, emulsified sausage has good texture characteristics and convenient edibility, such products have a wide variety, won the favor of consumers, but the products are easy to produce oil and water. In order to improve the water and oil retention of products, certain measures need to be taken to deal with this phenomenon.

In recent years, as the main ingredient of food or food quality improver, curdlan gel has attracted the attention of many scholars. For example, Hao Lijing[2]The effects of codelan gum on the quality of emulsified chicken sausages were studied by using the cooking loss rate, freeze-thaw loss rate and sensory score as indicators. Zhao Chunbo[3]According to the results of principal component, correlation and cluster analysis of the texture index of emulsified sausage, a comprehensive evaluation model of the texture of curdlan gel on low-salt emulsified sausage was constructed, and according to the analysis of the model and the results of water retention rate and texture index of emulsified sausage, it was suggested that the amount of KCl substituted salt was 30%, and the amount of Curdlan gel added was 0.3%~0.6%, which could produce emulsified sausage with low sodium salt content and good texture characteristics.Numerous studies have shown that cadrel gum can significantly improve the water retention of meat products. With the increase of the amount of curdlan gel, the cooking loss rate and centrifugal loss rate of emulsified sausage decreased significantly ($P<0.05$), which was due to the fact that curdlan gel could bind the water in the emulsified sausage, thereby effectively reducing the water loss of minced meat during the cooking process. By Hu et al[4]Studies have shown that during the heating process of minced meat, Curdlan gel can absorb a large amount of water in the form of a high-level gel, and the molecules of Curdlan gel can be filled into the pores of the protein matrix, which can form a denser uniform network structure through hydrogen bonding[5], resulting in high water holding capacity. Jiang Shuai[6]The effects of different dosages of cadrel gum on Frankfurter sausages were studied, and it was found that the cooking loss rate of sausages decreased significantly with the increase of the addition amount ($P<0.05$).

Curdlan gel is a kind of gel polysaccharide produced by microorganisms, and its suspension can form both thermoirable and reversible gels after heating, which can improve the water retention and firmness of the product[4]. It is widely used as a gelling agent and thickener in food[8]. However, Curdlan gel is mostly used in surimi and other products, and less in low-temperature meat products[111312].

At present, there is no specific amount of curdelan gel for the best water retention of beef emulsified sausage. The use of curdlan gel to make emulsified sausages can make the free water in the meat play a good binding role, promote the water-holding capacity of emulsified sausage meat, and the appropriate amount of adding curdlan gel can greatly improve the taste, appearance and texture of the product, so as to increase sales volume and reduce production costs as much as possible, the use of curdlan gel is an important development way to improve product quality and expand emulsified sausage consumption, which has a certain reference value for the production of emulsified sausage, and has certain guiding significance for the improvement of the quality of emulsified sausage. In this study, beef emulsified sausage was used as the carrier to add curdlan gel to emulsified sausage, and the effects of different dosages of curdlan gel on the cooking loss rate and centrifugal loss rate of emulsified sausage were studied, and the optimal addition amount of curdlan gel produced by emulsified sausage was determined, which provided an important theoretical basis for the application of emulsified sausage in meat products.

2. MATERIALS AND METHODS

2.1. Test materials

Fresh tendon and skinless beef tendon meat, beef casing, salt, sugar, light soy sauce, soy sauce, vinegar, white pepper, cooking wine, are all sold in the market;

2.2. Experimental instruments

Table 1. . Main instruments and equipment

Instrument	Model	Factory
Mincer	SY6A	Guangdong Zhongshan Letgoo Liguo Company
Centrifugal machine	SR-800	Changzhou Surui Instrument Co,ltd
Electronic balance	AL-104	Mettler-Toledo Instrument Co,ltd
Steamer	WS-z50	Venus factory
Refriger ator	BCD-471WDCDX	Haier GROUP
Small manual enema machine	No have	No have

2.3. Methods

2.3.1. Emulsified sausage production process

Raw meat pretreatment→ marinating→ chopping→ filling→ piercing eyes→ baking→ cooling→ finished → cooling

2.3.2. Operational points

(1) Raw material pretreatment: select fresh beef tendon meat, then remove dirt and tendons, and cut it into diced meat for marinating.

(2) Pickling: Put in an appropriate amount of auxiliary materials and mix well, and marinate according to the appropriate time to make it more flavorful.

(3) Chopping and mixing: Put the marinated meat into the chopper for chopping and mixing until the meat is slurry and add an appropriate amount of ice water. The addition of ice water is to prevent the protein denaturation caused by excessive temperature during the chopping process, and the addition of ice water can not only absorb heat, but also make the fluidity of the emulsion better, which is conducive to the filling stage.

(4) Filling: Put the stirred filling into the enema machine, put the casing on the filling nozzle of the enema machine, tie the knot every 15cm or so, and the elasticity is moderate.

(5) Piercing the eyes: The emulsified intestine that has been filled with a small needle must be punctured and deflated.

(6) Steaming: Put it in a cooking pot for about 40min. When the surface of the casing is dry, the color of the partial sunken shall prevail.

(7) Cooling: After the enema is steamed, it is cooled to obtain the finished product.

2.4. One-factor experimental design

2.4.1. Effect of curing time on the quality of emulsified sausage

The effects of 30min, 60min, 90min, 120min and 150min on the quality of the finished product were investigated.

2.4.2. Effect of chopping and adding water on the quality of emulsified sausage

The curing time was fixed for 90 min and the cooking time was 40 min, and the effects of the amount of water added to the chopping and mixing were 6%, 8%, 10%, 12% and 14% on the finished emulsified sausage.

2.4.3. Effect of cooking time on the quality of emulsified sausage

The fixed marinating time was 90 min and the amount of chopping and mixing water was 10%, and the effects of cooking time of 30 min, 35 min, 40 min, 45 min and 50 min on the quality of emulsified sausage were investigated.

2.4.4. Orthogonal test of emulsified sausage process optimization

On the basis of the single factor test, the sensory score and water retention capacity were used as the evaluation indexes, and the three factors of pickling time (A), chopping and mixing water addition (B) and cooking time (C) were selected to carry out the three-factor and three-level orthogonal test, and the orthogonal test is shown in Table 2.

Table 2. Levels of orthogonal test factors

Level	Pickling time (min)	Cut and mix with water (%)	Cooking time (min)
1	60	8	35
2	90	10	40
3	120	12	45

2.4.5. Sensory evaluation methods for emulsified intestines

Taking the sensory score as the criterion for determining the best process of emulsified sausage, the emulsified sausage cooked under different process conditions was stripped of the casing, cut into squares and placed in the tray, and 8 sensory evaluators were selected to blindly evaluate the color, fragrance, delicate tissue structure, elasticity and overall acceptance and taste of emulsified sausage[14]6 aspects of evaluation and scoring, each group needs to rinse the mouth with warm water before the assessment, remove the aftertaste in the mouth, and prohibit contact and communication between the evaluators, all of which need to be independently and objectively evaluated.

2.5. Differential test of water retention of 1 and 2 pairs of emulsified intestines

2.5.1. The selection of the amount of glue added

In this experiment, the water retention effect of emulsified sausage made by adding a certain amount of Curdlan gel is better, and the experiment is carried out by adding the amount of Curdlan gel 1 and the amount of Curdlan gel 2, such as the addition amount of Curdlan gel 1 is 0.4%, 0.6%，1%，1.4%，1.6%, and the addition amount of Curdlan gel 2 is 0.4%, 0.6%，1%，1.4%，1.6%, and the optimal addition amount is selected through the test results.

Table 3. Sensory evaluation criteria for emulsions

sports event	Evaluation criteria	Sensory score
colour	Normal colour, no bad colour	14-20
	Colour is more normal, slightly darker	7-13
	Colour dullness is severe	0-6
Organisational status	Smooth cut, fine texture	14-20
	Smoother cut surface, finer texture	7-13
	Rough cut, rough texture	0-6
flavours	Salty, light, fresh and flavourful	14-20
	Saltier or lighter in flavour	7-13
	Too salty or too light in flavour	0-6
how food feels in the mouth	Easily chewed, no graininess or woodiness	14-20
	Easier to chew, with a slight grainy and woody feel	7-13
	Rough mouthfeel, heavily wooded	0-6
Overall acceptability	ideal	14-20
	preferable	7-13
	Very unsatisfactory.	0-6

2.5.2. Methods for determining water retention

2.5.2.1 Determination of cooking loss rate

According to Abbasi[15]The prepared emulsified sausage was wiped clean, the mass of the emulsified sausage was weighed as m1, placed in the cooking pot at 120 °C for 40min, cooled to room temperature, the surface moisture was wiped dry, and the mass of the emulsified sausage was weighed to m2. The cooking loss is calculated according to the following formula. Parallel measurements were performed 3 times, and the test results were averaged.

$$X(\%)=100$$

During the ceremony:

X——The loss rate of cooking refers to the degree of loss of moisture, soluble substances, and nutrients in food during the cooking process. Unit in%;

M1——the mass of the sample before cooking(g);

M2—— the mass of the sample after cooking(g).

2.5.2.2 Determination of centrifugal loss rate

Refer to Cao [16] and so on, about 3g of emulsified sausage was cut and its mass G1 was accurately weighed, then wrapped in filter paper and placed in a 50ml centrifuge tube for 15 min (3000 r/min). After centrifugation, the mass of the meat sample is weighed and recorded as G2, and the calculation formula is as follows. Parallel measurements were carried out 3 times, and the average test results were taken.

$$W(\%)=00$$

W=Centrifuge loss rate, which refers to the loss of emulsified intestines generated by the operation of a centrifuge, in%;

G1=The mass of the sample before centrifugation(g);

G2= The mass of the sample after centrifugation(g).

2.5.3. Data Processing

Each trial was repeated 3 times, 3 parallels were set, and the data were analyzed for significant differences by SPSS 25 software, which was expressed as mean ± standard deviation, $p<0.05$ indicated that there was a significant difference between the data, and Orgin 2022 software was used for data collation and graphing.

3. RESULTS AND ANALYSIS

3.1. Analysis of single factor results of process optimization of emulsified sausage

3.1.1. Determination of pickling

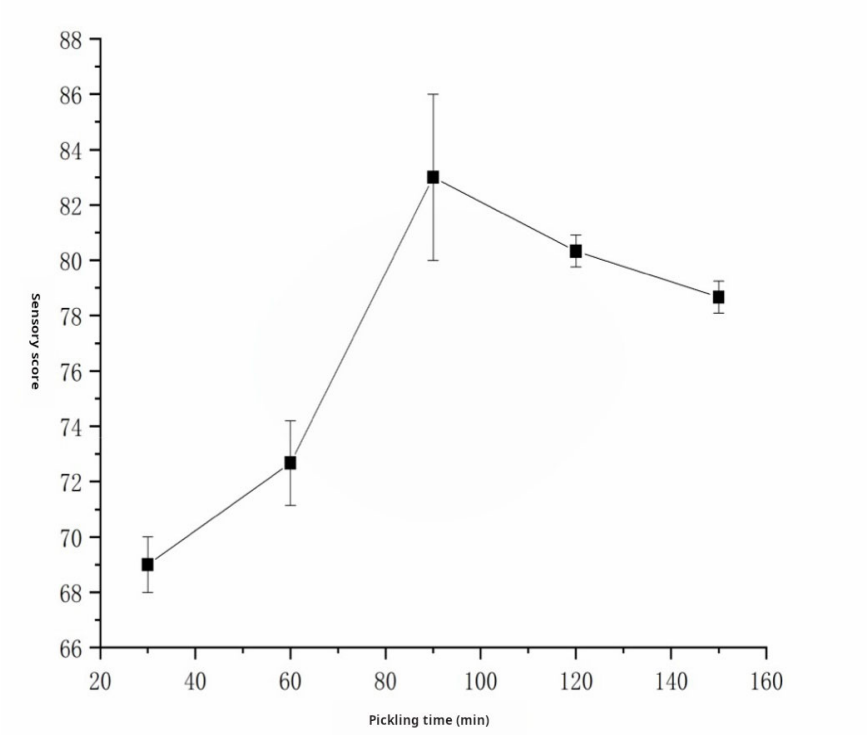

Figure 1. Effect of curing time on sensory scores

As can be seen from Figure 1, the marinating time is an important factor affecting the taste of emulsified sausage, with the increase of curing time, the sensory score of emulsified sausage gradually increases, and then decreases slightly, reaching the highest score at 90min, through the results, it is found that the appropriate marinating time can significantly improve the taste characteristics of emulsified sausage, and the optimal value of 90min is obtained, so that more proteins can be proposed, using this value, the following test is carried out.

It can be seen from Figure 2 that when other conditions remain unchanged, with the increase of the amount of water added to the chopping and mixing, the sensory score of the emulsified sausage first rises and then decreases, and the highest score appears at 10%, and it is found through analysis that when there is sufficient water in the filling, the freshness of the emulsified sausage can be improved, and the stability of the emulsified sausage can be improved, so as to ensure the taste, and the excessive amount of water leads to the reduction of the acceptability of the emulsified sausage, and the texture of the emulsified sausage becomes worse, and the optimal value of 10% is obtained, and the following test is carried out.

3.1.2. Determination of the amount of chopping and mixing

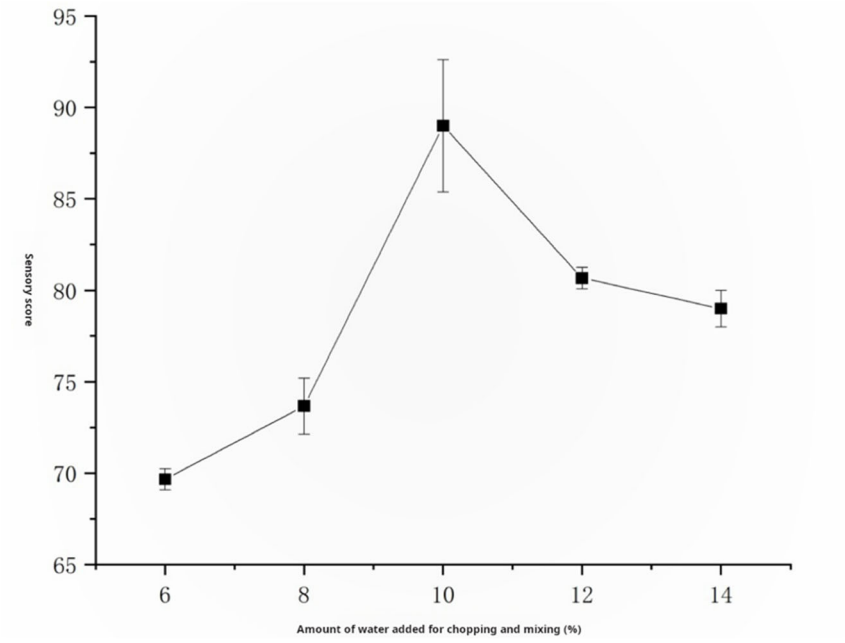

Figure 2. Effect of chopping and adding water on sensory scores

3.1.3. Determination of cooking time

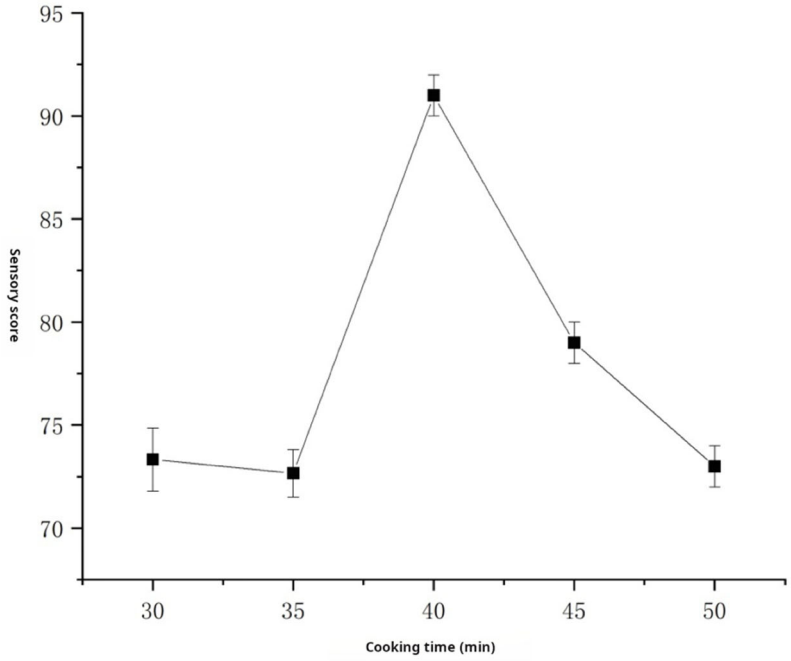

Figure 3. Effect of cooking time on sensory scores of emulsified sausage

It can be seen from Figure 3 that the sensory score of emulsified sausage is significantly increased at 40min, the cooking time can affect the taste and texture of emulsified sausage, the hardness and delicacy of emulsified sausage increase significantly with the extension of cooking time at 30min-40min, and the flavor and taste of emulsified sausage are declining and the sensory quality becomes worse and worse at 40min, and the overall acceptance reaches the maximum at 40min, and the appropriate cooking time can improve the quality characteristics of emulsified sausage, but too long cooking time can lead to the decline of quality, so the optimal value is 40min.

3.2. Process optimization orthogonal test results of emulsified sausage

Table 4. Emulsified intestinal orthogonal test table

Test number	Factor				Sensory rating
	Pickling time (min)	Cut and mix with water (%)	Cooking time (min)	Blank	
1	1	1	1	1	77.9
2	1	2	2	2	80
3	1	3	3	3	81.5
4	2	1	2	3	81.3
5	2	2	3	1	82.3
6	2	3	1	2	81.1
7	3	1	3	2	82.5
8	3	2	1	3	85.5
9	3	3	2	1	81.3
K1	79.8	80.567	81.5	80.5	
K2	81.567	82.6	80.867	81.2	
K3	83.1	81.3	82.1	82.767	
R	3.3	2.033	1.233	2.267	

The sensory results of the orthogonal test in Table 3 show that the order of action of each factor is A>B>C, and the relationship between the level values of each factor is as follows: A3>A2>A1, B2>B3>B1;C3>C1>C2, and the optimal combination is A3B2C3 based on comprehensive K values and intuitive comparative analysis. Through the orthogonal test table, we can see the order of the influence of each factor on the emulsified sausage, among which the curing time has the greatest effect, followed by the amount of water added to the chopping and mixing, and the cooking time. Therefore, it is concluded that the optimal preparation process of emulsified sausage is as follows: marinating time is 120min, chopping and mixing water is 10%, and cooking time is 45min. Based on this preparation process, a validation test was carried out, and a sensory score of 86.7 was achieved under this preparation process.

3.3. Effect of Curdlan gel on emulsified sausage cooking loss rate and centrifugal loss rate

The cooking loss rate and centrifugal loss rate reflect the ability of emulsified sausage to retain water, which is an important indicator to determine the water retention of emulsified sausage. That is, the smaller the cooking loss rate, the better the water retention, as can be seen from the table, the cooking loss rate and centrifugal loss rate did not continue to decline with the increase of Curdlan gel, but showed a trend of first decreasing and then rising, indicating that the more Kederan glue was added, the better the water retention effect, which was similar to Zhang Xin[17]The results of the study on the cooking loss rate of emulsified sausage of low-salt beef were consistent.

3.3.1. Effect of Curdlan gel No. 1 on the water retention of emulsified intestines

It can be seen from Table 4 that the cooking loss rate of Curdlan gel No. 1 with the addition of 0.4% reached 26.23%, and the centrifugal loss rate was 10.2%, with the increase of the amount of Curdlan gel added, the cooking loss rate and centrifugal loss rate gradually decreased, and when the addition amount of Curdlan gel No. 1 was 1.4%, the cooking loss rate and centrifugal loss rate of emulsified sausage reached the lowest, which decreased by 10.73% compared with the addition of 0.4% Curdlan gel At the above time, the cooking loss rate and centrifugal loss rate began to increase. There was no significant difference in the cooking loss rate of emulsified sausage with the addition of 1%~1.6% Curdlan gel No. 1 (P>0.5), and there was a significant difference in the centrifugal loss rate and

cooking loss rate between the addition of 0.4% and 1.6% of Curdlan gel and the addition of 1.6% Curdlan gel (P<). 0.05), improve the water retention of beef emulsified sausage.

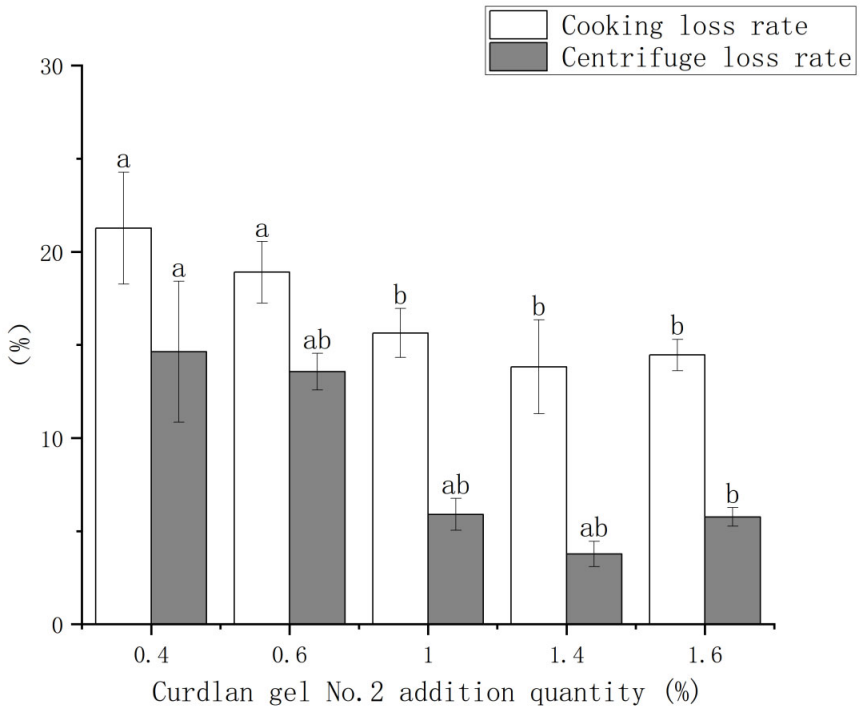

Figure 4. Effect of different dosages of Curdlan gel No. 1 on the water retention of emulsified sausage

Note: Data are presented as mean ± standard deviation (n=3). a~c in the same column of letters, the same means that the difference is not significant p>(0.05), and the absence indicates a significant difference p<(0.05). Same as in Table 5.

3.3.2. Effect of Curdlan gel No. 2 on the water retention of emulsified intestines

It can be seen from Table 5 that there is a significant difference between the addition of 0.4% Curdlan gel No. 2 and the addition of 1.4% and 1.6% Curdlan gel 2 (P<0.05), while the cooking loss rate and centrifugal loss rate of Curdlan gel 2 with 1.4% are the lowest, and there is basically no significant difference in the centrifugal loss rate of 1%~1.6% Curdlan gel 2 (P>0.05), while there is basically no centrifugal loss rate in emulsified sausage when adding 1.4% Curdlan gel No. 2, which is basically unchanged from the addition of 0.4% When the addition amount increased to more than 1.4%, the cooking loss rate and centrifugal loss rate began to increase, but they were lower than the loss rate of 0.4% Curdlan gel 2. This is mainly due to the fact that Curdlan gel can intertwine with myofibrillar protein to form a tight network structure, which can bind more water molecules and play the role of plastic huddle, so as to reduce the loss of juice during the cooking process of beef emulsified sausage. The results showed that the addition of 1.4% Curdlan gelNo. 2 made the emulsified sausage have the best water retention.

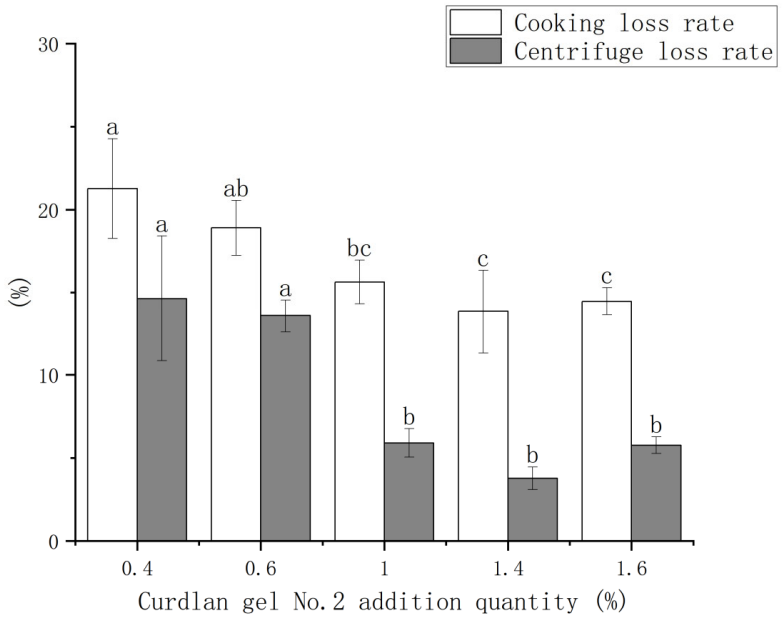

Figure 5. Effect of Different Additives of Curdlan gel No. 2 on the Water Retention of Emulsified Intestines

By comparing Table 6 and Table 7, it was found that the cooking loss rate of Curdlan gel No. 2 was significantly lower than that of Curdlan gelo No. 1 under the same addition amount. When the addition amount of Curdlan gel 2 was 0.4% and 0.6%, the centrifugal loss rate was higher than that of Curdlan gel 1, but the centrifugal loss rate was significantly lower than that of Curdlan gel 1 when the addition amount was 1%-1.6%. It can be seen that the water retention effect of Curdlan gel No. 2 on emulsified intestines is better than that of Curdlan gel No. 1, because the concentration of Curdlan gel No. 1 is too large and it is not easy to maintain stability at high temperature. The addition of Curdlan gel effectively improves the water retention of emulsified sausage, improves the stability of the product, improves the overall quality of emulsified sausage, reduces costs, and is an ideal quality improver.

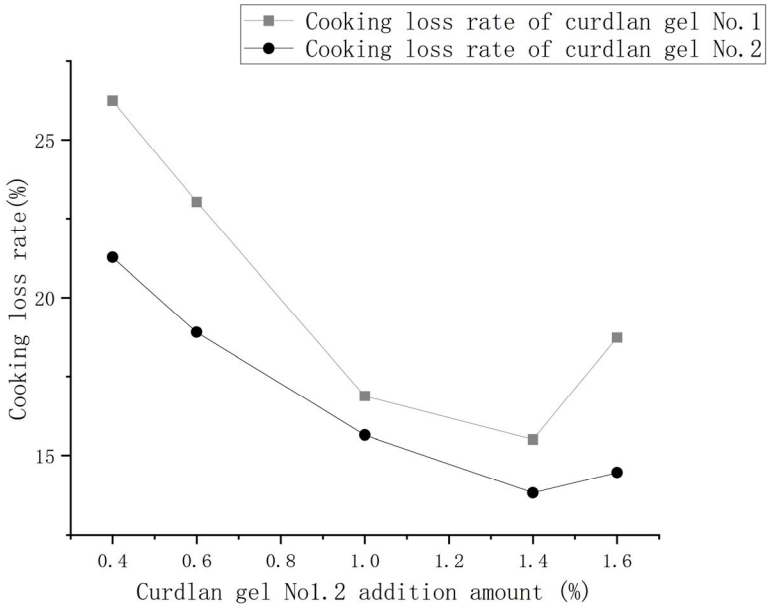

Figure 6. Comparison of cooking loss rates of Curdlan gel No.1 and No.2

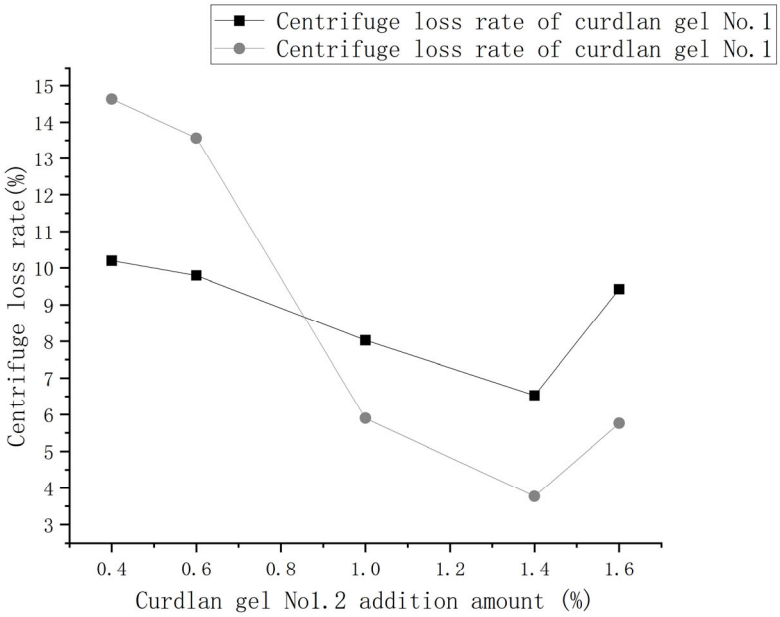

Figure 7. Comparison of centrifugal loss rates of Curdlan gel 1 and 2

4. CONCLUSION

Within the scope of this experiment, the water retention and process optimization of Curdlan gel emulsified sausage were analyzed, and the beef tendon meat was used as the test raw material, and the beef tendon meat was removed, cut and mixed for later use, and the effects of curing time, chopping and mixing water and cooking time on the sensory score of emulsified sausage were analyzed through a single factor experimental study, and the significant difference between the cooking loss rate and centrifugal loss rate of Curdlan gel emulsified sausage was analyzed, and the optimal water retention of emulsified sausage was obtained, and the optimal amount of degran glue was determined when making emulsified sausage.

The optimal conditions for the preparation of emulsified sausage were as follows: marinating time of 120min, chopping and mixing of water of 10%, cooking time of 45min, and the sensory score of emulsified sausage was obtained by preparing emulsified sausage for sensory score of 86.7 points. Through the analysis of significant differences, the optimal addition of water retention of emulsified sausage was 1.4% for Curdlan gel 1 and 1.4% for Curdlan gel 2, and the water retention effect of the prepared products was the best, with the lowest cooking loss rate of 15.5% and the lowest centrifugal loss rate of 6.53%, and the lowest cooking loss rate of 13.82% and the lowest centrifugal loss rate of 3.77% in Curdlan gel 2. In contrast, the water-holding effect of Curdlan gel No. 2 on emulsified intestines is better than that of Curdlan gel No. 1. Proper addition of Curdlan gel can effectively reduce the cooking loss of emulsified sausage, maintain the moisture of the meat itself, reduce water loss under heating conditions, and improve the water retention rate of emulsified sausage. Therefore, the addition of Curdlan gel can significantly improve the product quality and yield of emulsified sausage, and the test results can provide a reference for the water retention of Curdlan gel on emulsified sausage.

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