Cooking Process Optimization of Potatoes in “Braised Beef with Potatoes”

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Abstract: As the world's fourth largest food crop, potato industry had a broad development prospect, but there were few studies on “braised beef with potatoes” dishes. In this paper, cooking process parameters of the dishes were optimized by single factor experiment and L9 (3^4) orthogonal experiment, to obtaining potatoes had a “soft but not rotton” texture. The Sensory evaluation experiment showed that when potatoes were cut into cubes with a diameter of 2cm, soaked in clean water for 15 minutes, and then cooked with pretreated beef in an induction cooker with 1000w power for 15 minutes, the product quality was the best. Among the four cooking parameters, the size of potato piece had the greatest impact, followed by soaking time. These two factors might directly affect the content and gelatinization degree of potato starch, which could significantly improve the visual effect and taste of dishes.

1 INTRODUCTION

Potato (*Solanum tuberosum L.*) is an annual herbaceous plant of the Solanaceae genus Solanum. Its tuber is an important food and vegetable. At the beginning of 2015, the Ministry of Agriculture launched the strategy of potato staple food (Lu, 2015). Potatoes will be more and more widely used in cooking and food industry. Different from the crispy taste of potatoes in fried potato shreds, the potato pieces in potato goulash are generally noodles taste. It is generally believed that potato starch granules are oval in shape. The higher the starch content, the lower the amylose content, the larger the starch granules, the more water absorbed in the cooking process, the cooked potato will have a “soft but not rotton” texture and a “flour” feel, which have good palatability (Huang, 2017). The texture of food are often obtained by means of sensory evaluation and instrumental analysis (Liu, 2016). In the research on frozen potato strips and potato chips (Kong, 2016), it is found that sensory evaluation and instrumental analysis have a good correlation. At present, the production of goulash with potato is still in the empirical stage. With the development of the food industry, it is necessary to make the production process of goulash with potato scientific and standardized.

2 MATERIALS AND METHODS

2.1 Materials and Instruments

Materials: Fresh potatoes including Holland No.15 (produced in Inner Mongolia Autonomous Region), "V7" yellow potatoes (produced in Heilongjiang Province) and “Shapoti” potatoes (Produced in Hebei Province), the above potatoes were purchased from Hankou North Farmers Market. Horqin Beef; Yunhe Salt; Wang Zhihe Cooking Wine; Lee Kum Kee Light Soy Sauce; Huiyi Soy Sauce; Arowana Soybean Oil; the above ingredients were purchased from Wal-Mart.

Experiment instruments: WT2118 Midea uniform-fire induction cooker, Matsunami S3 kitchen electronic scale, Nitori pan from Japan, Standard sensory laboratory.

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2.2 Experiment Methods and Measurement Index

2.2.1 the Cooking Process of Braised Beef with Potatoes

In this experiment, beef was pre-processed into semi-finished products, and finally potatoes were added for co-fired. Cut the beef into standard mahjong pieces and blanch the meat to remove bloody foam. Added ginger and garlic to the oil pan and sauted until fragrant. Added the beef and stir-fried for one to two minutes; then added cooking wine, light soy sauce, dark soy sauce, and salt; finally, poured in water and the amount of water needed to cover the beef. After simmered for 2 hours, the beef was semi-finished product. In the experiment, half-finished beef products were taken, potatoes and water were added, and the amount of water should be more than potatoes. After co-simmering, the goulash with potato were completed. The basic cooking process of semi-finished potato products was as follows: potatoes were cut into cubes with a diameter of 2 cm, soaked in clean water for 15 minutes, and the semi-finished beef is braised on a 1000w induction cooker for 12 minutes.

In the preliminary experiment, we compared different potato varieties including V7, Holland No.15 and Shapoti which matured from October to November and finally selected V7 potato.

2.2.2 Single Factor Experiment of Cooking Process of Potatoes in "Goulash with Potatoes"

The single factor experiment mainly optimized the cooking technology from four aspects: the size of the potato pieces, the time of soaking in water, the firepower of the braising, and the braising time. In the single-factor experiment, only the process of this factor was different from the basic process, and other cooking parameters were the same.

Potato pieces size: potato pieces were divided into hob pieces and cube shapes. In this experiment, the potato raw materials were cut into small hob pieces (1cm*2cm*3cm), large hob pieces (2cm*3cm*4cm), and cubes with diameters of 2cm, 2.5cm, and 3cm respectively.

Soaking time: The potatoes were treated with no soaking, soaking for 15 minutes, 2 hours and 24 hours respectively.

Braising power: In order to obtain a stable firing efficiency, an induction cooker is selected as a cooking tool in this experiment. The maximum power of a common induction cooker is 2100w, which is equivalent to "big fire" of a gas stove. In the experiment, 5 different powers of the induction cooker "600w, 800w, 1000w, 1200w, 1600w" were selected for braising.

Braising time: Under the power of 1000W induction cooker, potatoes and beef semi-finished products were co-fired for 8 minutes, 10 minutes, 12 minutes, 15 minutes, and 18 minutes. Then compared the product quality.

2.2.3 The Orthogonal Experiment of Cooking Process of Potatoes in "Goulash with Potatoes"

On the basis of the single factor experiment, nine groups of orthogonal experiments were carried out with the four factors and the corresponding three levels as shown in Table 1.

Table 1: Orthogonal experiment factors and levels table of "Braised beef with potato".

	A	B	C	D
1	2*2*2	0	1000	12
2	2.5*2.5*2.5	15	1200	15
3	3*3*3	120	1600	18

Note: A Potato pieces size/cm, B Soaking time/min, C Braising power/w, D Braising time/min.

2.2.4 Sensory Evaluation Experiment of Potatoes in "Goulash with Potatoes"

In the experiment, 10 experienced sensory evaluators were selected to evaluate samples from single-factor experimental samples and orthogonal experimental, according to the sensory evaluation standards (Table 2). All the samples were used three-digit random number coding.

Table 2: Sensory evaluation creterion of "Braised potatoes".

	Scale rule	score
Texture (45)	soft but not rotton	31-45
	rotten or not completely cooked	16-30
	mushy or raw and hard	1-15
Taste (20)	mellow and delicious	14-20
	slightly strong or lacking	8-13
	too strong or lacking; discordant	1-7
Appearance (15)	a complete and uniform shape, appropriate amount of sauce, the consistency appropriate	11-15
	relatively complete and consistent, moderate sauce, too thick or too thin	6-10
	scattered, different sizes, too little or too much sauce, too thick or too thin	1-5
Flavour (10)	a strong aroma of potatoes	8-10
	generally fragrant of potatoes, no peculiar smell	4-7
	weak or absent fragrant of potatoes, with some peculiar smell	1-3
Colour (10)	yellow and bright	8-10
	yellowish brown or white, slightly dim	4-7
	dark brown or pale, dull or tarnished	1-3

2.2.5 Experimental Data Statistics

Sensory evaluation score of single factor experiment and orthogonal experiments were calculated based on the average of ten parallel experiments. In the single factor experiment, Excel was used to analyze the mean value and standard deviation of sensory evaluation indexes while the range analysis was performed by orthogonal assistant II V3.4. The model settings do not consider interactions, but examine the main effects of various factors.

3 RESULTS AND ANALYSIS

3.1 Single Factor Experiment of Cooking Process of Potatoes in "Braised Beef with Potatoes"

3.1.1 The Effect of Potato Piece Size on Potatoes Sensory in "Goulash with Potatoes"

In the experiment, the potatoes were cut into cubes with different diameters and hob pieces. The hob is a common knife method in Chinese cooking. Standing knife was used to cut the rolling food materials obliquely into basically the same block. It could be seen from Figure 1 that when the potato was cut into the hob, the sensory score was lower. This might be due to the irregular shape of the hob and uneven heating. In the modern food industry, tuber food was often cut into cubes. Cubes in the heating process conducted heat more evenly, which made product's quality more stable. In this experiment, the total sensory score of potatoes cut into a cube with a diameter of 2.5 cm was significantly better than other size. Of course, the size of the potato slice was closely related to the cooking method and the fire power, which involved with heating transfer and physical and chemical changes of potatoes' starch and other components under the action of heating.

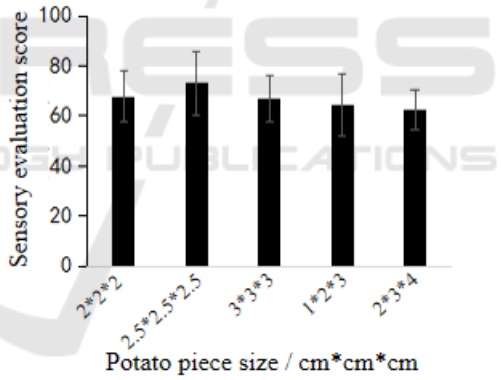

Figure 1: The effect of potato piece size on sensory.

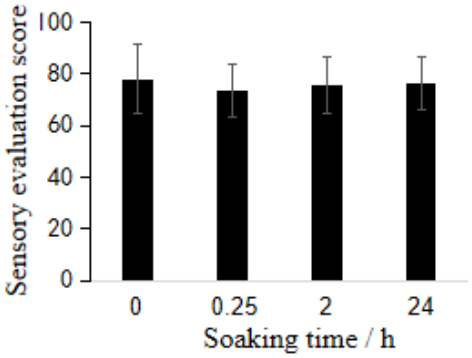

Figure 2: The effect of soaking time on sensory.

3.1.2 The Effect of Soaking Time on Potatoes Sensory in "Goulash with Potatoes"

The phenolic substances in the potatoes were exposed to the air after peeled. It might caused enzymatic browning, which affected the color, flavor and nutrition of the potatoes. In the cooking process, water soaking was usually used to isolate the air and prevent enzymatic browning. However, during the soaking process, the starch and moisture content of potatoes changed, which directly affects the taste of potatoes. It was generally believed that in the process of high temperature cooking, a large number of hydrophilic groups inside starch granules absorbed water and expanded. The larger the granules, the greater the expansion, the higher the bulkiness, and the better the palatability of the finished product (Huang, 2017). From Figure 2, it could be seen that the sensory evaluation score of the potato without soaking was slightly higher. In our early "stir-fired crisp potato shreds" experiment , the key procedure to getting crispy potato shreds might be soaking in water to wash off the surface starch before stir-frying (Li, 2017) while in this experiment potatoes could not be soaked in order to obtain a "soft but not rotton" texture and a "flour" feel. So it was obviously founded that the starch attached to the potato surface during the cutting process and the water content in potatoes had a great influence on the crispy or soft texture of the final dish which was deserved further study.

3.1.3 The Effect of Braising Power on Potatoes Sensory in "Goulash with Potatoes"

Braising is a cooking method that used water and oil as the heat-transfer medium. Generally, when cooking dishes we followed the culinary rule of "firstly boil the soup on a high fire, then slowly cook on a medium heat, finally concentrate the juice on a high fire." There was no precise definition on fire power, mainly relying on empirical judgments such as "hand feel method" and "pot test method". So many mistake were happened in practice, which would decrease the quality of dishes. It was necessary to make the definition of fire power clearly, and standarize the cooking technology. Figure 3 showed that when the fire power was 1600w, the sensory evaluation score of potatoes was the highest, while the sensory score was the lowest at 800w. From 800w to 1600w, with the increase of heating power, the sensory score showed an obvious upward trend. It might be due to the potato starch gelatinization was more complete with the higher heating power. The dish tasted more rich and delicious. It was generally believed that the gelatinization temperature of potato starch was 65-70℃, and amylose content is positively correlated with the gelatinization temperature, the degree of difficulty of gelatinization. Amylopectin content is significantly negatively correlated with the disintegration value (Li, 2021).

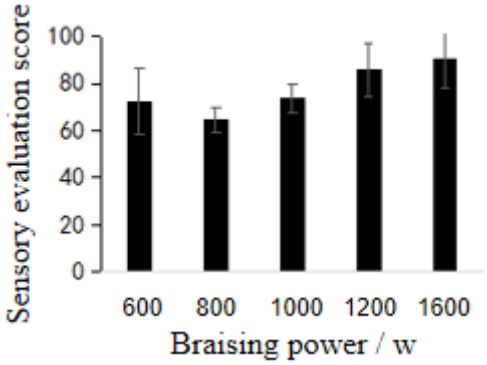

Figure 3: The effect of braising power on sensory.

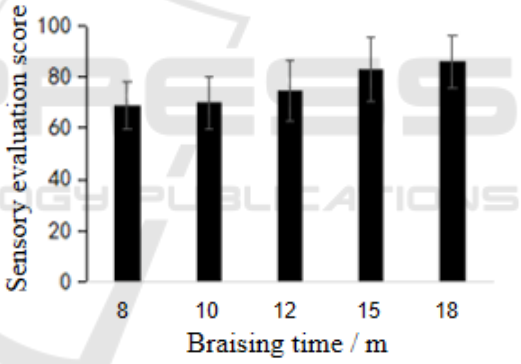

Figure 4: The effect of braising time on sensory.

3.1.4 The Effect of Braising Time on Potatoes Sensory in "Goulash with Potatoes"

When the cooking power of the induction cooker was 1000W, the sensory score of the dish was more and more higher as the cooking time increased from 8 minutes to 18 minutes. At 18 minutes, "goulash with potato" had the best sensory evaluation. In the cooking industry, different materials had different maturity standards ranged from "breaking raw" to "burnt". Taken potatoes which had a higher starch content as an example, we called it "breaking raw" when part of potato starch was gelatinized. If cook them a little more time, most part of starch was gelatinized and potato were loosely structured, then

flavor substances were easy to enter, the dishes had richer taste. If overfired, potatoes were sticky on the surface, and even became a paste. If continued to cook the potatoes, Caramelization reaction and Maillard reaction would occurred. Not only appearance and flavor of the dishes deteriorated, but also the nutrition was decreasd. In addition, salt content also has an effect on the gelatinization of potato starch. With the increase of sodium chloride, the initial pasting temperature and peak temperature of potato starch were increased and retrogradarion phenomenon of starch paste was also increased (Xiong, 2021).

3.2 Orthogonal Experiment of Cooking Process of Potatoes in “Goulash with Potato”

According to the results of the single factor experiment and taking into account the mutual influence of various factors, the four factors including potato block size, soaking time, cooking power and cooking time were selected in the orthogonal experiment. The experimental results were showed in Table 3. When potatoes were cut into cubes with a diameter of 2cm, soaked in clean water for 15 minutes, and then cooked with pretreated beef in an induction cooker with 1000w power for 15 minutes, the product quality was the best. Among them, the size of potato piece had the greatest impact on product quality, followed by soaking time. And the braising power also couldnot be ignored.

Table 3: Orthogonal experiment result of “Braised beef with potato”.

	A	B	C	D	Sensory score
Exp.1	2*2*2	0	1000	12	81.3
Exp.2	2*2*2	15	1200	15	86.9
Exp.3	2*2*2	120	1600	18	85.1
Exp.4	2.5*2.5*2.5	0	1200	18	68.1
Exp.5	2.5*2.5*2.5	15	1600	12	76.7
Exp.6	2.5*2.5*2.5	120	1000	15	78.6
Exp.7	3*3*3	0	1600	15	72.7
Exp.8	3*3*3	15	1000	18	80.1
Exp.9	3*3*3	120	1200	12	74.4
Mean 1	84.8	74.1	80.0	77.5	
Mean 2	74.5	81.2	76.5	79.4	
Mean 3	75.8	79.4	78.2	77.8	
Range	10.3	7.1	3.5	1.9	

During the cooking process of “goulash with potatoes”, potato starch was gelatinized under the action of heating, which led to soft texture of potatoes. The key point of “soft but not rotton” texture was the degree of gelatinization of potato starch. There were many factors affecting the degree of starch gelatinization. In this article, the size of potato block determined the heat condition of potato and directly affected its gelatinization degree under the condition of the heating power was similar. Soaking process determined how much residual starch attached to the potato surface during the cutting process and the water content in potatoes, this also affected starch gelatinization. Of course, potatoes varieties, the content of amylose and amylopectin and the salt added in cooking and processing have a certain impact on the quality of dishes, these problems were worth in-depth study.

4 CONCLUSION

In order to obtain "soft but not rotton" braising potato, sensory evaluation was used in the article. Through single factor and orthogonal experiments, the cooking process parameters were optimized in “braised beef with potato” dishes. When V7 potatoes were selected and cut into cubes with a diameter of 2cm, soaked in clean water for 15 minutes, and then braised with pretreated beef in an induction cooker with 1000w power for 15 minutes, the sensory evaluation of dishes was the best. Among the four

cooking parameters, the size of potato piece had the greatest impact while soaking time were followed. Through different cooking operations, potatoes could not only obtaining a "soft but not rotton" texture, but also a "crispy" taste. The key point was the degree of starch gelatinization. The followed studies should focus on establishing relationships between starch content and microstructure with food texture properties. Only in this way we can have a deep understanding of the cooking process and provide theoretical support for the industrialization of cooking products.

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