Optimization of Jasmine - Cranberry Compound Flavor Low-sugar Biscuits

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Abstract [**Objectives**] This study was conducted to develop a low-sugar functional nutritional biscuit with a composite flavor of jasmine and cranberry. [**Methods**] On the basis of traditional biscuit production techniques, this paper improved the formula by adding jasmine powder, erythritol, and dried cranberries, and used single-factor and orthogonal experiments to develop a low-sugar biscuit. [**Results**] The experiments yielded the optimal formula for low-sugar jasmine - cranberry biscuits: low-gluten flour 120 g, erythritol 50 g, butter 60 g, egg liquid 34 g, jasmine powder 4 g, and dried cranberries 20 g. Verification confirmed that the biscuits prepared based on this optimal formula had excellent comprehensive sensory quality, with an average sensory score of 95.3 points. [**Conclusions**] The low-sugar baked jasmine - cranberry biscuits produced by this process have excellent quality and nutrition, and a unique flavor combining the fresh aroma of jasmine with the sweet-and-sour taste of cranberries, and are suitable for promotion.

Key words Jasmine; Cranberry; Low-sugar; Functional biscuit

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Biscuits have the advantages of being easy to carry and having a long shelf life, and are deeply loved by the public. However, most biscuits have the drawback of high oil and high sugar content. With the enhancement of people's health awareness and the emergence of new "national trend + health" baked products[1-2], people are paying increasing attention to the healthiness of food ingredients, and the market prospects for functional low-sugar and highly-nutritious biscuits are becoming increasingly broad[3-4].

Cranberry (*Vaccinium macrocarpon*) is an evergreen shrub of the genus *Vaccinium* in the family Ericaceae. Cranberry is relatively acidic and has significant positive effects on maintaining health. The natural components contained in cranberry can eliminate harmful *Helicobacter pylori* in the digestive system, and the cranberry fruit also contains antioxidant substances, possessing anti-aging, anticancer, and other effects[5].

Jasmine (*Jasminum* spp.) is an aromatic plant belonging to the genus *Jasminum* of the Oleaceae family. At present, it is mainly used for scenting scented tea and as a raw material for essence. Its effects include regulating digestive function, relieving fatigue, and improving spleen-stomach deficiency-cold[6].

Erythritol is a low-calorie sweetener with a sweetness of only 60% - 70% that of sucrose and an extremely low calorie content of only 0.24 kcal/g. The application of erythritol in low-sugar baked products has become an important development trend, and it can meet the needs of diabetic patients and health-conscious consumers seeking weight loss[7-8]. According to industry reports such as *China Food News*, despite changes in the international trade environment, the innovative application of erythritol in low-sugar baked products remains an important development direction[9].

In this study, jasmine powder was added on the basis of traditional biscuit ingredients to fully utilize the unique flavor and health-promoting components of jasmine. Erythritol was used to replace traditional sucrose to leverage its notable advantages of low calorie content, good sweetness properties, and structural compactness and softness[10]. Dried cranberries were added to enrich the mouthfeel of the biscuits and impart the unique sweet-and-sour flavor of cranberries. The optimal process formulation for low-sugar jasmine - cranberry biscuits was analyzed, so as to provide a theoretical and practical basis for producing new nutritious and low-sugar biscuits.

Materials and Methods

Experimental materials

Materials and reagents Low-gluten flour, Yutai Shizhen Huiying Agricultural Technology Co., Ltd.; erythritol, Anhui Weilai Biotechnology Co., Ltd.; butter, Fonterra Commercial Trading (Shanghai) Company Ltd.; dried cranberries, Longyan Tingran Food Co., Ltd.; jasmine powder, Xinghua Yufeng Food Co., Ltd.; eggs, commercially available.

Equipment and apparatuses Kitchen electronic scale, Yongkang Haoran Weighing Apparatus Co., Ltd.; beakers, Citotest Labware Manufacturing Co., Ltd; stainless steel basins, commercially available; silicone spatula, Zhejiang Supor Co., Ltd.; baking paper, Shanghai Aisibixi Food Co., Ltd.; kitchen knife, Yangjiang Shibazi Group Co., Ltd.; freezer, BC/BD-60W451EU1; food baking oven, KQD5OF-02.

Experimental methods

Biscuit formula and preparation process The basic formula of

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the biscuits was as follows: low-gluten flour 120 g, erythritol 50 g, butter 60 g, dried cranberries 20 g, egg liquid 32 g, and jasmine powder 4 g.

The preparation process is shown in Fig. 1.

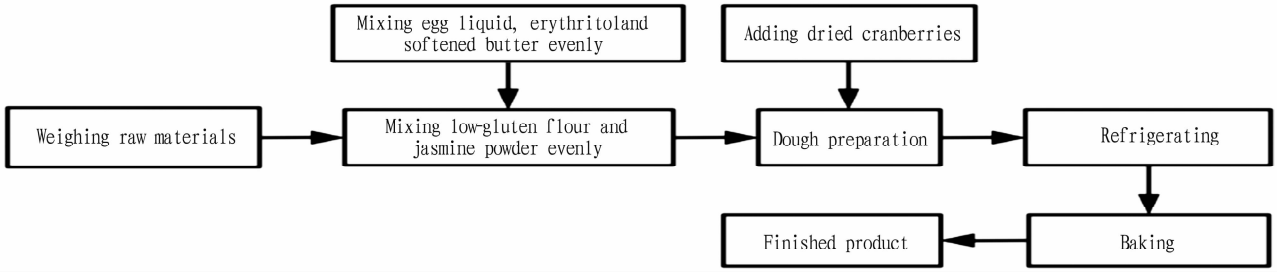

Fig. 1 Preparation process of the biscuits

Operation procedures

(1) Raw material pretreatment. First, 60 g of butter was cut into small pieces and softened at room temperature (25 ± 2) ℃ until it could be easily pressed and deformed with a finger (an ointment-like state). Next, 20 g of dried cranberries were cut into particles of 3 – 5 mm in size for later use. Next, 120 g of low-gluten flour and 4 g of jasmine powder were placed in a dry container and stirred evenly with a spatula. In addition, 50 g of erythritol and 34 g of fresh egg liquid (fully beaten to homogeneity) were accurately weighed and separately packed for standby use.

(2) Emulsification of wet ingredients. The softened butter and erythritol were placed in a clean 200 ml glass mixing bowl and stirred evenly in the same direction with a heat-resistant silicone spatula at a frequency of 60 – 80 times per minute for 180 s, until the mixture had a uniform milky-white color and a fine texture without graininess. A stepwise emulsification method was adopted. In specific, 50% of the total egg liquid, approximately 17 g, was first added, followed by continuous stirring for 120 s until the system was completely emulsified and presented a bright and smooth state. Then, the remaining egg liquid was added, and stirring was continued for 90 s until the mixture presented a fine and uniform cream-like state, with no obvious oil droplets separating on the surface and moderate and uniform stirring resistance.

(3) Mixing of dry ingredients. The evenly mixed powder ingredients were sieved through an 80-mesh standard test sieve and added to the emulsified system in three portions. After each addition of powder, a spatula was used to mix by alternating cutting and folding motions (cutting in at a 45° angle along the bowl wall and folding up from the bottom). Each mixing period was controlled within 30 s. After the final addition of powder, mixing was continued until the dough had no visible dry powder particles, with the total mixing time not exceeding 150 s. During this process, the mixing intensity and time must be strictly controlled to prevent excessive gluten formation from affecting the texture of the biscuits.

(4) Addition of dried fruit. The pretreated dried cranberry particles were evenly sprinkled on the surface of the dough, and a folding technique (folding the dough in half from the middle and then gently pressing) was adopted 5 – 6 times until the dried fruit particles were basically evenly distributed in the dough. During operation, attention should be paid to avoid excessive kneading to prevent the dough temperature from rising and causing the butter to melt and exude.

(5) Dough shaping and maturation. A food-grade silicone mat was laid on the workbench. The mixed dough was placed on the mat and gently pressed and shaped with the palm into a rectangular block with a cross-section of approximately 5 cm × 3 cm. The dough was tightly wrapped in three layers of food-grade cling film (0.01 mm thick) to ensure complete sealing. It was then placed in a constant-temperature refrigerator (4 ± 1) ℃ and left to rest and mature for 60 min. During this process, sufficient recrystallization of butter was achieved to reduce dough adhesiveness, while aroma compounds of jasmine were fully integrated with the base materials.

(6) Slicing and placing on the baking tray. The dough was taken out from the refrigerator. The cling film was removed, and the dough was placed on a clean workbench. A graduated stainless steel cutter (blade thickness 0.3 mm) was used to quickly cut perpendicular to the long axis of the rectangular block to obtain uniform slices with a thickness of (0.7 ± 0.1) cm. The biscuit blanks were neatly arranged on an aluminum alloy baking tray (30 cm × 40 cm) lined with food-grade non-stick baking paper, with a center-to-center spacing of no less than 2.5 cm. No more than 20 blanks were placed on each tray to ensure uniform heat distribution.

(7) Baking. To ensure that the biscuits are heated evenly during baking, maintain a stable color, and avoid sticking caused by expansion, the specific procedures were as follows: First, a layer of heat-resistant baking paper was evenly laid on the surface of the baking tray. Second, the cut and shaped biscuit blanks were neatly arranged on the baking tray, with a gap of approximately 1 – 2 cm between adjacent blanks to reserve sufficient space for expansion. Subsequently, the baking tray holding the biscuit blanks was placed into a constant-temperature oven preheated to 160 ℃, and the baking time was set to 20 min. During the baking process, the surface browning of the biscuits should be continuously observed. If local rapid or excessive browning was observed, the oven temperature or the position of the baking tray

was adjusted in a timely manner to guarantee consistent color of the finished products. The temperature could be appropriately reduced 2 min before the end of baking to prevent over-carbonization, so that the desirable golden color and crisp texture were obtained.

(8) Cooling and setting. After baking was completed, the baking tray should be immediately removed from the oven and placed on a clean workbench to cool naturally for 2 min, allowing the biscuits to initially set and maintain structural integrity. Subsequently, the biscuits were carefully transferred from the baking tray to a cooling rack or cooling bench and fully cooled at ambient temperature (approximately 25 ℃) to prevent moisture reabsorption or texture softening caused by residual heat accumulation. The cooling process facilitated the stabilization of internal moisture distribution within the biscuits and improved the crispness and shelf stability of the final product.

Experimental design

To systematically investigate the effects of key ingredient addition levels on the sensory quality of the biscuits, the single-factor experimental method was adopted in this study. Jasmine powder, erythritol, egg liquid and butter were set as variables respectively, and the regulating effects of their addition amounts on the flavor characteristics of biscuits were examined, so as to provide a scientific basis for formula optimization.

Single-factor experiment

(1) Effect of jasmine powder addition level on biscuit flavor. The fixed baseline formula for the experiment was as follows: low-gluten flour 120 g, egg liquid 32 g, dried cranberries 20 g, erythritol 50 g, and butter 60 g. On this basis, the jasmine powder addition levels were set at 2, 4, 6, 8, and 10 g, respectively, giving a total of five treatment groups. Biscuit samples were prepared under the same process conditions, and their flavor differences were compared through sensory evaluation, so as to determine an optimized range for the addition level of jasmine powder.

(2) Effect of erythritol addition level on biscuit flavor. The fixed baseline formula for the experiment was as follows: low-gluten flour 120 g, egg liquid 32 g, dried cranberries 20 g, jasmine powder 4 g, and butter 60 g. On this basis, the erythritol addition levels were set at 40, 45, 50, 55, and 60 g, respectively, giving a total of five treatment groups. Biscuit samples were prepared under the same process conditions, and their flavor differences were compared through sensory evaluation, so as to determine an optimized range for the erythritol addition level.

(3) Effect of egg liquid addition level on biscuit flavor. The fixed baseline formula for the experiment was as follows: low-gluten flour 120 g, erythritol 50 g, dried cranberries 20 g, jasmine powder 4 g, and butter 60 g. The egg liquid addition levels were 28, 30, 32, 34, and 36 g, respectively, giving a total of five treatment groups. Biscuit samples were prepared under the same process conditions, and their flavor differences were compared through sensory evaluation, so as to determine an optimized range for the egg liquid addition level.

(4) Effect of butter addition level on biscuit flavor. The fixed baseline formula for the experiment was as follows: low-gluten flour 120 g, erythritol 50 g, egg liquid 32 g, dried cranberries 20 g, and jasmine powder 4 g. The butter addition levels were 50, 55, 60, 65, and 70 g, respectively, forming a total of five treatment groups. Biscuit samples were prepared under the same process conditions, and their flavor differences were compared through sensory evaluation, so as to determine an optimized range for the butter addition level.

Orthogonal experiment On the basis of the aforementioned single-factor experiments, to further systematically investigate the comprehensive effects of each raw material variable on the flavor quality of low-sugar jasmine – cranberry biscuits, this study referred to the orthogonal experimental method widely applied in similar food formula optimization[11-12]. Four key factors that contributed significantly to product flavor and may have interactive effects were selected: jasmine powder (A), erythritol (B), butter (C), and egg liquid (D), to construct an orthogonal experimental scheme with four factors and three levels. Through the arrangement of experimental combinations using an orthogonal array, this study aimed to comprehensively evaluate the influence patterns of different levels of each factor on sensory scores with a relatively small number of experiments and screen the optimal formulation combination. The factors and levels of the orthogonal experiment are shown in Table1.

Table 1 Levels of factors for orthogonal experiment g

Level	A Jasmine powder amount	B Erythritol amount	C Egg liquid amount	D Butter amount
1	2	45	30	55
2	4	50	32	60
3	6	55	34	65

In this experiment, nine formula combinations were designed and prepared according to the $L_9(3^4)$ orthogonal array. Each experimental group was performed in duplicate to ensure data stability. After the experiment was completed, a trained evaluation panel conducted blind evaluations and scoring of each group of samples according to preset sensory evaluation criteria (including dimensions such as color, aroma, taste, texture, and overall acceptability), and the average value was taken as the sensory score result for that experimental group. Finally, based on the range analysis and analysis of variance of the orthogonal experimental results, the ranking of the degree of influence of each factor on sensory scores and the optimal level combination were determined, thereby providing a scientific basis for the process optimization of low-sugar jasmine – cranberry biscuits.

Analytical and testing methods

With reference to GB/T 20980 *General Rules for Biscuit Quality*[13], 10 trained students conducted sensory evaluation of the biscuits in terms of color, taste, structure, and flavor and

odor, using a 100-point sensory evaluation system. The specific scoring criteria are shown in Table 2.

Table 2 Detailed rules for sensory quality evaluation of low-sugar baked jasmine – cranberry biscuits

Evaluation indicators	Sensory evaluation criteria	Score // points
Color (20)	Light yellow, uniform and glossy color, with no burnt or pale appearance on the surface	15 – 20
	Uneven color depth, relatively uniform color, with slight burnt or pale appearance	7 – 14
	Obviously deep brown or pale surface	1 – 6
Texture (30)	Crisp, non-sticky to teeth and relatively soft	21 – 30
	Relatively soft, slightly stick to teeth	11 – 20
	Excessively hard or soft texture, obviously sticky to teeth	1 – 10
Structure (20)	Distinct layered cross-section, fine texture, no large pores	15 – 20
	Relatively clear layered cross-section, slightly rough texture, a few large pores	7 – 14
	Indistinct layered cross-section, rough texture, obvious large pores or overly compact structure	1 – 6
Taste and aroma (30)	Moderate jasmine flavor, pure aroma and appropriate sweetness	21 – 30
	Slightly weak jasmine aroma, slightly excessive or insufficient sweetness	11 – 20
	Almost no jasmine flavor or excessively weak/strong flavor, with sweetness too strong or too weak	1 – 10

Results and Analysis

Results of single-factor experiments

Determination of the optimal jasmine powder addition level

To clarify the appropriate addition proportion of jasmine powder in the biscuit formula, this study systematically investigated the effects of different addition levels (2, 4, 6, 8, and 10 g) on the comprehensive sensory scores of the biscuits through single-factor experiments. According to the results shown in Fig. 2, the overall sensory score increased first and then decreased with the addition level of jasmine powder increasing, presenting an inverted U-shaped distribution.

Specifically, when the jasmine powder addition level was less than 4 g, the jasmine aroma presented by the biscuits was relatively faint and failed to fully reflect the flavor characteristics, and the sensory evaluation score was only 85 points. When the addition level was increased to 4 g, the jasmine flavor of the biscuits reached the optimal balance point, with a rich but not pungent aroma, harmonious color, and relatively high taste coordination, and the comprehensive sensory score significantly increased to 90 points, which was the optimal level in this experiment. However, when the jasmine powder addition level continued to increase beyond 4 g (such as 6, 8, and 10 g), it led to an overly strong floral aroma that masked the flavors of other auxiliary ingredients, and simultaneously caused problems such as darkened color and slightly hard texture of the biscuits, and even a slight bitter taste, seriously affecting overall acceptability. The sensory scores consequently declined gradually to 87, 81 and 79 points.

Based on the above experimental results and statistical analysis of sensory evaluation data, the optimal addition level of jasmine powder was preliminarily determined to be 4 g. This amount could effectively enhance the aroma characteristics of the product without causing flavor imbalance or texture deterioration, meeting the technological requirements for balancing flavor and quality of low-sugar baked biscuits.

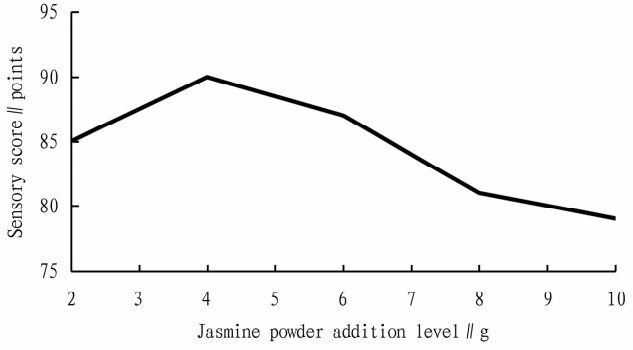

Fig. 2 Effect of jasmine powder content on flavor

Determination of the optimal erythritol addition level To clarify the appropriate addition proportion of erythritol in the biscuit formula, this study systematically investigated the effects of different addition levels (40, 45, 50, 55, and 60 g) on the comprehensive sensory scores of the biscuits through single-factor experiments. It can be seen from Fig. 3 that with the erythritol addition level increasing, the comprehensive sensory score showed a trend of first increasing and then decreasing, exhibiting an overall inverted U-shaped distribution.

Specifically, when the erythritol addition level was less than 50 g, the biscuits had insufficient sweetness, and due to the limited extent of the Maillard reaction, the color was relatively dull and the surface gloss was reduced, and the sensory evaluation scores were only 76 – 79 points. When the addition level was increased to 50 g, the balance between sweetness and toasted aroma of the biscuits reached the optimum, and the biscuits presented a uniform light golden-yellow color, good gloss, and a loose and crisp texture. The comprehensive sensory score significantly increased to 85 points, which was the optimal level in this experiment. However, when the erythritol addition level continued to increase beyond 50 g (such as 55 and 60 g), it led to a pronounced cloying sweetness, hardened texture, and rough mouthfeel, and even caused flavor imbalance, seriously affecting overall acceptability, and the sensory scores gradually decreased to 82 and 73 points.

Based on the above experimental results and statistical analysis of sensory evaluation data, the optimal addition level of erythritol was preliminarily determined to be 50 g. This amount could effectively improve the sweetness and color performance of the product without causing cloying flavor or texture deterioration, satisfying the processing requirements for sweetness regulation and quality coordination of low-sugar baked biscuits.

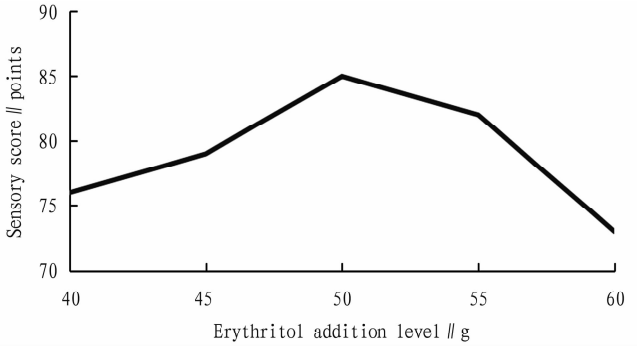

Fig. 3 Effect of erythritol addition level on biscuit flavor

Determination of the optimal egg liquid addition level To clarify the appropriate addition proportion of egg liquid in the biscuit formula, this study systematically investigated the effects of different addition levels (28, 30, 32, 34, and 36 g) on the comprehensive sensory scores of the biscuits through single-factor experiments. Combined with the results shown in Fig. 4, it can be seen that with the egg liquid addition level increasing, the comprehensive sensory score showed a trend of first increasing and then decreasing, exhibiting an overall inverted U-shaped distribution.

Specifically, when the egg liquid addition level was less than 32 g, the dough had insufficient cohesiveness and poor extensibility, and was prone to cracking during shaping. After baking, the biscuits were dry, hard, and rough, with insufficient flavor release, and the sensory evaluation scores were only 81 – 83 points. When the addition level was increased to 32 g, the dough had moderate hardness and softness, showing optimal cohesiveness, extensibility, and processing suitability (easy to shape and not prone to cracking). After baking, the biscuits had a golden-yellow color, a crisp texture, and fine and uniform internal pores, and the comprehensive sensory score significantly increased to 89 points, which was the optimal level in this experiment. However, when the egg liquid addition level continued to increase beyond 32 g (such as 34 and 36 g), it led to an overly wet and sticky dough that easily adhered to utensils during processing. During baking, excessive spreading of the dough resulted in irregular shapes. After cooling, the biscuits exhibited hard texture, excessive toughness and sticky interior. Correspondingly, the sensory scores gradually decreased to 87 and 84 points.

Based on the above experimental results and statistical analysis of sensory evaluation data, the optimal addition level of egg liquid was preliminarily determined to be 32 g. This amount could effectively optimize the processing properties of dough and the mouthfeel of finished products without causing molding difficulties or texture defects, meeting the technological requirements for structural stability and flavor delicacy of low-sugar baked biscuits.

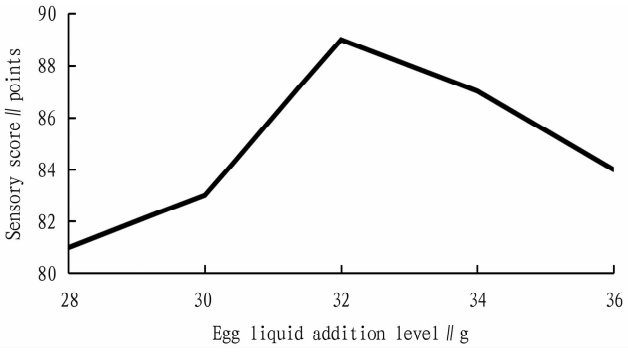

Fig. 4 Effect of egg liquid addition level on biscuit flavor

Determination of the optimal butter addition level To clarify the appropriate addition proportion of butter in the biscuit formula, this study systematically investigated the effects of different addition levels (50, 55, 60, 65, and 70 g) on the comprehensive sensory scores of the biscuits through single-factor experiments. Combined with the results shown in Fig. 5, it can be seen that with the butter addition level increasing, the comprehensive sensory score showed a trend of first increasing and then decreasing, exhibiting an overall inverted U-shaped distribution.

Specifically, when the butter addition level was less than 60 g, the dough was dry and hard, showing poor cohesiveness and low plasticity. The baked biscuits were tough rather than crisp, presented a hard mouthfeel and insufficient flavor, and their sensory scores ranged only from 79 to 84 points. When the addition level was increased to 60 g, both the dough processing characteristics and the sensory quality of the biscuits reached the optimal state. The extensibility and oil-holding capacity of the dough were balanced, and after baking, the biscuits had a regular shape, a crisp texture, and uniform oil distribution. The comprehensive sensory score significantly increased to 90 points, which was the optimal level in this experiment. However, when the addition level of butter was further increased above 60 g (such as 65 and 70 g), the dough became soft and sticky. Severe oil exudation occurred during processing and baking, leading to spread-out biscuit shape and greasy texture. Correspondingly, the sensory scores gradually decreased to 85 and 78 points.

Based on the above experimental results and statistical analysis of sensory evaluation data, the optimal addition level of butter was preliminarily determined to be 60 g. This amount could effectively improve the crisp mouthfeel and flavor layers of the product without causing excessive oil or morphological deterioration, meeting the technological requirements for texture optimization and flavor coordination of low-sugar baked biscuits.

Analysis of orthogonal experiment results

The single-factor experiments preliminarily determined the suitable range for each factor. However, interactive effects may exist among the factors. To obtain the globally optimal formula, an

orthogonal experiment was therefore conducted. The results obtained are shown in Table 3.



Fig. 5 Effect of butter addition level on biscuit flavor

Table 3 Results of the orthogonal experiment

No.	A	B	C	D	Sensory score // points
1	1	1	1	1	80
2	1	2	2	2	90
3	1	3	3	3	78
4	2	1	2	3	79
5	2	2	3	1	94
6	2	3	1	2	84
7	3	1	3	2	81
8	3	2	1	3	79
9	3	3	2	1	70
K_1	248	240	243	244	
K_2	257	263	239	255	
K_3	230	232	253	236	
k_1	82.7	80.0	81.0	81.3	
k_2	85.7	87.7	79.7	85.0	
k_3	76.7	77.3	84.3	78.7	
R	9.0	10.4	4.6	6.3	
Order of influence	B > A > D > C				
Optimal combination	A_2	B_2	C_3	D_2	

The results indicated that A represented the addition level of jasmine powder, B the addition level of erythritol, C the addition level of egg liquid, and D the addition level of butter. Erythritol addition level exerted the greatest effect on biscuit quality, followed by jasmine powder and butter addition levels, while egg liquid addition level showed the weakest influence. This highlights that in a low-sugar biscuit system, the type and amount of the core sweetener have a decisive influence on the overall sensory quality. This is consistent with the findings of Rózyło *et al.* in low-sugar shortbread, namely that the erythritol addition level is a key parameter determining the overall acceptability and functional properties of the product. Finally, the optimal combination obtained was 50 g of erythritol, 4 g of jasmine powder, 34 g of egg liquid, and 60 g of butter, which yielded low-sugar baked jasmine – cranberry biscuits of the best quality.

Result verification

To verify the stability and reliability of the formula optimized by the orthogonal experiment (jasmine powder 4 g, erythritol 50 g, egg liquid 34 g, butter 60 g, supplemented with low-gluten flour 120 g and dried cranberries 20 g), this study conducted three parallel verification tests according to the optimal parameter combination and evaluated the sensory quality of the finished product. The results are shown in Table 4.

Table 4 Results of the verification test

Parallel test	Sensory score // points	Average score // points
1	95.3	
2	95.5	95.3
3	95.1	

As shown in Table 4, the sensory scores of the three parallel tests were 95.3, 95.5, and 95.1 points, respectively, with an average score of 95.3 points. The experimental results showed that under the optimal formula, the finished biscuits had a full and well-proportioned appearance, an attractive color, and clear patterns, retaining both the fresh floral aroma of jasmine and the sweet-and-sour fruity taste of cranberries, forming a unique and harmonious flavor profile. In terms of mouthfeel, they were fine, crisp, and sweet without being cloying, fully meeting the quality requirements of low-sugar healthy biscuits. These results provide reliable technical support for the industrial production of the formula.

Conclusion and Discussion

This study aimed to develop a low-sugar jasmine – cranberry biscuit that combines a unique flavor with health properties. The elegant jasmine floral aroma was integrated with the sweet-sour cranberry fruity taste, and sucrose was substituted with the functional sweetener erythritol, which preliminarily fulfilled the dual design objectives of flavor and health for the product.

In terms of process optimization, the study first determined the key addition ranges of core ingredients such as jasmine powder, dried cranberries, and erythritol through single-factor experiments. Subsequently, a three-factor three-level orthogonal experiment was used for refined formulation, and the optimal formula combination of the product was ultimately determined as follows: low-gluten flour 120 g, jasmine powder 4 g, dried cranberries 20 g, erythritol 50 g, butter 60 g, and egg liquid 34 g. This formula is the optimal solution after balancing all factors.

Verification confirmed that the biscuits prepared based on this optimal formula had excellent comprehensive sensory quality, with an average sensory score of 95.3 points. In terms of flavor, the product achieved a harmonious blend of floral and fruity aromas, with no obvious undesirable flavors. In terms of texture, it maintained the crisp mouthfeel expected of crisp biscuits, and had a pure sweet taste and no aftertaste of bitterness. In terms of appearance, shape, and color, it also met the standards of high-quality biscuits. This demonstrates that the formula is superior to comparable low-sugar products with a single flavor in terms of flavor complexity and texture balance[15]. Furthermore, the product

aligns with the major trend of the biscuit industry toward healthy "low-sugar, low-fat and high-fiber" products put forward by Huajing Industrial Research Institute, and shows obvious potential for industrialization.

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