

Study on the Formulation of Mango Double Skin Milk

Xiaoyan LAN*, Shiyu MOU, Zhuo CHEN, Chunfang PENG

Yibin Vocational & Technical College, Yibin 644000, China

Abstract [Objectives] This study was conducted to explore the optimal formulation of mango double skin milk. [Methods] The amounts of milk, mango concentrate, egg white, and sugar were optimized through single-factor experiments and orthogonal experiments. The raw materials were pretreated, and then the optimal range of each ingredient was determined through single-factor experiments, followed by further determination of the optimal formulation through orthogonal experiments. [Results] The sensory evaluation results showed that the optimal formulation was milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g. [Conclusions] The product prepared with this formulation exhibits fine and smooth-tender texture, standard and uniform color, and is free of off-flavors. It delivers intense milk and mango aroma with a unique flavor, which is well-accepted by consumers.

Key words Mango double skin milk; Single-factor experiment; Orthogonal experiment; Sensory evaluation

DOI:10.19759/j.cnki.2164-4993.2026.04.014

Mango double skin milk, as an innovative dessert that combines the traditional dessert double skin milk with the flavor of tropical fruits, has received widespread attention and popularity in recent years. Double skin milk (steamed milk egg custard) is a representative culinary cultural icon of Shunde. It is renowned for its unique double-layer milk skin and silky smooth texture, and highly favored by consumers^[1-3]. Mango, as a representative of tropical fruits, is famous for its rich aroma and sweet taste^[4]. Traditional double skin milk has high nutritional value and a distinct flavor, and is rich in milk protein, while mango juice is abundant in vitamin C. This combination endows the product with excellent nutritional and health benefits and enriches the variety of double skin milk products^[5]. Combining mango with double skin milk not only enhances its nutritional value, but also imparts new flavors and a novel eating experience.

We have found that the innovation of mango double skin milk is not only reflected in its flavor, but also in the improvement of its production process. Through experiments, we can systematically analyze the impact of each ingredient on the final product quality and identify the optimal ingredient combination. In this study, the optimal formulation of mango double skin milk was explored through single-factor experiments and orthogonal experiments which optimized the amounts of key ingredients such as milk, mango, egg white, and sugar, so as to achieve the best taste and flavor^[6]. In specific, egg white and milk were selected as the main raw materials, and a fragrant, nutritious, and healthy dessert suitable for post-meal consumption was produced by adjusting their proportions^[7]. Sensory evaluation served as an important means of

assessing product quality, with scores given for color, aroma, taste, and overall preference of samples with different formulations. This study also contributes to promoting the innovation and development of traditional desserts and meeting consumers' demands for healthy, delicious, and diverse dessert options^[8].

The sensory evaluation in this study adopted the standardized evaluation method to ensure the objectivity and reliability of the results. The product formulation most acceptable to consumers was determined by scoring the color, aroma, taste, and overall preference of samples with different formulations. This study provides guidance for the commercial production of mango double skin milk.

Materials and Methods

Raw materials and apparatuses

The raw materials required for this experiment and their specifications are shown in Table 1. The experimental equipment and specifications are shown in Table 2.

Experimental methods

Process flow The process flow of this experiment is shown in Fig. 1.

Preparation of raw materials and equipment The pretreatment of milk included heating 105 ml of whole milk to 90–95 °C in a sterilized container to ensure proper denaturation of milk proteins, facilitating the formation of a stable milk skin. After heating, the milk was allowed to stand in a sterilized bowl until it was cooled to room temperature to allow the formation of the milk skin.

For the mango concentrate, 15 g of mango concentrate was selected, and 15 g of white sugar was weighed.

For the egg white treatment, 30 g of egg white was separated from two fresh eggs, and a sterilized mixer was used to stir at low speed until the egg white was broken up, avoiding over-whipping, which would affect subsequent mixing with milk and the coagulation effect during steaming.

During the preparation of all raw materials, all apparatuses were sterilized previously to prevent contamination. Frequent

Received: May 30, 2026 Accepted: August 2, 2026

Supported by The third batch of the National Vocational Education Teacher Innovation Team in 2023 "Yibin Vocational Technical College Liquor Technology Major" (Teacher Letter (2023) No. 9) Stage Research Results; College-level Project of Yibin Vocational & Technical College (JG2025YB-031; 26ZR17).

Xiaoyan LAN (1982–), female, P. R. China, associate professor, devoted to research about food processing and detection.

* Corresponding author.

opening of the lid during milk heating was avoided, as it could cause temperature fluctuations that affect coagulation. Temperature control and lid opening were maintained within controllable ranges.

Table 1 Specifications of experimental raw materials

Raw material	Specification requirements	Remarks
Milk	Wholefat	Fat content $\geq 3.5\%$
Concentrated mango juice	Within shelf life	Highly concentrated, with rich fruity aroma
Egg white	Fresh and undamaged	Egg white from approximately 2 eggs
White granulated sugar	Refined, impurityfree	Purity $\geq 99.8\%$

Table 2 Specifications and applications of experimental apparatuses

Apparatus	Specification/Model	Application	Remarks
Stirrer	Hand held	Mixing raw materials	–
Steamer	Stainless steel, diameter 28 cm	Steaming double skin milk custard	Volume: 10 L
Electronic balance	Precision 0.1 g, maximum weighing capacity 5 kg	Weighing raw materials	–
Eggwhite separator	Hand held	Separating egg white	–
Graduated cylinder	200 ml	Measuring milk	Keep the cylinder dry

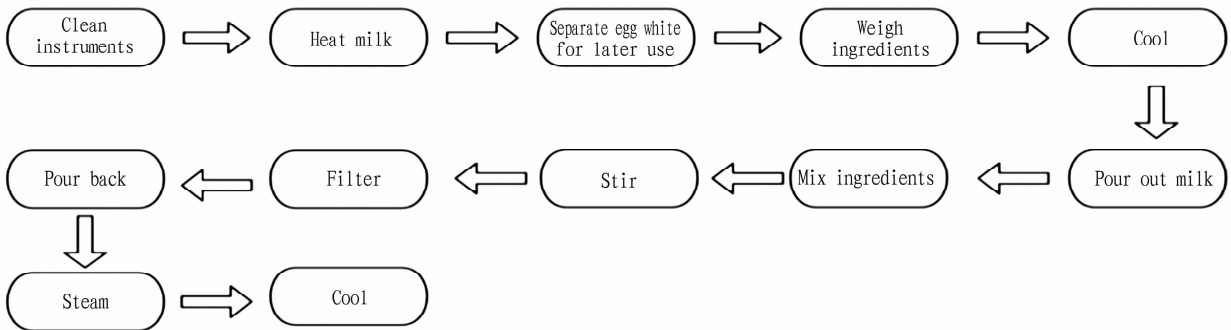


Fig. 1 Process flow chart

Design of single-factor experiments In the single-factor experiments, the amounts of milk, mango, egg white, and sugar were optimized separately to determine the effect of each ingredient on the quality of mango double skin milk. The experimental design for each ingredient is as follows:

Milk amount: The initial milk amount of 95 ml was increased to 115 ml in 5 ml increments, forming 5 levels: 95, 100, 105, 110, and 115 ml. This step was aimed at evaluating the effects of different milk amounts on milk skin formation and taste richness.

Mango concentrate amount: Starting from 5 g and increased to 25 g in 5 g increments, 5 levels were designed: 5, 10, 15, 20, and 25 g. The aim was to observe the effects of different mango amounts on the overall taste of the double skin milk.

Egg white amount: Starting from 20 g and increasing to 40 g in 5 g increments, the formed 5 levels were as follows: 20, 25, 30, 35, and 40 g. This step was aimed at testing the effects of different egg white amounts on the coagulation effect and texture of the double skin milk.

Sugar amount: The initial amount of 5 g was increased to 25 g in 5 g increments, forming 5 levels: 5, 10, 15, 20, and 25 g. This step was performed to determine the effects of different sugar amounts on the sweetness and flavor balance of the double skin milk.

In the single-factor experiments, only one variable was

adjusted at a time while other variables were kept constant. For example, when testing the milk amount, the amounts of mango concentrate, egg white, and sugar were maintained at their preset levels of 15, 15, and 30 g, respectively. All experiments were conducted under the same steaming conditions, *i. e.*, steaming for 15 min, to ensure consistency of the experimental results. The sensory score for each experiment was recorded, so as to determine the optimal amount of each ingredient and to provide baseline data for subsequent orthogonal experiments.

Design of orthogonal experiments On the basis of the single-factor experiments, in order to further optimize the formulation of mango double skin milk, this study adopted an orthogonal experimental method, with milk amount, mango amount, egg white amount, and sugar amount as the investigated factors, each at three levels (Table 3). The experimental design was carried out using an orthogonal array, with sensory score as the evaluation index, aiming to identify the optimal formulation combination to ensure that the mango double skin milk achieves the best performance in color, aroma, taste, and overall preference.

Sensory evaluation

Sensory evaluation and scoring were conducted on four aspects of mango double skin milk: color, aroma, overall preference, and taste, with a total score of 100 points (Table 4). The sensory evaluation panel consisted of laboratory teachers and

students, totaling 10 members.

Table 3 Levels of factors for orthogonal experiments

Level	Factor			
	Milk amount A//ml	Egg white amount B//g	Egg white amount C//g	Sugar amount D//g
1	100	10	25	10
2	105	15	30	15
3	110	20	35	20

Table 4 Sensory evaluation criteria

Item	Total score	Score	Index
Color	20	16 – 20	Standard and uniform color
		11 – 15	Nonuniform color
		0 – 10	Failure to present natural creamyyellow color
Aroma	20	16 – 20	Intense milk and mango aroma
		11 – 15	Insufficient aroma
		0 – 10	Present of off-flavor
Overall preference	30	21 – 30	Comprehensive evaluation of product aroma
		11 – 20	Comprehensive evaluation of product taste
		0 – 10	Comprehensive evaluation of product color
Taste	30	21 – 30	Smooth and tender
		11 – 20	Coarse mouthfeel
		0 – 10	Sweet, rich and smooth

Results and Analysis

Results and analysis of single-factor optimization experiments

Effect of milk amount on the quality of double skin milk In the single-factor optimization experiments, the amount of milk had a significant effect on the quality of the double skin milk. The experiment showed that as the milk amount increased from 95, 100, 105, 110, and finally to 115 ml, with an increment of 5 ml each time, the texture and taste of the double skin milk underwent noticeable changes.

The experimental results showed that with 105 ml of milk, the milk aroma of the double skin milk was enhanced, the taste became smoother, and the sensory score increased to 94 points. With the milk amount increasing, when the milk amount was below 105 ml, the milk aroma was insufficient and the taste was thin. When the milk amount exceeded 105 ml, the milk flavor became too strong and overshadowed the mango aroma. Therefore, the milk amount was fixed at 105 ml, at which the double skin milk achieved a smooth texture while maximally retaining the mango fragrance. This amount was considered optimal for further investigating the effects of other ingredients on the quality of the double skin milk (Fig. 2).

Effect of mango concentrate amount on the quality of double skin milk

In the single-factor optimization experiments, the amount of mango concentrate significantly affected the flavor and taste of the double skin milk. The mango concentrate amount was increased from 5, 10, 15, 20, to 25 g, with an increment of 5 g each time. The experimental results showed that the increase in

mango concentrate amount led to noticeable changes in the mango flavor and overall taste of the double skin milk.

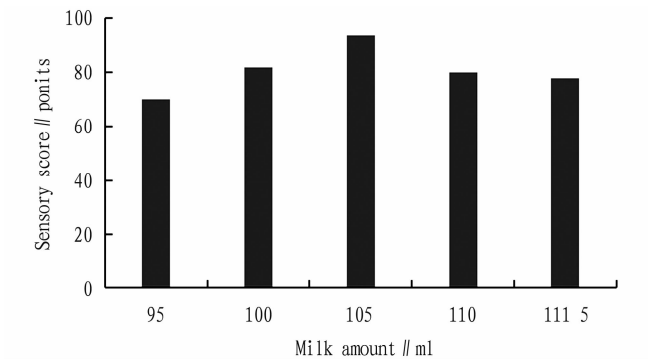


Fig. 2 Sensory scores of double skin milk under different milk amounts

When the amount of mango concentrate was increased to 15 g, the mango aroma and flavor of double skin milk were significantly enhanced, achieving a good balance with milk flavor, and the sensory score further rose to 90 points. When the dosage of mango concentrate exceeded 15 g, the mango flavor of double skin milk overshadowed the milk flavor to a certain extent. At the amounts below 15 g, the mango flavor was weak and the overall taste was dominated by milk flavor.

The mango concentrate amount of 15 g was considered optimal, as it maximized the fresh mango flavor while maintaining the rich milk aroma of the double skin milk, providing an important reference for the subsequent orthogonal experiments (Fig. 3).

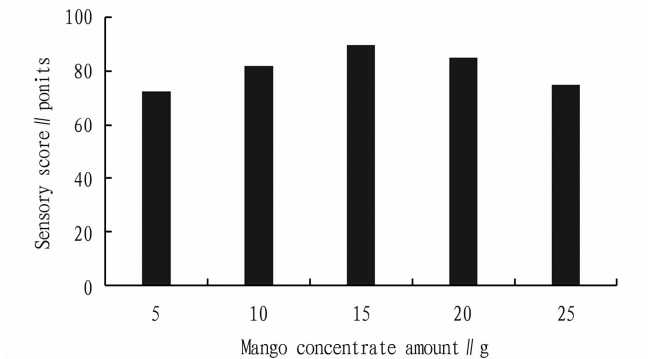


Fig. 3 Sensory scores of double skin milk under different mango concentrate amounts

Effect of egg white amount on the quality of double skin milk

In the single-factor optimization experiments, the amount of egg white played a decisive role in the texture and stability of the double skin milk. The egg white amount was increased from 20, 25, 30, 35, to 40 g, with an increment of 5 g each time, to observe its effect on the quality of the double skin milk.

When the amount reached 30 g, the texture of the double skin milk became delicate and the custard showed a certain elasticity, with the sensory score significantly increasing to 91 points. At this point, the texture and stability of the double skin milk reached their optimal state, and the double skin milk exhibited a

smooth and tender mouthfeel and good elasticity. When the egg white amount exceeded 30 g, although the coagulation effect was stronger, the texture became rough and the desired delicate mouthfeel was lost. When it was below 30 g, the coagulation effect was poor and the texture was loose.

Based on comprehensive evaluation, the egg white amount of 30 g was considered optimal, ensuring the stability of the double skin milk. In the subsequent orthogonal experiments, the egg white amount was fixed at 30 g to further explore its optimal combination with other ingredients (Fig. 4). This experimental results indicate that an appropriate amount of egg white is a key factor in ensuring the quality of the double skin milk.

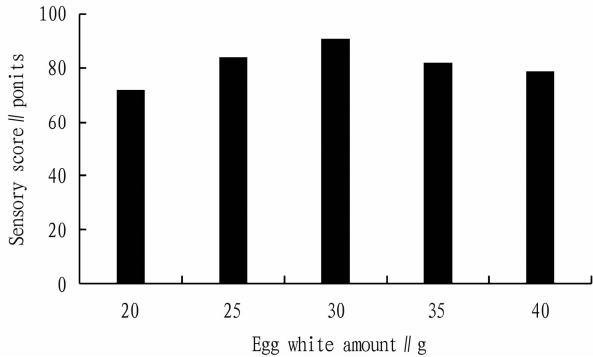


Fig. 4 Sensory scores of double skin milk under different egg white amounts

Effect of sugar amount on the quality of double skin milk In the single-factor optimization experiments, the amount of sugar played a crucial role in the sweetness and overall flavor balance of the double skin milk. To evaluate the specific effects of sugar amount on the quality of the double skin milk, five single-factor experiments were conducted, with sugar amounts of 5, 10, 15, 20, and 25 g, increasing by 5 g each time.

When the sugar amount reached 15 g, the sweetness was moderate, effectively balancing the acidity of the mango concentrate and the creamy aroma of the milk. When the sugar amount exceeded 15 g, the excessive sweetness disrupted the overall flavor balance, making the product overly sweet. When it was below 15 g, the sweetness was insufficient, resulting in a noticeably bland overall flavor.

Based on the comprehensive experimental data, 15 g of sugar was considered the optimal amount. This amount not only enhanced the overall flavor of the double skin milk, but also accentuated the fresh taste of mango, making the dessert more palatable (Fig. 5). This result confirmed the importance of an appropriate sugar amount in ensuring the flavor balance of the double skin milk.

Results and analysis of orthogonal experiments

Through orthogonal experiments, the effects of different ingredient ratios on the sensory quality of mango double skin milk were analyzed. The experimental results showed that the optimal formulation combination was milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g. Under this formulation, the

double skin milk achieved the highest scores in color, aroma, taste, and overall preference, confirming its effectiveness (Table 5).

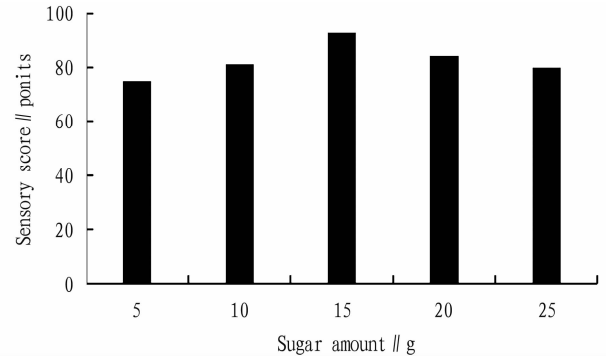


Fig. 5 Sensory scores of double skin milk under different sugar amounts

Table 5 Optimal formulation results from orthogonal experiments

No.	Milk (A)	Mango concentrate (B)	Egg white (C)	Sugar (D)	Sensory score
1	1	1	1	1	85.0
2	1	2	2	2	89.0
3	1	3	3	3	83.3
4	2	1	2	3	87.8
5	2	2	3	1	86.8
6	2	3	1	2	89.0
7	3	1	3	2	84.3
8	3	2	1	3	84.5
9	3	3	2	1	84.3
K_1	257.3	257.1	258.5	256.1	
K_2	263.6	260.3	261.1	262.3	
K_3	253.1	256.5	254.4	255.6	
k_1	85.7	85.7	86.1	85.3	
k_2	87.8	86.7	87.0	87.4	
k_3	84.3	85.5	84.8	85.2	
R value	3.5	1.2	2.2	2.2	
Optimal level	A_2	B_2	C_2	D_2	
Optimal combination	$A_2B_2C_2D_2$				

Through orthogonal experiments, we thoroughly investigated the effects of four factors, namely milk amount (A), mango concentrate amount (B), egg white amount (C), and sugar amount (D), on the sensory quality of mango double skin milk. Each factor was set at three levels. By varying these parameters, we evaluated the effects of different formulations on the flavor and taste of the double skin milk and recorded the sensory scores.

The experimental results showed that milk amount and sugar amount had significant effects on the quality of the double skin milk, with R values of 3.5, indicating that they were the main factors affecting sensory scores. The effect of mango concentrate amount was relatively smaller, with an R value of 1.2. The R values of egg white amount and sugar amount were 2.2 and 2.2, respectively, also relatively small. Therefore, the order of importance was determined: A (milk amount) and D (sugar amount)

were equally important and had the greatest influence, followed by C (egg white amount), and finally B (mango concentrate amount).

Among all experimental combinations, formulation A₂B₂C₂D₂, *i. e.* , milk 105 g, mango concentrate 15 g, egg white 30 g, and sugar 15 g, achieved the highest value, confirming the effectiveness of this combination. The result revealed the optimal ingredient ratio and provided clear guidance for the production of mango double skin milk.

The identification of this optimal formulation not only achieved a balance between the flavors of milk and mango, but also ensured a delicate texture and appropriate sweetness of the double skin milk. Through orthogonal experiments, we were able to precisely identify the key factors affecting the quality of the double skin milk and find the best formulation to enhance its sensory quality. These results provide an important reference for the commercial production and quality control of mango double skin milk.

Verification test

The verification test was conducted to confirm the feasibility and repeatability of the optimal formulation obtained from the orthogonal experiments. Following the optimal formulation, *i. e.* , milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g, the double skin milk was repeatedly prepared in three independent trials. The sensory scores were 94, 92 and 93, respectively, with an average of 93, confirming the reliability of the formulation. The verification results demonstrated that this formulation could stably produce high-quality mango double skin milk with good feasibility and repeatability. It provides a solid experimental basis for the commercial production of mango double skin milk.

Conclusions and Discussion

In this study, the formulation of mango double skin milk was

systematically optimized through single-factor experiments and orthogonal experiments. The final formulation was determined as milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g. The orthogonal experiments further verified the superiority of this formulation combination, in which the ratio of milk to mango was particularly important, as it determined the richness and the balance of fruit aroma in the double skin milk. Through the verification test, the feasibility and repeatability of this optimal formulation were confirmed, with an average sensory score of 93 points, indicating the high application value of the optimal formulation in actual production.

The mango double skin milk prepared with this formulation had a delicate and smooth texture with no off-flavors. It emits a rich aroma of milk and mango, and is well received by consumers for its unique flavor.

References

[1] LIANG S. Innovation of desserts in the context of health consciousness [J]. China Food Industry, 2024, (13): 173–175. (in Chinese).

[2] LUO ZH, GUO LP. The unforgettable Shunde double skin milk[J]. Little Macaque Intellectual Pictorial, 2021, (101): 46. (in Chinese).

[3] WANG MR. Double skin milk becomes the "new favorite" of milk tea [J]. Food Industry, 2022, (7): 52–54. (in Chinese).

[4] WEI W, ZHANG FJ. Research and development of *Hericium erinaceus* and carrot double skin milk [J]. Farm Products Processing, 2023, (5): 13–17, 22. (in Chinese).

[5] LI SB, JIANG Y. Study on red bean double skin milk[J]. China Dairy, 2013, (3): 60–61. (in Chinese).

[6] HOU HL, ZHANG YY, ZHANG D, *et al.* Optimization of processing technology for carrot-flavored double skin milk[J]. China Dairy, 2020, (10): 63–66. (in Chinese).

[7] YU C, ZENG CZ, LI Y, *et al.* Analysis of the food safety enterprise standard of double skin milk filing in Guangdong province[J]. Journal of Food Safety and Quality, 2021, 12(8): 3423–3228. (in Chinese).

[8] ZHANG T, GONG GH. Research and development of double skin milk [J]. Statistics and Management, 2016(6): 170–171. (in Chinese).

Editor: Yingzhi GUANG

Proofreader: Xinxiu ZHU



(Continued from page 58)

[11] LI J, HUANG S, YE JQ, *et al.* Exploration of project-oriented teaching reform in food analysis courses under the OBE concept [J]. The Food Industry, 2025, 46(11): 139–141. (in Chinese).

[12] XU LL, YE YC. Analysis of countermeasures for the application of artificial intelligence technology in food processing[J]. Modern Food, 2025 (20): 67–69. (in Chinese).

[13] GAO YF, ZHAO XL, WANG YG, *et al.* Focusing on academic frontiers and promoting innovation in biotechnology and food processing: An overview of the 2025 National Conference on Biotechnology and Food Processing Innovation and Industrial Development[J]. China Biotechnology, 2025, 45(9): 143–146. (in Chinese).

[14] JIAO TT, SHI WF, WANG J, *et al.* Exploration of teaching methods for the "Snack Food Processing Technology" course[J]. Modern Flour

Milling Industry, 2025, 39(2): 54–57. (in Chinese).

[15] ZHANG Y, WANG AX. Teaching reform of food processing technology courses under the background of "AI+curriculum ideological and political education"[J]. Mod Agric Sci Technol, 2025(22): 208–212. (in Chinese).

[16] DENG N, WANG JH, LI H. Exploration and practice of the "five-in-one" teaching reform of "Food Nutrition" in universities from the perspective of new engineering[J]. The Food Industry, 2025, 46(10): 156–162. (in Chinese).

[17] REN XF, LIANG QF, WANG B, *et al.* Teaching practice on frontier of food physical processing technology [J]. Agricultural Engineering, 2019, 9(9): 113–115. (in Chinese).

[18] DONG J, YAO MA. Exploration and practice of curriculum ideological and political education in the "Food Processing Technology" course[J]. Modern Flour Milling Industry, 2024, 38(6): 44–46. (in Chinese).