Canrea Journal: Food Technology, Nutritions, and Culinary, 2025; 8 (1): 83–104
OPEN ACCESS

e-ISSN : 2621-9468

Type of the Paper (Article)

Development and sensory evaluation of edible flower incorporation in pastry products using avant-garde techniques

Kluivert Raúl Mendoza Guevara [1], Javier Alfonso Paz Sánchez [1], Sofía L. Bohórquez-Medina[1,2]*, and Andrea L. Bohórquez-Medina[1,2]

[1] Carrera de Arte Culinario, Facultad de Administración Hotelera, Turismo y Gastronomía, Universidad San Ignacio de Loyola, Lima, Peru
[2] Grupo de Investigación en Gastronomía y Arte Culinario (GIGAC), Universidad San Ignacio de Loyola, Lima, Peru

Abstract

Edible flowers have traditionally been used as decorative elements in haute cuisine, their potential as a main ingredient in the creation of distinctive flavors has been little investigated, especially in the field of pastry. The aim of this research was to develop a gastronomic proposal that utilizes innovative techniques for incorporating edible flowers into pastry products and to evaluate their acceptability. The edible flowers used in this study were Hibiscus (Jamaica), Jasmine, and Lavender. For each flower, three samples were prepared with varying concentrations. To determine the optimal formulation and its acceptability, a sensory evaluation was conducted with an expert panel consisting of 10 participants. The panel assessed key attributes, including aroma, color, flavor, texture, aftertaste, and overall acceptability, using a 9-point Likert scale. The findings revealed that Hibiscus sample 1, with a dosage of 15 g, was the most acceptable, making it ideal for use in pastry creams. For Jasmine, sample 3, containing 5 g, was preferred, while for Lavender, sample 2, with 3 g, was favored due to the flower's more intense flavor. This research proposes using edible flowers as the main element in pastry products, demonstrating their successful integration into various preparations and their role as unique components in desserts.

Article History
Received January 5, 2025
Accepted June 18, 2025
Published June 29, 2025

Keywords
Edible Flowers, Pastry Innovation, Sensory Evaluation, Flower Desserts, Culinary Applications.

1. Introduction

Edible flowers have long held aesthetic, cultural, and symbolic value across global traditions, yet their culinary use remains relatively limited. Historically employed to decorate gardens, living spaces, and dishes, flowers have recently gained renewed attention for their potential as functional food ingredients. Many still perceive edible flowers as purely ornamental (1); however, research suggests that their consumption can offer nutritional benefits, as their components pollen, nectar, petals, and other floral tissues contain proteins, amino acids, sugars, vitamins, minerals, carotenoids, flavonoids, and antioxidants (2).

The market for edible flowers is expanding, driven by globalization and a growing interest in traditional, health-oriented diets. Euromonitor International notes their increasing presence in high-end cuisine, although their potential extends far beyond garnishing (3). Culinary traditions across Europe, Asia, and the Middle East have long incorporated flowers into recipes such as teas, sauces, liquors, salads, and hot dishes, with records of historical uses ranging from rose purées in Ancient Rome to marigold-infused omelets in medieval France

* Correspondence: **Sofía L. Bohórquez-Medina** sofia.bohorquez@usil.pe bohorquez.m.sofia@gmail.com

ISSN 2621-9468 online, DOI 10.20956/canrea.v8i1.1740

and dahlia-based soups in Mexico (4). However, the integration of edible flowers into South American cuisines remains limited, and their use in desserts is even less common (4).

Scientific literature has begun to highlight the bioactive properties of edible flowers including antioxidant (5), anti-inflammatory, antibacterial (6), and antidiabetic effects yet applications in food systems remain narrowly focused (7). Studies have explored their incorporation into dairy products, beverages, cookies, and even sausages, noting both enhancements and limitations in flavor, texture, and color (5,8). While some formulations, such as those enriched with Hibiscus sabdariffa or *Clitoria ternatea*, improve visual appeal and brightness, others show minimal sensory differences or consumer resistance to unfamiliar flavors (9). Nevertheless, the controlled addition of edible flowers has demonstrated potential to enrich food products (10), offering both nutritional and aesthetic value (8).

In parallel, advancements in culinary science, particularly in molecular gastronomy have opened new avenues for innovation. Techniques such as spherification, gelation, foaming, and cryo-cooking allow chefs to reimagine ingredient the functionality (11), structure, and presentation of ingredients (12). Ingredients such as agar-agar, hydrocolloids, and emulsifiers are increasingly employed to integrate unconventional components like flower extracts into stable, visually striking preparations. These tools support the shift toward “clean label” formulations that reduce synthetic additives and appeal to health-conscious consumers (13–15).

Despite this progress, the broader culinary integration of edible flowers is constrained by challenges such as perishability, seasonal availability, limited toxicological data, and low consumer awareness. Moreover, most existing studies lack rigorous sensory analysis led by expert panels, particularly in the context of baked goods (16) and pastries (17). The majority of research focuses on beverages, yogurts, and savory products (18), while applications in patisserie remain understudied (19).

This study responds to these gaps by evaluating the incorporation of three edible flowers jasmine (*Jasminum grandiflorum*), lavender (*Lavandula angustifolia*), and hibiscus (*Hibiscus sabdariffa* and *H. rosa-sinensis*) into pastry formulations using advanced culinary techniques. Through expert-led sensory evaluations, we aim to assess the organoleptic contributions of each flower in terms of aroma, flavor, texture, and color. By doing so, we seek to reposition edible flowers as not merely decorative elements but as central, functional components in the creation of innovative, flavor-forward, and nutritionally enriched pastry products relevant to contemporary gastronomy.

Edible flowers represent a continuation of long-standing culinary and medicinal traditions. According to Santos and Reis, their use reflects cultural heritage, with fresh flowers valued for their nutritional and sensory properties (20). In Brazil, these botanicals are increasingly incorporated into jams, beverages, desserts, and infusions in both fresh and dried forms. In Europe, edible wildflowers are recognized as nutrient-dense foods, available commercially in countries like Spain, France, and Italy (21).

Wen et al. classify edible flowers as safe and non-toxic, highlighting their traditional medicinal roles and growing incorporation into modern foods to enhance appeal and nutritional value (22). Their unique flavors and micronutrient content support their rising popularity, enabling use in breads, cheeses, desserts, and beverages (23). In China, for instance, *Osmanthus fragrans* has been cultivated for millennia. Its distinctive aroma and health benefits have spurred increased culinary applications and consumer interest (24). A related study confirmed that many consumers are drawn to the novel sensory experiences edible flowers provide, viewing them as intriguing additions that enhance both visual and taste dimensions of dishes (25).

Jasmine (*Jasminum grandiflorum* Linn), widely grown in regions like Asia, the Mediterranean, and Northeast Africa, is known for its white, fragrant flowers and its therapeutic properties, including antidiabetic and antiseptic effects (26). In addition to its ornamental use, jasmine is one of the most widely used medicinal plants because of its antioxidant, antibacterial, and anti-inflammatory properties (27).

Lavender (*Lavandula angustifolia*) is cultivated mainly for essential oils used in cosmetics and perfumery, but it also has applications in food products particularly in dried form due to its calming effects and antimicrobial activity. Its low toxicity and versatility make it suitable for both culinary and cosmetic uses (28).

Hibiscus flowers, particularly *Hibiscus sabdariffa* and *Hibiscus rosa-sinensis*, are celebrated for their aromatic complexity and health benefits. The former contains volatile compounds such as 1-octen-3-ol, furfural, and acetic acid, with cold infusions preserving higher levels of aroma-related compounds (29,30). *H. rosa-sinensis* is used in alcoholic beverages for its fruity, floral notes resulting from its ester and alcohol content. It is also rich in polyphenols, flavonoids, and anthocyanins, known for antioxidant properties (31). These bioactive compounds can be efficiently extracted using methods like ethanol maceration (32). Additionally, precise botanical identification such as distinguishing *H. rosa-sinensis* from *Rhododendron arboreum* is essential to ensure authenticity and safety in food and pharmaceutical applications (33).

Since the mid-1990s, scientific fields such as chemistry and physics have increasingly shaped culinary innovation. Molecular gastronomy, introduced by Hervé and Kurti, explores the physicochemical transformations of food during cooking and their effects on sensory perception (34,35). This interdisciplinary science fosters collaboration in sensory analysis, food composition, non-traditional ingredients, and techniques beyond classical methods (36). Initially met with scepticism due to unfamiliar textures and formats such as foams, pearls, and spherification (37); molecular cuisine has evolved into a platform for sensory experimentation (38).

Spherification, pioneered by Ferran Adrià and refined by Oriol Castro, encapsulates flavored liquids in sodium alginate membranes that burst upon consumption. Techniques vary depending on pH and calcium content, enabling controlled release and longer storage (39). Edible foams, stabilized by emulsifiers like sucrose esters and lecithin, create novel textures and visual appeal (32). Their use in preparations such as mango foams (40,41) supports the “clean label” movement by reducing synthetic additives (41,42).

These techniques enhance traditional pastry foundations, where texture, structure, and flavor must be carefully balanced (43,44). Pastry cream is a protein-stabilized emulsion of milk (44,45), sugar, and modified starch, which forms a gel when heated (46,47). Ganache, a blend of chocolate, sugars, cream, and fruit purées (48), is widely used in truffles and fillings(49). Gelation, especially with agar-agar a red algae-derived polysaccharide enables the formation of semi-solid structures, improving both stability and texture (40,45).

In modern pastry-making, these methods support the creation of intricate desserts by blending traditions with scientific techniques. As Salcán León, Padilla, and López note, desserts aim to deliver not only taste but also a rich multisensory experience through varied textures and fillings (44).

2. Materials and Methods

In the present study, we formulated three samples of flower pastry preparations: Formula with Jamaica Flower (FJM); FJM1 (Pastry cream with 15 g of infusion of Jamaica Flower), FJM2 (Pastry cream with 20 g of infusion of Jamaica Flower), FJM3 (Pastry cream with 25 g of infusion of Jamaica Flower).

Formula with Jazmin Flower (FJZ); FJZ1 (White chocolate ganache with 1 g. of infusion of Jazmin Flower), FJZ2 (White chocolate ganache with 2 g of infusion of Jazmin Flower), FJZ3 (White chocolate ganache with 5 g of infusion of Jazmin Flower).

Formula with Lavender Flower (FL); FL1 (Gel with 2 g of infusion with lavender flower), FL2 (Gel with 5 g of infusion with lavender flower), FL3 (Gel with 7 g of infusion with lavender flower).

2.1. Infusion-Based Extraction

For the Jasmine infusion, we employed a direct infusion method using milk to create the Jasmine ganache (Figure 1). The milk was heated to approximately 70–80°C to prevent any volatile compound degradation or flavor alteration caused by the sugars. Once heated, Jasmine flowers were added, and the saucepan was covered with the heat turned off, allowing the infusion to steep for 15 minutes to concentrate the aroma. The infused milk was then strained and combined with white chocolate. Finally, the mixture was transferred to a siphon and charged with gas to produce a jasmine ganache foam.

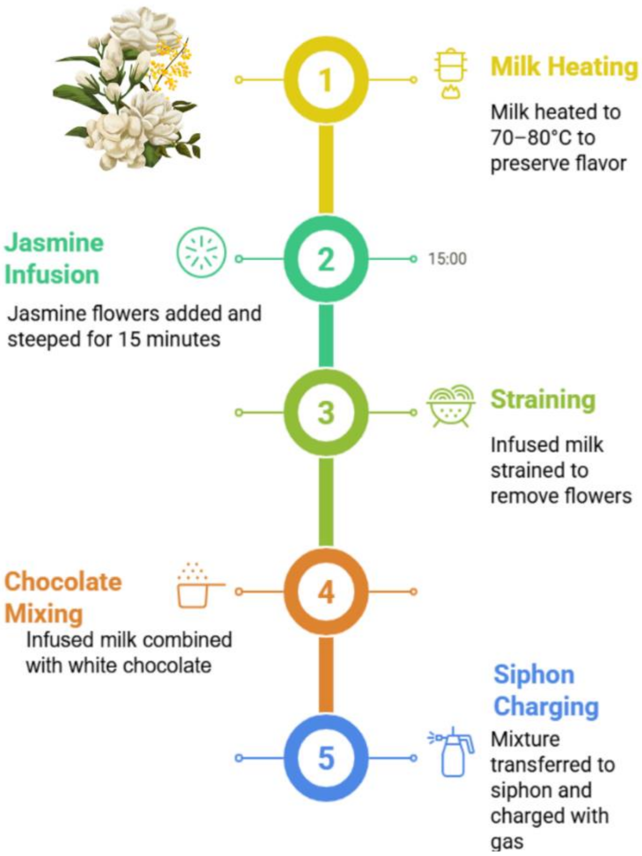

Figure 1. Jazmine ganache production flow chart.

2.2. Jamaica (Hibiscus) Infusion Process

The same infusion method was applied to Jamaica (Hibiscus), but with an aqueous base instead of milk (Figure 2). This substitution was necessary due to the citric acids present in hibiscus, which interact with milk casein. According to Cornejo and Párraga and Viteri et al (50,51), hibiscus has a pH range of 2.39–2.80, making water a more suitable medium. The resulting infusion served as the base for a classic pastry preparation, where it was stabilized using starch (corn starch). For the infusion, water was heated to approximately 95°C before adding dried hibiscus and cinnamon. The heat was then turned off, and the mixture was covered to allow the aromas and flavors to concentrate.

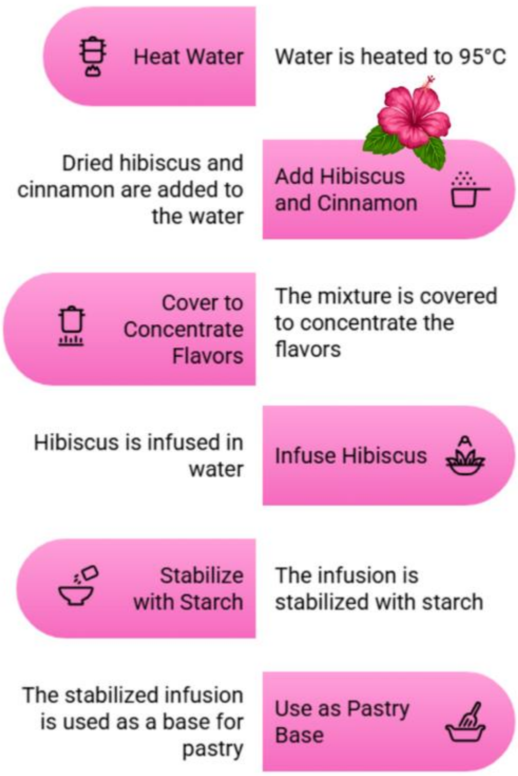

Figure 2. Hibiscus pastry cream production flow chart.

The Lavender gel was prepared using an infusion extraction method similar to that employed for hibiscus. Water was heated to 95°C, after which lavender and anise were added. The mixture was allowed to infuse for 15 minutes to maximize flavor extraction (Figure 3). Agar-agar was then incorporated while maintaining the temperature above 80°C, as it requires a melting point of 80–85°C and solidifies between 32–40°C (52). The agar-agar was added at a ratio of 1.5 grams per 100 milliliters of water to achieve a smooth, firm gel. Finally, the mixture was cooled and blended to create a silky lavender gel.

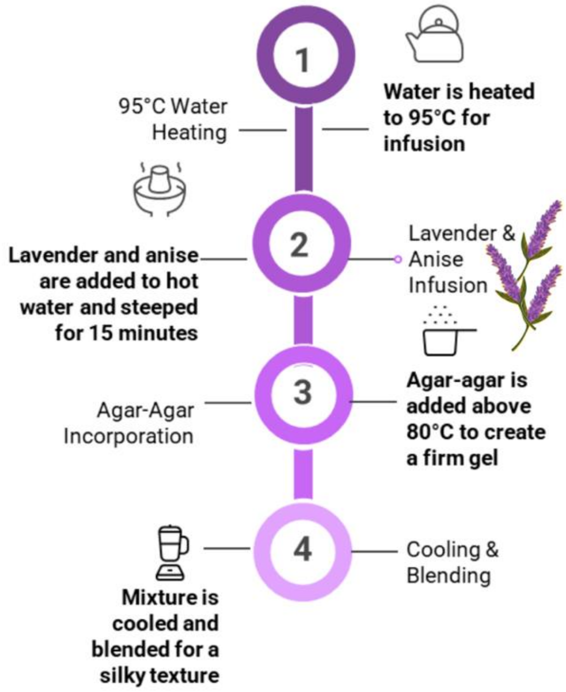

Figure 3. Lavender gel production flow chart.

2.3. Production of Formulation

To prepare the pastry cream infused with hibiscus flower, the milk was heated, the hibiscus flower was added, allowed to infuse, strained, and heated again. The egg yolks were whitened with sugar, the hot milk was added again, tempered with the yolks, and cooked until it reached 83°C. Then, the hydrated gelatin was added, the mixture was allowed to cool, and the cream was folded in. It was poured into molds to freeze, and once frozen, it was placed in an alginate bath for 2 minutes to specify the hibiscus pastry cream. For the preparation of the ganache infused with jasmine flowers, the white chocolate was finely chopped, while in a saucepan, the cream infused with jasmine flowers was heated. The mixture was poured over the chopped white chocolate, and once melted, it was mixed until the mixture was homogeneous. Once the mixture cooled, it was combined with cream, and we filled the siphon, introduced a charge, and could pour the foam. As for the lavender gel, the water was heated to a boil, the lavender and anise flowers were added, and allowed to infuse. The mixture was strained, the liquid was heated, sugar, agar-agar, and xanthan gum were added, brought to a boil, poured into molds, and left to freeze until firm.

2.3.1. Texture and Baking Characteristics of The Inclusion of Flower into Pastry Preparations

Regarding the infused pastry cream, it was observed that when hibiscus flower is incorporated into this preparation, a more viscous texture is generated, and the natural creaminess of the pastry cream is diminished, possibly due to the flower's acidity. As for the white chocolate ganache infused with jasmine flower, no texture changes were observed only in flavor intensity, perhaps due to the fatty element that composes the ganache. In contrast to the lavender gel, where a color change was observed, no texture changes were noted, possibly due to the gel's inherent consistency.

2.3.2. Formulation and Tests

To test the inclusion of a flower into pastry preparations, we began with three bases pastry recipes as a pastry cream with three different amount of Jamaica Flower (Table 1), white chocolate ganache with the infusion of Jazmin flower in three different amounts (Table 2), and finally a gel recipe with three amounts of lavender flower (Table 3).

Table 1. Ingredients of each formula with Jamaica Flower (FJM).

Ingredients	(FJM1)	%	(FJM2)	%	(FJM3)	%
Jamaica Flowers	20	4.91	15	3.69	25	6.14
Water	250	61.43	250	61.43	250	61.43
Sugar	50	12.29	50	12.29	50	12.29
Egg yolk	60	14.74	60	14.74	60	14.74
Gelatine	3	0.74	3	0.74	3	0.74
Cornstarch	20	4.91	20	4.91	20	4.91
Gluconolactate	4	0.98	4	0.98	4	0.98
Total	407	100	402	100	412	100

Table 2. Ingredients of each formula with Lavanda Flower (LVD).

Ingredients	(LVD1)	%	(LVD2)	%	(LVD3)	%
Lavanda Flowers	2	0.53	5	1.33	7	1.87
Water	250	66.67	250	66.67	250	66.67
Sugar	50	13.33	50	13.33	50	13.33
Agar Agar	1	0.27	1	0.27	1	0.27
Xantana	1	0.27	1	0.27	1	0.27
Anise	1	0.27	1	0.27	1	0.27
Honey	40	10.67	40	10.67	40	10.67
Lemon	30	8.00	30	8.00	30	8.00
Total	375	100	378	100	380	100

Table 3. Ingredients of each formula with Jazmin Flower (JZM).

Ingredients	(JZM1)	%	(JZM2)	%	(JZM3)	%
Jazmin Flowers	1	0.24	2	0.48	5	1.20
Milk Cream	200	48.08	200	48.08	200	48.08
Whipped Milk Cream	100	24.04	100	24.04	100	24.04
Gelatin	3	0.72	3	0.72	3	0.72
Star Anise	2	0.48	2	0.48	2	0.48
White chocolate	100	24.04	100	24.04	100	24.04
Sugar	10	2.40	10	2.40	10	2.40
Total	416	100	417	100	420	100

2.4. Sensory Evaluation

A sensory evaluation of nine samples made with flower preparation as seen in Figure 4 (FJM1, V2, FJM3, FJZ1, FJZ2, FJZ3, FL1, FL2, FL3) was conducted with a panel of experts. This evaluation utilized both a Likert scale and a star diagram to identify additional sensory characteristics perceived by the expert panel. Furthermore, the sensory evaluation was conducted with an expert panel (n=10). The sensory evaluation utilized a nine-point scale: "Dislike Extremely", "Dislike Very Much", "Dislike Moderately", "Dislike Slightly", "Neutral", "Like Slightly", "Like Moderately", "Like Very Much" and "Like Extremely". The 9-point hedonic scale, developed by the U.S. Army in the 1950s (53), is widely utilized in food science to assess preferences for various food items. This scale is defined as follows: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely (53). A sensory adaptation of this scale has been employed to evaluate the perceived intensities of taste qualities, including salty, sweet, sour, and bitter (54). For instance, Drewnowski and colleagues implemented a 9-point sensory scale where 1 corresponds to at all and 9 to sensation being assessed (54). To the best of our knowledge, both the sensory and hedonic 9-point scales have traditionally been utilized as single-attribute scales, designed to reflect the gradations of sensation associated with a single characteristic (55). Consumer acceptability has been gauged using the 9-point hedonic box scale, articulated verbally with anchors such as at 1, at 9, and like nor dislike at 5 (56). The hedonic test is employed to evaluate the overall liking of a product using a nine-point hedonic scale, ranging from one, "Extremely dislike" to nine "Extremely like" (57). The primary application of hedonic scales in food science is to compare responses to different food items (57). The sensory properties of products have been assessed through acceptance tests, where samples are presented monadically, and the intensity scale method utilizing a 9-point Likert scale (58). There is potential for enhancing the hedonic scale for sensory evaluation, particularly in the development of mixed beverages containing lemongrass and agarwood. Notably, most sensory evaluations conducted in Indonesia employ a 5-point hedonic scale for quantification (59–63), while international researchers predominantly utilize the 9-point hedonic scale. The 9-point hedonic scale offers a broader range compared to the 5-point scale, thereby providing greater sensitivity in measurement (56,64–66). Furthermore, data analysis utilizing the 9-point hedonic scale can be refined through various statistical methods, yielding more robust analyses (67,68).

In this study, SPSS and Excel were used to analyze sensory evaluation data. A normality test was conducted to determine whether the studied variables met the assumption of normality. Subsequently, a homogeneity of variances test indicated that all sensory attributes followed a normal distribution. Levene's test was performed to evaluate the null hypothesis that group variances are equal. Finally, a one-way ANOVA and Tukey test were conducted.

To minimize potential bias, the sensory evaluation was conducted individually by each expert panelist under controlled conditions. Each panelist received all necessary materials, including product samples, drinking water for palate cleansing, response sheets, and writing instruments. Evaluations took place at the Faculty of Hospitality, Tourism, and Gastronomy at San Ignacio de Loyola University in Lima, Peru. In this study, the expert panel was composed of culinary professionals. As noted by Frøst et al. (69), professional chefs actively engage their senses and possess highly refined palates. Culinary experts draw on their extensive experience and training in food tasting to apply sensory evaluation methods effectively. This expertise enables them to identify aromas more efficiently and generate relevant sensory vocabulary with precision (69). When asked to provide sensory descriptors, chefs not only present a wide range of descriptors but also spontaneously propose culinary applications. This level of proficiency has led to their formal inclusion in sensory evaluation studies as expert panels (70).

In alignment with previous studies conducted by Boumail et al. (70) and Frøst et al. (69), we assembled an expert panel consisting of ten professional chefs from the Bachelor of Arts in Culinary Arts program at the Faculty of Hospitality, Tourism, and Gastronomy at San Ignacio de Loyola University in Lima, Peru. These chefs are recognized for their refined palates and rely on both sensory experience and formal training in food tasting to discern a wide range of flavors, textures, and other sensory attributes. This ability is well-documented in the literature on sensory analysis. Moreover, their expertise facilitated the generation of a diverse and nuanced set of sensory descriptors, essential for a comprehensive sensory evaluation. All participating chefs had prior experience with multiple sensory analysis sessions.

Moreover, we affirm that the necessary protocols for safeguarding the rights and privacy of all participants were implemented during the conduct of the current research. There was no coercion to participate, and full disclosure of study requirements and associated risks was provided. Participants were required to give verbal consent, and no participant data was released without their knowledge. Additionally, participants had the option to withdraw from the study at any time. Figure 4 shows the developed products, while Figure 5 outlines the sensory analysis steps. These components are synthesized in Figure 6, which provides a visual summary of the experimental design and the sensory evaluation procedure.

Figure 4. Developed products.

Figure 5. Sensory analysis procedure.

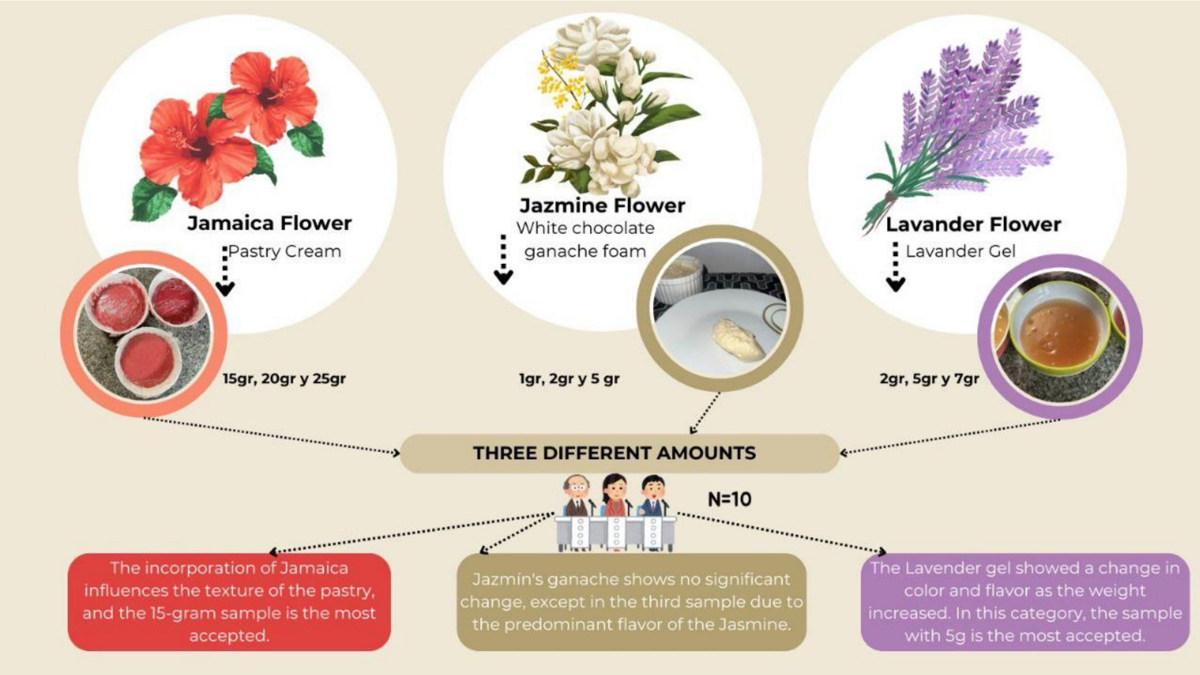

Figure 6. Experimental design and sensory evaluation procedure for hibiscus, lavender, and jasmine jelly samples.

3. Results and Discussion

Levene's test for equality of variances is a statistical test used to evaluate the null hypothesis that the variances among groups are equal. If the significance value (p-value), found in the “Sig”. column, is greater than 0.05, it indicates that the assumption of then homogeneity of variances is met (Table 4).

Table 4. Levene’s test for homogeneity of variances in texture, aroma, taste, color, aftertaste, and overall acceptance among jelly samples.

	Levene Statistic	df1	df2	Sig.
Aroma	.886	8	81	.532
Color	.361	8	81	.938
Taste	.341	8	81	.947
Texture	1.363	8	81	.225
Aftertaste	.333	8	81	.951
Overall_Acceptability	.334	8	81	.950

In other words, the variances between the groups are not significantly different, suggesting there are no significant differences in sensory variability across the samples.

From the table, it was found that the significance value, p 0.039, which is smaller than 0.05. When the p-value is less than 0.05; the null hypothesis is rejected. It can be concluded that there is a significant difference in the texture acceptance level between groups (Table 5 and Table 6). There is not a significant difference in the aroma, taste, color, aftertaste and Overall Acceptance level. There is a significant difference in texture analysis.

Table 5. One-way ANOVA results for sensory attribute ratings of edible flower jelly samples.

		Sum of Squares	df	Mean Square	F	Sig.
Aroma	Between Groups	31.289	8	3.911	1.702	.110
	Within Groups	186.100	81	2.298		
	Total	217.389	89			
Color	Between Groups	29.622	8	3.703	1.342	.235
	Within Groups	223.500	81	2759		
	Total	253.122	89			
Taste	Between Groups	45.422	8	5.678	1.232	.291
	Within Groups	373.200	81	4.607		
	Total	418.622	89			
Texture	Between Groups	61.200	8	7.650	2.161	.039
	Within Groups	286.800	81	3.541		
	Total	348.000	89			
Aftertaste	Between Groups	33.756	8	4.219	1.011	.435
	Within Groups	338.200	81	4.175		
	Total	371.956	89			
Overall Acceptability	Between Groups	30.000	8	3.750	.868	.547
	Within Groups	350.100	81	4.322		
	Total	380.100	89			

Table 6. Tukey HSD post-hoc analysis of sensory attributes (aroma, color, texture, taste and aftertaste) across samples.

Aroma			Color		Texture		Taste		Aftertaste	
F	N	Subset for alpha = 0.05	F	Subset for alpha = 0.05	F	Subset for alpha = 0.05	F	Subset for alpha = 0.05	F	Subset for alpha = 0.05
		1		1		1		1		1
FJZ1	10	4.70	FJZ2	5.40	FJZ1	4.30	FL1	4.30	FJZ3	4.40
FJZ2	10	4.80	FJZ3	5.50	FJZ3	4.30	FJZ2	4.70	FL1	4.40
FJM1	10	5.20	FJZ1	5.60	FJZ2	4.40	FJZ1	4.80	FJZ1	4.60
FJZ3	10	5.40	FL1	5.60	FJM3	5.00	FL3	5.00	FL3	4.60
FL1	10	5.70	FL2	6.30	FL1	5.50	FJZ3	5.30	FJZ2	4.70
FJM2	10	5.90	FJM1	6.60	FJM2	5.80	FL2	5.40	FL2	5.10
FL2	10	6.10	FJM2	6.70	FL2	6.00	FJM3	5.90	FJM3	5.40
FJM3	10	6.30	FJM3	6.80	FL3	6.00	FJM2	6.20	FJM1	5.80
FL3	10	6.40	FL3	6.80	FJM1	6.70	FJM1	6.60	FJM2	6.20
Sig.		.244	Sig.	.626	Sig.	.117	Sig.	.300	Sig.	.568

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10,000. Formulation (F)

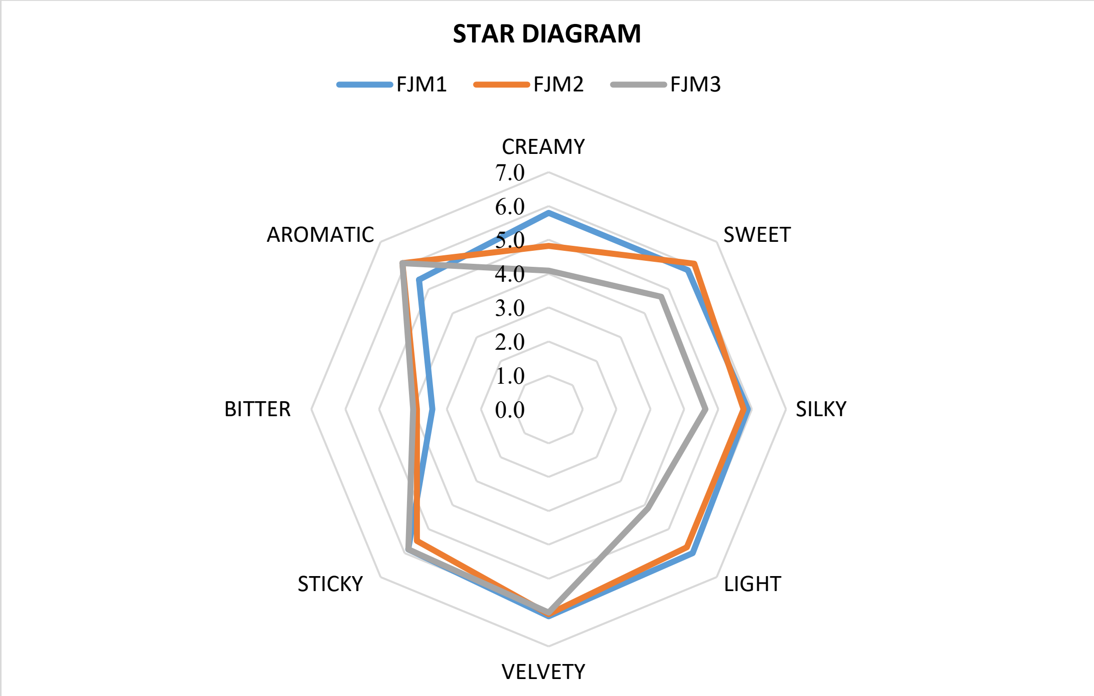

Figure 7. Star diagram of sensory attributes of the pastry cream with Jamaica flower (FJM1 (15g), FJM2 (20g), FJM3(25g)).

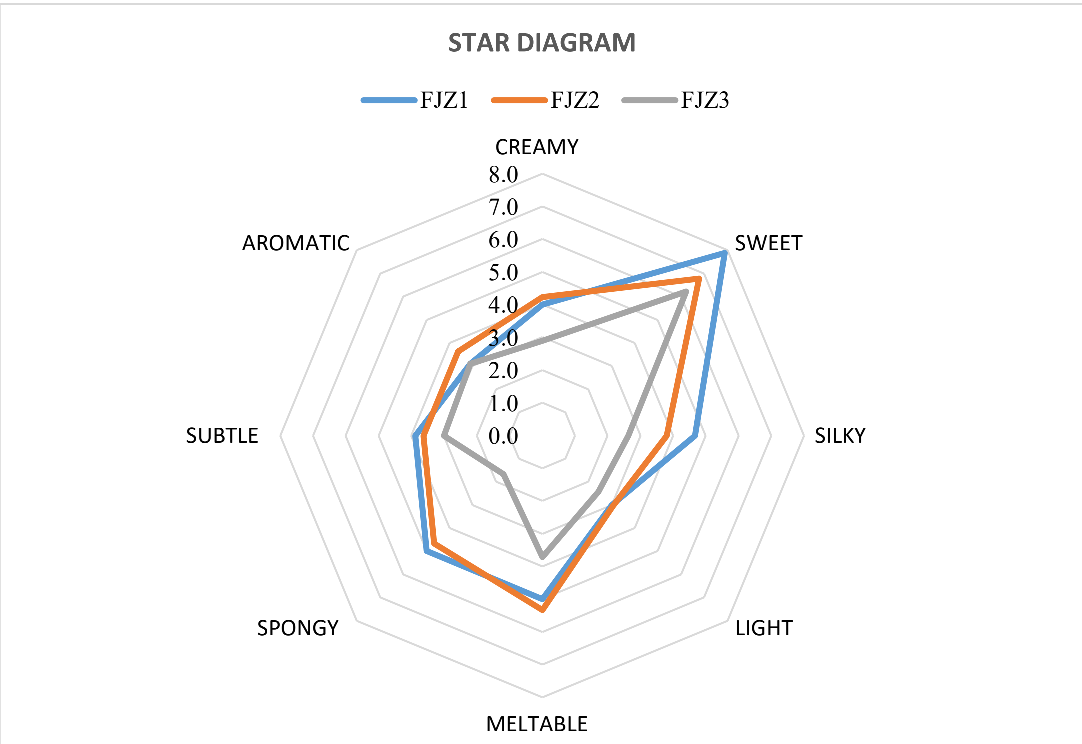

Figure 8. Star diagram of sensory attributes of the white ganache with Jazmin Flower (FJZ1 (1g), FJZ2 (2g), FJZ3(5g)).

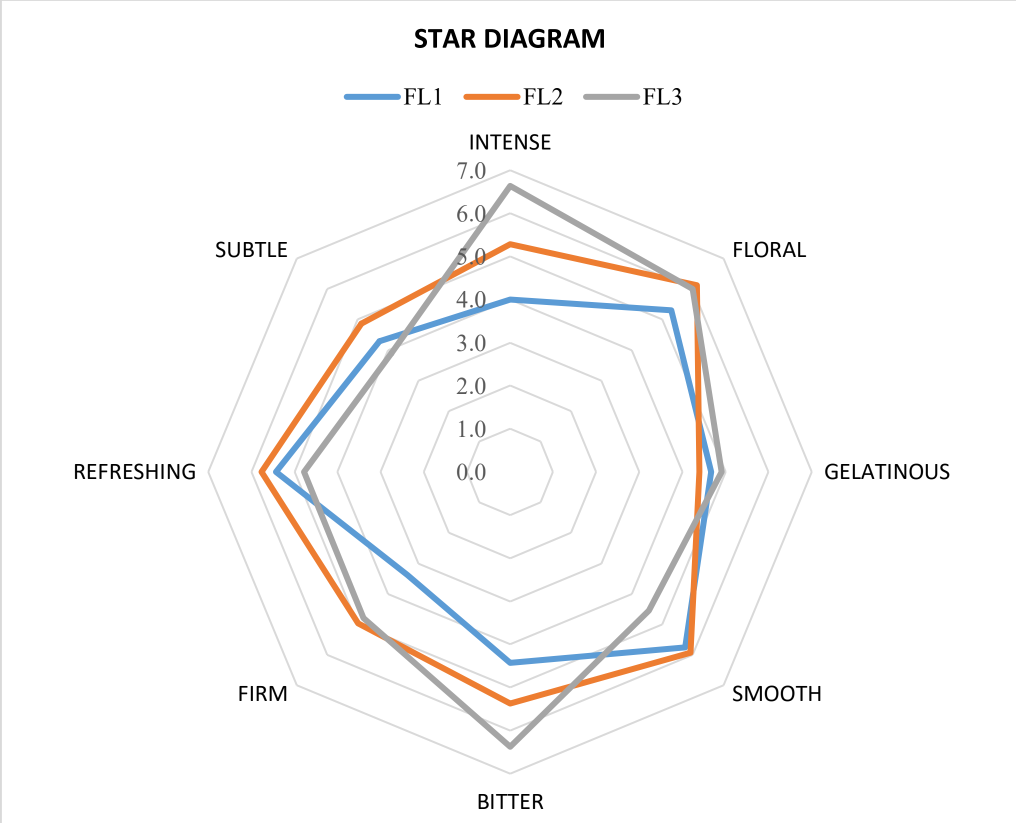

Figure 9. Star diagram of sensory attributes of the Gel with Lavanda Flower (FL1 (2g), FL2 (5g), FL3(7g)).

In our study, we demonstrated that Hisbiscus and Jasmine pastry products received the highest levels of acceptance (Table 7). Research conducted by Nicknezhad et al. examined the consumption of edible flowers in Iran, evaluating Chrysanthemum, marigold, yucca, gladiolus, and hibiscus flowers. Among these, Chrysanthemum exhibited the highest acceptability in terms of aroma and color, making it one of the most sought-after flowers. Similarly, in our study, the Jamaica pastry was favored for its taste, texture, and aroma. However, the yucca flower had a limited impact, particularly regarding its scent, which rendered it less appealing to tasters. In contrast, our research indicated that the Jasmine flower was slightly less favored than the other two, as it possessed a much more subtle flavor that was overshadowed by the other ingredients in the ganache. Our study found that the Jamaica flower demonstrated greater acceptance in the flavor category compared to the Jasmine and Lavender samples as seen in Figure 7,8 and 9. The aforementioned study employed the non-parametric Friedman test to assess the intensity of flavor, aroma, and color. It revealed that throughout the tasting process, hibiscus was the only flower that maintained its appeal; however, its aroma was among the lowest. This finding contrasts with our study, where sample 3 of Jamaica excelled in aroma, being the preparation with the highest concentration of Jamaica in the pastry cream (6).

Table 7. Descriptive analysis of expert panel ratings for texture, aroma, flavor, color, aftertaste, and overall acceptance.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Aroma	FJM1	10	5.20	1.751	.554	3.95	6.45	1	8
	FJM2	10	5.90	1.912	.605	4.53	7.27	2	8
	FJM3	10	6.30	1.494	.473	5.23	7.37	4	9
	FJZ1	10	4.70	1.160	.367	3.87	5.53	2	6
	FJZ2	10	4.80	1.317	.416	3.86	5.74	2	7
	FJZ3	10	5.40	.843	.267	4.80	6.00	4	7
	FL1	10	5.70	1.252	.396	4.80	6.60	3	7
	FL2	10	6.10	1.595	.504	4.96	7.24	3	8
	FL3	10	6.40	1.955	.618	5.00	7.80	2	9
	Total	90	5.61	1.563	.165	5.28	5.94	1	9
Color	FJM1	10	6.60	1.897	.600	5.24	7.96	2	8
	FJM2	10	6.70	2.003	.633	5.27	8.13	2	9
	FJM3	10	6.80	1.619	.512	5.64	7.96	4	9
	FJZ1	10	5.60	1.578	.499	4.47	6.73	3	8
	FJZ2	10	5.40	1.647	.521	4.22	6.58	2	8
	FJZ3	10	5.50	1.716	.543	4.27	6.73	2	8
	FL1	10	5.60	1.350	.427	4.63	6.57	3	7
	FL2	10	6.30	1.059	.335	5.54	7.06	5	8
	FL3	10	6.80	1.874	.593	5.46	8.14	4	9
	Total	90	6.14	1.686	.178	5.79	6.50	2	9
Taste	FJM1	10	6.60	2.221	.702	5.01	8.19	1	8
	FJM2	10	6.20	2.251	.712	4.59	7.81	1	8
	FJM3	10	5.90	2.132	.674	4.38	7.42	2	9
	FJZ1	10	4.80	2.098	.663	3.30	6.30	2	8
	FJZ2	10	4.70	1.767	.559	3.44	5.96	2	7
	FJZ3	10	5.30	2.111	.667	3.79	6.81	1	8
	FL1	10	4.30	2.111	.667	2.79	5.81	2	8
	FL2	10	5.40	2.011	.636	3.96	6.84	2	8
	FL3	10	5.00	2.539	.803	3.18	6.82	1	8
	Total	90	5.36	2.169	.229	4.90	5.81	1	9
Texture	FJM1	10	6.70	2.406	.761	4.98	8.42	1	8
	FJM2	10	5.80	2.394	.757	4.09	7.51	1	8
	FJM3	10	5.00	2.261	.715	3.38	6.62	2	8
	FJZ1	10	4.30	1.703	.539	3.08	5.52	2	7
	FJZ2	10	4.40	1.776	.562	3.13	5.67	2	7
	FJZ3	10	4.30	1.337	.423	3.34	5.26	2	7
	FL1	10	5.50	1.581	.500	4.37	6.63	3	8
	FL2	10	6.00	1.333	.422	5.05	6.95	4	8
	FL3	10	6.00	1.764	.558	4.74	7.26	3	8
	Total	90	5.33	1.977	.208	4.92	5.75	1	8
Aftertaste	FJM1	10	5.80	2.201	.696	4.23	7.37	2	8
	FJM2	10	6.20	2.150	.680	4.66	7.74	1	8

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
	FJM3	10	5.40	1.955	.618	4.00	6.80	2	8
	FJZ1	10	4.60	2.271	.718	2.98	6.22	2	8
	FJZ2	10	4.70	2.214	.700	3.12	6.28	1	7
	FJZ3	10	4.40	2.119	.670	2.88	5.92	1	7
	FL1	10	4.40	1.578	.499	3.27	5.53	2	7
	FL2	10	5.10	1.729	.547	3.86	6.34	2	7
	FL3	10	4.60	2.066	.653	3.12	6.08	2	7
	Total	90	5.02	2.044	.215	4.59	5.45	1	8
Overall Acceptability	FJM1	10	6.40	2.459	.777	4.64	8.16	1	9
	FJM2	10	6.10	2.234	.706	4.50	7.70	1	8
	FJM3	10	5.80	1.932	.611	4.42	7.18	2	8
	FJZ1	10	4.90	2.183	.690	3.34	6.46	2	8
	FJZ2	10	4.70	2.058	.651	3.23	6.17	2	7
	FJZ3	10	5.00	2.000	.632	3.57	6.43	2	7
	FL1	10	4.80	1.619	.512	3.64	5.96	2	7
	FL2	10	5.70	1.889	.597	4.35	7.05	2	8
	FL3	10	5.50	2.224	.703	3.91	7.09	2	8
	Total	90	5.43	2.067	.218	5.00	5.87	1	9

In a second study presented by Juliyarsi et al., the authors reported that the addition of *Clitoria ternatea* flowers significantly influenced the color of the candy due to their natural blue hue. In contrast, the lavender flower used in our sample did not produce a characteristic blue or violet color. This study indicates that *Clitoria ternatea* contains unique compounds that contribute to its vibrant blue color, thereby enhancing its visual appeal. However, the flower did not significantly affect the flavor, aroma, or texture of the candy. In our study of the Jamaican flower, we observed a noticeable impact on texture, with flavor notes that balanced between acidic and sweet, accompanied by a distinct and pleasant aroma (7). Our findings demonstrate a clear variation in the color of our products: the pastry cream exhibited a predominant cherry color, the jasmine ganache was yellow, and the lavender resulted in a medium pinkish cream color.

The incorporation of hibiscus flower extract into pastry cream resulted in a softer and less stable texture, which can be attributed to the disruption of protein interactions. Research indicates that anthocyanins derived from Hibiscus sabdariffa interact with milk proteins, thereby modifying the protein network and influencing viscosity and gelation within dairy matrices, as evidenced in our hibiscus-infused pastry cream. Prior investigations have explored the interactions between anthocyanins from Hibiscus sabdariffa and milk proteins (71). These studies demonstrated that anthocyanins bind to casein micelles and whey proteins through mechanisms such as hydrogen bonding and hydrophobic interactions, leading to alterations in the structural integrity of the protein network and subsequently affecting viscosity and gelation properties in dairy systems. In our research, the addition of hibiscus flower extract to pastry cream yielded a softer and less stable texture, likely due to compromised protein-protein interactions. The cited study, "Interaction of anthocyanins from Hibiscus sabdariffa with milk proteins: Impacts on stability and functional properties, casein and β-lactoglobulin, resulting in a decrease in α-helix content and an increase in random coil structures. Such modifications have implications for the solubility, emulsifying activity, and foaming capacity of the proteins. In summary, the integration of Hibiscus sabdariffa into dairy matrices can significantly alter texture and stability as a result of anthocyanin-protein interactions (71).

A study conducted by Abril et al. on the incorporation of edible flowers in sausage revealed that the flowers used Blue Borage, Rose, Geranium, and Witness did not exhibit a significant difference in color. Consequently, the researchers concluded that the edible flowers did not influence the product's color. When evaluating the aroma of their product through a panel of experts, they found that Geranium, Rose, and Witness had notably pronounced scents. As a result, they deduced that the addition of edible flowers alters the aroma of the product in which they are incorporated. This finding can be compared to our results, particularly with sample number 3 of each edible flower, as Jamaica 3, Jasmine 3, and Lavender 3 yielded average values of 6.30, 5.40, and 6.40, respectively, which are the highest values for each edible flower. Thus, it can be confirmed that our results closely align with those of this study. Additionally, this study assessed the flavor of their product, noting that Blue Borage received a score of 4.00 (good), followed by Witness at 3.73, Rose at 3.64, and Geranium at 3.33, with the latter three categorized as having a regular flavor. They concluded that the addition of flowers does not significantly alter the flavor of their product (1).

On the other hand, our research involving samples 2 and 3, with the exception of sample 1 from Jamaica, indicates that a significant change in flavor occurs due to the varying intensities of the flowers. However, in sample 1, which includes jasmine and lavender, there is no noticeable change in flavor attributed to the flowers, likely due to the lower dosage used. It is important to note that a hedonic scale was employed in the three investigations mentioned above.

At last, the study conducted by Kumar et al. (72) investigated the impact of floral extracts on the sensory acceptability, bioactive content, and shelf life of products made from African millet, oats, and a milk-based functional beverage (FB). Preliminary trials were performed using varying concentrations of rose syrup (8-14%) and marigold powder (0.40-0.55%), with optimal concentrations selected based on sensory evaluation. The chosen beverages underwent physicochemical analysis, evaluations of bioactive compounds, and storage stability studies at 4 ± 1 degrees Celsius. The results indicated that the optimal concentrations of rose syrup and marigold powder were 10% and 0.50%, respectively. A significant decrease in dietary fiber and beta-glucan content was observed following the addition of rose syrup. The rose-flavored beverage achieved the highest overall acceptability, with a score of 7.83 ± 0.23, and demonstrated storage stability of up to 50 days under refrigeration. The study concluded that floral extracts not only enhanced sensory acceptability but also improved the phytochemical profile and stability of the prepared beverages (72) . These findings align with the results obtained in our study on Jamaican pastry cream, jasmine ganache, and lavender jelly, where samples with higher flower content also exhibited high overall acceptability. In this study, Jamaican pastry cream sample 3 received the highest scores for odor and color, while sample 1 excelled in flavor and texture. Jasmine ganache revealed that sample 3, which contained a higher proportion of flowers, had superior flavor and overall acceptability. Similarly, lavender jelly performed best in odor and color in sample 3, while sample 2 excelled in flavor and overall acceptability. The consistency of high acceptability scores in both studies can be attributed to the meticulous formulation of the products and the careful selection of ingredients that enhance their organoleptic properties.

4. Conclusions

This study introduced a novel gastronomic proposal in which edible flowers play a central role in pastry innovation. Through the successful incorporation of hibiscus, lavender, and jasmine into dessert formulations, we demonstrated their potential to enhance flavor, aroma, color, and overall sensory appeal. Among the evaluated samples, hibiscus Sample 1, lavender Sample 2, and jasmine Sample 3 received the highest acceptance scores, confirming their promise for future applications in high-quality pastry products.

Our findings emphasize that even small quantities of edible flowers can significantly influence the sensory profile of desserts. While hibiscus strongly impacted texture and color, lavender enhanced aroma and visual appeal, and jasmine subtly affected flavor. These results underscore the importance of thoughtful formulation to balance aesthetic, sensory, and safety considerations.

Although edible flowers present exciting opportunities, their integration remains limited by concerns related to toxicity, sensory dominance, and consumer unfamiliarity. Our formulations addressed these issues through moderate, controlled inclusion levels. However, further research is needed to refine optimal dosages, assess long-term safety, and explore consumer perceptions particularly in the Peruvian context, where data remain scarce.

This work encourages culinary professionals to explore edible flowers as functional, creative ingredients. By combining traditional knowledge with modern sensory techniques, we hope to inspire pastry creations that are both visually engaging and gastronomically meaningful.

Acknowledgements

Not applicable.

Author Contributions

K.K., M.G. and J. A., P.S. writing - original draft, data curation and product development; B.M., S. L., B.M., A.L. conceptualization, methodology, writing - original draft, writing - review & editing.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Data Availability Statement

Invalid.

Conflicts of Interest

Authors may declare no conflict of interest.

References

1. México M, Maribel L, Carvajal A, Superior I, Tungurahua T, Freddy AE, et al. Adición de flores comestibles en la elaboración de un embutido escaldado tipo pastel mexicano. Cienc Lat Rev Científica Multidiscip. 2022 Nov;6(5):4015–32.
2. Fernandes L, Casal S, Pereira JA, Saraiva JA, Ramalhosa E. Edible flowers: A review of the nutritional, antioxidant, antimicrobial properties and effects on human health. J Food Compos Anal. 2017 Jul;60:38–50.
3. Rodrigues H, Cielo DP, Goméz-Corona C, Silveira AAS, Marchesan TA, Galmarini M V., et al. Eating flowers? Exploring attitudes and consumers' representation of edible flowers. Food Res Int. 2017 Oct;100:227–34.
4. Pires TCSP, Dias MI, Barros L, Ferreira ICFR. Nutritional and chemical characterization of edible petals and corresponding infusions: Valorization as new food ingredients. Food Chem. 2017 Apr;220:337–43.
5. Kaisoon O, Siriamornpun S, Weerapreeyakul N, Meeso N. Phenolic compounds and antioxidant activities of edible flowers from Thailand. J Funct Foods. 2011 Apr;3(2):88–99.
6. Nicknezhad S, Hashemabadi D, Allahyari MS, Marzban S, Ben Hassen T, Surujlal J. Sensorial analysis of factors influencing consumers' perceptions toward the consumption of edible flowers in Iran. J Agric Food Res. 2023 Jun;12:100580.
7. Juliyarsi I, Melia S, Setiawan RD, Pangestu S. Sensory Properties of Dadih Jelly Candy with The Addition of Clitoria Ternatea Flower Extract. J Nutr Sci. 2023 May;4(1):17–21.
8. Gentscheva G, Milkova-Tomova I, Buhalova D, Pehlivanov I, Stefanov S, Nikolova K, et al. Incorporation of the Dry Blossom Flour of Sambucus nigra L. in the Production of Sponge Cakes. Mol 2022, Vol 27, Page 1124. 2022 Feb;27(3):1124.
9. Iancu ML. Edible flowers in novel foods: primary studies in the manufacture of flower compote of acacia (Robinica pseudoacacia), rose (Rosa damascena) and elder (Sambucus nigra). 27(2):164–71.
10. Lestari PD, Kawiji, Yulviatun A, Martien R, Muhammad DRA. Physical and sensory characteristics of milk and white compound chocolate added with Asian pigeonwings flower (Clitoria ternatea). E3S Web Conf. 2021 Dec;332:01001.
11. Sik B, Ajtony Z, Lakatos E, Gál LH, Székelyhidi R. Evaluation of the physical, antioxidant, and organoleptic properties of biscuits fortified with edible flower powders. Food Sci Nutr. 2024;12(5):3265–72.
12. Jadhav HB, Badwaik LS, Annapure U, Casanova F, Alaskar K. A Review on the Journey of edible flowers from farm to consumer's plate. Appl Food Res. 2023;3(2).
13. Borges C, Santos S, Cruz M, Marques B, do Carmo V, Furtado M. From the Field to the Pot: Phytochemical and Functional Analyses of Calendula officinalis L. Flower for Incorporation in an Organic Yogurt. 2019;
14. Pires TCSP, Dias MI, Barros L, Barreira JCM, Santos-Buelga C, Ferreira ICFR. Incorporation of natural colorants obtained from edible flowers in yogurts. Lwt. 2018;97:668–75.
15. Qiu L, Zhang M, Mujumdar AS, Chang L. Effect of edible rose (Rosa rugosa cv. Plena) flower extract addition on the physicochemical, rheological, functional and sensory properties of set-type yogurt. Food Biosci. 2021;43:101249.
16. Podgórska-Kryszczuk I, Pankiewicz U. Assessment of the fungistatic properties of Calendula officinalis L. water extract and the effect of its addition on the quality of

wheat bread. Appl Sci. 2023;13(12):7286.
17. Hnin KK, Zhang M, Wang B. Development of nutritional properties in cookies with the incorporation of different levels of rose flower powder by microwave-vacuum drying. Dry Technol. 2021;39(9):1136–48.
18. Madane P, Das AK, Pateiro M, Nanda PK, Bandyopadhyay S, Jagtap P, et al. Drumstick (Moringa oleifera) flower as an antioxidant dietary fibre in chicken meat nuggets. Foods. 2019;8(8):307.
19. Purohit SR, Rana SS, Idrishi R, Sharma V, Ghosh P. A review on nutritional, bioactive, toxicological properties and preservation of edible flowers. Futur Foods. 2021;4:100078.
20. Santos IC dos, Reis SN. Edible flowers: traditional and current use. Ornam Hortic. 2021 Nov;27(4):438–45.
21. Benítez G, Molero-Mesa J, González-Tejero MR. Wild Edible Plants of Andalusia: Traditional Uses and Potential of Eating Wild in a Highly Diverse Region. Plants. 2023 Mar;12(6):1218.
22. Wen H, Li S, Wei Y, Dong J, Liang Z, Guo L, et al. Yunnan edible flowers and their potential in future foods: focus on ethnological applications, chemical and pharmacological research. J Futur Foods. 2025 Mar;5(2):119–33.
23. Chetia I, Vijayakumar A, Badwaik LS. Edible flowers' flavor, safety and their utilization as functional ingredients: a review. J Food Sci Technol. 2024 Sep;1–13.
24. Yang J, Gu T, Lu Y, Xu Y, Gan RY, Ng SB, et al. Edible Osmanthus fragrans flowers: aroma and functional components, beneficial functions, and applications. Crit Rev Food Sci Nutr. 2024 Oct;
25. Guiné RPF, Florença SG, Moya KV, Anjos O. Edible Flowers, Old Tradition or New Gastronomic Trend: A First Look at Consumption in Portugal versus Costa Rica. Foods 2020, Vol 9, Page 977. 2020 Jul;9(8):977.
26. Anitha C, Tharakan ST. Phytochemical and pharmacological properties of five different species of jasminum. Plant Arch. 2021;21(2):126–36.
27. Li D, Tang X, Liu C, Li H, Li S, Sun S, et al. Jasmine (Jasminum grandiflorum) Flower Extracts Ameliorate Tetradecanoylphorbol Acetate Induced Ear Edema in Mice. Nat Prod Commun. 2020 Apr;15(4).
28. Lis-Balchin M. Lavender: The Genus Lavandula -. Taylor & Francis. 2002.
29. Farag MA, Rasheed DM, Kamal IM. Volatiles and primary metabolites profiling in two Hibiscus sabdariffa (roselle) cultivars via headspace SPME-GC-MS and chemometrics. Food Res Int. 2015;78:327–35.
30. Zannou O, Kelebek H, Selli S. Elucidation of key odorants in Beninese Roselle (Hibiscus sabdariffa L.) infusions prepared by hot and cold brewing. Food Res Int. 2020;133:109133.
31. Pieracci Y, Pistelli L, Lari M, Iannone M, Marianelli A, Ascrizzi R, et al. Hibiscus rosa-sinensis as Flavoring Agent for Alcoholic Beverages. Appl Sci 2021, Vol 11, Page 9864. 2021 Oct;11(21):9864.
32. Indah D, Sari K, Mayangsari FD, Pratiwi ED, Pratiwi D. Optimization of the Mixing of Hibiscus Flower (Hibiscus rose sinensis) Extract as a Lip Balm Color with Variations in Concentration. J Fundam Appl Pharm Sci. 2023 Sep;4(1):38–45.
33. Ramadurga B, Jat RK, Badami S. Macro-Microscopic Identification of Dried Flowers of Hibiscus rosa-sinensis L. and its Differentiation from Adulterant Rhododendron

arboreum Sm. Pharmacogn J. 2019;11(3):608–12.
34. Yıkmış S, Türkol M, Abdi G, İmre M, Alkan G, Türk Aslan S, et al. Culinary trends in future gastronomy: A review. J Agric Food Res. 2024 Dec;18:101363.
35. Friel Blanck J. Molecular Gastronomy: Overview of a Controversial Food Science Discipline. J Agric Food Inf. 2007;8(3):77–85.
36. Ruiz J, Calvarro J, Sánchez del Pulgar J, Roldán M. Science and Technology for New Culinary Techniques. J Culin Sci Technol. 2013;11(1):66–79.
37. Domínguez-Aguirre LR, Samaniego-Gancino RF. La cocina molecular. Una revisión sistemática de la literatura. Rev Gastron y Cocina. 2023 May;2(1).
38. Duarte-Casar R, Rojas-Le-Fort M. Desmitificando la Esferificación. Rev Gastron y Cocina. 2022 Oct;1(1):2022.
39. Caporaso N, Formisano D. Developments, applications, and trends of molecular gastronomy among food scientists and innovative chefs. Food Rev Int. 2016 Oct;32(4):417–35.
40. Heymans R, Tavernier I, Dewettinck K, Van der Meeren P. Crystal stabilization of edible oil foams. Trends Food Sci Technol. 2017 Nov;69:13–24.
41. Hu X, Meng Z. An overview of edible foams in food and modern cuisine: Destabilization and stabilization mechanisms and applications. Compr Rev Food Sci Food Saf. 2024 Jan;23(1):e13284.
42. García-Segovia P, Garrido MD, Vercet A, Arboleya JC, Fiszman S, Martínez-Monzo J, et al. Molecular Gastronomy in Spain. J Culin Sci Technol. 2014;12(4):279–93.
43. Rocio B, León S, Superior I, La T, Ecuador M, Saúl F, et al. Guía para la Elaboración de Pastelería para Adultos Mayores con Enfermedad de Diabetes. Cienc Lat Rev Científica Multidiscip. 2023 Jan;7(6):7338–50.
44. Huang Q, Wu Y, Xu X, Cheng X, Tao Y, Jing X, et al. Designing novel ice creams using nut oil emulsion gels based on blueberry pectin and CaCl2 as fat replacers: Insights from physicochemical and sensory properties. Int J Biol Macromol. 2024 Nov;279:135344.
45. Stankov SS, Fidan HN, Hristov TG, Nikovska KN. Physical and sensory characteristics of edible foams obtained with nitrous oxide. IOP Conf Ser Mater Sci Eng. 2021 Jan;1031(1):012115.
46. Cai Q, Zhong Y, Xu M, Huang Q, Lu X. 3D printed high oil custard cream: Effects of whey protein isolate, hydroxypropylated starch and carrageenan on physicochemical properties and printing performance. LWT. 2022 Feb;156:113039.
47. de Wijk RA, van Gemert LJ, Terpstra MEJ, Wilkinson CL. Texture of semi-solids; sensory and instrumental measurements on vanilla custard desserts. Food Qual Prefer. 2003 Jun;14(4):305–17.
48. Neuwirth V, Lapčíková B, Lapčík L, Valenta T, Míšková Z. Effect of technological processing and recipe formulation on the physico-chemical properties of ganaches and chocolate pralines. J Food Eng. 2024 Oct;378:112124.
49. Lapčíková B, Lapčík L, Valenta T, Neuwirth V. Chocolate Ganaches: Formulation, Processing and Stability in View of the New Production Trends. Foods 2024, Vol 13, Page 2543. 2024 Aug;13(16):2543.
50. Cornejo LA, Párraga RC. Capacidad antioxidante y contenido fenólico de una bebida a base de la flor de jamaica (Hibiscus sabdariffa). Cienciamatria. 2021;7(12):229–49.
51. Viteri Borja JG, Párraga Alava RC, García Mendoza JJ, Barre Zambrano RL, Romero Bravo JP. Calidad fisicoquímica y sensorial de cerveza artesanal estilo blonde ale con infusión

de flor deshidratada de jamaica (Hibiscus sabdariffa). Manglar. 2022;19(4):331–9.
52. Oñate KPL. Uso de agar-agar para la elaboración de gelatinas transparente talladas en 3D. Mag las Ciencias Rev Investig e Innovación. 2021;6(2):44–54.
53. Peryam DR, Haynes JG. Prediction of soldiers' food preferences by laboratory methods. J Appl Psychol. 1957;41(1):2.
54. Drewnowski A, Henderson SA, Shore AB, Barratt-Fornell A. Nontasters, tasters, and supertasters of 6-n-propylthiouracil (PROP) and hedonic response to sweet. Physiol Behav. 1997;62(3):649–55.
55. Kalva JJ, Sims CA, Puentes LA, Snyder DJ, Bartoshuk LM. Comparison of the hedonic general labeled magnitude scale with the hedonic 9-point scale. J Food Sci. 2014;79(2):S238–45.
56. Yang J, Lee J. Korean consumers' acceptability of commercial food products and usage of the 9-point hedonic scale. J Sens Stud. 2018;33(6):e12467.
57. Osunbade OA, Ajiboye TS, Adisa OA, Olatunji O, Oyewo I. Evaluation of consumers acceptability of cassava cooked paste (EBA) using 9-points hedonic, jar, and cata methods. Int J Multidiscip Res Publ(IJMRAP). 2021;4(4):48–54.
58. Fibri DLN, Marsono Y, Murdiati A, Putro AW, Putri RG. Sensory properties of gluten-free cookies high in dietary fiber. Canrea J Food Technol Nutr Culin J. 2024;230–45.
59. Adrianar N, Batubara R, Julianti E. Value of consumers preference towards to agarwood tea leaves (Aquilaria malaccensis Lamk) based on the location of leaves in the trunk. Peronema For Sci J. 2015;4(4):12–6.
60. Larasati A, Issutarti I. The analysis of consumer preferences on mulberry leaves tea as an antioxidant-enriched product. In: 2nd International Conference on Accounting, Management, and Economics 2017 (ICAME 2017). Atlantis Press; 2017. p. 41–51.
61. Batubara SC, Pratiwi NA. Pengembangan minuman berbasis teh dan rempah sebagai minuman fungsional. J Ind Kreat dan Kewirausahaan. 2018;1(2).
62. Wangiyana I, Triandini I, Anita Nugraheni YMM. Hedonic test of agarwood tea from Gyrinops versteegii with different leaves processing method. J Ris Ind Has Hutan. 2021;13(2):99–110.
63. Triandini IGAAH, Wangiyana IGAS. Mini-review uji hedonik pada produk teh herbal hutan. J Silva Samalas. 2022;5(1):12–9.
64. Feng Y, O'Mahony M. Comparison between American and Chinese consumers in the use of verbal and numerical 9-point hedonic scales and R-Index ranking for food and personal products. Food Qual Prefer. 2017;60:138–44.
65. Wangiyana IGAS, Nikmatullah A. A Mini Review on Agarwood Tea Development Towards Alternative Utilization of Agarwood Commodity in Indonesia: Mini Review: Agarwood Tea Development. Biol Sci. 2022;65(2):189–96.
66. Wichchukit S, O'Mahony M. The 9-point hedonic and unstructured line hedonic scales: An alternative analysis with more relevant effect sizes for preference. Food Qual Prefer. 2022;99:104575.
67. Wangiyana IGAS, Kurnia N, Triandini IGAAH, Fatihatum F. Sensory evaluation of palm sugar candy from Arenga sap water and agarwood leaves infusion using a 9-point hedonic scale. J Agrotek UMMAT. 2024;11(2):142–55.
68. Aini H, Kurnia N, Wangiyana IGAS. Sensory evaluation of lemongrass beverage mixed with agarwood infusion using 9-point hedonic scale. J Silva Samalas. 2024;7(2):28–35.
69. Frøst MB, Giacalone D, Rasmussen KK. Chapter 19 - Alternative methods of sensory

testing: Working with chefs, culinary professionals and brew masters. In: Delarue J, Lawlor JBBTRSPT (Second E, editors. Woodhead Publishing Series in Food Science, Technology and Nutrition. Woodhead Publishing; 2023. p. 441–60.
70. Boumail A, Girard F, Tanaka KH, Frøst MB, Turgeon SL, Perreault V. Sensory characterization of conifer-based extracts for culinary uses. Int J Gastron Food Sci. 2025;39:101078.
71. Wang Y, Wang S, Zhang X, Wu W, Bai W, Tian L. Non-covalent interactions of roselle anthocyanins with milk proteins and egg white protein. Food Hydrocoll. 2024;154:110125.
72. Kumar A, Kaur A, Tomer V, Gupta K, Kaur K. Effect of Rose Syrup and Marigold Powder on the Physicochemical, Phytochemical, Sensorial and Storage Properties of Nutricereals and Milk-Based Functional Beverage. J Am Coll Nutr. 2021;40(2):133–40.