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Sensorial analysis of factors influencing consumers' perceptions toward the consumption of edible flowers in Iran

Samira Nicknezhad [a], Davood Hashemabadi [a], Mohammad Sadegh Allahyari [b], Soroush Marzban [c], Tarek Ben Hassen [d,*], Jhalukpreya Surujlal [e]

[a] Department of Horticulture, Rasht Branch, Islamic Azad University, Iran
[b] Department of Agricultural Management, Rasht Branch, Islamic Azad University, Rasht, Iran
[c] Department of Agricultural Extension and Education, School of Agriculture, Shiraz University, Shiraz, Iran
[d] Program of Policy, Planning, and Development, Department of International Affairs, College of Arts and Sciences, Qatar University, Qatar
[e] Faculty of Economic and Management Science, North-West University, South Africa

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ABSTRACT

Global consumers want more from their food, and adding edible flowers may improve the appearance of certain dishes. In Iran, some flowers, such as roses and saffron, have been utilized for over 3000 years. However, consuming editable flowers is a novelty and remains underutilized due to several socio-economic factors. Accordingly, this paper aims to determine the factors determining the acceptance and consumption of edible flowers in Iran and highlight the most popular of five edible flowers identified in Rasht County, Iran (chrysanthemum, marigold, gladiolus, yucca, and hibiscus). A four-stage investigation was carried out from 7 to September 30, 2020 to gather information on the evaluation of the flowers. The visual, aroma, and ability to consume and taste the flowers were all evaluated throughout these stages. After being chosen randomly, 82 residents of Rasht county, both male and female, from various socio-economic backgrounds, were invited to participate in the study. The research was based on a questionnaire consisting of six sections. The survey results suggested (i) most participants had previously consumed edible flowers, usually as herbal distillates and food garnishing; (ii) the viewing phase influenced the purchase and eating of edible flowers the most; (iii) the purple chrysanthemum was the most attractive flower, followed by orange marigold, white gladiolus, purple hibiscus, and yucca; (iv) the visual appeal of edible flowers was the essential element in the acceptability and readiness to eat these novel food resources; (v) the selection of edible flowers is influenced by a variety of factors, including product type, consumer experience, personal taste, budget, and social and cultural influences. Our findings indicated that edible flowers, such as those specified in the study, have several uses in cooking, promotion, and media representation beyond just being used as garnish or in salads. They can also be processed into valuable components and ingredients for desserts, aperitifs, and sweets. This highlights the potential for using edible flowers in beverages as well.

1. Introduction

Recently, a growing number of consumers have shown an interest in eating more aesthetically pleasing and healthy food. One major driver of this trend is the increasing interest in functional foods and nutraceuticals. These foods offer health benefits beyond essential nutrition, such as boosting immune function, aiding digestion, or reducing the risk of chronic diseases. As more research is conducted on the health-promoting properties of various foods, new and previously unknown beneficial foods are being discovered and marketed to consumers [1]. The increasing awareness of the relationship between diet and health has led to a greater demand for foods that taste good and provide nutritional benefits [2]. In particular, there has been a shift towards plant-based diets, with consumers seeking fruits, vegetables, whole grains, and other plant-based foods that are rich in nutrients and offer a range of health benefits [3,4].

In this context, new alternative foods, such as edible flowers (EF), whose sustainable production and high dietary content provide regular

* Corresponding author.
E-mail addresses: samira.nick.sn@gmail.com (S. Nicknezhad), Davoodhashemabadi@yahoo.com (D. Hashemabadi), allahyari@iaurasht.ac.ir (M.S. Allahyari), s.marzban@shirazu.ac.ir (S. Marzban), thassen@qu.edu.qa (T. Ben Hassen), Babs.Surujlal@nwu.ac.za (J. Surujlal).

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access to food, could be an option [5]. To be classified as edible, a flower must be nontoxic, innocuous, and have nutritious qualities [6,7]. Flowers have a long history of usage in human medicine, dating back to prehistoric times, for instance, in ancient Rome and Greece and also in China and India [8]. Especially in the Middle East, EF have been used as food and medicine since ancient times. In addition to their medicinal uses, EF have been an essential part of traditional Middle Eastern cuisine for generations. Some examples include using rose petals in desserts, such as rose-flavored ice cream or rose water syrup, and incorporating dried hibiscus flowers into tea [9]. However, their usage in everyday meals gradually became neglected in industrialized societies [10]. Contrary to widespread beliefs, flowers are more than mere decorative elements for savory dishes and desserts. They offer a distinctive blend of sensory experiences and enhance the nutritional value of food preparation [11].

More recently, the positive health effect evaluation and nutraceutical components of EF have advanced successfully, with great attention from the scientific community [12]. Consequently, with their culinary potential and favorable health benefits, EF have received increased interest, particularly among gourmet chefs [13,14]. Flowers are versatile ingredients that can be used in various dishes, including salads, soups, and baked goods, providing visual appeal and unique flavors. As a result, interest in EF is growing, and global sales of fresh, high-quality flowers for human consumption are expanding. Meanwhile, EF are offered at fancy restaurants and are a frequent subject of several magazine articles, providing an excellent illustration opportunity [15]. However, their usage in culinary preparations is more typically associated with special events, gourmet cuisine, and particular chefs' recipes or ideas [16].

In addition, many EF are a rich source of vitamins, minerals, and antioxidants, making them a healthy addition to meals. Indeed, EF contain vitamins, antioxidants, phenols, flavonoids, and minerals, especially when consumed in *natura* or minimally processed [17]. According to several studies [6,12,18,19], regular consumption of EF, mainly those rich in phenol and flavonoid chemicals, lowers the risk of developing cardiovascular disease, obesity, and cancer. Overall, flowers offer a unique combination of aesthetic appeal and nutritional benefits, making them a valuable ingredient in the world of cuisine. Consequently, generating contentment with the appearance and flavor of the flowers, as well as knowing their function in health improvement, may help integrate EF into the diet. In this context, studies on EF and socio-economic factors may help to introduce natural plants as new food sources [8]. Aside from the nutritional benefits, they are also simple to cultivate and adapt to the environment since they do not need pesticides or fertilizers to be grown, resulting in more sustainable and ecological farming [5]. However, EF generally remain underutilized due to several socio-economic factors [20].

Indeed, like other novel foods, consuming EF is influenced by several sensory factors. According to Pires et al. [21], color is essential in picking EF, just as it is with decorative flowers. Takahashi et al. [8] also state that floral scent piques customers' interest and encourages them to consume them as a meal. According to these researches, flower color, scent, taste, and texture are essential in choosing and consuming EF. Some researchers, for instance, Guiné et al. [22], who have examined the influence of social-demographic factors on the consumption of EF, find that consumption of these flowers, particularly in salads, rises as educational level increases. Guiné et al. [22] discovered that flavor was the most critical element in choosing and eating EF. In another research, Guiné et al. [16] found that flower color was a distinguishing quality highly valued by EF consumers. Chen and Wei [23] highlighted that curiosity and aroma seem to be the most influential characteristics influencing consumer views about the intake of EF as "ready to eat". Furthermore, according to Purohit et al. [20], consumer approval and preference for EF vary by location. For instance, in some countries, EF consumption is higher in tribal belts and rural regions than in urban areas.

Different variables impact food choices and eating patterns, such as biological, physiological, cultural, economic, and political issues [24,25]. Additionally, because each country has a unique cultural past, consumers' interest and acceptance of unknown items vary by country [26]. Indeed, in certain European countries, such as England, Spain, or Italy, the use of EF is popular [27]. However, it is less common in other South American countries, such as Brazil [28]. For instance, in Iran, some flowers, such as roses and saffron, have been utilized in local cuisine for over 3000 years. Saffron and rosewater are commonly used in traditional dishes such as sholezard (a sweet rice pudding) and baklava (a sweet pastry) [29]. However, using EF for dishes is a novelty. Today, some well-known EF may be grown in Iran, such as marigold (*Tagetes erecta* L.), hibiscus (*Hibiscus syriacus*), gladiolus (*Gladiolus grandiflora*), and yucca (*Yucca gloriosa*). Marigold, chrysanthemum, yucca, gladiolus, hibiscus phenols, flavonoids, and antioxidants have promoted these flowers as novel food sources.

Although the edibility of these flowers has been established, people are still hesitant to consume them, and there is little information on the marketing and supply of these plants for producers. Despite the growing popularity of EF, their increasing use in cooking, and their potential for improving the nutritional content of food, little is known about consumer attitudes towards EF and their role in the food industry [23]. This information will be valuable in understanding the potential for EF as a food item and the opportunities for their use in the food industry. Additionally, research into consumer knowledge of EFand their health benefits will help promote this food item's use and support its continued popularity. Overall, the limited research on consumer attitudes toward EF highlights the need for further investigation in this area.

Accordingly, it is essential to explore consumers' attitudes regarding these foods and their willingness to accept or consume them, given the recent introduction of a new food source. In addition to the flower's nutritional content and health benefits, elements such as gender, age, educational level, geographical area, personal qualities, price, and supply manner all have a role [8]. Hence, consumers must prioritize sensory preferences for EF to be more widely accepted by consumers [20]. Accordingly, this paper aims to determine the factors determining the acceptance and consumption of EF in Iran, as well as to highlight the most popular of five EF identified in Rasht County, Iran (*chrysanthemum, marigold, gladiolus, yucca, and hibiscus*).

2. Materials and methods

2.1. Plant materials

The study focuses on Rasht County in Iran's Guilan Province. The county, and the province of Guilan in general, which is situated in northern Iran, has Mediterranean weather with mild temperatures, abundant water supplies (average annual rainfall of 1500 mm), and rich soil. Consequently, the province is one of Iran's most important agricultural centers, particularly for producing rice and olive oil [30,31].

Among the most well-known EF are *gladiolus, chrysanthemum, marigold, yucca, and hibiscus*. These flowers may be prevalent in Rasht County's green areas during different times of the year. For our research, White gladiolus (*Galdiolus* sp.) and purple spray chrysanthemum (*Chrysanthemum morifloium*) were purchased from florists. Orange marigold (*Tagetes erecta* L.), yucca (*Yucca elephantipes*), and purple hibiscus (*Hibiscus syriacus*) were collected from the parks and green spaces located in Rasht county in September 2020. The flowers were trimmed with 1 cm of their peduncles and gathered during the chilly hours of the day. The entirely undamaged and uniform flowers were separated, placed in covered containers, and frozen at 4 °C until the experiment period.

2.2. Responding panel members and questionnaire development

In order to collect information on the assessment of the flowers, a study consisting of four stages was carried out from 7 to September 30,

2020. These stages included the examination of the flowers' visuals, scent, ability to be consumed, and taste. In total, 82 residents of Rasht county, chosen randomly, both male and female, from various socio-economic backgrounds, were invited to participate in the study. A questionnaire was designed in light of the outcomes of the investigation conducted by Kelley et al. [32].

The study followed the principles outlined in the Helsinki Declaration, and the Islamic Azad University Human Subjects Institutional Review Board authorized all methods involving research study participants. Participation in the research was voluntary and without financial compensation. Before consenting to privacy and information management rules, all participants were informed about the research's purpose and context.[1] The questionnaire was divided into six sections: 1) Participants' socio-demographic features (e.g., age, family size, educational level, income, etc.); 2) Participants' consumption of EF and their purpose; 3) Visual (e.g., How appealing is it for you? How much do you like to taste it? etc.); 4) Smelling (e.g., How desirable is it for you? etc.); 5) Consumption (e.g., I'll use it in food garnishing, I'll purchase this flower in the future, etc.); 6) Taste (e.g., How appealing is it for you after tasting? How desirable is it for you after tasting? etc.).

In the first and second stages of the study, the participants evaluated the flowers by looking at and smelling them. They then stated how pleased they were with the flowers' appearance and how desirable they found them. The next question was whether or not they wanted to try them. In the last step, participants were questioned about the contexts in which they would use EF, given the options: garnishing dishes, preparing salads, and producing pickles or jams.

Participants were also asked to offer their perspectives on various topics, such as buying, cultivating, growing, and promoting flowers to others. After the participants tasted the flowers, they were questioned about their perceptions of the flowers' sweetness, bitterness, sourness, and astringency. After that, they expressed their eagerness to try the flavors. After tasting each flower, the participants wiped their lips clean so that the taste of the flower that came before it would not remain on their tongues. This helped reduce the number of errors that were made. The items were assessed by the participants on a scale of 0 (least satisfied) to 10 (most satisfied) (the highest level of satisfaction).

2.3. Data collection and analysis

The time between preparing the flowers and testing and evaluating the qualities was less than 24 h. The flowers were cleaned with distilled water 2 h before the panel began. After drying, the peduncles were removed from the flowers and packed in clear covered containers. The containers were labeled with the flower names and distributed separately to the responders. After tasting each flower, participants were given a bottle of mineral water with the sample to rinse their lips. Following that, the questionnaire was completed by the participants. The test was conducted in a conference hall of the Department of Agriculture at Rasht Branch, Islamic Azad University, with suitable lighting, ventilation, temperature, and comfortable chairs. During the 40-min test, respondents rated the EF regarding scent, fragrance, taste, and flavor from 0 (least satisfied) to 10 (most satisfied) based on their notion of ideal quality and with no prior instruction. It should be mentioned that they assessed the flowers concurrently and individually and could not share their thoughts on the flower's qualities or complete the questionnaire. The study involved only adult participants (18 years and older).

Regarding data analysis, the statistical software SPSS and Microsoft Excel were used to analyze the variance and mean comparisons. The results were presented both descriptively and inferentially. The nonparametric Friedman and Kruskal-Wallis tests were used to compare the flowers' attractiveness and desirability. A Chi-square analysis was performed at each stage to test the correlation between attractiveness and desirability. The Kruskal-Wallis and Mann-Whitney tests were used in order to investigate the demographic characteristics. In the end, multivariate linear regression was used to describe the willingness to purchase based on the variables of desirability and attractiveness.

[1] Participants gave informed consent via the statement "I am aware that my responses are confidential, and I agree to participate in this survey" where an affirmative reply was required to enter the survey. They were able to withdraw from the survey at any time without giving a reason. The products tested were safe for consumption.

3. Results

3.1. Socio-demographic characteristics of the study participants and edible flower consumption history

The socio-demographic features indicate that the participants were, on average, 35 years old, with 67.1% female and 32.9% male. The majority of responders (42.7%) were part of four-person households. The most common educational level (36.6%) was a master's degree or more, while the majority of respondents (45.1%) had a monthly salary of less than 30 million IRR (Table 1). Regarding the history and way of EF intake, 76.8% of the participants said they had eaten EF before. The most popular intake methods were herbal distillates (61%), followed by food garnishing (50%) (Fig. 1).

3.2. Attractiveness and desirability of edible flowers

The participants evaluated the attractiveness and desirability of the EF at three stages: viewing, smelling, and tasting, as well as how they were consumed. The purple chrysanthemum was the most attractive in the viewing (M = 8.04; SD = 2.30) and smelling (M = 6.32; SD = 2.72) phases. The purple hibiscus (M = 5.78; SD = 1.48) and purple chrysanthemum (M = 5.78; SD = 2.37) were the most attractive after tasting the flowers.

The yucca had the lowest attraction at the viewing (M = 6.21; SD = 2.70), smelling (M = 4.05; SD = 2.87), and tasting (M = 3.73; SD = 2.30) phases. Also, the chrysanthemum and yucca were the most and least desirable species during the viewing and smelling phases. The purple hibiscus (M = 5.90; SD = 2.90) and purple chrysanthemum (M = 5.27; SD = 2.96) had the most desirability, while the yucca (M = 3.77; SD = 2.09) received the lowest. In addition, after seeing the flowers, the participants showed the greatest desire to taste the purple

Table 1
Descriptive statistics of the participants' demographic attributes (n = 82).

Variable		Frequency	Percentage
Age (year)	<25	20	24.4
	25–35	22	26.8
	35–45	18	22
	>45	22	26.8
Gender	Female	55	67.1
	Male	27	32.9
Role in the household	Mother	27	32.9
	Father	20	24.4
	Adult leaving with his/her parents	35	42.7
Family size	2	9	11
	3	20	24.4
	4	35	42.7
	5 and greater	18	22
Educational level	Under diploma	16	19.5
	Diploma	14	17.1
	Bachelor's degree	22	26.8
	Master's degree or higher	30	36.6
Monthly income (million IRR)	<30	37	45.1
	30–50	36	34.9
	50–70	6	7.3
	>70	3	3.7

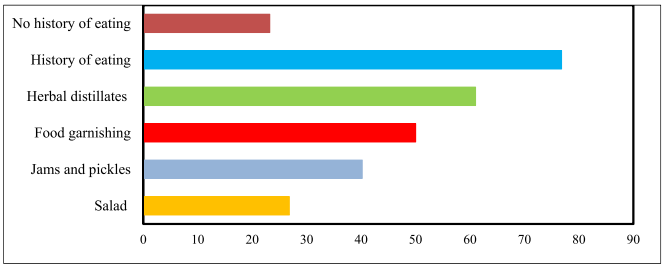

Fig. 1. Participants' consumption of EF and their purpose (n = 82).

chrysanthemum flowers and the least want to taste the white gladiolus flowers (Table 2).

The purple chrysanthemum was the most extensively utilized flower in garnishing meals, producing salads, and making pickles and jams during the flower consumption step. Furthermore, consumers were more eager to buy, grow, and suggest the purple chrysanthemum to others than the other flowers. The yucca and white gladiolus were the least popular as salad ingredients, jams, pickles, and meal garnishing. The yucca had the lowest readiness to buy (M = 4.5; SD = 3.08), while the willingness of consumers to cultivate and promote the gladiolus to others was found to be lower than the other flowers (Table 2).

3.3. Comparison of attractiveness and desirability of the studied flowers at the viewing, smelling, and tasting steps

Firstly, regarding the flowers' attractiveness, it was shown to be stronger during the viewing stage than during the smelling and tasting steps. The purple chrysanthemum and the yucca were the most and least attractive to the responders during the viewing stage. Furthermore, except for hibiscus, the attractiveness of all flowers was more significant at the smelling stage than at the tasting step (Table 2).

The nonparametric Friedman test was used to compare each flower's attractiveness at the three different steps: viewing, smelling, and tasting. The Friedman test was used to determine any significant differences in the ratings for each flower across the three steps. Based on the results, the attractiveness of the flowers was significantly ($P < 0.01$) higher at the viewing stage than at the smelling and tasting steps. As the participants proceeded from the viewing step to the tasting step, the flowers lost their attractiveness, except for the hibiscus, whose attractiveness was higher at the tasting stage than at the smelling (Table 3).

The Kruskal-Wallis test aimed at comparing the attractiveness of all five flowers within each step of the evaluation process, namely viewing, smelling, and tasting. Specifically, the Kruskal-Wallis test was used to determine if significant differences existed in the participants' ratings of the flowers' attractiveness and desirability at each step. According to the results of the Kruskal-Wallis test, the attractiveness of the studied flowers was significant ($P < 0.01$) at the viewing, smelling, and tasting steps. The purple chrysanthemum and yucca were the most and least appealing in all three stages, respectively (Table 4).

Secondly, regarding the desirability, the results revealed that the flowers were more desirable at the viewing steps than at the smelling and tasting stages. The purple chrysanthemum was the most desirable, and the yucca was the least desirable at the viewing step. The attractiveness of the flowers was more significant at the smelling stage than at the tasting step, except for the purple hibiscus, whose desirability was higher at the tasting step (Table 2).

The Friedman test also revealed that the difference in the desirability of the studied flowers was significant ($p < 0.01$) at the viewing, smelling, and tasting steps. Based on Table 5, the desirability of the flowers was decreased at the smelling and tasting steps versus the viewing step, except for the purple hibiscus and white gladiolus, whose tastes were more desirable than their smell (Table 5).

Table 6 shows that the attractiveness of the flowers evaluated was significant ($p < 0.01$) at the three steps of viewing, smelling, and tasting. The purple chrysanthemum was the most desirable during the seeing and smelling steps. Furthermore, the yucca had the lowest attractiveness throughout all three viewing, smelling, and tasting steps. According to the responders, the purple hibiscus had the greatest taste desirability of the flowers evaluated (Table 6).

Furthermore, participants were asked to score their willingness to taste each flower on a scale of 0 (none) to 10 (very much) throughout the viewing stages. Purple chrysanthemum and white gladiolus had the most significant and lowest willingness, respectively. Following the tasting, participants were asked to rate the desirability of the flavors. Purple hibiscus and white yucca had the greatest and lowest attractiveness, respectively (Table 2).

3.4. Relationship between attractiveness, desirability, and the flower purchase

The Chi-square test examined the connection between floral attractiveness throughout the viewing and smelling phase and purchasing. The link between attractiveness at the viewing stage and flower purchase was significant at the $p < 0.01$ level for the orange marigold, white gladiolus, purple chrysanthemum, and purple hibiscus and at the $p < 0.05$ level for the yucca (Table 7). The interaction between

Table 2
The attractiveness and desirability of the EF at different steps.

Step	Items (Scale of 0–10)	EF									
		Orange marigold		White gladiolus		Yucca		Purple chrysanthemum		Purple hibiscus	
		M[a]	SD[b]	M	SD	M	SD	M	SD	M	SD
1. Viewing	How appealing is it for you?	7.19	2.44	6.49	3.19	6.21	2.70	8.04	2.30	6.29	2.96
	How desirable is it for you?	7.02	2.67	6.63	2.91	5.83	3.04	7.69	2.43	6.33	2.99
	How much do you like to taste it?	5.63	3.23	5.29	3.41	5.43	3.23	6.33	3.27	5.71	3.44
2. Smelling	How appealing is it for you?	5.47	2.87	4.96	3.01	4.05	2.87	6.32	2.72	4.57	2.91
	How desirable is it for you?	5.84	2.81	4.88	3.05	3.93	2.80	6.09	2.77	4.48	3.15
3. Consumption	I'll use it in food garnishing.	6.06	3.43	4.84	3.51	4.85	3.41	6.74	3.34	5.18	3.49
	I'll use it in making salads.	5.16	3.77	4.11	3.39	4.02	3.23	6.06	3.64	4.84	3.49
	I'll use it in making jams and pickles.	4.56	3.80	3.56	3.32	3.61	3.25	4.98	3.73	4.17	3.53
	I'll purchase this flower in the future.	6.30	3.60	5.40	3.69	4.50	3.08	6.87	3.14	5.20	3.30
	I will grow it myself.	5.71	3.76	4.23	3.59	4.55	3.41	6.04	3.66	4.87	3.91
	I'll recommend it to others.	6.60	3.64	5.26	3.63	5.33	3.37	7.07	3.34	5.43	3.67
4. Tasting	How appealing is it for you after tasting?	4.5	1.51	4.88	2.66	3.73	2.30	5.78	2.37	5.78	1.48
	How desirable is it for you after tasting?	4.34	2.64	4.57	3.02	3.77	2.09	5.27	2.96	5.90	2.90

*Scores ranged from 0 (none) to 10 (very high).
[a] M: Mean.
[b] SD: Standard deviation.

Table 3
A comparison of the attractiveness of each flower based on the Friedman test.

Flower species	Mean rank			χ^2	*p*-value
	Visual attractiveness	Smell attractiveness	Taste attractiveness		
Orange marigold	2.62	1.81	1.57	55.19[a]	0.00
White gladiolus	2.30	1.85	1.84	12.93[a]	0.00
Yucca	2.54	1.80	1.66	42.06[a]	0.00
Purple chrysanthemum	2.59	1.76	1.66	50.92[a]	0.00
Purple hibiscus	2.40	1.68	1.92	24.64[a]	0.00

[a] *p*-value <0.01.

Table 4
A comparison of the attractiveness of the studied flowers based on the Kruskal-Wallis test.

Flower species	Mean rank		
	Visual attractiveness	Smell attractiveness	Taste attractiveness
Orange marigold	215.66	220.36	187.95
White gladiolus	196.07	201.46	205.07
Yucca	175.14	166.05	156.62
Purple chrysanthemum	257.66	255.37	241.77
Purple hibiscus	182.98	184.26	236.08
Kruskal-Wallis	25.89[a]	27.89[a]	29.19[a]
p-value	0.00	0.00	0.00

[a] *p*-value <0.01.

attractiveness at the smelling phase and flower purchase was significant at the $p < 0.01$ level for white gladiolus, purple chrysanthemum, and purple hibiscus, and at the $p < 0.05$ level for orange marigold, while it was negligible for yucca (Table 7).

The Chi-square test was used to examine the association between attractiveness at the viewing and smelling phases and the desire to buy the flower. According to the findings, attractiveness at the viewing stage significantly influenced marigold, chrysanthemum, and hibiscus purchases ($p < 0.01$). At the same time, the interaction between desirability at the viewing step and desire to buy was negligible for gladiolus ($p > 0.05$) and yucca ($p > 0.05$). (Table 8). The interaction between desirability at the smelling stage and flower purchase indicated that, except for the gladiolus, attractiveness at the smelling stage substantially affected the purchase of all flowers ($p > 0.05$). (Table 8).

3.5. Participants' willingness to consume edible flowers

According to the Kruskal-Wallis and Mann-Whitney tests, the only factor that significantly impacted the amount of yucca consumed was the individual's role within the household ($p < 0.01$). Other demographic characteristics, on the other hand, did not have any meaningful influence (Table 9).

In order to explain the inclination to consume EF based on the attractiveness criteria at the viewing, smelling, and tasting processes, multiple linear regression was utilized. It was revealed that the chrysanthemum and yucca flowers appealed at all phases of the experience,

Table 6
A comparison of the desirability of the studied flowers based on the Kruskal-Wallis test.

Flower species	Mean rank		
	Visual desirability	Smell desirability	Taste desirability
Orange marigold	218.13	236.04	188.80
White gladiolus	202.88	199.35	199.57
Yucca	171.93	162.21	165.17
Purple chrysanthemum	245.97	246.29	226.55
Purple hibiscus	188.59	183.62	247.40
Kruskal-Wallis	19.16[a]	29.38[a]	24.43[a]
p-value	0.00	0.00	0.00

[a] $p < 0.01$.

Table 7
The relationship between attractiveness at the viewing and smelling steps and the flower purchase.

Flower species	Visual attractiveness × flower purchase	Smell attractiveness × flower purchase
	χ^2	χ^2
Orange marigold	122.59[a]	140.69*
White gladiolus	133.26[a]	165.92[a]
Yucca	135.44*	121.63[ns]
Purple chrysanthemum	127.86[a]	180.25[a]
Purple hibiscus	157.30[a]	176.80[a]

[a] $p < 0.01$, *$p < 0.05$, and ns: non-significance.

Table 8
The relationship between desirability at the viewing and smelling steps and the flower purchase.

Flower species	Visual attractiveness × flower purchase	Smell attractiveness × flower purchase
	χ^2	χ^2
Orange marigold	179.36[a]	138.55[a]
White gladiolus	125.85[ns]	119.69[ns]
Yucca	119.42[ns]	141.21[a]
Purple chrysanthemum	162.92[a]	143.55[a]
Purple hibiscus	135.39[a]	128.63*

[a] $p < 0.01$, *$p < 0.05$, and ns: non-significance.

Table 5
A comparison of the desirability of each flower based on the Friedman test.

Flower species	Mean rank			χ^2	*p*-value
	Visual desirability	Smell desirability	Taste desirability		
Orange marigold	2.52	1.95	1.53	47.87[a]	0.00
White gladiolus	2.42	1.77	1.80	25.27[a]	0.00
Yucca	2.43	1.82	1.75	26.37[a]	0.00
Purple chrysanthemum	2.54	1.82	1.65	44.97[a]	0.00
Purple hibiscus	2.27	1.64	2.09	19.79[a]	0.00

[a] *p*-value <0.01.

Table 9
Participants' willingness to consume based on their demographic attributes.

Flower species	Orange marigold	White gladiolus	Yucca	Purple chrysanthemum	Purple hibiscus
Kruskal-Wallis					
Age	3.31^{ns}	1.95^{ns}	2.53^{ns}	0.69^{ns}	3.48^{ns}
Role in the household	1.38^{ns}	1.39^{ns}	7.15[a]	1.75^{ns}	2.64^{ns}
Family size	6.22^{ns}	9.00^{ns}	10.62^{ns}	7.55^{ns}	12.55^{ns}
Education	5.09^{ns}	2.59^{ns}	1.27^{ns}	3.14^{ns}	1.38^{ns}
Monthly income	3.40^{ns}	7.58^{ns}	4.91^{ns}	1.14^{ns}	5.90^{ns}
Mann-Whitney					
Gender	657.50^{ns}	694.50^{ns}	646.0^{ns}	615.00^{ns}	732.50^{ns}

[a] $p < 0.05$, and ns: non-significance.

including viewing, smelling, and tasting. This significantly affected the desire of responders to eat them ($p < 0.01$). The attractiveness of the white gladiolus and the purple hibiscus during the viewing and smelling steps, respectively, impacted the willingness of the participants to purchase them at the $p < 0.01$ and $p < 0.05$ levels. Additionally, the orange marigold was the only flower whose attractiveness during the smelling phase significantly improved respondents' inclination to eat it. This was due to the orange marigold's unique scent ($p < 0.01$). (Table 10).

The multivariate linear regression test characterized the desire to consume based on desirability factors at the viewing, smelling, and tasting steps. The regression model was found to be significant ($p < 0.01$). Their desirability highly impacted participants' willingness to consume the purple chrysanthemum and yucca at all three steps. The willingness to consume the marigold, gladiolus and hibiscus was substantially ($p < 0.01$) affected by attractiveness at the viewing, smelling, and tasting phases (Table 11).

Finally, the studied flowers could be arranged in the order of the chrysanthemum (83.28), marigold (74.38), hibiscus (68.75), gladiolus (65.1), and yucca (59.81) from the highest to the lowest level of acceptance, based on the results of 13 questions asked in four steps and the sum of the mean scores given by the participants (Fig. 2).

4. Discussion

The findings indicated that over two-thirds of the participants had previously consumed EF, usually as herbal distillates and food garnishing. According to Kelley et al. [33] and Guiné et al. [22], most of their respondents utilized EF in salad garnishing or preparation, which is consistent with our results. In Guiné et al. [16] study, the primary reasons for using EF in cuisine were food garnishing, taste and flavor, freshness, and aroma. However, in the current study, participants exhibited higher readiness to consume flowers at the viewing stage than at the tasting step.

As is the case for other food categories, the selection of EF is a complex and challenging process for consumers. Several factors can influence consumers' food selection process, including the type of product, the individual's past experience with the food item, their personal preferences and taste, their available budget, and the influence of social and cultural factors [23,34]. Furthermore, while selecting EF, some individuals evaluate unusual combinations, aesthetic elements, color, taste, flavor, scent, and shape and refer to these criteria during decision-making [18,23]. The sensory evaluation of EF involves assessing various characteristics, such as appearance, aroma, taste, and texture, to determine their overall quality and appeal. Based on our findings, the analyzed flowers may be ranked in the order of the most to least attractive and desired flowers: purple chrysanthemum, orange marigold, white gladiolus, purple hibiscus, and yucca.

However, the attractiveness and desirability at the tasting phase were radically different from the viewing and smelling steps. Participants stated that the purple hibiscus and yucca had the highest and least pleasant and desired tastes, respectively, with the purple chrysanthemum, white gladiolus, and orange marigold falling between these two extremes. These findings, however, were not unexpected and highlighted the influence of color, shape, and scent on the attractiveness and desirability of flowers while seeing and smelling them. However, the tasting findings revealed that qualitative elements impact the attractiveness and desirability of EF in addition to aesthetic traits. According to Kelley [33,35], size, shape, color, and above all, fragrance and taste are the main criteria in the quality assessment of EF. From the perspective of these researchers, flower color endows the foods a beauty in addition to nutritional and medicinal values. It is important in EF's sales, attractiveness, and marketability. Chitrakar et al. [36] state that color is the first sensory feature observed by consumers. The fragrance also is highly effective in attracting consumers and stimulating their curiosity, causing motivation for the consumption of EF. In general, color and fragrance are essential factors in selecting EF as food sources. The present research resulted in the same conclusion.

When all five flowers were viewed, their attractiveness and desirability were more significant than when they were smelled. This demonstrates that color, visual elements, and smelling sense stimulation are more important in food selection than oral senses, aroma, taste, and texture. The means for the flowers at the viewing and tasting phases are compared to corroborate this notion. When the flowers were viewed, participants may have been influenced by their overall appearance, including the colors and shapes of the petals and the way they were arranged or presented. In contrast, when the flowers were smelled, participants may have been more focused on the specific scent of each flower and how it related to their personal preferences.

Further, participants were asked to rate their readiness to taste each of the five flowers presented to them during the viewing stage. The researchers were interested in understanding how participants' initial perceptions of the flowers would affect their willingness to taste them. After the viewing stage, participants were asked to taste each flower and re-evaluate their attractiveness and desirability. The researchers found that participants were more willing to taste the flowers during the viewing stage than during the tasting stage. This could be attributed to

Table 10
Participants' willingness to consume the flowers based on the variables of attractiveness.

Flower species	Visual attractiveness	Smell attractiveness	Taste attractiveness	Constant	R^2	F
Ornage marigold	0.23^{ns}	0.36[a]	0.17^{ns}	1.30^{ns}	0.38^{ns}	16.15[a]
White gladiolus	0.25[a]	0.30[a]	0.20^{ns}	0.40^{ns}	0.29^{ns}	10.59[a]
Yucca	0.33[a]	0.21[a]	0.23[a]	0.65^{ns}	0.43^{ns}	19.64[a]
Purple chrysanthemum	0.29[a]	0.32[a]	0.24[a]	0.39^{ns}	0.37^{ns}	15.80[a]
Purple hibiscus	0.25*	0.35[a]	0.14^{ns}	0.88^{ns}	0.40^{ns}	17.93[a]

[a] $p < 0.01$, *$p < 0.05$, and ns: non-significance.

Table 11
Participants' willingness to consume the flowers based on the variables of desirability.

Flower species	Visual attractiveness	Smell attractiveness	Taste attractiveness	Constant	R^2	F
Ornage marigold	0.35[a]	0.30[a]	0.17[ns]	0.74[ns]	0.43[ns]	19.93[a]
White gladiolus	0.32[a]	0.29[a]	0.20[ns]	0.07[ns]	0.37[ns]	15.38[a]
Yucca	0.21[a]	0.26[a]	0.25[a]	1.24[ns]	0.42[ns]	19.31[a]
Purple chrysanthemum	0.32[a]	0.24*	0.27[a]	0.86[ns]	0.41[ns]	18.62[a]
Purple hibiscus	0.38[a]	0.27[a]	0.11[ns]	0.62[ns]	0.44[ns]	20.92[a]

[a] $p < 0.01$, $*p < 0.05$, and ns: non-significance.

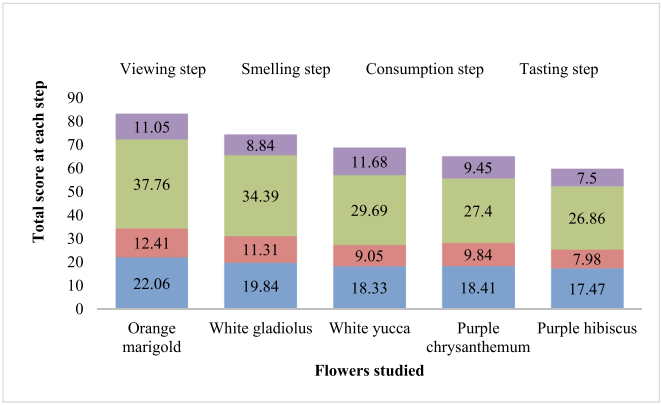

Fig. 2. A comparison of participants' overall acceptance of the studied flowers.

several factors, such as the anticipation of tasting something new and unique or the visual appeal of the flowers. However, once participants tasted the flowers, the desirability of all flowers decreased, except for the purple hibiscus, which participants expressed to have a slightly more satisfactory taste after tasting it. This finding suggests that participants' initial perceptions of the flowers may have influenced their willingness to taste them, but the taste itself was the ultimate factor in determining their desirability.

Liking a food item is the most crucial factor affecting consuming new foodstuffs. Interest in food or foodstuff includes accepting the main quality of its taste (sweetness, sourness, bitterness, saltiness, etc.) [37,38]. In nature, most toxins are bitter, so the non-acceptance of bitter foods is a survival instinct [39]. Humans can usually tolerate a small amount of bitterness in foods because this bitterness is often consistent with plants' nutritional and medicinal components. On the other hand, sweetness is intrinsically appealing and acceptable [40,41]. So, the sweet taste has higher acceptance, while the bitter taste is the opposite [39,42].

In the present work, the chrysanthemum and purple hibiscus, which had the highest taste and flavor acceptance, were sweet, and the bitter yucca had the lowest acceptance. Overall, if EF are to be eaten or bought, they must be aesthetically pleasing. Color, for example, influences consumer acceptance or rejection of new food products. Even if food is delicious and pleasurable, color and visual qualities impact its acceptability and desire [43]. For instance, choosing a color appropriate for selling EF is critical because color influences selection. Kelley et al. [33,44] conducted research in which participants watched and scored 27 images of meals, including EF. The findings revealed that color was the most significant component in decision-making (63%). As a result, the beauty and desirability of flowers are among the elements influencing people's propensity to buy and eat them.

Demographic features, such as age, gender, education level, income, and cultural background, significantly impact the acceptability of new food. Kelley et al. [35] discovered that demographic factors such as gender, age, education, and income substantially affected the purchase and consumption of EF. According to the results of the current study, the only element that influenced the purchase of the investigated EF was the role in the household (mother, father, or adult living with his/her parents), which had a significant effect solely on the purchase of yucca. As a result, unlike Kelley et al. [35], the selection and consumption of EF may be influenced by variables other than demographic characteristics.

Finally, the survey tool and instrument have limitations that affect the sample's representativeness. The primary limitation of this research is the sample bias. The study participants were randomly chosen, hired voluntarily, and not rewarded. Our study does not represent the general Iranian population. For example, individuals with a high degree of education and women were overrepresented in our sample. Further, we acknowledge that the gender distribution of the study population, which included 67% females, may have influenced the study results. While our results suggest that edible flowers were generally well-accepted among the study population, we recognize that gender may play a role in shaping preferences and attitudes towards novel food products such as edible flowers. Because of this bias, it is difficult to generalize the survey results to the entire Iranian population. Nonetheless, our study contributes valuable insights into the factors influencing consumers' perceptions toward the consumption of EF in Iran. Our findings will contribute to the existing literature on sensory analysis and consumer behavior and serve as a basis for further research in this area. Indeed, given these limitations, we believe that further research is necessary to explore the impact of gender on the acceptability of edible flowers among different populations. This would enable a more nuanced understanding of the factors that drive consumer acceptance of novel food products and could inform strategies to promote the consumption of edible flowers among diverse populations.

5. Conclusion

During the viewing and smelling phases, the purple chrysanthemum was considered the most beautiful and desirable of the flowers. However, participants chose the purple hibiscus as the most appealing in the tasting stage. The deep purple variety of the chrysanthemum was the most commonly used in salads, as a garnish, and in pickles and jams. Participants were more likely to recommend and buy the chrysanthemum than the other flowers. The appearance of the flowers was found to be more attractive than their scent and taste. Participants' willingness to consume the flowers increased after viewing but remained essentially unchanged after tasting.

The aesthetic appeal significantly influenced only 3 flowers (marigold, chrysanthemum, and hibiscus), but the visual beauty significantly impacted all the flowers. The scent of the yucca did not significantly affect the buying of white gladiolus. However, its fragrance did not significantly impact the purchase of the yucca itself. Family status was the only demographic factor that played a role in purchasing yucca, as demographic characteristics did not affect the desire to buy the researched EF. The participants generally gave the highest acceptance to the chrysanthemum and the least to the yucca.

Our research findings suggest that the potential uses of the EF specified in the study are not limited to just being a simple garnish and can be utilized in many creative and innovative ways in the culinary world. Indeed, they have various applications in cooking, promotion, and media representation beyond merely serving as a decorative addition to salads or as a garnish. These flowers can also be transformed into

valuable components and ingredients for various desserts, aperitifs, and sweets. This highlights the potential for using EF in beverages as well. Given their visually appealing qualities, it is likely that they will play a crucial role in the depiction of food in the media and among food enthusiasts and bloggers.

Further, our findings confirm that the sensory evaluation of EF is complex and multifaceted, and understanding the factors that influence participants' perceptions can help develop new food products and marketing strategies. By incorporating insights gained from sensory evaluation research, food producers and marketers can create unique and appealing products that cater to consumers' diverse preferences and tastes.

Consequently, two perspectives are suggested at each level. A first perspective is an artistic approach that explores the aesthetic use of flowers, such as incorporating them into ice cubes, cocktails, or colorants. The second perspective is a culinary and practical use, focusing on the sensory experience and the mastery of the craft, such as incorporating the flowers into hot infusions, syrups for cold drinks, ice creams, and "Eskamou." Further, using edible flowers in creative and artistic ways is becoming increasingly popular. With their natural beauty and unique characteristics, edible flowers provide a range of creative possibilities for chefs and mixologists. The artistic approach to edible flowers broadens the possibilities for using them aesthetically, such as in decorative elements for cocktails, as natural colorants in desserts, or as an edible garnish for various dishes. In the culinary world, edible flowers can be used as a natural ingredient to enhance the visual appeal of dishes.

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Data availability

The data that has been used is confidential.

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