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Sensory analysis of pansies subjected to different post-harvest technologies: high hydrostatic pressure, alginate coating and crystallisation

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Abstract

The present study aimed to investigate consumers' knowledge about edible flowers and post-harvest technologies through an online survey. Simultaneously, the effects of some post-harvest technologies (high hydrostatic pressure (HHP), alginate coating and crystallisation) on sensory characteristics of pansies were evaluated in loco by chefs and consumers. Most of the participants recognised edible flowers as a food component and had a favourable opinion about them. 79% were willing to pay more to acquire a product with a longer shelf-life. The sensory profiles of chefs and consumers were different; however, the scores for HHP were similar, except for the overall acceptance (p=0.025). The chefs rated the HHP pansies with the highest scores for visual appearance (p=0.015), texture (p=0.032) and overall acceptance (p=0.001). The consumers did not find significant differences in overall acceptance between treatments. So, this work gives important information about the consumers' opinion of edible flowers that can help the producers.

Keywords: edible flowers, post-harvest technologies, online survey, sensory analysis

Introduction

Floriphagia is the consumption of flowers as a food,[1] and it is an old practice that has now been again appearing. Edible flowers have gained popularity as a creative and innovative ingredient in the culinary world because they provide flavour, aroma, and colour. Gourmet chefs and consumers use flowers in culinary as solids (in dishes as roasts, salads, soups, cakes and jellies), liquids (alcoholic beverages, teas and cold drinks made from flowers), and in the form of flavourings (olive oils, other oils and vinegar).[2] However, the idea of eating flowers is still viewed with suspicion by some consumers. It involves a kind of neophobia (the reluctance to try novel foods), or sometimes they have difficulty in knowing which flowers can be ingested without having toxicity problems, as well as, they don't know how to use them in dishes or where to buy.[3]

Sensory analysis is an experimental method of food analysis, which provides information about the degree of food acceptance. It is also widely used for the determination of overall quality. Regarding edible flowers, there is little information on organoleptic appreciation by consumers or gourmet chefs. Only studies involving *Ageratum houstonianum, Antirrhinum majus, Begonia semperflorens, Borago officinalis, Calendula officinalis, Dianthus × barbatus, Fuchsia hybrid, Pelargonium peltatum, Petunia × hybrid, Tagetes erecta, Tropaeolum majus* and *Viola × wittrockiana*,[3] *Allium* species,[4] daylilies,[5] and viola, borage and nasturtium[6] were done until now. Furthermore, two more studies on consumers' attitudes toward edible flowers have been performed.[7,8] However, the organoleptic properties of edible flowers are subjective and consequently susceptible to change depending on the tastes of the consumers and the geographical area[3] and how the flowers are cooked and seasoned. Moreover, Kelley et al.[6] referred to the importance of flowers' colour. They verified that consumers preferred a mix of flower colours over single colours. Furthermore, some specific colour contrasts were preferred over others (the yellow and orange hues were the most preferred, while blue and combinations of other colours were less favoured). Concerning consumer's attitudes toward edible flowers, curiosity, aroma and health consciousness were factors with significant influence on the consumption of edible flowers.[7] Generally, the consumers associate food products made with flowers with "health care".[8]

Furthermore, there is no study about sensory analysis of edible flowers subjected to new post-harvest technologies. Until now, some new post-harvest technologies have been tested in edible flowers with good results, such as high hydrostatic pressure[9] and edible coating[10,11] in pansies, as well as crystallisation. The application of these technologies had the purpose to increase the shelf-life of this high perishable product and develop new forms of presentation. Until this moment, the unique technologies used by the industry are cold storage and hot air drying; however, both treatments have some drawbacks. Edible flowers stored in cold have a limited shelf-life (approx. 2 to 3 days), and heat may induce undesirable biochemical and nutritional changes in the processed product that may affect its overall quality. Therefore, the food industry is very interested in improving

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marketability of edible flowers, not only as fresh but also as processed products. In this sense, the finding of new food technologies able to increase the shelf-life of this product, will bring important economic benefits, beyond allowing the preservation of product quality for longer periods of time. So, it is essential to evaluate consumer and gourmet chefs acceptance and perception of organoleptic attributes because those technologies can affect flavour, taste and texture in edible flowers. Still, the opinions of consumers will help the edible flowers producers improve the characteristics that should be included in the final product and understand the importance of some sensory features that affect consumers in their purchase decision. So, the objectives of this work were to determine the sensory profile and consumers acceptability of pansies (*Viola* × *wittrockiana*) subjected to three post-harvest technologies (high hydrostatic pressure, alginate coating and crystallisation). Consumers and chefs were asked to participate in this study. The inclusion of chefs in a sensory panel is important because they are a relevant group that purchase and use edible flowers in their dishes and they have higher sensitivity to evaluate organoleptic changes than consumers. Furthermore, an online survey was done previously to understand the knowledge of the population on edible flowers and post-harvest technologies.

Materials and methods

Online survey

The questionnaire was placed on social networks websites or sent by email, and any person could participate in the study (https://docs.google.com/forms/d/1YJtu9nChXRqF64ym2EK-Za-zke3uiY-6fZsNUzCoyFo/edit). The total number of participants was 422. The first questions were about demographic information (gender, age, educational level and geographical origin). Afterwards, seventeen multiple-choice questions were performed to assess the knowledge of participants on edible flowers and post-harvest technologies, if they were consumers or users of edible flowers, and the habits of the respondents about consuming edible flowers. In more detail, consumers' knowledge of the use of flowers as a food ingredient, perceptions of shelf-life, opinions about their use, consumption habits, characteristics more valorised, and which words are more associated to edible flowers were surveyed. Furthermore, to evaluate the perception of participants on post-harvest technologies, five more questions were added. Their knowledge on some technologies was assessed, being asked: which technologies could be used on flowers; if these technologies can increase shelf-life of flowers; if they would be willing to taste flowers treated with post-harvest technologies; and what added value of the price they would be willing to pay.

Data were collected between June and July 2018. All ethical issues were followed when designing and applying the questionnaire, as well as, the confidentiality of the answers obtained was guaranteed.

Samples

Fresh pansies (*Viola*×*wittrockiana*) were bought in a store of edible flowers, and they were immediately transported to the laboratory under refrigeration.

Post-harvest Technologies

High Hydrostatic Pressure (HHP): Fresh pansies were placed into polyethene bags and treated at 75 MPa for 5 and 10 min, in a hydrostatic pressure vessel (55 L of volume) of hyperbaric equipment (Burgos, Spain), according to the best results obtained by Fernandes et al.[9]

Alginate coating

Fresh pansies were immersed in 0.5% (w/v) alginate solution (Panreac Química SA, Barcelona, Spain), prepared in sterile distilled water, for 30 min, according to the method described by Fernandes et al.[10,11] The residual alginate solution was left to drain for 5 min before immersion in 1% $CaCl_2$ solution (w/v) for 30 min to induce spontaneous cross-linking reactions. Surface water was carefully blotted using paper towels.

Crystallisation

Fresh pansies were painted with pasteurised egg white on the front and back of the flowers, using a fine brush. Then, they were sprinkled with sugar evenly over the wet petals, with the flowers placed down on paper. Flowers were stored under refrigeration (4°C) for about 48h. After this period, the flowers were stored at room temperature (approx. 20°C).

Sensory analysis

A sensory analysis was conducted to investigate the perceptions and acceptability of pansies subjected to the three post-harvest technologies by two customer segments. The two segments were defined as professional chefs (chefs who worked in gourmet restaurants) and typical consumers aged between 20 and 60. Chefs and consumers are both influential product users. Eight Portuguese gourmet chefs were recruited and selected on the basis that they already use or will possibly use edible flowers in their restaurants. Thirty consumers (24 females and 6 males) were recruited among the university community (students, teachers and other staff) from the Polytechnic Institute of Bragança (Portugal). All participants were screened for any related food allergies, and they signed a Statement of Voluntary Participation. The sensory analyses were carried out in July 2018. Three flowers of each treatment were presented to the panellists on a glass dish (100 mm × 15 mm), coded with 3-digit random numbers. The order of sample presentation was randomized, in order that the samples were presented in different positions to each panelist to minimize positional errors. The evaluators were provided with plain water. After being introduced to the objective of the study and the testing procedure, the participants were asked to rate five different organoleptic characteristics: visual appearance, odour, flavour, texture and overall acceptance. Concerning taste, if chefs/consumers felt a particular attribute, namely: sourness, astringency, spiciness and sweetness, they were also asked to rate it on a 9-point hedonic scale, from "dislike extremely" to "like extremely".

Furthermore, the following multiple-choice questions were asked: if they usually buy edible flowers; if they answered negatively, it was asked, why not?; if responded positively, it was asked what kind of flowers they buy; if they would buy this new product; which price they were willing to pay and what variety of dishes this new product would/might be included. Finally, they were asked to say what they liked and disliked more about the product, using open-ended questions.

Statistical analysis

SPSS Statistic software, version 18.0 (SPSS Inc., Chicago, USA), was used to the statistical treatment of the data. The Chi-Squared test was performed ($\alpha = 0.05$) to compare groups with different demographic characteristics (gender, age, geographic origin and educational level). To perform statistical analysis, due to the low number of responses of some of the groups, class joining was performed. For example, the educational classes were divided into two categories: college/technical

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degree and graduate, as well as the age (<30, 31-40, 41-50, >50 years). In sensory data analysis, to evaluate how the three post-harvest technologies can affect sensory attribute likings of the edible flowers, the Kruskal-Wallis non–parametric method was used, followed by multiple comparisons of order means as described in Maroco.[12] The Mann-Whitney test was used to evaluate the role of the participant's type (consumers and chefs). Spearman's correlation coefficients were determined to assess the presence or not of significant correlations between the measured parameters (ordinal scale).

Results and discussion

Online survey

Demographic information of participants

The demographic questions are described in Table 1, and they included age, gender, educational level and geographical origin. Of the 422 participants, 78.7% were female and 21.3% male. The age of most of the participants was between 20 and 40 (74.6%). Regarding education, the majority of the participants had a bachelor's degree (40.3%), followed by a master's degree (28.0%). Table 1 shows that 62.1% (n=262) of the participants were from the North of Portugal, 15.9% (n= 67) from the Centre and 13.0% (n=55) from other countries.

Table 1 Demographic information of participants on the online survey about edible flowers and post-harvest technologies

Variables	n (%)
Gender	
Female	332 (78.7)
Male	90 (21.3)
Age (years)	
<20	4 (0.9)
20-30	169 (40.0)
31-40	146 (34.6)
41-50	64 (15.2)
51-60	30 (7.1)
☐60	9 (2.1)
Education	
Basic Education	6 (1.4)
Secondary Education	80 (19.0)
Technical/ Professional degree	22 (5.2)
Bachelor's degree	170 (40.3)
Master's degree	118 (28.0)
Doctorate and post doctorate degrees	26 (6.2)
Geographical Origin	
North of Portugal	262 (62.1)
Centre of Portugal	67 (15.9)
South of Portugal	32 (7.6)
Islands (Azores and Madeira)	6 (1.4)
Other countries	55 (13.0)

Consumers' knowledge and habits about edible flowers' consumption

Most of the participants expressed knowledge on the use of flowers as a food component (94.5 %, n=399) and had a favourable opinion about them (73.5 %, n=310) (Table 2). However, only half of the respondents (54.0 %, n = 228) had already eaten edible flowers. Similar results were reported by Guiné et al.,[2] who stated that of the 100 participants in a direct survey, 91% mentioned knowing edible flowers. Nevertheless, a higher percentage of the participants (76.81%) had consumed edible flowers at least once. In our study, the group that never ate flowers (46.0 %) reported that the leading causes were because they can't easily find this product for sale (61.3 %) and did not know this product (17.0 %). This lack of consumption might be because edible flowers can only be sold in specialised points, not known to everyone.[13] However, according to Fernandes et al.,[13] there are several world flower producers and many places, which sell edible flowers with other vegetable crops. Furthermore, 93.8% of the group that never ate flowers was interested in tasting them, probably because unfamiliar foods catch the attention of consumers based on the induction of curiosity.[14]

The group of people that had already tasted flowers said that they had consumed the flowers fresh (89.1%), at restaurants (58.7%) or at home (36.1%). On the contrary to our results, Guiné et al.[2] reported that most of the participants ate for the first time edible flowers in their own homes (76%), while restaurants come in second (21%). Salads (57.0%), desserts (40.4%) and appetisers (36.8%) were the dishes where the flowers were most consumed. Between the words purposed to define edible flowers, the most associated were attractive/ appealing (54.0%), decoration (51.4%), colorful (50.0%), innovative (47.9%) and exotic (46.9 %). So, edible flowers for participants are associated with words that are related to the form of utilisation (decoration), sensory properties (colourful), liking (appellative/ attractive) and elements that denote new/unfamiliar food category (exotic and innovative). However, a small percentage of participants associated negative words to edible flowers, such as strange (6.9 %), toxic (1.4 %) and repulsive (0.7 %). The strange and repulsive words were associated with edible flowers because they can be considered unfamiliar to some participants. On the other hand, the "toxic" word was probably mentioned because some participants connected the presence of toxic compounds to some flowers.[15] The main reason to consume edible flowers was for decoration (49.3%). This high percentage may be related to the fact that most cookbooks and magazines include flowers and petals to decorate salads, sweet meals, ice creams and drinks.[16] Organoleptic (37.9%), medicinal (37.4%) and nutritional (36.7%) properties and the fact of edible flowers be considered a healthy product (36.7%), were also selected reasons by the participants. Other studies also reported that edible flowers were associated with a healthy product by the consumers.[7,9] Furthermore, the visual appearance (81.0%) and taste (59.7%) were the main characteristics valued in edible flowers, as we eat first with our eyes and then with our mouth.[6] Eating includes more than simply oral senses, flavour, and texture; it also involves colour, appearance, and stimulation of the visual senses.[17] Furthermore, Kelley et al.[6] mentioned that colour was the most influential factor when consumers purchase edible flowers. The odour (33.6%), flower species (14.2%) and size (6.2%) were properties less valorised by the participants of our survey.

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Consumers' knowledge and opinion about post-harvest technologies

Most of the participants thought that the shelf-life of flowers after harvest was up to two days (43.8%) and five days (43.8%) (Table 2). However, almost all agreed (96.2%) that post-harvest technologies can be used to increase the shelf-life of edible flowers. From the participants, most of them know refrigeration (77.0%), freezing (61.4%), crystallisation (44.5%) and hot air dehydration (39.8%). On the contrary, participants' awareness about radiation (16.4%), edible coating (15.9%), HHP (14.5%) and ohmic heating (6.2%) was low; most of them probably are 'unfamiliar' with these new post-harvest technologies. So, when asked, "Which are the post-harvest technologies that can be applied to increase shelf-life of edible flowers?" most of the participants reported those they knew best, such as refrigeration (57.0%), freezing (40.5%), crystallisation (36.5%) and hot air dehydration (32.3%). Most of the participants showed willingness to taste flowers treated with post-harvest technologies (88.4%) and pay more for flowers with a longer shelf-life (80.3%) (Table 2). However, the added price that they would be willing to pay were 1 euro more (35.1%), 3 euros more (33.4%) and 5 euros more (11.8%).

Table 2 Participants' answers to the online survey about edible flowers and post-harvest technologies

Variables	n (%)
Place where had tasted	
Restaurant	135 (58,7%)
Bakery	21 (9.1 %)
Events (ex: party, conference)	61 (26.5 %)
Home	83 (36.1 %)
Others (work, school, field)	10 (2.4 %)
How was the flower tasted	
Fresh	203 (89 %)
Dried	57 (25 %)
Crystallized	39 (17.1 %)
Preserved with syrup	1 (0.4 %)
Dishes where had tasted	
Salads	130 (57.0 %)
Appetizers	84 (36.8 %)
Meat dish	72 (32%)
Fish dish	40 (17.5 %)
Desserts	92 (40.4 %)
Drinks	44 (19.3 %)
Alone	32 (14.0 %)
Others (soup, cereals)	6 (1.4 %)
Characteristics valued in edible flowers	
Visual appearance	342 (81.0 %)
Odor	142 (33.6 %)
Taste	252 (59.7 %)
Size flower	26 (6.2 %)
Specie	60 (14.2 %)

Post-harvest technologies	They know	It can be used to increase the shelf-life of flowers
Refrigeration	325 (77.0 %)	228 (57.0 %)
Freezing	259 (61.4 %)	162 (40.5 %)
Hot air dehydration	168 (39.8 %)	129 (32.3 %)
Freeze-dried	128 (30.3 %)	96 (24.0%)
Crystallization	188 (44.5 %)	146 (36.5 %)
Osmotic dehydration	108 (25.6 %)	76 (19.0 %)
Edible coating	67 (15.9 %)	61 (15.2 %)
HHP	61 (14.5 %)	46 (11.5 %)
Radiation	69 (16.4 %)	21 (5.3%)
Ohmic heating	26 (6.2 %)	7 (1.8 %)
Didn't know	---	2 (0.5%)
Others	---	5 (1.2 %)

Relationships between demographic characteristics and attitudes/knowledge on edible flowers/post-harvest technologies

The participants' responses were divided into groups to test significant differences in edible flowers and post-harvest attitudes and knowledge based on gender, age, educational level and geographical origin. Concerning the topic "Have already tasted edible flowers?" no significant differences between gender (p=0.365), education level (p=0.365) and geographical origin (p=0.679) were detected. However, a statistically significant difference was found (p-value <0.01) for age. Younger participants (<30 years old) have tasted less edible flowers than the other age groups.

Concerning the questions "Can post-harvest technologies increase the shelf-life of flowers?" and "Are you willing to pay added-price for edible flowers with high shelf-life?", no significant differences between all demographic characteristics were detected (p>0.05).

Regarding knowledge on post-harvest technologies, statistically significant differences between educational level and age were detected (p<0.01 in both cases). On the contrary, most participants knew one or two post-harvest technologies, independently if they were male or female. On the other hand, ≤30 years old participants knew more post-harvest technologies than the others age groups. However, most of the participants, independently of the age group, answered that they knew one or two post-harvest technologies. Graduated participants (with master, doctorate and post-doctorate degrees) were able to identify more post-harvest technologies than people with basic degrees.

Sensory analysis

Consumers' and gourmet chefs' opinion on edible flowers

Consumers and gourmet chefs were asked about their purchasing habits of edible flowers (Table 3). Most of the interviewed chefs buy edible flowers, and they like more to purchase fresh flowers. On the contrary, most consumers (93.3 %) reported that they do not purchase

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edible flowers because they didn't know that some were edible (33.3%). 53.3% of the consumers also reported that it is a product not easy to find. Identical factors were previously mentioned in the online survey for never having tasted flowers. So, probably some consumers don't use or ever tried to buy edible flowers because most grocery or speciality food stores don't have this kind of product. Only one consumer said that he/she didn't like this kind of product, and another that it was expensive. So, differences in the use of edible flowers were observed between consumers and gourmet chefs. However, most of the consumers didn't express a negative opinion about consuming edible flowers as food. They did not mention, for example, that they don't like them or reported other depreciative characteristics.

Table 3 Responses to variables, including attitudes about bought edible flowers by chefs *versus* consumers

Variable (n)	Chefs		Consumers	
Have bought edible flowers before	Yes	No	Yes	No
	7	1	2	28
If Yes				
Fresh	6		2	
Dry	2		-	
Crystallised	1		-	
If No				
Don't known	-		10	
Don't like	-		1	
Difficult to find	-		16	
Expensive	-		1	
Others	1		-	

Sensory profile of the gourmet chefs

Figure 1A shows the sensory profiles for pansies subjected to high hydrostatic pressure, alginate coating and crystallisation of the gourmet chefs. Comparing treatments, only significant differences were detected in visual appearance ($p=0.015$), texture ($p=0.032$) and overall acceptance ($p=0.001$). For these characteristics, high hydrostatic pressure was the treatment with the highest liking scores, while the results for alginate coating and crystallisation were similar. Regarding visual appearance (a key factor for the successful acceptance of edible flowers), the pansies were rated high (9) when subjected to HHP. Texture and taste also showed high rates (8 and 7, respectively) for HHP pansies, followed by alginate coating. In terms of bitterness, astringency, spiciness, sweetness and odour, most of the chefs mentioned that these properties were quite challenging to detect, giving some of them a zero classification. So, these attributes were classified with low rates for all treatments. It may probably be attributed to the light flavor and taste intensity of fresh flowers, as Benvenuti et al.[3] reported.

Furthermore, the applied treatments do not promote new tastes and flavours to pansies. Concerning flowers' overall acceptance, pansies subjected to HHP (9) had good acceptance by chefs, while alginate and crystalised had low scores, so low acceptance. Concerning the chefs' comments, they stated that the sugar masks the colour and the appearance of the flower, and they mentioned that the most prominent flavour was the sweetness of the sugar in the crystallised pansies. Thus, they classified crystallised pansies with low scores. Regarding alginate coated pansies, chefs mentioned that a bright layer on the flower was visible, a negative attribute for them. On the contrary, pansies subjected to HHP treatment seemed to be a new product, with the potential to be used in the cuisine by chefs. Chefs stated that pansies treated with HHP looked like the fresh ones, with the same colour intensity, texture and visual appearance.

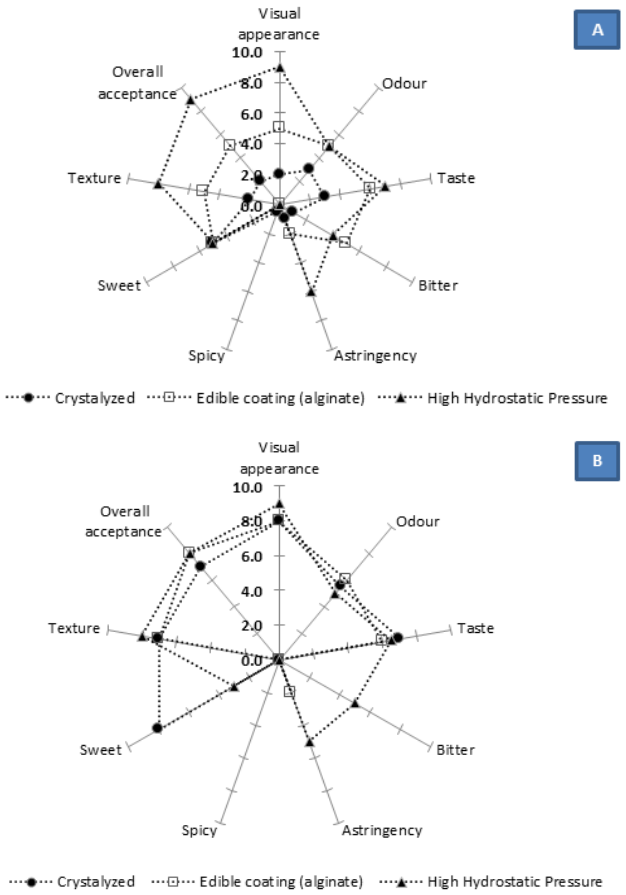

Figure 1 Sensory profile (visual appearance, odour, taste, bitterness, astringency, spiciness, sweetness, texture and overall acceptance) detected by the chefs (A) and consumers (B) for pansies treated with three post-harvest technologies.

Sensory profile of the consumers

Figure 1B shows the sensory profiles by consumers of pansies subjected to the three post-harvest treatments. No significant differences ($p>0.05$) were detected between treatments concerning texture, odour, taste and overall acceptance. Pansies subjected to HHP showed greater values on visual appearance (9), bitterness (5) and astringency (5) than the crystallised ones. When comparing HHP with alginate coating, no significant differences were detected in visual appearance, astringency and sweetness. As expected, crystallised pansies were highly rated for sweetness (8) because probably the consumers liked the taste of sugar. The consumers didn't detect the spiciness in all treatments because probably pansies don't have a spicy taste, as Benvenuti et al. (2016) reported. Furthermore, most of the consumers in the final comments stated that flowers were not very fragrant and had a light taste. In general terms, consumers evaluated

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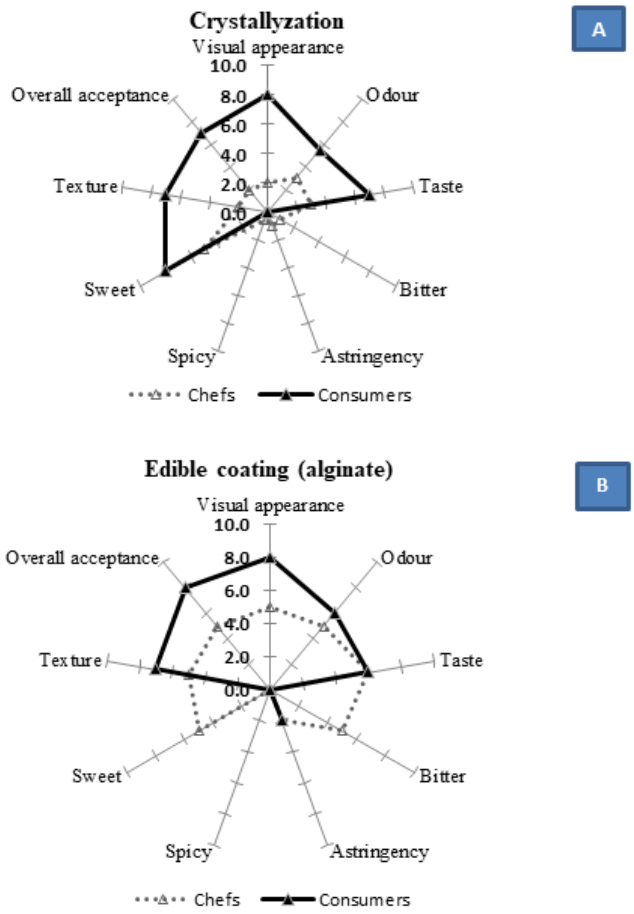
the pansies subjected to all treatments with high overall acceptance rates (≥7), not being detected significant differences (p=0.500).

Comparison between the sensory profiles of gourmet chefs and consumers

Figure 2 summarises the results of the hedonic evaluations performed by chefs and consumers for each post-harvest treatment. Concerning crystallised pansies (Figure 2A), differences between consumers and chefs were detected. The gourmet chefs classified the crystallised pansies differently in what regards visual appearance (p=0.025), texture (p=0.015) and overall acceptance (p=0.012) when compared with consumers. These ranked the crystallised pansies with high marks. For alginate coated pansies, both groups classified odour and taste with similar values (Figure 2B). However, consumers reported greater liking values of texture (p=0.024), visual appearance (p=0.002) and overall acceptance (p=0.014) than chefs. Differences between consumers and chefs preferences were also detected for viola and borage flowers.[6] On the contrary, chefs and consumers gave similar scores of liking to pansies treated with HHP (Figure 2C), except for overall acceptance (p=0.025). These similarities in ratings may indicate that no separate marketing strategy is necessary for pansies treated with HHP.



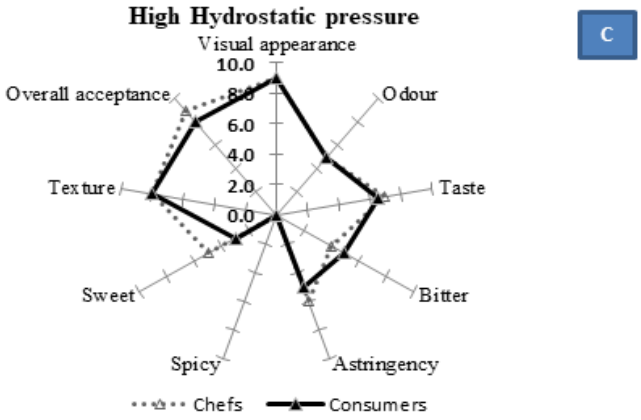


Figure 2 Comparison of sensory perceptions between chefs and consumers for pansies treated with HHP (A), alginate coating (B) and crystallised (C) (median).

Significant correlations were detected between the overall acceptance with visual appearance, odour, texture and taste for both groups. These correlations were higher for chefs than consumers. For chefs, those correlations were 0.919 for visual appearance, 0.887 for texture, and 0.697 for taste. For consumers, the correlations were 0.668 for visual appearance, 0.761 for taste, 0.739 for texture and 0.407 for odour.

Consumers' and chefs' purchasing intentions to buy post-harvest treated pansies

The opinions of chefs and consumers on their intention to buy post-harvest treated pansies, their price, and the more suitable dishes to include pansies subjected to the three different post-harvest technologies are described in Table 4. All chefs would purchase HHP pansies, and 66.7 % of them would pay ≤5€ for a package with 12 flowers. Regarding other post-harvest treatments, only 50% of chefs showed intention to buy alginate coated pansies, and 37.5% crystallised pansies. On the contrary, more than 60% of consumers would be willing to purchase flowers subjected to the three treatments. However, most of the consumers would buy the treated flowers at a price lower than 5 euros. Only a small percentage reported the highest price values (>10-15 euros). Concerning the price of crystallised flowers, consumers and chefs were willing to pay lower values than those practised in the market. As an example, a Portuguese enterprise sells a container with 12 flowers for 26.90€, and another enterprise sells a package of 20 flowers for 22.7€.[18,19]

There was a significant correlation between purchasing with the visual appearance and overall acceptance for the consumers' group. The relationship between purchase and visual appearance for treated pansies was 0.419 and for overall acceptance 0.338 (p=0.01). This indicated that consumer ratings of the visual appearance of flowers were related to their purchase intent. Our results were similar to those reported by Kelley et al.[6,20] They detected that the visual aspect had been indicated as an important factor for the successful use of edible flowers. Furthermore, it was the most valorised characteristic of edible flowers, according to the online survey participants.

Both groups were asked about the more suitable dishes to include treated flowers. A variety of responses were given (Table 4). Most of the consumers and chefs reported that crystallised flowers should be included in desserts or eaten alone. On the other hand, for chefs,

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alginate coated pansies should be included in fish dishes (4), while for consumers in salads (12) and desserts (9). Concerning HHP flowers, chefs preferred fish dishes (6) and desserts (6), and consumers salads (9), drinks (9) and desserts (9).

Table 4 Opinions of chefs and consumers about their intention to buy, what price would they pay and which will be the more suitable dishes to be included pansies treated with three different post-harvest technologies

Frequencies (%)		Cristallyzed		Alginate coating		HHP	
		Chefs	Consumers	Chefs	Consumers	Chefs	Consumers
Would buy	Yes	37.5	61.5	50	77.3	100	66.7
	No	62.5	38.5	50	22.7	0	33.3
Price (€)	≤5	66.7	50	50	52.9	75	66.7
	>5-10	33.3	37.5	50	41.2	25	25
	>10-15	-	12.5	-	5.9	-	8.3
Dishes to include (n):							
Salads		1	4	2	12	5	9
Entries		-	8	2	7	4	7
Fish dishes		-	2	4	4	6	2
Meat dishes		-	1	2	2	5	1
Drinks		-	9	1	6	2	9
Desserts		3	14	2	9	6	9
Alone		2	2	-	-	3	-
Other		-	-	-	-	2	-

Conclusion

In summary, most of the online survey participants recognised edible flowers as a food component and expressed a positive opinion about them. However, only half of the inquired people had already tasted edible flowers. Furthermore, consumers recognised the importance of post-harvest technologies. Refrigeration, freezing and crystallisation were the processes most known and mentioned by the participants. Moreover, more than 79% were willing to pay more for edible flowers with longer shelf-life.

Regarding sensory profiles of gourmet chefs and consumers, these were different: chefs and consumers highlighted the organoleptic properties of pansies treated with HHP. However, concerning alginate coated and crystallised pansies, differences between both groups were detected. Consumers rated the alginate coated and crystalised pansies with high scores, while chefs rated these pansies with intermediary and low values, respectively. All chefs indicated that they would purchase the pansies treated with HHP, but only 50% would buy the alginate coated and 37.8% the crystallised pansies. On the contrary, at least 60% of the consumers were willing to purchase the flowers subjected to the three treatments. In summary, the results obtained in the present study are beneficial for the commercialisation and marketing of pansies treated with different post-harvest technologies, showing that consumers might purchase them and not only the gourmet chefs. Furthermore, the consumers liked the pansies subjected to the three methodologies evaluated.

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Conflicts of interest

The authors declare that there is no conflicts of interest.

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