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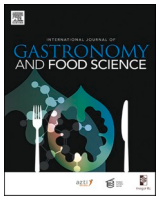

Sensory dimensions of typicality and association with affective-related responses: A study on local multifloral honey

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ABSTRACT

Local foods offer benefits for the sustainability of the food supply chain, yet they face challenges due to variability in production and market saturation. This highlights the importance of strategies to enhance their value. Among local foods, multifloral honey is one of the products most closely tied to the territory. A comprehension of how multifloral honey is structured from a sensory standpoint can prove advantageous in enhancing its recognition and valorization among consumers. The present study aimed to promote multifloral honey in the case of a local area, identifying typical examples of multifloral honey and their sensory determinants, and identifying the association among sensory attributes and affective-related responses of consumers. Thirty samples of multifloral honey were collected from a target local area (Trento province - Italy). Experts in honey sensory evaluation (n = 47) performed a rapid descriptive task (check-all-that-apply questions) and a categorization task (typicality evaluation). Six samples representative of the category sensory space were selected for consumer evaluation. Consumers recruited from the local area (n = 131) rated liking and elicited post-consumption emotional product associations. The results unveiled the sensory representation of the multifloral honey category, with samples arrangement in accordance with category typicality. The study defined the sensory characteristics associated with typicality of the multifloral honey from the target local area and identified local consumers' affective-related responses to the features that define the typicality. Beyond the honey realm, this approach can represent a model of a methodological approach for studying the enhancement of local foods that exhibit relevant sensory variability.

1. Introduction

1.1. The opportunity of local foods

The expansion of organized large-scale food distribution has generated interest among consumers in locally-aligned approaches to food production and distribution, commonly referred to as local foods (Guerrero et al., 2010). A relevant part of western consumers demonstrated high acceptance for locally produced foods and declared a willingness to pay a premium for this origin attribute (Kallas et al., 2019; Bigerna et al., 2023). Moreover, local foods create a more direct connection between producers and consumers (Giampietri et al., 2018) and contribute to the economic development of rural areas (Mundler and Laughrea, 2016). For these reasons, research on local foods has attracted the interest of the international scientific community (Luo et al., 2022), and it has also received institutional (e.g., European CAP Network - Council of the European Union, 2013) and community support (e.g., Slowfood, Locavores – Stanton et al., 2012). However, local foods are challenged by limited diversity, inaccessibility, and inconvenience (Paciarotti and Torregiani, 2021), and recent studies furthermore point to saturation in direct food sales (Plakias et al., 2020). To mitigate these possible risks, local foods stakeholders need to enhance their understanding of factors influencing the uptake of local foods.

The importance of consumers in advancing local foods promotion strategies has been recently emphasized in literature (Tiganis et al., 2023; Aouinaït et al., 2022). Several studies have consistently supported

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the association between local food purchases and the expectation of better quality and taste (Carzedda et al., 2018; Bavorova et al., 2016; Annunziata and Mariani, 2018). Consequently, taste expectations represent one of the most influential factors in food purchasing decisions for local foods (Feldmann and Hamm, 2015). Considering the primary role taste plays in the choice of local foods, research approaches involving actual taste in terms of perception and hedonics can be effective for investigating the acceptability of these products.

1.2. Sensory representation of a local food category

Local foods differ from industrial products due to their diverse ingredients and production methods, resulting in a wide-ranging sensory experience. This variability has led to the development of certification and protection systems in Europe, like PDO labels, indicating specific characteristics (e.g., DOP Miel de Corse). This suggests that for local products there may exist a specific merchandising category (often codified), which is based on recognized characteristics of ingredients and production methods. However, a deeper understanding of the sensory characteristics that define a local product can contribute to improving its recognition and valorization. In this context, understanding how the category of a product is represented from a sensory perspective has merit.

Categorization of food relies on cognitive processes where objects with common characteristics are grouped, drawing inferences about their properties (Rosch and Lloyd, 1978). The Prototype Theory was developed to provide a deeper understanding of category formation (Ashby et al., 1998). According to this theory, within a category, certain instances or objects are regarded as more 'prototypical' or representative of the category itself (Hampton, 1979). Objects within a category can be assessed based on their degree of "typicality", where objects that closely resemble the prototype are deemed highly typical (Rosch and Mervis, 1975). Categories appear to be structured in a graded manner, suggesting that different members of the same category differ in their typicality, i.e., in how well they represent the category and its prototypes (Goldstone et al., 2012). Research shows how a graded structure based on the representativeness of category members operates not only cognitively (Hampton, 1979) but also across sensory modalities (Chrea et al., 2009; Chollet et al., 2022). The same principle has also been applied to more complex matrices, such as food products and recipes, with research investigating the representation of food categories and the features of prototypical exemplars (Storms et al., 2001; Cadota et al., 2010; Hoek et al., 2011; Cliceri et al., 2019).

This body of research provides examples of how food categorization can be a valuable tool for improving understanding of the mental representation of a real food category, thereby identifying its most representative exemplars and prototypical attributes. Applying this framework to a highly variable product category, such as local foods, can provide valuable insights into the identification of prototypical exemplars and the study of the graded structure of the category. This knowledge can be essential in understanding the recognizability of a local product and, consequently, in facilitating its marketing.

1.3. Multifloral honey as a model of local food

A food category particularly representative of local foods is multifloral honey. Unlike monofloral honey, wildflower honey is more closely tied to its region because its sensory profile depends heavily on the unique mix of local flora, making it difficult to replicate in different geographic areas. Multifloral honey is a product for which an exclusive botanical origin of the natural sources used by honeybees (*Apis mellifera*) can not be defined on the base of sensory and physicochemical characteristics (e.g., Directive, 2001/110/EC - Council of the European Union, 2001). For this reason, a honey that does not fit the characteristics of other monofloral honeys can be commercially classified as a multifloral honey. In Italy, the production of multifloral honey varies significantly depending on the geographical area and seasonality, with average yields ranging from 2 to 18 kg/hive for spring multifloral honey and from 0 to 6 kg/hive for summer multifloral honey (Osservatorio Nazionale Miele, 2023). Considering that in recent years Italy's self-sufficiency in honey production is around 54% of demand, the multifloral honey produced is absorbed by the market, though it commands a lower average price compared to other honey categories (ISMEA, 2024).

In terms of flavor, multifloral honey offers a wide variety of compositions from both a physicochemical and sensory perspective, considering that multifloral honey can indeed vary based on several local factors, including floral composition, soil composition, and local climate conditions (Lazarevic et al., 2013). If, on one hand, the high variability present in multifloral honey is responsible for its commercial classification, on the other hand, this aspect allows for gaining complexity and uniqueness. A limitation of this variability is that the sensory profile associated with multifloral honey is not unique, unlike what can happen with monofloral honey (Persano-Oddo et al., 2000), resulting in a category structured in a broader way from a perceptual point of view. This aspect poses some critical issues: for consumers, it is more difficult to develop a perceptual concept of multifloral honey, and for producers, it is more challenging to enhance the product by leveraging the sensory component. To overcome these issues, it may be pertinent to determine the sensory boundaries of the category first. In turn, a valorization strategy need not be limited to the overall profile of the product but can extend to the association between hedonic responses and distinctive sensory descriptors (e.g., Cabrera and Santander, 2022).

1.4. Research aims and overview of the empirical approach

Building on the above, the present study aims to enhance the sensory recognition of local Italian multifloral honey production by identifying typical characteristics of multifloral honey (Aim 1) and investigating the associations between sensory attributes and affective-related responses among Italian consumers (Aim 2). Furthermore, given the lack of studies specifically focused on multifloral honey, this contribution sought to thoroughly investigate the sensory profile of this food category and the potential variability in affective-related responses. This investigation may be of interest considering that, to our knowledge, it has never been investigated what makes one honey more typical than another within the multifloral category.

The empirical approach used a two-step approach informed by Zocchi et al. (2020) where interviews with local producers were used to select honey samples for sensory evaluation. Secondly, a consumer test was performed with target consumers to investigate the perception of sensory properties and hedonic responses.

In the present contribution, two methodological changes were made relative to Zocchi et al. (2022). The first was to use of a quantitative methodology for selecting typical samples of the category, employing an extensive sampling of the local area of reference, and utilizing an expert panel to determine the descriptive profile and sensory conformity to the category (Marcazzan et al., 2018). This step was necessary to appropriately select a subset of samples for the consumer test while still representing the sensory variability present within the product category (Ciappini et al., 2022). A second change was the use of a sufficiently large consumer sample size, an important factor for investigating associations with hedonic responses to honey samples (Kortesniemi et al., 2018; Starowicz et al., 2021). Finally, a third change involved the use of "beyond liking" methods (Giacalone et al., 2022) based on the measurement of emotional associations, aiming to provide a more informative interpretation of consumer responses (Meiselman, 2021; Ramon-Canul et al., 2023).

Full empirical details are given below. In brief, the steps to achieve Aim 1 were: I. collect multifloral honey samples from the local target area involving local entities, II. involve experts in honey sensory evaluation to evaluate typicality and sensory properties of samples, and III.

perform statistical analysis to highlight typical samples of multifloral honey category and characterizing sensory properties. The steps to achieve Aim 2 were: I. perform statistical analysis to select a limited number of typical samples able to represent the sensory variability of the category; II. involve consumers to evaluate affective-related responses (liking, emotions), and III. Perform statistical analysis to assess the association between sensory properties and affective-related responses.

2. Materials and methods

2.1. Honey samples

The sampling process encompassed major local entities involved in honey production in the select local area (Trentino region, Italy, 6207 km^2). These entities included beekeeping professional associations (Federazione Associazioni Apicoltori del Trentino; Associazione Apicoltori Trentini), as well as a public institution (Fondazione Edmund Mach). The stakeholder selection aimed for comprehensive coverage of the local area, ensuring samples with maximum variability, and representing the available local products.

A total of 42 honey samples were included in the study. 30 samples of multifloral honey, produced in August 2021 and intended for market distribution, were collected as local honey samples. Additionally, 6 monofloral honeys (Dandelion, Rhododendron, Acacia, Fir honeydew, Chestnut, and Linden) produced in the local area, along with 6 multifloral honeys also sourced locally, were gathered for training purposes. The training samples were from the 2020 season and were obtained from the market.

Samples utilized for the sensory and typicality evaluation (Section 2.2) were initially mixed within their original containers and portioned into 30g glass jars, each containing 14g (±1g) of honey. For the consumer test (Section 2.4), the samples were also mixed in their original containers and then portioned into 30g plastic glasses. Each glass was filled with 6g (±1g) of honey. To facilitate the portioning process, samples that were crystallized were kept at 40 °C for 24 h before preparation. Subsequently, all the samples were sealed with caps and labelled with a unique 3-digit numerical code.

2.2. Sensory and typicality evaluation

2.2.1. Subjects

A panel of 43 highly trained judges was recruited for the study (74% females, mean age = 49.3 years). Inclusion in the panel required official registration in the National Register of Experts in Sensory Analysis of Honey, an organization set up by the Italian Ministry of Agriculture for the training of honey tasters and the management of their proficiency in terms of the ability to recognize and describe monofloral honeys. The use of product experts facilitated achieving a high level of category recognition and descriptive proficiency. Additionally, it allowed the use of an existing evaluation methodology (Marcazzan et al., 2018), thus leading to shortened training times. The judges were involved remotely. This became necessary to engage an adequate number of expert judges in honey sensory analysis throughout the study and to address potential restrictions on experimental activity due to the SAR-CoV-19 pandemic. At the time of conducting the tests, there were no social restrictions in place in Italy.

2.2.2. Procedure

The activities were divided into two main phases: panel training and panel evaluation. Boxes containing all the necessary items to conduct the assessments (coded samples, teaspoons, evaluation tray, napkin, sensory descriptor sheet) were assembled for both phases and then sent to the participants' homes. The procedure followed what the judges had already done for remote evaluation of honey, starting with an initial online group discussion regarding the evaluation instructions, followed by assessment of samples with microphones and cameras deactivated or offline. Laboratory staff remained available online throughout the evaluations for any assistance needed, and at the end of the session, they verified the correct data submission. The remote procedure aligns with the recommendations outlined in Dinnella et al. (2022). The evaluations spanned from June to September 2021. In all the phases data were collected via EyeQuestion online software (www.eyequestion.com, Logic8, The Netherlands).

2.2.2.1. Panel training. The purpose of the training sessions was to familiarize the judges with the remote evaluation method and to verify their performance in the sensory evaluation of reference honeys before the official evaluation. Judges were instructed to conduct individual assessments in a comfortable place, illuminated by white or natural light, and devoid of any odors. Additionally, judges were also asked to refrain from smoking or using products with persistent smells or tastes 30 min prior to the evaluation. In the first training session, 7 samples (6 plus a replicated sample) of local monofloral honey were evaluated to focus on the main sensory properties that can contribute to local multifloral honeys. In the second training session, 6 local multifloral honeys were evaluated to assess the descriptive performance within the product category under study.

A rapid descriptive test using the rate-all-that-apply (RATA) method (Ares et al., 2014a) was conducted to measure the sensory properties of the samples. The descriptors used refer to the honey odor and flavor wheel (Marcazzan et al., 2014) as well as to attributes of color, taste, tactile and chemesthetic sensations (Table 1). Judges were first asked to indicate its appropriateness to describe their perception of odor/flavor macro-category descriptors (floral, fruity, warm, aromatic, chemical, vegetal, animal), basic tastes, and trigeminal sensations. To facilitate the evaluation, a hierarchical structure of macro- and subcategories for the odor/flavor descriptors was employed. Here, if a macro-category was selected as appropriate, the relative subcategory descriptors were presented. Judges were also given the option of selecting only the macro-category, without being required to complete the selection of the subcategory descriptors. Macro-category and subcategory descriptors were randomized across judges. For the selected descriptors, judges were finally asked to evaluate their intensity on a linear scale (0 = "weak"; 50 = "moderate"; 100 = "strong"). This scale was selected to maintain consistency with the type of scale previously used by the expert judges (profile method - Marcazzan et al., 2014). A categorization task with a dichotomous response (typical/not typical of the category) was conducted to measure the samples' adherence to the multifloral category. The use of a dichotomous response was employed to make the categorization more restrictive and to use an evaluation approach already familiar to expert judges. For both training session, the order of sample presentation was randomized between judges and a 60-s pause was observed between samples to rinse the mouth with water.

For each macro-category, the level of agreement in the use of the descriptor was assessed by considering the distribution of correlation scores (Spearman's rank correlation coefficient) between individual scores and panel occurrences (supplementary: Fig. S1). At the end of the training phase, a discussion was held to clarify the use of the descriptors, particularly for those that showed less agreement (RHO <0.3), namely vegetal odor and flavor, astringency, and pungency. Moreover, the judges were shown their individual level of agreement with the rest of the panel for each macro-category of descriptors. A low level of agreement was considered for RHO values below 0.3.

2.2.2.2. Panel evaluation. The purpose of the final evaluation was to describe the profile of the multifloral honey samples selected for the study. The evaluation was divided into 6 sessions. An online meeting was held for the first session to illustrate the evaluation methods and timing, while the following 5 sessions were carried out offline and were used for individual evaluations. The samples were randomly assigned to 5 blocks of 6 samples each. In each evaluation session they were asked to

Table 1
List of attributes employed in the check-all-that-apply (CATA) question assessment of multifloral honey samples.

Sensory modality	Macro category descriptors	Subcategory descriptors	References
Sight		Almost colorless, Straw yellow, Light amber, Amber, Dark amber, Very dark amber	
Odor/Flavor	Floral	Floral	Orange Blossoms, Rose Blossoms
	Fruity	Fresh fruit	Strawberry, Apple, Pear, Fresh Raspberry
		Tropical fruit	Mango, Papaya
		Fermented fruit/Wine-like	Cider, White Wine
		Processed fruit	Apricot Juice, Peeled Tomatoes
	Warm	Fine/Lactic/Bitter almond	Beeswax, Condensed Milk, Coumarin
		Caramelized/Toasted/Malted/Charred	Toasted Nuts, Caramelized Sugars, Burnt Bread
		Vanilla	Vanilla Bean
	Aromatic	Spicy	Cloves, Nutmeg
		Resinous/Balsamic/Camphoraceous	Pine, Peppermint, Eucalyptus
		Citrus/Orange-like	Orange, Lemon
	Vegetal	Woody	Oak Moss
		Green	Freshly Cut Grass, Raw Fresh Beans
		Moist	Raw Champignon Mushrooms, Boiled Spinach
		Dry	Green Tea, Hay
	Chemical	Pharmacy/Medicinal/soap	Medicine Cabinet, Marseille Soap
		Smoky	Jute Smoke, Cigarette Butt
		Pungent/Vinegary	White Wine Vinegar
		Plastic/Petroleum/Phenolic	Plastic, Phenol, Vegetable Tar
		Ammoniacal	Ammonia
	Animal	Degraded	Decayed Plant or Animal Matter
		Sulfurated	Hard-Boiled Egg
		Proteinaceous	Dried Porcini Mushrooms, Bouillon Cube
		Valerian	Butyric Acid
		Rancid	Rancid Nuts, Rancid Oil
Taste		Sweet	Granulated Sugar
		Sour	Lemon Juice
		Bitter	Coffee
		Salty	Kitchen Salt
Chemesthetic sensations		Pungent	Black Pepper, Chili Pepper
		Astringent	Unripe Banana

sample 1 block of samples. Within each block, the samples evaluated were the same among judges and presented in a randomized order. For each judge, the blocks were randomized among sessions. The sensory evaluation method was the same used in the training phase, even if check-all-that-apply (CATA) method (Adams et al., 2007) was preferred instead of RATA for having shown during the training spatial sensory configurations comparable to the RATA (RV coefficient = 0.851). The minimum RV coefficient considered as an indicator of good agreement between sample configurations ranges from 0.65 to 0.85 (Vidal et al., 2014), and a cut-off of 0.75 was considered for this study. Given the acceptable RV value and considering the lower effort required to complete the task, the CATA method was chosen for the final evaluation. The number of judges lower than the recommended sample size for the CATA test (n = 60–80, Ares et al., 2014b) can, however, be considered acceptable given the involvement of trained judges (Alexi et al., 2018).

2.3. Selection of prototype samples for consumer testing

Prior to the consumer testing, a two-step selection process was conducted to identify samples prototypical of the multifloral category sensory space. In the first step, only samples corresponding to the multifloral honey category from a sensory perspective were retained. A cutoff of 75% of typicality rate was set. This means that, for each sample, at least 75% of the experts had to declare a sample as belonging to the category of multifloral honey (see Section 2.5.1). In the second step, an in-house algorithm based on bootstrapping (n = 1000) was applied to provide 6 samples that maximized sensory differences across the highest number of descriptors (Section 2.5.1). The 6 resulting samples were prototypical of the multifloral honey category and encompassed the sensory attributes that characterize the category. This sample reduction step led to the maximum possible variability in the descriptors within a reduced number of samples, allowing the relationship between sensory properties and affective-related measures to be studied more efficiently (Aim 2).

2.4. Consumer test

2.4.1. Consumers

One hundred and thirty-one honey consumers (50 % females) were recruited for the study during a public event at the Science Museum (Museo della Scienza - MUSE) of the city of Trento (Italy), to attract a diverse and local audience. The group of participating consumers was balanced by gender and included a population of young subjects with a high level of education (Table 2). The recruitment of subjects from the local area where the samples were produced was fundamental to ensure that the participants were representative of the context in which the product is consumed.

2.4.2. Procedure

The evaluation of the samples by consumers was conducted in a single session, which was structured into two main parts: I. Collection of affective-related responses (liking and emotions) following the tasting;

Table 2
Socio-demographic variables and frequency of honey consumption of the consumer panel (n = 131).

Gender	%
Male	50.0
Female	50.0
Age group (yo)	
18–25	27.5
26–35	29.8
36–45	16.8
46–55	13.7
56–65	8.4
66–75	3.1
Education level	
Middle school	1.5
High school	39.7
University	48.1
Doctorate or equivalent	9.9
Number of family members	
1–2	23.7
3–4	63.4
5–6	12.9

II. Compilation of a questionnaire. Consumers were requested to assess the 6 samples previously selected to be prototypical of the category (Section 2.3). The samples were randomly presented on a tray and delivered within the evaluation booth compliant with EN ISO 8589:2010. For each sample, consumers were asked to observe, smell, and taste it, and then rate their level of overall liking on a 9-point hedonic scale (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; 9-Like extremely). Then, they were asked to express the emotional states they experienced by choosing from a randomized list of emotions (CATA question), which consisted of different combinations of emotions varying in valence and state of activation (arousal) (Circumplex-inspired emotion questionnaire - Jaeger et al., 2021). Lastly, participants completed a questionnaire with socio-demographic, frequency of consumption/purchase and gastronomic use of honey, which marked the end of the session. Data were collected via EyeQuestion online software (www.eyequestion.com, Logic8, The Netherlands). The assessments were conducted over a 4-day period in Central Location Test mode in October 2021.

All the procedures to collect consent for subject participation and experimental activities of the present research have been reviewed and approved by the Ethics Committee of the University of Trento (Protocol No. 2021-031).

2.5. Data analysis

All data analyses were performed with an alpha level of 0.05 and using R Statistics Package version 4.3.9 (R Core Team, 2015), packages cata, FactoMinerR, and factoextra.

2.5.1. Sensory profiling data

2.5.1.1. Sensory characterization of the overall sample of multifloral honey. Data obtained from the CATA questions in the evaluation session were treated as dichotomous responses, where a checked term was assigned a value of 1 and an unchecked term a value of 0, for each term presented in the ballot. The Cochran's Q test (Meyners and Castura, 2014) was employed to identify sensory attributes that significantly discriminate among samples. Additionally, a Correspondence Analysis (Benzécri, 1973) was conducted on occurrences from statistically significant attributes to create a perceptual map. The analyses were carried out on: I. All the samples, II. Typical samples of the category, and III. Prototypical samples of the category.

2.5.1.2. Selection of typical samples. Data from the categorization task (Section 2.2.2) was treated as dichotomous responses, where a checked term (typical sample) was assigned a value of 1, and an unchecked term (non-typical sample) was assigned a value of 0. For each sample, the occurrences were computed to identify a typicality rate, where a higher percentage of typicality indicates greater category centrality (Cliceri et al., 2019). A category typicality rate of 75% (i.e., 32 out of 43 judges) was used as a cut-off to determine samples that were considered typical to the multifloral honey category from a sensory perspective.

2.5.1.3. Selection of prototypical samples. Considering only typical samples (typicality rate >75%), a bootstrap without replacement was performed to randomly generate (n = 1000) different subsets, each containing 6 samples. For each subset, the occurrence matrix of descriptors was obtained, and for each descriptor, its corresponding dispersion index was calculated using the interquartile range (IQR). Subsequently, the median of all the IQRs for each subset was computed. The distribution of median IQRs from all iterations was considered, and subsets with IQR values above the 95th percentile were selected (n = 10). These chosen subsets were evaluated in conjunction with the global perceptual map and subjected to qualitative sensory assessment (internal focus group), considering criteria such as the exclusion of samples with any sensory defects. The final aim was to identify which subset effectively maximized the variability of each sensory descriptor, thereby representing the range of sensory diversity present among typical samples.

2.5.2. Consumer testing

2.5.2.1. Liking for prototypical samples. Liking data were submitted to a two-way ANOVA mixed models (fixed factor: product; random factor: subjects) to estimate the effect of the product on liking, followed by the Tukey HSD test.

2.5.2.2. Emotions for prototypical samples. Data obtained from the Circumplex-inspired emotion questionnaire in Check-All-That-Apply format were treated as dichotomous responses, where a checked term was assigned a value of 1 and an unchecked term a value of 0, for each pair of emotions in the ballot. The Cochran's Q test (Meyners and Castura, 2014), was employed to identify differences between samples in the frequency of use for each pair of emotions.

2.5.2.3. Association between sensory properties and affective-related responses. The Spearman's rank correlation coefficient (RHO) was employed on prototypical samples to investigate the association between sensory attributes from the Check-All-That-Apply method and: I. liking mean scores, and II. occurrences of significant discriminating pairs of emotions.

3. Results

3.1. Sensory characteristics and typicality for multifloral honey samples

In terms of category typicality, the experimental samples exhibited a high variability in terms of typicality rates (min = 43%; max = 100%; median = 85%) (Q = 247.7; p-value <0.001), suggesting the presence of product category stratification. As a result of the selection procedure, the typical samples showed diminished variability in terms of typicality rates, with a minimum of 75%, a maximum of 100%, and a median of 92.9%. This pattern was similarly found in the prototypical samples, where the minimum score was 76.2%, the maximum was 95.2%, and the median was 89.3%.

Table 3
Cochran Q test on Check-all-that-apply (CATA) scores of odor/flavor category, taste, and sensations attributes of multifloral honeys. Significant differences (alfa <0.05) are indicated in **bold**.

Attributes	*All samples (n=30)*		*Typical samples (n=20)*		Prototypical samples (n = 6)	
	Q	p-value	Q	p-value	Q	p-value
Almost colorless	70.4	**<0.001**	38.8	**0.005**	4.8	0.439
Straw yellow	48.7	**0.012**	10.2	0.948	3.0	0.707
Light amber	54.4	**0.003**	25.1	0.158	13.3	**0.021**
Amber	49.8	**0.010**	36.5	**0.009**	10.2	0.070
Dark amber	56.1	**0.002**	38.7	**0.005**	5.5	0.361
Very dark amber	63.8	**<0.001**	–	–	–	-
o-Floral	209.8	**<0.001**	78.3	**<0.001**	25.0	**<0.001**
o-Fruity	90.8	**<0.001**	61.9	**<0.001**	27.4	**<0.001**
o-Warm	276.9	**<0.001**	127.6	**<0.001**	59.2	**<0.001**
o-Aromatic	198.3	**<0.001**	103.2	**<0.001**	43.2	**<0.001**
o-Chemical	109.5	**<0.001**	64.9	**<0.001**	22.3	**<0.001**
o-Vegetal	48.8	**0.012**	28.7	0.071	10.5	0.063
o-Animal	165.2	**<0.001**	97.1	**<0.001**	51.8	**<0.001**
f-Floral	228.4	**<0.001**	120.0	**<0.001**	41.8	**<0.001**
f-Fruity	174.4	**<0.001**	56.8	**<0.001**	15.3	**0.009**
f-Warm	260.8	**<0.001**	111.0	**<0.001**	36.9	**<0.001**
f-Aromatic	220.6	**<0.001**	129.9	**<0.001**	66.3	**<0.001**
f-Chemical	221.0	**<0.001**	135.7	**<0.001**	75.2	**<0.001**
f-Vegetal	45.1	**0.029**	26.7	**0.112**	10.3	0.067
f-Animal	132.3	**<0.001**	63.9	**<0.001**	32.8	**<0.001**
Sweet	68.0	**<0.001**	29.6	0.057	12.4	**0.030**
Bitter	335.3	**<0.001**	217.6	**<0.001**	82.5	**<0.001**
Sour	118.9	**<0.001**	23.7	0.207	4.0	0.552
Salty	297.4	**<0.001**	76.2	**<0.001**	30.8	**<0.001**
Pungent	50.4	**0.008**	23.9	0.201	7.0	0.219
Astringent	125.9	**<0.001**	52.1	**<0.001**	23.8	**<0.001**

o-odor; f-flavor.

Sensory characterization through the CATA questionnaire revealed high sensory variability across the collected samples. Specifically, all descriptors related to visual, odor and flavor categories were found to be discriminative ($p < 0.05$), including both descriptors of retro nasal odors, tastes, and mouthfeel sensations (Table 3). The sensory variability generally decreased when moving from the overall sample set to the typical samples (Typicality rate >75%) (26 vs. 19 discriminant attributes), due to the removal of samples with low typicality and more pronounced sensory properties. However, sensory variability remained essentially unchanged when transitioning from typical samples to prototypical samples (19 vs. 16 discriminant attributes). The same pattern, but with a higher level of detail, can be inferred from the observation of the subcategories of odor and flavor descriptors (Table 4). In the overall sample set, 44 attributes out of 50 were found to be discriminative, a number that decreased to 37 out of 50 for the typical sample set and 35 out of 50 for the prototypical sample set. By eliminating non-typical samples (response rate <75%) and selecting prototypical samples of the sensory space, a comparable sensory variability to the overall sample set was achieved (RV coefficient = 0.87; p-value<0.001) while employing a reduced number of samples (80% sample reduction). This highlighted how the selected prototype samples were able to cover the sensory variability present across the typical samples.

3.2. Sensory stratification of the multifloral honey category

The first two components of the perceptual map, obtained from CATA sensory responses on all experimental samples, accounted for 64.9% of the explained variance (Fig. 1). This map illustrates how samples differed along the first dimension (explaining 46.3% of the variance) as a function of attributes related to the Floral category (o-/f-Floral), the Warm category (o-/f- Vanilla), the Fruity category (o-/f-Fresh fruity), and the Straw yellow color and the absence of color, contrasting with attributes related to the Chemical category (o-/f-Smoky), the Animal category (o-/f- Proteinaceous), the Warm category (o-/f- Caramelized/Toasted/Malted/Charred), the Vegetal category (o-/f- Woody), the Salty taste, and the Dark amber and Very dark amber color. Along the second dimension (explaining 18.6% of the variance), samples were described according to the frequency of using attributes related to the Chemical category (o- Ammoniacal) and the Animal category (f-Sulfurous, o-Rancid, o-/f- Degraded, o-Valerian), as opposed to attributes related to the Aromatic category (o-/f- Resinous/Balsamic/Camphoraceous), the Chemical category (o-/f- Pharmacy/Medicinal/Soap) and the Bitter taste.

Considering the typicality rate, the perceptual map allowed identifying the typicality stratification based on sensory properties, pinpointing the prototypical samples at the center of the map. This centrality indicates that the prototype samples exhibit sensory characteristics that are intermediate to all samples concerning the most discriminating descriptors. The evaluation of the correlations between typicality rate and sensory descriptors has allowed us to identify specific descriptors that significantly explained the shift from areas of lower to higher typicality. Specifically, the following descriptors were found to be positively associated with category typicality rate: o-/f-Fruity and o-Vegetal categories, the Sour taste, Light Amber and Amber colors, o-Dry, f-Tropical fruit, o/f-Fermented fruit/Wine-like, and f-Pungent/Vinegary subcategories (Fig. 2).

3.3. Consumer affective-related responses across multifloral honey samples

The consumer panel involved resulted in low consumption of monofloral honey (42% of participants consuming less than 1 portion per

Table 4
Cochran Q test on Check-all-that-apply (CATA) scores of odor/flavor subcategory attributes of multifloral honeys. Significant differences (alfa <0.05) are indicated in **bold**.

Attribute category	Attribute subcategory	All samples (n = 30)		Typical samples (n = 20)		Prototypical samples (n = 6)	
o-Floral		Q	p-value	Q	p-value	Q	p-value
	Floral	194.9	**<0.001**	74.7	**<0.001**	22.9	**<0.001**
o-Fruity	*Fresh fruity*	147.6	**<0.001**	64.7	**<0.001**	25.3	**<0.001**
	Tropical fruit	55.0	**0.002**	16.7	0.609	5.7	0.341
	Processed fruit	141.0	**<0.001**	76.3	**<0.001**	24.2	**<0.001**
	Fermented fruit/Wine-like	100.0	**<0.001**	55.0	**<0.001**	24.1	**<0.001**
o-Warm	*Fine/Lactic/Bitter almond*	78.7	**<0.001**	51.4	**<0.001**	17.6	**0.003**
	Caramelized/Toasted/Malted/Charred	569.9	**<0.001**	266.0	**<0.001**	89.5	**<0.001**
	Vanilla	86.4	**<0.001**	52.8	**<0.001**	18.3	**0.003**
o-Aromatic	*Spicy*	56.6	**0.002**	41.8	**0.002**	21.3	**0.001**
	Resinous/Balsamic/Camphoraceous	227.6	**<0.001**	145.8	**<0.001**	54.3	**<0.001**
	Citrus/Orange-Like	19.8	0.899	12.6	0.857	1.8	0.881
o-Chemical	*Plastic/Petroleum/Phenolic*	57.0	**0.001**	45.9	**0.001**	24.1	**<0.001**
	Pharmacy/Medicinal/Soap	235.9	**<0.001**	82.3	**<0.001**	38.6	**<0.001**
	Smoky	292.6	**<0.001**	139.7	**<0.001**	55.5	**<0.001**
	Pungent/Vinegary	107.6	**<0.001**	68.2	**<0.001**	18.6	**0.002**
	Ammoniacal	88.7	**<0.001**	68.2	**<0.001**	23.6	**<0.001**
o-Vegetal	*Green*	70.5	**<0.001**	33.0	**0.024**	6.4	0.271
	Moist	69.5	**<0.001**	32.7	**0.026**	13.1	**0.023**
	Dry	46.3	**0.022**	25.6	0.142	9.5	0.092
	Woody	154.7	**<0.001**	87.7	**<0.001**	30.6	**<0.001**
o-Animal	*Sulfurous*	39.0	0.102	23.4	0.218	7.7	0.173
	Proteinaceous	173.9	**<0.001**	79.3	**<0.001**	32.4	**<0.001**
	Valerian	150.3	**<0.001**	97.1	**<0.001**	48.7	**<0.001**
	Rancid	46.3	**0.022**	27.2	0.099	4.3	0.509
	Degraded	51.7	**0.006**	25.9	0.132	4.2	0.520
f-Floral	*Floral*	209.5	**<0.001**	111.4	**<0.001**	38.8	**<0.001**
f-Fruity	*Fresh fruity*	140.6	**<0.001**	70.5	**<0.001**	22.0	**0.001**
	Tropical fruit	228.4	**<0.001**	100.2	**<0.001**	10.3	0.067
	Processed fruit	185.3	**<0.001**	82.0	**<0.001**	30.4	**<0.001**
	Fermented fruit/Wine-like	106.5	**<0.001**	62.3	**<0.001**	12.3	**0.031**
f-Warm	*Fine/Lactic/Bitter almond*	88.7	**<0.001**	61.5	**<0.001**	29.4	**<0.001**
	Caramelized/Toasted/Malted/Charred	565.0	**<0.001**	268.0	**<0.001**	99.6	**<0.001**
	Vanilla	274.5	**<0.001**	167.0	**<0.001**	44.0	**<0.001**
f-Aromatic	*Spicy*	35.0	0.203	23.8	0.205	6.7	0.244
	Resinous/Balsamic/Camphoraceous	275.0	**<0.001**	127.3	**<0.001**	48.9	**<0.001**
	Citrus/Orange-Like	31.8	0.330	24.3	0.184	3.3	0.656
f-Chemical	*Plastic/Petroleum/Phenolic*	71.7	**<0.001**	49.9	**<0.001**	23.0	**<0.001**
	Pharmacy/Medicinal/Soap	321.3	**<0.001**	130.8	**<0.001**	57.5	**<0.001**
	Smoky	227.1	**<0.001**	64.8	**<0.001**	26.4	**<0.001**
	Pungent/Vinegary	73.5	**<0.001**	43.2	**0.001**	5.2	0.392
	Ammoniacal	45.4	**0.027**	28.7	0.070	10.9	**0.052**
f-Vegetal	*Green*	67.0	**<0.001**	23.6	0.210	7.0	0.223
	Moist	43.6	**0.040**	19.0	0.455	9.8	0.081
	Dry	24.9	0.685	17.7	0.542	0.8	0.974
	Woody	109.3	**<0.001**	49.6	**<0.001**	24.7	**<0.001**
f-Animal	*Sulfurous*	44.6	**0.032**	28.2	0.079	11.7	**0.040**
	Proteinaceous	121.3	**<0.001**	42.5	**0.002**	18.3	**0.003**
	Valerian	90.6	**<0.001**	64.2	**<0.001**	23.3	**<0.001**
	Rancid	28.3	0.500	16.2	0.646	2.0	0.849
	Degraded	55.0	**0.002**	30.6	**0.044**	11.3	**0.045**

o-odor; f-flavor.

month or none at all) and multifloral honey (31.3% of participants consuming less than 1 portion per month or none at all), thus indicating a representation of occasional consumers of honey (Table 5). Comparable reported consumption between monofloral and multifloral honey was found (Chi-square test, p = 0.449). The primary uses of honey are as an ingredient in hot beverages (68.7%) and in desserts and sweets (52.7%). Only 30.5% consume honey as it is. The main places where honey is purchased are from beekeepers (45.8%), at supermarkets (39.7%), and in local markets (26.7%).

The prototypical samples of multifloral honey evaluated by consumers were found to be generally above the neutral liking level (sample T: mean = 6.0, Tukey HSD test (THT) group = a; sample R: mean = 6.5, THT group = ab; sample P: mean = 6.1, THT group = ab; sample O: mean = 6.1, THT group = ab; sample K: mean = 6.4, HSD group = ab; sample X: mean = 6.6, HSD group = b). The liking scores showed moderate yet significant variation (F = 2.99; p-value = 0.011).

The measurement of emotions using the Circumplex-inspired emotion questionnaire allowed for characterizing the samples in emotion pairs varying in arousal and valence levels (Table 6). Overall, positive valence emotion pairs were the most frequently mentioned (17.4%), followed by negative arousal (12.6%), positive arousal (10.5%), and negative valence (5.8%). Particularly, the samples showed significant differences for the emotion pair "Enthusiastic, Inspired" (Q = 10.8; p-value = 0.044), "Relaxed, Calm" (Q = 16.1; p-value = 0.007), and "Tense, Bothered" (Q = 13.8; p-value = 0.017).

3.4. Relationship between affective-related responses and sensory stratification of multifloral honey

The global map obtained through Multiple Factor Analysis (explaining 57.9% of the variance in the first two dimensions) allowed us to correlate affective-related responses (liking, emotions) with

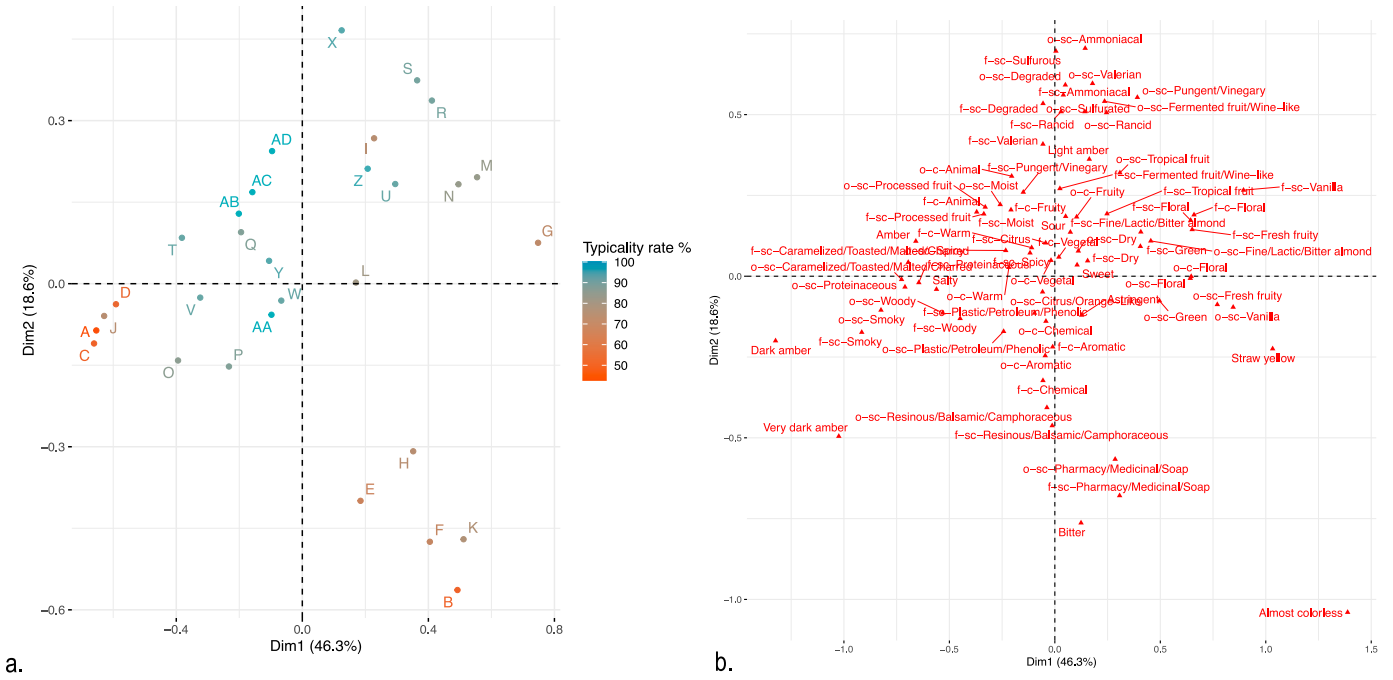

Fig. 1. Perceptual map derived from Correspondence Analysis of Check-All-That-Apply (CATA) responses for 30 samples of multifloral honey (A-AD). In the score plot (a.), color intensity indicates the level of association with the sensory category of multifloral honey (typicality rate). Acronyms used: o – "odor"; f – "flavor"; c – "sensory attribute category"; sc – "sensory attribute subcategory". (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

sensory characterization scores (Fig. 3). General higher hedonic scores were identified for samples *K*, *X*, and *R* compared to samples *O*, *P*, and *T*. A more thorough analysis of the liking trend can be accomplished by examining the emotion pairs assessed through the Circumplex-inspired emotion questionnaire and which have been found to significantly discriminate between the samples (Section 3.3). Overall, liking showed a positive association with the emotion pair "Enthusiastic, Inspired" and "Relaxed, Calm," while it is negatively associated with the emotion pair "Tense, Bothered." For the most liked samples, the use of emotions provides more insight into preference trends, with liking towards sample *K* being more associated with the emotion pair "Enthusiastic, Inspired," while sample *R* is more associated with the emotion pair "Relaxed, Calm."

Examining the associations between liking and sensory properties can provide further details to the presented framework. The most liked samples showed positive associations with the following sensory categories of descriptors: Fruity (o-/f- Fresh fruity), Floral (o-/f- Floral), and Warm (o-/f- Vanilla, o-/f- Fine/Lactic/Bitter almond), while they are negatively associated with the sensory categories: Vegetal (o-/f- Woody), Chemical (o-/f- Plastic/Petroleum/Phenolic, o-/f- Smoky), Animal (o-/f- Proteinaceous), and Warm (o-/f- Caramelized/Toasted/Malted/Charred). To explain the stratification observed in the area of positive preferences, the global map showed an association between liking for sample *K* and the emotion pair "Enthusiastic, Inspired" with the categories: Aromatic (o-/f- Resinous/Balsamic/Camphoraceous), Chemical (o-/f- Pharmacy/Medicinal/Soap), and Astringent. Similarly, there is an association between liking for sample *R* and the emotion pair "Relaxed, Calm" with the categories: Fruity (o- Processed fruit, o-/f- Fermented fruit/Wine-like).

To generalize the trends shown in the global map, the specific correlations between sensory descriptors and hedonic responses were explored (Fig. 4). Considering the liking, the sensory categories of descriptors positively correlated (RHO >0.5) were found to be Floral (o-/f- Floral), Fruity (o-/f- Fresh fruity), and Warm (f- Fine/Lactic/Bitter almond, o-/f- Vanilla). Conversely, the sensory categories negatively correlated (RHO < −0.5) were Vegetal (o-/f- Woody), Chemical (o-/f- Plastic/Petroleum/Phenolic, o-/f- Smoky), Animal (o-/f- Proteinaceous), Aromatic (o- Spicy), and Warm (o-/f- Caramelized/Toasted/Malted/Charred).

Regarding emotions, the pair "Relaxed, Calm" was positively correlated (RHO >0.5) with the sensory categories Warm (o-/f- Vanilla, f- Fine/Lactic/Bitter almond), Fruity (o- Processed fruit), and Sweet. On the other hand, the emotion pair "Enthusiastic, Inspired" was positively correlated (RHO >0.5) with the sensory category Aromatic (o- Resinous/Balsamic/Camphoraceous) and Astringent. Lastly, the emotion pair "Tense, Bothered" was positively correlated (RHO >0.5) with the sensory categories Animal (o-/f- Proteinaceous), Chemical (o-/f- Plastic/Petroleum/Phenolic, o-/f- Smoky), Vegetal (o-/f- Woody), Warm (o-/f- Caramelized/Toasted/Malted/Charred), Aromatic (o- Spicy), and Salty.

4. Discussion

4.1. The sensory graded structure of the multifloral honey category

With the aim of identifying the sensory representation of the multifloral honey category and determining its typicality limits (Aim 1), samples from a geographically defined area were collected with the intention of encompassing a wide spectrum of sensory variations inherent in this distinct food category. The sensory space described by expert judges revealed a graded structure that underlies the typicality representation of this food category. The spatial arrangement, driven by the overall sensory similarities and differences among the samples, has indeed offered an organizational pattern that mirrors the characteristics of the most typical samples of the category, with those having higher typicality positioned in the center of the spatial configuration. This central region housed the prototypical samples of the multifloral honey category, which are defined as samples that share most characteristic attributes of the category. The presence of a graded structure in the multifloral honey category, based on a feature-based approach, confirms that even for a complex concept such as "local food", there are prototypical elements and a variation in typicality that results in typical

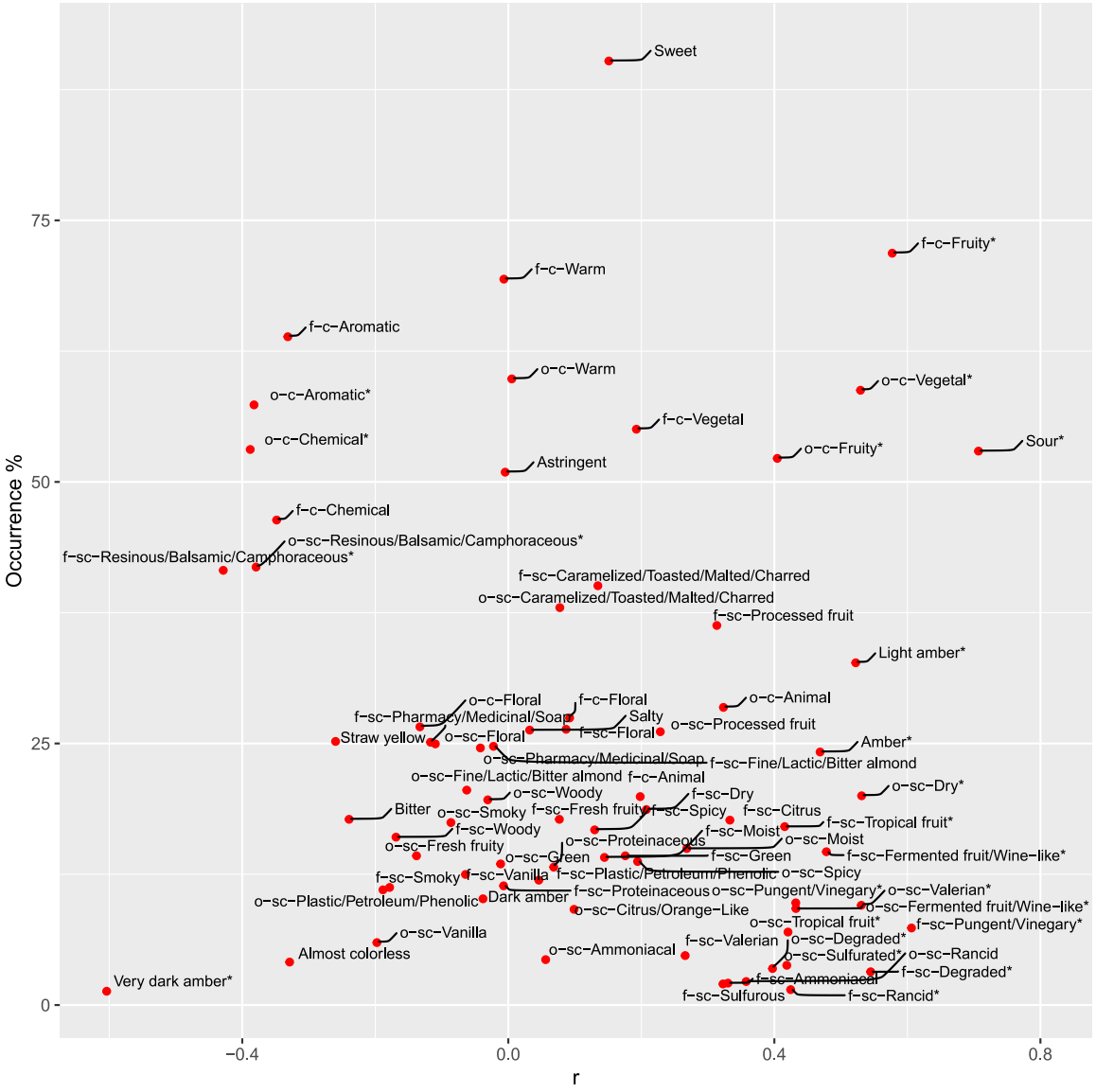

Fig. 2. Spearman's correlation coefficients (RHO) between Check-All-That-Apply (CATA) attributes occurrences and typicality rate vs. percentage occurrences of CATA attributes (Occurrence %). Acronyms used: o – "odor"; f – "flavor"; c – "sensory attribute category"; sc – "sensory attribute subcategory"; * = $p < 0.05$.

Table 5
Frequency of honey consumption, gastronomic use and location of purchase of honey in the consumer panel (n = 131).

Consumption frequency of monofloral honey	%
No consumption	19.1
< 1 portion/month	22.9
1-3 portions/month	13.7
1 portion/week	7.6
2-4 portions/week	13.7
5-6 portions/week	6.9
1 portion/day	9.2
2-3 portions/day	5.3
4-5 portions/day	1.5
>5 portions/day	0.0
Consumption frequency of multifloral honey	
No consumption	12.2
< 1 portion/month	19.1
1-3 portions/month	19.1
1 portion/week	12.2
2-4 portions/week	13.7
5-6 portions/week	7.6
1 portion/day	9.2
2-3 portions/day	5.3
4-5 portions/day	1.5
>5 portions/day	0.0
Gastronomic use of honey (%)	
As it is	30.5
In appetizers	14.5
In first courses/pasta dishes	2.3
In second courses/meat or fish	7.6
In desserts and sweets	52.7
In side dishes	7.6
In sauces	7.6
In hot beverages	68.7
In cold beverages	5.3
Location of honey purchase (%)	
Hypermarket - Supermarket	39.7
Beekeeper	45.8
Local market	26.7
Store - Delicatessen	22.1
Online shop	0.8
Self-production	7.6
I don't buy the honey I consume	4.6

members, atypical members, and related non-members (Hampton, 1979). This is consistent with the assertion that the presence of a graded structure is a defining characteristic of natural categories (Rosch and Mervis, 1975).

The positioning of samples with higher typicality closer to the center of the perceptual map suggests that prototypical instances within the multifloral honey category exhibit a well-balanced representation of sensory descriptors, consistent with the fact that multifloral honey should not exhibit sensory characteristics so pronounced that they do not overlap with the characteristic sensory profile of other monofloral honeys. Considering this, previous studies on the sensory characterization of honey have regarded multifloral honey as the central product within the honey category (Deneulin et al., 2018). However, sensory characterizations involving both multifloral and monofloral honey have yielded contrasting results. Some studies have found a centrality of multifloral honey compared to other categories (e.g., Price et al., 2019), while others have not (e.g., Ciappini et al., 2022; Zocchi et al., 2020). The observed variability may be based on the type of monofloral honeys compared to multifloral honeys, considering the limited sample size investigated. Nonetheless, the present study emerges as having considered a large number of samples of multifloral honey, thereby enabling the examination of the sensory structure and typicality gradient within this category. The sensory diversity observed within the category space can be characterized by sensory combinations linked to geographical origin, the identification of which can lay the groundwork for the promotion of local multifloral honey. Combinations of these sensory attributes at moderate or mild intensities can give rise to local multifloral honeys sensory profiles in the considered local area.

In this contribution, we have proposed an approach to recreate a comparable graded structure while utilizing a limited number of exemplars. The reduction approach employed a feature-based methodology that, through an iterative process, enabled the identification of combinations of exemplars capable of maximizing sensory variability across as many sensory attributes as possible. This approach allowed us to derive a graded structure with high similarity to the overall sample, highlighting how the category structure can be supported even with a reduced number of exemplars. The limited sample size was functional in enabling consumers to make assessments based on a selection of exemplars that are representative of the category. Previous studies have shown that the category representation derived from feature-based approaches remains stable across subjects with different levels of familiarity with the evaluated elements (e.g., Chrea et al., 2009; Cliceri et al., 2019). This suggests that the category representation derived from product experts is likely to be the same as that observed among consumers.

4.2. Sensory drivers of consumers' liking and emotional product associations

To comprehensively investigate and interpret the graded structure of the multifloral honey category, both the assessment of liking levels and the evaluation of post-tasting emotions have been considered (Aim 2). Consumers displayed a preference polarization towards specific areas of the sensory space, with a pronounced preference for samples associated with the Fruity category (f- Fresh fruit), the Floral category (o-/f- Floral), the Warm category (f- Fine/Lactic/Bitter almond; o-/f- Vanilla), the

Table 6
Cochran Q test on Check-all-that-apply (CATA) scores of pairs from Circumplex-inspired emotion questionnaire (CEQ) for prototypical multifloral honeys. Significant differences (alfa <0.05) are indicated in **bold**.

Arousal/Valence	CEQ emotion pairs	Sample (occurrences)						Q	p-value
		T	R	P	O	K	X		
Positive/Positive	*Active, Alert*	17	21	19	20	29	25	5.3	0.375
	Energetic, Excited	10	13	17	17	18	13	4.2	0.524
	Enthusiastic, Inspired	18	13	12	21	34	21	10.8	**0.044**
Negative/Positive	*Happy, Satisfied*	20	30	28	28	29	27	3.3	0.654
	Secure, At ease	18	19	23	21	16	31	8.2	0.143
	Relaxed, Calm	42	41	21	24	32	31	16.1	**0.007**
Negative/Negative	*Passive, Quiet*	21	12	20	12	11	18	7.5	0.187
	Blue, Unispired	2	5	9	6	8	4	6.3	0.283
	Bull, Bored	7	6	9	14	7	6	6.2	0.283
Positive/Negative	*Unhappy, Dissatisfied*	14	8	14	14	7	7	7.4	0.194
	Tense, Bothered	14	4	12	14	5	5	13.8	**0.017**
	Jittery, Nervous	0	6	5	2	6	2	7.8	0.053

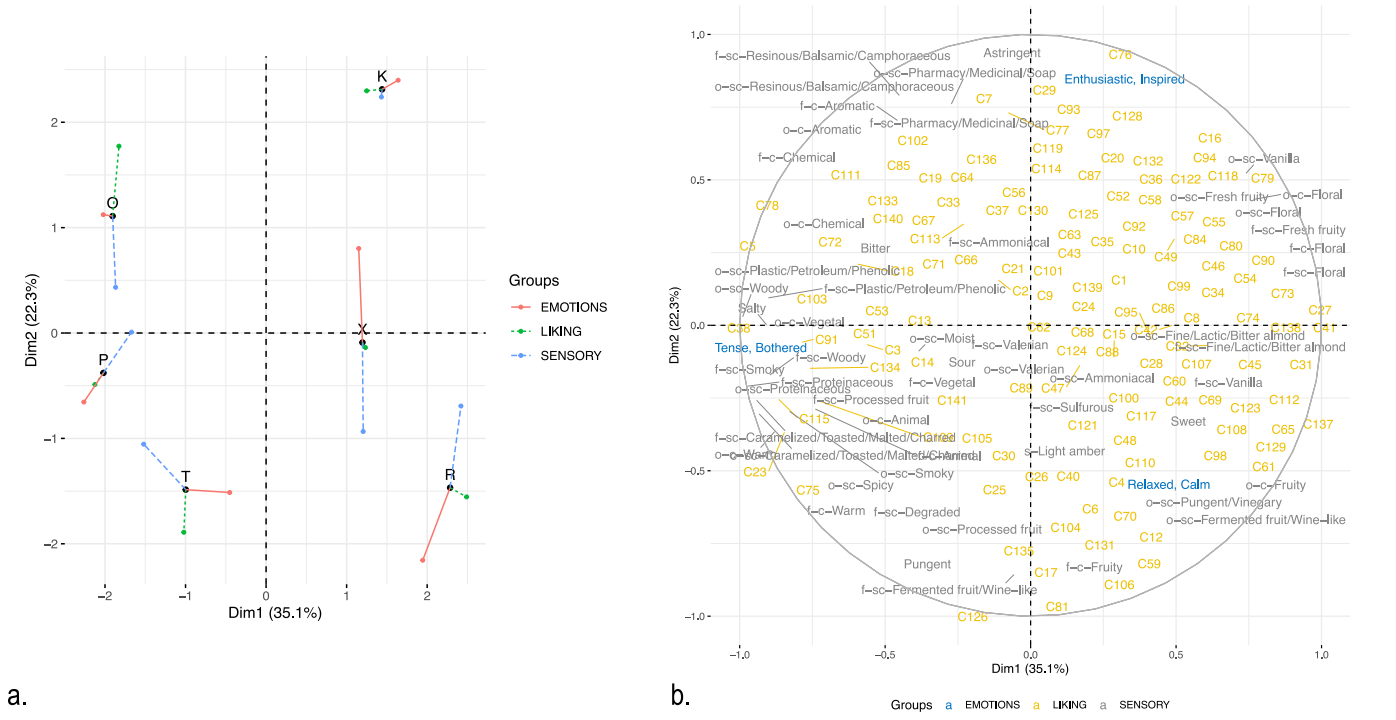

Fig. 3. Global map of 6 samples of prototypical multifloral honey derived from Multiple Factor Analysis computed on liking scores (yellow), Circumplex-inspired emotion scores (blue), and Check-All-That-Apply (CATA) responses (gray). In the score plot (a), projection of variable typology onto the global space was reported. In the loading plot (b), only sensory attributes and emotion pairs significantly discriminating among samples were presented (Cochran Q test, alpha <0.05). Acronyms used: s – "sight"; o – "odor"; f – "flavor"; c – "attribute category"; sc – "attribute subcategory". The alphanumeric codes in yellow identify specific consumers. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Chemical category (o- Pungent/Vinegary), and the Sweet taste. Consistent with the findings of this study, Argentine consumers have shown a greater preference for light and amber honeys compared to dark honeys and the flavor descriptors traditionally associated with them (Ciappini et al., 2022). The same trend has been observed among Uruguayan (Gámbaro et al., 2007) and Finnish consumers (Kortesniemi et al., 2018). In contrast to this preference trend, consumers in the Democratic Republic of Congo favored dark honeys over light ones, aligning with the preferences of Irish (Murphy et al., 2000), German, Austrian, and Swiss consumers (Bogdanov et al., 2004). Considering the Italian consumers within the investigated age segment (young adults), the findings of the present study indicate preference drivers that contrast with those identified by Zocchi et al. (2022). In their research, honey preferences were linked to salty taste, dark amber color, and caramel and smoky flavors, whereas samples characterized by floral and fruity flavors, as well as a sweet taste, were found to be less preferred. This variability in liking sensory drivers in honey clearly underscores the importance of assessing consumer preferences to identify sensory descriptors that align with the preferences of local or target consumers.

An additional aspect investigated in this study, which proves valuable in explaining hedonic orientations, pertains to the examination of emotions elicited by consumers following the consumption of multifloral honeys (Aim 2). As suggested by King and Meiselman (2010) and Giacalone et al. (2022), the study of emotions adds an additional dimension to understand consumer preference. The Circumplex-inspired emotion questionnaire was employed here to measure possible combinations of emotions with varying valence (positive, negative) and arousal levels (high, low). This measurement allowed for the identification of emotional drivers linked to specific sensory properties, aiding in a better interpretation of preference scores.

Almli et al. (2011) and Guerrero et al. (2010) have suggested that traditional food products evoke emotions and values in consumers. In the case of honey, research has demonstrated the significant role that the emotional component may play in determining the acceptability of honey (Stolzenbach et al., 2013). Here indications that local and familiar honeys can elicit responses related to positive valence and high arousal emotions emerged (e.g., "joy" and "excitement"). This evidence partially aligns with the findings of the present study, suggesting in general that the sensory graded structure of the multifloral honey category can generate positive emotions that vary in arousal levels. Given that consumers use positive emotions to express their reactions to foods they like (King and Meiselman, 2010), the variability in arousal levels may underlie the differences in preference observed among consumers.

4.3. Limitations and suggestions for future research

The present study has some limitations that may serve as avenues for future research. In this study, we assumed that the category representation identified by product experts aligns with that of consumers. Previous studies have shown that the category representation derived from feature-based approaches remains stable across subjects with different levels of familiarity (e.g., Chrea et al., 2009). However, a more precise confirmation of this evidence can be obtained by comparing the category representation made by product experts and consumers. This is because the ability to recognize specific sensations and their salience may differ among subject groups (e.g., Cliceri et al., 2017), thus potentially impacting how the category is structured. Similarly, it may be of interest to investigate how perceptions of typicality vary when transitioning from product experts to consumers with low familiarity with the local food.

The present study employed a cross-sectional study approach. However, it is plausible that local products, such as multifloral honey, may be influenced by seasonality and inherent product variability. This leads to the proposition that longitudinal studies may offer a precise framework for understanding category representation and the sensory characteristics of prototype exemplars.

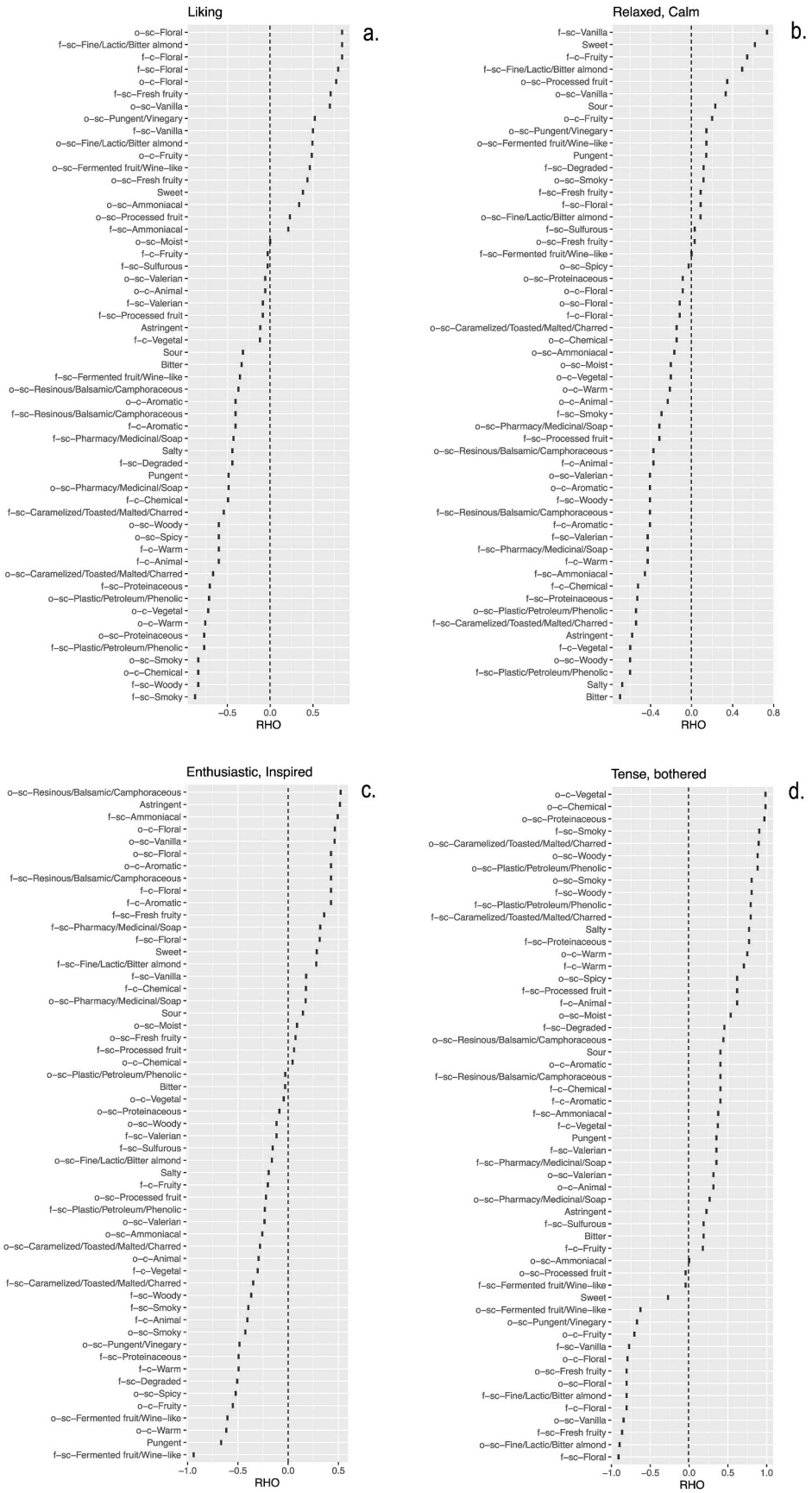

Fig. 4. Spearman's correlation coefficients (RHO) between Check-All-That-Apply (CATA) attributes significantly discriminating among 6 samples of prototypical multifloral honey vs. hedonic scores: liking (a.); "Relaxed, Calm" CEQ emotions (b.), "Enthusiastic, inspired" CEQ emotions (b.), and "Tense, Bothered" CEQ emotions (d.).

Furthermore, the study provided a representation of preferences among a young adult and educated population in Italy. Despite this demographic group showing increasing trends in honey consumption in the Italian market (ISMEA, 2020), conducting research on other population segments typically associated with honey consumption (e.g., elderly individuals) could be important for gaining a better understanding of product category representation and associated preferences in the Italian population.

5. Conclusions

With the overall aim to promote multifloral honey production, this contribution sought to identify the association among sensory attributes and affective-related responses of consumers within typical samples of the category. The sensory space described by expert judges revealed a grouping of samples that underlies the typicality representation of this food category. Here prototypical samples were positioned at the center of the sensory space, characterized by a balanced representation of sensory attributes. Specifically, fruity flavor, vegetal flavor, sour taste, and light amber color were strongly associated with the typicality of multifloral honey from the target local area (Trentino province – Italy). Consumer preference was driven by fruity, floral, and sweet in opposition to warm, and chemical sensory categories. Furthermore, the study examined consumers' emotions following consumption to better explain hedonic orientations, illustrating how the sensory graded structure of the multifloral honey category can generate positive emotions that vary in arousal levels. In conclusion, the study contributes valuable insights into multifloral honey's sensory representation, consumer preferences, and implications for valorization. By understanding the nuances of sensory profiles producers can develop premium varieties that align with consumer expectations, enhancing consumer engagement in the multifloral honey category. This approach can serve as a methodological model for studying the valorization of local food categories that exhibit significant sensory variability.

CRediT authorship contribution statement

D. Cliceri: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **L. Menghi:** Writing – review & editing, Investigation. **G.L. Marcazzan:** Resources, Methodology. **I. Endrizzi:** Resources, Investigation. **S.R. Jaeger:** Writing – review & editing. **F. Gasperi:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Implication for gastronomy

The above insights into the sensory structure of multifloral honey have relevant implications for various aspects of gastronomy. Firstly, our study highlights the importance of environmental factors in shaping the sensory characteristics of multifloral honey. By pinpointing a specific area for honey collection, we were able to demonstrate how even on a local scale, diverse sensory properties can be obtained within samples typical of the multifloral honey category. This variability has proven impactful not only on the sensory profile but also on consumer acceptability. This underscores the importance of having a thorough sensory understanding of local multifloral honeys, with reference to beekeepers, chefs, and gastronomes.

Specifically, the study shed light on the complex nature of sensory perception within this food category. The fact that prototypical samples are characterized by a balanced presence of sensory descriptors without the dominance of any salient attributes suggests that multifloral honey is a nuanced and multifaceted product. As previously suggested for Italian and Danish honeys, promotion strategies for consumers may be based on the uniqueness of specific sensory properties (Zocchi et al., 2020; Stolzenbach et al., 2011). By identifying the sensory attributes associated with positive affective responses, honey producers, chefs and gastronomes can strive to propose products that align more closely with consumer sensory expectations and preferences.

Finally, the study demonstrated how diversity in preferences can also be explained by different emotional experiences. Understanding the emotions associated with the consumption of multifloral honeys with varying sensory properties can support the creation of more consistent consumption expectations and more effective product communication. Recognizing that specific sensory attributes evoke distinct emotional responses among consumers can guide marketing strategies and dish developments that emphasize the emotional aspects of multifloral honey consumption.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used chatGPT 3.5 (OpenAI) to improve readability and language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Danny Cliceri reports financial support was provided by Trento and Rovereto Bank Foundation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijgfs.2024.101055.

Data availability

Data will be made available on request.

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