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Exploring consumers' knowledge and perceptions of unconventional food plants: case study of addition of *Pereskia aculeata* Miller to ice cream

Suelen MAZON[1], Daiana MENIN[2], Bruna Marina CELLA[2], Carla Cristina LISE[2], Thiago de Oliveira VARGAS[1], Marina Leite Mitterer DALTOÉ[2]*

Abstract

Unconventional food plants (UFPs) are by definition little known and infrequently consumed by population, although are recognized as having high nutritional value and economic potential. The objective was to assess the knowledge about UFPs by the population in the southwestern region of the state of Paraná, Brazil; and more particularly to evaluate the holistic perception of an ice cream prepared with the UFP *ora-pro-nóbis*, a plant that is gaining attention in recent years We applied a questionnaire to assess knowledge of several UFPs; check-all-that-apply questions to evaluate the knowledge, habits and perceptions regarding UFPs; and word association (WA) and acceptance tests for holistic and hedonic evaluation of the ice cream. The results revealed that the best known UFP species were taro and roselle, followed by ora-pro-nóbis and lamb's ear. They also revealed that among participants, the majority (63%) had heard of UFPs, but only 19.4% stated they had the custom of eating these plants. The respondents also indicated interest in buying UFPs, but stated it was not easy to find them for sale. In the WA test, ice cream was described mainly in the categories tasty, innovation, sweet taste, plant flavor, smooth and creamy, and the acceptance index was 74%.

Keywords: check-all-that-apply; correspondence analysis; ora-pro-nóbis; word association.

Practical Application: Strategic moves to increase UFP consumption can be guided by increased public knowledge of and acceptance of UFP.

1 Introduction

Many unconventional food plants (UFPs) are recognized by the scientific community as important complementary sources to combat nutritional deficiencies (Bacchetta et al., 2016; Barreira et al., 2015; Menendez-Baceta et al., 2017; Sanchez-Bel et al., 2015). They often contain high concentrations of minerals and proteins and high levels of vitamins A and C, along with significant percentages of fiber (Aberoumand & Deokule, 2009). However, due to the lack of knowledge of these plants, their consumption around the world is low (Almeida & Corrêa, 2012; Bacchetta et al., 2016; Menendez-Baceta et al., 2017).

A recent study highlights the importance of involving different sectors to obtain holistic data for consequent promotion of the use of UFPs, such as pharmeceutical, botanical, agronomic, nutritional, immunological, rural and gastronomic (Bacchetta et al., 2016).

The most common UFPs found in the southwestern region of Paraná, Brazil, are verdolaga (*Portulaca oleraceae*), nasturtium (*Tropaeolum majus*), air yam (*Dioscorea bulbifera*), amaranth (*Amaranthus spp.*), lamb's ear (*Stachys byzantina*), taro (*Colocasia esculenta*), roselle (*Hibiscus sabdariffa*) and ora-pro-nóbis (*Pereskia aculeata*), and they are most often classified as weeds (amaranth and verdolaga) or medicinal plants (lamb's ear and roselle).

Verdolaga contains high concentrations of omega-3, omega-6 and antioxidant compounds (Oliveira et al., 2009). It is used in folk medicine for its diuretic, anti-inflammatory and vermifuge effects (Albuquerque et al., 2007; Xiang et al., 2005). As a food, it can be consumed in salads, juices and stir-fries, imparting a mildly acidic flavor (Oliveira et al., 2009).

Nasturtium is an ornamental, edible and medicinal plant. In cuisine, the flowers are used to decorate plates, especially salads, and have a spicy flavor (Mlcek & Rop, 2011). For medicinal use, it is considered an important source of carotenoids (Garzón & Wrolstad, 2009), and for having antibacterial, diuretic, expectorant and laxative activities (Mlcek & Rop, 2011).

Air yam, as the name suggests, is a bulb that grows above ground. It is used in folk medicine to treat cancer and skin infections (Wang et al., 2012). In cuisine, it is used in baked goods and purees, to replace potato flour.

Amaranth is a plant with many uses, of all parts. It is rich in iron, potassium, calcium, magnesium and vitamins (Jiménez-Aguilar & Grusak, 2017). It also has nutraceutical properties for the treatment of infections, hepatic problems, cancer and degenerative diseases (Peter & Gandhi, 2017).

Taro is rich in fibers (0.6 to 0.8 g/100 g), proteins (2 to 6 g/100 g), carbohydrates (70-80 g/100 g) and vitamins (Kumar et al., 2017). As an important source of starch, it is employed to make four

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[1]*Departamento de Ciências Agrárias, Universidade Tecnológica Federal do Paraná – UTFPR, Pato Branco, PR, Brasil*
[2]*Departamento de Química, Universidade Tecnológica Federal do Paraná – UTFPR, Pato Branco, PR, Brasil*
*Corresponding author: marinadaltoe@utfpr.edu.br

and is consumed in soups and purees. Regarding medicinal use, it is recognized as having wound-healing properties (Gonçalves et al., 2013).

Roselle is also known for its nutraceutical properties, since its flowers and fruits are rich in phenolic compounds, mainly anthocyanins, which have potent antioxidant, anti-inflammatory, anti-obesity, diuretic and anti-cancer activities, besides combating degenerative diseases (Riaz & Chopra, 2018). In cuisine, its flowers are used to prepare teas, jellies, and juices. Extracts from the flowers are also used as natural colorants in the food, cosmetic and pharmeceutical industries (Jabeur et al., 2017).

Lamb's ear is used in folk medicine to combat respiratory diseases. Some studies have also reported it alleviates abdominal pain and menstrual disturbances (Sarikurkcu et al., 2016). In cuisine, its leaves are prepared breaded and fried as an appetizer.

Among these UFP species, ora-pro-nóbis (OPN) stands out (Kinupp & Lorenzi, 2014). It is often referred to as "green meat" or "vegetable meat" due to its high protein content (Madeira et al., 2016). Research also indicates its leaves are an important source of fiber, calcium and iron (Almeida et al., 2012; Martin et al., 2017), bioactive compounds such as antioxidants (Almeida et al., 2012) and anti-inflammatory substances (Pinto et al., 2015). Encouragement of its use is seen as an important strategy to improve nutrition and income among poor people (Almeida & Corrêa, 2012). It can be consumed raw, cooked or as an ingredient in food products (Amaral et al., 2018). In particular, the absence of toxicity of its leaves and high mucilage concentration (Martin et al., 2017) make it attractive for use in processed foods.

The objective of this study was to assess public knowledge, habits and perception regarding UFPs, and in particular, the holistic and hedonic perception of an ice cream prepared with ora-pro-nóbis (OPN).

2 Materials and methods

2.1 Participants

The survey was conducted among 84 participants (31 men and 53 women), with ages between 20 and 51 years, in the city of Pato Branco, located in the state of Paraná, Brazil.

2.2 Questionnaire to evaluate recognition of UFPs

To learn which UFPs are known to the population, we applied a questionnaire containing the images and names of eight UFPs commonly found in the region studied. The participants were asked to mark an X under the unconventional food plants they recognized. The answers were submitted to the z-test, a significance test that allows accepting or rejecting hypotheses. In this study, the test involved all the images at significance level of 5% (Belusso et al., 2016).

2.3 Check-All-That-Apply (CATA) questionnaire to assess the knowledge, habits and perceptions regarding the UFPs.

To evaluate the knowledge, habits and perceptions regarding the UFPs, we applied a CATA questionnaire composed of 16 statements. For each statement there was an opposite one, with the intention of obtaining reliable results. The responses of participants who marked a statement as well as its opposite were eliminated.

The statements were presented in four randomly selected orders (four versions of the questionnaire), to prevent errors in function of the order (Ares & Jaeger, 2013). Again, the z-test was applied to the data at significance of 5% (Belusso et al., 2016).

2.4 Preparation of the ice cream containing ora-pro-nóbis

Since ora-pro-nóbis is rich in mucilage (Martin et al., 2017), it was used in the formulation with the main function of replacing the emulsifiers and stabilizers normally used in ice cream. The ice cream was prepared with the following ingredients: 28% milk, 28% cream, 13.5% egg yolk, 8% sugar and 22.5% raw ora-pro-nóbis leaves.

The ingredients were combined as described by Rodrigues et al. (2006). The milk and cream were mixed under constant stirring at 50 °C. At the same time, the egg yolks and part of the sugar (50%) were whipped until obtaining a smooth cream, and the ora-pro-nóbis leaves and the rest of the sugar were boiled in water for 15 minutes to make a syrup. Then this syrup was mixed with the milk and cream to obtain a second syrup, which was pasteurized at 70 °C for 30 minutes under constant stirring. After pasteurization, the syrup was cooled in an ice bath to -4 °C and packaged and stored for maturation at 4 °C for 4 hours. After maturation, the syrup was whipped in an ice bath at -8 °C for 10 minutes, after which it was placed in a freezer (- 17 °C) and stored until the taste tests.

2.5 Word Association (WA) tests and acceptance trials of the ora-pro-nóbis ice cream

To the taste trials of the ora-pro-nóbis ice cream, the samples were removed from the freezer (-17 °C) 5 minutes beforehand (Varela et al., 2014). Each sample was labeled with a random three-digit code and served in small plastic cups (50 mL).

For the WA test, the participants were told: "Please write the first four words representing sensations or feelings that come to your mind when tasting the sample of ora-pro-nóbis ice cream."

The WA analysis was based on Antmann et al. (2011). All the associations were included and the words with similar meanings were grouped. Four researchers conducted the grouping procedure independently. After evaluating the data individually, they met to reach agreement about the classifications. The final categories and their names were determined by consensus among the researchers, considering the four independent classifications. Categories consisting of words mentioned by more than 5% of the participants were included in the analysis.

The ora-pro-nóbis ice cream was submitted to subjective evaluation on a 9-point hedonic scale (ISO 11136, International Organization for Standardization, 2017).

Correspondence analysis was applied to verify the association between the hedonic responses and the words suggested in the word association test (Mitterer-Daltoé et al., 2017). For statistical analysis, the nine points were reduced to three

groups: Group 1 (points 1, 2 and 3); Group 2 (points 4, 5 and 6); and Group 3 (points 7, 8 and 9). The data were analyzed by the Statistica 12.7 program.

The study was approved by the Ethics Committee for Human Research of Federal Technological University of Paraná (number 93290318.0.00005547).

3 Results and discussion

3.1 Recognition of the UFPs

Figure 1 presents the results of the knowledge about the UFPs. Taro and roselle were the best known plants, marked by 76.2% and 73.4% of the respondents, respectively.

The next best-known UFPs were ora-pro-nóbis, marked by 44.1% of the participants; lamb's ear, 40.5%; and air yam, 36.9%. Nasturtium and amaranth were recognized by 28.6% and 27.4% of the participants, and verdolaga was in last place, with only 11.9%.

3.2 Check-All-That-Apply (CATA) questionnaire

The CATA questionnaire contained statements about the knowledge, habits and perceptions regarding the UFPs. Table 1 shows the frequency of each statement marked. The z-test indicates the significance of the difference between each statement and its opposite.

Table 1. Results of the check-all-that-apply questionnaire. Frequencies for each statement and z-test.

Statements	Checks	Z-test
P1. I've never heard about UFPs.	14	6.26
P2. I've heard about UFPs.	53	
P3. I customarily consume UFPs.	16	4.97
P4. I don't consume UFPs.	47	
P5. I'd buy UFPs at markets regardless of the price.	9	6.22
P6. If the price were accessible, I'd buy UFPs at markets.	47	
P7. I grow at least one UFP at home.	13	7.60
P8. I don't grow UFPs at home.	62	
P9. I've already worked with/studied UFPs.	16	4.82
P10. I've never worked with/studied UFPs.	46	
P11. I don't often find UFPs at supermarkets and street markets.	45	7.65
P12. I often find UFPs at supermarkets and street markets.	1	
P13. Even if I had the opportunity, I wouldn't consume UFPs, even knowing of their health benefits.	0	9.73
P14. If I had the opportunity, I'd consume UFPs because of their health benefits.	60	
P15. I think it's risky to consume food plants not normally consumed by people.	3	8.30
P16. I don't think it's risky to consume food plants not normally consumed by people.	56	

N = 84. α = 0.05. $z_{critical}$: 1.96.

Figure 1. Number of participants who recognized each UFP. Different letters represent significant differences. $Z_{critical}$ = 1.96.

The majority (63%) of the respondents had heard of the UFPs, but only 19.4% stated they had the custom of consuming these plants. The participants also expressed interest in buying the UFPs, if the price was accessible, bud did not consider it easy to find them in commerce (supermarkets and street markets). This low consumption of UFPs but positive attitude about consuming them indicates potential for marketing efforts to increase their consumption.

Furthermore, the majority (71.4%) of the participants expressed willingness to consume UFPs because of the beneficial health effects, and stated they did not believe it is risky to consume unconventional food plants (66.7%). The perception of health benefits revealed by the participants also favors their promotion, since the healthy perception of a determined food has a positive influence on buying behavior (Carrillo et al., 2011; Clarke & Best, 2017).

3.3 Word association and hedonic test

Table 2 presents the categories obtained by applying the word association technique. The participants spontaneously mentioned 266 terms in response to the stimulus employed. Fifteen categories were established by consensus among the four researchers who took part in analyzing the data. Words with similar meanings were grouped in the same category (Varela & Fiszman, 2013). The categories were: *milk flavor*, *plant flavor*, *egg flavor*, *sweet taste*, *bitter taste*, *creamy*, *crunchy*, *agreeable texture*, *tasty*, *bad*, *strange*, *smooth*, *refreshing*, *healthy* and *nostalgia*.

As can be seen in the table, the category cited the most regarding the OPN ice cream was *tasty.* This category appeared 64 times, cited by 76.2% of the participants, and was represented by the words *tasty*, *delicious*, *good* and *savory*. With an acceptance index of 74%, the OPN ice cream was described by the following taste/flavor sensory categories: *milk flavor* (10), *egg flavor* (5), *plant flavor* (17), *sweet taste* (23), *bitter taste* (5), *refreshing* (12) and *smooth* (15). With respect to texture, the responses were: *creamy* (18), *crunchy* (15) and *agreeable texture* (9). The categories *creamy* and *agreeable texture* suggest the efficacy of using the ora-pro-nóbis as an emulsifier and stabilizer of ice cream. In turn, the term *crunchy*, although uncommon in characterizing ice cream, was mentioned spontaneously by 17.8% of the participants. This category, represented by the terms *crunchy*, *pistachio*, *chips* and *flakes*, refers to the sensation perceived due to the presence of small leaf segments of OPN in the ice cream.

Table 2. Frequency of the categories mentioned for the ice cream containing ora-pro-nóbis.

Categories	No. of mentions
Milk flavor (milk, cream)	10
Egg flavor	5
Plant flavor (tea, salad, herbal taste, spicy)	17
Bitter taste	5
Sweet taste	23
Refreshing (fresh, chilled)	12
Smooth (neutral taste, smooth taste)	15
Creamy	18
Crunchy (crunchy, pistachio, chips, flakes)	15
Agreeable texture	9
Tasty (tasty, delicious, good, savory)	64
Bad (bad, poor texture, ugly color)	11
Innovation (exotic, innovation, different)	43
Healthy	5
Nostalgia (nostalgia, comfort, happiness, relief, interior recollection, nature, peace)	14

The second most cited category was *innovation*. The category appeared 43 times and was represented by the words *different, exotic* and *innovation*, suggesting a perception of the product as innovative for ice cream.

The category *nostalgia* was mentioned 14 times (16.6%) and was represented by the words *nostalgia, comfort, happiness, relief, interior recollection, nature* and *peace*. These reveal the influence of past experiences in the cognitive evaluation of the ice cream.

The results of the word association test indicate the potential of using ora-pro-nóbis in ice cream. This affirmation is corroborated by the positive analysis of the following categories: *tasty, creamy, innovation, nostalgia* and *healthy* (although cited by only 5 participants). The positive hedonic perception of a product/food is considered a prerequisite for success in the market (Andrade et al., 2018; Mustonen et al., 2007), and the idea of innovation in consumers' minds can be favorable, since there is growing demand for different types of food products than those traditionally available (Fernández-Ruiz et al., 2013). Paradoxically, it is known that memory has a significant effect on the positive perception of foods (Morin-Audebrand et al., 2012), and past experiences (Ajzen, 1991; Verbeke & Vackier, 2005) and familiarity can influence the food buying behavior (Carrillo et al., 2011; Fotopoulos et al., 2009; Steptoe et al., 1995).

The responses in the *healthy* category corroborate the potential for application and consumption of ora-pro-nóbis, since consumers' interest in healthy foods influences their choices (Steptoe et al., 1995). Knowing the main factors underpinning food choice provides important insight about the interest and attitudes of consumers in relation to healthy foods, as well as their concerns about factors that involve the buying decision (Carrillo et al., 2011).

To combine the terms elicited by the word association technique and the hedonic evaluation and better understand the perception of consumers, we applied correspondence analysis (CA) (Beh et al., 2011; Latorres et al., 2016). CA is a technique of interdependence whose main benefit is the ability to represent rows and columns on a perceptual map (Hair et al., 2009).

Figure 2 presents the results of the CA and reveals that the first two dimensions explained 100% of the association between the categories and hedonic scale groups. The good relation between the categories and hedonic scores is corroborated by the Quality indicator, which had value of 1 for all the hedonic groups. The Quality indicator denotes the sum of the relative contributions, and is part of the variability of each profile explained by the two axes: the nearer it is to 1, the better the representation is of a profile (González et al., 2011).

Analysis of the perceptual map reveals the associations attributed to the ora-pro-nóbis ice cream for each hedonic group.

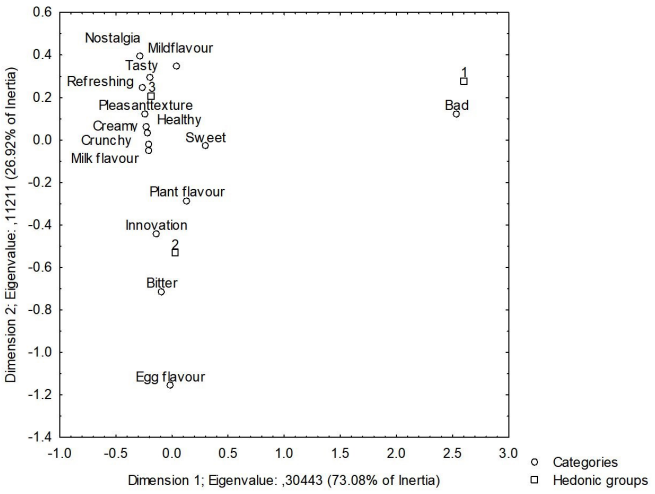

Figure 2. Correspondence analysis of the categories mentioned in the WA and points on the hadonic scale. Group 1 (points 1, 2 and 3); Group 2 (points 4, 5 and 6) and Group 3 (points 7, 8 and 9).

For Group 1, corresponding to the points "disliked extremely", "disliked very much" and "disliked moderately", the related category is *bad*, represented by the terms *bad*, *bad texture* and *ugly color*. In turn, for Group 2, represented by the points in the center of the scale, which can be called indifferent points, the associated categories are *plant flavor, innovation, bitter taste* and *egg flavor.* For Group 3, represented by positive hedonic evaluation of the ice cream, the associated categories are *tasty, nostalgia, mild flavor, refreshing, pleasant texture, healthy, creamy, crunchy, sweet,* and *milk flavor.*

It is interesting to note the new understanding generated by applying correspondence analysis to the results in relation to the descriptor *innovation*. When evaluated just by the number of citations (n=43) (Table 2), the interpretation was that the ora-pro-nóbis ice cream, with good overall acceptance rate of 74.5%, was characterized as an innovative product. However, when relating the scores and descriptors generated by the participants, it can be seen that the term *innovation* was associated not with the responses having the highest score, but rather by those in the indifferent part of the hedonic scale. This result indicates behavior known as food neophobia, which can be defined as fear of eating new foods (Dovey et al., 2008; Lafraire et al., 2016), and its presence has been related to lower acceptance rates (Tuorila et al., 2008).

4 Conclusions

Despite the low consumption of unconventional food plants by the population studied, the survey results show there is good potential for increased consumption of these plants, since the participants indicated interest in consuming them. A clear strategy to promote consumption is to increase the commercial presence, since the respondents revealed difficulty in finding the UFPs at markets. In this respect, the promotion of consumption combined with greater presence in commerce can strengthen the productive chain of UFPs, increase the income of smallholders, and add foods rich in nutrients to people's diets.

In addition to the potential market, the ice cream with OPN proved to be an important alternative use of this plant, readily acceptable by the public. This alternative use of OPN demonstrated possible uses of others UFPs could be well received which would certainly help in market development of these plants.Another important conclusions is that the correspondence analysis between the descriptors obtained by the word association method and the points on the hedonic scale revealed the possible presence of food neophobia among the participants, as indicated by the innovation descriptor. Studies in many countries have shown that food neophobia affects both the quality and variety of foods in diets. This should be considered an important factor in studies of the types of foods consumed by a population.

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