

## Social representations and food neophobia of vegetarian ready-to-eat meals cooked by sous-vide method

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### Summary

This study aimed to analyse the frequency of orange-fleshed sweet potato and pumpkin consumption, the social representations of sous-vide cooked vegetarian ready-to-eat meals (vegetable millefeuille, vegetable mixture and sweet potato provencal), and the correlation between the three meals mentioned, food neophobia and willingness to buy and try. The study involved 1 034 individuals aged 18 and above from Argentina. A correspondence analysis was performed to visualize the attributes of three stimuli evaluated through word association. The results reflect a high frequency of words related to hedonic terms. A negative correlation between the participants' levels of food neophobia and their willingness to buy and try each product was found. Participants with lower levels of neophobia showed a greater intention to consume and purchase the vegetable millefeuille and the vegetable mix. Participants with higher neophobia scores demonstrated less willingness to buy sweet potatoes provencal. Using pumpkin and sweet potato as ingredients of prepared dishes presents an opportunity to increase the demand and added value of widely available vegetables that are part of the world gastronomy industry.

### Keywords

ready-to-eat meals; vegetables; food neophobia; consumers

The demographic, epidemiological, and socioeconomic transformations witnessed in recent decades have profoundly impacted people's purchasing, meal preparation and consumption habits [1]. With a decrease in the time dedicated to cooking and a lack of culinary skills among consumers, there has been a surge in demand for convenient and easy-to-prepare food options [2, 3]. In response to this growing demand, the food and gastronomy industry has directed its efforts toward developing ready-to-eat (RTE) meals, known for their quick preparation [4, 5]. However, many of these prepared meals must meet the nutritional guidelines set by the World Health Organization (WHO), as they tend to be high in energy, fat, and sodium while lacking essential micronutrients [6]. Consequently, given the growing interest in plant-

based products that are natural, health-promoting, minimally processed and free of additives [7], a notable development has been observed in the gastronomy field, both in terms of the variety of the menu and the use of culinary methods [8].

In recent years, RTE vegetarian meals have gained popularity in the market due to the growing trend of reducing meat consumption [9] and increasing the proportion of plant-based foods in the diet [10]. In this context, pumpkin (*Cucurbita moschata* L.) and orange-fleshed sweet potato (*Ipomoea batatas* L.) stand out as two interesting raw materials for developing RTE meals. These vegetables hold significant economic importance, as their cultivation supports regional economies and are available throughout the year at affordable prices [11]. In Argentina, they are widely

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consumed by people of all ages and social strata [12, 13]. From a nutritional perspective, they are valuable sources of carbohydrates, dietary fibre, minerals, vitamins and compounds with antioxidant activity, such as  $\beta$ -carotenes [11].

Despite its outstanding nutritional and culinary characteristics, sweet potato consumption in Argentina remains low compared to pumpkin [12]. According to ILIC et al. [14], adapting culinary practices can influence the experience of eating vegetables. Therefore, developing food products that require minimal preparation could help increase sweet potato consumption [15].

Traditional thermal processing methods reduce vegetables' nutritional value [16]. In response to this issue, the food field aims to incorporate new technologies to develop innovative products [17], improve its competitive position [18] and allows reducing the loss of prepared meals and therefore reducing food waste [16].

Sous-vide cooking is an innovative method of thermal processing [16] that finds applications in home cooking, catering, molecular gastronomy and the food industry [19]. It enables the creation of convenient products with high nutritional value and improved sensory attributes while extending their shelf life [20]. This method involves vacuum-sealing the product in food-safe, heat-resistant plastic bags and cooking it in a controlled temperature water bath below 100 °C for a specific duration [16, 20]. By employing vacuum packaging and lower cooking temperatures, the cellular structure of vegetables remains intact [16], preserving essential nutritional compounds like vitamins, minerals, and antioxidants [16, 17].

Despite the recognized benefits of sous-vide cooking within the scientific community, vacuum-cooked RTE meals are not yet widely available globally [17] and are not currently found in the Argentine market. However, it is expected that in the coming years, vacuum-cooked food products will likely attract more interest and market share as convenient, health-promoting and nutritious options [19]. Therefore, it is crucial to explore the meanings individuals attribute to vacuum-cooked RTE vegetarian meals [21] to predict such products' potential success or failure [22]. This network of ideas, knowledge and beliefs surrounding a topic, shared by a group, together with explaining and guiding feelings as well as practices, is known as social representation [3]. The theory of social representations has been utilized in studies within the field of food science [23].

Free word association is a projective technique employed to examine the contents of social representations [21]. This technique allows a deeper

understanding of consumers' thoughts and feelings about a product [24]. It involves presenting visual and verbal food stimuli to participants together with recording the first words and expressions that come to their minds [25]. Generally, consumers' initial associations can be the most influential in their decision to acquire food products [24].

The high failure rate of products launched in the market has made neophobia an increasingly investigated phenomenon, given its role as a mediating variable influencing food consumption [26]. Food neophobia is a lack of unwillingness or refusal to eat or the tendency to avoid new foods [27]. The Food Neophobia Scale (FNS), developed by PLINER and HOBDEN [28], is the most popular and accurate instrument for measuring consumer neophobia [26, 29]. This tool provides information that can help identify product attributes in consumer preferences for the development of new products [27].

In view of these considerations, the objectives of this study were: i) to analyse the frequency of consumption of sweet potato and pumpkin, ii) to determine the social representations of vegetarian ready-to-eat meals cooked by sous-vide and iii) to evaluate the correlation between the products, food neophobia and willingness to buy and try.

## MATERIALS AND METHODS

### Participants

The participants were recruited through social networks and their participation was confirmed through a consent form before starting the survey. The study involved 1 034 individuals over 18 years of age from Argentina. Regarding recruitment, participants did not need to be regular consumers of vegetarian RTE products, as this product category is still in its early stages in the Argentine market. This study did not aim to gather information from a sample population representative of the real market [3]. Instead, the focus was on determining the frequency of pumpkin and sweet potato consumption, exploring the social representations of sous-vide-cooked RTE vegetarian meals, assessing the level of food neophobia among participants and gauging their willingness to purchase and try the products.

### Questionnaire design and data collection

The data collection approach involved the design of an online questionnaire. Participants received a direct message via social networks containing a link to the questionnaire, accessible online from April 2022. The questionnaire

**Tab. 1.** Preparation of samples used as graphic stimuli in the projective word association technique.

Vegetarian ready-to-eat meals	Preparation of sample
Vegetable mix	Gem variety orange-fleshed sweet potatoes (40 %) were peeled and sliced into 2.0 mm thick slices, pumpkin (40 %) was cut into cubes measuring 3 × 3 × 3 cm and green beans (20 %) were cut into 5 cm strips. The prepared mix was then vacuum-sealed using polyamide-polyethylene bags (O <sub>2</sub> permeability of 25–30 cm <sup>3</sup> ·m <sup>-2</sup> ·d <sup>-1</sup> ; water vapour permeability of 5 cm <sup>3</sup> ·m <sup>-2</sup> ·d <sup>-1</sup> ) with the VacPack machine (International Cooking Concepts, Barcelona, Spain). The heat treatment involved sous-vide cooking in a water bath with constant circulation and temperature and time control using Roner Compact machine (International Cooking Concepts). Cooking took place at 80 °C for 30 min. Subsequently, the mix was rapidly cooled in a water bath at 0 °C for 5 min.
Vegetable millefeuille	Gem variety orange-fleshed sweet potatoes (35 %) and zucchini (24 %) were sliced to a thickness of 3 mm and a diameter of 40 mm. Dried tomatoes (11 %), Danbo cheese – a type of ripened cheese, medium moisture and fat, semi-hard and elastic consistency, compact and soft in texture, uniform yellowish white colour (21 %) and a binder consisting of milk, maize starch and eggs (9 %) were also included. For assembly, the ingredients were layered together. The prepared millefeuille was vacuum-packed using the same conditions as the vegetable mix. The heat treatment involved sous-vide cooking in a water bath with constant circulation and temperature and time control using Roner Compact machine. Cooking took place at 80 °C for 45 min. Subsequently, the millefeuille was rapidly cooled in a water bath at 0 °C for 5 min.
Sweet potato provencal	Gem variety orange-fleshed sweet potatoes were peeled and sliced to a thickness of 2 mm and a diameter of 40 mm. A Provencal flavouring mixture was added, consisting of oil (56 %), vinegar (17 %), onion (17 %), parsley (7 %) and garlic (3 %). The prepared sweet potato was vacuum-packed using the same conditions as the vegetable mix. The heat treatment involved sous-vide cooking in a water bath with constant circulation and temperature and time regulation control using Roner Compact machine. Cooking took place at 80 °C for 30 min. Subsequently, the sweet potato provencal was rapidly cooled in a water bath at 0 °C for 5 min.

encompassed various aspects, including socio-demographic information (gender, age, occupation, marital status, level of education attained and number of people in the household), pumpkin and orange-fleshed sweet potato consumption frequency, free word association tests, a food neophobia scale and a question regarding the participants' willingness to purchase and try sous-vide cooked products.

#### Frequency of consumption

The question aimed at determining the frequency of consumption of the vegetables used to prepare the meals included in this study, i.e. orange-fleshed sweet potato and pumpkin. Response options ranged from “Never” to “Every day”. Participants were asked to select the option that best represented their consumption habits.

#### Projective word association technique

Free word association techniques determined consumers' social representations of vegetarian RTE meals: vegetable millefeuille, vegetable mix and sweet potato provencal. Tab. 1 summarizes the preparation of the visual food stimuli used in the projective word association technique to investigate social representations. Actual photographs of three vegetarian RTE meals cooked by sous-vide technique were utilized. Participants evaluated

one stimulus at a time and were instructed to write down the first words or terms that came to mind when thinking about each product.

#### Food Neophobia Scale

The Food Neophobia Scale (FNS) developed by PLINER and HOBDEN [28] was used to measure the willingness to try new foods. It consists of ten statements:

- A. I constantly try new and different foods.
- B. I don't trust new foods.
- C. If I don't know what's in a food, I won't try it.
- D. I like foods from different countries.
- E. Ethnic food seems too strange to eat.
- F. On special occasions, I would try new foods.
- G. I am afraid to eat things I've never tried before.
- H. I am very picky about the foods I eat.
- I. I would eat almost anything.
- J. I enjoy trying new ethnic restaurants.

Each statement was rated on a 7-point Likert scale ranging from strongly disagree to agree strongly. The statements A, D, F, I and J were evaluated as follows: 1 = completely agree, 2 = moderately agree, 3 = slightly agree, 4 = neither agree nor disagree, 5 = slightly disagree, 6 = moderately disagree and 7 = completely disagree. On the other hand, statements B, C, E, G and H were

evaluated oppositely, with 1 = completely disagree and 7 = completely agree [28].

The neophobia index was calculated by summing the scores of the ten individual items to categorize consumers. A higher score indicated a greater reluctance of the individual to try new foods or, using the terminology of PLINER and HOBDEN [28], a higher level of “neophobia” of the consumer. Conversely, lower total values reflected a more open and tolerant attitude towards new foods, indicating a higher level of “neophilia” of the individual. Consumers were classified into three groups: neophilic, those who obtained a score between 10 and 24; a medium group, who obtained between 25 and 50 points, and neophobic, participants who obtained between 51 and 70 points [28].

### **Willingness to buy and taste the products**

After completing the word association tests, inquiries were made about the intention to purchase and try each product. A 7-point scale ranged from “Strongly no” to “Strongly yes”.

### **Statistical analysis**

The responses obtained from the free word association tests were analysed qualitatively. Initially, a recurrent term analysis was conducted, where terms with similar meanings were grouped into the same category. Four investigators participated in the classification process, considering word synonymy. After individually evaluating the data, the four investigators determined the final categories through consensus. The percentage of consumers responding within each category was calculated. A category was considered for further analysis if its terms were mentioned by more than 5 % of the people who were surveyed. A correspondence analysis was performed to visualize the attributes of the three stimuli evaluated through word association. Pearson’s correlation coefficients were calculated to examine the relationship between the product, food neophobia and willingness to buy and try. The data analysis was conducted using XLSTAT version 2022.4.1 (Addinsoft, New York, USA).

## **RESULTS AND DISCUSSION**

### **Socio-demographic characterization and neophobia level**

Tab. 2 summarizes the socio-demographic characteristics and neophobia levels of the 1034 individuals who participated in the study. Most of the respondents were women (82 %), belonged

to the millennial generation (63 %) and had a higher educational level (82 %). According to CURTI et al. [25], females were the most likely to participate in online surveys, they also had a greater ability to verbalize their perceptions and feelings as well as they were mainly responsible for feeding the family. Additionally, individuals from the millennial generation showed a greater interest in vegetarian foods [18]. Regarding the participants’ occupation, 42 % indicated they only worked, while another 30 % reported working and studying simultaneously. A portion of 44 % of the participants were single and 63 % lived in a household of three or more people. Socio-demographic characteristics also play an essential role in food neophobia [27]. In this sense, the results showed that 65 % of the participants had a medium level of food neophobia.

### **Frequency of consumption**

Vegetables play a vital role in the health-promoting diet [30]. Specifically, pumpkin and orange-fleshed sweet potatoes are noteworthy for their content of carbohydrates, dietary fibre,  $\beta$ -carotene and other antioxidant compounds [11]. Understanding the preferences and demands surrounding these vegetables is crucial for developing consumer-accepted products [30].

The findings of this study revealed that 85 % and 75 % of the participants consumed pumpkin and sweet potato (occasionally and frequently), respectively. This coincided with a technical report from the National Institute of Agricultural Technology (Tucumán, Argentina) [12] which indicated that these vegetables are prominent in the Argentinian family diet. Thus, promoting vegetables with sweeter flavours could be a promising strategy for increasing vegetable consumption among the population [30].

Tab. 3 summarizes the frequency of vegetable consumption, categorized as frequent, occasional, and never, based on the obtained information. The results indicated that 66 % of the participants reported frequent consumption of pumpkin, while over half of the participants (55 %) stated that they consumed sweet potatoes occasionally or never. This consumption trend, as noted by CUSUMANO and ZAMUDIO [12], indicated that sweet potato consumption in Argentina is lower than that of pumpkin. This could be attributed to consumers’ need for more awareness regarding the nutritional qualities of sweet potatoes and their diverse preparation methods [12].

### **Social representation of ready-to-eat meals**

A total of 3333 words were mentioned by

**Tab. 2.** Participants' socio-demographic characterization and neophobia level.

Characteristics		Participants [%]			
		Total	Food neophobia group		
			Neophilic	Medium	Neophobic
Total proportion of participants		100	29	65	6
Gender	Female	82	23	54	5
	Male	18	6	11	1
Age group by generation	Centennials (18–23 years)	18	4	12	1
	Millennials (24–41 years)	63	19	41	3
	Gen X (42–52 years)	11	4	7	0
	Baby Boomers (53–73 years)	8	1	6	1
Marital status	Single	44	13	29	2
	Concubinage	27	9	18	1
	Married	23	6	15	2
	Divorced	4	1	3	0
	Widowed	1	0	1	0
Occupation	Working	42	11	28	3
	Working and studying	30	10	18	2
	Studying	18	5	12	1
	NEET	10	2	8	0
Level of education attained	Primary education	2	0	1	0
	Secondary education	16	4	11	1
	Tertiary or high education	82	24	53	5
Number of people in the household	1	12	5	6	1
	2	25	7	16	1
	3 or more	63	17	42	4

NEET – not in employment, education, or training.

**Tab. 3.** Frequency of consumption of pumpkin and sweet potato.

Vegetables	Frequency of consumption [%]		
	Frequent	Occasional	Never
Pumpkin	66	21	13
Sweet potato	45	30	25

Frequent consumption – participants consumed vegetables “Once or twice a week”, “Three or five times a week”, or “Every day”, occasional consumption – participants consumed vegetables “Once every fortnight”.

**Tab. 4.** Percentage of participants who responded within each category identified in the projective word association technique.

Category	Frequency of mention [%]		
	Vegetable millefeuille	Vegetable mix	Sweet potatoes provencal
Hedonic aspects	40	28	29
Feelings, emotions and memories	22	26	16
Ignorance	12	28	11
Nutrition and health	8	3	19
Sensory characteristics	5	7	10
Preparations and ingredients	7	5	8
Consumption occasions	5	3	6



participants when presented with visual stimuli and asked to write the first words that came to mind when thinking of three RTE vegetarian meals cooked by sous-vide: vegetable millefeuille, vegetable mix and sweet potatoes provencal. In the context of product development, it is essential to consider consumers' opinions [17] to develop strategies that encourage their consumption, particularly in a market where this category is incipient [31].

Tab. 4 shows the frequency of mentioning each category for the three RTE meals cooked by sous-vide and the examples of individual responses mentioned by the participants. The category most frequently mentioned by the participants in response to them was the hedonic aspects. Participants associated the vegetable millefeuille (40 %), sweet potato provencal (29 %) and vegetable mix (28 %) with positive characteristics such as "tasty", "I like it", "delicious" and "yummy". The higher frequency of mentioning the vegetable millefeuille in this category may be due to the creation of expectations based on previous experiences with similar products [32]. These results indicated a positive hedonic attitude among the participants [33], which could be valuable for product development and commercialization [18].

The second most mentioned category was related to the feelings, emotions and memories evoked by the meals in the participants. Sweet potato provencal (26 %) was mainly associated with terms such as "family", "grandmother", "mom", "home" and "childhood". This reflected a strong association with family consumption in childhood [25]. According to GUGLIUCCI et al. [3], associations with family are predominantly linked to females. These associations could be attributed to the fact that sweet potatoes, the main ingredient in the product, are commonly found in Argentinian family recipes [12].

The third most significant category was the participants' need for knowledge about the three studied preparations. The vegetable mix was the product most associated with this category (28 %), with comments such as "I don't know what it is", "I don't know" and "I have never tried it". This can be attributed to the participants' difficulty to identify the preparations that are not widely known worldwide, as sous-vide cooking is a relatively new culinary technique [17].

The fourth category was primarily related to nutrition and health aspects. This association can be attributed to consumers' increased awareness of the connection between food and health [18]. In this category, the vegetable mix (19 %) was predominantly associated with positive attributes

related to its nutritional value, such as "health", "healthy" and "nutrients". This suggested a positive perception of the nutritional value of these products [33]. According to ARAUJO MARTINS et al. [18], these characteristics play an essential role in consumer preference and choice regarding this type of preparation. In this regard, ROASCIO-ALBISTUR and GÁMBARO [17] argued that highlighting the nutritional benefits of sous-vide cooking on product packaging could motivate consumer choices.

The fifth category was related to the sensory characteristics of the meals. The results showed that the participants primarily associated the vegetable mix (10 %) with attributes such as "flavourful", "salty" and "colourful". Most of the words in this category referred to positive sensory characteristics of the products. The visual appearance and taste of the products are fundamental factors in establishing favourable sensory and hedonic responses in consumers [32]. The way of sous-vide cooking suggests better preservation of the organoleptic characteristics, as suggested by KATHURIA et al. [20].

Fig. 1 presents the correspondence analysis, visualizing the relationship between the three studied products and their associations. The high percentage of total variance explained by the map demonstrates that the selected categories effectively represented the associations made by individuals prior to being presented with the stimuli [34].

As mentioned earlier, Fig. 1 illustrates the associations between the stimuli and their respective categories. The stimulus "vegetable millefeuille" was primarily associated with the category "hedonic characteristic". On the other hand, when participants were presented with the stimulus "vegetable mix", they mainly associated it with positive terms related to "nutrition and health". However, it was also linked to "sensory characteristics" and "occasions of consumption". According to ROASCIO-ALBISTUR and GÁMBARO [17], the presentation of a product influences its consumption occasions, indicating that subsequent consumption choices are influenced by consumer dietary preferences [24].

Participants mainly associated "sweet potatoes provencal" with "feelings, emotions and memories", indicating a strong association with family consumption. This suggested that the product was not intended for individual consumption but for sharing with others. However, respondents also associated the product with the "other" category with terms such as ignorance. Similar findings were reported by ROASCIO-ALBISTUR and GAM-

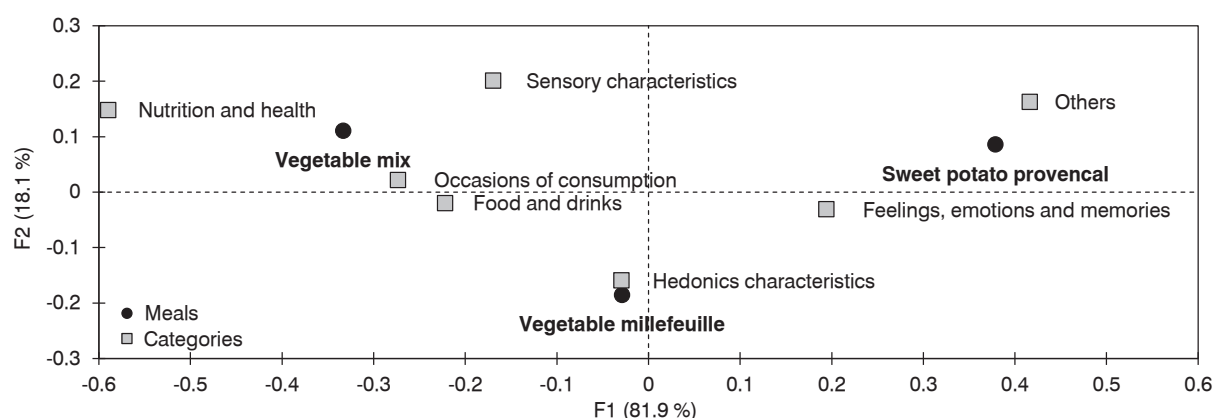


Fig. 1. Correspondence analysis of vegetarian ready-to-eat meals and their categories.

Tab. 5. Correlation between food neophobia and willingness to buy and try sous-vide-cooked products.

Product	Willingness	Food neophobia group			<i>r</i>
		Neophilic	Medium	Neophobic	
Vegetable millefeuille	To buy	4.40 ± 2.31 <sup>a</sup>	3.45 ± 2.25 <sup>b</sup>	1.97 ± 1.67 <sup>c</sup>	−0.219
	To try	5.45 ± 2.06 <sup>a</sup>	4.11 ± 2.34 <sup>b</sup>	2.92 ± 2.12 <sup>c</sup>	−0.261
Sweet potato provencal	To buy	3.78 ± 2.43 <sup>a</sup>	2.76 ± 2.15 <sup>b</sup>	1.87 ± 1.66 <sup>c</sup>	−0.227
	To try	4.68 ± 2.44 <sup>a</sup>	3.36 ± 2.36 <sup>b</sup>	2.32 ± 2.01 <sup>c</sup>	−0.269
Vegetable mix	To buy	4.51 ± 2.32 <sup>a</sup>	3.94 ± 2.34 <sup>b</sup>	3.12 ± 2.35 <sup>c</sup>	−0.126
	To try	5.39 ± 2.11 <sup>a</sup>	4.49 ± 2.38 <sup>b</sup>	3.75 ± 2.37 <sup>c</sup>	−0.157

Values represent mean ± standard deviation. Pairs of means with the same upperscript letter in the row do not differ significantly according to Tukey's test ( $p < 0.05$ ).

*r* – Pearson's correlation coefficient, correlation is significant at 0.01 level (2-tailed).

BARO [17], who observed that consumers in Uruguay had limited knowledge about sous-vide cooking. The lack of awareness and understanding of new products produced using novel processing technologies can lead to insecurity and distrust, discouraging their consumption [18]. This could be attributed to a significant portion (10 %) of the national sweet potato production primarily used for traditional solid sweets, with only a small portion used to produce pre-fried sticks and fried snacks [15]. In this context, diversifying the range of sweet potato products could increase the demand for this vegetable, benefiting producers and consumers [12].

#### Correlation between food neophobia and willingness to buy and try meals

Tab. 5 summarizes the data regarding the participants' willingness to purchase and try sous-vide-cooked products based on their food neophobia level and the correlations observed between these variables.

The findings indicated an inversely proportional correlation meaning that the higher the

willingness to buy and consume the three analysed products, the lower the food neophobia level among the participants. They were more willing to try new products obtained through innovative technologies [29] than those with high or moderate levels of neophobia. These findings suggest that the willingness to explore new, non-traditional food options, influenced by consumer perception [29] and ease of consumption [31], can mitigate food neophobia.

## CONCLUSIONS

Understanding people's representations of vacuum-cooked vegetarian RTE meals is crucial for designing strategies to introduce them to the market and encourage their consumption, either as main dishes or as accompaniments to other preparations. In this context, the free word association technique provided valuable insights into the participants' social representations of vacuum-cooked vegetarian RTE meals in a market where products made by this cooking method

are unfamiliar. The hedonic aspects were the most commonly associated concepts with the three analysed products, followed by the feelings, emotions and memories evoked. However, many participants expressed their need for more knowledge, possibly due to the absence of this type of products in the domestic market.

Consumers' interest in health-promoting and additive-free plant-based products that are easy to prepare drives the development of vacuum-cooked vegetarian RTE meals, which can be potentially characterized by preserved nutrient. In this context, pumpkins and sweet potatoes emerge as excellent vegetables of high value, as a potential component to expand and diversify the product offerings in the market as well as to contribute to improving the quality of the population's diet.

Finally, considering the infrequent consumption of orange-fleshed sweet potatoes compared to pumpkins nationwide, it is imperative to highlight the importance of providing information to the population about their nutritional properties and health benefits to promote their consumption.

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