

# Spotting the sensory preferences of artichokes to improve the consumption of this functional food

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**Abstract** - Given the greater varietal supply of the globe artichoke and evaluating its use for human consumption, it is important to carry out market positioning work, including the recognition of the newly available cultivars. Sensory analysis comes up as an important instrument to assess the potential of insertion of artichoke into the market. Within this perspective, the aim of the present study was to determine the sensorial quality characteristics of three globe artichoke cultivars produced in the Rosario's Horticultural Belt and associated with the preference of consumers. The cultivars were Opal, Madrigal and Romanesco. For sensory evaluation, the method called CATA (Check All That Apply) was used. The results of the CATA test were analyzed using multivariate statistics, applying the Correspondence Analysis. The most distinguishing elements between artichokes were the color and aroma. When associating these results with which was the artichoke that consumers liked the most, it was observed that the Romanesco obtained the best rating. Consumers preferred sweet and tender artichokes. This information could guide the production strategies of the horticulturists to offer cultivars that meet these characteristics.

**Key words:** artichokes, sensory analysis, CATA.

## I. INTRODUCTION

The cultivation of the globe artichoke (*Cynara cardunculus* var. *scolymus* L.) in Argentina began at the start of 1900s with the arrival of Italian and Spanish immigrants. They introduced the first cultivars and adapted their agricultural practices to the conditions of the local climate and soil. Currently, Argentina is the fourth largest producer of globe artichokes in the world, after Italy, Egypt and Spain [1].

The Horticultural Belt of Rosario (Argentina) has a long tradition in the production of cultivars destined for fresh consumption. The edible portion of the plant consists of the flower buds before the flowers come into bloom. The budding artichoke flower-head is a cluster of many budding small flowers (an inflorescence) together with many bracts, on an edible basis [2]. Artichokes also have nonfoods as their leaves that they are a source of antioxidant compounds, such as luteolin and dicaffeoylquinic acids (cynarin) [3], and the roots contain inulin, an oligosaccharide known to have a positive effect on human intestinal flora, and thus a positive impact on health [4] [5]. It is not only a source of pharmaceutically useful compounds, but also potentially good energy crop [6][2].

At present, different technologies have been used for the production of the globe artichoke, such as the use of seed reproductive materials and drip irrigation, which facilitates their production, expanding the varietal spectrum and prolonging the supply period in the market. The producers have incorporated cultivars with different characteristics in terms of shape, color, texture and taste [2]. However, such differences are not clearly identified by consumers, who are often unaware of the species in question and its mode of consumption.

The quality in fruits and vegetables can have different meanings, according to the different parties involved in the distribution chain. Mainly, it can be divided into product-oriented quality and consumer-oriented quality. When referring to quality from the point of view of the consumer its measurement becomes less tangible and quantifiable. In this case, sensorial analysis becomes a very useful tool, since it allows the identification of important value attributes for consumers, which would otherwise be very difficult to measure [7].

Given the greater varietal supply of the globe artichoke and evaluating its use for human consumption, it is important to carry out market positioning work, including the recognition of the newly available cultivars. The innovative sensorial Check All That Apply (CATA) technique has sprung up in search of a direct link with consumers. The CATA methodology consists in statements used by consumers to mark out as many options as are needed, to express their opinion about the product under

analysis. Such methodology is descriptive, not lengthy, and flexible. It can be apply on the consumers without the need for trained appraisers [8].

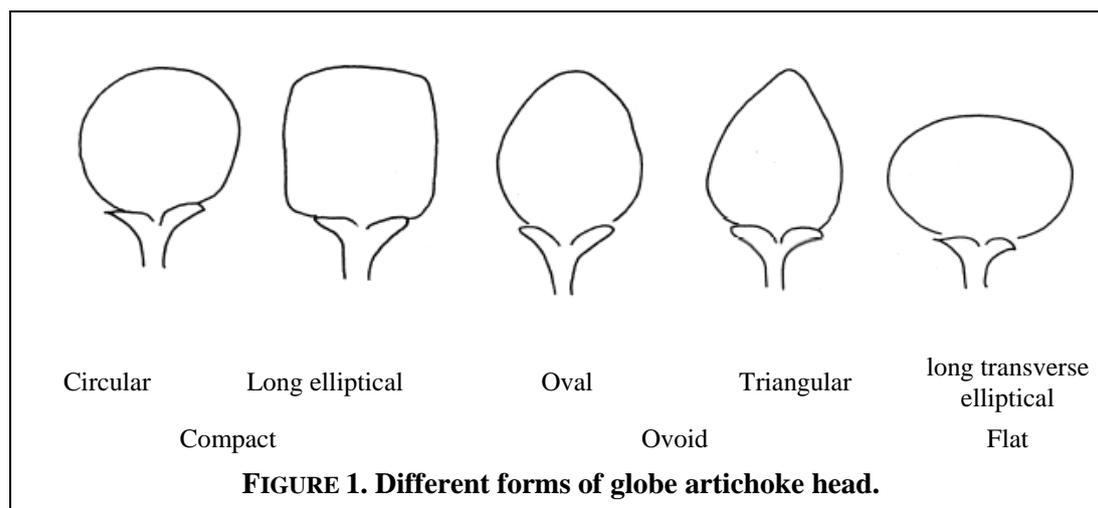
Techniques involving consumers are apply in knowing the relationship among several factors and help interpret the perception of food by the human being linked to the pleasure experienced in its consumption [9]. Sensory analysis comes up as an important instrument to assess the potential of insertion of new product into the market [8].

Within this perspective, the aim of the present study was to determine which sensory characteristics are preferred by consumers for the globe artichokes. This will allow proposing strategies for their production and commercialization and increasing the consumption of this functional food.

## II. MATERIAL AND METHOD

The work was carried out with globe artichoke heads harvested during September and October of 2017 in the area of Rosario (33° 52 18 S, 60° 40 46 W, Argentina). Three cultivars were used: the hybrids Opal and Madrigal were provided by Nunhems Company, the Romanesco was produced using asexual reproduction. It is also known as French variety and being the most traditional farming material in the area.

For the sensory evaluation, the method called CATA (Check All That Apply) was used. It consists on the participants selecting the terms that they consider appropriate for the description of each product from a set of terms provided [9]. For this purpose, the classification shown in Fig. 1 was used [11]. In order to make the descriptors of the shape of artichokes more accessible, terms that were more familiar to consumers were used. The circular and long elliptical forms were jointed under the term "compact", oval and triangular as "ovoid" and the long transverse elliptical form was identified as "flat" (Fig. 1).



For the selection of the proper terms for CATA, five previous sessions were conducted with trained sensorial assessors. As a result of this preliminary work, the trained assessors selected 21 terms with the score sheet was drawn (Fig. 2). The color of the bracts was established by differentiating between green and violet. The presence of "hairs or spikes" was explained as very developed flowers that appear when the heads are overripe. Consumers also had to indicate their preference in a hedonic verbal scale of 9 points [12].

Fifty people participated in the CATA test [13], aged between 20 and 60 years old. They were the students and teachers of culinary schools of Rosario, such as the "Asociación de Empresarios Hoteleros Gastronómicos de Rosario" (AEHGAR), "Instituto Superior" (ISHYR), "Instituto de María de los Ángeles Soso" (MAS) and students of "Licenciatura en Nutrición de la Universidad del Centro Educativo Latinoamericano" (UCEL). Participants were selected considering their knowledge of food, their taste and preference for ingredients, their ability to observe and their vocabulary to describe food.

The heads of the three cultivars were presented raw, in order to evaluate their appearance, and cooked to the point of tenderness to complete the evaluation of the sensorial characteristics.

*You will receive three samples of artichokes. For each of them, SELECT ALL the following terms that describe it. Rinse your mouth with water between samples. Finally mark with a cross how much you like this artichoke.*  
 Sample No.: .....

<input type="checkbox"/> Ovoid <input type="checkbox"/> Flat <input type="checkbox"/> Compact <input type="checkbox"/> Green Bracts <input type="checkbox"/> Violet (purple) bracts <b>Bracts (Edible portion)</b> <input type="checkbox"/> Inedible bracts <input type="checkbox"/> Edible bracts <10%	<input type="checkbox"/> Edible bracts <50% <input type="checkbox"/> Edible bracts >50% <b>Bottom(fund)</b> <input type="checkbox"/> Bitter taste <input type="checkbox"/> Sweet taste <input type="checkbox"/> Fresh herb flavor <input type="checkbox"/> Tomatoe flavor <input type="checkbox"/> Olive flavor	<input type="checkbox"/> Herbaceous aroma <input type="checkbox"/> Aroma of olive oil <input type="checkbox"/> Chlorophyll aroma <input type="checkbox"/> Tomato aroma <input type="checkbox"/> Tender texture <input type="checkbox"/> Fibrous texture <input type="checkbox"/> With presence of hairs or spikes
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<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dislike extremely			Neither like nor dislike				Like extremely	

**FIGURE 2. Example of CATA score sheet**

The results of the CATA test were analyzed using multivariate statistics, applying the Correspondence Analysis (CA) methodology by R-project v.3.5.0 [14]. CA is a multidimensional scaling multivariate technique that uses non-metric data in the crossed design to create percentage maps including all variable categories [15].

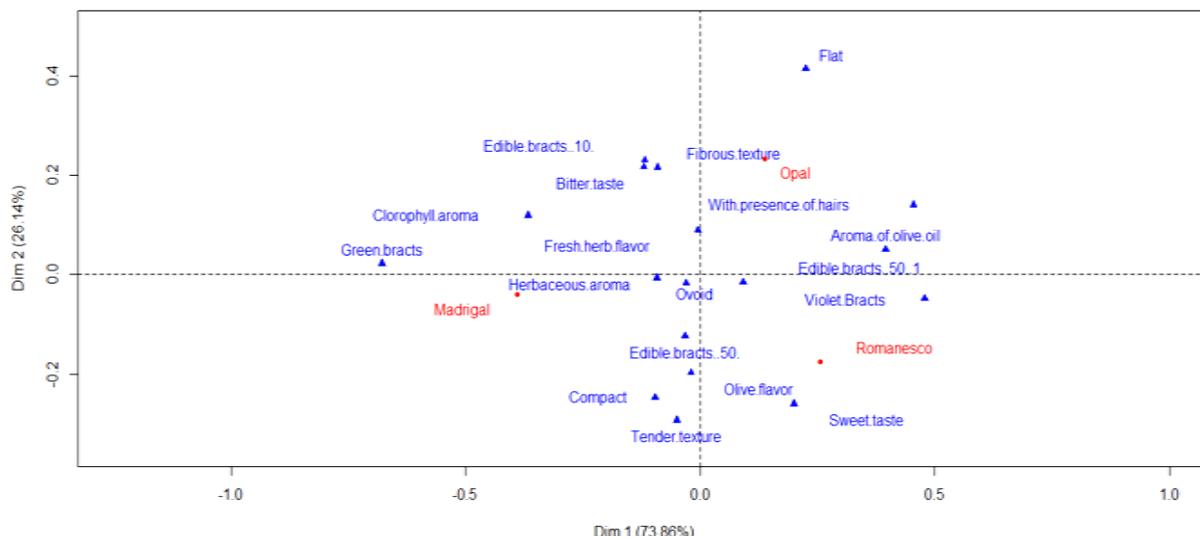
**III. RESULTS**

**TABLE 1  
DESCRIPTOR SELECTION FREQUENCIES OBTAINED WITH THE CATA QUESTIONNAIRE**

	Ovoid	Flat	Compact	Green Bracts	Violet bracts	Inedible bracts	Edible bracts <10%	Edible bracts <50%	Edible bracts >50%	Bitter	Sweet	Fresh herb flavor	Tomato Flavor	Olive flavor	Herbaceous aroma	Aroma of olive oil	Chlorophyll aroma	Tomato aroma	Tender texture	Fibrous Texture	Presence of hair or spikes
Romanesco	35	4	25	9	47	0	9	25	14	21	15	14	1	9	28	9	3	0	36	14	34
Madrigal	42	3	25	47	11	0	15	24	11	32	8	15	0	8	29	3	8	0	32	23	9
Opal	33	8	12	16	34	2	16	17	12	35	7	16	1	5	25	8	5	1	15	24	35

Table 1 shows the number of times that consumers marked each statement. It was observed that the descriptors inedible bracts, tomato flavor and aroma were practically not chosen. The most selected terms were “Ovoid”, “Green or Violet bracts”, “Bitter taste”, “Herbaceous aroma”, “Tender texture” and “Presence of hair or spikes”. In order to better appreciate the relationship between the CATA terms and the hedonic points, a Correspondence Analysis (CA) was conducted. The inedible bracts, tomato flavor and aroma were excluded from the statistical analysis so as not to generate distortions.

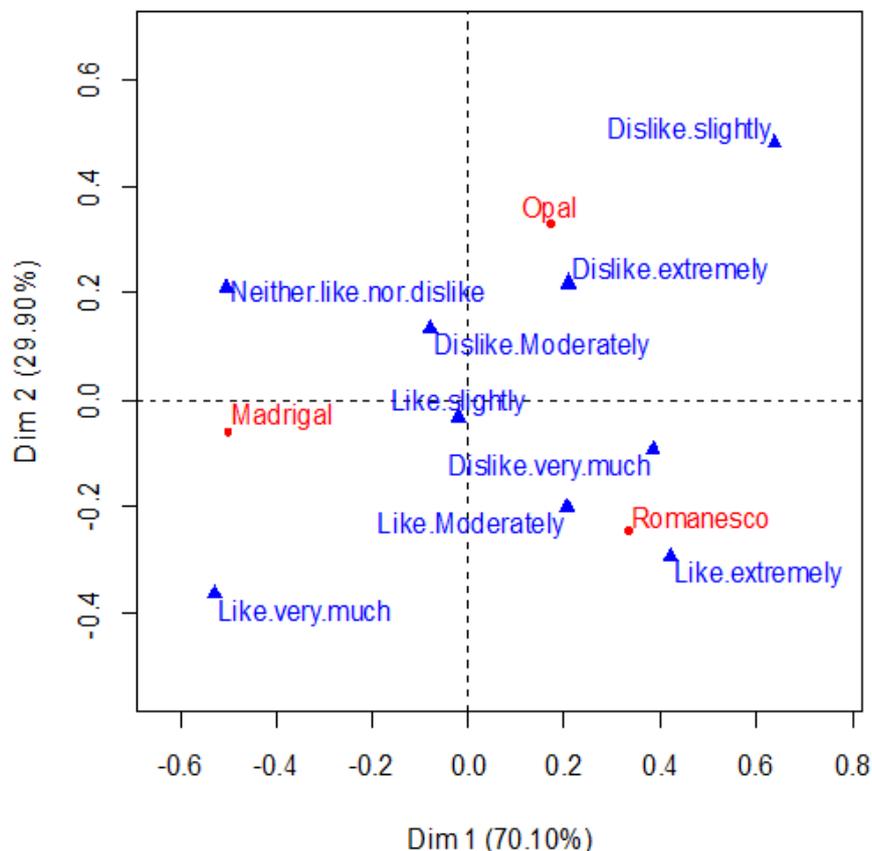
Fig. 3 shows the Correspondence Analysis factorial map. Its first dimension (Dim 1) explained 73.86% of the differences found between the globe artichokes. The most distinguishing elements were the color, Aroma of olive oil and Chlorophyll aroma. Madrigal was associated with Green bracts and Chlorophyll aroma, while the Romanesco and Opal artichokes were related with the Aroma of olive oil and the violet bracts. The "presence of hairs" was a descriptor close to the Opal artichokes.



**FIGURE 3. Factorial Map obtained by Correspondence Analysis on the CATA evaluations on Romanesco, Madrigal and Opal artichokes.**

The second dimension (Dim 2) explained the 26.14% of variations. The descriptors of form “flat” and “compact”, the “bitter” and “sweet” taste, and the “fibrous” and “tender” terms of texture differentiated the samples. Romanesco was described as the sweetest. The Opal was described as bitter, fibrous and flat.

Fig. 4 shows the Correspondence Analysis map of the artichoke consumers preferences. While Opal was closest of phrases that express dislike, Madrigal was near to the neutral phrase “Neither like or dislike”, but the phrases related to liking too. Romanesco is between the phrases “Like extremely” and “Dislike very much”.



**FIGURE 4. Correspondence Analysis on the preference of the consumers for the different artichokes cultivars: Romanesco, Madrigal y Opal.**

In short, the Romanesco had consumers who appreciated it but it also had detractors, Madrigal was more homogenous in preference, and Opal had the more negative comments. Participants preferred tender and sweet artichokes, characteristics mainly offered by the Romanesco. Madrigal was accepted because it is not bitter or fibrous either.

Food preferences are related to culture and culinary habits. While in Spain green and small heads were preferred (Blanca de Tudela), in Italy they opted for the violet and median variety (Romanesco). In Bretagne (France), they preferred green and large heads (Camus de Bretagne) and in Provence (France), violet and medium heads (Violeta de Provenza) [16]. The color of the head was the variable that had the most influence on the habits of consumption of each zone [17].

Consumers from Texas (USA) preferred fresh, large and green artichokes compared to small and violet canned cultivars, since the taste, the freshness and the aspects related to the nutrition were the three main factors that influence in the decisions of purchase of the artichoke consumers [18].

#### IV. CONCLUSION

The CATA technique made it possible to obtain information about the sensorial characteristics of the three globe artichoke cultivars that were evaluated. It proved to be an important tool for researching consumer market.

The preference of consumers was associated with the differentiator's sensory attributes. They like sweet and tender artichokes as Romanesco. This information could guide the production strategies to offer cultivars that meet these characteristics.

It is necessary to continue this line of work, to deepen the knowledge of the different cultivars in relation to consumers and the use of artichokes.

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