



Comparison of consumer-based methodologies for sensory characterization: Case study with four sample sets of powdered drinks



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ABSTRACT

Interest in consumer-based methodologies for sensory characterization has largely increased in the last decade. However, research on their applicability and reliability is still necessary. In this context, the aim of the present work was to compare three consumer-based methodologies and descriptive analysis for sensory characterization, considering as case study four sets of orange-flavoured powdered drinks, differing in the number of samples and the extent to which they represented the whole product category. A trained assessor panel evaluated sample sets using descriptive analysis, while groups of 100 consumers evaluated samples using one of three methodologies: CATA questions, projective mapping (PM) and polarized sensory positioning (PSP). Across the four sample sets, the three-consumer based methodologies provided similar information regarding the main similarities and differences among samples, which did not largely differ from that obtained using descriptive analysis. The main difference among the methodologies was related to the relative importance given to the sensory characteristics when evaluating differences among samples, which led to differences in the dimensionality of the sensory spaces. Sample configurations from PM and PSP required more dimensions than those from descriptive analysis and CATA questions to fully explain differences among samples. None of the consumer-based methodologies outperformed descriptive analysis in terms of ability to discriminate samples, being CATA questions the methodology that showed the lowest discrimination. Implications for the selection of consumer-based methodologies for specific applications are discussed.

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1. Introduction

Interest in consumer-based methodologies for sensory characterization as complementary tools to descriptive analysis has largely increased in the last ten years (Valentin, Chollet, Lelievre, & Abdi, 2012; Varela & Ares, 2012). These methodologies enable to more fully integrate consumers' perception into the new product development process, which might contribute to increase the success of the developed products when launched into the marketplace (Ares, 2015). The other major advantage of this approach is that it does not require to train and maintain a sensory panel, which reduces the time and resources needed to obtain sensory product characterizations (Hopfer & Heymann, 2013).

Consumer-based methodologies for sensory characterization can be divided into three main types, according to the task assessors are requested to perform: methodologies based on the evaluation of individual attributes, holistic methodologies and those

based on the comparison with reference products (Varela & Ares, 2012). Methodologies based on the evaluation of individual attributes are similar to conventional descriptive analysis: assessors are asked to focus their attention on multiple attributes and to evaluate each of them (Varela & Ares, 2014). One of the most popular attribute-based approaches is the application of CATA questions, which basically consists of asking consumers to select all the terms from a list that applies to describe the focal product (Ares & Jaeger, 2015). Holistic methodologies are based on the evaluation of global similarities and differences among samples (Varela & Ares, 2014). Projective mapping is one of the most popular holistic methods (Dehlholm, 2014). In this methodology assessors are asked to provide a bi-dimensional projection of samples based on overall similarities and differences (Risvik, McEwan, Colwill, Rogers, & Lyon, 1994). After the bi-dimensional representation is obtained assessors are usually asked to provide some words to describe each of the samples (Perrin & Pagès, 2009). Finally, methodologies based on the comparison with references, such as polarized sensory positioning (PSP), require assessors to compare samples with a set of fixed references, which enables

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aggregation of data from samples evaluated in different moments in time (Teillet, 2014).

Differences in how assessors evaluate samples are expected to influence the performance of the methodologies and their suitability for specific applications (Ares & Varela, 2014). Several studies have compared consumer-based methodologies with each other and also with descriptive analysis with trained assessors in different product categories (Albert, Varela, Salvador, Hough, & Fiszman, 2011; Ares, Deliza, Barreiro, Giménez, & Gámbaro, 2010; Ares, Varela, Rado, & Giménez, 2011; Cadena et al., 2014; Dehlholm, Brockhoff, Mejnert, Aaslyng, & Bredie, 2012; Fleming, Ziegler, & Hayes, 2015; Louw, Malherbe, Næs, Lambrechts, & van Rensburg, 2013; Moussaoui & Varela, 2010; Reinbach, Giacalone, Machado Ribeiro, Bredie, & Bom Frøst, 2013; Veinand, Godefroy, Adam, & Delarue, 2011). These studies have reported that consumer-based methodologies provide comparable results and that no clear superiority exists for one methodology over the others.

However, the comparison of consumer-based methodologies has been limited to specific sample sets (Ares, 2015). Thus, it is still necessary to further compare methodological approaches for sensory characterization with consumers in order to develop recommendations for best practice. In particular, studies comparing the validity, reliability, repeatability and reproducibility of these methodologies under different experimental conditions, such as sample set size, degree of difference among samples and product complexity, may enable practitioners to make informed decisions when selecting the methodology that best suits for a particular application.

The present work aimed at performing a comparative analysis of three consumer-based methodologies for sensory characterization (check-all-that-apply –CATA– questions, polarized sensory positioning and projective mapping) when applied to the evaluation of four sets of orange-flavoured powdered drinks, differing in the number and characteristics of the samples. The methodologies were compared in terms of similarity of sample configurations, similarity to results from descriptive analysis with trained assessors, repeatability, reproducibility and stability of sample configurations.

2. Materials and methods

2.1. Samples

Powdered drinks are a highly popular product category in Uruguay, particularly among low/medium income people. A wide range of products of different characteristics are commercially available in the marketplace. In the present work a total of eighteen samples of commercial orange-flavoured powdered drinks were used (A–R).

According to previous studies, commercial samples of orange-flavoured powdered drinks can be sorted into three main groups, based on their composition and market positioning (Ares, de Saldamando et al., 2013; de Saldamando, Antúnez, Torres-Moreno, Giménez, & Ares, 2015). Samples sweetened with artificial sweeteners were characterized by their sourness, samples within the economy segment (i.e. having the lowest prices) were characterized by their low total flavour intensity, whereas samples within premium or medium prices that contained sugar were characterized by their sweetness and high total flavour intensity.

The eighteen samples were *a priori* allocated to four sample sets, which differed in the number of samples and the extent to which they represented the orange-flavoured powdered drink category. Sample sets 1 and 2, composed of 6 and 9 samples respectively, intended to provide a broad representation of the orange-flavoured powdered drink category by including commercial

samples of the three main groups discussed above. Sets 3 and 4, composed of 6 and 9 samples respectively, provided a limited representation of the category by only including commercial samples of the economy segment. Samples in Sets 3 and 4 were expected to be more similar than those included in Sets 1 and 2. The characteristics of the four sample sets are shown in Table 1.

For the PSP tasks, two sets of poles were selected, one for the evaluation of sample sets that provided a broad representation of the orange-flavoured powdered drink category (Sets 1 and 2) and another one for the evaluation of sample sets that represented a limited portion of the category (Sets 3 and 4). Poles were selected based on results from previous studies to represent the main sensory characteristics responsible for differences among samples (Ares, Dauber, Fernández, Giménez, & Varela, 2014; de Saldamando et al., 2015). For each of the sets, two of the three poles corresponded to samples included in the evaluated sets.

Samples were prepared by diluting the powders in tap water as recommended by the manufacturer on the package. They were stored at 10 °C until they were served to assessors, within 4 h. Samples were served in plastic glasses, coded with three-digit random numbers.

2.2. Descriptive analysis

A panel of twelve assessors, ages ranging from 23 to 48 years old (8 female) evaluated samples using descriptive analysis. Assessors had been selected and trained according to the guidelines of the ISO 8586:2012 standard (ISO, 2012) and had previous experience in the evaluation of powdered drinks.

In a first session, assessors were presented with 6 samples of powdered drinks, representing a wide range of sensory characteristics. They were asked to generate their individual descriptors using a modified grid method (Damasio & Costell, 1991). By open discussion with the panel leader, assessors agreed on the best descriptors to fully describe the samples, their definitions and how to evaluate them. Table 2 shows the list of descriptors used for descriptive analysis, which consisted of 12 descriptors.

Assessors were trained in the quantification of the selected descriptors using unstructured scales, considering the references shown in Table 2. A total of sixteen 15 min sessions, performed on separate days, were considered to train the panel. Once the training phase ended, samples were evaluated using 10-cm unstructured line scales anchored from 'low' to 'high'. Samples were presented following a William's Latin square design. Two replications of each sample were evaluated by each assessor. A

Table 1
Characteristics of the four sets of orange-flavoured powdered drinks considered in the study.

Sample set	Number of samples	Representation of the orange-flavoured powdered drink category	Samples ^a
1	6	Broad	A ² , B ¹ , C ³ , D ⁴ , E ⁴ , F ⁴
2	9	Broad	A ² , B ¹ , C ³ , D ⁴ , E ⁴ , F ⁴ , G ² , H ⁴ , I ⁴
3	6	Limited	J ⁴ , K ⁴ , L ⁴ , M ⁴ , N ⁴ , O ⁴
4	9	Limited	J ⁴ , K ⁴ , L ⁴ , M ⁴ , N ⁴ , O ⁴ , P ⁴ , Q ⁴ , R ⁴

^a Sample characteristics in terms of market positioning and composition.

¹ Premium segment sweetened with both sugar and high intensity sweeteners.

² Premium segment sweetened with high intensity sweeteners.

³ Medium segment sweetened with both sugar and high intensity sweeteners.

⁴ Economy segment sweetened with both sugar and high intensity sweeteners.

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