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# Comparison of rapid sensory characterization methodologies for the development of functional yogurts

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ABSTRACT

Functional food development is a long, complex, expensive and risky process. Methodologies that provide reliable information about the sensory characteristics of the developed products in short time frames can speed up the product development process and contribute to the success of the developed products in the marketplace. In this context, the aim of the present work was to compare three rapid methodologies for sensory characterization with descriptive analysis during the development of low-fat functional yogurts, enriched with probiotics and prebiotics. Eight low-fat probiotic yogurts enriched with a prebiotic ingredient were formulated following a $2^3$ full factorial design with the following factors: sugar concentration, prebiotic ingredient and stabilizer concentration. A panel of 9 trained assessors evaluated samples using descriptive analysis. Besides, the yogurts were evaluated by 3 groups of 81 consumers using three rapid methodologies: check-all-that-apply (CATA) questions, projective mapping and polarized sensory positioning. The three rapid methodologies provided similar information on the main differences among samples. However, several differences can be highlighted. Sample configurations from CATA questions were the most similar to those provided by descriptive analysis, whereas projective mapping provided the least similar configurations. The three methodologies also differed in their ability to detect differences among samples due to formulation variables and the stability of sample configurations.


## 1. Introduction

Probiotics and prebiotics are one of the most profitable categories within the functional food market (Bigliardi & Galati, 2013; Cruz et al., 2010). Combinations of these functional ingredients are increasingly incorporated into food products, fermented milk being the most popular vehicle (Al-Sheraji et al., 2013). Probiotics are live microorganisms, which confer health benefits to the host when consumed in adequate quantities (Guarner & Schaafsma, 1998). Prebiotics are short-chain carbohydrates non-digestible in the human gastrointestinal tract that enhance the activity of intestinal flora and exert health benefits to the health (Quigley, Hudson, & Englyst, 1999). The addition of probiotics and prebiotics to food products can modify their sensory characteristics which can decrease consumer overall liking (Cruz et al., 2010; Gallardo-Escamilla, Kelly, & Delahunty, 2005; La Torre, Tamime, & Muir, 2003; Luckow, Sheehan, Fitzgerald, & Delahunty, 2006).

Consumers should ingest functional foods on a regular basis to achieve the health benefits derived from them, so the sensory characteristics of functional foods must not discourage sustained consumption (Sarubin, 2000; Siró, Kápolna, Kápolna, & Lugasi, 2008). Therefore, food companies should rely on valid methodologies to assess the impact of functional ingredients on the sensory characteristics of the products.

The sensory characteristics of products have been traditionally assessed using descriptive analysis with trained assessors (Lawless & Heymann, 2010; Stone & Sidel, 2004). Although this methodology provides detailed, reliable and reproducible results, it is time consuming (Murray, Delahunty, & Baxter, 2001).

Functional food development is a complex, expensive and risky process, which involves long-term studies to gather scientific evidence of their health effects (Jones & Jew, 2007). Therefore, it is important to speed up the product development process and to assure the success of the developed products from the early stages of product development. In this context, methodologies that allow gathering information about the sensory characteristics of products in short time frames, and directly from consumers, are valuable tools.

Several rapid methodologies for sensory characterization have been recently developed. These methodologies can be performed without prior training, which makes them simple and flexible alternatives for sensory characterization with both trained assessors and consumers (Varela & Ares, 2012). They can be divided into three main types: methodologies based on the evaluation of specific attributes, holistic

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methodologies, based on global similarities and differences between products, and methodologies based on the comparison of products with references (Valentin, Chollet, Lelievre, & Abdi, 2012).

A check-all-that-apply (CATA) question is one of the most novel methodologies based on the evaluation of specific attributes (Adams, Williams, Lancaster, & Foley, 2007). A CATA question consists of a list of words or phrases from which respondents should select all that they consider appropriate to describe a product (Varela & Ares, 2012). This methodology has been reported to be a simple, valid and reproducible alternative for gathering information about the sensory characteristics of a wide range of products (Bruzzone, Ares, & Giménez, 2012; Dooley, Lee, & Meullenet, 2010; Jaeger et al., 2013; Meyners, Castura, & Carr, 2013; Parente, Manzoni, & Ares, 2011; Plaehn, 2012).

Projective mapping (PM) or Napping® is a holistic method based on assessors' individual perception of overall similarities and dissimilarities among products. Assessors are asked to provide a two dimensional representation of a group of samples, according to their own criteria (Risvik, McEvan, Colwill, Rogers, & Lyon, 1994). In this representation, the Euclidean distance between each pair of samples is a measure of their dissimilarity. The criteria used by assessors to locate samples depend on the relative importance they attach to their sensory characteristics, which makes projective mapping a flexible and spontaneous methodology (Varela & Ares, 2012).

Polarized sensory positioning (PSP) is a reference-based method that has been developed by Teillet, Schlich, Urbano, Cordelle, and Guichard (2010) for sensory characterization of mineral water. The methodology is based on the evaluation of the global difference between samples and a fixed set of reference products, named poles (Teillet, 2014). The main advantage of this methodology is the possibility of aggregating data collected in different sessions (Ares & Varela, 2014).

Compared to descriptive analysis, rapid methodologies for sensory characterization have been used for a relatively short period of time and have been used in a limited number of applications. Therefore, research on their applicability, reliability, and reproducibility for sensory characterization of products with different sensory complexity is still needed in order to allow them to be established as standard tools in sensory and consumer science (Ares & Varela, 2014).

In this context, the aim of the present work was to compare three rapid methodologies for sensory characterization (check-all-that-apply questions, projective mapping and polarized sensory positioning) with descriptive analysis during the development of low-fat functional yogurts, enriched with probiotics and prebiotics.

## 2. Material and methods

### 2.1. Samples

Eight low-fat yogurts enriched with a prebiotic ingredient were formulated following a $2^3$ full factorial design with the following factors: sugar concentration (4.0% vs. 8.0%), prebiotic ingredient (native inulin — Frutafit IQ, Sensus, Netherlands, and fructooligosaccharide (FOS) — Orafti® P95, Beneo GmbH, Mannheim, Germany) and stabilizer concentration (Dairy Blend YG LP, TIC Gums, White Marsh, Maryland, USA). The concentration of the prebiotic ingredient in all formulations was 6.0%. A similar percentage of inulin has been considered in the development of milk desserts (Tárrega, Rocafull, & Costell, 2010). Besides, all yogurts contained 1% modified starch (National 465, National Starch, Trombudo Central, Santa Catarina, Brazil) and 2% skim milk powder (Conaprole, Montevideo, Uruguay). The rest of the formulation consisted of skimmed pasteurized milk (0.1% fat content) as shown in Table 1. Sample formulations (Table 1) were selected based on results from previous studies (Bruzzone, Ares, & Giménez, 2013) and preliminary tests in order to obtain yogurts with perceivable differences in their sensory characteristics.

**Table 1**
Formulation of the yogurt samples considered in the study.

| Samples | Prebiotic component (6%) | Commercial sugar (%) | Stabilizer (%) |
|---|---|---|---|
| 1 | Inulin | 4.0 | 0 |
| 2 | Inulin | 4.0 | 0.075 |
| 3 | Inulin | 8.0 | 0 |
| 4 | Inulin | 8.0 | 0.075 |
| 5 | FOS[a] | 4.0 | 0 |
| 6 | FOS | 4.0 | 0.075 |
| 7 | FOS | 8.0 | 0 |
| 8 | FOS | 8.0 | 0.075 |

[a] Fructooligosaccharide.

Yogurts were prepared using a Thermomix TM 31 (Vorwerk Mexico S. de R.L. de C.V., Mexico D.F., Mexico). The solid ingredients were mixed with the milk, previously heated to 50 °C. The dispersion was mixed for 1 min under gentle agitation (100 rpm), heated to 90 °C for 5 min and cooled to 42 °C. Then, the mix was placed in 1000 mL glass containers and inoculated with 1 mL of lactic cultures, prepared by dispersing lyophilized cultures of *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, *Lactobacillus acidophilus*, and *Bifidobacterium lactis* (Yo-Mix 205 LYO 250 DCU, Danisco, France) in UHT skim milk to a concentration of 250 DCU/L. After the addition of cultures the mix was manually agitated for 30 s.

Fermentation was carried out in a temperature controlled oven at $42 \pm 1$ °C and stopped when the sample reached a pH of 4.55 (after 6 h, depending on the formulation). When the final pH was reached, the coagulum was broken by agitating each yogurt for 3 min using a Thermomix TM 31 at 100 rpm. After that, yogurts were placed in 500 mL glass containers, cooled under agitation to 25 °C in a water bath at 5 °C, and then stored refrigerated (5 °C) for 24 h, prior to evaluation.

Samples for all the sensory evaluations performed by trained assessors and consumers were served in plastic containers at 10 °C and coded with 3-digit random numbers and presented following a William's Latin square design. Twenty grams of yogurt were served for all the evaluations performed by consumers, except for the projective mapping tasks, when 30 g were served to each assessor. For the evaluations performed by the trained assessors, 30 g of yogurt were served.

### 2.2. Descriptive analysis

The sensory panel consisted of nine assessors, ages ranging from 23 to 48 years old, 66% female. Assessors were selected and trained according to the guidelines of the ISO 8586:2012 standard (ISO, 2012).

In a first session, assessors were presented with four yogurt samples, representing a wide range of sensory characteristics (two commercial samples of plain stirred yogurt, and two formulated yogurts, one with each type of prebiotic component). Assessors were asked to try the yogurts and to individually generate attributes to describe them. Then, through open discussion with the panel leader, assessors agreed on the best attributes to fully describe samples, their definitions and how to evaluate them. The final list of attributes was the following: syneresis, ropiness, thickness, creaminess, roughness, lumpiness, melting, sweetness, sourness, vanilla flavor, milky flavor, sweet aftertaste and sour aftertaste. Definitions and references are shown in Table 2.

In successive sessions, assessors were trained in the quantification of the selected descriptors using unstructured scales. Commercial and formulated yogurts with different sensory characteristics were used during training. A total of fifteen sessions lasting 20 min each were used to train the panel. The sessions were carried out on separate days. Assessors' performance was checked using PanelCheck® (Tomic et al., 2010).

After the training phase samples were evaluated using 10-cm unstructured line scales anchored with the terms 'low' at the left and 'high' at the right. Two replications of each sample were evaluated by each assessor. Assessors evaluated four yogurts in each session.