Consumer-based product characterization using Pivot Profile, Projective Mapping and Check-all-that-apply (CATA): A comparative case with Greek yogurt samples

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ABSTRACT

Product characterization has been a primary concern for the food industry, and methodologies based on consumers' perceptions have become popular and widely used by industries to replace classical methods. Although there are several studies on other methods, the potential of reference-based one such as Pivot Profile is still little explored. Therefore, the aims of this study were to characterize Greek yogurt samples according to consumers' perceptions using three different methodologies: Pivot Profile (PP), Check-all-that-apply (CATA), and Projective Mapping (PM), and to assess which method is easier for consumers to describe products. The rapid methodologies assessed were equally effective in characterizing the different samples; however, some drawbacks evidenced in the study can help in targeting and choosing the best method to perform the sensory characterization. Pivot Profile showed some advantages, bypassing some limitations presented by the other methods. In addition, its experimental versatility also allows for broad applications evidencing the PP technique as a promising tool for routine use. Some implications of using it were also discussed. We suggest the supplemental use of Multidimensional Alignment (MDA) as it shows more accurately the correlations between attributes and samples, especially in the case of PP data.

1. Introduction

Consumers have been bombarded with a wide range of new food products, which has led the food industry to use sensory profiling tools to develop more attractive products and meet consumers' expectations (van Kleef, van Trijp, & Luning, 2005). Descriptive Analysis (DA) is recognized as an adequate technique to determine the sensory profile of processed foods, thus providing detailed, robust, and reproducible results. However, it has been criticized for being expensive and very time-consuming (Moussaoui & Varela, 2010), which can impair its application in small companies, besides being logistically impractical for large companies due to their great diversity of products (Cruz et al., 2013). Furthermore, trained assessors tend to perceive attributes that may not be important or perceptible to consumers (Moussaoui & Varela, 2010).

In response to this demand, sensory methodologies based on consumers' perceptions have become popular and widely used by industries in recent years to replace the classical methods (Ares, 2015). These

methods do not require training, have a low financial impact, optimize time and resources in companies, and provide information highly correlated with traditional methods (Varela & Ares, 2012). Among the rapid methods used to capture consumers' perceptions, verbal-based tasks (intensity scales, CATA, Flash Profiling), similarity-based methods (Projective Mapping and Sorting), and reference-based methods (Polarized Sensory Positioning - PSP, Polarized Projective Mapping - PPM and Pivot Profile) have stood out (Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012).

Projective Mapping (PM) is one of the most popular holistic methods (Savidan & Morris, 2015), with an emerging number of studies in the past several years (Vidal et al., 2014). As the main advantage, PM provides a global judgment about products, integrating all the sensory characteristics (Dehlholm, Brockhoff, Meinert, Aaslyng, & Bredie, 2012; Perrin et al., 2008; Risvik, McEwan, & Rødbotten, 1997). Check-all-that-apply (CATA) questions consist of a list of words or phrases from which respondents should select all of the words they consider

appropriate to describe the sample (Dooley et al., 2010). It is considered a practical approach to provide information about sensory perceptions, with high correlations to the sensory profiles generated by trained assessors (Ares & Jaeger, 2015; Jaeger et al., 2014).

Recently, Pivot Profile (PP) has been proposed as a new approach for a rapid and comparative description of food products (Lelièvre-Desmas, Valentin, & Sylvie Chollet, 2017; Thuillier, Valentin, Marchal, & Dacremont, 2015). PP has as a main strategy capturing the differences between two samples through free comments: a product under examination and a reference one, which is called a pivot (Valentin et al., 2012). Although promising, Pivot Profile has been little explored, with no studies on the comparative use of PP with other sensory methods based on different efforts such as PM and CATA.

The comparison of consumer profiling methodologies based on product's similarities according to consumers' perception and the difficulty in performing the tasks can provide useful information for food companies to select the most suitable methodology (Ares, Varela, Rado, & Giménez, 2011). Studies on the performance of consumer-based methodologies are still hot topics (Antúnez, Vidal, Saldamando, Giménez, & Ares, 2017; Ares et al., 2013; Bruzzone et al., 2015; Cadena et al., 2014; Fonseca et al., 2016; Reinbach, Giacalone, Ribeiro, Bredie, & Frøst, 2014), which demonstrate the importance of this theme to encourage new studies.

In this context, the present study aimed to evaluate the performance of Pivot Profile to describe the sensory characteristics of a food product category, when compared to other consumer-based sensory methodologies (Projective Mapping and Check-all-that-apply) and assess which one of the three methods is easier for consumers describing products. Greek yogurt was chosen for this study mainly due to its increased popularity. Although they became the flagship of the dairy industry occupying more space on market shelves, reports on the sensory profiling of them are still scarce, and based on consumer perception, they are non-existent. Information about product formulation that is aligned as much as possible with consumer preferences can help product optimization and increase competitiveness in today's competitive global market.

2. Material and methods

2.1. Samples

A wide range of products belonging to Greek yogurt category are available in the market, and they are consumed by different groups of consumers. In this sense, seven commercial Greek yogurt samples were purchased at local supermarkets in the city of Campinas (São Paulo, Brazil), as follows: traditional Greek yogurts (GKY1, GKY2, GKY3, GKY4, and GKY5) and Greek yogurts labeled as light (GKYL1 and GKYL2). For each test, approximately 30 g of sample was served at 10 °C in 50-mL disposable cups coded with three random digits. All samples were approved by the Federal Inspection Service (SIF) and marketed throughout the Brazilian territory.

2.2. Consumers

Participants were recruited from the University of Campinas (UNICAMP) among students, staff, and visitors, through emails, posters, and invitations via social networks. They were selected according to their Greek yogurt consumption habits (at least once a week), interest in the study, and availability to participate in the study. One hundred consumers (gender and aged-balanced - 55% female and 45% male, aged from 18 to 65 years) participated in each test, being restricted the participation in only one sensory test to avoid the learning effect.

2.3. Sensory evaluation

Sensory evaluation was carried out during three different days, with

one session for each test and 1-week interval between tests. The tests were conducted in individual booths with adequate temperature and lighting, ensuring the comfort and privacy of panelists (Stone, Bleibaum, & Thomas, 2012). Panelists were also provided with water and unsalted crackers for palate cleansing. The sessions were conducted in the Sensory Analysis Laboratory of the Department of Food and Nutrition. Approval for the study was obtained from the Ethics Committee of the State University of Campinas, and a free and informed consent form was signed by all volunteers.

2.3.1. Projective Mapping

One hundred consumers were asked to try seven Greek yogurt samples (coded with three random digits), and to place them on an A4 white sheet of paper (210 × 297 mm) according to their similarities or dissimilarities. Consumers were instructed to perform the task according to their own criteria, and there were no right or wrong answers. They were also informed that two samples close together on the sheet correspond to very similar samples, while different samples should be placed very distant from each other (Cadena et al., 2014; Valentin et al., 2012). After positioning the samples on the evaluation sheet, consumers were asked to provide 3 to 5 words to describe the sensory characteristics of each sample or group of samples.

2.3.2. Check-all-that-apply - CATA

One hundred consumers answered CATA questions containing 24 sensory attributes, as follows: white, yellow, homogeneous appearance, bright, firm, sweet aroma, vanilla aroma, acidic aroma, cheese aroma, sweet taste, vanilla flavor, salty, fat flavor, milk flavor, cheese flavor, sour, bitter, astringent, sweet aftertaste, bitter aftertaste, viscous, creamy, and fluid. The terms were selected based on previous studies (Akalın et al., 2012; Desai, Shepard, & Drake, 2013), and the descriptors raised using the Projective Mapping. The presentation order of the terms of the CATA question was balanced between and within participants following a Williams' Latin square experimental design (Ares, Antúnez, Giménez and Jaeger, 2015b). Consumers were asked to check all attributes they considered appropriate to describe each sample in digital forms using Fizz Sensory Analysis Software (Biosystèmes, France) (Ares, Antúnez, Bruzzone, et al., 2015a). The samples were coded with three random digits and served in sequential monadic order, taking care to avoid carry-over effects (Macfie et al., 1989).

2.3.3. Pivot Profile

The simulations with different pivot products have demonstrated that the choice of pivot exerted slight changes in the settings generated, and it is not a critical issue for the good performance of the method (Thuillier et al., 2015). As noted by Lelièvre-Desmas et al. (2017), the selection of pivot does not highly affect the product positioning, as well as the number of terms used to describe them. Considering that the pivot should represent the diversity of the products under study, being an appropriate choice when it is a "central product", the sample GKY5 was chosen as a pivot, as it had intermediate protein and fat levels among all samples, resulting in an intermediate texture, which it is an important characteristic for consumers when ingesting Greek yogurt.

One hundred consumers of Greek yogurt were asked to try six pairs of samples (one pair at a time), consisting of the pivot, marked as *P* (sample GKY5), and a coded sample. The samples were coded with three random digits and served in sequential monadic order, taking care to avoid carry-over effects (Macfie et al., 1989). Consumers were asked to try both samples (coded sample and pivot) and answer two open questions, using the Fizz Sensory Analysis Software (Biosystèmes, France). First, they were asked to report which attributes the coded sample had greater intensity than the pivot and then which attributes the coded sample had lesser intensity than the pivot. The definition of sensory descriptors was not mandatory, and consumers were free to describe the characteristics of each sample and were instructed to avoid hedonic terms and negative forms (Fonseca et al., 2016; Lelièvre-