Check all that apply and free listing to describe the sensory characteristics of low sodium dry fermented sausages: Comparison with trained panel

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ABSTRACT

The urgent need for sodium reduction in meat products to enable healthy food choices has led food industry to search for more dynamic and fast methodological approaches to assess the sensory characteristics of their products. In the present study, dry fermented sausages with reduction in NaCl, replaced by KCl, CaCl$_2$, and a blend of KCl and CaCl$_2$ were evaluated for their sensory properties using a check all that apply questionnaire (CATA) and a free listing task. The results were compared with those of a trained panel using quantitative descriptive analysis (QDA). The absence of concordance was observed between the CATA and free listing towards the two bidimensional sensory maps and configuration of the samples in comparison to QDA. However, free listing was able to generate a similar and resumed vocabulary when compared to QDA. Our findings suggest the potential of free listing as sensory descriptive methodology in the development of reformulated food products with respect to sodium reduction.

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1. Introduction

Excessive sodium intake has been widely discussed by public health agencies that, concerned about the increased risk for cardiovascular diseases, have recommended reducing sodium chloride consumption (World Health Organization (WHO), 2012), the primary source of sodium in processed foods. The reduction of sodium chloride can be achieved by reducing or partially replacing NaCl by other chloride salts, thus allowing consumers to adapt to the new flavor intensity (Dotsch et al., 2009). In fermented meat products, reformulation studies using different chloride salts have shown that a reduction of up to 50% NaCl is possible from a technological and microbiological point of view (Campagnol, Santos, Terra, & Pollonio, 2012; Dos Santos, Campagnol, Morgano, & Pollonio, 2014). However, in hedonic sensory studies with consumers, many authors have reported low acceptance, due to the development of a bitter and metallic taste (Guàrdia, Guerrero, Gelabert, Gou, & Arnau, 2008), particularly when KCl is used as a salt substitute (Campagnol et al., 2012; Dos Santos et al., 2014).

Traditionally, the sensory profile of processed food products is developed using quantitative descriptive analysis (QDA). QDA is a standardized methodology involving the evaluation of both the qualitative and quantitative sensory characteristics of the product, which is performed with a team previously assessed for their repeatability and discrimination abilities, subjected to numerous training sessions (Drake, 2007). QDA is time-demanding for its implementation and depends on the availability of a trained panel, in addition to a sensory profile that is unique to a particular class of product (Cadena et al., 2013; Morais, Cruz, Faria, & Bolini, 2014).

Check all that apply (CATA) has been identified as a promising methodology aimed to establish the sensory profiling of food matrices using consumers (Ares & Jaeger, 2013; Ares, Saldamando, Giménez, & Deliza, 2014; Cruz et al., 2013; Jorge, Mendes, Auriema, Ramos, & Ramos, 2015) The primary advantage of a CATA questionnaire is that it allows multiple options to be selected, instead of limiting consumers to select only one response or focusing their attention and evaluating specific attributes. CATA questionnaire has been applied to the development of functional yogurts (Cadena et al., 2014; Cruz et al., 2013) and milk desserts (Ares, Barreiro, Deliza, Giménez, & Gámbaro, 2010).

Free listing is a technique regularly used in anthropological studies aimed to investigate cultural domain analysis (Rusell Bernard, 2005), which is defined as the study of how people in a group think about lists of things that are somehow related (Hough & Ferraris, 2010). Free listing has been increasingly used in several studies on consumer science, such as reports on the insight in the menus in Argentina (Libertino, Ferraris, López Osornio, & Hough, 2012), cross-cultural

study to generate consumers' texture vocabulary in Spanish-speaking countries (Antmann et al., 2011), and relevance of package characteristics of milk desserts (Ares & Deliza, 2010) as well as to discover consumers' perception of wellbeing in food-related consumption of wine (Ares et al., 2014). Hough and Ferraris (2010) presented free-listing in a food science audience with the possibility of sensory descriptors would be generated by a trained panel and/or consumers, and frequently listed descriptors would be more relevant to the sample set or product category than those less frequently listed. However, to the best of our knowledge, this study has not been done.

Dry fermented sausages are traditional meat products characterized by high sodium levels (approximately 6% in the final product) and have therefore been the targets of sodium reduction with a requirement to preserve their sensory properties and consumer acceptance. In this context, the aim of this study was to evaluate the performance of CATA questionnaires and free-listing for establishing a sensory profile of dry fermented sausages with a reduction or replacement of 50% NaCl with KCl, $CaCl_2$, and a blend KCl and $CaCl_2$ (1:1). For comparison and reference, the sensory descriptors of the dry fermented sausages were also assessed by a trained panel through the quantitative descriptive analysis method.

2. Materials and methods

2.1. Dry fermented sausages: experimental design

The NaCl content of the dry fermented sausages was reduced by 50% or substituted by KCl, $CaCl_2$, or a blend of KCl and $CaCl_2$ (1:1), were prepared as follows: control (2.5% NaCl), 50% salt reduced (1.25% NaCl, F1), 50% replaced by KCl (1.25% NaCl and 1.25% KCl, F2), 50% replaced by $CaCl_2$ (1.25% NaCl and 1.25% $CaCl_2$, F3), and 25% replaced by KCl and $CaCl_2$ (1.25% NaCl, 0.625% KCl and 0.625% $CaCl_2$, F4). In addition, a commercial sample of dry fermented sausage was also used in this study (containing 43.5 g fat, 25 g protein, 1645 mg sodium, and 120 mg calcium/100 g of product according to the label, COM) from a commercial brand marketed in the Brazilian territory. The commercial sample was purchased in a supermarket in the city of Campinas (SP), stored in a cooler with ice, and immediately brought to the laboratory, where it was refrigerated (4 °C ± 1 °C) together with the other samples.

The dry fermented sausages were produced using the primary following ingredients: pork meat (650 g/kg), beef (200 g/kg), and pork back fat (150 g/kg). The raw material was ground with a disk (8 mm) and mixed with the correct amount of NaCl and other ingredients for each treatment. The manufacturing process was as described by Dos Santos et al. (2015). The following ingredients were added to each meat mixture: glucose (5 g/kg), sucrose (5 g/kg), sodium nitrate (0.15 g/kg), sodium nitrite (0.15 g/kg), sodium ascorbate (0.25 g/kg), white pepper (2 g/kg), garlic (3 g/kg), nutmeg (0.02 g/kg), and starter culture (0.25 g/kg; SPX Floracarn, Chr. Hansen). After complete homogenization, the treatments were stuffed in collagen casings (diameter of 60 mm) and cut into slices of approximately 15 cm in length. In total, 40 pieces (approximately 300 g each) were prepared for each treatment. After being stuffed, the samples were subjected to a bath containing a 20% solution of potassium sorbate, and the samples were then ripened in a laboratory ripening cabinet (Menoncin, Erechim, Brazil). The temperature and relative humidity (T°/UR%) was set as follows: first day, 25 °C/95%; second day, 24 °C/93%; third day, 23 °C/90%; fourth day, 22 °C/85%; fifth day, 21 °C/80%; sixth day, 20 °C/75%; and from the seventh day to the nineteenth day, 18 °C/75%. The air speed remained at 5 m/s throughout the manufacturing process.

2.2. Quantitative descriptive analysis (QDA)

The study protocol was approved by the Research Ethics Committee of the University of Campinas under protocol number 130260. Twenty-five assessors were pre-selected by triangular tests, who found a

difference in the salty taste between the dry fermented sausages with different NaCl level. Each assessor participated in nine repetitions, and the assessors with more than 80% correct responses were selected, totaling 18 assessors.

The network method (Moskowitz, 1983) was used at this stage to determine the descriptors for the six samples of dry fermented sausages. The samples were presented in pairs, and each panelist described the similarities and differences with respect to the appearance, aroma, flavor, and texture of the attributes. References were determined by a consensus between all assessors, and they were then trained using the identified references for the product attributes, as shown in Table 1.

The quantification of the sensory descriptors was performed in nine training sessions (one hour, three times a week) with the selected assessors (8 female and 7 male, aged 21–40). The six samples were evaluated in nine repetitions in a monadic form, following a balanced complete block design (MacFie, Bratchell, Greenhoff, & Vallis, 1989). A two-way analysis of variance (ANOVA) with two sources of variation (sample and repetition) to each descriptor and each assessor was applied, and the final panel was chosen to participate according to their discriminating capability ($p < 0.50$) and repeatability ($p > 0.05$) using data collected during the training sessions (Cadena, Cruz, Faria, & Bolini, 2012; Cadena et al., 2013). The fifteen selected assessors assessed six samples per session in a total of six sessions. Each evaluator received an assessment form and was invited to rate the intensity of each attribute on a linear scale with 9 cm (unstructured) anchored on the left end by "little" or "none" and on the right end by "very" (Drake, 2007; Stone, Bleibaum, & Thomas, 2012).

2.3. Check all that apply (CATA)

One-hundred and six consumers (43% male, 57% female, aged 18–55) were asked to complete a check-all-that-apply (CATA) questionnaire with 15 terms related to the sensory characteristics of the dry fermented sausages, which were defined by the trained panel through QDA, as described above.

The consumers were asked to check all of the terms that they considered appropriate to describe each dry fermented sausage. The sensory terms listed was balanced within and across consumers, following William's Latin Square experimental design. This implies that each consumer received the CATA question with the terms in different order and this order was modified from sample to sample along the test. This measure is needed as primary bias are expected to appear within each participant along the test progresses, i.e., there is a frequent section of terms which more easily catch their attention within the list of the options (Ares et al., 2014).

2.4. Free listing

One-hundred and six consumers (45% male, 55% female, aged 18–56) were invited to participate in the free listing questionnaire, which was performed one week after the CATA question. The consumers were asked, in a free manner, to write all terms that were related to each of the six samples of dry fermented sausage with respect to the appearance, aroma, flavor, and texture. They were given a sheet of paper with written instructions and asked to complete the task in less than 30 min, on average. The samples were presented in a monadic form and according to balanced complete block design, as reported by MacFie et al. (1989).

2.5. Statistical analysis

One-way analysis of variance (ANOVA), considering samples as the fixed effect (Ares & Deliza, 2010) was applied to the QDA data obtained for each attribute at a 95% significance level. In addition, the principal component analysis (PCA) was also applied to the mean values of attribute intensity using a Pearson correlation (Aquino et al., 2014).