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Application of a check-all-that-apply question for evaluating and characterizing meat products

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ABSTRACT

Four different mortadella samples were technologically characterized by physical/chemical and instrumental analyses and were sensorially characterized by acceptance testing and check-all-that-apply (CATA) questions. Samples were divided into three groups by using a principle component analysis (PCA) of the technological characteristics and by using an internal preference map (IPM) of the sensory attributes from the acceptance test. CATA divided these samples into four different external preference map (EPM) groups because each sample was associated with different sensory attributes. The PCA indicated that there was a relationship between the instrumental color and texture analyses and the CATA attributes, whereby identifying the terms that positively or negatively contributed to sample acceptance. The CATA questions effectively discriminated between the meat products regarding their sensory characteristics. In addition, these attributes were linked to chemical and instrumental quality parameters. Thus, the CATA questions are a potential tool for evaluating and developing novel products.

1. Introduction

Affective sensory methods that use a hedonic scale assess the personal response (preference and, or, acceptance) by current or potential customers of a product, but the designs need to be carefully tailored to the expected consumer group. Conversely, quantitative descriptive analyses (QDA), which use trained evaluators, can provide more detailed and accurate information than affective methods (Meilgaard, Civille, & Carr, 1999). However, QDA is expensive and time-consuming, because the vocabulary and associated panel training must be adapted to each type of product (Ares & Jaeger, 2013).

Due to these restrictions, there is a large interest in developing reliable and fast methods for sensory characterization of food products (Ares, Varela, Rado, & Giménez, 2011). Thus, methods such as the check-all-that-apply (CATA) questions have gained prominence. CATA is a sensory assessment tool that is easier to understand and faster than the methods that use trained evaluators (Ares, Deliza, Barreiro, Giménez, & Gámbaro, 2010). These questions allow the respondents to select attributes relevant to them rather than analyzing all of the attributes of a scale. In addition, these methods are less expensive than methods that involve a trained sensory panel (Ares, Barreiro, Deliza, Giménez, & Gámbaro; Ares, Deliza, et al., 2010; Ares & Jaeger, 2013; Ng, Chaya, & Hort, 2013).

Although CATA is not a novel method, it has not been extensively studied. Generally, previous studies have used CATA with other sensory methods to show the perception differences between consumers (Piqueras-Fiszman, Ares, Alcaide-Marzal, & Diego-Más, 2011), to analyze the acceptance of cosmetics (Parente, Manzoni, & Ares, 2011), to study the development of dairy products (Ares, Barreiro, et al., 2010; Ares, Deliza, Barreiro, Giménez, & Gámbaro, 2010; Dooley, Lee, & Meullenet, 2010), to assist with packaging development projects (Puyares, Ares, & Carrau, 2010) and to study the consumer perception and specific sensory properties of drinks (Ares et al., 2011; Giacalone, Bredie, & Frøst, 2013) and squash (Ng et al., 2013). However, recent studies have stated that the practices used to develop these types of questions should be studied further because they appear to influence participant responses (Ares & Jaeger, 2013).

Meat and meat products are popular widely consumed foodstuffs, being essential components in the diets of developed countries, but nowadays, consumers demand natural and healthy food products, including meat products, with better nutritional properties (Trindade et al., 2011). So, interest in novel processed meat products has increased in recent years. In addition, methods that use consumer perception to collect information regarding the profile of a specific product are being used more widely (Resurreccion, 2004). In the processed meat industry, sausages and mortadellas are popular choices for consumers, mainly due to their convenience and availability (Steenblock, Sebranek, Olson, & Love, 2001). These meat products can have various different ingredients (e.g. meat, fats, mechanically deboned meat,

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additives, non-meat proteins, hydrocolloids) and can be made by many different formulations and in many forms (Poulanne, 2010). Thus, a range of different products can be created.

Studies that involve the sensory analysis of meat products are generally used to compare the effects of treatments against a control based on a hedonic scale (Cáceres, García, & Selgas, 2008) or on a hedonic scale with QDA (Nowak, von Mueffling, Grotheer, Klein, & Watkinson, 2007; Viuda-Martos, Ruiz-Navajas, Fernández-López, & Pérez-Alvarez, 2010; Viuda-Martos, Ruiz-Navajas, Fernández-López, & Pérez-Álvarez, 2009).

The lack of empirical studies regarding the consumer satisfaction of meat products and the relevance of consumer satisfaction to the industry reinforces the need to evaluate methods for studying consumer perceptions when assessing the sensory parameters of meat products. In this sense, the CATA questions may be an alternative method for this purpose. To our knowledge, there are no studies using this method to evaluate meat products and, therefore, we evaluate the use of CATA questions for the sensory characterization of different commercial brands of mortadellas.

2. Materials and methods

Four different types of mortadella, certified by the Federal Inspection Service (Serviço de Inspeção Federal — SIF, Brazil) and coded M1, M2, M3 and M4, were purchased from local businesses in the city of Lavras (state of Minas Gerais, Brazil). All of the samples were labeled as "mortadella" (MAPA, 2000), and only M1 had been subjected to the smoking process. The specific ingredients described in the label of each product were shown in Table 1.

2.1. Technological characterization of the mortadella samples

The sausages were submitted to physical and chemical analyses of total moisture (AOAC 950.46B), fat (AOAC 960.39), protein (AOAC 981.10, using 6.25 as conversion factor) and ash (AOAC 950.46) contents (in triplicate) using the Association of Official Analytical Chemists (AOAC, 2002) procedures. Total carbohydrate was obtained by difference (total weight minus moisture, protein, fat and ash). Average pH values were measured using a potentiometer (Digimed, modelo DM 20, São Paulo, Brasil) by inserting a combined penetration electrode into the product at three different points. Water activity was measured using an Aqualab® Water Activity Meter CX2 device (Decagon Devices Inc., WA, USA).

Samples were also analyzed for calcium (% on a dry matter basis—DMB) by wet digestion (Damin, Silva, Vale, & Welz, 2007) and atomic absorption spectroscopy detection (AOAC 985.35; AOAC, 2002) and for residual sodium nitrite (mg $NaNO_2 \cdot kg^{-1}$ of sample) using AOAC official method 973.31 (AOAC, 2002). The degree of lipid oxidation in the products was evaluated by measuring the 2-thiobarbituric acid reactive substances (TBARS index), as described by Raharjo and Sofos (1993) with little modifications. Briefly, 10 g of sausage was homogenized with 40 mL of 5% trichloroacetic acid (TCA) and 1 mL of 0.15% butyl hydroxytoluene (BHT). After filtering (Whatman #1 filter paper), 2 mL of the filtrate was blended with 2 mL of 0.08 M tiobarbiturci acid (TBA) solution, heated in boiling water for 5 min and the absorbance measured at 531 nm. The concentration of malonaldehyde (MDA; expressed as mg $MDA \cdot kg^{-1}$ of sample) was determined using an analytical curve of 1.1,3.3-tetraethoxypropane (TEP).

The objective color was determined from the average of five readings taken from various surface points with a CR-5 colorimetric spectrophotometer (Konica Minolta Sensing Inc. Osaka, Japan). This spectrophotometer used a D65 standard illuminant, an observer angle of 10°, aperture of 30 mm and specular component excluded (SCE) mode. The following color indices were evaluated in a CIELAB system: lightness (L^*), redness (a^*) and yellowness (b^*). From these color indices, the angular coordinates of chroma (C^*) and hue angle (h^*) were calculated using the following formulas (Ramos & Gomide, 2007): $C^* = (a^{*2} + b^{*2})^{1/5}$ and $h^* = \arctan(b^* / a^*)$.

Sausages were tested by the texture profile analysis (TPA) method according to Pereira et al. (2011) using a universal TA.XT2i Texture Analyzer (Stable Micro Systems Ltd., Surrey, England) of 50 kgf cell. Six core (cubes with 10 mm edge) samples were obtained and compressed twice to 50% of their original height, at room temperature, with compression flat cylindrical aluminum probe (36 mm diameter). A cross-head speed of 180 mm/min was applied. There was no time to rest between the two cycles of compression. Force time curves were recorded and the attributes were calculated as follows (Ramos & Gomide, 2007): hardness (N), peak force required for first compression; fracturability (N), the force required to produce the first fracture; springiness (mm), distance sample recovers after first compression; adhesiveness (N mm), the negative force area for the first bite representing the work necessary to pull the compressing plunger away from the sample; cohesiveness, ratio of positive force area during the second compression to that in the first compression; and chewiness (N mm), the product of hardness, cohesiveness and springiness.

Table 1
Specific ingredients listed (x) on the samples' labels.

Ingredients	Sample code			
	M1	M2	M3	M4
Mechanically deboned poultry meat	x	x	x	x
Beef meat	x		x	x
Pork and poultry meat	x	x		
Pork fat	x	x	x	
Poultry skin and whey		x		
Pork skin			x	
Beef offal, bacon and gelatin				x
Water, salt, sugar, starch	x	x	x	x
Dehydrated glucose, modified starch and yeast extract	x			
Soy protein		x	x	x
Maltodextrin and powdered milk			x	
Sodium erythorbate (antioxidant), monosodium glutamate (flavor enhancer) and sodium tripolyphosphate (stabilizer)	x	x	x	x
Sodium nitrite (preservative), cochineal carmine (natural dye), garlic, nutmeg and coriander (natural flavorings)	x	x		
Sodium nitrate and sodium nitrite (preservatives)			x	x
Dehydrated cornstarch (emulsifier)		x		
Sodium lactate (acidity regulator), disodium pyrophosphate and sodium polyphosphate (stabilizers) and natural smoke flavor (natural flavoring)			x	
Cloves (natural flavoring)	x			
Pepper (natural flavoring)		x	x	

2.2. Sensory analyses

Sensory analyses were performed after approval by the National Research Ethics System (SISNEP, Brazil) under protocol CAAE 12961113.6.0000.5148, conforming to Resolution number 196/96 of the National Health Council (BRASIL, 1996).

The CATA questions were first defined by using the method proposed by Ares, Giménez, Barreiro, and Gámbaro (2010) with little modifications. Eleven untrained participants, consisting of professors, undergraduate and graduate students, with ages ranging between 19 and 55 years, were randomly recruited at the Federal University of Lavras (UFLA). All participants were frequent consumers (more than once per week) of mortadella. The four mortadellas samples were cut into cubes of approximately 25 mm edge and were presented in a single testing session (Repertory Grid technique), wherein judges used an open-ended question to establish the appropriate terms for describing their color, appearance, flavor, odor and texture. The most mentioned terms for each attribute (Table 2) were chosen to compose the CATA questions.

In the second stage, 86 untrained participants, consisting of professors, undergraduate and graduate students, with ages ranging between