Meat Science 131 (2017) 90–98

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Sensory profiling of low sodium frankfurter containing garlic products: Adequacy of Polarized Projective Mapping compared with trained panel

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ARTICLE INFO

Keywords:
Polarized Projective Mapping
Descriptive Analysis
Meat products
Sodium reduction
Garlic extract

ABSTRACT

Rapid methods to optimize the development of low-sodium meat products using consumers are a mandatory goal for the industry. The aim of the present study was to investigate the sensory profile of low sodium sausages containing garlic compounds obtained by Polarized Projective Mapping (PPM) performed by naive consumers. Descriptive Analysis (DA), with trained assessors was also carried out for comparison purposes. Adequate correlation (RV = 0.649, $p < 0.001$) was observed between both sensory methodologies for product characterization; however, Polarized Projective Mapping provided better discrimination of the samples when compared to the sensory space provided by DA. Additionally, the PPM was also able to generate a discriminative vocabulary of sensory characteristics of low sodium sausages. The results suggest the great potential for using PPM as a quick alternative to classical descriptive method in the sensory characterization and development of reformulated of food products concerning the sodium reduction.

1. Introduction

In many industrialized countries, sodium intake exceeds the nutritional recommendations, and has been linked to various health problems such as hypertension and increased risk of cardiovascular diseases (WHO, 2007). Sodium chloride (NaCl) is the main source of sodium in the human diet and an important ingredient in the meat industry, with numerous technological advantages such as preservative effect and inhibition of growth of pathogens, besides its positive effect on food texture, improvement of palatability and overall flavor, and suppression of the bitter taste in some formulations (Dötsch et al., 2009; Ruusunen & Puolanne, 2005).

To prevent failures affecting acceptability, sodium reduction should be accompanied by compensatory strategies such as the use of salt substitutes (KCl, $CaCl_2$, $MgCl_2$) and flavor enhancers (Campagnol, Dos Santos, Wagner, Terra, & Pollonio, 2011), in addition to complete monitoring of the products through appropriate sensory evaluation techniques.

Some spices, such as fresh garlic and its derivatives, have attracted the attention of food industry, since they can delay lipid oxidation, besides contributing to the sensory quality and nutritional value of foods to which they are added (Ozcan, Erel, & Herken, 2009; Tang & Cronin, 2007). Regarding the sensory quality, Descriptive Analysis (DA) is the technique widely used for sensory characterization of food products, which involves steps such as training and selection of the assessors (Lawless & Heymann, 2010). This methodology provides robust, detailed, and consistent information with high reproducibility, even when slight differences are observed between products (Moussaoui & Varela, 2010). However, this method has some disadvantages concerning the time and resources for its implementation, which can be a costly and time-consuming practice, impairing its use by small companies (financial constraint) and large industries (wide range of products) (Varela & Ares, 2012). Another disadvantage is that sensory characterization is performed by highly trained assessors, who can perceive and describe the sensory characteristics of the product, differently from consumers.

The imperative need for sodium reduction in meat products to enable healthy food choices has led the food industry to search for more dynamic methodological approaches to sensory profiling of food products. Therefore, new methodologies considered more versatile and flexible, using consumers, trained or semi-trained assessors as analysis tools have been studied and gained increasing popularity in the

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http://dx.doi.org/10.1016/j.meatsci.2017.05.002
Received 11 December 2016; Received in revised form 20 March 2017; Accepted 1 May 2017
Available online 04 May 2017
0309-1740/

Table 1
Definitions of attributes and references used in the sensory evaluation of low sodium frankfurter added with garlic products.

Attributes	Definition	References
Appearance		
Orange color	Orange coloring derived from meat products externally treated with annatto	According to the Munsell color palette system MIN: 2.5 YR 6/12 MAX: 10R 4/10
Pink color	Intermediate color between magenta and red, characteristic of cured meat products, ranging from pale (grayish) to stained (reddish)	MIN: turkey blanquette (brand Sadia) MAX: Coppa (brand Sadia)
Brightness	Quality of the product when reflecting light	MIN: canned sliced sausage (brand Swift) MAX: canned sliced sausage with oil on the surface (brand Swift)
Homogeneity	Presence of dark spots from condiments and raw material	MIN: hot dog sausages (brand Perdigão) MAX: Light bologna sausage (brand Taeq)
Aroma		
Characteristic sausage aroma	Characteristic aroma of traditional hot-dog sausage consisting of comminuted, cured, seasoned, and cooked meat, plus fat and additives.	MIN: heating water of sausages (brand Rosfrios) MAX: sausage (brand Rosfrios)
Spicy aroma	Aroma of spice traditionally used in hot-dog sausages	MIN: diluted ham pate (brand Sadia, 30 g/25 mL water) MAX: ham pate (brand Sadia) containing seasonings for sausage (1 g/30 g pate)
Garlic aroma	Characteristic aroma of garlic (*Allium sativum L.*)	NONE: water MAX: 3 slices of fresh garlic into 100 mL water
Smoky aroma	Characteristic aroma of smoky meat	NONE: water MAX: 3 drops of wood smoked aroma (brand Newmax) into 30 g ham pate (brand Sadia)
Cooked meat aroma	Characteristic aroma of beef and/or cooked chicken.	MIN: water from the canned sausage (brand Swift) diluted to 25% MAX: corned beef (brand Swift)
Flavor		
Garlic flavor	Characteristic flavor of products containing garlic (*Allium sativum L.*)	MIN: sausage (brand Rosfrios) MAX:3 g garlic powder in 30 g ham pate (brand Sadia)
Salty taste	Taste produced by aqueous salt solutions, e.g. sodium chloride solution (NaCl)	MIN: 0.3% salt solution MAX: turkey blanquette (brand Sadia)
Spicy flavor	Characteristic flavor of comminuted, cured, seasoned and cooked meat, plus fat and additives.	MIN: ham pate (brand Sadia) MAX: ham pate (brand Sadia) containing seasonings (1 g/30 g)
Characteristic of sausage flavor	Characteristic flavor of traditional hot-dog sausages.	MIN: chicken sausage (brand Seara) MAX: hot dog sausages (brand Rosfrios)
Fat flavor	Characteristic flavor of animal fat used in embedded emulsified foods	MIN: turkey blanquette (brand Sadia) MAX: Hamburg-type dry fermented sausage
Smoky flavor	Characteristic flavor of smoky meat	NONE: Cream Cracker biscuit MAX: 3 drops of wood smoked aroma (brand Newmax) into 30 g ham pate (brand Sadia)
Texture		
External hardness	Resistance exerted by the product at first bite. It relates to the force used by the type of casing used for filling	MIN: canned sausage (brand Swift) MAX: Viena-type sausage (brand Ceratti)
Softness	Ease in chewing the sample	MIN: cubed Bologna sausage MAX: canned sausage (softer)
Juiciness	Amount of moisture released during chewing the sample.	MIN: cubed Bologna sausage MAX: cubed ham (brand Sadia)

last years (Pintado et al., 2016; Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012).

Projective mapping is an emerging and one of the most used methodologies for sensory characterization, providing quick access to global similarities and differences among products in a simple and spontaneous way (Varela & Ares, 2012). When information about the sensory characteristics that distinguish samples is required, participants are asked to set out separately the comments to describe each sample or group of samples (Pagès, 2005). However, the major drawback of the technique is that all samples should be simultaneously evaluated in the same session.

To overcome this disadvantage, a prominent reference-based methodology and scarcely used, called Polarized Projective Mapping (PPM) has been suggested. Similarly to Projective Mapping, the panelist is requested to place the samples on a sheet of paper according to their similarities and differences; however, for PPM, three poles are pre-positioned, and panelists should compare the samples between them and between each pole (Ares et al., 2013; Saldamando, Antunez, Torres-Moreno, Gimenez, & Ares, 2015b).

Studies considering PPM and Descriptive Analysis (DA) are non-existent. Thus, this study aimed to investigate the effectiveness of PPM methodology carried out with consumers to sensory profiling low sodium sausages containing garlic compounds, comparing product spaces and description of products with those obtained by a classical Descriptive Analysis (DA) performed by trained assessors.

2. Material and methods

2.1. Garlic products

Four garlic products were prepared for use in the frankfurters, as follows: a) Fresh garlic (*Allium sativum L.*, family: *Liliaceae*), purchased in a food market in the city of Campinas (São Paulo/Brazil), manually peeled in a refrigerated environment and ground in a blender immediately before the addition to the food mixture; b) Commercial Garlic powder (Fuchs Gewürze, Brazil); c) Commercial garlic oil (IFF International Flavors & Fragrance Inc.); and d) Garlic extract, obtained by pressurized liquid extraction (PLE extract) according to Farías-Campomanes, Horita, Pollonio, and Meireles (2014). PLE is a promising technique that allows preserving garlic's compounds, and the extract