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Effect of smoking and fat content on the dynamic perception of bacon by Brazilian consumers

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Abstract

The high heterogeneity of meat and meat products can influence the sensory perception of the consumers, being necessary to measure the real impact of these non-controllable variables on the dynamic sensory properties of the smoked bacon during tasting. The aim of this study was to evaluate the effect of smoking and fat content on the dynamic sensory perception of bacon by Brazilian consumers. For this, four different samples were prepared, varying the fat content (from "low" to "high") and the type of smoking shown on the product label (natural and artificial). Thirty-five habitual smoked bacon consumers evaluated the dynamic sensory properties of the product using the Temporal Dominance of Sensations (TDS) method. The results were submitted to univariate (bandplot by attribute) and multivariate analyzes (Principal Component Analysis) to study both the dominance rate and its duration, respectively. The main attributes modified during tasting were "salty," "fatty," and "succulent," thus showing that the dynamic sensory perception of smoked bacon was modified by the type of smoking and the fat content of the sample.

Keywords: Sensory properties; Temporal Dominance of Sensations; Brazilian consumers.

1. Introduction

According to the annual report of the Brazilian Association of Animal Proteins of 2016, 89% of the pork meat produced in Brazil was destined to the production of industrialized products, and among them, the bacon stands out (Saldaña *et al.*, 2019). Therefore, this product is noteworthy from a sensometric perspective, since any change in its composition and/or processing will modify its sensory properties, which will reflect on product sales (Saldaña *et al.*, 2018a).

The sensory properties of meat products are very important intrinsic factors, since they are responsible for the formation of preference and, consequently, for consumers' purchase intention (Tuorila and Monteleone, 2009). Descriptive analysis is the most sophisticated method for the quantitative description of the sensory properties of food, allowing to obtain the sensory profile of the product (Alcantara

and Freitas-Sá, 2018). The sensory profile obtained by a well-trained assessor's panel depends mainly on the products and the assessors. Commonly, the products are subjected to different treatments using a certain statistical design, for example "to reduce the content of sodium chloride of salamis, a randomized block design was used" (De Almeida *et al.*, 2016) and "to modify the content of fat and salt in cooked bologna type sausages, a factorial design was used" (Ventanas *et al.*, 2010). However, it is not always possible to develop a homogeneous product within the same treatment, as there are factors that we cannot control as we would like. In this regard, Bavay *et al.* (2014) demonstrated the inherent heterogeneity within the same variety of apples. In an analogous way to products of plant origin, products of animal origin are subject to variations in the proportion of fat and meat. Bacon is a product in which this characteristic is

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intensified, since the proportion of meat and fat in the pork belly is very variable. This heterogeneity can cause changes in sensory properties related to texture, aroma and taste. For example, within the same treatment, a high-fat bacon smoked with Eucalyptus wood, may have a lower salt taste intensity, since fat is usually a barrier to rapid dissolution of salt in saliva.

In this sense, the sensory profile of a meat product not only depends on the type of smoking (Saldaña *et al.*, 2018b) but also on the fat content (Lorido *et al.*, 2015). However, few researchers have addressed the impact of these variables on the dynamic sensory profile of a product. The sensory changes due to different smoking process, as well as the variations in the meat/fat ratio are even more evident when studying the dynamic sensory properties of a meat product, which involve chewing and flavor release (Galmarini *et al.*, 2016). In addition, the dynamic sensory methodologies are considered more realistic due to the possibility of studying the evolution of the sensory characteristics during tasting. The past decade has witnessed the development of different dynamic sensory methodologies to investigate changes in products over time. Among them, the Temporal Dominance of Sensations (TDS) has become fairly popular (Schlich, 2017). TDS is a dynamic multi-attribute methodology used to evaluate the temporal perception of dominant attributes of a product during consumption (Pineau *et al.*, 2009). This methodology consists in the selection of dominant attributes by the consumers (an attribute is automatically deselected upon selection of another one) until all the sensations end.

Considering this panorama, the aim of this work was to evaluate the impact of the type of smoking and fat content on the dynamic sensory perception of bacon by Brazilian consumers using TDS.

2. Materials and methods

1.1. Samples
Two commercial bacons were purchased in a local market (São Paulo – Brazil), based on the smoking claim of the product label: a naturally and an artificially smoked product. Two meat/fat ratios were obtained for each smoking claim, summarizing 4 samples as shown in Figure 1.

1.2. Dynamic sensory evaluation
TDS test was performed in standardized sensory booths of the Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ) /

Universidade de São Paulo (USP). Samples were cut into cubes of approximately 2.5 g, cooked in a hot plate (200 °C) for five minutes, subsequently served monadically in disposable plastic plates coded with three-digit random numbers following a William's Latin Square design to avoid biases. The data were collected using SensoMaker software (Pinheiro *et al.*, 2013).
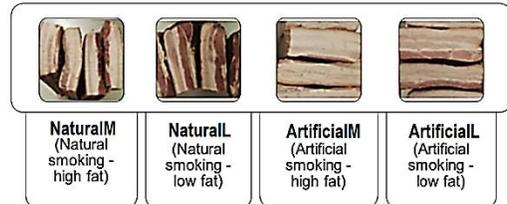
Figure 1. Smoked bacon samples used in the current work.

1.2.1. Attributes
The selected attributes (Table 1), based on previous studies (Saldaña *et al.*, 2018b, 2019), were presented to the consumers according to Williams design to avoid biases, but each consumer received the same presentation order to facilitate attribute location (Merlo *et al.*, 2018).

Table 1
Attributes and definitions used to describe the samples over time

Attribute	Definition
Salty	Basic taste related to sodium chloride (NaCl)
Fatty	Perception of fat content during chewing
Smoky	Characteristic taste of smoke
Crunchy	Characteristic noise emitted during chewing
Succulent	Liquid released during chewing
Stringy	Presence of fibers perceived during chewing
Salty aftertaste	Residual salty taste after bacon intake
Smoky aftertaste	Residual smoked taste after bacon intake

1.2.2. Participants
A total of 45 consumers were recruited at *ESALQ/USP* according to their frequency of bacon consumption (at least once a month), as well as their motivation and availability of time to participate in the familiarization and formal evaluation. However, only 35 consumers (18 - 59 years old) performed the test adequately. This amount of participants still represents a number higher than the minimum recommended (Pineau and Schilch, 2015).

1.2.3. Familiarization
A 30-minute familiarization session consisted of an introduction to sensory analysis of foods, followed by a presentation of the TDS test to consumers.
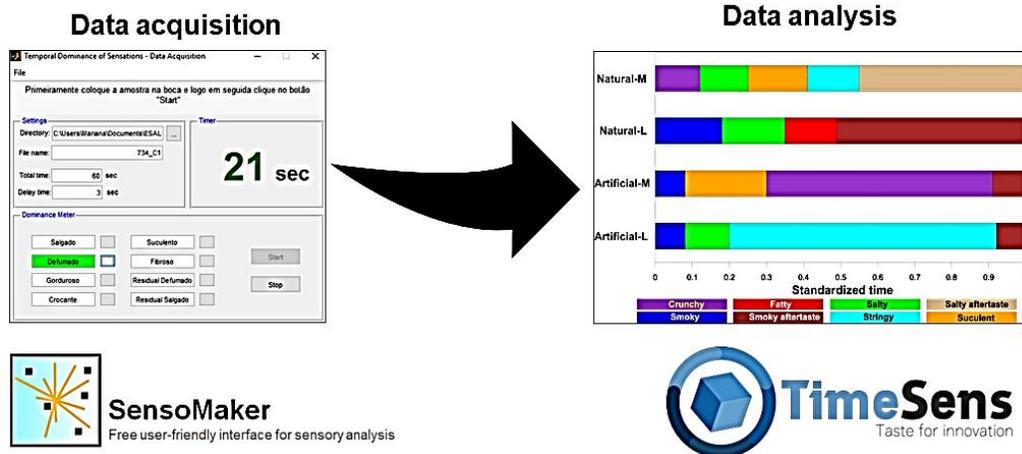
Figure 2. Temporal Dominance of Sensations: from data acquisition to data analysis.

A strawberry-flavored chocolate was used to help consumers to fix the concept of dominant sensation, defined as "the sensation that catches/triggers your attention at a given time, while testing a product" (Pineau *et al.*, 2009). In addition, a previous test was done with a sample of cereal bar prior to performing the formal evaluation, to make sure that the consumers understood the test.

1.2.4. Evaluation Protocol

Attributes were presented simultaneously on the computer screen (Figure 2). Then, the participants were instructed to start the test clicking on the "start" button and to choose the dominant sensation. Participants could select as many dominant sensations as they wanted or never select a sensation. After 60 seconds the test was finished. Water and bread were used for rinsing between bacon samples.

1.3. Data analysis

Data analysis was performed using TimeSense software (INRA, Dijon, France). Time was standardized between 0 (start of the test) and 1 (60 seconds) to align the tasting duration, allowing the comparison of the individual results. A bandplot by descriptor was used to represent the sequence of dominant sensations in each sample. The height of the bars corresponded to the dominance rate of the sample (Galmarini *et al.*, 2017). In addition, the standardized duration of the dominances was represented by a biplot Principal Component Analysis (PCA), based on a covariance matrix (Thomas *et al.*, 2016).

3. Results and discussion

Different dominant attributes during tasting (different sequence and dominance rate)

were observed (Figure 3), indicating that the dynamic sensory profile of bacon samples was affected by the smoking method and the meat/fat content.

Bacons naturally smoked presented differences in the salty flavor, smoky aftertaste, and stringy attributes due to differences in the proportion of fat. Interestingly, there was no noticeable change in the fatty attribute. This is probably because, at the time of cooking, a large part of the fat content was melted, reducing the changes in the perception of the fatty attribute. For the "artificial" samples, the fatty, succulent, salty, smoky and salty aftertaste attributes presented differences in the sequence and dominance rate due to the fat content. At the beginning of the tasting, the artificialM (artificial sample with the highest fat content) was perceived as fatty and succulent, while the artificialL (artificial sample with lower fat content) was perceived as smoky and salty. From half of the tasting onwards, the artificialL presented the highest rate and duration for the salty aftertaste and smoky aftertaste attributes. It is clear, then, that there is an interaction between the fat content and the type of smoking in bacons. In artificial smoking, differences in the fat/meat content of the bacons are even more pronounced. Once the effect of the type of smoking and the meat/fat ratio on the dynamic sensory perception of consumers has been demonstrated, it is necessary to study the standardized duration of the dominance. In Figure 4, the four samples and the eight attributes are displayed from a multivariate perspective. The confidence ellipses indicate whether two samples are similar (overlapping) or not (not overlapping).
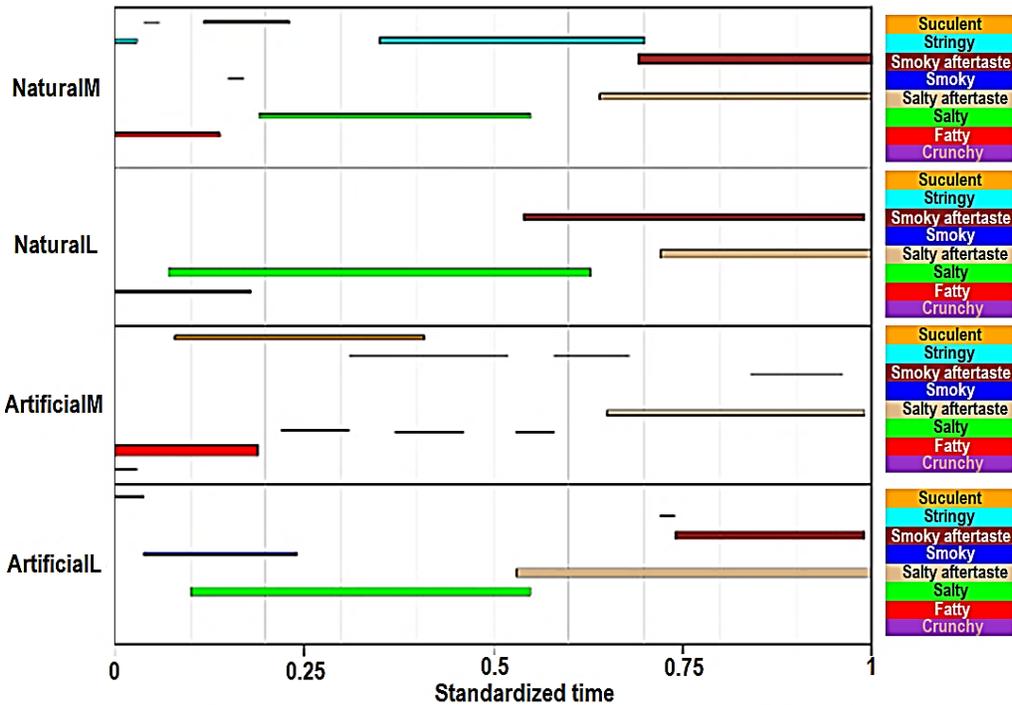
Figure 3. Bandsplot by attribute of the smoked bacon samples.

First, the standardized duration of the succulent and fatty attributes was similar, since both vectors presented the same module and direction. These attributes were associated with samples with high fat content, both for the artificial and natural smoking process. This result was expected since they had a higher fat content. On the other hand, salty and smoky aftertaste attributes are opposed to succulent and fatty and, at the same time, are associated with products with less fat content. This behavior may be due to the fact that bacons with higher fat content leave a fatty mouth coating during product chewing, reducing the contact of the salt crystals with the saliva, decreasing dissolution and, therefore, the perception of saltiness (Chabanet *et al.*, 2013; Lorido *et al.*, 2015). The smoky aftertaste attribute, which characterizes the samples with low fat content, presented a behavior similar to the salty attribute. Probably the same phenomenon described in the salt particles occurred, i.e., fat prevented the molecules associated with the smoky aftertaste attribute from being easily released from the fat matrix, and considering that the chewing process lasts a few seconds, this sensation lasted a short time (Ventanas *et al.*, 2010). The smoky and salty aftertaste attributes had an intermediate importance, varying only in the second dimension, which explained 17.3% of the variance of the data. Finally, the crunchy and stringy attributes were poorly represented by the first two dimensions; therefore, they did not have great relevance in the present study.
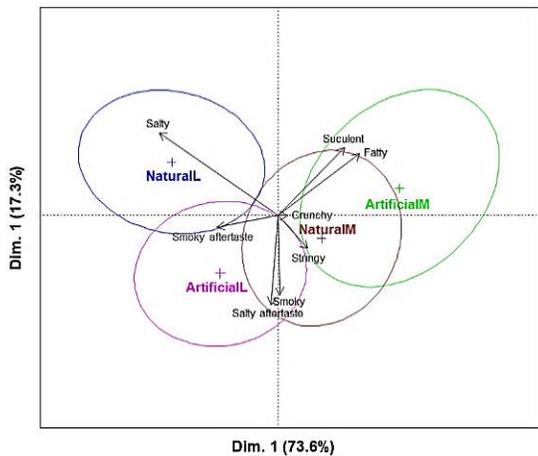

Figure 4. PCA of the duration of dominance for bacon samples.

The evidence from this study suggests that standardizing the meat/fat content is essential for the study of the dynamic sensory properties of meat products.

4. Conclusions

The type of smoking and the fat content modified the dynamic sensory perception of bacons. Samples with high fat content had higher rate and duration of dominance for

the fatty and succulent attributes, whereas for the low-fat samples these characteristics were observed for the salty attribute. The type of smoking also modified the sensory dynamics, without a clear pattern of increase or decrease of specific attributes.

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