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Comparison between temporal dominance of sensations (TDS) and key-attribute sensory profiling for evaluating solid food with contrasting textural layers: Fish sticks

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ABSTRACT

This study compared the performance of two sensory description methods, Temporal Dominance of Sensations (TDS) and key-attribute sensory profiling, in order to assess the sensory attributes of fish sticks (two different commercial brands) cooked by three different procedures (deep frying, conventional oven and microwaving).

The TDS method has scarcely ever been applied to solid food and battered fish sticks are a particularly challenging case for sensory assessment, as the presence of contrasting texture layers complicates the description and evaluation of their attributes.

The results of the TDS (untrained panellists) and key-attribute sensory profiling (trained panellists) methods were compared by Canonical Variates Analysis (CVA). Both methods gave similar results for the different samples. However, TDS made it possible to monitor the appearance and evolution of the different attributes over the consumption time, with the additional advantage of requiring practically no training.

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1. Introduction

The complex process of mastication, in which food is minced into small particles (with the intervention of the teeth, tongue and palate, mixture with saliva and changes in temperature) until a bolus that can be swallowed is formed, can be situated in a space in which structure, lubrication and time are all involved (Hutchings & Lillford, 1988; Lenfant, Loret, Pineau, Hartmann, & Martin, 2009). It is well known that the way the food breaks in the mouth affects both the perception of its texture and consumer preferences. The use of dynamic sensory analysis methods such as Temporal Dominance of Sensations (TDS) has proved useful for studying the temporal dimension of texture perception in the mouth. With this descriptive sensory method, users assess which sensation is dominant and score its intensity over time until the sensation ends or another appears as dominant (Labbe, Schlich, Pineau, Gilbert, & Martin, 2009). This technique allows the impact that each aspect of perception has upon the consumer to be broken down over the time of consumption and the results to be linked to acceptance.

Researchers have used TDS methodology to study the perception of some beverages such as wines (Meillon et al., 2010), hot beverages (Le Révérend, Hidrio, Fernandes, & Aubry, 2008) and a liquid dairy product (Pineau et al., 2009). Wheat flakes appear to be the only solid food in which this technique has been employed (Lenfant et al., 2009).

Though food perception analysis is a complex process per se, some kinds of food have complex structures that make this process even more arduous. Therefore, evaluating these products by means of dynamic sensory techniques can advance the understanding the keys to their perception.

Battered or breaded products are made up of different layers with very different textures (crunchy fried exterior, tender and juicy interior) and their flavours come from the breading, from the frying oil and from the substrate – meat, fish, cheese, etc. Frozen prefried battered products constitute an extensive sector of the ready-meals market. Fish sticks, cheese sticks, onion and squid rings, fried chicken and tempura vegetables are very popular food items. Final cooking of battered or breaded foods, at home or outside the home, leads to a product that is soft on the inside and crisp on the outside (Fiszman, 2008). This particular contrasting texture is a key quality factor and is easily obtained by deep frying, which is the most common final cooking procedure. However, other cooking procedures such as conventional or microwave ovens can be used.

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In fact, nowadays there are products with cooking instructions that suggest all three cooking procedures (deep frying, oven cooking and microwaving) as equally suitable. The use of conventional ovens and microwaves implies a 'lighter' food, as it does not absorb any more oil than it had already absorbed during the industrial prefrying process. However, conventional ovens (recommended heating/cooking times of 10–12 min, longer than the 2–3 min in the fryer) can dry out the products too much, and microwave ovens (with shorter recommended times) often result in sogginess (Datta, 2001). Deep frying achieves a highly appreciated textural contrast between crunchiness and juiciness. In a conventional oven, a drier texture is obtained, while a microwave oven produces moister, soggier textures. The texture changes induced by these two alternative methods are an interesting subject of study.

The aims of the present study were (1) to measure the dominant sensation at each point of the mastication process using the TDS technique and (2) to compare the information obtained by TDS with that obtained by key-attribute sensory profiling of the same two commercial brands of prefried fish sticks cooked by three different cooking procedures: deep fat frying (DF), conventional forced-air electric oven (CO) and microwave oven (MW).

2. Materials and methods

2.1. Test materials

Two different brands of commercial frozen precooked breaded fish sticks (H and C), purchased in a local supermarket, were used in this study. Both manufacturers recommended deep frying as the first option for final cooking of the fish sticks, which were rectangular in section. The dimensions of the fish sticks were $8 \times 2 \times 1$ cm for the both commercial brands. The samples consisted of one tip of each fish stick ($2 \times 2 \times 1$ cm).

2.2. Cooking procedures

The cooking temperature and time were determined in preliminary tests and the following protocol was adopted:

Deep frying (DF): One fish stick at a time, 180 °C, 3 min, in sunflower oil in a domestic fryer with thermostat (Fritaurus Professional 4, Barcelona, Spain). A large excess of oil was employed in the fryer (4 l).

Conventional oven (CO): Two fish sticks at a time, 200 °C, 14 min, in air convection mode in a conventional domestic electric oven (Fagor 2H 114, Mondragón, Spain). After 7 min the sticks were turned upside down. The fish sticks were placed symmetrically on the same tray. The oven and the oven tray were always the same and the trays were placed at the same level in the oven each time.

Microwave oven (MW): One fish stick at a time, maximum power (800 W), 140 s, in a domestic MW oven (Samsung M1727, Barcelona, Spain). After 40 s the fish stick was turned upside down. The fish sticks were put in exactly the same place in the oven.

After cooking, the fish sticks were left to rest for 1 min at room temperature before performing the measurements. One tip of each fish stick was then cut to obtain the samples and the rest of the fish stick was discarded.

For the sake of clarity, in the present paper the samples have been named with letters indicating the cooking procedure (DF, CO or MW) followed by the letter corresponding to the brand (H or C).

2.3. Sensory evaluation

Data acquisition was carried out using Fizz Software (Biosystems, Counternon, France).

2.3.1. TDS

2.3.1.1. Selection of terms and panel instruction. All the panellists ($n = 9$) were familiar with sensory evaluation but were untrained in fish stick evaluation. Two preliminary sessions were conducted. In the first session the panellists were introduced to the notion of the temporality of sensations and to the TDS technique and had to describe all the in-mouth sensations they felt while tasting all the samples (n = 6). The seven most-cited sensations were selected for the TDS analysis. They were 'crunchiness', 'juiciness', 'oiliness', 'fried flavour', 'perception of different textures', 'ease in forming a single smooth bolus', and 'ease in swallowing'. The latter three will be shortened to 'different textures', 'bolus' and 'swallowing' throughout the rest of this paper. It should be noted that 'crunchiness', 'juiciness', 'oiliness' and 'fried flavour' are typical attributes that normally appear in the sensory profiling of products of this type, such as chicken nuggets (Jackson et al., 2009; Mah & Brannan, 2009) or fish nuggets (Albert, Varela, Salvador, & Fiszman, 2009). Other attributes such as 'different textures', 'bolus' and 'swallowing' involve the time dimension in a more direct way, and probably arose when the subjects were asked to indicate the sensations perceived during all the mastication process. For example, they explained that 'different textures' is detectable when the fish stick has undergone structural breakdown and some in-mouth handling; at this point, both crunchy, hard pieces of the breading and some soft, juicy pieces of the fish were detectable. The same is true for 'bolus': to form a detectable coherent, smooth bolus ready for swallowing, part of the food structure must be reduced to some extent and degree of lubrication must be increased by mixing with saliva. In the case of 'ease in swallowing', it is evident that this can only be assessed when swallowing; it largely depends on the bolus deformability, fluidity, and stickiness, which modulate its flow speed (Funami, 2011). None of these latter attributes have been proposed or found in conventional sensory analyses of this type of product (Albert et al., 2009; Albert, Varela, Salvador, Hough, & Fiszman, 2011; Antonova, Mallikarjunan, & Duncan, 2003; Jackson et al., 2009; Lee, Joaquin, & Lee, 2007; Mah & Brannan, 2009).

In the second session, the panellists participated in a simulation of a TDS session with several samples of fish sticks in order to solve questions and get used to the computer program and methodology.

2.3.1.2. Formal assessment. The TDS evaluation took place in sessions held on three different days in order to conduct three replications. In each of these sessions, six (two brands × three different cooking methods) one-bite-size samples at consumption temperature were presented monadically on a plastic tray according to a complete balanced experimental design. On the computer screen, the panellists were presented with the list of the seven parameters, each associated with its corresponding unstructured scale ranging from 'weak' to 'strong'. The panellists put the bite- size portion of fish stick (always one of the tips of the fish stick) into their mouths and simultaneously started the software by clicking on the Start button to start the chronometer. They selected and rated the intensity of the sensations they perceived as dominant (the most intense sensation) at each instant while chewing the sample. The panellists were free to choose the same attribute for the same sample as often as they thought necessary or never to select any particular attribute as dominant. The evaluation ended when the panellists no longer perceived sensations and clicked the Stop button, stopping the chronometer. In the 1-min break that was enforced between samples, the panellists had to rinse their mouths with slightly sweet, carbonated water. The order of the descriptors was different for each panellist in order to guard against list order bias.

2.3.2. Key-attribute sensory profiling

2.3.2.1. Panel training. A 9-member trained sensory panel with three years experience in the descriptive analysis of fish sticks

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