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Methods for a deeper understanding of the sensory perception of fruit fillings

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ABSTRACT

Variations in ingredients essentially affect the quality of fruit filling systems in terms of texture. The sensory perception of semi-solid systems is a rather subtle issue. Their oral processing is quite limited in terms of chewing, as almost no mastication for bolus formation is required. However, a number of textural features assessed during their consumption can modulate their perceived flavour and several relatively new sensory evaluation techniques can provide a deeper understanding of the perception of fruit fillings.

In the present work, six fruit fillings were prepared with three different hydrocolloid systems: tapioca starch alone (TS), modified waxy corn starch (C), and a mixed system with tapioca starch plus pectin (P). Each of these was prepared with sucrose or with polydextrose and intense sweeteners. The samples were subjected to two sensory techniques: Temporal Dominance of Sensations (TDS) with trained assessors (evaluating the texture and flavour modalities separately) and a check-all-that-apply question with consumers, including the evaluation of an "ideal fruit filling". Finally, the results were correlated with the consumers' liking for the samples. The results indicated that flavour TDS curves mainly depended on the type of sweetener (sugar or intense sweetener) while, as expected, the texture TDS curve patterns were dependent on the type of hydrocolloid system. The best-liked set of samples was that with sugar (demonstrating that flavour dominated over texture for fruit filling acceptability) and, among these, TS was the preferred hydrocolloid system, for its creamy, fondant texture.

1. Introduction

Product reformulation to fit consumer demands and segmentation is an immensely important activity when designing food. It is said that product quality is a major determinant of consumer choice. However, "quality" is a somewhat vague concept. In the case of fruit-containing semi-solid products (fruit fillings, jams, etc.), it is evident that the ingredients, particularly hydrocolloids, affect their quality in terms of both physical properties (instrumental texture and rheological) (Basu, Shivhare, & Singh, 2013) and sensory properties, which are not always taken into account sufficiently in the product design phase. In particular, it is important to understand the relationships between the perception of the gel texture and its structure (Renard, van de Velde, & Visschers, 2006) and how it, in turn, can modulate the perception of the flavour attributes. People like to be in full control of the food placed in their mouth. In the case of gels, gummy or slimy products or those containing unexpected lumps or hard particles are rejected (Grujić, Grujić, & Poljašević, 2010).

In the world of food hydrocolloid applications, rheological properties are very widely studied to assess all the components' technical functionality in product development and quality control and to correlate them with sensory attributes (Dervisi, Lamb, & Zabetakis, 2001). However, perceived texture is a very complex sensory issue that comprises numerous different channels. Texture perception can involve one or many stimuli, including visual, auditory, tactile and kinaesthetic factors, working in combination. While seeing and touching can provide useful information, oral processing is the most important stage of textural perception and appreciation. Oral processing of food involves a series of complex operations, including grip and first bite, first stage transportation, chewing, second stage transportation, bolus formation, and swallowing. Texture perception and appreciation is a dynamic process,

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based on the perception obtained from continuous oral destruction (and breakdown) of food material (Chen, 2009). In the case of soft semi-solid systems these steps are slightly simplified since almost no particle reduction is necessary. They are usually processed by directly put them on the tongue (Van Vliet, van Aken, de Jongh, & Hamer, 2009) and palating (tongue compressive movements involving yielding): forces originating from the compression between tongue and hard palate are perceived by tongue receptors and result in tactile sensations (Pascua, Koç, & Foegeding, 2013). These actions are milder operations than mastication, but other sensations such as creaminess or fondant become important. A study with consumers that explored the vocabulary of texture highlighted the importance of creaminess, since it was the most frequently cited texture term, mentioned by more than 50% of the participants (Antmann et al., 2011).

Variations in ingredients or their concentration usually lead to changes in gel structures being perceived by the consumers through what is called mouth-feel. Mouth-feel has been defined as the sensory experience derived from the sensation in the mouth or on the tongue during and after ingestion of a food material (Basu & Shivhare, 2010). It is especially important in semi-solid foods. In these materials, different hydrocolloid systems give the final product different consistencies and are responsible for its main texture features. In fruit fillings, the fruit pulp interacts with the hydrocolloid matrix in many different ways, depending on the nature of the matrix (and a number of factors such as pH, quantity of fruit, type of fruit, fruit puree particle size and solid content). It provides an acidic and fruity flavour, which in turn is perceived with differing intensity depending on the whole system, and also gives graininess, depending on the size and distribution of its particles and their integration into the matrix (Baiano, Mastromatteo, & DelNobile, 2012; Basu & Shivhare, 2010; Wei, Wang, & Wu, 2001). Sugar also plays an important function in giving fruit filling mass body and a sweet flavour. When sugar is removed to produce sugar-free fruit fillings, alternative components come to have a role: bulking agents such as polydextrose contribute body while intense sweeteners contribute a sweet flavour. However, reformulation is not easy since the acid/sweetness balance alters the global flavour perception.

One aspect which is often overlooked is examining flavour and textural changes during a masticatory/consumption sequence. When a food product is put in the mouth a first impact suddenly appears, producing a sensation that dominates over others and probably leading to like or dislike at a certain point. This first sensation is followed by a cascade or sequence of sensations. To record the emergence of each salient sensation – both texture- and flavour-related – during the consumption of a food product, sensory techniques involving the additional dimension of time are required. The Temporal Dominance of Sensations (TDS) method developed in recent years makes it possible to record the evolution of sensory perceptions in the mouth during product tasting (Pineau et al., 2009). This method has already been used for a number of products with different texture properties: cereals (Lenfant, Loret, Pineau, Hartmann, & Martin, 2009), dairy products (Pineau et al., 2009), yoghurt (Bruzzone, Ares, & Giménez, 2013) and ice cream (Varela, Pintor, & Fiszman, 2014).

In two previous papers (Agudelo, Varela, Sanz & Fiszman 2014a, 2014b), the rheological performance and stability of a mixture of native tapioca starch plus low-methoxyl pectin were studied and compared with a modified starch control sample. In an acid medium, an improvement in native starch performance during processing (freezing or baking) and during long storage periods was demonstrated. However, one of the most important steps in new product development processes is identifying the consumers' ideal products and directions for product reformulation (Ares, Dauber, Fernández, Giménez, & Varela, 2014). In product design, one key step is the selection of a product formulation that is aligned as much as possible with their sensory preferences (Van Kleef, Van Trijp, & Luning, 2005). In this regard, one of the main challenges for Sensory and Consumer Science is to provide actionable information for making specific changes in product formulation, not just product descriptions (Ares et al., 2014; Moskowitz & Hartmann, 2008).

CATA (check-all-that-apply) question is a user-friendly method that is increasingly being used due to their simplicity and ease of use (Varela & Ares, 2012) to obtain an exploratory, rapid profile from consumers. In this approach, consumers are presented with a list of terms and are asked to select those that in their opinion fit the product. The relevance of each term is determined by calculating its frequency of selection. The attributes are not limited to sensory aspects but can also be related to hedonic and emotional aspects, product use and concept fit (Dooley, Lee, & Meullenet, 2010). The method has been applied to salty snacks (Adams, Williams, Lancaster, & Foley, 2007), strawberries (Lado, Vicente, Manzzioni, & Ares, 2010), ice cream (Dooley et al., 2010; Varela et al., 2014), chocolate milk desserts (Ares, Deliza, Barreiro, Gimenez, & Gambaro, 2010), orange-flavoured powdered drinks (Ares, Varela, Rado, & Giménez, 2011a, 2011b) and the texture of milk desserts (Bruzzone, Ares, & Giménez, 2011). Some of these authors have used it in addition to hedonic ratings to provide an alternative to classical external preference maps generated from sensory profiles. Valentin, Chollet, Lelievre, and Abdi (2012) have recently reviewed the new descriptive methods in food science and concluded that CATA is powerful enough to discriminate between samples. Compared with descriptive analysis, the main advantage of CATA from both the assessors' and the experimenter's points of view is its great simplicity.

Reformulation of fruit fillings by changing the hydrocolloid system and/or replacing the total amount of sugar with intense sweeteners implies subtle changes in texture and flavour which are in turn interrelated. It has been showed that “first impact” in mouth could be important (Varela et al., 2014) as well as the appearance and evolution of the sensations during consumption tested by TDS with trained panels. Each hydrocolloid imparts a texture profile (different from any other) that behaves distinctively under oral processing; in addition presence of fruit particles, depending of the matrix could also contribute graininess or not. On the other hand, the use of high-potency sweeteners or sugar also contribute distinctive flavour profiles in which the sweet perception is important but also its evolution with time and its effect on the acid/fruity flavours balance or the appearance of off-flavours as well. On the other hand, the overall perception of consumers of sensory attributes and their relation with liking is of fundamental importance to validate a final formulation. For this reason both sensory aspects of the reformulated fruit fillings have been tested in the present study.

The objectives of the present work were 1) to assess three hydrocolloid systems (tapioca starch, modified waxy corn starch and a tapioca starch-pectin blend) in reformulated fruit fillings, using two relatively novel sensory techniques: temporal dominance of sensations and check-all-that-apply, and 2) to link these sensory results with product liking. Two series of reformulated samples were prepared: with sugar or with an intense sweetener plus polydextrose as a bulking agent.

2. Materials and methods

2.1. Ingredients

The ingredients employed were native tapioca starch (TS) (moisture content 13.7 g/100 g, Sucroal S.A., Colombia), citric