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Yogurt viscosity and fruit pieces affect satiating capacity expectations

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ABSTRACT

The extent to which a food is expected to deliver satiation is called expected satiation. Many factors affect this expectation, including a number of sensory properties such as texture. The present study explores the relationships between two kinds of texture variations in a yogurt and its expected satiating capacity (ESC). One texture variation consisted in adding three types of pineapple particles: fresh pineapple purée (+PP samples), small cubes of fresh pineapple (+PF samples), and small cubes of lyophilized pineapple (+LP samples). The other texture variation was the viscosity of the yogurt base: yogurt thickened with starch (high viscosity yogurt, HVY-samples) and without starch (low viscosity yogurt, LVY-samples). A total of 8 samples were obtained: the two basic yogurts without added fruit (sample LVY and sample HVY), and each of these with one of the three kinds of pineapple particles (samples LVY + PP, LVY + FP, LVY + LP, HVY + PP, HVY + FP and HVY + LP).

A total of 98 consumers described the sensory characteristics of the 8 yogurts on a CATA questionnaire and evaluated the expected satiating capacity (ESC) and acceptability that the yogurts elicited. In addition, the consumers were asked about the characteristics they had considered when evaluating the ESC of the samples. Correspondence Analysis was used to understand how the consumers perceived and described the differences in yogurt texture. Penalty Analysis and Partial Least Squares regression were conducted to explain the differences in ESC among the yogurt samples and to determine the attributes that had significant positive and negative effects.

The results indicated that starch addition (a more viscous product base) increased the mean ESC values regardless of the pineapple particle added. This could be attributed to more extensive oral handling due to the creaminess and mouth coating contributed by these yogurts. Second in importance for higher ESC perception was the presence of lyophilized pineapple cubes, which required some chewing before swallowing since they are dry and crispy.

The attributes that were related more to ESC were principally those associated with the yogurt base texture (creamy, mouth coating, consistent, dense, fatty, thick and homogeneous) and others related to the fruit added, such as integrated texture or pleasant fruit pieces.

1. Introduction

The expected satiation of a food, that is, the extent to which that food is expected to deliver satiation, is assumed to be one of the determinants of consumed portion (Brunstrom & Rogers, 2009), although to better understand human food intake regulation, further investigation of the effect of satiety expectations on actual intake may be important. Most research on expected satiety is being done showing pictures of the targeted foods without tasting them (e.g. Brunstrom & Shakeshaft, 2009; McCrickerd, Lensing, & Yeomans, 2015; Toepel et al., 2015). However, tasting informs the consumer about the texture and other sensory features of the samples, aiding in the evaluation of satiating capacity expectations (ESC).

It is widely recognized that texture has an effect on the expected satiating capacity of food. The texture-fullness sensation is likely a learned association between sensory properties and experiences of fullness after finishing a meal. In turn, the notion that a longer orosensory exposure time is related to a higher satiating efficiency is congruent with the idea expounded by Yarmolinsky, Zuker, and Ryba (2009) that the taste system, which has evolved to serve as a dominant regulator and driver of feeding behavior, serves as a nutrient sensing system.

According to Hogenkamp, Stafleu, Mars, Brunstrom, and de Graaf (2011), consumers' expectations about the satiating capacity of a food may differ markedly not only across a broad range of food products, but also between foods within a single product category. These authors measured the satiation expected of custards with different textures ("liquid", "semi-liquid" and "solid") but similar macronutrient compositions, and concluded that an increase in thickness results in an increase in expected satiation.

Higher viscosity in a food leads to longer orosensory stimulation, which may facilitate the association between sensory signals and metabolic consequences (Mars, Hogenkamp, Gosses, Stafleu, & de

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Graaf, 2009). More solid products require more labor and time in the mouth, causing longer oro-sensory exposure. An increase in oral processing may result in a greater timespan to allow satiation signals which induce meal termination (Hogenkamp & Schiöth, 2013). On the same lines, Forde, van Kuijk, Thaler, de Graaf, and Martin (2013) stated that for equal energy value within a meal, oral-sensory exposure time could contribute to higher satiation.

From a different angle, a number of studies that have investigated the role of food form or food texture (i.e. liquid vs. solid) on intake have demonstrated that the food form of a preload modulates subsequent intake. DiMeglio and Mattes (2000) found that liquid carbohydrate promoted a positive energy balance, whereas a comparable solid carbohydrate elicited precise dietary compensation. In another study, Flood and Rolls (2007) examined four soup forms: broth and vegetables served separately, chunky vegetable soup, chunky-pureed vegetable soup, or pureed vegetable soup, and found that subjects perceived the thicker soups to be higher in energy value and more filling than the less viscous soups. Also, Mourao, Bressan, Campbell, and Mattes (2007) stated that regardless of the predominant energy source, the beverage food form of a food elicited a weaker compensatory dietary response than the matched solid food form.

Another approach offered by Brustrom's research team is that rather than affirm that beverages categorically deliver less satiation than solid foods, it would be practical to evaluate the satiation of different beverages against the continuum of satiety responses that might otherwise be observed in a range of solid foods (Martin, Hamill, Davies, Rogers, & Brunstrom, 2015). Studies by the same research team on the "expected satiety" of a variety of solid foods documented four- to five-fold differences in the amount of satiety these foods are expected to confer (Brunstrom, Shakeshaft, & Scott-Samuel, 2008). These expectations have been shown to be an excellent predictor of the energy value that individuals self-select and ultimately consume (Wilkinson et al., 2012). Moreover, this kind of meal planning appears to be extremely common (Fay et al., 2011).

Not only viscosity but also the presence of solid food particles and the complexity of the food items have been reported as modulators of expectations about satiation (Marcano, Morales, Vélez-Ruiz, & Fiszman, 2015). In this context it is important to investigate how different food forms influence the expectations of satiating capacity and how they change the sensory profiling of the samples. In this way, the consumers would provide the clues to knowing which sensory attributes are more related to satiation expectations. For sensory profiling several relatively new techniques are rapid and easy to apply. Check-all-that-apply (CATA) questions, a technique that has been applied increasingly in food research, consist of multiple-choice lists of words or phrases from which consumers select those they consider appropriate for describing the sample they have tasted. The main advantage of this type of questionnaire is that it allows multiple options to be selected instead of limiting respondents to only one answer or forcing consumers to focus their attention on specific attributes to be evaluated (Smyth, Dillman, Christian, & Stern, 2006). The list of words or phrases in the CATA questionnaire can include terms related to both sensory and non-sensory characteristics, such as occasions when used, expectations, etc. (Varela & Ares, 2012).

Combining these lines of research, in the present study the authors want to know the relative importance of viscosity (the same yogurt thickened or not with starch) and the form of an added fruit (pineapple cut or processed in different ways) on the participants' ESC elicitation. The sensory description (sensory profile) and acceptability evaluation of the samples will contribute extra cues for studying these expectations. In addition, the yogurt's characteristics that the participants take into consideration for evaluating ESC will provide further information to enrich the discussion.

In short, the aim of the present study was to investigate the role and relative importance of the viscosity of the yogurt base and the presence (and form) of fruit in the perception of expected satiating capacity.

2. Materials and methods

2.1. Materials

The materials used in the preparation of the yogurt samples were commercial pineapple-flavored stirred yogurt (fat content 0.1 g/100 g, protein content 4.3 g/100 g as declared by the supplier, Hacendado, Spain), pregelatinized starch refined from waxy maize (Novation™ 5600, National Starch & Chemical Ld., UK), minimally-processed fresh pineapple (commercial refrigerated peeled and cored fresh pineapple, Bonnysa Agroalimentaria S.A., Spain), and lyophilized pineapple cubes (8 × 8 mm, kindly provided by Snack Saludable S.L., Barcelona, Spain).

2.2. Yogurt sample preparation

The pineapples were pureed using a domestic blender (excess liquid discarded by 2-min draining in a circular sieve with a mesh of 1.5 mm square openings) or cut manually into cubes (8 × 8 mm). Pineapple purée or fresh pineapple cubes were added to each type of yogurt (approximately 11 g/100 g of yogurt on a wet basis). In the case of lyophilized pineapple, just before sample tasting 6 cubes (8 × 8 mm) were added to each yogurt base in the plastic jars prepared for the sensory evaluation; this amount of cubes was the same as in the sample prepared with fresh pineapple cubes.

Two sets of yogurt samples were prepared, one using yogurt without starch (LVY-samples) and another using yogurt with starch (HVY-samples, the same commercial yogurt with the addition of 2 g of starch/100 g yogurt). The viscosity values (mean of three repetitions) of the yogurts without starch and with starch were 3275 mPa.s and 8457 mPa.s respectively (Viscotester VT5 Haake, spindle R4, speed 20 rpm, at 20 ± 2 °C). The samples were prepared by adding the three kinds of pineapple to each kind of yogurt: fresh pineapple purée (samples LVY + PP and HVY + PP), small cubes of fresh pineapple (samples LVY + FP and HVY + FP) and small cubes of lyophilized pineapple (samples LVY + LP and HVY + LP). LVY and HVY samples (without added pineapple) were also used in the study.

2.3. Sensory analysis

2.3.1. Consumers

A total of 98 consumers participated in the test (61 women and 37 men, aged 18–62 years, mean age 27 years). All were consumers of yogurt and declared no food allergies or lactose intolerance. All were recruited among the staff and student population of the Polytechnic University of Valencia and the students and employees of the Institute of Agrochemistry and Food Technology (IATA-CSIC).

2.3.2. Samples

The 8 samples were coded with random three-digit numbers and presented to the consumers in a balanced rotation order, following Williams' design (MacFie & Thomson, 1988). The consumers were provided with 80 mL white plastic cups, each with 30 g of the sample, and plastic spoons. They were instructed to rinse their mouths with water between samples. The yogurts were served at the usual consumption temperature (8 to 10 °C). The lyophilized pineapple cubes in samples LVY + LP and HVY + LP were added just before serving.

2.3.3. Evaluation procedure

All the assessments were carried out in sensory booths, designed in accordance with ISO 8589 (ISO, 2007), under artificial daylight and temperature control (22 °C). Still mineral water was available for rinsing between samples but it was not enforced.

To meet the aim of this study consumers evaluated different aspects of yogurt samples. Each consumer attended one session and for each sample he/she rated first acceptability, then described the characteristics of the sample through a CATA (check all that apply) question,