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Prebiotic gluten-free bread: Sensory profiling and drivers of liking

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ABSTRACT

The wide prevalence of celiac disease and wheat allergy has led to a growing demand for gluten-free foods that present a suitable sensory acceptance. This research aimed to identify the drivers of liking of prebiotic gluten-free breads. A consumer test with 65 celiac people was performed. In addition, the sensory profiling was carried out by 15 trained assessors using quantitative descriptive analysis (QDA). By using QDA, the samples differed significantly in relation to all attributes, and partial least squares (PLS) regression was used to identify the drivers of liking of gluten-free breads. The results show that the most desired sensory properties of such products are apparent softness, traditional bread aroma, sweetness and crumb color. In this context, these attributes can be considered drivers of liking of prebiotic gluten-free breads and they should be taken into consideration by bakery processors at the development of new gluten-free products.

1. Introduction

Celiac disease (CD) is a common condition that may begin in childhood or adult life, in which the absorptive surface of the small intestine is damaged in response to gluten. This condition is characterized by chronic inflammation and atrophy of the intestinal villi, which impair the digestion and absorption processes (Bingley et al., 2004). Recent epidemiological studies have shown that CD is one of the most common lifelong disorders, affecting about 1% of the world population (Catassi & Yachha, 2008). Despite considerable scientific progress in understanding CD and in preventing or curing its manifestations, to date a strict gluten-free diet for life is the only treatment for CD patients (Niewinsky, 2008).

Bread is one of the most consumed products among baked foods (Bakke & Vickers, 2007). The growing demand for high-quality gluten-free bread represents a challenging task in terms of technology and nutrition, due to low quality for baking of gluten-free flour and a lack of fiber, vitamins and nutrients (Hüttner, Dalbello, & Arendt, 2010). Several studies have investigated the substitution of gluten by ingredients able to mimic its functional properties (Bernardi, Sánchez, Freyre, & Osella, 2010; Blanco, Ronda, Pérez, & Pando, 2011; Crockett, Ie, & Vodovotz, 2011; Krupa-Kozak, Troszynska, Baczek, & Soral-Smietana, 2011; Onyango, Mutungi, Unbehend, & Lindhauer, 2011; Sciarini, Ribotta, León, & Pérez, 2008). Alternatively, food companies have also used a diversity of lactic cultures and yeast during its processing (Moroni, Arendt, & Bello, 2011), resulting in a more appreciated flavor of the product.

Prebiotic is a non-viable food component that confers a health benefit on the host associated with modulation of the microbiota (Food and Agriculture Organization, 2007, 11 pp.). The use of prebiotic ingredients may be advantageous due to its nutritional value and the possibility of improving some sensory properties of food formulations, enhancing taste to the products (Wang, 2009). The supplementation of food products with prebiotic ingredients in order to achieve healthier and better sensory characteristics has already been reported for some products, such as petit suisse cheese (Cardarelli, Buriti, Castro, & Saad, 2008), fermented dairy beverages (Castro, Cunha, Barreto, Camboni, & Prudencio, 2008), yogurts (Aryana & McGrew, 2007; Cruz et al., 2013), soy-based desserts (Granato, Bigaski, Castro, & Masson, 2010) and sausage (Mendoza, García, Casas, & Selgas, 2001).

In this context, the identification of the most relevant sensory properties of prebiotic gluten-free breads can facilitate the development and assessment of new bakery products that best interpret the hedonic dimension of this increasing target group of consumers (Pagliarini, Laureati, & Lavelli, 2010). The objective of the present study was to apply the sensory profiling method to six gluten-free bread formulations using the quantitative descriptive analysis

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(QDA). Besides, partial least squares (PLS) regression was performed to assess the correlation between the consumer acceptability data and the results obtained by using QDA.

2. Material and methods

2.1. Material

Bread Samples were produced with rice flour (Salutem, Brazil), potato starch (Yoki, Brazil), cassava starch (Amafil, Brazil), sour tapioca flour (Hikari, Brazil), egg, organic palm oil (Agropalma, Brazil), water, sea salt (Jasmine, Brazil), and dry yeast (Fermipan, Brazil). These ingredients were obtained from local traders in the city of São Paulo, Brazil and were all gluten-free. The sweeteners, sugar, and prebiotics were: raw sugar (Mãe Terra, Brazil); sucralose (Linea sucralose); fructose (Lowçucar); stevia (Stevia Plus); fructooligosaccharides (Nutraflora® P95, Corn Products Brazil); and inulin (Orafti (Beneo)® GR, Clariant Brazil).

2.2. Methods

Formulations and loaves were developed and produced in a functional food industry specialized in gluten-free, dairy-free and sugar-free products, located in São Paulo – SP, Brazil, called "Sabor de Saúde".

2.2.1. Prebiotic gluten-free breads processing

The concentrations of rice flour (25.0 g/100 g), potato starch (6.0 g/100 g), cassava starch (8.0 g/100 g), sour tapioca flour (2.0 g/100 g), egg (17.0 g/100 g), organic palm oil (4.0 g/100 g), sea salt (0.9 g/100 g), and dry yeast (0.8 wt.%) were kept constant. The concentrations of sweeteners and prebiotics varied, and the water was added to make the formulation to 100 g/100 g (Table 1).

The solid ingredients were mixed in a dry pan. The water was heated to 40 °C and added to the liquid ingredients in an industrial planetary mixer (Hobart, Es10 Ecomax) under constant agitation. Subsequently, the mixture of dry ingredients were added to the mixer and mixed for 10 min in a medium speed, until dough formation. Then, the dough was placed in 250 mm × 10 mm × 10 mm forms and rested for 30 min. The electric oven (Forno Turbo 4E, Tedesco, FTT120E) was preheated to 180 °C.

Forms were placed into the oven and baked for 30 min. After being removed from the oven, 10 min were expected and then the loaves were removed from the forms and left about 2 h for the bread cooling. The breads were thus sliced in 1 cm each slice and packaged in plastic vacuum package with about 12–14 slices (approximately 300 g) and stored frozen at freezer until the day of evaluations.

Table 1
Proportion of ingredients in gluten-free bread formulations.

Ingredients	Formulations (g/100 g)					
	F1	F2	F3	F4	F5	F6
Rice flour	25	25	25	25	25	25
Potato starch	6	6	6	6	6	6
Cassava starch	8	8	8	8	8	8
Sour tapioca flour	2	2	2	2	2	2
Egg	17	17	17	17	17	17
Organic palm oil	4	4	4	4	4	4
Sea salt	0.9	0.9	0.9	0.9	0.9	0.9
Dry yeast	0.8	0.8	0.8	0.8	0.8	0.8
Water	35	36.14	35.55	36.05	35.55	35.55
Raw sugar	1.3	–	–	–	–	–
Sucralose	–	0.16	–	–	–	–
Fructose	–	–	0.75	–	–	–
Stévia	–	–	–	0.25	–	–
Frutooligossacarídeos (FOS)	–	–	–	–	0.75	–
Inulin	–	–	–	–	–	0.75

2.2.2. Preparation of the samples

For samples presentation to the assessors, samples were heated in a preheated laboratory ventilated electric oven (Mueller, Questo Branco 44L) at 180 °C for 10 min according to the use information reported on their labels.

2.3. Sensory analyses

Sensory analyses were carried out in individual air-conditioned (22 °C) booths with white light. Water was provided for palate cleansing. Sessions were held at the Laboratory of Sensory Science and Consumer Study of FEA/DEPAN (University of Campinas) and samples (a quarter of a slice of bread including dough and crust) were presented in white disposable plates with 3-digit numbers randomly coded. Approval for the study was obtained from the Ethics Committee of the University of Campinas, and written consent was given by all volunteers.

2.4. Quantitative descriptive analysis

The sensory profiling of all the six gluten-free bread samples was generated by the quantitative descriptive analysis (QDA) according to methodology proposed by Stone and Sidel (2004, 408 pp.). This technique has been adopted to analyze several food products, and its principles and steps are well established (Adhikari, Dooley, Chambers IV, & Blumiratana, 2010; Albenzio et al., 2013; González, Adhikari & Sancho-Madriz, 2011; Granato et al., 2010; Murtaza,.Rehman, Anjum, & Huma, 2013; Volpini-Rapina, Sokei, & Conti-Silva, 2012).

2.4.1. Selection of assessors

A pre-selection of candidates by way the Wald sequential approach (Amerine, Pangborn, & Roessler, 1965, 602 pp.; Meilgaard, Civille & Carr, 1999, 416 pp.) was used to select potential assessors for the quantitative descriptive analysis. Two gluten-free bread samples were prepared and previously tested to obtain a 0.1% significant difference level. Triangle difference tests were applied with 62 celiac consumers using these gluten-free bread samples (Cadena & Bolini, 2012). After the pre-selection, 32 judges were chosen.

2.4.2. Development of descriptive terminology

For the stage of development of descriptive terminology, Kelly's Repertory Grid Method was used (Moskowitz, 1983, 605 pp.). All samples were presented by pair, and the panelists described the same and rough aspects for each pair evaluated in appearance, aroma, flavor, and texture. A total of 21 descriptive terms were defined through panel discussion and redundant terms were excluded by consensus of all judges. Overall, 15 sensory attributes covering appearance, aroma, taste and texture were generated.

2.4.3. Training session

References were determined by a consensus of all the assessors and they were then further trained with respect to the product attributes using identified reference (Table 2). Training for the formation of sensory memory and equalization amongst the assessors was carried out by direct contact of the individuals with the reference of maximum and minimum intensity for each attributes. The panel was trained in six 1 h training sessions, to perform the QDA trials.

Each subject evaluated the six gluten-free bread samples in four replications. Panelists were chosen for participation according to their discriminating capability ($p \leq 0.30$) and repeatability ($p > 0.05$), using the data collected during the training sessions;