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Development of chocolate dairy dessert with addition of prebiotics and replacement of sucrose with different high-intensity sweeteners

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ABSTRACT

The aims of this study were (1) to optimize the formulation of a prebiotic chocolate dairy dessert and assess the extent to which sensory properties were affected by adding different concentrations of prebiotics (inulin and fructooligosaccharides) combined with different levels of xanthan and guar gums, and (2) to analyze the ideal and relative sweetness of prebiotic chocolate milk dessert sweetened with different artificial and natural sweeteners. Acceptability was evaluated by 100 consumers using a 9-cm hedonic scale, and the level of sample creaminess was evaluated using a 9-point just-about-right (JAR) scale. Data were subjected to a multivariate regression analysis and fitted to a model provided by response surface methodology. The optimal concentrations were 7.5% (wt/wt) prebiotic and 0.20% (wt/wt) gum (guar and xanthan, in a 2:1 ratio). The ideal sweetness analysis revealed that the ideal concentration of sucrose was 8.13%. The relative sweetness analysis showed that Neotame (NutraSweet Corp., Chicago, IL) had the highest sweetening power compared with the prebiotic chocolate dairy dessert containing 8% sucrose, followed by sucralose, aspartame, and stevia. The study of sweetness in this product is important because consumers desire healthier functional products with no added sugar.

Key words: just-about-right (JAR) scale, prebiotic, response surface modeling, magnitude estimation, equisweetness

INTRODUCTION

Functional product development provides an opportunity to contribute to the improvement of food quality and consumer health and well-being (Siró et al., 2008). Prebiotic ingredients such as inulin and oligofructose are good examples of this processed food category, being nondigestible fructans of interest in human nutrition because of their ability to stimulate growth or activity of colonic bacteria that benefit the host and to inhibit growth of pathogens and harmful microorganisms (Saad et al., 2013). Addition of prebiotic ingredients to processed dairy foods is a reality (Isik et al., 2011; Arango et al., 2013; Cruz et al., 2013; Pimentel et al., 2013) and has been explored by the food industry.

The just-about-right (**JAR**) scale is an alternative method to acceptance tests that combines assessment of attribute intensity and hedonics by consumers, providing information on how consumers feel about a product and how much a sample deviates from an ideal point (Gacula et al., 2007). When applied together with response surface methodology (**RSM**; De Marchi et al., 2009; Cruz et al., 2010b; Mondragón-Bernal et al., 2010), the JAR scale can be a useful tool for optimizing the sensory quality of foods, as an optimal formulation derived from JAR responses maximizes consumer acceptance in the sense that it is the best possible formulation given a fixed set of ingredients.

When replacing sucrose with sweeteners, it is essential to have a clear understanding of which sweetener and what concentration of sweetener best match the sweetness intensity and characteristics of the equivalent product sweetened with sucrose. To substitute sucrose successfully, it is necessary to know sweetener concentrations that would be used and their sweetness equivalency related to sucrose. One of the most used methodologies to obtain this information is magnitude estimation and graphical presentation of the normalized results using Steven's power function (Cardoso and Bolini. 2007; Moraes and Bolini, 2010; Souza et al., 2011; De Souza et al., 2013; Esmerino et al., 2013).

Dairy desserts are appreciated by consumers and can be formulated with several ingredients as stabilizers. These ingredients interact, resulting in a wide variety of textures, flavors, and appearances (Verbeken et al., 2006), which, in turn, influence the nutritional, physical, and sensory characteristics, with direct effects on consumer acceptability (Arcia et al., 2011) However, to date, these published studies only evaluated the effect

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on the physicochemical and structural characteristics of the products.

In this context, the main aim of this study was to optimize the formulation of a prebiotic chocolate dairy dessert formulated with different concentrations of prebiotics (inulin and fructooligosaccharides) and thickeners (xanthan and guar gum) using JAR responses and RSM, evaluating the extent to which the sensory properties are affected by adding these ingredients. A second aim of this work was to analyze the ideal and relative sweetness of the optimized prebiotic chocolate milk dessert sweetened with different artificial and natural sweeteners.

MATERIALS AND METHODS

Ingredients and Preparation of Chocolate Dairy Dessert

This study was developed in 2 stages. The first stage was to optimize formulation of the chocolate dairy dessert with the addition of prebiotics and gums. The next stage proceeded with the study of the replacement of sucrose by sweeteners.

The samples were produced with prebiotic Biofis Inufos (Siba Ingredientes, São Paulo, SP, Brazil), guar and xanthan gums (SweetMix, Sorocaba, Brazil), commercial skim milk powder (Molico, Nestlé, Araraquara, SP, Brazil), commercial UHT skim milk (Molico, Nestlé), cocoa powder (Garoto, Vila Velha, ES, Brazil), sucrose (União, Tarumã, SP, Brazil), and light cream (Nestlé, Araçatuba, SP, Brazil). Chocolate milk dessert samples were sweetened with different high-intensity sweeteners and sucrose. The sweeteners were Neotame (NutraSweet, Chicago, IL; obtained from SweetMix), sucralose (SweetMix), stevia with 95% rebaudioside (SweetMix), and aspartame (SweetMix).

The solid ingredients were mixed in a dry pan. The UHT skim milk was heated to 40°C and added to the mixture of solid ingredients under constant agitation. Subsequently, the temperature was increased to 90 ± 2°C for 3 min for pasteurization. The temperature was then reduced to 40°C, cream was added, and the mixing continued for another 2 min. The samples were put into plastic cups (40 mL), covered to avoid drying, and stored under refrigeration (4 ± 1°C) until sensory analysis.

Optimization of Chocolate Dairy Dessert Formulation

Nine chocolate milk desserts were formulated (Table 1) with different concentrations of prebiotic (5.0, 7.5, and 10.0% wt/wt) and gum (0.10, 0.20, and 0.30% wt/wt). The concentrations of sucrose (11.0% wt/wt), skim milk powder (10.0% wt/wt), cocoa powder (4.0% wt/wt), and cream (25.0% wt/wt) were kept constant. The UHT skim milk was added to 100% (wt/wt) of formulation. Previous studies determined the level of the ingredients used in this study.

Optimization Design. To determine the optimal concentration of guar and xanthan gums (in a 2:1 ratio) and prebiotics to be used in formulating the dairy dessert, an experiment was conducted using a completely randomized design, as shown in Table 2. The acceptance test was performed with 100 habitual consumers (32 male and 68 female) of dairy desserts, not trained and representative of the target public. An hedonic test was carried out using a continuous 9-cm unstructured line scale with the anchors "dislike extremely" and "like extremely" for the attributes of appearance, aroma, taste, texture, and overall impression. Sensitivity in defining consumer perception is greater with use of line scales than with the 9-point hedonic scale (Greene et al., 2006). In addition, a JAR scale (Desai et al., 2013)

Table 1. Experimental design composed of the variables in coded units and original values for experimental formulations (F) 1 through 9[1]

	Codified levels of the variables		Levels of the original variables	
Experiment	X_1	X_2	G (%)	P (%)
F1	+1	−1	0.30	5.00
F2	0	−1	0.20	5.00
F3	−1	−1	0.10	5.00
F4	+1	0	0.30	7.50
F5	0	0	0.20	7.50
F6	−1	0	0.10	7.50
F7	+1	+1	0.30	10.00
F8	0	+1	0.20	10.00
F9	−1	+1	0.10	10.00

[1]Where X_1 = codified level of gum; X_2 = codified level of prebiotic; G = gum content (%); and P = prebiotic content (%).