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Optical, mechanical and sensory properties of based-isomaltulose gummy confections

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ABSTRACT

The replacement of traditional sugars by isomaltulose could be a revolution in the confectionery sector, since isomaltulose is a functional, digestible, non-cariogenic and low glycemic disaccharide. This study assesses the addition of isomaltulose (ranging between 30 and 70% in combination with fructose) with different percentages of gelatine (6–10%) in gummy confection by analysing its effect on composition, water activity (a_w), pH, mechanical and optical properties, and sensory perception. Results show that the combination of 30% isomaltulose and 70% fructose in the total amount of sugars would be suitable for developing functional gummy confections. Besides its stability (a_w (0.79 ± 0.02) and °Brix (73.5 ± 1.3)) and great similarity to commercial gummies in terms of optical and mechanical properties, it received high global acceptability and intention of buying scores. Additionally, the correlation between instrumental and sensory parameters leads to the conclusion that the instrumental texture could be suitable for evaluating consumer's global acceptability for this innovative product.

1. Introduction

Confectionery products are not exactly foods, but they are widely consumed by children and adults. According to the Spanish association of confectionary products, more than 50% of adults regularly consume candies and chewing gums (Martínez, 2012). Confectionery is a lucrative and continuously growing market in Europe. Between 2005 and 2009 the whole category of confectionery products increased by 19% and it is expected it to grow by 16% through 2014 (Moloughney, 2011). The growth in the consumption of confectionery products is related to the pleasurable effects and wellness they are capable of providing us when consumed in moderate quantities. In fact, O'Neil, Fulgoni, & Nicklas (2011) reported a lower body fat index and precursors for type 2 diabetes development in subjects who consumed a moderate amount of confectionaries compared to those who do not eat these products. Nevertheless, excessive consumption has been associated with a high incidence of some health diseases such as obesity, tooth decay and hyperglycaemia. Despite the positive effects of their consumption in moderation, the overconsumption of confectionery products by children continues to concern parents.

Among confectionery products, gummy confection is second in sales (Moloughney, 2011). Therefore, there is continual consumer demand for more exciting textures, flavours and appearances in gummy confections. In addition, consumer demand is turning away from traditional products to low-sugar or healthier products. Traditional gummy confection consists of high amounts of sucrose and glucose syrup

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combined with a gelling agent, commonly known as gelatine, along with acids, flavourings and colourings (Marfil, Anhê, & Telis, 2012). The replacement of sucrose and glucose syrup with healthier natural sugars could lead to the production of added value gummy confections. In this context, isomaltulose has been pointed out as a suitable sucrose replacer in most food and beverages (Lina, Jonker, & Kozianowski, 2002). Isomaltulose is a reducing sugar occurring naturally, in little quantity, in honey, sugar cane juice and some molasses (Bárez et al., 2000). Commercial isomaltulose, also known as Palatinose®, is obtained from sucrose by enzymatic rearrangement of the glycosidic linkage from a (1,2)-fructoside to a (1,6)-fructoside followed by crystallization (Schiweck, Munir, Rapp, Schenider, & Bogel, 1990). Isomaltulose is characterized as having a profile of colour, texture and taste which is similar to sucrose (regular sugar) although there are some differences. It has only half the sweetening power of sucrose and its solubility is only 30% at 25 °C (Kaga & Mizutani, 1985; Schiweck et al., 1990). In terms of health, the linkage (1,6)-fructoside is hardly hydrolysed by enzymes produced by oral bacteria, therefore isomaltulose preserves dental health due to prevention of tooth decay (Matsuyama, Sato, & Hoshino 1997). It is also considered suitable for the formulation of foods for athletes and diabetics because of its low-glycemic and low-insulinemic indexes (Kawai, Yoshikawa, Murayam, Okuda, & Yamashita, 1989; Lina et al., 2002), since it provides the same amount of energy as common sugar, but for a significantly longer period. Unlike artificial sweeteners such as sodium cyclamate, saccharin, aspartame, polyols (sorbitol), isomaltulose has not laxative effect. In fact, only bifidobacteria, no enterobacteria, are able to ferment isomaltulose, which limits the growth of microorganisms of putrefaction to cause diarrhoea (Weidenhagen & Lorenz, 1957a, 1957b).

As mentioned before, the main technological handicap for the successful replacement of sucrose and glucose syrup with isomaltulose in gummy confections could be its lower solubility and sweetening power than common sugar. Therefore, the mixture of isomaltulose with other natural healthier sugar, such as fructose (common sugar in the formulation of sweet foods) could be an alternative, which solves these problems. Fructose is one of the sugars found in plants, fruits and especially in honey. Industrially, the hydrolysis of sugar cane leads to an equal amount of glucose and fructose. The most important properties of this sugar are its sweetening power, which is nearly twice that of sucrose, and its high hygroscopicity (ideal for syrups) and insulin-independent metabolism, which has led it to become the quintessential substitute for sucrose. Although recent studies have refuted this property since they show that fructose is ultimately metabolized as glucose, and is therefore not recommended for diabetics (Elliot et al., 2002), fructose is safe for healthy individuals as long as it is consumed in moderate quantities (Mann et al., 2004).

Any substitution of one ingredient by another, or by a combination of ingredients, can affect the physical and chemical properties of the food matrix, and therefore sensory acceptability. In this context, the aim of this study was to evaluate the possible replacement of sucrose and glucose syrup with isomaltulose and fructose, by analysing their effect on physicochemical, textural and optical properties in different gummy confection formulations. Additionally, a sensory acceptance study was carried out and a correlation between instrumental measures and sensory attributes was made for the formulation, which most resembled (from the point of view of instrumental parameters) commercial gummy confections.

2. Materials and methods

2.1. Materials

Isomaltulose (Beneo-Palatinit; Germany), sucrose (Azucarera Ebro S.L.; Spain), fructose (Gabot Biochemical Industries; Israel), glucose syrup 43 DE (Emilio Peña, S.A., Spain), corn starch (Roquette, France), gelatine A 220 Bloom (Junca Gelatines S.L.; Spain), strawberry flavouring (Flavorix Aromáticos S.A.; Spain), natural red liquid colour (Roha Europe S.L.; Spain) and sunflower oil (Koipesol, Spain) were used as ingredients in the formulation of gummy confections.

2.2. Experimental procedure

The gummy confections prepared consisted of 6–10% of gelatine, 40% of water and 50–54% of sugars as recommended for gummy confections (Edwards, 2002). Also, 0.2 ppm of red colouring and 0.5 ppm of strawberry flavouring were added in all cases. Six different mixtures of sugars were studied. The control sample (code: S) was prepared with 40% of sucrose and 60% of glucose syrup (40:60 (w/w)) of the total sugar content. Other samples were obtained combining different sugars (isomaltulose, glucose syrup or fructose). In order to simplify the description of each sample, the percentage of the total amount of sugars replaced is shown between brackets along with the code used: isomaltulose:glucose syrup (40:60, w/w), (code: I), fructose:glucose syrup (40:60, w/w) (code: F); isomaltulose:fructose (30:70, w/w) (code: I30) and isomaltulose:fructose (50:50, w/w) (code: I50). In this study, the gelatine percentage (6, 8 or 10%) was always shown next to these codes. In addition to the control sample, a total of 14 different formulations were studied.

A thermal blender (Thermomix, TM31, Vorwerk, Germany) was used to blend the sugars and water until they reached boiling temperature at 300 rpm for 10 min. This mixture was shaken until reaching 60 °C following which pH and °Brix were measured. The gelatine was then dissolved in water in a gelling agent: water ratio of 1:2 (w/w) to obtain a homogeneous mix and subsequently added to the syrup with the flavouring and colouring agents. All the ingredients were blended for 5 min at 60 °C and 300 rpm. The final mixture was poured into silicone moulds with a thin layer of sunflower oil. The silicone moulds have cylindrical shape with a diameter of 28 mm and a height of 20 mm. Then, the moulds were placed in a chamber at 20 °C for 24 h. The samples were removed from their mould and analyses of texture, colour, water activity and moisture performed.

2.3. Analytical determinations

2.3.1. Physicochemical analyses

Soluble solid content (°Brix) (measured with a refractometer at 20 °C, ATAGO 3 T), and pH (by a pH-meter, SevenEasy,