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Frozen yogurt with added inulin and isomalt

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ABSTRACT

The objective of this study was to produce a frozen yogurt containing low fat and no added sugar. Samples containing 5% polydextrose, 0.065% aspartame and acesulfame-K mixture, and different levels of inulin and isomalt (5.0, 6.5, and 8.0%) were produced at pilot scale and analyzed for their physical and chemical properties including proximate composition, viscosity, acidity, overrun, melting rate, heat shock stability, as well as sensory characteristics, and viability of lactic acid bacteria. With the addition of inulin and isomalt, viscosity increased by 19 to 52% compared with that of sample B (reduced-fat control). The average calorie values of samples substituted with sweeteners were about 43% lower than that of original sample. Low-calorie frozen yogurt samples melted about 33 to 48% slower than the reduced-fat control sample at 45 min. Based on quantitative descriptive profile test results, statistically significant differences among products were observed for hardness, iciness, foamy melting, whey separation, and sweetness characteristics. The results of principal component analysis showed that the sensory properties of the sample containing 6.5% inulin and 6.5% isomalt were similar to those of control. Lactic acid bacteria counts of frozen yogurt were found to be between 8.12 and 8.49 log values, 3 mo after the production. The overall results showed that it is possible to produce an attractive frozen yogurt product with the incorporation of inulin and isomalt with no added sugar and reduced fat.

Key words: frozen yogurt, inulin, isomalt

INTRODUCTION

Frozen yogurt as also known as yogurt ice cream, characterized by the acidic taste of yogurt and the cooling effect of ice cream (Tamime and Robinson, 1999), is a dairy product produced with *Streptococcus thermophilus* or *Lactobacillus delbrueckii* spp. *bulgaricus* (Hui, 1992; Marshall et al., 2003). Survival of yogurt cultures in frozen yogurt has great importance for the therapeutic image of the product, as yogurt has been a healthful product with high biological value (Tamime and Robinson 1999) and probable benefits, which are improvement of the immune system by destruction of bacterial cells, lactose digestion, regularity of intestinal flora, detoxification of harmful products, reduction of carcinogenic end products, and suppressing the multiplication of food-sourced pathogens (Hui, 1993). In addition, frozen yogurt is expected to present acceptable quality of flavor, body, texture, cooling effect, viscosity, whipping ability, and freezing properties of dairy frozen desserts (Chandan, 1997).

Several researchers focused on producing functional frozen yogurt or yogurt ice cream containing stabilizers (Martinou-Voulasiki and Zerfiridis, 1990), inulin (El-Nagar et al., 2002), fat-replacers (Kaur et al., 2007; Aykan et al., 2008), or different hydrocolloids (Soukoulis and Tzia, 2008), and several others investigated the characteristics of these products (Inoue et al., 1998; Zhenjian and Haili, 2003; Özdemir et al., 2005; Singh et al., 2006; Guner et al., 2007). However, limited information is available on the properties of functional frozen yogurt having fat and sugar replacements.

To produce a low-calorie frozen yogurt, inulin and sugar alcohols deserve particular attention. Inulin, a soluble dietary fiber, can be used to improve the quality of the product with nutritional and technological advantages (Franck, 1998; Rowan, 1998). Addition of inulin in low-fat frozen yogurt formulation (El-Nagar et al., 2002) or using inulin as a corn syrup replacer in reduced-fat ice cream (Schaller-Povolny and Smith, 1999, 2001, 2002) are good examples of its application in frozen desserts. On the other hand, sugar alcohols, such as isomalt, are used as sugar replacers in frozen desserts (Marshall and Goff, 2003) for their low glycemic index (Macrae et al., 1993) and low caloric value (McNutt and Sentko, 1996).

The objective of this study was to produce a low-calorie frozen yogurt containing reduced fat and no added sugar, which were replaced with inulin, isomalt, polydextrose, and intensive sweeteners, and having acceptable rheological and sensory attributes.

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Table 1. Frozen yogurt formulations[1]

Sample	Description	Inulin (%)	Isomalt (%)
A	Control (with sugar and whole fat)	—	—
B	Control (with sugar and reduced fat)	—	—
C	No sugar and reduced fat	8.0	5.0
D	No sugar and reduced fat	6.5	6.5
E	No sugar and reduced fat	5.0	8.0

[1]Each formulation was replicated twice. The total solids amount was 35.13% (6% fat) in sample A and 32.13% (3% fat) in the rest of the samples. Sugar (18%) in samples A and B was replaced 100% by inulin + isomalt + polydextrose (wt/wt) in samples C, D, and E, which also contained 5% polydextrose and 0.065% aspartame/acesulfame-K mixture (at a proportion of 70:30).

MATERIALS AND METHODS

Ingredients

Food additives were polydextrose (Litesse-Ultra, Danisco Sweeteners, Copenhagen, Denmark), inulin (Raftiline GR, Dora Company, Istanbul, Turkey), and isomalt (Palatinit ST-PF, Kurmed Company Ltd., Istanbul, Turkey). Starter cultures (MYE-96), yogurt and thermophilic culture development medium (Thermo W1) were obtained from the Maysa Company, Istanbul, Turkey. All of the production trials were carried out at pilot scale in a commercial ice cream manufacturing plant in Turkey.

Experimental Design

Before starting to produce different formulations of frozen yogurt samples (5 different formulations as described in Table 1), the optimum pH value of the product (control sample formulation, sample A in Table 1) was evaluated by conducting a consumer preference and acceptance test (Meilgaard et al., 2007). Forty kilograms of samples having 2 different pH values (pH 4.8 and 5.2) were produced and evaluated by 88 panelists using a simple comparison sensory test. In the test, one sample pair was provided for each panelist by balancing the presentation of samples and then the panelists were asked for their preference, degree of liking, and purchase intent for the preferred sample. The degree of liking was evaluated on a category scale composed of 7 scores: 1 (extremely dislike), 2 (dislike), 3 (slightly dislike), 4 (neither like nor dislike), 5 (lightly like), 6 (like), and 7 (extremely like). In addition, the panelists were asked to evaluate their purchase intent on a category scale composed of 5 points: 1 (definitely will not buy), 2 (probably will not buy), 3 (not sure), 4 (will probably buy), and 5 (will definitely buy).

Based on the preference of the panelists, the pH value of the samples was determined, and 5 new formulations were prepared using 40-kg batches (Table 1). These samples were further analyzed for their composition, viscosity, melting rate, sensory characteristics, and lactic acid bacteria (**LAB**) count.

Frozen Yogurt Production

Ingredients were weighed to obtain a 40-kg mixture for each batch of production. The formula of frozen yogurt samples used in the study was designed according to the original recipes of a commercial ice cream manufacturing plant in Turkey (Algida, Unilever Inc., Tekirdağ). Nonfat milk solids (10.5%), sweetening agents (sugar or inulin + isomalt + polydextrose + aspartame + acesulfame-K, Raftiline GR, Dora Company; Palatinit St-PF, Kurmed Company Ltd.; Litesse-Ultra, Danisco Sweeteners), and stabilizer mixture (0.1% locust bean gum + 0.1% guar gum + 0.1% carboxymethylcellulose + 0.03% carrageenan + 0.3% emulsifier; Algida, Unilever Inc.) were incorporated with cream and water in a mixing tank. Then, the mixture was heated at 85°C for 10 min and homogenized under a pressure of 190 bar. The mixture was cooled down to 44°C and transferred into a sterile container (approximately 37-kg mix). Following the inoculation of 5% starter culture, the mixture was incubated at 40°C until a pH value of 5.2 was reached. The samples with a pH of 4.8 used for the consumer preference and acceptance test were also produced in the same manner. The cultured mixture was placed in a resting tank and cooled down to 5°C while stirring. Vanilla flavor (0.1%; oil-soluble, nature-identical flavor, Aromsa Food Flavor and Additives Co., Inc., Istanbul, Turkey) was added at this stage, and cultured mixture was pumped into the ice cream freezer (Hoyer freezer MF50, APV Technohoy, Axel Kiers Vej 28–30, Aarhus-Højbjerg, Denmark) where the temperature of the samples reached −6°C. The samples were then packed into 1-, 2-, and 5-L plastic cups and placed in a freezer at −23°C. The samples were then transferred from Algida, Unilever Inc., to the laboratories of Istanbul Technical University (Turkey) and stored at −18°C until analysis.