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Physicochemical, bioactive, and sensory properties of persimmon-based ice cream: Technique for order preference by similarity to ideal solution to determine optimum concentration

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ABSTRACT

In the present study, persimmon puree was incorporated into the ice cream mix at different concentrations (8, 16, 24, 32, and 40%) and some physicochemical (dry matter, ash, protein, pH, sugar, fat, mineral, color, and viscosity), textural (hardness, stickiness, and work of penetration), bioactive (antiradical activity and total phenolic content), and sensory properties of samples were investigated. The technique for order preference by similarity to ideal solution approach was used for the determination of optimum persimmon puree concentration based on the sensory and bioactive characteristics of final products. Increase in persimmon puree resulted in a decrease in the dry matter, ash, fat, protein contents, and viscosity of ice cream mix. Glucose, fructose, sucrose, and lactose were determined to be major sugars in the ice cream samples including persimmon and increase in persimmon puree concentration increased the fructose and glucose content. Better melting properties and textural characteristics were observed for the samples with the addition of persimmon. Magnesium, K, and Ca were determined to be major minerals in the samples and only K concentration increased with the increase in persimmon content. Bioactive properties of ice cream samples improved and, in general, acetone-water extracts showed higher bioactivity compared with ones obtained using methanol-water extracts. The technique for order preference by similarity to ideal solution approach showed that the most preferred sample was the ice cream containing 24% persimmon puree.
Key words: persimmon, ice cream, bioactivity, technique for order preference by similarity to ideal solution

INTRODUCTION

Ice cream, a sweet dairy product including milk, sweeteners, stabilizers, emulsifiers, and flavorings, is produced by mixing its ingredients, followed by pasteurization and homogenization. Afterward, it is aged at low temperature and finally frozen (Frøst et al., 2005; Karaman and Kayacier, 2012). Ice cream is commonly enjoyed by people of all ages due to its cooling effect and the nutritive value of ice cream is high, as it is a milk-based dessert. Development of new ice cream formulations that are highly enjoyed by consumers is one of the driving forces of ice cream manufacturers. Many kinds of ice cream formulations exist in the market, but new formulations are also required to enlarge the market proportion (Karaman and Kayacier, 2012). Many studies are present in the literature about development of new ice cream formulations (Dervisoglu, 2006; Dervisoglu and Yazici, 2006; Favaro-Trindade et al., 2007; Erkaya et al., 2012; Karaman and Kayacier, 2012).

Fruits are good sources for the fortification of ice creams because of their sweet and desired taste and aroma. Persimmon is a fruit widespread in China, Japan, and Korea and is also traditionally used for medicinal purposes (George and Redpath, 2008; Ferrini and Pennati, 2008; Luo and Wang, 2008). China is ranked first in the production of persimmons in the world, with 1,655,000 t of annual production (Liu et al., 2007), whereas Turkey produces about 20,000 t annually (Ercisli and Akbulut, 2009). It is a popular and widespread fruit because it is a good source of antioxidants, carotenoids, and polyphenols (George and Redpath, 2008). Some scientists have reported that the persimmon is one of the richest fruits containing bioactive components (Daood et al., 1992; Gorinstein et al., 1998). The antioxidant activity of persimmon is reported by many researchers in the literature (Jung et al., 2005; Lee et al., 2008; Fukai et al., 2009; Jang et al., 2010; Veberic et al., 2010; Karaman et al., 2013). The persimmon is consumed in Europe as a fresh fruit because of its positive health effects. The shelf life of

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the matured fruit is rather short (less than 4 wk) and mature fruits should be consumed in a short time after harvesting because of easy deterioration of the fruit. The fruit, even in convenient storage conditions, has a limited shelf life compared with other fruits. Therefore, after harvesting, a significant amount of mature persimmons should be handled and processed into certain products to preserve the fruit's bioactive components. One possible process might be incorporation of persimmon fruit into ice cream. It is possible to improve the nutritional, physicochemical, and textural properties of ice cream in this way.

In the present study, the goal was to improve the quality of ice cream by incorporating different concentrations of persimmon puree into the ice cream. At this point, selection of the optimum persimmon concentration is a difficult task based on 2 selected properties (sensory score and bioactivity), as one sample might display superior bioactivity, whereas the other sample might be the choice because of sensory properties. In these specific conditions, and similar circumstances, the technique for order preference by similarity to ideal solution (**TOPSIS**) might be applied to ease the comparison of the samples based on the results. The TOPSIS is one of the multi-criteria decision-making techniques that provides a decision hierarchy and requires pairwise comparison between criteria (Ballı and Korukoğlu, 2009). Multi-criteria decision making determines the best option among all of the alternatives in the presence of multiple decision criteria (Işıklar and Büyüközkan, 2007). According to the TOPSIS, the alternative that is nearest to the positive ideal solution and farthest from the negative ideal solution is the best alternative (Benítez et al., 2007; Lin et al., 2008). Although the utilization of multi-criteria decision-making techniques has been reported in different areas, to the best of our knowledge, only 1 study (Gurmeric et al., 2013) about this subject in the field of food science exists in the literature.

In the present study, the effect of persimmon puree addition on some physicochemical, textural, sensory, and bioactive properties of ice cream was investigated, and the TOPSIS multi-decision criteria were used for the determination of optimum persimmon puree concentration based on sensory and bioactive properties.

MATERIALS AND METHODS

Materials

Ultra-high temperature-treated milk (Dost; AkGida Co., Sakarya, Turkey) was purchased from a local market in Kayseri, Turkey. Cream (35% milk fat) was obtained from Pinar Dairy Co. (İzmir, Turkey). Stabilizer (salep) and emulsifier (mono- and diglyceride) were provided by Özselamoğlu Food Ing. Co. (Kayseri, Turkey). Table sugar (Panküpü Co., Kayseri, Turkey) was used to sweeten the ice creams. Fresh persimmons were purchased from a local market in Kayseri, Turkey.

Ice Cream Production

Ice cream samples were manufactured according to the process flowchart given in Figure 1. First, milk was heated to 50°C and skim milk powder was added to increase the DM content of the ice cream mix. Cream and table sugar were incorporated at 60 and 70°C, respectively. After addition of the emulsifier and stabilizers, the ice cream mix was pasteurized at 85°C for 5 min and then rapidly cooled to 50°C. At this stage, persimmon puree was obtained by homogenization of fresh persimmons using a Waring blender (Waring Commercial Blender; Waring Products Inc., Torrington, CT). Persimmon puree was added to the ice cream mix at 5 different concentrations: 8, 16, 24, 32, and 40% (wt/wt). The ice cream mixes enriched with persimmon puree were aged at 4°C for 24 h. After the aging process, the samples were frozen using an ice cream maker (Simac II Gelataio GC 6000; Simac, Treviso, Italy), rapidly hardened at −24°C, and stored until the physicochemical, bioactivity, and sensory analyses.

Physicochemical Analysis

Dry matter, ash, and fat analyses were conducted as outlined by official procedures (AOAC International, 2000). Protein content of the samples was determined according to the Dumas method using an automatic nitrogen analyzer (FP 528 LECO, ABD; Leco Corp., St. Joseph, MI). The pH values of samples were determined using a pH meter (inoLab Level 3 Terminal; WTW GmbH, Weilheim, Germany). Viscosity values were measured using an automatic vibrated viscometer (Vibro Viscometer SV-10; A&D Co. Ltd., Tokyo, Japan). The color values of samples were measured using a colorimeter (Lovibond RT Series Reflectance Tintometer; The Tintometer Ltd., Amesbury, UK); L* defines the lightness and a* and b* define the red-greenness and blue-yellowness, respectively. The melting ratio and complete melting time were determined according to the procedure described by Güven and Karaca (2002). A 25-g sample was subjected to melting at a constant temperature (25°C). The melting ratio after 30 min was recorded, and the complete melting time (s) was determined.

Major Sugar Composition of Ice Creams

An HPLC system (Agilent 1100 Series; Agilent Technologies Inc., Santa Clara, CA) equipped with a