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Fruit juice drink production containing hydrolyzed collagen

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ABSTRACT

Fruit juice drinks containing hydrolyzed collagen were formulated and produced as a new functional drink from orange, apple and white grape juice blends containing ingredients such as hydrolyzed fish collagen, citric acid, ascorbic acid, and natural mint flavour. Difference and preference sensory tests were conducted to select the most preferred formulation containing an addition of 1–3% hydrolyzed collagen. The results indicate that the formulation with the addition of 2.5% hydrolyzed collagen was significantly preferred. Drinks at pH 3.96–4.04 were pasteurized at 95 °C until reaching P value necessary for 3D decimal reduction of *Alicyclobacillus acidoterrestris*. Addition of hydrolyzed collagen increased the protein content of the drinks from 0.56 to 2.22–2.48 g/100 mL. The *in vitro* bioavailability results indicated that the orange (95.37%) and apple (90.71%) drinks showed a higher bioavailability (5–14%) than the white grape juice blends. The ascorbic acid content (81.39–113.5 mg/100 mL), total phenolic content (86.93–117.43 mg GAE/100 mL), and antioxidant capacity ABTS assay results (104–127 μmol TEAC/100 mL) varied widely in the drinks.

1. Introduction

Functional food sales in the world's key markets are in the areas of health such as: cardiovascular, gut and bone diseases as well as anti-ageing. The global functional food market holds a strong position worldwide to quote some examples, 38.4% of the Japanese, 31.1% of the USA, and 28.9% of the European markets in 2010. The functional beverages sector accounts for approximately 12.5% of the world market (Anon, 2011). Fruit juice products are suitable for functional food production due to their nutritive and technological properties. Hence, new ingredients having functional properties are of interest for the development of novel functional beverages. One of the remarkable ingredients of the food industry is hydrolyzed collagen which contains 8 out of 9 essential amino-acids and glycine, and the proline concentration is nearly 20 times higher than other protein-rich foodstuffs (Anon, 2009). In humans and animals, 25% of their body protein is in the form of collagen. Due to the decrease of collagen synthesis in the body, its demand for the skin, hair, and bone tissues increases with ageing (Iwai et al., 2005). Some clinical studies reported that 10 g daily oral intake of hydrolyzed collagen decreased joint pain (Moskowitz, 2000; Ruiz-Benito et al., 2009), reduced the skin wrinkles (Tanaka, Koyama, & Nomura, 2009), and improved skin properties (Matsumoto, Ohara, Ito, Nakamura, & Takahashi, 2006). Other studies have suggested that a hydrolyzed collagen enriched diet can improve bone collagen metabolism (Guillerminet et al., 2010; Koyama et al., 2001), reduce pain in patients with osteoarthritis of knee or hip when the blood concentration of hydroxyproline increases (Moskowitz, 2000), and also prevent osteoporosis (Bonjour, 2005). Oesser, Adam, Babel, and Seifert (1999) determined the high bioavailability of collagen where the distribution of labelled

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amino acids in skin was confirmed, and 58% of the peak value of the labelled amino acids remained 192 h after oral administration in mice.

Hydrolyzed collagen is obtained by hydrolyzing gelatin with an enzyme or an acid and is commercially available with molecular weights from 500 up to 20,000 Da. Understanding the properties of hydrolyzed collagen and the concomitant food type is very important for innovated products. As a food ingredient, usage of low molecular weight (2000–5000 Da) hydrolyzed collagen is preferred as it prevents precipitation and turbidity problem in food drinks (Moskowitz, 2000). Collagen can react with acidic polysaccharides and tannins, which decrease sensory quality of the products, and therefore, high polyphenolic content foods are not suitable for production of functional food with hydrolyzed collagen. In food legislations, there is no restriction for the amount of collagen usage in foods. However, 2 to 30% hydrolyzed collagen addition to liquid foods is proposed in view of its positive effects. In addition, a hydrolyzed collagen concentration higher than 30% can cause a viscosity increase in beverages which in turn can have an important effect on the processing line and product quality (Takemori, Yasuda, Mitsui, & Shimizu, 2007). Based on all the properties discussed above, beverages can be satisfactorily formulated with hydrolyzed collagen to improve their functional and nutritional properties.

Functional drinks, in liquid form, are mostly produced by the cosmetic industry for the improvement of moisture-retaining properties of the skin and wrinkles prevention by boosting collagen levels. Collagen drinks, originating from Asian countries such as Japan and China as well as from the USA (Lotte collagen, Colla-plus, Meiji and Shiseido, among others) are sold as a liquid beauty elixir. In addition to these liquid products, a DXN Cobeauté Collagen Powder Drink (DXN Marketing Sdn. Bhd., Selangor, Malaysia) is also available in a premixed powder form, which is a unique product that is formulated from hydrolyzed collagen and natural orange juice but also sold as a supplementary beauty drink. However, although the absorption of specific amino acids from hydrolyzed collagen has been studied clinically in different matrices (Moskowitz, 2000; Ohara, Ito, Iida, & Matsumoto, 2009; Tanaka et al., 2009; Walrand, Chiotelli, Noirt, Mwewa, & Lassel, 2008), fruit juice drink product of hydrolyzed collagen was not studied or published in the food literature. Therefore, hydrolyzed collagen addition to the natural fruit juice without sugar and preservatives can be a new innovative approach for the production of healthy and functional new drink where perceived natural character will be an important factor (Siegrist, 2008). In the nutritionally adequate and well-balanced diets, collagen need is mostly provided as a result of eating fish, meat and offal. However, when normal diet do not provide sufficient collagen to meet the nutritional requirements of an individual, functional foods with hydrolyzed collagen can be consumed as part of the normal diet to satisfy the need. Our aim was to develop a food product which contains hydrolyzed collagen and sustain the daily necessary intake of collagen within the functional fruit juice drinks which can be easily and freshly consumed. Our formulation is based on 100% fruit juices and the production was done according to the fruit juice industry process. Therefore, this will be a unique market sold as a fruit juice drink but with potential health-promoting properties.

The aim of this study was to investigate the development of natural fruit juice-based drinks containing hydrolyzed collagen namely collagen juice drink (CJD); added citric acid, ascorbic acid and natural mint were added for improved flavour. The other objectives are to determine the temperature-time data for pasteurization of the functional drink as well as to examine the *in vitro* bioavailability of hydrolyzed collagen in CJD.

2. Materials and methods

2.1. Materials

The hydrolyzed collagen (Peptan™, F/2000 Da) enzymatically derived from fish was provided by Rousselot (2011) SAS, a Vion Company (Puteaux, France). The following were purchased from local markets: ascorbic acid (99% purity, Applichem), the natural mint flavour (Aromsa Besin Aroma ve Katkı Maddeleri San. ve Tic. A.Ş., Gebze-Kocaeli, Turkey), the citric acid (Merck KGaA, Darmstadt, Germany), orange and apple juice (Dimes Gıda San. ve Tic. A.Ş., Tokat, Turkey), and white grape juice from Kavaklıdere Şarapları A.Ş. Ankara, Turkey. Juices were filled into glass jars having 190 mL volume with a 90.7 mm height.

2.2. Methods

The formulation, production, and pasteurization of the CJD were carried out at the Ege University, Food Engineering Department Pilot Plant.

2.2.1. Formulation and Production

Four different CJDs were formulated as orange, orange-white grape, apple and apple-white grape drinks from 100% fruit juices. The final °Brix values of the CJD were adjusted to 10.4–13.5 by addition of ingredients according to the water to fruit juice proportions considering the limits in the regulation of Turkish Food Codex for fruit drinks without alcohol (NO: 2007/26) which is in accordance with Directive 2012/12/EU of The European Parliament and of The Council. Citric acid (0.1–0.2%) was added to the drinks for acidification and taste improvement. Due to its antioxidant properties, 0.1% of ascorbic acid was added into the CJD where the limit for addition is considered as a GRAS in the Turkish Food Codex regulation on food additives which is drafted in accordance with Regulation (EC) No 1333/2008 of the European Parliament and of the Council on food additives.

Natural mint flavour (0.02–0.03%) was added to the CJD to mask collagen taste and odour due to its fish origin as suggested by the flavour producing company "Aromsa Besin Aroma & Katkı Maddeleri San. & Tic. A.Ş., Gebze-Kocaeli, Turkey".

In pre-trials, five different concentrations of hydrolyzed collagen were added (1, 1.5, 2, 2.5 and 3%) to the CJD due to the amount that allows the physiological and/or pharmacological effects to be exerted. In case of a liquid food such as beverages, the intake level preferably ranges from 1 to 10% by weight (Matsumoto, Ohara, Nakajima, Sugihara, & Takasaki, 2010). Sensory difference and preference tests were conducted to select the most preferred formulations and percent of hydrolyzed collagen for each product series.