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Evaluation of physicochemical properties of foam mat dried sour cherry powder

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ABSTRACT

In this study, the effects of egg white (1, 2 and 3 g/100 g) and methylcellulose (1, 1.5 and 2 g/100 g) were investigated on the density and drainage volume of sour cherry foam. Then, foamed sour cherry juice was spread on aluminum trays (3.0 ± 0.02 mm thickness) and put in drying chamber with the air temperature of 50, 65 and 80 °C. Physicochemical properties such as solubility, total anthocyanin content (TAC), pH, browning index, acidity and drying time of foam mat dried sour cherry powder were evaluated. As the concentration of methylcellulose increased, drainage volume, foam density, TAC, browning index and drying time were reduced; however solubility and pH of the samples had an increasing trend. Almost all chemical properties (except for pH) indicated a decreasing trend with the rise in egg white levels. Furthermore, it was observed that at the drying temperature of 65 °C, sour cherry powder had the maximum solubility, TAC and pH. Browning index and drying time decreased by increasing the drying temperature. Only the effect of drying temperature on acidity was significant in a way that by the increase of drying temperature, total acidity increased.

1. Introduction

Sour cherry (*Prunus cerasus* L.) is a member of the *Rosaceae* family and subfamily of *Prunoideae*. Sour cherry has a great nutritional value because of the high content of vitamins, fibers and polyphenolids (anthocyanins and other flavonoids), as well as alkaloids and melatonin (Jia, Baogang, Xiaoyuan, & Yongqing, 2012). It is mainly used for processing purposes such as production of juice, wine and jam (Petersen & Poll, 1999). Dehydration is the most commonly used technique for increasing the shelf-life of fruits and opens perspectives for the use of these products in different food formulations.

Foam mat drying is a process in which liquid or semi-liquid food is whipped to a stable form of foam by incorporating a large volume of gasses (mostly air) in the presence of a foaming agent and then subsequently dried. Therefore, it is necessary to add foaming agents and foam stabilizers to induce foaming and enhance the stability of the foams once formed, respectively (Bates, 1964; Sankat & Castaigne, 2004). The foam is then extruded onto a perforated tray and dried by several methods such as hot-air (the common method), vacuum, microwave and freeze-drying techniques until the moisture content of the product is reduced to a certain level (Muthukumaran, Ratti, & Raghavan, 2008; Thuwapanichayanan, Prachayawarakorn, & Soponronnarit, 2008; Zheng, Liu, & Zhou, 2011). The advantages of this process are as follows: being relatively simple and inexpensive process, rapid drying rates at lower temperatures, the produced powder is capable of instant rehydration in cold water and enhanced product quality, etc (Falade, Adeyanju, & Uzo-Peters, 2003; Kadam & Balasubramanian, 2011; Kadam, Wilson, & Kaur, 2010).

As foam mat drying involves heat treatment, so there must be some effect on the physicochemical characteristics of sour cherry powder. Similar foam mat drying studies were reported for soymilk (Akintoye & Oguntunde, 1991), starfruit (Karim & Wai, 1999), cowpea (Falade et al., 2003), mango (Kadam et al., 2010), apple juice (Raharitsifa, Genovese, & Ratti, 2006), tomato juice (Kadam & Balasubramanuan, 2011), mandarin (Kadam et al., 2011), banana (Thuwapanichayanan, Prachayawarakorn, & Soponronnarit, 2012) and shrimp (Azizpour, Mohebbi, Haddad Khodaparast, & Varidi, 2014).

Aim of this study was to evaluate the effect of different drying temperatures, foaming agent (egg white) and foam stabilizer (Methyl cellulose) on the physicochemical quality of the foam mat

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dried sour cherry powder.

2. Materials and methods

2.1. Materials

Concentrate of sour cherry (65 °Brix) without additives were purchased from the Shahd Company (Mashhad, Iran.). Methyl cellulose (MC) and Maltodextrin (Dextrose Equivalent = 6) were procured from Sigma Chemical Company (Missouri, United States). Eggs were provided from local market (Mashhad, Iran) to extract fresh egg white (EW).

2.2. Sample preparation

For the hydration of the gum, 6 g MC powder was dissolved in 200-mL of distilled water and stirred with a magnetic stirrer (at 60 °C) until the hydration process was completed. The sample kept at refrigerator temperature (4 °C) for 18 h. The egg white extract was homogenized and used as the foaming agent.

2.3. Foam production

To prepare 120 g of the samples, the desired quantity of sour cherry concentrate (65 °Brix) transferred to a 250-mL beaker (calculations carried out so that the juice concentration of the final mixture was 10 °Brix). Afterwards, the MC solution was prepared the day before the designated amounts (1, 5.1, 2 g/100 g) and EW (1, 2, 3 g/100 g) was added. Then, 8 g/100 g maltodextrin added to the mixture to prevent the adhesion of sour cherry powder (these values were determined based on preliminary experiments). Finally, distilled water added to reach a mixture weight of 120 g. The mixture then whipped by a kitchen mixer (model, kalorance, China.) with the maximum speed for 4 min. Then the foamed samples removed from the foaming device and analyzed for foam density (FD) and drainage volume (DV).

2.4. Drying experiment

The produced foam spread uniformly on aluminum trays with the thickness of 3.0 ± 0.02 mm and then put into the drying chamber. The drying experiment performed at three levels of drying temperatures (50, 65 and 80 °C) in a batch cabinet drier with air velocity of 1.5 m/s (Jeio Tech Co., Inc. OF-02G, Korea). The drying procedure continued as long as the moisture content of the sample reduced to about 2–4 (g water/100 g sample) (wet basis). Then the dried mat removed from the plate and milled by a kitchen miller (Pars Khazar, Iran.) and then sieved (40 μm screen mesh). Afterwards, the sour cherry powder packaged and stored at 4 °C for further analysis. The flow chart followed to prepare sour cherry powder is shown in Fig. 1.

2.5. Foam analysis

2.5.1. Foam density

50-mL of the foam poured into a 50-mL graduated cylinder at controlled ambient temperature (22–25 °C) (Bag, Srivastav, & Mishra, 2011). The samples weighed and FD calculated according to the following equation:

$$\text{Foam Density} = \frac{\text{Weight of foam } (g)}{\text{Volume of foam } (\text{cm}^3)} \quad (1)$$

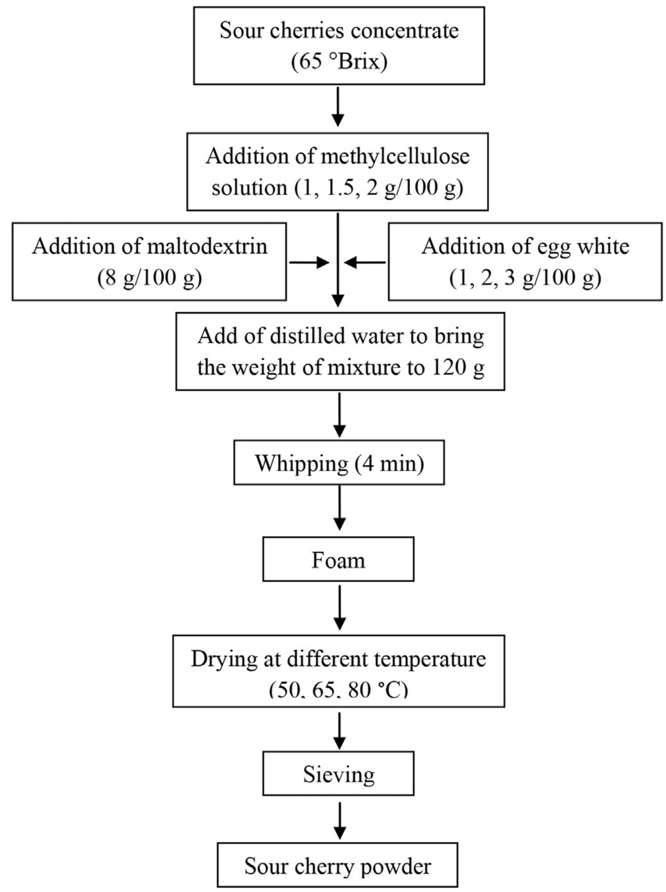

Fig. 1. Process flow chart used for preparation of sour cherry powder.

2.5.2. Drainage volume

DV was determined using a method described by Sauter and Montoure (1972) with slight modification. Fifty grams of the foam were poured into a Buchner filter (80 mm diameter) and placed on a 50-mL graduated cylinder. The liquid volume drained from the foam during 60min intervals reported as the DV.

2.6. Analysis of reconstituted sour cherry juice

2.6.1. Solubility

Solubility measured as described by Cano-Chauca, Stringheta, Ramos, and Cal-Vidal (2005) with some modifications. 100-mL of distilled water transferred into a blender jar. The powder sample (1 g) carefully added to the blender operating at 1500 rpm for 5 min. The solution placed in a tube and centrifuged at 4300 × g for 10 min. An aliquot of 25-mL of the supernatant was then transferred to Petri dishes and immediately oven-dried at 105 °C for 5 h. The solubility calculated as follows:

$$S = \frac{m_2 - m_1}{0.25} \times 100 \quad (2)$$

where S, m_1 and m_2 are solubility, the weight of the empty petri dish and the weight of the petri dish after 5 h of drying, respectively.

2.6.2. Total anthocyanin content (TAC)

The TAC of the sour cherry juice was determined using the pH differential method with two buffer systems. Sample preparation conducted as described for color measurement. The potassium chloride buffer was pH 1.0 (0.025 mol/L) and sodium acetate buffer