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Effect of hot air drying and sun drying on color values and β-carotene content of apricot (*Prunus armenica* L.)

Ihsan Karabulut[a,*], Ali Topcu[b], Ayhan Duran[a], Semra Turan[b], Bülent Ozturk[c]

[a]*Department of Food Engineering, Engineering Faculty, Inonu University, 44280 Malatya, Turkey*
[b]*Department of Food Engineering, Engineering Faculty, Hacettepe University, 06532 Beytepe, Ankara, Turkey*
[c]*Fruit Research Center, 44110 Malatya, Turkey*

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Abstract

In this study, sulphurated and nonsulphurated Hacihaliloglu apricots (*Prunus armenica* L.) which is the most widely produced cultivar in Turkey were used to study the effects of different hot air drying temperatures (50, 60, 70, and 80 °C) and sun drying on color and β-carotene content of apricot. The time required to obtain the desired final dry matter in hot air drying was lower than sun drying. Sulphuration also decreased drying time at all drying conditions. Color values and β-carotene content of hot air dried samples were favorable in comparison to air drying. β-carotene content in dried apricots at 70 and 80 °C was 7.14, 7.17 mg $100\,g^{-1}$ dry matter and 6.12, 6.48 mg $100\,g^{-1}$ dry matter for sulphurated and nonsulphurated apricots, respectively. A good relationship was found between treatments (drying temperatures and drying times) and β-carotene content for sulphurated and nonsulphurated apricots ($R^2 = 0.9422$ and 0.9129, respectively).

Keywords: Apricot; Drying; Color; Carotene; Sulphur

1. Introduction

Turkey is the largest apricot producer of the world. It was reported that the favorable climatic and geographical factors in the Malatya region, of Eastern Turkey, is particularly important for apricot production and processing. This region produces 50% fresh apricots and 90% dried apricots of the whole country (Asma, 2000; FAO, 2002).

It was reported that carotenoids are important components of fruits and vegetables because they give specific coloration to fruit and besides show protective activity against a variety of degenerative diseases (Van den Berg et al., 2000). β-carotene, which gives specific color to apricot, was found as the most abundant carotenoid. Also, it is the most important provitamin A, mainly because of its prevalence in plant foods consumed by man and it is the provitamin A with the greatest activity (Buerfeind, 1981).

Sulphuration is the most common commercially applicable method for preventing quality losses of foods. Both enzymatic and non-enzymatic browning and microbial activity are prevented by using sulphites at low concentration (Joslyn & Braverman, 1954). It was reported that sulphites cause some health problems such as asthmatic reactions in some sensitive individuals (Taylor, Higley, & Bush, 1986). Consequently, alternative preservative techniques should be considered for extending of the shelf-life of foods. Alternatively, nonsulphurated-sun dried apricot has been produced in Turkey. These apricots have dark color and no sensible sulphur taste, which has attracted consumers' attention at recent years.

The objective in drying apricots is to reduce the moisture content to a level that allows safe storage over extended period. In Turkey, the most common drying method for apricots is open air sun drying, requiring low capital, simple equipment and low energy input (El Halouat & Labuza, 1987). Hot air drying has gained importance because it has many advantages over sun drying, such as reduced microbial contamination, controllable drying

*Corresponding author. Tel.: +90 422 341 0010; fax: +90 422 341 0046.
E-mail address: ikarabulut@inonu.edu.tr (I. Karabulut).

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parameters which give more uniform product with less quality degradation, least negative effect of weather conditions, shorter drying times, and lower labor costs (Barbosa-Cànovas & Vega Mercado, 1996).

Recently, there have been many studies on the drying behavior and kinetic and the effect of pretreatments on quality of apricots (Doymaz, 2004; Mahmutoglu, Saygi, Borcakli, & Ozay, 1996; Piga, Poiana, Pinna, Agabbio, & Mincione, 2004; Togrul & Pehlivan, 2003). However, few data can be found concerning drying conditions which affect color and β-carotene content of apricot. It is, therefore, the objective of this study is to investigate the effect of hot air drying and sun drying on quality (color and β-carotene content) of both sulphurated and non-sulphurated apricot.

2. Materials and methods

2.1. Material

Hacihaliloglu apricots (*Prunus armenica L.*), which is the most widely produced cultivar, were obtained from Malatya Fruit Research in the first days of July 2005. Fresh apricots and sulphurated apricots to approximately 2000 mg kg^{-1} (wet basis) apricots were placed into polyethylene bags and stored at 4 °C with and 50% relative humidity until dried. Sulphuration process was carried out by burning elemental sulphur in a specially constructed room. Apricots were then dried either by using hot air drying or sun drying on the earth ground.

2.2. Hot air drying

For hot air drying, a laboratory tray-dryer (Model UOP 8A, Armfield Ltd, Hampshire, UK) was used. The apparatus includes an anemometer (AIRFLOW, UK), aspirated psychrometer, controllers for variable fan speed and heater. Samples of 25 fresh and 25 sulphurated apricots were separately placed on the steel sieved trays which were designed to increase air passage from both surfaces hence the effectiveness of drying. Initial moisture content of homogenized apricots was determined at 80 °C by using an Infrared Moisture Analyzer (OHAUS, MB200, USA). To determine the effect of drying air temperature on quality of apricots four temperature (50, 60, 70 and 80 °C) treatments and constant drying air velocity (1.0 ± 0.011 m s^{-1}) were selected. Drying air was drawn into the chamber by an axial flow fan, at one end of the tunnel. Before starting drying, the dryer was run for 30 min to obtain steady-state conditions. The steel shelves loaded in drying chamber of the dryer. After having reached a suitable dryness level, the stones were taken out by pressing onto them with the fingers.

2.3. Sun drying

Sulphurated and nonsulphurated apricots were placed on field covered with cloth and were dried under direct sunlight with an overall maximum daytime air temperature of around 38 °C and a minimum night temperature of approximately 29 °C until samples achieve its final moisture content.

Total drying time was established for both hot air drying and sun drying processes as the following: at the beginning and during drying, weight of same five apricots were determined by a digital balance with accuracy of 0.01 g (Avery Berkel, Model CB062–10ABAAGA). When moisture content of the samples decreased to 23–25% (wet basis) based on weight loss calculations, drying process was stopped.

Dried apricots were placed into polyethylene bags and stored at 4 °C and 50% relative humidity until subsequent analysis.

2.4. Color measurements

Color values on the surface (ground skin color) of apricot samples were measured with a Konica Minolta color reader CR-10 (Osaka, Japan). The measurements were displayed in L*, a*, and b* values which represents light–dark spectrum with a range from 0 (black) to 100 (white), the green–red spectrum with a range from −60 (green) to +60 (red), and the blue–yellow spectrum with a range from −60 (blue) to +60 (yellow) dimensions, respectively. C* (chroma), changes from 0 (dull) to 60 (vivid), were calculated by using the following equation:

$$C^* = \sqrt{a^{*2} + b^{*2}},$$

h* (hue angle) is expressed in degrees: 0° (red), 90° (yellow), 180°(green), and 270° (blue) and it was calculated by using the following equation:

$$h^* = \arctan(b^*/a^*).$$

Color of central region on both sides of ten apricots was measured for each treatment and average values were reported.

2.5. Analysis of β-carotene by HPLC

β-carotene content of edible portion (flesh and skin) of apricots was analysed according to the methods of Gokmen, Bahceci, and Acar (2002) with some modification. The sample of apricot (5 g) was weighed into a homogenizer cup and homogenized with a Virtis homogenizer at medium speed for 2 min, with 30 ml of extraction solution (methanol/stabilized THF 1:1). The homogenates were centrifuged (5000*g*) for 15 min and supernatant was collected into a 100 ml volumetric flask. The extraction process was repeated three times with 20 ml of extraction solution until no color appeared in the pellet. The extract was filtered through a 0.45 μm membrane filter and 20 μl was injected into the HPLC column.

Separations were achieved on a Luna 5 μm C8 column (150 × 4.60 mm from Phenomenex) at 35 °C and based on isocratic elution. Elution was performed at a solvent flow