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Product Quality and Safety

Colour and rehydration properties of bay leaves dried by convective and microwave methods

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***Abstract**. This study aims to evaluate the effect of the convective and microwave dying methods on the colour parameters (L*, a*, b*, C, α and ΔE) and rehydration ratio of bay leaves. Drying experiments were conducted using 350 and 460W of microwave powers and air temperatures of 50, 60 and 70°C. Different microwave powers show significant effect on colour of dried bay leaves. Increasing microwave power, a* (redness/greenness), α (hue angle) and ΔE (total colour changes) values increased whereas L* (lightness), b* (yellowness/blueness) and C (Chroma) values decreased. For the convective drying, although there are changes in the values of the colour parameters (L*, a*, b*, C and α), there are no significant differences in the values of the total colour changes (ΔE) statistically (P>0.05). The effect of microwave power levels and air temperature on rehydration characteristics was determined. It was found that the rehydration ratio values decreased with an increasing temperature and increasing power levels. The highest rehydration ratio was recorded for the samples dried at 350W and the lowest ratio was seen in a sample dried at 70°C. Microwave drying can be a practical drying process, an alternative to convective drying for drying bay leaves.*

Keywords: bay leaves, colour, convective drying, microwave drying, rehydration

Introduction

Bay laurel (*Laurus nobilis* L.) is a large shrub and aromatic evergreen tree. Mediterranean region countries produce its berries and aromatic leaves for trade. Bay laurel leaf has dark green colour and elliptical shape. The berries of bay laurel are black, ovoid and aromatic. Featured phenolic compounds such as epicatechin, flavonol, flavone derivatives procyanidin trimer and procyanidin dimer were reported by Dias et al. (2014). Dried bay leaves have a significant role in Mediterranean diet as a spice to improve the flavour of beverages, vinegar, stews, soups, meat and fish dishes (Peris and Blazquez, 2015). Bay leaves are also used as a traditional remedy. It is believed to have some healing properties, including antimicrobial, analgesic, cytotoxic, anti-inflammatory, anti-asthmatic, antioxidant, and anti-arthritic (Boulila et al., 2015).

Drying, removing of moisture depending on simultaneous heat and mass transfer, avoids both food spoilage and decay, provides long storage periods for food without deterioration (Nadian et al., 2015). Furthermore, drying allows storability of agricultural products at room temperature and obtaining simplified usage of products through reducing their packaging volume and weight (Liu et al., 2016). Bay leaves are dried all year round in Turkey, where almost 90% of the world supplies of the needs of bay leaves and approximately 10000 tons are exported per annum (Aktaş et al., 2015). Bay leaves are dried by different drying processes. The most common drying process used in the food industry is convective air drying (Velescu et al., 2013). However, vegetables and fruits undergo chemical, structural, nutritional and physical changes that can influence quality parameters such as colour, flavour, nutritional and texture value during convective drying (Di Scala and Crapiste, 2008). Market value can change depending on the values of these attributes. Furthermore, the consumers' acceptance of dried products may be affected because of these quality changes (Sablani, 2006). Most of the dried food materials are commonly rehydrated before or during utilization. Thus, a decent data of rehydration properties, as an important quality parameter caused by drying conditions, could be applicable and should be purchased (Planinic et al., 2005). Rehydration characteristic is an important point of view when choosing processing and engineering methods. It is substantial to know how water absorption can be performed, but also how the processing factors will affect (Ergün et al., 2016).

Colour is one of the crucial quality properties of dried food materials when it is discussed to costumer attitudes. A trained supervisor is generally hired to make colour assessment, but human supervision is annoying, demanding, highly priced, and naturally untrusted (Udomkun et al., 2017). Hunter colour parameters (*L, a* and *b*) have shown important to describe visual colour disruption and supply beneficial data for quality control in vegetables and fruits (Bal et al., 2011). The *L*a*b** model developed by the Commission Internationale d'Eclairage (CIE) in 1976 has been accepted as the international standard. The *L*, a** and *b** colours are described as a luminance or lightness component (ranging from 0 to 100), value of the scale from green to red (ranging from −120 to +120) and value of scale from blue to yellow (ranging from

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−120 to +120), respectively. The L^*, a^* and b^* colour is device independent, providing consistent colour regardless of the output or input devices such as printer, monitor, scanner or digital camera. The values of L^*, a^* and b^* are usually used in investigations of agricultural materials (Yam and Papadakis, 2004). Chroma (C), which is proportional to its intensity and indicates the colour saturation, and the Hue angle (α), which indicates the colour of agricultural materials to assist in describing colour changes during drying have been calculated by the a^* and b^* colour parameters (Karaaslan and Tuncer, 2008).

In literature, drying of bay leaves has been investigated by some researchers (Gunhan et al., 2005; Doymaz, 2014; Ghnimi et al., 2016). The aim of this work is to determine changes of colour parameters and to calculate rehydration ratio of bay leaf drying using convective and microwave methods.

Material and methods

The bay leaves used for the drying tests were collected from the bay leaves trees in Bursa, Turkey and then stored to dry at 4±0.5°C. Firstly, the moisture content on a dry basis was determined as 0.81 (g water.g dry matter^{-1}) by using oven drying (ED115 Binder, Tuttlingen, Germany) at 105°C for 24h. The sample leaves were dried to 0.81 (g water.g dry matter^{-1}). Then, convective and microwave drying were applied in the drying experiments. Three sets each were performed for all the experiments. Also, 6g of fresh bay leaves were used for each drying experiment.

For convective drying, the laboratory modified convective oven (Whirlpool, Italy) was used to dry the leaves. The bay leaves were put on a rotating round shaped glass plate with a diameter of 400mm in a thin layer. Air velocity was set as 1.5 m s^{-1} and air temperatures kept as 50, 60 and 70°C. Changing of moisture content was measured by a digital balance (Shimadzu, Japan) with sensibility fitting as 0.01g was located below the oven.

The microwave drying was applied at 350 and 460W output power levels by using Microwave oven (Arçelik, Turkey). A thin layer of bay leaves was placed on a rotating round-shaped glass plate with a diameter of 245mm. The losing of sample moisture was recorded by using digital balance (Radwag, Poland) 0.01g precision.

The measurement of colour of dried bay leaves was read on a colourimeter (HunterLab, USA). The colour was described as L^* values for lightness, a^* values for redness/greenness and b^* values for yellowness/blueness. On the other side L_0^*, a_0^* and b_0^* are colour parameters for fresh samples. The colourimeter was calibrated on a standard black and white plate prior to each measurement. The sample, contained in a glass cell, was placed close to the nose cone of the colourimeter and onto the light supply to record values of L^*, a^* and b^*. The readings of these values were performed from the surface of the sample. The average value of ten readings at different locations on the sample was reported. Furthermore, the Chroma (C), Hue angle (α) and total colour difference (ΔE) values were calculated by using Eq. (1), Eq. (2) and Eq. (3), respectively, and these parameters were used to define the colour changing (Maskan, 2001):

$$C = \sqrt{(a^2 + b^2)} \quad , \tag{1}$$

$$\alpha = \tan^{-1}(\frac{b}{a}) \quad , \tag{2}$$

$$\Delta E = \sqrt{(L_0^* - L^*)^2 + (a_0^* - a^*)^2 + (b_0^* - b^*)^2} \quad , \tag{3}$$

Rehydration ratio (R) is among the most crucial attributes of dried agricultural materials quality and was calculated using Eq. 4 as (Sunjka et al., 2008); where, M_1 and M_2 are sample weights (g) before and after rehydration, in return.

$$R = \frac{M_2 - M_1}{M_1} \quad , \tag{4}$$

For rehydration ratio measurement, 1±0.1g dried bay leaves samples were immersed in a glass beaker full of 400mL of distilled water at 20°C (±1°C) for 4h (Doymaz, 2012). Then, the bay leaves were dewatered, blotted with tissue paper then weighed by use of an electronic digital balance (Radwag, Poland) with ±0.001g accuracy.

In this research, randomized plots factorial design of experimental type was used. The study employed three sets each to measure the examined constituent. For the analysis, JMP (Version 7.0, SAS Institute Inc., USA) software was used. The study tested mean differences for significance and the outcome of the least significant difference (LSD) test was 5% level of significance.

Results and discussion

Colour parameters of dried bay leaves under different drying treatments are shown in Figure 1. As it has been seen, the values of L^* increased with decreasing microwave power and increasing air temperature. Aral and Beşe (2016) reported similar observation with hawthorn and explained that longer drying time caused decreasing values of L^*. The reducing of L^* value means darkening of the colour of the dried fruit. The values of a^* changed from -8.886 for the leaves dried at 350W to a -5.82 for the leaves dried at 50°C. It is found that there are no significant changes of the values of a^* between samples dried at 50 and 60°C ($P>0.05$).

The values b^* for the samples dried at 50, 60 and 70°C, 350 and 460W drying conditions showed 20.76, 14.438, 17.794, 18.280 and 14.584, respectively. The values of b^* increased with decreasing the power level. After calculation, the lowest C value was found in a sample dried at 60°C (15.705). The highest hue angle (α) value was seen in a sample dried at 460W (116.916), whereas the lowest value of hue angle was seen in a sample dried at 50°C (105.692). Although the values of the hue angle are different, there are no significant differences between microwave dried samples (P>0.05).

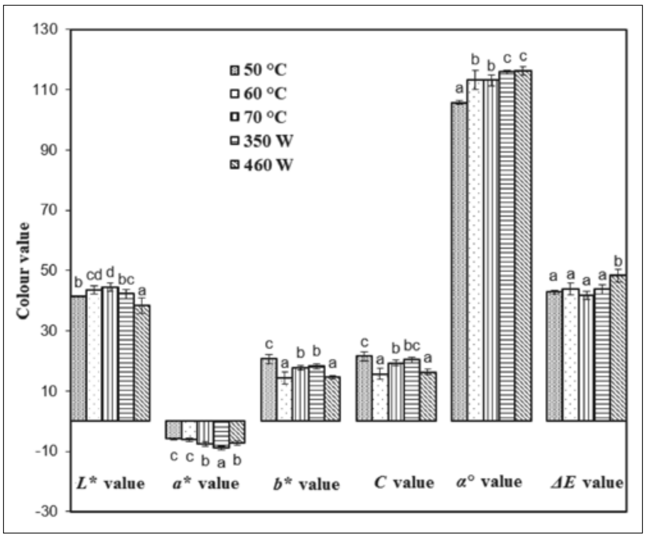

Figure 1. Colour changes at given drying conditions

According to calculation of total colour changes (ΔE), except 460W drying application, there are no significant changes statistically between all dried treatments (P>0.05). Ali et al. (2014) investigated colour changes of moringa leaves using different oven drying temperatures 40, 50 and 60°C. The values of colour parameters were reported contrast to the present study. Different drying conditions may cause this situation.

Rehydration attributes have been sustained as a measure of the caused damage in the material during drying treatments. The capacity of food materials to regain water depends principally on the inner structure of the dried samples and the extent of proteins and starch which are the water-holding components that have been damaged during drying (Doymaz, 2017). Rehydration ratio values of bay leaves dried at different drying treatments are shown in Figure 2. It is indicated that the rate of microwave dried bay leaves was higher than the rate of those dried by convective methods. It was seen that 350W is the best option for all treatments. Increasing microwave power level causes decreasing in the rehydration ratio. Horuz and Maskan (2015) observed similar results with pomegranate and explained that during drying at high microwave powers irreversible cellular break and infraction occurs, eventuating loss of texture integrity producing an intense structure of decadent, greatly contracted capillaries with decreased hydrophilic characteristics. Because of reducing hydrophilic characteristic rehydration capacity decreases, inhibition of water disallows unfilled pores in leaves. For convective drying, rehydration ratio values decreased with increasing temperature degree because of the deterioration of the cell wall. This behavior is reported by Seremet et al. (2016) with pumpkin slices.

Conclusion

Colour changes and rehydration ratio of convective and microwave dried bay leaves was investigated. The colour parameters affected from all drying applications. The highest L* and a* values were found the sample dried at 70°C treatment and 50°C, respectively. It was indicated that no significant changes of C value, when drying bay leaves at 60°C air temperature and 460W microwave drying (P>0.05). Between drying treatments, 350W microwave drying showed the highest rehydration ratio, whereas 70°C had the lowest rehydration ratio. Microwave drying method may be suitable to dry bay leaves which have good colour and high rehydration ratio.

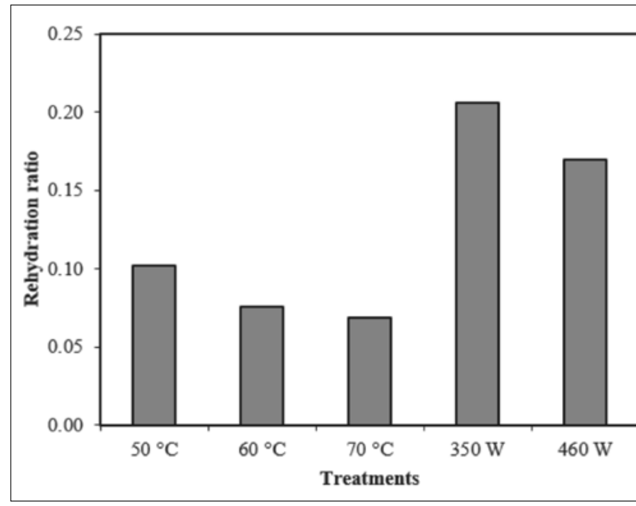

Figure 2. Rehydration ratios at given drying conditions

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