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EFFECT OF DRYING PROCESSES ON STABILITY OF ANTHOCYANIN EXTRACTS FROM SAFFRON PETAL

Somayeh Heydari[i]*, Roya Rezaei[ii] and Gholam Hossein Haghayegh[iii]

[i] Faculty of Agriculture, higher education complex of Torbat-e jam, Torbat-e jam, Iran
[ii & iii] Department of medicinal plants, Faculty of Agriculture, University of Torbat-e Heydariyeh, Torbat-e Heydariyeh, Iran
Corresponding Author: Somayeh Heydari, Email: so_heydari_83@yahoo.com

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ABSTRACT. Saffron (Crocus sativus) has cyanic color flowers with major colorant of anthocyanin. Attractive color and functional properties of anthocyanins make them a good substitute for synthetic pigments in the food industry. These natural soluble water colorants are rather unstable and influenced by final processing treatment. The drying process is critical to the stability of saffron petals anthocyanins. Four different dehydration methods were evaluated: traditional method (at room temperature and under the sun); dehydration with electrical oven at different temperatures; and dehydration with microwave at different powers. The results showed that the highest amount of anthocyanin was obtained when saffron petals treated by traditional methods (at room temperature and under the sun). According to the results, the stability of saffron petals anthocyanins gradually accessed with increase of the heating temperature and decrement of heating time until 100 °C. However, heated at 120 and 140 °C, the anthocyanins could break down, and their residual amounts declined within 20 min and 10 min, respectively. The results suggested that saffron petals anthocyanins tended to degrade at high temperatures (>100 °C). Between these methods, drying at room temperature and drying with microwave at 900 W obtained the highest and the lowest results respectively.

1. Introduction

The first property that the consumer observes in every food product is its visual color, which is an indicator of pigment con-centration that is measurable immediately. Color can be changed during heat processing based on different reactions of pigments such as pigment degradation, browning reactions like Millard reactions, enzymatic browning and oxidation of ascorbic acid (Maskan, 2006). Most of the synthetic colors which are used in the food industry have chemical sources with harmful health effects. Since the anticancer and antioxidant properties of natural colorants are proven, today there are more tendencies to use natural colorant sinstead of synthetic ones (Andersen, Jordheim, Lew, & Hung-Wen, 2010).

Anthocyanins as natural pigments are found in roots, leaves, fruits and flowers of plants. Attractive color and functional properties (like prevention of neuronal and cardiovascular, cancer and diabetes illnesses) of anthocyanins make them a good substitute for synthetic pigments in the food industry (Castaoveda-Ovando, Pacheco-Hernondez, Priez-Hernandez, Rodriguez, & Galoan-Vidal, 2009). These natural soluble water colorants are rather unstable and influenced by final processing temperature, storage temperature, pH, chemical structure and concentration of anthocyanin, light, oxygen, enzymes, proteins and metallic ions (Patras, Brunton, O'Donnell, & Tiwari, 2010). Among these factors that can influence anthocyanin stability, the most significant is temperature. Anthocyanins present a very high thermal sensitivity [13]. Thus, measurement of anthocyanin content and investigation of their degradation is useful for the food industry.

It has been early recognized that anthocyanin-rich plant extracts might have potential as natural food colorants, especially if suitable purified and stable materials become commercially available (Francis, 1975). Saffron (Crocus sativus) which is produced largely in Iran, with more than 90% of total annual saffron production in the world (Kafi, 2006), has cyanic color flowers with major colorant of anthocyanins (Nørbæk, Brandt, Nielsen, Ergaard, & Jacobsen, 2002).The existence of anthocyanins in saffron's petal had been proven before by Williams, Harborne, and Goldblatt (1986) and Nørbæket al. (2002) too. Since nearly 86.4% wet base or 96.36% dry base of total weight of saffron flowers is related to the petals (Hemmati, 2001) and a large scale of saffron flowers is disposed to the nature after picking stigmas annually; anthocyanins of petal extract can be used as a natural resource of colorants in the food industry adding to its other medicinal/industrial applications (Kafi, 2006). Temperature and heating time has a significant impact on the stability of anthocyanins. According to the importance of anthocyanins, as well as their instability and sensitivity, the present study aimed to investigate the effects of drying processes on the stability of anthocyanins of saffron petal.

2. Materials and methods

2.1. Collection of material

Saffron flowers were collected before sunlight from a farm near Torbat-E-Heydariyeh (Iran) in November, 2013. The flowers were transported and kept in cool condition (4 °C) before treatment. Petals for the experiments were separated by hand from flowers at 24 °C indoor. After removing stigmas and anther, Traditional drying (at room temperature and under the sun) was performed, and the rest petals (in vesicular box) were moved to the laboratory. In laboratory petals after cleaning were drying based on two different methods consisting oven drying and microwave drying.

2.2. Saffron petals dehydration process

In traditional method, the petals (20 g of fresh petals) were dehydrated by spreading them on a piece of paper at room temperature for four days and under the sun for two days. The dehydration of samples was carried out at three different powers (180, 360, 720 and 900 W), using a National Model microwave. In drying with electric oven, 20 g of saffron stigmas were placed in Petri plates and oven at different temperature (40, 60, 80, 100, 120, 140 °C), using a 75 L MEMERT oven. In this work, all the drying treatments of saffron petals was done with final moisture content at or below the 12 % and until start testing stored in dark and dry environment. All experiments were repeated three times and the tray load was the same in all experiments.

2.3. Extraction of anthocyanin

Saffron petals were powdered and passed through a 40 Mesh sieve. For extraction of anthocyanin from saffron petals in every experiment, 0/1 g of dried saffron petals were mixed with 250 ml of hydrochloric acid solution of 0/1 normal in a dark colored bottle. After five minutes in 25 ◦C ± 1, samples were filtered through a filter paper (Whatman no. 1). For determination of anthocyanin, Measurements of absorbance of solution at 518 nm were carried out with a 1 cm pathway cell on a JENWAY UV-Visible 6300 spectrophotometer.

3. Results and discussion

3.1. Effect of temperature

As anthocyanins are not stable at high temperature, heat treatment is one of the most important factors that influence anthocyanin stability. In order to investigate the degradation temperature of anthocyanins, saffron petals were heated in oven drying at six different temperatures (40 °C, 60 °C, 80 °C, 100 °C, 120 °C and 140 °C, respectively). From Figure 1, it was observed that the stability of saffron petals anthocyanins gradually accessed with increase of the heating temperature and decrement of heating time until 100 °C. However, heated at 120 and 140 °C, the anthocyanins could break down, and their residual amounts declined within 20 min and 10 min, respectively. The results suggested that saffron petals anthocyanins tended to degrade at high temperatures (>100 °C). According to the results (Table 1), saffron petals in Traditional methods (at room temperature and under the sun) contained the highest amount of anthocyanin after drying according to the temperature instability of anthocyanins. Analysis of the results confirmed that the lower temperature in oven drying need longer drying times (treatment A, B), therefore a poor quality material would be produced. This is probably due to enzymatic activity, which results in biodegradation of anthocyanin [14]. At higher temperatures processing need considerable less time (treatments E and F) but thermal degradation of anthocyanin occur. Saffron petals at an optimum temperature of 80-100°C in oven drying contained the highest amount of anthocyanin after drying (Fig. 1).

3.2. Effect of different drying processes on anthocyanin extracts from Saffron petals

All the drying treatments produced saffron with final moisture content at or below the 12 % required. The total anthocyanin content increased, when saffron petals dehydrated at higher temperature up to 100 °C in oven drying (Tables 1) but at low temperatures (treatments A, and B), and high temperatures (treatments E and F) the amount of anthocyanin is lower than the others treatments. This is due to probably of thermal degradation in high temperatures or biodegradation in low temperatures [15]. The loss of anthocyanin occurring in the higher temperature treatments would be the result of nonenzymatic thermal degradation, but it would appear that by keeping the high temperature in relatively short time, this loss was minimized and no enzymatic degradation would have occurred and the enzymes were denatured.

In recent years, microwave-assisted extraction (MAE) technology developed rapidly, especially in extraction of natural products [42]. Many applications of microwave in extraction of anthocyanins are reported [43, 44]. In this study, the influence of microwave processing on the stability of saffron petals anthocyanins was investigated by a microwave oven (PJ21C-AU, Guangdong, China). From Figure 2, it was observed that the stability of saffron petals anthocyanins gradually decressed with increase of the output power and decrement of treatment time. In the process of conventional heating, the heat transfer is mainly performed by conduction and convection only; in contrast, in the MAE process, the heat transfer is performed in three ways—radiation, conduction and convection [45]. As a result, heat is produced from within cells as well as from the outside. So, the thermal degradation of saffron petals anthocyanins also exists because of the fast heating in the microwave-assisted process.

Between these methods traditional methods (at room temperature and under the sun) contained the highest amount of anthocyanin after drying (Figure 3). Significant increase in the relative anthocyanin absorbance at room temperature is according to the temperature instability of anthocyanins. This indicates that the type of drying would be a means of producing high quality anthocyanin from saffron petals.

4. CONCLUSIONS

The results showed that the highest amount of anthocyanin was obtained when saffron petals treated by traditional methods (at room temperature and under the sun). Significant increase in the relative anthocyanin absorbance at Traditional method (at room temperature) is according to the temperature instability of anthocyanins. According to the results the stability of saffron petals anthocyanins gradually accessed with increase of the heating temperature and decrement of heating time until 100 °C. However, heated at 120 and 140 °C, the anthocyanins could break down, and their residual amounts declined within 20 min and 10 min, respectively. The results suggested that saffron petals anthocyanins tended to degrade at high temperatures (>100 °C). Between these methods, drying at room temperature and drying with microwave at 900 W obtained the highest and the lowest results respectively.

Table 1. Effect of different drying processes on stability of saffron petals anthocyanins.

Treatment code	Drying protocols	Drying time (min)	Absorbance of anthocyanin
	Electronic oven drying at (°C)		
A	40	120	0.222
B	60	90	0.254
C	80	40	0.263
D	100	30	0.270
E	120	20	0.250
F	140	10	0.220
	Microwave drying at		
G	180 W	16	0.249
H	360 W	8	0.242
I	720 W	7	0.200
J	900 W	6	0.168
K	Traditional method (at room temprature)	4 days	0.332
L	Traditional method (under the sun)	2 days	0.295

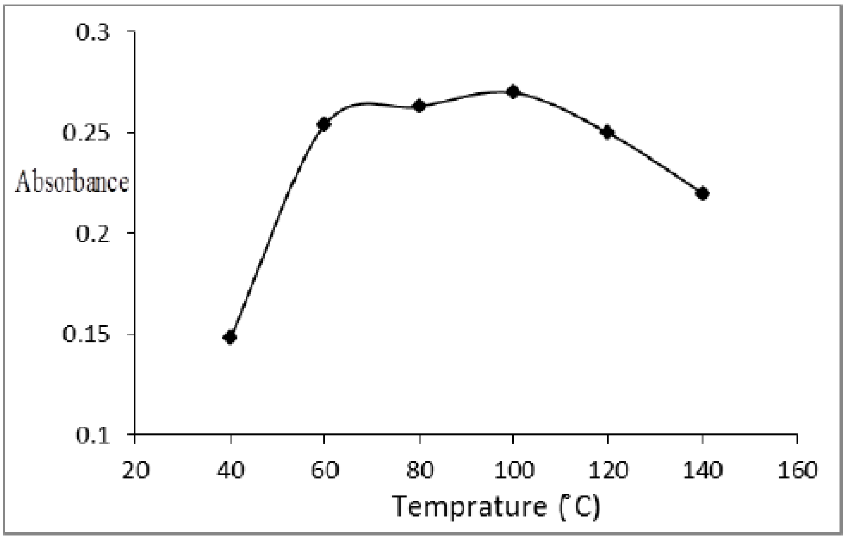

Figure 1. Effect of heating on stability of saffron petals anthocyanins.

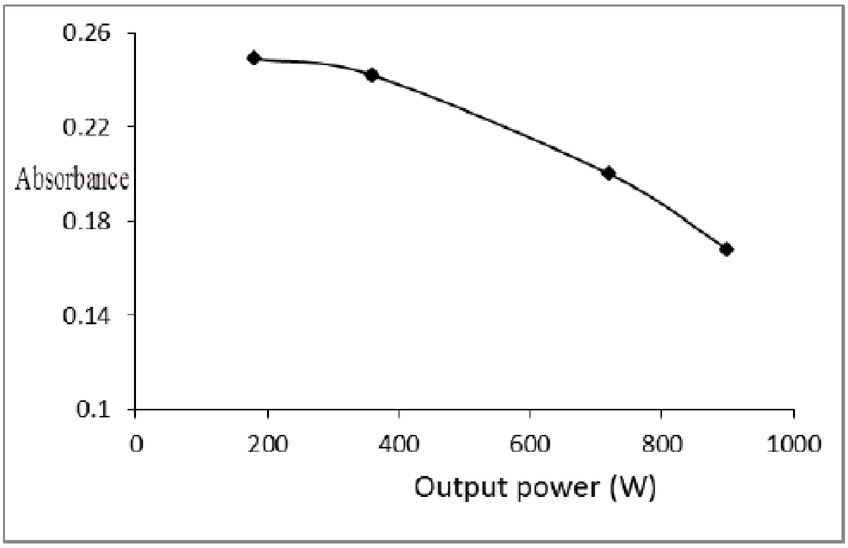

Figure 2. Effect of output power on stability of saffron petals anthocyanins.

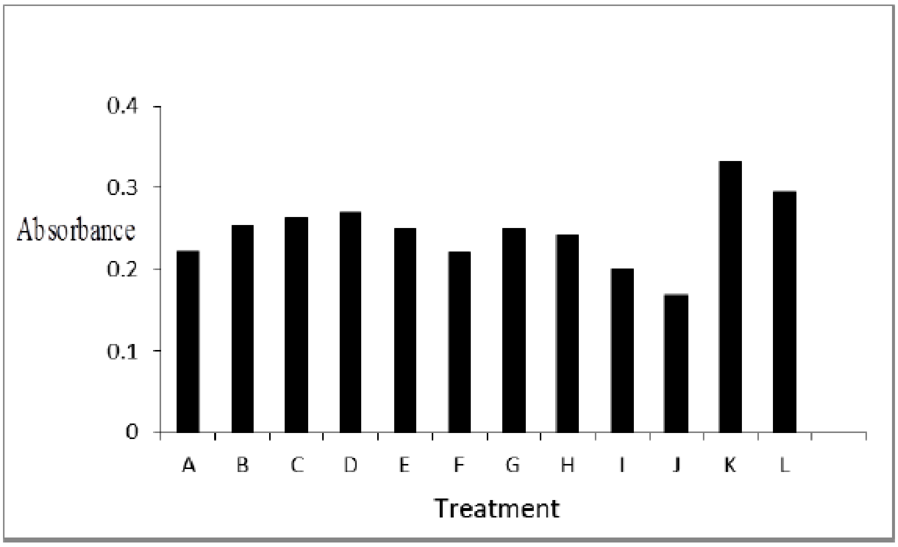

Figure 3. Comparison of anthocyanin content of different drying treatments.

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