



Effect of Different Drying Methods on Some Biochemical Properties of Iranian Ox-tongue (*Echium amoenum* Fisch. & Mey.)

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ABSTRACT

Background & Aim: Iranian ox-tongue (*Echium amoenum* Fisch. & Mey.) is an endemic Iranian medicinal plant belongs to Boraginaceae family. The violet-blue petals of this plant have been used in traditional medicine. Drying is one of the most critical and fundamental operations in the post-harvest processing of medicinal plants.

Experimental: This research was carried out in Islamic Azad University, Isfahan (Khorasgan) branch in 2015. The experiment was arranged based on completely randomized design with three repetitions. Drying methods are including sun and shade drying, oven-drying (45, 65 and 85°C) and microwave drying (200, 300 and 400 W). Drying time of Iranian Ox-tongue petals and some biochemical properties such as total chlorophyll, the amount of carotenoids, anthocyanin content and total flavonoids were measured.

Results: The results showed that different drying methods had significant effects on drying time, chlorophyll, carotenoids, total flavonoid and anthocyanin contents of Iranian ox-tongue petals. The maximum and minimum drying times were measured in shade drying and microwave 400 W, respectively. The anthocyanin content gradually decreased with the increase of oven temperatures and microwave powers. Also shade drying method had the highest amount of total chlorophyll and carotenoids. Generally, regarding the biochemical composition, traditional shade drying is the optimum method for drying of Iranian ox-tongue petals.

Recommended applications/industries: According to this study, shade drying could be recommended in terms of qualitative characteristics of mentioned medicinal plant.

1. Introduction

Iranian ox-tongue (*Echium amoenum* Fisch. & Mey.) belongs to Boraginaceae family and is an herbaceous and perennial endemic Iranian medicinal plant and naturally is grown in mountainous regions of North of Iran (Babakhanzadeh-Sajirani *et al.*, 2014) at an altitude ranging from 60-2200 meters (Soltani, 2005; Mozaffarian, 1998).

Flowers and leaves are the main medicinal parts of the Iranian ox-tongue (Abed *et al.*, 2014). Dried violet-blue petals of ox-tongue in Iranian traditional medicine have been used as diaphoretic, tranquillizer, cough suppressant, tonic and as a remedy for sore throat (Amin, 1991; Mehrabani *et al.*, 2005). The major components of Iranian ox-tongue petals including anthocyanin, flavonoids, saponins, unsaturated terpenoids, sterols and essential oils (Shafaghi *et al.*, 2002).

The most fundamental and common method for post-harvest preservation of medicinal plants is drying. The reduction of the water content of freshly harvested medicinal plants is imperative for handling and storage purpose and less susceptible to microorganisms (Tanko *et al.*, 2005; Ghasemi-Pirbalouti *et al.*, 2013). Drying reduces the enzymatic activity inhibiting chemical reaction as hydrolysis, oxidation, and fermentation (Santana *et al.*, 2014). Drying of medicinal plants must be carefully performed in order to preserve the aroma, appearance, and nutritional values (Crivelli *et al.*, 2002). According to basis of heat source of energy utilization, the methods for drying medicinal plants could be categorized into natural and mechanical (Cai *et al.*, 2004).

Sun drying is the cheapest and is traditionally practiced for medicinal plants; however, the long drying time, contamination and spoilage of product exposed to the open environment are undesirable in terms of economic reasons (Kostaropoulos and Saravacos, 1995).

Due to the advantages such as a lower impact on product quality, reduction in drying time, and less energy use, microwave drying is becoming surprisingly popular as an alternative conventional drying technique (Zhang *et al.*, 2006; Vadivambal and Jayas, 2007).

There is little information about the influence of the different drying methods on the quality characteristics of Iranian ox-tongue; therefore the aim of present study is to evaluate the effect of different drying methods on some biochemical properties of Iranian ox-tongue petals.

2. Materials and Methods

2.1. Plant materials

The fresh flowers of Iranian ox-tongue (*Echinum amoenum* Fisch & Mey.) were collected in April 2015 from natural habitat at the Sajiran region in Gilan province. This area located to the north region of Iran (Latitude: 36° 52' 97" N, Longitude: 50° 14' 31" E, elevation 770 m). Plants were kept in cooled bags for transport to the laboratory. In this experiment the fresh petals at eight different methods of drying were evaluated as sun-drying of plant material under open

air sunny conditions, shade-drying under conventional open air conditions, oven-drying (Memmert 660, Germany) at 45, 65 and 85°C and microwave drying (Panasonic NN-1000W) at 200, 300 and 400 W.

A 300 gr samples was used in each experiment and the drying process was continued until the mass of the samples reduced to a moisture content of about 10% on a wet weight basis.

2.2. Determination of Biochemical properties

The total chlorophyll and carotenoid content was determined according to a method introduced by Arnon (1967). The content of chlorophyll was obtained by summarizing chlorophyll a and b content and results were expressed in mg/g of FW (equations 1, 2 and 3). Also the amount of carotenoid content was calculated by the equations 4, and results were reported in mg/g of FW.

$$(1) \text{Chl}_a = [12.25A_{663} - 2.79A_{645}] \times V/W \times 1000$$

$$(2) \text{Chl}_b = [12.12A_{645} - 5.10A_{663}] \times V/W \times 1000$$

$$(3) \text{Chl}_{\text{total}} = \text{Chl}_a + \text{Chl}_b$$

$$(4) \text{Carotenoid} = [(1000 A_{470}) - 1.82 \text{Chl}_a - 85.02 \text{Chl}_b] / 198$$

Where Chl_a = (chlorophyll a), Chl_b = (chlorophyll b), V = (volume of used acetone) and W = (used leaf fresh weight).

The total anthocyanin content was measured by Wagner (1979) methods. Briefly, a mass of 0.1 g of sample was soaked in 10 ml of acidified methanol. The tissue was crushed and kept at 25 °C for 24 h in dark. The extracts were then centrifuged at 4000×g for 5 min at room temperature. The absorption rate of the supernatant was read by spectrophotometer at 550 nm. In order to measure the amount of anthocyanin's the molar absorption coefficient of 33000 mol⁻¹ cm⁻¹ was used and anthocyanin content was reported in mmol per g of fresh mass.

Total flavonoids content was determined by aluminum chloride colorimetric method (Pourmorad *et al.*, 2006). Plant extracts (0.5 ml) were separately mixed with 1.5 ml of methanol, 0.1 ml of 10% aluminum chloride, 0.1 ml of 1 M potassium acetate and 2.8 ml of distilled water. They were kept at room temperature for 30 min; the absorbance of the reaction

mixture was measured at 415 nm with a spectrophotometer and results were reported as mg dry weight equivalents per gram quercetin.

2.3. Statistical analysis

The experiment was arranged based on completely randomized design (CRD) with three repetitions. Statistical analyses were performed using SAS 9.1 software. Mean were separated using Duncan's multiple test at 5% significance.

3. Results and discussion

The results indicated that the drying time and some biochemical characteristics such as total chlorophyll, carotenoids, anthocyanin content and total flavonoids were varied in different drying methods and significant difference ($P < 0.01$) was observed between them.

The mean value of drying time in different drying methods showed significant difference ($P < 0.01$). The maximum drying time (2280 min) was measured at the shade drying method. Although, the minimum drying time (57 min) was spent in the microwave 400 W, the longest drying period was 40 times higher compared with the shortest drying period. Sun drying methods and oven drying at 45 °C has not significant differences in terms of drying time. Among the oven drying methods, oven 85 °C has the lowest drying time (Fig 1). The higher energy power of microwave and oven drying made the drying process faster but contributed more significantly to the loss of the active compounds than a smaller energy input (Dermelj *et al.*, 1995). In over all, Water content and temperature has effect on drying time of medicinal plants and the ideal temperatures can vary greatly among species. In terms of drying time, our results in high temperatures and high microwave watts were agreement with Ebadi *et al.* (2011) on drying of Savory (*Satureja hortensis* L.).

The sun drying is the most common and the cheapest drying method of agricultural products in several countries. This method is successfully employed in various agricultural products (Doymaz, 2009), but for medicinal plants this method is not recommended, because solar drying as commonly leads to photodecomposition reactions (Santana *et al.*, 2014)

and the long drying time is undesirable for economic reasons.

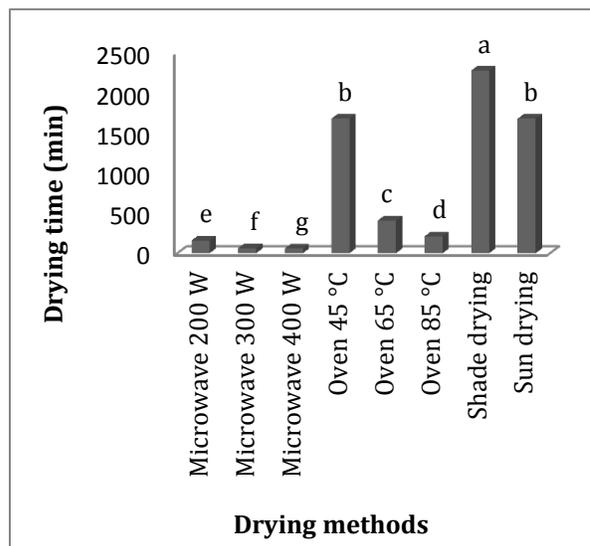


Fig 1. Drying time of Iranian ox-tongue dried petals in different drying methods. (Significant difference at 5% probability level has been indicated with different letters).

Chlorophyll is a group of compounds responsible for color intensity of plants. Mean comparison results showed significant differences in total chlorophyll content among drying methods. The highest amounts of total chlorophyll were observed in shade drying and oven drying at 45 °C. also microwave 400 W and oven 85 °C have the lowest amounts of total chlorophyll content (Fig 2). These results are agreement with flinging of Diaz-Moroto *et al.* (2002) on parsley leaves drying. It is generally accepted that the different drying techniques affect different pigments in a variety of ways and that the dehydration process results in the qualitative and quantitative changes in dried plants (Drostinova *et al.*, 2015). In tumor or cancer therapy chlorophyll or chlorophyll derivatives can be utilized as a photodynamic agent (Brandis *et al.*, 2006).

The amount of carotenoid content varied from 0.026 mg/g in microwave 200 W to 0.048 mg/g in shade drying methods (Fig 3). These finding are agreement with previous study by Komes *et al.* (2011) of dehydrated lemon balm leaves (*Mellisa officinalis*

L.), marigold flowers (*Calendula officinalis* L.) and borage petals (*Borago officinalis* L.). The results obtained by Kamel *et al.* (2013) have shown that all methods of drying used (air drying, oven drying, microwave drying) significantly decreased the yield of carotenoids in the edible parts of leafy vegetables and the greatest reduction was observed using microwave drying method and less effect was observed using air drying. Susceptibility of these beneficial compounds to degradation at high temperatures was reported by Komes *et al.* (2013).

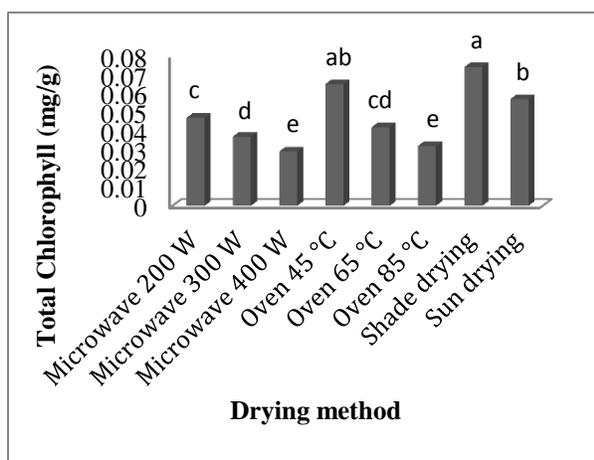


Fig 2. Total chlorophyll content of Iranian ox-tongue dried petals in different drying methods (Significant difference at 5% probability level has been indicated with different letters).

Also Diaz-Moroto *et al.* (2002) reported that increasing the temperature, usually results in a decrease of the quality of dried herbs. The biological importance of carotenoids is related to antioxidants properties. Carotenoids can fact as antioxidant and may possess some anti-carcinogenic properties (Krinsky, 1989).

In terms of total anthocyanin content the highest and lowest amounts were measured by using shade drying (1.051 mmol/g) and oven drying at 85 °C (0.442 mmol/g) respectively (Fig 4). The anthocyanin content gradually decreased with the increasing of temperature. Anthocyanins are sensitive to pH, temperature, light, oxygen, enzyme and sulfur dioxide (Nadi, 2016). Anthocyanins have been reported to be destroyed by high heat during processing and storage of food

(Morales-Delgoet *al.*, 2014). Anthocyanins were responsible for biological membrane stability and protect against free radical produced by radiation (Handley *et al.*, 2011).

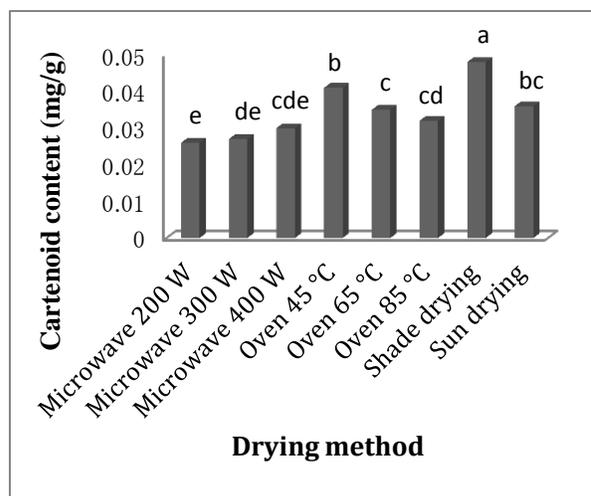


Fig 3. Carotenoid content of Iranian ox-tongue dried petals in different drying methods (Significant difference at 5% probability level has been indicated with different letters).

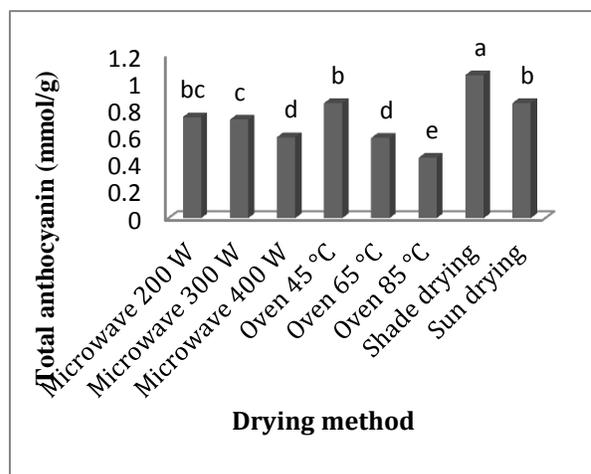


Fig 4. Total anthocyanin content of Iranian ox-tongue dried petals in different drying methods (Significant difference at 5% probability level has been indicated with different letters).

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Different drying methods have significant effects on total flavonoids content of dried petals. As you can see in Fig 5, with the increase of microwave power and oven temperature, the flavonoids content were increased. On the other hand, the natural drying methods have not significant differences in total flavonoids. These components might be formed in high temperatures. The differences in flavonoids content in dried petals of ox-tongue might be due to the duration of samples to high temperatures exposure. The concluded results were agreement with Ben Haj Saeid *et al.* (2013) on drying leaves of *Allium roseum* L. Flavonoids are the group of plant metabolites which provide health benefits through cellsignaling pathways and antioxidant effects.

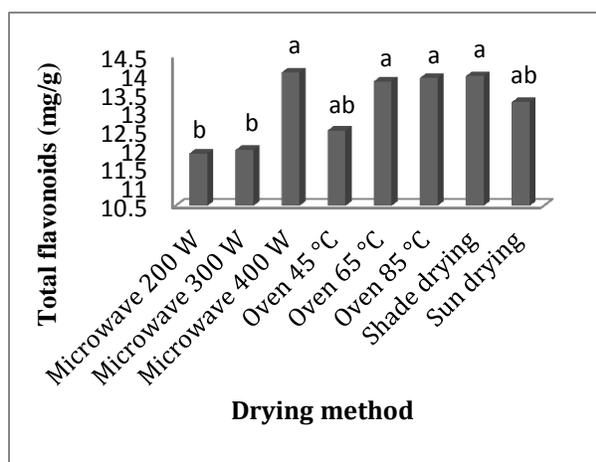


Fig 5. Total flavonoids content of Iranian ox-tongue dried petals in different drying methods (Significant difference at 5% probability level has been indicated with different letters).

4. Conclusion

Drying is one of the basic process of medicinal plants that is affected on quantitative and qualitative characteristics. As the bioactive components of medicinal plants may be very sensitive to drying procedures, for obtaining the highest quality of medicinal plants, it is necessary to investigate the influence of drying methods on quality parameters. According to our results, shade drying was the most favorable among the different drying methods which preserves the higher amount of all biochemical compounds.

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