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Effects of growing stages and drying methods on quality of shahsparam (*Tanacetum balsamita* L.)

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ABSTRACT: Shahsparam is widely used in Iranian traditional foods. Its effects may be correlated with the antioxidants properties. Methalonic extract of shahsparam aerial part at growing stages with four drying methods was screened for phenolic and antioxidant compounds. The extract showed good antioxidant properties also, showed good reducing power activity at flowering stage but drying methods caused to antioxidant properties decreased. In after- flowering stage antioxidant properties was decrease but in drying by sun increased significantly. The extract showed that total phenol was not significant by growing stages. In all of drying methods total phenol was slightly increased, also drying with microwave was better than other due to high quality and reduces drying time. These results introduced shahsparam aerial part as an edible source of natural antioxidants, also type of drying methods and growing stage were affected on shahsparam food quality. Also these results can be advantage for food industrial.

Keywords: Antioxidant properties, Total phenol, Drying-methods, Tanacetum balsamita L

INTRODUCTION

The genus Tanacetum (Compositae) consists of 26 species in Iran one of which is Tanacetum balsamita L. (Mozaffarian,V. 1996). T. balsamita, locally named Shahesparam, is an aromatic species which grows widely in Azerbaijan province. It has been used in Iranian folk medicine as a tranquilizer and cardiac tonic (Amin Gh. 1991). Some of the medicinal Tanacetum species such as T. parthenium and T. vulgare are known to be rich in flavonoids (Fleming, 2000) but the flavonoid compositions of T. balsamita have not been the subject of much study (Williams CA, Harborn JB and Eagles J. 1999).

Drying, as a preservation method, is a very important aspect of food processing. Drying can be defined as a simultaneous heat and mass transfer operation in which the water activity of the material is lowered by the evaporation of water into an unsaturated gas stream (Khraiseheh et al., 1997). The main function of drying is to lower the water activity of the product and consequently, to inhibit the growth of microorganisms and decrease chemical reactions in order to prolong the shelf life of the product at room temperature. It also results in less space needed for storage and lighter weight for transportation. Hot-air drying is the most widely used method to produce dried foods and agricultural products (Vega-Mercado et al., 2001) due to the low investment and operating cost. However, a disadvantage of hot-air drying is that it takes a long time, even at high temperature, which in turn may cause serious damage to the product's quality attributes, such as flavor, color, texture, nutrient status and beneficial substances to health (Tsami et al., 1999). Therefore, there is a need to optimize the conditions to produce high-quality dried products. The drying time can be reduced by microwave energy (Inchuen et al., 2008), which is rapidly absorbed by the water molecules in the product, resulting in rapid evaporation of the water and thus a higher drying rate. Moreover, microwave application has been reported to improve product qualities, such as aroma and to result in faster and better rehydration compared with hot-air drying alone (Maskan, 2000). However, it may result in a poor quality product if not properly applied (Zhang et al., 2006).

The quality of a dried product is strongly dependent on the conditions in the drying process. It is of interest to investigate the effects of different drying methods (microwave, oven, sun and sun drying) on the quality of Tanacetum balsamita L. and especially the beneficial antioxidant activity of the plants.

Sun-drying of medicinal plants is a popular practice in Iran, as a way of preserving the medicinal plants for future use, however, like any other food processing techniques, sun-drying has been reported to affect the amount and biological activity of the chemical constituent present in both plant and animal food (Akindahunsi & Oboh, 1999; Yoshinaga et al., 2002).

The major challenge during drying of food materials is to reduce the moisture content of the material to the desired level without substantial loss of flavor, taste. Beside the adverse influence of drying on food

One of the most important ways to reduce the adverse influence of drying on food quality or to ensure basic quality properties of the final product is to carefully design the process and implement it consistently (Lewicki, 2006). Sun drying allows for the production of a product rich in color and translucent in appearance, but it has some disadvantages (e.g. it is a time-consuming process, weather depended, labour demanded) and it is greatly exposed to possible environmental contamination (Maskan, 2001). Nevertheless, sun and oven drying methods are still widely used to produce dried products because of their low costs (Soysal & Öztekin, 2001). New and innovative techniques that increase the drying rate and enhance product quality have achieved considerable attention in the recent past. Microwave drying is one of them, gaining popularity because of its inherent advantages over conventional heating such as reducing the drying time of biological material without quality loss. In an industrial level, food processing using this technique has been reported to be both cost-effective and feasible (Mongpraneet, Abe, & Tsurusaki, 2002; Nindo, Sun, Wang, Tang, & Powers, 2003).

Processing methods are known to have variable effects on total phenolic compound (TPC) and antioxidant activity (AOA) of plant samples. Effects include little or no change, significant losses, or enhancement in AOA (Nicoli, Anese, & Parpinel, 1999). Food processing can improve the properties of naturally occurring antioxidants or induce the formation of new compounds with AOA, so that the overall AOA increases or remains unchanged (Tomaino et al., 2005). Increase in AOA following thermal treatment has been reported in tomato (Dewanto, Wu, Adom, & Liu, 2002a), sweet corn (Dewanto, Wu, & Liu, 2002b), Shiitake mushroom (Choi, Lee, Chun, Lee, & Lee, 2006), and ginseng (Kang, Kim, Pyo, & Yokozawa, 2006). Increase in AOA following thermal treatment has been attributed to the release of bound phenolic compounds brought about by the breakdown of cellular constituents and the formation of new compounds with enhanced AOP (Dewanto et al., 2002a, 2002b; Tomaino et al., 2005).

Many studies have reported losses in TPC and AOA of plant samples following thermal treatments. Losses were mainly reported in vegetables (Ismail, Marjan, & Foong, 2004; Roy, Takenaka, Isobe, &

Tsushida, 2007; Toor & Savage, 2006). Losses in AOP of heat-treated samples have been attributed to thermal degradation of phenolic compounds (Larrauri, Rupérez, & Saura-Calixto, 1997). Declines in AOA have been attributed to degradative enzymes, thermal degradation of phytochemicals, and to loss of antioxidant enzyme activities (Lim & Murtijaya, 2007). Declines in TPC and AOA are often accompanied by loss of other bioactive properties (Roy et al., 2007).

Thus, the objective of the present study was to explore the effects of drying methods on the chemical composition, color, total phenolic content and antioxidant activities of Thai red curry powder.

MATERIAL AND METHODS

Sample preparation

Leaves of shahsparam (Tanacetum balsamita L.) were purchased in Zarringiah Medicinal Plants Company (ZMPC) from West-Azerbaijan in Iran. Leaves were subject to four different drying methods, i.e., microwave-, oven-, sun-, and shade-drying. For each drying method, 1 g of fresh leaves was used. In microwave-drying, leaves were dried in a microwave oven (Sharp R-248E; 800 W) for 4 min. Oven-drying involved drying for 5 h in an oven (Memmert ULE 500) at 50 _C. Leaves were sun-dried in the greenhouse for two days with about 22 h of daylight. Mid-day temperature in the greenhouse can reach 30_C. Leaves were shade-dried for three days in the laboratory at ambient temperature of 25–30 _C and relative humidity of 29%. For each of the above drying methods, leaf pieces were spread out evenly on a Petri dish.

Determination of total phenolic content

Total phenolic compound content was determined by the Folin- Ciocalteau method (Ebrahimzadeh et al., 2008b; Ghasemi et al., 2009). The extract sample (0.5 ml of different dilutions) was mixed with 2.5 ml of 0.2 N Folin-Ciocalteau reagents and 7 ml distillated water for 3 min and 2.0 ml of 75 g/l sodium carbonate were then added. The absorbance of reaction was measured at 725 nm after 2 h of incubation at room temperature. Results were expressed as gallic acid equivalents.

Ferric Reducing Antioxidant Power (FRAP) Assay

Characteristic parameters of the FRAP method (Benzie and Strain, 1996, 1999) are as follows:

Reagents:

1. 300 mm acetate buffer, pH 3.6 (3.1 g sodium acetate · 3 H2O and 16 ml acetic acid in 1000 ml buffer solution).
2. 10 mm 2,4,6-tripyridyl-s-triazine (TPTZ) in 40 mm HCl
3. 20 mm FeCl3 · 6 H2O in distilled water. FRAP working solution: 25 ml of solution (1), 2.5 ml of solution (2) and 2.5 ml of solution (3). The working solution must be prepared always freshly. The aqueous solution of a known amount of Fe(II) was used for calibration.

Assay: Blank FRAP reagent.

Sample: 1.5 ml FRAP reagent and 50 µl sample solution

Table 1. The effects of flowering stage and drying methods on total phenol and antioxidant properties of Tanacetum balsamita L. ($p \leq 0.01$).

	Growth stage	fresh	microwave	Oven	Sun	shade
phe nol	vegetative	37.06±0.51	40.27±0.15	39.32±0.66	39.42±0.18	37.64±0.7
	flowering	37.06±0.62	41.03±0.46	43.02±1.39	39.63±0.34	40.93±0.61
	after-flowering	37.66±0.69	40.97±0.68	37.36±0.34	39.22±0.13	34.51±0.14
anti oxid ant	vegetative	66.46±1.3	30.64±4.34	45.39±2.22	73.19±1.5	48.40±7.4
	flowering	79.83±0.75	44.30±2.94	53.92±2.56	55.55±1.0.1	15.95±3.16
	after-flowering	29.83±5.62	41.20±1.76	63.45±2.24	82.61±1.12	73.78±0.25

Effects of growth stage and drying methods on total phenolic compound

The changes in total phenol were shown in Table 1. In this study three growth stages were not affecting on total phenol, nevertheless total phenol affected by drying methods. Results showed that in three growth stage total phenol was not significantly different but drying methods were due to changes in total phenolic compounds. In vegetative stage, drying plants by microwave is significantly ($p \leq 0.01$) effected on total phenolic compounds. While drying with shade has minimum effects on total phenolic compounds (37.27). In flowering stage all methods significantly ($p \leq 0.01$) increased total phenolic compounds but drying by oven mainly significantly increased total phenolic compounds and sun-drying has low effect. In after-flowering stage microwave and sun-drying increased total phenol, but shade and oven drying methods decreased.

The phenolic concentrations of the dried shahsparam plant were higher than the concentration of fresh sample due to the moisture loss. In fact, (Martin-Tanguy, 1997) mentioned that phenols could be considered as markers of flowering induction. In this context, some phenolic compounds of Soy stimulate the development of flowers. Further, (Ayan et al. 2007) reported that total phenol content reached the highest level at floral budding in Hypericum hyssopifolium and Hypericum scabrum and at full-flowering in Hypericum pruinatum. Moreover, (Verma and Kasera 2007) indicated that peak concentration of total phenol was observed at flowering stage in Boerhavia diffusa and Sida cordifolia. In thermal methods (microwave, sun and oven) microwave heating is based on the transformation of alternating electromagnetic field energy into thermal energy by affecting the polar molecules of a material. Then the materials can absorb microwave energy directly and convert it into heat. (Kratchanova et al. 2003) found that microwave heating led to the destruction of parenchyma cells in orange peel, while Garau et al. (2007) found that hot-air drying of orange peel around 50-60℃ apparently promoted the minor disruption of cell wall polymers. The intense heat generated from the microwaves and sun creates a high vapor pressure and temperature inside plant tissue, resulting in the disruption of plant cell wall polymers. Consequently, cell wall phenolic compounds or bond phenolics can be released, thus causing phenolic compounds increase in extracted samples. The short time required for microwave drying might have increased the phenolic content of microwave method dried samples. It is also noted that the large drying period for which the product is exposed to the atmospheric oxygen has an adverse effect on some quality aspects like reduction in compound that have phenolic propertie like ascorbic acid (Sarsavadia, 2007). In contrast to the results obtained in this investigation not agree with Lim and Murtijaya (2007) reported that microwave drying caused a greater decrease in the TPC of Phyllanthus amarus than hot-air drying. Thus, the effect of drying methods on phenolic compounds from different materials may not be the same.

Effects of growth stage and drying methods on antioxidant properties

The changes in antioxidant properties were shown in Table 1. In this study antioxidant properties significantly is affected by growth stages and drying methods. Results showed that in vegetative stage antioxidant properties were a significant ($p \leq 0.01$) increased by sun-drying method. While microwave, oven and shade were due to decrease antioxidant properties in vegetative growth stage in Shahesparam medicinal plant.

All phenolic compounds have antioxidant properties. In this study increase in antioxidant properties properties are possible due to agent except of phenols like vitamin C.

In flowering growth stage antioxidant properties was a significant ($p \leq 0.01$) increased. In flowering growth stage all of drying methods decreases antioxidant properties and shade method mostly is decreased. In after-flowering growth stage antioxidant properties was decreased. Antioxidant properties in after-flowering were increased in all of drying methods and sun-drying method was mostly increased antioxidant properties.

Medicinal plants contain numerous phytochemicals in addition to phenolic compounds; however, the various conventional food processing techniques could affect the antioxidant phytochemical and activity.

The reducing property of the Shahesparam was determined by assessing the ability of the Shahesparam, to reduce Fe (III) to Fe (II). This result is in agreement with the result of Y. oshinaga et al. (2002) that sun-drying will influence the radical scavenging activity of Horse mackerel and Sardine.

These results could be mainly attributed to environmental parameters, for example an increase of the content of ultraviolet (UV) radiation associated with an increase in solar radiation received by the plants. The increased temperature and sunshine of plant may have also caused an increasing antioxidant property to protect plants (Too et al., 2004). Therefore, at flowering stage Shahesparam received higher content of light and UV radiations and showed high content of antioxidant capcity than at vegetative and after-flowering, also flower parts in shahsparam have a rich source for antioxidant compounds. Studying seasonal changes of phenolic contents in Boerhavia diffusa and Sida cordifolia (Verma and Kasera, 2007) revealed that the total phenol content increased at the flowering stage as compared to vegetative one.

Reduction in antioxidant activity the shade-dried than sun-dried samples showed in Table 1. These results suggest that antioxidants extracted from shahsparam are light sensitive, even when plants are exposed to indirect light under shade drying.

CONCLUSION

The finding of the present investigation suggests the antioxidant properties and phenolic compounds changed by growth stage and drying methods. It was founds that drying methods and grows stage significantly affect on antioxidant properties and phenolic compounds. Phenolic compounds were increased in flowering stage and drying with microwave but antioxidant properties have extensive changes in shahsparam so that flowering stage increased antioxidants and drying with the sun same. Nevertheless drying with microwave was possible better than methods because of during time for drying plants that were slightly lower than methods. The antioxidant properties value for Microwave-dried sample were lower than other methods but phenolic compounds value for microwave-dried sample were slightly higher than methods.

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