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# **Influence of drying temperatures on essential oil content in savory *Satureja montana* L. (*Lamiaceae*)**

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## **Abstract**

Aromatic and medicinal plants like savory which produce essential oil and other active components are used in medicine and food processing industry as flavor, spice etc. On the market savory is present as dried herb, leaf drug, essential oil, extracts etc. Essential oil glands and trichomes of savory are located on the surface of stems, leaves and calyces, accordingly drying and processing of savory have huge influence on essential oil content in savory drugs.

A research on wild growing savory from the Istrian peninsula was carried out at Polytechnic of Rijeka, Agricultural Department in Poreč. Drying kinetics and influence of drying temperatures (35, 40, 45, 50, 55 and 60°C) were investigated on selected parameters of savory collected in winter 2012, in the area of Rovinjsko selo in Istria, Croatia. The percentage of dried leaves in fresh herb, essential oil content and proportion of dried leaves in fresh and dried herb were defined. The average of initial water content was 80,06 %, essential oil content 0,776 ml100g<sup>-1</sup> and the proportion of dried leaves was 50,56 % in the dried herb. Higher drying temperatures expectedly reduced the essential oil content. The reduction of essential oil content

at 45°C was 14,8 %, while further temperature increase to 50°C resulted with a 59,4 % lower content of essential oil in the drug.

**Key words:** savory, drying temperatures, drying kinetics, leaf drug, essential oil

## Utjecaj temperature sušenja na količinu eteričnog ulja primorskog vrisaka *Satureja montana* L. (*Lamiaceae*)

### Sažetak

Aromatično i ljekovito bilje bogato eteričnim uljem i drugim bioaktivnim tvarima, kao npr. primorski vrisak, se koristi u medicinske svrhe, u prehrambenoj industriji kao aroma ili kao začim. Na tržištu ih pronalazimo u obliku suhe herbe, droge suhog lista, čajeva, u obliku eteričnog ulja i drugih ekstrakata. Kvaliteta droga na tržištu u velikoj mjeri ovisi, između ostalog, o ekološkim uvjetima uzgoja i o daljoj preradi biljne sirovine. Eterično ulje primorskog vrisaka se nalazi u žljezdama lociranim na površini stabljika, listova i cvjetnim čaškama, prema tome, proces sušenja direktno utječe na količinu eteričnog ulja primorskog vrisaka na tržištu.

Ispitivanje samoniklog primorskog vrisaka, kinetike i utjecaja temperatura sušenja na sadržaj eteričnog ulja u osušenoj herbi obavljeno je na Poljoprivrednom odjelu u Poreču, Veleučilišta u Rijeci. Primorski vrisak sa lokacije Rovinjsko selo je ubran u zimskom periodu 2012. godine, određen je % udio lista u svježoj herbi, količina eteričnog ulja i % udio lista u suhoj herbi. Sušenje je obavljeno na temperaturama 35, 40, 45, 50, 55 i 60°C i ispitan utjecaj temperature na gubitak eteričnog ulja. Prosječni početni sadržaj vode u biljnom materijalu je iznosio 80,06 %, sadržaj eteričnog ulja 0,776 ml na 100 g suhog lista, a % udio lista u suhoj herbi je prosječno iznosio 50,56 %. Povišenje temperature sušenja primorskog vrisaka na 45°C uvjetuje gubitke od 14,8 %, dok se daljim povišenjem temperature na 50°C prosječno gubi 59,4 % od ukupnog sadržaja eteričnih ulja.

**Ključne riječi:** primorski vrisak, temperature sušenja, kinetika sušenja, droga lista, eterično ulje

## **Introduction**

Owing to its essential oil content and other active components, *Satureja* is traditionally used for medication and as spice. On the market, winter savory is rarely present fresh, commonly as dried herb, leaf drug, as tea compound, essential oil, or as extracts. Food industry commonly uses the dry form of savory. The essential oil of *Satureja* has been used as a flavouring agent in foods and beverages. Due to its antimicrobial activity, savory has potential as a natural agent for food preservation, extending the shelf life of foods as well (Adiguzel et al., 2006.). The essential oil content and the variability of composition in genus *Satureja* are frequently investigated (Chizzola, 2003; Bivati et al., 2004; Aval et al. 2011, Ibrailu et al., 2010, Ibrailu and Elezi, 2011; Blažeković-Dimovska et al., 2012). In the literature, much research is focused on antioxidant, antibacterial or antifungal (Azaz et al., 2002; Suarez et al. 2003; Gontaru et al., 2008; Zuzarte et al., 2011; Ghotbabadi et al. 2012), as well as on insecticidal properties of genus *Satureja* (Michaelakis et al. 2007; Maedeh et al. 2011). Other investigation types are concentrated on possibilities and effect of companion planting with vegetables such as beans, but also with plants from the onion family, to improve the growth of both species (Kuepper and Dodson, 2001). Plants are capable to preserve agricultural soil (Pohajda 2011, Pohajda 2012) on natural site, greatly reducing erosion (Adiguzel et al., 2006). The location with its characteristics has significant influence on plant quality in cultivation (Dudaš, 2005) as well as on natural vegetation (Erhatic et al., 2011; Dudaš et al., 2013).

Essential oil glands and trichomes on *Satureja* plant are located on the surface of stems, leaves and calyces (Redžić et al. 2006; Dunkić et al., 2007; Satil and Kaya 2007). The quality of *Satureja*, in terms of essential oil content and composition, is primarily defined genetically. Location with environmental and cultivation conditions, harvesting process, transport and primary processing (crushing, drying, separation of stems) as well as storage conditions, effect the quality, especially the essential oil content, colour and other herb parameters. Pre-harvesting and post-harvesting manipulation of the plant material directly effects the overall quality of herbs. Dehidratation of herbs can be performed using different methods. The most popular method is convective drying (Jaloszynski et al., 2008). Sun and oven drying, as primary method of processing, are frequently performed by producers of raw material, often with simple techniques in bad phytosanitary conditions. Currently, there are many investigations and activities focused on drying of agricultural products, including herbs and spices, using recent methods and technology (Soysal, 2005; Pliestić et al., 2007; Rodríguez et al., 2011; Chenarbon et al., 2012, Śledź and Witrowa-Rajchert; 2012).

Drying of agricultural products effects degradation in colour, shrinkage, change in flavour and consistency of raw material etc. According to Arslan et al., 2012 oven drying (50°C)

of *Satureja tymbra* leaves revealed better colour values and less degradation than microwave (700 W) and sun drying. Inappropriate drying temperatures reduce volatile compounds in *Satureja* caused with direct exposition of glands and trichomes on leaves or other plant parts to the heat. Low drying temperatures are more appropriate for herb but prolong the drying process consequently increasing the cost of drying.

The aim of investigation was to determine drying kinetics and to prove influence of six drying temperatures on the drying duration and quality of *Satureja montana* L. collected in Istria.

### **Material and Methods**

Plant material used in this study was wild *Satureja montana* L. collected near Rovinjsko selo/Istria, located 125 m above sea level (N 45°06' 56.98" , E 13°41'55.87"). Savory was collected during the winter period, in December 2012. The identification of plant material was done according to Pericin (2001). The aerial parts of plants were dried at 35°C, 40°C, 45°C , 50°C, 55°C and 60°C using Status drier BY 1103“450 W. Dried aerial parts of *Satureja montana* L. were prepared by separation of leaves from stems. Thirty (30) grams of dried leaves were subjected to hydrodistillation for 2 hours using Clevenger apparatus type. The oil content was calculated as a volume obtained from 100 g dried leaves.

The following parameters were monitored: drying kinetics, dry matter content (%), ratio of leaves in the dried herb (%) and essential oil content (ml100g<sup>-1</sup>). Collected data were statistically analysed using SPSS v. 17.00 for descriptive statistics: standard deviation (SD) and coefficient of variation (s %).

### **Results and discussion**

Table 1 presents basic data of *Satureja montana* L. collected in the winter period. The percentage (%) of dried leaves in fresh herb ranged between 18,50 % and 20,83 % with low variation coefficient of 5,056 %. In average of six samples, leaf ratio to dried herb was 50,56 %, with lowest value of 48,19 %. The percentage of leaves in dried herb presents a quality parameter; a value below 50 % indicates plant material of lower quality. The plant material from the same location in summer ranged between 59,02 % and 66,74 % (Dudaš et al., 2013), depending on the plant developing stage.

The essential oil content in average of six samples ranged between 0,71 and 0,82 ml100<sup>-1</sup> dried leaves. *Satureja montana* collected in the winter period contains a low amount of essential oil.

Table 1: Basic dates of *Satureja montana* L. dried by 35°C

Nr.	% dry leaves in fresh herb	Essential oil content ml100g <sup>-1</sup>	% leaves in dried herb
1	20,72	0,79	48,19
2	19,87	0,81	49,55
3	18,50	0,71	52,11
4	18,62	0,75	54,76
5	19,89	0,82	49,56
6	20,83	0,78	49,21
Mean	19,74	0,776	50,56
± SD	± 0,997986	± 0,040825	± 2,429071
% s	5,056	5,261	4,804

Figure 1 presents weight reduction by drying of plant material through all applied temperatures in function of time. Small samples of fresh material (100 g) were dried at six temperatures, in course of this, changes of the mass were recorded throughout 20 minutes until constant weight in two consecutive times (2 x 20 minutes).

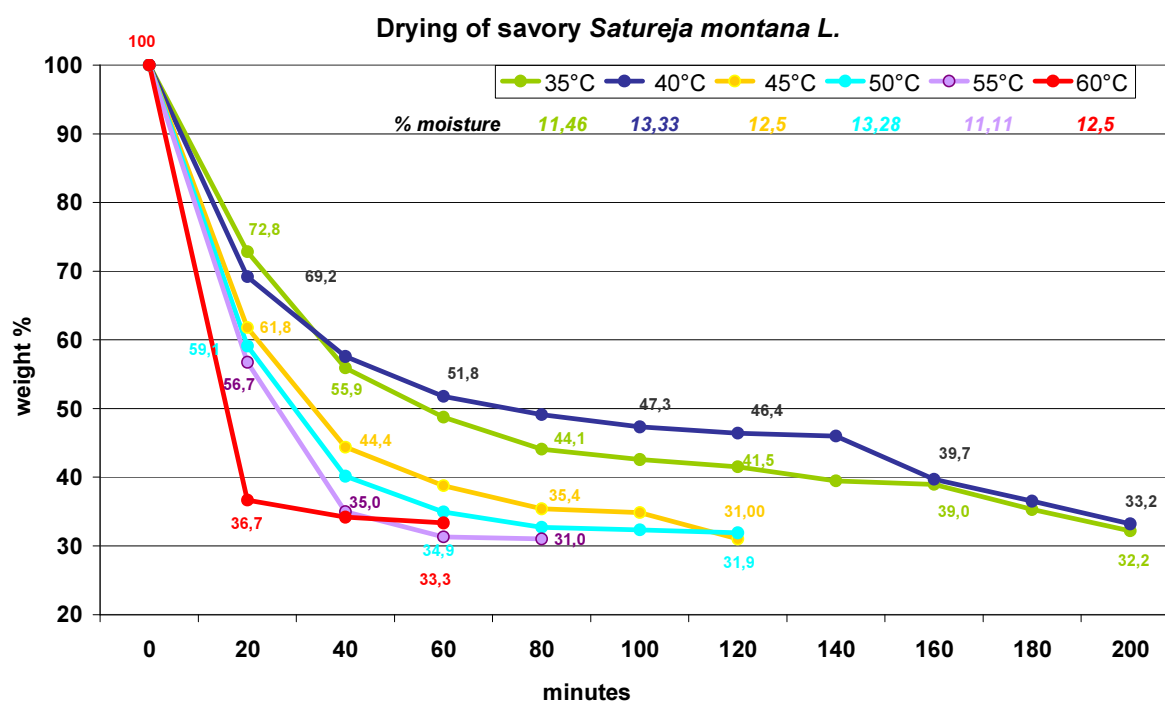


Figure 1: Drying curves of *Satureja montana* L.

Drying rate is directly correlated with temperature (60 minutes by 60°C, 120 minutes by 45°C and 200 minutes by 35°C). The highest changes on mass of the sample were evidenced in the first 20 minutes, the amount of reduction depending on the temperature. The percentage (%) of moisture of plant sample after drying ranged between 11,11 and 13,33 %.

Table 2 presents essential oil content as a function of drying temperatures. Rising temperatures from 35°C to 45°C causes reduction of essential oil by 14,8 %, further increase of temperature till 55°C causes additional reduction with the final loss of 59,4 % of essential oil .

Table 2: Influence of drying temperature on loss of essential oil content in %

Drying temperature °C	Essential oil content ml 100g <sup>-1</sup>	Reduction of essential oil %
35	0,79	-
40	0,73	8,0
45	0,67	14,8
50	0,32	59,4
55	0,29	63,2
60	0,17	78,5
<b>Mean ± SD</b>	<b>0,495 ± 0,265009</b>	
<b>s %</b>		<b>53,54</b>

Descriptive statistics for essential oil content shows a high standard deviation and coefficient of variation by 53,54 % between groups caused by drying temperature. Initial coefficient of variation (s %) for six samples of the same plant material dried at 35°C was 5,261 % (table 1). In order to protect the essential oil content in savory, it is recommended to choose lower temperatures of drying. Sefidkon et al. 2006 concluded in their study (sun drying, shade-drying and oven-drying at 45°C) that drying of *S. hortensis* in the oven at 45°C is more suitable, thus recommending it for obtaining fast drying and high oil content, as well as for high-percentage of carvacrol.

## **Conclusion**

*Satureja montana* L. collected in the winter period near Rovinjsko selo, Istria showed low variation in monitored parameters (ratio of leaves in dried herb with

s=4,802 % and essential oil content with s= 5,261%). The percentage (%) of leaves in dried herb and essential oil content were expectedly lower than in the summer period.

The drying process causes changes in quality of the savory drug. The drying rate is directly correlated with temperature: higher temperatures reduce the time (costs) of drying, but at the same time they reduce the quality of the dried herb. Especially temperatures above 40°C bring reduction in essential oil content higher than 10 %.

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