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Wild-growing Savory *Satureja montana* L. (*Lamiaceae*) from Different Locations in Istria, Croatia

Slavica Dudaš

Polytechnic of Rijeka, Agricultural Department, Poreč, Croatia, sdudas@veleri.hr

Petar Šegon

Polytechnic of Rijeka, Agricultural Department, Poreč, Croatia

Renata Erhatic

College of Agriculture at Križevci, Croatia, rerhatic@mail.vguk.hr

Vesna Kovačević

Polytechnic of Rijeka, Agricultural Department, Poreč, Croatia, vesna.kovacevic@veleri.hr

Abstract

Winter Savory is a well known aromatic and medicinal plant which produces essential oil rich in monoterpenes like carvacrol and p-cymene. Except essential oil, savory contains also other active compounds like rosmarinic and hydroxycinnamic acid. Owing to the active components and pleasant aroma, savory is often used in folk and traditional medicine: as a natural preservative of dried fruits and meat, as flavor in the processing industry and as spice. The Istrian region is well covered with a natural population of savory *Satureja montana* L. An investigation on savory from the natural population of Istria was carried out at the Polytechnic of Rijeka, Agricultural Department in Poreč.

The variability of selected parameters was investigated on savory collected at three locations (Rovinjsko selo, Tinjan and Učka) and at three different dates (12.6., 18.7. and 12.8.2010). Defined were the ratio of dried leaf in fresh and dried herb, dry mass content and essential oil content in the dried leaf. The highest amount of essential oil was detected in plant material from June (2,33 ml100g⁻¹ Rovinjsko selo; 2,11 ml100g⁻¹ Tinjan and 1,83 ml100g⁻¹ Učka), lowest in August (1,11 ml100g⁻¹ Rovinjsko selo, 1,05 ml100g⁻¹ Tinjan and 1,00 ml100g⁻¹ Učka). Regarding to location, the best results were observed in the drugs from Rovinjsko selo and the

lowest from Učka. The proportion of dried leaf to fresh herb of savory ranged between 21,3% and 30,7 % depending on location and harvest date.

Key words: *Satureja montana L.*, collecting, different location, harvest date, leaf proportion, essential oil

Primorski vrisak *Satureja montana L.* (Lamiaceae) sa različitim lokacija u Istri

Sažetak

Primorski vrisak je poznata ljekovita i aromatična biljka sa eteričnim uljima bogatim aromatičnim monoterpenima kao što su karvakrol i p-cimen. Osim eteričnog ulja primorski vrisak sadrži i druge bioaktivne tvari, prije svega ružmarinsku i hidroksicinaminsku kiselinu. Istarska regija je bogata samoniklim primorskim vriskom *Satureja montana L.* Zbog sadržaja bioaktivnih tvari i eteričnih ulja kao i ugodne arome, primorski vrisak se koristi u pučkoj medicini i prerađivačkoj industriji kao aroma i začim, osim toga kao prirodni konzervans pri preradi mesa i skladištenju suhog voća.

Ispitivanje varijabilnosti odabranih parametara herbe i lista primorskog vrisaka iz prirodne populacije istarskog područja i utjecaj termina sakupljanja na kvalitetu primorskog vrisaka obavljeno je na Poljoprivrednom odjelu u Poreču Veleučilišta u Rijeci. Primorski vrisak sa lokacija Rovinjsko selo, Tinjan i Učka je ubran 12.6., 18.07. i 12.08.2010. godine i osušen prirodno na sobnoj temperaturi. Određen je gubitak mase sušenjem, % udio lista u suhoj herbi, % udio suhog lista u svježoj herbi, sadržaj suhe tvari i eteričnog ulja.

Najviši sadržaj eteričnog ulja je utvrđen u drogama iz prvog termina berbe, a najniži u posljednjem terminu berbe (na lokaciji Rovinjsko se sadržaj kretao između 2,33 ml/100 g i 1,11 ml/100 g suhog lista u ovisnosti o terminu berbe). Sadržaj eteričnog ulja je varirao i u ovisnosti o lokaciji u svim terminima berbe (u drugom terminu berbe sa lokacije Rovinjsko selo 1,96ml/100 g, sa lokacije Tinjan 1,33 ml/100g a sa lokacije Učka sa 1,44 ml/100 g suhog lista). Udio suhog lista u svježoj herbi se kretao između 21,3 i 30,7 % u ovisnosti o terminu berbe i lokaciji.

Ključne riječi: *Satureja montana L.*, sakupljanje, lokacija, termin sakupljanja, % udio lista, eterično ulje

Introduction

Satureja montana L. belongs to the botanical family *Lamiaceae* (syn. *Labiatae*) with more than 252 genera and over 7000 species. Genus *Satureja* includes more than 30 species. Frequently widespread in Istria, wild growing *Satureja* is represented with 9 species and subspecies in the natural population of Istria (Pericin, 2001). Summer Savory (*Satureja hortensis* L.) dominates the cultivation (Blažeković-Dimovska et al. 2012). Both, *Satureja hortensis* and *Satureja montana*, are known as excellent companion plants for beans, keeping bean weevils away, and for roses against mildew and aphids (Kuepper and Dodson 2001, Roberts, 2007). Winter Savory (*Satureja montana* L.) is a well known aromatic and medicinal plant which produces essential oil and other active compounds like rosmarinic and hydroxycinnamic acid (Stahl-Biskup, 1998; Chizzola, 2003). The main chemical compounds of essential oil are aromatic monoterpenes which are responsible for characteristic odour and taste (Chizzola, 2003). The typical phenolic compound of *Satureja montana* is carvacrol and the prevailing carvacrol chemotype occurs also in Italy and the former Yugoslavia (Stahl-Biskup, 1998 and Lawrence, 1988). By investigation of essential oil of *Satureja montana* L. from Dalmatia forty-three compounds were identified, representing approximately 99 % of the oil. Major components were carvacrol (44.5%), *p*-cymene (16.9%) and γ -terpinene (8.7%) (Marin et al. 2012). These components are responsible for antimicrobial effects in human medicine (Suarez et al. 2003; Bakkali et al. 2008; Oberg, 2009; Zuzarte 2011; Murgenthath and Pabbithi, 2012) as well as for antimicrobial and insecticidal effect with applying on plants (Biavati et al., 2004; Michaelakis et al., 2007; Dunkić et al., 2010; Mihajlov Krstev et al., 2010, Barbosa et al., 2011; Djenane et al., 2011; Mollaei et al., 2011; Marin et al., 2012). There is also a review about essential oils from *Lamiaceae* plants as weed germination inhibitors (Angelini et al., 2003). Plants have a role in preservation and protection of agricultural soil (Pohajda, 2011; Pohajda 2012): savory binds soil on rocky and eroded slopes growing wild on such sites (Adiguzel et al. 2006). Literature review on essential oil content and oil composition in savory species show that variability depends on the location on the natural site (Chizzola, 2003; Redžić and Pajević, 2006; Ibraliu et al., 2010; Niemeyer, 2010; Ibraliu and Elezi, 2011; Marieschi et al., 2011; Ascun et al., 2012; Aval et al., 2012; Barros et al., 2012; Ghotbabadi, 2012; Rzepa et al., 2012). Growing conditions and agricultural technique, such as the amount and type of fertilizer affects the quality of herbs (Dudaš, et al. 2002; Alizadeh et al., 2010). In

the post harvest period, processing has huge influence on the quality of the aromatical plants: drying type and applied temperature (Soysal, 2005; Piga et al., 2007; Pliestić et al., 2007; Arslan and Özcan, 2011; Śledź and Witrowa-Rajchert, 2012; Chenarbon et al., 2012; Rodriguez et al., 2012) as well as distillation technique (Rezvanpanah et al., 2008; Rezvanpanah et al., 2011).

This investigation was performed to assay the quality of *Satureja montana* L. growing wild on different parts of Istria collected at three different periods.

Material and Methods

The plant material of wild growing *Satureja montana* L. was collected on tree locations in Istria (Rovinjsko selo, elevation 125 m, location (N 45°06' 56.98" , E 13°41'55.87"), Tinjan 259 m over See (45°12'23.18" N and 13°50'08.34" E) and Učka on 466 m over See level (45°19'11.78" N. and 14°10'15.10" E)). The collecting took place in summer 2010 at 12th June, 18th July and 12th August. Identification of collected plant material was done according to Pericin (2001). Aerial parts of plants were dried in the shade at room temperature. Dried aerial parts of *Satureja montana* L. were prepared by separation of leaves from stems, after which grading was done: percentage (%) of water loss by drying, the content of dry mass in the plant and the percentage (%) of part of leaves in dried herb. Thirty (30) grams of dried leaves were subjected to hydro distillation for 2 hours using Clevenger type apparatus. The oil content was calculated as a volume obtained from 100 g dried leaves.

Collected data were analysed using SPSS v. 17.00 for descriptive statistics like standard deviation (SD) and coefficient of variation (s %).

Results

Tables 1-3 show basic dates of collected *Satureja montana*, figures 1-3 show their relationships graphically. In average, weight reduction through drying ranged between 58,34 % and 66,64 %. Figure 1 shows the tendency of reduction in mass, caused by drying, which depended on the collecting period. The dry mass content varied according to locations and time of collecting. Herbs from late summer contained more dry mass than herbs from early summer, with the exception of drugs from Rovinjsko selo in August.

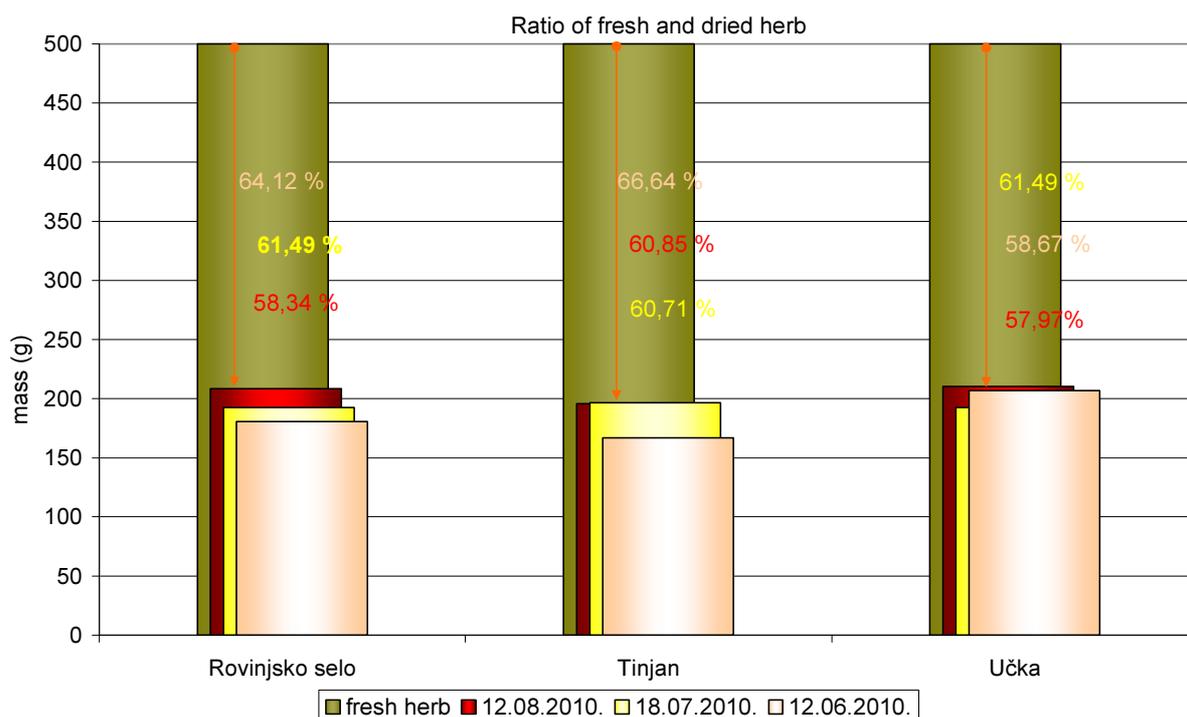


Figure 1: Ratio of fresh and dried savory herbage

The percentage (%) of dried leaf content in fresh herb varied between 20,73 and 29,38 %, in average with 23,95 %, and standard deviation 2,745% (Table 1, Figure 2). After drying and separation of stems from the leaves, from 100 kg of fresh aerial parts of *Satureja*, an average of 24 kg remains as dried leaves drug (Figure 2).

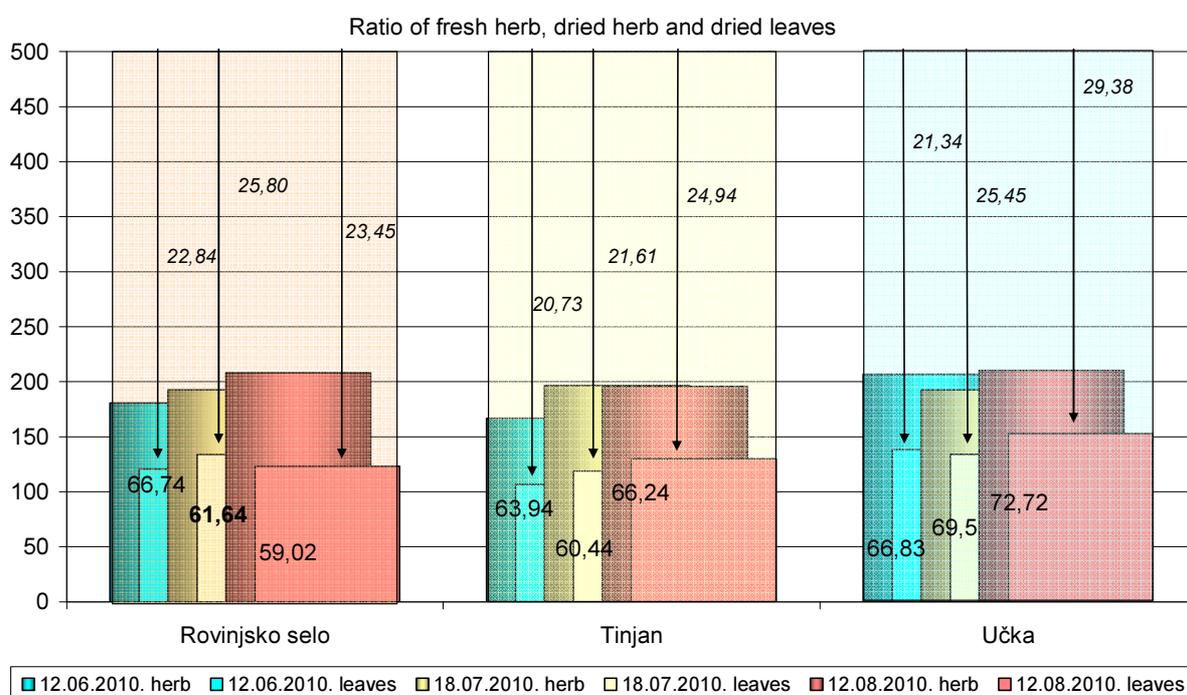


Figure 2: Ratio between fresh, dried herb and dried leaf drug of savory

The percentage (%) of leaf in dried herb ranged between 63,94 and 66,83 % in the first collecting period (Table 2, Figure 3). During the vegetation period, percentages of leaves increased until the flowering period, after which the percentage of leaves to stems decreased. Figure 3 shows the increasing tendency of leaf percentage in dried herb from early to late summer on the coastal location and in the continental part of Istria. As expected, the slowest development had savory from the mountain areas of Učka, while the fastest development showed savory from a good, sunny exposition near Rovinjsko selo. As follows, the percentage (%) of leaf in the dried herb from Rovinjsko selo, which is more coastally located and with flowering that started in August, decreased values towards later summer period. At the same time, savory from Tinjan and Učka developed slower and without flowering till August the 12th, the date of collecting. At this time, savory from Tinjan and Učka were in a high vegetative growth stage and showed increased values of leaf percentage in dried herb.

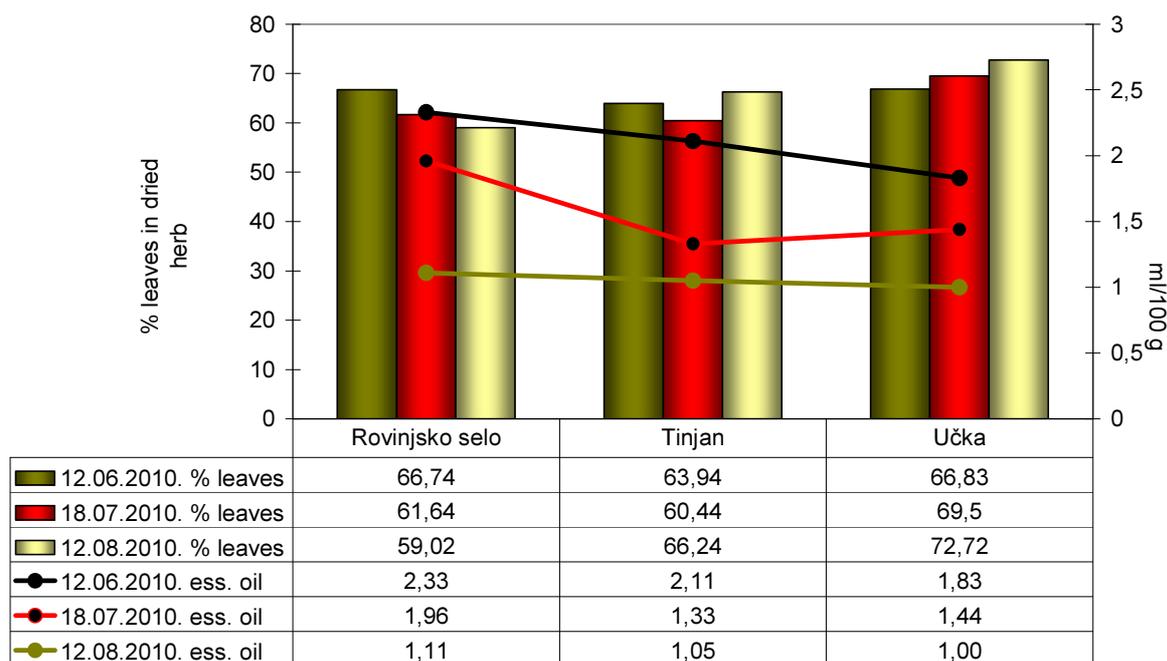


Figure 3: Percentage of leaves in dried herb and essential oil content of *Satureja montana*

Table 3 shows essential oil content depending on location and collecting date. The highest content was detected in the drugs from Rovinjsko selo at all three collecting periods; while the lowest was from plants of the Učka region. Essential oil content varied in dependence to the time of harvesting. A decreasing tendency of essential oil content was detected at all three locations, from early to later summer.

Table 1: Review of parameters by drying of *Satureja montana* aerial parts

Collecting data in 2010	12.06.	18.07.	12.08.	12.06.	18.07.	12.08.	12.06.	18.07.	12.08.	Statistical parameter			
Location/ parameters	Rovinjsko selo			Tinjan			Učka			Min.	Max.	Mean \pm SD	s%
<i>Fresh herb g (Fm)</i>	500,00	500,00	500,00	500,00	500,00	500,00	500,00	500,00	500,00	500,00	500,00	500,00 \pm 0,000	0,00
<i>Dried herb g (Dm)</i>	180,70	192,57	208,30	166,72	196,47	195,77	206,67	192,57	210,17	166,72	210,17	194,43 \pm 13,961	7,18
<i>Mass loss by drying %</i>	64,12	61,49	58,34	66,64	60,71	60,85	58,67	61,49	57,97	57,97	66,64	61,14 \pm 2,820	4,61
<i>Leaves g (10 % moisture)</i>	114,20	129,02	117,27	103,65	108,06	124,7	106,71	127,25	146,88	106,71	146,88	119,74 \pm 13,719	11,46
<i>Dry leaves in Fm (%)</i>	22,84	25,80	23,45	20,73	21,61	24,94	21,34	25,45	29,38	20,73	29,38	23,95 \pm 2,745	11,46
<i>Dry weight (Dw) %</i>	8,80	13,13	9,94	8,64	8,76	10,95	10,65	11,80	14,58	8,64	14,58	10,81 \pm 2,071	19,16
<i>Dry to fresh mass ratio (Dw gg⁻¹)</i>	0,088	0,131	0,099	0,086	0,088	0,110	0,107	0,120	0,146	0,086	0,146	0,108 \pm 0,021	19,44

Table 2: % leaf in the dried herb of *Satureja montana* from three different location in Istria

Collecting data/ Location	12.06.	18.07.	12.08.	Mean \pm SD	s%
Rovinjsko selo	66,74	61,64	59,02	62,47 \pm 3,926	6,28
Tinjan	63,94	60,44	66,24	63,54 \pm 2,921	4,59
Učka	66,83	69,50	72,72	69,68 \pm 2,949	4,23
Mean \pm SD	65,84 \pm 1,64	63,86 \pm 4,92	65,99 \pm 6,85	65,23 \pm 3,89	3,89
s%	2,49	7,70	10,38	5,96	4,94

Table 3: Essential oil content (ml100⁻¹ g dried leaves)

Collecting data in 2010./ Location	12.06.	18.07.	12.08.	Mean ± SD	s%
Rovinjsko selo	2,33	1,96	1,11	1,80 ±0,626	34,77
Tinjan	2,11	1,33	1,05	1,50 ± 0,549	36,60
Učka	1,83	1,44	1,00	1,42 ± 0,415	29,23
Mean ± SD	2,09 ±0,251	1,58 ±0,337	1,05 ±0,055	1,57 ±0,518 1,573±0,200	32,99
s%	12,01	21,33	4,76	12,71	23,11

Conclusion

The aim of investigation was to monitor and analyse variation in quality represented by the selected parameters of *Satureja montana* L. growing wild on different parts in Istria, collected at three different periods. The variability of *Satureja montana* L. was affected by location and date of collecting. The highest coefficient of variation was given in parameter -essential oil content, between dates of collecting with 32,99 %, and between locations with 12,71%. Other parameters, like dried weight, had a coefficient of variation 19,44 %, while the ratio of dried leaf showed high variation with 19,16 %. The lowest value of variation showed the percentage of leaf in dried herb with 3,89 % between locations and 5,96 % variation between dates of collection.

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