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ESSENTIAL OIL COMPOSITION OF *SESELI RIGIDUM* WALDST. FROM BULGARIA

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Abstract

The essential oils of flowers, leaves, stems and roots of *Seseli rigidum* Waldst., wild growing in Bulgaria were analyzed by GC and GC/MS. Their chemical composition was compared on the basis of 39 components in concentration above 0.2%. The oils obtained from overground parts were characterized by high amount of monoterpene hydrocarbons (83.3–90.0%). β-Phellandrene was the major component in the flower and stem oils and its concentration was 47.5 and 63.1%, respectively. Sabinene was the main compound in the leaf oil (39.8%) and also a dominant one in the stem (6.5%) and flower (19.8%) oils. The principal component of root essential oil is Z-falcarinol (48.7%), followed by sabinene (12.4%) and elemol (8.7%).
Key words: *Seseli rigidum*, Apiaceae, essential oil composition

Introduction. The genus *Seseli* L. (family Apiaceae) comprises 34 species distributed in Europe [1]. Some *Seseli* species have been used in folk medicine since ancient time against human inflammation, swelling, rheumatism, pain, common cold as well as exhibited antihelmintic, and carminative activity [2]. In Bulgaria this genus is represented by 9 species [3]. One of them, *S. rigidum* Waldst., is an endemic plant on the Balkan Peninsula [1]. The literature survey revealed three articles dealing with essential oil composition of this species of Serbian origin [4–6].

Herein, we report the chemical composition of the essential oils prepared by microsteam distillation-extraction from separated plant parts (flowers, leaves, stems and roots) of *S. rigidum* wild growing in Bulgaria.

Materials and methods. ***Plant material.*** The plant material was collected from the vicinity of Smolyan (Western Rhodope Mountains, Bulgaria) at flowering stage on 02 August 2011. The plant was separated into flowers (sample F), leaves (L), stems (S) and roots (R) and dried at room temperature.

Isolation of essential oil. The essential oils were prepared from air-dried plant material (4 g) by micro steam distillation-extraction for 2 h in modified Lickens–Nickerson apparatus using diethyl ether as a solvent. The oil yields are presented on Table 1.

Gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS). GC analysis was performed on HP 5890 gas chromatograph (FID), carrier gas nitrogen, linear velocity of 25 cm/s, split ratio of 1:100, fused silica capillary column HP-5MS (poly-5%-diphenyl-95%-dimethylsiloxane), 30 m × 0.25 mm, 0.25 µm film thickness. The injector and detector temperature was 260 °C, column temperature was programmed from 50 °C to 240 °C at rate of 4 °C/min, and 10 min at 240 °C. The quantitative estimation was determined by relative peak area (electronic integration). GC/MS analysis was performed on HP 6890 instrument. All chromatographic conditions and the column were as described above, but the carrier gas was He. The oil components were identified by comparison of their retention indices and mass spectra, with those published in the literature [7, 8] and presented in NIST 98 as well as a library developed by us. A homologues series of n-alkanes (C_5– C_{20}) under the same conditions were used as reference points for calculation of RI.

Results and discussion. The investigated samples showed higher essential oil yield from flowers and leaves (0.56 and 0.40% w/w respectively) and lower one from stems and roots (0.24 and 0.16% w/w respectively). A total of 39 compounds (Table 1) representing 94.7–97.3% were identified.

As it can be seen, the oils from flowers, leaves and stems were characterized by high amount of monoterpene hydrocarbons (89.5, 90.0 and 83.3% respectively), among which β-phellandrene and sabinene were the principal components. The main difference was observed in the percentage ratio of these two components. Their amount was almost equal (37.0 and 39.8%) in the leaves. In flowers and stems, the content of β-phellandrene increased up to 47.5 and 63.1%, while that of sabinene decreased to 19.8 and 6.5% respectively. α-Phellandrene, α-pinene and myrcene were also dominant compounds. γ-Terpinene was another component whose concentration varied significantly from 0.3 and 0.5% in leaves and stems to 5.0% in flowers. The literature survey revealed that sabinene and β-phellandrene have been reported to dominate in oils from *S. globiferum* [9, 10], *S. buchtormense* [11], *S. tortuosum* [12, 13], *S. libanotis* [14], etc. It is worth noting that the high percentage of β-phellandrene (63.1%) in the stem oil of the Bulgar-

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Essential oil composition (%) in different plant parts of *S. rigidum*

RI	Compound	Flowers	Leaves	Stems	Roots
926	α-thujene	0.8	0.4	0.2	0.3
932	α-pinene	3.4	4.0	3.2	0.4
973	sabinene	19.8	39.8	6.5	12.4
975	β-pinene	0.5		0.6	0.3
991	myrcene	3.1	2.8	3.0	0.3
1004	α-phellandrene	7.9	4.6	5.9	0.6
1017	α-terpinene	0.4	0.2		0.5
1024	p-cymene	0.4	0.7	1.0	0.4
1028	β-phellandrene	47.5	37.0	63.1	2.8
1048	*trans*-β-ocimene	0.9	0.5	0.2	0.5
1058	γ-terpinene	5.0	0.5	0.3	0.4
1066	*cis*-sabinene hydrate	0.4	0.2	0.2	0.4
1086	α-terpinolene	0.2	0.2	0.3	
1095	linalool	0.5	0.3	0.4	0.4
1130	terpinene-1-ol			0.7	
1174	terpienene-4-ol	1.4	0.9	0.3	1.3
1183	cryptone		0.6	2.3	0.2
1186	α-terpineol			0.5	
1223	citronelol		0.3	0.5	0.2
1238	cuminal			0.5	
1287	bornyl acetate			0.5	
1290	p-cymene-7-ol			0.5	
1335	δ-elemene	0.3		0.3	
1389	β-elemene		0.2	0.4	0.7
1408	dodecanal			0.5	1.0
1422	β-caryophyllene	0.3	0.3	0.6	1.2
1440	*trans*-β-farnesene				0.5
1452	α-humulene		0.2		1.3
1478	γ-muurolene				0.5
1484	germacrene D	0.9	2.4	2.1	4.2
1500	bicyclogermacrene	0.3	0.3	1.0	1.0
1524	β-sesquiphellandrene				1.5
1531	*cis*-nerolidol				0.6
1553	elemol				8.7
1559	germacrene B		0.4		3.0
1577	spatulenol				0.5
1586	caryophyllene oxide				0.5
1616	Z-asarone	1.9			
2035	Z-falcarinol	0.2	0.5	0.3	48.1
	Monoterpene hydrocarbons	89.5	90.0	83.3	18.5
	Oxygenated monoterpenes	2.3	2.3	5.4	2.5
	Sesquiterpene hydrocarbons	1.8	3.8	4.4	13.9
	Oxygenated sesquiterpenes				10.3
	Aromatic compounds	2.3	0.7	2.0	0.4
	Others	0.2	0.5	0.8	49.1
	Total	96.1	97.3	95.9	94.7
	Oil yield (% w/w)	0.56	0.40	0.24	0.16

ian sample has not been detected so far. Further, oxygenated monoterpenes were found in low concentrations in flowers (2.3%), leaves (2.3%) and roots (2.5%), while their amount in stems was 2.5 times more (6.4%). Cryptone (2.3%) was the main oxygenated monoterpene in the stem oil. Linalool, *cis*-sabinene hydrate, terpinene-1-ol, terpinene-4-ol, α-terpineol, and citronelol were registered from traces up to 1.4%. Flower essential oil differed from those obtained from leaves and stems by the presence of Z-asarone (1.9%). To the best of our knowledge, cryptone is described for the first time in representatives of genus *Seseli*, while euasarone, an isomer of asarone (E/Z), has been previously reported as a component of *S. libanotis* [15]. The results showed that sesquiterpenoids are not characteristic of overground parts of this species. The maximum of sesquiterpene hydrocarbons was found in the stem oil (4.4%) and no oxygenated analogues were detected in aerial plant parts.

Further, *S. rigidum* roots were the poorest in essential oil content, but richest in the number of detected compounds among the studied samples. Although most of the individual components were present in the aerial plant parts, the roots differed in the ratio of the main type of compounds. Thus monoterpene hydrocarbons constituted only 18.5% of the total oil with sabinene (12.4%) as a main monoterpene. β-Phellandrene that was found as one of the major constituents in the oils from overground parts was present in the root oil in small amount (2.8%). Root oil was richer in sesquiterpenoids compared to the oils described above. Thus germacrene D (4.2%), germacrene B (3.0%), β-sesquiphellandrene (1.5%), α-humulene (1.3%) and β-caryophyllene (1.2%) were dominant among sesquiterpene hydrocarbons, while the main sesquiterpenes in the oils of overground parts were germacrene D and bicylogermacrene (0.9–2.4% and 0.3–1.0% respectively). Moreover, oxygenated sesquiterpenes (10.3%) were found in the root oil only. A relatively high percentage of elemol (8.7%) in the studied oil is worth noting. A substantial difference in the amount of Z-falcarinol was also observed. This polyacetylene alcohol was found to be the principal component in the root essential oil (48.1%), while its amount in the other essential oils was less than 0.5%. Polyacetylenes such as falcarinol and falcarindiol are widely spread among the Apiaceae plant family [16].

The observed differences in the oil yield and distribution of terpenoids in the different plant parts of *S. rigidum* are probably due to their needs of the respective compounds as attractants, defence and protection from insects, animals or pathogens (antifungal, antibacterial, etc.).

Finally, the obtained results were compared with those published in the literature for the same species collected in Serbia [4–6]. Monoterpene hydrocarbons seem to be characteristic of *S. rigidum* aerial parts as their amount in all samples is greater than 68% and reaches 90% in the leaves of the Bulgarian sample. However, some qualitative and quantitative differences were observed. Thus β-phellandrene, the major component in our sample, has been detected in traces only in one of the studied Serbian *S. rigidum* [6]. Instead, α-pinene was a dominant compound (48.5–57.4%), while its content did not exceed 4% in our samples. Limonene was absent in the Bulgarian plant, but reached 10% in the Serbian sample. The content of sabinene varied between 6.5 and 39.8% in the different plant parts of *S. rigidum* of Bulgarian origin, while its amount was 1.4, 4.0 and 5.5% in the Serbian samples, respectively [4–6]. The discussed differences could be due to environmental conditions or to existence of chemotypes of this endemic species. Thus the investigation of essential oil of *S. rigidum* needs to be extended to other Bulgarian native populations for clarification of this intraspecific variability.

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