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VOLATILE CONSTITUENTS OF *Satureja isophylla* AND *S. cuneifolia* FROM IRAN

Zohreh Habibi,[1*] Sajjad Sedaghat,[1] Tahereh Ghodrati,[1] Shiva Masoudi,[2] and Abdolhossein Rustaiyan[3]

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The Iranian flora comprises 12 species of *Satureja*, among which 8 species are endemic [1, 2]. Some *Satureja* species are used as flavoring agents and for medical purposes. An infusion of the aerial parts of *S. brevicalix* is used as a digestive, a gastralgic, an antispasmodic, and to help in parturition. A decoction is also used as a vermifuge. The aerial parts are also used in repellent fumigations against insects, and a concentrated decoction is sprayed on stored potatoes to protect them from pests [3].

The extract obtained from the aerial part of *S. obovata* Lag. subsp. *obovata* var. *valentina* was found to be a vascular and intestinal smooth muscle cell relaxant [4].

S. cuneifolia is an important species which is used to produce essential oil and aromatic water in the mountainous regions of the Aegean and Mediterranean parts of Turkey. This species is used as a condiment and a herbal tea for its stimulant, tonic, and carminative actions. K. H. C. Baser et al. has recently found analgetic activity in the oil of *S. cuneifolia* [5].

The constituents of the oil of two *Satureja* species, *S. atropatana* and *S.mutica*, have been the subject of our recent studies [6].

Previous chemical investigation on different species of *Satureja* have shown the presence of flavonoids [7–9], mono- and sesquiterpenoids [10], diterpenoids [11], and triterpenoids [12].

The literature reports some work on the composition of the essential oil of *S. cuneifolia* from Turkey [13, 14].

In this paper we report on the composition of the essential oils from the aerial parts of *S. isophylla* and *S. cuneifolia* growing wild in Iran.

The composition of the oils of *S. isophylla* and *S. cuneifolia* is given in Table 1. In *S. isophylla* oil, 28 components, which represented about 95.6% of the total composition, were identified. The oil of *S. isophylla* consisted of nine monoterpene hydrocarbons (21.1%), three oxygenated monoterpenes (12.1%), eleven sesquiterpene hydrocarbons (24.2%), and five oxygenated sesquiterpenes (38.2%).

α-Eudesmol (24.2%) and β-caryophyllene (12.1%) were the major components in this oil, followed by camphor (9.4%), γ-eudesmol (6.8%), elemol (4.7%), β-bourbonene (4.5%), and camphene (4.4%).

Furthermore, 22 components in the oil of *S. cuneifolia*, which represented about 97.2% of the total oil, were identified.

The oil of *S. cuneifolia* consisted of three monoterpene hydrocarbons (3.0%), ten oxygenated monoterpenes (87.6%), and nine sesquiterpenes (6.6%). The major components of this oil were carvacrol (57.9%) and linalool (22.9%).

The first study on the essential oil of *S. cuneifolia* of Balikesir origin, in Turkey, was reported in 1991. The oil, obtained in 1.89% yield, contained carvacrol (46.36%), *p*-cymene (15.76%), and γ-terpinene (13.04%) as major constituents [13].

In another previous investigation, the essential oils of 19 samples of *S. cuneifolia* from different regions in Turkey have been analyzed by GC and GC/MS. Eleven oil samples were found to be rich in carvacrol (26–72%), in agreement with our research, while in eight samples thymol (22–58%) was the main constituent [14].

1) Department of Chemistry, Shahid Beheshti University, Eveen, Tehran, Iran, e-mail: zohre1340@hotmail.com; 2) Department of Chemistry, Islamic Azad University, Central Tehran Branch, Tehran, Iran; 3) Department of Chemistry, Science & Research Campus, Islamic Azad University, Tehran, Iran. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 597-598, November-December, 2007. Original article submitted July 31, 2006.

TABLE 1. Chemical Composition of the Essential Oils of *Satureja isophylla* and *S. cuneifolia*

Compound	RI	*S. isophylla*	*S. cuneifolia*	Compound	RI	*S. isophylla*	*S. cuneifolia*
α-Thujene	931	0.7	-	β-Gurjunene	1432	0.6	-
α-Pinene	939	3.3	-	α-Humulene	1454	-	0.2
Camphene	953	4.4	-	γ-Muurolene	1477	0.3	-
Sabinene	976	1.8	-	Germacrene D	1480	2.1	-
α-Terpinene	1018	0.8	0.2	β-Selinene	1485	0.2	0.2
p-Cymene	1026	3.7	1.7	α-Selinene	1494	-	0.2
Limonene	1031	3.9	-	Bicyclogermacrene	1494	1.0	-
γ-Terpinene	1062	2.0	1.1	α-Muurolene	1499	0.2	-
cis-Linalool oxide	1074	-	1.7	γ-Cadinene	1513	0.6	0.2
trans-Linalool oxide	1088	-	1.6	δ-Cadinene	1524	2.4	-
Terpinolene	1088	0.5	-	Elemol	1549	4.7	-
Linalool	1098	-	22.9	Spathulenol	1576	0.8	-
Camphor	1143	9.4	-	Caryophyllene oxide	1581	1.7	2.3
Borneol	1165	-	1.1	γ-Eudesmol	1630	6.8	-
Terpin-4-ol	1177	2.3	0.7	β-Eudesmol	1649	-	0.2
α-Terpineol	1189	0.4	0.1	α-Eudesmol	1652	24.2	-
Nerol	1228	-	0.3	7-*epi*-α-Eudesmol	1658	-	0.2
Carvacrol, methyl ether	1244	-	0.6	Total		95.6	97.2
Thymol	1290	-	0.7	Grouped components			
Carvacrol	1298	-	57.9	Monoterpene hydrocarbons		21.1	3.0
α-Copaene	1376	0.2	-	Oxygen-containing monoterpenenes		12.1	87.6
β-Bourbonene	1384	4.5	-	Sesquiterpene hydrocarbons		24.2	3.9
α-Gurjunene	1409	-	0.3	Oxygen-containing sesquiterpenenes		38.2	2.7
β-Caryophyllene	1418	12.1	2.8				

The available literature reports numerous studies on essential oils from *Satureja* species. These studies show that the genus *Satureja* may or may not contain phenols. Phenol-containing species are divided into “carvacrol-type” and “thymol-type.” The oil of *S. cuneifolia* can be assigned to the former group; however, we were unable to find any phenols in the oil of *S. isophylla*.

Carvacrol has also been found as the major component of some other *Satureja* species such as two subspecies of *S. montana* [15], *S. cilicical* [16], and *S. hortensis* [17].

The dominant compounds in the oil of *S. boliviana* and *S. brevicalix* were menthone (24.2% and 35.7%) and isomenthone (29.7% and 25.1%) respectively [18].

The volatile oil of *S. brownei* contained mainly pulegone (64.3%)[19].

In the oil of *S. bachtiarica*, grown in Iran, thymol (44.5%) and γ-terpinene (23.9%) were the major constituents [20].

Thirty-seven components were identified in the oil of *S. atropatana*, which represented about 99.3% of the total composition of the oil.

Carvone (21.5%), menthol (18.1%), 1,8-cineole (13.1%), methyl chavicol (11.1%), and menthone (10.5%) were the major constituents.

Thirty-nine components were identified in the oil of *S. mutica*, making up 95% of the total oil. Menthol (37.4%), menthone (17.2%), and 1,8-cineole (9.3%) were the main components in this oil [6].

Plant Material and Isolation Procedure. The aerial parts of the two *Satureja* species were collected at the following places: *S. isophylla* growing wild in Niknam Village, near Challous Road, Province of Mazandaran, North of Iran; and *S. cuneifolia* from Mianjangal, Fasa, Province of Fars, both in July 2003, during the flowering stage. Voucher specimens were deposited at the Herbarium of the Research Institute of Forests and Rangelands (TARI), Tehran, Iran. The oils of the aerial parts of two plants were obtained by hydrodistillation using a Clevenger- type apparatus for 4 h. After decanting, the oils were dried over anhydrous sodium sulfate. They were isolated in yields of 0.8% and 0.9% (w/w), respectively.

Oil Analysis Procedure. GC analysis was performed on a Shimadzu GC-15A equipped with a split/splitless injector (250°C) and a flame ionization detector (250°C). N_2 was used as carrier gas (1 mL/min). The capillary used was DB-5 (50 m $\times$ 0.2 mm, film thickness 0.32 μm). The column temperature was kept at 60°C (held 3 min) and then heated to 220°C with a 5°C/min rate and kept constant at 220°C for 5 min. Relative percentage amounts were calculated from peak area using a Shimadzu C-R4A chromatopac without the use of correction factors.

GC/MS analysis was performed using a Hewlett-Packard 5973 with a HP-5MS column (30 m $\times$ 0.25 mm, film thickness 0.25 μm). The column temperature was kept at 60°C for 3 min and programmed to 220°C at a rate of 5°C/min and kept constant at 220°C for 5 min. The flow rate of helium as carrier gas was 1 mL/min. MS were taken at 70 ev.

Identification of the constituents of each oil was made by comparison of their mass spectra and retention indices (RI) with those given in the literature and those of authentic samples [21].

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