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Original Article

Chemical Composition of the Essential oil of *Satureja bachtiarica* Bunge. from Iran

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Abstract

Due to various usages of *Satureja* species or their oils, we were interested in studying essential oil contents and compositions of *Satureja* species in Iran. So, the essential oil of aerial parts of *Satureja* bachtiarica Bunge. growing in Iran was obtained by hydrodistillation and was analyzed by GC-MS. Twenty eight compounds constituting 99.80% of the oil were identified and yield of the oil was 2.7% (V/W). The major components were found to be thymol (65.1%), γ-terpinene (15.0%), β-caryophyllene (4.85%), p-cymene (4.4%), linalool (3.5%) and borneol (3.05%).

Keywords: Essential oil; *Satureja*; hydrodistillation; thymol.
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1. Introduction

Satureja is a member of Lamiaceae: Nepetoideae, mainly distributed in the Mediterranean region. The genus embraces over 30 species whose center of distribution is located in the eastern part of the Mediterranean. In Iran, 14 species are present in northern, northwestern and western parts [1]. The genus of *Satureja* with the Persian name of *"Marze"* consists of 14 species in Iran, 9 of them are endemic. One of these endemic species is *Satureja* bachtiarica [2]. These are annual or perennial semi-bushy aromatic plants that inhabit arid, sunny, stony and rocky habitats [3]. Its strong aromatic odor is due to the presence of volatile oils especially thymol. Aerial parts of some species of *Satureja* are used widely as a flavoring agent for much kind of food products and also as a traditional herbal medicine for the treatment of gastrointestinal disorders. So, the essential oil composition and antimicrobial activities of some *Satureja* species have been studied.

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2. Materials and methods

In this work, the plant material was collected from Sepidan near Shiraz, Fars Province, Iran in May 2008. A voucher specimen has been deposited in the herbarium of the Faculty of Pharmacy, Shiraz University of Medical Sciences, Shiraz, Iran (No: 67). The aerial parts were air-dried at ambient temperature and hydroditilled using a Clevenger-type apparatus for 4 h. The oil was yellow in color. It was dried over anhydrous

sodium sulphate and stored at 4-6 °C.

GC/MS analysis was carried out using a Hewlett-Packard 6890/5973 equipped with a HP-5 capillary column (phenyl methyl siloxane, 25 m×0.25 mm i.d) with He as the carrier gas with velocity of 0.9 ml/min and split ratio, 1:20. Oven temperature was performed as follows: 60 °C (3 min) to 240 °C at a rate of 3 °C/min; Electron ionization energy for MS detection was 70 eV. The Injector and MS transfer line temperatures were set at 250 °C. Kovat's Indices (KI) was determined by using retention times of *n*-alkanes that were injected after the essential oil under the same chromatographic conditions. The components of the oil were identified by calculation of Kovat's Indices (KI) and by comparison of their mass spectra with the Wiley library or with the published mass spectra [4-5].

3. Results and discussion

The constituents of the essential oil of *Satureja bachtiarica* Bunge with yield of 2.7% (V/W) are presented in Table 1. Twenty eight compounds were identified in the oil and the percentage of monoterpene hydrocarbons and phenolic compounds were 93.88% and 65.1%, respectively. The main constituents of the oil were thymol (65.1%), γ-terpinene (15.0%), β-caryophyllene (4.85%), *p*-cymene (4.4%), linalool (3.5%) and borneol (3.05%). The sample studied by us was different from the other researches. According to Sefidkon and Jamzad [2], carvacrol (49.3%), *p*-cymene (12.7%), trans-α-bergamotene (5.8%) and thymol (4.5%) were identified in Fars's sample. But in Yazd's sample in the same report, carvacrol (66.5%), p-cymene (15.2%) and linalool (4.6%) were found. Whereas in our investigation, thymol was 65.1% and we did not identify any carvacrol.

The essential oil isolated by steam distillation from the aerial parts of *S. bachtiarica*, collected from Chohar Mahal-e-Bachtiari province (southwest of Iran) at the flowering stage, showed the major components were thymol (44.5%), γ-terpinene (23.9%), *p*-cymene (7.3%), β-caryophyllene (5.3%) and borneol (4.2%) [7]. The result indicates highest amount of thymol in current research.

Analysis of essential oil in other *Satureja* species was investigated, too. For example, chemical composition and antioxidant and antimicrobial activity of two *Satureja* essential oils in Bosnia and Herzegovina was done [8]. The major constituents of essential oils obtained from the plant material of S. *montana*, collected from two different localities (Trebinje and Konjic), were thymol (31.7%) and geraniol (22.3%), respectively. In this work, the most abundant compounds in the essential oils of *S. subspicata* collected at two different stages of development were thymol (28.6%), and spathulenol (37.6%). The screening of antimicrobial activity of essential oil samples was individually evaluated against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Bacillus subtilis* using a paper disc diffusion method. All tested microorganisms were inhibited by essential oil samples. Antioxidant activity was tested using the DPPH radical-scavenging method. All samples showed activity comparable to thymol, which was used as a positive probe.

In another study, the aerial parts of *Satureja khuzistanica* Jamzad and *Satureja bachtiarica* Bunge were collected at two stage of plant growth (before flowering and full flowering) from their natural habitats [6]. After drying the plant materials in shade, essential oils were obtained by hydrodistillation and analyzed. The results showed the oil of S. bachtiarica contained 36.5% p-cymene, 19.9% carvacrol, 19.2% thymol and 9.1% γ-terpinene before flowering. 25.2% p-cymene, 25.8% carvacrol, 18.5% p-menth-3-en-8-ol, 5.0% thymol and 4.3% pulegone at full flowering stage were found as main components. The oil of *S. khuzistanica*, contained 88.9% and 91.4%

Table 1. Composition of essential oil of Satureja bachtiarica Bunge from Iran.

Peak No.	Components	KI (HP-5)	% in oil	Identification
1	Thujene-α	929	0.14	MS, KI
2	α-Pinene	937	0.15	MS, KI
3	Camphene	952	0.15	MS, KI
4	β-Pinene	979	0.05	MS, KI
5	Myrecene	989	0.4	MS, KI
6	α-Phellandrene	1006	0.1	MS, KI
7	δ-3-Carene	1011	0.02	MS, KI
8	α-Terpipene	1020	1.10	MS, KI
9	p-Cymene	1025	4.4	MS, KI
10	Limonene	1034	0.21	MS, KI
11	cis-Ocimene	1042	0.12	MS, KI
12	trans-β-Ocimene	1053	0.13	MS, KI
13	γ-Terpinene	1060	15.0	MS, KI
14	cis-Sabinene hydrate	1076	0.2	MS, KI
15	Terpinolene	1091	0.06	MS, KI
16	Linalool	1112	3.5	MS, KI
17	Borneol	1177	3.05	MS, KI
18	Thymol	1290	65.1	MS, KI
19	α-Gurjuene	1410	0.11	MS, KI
20	β-Caryophyllene	1427	4.85	MS, KI
21	Aromadendrene	1442	0.12	MS, KI
22	a-Humulene	1456	0.21	MS, KI
23	Alloaromadendrene	1462	0.1	MS, KI
24	Ledene	1495	0.2	MS, KI
25	β-Bisoblene	1510	0.1	MS, KI
26	γ-Cadinene	1515	0.02	MS, KI
27	δ-Cadinene	1524	0.04	MS, KI
28	Caryophyllene oxide	1585	0.17	MS, KI
	Identification		99.80	
	Monoterpene hydrocarbons		93.88	
	Sesquiterpene hydrocarbons		5.92	
	Alcoholic compounds		6.75	
	Phenolic compounds		65.1	

Note: The compounds have been sorted according to retention indices on HP-5 MS capillary column.

carvacrol at before flowering and full flowering stage, respectively. Due to the antimicrobial effects of phenolic compounds, thymol and carvacrol, in this investigation, the antimicrobial effects of these oils were determined against five gram positive bacteria *Bacillus subtilis, Bacillus cereus, Micrococcus loteus, Staphylococcus sp.* and *Staphylococcus areous* and three gram negative bacteria *Kellebsiella pneumonia, Kellebsiella oxytoca* and *Pseudomonas aeroginosa*. The result showed the oil of S. khuzistanica had strong antibacterial effect in both harvesting stage. The antibacterial effect of *S. bachtiarica* oil was stronger before flowering stage, because of more percentage of phenolic compounds. So these oils can be used instead of synthetic antibiotics that their resistance against bacteria increased daily.

On the other hand, the effect of distillation methods and stage of plant growth on the essential oil content and composition of *Satureja rechingeri* Jamzad was investigated [9]. The aerial parts of *S. rechingeri* were collected in two stages of plant growth (at the beginning of and full flowering stage) from Ilam province in the west of Iran. The essential oils were isolated by steam, hydro- and water-steam-distillation from the aerial parts at complete flowering stage. In addition, the

Table 2. Percentage of phenolic compounds in some species Satureja.

Satureja species	Carvacrol (%)	Thymol (%)	Yield of the oil % (W/W)	Collection site	Collection date	Reference
S. spicigera	4.0	35.1	3.82	Gilan	2002	1
S. bachtiarica	49.3	4.5	2.15	Fars	-	2
S. bachtiarica	66.5	0.3	1.65	Yazd	-	2
S. bachtiarica	19.9-25.8	5-19.2	-	Shahrekord	-	6
S. khuzistanica	88.9-91.4	-	-	Poldokhtar	-	6
S. Montana	23.3	31.7	-	Trebinje	2005	8
S. montana	10.6	3.8	-	Konjic	2005	8
S. subspicata	27.9	28.6	-	Konjic	2005	8
S. subspicata	0.3	0.1	-	Konjic	2005	8
S. mutica	30.9	26.5	2.31	Khorasan	-	10
S. macrantha	0.4	8.1	1.48	Azarbayejan	-	10
S. intermedia	1.0	32.3	1.45	Ardebil	-	10

essential oil of plant material at the beginning of flowering was obtained by hydrodistillation. The highest oil yield was obtained at the beginning of flowering 4.72% (w/w). The oil yields at full flowering stage were 2.46–4.24% (the highest is for hydrodistillation and the lowest is for steamdistillation). The main components in all of the oils were carvacrol 84.0–89.3%. This article showed *S. rechingeri* can be introduced as a rich carvacrol source in the complete flowering period.

In a report from Iran, thymol was known as a major compound in *S. spicigera* that was collected from Roodbar in Gilan province (northern of Iran) [1]. This research showed the comparison of results with that of other *Satureja* species showed that the oil composition of *S. spicigera* is like that of *S. bachtiarica*.

In Table 2, there is percentage of thymol, carvacrol and yield of some species *Satureja*. It was seen the percentage of phenolic compound, such as thymol and carvacrol in species of *Satureja* is different. Also, comparison between our sample with other samples and different species of *Satureja* showed that the amount of thymol in our sample was high and we did not have any carvacrol. These results show that the amount of carvacrol and yield of essential oil of species *Satureja* is different and these differences can be due to ecological factors or species variations. Finally, our studies released highest amount of thymol amoung *Satureja* oil analysis reported, previously. Due to wide range application of thymol current chemo type could be a good candidate for further study.

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