



## Chemical characterization of volatile oils of different parts of *Satureja Bachtarica* Bunge

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### ABSTRACT

In this study, essential oils from different organs of *Satureja bachtiarica* Bunge were obtained by hydro-distillation. Quality and quantity of chemical composition of essential oils were determined by capillary gas chromatography and using gas chromatography and mass spectrometric detection. The numbers of compounds were identified in the essential oils of leaves; stem and aerial parts were 45, 39 and 35, respectively. Also, carvacrol was the main component found in essential oils from leaves (39.3%), stem (39.4%) and aerial parts (67.88%) of *S. bachtiarica* in flowering stage. In addition, results showed that there were some different in compositions of the essential oils of different parts of *S. bachtiarica* and there are some minor components in each oil that are not present in the others parts. In addition chemical analysis of essential oils obtained from leaves and stem of *S. bachtiarica* were rich in oxygenated monoterpenes (55.64% and 67.53%) while oxygenated monoterpene (77.22%) were the main class of compounds in the essential oils from aerial parts of *S. bachtiarica*. Results of this study showed that the essential oils from different organs of *S. bachtiarica* have a potential to be used as a new carvacrol source in drug and food industries.

### Keywords

*Satureja bachtiarica*; Lamiaceae; essential oil; carvacrol; 4-terpineol.



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## INTRODUCTION

The genus *Satureja* belongs to the family *Lamiaceae*, subfamily *Nepetoideae* and the tribe *Saturejeae*, and comprises more than 200 species of herbs and shrubs, mainly distributed in the Mediterranean region. The flora of Iran has 14 *Satureja* species; nine species are endemic, which commonly found in Rocky Mountains [1-4]. *Satureja bachtiarica* Bunge., one of these species, is an aromatic herb with little flowers (1.5 mm), linear to lineoblanceolate leaves that complexes on stem, the under and surface of their leaves are hire-covered and it grows wild on rocky or eroded slopes, gravelly places and coastal dunes, fallow fields and roadsides, in west, center and southwest in Iran [5].

One of the diagnostic characteristics of the subfamily *Nepetoideae* is that its representatives contain more than 0.5% of essential oil, and *Satureja hortensis* L. and *Satureja montana* L. are two notable *Satureja* species in the world that have several uses in medicinal and food industries [6, 7]. The leaves, flowers and stems of *Satureja* species are used as herbal tea, in production of traditional medicine to treat various ailments such as cramps, muscle pains, nausea, indigestion, diarrhea and infectious diseases [8-11]. In addition, it is reported that a 3 infusion of the aerial parts of *S. breviculix* is used as a digestive, a gastralgie, an antispasmodic and to help in parturition [8]. *Satureja kitaibellii* is used to treat bronchitis in adults and children, while also used to treat skin, respiratory, digestive and urinary inflammation. An infusion of *S. brownei* is used as a remedy for respiratory diseases and cough [12]. In the recent years, several studies to investigation the biological properties of active substance extracted from *Satureja* species, such as extracts, essential oils and their constituents, planned and as a result, antiviral, antinociceptive, anti-inflammatory, antibacterial, antifungal, antispasmodic, antidiarrhea and vasodilatory activity of these substances documented [3, 6, 13, 14].

Due to these properties and usages of *Satureja* species or their oils, many phytochemical studies so far investigated the chemical composition of essential oil from *Satureja* species from different sources and chemotypes as well as its variation in different seasons and during the plant life cycle [4, 15-17]. In addition, chemical characterization of essential oils from five endemic *Satureja* species of Iran, *S. bachtiarica* [18], *Satureja khuzistanica* Jamzad [6] *Satureja intermedia* C.A. Mey. [19] *Satureja sahandica* Bornm. [16] and *Satureja rechingeri* Jamzad [4] were reported previously.

The major compounds found in *S. bachtiarica* oil were thymol (44.5%) and  $\gamma$ - terpinene (23.9%). The oil of *S. khuzistanica* was particularly rich in *p*-cymene (39.6%) and carvacrol (29.6%). Thymol (19.6–41.7%), *p*-cymene (32.5–54.9%) and  $\gamma$ - terpinene 4 (1.0–12.8%) were the main components of *S. sahandica* oil, while that the major compound of *S. rechingeri* was carvacrol (84.0–89.3%). At the same time, *S. intermedia* oil contained thymol (32.3%),  $\gamma$ -terpinene (29.3%) and *p*-cymene (14.7%).

Essential oils are aromatic oily liquids obtained from different plant materials. They are highly complex mixtures of mono (C10) and sesquiterpenes (C15), including biogenetically related phenols [20, 21]. Biological activities of essential oils depends on the qualitative and quantitative of their components, which it is affected by the plant genotype, plant chemotype, organ of plant, geographical origin, season, environmental, agronomic conditions, extraction method and storage condition of plant and essential oils [22, 23].

Until now, we have found only one published report on phytochemical composition of *S. bachtiarica*, therefore, in the present study for the first time; essential oils of stem, leaves and aerial parts of *S. bachtiarica* were obtained separately and analyzed by GC and GC-MS.

## RESULTS AND DISCUSSION

The results obtained by GC and GC-MS analyses of the essential oils used in this study are presented in Table 1. The oils were yellow in color and had distinct sharp odor. The yield of essential oils distilled from leaves, stem and aerial parts of *S. bachtiarica* were 1.54%w/w, 0.98% and 1.32%, respectively. Also, total ion chromatograms of volatile compounds from leaves, stem and aerial parts of tested plant were shown (Fig. 1-3).

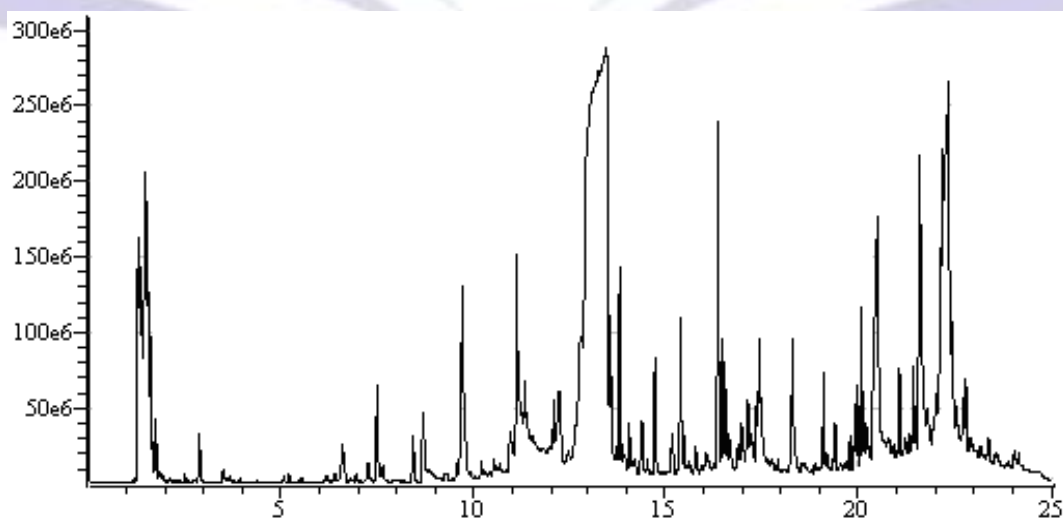


Fig. 1. GC-MS total ion chromatograms of volatile compounds from leaves of *S. bachtiarica* Bunge.

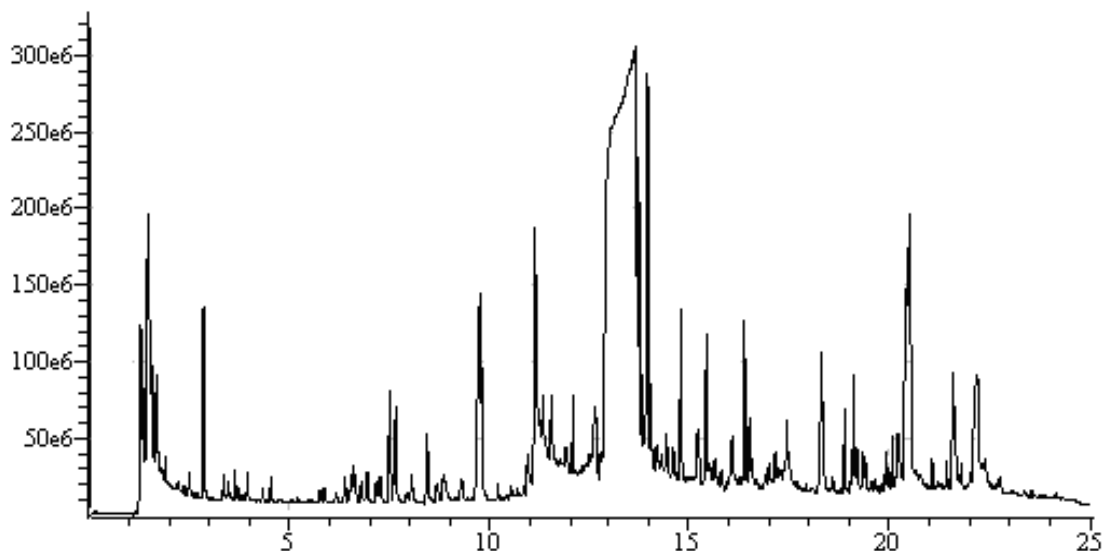


Fig. 2. GC-MS total ion chromatograms of volatile compounds from stems of *S. bachtiarica* Bunge.

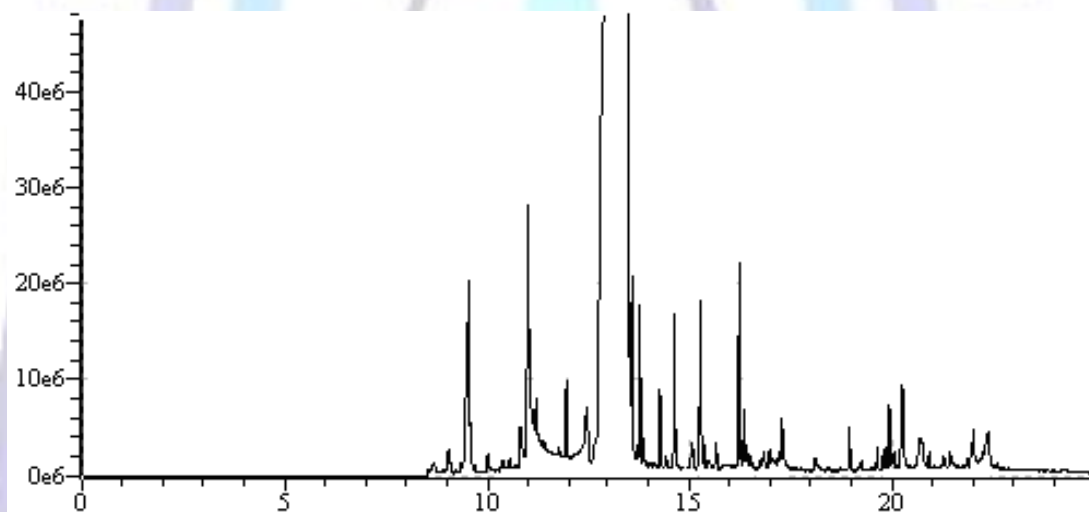


Fig. 3. GC-MS total ion chromatograms of volatile compounds from aerial parts of *S. bachtiarica* Bunge.

In the leaf essential oil, forty-five constituents, representing 88.11% of the total components in the oil characterized. The major compounds were carvacrol (39.3%), palmitic acid (5.13%),  $\alpha$ -terpineol (3.21%), 4-terpineol (2.62%) and linalool (2.08%). The stem essential oil characterized by thirty-nine constituents, representing 93.50% of the total components in the oil and its major compounds were carvacrol (39.40%), palmitic acid (9.49%), 4-terpineol (5.40%), linalool (5.10%) and  $\alpha$ -terpineol (2.79%), respectively. In addition chemical analyses of essential oils obtained from leaves and stem of *S. bachtiarica* contained oxygenated monoterpenes (55.64% and 67.53%), oxygenated sesquiterpenes (15.14% and 20.12%), sesquiterpenes (1.36% and 2.02%) and monoterpenes (0.75% and 1.94%), respectively (Table 1). In addition, Thirty five constituents, representing 89.01% of the total components in the oil of aerial parts of *S. bachtiarica*, identified and its major compounds were carvacrol (67.88%), 4-terpineol (2.93%), linalool (2.56%) and *p*-cymene (1.85%). Also, oxygenated monoterepen (77.22%), monoterepen (4.48%), oxygenated sesquiterepen (3.4%) and sesquiterepen (2.74%) were the main class of compounds in the aerial parts of *S. bachtiarica* (Table 1).

**Table 1.** The chemical composition of essential oils obtained from leaves, stem and aerial parts of *Satureja Bachtiarica* Bunge

No	Compounds	RI *	Essential oils		
			Leaves (%)	Stem (%)	Aerial parts (%)
1	$\alpha$ -Thujene	930	0.03	0.03	0.15
2	$\alpha$ -Pinene	939	0.03	0.05	0.20
3	$\beta$ -Myrcene	991	0.05	----	0.58
4	$\alpha$ -Phellandrene	1003	0.03	----	0.08
5	$\beta$ -Phellandrene	1030	----	0.05	----
6	$\alpha$ -Terpinene	1017	0.05	0.18	0.47
7	<i>p</i> -Cymene	1025	0.65	1.66	1.85
8	$\gamma$ -Terpinene	1060	0.23	1.05	1.18
9	cis-Sabinene Hydrate	1070	0.73	----	0.49
10	trans-Linalool oxide	1073	0.06	----	----
11	trans-Sabinene hydrate	1098	0.06	----	----
12	Terpinolene	1089	----	----	0.25
13	Linalool	1097	2.08	5.10	2.56
14	1,8-Cineol	1031	0.05	1.71	0.10
15	Camphor	1146	----	0.03	----
16	cis-Limonene oxide	1137	----	0.03	----
17	<i>P</i> -Menth-2-en-1-ol	1131	0.09	----	----
18	trans-Pinene hydrate	1123	0.06	0.16	----
19	trans-Pinocarveol	1139	----	----	0.06
20	Cuminal	1242	----	0.80	----
21	Borneol	1169	0.74	0.83	0.44
22	4-Terpineol	1177	2.62	5.40	2.93
23	<i>p</i> -Cymene-8-ol	1183	0.37	1.18	----
24	$\alpha$ -Terpineol	1189	3.23	2.79	1.25
25	Cis-Dihydro carvone	1193	----	----	0.28
26	trans-Dihydro carvone	1201	----	1.20	----
27	cis- <i>p</i> -Menth-1(7),8-diene-2-ol	1231	0.53	----	----
28	Thymol methyl ether	1235	1.50	1.32	0.32
29	Decanal	1197	1.21	2.63	----
30	Carvacrol	1299	39.30	39.40	67.88
31	Eugenol	1359	0.91	2.38	0.66
32	Thymyl acetate	1352	0.36	----	----
33	trans- $\beta$ -Damascenone	1358	0.13	0.09	----
34	trans-Caryophyllen	1419	0.43	0.19	0.42



35	Geranyl acetone	1455	0.66	----	0.79
36	$\beta$ -Ionene	1489	0.39	0.59	0.26
37	$\beta$ -Bisabolene	1506	0.88	1.31	1.19
38	Cis-Nerolidol	1533	----	1.20	----
39	$\alpha$ -Humulene	1455	0.09	----	0.08
40	trans-Nerolidol	1563	0.05	----	T0.03
41	Cis- $\alpha$ -Bisabolene	1507	----	0.12	----
42	Dodecanoic acid(lauric)	1567	0.57	1.46	----
43	Caryophyllene oxide	1583	1.58	2.09	1.37
44	$\beta$ -Eudesmol	1651	0.90	0.92	0.36
45	Spathulenol	1578	0.63	0.10	----
46	10-epi- $\gamma$ -Eudesmol	1624	0.45	0.08	0.03
47	Elemol	1550	0.03	----	0.06
48	Guaiol	1601	0.59	----	----
49	Agarospinol	1648	0.83	0.94	0.09
50	$\alpha$ -Bisabolol	1686	1.93	1.05	0.51
51	Farnesol	1701	0.03	----	----
52	Tetra decanoic acid(Myristic)	1750	1.74	3.05	0.09
53	Farnesyl acetone	1865	0.52	0.88	0.05
54	Palmitic acid	1938	5.13	9.49	0.87
Total			88.11%	93.5%	88.11%
Yield % (w/w)			1.54%	0.98%	1.23%
Monoterepen			0.75	1.94	4.48
Oxygenated monoterepen			55.40	67.53	77.22
Sesquiterepen			1.36	2.02	2.74
Oxygenated Sesquiterepen			15.14	20.12	3.40

\* Retention indices

Results showed that there were some different in compositions of the essential oils of different parts of *S. bachtiarica* and there are some minor components in each oil that are not present in the others parts.

The essential oils from leaves, stem and aerial parts of Iranian *S. bachtiarica* have been planned for the first time and the chemical composition these organs compared with oil contents and compositions of the other *Satureja* species. Assessment prevalent compounds available in different parts of *S. bachtiarica* showed that carvacrol is the main component in leaves, stem and aerial parts of plant (39.3%, 39.4% and 67.88%), respectively and the percentage of carvacrol in aerial parts were higher than plant leaves and stems. These results were in agreement with report of [18] that stated thymol (44.5%) was the main component available in essential oil extracted from *S. bachtiarica*. On the other hand, comparison of the major components of other *Satureja* species with our study showed that our results were agree with results of [19] and [4] that reported carvacrol is the prevalent constituent in their studied *S. mutica* (30.9%) and *S. rechingeri* (89.3%). But in this respect, there were differences with other species such as *S. spicigera* [27]. *S. sahendica* [16], *S. intermedia* [19] that thymol were their major components.

The percentages of essential oils were acceptable on comparison with other *Satureja* species. The highest oil yield was obtained from *S. mutica* (2.31%) and the oil yields of both of the other species were about 1.5%. Due to the high amounts of carvacrol, and other terpenoids in the oils of *S. bachtiarica* and similarity of the oil composition to *S. hortensis* and *S. montana*, it can be concluded that the herbs and essential oils of *S. bachtiarica* can be used as flavoring agents in food and also in the medicinal and perfume industries. The low amounts of phenols, of *p*-cymene and linalool in the oil of *S.*



*bachtiarica*, suggest that this plant could have specific usage in the medical industry. This should be tested in further research.

## EXPERIMENTAL SECTION

### Planet Material

The fresh leaves stem and aerial spices of *Satureja bachtiarica* Bunge were collected during the flowering stage of plant from Highland of Zagros Mountain (1600-2200 m above sea level) in Ilam province in the West of Iran, in April 2008. All samples were air dried and stored at room temperature in darkness until distillation.

### Extraction of the Essential Oil

The essential oil of all air-dried samples (100 g) was isolated by hydro-distillation for 2- 4 h, using a Clevenger-type apparatus according to the method recommended in British Pharmacopoeia [24]. The distilled oils were dried over anhydrous sodium sulfate and stored in tightly closed dark vials at 4 °C until use and further analysis.

### GC and GC/MS Analysis

GC analyses were carried out on a Shimutzu 17A gas chromatograph equipped with a FID (Flame Ionization Detector) and a BP-10 (non-polar) capillary column (30 m×0.32 mm; 0.25 µm film thickness). The oven temperature was held at 60 °C for 3 min then programmed at 5 °C /min to 260 °C. Other operating conditions were as follows: Carrier gas He, at a flow rate of 5 ml/min; injector temperature 230 °C; detector temperature 245 °C; split 40, column flow ratio, 1:8ml/min. GC/MS analyses were performed on a Shimutzu 17A GC coupled with Shimutzu QP5050A Mass system. The operating conditions were the same conditions as described above but the carrier gas was He. Mass spectra were taken at 70 eV. Mass range was from m/z 50–500 amu. Quantitative data was obtained from the electronic integration of the FID peak areas. The components of the oil were identified with the comparison of their mass spectra and retention indices with those published in the literature [25, 26] and presented in the MS computer library (WILEY229.L and NIST 1998).

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