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Essential Oil Composition of *Salvia tebesana* Bunge (Lamiaceae) from Iran

Seyed Mostafa Goldansaz [*1], Mohammad Hossein Hakimi Meybodi [2], Ali Mirhosseini [3] and Mohammad Hossein Mirjalili [4]

[1]*Department of Natural resources, Sari University of Agricultural Sciences and Natural Resources, Sari, Iran*
[2] *Natural Resources and Desert Studies, Faculty of Natural Resources and Eremology, Yazd University, Yazd, Iran*
[3] *Natural Resources and Agricultural Education and Research Center, Yazd, Iran*
[4] *Department of Agriculture, Medicinal Plants and Drugs Research Institute, Shahid Beheshti University, G. C., Tehran, Iran*

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Abstract: *Salvia tebesana* Bunge (Lamiaceae) is an endemic medicinal species which grows wild in center of Iran. In the present study, chemical composition of the essential oil of the plant at two developmental stages (vegetative and full flowering) was reported for the first time. The essential oils were obtained by hydrodistillation from air-dried samples and analyzed by GC-FID and GC-MS. The yield of oil (w/w %) in different stages was in the order: full flowering (0.32 %) > vegetative (0.14 %). In total 44 and 61 constituents were identified and quantified in the studied samples representing 99.6 and 99.2 % of the total oil, respectively. The main constituents were 7-epi-α-eudesmol, (*E*)-nerolidol, (*E*)-caryophyllene, α-pinene, caryophyllene oxide, and δ-cadinen. Oxygenated sesquiterpens (43.7% and 48.2%) followed by sesquiterpene hydrocarbons (30.3% and 32.7%) were the main group of compound in the oil of the plant at vegetative and full flowering stages, respectively.
Keywords: *Salvia tebesana*; Lamiaceae; essential oil; gas chromatography.

1. Plant Source

The genus *Salvia* L. (tribe Mentheae: subtribe Salviinae), is one of the largest genera in the family Lamiaceae and represents approximately 1000 species displaying a remarkable diversity in growth forms, floral morphology, pollination biology, and secondary compounds [1]. *Salvia* is represented in the flora of Iran by 61 species, 17 of which as *Salvia tebesana* Bunge are endemic. *S. tebesana* is restricted to some regions around Tabas, Iran, where is locally named 'Maryamgoli Tabasi' [2].

The aerial parts of the plant were collected at both vegetative and full flowering stages during April and May 2015 from its natural habitat near Tabas (33° 23′ N, 57° 15′ E at an altitude of 1507 m). A voucher specimen has been deposited in the Herbarium of the Medicinal Plants and Drugs Research Institute, Shahid Beheshti University, Tehran, Iran.

* Corresponding author: E-mail: Mostafagoldansaz@gmail.com

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2. Previous Studies

The essential oil composition of *Salvia* species has been extensively studied from different distribution regions of the world [3-7]. There are different studies on genus of salvia such as *S. atropatana*, *S. oligophylla*, *S. aethiopis*, *S. bracteata*, *S. sclraea*, *S. reuterana*, *S. macrosiphon* which were obtained in yields of 0.2, 0.45, 0.23, 0.51, 0.3, 0.49 and 0.5% (w/w), respectively. The main composition of these genus is Caryophyllene oxide (19.26%), Occidentotal (24%), α–Copanaene (16.64%), α-pinene (29.60%), Germacrene D (12.67%), Germacrene D (11.17%), and Sclareol (8.60%), respectively [8, 9]. In the following, the literature survey showed that the oil of *Salvia* species has been found to be rich in β-phellandrene, linalool, camphor, spathulenol, α-pinene, caryophyllene oxide, myrcene, α-terpinene and germacrene D [10-14]. Salvia is used for antioxidant [15], antiinflammatory [16], wound treatment, bathing, washing, skin, hair care [17], opioid receptor activities [18], antifungal [19], antivirial [20], and antibacterial [21]. The present study describes the chemical composition of the essential oil from the aerial parts of *S. tebesana*, which has not been studied previously.

3. Present Study

The powdered aerial parts (100 g) from the both growth stages were hydrodistilled using a Clevenger type apparatus for 3 h [22]. The resulting essential oil was dried over anhydrous sodium sulfate and stored at 4°C until analyzed and tested.

Essential oil analysis: GC-FID analyses of the oil were conducted using a Thermoquest-Finnigan instrument equipped with a DB-5 fused silica column (60 m × 0.25 mm i.d., film thickness 0.25 μm). Nitrogen was used as the carrier gas at a constant flow of 1.1 mL/min. The split ratio was 1/50. The oven temperature was raised from 60 ºC to 250 ºC at a rate of 5 ºC/min. The injector and detector (FID) temperatures were kept at 250 ºC and 280 ºC, respectively. GC-MS analysis was carried out on a Thermoquest-Finnigan Trace GC-MS instrument equipped with the same column and using the same temperature programming as mentioned for GC. Transfer line temperature was 250 ºC. Helium was used as the carrier gas at a flow rate of 1.1 mL/min, with a split ratio equal to 1/50. The constituents of the essential oils were identified by calculation of their retention indices under temperature-programmed conditions for n-alkanes (C6–C24) and the oil on a DB-5 column under the same conditions. Identification of individual compounds was made by comparison of their mass spectra with those of the internal reference mass spectral library (Wiley 7.0) or with authentic compounds confirmed by comparison of their retention indices with authentic compounds or with those reported in the literature [23].

The essential oils had a light yellow color with distinct sharp odor. The yield of the essential oils (w/w %) of the plant at vegetative and full flowering stages were 0.14% and 0.32%, respectively. The qualitative and quantitative analytical results are listed in Table 1 together with the retention indices of the identified compounds, where all the constituents are arranged in order of their elution on the DB-5 column. In total 44 and 61 constituents were identified and quantified in the studied samples representing 99.6 and 99.2 % of the total oil, respectively. A comparison among the composition of the essential oils revealed both quantitative and qualitative differences. The GC and GC–MS analyses showed that the distribution of monoterpene hydrocarbons and oxygenated monoterpenes of the oil from the aerial parts of the plant at vegetative stage was remarkably different from that of the oils at the flowering stage. The results revealed that the monoterpene hydrocarbons from the plant oil at vegetative stage (17.2%) were present in higher amount than in the other sample (8.3%). Terpinen-4-ol, α-terpineol, myrtenol, *cis*-*p*-mentha-1(7),8-dien-2-ol, *trans*-2-hydroxy-pinocamphone, geranial and *p*-mentha-1-en-2-ol were found only in the oil of the plant at flowering stage. The major constituent of the oil at vegetative stage were α-pinene (14.8%), 7-epi-α-eudesmol (14.7%), caryophyllene oxide (12.7%), and (*E*)-caryophyllene (9.4%), but it was found that these compounds decreased gradually in subsequent developmental stage. On the contrary, (*E*)-nerolidol was found in the plant oil which increased remarkably during flowering stage. Essential oil composition of the Iranian *Salvia* species has been previously studied. Almost all of the reported oils contained α- and β-pinene as the monoterpene hydrocarbons, but the α-isomer was usually in higher concentration. The other reported

major compounds in the oil of *Salvia* species were camphene and borneol for *S. santolinifolia* and *S. eremophila*. β-caryophyllene or caryophyllene oxide were reported as the major compounds of the oils of *S. atropatana*, *S. hypoleuca* and *S. chloroleuca* [14]. (*Z*,*E*)-Geranyl linalool (2.4%) was only found in the oil of the plant at vegetative stage.

Table 1. Essential oil composition of *Salvia tebesana* Bunge

No.	Compound [a]	RI [b]	%	
			Vegetative	Full flowering
1	**α-Pinene**	**938**	**14.8**	**7.5**
2	Camphene	950	0.6	0.1
3	β-Pinene	979	0.8	0.3
4	*p*-Cymene	1025	0.7	0.2
5	Sylvestrene	1029	0.3	0.2
6	Camphor	1148	0.3	0.2
7	Borneol	1172	1.1	1.2
8	Terpinen-4-ol	1182	-	0.3
9	α-Terpineol	1196	-	0.2
10	Myrtenol	1202	-	0.2
11	*cis*-*p*-Mentha-1(7),8-dien-2-ol	1233	-	0.1
12	Isoamyl hexanoate	1250	-	0.4
13	*trans*-2-hydroxy-Pinocamphone	1252	-	0.1
14	Geranial	1273	-	0.2
15	*p*-Mentha-1-en-7-al	1276	-	0.2
16	Bornyl acetate	1288	0.9	2.1
17	*p*-Menth-1-en-9-ol	1300	-	0.3
18	α-Cubebene	1350	-	0.2
19	(2*E*)-Undecenal	1364	-	0.1
20	Isoleden	1374	-	0.2
21	α-Copaene	1378	-	1.9
22	(3*Z*)-Hexenyl hexanoate	1381	-	0.2
23	β-Cubebene	1391	1.5	0.2
24	1-Tetradecene	1405	0.8	0.2
25	α-Gurjunene	1412	-	1.2
26	**(*E*)-Caryophyllene**	**1425**	9.4	**7.7**
27	4,8 β-epoxy-Caryophyllane	1431	0.4	0.5
28	β-Gurjunene	1435	0.6	0.1
29	α-Guaiene	1438	-	0.5
30	Aromadendrene	1443	3.8	4.5
31	α-Humulene	1457	0.9	0.8
32	9-epi-(*E*)-Caryophyllene	1464	1.1	1.3
33	γ-Gurjunene	1475	0.8	0.1
34	γ-Muurolene	1479	0.5	0.9
35	β-Selinene	1489	0.2	0.8
36	Viridiflorene	1498	1.6	1.6
37	α-Muurolene	1503	0.8	0.8
38	γ-Cadinene	1518	3.8	3.0
39	**δ-Cadinene**	**1528**	4.1	**4.7**
40	γ-Cuprenene	1538	0.6	1.5
41	α-Calacorene	1547	0.2	0.2
42	*cis*-Muurol-5-en-4β-ol	1559	0.8	1.2
43	3,5,9-Trimethyl-deca-2,4,8-trien-1-ol	1565	3.9	3.5
44	**(*E*)-Nerolidol**	**1571**	1.7	**12.1**
45	α-Cedrene epoxide	1579	0.4	0.5
46	**Caryophyllene oxide**	**1590**	12.7	**6.8**
47	Viridiflorol	1598	0.5	0.4
48	Ledol	1610	2.9	2.3
49	Humulene epoxide II	1615	0.6	0.4
50	1,10-di-epi-Cubenol	1620	0.6	0.2
51	10-epi-γ-Eudesmol	1626	0.8	1.0
52	1-epi-Cubenol	1634	0.3	0.8
53	γ-Eudesmol	1638	0.4	0.4
54	α-Muurolol	1648	3.6	3.4
55	**7-epi-α-Eudesmol**	**1663**	**14.7**	**17.5**

56	14-hydroxy-9-epi-(*E*)-Caryophyllene	1679	0.3	0.6
57	(*E*)-Nerolidyl acetate	1726	0.6	0.1
58	iso-Longifolol acetate	1823	-	0.2
59	Hexahydrofarnesyl acetone	1846	1.4	0.5
60	(*Z*,*E*)-Geranyl linalool	2003	2.4	-
61	(*E*,*E*)-Geranyl linalool	2033	0.4	0.3
	Monoterpene hydrocarbons		17.2	8.3
	Oxygenated monoterpenes		2.3	5.1
	Sesquiterpene hydrocarbons		30.3	32.7
	Oxygenated sesquiterpenes		43.7	48.2
	Others		6.1	4.9
	Total identified		**99.6**	**99.2**

[a]) Mode of identification: retention index (RI), mass spectrometery (MS), and co-injection (CoI) with some available authentic compounds. [b]) RI: calculated retention indices determined in the present work relative to C6–C24 *n*-alkanes on the DB-5 column [23,24].

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