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Comparison of *Salvia verticillata* essential oil components in wild and cultivated population

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ABSTRACT

Aerial parts of S. Verticillata were collected in the full flowering stage from natural sites in Ghazvin province on June 2011 Also, the seeds of this plant cultivated in the research farm of the Sadra city in Fars province on November 2011. Aerial parts of the cultivated plants harvested at full flowering stage. The essential oils (Eos) obtained by hydro-distillation of dried aerial parts and analyzed by GC and GC/MS. 51 components were characterized for cultivating plants with (E) -Caryophyllene (17.8), β-Phellandrene (14.2), α-Humulene (10.2), α-Pinene (5.7), Germacrene D (5.2) dominating constituents, 64 constituents were identified for wild plants with (E) -Caryophyllene (14.7), α-Gurjunene (12.8), Germacrene D (8.7), α-Humulene (7.7), β-Phellandrene (6.6), β-Pinene (6.5) and Bicyclogermacrene (6.4) as the major constituents.

Key words: *Salvia verticillata*, EO, Wild, Cultivated

INTRODUCTION

Salvia species are aromatic plants, rich in essential oils which have been used in food, cosmetics, perfumes and pharmaceutical products [2]. They are used in traditional medicine to treat various conditions like sore throats, colds, digestive disorders or as an insect repellent [7]. *S. verticillata* L. (Purple rain or lilac sage) is a herbaceous perennial native from Labiatae (mint family) to a wide area ranging from central Europe to western Asia, and naturalized in northern Europe and North America. [4,5]. This plant widely grown in some parts of Iran such as Tehran, Karaj, Mazandran [5], Ghazvin [18], Gilan and Tabriz. *S. verticillata* has a leafy base of mid-green leaves covered with hairs, putting up leaf-covered stems that carry 0.91 m inflorescences. The tiny lavender flowers grow tightly packed in whorls, with tiny lime-green and purple calyces. The specific epithet *verticillata* refers to the whorls that grow in verticils. [4,5]. It is used locally in folk medicine as a medicinal plant for reducing blood sugar, antiseptic and anti-seizure [18] and as a garden ornamental. It has been reported as an antioxidant and acetylcholinesterase inhibitor [13,15]. The plant contains a variety of polyphenols, volatile oils and diterpenoids [8,10]. The essential oils of *S. verticillata* have shown moderate to high inhibitory activity against bacteria [17] and *S. verticillata* may have the potentiality of being used in lost or declining cognitive functions [16]. In a spectrophotometric method based on the reduction of the stable DPPH free radical, it was suggested that *S. verticillata* can be considered as a natural source of radical scavenger [11,13]. The anti-diabetic effects of aerial parts of *S. verticillta* ethanolic extract was established in normal and streptozotocin (STZ) - induced diabetic rats. Also the effects of hydroalcoholic extract from *S.*

verticillata on pharmacological models of seizure, anxiety and depression in Mice by [12] was established. In order to meet domestic needs, efforts have now been made to cultivate *S. verticillata* in Iran since it was not cultivated earlier in any part of Iran.

MATERIALS AND METHODS

Plant material*:*
The aerial parts of *S. sclarea* was collected in the full flowering stage from natural sites in Sepidan (Fars province) on June 2011. Also, the seeds of this plant cultivated in research farm of the Sadra city in Fars province on November 2011. The plant material was identified by staff at the herbarium of the Fars Research Center for Agriculture and Natural Resources, Shiraz, Iran.

Essential oil extraction
Air dried aerial parts of the plants at the flowering stage were subjected to hydro-distillation for 3hr using a Clevenger-type apparatus according to the method recommended in the European Pharmacopoeia (European Pharmacopoeia). The obtained oils were dried over anhydrous sodium sulfate and stored in sealed vials at +4°C in the dark until analyzed and tested.

Identification of the oil components*:*
GC analysis was carried out using an Agilent-technology chromatograph with a HP-5 column (30 m × 0.32 mm i.d. × 0.25 μm). The oven temperature was from 60°C to 210°C at 3°/min; then 210°C to 240°C at the 20°C / min, and held for 8.5 min, injector temperature 280°C; detector temperature, 290°C; carrier gas, N2 (1 ml/min); split ratio of 1:50. GC-MS analysis was carried out using an Agilent 7890 operating at 70 EV ionization energy, equipped with a HP-5 MS capillary column (phenyl methyl siloxane, 30 m × 0.25 mm i.d. × 25 μm.) With him as the carrier gas, and a split ratio of 1:50. Retention indices were determined using retention times of *n*-alkanes that were injected after the essential oil under the same chromatographic conditions. The retention indices for all components were determined according to the method using *n*-alkanes as standard. The compounds were identified by comparison of retention indices (RRI, HP-5) with those reported in the literature and by comparison of their mass spectra with the Adams library and stored in NIST and Wiley libraries [1,6,9].

RESULTS AND DISCUSSION

The essential oils were analyzed by GC and GC–MS. In total, 51 and 64 constituents representing 99.9 and 99.4 % of the total were identified and quantified in the cultivated and wild plant, respectively (Table 1). (E) -Caryophyllene (17.8), β-Phellandrene (14.2), α-Humulene (10.2), α-Pinene (5.7), Germacrene D (5.2), β-Pinene (4.8), Sabinene (4.5), 1, 8-Cineole (4.4) and Caryophyllene oxide (4.0) were found to be the major constituents in the cultivated plants. The main components in wild plants were (E) -Caryophyllene (14.7), α-Gurjunene (12.8), Germacrene D (8.7), α-Humulene (7.7), β-Phellandrene (6.6), β-Pinene (6.5) and Bicyclogermacrene (6.4). It was found that the quantity of the major compounds of *S. verticillata* oil was increased in cultivated plants, e.g., (E) -Caryophyllene, β-Phellandrene, α-Humulene but some compounds such as α- Gurjunene, Germacrene D and β-Pinene and Bicyclogermacrene. The essential oil constituents between wild and cultivated populations of *S. verticillata* have not been investigated previously and a few studies have been carried out on *S. verticillata*, growing wild. For instance Baser *[3]* reported that carvacrol (27%) and spathulenol (17%) were a main component in *S. verticillata spp.* [8] studied the essential oil composition of three wild-growing populations of *S. verticillata* in Serbia. The main component was germacrene D in two populations (48.0% and 24.6% of oil, respectively) but (E) - caryophyllene (10.2%) in the third. Also [14] results showed that β- caryophyllene is the major component of the oil of aerial parts of *S. verticillata.* Chemical composition revealed 29 components present in *S. verticillata* with camphene (16.03%), β-pinene (15.24%) and sabinene (14.54%) as the major constituents. Low oil content and high variability in oil composition may restrict the industrial use of wild-growing *S. verticillata* plants. This study showed *S. verticillata* had better compatibility for culture and domestication in Sadra climatic condition to contribute to use of these as an alternative and natural products for food and medicinal uses.

Table 1. Essential oil composition (%) of *Salvia verticillata* in field conditions

NO	Compound	RI[a]	% in Oil	NO	Compound	RI[a]	% in Oil	NO	Compound	RI[a]	%in Oil
1	α-Thujene	926	0.536	18	γ-Terpinene	1057	0.276	35	Neryl acetate	1363	0.167
2	α-Pinene	934	5.735	19	cis-Sabinene hydrate	1065	0.255	36	α-Copaene	1374	0.081
3	Camphene	947	0.351	20	Terpinolene	1087	0.145	37	β-Bourbonene	1383	1.562
4	Sabinene	973	4.538	21	Linalool	1099	0.95	38	β-Elemene	1390	0.219
5	β-Pinene	978	4.78	22	n-Nonanal	1103	0.058	39	α-Gurjunene	1409	3.485
6	3-Octanone	984	0.055	23	allo-Ocimene	1127	0.044	40	(E)-Caryophyllene	1422	17.813
7	Myrcene	991	3.025	24	Borneol	1163	0.351	41	β-Copaene	1428	0.252
8	3-Octanol	994	0.012	25	n-Nonanol	1168	0.121	42	α-Humulene	1455	10.162
9	α-Phellandrene	1005	1.168	26	Terpinene-4-ol	1175	0.268	43	allo-Aromadendrene	1460	0.965
10	δ-3-Carene	1010	0.117	27	α-Terpineol	1189	0.292	44	9-epi-(E)-Caryophyllene	1467	0.406
11	α-Terpinene	1016	0.108	28	n-Decanal	1204	0.052	45	Germacrene D	1481	5.179
12	p-Cymene	1024	0.257	29	Nerol	1226	0.05	46	Bicyclogermacrene	1496	3.929
13	β-Phellandrene	1031	14.236	30	Geraniol	1253	0.086	47	(E,E)-α-Farnesene	1507	0.5
14	1,8-Cineole	1033	4.354	31	Linalyl acetate	1255	1.701	48	(E)-γ-Bisabolene	1541	0.704
15	(Z)-β-Ocimene	1036	0.876	32	n-Decanol	1269	0.046	50	Spathulenol	1577	2.844
16	Benzene acetaldehyde	1042	0.016	33	δ-Elemene	1335	0.518	51	Caryophyllene oxide	1582	4.019
17	(E)-β-Ocimene	1046	1.268	34	α-Cubebene	1347	0.025	52	Caryophylla-4(14),8(15)-dien-5-β-ol	1634	1.042

[a] *RI, retention indices relative to C8-C25 n-alkanes on the HP-5 column; t, trace <0.1%*

Table 1. Essential oil composition (%) of *Salvia verticillata* in wild conditions

NO	Compound	RI[a]	%in Oi	NO	Compound	RI[a]	%in Oil	NO	Compound	RI[a]	%in Oil
1	Tricyclene	922.5	0.011	23	allo-Ocimene	1129	0.188	45	Germacrene D	1490	8.684
2	α-Thujene	926.1	0.319	24	(2E,6Z)-Nonadienal	1151	0.092	46	Bicyclogermacrene	1504	6.384
3	α-Pinene	935.3	2.324	25	Borneol	1165	0.53	47	γ-Cadinene	1517	0.482
4	Camphene	948.2	0.353	26	n-Nonanol	1170	0.138	48	δ-Cadinene	1526	1.181
5	Sabinene	974.2	0.612	27	Terpinene-4-ol	1176	0.216	49	(E)-γ-Bisabolene	1544	0.944
6	β-Pinene	983.9	6.541	28	α-Terpineol	1189	0.082	50	(E)-Nerolidol	1566	0.404
7	3-Octanone	986.2	0.037	29	Methyl salicylate	1193	0.085	51	Germacrene D-4-ol	1578	1.35
8	Myrcene	993.7	1.419	30	n-Decanal	1204	0.139	52	Spathulenol	1581	0.97
9	α-Phellandrene	1007	0.724	31	Linalyl acetate	1255	0.383	53	Caryophyllene oxide	1586	1.557
10	δ-3-Carene	1013	1.351	32	Undecanal	1305	0.088	54	Viridiflorol	1604	0.816
11	α-Terpinene	1017	0.145	33	δ-Elemene	1336	0.878	55	α-Cadinol	1655	0.905
12	p-Cymene	1026	0.199	34	α-Cubebene	1349	1.293	56	Valeranone	1672	0.694
13	β-Phellandrene	1034	6.614	35	α-Copaene	1375	0.621	57	Eudesm-7(11)-en-4-ol	1694	2.786
14	(Z)-β-Ocimene	1039	1.3	36	β-Bourbonene	1384	0.476	58	Unknown	1842	0.588
15	Benzene acetaldehyde	1043	0.046	37	β-Cubebene	1389	0.311	59	n-Hexadecanoic acid	1979	2.025
16	(E)-β-Ocimene	1048	1.033	38	α-Gurjunene	1414	12.825	60	Phytol	2118	0.511
17	γ-Terpinene	1059	0.681	39	(E)-Caryophyllene	1424	14.706	61	Sclareol	2222	0.415
18	cis-Sabinene hydrate	1066	0.067	40	β-Copaene	1435	0.324	62	n-Tricosane	2298	0.169
19	p-Mentha-2,4(8)-diene	1086	0.109	41	cis-Thujopsene	1437	0.1	63	Unknown	2463	0.345
20	Terpinolene	1088	0.215	42	α-Humulene	1461	7.664	64	n-Pentacosane	2500	0.334
21	Linalool	1100	0.183	43	allo-Aromadendrene	1466	1.708				
22	n-Nonanal	1104	0.322	44	γ-Gurjunene	1474	1.005				

[a] *RI, retention indices relative to C8-C25 n-alkanes on the HP-5 column; t, trace <0.1%*

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