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Research Article

Geographical impact on essential oil composition of endemic *Salvia absconditiflora* collected from different parts of Turkey

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ABSTRACT

This study was carried out to determine the content of the essential oils of *Salvia absconditiflora* Greuter & Burdet populations which are naturally found in Mediterranean, Iran-Turan and Euro-Sibirya phytogeographical regions. *S. absconditiflora* plant samples were collected from eight different provinces (Aksaray, Kahramanmaraş, Karaman, Kayseri, Konya, Niğde, Nevşehir and Yozgat) of Turkey. Essential oils of plant samples were isolated by the hydro-distillation method using a Clevenger-type apparatus and the components were determined by GC-FID and GC-MS analysis. Although the major components of *S. absconditiflora* were found as α-pinene, camphene, 1,8-cineole, camphor, and borneol in almost all samples β-pinene, β-caryophyllene, bornyl acetate, caryophyllene oxide, β-eudesmol and valeranone were recorded as the other important components in some samples.

Keywords: Essential oil, Hydro-distillation, GC-FID, GC-MS, *Salvia absconditiflora*

1. INTRODUCTION

The genus *Salvia* L. (sage) is a member of Lamiaceae family, is a widespread group consisting of 900 species in the world and 96 species and 4 subspecies in Flora of Turkey, 51 % of which are endemic. *Salvia* members produce many secondary metabolites including terpenes and phenolics [1,2]. Many species of the genus are used the pharmaceutical and cosmetics industry and drink as herbal tea in many countries. They have important medicinal uses including treatment for colds, aches, microbial infections, malaria, cancer, Alzheimer's, and cardiovascular disease all over the World. They are generally known under the name "adaçayi" and are widely used as herbal tea. Also, they are used against wounds, inflammation and skin diseases in folk medicine [1,3,4].

Salvia absconditiflora Greuter & Burdet (Synonym: *S. cryptantha* Montbret & Aucher ex Bentham) is an aromatic, endemic and perennial herbaceous plant. *S. absconditiflora*, known locally name "karaşalba" in Turkey, is characterized by branched to dendroid hairs and sessile glands [5]. The tea prepared with the aerial parts of *S. absconditiflora* is used for stomach disorders and the plant is also utilized as a colorant [1]. It is reported that *S. absconditiflora* has antitumoral potential against breast cancer [6].

There are some reports in the literature about the chemical composition of *S. absconditiflora* essential oil [4,7-12]. Here, we present our findings on the chemical constituents of the essential oils obtained from *S. absconditiflora* grown in eight different provinces of Anatolia.

2. MATERIALS AND METHODS

2.1. Plant Material

The samples were collected from the following regions of Turkey by Süleyman Doğu. The voucher specimens (S.D.) are deposited at the Herbarium of the Department of Biology, Necmettin Erbakan University, Konya, Turkey. Detailed information was given in Table 1.

2.2. Isolation of essential oil

The samples were isolated by hydro-distillation for 3 hours, using a Clevenger-type apparatus. The obtained oil was dried over anhydrous sodium sulfate and stored at +4°C in the dark until analyzed and tested. The essential oils were analyzed by GC-FID and GC-MS systems, simultaneously. All processes were performed with reference to Kaya et al. [13].

2.3. Identification of the Components

Wiley GC/MS Library, MassFinder 4 Library and in-house "Başer Library of Essential Oil Constituents" built up by genuine compounds and components of known oils were used for the identification [14,15].

3. RESULTS AND DISCUSSION

The essential oils were obtained by hydro-distillation from air-dried aerial parts of *S. absconditiflora* collected from eight different regions in Turkey. The essential oils were subsequently analyzed by GC-FID and GC-MS and the individual identified components and their relative percentages are given in Table 2.

Sixty-eight compounds were identified from the oil of Niğde representing 97.0% of the total oil, forty compounds were identified from the oil of Aksaray representing 97.9% of the total oil, sixty-four compounds were identified from the oil of Kahramamaraş representing 96.5% of the total oil, forty-nine compounds were identified from the oil of Yozgat representing 95.3% of the total oil, sixty-nine compounds were described from the oil of Nevşehir representing 94.4% of the total oil, fifty-three compounds were identified from the oil of Konya representing 99.8% of the total oil, ninety-four compounds were identified from the oil of Karaman representing 96.2% of the total oil, and seventy-five compounds were identified from the oil of Kayseri representing 97.9% of the total oil.

α-Pinene (7.9-26.7%) and camphene (5.1-14.3%) were found as major components in all samples. Other main compounds were 1,8-cineole (6.1-36.4%) (except Kahramanmaraş, Yozgat, and Nevşehir samples) camphor (5.0-19.4%), (except Aksaray and Yozgat samples) and borneol (5.5-20.9%) (except Aksaray, Yozgat, and Nevşehir samples). However, β-pinene (5.5% and 15.9%) for Nevşehir and Aksaray samples, bornyl acetate (5.6%) for Yozgat sample, β-caryophyllene (6.1%) for Kahramanmaraş sample, caryophyllene oxide (8.2%) for Nevşehir sample, valeranone (6.0-7.8%) for Nevşehir and Yozgat samples, and β-eudesmol (5.4%) for Kahramanmaraş sample were found as the other important components.

In an earlier study, Bayrak and Akgül (1987) reported that twenty-two constituents of the oil of *S. crypthantha* contained borneol (24.8%), camphor (17.5%), 1,8-cineole (10.4%) and α-pinene (5.8%) as main components [7].

Table 1. Information on *S. absconditiflora* samples

Cities	Collection place	Altitude	Coll. date	Coll. number
Niğde	Ulukışla	1400 m	22.05.2018	S.D. 3025
Aksaray	Nevşehir 23. km	1053 m	20.05.2018	S.D. 3020
Kahramanmaraş	Göksun 27. km	850 m	22.05.2018	S.D. 3024
Yozgat	Çayıralan-Çandır 3. km	1450 m	20.05.2018	S.D. 3023
Nevşehir	Avanos	1100 m	20.05.2018	S.D. 3021
Konya	Konya-Beyşehir 10. km	1100 m	17.05.2018	S.D. 3018
Karaman	Ermenek Balkusan vadisi	1300 m	18.05.2018	S.D. 3019
Kayseri	Özvatan-Çayıralan 8.km	1300 m	20.05.2018	S.D. 3022

Table 2. The composition of the essential oils of *S. absconditiflora*

RRI	Compound	1	2	3	4	5	6	7	8	IM
1014	Tricyclene	0.2	0.3	0.7	0.5	0.7	0.4	0.5	0.5	MS
1032	*α*-Pinene	**15.3**	**24.8**	**14.5**	**16.9**	**26.7**	**11.5**	**20.3**	**7.9**	RRI, MS
1035	*α*-Thujene	0.1	0.5	0.1	0.3	0.4	0.1	0.2	0.1	RRI, MS
1072	*α*-Fenchene	0.2	-	0.1	0.1	-	-	0.1	0.1	RRI, MS
1076	Camphene	**6.2**	**5.1**	**12.6**	**12.7**	**14.3**	**8.5**	**9.3**	**10.5**	RRI, MS
1093	Hexanal	-	-	-	-	-	-	tr	-	RRI, MS
1118	*β*-Pinene	1.1	**15.9**	2.6	3.4	**5.5**	3.2	3.1	1.6	RRI, MS
1132	Sabinene	0.1	-	0.1	0.2	0.6	0.1	0.1	0.1	RRI, MS
1135	Thuja-2,4(10)-diene	-	-	tr	-	-	-	tr	-	MS
1174	Myrcene	0.2	2.2	0.6	0.6	1.1	1.7	1.5	0.5	MS
1176	*α*-Phellandrene	0.1	-	0.1	0.1	0.1	0.1	0.1	0.1	RRI, MS
1188	*α*-Terpinene	0.1	0.3	0.2	0.3	0.2	0.3	0.2	0.2	RRI, MS
1194	Heptanal	-	-	-	-	-	-	tr	-	RRI, MS
1203	Limonene	0.9	3.8	1.3	2.5	2.3	1.2	3.6	0.8	RRI, MS
1213	1,8-Cineole	**12.9**	**6.1**	4.7	2.3	2.0	**36.4**	**6.8**	**13.2**	RRI, MS
1244	2-Pentyl furan	tr	0.2	tr	0.1	0.1	-	0.1	-	MS
1246	*(Z)-β*-Ocimene	0.1	-	0.4	0.3	1.0	0.3	0.3	0.1	MS
1255	*γ*-Terpinene	0.2	0.4	0.3	0.5	0.3	0.4	0.3	0.3	RRI, MS
1266	*(E)-β*-Ocimene	tr	-	0.1	tr	0.2	tr	tr	tr	MS
1280	*p*-Cymene	0.5	1.9	0.6	0.9	0.1	0.6	0.5	0.5	RRI, MS
1290	Terpinolene	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.1	RRI, MS
1304	1-Octen-3-one	-	-	-	-	-	-	tr	-	MS
1353	Hexyl isobutyrate	-	-	0.1	-	0.2	-	0.1	0.1	MS
1360	1-Hexanol	-	-	-	-	-	-	-	0.3	MS
1386	1-Octenyl acetate	-	-	-	-	-	-	tr	-	MS
1393	3-Octanol	-	-	-	-	-	-	tr	-	MS
1400	Nonanal	-	-	0.1	-	0.1	-	tr	-	MS
1424	Hexyl butyrate	-	-	0.1	-	0.2	-	-	-	MS
1438	Hexyl 2-methyl butyrate	-	-	0.1	-	0.3	-	0.1	0.2	MSMS
1452	*α,p*-Dimethylstyrene	tr	-	-	-	-	-	tr	-	MS
1452	1-Octen-3-ol	0.1	-	tr	0.1	-	0.1	0.3	0.1	MS
1466	*α*-Cubebene	-	-	0.1	-	0.1	0.1	0.1	-	MS
1474	*trans*-Sabinene hydrate	-	-	0.1	-	-	0.1	0.1	0.1	MS
1483	Octyl acetate	-	-	tr	-	0.1	-	tr	-	RRI, MS
1493	*α*-Ylangene	-	-	0.1	-	-	0.1	0.1	-	MS
1496	2-Ethyl hexanol	-	-	-	-	-	-	-	0.2	MS
1497	*α*-Copaene	0.1	4.4	1.9	1.1	0.5	0.3	1.1	0.8	RRI, MS
1519	Hexyl valerate	-	-	-	-	-	-	-	0.1	MS
1528	*α*-Bourbonone	-	-	-	-	-	-	0.1	-	MS
1532	Camphor	**11.5**	1.6	**9.0**	4.6	**5.0**	**16.5**	**15.8**	**19.4**	RRI, MS
1544	*α*-Gurjunene	0.1	-	-	-	-	-	0.1	-	MS
1547	Octyl isobutyrate	-	-	-	-	-	-	-	0.1	MS
1553	Linalool	0.5	-	0.2	-	-	0.2	0.1	0.1	RRI, MS
1556	*cis*-Sabinene hydrate	-	-	-	-	-	0.1	0.1	0.1	MS

Table 2. Continued

RRI	Compound	1	2	3	4	5	6	7	8	IM
1559	*β*-Maaliene	0.1	-	-	-	-	-	-	-	MS
1562	Isopinocamphone	tr	-	-	-	-	-	0.1	-	RRI, MS
1562	Octanol	0.1	-	0.1	-	0.2	0.1	0.1	0.9	RRI, MS
1571	*trans-p*-Mentha-2-en-1-ol	-	-	-	-	-	-	0.2	-	MS
1586	Pinocarvone	0.1	-	-	-	-	-	-	-	RRI, MS
1588	Bornyl formate	-	-	-	-	-	-	0.1	-	MS
1589	Aristolene	0.1	-	-	-	-	-	-	-	MS
1589	*β*-Ylangene	-	-	0.1	-	-	-	-	-	MS
1590	Bornyl acetate	2.2	1.1	1.7	**5.6**	0.8	1.7	2.5	1.1	RRI, MS
1597	*β*-Copaene	-	-	0.2	-	0.1	0.1	0.2	-	MS
1600	*β*-Elemene	-	-	-	-	tr	-	-	-	RRI, MS
1610	Calarene	0.1	-	-	-	-	-	0.3	-	MS
1611	Terpinen-4-ol	1.0	-	0.3	-	0.1	0.7	0.3	0.7	RRI, MS
1612	*β*-Caryophyllene	3.3	4.3	**6.1**	4.9	3.1	0.3	0.8	4.7	RRI, MS
1620	Selina-5,11-diene	0.3	-	-	-	-	0.1	-	-	MS
1623	Octyl butyrate	-	-	0.1	-	0.2	-	-	-	MS
1628	Aromadendrene	2.8	1.0	-	0.2	-	0.4	-	0.8	MS
1634	Octyl 2-methyl butyrate	-	-	-	-	0.1	-	-	0.1	MS
1638	*cis-p*-Mentha-2-en-1-ol	-	-	-	-	-	-	0.1	-	MS
1648	Myrtenal	-	-	-	-	-	-	0.1	0.1	MS
1650	*γ*-Elemene	-	-	-	-	0.1	-	-	-	MS
1651	Bornyl isobutyrate	0.1	-	-	-	-	-	0.2	-	MS
1659	*γ*-Gurjunene	0.1	-	-	-	-	-	0.2	-	MS
1661	Alloaromadendrene	0.2	-	-	-	-	-	0.1	0.1	MS
1670	*trans*-Pinocarveol	0.2	-	-	-	-	-	0.3	0.1	RRI, MS
1682	*δ*-Terpineol	-	-	0.1	-	-	0.1	-	-	MS
1683	*trans*-Verbenol	0.1	-	-	-	-	-	-	-	RRI, MS
1687	*α*-Humulene	0.2	1.0	0.3	0.3	0.2	0.2	tr	0.5	RRI, MS
1688	Selina-4,11-diene	-	-	tr	-	-	-	-	0.1	MS
1698	Myrtenyl acetate	0.1	-	-	-	-	-	-	-	MS
1704	*γ*-Muurolene	-	0.8	1.0	1.0	0.3	0.4	0.9	-	MS
1706	*α*-Terpineol	-	-	0.2	-	-	0.1	-	0.4	RRI, MS
1708	Ledene	1.0	-	-	-	-	0.2	0.3	tr	MS
1709	*α*-Terpinyl acetate	-	-	-	-	0.3	-	-	-	RRI, MS
1718	4,6-Guaiadiene	-	-	-	-	-	-	-	0.1	MS
1719	Borneol	**20.9**	0.6	**5.5**	3.5	1.0	**6.1**	**9.8**	**9.1**	RRI, MS
1726	Germacrene D	-	0.6	-	-	1.5	-	-	-	MS
1740	*α*-Muurolene	-	tr	-	0.2	0.1	0.1	-	-	MS
1742	*β*-Selinene	0.6	-	1.7	1.0	0.2	0.2	0.9	0.9	MS
1744	*α*-Selinene	0.5	-	0.8	0.5	0.1	0.1	0.6	0.4	MS
1751	Carvone	-	-	-	-	-	-	-	-	RRI, MS
1755	Bicyclogermacrene	0.2	1.1	-	-	-	-	0.6	-	MS
1755	*β*-Curcumene	-	-	-	-	-	-	-	0.2	MS
1758	*cis*-Piperitol	-	-	-	-	-	-	0.1	-	RRI, MS

Table 2. Continued

RRI	Compound	1	2	3	4	5	6	7	8	IM
1770	Isobornyl isovalerate	0.1	-	-	-	-	-	0.3	-	MS
1773	*δ*-Cadinene	0.1	1.5	1.2	1.6	0.5	0.5	1.3	0.4	MS
1776	*γ*-Cadinene	-	1.4	0.4	0.5	0.1	0.1	0.4	0.2	MS
1786	*ar*-Curcumene	-	-	-	-	-	-	-	0.7	MS
1796	Selina-3,7(11)-diene	-	-	0.8	-	-	0.5	1.0	1.4	MS
1799	Cadina-1,4-diene	-	-	0.1	-	-	-	0.1	-	MS
1804	Myrtenol	1.8	-	-	-	-	0.2	0.9	0.6	MS
1805	*α*-Campholene alcohol	0.1	-	0.3	-	-	0.2	0.5	0.7	MS
1849	Calamenene	-	1.5	0.4	0.3	0.4	0.1	0.3	0.2	MS
1868	*(E)*-Geranyl acetone	-	-	0.1	-	0.1	-	-	-	MS
1900	*epi*-Cubebol	-	-	0.1	-	-	-	0.1	-	MS
1941	*α*-Calacorene	-	-	0.2	-	-	0.1	0.1	-	MS
1957	Cubebol	-	0.6	0.2	-	0.2	-	tr	0.1	MS
1958	*(E)-β*-Ionone	0.1	-	-	-	-	-	-	-	MS
2001	Isocaryophyllene oxide	-	-	-	-	0.1	-	-	-	MS
2008	Caryophyllene oxide	1.0	2.9	2.4	1.8	**8.2**	0.1	0.3	0.8	RRI, MS
2012	Maaliol	0.2	-	-	-	-	-	-	-	MS
2033	*epi*-Globulol	0.2	-	-	-	-	-	-	-	MS
2037	Salvial-4(14)-en-1-one	-	-	-	-	0.3	-	-	-	MS
2045	Humulen epoxide-I	tr	-	-	-	-	-	-	-	MS
2050	*(E)*-Nerolidol	-	0.8	-	-	-	-	0.1	-	MS
2057	Ledol	-	-	-	-	-	-	tr	0.1	MS
2071	Humulen epoxide-II	-	1.3	0.2	-	0.2	0.1	-	0.2	MS
2073	*β*-Caryophyllene alchool	-	-	0.1	-	0.1	-	-	0.1	MS
2088	1-*epi*-Cubenol	-	tr	0.1	0.2	-	-	0.1	-	MS
2096	*cis*-Sesquisabinene hydrate	-	-	-	-	-	-	-	0.3	MS
2098	Globulol	0.8	-	-	-	-	-	-	-	MS
2104	Viridifrolol	0.2	-	-	0.9	0.8	2.7	-	2.5	MS
2130	Salviadienol	-	-	-	-	0.6	-	0.1	-	MS
2131	Hexahydrofarnesyl acetone	-	tr	-	0.3	0.3	-	0.2	-	MS
2144	Rosifoliol	0.3	-	-	-	-	-	tr	0.1	MS
2144	Spathulanol	0.8	2.3	-	-	-	-	1.2	-	MS
2145	Valeranone	1.1	2.5	3.6	**7.8**	**6.0**	1.3	-	2.8	MS
2161	Muurola-4,10(14)dien-1-ol	-	-	0.3	-	-	-	0.1	-	MS
2170	*β*-Bisabolol	-	-	-	-	-	-	-	1.8	RRI, MS
2178	*T*-Cadinol	-	1.1	0.2	-	-	-	-	-	MS
2185	*γ*-Eudesmol	-	-	-	-	-	-	0.4	-	MS
2186	Eugenol	-	-	-	-	-	-	0.1	-	RRI, MS
2187	*T*-Cadinol	-	-	-	-	-	-	-	0.1	MS
2204	Eremoligenol	-	-	-	-	-	-	0.2	-	MS
2209	T-Muurolol	-	-	0.1	-	0.1	-	0.1	-	MS
2210	Copaborneol	-	-	-	-	-	-	-	0.2	MS
2210	Hinesol	-	-	-	-	-	-	0.2	-	MS
2211	Clovenol	0.3	-	0.3	-	-	-	-	0.1	MS

Table 2. Continued

RRI	Compound	1	2	3	4	5	6	7	8	IM
2250	*α*-Eudesmol	0.7	tr	1.7	1.0	0.5	0.2	1.5	0.8	RRI, MS
2256	Cadalene	-	-	-	-	-	-	0.1	0.1	MS
2257	*β*-Eudesmol	2.0	1.7	**5.4**	3.8	-	0.4	1.8	2.6	RRI, MS
2269	Guaia-6,10(14)dien-4*β*-ol	-	-	-	0.7	0.1	-	-	-	MS
2273	Porosadienol	-	-	0.6	-	0.1	-	0.3	0.7	MS
2278	Torilenol	-	-	-	-	0.6	-	-	-	MS
2296	*(Z)-α-trans*-Bergamotol acetate	-	1.4	-	-	-	-	-	-	RRI, MS
2316	Caryophylladienol I	0.5	-	0.1	0.5	0.3	-	-	-	MS
2324	Caryophylladienol II	-	-	1.0	-	0.3	-	-	0.4	MS
2369	Eudesma-4(15)7-dien-1-*β*-ol	-	-	-	-	1.2	-	-	-	MS
2389	Caryophyllenol I	1.3	-	1.9	1.4	0.2	-	0.1	0.8	MS
2392	Caryophyllenol II	0.5	-	1.1	0.9	0.7	-	-	0.5	MS
2500	Pentacosane	-	-	-	0.2	-	-	-	-	RRI, MS
2512	Benzophenone	-	-	-	-	-	-	-	0.1	RRI, MS
2622	Phytol	-	-	-	1.0	0.2	-	0.1	-	MS
2679	Manool	-	-	4.0	4.0	1.0	-	-	-	RRI, MS
2700	Heptacosane	-	-	-	1.1	-	-	-	-	RRI, MS
2931	Hexadecanoic acid	tr	0.8	0.5	2.4	0.5	-	0.1	-	RRI, MS
	Total	**97.0**	**97.9**	**96.5**	**95.3**	**94.4**	**99.8**	**96.2**	**97.9**	

RRI: Relative retention indices calculated against *n*-alkanes; %: calculated from FID data; tr: Trace (< 0.1 %); IM: Identification method based on the relative retention indices (RRI) of authentic compounds on the HP Innowax column; MS, identified on the basis of computer matching of the mass spectra with those of the Wiley and MassFinder libraries and comparison with literature data; 1-Niğde, 2-Aksaray, 3-Kahramanmaraş, 4-Yozgat, 5-Nevşehir, 6-Konya, 7-Karaman, 8-Kayseri.

Başer et al. (1995) reported that there were sixty constituents in *S. crypthantha* oil gathered from Ankara and Eskişehir. The main components were 1,8-cineole (15.7-37.1%), camphor (5.95.0-13.04%), α-pinene (1.0-11.9%) and camphene (0.9-7.7%) [8].

Akgül et al. (1999) published that the essential oil of *S. crypthantha* collected from Karaman was characterized by camphor (18.1%), 1,8-cineole (17.8%), bornyl acetate (11.4%) and borneol (5.8%) as main components [9]. These results are similar to our Karaman samples except bornyl acetate.

Tepe et al. (2004) published the essential constituents of the oil of *S. crypthantha* samples collected from Sivas. Fifty-three constituents were identified representing 90.9% of the total oil and α-pinene (18.1 %), eucalyptol (15.3%), camphor (7.7%), camphene (6.4%) and borneol (4.8%) were found as main compounds in *S. crypthantha* oil [10].

Saadia et al. (2010) reported that sixteen constituents were described representing 98.5% of the oil of *S. crypthantha* at the flowering stage collected from Derbent, Konya. This oil is characterised by the monoterpene hydrocarbons and oxygenated monoterpenes, and camphor (25.6 %), 1,8-cineole (20.3 %), β-pinene (12.8 %), *n*-hexane (10.6 %), heptane (8.9 %), borneol (5.1 %) and α-pinene (4.1 %) were detected as main constituents [11]. β-pinene, n-hexane and heptane were not recorded as main constituents in our Konya samples.

İpek et al. (2012) studied essential oils of *Salvia cryptantha* and they reported nine components of the Ereyli, Konya sample were detected representing 94.75% of the oil. Valencene (31.80%), eucalyptol (23.61%), and β-pinene (15.63%) were found to be the major compounds [12]. When we compare our findings with this study, only eucalyptol as the main compound shows similarity with our Konya results.

Doğan et al. (2017) published that the essential oil of *S. crypthantha* was collected from Darende, Sivas. Sixty-three constituents were described representing 98.7% of the oil and 1.8-cineole (21%), camphor (19.1%), α-pinene (12.5%), and camphene (8.7%) were found as the main compounds [4].

Comparing our results on *S. absconditiflora* essential oil with those previously reported, we can see that they are almost notably the same. However, there are still some differences. These variations may be due to geographical, edaphic and climatological factors, the time of flowering, drying conditions, and made of distillation. These factors also play a role in the composition of the oil. Moreover, due to the frequent occurrence of chemotypes in Lamiaceae species, it is possible to see different compositions in oils of the same plant species [11,13].

4. CONCLUSION

Hydro-distilled eight *S. absconditiflora* oils were analyzed by using GC-FID and GC-MS systems, simultaneously. A total of 68, 40, 64, 49, 69, 53, 94 and 75 components were identified from the essential oils of *S. absconditiflora* respectively, which represented 97, 97.9, 96.5, 95.3, 94.4, 99.8, 96.2 and 97.9% of the oils. Borneol, α-pinene, camphene, camphor, and 1,8-cineole were described as the main compounds for the oil of almost all samples. However β-pinene, β-caryophyllene, bornyl acetate, caryophyllene oxide, β-eudesmol and valeranone are the other important components in some other samples.

Ethical approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Author contribution

Concept: AK; Design: AK; Supervision: AK, BD; Materials: SD; Data Collection and/or Processing: AK, BD; Analysis and/or Interpretation: AK, BD; Literature Search: AK; Writing: AK; Critical Reviews: AK, BD.

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Conflict of interest

The authors declared that there is no conflict of interest.

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