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Volatile components of leaf and flowers of natural mountain sage (*Sideritis* spp.) taxa from Davraz Mountain, Isparta-Turkey

Abstract: This study was conducted to volatile components of Natural Mountain Sage (*Sideritis* spp.) in Davraz Mountain of Isparta, Turkey. For this aim, samples of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, *S.hispida* P. H. Davis, *S. libanotica* Labill. subsp. *linearis* ve *S. perfoliata* L. taxa, which grow naturally in Davraz Mountain, were collected and examined in terms of volatile constituents and their percentiles. As result, 45 different volatile constituents were identified regarding the leaves and flowers of the samples of S*ideritis condensata* (Boiss. & Heldr.) subsp. *condensata* and β-Pinene, 3-Octanole and Limonene were determined as main components. Also, 42 different volatile components were identified for *S. hispida* P. H. Davis and (E)-2-Hexenal, β-Myrcene and Caryophyllene were found as main components. 40 different volatile constituents were identified, regarding the leaves and flowers of the samples of *S. libanotica* Labill. subsp. *linearis.* (E)-2-Hexenal, 3-Octanole and Limonene were main components for this taxa. 37 different volatile components were identified for *S. perfoliata* and α-Pinene, β-Pinene and Limonene were found as main components.

Key words: *Sideritis*, Davraz Mountain, Volatile components, Isparta, Turkey.

Introduction

Medicinal and aromatic plants, have been used for many purposes; as a source of tea, spices, condiment, cosmetics and volatile oils. The group of medicinal and aromatic plants, particularly those which are rich with respect to volatile constituents and oil extracts, place a significant importance. Volatile components (essences, etheric oils) and aromatic extracts, are frequently used by fragrance and taste industries, in manufacturing perfumes, food additives, cleaning products, cosmetics and drugs; also as a source of aroma chemicals, or as the starting material for synthesis reaction regarding nature identical, semi-synthetic, and useful aroma chemicals. In particular, there has been a large increase in the demand for volatile components, to be used in aromatherapy applications that have shined out in recent years [1; 2].

Turkey has a significant importance in terms of production and trade of medicinal and aromatic plants. Particularly Isparta province in Turkey, has become one of the most important production centers as of medicinal and aromatic herbs. In accordance with the floristic research conducted in terms of the flora, regarding Isparta province, located at the intersection of the Mediterranean and Iranian-Turanian regions with regard to floral region, it is known that a total of 2280 different plant taxa are distributed, 190 of which have high medicinal, aromatic and perfume values and 160 of which have high spice values [3].

The cosmopolitan *Lamiaceae* family, which usually consists of fragrant, one or perennial herbaceous, rarely encountered as shrubs or trees, contains 546 species, 45 genera, and a total of 731 taxa [4]. The genus *Sideritis*, a member of the *Lamiaceae*, constitute of one or perennial herbs or small bushes, about 20-90 cm high, pilous or tomentose, with leaves in full edges or dentated, its brahteols in the form of leaves, calyx, tubular or bell-shaped, with 5-10 nervated, 5 petals, its corolla usually yellow, sometimes white or red, and have a broad distribution in subtropical and middle regions [4,5].

Sideritis L. genus has more than 150 taxa, mostly encountered in the Mediterranean Region. This genus is represented by 46 species and 55 taxa, 42 of which are considered to be endemic [4,6]. Since Turkey is one of two main genetic centers of *Sideritis* L. genus, its endemic rate (79.5%) is quite high [7]. The genus *Sideritis,* is used extensively, colloquially as a herbal tea, due to its calmative, anti-inflammatory, antispasmodic, carminative, analgesic, sedative, cough suppressant and anticonvulsant features, against stomach pains, coughs caused by cold, and various diseases such as digestive complaints [8].

Davraz Mountain, which is located within the boundaries of Isparta province, in the Lakes District of Mediterranean Region, is rich in botany and also a natural area that contains rich populations of rare, endangered and endemic plant species. In this study that was conducted in Davraz Mountain, samples of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, *Sideritis hispida* P. H. Davis, *Sideritis libanotica* Labill. subsp. *linearis* ve *Sideritis perfoliata* L. taxa, which grow naturally in Davraz Mountain, were collected and examined in terms of volatile constituents and their percentiles. Studies have been conducted on the volatile components of mountain sage (*Sideritis*) species, in different regions of Turkey. By the way, volatile components of leaf and flowers of *Sideritis* taxa from Davraz Mountain were detected for the first time by this study.

Material and methods

Davraz Mountain is located within the C3 frame throughout the gridding system prepared based on Turkish flora. The research material consists of *Sideritis* L. samples which were collected from Davraz between 2017 and 2018 (Figure 1).

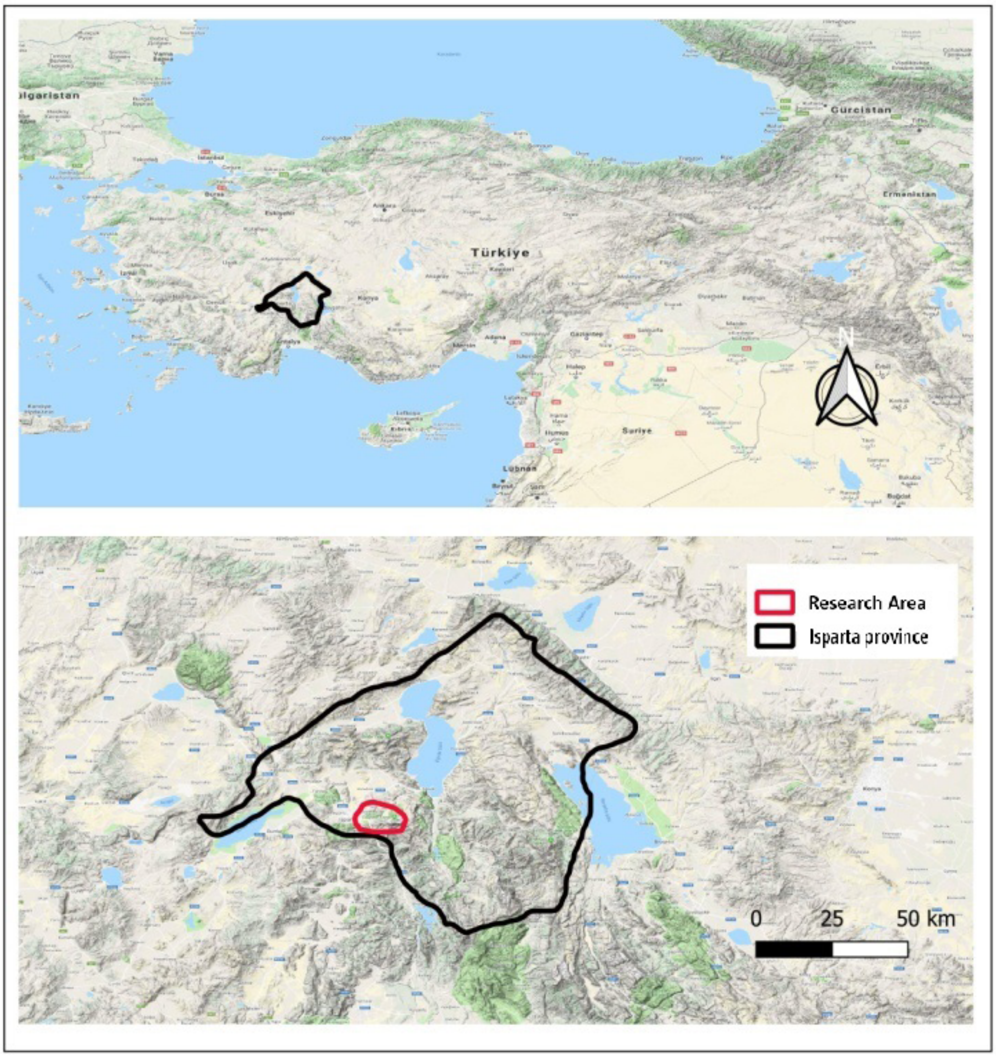

Figure 1 – Research area

The samples were collected from the field were taken to the Forest Botany laboratory of the Faculty of Forestry in Isparta University of Applied Sciences. Leaf and flower samples pertaining to another bulk of the plant samples collected from the research area, were transferred to the laboratory on the same day, at once, in paper packages and without being exposed to sunlight. Plant samples were dried at room temperature (25°C). Volatile constituents of leaves and flowers were examined through Headspace-Solid Phase Micro Extraction (HS-SPME) technique combined with gas chromatography/mass spectrometry (GC/MS). Grounding on Solid Phase Micro Extraction technique, 2 g of the leaves and floral samples, collected from each sample were placed in a 10 mL vial, with the mouth sealed with a silicone lid, and then stored at 60°C temperature for 30 min. The SPME apparatus was passed through the headspace, with a fused slica fiber of 75 µm, coated with Carbokzen/Polydimethylsiloxane (CAR/PDMS) and then injected directly into the kpiler column of the Shimadzu 2010 Plus GC-MS device (Restek Rx-5 Sil MS 30 m x 0.25 mm, 0.25 µm). The device was connected to the same brand, mass selector detector, which was operated in Hand mode (70 eV). Helium with a flow rate of 1.61 mL per minute was used as the carrier gas. Injection and detection temperatures were set at 250°C. Retention Indices (RI) of volatile constituents were calculated in accordance with alkane standard mixtures C7-C30, under the above mentioned chromatographic conditions. Wiley, NIST Tutor and FFNSC libraries were used to identify volatile constituents.

Since the percentiles determined in the study with respect to each volatile components and their fields, could not meet the pre-requisites of parametric tests in determining statistical data, non-parametric tests were used. Kruskal-Wallis Test was used as a non-parametric test in order to determine the difference between species.

Results and discussion

The leaves and flowers of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata,* were collected from three different sampling sites: Büyükhacılar (1015 m), Çobanisa (1068 m) and Darıderesi (1113 m). The above-ground parts, including flowers, leaves and stems, are consumed as a herbal tea, upon brewing in boiled water for 5-10 min. It has been found out to be used colloquially as a pain relief, remedy against stomach pain, and as appetizer. Using Solid Phase Micro Extraction (HS-SPME) technique, combined with gas chromatography/mass spectrometry (GC/MS), 45 different volatile constituents were identified regarding the leaves and flowers of the samples of S*ideritis condensata* (Boiss. & Heldr.) subsp. *condensata* collected from the 1st sample area, 40 different volatile constituents were identified regarding the leaves and flowers of the samples collected from the 2nd sample area, and 39 from the 3rd sample area respectively, making up a total of 62 different volatile constituents, their main components and their percentages were identified respectively as follows: β-Pinene (11.44%, 11.44%, 12.29%), 3-Octanole (11.83%, 11.90%, 11.73%), Limonene (15.31%, 14.37%, 14.52%), Caryophyllene (13.55%, 12.04%, 17.31%). It was observed upon examining the classes of volatile components that, monoterpene and sesquiterpene hydrocarbons were high in all three sample areas.

The leaves and flowers of *Sideritis hispida* P. H. Davis, were collected from three different sampling sites: Akdoğan (1128 m), Büyükhacılar (1033 m) and Yazısöğüt (989 m). The above-ground parts, including flowers, leaves and stems, are consumed as a herbal tea, upon brewing in boiled water. It has been found out to be used colloquially as a pain relief, intestinal regulator and antitussive. Using Solid Phase Micro Extraction (HS-SPME) technique, combined with gas chromatography/mass spectrometry (GC/MS), 42 different volatile components were identified regarding the leaves and flowers of the samples of *Sideritis hispida* P. H. Davis, collected from the 1st sample area, 40 different volatile constituents were identified regarding the leaves and flowers of the samples collected from the 2nd sample area, and 44 from the 3rd sample area respectively, making up a total of 46 different volatile constituents, their main components and their percentages are identified respectively as follows: (E)-2-Hexenal (10.22%, 13.04%, 12.03%), β-Myrcene (35.08%, 36.54%, 35.86%), Caryophyllene (10.07%, 11.78%, 11.26%), p-Cymene (9.64%, 8.80%, 8.11%). It was observed upon examining the classes of volatile components that, monoterpene and sesquiterpene hydrocarbons together with aromatic alcohol, were high in all three sample areas.

The leaves and flowers of *Sideritis libanotica* Labill. subsp. *linearis* were collected from three different sample areas: Direkli (930 m), Büyükhacılar (1354 m) and Sav (1152 m). The above-ground parts, including flowers, leaves and stems, are consumed as a herbal tea, upon brewing in boiled water for 5-10 minutes.

Table 1 – Volatile components of leaf and flowers of taxa *Sideritis* L.

	R.T.	Components	*S. condensata* subsp. *condensata*			*S. hispida*			*S. libanotica* subsp. *linearis*			*S. perfoliata*			Formula	Category
			1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site		
1.	1.670	2-Methylpropanal	*	*	*	0.09	0.11	0.15	0.24	0.27	0.22	*	*	*	C_4H_8O	AA
2.	1.873	Acetic acid	1.70	*	*	0.50	0.59	0.61	1.37	1.36	2.07	0.70	0.11	0.91	$C_2H_4O_2$	FA
3.	2.178	2-Butenal	*	*	0.23	2.33	1.90	1.10	0.68	0.55	*	0.15	0.36	*	C_4H_6O	AAI
4.	2.220	3-Methyl butanal	0.19	*	*	*	*	*	0.21	0.17	0.54	*	*	*	$C_5H_{10}O$	AA
5.	2.311	Butanal	*	*	*	*	*	*	0.31	0.19	0.33	*	*	*	C_4H_8O	AA
6.	2.531	1-Penten-3-one	*	*	*	*	*	*	*	*	*	0.33	0.03	*	C_5H_8O	AAI
7.	2.540	2-Pentanone	1.98	1.50	*	*	*	*	0.36	*	*	*	*	0.41	$C_5H_{10}O$	AA
8.	2.665	3-Pentanone	1.05	*	*	*	*	*	0.43	0.19	0.48	*	*	*	C_5H_8O	AA
9.	2.680	Pentanal	*	*	*	*	*	0.55	*	*	*	*	*	*	$C_5H_{10}O$	AAI
10.	2.695	2-ethyl-Furan	0.51	0.89	0.56	1.45	1.52	1.65	1.92	1.20	1.98	0.18	0.15	0.27	C_6H_8O	AA
11.	3.307	(E)- 3-Penten-2-one	*	*	*	0.71	0.87	0.75	*	*	*	*	0.09	*	C_5H_8O	AAI
12.	3.295	3-Methyl-1-butanol	0.59	*	*	*	*	*	0.29	*	*	*	*	*	$C_5H_{12}O$	AA
13.	3.361	1-Butanol	0.90	*	*	*	*	*	0.23	*	*	*	*	*	$C_4H_{10}O$	AA
14.	3.606	(E)-2-Pentenal	*	*	0.20	0.73	0.62	0.79	0.72	0.66	0.54	0.75	0.07	0.30	C_5H_8O	AAI
15.	3.905	1-Pentanol	*	*	*	*	*	*	*	*	*	0.21	*	*	$C_5H_{12}O$	AAI
16.	3.912	(Z)-3-Hexenal	*	*	*	*	*	*	*	*	*	0.24	*	*	$C_6H_{10}O$	AA
17.	4.596	Hexanal	0.18	0.53	0.47	1.21	1.64	1.45	0.33	0.84	0.75	0.96	0.13	0.56	$C_6H_{12}O$	AA
18.	6.085	(E)-2-Hexenal	1.96	3.59	3.22	10.22	13.04	12.03	18.84	19.32	22.24	0.29	0.51	0.13	$C_6H_{10}O$	AA
19.	6.180	cis-3-Hexene-1-ol	0.72	0.61	0.69	0.52	0.32	0.42	2.01	2.08	2.18	0.22	0.06	0.38	$C_6H_{12}O$	AA
20.	6.522	(E)- 2-Hexen-1-ol	*	*	0.49	*	*	*	0.65	0.43	0.46	0.28	*	0.74	C_6H_{12}	AA
21.	6.646	n-Hexanol	0.23	0.28	0.41	*	0.46	0.52	0.22	0.48	0.52	0.22	0.03	0.64	$C_6H_{14}O$	AA
22.	7.267	2-Heptanone	0.64	*	*	*	*	*	0.19	*	*	*	*	0.16	$C_7H_{14}O$	AA
23.	7.676	n-Heptanal	*	*	*	*	0.37	0.21	*	*	*	0.20	*	*	$C_7H_{14}O$	AA
24.	7.970	Sorbaldehyde	0.19	*	0.32	2.03	2.14	2.04	0.18	0.89	0.72	0.23	0.08	0.74	C_6H_8O	AA
25.	8.495	α-Thujene	0.63	0.50	*	0.80	0.84	0.57	0.57	0.44	*	0.23	0.47	0.20	$C_{10}H_{16}$	MH
26.	8.734	α-Pinene	5.65	4.06	6.05	0.95	0.62	0.66	3.92	3.85	2.56	41.83	51.02	41.92	$C_{10}H_{16}$	MH
27.	9.172	Benzene	*	*	*	*	*	*	*	*	*	*	*	0.54	C_6H_6	AH
28.	9.365	Camphene	*	*	*	*	*	*	*	*	*	*	0.22	0.16	$C_{10}H_{16}$	MH
29.	9.676	(Z)-2-Heptenal	*	*	*	0.76	*	0.74	*	*	*	0.22	0.05	*	$C_7H_{12}O$	AA
30.	9.788	Benzaldehyde	0.91	1.42	0.43	0.84	0.70	0.58	0.20	0.75	0.03	0.19	0.09	0.41	C_7H_6O	AAI

Continuation of table 1

	R.T.	Components	*S. condensata* subsp. *condensata*			*S. hispida*			*S. libanotica* subsp. *linearis*			*S. perfoliata*			Formula	Category
			1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site		
31.	9.807	Methyl 2-hexenoate	1.09	*	*	*	*	*	*	*	*	*	*	*	$C_7H_{12}O_2$	EC
32.	10.268	β-Phellandrene	0.42	0.32	0.22	0.41	0.56	0.67	0.47	0.46	0.26	0.28	0.37	0.62	$C_{10}H_{16}$	MH
33.	10.400	β_Pinene	11.44	11.44	12.29	0.95	0.80	0.75	4.10	5.09	5.70	11.46	11.30	12.47	$C_{10}H_{16}$	MH
34.	10.445	Vinyl amyl ketone	0.32	0.32	*	*	*	*	0.34	0.28	0.29	0.19	*	0.81	$C_8H_{14}O$	AAI
35.	10.647	3-Octanol	11.83	11.90	11.73	1.63	1.34	1.45	22.19	19.11	20.87	5.65	4.00	4.68	$C_8H_{16}O$	AAI
36.	10.766	6-Methyl-5-hepten-2-one	*	*	*	0.33	0.52	0.42	*	0.38	*	*	*	*	$C_8H_{14}O$	AAI
37.	10.802	3-Octanone	2.58	2.74	0.81	*	0.56	0.54	1.65	*	1.64	*	*	*	$C_8H_{14}O$	AAI
38.	10.943	β-Myrcene	4.43	5.18	2.26	35.08	36.54	35.86	4.62	3.99	2.95	1.70	2.00	1.52	$C_{10}H_{16}$	MH
39.	11.186	2,4-Heptadienal	*	*	*	2.32	2.72	2.35	0.75	0.70	1.44	0.19	0.22	0.21	$C_7H_{10}O$	AA
40.	11.347	Decane	*	*	*	0.18	0.27	0.21	*	*	*				$C_{10}H_{22}$	AH
41.	11.440	Octanal	*	0.45	*	*	*	*	*	0.34	0.50	0.34	0.09	0.32	$C_8H_{16}O$	AA
42.	11.498	Phellandrene	*	*	*	*	*	*	*	*	*	*	0.45	*	$C_{10}H_{16}$	MH
43.	11.543	Hex-3(Z)-enyl acetate	*	*	*	*	*	*	0.23	0.28	0.22	*	*	0.20	$C_8H_{14}O_2$	FA
44.	11.640	δ-3-Carene	*	*	*	0.26	0.33	0.21	*	*	*	*	0.31	*	$C_{10}H_{16}$	MH
45.	11.923	α-Terpinene	*	*	*	0.59	0.53	0.55	*	0.25	*	0.29	0.15	*	$C_{10}H_{16}$	MH
46.	12.255	p-Cymene	1.43	0.27	*	9.64	8.80	8.11	1.20	1.09	0.75	0.44	0.34	0.44	$C_{10}H_{14}$	MH
47.	12.414	Limonene	15.31	14.37	14.52	2.83	2.49	2.41	14.70	13.73	10.77	11.90	11.12	10.71	$C_{10}H_{16}$	MH
48.	12.632	1,8-Cineole	0.38	0.14	*	*	*	*	*	0.49	0.30	0.24	*	*	$C_{10}H_{18}O$	OM
49.	12.725	cis-Ocimene	0.23	0.79	0.44	0.25	0.36	0.28	1.23	0.79	1.22	*	1.74	1.06	$C_{10}H_{16}$	MH
50.	12.801	Oct-3(E)-en-2-one	*	*	*	0.22	*	*	*	*	*	*	*	*	$C_8H_{14}O$	AAI
51.	12.943	Benzeneacetaldehyde	*	*	0.22	0.22	0.30	0.25	*	*	*	*	*	*	C_8H_8O	OC
52.	13.163	β-Ocimene	*	0.91	0.46	1.04	1.41	1.12	0.66	*	*	*	0.39	0.80	$C_{10}H_{16}$	MH
53.	13.544	γ-Terpinene	*	*	*	0.42	0.37	0.22	*	0.50	0.26	0.46	0.26	*	$C_{10}H_{16}$	MH
54.	14.039	E,E-3,5-octadien-2-one	*	*	*	0.47	*	*	*	*	*	0.88	0.03	*	$C_8H_{12}O$	AAI
55.	14.593	α-Terpinolene	*	*	*	*	*	*	*	0.27	0.43	*	0.92	0.15	$C_9H_{18}O$	AAI
56.	15.138	Furan, 3-(4-methyl-3-pentenyl)	*	*	*	0.12	0.55	0.33	*	*	*	*	*	*	$C_{10}H_{14}O$	OM
57.	15.246	Dodecane	*	*	*	0.73	0.25	0.58	*	*	*	*	*	*	$C_{12}H_{26}$	AH
58.	15.265	Linalool	3.13	0.59	0.31	*	*	*	0.64	1.31	0.79	0.76	0.18	1.74	$C_{10}H_{18}O$	OM
59.	15.389	Nonanal	*	0.22	*	0.29	*	0.40	*	0.37	0.78	0.56	*	*	$C_9H_{18}O$	AAI
60.	15.928	Octanoic acid	1.38	*	*	*	*	*	*	*	*	*	*	*	$C_8H_{16}O_2$	FA
61.	16.297	Alloocimen	*	1.36	*	*	*	*	*	*	*	*	0.20	0.58	$C_{10}H_{16}$	MH

Continuation of table 1

	R.T.	Components	S. condensata subsp. condensata			S. hispida			S. libanotica subsp. linearis			S. perfoliata			Formula	Category
			1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site	1 . Site	2. Site	3. Site		
62.	18.719	<ethyl->Octanoate	0.18	*	*	*	*	*	*	*	*	*	*	*	$C_{10}H_{20}O_2$	FA
63.	18.824	Isopentyl cyclobutanecarboxylate	*	*	*	*	*	*	*	*	*	*	*	0.36	$C_8H_{14}O_2$	FA
64.	18.852	α-Terpineol	0.23	*	*	*	*	*	*	0.28	0.26	0.23	*	*	$C_{10}H_{18}O$	OM
65.	19.285	Decanal	*	*	*	*	*	*	*	*	0.31	0.22	0.25	*	$C_{10}H_{20}O$	OM
66.	19.692	β-Cyclocitral	*	*	*	*	*	*	*	*	*	0.21	*	*	$C_{10}H_{16}O$	OM
67.	20.776	Pentyl hexanoate	0.20	*	*	*	*	*	*	*	*	*	*	*	$C_{11}H_{21}O_2$	FA
68.	20.785	Methyl 2,4-decadienoate (2E,4Z)	0.95	*	*	*	*	*	*	*	*	*	*	*	$C_{11}H_{18}O_2$	FA
69.	22.715	Carvacrol	*	*	*	*	*	*	*	0.57	*	*	*	*	$C_{10}H_{14}O$	OM
70.	24.476	.α.-Cubebene	0.30	1.00	0.61	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
71.	25.091	Cyclosativene	*	*	0.49	0.36	0.20	0.23	*	*	*	*	*	0.31	$C_{15}H_{24}$	SH
72.	25.334	α-Copaene	6.14	6.73	5.06	3.64	0.38	2.46	0.47	0.63	0.41	1.61	*	1.68	$C_{15}H_{24}$	SH
73.	25.605	.β. Bourbonene	2.77	1.33	2.16	1.74	0.53	1.32	0.80	1.60	1.69	1.52	*	1.26	$C_{15}H_{24}$	SH
74.	25.813	.β. Elemene	0.43	1.12	0.75	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
75.	26.001	Nepetalactone	*	*	*	*	*	*	*	*	0.78	*	*	*	$C_{10}H_{14}O_2$	FA
76.	26.905	Caryophyllene	13.55	12.04	17.31	10.07	11.78	11.26	10.82	12.10	10.32	12.17	12.11	10.49	$C_{15}H_{24}$	SH
77.	27.453	Aromadendrene	*	*	0.41	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
78.	27.688	Cadina-1(6),4-diene<10betaH->	*	0.16	0.52	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
79.	27.934	(E)- β-Farnesene	0.42	1.38	1.66	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
80.	28.003	.α.-Humulene	0.20	0.43	0.37	0.17	0.34	0.42	*	*	*	0.24	0.10	0.16	$C_{15}H_{24}$	SH
81.	28.228	β-Cubebene	*	0.55	0.73	*	*	*	*	0.18	*	*	*	*	$C_{15}H_{24}$	SH
82.	28.661	α-Amorphene	*	0.61	0.82	*	*	*	*	*	*	*	*	0.15	$C_{15}H_{24}$	SH
83.	28.822	Curcumene	*	*	0.22	*	*	*	*	*	*	0.70	*	*	$C_{15}H_{22}$	SH
84.	28.867	Germacrene-D	1.12	4.81	4.26	0.23	*	0.19	0.63	0.71	0.65	*	*	0.38	$C_{15}H_{24}$	SH
85.	29.189	Viridiflorene	*	0.96	*	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
86.	29.323	Germacrene B	*	*	*	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
87.	29.326	γ-Gurjunene	0.20	0.85	2.77	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
88.	29.883	γ-Cadinene	0.18	0.80	0.99	*	*	*	*	*	*	*	*	0.22	$C_{15}H_{24}$	SH
89.	30.059	δ-Cadinene	0.87	2.60	4.19	0.68	0.50	0.62	*	*	0.45	0.33	*	0.21	$C_{15}H_{24}$	SH
90.	30.617	α-Muurolene	*	0.25	0.35	*	*	*	*	*	*	*	*	*	$C_{15}H_{24}$	SH
91.	32.035	Caryophyllene oxide	0.26	*	*	1.99	1.83	1.97	*	*	*	*	*	*	$C_{15}H_{24}O$	OS

Continuation of table 1

	R.T.	Components	*S. condensata* subsp. *condensata*			*S. hispida*			*S. libanotica* subsp. *linearis*			*S. perfoliata*			Formula	Category
			1 . Site	**2. Site**	**3. Site**	**1 . Site**	**2. Site**	**3. Site**	**1 . Site**	**2. Site**	**3. Site**	**1 . Site**	**2. Site**	**3. Site**		
92.	32.101	2-ethyl-Hexanol	*	*	*	*	*	*	*	0.83	0.34	*	*	*	$C_8H_{18}O$	AA
TOTAL			**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**		
Number of Components			**45**	**40**	**39**	**42**	**40**	**44**	**40**	**43**	**41**	42	37	41		
AA: Aromatic alcohol			9.14	7.85	6.16	18.60	22.32	21.56	27.04	27.23	31.26	3.38	1.10	4.35		
AAI: Aromatic aldehyde			15.64	16.6	13,4	7.55	6.51	6.58	26.19	22.79	25.73	8.91	4.89	5.60		
AH: Aromatic hydrocarbon			*	*	*	0.91	0.52	0.79	*	*	*	*	*	0.54		
EC: Ester compound			1.09	*	*	*	*	*	*	*	*	*	*	*		
FA: Fatty acids methyl ester			4.41	*	*	0.50	0.59	0.61	2.07	2.10	3.33	0.70	0.11	1.47		
MH: Monoterpen hydrocarbon			39.54	39.20	36.24	53,22	53.65	51.41	31.34	29.51	24.24	68.78	81.26	71.44		
OC: Other component			*	*	0.22	0.22	0.30	0.25	*	*	*	*	*	*		
OM: Oxygenated monoterpen			0.26	*	*	1.99	1.83	1.97	*	*	*	*	*	*		
OS: Oxygenated seskiterpen			3.74	0.73	0.31	0.12	0.55	0.33	0.64	3.15	1.92	1.66	0.43	1.74		
SH: Seskiterpen hydrocarbon			26.18	35.62	43.67	18.88	13.73	16.50	12.72	15.22	13.52	16.57	12.21	14.86		

It has been found out to be used colloquially as a pain relief, as a remedy against stomach pain, as an intestinal regulator, carminative, diuretic, cough suppressant and appetizer. Using Solid Phase Micro Extraction (HS-SPME) technique, combined with gas chromatography/mass spectrometry (GC/MS), 40 different volatile constituents were identified, regarding the leaves and flowers of the samples of *Sideritis libanotica* Labill. subsp. *linearis* collected from the 1st sample area, 43 different volatile constituents were identified regarding the leaves and flowers of the samples collected from the 2nd sample area, and 41 from the 3rd sample area respectively, making up a total of 54 different volatile constituents, their main components and their percentages are identified respectively as follows (E)-2-Hexenal (18.84%, 19.32% and 22.24%), 3-Octanole (22.19%, 19.11% and 20.87%), Limonene (14.70%, 13.73% and 10.77%), Caryophyllene (10.82%, 12.10% and 10.32%). It was observed upon examining the classes of volatile components that, monoterpene hydrocarbons together with aromatic alcohol and aromatic aldehydes were high in all three sample areas.

The leaves and flowers of *Sideritis perfoliata* L. were collected from three different sample areas: Yazısöğüt (1010 m), Büyükhacılar (1365 m) and Sav (1089 m). The above-ground parts, including flowers, leaves and stems, are consumed as a herbal tea, upon brewing in boiled water. It has been found out to be used colloquially as a pain relief, as a remedy against stomach pain, as an intestinal regulator, carminative, and cough suppressant. Using Solid Phase Micro Extraction (HS-SPME) technique, combined with gas chromatography/mass spectrometry (GC/MS), 42 different volatile constituents were identified, regarding the leaves and flowers of the samples of *Sideritis perfoliata* L. collected from the 1st sample area, 37 different volatile components were identified regarding the leaves and flowers of the samples collected from the 2nd sample area, and 41 from the 3rd sample area respectively, making up a total of 59 different volatile constituents, their main components and percentages are identified respectively as follows: α-Pinene (41.83%, 51.02% and 41.92%), β-Pinene (11.46%, 11.30% and 2.47%), Limonene (11.90%, 11.12% and 10.71%), Caryophyllene (12.17%, 12.11% and 10.49%). It was observed upon examining the classes of volatile constituents that, monoterpene and sesquiterpene hydrocarbons were high in all three sample areas.

There is no statistically significant difference regarding the fields of collection, of volatile constituents pertaining to leaves and flowers of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, *S. hispida* P. H. Davis, and *S. libanotica* Labill. subsp. *linearis*. As a result of Kruskal-Wallis test, applied to find out the proportions of the classes of volatile constituents pertaining to leaves and flowers of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, the difference between the median of the sites 2 and 3 was found to be statistically significant ($p2=0.004 < 0.05$, $p3=0.006<0.05$). No statistically significant difference was found between the median of the sites 2 and 3 regarding the volatile constituents pertaining to leaves and flowers of *S. hispida* P. H. Davis, as a result of Kruskal-Wallis test, applied to find out the proportions of the fields. The difference between the median of the site 1, was found to be statistically significant regarding the leaves and flowers of *S. libanotica* Labill. subsp. *linearis* ($p=0.043 < 0.05$) whereas the difference between the median of the site 2 was found to be statistically significant ($p=0.000 < 0.05$), as a result of Kruskal-Wallis test, applied to find out the proportions of the sites of volatile constituents pertaining to leaves and flowers of *S. perfoliata* L.

Sideritis L. taxa, which is colloquially called as "mountain tea", is used as a herbal tea, upon brewing for 5-10 min in boiled hot water. It has been found out to be used as a pain relief, as a remedy against stomach pains, as a cough suppressant, carminative, intestinal regulator, diuretic and appetizer.

The leaves and flowers regarding 4 different natural *Sideritis* taxa, which are distributed in Mount Davraz, were collected from three different sample areas. Using Solid Phase Micro Extraction (HS-SPME) technique, combined with gas chromatography/mass spectrometry (GC/MS), 62 different volatile constituents were identified, regarding the leaves and flowers of the samples of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, 46 different volatile constituents were identified regarding the leaves and flowers of the samples of *Sideritis hispida* P. H. Davis, 54 different volatile constituents were identified regarding the leaves and flowers of the samples of *Sideritis libanotica* Labill. subsp. *linearis* and 59 as of *Sideritis perfoliata* L. respectively.

The main components of the volatile constituents as of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata* were identified as β-Pinene, 3-Octanol, Limonene, Caryophyllene; the main components of the volatile constituents as of *S. hispida* P. H. Davis were identified as (E)-2-Hexenal, β-Myrcene, Caryophyllene, p-Cymene; the main components of the volatile components as of *S. libanotica* Labill. subsp. *linearis* were identified as (E)-2-Hexenal, 3-Octanol, Limonene, Caryophyllene and the main components of the volatile constituents as of *S. perfoliata* were identified as α-Pinene, β-Pinene, Limonene and Caryophyllene, respectively. The Caryophyllene component was identified among the main components in each of the 4 different, natural *Sideritis* taxa that were widely distributed in Davraz Mountain. The Limonene component was encountered among the main components in the other 3 taxa except for *S. hispida* P. H. Davis.

Table 2 – Kruskal-Wallis test as a result of *Sideritis* L.

		1. Site	2. Site	3. Site
Sideritis condensata (Boiss. & Heldr.) subsp. condensata	Chi-Square	4,955	15,126	14,628
	df	4	4	4
	Asymp. Sig.	,292	,004	,006
		1. Site	2. Site	3. Site
Sideritis hispida P. H. Davis	Chi-Square	2,120	3,448	1,697
	df	3	3	3
	Asymp. Sig.	,548	,328	,638
		1. Site	2. Site	3. Site
Sideritis libanotica Labill. subsp. linearis	Chi-Square	11,468	4,318	2,855
	df	5	5	5
	Asymp. Sig.	,043	,505	,722
		1. Site	2. Site	3. Site
Sideritis perfoliata L.	Chi-Square	,578	22,862	7,404
	df	4	4	4
	Asymp. Sig.	,966	,000	,116

Ezer and Abbasoğlu [9], has identified the volatile oil components pertaining to the four types of *Sideritüs,* 3 of which are endemically distributed in Turkey through GC and GC/MS (gas chromatography/mass spectrometry). α-pinene and β-pinene were found as the main constituents in *S. congesta* and *S. argyrea*. β-caryophyllene and α-pinene were found as the main constituents in *S. condensata*. Limonene was found as the main constituents in *S. perfoliata*. The results of the study differ from the results of this thesis study in terms of *S. condensata*. β- caryophyllene and α-pinene were found as the main constituents in *S. condensata*, with respect to the study conducted by Ezer and Abbasoğlu [9], whereas the main constituents were found as β-Pinene, 3-Octenol, Limonene and Caryophyllene in our study. Ezer and Abbasoğlu [9] has determined the main constituent of *S. perfoliata* as limonene. This result supports the results of our study. In our study, α-Pinene, β-Pinene, and Caryophyllene were also determined among the main components in *S. perfoliata*.

Kirimer et al. [10] reported the volatile oil constituents pertaining to six samples of *Sideritis condensata* Boiss, endemically present in Turkey through GC and GC/MS. They have determined Germacrene-D and hexadecanoic acid as main components. However, the result of the study differs with that of the results of our study. In our study, the main components were divergently reported as β-Pinene, 3-Octenol, Limonene, and Caryophyllene. What's more, the main components of *S. perfoliata*, in our study were reported as α-Pinene, β-Pinene, and Caryophyllene.

Özkan et al. [11] reported the volatile oil constituents pertaining to *Sideritis condensata*, *S. pisidica* and *S. perfoliata*, making use of GC and GC/MS. The main components of *S.condensata* were determined as carvacrol, germacrene-D, β-pinene and β- caryophyllene, the main components of *S. pisidica* were determined as α-bisabolol, sabinene, α-pinene and β-caryophyllene, whereas the main components of *S. perfoliata* were determined as α-bisabolol, myrcene, β-caryophyllene and germacrene-D. The result of this study differs with the result of this thesis. The main components of *S. condensata* were determined as carvacrol, germacrene-D, and β-pinene in the study of Özkan et al. [11] where as the main components in *S. condensata* as of our study is found out to be β-Pinene, 3-Octanol, Limonene, and Caryophyllene.

However, β-Pinene component was identified as the main component in both studies. The main components in *S. perfoliata* as of the study conducted by Özkan et al. (2005) were determined as α-bisabolol, myrcene, β-caryophyllene and germacrene-D, whereas the main components of *S. perfoliata* in our study were found out to be α-Pinene, β-Pinene, Limonene, and Caryophyllene.

Krimer et al. [12] has reported the volatile oil constituents pertaining to *Sideritis hispida* P. H. Davis, which is endemically widespread in Turkey, making use of GC and GC/MS. They have identified 63 different constituents, where β-caryophyllene and carvacrol were defined as main components. The result of their study differs with the result of this thesis. In our study the main components of *S. hispida* were reported as (E)-2-Hexenal, β-Myrcene, Caryophyllene, and p-Cymene.

In a study conducted by Özderin [13] on natural tea herbs and their volatile oil constituents as of Muğla-Ula Region, the main components of *Sideritis libanoitica* Labill subsp. *linearis* were reported as myrcene, linalool, β pinene, α-cadino and caryophyllene. The result of their study differs with the result of this thesis. However, the caryophyllene component was determined among the main components, in both studies.

Conclusion

This study determines the volatile constituents and their percentiles regarding the leaves and flowers pertaining to *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, *S. hispida* P. H. Davis, *S. libanotica* Labill. subsp. *linearis* and *S. perfoliata*, widespreadly encountered in Davraz Mountain. Results are important to reveal the economic value of the plants in the region, which are widely consumed as natural herbal tea, and to provide a perception of conscious consumption.

Moreover, *Sideritis* tea is widely consumed colloquially as a pain relief, remedy against stomach pains, as a cough suppressant, carminative, intestinal regulator, diuretic and appetizer. These and similar studies should be upgraded in order to ensure people to consume *Sideritis* more consciously.

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