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Determination of Volatile Components in Mountain Tea (*Sideritis condensata* Boiss. Et. Heldr. Apud Bentham) Grown in its Natural and Agricultural Field Environment

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Research Article

Abstract- In this study, it was aimed to compare the volatile components of Sideritis condensata Boiss. Et. Heldr. Apud Bentham species mountain tea collected from nature and grown under field conditions with HS-SPME GC-MS technique. The cuttings of the plant were collected from Isparta Province, Yenişarbademli District, rocky location of Dedegöl Mountain in April 2020, and were transferred to field conditions at the end of May in the same year after rooted in a greenhouse environment. In June-July 2021, during the flowering period, leaf and flower samples peculiar to the species were collected from both field and natural environments and dried under room conditions. Using solid based micro-extraction technique, 72 volatile components were determined in natural growing environment and 88 volatile components in field environment in S. *condensata* by gas chromatography mass spectrometry (GC-MS). Among the volatile components found in natural habitat and field environment, *α*-pinene (9.30%-2.32%), *β*-pinene (18.12%-5.66%), *β*-ocimene (4.46%-1.06%), trans-caryophyllene (12.77%-0.83%), germacrene-D (10.59%-0.67%), *γ*-cadinene (2.09%-10.94%), *α*-gurjunene (0.03%-16.68%), farnesene (0.98%-6.00%) were identified as the main components of *Sideritis condensata*. When the volatile components were examined, it was observed that sesquiterpene hydrocarbons were high.

Keywords *- Sideritis condensata, solid-based micro extraction technique, endemic, volatile component, β-pinene, α- pinene, germacrene-D*

Dağ Çayı (*Sideritis condensata* Boiss. Et. Heldr. Apud Bentham)'ın Doğal ve Tarla Ortamındaki Uçucu Bileşenlerinin Belirlenmesi

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Araştırma Makalesi

Öz- Bu çalışmada doğadan toplanan ve tarla koşullarında yetiştirilen *Sideritis condensata* Boiss. Et. Heldr. Apud Bentham türü dağ çayının uçucu bileşenlerinin HS-SPME GC-MS tekniği ile karşılaştırılması amaçlanmıştır. Bitkinin çelikleri Isparta İli, Yenişarbademli İlçesi, Dedegöl Dağı kayalık mevkiinden 2020 yılı Nisan ayında toplanmış ve sera ortamında köklendirilerek aynı yıl Mayıs ayı sonunda tarla koşullarına aktarılmıştır. 2021 yılı Haziran-Temmuz ayında (çiçeklenme dönemi) hem tarla hem de doğal koşullardan türe ait yaprak ve çiçek örnekleri toplanmış ve oda koşullarında kurutulmuştur. Katı faz mikro ekstraksiyon tekniği kullanılarak, gaz kromatografisi kütle spektrometresi (GC-MS) ile *S. condensata* 'da doğal yetişme ortamında 72 adet uçucu bileşen ve tarla ortamında 88 adet uçucu bileşen belirlenmiştir. Doğal yetişme ortamı ve tarla ortamındaki uçucu bileşenlerinden *α*-pinene (9.30%-2.32%), *β*-pinene (18.12%-5.66%), *β*-ocimene (4.46%-1.06%), trans-caryophyllene (12.77%-0.83%), germacrene-D (10.59%-0.67%), *γ*-cadinene (2.09%-10.94%), *α*-gurjunene (0.03%-16.68%), farnesene (0.98%-6.00%) *Sideritis condensata* 'nın ana bileşenleri olarak tespit edilmiştir. Uçucu bileşen sınıflarına bakıldığında seskiterpen hidrokarbonların yüksek oranda olduğu bulunduğu görülmüştür.

Anahtar Kelimeler *- Sideritis condensata, katı faz mikro ekstraksiyon tekniği, endemik, uçucu bileşen, β-pinene, α- pinene, germacrene-D*

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1.Introduction

Turkey is one of the richest countries in the world in terms of natural vegetation. The main reason for this is the fact that the Mediterranean, Iranian-Turanian and Euro-Siberian which are among the few phytogeographic regions on Earth are located in Anatolia and merge with each other in some places (Durmuşkaya, 2005). Turkey is a country with fertile soils in terms of medicinal and aromatic plants owing to its location on different climatic zones, its having a large surface area and geographical location. There are 11,466 plant taxa that grow naturally in Turkey, and about 3649 of these are endemic (Güner et al., 2012) About 1000-2000 of these plant taxa are used for medicinal purposes (Arslan et al., 2000). Besides its rich flora, Turkey also has a wide diversity of medicinal and aromatic plants. (Arslan et al., 2015).

The Mediterranean region is rich in medicinal and aromatic plants. Many aromatic plants such as *Sideritis, Salvia, Thymus, Thymbra, Satureja, Origanum, Micromeria* and *Tilia* are also popularly used as herbal tea by public (Başer, 2000). In addition to being used as spices, medicinal and aromatic plants are also used as raw materials in many industries such as cosmetics and pharmacy (Çelik, 2019). Most of the studies conducted on the medicinal plants in Turkey so far are predominantly about anatomical, botanical and chemical analyses (Baydar, 2016). Medicinal and aromatic plants are among the significant product groups which provide a source of raw materials as spices and essential oil for the food industry and cosmetic industries (Soysal, 2000). A significant part of the medicinal and aromatic plants consumed in Turkey are already obtained from nature (Çiçekli, 2014). The Lamiaceae family is one of the most important plant groups since so many of the plants in his family are used as aromatic and medicinal herbs. (Dönmez, 2022). Lamiaceae family is one of the most significant families of Angiospermae and is a large family that represents many useful plants such as mountain tea, sage, thyme, and mint (Kaya, 1997). Lamiaceae family includes 546 species, 45 stocks and a total of 731 taxa which contain usually fragrant single or perennial herbaceous, rarely shrubs or trees (Davis, 1982). There are 44 species (55 taxa) of *Sideritis* spp., a significant stock in the Lamiaceae family (Duman et al., 2005; Şahin et al., 2008). *Sideritis condensata* is called “Cocooned Thyme” in Turkey (Yordanova and Apostolova, 2000). *Sideritis* species, which are known as mountain tea, highland tea or sage in Turkey, are currently only utilized in the domestic market. However, certain species are under danger in their natural habitats due to intensive gathering or grazing. This makes it important to develop the cultivation and utilization of these economically significant species at further stages (Gümüşçü and et al., 2011). *Sideritis* L. belongs to Lamiaceae Lindl. (Labiatae Juss.) family which contains the most common and diverse plants in the world (Heywood, 1996). In *Sideritis,* inflorescences and leaves are the parts that are used. It is traditionally used as a stimulant, appetite stimulant, stomach pain reliever and used for dyspeptic (indigestion) complaints (Saraç and Uğur, 2007). In alternative medicine, it is used as a sedative, carminative, antiflamator, antipasmodic, cough suppressant, stomach pain reliever, anticonvulsant, and used to relieve coughs caused by cold and digestive complaints. Aqueous extracts of some types of *Sideritis* have antidepressant properties (Tabanca et al., 2001).

The *Sideritis* species, commonly referred to as "Sage and Mountain Tea," are used as a nervous system stimulant, anti-inflammatory, antisposmodic, carminative, analgesic, sedative, antitusif, gastroprotective, and antikonvulsant in the treatment of coughs brought on by colds. (Kırımer et al., 1999).

In this study*, Sideritis condensata* Boiss. Et. Heldr. Apud Bentham’s volatile components of flowers and leaves belonging to two different areas were determined by SPME analysis. Both growing areas, natural and field environment, were considered. The results of the analysis were compared with the ones in the literature.

2. Material and Method

2.1. Material

In this study, *S. condensata species* collected from Isparta Province, Yenişarbademli District, rocky location of Dedegöl Mountain, at 2300 metres altitude, 37°69'35"N; 31°30'90"E coordinates was used as the material. Bedrock limestone rocks make up the area, and brown forest soil predominates (Mutlu et al, 2003). *S. condensata* plant collected from Dedegöl Mountain was cultivated by taking the cuttings of the plant. The plant was diagnosed by us using the distinction key in "Flora of Turkey" (Davis, 1982). *S. condensata* was given the herbarium number ISPO 1501 at Isparta University of Applied Sciences and the sample was recorded in the herbarium.

2.2. Features of the growing environment in field conditions

The soil properties of the research area were analyzed according to the method suggested by Rowell (Rowell, 1996). The soil texture was determined to include 1.1% clay loam, organic matter content, by using Walkley-Black Method, 7.20% lime content by using Schiebler calcimeter, 0.38% salt content, 3.9 mg/kg avaliable phosphorus, and 119.0 mg/kg in 1N NH_4OAc avaliable potassium. Moreover, the soil Ph was found to be slightly acidic (pH 6.5). The study was carried out under field conditions at an altitude of 1278 metres.

2.3. Method

The cuttings of *S. condensata* plant were collected from nature in April 2020 and cultivated by using 1000 ppm indole butyric acid in a controlled greenhouse environment. The rooting rate of the cuttings taken was determined as 30 ± 2%. At the end of May, the rooted seedlings were planted in the experimental field of the Rose and Aromatic Plants Application and Research Center of Isparta University of Applied Sciences at the planting norm of 1 × 0.5 m and in the same year. Weed control was applied before planting. In June-July 2021 (flowering period), leaf and flower samples belonging to the species were collected both from the field and from natural conditions. The collected samples were placed in paper bags and transferred to the laboratory on the same day without any delay and exposure to the sunlight. The samples were dried at room temperature (25 °C) until they reached a constant weight. The floral volatile components of the samples were combined with gas chromatograohy/ mass spectrometry (GC/ MS) and determined by the Headspace-Solid Based Micro Extraction (HS-SPME) technique. Based on solid-based micro extraction technique, 2 grams of leaf-flower samples taken from each flower were placed in a 10 ml vial and kept at 60 °C for 30 minutes after the mouth was closed with a silicone lid. The SPME apparatus with 75 µm thin Carboxene/Polydimethylsiloxane (CAR/PDMS) coated fiber through the headspace to adsorb volatile substances was directly injected into the capillary column of a Shimadzu 2010 Plus GC-MS instrument. This process was repeated three times and the accuracy of the results was compared and the results were obtained by taking the averages. The device, operated in EI mode (70 eV), was connected to a mass selective detector of the same brand. Helium with a flow rate of 1.61 mL per minute was used as the carrier gas. Wiley, NIST Tutor and FFNSC libraries were used to identify volatile components.

3. Findings and Discussions

The results of SPME (solid-based micro extraction) analysis conducted to determine the volatile components of *S. condensata* in its natural growing environment and field environment are given in Table 1.

In this study, 72 volatile components in the mountain tea (*S. condensata*) sample obtained from its natural environment and 88 volatile components in the one collected from the field were found as a result of SPME analyses. According to the results of solid-based micro extraction technique (SPME) conducted in natural growing environment; 0.47% of aromatic alcohols, 4.20% of aromatic aldehydes, 0.13% of aromatic hydrocarbons, 43.42% of monoterpene hydrocarbons, 0.37% of oxygenated monoterpenes, 1.11% of oxygenated sesquiterpenes, 3.66% of other components, 46.12% of sesquiterpene hydrocarbons, 0.06% of methyl ester, 0.07% of phenylpropanoid, 0.22% of hydrocarbon and 0.1% of monopertene aldehydes were found and the components with the highest proportions were α-pinene (9.30%),β-pinene(18.12%), β-ocimene(4.46%), trans-caryophyllene(12.77%), germacrene-D(10.59%), γ-cadinene (2.09%), α-gurjunene (0.03%), farnesene (0.98%). According to the results of solid-based micro extraction technique (SPME) conducted in the field environment, 0.64% of aromatic alcohols, 1.73% of aromatic aldehydes, 14.13% of monoterpene hydrocarbons, 4.03% of oxygenated monoterpenes, 3.03% of oxygenated sesquiterpenes, 7.35% of other components, 67.82% of sesquiterpene hydrocarbons and 0.78% of hydrocarbon were found and the components with the highest proportions were *α*-pinene(2.32%), *β*-pinene(5.66%), *β*-ocimene(1.06%), trans-caryophyllene(0.83%), germacrene-D (0.67%), *γ*-cadinene(10.94%), *α*-gurjunene(16.68%), farnesene(6.00%). We also found that the amount of sesquiterpene hydrocarbons is high both in its natural habitat and field environment. In total 103 different volatile components were identified.

In the samples of *S. condensata* obtained from its natural growing environment, *α*-pinene(9.30%), *β*-pinene(18.12%), *β*-ocimene(4.46%), trans-caryophyllene(12.77%), germacrene-D (10.59%), *γ*-cadinene (2.09%), *α*-gurjunene (0.03%), farnesene (0.98%) were found, and in the samples obtained in the field environment, *α*-pinene (2.32%), *β*-pinene (5.66%), *β* -ocimene(1.06%),trans-caryophyllene (0.83%), germacrene-D (0.67%), *γ*-cadinene (10.94%), *α*-gurjunene (16.68%), farnesene (6.00%) were found to be higher than that of natural habitat's (Table 1).

Sarıkaya (2019) found 62 volatile components in the leaves and flowers of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata*, 46 volatile components in the leaves and flowers of *Sideritis hispida* P. H. Davis, 54 volatile components in the leaves and flowers of *Sideritis libanotica* Labill. subsp. *linearis* and 59 volatile components in the leaves and flowers of *Sideritis perfoliata* L., and he found that the major components of *Sideritis condensata* (Boiss. & Heldr.) subsp. *condensata* were *β*-Pinene (11.44%, 11.44%, 12.29%), 3-Octanol (11.83%, 11.90%, 11.73%), Limonene (15.31%, 14.37%, 14.52%), Caryophyllene (0.26%). While the *β*-Pinene component was the highest in both Sarıkaya (2019)'s study and this study in natural and field environments, it differed in terms of 3-Octanol, Limonene, Caryophyllene components. Again in Sarıkaya's (2019) study, *Sideritis condensata* (Boiss & Heldr.) subsp. *condensata* had the greatest concentrations of monoterpene hydrocarbon (39.54%) and sesquiterpene hydrocarbon (43.67%). The two hydrocarbons with the greatest rates in this study were monoterpene hydrocarbon (43.49% in the natural environment; 14.13% in the field environment) and sesquiterpene hydrocarbon (46.12% in the natural environment; 67.82% in the field environment). These findings align with those of Sarıkaya's (2019) study.

In the literature review, while 62 diverse volatile components were identified in the study conducted on *Sideritis condensata* (Boiss & Heldr.) subsp *condensata* by Demir (2019), *β*-pinene (11.44%, 11.44%), 3-Octanol (11.83%, 11.90%), Limonene (15.31%, 14.37%), Caryophyllene (13.55%, 12.04%) were also determined as the main components. In this study, while 3-Octanol and Limonene were not detected among the main components, the other two components were determined among the main components and differently, *α*-pinene, *β*–ocimene, germacrene-D components were found among the main components. Kırımer (2001) reported that Lamiaceae family has species rich in essential oils, but *Sideritis* species from the same family is poor in essential oils. Çarıkçı (2005), in his study, determined five components of diterpene structure in *S. condensata*; these were identified as Linearol, Isolinearol, Siderol, Sideridiol and Asetoksi Sideroxol. In this study, 72 volatile components from the natural growing environment and 88 volatile components from the field environment were determined. The main components determined in the studies on the determination of volatile components of *S. condensata* in the literature generally support the results of our study. The varying altitude, climate, and ecological conditions under which the sample material was gathered are regarded to be the cause of the determination of the various components.

Table 1
Volatile component composition of *Sideritis condensata* in its natural habitat and field environment

Mountain Tea (*Sideritis condensata* Boiss. Et. Heldr. Apud Bentham)					
R.T	**Components**	**Natural Habitat**	**Field Environment**	**Formula**	**Category**
8.445	Tricyclene	0.02	-	$C_{10}H_{16}$	MH
8.618	α-Thujene	0.43	0.11	$C_{10}H_{16}$	MH
8.891	*α*-Pinene	9.30	2.32	$C_{10}H_{16}$	MH
9.441	Camphene	0.16	0.06	$C_{10}H_{16}$	MH
9.566	Verbenene	-	0.05	$C_{10}H_{14}$	MH

Table 1
Volatile component composition of *Sideritis condensata* in its natural habitat and field environment (continues.)

Mountain Tea (*Sideritis condensata* Boiss. Et. Heldr. Apud Bentham)					
R.T	**Components**	**Natural Habitat**	**Field Environment**	**Formula**	**Category**
9.789	*(E)*-2-Heptenal	0.02	-	$C_7H_{12}O$	AAI
9.885	Benzaldehyde	0.49	0.17	C_7H_6O	AAI
10.357	Sabinene	0.91	0.27	$C_{10}H_{16}$	MH
10.563	*β*-Pinene	18.12	5.66	$C_{10}H_{16}$	MH
10.712	1-Octen-3-ol	0.47	0.02	$C_8H_{16}O$	AA
11.036	*β*-Myrcene	2.37	0.13	$C_{10}H_{16}$	MH
11.289	*(E,E)*-2,4-Heptadienal,	0.28	0.23	$C_7H_{10}O$	AAI
11.398	Ethyl hexanoate	-	0.17	$C_8H_{16}O_2$	OM
11.542	Octanal	0.10	0.29	$C_8H_{16}O$	AAI
11.555	*n*-Octanal	0.03	0.17	$C_8H_{16}O$	AAI
11.611	l-Phellandrene	0.05	0.03	$C_{10}H_{16}$	MH
11.860	(*E,E*)-2,4-Heptadienal	0.11	0.15	$C_7H_{10}O$	AAI
11.869	2-Propylfuran	-	0.15	$C_7H_{10}O$	AA
11.925	Hexyl acetate	-	0.05	$C_8H_{16}O_2$	ME
12.034	*α*-Terpinene	0.06	0.07	$C_{10}H_{16}$	MH
12.320	*p*-Cymene	0.25	-	$C_{10}H_{14}$	MH
12.502	Limonene	5.56	2.73	$C_{10}H_{16}$	MH
12.641	1,8-Cineole	0.11	2.66	$C_{10}H_{18}O$	OM
12.830	*cis*-Ocimene	1.40	0.73	$C_{10}H_{16}$	MH
13.034	Benzeneacetaldehyde	0.12	0.02	C_7H_6O	AAI
13.252	*β*-Ocımene Y	4.46	1.06	$C_{10}H_{16}$	MH
13.650	*γ*-Terpinene	0.12	0.09	$C_{10}H_{16}$	MH
14.705	*α* –Terpinolene	0.15	0.14	$C_{10}H_{16}$	MH
14.870	1-Methyl-4-isopropenylbenzene	0.07	0.09	$C_{10}H_{14}$	MH
15.324	Linalool	0.09	0.05	$C_{10}H_{18}O$	OM
15.489	*n*-Nonanal	0.05	0.47	$C_9H_{18}O$	AAI
15.655	1-Octen-3-yl-acetate	0.03	-	$C_8H_{14}O$	ME
16.297	*α*-Campholene aldehyde	0.02	-	$C_{15}H_{24}$	SH
16.310	*α* - Campholenal	-	0.12	$C_{10}H_{16}O$	OC
16.436	p-Mentha-1,5,8-triene	0.06	-	$C_{10}H_{14}$	MH
16.853	3,7-Dimethyl-1,3,6-Octatriene	0.13	-	C_8H_{12}	AH
16.754	6,6-Dimethylbicyclo[3.1.1]heptan-2-one	-	0.06	$C_9H_{14}O$	AAI
16.867	trans-Pinocarveol	-	0.28	$C_{10}H_{16}O$	OC
17.106	Carveol	-	0.03	$C_{10}H_{16}O$	OC
17.668	Pinocarvone	-	0.39	$C_{10}H_{14}O$	OM
18.402	4-Terpineol	-	0.02	$C_{10}H_{18}O$	OM
18.571	4-Methylacetophenone	-	0.47	$C_9H_{10}O$	AA
18.789	Methyl salicylate	0.24	-	C_8H_9NO	OC
18.926	Myrtenal	0.15	0.53	$C_{10}H_{14}O$	OM
19.194	Dodecane	0.08	0.43	$C_{12}H_{26}$	H
19.377	Capraldehyde	0.1	-	$C_{10}H_{20}O$	MA
19.386	Decanal	-	0.28	$C_{10}H_{20}O$	MA
20.292	Z-3-hexenyl 2-methylbutanoate	0.03	0.06	C_6H_{12}	SH
20.375	2,6-Dimethyl-1,7-Octadiene-3-ol	0.02	-	$C_{10}H_{18}O_2$	OM
20.480	Hexyl 2-methylbutyrate	-	0.16	$C_{11}H_{22}O_2$	ME
20.491	Butanoic acid	0.03	-	$C_{11}H_{22}O_2$	ME
20.690	Cuminaldehyde	3.00	0.17	$C_{10}H_{12}O$	AAI
20.749	Carvone	-	0.15	$C_{10}H_{14}O$	OM
21.655	E-Citral	-	0.03	$C_{10}H_{16}O$	OC
22.539	1-Tridecene	-	0.59	$C_{13}H_{26}$	MH
22.553	1-Heptadecene	0.02	-	$C_{17}H_{34}$	H
22.653	Benzyl isobutyrate	-	0.04	$C_{11}H_{14}O_2$	OC
22.860	Tridecane	0.08	0.09	$C_{13}H_{28}$	H
22.899	Carvacrol	-	0.06	$C_{10}H_{14}O$	OM
23.596	3(Z)-Hexenyl-tiglate	0.21	0.49	$C_{11}H_{18}O_2$	OC
23.848	Hexyl-tiglate	0.11	0.13	$C_{11}H_{20}O_2$	OC
23.926	Bicycloelemene	-	0.52	$C_{15}H_{24}$	OC
24.472	*α*-Cubebene	1.01	2.67	$C_{15}H_{24}$	OC
24.598	Eugenol	0.07	-	$C_{10}H_{12}O_2$	PP
25.226	Ylangene	0.23	0.17	$C_{15}H_{24}$	SH
25.474	*α*-Copaene	3.05	4.08	$C_{15}H_{24}$	SH

Table 1
Volatile component composition of *Sideritis condensata* in its natural habitat and field environment (continues.)

Mountain Tea (*Sideritis condensata* Boiss. Et. Heldr. Apud Bentham)					
R.T	**Components**	**Natural Habitat**	**Field Environment**	**Formula**	**Category**
25.742	*β*-Bourbonene	1.96	2.97	$C_{15}H_{24}$	OC
25.883	epı-bıcyclosesquıphellandrene	0.77	1.33	$C_{15}H_{24}$	SH
25.917	*β*-Elemene	-	0.93	$C_{15}H_{24}$	SH
26.081	Sativen	-	0.29	$C_{15}H_{24}$	SH
26.241	Phenyl ether	0.06	-	$C_{12}H_{10}O$	OC
26.345	Tetradecane	0.04	0.26	$C_{14}H_{30}$	H
26.538	*α*-Gurjunene	0.03	16.68	$C_{15}H_{24}$	SH
27.005	*trans*-Caryophyllene	12.77	0.83	$C_{15}H_{24}$	SH
27.281	*β*-Cubebene	0.52	0.31	$C_{15}H_{24}$	SH
27.424	*β*-Gurjunene	0.23	-	$C_{15}H_{24}$	SH
27.548	*α* – Cedrol	-	0.58	$C_{15}H_{26}O$	OS
27.568	(+)-Aromadendrene	0.55	0.53	$C_{15}H_{24}$	SH
27.799	Isoledene	0.64	-	$C_{15}H_{24}$	SH
27.883	*γ* –Gurjunene	-	0.35	$C_{15}H_{24}$	SH
28.057	Cadina-1(6),4-diene <10- *β* -H->	-	7.52	$C_{15}H_{24}$	SH
28.079	(E)-*β*-Farnesene	5.28	0.52	$C_{15}H_{24}$	SH
28.321	Alloaromadendrene	-	0.77	$C_{15}H_{24}$	SH
28.340	(+)-Epi-bicyclosesquiphellandrene	0.43	0.23	$C_{15}H_{24}$	SH
28.545	Germacrene-D	10.59	1.34	$C_{15}H_{24}$	SH
28.661	Epi-bicyclosesquiphellandrene	-	0.23	$C_{15}H_{24}$	SH
28.699	δ-Cadinene	0.25	3.94	$C_{15}H_{24}$	SH
28.799	γ-Cadinene	2.09	10.94	$C_{15}H_{24}$	SH
28.786	δ – Muurolene	-	1.07	$C_{15}H_{24}$	SH
29.282	*α*-Bergamotene	2.01	6.00	$C_{15}H_{24}$	SH
29.469	Bicyclogermacrene	4.36	0.61	$C_{15}H_{24}$	SH
29.541	*α*-Muurolene	0.52	1.06	$C_{15}H_{24}$	SH
29.714	Farnesene	0.98	6.00	$C_{15}H_{24}$	SH
29.829	*β*-Bisabolene	0.20	0.19	$C_{15}H_{24}$	SH
30.581	Calamenene	-	1.18	$C_{15}H_{22}$	SH
30.714	*α* – Cadinene	-	0.42	$C_{15}H_{24}$	SH
30.731	*α*-Muurolene	0.39	-	$C_{15}H_{24}$	SH
30.859	*α*-Calacorene	0.07	0.07	$C_{15}H_{20}$	OC
31.492	Isocaryophyllene	-	0.24	$C_{15}H_{24}$	SH
31.991	Cedr-8-en-13-ol	-	1.08	$C_{15}H_{24}O$	OS
32.145	(-)-Caryophyllene oxide	0.26	1.37	$C_{15}H_{24}O$	OS
35.269	*cis*-Farnesol	0.85	-	$C_{15}H_{26}O$	OS
42.370	*ar*-Curcumene	0.21	-	$C_{15}H_{22}$	SH
	Total :	**100**	**100**		
	Number of Components :	**72**	**88**		

S. condensata was collected from natural habitat and cultivated with cuttings. This study identified the volatile components of S. condensata from both its natural habitat and the field environment, which were created with cutting in the environment. The volatile components of Mountain Tea (*S. condensata*) produced in the field environment and the one grown in its natural environment were compared to determine the volatile components. 103 different components,72 in the natural habitat and 88 in the field environment of *S. condensata* collected from Yenişarbademli District, rocky location of Dedegöl Mountain in Isparta Province and produced in the field environment were determined. *α*-pinene, *β*-pinene, *β*-ocimene, trans-caryophyllene, germacrene-

D, γ-cadinene , α-gurjunene, farnesene were identified as the main components and it was found that Sesquiterpene Hydrocarbon was high.

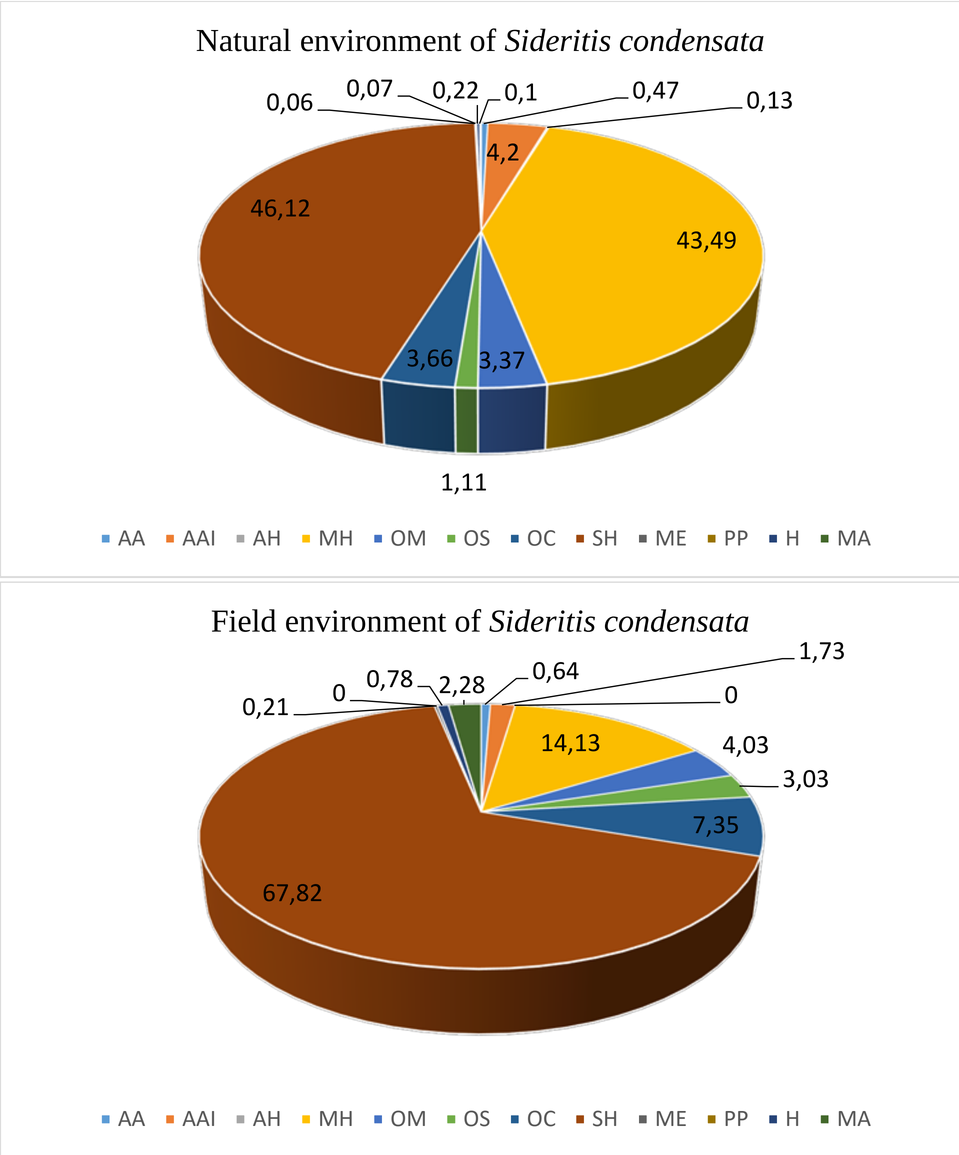

Figure 1. Classification of volatile components of *S. condensata*

While the highest rate of β-Pinene (18.12%) component was found in the analysis results of *S. condensata* collected from natural feces, the highest rate of γ-Cadinene (20.94%) component was found in the field environment. These results showed that *S. condensata* is rich in β-Pinene and γ-Cadinene components. According to the results of the analysis, Sesquiterpene hydrocarbons were found to be the highest in the natural environment (46.12%) and in the field environment (67.82%). While the Monoterpene hydrocarbon ratio of *S. condensata* collected from the natural environment was 43.49%, the Monoterpene hydrocarbon ratio of *S. condensata* collected from the field environment was determined as 14.13%.

4. Results and Recommendations

Important variations were determined between the monoterpene hydrocarbon ratios of *S. condensata* transferred from the natural environment to the field environment. The discrepancies seen in the components may be due to variances in the soil's structure and altitude. In addition, it has been determined that the flowering periods of *S. condensata* specimens are similar in their natural environment and field environment. It has been determined by the study that it is the main source of information for possible environmental changes that may occur in nature. Therefore, it is of crucial importance to evaluate the various types of mountain tea species in our country. Species with high medicinal and aromatic value, such as mountain tea, sage, thyme and linden are collected so excessively that they face extinction risk. Recently, collecting various mountain tea species from nature due to its medicinal value has increased. Necessary precautions and trainings are recommended to raise the awareness of collectors. Studies should also be increased to grow the culture. Furthermore, the study provided a base for the plans to be made for species conservation and sustainable forestry activities within the scope of the protection of biological diversity. In order to ensure the increase in quality production, it is necessary to continue the studies to grow the culture. With this study, the production of *S. condensata,* which is one of the medicinal and aromatic plants, has spreaded to larger areas, which contributed to the commercial value of the plant and enabled the producer to grow more quality products. The studies should be encouraged to grow the culture for reproduction of the plant.

It has been stated that the efforts of growing culture of *S. condensata* have positive outcomes and will form a basis for the plans to enable the producers and farmers to conduct their activities in the future. Information about suitable growing envrionments of *S. condensata* has been obtained. It has been the main source of information for possible environmental changes that may occur in nature. It is also predicted that this study on *S. condensata* will be a source for other studies to be carried out on the transfer of its medicinal and aromatic properties from its natural habitat to the field.

Explanation

This study was produced from a part of the PhD Thesis titled “Determination of some Botanical Characteristic and Agricultural Performances of Mountain Tea (*Sideritis* spp.) Taxa Spreading Naturally in Isparta Province” Isparta University of Applied Sciences, Graduate Education Institute. We are deeply grateful to Isparta University of Applied Sciences Scientific Research Projects Management Unit, who financially supported the thesis with the Project number 2021-D1-0132.

Author Contributions

All authors contributed equally to the writing and analysis of this article.

Conflict of Interest

The authors declared no conflict of interest.

References

Arslan, N., Yılmaz, G., Akınerdem, F., Özgüven, M., Kırıcı, S., Arıoğlu, H., Gümüşçü, A., Telci, İ. (2000). Nişasta-şeker Tütün ve Tıbbi Aromatik Bitkilerin Tüketim Projeksiyonları ve Üretim Hedefleri, *Türkiye Ziraat Mühendisliği V. Teknik Kongresi*, 1. Cilt,17-21 Ocak, Ankara, Türkiye, 453-483 ss.

Arslan, N., Baydar, H., Kizil, S., Karik, Ü., Şekeroğlu, N., Gümüşcü, A. (2015). Tıbbi Aromatik Bitkiler Üretiminde Değişimler ve Yeni Arayışlar, *Türkiye Ziraat Mühendisliği VIII. Teknik Kongresi,* 1. Cilt, 20-21 Mart, Ankara, 483-507 ss.

Başer, K. H. C. (2000). Uçucu Yağların Parlak Geleceği, *Tıbbi ve Aromatik Bitkiler Bülteni*, Anadolu Üniversitesi Tıbbi ve Aromatik Bitki ve İlaç Araştırma Merkezi, Sayı:15, Eskişehir.

Baydar, H. (2016). Tıbbi ve Aromatik Bitkiler Bilimi ve Teknolojisi, *Nobel Akademik Yayınları,* Isparta, 39-59 ss.

Çarıkçı, S. (2005). *Sideritis condensata* Boiss. & Heldr Phytochemical Analysis of the Plant, *Master Thesis*, Balıkesir University, Graduate School of Natural and Applied Sciences, Balıkesir. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Çelik, A. (2019). Medicinal and Aromatic Plants Market and Development Opportunities in Hatay Province, *PhD Thesis,* Çukurova University, Graduate School of Natural and Applied Sciences, Çukurova. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Çiçekli, M. (2014). The Effects of Inputs Applied to Some Medicinal and Aromatic Plants Grown Organically and Conventionally on Some Yield and Quality Parameters, *PhD Thesis,* Ege University, Graduate School of Natural and Applied Sciences, İzmir. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Davis, P.H. (Ed.). (1982). Flora of Turkey and The East Aegean Islands, Edinburgh University Press, Edinburgh, 7, pp. 297.

Demir, S. (2019). Davraz Mountain (Isparta) Some Natural Mountain Island Tea (*Sideritis* spp.) Determination of Leaf and Flower Volatile Components of Taxa, *Master Thesis,* Isparta University of Applied Sciences, Graduate School of Education, Isparta. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Dönmez, E., (2022). Volatıle Oil Composition Of Teucrium Species Of Natural And Cultivated Origin in The Lake District Of Turkey, *Applied Ecology and Environmental Research,* 20(3):2235-2245. https://www.aloki.hu/pdf/2003_22352245.pdf

Duman, H., Kırımer, N., Ünal, F., Güvenç, A., Şahin, P. (2005). Türkiye *Sideritis* L. Türlerinin Revizyonu, *Tübitak Projesi Sonuç Raporu,* Proje No: TBAG-1853 (199T090), Ankara.

Durmuşkahya, C. (2005). Vegetation Ecology of the Lower Gediz Basin. *PhD Thesis,* Celal Bayar University, Graduate School of Natural and Applied Sciences, Department of Biology, Manisa. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Gümüşçü, A., Tugay, O. & Kan, Y. (2011). Comparison of Essential Oil Compositions of Some Natural and Cultivated Endemic *Sideritis* Species, *Advances in Environmental Biology,* 5(2): 222-226. http://www.aensiweb.com/old/aeb/2011/222-226.pdf

Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, M.T. (2012). Türkiye Bitkileri Listesi, *Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırma Derneği Yayını*, İstanbul.

Heywood, V.H. (1996). Flowering Plants of The World, BT Batsford Ltd., pp. 239, London.

Kaya, A. (1997). Morphological, Anatomical and Chemical Researches on Acinos Miller Species Grown in Turkey, PhD Thesis, Anadolu University, Health Sciences Institute, Eskişehir. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Kırımer, N., Tabanca, N., Tümen, Duman, H.G., Başer, K. H. C. (1999). Composition of Essential Oil of Four Endemic *Sideritis* Species from Turkey, *Flavour and Fragrance Journal*, 14(6): 421-425.

Kırımer, N., Tabanca, N., Demirci, B., Başer, K.H.C., Duman, H., Aytaç, Z. (2001). The essential oil of a new *Sideritis* species: *Sideritis ozturkii* Aytac and Aksoy, *Chemistry of Natural Compounds,* 37: 234–237.

Mutlu, B., Erik, S. (2003). Flora of Kızıldağ Mountain (Isparta) and Environs, *Turkish Journal of Botany*, 27(6): 463-493.

Rowell, D.L. (1996). Soil Science: Methods and Applications, Longman, London.

Saraç, N., Uğur A. (2007). Antimicrobial activities and usage in folkloric medicine of some Lamiaceae species growing in Mugla, Turkey. *Eurasian Journal of Biosciences*, 1(4): 28-34.

Sarıkaya, A., & Canıs, S. (2019). Volatile components of leaf and flowers of natural mountain sage (Sideritis spp.) taxa from Davraz Mountain, Isparta-Turkey, *International Journal of Biology and Chemistry*, 12(2):70-79.

Soysal, Y. (2000). A Research on the Drying of Various Medicinal and Aromatic Plants on a Business Scale, PhD Thesis, Çukurova University, Graduate School of Natural and Applied Sciences, Çukurova. Access address: https://tez.yok.gov.tr/UlusalTezMerkezi

Şahin, F.P., Duman H., Ezer N. (2008). Comparative Morphological Investigation of *Sideritis* Species II: *S. cilicica* Boiss. & Bal & *S. niveotomentosa* Hub.-Mor., *Turkish Journal of Pharmaceutical Sciences*, 5(1): 35-44.

Tabanca, N., Kırımer, N., Başer, K. H. C. (2001). The Composition of Essential Oils from Two Varieties of *Sideritis erythrantha* var *erythrantha* and var *cedretorum*, *Turkish Journal of Chemistry*, 25: 201- 208.

Yordanova, M., Apostolova, I. (2000). Estimation of the status of representative populations of *Sideritis scardica* Griseb'in the Rhodopi Mts, *Phytologia Balcanica*, 6(1): 43-57. http://www.bio.bas.bg/~phytolbalcan/2000-6-1/2000-6-1-04.pdf