Nat. Volatiles & Essent. Oils, 2017; 4(1): 18-28

NVEO
Natural Volatiles & Essential Oils

RESEARCH ARTICLE

The chemical composition of *Salvia verticillata* L. subsp. *verticillata* from Turkey

Nurhayat Tabanca[1,*], Betül Demirci[2], Zeki Aytaç[3], K. Hüsnü Can Başer[4]

[1]USDA-ARS, Subtropical Horticulture Research Station, 13601 Old Cutler Rd., Miami, FL 33158 USA
[2]Department of Pharmacognosy, Faculty of Pharmacy, Anadolu University, Eskisehir, 26470, TURKEY
[3]Department of Biology, Faculty of Science, Gazi University, 06500 Ankara, TURKEY
[4]Near East University, Faculty of Pharmacy, Department of Pharmacognosy, Lefkosa (Nicosia), N. Cyprus, Mersin 10, TURKEY

*Corresponding author. Email: Nurhayat.Tabanca@ars.usda.gov

Abstract

Water-distilled essential oil was obtained from dried aerial parts of *Salvia verticillata* L. subsp. *verticillata* (Lamiaceae) from south eastern region of Turkey. The essential oil was analyzed simultaneously by GC-FID and GC-MS systems where 39 components were identified. Spathulenol (31.0%), α-pinene (8.2%), limonene (4.1%) and hexahydrofarnesyl acetone (3.8%) were found as the main constituents.

Keywords: *Salvia verticillata* subsp. *verticillata*, sage, Essential oil, Spathulenol, Sesquiterpene

Introduction

The genus *Salvia* L. (Lamiaceae) is represented by 98 species, four subspecies and three varieties, of which 56 are endemic in Turkey (Celep and Kahraman 2012). *Salvia* species are commonly used in Anatolia for colds, stomach aches, sore throats (Tabanca et al., 2006; Ozek et al., 2010; Askun et al., 2010), to treat inflammatory skin diseases, to stop bleeding or as an antiseptic for wounds (Suntar et al., 2011). The most well-known species, *S. fruticosa* Mill. (Syn: *S. triloba* L.), locally known as “adaçayı”, “elmaçayı”, is consumed as a hot tea and wildcrafted for sale in local markets in Turkey (Demirci et al., 2002; Askun et al., 2010; Suntar et al., 2011; Gurdal and Kultur, 2013). The essential oil of *S. fruticosa* is known as “elma yağı” in Turkey and has been reported to have carminative, stomachic, diuretic effects, to reduce sweating, and to treat foot infections (Demirci et al., 2002; Orhan & Aslan, 2009; Suntar et al., 2011). *Salvia* species have been traditionally used for various purposes in different parts of Turkey (Table 1). The decoction prepared from leaves and stems of *S. fruticosa* (“adaçayı”, “kara ot”) has been reportedly used for cold, tonsillitis, bronchitis, carminative, digestive and stomachache by Turkish migrants in Cologne, Germany (Pieroni et al., 205). The use of *S. fruticosa* for respiratory and digestive diseases are also extended to Cyprus (Gurdal & Kultur, 2013).

Salvia verticillata is morphologically quite close to *S. russellii* Bentham and differs from it with oblong to ovate leaves (not linear-oblong) and mucronate calyx teeth (Hedge, 1982). In the Flora of Turkey, *S. verticillata* was described as *S. uberrima* by Rechinger in 1941, later it was reduced to a synonym of *S. verticillata* subsp. *verticillata* (Hedge, 1982). The plant of Euro-Siberian origin is distributed in north and east part of Anatolia (Hedge 1982). *Salvia verticillata* L. has two subspecies (subsp. *amasiaca* (Freyn. & Bornm.) Bornm. and subsp. *verticillata*) and they differ from each other with leaf shape and indumentum structure (Hedge, 1982). Subsp.

verticillata is known as “dadırak” and subsp. a*masiaca* is locally called as “hart şalbası” in Turkey (www.bizimbitkiler.org.tr). Based on traditional literature in Turkish folk medicine, subsp. *amasiaca* is locally known as “yağlıkara” in Kayseri (central part of Turkey) (Sezik et al., 2001), “adaçayı” in Kırklareli (Thrace) (Kultur, 2007). In the Eastern part of Turkey, both subspecies are locally known as “Karabaş otu” and are used for cold and gastrointestinal disorders (Table 1) (Altundag & Ozturk, 2011).

Particular attention has been paid by our group to *Salvia* essential oils due to a wide range of chemical biodiversity (Baser, 2002). Therefore, in the present study, we have investigated the chemical composition of *S*. *verticillata* subsp*. verticillata* essential oil from Turkey.

Table 1. Traditional uses of *Salvia* species from Turkey

Species	Local Name/ Locality	Used parts	Preparations/ utilization method	Use	References
S. absconditiflora (Montbret & Aucher) Greuter & Burdet	Adaçayı/ Sivas & Yozgat: central Anatolia	WP	Dec or Inf, Int	Cold and sore throat	Ozudogru et al., 2011
S. absconditiflora (Montbret & Aucher) Greuter & Burdet	Öksürük otu/ Kahramanmaraş: southern-eastern Anatolia	L	Inf, Int	Cough and bronchitis	Demirci & Ozhatay, 2012
S. abscondiflora (Montbret & Aucher) Greuter & Burdet	Boz şabla, kara şabla, sarı şabla/ Niğde: central Anatolia	AP	Inf, Int	Cold	Ozdemir & Alpinar, 2015
S. abscondiflora (Montbret & Aucher) Greuter & Burdet	Kara ot, garaot, garaod/ Manisa: western Anatolia	AP F L	Inf, Lcw, Mx, Ca	Stomachache, cold, flu, bronchitis, asthma, herbal tea	Sargin et al., 2015
S. aramiensis Rech. Fil.	Adaçayı/ Antakya: southern Anatolia	L	Dec, oral	Bronchitis, cold, flu, antidiabetic	Guzel et al., 2015
S. cadmica Boiss.	Meryemana adaçayı/ Niğde: central Anatolia	AP	Crushed, Ext	Bleeding	Ozdemir & Alpinar, 2015
S. candidissima Vahl. subsp. *candidissima*	Galabor/ eastern Anatolia	L	Inf, Int	Cold	Altundag & Ozturk, 2011
S. dichroantha Stapf.	Yağlıkara/ Kayseri: central Anatolia	L	Inf, Int	Abdominal pain, stomachache	Sezik et al., 2001
S. fruticosa Mill.	Adaçayı, boşalba/ Canakkale: western Anatolia	L	Dec	Antiseptic, dyspepsia, cold, tonsillitis	Uysal et al., 2012
S. fruticosa Mill.	Adaçayı, almakeyik, almageyik/ Muğla: western Anatolia	L	Inf, Int	Stomachache, flatulence, cold, tonsillitis, laxative, antipyretic	Gurdal & Kultur, 2013
S. hydrangea DC.	Koçotu/ eastern Anatolia	Herb	Inf	Cold, diabetes, stomach disorders, antipyretic, emmenagogue	Altundag & Ozturk , 2011
S. hypargeia Fisch. & C.A. Mey.	Kök çayı/ Niğde: central Anatolia	R	Inf, Int	Cold	Ozdemir & Alpinar, 2015
S. multicaulis Vahl	Adaçayı/ Elazığ: eastern Anatolia	AP	Dec	Diabetes disease	Cakilcioglu & Turkoglu, 2010
S. multicaulis Vahl	Adaçayı/ eastern Anatolia	Herb	Dec, Int	Cold, antiinflammatory	Altundag & Ozturk 2011

Species	Local Name/ Locality	Used parts	Preparations/ utilization method	Use	References
S. multicaulis Vahl	Adaçayı, dağ çayı/ Malatya: eastern Anatolia	F, L	Dec, Int	Cold, flu, digestive, tonsillitis	Tetik et al., 2013
S. multicaulis Vahl	Ada çayı/ Elazığ: eastern Anatolia	AP	Dec, Dpt	Cold, flu	Hayta et al., 2014
S. multicaulis Vahl	Boz kulak, mavi-mor şabla/ Niğde: central Anatolia	AP	Inf, Int	Sedative	Ozdemir & Alpinar, 2015
S. nemorosa L.	Gemtaş/ eastern Anatolia	Herb Herb	Pounded, Ext Dec, Inf, Int	Hemostatic Cold, catarrh	Altundag & Ozturk, 2011
S. russellii Bentham	Şaplamaotu/ Niğde: central Anatolia	Herb	Dec, Int	Cold, abdominal pain	Sezik et al., 2001
S. sclarea L.	Dağ çayı/ eastern Anatolia	L	Inf, Int	Cold	Altundag & Ozturk , 2011
S. sclarea L.	Misk adaçayı, yağlı kara/ Niğde: central Anatolia	F B, L	As a spice, Int, Inf, Int	Digestive Diarrhea, sedative	Ozdemir & Alpinar, 2015
S. sclarea L.	Polağ/ Malatya: eastern Anatolia	AP	Raw	Antacid	Tetik et al., 2013
S. tomentosa Mill.	Şalba, şabla, boz şalba, boz sabla, borçağla/Isparta: southern Anatolia	L EO L L L	Inf, Int Ext Dec, Ext Inf, Int Inf, Int	Stomachache Inflamed wounds Inflamed wounds Asthma Analgesic	Tuzlaci & Erol, 1999
S. tomentosa Mill.	Adaçayı/ Denizli: western Anatoli	AP AP	Dec Dec	As food Stomach diseases	Kargioglu et al., 2010
S. tomentosa Mill.	Boş yaprağı, adaçayı/ Balıkesir: western Anatolia	L	Inf, Int	Cold, flu, tonsillitis	Polat & Satil, 2012
S. tomentosa Mill.	Kurtluca otu, yakı otu/ Manisa: western Anatolia	L	Ext, Poul	Abdominal pain	Bulut & Tuzlaci, 2013
S. tomentosa Mill.	Yakı otu, yakı şablası, yaka çalpası, şalpa/ Manisa: western Anatolia	L AP	Int, Mx, Ca, Ms, Bs, Grg	Angina, bronchitis, pharyngitis and laryngitis, cold and flu, gall bladder stones, diarrhea, sedative, insomnia, carminative, costiveness and intestinal spasm, dyspepsia, herbal tea	Sargin et al., 2015
S. tomentosa Mill.	Adaçayı, yara otu, buhur ağacı/ Antakya: southern Anatolia	L	Olea, Ext Inf, Int	This oleate is applied to wounds in muslin pad Infusions used for the treatment of stomach pain	Guzel et al., 2015
S. verbenaca L.	Şalba/ Kahramanmaraş: southern-eastern Anatolia	L	Inf, Ext	Fungal infections	Demirci & Ozhatay, 2012
S. verticillata L. subsp. *amasiaca* Bornm.	Yağlıkara/Kayseri: central Anatolia	L	Inf, Int	Abdominal pain, stomachache	Sezik et al., 2001
S. verticillata L. subsp. *amasiaca* Bornm.	Adaçayı /Kırklareli: Thrace	L	Dec, Int	Cardiovascular diseases	Kultur, 2007

S. verticillata L. subsp. *amasiaca* Bornm.	Karabaş otu/ eastern Anatolia	Herb	Dec, Inf, Int	Laxative, cold, nausea	Altundag & Ozturk, 2011

Species	**Local Name/ Locality**	**Used parts**	**Preparations/ utilization method**	**Use**	**References**
S. verticillata L. subsp. *verticillata*.	Karabaş otu/ eastern Anatolia	Herb	Dec, Int	Catarrh, cold, laxative	Altundag & Ozturk, 2011
S. virgata Jacq.	Ballıbaba/ Denizli: western Anatoli	AP	Dec	As food	Kargioglu et al., 2010
S. virgata Jacq.	Kazan karası/Sivas & Yozgat: central Anatolia	Stem	Era	As food	Ozudogru et al., 2011
S. virgata Jacq.	Yaban çayı/ Kars: eastern Anatolia	L Stem	Inf	Cardiac diseases	Gunes & Ozhayat, 2011
Salvia viridis L.	Adaçayı/ Denizli: western Anatolia	AP	Dec	As food	Kargioglu et al., 2010

Plant parts used: AP: aerial parts; B: brances; EO: essential oils; F: flowers; L: leaves; R: roots; WP: whole parts; Preparations and utilization methods: Bs: skin bath; Ca: cataplasm; Dec: decoction; Dpt: drink one water glass of plant after meal; EO: essential oil; Era: fresh stems are eaten after peeling; Ext: externally; Grg: gargle; Inf: infusion; Int: Internally; Lcw: leaves are eaten by chewing;); Ms: mash; Mx: mixture (pickles, jam, salad, tzatziki, mixed paste, mixed ointments, mixed mash by adding other plants; Olea: oleate, *S. tomentosa* leaves are prepared by soaking into warmed olive oil and filtered; Poul: poultice

Materials and Methods

Plant material

The aerial parts of *S. verticillata* subsp*. verticillata* were collected while flowering from Şırnak: Şenobo to Hakkari, 72 km, 1550 m, rocky slopes*, Aytaç 8194 et al.* collected on July 15th, 2001. A voucher specimen has been deposited at the GAZI Herbarium in Ankara, Turkey.

Figure 1. Herbarium specimen of the plant material.

Isolation of the essential oil

The air-dried plant materials (flowers, leaves, and stems) were hydrodistilled for 3 hours using a Clevenger-type apparatus. The essential oil was dried over anhydrous sodium sulfate and stored at 4 °C in the dark until analyzed. The oil yield was calculated as 0.05%, v/w on dry weight basis.

Gas chromatography (GC) and gas chromatography–mass spectrometry (GC-MS) analysis conditions

The GC-MS analysis was carried out with an Agilent 5975 GC-MSD system. Innowax FSC column (60 m x 0.25 mm, 0.25 μm film thickness) was used with helium as carrier gas (0.8 mL/min). GC oven temperature was kept at 60 °C for 10 min and programmed to 220 °C at a rate of 4°C/min, and kept constant at 220°C for 10 min and then programmed to 240 °C at a rate of 1 °C/min. Split ratio was adjusted at 40:1. The injector temperature was set at 250 °C. Mass spectra were recorded at 70 eV. Mass range was from *m/z* 35 to 450.

The GC analysis was carried out using an Agilent 6890N GC system. FID detector temperature was 300°C. To obtain the same elution order with GC-MS, simultaneous auto-injection was done on a duplicate of the same column applying the same operational conditions. Relative percentage amounts of the separated compounds were calculated from FID chromatograms. The analysis results are given in Table 2.

Identification of the essential oil components was carried out by comparison of their relative retention times with those of authentic samples or by comparison of their relative retention indices (RRI) to series of *n*-alkanes. Computer matching against commercial (Wiley GC/MS Library, MassFinder 3 Library) (McLafferty & Stauffer, 1989; König, Joulain, & Hochmuth, 2004)) and in-house "Başer Library of Essential Oil Constituents" built up by genuine compounds and components of known oils, as well as MS literature data (Joulain & König, 1998; ESO 2000, 1999) was used for the identification of oil components.

Results and Discussion

The chemical composition of the essential oil from aerial parts of *S. verticillata* subsp. *verticillata* was characterized by GC-FID and GC-MS analysis. The results are shown in Table 2. Thirty-nine components were identified representing 83.8% of the sample. The major components were spathulenol (31.0%), α-pinene (8.2%), limonene (4.1%) and hexahydrofarnesyl acetone (3.8%).

Literature survey indicated that the oil of *S. verticillata* consisted mainly of the sesquiterpenes β-caryophyllene, germacrene D and α-humulene (Table 3). The chemical composition of *S. verticillata* subsp. *verticillata* from Turkey has previously been investigated and germacrene D (10-16%) was reported as the main component (Baser, 2002). The other subspecies of *S. verticillata* essential oil, subsp*. amasiaca*, showed significant quantitative and qualitative differences. For example; β-pinene, α-pinene, β-phellandrene, limonene and 1,8-cineole were the main components in Bitlis samples (eastern part of Turkey) (Altun et al., 2007) while β-pinene, 1,8-cineole, α-copaene, α-gurjunene were the major components in another Bitlis sample (Askun et al., 2010). Other two samples of subsp. *amasiaca* from the central part of Turkey (Eskişehir and Sivas) displayed quite different chemical profiles (Table 3). In Eskişehir sample, hydrodistilled essential oil showed germacrene D, β-caryophyllene and hexadecenoic acid as major constituents (Kunduhoglu et al., 2011), whereas volatiles obtained by a thermal desorption-GC-MS technique gave a different profile for a Sivas sample with palmitic acid, 7-methyl-*Z*-tetradecen-1-ol-acetate, heptacosane as the main constituents (Hatipoglu et al., 2016).

Table 2. The chemical composition of essential oil of *S. verticillata* subsp. *verticillata*

RRI	Compound	%
1032	**α-Pinene**	**8.2**
1093	Hexanal	0.5
1118	β-Pinene	2.0
1174	Myrcene	1.4
1176	α-Phellandrene	0.6
1203	**Limonene**	**4.1**
1213	1,8-Cineole	2.5
1255	γ-Terpinene	1.1
1280	*p*-Cymene	1.0
1532	Camphor	0.6
1553	Linalool	2.2
1591	Bornyl acetate	0.3
1611	Terpinen-4-ol	0.6
1612	β-Caryophyllene	0.7
1670	*trans*-Pinocarveol	0.2
1706	α-Terpineol	1.0
1719	Borneol	0.4
1725	Verbenone	0.8
1751	Carvone	0.1
1758	*cis*-Piperitol	0.2
1772	Citronellol	0.6
2008	Caryophyllene oxide	1.9
2037	Salvial-4(14)-en-1-one	0.4
2071	Humulene epoxide-II	0.9
2098	Globulol	0.6
2104	Viridiflorol	0.6
2131	**Hexahydrofarnesyl acetone**	**3.8**
2144	**Spathulenol**	**31.0**
2187	T-Cadinol	0.7
2198	Thymol	0.4
2211	Clovenol	1.8
2239	Carvacrol	2.1
2255	α-Cadinol	0.6
2278	Torilenol	0.5
2324	Caryophylla-2(12),6(13)-dien-5β-ol (=*Caryophylladienol II*)	1.8
2369	Eudesma-4(15),7-dien-4β-ol	0.5
2389	Caryophylla-2(12),6-dien-5β-ol (=*Caryophyllenol I*)	2.8
2392	Caryophylla-2(12),6-dien-5β-ol (=*Caryophyllenol II*)	2.0
2931	Hexadecanoic acid	2.3
	Total	83.8

RRI Relative retention indices calculated against *n*-alkanes, % calculated from FID data, tr :Trace (< 0.1 %)

Table 3. Main components of *S. verticillata* essential oils based on the literature

***Salvia* Species**	**Main compounds**	**Plant Parts***	**Extraction technique****	**Country**	**References**
verticillata	β-caryophyllene 24.7%, γ-muurolene 22.8%, limonene 8.9%, α-humulene 7.8%, germacrene B 6.6%	AP	SD	Iran	Sefidkon & Khajavi, 1999
verticillata	β-caryophyllene 13.3%, γ-muurolene 10.3%, *trans*-chrysanthenol 6.1%	AP	HD	Serbia	Chalchat et al., 2001
verticillata subsp. *amasiaca*	β-caryophyllene 17%	AP	HD	Turkey	Baser, 2002
verticillata subsp. *verticillata*	germacrene D 10-16%				
verticillata	β-pinene 30.7%, *p*-cymene 23.0%, lauric acid isopropyl ester 16.8%	AP	HD	Greece	Pitarokili et al., 2006
verticillata	germacrene D 48%, β-caryophyllene 13.4%, α-cadinol 10.4%, α-humulene 7.2%	AP	HD	Vrdnik, Serbia	Krstic et al., 2006
	germacrene D 24.6%, β-caryophyllene 19%, bicyclogermacrene 16.7%, α-humulene 10.2%			Rimski Sanac, Serbia	
	β-caryophyllene 10.2%, β-cubebene 8.6%, spathulenol 6.5%			Tara mount., Serbia	
verticillata	β-caryophyllene 31.5%, germacrene D 16.2%, limonene 15.5%, α-pinene 10.4%, α-humulene 9.4%	AP	HD	Iran	Yousefzadi et al., 2007
verticillata subsp. *amasiaca*	β-pinene 23.0%, α-pinene 21.6%, β-phellandrene 13%, limonene 11%, 1,8-cineole 10.9%	AP	HD	Bitlis, Turkey	Altun et al., 2007
verticillata	1,8-cineole 38.3%, camphor 23.0%	AP	HD	Iran	Forouzin et al., 2009
verticillata	α-pinene 10.7%, limonene 5.9%, camphor 5.2%	-	HS-GC-MS	Poland	Rzepa et al., 2009
verticillata subsp. *amasiaca*	β-pinene 21.4%,1,8-cineole 16.1%, α-copaene 5.4%, α-gurjunene 4.6%	AP	HD	Bitlis, Turkey	Askun et al., 2010
verticillata	β-caryophyllene 65.3%, α-humulene 25.4%	AP	HD	Brumov-Bylnice-Czech Republic (CR)	Smekalova et al., 2010
	β-caryophyllene 64.5%, α-humulene 26.6%			Brezova, (CR)	
	β-caryophyllene 62.2%, α-humulene 25.2%			Suchovské Mlýny, (CR)	
	β-caryophyllene 64.0%, α-humulene 23.8%			Radobýl, (CR)	
	β-caryophyllene 58.3%, α-humulene 23.4%			Rydvaltice, (CR)	
	β-caryophyllene 68.5%, α-humulene 25.9%			Březina lom, (CR)	
	β-pinene 29%, β-caryophyllene 20.22%, α-humulene 15.6%, limonene 13.9%			Macošská stráň, (CR)	
verticillata	α-pinene, β-pinene, β-caryophyllene, caryophyllene oxide, germacrene D	-	-	Poland	Strzalka et al., 2011
verticillata subsp. *amasiaca*	germacrene D 36.6%, β-caryophyllene 7.6%, hexadecenoic acid 6.7%	AP	HD	Eskişehir, Turkey	Kunduhoglu et al., 2011

***Salvia* Species**	**Main compounds**	**Plant Parts***	**Extraction technique****	**Country**	**References**
verticillata	β-caryophyllene 17.8%, β-phellandrene 14.2%, α-humulene 10.2%, α-pinene 5.7%, germacrene D 5.2%	AP cult	HD	Iran	Nasermoadeli et al., 2013
	β-caryophyllene 14.7%, α-gurjunene 12.8% , germacrene D 8.7%, α -humulene 7.7%, β-phellandrene 6.6%, β-pinene 6.5%, bicyclogermacrene 6.4%	AP wild			
	β-caryophyllene 24.4%, β-phellandrene 9.1%, α-humulene 8.6%, bicyclogermacrene 6.3%, spathulenol 6.0% and β-pinene 5.00%	AP	HD	Iran	Dehaghi et al., 2014
verticillata	β-caryophyllene 41.0%, α-humulene 14.0%%, germacrene D 13.0%	AP	HD	Ardebil, Iran	Rajabi et al., 2014
	β-caryophyllene 24.0%, spathulenol 11.0%, caryophyllene oxide 10.0%, α-humulene 8.1%%, germacrene D 6.4%, α-cedrene 5.7%			Khoi, Iran Azarbaijan-Gharbi, Iran	
	β-caryophyllene 17.0%, spathulenol 17.0%, caryophyllene oxide 7.0%, α-humulene 5.4%%, γ-gurjunene 4.3%, germacrene D 3.5%			Tehran, Iran	
verticillata subsp. *amasiaca*	Palmitic acid 17.8%, 7-methyl-*Z*-tetradecen-1-ol-acetate 10.0%, heptacosane 8.4%	AP	TD-GC-MS	Sivas, Turkey	Hatipoglu et al., 2016

*AP: aerial parts; cult: cultivated; **HD: hydrodistillation; TD-GC-MS: thermal desorption-GC-MS

Salvia species (sage) are well-known as aromatic and medicinal plants world-wide. They have an important role not only in folk medicine, but also in cosmetics, phytotherapy, and the flavoring of food products (Bozin et al., 2007). In this study, we investigated the chemical composition of *S. verticillata* subsp. *verticillata* essential oil from Şırnak (southern eastern part of Turkey). The chemical composition of *Salvia* essential oils is highly variable, depending on geographic origin, plant part, harvesting, drying, storage, genetic factors and oil extraction process. Chemical variability of essential oils directly affects their biological activity. More research is necessary to better understand the variabilities in the chemical profile of *S. verticillata* and other *Salvia* species.

REFERENCES

Askun, T., Baser, K. H. C., Tumen, G., Kurkcuoglu, M. (2010). Characterization of essential oils of some *Salvia* species and their antimycobacterial activities. *Turkish Journal of Biology*, 34, 89-95.

Altun, M., Unal, M., Kocagoz, T., Goren, A. C. (2007). Essential oil compositions and antimicrobial activity of *Salvia* species. *Journal of Essential Oil Bearing Plants,* 10, 251-258.

Altundag, E., Ozturk, M. (2011). Ethnomedicinal studies on the plant resources of east Anatolia, Turkey. *Procedia Social and Behavioral Sciences*, 19, 756-777.

Baser, K.H. C. (2002). Aromatic biodiversity among the flowering plant taxa of Turkey. *Pure and Applied Chemistry*, 74, 527-545.

Bozin, B., Mimica-Dukic, N., Samojlik, I., Jovin, E. (2007). Antimicrobial and antioxidant properties of rosemary and sage (*Rosmarinus officinalis* L. and *Salvia officinalis* L., Lamiaceae) essential oils. *Journal of Agricultural and Food Chemistry*, 19, 7879-7885.

Bulut, G., Tuzlaci, E. (2013). An ethnobotanical study of medicinal plants in Turğutlu (Manisa-Turkey). *Journal of Ethnopharmacology*, 149, 633-647.

Cakilcioglu, U., Turkoglu I. (2010). An ethnobotanical survey of medicinal plants in Sivrice (Elazığ-Turkey). *Journal of Ethnopharmacology*, 132, 165-175.

Celep, F., Kahraman, A. *Salvia* L. (2012). In A. Güner, S. Aslan, T. Ekim, M. Vural, M.T. Babac (Eds.). *Turkiye Bitkileri Listesi (Damarli Bitkiler*) Nezahat Gokyigit Botanik Bahcesi ve Flora Arastirmalari Dernegi Yayini, Istanbul.

Chalchat, J. C., Gorunovic, M.S., Petrovic S. D., Maksimovic Z. A. (2001). Chemical compositions of two wild species of the genus *Salvia* L. from Yugoslavia: *Salvia aethiopis* and *Salvia verticillata*. *Journal of Essential Oil Research*, 13, 416-418.

Dehaghi, N. K., Ostad, S. N., Maafi, N., Pedram, S., Ajani, Y., Hadjiakhoondi, A., Khanavi, M. (2014). Cytotoxic activity of the essential oil of *Salvia verticillata* L. *Research Journal of Pharmacognosy*, 1, 27-33.

Demirci, B., Tabanca, N., Baser, K. H. C. (2002). Enantiomeric distribution of some monoterpenes in the essential oils of some *Salvia* species. *Flavour and Fragrance Journal,* 17, 54-58.

Demirci, S., Ozhatay, N. (2012). An ethnobotanical study in Kahramanmaraş (Turkey); wild plants used for medicinal purpose in Andırın, Kahramanmaraş, *Turkish Journal of Pharmaceutical Sciences*, 9, 75-92.

Forouzin, F., Jamei, R., Heidari, R. (2015). Compositional analysis and antioxidant activity of volatile components of two *Salvia* spp. *Tropical Journal of Pharmaceutical Research*, 14, 2009-2013.

Gunes, F., Ozhatay, N. (2011). An ethnobotanical study from Kars (Eastern) Turkey, *Biological Diversity and Conservation*, 4, 30-41.

Gurdal, B., Kultur, S. (2013). An ethnobotanical study of medicinal plants in Marmaris (Muğla, Turkey). *Journal of Ethnopharmacology*, 146, 113-126.

Guzel, Y., Guzelsemme, M., Miski, M. (2015). Ethnobotany of medicinal plants used in Antakya: A multicultural district in Hatay province of Turkey. *Journal of Ethnopharmacology,* 174, 118-152.

Hatipoglu, S. D., Zorlu, N., Dirmenci, T., Goren, A. C., Ozturk, T., Topcu, G. (2016). Determination of volatile organic compounds in fourty five *Salvia* species by thermal desorption-GC-MS technique. *Records of Natural Products*, 10, 659-700.

Hayta, S., Polat, R., Selvi, S. (2014). Traditional uses of medicinal plants in Elazığ (Turkey). *Journal of Ethnopharmacology*, 154, 613-623.

Hedge, I. (1982). *Salvia* L. in Davis et al. (Eds.). *Flora of Turkey and the East Aegean Islands*, Vol. 7, 400-461, Edinburgh U. press, Edinburgh.

http://www.bizimbitkiler.org.tr (accessed on April 20, 2017).

Kargioglu, M., Cenkci, S., Serteser, A., Konuk, M., Vural, G. (2010). Traditional uses of wild plants in the Middle Aegean Region of Turkey. *Human Ecology*, 38,429-450.

Krstic, L., Malencis, D., Anackov, G. (2006). Structural investigations of trichomes and essential oil composition of *Salvia verticillata*, *Botanica Helvatica*, 116, 159-168.

Kultur, S. (2007). Medicinal plants used in Kırklareli Province (Turkey). *Journal of Ethnopharmacology*, 111, 341-364.

Kunduhoglu, B., Kurkcuoglu, M., Duru, M. E., Baser, K. H. C. (2011). Antimicrobial and anticholinesterase activities of the essential oils isolated from *Salvia dicroantha* Stapf., *Salvia verticillata* L. subsp. *amasiaca* (Freyn and Bornm.) Bornm. and *Salvia wiedemannii* Boiss. *Journal of Medicinal Plants Research*, 5, 6484-6490.

Nasermoadeli, S., Rowshan, V., Abotalebi, A., Nasermoadeli, L., Charkhchian, M. M. (2013). Comparison of *Salvia verticillata* essential oil components in wild and cultivated population. *Annals of Biological Research*, 4, 252-255.

Orhan, I., Aslan, M. (2009). Appraisal of scopolamine-induced antiamnesic effect in mice and *in vitro* antiacetylcholinesterase and antioxidant activities of some traditionally used Lamiaceae plants. *Journal of Ethnopharmacology*, 122, 327-332.

Ozdemir, E., Alpinar, K. (2015). An ethnobotanical survey of medicinal plants in western part of central Taurus Mountains: Aladağlar (Niğde-Turkey). *Journal of Ethnopharmacology*, 166, 53-65.

Ozek, G., Demirci, F., Ozek, T., Tabanca, N., Wedge, D.E., Khan, S.I., Baser, K. H. C., Duran, A. H. (2010). Gas chromatographic–mass spectrometric analysis of volatiles obtained by four different techniques from *Salvia rosifolia* Sm., and evaluation for biological activity. *Journal of Chromatography A*, 1217, 741-748.

Ozudogru, B., Akaydin, G., Erik, S., Yesilada, E. (2011). Inferences from an ethnobotanical field expedition in the selected locations of Sivas and Yozgat provinces (Turkey). *Journal of Ethnopharmacology*, 137, 85-98.

Pieroni, A., Muenz, H., Akbulut, M., Baser, K. H. C., Durmuskahya, C. (2005). Traditional phytotherapy and trans-cultural pharmacy among Turkish migrants living in Cologne, Germany. *Journal of Ethnopharmacology*, 102, 69-88.

Pitarokili, D., Tzakou, O., Loukis, A. (2006). Essential oil composition of *Salvia verticillata, S. verbenaca*, *S. glutinosa* and *S. candidissima* growing wild in Greece. *Flavour and Fragrance Journal,* 21, 670-673.

Polat, R., Satil, F. (2012). An ethnobotanical survey of medicinal plants in Edremit Gulf (Balıkesir -Turkey). *Journal of Ethnopharmacology*, 139, 626-641.

Rajabi, Z., Ebrahimi, M., Farajpour, M., Mirza, M., Ramshini, H. (2014). Compositions and yield variation of essential oils among and within nine *Salvia* species from various areas of Iran. *Industrial Crops and Products*, 61, 233-239.

Rzepa, J., Wojtal, L., Staszek, D., Grygierczyk, G., Labe, K., Hajnos, M., Kowalska, T., Waksmundzka-Hajnos, M. (2009). Fingerprint of selected *Salvia* species by HS-GC-MS analysis of their volatile fraction*, Journal of Chromatographic Science*, 47, 575-580.

Sargin, S. A., Selvi, S., Lopec, V. (2015). Ethnomedicinal plants of Sarıgöl district (Manisa), Turkey. *Journal of Ethnopharmacology*, 171, 64-84.

Sefidkon, F., Khajavi, M. S. (1999). Chemical composition of the essential oils of two *Salvia* species from Iran: *Salvia verticillata* L. and *Salvia santolinifolia* Boiss. *Flavour and Fragrance Journal,* 14, 77-78.

Sezik, A., Yesilada, E., Honda, G., Takaishi, Y., Takeda, Y., Tanaka, T. (2001). Traditional medicine in Turkey X. Folk medicine in Central Anatolia. *Journal of Ethnopharmacology*, 75, 95-115.

Smekalova, K., Duzek, K., Diskova, E. (2010). *Salvia verticillata* L. and *Salvia pratensis* L.-the variability of essential oil content in the Czech Republic. *Acta Horticulturae*, 860 (Proceedings of the IVth International Symposium on Breeding Research on Medicinal and Aromatic Plants, 2009), 51-60.

Strzalka, M., Chwedoruk, D., Halas, L., Janeczko, Z. (2011). Chemical composition of essential oils found in selected *Salvia* species. *SOFW Journal*, 137, 18, 20-24, 26-29.

Suntar, I., Akkol, E.K., Keles, H., Oktem, A., Baser, K. H. C., Yesilada, E. (2011). A novel wound healing ointment: a formulation of *Hypericum perforatum* oil and sage and oregano essential oils based on traditional Turkish knowledge. *Journal of Ethnopharmacology,* 134, 89-96.

Tabanca, N., Demirci, B., Baser, K. H. C., Aytac, Z., Ekici, M., Khan. S. I., Jacob, M.R., Wedge, D.E. (2006). Chemical composition and antifungal activity of *Salvia macrochlamys* and *Salvia recognita* essential oils. *Journal of Agricultural and Food Chemistry*, 54, 6593-6597.

Tetik, F., Civelek, S., Cakilcioglu, U. (2013). Traditional uses of some medicinal plants in Malatya (Turkey). *Journal of Ethnopharmacology*, 146, 331-346.

Tuzlaci, E., Erol, M. K. (1999). Turkish folk medicinal plants. Part II: Egirdir (Isparta). *Fitoterapia*, 70, 593-610.

Uysal, I., Guzel, S., Tutenocakli, T., Ozturk, M. (2012). Studies on the medicinal plants of Ayvacık-Çanakkale in Turkey, *Pakistan Journal of Botany*, 44, 239-244.

Yousefzadi, M., Sonboli, A., Karimic, F., Ebrahimi, S. N., Asghari, B., Zeinalia, A. (2007). Antimicrobial activity of some Salvia species essential oils from Iran. *Zeitschrift für Naturforschung C*, 62, 514-518.