Essentıal Oıl Composıtıon of *Scandıx Iberıca* Bıeb. and *Scandıx Stellata* Banks and Sol (Apıaceae) from Dıfferent Parts, a Chemotaxonomıc Approach

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Abstract: To investigate and compare, the essential oil composition of different parts of two *Scandix* species (Apiaceae). The essential oil of the aerial parts of two species was obtained by hydrodistillation and analyzed by gas chromatography (GC) and gas chromatography - mass spectrometry (GC-MS). The essential oil yields of S. stellata were determined as 0.3(v/w) in aerial part, 0.2 (v/w) in leaf and fruits. 51 constituents were identified and comprised 85.1 % of the total essential oil from S. stellata Banks et. Sol. aerial parts, and identified thirty constituents in leaf and 27 constituents in fruits and also comprised 98.1% in leaf and 88.9% in fruit total essential oil. Fourty two constituents were identified and comprised 96.6% of the total essential oil from S. iberica aerial parts. The predominant compounds of the aerial part oils of S. stellata were n-hexadecanoic (15.9%) and oleic acids (10.0%), spathulenol (9.4%) and also n-hexadecanoic (27.5%), oleic acids (14.2%), spathulenol (12.1%) and stearic acid (8.2%) were the major compounds in fruit. In S.stellata leaf oil, n-hexadecanoic acid (12.5%), spathulenol (12.1%) and germacrene-D (6.2%) were the major compounds. The predominant compounds of S. iberica oil were n-hexadecanoic acid (23.1%), 1-Octadecane-sterol (31.1%) in aerial parts; pentadecane (28.1%) caryophyllene oxide (10.2%) and heptadecane (9.1%) in leafs;β–monolein (18.1%), n-hexadecanoic acid (12.5%), 1-Octadecane-sterol (11.4%), spathulenol (9.1%) were determined as main compounds in oil of S. iberica fruits. Fatty acid, sesquiterpene and saturated hydrocarbons were determined as significant compounds for the characterization of S. stellata and S. iberica essential oil.

Keywords: Chemotaxonomy, essential oil, n-hexadecanoic acid, oleic acid, *Scandix stellata* and *Scandix iberica,* spathulenol.

1. INTRODUCTION

The flowering plant family Apiaceae (Umbelliferae) comprises 300–455 genera and 3000–3700 species about ten times as many species and is cosmopolitan in distribution. Apiaceae (Umbelliferae) is one of the best known families of flowering plants (Davis, 1972).

The family Umbelliferae is rich in secondary metabolites. The occurrence of essential oils and oleoresin is a characteristic feature of this family that is secreted in schizogenous canals in root, stem, leaves and inflorescence (Heywood, 1972). These are aromatic plants comprising diverse volatile compounds from the fruits and leaves which in turn causes a distinctive flavour. The members of Apiaceae are distributed throughout the World, however the frequency is higher in temperate regions and are less common in the tropics. (Berenbahum, 1990; Christensen and Brandt, 2006).

Essential oil or oleoresin at different organs cause a characteristic pungent or aromatic smell in the members of Apiaceae (Singh and Jain, 2007).

The genus *Scandix* contains 20 species with 15 of them mostly confined to the Mediterranean region (Zohary, 1972; Kubeczka, 1982; Downie et.al, 2000) and only *Scandix pecten-veneris* widely distributed (Cohen, 2000). It is represented with 8 species and 9 taxa in Flora of Turkey (Davis, 1972). *Scandix iberica* Bieb and *Scandix stellata* Banks & Sol is an annual herb [1]. The species was reported as called, as well. *Scandix stellata* "Dağ kişkişi" and *S. iberica* "Atkişnek" of Turkish name (Baytop, 1997).

Some wild plants such as S. pecten veneris is reported to be consumpted in greece for more than 2 thousand years. There are also other reports that *scandix* members have been eaten as raw or cooked. *Scandix* was supposed to have sold at markets in athens. It is documented that *Scandix* is still used for cooking in Greek, mostly in villages.

(Psaroudaki, *et al*., 2012). *Scandix* was mentioned in one of the old resources by Dodoneous in 1578 as a good herb, but of small estimation and value, and taken but only for a wild wurt or herb" (Hulme, 1902). *Scandix iberica* has used for medical purposes, like that genital disorders, liver protecting in Malatya region (Tetik, *et al*, 2013).

Tsakalidi (2014) was reported that that *S. pecten-veneris* is a species which grows in arable land and

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waste places and prospers in sandy, loam and clay soils. It is grown from seeds, mainly during autumn and early winter, although a few seeds germinate in spring in cultivated fields. The leaves are the main edible parts of the plant and are either consumed boiled by just adding olive oil, or in pies. *S. pecten-veneris* is rich in minerals, fatty acids and fibres, phenols and alpha-tocopherol. *Scandix* is quite effected by climate changes. it was once widespread and often abundant in the lowlands, but its growth has considerably declined lately due to the introduction of chemical herbicides, fertilizers and the destruction of field margins (Tsakalidi, 2014).

The extract prepared by aqueous ethanol from different parts of *Scandix* species were analysed with HPLC method by Bakr and Saed. Using six diagnostics compounds belonging to phenolic compounds, their flavonoids and the other phenolic acids, as standards. According to their study, quercetin and rutin (flavenoids) were found in all stems and leaves of species except leaf of *Scandix iberica*. Ellagic acid and ferulig acid (phenolic acid) were detected in all stems and leaves of species except leaf of *Scandix stellata.* According to the content of leaves and stems of all *Scandix* species were reported to contain both quercetin and rutin, while *Scandix iberica* comprising only rutin (Bakr and Saed, 2014).

In this study essential oils composition of two *Scandix* species (*S. iberica* and *S. stellata*) were determined and compared among the genus patterns in view of chemotaxonomy and natural product. There are no study on the *Scandix* essential oil composition, but just only *S. iberica* fruits and flowers has studied by Kaya *et al*., (2007).

2. EXPERIMENTAL

2.1. Plant Material

The *Scandix iberica and S. stellata* plants were collected from natural habitats in Elazığ, in May 2015. The leaf and fruit were dried in the shade at room temperature. The voucher specimen for *S. iberica* and *S.stellata* (Demirpolat, 1003, 1004) has been deposited in the Fırat University Herbarium (FUH).

2.2. Extraction of the Essential Oil

The essential oil was extracted by hydrodistillation using a modified Clevenger apparatus coupled to a 2 L round-bottom flask. A total of 100 g of fresh plant material (aerial parts) and 1 L of water were used for the extraction. The chemical analysis were performed in Plant Products and Biotechnology Res. Lab. The extraction was performed over 3 hour period. The yields of oils were calculated on the basis of the dry mass.

2.3. Gas Chromatographic (GC) Analysis

The essential oil was analysed using HP 6890 GC equipped with FID detector and HP- 5 MS (30 m x 0.25mm *I.d.,* film tickness 0.25 μm) capillary column was used. The column and analysis conditions were the same as in GC-MS expressed as below. The percentage composition of the essential oils was computed from GC-FID peak areas without correction factors.

2.4. Gas Chromatography / Mass Spectrometry (GC-MS) Analysis

GC-MS analyses of the oils were performed on a Hewlett Packard Gas Chromatography HP 6890 interfaced with Hewlett Packard 5973 mass spectrometer system equipped with a HP 5-MS capillary column (30 m x 0.25mm id, film thickness 0.25 μm). The oven temperature was programmed from 70-240^{o}C at the rate of 5^{o}C/min. The ion source was set at 24C^{o}and electron ionization at 70 eV. Helium was used as the carrier gas at a flow rate of 1 mL/min. Scanning range was 35 to 425 amu. Diluted oil in *n*-hexane (1.0 μL) was injected into the GC-MS. The identification of constituents was performed on the basis of Retention Indices (RI) determined by co-injection with reference to a homologous series of *n*-alkanes, under identical experimental conditions. Further identification was performed by comparison of their mass spectra with those from NIST 98 Libraries (on ChemStation HP) and Wiley 7th Version. The relative amounts of individual components were calculated based on the GC (HP-5MS column) peak area (FID response) without using correction factors. The identified constituents of the essential oils are listed in Table **1**.

Evaluation of the Data's; Cluster analysis were performed to show chemical similarities and chemotaxonomic relationships among the *Scandix* species. The literature reviews on the *Scandix* essential oils in view of major essential oil were performed in Table **2**, to compare the results and evaluation of the chemotaxonomy of the genus

Table 1: The Essential Oil Composition of Leaf and Fruits of *Scandix Stellata* and *S. İberica*

No	Compounds	RI	*S. stellata*[1]	*S.stel.*[2]	*S. stel.*[3]	*S. iberica*[1]	*S. ib.*[3]	*S. ib.*[2]
	β-Pinene	1056	0.1	-	-	-	-	-
	Nonanal	1150	-	-	0.1	0.3	-	-
	Phosphoric acid	1161	0.1	-	-	-	-	-
	Cryptone	1176	0.1	-	-	-	-	-
	p-Cymen-8-ol	1207	-	-	1.0	-	-	-
	Ethanone	1209	0.1	-	-	-	-	-
	13-Z-5-Octatriene	1214	0.1	-	-	-	-	-
	Coigenal	1232	0.1	-	-	-	-	-
	Nuciferol	1265	0.3	-	-	-	-	-
	Isovalerone	1272	0.7	-	-	-	-	-
	Tridecane	1294	-	-	-	-	6.5	-
	1-Methyl-4-(1-methylpropyl)-benzene	1335	0.3	-	-	-	-	-
	Copaene	1360	0.3	-	0.6	0.3	-	-
	Triacontane	1365	0.2	-	-	-	-	-
	α-Calacorene	1372	0.2	-	-	-	-	-
	Tridecanal	1377	0.5	-	-	-	-	-
	2,4-Dodecadienal	1389	0.1	-	-	-	-	-
	α-Caryophyllene	1393	0.1	-		-	4.7	-
	Geranylacetone	1396	0.1	-	-	-	-	-
	Dehdro-isolongifolene	1400	-	1.2	-	-	-	-
	(+)Epibicyclosesquiphellandrene	1418	0.1	-	-	-	-	-
	Cetanol	1428	0.1	-	-	-	-	-
	β-Ianone	1431	0.4	-	-	-	-	-
	Germacrene-D	1432	0.7	0.9	6.2	-	0.7	-
	3-Hexen-1-benzoate	1435	0.3	-	-	-	-	-
	Guaiacol	1441	0.1	-	-	-	-	-
	Bicylogermacrene	1445	-	0.5	2.9	-	-	-
	Pentadecane	1448	0.8	-	1.1	-	**28.1**	-
	1,3-Benzene diol,5-pentyl	1455	-	-	-	-	0.5	-
	Geranyl acetate	1457	0.1	-	-	-	-	1.2
	Cobalt	1459	0.4	-	0.4	-	-	-
	Calamenene	1460	0.1	-	-	-	-	-
	1,1-dimethyl propyl ethyl malononitrile	1462	0.2	-	-	-	-	-
	Elema,1,3,11(13)-trien-12-ol	1464	0.2	-	-	-	-	-
	Cedrane	1478	0.4	-	-	-	-	-
	Isoaromadendrene epoxide	1480	0.8	-	2.1	0.4	-	-
	Dodecanoic acid- Lauric acid	1483	0.1	-	-	-	-	-
	Solanesol	1485	0.2	-	-	-	-	-
	1,5-epoxisalvial-4(14)ene	1488	2.1	4.5	4.9			2.1

Table 1 continued…

No	Compounds	RI	*S. stellata*[1]	*S.stel.*[2]	*S. stel.*[3]	*S. iberica*[1]	*S. ib.*[3]	*S. ib.*[2]
1.	Cyclopentane-1-methyl -1- 2 methyl, 2- properly	1490	-	-	-	0.5	-	-
2.	Spathulenol	1493	**9.4**	**12.1**	**12.1**	3.7	4.7	**9.4**
3.	Caryophyllene oxide	1496	1.2	3.3	3.9	1.1	**10.2**	-
4.	2,9-dimethylspiro [5.5] undecane	1498	-	-	-	1.4	-	-
5.	Salvial-4(14)-en-1-one	1502	-	2.3	3.2	0.4	-	0.2
6.	Geranyl butanoate	1503	-	-	-	0.4	-	-
7.	Cis-Decalalin	1508	1.7	-	-	-	-	-
8.	Nor-copaene	1510	1.7	1.7	1.7	0.9	-	-
9.	Crypton	1512	-	-	1.3	0.7	-	-
10.	Camphene	1513	-	1.7	-	-	1.4	-
11.	α-Copaene-8-ol	1515	1.9	-	-	0.5	-	-
12.	Isolongifolone	1518	-	-	2.5	-	-	-
13.	Phenethyl iodide	1519	-	-	-	0.6	-	-
14.	Ledene oxide	1522	-	-	-	0.4	3.2	-
15.	Adamante	1527	-	-	-	-	2.8	-
16.	Aromadendrene	1532	-	1.1	-	-	-	1.1
17.	Widdrol	1536	-	-	-	1.0	-	-
18.	Longipinocarveol	1538	-	1.6	2.5	-	-	-
19.	Indole	1539	-	1.2	-	-	-	-
20.	Valeranal	1540	-	-	1.7	0.7	2.8	-
21.	Caryophylladienol II	1542	2.4	-	-	-	-	-
22.	β-Selinene	1547	4.1	-	4.5	1.5	-	-
23.	8-heptadecene	1548	-	1.3	1.7	-	0.9	-
24.	Jasmone	1553	-	-	-	0.4		-
25.	Dehyddroaromadendrene	1555	-	-	-	0.6	0.6	-
26.	Formic acid	1557	-	-	-	-	0.8	-
27.	Heptadecane	1558	-	-	2.1	-	**9.1**	-
28.	3-Heptedecanal	1560	-	-	0.5	-	5.7	
29.	Pentacosane	1561	-	-	-	0.3		-
30.	3-Tridecanol	1563	-	-	-	0.4	1.5	-
31.	Stenol	1564	-	-	-		4.1	-
32.	Vulgarol B	1566	1.3	2.2	2.9	0.7	-	-
33.	methyl cavicol	1568	2.8	0.6	-	-	-	-
34.	Ledene	1569	-	1.7	1.7	0.3	-	-
35.	Piperitenone	1583	0.7	0.6	1.8	0.5	-	-
36.	Aromadendrene oxide	1588	0.5	0.7	-	0.5	-	-
37.	Eucarvone	1593	-	0.9	-	1.2	-	-
38.	Methoxy-6-vinylphenol	1595	0.9	-	-	0.3	-	-
39.	Quinolinone	1608	-	0.6	1.3	-	-	-
40.	Tetradecanal	1614	0.2	-	-	0.5	-	-

Table 1 continued…

No	Compounds	RI	*S. stellata*[1]	*S.stel.*[2]	*S. stel.*[3]	*S. iberica*[1]	*S. ib.*[3]	*S. ib.*[2]
41.	Cis-1-ethynyl-2-methyl-1-cylohexanol	1615	0.9	-	-	-	-	-
42.	Ethol	1618	-	-	-	-	0.6	-
43.	Hexhydrofarenysl acetone	1625	-	-	2.4	-	-	-
44.	2-pentadecanone	1629	1.4	0.6	2.1	2.1	1.8	-
45.	Isobuthyl phytalate	1637	1.6	-	1.1	1.6	-	-
46.	1-cyano-4(5 hexeney) benzene	1642	-	-	-	-	-	**8.2**
47.	Cyclohexadecane	1647	-	-	-	**7.9**	-	-
48.	Pentadecanol	1652	0.1	-	0.1	-	-	-
49.	Phthalic acid	1686	0.1	-	-	-	-	-
50.	Tetradecanoic acid	1689	-	-	-	3.3	-	-
51.	n- Hexadecanoic acid-palmitic	1692	**15.9**	**27.5**	**12.5**	**23.1**	4.1	**12.5**
52.	Palmitin-2-mono	1671	-	-	-		-	-
53.	1-Octadecane-stearol	1774		-	-	**31.1**	-	**11.4**
54.	Thiosülphric acid ester	1767	0.4	-	-		-	-
55.	Phytol	1790	0.3	-	-	0.9	-	-
56.	Steraic acid-octadecanoic	1820	0.3	**8.2**	-	2.3	-	-
57.	Loxanol	1822	-	-	-	0.4	-	-
58.	Pentadecanoic acid	1824	3.5	-	-	-	-	-
59.	Linoleic acid	1828	0.8	4.9	5.9	-	1.2	-
60.	12-Hydroxydodecanoic acid	1873	0.1	-	-	-	-	-
61.	4-n-Pentylthiane,5,S-dioxide	1889	0.1	-	-	-	-	-
62.	Vanicol	1895		0.8	-	-	-	-
63.	Palmitic acid chloride	1896	0.7	-	-	1.5	-	-
64.	Heneicosane	1900	0.2	-	-	-	-	-
65.	Oleic acid (9Z-octadecanoic acid)	1904	**11.0**	**14.2**	-	0.3	-	1.1
66.	Thiosulfuric acid	1928	-	-	-	0.7	-	-
67.	Docosanoic acid	1830	-	-	-	-	-	2.4
68.	Cis-13-Octadecanal	1917	0.2	-	-	-	-	-
69.	Cinnamyl cinnamate	1929	3.9	-	-	-	-	-
70.	D-Glucosamine	1928	-	-		-	-	7.9
71.	Propenoic acid	1935	-	-	-	-	-	2.1
72.	n-Nonadecane	1946	0.5	-	-	-	-	-
73.	Eicosanoic acid	1929	-	1.2	-	-	-	-
74.	Scatole	1952	3.1	-	-	-	-	**11.0**
75.	14-β-pregna	1930	-	-	-	0.4	-	-
76.	Hexahydropyridine	1961	-	-	-	0.5	-	-
77.	Nonadecane	1967	0.7	-	-	-	-	-
78.	Acetoxymethyl silane	1944	-	-	-	-	-	6.9
79.	β-monolein	1962	-	-	-	-	-	**18.1**
Toplam			**85.1**	**98.1**	**88.9**	**96.6**	**95.3**	**95.6**

RI: Retention index, **1: aerial parts; 2: fruit; 3:leaf.**

patterns. For this purpose SPSS 10.0 Packet program has used. The illustrations has shown that in Figure **1**.

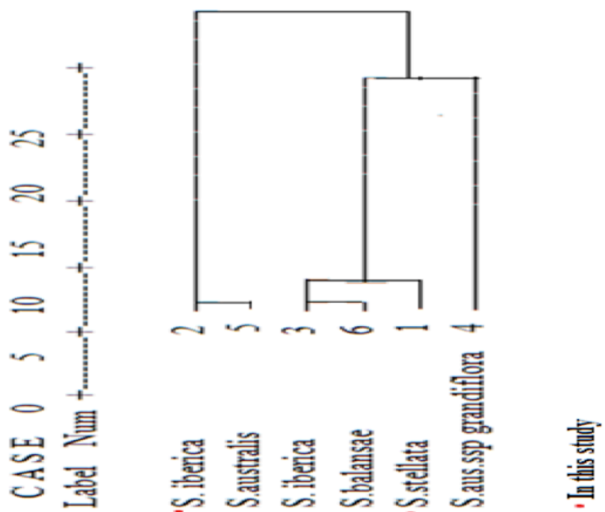

Figure 1: Dendrogram of *Scandix* species.

3. RESULT

In this study, the essential oil composition of different parts (leaf, fruits and aerial parts individually) of *S. stellata* and *S. iberica* collected from Turkey were determined. The qualitative and quantitative essential oil composition of both species from different parts were determined and compared with each other. The essential oil yields of *S. stellata* were determined as 0.3(v/w) in aerial part, 0.2 (v/w) in leaf and fruits. Fifty one constituents were identified and comprised 85.1 percentage of the total essential oil from *S. stellata* aerial parts, and identified thirty constituents in leaf and twenty seven constituents in fruits and also comprised 98.1% in leaf and 88.9% in fruit essential oil respectively. The results are given in Table **1**.

It is possible to said that, *Scandix* essential oils has contained mostly fatty acid group in the different parts of the oil generally. The essential oil yields of *S. iberica* were determined as 0.3(v/w) in aerial part, leaf and 0.2 (v/w) in fruits. Fourty two constituents were identified and comprised 96.6% percentage of the total essential oil from *S. iberica* aerial parts, and identified twenty two constituents in leaf and fifteen constituents in fruits and also comprised 95.3% in leaf and 95.6% in fruit essential oil respectively.

The predominant compounds of of *S. stellata* oils from aerial part were n-hexadecanoic (15.9%), oleic acids (11.0%) spathulenol (9.4%); and n- hexadecanoic (27.5%), oleic acids (14.2%), spathulenol (12.1%) and steraic acid (8.2%) were the major compounds in fruit oil. The main compounds in the essential oil of *S.stellata* leaf were determined as n-hexadecanoic acid (12.5%), spathulenol (12.1%) and germacrene-D (6.2%) (Table **1**). On the other hand, the predominant compounds of the aerial part oils *S. iberica* were found n-hexadecanoic acid (23.1%), 1-Octadecane-sterol (31.1%) in aerial parts; pentadecane (28.1%) caryophyllene oxide (10.2%) and heptadecane (9.1%) in *S. iberica* leaf; β-monolein(18.1%), n-hexadecanoic acid (12.5%), 1-Octadecane-sterol (11.4%), spathulenol (9.1%) were determined as main compounds in the essential oil of *S. iberica* fruits.

4. DISCUSSION

In the essential oils of both *Scandix* species, it is determined that the fatty acid groups were predominant and the abundant compounds of the oils. Kaya *et al.* (2011) microdistilled oils from the flower and fruit of *S. iberica* and they found total of 29 and 27 compounds were identified representing 99.3% and 99.4% of the flower and fruit oils, respectively. The main constituent was found to be methyl chavicol (85.8-90.5%) in both samples, fruit and flower oils (Kaya, *et al*., 2011). In the essential oil analysis from the herbal parts of *Scandix australis* subsp. *grandiflora,* five components were characterized representing 99.84% of the total components. Methyl chavicol (95.91 %) was the major constituent of the oil obtained in 0.4% yield (Tümen and Baser, 1997) On the other hand, Velasco-Negueruela *et al*. (1991) reported that the oil of *S. australis* contained methyl chavicol (8.47%) and major constituent (E)-anethole (86%). Methyl chavicol and its isomer anethole are reported to possess sedative and anticonvulsant activity related to their neurotropic property (Leal-Cardoso, *et al*., 2004). When we compared the present analysis results were found that it was not similar with this study findings and we found methyl chavicol only in aerial parts of *S. stellata* and fruits in low rates (%2.8, %0.6) rexpectively.

In the essential oil of *S. iberica* comprises the high rate of n-hexadecanoic acid and it is specific inhibitors of phospholipase A2 as anti-inflammatory agents. So use of medicated oils rich in n-hexadecanoic acid for the treatment of rheumatic symptoms in the traditional medical system. Like that Ayurveda use of anti-inflammatory drugs in India (Aparna *et al*., 2012). It is reported that N-hexadecanoic acid to be effective against fourth instar larvae of Culex quinquefasciatus**,** Anopheles stephensi and Aedes aegypti *(Rahuman* et al*., 2000). It is possible to said that this essential oil can be used as a effective herbicide for the mentioned* *insect group and it may be used for the bio-technological treatments.*

The essential oils of the three *Scandix* specimens, *S. australis* L., and two specimens of *S. pecten-veneris* L. sampled from Athens and mountain Parnassos were found as similar, containing mainly the saturated hydrocarbons tridecane, pentadecane and heptadecane and the unsaturated alde-hyde tetradecenal. So that the Greek *Scandix* plants were found to contain low amounts of oils, whereas they were determined to present an intriguing potential for use as a natural source of economically interesting saturated hydrocarbons, molecules usually obtained through oil and gas industries. The determined exclusive presence of these compounds in all investigated Greek specimens, originated from diverse and remote locations, is indicative of a distinct chemotype among the Greek *Scandix* taxa (Evergetis *et al*., 2015).

In the analyses of an essential oil sample obtained from dry fruits of *Scandix balansae* Reut. ex Boiss. allowed the identification of 81 components, comprising 91.4% of the total oil composition. The major identified volatile compounds were medium-chain-length n-alkanes, tridecane (6.7%), pentadecane (13.4%), and heptadecane (19.3%), and a long-chain homolog nonacosane (7.6%). They find of a number of minor oil constituents, among them tetradecyl 3-methylbutanoate, and octadecyl 2-methylpropanoate, 3-methylbutanoate, and pentanoate (Radulovic *et al*., 2013). The results of this work shows parallelism with our studies as shown in Table **2**. Both *Scandix* species has many alkane hydrocarbon compounds (tridecane pentadecane, heptadecane).

In the cluster analysis, according to the major components of the essential oils, it is determined that three chemical groups present and they are not similar to each other (Figure **1**). *S. australis* subsp. *grandiflora* essential oil was differentiated from the others as a single group, and *S. iberica* (with this study) and *S. australis* placed as sister and similar group. Otherwise *S. balansae, S. stellata* (this study) and *S. iberica* were the same group. It is possible to say that the essential oil composition of *Scandix* genus were more different and it is possible to say that chemical variation is important in this genus. So, this results gives some clues on the chemotaxonomy of this genus member. The search for compound that could represent possible chemotaxonomic markers included a thorough identification of both, major and minor components, as well as the determination of the concentration of oil constituents. Different lipids group has chemotaxonomic importance like fatty acids (Bagci, 2007) and essential oils (Kanani, 2011) in Apiaceae family members.

In conclusion, from the essential oil analyses in both *Scandix* species, in the major compounds, fatty acid groups primarily n-hexadecanoic and oleic and steraic acids, and for *S. iberica* 1-octadecane stereol; sesquiterpene (spathulenol) and saturated hydrocarbons (heptadecane and pentadecane) determined respectively are important for the characterization of *S. stellata* and *S. iberica* essential oil. It is possible to say that these components has

Table 2: Major Compounds of Essential Oil of *Scandix* Species Used in the Cluster Analysis

	Major Compounds	*S.stellata**	*S.iberica**	*S.iberica (1)*	*S. Australis* Subsp. *Grandiflora (2)*	*S. Australis (3)*	*S.Balansae (4)*
1	Hexadecanoic acid	15.9	23.1	-	-	-	4.3
2	Methyl chavicol	2.8	-	85.8	95.91	8.47	-
3	Oleic acids (9Z-Octadecanoic acid)	11.0	-	-	-	-	2.2
4	(E)-anethole	-	-	2.5	2.49	86.0	-
5	(Z)-β-ocimene	-	-	2.6	22	-	-
6	Cyclohexadecane		7.9	-	-	-	-
7	1-Octadecane-stearol		31.1	-	-	-	0.2
8	Spathulenol	9.4	3.7	0.1	0.01	-	-
9	Heptadecane	-	-	-	-	-	19.3
10	Tridecane	-		-	-	-	6.7
11	Pentadecane	0.3	-	-	-	-	13.4

*: In this study; 1: Kaya et.al. 2011; 2: Tümen and Baser, 1997; 3: Velasco-Negueruela *et al*., 1991; 4: Radulovic *et al*., 2013.

possible chemotaxonomical importance and they may be used as chemical markers. This study demonstrates the occurrence of 1- octadecane sterol/n-hexadecanoic acid and Cyclohexadecane of *S. iberica* and n- hexadecanoic and Oleic acids/Spathulenol chemotype in *S. stellata* in the eastern Anatolian region of Turkey and the essential oil results have given some clues on the chemotaxonomy of the genus patterns and usability of this species as natural product.

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