AkiNik

American Journal of Essential Oils and Natural Products

Available online at www.essencejournal.com

AJEONP American Journal of Essential Oils and Natural Products

ISSN: 2321-9114
AJEONP 2017; 5(3): 16-20

Received: 10-05-2017
Accepted: 12-06-2017

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Essential oil composition and fatty acid profile of two endemic *Gypsophila* species from turkey

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Abstract
Essential oil composition and fatty acid profile of *Gypsophila tuberculosa* Hub.-Mor. *Gypsophila eriocalyx* Boiss. were analyzed by GC-MS. Forty-one compounds were identified in the essential oil of *G. tuberculosa* that represent 81.4 ± 0.5% (*n*=3) of the oil. The major components of the oil were hexadecanoic acid (25.3 ± 0.6%), hentriacontane (13.00 ± 0.06%), dodecanoic acid (7.55 ± 0.2%), tetradecanoic acid (6.53 ± 0.1%) and pentacosane (3.06 ± 0.07%). Sixty-one compounds were identified in the essential oil of *G. eriocalyx* that represent 70.32 ± 1.53% (*n*=3) of the oil. The major components of the oil were octacosane (6.83 ± 0.2%), eicosanal (6.19 ± 0.23%), triacontane (6.03 ± 0.16%), heneicosane (5.78 ± 0.2%), hexadecanoic acid (4.64 ± 0.14%), tricosane (4.50 ± 0.14%), hexahydrofarnesyl acetone (4.44 ± 0.2%), heptacosane (3.40 ± 0.12%), phytol (2.59 ± 0.07%) and pentacosane (2.32 ± 0.08%). Fourteen compounds were identified in the fatty acid of *G. tuberculosa* that represent 96.4 ± 1.4% (*n*=3) of the fatty acid. The major components of the fatty acid were (*Z*)-9-octadecenoic acid methyl ester (18:1) 42.0 ± 0.4%, (*Z,Z*)-9,12-octadecadienoic acid methyl ester (18:2) 19.6 ± 0.3% and hexadecanoic acid methyl ester (16:0) 17.7 ± 0.4% (*n*=3). Four compounds were identified in the fatty acid of *G. eriocalyx* that represent 71.8 ± 0.9% (*n*=3) of the fatty acid. The components of fatty acid were (*Z*)-9-octadecenoic acid methyl ester (18:1) 36.0 ± 0.2%, hexadecanoic acid methyl ester (16:0) 25.2 ± 0.5% and (*Z,Z*)-9,12-octadecadienoic acid methyl ester (18:2) 10.5 ± 0.6 (*n*=3).

Keywords: *Gypsophila tuberculosa*, *Gypsophila eriocalyx*, essential oil, fatty acid, GC-MS, Caryophyllaceae

1. Introduction
Gypsophila L.: species are members of Caryophyllaceae family and distributed mainly in Mediterranean and Iran-Turan areas in Turkey, *Gypsophila* has 56 species in 10 sections and 33 species are endemic to Turkey. By this way, it has made a significant contribution to the biodiversity of Turkey [1].

Previously, antimicrobial activity and chemical constituents of the essential oils from flower, leaf and stem of *Gypsophila bicolor* from Iran were investigated. The main components of the essential oil from flower were germacrene-D (21.2%), *p*-cymene (20.6%), bicyclogermacrene (17.6%), γ-dodecadienolactone (13.7%) and terpinolene (9.4%). The main components of the essential oil from leaves were germacrene-D (23.4%), terpinolene (14.5%), bicyclogermacrene (7.5%), γ-dodecadienolactone (6.8%), *p*-cymene (6.7%) and *cis*-β-ocimene (6.3%). The main components of the essential oil from stems were γ-dodecadienolactone (28.5%), bicyclogermacrene (14.8%), germacrene-D (12.6%), *p*-cymene (12.5%), terpinolene (11.6%) and *trans*-β-ocimene (4.2%). The essential oils had moderate effect on Gram-positive and Gram negative bacteria, but had significant effect on the fungi [2].

Additionally, antioxidant properties of 50% aqueous methanol extracts of some plants growing wild in Turkey were reported by various antioxidant assays, such as free radical scavenging, hydrogen peroxide (H_2O_2) scavenging and metal (Fe^{2+}) chelating activities. Leaves and fruit extracts of *Gypsophila eriocalyx* had low antioxidant properties [3].

Turkish coven is commonly obtained from *Gypsophila graminifolia*, *G. arrostii* var. *nebulosa*, *Gypsophila eriocalyx*, *G. bicolor*, *Gypsophila perfoliata* and *Gypsophila venusta* subsp. *venusta*. *Gypsophila* taxa include 15 to 20% saponin glycoside and also include gypsogenine which is a pentacyclic and sugars as galactose, xylose, arabinose, fructose and rhamnose. Antiviral impacts of *G. arrostii* var. *nebulasa*, *G. bicolor*, *G. perfoliata* and *G. eriocalyx* species were reported. They have antiviral impacts on *Vesicular stomatitis* virus.

But they don't have impact on *Parafainfluenza* type-1 virus. *G. bicolor* species has impact against the other viruses (*Poliovirus* type-1, *Herpes simplex* type-1, type-2, *V. stomatitis* and *Influenza* A_2) except *Parafainfluenza* type-1 virus [4].

There were very few reports on the phytochemistry of the *Gypsophila* L. species in the literature. This prompted us to investigate the essential oil and fatty acid composition of *Gypsophila tuberculosa* and *Gypsophila eriocalyx*. To the best of our knowledge this is the first report on the essential oil composition and fatty acid profile of *Gypsophila tuberculosa* and *Gypsophila eriocalyx*.

2. Materials and Methods

2.1 Plant Materials

Plant materials were collected during the flowering period; *G. tuberculosa* on 16.07.2015 from Aşağı Ulupınar town between Darende and Malatya (1480 m) and *G. eriocalyx* on 20.07.2015 from Jipsli Hills Soğuk Çermik way in Sivas (1440 m) in Turkey by Çelik and Budak.

2.2 Isolation of Fatty Acids

The plants were dried in shadow and ground with an electric mill (Retsch SM 100). The plants were extracted with hexane successively for three days at room temperature. After filtration through a filter paper, the extracts were concentrated by rotary evaporator. The crude extracts were stored at 4 °C. Methyl-ester derivatives of fatty acids (FAME), found in hexane extracts was obtained by transesterification method [5]. In this method 500 mg dried hexane extracts were dissolved in 5 mL hexane and then extracted with 2 M methanolic KOH at room temperature. The mixture was shaken for 2 min and allowed to stand for 10 min. The upper phase were removed and analyzed by GC-MS system.

2.3 Isolation of the Essential Oils

Aerial parts of the air dried plants subjected to hydrodistillation for 3 h, using a Clevenger-type apparatus to produce essential oils. Condenser of the Clevenger was attached to a microchiller that set to 4 °C. *G. tuberculosa* and *G. eriocalyx* afforded oils from the aerial parts with 0.03 and 0.01% (v/w) yields, respectively. The oils were recovered with 1 ml *n*-hexane and preserved in amber vials under -20 °C until the day they were analyzed.

2.4 Gas chromatography/mass spectrometry for fatty acids

The fatty acid compositions of the hexane extracts were investigated by means of Gas Chromatography-Mass Spectroscopy (GC-MS) system. The fatty acid methyl esters were analyzed using Agilent 5975C GC-MSD system with Innowax FSC polar column (30m x 0.25 mm, 25 µm). The inlet temperature was set at 250 °C. Helium was the carrier gas at a constant flow rate of 1 ml/min. Split ratio was set to 50:1. The oven temperature was programmed from 40 °C to 210 °C at rate of 5 °C/min and kept constant at 210 °C for 10 min. EI/MS was taken at 70 eV ionization energy. Mass range was from *m/z* 35-450 amu (atomic mass unit). Relative percentage amounts of the separated compounds were calculated from integration of the peaks in MS chromatograms. Identification of fatty acid components were carried out by comparison of their retention indices (RI) obtained by series of *n*-alkanes (C5 to C30) to the literature and with mass spectra comparison [6-10]. Mass spectra comparison was done by computer matching with commercial Wiley 8th Ed./NIST 05 Mass Spectra library, Adams Essential Oil Mass Spectral Library and Pallisade 600K Complete Mass Spectra Library. Analysis was completed in 50 minutes. The analysis was carried out in triplicate and the results were given as the mean ± standard deviation.

2.5 Gas chromatography/mass spectrometry for essential oils

The GC-MS analysis was performed with an Agilent 5975C Inert XL EI/CI MSD system operating in EI mode. Essential oil samples were diluted 1/10 (v/v) with *n*-hexane. Injector and MS transfer line temperatures were set at 250˚C. Innowax FSC column (60 m x 0.25 mm, 0.25 µm film thickness) and helium as carrier gas (1 ml/min) were used in both GC/MS analyses. Splitless injection was employed. Oven temperature was programmed to 60˚C for 10 min. and raised to 220˚C at rate of 4˚C/min. Temperature kept constant at 220˚C for 10 min. and then raised to 240˚C at a rate of 1˚C/min. Mass spectra were recorded at 70 eV with the mass range *m/z* 35 to 425. Relative percentage amounts of the separated compounds were calculated from integration of the peaks in MS chromatograms. Identification of essential oil components were carried out by comparison of their relative retention indices (RRI) obtained by series of *n*-alkanes (C5 to C30) to the literature and with mass spectra comparison [11-30]. Mass spectra comparison was done by computer matching with commercial Wiley 8th Ed./NIST 05 Mass Spectra library, Adams Essential Oil Mass Spectral Library and Pallisade 600K Complete Mass Spectra Library. The analysis was carried out in triplicate and the results were given as the mean ± standard deviation

3. Results and Discussion

Essential oil composition and fatty acid profile of *Gypsophila tuberculosa* Hub.-Mor. and *Gypsophila eriocalyx* Boiss. were analyzed by GC-MS. Fourteen compounds were identified in the fatty acid of *G. tuberculosa* that represent 96.4 ± 1.4% (*n*=3) of the fatty acid. The extract consisted of nine saturated fatty acids (33.2 ± 0.6%) and five unsaturated fatty acids (63.2 ± 0.8%). The major components of the fatty acid were (*Z*)-9-octadecenoic acid methyl ester (18:1) 42.0 ± 0.4%, (*Z,Z*)-9,12-octadecadienoic acid methyl ester (18:2) 19.6 ± 0.3% and hexadecanoic acid methyl ester (16:0) 17.7 ± 0.4% (*n*=3). Four compounds were identified in the fatty acid of *G. eriocalyx* that represent 71.8 ± 0.9% (*n*=3) of the fatty acid. The extract consisted of one saturated fatty acid (25.2 ± 0.5%) and two unsaturated fatty acids (46.7 ± 0.4%). The components of fatty acid were (*Z*)-9-octadecenoic acid methyl ester (18:1) 36.0 ± 0.2%, hexadecanoic acid methyl ester (16:0) 25.2 ± 0.5% and (*Z,Z*)-9,12-octadecadienoic acid methyl ester (18:2) 10.5 ± 0.6 (*n*=3). The fatty acid composition of *Gypsophila tuberculosa* and *Gypsophila eriocalyx* are represented in Table 1.

The essential oils of *Gypsophila tuberculosa* Hub.-Mor. afforded very low oils yields (0.03% (v/w) yield). Forty-one compounds were identified in the essential oil of *G. tuberculosa* that represent 81.4 ± 0.5% (*n*=3) of the oil. The major components of the oil were hexadecanoic acid (25.3 ± 0.6%), hentriacontane (13.00 ± 0.06%), dodecanoic acid (7.55 ± 0.2%), tetradecanoic acid (6.53 ± 0.1%) and pentacosane (3.06 ± 0.07%).

Sixty-one compounds were identified in the essential oil of *G. eriocalyx* that represent 70.32 ± 1.53% (*n*=3) of the oil. The major components of the oil were octacosane (6.83 ± 0.2%), eicosanal (6.19 ± 0.23%), triacontane (6.03 ± 0.16%),

heneicosane (5.78 ± 0.2%), hexadecanoic acid (4.64 ± 0.14%), tricosane (4.50 ± 0.14%), hexahydrofarnesyl acetone (4.44 ± 0.2%), heptacosane (3.40 ± 0.12%), phytol (2.59 ± 0.07%) and pentacosane (2.32 ± 0.08%). The essential oil composition of *Gypsophila tuberculosa* and *Gypsophila eriocalyx* are given in Table 2.

When we compared the results of the essential oil analysis of *G. tuberculosa* and *G. eriocalyx*, some differences were observed in their quantiative and qualitative compositions. Hexadecanoic acid, hentriacontane, dodecanoic acid, tetradecanoic acid, diisobutyl pthalate and pentacosane were detected in higher quantity in *G. tuberculosa*, while octacosane, eicosanal, triacontane, heneicosane, hexadecanoic acid, tricosane, hexahydrofarnesyl acetone, heptacosane, phytol and pentacosane prevailed in *G. eriocalyx*. Octacosane, eicosanal and triacontane were not detected in *G. tuberculosa*. Dodecanoic acid, tetradecanoic acid and hentriacontane contained at very low amounts in *G. eriocalyx*. Heneicosane and tricosane contained at very low amounts in *G. tuberculosa*. Hexadecanoic acid contained at 4.64% levels in *G. eriocalyx* and in a nearly six amount in *G. tuberculosa*. Also pentacosane, heptacosane, hexahydrofarnesyl acetone and phytol were comparable.

Previously, essential oils with high content of germacrene-D, *p*-cymene, bicyclogermacrene, γ-dodecadienolactone, terpinolene, *cis*-β-ocimene and *trans*-β-ocimene were reported for *Gypsophila bicolor* from Iran [2] however these compounds were not detected in the oil of *Gypsophila tuberculosa* and *Gypsophila eriocalyx*. *G. tuberculosa* and *G. eriocalyx* showed very different chemical behaviour from *G. bicolor*.

3.1 Tables and Figures

Table 1: The fatty acid composition of *Gypsophila tuberculosa* and *Gypsophila eriocalyx*

G.tuberculosa							*G. eriocalyx*					
RI[1]	**Compound**	**I[2]**	**II**	**III**	**Mean[3]**	**SD[4]**	**I**	**II**	**III**	**Mean**	**SD**	**Id. Met.[5]**
1099	Decanoic Acid ME (Capric acid)	0.2	0.2	0.2	0.2	0.00	-	-	-	-	-	RI, MS
1299	Dodecanoic Acid ME (Lauric acid)	1.3	1.3	1.3	1.3	0.00	-	-	-	-	-	RI, MS
1499	Tetradecanoic Acid ME (Myristic acid)	2.2	2.4	2.3	2.3	0.1	-	-	-	-	-	RI, MS
1599	Pentadecanoic Acid ME	0.2	0.3	0.3	0.3	0.06	-	-	-	-	-	RI, MS
1678	(*Z*)-9-Hexadecenoic Acid ME*(Palmitoleic acid)	0.5	0.5	0.5	0.5	0.00	-	-	-	-	-	RI, MS
1687	(*Z*)-11-Hexadecenoic Acid ME	0.2	0.2	0.2	0.2	0.00	-	-		-	-	RI, MS
1700	Hexadecanoic Acid ME (Palmitic acid)	17.3	18.0	17.8	17.7	0.4	25.7	24.7	25.2	25.2	0.5	RI, MS
1800	Heptadecanoic Acid ME (Margaric acid)	0.3	0.3	0.3	0.3	0.00	-	-	-	-	-	RI, MS
1867	(*Z,Z*)-9,12-Octadecadienoic Acid ME* (Linoleic acid)	19.2	19.8	19.8	19.6	0.3	11.1	10.0	10.5	10.5	0.6	RI, MS
1874	(*Z*)-9-Octadecenoic Acid ME* (Oleic acid)	41.5	42.3	42.1	42.0	0.4	35.9	36.2	36.0	36.0	0.2	RI, MS
1899	Octadecanoic Acid ME (Stearic acid)	3.1	3.2	3.5	3.3	0.2	-	-	-	-	-	RI, MS
1984	(Z)-11- Eicosenoic Acid ME (Gondoic acid)	0.9	0.9	1.0	0.9	0.06	-	-	-	-	-	RI, MS
1999	Eicosanoic Acid ME (Arachidic acid)	3.8	4.1	4.1	4.0	0.2	-	-	-	-	-	RI, MS
2299	Docosanoic Acid ME (Behenic acid)	4.1	3.7	3.8	3.9	0.2	-	-	-	-	-	RI, MS
	Total saturated acid	32.5	33.5	33.6	33.2	0.6	25.7	24.7	25.2	25.2	0.5	
	Total unsaturated acid	62.3	63.7	63.6	63.2	0.8	47.0	46.2	46.5	46.7	0.4	
	Total	94.8	97.2	97.2	96.4	1.4	72.7	70.9	71.7	71.8	0.9	
	Unsaturated/saturated	1.9	1.9	1.9	1.9	0.00	1.8	1.9	1.8	1.8	0.06	

In addition to the above data, phytol was detected as a considerable component as 28.2 percentage for *G. eriocalyx*.

*: Fatty acids with *cis* (Z) configuration, ME: Methyl ester,

1. RI: Retention indices, 2. The results of the analysis in each replicate,

3-4. The analysis were carried out in triplicate results are given as mean % area ± standard deviation (SD), calculated from MS data

5. Identification method: RI: identification based on the retention times (RI) of genuine compounds on the HP Innowax column and the literature data; MS: identification based on MS comparison with the database or the literature data.

Table 2: The essential oil composition of *G. tuberculosa* and *G. Eriocalyx*

G. tuberculosa									*G. eriocalyx*					
No	**RRI[1]**	**RRI Lit.[2]**	**Compound**	**I[3]**	**II**	**III**	**Mean[4]**	**SD[5]**	**I**	**II**	**III**	**Mean**	**SD**	**Id. Met.[6]**
1	1256	1244	2-pentyl furan	-	-	-	-	-	0.09	0.08	0.08	0.08	0.006	RI, MS
2	1300	1300	Tridecane	-	-	-	-	-	0.09	0.09	0.09	0.09	0.00	RI, MS, Ac
3	1398	1399	Nonanal	0.32	0.33	0.34	0.33	0.01	0.33	0.31	0.31	0.32	0.01	RI, MS
4	1400	1400	Tetradecane	0.25	0.26	0.26	0.26	0.006	0.36	0.34	0.34	0.35	0.01	RI, MS, Ac
5	1501	1500	Pentadecane	0.26	0.26	0.26	0.26	0.00	0.1	0.1	0.1	0.1	0.00	RI, MS, Ac
6	1504	1506	Decanal	0.82	1.13	1.2	1.05	0.2	2.00	1.88	1.48	1.79	0.3	RI, MS
7	1509	1516	Theaspirane A	-	-	-	-	-	0.04	0.03	0.04	0.04	0.006	RI, MS
8	1536	1541	Benzaldehyde	-	-	-	-	-	0.07	0.07	0.07	0.07	0.00	RI, MS
9	1543	1549	1-tetradecene	-	-	-	-	-	0.08	0.07	0.07	0.07	0.006	RI, MS
10	1549	1553	Theaspirane B	-	-	-	-	-	0.19	0.17	0.17	0.18	0.01	RI, MS
11	1549	1553	β-Linalool	0.33	0.34	0.35	0.34	0.01	-	-	-	-	-	RI, MS
12	1580	1562	Longifolone	-	-	-	-	-	0.09	0.09	0.08	0.09	0.006	RI, MS
13	1601	1600	Hexadecane	0.33	0.34	0.36	0.34	0.02	0.45	0.45	0.44	0.45	0.006	RI, MS, Ac
14	1603	1604	2-undecanone	-	-	-	-	-	0.06	0.05	0.06	0.06	0.006	RI, MS
15	1609	1612	β-caryophyllene	-	-	-	-	-	0.13	0.12	0.13	0.13	0.006	RI, MS
16	1612	1613	β-cedrene	-	-	-	-	-	0.13	0.12	0.13	0.13	0.006	RI, MS
17	1633	1638	β-cyclocitral	-	-	-	-	-	0.05	0.05	0.08	0.06	0.02	RI, MS
18	1635	1644	Thujopsene	-	-	-	-	-	0.1	0.1	0.1	0.1	0.00	RI, MS

19	1653	1655	(*E*)-2-Decanal	-	-	-	-	-	0.46	0.43	0.45	0.45	0.02	RI, MS
20	1672	1671	(*E*)-β-Farnesene	-	-	-	-	-	0.15	0.15	0.1	0.13	0.03	RI, MS
21	1683	1687	α-Humulene	-	-	-	-	-	0.06	0.07	0.08	0.07	0.01	RI, MS
22	1701	1700	Heptadecane	0.31	0.33	0.34	0.33	0.02	0.38	0.38	0.40	0.39	0.01	RI, MS, Ac
23	1717	1722	Dodecanal	0.23	0.30	0.30	0.28	0.04	0.66	0.66	0.68	0.67	0.01	RI, MS
24	1735	1742	β-Selinene	0.22	0.24	0.24	0.23	0.01	-	-	-	-	-	RI, MS
25	1763	1766	Decanol	-	-	-	-	-	0.23	0.23	0.23	0.23	0.00	RI, MS
26	1775	1779	(*E*,*Z*)-2,4-Decadienal	0.12	0.13	0.13	0.13	0.006	0.1	0.11	0.12	0.11	0.01	RI, MS
27	1785	1786	Ar-curcumene	-	-	-	-	-	0.03	0.03	0.03	0.03	0.00	RI, MS
28	1801	1800	Octadecane	0.28	0.28	0.30	0.29	0.01	0.5	0.51	0.52	0.51	0.01	RI, MS, Ac
29	1823	1827	(*E*,*E*)-2,4-Decadienal	0.54	0.55	0.58	0.56	0.02	0.12	0.13	0.13	0.13	0.006	RI, MS
30	1824	1830	Tridecanal	-	-	-	-	-	0.5	0.51	0.51	0.51	0.006	RI, MS
31	1835	1838	(*E*)-β-Damascenone	0.18	0.18	0.18	0.18	0.00	-	-	-	-	-	RI, MS
32	1863	1868	(*E*)-Geranyl acetone	1.14	1.16	1.2	1.17	0.03	0.6	0.6	0.6	0.6	0.00	RI, MS
33	1901	1900	Nonadecane	0.78	0.70	0.72	0.73	0.04	1.3	1.3	1.3	1.3	0.00	RI, MS, Ac
34	1932	1933	Tetradecanal	-	-	-	-	-	0.96	0.97	0.96	0.96	0.006	RI, MS
35	1953	1958	(*E*)-β-Ionone	0.51	0.52	0.54	0.52	0.02	0.71	0.74	0.75	0.73	0.02	RI, MS
36	1969	1973	1-Dodecanol	0.86	0.88	0.91	0.88	0.03	-	-	-	-	-	RI, MS
37	2001	2000	Eicosane	0.71	0.74	0.76	0.74	0.03	1.1	1.14	1.16	1.13	0.03	RI, MS, Ac
38	2029	2036	2-pentadecanone	0.39	0.41	0.42	0.41	0.02	-	-	-	-	-	RI, MS
39	2102	2100	Heneicosane	0.53	0.56	0.56	0.55	0.02	5.97	5.68	5.68	5.78	0.2	RI, MS, Ac
40	2133	2131	Hexahydro farnesyl acetone	1.73	1.96	2.00	1.9	0.1	4.64	4.32	4.37	4.44	0.2	RI, MS
41	2146	2135	Hexadecanal	-	-	-	-	-	1.01	1.01	1.02	1.01	0.006	RI, MS
42	2175	2179	Tetradecanol	-	-	-	-	-	0.5	0.77	0.76	0.68	0.2	RI, MS
43	2190	2198	1-Docosene	2.21	2.21	2.21	2.21	0.00	-	-	-	-	-	RI, MS
44	2202	2200	Docosane	0.52	0.63	0.64	0.6	0.07	1.6	1.6	1.6	1.6	0.00	RI, MS, Ac
45	2240	2242	2-Heptadecanone	0.17	0.17	0.22	0.19	0.03	0.11	0.13	0.13	0.12	0.01	RI, MS
46	2277	2282	Decanoic acid	1.57	1.46	1.65	1.56	0.1	-	-	-	-	-	RI, MS
47	2303	2300	Tricosane	0.8	0.8	0.83	0.81	0.02	4.67	4.42	4.42	4.50	0.14	RI, MS, Ac
48	2338	2345	Galaxolide I	-	-	-	-	-	0.12	0.13	0.14	0.13	0.01	RI, MS
49	2345	2353	Galaxolide II	-	-	-	-	-	0.08	0.09	0.09	0.09	0.006	RI, MS
50	2357	2353	Octadecanal	-	-	-	-	-	1.77	1.71	1.71	1.71	0.00	RI, MS
51	2383	2381	Farnesyl acetone C	1.52	1.54	1.44	1.5	0.05	0.8	0.8	0.8	0.8	0.00	RI, MS
52	2381	2384	1-Hexadecanol	-	-	-	-	-	0.44	0.4	0.4	0.4	0.02	RI, MS
53	2403	2400	Tetracosane	0.64	0.64	0.61	0.63	0.02	0.5	0.5	0.5	0.5	0.00	RI, MS, Ac
54	2489	2503	Dodecanoic acid	7.72	7.66	7.28	7.55	0.2	0.17	0.16	0.17	0.17	0.006	RI, MS
55	2505	2500	Pentacosane	3.1	3.1	2.98	3.06	0.07	2.41	2.28	2.27	2.32	0.08	RI, MS, Ac
56	2570	2582	Eicosanal	-	-	-	-	-	6.45	6.07	6.04	6.19	0.23	RI, MS
57	2589	2607	1-Octadecanol	0.89	0.9	0.84	0.88	0.03	0.7	0.66	0.52	0.63	0.09	RI, MS
58	2594	2617	Tridecanoic acid	0.38	0.39	0.35	0.37	0.02	-	-	-	-	-	RI, MS
59	2604	2600	Hexacosane	0.59	0.6	0.56	0.58	0.02	0.33	0.32	0.32	0.32	0.006	RI, MS, Ac
60	2616	2622	Phytol	1.12	1.11	1.07	1.1	0.03	2.67	2.55	2.55	2.59	0.07	RI, MS
61	2702	2670	Tetradecanoic acid	6.63	6.6	6.37	6.53	0.1	0.26	0.26	0.26	0.26	0.00	RI, MS
62	2705	2700	Heptacosane	1.89	1.86	2.17	1.97	0.2	3.54	3.34	3.33	3.40	0.12	RI, MS, Ac
63	2801	2800	Octacosane	-	-	-	-	-	7.05	6.72	6.72	6.83	0.2	RI, MS, Ac
64	2806	2822	Pentadecanoic acid	1.69	1.75	1.64	1.69	0.06	-	-	-	-	-	RI, MS
65	2841	2857	Gamma palmitolactone	0.42	0.42	0.39	0.41	0.02	0.29	0.23	0.23	0.25	0.03	RI, MS
66	2910	2900	Nonacosane	-	-	-	-		1.68	1.62	1.65	1.65	0.03	RI, MS, Ac
67	2916	2931	Hexadecanoic acid	25.7	25.48	24.65	25.3	0.6	4.8	4.56	4.55	4.64	0.14	RI, MS
68	3007	3000	Triacontane	-	-	-	-	-	6.21	5.98	5.91	6.03	0.16	RI, MS, Ac
69	3097	3100	Hentriacontane	13.04	12.94	13.03	13.00	0.06	1.07	1.27	1.27	1.20	0.12	RI, MS, Ac
			Total	81.47	81.86	80.88	81.4	0.5	72.06	69.7	69.2	70.32	1.53	

In addition to the above data, diisobutyl phthalate is a common plasticizer contaminant and it was detected as a considerable component as 4.23 and 1.42 percentage for *G. tuberculosa* and *G. eriocalyx*, respectively.

[1]RRI: Relative retention time indices calculated against n-alkanes (C5-C30).

[2]RRI Lit.: Relative retention time given in the literature for the compound in similar columns and analysis conditions.

[3]The results of the analysis in each replicate.

[4,5]The analysis were carried out in triplicate results are given as mean % area ± standard deviation (SD), calculated from MS data.

[6]Identification method: RI: identification based on the relative retention times (RRI) of genuine compounds on the HP Innowax column and the literature data; MS: identification based on MS comparison with the database or the literature data, Ac: Identification is done according to RRI and MS values of the authentic compounds

4. Conclusions

The essential oil composition and fatty acid profile of *G. eriocalyx* and *G. tuberculosa* are investigated for the first time. The major components of the fatty acid of both species were oleic acid, palmitic acid and linoleic acid. The unsaturated fatty acids content of both species were higher than their saturated fatty acids content. The essential oils of *G. eriocalyx* and *G. tuberculosa* were dominated by fatty acid derivatives and *n*-alkanes. Hexadecanoic acid is found as a major component in essential oil of *G. tuberculosa*. People should be worried to use of *G. tuberculosa* essential oil as the high content of hexadecanoic acid might cause serious cardiac problems.

5. Acknowledgments
We are indebted to YTU BAP 2015-01-07-KAP05 and TUBITAK (Project no. TBAG-111T820) for the financial support.

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