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Evaluation of volatile oil components of Salvia multicaulis (Vahl) plant growing in Malatya-Akçadağ region

Damla Sönmez [a], Ülkü Yılmaz [b*], Şanlı Kabaktepe [c]

[a] Malatya Turgut Ozal University, Department of Biology, Graduate School of Natural and Applied Sciences, Malatya Türkiye – 44900
[b] Malatya Turgut Ozal University, Faculty of Engineering and Natural Sciences, Department of Engineering Basic Sciences, Malatya Türkiye – 44900
[c] Malatya Turgut Ozal University, Battalgazi Vocational School, Malatya Türkiye – 44210

*Corresponding author

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ABSTRACT

This study aimed to determine the chemical content of the *Salvia multicaulis* Vahl plant collected in two different locations (38°27'07.9"N 38°01'56.6"E; 38°29'53.0"N 37°55'55.0"E) in Akçadağ district of Malatya province. The essential oils of the above-ground parts of plants were prepared with Clevenger apparatus. The plant was collected in May, June, and July in two different locations. According to analysis of GC-MS the major components were identified as eucalyptol (13.88, 18.39%; 14.89, 21.33%; 19.57, 23.29%), α-pinene (11.60, 10.02%; 13.72, 11.00%; 11.64, 11.69%), and camphor (10.87, 7.43%; 16.02, 6.18%; 16.41, 4.70%).

Keywords: *Salvia multicaulis*, hydrodistillation, essential oil, chemical composition.

1. Introduction

Salvia L. belongs to the Lamiaceae family and is a remarkable plant genus that has spread naturally to large areas worldwide [1,2]. It has approximately a hundred different species in Türkiye. *Salvia* species have been used in the treatment of many diseases since ancient times. They are also used as local tea and spices. This plant show anti-inflammatory, antiviral and cytotoxic properties due to their natural chemical content, especially their rich terpene, terpenoid and flavonoid content [3-5]. *Salvia multicaulis* is a perennial plant that grows in South Asia and Turkey. It is used in traditional medicine, cosmetics, perfumes, and spices [6-8]. According to literature data, the essential oils and extracts of the plant derived from Iran, Leobnan, and Türkiye show antibacterial, antifungal, anticholinesterase, and antioxidant activities [9-13]. It has also been noted that the plant can be used as a natural pesticide [14].

This study aimed to investigate the chemical composition of *Salvia multicaulis* Vahl essential oils growing in the Akçadağ district of Malatya province.

2. Experimental

2.1 Plant Material

The over-ground parts of *Salvia multicaulis* were collected in two different locations in Malatya; Yukarı Örükçü (Y: 38°27'07.9"N 38°01'56.6"E) and west of Ancar (Derinboğaz) (D: 38°29'53.0"N 37°55'55.0"E) in 2023 May, June, and July months. After identifying the plant, it was kept in Malatya Turgut Özal University Herbarium with MTU 1318 herbarium number. The plants were dried without sunshine. The chemical compositions were determined by GC-MS analysis.

2.2. Preparation of volatile oils

Essential oils were obtained from 100 gram ground-dry plant pieces hydrodistillation for 6 h using Clevenger-type glass apparatus. Oil portions were dried over sodium sulfate and stored at +4 °C. Nearly 1-1,5 mL of volatile oil was gained for every plant part.

2.3. GC-MS analysis

The chemical composition of essential oil analysis for 6 plant parts was performed using a 19091N-136 HP-INNOWAX (60mx0.25x0.25) column by the Agilent Technologies 6890N Network GC System and 5973 Inert Mass Selective Detector device. Device parameters during the essential oil analysis; carrier gas: helium, column flow rate: 0.9 ml/min, pressure: 41.8 kPa, injection temperature: 250 °C, and ion source temperature: 200 °C. The column temperature was initially set at 40 °C for 2 minutes, then increased to 260°C at a rate of 4°C/min, and waited 5 minutes under these conditions. The compounds were identified by comparing them with the Wiley and Nist GC/MS Library (W10N14) in the mass spectrometer at İnönü University.

* Corresponding author. e-mail address: ulku.yilmaz@ozal.edu.tr
ORCID : 0000-0002-2806-4781

2.4. ATR-FTIR analysis

Infrared spectra were recorded with an ATR unit in the 4000-650 cm^{-1} range on a Perkin-Elmer Spectrum One FT-IR spectrometer at İnönü University.

3. Results and Discussion

The chemical components determined as a result of the GC-MS analysis of the essential oils obtained from the above-ground parts of *S. multicaulis* collected from two different settlements in May, June, and July were given in three different tables (Tables 1, 2, and 3). In addition, the chromatograms of GC-MS analysis were added below (Figure 1-6).

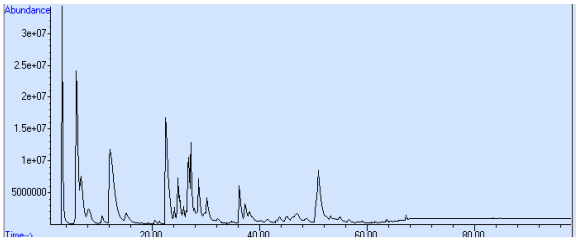

Figure 1. GC chromatogram of *Salvia multicaulis* volatile oils from Y location collected in May 2023

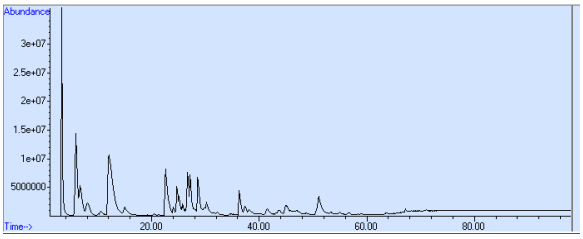

Figure 2. GC chromatogram of *Salvia multicaulis* volatile oils from D location collected in May 2023

Table 1. Chemical composition of *Salvia multicaulis* volatile oils collected in May 2023

Entry	RT(min)	Compounds	%(Y)	%(D)
1	5,870	α-Pinene	11.60	10.02
2	6,706	Camphene	5.44	5.37
3	8,039	β-Pinene	2.26	3.19
4	10,093	δ-3-Carene	-	0.18
5	10,562	Myrcene	0.66	0.80
6	12,016	Eucalyptol	13.88	18.39
7	14,957	*p*-Cymene	1.63	2.03
8	20,421	1-Octen-3-ol	0.24	0.19
9	21,285	Photonerol A	-	0.09
10	21,388	Linalyl oxide	0.12	-
11	22,544	Camphor	10.87	7.43
12	24,032	Linalyl acetate	0.80	0.79
13	24,707	Bornyl acetate	3.89	4.26
14	25,611	α-Bergamotene	0.32	0.36
15	25,794	Myrtenal	0.79	0.85
16	26,658	Isoborneol	4.48	4.71
17	27,167	Myrtenyl acetate	6.08	6.00
18	27,866	Dehydroaromadendrene	0.87	-
19	28,558	Myrtenol	3.97	4.88
20	29,817	Eremophilene	-	0.79
21	30,194	Curcumene	3.38	2.19
22	32,191	Calamenene	0.51	0.51
23	34,560	α-Calacoren	-	0.08
24	34,846	(Z)-Jasmone	0.12	0.09
25	36,254	Methyl eugenol	4.49	4.72
26	37,335	Caryophyllene oxide	1.66	1.20
27	38,131	(E)-Nerolidol	1.76	0.65
28	41,495	Ledol	0.55	1.08
29	43,097	Eugenol	0.14	0.09
30	43,658	Spathulenol	0.75	0.86
31	44,951	Jatamansone	-	2.05
32	45,844	Patchouli alcohol	0.85	0.63
33	46,908	Valencene	2.34	1.19
34	51,045	α-Eudesmol	10.25	7.20
35	53,168	α-Caryophylladienol	0.53	-
36	53,723	α-Caryophyllene	0.31	-
37	54,135	Aromadendren	0.25	-
38	56,596	Santalol	0.39	-
39	56,624	Isoaromadendrene epoxide	-	0.28
40	58,324	Alloaromadendrene	0.12	-
41	58,976	α-Selinene	0.13	0.15
		Total	**96.42**	**94.43**

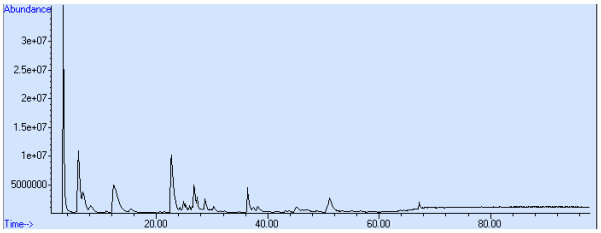

Figure 3. GC chromatogram of *Salvia multicaulis* volatile oils from Y location collected in June 2023

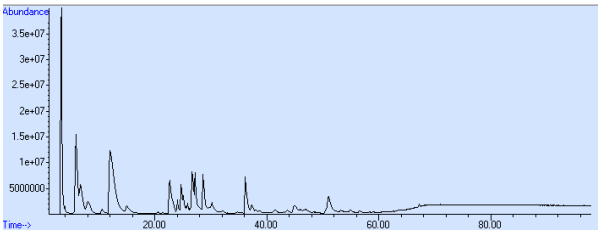

Figure 4. GC chromatogram of *Salvia multicaulis* volatile oils from D location collected in June 2023

The oil components that collected in May from two different locations (Y, and D) were shown in Table 1. 41 compounds in essential oil detected. The main compounds of the essential oil were identified as α-pinene (11.60, 10.02%), eucalyptol (13.88, 18.39%), camphor (10.88, 7.43%), α-eudesmol (10.25, 7.20%).

The compounds in Table 2 belong to June. The main compounds of the essential oil were observed as α-pinene (13.72, 11.02%), camphene (6.93, 6.11%), eucalyptol (14.89, 21.33%), camphor (16.02, 6.18%).

The latest table (Table 3) contains the compound composition of plant oil in July. According to the last table, the main components are α-pinene (11.64, 11.69%), camphene (8.27, 7.21%), eucalyptol (19.57, 23.93%), camphor (16.41, 4.70%), isoborneol (5.12, 5.05%).

The literature shows that although the major compounds that constitute the chemical composition of the *Salvia multicaulis* plant species are similar in different geographies where it grows, the percentages vary. However, it can also be seen that the minor components in the composition can be different in the reports. For example, the major component ratios of the *Salvia multicaulis* species collected in Diyarbakır in 2015 and investigated for chemical composition were recorded as *α*-pinene 8.32%, camphene 4.08%, camphor 14.92%, eucalyptol 33.05% and caryophyllene 16.25% [3]. The major compounds in the chemical

composition of the same plant collected from Sivas in 2001 were recorded as *α*-pinene 21.90%, *β*-Pinene 4.70%, camphene 7.80%, camphor 11.00%, eucalyptol 20.10%, borneol 7.30 and caryophyllene 4.20% [10]. Another article noted that the major chemical components of the plant limonene 10.25%, eucalyptol 50.96%, camphor 5.16%, and caryophyllene oxide 9.85% from Siirt province [15].

Table 2. Chemical composition of *Salvia multicaulis* volatile oils collected in June 2023

Entry	RT(min)	Compound	%(Y)	%(D)
1	5,870	α-Pinene	13.72	11.00
2	6,706	Camphene	6.93	6.11
3	8,039	β-Pinene	3.28	3.42
4	10,562	Myrcene	0.54	0.80
5	12,016	Eucalyptol	14.89	21.33
6	14,957	*p*-Cymene	1.78	2.12
7	20,421	1-Octen-3-ol	0.24	0.24
8	21,285	Photonerol A	-	0.18
9	21,411	Thujone	0.21	-
10	22,544	Camphor	16.02	6.18
11	24,032	Linalyl acetate	0.96	1.37
12	24,707	Bornyl acetate	1.97	2.78
13	25,056	Isobornyl acetate	-	1.83
14	25,233	γ-Terpinen	1.32	-
15	25,611	α-Bergamotene	-	0.35
16	25,794	Myrtenal	1.35	0.88
17	26,218	α-Farnesene	-	0.40
18	26,401	2,4(10)-Thujadien	0.77	-
19	26,658	Isoborneol	5.17	5.30
20	27,167	Myrtenyl acetate	2.68	5.50
21	28,558	Myrtenol	3.84	5.40
22	29,783	β- Acoradiene	-	0.96
23	30,194	Curcumene	1.76	2.08
24	32,191	Calamenene	0.58	0.49
25	34,560	α-Calacoren	0.08	0.09
26	34,846	(Z)-Jasmone	0.07	0.09
27	35,178	Longifolen	-	0.10
28	36,254	Methyl eugenol	4.78	4.66
29	37,335	Caryophyllene oxide	1.30	1.40
30	38,131	(E)-Nerolidol	2.36	0.49
31	41,495	Ledol	-	0.83
32	41,621	(+)-Eremophilene	0.45	-
33	43,097	Eugenol	0.26	0.11
34	43,658	Spathulenol	0.48	0.66
35	44,951	Jatamansone	1.83	2.03
36	46,908	Valencene	1.30	1.21
37	48,882	(+)-Eremophilene	0.64	-
38	51,045	α-Eudesmol	6.00	4.43
39	53,168	α-Caryophylladienol	0.19	0.59
40	53,723	α-Caryophyllene	0.17	-
41	54,135	Aromadendren	0.35	0.17
42	54,936	Isoaromadendrene epoxide	-	0.54
43	56,596	Santalol	-	0.32
44	58,976	α-Selinene	-	0.11
		Total	**98.27**	**96.55**

Because the main components belong to the terpene and terpenoid classes, they have plenty of aliphatic C-H bonds. Therefore, strong peaks of C-H stretching were observed in the infrared spectra (Figure 7-12) around 2920 cm^{-1}. In addition, camphor, which is found in all oil compositions, is a terpene derivative ketone. Therefore, it carries a carbonyl group. The strong peak seen at approximately 1740 cm^{-1} in the IR spectra belongs to the C=O bond. Also, a C-O-C strong stretching band belonging to etheric bond of eucalyptol was observed at nearly 1235 cm^{-1}. Moreover, the broad peak around 3400 cm was observed in IR spectra due to a terpene alcohol isoborneol, found in all oil compositions. These values are compatible with the literature. For example, When the infrared spectra of plant-derived oils were analysed in the literature, it was recorded that the stretching bands of the C=O group were observed in the range of 1711-1746 cm, the sigma bonds C-O were observed in nearly 1238 cm, and the asymmetric and symmetric stretching bands derived from aliphatic C-H groups were observed in the range of 2800-3000 cm. [16]. In addition, the C=O groups carried by synthetic organic compounds also give strong stretching bands around 1700 cm, confirming the existence of this group [17].

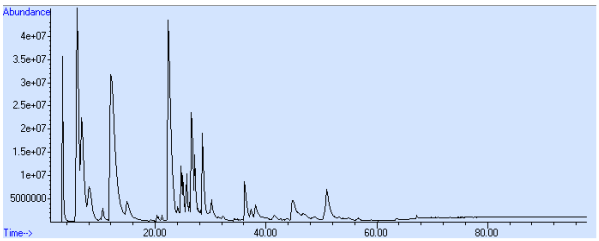

Figure 5. GC chromatogram of *Salvia multicaulis* volatile oils from Y location collected in July 2023

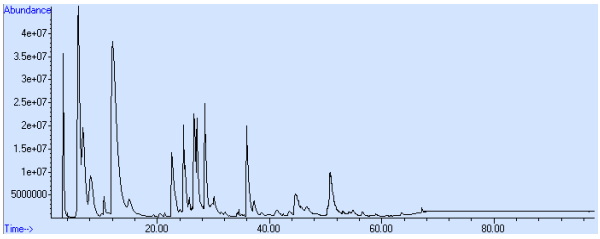

Figure 6. GC chromatogram of *Salvia multicaulis* volatile oils from D location collected in July 2023

Table 3. Chemical composition of *Salvia multicaulis* volatile oils collected in July 2023

Entry	RT(min)	Compound	%(Ö)	%(A)
1	5,567	Tricyclene	0.17	0.12
2	5,870	α-Pinene	11.64	11.69
3	6,706	Camphene	8.27	7.21
4	8,039	β-Pinene	3.64	4.30
5	10,093	δ-3-Carene	0.17	0.17
6	10,562	Myrcene	0.75	0.90
7	11,209	Sabinene	-	0.31
8	12,016	Eucalyptol	19.57	23.93
9	14,957	*p*-Cymene	2.52	2.58
10	19,208	1-Octen-3-yl acetate	0.09	0.14
11	20,421	1-Octen-3-ol	0.16	0.23
12	21,360	*p*-Menth-1en-9-ol	-	0.21
13	21,388	Linalyl oxide	0.17	-
14	22,544	Camphor	16.41	4.70
15	24,055	Champene	0.84	0.33
16	24,707	Bornyl acetate	1.80	4.86
17	24,999	Terpinene-4-ol (linalol)	1.58	-
18	25,794	Myrtenal	1.73	0.84
19	26,155	Verbenol	0.53	0.22
20	26,658	Isoborneol	5.12	5.05
21	27,167	Myrtenyl acetate	3.13	4.93
22	28,146	α-Farnesene	0.27	-
23	28,558	Myrtenol	4.35	5.54
24	30,194	Curcumene	1.92	2.23
25	31,367	Isopiperitenone	0.28	-
26	31,396	β-Cadinene	-	0.31
27	32,191	Calamenene	0.39	0.30
28	34,423	Piperitenone	0.08	-
29	34,846	(Z)-Jasmone	0.06	0.13

30	35,447	Perillyl alcohol	-	0.06
31	36,254	Methyl eugenol	2.05	5.00
32	37,335	Caryophyllene oxide	0.66	1.19
33	38,131	(E)-Nerolidol	1.35	-
34	39,287	α-Copaen-11-ol	0.27	-
35	39,979	Germacrene-B	-	0.28
36	41,495	γ-Elemene	-	0.64
37	41,524	Viridiflorol	0.49	-
38	42,634	Carvacrol	0.06	-
39	43,658	Spathulenol	-	0.43
40	44,951	Jatamansone	2.60	2.85
41	44,788	Longifolene	0.87	1.21
42	46,908	Valencene	0.40	-
43	51,045	α-Eudesmol	3.22	4.60
44	53,168	α-Caryophylladienol	0.07	0.40
45	54,135	Aromadendren	0.01	-
46	56,624	Isoaromadendrene epoxide	0.16	0.31
47	58,976	α-Selinene	0.06	0.30
48	60,790	Ascaridol	-	0.03
		Total	**97.91**	**97.97**

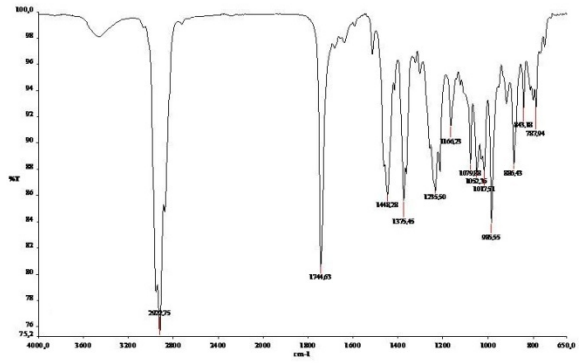

Figure 7. IR spectra of *Salvia multicaulis* volatile oils from Y location collected May 2023

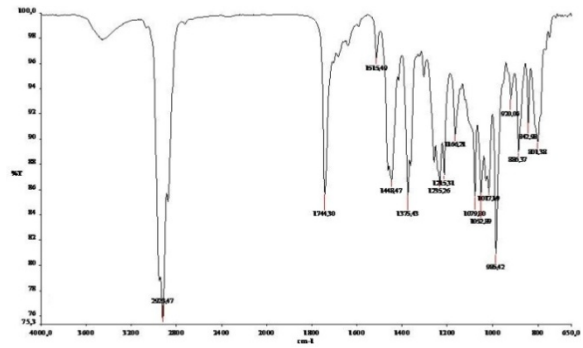

Figure 8. IR spectra of *Salvia multicaulis* volatile oils from D location collected May 2023

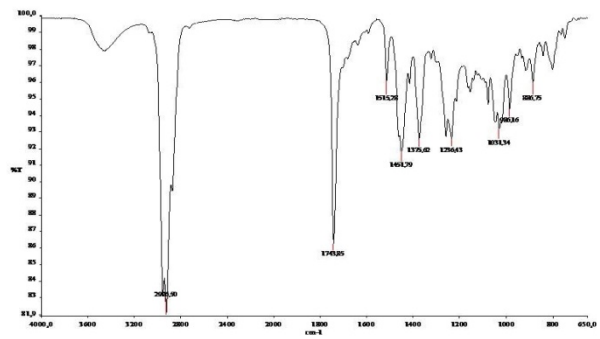

Figure 9. IR spectra of *Salvia multicaulis* volatile oils from Y location collected June 2023

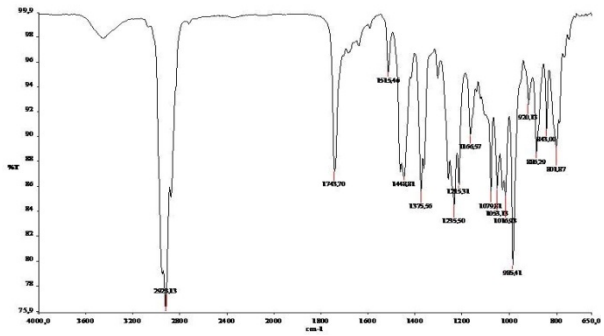

Figure 10. IR spectra of *Salvia multicaulis* volatile oils from D location collected June 2023

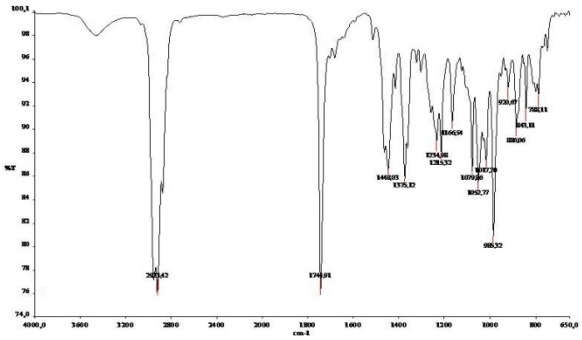

Figure 11. IR spectra of *Salvia multicaulis* volatile oils from Y location collected July 2023

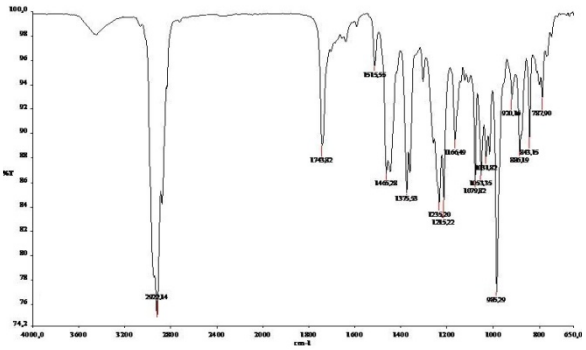

Figure 12. IR spectra of *Salvia multicaulis* volatile oils from D location collected July 2023

4. Conclusions

In brief, this study determined the chemical components of the essential oils of the *Salvia multicaulis* plant collected in two different locations in the Akçadağ district in May, June, and July. GC-MS analysis showed that the compound in the volatile oil composition was present in different percentages in different locations. For example, eucalyptol (the main component) was observed in location Y at 14.88% and location D at 21.33% in June.

Acknowledgements

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