

CHEMICAL COMPOSITION OF THE ESSENTIAL OIL OF *Salvia officinalis* FROM ALGERIA

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Sage (*Salvia* spp.), belonging to the Lamiaceae family, is an aromatic plant and includes about 900 species that grow in several regions all over the world [1]. This genus showed a very high variability of both morphological and cariological characters [2]. Since ancient times, this genus has been used in folk medicine and as a flavoring agent [3].

However, recently many studies have focused on the chemical composition [4], histochemical analysis [5], biological [6], antimicrobial [7], and antioxidant properties [8, 9] of this species.

Many papers on the secondary metabolites of *S. officinalis* can be found in the literature. Recent publications have shown some interesting features of its chemical composition, which is determined by their volatile [10–19] and nonvolatile compounds [20], and their applications in antibacterial [14], antifungal [10], and antioxidant activities [8].

In Algeria flora there are 18 species [21]; however, there are no studies on sage oil of these species growing in Algeria. Here we report our findings on the chemical composition of the essential oil of *S. officinalis* collected from Algiers city of Algeria.

Air-dried overground parts of *S. officinalis* were subjected to hydrodistillation using a Clevenger-type apparatus. A liquid yellow colored oil was obtained with a yield of 0.9% (w/w), based on dry weight of the plants. The oil was analyzed by GC and GC/MS techniques.

The chemical compositions of the essential oil of *S. officinalis* are given in Table 1 in the order of the retention indices, area percentage, and chemical group of the constituents. Forty-eight compounds were characterized in this oil, representing 90.5% of the total oil. The monoterpene fractions (72.2%) were most abundant in this oil and it was particularly rich in oxygenated derivatives (90.7% of this fraction); camphor (20.4%), α -thujone (19.6%), 1,8-cineole (12.3%), and β -thujone (8.0%) were found as the major compounds. In contrast, the sesquiterpene fraction (18.2%) represents a lower percentage in the oil, represented by viridiflorol (8.0%) as the major component. However, twenty components comprised between 0.1–8.0 %, while twenty-three compounds were present in trace amounts (Table 1). The chemical composition of our oil was found to be closely similar to that of the same species collected in Italy [9], Yugoslavia [11], Bulgaria [17], and Iran [19] which were characterized by its large amount of oxygenated fraction.

According to previous data of the chemical composition of the oils obtained by hydrodistillation, steam distillation, or ethanol extraction from aerial parts of *S. officinalis* from different countries [6, 8, 9, 11–19], α -thujone, α -humulene, and camphor have been reported to be the major compounds in these oils (Table 2).

Finally, our results are in agreement with samples of Italian [9], French, Romanian, Czech, Portuguese [13], and Turkish [17] sage oils characterized by camphor (22.0–32.9%) as the most important component, in contrast, samples from many countries are represented by α -thujone (21.5–31.5%) and α -humulene (14.7%) [7] as the major compounds in their oils. However, a comparison of the composition of the Iranian sage oils during the different developmental stages revealed that 1,8-cineole (15.3–22%), α -thujone (9.1–25.1%), and β -pinene (7.1–16.4%) were the principal compounds [19] (see Table 2).

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TABLE 1. Chemical Composition of Essential Oil of *Salvia officinalis*

RI ^a	Compound ^c	%	RI ^a	Compound ^c	%
846	(Z)-3-Hexen-1-ol	Tr. ^b	1285	Isobornyl acetate	0.6
862	(E)-2-Hexen-1-ol	Tr.	1292	Thymol	Tr.
924	Tricyclene	0.2	1299	Carvacrol	Tr.
931	α -Pinene	0.6	1311	<i>trans</i> -Pinocarvyl acetate	Tr.
946	Camphene	1.4	1325	<i>trans</i> -Carvyl acetate	Tr.
970	Sabinene	Tr.	1346	α -Cubebene	Tr.
974	β -Pinene	1.4	1357	Eugenol	Tr.
987	Myrcene	1.3	1378	α -Copaene	Tr.
1002	3-Octanal	Tr.	1387	β -Bourbonene	Tr.
1003	α -Phellandrene	0.3	1425	β -Caryophyllene	4.5
1022	<i>p</i> -Cymene	0.2	1460	α -Humulene	3.1
1033	1,8-Cineole	12.3	1465	<i>allo</i> -Aromadendrene	Tr.
1056	γ -Terpinene	0.7	1482	Germacrene D	Tr.
1087	Terpinolene	0.5	1490	Viridiflorene	Tr.
1112	α-Thujone	19.6	1505	γ -Cadinene	Tr.
1121	β -Thujone	8.0	1518	δ -Cadinene	0.2
1152	Camphor	20.4	1529	<i>trans</i> -Calamenene	0.2
1169	Borneol	2.5	1537	α -Cadinene	Tr.
1179	Terpinen-4-ol	0.8	1589	Caryophyllene oxide	1.0
1185	<i>p</i> -Cymen-8-ol	Tr.	1603	Viridiflorol	8.0
1191	α -Terpineol	0.4	1615	Humulene epoxide II	0.7
1197	Myrtenol	0.4		Monoterpene hydrocarbons	6.7
1202	<i>trans</i> -Piperitol	Tr.		Oxygenated Monoterpenes	65.5
1219	<i>trans</i> -Carveol	Tr.		Sesquiterpene hydrocarbons	8.4
1227	<i>cis</i> -Carveol	Tr.		Oxygenated Sesquiterpenes	9.8
1242	Neral	Tr.		Other	0.1
1254	<i>trans</i> -Sabinene hydrate acetate	Tr.		Total	90.5

^aRetention Indices on non-polar DB-5 column. ^bTrace (<0.1%). ^cmain compounds in bold letters.

Plant Materials. Overground parts of *S. officinalis* were collected at the flowering stage in Algiers (Algeria) in June 2004. Plants were identified and authenticated by a plant taxonomist. Voucher specimens were kept at the Herbarium of the National School of Agronomy, Algiers, Algeria with numbers HNIA/FA/N: P124. The essential oil of the plant was isolated from air-dried and pulverized overground parts by hydrodistillation for 3 h using Clevenger-type apparatus. The oil obtained was dried over anhydrous sodium sulfate. Essential oil yield was 0.9% (w/w).

GC and GC/MS Analysis. The chemical composition of the essential oil of *S. officinalis* was examined by GC on a Shimadzu chromatograph using a fused silica capillary column with stationary phase DB-5. The various parameters fixed for DB-5 column are: 30 m \times 0.32 mm, 0.25 μ m film thickness column; temp. prog., 60°C for 3 min, then 3°/min to 240°C for 5 min; detector and injector heaters 250°C; nitrogen was used as carrier gas at a flow rate 1 mL/min in the split mode 1:50, with injection volume 0.2 μ L. GC/MS-EI analysis were performed with a GC/MS CE-TRACE GC 2000 Thermo-Finnigan chromatograph linked to a TRACE MS mass spectrometer under the following conditions: column, DB-5 fused silica capillary column (30 m \times 0.32 mm, film thickness 0.25 μ m); carrier gas, helium at 1 mL/min; injector temperature, 250°C; column temperature was kept at 60°C for 3 min and programmed to 240°C at a rate of 3°C/min; The ionization energy was 70 eV and the source temperature was 200°C. Acquisition mass range, *m/z* 40–450.

TABLE 2. Main Compounds of *Salvia officinalis* Oils from Different Countries

Countries, reference	Principals Compound, %															Yield, %*	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Island, [6] ^a		45.5		8.3	15.9			8.4									1.0**
Italy, [8] ^a		23.00				26.85				6.65	5.80	11.82					-
Cuba, [9] ^a		12.95	13.46					14.74	10.89								1.2
Yugoslavia, [11] ^a	6.0	22.1		16.2				11.0									2.0
Georgia, [12] ^c		31.56		17.53				17.55									1.1
Romania, [13] ^a		21.85	11.71			11.25	9.15										-
Portugal, [13] ^a		22.82	10.92	15.71								8.93					0.12
France, [13] ^b		20.90		13.43	22.00											7.26	2.05
Hungary, [13] ^b				17.04	30.79			17.60		4.43							2.90
Czech Republic, [13] ^b		25.10		11.93	24.17		6.83										2.50
				11.69	31.79			20.57						6.80			2.20
Brazil, [14] ^a		24.8		14.8	10.9							11.1					-
Serbia, [15] ^b		24.8		14.8	10.9							11.1					-
Bulgaria, [16] ^a		21.5		16.2			11.2						7.6				1.1
Turkey, [17] ^a		29.4		12.5	11.7			17.4									1.4
Spain, [18] ^a		20.6			22.9			15.1				7.9					-
Iran, [19] ^a		9.1-25.2		15.3-22.3							3.5-11	7.1-16.4					0.2-0.9*

^aHydrodistillation; ^bSteam distillation; ^cEthanol extraction; *m/m; **v/m.

1 - β -Caryophyllene; 2 - α -Thujone; 3 - Viridiflorol; 4 - 1,8-Cineole; 5 - Camphor; 6 - Manool; 7 - α -Humulene; 8 - β -Thujone; 9 - Pinocarveol; 10 - Camphene; 11 - *p*-Cymene; 12 - Borneol; 13 - β -Pinene; 14 - Ledol; 15 - Umbellol.

Component Identification. In order to determine retention indices (RI), a series of *n*-alkane (C₅-C₂₈) mixture was analyzed under the same operating conditions on the DB-5 column. The retention indices were calculated according to the Van den Dool and Kratz formula [22]. Identification of components was made on the basis of their retentions indices and by computerized matching of the acquired mass spectra with those stored in the spectrometer database using the NIST mass spectral library and the literature [23].

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