

CHEMICAL COMPOSITION OF THE ESSENTIAL OILS FROM FLOWERS, STEMS, AND ROOTS OF *Salvia multicaulis* GROWING WILD IN IRAN

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The genus *Salvia* (Lamiaceae) grows in the temperate and warmer zones of the world. Fifty-eight species are found in Iran, among which 17 are endemic [1]. *Salvia multicaulis* is an evergreen shrub growing to 0.3m × 0.25 m, native to South-West Asia, particular Eastern, Central, and Southern Turkey. Some species of genus *Salvia* are used as medicinal, aromatic, and ornamental plants. *Salvia officinalis* (sage) is one of the most widespread species and is used as a spice, condiment, and medicine [2, 3]. The essential oils of some *Salvia* species have been formulated into different products such as bactericides or fungicides [4]. Recently, many investigations have been reported on the essential oils and biological activity of *Salvia* species [5–8].

In this work, hydrodistilled essential oils from crushed dry flowers, stems, and roots of *Salvia multicaulis* Vahl. (Lamiaceae) from Semnan province (Iran) were studied by GC and GC/MS [9]. The air-dried flowers, stems, and roots of the plant yielded 0.38, 0.29, and 0.18% (w/w) yellowish colored oil, respectively. The percentage composition of the flower, stem, and root oil of *S. multicaulis* is given in Table 1.

Twenty-one constituents (94.28%) were identified in flower oil: seven monoterpene hydrocarbons (33.73%), five oxygenated monoterpenes (47.79%), eight sesquiterpene hydrocarbons (12.54%), and one oxygenated sesquiterpene (0.22%). 1,8-Cineol was the most abundant constituent (25.27%), followed by α -pinene (18.32%), camphor (12.40%), camphene (8.45%), and bornyl acetate (7.89%).

Eight constituents (98.05%) were identified in stem oil: three monoterpene hydrocarbons (36.9%) and five oxygenated monoterpenes (61.15%). In this oil we could not find any trace of sesquiterpenes. It was characterized by a higher amount of 1,8-cineol (24.83%), camphor (24.20%), α -pinene (20.91%), and camphene (13.03%).

Nine compounds (95.37%) were identified in root oil: two monoterpene hydrocarbons (10.96%), four oxygenated monoterpenes (75.43%), two sesquiterpene hydrocarbons (5.56%), and one oxygenated sesquiterpene (3.66%). It was characterized by the presence of higher amounts of borneol (48.75%), followed by camphor (17.17%), 1,8-cineol (7.96%), and α -pinene (6.59%). In this oil oxygenated monoterpenes predominated over monoterpene hydrocarbons and sesquiterpenes.

According to the above-mentioned information, the flower and root oils were characterized by large amounts of monoterpenes (81.52 and 86.39%, respectively) while the constituents of stem oil were only monoterpenes (98.05%).

A comparison of the chemical composition of *Salvia multicaulis* with previous published reports reveals that bornyl acetate (18.1%), β -caryophyllene (16.5%), and α -pinene (15.6%) were the major constituents of the flowering shoots [10], while the main constituents of the oil from leaves and flowers [11] were α -pinene (26.0%), 1,8-cineol + limonene (20.0%), and camphor (19.0%); on the other hand, the main components of the oil from aerial parts [12] were α -copaene (8.0%), α -pinene (6.6%), myrtenol (5.7%), and sabinyl acetate (5.3%); other reports on the oil of flowering aerial parts [13] showed that the main components were camphor (11.0%), 1,8-cineol (10.7%), borneol (8.6%), and α -pinene (7.5%).

To the best of our knowledge, this is the first report on the essential oils of the stem and root of *Salvia multicaulis* Vahl.

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TABLE 1. Comparison between Percentage Composition of Flower, Stem and Root Oils of *Salvia multicaulis* Vahl.

Compound	Retention indices	Flowers oil	Stems oil	Roots oil
		%		
α -Thujene	931	0.37	-	-
α -Pinene	936	18.32	20.91	6.59
Camphene	953	8.45	13.03	4.13
Sabinene	976	0.30	-	-
β -Pinene	980	4.60	2.96	-
Myrcene	991	1.12	-	-
1,8-Cineol	1033	25.27	24.83	7.96
γ -Terpinene	1059	0.57	-	-
Camphor	1145	12.40	24.20	17.17
Borneol	1167	1.91	4.96	48.75
Terpinen-4-ol	1178	0.32	-	-
α -Terpineol	1191	-	1.34	-
Bornyl acetate	1286	7.89	5.82	1.55
α -Ylengene	1374	0.48	-	-
α -Copaene	1376	0.21	-	-
β -Caryophyllene	1418	5.80	-	-
Calarene	1428	0.56	-	4.37
α -Humulene	1452	3.47	-	1.19
α -Amorphene	1470	1.02	-	-
α -Muurolene	1499	0.37	-	-
δ -Cadinene	1524	0.63	-	-
Caryophyllene oxide	1581	0.22	-	-
β -Eudesmol	1650	-	-	3.66
Total percentage		94.28	98.05	95.37

The compounds have been sorted according to retention indices on an HP-5 MS capillary column.

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