Chemistry of Natural Compounds, Vol. 46, No. 5, 2010

CHEMICAL COMPOSITION OF THE ESSENTIAL OIL OF *Salvia grossheimii* FROM IRAN

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UDC 547.913

Fifty eight species of the genus *Salvia* (Lamiaceae) are found in Iran, 17 of which are endemic [1]. Due to the use of this genus or their essential oils in the food and drug industries [2], we are investigating the oils of *Salvia* spp. which grow wild or are cultivated in Iran. In this paper, we describe the analysis of the essential oil of *S. grossheimii* Sosn. which grows wild in many regions of Iran especially in Azarbayejan province. A literature search did not reveal any reference to previous work on the essential oil of this species.

The aerial parts of *Salvia grossheimii* were collected from Azarbayejan province-koh Mishodagh. Essential oil isolated by hydrodistillation from the aerial parts was obtained in yields of 0.4% (w/w).The essential oil yields of other species in Iran were: *S. nemorosa*, 0.12% [3], *S. reuterana*, 0.15% [3], *S. virgata*, 0.48% [4], *S. syriaca*, 0.3% [4], *S. atropatana*, 0.1% [5], *S. multicaulis*, 0.2% [6], *S. sahandica*, 0.46% [7], *S. spinosa* 0.1% [8], *S. limbata* 0.07% [9], and *S. mirzayanii*, 2.2% [10].

A total of thirty-four compounds were characterized representing about 99.4% of the total components detected in *S. grossheimii*. The compounds identified with their percentages are given in Table 1.

Based on the analysis of essential oil, the components were classified in three groups as follows: monoterpenes, sesquiterpenes, and esters. The oil was characterized by a high content of sesquiterpenes, which composed 88.8% of the oil. The main components were germacrene D (45.4%), β-caryophyllene (22.4%), and bicyclogermacrene (7.1%).

The identification of the compounds in the essential oil of different species of this genus in Iran shows that the major components of *S. nemorosa, S. virgata, S. atropatana, and S. multicaulis* is β-caryophyllene [3–6]. Germacrene B and germacrene D are the main components in *S. syriaca* [4], while (*E*)-β-ocimene, α-gurjunene, and germacrene D are the major constituents in *S. reuterana* [4]. (*E*)-β-ocimene, β-caryophyllene, and isopentyl isovalerate are the major constituents in *S. spinosa* [8], while germacrene D, linalyl acetate, and linalool are the main components in *S. limbata* [9].

Twelve monoterpenes were identified in the essential oil of *S. grossheimii,* with contents ranging from 0.04 to 3.5% in the oil analyzed. Besides the mono- and sesquiterpenes, one ester, bornyl acetate (0.1%), was identified in the oil too.

Plant Material and Isolation Procedure. Aerial parts of the plant (250 g) were collected during flowering in May 2006 from Azarbayejan province (Koh-Mishodagh) in Iran. A voucher specimen has been deposited in the Herbarium of the Research Institute of Forest and Rangelands (TARI). The essential oil was obtained by hydrodistillation of air-dried aerial parts in a clevenger-type apparatus for 3 h. The sample oil which was light yellow in color and was dried over anhydrous sodium sulfate and stored under nitrogen in a sealed vial until required.

Gas Chromatography-Mass Spectrometry. GC and GC-MS analyses were performed using a Shimadzu GC-9A gas chromatograph and Varian 3400 GC-MS system equipped with a DB-5 fused silica column based on techniques published before [8, 9].

Identification of Components. The components of the oil were identified by comparison of their mass spectra to with those of a computer library or with authentic compounds and confirmed by comparison of their retention indices, either those of authentic compounds or data published in the literature [11].

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 0009-3130/10/4605-0822

TABLE 1. Composition of the Essential Oil of *Salvia grossheimii*

Compound	RI	%	Compound	RI	%
α-Pinene*	942	3.5	β-Elemene	1394	0.3
Camphene	956	0.7	α-Gurjunene	1412	0.3
Sabinene*	980	0.5	β-Caryophyllene	1426	22.4
β-Pinene*	986	2.7	β-Copaene	1435	0.3
p-Cymene*	995	0.2	Aromadendrene	1439	0.7
Limonene*	1035	0.5	α-Guaiene	1447	0.3
1,8-cineole*	1038	1.9	α-Humulene	1462	3.5
Terpinolene*	1093	0.1	*allo*-Aromadendrene	1469	0.5
trans-Pinocarveol	1141	0.1	Germacrene D	1483	45.4
Borneol	1172	0.2	Bicyclogermacrene	1507	7.1
Terpinen-4-ol	1180	0.1	Germacrene A	1509	0.5
α-Terpineol*	1187	0.1	(*E,E*)-α-Farnesene	1514	0.9
Bornyl acetate	1292	0.1	δ-Cadinene	1526	0.9
α-Cubebene	1356	0.1	Spathulenol	1582	0.7
α-Copaene	1376	1.0	Globulol	1585	1.9
β-Bourbonene	1386	0.6	β-Eudesmol	1652	0.3
β-Cubebene	1392	0.5	α-Eudesmol	1656	0.5

Identification method: RI, MS, *RI, MS, CoI (Co-injection with an authentic sample).
RI: retention indices relative to C_6–C_{24} *n*-alkanes on the DB-5 column.

ACKNOWLEDGMENT

The authors would like to thank the Research Institute of Forests and Rangelands for financial support.

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