Volatile Oil Composition of the Aerial Parts of *Ajuga orientalis* L. from Iran[§]

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The volatile oil content and composition of the aerial parts of *Ajuga orientalis* L. (Lamiaceae) grown in northern parts of Iran have been analyzed by GC/MS. Thirty compounds were identified, representing 97.9% of the total oil. The main compounds were germacrene-D (24.2%), β-cubebene (18.3%), β-caryophyllene (16.9%) and α-cubebene (5.3%).

Key words: Ajuga orientalis, Volatile Oil, Germacrene-D

Introduction

One of the most important families in Iran is Lamiaceae that includes several medicinal, ornamental, aromatic and perfume plants (Amin, 1991; Jalili and Jamzad, 1999). *Ajuga*, commonly known as bugle or bugleweed, is one of the best-known genera within the Ajugoideae tribe of this family which is found in many parts of Iran and the world (Pedersen, 2000; Rechinger, 1982). There are about 40 known species belonging to this genus (Evans, 1989). The Iranian flora comprises 5 species of *Ajuga* and one of them is *Ajuga orientalis* L. (Rechinger, 1982).

Ajuga species are used in folk medicine of different parts of the world for the treatment of rheumatism, gout, asthma, diabetes, malaria, ulcers and diarrhea and have antibacterial, antitumor, antifeedant, and vulnerary properties (Chen *et al.*, 1996; Ben Jannet *et al.*, 2000; Zargari, 1990). There are some reports on the phytochemical analysis of species belonging to *Ajuga* found in the literature but only a very small number of these species have so far been studied chemically for their essential oils. Some scientific studies on *Ajuga* species showed the presence of many compounds belonging mainly to the groups of alkaloids, anthocyanins, tannins, withanolides, clerodane and neoclerodane diterpenoids, sterols, ionone, iridoid, phenethyl alcohol and phenylpropanoid glycosides (Akbay *et al.*, 2003; Baser *et al.*, 1999, 2001; Ben Jannet *et al.*, 2000; Chen *et al.*, 1996; Nawaz *et al.*, 2000; Shimomura *et al.*, 1987; Takasaki *et al.*, 1998; Terahara *et al.*, 2001). Nothing is known about the volatile oil content and composition of the title plant.

Methods and Materials

Plant material

Aerial parts of *A. orientalis* were collected during the flowering period from wild-growing plants around Mahmood Abad slopes in the north of Iran at an altitude of ca. 1900 m in June 2001. The plant identity was confirmed in Research Institute of Forests and Rangelands, Tehran, Iran.

Essential oil isolation

The aerial parts (100 g) of the plant were dried at room temperature, powdered and hydrodistilled for 3 h using a Clevenger-type apparatus (British Pharmacopoeia, 1998). The oil was dried over anhydrous sodium sulfate and stored at refrigerator.

Essential oil analysis

The oil was analyzed by GC/MS using a Hewlett Packard 6890 mass selective detector coupled with a Hewlett Packard 6890 gas chromatograph, equipped with a cross-linked 5% PH ME siloxane HP-5MS capillary column (30 m × 0.25 mm, film thickness 0.25 μm). Operating conditions were as follows: carrier gas, helium with a flow rate of 2 ml/min; column temperature, 60–275 °C at a rate of 4 °C/min; injector temperature, 280 °C; injected volume, 0.1 μl of the oil; split ratio, 1:50.

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The MS operating parameters were as follows: ionization potential, 70 eV; ion source temperature, 200 °C; resolution, 1000.

Identification of components in the oil was based on retention indices relative to *n*-alkanes and computer matching with the WILEY275.L library, as well as by comparison of the fragmentation patterns of the mass spectra with those reported in the literature (Adams, 1995; Ghannadi and Mehregan, 2003; Mclafferty and Stauffer, 1991; Sandra and Bicchi, 1987).

Results and Discussion

This is the first report on the content and composition of the volatile oil of *Ajuga orientalis* L. Aerial parts of *A. orientalis* yielded 0.1% (v/w) of a yellowish oil with an aromatic turpentiny aroma and taste. Thirty components were characterized, representing 97.9% of the total oil components detected. These are listed in Table I with their percentage share. The major constituents of the oil were germacrene-D (24.2%), β-cubebene (18.3%), β-caryophyllene (16.9%), α-cubebene (5.3%), β-selinene (4.5%), bicyclogermacrene (4.4%) and α-humulene (4.2%). Other components were present in amounts less than 4.0%. The oil was rich in hydrocarbon sesquiterpenes. Contrary to the earlier reports that pinenes were present as major compounds in the oil of *A. chamaepitys* subsp. *chia* var. *chia* and *A. bombycina* (Baser *et al.*, 1999, 2001), in the present study these compounds could not be found. The monoterpene portion of our volatile oil was only less than 1%. In accord with the results of these studies, germacrene-D, the most prominent component of our oil, has been found in high amounts in *A. bombycina* and *A. chamaepitys* subsp. *chia* var. *chia* and var. *ciliate* volatile oils. Germacrene-D has also been previously detected as one of the main oil components in other taxa of Lamiaceae family such as *Hyssopus*, *Teucrium*, *Acinus*, *Micromeria* and *Scutellaria* (Ghannadi and Mehregan, 2003; Kerrola *et al.*, 1994). Several applications of *Ajuga* species in folk medicine and recent activities of their compounds offer that *A. orientalis* volatile oil may have a potential to be of great use in next pharmacological and biological screening tests.

Table I. Composition of the volatile oil of *Ajuga orientalis* from Iran.

Compound	Percentage	Retention index
1-Octen-3-ol	0.1	976
Limonene	0.1	1026
cis-β-Ocimene	0.1	1034
trans-β-Ocimene	0.1	1044
Linalool	0.2	1100
Methyl salicylate	0.1	1192
Bicycloelemene	0.4	1336
α-Cubebene	5.3	1349
α-Copaene	3.7	1374
β-Burbunene	1.4	1383
β-Cubebene	18.3	1393
α-Gurjunene	0.5	1407
β-Caryophyllene	16.9	1418
β-Gurjunene	0.7	1428
cis-β-Farnesene	0.3	1441
α-Humulene	4.2	1452
trans-β-Farnesene	0.7	1457
Germacrene-D	24.2	1480
β-Selinene	4.5	1489
α-Amorphene	0.3	1491
Bicyclogermacrene	4.4	1496
cis-α-Bisabolene	0.6	1504
γ-Cadinene	3.9	1516
δ-Cadinene	1.7	1521
Cadina-1,4-diene	0.2	1528
Germacrene-D-4-ol	1.6	1572
Caryophyllene oxide	1.1	1578
epi-α-Cadinol	1.1	1634
Cubenol	0.4	1638
α-Muurolol	0.8	1646

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