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Natural Product Research: Formerly Natural Product Letters
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gnpl20

Chemical composition and antibacterial activity of the volatile oil from seeds of Artemisia annua L. from Iran

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Published online: 21 Feb 2012.

To cite this article: Zohreh Habibi , Shamimeh Ghanian , Sabrieh Ghasemi & Maryam Yousefi (2013): Chemical composition and antibacterial activity of the volatile oil from seeds of Artemisia annua L. from Iran, Natural Product Research: Formerly Natural Product Letters, 27:2, 198-200

To link to this article: http://dx.doi.org/10.1080/14786419.2012.662652

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Natural Product Research, 2013
Vol. 27, No. 2, 198–200, http://dx.doi.org/10.1080/14786419.2012.662652

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SHORT COMMUNICATION

Chemical composition and antibacterial activity of the volatile oil from seeds of *Artemisia annua* L. from Iran

Zohreh Habibi[a]*, Shamimeh Ghanian[a], Sabrieh Ghasemi[a] and Maryam Yousefi[b]

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(*Received 29 August 2011; final version received 9 November 2011*)

The composition of essential oil of the seeds of *Artemisia annua* L. was analysed by GC-MS. Overall, 16 volatile components were identified on the basis of their mass spectra characteristics and retention indices representing 95.5% of the total oil. *Trans*-3(10)-caren-4-ol (22.3%), artemisia ketone (18.6%), 1,8-cineole (14.9%), δ-selinene (13.0%) and α-pinene (8.2%) were the major compounds. Oxygenated monoterpenes were the main compounds with 51.6% followed by sesquiterpene hydrocarbons (13.3%), monoterpene hydrocarbons (9.9%) and other compounds (8.3%). The essential oil was highly active against *Escherichia coli* and *Enterococcus faecalis*.

Keywords: essential oil; *Artemisia annua*; seed; *trans*- 3(10)-caren-4-ol, artemisia ketone

1. Introduction

Artemisia is an annual, aromatic, antibacterial herb, native of Asia and with up to 500 species is one of the largest genera of the Asteraceae family. *Artemisia annua* L. (sweet wormwood) can be included among the medicinal aromatic herbs and grows as a wild herb in Europe and America (Leonova, 1978). There are approximately 34 native *Artemisia* spp. in Iran (Mozaffarian, 1996). Artemisia species have been reported to contain coumarins, flavones, steroids, phenolic compounds, purines, lipids, aliphatic compounds and terpene peroxides such as artemisia ketone, artemisinic alcohol, arteannuin B and myrcene hydroperoxide that some of them also have been identified in essential oils (Ahmad & Mishra, 1994; Bertea, Frejie, & van der Woude, 2005; Brown, Liang, & Sy, 2003).

There are a number of studies concerning the chemical composition of the *A. annua* essential oil obtained from the species growing in different regions of the world, but there is no analysis concerning the chemical composition of the seeds' oil. There is only one report about the isolation of 14 sesquiterpenes, three monoterpenes and one diterpene from the dichloromethane extract of *A. annua* seeds. The aim of this study is to find the chemical profile of the seeds' essential oil of *A. annua* growing wild in Iran.

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Table 1. Chemical composition of *A. annua* seeds oil.

No.	Compound	RI	Percentage
1	3,3-Diethyl pentane	732	4.83
2	A-Pinene	954	8.21
3	Camphene	969	1.42
4	5-Methyl-1,3,6-heptatriene	990	0.25
5	B-Pinene	997	0.21
6	1,9-Decadiyne	1010	2.49
8	1,8-Cineole	1033	14.93
7	*cis*-Ocimene	1051	0.1
9	Artemisia ketone	1075	18.66
10	*trans*-3(10)-Caren-4-ol	1169	22.33
11	Pinocarvone	1188	5.67
12	4,11-Oxacyclotetradecadiene	1400	0.49
13	*trans*-Caryophyllene	1430	0.24
14	Δ-Selinene	1510	13.05
15	Caryophyllene oxide	1593	2.4
16	6-Dodecanone	1855	0.25
Total			95.53

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2. Result and discussion

Sixteen compounds were identified in volatile from the seeds of *A. annua* comprising 95.5% of the total oil in 0.2% (w/w) yield. The oil was rich in *trans*-3(10)-caren-4-ol (22.3%), artemisia ketone (18.6%), 1,8-cineole (14.9%), δ-selinene (13.0%) and α-pinene (8.2%). Oxygenated monoterpenes were the main compounds with 51.6% followed by sesquiterpene hydrocarbons (13.3%), monoterpene hydrocarbons (9.9%) and other compounds such as alkanes and alkynes (8.3%) (Table 1).

As *A. annua* is one of the most important medical plants, many investigations have been carried out on the chemical compositions of its oil all over the world, specially there are some reports from the north of Iran. Camphor (48.00%), 1,8-cineole (9.39%), camphene (6.98%) and spathulenol (4.89%) were the major components of the essential oil obtained from the dried flowering aerial parts of *A. annua* (Gorgan province, north of Iran) (Verdian-rizi, Sadat-Ebrahimi, Hadjiakhoondi, Fazeli, & Pirali Hamedani, 2008). Camphor (16.30%), β-selinene (10.41%), artemisia ketone (8.79%), germacrene-D (7.14%), α-pinene (4.79%), 1,8-cineol (4.38%) and γ-selinene (4.09%) were found to be the major components among the compounds in the oil the of aerial parts *A. annua* (Ramian mountains, Golestan province, north of Iran) (Mohammadhosseini, Mazloomifar, Nekoei, Yazarloo, & Rahimi, 2011). Also, the chemical composition of the essential oil of *A. annua* (from Gorgan province, north of Iran) at different growth stages (pre-flowering, flowering and post-flowering) were investigated. Camphor (36.7–48.00%), 1,8-cineole (9.4–13.9%), camphene (1.7–6.9%), spathunelol (3.7–4.9%), α-pinene (2.5–3.5%) and artemisia ketone (2.7–5.5%) were the main compounds in all samples. Monoterpenes were the main group of compounds in pre-flowering (69.96%), flowering (72.44%) and post-flowering (70.96%) stages (Verdian-rizi, 2008). According to the chemical profiles, monoterpenes, specially camphor, were the main groups in all oils; but according to location, altitude and growing stage different compounds have been reported. It is noteworthy that *trans*-3(10)-caren-4-ol having the highest percentage of the total seed's oil has not been reported in any oils from the aerial parts of *A. annua* from

Table 2. Antimicrobial activity of the oil.

Microorganism	Inhibition zone diameter (mm)[a]				
	Essential oil	Gentamycin	Tetracycline	Ampicillin	Penicillin
Staphylococcus aureus	14	20	18	8	–
Bacillus subtilis	14	26	25	12	13
Enterococcus faecalis	19	18	16	7	–
Escherichia coli	20	22	22	27	20

Notes: (–), Inactive; (7–14), moderately active; (>14), highly active.
[a]Diameter of inhibition zones (mm) including diameter of sterile disk (6 mm).

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Iran, also camphor which was the dominant compound in all the mentioned oil was not detected in the seed's oil. 1,9-Decadiyne is a diacetylene derivative of the seed's oil (2.4%) and there are some reports about diacetylenes in other *Artemisia* species such as *A. scoparia* oil that was dominated by the diacetylenes 1-phenyl-2,4-pentadiyne (34.2%) and capillene (4.9%). Other major components were β-pinene (21.3%), methyl eugenol (5.5%), α-pinene (5.4%), myrcene (5.2%), limonene (5.0%) and (*E*)-β-ocimene (3.8%) (Sharopov & Setzer, 2011).

We investigated the antibacterial activity of the oil against four microorganisms: *Staphylococcus aureus* ATCC 25923, *Bacillus subtilis* ATCC 9372, *Enterococcus faecalis* ATCC 15753, *Escherichia coli* ATCC 9763. The results are presented in Table 2. The essential oil was active against all bacteria, especially against *E. coli* and *E. faecalis*.

Supplementary material

Experimental details relating to this article are available online.

Acknowledgements

The authors are grateful to Dr V. Mozaffarian (Research Institute of Forest and Rangelands, Tehran) for helpful assistance in collecting plant material and for botanical identification. Also we are grateful for the financial support of this work by Research Council of Shahid Beheshti University.

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