

Chemical compositions of essential oils from two *Artemisia* species used in Mongolian traditional medicine

N.Javzmaa^{1*}, Sh.Altantsetseg¹, S.Shatar¹, A.Amarjargal²

¹Institute of Chemistry and Chemical Technology, Mongolian Academy of Sciences, MAS 4th building, Peace Avenue, Bayanzurkh district, Ulaanbaatar 13330, Mongolia

²Mongolian University of Khovd, Khovd aimag, Mongolia

*Corresponding author: njavzmaa@gmail.com

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ABSTRACT

Essential oils of aromatic and medicinal plants generally have a diverse range of activities because they possess many active constituents that work through a several modes of action. *Artemisia*, the largest genus of the family Asteraceae, has a number of effects against human and plant diseases. The main purpose of the present study was to investigate chemical compositions of essential oils of two *Artemisia* species, *Artemisia palustris* L and *Artemisia sericea* Weber ex Stechm from the Mongolian steppe zone using gas chromatography and gas chromatography-mass spectrometry. The essential oil of *A.palustris* was characterized by the presence of monoterpene hydrocarbons such as *trans*- β -ocimene (59.1%), *cis*- β -ocimene (11.6%) and myrcene (7.1%), while the oil of *A.sericea* was dominated by the presence of three oxygenated monoterpenoids as 1,8-cineole (25.8%), borneol (22.5%) and camphor (18.8%) which are used for preparation of a fragrance and medicinal products.

Keywords: *Artemisia palustris* L, *Artemisia sericea* Weber, β -ocimene, 1,8-cineole, camphor

INTRODUCTION

The Asteraceae family is endowed with essential oil-yielding plants, in particular, the genus *Artemisia* occupies a top position for its bio-prospection [1]. The genus consists of a small herbs and shrubs, found in northern temperate regions and comprises of about 500 species from South Asia, North America, and European countries [2]. In Mongolia, 103 *Artemisia* species have been found [3].

Generally, the species of the genus *Artemisia* are called as the common names mugwort, wormwood, and sagebrush. Due to the presence of terpenoids and sesquiterpene lactones, the most of the species possess strong aromas and bitter tastes, which discourage herbivores and may have had a selective advantage [4]. The *Artemisia* species have wide and various applications to the plant and human disease control, as well as in the pharmaceutical industry [5]. Some species are used in Tibetan-Mongolian traditional medicine because they do not only repel helminths of the intestine, but also have antioxidative, anticancer, antiviral and allelopathic activities [3]. In Mongolian traditional medicine, the leaves of *A.palustris* show the beneficial influence for treatment of skin diseases, while the seeds are useful for treatment of bronchitis and tuberculosis [6]. The aerial parts of *A.sericea* are used for treatment of pneumonia, inspiratory and gastric diseases [7].

From the previous research, the aerial parts of *A.palustris*

growing in Siberia, Russia have known to contain flavonoids (luteolin, quercetin, hyperozide, cinarozid, and chalcones), coumarin (umbelliferone) and essential oil which mainly consisted of *trans*- β -ocimene (50%), *cis*- β -ocimene (40%), myrcene (2%) and some sesquiterpenes [10]. The increasing importance of essential oils in various domains of human life (pharmacy, cosmetics, food and beverage industries), especially the essential oil rich in β -ocimene, has attracted researchers interests to the essential oil *A.palustris* from the Mongolian flora. There are results described about seed oil of *A.palustris* growing in Mongolia [9]. However, its essential oil has not been studied yet. The *Artemisia* species from the Mongolian unexplored flora could be unusual resources of essential oils. To the best of our knowledge, *A.sericea* has also not been previously investigated for its chemical compositions and in particular, the essential oil.

In the present work we analyzed the chemical compositions of the essential oils of the aerial parts *A.palustris* and *A.sericea* occurring in Mongolia and compared them with oils of other *Artemisia* species to determine their characteristic profile.

EXPERIMENTAL

Plant material: The aerial parts of *A.palustris* were collected at the full bloom stage in September 2009, while, *A.sericea* was harvested at the fruiting stage in August 2008 from the Terelj region of Khentii mountains located in the east of Ulaanbaatar, Mongolia (Table 1).

Voucher specimens are deposited in the Herbariums of the Institute of General and Experimental Biology of the Mongolian Academy of Sciences.

Preparation of oil: Air-dried aerial parts of each plant species (70-80 g) were hydrodistilled in the Clevenger type apparatus for 3 h. The essential oil yields of *A. palustris* were 1.4%, while *A. sericea* 0.4%, respectively. The essential oils were dried over anhydrous calcium chloride and stored in sealed vials at 4°C before analysis.

Gas chromatography (GC) - gas chromatography and mass spectrometry (GC/MS): GC analysis was carried out on Hewlett Packard HP 5890II Gas chromatography fitted with a fused silica DB-Wax column (30 m x 0.25 mm; film thickness: 0.25 µm); carrier gas was nitrogen with linear velocity 38 ml/min, split ratio was adjusted as 30:1. The injector and detector temperature were 250°C, column temperature was programmed from 80°C to 200°C at a rate 2°C/min, 0.5 µl solutions of the essential oil samples in dichloromethane (1%) were injected. Quantitative data were obtained from an electronic integration of the flame ionization detector (FID) peak area. GC/MS analysis was performed on HP 5971A instrument with MS detector 5890 II of the same company which was operated in EI mode (70 eV). GC/MS fitted with a Supelcowax 10 column (60 m x 0.25 mm; film thickness: 0.25 µm); carrier gas was helium with linear velocity 10 ml/min, split ratio 30:1. The injector temperature was 250°C. The column temperature was programmed from 80°C to 120°C at a rate 3°C/min. The detector temperature was 280°C. GC condition and capillary column used were as described above, with exception of the carrier gas, which was helium.

Identification of components: The separated components were identified by matching with mass-spectral library data and by comparison of Kovat's indices with those of authentic components and with published data [10,11].

RESULTS AND DISCUSSION

Two *Artemisia* species collected at full flowering and fruiting stage were hydrodistilled and gave the oil yields as shown in Table 1.

Table 1. Essential oil yields of two *Artemisia* species

Plant name	Date of collecting	Vegetation period	Oil yield (%)
<i>A. palustris</i>	September 2009	in full bloom	1.4
<i>A. sericea</i>	July 2008	in ripe fruits	0.4

GC and GC-MS analyses led to the detection of 19 constituents, accounting for 89.5% of *A. palustris* and 10 constituents, representing 91.9% of the *A. sericea* essential oil (Table 2).

The essential oil from the *A. palustris* was characterized by the presence of monoterpene hydrocarbons, among which (*E*)- β -ocimene(*trans*) and (*Z*)- β -ocimene(*cis*) were dominated (Figure 1). Myrcene, 1,8-cineole, and

spathulenol were detected in low percentages. β -ocimene is one of the most ubiquitous volatiles in floral scents and was found naturally as a mixture of stereoisomers. The *trans*-isomer is more common and more abundantly emitted in floral volatiles than the *cis*-isomer [12,13].

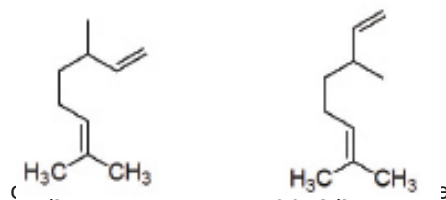


Fig. 1. Structures of two β -ocimene stereoisomers, *cis*- and *trans*- β -ocimene (also referred to as (*Z*)- and (*E*)- β -ocimene, respectively)

Trans- β -ocimene occurs in 71% of the 90 plant families in the list of identified floral-scent compounds compiled by Knudsen *et al* [13]. Ocimene is widely used as a perfumer agent in the cosmetic industry due to the pleasant aroma [14]. In addition, many other researchers reported about its anti-inflammatory, antifungal and antiviral activities [15-17].

Here, β -ocimene contents of *A. palustris* are compared with those data of other *Artemisia* species, which were reported previously (Table 2).

As can be seen from Table 2, the content of (*E*)- and (*Z*)- β -ocimenes (11.6% and 59.1%) in the essential oil of *A. palustris* was the highest in comparison with other *Artemisia* species from the Mongolian flora. A noticeable high amount of *cis*- β -ocimene (11.6%) was found in *A. palustris* than other *Artemisia* species due to the remarkable high percentage of *trans*- β -ocimene (59.1%). It's well known that *cis*- β -ocimene is an enzymatically synthesized product from the its *trans* isomer [13]. However, it was less than the combined amount of β -ocimene (90%) in the essential oil of *A. palustris* from Russia. The observed difference is significant and it could be due to the distinction of geo-ecological conditions.

The essential oil of *A. sericea* was found to be rich with oxygenated monoterpenoids as 1,8-cineole (25.8%), borneol (22.5%) and camphor (18.8%), which consequently, the most interesting results of this study. The essential oils of some *Artemisia* species, such as *A. gmelini*, *A. frigida*, *A. anethifolia*, *A. macrocephala*, and *A. rutifolia*, contain similar constituents, which are widely used for the treatment of pneumonia. Obviously, essential oil of *A. sericea* can be used for the same treatment. Essential oils compositions of the *Artemisia* species are shown in Table 3.

One of the main constituents of the *A. sericea* is 1,8-cineole, a monoterpene cycle, which has also been named eucalyptol. It is used in flavorings, fragrances, and cosmetics production because of its pleasant spicy and aromatic fragrance. 1,8-cineole also possesses an insecticide activity and medicinal properties for treatment of acute and chronic bronchitis, sinusitis and

Table 2. Chemical constituents in some *Artemisia* essential oils rich with β -ocimene

Constituents	RI*	Amount, %					
		<i>A.palustris</i> (present study)	<i>A.scoparia</i>	<i>A.oxycephala</i>	<i>A.dolosa</i>	<i>A.medioxim</i>	<i>A.aksaiensis</i>
α -pinene	939	0.4	15.2	0.7	3.8	1.3	6.5
Camphene	953	-	0.2	0.6	0.1	0.4	0.3
Sabinene	976	0.2	3.8	0.1	0.7	-	1.8
β -pinene	980	0.4		0.5	1.7	-	4.3
Myrcene	991	7.1	9.6	10.5	6.4	3.9	16.1
<i>p</i> -cymene	1026	0.2	0.5	-	1.0	6.6	0.7
Limonene	1031	0.1	10.2	1.2	7.0	-	8.1
<i>cis</i>-β-ocimene	1040	11.6	1.0	0.7	0.6	7.1	1.2
<i>trans</i>-β-ocimene	1050	59.1	29.4	15.3	16.1	13.8	13.2
1,8-Cineole	1033	3.2	25.8	-	0.2	-	-
<i>cis</i> -sabinenehydrate	1097	0.1	-	-	0.8	-	-
Linalool	1098	0.2	-	-	-	-	0.3
Camphor	1144	0.6	-	0.3	0.1	1.5	-
Chryzanthanol	1118	1.4	-	-	-	-	-
Terpinen-4-ol	1177	1.0	0.2	-	1.5	0.6	1.3
α -terpineol	1189	-	0.1	-	0.4	0.5	0.3
β -caryophyllene	1418	0.6	1.6	0.7	6.9	-	2.5
Farnesene	1458	0.3	0.4	0.3	-	1.3	0.2
Germacrene-D	1484	0.4	-	26.3	14.4	-	12.3
Spathulenol	1576	2.3	0.2	-	0.5	-	0.7
Caryophyllene oxide	1586	0.3	0.1	-	0.7	-	0.1

*RI: Retention index

Table 3. Essential oils constituents of some *Artemisia* species-rich with 1,8-cineole, borneol, and camphor

Constituents	*RI	Amount, %					
		<i>A.sericea</i> (present study)	<i>A.gmelinii</i>	<i>A.frigida</i>	<i>A.anethifolia</i>	<i>A.macrocephala</i>	<i>A.rutifolia</i>
α -pinene	939	1.7	0.8	0.7	0.6	13.0	1.2
Camphene	953	2.2	6.1	1.3	2.7	1.2	1.3
Sabinene	976	-	0.5	0.2	0.2	7.5	0.2
β -pinene	980	-	0.3	0.5	0.3	6.8	0.2
Myrcene	991	2.4	0.2	-	-	0.6	0.1
<i>p</i> -cymene	1026	-	0.6	0.6	0.2	7.1	1.4
Limonene	1031	-	0.1	0.2	-	7.3	0.2
1,8-cineole	1033	25.8	20.6	27.2	1.2	22.0	25.1
γ -terpinene	1058	-	-	-	-	15.7	0.2
<i>cis</i> -sabinenehydrate	1097	-	0.1	0.7	0.2	0.1	0.1
Camphor	1144	18.8	40.9	35.0	26.0	31.0	21.7
Chryzanthanol	1118	-	4.7		0.2		0.4
Borneol	1168	22.5	6.9	3.0	5.1	0.3	0.6
Terpinen-4-ol	1177	2.8	2.9	4.5	0.7	0.4	3.5
α -terpineol	1191	1.1	1.4	2.9	0.4	0.1	1.6
β -caryophyllene	1418	2.5	0.7	0.1	1.0	1.8	-
Germacrene-D	1484	12.1	0.5	1.5	-	3.2	-

*RI: Retention index

respiratory infections [18]. Borneol and camphor are the other main constituents in the essential oil and both are well-known compounds as an antiseptic, antispasmodic, carminative, cardiac stimulant, respiratory aid, and anthelmintic properties [19]. In addition, in the essential oil of *A.sericea*, the traces of only two sesquiterpenes, such as germacrene-D (12.1%) and β -caryophyllene (2.5%) were detected with some other minor monoterpenes including camphene (2.2%), terpinen-4-ol (2.8%) and myrcene (2.4%).

CONCLUSION

In the study, chemical compositions of the essential oils of *A.palustris* and *A.sericea*, from Mongolia were investigated for the first time. The results of the present research have shown that the *A.sericea* was rich in bioactive oxygenated monoterpenes such as 1,8-cineole, borneol, and camphor, while the *A.palustris* contained monoterpene hydrocarbons including (*E*)- β -ocimene, (*Z*)- β -ocimene and myrcene. The essential oil of *A.sericea* could also be used for treatment of asthma, bronchitis, and tuberculosis because of the presence of aromatic alcohols and ketones. Due to the high amounts of β -ocimene, which is the main component of perfumes and cosmetics, the essential oil of *A.palustris* can be used as a top-priority natural resource of the β -ocimene.

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