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Composition of the essential oil of *Achillea filipendulina* Lam. from Tajikistan

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ABSTRACT

Achillea filipendulina Lam. was collected from two different sites in south-central Tajikistan. The essential oils were obtained by hydrodistillation and analyzed by gas chromatography – mass spectrometry. A total of 51 compounds were identified representing 99.0 and 98.8% of total oil compositions. The major components of A. filipendulina oil were santolina alcohol (43.6-46.3%), 1,8-cineole (8.8-11.4%), borneol (5.3-6.0%), isoborneol (4.8-5.4%), and cis-chrysanthenyl acetate (6.5-9.3%).

Keywords: Santolina alcohol, 1,8-cineole, *Achillea filipendulina*, essential oil composition, Tajikistan, GC-MS

INTRODUCTION

There are around 115 species in the genus *Achillea* (Asteraceae) distributed mainly in Eurasia [1], seven of have been recognized in Tajikistan. *Achillea filipendulina* Lam. is distributed in Central Asia, the Caucasus and Iran [2]. This plant, locally named "buimodaron", grows 40-120 cm and flowers from June to September, and has been used since ancient times in traditional herbal medicines for a variety of ailments [3,4]. Decoctions of *A. filipendulina* have been used to treat sciatica, gout, arthritis, gastrointestinal disturbances, congestion, cardiovascular diseases, and malaria, as well as a diuretic, anthelmintic and purgative. Externally, the plant has been used to treat scabies and wounds.

In previous reports, the essential oil of *A. filipendulina* from Kazakhstan was composed largely of santolina alcohol (29.0%), borneol (27.8%), 1,8-cineole (19.1%), and bornyl acetate (8.1%) [5], while samples from Iran were dominated by santolina alcohol (43.6-47.8%) with lesser amounts of 1,8-cineole (4.1-8.1%) and borneol (3.9-9.1%) [6]. Rahimmalek and co-workers have reported two samples of *A. filipendulina* essential oils to contain 2,7-dimethyl-4(*E*),6-octadien-2-ol (23.4-24.1%, but this compound is most likely santolina alcohol), borneol (7.9-8.3%), bornyl acetate (11.6-14.7%), germacrene D (11.8-23.4%), and only small amounts of 1,8-cineole (0.2-1.7%) [7]. The floral essential oil from Iran, on the other hand, was dominated by limonene (26.7%), carvacrol (9.3%), 1,8-cineole (8.7%), borneol (7.8%), and α-humulene (5.6%) [8]. In this report, we present the essential oil composition of two samples collected from different sites of south-central Tajikistan.

MATERIALS AND METHODS

Plant Material: Aerial parts of *A. filipendulina* were collected from the two regions of Tajikistan: Sample #1, the Khonaobod village, Muminobod region (38.107547 N, 69.966431 E, 1200 m above sea level), on 7 May 2010; Sample #2, the Chormaghzak village, Yovon region, (38.417502 N, 69.172175 E, 1300 m above sea level), on 25 July 2010. The plant was identified by F.S. Sharopov, and a voucher specimen (TJ2010-032) has been deposited in the herbarium of the Chemistry Institute of the Tajikistan Academy of Sciences. The air-dried samples were crushed and hydrodistilled for 3 h to give the yellow essential oils, 0.5-0.75% yield.

Gas Chromatographic-Mass Spectral Analysis: A gas chromatographic-mass spectral analysis was performed on the essential oils of *A. filipendulina* using an Agilent 6890 GC with Agilent 5973 mass selective detector (EIMS, electron energy = 70 eV, scan range = 45-400 amu, and scan rate = 3.99 scans/s), and a fused silica capillary column (HP 5 ms, 30 m x 0.25 mm) coated with 5% phenyl-polymethylsiloxane (0.25 µm phase thickness). The carrier gas was helium with a flow rate of 1 mL/min, and the injection temperature was 200°C. The oven temperature was programmed to initially hold for 10 minutes at 40°C, then ramp to 200°C at 3°C/min and finally to 220°C at 2°C/min. The interface temperature was 280°C. A 1% w/v solution of each sample in CH_2Cl_2 was prepared, and 1 µL was injected using a splitless injection technique. Identification of the oil components was based on their retention indices determined by reference to a homologous series of *n*-alkanes, and by comparison of their mass spectral fragmentation patterns with those reported in the literature [15], and stored on the MS library [NIST database (G1036A revision D.01.00)/ChemStation data system (G1701CA, version C.00.01.080)]. The percentages of each component are reported as raw percentages based on total ion current without standardization. The chemical compositions of the *A. filipendulina* oils are summarized in Table 1.

RESULTS AND DISCUSSION

A. filipendulina Lam. was collected from two different areas in south-central Tajikistan, and the essential oils obtained by hydrodistillation. The chemical compositions of the oils were determined by GC-MS (see Table 1). A total of 51 compounds were identified representing 99.0% and 98.8% of the two samples, respectively. The major components of *A. filipendulina* oil from this present work were santolina alcohol (46.3% and 43.6%), 1,8-cineole (8.8% and

11.4%), borneol (5.3% and 6.0%), isoborneol (4.8% and 5.4%), *cis*-chrysanthenyl acetate (6.5% and 9.3%), camphor (3.6% and 0.6%), and ascaridole (1.6% and 2.5%). These results are qualitatively consistent with those previously reported by Sadyrbekov *et al.* [5], Mosayebi *et al.* [6], and, probably, Rahimmalek *et al.* [7].

Table 1. Composition of *Achillea filipendulina* Lam. essential oil from Tajikistan.

RI[a]	Compound	Percent Composition	
		Sample #1	Sample #2
906	Santolina triene	1.3	0.9
941	α-Pinene	1.0	0.8
953	Camphene	0.9	1.1
976	Sabinene	0.3	0.1
978	β-Pinene	0.5	0.7
992	Myrcene	0.9	0.2
1002	Yomogi alcohol	0.2	0.3
1004	α-Phellandrene	0.2	---
1016	α-Terpinene	1.0	0.3
1024	*p*-Cymene	1.3	1.8
1032	**1,8-Cineole**	**8.8**	**11.4**
1040	**Santolina alcohol**	**46.3**	**43.6**
1059	γ-Terpinene	0.6	---
1060	Bergamal	---	0.6
1067	*cis*-Sabinene hydrate	0.5	0.2
1071	Unidentified	0.4	0.5
1084	Artemisia alcohol	0.3	0.4
1088	Terpinolene	0.1	0.1
1097	*trans*-Sabinene hydrate	0.6	0.4
1101	Isopentyl 2-methylbutanoate	---	0.1
1105	α-Thujone	1.0	1.1
1116	β-Thujone	1.1	0.2
1121	*cis*-*p*-Menth-2-en-1-ol	0.2	0.2
1126	α-Campholenal	0.1	0.4
1137	*trans*-Pinocarveol	0.3	0.6
1140	*trans*-*p*-Menth-2-en-1-ol	0.1	0.1
1143	Camphor	3.6	0.6
1153	Menthone	0.1	---
1161	Pinocarvone	---	0.8
1165	**Isoborneol**	**4.8**	**5.4**
1167	**Borneol**	**5.3**	**6.0**
1174	*cis*-Pinocamphone	0.4	0.6
1177	Terpinen-4-ol	1.6	1.0
1184	*p*-Cymen-8-ol	0.1	0.1
1190	α-Terpineol	0.7	0.2
1195	Myrtenol	0.2	0.4
1206	*trans*-Piperitol	0.1	0.1
1217	*trans*-Carveol	0.1	0.1
1225	Isobornyl formate	---	0.1
1227	Nerol	---	0.1
1236	**Ascaridole**	**1.6**	**2.5**
1240	Unidentified	0.6	0.7

1254	*cis*-Piperitone epoxide	0.3	0.2
1257	*trans*-Piperitone epoxide	---	0.2
1263	***cis*-Chrysanthenyl acetate**	**6.5**	**9.3**
1268	*trans*-Ascaridol glycol	0.3	0.2
1285	**Isobornyl acetate**	**3.0**	**2.9**
1291	Thymol	0.3	0.1
1300	Carvacrol	0.3	0.2
1365	Neryl acetate	0.2	0.5
1392	β-Elemene	0.1	---
1418	(*E*)-Caryophyllene	0.1	---
1481	Germacrene D	0.2	0.2
	Total identified	99.0	98.8
	Monoterpene hydrocarbons	8.0	6.0
	Oxygenated monoterpenoids	89.2	91.2
	Sesquiterpene hydrocarbons	0.3	0.2
	Others	1.5	1.2

[a]*RI = "Retention Index", determined in reference to a homologous series of n-alkanes on an HP-5ms column.*

The high concentrations of santolina alcohol, 1,8-cineole, and borneol in *A. filipendulina* as revealed in this study and previous works likely account for the traditional uses of this plant for treatment of infections, inflammation, etc. Santolina alcohol [9], 1,8-cineole [10], and borneol [11,12] have shown antimicrobial effects. Additionally, 1,8-cineole [13] and borneol [14] have shown synergistic effects, likely due to penetration enhancement.

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