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COMPONENT COMPOSITION OF ESSENTIAL OILS FROM FOUR SPECIES OF THE GENUS *Achillea* GROWING IN KAZAKHSTAN

D. T. Sadyrbekov,[1] E. M. Suleimenov,[1] E. V. Tikhonova,[1] G. A. Atazhanova,[1] A. V. Tkachev,[2] and S. M. Adekenov[1]

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The component composition of the four species Achillea filipendulina, A. sudetica, A. ledebourii, *and* A. cartilaginea *was studied by GC-MS. It was found that the principal components of the essential oil (%) were santolina alcohol (29.1) and borneol (27.9) for* A. filipendulina, *linalool (11.8) and caryophyllene (8.9) for* A. sudetica, *germacrene D (20.55) for* A. ledebourii, *and α-thujone (26.15) and β-thujone (11.76) for* A. cartilaginea. *The chemical composition of the essential oils from* A. sudetica, A. ledebourii, *and* A. cartilaginea *was studied for the first time.*

Key words: *Achillea* L., essential oils, GC-MS.

The genus *Achillea* L. (Asteraceae) numbers 45 species in the CIS. Of these, 11 grow in Kazakhstan [1].

In continuation of a study of the component composition of essential oils of plants from the genus *Achillea*, [2], we selected the four species *A. filipendulina*, *A. sudetica*, *A. ledebourii*, and *A. cartilaginea* as the next specimens for chemical research.

A. filipendulina Lam. grows in the Caucasus and in Central Asia. The decoction is used in folk medicine as an abortifacient [3] and for gastrointestinal illnesses [4]. The flavonoid [5] and coumarin [6, 7] contents have been reported. The component composition of the essential oil of *A. filipendulina* was studied and found to contain borneol [8], santolina alcohol, filipendulol [4, 9], 2-methylhept-2-ene, α-pinene and camphene [10-12], and linalool [13].

Dembitskii et al. [4, 9] carried out a detailed chemical investigation of this species. The essential oil obtained by steam distillation of raw material collected in South-Kazakhstan district was studied by GC after preliminary vacuum fractionation with subsequent chromatographic separation over aluminum oxide. This established that the principal components of the essential oil were (%) santolina alcohol (43), filipendulol (12.7), 1,8-cineol (10.2), and borneol (5.3).

A. sudetica Opiz. grows in the Alps and Sudeten and Carpathian mountains [14]. Roots of this species contained alkaloids [15].

A. ledebourii Heimerl. is found in western Siberia [1]. The chemical composition of this species has not been studied.

A. cartilaginea Ledeb. is distributed over western and eastern Siberia [1]. The chemical composition of this plant includes flavonoids [16-21] and lactones [20, 22].

The total amount of components was 99.5% for *A. filipendulina*, 93.9 for *A. sudetica*, 99.9 for *A. ledebourii*, and 97.0 for *A. cartilaginea*.

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1) Institute of Phytochemistry, Ministry of Education and Science of the Republic of Kazakhstan, 470032, Karaganda, ul. Gazalieva, 4, fax (3212) 43 37 73, e-mail: arglabin@phyto.kz; 2) Novosibirsk Institute of Organic Chemistry, Siberian Division, Russian Academy of Sciences, 630090, Novosibirsk, pr. Akad. Lavrent′eva, 9, fax +7-(3832) 34 47 52, e-mail: atkachev@nioch.nsc.ru. Translated from Khimiya Prirodnykh Soedinenii, No. 3, pp. 243-245, May-June, 2006. Original article submitted January 23, 2006.

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TABLE 1. Chemical Composition of Essential Oils

Component	Content, %				Component	Content, %			
	1	2	3	4		1	2	3	4
α-Thujene	-	-	-	1.4	Eugenol	-	0.1	-	0.7
α-Pinene	0.2	1.8	-	1.7	β-Elemene	-	-	0.9	-
Camphene	0.9	0.7	-	1.7	*cis*-Jasmone	-	-	-	0.4
Benzaldehyde	-	0.1	-	-	α-Ylangene	-	0.1	-	-
Sabinene	0.6	0.4	-	0.5	β-Burbonene	-	0.1	-	-
β-Pinene	0.2	3.1	-	0.5	Methyleugenol	-	0.8	-	-
Oct-1-en-3-ol	-	0.3	-	-	Caryophyllene	-	1.6	6.5	0.1
2,3-Dehydro-1,8-cineol	-	0.1	-	0.1	unident.	-	-	0.9	-
α-Phellandrene	-	-	-	0.1	β-Sabinene	-	-	-	0.1
α-Terpinene	-	0.1	-	1.7	*cis*-Nerolidol	-	-	-	1.3
p-Cymene	1.2	0.4	-	4.5	Humulene	-	0.2	1.2	-
β-Phellandrene	-	-	-	0.2	β-Farnesene	-	-	1.5	-
Linonene	-	0.7	-	-	β-Santalene	-	0.1	-	-
1,8-Cineol	19.1	5.9	1.0	8.8	Cabreuva oxide D	-	0.1	-	-
Bicycloelemene	-	-	2.8	-	γ-Murolene	-	1.1	-	-
Santolina alcohol	29.0	-	-	-	α-Curcumene	-	0.6	-	-
cis-β-Ocimene	-	0.1	-	-	*trans*-β-Ionone	-	0.1	-	-
γ-Terpinene	0.6	0.5	-	2.5	α-Zingiberene	-	0.9	1.0	-
cis-Sabinene hydrate	0.9	0.1	-	-	Bicyclogermacrene	-	-	4.5	-
Non-1-en-3-ol	-	0.2	-	-	δ-Cadinene	-	-	0.9	-
Terpinolene	-	0.1	-	0.6	β-Sesquiphellandrene	-	0.5	-	-
trans-Sabinene hydrate	0.5	0.1	-	0.4	unident.	-	0.2	-	-
Linalool	-	11.8	-	0.2	Elemol	-	0.8	-	-
cis-α-Thujone	-	-	-	26.2	*trans*-Nerolidol	-	0.7	-	-
cis-β-Thujone	-	-	-	11.8	Spatulenol	-	1.4	10.9	0.2
unident.	-	0.2	-	-	Caryophyllene oxide	-	2.1	6.2	1.0
trans-*p*-Menth-2-en-1-ol	-	0.1	-	0.85	unident.	-	-	5.5	-
Isothujanol	-	-	-	0.1	unident.	-	-	4.0	-
cis-Sabinol	-	-	-	1.2	α-Cadinol	-	-	1.7	-
α-Campholenic aldehyde	-	0.2	-	-	unident.	-	-	1.1	-
trans-Pinocarveol	-	0.3	-	-	unident.	-	-	21.4	-
Camphor	-	3.3	3.5	6.8	unident.	-	-	1.2	-
Sabinaketone	-	-	-	0.1	6,10,14-Trimethyl-2-pentadecanone	-	-	1.4	-
Pinocarvone	2.5	0.6	-	0.1	Phytol	-	-	1.3	-
Borneol	27.8	5.9	-	2.1	Eremoligenol	-	-	-	0.4
Pinocamphone	0.9	-	-	-	unident.	-	-	-	0.3
Terpin-4-ol	3.3	0.9	-	7.8	Viridiflorol	-	1.0	-	-
m-Cymen-8-ol	-	-	-	0.2	Salvial-4(14)-en-1-one	-	0.2	-	-
α-Terpineol	1.5	1.7	-	1.1	Humulen-6,7-epoxide	-	0.9	-	-
cis-Piperitol	-	-	-	0.6	γ-Eudesmol	-	6.9	-	-
trans-Piperitol	-	-	-	0.4	Caryophylla-4(12),8(13)-dien-5α-ol	-	0.6	-	0.8
Cuminic aldehyde	-	-	-	0.1	*epi*-α-Cadinol	-	0.3	-	-
unident.	0.6	-	-	-	β-Eudesmol	-	1.1	-	3.4
Myrtenol	-	0.5	-	-	unident.	-	-	-	0.2
unident.	-	0.3	-	-	Caryophylla-3,8(13)-dien-5α-ol	-	-	-	0.3
trans-Carveol	-	0.5	-	-	Caryophylla-3,8(13)-dien-5β-ol	-	-	-	0.3
Carvone	-	0.2	-	-	unident.	-	-	-	0.3
cis-Chrysanthenyl acetate	1.2	0.2	-	-	α-Eudesmol	-	1.9	-	-
Thuj-4-en-2α-ol acetate	-	0.3	-	-	unident.	-	0.6	-	-
Bornyl acetate	8.1	8.9	-	2.3	unident.	-	0.3	-	-
Cuminic alcohol	-	-	-	0.1	unident.	-	5.9	-	-
trans-Sabinyl acetate	-	-	-	0.5	α-Bisabolol	-	0.5	-	
Terpin-4-ol acetate	-	-	-	0.4	Eudesma-4(15),7-dien-1-ol	-	0.7	-	-
Carvacrol	-	-	-	0.1	unident.	-	4.4	-	-
Germacrene D	0.4	-	20.5	-	Curcuphenol	-	0.1	-	-
Thymol	-	0.1	-	-	*trans*-*trans*-Farnesol	-	0.1	-	-
unident.	-	0.2	-	-	Chamazulene	-	5.1	-	-
trans-Carveol acetate	-	0.1	-	-	unident.	-	0.5	-	-
unident.	-	0.2	-	-	Σcomponents	99.5	93.9	99.9	97.0

1, *A. filipendulina*; 2, *A. sudetica*; 3, *A. ledebourii*; 4, *A. cartilaginea*. Components are given in the order of increasing retention time.

The principal components of the studied essential oils (%) were santolina alcohol (29.1) and borneol (27.9) for *A. filipendulina*, linalool (11.8) and caryophyllene (8.9) for *A. sudetica*, germacrene D (20.55) for *A. ledebourii*, and α-thujone (26.15) and β-thujone (11.76) for *A. cartilaginea*. Table 1 compares the compositions of the essential oils.

Thus, GC-MS was used to study for the first time the chemical composition of the four *Achillea* species. For *A. sudetica*, *A. ledebourii*, and *A. cartilaginea* the component composition was studied for the first time. The similarity of the principal components of the essential oil of *A. filipendulina*, santolina alcohol, 1,8-cineol, and borneol, and those in the literature [4, 9] leads to the conclusion that the chemotype of the species cultivated at the Botanical Garden of the Institute of Phytochemistry was close to that growing in southern Kazakhstan.

EXPERIMENTAL

Raw material of *A. ledebourii* was collected in eastern Kazakhstan district in 2001; *A. cartilaginea*, near Balkhash in 2001; *A. filipendulina* and *A. sudetica*, from plants introduced at the Botanical Garden of the Institute of Phytochemistry, Karaganda, in 2002. All samples of essential oils were produced by steam distillation in a Clevenger apparatus over 3 h. The yield of essential oils was 0.76% for *A. filipendulina*; 0.4, *A. sudetica*; 0.23, *A. ledebourii*; and 0.18, *A. cartilaginea*.

The component composition of the essential oils was analyzed by GC-MS in a Hewlett—Packard instrument with a quadrupole detector. We used an Innowax column (polyethylene glycol 20 M) FSC (60 m × 0.25 mm) with He carrier gas. The flow rate was 1 mL/min. The GC column was held at 60°C for 10 min with the temperature programmed to 220°C at 4°C/min and then held isothermally for 10 min. The fow rate was regulated to 50 mL/min. The injector and detector temperatures were 250°C. The mass spectral conditions were EI at 70 eV and mass range *m/z* 35-425. The quantitative content of the components was calculated automatically from the peak areas of the whole chromatogram of the ions. The components were identified from the mass spectra and retention times using the Wiley GC/MS library.

REFERENCES

1. N. V. Pavlov, *Flora of Kazakhstan* [in Russian], Vol. IX, Nauka Kazakhskoi SSR, Alma-Ata (1966).
2. E. M. Suleimenov, G. A. Atazhanova, T. Ozek, B. Demirci, A. T. Kulyyasov, S. M. Adekenov, and K. H. Baser, *Chem. Nat. Comp.*, 447 (2001).
3. P. Hunk, M. Safi, A. Macey, and G. B. Kerr, *National Demographic Family Guidance Survey of Settled Population Afghanistan*, Vol. 4, 1 (1975).
4. A. D. Dembitskii, R. K. Yurina, L. A. Ignatova, and M. I. Goryaev, *Izv. Akad. Nauk Kaz. SSR, Ser. Khim.*, **1**, 49 (1969).
5. K. Valant, *Naturwissenschaften*, **65**, 8, 437 (1978).
6. I. D. Sham′yanov, A. Mallabaev, and G. P. Sidyakin, *Khim. Prir. Soedin.*, 784 (1974).
7. U. Rakhmankulov, S. Kasymov, K. Taizhanov, E. E. Korotkova, and G. P. Sidyakin, *Rastit. Resur.*, **15**, 79 (1979).
8. M. I. Goryaev, *Essential Oils of USSR Flora* [in Russian], Izd. Akad. Nauk Kaz. SSR, Alma-Ata (1952).
9. A. D. Dembitskii, R. K. Yurina, and M. I. Goryaev, *Izv. Akad. Nauk Kaz. SSR, Ser. Khim.*, **4**, 45 (1974).
10. M. Kh. Khakimov and K. P. Tsukervanik, *Tr. Inst. Khim. Akad. Nauk Uzb. SSR*, **1**, 34 (1948).
11. F. M. Mester, R. A. Khazanovich, and Kh. Kh. Khalmatov, in: Materials of the Jubilee Republic Conference Dedicated to the 50th Anniversary of Soviet Rule, Tashkent (1967), 22.
12. Kh. Kh. Khalmatov, *Rastit. Resur.*, **1**, 161 (1973).
13. S. D. Mustafieva and E. R. Akhmedova, *Rastit. Resur.*, **1**, 79 (1989).
14. V. L. Komarov, *Flora of the USSR* [in Russian], Vol. XXVI, Izd. Akad. Nauk SSSR, Moscow and Leningrad (1961).
15. F. Bohlmann and C. Zdero, *Chem. Ber.*, **106**, 1328 (1973).
16. N. A. Kaloshina, in: Colletion of Scientific Work of Vitebsk Medical Institute [in Russian], **1**, 13, 56 (1969).
17. N. D. Neshta and N. A. Kaloshina, in: Materials of the IInd Conference of Pharmacists of the Belorussian SSR [in Russian], Minsk (1970), 38.

18. N. D. Neshta and N. A. Kaloshina, in: Materials of the XXVIIth Scientific Session of Vitebsk State Medical Institute [in Russian], (1970), 141.
19. N. D. Neshta and N. A. Kaloshina, *Khim. Prir. Soedin.*, 664 (1971).
20. N. D. Neshta and N. A. Kaloshina, in: Abstracts of Papers of the First Scientific Conference of Pharmacists of the Urals and Siberia [in Russian], Tyumen′ (1974), 48.
21. N. D. Neshta, G. G. Zapesochnaya, N. A. Kaloshina, and A. I. Ban′kovskii, *Khim. Prir. Soedin.*, 796 (1973).
22. N. D. Neshta and N. A. Kaloshina, *Khim. Prir. Soedin.*, 652 (1972).