Acta Physiol Plant (2014) 36:2283–2286
DOI 10.1007/s11738-014-1562-4

SHORT COMMUNICATION

Comparative study on the essential oils of *Myosotis arvensis* and *Myosotis palustris* herbs (*Boraginaceae*)

Paulina Znajdek-Awiżeń · Wiesława Bylka · Dorota Gawenda-Kempczyńska · Iwona Paszek

Received: 23 August 2013 / Revised: 28 April 2014 / Accepted: 30 April 2014 / Published online: 22 May 2014

Abstract The essential oils were obtained from *Myosotis arvensis* L. and *M. palustris* L. by hydrodistillation and subsequently analyzed by GC–MS. Fifteen components in *M. arvensis* and twenty-one in *M. palustris* representing, respectively, 89.63 and 93.19 % of the total oils were identified on the basis of their retention time, mass spectra characteristics and semi-quantitative data were obtained from relative peak area percentages. The 3-methyl-benzaldehyde was found to be the major constituent of both tested oils (42.76 % in *M. arvensis* and 45.80 % in *M. palustris*). Additionally, methyl salicylate was a characteristic compound for *M. arvensis* and α-bisabolol oxide B for *M. palustris*.

Keywords *Myosotis arvensis* · *M. palustris* · Essential oils composition

Introduction

Genus *Myosotis* belongs to the *Boraginaceae* family and includes about 100 species occurring mainly in western Eurasia and New Zealand.

Communicated by M. H. Walter.

P. Znajdek-Awiżeń (✉) · W. Bylka
Department of Pharmacognosy, Poznan University of Medical Sciences, 4 Swiecickiego, 60-781 Poznan, Poland
e-mail: paulina.znajdek@gmail.com

D. Gawenda-Kempczyńska · I. Paszek
Department of Biology and Pharmaceutical Botany, Nicolaus Copernicus University, Collegium Medicum in Bydgoszcz, 9 Marii Curie-Sklodowskiej, 85-094 Bydgoszcz, Poland

Both species differ in morphology and occupy various habitats. *M. palustris* is covered with straight hairs, decumbent to upright angular stem, rhizome and crown diameter of 5–8 mm. *M. arvensis* is also covered with hairs, crown with a diameter of 4–5 mm and petioles which are 2–3 times longer than calyx during fruiting. Hairs on the floral cup are hook shaped (Rutkowski 1998).

M. palustris prefers places with moderate light (light indicator according to Ellenberg—L7) and soil with high humidity (moisture indicator—F8). It occurs in wet meadows, at the edge of waters, wetlands. *M. arvensis* prefers a slightly smaller amount of light than *M. palustris.* It occurs in wet meadows, at the edge of waters, wetlands (light indicator—L6) on fresh and dry soils (moisture indicator—F5) like fields, fallows, roadsides, grasslands and forest edges (Jäger 2011).

According to the literature, the species of genus *Myosotis* contain alkaloids, saponins and higher fatty acids (Shinkarenko 2008). However, detailed reports on the chemical constituents of *M. arvensis* and *M. palustris* are scarce so far.

Folk medicine recommends *M. arvensis* in the treatment of malignant tumor of the oral cavity and sex organs and in tuberculosis (Shinkarenko and Vasil'ev 2008). Study conducted in mice showed that aqueous extracts of the aerial part of the *M. arvensis* exert anxiolytic and antidepressant activity (Polomeyeva et al. 2011). It was also proved that oil extracts of both herbs inhibit the development of bacteria microorganisms, e. g., *Shigella sonnei* and *Candida albicans.* Moreover, the extracts of *M. arvensis* inhibit viability of *Staphylococcus aureus* and *Streptococcus faecalis* and the *M. palustris* extracts inhibit the growth of *Pseudomonas aeruginosa* (Shinkarenko 2008).

It has already been shown that essential oils may, despite their small amounts, contribute to the therapeutic activities of the plants (Radulović et al. 2006). Among the major biological activities of essential oils antibacterial, antifungal and anti-inflammatory properties are mentioned. The aim of this study was phytochemical investigation and comparison of the components of the *M. arvensis* and *M. palustris* volatile oils. To the best of our knowledge, there are no previous reports on the essential oil profile of species belonging to genus *Myosotis* (*Boraginaceae*).

Materials and methods

Plant material

M. arvensis and *M. palustris* herbs were collected from the natural habitats in Central Poland (May and June 2012). Voucher specimens have been deposited in the Department of Pharmacognosy, Poznan University of Medical Sciences, Poznan.

Oil extraction

A 30 g samples of dried *M. arvensis* and *M. palustris* herbs were hydrodistillated in a Clevenger-type apparatus with 500 ml of distilled water for 3 h.

Identification of essential oils composition (GC–MS analysis)

The analysis of chemical composition of essential oils was performed using Varian 4000 GC–MS, electron energy of 70 eV and ion source temperature of 200 °C. The instrument was equipped with VF-5 ms silica column (30 m × 0.25 mm × 0.39), $d_f = 25$ µm. Helium was the carrier gas at the flow rate of 1 mL/min and the split ratio 1:10. The oven temperature was programmed at 40 °C (held for 2 min) then gradually increased to 280 °C at the rate of 15 °C/min. The detector temperatures were: 180 °C for ion trap, 50° for manifold and 220 °C for the transfer line. Identification of components was based on comparison of their retention time, as well as mass spectra with standards from the NIST mass spectra library and literature data (Adams 2007). Semi-quantitative data were obtained from relative peak area percentages.

Results and discussion

Hydrodistillation of the herbs of *M. arvensis* and *M. palustris* yielded 0.51 and 0.54 % v/w of yellowish essential oils, respectively. The GC–MS analysis of *M. arvensis* volatile oil revealed the presence of at least 15 components representing 89.63 % of the total oil, while in *M. palustris* essential oil 21 chemical structures were identified and accounted for 93.19 % of the ingredients of the essential oil fraction. For most of the chemical structures, a good match factor of 800–900 was obtained and some of the compounds were even identified with a very good match factor of >900, while for several constituents match factor was >700 (Table 1). The constituents found in *M. arvensis* and *M. palustris* essential oils belong to various chemical groups representing primarily alcohols, aldehydes, ketones, esters, terpenes and saturated fatty acids. The 3-methylbenzaldehyde was found to be the major constituent of both tested oils (42.76 % in *M. arvensis* and 45.80 % in *M. palustris*). Other compounds common for both species are: hexadecanoic acid, 2-hexyl-1-octanol, octanal, 2-methylcyclopentanol, 4-methyl-benzenemethanol, 3-decen-1-ol, 4-nitrophenyl ester *o*-toluic acid and hexahydroxyfarnesylacetone. Although the compositional data of the essential oils showed some similarities, the components present in minor amounts are quite different for the two tested species, e. g., *M. palustris* oil is richer in unsaturated aliphatic alcohols.

Some of the identified constituents have already been described in many plant species and were demonstrated to possess medicinal properties, e. g., α-bisabolol oxide B characteristic for *M. palustris* and methyl salicylate characteristic for *M. arvensis*. α-Bisabolol is (α,4-dimethyl-α-(4-methyl-3-pentenyl)-3-cyclohexene-1-methanol) monocyclic sesquiterpene alcohol. Its oxidation products are mainly bisabolol-oxide A and B (Kamatou 2010). The compound is also present in some species belonging to *Boraginaceae,* e.g., *Auxemma glazioviana* Taub. (Costa et al. 2007). In tested *M. palustris* essential oil α-bisabolol is present in an oxidized form as α-bisabolol oxide (B). A particularly important medicinal activity of α-bisabolol includes anti-inflammatory, antibacterial and anti-irritant properties. Due to the non-allergenic activity it is widely used in dermatology and cosmetology as an ingredient of different kinds of cosmetics including deodorants, hand, body and after-shave creams, lipsticks, after-sun products, as well as baby care cosmetics (Kamatou 2010; Anonymous 2008).

Methyl salicylate present in *M. arvensis* oil is a well-known organic ester which exerts anti-inflammatory, analgesic and rubefaction activity. It commonly occurs in many plants, especially belonging to families: *Betulaceae* (genus *Betula*) and *Rosaceae* (genus *Spiraea*) (Zhang et al. 2011).

A lot of fatty acids exhibit antibacterial and antifungal activity (Dilika et al. 2000) among other hexadecanoic acid (palmitic acid) (McGraw et al. 2002) present in large quantities in the *M. arvensis* and *M. palustris* essential oil. The compound is widely distributed in plants including *Boraginaceae* family, e.g., *M. ramosissima*, *M. sicula*,

Table 1 Compounds identified in the essential oils of *M. arvensis* and *M. palustris*

No.	Name	Retention time (min)		Peak area (%)		Match factor		Molecular mass (g/mol)	Molecular formula
		A	*B*	*A*	*B*	*A*	*B*		
1	2-Methylcyclopentanol	4.98	4.97	1.09	3.05	782	734	100	$C_6H_{12}O$
2	2-Heptenal	–	7.29	–	1.29	–	775	112	$C_7H_{12}O$
3	Octanal	7.86	7.86	0.95	0.73	825	856	128	$C_8H_{16}O$
4	2-Octenal	–	8.53	–	0.76	–	823	126	$C_8H_{14}O$
5	Bicyclo[4.2.0]octa-1,3,5-trien-ol	8.74	–	0.96	–	907	–	120	C_8H_8O
6	3-Methyl-benzaldehyde	8.94	8.93	42.76	45.80	783	785	120	C_8H_8O
7	2-Nonen-1-ol	9.04	–	0.90	–	801	–	142	$C_9H_{18}O$
8	3-Nonen-1-ol	–	9.04	–	2.30	–	827	142	$C_9H_{18}O$
9	4-Methyl-benzenemethanol	9.45	9.44	2.36	2.24	916	899	122	$C_8H_{10}O$
10	6-Nonenal	–	9.66	–	1.26	–	828	140	$C_9H_{16}O$
11	Methyl salicylate	10.09	–	0.72	–	909	–	152	$C_8H_8O_3$
12	3-Decen-1-ol	10.12	10.12	1.97	1.21	836	835	156	$C_{10}H_{20}O$
13	7-Decen-1-al	–	10.68	–	1.35	–	834	154	$C_{10}H_{18}O$
14	2,4-Nonadienal	–	11.24	–	2.15	–	884	138	$C_9H_{14}O$
15	2-Pentadecyn-1-ol	–	11.63	–	1.50	–	764	224	$C_{15}H_{28}O$
16	2-Tetradecen-1-ol	–	12.02	–	0.92	–	883	212	$C_{14}H_{28}O$
17	β-Ionone	–	12.70	–	0.73	–	903	192	$C_{13}H_{20}O$
18	β-Ionone-5-6-epoxide	–	12.73	–	0.87	–	906	208	$C_{13}H_{20}O_2$
19	7-Tetradecen-1-ol	13.69	–	0.83	–	870	–	212	$C_{14}H_{28}O$
20	6-Pentadecen-1-ol	–	13.70	–	0.63	–	893	226	$C_{15}H_{30}O$
21	α-Bisabolol oxide B	–	14.15	–	1.26	–	840	238	$C_{15}H_{26}O_2$
22	Hexahydrofarnesylacetone	15.35	15.35	0.72	2.63	822	845	268	$C_{18}H_{36}O$
23	Hexadecanoic acid	16.15	16.15	15.18	7.79	811	859	256	$C_{16}H_{32}O_2$
24	4-Nitrophenyl ester *o*-toluic acid	16.18	16.28	7.47	2.57	934	948	257	$C_{14}H_{11}NO_4$
25	2-Hexyl-1-decanol	18.71	–	0.79	–	831	–	242	$C_{16}H_{34}O$
26	17-Pentatriacontene	20.57	–	1.04	–	843	–	490	$C_{35}H_{70}$
27	2-Hexyl-1-octanol	22.40	22.40	11.89	12.15	839	852	214	$C_{14}H_{30}O$
Total identified				89.63	93.19				

A Myosotis arvensis, *B Myosotis palustris*

(Özcan 2008) and other like *Asteraceae,* i. a., *Taraxacum officinale* F. H. Wigg. (Bylka et al. 2010), *Ranunculaceae,* e. g., *Trollius europaeus* L. (Witkowska-Banaszczak 2013), *Lamiaceae* (*Salvia* species, *Stachys* species) (Azcan et al. 2004; Skaltsa et al. 2003). One of the most interesting properties of palmitic acid is the supposed inhibition of HIV-1 infection (Paskaleva et al. 2010). In addition, the constituent exerts antitumor activity against human leukemic cells (Harada et al. 2002). Other compound with anticancer potential is β-ionone, unsaturated cyclic ketone present in *M. palustris* oil. Its ability of mammary cancer suppression was proved in the study conducted in rats (Liu et al. 2008).

Some of the chemical structures common for both species tested in this study present antibacterial activity. Octanal widely used in perfumery exhibits antimicrobial activity against *E. coli*, *S. cerevisiae*, *S. aureus* and *A. niger*. It is also a strong antioxidant agent (Liu et al. 2012).

Hexahydroxyfarnesylacetone (6,10,14-trimethyl-2-pentadecanone) may repel insects, while according to some studies aliphatic methyl ketones with long chains exert such activity (Innocent et al. 2008). Also, identified aliphatic alcohols including 2-nonen-1-ol, 2-tetradecen-1-ol, 7-tetradecen-1-ol, and 2-hexyl-1-decanol are common components of essential oils extracted from different plants and for which antimicrobial activity was demonstrated (Manilal et al. 2009; Üçüncü et al. 2010; Ogunlesi et al. 2010; Rahmat et al. 2006).

In conclusion, the identification of *M. arvensis* and *M. palustris* components of essential oils may contribute to extending the knowledge of the chemical composition of these two species at the same time revealing species differences. The presence of components possessing proven biological properties may partly justify the use of plant from genus *Myosotis* in folk medicine.

Author contribution Authors collected the material to be tested, obtained the essential oils and developed the results of GC–MS analysis. The authors prepared the documentation and described the results of the research in this paper.

References

Adams RP (2007) Identification of essential oil components by gas chromatography/mass spectrometry, 4th edn. Allured Publishing Corporation, USA

Anonymous (2008) Matricaria chamomilla, monograph. Altern Med Rev 1:58–62

Azcan N, Ertan A, Demirci B, Baser KHC (2004) Fatty acid composition of seed oils of twelve *Salvia* species growing in Turkey. Chem Nat Compd 40(3):218–221

Bylka W, Matławska I, Frański R (2010) Essential oil composition of *Taraxacum officinale*. Acta Physiol Plant 32:231–234

Costa JGM, Rodrigues FFG, Machado LL, Lemos TLG (2007) Essential oil of *Auxemma glazioviana* Taub. (*Boraginaceae*): chemical composition, antibacterial and antioxidant activities. Res. J Biol Sci 2(3):369–371

Dilika F, Brenner PD, Meyer JJM (2000) Antibacterial activity of linoleic and oleic acids isolated from *Helichrysum pedunculatum*: a plant used during circumcision rites. Fitoterapia 71:450–452

Harada H, Yamashita U, Kurihara H, Fukushi E, Kawabata J, Kamei Y (2002) Antitumor activity of palmitic acid found as selective cytotoxic substance in a marine red alga. Anticancer Res 22(5):2587–2590

Innocent E, Gikonyo NK, Nkunya MHH (2008) Repellency property of long chain aliphatic methyl ketones against *Anopheles gambiae* s.s. Tanzan J Health Res 10(1):50–54

Jäger EJ (ed.) (2011) Rothmaler – Exkursionflora von Deutschland. Gefäβpflanzen: Grundband. Spektrum Akademischer Verlag

Kamatou G (2010) A review of the application and pharmacological properties of alpha-bisabolol and alpha-bisabolol-rich oils. J Am Oil Chem Soc 87:1–7

Liu JR, Sun XR, Dong HW, Sun CH, Sun WG, Chen BQ, Song YQ, Yang BF (2008) β-Ionone suppresses mammary carcinogenesis, proliferative activity and induces apoptosis in the mammary gland of the Sprague-Dawley rat. Int J Cancer 12:2689–2698

Liu K, Chen Q, Liu Y, Zhou X, Wang X (2012) Isolation and biological activities of decanal, linalool, valencene and octanal from sweet orange oil. J Food Sci 77(11):1156–1161

Manilal A, Sujith S, Selvin J, Shakir C, Kiran S (2009) Antibacterial activity of *Falkenbergia billebrandii* (Born) from the Indian coast against human pathogens. Phyton. Int J Exp Bot 78:161–166

McGraw LJ, Jager AK, Van Staden J (2002) Isolation of antibacterial fatty acids from *Schotia brachypetala*. Fitoterapia 73:431–433

Ogunlesi M, Okiei W, Osibote EA (2010) Analysis of the essential oil from the leaves of *Sesamum radiatum*, a potential medication for male infertility factor, by gas chromatography–mass spectrometry. Afr J Biotechnol 9(7):1060–1067

Özcan T (2008) Analysis of the total oil and fatty acid composition of seeds of some *Boraginaceae* taxa from *Turkey*. Plant Syst Evol 274:143–153

Paskaleva EE, Xue J, Lee DYW, Shekthman A, Canki M (2010) Palmitic acid analogs exhibit nanomolar binding affinity for the HIV-1 CD4 receptor and nanomolar inhibition of gp120-to-CD4 fusion. PLoS One 5(8):e12168

Polomeyeva NYu, Gurto RV, Bryushinina OS, Slepichev VA, Kaigorodstev AV, Smirnov VYu, Suslov NI, Udut VV (2011) Anxiolytic and antidepressant effects of aqueous tincture of the aerial part of *Myosotis arvensis*. Bull Exp Biol Med 151(5):604–606

Radulović N, Stojanović G, Palić R (2006) Composition and antimicrobial activity of *Equisetum arvense* L. essential oil. Phytother Res 20:85–88

Rahmat A, Edrini S, Ismail P, Taufiq Y, Yun H, Abu Bakar MF (2006) Chemical constituents, antioxidant activity and cytotoxic effects of essential oil from *Strobilanthes crispus* and *Lawsonia intermis*. J Biol Sci 6(6):1005–1010

Rutkowski L (1998) Klucz do oznaczania roślin naczyniowych Polski niżowej. Wyd. Nauk. PWN, Warszawa

Shinkarenko YuV (2008) Content of flavonoids in plant species of genus *Myosotis* L. Chem Sustain Dev 16:593–598

Shinkarenko YuV, Vasil'ev VG (2008) Phenolcarboxylic acids from *Myosotis krylovii* and *M. palustris*. Chem Nat Compd 44:632–633

Skaltsa HD, Demetzos C, Lazari D, Sokovic M (2003) Essential oil analysis and antimicrobial activity of eight *Stachys* species from Greece. Phytochemistry 64(3):743–752

Üçüncü O, Cansu TB, Özdemir T, Alpay Karaoğlu S, Yayli N (2010) Chemical composition and antimicrobial activity of the essential oil of mosses from Turkey. Turk J Chem 34:825–834

Witkowska-Banaszczak E (2013) Identification of the components of the essential oil from *Trollius europeaus* flowers. Acta Physiol Plant 35:1421–1425

Zhang D, Liu R, Sun L, Huang C, Wang C, Zhang DM, Zhang TT, Du GH (2011) Anti-inflammatory activity of methyl salicylate glycosides isolated from *Gaultheria yunnanensis* (Franch.) Rehder. Molecules 16(5):3875–3884