Journal of Medicinal Plants and By-products (2012) 1: 71-74

Original Article

Chemical Composition of the Essential Oil of *Tanacetum polycephalum* subsp. *polycephalum* from Different Locations of Azerbaijan Province, Iran

Mohammad-Bagher Rezaee*, Kamkar Jaimand and Mahmood Naderi

Phytochemistry Group, Department of Medicinal Plants & By-products, Research Institute of Forest and Rangelands, P.O.Box 1318, Tehran, Iran

Article History: Received: 15 August 2012/Accepted in revised form: 17 September 2012

Abstract

The genus *Tanacetum* is one of the most important medicinal plant that contains 26 species in Iran, 12 of them are endemic. This paper reports the essential oil (EO) composition of *Tanacetum polycephalum* subsp. *polycephalum* growing wild in Iran. Flowers and leaves were collected from different location of Azerbaijan province (Marand, Mianeh and Tabriz), hydro-distilled to produce the oils and analyzed by gas chromatography/mass spectrometry (GC/MS). The yields of leaves and flowers oils were in the range of 0.04 -1.0% (V/W). Main components of leaves EO from Marand, Mianeh and Tabriz were 1,8-cineole (63.5%) and chrysanthenone (5.5%), while for flowers were chrysanthenone (39.5%) and 1,8-cineole (18.9%). For Mianeh sample, principal components of leaves were 1,8-cineole (34.8%) and chrysanthenone (16.1%) and for flowers were dihydro-eudesmol (12.0%) and nootkatin (9.6%). Camphor (29%) and 1,8-cineole (14.3%) were identified as the main constituents of plant leaves from Tabriz and for flowers were trans-sabinene hydrate (56.7%), and 1,8-cineole (10.7%).

Key words: *Tanacetum polycephalum* subsp. *polycephalum*, Essential oil, hydrodistillation, 1,8-cineole, chrysanthenone, Azerbaijan, GC/MS

Introduction

The Asteraceae is the largest plant family. The family comprises more than 1600 genera and 23000 species [1,2]. Its many genera and species, its worldwide distribution and the fact that it comprises many useful plants have made it the subject of many karyological studies [3]. Many karyological and cytological studies have been performed in the Asteraceae [4-7]. The native flora of Iran comprises about 8000 angiosperm species. The genus *Tanacetum* (L.), formerly *Pyrethrum* (Zinn.), is a large, poorly defined classification group in the Asteraceae (Compositae) containing polymorph species, many of which have applications as herbal medicines [8]. *Tanacetum* is one of the largest genera of the family Asteraceae, containing 250-500 taxa depending on the opinions of the authors who have studied the genus [9-17]. It is distributed throughout the Northern Hemisphere, with very few representatives (not more than 10 species) in the Southern Hemisphere. It seems that the genus is a polyphyletic complex and should be revised carefully regarding its species and subgenus [3, 18, 19]. The genus *Tanacetum* belongs to the tribe Anthemideae of the Compositae and comprises only one species of herbaceous plant, *Tanacetum polycephalum* subsp. *polycephalum* Syn.: *Tanacetum polycephalum* Schultz-Bip. subsp. *farsicum* Podl. [20]. The genus *Tanacetum* is represented by 26 species in the flora of Iran, 12 of them are endemic [21]. *Tanacetum polycephalum* is used in folk medicine to treat many disorders [22], therefore, it seem interesting to investigate its biological activity and chemical analysis. Essential oils are a complex mixture of natural compounds, mainly monoterpenes, sesquiterpenes and their oxygenated derivatives, Asteraceae is a valuable source of essential oil-containing plants and there are many reports on the volatile constituents of the oils of these plants [23-25]. These oils have been shown to possess antibacterial [26] and antioxidant activity [27].

Materials and Methods

*****Corresponding author: Phytochemistry Group,Department of Medicinal Plants & By-products, Research Institute of Forest and Rangelands, P.O.Box 1318, Tehran, Iran
Email Address: mbrezaeei@rifr-ac.ir

Plant materials

The plant of *Tanacetum polycephalum* subsp *polycephalum* was collected from different location in Azarbijan province (Marand between znozgh and Kamar Mountains, Tabriz to Ahar Ghanly dareh and Mianeh to Ghareh Chaman at altitude of 1700 m) during August-October 2011.

All samples were collected by M. Golipour and identified by V. Mozaffarian in herbarium of Research Institute of Forests & Rangelands (TARI). Samples were hydro-distilled, produced the oils in the yields of leaf 0.3% and flower 0.5% (V/W) from Marand samples and leaf 0.6% and flower 0.4% (V/W) from Mianeh samples and leaf 1.0% and flower 0.04% (V/W) from Tabriz samples, respectively, and analyzed by GC and GC/MS.

GC analysis

GC analysis was performed on a Shimadzu 15A gas chromatograph equipped with a split/splitless injector and a flame ionization detector at 250°C. N2 was used as a carrier gas (1 mL min-1) and a DB-5 type was utilized as the capillary (50 mx0.2 mm, film thickness 0.32 µm). Temperature within the column for 3 min was retained at 60°C, after that the column was heated at a rate of 5°C min-1 until it reached at 220°C and maintained in this condition for 5 min. The percentage of relative amounts was calculated from peak area using a Shimadzu C-R4A Chromatopac without applying correction factors.

Gas Chromatography - Mass Spectrometry (GC/MS)

The GC/MS unit consisted of a Varian Model 3400 gas chromatograph coupled to a Saturn II ion trap detector was used . The column was same as GC, and the GC conditions were as above. Mass spectrometer conditions were: ionization potential 70 eV; electron multiplier energy 2000 V. The identity of the oil components was established from their GC retention indices, relative to C7- C25 n-alkanes, by comparison of their MS spectra with those reported in the literature [28-30], and by computer matching with the Wiley 5 mass spectra library, whenever possible, by co-injection with standards available in the laboratories.

Results and Discussion

The yield of essential oil obtained by hydrodistillation from flower and leaves of the dried plant in full flowering stage is between 0.04 up to 1%. The composition of the essential oil of flower of *Tanacetum Polycephalum* subsp. *polycephalum* is listed in Table 1.

Twenty four to thirty constituents, representing 98 and 99 % of the total components in the oil, have been identified in the essential oil extracted from the flower and leaves of this plant which collected from different location in Azerbaijan province in Iran. As shown in Table 1. The major compound in the oil of Marand samples for leaf were 1,8-cineole (63.5%), chrysanthenone (5.5%) and for flower were chrysanthenone (39.5%), 1,8-cineole (18.9%), and Mianeh sample for leaf were 1,8-cineole (34.8%), chrysanthenone (16.1%) and for flower were dihydro-eudesmol (12%), nootkatin (9.6%), and for Tabriz sample for leaf were camphor (29%),1,8-cineole (14.3%), and for flower were trans- sabinene hydrate (56.7%), 1,8-cineole (10.7%). On the other hand the percent of the chemical compounds are not the same. These behaviors can be related to the plant parts, and also the ecological conditions of the plant habitats. Javidnia *et al*. (2008) analyzed the essential oil of *Tanacetum polycephalum*. subsp. *farsicum* Podl growing wild in Iran by GC and GC/MS. Thirty-eight components representing 84.5% of the total oil were identified. The main components of the oil were trans-chrysanthenyl acetate (24.7%), 1,8-cineole (9.2%), trans- chrysanthenol (8.9%), cis-chrysanthenyl acetate (7.1%) and cis-chrysanthenol (6.7%), which only 1,8-cineole were be common samples from Marand for leaves were 1,8-cineole (63.5%) [32].Nori-Shargh *et al*. (1999) studied the oils obtained by steam distillation of the flowers and leaves of *Tanacetum polycephalum* growing wild in Iran by a combination of GC and GC/MS.

About 10 compounds in the flowers and 10 compounds in the leaves have been identified. The main constituents of the oil of the flowers were camphor (59.1%), camphene (14.9%) and 1,8-cineole (10.1%), whereas the leaves oil comprised mainly camphor (53.5%), bornyl acetate (12.1%), camphene (10.9%), 1,8-cineol (7.8%) and borneol (6.1%), which only 1,8-cineole were be common [23]. Amiri (2007) also studied the chemical composition of the essential oil obtained by hydrodistillation from *Tanacetum polycephalum* by GC and GC/MS and identified 39 compounds constituting 94.02% of the oil which, the major components were borneol (28.3%), β-pinene (10.1%), α-pinene (6.5%), camphene (6.0%), α-terpineol (5.2%) and 1,8-cineol (5.1%) (32). From the study of Sefidkon *et al*. (2007) on different varieties of *T. polycephalum* subsp. *polycephalum* essential oil, main components were identified as camphor (15.0%-37.3%), 1,8-cineole (7.2%-8.8%), borneol (7.4%-9.4%) and β-thujone (0.7%-7.2%) [32].

The comparing of the chemical compounds in the essential oil of *Tanacetum polycephalum* Subsp. *polycephalum* flower and leaf with other species [31, 32] show that most of the compounds in the oils of this flower and others are not similar. On the other hand the percent of the chemical compounds are not the same. These behaviors can be related to the type of the plant, aerial or flower and leaf parts and also the geographical regions of the plant growing places. The results can help to do more investigation for antibacterial activities of the oil. Comparing the results of different studies on essential oil composition of *T. polycephalum* reveals that their

constituents are variable according to their habitat that may be regarded to different chemotyps

Table 1 Percentage composition of essential oil of the leaves and flowers of *Tanacetum polycephalum* subsp. *polycephalum* from different parts of Azerbaijan province (Marand, Mianeh and Tabriz), Iran

Compound	R.I.[a]	Marand		Mianeh		Tabriz	
		Leaves	Flowers	Leaves	Flowers	Leaves	Flowers
2-heptanone	897	-	-	-	-	-	2.2
α-pinene	932	-	0.8	-	-	-	0.5
Camphene	950	-	3.0	2.1	1.0	-	0.9
β-pinene	978	-	-	0.5	-	-	0.3
β-myrcene	992	0.4	-	-	-	-	0.2
α-terpinene	1017	1.1	2.0	3.9	-	-	1.4
1,8-cineole	1030	63.5	18.9	34.8	0.6	14.3	10.7
(E)-β-ocimene	1044	-	-	0.6	-	-	0.2
Artemisia ketone	1063	-	-	0.5	-	-	0.2
trans-linalool oxide	1071	0.5	-	-	-	-	-
trans-sabinene hydrate	1099	0.5	1.8	-	1.7	13.8	56.7
trans-thujone	1113	-	0.4	-	0.7	2.0	4.7
Chrysanthenone	1130	5.5	39.5	16.1	1.1	3.1	6.3
Camphor	1145	2.2	7.8	6.6	4.1	29.0	4.1
Neo-3-thujanol	1154	0.8	1.1	1.7	-	2.4	1.3
δ-terpineol-borneol	1165	0.9	2.4	3.0	2.1	2.0	0.8
Terpin-4-ol	1175	-	-	0.7	0.6	0.7	0.3
Iso-dihydrocarveol	1212	-	-	0.6	1.6	-	0.5
trans-chrysanthenyl acetate	1245	-	-	-	1.0	1.0	-
cis-ethyl chrysanthemumate	1271	-	0.7	1.8	3.6	4.1	1.4
Bornyl acetate	1286	1.0	1.3	1.2	3.6	1.7	0.7
Methyl decanoate	1325	-	-	-	-	0.7	-
Neryl acetate	1362	-	0.4	0.8	1.6	1.5	0.3
Carvacrol acetate	1375	-	0.4	0.7	1.9	-	0.2
Aromadendrene	1441	-	-	0.9	0.6	-	-
α-himachalene	1450	-	-	-	3.5	-	-
n-dodecanol	1468	0.6	-	-	1.2	-	-
Germacrene D	1488	-	-	-	2.7	-	-
Viridiflorene	1496	-	0.5	3.4	2.5	-	0.5
β-sesquiphellandrene	1522	-	-	0.6	0.7	-	-
trans-calamenene	1531	-	-	-	2.9	-	-
cis-calamenene	1541	0.4	-	-	3.3	0.6	1.1
α-calacorene	1546	6.6	4.2	8.9	1.5	7.2	1.3
Germacrene B	1560	1.6	0.9	-	5.6	0.6	-
n-tridecanol	1570	0.6	0.6	0.4	0.7	-	-
Geranyl isovalerate	1608	0.6	-	-	1.4	1.0	0.2
Humulene epoxide II	1612	1.0	-	-	0.8	3.1	0.2
β-cedrene epoxide	1623	0.5	-	-	2.0	-	-
γ-eudesmol	1630	1.5	2.0	0.8	1.4	3.1	0.5
α-muurolol	1647	1.0	0.9	0.5	1.7	0.7	0.3
Dihydro-eudesmol	1660	2.3	2.1	4.1	12.0	-	0.3
n-tetradecanol	1671	-	-	0.9	-	-	-
Germacrone	1694	-	-	1.1	4.7	-	-
Curcumenol	1735	-	-	-	1.9	1.1	-
(E, Z)-farnesol	1749	2.6	1.1	-	-	-	-
Cyclopentadecanolide	1834	2.8	2.0	1.5	9.1	1.6	0.6
n-nonadecane	1896	-	0.4	-	-	-	-
Phytol	1943	-	-	-	1.2	-	-
Nootkatin	1960	-	0.7	-	9.6	2.2	-
Iso-bergaptene	2034	0.5	-	-	-	0.6	-
n-octadecanol	2084	-	-	-	-	0.7	-
n-heneicosane	2106	-	0.8	-	0.7	-	-
n-tricosane	2288	-	1.6	-	1.8	-	-

[a]R.I.: Retention Indices

References

1. Kadereit JW, Jeffrey C, (eds.). Flowering plants vol. VIII. Eudicots. Asterales. Springer-Verlag Press. Berlin Heidelberg. 2007.

2. Funk VA, Susanna A, Stuessy T, Bayer R, (eds.). Systematics, Evolution and Biogeography of the Compositae. International Association for Plant Taxonomy. Washington D.C. 2009.
3. Watanabe W. Index to chromosome numbers in Asteraceae. http://www-asteraceae.cla.kobe-u. ac.jp/index.html. 2002.
4. Carr GD, King RM, Powell AM, Robinson H. Chromosome number in Compositeae XVIII. Am. J. Bot. 1999;86:1003-1013.
5. Valles J, Torrell M, Garcia–Jacas T, Vilatersana N, Susanna A. The genus Artemisia and its allies: phylogeny of subtribe Artemisiinae (Asteraceae) based on nucleotide sequence on nuclear ribosomal DNA internal transcribed spacers (ITS). Plant Biol. 2003;5:274-278.
6. Chehrehani A, Mehanfar N. New chromosome counts in the tribe Anthemideae (Asteraceae) from Iran. Cytologia. 2008;73:189-196.
7. Chehrehani A, Hajisadeghian S. New chromosome counts in some species of Asteraceae from Iran. Nordic J. Bot. 2009;27:247-250.
8. Brown AMG, Edwards CM, Hartman TVP, Marshal JA, Smith RM, Davey MR, Power JB, Lowe KC. Sexual hybrids of *Tanacetum*: biochemical, cytological and pharmacological characterization. J. Exp. Bot. 1999;50:435-444.
9. Arthur ED, Plummer AP. Biogeography and management of native western shrubs: a case study, section Tridentatae of Artemisia. Great Basin. Nat. Memories. 1978;2:229-243.
10. Mabberley DJ. The plant book. Cambridge University Press. Cambridge, U.K. 1990.
11. Ling YR. The old world Seriphidium (Compositae). Bullet. Bot. Res. (Harbin). 1991a;11:1-40.
12. Ling YR. The old world Artemisia (Compositae). Bullet. Bot. Res. (Harbin). 1991b 12:1-108.
13. Ling YR. The new world Artemisia L. In Advances in Compositae Systematics. Royal Botanic Gardens, Kew, U.K. 1995a; pp: 255-281.
14. Ling YR. The new world Seriphidum (Besser) Fourr. In Advances in Compositae Systematics. Royal Botanic Gardens, Kew, U.K. 1995b; pp: 283-291.
15. Bremer K, Humphries CJ. Generic monograph of the Asteraceae-Anthemideae. Bullet. Nat. Hist. Mus. London (Botany). 1993;23:71-177.
16. Kadereit JW, Jeffrey C. (eds.). Flowering plants vol. VIII. Eudicots. Asterales. Springer-Verlag Press. Berlin Heid elberg. 2007.
17. Funk VA, Susanna A, Stuessy T, Bayer R. (eds.). Systematics, Evolution and Biogeography of the Compositae. International Association for Plant Taxonomy. Washington D.C. 2009.
18. Judd WS, Campbell CS, Kellogg EA, Steves PF. Plant systematic a phylogenetic approach. Massachusetts, USA. 1999.
19. Watson LE, Evans TM, Olurat ET. Molecular phylogeny and biogeography of tribe Anthemideae (Astraceae) based on chloroplast gene ndhf. Mol. Phylogen. Evol. 2000;15:59-69.
20. Rechinger KH. (ed.). Flora Iranica, Anthemideae. Vol. 158, pp. 118-119. Toribus D. PODLECH, Munchen, & aliis. 1986.
21. Mozaffarian V. A Dictionary of Iranian Plant Names. Farhang Moaser, Tehran, Iran. 1996.
22. Zargari A. Medicinal Plants. Vol 3. Tehran University Press, Tehran, Iran. 1996;pp: 321-322.
23. Nori-Shargh D, Norouzi-Arasi H, Mirza M, Jaimand K, Mohammadi S. Chemical composition of the essential oil of *Tanacetum polycephalum* (Schultz Bip. ssp. heterophyllum), Flavour Fragr. J. 1999;14:105–106.
24. Javidnia K, Miri R, Soltani M, Khosravi AR.. Composition of the essential oil of *Tanacetum polycephalum* Schultz Bip. subsp. farsicum Podl. from Iran. 2008;20:209-211.
25. Najafi Gh, Sefidkon F, Mozaffarian V, Zare-Maivan H. The Essential Oil of *Tanacetum polycephalum* Schultz-Bip. Sub sp. *argyrophyllum* (K. Koch.) Podlech from Iran, J Essent. Oil Res. 2007;19:460-462.
26. Polatoglu K, Demirci F, Demirci B, Gören N, Can Baser KH. Antimicrobial Activity and Essential Oil Composition of a New T. argyrophyllum (C. Koch) Tvzel var. argyrophyllum Chemotype. 2010.
27. Amiri H. Chemical Composition, Antibacterial and Antioxidant Activity of the Essential Oil of *Tanacetum polycephalum* Schutz. Bip. Int. J. Bot. 2007;3:321-324.
28. Shibamoto T. Retention Indices in Essential Oil Analysis. In: Capillary Gas Chromatography in Essential oil analysis. Edits., P.Sandra and C.Bicchi, pp. 259-274, Dr. Alfred Huethig Verlag, Heidelberg. 1987.
29. Davies NW. Gas Chromatographic Retention Index of Monoterpenes and Sesquiterpenes on Methyl silicone and Carbowax 20 M phases. J. Chromatogr. 1990;503:1-24.
30. Adams RP. Identification of essential oils by Ion trap Mass Spectroscopy. Academic Press, San Diego, CA.1989.
31. Amiri H. Chemical Composition, Antibacterial and Antioxidant Activity of the Essential Oil of *Tanacetum polycephalum* Schutz. Bip. Int. J. Bot. 2007;3:321-324.
32. Sefidkon F, Najafi GH, Mozaffarian V. Essential oil variability Of eight populations Of *Tanacetum polycephalum* from Iran, Trade Science Inc. 2007; 3(1):75-79