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ESSENTIAL OIL COMPOSITION OF FEVERFEW (*Tanacetum parthenium*) IN WILD AND CULTIVATED POPULATIONS FROM IRAN

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Tanacetum parthenium (L.) Schultz-Bip. (feverfew) belongs to the family Asteraceae and subfamily Anthemideae and is distributed all over the world [1, 2]. In the flora of Iran 26 annual and perennial species are grown naturally, 12 of which are endemic [3]. The leaves of *T. parthenium* have a long reputation in folk for the treatment of headaches, rheumatoid arthritis, skin rashes, and menstrual cramps [4, 5]. Over the past 15 years, numerous pharmacological, chemical, and clinical studies have confirmed the value of the use of feverfew preparations in the symptomatic relief of migraine symptoms and other activities [5–8]. Most of the studies reported so far emphasized the analysis and quantification of the sesquiterpene lactones (e.g., parthenolides, canin, and santamarin) and flavonoid glycosides (e.g., luteolin, tanetin, and apigenin) of the plant [9–16]. The identification of the oil components of *T. parthenium* by hydrodistilled and supercritical fluid extraction (SFE) was reported in [13, 17]. The purpose of our investigation was to compare the essential oil composition of aerial parts of *T. parthenium* between growing wild populations, which has not been studied previously, and one foreign imported accession as a cultivated plant in Iran.

The essential oil contents of *T. parthenium* based on the dry weight of wild and cultivated plants were 0.1 and 0.4% (w/w), respectively. The essential oil compositions are presented in Table 1, where all compounds are arranged in order of their elution on the DB-1 column. In total, 33 and 30 constituents were identified and quantified in wild and cultivated samples, representing 95.7 and 97.5% of the total oil, respectively. In the oil of the wild sample, camphor (50.5%), germacrene-D (9.2%), camphene (7.7%), and (*E*)-sesquilavandulol (4.8%) were the main compounds, while camphor (57.6%), (*E*)-chrysanthenyl acetate (25.1%), camphene (4.6%), and bornyl angelate (2.2%) were detected as the major constituents in the oil of the cultivated sample. It is noteworthy that (*E*)-chrysanthenyl acetate and bornyl angelate were only observed in the oil of the cultivated sample and (*E*)-sesquilavandulol (4.8%) and (*E*)-myrtanol (4.7%) were completely absent in the oil of this sample.

The classification of the identified compounds, based on functional groups, is summarized at the end of Table 1. As can be seen, oxygenated monoterpenes were the main group of compounds in the oil of cultivated (85.9%) and wild (60.6%) samples. The oil of wild plants consisted mainly of ten monoterpene hydrocarbons (11.6%), nine oxygenated monoterpenes (60.6%), eight sesquiterpene hydrocarbons (14.9%), and six oxygenated sesquiterpenes (8.6%), while the oil of cultivated plants consisted principally of nine monoterpene hydrocarbons (6.8%), thirteen oxygenated monoterpenes (85.9%), four sesquiterpene hydrocarbons (1.9%), and four oxygenated sesquiterpenes (2.9%).

Our results revealed that camphor + chrysanthenyl acetate could be introduced as the chemotype of the cultivated sample, whereas for the wild sample camphor + germacrene-D could be characterized as the chemotype. These findings may have originated from their different genotypes and different climatic, edaphic, and ecological factors where they are grown.

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TABLE 1. Essential Oil Composition of Wild and Cultivated Samples of *T. parthenium* from Iran

Component	RI	Wild, %	Cultivated, %	Component	RI	Wild, %	Cultivated, %
Tricyclene	926	1.1	0.2	Bornyl acetate	1274	1.5	1.4
α-Pinene*	935	0.5	0.3	Neryl acetate	1352	-	Tr.
Dihydrosabinene	940	0.2	-	β-Terpinyl acetate	1359	-	0.1
Camphene	950	7.7	4.6	α-Copaene	1385	0.3	Tr.
Sabinene	970	0.2	Tr.	β-Elemene	1393	0.1	-
β-Pinene*	976	0.4	Tr.	(*E*)-Caryophyllene	1426	0.3	0.5
α-Phellandrene	1002	0.1	-	(*Z*)-β-Farnesene	1449	2.1	1.2
p-Cymene	1016	0.5	1.1	γ-Gurjunene	1480	0.1	-
Limonene	1025	0.5	0.3	(*Z*,*E*)-α-Farnesene	1482	1.5	-
γ-Terpinene	1052	0.4	0.3	Germacrene-D	1485	9.2	0.2
Terpinolene	1083	-	Tr.	Bicyclogermacrene	1501	1.1	-
Linalool*	1086	-	0.2	δ-Cadinene	1522	0.2	-
Filifolone	1088	1.4	-	Bornyl angelate	1556	-	2.2
Chrysanthenone	1107	1.3	-	Spathulenol	1575	0.4	-
α-Campholenal	1111	-	0.4	Caryophyllene oxide	1584	-	0.4
α-Cyclocitral	1121	-	0.1	Viridiflorol	1605	0.6	0.1
Camphor	1135	50.5	57.6	(*E*)-Sesquilavandulol	1618	4.8	-
Pinocarvone	1147	Tr.	Tr.	α-Cadinol	1651	1.5	0.2
Borneol*	1157	0.6	0.5	Valeranone	1670	0.1	-
4-Terpineol	1168	0.5	0.5	(*Z*)-Nucliferol acetate	1846	1.2	-
α-Terpineol	1180	-	Tr.	Monoterpene hydrocarbons		11.6	6.8
(*E*)-Carveol	1197	-	Tr.	Oxygenated monoterpenes		60.6	85.9
(*E*)-Chrysanthenyl acetate	1222	-	25.1	Sesquiterpene hydrocarbons		14.9	1.9
(*E*)-Myrtanol	1265	4.7	-	Oxygenated sesquiterpenes		8.6	2.9
Lavandulyl acetate	1271	0.1	-	Total		95.7	97.5

RI: retention indices relative to C6-C24 *n*-alkanes on the DB-1 column; Tr.: trace <0.1%.
Method of identification: RI, MS; *RI, MS, Col.

The seeds of *T. parthenium* as foreign accession were obtained from the Botanical Garden of Zagreb University, Croatia and were sowed in a greenhouse in February 2003. The seedlings were transplanted in the experimental field located in the north of Tehran (35° 48′ 285″ N, 51° 23′ 494″ E and altitude 1785 m) in May 2003. The aerial parts of 2-year-old cultivated populations were collected at the full flowering stage in July 2004. Also, the aerial parts of growing wild populations of the plant were gathered during full flowering from Tehran province: Fasham road, Oshan at an altitude of 2000 m in August 2004. Plant material was taken immediately to the laboratory to be dried at ambient temperature. Voucher specimens of wild and cultivated samples with herbarium numbers of MP-886 and MP-887, respectively, have been deposited at the Medicinal Plants and Drugs Research Institute Herbarium, Shahid Beheshti University of Tehran.

Air-dried aerial parts (100 g) of each sample were subjected to hydrodistillation for 3 h using a Clevenger-type apparatus. The distilled oils were dried over anhydrous sodium sulfate and stored in tightly closed dark vials at 4°C until analysis. All of the oils were light yellow and had a distinct sharp odor.

Gas Chromatography Analysis. GC analysis was performed using a Thermoquest-Finnigan gas chromatograph equipped with a fused silica capillary DB-1 column (60 m × 0.25 mm, film thickness 0.25 μm). Oven temperature was increased from 60°C to 250°C at a rate of 4°C/min. Injector and detector (FID) temperatures were kept at 250°C and 280°C, respectively. Nitrogen was used as the carrier gas at a flow rate of 1.1 mL/min.

Gas Chromatography-Mass Spectrometry Analyses. GC-MS analysis was carried out on a Thermoquest-Finnigan Trace GC-MS instrument equipped with a DB-1 fused silica capillary column (60 m × 0.25 mm i.d., film thickness 0.25 μm). The oven temperature was raised from 60°C to 250°C at a rate of 5°C/min, then held at 250°C for 10 min. Transfer line

temperature was 250°C. Helium was used as the carrier gas at a flow rate of 1.1 mL/min. Split ratio was kept at 1/50. The quadrupole mass spectrometer was scanned over 45–465 amu with an ionizing voltage of 70 eV and an ionization current of 150 μA.

Identification of Compounds. The constituents of the essential oils were identified by calculation of their retention indices under temperature-programmed conditions for *n*-alkanes (C_6–C_{24}) and the oil on a DB-1 column under the same chromatographic conditions. Identification of individual compounds was made by comparison of their mass spectra with those the internal reference mass spectra library or with authentic compounds and confirmed by comparison of their retention indices with authentic compounds or with those reported in the literature [18, 19]. For quantification purpose, relative area percentages obtained by FID were used without the use of correction factors.

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