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ESSENTIAL OIL COMPOSITION OF *Tanacetum kotschyi* FROM TURKEY

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Tanacetum kotschyi (Boiss.) Grierson is a delicate small sized (8–20 cm) perennial herb growing in cracks on limestone slopes or screes at 1450–3580 m altitude. This species naturally grows in eastern Anatolia [1]. To the best of our knowledge, this is the first report on the chemistry of *T. kotschyi.*

Tanacetum species generally have essential oils with a high content of camphor, 1,8-cineole, thujone, borneol, chrysanthenyl alcohols, and esters [2]. In rare occasions some *Tanacetum* species were also found to be rich in carvone, pinane, and irregular monoterpenes [3–5].

Various biological activities have been reported for the essential oils of *Tanacetum* species [6–9]. The anticancer activity of *T. gracile* essential oil with a high lavandulol content has been reported [10]. *Tanacetum* species are also rich in sesquiterpene lactones and flavonoids, which have been shown to possess various biological activities [11]. In our ongoing phytochemical and activity screening project of *Tanacetum* species in Turkey, here we report on the essential oil composition and antioxidant property of *T. kotschyi*.

Plant materials identified by Dr. Kerim Alpinar were collected during the flowering period in 27 July 2006 from Guzeldere – Van at 2800 m altitude and deposited at the Herbarium of the Faculty of Science, Istanbul University (Voucher No. ISTE 83754), Turkey. Oils were obtained separately from flowers and stems (100 g each) with 0.25 (v/w) and 0.15 (v/w) yields by hydrodistillation. The essential oil analyses were performed simultaneously by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) systems. Analyses were done with Agilent 6890N GC and Agilent 5975 GC-MSD systems equipped with an Innowax FSC column. Identification of essential oil components was achieved by peak matching as well as by comparison of their retention times with authentic samples, or by comparison of their relative retention index (RRI) to series of *n*-alkanes. Computer matching against commercial (Wiley GC/MS Library, Adams Library, MassFinder 2.1 Library) [12] and in-house "Baser Library of Essential Oil Constituents" built up of genuine compounds and components of known oils, as well as MS literature data [13, 14], was used for identification. Antioxidant activities of the oils were determined with DPPH radical protocol [15]. A modified protocol for HPTLC-DPPH [16] was used.

The compounds identified in the flower and stem oils of *T. kotschyi* are given in Table 1 with percentages. Sixty-seven and eighty-two compounds were detected representing 90.5% (A), 81.1% (B) of *T. kotschyi* flower and stem oils, respectively. The flower and stem oils are dominated by oxygenated monoterpenes (71.3%, 44.6) and oxygenated sesquiterpenes (13.5%, 28.1%). The flower and stem oils are rich in irregular monoterpene artemisia ketone 54.6% (A), 26.5% (B), longiverbenone (vulgarone B), 9.2% (A), 8.9 (B) and artemisia alcohol 4.6% (A), 5.2% (B). Stem oil is also rich in intermedeol (9%). High content of irregular monoterpenes is rare in *Tanacetum* species. According to previous literature on *T. vulgare* essential oils, various chemotypes with a high content of artemisia ketone were reported [17]. However, until now no other *Tanacetum* species has been reported to have a high content of artemisia ketone. The DPPH scavenging properties of the oils and positive control for 15 mg/mL concentration: A, 1.36 ± 0.73%, B, 11.92 ± 4.14%, α-tocopherol, 94.6 ± 0.96% (results are given in means of three parallel experiments with SD). Insignificant activity was observed in both oils when compared with the positive control α-tocopherol.

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TABLE 1. Composition (%) of Flower (A) and Stem (B) Oils of *Tanacetum kotschyi*

Compound	RRI	A, %	B, %	Compound	RRI	A, %	B, %
α-Pinene	1032	0.4	0.2	Naphthalene	1763	0.1	0.1
Camphene	1076	0.1	0.1	δ-Cadinene	1773	0.5	0.8
Hexanal	1093	Tr.	–	7-*epi*-α-Selinene	1785	–	0.1
β-Pinene	1118	0.1	0.2	Myrtenol	1804	0.1	0.1
2-Methyl butyl acetate	1136	0.3	0.4	Nerol	1808	0.1	–
Limonene	1203	Tr.	0.2	*trans*-*p*-Mentha-1(7),8-dien-2-ol	1811	–	0.1
1,8-Cineole	1213	0.7	1.9	*trans*-Carveol	1845	–	0.1
2-Pentylfuran	1244	Tr.	–	Calamenene	1849	0.2	0.4
γ-Terpinene	1255	–	Tr.	Geraniol	1857	0.4	0.1
2-Methyl butyl butyrate	1275	–	0.1	*cis*-*p*-Mentha-1(7),8-dien-2-ol	1896	–	0.1
p-Cymene	1280	Tr.	0.1	*epi*-Cubebol	1900	0.5	1.6
Isoamyl isovalerate	1285	Tr.	0.1	α-Calocarene	1941	0.1	0.1
Octanal	1296	Tr.	–	Cubebol	1957	0.6	2.2
Artemisia ketone	1358	54.6	26.5	Caryophyllene oxide	2008	0.7	2.1
Yomogi alcohol	1403	4.6	2.4	*trans*-β-Ionone-5,6-epoxide	2009	–	0.1
Artemisyl acetate	1429	0.2	0.1	Isoamylphenyl acetate	2016	–	0.1
α-Cubebene	1466	–	0.1	(*E*)-Nerolidol	2050	0.2	0.3
Longipinene	1482	0.3	1	Caryophylla-2(12),6(13)-dien-5-one	2074	0.2	0.7
α-Ylangene	1493	–	0.1	Cubenol	2080	0.3	0.1
α-Copaene	1497	0.2	0.3	1-*epi*-Cubenol	2088	0.5	0.1
α-Campholene aldehyde	1499	–	Tr.	Spathulenol	2144	0.5	0.3
Artemisia alcohol	1510	4.6	5.2	*T*-Muurolol	2209	0.3	0.6
Longicyclene	1513	–	Tr.	Phenyl ethyl tiglate	2214	0.1	–
Camphor	1532	0.4	1.6	α-Bisabolol	2232	Tr.	0.3
Benzaldehyde	1541	0.1	Tr.	*trans*-α-Bergamotol	2247	–	0.1
Linalool	1553	2.3	0.6	Intermedeol (11-eudesmol-4)	2264	–	9
Octanol	1562	Tr.	0.1	Longiverbenone (Vulgarone B)	2265	9.2	8.9
cis-Chrysanthenyl acetate	1582	Tr.	0.4	Caryophylladienol I	2316	0.1	0.3
Pinocarvone	1586	0.3	–	Tricosane	2300	0.3	–
Myrcenone	1591	Tr.	–	Caryophylladienol II	2324	0.3	0.9
β-Elemene	1600	Tr.	–	10-Hydroxycalamenene	2376	–	0.2
Terpinen-4-ol	1611	0.2	0.3	1-Heptadecanol	2384	–	0.1
Lavandulyl acetate	1617	0.9	1.9	Caryophyllenol II	2392	0.1	0.2
Hexyl tiglate	1631	Tr.	–	Pentacosane	2500	0.6	0.2
trans-*p*-Mentha-2,8-dien-1-ol	1639	–	0.1	1-Octadecanol	2607	0.3	0.4
Myrtenal	1648	0.1	0.1	Phytol	2622	–	0.7
cis-Verbenol	1663	Tr.	–	Tetradecanoic acid	2670	–	Tr.
Citronellyl acetate	1668	–	0.3	Heptacosane	2700	0.5	0.3
(*Z*)-β-Farnesene	1668	–	0.1	Benzyl phenyl acetate	2718	–	0.1
trans-Pinocarveol	1670	0.2	0.2	1-Eicosanol	2795	–	0.1
(*Z*)-3-Hexenyl tiglate	1681	Tr.	–	Benzyl salicylate	2804	0.1	0.1
trans-Verbenol	1683	0.3	0.6	Pentadecanoic acid	2822	–	Tr.
Lavandulol	1686	0.2	0.7	Nonacosane	2900	Tr.	0.1
Heptadecane	1700	–	Tr.	Hexadecanoic acid	2931	1.7	1.7
α-Terpineol	1706	0.6	0.6	Monoterpenes		0.6	0.8
Borneol	1719	Tr.	0.2	Oxygenated Monoterpenes		71.3	44.6
Bicyclosesquiphellandrene	1722	Tr.	0.1	Sesquiterpenes		1.3	3.1
Verbenone	1725	0.2	0.1	Oxygenated Sesquiterpenes		13.5	28.1
Germacrene D	1726	–	0.1	Others		3.8	4.5
α-Muurolene	1740	–	0.1	Total		90.5	81.1
β-Selinene	1742	Tr.	–				

RRI: Relative retention indices; Tr.: trace (< 0.1%).

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