Essential Oil Composition of *Tanacetum parthenium* from Eastern Black Sea Region, Turkey

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Summary

Feverfew (*Tanacetum parthenium L.*), which belongs to the family Asteraceae, is a perennial herbaceous plant with small flowers like chamomile. In this study, we investigated the essential oil composition of *Tanacetum parthenium* collected from Gumushane Province, Turkey. Forty-four components representing 86.04% of the oil were identified in the essential oil of aerial parts of *T. parthenium* obtained by hydrodistillation and examined by GC and GC-MS. The main component of the sample was camphor (39.47%), followed by guaiol (5.21%), caryophyllene oxide (3.91%), bornyl acetate (3.09%), (E)-verbenol (2.68%), camphene (2.29%) and α-cadinol (2.12%). Presence of camphor highlighted the potential of this plant as a drug source in the alternative medicine due to its antiseptic, antipruritic, aphrodisiac, contraception and lactation suppressant effects. Guainol was found in this study for the first time in *T. parthenium*. In addition, other important finding was the lack of trans-chrysanthenyl acetate in our *T. parthenium* sample.

Key words

Tanacetum parthenium; feverfew; essential oil; GC-MS; camphor; guaiol

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Introduction

Feverfew (*Tanacetum parthenium* L.) from the family Asteraceae is an aromatic herb native to Europe, America, North Africa and Asia (Pareek et al., 2011). It is a bushy perennial, 30-100 cm high with yellow-green leaves almost hairless and less than 8 cm in length (Lim, 2014). The plant is used in the treatment of migraine headaches, high fever and arthritis in traditional medicine (Newall et al., 1996), and shows anti-inflammatory (Mathema et al., 2012; Wang and Li, 2015), antibacterial (Izadi et al., 2010; Mohsenzadeh et al., 2011), antifungal (Hethelyi et al., 1991; Neszmelyi et al., 1992) and insecticidal effects (Pavela et al., 2010). Nowadays, its dried herbal preparations in capsule and tablets have been sold as food supplement products and disease prevention in world markets (Awang, 2009). The major constituents of *T. parthenium* oils were reported to be camphor, trans-chrysanthenyl, camphene, bornyl acetate and p-cymene (Saharkiz et al., 2007; Omidbaigi et al., 2007; Haziri et al., 2009; Stevanović et al., 2009, 2016; Mojab et al., 2010; Izadi et al., 2010; Mohsenzadeh et al., 2011. These studies also showed that the composition of volatile oil could vary depending on genotype, climatic conditions and location. Available literature on the essential oil composition of *T. parthenium* in Turkey is very limited (Akpulat et al., 2005; Polatoglu et al., 2010). Therefore, in this paper we report the essential oil composition of *T. parthenium* wild-growing in the Eastern Black Sea Region of Turkey.

Material and methods

Plant materials

The plant material was collected from the Kose Mountain, Gumushane, Turkey, which is located at a crossing region between the Euro-Siberian and Irano-Turan floristic regions, during the flowering season at an altitude of 1908 m in August 2016. The taxonomic identification of plant material was confirmed by a senior plant taxonomist, Ali Kandemir, from the Department of Biology, Erzincan University, Erzincan, Turkey. The collected plant material was dried in shadow and ground by grinder with a 2 mm in diameter mesh. The voucher specimen has been deposited at the Herbarium of the Department of Science, Erzincan University, Education Faculty, Erzincan, Turkey.

Isolation of essential oils

The aerial parts of air-dried plant samples were subjected to hydrodistillation using a Clevenger-type apparatus for three hours (0.62% yield). The obtained essential oil was dried over anhydrous sodium sulphate, filtered, and then, stored at +4°C until analysis.

GC and GC-MS analysis conditions

The analysis of the essential oil was performed using a Thermofinnigan Trace GC/A1300, (E.I) equipped with a SGE/BPX5 MS capillary column (30 m x 0.25 mm i.d., 0.25 μm). Helium was the carrier gas, at a flow rate of 1 mL/min. Injector temperature was set at 220°C. The programme used was 50-150°C at a rate of 3°C/min, held isothermal for 10 minutes and finally raised to 250°C at 10°C/min. Diluted samples (1/100, v/v, in methylene chloride) of 1.0 μL were injected manually and in the splitless mode. Quantitative data were obtained from FID area percentage data. GC-MS detection an electron ionization system with ionization energy of 70 eV was used. Injection and MS transfer line temperatures were set at 220°C and 290°C, respectively. The components were identified based on the comparison of their relative retention time and mass spectra with those of standards, Wiley7N, TRLIB library data of the GC-MS system and literature data. The results were also confirmed by the comparison of the compounds elution order with their relative retention indices on non-polar phases reported in the literature (Adams, 2007).

Results and Discussion

The essential oil yield (v/w, on dried mass basis) of *T. parthenium* was 0.62%, similar to those reported previously for *T. parthenium* (0.10–0.83%) (Hendriks et al., 1996; Omidbaigi et al., 2007; Mirjalili et al., 2007; Polatoglu et al., 2010; Stanković et al., 2016).

The results of the analysis of *T. parthenium* essential oils are given in Table 1. In the current study, the oil from aerial parts of *T. parthenium* was analyzed with GC/MS and the analysis allowed the identification of total 44 compounds, which represented 86.04% of the essential oil (Table 1). The main components of the oil were camphor (39.47%), guaiol (5.21%), caryophyllene oxide (3.91%), bornyl acetate (3.09%) and (E)-verbenol (2.68%) (Table 1).

In general, camphor is known to be the main component of *T. parthenium* essential oil, with percentages ranging from 18.34 to 63.00 (Hendriks et al., 1996; Akpulat et al., 2005; Stevanović et al., 2009; Mojab et al., 2010; Stanković et al., 2016). As can be seen from these data, camphor percentage of our essential oil sample was similar to the previous studies. These differences may be related to genotypic differences and the presence of conditions that promote camphor synthesis (Lim, 2014).

Trans-chrysanthenyl acetate is a component found in *T. parthenium* plant, with percentages ranging from 13.83 to 33.8 (Hendriks et al., 1996; Mojab et al., 2007; Omidbaigi et al., 2007; Rateb et al., 2007; Saharkhiz et al. 2007; Stevanović et al., 2009; Izadi et al., 2010; Stanković et al., 2016) Interestingly, we could not detect trans-chrysanthenyl acetate in our sample. The lack of trans-chrysanthenyl acetate was surprising. However, some researchers (Akpulat et al., 2005; Haziri et al., 2009) reported that *T. parthenium* essential oil did not contain trans-chrysanthenyl acetate. Likewise, Polatoglu et al. (2010) investigated the essential oil of *T. parthenium* samples collected from two separate locations of Turkey and did not find trans-chrysanthenyl acetate in one of the samples. Consistent with our findings, the differential results regarding the presence of trans-chrysanthenyl acetate probably appear to be associated with genotypic differences and varying environmental conditions (Gosztola et al., 2010; Patel et al., 2016; Moniodis et al., 2018).

In our *T. parthenium* sample, guaiol constituted 5.21% of essential oil. It is generally known as a compound not found in *T. parthenium*. However, Haider et al. (2011) reported that *Tanacetum dolichophyllum* had very low guaiol percentage. This observation is consistent with our finding. The presence of guaiol may be due to genotypic and environmental variation.

In our study guaiol was for first time found in *T. parthenium* essential oil. In earlier studies conducted on this plant, guaiol

Table 1. Chemical composition of the essential oil of *Tanacetum parthenium* growing in Eastern Black Sea Region of Turkey

RI*	Components	Composition (%)	Identification
946	Camphene	2.29	GC–MS, RI, Col+
1020	p-cymene	0.80	GC–MS, RI, Col
1100	n-Nonanal	0.33	GC–MS, RI, Col
1118	(Z)-p-Menth-2-en-1-ol	2.09	GC–MS, RI, Col
1132	(Z)-Limonene oxid	0.83	GC–MS, RI, Col
1140	(E)-Verbenol	2.68	GC–MS, RI, Col
1141	Camphor	39.47	GC–MS, RI, Col
1165	Borneol	0.89	GC–MS, RI
1174	Terpinen-4-ol	0.95	GC–MS, RI
1179	(Z)-Pinocarveol	0.20	GC–MS, RI
1186	α-Terpineol	1.04	GC–MS, RI, Col
1207	(E)-Pipentol	0.55	GC–MS, RI
1204	Verbonone	0.32	GC–MS, RI
1249	Geraniol	0.74	GC–MS, RI
1258	(E)-Myrtanol	0.14	GC–MS, RI
1287	Bornyl acetate	3.09	GC–MS, RI
1289	Thymol	0.38	GC–MS, RI, Col
1298	Carvacrol	0.46	GC–MS, RI
1373	α-Yılangene	0.43	GC–MS, RI
1374	α-Copaene	1.50	GC–MS, RI
1417	β-caryophyllene	0.25	GC–MS, RI, Col
1440	(Z)-β-Farnasene	0.32	GC–MS, RI
1475	γ-Gurjunene	0.18	GC–MS, RI
1484	Germacrene D	0.31	GC–MS, RI
1509	Tridecanol	0.34	GC–MS, RI
1555	(E)-Veltonal	0.42	GC–MS, RI
1577	Spathulenol	1.42	GC–MS, RI
1582	Caryophyllene oxide	3.91	GC–MS, RI
1600	Guaiol	5.21	GC–MS, RI
1622	10-epi-γ-eudesmol	0.37	GC–MS, RI
1630	γ-Eudesmol	1.79	GC–MS, RI
1639	Caryophylla-4(12),8(13) diene 5 β-ol	2.09	GC–MS, RI
1649	β-Eudesmol	0.98	GC–MS, RI
1652	α-Cadinol	2.12	GC–MS, RI
1670	Bulsenol	0.54	GC–MS, RI
1685	α-Bisabolol	0.50	GC–MS, RI
1687	Eudesma-4(15),7-dien-1-b-ol	1.32	GC–MS, RI
1742	(2E,6E)-Farnesol	0.63	GC–MS, RI
1760	(Z)-Lanceol	0.49	GC–MS, RI
1803	14-Hydroxy-δ-cadinene	0.29	GC–MS, RI
1874	1-Hexadecanol	0.83	GC–MS, RI
1921	Methyl palmitate	0.20	GC–MS, RI
1959	n-Hexadecanoic acid	2.51	GC–MS, RI
2000	n-Eicosane	0.84	GC–MS, RI
Total		**86.04**	GC–MS, RI

*RI - retention index; +CoI - co-injection. Compounds listed in order of elution from a BPX5 MS column.

was not observed so far. These differences in the essential oil composition of *T. parthenium* may be attributed to varying ecological conditions.

Conclusion

This study examined the essential oil compositions of *T. parthenium* growing on the Kose Mountain, Gumushane, Turkey. The results of our study revealed that camphor was by far the most abundant component of *T. parthenium* essential oil. Another important finding of the current study, unlike most previous studies, was the lack of trans-chrysanthenyl acetate as main component in feverfew essential oil.

Taken together, these findings suggest that the variation in essential oil composition of *T. parthenium* may be greater than those previously thought. For this reason, much research is needed to evaluate the magnitude of variation in the volatile oil composition of *T. parthenium*.

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