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Comparative essential oil composition of various parts of the turpentine tree (*Pistacia terebinthus* L) growing wild in Turkey

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Abstract: The essential oil contents (dry weight basis) of young shoots, flowers, unripe and ripe fruits of the turpentine tree (*Pistacia terebinthus* L) were determined as 0.74, 0.70, 0.54 and 0.73% respectively. The main components identified by GC/MS analysis (the identified components represents 90.7, 96.1, 98.0 and 99.0% of the respective oils) were limonene (3.0, 9.4, 34.2 and 32.8%), α-pinene (5.3, 12.4, 15.6 and 5.3%), β-pinene (1.4, 8.0, 11.5 and 22.5%) and germacrene D (trace, 19.9, 3.5 and 4.6%). Minor qualitative and major quantitative variations in some compounds of the analysed oils were determined with respect to the different parts of the turpentine tree.

Keywords: *Pistacia terebinthus*; anacardiaceae; essential oils; limonene; α-pinene; β-pinene

INTRODUCTION

Pistacia terebinthus L is a typical representative of Mediterranean flora. The plant, a member of the family Anacardiaceae, is a dioecious tree which grows widely in southern and western regious of Turkey and is called 'menengiç' in Turkish. Its flowers, which appear between March and April in close compound clusters, are reddish-purple in colour and grow from the ends of the previous year's shoots. Its fruits are small globular nutlets which are dark greenish when ripe.[1] In Turkey the turpentine tree is found growing on dry rocky slopes and hillsides or in pine forests, particularly in the Taurus mountains, from just above sea level to 1600 m.[2,3]

In several regions of the world, different parts of the turpentine tree are exploited for various purposes. Archaeological evidence indicates that the nuts were being used as a food as early as 7000 BC. The young shoots and fruits are used for human nutrition. The fruits have been regarded as an appetiser in southern Turkey for several thousand years. The fruits are also used in the baking of a speciality village bread and as a coffee substituent either before or after roasting. In folk medicine, leaf extracts are used as a stomachic, and the fruits are used in the treatment of gastralgia (internally), rheumatism and cough (externally) and as a stimulant, diuretic and antitussive.[2,4]

Little is known about the composition of the essential oil of *P terebinthus*.[5,6] Papageorgiou *et al*[6] have reported the chemical composition of the essential oil of Chios turpentine resin, and α-pinene, β-pinene, sabinene and terpinen-4-ol were found as major components. The turpentine tree was also studied as an essential oil plant by Robeva *et al.*[7]

No detailed study on the essential oil composition of different parts of *P terebinthus* has been performed hitherto. The purpose of this research was to elucidate and compare the essential oil contents and components of young shoots, flowers, unripe and ripe fruits of the turpentine tree growing wild in southern Turkey.

MATERIALS AND METHODS

Plant material

Turpentine tree (*P terebinthus*) young shoots, flowers, unripe and ripe fruits were collected from plants growing wild in the Içel province (Büyükeceli/Gülnar) of Turkey in April, May, June and August respectively. The samples were transported in polypropylene bags to the laboratory and dried to constant weight at room temperature before analysis. Herbarium specimens were deposited at the Department of Biology, Selçuk University (Korrya, Turkey).

Reference compounds

Pure commercial oil components were purchased from Sigma Chemical Co (St Louis, MO, USA).

Recovery of essential oils

Prior to distillation the samples (200 g) were ground to pass a 1.0 mm screen. Dried and ground materials (100 g) from all the individual samples were subjected

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Table 1. Percentage composition of essential oils from various parts of *Pistacia terebinthus*

RI[a]	*Component*	*Young shoots*	*Flowers*	*Unripe fruits*	*Ripe fruits*	*Identification*
923	Tricyclene	tr	tr	tr	tr	a, b
936	α-Pinene	5.3	12.4	15.6	5.3	a, b
949	Camphene	2.2	2.2	4.3	0.7	a, b
980	β-Pinene	1.4	8.0	11.5	22.5	a, b
998	Myrcene	—	0.7	1.6	1.9	a, b
1005	α-Phellandrene	—	4.3	5.4	11.4	a, b
1022	*p*-Cymene	27.3	—	—	—	a, b
1028	Limonene	3.0	9.4	34.2	32.8	a, b
1048	(*E*)-β-Ocimene	—	0.2	0.7	1.8	a
1059	γ-Terpinene	tr	1.0	0.4	0.5	a, b
1086	Terpinolene	tr	0.8	6.9	7.0	a, b
1098	Linalool	—	tr	0.5	1.0	a, b
1121	α-Campholenal	4.2	—	—	—	a
1136	*trans*-Sabinol	3.8	—	—	0.3	a
1146	*trans*-Verbenol	8.8	—	—	—	a
1148	Camphor	—	tr	tr	0.2	a, b
1160	Borneol	—	tr	1.0	1.2	a, b
1172	Terpinen-4-ol	6.0	3.8	tr	0.7	a, b
1180	*p*-Methyl acetophenone	2.0	—	—	—	a
1183	*p*-Cymen-8-ol	4.6	—	—	—	a
1187	α-Terpineol	—	tr	1.4	1.6	a,b
1192	Myrtenal	1.7	—	—	—	a
1194	Myrtenol	tr	tr	tr	tr	a
1203	Verbenone	5.7	—	—	—	a
1214	*trans*-Carveol	1.0	tr	tr	tr	a
1239	Carvone	tr	tr	tr	—	a
1249	Piperitone	tr	tr	tr	tr	a
1282	Bornyl acetate	6.6	0.8	tr	tr	a
1290	*trans*-Verbenyl acetate	tr	—	—	—	a
1295	Carvacrol	tr	tr	tr	tr	a,b
1349	α-Cubebene	—	0.6	tr	tr	a
1373	α-Copaene	—	0.7	0.4	1.4	a
1382	β-Bourbonene	—	tr	tr	tr	a
1388	β-Cubebene	—	tr	tr	0.2	a
1416	(*E*)-Caryophyllene	tr	8.9	3.3	1.6	a,b
1430	β-Gurjunene	—	0.2	tr	tr	a
1436	Aromadendrene	tr	tr	tr	tr	a
1438	α-Humulene	—	2.3	1.5	0.8	a
1478	Germacrene D	tr	19.9	3.5	4.6	a
1483	β-Selinene	—	tr	tr	tr	a
1488	*cis*-β-Guaiene	—	tr	0.4	—	a
1492	α-Selinene	—	0.9	tr	tr	a
1494	Bicyclogermacrene	—	1.3	tr	tr	a
1496	α-Muurolene	—	0.9	0.5	tr	a,b
1503	α-Bulnesene	—	0.4	—	tr	a
1508	γ-Cadinene	—	0.7	0.6	tr	a,b
1522	δ-Cadinene	—	6.6	2.4	1.2	a,b
1531	Cadina-1,4-diene	—	0.6	tr	—	a
1535	α-Cadinene	tr	0.2	tr	tr	a
1546	Elemol	tr	0.4	tr	0.3	a
1552	Germacrene B	tr	tr	tr	tr	a
1559	Calacorene B	tr	tr	tr	—	a
1562	(*E*)-Nerolidol	tr	tr	tr	tr	a
1578	Caryophyllene oxide	7.1	0.6	tr	tr	a,b
1593	Guaiol	—	tr	tr	tr	a
1621	10-*epi*-γ-Eudesmol	—	1.9	tr	tr	a
1632	γ-Eudesmol	—	tr	1.0	tr	a
1643	*epi*-α-Muurolol	—	2.3	tr	tr	a
1649	β-Eudesmol	—	0.4	tr	—	a
1654	α-Eudesmol	—	tr	0.9	tr	a
1655	α-Cadinol	—	2.7	tr	tr	a
1676	Apiole	—	tr	—	—	a
Total (%)[b]		90.7	96.1	98.0	99.0	

[a] Retention indices relative to C_9–C_{24} *n*-alkanes on HP 5MS column.

[b] Relative percentage obtained from peak area.

a, Identification by RT and comparison with mass spectra.

b, Identification by RT and comparison with mass spectra; co-chromatography with authentic material.

tr, Trace (<0.1%).

to hydrodistillation for 3 h using a Clevenger-type apparatus. The essential oils obtained were dried over anhydrous sodium sulphate.

GC/MS analysis

GC/MS analysis was carried out using a Hewlett Packard (HP) 5973/6890 GC/MS system operating in the EI mode at 70 eV, equipped with an HP 5MS capillary column (30 m × 0.25 mm, film thickness 0.25 μm). The column was heated from 60 to 280 °C at a rate of 3 °C min^{-1}. The carrier gas was He at a flow rate of 1 ml min^{-1}. The split ratio was 1:10.

The identification of the compounds was based on comparison of their Kovats indices (RI), retention times (RT) and mass spectra with those obtained from authentic samples and/or the NIST/NBS and Wiley libraries and Ref 8.

RESULTS AND DISCUSSION

The components identified in the essential oils are listed in Table 1 in order of their experimental retention indices (RI).

All the essential oils exhibited a light yellow colour and a typical turpentine odour. The yields of the essential oils of dried young shoots, flowers, unripe and ripe fruits from *P terebinthus* were 0.74, 0.70, 0.54 and 0.73% (v/w) respectively. The essential oil yields of three parts (excluding unripe fruits) were found in similar amounts. GC/MS analysis of young shoot, flower, unripe and ripe fruit oils resulted in the identification of 32, 53, 51 and 48 components respectively.

The major constituents of young shoot oil were *p*-cymene, *trans*-verbenol, bornyl acetate, terpinen-4-ol and α-pinene, while germacrene D, α-pinene, limonene and β-pinene were established as the main components of flower oil. Limonene, α-pinene, β-pinene, terpinolene and α-phellandrene were the important components of unripe fruit oil. Limonene, β-pinene, α-phellandrene and α-pinene were identified as the major components of ripe fruit oil.

Limonene and β-pinene were identified as the most abundant main constituents of unripe and ripe fruit oils. β-Pinene, α-phellandrene, limonene, (*E*)-β-ocimene and terpinolene contents increased with advanced vegetation, but α-pinene and limonene contents decreased in ripe fruit oil. Myrcene, α-phellandrene, (*E*)-β-ocimene, α-copaene and δ-cadinene were not found in young shoot oil. Also, flower oil was very rich in germacrene D. The most prominent components in all oils were α-pinene, β-pinene, limonene and germacrene D. *p*-Cymene, α-campholenal, *trans*-verbenol, *p*-methyl acetophenone, *p*-cymen-8-ol, myrtenal and verbenone were determined only in young shoot oil. Germacrene D contents decreased after the flowering period. All the oils consisted of monoterpenic hydrocarbons, oxygenated monoterpenes and sesquiterpenes. Also, all the oils contained lesser amounts of oxygenated monoterpenes such as linalool, terpinene-4-ol, α-terpineol and borneol.

A few reports on the essential oil from this species of different or similar origins have been published previously. The oil obtained from air-dried resinous gum of *P terebinthus* of Greek origin contained α-pinene (39.6%), β-pinene (19.5%), sabinene (6.5%), terpinen-4-ol (3.8%) and δ-3-carene (3.3%) as the main constituents.[6]

Küsmenoğlu *et al*[9] established the presence of α-pinene (54.4%), terpinolene (18.9%) and δ-3-carene (4.0%) as important components in the essential oil of the hulls of fresh ripe fruits of *P vera*. Dung *et al*[10] found that the oil of *P weinmenifolia* from Vietnam contained α-pinene (38.8%), myrcene (17.4%), camphene (5.2%), β-pinene (8.1%), α-terpineol (2.7%) and limonene (1.4%).

Our results were generally similar to the literature findings with regard to the components. Some variations may be due to the different climatological and handling factors. The essential oil composition also varies qualitatively and/or quantitatively with collection and ripening times.

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