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RESEARCH ARTICLE

Chemical characterization of *Schinus molle* L. essential oils from North Cyprus

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Abstract

Analysis of hydrodistilled essential oils from dried leaves and fruits of *Schinus molle* L. collected from two localities in Lefkoşa (Nicosia), Northern Cyprus were analyzed by GC-FID and GC/MS. α-Phellandrene (31.5 -31.6%), (26.7-36.3%), limonene (10.1-11.4%), (12.5-13.5%), and β-phellandrene (9.9-10.9%), (10.3-12.2%) were identified as the major constituents, respectively. Moreover, myrcene was a main constituent identified only in fruits (18.5-19.9%), while bicyclogermacrene was the main component characterized in the leaf oils (12-11.1%).

Keywords: Essential oil, *Schinus*, Anacardiaceae

Introduction

Schinus molle L. (Anacardiaceae) (Peruvian pepper tree) is an evergreen tree native to South America but used in landscape architecture in many countries in the tropical and temperate regions of the World. It is planted on road sides and gardens as a shade tree (Belhamel et al., 2008). It is native in South America, grows in America, Asia, Australia some parts of Europe and exotic in Cyprus as well as in Turkey (Orwa et al., 2009).

Leaves are imparipinnate, leaflets are linear-lanceolate. It is easily distinguished from the related *S. terebinthifolius* Raddi (Brazilian pepper tree) by having compound leaves. *S. molle* fruits are small, round berries, 5-9 mm in diameter, the colour of berries is bright red when mature, later turning to black (Orwa et al., 2009).

This plant plays an important role in Chilean folk medicine. The whole fruits of *S. molle* are soaked or fermented in hot water to make a drink which is used for many health purposes, such as diuretic, digestive, antiseptic, for pain relief and haemorrhoids. The plant has also been used in the treatment of menstrual disorders, respiratory infections, and urinary tract infections (Perez-Lopez et al., 2011). In some traditional cuisines, *S. molle* fruits have been used as a replacement for black pepper and to prepare alcoholic beverages (Maringiu et al., 2004).

There are several studies from different places around the world revealing the variation in the chemistry of *S. molle* essential oil. Water distilled oils from dried fruits and leaves of *S. molle* from Turkey revealed 80 different components representing 98.2% to 99.8% of the oil, respectively. Fruit oil contained α-phellandrene (22.1% and 38.1%), β-phellandrene (10.4% and 11.8%) and limonene (9.6%). Whereas, the main components in the leaf oil were α-phellandrene (45.7%), β-phellandrene (13.6%) and limonene (13.4%) (Baser et al., 1997). The main components of the leaf extracts from Izmir, Turkey were germacene D (20.7%) and β-caryophyllene (13.4%) (Onder et al., 2010). In Algeria, the main components were reported as α-phellandrene (26.5%), limonene (8.6%), β-phellandrene (12.4%), elemol (8.6%) and α-eudesmol (6.1%) (Belhamel et al., 2008). From the Costa Rican material, the main components of the essential oil of the leaves were β-pinene and α-pinene (Diaz et al., 2008). The main components of essential oil extracted from *S. molle* fruit collected from Syria (Damascus) were α-phellandrene (24.8%), β-pinene (14.7%), β-phellandrene (11%) and limonene (10.5%) (Ibrahim and Al-naser, 2014). The main components of essential oils obtained from leaves, stems and fruits of the Tunisian *plant* were β-eudesmol (14.8%), elemol (13.7%), α-eudesmol (12.7%), limonene (9.2%) and spathulenol (7.2%). Whereas, the main components in stem were elemol (20.7%), 6-epi-shyobunol (20.3%) and α-eudesmol (7.0%). Fruit essential oils were characterized by 6-epi-shyobunol (16.2%), limonene (15.3%), spathulenol (8.1%) and 4-epi-cubebol (7.8%) (Abir et al., 2016).

The essential oil of *S. molle* showed the maximum fungitoxic activity as compared with some other essential oils during the screening against common storage and animal pathogenic fungi (Dikshit et al., 1986). Some oils of *S. molle* showed potential anti-tumoral effects, either alone or in combination (Diaz et al., 2008). *S. molle* essential oils showed insecticidal activity against *Trogoderma granarium* and *T. castaneum* (Abdel-sattar et al., 2008). The essential oil and hexane extract of the plant showed potential result in term of antimicrobial and insect repellent activity (Onder et al., 2010). The essential oils extracted from *S. molle* leaves showed inhibitory effects, reduced growth of *Staphylococcus aureus, Staphylococcus epidermidis, Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Salmonella setubals*, and *Candida albicans* (Simionatto et al., 2011). The essential oil isolated from the fruits showed higher antioxidant activity than the oil isolated from leaves (Abir et al., 2016). Five terpenes isolated from the bark resin of *S. molle* provided significant growth inhibitory effect against human colon carcinoma (Gonzalo et al., 2017).

The main aim of this study was to determine the chemical composition of *S. molle* essential oils from different locations in North Cyprus.

Materials and Methods

Plant material

Leaves and fruits of *Schinus molle* L. were collected on 6/10/2017 from Near East University Campus, Nicosia, North Cyprus. While, the other *S. molle* leaves and fruits were collected on 10/11/2017 from Kucukkaymakli area (KK), Şehit Mehmet street. Air dried leaves and fruits were used for distillation. The plant material was identified by Prof. Baser. Herbarium vouchers are deposited at the Herbarium of the Near East University (NEUN 6896 for the Near East University sample, and NEUN 6897 for the Küçükkaymaklı sample).

Leaves and fruits of plants from two locations were separately hydrodistilled using a Clevenger type apparatus for 3 h. Yields of essential oil for NEU sample were 1.88% (leaf), 0.48% (fruit); and for Küçükkaymaklı (KK) sample 1.62% (leaf), 0.62% (fruit) on moisture-free basis.

GC-MS analysis

The GC-MS analysis was carried out with an Agilent 5975 GC-MS system. Innowax FSC column (60 m, 0.25 mm film thickness) was used with helium as carrier gas (0.8 mL/min). GC oven temperature was kept at 60 °C for 10 min and programmed to 220 °C at a rate of 4 C°/min, and kept constant at 220 °C for 10 min. Then, programmed to 240 °C at a rate of 1 °C/min. Split ratio was adjusted at 40:1. The injector temperature was set at 250 °C. Mass spectra were recorded at 70 eV. Mass range was from *m/z* 35 to 450.

GC analysis

The GC analysis was carried out using an Agilent GC system. FID detector temperature was 300 °C to obtain the same elution order with GC-MS, simultaneous auto-injection was done on a duplicate of the same column applying the same operational conditions. Relative percentage amounts of the separated compounds were calculated from FID chromatograms.

Identification of components

Characterization of the essential oil components was carried out by comparison of their retention times with those of authentic samples or by comparison of their Linear Retention Indices (LRI) to a series of n-alkanes. Computer matching against commercial Wiley GC/MS library (MacLafferty and Stauffer, 1989), MassFinder 3 Library (Koenig et al., 2004) and in house "Baser Library of Essential Oil Constituents" built up by genuine compounds and components of known oils, as well as MS literature data (Joulain and Koenig, 1998: ESO, 2000) was used for the identification.

Results and Discussion

As shown in Table 1, in total 67 constituents were identified. The main component was α-phellandrene in leaves and fruits of both NEU and K.K locations as 31.6% and 36.3%; 31.5% and 26.7%, respectively. Limonene was the second major component in leaves and fruits of NEU (11.4% and 13.3%) and KK localities (10.1% and 12.5%), resp. The third major component was β-phellandrene in NEU (10.9% and 12.2%) and KK (10.3% and 9.9%) in leaf and fruit samples, resp. Leaf oils contained bicyclogermacrene as main constituent in NEU (11.1%) and KK (12.0) samples. Elemol content in leaf oils varied between 9.3% (KK) and 6.3% (NEU). Fruit oils from both localities contained myrcene (19.9% for NEU; 18.5% for KK) as a major constituent. Its content was lesser in leaf oils. Moreover, fruits of KK contained the highest percentage of p-cymene (8.1%). In the other samples, the percentages were not more than 4.2%.

The results of this study have been compared with the previous results reported from Turkey and elsewhere. α- Phellandrene was a main component in leaf and fruit oils from Turkey (45.7 % and 38 %), respectively (Baser et al., 1997). However, no component in the leaf oils of the other Turkey sample was more than 7 % (Onder et al., 2010). The leaf oils of Algeria contained α-phellandrene (26.5 %), β-phellandrene (12.4%), β-eudesmol (14.8 %) and elemol (13.7 %) as main components (Belhamel et al., 2008). While, the Egyptian fruit oil contained α-phellandrene (25.1 %), limonene (20.9%) and myrcene (16.4%) as main components. In contrast, the Egyptian leaf oils contained p-cymene (9.4 %) as a main component, limonene, α-pinene and myrcene contents were less than 5 % (Dalia et al., 2016). The Tunisian leaf and fruit oils contained different main components. 6-epi-shyobunol (16.2 %), limonene (15.3 %) and spathulenol (8.1%) were the main components in the Tunisian fruit oils. Whereas, the leaf oils contained β-eudesmol (14.8 %), elemol (13.7 %) and α-eudesmol as the major components (Abir et al., 2016). The leaf oil of Costa Rican origin contained α-pinene (22.7%) and β-pinene (31.1%) as main components (Diaz et al., 2008). The Syrian fruit oils showed α-phellandrene (24.8 %), β-pinene (14.7 %) and β-phellandrene (11%) as main components (Ibrahim and Al-naser, 2014). The Uruguaian leaf oil contained bicyclogermacrene (29.2 %) as main component (Carmen et al., 2011).

The result of this study showed similarity with fruit and leaf oils from Turkey, Algerian leaf oils and Syrian fruit oils by having α-phellandrene and β-phellandrene as main components. Whereas, the differences in main components were observed Uruguaian oil, which contained bicyclogermacrene; and Costa Rican oils, which contained α-pinene and β-pinene as major components.

Table 1. Chemical components of *Schinus molle* essential oil.

LRI	Compound Name	KK% Fruit	NEU% Fruit	KK% Leaf	NEU% Leaf
1020	α-pinene	3.7	4.0	3.9	5.2
1119	β-pinene	0.2	0.2	0.1	0.1
1131	sabinene	0.1	0.1	0.3	0.2
1173	myrcene	18.5	19.9	1.9	1.4
1178	α-phellandrene	26.7	36.3	31.5	31.6
1181	pseudolimonene	0.1	0.1	0.1	0.1
1212	limonene	12.5	13.3	10.1	11.4
1221	1,8-cineole	0.4	-	-	-
1223	β-phellandrene	10.3	12.2	9.9	10.9
1263	(*E*)-β-ocimene	-	-	0.1	-
1288	*p*-cymene	8.1	4.2	2.1	4.2
1299	terpinolene	0.1	0.2	0.2	0.2
1400	methyl octenoate	0.9	0.5	-	-
1499	bicycloelemene	-	0.1	1.0	0.5
1555	α-gurjunene	-	-	0.2	-
1556	linalool	0.1	-	-	0.1
1580	*cis*-sabinene hydrate	-	0.1	-	-
1581	*trans*-*p*-menth-2-en-1-ol	0.4	-	-	-
1605	bornyl acetate	0.1	0.1	-	-
1613	β-elemene	0.1	-	0.7	0.4
1625	terpinen-4-ol	0.2	-	-	-
1627	β-caryophyllene	-	-	0.2	0.2
1638	aromadendrene	0.1	0.2	0.3	0.4
1661	γ-elemene	-	-	0.3	0.2
1685	allo aromadendrene	-	-	0.1	0.1
1688	epi-zonarene	-	-	tr	-
1701	*trans*-piperitol	0.2	-	-	-
1702	α-humulene	-	-	0.2	0.1
1710	cryptone	0.3	0.1	-	tr
1715	carvotanacetone	0.1	-	-	-
1717	�-humulene	-	-	0.1	-
1726	ledene	-	-	0.2	0.2
1742	valencene	-	-	-	0.3
1743	germacrene D	-	-	0.3	-
1752	α-muurolene	0.1	-	0.5	0.3
1756	β-selinene	-	-	-	0.2
1759	selina-4,11 diene	-	-	-	0.2
1762	phellandral	0.1	-	-	-
1769	bicyclogermacrene	1.1	2.0	12.0	11.1

1786	δ-cadinene	0.3	0.1	1.4	0.6
1692	γ-cadinene	-	-	0.2	0.1
1802	cadina-1,4-diene (=cubenene)	-	-	0.1	-
1822	cuminaldehyde	0.1	-	-	-
1836	*p*-mentha-1(7),5-dien-2-ol	2.1	0.8	0.2	-
1859	carveol	0.1	-	-	-
1871	germacrene B	-	-	0.1	-
1873	*p*-cymen-8-ol	0.1	-	-	-
1916	epicubebol	-	-	0.1	-
1931	α-phellandrene epoxide	0.5	0.1	-	-
2072	ledol	-	-	0.1	-
2085	germacrene D-4-ol	-	-	-	0.3
2092	cubenan-11-ol	-	-	0.1	-
2098	cubenol	-	-	0.1	-
2108	elemol	4.0	1.4	9.3	6.3
2124	viridiflorol	-	-	0.6	-
2148	10-epi-γ-eudesmol	-	-	0.2	-
2160	spathulenol	2.0	2.0	2.0	5.3
2205	γ-eudesmol	0.6	0.2	1.7	1.1
2217	eremoligenol	-	-	-	0.2
2222	T-muurolol	0.1	-	0.4	0.2
2226	α-guaiol	0.1	-	0.1	0.2
2231	δ-cadinol	-	-	0.1	-
2244	thymol	0.7	0.2	0.2	0.2
2261	α-eudesmol	1.2	0.7	1.8	2.2
2268	α-cadinol	0.2	-	0.8	0.3
2273	β-eudesmol	1.4	0.6	1.9	2.4
	Total %	**98.4**	**99.7**	**97.8**	**99.0**

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