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The essential oil of *Acinos suaveolens* (Sm.) G. Don fil. *Acinos arvensis* (Lam.) Dandy and *Acinos rotundifolius* Pers. growing wild in Turkey

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ABSTRACT: In this study, water-distilled essential oil of three species of *Acinos* Miller (Lamiaceae) were analysed by GC–MS. Oils from *A. suaveolens* (Sm.) G. Don fil. were found to contain pulegone (23.2–80.7%) and isomenthone (1.1–54.1%). Oils from *A. arvensis* (Lam.) Dandy and *A. rotundifolius* Pers. were found to contain germacrene-D (14.3% and 14.4–73.1%) hexadecanoic acid (14.0% and 17.5–30.2%). Copyright © 1999 John Wiley & Sons, Ltd.

KEY WORDS: *Acinos suaveolens* (Sm.) G. Don fil.; *A. arvensis* (Lam.) Dandy; *A. rotundifolius* Pers.; Lamiaceae; essential oil; composition; pulegone; isomenthone; hexadecanoic acid; germacrene-D

Introduction

In Turkey, *Acinos* is represented by five species comprising six taxa. These taxa are: *A. troodi* (Post) Leblebici subsp. *vardaranus* Leblebici; *A. troodi* subsp. *grandiflorus* Hartvig & Strid; *A. alpinus* (L.) Moench; *A. suaveolens* (Sm.) G. Don fil.; *A. arvensis* (Lam.) Dandy; and *A. rotundifolius* Pers. *A. suaveolens* grows in north-west and west Anatolia. *A. arvensis* is distributed in north Anatolia. *A. rotundifolius* is the most widespread *Acinos* species in Turkey (rare in the extreme east).[1,2]

Some species of the genus *Acinos* are strongly or slightly odorous. They are used for medicinal purposes. For example, a decoction of *A. suaveolens* is used in some regions as a sedative and in others as an anti-inflammatory.[3] *A. arvensis* is used internally in melancholy, for shortness of breath and for improving digestion. It was once used to treat bruises, toothache, sciatica and neuralgia.[4]

The composition of *A. suaveolens* and *A. arvensis* oils have been the subject of previous studies.[5–9] To the best of our knowledge, there is no previous publication on the composition of the oil of *A. rotundifolius*.

Here, we report the results of analysis of three *Acinos* species as part of our ongoing work on the *Acinos* species of Turkey.[10]

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Experimental

Plant Material

Plant materials were collected from wild populations. *A. suaveolens* were collected from Kırklareli (1 sample) and Balıkesir (3 samples) provinces. *A. arvensis* plants were collected from Kastamonu (1 sample) provinces. *A. rotundifolius* plants were collected from Eskişehir (2 samples), Balıkesir (1 sample) and Kastamonu (1 sample) provinces. Voucher specimens are kept at the Herbarium of the Faculty of Pharmacy (ESSE), Anadolu University, Eskişehir, Turkey (Table 1).

Table 1. Plant materials used in this study

Collection sites	Date of collection	Oil yield	ESSE
A. suaveolens			
1. Balıkesir: Marmara Island	June 1994	0.64	10529
2. Balıkesir: Kaz Mountain (Gürlek)	July 1992	1.17	10510
3. Balıkesir: Kaz Mountain (Babadağ)	June 1987	0.64	8462
4. Kırklareli: Dereköy	May 1994	–	10530
A. arvensis			
1. Kastamonu: Araç	July 1993	0.02	10508
A. rotundifolius			
1. Eskişehir	May 1993	0.02	10518
2. Eskişehir: Sivrihisar	June 1993	0.03	10515
3. Balıkesir: Susurluk	March 1995	0.03	10540
4. Kastamonu: Araç	July 1993	0.03	10527

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Table 2. Composition of the essential oils of *Acinos suaveolens*

Compound	RI	A	B	C	D
α-Pinene	1032	0.8	0.2	0.5	
Camphene	1076	0.1		0.1	
β-Pinene	1118	0.9	0.4	0.7	
Sabinene	1132	0.2	0.2	0.3	
Myrcene	1174	0.3	0.2	0.1	
Limonene	1203	1.6	2.8	2.9	
1,8-Cineole	1223	0.1		0.1	
3-Methyl-cyclopentanone	1225			0.2	
p-Cymene	1280			0.2	
3-Octanol	1398	0.3	0.2	0.3	
1-Octen-3-ol	1452	0.2	0.1	0.1	
cis-1,2-Limonene epoxide	1458			0.2	
trans-1,2-Limonene epoxide	1468			0.2	
Menthone	1474	0.2	1.1	5.0	
Isomenthone	1503	8.8	45.4	54.1	1.1
β-Bourbonene	1529	0.1	t	0.2	
Linalool	1553				10.0
Linalyl acetate	1565				0.9
cis-Isopulegone	1583		0.3	0.3	
trans-Isopulegone	1597		0.7	0.9	
Terpinen-4-ol	1611			0.1	
β-Caryophyllene	1612	0.3			
p-Menth-3-en-8-ol	1621			0.2	
Pulegone	1661	80.7	45.7	23.2	37.1
Neoisomenthol	1707			0.1	
Borneol	1719	0.2	0.2	0.6	
Germacrene D	1726	0.1			4.0
Piperitone	1748		0.3	0.7	
Carvone	1755	0.1	t	0.2	
Perilla aldehyde	1808			0.7	
trans-Carveol	1845			0.2	
Piperitenone	1949	0.7	0.7	0.7	
Caryophyllene oxide	2008	0.5			
(*E*)-Nerolidol	2053				12.6
Cumin alcohol	2113			0.1	
Spathulenol	2144	0.7			
Nonanoic acid	2192				0.2
Thymol	2205	0.1	t	t	1.0
Carvacrol	2246		0.1	0.1	6.0
Decanoic acid	2300			0.1	
Tetradecanoic acid	2713				1.6
Hexadecanoic acid	2931			0.3	17.2

A, Balıkesir: Marmara Island.
B, Balıkesir: Edremit, Kaz Mountain (Gürlek).
C, Balıkesir: Edremit, Kaz Mountain (Babadağ).
D, Kırklareli: Dereköy.
t, <0.1%.

Essential Oil Distillation

Air-dried aerial parts were subjected to hydrodistillation for 3 h using a Clevenger-type apparatus.

Gas Chromatography–Mass Spectrometry

The essential oils were analysed by GC–MS using a Hewlett-Packard GCD system fitted with an Innowax FSC column (60 m × 0.25 mm with 0.25 μm film). Helium was used as the carrier gas. GC oven temperature was kept at 60°C for 10 min and programmed to 220°C for 10 min. Split flow was adjusted at 50 ml/min. The injector and detector temperatures were at 250°C. MS were taken at 70 eV. Mass range was m/z 30–425. A library search was carried out using the Wiley GC–MS Library and the TBAM Library of Essential Oil Constituents. The compounds identified in the oil are listed for *A. suaveolens* in Table 2, for *A. arvensis* in Table 3 and for *A. rotundifolius* in Table 4.

Results and discussion

A. suaveolens

The results have shown that *A. suaveolens* is a distinct species among the others in that it has the highest oil content, with considerable amounts of pulegone and isomenthone.

Table 3. Composition of the essential oil of *Acinos arvensis*

Compound	RI	A
Pentanal	993	0.02
α-Pinene	1032	0.2
β-Pinene	1118	0.1
Sabinene	1132	0.1
Myrcene	1174	0.02
Limonene	1203	0.7
β-Phellandrene	1218	0.01
1,8-Cineole	1223	1.2
p-Cymene	1280	0.3
3-octanol	1398	0.01
Nonanal	1400	0.1
α-Cubebene	1466	0.1
Menthone	1474	0.03
(*E*,*Z*)-2,4-Heptadienal	1479	0.02
α-Copaene	1497	0.7
Decanal	1506	0.1
α-Bourbonene	1529	0.2
β-Bourbonene	1529	7.0
β-Cubebene	1553	0.3
Linalool	1553	0.2
Octanol	1562	0.02
Linalyl acetate	1565	0.1
Junipene	1583	0.03
Bornyl acetate	1591	0.1
trans-β-Bergamotene	1594	0.04
β-Elemene	1600	2.1
β-Caryophyllene	1607	2.1
β-Cyclocitral	1638	0.03
Myrtenal	1648	0.04
Aromadendrene	1658	0.3
Pulegone	1661	0.2
trans-Pinocarveol	1664	0.1
(*E*)-β-Farnesene	1671	0.3
α-Humulene	1684	0.04
trans-Verbenol	1684	0.5
Heptadecane	1700	0.1
α-Terpineol	1707	0.02
α-Terpinyl acetate	1707	0.04
Borneol	1719	0.2
Germacrene D	1726	14.3
α-Muurolene	1740	0.3
Carvone	1755	0.3
(*E*,*E*)-α-Farnesene	1758	0.03
Naphthalene	1765	0.2
δ-Cadinene	1772	0.5
γ-Cadinene	1776	0.2
Octadecane	1800	0.02
(*E*,*E*)-2,4-Decadienal	1827	0.1
β-Damascenone	1838	0.04
Calamenene	1859	0.1
p-Cymen-8-ol	1864	0.02
(*E*)-Geranyl acetone	1868	0.3
Hexanoic acid	1871	t
1-Methyl naphthalene	1878	0.02
epi-Cubebol	1900	0.1
Geranyl isovalerate	1904	0.03
α-Calacorene I	1941	0.02
Cubebol	1957	0.1
β-Ionone	1957	0.2
α-Calacorene II	1984	0.1
Isocaryophyllene oxide	2000	0.4
Caryophyllene oxide	2008	3.2
11-Norbourbonan-1-one	2045	0.5
(*E*)-Nerolidol	2053	0.02
Germacrene D-4-ol	2069	0.6
Octanoic acid	2084	0.3
(*E*)-3-Hexen-1-yl-benzoate	2127	0.1
Hexahydrofarnesyl acetone	2131	1.1
Spathulenol	2144	1.4
T-Cadinol	2187	0.3
Nonanoic acid	2192	0.3
T-Muurolol	2207	0.6
δ-Cadinol	2219	0.1
α-Cadinol	2255	1.2
Decanoic acid	2300	0.3
Isopimaradiene	2349	0.4
Manoyloxide	2376	0.4
Pentacosane	2500	1.1
Dodecanoic acid	2503	0.8
Abietatriene	2524	3.0
Hexacosane	2609	0.1
Phytol	2622	0.3
Benzyl benzoate	2655	0.3
Heptacosane	2700	1.2
Tetradecanoic acid	2713	1.8
Pentadecanoic acid	2822	0.6
Hexadecanoic acid	2931	14.0

A, Kastamonu: Araç.
t, <0.01.

Forty-two components were identified, representing 91.4–98.4% of the total oils of *A. suaveolens*. Except for one case, the oils were characterized by a high percentage of oxygenated monoterpenes (55.1–94.4%), mainly pulegone (23.2–80.7%) and isomenthone (1.1–54.1%). A sample from Kırklareli: Dereköy gave an interesting composition with 37.1% pulegone, 17.2% hexadecanoic acid, (*E*)-nerolidol 12.6%, linalol 10.0%, carvacrol 6.0% and germacrene D 4.0%.

If the results of *A. suaveolens* oils are compared with the previously published data, it can be seen that the oil of Yugoslav origin was rich in pulegone (96.9%),[5] the oil from Greece contained pulegone (69.0%) and isomenthone (17.0%),[6] and an oil sample from Turkey contained isomenthone (50.9%) and pulegone (33.2%).[7]

A. arvensis

Eighty-seven components were identified, representing 68.0% of the total oil of *A. arvensis*. Major components were characterized as germacrene-D (14.3%) and hexadecanoic acid (14.0%). β-bourbonene content of the oil was found to be 7.0%. Furthermore, caryophyllene oxide (3.2%) and abietatriene (3.0%) were noted. Previously *A. arvensis* oil from Canada was reported as rich in germacrene-D (51.4%), caryophyllene (7.9%), β-bourbonene (4.8%), and cadinene (3.0%), and a sample of oil from Greece was reported to contain pulegone (51.3%), isomenthone (18.1%), alloocimene (6.9%) and menthone (4.2%).

A. rotundifolius

Sixty-four components were identified, representing 65.3–99.7% of the total oil of *A. rotundifolius*. Major components were germacrene-D (14.4–73.1%) and hexadecanoic acid (17.5–30.2%). However, menthol (23.9%), spathulenol (1.6–14.7%), bicyclogermacrene (1.4–10.4%), caryophyllene oxide (2.7–3.6%), α-cadinol (1.0–3.2%) contents in the oils were found to be high.

Our results generally agree with those reported earlier.[3–7,9] However, pulegone (51%) has been reported as the main constituent in the oil of *A. arvensis* from Greece.[7] This does not agree with our findings, since the only species which contains pulegone in the oil is *A. suaveolens*. Therefore, the taxonomic identification of *A. arvensis* collected in Greece is doubtful. It should, in our view, be considered as *A. suaveolens*.

Table 4. Composition of the essential oils of *A. rotundifolius*

Compound	RI	A	B	C	D
Limonene	1203		0.2	0.3	
1,8-Cineole	1223	1.2	0.9	1.1	
(*Z*)-β-Ocimene	1246	t			
(*E*)-β-Ocimene	1266	0.3			
p-Cymene	1280		0.1		
3-Octanol	1398			0.1	
Menthone	1474			1.9	
α-Copaene	1497	0.3	0.6	1.5	
β-Bourbonene	1529	1.2	2.2	1.8	2.7
β-Cubebene	1550	t	0.2	0.6	
β-Elemene	1600	2.5	2.1	2.9	
Terpinen-4-ol	1611		0.6	0.4	
β-Caryophyllene	1612	1.5	0.5	0.6	
Neoisomenthol	1707			0.3	
Myrtenal	1648		0.1		
Menthol	1651			23.9	
Aromadendrene	1658		0.1		
Pulegone	1661			2.0	
Acetophenone	1671	0.4	0.1	0.2	
(*E*)-β-Farnesene	1671	2.4	1.1	0.1	
α-Humulene	1684		0.2	0.1	
γ-Muurolene	1704		0.3	0.3	
Germacrene-D	1726	73.1	18.5	32.6	14.4
α-Muurolene	1740		0.4	0.4	
α-Selinene	1740		0.1		
Eremophilene	1744	0.4			
Bicyclogermacrene	1751	10.4	3.0	1.4	
(*E*,*E*)-α-Farnesene	1758	1.0	0.1		
δ-Cadinene	1772	0.4	0.6	0.6	
γ-Cadinene	1776		0.2	0.1	
Myrtenol	1808		0.1		
(*E*,*E*)-2,4-Decadienal	1827		0.1		
β-Damascone	1830		0.1		
β-Damascenone	1838		0.1		
Calamenene	1849		0.1		
p-Cymen-8-ol	1864		0.2		
(*E*)-Geranyl acetone	1868		0.2		
1,5-Epoxy-salvial-4(14)-ene	1945		1.1	0.2	
Cubebol	1957		0.1	0.1	
β-Ionone	1957		0.5		
Isocaryophyllene oxide	2000		0.3		
Caryophyllene oxide	2008		3.6	0.2	2.7
11-Norbourbonan-1-one	2045		0.4		
Germacrene D-4-ol	2069	0.4	0.4	0.5	
Humulene epoxide-II	2069		t		
Octanoic acid	2084		0.1		
Globulol	2096		0.4		
Viridiflorol	2100		0.4		
Cumin alcohol	2113		0.1		
Hexahydrofarnesyl acetone	2131		0.8	0.2	
Spathulenol	2144	0.3		1.6	15.0
T-Cadinol	2187			0.4	
T-Muurolol	2207	0.4		0.7	1.2
α-Cadinol	2255	1.0		1.7	3.2
Pentacosane	2500	1.1	0.8	0.4	
Dodecanoic acid	2503		0.4		
Hexacosane	2609		0.1		
Phytol	2622		0.7	0.3	1.0
Heptacosane	2700	1.1	1.6	0.7	
Tetradecanoic acid	2713		0.9		2.7
Octacosane	2800		0.1		
Pentadecanoic acid	2822		0.4		
Nonacosane	2900	0.4	1.9	0.9	
Hexadecanoic acid	2931		17.5	0.3	30.2

A, Eskişehir.
B, Eskişehir: Sivrihisar.
C, Balıkesir: Susurluk.
D, Kastamonu: Araç.
t, <0.01.

References

1. P. H. Davis and E. Leblebici, in *Flora of Turkey and the East Aegean Islands*, Vol. 7, pp. 331–335, University Press, Edinburgh (1982).
2. P. H. Davis, R. R. Mill and Kit Tan, *Flora of Turkey and the East Aegean Islands*, Vol. 10, pp. 207–208, Suppl., University Press, Edinburgh (1988).
3. S. Pavlovic, G. A. Kuznetsova, P. Zizanovic, A. L. Shevarda, R. Jancic and S. Vujcic, *Arh. Farm.*, **34**, 65–71 (1984).
4. D. Bown, *Encyclopedia of Herbs & Their Uses*, p. 228, The Herb Society of America, Dorling Kindersley, New York (1995).
5. S. Pavlovic, G. A. Kuznetsova, P. Zizanovic, A. L. Shevarda, R. Jancic and S. Vulcic, *Arh. Farm.*, **34**, 65–71 (1984).
6. E. Kokkalou, *Planta Med.*, **4**, 340–342 (1988).
7. G. Tümen, *J. Essent. Oil Res.*, **3**, 191–192 (1991).
8. C. Soules and S. Katsiotis, *Plantes Medic. Phytother.*, **22**, 180–183 (1988).
9. B. M. Lawrence, 'Essential oils 1979–1980', *Perfumer and Flavorist*, 97 (1981).
10. A. Kaya, Morphological, anatomical and chemical studies on *Acinos* species growing in Turkey, PhD Dissertation, Anadolu University (1997).