SHORT REPORT

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Volatile Constituents of Romanian Coriander Fruit

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Abstract: The essential oils of Romanian coriander fruits (cultivar "Sandra") were obtained by hydrodistillation and analyzed by means of GC and GC-MS. Sixty compounds were identified in the total essential oils. Monoterpenes were the most dominant class of compounds, with linalool (48.4-54.3%) being the major component. Other significant compounds were γ-terpinene (9.2-12.1%), α-pinene (5.5-9.3%) and limonene (4.7-6.3%).

Keywords: *Coriandrum sativum*; essential oil composition; linalool; γ-terpinene; α-pinene; limonene.

1. Plant Source

Coriander (*Coriandrum sativum* L., Umbelliferae) is a long cultivated annual herb, native to Mediterranean Europe and Western Asia, now extensively cultivated in many temperate countries [1,2,3]. The genus name *Coriandrum* is derived from 'koros' in reference to the fetid smell of the leaves [3]. Hippocrates (ca. 460-377 B.C.E.) refers coriander in traditional Greek medicine [3]. This plant, preserved in Tutankhamun's tomb (1325 BC), is now used as a flavoring agent in food (confectionary, bread, curry powder), perfumes, cosmetics and pharmaceutical preparations [1,3,4]. The parts most in use are the dried ripe fruits (commonly called coriander seeds) and leaves [4]. Traditionally *C. sativum* fruits have been used as an aromatic carminative, stomachic, antispasmodic and laxative [3,4,5]. Studies have shown its sedative and anxiolytic activity [6,7]. Additionally, coriander fruit extracts present blood pressure lowering activity [8]. In this work, we report on essential oil composition of coriander fruits (original Romanian cultivar "Sandra") cultivated in Secuieni experimental fields under the same pedo-climatic condition.

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2. Previous Studies

According to literature coriander fruits contain 0.1 to 2% essential oil of which 45 to 85% linalool [3-5]. The essential oil from fruits of *C. sativum* of Italian origin was found to contain large amounts of linalool (65-79%) [9]. Also in this essential oil were also present camphor (3%), γ-terpinene (4-7%), geranyl acetate (2-4%), α-pinene (1-3%), geraniol (1-2%) and limonene (1-3%) [9]. The essential oil of *C. sativum* from Canada was also characterised by the abundance of linalool (64.0-84.6%), with the monoterpenes camphor (3.4-6.2%), α-pinene (1.2-3.2%), phellandrene (1.7-4.1%), linalool acetate (2.4-3.3%), limonene (0.7-1.8%), p-cymene (0.5-1.3%) and geranyl acetate (0.9-1.6%) being the others significant metabolites [10]. Sriti et al. studied the composition of the essential oil of Tunisian *C. sativum* fruits; linalool was present in 86.1%, while the amount of the other characteristic compounds were lower [11]. The major constituents of the fruits essential oil of *C. sativum* from Bangladesh were linalool (37.7%), geranyl acetate (17.6%) and γ-terpinene (14.4%) [12].

3. Present Study

Mature infructescences of coriander samples (C1-C6) were collected from the experimental fields Secuieni (Romania) in 2009. *C. sativum* cv. 'Sandra' was cultivated under the same pedo-climatic condition, the differences being the distance between plants and between planting rows. Air dried fruits of each sample were subjected separately to hydrodistillation for 3 hours using a modified Clevenger-type apparatus with a water-cooled oil receiver to reduce artifacts, to obtain the essential oils. The essential oils were dried over anhydrous sodium sulfate and kept at -4^{o} C until analysis.

GC/MS: Analysis of the essential oils was performed using a Hewlett Packard (Hewlett Packard GmbH, Waldbronn, Germany) model 5973-6890 GC-MS system operating in the EI mode at 70eV, equipped with a split/splitless injector (200 ^{o}C). The transfer line temperature was 250 ^{o}C. Helium was used as carrier gas (1 mL/min) and the capillary column used was HP 5MS (30 m × 0.25 mm; film thickness 0.25 μm; Agilent, Palo Alto, CA, USA). The temperature program was the same with that used for the GC analysis; split ratio 1:10. The injected volume was 1μL. Total scan time 83.33 min. Acquisition mass range 40-400 amu. The identification of the compounds was based on comparison of their retention indices (RI), their retention times (RT) and mass spectra with those obtained from authentic samples (purchased from the Sigma-Aldrich Co, (Sigma-Aldrich, Buchs SG, Switzerland) and/or the NIST/NBS, Wiley libraries (available through Hewlett Packard) and the literature [13].

GC/FID: GC analysis of the essential oils was carried out using a SRI (Brooks, Hatfield, PA, USA) 8610C GC-FID system, equipped with DB-5 capillary column (30 m x 0.32 mm; film thickness 0.25 μm; J & W, CA, USA) and connected to a FID detector. The injector and detector temperature was 280 ^{o}C. The carrier gas was He, at flow rate of 1.2 mL/min. The thermal program was 60 ^{o}- 280 ^{o}C at a rate of 3 ^{o}C/min; split ratio 1:10. Two replicates of each oil were processed in the same way. The injected volume was 1μL.

Six samples of *C. sativum* fruits cultivated under different conditions were hydrodistilled to yield 2.00 % v/w (C1-C5) and 1.87% v/w (C6) of yellow essential oils with a pleasant odor. Sixty one compounds were characterized representing 99.7-99.9% of the total essential oils (Table 1). Monoterpenes was the predominant class of compounds, with linalool (48.4-54.3%) being the major component which has a floral and pleasant note. Other significant compounds were: γ-terpinene (9.2-12.1%), α-pinene (5.5-9.3%), limonene (4.7-6.3%), camphor (5.1-5.7%), linalool acetate (1.8-7.5%), neryl acetate (t-4.4%) and geranyl acetate (0-6.2%). The results were in accordance with literature, where monoterpenes have been reported to be the main class in *C. sativum* fruit oils [3-5, 10-13] with linalool being the predominant compound, while camphor and limonene were present in the oil. According to Teuscher the essential oil composition of coriander fruits depends on the chemotype [5].

Chemotypes from Arabian peninsula and the Indian subcontinent do not contain limonene or camphor [5].

The most appropriate sample for commercial use was C4, having a yield of 2.0 % v/w, the highest percentage of linalool (54.3%), and the other typical constituents in percentages close to those of the European Pharmacopoeia [14]. Linalool is a metabolite with antiseptic, bactericide, viricide, fungicide, insectifuge, sedative, spasmolytic, cancer-preventive properties, widely used in perfumery [15].

Table 1. Chemical composition (%) of the essential oils of *Coriandrum sativum* cv. "Sandra" fruits from Romania.

RIlit.	RIexp.	Compounds	Sample C1	Sample C2	Sample C3	Sample C4	Sample C5	Sample C6
		Monoterpenes hydrocarbons						
927	925	Tricyclene	t	-	-	t	t	t
930	927	α-Thujene	t	-	t	t	t	t
939	**937**	**α-Pinene**	**5.5**	**7.9**	**8.3**	**9.1**	**7.4**	**9.3**
954	952	Camphene	1.2	1.4	1.4	1.5	1.4	1.6
975	972	Sabinene	t	-	t	t	t	t
979	977	β-Pinene	1.7	2.5	2.2	2.2	2.4	2.4
991	989	Myrcene	1.4	2.0	1.6	1.6	2.0	1.7
1017	1015	α-Terpinene	t	t	t	t	t	t
1025	1022	p-Cymene	t	-	-	t	t	t
1029	**1026**	**Limonene**	**4.7**	**-**	**-**	**6.1**	**6.3**	**5.9**
-		**p-Cymene + Limonene**	**-**	**6.7**	**5.6**	**-**	**-**	**-**
1032	1029	(*Z*)-β-Ocimene	-	-	-	t	-	-
1044	1041	(*E*)-β-Ocimene	-	-	-	t	-	-
1060	**1058**	**γ-Terpinene**	**9.2**	**11.5**	**11.0**	**11.4**	**11.4**	**12.1**
1089	1086	Terpinolene	1.0	1.3	1.0	1.0	1.3	1.1
		∑	24.7	33.3	31.1	32.9	32.2	34.1
		Oxygenated monoterpenes						
1097	**1094**	**Linalool**	**50.7**	**48.4**	**53.8**	**54.3**	**49.6**	**51.3**
1146	**1143**	**Camphor**	**5.7**	**5.3**	**5.3**	**5.1**	**5.1**	**5.3**
1153	1150	Citronellal	-	-	t	t	-	t
1165	1161	Pinocarvone	t	-	t	t	t	t
1169	1165	Borneol	0.3	0.2	t	t	0.2	t
1177	1173	Terpinen-4-ol	0.6	0.5	0.4	0.4	0.5	0.4
1189	1185	α-Terpineol	0.9	0.7	0.6	0.5	0.7	0.6
1196	1193	Myrtenol	t	-	-	-	t	-
1205	1202	Verbenone	t	-	-	-	t	t
1226	1223	Citronellol	0.5	0.4	0.2	t	0.4	t
1238	1234	Neral	-	0.1	t	-	-	-
1238	1235	*trans*-Chrysanthenyl acetate	-	-	-	-	-	-
-		Neral + *trans*-Chrysanthenyl acetate	0.1	-	-	t	0.1	t
1243	1239	Carvone	t	t	-	-	t	t
1253	1248	Geraniol					3.3	
1257	1253	Linalool acetate					1.8	

-		Geraniol + Linalool acetate	7.6	5.2	4.3	3.4	-	4.1
1267	1264	Geranial	0.2	0.2	0.2	t	0.2	t
1290	1286	Thymol	t	t	-	-	t	t
1299	1296	Carvacrol	t	t	-	-	t	t
1327	1323	Myrtenyl acetate	0.1	0.1	t	t	0.1	t
1353	1348	Citronellyl acetate	t	t	t	-	t	t
1362	**1358**	**Neryl acetate**	t	**4.2**	t	**3.0**	**4.4**	t
1375	1370	Linalool isobutanoate	t	-	-	t	-	-
1381	**1377**	**Geranyl acetate**	**6.2**	**-**	**3.5**	**-**	**-**	**3.6**
		∑	72.9	65.3	68.3	66.7	66.4	65.3
		Sesquiterpenes hydrocarbons						
1419	1415	(*E*)-Caryophyllene	0.6	0.4	0.3	0.3	0.5	0.4
1455	1451	α-Humulene	t	t	-	-	t	-
1500	1496	Bicyclogermacrene	0.1	t	-	-	0.1	t
1561	1556	Germacrene B	-	-	t	-	-	-
		∑	0.7	0.4	0.3	0.3	0.6	0.4
		Oxygenated sesquiterpenes						
1563	1558	(E)-Nerolidol	t	-	-	-	-	-
1577	1572	Spathulenol	t	-	-	-	-	-
1583	1579	Caryophyllene oxide	t	-	-	-	-	-
1593	1598	Viridiflorol	0.1	-	-	-	-	-
1608	1602	Humulene epoxide II	t	-	-	-	-	-
1640	1635	*epi*-α-Cadinol	t	t	-	-	t	-
		∑	0.1	t	-	-	t	-
		Phenylpropanoids						
1196	1192	Methyl chavicol	0.1	0.2	-	t	t	-
1285	1283	(*E*)-Anethole	0.4	0.4	t	t	0.2	-
		∑	0.5	0.6	t	t	0.2	-
		Other components						
1202	1201	Decanal	0.1	0.1	t	t	0.1	t
1307	1305	Undecanal	t	t	t	-	t	-
1389	1385	Tetradecene	-	-	-	-	t	-
1409	1405	Dodecanal	t	-	-	-	t	-
1466	1460	(2*E*)-Dodecenal	0.2	t	-	-	0.2	-
1510	1506	Tridecanal	tr	-		-	-	-
1613	1608	Tetradecanal	t	t	-	-	t	-
1655	1651	2-Tetradecenal	-	t	-	-	0.2	-
1664	1660	Tetradec-2-enal	0.3	t	-	-	0.2	-
1700	1700	Heptadecane	t	-	-	-	t	-
1840	1837	Hexahydrofarnesyl acetate	0.2	t	-	-	t	-
		∑	0.8	0.7	t	t	0.7	t
		Total (%)	99.7	99.7	99.7	99.9	99.9	99.8

RIlit.= literature retention indices [13];RIexp.= experimental retention indices relative to C_9-C_{23} *n*-alkanes on the HP-5MS column; t= trace (<0.1%)

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