



Progress in Essential Oils

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Carrot Oil

Staniszewska and Kula (2001) analyzed the composition of a lab-prepared oil of *Daucus carota* L. ssp. *carota* that was obtained from wild carrot flowering umbels growing in their naturalized habitat in Poland. Using a combination of GC and GC/MS, the oil was found to contain the following constituents:

α -thujene (0.32 percent)
 α -pinene (40.67 percent)
camphene (1.64 percent)
sabinene (18.34 percent)
 β -pinene (2.25 percent)
myrcene (7.04 percent)
 α -phellandrene (0.03 percent)
 α -terpinene (0.67 percent)
p-cymene (1.38 percent)
limonene (5.26 percent)
(Z)- β -ocimene (3.25 percent)
(E)- β -ocimene (0.98 percent)
 γ -terpinene (1.53 percent)
pinol + *cis*-sabinene hydrate (0.38 percent)
terpinolene (0.41 percent)
linalool (0.99 percent)
 α -campholenal (0.11 percent)
trans-pinocarveol (0.03 percent)
terpinen-4-ol (4.84 percent)
myrtenal (0.02 percent)
 α -terpineol (0.26 percent)
bornyl acetate (0.13 percent)
 α -terpinyl acetate (0.09 percent)
neryl acetate (0.02 percent)
geranyl acetate (1.09 percent)
 α -copaene (0.08 percent)
 β -bourbonene (0.05 percent)
 β -elemene (0.20 percent)
cis- α -bergamotene (0.03 percent)
 β -caryophyllene (1.63 percent)
 β -gurjunene (0.06 percent)
trans- α -bergamotene (0.03 percent)
(Z)- β -farnesene (0.51 percent)
 α -cadinene[†] (0.34 percent)
(E)- β -farnesene (0.22 percent)
germacrene D (2.51 percent)
bicyclgermacrene (0.44 percent)
 α -farnesene* (0.30 percent)
 β -bisabolene (0.58 percent)
 γ -cadinene (0.04 percent)
(E)- γ -bisabolene (0.21 percent)
 α -bisabolene* (0.03 percent)
palustrol (0.02 percent)
 α -bisabolol (0.11 percent)

hexahydrofarnesyl acetone (0.01 percent)
hexadecanoic acid (0.04 percent)
tricosane (0.05 percent)
tetracosane (0.02 percent)
pentacosane (0.05 percent)

*correct isomer not identified; [†]incorrect identification based on GC elution order

In addition, trace amounts (< 0.01 percent) of tricyclene, p-mentha-1,5,8-triene, (Z)-3-octenol, a furanoid linalool oxide isomer, perillene, *cis*- and *trans*-p-menth-2-en-1-ol, a β -terpineol isomer, verbenone, *trans*-carveol, carvone, geraniol, eugenol, δ -elemene, α -cubebene, methyl eugenol, α -bourbonene, *cis*-chrysanthenyl isobutyrate, β -cubebene, geranyl acetone, ethyl cinnamate, aromadendrene, allo-aromadendrene, a methyl isoeugenol isomer, β -selinene, α -selinene, α -muurolene, pentadecane, δ -cadinene, cadi-1,4-diene, (E)-nerolidol, spathulenol, caryophyllene oxide, germacrene D-4-ol, 10-epi-junenol, hexadecane, humulene epoxide II, cyclocolorenon B, junenol, T-cadinol, T-muurolol, cubenol, α -cadinol, heptadecane, β -santalol, octadecane, nonadecane, eicosane, heneicosane and docosane were found in the same oil.

Gora et al. (2002) examined the composition of oils of *D. carota* ssp. *carota* that were produced from different plant parts, such as vegetative herbage, flowering umbels and seed. A summary of the results of this study is presented in T-1.

It was of interest to note that Schnitzler et al. (2003) determined that the monoterpene hydrocarbons α -pinene, myrcene and terpinolene were the most important

Compound	Herbage oil	Flowering umbel oil	Seed oil	Compound	Herbage oil	Flowering umbel oil	Seed oil
α -thujene	0.35	0.11	0.74	α -terpineol	0.16	0.11	0.32
α -pinene	16.05	42.76	21.14	bornyl acetate	0.21	0.14	0.17
camphene	0.58	1.55	0.89	geranyl acetate	0.63	1.93	3.74
sabinene	37.74	21.35	45.26	β -elemene	-	0.21	-
β -pinene	0.83	1.98	4.09	β -caryophyllene	0.63	2.88	0.59
myrcene	12.88	6.57	3.99	(Z)- β -farnesene	0.50	1.38	0.19
α -terpinene	1.18	0.11	1.42	α -cadinene [†]	-	0.20	-
p-cymene	0.98	0.53	0.18	(E)- β -farnesene	0.43	0.46	0.55
limonene	6.73	3.55	3.60	germacrene D	2.36	0.11	0.12
(Z)- β -ocimene	1.88	2.83	0.99	β -selinene	0.65	1.50	0.55
(E)- β -ocimene	0.53	0.80	0.35	bicyclogermacrene	-	0.76	-
γ -terpinene	2.94	0.99	2.39	α -farnesene*	-	0.14	-
terpinolene	0.76	0.33	0.55	β -bisabolene	0.23	0.77	0.10
linalool	0.39	0.54	1.63	spathulenol	0.03	-	-
α -campholenal	-	0.17	-	caryophyllene oxide	0.07	0.10	0.06
<i>trans</i> -pinocarveol	0.08	0.02	0.06	α -bisabolol	0.84	0.23	0.08
<i>cis</i> -verbenol	3.62	-	0.11				
terpinen-4-ol	3.62	1.07	4.54				

*correct isomer not identified; [†]incorrect identification based on GC elution order

terpenoid compounds contributing to the aroma of fresh carrot roots [ex *D. carota* L. ssp. *sativus* (Hoffm.) Arcang.]. Other monoterpene hydrocarbons, such as sabinene, limonene, (*Z*)- β -ocimene, γ -terpinene and *p*-cymene, were found to be minor contributors to the aroma of various cultivars of carrot.

Mockute and Nivinskiene (2004) examined the composition of oils produced from seeds of *D. carota* ssp. *carota* collected from different regions of Lithuania between 1995 and 2000. A summary of the composition found is as follows:

α -pinene (16.0-24.5 percent)
camphene (0.2-2.4 percent)
sabinene (28.2-37.5 percent)
 β -pinene (1.0-3.0 percent)
myrcene (t-0.2 percent)
 α -terpinene (1.5-2.4 percent)
p-cymene (0.3-1.9 percent)
limonene (2.3-4.2 percent)
 β -phellandrene (t-0.2 percent)
(*E*)- β -ocimene (t-0.8 percent)
 γ -terpinene (t-0.8 percent)
cis-sabinene hydrate (0.1-1.1 percent)
terpinolene (1.0-1.8 percent)
trans-sabinene hydrate
(0.2-1.0 percent)
linalool (1.4-4.0 percent)
cis-*p*-menth-2-en-1-ol
(0.1-0.5 percent)
 α -campholenal (0.2-2.5 percent)
trans-pinocarveol (0.1-1.9 percent)
trans-sabinol (0.1-1.6 percent)
trans-verbenol (0.1-2.8 percent)
sabina ketone (0.1-1.0 percent)
cis-chrysanthenol (0.1-0.8 percent)
pinocarpone (0.1-0.7 percent)
borneol (t-0.6 percent)
p-mentha-1,5-dien-8-ol
(0.2-1.8 percent)
terpinen-4-ol (4.6-7.5 percent)
thuj-3-en-10-al (t-0.5 percent)
p-cymen-8-ol (0-0.4 percent)
 α -terpineol (0.4-1.3 percent)
myrtenal (0.1-1.5 percent)
myrtenol (0.3-1.6 percent)
verbenone (0.6-1.4 percent)
trans-carveol (0.1-0.5 percent)
trans-chrysanthenyl acetate
(t-0.2 percent)
myrtenyl acetate (t-0.2 percent)
cuminaldehyde (0.1-0.5 percent)
carvone (0-0.3 percent)
cis-chrysanthenyl acetate
(t-0.2 percent)
geranial (0-0.1 percent)
 α -terpinen-7-al (t-0.4 percent)
bornyl acetate (0.3-1.1 percent)
p-cymen-7-ol (t-0.7 percent)
 α -terpinyl acetate (0.1-0.7 percent)
eugenol (0-0.1 percent)
 α -copaene (t-0.2 percent)
geranyl acetate (0.1-1.0 percent)
methyl eugenol (0-0.3 percent)

cis- α -bergamotene (t-0.2 percent)
 β -caryophyllene (0.2-2.0 percent)
trans- α -bergamotene (t-0.2 percent)
 α -humulene (0.1-0.3 percent)
(*E*)- β -farnesene (0.1-0.4 percent)
 α -acoradiene (0-0.3 percent)
 β -acoradiene (0-0.2 percent)
 γ -curcumene (0-0.4 percent)
germacrene D (t-0.8 percent)
 β -selinene (0-0.6 percent)
bicyclogermacrene (0-0.2 percent)
(*E*)-methyl iso Eugenol (0-0.3 percent)
 β -bisabolene (0.3-0.8 percent)
(*Z*)- γ -bisabolene (0.1-0.4 percent)

δ -cadinene (0.1-0.4 percent)
 β -sesquiphellandrene (0.1-0.3 percent)
 β -vetivene (0-1.6 percent)
 spathulenol (t-0.5 percent)
trans-sesquisabinene hydrate (0.1-0.4 percent)
 caryophyllene oxide (0.4-4.7 percent)
 humulene epoxide II (0.1-0.4 percent)

t = trace (< 0.1 percent)

The composition of the carrot seed oils obtained from wild Lithuanian plants is dissimilar to the oils encountered in commerce.

Gonny et al. (2004) compared the composition of oils produced from the aerial parts of *D. carota* harvested from plants

collected in their natural habitat in Corsica, France. They examined oils produced from plants harvested prior to flowering, at full flowering and at the end of flowering. The results can be seen summarized in T-2.

Raina et al. (2004) analyzed an oil produced from North Indian carrot seed using GC and GC/MS. They found that the composition of the oil was as follows:

α -thujene (0.2 percent)
 α -pinene (0.1 percent)
 sabinene (0.1 percent)
 β -pinene (1.9 percent)
 limonene (0.2 percent)
 (Z)- β -ocimene (0.1 percent)
 terpinen-4-ol (0.1 percent)
 α -terpineol (0.1 percent)
 α -cubebene (1.6 percent)

Comparative percentage composition of the aerial parts of *Daucus carota* oils harvested at different growth stages

T-2

Compound	Vegetative stage oil	Full-flowering stage oil	Post-flowering stage oil
α -pinene	26.5	39.5	18.9
camphene	1.2	1.4	0.8
sabinene	19.9	15.1	10.4
β -pinene	2.2	2.9	1.5
myrcene	5.5	6.9	4.2
α -terpinene	1.3	0.7	0.3
p-cymene	0.4	0.2	0.1
limonene	5.7	4.5	2.2
β -phellandrene	1.9	1.3	0.3
(Z)- β -ocimene	1.5	1.6	0.4
(E)- β -ocimene	0.7	0.5	0.1
γ -terpinene	2.9	2.0	0.7
terpinolene	0.8	0.4	0.2
linalool	1.0	0.7	0.2
terpinen-4-ol	4.6	2.0	1.1
α -terpineol	0.5	0.3	0.1
bornyl acetate	0.7	0.6	0.3
(E)- β -farnesene	0.4	0.6	0.2
α -humulene	1.0	0.8	0.3
(E)-methyl isoeugenol	1.5	3.5	41.6
germacrene D	1.9	1.7	0.7
6-epi-shyobunone	0.4	0.1	t
β -himachalene	0.8	0.3	t
β -bisabolene	0.6	0.6	4.8
shyobunone	1.3	0.3	t
δ -cadinene	0.2	0.2	0.1
elemicin	1.1	1.4	4.8
11 α (H)-himachal-4-en-1 β -ol	-	1.3	1.6
(E)-asarone	0.5	-	0.1
eudesm-7(11)-en-4 α -ol	0.6	0.3	0.2

t = trace (< 0.1 percent)

Comparative percentage composition of the oils produced from *Daucus carota* ssp. *carota* harvested at different growth stages

T-3

Compound	Herbage oil	Flowering umbels oil	Mature umbels oil
α -thujene	0.8	0.5	0.8
α -pinene	30.0	42.0	17.2
camphene	1.4	2.1	0.8
sabinene	30.1	19.5	40.5
β -pinene	2.0	2.6	2.4
myrcene	5.2	3.1	2.5
α -phellandrene	-	t	t
α -terpinene	1.1	1.1	1.3
p-cymene	2.2	0.6	0.5
limonene	5.3	3.7	2.3
(Z)- β -ocimene	0.2	0.2	0.4
(E)- β -ocimene	0.1	0.1	1.0
γ -terpinene	2.3	1.7	1.6
terpinolene	0.6	0.4	0.5
linalool	0.8	1.3	2.2
<i>trans</i> -pinocarveol	0.8	1.1	0.3
<i>cis</i> -verbenol	1.0	1.6	0.4
terpinen-4-ol	6.1	2.9	4.9
α -terpineol	0.3	0.4	0.3
bornyl acetate	0.1	0.2	0.2
geranyl acetate	0.2	1.8	16.5
β -caryophyllene	0.3	1.6	0.3
(Z)- β -farnesene	0.5	0.3	0.1
(E)- β -farnesene	0.3	0.2	0.1
germacrene D	0.7	0.1	0.1
β -selinene	0.2	0.4	0.1
bicyclogermacrene	-	0.4	t
β -bisabolene	0.1	0.5	0.1
spathulenol	0.5	t	0.1
caryophyllene oxide	0.5	2.5	0.1
α -bisabolol	1.0	0.3	t

t = trace (> 0.1 percent)

β -gurjunene (5.8 percent)
 germacrene D (0.2 percent)
 bicyclogermacrene (0.3 percent)
 (E,E)- α -farnesene (0.7 percent)
 germacrene B (0.3 percent)
 spathulenol (0.8 percent)
 caryophyllene oxide (0.5 percent)
 γ -eudesmol (0.1 percent)
 α -cadinol (0.6 percent)
 β -bisabolol (8.4 percent)
 (Z,E)-farnesol (0.2 percent)
 carotol (52.4 percent)
 α -sinensal[†] (0.4 percent)
 daucol (3.9 percent)
 octadecane (0.1 percent)
 nonadecane (4.6 percent)
 (E,E)-farnesyl acetone (1.3 percent)
 (E)-phytol (1.3 percent)
 tricosane (1.3 percent)
 tetracosane (5.8 percent)
 octacosane (1.0 percent)

[†]incorrect identification based on GC elution order

Trace amounts (< 0.1 percent) of myrcene, (E)- β -ocimene, linalool, *cis*-carveol, geraniol, *trans*- α -bergamotene, δ -cadinene, (E)-nerolidol, α -muurolol and (E,E)-farnesol also were found in this oil.

Staniszewska et al. (2005) used a combination of analytical techniques to analyze oils produced from vegetative herbage, flowering umbels and mature umbels of *D. carota* ssp. *carota* grown in Poland. The results of this study can be seen in T-3. In addition, the authors also compared the oils produced from the seeds of 'Koral' and 'Perfekcja' cultivars of *D. carota* ssp. *sativus* with a commercial sample of carrot seed oil, as can be seen from the data presented in T-4.

M. Staniszewska and J. Kula, *Composition of the essential oil from wild carrot umbels (Daucus carota L. ssp. carota) growing in Poland*. J. Essent. Oil Res., **13**, 439-441 (2001).

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V.K. Raina, A. Kumar, A.A. Naqvi, S. Tandon, K.K. Aggarwal and A.P. Kahol, *Composition of North Indian carrot seed oil*. Indian Perfum., **48**, 425-428 (2004).

M. Staniszewska, J. Kula, M. Wiczorkiewicz and D. Kusewicz, *Essential oils of wild and cultivated carrots — the chemical composition and antimicrobial activity*. J. Essent. Oil Res., **17**, 579-583 (2005).

Comparative percentage composition of seed oils produced from *Daucus carota* ssp. *sativus*

T-4

Compound	'Koral' seed oil	'Perfekcja' seed oil	Commercial carrot seed oil
α -thujene	-	0.1	1.9
α -pinene	15.0	18.0	9.0
camphene	0.9	1.3	0.9
sabinene	1.8	2.1	11.5
β -pinene	2.2	2.9	4.5
myrcene	1.0	1.4	1.4
α -phellandrene	t	-	0.2
α -terpinene	t	0.1	1.5
p-cymene	2.5	0.6	5.6
limonene	0.9	1.5	1.5
γ -terpinene	-	0.1	3.2
terpinolene	0.1	0.2	-
linalool	0.2	0.6	0.8
<i>trans</i> -pinocarveol	0.5	1.2	0.4
<i>cis</i> -verbenol	1.5	3.2	0.2
pinocarvone	0.2	0.4	1.0
terpinen-4-ol	-	0.2	3.0
α -terpineol	0.1	0.8	1.0
geraniol	0.4	0.1	0.3
bornyl acetate	0.3	0.6	0.6
geranyl acetate	0.1	0.3	13.8
daucene	4.0	2.0	1.8
<i>cis</i> - α -bergamotene	0.2	0.6	0.8
β -caryophyllene	5.3	5.3	4.1
<i>trans</i> - α -bergamotene	0.2	1.1	1.3
(Z)- β -farnesene	2.0	1.2	1.6
α -cadinene [†]	0.3	1.2	0.7
(E)- β -farnesene	-	-	t
germacrene D	-	-	t
β -selinene	0.9	0.5	3.5
bicyclogermacrene	0.3	0.4	0.3
α -selinene	0.3	0.1	0.7
β -bisabolene	2.3	2.2	2.6
β -sesquiphellandrene	0.2	0.3	0.2
(E)-nerolidol	0.4	0.5	0.2
caryophyllene oxide	1.7	3.1	1.6
carotol	48.0	36.9	10.7
daucol	1.2	2.9	t
α -bisabolol	0.2	0.7	t

t = trace (< 0.1 percent); [†]incorrect identification based on GC elution order

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