Progress in Essential Oils

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Carrot Seed and Leaf Oil

Although there are 15 subspecies of *Daucus carota* and two varietal forms of *D. carota* L. subsp. *sativus* (Hoffm.) Archang, carrot seed oil is obtained solely from the infertile mature fruit (seeds) of a range of commercial cultivars of the vegetable carrot that have been developed through selection from the original wild carrot of the same taxonomic origin.

The oil of carrot and carrot seed has been the subject of a number of reviews (Lawrence, 1976, 1980, 1988, 1990, 1992, 1999, 2003 and 2006).

Valterova et al. (1997) examined the headspace monoterpene hydrocarbons of *D. carota* subsp. *sativus* leaves using multidimensional GC and two chiral columns. The hydrocarbons characterized in the leaf headspace were:

α-pinene (21.4%)
camphene (0.9%)
β-pinene (4.3%)
sabinene (43.8%)
δ-3-carene (0.1%)
myrcene (9.9%)
α-terpinene (4.7%)
limonene (6.6%)
β-phellandrene (0.6%)
(Z)-β-ocimene (<0.1%)
γ-terpinene (5.5%)
(E)-β-ocimene (1.1%)
p-cymene (0.5%)
terpinolene (0.1%)
allo-ocimene* (0.5%)

*correct isomer not identified

Chiral analysis of five constituents found in the headspace revealed the following enantiomeric ratios:

(1S,5S)-(-)-α-pinene (66%):(1R,5R)-(+)-α-pinene (34%)
(1S,4R)-(-)-camphene (71%):(1R, 4S)-(+)-camphene (29%)
(1S, 5S)-(-)-β-pinene (22%)-(1R,5R)-(+)-β-pinene (78%)
(1S,5S)-(-)-sabinene (22%):(1R,5R)-(+)-sabinene (78%)
(4S)-(-)-limonene (28%):(4R)-(+)-limonene (72%)

Jasicka-Misiak et al. (2004) used GC/MS only to examine the composition of a commercial sample of carrot seed oil. The constituents characterized in this oil were:

α-thujene (1.9%)
α-pinene (3.9%)
camphene (0.9%)
β-pinene (1.9%)
myrcene (1.4%)
α-terpinene (1.4%)
o-cymene (1.3%)
limonene (1.8%)
γ-terpinene (1.4%)
terpinolene (0.6%)
linalool (0.5%)
pinen-4-ol† (0.4%)
terpinen-4-ol (0.2%)
δ-3-carene † (0.8%)
neryl acetate (1.1%)
β-gurjunene (3.2%)
zingiberene† (2.1%)
α-farnesene*† (3.4%)
β-caryophyllene (10.7%)
α-cedrene (2.7%)
α-himachalene (0.6%)
β-cubebene† (0.5%)
α-longipinene† (0.8%)
aromadendrene (1.9%)
β-farnesene* (4.0%)
α-bisabolol† (0.3%)
vitamin A aldehyde† (0.7%)
isolimonene† (3.2%)
caryophyllene oxide (4.3%)
carotol (38.9%)
γ-cadinene† (0.3%)
daucol (2.0%)

*correct isomer not identified
†incorrect identification

Kula et al. (2006) analyzed the oils produced from the fresh and air-dried flowering umbels of the 'Perfkcja,' 'Koral' and 'Dolanka' cultivars of *D. carota* subsp. sativus using GC-FID and GC/MS. They found that the oils contained the most of the same constituents, but they varied in quantitative levels. A summary of the combined analyses can be seen as follows:

α-pinene (39.6–46.2%)
camphene (t–2.1%)
sabinene (1.5–7.5%)
β-pinene (0–2.6%)
myrcene (12.3–23.7%)
p-mentha-1,5,8-triene (t–0.6%)
p-cymene (t–3.9%)
limonene (0.4–6.9%)
(Z)-β-ocimene (0.1–1.0%)
γ-terpinene (t–0.9%)
linalool (t–0.5%)
cis-p-menth-2-en-1-ol (t–0.2%)
terpinen-4-ol (0.3–1.4%)
bornyl acetate (t–0.2%)
eugenol (0.3–0.8%)
β-elemene (t–0.1%)
β-caryophyllene (4.6–13.2%)
geranyl acetone (t–0.5%)
aromadendrene (1.3–3.7%)
trans-α-bergamotene (0–0.1%)
(Z)-β-farnesene (t–3.0%)
α-cadinene† (t–0.3%)
(E)-β-farnesene (0–1.3%)
β-selinene (t–0.6%)
zingiberene (0–0.4%)
bicyclogermacrene (t–0.3%)
β-bisabolene (t–0.1%)
(E)-γ-bisabolene (0.1–0.4%)
(E)-nerolidol (t–0.5%)
spathulenol (t–0.7%)
caryophyllene oxide (0–1.2%)
carotol (1.2–6.1%)
α-bisabolol (t–0.4%)

†incorrect identification
t=trace (<0.1%)

In addition, trace amounts (<0.1%) of tricyclene, *trans*-p-menth-2-en-1-ol, *cis*-verbenol, borneol, geranyl acetate, germacrene D and α-cadinol were found in this oil.

The constituents characterized in the air-dried aerial parts of *D. carota* subsp.

sativus that was produced commercially in Corsica (France) was the subject of study by Rossi et al. (2007).Using a combination of GC-FID, GC/MS and ^{13}C-NMR, the authors determined that the oil contained the following constituents:

α-pinene (15.9%)
camphene (0.7%)
sabinene (2.7%)
β-pinene (1.1%)
myrcene (2.0%)
p-cymene (0.2%)
limonene (1.7%)
(Z)-β-ocimene (0.1%)
γ-terpinene (0.2%)
terpinen-4-ol (0.2%)
bornyl acetate (0.5%)
methyl eugenol (0.2%)
α-cedrene (0.3%)
β-cedrene (0.2%)
trans-α-bergamotene (0.2%)
veratraldehyde (0.2%)
(E)-β-farnesene (0.5%)
methyl (E)-isoeugenol (21.8%)
germacrene D (0.5%)
6-epi-shyobunone (0.5%)
β-selinene (0.5%)
α-selinene (0.9%)
β-bisabolene (21.3%)
shyobunone (1.3%)
elemicin (16.3%)
(E)-α-bisabolene (1.1%)
11α-himachal-4-en-1β-ol (0.7%)
(E)-asarone (0.8%)
α-bisabolol (0.2%)
selina-7(11)-en-4α-ol (0.7%)
isocalamenediol (0.2%)

Carrot seeds that were purchased locally in Konya (Turkey) were dried, ground and subjected to hydrodistillation by Özcan and Chalchat (2007). This oil, which was analyzed by GC-FID and GC/MS was determined to possess the following composition:

α-pinene (0.7%)
sabinene (0.1%)
β-pinene (0.5%)
myrcene (0.2%)
limonene (0.4%)
terpinolene (0.1%)
linalool (0.3%)
nonanal (0.1%)
trans-verbenol (0.1%)
p-cymen-8-ol (0.1%)
α-terpineol (0.1%)
daucene (8.7%)
cis-α-bergamotene (0.1%)
β-caryophyllene (1.1%)
(Z,E)-α-farnesene (0.2%)
trans-α-bergamotene (2.4%)
epi-β-santalene (0.2%)
(Z,Z)-α-farnesene (5.9%)
germacrene D (2.3%)
ar-curcumene (0.2%)
β-selinene (2.2%)
α-selinene (0.9%)
bicyclogermacrene (1.9%)
β-bisabolene (1.9%)
(Z)-γ-bisabolene (0.1%)
β-sesquiphellandrene (0.5%)
15-copaenol† (0.3%)
carotol (66.8%)
daucol (0.5%)
α-eudesmol + α-cadinol (0.2%)

†identification requires corroboration

The leaf oil of *D. carota* subsp. *sativus* produced by 3-hr. hydrodistillation from plants of Iranian origin was found by Mojab et al. (2008) using GC-FID and GC/MS to possess the following composition:

(Z)-3-hexenol (0.5%)
hexanol (0.5%)
heptanal (0.1%)
α-pinene (2.9%)
camphene (0.3%)
sabinene (1.9%)
myrcene (14.5%)
octanal (0.1%)
α-terpinene (0.1%)
o-cymene (0.5%)
limonene (3.2%)
(Z)-β-ocimene (0.1%)
(E)-β-ocimene (0.3%)
α-terpinene (0.5%)
octanol (0.1%)
terpinolene (0.3%)
linalool (0.5%)
p-mentha-1,5,8-triene (0.1%)
2-pinenol† (0.1%)
ipsdienol† (0.1%)
nonenal* (2.0%)
nonanol (0.1%)
terpinen-4-ol (2.0%)
α-terpineol (1.3%)
methyl chavicol (0.5%)
β-cyclocitral (0.1%)
allo-ocimene† (0.7%)
p-anisaldehyde (0.4%)
(E)-anethole (23.5%)
perilla alcohol (0.1%)
theaspirane A (0.1%)
δ-elemene (0.5%)
α-longipinene (0.4%)
eugenol (0.8%)
α-ylangene (0.1%)
α-copaene (0.4%)
β-longipinene (1.2%)
β-caryophyllene (2.5%)
α-bergamotene* (1.2%)
α-humulene (1.9%)
(E)-β-farnesene (2.3%)
2,6-dimethyl-2,4-heptadiene† (0.4%)
γ-decalactone† (1.2%)
germacrene D (4.1%)
γ-cadinene (1.7%)
β-selinene (1.0%)
methyl isoeugenol* (1.2%)
α-muurolene (0.1%)
(E,Z)-α-farnesene (1.0%)
α-cedrene (0.1%)
α-amorphene (0.1%)
β-guaiene† (0.1%)
δ-cadinene (1.0%)
(E)-γ-bisabolene (0.1%)
δ-selinene (0.1%)
(Z)-α-bisabolene (0.5%)
germacrene B (0.3%)
1,10-epoxy-germacrene D (0.3%)
caryophyllene oxide (2.8%)
salvia-4(14)-en-1-one (0.3%)
longiborneol† (0.5%)
fonenol† (0.4%)
adamantane† (0.5%)
α-cadinol (0.3%)
T-cadinol (0.3%)
valencene† (0.3%)
α-bisabolol (1.9%)
isocaryophyllene† (0.1%)
bisabolol oxide A† (0.1%)
tetradecanoic acid (0.3%)
17-octadecenal† (0.1%)
longifolenaldehyde† (0.1%)
1-octadecene (0.4%)
peucelinenediol† (0.1%)
cembrene (0.3%)
methyl linolenate (0.1%)
hexadecanoic acid (0.9%)
1-nonadecane (1.7%)
(Z)-9-octadecenoic acid† (0.1%)
phytol (3.0%)
linoleic acid (0.1%)
ethyl linoleate (0.3%)

*correct isomer not identified
†incorrect identification

This reviewer finds it amazing that so many high-boiling constituents were characterized by Mojab et al. after only a 3-hr. hydrodistillation.

De Rapper (2013) reported that a commercial oil of *D. carota* possessed the following composition:

decane (0.4%)
α-pinene (3.4%)
camphene (0.2%)
β-pinene (0.6%)
sabinene (3.0%)
myrcene (1.0%)
limonene (0.7%)
γ-terpinene (0.3%)
p-cymene (0.7%)
2-butoxyethanol† (0.1%)
daucene (1.5%)

β-gurjunene (0.1%)
γ-muurolene (0.3%)
linalool (0.2%)
α-funebrene (1.5%)
α-santalene (0.6%)
bornyl acetate (0.4%)
β-funebrene (2.4%)
β-caryophyllene (5.7%)
cis-α-bergamotene (0.3%)
epi-β-santalene (0.2%)
sesquisabinene A (4.1%)
β-sesquiphellandrene (4.6%)
α-humulene (0.5%)
trans-α-bergamotene (0.8%)
verbenone (0.1%)
β-bisabolene (5.3%)
α-selinene (0.2%)
carvone (0.2%)
geranyl acetate (1.1%)
bisabolene[*] (1.6%)
ar-curcumene (0.1%)
germacrene D (0.1%)
geraniol (1.0%)
caryophyllene oxide (3.6%)
carotol (44.4%)
6-epi-cubenol (2.3%)
spathulenol (0.1%)
α-eudesmol (0.2%)
daucol (0.6%)
γ-eudesmol (0.4%)
(Z)-asarone (0.3%)

[*]correct isomer not identified; [†]incorrect identification

Trace amounts (<0.1%) of α-thujene, thuja-2,4(10)-diene, α-terpinene, β-phellandrene, terpinolene, p-cymenene, sulcatol (also known as 6-methyl-5-hepten-2-ol), *trans*-sabinene hydrate, β-elemene, α-longipinene, δ-cadinene, myrtenol, *cis*-carveol, p-cymen-8-ol and α-bisabolol were also found in this oil.

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