



Progress in Essential Oils

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Marjoram Oil

The composition of marjoram oil, which is obtained from *Origanum majorana* L., differs from that of the plant because on steam distillation the heat labile *cis*- and *trans*-sabinene hydrate and their corresponding acetates can be converted to terpinen-4-ol. Novak et al. (2007) pointed out that *cis*-sabinene hydrate possesses an intensive, spicy, marjoram-like aroma. In addition to the 'sabinyl'-rich oils, a chemotype whose oil is rich in carvacrol can also be found.

A phenol-rich oil of *O. majorana* that was produced in the laboratory from plants collected in Calabria (Italy) was found by Gionfriddo et al. (2001) to contain the following major components:

camphor (1.8%)
carvacrol (68.5%)
thymol (12.2%)

Daferera et al. (2003) determined that the composition of an oil produced from *O. majorana* that was rich in carvacrol contained the following constituents:

α -pinene (0.7%)
camphene (<0.1%)
 β -pinene (0.4%)
myrcene (1.3%)
 α -terpinene (5.4%)
p-cymene (5.8%)
 β -phellandrene (1.8%)
 γ -terpinene (9.3%)
terpinolene (1.5%)
linalool (5.6%)
borneol (0.5%)
terpinen-4-ol (9.4%)
 γ -terpineol (2.4%)
linalyl acetate (0.8%)
thymol (0.8%)
carvacrol (45.1%)
neryl acetate (0.5%)
geranyl acetate (0.5%)
 β -caryophyllene (1.0%)

An oil of marjoram of commercial origin was determined by Pavela (2006) to possess the following composition:

α -thujene (1.1%)
 α -pinene (0.8%)
sabinene (8.8%)
 β -pinene (0.5%)
myrcene (1.9%)
 α -phellandrene (0.8%)
 α -terpinene (8.6%)
p-cymene (1.2%)
limonene (4.2%)
1,8-cineole (0.2%)
 γ -terpinene (13.1%)
trans-sabinene hydrate (4.2%)
terpinolene (3.1%)
cis-sabinene hydrate (11.7%)
cis-p-menth-2-en-1-ol (2.4%)
trans-p-menth-2-en-1-ol (1.6%)
borneol (t)
terpinen-4-ol (21.1%)
 α -terpineol (4.9%)
cis-piperitol (0.5%)
cis-dihydrocarvone (0.3%)
terpinen-3-ol[†] (0.7%)
trans-sabinene hydrate acetate (0.6%)
linalyl acetate (1.5%)
bornyl acetate (t)
 β -caryophyllene (2.5%)
 α -humulene (0.1%)
bicyclogermacrene (1.2%)
caryophyllene oxide (0.1%)

t=trace (<0.1%)
†incorrect identification

The volatile components of an aqueous extract of marjoram leaves were analyzed using a PDMS-DVB fiber combined with GC/MS by Pérez et al. (2007). The components that were characterized were as follows:

benzaldehyde^a (0.81)
p-cymene (2.50)
linalool (0.81)
sabinene hydrate^{*} (8.60)
borneol (0.20)
menthol (0.38)
terpinen-4-ol (96.50)
4-isopropenyltoluene[†] (1.10)
 α -terpineol (21.80)
carvone (2.20)
p-menth-5-en-3-one[†] (0.24)

^a μ g/g

^{*}correct isomer not characterized

[†]incorrect identification based on GC elution order

Origanum majorana plants were grown from seeds collected from a wild population growing near the village of Vouini (Limassol District, Cyprus) by Novak et al. (2007). Oils were produced from 50 plants grown in Vienna and analyzed by GC/MS. Examination of the results reported in **T-1** reveals that the oils could be subdivided into three chemotypes; a sabinyl chemotype (28), an α -terpineol chemotype (2) and a mixed chemotype (18).

Gharib et al. examined the oils produced from marjoram plants grown under different compost and fertilizer regimens in Egypt using GC/MS. The oils were found to range in composition, irrespective of the fertilization regimen, as follows:

α -pinene (2.1–4.8%)
sabinene (6.2–8.3%)
myrcene (1.1–2.0%)
 α -phellandrene (0.1–2.4%)
 α -terpinene (0.2–13.1%)
p-cymene (6.6–13.9%)
 γ -terpinene (9.1–16.4%)
trans-sabinene hydrate (1.6–6.6%)
terpinolene (6.7–18.5%)
 α -terpineol[†] (0.1–1.1%)
terpinen-4-ol (17.8–24.2%)
p-menth-1-en-8-ol[†] (2.8–4.3%)
nerol (0.1–0.3%)
linalyl acetate (2.0–5.3%)
bornyl acetate (0.1–0.7%)
 α -terpinyl propionate (0–0.6%)
bicycloelemene (0.1–0.4%)
neryl acetate (0.1–0.6%)
geranyl acetate (0.2–0.5%)
 β -caryophyllene (2.4–3.2%)
aromadenerene (0.1–0.8%)
 α -humulene (0.2–0.3%)
ledene (0–0.6%)
bicyclogermacrene (0.5–1.5%)
 α -cadinene (t–0.1%)
spathulenol (0.1–1.1%)
caryophyllene oxide (0–0.2%)

[†]incorrect identification based on GC elution order

[†]should be α -terpineol

t=trace (<0.05%)

Marjoram plants cultivated in Egypt were harvested in spring (flowering),

summer (fruiting), autumn (second fruiting) and winter (pre-flowering). Oils that were produced from plants harvested in each season were analyzed by GC/MS.

A summary of the results of those analyses can be seen in **T-2**. The high thymol content for the oil produced from plants harvested during flowering in the spring is

T-1. Percentage composition of the oils from three chemotypes of *Origanum majorana*

Compound	Type 1	Type 2	Type 3
α -thujene	0.5	0.3	0.1
α -pinene	1.1	0.7	0.4–0.6
camphene	0.5	0.6	0.6–0.8
sabinene	9.2–9.6	5.0–5.4	1.1
β -pinene	0.6	0.3	0.2
myrcene	2.0	1.5	1.0
limonene + β -phellandrene	3.2–3.4	2.3	1.3
1,8-cineole	0.6	0.5–0.7	0.2–0.6
(Z)- β -ocimene	0.1	0–t	0
γ -terpinene	0.2	0–t	0
<i>trans</i> -sabinene hydrate	4.0–4.2	2.3–2.5	0.5–0.9
<i>cis</i> -sabinene hydrate + linalool	59.7–61.5	32.1–33.1	3.0–5.4
borneol	1.7–1.9	1.8–2.0	2.2
terpinen-4-ol	0.3	0.2	0.2
α -terpineol	3.6–3.8	39.3–40.7	69.9–75.1
<i>cis</i> -sabinene hydrate acetate	0.9–1.1	0.6–0.8	0
linalyl acetate	3.1–3.7	3.3–4.1	4.5–8.3
bornyl acetate	0.2	0.2	0.1–0.3
β -caryophyllene	2.2–2.4	2.2–2.4	3.0–4.0
α -humulene	0.1	0.1	0.2
bicyclogermacrene	2.5–2.7	2.9–3.3	3.5–3.9
germacrene D-4-ol	0.2–0.4	0.6–0.8	0.2

t=trace (<0.1%)

T-2. Percentage composition of marjoram oil produced from plants harvested throughout the season

Compound	Spring oil	Summer oil	Autumn oil	Winter oil
sabinene	4.5	6.1	7.4	4.2
β -pinene	1.0	0.9	0.4	0.3
α -phellandrene	0.1	-	-	-
α -terpinene	4.4	13.3	0.4	2.8
p-cymene	2.3	4.2	13.9	3.3
γ -terpinene	8.3	18.3	-	5.3
<i>trans</i> -sabinene hydrate	-	0.2	5.1	5.6
terpinolene	2.9	2.6	43.1	0.3
<i>cis</i> -sabinene hydrate	25.3	7.4	-	54.4
<i>cis</i> -p-menth-2-en-1-ol	0.3	0.9	0.5	0.5
<i>trans</i> -p-menth-2-en-1-ol	0.1	0.5	-	-
terpinen-4-ol	7.7	37.4	20.5	16.3
α -terpineol	1.3	2.7	6.4	4.1
methyl thymol	0.1	-	-	-
linalyl acetate	-	-	-	0.9
thymol	38.4	-	-	-
δ -elemene	-	0.5	-	-
β -caryophyllene	1.5	2.6	0.7	0.9
bicyclogermacrene	-	1.7	-	0.6
spathulenol	-	-	0.3	-

surprising and needs repeating to ensure the value of the result.

The leaves of *O. majorana* were found by Wood et al. (2008) to contain 208 µg/kg of rotundone.

Young pot-raised *O. majorana* plants were micro-hydrodistilled to yield oils which were bulked and analyzed by Banchio et al. (2008) using GC-FID and GC/MS. The oil was found to possess the following composition:

tricyclene (0.1%)
α-pinene (0.2%)
camphene (0.2%)
sabinene (0.1%)
α-terpinene (0.2%)
p-cymene (0.1%)
limonene (0.2%)
1,8-cineole (0.3%)
γ-terpinene (0.5%)
cis-sabinene hydrate (8.4%)
terpinen-4-ol (55.1%)
cis-piperityl acetate (1.3%)
trans-piperityl acetate (0.5%)
borneol (1.4%)
trans-sabinene hydrate (13.2%)
α-terpineol (9.1%)
trans-carveol (1.0%)
camphor (0.7%)
β-caryophyllene (1.8%)
α-humulene (3.7%)

A commercial oil of marjoram of Albanian origin was analyzed by GC and GC/MS by Jirovetz et al. (2008). This oil, which was also screened for its antimicrobial activity (as were some of its major and minor components) was found to contain the following components:

α-thujene (0.8%)
α-pinene (0.8%)
sabinene (8.3%)
β-pinene (0.5%)
myrcene (2.1%)
α-phellandrene (0.4%)
p-cymene (1.3%)
α-terpinene (8.9%)
limonene (2.0%)
β-phellandrene (2.2%)
α-terpinene (14.0%)
cis-sabinene hydrate (3.8%)
terpinolene (2.2%)
trans-sabinene hydrate (15.5%)
linalool (1.4%)
cis-p-menth-2-en-1-ol (2.3%)
terpinen-4-ol (21.3%)
α-terpineol (3.3%)
cis-piperitol (0.1%)
trans-piperitol (0.5%)
cis-sabinene hydrate acetate (0.1%)
geraniol (0.1%)

linalyl acetate (2.2%)
trans-sabinene hydrate acetate (0.1%)
β-caryophyllene (2.3%)
α-humulene (0.1%)
bicyclogermacrene (1.4%)
caryophyllene oxide (0.1%)

These same results were reported in another publication, this time by Schmidt et al. (2008).

A commercial sample of marjoram oil that was produced in Kashmir (India) was reported (Anon, 2008) to contain the following constituents:

α-thujene (0.6%)
α-pinene (0.8%)
sabinene (5.5%)
β-pinene (0.5%)
myrcene (1.5%)
3-octanol (0.1%)
α-phellandrene (0.3%)
α-terpinene (6.7%)
p-cymene (4.4%)
limonene (1.6%)
β-phellandrene (1.6%)
β-ocimene* (0.1%)
γ-terpinene (10.9%)
cis-sabinene hydrate (2.5%)
terpinolene (2.8%)
linalool (2.5%)
trans-sabinene hydrate (6.3%)
terpinen-1-ol (1.8%)
terpinen-4-ol (30.2%)
α-terpineol (4.7%)
dihydrocarvone* (0.2%)
cis-piperitol (0.8%)
nerol (0.1%)
linalyl acetate (2.5%)
bornyl acetate (0.1%)
thymol (2.0%)
neryl acetate (0.1%)
geranyl acetate (0.2%)
β-caryophyllene (2.8%)
α-humulene (0.1%)
germacrene D (0.1%)
bicyclogermacrene (1.4%)
β-bisabolene (0.2%)
spathulenol (0.2%)
caryophyllene oxide (0.3%)
isospathulenol (0.2%)

*correct isomer not identified

In addition, trace amounts (<0.05%) of (Z)-3-hexenol, camphene, methyl carvacrol, citronellyl formate, carvacrol, α-copaene, β-bourbonene, ledene and δ-cadinene were also found in this oil.

Marjoram oil produced from plants cultivated in Sharkia region (northeastern Cairo, Egypt) was analyzed using GC/MS by Viuda-Martos et al. (2010).

The oil composition was found to be as follows:

α-thujene (0.6%)
α-pinene (0.6%)
sabinene (5.0%)
myrcene (1.4%)
α-terpinene (5.2%)
p-cymene (6.1%)
limonene (3.6%)
γ-terpinene (9.3%)
terpinolene (2.4%)
(E)-β-ocimene (4.1%)
linalool (3.3%)
camphor (0.4%)
terpinen-4-ol (41.4%)
α-terpineol (6.5%)
thymol (0.6%)
β-caryophyllene (1.4%)

Ramos et al. (2011) collected *O. majorana* plants from a site 3,340 m above sea level near San Isidro de Apartaderos (Merida, Venezuela). Hydrodistillation of fresh leaves for 3 h yielded an oil in 0.6%. Analysis of the oil by GC-FID and GC/MS revealed that it contained the following constituents:

α-thujene (0.2%)
sabinene (1.4%)
myrcene (0.5%)
α-terpinene (3.6%)
p-cymene (2.4%)
β-phellandrene (1.5%)
γ-terpinene (7.2%)
trans-sabinene hydrate (4.4%)
terpinolene (2.0%)
cis-sabinene hydrate (30.2%)
cis-p-menth-2-en-1-ol (2.0%)
trans-p-menth-2-en-1-ol (1.1%)
borneol (0.4%)
terpinen-4-ol (28.8%)
α-terpineol (6.9%)
cis-piperitol (0.5%)
trans-piperitol (0.5%)
linalyl acetate (3.9%)
eugenol (0.3%)
neryl acetate (0.3%)
geranyl acetate (0.6%)
β-caryophyllene (0.6%)
bicyclogermacrene (1.1%)

Trace amounts (<0.05%) of butyl acetate and geraniol were also characterized in this oil.

An oil produced by hydrodistillation from the dry leaves of *O. majorana* obtained from a commercial spice company in China was subjected to analysis by Jiang et al. (2011) using GC-FID and GC/MS. The components characterized in this oil were:

β -phellandrene (0.7%)
 p-cymene (6.8%)
 linalool (0.4%)
trans-p-menth-2-en-1-ol (0.7%)
cis-p-menth-2-en-1-ol (0.7%)
 terpinen-4-ol (33.0%)
 p-cymen-8-ol (0.5%)
 α -terpineol (6.7%)
cis-piperitol (0.6%)
 linalyl acetate (0.7%)
 α -terpinyl acetate (2.3%)
 δ -elemene (0.4%)
 geranyl acetate (0.3%)
 α -copaene (1.9%)
 β -caryophyllene (2.3%)
 aromadendrene (0.7%)
 γ -muurolene (0.3%)
 calamenene* (0.4%)
 spathulenol (6.0%)
 caryophyllene oxide (11.9%)
 humulene oxide* (0.4%)
 β -eudesmol (0.3%)

*correct isomer not identified

In addition, the authors reported a further 17 compounds in the oil. However, as these were all incorrect identifications they are not included in this review.

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