Progress in Essential Oils

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Melissa or Lemon Balm Oil

Tekel et al. (1997) determined that the use of uracil herbicides (Bromacil, Lenacil or Terbacil) during the life cycle of *Melissa officinalis* L. did not affect the composition of the main oil components such as citronellal, neral, geranial, geranyl acetate, β-caryophyllene and caryophyllene oxide. Although the authors did not determine the herbicide residues of the oil, they did determine that the highest residues in the plant material were 0.005–0.007 mg/kg.

An oil produced from the air-dried leaves of the 'Citra' cultivar of *M. officinalis* grown in the Slovak Republic was analyzed by Holla et al. (1997). The constituents found in this oil were as follows:

α-pinene (0.05%)
2,5-diethyltetrahydrofuran (0.08%)
hexenal* (0.05%)
1,3,5-octatriene* (< 0.05%)
β-pinene (0.14%)
myrcene (0.12%)
limonene (0.11%)
1,8-cineole (0.14%)
3-octanone (0.12%)
β-ocimene* (0.26%)
4-octen-3-one† (0.18%)
2,3-octanedione† (< 0.05%)
6-methyl-5-hepten-2-one (0.31%)
rose oxide* (0.12%)
rose oxide* (0.07%)
3-octanol (0.12%)
linalool oxide * (0.24%)
menthone (0.60%)
1-octen-3-ol (0.25%)
α-cubebene (0.26%)
isomenthone (0.42%)
citronellal (11.31%)
α-copaene (0.67%)
β-bourbonene (0.06%)
linalool (0.08%)
isopulegol* (0.07%)
isopulegol* (0.06%)
menthyl acetate (0.27%)
β-caryophyllene (4.20%)
menthol (0.12%)
α-humulene (0.13%)
neral (22.18%)
methyl geranate (0.36%)
geranial (33.60%)
γ-muurolene (0.26%)
α-muurolene (0.14%)
geranyl acetate (5.89%)
caryophyllene oxide (8.35%)
geranic acid (1.05%)
tetradecanoic acid (0.80%)
hexadecanoic acid (1.01%)
heptacosane (< 0.05%)

* correct isomer not identified; † doubtful components based on GC elution order

In addition, the author tentatively identified a number of constituents that are not listed above. It is the belief of this reviewer that none were correctly identified, hence they are not included in this review.

Comparative percentage composition of the oil and headspace volatiles of *Melissa officinalis* subjected to different treatment **T-1**

Compound	Oil	HS-1	HS-2	HS-3
α-pinene	0.9	6.8	t	t
sabinene	0.8	6.4	t	t
β-pinene	0.5	1.0	t	t
myrcene	0.5	0.6	t	t
δ-3-carene	3.8	2.7	0.6	1.0
p-cymene	3.6	3.0	1.4	0.3
limonene	39.4	34.8	5.2	17.1
(E)-β-ocimene	0.3	0.8	t	0.3
γ-terpinene	0.7	0.3	t	0.7
isopulegol	0.6	0.4	0.8	0.6
citronellal	10.1	2.5	1.6	1.3
neral	2.7	0.8	8.2	0.9
citronellol	21.8	34.1	56.5	4.4
nerol	0.2	0.4	0.4	0.3
geranial	4.3	1.2	11.3	20.2
eugenol	1.9	0.4	1.0	0.5
citronellyl acetate	1.0	0.5	3.0	0.3
neryl acetate	0.6	0.6	3.7	0.3
α-cubebene	1.1	0.6	2.5	1.4
β-elemene	0.3	0.5	1.4	1.6
β-caryophyllene	1.3	0.2	0.7	2.0

HS-1 = headspace volatiles of untreated oil; HS-2 = headspace volatiles of heated oil; HS-3 = headspace volatiles of heated oil when volume reduced by 50%

Comparative percentage composition of main components of *Melissa officinalis* plants harvested at different cut heights **T-2**

Compound	Whole herb oil	Top 1/3 oil	Top 2/3 oil
citronellal	6.44	2.82	3.49
linalool	0.41	1.14	1.02
β-caryophyllene	5.13	6.97	6.38
geranial	34.56	36.09	34.98
neral	22.31	23.65	22.41
caryophyllene oxide	17.82	15.64	17.43

Range in percentage composition of the oils of *Melissa officinalis* produced from 11 seed sources in two locations in Turkey **T-3**

Compound	Menemen oils	Bozdağ oils
α-pinene	0–12.82	0–1.05
β-pinene	1.50–44.49	0–10.72
linalool	0.40–9.00	0–4.25
citronellal	1.31–10.03	0–20.29
borneol	0–4.19	–
neral	0–26.61	3.25–32.12
geraniol	0–23.22	0–19.75
geranial	4.52–58.64	37.69–84.65

Percentage composition of *Melissa officinalis* oils of Greek origin **T-4**

Compound	Malakasa oil	Evvoia Island oil	Cretan oil
α-thujene	5.3	t	t
α-pinene	6.6	t	6.9
sabinene	8.2	6.9	17.4
β-pinene	13.6	6.4	18.2
α-terpinene	4.9	t	t
p-cymene	4.0	2.0	t
limonene	3.0	t	t
γ-terpinene	8.2	5.5	4.8
cis-sabinene hydrate	1.0	t	t
terpinolene	2.1	t	t
linalool	t	5.9	t
trans-sabinene hydrate	2.1	t	t
trans-pinocarveol	2.1	t	–
pinocarvone	1.5	t	–
terpinen-4-ol	7.7	7.3	4.7
myrtenal	2.5	t	t
(E)-β-damascenone	t	2.8	t
β-bourbonene	2.3	2.8	t
β-caryophyllene	7.2	10.0	15.3
α-acoradiene	–	–	5.9
germacrene D	1.7	9.4	14.0
caryophyllene oxide	15.8	24.4	12.6
caryophyllenol II	t	5.0	t
hexahydrofarnesyl acetone	t	2.2	t
manoyl oxide	t	3.0	–

Pino et al. (1999) determined that an oil of *M. officinalis* produced from plants grown in Cuba possessed the following major components:

6-methyl-5-hepten-2-one (2.5%)
cis-linalool oxide[f] (0.3%)
trans-linalool oxide[f] (0.4%)
linalool (0.6%)
citronellal (0.2%)
citronellol (0.8%)
nerol (0.9%)
neral (29.9%)
geranial (41.0%)
geranyl formate (0.2%)
neryl acetate (0.8%)
geranyl acetate (4.4%)
caryophyllene oxide (5.3%)
ar-turmerone (0.4%)
14-hydroxy-9-epi-β-caryophyllene (0.1%)
(Z,E)-farnesyl acetate (0.2%)
(E,E)-farnesyl acetate (0.3%)

[f] = furanoid form

Oberhofer et al. (1999) examined the headspace volatiles of a sample of *M. officinalis* oil subjected to heating conditions. The genuine oil was placed in a small receptacle on top of an aroma lamp to duplicate the aroma lamp used by aromatherapists. The composition of the original oil was compared with the headspace volatiles of a heated sample and a heated sample that has been evaporated to 50% of its volume. The comparative results that clearly show that drastic changes take place when the oil was subjected to the aroma lamp are shown in **T-1**.

Holla et al. (2000) reported that there were some changes that took place in oil produced from *M. officinalis* during the commencement until the end of flowering. These changes are summarized as follows:

citronellal (11.4–27.5%)
neral (13.9–21.1%)
geranial (21.1–34.7%)
caryophyllene oxide (8.1–12.0%)

Klimek et al. (2000) also examined the changes in oil composition during the life cycle of *M. officinalis*. They found that the composition ranged as follows:

myrcene (0–0.20%)
1-octen-3-ol (0–0.87%)
5-methyl-3-heptanone (0–0.63%)

6-methyl-5-hepten-2-one (0.04–0.54%)
(E)-β-ocimene (0–0.67%)
linalool (0.16–1.32%)
isopulegol (0–0.20%)
citronellal (3.68–46.77%)
citronellol (0.03–2.65%)
nerol (0–0.79%)
methyl citronellate (0.90–4.57%)
geraniol (0.05–1.42%)
neral (4.59–27.39%)
geranial (6.27–37.17%)
methyl geranate (0–0.68%)
geranyl acetate (0.01–2.05%)
β-caryophyllene (0.01–12.20%)
α-humulene (0–0.54%)
γ-cadinene (0–1.41%)
germacrene D (0.06–1.52%)
cadina-3,9-diene (0.07–0.65%)
β-ionone* (0–0.09%)
caryophyllene oxide (2.41–25.31%)
humulene epoxide* (0–0.24%)
α-muurolol (0–0.10%)
hexahydrofarnesyl acetate (0–0.14%)

* correct isomer not identified

Mrlianova et al. (2001) examined the effect of harvest cut height of *M. officinalis* on the composition of oils produced by cutting either the top third, top and middle two-thirds or the whole above ground plants. Their results are presented in **T-2**.

Sari and Ceylan (2002) analyzed oils produced from plants grown in two locations in Turkey (Menemen and Bozdaq) from 11 different seed sources. The compositions of the oils produced in each of the two locations are summarized in **T-3**.

Mimica-Dukic et al. (2004) analyzed an oil produced from *M. officinalis* collected in the vicinity of Vojvodina (Serbia). The oil was characterized as containing the following constituents:

α-pinene (0.3%)
camphene (0.2%)
β-pinene (0.3%)
isolimonene (0.7%)
3-octanol (0.4%)
δ-3-carene (0.3%)
limonene (2.2%)
(Z)-β-ocimene (0.2%)
linalool (0.5%)
α-thujone (0.2%)
β-thujone (0.8%)
trans-rose oxide (0.3%)
citronellal (13.7%)
isomenthone (3.0%)
menthol (2.9%)
methyl chavicol (0.1%)
nerol (0.5%)

Comparative percentage composition of laurel leaf oil produced from young and old leaves **T-5**

Compound	Young leaf oil	Old leaf oil
toluene	0.1	0.1
hexanal + (Z)-3-hexenal	0.3	0.2
(E)-2-hexenal	0.2	0.1
(Z)-3-hexenol	0.2	0.4
hexanol + (E)-2-hexenol	0.1	t
α-thujene	0.3	0.3
α-pinene	5.0	3.9
camphene	1.1	0.6
sabinene	7.1	7.6
β-pinene	3.8	3.0
2,3-dehydro-1,8-cineole	t	0.1
myrcene	1.4	0.9
α-phellandrene	0.1	0.2
δ-3-carene	0.2	t
p-cymene	t	0.1
limonene	2.0	2.5
1,8-cineole	24.2	32.1
γ-terpinene	0.1	0.2
trans-sabinene hydrate	0.3	0.5
terpinolene	0.1	t
cis-sabinene hydrate	0.1	0.4
linalool	1.5	0.7
borneol	t	0.3
terpinen-4-ol	0.3	0.7
α-terpineol	1.8	1.3
trans-sabinene hydrate acetate	0.6	t
2-hydroxy-1,8-cineole	t	0.1
3-hydroxy-1,8-cineole	t	0.1
linalyl acetate	t	0.1
thuj-4-en-2-yl acetate	t	0.1
2,6-dimethyl-octa-1,7-diene-3,6-diol	t	0.1
bornyl acetate	1.1	0.6
δ-terpinyl acetate	0.2	0.4
2-acetoxy-1,8-cineole	0.3	0.1
α-terpinyl acetate	4.8	6.5
eugenol	0.1	1.6
α-ylangene	0.2	t
α-copaene	0.3	0.1
elemene*	0.1	0.1
β-cubebene	0.1	t
β-elemene	1.8	1.4
vanillin	t	0.1
methyl eugenol	0.2	1.2
β-caryophyllene	0.8	0.3
α-guaiene	0.1	0.1
(E)-isoeugenol	0.6	0.1
germacrene D	0.6	0.4
β-selinene	0.1	0.1
germacrene A	1.2	0.4
γ-cadinene	0.3	0.1
δ-cadinene	0.3	0.1
homovanillyl alcohol‡	0.2	t
germacrene D-4-ol	0.2	0.2
neophytadiene	0.2	0.3
spirafoliolide	3.7	2.2

t = trace (< 0.05%); ‡ doubtful natural occurrence in oil

citronellol (0.8%)
neral (16.5%)
geraniol (3.4%)
methyl citronellate (2.7%)
geranial (23.4%)
bornyl acetate (0.2%)
cis-limonene oxide (0.4%)
cis-carvyl acetate (0.1%)
neryl acetate (1.6%)
α-copaene (0.1%)
geranyl acetate (0.8%)
(E)-β-damascenone (0.1%)
dodecenal* (0.4%)
β-caryophyllene (4.6%)
α-humulene (0.4%)
β-selinene (0.1%)
germacrene D (2.4%)
δ-cadinene (0.2%)
(Z)-β-farnesene (0.1%)
ledol (0.2%)
caryophyllene oxide (1.7%)
nonadecane (0.2%)
1-eicosene (0.1%)
eicosane (0.5%)
heneicosane (0.3%)
pentacosane (0.5%)

* correct isomer not identified

Harshavardhan et al. (2005) examined the effect of fertilizer on biomass yield and oil composition. They found that irrespective of fertilization practice the oil composition varied as follows:

limonene (1.43–3.51%)
1,8-cineole (0.64–0.88%)
(Z)-β-ocimene (1.49–1.97%)
6-methyl-5-hepten-2-one (0.81–0.95%)
citronellal (0.56–0.73%)
α-copaene (0.51–0.59%)
linalool (1.04–1.12%)
β-caryophyllene (1.37–2.67%)
α-humulene (0.67–0.87%)
neral (27.10–28.43%)
geranial (37.28–39.86%)
geranyl acetate (2.78–8.67%)
geraniol (5.73–10.26%)
caryophyllene oxide (0.85–4.60%)
(E)-nerolidol (1.18–4.46%)

Melissa officinalis leaf oil was produced from plants collected in three different localities in Greece (Malakasa, Evvooia Island and Crete) and harvested in their flowering stage. These three oils were analyzed using GC-FID and GC/MS by Basta et al. (2005) and their compositions can be seen summarized in **T-4**. In addition, trace amounts (< 0.05%) of camphene, myrcene, α-phellandrene, 1,8-cineole, (Z)-β-ocimene, phenylacetaldehyde, (E)-β-ocimene, β-thujone, *cis*-p-menth-2-en-1-ol, *trans*-verbenol, borneol, p-mentha-1,5-dien-8-ol, bornyl acetate, thymol, carvacrol, α-humulene, (E)-β-ionone, bicyclogermacrene, *trans*-β-guaiene and β-bisabolene were found in one or more of the three oils. As can be seen from the results in **T-4**, these oils, which were rich in hydrocarbons and caryophyllene oxide, are atypical for *M. officinalis* oils.

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A. Basta, O. Tzakou and M. Couladis, *Composition of the leaves essential oil of* Melissa officinalis *s.l. from Greece.* Flav. Fragr. J., **20**, 642–644 (2005).

Laurel Leaf Oil

Giamperi et al. (2002) screened a number of oils for their antifungal activity against two pathogenic fungi. The composition of a commercial oil of *Laurus nobilis* L. that was obtained in Italy was determined to possess the following composition:

α-thujene (0.5%)
α-pinene (6.7%)
camphene (0.7%)
sabinene (8.3%)
β-pinene (5.3%)
myrcene (0.6%)
α-phellandrene (0.1%)
α-terpinene (0.5%)
p-cymene (0.3%)
β-phellandrene (0.5%)
1,8-cineole (47.5%)
γ-terpinene (0.8%)
linalool (2.8%)
cis-p-menth-2-en-1-ol (0.2%)
trans-sabinol (0.3%)
cis-limonene oxide (0.1%)
trans-p-menth-2-en-1-ol (0.1%)
menthofuran[†] (0.2%)
borneol (0.6%)
terpinen-4-ol (3.4%)
myrtenal (0.2%)
α-terpineol (2.8%)
nerol (0.1%)
trans-sabinyl acetate (0.2%)
thymol (0.5%)
bornyl acetate (0.5%)
carvacrol (0.3%)
α-terpinyl acetate (12.6%)
neryl acetate (0.2%)
methyl eugenol (1.4%)
β-elemene (0.2%)
β-caryophyllene (0.4%)
caryophyllene oxide (0.5%)
14-hydroxy-9-epi-β-caryophyllene (0.2%)

[†] doubtful identity

In addition, trace amounts (< 0.1%) of hexanal, (E)-2-hexenal, benzaldehyde, tricyclene, δ-3-carene, (Z)-β-ocimene, (E)-β-ocimene and linalyl acetate were found in the oil.

Kilic et al. (2004) compared the composition of laurel leaf oil produced from both young and old leaves obtained from trees growing in the North Black Sea region of Turkey. The constituents found in these oils are shown in **T-5**. In addition, trace amounts (< 0.05%) such as tricyclene, α-terpinene, 2-nonanone, p-mentha-1,3,8-triene, *trans*-p-menth-2-en-1-ol, *trans*-pinocarveol, a sabinol isomer, sabina ketone, pinocarvone, δ-terpineol, thuj-3-en-10-al, 2,6-dimethyl-octa-3,7-diene-2,6-diol, nerol, geranial, an octenyl acetate, p-cymen-7-ol, a p-menthadien-8-ol, 2-undecanone, *trans*-pinocarvyl acetate, neryl acetate, a tetradecene, α-humulene, allo-aromadendrene, bicyclogermacrene, 7-epi-α-selinene, cubebol, elemicin, spathulenol, caryophyllene oxide, humulene epoxide II, (E)-isoelemicin, a eudesmol acetate, farnesyl acetone, phytadiene,

Percentage composition of oils produced from the buds, flowers and fruits of *Laurus nobilis* **T-6**

Compound	Bud oil	Flower oil	Fruit oil
tricyclene	0.1	t	t
α-thujene	0.1	0.2	0.1
α-pinene	7.0	5.1	3.3
camphene	3.4	2.4	1.7
sabinene	2.4	1.7	1.7
β-pinene	4.6	3.7	2.1
myrcene	0.7	0.6	0.5
α-phellandrene	t	0.1	t
δ-3-carene	–	0.4	–
p-cymene	–	–	0.1
1,8-cineole	16.8	8.8	9.5
(Z)-β-ocimene	0.1	0.3	–
phenyl acetaldehyde	0.1	–	–
(E)-β-ocimene	8.1	2.7	22.1
trans-sabinene hydrate	0.1	t	t
linalool	0.8	–	–
pinocarvone	–	–	0.1
borneol	0.7	0.4	0.3
α-terpineol	–	t	0.4
linalyl acetate	0.7	–	0.2
bornyl acetate	2.0	2.1	1.1
2-undecanone	–	–	0.1
δ-terpinyl acetate	0.2	0.3	0.1
α-terpinyl acetate	1.6	1.8	1.2
eugenol	0.3	–	t
α-ylangene	0.5	0.9	0.2
α-copaene	0.2	0.3	0.1
elemene*	0.1	0.4	0.1
β-elemene	2.6	5.4	2.0
methyl eugenol	0.3	–	0.1
β-caryophyllene	0.9	5.1	0.3
(E)-isoeugenol	0.3	0.5	0.1
α-humulene	0.2	0.5	0.1
allo-aromadendrene	0.1	–	0.1
(E)-β-farnesene	0.2	0.1	0.1
germacrene D	6.6	2.4	1.5
β-selinene	0.1	0.3	0.1
bicyclogermacrene	1.2	2.2	4.5
α-farnesene*	0.8	1.3	0.3
germacrene A	0.8	1.1	0.6
γ-cadinene	–	–	0.3
δ-cadinene	t	–	0.1
elemol	0.4	–	–
germacrene D-4-ol	0.7	–	0.5
α-eudesmol	2.7	11.8	–
costunolide	–	–	2.9

* correct isomer not identified; t = trace (< 0.05%)

dehydro-costunolide and squalene were found in one or both oils.

Kilic et al. also compared the composition of oils produced from buds, flowers and fruits of *L. nobilis*. The comparative results of this study are presented in **T-6**. Trace amounts (< 0.05%) of limonene were found in all three oils while a trace amount of β-cubebene and γ-muurolene was found only in the fruit oil.

In a follow-up study, Kilic et al. (2005) isolated the glycosidically bound volatiles of the leaves and buds of *L. nobilis* using β-D-glucosidaze or hesperidinase enzymatic hydrolysis followed by GC/MS. The volatiles isolated from the leaves and buds are shown in **T-7**.

Comparative percentage composition of the volatiles liberated from the leaves and buds of *Laurus nobilis* by enzymatic hydrolysis **T-7**

Compound	Leaf volatiles	Bud volatiles
isoamyl alcohol	1.5	1.2
2-methylbutanol	2.0	1.0
amyl alcohol	2.0	2.0
3-methyl-2-butenol	1.4	1.5
(Z)-3-hexenol	4.5	2.5
hexanol	1.3	2.0
2,3-dehydro-1,8-cineole	2.0	2.3
benzyl alcohol	4.0	1.5
linalool oxide*[f]	–	24.0
linalool oxide*[f]	–	26.7
linalool	2.0	1.0
hotrienol	0.3	5.0
2-phenethanol	2.6	1.1
nerol oxide	0.3	5.0
linalool oxide*[p]	–	1.1
p-mentha-1,5-dien-8-ol	2.7	3.5
borneol	0.5	11.0
3,7-dimethylocta-1,5-diene-3,7-diol	0.5	1.0
α-terpineol	2.5	5.0
p-mentha-1(7),5-dien-8-ol	2.9	–
2-hydroxy-1,8-cineole*	19.5	–
2-hydroxy-1,8-cineole*	8.2	1.1
geraniol	1.5	1.0
3,7-dimethylocta-1,7-diene-3,6-diol	0.2	1.0
menthadien-8-ol*	3.6	0.7
menthadien-8-ol*	4.4	0.5
menthadien-8-ol	0.3	1.2
eugenol	0.7	2.2
(E)-β-damascenone	–	9.0
trans-soberol	0.4	0.9
soberol*	0.2	2.6
vanillin	2.2	2.0
(E)-isoeugenol	4.7	–
tyrosol	2.1	–
p-menth-1-ene-7,8-diol	2.0	1.4
4-hydroxy-3-methoxyphenylpropan-2-one	14.5	–
methoxytyrosol	1.7	1.5
3-hydroxy-β-damascone	–	5.3
3-hydroxy-7,8-dehydro-β-ionol	–	1.9
hydroxycineole acetate	0.2	0.6
3-oxodamascone	–	1.0
3-oxo-α-ionol	26.0	1.2
4-hydroxy-3-methoxyphenylacetic acid	6.4	4.6
3-hydroxy-5,6-epoxy-β-ionone	0.7	1.4
3-hydroxy-β-ionone	0.3	1.0
3-oxo-7,8-dihydro-α-ionol	10.0	1.1
vomifoliol	1.0	2.1

* correct isomer not identified; [f] = furanoid form; [p] = pyranoid form

A bay laurel oil (*L. nobilis*) that was produced by hydrodistillation from leaves of Turkish origin was reported by Dadadalioglu and Evrendilek (2004) to contain the following main components:

α-pinene (6.11%)
sabinene (12.12%)
β-terpinene[‡] (0.06%)
1,8-cineole (60.72%)
γ-terpinene (1.04%)
linalool (0.73%)
terpinen-4-ol (3.29%)
α-terpineol (2.04%)
α-terpinene[†] (12.53%)
eugenol (0.53%)
β-caryophyllene (0.40%)
methyl eugenol (0.68%)

[‡] does not exist naturally, unless it was used as a bad name for sabinene; [†] incorrect identification based on GC elution order

Macchioni et al. (2006) screened the oils of two Laurus species for their acaricidal activity. The oil of *L. nobilis* produced by water distillation from leaves picked off wild growing trees at Alberaccio (Italy) was analyzed by both GC-FID and GC/MS. The composition of this oil was determined to be:

(E)-2-hexenal (0.1%)
α-thujene (0.6%)
α-pinene (5.2%)
camphene (0.5%)
sabinene (10.6%)
β-pinene (4.7%)
myrcene (1.3%)
α-phellandrene (0.5%)
δ-3-carene (0.1%)
α-terpinene (0.4%)
p-cymene (0.3%)
limonene (2.0%)
1,8-cineole (39.2%)
(E)-β-ocimene (0.1%)
γ-terpinene (0.7%)
cis-sabinene hydrate (0.6%)

terpinolene (0.3%)
linalool (7.4%)
trans-sabinene hydrate (0.2%)
cis-p-menth-2-en-1-ol (0.1%)
trans-p-menth-2-en-1-ol (0.1%)
δ-terpineol (0.3%)
borneol (0.2%)
terpinen-4-ol (2.1%)
α-terpineol (2.5%)
linalyl acetate (0.1%)
isobornyl acetate (0.4%)
α-terpinyl acetate (11.3%)
eugenol (1.2%)
methyl eugenol (4.5%)
β-caryophyllene (0.2%)
bicyclogermacrene (0.2%)
δ-cadinene (0.1%)
elemicin (0.2%)
spathulenol (0.5%)
caryophyllene oxide (0.2%)
β-eudesmol (0.2%)

Over the years, spices have been used to season olive oil products in Spain. Pérez et al. (2007) used headspace analysis (SPME) combined with GC/MS to determine the volatiles above a stirred 1% w/v mixture of chopped laurel leaves in water using a PDMS-DVB fiber. The volatiles characterized were as follows:

benzaldehyde (0.18)[a]
1,8-cineole (9.90)
linalool (3.70)
borneol (0.16)
terpinen-4-ol (0.64)
α-terpineol (0.57)
eugenol (0.98)
methyl eugenol (10.20)

[a] = mg/g laurel leaves

The value of this analysis is questionable because (a) the age of the laurel leaves is unknown; (b) the storage conditions under which the leaves had been held is unknown; and (c) the second major component of laurel leaf oil is α-terpinyl acetate, which was not even detected in this analysis.

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