Progress in Essential Oils

Brian M. Lawrence, Consultant

Lovage Root Oil

An oil of lovage root produced from *Levisticum officinale* Koch plants grown in Iran from seed of Hungarian origin was the subject of analysis by Dayeni et al. (2006). The constituents that were characterized in this oil were as follows:

α-pinene (0.72%)
camphene (0.15%)
β-pinene (0.84%)
myrcene (0.05%)
α-phellandrene (2.65%)
γ-terpinene (0.01%)
allo-ocimene* (0.01%)
trans-pinocarveol (0.01%)
pentylbenzene (0.14%)
6-butyl-1,4-cycloheptadiene† (2.90%)
α-terpinyl acetate (0.45%)
β-elemene (0.03%)
patchoulane† (0.37%)
junipene° (0.08%)
isobornyl isovalerate (0.04%)
δ-cadinene (0.03%)
β-eudesmol (0.03%)
(Z, Z)-α-farnesene (0.13%)
T-muurolol (0.91%)
3-butylidene phthalide* (1.48%)
3-butyl phthalide (85.20%)
3-butylidene dihydrophthalide* (2.67%)
aristolene (0.55%)
phytol (0.13%)

* correct isomer not identified
† incorrect identification
° also known as longifolene

Commercial lovage root samples obtained from different European countries were hydrodistilled and their oils were analyzed by a combination of GC-FID and GC/MS by Raal et al. (2008). The oils ranged in composition as listed here.

nonane (0–3.0%)
α-pinene (0–1.7%)
camphene (0–0.6%)
sabinene (0–0.6%)
β-pinene (0–1.6%)
dehydro-1,8-cineole (0–0.8%)
myrcene (t–1.6%)
2-methyl-6-methylene-1,7-octadiene* (0–1.0%)
α-phellandrene (0–1.3%)
p-cymene (0–0.1%)
limonene (0–0.4%)
β-phellandrene (0.4–48.9%)
phenylacetaldeyhde (0–17.2%)
γ-terpinene (0–0.1%)
terpinolene (0–1.6%)
linalool (0–0.5%)
trans-p-menth-2-en-1-ol (0–0.4%)
isothujyl alcohol (0–0.1%)
pentylbenzene (0–0.9%)
pentylhexa-1,5-diene (0–12.3%)
p-mentha-1,5-dien-8-ol (0–0.1%)
terpinen-4-ol (0–0.2%)
2-methylene-6,6-dimethylbicyclo [3.2.0] heptan-3-ol* [a] (0–0.7%)
α-terpineol (0–0.9%)
trans-carveol (0–0.2%)
geraniol (0–0.5%)
perillaldehyde (0–0.4%)
bornyl acetate (0–0.5%)
trans-sabinyl acetate (0–12.1%)
perillyl alcohol (0–0.6%)
α-terpinyl acetate (0–26.1%)
geranyl acetate (0–0.3%)
α-copaene (0–0.2%)
β-elemene (0–0.7%)
β-caryophyllene (0–1.2%)
(Z)-β-farnesene (0–0.1%)
germacrene D (0–0.6%)
β-selinene (0–0.6%)
bornyl 2-methylbutyrate (0–0.9%)
elemol (0–0.8%)
(Z)-3-butylidene phthalide (0.8–28.6%)
(E)-3-butylidene phthalide (0.4–3.9%)
(Z)-ligustilide (9.4–70.9%)
(E)-ligustilide (0–0.5%)
methyl pentadecanoate (0–1.2%)
methyl hexadecadienoate* (0–0.5%)
methyl hexadecenoate* (0–6.1%)

* correct isomer not identified
t = trace (< 0.1%)
[a] also known as pinocarveol

As the root oils were found to vary considerably depending upon the country of origin of the roots, it is of value to see the important components that were found in each root oil (see **T-1**).

M. Dayeni, R. Omidbaigi and M.R. Bastan, *Essential oil content and composition of* Levisticum officinale *large scale cultivation in Iran*. J. Essent. Oil Bear. Plants, **9**, 152–155 (2006)

A. Raal, E. Arak, A. Orav, T. Kailas and M. Müürisepp, *Composition of the essential oil of* Levisticum officinale *W.D.J. Koch from some European countries*, J.Essent. Oil Res., **20**, 318–322 (2008).

Lovage Leaf Oil

Samiee et al. (2006) compared the composition of an oil produced from the leaves of *L. officinale* with that of a methanol extract of the same batch of air-dried leaves of Iranian origin. A comparative composition of the oil and extract can be seen in **T-2**.

Raal et al. (2008) determined that a leaf oil of *L. officinale* of Estonian origin possessed the following composition:

nonane (0.1%)
α-pinene (0.6%)
camphene (0.1%)
sabinene (0.5%)
β-pinene (0.1%)
dehydro-1,8-cineole (1.4%)
myrcene (1.4%)

2-methyl-6-methylene-1,7-octadiene* (0.1%)
α-phellandrene (0.3%)
p-cymene (0.1%)
β-phellandrene (11.3%)
phenylacetaldehyde (0.1%)
γ-terpinene (0.2%)
terpinolene (0.2%)
linalool (0.1%)
trans-p-mentha-2,8-dien-1-ol (0.1%)
isothujyl alcohol (0.1%)
pentylcyclohexa-1,5-diene (0.1%)
p-mentha-1,5-dien-8-ol (0.1%)
terpinen-4-ol (0.2%)
pinocarveol* (0.1%)
α-terpineol (2.4%)
geraniol (0.1%)
perillaldehyde (0.1%)
bornyl acetate (0.2%)
α-terpinyl acetate (55.8%)
geranyl acetate (0.5%)
germacrene D (0.1%)
(Z)-3-butylidene phthalide (0.5%)
(E)-3-butylidene phthalide (1.1%)
(Z)-ligustilide (17.0%)
(E)-ligustilide (2.5%)
methyl pentadecanoate (0.1%)
methyl hexadecadienoate* (0.1%)
methyl hexadecenoate* (0.8%)

* correct isomer not identified

In addition, trace amounts (< 0.1%) of *trans*-p-menth-2-en-1-ol, pentylbenzene, *trans*-carveol, perillyl alcohol, β-caryophyllene and (Z)-β-farnesene were found in this oil.

K. Samiee, M.R. Akhgar, A. Rustaiyan and S. Masoudi, *Composition of the volatiles of* Fergulago carduchorum *Boiss. et Hausskn. and* Levisticum officinale *Koch obtained by hydrodistillation and extraction*, J. Essent. Oil Res., **18**, 19–22 (2006).

A. Raal, E. Arak, A. Orav, T. Kailas and M. Müürisepp, Composition of the essential oil of *Levisticum officinale* W.D.J. Koch from some European countries, J. Essent. Oil Res., **20**, 318–322 (2008).

Cyperus articulatus Oil

An oil produced from the rhizomes of *Cyperus articulatus* L. (a tropical sedge) known locally as "priprioca," "piriprioca" or even "piripiri" is available commercially in Brazil in limited quantities. The oil is of interest because of its use in the local Brazilian cosmetic industry.

A survey of the literature reveals that in this oil Couchman et al. (1968) characterized the presence of α-copaene, myrtenal, myrtenol and a sesquiterpene ketone, which they named articulone.

Percentage composition of important components of lovage root oil produced from different root sources in Europe **T-1**

Compound	1	2	3	4	5	6
β-phellandrene	3.9	0.4	0.8	0.7	8.7	48.9
phenylacetaldehyde	-	< 0.1	-	-	0.1	17.2
pentylcyclohexadiene	12.3	0.2	0.3	-	0.1	0.6
trans-sabinyl acetate	0.1	-	-	-	12.1	-
α-terpinyl acetate	-	1.0	0.9	1.1	26.1	7.3
(Z)-3-butylidene phthalide	0.8	5.8	29.0	28.6	8.0	1.0
(E)-3-butylidene phthalide	0.9	2.8	3.0	2.2	3.9	0.4
(Z)-ligustilide	70.9	52.4	44.6	49.7	25.4	9.4
(E)-ligustilide	0.5	0.3	0.4	-	-	0.4
methyl hexadecenoate*	-	6.1	-	-	1.4	-

* correct isomer not identified
Root oil sources: 1 and 2. Estonia; 3. France; 4. Belgium; 5. Netherlands; 6. Scotland (UK)

Comparative percentage composition of the oil and extract of *Levisticum officinale* leaves **T-2**

Compound	Leaf Oil	Leaf Extract
α-thujene	0.3	0.3
α-pinene	0.6	0.8
camphene	0.1	-
sabinene	6.5	6.3
β-pinene	0.5	0.6
myrcene	2.3	1.7
decane	-	0.4
α-phellandrene	1.3	0.8
α-terpinene	0.4	0.3
p-cymene	0.8	0.9
β-phellandrene	16.7	23.0
(Z)-β-ocimene	4.5	6.1
(E)-β-ocimene	0.2	-
γ-terpinene	7.8	12.1
terpinolene	0.5	-
linalool	0.4	-
isoamyl 2-methylbutyrate	0.6	-
undecane	-	0.2
isoamyl isovalerate	0.2	-
allo-ocimene*	0.1	-
terpinen-4-ol	1.1	-
naphthalene	-	20.6
α-terpineol	1.1	-
α-terpinyl acetate	40.5	-
tetradecane	-	1.6
α-acoradiene	0.8	-
γ-curcumene	-	0.8
germacrene D	1.4	7.0
pentadecane	-	0.4

* correct isomer not identified

Using 2,4-dinitrophenyl hydrazone formation of a ketone found in the rhizome oil of a number of *Cyperus* species followed by proton NMR, Neville et al. (1968) determined that the ketone previously known as cyperenone was more correctly designated as isopatchoul-4(5)-en-3-one.

Nyasse et al. (1988 a) characterized the presence of α-corymbolol

(syn: selin-11-ene-1,5-diol) and the corresponding ketone corymbolone (syn: 5α-hydroxy-selin-11-en-1-one) in an oil of *C. articulatus* produced in Cameroon. In a follow-up study the same authors (Nyasse et al, 1988 b) also identified mandassidione (syn: 3-methyl-2-[2-(1-methylethenyl)-5-oxohexyl]-2-cyclopenten-1-one), mustakone (syn: copa-3-en-2-one) and isopatchoul-4(5)-en-3-one in the same oil.

Zoghbi et al. (2006) analyzed the oils produced from five lab-distilled samples of Brazilian *C. articulatus* (stems and rhizomes), which were harvested from plants at their flowering stage. The oils were found to range as follows:

α-pinene (5.7–12.9%)
camphene (0–0.1%)
thuja-2,4(10)-diene (0.4–1.2%)
sabinene (0–0.4%)
β-pinene (4.2–7.4%)
p-cymene (0.2–0.8%)
limonene (0.6–1.3%)
1,8-cineole (0–0.8%)
p-cymenene (0–0.4%)
α-campholenal (0.3–0.7%)
trans-pinocarveol (3.8–7.5%)
trans-verbenol (1.4–2.7%)
cis-verbenol (0.3–1.2%)
pinocarvone (1.4–2.1%)
p-mentha-1,5-dien-8-ol (0.8–3.0%)
terpinen-4-ol (0.2–1.0%)
p-cymen-8-ol (0–0.8%)
myrtenal + myrtenol (4.1–7.7%)
verbenone (1.1–3.9%)
trans-carveol (0.2–0.6%)
cis-carveol (0–0.1%)
carvone (0.2–0.5%)
p-cymen-7-ol (0–0.2%)
cypera-2,4-diene (0–0.3%)
α-copaene (2.0–2.3%)
β-elemene (0–0.3%)
cyperene (1.1–4.3%)
β-caryophyllene (0–0.7%)
α-guaiene (0–0.6%)
α-humulene (0–1.5%)
rotundene (0.4–0.8%)
germacrene D (0–1.0%)
eudesma-2,4,11-triene (0–0.9%)
β-selinene (0.3–2.7%)
α-selinene (0–1.7%)
α-bulnesene (0.6–2.1%)
δ-cadinene (0.4–1.0%)
trans-calamenene (0.3–0.8%)
α-calacorene (0.7–1.4%)
ledol (3.2–4.6%)
caryophyllene oxide (4.6–13.7%)
humulene epoxide II (1.3–11.2%)
β-copaen-4α-ol (0–1.0%)
dillapiole (0–1.4%)

Comparative percentage composition of black and red rhizome oils of *Cyperus articulatus* **T-3**

Compound	Black rhizome oil	Red rhizome oil
α-thujene	-	0.2
α-pinene	5.2	2.9
camphene	t	-
sabinene	5.2	0.9
myrcene	-	1.0
p-cymene	0.5	0.2
1,8-cineole	0.7	0.7
γ-terpinene	t	-
cis-linalool oxide[f]	0.4	-
trans-linalool oxide[f]	t	-
p-cymenene	t	-
linalool	1.7	-
α-fenchyl alcohol	-	0.4
trans-pinocarveol	5.2	0.8
cis-verbenol	-	0.7
camphor	1.0	-
pinocarvone	0.3	0.4
isoborneol	0.3	0.3
borneol	-	0.5
terpinen-4-ol	1.1	0.3
α-terpineol	1.8	1.2
β-cyclocitral	0.5	0.1
dihydrocarveol	t	-
trans-carveol	4.0	-
cis-carveol	4.7	-
geraniol	t	-
piperitone	-	10.1
neral	-	0.7
perillaldehyde	t	-
carvacrol	0.4	-
geranyl formate	1.1	-
cyprotene	-	0.3
neryl acetate	t	-
cyperadiene*	-	0.6
α-copaene	0.2	-
cyperene	2.3	-
β-maaliene	-	8.4
β-caryophyllene	0.3	0.2
β-gurjunene	-	0.1
aromadendrene	2.3	0.3
cubeb-11-ene	1.2	-
β-spathulene	-	0.2
α-humulene	0.5	-
allo-aromadendrene	-	1.0
rotundene	-	1.5
γ-muurolene	t	-
germacrene D	0.4	3.0
α-muurolene	t	-
γ-cadinene	-	1.3
α-bulnesene	0.7	-
cis-calamenene	0.6	0.1
δ-cadinene	-	0.1
(Z)-nerolidol	1.4	-
cyperene epoxide	-	2.2

Comparative percentage composition of black and red rhizome oils of *Cyperus articulatus* **T-3 contd.**

Compound	Black rhizome oil	Red rhizome oil
β-calacorene	-	0.4
caryophyllene oxide	1.3	0.4
guaia-5-en-11-ol	14.9	-
cedrol	19.0	-
1-epi-cubenol	-	3.3
α-cadinol	3.4	-
β-bisabolol	2.5	-
cyperotundone	9.6	42.3
germacrone	-	5.3
cyclocolorenone	-	0.7

* correct isomer not identified
t = trace (< 0.1%)
[f] furanoid form

patchoulenone (0.4–1.6%)
caryophylla-4(14),8(15)-dien-5α-ol (0–0.6%)
eudesma-3,11-dien-5-ol (0–1.6%)
cyperotundone (2.1–5.4%)
α-cyperone (1.4–5.9%)
aristolone (0.5–0.6%)

Olawore et al. (2006) compared the composition of oils produced from the black and red rhizomes of Nigerian origin using a combination of GC and GC/MS. The results of this study can be seen in **T-3**.

F.M. Couchman, A.R. Pinder and N.H. Bromham, *Essential oil of* Cyperus articulatus. Tetrahedron, **20**, 2037–2045 (1964).

G.A. Neville, I.C. Nigam and J.L Holmes, *Identification of ketones in* Cyperus. Nuclear *magnetic resonance and mass spectral examination of the 2,4-dinitrophenylhydrazones*. Tetrahederon, **24**, 3891–3897 (1968).

B. Nyasse, R. Ghogoma Tih, B.L. Sondengam, M.T. Martin and B. Bodo, *Isolation of α-corymbolol, an eudesmane sesquiterpene diol from* Cyperus articulatus. Phytochemistry, **27**, 179–181 (1988 a).

B. Nyasse, R. Ghogoma Tih, B.L. Sondengam, M.T. Martin and B. Bodo, *Mandassidione and other sesquiterpene ketones from* Cyperus articulates. Phytochemistry, **27**, 3319–3321 (1988 b).

M. das Gragas B. Zoghbi, E.H.A Andrade, J. Oliveria, L.M.M. Carreira and G.M.S.P. Guilhon, *Yield and chemical composition of the essential oil of the stems and rhizomes of* Cyperus articulatus *L. cultivated in the state of Pará, Brazil.* J. Essent. Oil Res., **18**, 10–12 (2006).

N.O. Olawore, L.A Usman, I.A. Ogunwande and K.A. Adeleke, *Constituents of rhizome essential oils of two types of* Cyperus articulatus *L. grown in Nigeria.* J. Essent. Oil Res., **18**, 604–606 (2006).