Progress in Essential Oils

Brian M. Lawrence, Consultant

Galangal Oil

Galangal or greater galangal oil is obtained from the steam distillation of comminuted rhizomes of *Alpinia galanga* Willd. a spice which has a woody, floral spicy aroma that is dissimilar to ginger. A limited amount of oil of galangal is produced in various countries in southeast Asia.

Jansen & Scheffer (1985) determined that the oil of *A. galangal* contained 1'-acetoxychavicol acetate, 1'-acetoxyeugenol acetate and 1'hydroxychavicol acetate as trace constituents. They further determined that 1'-acetoxychavicol acetate showed moderate antimicrobial activity against Gram-postive bacteria, a yeast and some dematophytes.

It is of interest to note that p-hydroxycinnamaldehyde was identified as a constituent of an *A. galanga* rhizome extract (Barik et al. 1987). This was the first time that p-hydroxycinnamaldehyde was identified as being naturally occurring.

Charles et al. (1992) compared the composition of oils produced from the leaves and rhizomes of *A. galangal*. The results of this study are shown in T-1.

Zhengebal (1993) identified ethyl (E)-cinnamate and ethyl 4-methoxy-(E)-cinnamate as components of an oil of *A. galangal*. Both constituents were tested for their potential anticarcinogenity using the glutathione S-transferase assay. They found that both ethyl (E)-cinnamate and ethyl 4-methoxy-(E)-cinnamate exhibited significant activity in the liver and intestines of the test animal (mouse).

Zhu et al. (1995) analyzed a lab-distilled oil that was produced from plants collected in Zhanjiang, Guangdong (China) using GC and GC/MS. The components identified in this oil were:

butyl isobutyrate (0.27 percent)
δ-4-carene† (0.10 percent)
α-thujene (0.12 percent)
α-pinene (5.69 percent)
camphene (5.82 percent)
β-pinene (8.94 percent)
myrcene (1.21 percent)
butyl 2-methylbutyrate (0.34 percent)
δ-3-carene (0.37 percent)
1,8-cineole (41.15 percent)
(E)-β-ocimene (0.13 percent)
γ-terpinene (0.57 percent)
δ-2-carene† (0.28 percent)
2-methylbutyl 2-methylbutyrate (0.13 percent)
isoamyl 2-methylbutyrate (0.10 percent)
camphor (0.41 percent)
terpinen-4-ol (0.34 percent)
α-terpineol (1.15 percent)
α-fenchyl acetate (0.27 percent)
3-phenyl-2-butanone (0.10 percent)
bornyl acetate (0.10 percent)
δ-elemene (0.27 percent)
α-copaene (0.36 percent)

Comparative percentage composition of the rhizome and leaf oils of *A. galanga* of Malaysian origin **T-1**

Compound	Rhizome oil	Leaf oil
α-pinene	1.16	9.00
β-pinene	0.04	1.69
myrcene	94.51	52.34
limonene	0.35	0.52
1,8-cineole	0.13	0.12
(Z)-β-ocimene	2.05	17.06
borneol	-	4.13
bornyl acetate	-	1.38
β-caryophyllene	0.11	3.53
β-bisabolene	0.57	3.04
(E)-β-farnesene	0.94	1.31
caryophyllene oxide	-	1.04

β-caryophyllene (8.43 percent)
cis-α-bergamotene (2.05 percent)
α-guaiene (0.29 percent)
α-humulene (0.71 percent)
γ-muurolene (0.10 percent)
β-gurjunene (0.29 percent)
eremophilene (0.68 percent)
α-selinene (1.04 percent)
α-farnesene* (4.88 percent)
γ-cadinene (3.77 percent)
δ-cadinene (0.81 percent)
caryophyllene oxide (2.94 percent)

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

Mori et al. (1995) prepared an oil of galangal by steam distillation and then separated it into hydrocarbon and an oxygenated fraction. The constituents of the hydrocarbon fraction were as follows:

α-pinene (0.03 percent)
camphene (0.06 percent)
sabinene (0.08 percent)
β-pinene (0.42 percent)
myrcene (0.42 percent)
α-terpinene (0.65 percent)
p-cymene (0.29 percent)
limonene (1.69 percent)
γ-terpinene (1.95 percent)
terpinolene (0.35 percent)
δ-elemene (1.53 percent)
tetradecane (0.19 percent)
β-caryophyllene (16.37 percent)
α-bergamotene* (0.18 percent)
β-farnesene* (21.45 percent)
α-humulene (7.71 percent)
β-bisabolene (6.06 percent)
pentadecane (5.58 percent)
β-sesquiphellandrene (13.27 percent)
δ-cadinene (2.26 percent)
γ-elemene† (1.89 percent)

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

The constituents of the polar (oxygenated) fraction were found to be as follows:

1,8-cineole (49.56 percent)
acetic acid (1.78 percent)
linalool (0.29 percent)
bornyl acetate (0.15 percent)
terpinen-4-ol (1.18 percent)
citronellyl acetate (0.15 percent)
α-terpineol (1.33 percent)
2-acetoxy-1,8-cineole (1.77 percent)
2-acetoxy-1,8-cineole* (17.26 percent)
geranyl acetate (0.68 percent)
thymyl acetate (0.34 percent)
chavicyl acetate (1.51 percent)
methyl eugenol (0.56 percent)
eugenol (0.20 percent)
eugenyl acetate (0.27 percent)
chavicol (2.74 percent)
1-acetoxy-chavicyl acetate (13.97 percent)

*correct isomer not identified

In addition, the authors noted that the potent odorants of galangal oil were 1,8-cineole, linalool, geranyl acetate, eugenol and chavicyl acetate.

Kubota et al. (1998 and 1999) examined the composition of an oil of *A. galangal* and determined that the potent odorant components in the oxygenated fraction of the oil were:

1,8-cineole (49.6 percent)
linalool (0.2 percent)
geranyl acetate (0.7 percent)
chavicol acetate (1.5 percent)
eugenol (0.2 percent)
bornyl acetate (0.3 percent)
methyl eugenol (0.6 percent)
acetic acid (1.8 percent)
citronellyl acetate (0.2 percent)
trans-2-acetoxy-1,8-cineole (1.8 percent)
trans-3-acetoxy-1,8-cineole (17.3 percent)
1'-acetoxychavicol acetate (14.0 percent)
chavicol (2.7 percent)
terpinen-4-ol (1.2 percent)
δ-terpineol (0.2 percent)
α-terpineol (1.3 percent)
cis-2-acetoxy-1,8-cineole (0.3 percent)
cis-3-acetoxy-1,8-cineole (0.3 percent)
thymol acetate (0.3 percent)
thymol (0.1 percent)

The authors described the odor character of the cineole and chavicol derivatives as follows:

trans-2-acetoxy-1,8-cineole and *trans*-3-acetoxy-1,8-cineole: woody, musty
cis-2-acetoxy-1,8-cineole and *cis*-3-acetoxy-1,8-cineole: earthy
1'-acetoxychavicol acetate: cool, floral, ginger-like

Kubota et al. also determined the enantiomeric distribution of the chavicol and cineole derivatives as follows:

(S)-1'-acetoxychavicol acetate (100 percent): (R)-1'-acetoxychavicol acetate (0 percent)
(1R,4S,6R)-*trans*-2-acetoxy-1,8-cineole (82 percent): (1S,4S,6S)-*trans*-2-acetoxy-1,8-cineole (18 percent)
(1S,4R,6R)-*cis*-2-acetoxy-1,8-cineole (100 percent): (1R,4S,6S)-*cis*-2-acetoxy-1,8-cineole (0 percent)
(1R,4S,5S)-*trans*-3-acetoxy-1,8-cineole (97 percent): (1S,4R,5R)-*trans*-3-acetoxy-1,8-cineole (3 percent)
(1R,4S,5R)-*cis*-3-acetoxy-1,8-cineole (60 percent): (1S,4R,5S)-*cis*-3-acetoxy-1,8-cineole (40 percent)

Yang and Eilerman (1999) determined that the pungent principle of *A. galanga*

Comparative percentage composition of *Alpinia galanga* rhizome oils **T-2**

Compound	Fresh dried	Convection dried	Microwave dried	Infrared
α-pinene	2.37	3.66	3.66	3.50
camphene	0.13	0.21	0.18	0.14
β-pinene	0.35	1.14	1.30	0.67
sabinene	0.25	0.39	0.48	0.18
myrcene	0.40	0.66	0.73	0.76
α-terpinene	0.39	-	-	-
limonene	0.84	0.91	1.16	1.02
1,8-cineole	23.13	40.17	38.34	39.56
γ-terpinene	3.04	1.00	1.28	1.88
p-cymene	2.18	0.73	0.64	1.15
menthone	0.18	-	-	-
linalool	0.60	0.23	0.23	0.20
β-caryophyllene	3.08	0.23	0.28	0.74
terpinen-4-ol	9.04	7.24	7.78	6.77
α-terpineol	1.92	2.03	1.72	2.05
β-farnesene*	4.18	3.47	4.21	3.06
borneol	3.46	0.91	0.79	0.37
neral	12.51	8.13	9.23	7.64
geranyl acetate	4.82	2.02	1.88	3.02
geranial	9.83	7.94	6.96	7.00
caryophyllene oxide	3.25	2.64	2.64	3.50
eugenol	0.21	0.38	1.01	0.26
carvacrol	1.48	1.08	1.05	2.13
α-bisabolol	0.87	0.46	0.75	0.86
bisabolol oxide*	0.13	0.99	0.63	0.38

*correct isomer not identified

was in fact 1'-acetoxy-chavicol acetate (which they renamed galangal acetate). They found that on screening galangal acetate or the oleoresin of *A. galanga* on a sensory basis they were found to possess a capsaicin-like pungency, however the hot sensation was perceived initially on the tip of the tongue before spreading throughout the oral cavity. Furthermore, Yang and Eilerman determined that galangal acetate was not stable in aqueous solution where it undergoes hydrolysis/isomerization reactions to 1'-hydroxy-chavicol acetate, p-acetoxy-cinnamyl alcohol and p-coumaryl diacetate.

Of limited interest is the study of the flower oil of *A. galanga* by Syamasundar et al. (2000); however, it is included for completeness. The flower oil, which was prepared by water distillation, was subjected to analysis by GC and GC/MS. The constituents characterized in this oil were as follows:

(E)-2-hexenal (0.42 percent)
α-pinene (1.4 percent)
camphene (0.93 percent)
6-methyl-5-hepten-2-one (0.63 percent)
sabinene (7.36 percent)
β-pinene (0.14 percent)
myrcene (0.56 percent)
δ-3-carene (0.13 percent)
α-phellandrene (0.06 percent)
α-terpinene (0.31 percent)
p-cymene (0.56 percent)
limonene (1.33 percent)
β-phellandrene (11.48 percent)
1,8-cineole (1.15 percent)
(Z)-β-ocimene (0.09 percent)
(E)-β-ocimene (1.09 percent)
trans-sabinene hydrate (0.26 percent)
γ-terpinene (0.06 percent)
fenchone (0.09 percent)
p-mentha-2,4(8)-diene (1.00 percent)
terpinolene (0.06 percent)
α-fenchol (0.04 percent)
β-fenchol (0.07 percent)
cis-p-menth-2-en-1-ol (0.05 percent)
(E)-tagetone (0.84 percent)
camphor (0.05 percent)
β-terpineol* (0.17 percent)
(Z)-tagetone (0.07 percent)
p-mentha-1,5-dien-8-ol (0.32 percent)
borneol (0.05 percent)
δ-terpineol (0.15 percent)
terpinen-4-ol (1.25 percent)

Percentage composition of the rhizome and leaf oils of *Alpinia galanga*

T-3

Compound	Rhizome oils		Leaf oils	
	B	H	B	H
tricyclene	-	-	0.1	0.1
α-thujene	-	-	0.1	0.1
α-pinene	0.5	3.0	6.6	6.3
camphene	0.5	3.1	5.0	5.1
sabinene	-	0.1	0.1	0.1
β-pinene	0.9	12.9	21.5	23.5
myrcene	0.2	0.5	1.4	0.7
α-phellandrene	-	-	0.1	t
α-terpinene	-	-	0.1	-
p-cymene	0.7	0.6	0.2	0.3
limonene	3.7	3.5	3.3	3.0
1,8-cineole	33.6	30.2	34.4	36.7
(Z)-β-ocimene	-	6.4	t	-
(E)-β-ocimene	-	-	0.8	0.3
γ-terpinene	-	-	0.5	0.3
fenchone	0.5	-	-	-
p-cymenene	-	0.1	0.1	0.1
terpinolene	-	-	0.3	0.2
linalool	0.6	0.4	0.1	0.1
α-fenchol	0.3	0.1	0.1	0.1
β-fenchol	0.2	0.3	-	-
camphor	5.0	14.0	7.8	12.8
β-terpineol*	0.3	0.3	0.2	t
isoborneol	0.3	0.3	-	0.2
borneol	0.9	0.9	0.2	0.6
terpinen-4-ol	1.3	0.9	0.6	0.7
α-terpineol	9.3	2.3	2.2	1.2
myrtenal	0.2	0.6	0.1	0.5
α-fenchyl acetate	12.7	1.1	0.1	0.5
geraniol	0.3	1.1	0.1	0.1
bornyl acetate	0.6	1.5	0.9	0.6
methyl (Z)-cinnamate	0.1	0.1	0.1	0.2
methyl (E)-cinnamate	5.3	2.6	0.9	0.6
β-patchoulene	0.3	1.5	0.1	0.2
gurjunene*	0.6	0.2	0.9	1.2
β-caryophyllene	-	0.2	1.7	1.3
β-gurjunene	0.2	0.2	0.2	0.2
(E)-β-farnesene	0.2	0.3	0.2	0.3
allo-aromadendrene	0.3	0.2	0.2	0.1
α-humulene	-	0.1	0.3	0.3
ar-curcumene	0.4	-	t	t
pentadecane	0.6	1.0	0.1	0.1
γ-cadinene	0.3	0.3	0.2	0.2
δ-cadinene	0.2	-	0.5	0.3
(E)-nerolidol	-	0.2	0.1	t
caryophyllene oxide	0.3	0.4	0.1	0.1
γ-eudesmol	0.1	-	t	t
T-cadinol	-	0.1	-	0.1
β-eudesmol	1.1	0.4	0.1	0.3
α-cadinol	0.2	0.3	0.1	0.1
β-bisabolol	0.5	-	0.1	0.7
farnesol*	3.1	-	1.1	-
α-bisabolol	-	0.3	0.1	0.1
(Z,E)-farnesol	0.2	0.1	0.1	0.1
(E,E)-farnesol	0.2	-	-	-

*correct isomer not identified; B = Bangalore, H = Hyderabad

p-cymen-8-ol (0.04 percent)
α-terpineol (1.15 percent)
myrtenal (0.04 percent)
methyl chavicol (0.04 percent)
myrtenol (0.04 percent)
α-fenchyl acetate (0.06 percent)
carvone (0.07 percent)
geraniol (0.55 percent)
p-menth-1-en-7-ol (0.84 percent)
bornyl acetate (0.69 percent)
(Z)-methyl cinnamate (0.56 percent)
methyl eugenol (8.57 percent)
geranyl acetate (0.77 percent)
β-patchoulene (9.50 percent)
β-cubebene (0.10 percent)
α-gurjunene (0.08 percent)
β-caryophyllene (1.36 percent)
α-bergamotene* (3.01 percent)
β-gurjunene (0.07 percent)
α-humulene (0.45 percent)
allo-aromadendrene (0.17 percent)
ar-curcumene (0.37 percent)
germacrene D (0.09 percent)
(E,E)-α-farnesene (1.53 percent)
β-bisabolene (0.45 percent)
γ-cadinene (0.48 percent)
δ-cadinene (0.10 percent)
nerolidol* (1.20 percent)
spathulenol (0.10 percent)
caryophyllene oxide (1.04 percent)
carotol (10.11 percent)
T-cadinol (0.13 percent)
β-eudesmol (0.30 percent)
β-bisabolol (0.20 percent)
α-bisabolol (1.24 percent)
(Z,E)-α-farnesol (0.12 percent)
(E,E)-α-farnesol (0.17 percent)
benzyl benzoate (1.00 percent)

*correct isomer not identified

Quynh and W. Duszkiewicz-Reinhard (2002) compared the composition of rhizome oils of *A. galanga* produced from rhizomes that were either fresh, convection dried (40°C) or infrared dried (40°C) (see T-2). The authors found that convection drying caused the least oil loss (67 percent) while the oil yield of fresh chopped rhizome was 1.37 percent.

The oils from the rhizomes and leaves of *A. galanga* grown in Bangalore and Hyderabad (India) were analyzed by a combination of GC and GC/MS by Mallavarapu et al. (2002). Although both rhizome and leaf oils were rich in 1,8-cineole, there were quantitative differences between both sets of oil; however, the differences were greatest for the rhizome oils as can be seen in T-3.

Raina et al. (2002) compared the composition of oils produced from fresh rhizomes and leaves obtained from plants harvested from Pant Nagar, Uttaranchal (N. India). The composition of the two oils can be seen in T-4.

Jantan et al. (2004) analyzed an oil produced from fresh rhizomes of *A. galanga* of Malaysian origin. Using GC and GC/MS as their method of analysis, the components that were identified can be seen as follows:

Percentage composition of the rhizome and leaf oils of *Alpinia galanga* **T-4**

Compound	Rhizome oil	Leaf oil	Compound	Rhizome oil	Leaf oil
methyl isobutyl ketone	0.1	0.1	neryl acetate	t	-
amyl acetate	0.1	-	eugenol	0.3	0.5
tricyclene	0.1	0.1	methyl-E-cinnamate	1.3	1.1
α-thujene	0.1	0.1	α-copaene	0.4	0.4
α-pinene	5.6	5.6	β-elemene	2.4	1.8
camphene	5.4	4.4	tetradecane	t	-
sabinene	0.2	0.2	β-caryophyllene	0.7	0.7
β-pinene	11.9	22.7	α-bergamotene*	0.2	0.2
myrcene	1.4	1.0	(Z)-β-farnesene	0.4	0.3
α-phellandrene	0.6	-	α-humulene	0.1	0.1
α-terpinene	0.1	-	(E)-β-farnesene	t	-
p-cymene	0.2	0.2	ar-curcumene	0.2	0.1
1,8-cineole	39.4	32.5	α-muurolene	0.1	-
(E)-β-ocimene	0.3	0.2	α-selinene	0.1	-
γ-terpinene	0.5	0.2	γ-elemene	0.2	-
trans-sabinene hydrate	0.1	0.1	β-bisabolene	0.4	0.2
terpinolene	0.2	t	γ-cadinene	0.1	0.5
fenchone	0.4	0.1	δ-cadinene	0.1	-
cis-sabinene hydrate	0.4	0.3	elemol	t	-
α-fenchol	0.1	-	(E)-nerolidol	0.2	0.2
β-thujone	0.1	0.1	spathulenol	t	0.1
camphor	3.8	12.8	guaiol	4.3	4.5
trans-β-terpineol	0.1	0.2	T-cadinol	0.1	0.1
isoborneol	0.8	0.6	T-muurolol	0.1	-
terpinen-4-ol	0.8	0.5	α-eudesmol	1.9	1.2
α-terpineol	6.6	2.6	(Z,E)-farnesol	0.1	0.1
α-fenchyl acetate	5.6	0.1	(E,E)-farnesol	0.1	0.3
carvone	t	0.5	bornyl benzoate	t	0.3
geranial	0.1	0.4	octadecane	0.1	0.1
isobornyl acetate	0.3	0.9			

t = trace (< 0.1 percent); correct isomer not identified

α-thujene (0.1 percent)
α-pinene (2.0 percent)
camphene (0.1 percent)
sabinene (0.5 percent)
β-pinene (0.6 percent)
myrcene (0.1 percent)
δ-3-carene (0.1 percent)
α-terpinene (t)
p-cymene (0.1 percent)
1,8-cineole (40.5 percent)
(E)-β-ocimene (t)
γ-terpinene (0.3 percent)
trans-sabinene hydrate (t)
terpinolene (0.1 percent)
linalool (0.1 percent)
α-fenchol (t)
cis-p-menth-2-en-1-ol (0.1 percent)
trans-p-menth-2-en-1-ol (0.1 percent)
camphor (t)
citronellal (t)
borneol (0.4 percent)
terpinen-4-ol (1.3 percent)
p-cymen-8-ol (0.1 percent)
α-terpineol (1.1 percent)
cis-piperitol (0.1 percent)
trans-piperitol (0.1 percent)
α-fenchyl acetate (0.1 percent)
citronellol (t)
chavicol (2.0 percent)
bornyl acetate (0.1 percent)
carvacrol (0.1 percent)
δ-elemene (0.1 percent)
chavicyl acetate (2.5 percent)
eugenol (0.7 percent)
α-copaene (0.4 percent)
geranyl acetate (0.3 percent)
β-elemene (0.3 percent)
tetradecane (0.2 percent)
methyl eugenol (1.5 percent)
β-caryophyllene (3.6 percent)
β-gurjunene (0.2 percent)
trans-α-bergamotene (2.0 percent)
(Z)-β-farnesene (0.4 percent)
α-humulene (0.7 percent)
(E)-β-farnesene (3.2 percent)
ar-curcumene (0.5 percent)
β-selinene (0.7 percent)
pentadecane (2.9 percent)

β-bisabolene (8.4 percent)
β-sesquiphellandrene (2.6 percent)
(Z)-nerolidol (0.1 percent)
(E)-nerolidol (0.2 percent)
caryophyllene oxide (0.8 percent)
γ-eudesmol (0.7 percent)
β-eudesmol (0.7 percent)
β-bisabolol (1.1 percent)
(Z,E)-farnesol (3.8 percent)
1-heptadecene (1.6 percent)
heptadecane (0.2 percent)
(Z,Z)-farnesol (0.2 percent)
(E,E)-farnesol (0.2 percent)
(E,E)-farnesyl acetate (1.7 percent)
1-nonadecene (0.1 percent)

t = trace (< 0.1 percent)

The same authors also examined the composition of the seed oil of *A. galanga* and found that it was quite dissimilar to the rhizome. They found that it possessed the following composition:

sabinene (0.1 percent)
β-pinene (0.1 percent)
1,8-cineole (0.2 percent)
terpinolene (t)
linalool (0.1 percent)
geraniol (0.1 percent)
carvacrol (0.1 percent)
citronellyl acetate (0.5 percent)
eugenol (t)
α-copaene (0.1 percent)
geranyl acetate (1.2 percent)
β-elemene (0.5 percent)
tetradecane (0.2 percent)
methyl eugenol (0.4 percent)
β-caryophyllene (3.0 percent)
β-gurjunene (0.1 percent)
trans-α-bergamotene (0.4 percent)
α-humulene (0.3 percent)
(E)-β-farnesene (22.7 percent)
β-selinene (1.6 percent)
pentadecane (0.3 percent)
β-bisabolene (37.6 percent)
β-sesquiphellandrene (1.0 percent)
(Z)-nerolidol (0.4 percent)
(E)-nerolidol (0.7 percent)
caryophyllene oxide (1.0 percent)
γ-eudesmol (0.5 percent)
β-eudesmol (0.4 percent)
β-bisabolol (1.2 percent)
(Z,E)-farnesol (3.9 percent)
1-heptadecene (4.0 percent)
heptadecane (0.7 percent)
(Z,Z)-farnesol (0.5 percent)
(E,E)-farnesol (1.0 percent)
(E,E)-farnesyl acetate (7.9 percent)
1-nonadecene (0.3 percent)

t = trace (< 0.1 percent)

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Celery Leaf and Seed Oils

Pino et al. (1997) analyzed an oil produced from celery leaves obtained from plants grown experimentally in Cuba. In this oil the following components were identified:

toluene† (0.13 percent)
(Z)-3-hexenol (0.08 percent)
α-pinene (0.20 percent)
sabinene (0.30 percent)
β-pinene (9.46 percent)
limonene (18.30 percent)
(E)-β-ocimene (0.11 percent)
γ-terpinene (2.35 percent)
terpinolene (0.05 percent)
linalool (0.01 percent)
p-mentha-1,3,8-triene (0.02 percent)
allo-ocimene* (0.03 percent)
pentylbenzene (0.03 percent)
terpinen-4-ol (0.03 percent)
α-terpineol (0.02 percent)
β-damascenone* (0.15 percent)
β-elemene (0.13 percent)
β-caryophyllene (13.50 percent)
α-humulene (1.73 percent)
β-selinene (8.30 percent)
β-chamigrene (1.60 percent)
δ-cadinene (0.07 percent)
cadina-1,4-diene (0.01 percent)
3-isobutyl phthalide (0.03 percent)

Comparative percentage composition of the oils and hexane extracts of celery cultivars **T-5**

Compound	Oils			Extracts	
	Helios	Zefir	Orient	Helios	Zefir
2-hexanol	1.3	1.2	-	-	-
α-pinene	0.3	0.3	0.3	t	t
β-pinene	3.4	3.3	6.8	2.2	1.8
myrcene	0.6	0.6	0.9	0.1	0.5
limonene	74.8	76.6	74.9	41.3	37.9
trans-sabinyl acetate	0.2	0.3	0.2	0.1	0.2
β-caryophyllene	0.1	0.1	0.1	t	0.2
β-selinene	16.8	15.3	14.0	16.9	18.3
α-selinene	2.0	1.8	1.7	2.5	2.4
kessane	0.2	t	t	0.7	0.6
caryophyllene oxide	0.1	t	t	0.3	0.5
butyl phthalide	t	t	0.3	8.1	7.9
dehydrosedanolide‡	t	t	0.4	26.8	26.5
sedanolide	t	t	t	0.8	3.3

t = trace (< 0.1 percent); ‡also known as 3-butyl-4,5-dihydrophthalide

caryophyllene oxide (0.03 percent)
3-butyl phthalide (4.91 percent)
3-butyl-4,5-dihydrophthalide‡ (32.10 percent)
hexadecanoic acid (0.24 percent)

*correct isomer not identified; †probably environmental contamination; ‡also known as sedanenolide

A commercial sample of celery seed oil was the subject of analysis by Lawrence (1999). The components identified in this oil were:

myrcene (0.64 percent)
limonene (44.07 percent)
γ-terpinene (0.01 percent)
p-mentha-1,3,8-triene (0.06 percent)
p-cymene (0.02 percent)
terpinolene (0.03 percent)
pentylcyclohexa-1,3-diene (3.41 percent)
1-octen-3-yl acetate (0.05 percent)
pentylbenzene (3.85 percent)
p-cymenene (0.02 percent)
(E)-3-pentenylbenzene (0.03 percent)
4-acetyl-1-methylcyclohexene† (0.06 percent)
linalool (0.16 percent)
β-caryophyllene (2.23 percent)
trans-dihydrocarvone (0.12 percent)
cis-dihydrocarvone (0.04 percent)
trans-p-mentha-2,8-dien-1-ol (0.09 percent)
α-humulene (0.19 percent)
cis-p-mentha-2,8-dien-1-ol (0.14 percent)
β-selinene (27.81 percent)
α-selinene (4.39 percent)
carvone (0.18 percent)
trans-carvyl acetate (0.09 percent)
ar-curcumene (0.14 percent)
trans-carveol (0.18 percent)
cis-carveol (0.10 percent)
cis-p-mentha-1(7),8-dien-2-ol (0.06 percent)
caryophyllene oxide (0.47 percent)
α-eudesmol (0.08 percent)
(Z)-3-butyldiene phthalide (0.05 percent)
3-butylphthalide (0.14 percent)

†tentative identification

Analysis of an oil of celery seed of Indian origin by Mohan Rao et al. (2000) revealed that it was found to contain the following constituents:

α-pinene (0.09 percent)
β-pinene (1.22 percent)
myrcene (1.30 percent)
limonene (50.90 percent)
linalool (0.20 percent)
trans-p-mentha-2,8-dien-1-ol (0.84 percent)
cis-limonene oxide (1.12 percent)
trans-limonene oxide (1.57 percent)
β-terpineol* (0.12 percent)
pentylbenzene (1.63 percent)
p-mentha-1,8-dien-4-ol (0.09 percent)
cis-dihydrocarvone (0.13 percent)
trans-dihydrocarvone (0.15 percent)
myrtenal (0.15 percent)
myrtenol (0.38 percent)
trans-carveol (0.91 percent)
carvone (1.86 percent)
perillaldehyde (0.12 percent)
trans-carvyl acetate (0.29 percent)
p-mentha-1(7),8-dien-2-ol* (0.23 percent)
β-elemene (0.09 percent)
tetradecane (0.14 percent)
β-caryophyllene (0.08 percent)
β-selinene (19.53 percent)
α-selinene (1.61 percent)
limonene diepoxide (0.39 percent)
caryophyllene oxide (2.29 percent)
humulene epoxide* (0.21 percent)
apiole (0.13 percent)
3-butylphthalide (6.92 percent)
β-eudesmol (0.72 percent)
3-butyl-3a,4,5,6-tetrahydrophthalide‡ (0.67 percent)
heptadecane (0.38 percent)

*correct isomer not identified; ‡also known as sedanolide

In addition, the authors also characterized the presences of a number of trace components (< 0.01 percent) such as a pentylcyclohexadiene isomer, a pinene oxide isomer, p-cymene, *trans*-p-menth-2-en-1-ol, *cis*-carvyl acetate, p-menth-1-en-9-ol, allylphenylether, and butyl phenyl ketone in the same oil. These latter three compounds were probably identified in error.

Ludwiczuk et al. (2001) compared the composition of seed (fruit) oils of three stalk celery cultivars (Helios, Zefir and Orient) with hexane extracts of two of the seed (fruit) cultivars (Helios and Zefir) grown in Poland. The results obtained from this comparative study are presented in T-5.

An oil of celery seed was analyzed using GC and ^{13}C-NMR by Kubeczka and Formacek (2002). The constituents found in the oil were as follows:

α-pinene (0.15 percent)
camphene (0.04 percent)
β-pinene (0.90 percent)
sabinene (0.03 percent)
δ-3-carene (0.03 percent)
myrcene (0.79 percent)
limonene (85.13 percent)
β-phellandrene (0.05 percent)
(Z)-β-ocimene (0.01 percent)
(E)-β-ocimene (0.02 percent)
p-cymene (0.18 percent)
pentylcyclohexa-1,3-diene (0.12 percent)
pentylbenzene (1.93 percent)
cis-limonene oxide (0.13 percent)
trans-limonene oxide (0.27 percent)
linalool (0.09 percent)
β-caryophyllene (0.10 percent)
cis-dihydrocarvone (0.16 percent)
β-selinene (3.68 percent)
α-selinene (0.46 percent)
carvone (0.45 percent)
trans-carveol (0.34 percent)
cis-carveol (0.18 percent)
caryophyllene oxide (0.26 percent)
myristicin (0.18 percent)
3-butylphthalide (1.93 percent)

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