Progress in Essential Oils

Brian M. Lawrence, Consultant

Tagetes Oil

Garg and Mehta (1998) characterized three new acyclic monoterpene ketones in a steam-distilled oil of *Tagetes minuta*. They were 3,7-dimethyl-1-octen-6-one, 3,7-dimethyl-5-hydroxy-1-octen-6-one and 3,7-dimethyl-1,7-dien-6-one. The main constituents of this oil were found to be:

(Z)-β-ocimene (38.72 percent)
dihydrotagentone (9.07 percent)
(Z)-tagetone (7.00 percent)
(Z)-tagetenone (7.00 percent)
(E)-tagetenone (13.00 percent)

Larrán et al. (2001) screened a number of oils against the causal fungus of the chalkbrood disease of honeybees. One of the oils screened was *T. minuta,* produced from plants cultivated in Argentina. The main constituents of this oil were found to be:

limonene (3.2 percent)
(Z)-β-ocimene (44.3 percent)
dihydrotagetone (7.2 percent)
(E)-tagetone (5.3 percent)
(Z)-tagetone (0.7 percent)
(Z)-tagetenone (12.2 percent)
(E)-tagetenone (7.7 percent)

The main constituents of *T. minuta* oil, produced from plants grown in Kumaon, Uttaranchal (India), were the subject of analysis by Chowdhury (2001). He characterized the following constituents in this oil:

α-pinene (2.18 percent)
myrcene (5.94 percent)
isolimonene† (4.63 percent)
p-cymene (2.10 percent)
β-ocimene* (0.50 percent)
1-penten-3-ol† (5.10 percent)
dihydrotagetone (3.50 percent)
linalool (1.68 percent)
linalyl acetate (2.24 percent)
carvotanacetone† (1.37 percent)
2-nonanone† (2.68 percent)
β-cubebene† (3.75 percent)
menthol† (1.84 percent)
tagetone* (17.40 percent)
β-ionone* (3.06 percent)
α-terpineol (1.35 percent)
γ-terpineol‡ (1.20 percent)
neral + geranial† (2.27 percent)
phenylacetaldehyde† (1.72 percent)
tagetenone* (1.10 percent)
β-caryophyllene (11.07 percent)
β-bisabolene (2.45 percent)
nerolidol* (0.93 percent)
spathulenol (2.88 percent)
carvacrol† (3.72 percent)
isoeugenol*† (2.69 percent)

†questionable identity; *correct isomer not identified; ‡natural occurrence of this compound has never been unequivocally proven

Although this was reported to be a GC/MS study, it is an example of computerized compound characterization without a scientific judgment on the accuracy of information generated. The literature review carried out by this author was incredibly poor. If he had performed a careful examination of the published literature, he would have a greater knowledge about the constituents that have been characterized in the numerous studies. This should have influenced him to examine his own results before placing them in the public domain.

The effect of drought stress on the oil yield, and the composition of drought-tolerant and nondrought-tolerant *T. minuta* was studied by Mohamed et al. (2001). At a reduced water intake, a drought-tolerant clone had significantly higher oil content than a nondrought-tolerant clone grown under the same

Comparative percentage composition of two clones of *Tagetes minuta* of differing drought tolerance grown under water stress **T-1**

Compound	Oil from nondrought-tolerant clone	Oil from drought-tolerant clone
sabinene	0.82	0.28
3-hexenyl acetate*	-	t
limonene	18.32	13.55
(Z)-β-ocimene	0.40	-
(E)-β-ocimene	t	-
dihydrotagetone	2.08	4.63
cis-linalool oxide†	0.75	0.60
trans-linalool oxide†	1.56	1.17
linalool	1.80	1.24
camphor	0.20	t
trans-sabinene hydrate	t	-
(E)-tagetone	28.02	23.81
(Z)-tagetone	17.75	18.33
terpinen-4-ol	0.91	0.87
elsholtzia ketone	0.88	1.18
verbenone	-	t
pulegone	0.22	0.26
(Z)-anethole	0.30	0.50
(E)-anethole	t	0.80
tridecane	t	t
longifolene	2.20	2.32
α-gurjunene	3.22	3.05
β-caryophyllene	1.95	4.71
β-gurjunene	t	0.48
aromadendrene	0.60	0.64
α-humulene	1.52	3.59
α-muurolene	-	t
germacrene B	1.20	3.30
pentadecane	0.60	t
spathulenol	7.85	8.16
caryophyllene oxide	0.44	0.80
globulol	1.28	0.57
ledol	-	t
hexadecane	t	t
Oil content percent dwb	1.34	1.48

*correct isomer not identified; †furanoid form

reduced water intake. A comparison between the composition of the two clones can be seen in T-1.

Singh and Singh (2002) examined the composition of the oils of different plant parts harvested at specific growth stages. Their results are summarized in T-2.

Osée Muyima et al. (2004) determined the main constituents of an oil of *T. minuta* plants that was collected from wild plants growing in cornfields. They were as follows:

sabinene (3.65 percent)
limonene (21.26 percent)
dihydrotagetone (28.83 percent)
(Z)-β-ocimene (35.56 percent)
(E)-β-ocimene (1.25 percent)
allo-ocimene* (1.26 percent)
(Z)-tagetone (0.98 percent)
(E)-tagetone (5.38 percent)
(E)-tagetenone (1.05 percent)

*correct isomer not identified

Senatore et al. (2004) compared the composition of *T. minuta* oils produced from plants grown in two areas of the United Kingdom, Egypt and South Africa. A summary of these analytical results can

Percentage composition of the main constituents of the oils of different plant parts harvested at specific growth stages **T-2**

Compound	Early growth-stage oil	Peak growth-stage oil	Flower bud-stage oil	Full bloom-stage oil	Senescence-stage oil
limonene	5.12	5.54	6.77	5.74	1.78
β-ocimene*	17.87	13.92	15.19	26.21	41.51
dihydrotagetone	17.85	32.05	34.11	25.39	18.21
(E)-tagetone	4.21	2.17	1.84	2.33	2.13
(Z)-tagetone	22.19	24.31	17.49	14.98	14.01
(Z)-tagetenone	5.03	1.81	2.17	2.00	2.56
(E)-tagetenone	21.63	15.22	15.89	16.32	13.46

*correct isomer not identified

Percentage composition of *Tagetes minuta* oil produced in different countries **T-3**

Compound	1	2	3	4	Compound	1	2	3	4
2-hexenal*	-	0.2	-	-	(Z)-tagetone	23.0	9.8	6.9	8.5
amyl acetate	-	0.2	-	-	menthone	-	-	-	0.3
α-thujene	-	-	-	0.4	borneol	1.0	0.9	0.1	0.1
α-pinene	-	-	0.1	-	terpinen-4-ol	0.6	0.4	-	0.1
camphene	-	-	-	0.1	α-terpineol	-	0.1	0.1	-
sabinene	0.3	1.8	0.9	0.9	elsholtzia ketone	0.3	0.6	0.2	0.6
octanal	-	-	0.1	0.3	linalyl acetate	-	-	-	0.1
myrcene	-	-	0.2	0.2	bornyl acetate	-	-	-	0.1
α-phellandrene	-	-	0.2	0.3	(Z)-tagetenone	0.5	-	8.1	4.0
3-hexenyl acetate*	-	0.2	-	-	(E)-tagetenone	0.1	0.1	8.4	5.8
hexyl acetate	-	-	-	0.1	β-elemene	-	0.2	-	-
α-terpinene	-	-	-	0.1	longifolene	-	-	-	0.1
p-cymene	-	0.3	t	0.1	α-gurjunene	1.9	0.3	0.7	0.5
1,8-cineole	-	0.1	-	0.1	β-caryophyllene	0.2	0.2	2.3	1.8
limonene	5.4	12.3	7.1	5.7	α-cadinene‡	0.2	-	-	0.1
(Z)-β-ocimene	0.8	1.3	50.9	32.0	α-humulene	0.2	0.1	1.0	0.8
β-phellandrene	-	-	t	-	β-ionone*	-	0.1	-	-
dihydrotagetone	34.3	54.1	3.0	16.4	germacrene D	-	0.1	0.3	0.6
γ-terpinene	-	-	0.1	-	γ-elemene‡	-	-	1.7	2.2
octanol	-	-	-	0.1	δ-cadinene	-	-	-	0.1
terpinolene	-	-	0.1	-	β-bisabolene	-	-	-	0.1
cis-linalool oxide†	0.4	0.4	-	0.3	ledol	0.1	-	-	-
trans-linalool oxide†	0.5	-	0.4	0.8	spathulenol	0.6	0.6	0.3	0.2
trans-p-menth-2-en-1-ol	2.1	-	-	-	caryophyllene oxide	0.2	0.2	-	0.2
linalool	0.7	2.2	-	0.2	globulol	-	0.1	-	-
piperitone	-	0.3	0.2	0.2	viridiflorol	0.1	-	-	-
verbenol*	0.2	-	0.2	-	(Z,E)-farnesol	0.2	-	-	0.1
(E,E)-allo-ocimene	-	-	1.6	2.0					
trans-sabinene hydrate	-	-	0.1	-					
(E)-tagetone	17.1	9.9	2.2	1.0					

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

be seen in T-3. As shown, the oils produced in the United Kingdom both were found to be rich in dihydrotagetone (34.3 percent and 54.1 percent), whereas the oils from Egypt and South Africa both were found to contain (Z)-β-ocimene (30.2 percent and 50.9 percent, respectively).

The analysis of a fruit oil of *T. minuta* was performed by Kaul et al. (2005). The results of this study revealed that the fruit oil had the following composition:

α-pinene (0.4 percent)
sabinene (0.7 percent)

Comparative percentage composition of the leaf and flower oils of *Tagetes minuta* **T-4**

Compound	Leaf oil	Flower oil
α-pinene	0.1	t
camphene	-	0.7
sabinene	0.8	0.2
myrcene	0.1	0.1
α-phellandrene	-	0.3
α-terpinene	0.1	-
limonene	8.8	0.6
(Z)-β-ocimene	5.1	25.5
(E)-β-ocimene	0.1	0.2
dihydrotagetone	61.1	4.1
terpinolene	0.5	1.8
linalool	0.7	0.1
camphor	5.7	4.0
(E)-tagetone	9.7	58.0
(Z)-tagetone	0.2	0.2
terpinen-4-ol	0.2	-
(Z)-tagetenone[a]	-	0.1
(E)-tagetenone[a]	0.1	0.4
piperitone	t	0.2
β-caryophyllene	0.4	0.2
germacrene B	t	0.1
(Z)-nerolidol	0.1	-
caryophyllene oxide	-	0.1

t = trace (< 0.1 percent); [a]also known as ocimenone

myrcene (0.5 percent)
limonene + β-phellandrene (4.7 percent)
(Z)-β-ocimene (36.8 percent)
dihydrotagetone + (E)-β-ocimene (15.5 percent)
octanol (0.2 percent)
γ-terpinene (0.8 percent)
terpinolene (0.2 percent)
linalool (0.2 percent)
2-phenethyl alcohol (0.2 percent)
α-thujone (0.5 percent)
β-thujone (0.5 percent)
(E)-tagetone (1.3 percent)
(Z)-tagetone (17.1 percent)
(Z)-tagetenone (3.0 percent)
(E)-tagetenone (7.5 percent)
methyl thymol (1.2 percent)
thymol (0.5 percent)
β-elemene (0.4 percent)
β-caryophyllene (0.7 percent)
α-humulene (0.5 percent)
δ-cadinene (0.2 percent)
caryophyllene oxide (0.1 percent)

The leaf and flower oils of *T. minuta* that were produced from plants grown in Italy were the subjects of analyses by Marotti et al. (2004). They found that the oils were quite dissimilar, as can be seen from the data presented in T-4. It was interesting to note that the oil content of the flowers was 15.0 percent, whereas that of the leaves was 6.6 percent.

Eguaras et al. (2005) screened honeybee pathogens and a parasitic mite against an oil of *T. minuta*. The main components of this oil, which was found to have moderate antimicrobial and miticide activity, were as follows:

limonene (5.8 percent)
(Z)-β-ocimene (62.8 percent)
dihydrotagetone (4.2 percent)
(E,E)-allo-ocimene (1.1 percent)
(E)-tagetone (1.4 percent)
(Z)-tagetone (2.3 percent)
(Z)-tagetenone (10.2 percent)
(E)-tagetenone (6.6 percent)

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Australian Sandalwood Oil

The oil of Australian sandalwood is produced from the heartwood of a small endemic tree to Western Australia [*Santalum spicatum* (R.Br.)A.DC., syn. *Fusanus spicatus* R.Br.; *Eucarya spicata* (R.Br.) Sprague et Summerh.; *Santalum cygnorum* Miq.]. Limited quantities of the fragrant oil have been produced since the beginning of the 20th century for use in the perfumery industry. It was reported (Anon, 1919) that it possessed a santalol content of 75-80 percent. Penfold (1928, 1932) categorically

Percentage composition of specific components of Western Australian sandalwood oil produced from wood obtained from different parts of a single tree **T-5**

Wood origin	epi-α-bisabolol	(Z)-α-santalol	(E,E)-farnesol	(Z)-β-santalol	(Z)-nuciferol
roots	3.9	6.9	3.1	2.7	2.0
butt	3.1	10.0	5.3	3.8	2.2
midtrunk	12.1	1.6	6.6	0.6	2.5
30 cm above first branch	18.8	0.6	8.8	-	1.5
high branch	17.2	-	8.0	-	-
dead branch	20.2	-	5.2	-	0.6

established the fact that the oil contained both α- and β-santalol. A fraction of *S. spicatum* oil was found to contain (E)- and (Z)-10-2,6,10-trimethyldodeca-2,6-10-triene compounds that were found (Birch et al., 1970) to be termite attractants. As these two compounds were synthesized by the reduction of a mixture of farnesyl acetates, it is possible that they were, in fact, artifacts produced during oil isolation or fractionation.

Adams et al. (1975) analyzed two hydrocarbon fractions (6.0 percent) of Australian sandalwood oil and found that they contained the following components:

α-santalene (21-24 percent)
epi-β-santalene (11-14 percent)
β-santalene (20 percent)
β-curcumene (8 percent)
ar-curcumene (7-12 percent)
dendrolasin (6-13 percent)

Brophy et al. (1991) subjected a lab-distilled oil to analysis by GC and GC/MS. The constituents identified in this oil were as follows:

α-santalene (0.3 percent)
α-bergamotene* (0.2 percent)
β-santalene (0.1 percent)
epi-β-santalene (0.2 percent)
β-farnesene* (0.2 percent)
β-bisabolene (0.6 percent)
β-curcumene (0.8 percent)
γ-bisabolene* (< 0.1 percent)
ar-curcumene (0.5 percent)
geranyl acetone (1.1 percent)
dendrolasin (2.0 percent)
(E)-nerolidol (1.3 percent)
α-bisabolol (0.5 percent)
epi-α-bisabolol (10.7 percent)
farnesol* (0.1 percent)
α-santalol (9.1 percent)
(Z)-*trans*-α-bergamotol (0.4 percent)
(E,E)-farnesol (31.6 percent)
epi-β-santalol (2.9 percent)
(Z)-β-santalol (5.4 percent)
(E)-β-santalol (0.6 percent)
(Z)-lanceol (3.9 percent)
(Z)-nuciferol (6.5 percent)

*correct isomer not identified

Piggott et al. (1997) determined that the yield of volatiles of *S. spicatum* wood produced by steam distillation was 93.5 percent, as compared with 50-60 percent when the wood was extracted. The main volatile constituents of the oil were found to be:

epi-α-bisabolol (6.6 percent)
(Z)-α-santalol (21.6 percent)
(E,E)-farnesol (11.0 percent)
(Z)-β-santalol (8.1 percent)
(Z)-nuciferol (6.9 percent)

In addition, the authors found that the previous components varied quantitatively, depending upon from which part of the tree the wood was obtained, as can be seen in T-5.

A trade publication obtained from the producer of Australian sandalwood oil noted that the oil produced by it possessed the following composition:

α-santalene (0.73 percent)
epi-β-santalene (0.39 percent)
β-santalene (0.93 percent)
β-farnesene* (0.62 percent)
ar-curcumene (0.48 percent)
α-farnesene* (0.28 percent)
β-curcumene (0.52 percent)
γ-curcumene (0.76 percent)
dedrolasin (0.89 percent)
(E)-nerolidol (0.51 percent)
β-bisabolol (1.60 percent)
α-santalol (27.55 percent)
(E,E)-farnesol (8.26 percent)
epi-α-bisabolol (4.74 percent)
(Z)-*trans*-α-bergamotol (4.04 percent)
epi-β-santalol (1.68 percent)
β-santalol (7.40 percent)
(Z)-nuciferol (8.26 percent)
(Z)-lanceol (4.54 percent)

*correct isomer not identified

A commercial oil of Australian sandalwood oil was analyzed by Valder et al. (2003) using fractional distillation, GC/FID, GC/MS, ^{1}H- and ^{13}C-NMR. The constituents characterized in this oil were as follows:

sesquithujene (0.3 percent)
cis-α-bergamotene (0.1 percent)
α-santalene (1.5 percent)
α-cedrene (0.3 percent)
trans-α-bergamotene (0.6 percent)
β-cedrene (0.1 percent)
epi-β-santalene (0.9 percent)
β-santalene (1.3 percent)
sesquisabinene B (0.1 percent)
amorpha-4,11-diene (0.1 percent)
α-acoradiene (0.4 percent)
trans-β-bergamotene (0.1 percent)
γ-curcumene (0.7 percent)
β-acoradiene (0.1 percent)
zingiberene (0.1 percent)
β-bisabolene (0.4 percent)
(Z)-γ-bisabolene (0.1 percent)
α-alaskene† (0.2 percent)
β-curcumene (1.4 percent)
(E)-β-farnesene (0.2 percent)
sesquicineole (0.3 percent)
(E)-γ-bisabolene (0.1 percent)
β-sesquiphellandrene (0.5 percent)
(E)-α-bisabolene (0.1 percent)
ar-curcumene (0.8 percent)
dendrolasin (2.0 percent)
sesquisabinene hydrate* (0.1 percent)
(E)-nerolidol (0.5 percent)
nor-helifolen-12-al (0.4 percent)
guaiol (0.2 percent)
β-bisabolol + epi-β-bisabolol (1.9 percent)
cyclosantalal (0.2 percent)
α-bisabolol* (4.9 percent)
α-teresantalic acid (0.2 percent)
(E,E)-farnesyl acetate (0.1 percent)
β-santalal* (0.2 percent)
campherenol (0.4 percent)
(E,E)-farnesol (9.3 percent)
(Z)-*trans*-α-bergamotol (4.7 percent)
(Z)-α-santalol (13.3 percent)
(E)-α-santalol (0.4 percent)
11-epi-6,10-epoxybisabol-2-en-12-ol (1.0 percent)
epi-β-santalol (1.4 percent)

(Z)-β-santalol (5.9 percent)
(Z)-γ-curcumen-12-ol (4.4 percent)
(E)-β-santalol (0.5 percent)
(Z)-β-curcumen-12-ol (7.2 percent)
(Z)-lanceol (2.0 percent)
cis-12-hydroxysesquicineole (1.7 percent)
(Z)-nuciferol (5.6 percent)
spirosantalol (0.5 percent)
bisabola-2,10-diene-6,13-diol (2.4 percent)
bisabola-2,10-diene-7,13-diol (0.6 percent)
α-santaldiol (0.9 percent)
β-santaldiol (0.2 percent)

*correct isomer not identified; †also known as γ-acoradiene

Trace amounts (< 0.1 percent) of santene, limonene, p-cymenene, a p-menthatriene isomer, di-epi-α-cedrene, epi-sesquithujene, sesquisabinene A, muurola-4,11-diene, β-alaskene, (Z,E)-α-farnesene, α-bulnesene, (Z)-α-bisabolene, β-selinene and α-selinene also were found in this same oil.

Ylang-Ylang Oil

A sample of ylang-ylang oil was determined by Takeoka et al. (1990) to contain α-copaene in the following enantiomeric ratio: (+)-α-copaene (< 1 percent):(-)-α-copaene (> 99 percent). Six years later, Casabianca (1996) obtained exactly the same results.

Casabianca et al. (1997) used multidimensional chiral chromatography and ^{13}C:^{12}C isotope ratio measurements on a range of samples of oils and concretes of ylang-ylang of various origins, such as Comoro Islands, Mayotte and Madagascar. The constituents of the oils that were examined

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were prenyl acetate, p-methyl anisole (p-cresyl methyl ether), linalool, β-caryophyllene, methyl benzoate, benzyl acetate, cinnamyl acetate, benzyl benzoate and benzyl salicylate. Using the procedure described by Mosandl (1992) and the following formulation, the $\delta^{13}C$ levels for the previously listed compounds can be seen in T-6.

$$5^{13}C‰ = \left[\frac{(^{13}C/^{12}C \text{ of test substance})}{(^{13}C/^{12}C \text{ of standard PDB})} - 1 \right] x10^{3}$$

Also, Casabianca et al. used chiral GC to examine the enantiomeric distribution of linalool in the ylang-ylang samples. These results are shown in T-7. As can be seen, linalool found in the so-called extra oils and the concretes was determined to be more enantiomerically pure than the other oils — particularly the oil, which was obtained commercially in France.

In a trade report by Bruker Daltonics (Anon, 2002) it was shown that with the use of a SolGelWAX capillary column, the following compounds, such as p-methyl-anisole, α-copaene, linalool, β-caryophyllene, methyl benzoate, α-humulene, α-amorphene, germacrene D, benzyl acetate, δ-cadinene, an α-farnesene isomer, geranyl acetate, (E)-cinnamyl acetate, an isomer of farnesyl acetate, a farnesol isomer, benzyl benzoate and benzyl salicylate, were readily separated and identified by MS.

A commercial sample of ylang-ylang oil of unknown origin was analyzed by Kubeczka and Formacek (2002) using capillary GC and ^{13}C-NMR. As a result of this analysis, the oil was found to possess the following composition:

α-pinene (0.26 percent)
β-pinene (0.10 percent)
3-methyl-3-butenyl acetate (0.96 percent)
1,8-cineole (0.21 percent)
3-methyl-2-butenyl acetate (2.06 percent)
hexyl acetate (0.26 percent)
(Z)-3-hexenyl acetate (0.17 percent)
p-cresyl methyl ether (9.67 percent)
α-copaene (0.58 percent)
β-cubebene (0.23 percent)
linalool (10.09 percent)
β-ylangene (0.11 percent)
β-elemene (0.24 percent)
β-caryophyllene (4.03 percent)
methyl benzoate (5.68 percent)
α-humulene (1.45 percent)
γ-muurolene (0.44 percent)
germacrene D (17.05 percent)
benzyl acetate (14.66 percent)
bicyclogermacrene (0.48 percent)
(E,E)-α-farnesene (7.41 percent)
geranyl acetate (5.87 percent)
δ-cadinene (0.44 percent)
methyl salicylate (0.17 percent)
2-phenethyl acetate (0.15 percent)
(E)-anethole (0.40 percent)
geraniol (0.26 percent)
3-methyl-2-butenyl benzoate (0.90 percent)
cinnamyl acetate (4.59 percent)
α-cadinol (0.59 percent)
(E,E)-farnesyl acetate (1.54 percent)
(E)-isoeugenol (0.47 percent)
(E,E)-farnesol (1.27 percent)
benzyl benzoate (4.57 percent)
benzyl salicylate (2.12 percent)

Variation in $\delta^{13}C$ for selected constituents of ylang-ylang oil and concrete

T-6

Compound	$\delta^{13}C^{0}/_{00}$					
	1	2	3	4	5	6
prenyl acetate	-26.0	-26.9	-26.1	-23.5	-	-26.5
p-methyl anisole	-31.0	-31.5	-31.3	-30.1	-27.8	-30.0
linalool	-31.4	-32.3	-32.2	-29.4	-31.1	-31.6
β-caryophyllene	-26.5	-27.8	-27.2	-26.8	-31.5	-25.6
methyl benzoate	-29.6	-29.6	-29.8	-28.5	-27.8	-28.1
benzyl acetate	-30.3	-29.3	-30.7	-27.5	-28.9	-27.1
cinnamyl acetate	-29.3	-30.9	-31.2	-27.1	-	-
benzyl benzoate	-31.1	-30.8	-30.8	-29.4	-30.1	-29.2
benzyl salicylate	-32.9	-32.2	-31.9	-32.1	-32.6	-31.4

1. ylang-ylang oil extra Comoro Islands; 2. ylang-ylang oil extra Mayotte; 3. ylang-ylang oil extra Madagascar; 4. commercial sample of ylang-ylang oil extra; 5. Comoro Islands ylang-ylang concrete; 6. Madagascan ylang-ylang concrete

Enantiomeric distribution of linalool in ylang-ylang oils and concrete

T-7

Linalool origin	% (3R)-(-)-linalool	% (3S)-(+)-linalool
1. ylang-ylang extra Comoro Islands	98.0	2.0
2. ylang-ylang extra Mayotte	98.0-98.5	1.5-2.0
3. ylang-ylang extra Madagascar	98.0-99.0	1.0-2.0
4. ylang-ylang third Comoro Islands	84.0-90.0	10.0-16.0
5. ylang-ylang third Mayotte	85.0-95.0	5.0-15.0
6. ylang-ylang third Madagascar	80.0-93.5	6.5-20.0
7. ylang-ylang concrete Comoro Islands	98.0	2.0
8. ylang-ylang concrete Madagascar	99.0	1.0
9. ylang-ylang extra commercial	80.0	20.0
10. synthetic linalool	50	50

1-6 and 9 are oils

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