



Progress in Essential Oils

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Sage Oil Part 1

Sage oil is obtained by steam distillation of *Salvia officinalis* L. Sage, or common sage, is a hardy, perennial, woody sub-shrub native to the Mediterranean countries, the Balkan Peninsula and the Adriatic Islands. Sage leaves have a long history of use as a medicinal and a culinary herb. Because it has a strong, fragrant aromatic aroma, oils and extracts of sage (sometimes called Dalmatian sage) are used in the manufacture of perfumes and cosmetics. Sage oil is produced in commercial quantities in Albania, Argentina, Bosnia and Herzegovina, Bulgaria, Croatia, France, Hungary, Serbia, Montenegro and Romania.

Since 2001, numerous studies on the composition of oils produced from *S. officinalis* have been reported; however, as many of the studies are somewhat repetitive, the format of this review will be changed so that the published data

can be more concisely examined. Only the more unusual or more scientifically significant studies will be reviewed in the usual fashion.

Wild sage (*S. officinalis* L.) plants were collected in the sunny hillsides in the Doli-Ston district of Dubrovnik (Croatia) between June and December by Pitarevic et al. (1984). According to the authors, sage leaves are normally harvested from June to December, weather conditions permitting. Oils produced from the different harvests were analyzed for oil yield and major constituent variations. Their results are summarized in **T-1**.

Santos-Gomes and Fernandes-Ferreira (2001) collected *S. officinalis* plants from an experimental garden in Arouca (northern Portugal). The leaves, stems and flowers were separated from the plants and oils separately produced using water distillation. Each oil was analyzed using both GC-FID and GC/MS;

the results of this study can be seen in **T-2**. In addition, trace amounts (<0.05%) of butyl acetate, *trans*-carvyl acetate, *cis*-carvyl acetate, neryl acetate and aromadendrene were also found in one or all of the plant part oils.

Sage plants collected during their flowering stage in the vicinity of the village of Gradiste (Sicevo Gorge, southeastern Serbia) were separated into plant parts and oils produced from them were analyzed by Velickovic et al. (2002). These comparative analyses are presented in **T-3**. A trace amount of α -phellandrene was also found in all three plant part oils.

Avato et al. (2005) examined the chemical composition of oils produced from in vitro shoots and micro-propagated plants and compared them with oils produced from field-grown mother plants and derived rooted cuttings. The oil composition of in vitro shoots was determined to be:

α -pinene (1.6%)
 camphene (0.5%)
 β -pinene (0.5%)
 decane (0.9%)
 1,8-cineole (3.1%)
 α -thujone (3.5%)
 β -thujone (2.3%)
 camphor (5.7%)
 borneol (2.0%)
 terpinen-4-ol (0.6%)
 bornyl acetate (2.6%)
 methyl eugenol (19.8%)
 α -humulene (4.0%)
 viridiflorene (31.7%)
 humulene epoxide II (1.6%)
 pimara-8(14),15-diene (19.8%)

A trace amount (<0.1%) of β -caryophyllene was also found in this in vitro shoot oil. A comparison between oils obtained from micropropagated plants (2- to 18- months-old), mother plants and rooted cutting plants (2-months-old) can be seen in **T-4**.

T-1. Seasonal variation in oil yield and composition of *Salvia officinalis*

Compound	Jun oil	Jul oil	Aug oil	Sep oil	Oct oil	Nov oil	Dec oil
α -pinene	3.0	3.1	2.0	3.6	2.7	3.0	2.3
camphene	1.7	2.4	3.2	2.7	2.0	3.1	2.3
β -pinene	0.7	0.9	0.8	1.0	1.0	1.6	1.0
myrcene	1.0	1.2	1.0	1.0	1.0	1.1	0.9
limonene	1.0	1.2	1.5	1.2	0.9	1.0	1.2
1,8-cineole	13.2	10.8	8.6	9.1	8.7	5.8	7.2
γ -terpinene	-	0.4	0.3	0.3	0.4	0.4	0.3
p-cymene	-	1.0	1.0	1.1	1.0	0.6	0.6
α -thujone	23.1	33.1	12.3	22.4	22.9	27.3	10.9
β -thujone	25.0	20.6	40.1	32.7	34.8	25.1	35.6
camphor	9.5	8.6	16.4	9.6	7.1	12.0	11.2
linalool	0.5	0.4	0.5	0.3	0.3	0.3	0.3
linalyl acetate	0.8	0.7	0.6	0.4	0.3	0.5	0.4
bornyl acetate	0.9	0.5	0.6	0.4	0.6	0.6	1.1
borneol	1.4	1.8	2.1	2.0	1.6	1.9	3.4
β -caryophyllene	0.6	0.7	0.3	0.5	0.5	-	0.2
α -humulene	1.2	1.9	0.8	1.3	2.3	3.5	2.9
oil yield (%)	2.8	3.1	2.9	2.4	2.2	2.1	1.8

Trace amounts (<0.05%) of methyl pyrazine, furfural, 2-ethylpyrazine, benzaldehyde, 5-methylfurfural, 3-octanol, 2-ethyl-3-methylpyrazine, benzyl alcohol, phenylacetaldehyde,

2-acetylpyrrole, *trans*-linalool oxide (furanoid), maltol, carvotanacetone, *cis*-carvone oxide, isolekene, β -bourbonene, α -isocomene, (E)-jasnone, α -gurjunene, (E)-isoeugenol, caryophyllene

alcohol and spathulenol were also found by Avato et al. in one or more of the oils.

Mirjalili et al. (2006) analyzed oils produced from *S. officinalis* grown in an experimental garden in Evin (north of Tehran, Iran). The authors compared the composition of oils produced throughout the life cycle of the plant. The analyses were performed using GC-FID and GC/MS and the results obtained are shown in **T-5**. Trace amounts of α -ylangene and β -eudesmol were found in at least two of the oils.

The oils produced in the laboratory by hydrodistillation from cultivars of *S. officinalis* that were harvested at full flowering in Hungary were the subject of analysis by Horvath et al. (2008). As can be seen from the results shown in **T-6**, there were quantitative differences in the oils of different cultivars.

Sage grown at the Experimental Station of Suleyman Demirel University (Isparta, Turkey) was harvested in four different months (June, July, August, September) from which oils were produced in yields of 1.43%, 3.24%, 1.60% and 1.88%, respectively. The results of the analysis of these oils using GC/MS only by Baydar et al. (2009) can be seen in **T-7**.

A lab-distilled oil produced from the fresh leaves of *S. officinalis* by hydrodistillation was analyzed by Tedone et al. (2011). The components characterized in this oil were as follows:

(Z)-salvene (0.1%)
 α -thujene (0.2%)
 α -pinene (1.0%)
camphene (2.4%)
sabinene (0.3%)
1-octen-3-ol (0.4%)
3-octanone (0.1%)
 β -pinene (2.3%)
myrcene (1.7%)
3-octanol (0.1%)
 α -phellandrene (0.1%)
 α -terpinene (0.3%)
p-cymene (0.3%)
limonene (2.1%)
1,8-cineole + β -phellandrene (14.3%)
 γ -terpinene (0.6%)
terpinolene (0.6%)
linalool (0.2%)
 α -thujone (27.1%)
 β -thujone (4.4%)
trans-sabinol (0.4%)
camphor (21.8%)
thujyl alcohol (0.2%)
 δ -terpineol (0.1%)
borneol (0.5%)
terpinen-4-ol (0.6%)
 α -terpineol (0.2%)

T-2. Comparative percentage composition of oils produced from the leaves, stems and flowers of *Salvia officinalis*

Compound	Leaf oil	Stem oil	Flower oil
(Z)-salvene	0.4	0.9	0.1
(E)-salvene	t	0.1	t
tricyclene	0.1	t	0.2
α -thujene	0.1	0.3	0.4
α -pinene	4.2	1.0	5.6
camphene	2.6	1.0	4.9
sabinene	0.2	0.8	0.4
β -pinene	2.2	1.8	17.0
myrcene	0.9	1.1	0.9
decane	t	t	0.1
α -terpinene	0.1	0.2	0.3
p-cymene	0.1	0.1	0.1
limonene	1.6	0.8	0.1
1,8-cineole	6.5	2.0	17.3
(Z)- β -ocimene	0.1	t	-
(E)- β -ocimene	t	t	0.1
γ -terpinene	0.3	0.6	0.5
<i>cis</i> -linalool oxide ^f	0.2	0.3	0.2
terpinolene	0.5	0.3	0.2
undecane	0.2	0.1	0.1
α -thujone	25.5	55.1	17.7
β -thujone	3.9	6.7	3.4
α -campholenal	t	2.2	-
camphor	19.5	5.6	3.5
isopinocampone ^o	t	0.2	-
borneol	0.1	0.7	8.8
pinocampone ^o	3.4	0.1	-
terpinen-4-ol	0.2	0.3	0.4
α -terpineol	0.3	0.1	0.2
bornyl acetate	1.2	0.7	1.7
<i>cis</i> -sabinyl acetate	0.2	0.3	-
δ -elemene	0.1	t	-
β -bourbonene + geranyl acetate	0.2	t	0.1
tetradecane	-	-	0.1
β -caryophyllene	3.2	1.1	4.8
α -humulene	7.5	5.2	4.3
allo-aromadendrene	0.1	0.1	0.1
germacrene D	0.1	0.1	0.1
α -selinene	0.1	0.1	0.1
α -muurolene	-	-	0.1
γ -cadinene	-	-	0.1
δ -cadinene	0.1	t	0.3
caryophyllene oxide	0.2	0.1	0.2
viridiflorol	6.3	5.1	3.2
(Z)- α - <i>trans</i> -bergamotol acetate	0.2	0.4	-
manool	5.9	4.7	0.8

^f furanoid form

t = trace (<0.05%)

^o Based on GC retention indices, these two components should be exchanged.

bornyl acetate (0.5%)
 β -bourbonene (0.1%)
 β -caryophyllene (1.6%)
aromadendrene (0.1%)
 α -humulene (2.8%)
allo-aromadendrene (0.1%)
 γ -muurolene (0.2%)
germacrene D (0.1%)
viridiflorene (0.1%)
 γ -cadinene (0.1%)
 δ -cadinene (0.2%)
spatulanol (0.1%)
caryophyllene oxide (0.5%)
viridiflorol (7.8%)
humulene epoxide II (0.8%)
manool (3.0%)

In addition, a trace (<0.05%) amount of (E)-salvene was also characterized in this oil.

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Sage Oil, Part 2

Sage oil analyses have revealed that a wide variation in quantitative composition was relatively common. In fact, using the

T-3. Comparative analyses of oils from plant parts of *Salvia officinalis*

Compound	Flower oil	Leaf oil	Stem oil
α -thujene	0.3	0.1–1.6	t
α -pinene	1.1–5.0	0.8–3.7	0.8
camphene	0.4–1.5	t–1.9	0.6
sabinene	0.1	0.1	0.3
β -pinene	1.3–5.7	1.1–3.1	0.1–1.2
myrcene	0.3–0.6	0.4–0.6	0.2
3-octanol	t	t–0.1	0.2
α -terpinene	0.1–0.3	0.1–0.3	0.2
p-cymene	0.3–0.4	0.4–0.6	0.1–0.3
limonene	0.7–0.9	0.8–0.9	0.1–0.3
1,8-cineole	11.2–17.7	12.6–16.2	1.1–6.8
(Z)- β -ocimene	0.2	t–0.1	t
(E)- β -ocimene	t	0.2–0.4	0.1–0.3
γ -terpinene	0.1–0.5	0.1–0.4	0.1
fenchone	-	0.1–0.2	-
terpinolene	0.1–0.2	0.3–0.4	0.1
linalool	0.3–0.4	t	0.4–0.5
α -thujone	15.0–15.9	22.1	16.6–35.6
β -thujone	2.3–3.1	2.9–3.0	2.3–4.1
2-ethylhexanoic acid	-	0.1	0.1–0.2
camphor	1.8–2.2	4.4–5.4	3.6–5.5
pinocamphone	-	0.2	0.3–0.6
borneol	3.4–5.2	2.6–3.2	1.8–2.3
terpinen-4-ol	0.2–0.3	0.3–0.4	0.3–0.6
myrtenol	-	-	0.1–0.2
α -fenchyl acetate	0.2	0.1–0.2	-
linalyl acetate	-	-	0.1–0.2
bornyl acetate	0.2–0.4	0.3	0.4–0.7
carvacrol	-	-	0.1–0.3
α -cubebene	0.2	0.2	0.1–0.3
eugenol	-	-	0.2
α -ylangene	0.4–0.5	0.4–0.6	0.2–0.4
α -copaene	1.0–1.5	1.1–1.8	0.5–1.1
β -bourbonene	0.2–0.4	0.2–0.4	0.2–0.4
β -caryophyllene	8.1–11.1	6.0–8.1	3.7–6.9
aromadendrene	0.2	0.2	0.1–0.3
α -humulene	11.1–12.9	11.0–12.7	8.8–15.0
allo-aromadendrene	0.2–0.3	0.1–0.2	0.1–0.2
γ -muurolene	1.9–2.5	1.8–2.9	1.1–2.1
α -muurolene	1.2–1.7	1.1–1.7	0.7–1.5
γ -cadinene	0.7–0.9	0.6–1.0	0.4–0.9
δ -cadinene	2.3–3.2	2.1–3.5	1.4–2.7
trans-calamenene	0.2	0.2	0.1–0.2
(E)- γ -bisabolene	0.1–0.2	0.1–0.2	t–0.1
α -calacorene	0.2–0.3	0.2–0.4	0.1–0.3
caryophyllene oxide	0.3–0.5	0.4–0.5	0.6–0.8
viridiflorol	9.0–13.3	5.7–7.0	8.5–18.6
β -bisabolol	0.2–0.3	0.3–0.5	0.3–0.7
epi- α -bisabolol	0.7–1.1	1.2–1.6	1.9–3.8
(Z)- α -trans-bergamotol	0.3–0.8	t–0.1	t
(Z,E)-farnesol	0.1–0.2	0.7–1.2	0.9–2.3
caryophyllene acetate	-	-	0.1–0.2
(Z,Z)-farnesol	0.1–0.3	0.2–0.3	-
(Z)-lanceol	-	0.1–0.2	0.2–0.4
(Z)- α -trans-bergamotol acetate	-	-	0.2–0.3
(Z,E)-farnesyl acetate	0.2–0.3	0.1–0.2	0.1–0.3
sclareol	3.3–3.7	1.1–2.0	7.2–8.5

t = trace (<0.05%)

T-4. Comparative composition (%) of oils of micro-propagated plants, mother plants and rooted cuttings of *Salvia officinalis*

Compound	1	2	3
α -pinene	0.1–0.2	0.2	0.1
camphene	t–0.1	0.1	0.2
sabinene	t–0.1	0.1	0.2
β -pinene	0.1–0.2	0.3	0.5
3-octanone	t	0.2	t
myrcene	0.2–0.5	1.0	0.6
α -terpinene	t	t	0.2
limonene	0.1–0.3	0.2	t
1,8-cineole	4.3–7.3	8.5	5.0
(Z)- β -ocimene	0–t	0.1	0.1
(E)- β -ocimene	0–t	t	0.3
γ -terpinene	t–0.2	0.2	0.1
cis-sabinene hydrate	0.4	0.3	0.5
p-cresol	0–t	0.1	0.1
o-guaiacol	-	0.1	-
trans-sabinene hydrate	0.1–0.2	0.3	0.2
linalool	0.3–0.5	0.3	0.5
α -thujone	11.1	13.1	13.7
β -thujone	6.2–8.7	13.7	12.0
camphor	32.6	14.4	16.8
isoborneol	t–0.3	0.1	0.3
borneol	4.1–5.6	4.2	6.6
terpinen-4-ol	0.4–1.0	0.6	0.5
p-cymen-8-ol	0.9–1.0	0.7	1.3
α -terpineol	0.8–1.2	0.6	0.5
myrtenol	1.0–1.1	0.3	0.7
bornyl acetate	2.4–2.6	0.7	1.8
2-heptylfuran	1.0–1.7	0.6	0.4
m-acetanisole*	0.0–0.2	0.4	0.2
myrtenylacetate	0.1–0.2	0.1	0.1
syringol**	0.5–1.2	0.4	0.3
eugenol	t	0.2	0.5
β -longipinene	-	0.2	0.3
β -caryophyllene	2.8–11.6	11.8	9.4
β -cedrene	t–0.2	0.1	0.3
aromadendrene	0.7–1.2	0.4	0.3
α -humulene	2.8–3.1	4.8	4.0
allo-aromadendrene	0.2–1.5	0.2	1.0
trans-cadina-1(6),4-diene	0.1–0.2	0.1	0.3
γ -gurjunene	t–0.1	0.1	0.1
viridiflorene	0.5	0.8	0.4
α -muurolene	0.3	t	-
δ -cadinene	0.2–0.3	0.1	0.5
β -thujaplicinol	t	t	0.1
caryophyllene oxide	0.2	1.3	0.6
viridiflorol	4.8–6.5	7.7	7.9
humulene epoxide II	t–0.2	0.4	0.2
pimara-8(14),15-diene	1.7–7.2	10.2	10.4

1 = micropropagated plant oils

2 = mother plant oil

3 = rooted cuttings oil

t = trace (<0.05%)

* also known as m-methoxyacetophenone

** also known as 1,4-dihydroxy-3,5-dimethoxybenzene

four components (1,8-cineole, α -thujone, β -thujone and camphor), the following chemical forms have been found:

1. α -thujone > camphor > 1,8-cineole > β -thujone
2. α -thujone > 1,8-cineole > camphor > β -thujone
3. α -thujone > 1,8-cineole > β -thujone > camphor
4. α -thujone > camphor > β -thujone > 1,8-cineole
5. α -thujone > β -thujone > camphor > 1,8-cineole
6. β -thujone > 1,8-cineole > camphor > α -thujone
7. β -thujone > α -thujone > 1,8-cineole > camphor
8. β -thujone > camphor > 1,8-cineole > α -thujone
9. camphor > α -thujone > 1,8-cineole > β -thujone
10. camphor > α -thujone > β -thujone > 1,8-cineole
11. 1,8-cineole > camphor > α -thujone > β -thujone

Most commercial oils are in agreement with this.

Because of this wide variation in quantitative data found in various sage oils, the components that have been characterized in the oil since the earlier reviews (Lawrence 1977, 1980, 1981, 1983, 1985, 1986, 1988, 1989, 1991, 1994, 1998, 2001) can be seen listed in **T-8**.

B.M. Lawrence, *Sage oil*. In: *Progress in Essential Oils*. *Perfum. Flav.*, **2**(5), 41, **2**(6), 50 (1978); **5**(1), 58, **5**(2), 37, **5**(5), 29–30 (1980); **6**(3), 49 (1981); **8**(1), 65–66 (1983); **9**(6), 65–68 (1985); **11**(4), 79–80 (1986); **13**(3), 53–56 (1988); **14**(6), 90, 94 (1989); **16**(4), 51–53 (1991); **19**(2), 70–71, **19**(6), 61 (1994); **23**(2), 47–52 (1998); **26**(3), 66–72 (2001).

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T-5. Comparative percentage composition of oils of *Salvia officinalis* produced during its life cycle

Compound	1	2	3	4	5
tricyclene	0.1	0.2	0.3	0.2	0.3
α -pinene	2.7	3.1	4.6	3.3	3.5
camphene	3.4	2.5	4.7	4.0	1.6
sabinene	t	t	t	t	0.3
β -pinene	8.0	12.3	16.4	10.5	7.1
myrcene	0.5	0.6	0.7	0.5	t
α -terpinene	0.2	0.1	t	-	0.2
p-cymene	-	t	t	t	0.2
(E)- β -ocimene	1.3	1.0	0.9	0.6	-
γ -terpinene	0.3	0.2	0.2	0.1	0.5
terpinolene	0.1	t	t	0.1	0.2
1,8-cineole	16.8	19.3	22.3	19.5	15.3
trans-sabinene hydrate	0.3	0.3	0.4	t	-
linalool	t	0.1	0.1	t	0.3
α -thujone	12.8	13.2	9.1	9.5	25.1
β -thujone	1.1	2.7	2.1	1.1	5.0
α -campholenal	1.1	-	-	-	-
camphor	7.1	2.1	1.6	2.8	6.3
borneol	8.4	6.9	11.0	14.6	3.5
terpinen-4-ol	0.4	0.4	0.8	1.3	0.6
α -terpineol	0.2	0.1	0.1	0.2	0.2
myrtenol	0.1	0.1	t	-	-
isobornyl acetate*	0.2	0.1	0.2	0.3	0.6
α -cubebene	-	0.1	0.1	t	0.1
α -copaene	-	0.1	0.1	t	0.2
β -bourbonene	-	t	t	t	0.1
β -caryophyllene	10.5	10.6	4.9	3.6	7.3
β -cedrene	-	0.1	0.1	t	0.2
trans- α -bergamotene	0.1	0.1	t	0.1	0.6
α -humulene	8.2	9.2	8.7	12.1	11.6
γ -gurjunene	0.1	0.1	t	-	t
γ -muurolene	t	0.3	0.4	0.2	0.4
germacrene D	t	0.1	0.1	t	t
γ -elemene*	0.1	0.1	0.1	0.1	0.5
γ -cadinene	t	0.1	0.2	0.1	0.2
δ -cadinene	t	0.4	0.4	0.2	0.5
α -calacorene	-	-	-	-	0.1
spathulenol	-	-	-	-	0.1
caryophyllene oxide	0.5	0.3	t	-	0.5
globulol**	10.4	8.1	6.4	10.0	2.6
citronellyl propionate*	0.6	0.4	0.3	0.1	0.6
(Z)- α -santalyl acetate	-	t	t	t	0.1
manool	2.6	2.2	1.4	2.1	1.8

1 = vegetative stage oil

2 = bud stage oil

3 = flowering stage oil

4 = immature fruit stage oil

5 = mature fruit stage oil

t = trace (<0.1%)

* incorrect identification based on GC elution order

** incorrect identification, should be viridiflorol

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T-6. Percentage composition of oils of various cultivars of *Salvia officinalis*

Compound	1	2	3	4
α-pinene	1.6	1.6	3.5	3.7
camphene	0.6	2.1	4.7	4.7
β-pinene	10.1	4.7	10.3	11.0
limonene	0.4	t	0.4	0.3
1,8-cineole	9.3	0.7	0.8	2.1
α-thujone	13.3	8.8	13.2	12.7
β-thujone	2.5	1.7	2.2	1.7
camphor	7.5	12.1	9.5	12.5
pinocamphone	0.3	1.2	1.8	1.3
borneol	0.2	1.3	2.8	7.7
β-caryophyllene	7.3	2.4	2.0	1.3
α-humulene	14.9	36.9	23.8	13.8
γ-muurolene	3.7	1.6	1.0	1.4
δ-cadinene	4.9	3.2	2.2	2.2
ledol*	4.8	5.3	2.9	0.7

t = trace (<0.1%)

* incorrect identification; should be viridiflorol

T-7. Comparative percentage composition of sage oil produced from plants harvested in four different months

Compound	June oil	July oil	August oil	September oil
α-pinene	1.3	3.3	1.7	2.9
camphene	1.9	2.7	2.6	4.4
β-pinene	2.3	2.8	1.6	1.7
limonene	1.0	1.3	1.5	1.6
1,8-cineole	13.9	20.4	17.2	19.9
γ-terpinene	0.6	0.4	0.4	0.5
p-cymene	0.4	0.4	0.4	0.4
α-thujone	13.8	14.2	22.0	21.8
β-thujone	9.3	9.2	9.3	7.1
linalool	0.4	0.5	0.2	0.3
camphor	20.7	23.7	26.1	23.7
β-caryophyllene	9.2	4.1	2.6	2.3
α-terpineol	0.8	1.0	0.6	0.6
borneol	2.0	4.0	2.1	2.0
carvacrol	3.2	1.2	0.5	1.7

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Leleshwa, or Wild African Sage Oil

Wild African sage is a member of the Asteracea family whose leaves give off a highly aromatic camphorlike scent. The plant is known botanically as *Tarchonanthus camphoratus* L. (syn. *T. abyssinicus* Sch. Bip., *T. camphoratus* var. *litakunensis* (DC.) Harv., *T. minor* Less., *T. litakunensis* DC.).

Tarchonanthus camphoratus is a hardy perennial, evergreen, much-branched, narrow-crowned, semi-deciduous, dioecious shrub or small tree that can grow to 9 m, but is usually 2–6 m in height. The shrubby tree is native to Angola, Botswana, Ethiopia, Kenya, Lesotho, Namibia, Somalia, South Africa, Tanzania, Uganda and Zimbabwe. It is known as ‘Vaalbos,’ or ‘Widekamferbos’ (Afrikaans), ‘Mkalambati’ (Swahili), ‘Amathola’ (Zulu) and ‘Leleshwa’ (Masai). The etiology of the name *Tarchonanthus* is derived from the Greek words ‘Tarchos,’ meaning funeral rites, and ‘Anthos,’ meaning flower; the combination’s meaning, then, is ‘funeral flower’ (Jackson, 1990). Obviously, the epithet *camphoratus* was used by Linnaeus because of the camphoraceous smell of the crushed leaves.

Tarchonanthus camphoratus, which can be found growing both in large uniform groups or in secondary deciduous land often associated with *Acacia* species, is commonly encountered in savanna regions across its distribution range.

T-8. Volatile components characterized in sage oil

Compound	Percent range	Reference
Monoterpene hydrocarbons		
(Z)-salvene ^a	t–1.7	5,8,10–12,16,18,23,36
(E)-salvene ^a	t–0.9	5,8,10–12,16,18,31,36
tricyclene	t–0.6	8–12,17,18,21,23,33,35–37
α-thujene	t–2.8	8,9,11–13,18,21,23,28,33–36,41,44
α-pinene	0.2–7.0	1,3–14,16–23,25–41,44,45
camphene	t–10.3	1,3–14,16–23,25–37,39–41,43–45
sabinene	t–7.0	5,8,9,11,12,17,18,22,23,28,29,33–36
β-pinene	0.1–17.9	1,3–41,43–45
α-phellandrene	t–0.3	8–11,16,18,22,23,27,35,36
α-terpinene	t–0.8	8,9–13,17,18,22–29,31–37,41
myrcene	t–2.5	1,4,5,7–14,17–19,21–23,27–29,31–41
p-cymene	t–1.9	1,7–18,21,23,27,29,31–37,39,40,45
o-cymene [†]	t	36
limonene	t–4.2	1,5,8,11–13,18,20–23,26–31,33–35,41
δ-3-carene [†]	t	35
(Z)-β-ocimene	0–5.7	8–10,13,18,22,23,26,34–37,41
(E)-β-ocimene	t–2.0	5,8,9,13,17,18,21,22,31,35–37,41,44
γ-terpinene	t–1.7	5,7,10–13,16,18,19,21–23,27–29,31–37,40,41
terpinolene	0–0.9	8–13,16–18,22,23,27,28,31,33–37,41
α-fenchene	t	18,35
β-fenchene	t	18
δ-3-carene	t–0.6	4,12,18,19
β-phellandrene	0–0.7	4,18,22
p-cymenene	t–0.2	12,14,21,39
allo-ocimene [*]	t	9
o-cymene [†]	0–0.2	26
verbenene ^{††}	1.6	12
δ-terpinene ^{†††}	0.1	16
β-terpinene ^{†††}	0–0.2	34
Sesquiterpene hydrocarbons		
α-copaene	t–0.9	8–11,17,18,21,27,31,34,35,45
β-copaene	t–1.1	37
β-bourbonene	t–0.3	8,9,17,23,27,32,35,36,40
isocaryophyllene	t–0.1	10,27
β-caryophyllene	0.3–16.0	1,2,4,23–37,39,40,41,45
α-humulene	0.8–36.9	1,2,4–19,21–37,39,42,44,45
aromadendrene	t–1.6	8–10,13,14,16,18,19,24,27,33–36,39
allo-aromadendrene	t–0.7	8–10,13,23,24,26,27,39,41
α-amorphene	0–0.2	22
trans-α-bergamotene	0–0.6	17
bergamotene [*]	0–0.2	14
(Z)-α-bisabolene [†]	0–0.9	26
β-bisabolene [†]	0–0.4	14,26,39
(E)-γ-bisabolene [†]	t–0.2	13
α-bourbonene [†]	0–0.1	22
α-amorphene [†]	0–0.4	22,35
β-cadinene ^{††}	0.1	16
α-cadinene	t–0.2	27
γ-cadinene	t–4.9	8,10,13,14,16,17,23,27,28,33,35–37,39
cadina-1,4-diene	t–0.2	27
δ-cadinene	t–4.9	8,10,13,17–19,21–24,27–29,31,34,35–37
α-calacorene	0–0.4	10,13,17,27

T-8. Volatile components characterized in sage oil (continued)

Compound	Percent range	Reference
<i>trans</i> -calamenene	0.1–0.2	13
<i>cis</i> -calamenene	0–0.1	27
β -cedrene	0–0.2	17
β -cubebene [†]	t–0.2	35,36
α -cubebene [†]	t–0.7	8,9,17,23,27,31,33–35,37
α -guaiene [†]	0–0.1	27,36
β -elemene	0–3.7	18,32,40,45
γ -elemene [†]	0.8	14,39
δ -elemene	t–0.1	8,13
(E,E)- α -farnesene	0–2.5	16,18,26
germacrene D	t–0.2	8,17,22,27,32,36,40,45
α -gurjunene [†]	t–0.1	9,27
β -gurjunene [†]	t–0.3	9,27
γ -gurjunene [†]	0–1.2	17,27,33
δ -gurjunene ^{††}	8.2	25
isocaryophyllene	t	10
ledene [†]	0–2.5	7,34,36
longifolene ^{††}	0–0.8	26
α -muurolene	0–4.3	8,13,22,27,35
γ -muurolene	t–2.0	9,10,13,14,21,23,27,31,34,37,39
α -selinene	t–0.5	8
γ -selinene [†]	4.5	43
β -selinene	0–0.1	10,14,27,36,39
β -sesquiphellandrene	0–0.1	22
valencene [†]	0.2–0.3	9,16
viridiflorene	0–1.5	10,27
α -ylangene [†]	0–0.6	8,27
<i>cis</i> - β -guaiene	t–0.4	27
Monoterpene alcohols		
borneol	0.2–13.4	4,5,7–14,16–32,34–37,39–41,43–45
terpinen-4-ol	t–2.3	5–10,12–14,16–19,21,23,26–29,31,35–37,39,44
α -terpineol	t–0.5	4,7–12,14,17–19,21,23,26–29,31,35–37,39,44
myrtenol	t–1.0	7,9,10,12,13,17,19,21,24,27,35,36
linalool	t–11.5	5,7,11,13,17,18,20–22,26,31,36,37,44,45
<i>cis</i> -sabinene hydrate	t–0.5	9,18,21,23,35,36,41
<i>trans</i> -sabinene hydrate	t–0.5	16–18,21,23,26,35
p-cymen-8-ol	t–0.1	9,23,27,29,35
α -fenchyl alcohol	t–0.2	18
terpinen-1-ol [†]	0.3–1.0	4,11
nerol ^{††}	t–0.2	44
<i>trans</i> -sabinol	0–t	18
<i>cis</i> -carveol	0.1–2.9	34
<i>trans</i> -carveol	0–0.2	10,19,27,35
isopulegol ^{††}	0.2	12
p-cymen-7-ol	t–0.1	27
thujol [†]	0–t	9
neomenthol ^{††}	0.7	26
Sesquiterpene alcohols		
viridiflorol	0.1–26.1	6–13,16,18–22,24,26–29,31–37,40,44
spathulenol	0.1–0.9	9,14,17,26,27,32,39,40

It possesses gray-green leaves that are densely covered with white-gray tomentum on their underside. Traditionally, the leaves, which are often referred to as 'Bushman's tobacco,' have been used for medicinal purposes. More recently, the oil has been used in cosmetic preparations (Van Wyk and Van Wyk, 1997).

Rovesti (1956) reported that the oil of *T. camphoratus* varied in composition from February to August from plants collected in Abyssinia (Ethiopia). He identified L-camphene and L-camphor in the oil, the latter of which varied from 1.1–8.4%.

An oil of *T. camphoratus*, which was produced by hydrodistillation from leaves collected in the vicinity of Naivasha (Rift Valley Province, Kenya) was the subject of analysis by Mwangi et al. (1994). Using a combination of GC-FID and GC/MS, the oil was found to have the following constituents:

α -pinene (5.4%)
 α -thujene (0.3%)
 α -fenchene (0.3%)
camphene (0.9%)
 δ -2-carene (1.1%)
 α -terpinene (0.3%)
limonene (0.7%)
1,8-cineole (16.5%)
 γ -terpinene (0.6%)
p-cymene (1.6%)
terpinolene (0.4%)
fenchone (0.4%)
trans-sabinene hydrate (0.2%)
 α -fenchyl acetate (0.8%)
camphor (0.4%)
trans-pinan-2-ol (4.1%)
trans-p-menth-2-en-1-ol (0.4%)
 α -fenchyl alcohol (29.1%)
terpinen-4-ol (4.4%)
myrtenal (0.1%)
cis-p-menth-2-en-1-ol (0.1%)
allo-aromadendrene (1.2%)
 γ -curcumene (0.3%)
 α -terpineol (8.5%)
ar-curcumene (3.4%)
trans-calamenene (0.1%)
p-cymen-8-ol (1.0%)
caryophyllene oxide (1.6%)
epi-cubenol (0.6%)
10-epi- γ -eudesmol (0.6%)
spathulenol (0.7%)
 β -bisabolol (0.5%)
T-cadinol (1.3%)
ar-turmerol (0.5%)
 α -eudesmol + unknown (0.1%)
 β -eudesmol (4.2%)
 α -cadinol (1.0%)

In addition, trace amounts (<0.05%) of dehydro-1,8-cineole, α -cubebene,

α -copaene, β -bourbonene, italicene, β -caryophyllene, *trans*-pinocarveol, *cis*-verbenol, δ -terpineol, *trans*-verbenol, α -muurolene, *cis*-piperitol, δ -cadinene, myrtenol, *trans*-carveol, α calacorene isomer, viridiflorol, a humulene epoxide isomer, cubenol and T-muurolol were also characterized in this oil.

Kiplimo (2007) analyzed an oil of *T. camphoratus* as a thesis project at Egerton University (Nakuru, Rift Valley Province, Kenya). Matasyoh et al. (2007) reported the data from the Kiplimo thesis and determined the antimicrobial activity of the oil, which was produced by hydro-distillation from leaves collected from the Botanic Garden associated with Egerton University. The composition of the oil, which was determined by a combination GC-FID and GC/MS, contained the following constituents:

α -thujene (0.2%)
 α -pinene (6.9%)
 camphene (3.8%)
 sabinene (0.3%)
 β -pinene (2.0%)
 δ -2-carene (0.9%)
 α -phellandrene (0.5%)
 α -terpinene (0.5%)
 p-cymene (1.3%)
 limonene (1.2%)
 1,8-cineole (14.3%)
 γ -terpinene (1.0%)
trans-sabinene hydrate (0.6%)
 terpinolene (1.0%)
 fenchone (0.9%)
 β -terpineol* (0.4%)
 nonanal (0.5%)
 α -fenchyl alcohol (15.9%)
trans-pinan-2-ol^a (6.5%)
trans-pinocarveol (0.4%)
 terpinen-1-ol (0.4%)
trans-verbenol (0.4%)
 exo-methyl camphenilol (0.7%)
 borneol (2.3%)
 terpinen-4-ol (4.7%)
 α -terpineol (13.2%)
 α -fenchyl acetate (0.2%)
 α -copaene (0.3%)
 β -caryophyllene (0.6%)
 aromadendrene (0.5%)
 γ -curcumene (2.2%)
 ar-curcumene (1.7%)
 valencene (0.2%)
 γ -cadinene (0.3%)
 δ -cadinene (0.7%)
 caryophyllene oxide (0.8%)
 α -cadinol (1.8%)
 β -eudesmol (5.8%)

A lab-distilled oil in 0.10% yield was determined by Van Vuuren (2007) using

T-8. Volatile components characterized in sage oil (continued)

Compound	Percent range	Reference
(Z)- α - <i>trans</i> -bergamotol	0.3–0.8	13
epi- α -bisabolol ^{††}	0.7–3.8	13
β -bisabolol [†]	0.2–0.7	13
caryophylla-4(12),8(13)-dien-5 β -ol	t–0.9	10,12
14-hydroxy-9-epi- β -caryophyllene	t–0.9	10,12
caryophyllenol*	0–0.4	10,26
elemol ^{††}	3.6–4.5	7
α -eudesmol	0–t	10
β -eudesmol	0–t	10
palustrol	0–0.9	34
(Z,E)-farnesol [†]	0.9–2.3	13
(Z,Z)-farnesol [†]	0.1–0.3	13
<i>trans</i> -ferruginol [†]	t–0.4	10
guaiol ^{††}	3.3	12
ledol ^b	0.6–5.3	14,26,30,34,39
(Z)-lanceol [†]	0.1–0.4	13,24
α -santalol [†]	0.3	12,16
(E)-sesquilandulol ^{††}	0–5.0	22
<i>cis</i> -sesquisabinene hydrate	t–0.1	27
(E)-sesquilandulol ^{††}	0–5.0	22
Diterpene alcohols		
manool	0.2–17.2	6–8,10,12,14,16–18,21,23,31,32,35,39,41,44
sclareol	0.1–8.5	13,26,34,39
Monoterpene esters		
bornyl acetate	t–5.0	1,4,5,7–14,16,18,19,21–24,26,29,31,33–37,39,43–45
linalyl acetate	0–0.8	1,13,18,19,24,44
α -fenchyl acetate	0–1.2	13,18
neryl acetate	t–0.1	8,10
<i>cis</i> -sabinyl acetate	t–0.6	10,23
<i>trans</i> -sabinyl acetate	0–0.2	27
dihydrolinalyl acetate ^{†††}	0–0.1	27
menthyl acetate [†]	0.5	32,40
myrtenyl acetate	1.6–3.0	34
geranyl acetate	t–0.3	8,19
<i>trans</i> -carvyl acetate	t	8
<i>cis</i> -carvyl acetate	t–0.1	8
myrtenyl acetate	t	9
isobornyl acetate ^{††}	0.1–1.2	17,32,40
geranyl formate [†]	0–t	10
geranyl propionate [†]	0–t	8
citronellyl propionate ^{††}	1.2	16
isobornyl acetate ^{††}	0.1–1.2	17,32,40
Sesquiterpene esters		
(E)- α - <i>trans</i> -bergamotol acetate	0–0.4	8,13
caryophyllene acetate [†]	0.1–0.2	13
(Z,E)-farnesyl acetate [†]	0.1–0.3	13
(Z)- α -santalyl acetate ^{††}	0–0.1	17

T-8. Volatile components characterized in sage oil (continued)

Compound	Percent range	Reference
Monoterpene ketones		
α -thujone	0.3–59.8	1–45
β -thujone	0.3–40.1	1–45
camphor	0.2–29.1	1–38,40–45
pinocamphone	t–2.0	8,10,12,13,23,27,34,35
isopinocamphone	t–3.4	8–10,16,21,23,34,35,36,41
fenchone	t–0.2	8,18
pinocarvone [†]	0.4	36
carvone [†]	t	14,39
dehydrosabinaketone ^{††}	0–0.3	24
piperitone	0.3	32,40
Aliphatic compounds		
decane	t–0.1	8
undecane	t–0.2	8
tetradecane	0.1	8
hexadecane	1.1	14,39
pentadecane	0.4	26
eicosane	2.0	26
hexanal	0–t	4
(E)-2-hexenal	0–0.7	4
(Z)-3-hexenol	0–t	4
3-octanol	t–0.2	9,13,35
1-octen-3-ol	0.2–0.4	9,35,36
3-octanone	t–0.1	9,35
2-ethylhexanoic acid ^{††}	0.1–0.2	13
Miscellaneous compounds		
1,8-cineole	0.1–43.6	1,3–32,34–45
<i>cis</i> -linalool oxide (furanoid)	t–0.1	8,9,23
α -campholenal	0–2.2	8,9,17,35,44
myrtenal	0–0.2	23,35
benzaldehyde [†]	t	35
phenylacetaldehyde [†]	t–0.4	10,35
caryophyllene oxide	0.1–1.7	9,10,12,13,16–18,21–23,26–29,31–35
α -bisabolol oxide A [†]	0.4–0.5	32,40
humulene epoxide II	0–3.1	8–10,12,18,23,24,29,31,32,37,40
epoxy-allo-aromadendrene [†]	2.2	32
8,14-cedrene oxide ^{††}	0–0.3	24
α -bisabolol oxide B [†]	0.4–1.0	32,40
allo-aromadendrene epoxide [†]	2.2	40
humuladienone ^{††}	1.4–3.0	19
lyral ^{††}	0.1	12
carvacrol	t–0.8	9,10,12–14,24,27,35,36,39
thymol	0–0.2	9,12,24,27
methyl thymol	t	32,40
eugenol	0–0.2	10,12–14,27,35
naphthalene [†]	0.9	36

* correct isomer not identified

[†] identification requires corroboration

^{††} incorrect identification

^{†††} does not occur naturally

^a also known as 2-methyl-3-methylenehept-5-ene

^b should be viridiflorol

GC/MS only to contain the following constituents (that are listed in elution order from a polar capillary column):

α -pinene (3.9%)
 α -thujene (0.1%)
camphene (1.7%)
 β -pinene (1.0%)
 δ -2-carene (4.1%)
 α -phellandrene (1.0%)
 α -terpinene (0.1%)
limonene (1.8%)
1,8-cineole (9.3%)
(Z)- β -ocimene (0.1%)
 γ -terpinene (0.1%)
p-cymene (2.1%)
terpinolene (0.1%)
(Z)-3-hexenyl acetate (0.3%)
hexanol (0.4%)
(Z)-3-hexenol (0.3%)
nonanal (0.1%)
(Z)-2-hexenol (0.1%)
 α -cubebene (0.1%)
 α -ylangene (0.4%)
 α -copaene (1.2%)
 β -bourbonene (0.5%)
 α -gurjunene (0.1%)
linalool (0.8%)
 β -ylangene (0.8%)
 β -copaene (1.2%)
terpinen-4-ol (0.7%)
 β -caryophyllene (13.4%)
guaia-6,9-diene (0.2%)
aromadendrene (0.2%)
 γ -gurjunene (0.1%)
allo-aromadendrene (3.4%)
epi-zonarene (0.3%)
 α -humulene (1.1%)
 γ -muurolene (3.2%)
 α -terpineol (1.0%)
ledene (0.2%)
borneol (0.1%)
 γ -guaiene (0.1%)
zonarene (1.3%)
 α -muurolene (1.6%)
valencene (0.7%)
 α -selinene (0.1%)
bicyclogermacrene (0.2)
 δ -cadinene (5.1%)
 γ -cadinene (2.0%)
cadin-1,4-diene (0.4%)
 α -cadinene (0.6%)
cis-calamenene (1.5%)
p-cymen-8-ol (0.1%)
 α -calacorene (0.5%)
palustrol (0.2%)
isocaryophyllene oxide (0.1%)
caryophyllene oxide (2.2%)
maaliol (0.1%)
perillyl alcohol (0.1%)
epi-globulol (0.1%)
salvia-4(14)-en-1-one (0.2%)
ledol (0.5%)
13-tetradecanolide (0.1%)
humulene epoxide II (0.1%)

caryophylla-2(12),6(13)-dien-5-one (0.1%)
 cubenol (1.1%)
 1-epi-cubenol (1.8%)
 gollbulol (1.1%)
 viridiflorol (0.5%)
 rosifoliol (0.6%)
 spathulenol (0.7%)
 neointermedeol (0.2%)
 6-epi-cubenol (0.1%)
 1,10-di-epi-cubenol (0.8%)
 T-cadinol (2.6%)
 T-muurolool (2.0%)
 α -muurolool (1.0%)
trans- α -bergamotol (0.3%)
 α -cadinol (4.3%)
 intermedeol (0.1%)
 4-(4'-methyl-3'-pentyl)-3-cyclohexenyl-propylketone (0.1%)
 alismol (0.1%)
 selin-11-en-4 α -ol (0.2%)
 caryophylla-2(12),6(13)-dien-5 β -ol (0.2%)
 carhyophylla-2(12),6(13)-dien-5 α -ol (0.8%)
 caryophylla-2(12),6-dien-5 α -ol (0.4%)
 10-hydroxy-calamenene (0.3%)
 eudesma-4(15),7-dien-1 β -ol (0.3%)
 caryophylla-2(12),6-dien-5 β -ol (0.1%)
 phytol (0.6%)

Trace amounts (<0.01%) of (E)- β -ocimene, fenchone, the furanoid form of *trans*-linalool oxide, isodene, α -bourbonene, β -maaliene, *trans*-p-menth-2-en-1-ol, cadina-1,5-diene, δ -terpineol and β -calacorene, while cuban-11-ol (0.4%) was only tentatively characterized in this oil.

A commercial oil of *T. camphoratus* of Kenyan origin was analyzed by Costa et al. (2008). The components characterized in the oil by GC-FID and GC/MS were as follows:

bornylene (0.1%)
 α -thujene (0.2%)
 α -pinene (14.7%)
 α -fenchene + camphene (7.2%)
 thuja-2,4(10)-diene (0.1%)
 sabinene (0.4%)
 β -pinene (3.8%)
 myrcene (0.2%)
 δ -2-carene (2.8%)
 α -phellandrene + δ -3-carene (1.1%)
 α -terpinene (0.6%)
 p-cymene (1.8%)
 limonene (1.7%)
 1,8-cineole (14.8%)
 γ -terpinene (1.1%)
cis-sabinene hydrate (0.2%)
 terpinolene (1.0%)
 fenchone (0.9%)
 linalool (0.1%)
trans-sabinene hydrate (0.1%)
 nonanal (0.1%)
 α -fenchyl alcohol (10.8%)

cis-p-menth-2-en-1-ol + *trans*-pinan-2-ol (3.2%)
trans-pinocarveol (0.3%)
trans-verbenol (0.2%)
 camphene hydrate (0.4%)
 δ -terpineol + borneol (0.3%)
 isopinocampone (0.1%)
 terpinen-4-ol (2.0%)
 p-cymen-8-ol (0.1%)
 α -terpineol (4.3%)
 verbenone (0.1%)
trans-piperitol (0.1%)
 α -fenchyl acetate (1.6%)
 α -copaene (0.3%)
 β -bourbonene (0.1%)
 7-epi-sesquithujene (0.1%)
 italicene (0.2%)
 β -caryophyllene (0.4%)
 calarene^a (0.1%)
 9-epi- β -caryophyllene (0.4%)
 cadina-1(6),4-diene (0.1%)
 γ -curcumene (2.5%)
 ar-curcumene + *trans*- β -bergamotene^t (1.4%)
 β -selinene (0.1%)
 γ -amorphene (0.1%)
 α -selinene (0.1%)
 α -muurolole (0.1%)
 β -curcumene (0.1%)
 γ -cadinene (0.2%)
 δ -cadinene (0.3%)
 ar-turmerol + spathulenol (0.1%)
 caryophyllene oxide (0.1%)
 T-muurolool (0.1%)
 β -eudesmol (0.3%)

^a also known as
^t tentative identification

Trace amounts (<0.05%) of (Z)-3-hexenol, hexanol, heptanal, tricyclene, benzaldehyde, sulcatol, *trans*-pinocampone, myrtenol, cuminaldehyde, carvone, (E)-2-decenal, bornyl acetate, a-cubebene, cyclosativene, β -elemene, α -funebrene, carvone hydrate, *trans*- α -bergamotene, cadina-3,5-diene, α -humulene, β -acoradiene, cadina-1,4-diene, α -cadinene, α -calacorene, α -agarofuran, guaiol, copaborneol, γ -eudesmol, epi-cubenol, intermedeol and α -bisabolol were also characterized in this oil. In addition, bornylene, 2-hydroxy-1,8-cineole and sesquifenchene were only tentatively identified in the oil.

Furthermore, the authors performed chiral analysis on the oil using a 25 m x 0.35 mm x 0.25 mm Megadex DETTBS- β 2,3-di-O-ethyl-6-O-butyl dimethyl-silyl- β -cyclodextrin column and found the following enantiomeric ratios:

(1R,5R)-(-)- α -thujene (79.2%):(1S,5R)-(+)- α -thujene (20.8%)
 (1R,5R)-(+)- α -pinene (34.8%):(1S,5S)-(-)- α -pinene (65.2%)

(1R,5R)-(+)- α -sabinene (11.7%):(1S,5S)-(-)-sabinene (88.3%)
 (1R,5R)-(-)- α -thujene (79.2%):(1S,5R)-(+)- α -thujene (20.8%)
 (5R)-(-)- α -phellandrene (99.2%):(5S)-(+)- α -phellandrene (0.8%)
 (4S)-(-)-limonene (23.5%):(4R)-(+)-limonene (76.5%)
 (3R)-(-)-linalool (93.4%):(3S)-(+)-linalool (6.6%)
 (1S)-(+)-terpinen-4-ol (13.6%):(1R)-(-)-terpinen-4-ol (86.4%)
 (1R)-(+)- α -terpineol (99.2%):(1S)-(-)- α -terpineol (0.8%)
 (1R,8aS)-(-)- δ -cadinene (19.3%):(1S,8aR)-(+)- δ -cadinene (80.7%)

Finally, based on the odor descriptions, their intensity and the quantitative levels of the constituents found in this oil, it would appear that the main contributors to its overall camphoraceous aroma were the three major components α -pinene, 1,8-cineole and α -fenchyl alcohol.

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