

## Study of Volatile Components of *Acacia farnesiana* Willd. Flowers

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**Abstract:** The chemical composition of the essential oil and the absolute of five populations of *Acacia farnesiana*, cultivated in Greece, have been investigated. The saturated hydrocarbons tricosane, nonadecane and heneicosane, along with methyl salicylate, characterized the chemical analysis of the essential oils and the absolutes, while hexadecanoic acid and  $\alpha$ -amyrine were important constituents of some absolutes.

**Keywords:** *Acacia* sp.; essential oil; absolutes; cultivated. © 2017 ACG Publications. All rights reserved.

### 1. Plant Source

Five populations (Acfa1-5) of *A. farnesiana* (inflorescences) were collected from random locations in county Attiki (November 2009). All vouchers of the examined material are deposited in the Herbarium of Athens University (ATHU).

### 2. Previous Studies

Genus *Acacia* (Leguminosae) comprises of more than 1200 species that grow in temperate and tropical regions, 10 of which are found in Europe [1]. *Acacia farnesiana* Willd. (common name Gazia) is a perennial, deciduous shrub, with American origin, but it grows wildly in many tropical and warm countries [2]. Its main use is in perfumery; however it has been widely used in folk medicine. Its flowers have antispasmodic, aphrodisiac, antipyretic and stimulant action, whereas its bark possesses emollient and astringent properties. The fruits and roots of *A. farnesiana* have been used in the treatment of various diseases such as dysentery, skin inflammations, conjunctivitis and tuberculosis [3].

### 3. Present Study

The present study aims at the investigation of the essential oil and the absolutes of inflorescences from various samples of *A. farnesiana* cultivated in Greece. A total of 106 components were identified, constituting the 90.1-99.9% of the total oils and absolutes. The composition of the studied essential oils and absolutes is reported in Table 1 according to the order of their elution on the HP-5 MS column (see supporting information).

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**Table 1.** Chemical composition (%) of essential oils (ACFA-EO) and “absolute” of *Acacia farnesiana* flowers.

Constituents	RI <sup>c</sup>	RI <sub>exp</sub>	Acfa-EO <sup>a</sup>					Acfa-abs <sup>b</sup>				
			1	2	3	4	5	1	2	3	4	5
(2E)-Hexenal	846	852	0.1	t	t	t	-	t	-	-	-	t
Hexanol	863	889	t	t	t	t	t	-	-	-	-	-
Nonane	900	900	t	t	t	t	t	-	-	-	-	-
Heptanal	902	901	t	-	-	-	t	-	-	-	-	-
(2E)-Heptenal	947	959	t	t	t	t	t	-	-	-	-	-
Benzaldehyde	952	960	t	t	t	t	t	1.4	t	t	t	t
Hexanoic acid	967	972	-	-	-	-	-	t	-	-	t	t
1-Octen-3-ol	974	976	t	t	t	t	t	-	-	-	-	-
6-Methyl-5-hepten-2-one	981	984	0.1	t	t	t	t	-	-	-	-	-
2-Amylfuran	984	986	t	t	t	t	t	-	-	-	-	-
Octanal	998	995	-	-	-	t	-	-	-	-	-	-
(2E,4E)-Heptadienal	1005	1005	t	t	t	t	t	-	-	-	-	-
(2E)-Hexenoic acid	1005	1006	-	-	-	-	-	t	-	-	t	t
1-p-Menthene	1021	1023	0.2	t	t	t	-	-	-	-	-	-
Limonene	1024	1026	t	t	t	t	-	-	-	-	-	-
Benzyl alcohol	1026	1029	t	t	t	-	t	2.2	2.8	5.3	2.5	6.5
Benzene acetaldehyde	1036	1040	-	-	-	-	-	t	-	-	-	t
(E)-β-Ocimene	1044	1048	t	-	t	-	-	-	-	-	-	-
(2E)-Octen-1-al	1049	1061	t	t	t	t	-	-	-	-	-	-
(2E)-Octen-1-ol	1060	1063	-	t	t	t	-	-	-	-	-	-
2-Nonanone	1087	1088	t	-	-	-	-	-	-	-	-	-
Linalool	1095	1094	0.2	t	0.5	t	0.3	t	-	-	t	t
Nonanal	1100	1100	0.7	0.6	t	0.4	t	t	-	-	t	t
Camphor	1141	1144	t	t	-	-	-	-	-	-	-	-
(2E,6Z)-Nonadienal	1150	1152	t	t	t	t	t	t	t	-	t	t
(2E)-Nonen-1-al	1157	1159	-	t	t	t	t	t	t	-	-	t
Benzyl acetate	1157	1161	0.9	t	0.8	t	t	t	t	t	t	t
Nonanol	1165	1165	-	t	-	-	-	-	-	-	-	-
Methyl salicylate	1190	1189	15.2	6.6	20.1	14.8	4.4	5.6	1.9	8.1	4.9	6.5
Decanal	1201	1201	0.6	0.7	0.5	0.6	t	t	-	-	t	t
β-Cyclocitral	1217	1215	0.1	-	t	t	t	-	-	-	-	-
Nerol	1227	1226	t	t	t	t	-	-	-	-	-	-
Neral	1235	1234	-	t	t	-	t	t	-	-	t	t
Chavicol	1247	1248	-	t	t	t	t	1.9	t	t	0.7	t
p-Anis aldehyde	1247	1250	-	-	-	-	-	t	t	t	t	-
Geraniol	1249	1251	1.0	0.6	0.7	0.6	0.5	t	t	t	1.6	t
(2E)-Decenal	1260	1259	-	-	t	-	-	-	-	-	-	-
Geranial	1264	1265	t	t	t	t	t	-	-	-	-	-
Thymol	1289	1287	t	t	-	-	-	-	-	-	-	-
(2E,4Z)-Decadienal	1292	1290	t	t	t	t	t	-	-	-	-	-
(2E,4E)-Decadienal	1315	1313	t	t	-	t	t	-	-	-	-	-
Methyl Geranate	1322	1320	t	t	t	t	t	-	-	-	-	-
Methyl-o-Anisate	1334	1332	t	t	t	t	t	t	t	t	t	t
Citronellyl acetate	1350	1348	t	-	-	-	-	-	-	-	-	-
Eugenol	1356	1355	t	t	t	t	t	t	-	-	t	t
Neryl acetate	1359	1359	0.4	t	0.5	t	t	t	-	-	-	t
Geranyl acetate	1379	1378	2.6	0.3	2.0	1.0	0.3	t	-	-	-	t
Tetradecane	1400	1400	-	t	t	-	-	-	-	-	-	-
Dodecanal	1408	1405	0.1	t	-	-	-	-	-	-	-	-
(E)-α-Ionone	1428	1427	0.4	0.4	0.6	0.4	t	-	-	-	t	t
Dihydro-β-Ionone	1434	1432	0.2	0.5	1.1	1.0	0.8	-	-	-	t	-

Constituents	RI <sup>c</sup>	RI <sub>exp</sub>	Acfa-EO <sup>a</sup>					Acfa-abs <sup>b</sup>				
			1	2	3	4	5	1	2	3	4	5
Geranyl acetone	1453	1452	0,5	-	t	t	t	-	-	-	-	-
( <i>E</i> )- $\beta$ -Farnesene	1454	1456	-	-	t	-	-	-	-	-	-	-
4-Methylpentadecane		1467	0.7	1.5	0.5	1.0	0.4	-	-	-	-	-
Methyl vanillin	1475	1476	-	-	-	-	-	1.3	-	t	t	-
( <i>E</i> )- $\beta$ -Ionone	1487	1485	2.7	0.9	3.9	2.2	0.8	t	t	t	t	t
2-Tridecanone	1495	1494	-	-	t	t	-	-	-	-	-	-
Pentadecane	1500	1500	t	t	t	t	t	-	-	-	-	-
( <i>E,E</i> )- $\alpha$ -Farnesene	1505	1504	t	-	-	-	-	-	-	-	-	-
( <i>E</i> )-Nerolidol	1561	1560	t	-	t	t	t	-	-	-	-	-
Spathulenol	1577	1572	2.4	-	-	-	-	-	-	-	-	-
Ethyl laurate		1595	-	-	-	-	-	-	-	-	t	-
Hexadecane	1600	1600	-	t	t	t	t	-	-	-	t	-
Vanillyl acetone		1694	-	-	-	-	-	0.7	-	t	t	-
2-Pentadecanone	1697	1696	t	t	t	t	t	-	-	-	-	-
Heptadecane	1700	1700	0.2	0.3	t	t	t	t	-	-	t	t
(2 <i>E</i> ,6 <i>Z</i> )-Farnesal	1713	1710	t	0.5	-	-	-	-	-	-	-	-
Tetradecanoic acid		1752	-	-	t	t	-	-	-	-	-	-
Benzyl benzoate	1759	1755	-	-	t	t	-	-	-	-	-	-
Myristic acid		1768	-	-	-	-	-	-	-	-	t	-
1-Octadecene	1789	1797	-	-	-	-	-	-	-	-	t	-
Octadecane	1800	1800	0.1	t	t	t	t	t	-	-	t	t
(2 <i>E</i> ,6 <i>E</i> )-Farnesyl acetate	1845	1844	0.5	-	0.6	t	0.5	-	-	-	-	t
Neophytadiene*		1852	-	-	-	-	-	-	-	t	1.0	1.2
Hexahydrofarnesyl acetate		1856	4.4	8.2	2.2	5.0	3.6	1.5	2.3	-	1.2	-
Nonadecene*		1895	0.1	t	t	t	t	-	-	-	-	-
Nonadecane	1900	1900	13.3	11.0	16.8	11.0	13.5	7.7	10.4	16.3	7.5	28.4
(5 <i>E</i> ,9 <i>E</i> )-Farnesyl acetone	1913	1910	-	t	2.5	t	-	-	-	-	-	-
Methyl hexadecanoate	1921	1915	-	-	-	-	-	t	-	-	t	t
Sandaracopimara-8(14),15-diene	1968	1962	0.3	0.4	t	0.5	t	-	-	-	-	-
Hexadecanoic acid	1959	1975	0.4	1.0	t	0.9	t	5.6	4.3	t	12.1	1.5
Ethyl hexadecanoate	1992	1990	-	-	-	-	-	0.7	t	t	-	1.7
Eicosane	2000	2000	0.8	0.8	1.1	0.8	1.0	1.4	t	t	0.7	1.3
Kaurene	2042	2037	5.3	5.3	3.1	3.0	3.8	t	2.2	t	1.3	2.9
Heneicosane	2100	2100	12.1	12.5	13.9	10.8	14.3	7.0	12.8	17.1	8.3	16.3
Linoleic acid	2132	2130	-	-	t	11.6	-	6.7	-	t	t	t
Oleic acid	2141	2140	-	-	-	4.2	-	8.1	48.2	22.8	7.8	12.7
Ethyl linoleate		2160	-	-	-	-	-	2.7	t	t	-	1.3
Ethyl oleate		2170	-	-	-	-	-	3.2	4.0	8.0	-	7.4
Stearic acid		2180	-	-	-	0.9	-	-	-	-	1.1	-
Docosane	2200	2200	0.9	1.3	1.2	0.9	1.7	t	t	t	0.6	t
Tricosane	2300	2300	14.0	20.2	14.7	12.2	23.8	4.2	8.7	16.4	8.2	8.4
Tetracosane	2400	-	1.1	2.1	1.3	1.0	3.0	t	t	t	0.8	t
Pentacosane	2500	-	6.7	12.3	7.0	4.9	15.7	1.8	2.2	5.9	4.0	2.2
Hexadecanoic acid. phenylmethyl ester		-	-	-	-	-	-	1.6	-	t	0.8	-
Hexacosane	2600	-	0.3	0.5	t	t	0.7	-	-	-	t	-
Heptacosane	2700	-	2.3	4.6	2.0	1.3	5.7	0.7	t	t	2.0	t
Octacosane	2800	-	0.1	0.3	t	t	t	-	-	-	t	-
Squalene		-	-	-	-	-	-	0.6	t	t	1.1	1.6
Nonacosane	2900	-	0.9	2.0	t	0.4	2.0	t	-	-	1.1	-
9,17-Octadecadienal		-	-	-	-	0.5	-	-	-	-	-	-

Constituents	RI <sup>c</sup>	RI <sub>exp</sub>	Acfa-EO <sup>a</sup>					Acfa-abs <sup>b</sup>				
			1	2	3	4	5	1	2	3	4	5
β-Amyrin	-	-	-	-	-	-	-	3.8	t	-	4.9	-
α-Amyrin	-	-	-	-	-	-	-	15.2	t	t	17.5	-
Lanosterol	-	-	-	-	-	-	-	4.5	-	-	3.9	-
<b>Total</b>			<b>92.9</b>	<b>95.4</b>	<b>97.6</b>	<b>91.9</b>	<b>96.8</b>	<b>90.1</b>	<b>99.8</b>	<b>99.9</b>	<b>95.6</b>	<b>99.9</b>
<b>Grouped components</b>												
Hydrocarbons			53.6	69.4	58.5	44.8	81.8	22.8	34.1	55.7	33.2	56.6
Aldehydes			1.5	1.3	0.5	1.0	t	1.4	t	t	t	t
Ketones			0.1	-	-	-	-	-	-	-	-	-
Alcohols			-	-	-	-	-	2.2	2.8	5.3	2.5	6.5
Esters			16.1	6.6	20.9	14.8	4.4	5.6	1.9	8.1	4.9	6.5
Monoterpenes			5.0	0.9	3.7	1.6	1.1	t	t	t	1.6	t
Sesquiterpenes			7.3	8.7	5.3	5.0	4.1	1.5	2.3	-	1.2	t
Diterpenes			5.6	5.7	3.1	3.5	3.8	t	2.2	t	1.3	2.9
Phenylpropane derivatives			t	t	t	t	t	1.9	t	t	0.7	t
Fatty acids & esters			0.4	1.0	t	17.6	t	28.6	56.5	30.8	21.8	24.6
Triterpenes-Steroles			-	-	-	-	-	23.5	t	t	26.3	-
Others			3.3	1.8	5.6	3.6	1.6	2.6	t	t	2.1	2.8

Constituents listed in order of elution from a HP-5 MS column

RI: Retention indices on HP-5 MS column relative to C<sub>9</sub>-C<sub>23</sub> n-alkanes

<sup>a</sup> essential oil, <sup>b</sup> absolute, <sup>c</sup> linear retention indices according to the literature [10], t: trace (<0.1%), -: not detected

\* correct isomer not identified

No significant quantitative or qualitative differences were found among the analyzed samples of essential oils. The experimental data are generally in agreement with literature. The essential oils were characterized by a high proportion of hydrocarbons. Methyl salicylate, a compound with known allergenic, analgesic, anti-inflammatory, antipyretic, cancer protective and carminative properties [4] was one of the dominating compounds. In the samples Acfa2eo and Acfa5eo the amount of methyl salicylate was lower than expected, which was probably due to the collection of these samples after rainfall. Eugenol, a phenylpropane derivative, reported by Demole et al. [5] from Egyptian *A. farnesiana*, was detected in most of the samples. In addition chavicol, another phenylpropane derivative, was identified for the first time. The presence of diterpenes is noteworthy since they have never been reported before from the essential oil of *A. farnesiana*. The diterpene kaurene has been previously detected in the essential oil of another *Acacia* species, *A. rigidula* [6].

Among the analyzed samples of floral absolutes mainly quantitative differences were observed. Experimental data were generally consistent with those of literature. According to previous studies the main components of the 'cassie absolute' were: benzyl alcohol, benzaldehyde, cuminal alcohol, farnesol, cuminal aldehyde, geraniol, geranial, geranyl acetate, α-ionone, β-ionone, linalool, linalyl acetate, nerolidol, α-terpineol, methyl salicylate, nonadecane, myrcene, 3-methyldec-3-en-1-ol, 3-methyldec-4-en-1-ol [5,7,8]. In our samples all the ingredients responsible for the aromatic odor of "cassie absolute" were present with the exception of cuminal alcohol, cuminal aldehyde, nerolidol, α-terpineol, myrcene, 3-methyl-dec-3-en-1-ol and 3-methyl-dec-4-en-1-ol. Methyl salicylate was present in amounts from 1.9 to 8.1%, lower than those cited in the literature. Geraniol was detected only in one sample (Acfa4abs, 1.6%) whereas in all the others it was present in traces. p-Anisaldehyde was found in traces in all samples except that of Acfa5abs, where p-anisaldehyde was not detected at all [9]. Eugenol previously reported by Demole et al. [5], was present in most samples, while chavicol, first time reported, was detected in two samples (Acfa1abs and Acfa4abs, 1.9% and 0.7% respectively). The diterpene kaurene is mentioned for the first time in "cassie absolute" (t-2.9%).

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## Supporting Information

Supporting Information accompanies this paper on <http://www.acgpubs.org/RNP>

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