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CHEMICAL COMPOSITION OF *Callistemon polandii* LEAF AND STEM ESSENTIAL OILS FROM THE PLAINS OF NORTHERN INDIA

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Callistemon (Myrtaceae) was first described by Robert Brown in 1814 as "a genus formed of those species of *Metrosideros* that have inflorescence similar to that of *Melaleuca* and distinct elongated filaments" [1]. Due to this very reason the genus *Callistemon* is commonly known as "Bottle brush" comprised about 30 described species together with at least a further seven undescribed species, all of which are endemic to Australia [2–4]. *Callistemons* (bottle brushes) are shrubs or small trees indigenous to Australia and New Caladonia. Many species grow in moist areas, often by creeks, whereas others are found on rock outcrops and ledges on mountain tops [5]. In India, *Callistemon* spp. were introduced as ornamental plants throughout the country, except in extremely dry and cool places [6]. In India ten species of *Callistemon*, including *C. polandii,* are found [7, 8]. The good looking spikes have made bottle brush a very popular ornamental plant for houses, offices, and gardens and new cultivars and hybrids are constantly being developed [7].

The essential oil of *C. lanceolatus* DC. has been reported to possess fungicidal activity [9, 10]. The oil of *C. lanceolatus* leaf has also been reported to restore the vitellogenin activity of allalectomized *Drysderus koengii* Fabr [11] and possess bee repellent [12] activity. On the other hand, the oil of *C. viminalis* leaf showed *in vitro* anthelmintic activity against earthworms, tapeworms, and hookworms, while an aqueous extract of the flowers and leaves showed antibacterial activity against Gram-positive bacteria [13].

Although the essential oil composition of the genus *Callistemon* from different parts of the world has been studied [5, 7, 8]. However, the leaf and stem essential oil constituents of *C. polandii* from India have not been studied in detail. This prompted us to carry out a detailed GC and GC-MS analysis of *C. polandii* leaf and stem oils from the plains of Northern India.

The essential oils were obtained by conventional hydrodistillation of leaf and stem of *C. polandii* in a Clevenger- type apparatus. Each gave essential oil in 0.008% and 0.004% yield (v/w) on a fresh weight basis. GC and GC/MS analysis of the oils resulted in the identification of a total of 60 and 44 constituents, representing 98.2% and 99.9% of the oils from the leaf and stem, respectively. The relative concentrations of the volatile components identified are presented in Table 1, according to their elution order on a BP-1 column. The major constituents in the leaf oil of *C. polandii* were palmitic acid (25.2%), myristic acid (10.8%), and caryophyllene oxide (9.6%), while the major constituents of the stem oil were palmitic acid (31.7%), caryophyllene oxide (6.4%), myristic acid (5.9%), and 9-hexadecanoic acid (5.6%). On comparing our stem oil results with those of leaf, it was observed that out of 44 and 61 compounds present in stem and leaf oils, respectively, 40 compounds were common in both the oils. The major compounds in both oils were palmitic acid (31.7% and 25.2%), caryophyllene oxide (6.4% and 9.6%), myristic acid (5.9% and 10.8%), and 9-hexadecanoic acid (5.6% and 1.3%) respectively. Thus, palmitic acid and 9-hexadecanoic acid were 1.3 and 4.3 times higher in the stem oil. On the other hand, caryophyllene oxide and tetradecanoic acid were 1.5 and 1.8 times less in stem oil than in leaf oil. Similarly, the compositions of *p*-cymene, tridecanoic acid, phenylethyl-*n*-octanoate, spathulenol, τ-cadinol, terpenyl-*n*-butyrate, α-phellandrene, and cubenol were also very close in stem and leaf oils.

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TABLE 1. Percentage Composition of *C.polandii* Leaf &Stem Essential Oils

Compound	KI	Leaf oil, %	Stem oil, %	Compound	KI	Leaf oil, %	Stem oil, %
α-Pinene	937	2.6	4.4	Dodecanoic acid	1546	1.7	3.0
β-Pinene	972	0.4	0.2	Spathulenol	1566	2.1	2.4
Myrcene	985	-	0.2	Caryophyllene oxide	1573	9.6	6.4
α-Phellandrene	996	1.1	1.2	Globulol	1590	0.4	-
p-Cymene	1012	3.0	3.1	Viridifloral	1596	0.9	1.6
Linalool	1079	0.6	0.4	*n*-Hexadecane	1603	1.2	-
trans-Pinocarveol	1131	0.4	0.2	Humulene epoxide-II	1608	0.2	0.8
Pinocarvone	1149	0.4	0.2	Cubenol	1614	1.0	0.6
Borneol	1162	0.4	0.5	*T*-Cadinol	1624	2.5	2.4
α-Terpeneol	1174	3.0	1.9	1-*epi*-Cubenol	1629	0.5	-
Myrtenol	1190	0.3	-	*epi*-α-Cadinol	1643	3.2	1.5
trans-Carveol	1197	0.5	-	Tridecanoic acid	1657	3.1	2.6
cis-Carveol	1215	0.8	0.5	(*Z,E*)-Farnesol	1692	0.3	-
Carvone	1236	1.0	0.5	*n*-Heptadecane	1700	0.6	0.5
Myrtenyl acetate	1244	1.3	0.5	*epi*-α-Bisabol-1-one	1723	0.3	-
Geranial	1257	0.6	1.1	(*E,Z*)-Farnesol	1737	-	1.5
Geranyl formate	1279	0.6	-	Tetradecanoic acid	1746	10.8	5.9
Sabinyl acetate	1289	0.4	-	*n*-Octadecane	1799	0.7	0.5
Citronellyl acetate	1333	0.3	-	Phenylethyl-*n*-octanoate	1828	3.0	2.5
α-Cubebene	1358	0.4	0.6	*iso*-Propyl myristate	1841	0.6	1.5
Geranyl acetate	1363	0.3	0.7	Pentadecanoic acid	1864	0.2	0.8
Methyl cinnamate	1369	0.3	-	*n*-Nonadecane	1898	0.2	0.9
α-Copaene	1376	0.3	-	9-Hexadecanoic acid	1920	1.3	5.6
β-Caryophyllene	1417	0.8	2.2	Palmitic acid	1949	25.2	31.7
α-Cadinene	1439	0.3	-	Ethyl hexadecanoate	2071	-	0.9
Aromadendrene	1451	0.6	-	Hexadecanol	2079	0.2	1.9
α-Humulene	1458	0.2	0.9	Heniacosane	2098	0.3	-
allo-Aromadendrene	1472	0.3	-	Phytol	2107	0.2	-
Terpenyl-*n*-butyrate	1494	2.0	2.1	Methyl octadecanoate	2120	-	0.5
β-Bisabolene	1514	0.2	0.9	9,12,15-Octadecatrienoic acid, ethyl	2143	1.5	0.6
δ-Cadinene	1523	1.8	-	ester			
α-Cadinene	1539	0.4	-	Octadecanoic acid	2154	0.2	1.0
				Methyl eicosanoate	2305	0.6	-

Note: compounds are listed in order of their elution on BP-1 column.

Apart from the above similarities, there were many differences in the compositions of various constituents of the stem and leaf oils such as α-pinene (4.4% and 2.6%), dodecanoic acid (3.0% and 1.7%), β-caryophyllene (2.2% and 0.8%), hexadecanol (1.9% and 0.2%), viridifloral (1.6% and 0.9%), *iso*-propyl myristate (1.5% and 0.6%), geranial (1.1% and 0.6%), and octadecanoic acid (1.0% and 0.2%), which were about 1.5 to 10 times higher in stem oil than in leaf oil. On the other hand, α-terpeneol (1.9% and 3.0%), *epi*-α-cadinol (1.5% and 3.2%), 9,12,15-octadecatrienoic acid, ethyl ester (0.6% and 1.5%), myrtenyl acetate (0.5% and 1.3%), and carvone (0.5% and 1.0%) were about 1.6 to 3 times less in stem oil than in leaf oil. Apart from the above, (*E,Z*)-farnesol (1.5%) was present only in stem oil, while δ-cadinene (1.8%) and *n*-hexadecene (1.2%) were present in leaf oil only.

On comparing our leaf oil results with those reported by [5, 8], drastic variations in the chemical composition of leaf essential oil was observed. The major constituents reported in [8] were 1,8-cineole (31.9%), myrcene (14.7%), methyl cinnamate (13.0%), and humulene (8.3%), while the major constituents in the leaf oil of *C. polandii* reported in [5] were β-caryophyllene (28.2%), α-humulene (21.7%), and caryophyllene oxide (13.5%). The major constituents of our leaf oil were palmitic acid (25.2%), tetradecanoic acid (10.8%), and caryophyllene oxide (9.6%). From the above observations it appears that *C. polandii* growing in the premise of CIMAP, Lucknow is a different chemotype.

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