SOUTHERN BRAZILIAN JOURNAL OF CHEMISTRY
SOUTH. BRAZ. J. CHEM., Vol. 23, No. 23, 2015

VOLATILE OIL CONSTITUENTS OF THE LEAVES AND WOODS OF *Cedrela odorata* AND *Dalbergia latifolia* FROM SOUTH WEST NIGERIA.

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ABSTRACT

The essential oils from the leaves and woods of *Cedrela odorata* and *Dalbergia latifolia* were obtained by hydrodistillation and characterized by Gas Chromatography-Mass Spectrometry (GC-MS) method. A total of 10, 39, 72, and 6 compounds representing 97.63%, 99.16%, 95.13% and 99.83% were identified in *Cedrela odorata* leaf, wood, *Dalbergia latifolia* leaf and wood respectively. The major components in *Cedrela odorata* leaf are α-copaene (4.40%), α-santalene (4.57%), cubenol (8.71%), β-elemene (23.06%) and (-)-spathulenol (42.49%) while the wood was dominated by γ-eudesmol (8.84%), z-nerolidol (9.23%), β-bisabolol (10.95%), α-curcumene (12.31%) and α-cedrene (17.56%). The leaf essential oil of *Dalbergia latifolia* had in its composition majorly α-bergamotene (4.23%), (-)-spathulenol (4.49%), β-caryophyllene oxide (5.04%), α-selinene (4.89%), 1-heptariacotanol (5.71%) and heptacosane (6.31%) while the wood contained mainly methylcyclohexane (4.93%), hexanal (6.43%), m-xylene (16.71%) and p-xylene (58.8%).

Key words: Volatile oil, Sesquiterpenes, (-)-spathulenol, α-bergamotene, β-elemene

RESUMO

Os oleos essenciais de folhas e madeira de *Cedrela odorata* e *Dalbergia latifolia* foram obtidos atraves de hidrodestilação e caracterizados corn cromatografia gasosa e espectrometria de massa (GC-MS). Um total de 10, 39, 72 e 6 compostos representando 97.63%, 99.16%, 95.13% e 99.83% foram identificados em folhas de madeira de *Cedrela odorata* e folhas de madeira de *Dalbergia latifolia*, respectivamente. Os componentes majoritarios de folhas de *Cedrela odorata* são α-copaeno (4.40%), α-santaleno (4.57%), cubenol (8.71%). β-elemeno (23.06%) e (-) -espatulenol (42.49%). Na madeira prevaleceram γ-eudesmol (8.84%), z-nerolidol (9.23%), β-bisabolol (10.95%), α-curcumeno (12.31%) e α-cedreno (1756%). O óleo essencial de folhas de *Dalbergia latifolia* consistia principalmente de α-bergamoteno (4.23%), (-)-espatulenol (4.49%), óxido de β-carofileno (5.04%), α-selineno (4.89%), 1-heptariaoctanol (5,71%) e heptacosano (6.31%). Na madeira prevaleceram metilciclohexano (4.93%), hexanal (6.43%). m-xileno (16.71%) e p-xileno (58.8%).

PALAVRAS CHAVE: Óleos voláteis, sesquiterpenos, α-bergamoteno, β-elemeno, (-)-espatulenol

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DOI: 10.48141/SBJCHEM.v23.n23.2015.83_revista2015.pdf

INTRODUCTION

Essential oils or volatile oils are a complex mixture of compounds synthesized by living organisms and isolated from different parts of plants. Essential oils differ from plant to plant; though have a number of physical properties in common. A vast majority are known to have medicinal properties (1).

Cedrela odorata L. (Meliaceae) is commonly referred to as Spanish cedar wood, cigar-box tree or Brazilian mahogany. *C. odorata* is a monoecious, deciduous, and medium-sized to large tree up to 40 m tall that arrays from Mexico to South America and the West Indies (2). The tree is known for its red, rot-resistant wood that is used to make furniture, guitars (3) and cigar boxes. The repelling smell of the wood to insects makes it suitable for the making clothing chests and wardrobes. The wood from this tree is among the most sought-after in Latin America and elsewhere as it is resistant to attacks by fungi and insects, and it keeps a pleasant fragrance for many years (4).

The plant is used in traditional medicine; the decoctions of the bark are used as a remedy for wounds, fever, bronchitis, indigestion and other gastrointestinal ailments, vomiting, haermorrage (5). *C. odorata* essential oil has been shown to have anti-microbial activity (2) and the stem extract has been found to possess anti-oxidant activity (6). Kipassa et al., 2008 (7) isolated limonoids from the stem bark. The odour from the essential from *C. odorata* is in resemblance to the odour of cedar-wood and some species of Cyperus oils. It is used mainly for the perfumery of soaps, some types of sprays and disinfectant (8).

The chemical compositions of the essential oils of some parts of *C. odorata* have been investigated and generally, have sesquiterpenoids in abundance (2, 5, 6, 9, and 10). However, there are no comprehensive reports on the essential from the wood of *C. odorata*.

Dalbergia latifolia Roxb. commonly referred to as Indian rosewood or Bombay black belongs to the Fabaceae family. The plant is usually a single stemmed tree with a dome shaped crown of lush green foliage with characteristic smell (11). It is widely distributed in tropical and subtropical regions of Bihar, Bundelkhand and Central India (12). Many *Dalbergia* species are important timber trees which are valued for their decorative and fragrant wood, rich in aromatic oils (13). Traditionally, *D. latifolia* is reported to be used as stimulant, appetizer, anthelmintic, spasmogenic, and also in the cure of dyspepsia, diarrhea, cutaneous affections and leprosy (14). It is also regarded as brain tonic to the nervous system (15). Some parts of the tree are reported to have antioxidant scavenging potential and antibacterial activities (16)**.** Ethanol extracts of *D. latifolia* root neuropharmacological activity as nootropic and also having anxiolytic property, demonstrated in albino rats (17).

Though different phytochemical and pharmacological studies have been done on *D. latifolia*, there are no previous references in literature on the essential oils from parts of the plant.

This paper therefore, presents the comprehensive characterization of the essential oils from the leaves and woods of *C. odorata* as well as *D. latifolia* from South west Nigeria with a view to comparing any existing literature on the four oils.

EXPERIMENTAL

Fresh samples were cut in March, 2014 from mature trees growing at the Botanical garden, University of Ibadan. They were authenticated at the Department of Botany, University of Ibadan by Mr. Donatus and the voucher specimen was deposited at the Forest Research Institute of Nigeria (FRIN) Herbarium with Voucher Number, 110039 and 110038 for *Cedrela odorata* and *Dalbergia latifolia* respectively. The stem-bark was scrapped off the wood; the fresh wood and leaves were chopped into pieces, air-dried and crushed using a fast rotating grinding machine.

Essential oil isolation

The ground samples were subjected to the hydro-distillation method using an all glass Clevenger apparatus according to the *British pharmacopoeia* (18) method for 4 h. The oils were collected in hexane and kept in the refrigerator at 4 ^{o}C until analyses.

Gas chromatography/ Mass spectrometry Analysis

The composition of the essential oils were determined by a Gas Chromatography- Mass spectrometry (GC-MS) using a Agilent 7890N GC Agilent mass detector Triple Quad 7000A in EI mode at 70 eV (m/z range 40 – 600 amu) and an Agilent ChemStation data system. The GC column was equipped with an HP-5MS column (30 m × 250 μm × 0.25 μm) a split-split less injector heated at 200 ^{o}C and a flame ionization detector (FID) at 230 ^{o}C. The oven temperature was programmed as follows; initial temperature 40 ^{O}C for 5 mins increased 5 ^{O}C/min to 180 ^{O}C for 6 mins and then 10 ^{O}C/min to 280 ^{O}C for 12 mins. Helium was the carrier gas used at the flow rate of 1 mL/min. The injection volume was 2 μL (split ratio 1:20).

The components were identified by comparison of their mass spectra with NIST 1998 library data of the GC-MS system as well as by comparison of their retention indices (RI) with relevant literature data (19). The relative amount of each individual component of the essential oil was expressed as the percentage of the peak area relative to the total peak area. RI values of each component were determined relative to the retention times of a homologous n-alkane series with linear interpolation on the HP-5MS column.

RESULTS AND DISCUSSION

The chemical composition of the volatile oils of *C. odorata* leaf, *C. odorata* wood, *D. latifolia* leaf and *D. latifolia* wood are presented in **table 1**. The percentage yields of the oils (w/w) based on dry matter are 0.82%, 0.5%, 0.43% and 0.39% respectively. The four oils had different shades of yellow.

C. odorata leaf oil contained 10 compounds representing 97.63% of the entire oil with predominantly 85.21% sesquiterpenes with 51.65% oxygenated sesquiterpenes and 34.56% sesquiterpene hydrocarbon. The sesquiterpene hydrocarbons present are β-elemene (23.03%), α-bergamotene (4.09%), δ-cadinene (4.13%), α-humulene (2.28%0 while the oxygenated sesquiterpenes are (-)-spathulenol (42.49%), cubenol (8.71%) and germacrene-D-4-ol (0.45%). Monoterpene hydrocarbon in the oil represents 8.97% as characterized by α-santalene (4.57%) and α-copaene (4.4%). The results from this study when compared

with Asekun and Ekundayo, 1999 had some variations. Asekun and Ekundayo (10) characterized 26 compounds which amount to 70.6% of the oil identified with about 30% of the constituents unidentified. Their analyses also had sesquiterpenes as the abundant compound with α-santalene (9.5%), the dominant compound. Similar compounds to both studies are α-copaene, β-elemene, α-santalene, α-bergamotene, α-humulene, and δ-cadinene. Variations in qualitative and quantitative compositions observed from different studies are due to seasonal and maturity variation, geographical origin, genetic variation, growth stages and postharvest drying and storage (20).

The wood of *C.odorata* had 39 compounds amounting to 99.16% of the oil; with 54.92% sesquiterpene hydrocarbon and 37.40% oxygenated sesquiterpene. The remaining 6.84% of the characterized compounds are monoterpenes and non-terpenoid compounds. The abundant sesquiterpene hydrocarbon are α-cedrene 17.56%), α-curcumene (12.3%), α-bergamotene (5.63%), and, β-farnesene (3.89%) while oxygenated sesquiterpenes found in abundance are β-bisabolol (10.95%), z-nerolidol (9.23%), γ-eudesmol (8.84%, α-eudesmol (5.43%). Our study also revealed the presence of α-curcumene, β-bisabolol, juniper camphor, δ-cadinene as observed by Motl and Trka, 1973 (8).

It is notable that the variation in the composition of the leaf and wood essentials presumably because of different parts of the plants where the samples were procured. Common constituents to the oils are α-santalene, α-copaene, β-elemene, α-bergamotene, (-)-spathulenol, and α-humulene. Generally, the result of this study conveniently describes *C. odorata* as a sesquiterpene chemo type thus confirming previous qualitative and quantitative analyses (2, 7, 8, 10).

The leaf oil of *D.latifolia* contained 72 compounds representing 95.13% of the oil with sesquiterpenes hydrocarbons, oxygenated sesquiterpenes and non-terpene compounds. The sesquiterpene hydrocarbon constituted 31.10% of the oil while 12.35% are oxygenated sesquiterpenes and the remaining components non-terpene compounds. The most abundant compounds are α-bergamotene (4.23%, α-selinene (4.89%), β-caryophyllene oxide (5.04%, (-)-spathulenol (4.49%), heptacosane (6.31%, and 1-heptariacotanol (5.7%).

On the other hand, 6 non-terpene compounds were identified in the wood oil of *D. latifolia* representing 95.13% of the entire oil. They are toluene (6.43%), methylcyclohexane (4.93%), ethylbenzene (11.90%), p-xylene (58.80%), m-xylene (16.71%) and allyltetramethoxybenzene (1.06%).

Three of the four essential oils; *C. odorata* leaf, *C odorata* wood and *D. latifolia* leaf had in common (-)-spathulenol, α-bergamotene and β-elemene. These compounds have been found to possess different biological activities (21, 22, 23, 24, 25) and is a lead to explore the bioassay of the oils especially *D. latifolia* whose essential oils have never been the subject of literature discussion.

CONCLUSIONS

This paper provides a comprehensive characterization of the volatile oils from four different oils viz; *C. odorata* (leaf), *C. odorata* (wood), *D. latifolia* (leaf) and *D. latifolia* (wood). It thus gives a vivid comparison of the leaf oil of *C. odorat*a with previously presented studies in literature and has also reported for the first time the characterization of the essential oils of *C. odorata* wood, leaf and wood oils of *D. latifolia*. The identified compounds which have been reported in some literatures to possess different biological activities lend support for the use of the two studied plants in ethno medical practice for various purposes. It is therefore worthwhile to explore the various biological properties of the essential oils with a view to ascertain their bioactivity.

Table 1: Chemical Constituents of The Essential Oils of *Cedrela odorata* and *Dalbergia latifolia* Leaves and Wood.

RI	CONSTITUENTS	COL	COW	DLL	DLW
677	1-Methylpyrrole	-	-	3.22	-
752	3-Methylheptane	-	-	0.09	-
760	Ethylcyclopentane	-	-	0.07	-
781	Methylcyclohexane	0.8	-	2.53	-
794	Toluene	-	-	1.26	6.43
806	Hexanal	-	-	0.12	-
819	2, 4-dimethyl-1-heptane	-	-	0.15	-
842	(z)-1, 3-dimethylcyclohexane	-	-	0.08	-
852	4-methyloctane	-	-	0.13	-
877	Methylcyclohexane	-	-	-	4.93
880	Ethycyclohexane	-	-	0.06	-
887	3,5-dimethyloctane	-	-	0.12	-
893	Ethylbenzene	-	-	1.38	11.9
905	Heptenal	-	-	0.12	-
907	p-Xylene	-	0.22	-	58.8
907	m-Xylene	-	-	-	16.71
969	1-Octen-3-ol	-	-	0.31	-
974	Vinylhexanoate	-	-	0.14	-
986	2,6-dimethylnonane	-	-	0.08	-
1040	2-pentylfuran	-	-	0.51	-
1048	(z)-2-(2-pentenyl)-furan	-	-	0.06	-
1086	2,2,6-trimethylcyclohexanone	-	-	0.17	-
1104	Nonanal	-	-	0.88	-
1112	E-2-Nonenal	-	-	0.36	-
1120	(E,Z)-2,6-Nonadienal	-	-	0.26	-
1179	(+)-dihydrocarvone	-	-	0.07	-
1186	Safranal	-	-	0.06	-
1202	Decanal	-	-	0.12	-
1204	β-Cyclocitral	-	-	0.33	-
1211	α-Santalene	4.57	1.28	1.95	-
1221	α-Copaene	4.40	0.74	1.55	-
1231	Naphthalene	-	-	0.07	-
1281	Isoaromadendrene	-	0.40	-	-
1281	Isoaromadendrene epoxide	-	-	2.21	-
1286	Diepicedrene-1-oxide	-	-	0.90	-
1293	Aristolene epoxide	1.75	-	-	-
1303	2,6,6-trimethyl-1-Cyclohexene -1-acetaldehyde	-	-	0.17	-
1357	2-(2,6,6-trimethy-1-cyclohexen-1-yl) ethanol	-	-	0.66	-
1377	δ-Elemene	-	-	2.38	-

1393	2-butyl-1-octanol	-	-	0.15	-
1398	β-Elemene	23.06	2.08	3.96	-
1400	α-Longipinene	-	0.67	-	-
1403	α-Patchoulene	-	0.95	-	-
1406	(-)-aristolene	-	-	0.20	-
1410	α-Cedrene	-	17.56	-	-
1419	Isoledene	-	-	0.29	-
1424	E-1,10-dimethyl-E-9-decalinol	-	-	1.31	-
1425	Epi-β-Santalene	-	0.33	0.35	-
1429	E-α-Ionone	-	-	0.27	-
1430	α-Bergamotene	4.09	5.63	4.23	-
1431	Elocene	-	1.14	-	-
1440	β-Farnesene	-	3.89	-	-
1446	β-Sesquiphellandrene	-	2.43	-	-
1461	γ-Gurjunene	-	0.90	2.09	-
1462	Aromadendrene oxide-(1)	-	-	0.68	-
1469	δ-Cadinene	4.13	-	2.80	-
1470	β-Eudesmene	-	0.45	3.26	-
1474	α-Selinene	-	-	4.89	-
1480	δ-Guaiene	-	0.54	-	-
1489	Guaia-1(10),11-diene	-	-	0.72	-
1492	Isotridecylalcohol	-	-	0.16	-
1502	2-isopropenyl-4a,8-dimethyl-1,2,3 4,4a,5,6,7-octahydronapthalene	-	-	1.2	-
1507	β-Caryophyllene oxide	-	0.71	5.04	-
1512	Pentadecane	-	-	0.31	-
1522	Elemol	-	1.8	0.28	-
1524	α-Curcumene	-	12.31	1.40	-
1530	Ledol	-	0.41	0.84	-
1531	α-Bisabolene epoxide	-	-	0.14	-
1536	(-)-Spathulenol	42.49	1.12	4.49	-
1543	α-Cedrol	-	1.54	-	-
1547	α-Calacorene	-	-	0.2	-
1559	(E)-Longipinocarveol	-	0.52	-	-
1564	Z-Nerolidol	-	9.23	-	-
1574	Longiverbenone	-	0.22	-	-
1571	α-Caryophyllene	-	-	0.94	-
1579	α-Humulene	2.28	0.24	-	-
1580	Cubenol	8.71	-	-	-
1593	β-Eudesmol	-	-	1.59	-
1598	α-Eudesmol	-	5.43	-	-
1619	β-Bisabolol	-	10.95	-	-
1625	α-Bisabolol	-	2.73	-	-
1626	γ-Eudesmol	-	8.84	-	-
1645	6-isopentyl-4,8a-dimethyl-4a,5,6,7,8,8a-hexahydro-1H-napthalene-2-one		1.32	-	-
1647	Juniper Camphor	-	1.12	-	-
1660	Germacrene-D-4-ol	-	0.45	-	-

1680	Eudesm-7(11)-en-4-ol	-	-	3.87	-
1729	Murolan-3,9(11)-diene-10-peroxy	-	-	0.65	-
1739	Allyltetramethoxybenzene	-	-	-	1.06
1754	Hexahydrofarnesylacetone	-	-	2.19	-
1909	Labda-8(20),12,14-triene	-	0.50	-	-
1968	Hexadecanoic acid	-	0.25	-	-
1997	(9Z)-9,17-Octadecanal	-	0.26	-	-
2045	Phytol	-	-	0.65	-
2072	Cembrene	-	-	0.61	-
2075	Heptacosane	-	-	0.31	-
2228	(Z)-9-Octadecenamide	-	-	0.47	-
2271	Methyldehydroabietate	-	-	0.19	-
2375	Eicosylacetate	-	-	0.75	-
2704	Diisooctylpthalate	-	-	0.6	-
2705	Heptacosane	-	-	6.31	-
2788	p-Cresol,2,2-methylenebis[6-tertbutyl]-	-	5.30	-	-
2804	Octacosane	-	-	3.16	-
2944	Andrographolide	-	1.35	-	-
3942	1-Heptariacotanol	-	-	5.71	-
	Total	**97.63**	**99.16**	**95.13**	**99.83**

COL - *Cedrela odorata* Leaves; COW - *Cedrela odorata* wood; DLL - *Dalbergia latifolia* leaves;
DLW - *Dalbergia latifolia* wood. RI – Retention Indices from present study.

ACKNOWLEDGEMENT

The authors are grateful for the TWAS-UNESCO Associateship awarded to Dr Sherifat A. Aboaba tenable at the H.E.J Research Institute of Chemistry, International Centre for Chemical and Biological Studies, University of Pakistan, Pakistan which provided funding for this research.

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The SOUTHERN BRAZILIAN JOURNAL OF CHEMISTRY (ISSN: 2674-6891; 0104-5431) is an open-access journal since 1993. Journal DOI: 10.48141/SBJCHEM. http://www.sbjchem.com. This text was introduced in this file in 2021 for compliance reasons.