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The wood essential oil composition of *Swietenia macrophylla* from Guanacaste, Costa Rica

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Abstract
The wood essential oil of *Swietenia macrophylla* has been obtained by hydrodistillation and analyzed by gas chromatography – mass spectrometry. The essential oil was composed largely of sesquiterpene hydrocarbons (65.9%) and oxygenated sesquiterpenoids (29.6%). The major components were δ-cadinene (33.0%), α-copaene (7.2%), α-cadinol (7.1%), τ-muurolol (6.1%), and τ-cadinol (4.5%).

Keywords: Big-leaf mahogany, caoba, δ-cadinene, α-copaene, α-cadinol, τ-muurolol, τ-cadinol

1. Introduction

Swietenia macrophylla King (Meliaceae), commonly known as “caoba” or big-leaf mahogany, is one of the most important timber trees of the Neotropics. The species ranges from Mexico to the southern Amazon region of Brazil, but has been introduced to the Philippines, Indonesia, India, Sri Lanka, and Hawaii [1]. Unfortunately, overexploitation and deforestation in its native ranges have led to a severe decline in its populations [2]. This species, along with the related species *S. humilis* Zucc. of the Pacific coast of Central America, and *S. mahogani* (L.) Jacq. of the Caribbean are listed by the Convention on International Trade in Endangered Species (CITES) [3] and the International Union for Conservation of Nature (IUCN) as vulnerable [4]. In addition to lumber, *S. macrophylla* is an important species in traditional medicine and numerous phytochemicals have been characterized from the tree, including limonoids and polyphenolics [5]. To best of our knowledge, there have has been no previous reports on the wood essential oil composition of of this tree, therefore in this work we report the chemical composition of the wood essential oil from the wood of *S. macrophylla* from Costa Rica.

2. Materials and Methods

2.1 Essential Oil

A 500-g sample of *Swietenia macrophylla* wood shavings, obtained from the workshop of Leonardo Vargas Garcia, La Cruz, Abangares, Guanacaste, Costa Rica, was hydrodistilled using a Mountain Home Biological SL-SS 20 L stainless steel essential oil distiller to give the essential oil in 1% (v/w) yield.

2.2 Gas Chromatography – Mass Spectrometry

The wood essential oil of *S. macrophylla* was analyzed by gas chromatography-mass spectrometry (GC-MS) as previously described [6]: Shimadzu GCMS-QP2010 Ultra operated in the electron impact (EI) mode (electron energy = 70 eV), scan range = 40–400 atomic mass units, scan rate = 3.0 scans/s, and GC-MS solution software v. 4.20. The GC column was a ZB-5 fused silica capillary column (30 m length × 0.25 mm internal diameter) with a (5% phenyl)-polymethylsiloxane stationary phase and a film thickness of 0.25 µm. The carrier gas was helium with a column head pressure of 552 kPa and flow rate of 1.37 mL/min. The Injector temperature was 260 °C and the ion source temperature was 260 °C. The GC oven temperature program was programmed for 50 °C initial temperature, temperature increased at a rate of 2 °C/min to 260 °C. A 5% *w/v* solution of the sample in CH2Cl2 was prepared and 0.1 µL was injected with a splitting mode (30:1). Identification of the essential oil components was based on their retention indices (RI) and their mass spectral fragmentation patterns with those in the literature [7] and stored in our own in-house library [8].

3. Results and Discussion

The yellow wood essential oil from *S. macrophylla* was obtained in 1% yield. Table 1 shows the chemical composition of the *S. macrophylla* wood oil. Sesquiterpene hydrocarbons (65.9%) and oxygenated sesquiterpenoids (29.6%) dominated the composition, with only minor amounts of diterpenoids (4.2%) and no monoterpenoids. The major sesquiterpene hydrocarbons were δ-cadinene (33.0%) and α-copaene (7.2%), while the major oxygenated sesquiterpenoids were α-cadinol (7.1%), τ-muurolol (6.1%), and τ-cadinol (4.5%). Interestingly, the wood essential oil of *Cedrela odorata* L. (Meliaceae) from Costa Rica was also rich in δ-cadinene (26.0-26.3%) and α-cadinol (4.7-5.0%), with lesser concentrations of τ-cadinol (2.6%) and τ-muurolol (2.2%) [6].

Essential oils from the fresh terminal shoots and mature and senescent leaves of *S. macrophylla* from Pará state, Brazil, have been reported [9]. Sesquiterpenes also dominated the shoot and leaf essential oils with germacrene D (66.5%, 60.0%, and 58.5%), and germacrene A (6.9%, 5.3%, and 4.7%) as the major sesquiterpene components, for shoots, mature leaves, and senescent leaves, respectively. Palmitic acid (5.7%, 1.8%, and 13.7%) and ethyl palmitate (3.8%, 7.7%, and 6.1%) were also major components in the shoot and leaf essential oils. In contrast, the leaf essential oil of*S. macrophylla* from Egypt showed α-humulene (39.6%), β-caryophyllene (29.1%), and (*E*)-nerolidol (10.2%) as the major components [10].

Table 1: Chemical composition of the wood essential oil of *Swietenia macrophylla*.

RI	Compound	%	RI	Compound	%
1368	Cyclosativene	0.1	1537	α-Cadinene	0.4
1370	Isoledene	tr	1542	α-Calacorene	2.6
1377	α-Copaene	7.2	1559	(*E*)-Nerolidol	0.1
1384	α-Isocomene	tr	1561	β-Calcorene	0.3
1386	β-Cubebene	tr	1570	Palustrol	0.5
1388	β-Elemene	0.3	1576	*iso*-Caryophyllene alcohol	0.1
1418	Aristolene	0.1	1576	Spathulenol	tr
1406	α-Gurjunene	0.8	1585	Globulol	1.0
1410	β-Maaliene	tr	1594	Viridiflorol	0.2
1412	*cis*-α-Bergamotene	0.3	1596	Cubeban-11-ol	1.0
1418	β-Caryophyllene	0.1	1604	Humulol	0.4
1423	β-Cedrene	tr	1606	Rosifoliol	0.5
1426	γ-Maaliene	0.1	1609	Cedrol	0.5
1430	β-Gurjunene	0.4	1614	1,10-di-*epi*-Cubenol	0.3
1433	α-Maaliene	0.2	1615	α-Corocalene	0.2
1437	Aromadendrene	0.1	1624	Rosifoliol isomer	0.9
1438	α-Guaiene	0.2	1628	1-*epi*-Cubenol	2.3
1448	*cis*-Muurola-3,5-diene	0.1	1632	γ-Eudesmol	0.2
1451	(*E*)-β-Farnesene	0.1	1643	τ-Cadinol (= *epi*-α-Cadinol)	4.5
1455	α-Humulene	0.8	1646	τ-Murrolol(= *epi*-α-Muurolol)	6.1
1460	Alloaromadendrene	1.6	1648	α-Muurolol (= Torreyol)	2.9
1465	β-Acoradiene	0.2	1658	α-Cadinol	7.1
1471	*trans*-Cadina-1(6),4-diene	1.0	1669	*epi*-β-Bisabolol	0.1
1474	γ-Muurolene	2.1	1672	Cadalene	0.8
1477	*trans*-4,10-Epoxyamorphene	0.1	1675	Bulensol	0.2
1493	β-Alaskene	0.1	1899	Rimuene	tr
1480	*ar*-Curcumene	0.2	1906	(5*E*,9*E*)-Farnesyl acetone	0.1
1486	δ-Selinene	0.1	1911	Isopimara-9(11),15-diene	0.1
1488	*cis*-β-Guiaene	0.3	1927	Cembrene A	0.1
1490	Viridiflorene (= Ledene)	1.6	1944	Pimaradiene I	0.1
1495	Epizonarene	0.6	1956	Palmitic acid	0.1
1498	α-Muurolene	2.8	1964	Pimaradiene II	2.4
1501	α-Selinene	0.3	1996	9β-Isopimara-7,15-diene	0.1
1510	β-Curcumene	0.4	2019	(*E*,*E*)-Geranyl linalool	0.1
1513	γ-Cadinene	2.6	2131	Nezukol	0.7
1524	δ-Cadinene	33.0		Sesquiterpene hydrocarbons	65.9
1526	*trans*-Calamenene	1.5		Oxygenated sesquiterpenoids	29.6
1526	Zonarene	1.4		Diterpenoids	4.2
1533	*trans*-Cadine-1,4-diene	0.7		Others	0.1
1535	γ-Calcorene	0.1		Total Identified	98.5

4. Conclusions

The wood essential oil of *Swietenia macrophylla* has a pleasant aroma and can be obtained as a side product of the lumber industry. However, the tree has been overexploited in its native range, so it would be interesting to compare and contrast the chemical compositions of wood oils from plantations in Asia and the Pacific, and to consider those as sources of *S. macrophylla* wood essential oil.

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