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RESEARCH NOTE

Studies in the Essential Oil Bearing Plants of Bangladesh. Part V. Composition of the Leaf Oils of *Eucalyptus citriodora* Hook and *E. alba* Reinw. ex Blume.

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Abstract

Eucalyptus citriodora and *E. alba* leaf oils, obtained by hydrodistillation, were analyzed by GC and GC/MS. Thirty-five components were identified in the *E. citriodora* oil. The main components were citronellal (77.0%), neoisopulegol (7.3%), citronellol (5.9%) and iso(iso)pulegol (4.1%). Fifty-nine components were identified in *E. alba* oil with the main components being β-pinene (24.0%) and α-pinene (12.9%).

Key Word Index

Eucalyptus citriodora, *Eucalyptus alba*, Myrtaceae, essential oil composition, citronellal, β-pinene, α-pinene.

Introduction

Eucalyptus genus is widespread in the world, especially in tropical and subtropical areas (1). Its wood is used as fuel and the oils, industrially obtained from the leaves, constitute an important by-product. These oils can be divided according to their composition in : medicinal oils with a high content of cineole; industrial oils with a high content of α-phellandrene and piperitone; perfumery oils with a high content of citronellal (2). Most of the literature about the commercially important *Eucalyptus* species have been by Lawrence (3).

In Bangladesh, nowadays, new *Eucalyptus* species were planted in the context of aforestation program. *E. camaldulensis, E. tereticornis* and *E. brassiana,* fast growing species, are recognized by the Forest Department; *E. citriodora* and *E. alba* are widely grown in the country (4).

E. citriodora, originating from Australia, was introduced in Bangladesh, mainly in the tea growing areas, in 1955. It is a tall graceful tree having strong lemon scented leaves, used mainly as timber plant. It is marked by a high content of citronellal (up to 90% of the whole oil) (2) and it is used in perfumery, soap and cosmetic industries and as source of citronellol, hydroxycitronellol and menthol.

Information is reported in literature on the oil produced in India (5,6), Spain (7), China (8,9), Pakistan (10), Latin-American (11-18) and African countries (19-24). *E. alba* is a deciduous tree, up to about 18 m

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Table I. Chemical composition of *Eucalyptus citriodora* leaf oil

Compound	Percentage	Compound	Percentage
tricyclene	<0.01	geraniol	0.02
α-pinene	0.06	geranial	0.05
sabinene	0.02	δ-terpineol	0.18
β-pinene	0.30	citronellyl acetate	0.38
myrcene	0.11	β-elemene	0.04
p-cymene	0.02	cis-jasmone	0.07
limonene	0.35	β-caryophyllene	0.80
bergamal[a]	0.30	α-humulene	0.05
γ-terpinene	0.05	germacrene D	0.04
p-mentha-3,8-diene	0.05	spathulenol	0.01
terpinolene	0.02	caryophillene oxide	0.14
linalool	0.10	β-asarone	0.02
cis-rose oxide	0.05		
trans-rose oxide	0.08	Hydrocarbons	1.91
neoisopulegol	7.28	Monoterpenes	0.99
citronellal	76.98	Sesquiterpenes	0.93
iso(iso)pulegol	4.13	Oxygenated compounds	96.27
neoiso(iso)pulegol	0.36	Alcohols	18.18
terpinen-4-ol	0.11	Esters	0.38
α-terpineol	0.01	Aldehydes	77.35
nerol	0.06	Ketones	0.07
citronellol	5.94	Oxides	0.27
neral	0.03	Phenol compounds	0.02

[a] 2,6-dimethyl-5-heptenal

high, having large lanceolate to ovate leaves, is planted as an attractive ornamental. No references are in literature about *E. alba* oil composition; some references are related to its plant biochemistry (25,26).

This paper reports the results obtained by GC and GC/MS on *E. citriodora* and *E. alba* oils obtained from trees grown in Bangladesh. There are no previous references in literature about these Bangladeshi oils, with the exception of one paper on *E. citriodora* oil composition by Khuda et al. in 1996 (27).

Experimental

The leaves of *E. citriodora* were collected from the plants grown on the campus of BCSIR laboratories, Chittagong. The leaves of *E. alba* were collected from the plants grown in Forest Research Campus of Chittagong. The plants were approx. 20 years old. The oils were isolated from the fresh leaves by hydrodistillation in a modified Clevenger-type apparatus. The yield was 2.2% (v/w) for *E. citriodora* and 0.85% for *E. alba*.

GC: Fisons chromatography 5160 Mega Series equipped with a Shimadzu data processor C-R 3A; fused silica capillary column, 25 m x 0.32 mm, coated with SE-52, 0.40-0.45 μm film thickness (Mega, Legnano, Italy); column temperature, 40°C (6 min) to 240°C at 3°C/min; injector temperature 250°C; detector temperature 280°C; injection mode, split; split ratio 1:50; volume injected, 1 μL of a solution 1/20 in pentane of the oil; carrier gas, He, 100 KPa.

GC/MS: CE Instruments MD 800 equipped with Adams' library (28), FFC banks (29) and Perfume library CE Instruments ; fused silica capillary column, 30 m x 0.25 mm coated with DB-5, 0.25 μm film thickness (J & W, Folson, California, U.S.A.); column temperature, 60°C to 240°C at 3°C/min, to 300°C at 30°C/min; injector temperature, 250°C; injection mode, split; split ratio, 1:20; volume injected, 1 μL of a solution 1/20 in pentane of the oil; carrier gas He, 83 KPa; linear velocity 40 cm/sec at 60°C; interface temperature 250°C; source temperature 200°C; EI + acquisition with mass range of 41-300 amu.

Results and Discussion

Table I shows the relative percentages as single components and as classes of substances for *E. citriodora* leaf oil. Table I shows the presence of 35 identified components that represent 98% of

Table II. Chemical composition of *Eucalyptus alba* leaf oil

Compound	Percentage	Compound	Percentage
(E)-hexenol*	0.09	methyl eugenol	0.14
α-thujene	0.04	α-gurjunene	0.22
α-pinene	12.91	β-caryophyllene	7.76
camphene	0.30	β-gurjunene	0.11
thuja-2,4(10)diene	0.01	aromadendrene	1.12
β-pinene	23.96	α-humulene	1.09
myrcene	0.65	allo-aromadendrene	0.54
(Z)-3-hexenyl acetate	0.12	γ-gurjunene	0.08
α-phellandrene	0.24	germacrene D	0.21
hexyl acetate	t	valencene	0.32
α-terpinene	0.09	bicyclogermacrene	4.82
p-cymene	1.06	δ-cadinene	0.16
limonene	5.17	elemol	0.52
1,8-cineole	1.39	germacrene B	0.24
(Z)-β-ocimene	1.35	ledol	0.59
(E)-β-ocimene	0.53	spathulenol	3.04
γ-terpinene	0.56	caryophyllene oxide	4.42
terpinolene	0.47	globulol	1.81
trans-sabinene hydrate	0.06	γ-eudesmol	2.64
β-fenchol	0.70	cedr-8(15)-en-9-α-ol	0.27
nopinone	0.07	β-eudesmol	3.14
trans-pinocarveol	0.26	α-eudesmol	2.29
iso(iso)pulegol	0.19	14-hydroxy-9-epi-β-caryophyllene	0.11
pinocarvone	0.06	cedren-13-ol (8)	0.25
borneol	0.76		
terpinen-4-ol	0.75		
α-terpineol	3.98	Hydrocarbons	64.55
α-fenchyl acetate	0.37	Monoterpenes	47.33
bornyl acetate	0.05	Sesquiterpenes	17.22
(Z)-methyl cinnamate	0.64	Oxygenated compounds	28.68
δ-elemene	0.16	Alcohols	22.82
isoledene	0.04	Esters	1.17
α-copaene	0.05	Ketones	0.13
β-bourbonene	0.03	Oxides	4.42
β-elemene	0.27	Phenol compounds	0.14

*correct isomer not determined

the whole oil. The main component was citronellal (77.0%), followed by citronellol (5.9%). Monoterpene and sesquiterpene hydrocarbons represented approximately 1% respectively, with limonene (0.4%) and β-caryophyllene (0.8%) as main components.

Regarding aldehydes, in addition to citronellal, a little amount of neral and geranial was present; among alcohols, in addition to citronellol (main alcohol), linalool, geraniol, α-terpineol, δ-terpineol and two sesquiterpene alcohols were present; citronellyl acetate was the only ester detected (0.38%). The oil also contained three oxides, cis-jasmone and β-asarone. Bangladeshi *E. citriodora* leaf oil has a composition similar to that of other *E. citriodora* oils with high content of citronellal produced in different countries.

Table II shows the presence of 59 identified components that represent about 93% of the whole oil. The main components were β-pinene (24.0%) and α-pinene (12.9%) followed by β-caryophyllene (7.8%) and limonene (5.2%). Monoterpene and sesquiterpene hydrocarbons were 64.7% of the oil. Concerning the alcohols (22.8% of the whole oil), α-terpineol (4.0%), spathulenol (3%), γ-eudesmol (2.6%), β-eudesmol (3.1%) and α-eudesmol (2.3%) were the main components. Ester content was 1.17%. The oil also contained two ketones (nopinone and pinocarvone), caryophyllene oxide and methyl eugenol.

The oil was marked by a large number and a high content of sesquiterpene hydrocarbons and alcohols and by the presence of moderate quantities of γ-, β-, and α-eudesmol.

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