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Essential oil composition of *Murraya exotica* from the plains of northern India#

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ABSTRACT: The essential oil composition of *Murraya exotica* leaves and flowers from CIMAP Research Farm, Lucknow, were analysed by GC and GC–MS, which resulted in the identification of 56 and 72 constituents, representing 99.8% and 99.2% of the oils, respectively. The leaf oil showed (*E*)-nerolidol (27.8%), α-zingiberene (10.0%), β-caryophyllene (9.7%), (*E*,*E*) farnesol (8.9%) and δ-elemene (5.1%) as the major constituents, while the flower oil showed (*E*,*E*,*E*)-α-springene (23.8%), (*E*)-nerolidol (18.7%), (*E*,*E*) α-farnesene (13.2%), methyl palmitate (6.8%) and germacrene B (5.9%) as the major constituents. Copyright © 2005 John Wiley & Sons, Ltd.

KEY WORDS: *Murraya exotica*; Rutaceae; essential oil composition; (*E*,*E*,*E*)-α-springene; nerolidol; β-caryophyllene; (*E*,*E*) farnesol; (*E*,*E*) farnesene

Introduction

Murraya exotica[1,2] L. (family Rutaceae) is a handsome evergreen shrub or small tree 3–4 m in height with a spreading crown and short, often crooked, trunk, found almost throughout India and the Andaman Islands up to 1500 m. The plant is commonly grown in gardens for its glossy green foliage and large clusters of fragrant flowers. It is a popular hedge plant and is well adapted for topiary work. Propagation may be done by seeds, cuttings or layering.[3]

The leaves are stimulant and astringent. The leaves and bark are reported to be used for diarrhoea and dysentery in The Philippines[3] and China.[4] The powdered leaves are applied to cuts. The leaves and root bark are sometimes used against rheumatism, cough and hysteria, and the twigs are used for cleaning teeth. The leaves possess antibiotic activity against *Micrococcus pyogenes* var. *aureus* and *Escherichia coli*.[3] The roots of *M. exotica* were used in China as a pain killer[4] and as an antifertility agent.[5,6] Recently El-Sakhawy *et al.*[7] reported strong antifungal activity against *Candida albicans* and modest antibacterial activity.

M. exotica has been the subject of several phytochemical studies, which revealed the presence of alkaloids, coumarins, flavanoids, carotenoids[8–10] and essential oil. In 1974 Gupta and Chandra characterized 11 constituents in *M. exotica* flower oil from India, in which β-pinene (25.6%) and citral (7.2%) were the major constituents. In 1979, Der Joan[12] reported five compounds: 1,8-cineole, hydroxy citronellal, iso-eugenol, geranyl acetate and dimethyl anthranilate. In 1988 Li *et al.*[2] reported the presence of 19 constituents in the leaf oil of *M. exotica* from China. Of 19 constituents, six were identified, of which caryophyllene (50.0%), humulene (7.1%), α-cadinene (5.1%) and α-curcumene were the major constituents. El-Sakhawy *et al.*[7] reported 29, 34 and 31 constituents in flower, leaves and fruit essential oils of *M. exotica* from Egypt, having 88.9%, 62.5% and 80.5% of α-pinene.

In our recent report[13] on the essential oil composition of *M. koenigii* from the eastern, southern, northern (plain and hills) states of India, significant differences were observed. Similar observations by other researchers showed that the chemical composition of the essential oil from other *Murraya* species may vary with the locality,[14] which prompted us to carry out the detailed analysis of leaf and flower essential oils of *Murraya exotica* from the northern plains of India.

Experimental

Plant Materials

The fresh leaves and flowers of *M. exotica* were collected from our CIMAP research farm, Lucknow, in the months of March and October 2001, respectively, and identified by one of us (SCS), Botany Division CIMAP Lucknow. A voucher specimen has been deposited in the Herbarium Division of our Institute.

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Isolation of Essential Oils

The leaves and flowers of *M. exotica* at flowering stage were hydrodistilled in a Clevenger-type apparatus, producing oils in 0.07% and 0.05% (v/w) yield, respectively, on fresh weight basis. The oil was dried over anhydrous sodium sulphate and stored in sealed glass vials in a refrigerator prior to analysis.

Gas Chromatography (GC)

GC analysis of the oils was performed on a Perkin-Elmer GC 8500, using a fused silica capillary column (25 m × 0.32 mm, film thickness 0.25 μm), coated with polydimethyl siloxane (BP-1). The oven temperature was programmed from 60 °C to 220 °C at 5 °C/min and then held isothermal at 220 °C for 13 min; injector temperature, 250 °C; detector temperature, 300 °C; carrier gas, nitrogen, at a linear velocity of 10 p.s.i.; split, 1:80.

Gas Chromatography–Mass Spectrometry (GC–MS)

GC–MS data were obtained on a Perkin-Elmer mass spectrometer, using a PE-5 column (30 m × 0.32 mm, film thickness 0.25 μm); carrier gas, helium. Temperature programming, 2 min at 100 °C, rising at 5 °C/min to 220 °C, with hold time of 20 min at 220 °C.

Identification of Compounds

Compounds were identified by comparing the retention indices of their peaks on the BP-1 column with literature values,[7–14] computer matching against the library spectra built up using pure substances and components of known essential oils, and finally confirming by comparison of the mass spectra of peaks with NIST and Wiley libraries and published data.[15–19] The relative amounts of individual components are based on peak areas obtained without FID response factor correction. The retention indices were obtained from gas chromatograms by logarithmic interpolation between bracketing *n*-alkanes. The homologous series of *n*-alkanes (C8–C22; Polyscience Inc. Niles, USA) were used as standards.

Results and Discussion

The volatile oils were obtained by conventional hydrodistillation of leaves and flowers of *M. exotica*, which gave oils in 0.07% and 0.05% (v/w) yield on a fresh weight basis. GC and GC–MS analysis enabled the identification of a total of 56 and 72 constituents, representing 99.8% and 99.2% of the total oils, respectively. The relative concentrations of the volatile components identified are presented in Table 1 according to their elution order on the BP-1 column. The leaf oil showed (*E*)-nerolidol (27.8%), α-zingiberene (10.0%), β-caryophyllene (9.7%), (*E*,*E*)-farnesol (8.9%) and δ-elemene (5.1%) as the major constituents, while the flower oil showed (*E*,*E*,*E*)-α-springene (23.8%), (*E*)-nerolidol (18.7%), (*E*,*E*)-α-farnesene (13.2%), methyl palmitate (6.8%) and germacrene B (5.9%) as the major constituents.

On comparing our results of *M. exotica* leaf oil with flower oil compositions, it was observed that out of 56 and 72 constituents present in the above oils, respectively, 40 constituents were common to both the oils, of which 23 minor constituents had more or less similar composition, while significant differences were observed among the remaining 17 common constituents.

(*E*)-nerolidol (27.8% and 18.7%), caryophyllene (9.7% and 3.1%), elemene (5.1% and 1.4%) and (*E*)-α-bergamotene (2.0% and 0.5%) were present in 1.5–4 times greater quantities in the leaf oil than in the flower oil, while α-zingiberene (10.0% and 2.5%), β-sesquiphellandrene (4.7% and 0.9%), γ-elemene (1.7% and 0.3%) and tridecanoic acid (1.6% and 0.3%) were 5–6 times more abundant in the leaf oil. Similarly, *n*-nonadecane (1.6% and 0.2%), terpinen-4-ol (1.0% and 0.1%) were 8 and 10 times, (*E*,*E*) farnesol (8.9% and 0.7%) and germacrene-D (2.6% and 0.2%) were each 13 times and tertradecanoic acid (1.8% and 0.1%) was 18 times more abundant in the leaf oil than in the flower oil. On the other hand, germacrene-B (5.9% and 3.5%), benzyl benzoate (1.0% and 0.1%), hexadecanal (0.8 and 0.1%) and (*E*,*E*)-α-farnesene (13.2% and 1.0%) were 2, 8, 10 and 13 times more abundant in the flower oil than

Table 1. Percentage composition of leaf and flower essential oils of *Murraya exotica* from India

Name of compound	RI	Leaf oil	Flower oil
α-Pinene	934	—	0.6
Camphene	947	t	0.2
β-Pinene	974	—	1.4
Myrcene	984	—	0.2
α-Phellandrene	995	—	0.1
α-Terpinene	1011	—	0.2
Limonene	1022	0.1	0.3
γ-Terpinene	1057	—	0.1
trans-Sabinene hydrate	1070	—	0.1
Terpinolene	1084	—	0.3
cis-Sabinene hydrate	1096	0.2	0.1
Phenylethyl alcohol*	1124	—	0.9
Lavandulol	1150	—	0.3
Borneol	1163	—	0.3
Terpinen-4-ol	1184	1.0	0.1
α-Terpineol	1192	—	0.9
Nerol	1209	—	0.1
Eugenol	1234	—	0.1
Geraniol	1244	—	0.1
Neryl formate	1256	—	0.1

Table 1. (*Continued*)

Name of compound	RI	Leaf oil	Flower oil
Bornyl acetate	1270	—	0.6
Lavandulyl acetate	1273	—	1.2
Carvacrol	1283	0.1	0.1
Methyl anthranilate	1328	—	0.1
δ-Elemene	1338	5.1	1.4
Neryl acetate	1353	0.2	—
α-Cubebene	1360	—	0.1
cis-Jasmone	1369	—	0.1
Isoledene	1372	—	0.1
α-Copaene	1379	0.5	0.2
β-Cubebene	1389	1.6	0.9
Methyl eugenol	1402	0.1	—
α-Gurjunene	1410	0.2	—
β-Caryophyllene	1426	9.7	3.1
(*E*)-α-Bergamotene	1432	2.0	0.5
γ-Elemene	1440	1.7	0.3
α-Humulene	1452	0.6	0.1
(*Z*)-β-Farnesene	1459	1.5	0.8
γ-Methyl ionone	1466	0.1	0.1
Germacrene-D	1473	2.6	0.2
Germacrene-B	1484	3.5	5.9
α-Zingiberene	1491	10.0	2.0
(*E*,*E*)-α-Farnesene	1497	1.0	13.2
cis-Calamenene	1503	0.6	0.2
γ-Cadinene	1512	—	0.7
β-Sesquiphellandrene	1520	4.7	0.9
α-Cadinene	1533	0.1	0.2
Elemol	1538	0.2	0.3
(*E*)-Nerolidol	1558	27.8	18.7
Spathulenol	1566	0.9	0.9
Caryophyllene oxide	1575	0.1	0.7
Globulol	1579	0.2	0.3
Viridiflorol	1589	0.6	0.1
trans-Sesquisabinene hydrate	1594	0.1	—
Humulene expoxide-II	1608	0.5	0.5
10-*epi*-γ-Eudesmol	1618	—	0.4
T-Cadinol	1625	2.2	—
β-Eudesmol	1632	0.1	0.3
α-Cadinol	1645	0.2	0.5
Tridecanoic acid	1666	1.6	0.3
(*Z*,*E*)-Farnesol	1679	0.4	0.3
Tetradecanol	1681	—	0.2
Pentadecan-2-one	1688	0.3	—
(*E*,*Z*)-Farnesol	1703	8.9	0.7
Pentadecanal	1713	0.5	—
Benzyl benzoate	1730	0.1	1.0
(*E*,*E*)-Farnesol	1741	0.2	—
Tetradecanoic acid	1763	1.8	0.1
n-Octadecane	1796	0.4	—
Hexadecanal	1820	0.1	0.8
Isopropyl myristate	1836	0.2	0.4
Octadecanol	1856	0.1	—
Pentadecanoic acid	1865	0.1	—
Hexadecanoic acid	1879	0.1	0.2
n-Nonadecane	1901	1.6	0.2
Methyl palmitate	1910	—	6.8
Oleic acid	1929	—	0.2
Palmitic acid	1961	0.4	—
n-Eicosane	2001	—	0.1
(*E*,*E*,*E*)-α-Springene	2013	—	23.8
Methyl linolenate	2058	—	1.1
Hexadecanol	2061	—	0.3
Phenylethyl anthranilate	2080	t	0.4
trans-Phytol	2153	2.7	—
Stearic acid	2179	t	—
Docosane	2203	0.2	—
Eicosanal	2221	t	—
Methyl pimarate	2239	—	0.1

* Correct isomer not identified.

in the leaf oil. Otherwise, *trans*-phytol (2.7%) and T-cadinol (2.2%) were only present in the leaf oil, while (*E*,*E*,*E*)-α-springene (23.8%), methyl palmitate (6.8%) and methyl lenolenate (1.1%) were only present in the flower oil.

On comparing our results of *M. exotica* leaf oil with those reported by El-Sahkhawy *et al.*[7] from Egypt, a contrasting observation was recorded in our oil with respect to the major constituent. In El-Sahkhawy's oil, the monoterpene α-pinene (62.5%) was the major constituent, while in our oil the sesquiterpenes (*E*)-nerolidol (27.8%), α-zingiberine (10.0%), β-caryophyllene (9.7%), (*E*,*E*)-farnesol (8.9%), and δ-elemene (5.1%) were the major constituents, a finding supported to a great extent by the findings of Li *et al.*,[2] who also reported a sesquiterpene (caryophyllene, 50%) as the major constituent.

From the above results it is evident that there is great variation in the percentage composition of the major constituents, which may be due to the variation in their agroclimatic and geographical conditions.

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