A New Sesquiterpene Lactone from *Bombax malabaricum*

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A new sesquiterpene lactone, 5-isopropyl-3-methyl-2,4,7-trimethoxy-8,1-naphthalene carbolactone (1) together with a known naphthoquinone, 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1,4-naphthoquinone (2) were isolated from the root bark of *Bombax malabaricum*. The structures of these two compounds were established by extensive one- and two-dimensional (1D- and 2D)-NMR spectral studies.

Key words *Bombax malabaricum*; Bombacaceae; sesquiterpene lactone; naphthoquinone

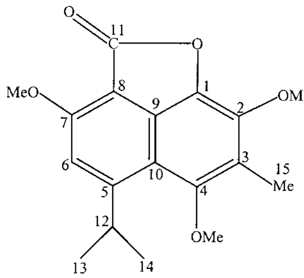
Bombax malabaricum DC. (syn. Salmalia malabaricum DC.) (Bombacaceae) is a medium sized deciduous tree, found throughout western and southern India,[1)] and is widely used in folk medicine as demulcent, diuretic, aphrodisiac, emetic and for curing impotence.[2)] Previous phytochemical studies of this species has resulted in the isolation of several sesquiterpenoids.[3—8)] In view of the medicinal importance of the plant we examined the root bark of *B. malabaricum* and report here the isolation and characterization of a new sesquiterpene lactone (**1**), and a known naphthoquinone (**2**).

Results and Discussion

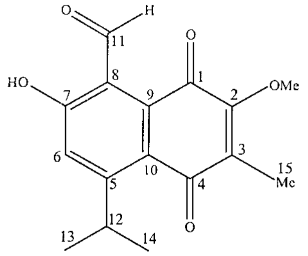
Compound **1**, isolated as an orange yellow crystalline solid, showed $[M+H]^+$ peak at m/z 317.1375 in its positive electrospray ionization time of flight mass spectrum (ESI-TOF-MS) corresponding to the molecular formula $C_{18}H_{20}O_5$. The ^{13}C-NMR spectrum of **1** showed signals for all the 18 carbons present in the molecule. The UV absorption maxima in MeOH at 224, 251, 336, 355 and 392 nm suggested the presence of a naphthalene system[6,9)] in **1**. Its IR spectrum showed a strong absorption band at 1745 cm^{-1}, indicating the presence of a five membered lactone carbonyl,[10)] which was confirmed by the presence of a carbon signal at δ 164.0 in its ^{13}C-NMR spectrum.

The ^{1}H-NMR spectrum of **1** showed the presence of an isopropyl group with a six-proton doublet at δ 1.36 (J=6.8 Hz) and a methine septet at δ 4.27 (J=6.8 Hz). It also exhibited the presence of three methoxyl groups at δ 4.21, 4.13 and 3.73. A sharp three-proton singlet at δ 2.23, which correlated with the carbon at δ 10.7 in its heteronuclear single quantum coherence (HSQC) spectrum indicated the presence of an aromatic methyl group in compound **1**. A sharp one-proton singlet at δ 7.28 indicated the presence of an aromatic proton on the naphthalene moiety. The heteronuclear multiple bond connectivity (HMBC) correlation (Fig. 1) of the isopropyl methine proton at δ 4.27 with C-5 (δ 157.7), C-6 (δ 111.1) and C-10 (δ 112.3), and the long range correlation of the aromatic proton signal at δ 7.28 with C-5 (δ 157.7), C-7 (δ 158.9), C-8 (δ 99.6), C-10 (δ 112.3) and C-12 (δ 29.1) located the isopropyl group at C-5 position and the lone aromatic proton at C-6 position. The presence of a strong nuclear Overhauser effect (NOE) correlation between the isopropyl methyl protons (δ 1.36) and the aromatic proton (δ 7.28), in the nuclear Overhauser enhancement spectroscopy (NOESY) spectrum (Fig. 1) further supported their placement at C-5 and C-6 positions, respectively. The methoxyl group at δ 4.13 was placed at C-7, based on HMBC correlation with this carbon at δ 158.9 and a strong NOE correlation with H-6 (δ 7.28) in its NOESY spectrum.

The aromatic methyl group at δ 2.23 was placed at C-3 as it showed ^2J correlation with C-3 (δ 121.1), and ^3J correlation with C-2 (δ 139.1) and C-4 (δ 151.4), respectively in its HMBC spectrum. The methoxyl groups at δ 4.21 and 3.73 were placed at C-2 and C-4 positions as they showed ^3J correlation with these carbons at δ 139.1 and 151.4, respectively in its HMBC spectrum. The NOE connectivities observed



1



2

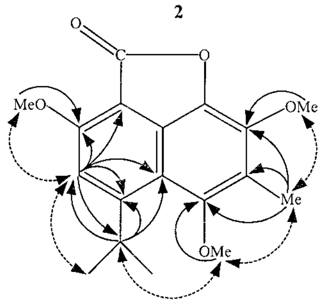


Fig. 1. HMBC (→) and NOESY (←---→) Correlations Observed in **1**

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between the aromatic methyl group at δ 2.23 and the methoxyl groups at δ 3.73 and 4.21 further supported their placement C-3, C-4 and C-2 positions, respectively. Thus, from the foregoing spectral studies the structure of compound **1** was elucidated as 5-isopropyl-3-methyl-2,4,7-trimethoxy-8,1-napthalene carbolactone.

Compound **2** was identified as 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1,4-naphthoquinone by comparing its physical and spectral data with literature values.[11)]

Experimental

General Procedures Melting points were determined on a Kofler hot-stage apparatus and are uncorrected. UV spectra were recorded on a Shimadzu UV-240 spectrophotometer. IR spectra were determined in KBr discs on a Perkin Elmer 283 double beam spectrophotometer. ^{1}H-NMR spectra were recorded on a Bruker Avance 400 spectrometer operating at 400.13 MHz and ^{13}C-NMR spectra on a Bruker AC 300 spectrometer operating at 75.43 MHz in DMSO-d_6 and $CDCl_3$ using tetramethylsilane (TMS) as an internal standard. ^{1}H–^{1}H correlation spectroscopy (COSY), HSQC, HMBC, NOESY (with 500 ms mixing time) spectra were recorded using standard pulse sequences. ESI-TOF-MS and ESI-MS/MS were recorded on a API Q-STAR PULSA of Applied Biosystem. Column chromatography (CC) separations were carried out by using Acme silica gel finer than 200 mesh (0.08 mm).

Plant Material The root bark of *B. malabaricum* DC. was collected in December 2000 at Tirumala Hills, Andhra Pradesh, South India. A voucher specimen (DG-006) was deposited in the Herbarium of the Department of Botany, Sri Venkateswara University, Tirupati, India.

Extraction and Isolation The shade dried and powdered root bark (2 kg) of *B. malabaricum* was exhaustively extracted with MeOH. The MeOH extract was triturated with *n*-hexane and the residue left behind was purified over a silica gel column using *n*-hexane and EtOAc and their step gradient mixtures as eluents. The *n*-hexane–EtOAc, 1 : 1 and 3 : 7 eluates yielded **1** (12 mg) and **2** (10 mg), respectively.

5-Isopropyl-3-methyl-2,4,7-trimethoxy-8,1-naphthalene Carbolactone (**1**): Orange yellow crystalline solid (MeOH), mp 120—122 °C. UV λ_{max} (MeOH) nm (log ε): 224 (4.59), 251 (4.52), 336 (3.90), 355 (4.05), 392 (3.58). IR (KBr) ν_{max} cm^{-1}: 1745 (lactone >C=O), 1635, 1615, 1480. ^{1}H-NMR (DMSO-d_6) δ: 7.28 (1H, s, H-6), 4.27 (1H, septet, J=6.8 Hz, C$\underline{H}$(Me)$_2$), 4.21 (3H, s, OMe-2), 4.13 (3H, s, OMe-7), 3.73 (3H, s, OMe-4), 2.23 (3H, s, Me-3), 1.36 (6H, d, J=6.8 Hz, CH(C$\underline{H}_3$)$_2$). ^{13}C-NMR (DMSO-d_6) δ: 164.0 (C-11), 158.9 (C-7), 157.7 (C-5), 151.4 (C-4), 139.1 (C-2), 131.5 (C-1), 131.2 (C-9), 121.1 (C-3), 112.3 (C-10), 111.1 (C-6), 99.6 (C-8), 61.5 (O$\underline{Me}$-4), 59.7 (O$\underline{Me}$-2), 57.0 (O$\underline{Me}$-7), 29.1 (C-12), 24.3 (C-13), 24.1 (C-14), 10.7 (C-15). ESI-MS/MS (positive mode) m/z (%): 317.1 $[M+H]^+$ (4), 302.0 $[M+H-Me]^+$ (4), 287.1 $[M+H-2Me]^+$ (100), 272.1 $[M+H-3Me]^+$ (45), 259.1 $[M+H-2Me-CO]^+$ (25), 244.1 $[M+H-3Me-CO]^+$ (66), 229.1 $[M+H-4Me-CO]^+$ (48), 215.1 $[M+H-3Me-CO-CHO]^+$ (31), 201.1 $[M+H-4Me-2CO]^+$ (34), 187.1 $[M+H-4Me-CO-C_3H_7+H]^+$ (19), 173.1 $[M+H-4Me-3CO]^+$ (15), 145.0 $[M+H-4Me-4CO]^+$ (35). ESI-TOF-MS m/z: 317.1375 $[M+H]^+$ (Calcd for $C_{18}H_{20}O_5$+H: 317.1389).

8-Formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1,4-naphthoquinone (**2**): Yellow needles (MeOH), mp 82—83 °C. UV λ_{max} (MeOH) nm (log ε): 220 (4.61), 252 (4.32), 276 (4.31), 340 (4.33). IR (KBr) ν_{max} cm^{-1}: 3420 (OH), 1720 (CHO), 1635 (>C=O), 1540, 1219, 1180, 772. ^{1}H-NMR ($CDCl_3$) δ: 12.32 (1H, s, OH-7), 10.45 (1H, s, CHO-11), 7.24 (1H, s, H-6), 4.15 (1H, septet, J=6.8 Hz, C$\underline{H}$(Me)$_2$), 4.02 (3H, s, OMe-2), 2.04 (3H, s, Me-3), 1.25 (6H, d, J=6.8 Hz, CH(C$\underline{H}_3$)$_2$). ^{13}C-NMR ($CDCl_3$) δ: 197.0 (C-11), 186.0 (C-4), 183.1 (C-1), 165.2 (C-7), 159.2 (C-5), 156.9 (C-2), 135.0 (C-9), 131.5 (C-3), 124.0 (C-10), 121.2 (C-6), 117.0 (C-8), 60.0 (O$\underline{Me}$-2), 30.0 (C-12), 23.8 (C-13, 14), 9.0 (C-15). ESI-MS/MS (positive mode) m/z (%): 289.1 $[M+H]^+$ (48), 274.1 $[M+H-Me]^+$ (68), 259.1 $[M+H-2Me]^+$ (100), 256.1 $[M+H-Me-H_2O]^+$ (27), 241.0 $[M+H-2Me-H_2O]^+$ (17), 231.1 $[M+H-2Me-CO]^+$ (26), 228.1 $[M+H-Me-H_2O-CO]^+$ (41), 213.0 $[M+H-2Me-H_2O-CO]^+$ (59), 203.1 $[M+H-2Me-2CO]^+$ (50), 200.1 $[M+H-Me-H_2O-CO-CHO+H]^+$ (31), 185.0 $[M+H-Me-H_2O-CO-C_3H_7]^+$ (33), 157.1 $[M+H-Me-H_2O-2CO-C_3H_7]^+$ (27), 129.0 $[M+H-Me-H_2O-3CO-C_3H_7]^+$ (33). ESI-TOF-MS m/z: 289.1020 $[M+H]^+$ (Calcd for $C_{16}H_{16}O_5$+H: 289.1076).

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References

1) The Wealth of India., "A Dictionary of Indian Raw Materials and Industrial Products," Vol. IX, 1972, p. 175.
2) Kirtikar K. R., Basu B. D., "Indian Medicinal Plants," Periodical Experts, Vol. 1, New Delhi, 1975, p. 356.
3) Seshadri V., Batta A. K., Rangaswamy S., *Curr. Sci.*, **40**, 630—631 (1971).
4) Seshadri V., Batta A. K., Rangaswamy S., *Indian J. Chem.*, **11**, 825 (1973).
5) Sankaram A. V. B., Reddy N. S., Shoolery J. N., *Phytochemistry*, **20**, 1877—1881 (1981).
6) Sood R. P., Suri K. A., Suri O. P., Dhar K. L., Atal C. K., *Phytochemistry*, **21**, 2125—2126 (1982).
7) Puckhaber L. S., Stipanovic R. D., *J. Nat. Prod.*, **64**, 260—261 (2001).
8) Sreeramulu K., Rao K. V., Venkata Rao C., Gunasekar D., *J. Asian Nat. Prod. Research*, **3**, 261—265 (2001).
9) Tanaka M., Yasue M., Imamura H., *Tetrahedron Lett.*, **24**, 2767—2773 (1966).
10) Silverstein R. M., Bassler G. C., Morrill T. C., "Spectrometric Identification of Organic Compounds," 5th ed., 1991, pp. 118—120.
11) Rao K. V., Sreeramulu K., Gunasekar D., *J. Nat. Prod.*, **56**, 2041—2045 (1993).