EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 5
Issue: 1
714-721
Year: 2018

CHEMICAL CONSTITUENTS FROM THE STEM BARK OF *BAUHINIA RACEMOSA* LAM. AND LEAVES OF *MACHILUS BOMBYCINA* KING EX HOOK. F.

Shahnaz Sultana[1,2], Kamaruz Zaman[3], Mohammed Ali[1]* and Showkat Rassol Mir[1]

[1]Phytochemistry Research Laboratory, School of Pharmaceutical Education and Research, Jamia Hamdard, New Delhi - 110 062, India.
[2]College of Pharmacy, Jazan University, Jazan, Saudi Arabia.
[3]Department of Pharmaceutical Sciences, Dibrugarh University, Dibrugarh – 786 004 (Assam), India.

***Corresponding Author: Prof. Mohammed Ali**
Phytochemistry Research Laboratory, School of Pharmaceutical Education and Research, Jamia Hamdard, New Delhi - 110 062, India.

Article Received on 08/11/2017 **Article Revised on 29/11/2017** **Article Accepted on 20/12/2017**

ABSTRACT
Bauhinia racemosa Lam. (Caesalpiniaceae), distributed in India and other regions of south eastern Asia, is used o treat diarrhoea, dysentery, epilepsy, liver ailments, blood diseases, fever, headache, inflammation, malaria, skin diseases, tumors and ulcers. *Machilus bombycina* King ex Hook. f. (Lauraceae), known as som, is found in China, India and other south eastern countries. Its leaves are beneficial to cure pimples and rheumatism. This study was planned to isolate phytoconstituents from these plant materials and to characterized their structures. The air-dried powders of the herbal drugs (1.0 kg each) were exhaustively extracted with methanol individually and the concentrated each extract was adsorbed on silica gel separately for preparation of slurries. Each dried slurry was subjected to silica gel column packed in petroleum ether. The columns were eluted with organic solvents in order of increasing polarity to isolate the compounds. Phytochemical investigation of a methanolic extract of the stem bark of *B. racemosa* led to isolate *n*-decanoyl O-α-D-galactopyranoside (capryl O-α-D-galactoside, **1**), linoleiyl O-α-D-arabinopyranoside (**2**), α-D-galctopyranosyl-(6→1′)-O-α-D-galactopyranoside (α-D-6-O-digalactoside, **3**), linoleiyl O-α-D-galactopyranosyl-(6′→1″)-O-α-D-galactopyranoside (linoleiyl O-α-D-digalactoside, **4**), α-D-galactoyranosyl-(6→1′)-O-α-D-galactopyranosyl -(6′→1″)-O-α-D-galactopyranoside (α-D-6-O-trigalactoside, **5**) and α-D-galactopyranosyl-(6→1′)-α-D-galactopyranosyl-(6′→1″)-α-D-galactopyranosyl-(6″→1‴)- α-D-galactopyranoside (α-D-6-O-tetragalactoside, **6**). Column chromatography of a methanolic extract of the leaves of *Machilus bombycina* afforded 8,21-dihydroxylanost-5,25 (26)-dien-3-olyl behenate (**7**) and 5,7-dihydroxy-3′,4′-dimethoxyflavanone-7-O-α-D-glucopyranosyl-(6″→1‴)-α-D-rhamnopyranoside (**8**). The structures of these phytoconstituents have been established by spectral data analysis and chemical reactions.

KEYWORDS: *Bauhinia Racemosa, Machilus Bombycina,* Phytoconstituents, Isolation, Characterization.

INTRODUCTION
Bauhinia racemosa Lam., syn. *B. parviflora* Vahl, *Piliostigma racemosa* (Lam.) Benth. (Caesalpiniaceae), called as bidi leaf tree, Burmese silk orchid, katmauli, Kachnal and Kachnaar, is distributed up to 1000 m in India, Myanmar, Cambodia, Caribbean, Sri Lanka, Thialand, Vietnam and Yunnan. It is a small crooked deciduous tree with spreading crown, bark dark brown, rough with vertical cracks; leaves bilobed, glabrous above, hairy below, base cordate; flowers pedicellate, white; pods turgid, rigid, falcate; seeds many, oblong, compressed, black. Its tender shoot juice is mixed with mother's milk and used to clean and cool the eye. The juice from the stem is taken with cumin and milk to cure dysentery. A root decoction is drunk to prevent obesity. A root bark decoction with black peppers is given to epileptic patients. The leaves are eaten as an anthelmintic and to treat diarrhoea and liver ailments. In Ayurveda, the bark is taken as an acrid, astringent, refrigerant and to alleviate blood diseases, diarrhoea, dysentery, fever, headache, inflammation, malaria, skin diseases, tumors and ulcers. A stem bark decoction with that of *Terminalia arjuna* is useful against throat diseases. The flowers are beneficial to subside cough, haemorrhage and piles.[1-4] The stem bark contained ß-sitosterol, β-amyrin and linoleiyl arabinoside[5-7]. Kaempferol, quercetin, scopoletin and scopolin were separated from the leaves.[8] Pacharin and resveratrol were reported from the heart wood.[9,10] The seed coats yielded flavonoids.[11] The roots produced a tetracyclic phenol and de-o-methylracemosol.[12-14]

Machilus bombycina King ex Hook. f., syn. *M. gamblei* King ex Hook. f., *M. suaveolens* S.K. Lee, *Persea gamblei* (King ex Hook. f.) Kosterm. (Lauraceae), known as som, is distributed in China, India

and other south eastern countries. It grows abundantly in its natural habitat in Assam particularly Brahmaputra valley up to 500 m, Khasi and Jayantia hillls and along the lower Himalayas.[15] It occurs as a medium sized tree with spreading branches, aromatic, alternate, oblanceolate-elliptic leaves, greenish-yellow flowers and globose fruits. Som is one of the primary food plants of *Antheraea assama* Westwood, the silkworm that produces muga or golden colour natural silk. Its leaf paste is applied to relieve rheumatism. The leaves and roots of *M. bombycina* are crushed with the leaves of *Achyrenthus aspera* and the juice is applied to cure pimples.[16] Its leaves possessed β –sitosterol, chlorogenic acid, phytic acid, tannins, catechol, morin, gallic acid and β-sitosterol D-glucoside.[17] The plant essential oil was mainly consisted of decanal, 11-dodecenal and dodecanal.[18] The major constituents of the flower oil were caryophyllene oxide, (E)-nerolidol, 11-dodecenal and 11-dodecenoic acid. The fruit oil was composed of the furanoid forms of *trans*- and *cis*-linalool oxides.[19,20] Keeping in view the various therapeutic values of the plants and the development of ecofriendly, biodegradable and safer herbal preparations the plant bark of *B. racemosa* and leaves of *M. bombycina* were screened for the isolation and characterization of their chemical constituents.

MATERIALS AND METHODS

General procedures

All chemicals were procured from Sigma-Aldrich unless otherwise stated. Melting points were determined on a thermoelectrically heated Perfit apparatus without correction. IR spectra were measured in KBr pellet on a Bio-Red FT-IR spectrometer. UV spectra were obtained in methanol with a Lambda Bio 20 spectrometer. The ^{1}H (400 MHz) and ^{13}C (100 MHz) NMR spectra were recorded on Bruker DRX 400 MHz spectrometer with TMS as an internal standard. Mass spectra were scanned on a Jeol D-300 (EI/CI) system. Column chromatography was performed on silica gel (Qualigens, Mumbai, India), 60–120 mesh and solvents used were purchased from Merck Specialties (E. Merck, Pvt. Ltd. New Delhi, India). The purity of the isolated compounds was checked on precoated TLC plates with silica gel 60 F_{254} (Merck, 0.25 mm) and the spots were visualized by exposure to iodine vapors and UV radiations and spraying with ceric sulfate solution.

Plant materials

The bark of *B. racemosa* was collected from Gulbarga, Karnataka. The leaves of *M. bombycina* were procured from Dibrugarh, Assam. The fruits of *Terminalia bellerica* were purchased from the local market of Khari Baowli, Delhi. The plant materials were identified by Prof. M. P. Sharma, Department of Botany, Jamia Hamdard. The specimen vouchers of the drugs were deposited in the herbarium of the Phytochemistry Research Laboratory, School of Pharmaceutical Education and Research, Jamia Hamdard for future reference.

Extraction and Isolation

Each 1 kg of the bark of *B. racemosa* and the leaves of *M. bombycina* were coarsely powdered and extracted exhaustively separately with methanol in a Soxhlet apparatus. The extracts were concentrated under reduced pressure to get dark brown masses, 125.1 g and 115.6, respectively. The dried residue (100 g each) was dissolved in minimum amount of methanol and adsorbed on silica gel column grade (60 - 120 mesh) separately to obtain slurries. Each slurry was air-dried and chromatographed over silica gel columns loaded in petroleum ether individually. Each column was eluted with petroleum ether, petroleum ether -chloroform mixtures, chloroform and chloroform - methanol mixtures in order of increasing polarity. Various fractions were collected separately and matched by TLC to check homogeneity. Similar fractions having the same R_f values were combined and crystallized to obtain the compounds.

Phytoconstituents isolated from *Bauhinia racemosa*

Capryl O-α-D-galactoside (1)

Elution of the column with chloroform-methanol (19:1) produced semisolid mass of **1**, yield 211 mg , UV λmax (MeOH) 205 nm (log ε 3.1); IR γ_{max} (KBr): 3419, 3269, 2942, 2837, 1725, 1632, 1453, 1387, 1218, 1081, 729 cm^{-1}; ^{1}H NMR (MeOD): δ 5.32 (1H, d, J = 4.5 Hz, H-1′), 4.46 (1H, m, H-5′), 4.36 (1H, m, H-2′), 3.79 (1H, m, H-3′), 3.62 (1H, m, H-4′), 3.18 (2H, d, J = 8.8 Hz, H_2-6′), 2.49 (2H, t, J =7.2 Hz, H_2-2), 1.54 (2H, m, CH_2), 1.31 (2H, m, CH_2), 1.27 (12H, brs, 6 x CH_2), 0.88 (3H, t, J = 6.3 Hz, Me-10); ^{13}C NMR (MeOD): δ 171.33 (C-1), 42.59 (C-2), 32.31 (C-3), 29.78 (C-4 to C-7), 25.36 (C-8), 22.69 (C-9), 14.21 (C-10), 105.22 (C-1′), 78.76 (C-2′), 74.27 (C-3′), 64.39 (C-4′), 79.48 (C-5′), 61.21 (C-6′); ESI MS *m/z* (rel. int.): 334 $[M]^+$ ($C_{16}H_{30}O_2$) (3.8), 179 (10.2), 171 (21.6), 163 (8.2), 155 (14.7).

Linoleiyl O-α-D-arabinopyranoside (2)

Further elution of the column with chloroform – methanol (19 : 1) afforded a pale yellow semisolid mass of **2**, yield 173 mg, IR γ_{max} (KBr): 3414, 3356, 2929, 2845, 1722, 1637, 1442, 1384, 1218, 1081, 729 cm^{-1}; ^{1}H NMR (MeOD): δ 5.38 (1H, m, H-12), 5.33 (1H, m, H-9), 5.09 (1H, m, H-10), 5.04 (1H, m, H-13), 2.74 (2H, m, H_2-11), 2.32 (2H, t, J = 7.5 Hz, H_2-2), 2.09 (2H, m, H_2-8), 1.94 (2H, m, H_2-14), 1.55 (2H, m, CH_2), 1.34 (2H, m, CH_2), 1.28 (12H, brs, 6 x CH_2), 0.85 (3H, t, J = 6.5 Hz, Me-18); 5.26 (1H, d, J = 4.8 Hz, H-1′), 4.23 (1H, m, H-2′), 3.87 (1H, m, H-3′), 3.61 (1H, m, H-4′), 3.34 (2H, d, J = 7.6 Hz, H_2-5′), ^{13}C NMR (MeOD): δ 170.53 (C-1), 145.63 (C-10), 121.03 (C-12), 119.32 (C-13), 116.43 (C-9), 38.45 (C-2), 32.75 (C-11), 31.38 (C-14), 29.57 (C-4), 29.37 (3 x CH_2), 29.29 (C-3), 29.23 (C-7), 27.86 (C-6), 25.23 (C-16), 22.67 (C-17), 14.12 (C-18), 105.34 (C-1′), 75.31 (C-2′), 73.29 (C-3′), 71.38 (C-4′), 65.28 (C-5′); ESI MS *m/z* (rel. int.): 412 $[M]^+$ ($C_{23}H_{40}O_6$) (3.4), 279 (12.2), 149 (8.2).

α-D-6-O-Digalactoside (3)

Elution of the column with chloroform - methanol (9:1) afforded pale yellow crystals of **3**, yield 216 mg, R_f: 0.24 (chloroform – methanol, 17 : 3), m. p. 120 – 121 °C; IR γ_{max} (KBr): 3511, 3317, 3260, 2925, 2837, 1457, 1385, 1226, 835 cm^{-1}; ^1H NMR (MeOD): δ 5.32 (1H, d, J = 4.8 Hz, H-1), 4.53 (1H, m, H-5), 4.10 (1H, m, H-2), 3.72 (1H, m, H-3), 3.58 (1H, m, H-4), 3.34 (2H, d, J = 8.7 Hz, H_2-6), 5.14 (1H, d, J = 4.6 Hz, H-1'), 4.48 (1H, m, H-5'), 4.05 (1H, m, H-2′), 3.76 (1H, m, H-3'), 3.52 (1H, m, H-4'), 3.14 (2H, d, J = 8.9 Hz, H_2-6'); ^{13}C NMR (MeOD): δ 105.38 (C-1), 75.71 (C-2), 74.42 (C-3), 71.34 (C-4), 83.79 (C-5), 63.49 (C-6), 93.74 (C-1′), 74.63 (C-2′), 73.23 (C-3′), 70.31 (C-4′), 79.36 (C-5′), 61.21 (C-6′); ESI MS *m/z* (rel.int.): 342 $[M]^+$ ($C_{12}H_{22}O_{11}$) (1.9), 179 (11.5).

Linoleiyl O-α-D-digalactoside (**4**)

Further elution of the column with chloroform – methanol (9 : 1) furnished a yellow semisolid mass of **4**, yield 208 mg, IR γ_{max} (KBr): 3411, 3326, 3251, 2922, 2839, 1724, 1632, 1452, 1387, 1213, 1089, 927, 734 cm^{-1}; ^1H NMR (MeOD): δ 5.42 (1H, m, H-12), 5.35 (1H, m, H-9), 5.19 (1H, m, H-10), 5.14 (1H, m, H-13), 2.78 (2H, m, H_2-11), 2.54 (2H, t, J=7.2 Hz, H_2-2), 2.12 (2H, m, H_2-8), 1.97 (2H, m, H_2-14), 1.55 (2H, m, CH_2), 1.32 (2H, m, CH_2), 1.29 (12H, brs, 6 x CH_2), 0.86 (3H, t, J=6.6 Hz, Me-18); 5.24 (1H, d, J = 4.8 Hz, H-1′), 4.06 (1H, m, H-2′), 3.77 (1H, m, H-3′), 3.63 (1H, m, H-4′), 4.36 (1H, m, H-5′), 3.37 (2H, d, J = 6.6 Hz, H_2-6′), 5.11 (1H, d, J = 5.2 Hz, H-1″), 4.02 (1H, m, H-2″), 3.71 (1H, m, H-3″), 3.59 (1H, m, H-4″), 4.19 (1H, m, H-5″), 3.14 (2H, d, J = 9.6 Hz, H_2-6″), ^{13}C NMR (MeOD): δ 172.21 (C-1), 37.59 (C-2), 34.21 (C-3), 28.48 (C-4), 28.35 (C-5), 28.33 (C-6), 28.71 (C-7), 29.13 (C-8), 119.26 (C-9), 145.76 (C-10), 38.49 (C-11), 132.79 (C-12), 116.19 (C-13), 29.27 (C-14), 27.78 (C-15), 25.26 (C-16), 22.68 (C-17), 14.16 (C-18), 105.32 (C-1′), 75.74 (C-2′), 74.47 (C-3′), 71.39 (C-4′), 83.69 (C-5′), 63.48 (C-6′), 93.73 (C-1″), 74.71 (C-2″), 73.27 (C-3″), 70.09 (C-4″), 79.29 (C-5″), 61.24 (C-6″); ESI MS *m/z* (rel. int.): 604 $[M]^+$ ($C_{30}H_{52}O_{12}$) (1.4), 425 (2.8), 279 (25.9), 179 (4.7).

α-D-6-O-trigalactoside (5)

Elution of the column with chloroform - methanol (17:3) yielded pale yellow crystals of **5**, yield 122 mg, m. p. 143 – 145 °C; IR γ_{max} (KBr): 3429, 33717, 3267, 2955, 2841, 1618. 1445, 1387, 1218, 1087, 873 cm^{-1}; ^1H NMR (MeOD): δ 5.41 (1H, d, J = 4.7 Hz, H-1), 4.51 (1H, m, H-5), 4.07 (1H, m, H-2), 3.92 (1H, m, H-3), 3.78 (1H, m, H-4), 3.32 (2H, d, J = 6.7 Hz, H_2-6), 5.34 (1H, d, J = 4.9 Hz, H-1′), 4.47 (1H, m, H-5'), 4.03 (1H, m, H-2′), 3.87 (1H, m, H-3'), 3.68 (1H, m, H-4'), 3.29 (2H, d, J = 8.1 Hz, H_2-6′), 5.15 (1H, d, J = 4.6 Hz, H-1″), 4.33 (1H, m, H-5″), 3.97 (1H, m, H-2″), 3.78 (1H, m, H-3″), 3.62 (1H, m, H-4″), 3.12 (2H, d, J = 7.9 Hz, H_2-6″); ^{13}C NMR (MeOD): δ 105.43 (C-1), 78.71 (C-2), 74.46 (C-3), 72.14 (C-4), 84.93 (C-5), 63.42 (C-6), 93.73 (C-1′), 75.83 (C-2′), 73.89 (C-3′), 71.41 (C-4′), 83.79 (C-5′), 62.41 (C-6′), 92.69 (C-1″), 74.79 (C-2′), 72.68 (C-3″), 67.18 (C-4′), 79.47 (C-5′), 60.88 (C-6′); ESI MS *m/z* (rel.int.): 504 $[M]^+$ ($C_{18}H_{32}O_{16}$) (1.3), 179 (11.5).

α-D-6-O- Tetragalactoside (6)

Elution of the column with chloroform-methanol (13:7) yielded a transparent sticky mass of **6**, yield 202 mg, R_f 0.3 (chloroform-methanol-formic acid, 95: 5: 0.1); UV λ_{max} (MeOH) 267 nm; IR λ_{max} (KBr); 3405, 3353, 3231, 2927, 2841, 1643, 1452, 1389, 1084, 875 cm^{-1}; ^1H NMR (MeOD): δ 5.41 (1H, d, J = 5.2 Hz, H-1), 4.16 (1H, m, H-5), 3.98 (1H, m, H-2), 3.77 (1H, m, H-3), 3.66 (1H, m, H-4), 3.41 (2H, d, J = 6.8 Hz, H_2-6), 5.13 (1H, d, J = 4.9 Hz, H-1′), 4.09 (1H, m, H-5′), 3.89 (1H, m, H-2′), 3.76 (1H, m, H-3′), 3.63 (1H, m, H-4′), 3.35 (2H, d, J = 5.9 Hz, H_2-6′), 4.95 (1H, d, J = 4.8 Hz, H-1″), 4.05 (1H, m, H-5″), 3.83 (1H, m, H-2″), 3.72 (1H, m, H-3″), 3.61 (1H, m, H-4″), 3.31 (2H, d, J = 6.2 Hz, H_2-6″), 4.88 (1H, d, J = 4.6 Hz, H-1‴), 4.01 (1H, m, H-5‴), 3.80 (1H, m, H-2‴), 3.67 (1H, m, H-3‴), 3.58 (1H, m, H-4‴), 3.15 (2H,d, J = 6.6 Hz, H_2-6‴), ^{13}C NMR (MeOD): δ 105.45 (C-1), 75.66 (C-2), 73.85 (C-3), 72.66 (C-4), 84.87 (C-5), 64.16 (C-6), 99.33 (C-1′), 74.78 (C-2′), 73.57 (C-3′), 72.13 (C-4′), 83.81 (C-5′), 63.42 (C-6′), 98.26 (C-1″), 74.42 (C-2″), 73.31 (C-3″), 71.93 (C-4″), 79.48 (C-5″), 62.21 (C-6″), 93.75 (C-1‴), 74.14 (C-2‴), 73.05 (C-3‴), 71.46 (C-4‴), 78.19 (C-5‴), 60.90 (C-6‴); ESI MS *m/z* (rel. int.); 666 $[M]^+$ ($C_{24}H_{42}O_{21}$) (5.2), 503 (11.3), 487 (8.8), 325 (12.5), 179 (7.1). Acid hydrolysis of 5 yielded D-galactose, R_f 0.21 (*n*-butanol-toluene-pyridine-water, 5:1:3:3), $[\alpha]_D^{20}$ +150.5°.

Phytoconstituents isolated from Machilus leaves

8, 21-Dihydroxylanostdien-3-olyl behenate (7)

Elution of the column with chloroform-methanol (49:1) produced colourless crystals of **7**, yield 163 mg, m. p. 233-235 °C; IR ν_{max} (KBr): 3510, 3416, 2918, 2854, 1721, 1640, 1461, 1373, 1272, 1123, 727 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.37 (1H, m, H-5), 4.92 (1H, s, H_2-26a), 4.90 (1H, s, H_2-26b), 4.38 (1H, dd, J = 5.3, 9.5 Hz, H-3α), 3.21 (2H, d, J = 6.5 Hz, H_2-21), 1.92 (3H, brs, Me-27), 1.21 (3H, s, Me-28), 1.19 (3H, brs, Me-29), 1.16 (3H, brs, Me-19), 1.14 (3H, brs. Me-30), 1.01 (3H, brs, Me-18), 2.72 (2H, m, H_2-7), 2.02 - 1.33 (21H, m, 9 × CH_2, 3 × CH), 2.35 (2H, t, J = 7.5 Hz, H_2-2′), 1.55 (2H, m, H_2-3′), 1.28 (36 H, brs, 18 x CH_2), 0.83 (3H, t, J = 6.1 Hz, Me-22′); ^{13}C NMR ($CDCl_3$): δ 39.34 (C-1), 25.75 (C-2), 79.30 (C-3), 42.32 (C-4), 142.97 (C-5), 121.71 (C-6), 28.26 (C-7), 71.81 (C-8), 50.12 (C-9), 36.79 (C-10), 23.07 (C-11), 29.13 (C-12), 45.42 (C-13), 56.76 (C-14), 33.94 (C-15), 31.60 (C-16), 59.55 (C-17), 11.79 (C-18), 21.09 (C-19), 30.79 (C-20), 63.06 (C-21), 37.25 (C-22), 24.14 (C-23), 42.83 (C-24), 140.74 (C-25), 116.13 (C-26), 19.40 (C-27), 19.15 (C-28), 19.04 (C-29), 18.79 (C-30), 173.16 (C-1′), 56.05 (C-2′), 47.87 (C-3′), 30.68 (C-4′), 29.72 (C-5′), 29.69 (C-6′), 29.64 (C-7′), 29.45 (C-8′), 29.28 (C-9′ to C-14′), 29.13 (C-15′ to C-18′), 27.23 (C-19′), 24.31 (C-20′), 21.11 (C-21′), 14.04 (C-22′); ESI MS *m/z* (rel. int.): 780 $[M]^+$ ($C_{52}H_{92}O_4$) (16.2), 457 (12.5), 440 (20.5), 339 (32.8), 313 (31.8), 127 (23.6).

3′, 4′-Dimethoxyeriodictyol 7-O- glucorhamnoside (8)
Elution of column with chloroform – methanol (3:1) furnished yellow crystals of **8**, yield 155 mg, m. p. 174 - 176 °C, UV λmax (MeOH): 287, 328 nm; IR γ_{max} (KBr): 3510, 3418, 3217, 2927, 2835, 1668, 1601, 1453, 1405, 1326, 1127, 1076 cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.01 (1H, d, J = 2.8 Hz, H-2′), 6.99 (1H, dd, J = 2.8, 8.4 Hz, H-6′), 6.96 (1H, d, J = 8.4 Hz, H-5′), 6.21 (1H, d, J = 2.0 Hz, H-8), 6.17 (1H, d, J = 2.0 Hz, H-6), 5.56 (1H, dd, J = 3.2, 12.9 Hz, H-2), 3.19 (1H, dd, J = 2.8, 17.0 Hz, H_2-3a), 2.81 (1H, dd, J = 3.2, 12.9 Hz, H_2-3b), 3.82 (3H, brs, OMe), 3.44 (3H, brs, OMe), 5.48 (1H, d, J = 4.8 Hz, H-1″), 4.84 (1H, m, H-5″), 4.71 (1H, dd, J = 4,8, 6.4 Hz, H-2″), 3.69 (1H, m, H-3″), 3.42 (1H, m, H-4″), 3.23 (2H, d, J = 8.4 Hz, H_2-6″), 5.27 (1H, d, J = 5.3 Hz, H-1‴), 4.79 (1H, m, H-5‴), 4.58 (1H, m, H-2‴), 3.51 (1H, m, H-3‴), 3.35 (1H, m, H-4‴), 1.21 (3H, d, J = 7.2 Hz, Me-6‴), ^{13}C NMR (DMSO-d_6): δ 78.41 (C-2), 42.23 (C-3), 197.03 (C-4), 162.96 (C-5), 99.14 (C-6), 165.07 (C-7), 95.48 (C-8), 162.50 (C-9), 103.25 (C-10), 130.89 (C-1′), 114.09 (C-2′), 146.35 (C-3′), 147.90 (C-4′), 117.94 (C-5′), 111.98 (C-6′), 55.60 (OMe), 58.57 (OMe), 100.56 (C-1″), 72.01 (C-2″), 70.63 (C-3″), 69.52 (C-4″), 76.20 (C-5″), 65.97 (C-6″), 96.31 (C-1‴), 72.92 (C-2″), 70.22 (C-3‴), 68.29 (C-4‴), 75.44 (C-5‴), 17.81 (C-6‴); ESI MS *m/z* (rel. int.): 624 $[M]^+$ ($C_{29}H_{36}O_{15}$) (5.2), 609 (5.7), 581 (12.1), 477 (14.9), 326 (25.8), 315 (11.9), 300 (33.6), 298 (32.1), 253 (38.7), 164 (21.2), 150 (25.5), 147 (22.3), 105 (35.8).

RESULTS AND DISCUSSION

Compound **1**, designated as capryl O-α-D-galactoside, showed IR absorption bands for hydroxyl groups (3419, 3269 cm^{-1}), ester function (1725 cm^{-1}) and long aliphatic chain (729 cm^{-1}.). Its mass spectrum displayed a molecular ion peak at *m/z* 334 consistent with a molecular formula of an acyl glycoside, $C_{16}H_{30}O_2$. The ^1H NMR spectrum of **1** exhibited a one-proton doublet at δ 5.32 (J = 4.5 Hz) assigned to anomeric H-1′ proton, other sugar protons as multiplets between δ 4.46 - 3.62 and as a two-proton doublet at δ 3.18 (J = 8.8 Hz) due to hydroxymethylene H_2-6′ protons, methylene protons nearby ester group as a two-proton triplet at δ 2.49 (J = 7.2 Hz), as two-proton multiplets at δ 1.54 and 1.31 and as a broad singlet at δ 1.27 (24H) and as a three-proton triplet at δ 0.88 (J = 6.3 Hz) accounted to terminal C-10 primary methyl protons. The ^{13}C NMR spectrum of **1** displayed signals for ester carbon at δ 171.33 (C-1), anomeric carbon at δ 105.22 (C-1′), other sugar carbons from δ 79.48 to 61.21, methylene carbons between δ 42.59 – 22.69 and methyl carbon at δ 14.21 (C-10). Acid hydrolysis of **3** yielded capric acid, m. p. 31 °C and D-galactose, R_f 0.21 (*n*-butanol-toluene-pyridine-water, 5:1:3:3). On the basis of these evidences, the structure of compound **1** has been characterized as *n*-decanoyl O-α-D-galactopyranoside (Fig 1).

The compound **2**, $[M]^+$ at *m/z* 412 ($C_{23}H_{40}O_6$), showed positive tests for glycosides and IR absorption bands for hydroxyl groups (3414, 3356 cm^{-1}), ester function (1722 cm^{-1}), unsaturation (1637 cm^{-1}) and long aliphatic chain (729 cm^{-1}). The mass spectrum exhibited ion peaks arising at *m/z* 279 $[CH_3(CH_2)_3(CH_2CH{=}CH)_2(CH_2)_7COO]^+$ and 149 $[(C_5H_9O_5]^+$ suggesting that linoleic acid was esterified with a pentose sugar unit. The ^1H NMR spectrum of **2** displayed four one-proton multiplets at δ 5.38, 5.33, 5.09 and 5.04 attributed to vinylic H-12, H-9, H-10 and H-13 protons, respectively. A one-proton doublet at δ 5.26 (J = 4.8 Hz) and a two-proton triplet at δ 2.32 (J = 7.5 Hz) were ascribed to anomeric H-1′ and methylene H_2-2 adjacent to the ester group, respectively. The other sugar protons resonated as one-proton multiplets at δ 4.23 (H-2′), 3.87 (H-3′) and 3.61 (H-4′) and as a two-proton doublet at δ 3.34 (J = 7.6 Hz, H_2-5′). A three-proton triplet at δ 0.85 (J=6.5 Hz) was due to C-18 primary methyl protons. The methylene protons appeared as two – proton multiplets between δ 2.74 – 1.34 and as a broad signal at δ 1.28 (12H). The ^{13}C NMR spectrum of **2** exhibited signals for ester carbon at δ 170.53 (C -1), vinylic carbons between δ 145.63 – 116.43, methyl carbon at δ 14.12 (C -18), anomeric carbon at δ 105.34 (C-1′) and other sugar carbons from δ 75.31 to 65.28. Acid hydrolysis of **2** yielded linoleic acid, R_f 0.48 (85% glacial AcOH) and D-arabinoside, R_f 0.70 (*n*-butonal : acetic acid: water (4:1:1.6). On the basis of the spectral data analysis and chemical reactions, the structure of **2** was elucidated as linoleiyl O-α-D-arabinopyranoside (Fig 1).

Compound **3**, named α-D-6-O-digalactoside, $[M]^+$ at *m/z* 342 ($C_{12}H_{22}O_{11}$), gave positive tests for glycosides and showed IR absorption bands for hydroxyl groups (3511, 3317, 3260 cm^{-1}). An ion fragment generated at *m/z* 179 $[C_6H_{11}O_6]^+$ indicated that two hexose units were linked in the molecule. The ^1H NMR spectrum of **3** exhibited two one-proton doublets at δ 5.32 (J = 4.8 Hz) and 5.14 (J = 4.6 Hz) assigned to anomeric H-1 and H-1′ protons, respectively, supported the existence of α-glycosidic units of the disaccharide. The other sugar protons resonated between δ 4.53 - 3.14. The ^{13}C NMR spectrum of **3** displayed signals for anomeric carbons at δ 105.38 (C-1) and 93.74 (C-1′) and the remaining sugar carbons from δ 83.79 to 61.21. The presence of the sugar H_2-6 signal in the deshielded region as a two – proton doublet at δ 3.34 (J = 8.7 Hz) in the ^1H NMR spectrum and C-6 carbon signal at δ 63.49 in the ^{13}C NMR spectrum suggested (6→1′) linkage of the sugar units. Acid hydrolysis of **3** yielded D-galactose, R_f 0.21 (*n*-butanol-toluene-pyridine-water, 5:1:3:3). On the basis of these evidences the structure of **3** has been formulated as α-D-galctopyranosyl-(6→1′)-O-α-D-galactopyranoside (Fig 1).

The compound **4**, designated as linoleiyl O-α-D-digalactoside, $[M]^+$ at *m/z* 604 ($C_{30}H_{52}O_{12}$), showed positive tests for glycosides and IR absorption bands similar to **2**. The mass ion peaks produced at *m/z* 279 $[CH_3(CH_2)_3(CH_2CH{=}CH)_2(CH_2)_7COO]^+$, 179

$[(C_6H_{11}O_6]^+$ and 425 $[M - 179]^+$ indicated that linoleic acid was esterified with a dihexose unit. The ^1H NMR spectrum of **4** displayed four one-proton multiplets between δ 5.42 – 5.14 assigned to vinylic H-12, H-9, H-10 and H-13 protons, two one-proton doublets at δ 5.24 (J = 4.8 Hz) and 5.11 (J = 5.2 Hz) due to anomeric H-1′ and H-1″ protons, respectively, other sugar protons from δ 4.36 to 3.14, methylene protons in the range of δ 2.78 – 1.29 and a three-proton triplet at δ 0.86 (J = 6.6 Hz) accounted to C-18 primary methyl protons. The ^{13}C NMR spectrum of **4** exhibited signals for ester carbon at δ 172.21 (C -1), vinylic carbons between δ 145.76 – 116.19, methyl carbon at δ 14.16 (C -18), anomeric carbon at δ 105.32 (C-1′) and 93.73 (C-1″) and other sugar carbons from δ 83.69 to 61.24. The presence of the sugar proton H_2-6′ signal in the deshielded region at δ 3.37 (d, J = 6.6 Hz) and carbon C-6′ signal at δ 63.48 in the ^{13}C NMR spectrum suggested (6′→1″) linkage of the sugar units. Acid hydrolysis of **4** yielded linoleic acid and D-galactose, R_f 0.21 (*n*-butanol-toluene-pyridine-water, 5:1:3:3). On the basis of the spectral data analysis and chemical reactions, the structure of **4** was elucidated as linoleiyl O-α-D-galactopyranosyl-(6′→1″)-O-α-D-galactopyranoside (Fig 1).

Compound **5**, named α-D-6-O-trigalactoside, $[M]^+$ at *m/z* 504 ($C_{18}H_{32}O_{16}$), was a homologous component of **3.** Its ^1H NMR spectrum showed three one-proton doublets at δ 5.41 (J = 4.7 Hz), 5.34 (J = 4.9 Hz) and 5.15 (J = 4.6 Hz) assigned to anomeric H-1, H-1′ and H-1″ protons, respectively, and other sugar protons resonating between δ 4.51 - 3.12. The ^{13}C NMR spectrum of **5** displayed signals for anomeric carbons at δ 105.43 (C-1), 93.73 (C-1′) and 92.69 (C-1″) and the remaining sugar carbons from δ 84.93 to 60.88. The presence of the sugar oxymethylene proton signals in the deshielded region as two – proton doublets at δ 3.32 (J = 6.7 Hz, H_2-6) and 3.29 (J = 8.1 Hz, H_2-6′) in the ^1H NMR spectrum and their respective carbon signals at δ 63.42 (C-6) and 62.41 (C-6′) in the ^{13}C NMR spectrum suggested (6/6′→1′/1″) linkages of the sugar units. Acid hydrolysis of **5** yielded D-galactose, R_f 0.21 ((*n*-butanol-toluene-pyridine-water, 5:1:3:3). On the basis of these evidences the structure of **5** has been formulated as α-D-galactoyranosyl-(6→1′)-O-α-D-galactopyranosyl-(6′→1″)-O-α-D-galactopyranoside (Fig 1).

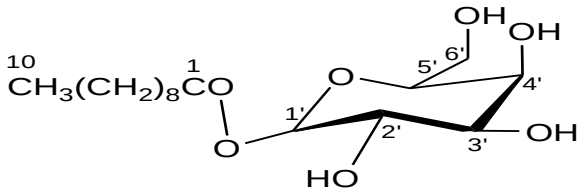
Compound **6,** $[M]^+$ at *m/z* 666 ($C_{24}H_{42}O_{21}$), was the known α-D-6-O-tetragalactoside and characterized as α-D-galactopyranosyl-(6→1′)-α-D-galactopyranosyl-(6′→1″)-α-D-galactopyranosyl-(6″→1‴)- α-D-galactopyranoside [21] (Jameel et al., 2015).

Compound **7**, named 8,21-dihydroxylanostdien-3-olyl behenate, responded positively to Liebermann-Burchardt test for triterpenoids and showed IR absorption bands for hydroxyl groups (3510, 3416 cm^{-1}), ester function (1721 cm^{-1}), unsaturation (1640 cm^{-1}) and long aliphatic chain (727 cm^{-1}). On the basis of mass and ^{13}C NMR spectra the molecular ion peak of **7** was determined at *m/z* 780 consistent with a molecular formula of a lanostanyl ester, $C_{52}H_{92}O_4$. The ion fragments arising at *m/z* 457 [$C_{1'}$ - O fission, $C_{30}H_{49}O_3]^+$, 339 [M – 457, $CH_3(CH_2)_{20}COO]^+$, 440 $[457 – OH]^+$, 127 [$C_{17} – C_{20}$ fission, $C_8H_{15}O$ side chain$]^+$ and 313 [440 – side chain, $C_{30}H_{48}O_3]^+$ indicated that the attachment of a behanate group linked to the lanostandiene unit possessing a C_8 side chain with a hydroxyl group and a vinylic bond.

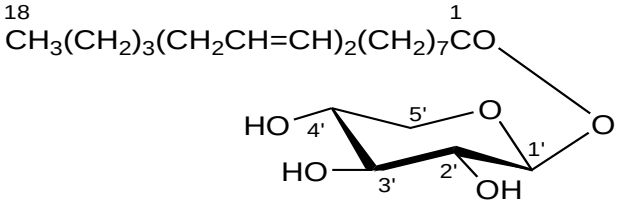
The ^1H NMR spectrum of **7** showed a one-proton multiplet at δ 5.37 assigned to vinylic H-5, two one-proton signals at δ 4.92 and 4.90 due to exocyclic methylene H_2-26 protons, a one-proton double doublet at δ 4.38 with coupling interactions of 5.3 and 9.5 Hz attributed to oxymethine H-3α proton, a two-proton doublet at δ 3.21 (J = 6.5 Hz) accounted to hydroxymethylene H_2-21 protons, six three-proton singlets between δ 1.92 – 1.01 accommodated to tertiary C-18 to C-30 methyl protons and a three – proton triplet at δ 0.83 (J = 6.1 Hz) ascribed to primary C-22′ methyl protons. The other methylene and methine protons resonated as multiplets from δ 2.72 to 1.55 and as a broad signal at δ 1.28 (36 H). The ^{13}C NMR spectrum of **7** showed signals for ester carbon at δ 173.16 (C-1′), vinylic carbons between δ 142.97 -116.13, oxymethine carbon at δ 79.30 (C-3), hydroxymethylene carbon at δ 63.06 (C-21), carbinol carbon at δ 71.81 (C-8) and methyl carbons from δ 21.09 to 14.04. The ^1H and ^{13}C NMR spectral data of the triterpenic unit of **7** were compared with the reported data of lanostene-type triterpenoids.[22,23] Acid hydrolysis of 7 yielded behenic acid, m. p. 79 – 80 °C. On the basis of above discussion the structure of **7** has been elucidated as 8,21-dihydroxylanost-5,25(26)-dien-3-olyl behenate, a new lanostane type-triterpenic ester (Fig 1).

Compound **8**, named 3′,4′-dimethoxyeriodictyol 7-O-glucorhamnoside, responded positively to phenolic and glycosidic tests and had UV absorption maxima at 287 and 328 typical for a flavanone derivative.[24] It showed a bathochromic shift of 40 nm on addition of $AlCl_3$ and $AlCl_3$/HCl suggesting the presence of a chelated hydroxyl function at C-5. Its IR spectrum disclosed a characteristic absorption for the conjugated carbonyl group (1668 cm^{-1}) and hydroxyl groups (3510, 3418, 3217 cm^{-1}). On the basis of its mass and ^{13}C NMR spectra the molecular ion peak of **8** was determined at *m/z* 624 consistent with a molecular formula of a flavonoid diglycoside, $C_{29}H_{36}O_{15}$. The important ion peaks generated at *m/z* 609 $[M - Me]^+$, 581 $[609 - CO]^+$, 147 [$C_{1'''}$ - O fission, $C_6H_{11}O_4]^+$, 477 $[M – 147]^+$, 326 [C_7 - O fission, $C_{12}H_{22}O_{10}]^+$, 298 [M – 326, $C_{17}H_{14}O_5]^+$ and 315 [$C_{1''}$ - O fission, $C_{17}H_{15}O_6]^+$ supported that a dihexoside unit was linked with the ring A of the flavanone. The ion fragments produced at *m/z* 300 $[315 – Me]^+$, 253 $[315 – 2 \times OMe]^+$, 164 [$C_{3,4} – C_{2,O}$ fission$]^+$ and 150 [$C_{3,2} – C_{2,O}$ fission$]^+$ indicated the presence of two methoxy groups in ring B and methylene protons at C-3.

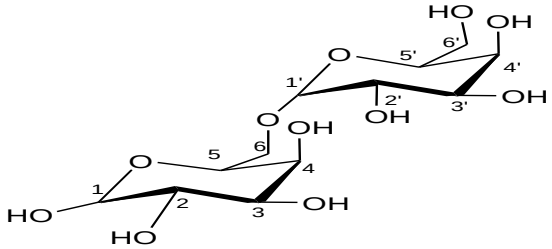
The ^{1}H NMR spectrum of **8** showed an ABX system of resonances as one-proton double doublets at δ 5.56 (J = 3.2, 12.9 Hz, H-2), 3.19 (J = 2.8, 17.0 Hz, H_2-3a) and 2.81 (J = 3.2, 12.9 Hz, H_2-3b) characteristic of oxymethine H-2 and methylene H_2-2 eq and H_2-2 ax, respectively, of a flavanone moiety. Four one-proton doublets at δ 7.01 (J = 2.8 Hz), 6.21 (J = 2.0 Hz), 6.17 (J = 2.0 Hz), 6.96 (J = 8.4 Hz), and a one-proton double doublet at δ 6.99 (J = 2.8, 8.4 Hz) were ascribed to meta-coupled H-2′, H-8 and H-6, *ortho*-coupled H-5′ and *meta*-, *ortho*-coupled H-6′ protons, respectively. Two one-proton doublets at δ 5.48 (J = 4.8 Hz) and 5.27 (J = 5.3 Hz), a three-proton doublet at δ 1.21 (J = 7.2 Hz) and two three-proton broad signals at δ 3.82 and 3.44 were accounted correspondingly to anomeric H-1″ and H-1‴, secondary methyl H_3-2‴ of rhamnose unit and two methoxy protons. The ^{13}C NMR spectrum of **8** displayed 29 signals including a carbonyl carbon of a flavanone at δ 197.03 (C-4), oxymethine at δ 78.41 (C-2), methylene carbon of the flavanone at δ 42.23 (C-3), methoxy carbons at δ 55.60 and 58.57, anomeric carbons at δ 100.56 (C-1″) and 96.31 (C-1‴), methyl carbon at δ 17.81 (C-6‴) and other sugar carbons between δ 76.20 – 65.97. The DEPT spectrum of **8** exhibited the presence of three methyl, two methylene, seven methine and eight quaternary carbons. The existence of the oxymethylene H_2-6″ proton signal in the deshielded region as a doublet at δ 3.23 (J = 8.4 Hz, H_2-6″) and its C-6″ carbon signal at δ 65.97 (C-6″) suggested (6″ →1‴) linkage of the sugar moieties. The ^{1}H and ^{13}C NMR spectral data of **8** were compared with the spectral values of the reported flavanones.[25,26] Acid hydrolysis of **8** yielded dimethoxyeriodictyol, D-glucose, R_f 0.18 (*n*-butanol – acetic acid – water, 4 : 1 : 5) and D-rhamnose, R_f 0.86 (*n*-butanol – acetic acid – water, 4 : 1 : 1.6). On the basis of these evidences the structure of **8** was formulated as 5,7-dihydroxy-3′,4′-dimethoxyflavanone-7-O-α-D-glucopyranosyl-(6″→1‴)-α-D- rhamnopyranoside, a new flavanone diglycoside (Fig 1).



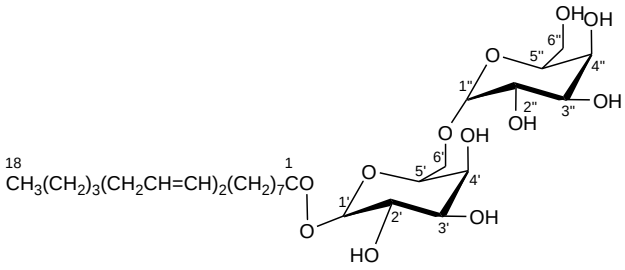
(1). Capryl-O-α-D-galactoside.



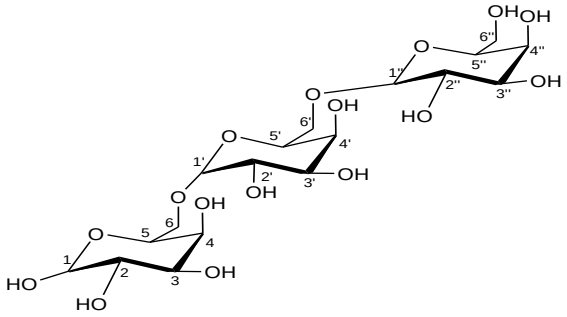
(2). Linoleiyl-O-α-D-arabinoside.



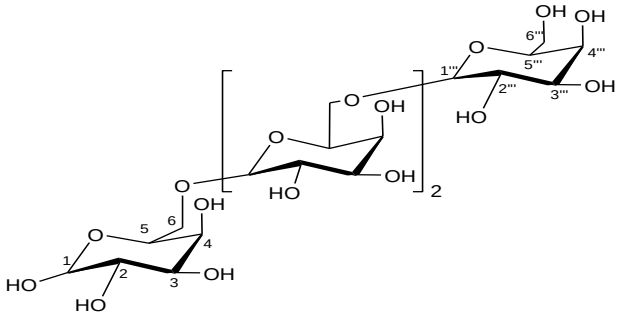
(3). α-D-6-O-Digalactoside.



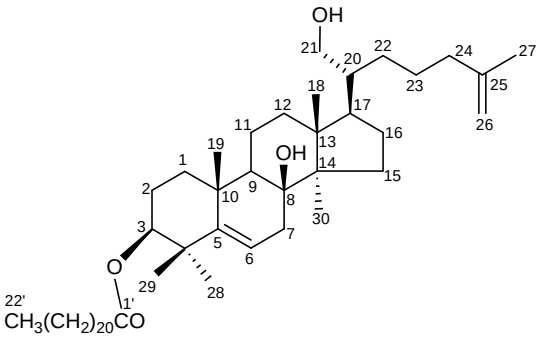
(4). Linoleiyl-O-α-D-digalactoside.



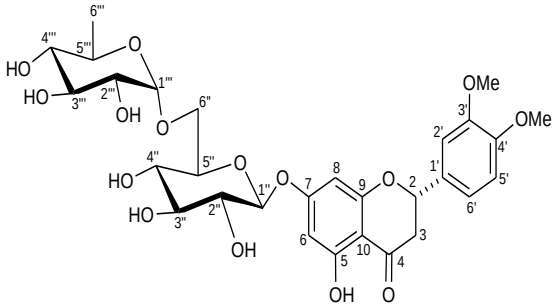
(5). α-D-6-O-Trigalactoside.



(6). α-D-6-O-Tetragalactoside.



(7). 8, 21-Dihydroxy lanostdien 3-olyl behenate.



(8). 3′, 4′-Dimethoxy eriodictyol-7-O-glucorhamnoside.

Fig. 1. Structural formulae of compounds 1 - 8 isolated from *Bauhinia racemosa* and *Terminalia bellerica.*

CONCLUSION

Phytochemical investigation of a methanolic extract of the stem bark of *Bauhinia racemosa* gave acyl glycosides and di-, tri- and tetragalactosides. The leaves of *Machilus bombycina* afforded a lanostene-type 3-olyl behenate and a flavanone-7-O-α-D-glucopyranosyl-(6″→1‴)-α-D-rhamnopyranoside. This work has enhanced understanding about the phytoconstituents of these plants. These secondary metabolites can be used as analytical markers for quality control of these herbal drugs.

ACKNOWLEDGMENT

The authors are thankful to the instrumentation centers, Central Drug Research Institute, Lucknow and Jawaharlal Nehru University, New Delhi for recording spectral data of the compounds.

REFERENCES

1. Kirtikar KR, Basu BD. Indian medicinal plants; v 2. Dehradun, India: Bishen Mahendra Pal Singh, 1975; 842-844.
2. Jain, S.K. Contribution to Indian ethnobotany. Scientific Publishers. India, 1997; 29-312.
3. Sahu T, Sahu J. *Buahinia racemosa* (kachnar): a review of its medicinal properties. World J Pharm Res., 2015; 4(5): 686-696.
4. Panda P, Das D, Dash P, Ghosh G. Therapeutic Potential of *Bauhinia racemosa*- A Mini Review. Int J Pharm Sci Rev Res., 2015; 32(2): 169-179.
5. Prakash A, Khosa RL. Chemical studies on *Bauhinia racemosa*. Current Sci., 1976; 45(19): 705-705.
6. Kumar RS, Sunderam RS, Sivakumar T, Sivakumar P, Sureshkumar R, Kanagasabi R, Vijaya M, Perumal BP, Gupta M, Mazumdar UK, Kumar MS, Kumar KA. Effect of *Bauhinia racemosa* stem bark on N–nitrosodiethylamine-induced hepatocarcinogenesis in rats. Amer J Chin Med., 2007; 35: 103–114.
7. Rahman MA, Akhtar J. A new linoleiyl arabinopyranoside from the bark of *Bauhinia racemosa* Lam and a new flavonoidal glycoside from the leaves of *Cordia dichotoma* Linn.. Natural Prod Res., 2016; 30(20): 2265-2273.
8. El–Hossary GA, Selim MA, Sayed AE, Khaleel AE. Study of the flavonoid Content of *Bassia muricata* and *Bauhinia recemosa*. Bull Fac Pharm Cairo Univ. 2000; 38: 93.
9. Anjaneyulu ASR, Reddy AVR, Reddy DSK, Ward RS, Adhikesavalu D, Cameron TS. Pacharin - a new dibenzo (2,3–6,7) oxepin from *Bauhinia racemosa*. Tetrahedron. 1984; 40 (21): 4245–4252.
10. Anjaneyulu ASR, Reddy AVB, Reddy DSK, et al. Rasveratrol - a novel tetracyclic phenol from *Bauhinia racemosa* Lamk. Tetrahedron, 1986; 42(9): 2417-2420.
11. Swantijian K, Pathak V, Srivastava BK. Characterisation of flavonoids from seed coat of *Bauhinia racemosa*. Asian Journal of Chemistry. 2002; 14(2): 1067-1068.
12. Prabhakar P, Gandhidasan R, Raman PV et al. De-o-methylracemosol – a tetracyclic 2,2-dimethylchroman from the roots of *Bauhinia racemosa*. Phytochemistry, 1994; 36(3): 817-818.
13. Jain R, Alam S, Saxena U. A new tetracyclic phenol and other constituents from the roots of *Bauhinia racemosa*. Indian J. 2002; 41B(6): 1321-1322.
14. Jain R, Saxena U, Rathore K, et al . Bioactivities of polyphenolics from the roots of *Bauhinia racemosa*. Archives Pharmacal Res., 2008; 31(12): 1525-1529.
15. Rahman A , Tanti B, Sarma GC , Kalita J. Genetic diversity of *Persea bombycina* from Goalpara district of Assam, India. Adv Biosci Biotechn. 2012; 3: 20-24.
16. Quattrocchi U, CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific names, Synonyms and Etymology, 2012, CRC, Boca Raton, Florida, 2012; 51.
17. Neog K, Das A, Unni BG, Ahmed GU, Rajan RK. Studies on Secondary metabolites of Som (*Persea bombycina* Kost), a primary host plant of Muga silkworm (*Antheraea assamensis* Helfer). Int J Pharm Tech Research, 2011; 3 (3): 1441 - 1447.
18. Choudhary SN, Leclercq PE. Essential Oil of *Machilus bombycina* King from Northeast India J Essent Oil Res., 1995; 7(2): 199-201.

19. Choudhury SN, Ghosh AC, Choudhury M, Leclercq PA. Constituents of the flowers and fruits oils of *Persea gamblei* (King ex Hook. f.) Kost. from India. J Essent Oil Res., 1997; 9(2): 177 - 180.
20. Choudhury SN, Vajczikova I. Variation in the essential oil composition of *Persea bombycina* (King ex Hook.f.) Kost and its effect on muga silkworm (*Antheraea assama* Ww) – a new report. Indian J Chem, 2003; 42B, 641 -647.
21. Jameel M, Ali A, Ali M. Isolation of antioxidant phytoconstituents from the seeds of *Lens culinaris* Medik. Food Chem, 2015; 175: 358–365.
22. Xia Q, Zhang H, Sun X, Zhao H , Wu L, Zhu D, Yang G, Shao Y, Zhang X, Mao X, Zhang L, She G. A comprehensive review of the structure elucidation and biological activity of triterpenoids from Ganoderma spp. Molecules, 2014, 19, 17478-17535.
23. Bagri P, Ali M, Aeri V, Bhowmik M. Isolation and antidiabetic activity of new lanostenoids from the leaves of *Psidium guajava* L. Int J Pharm Pharmac Sci., 2016; 8(9): 14-18.
24. Mabry TJ, Markham KR, Thomas MB. The Ultraviolet Spectra of Isoflavones, Flavanones and Dihydroflavonols. In: The Systematic Identification of Flavonoids. Springer, Berlin, Heidelberg, 1970; 165-226.
25. Hammami S, Jannet HB, Bergaoui A, Ciavatta L, Cimino G, Mighri Z . Isolation and Structure Elucidation of a Flavanone, a Flavanone Glycoside and Vomifoliol from *Echiochilon Fruticosum* Growing in Tunisia. Molecules, 2004; 9: 602-608.
26. Iwase Y, Takahashi M, Takemura Y, Ju-ichi M, Ito C, Furukawa H, Yano M. Isolation and identification of two new flavanones and a chalcone from *Citrus kinokuni*. Chem Pharm Bull., 2001; 49(10): 1356-1358.