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CHEMICAL CONSTITUENTS FROM THE RHIZOMES OF *ALPINIA OFFICINARUM* AND STEM BARKS OF *BALANITES AEGYPTIACA* AND *BOMBAX CEIBA*

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ABSTRACT

Alpinia officinarum Hance (Zingiberaceae) is a perennial herb and its rhizomes are used to treat colic, diarrhoea, dyspepsia, fever, flatulence, gastritis, indigestion, malaria, microbial infections, epigastric pain, stomach ache and vomiting. *Balanites aegyptiaca* (L.) Delile (Balanitaceae) is a deep-rooted, evergreen, multibranched, spiny shrub and its stem bark is prescribed to relieve epilepsy, yellow fever, heartburn, jaundice, mental diseases, roundworm infection, syphilis and wounds. *Bombax ceiba* L. (Malvaceae) is a tall tree and its bark is effective against cholera, cough, diarrhoea, dysentery, fevers, indigestion, jaundice, menorrhoea, piles, pleurisy, stings, skin diseases, stomach ache, wounds and to regulate menstruation. Our study was planned to isolate the chemical constituents from the rhizomes of *A. officinarum* and stem barks of *B. aegyptiaca* and *B. ceiba* and to characterize their structures. The air-dried plant materials were extracted with methanol separately. The concentrated methanolic extracts were subjected to silica gel (60-120 mesh) column chromatography individually. The columns were eluted with solvents successively in order of increasing polarity to isolate a variety of phytoconstituents. Phytochemical investigation of the rhizomes of *A. officinrum* gave a new triterpenoid identified as bauere-7, 20(30)-dien-3β-oyl octadecenoate (bauerenyl stearate, **1**), tetratriacontanoic acid (geddic acid, **2**), hexatriacontanoic acid (**3**), (Z)-cis-*n*-octatetracont-11-enoic acid (**4**), 13β-carboxylic acid *n*-hexadecanoic acid (**5**) and 1- hexadeanoyl-3-phosphatyl glycerol (**6**). The stem bark of *Balanites aegyptiaca* furnished α-D-glucopyranosyl-(6→1′)-O- α-D-glucopyranoside (6-O-α-D-glucosyl α-D-glucose, **7**) and 2-O-β-D-diglucosyl O-β-D-dirhamnoside (**8**). The stem bark of *Bombax ceiba* afforded lupeol (**9**) and 2-hexyl-7,8-dimethyl 1,4-naphthaquinone (**10**). Their structures were established on the basis of spectral data analysis and chemical reactions.

KEYWORDS: *Alpinia officinarum* rhizomes, *Balanites aegyptiaca* stem bark, *Bombax ceiba* stem bark, phytoconstituents, isolation, spectral data analysis.

INTRODUCTION

Alpinia officinarum Hance, syn. *Languas officinarum* (Hance) Farw. (family Zingiberaceae), commonly known as kulinjanm, sugandha bacha and lesser galangal, is a native to China and found in Hainan, Japan, Thailand, Viet Nam and India. It is cultivated in plains of West Bengal and Assam in the eastern Himalayas. The plant is a perennial herb up to 2 m in height, with lanceolate leaves, white flowers having streaks of red, growing from a spike at the top; thin, branched, woody, tough, aromatic, sweet, cylindrical, dark orange rhizomes with a brown coating, distinct nodes and internodes.[1] The rhizomes are anti-inflammatory, analgesic, anticoagulant, antidiabetic, antidiarrheal, anti-emetic, antioxidant, antiulcer, aromatic, bitter, carminative, digestive and stimulant, used to relieve colic, diarrhoea, dyspepsia, fever, flatulence, gastritis, indigestion, malaria, microbial infections, epigastric pain, stomach ache and vomiting; locally applied to infected gums. The seeds are used for treating heartburn, cholera, toothache, ague and colds.[2-4] The rhizomes contained phenylpropanoids,[5] diarylheptanoids,[6-17] diterpenes,[18], volatile oil consisting of α-farnesene, γ-muurolene, 2,6-dimethyl-6-(4-methyl-3-pentenyl) bicycle-[3.1.1] hept-2-ene, eucalyptol and cadina-1(10), 4-diene[19] and glycosides.[20] Flavonoids, hexahydrocurcumin, pinocembrin, chrysin and isorhamnetin were isolated from the aerial parts and the leaves.[21-23] The leaves afforded tetradecanyl capriate and bauerenyl arachidate.[24]

Balanites aegyptiaca (L.) Delile, syn. *Agialid aegyptiaca* (L.) Kuntze, *A. arabica* Tiegh., *Balanites arabica*

(Tiegh.) Blatt., *B. ferox* G. Don, *B. latifolia* (Tiegh.) Chiov., *B. racemosa* Chiov., *B. roxburghii* Planch., *Ximenia aegyptiaca* L. (Balanitaceae, Zygophyllaceae), commonly known as desert date, soap berry tree or bush, thoron tree, Egyptian myrobalan, Egyptian balsam or Zachum oil tree, is probably a native to Egypt and globally distributed from tropical Africa to Arabia, India, Pakistan and Myanmar. It is a deep-rooted, evergreen or semi-deciduous multibranched, spiny shrub or tree; bark dark brown to grey, deeply fissured. The plant is useful as an antihelminthic, emetic, febrifuge, purgative, vermifuge and to relieve aches, colds, skin boils, leucoderma, liver and spleen disorders, malaria, wounds, syphilis and wounds. The fruits are anthelmintic, arrow poison and purgative, eaten with porridge by nursing mothers and the oil is consumed to calm down headache, to improve lactation, to treat diarrhoea, infections, jaundice, leukoderma, liver and spleen disorders, mouth ulcer, whooping cough, sleeping sickness, skin diseases and to prevent pregnancy. A fruit paste is applied to relieve migraine, to subside acne, boils and ulcers and as a suppository to expel worms. The stem bark is useful as an abortifacient, antidote for arrow poison and snakebites, fish poison, molluscicide, piscicide, purgative, spasmolytic and to overcome epilepsy, yellow fever, heartburn, jaundice, mental diseases, roundworm infection, syphilis and as a fumigant to heal circumcision wounds. A soup prepared by boiling the roots is drunk against anthrax, diarrhoea, intestinal worms, malaria and stomach pain. A root infusion is utilized as an anthelmintic, antidote to snake bite, emetic and fish poison. The root bark infusion is administered orally to comfort diarrhoea and piles. A root paste is applied to reduce swelling due to insect bites. A paste of the shoot is used for dressing of wounds and as tooth brushes when frayed. The thorns are prescribed to cure leprosy. Wood gum mixed with maize meal porridge is eaten against chest complaints. The leaves are utilized as an antihelminthic, fish poison, to cure anthrax and to clean malignant wounds. The seeds are anthelmintic, antidote to arrow poison, antiseptic, expectorant, febrifuge, fish poison, purgative and vermifuge, used to treat burns, colic pain and cough. Kernel oil is used to subdue piles, skin disease, syphilis and wounds.[3,25]

The roots of *B. aegyptiaca* contained balanitins, diosgenin and steroidal glycosides.[26-28] The stem bark yielded balanitol (a sesquiterpene), saponins, deltonin and protodeltonin,[29] furanocoumarin, bergapten, a dihydrofuranocoumarin (marmesin),[30] balanitins 1, 2 and 3, diosgenin, glucose and rhamnose,[31] alkaloids N-trans-feruloyltyramine and N-*cis*-feruloyltyramine, vanillic acid, syringic acid and 3 hydroxy-1-(4hydroxy-3 methoxyphenyl)-1-propanone,[32] 10-methyl-n-heptacosane, diglucosyldirhamnoside[33] and 9-octadecanoic acid.[34] The stem wood afforded balanitis.[35] The leaves and branches furnished flavonoids and phenolic and sinapic acids.[36,37] The fruits produced balanitins A – G, balanitin-3, 6-methyldiosgenin, balanitoside, pregnane glycosides[35,38-41], fixed oil[42] and furostanol saponin balanitesin,[40] 3-O-methyl-d-glucose, 9-octadecenamide, 13-docosasenamide and fatty acids.[43] The seeds yielded balanitins, deltonin and isodeltonin, diosgenin and saponins,[44-47] fixed oil composed mainly of palmitic, stearic, oleic, and linoleic acids[48,49] and essential components omega-3 and omega-6,[50] balanitin-6, balanitin-7, 9-octadecenamide, 3-O-methyl-d-glucose, 13-docosenamide and fatty acids.[43,51,52] The flowers possessed narcissin, hirsutrin, quercetrin, ilixantrin, rutin and isorhamnetin.[53]

Bombax ceiba L., syn. *B. aculeatum* L., *B. heptaphyllum* Linn., *B. malabaricum* DC., *Gossampinus malabarica* (DC.) Merrill., *G. rubra* Buch.-Ham., *Melaleuca grandiflora* Blanco, *Salmalia malabarica* (DC.) Schott & Endl. (family Malvaceae), known as red silk-cotton, red cotton tree, kapok, simbal and simal, is distributed in Australia, southern China, India, Laos, Myanmar, Malaysia, Indonesia, Philippines, Papua New Guinea, Sri Lanka, Thailand and Vietnam up to 12,000 m. It is a tall trees, with unbranched trunk; bark grey, covered with hard small conical prickles; leaves palmate, leaflets 6, glabrous, entire, elliptic-lanceolate, acuminate, attenuate at base, leathery, unequal; flowers large, numerous, showy, red, yellow or white, borne near the end of branches; fruits oblong, 5- valved capsules; seeds brown, smooth, obovoid, oily, embedded in silky white wool.[54,55]

The flowers are anthelmintic, astringent and refrigerant, used as a remedy for boils, piles, swelling, sexual impotency, snake bites and weakness.[56] The fruits are regarded as an analgesic and applied to heal wounds. Unripe fruits are eaten to prevent dysentery.[3] The roots are aphrodisiac, astringent, diuretic, emetic, stimulant and tonic, administered internally to treat coughs, diarrhoea, heart and lung diseases, impotency, leucorrhoea, spermatorrhoea, urinary complaints and sexual debility. The roots and seeds are utilized to cure leprosy. Semal root powder along with *Ipomoea digitata* root, shatawar and misri is taken twice a day with milk to prevent nocturnal emission and semen problems. A root decoction is given to promote conception, to prevent miscarriage and to cure menorrhea and sexual debility. A root paste is lapped over acne, boils, pimples and skin eruptions.[3,54,55,57] The whole plant is effective against bronchitis, cough, cystitis, inflammation, piles, skin diseases, ulcers, wounds and urinary calculus.[3] The bark is antiangiogenic and diuretic, used to treat cholera, cough, diarrhoea, dysentery, fevers, indigestion, jaundice, menorrhoea, piles, pleurisy, stings, stomach ache, wounds and to regulate menstruation.[56] The bark and flowers are given to cure gonorrhea, leucorrhea, and menstrual disorders in women, to increase sperm count, to treat impotency, hydrocele and spermatorrhoea, and to regularize menstruation and urinary problems. A bark paste mixed with cow dung is applied over back muscle of leg at night to treat hotness and inflammation. A bark paste is applied to cure boils due to small-pox,

carbuncles, pimples and wounds. The bark exudate is taken orally to treat worms and diarrhoea. The bark juice of *Bombax ceiba* mixed with *Mangifera indica* and *Psidium guajava* is given to relieve dysentery and intestinal spasm.[54,55] Semal root powder mixed with black pepper and dry ginger powder is ingested to suppress cold and cough. Root bark is given to improve breast milk.[57] Stem thorns are applied to cure abscesses, acne, skin blemish, pigmentation and pimples.[3,57] A gummy exudate from its branches and stem, known as mochras, is aphrodisiac, astringent, blood purifier and thermogenic, used to relieve phlegmatic cough, bleeding gums, burning sensation, diarrhoea in children, dysentery, leucorrhoea, menorrhagia, nocturnal enuresis, puerperal discharge, stomatitis, spermatorrhoea, urinary incontinence, wounds and weakness. Seed powder with hing (*Ferula foeitida*) is taken as an abortifacient. Stem powder is used to treat asthma.[54.55] A leaf decoction together with the bark of *Mangifera indica* is taken orally to comfort diarrhoea. A leaf infusion is ingested as a blood purifier.[58]

The flowers of *B. ceiba* yielded hentriacontane, hentriacontanol, flavonoids, β-setosterol, its glucoside, essential oil, polysaccharides, anthocyanidins, bombasin 4-O-β -D-glucoside, bombalin, dihydrodehydrodiconiferyl alcohol 4-O-β-D-glucoside, trans-3-(p-coumaroyl) quinic acid, neochlorogenic acid, sexangularetin-3-O-sophoroside, mangiferin, isomangiferin, 7-O-methyl mangiferin, esculetin, scopoletin, fraxetin, scopolin, blumenol C glucopyranoside, benzyl β-D-glucopyranoside, phenylethyl rutinoside, protocatechulic acid, chlorogenic acid, methyl chlorogenate and vanillic acid; 4-*epi*-bombalin, 2-*O*-(3,4-dihydroxybenzoyl)-2,4,6-trihydroxyphenylacetic acid 4-*O*-β-D-glucopyranoside, *N*-[(2*E*)-3-(4-hydroxyphenyl)-1-oxo-2-propen-1-yl]-L-tyrosine ethyl ester, 4-hydroxy-5-(2-oxo-1-pyrrolidinyl)-benzoic acid, amurenlactone A, eugenyl β-rutinoside, syringin, 3-hydroxy-1-(4-hydroxy-3,5-dimethoxyphenyl)-1-propanone and phenolic acids.[59-65] The seeds contained a fixed oil composed of glycerides of arachidic, linoleic, myristic, oleic and palmitic acids, carotenes, n-hexacosanol, ethyl gallate and tocopherols; octadecyl palmitate, gallic acid, tannic acid, 1-gallayl-β-glucose, ethyl gallate, α-, β- and γ-tocopherols.[54] The plant gum was consisted of gallic and tannic acids, L-arbinose, D-galactose, D-galacturonic acid and D-galactopyranose.[54]The roots afforded *n*-triacontanol, β-sitosterol, 6-methoxy flavone 3-O-β-D glucopyranosyl-D-xylotyranoside, isohemigossypol-1-2-dimethyl ether, 8-formyl-7-hydroxy-5-isopropyl-2-methoxy-3-methyl-1, 4-napthaquinine, 7-hydroxy cadalene, cadinanes, mucilage, starch, bombamalones A-D, bombamaloside, isohemigossypol-1-methyl ester, lacinilene C, 2-O-methylisohemigossylic acid lactone, bombaxquinone B, sugars (arabinose and galactose), peptic substances and tannins.[66] The root bark yielded lupeol, β-sitosterol, a napthoquinone, hemigossylic acid lactone-7-methyl ether and hydroxycadalene. The stem bark contained lupeol, β-sitosterol and shamimicin.[54] The leaves yielded a flavonol C-glycoside, shamimin, taraxeryl acetate, squalene, taraxerone, β-sitosterol palmitate, taraxerol, 4-methyl stigmast-7-en-3-ol, 1H-indole-3-carboxylic acid, 6-O-palmitoylsitosteryl-D-glucoside, 12β-hydroxyl-pregnane-4, 16-diene-3, 20-dione, loliolide and 5-(hydroxymethyl) furfural.[67-69]

Keeping in view the various therapeutic values of the plants and the development of ecofriendly, biodegradable and safer herbal preparations the rhizomes of *A. officinarum* and stem barks of *B. aegyptiaca* and *B. ceiba* were screened for the isolation and characterization of their chemical constituents.

MATERIALS AND METHODS

General procedures

Melting points were recorded using one end open capillary tubes on a thermoelectrically heated melting point M-560 apparatus (Perfit, India) without correction. UV spectra were determined with Lambda Bio 20 spectrophotometer (Perkin Elmer, Schwerzenbach, Switzerland) in methanol. The IR spectra were recorded by using KBr pellets with Jasco FT/IR-5000 Spectrometer (FTS 135, Hong Kong). The ^{1}H (400 MHz) and ^{13}C (100 MHz) NMR spectra were recorded on Bruker DRX Spectrometer (Rheinstetten, Germany) using $CDCl_3$ and DMSO-d_6 as solvents and TMS (Fluka analytical, Sigma-Aldrich, Netherland) as an internal standard. Mass spectrometric detection was carried out on (Q-TOF-ESI) (Waters Corp., UK) instrument with a +ve and –ve ESI techniques. Column chromatography was performed on silica gel (Qualigens, Mumbai, India) with 60-120 mesh particle size and petroleum ether, chloroform, methanol and other 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 or under UV radiations and spraying with ceric sulfate solution.

Collection of plant materials

The rhizomes of *A. officinarum* and stem barks of *B. aegyptiaca* and *B. ceiba* were collected locally from Delhi and authenticated by Prof. M. P. Sharma, Taxonomist, Department of Botany, Jamia Hamdard, New Delhi. The voucher specimens of these plant materials are preserved in the herbarium of the Department of Pharmacognosy and Phytochemistry, Jamia Hamdard, New Delhi.

Extraction and isolation

The rhizomes of *A. officinarum* and stem barks of *B. aegyptiaca* and *B. ceiba* (1 kg each) were coarsely powdered and extracted separately and exhaustively with methanol in a Soxhlet apparatus. The extracts were concentrated under reduced pressure to get dark brown masses, 115.6 g, 119.5 g and 123.8 g, respectively. The dried residues (100 g each) were 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 (b. p. 60 – 80 °C) individually. Each column was eluted with petroleum ether, petroleum ether - chloroform (9:1, 3:1, 1:1, 1:3, v/v), chloroform and chloroform - methanol (99:1, 49:1, 19:5, 9:1, 17:3, 4:1 7:3, 1:1, v/v). Various fractions were collected separately and matched by TLC to check homogeneity. Similar fractions having the same R_f values were combined and crystallized with solvents. The isolated compounds were recrystallized to get pure compounds.

Isolation of phytoconstituents from the rhizomes of *Alpinia officinarum*

Bauerenyl stearate (1)

Elution of the column with petroleum ether–chloroform (1:1) gave colourless crystals of **1**, recrystallized from chloroform - methanol (1:1), 231 mg, R_f 0.61 (petroleum ether-chloroform, 3:2), m. p. 142-143 ^{0}C; IR υ_{max} (KBr): 2918, 2849, 1731, 1640, 1462, 1369, 1247, 1025, 961, 875, 719 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.27 (1H, d, J = 5.3 Hz, H-7), 5.01 (1H, brs, H_2-30a), 4.95 (1H, brs, H_2-30a), 4.48 (1 H, dd, 5.5, 9.8 Hz, H-3), 2.61 (1H, m, H-19β), 2.36 (1H, d, J = 15.5 Hz, H-18β), 2.19 (1H, m, H-9α), 1.06 (3H, brs, Me-23), 1.04 (3H, brs, Me-27), 1.02 (3H, brs, Me-28), 0.94 (1H, m, H-5α), 0.87 (3H, d, J = 7.8 Hz, Me-29), 0.85 (3H, brs, Me-24), 0.73 (3H, brs, Me-25), 0.71 (3H, brs, Me-26), 2.41 (2H, t, J = 7.2 Hz, H_2 -2′), 1.55 (2H, m, H_2-3′), 1.25 (24H, brs, H_2-4′ to H_2-16′), 1.21 (2H, m, H_2-17′), 0.82 (3H, t, J =6.5 Hz, Me-18′), 2.57 – 1.30 (18H, m, 9 x CH_2); ^{13}C NMR ($CDCl_3$): δ 39.18 (C-1), 27.03 (C-2), 80.96 (C-3), 38.43 (C-4), 50.34 (C-5), 25.60 (C-6), 118.88 (C-7), 143.82 (C-8), 48.67 (C-9), 37.79 (C-10), 23.69 (C-11), 36.31 (C-12), 37.75 (C-13), 42.16 (C-14), 31.92 (C-15), 31.94 (C-16), 41.16 (C-17), 55.40 (C-18), 36.69 (C-19), 154.64 (C-20), 40.19 (C-21), 38.86 (C-22), 16.49 (C-23), 27.21 (C-24), 19.47 (C-25), 21.69 (C-26), 21.61 (C-27), 33.15 (C-28), 26.14 (C-29), 107.11 (C-30), 171.78 (C-1′), 42.20 (C-2′), 35.15 (C-3′), 31,51 (C- 4′), 29.68 (C-5′), 29.68 (C-6′), 29.68 (C-7′), 29.65 (C-8′), 29.57 (C-9′),29.53 (C-10′), 29.51 (C-11′), 29.49 (C-12′), 29.45 (C-13′), 26.95 (C-14′), 26.91 (C-15′), 25.57 (C-16′), 22.16 (C-17′), 14.18 (C-18′); +ve ESI MS *m/z* (rel. int.): 690 [M]$^+$ ($C_{50}H_{82}O_2$) (2.7), 406 (11.8), 312 (18.3), 302 (23.2), 295 (15.2), 284 (22.6), 267 (19.2), 232 (16.4).

Geddic acid (2)

Elution of the column with petroleum ether - chloroform (1:3) gave colourless crystals of **2**, recrystallized from acetone-methanol (1:1), 391 g, R_f 0.61 (petroleum ether - chloroform, 2:3), m. p. 90-91 ^{0}C; IR υ_{max} (KBr): 3433, 2917, 2849, 1708, 1472, 1261, 1101, 1023, 802, 728 cm^{-1}; ^{1}H NMR ($CDCl_3$) : δ 2.25 (2H, t, J = 7.5 Hz, H_2-2), 1.56 (2H, m, H_2-3), 1.32 (2H, m, H_2-4), 1.29 (10H, brs, 5 x CH_2) 1.25 (48 H, brs, 24 × CH_2), 0.83 (3 H, t , J = 6.3 Hz, Me-34); ^{13}C NMR ($CDCl_3$): δ 179.19 (C-1), 34.01 (C-2), 31.97 (C-3), 29.73 (23 × CH_2), 29.47 (C-27, C-28), 29.37 (C-29), 29.27 (C-30), 29.15 (C-31), 24.79 (C-32), 22.68 (C-33), 14.01 (Me-34); +ve ESI MS *m/z* (rel. int.): 508 [M]$^+$ ($C_{34}H_{68}O_2$) (1.5).

Hexatriacontanoic acid (3)

Further elution of the column with petroleum ether - chloroform (1:3) furnished pale yellow crystals of **3**, recrystallized from acetone-methanol (1:1), 350 mg (0.09% yield), R_f 0.63 (petroleum ether - chloroform, 4.5 : 5.5). m. p. 87-88 ^{0}C; IR υ_{max} (KBr): 3345, 2917, 2845, 1707, 1472, 1301, 1262, 1101, 1023, 803,728 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 2.34 (2H, t , J = 7.2 Hz, H_2- 2), 1.65 (2 H, m, H_2-3), 1.27 (64 H, brs , 32 × CH_2), 0.89 (3 H , t , J = 6.0 Hz, Me-36); ^{13}C NMR ($CDCl_3$): δ 181.05 (C-1), 33.77 (C-2), 31.95 (C-3), 29.71 (30 × CH_2) 24.80 (C-34), 22.67 (C-35), 14.01 (C-36); +ve ESI MS *m/z* (rel. int.): 536 [M]$^+$ ($C_{36}H_{72}O_2$) (1.7).

(Z)-cis- *n*-octatetracont-11-enoic acid (4)

Elution of the column with chloroform yielded pale yellow crystals of **4**, recrystallized from methanol ,153 mg; R_f, 0.62 (petroleum ether - chloroform, 3:7). m. p. 101-102 ^{0}C; IR υ_{max} (KBr): 3432, 2917, 2849, 1708, 1640, 1462, 1263, 1107, 802, 729 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.07 (1H, m, $w_{1/2}$ = 9.2 Hz, H-11), 5.02 (1 H, m, $w_{1/2}$ = 10.1 Hz, H-12), 2.34 (2H, t, J = 7.3 Hz, H_2-2), 2.04 (4H, m, H_2-10, H_2-13), 1.65 (6H, m, 3 × CH_2), 1.28 (78 H, brs, 39 × CH_2), 0.89 (3H, t, J = 6.6 Hz, Me-48); ^{13}C NMR ($CDCl_3$): δ 179.83 (C-1), 139.27 (C-11), 114.05 (C-12), 33.18 (C-2), 33.77 (C-10), 31.03 (C-13), 29.78 (3 x CH_2), 29.69 (30 × CH_2), 29.36 (3 × CH_2), 28.96 (C-43), 28.89 (C-44), 26.97 (C-45), 24.96 (C-46), 22.68 (C-47), 14.09 (Me-48); +ve ESI MS *m/z* (rel. int.): 702 [M]$^+$ ($C_{48}H_{94}O_2$) (45.8), 531 (18.3), 505 (11.7).

***n*-Hexadecan-1,13β-dioic acid (5)**

Elution of the column with chloroform - methanol (98:2) afforded light green crystals of **5**, recrystallized from ethyl acetate, 220 mg (0.06 % yield), R_f 0.69 (petroleum ether - chloroform, 3:7); m. p. 195 - 196 ^{0}C, IR υ_{max} (KBr) : 3455, 2916, 2848, 1709, 1462, 1377, 1261, 1100, 909, 802, 720 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 2.83 (2H, t, J = 7.4 Hz, H_2-2), 2.36 (1 H, m, $w_{1/2}$ = 10.6 Hz, H-13β), 1.62 (2 H, m, CH_2), 1.29 (22 H, brs, 11 × CH_2), 0.82 (3 H, t, J = 6.8 Hz, Me-16); ^{13}C NMR ($CDCl_3$) : δ 179.87 (C-1), 179.83 (C-17), 36.11 (C-13), 32.73 (C-2), 30.89 (CH_2), 28.63 (9 × CH_2), 28.29 (CH_2), 21.62 (CH_2), 13.07 (CH_3 - 16); +ve ESI MS *m/z* (rel. int.): 300 [M]$^+$ ($C_{17}H_{32}O_4$) (10.1), 199 (17.3), 101 (43.7).

Palmityl glycerol phosphate (6)

Further elution of the column with chloroform-methanol (98:2) gave colourless crystals of **6**, recrystallized from acetone - methanol (1:1), 105 mg, R_f 0.67 (petroleum ether – chloroform - methanol, 5:4:1). m. p. 160-161 ^{0}C; IR υ_{max} (KBr): 3452, 2917, 2849, 1737, 1627, 1463, 1096, 802, 728, 719 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 4.12 (2 H, m, H_2-1), 3.85 (1 H, m, H-2), 3.62 ((2 H, m, H-3), 2.28 (2 H, m, H_2-2′), 1.61 (2 H, m, H_2-3′), 1.26 (24 H, brs, 12 × CH_2), 0.87 (3 H, t, J = 6.1 Hz, Me-16′); ^{13}C NMR

($CDCl_3$): δ 173.05 (C-1′), 62.05 (C-1), 73.15 (C-2), 64.89 (C-3), 33.65 (C-2′), 31.32 (C-3′), 29.08 (10 × CH_2), 24.36 (C-14′), 22.09 (C-15′), 14.16 (Me-16′); +ve ESI MS *m/z* (rel. int.): 410 $[M]^+$ ($C_{19}H_{39}O_7P$) (1.5), 239 (100).

Isolation of phytoconstituents from the stem bark of *Balanites aegyptiaca*

6-O-α-D-Glucosyl α-D-glucose (7)

Elution of the column with chloroform – methanol (9:1) afforded colourless powder of **7**, recrystallized from ethanol, 344 mg, R_f: 0.86 (*n*-butanol –AcOH-water, 5:4:1); m. p. 160 - 162 °C, IR υ_{max} (KBr): 3405, 3324, 2950, 2912, 1452, 1381, 1261, 1123, 1052 cm^{-1}; ^1H NMR (DMSO-d_6): δ 5.02 (1H, d, J = 6.0 Hz, H-1α), 4.65 (1H, m, H-5), 4.45 (1H, m, H-4), 4.32 (1H, m, H-3), 4.15 (1H, m, H-2), 3.62 (1H, d, J = 8.9 Hz, H_2-6), 4.65 (1H, d, J= 6.2 Hz, H-1′), 4.50 (1H, m, H-5′), 4.42 (1H, m, H-4′), 4.29 (1H, m, H-3′), 4.02 (1H, m, H-2′), 3.24 (1H, d, J = 9.1 Hz, H_2-6′); ^{13}C NMR ($CDCl_3$): δ 101.23 (C-1), 83.85 (C-5), 72.65 (C-2), 72.02 (C-3), 70.14 (C-4), 62.49 (C-6), 95.53 (C-1′), 83.81 (C-5′), 72.46 (C-2′), 70.97 (C-3′), 70.11 (C-4′), 60.01 (C-6′); +ve ESI MS *m/z* (rel. int.): 342 $[M]^+$ ($C_{12}H_{22}O_{11}$) (11.8), 179 (28.3), 163 (14.2).

2-O-β-D-Di-glucosyl O-β-D-dirhamnoside (8)

Elution of the column with chloroform – methanol (4:1) gave colourless crystals of **8**, recrystallized from ethanol, 237 mg, R_f : 0.73 (*n*-butanol –AcOH-water, 5:4:1); m. p. 182 - 184 °C, IR υ_{max} (KBr): 3399, 3345, 3232, 2937, 2841, 1631, 1417, 1379, 1049 cm^{-1}; ^1H NMR (DMSO-d_6): δ 5.20 (1H, d, J = 8.4 Hz, H-1β), 4.66 (1H, m, H-5), 3.96 (1H, m, H-2), 3.75 (1H, m, H-3), 3.62 (1H, m, H-4), 3.18 (1H, d, J = 9.3 Hz, H_2-6), 5.17 (1H, d, J= 7.3 Hz, H-1′), 4.41 (1H, m, H-5′), 3.91 (1H, m, H-2′), 3.71 (1H, m, H-3′), 3.54 (1H, m, H-4′), 3.03 (1H, d, J = 8.7 Hz, H_2-6′), 5.04 (1H, d, J= 8.9 Hz, H-1″), 4.39 (1H, m, H-5″), 3.88 (1H, m, H-2″), 3.68 (1H, m, H-3″), 3.48 (1H, m, H-4″), 0.91 (3H, d, J = 6.7 Hz, CH_3-6″), 4.99 (1H, d, J= 7.7 Hz, H-1‴), 4.24 (1H, m, H-5‴), 3.78 (1H, m, H-2‴), 3.67 (1H, m, H-3‴), 3.41 (1H, m, H-4‴), 0.87 (3H, d, J = 6.3 Hz, CH_3-6‴); ^{13}C NMR ($CDCl_3$): δ 103.61 (C-1), 75.69 (C-2), 72.91 (C-3), 70.98 (C-4), 83.81 (C-5), 61.17 (C-6), 102.70 (C-1′), 75.35 (C-2′), 72.65 (C-3′), 70.63 (C-4′), 76.84 (C-5′), 60.98 (C-6′), 97.60 (C-1″), 75.21 (C-2″), 72.45 (C-3″), 70.14 (C-4″), 76.23 (C-5″), 19.01 (C-6″), 92.11 (C-1‴), 74.11 (C-2‴), 72.04 (C-3‴), 69.92 (C-4‴), 75.06 (C-5‴), 17.77 (C-6‴); +ve ESI MS *m/z* (rel. int.): 634 $[M]^+$ ($C_{24}H_{42}O_{19}$) (5.6), 341 (12.3), 325 (18.2), 309 (7.1), 293 (9.1), 179 (32.8), 147 (21.4).

Isolation of phytoconstituents from the stem bark of *Bombax ceiba*

Lupeol (9)

Elution of the column with petroleum ether - chloroform (1:3) gave colourless needles of **9,** recrystallized from chloroform –methanol (1:1), 324 mg, R_f : 0.72 (toluene-ethyl acetate- formic acid, 5:4:1); m. p. 213 - 215 °C, UV λmax (MeOH): 274 nm (log ε 4.9); IR υ_{max} (KBr): 3374, 2951, 2923, 2845, 1635, 1465, 1382, 1273, 1123, 1073 cm^{-1}; ^1H NMR ($CDCl_3$): δ 4.62 (1H, d, J = 3.3 Hz, H-29a), 4.51 (1H, d, J = 3.3 Hz, H-29b), 3.15 (1H, dd, J = 5.9, 8.8 Hz, H-3α), 2.37 (1H, m, H-19), 1.69 (3H, s, Me-30), 1.01 (3H, s, Me-26), 0.97 (3H, s, Me-23), 0.89 (3H, s, Me-27), 0.83 (3H, s, Me-25), 0.79 (3H, s, Me-28), 0.76 (3H, s, Me-24); ^{13}C NMR ($CDCl_3$): δ 40.02 (C-1), 27.44 (C-2), 79.02 (C-3), 38.87 (C-4), 55.36 (C-5), 18.34 (C-6), 35.61 (C-7), 40.88 (C-8), 50.49 (C-9), 38.11 (C-10), 20.96 (C-11), 27.95 (C-12), 38.75 (C-13), 42.86 (C-14), 28.01 (C-15), 34.33 (C-16), 43.01 (C-17), 48.36 (C-18), 48.02 (C-19), 150.94 (C-20), 29.68 (C-21), 37.20 (C-22), 29.89 (C-23), 18.01 (C-24), 16.11 (C-25), 16.02 (C-26), 15.35 (C-27), 14.58 (C-28), 109.30 (C-29), 19.32 (C-30); +ve ESI MS *m/z* (rel. int.): 426 $[M]^+$ ($C_{30}H_{50}O$) (19.6), 272 (11.2), 231 (11.7), 218 (13.6), 218 (26.1), 207 (20.7), 190 (32.5), 189 (39.1), 163 (26.3), 154 (37.6), 136 (78.1), 122 (95.6), 107 (100).

2-Hexyl-7,8-dimethyl 1,4-naphthaquinone (10)

Elution of the column with chloroform furnished reddish mass of **10,** recrystallized from chloroform –methanol (1:1), 532 mg, R_f : 0.68 (toluene-ethyl acetate- formic acid, 5:4:1); m. p. 258-260 °C, UV λmax (MeOH): 297 nm (log ε 5.2); IR υ_{max} (KBr): 2960, 2931, 1701, 1621, 1532, 1464, 1381, 1274, 1125, 1037, 742 cm^{-1}; ^1H NMR ($CDCl_3$): δ 7.39 (1H, s, H-3), 7.22 (1H, s, H-6), 7.05 (1H, s, H-9), 2.71 (2H, m, H_2-11), 2.26 (3H, s, Me-17), 2.24 (3H, s, Me-18), 2.16 (2H, m, H_2-12), 1.37 (2H, m, H_2-13), 1.26 (2H, m, H_2-14), 1.06 (2H, m, H_2-15), 0.83 (3H, t, J = 6.6 Hz, Me-16); ^{13}C NMR ($CDCl_3$): δ 190.21 (C-1), 132.18 (C-2), 138.79 (C-3), 183.97 (C-4), 131.82 (C-5), 126.85 (C-6), 137.23 (C-7), 137.20 (C-8), 126.84 (C-9), 131.78 (C-10), 25.69 (C-11), 24.13 (C-12), 23.27 (C-13), 22.68 (C-14), 21.26 (C-15), 14.17 (C-16), 12.31 (C-17), 11.98 (C-18); +ve ESI MS *m/z* (rel. int.): 270 $[M]^+$ ($C_{18}H_{22}O_2$) (18.7), 255 (4.3), 242 (4.2), 240 (3.7), 185 (3.1), 157 (100).

RESULTS AND DISCUSSION

Compound **1**, named bauerenyl stearate, responded positively to Liebermann–Burchard test for triterpenoids and showed IR characteristic absorption bands for an ester group (1731 cm^{-1}), unsaturation (1640 cm^{-1}) and long aliphatic chain (875, 719 cm^{-1}). On the basis of mass and ^{13}C NMR spectra its molecular ion peak was established at *m/z* 690 consistent with a molecular formula of a pentacyclic triterpenic ester, $C_{48}H_{82}O_2$. The generation of the important ion fragments at *m/z* 284 $[CH_3(CH_2)_{16}COOH, C_{18}H_{36}O_2]^+$ and 267 $[CH_3(CH_2)_{16}CO, C_{16}H_{35}O]^+$ indicated that stearic acid was esterified with the triterpenic unit. The formation of the ion peaks at *m/z* 232 $[C_{8,14}$ - $C_{9,11}$ fission, $C_{17}H_{28}]^+$ and 284 $[(C_{5,6}$ - $C_{9,10}$ fission, $C_{21}H_{32}]^+$ supported the location of one of the vinylic linkage in ring B. The ^1H NMR spectrum of **1** displayed a one-proton doublet at δ 5.27 (J = 5.3 Hz) assigned to vinylic H-7 proton. Two one-proton singlets at δ 5.01 and 4.95 were ascribed to exocyclic C-30 methylene protons. A one-proton double doublet at δ 4.48 with coupling interactions of 5.5, 9.8 Hz was attributed to oxymethine H-3α proton and its

deshielding location indicated the presence of the ester group at this carbon. Six three-proton broad singlets at δ 1.06, 1.04, 1.02, 0.85, 0.73 and 0.71 were associated with the tertiary C-23, C-27, C-28, C-24, C-25 and C-26 methyl protons, respectively. A three-proton doublet at δ 0.87 (J = 7.8 Hz) and a three- proton triplet at δ 0.82 (J = 6.5 Hz) were accounted correspondingly to secondary C-29 and primary C-18′ methyl protons. A one-proton doublet at δ 2.36 (J = 15.8 Hz) was due to the β-oriented C-18 methine proton. A two-proton triplet at δ 2.41 (J = 7.2 Hz,) was due to methylene H_2 -2′ protons adjacent to the ester function. The remaining methine and methylene protons resonated in the range of δ 2.61-1.30. The appearance of all the methyl signals in the range of δ 1.06 - 0.82 indicated that all these functionalities were located on the saturated carbon. The ^{13}C NMR spectrum of **1** exhibited signals for ester carbon at δ 171.78 (C-1′), vinylic carbons at δ 118.88 (C-7), 143.82 (C-8), 154.64 (C-20) and 107.11 (C-30), oxymethine carbon at δ 80.96 (C-3) and methyl carbons between δ 33.15 - 14.18. The ^{1}H and ^{13}C NMR spectral values of **1** were compared with the published data of bauerenyl - type molecules.[70] Alkaline hydrolysis of **1** yielded stearic acid, m. p. 74 - 75 °C, TLC –comparable, and bauerdienol. On the basis of spectral data analysis and chemical reactions the structure of **1** has been formulated as bauere-7, 20(30)-dien-3β-oyl octadecenoate (Fig. 1)**.** This is a new pentacyclic triterpenoid isolated from a natural source for the first time.

Compound **2** and **3** were the known chemical constituents identified as tetratriacontanoic acid (geddic acid)[71,72] and hexatriacontanoic acid, respectively (Fig. 1).[73]

Compound **4** produced effervescences with sodium bicarbonate solution and decolourized bromine water suggesting unsaturated nature of a fatty acid. Its IR spectrum showed characteristic absorption bands for carboxylic group (3432, 1708 cm^{-1}), unsaturation (1640 cm^{-1}) and long aliphatic chain (802,729 cm^{-1}). Its mass spectrum exhibited a molecular ion peak at *m/z* 702 corresponding to a molecular formula of a fatty acid, $C_{48}H_{94}O_2$. It indicated two double bond equivalents; one each of them was adjusted in the vinylic linkage and carboxylic function. The ion peaks arising at *m/z* 531 [C_{10} - C_{11} fission, $CH_3(CH_2)_{35}CH{=}CH$, $C_{38}H_{75}]^+$ and 505 [C_{12} - C_{13} fission, $CH_3(CH_2)_{35}$, $C_{36}H_{73}]^+$ suggested the existence of the vinylic linkage at C-11 carbon. The ^{1}H NMR spectrum of **4** showed two one-proton multiplets at δ 5.07 ($w_{1/2}$ = 9.2 Hz) and 5.02 ($w_{1/2}$ = 10.1 Hz) assigned to cis-oriented vinylic H-11 and H-12 protons, respectively. A two-proton triplet at 2.34 (J = 7.3 Hz) was ascribed to methylene H_2-2 protons adjacent to the carboxylic function. The other methylene protons resonated as multiplets at δ 2.04 (4H) and 1.65 (6H) and as a broad singlet at δ 1.28 (78 H). A three-proton triplet at δ 0.89 (J = 6.6 Hz) was accounted to C-48 primary methyl protons.

The ^{13}C NMR spectrum of **4** displayed signals for carboxylic carbon at δ 179.83 (C-1), vinylic carbons at δ 139.27 (C-11) and 114.05 (C-12), methylene carbons between 33.18 - 22.68 and methyl carbon at δ 14.09 (C-1, C-48). On the basis of spectral data analysis and chemical reactions, the structure of **4** has been elucidated as (Z)-cis- *n*-octatetracont-11-enoic acid, a new fatty acid (Fig. 1).

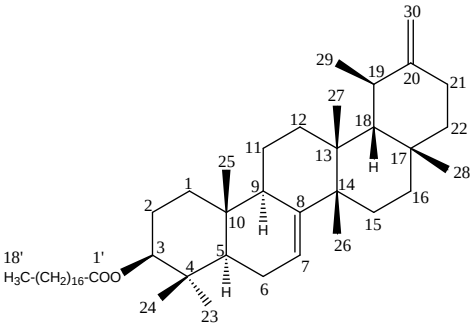
Compound **5** produced effervescences with sodium bicarbonate solution and showed distinctive IR absorption bands for carboxylic groups (3455, 1709 cm^{-1}) and long aliphatic chain (802, 720 cm^{-1}). The mass spectrum of **5** exhibited a molecular ion peak at *m/z* 300 corresponding to the molecular formula of dicarboxylic acid, $C_{17}H_{32}O_4$. A prominent ion peaks generated at *m/z* 101 [C_{11} – C_{12} fission, CH_3-$(CH_2)_2$-CH-COOH]$^+$ and [M – 101, $(CH_2)_{11}$-COOH]$^+$ supported the presence of one of the carboxylic function at C-13 position. The ^{1}H NMR spectrum of **5** displayed a two-proton triplet at δ 2.83 (J = 7.4 Hz) assigned to methylene H_2-2 protons adjacent to the carboxylic group, a one-proton multiplet at δ 2.36 with half-width of 10.6 Hz ascribed to α-oriented methine H-13 proton, other methylene protons as a two-proton multiplet at δ 1.62 and as a broad singlet at δ 1.29 (22 H). A three-proton triplet at δ 0.82 (J = 6.8 Hz) was ascribed to C-16 primary methyl protons. The ^{13}C NMR spectrum of **5** exhibited signals for carboxylic carbons at δ 179.87 (C-1) and 179.83 C-17), methine carbon at δ 36.11 (C-13), methylene carbons between δ 32.73 - 21.62 and methyl carbon at δ 13.07 (C-11). The absence of any signal beyond δ 2.83 in the ^{1}H NMR spectrum and between δ 179.83 - 36.11 in the ^{13}C NMR spectrum supported the saturated nature of the molecule. On the basis of foregoing account the structure of **5** has been formulated as 13β-carboxylic acid *n*-hexadecanoic acid (*n*-hexadecan-1,13β-dioic acid) (Fig. 1).

Palmityl glycerol phosphate (6)

Compound **6,** named palmityl glycerol phosphate, showed typical IR absorption bands for ester group (1737 cm^{-1}), hydroxyl function (3452 cm^{-1}) and long aliphatic chain (802, 728, 719 cm^{-1}). Its mass spectrum displayed the molecular ion peak at *m/z* 410 consistent with the molecular formula of fatty acid glyceride phosphate, $C_{19}H_{39}O_7P$. The formation of a prominent ion fragment at *m/z* 239 [CH_3 $(CH_2)_{14}CO]^+$ indicated that palmitic acid was esterified with glycerol phosphate. The ^{1}H NMR spectrum of **6** exhibited two two-proton multiplets at δ 4.12 and 3.62 assigned to oxymethylene H_2-1′ and H_2-3′ proton, respectively, and a one-proton multiplet at δ 3.85 attributed to hydroxymethine H-2 proton. A three-proton triplet at δ 0.87 (J = 6.1 Hz) was ascribed to C-16 primary methyl protons. The remaining methylene protons appeared as two-proton multiplets at δ 2.28 and 1.61 and as a broad singlet at δ 1.26 (24 H).

The ^{13}C NMR spectrum of **6** showed signals for ester carbon at δ 173.05 (C-1′), oxymethylene carbons at δ 62.05 (C-1) and 64.89 (C-3), hydroxymethine carbon at δ

73.15 (C-2), methylene carbons from δ 33.65 to 22.09 and methyl carbon at δ 14.16 (C-16′). The absence of any signal beyond δ 4.12 in the ^{1}H NMR spectrum and between δ 173.05 - 62.05 in the ^{13}C NMR spectrum supported the saturated nature of the molecule. The alkaline hydrolysis of **6** yielded palmitic acid. On the basis of spectral data analysis and chemical reactions, the structure of **6** has been established as 1- hexadeanoyl-3-phosphatyl glycerol (Fig. 1).



Bauerenyl stearate **(1)**

CH_3-$(CH_2)_{32}$-COOH

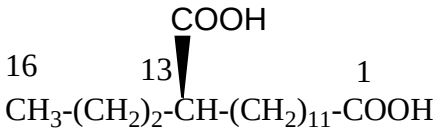
Geddic acid **(2)**

CH_3-$(CH_2)_{34}$-COOH

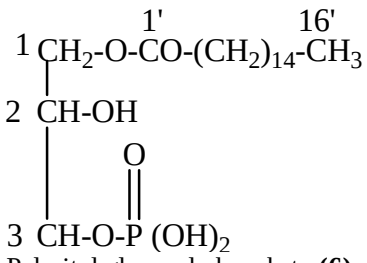
Hexatriacontanoic acid **(3)**

CH_3-$(CH_2)_{35}$-CH=CH-$(CH_2)_9$-COOH

***(Z)-cis-n*-Octatetracont-11-enoic acid (4)**



n-Hexadecan-1, 13*β*-dioic acid **(5)**

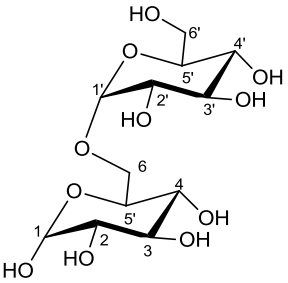


Palmityl glycerol phosphate **(6)**

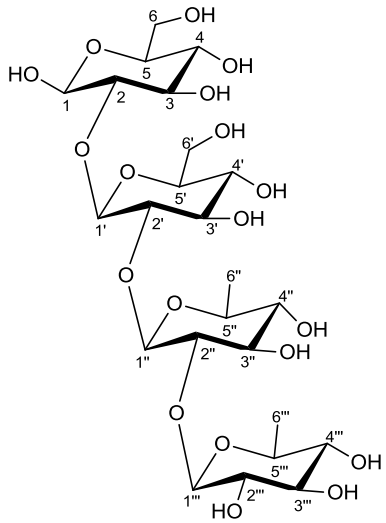
Fig 1: Structural formulae of the chemical constituents 1 – 6 isolated from the rhizomes of *Alpinia officinarum*.

Compound **7**, named 6-O-α-D-glucosyl α-D-glucose, $[M]^+$ at *m/z* 342 ($C_{12}H_{22}O_{11}$), gave positive tests of glycosides and exhibited IR absorption bands for hydroxyl groups (3405, 3324 cm^{-1}). The ion peaks generating at *m/z* 179 $[C_6H_{11}O_6]^+$ and 163 $[C_6H_{11}O_5]^+$ indicated that hexoside sugar units were present in the sugar unit. The ^{1}H NMR spectrum of **7** exhibited two one-proton doublets at δ 5.02 (J = 6.0 Hz) and 4. 65 (J = 6.2 Hz) ascribed to α-oriented anomeric H-1 and H-1′ protons, respectively, other sugar oxymethine protons between δ 4.65 -4.02 and two oxymethylene protons as two-proton doublets at δ 3.62 (J = 8.9 Hz, H_2-6) and 3.24 (*J* = 9.1 Hz, H_2-6′). The ^{13}C NMR spectrum of **7** displayed signals for anomeric carbons at δ 101.23 (C-1) and 95.53 (C-1') and other sugar carbons between δ 83.85 – 60.01. The presence of the sugar oxymethylene H_2-6 signal in the deshielded region at δ 3.62 in the ^{1}H NMR spectrum and carbon C-6 signal at δ 62.49 in the ^{13}C NMR spectrum suggested (6→1′) linkage of the sugar units. Acid hydrolysis of **7** yielded D-glucose, R_f 0.26 (*n*-butanol- acetic acid – water, 4: 1: 5). On the basis of spectral data analysis and chemical reactions, the structure of **7** was elucidated as α-D-glucopyranosyl-(6→1′)-O- α-D-glucopyranoside, a rare diglucoside ((Fig. 2).

Compound **8** was a known 2-O-β-D-diglucosyl O-β-D-dirhamnoside characterized as β-D-glucopyranosyl-(2→1′)-O-β- D-glucopyranosyl-(2′→1″)-O- β-D-rhamnopyranosyl- (2″→1‴)- O-β -D-rhamnopyranoside (Fig. 2).[33]



6-*O*-α-D-glucosyl α-D-glucoside (**7**)

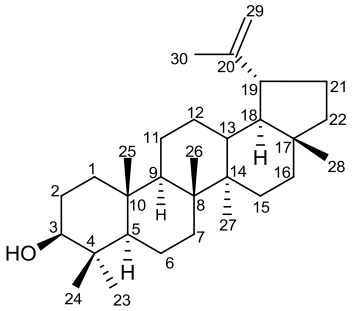


2-*O*-β-D-Diglucosyl β-D-dirhamnoside **(8)**

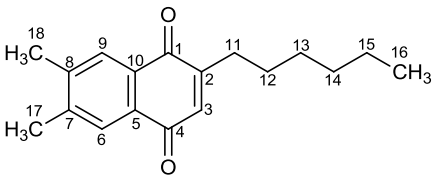
Fig 2: Structural formulae of the chemical constituents 7 and 8 isolated from the stem bark of *Balanites aegyptiaca*.

Compound **9** was a known pentacyclic triterpenol characterized as lupeol (Fig. 3).[74,75]

Compound **10** was a reddish coloured mass having UV absorption maximum absorption at 297 nm suggesting aromatic nature of the compound. Its mass spectrum displayed absorption bands for carbonyl groups (1701 cm^{-1}) and aromatic rings (1621, 1532, 1037 cm^{-1}). On the basis of mass and ^{13}C NMR spectra the molecular ion peak of **10** was determined at *m/z* 270 consistent with the molecular formula of an alkylated naphthadione, $C_{18}H_{22}O_2$. The ion peaks arising at *m/z* 255 $[M - Me]^+$, 240 $[255 - Me]^+$ and 185 $[M - C_6H_{13}]^+$ suggested the presence of dimethyl hexyl substituted naphthoquinone. The ion fragments formed at *m/z* 242 $[M - CO]^+$ and 157 $[242 - C_6H_{13}]^+$ indicated naphthoquinone nature of the molecule. The ^1H NMR spectrum of **10** showed three one-proton singlets in the deshielded region at δ 7.39, 7.22 and 7.05 assigned to para-coupled aromatic H-3, H-6 and H-9 protons, respectively, two three-proton singlets at δ 2.26 and 2.24 ascribed to C-17 and C-18 methyl protons linked to the aromatic ring, seven two-proton multiplets from δ 2.71 to 1.06 associated with the methylene protons and a three-proton triplet at δ 0.83 (J = 6.6 Hz) accounted to C-16 primary methyl protons. The absence of any ^1H NMR signal between δ 7.05 - 2.71 ruled out the existence of a vinylic or carbinol proton in the molecule. The ^{13}C NMR spectrum of **10** displayed signals for two carbonyl carbons at δ 190.21 (C-1) and 183.97 (C-4), aromatic carbons from δ 137.23 to 126.84, methylene carbons in the range of δ 25.69 – 21.26 and methyl carbons at δ 14.17 (C-16), 12.31 (C-17) and 11.98 (C-18). These data led to establish the structure of **10** as 2-hexyl-7,8-dimethyl 1,4-naphthaquinone, a new naphthadione (Fig. 3).



Lupeol **(9)**



2-Hexyl-7,8-dimethyl 1,4-napthaquinone **(10)**

Fig 3: Structural formulae of the chemical constituents 9 and 10 isolated from the stem bark of *Bombax ceiba*.

CONCLUSION

Phytochemical investigation of the rhizomes of *Alpinia officinrum* gave a new pentacyclic triterpenoid identified as bauere-7, 20(30)-dien-3β-oyl octadecenoate (bauerenyl stearate, **1**), two higher fatty acids (**2** and **3**), (Z)-*cis*- *n*-octatetracont-11-enoic acid (**4**), 13β-carboxylic acid *n*-hexadecanoic acid (**5**) and 1- hexadeanoyl-3-phosphatyl glycerol (**6**). The stem bark of *Balanites aegyptiaca* furnished 6-O-α-D-glucosyl α-D-glucose (**7**) and 2-*O*-β-D-diglucosyl β-D-dirhamnoside **(8).** The stem bark of *Bombax ceiba* afforded lupeol (**9**) and 2-hexyl-7,8-dimethyl 1,4-naphthaquinone (**10**). This work has enhanced understanding about the phytoconstituents of the undertaken plants. These compounds may be used as chromatographic markers for quality control assessments of crude plant materials and their traditional formulations, as these drugs are of controversial identity in the traditional systems of medicine.

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