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ISOLATION AND CHARACTERIZATION OF CHEMICAL CONSTITUENTS FROM THE LEAVES OF *AGERATUM CONYZOIDES* L. AND *JASMINUM SAMBAC* (L.) SOL. AND FRUITS OF *PYRUS COMMUNIS* L.

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ABSTRACT
Ageratum conyzoides L. (Asteraceae) is found in Central and South America, Africa, Australia and south-eastern Asia. It is used to cure colds, coughs, dyspepsia, eye diseases, headache, leprosy, malaria, pneumonia, rheumatism, skin, stomach and uterine disorders, sleeping sickness, snake bites and wounds. *Jasminum sambac* (L.) Sol. (Oleaceae) is distributed in north-eastern India and used to treat dysentery, epilepsy, fever, insanity, galactorrhoea, impotency, ophthalmic, respiratory and skin problems and body aches. *Pyrus communis* L. (Rosaceae) grows in central and eastern Europe and southwest Asia. Its fruits are taken to relieve arthritis, diarrhoea, cholera, colic, colitis, constipation, dropsy, fever, gallbladder disorders, gout, nausea, sclerosis, spasms and tumours. Our study was planned to isolate chemical constituents from the leaves of *A. conyzoides* and *J. sambac* and fruits of *P. communis* and to characterized their structures. Phytochemical investigation of a methanolic extract of the leaves of *A. conyzoides* gave (Z)-*n*- tripentacont-43-ene-22-one (**1**). The leaf methanolic extract of *J. sambac* afforded β- D- glucose (**2**), **g**lyceroloxy glycerol (**3**) and three new acyl glycosides characterized as lauryl O-β-D- xylopyranoside (**4**), *n*-tridecan-7β-olyl O-β-D- arabinopyranosyl-(2′→1″)-O-β-D-arabinopyranoside (*n*-tridecan-7β-olyl O-β-D-diarabinoside, **5**) and oleiyl O-β-D-arabinopyranosyl-(2′→1″)-O-β-D- glucopyranoside (oleiyl O-β-D-arabinoglucoside, **6**). A methanolic extract of the fruits of *P. communis* on subjection to silica gel column furnished gadoleic acid (**7**), oleiyl-O-β-D-glucopyranosyl-(6a→1b)-O-β-D-glucopyranosyl-(6b→1c)-O-β-D-glucopyranosyl-(6c→1d)-O-β-D-glucopyranoside (oleiyl β-D-tetraglucoside, **8**) and oleiyl-O-β-D-glucopyranosyl-(6a→1b)-O-β-D-glucopyranosyl-(6b→1c)-O-β-D-gluco - pyranosyl-(6c→1d)-O-β-D-glucopyranosyl-(6d→1e)-O-β-D-glucopyranosyl-(6e→1f)-O-β-D-glucopyranoside (oleiyl β-D-hexaglucoside, **9**). The structures of all the isolated phytoconstituents have been established on the basis of spectral data analysis and chemical reactions.

KEYWORDS: *Ageratum conyzoides* leaves, *Jasminum sambac* leaves, *Pyrus communis* fruits, Chemical constituents, Isolation, Characterization.

INTRODUCTION
Ageratum conyzoides L., syn. *A. ciliare* L., *A. hirsutum* Lam., *A. obtusifolium* Lam., *Eupatorium conyzoides* (L.) E. H. Krause (Asteraceae), known as billygoat-weed, chick weed, whiteweed and invading ageratum, is a native to tropical Central and South America, the West Indies and considered an invasive weed in Africa, Australia, south-eastern Asia and the United States. It is an erect, branching, aromatic, annual, up to 1 m high herb with ovate, opposite, tomentose leaves, white to mauve flowers in showy, flat-topped clusters, fruits ribbed or angled, black, one-seeded achenes.[1] The plant is used as an antidysenteric, antilithic, antiseptic, insecticide, nematicide and to treat burns, colds, coughs, colic, cuts, diarrhoea, dyspepsia, eye diseases, fever, headache, leprosy, malaria, pneumonia, rheumatism, skin disorders, sleeping sickness, snake bites, stomach ache, wounds and uterine disorders. Its leaf essential oil is applied to cure dandruff and as a hair wash.[2-4] The plant contained mono- and sesquiterpenes, triterpenoids, steroids, aurantiamide acetate, flavonoids, coumarins, benzofuran, chromene glucoside, tannins and alkaloids.[3,5-11] The leaf essential oil was composed mainly of precocenes I and II, caryophyllene, germacrene-D, ageratochromene, 6-methoxyquinoline1-oxide, β-caryophyllene oxide and β-

sinensal.[3,12-15] The predominant constituents of the flower essential oil were demothoxyagerato- chromene, α- and β-caryophyllenes, β-cubebene, germacrene-D and *trans*-β-farnesene.[16]

Jasminum sambac (L.) Sol., syn. *J. odoratum* Noronha, *Mogorium sambac* (L.) Lam., *Nyctanthes sambac* L. (Oleaceae), known as Arabian jasmine, is a native to the eastern Himalayas in Bhutan, India and Pakistan. It is cultivated in south-eastern Asia, Mauritius, Madagascar, Cambodia, China, Hawaii, Indonesia, Florida, Jamaica and Sri Lanka. It is a scrambling, up to 3 m high, evergreen, twining vine with pointed, entire, glabrous, dark green oval leaves; fragrant, white, waxy flowers; and small, globose, black berries. The plant has anti-depressant, antiseptic, anti-spasmodic, aphrodisiac, cicatrizant, expectorant, galactagogue, sedative, parturient and uterine stimulant properties. The flowers are used as a decongestant, to expel intestinal worms and to cure boils, jaundice, ulcers and eye, skin and venereal diseases. The leaves and flowers are antiseptic, astringent, febrifuge, decongestant, galactagogue and are useful to treat acne, asthma, bellyache, bronchitis, dysentery, epilepsy, fever, headache, galactorrhoea, impotency, insanity, itches, leprosy, ophthalmic problems, pulmonary catarrh, and wounds. Jasmine tea is drunk to cure cancer. The stems are employed as an antipyretic and in the treatment of abscesses. The root has anaesthetic, sedative and vulnerary properties. It is given to treat asthma, bronchitis, fevers, pulmonary catarrh, and venereal diseases. A root paste is applied to cure fractures and sprains. Jasmine sambac oil has analgesic, anaesthetic, antidepressant, antinociceptive, antiseptic, anti-inflammatory, aphrodisiac, carminative, cicatrizant, expectorant, sedative, uterine tonic, parturient, stimulant, lactifuge and antitumor properties.[17,18] The essential oil was composed mainly of *cis*-3-hexenyl acetate, benzyl acetate, methyl anthranilate, benzyl alcohol, *cis*-3-hexnyl benzoate, *cis* -3-hexnol, *cis*- jasmone, linalool, methyl salicylate, benzyl benzoate, indole, α-franasene, linalyl acetate, α-cadinol and β-elemene.[17,19-22] The plant yielded iridoidal glycosides[23], linalyl 6-O-malonyl-β-D-glucoside, β-primeveroside, 2- phenylethyl β-primeveroside, 2-phenylethyl 6-O-α-L-rhamnosyl-β-D-glucoside (β-rutinoside), 8, 9-dihydrojasminin, dotriacontanoic acid, dotriacontanol, oleanolic acid, daucosterol and hesperidin.[19, 24-28] The flowers afforded benzyl-O-β-D-glycosides, tertraol, molihuaoside D, sambacosides A and E, rutin, kaempferol-3-O-glycoside and quercetin-3-O-glycoside.[29]

Pyrus communis L., syn. *Pyrus sativa* DC. (Rosaceae), known as European pear and common pear, is a native to the central and eastern Europe and southwest Asia; found from northern Italy to Iran, Uzbekistan, China, Japan, Korea, India and Bhutan. It has a characteristic shape, with a round and wide bottom and a tapering top.[30] The fruit is eaten as an astringent, febrifuge, sedative and to relieve arthritis, diarrhoea, cholera, colic, colitis, constipation, dropsy, fever, gallbladder disorders, gout, nausea, sclerosis, spasms and tumours. It is useful to cure acne, pimples and other skin infections, throat problems, dandruff and scalp psoriasis and for shiny and smooth hair.[31,32] Pears are a good source of vitamins B2, C and E, carbohydrates, proteins, minerals, pectin, a water-soluble fiber, amino and organic acids, flavonols, flavan-3-ol and anthocyanin.[33–42], arbutin, hydroxycinnamic acids, catechins, procyanidins, chlorogenic acid, quercetin and rutin.[34,43,44] The twigs possessed nonacosane, lupeol, β-sitosterol, betulin, betulinic acid, daucosterol, hydroquinone and arbutin.[45] The peel and flesh contained arbutin, chlorogenic acid, rutin, catechin, epicatechin and vitamin C.[46] The compounds isolated from the stem bark were identified as lup-20(29)-ene-3α, 27-diol, lup-20(29)-ene-3α-ol and lup-20(29)-ene-3α, 28-diol.[47] The flowers furnished glycosides of quercetin and kaempfreol.[48] The seed oil contained fatty acids, tocochromanols, carotenoids, squalene and β-sitosterol.[49] Keeping in view the various therapeutic values of the plants and the development of ecofriendly, biodegradable and safer herbal medicinal preparations, the leaves of *A. conyzoides* and *J. sambac* and fruits of *P. communis* 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, 2 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 Specialities Private Limited (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.

Plant materials

The leaves of *Ageratum conyzoides* and *Jasminum sambac* and fruits of *Pyrus communis* were procured from Delhi and the plant materials were authenticated by Dr. M. P. Sharma, Department of Botany, Jamia Hamdard, New Delhi. The voucher

specimens of these drugs were deposited in the herbarium of the Phytochemistry Research Laboratory, Jamia Hamdard, New Delhi.

Preparation of extracts

Each 1 kg of the dried leaves of *A. conyzoides* and *J. sambac* and fruits of *P. communis* 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, 131.2 g, 165.7 g and 122.4 g, respectively. A small portion of the each extract was analyzed chemically to determine the presence of different chemical constituents.

Isolation of phytoconstituents

Each 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. Every 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.

Isolation of a phytoconstituent from the leaves of *Ageratum conyzoides*

(*Z*)-*n*-Tripentacont-43-ene-22-one (1)

Elution of the column with chloroform – methanol (19:1) furnished colourless powder of **1**, yield 128 mg, m. p. 131 – 132 °C; UV λmax (MeOH): 213 nm; IR γ_{max} (KBr): 2923, 2853, 1710, 1637, 1463, 1377, 1206, 1176, 1081, 909, 721 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.01 (1H, m, $w_{1/2}$ = 8.7 Hz, H-43), 4.95 (1H, m, $w_{1/2}$ = 9.1 Hz, H-44), 2.30 (4H, m, H_2-21, H_2-23), 2.18 (2 H, m, H_2-42), 2.15 (2 H, m, H_2-45), 1.35 (4H, m, 2 x CH_2), 1.33 (4H, m, 2 x CH_2), 1.25 (80 H, br s, 40 x CH_2), 0.88 (3 H, t, J = 6.3 Hz, Me-1), 0.84 (3 H, t, J = 6.5 Hz, Me-53); ^{13}C NMR ($CDCl_3$): δ 207.63 (C-15), 139.27 (C-43), 114.03 (C-44), 50.56 (C-21, C-23), 37.08 (CH_2), 33.81 (CH_2), 33.66 (CH_2), 33.18 (CH_2), 32.73 (CH_2), 31.92 (CH_2), 31.39 (CH_2), 30.88 (CH_2), 30.15 (CH_2), 30.03 (CH_2), 29.69 (10 x CH_2), 29.65 (10 x CH_2), 29.61 (6 x CH_2), 29.50 (CH_2), 29.36 (CH_2), 29.15 (CH_2), 28.94 (CH_2), 27.96 (CH_2), 27.42 (CH_2), 27.08 (CH_2), 26.68 (CH_2), 22.68 (C-55), 19.69 (C-2), 14.15 (C-1), 14.09 (C-53); ESI-MS *m/*z (rel. int.): 756 $[M]^+$ ($C_{53}H_{104}O$) (2.7), 323 (8.6), 295 (19.3), 153 (6.4), 127 (42.8).

Isolation of phytoconstituents from the leaves of *Jasminum sambac*

β-D-Glucose (2)

Elution of the column with chloroform - methanol (19:1) afforded colourless powder of **2**, recrystallized from methanol, yield 215 mg, R_f : 0.55 (*n*-butanol-acetic acid-water, 2:1:1), UV λ_{max} (MeOH): 207 nm, m. p. 146 – 148 °C; $[\alpha]_D^{22}$ + 52.7 ° (water, 10); IR γ_{max} (KBr): 3413, 3266, 2925, 2854, 1649, 1428, 1384, 1081, 960 cm^{-1}; ^1H NMR (DMSO d-$_6$): δ 5.25 (1H, d, J = 7.2 Hz, H-1), 4.65 (1H, m, H-5), 4.14 (1H, m, H-2), 3.79 (1H, m, H-3), 3.62 (1H, m, H-4), 3.11 (2H, d, J = 10.5 Hz, H_2-6); ^{13}C NMR (DMSO d-$_6$): δ 103.51 (C-1), 73.09 (C-2), 71.27 (C-3), 69.67 (C-4), 76.10 (C-5), 63.71 (C-6); ESI MS *m/*z (rel. int.): 180 $[M]^+$ ($C_6H_{12}O_6$) (100), 163 (3.1).

1-Glyceroloxy glycerol (3)

Elution of the column with chloroform - methanol (93:7) gave colourless semi-solid mass of **3**, yield 201 mg, UV λ_{max} (MeOH): 208 nm; IR γ_{max} (KBr): 3396, 3292, 2954, 2831, 1627, 1430, 1385, 1262, 1083, 1020, 834 cm^{-1}; ^1H NMR (DMSO-d_6): δ 4.43 (1H, m, H-2), 4.34 (1H, m, H-2′), 3.60 (2H, d, J = 5.2 Hz, H_2-1), 3.53 (2H, d, J = 5.2 H, H_2-1′), 3.37 (2H, d, J = 5.6 Hz, H_2-3), 3.32 (2H, d, J = 5.6 Hz, H_2-3′); ^{13}C NMR (DMSO- d_6): δ 71.25 (C-2), 71.23 (C-2′), 69.61 (C-1), 69.59 (C-1′), 63.80 (C-3), 63.78 (C-3′); ESI MS *m/*z (rel. int.): 166 $[M]^+$ ($C_6H_{14}O_5$) (5.2).

Lauryl O-β-D-xyloside (4)

Elution of the column with chloroform - methanol (9:1) afforded light yellow semi-solid mass of **4**, yield 216 mg, UV λ_{max} (MeOH): 211 nm, IR γ_{max} (KBr): 3420, 33352, 2935, 2837, 1721, 1614, 1452, 1378, 1261, 1193, 1086, 931, 722 cm^{-1}; ^1H NMR (DMSO-d_6): δ 5.05 (1H, d, J = 7.2 Hz, H-1′), 4.67 (1H, m, H-2′), 4.41 (1H, m, H-3′), 3.61 (1H, m, H-4′), 3.57 (2H, d, J = 6.1 Hz, H_2-5′), 2.51 (2H, d, J = 7.5 Hz, H_2-2), 1.87 (2H, m, H_2-2), 1.53 (2H, m, CH_2), 1.25 (4H, m, 2 × CH_2), 1.22 (10H, brs, 5 × CH_2), 0.82 (3H, t, J = 6.5 Hz, Me-12); ^{13}C NMR (DMSO-d_6): δ 171.28 (C-1), 56.21 (C-2), 33.42 (C-3), 29.97 (C-4), 29.89 (C-5), 29.68 (C-6), 29.54 (C-7), 29.27 (C-8), 28.16 (C-9), 22.68 (C-10), 18.29 (C-11), 13.04 (C-12), 98.43 (C-1′), 76.43 (C-2′), 71.39 (C-3′), 69.56 (C-4′), 63.62 (C-5′); ESI MS *m/*z (rel. int.): 332 $[M]^+$ ($C_{17}H_{32}O_6$) (18.3), 199 (8.5), 149 (5.3).

***n*-Tridecan-7β-olyl O-β-D-diarabinoside (5)**

Further elution of the column with chloroform - methanol (9:1) produced a colourless semi-solid mass of **5**, recrystallized from methanol, yield 205 mg, UV λ_{max} (MeOH): 212 nm, m. p. °C; IR γ_{max} (KBr): 3430, 3357, 3261, 2925, 2854, 1633, 1440, 1386, 1262, 1078, 771 cm^{-1}; ^1H NMR (DMSO-d_6): δ 5.26 (1H, d, J = 7.2 Hz, H-1′), 4.25 (1H, m, H-2′), 3.68 (1H, m, H-3′), 3.52 (1H, m, H-4′), 3.45 (2H, d, J = 7.6 Hz, H_2-5′), 5.07 (1H, d, J = 7.5 Hz, H-1″), 4.11 (1H, m, H-2″), 3.60 (1H, m, H-3″), 3.49 (1H, m, H-4″), 3.39 (2H, d, J = 8.8 Hz, H_2-5″), 3.84 (1H, m, $w_{1/2}$ = 8.0 Hz, H-7α), 2.21 (2H, m, H_2-6), 2.18 (2H, m, H_2-8), 1.98 (2H, m, CH_2), 1.63 (2H, m, CH_2), 1.53 (2H, m, CH_2), 1.16 (8H, brs, 4 × CH_2), 0.97 (3H, t, J = 5.6 Hz, Me-1), 0.91 (3H, t, J = 6.3 Hz, Me-13); ^{13}C NMR (DMSO-d_6): δ 18.30 (C-1), 27.36 (C-2), 29.89 (C-3), 28.89 (C-4), 28.71 (C-5), 56.22 (C-6), 70.51 (C-7), 50.08 (C-8), 33.27 (C-9), 24.86 (C-10), 29.06 (C-11), 25.11 (C-12), 18.48 (C-13), 103.12 (C-1′), 76.66 (C-2′), 73.08 (C-3′), 71.30 (C-4′), 63.20 (C-5′), 98.25 (C-1″),

75.18 (C-2″), 72.27 (C-3″), 69.92 (C-4″), 63.08 (C-5″); ESI MS *m/z* (rel. int.): 464 $[M]^+$ ($C_{23}H_{44}O_9$) (1.2), 265 (1.6), 199 (20.5), 149 (20.5), 133 (11.8), 85 (13.4).

Oleiyl O-β-D-arabinoglucoside (6)

Elution of the column with chloroform-methanol (17:3) furnished a pale yellow sticky mass of **6**, purified by TLC using chloroform-methanol (9:1), 307 mg, UV λ_{max} (MeOH): 213 nm, IR γ_{max} (KBr): 3510, 3437, 3386, 3241, 2928, 2839, 1722, 1631, 1449, 1351, 1260, 1159, 1078, 930, 854, 724 cm^{-1}; ^1H NMR (DMSO-d_6): δ 5.45 (1H, m, H-9), 5.23 (1H, m, H-10), 2.62 (2H, t, J = 7.2 Hz, H_2-2), 2.23 (2H, m, H_2-8), 2.06 (2H, m, H_2-11), 1.67 (2H, m, CH_2), 1.52 (2H, m, CH_2), 1.32 (2H, m, CH_2), 1.25 (4H, brs, 2 × CH_2), 1.19 (12H, brs, 6 × CH_2), 0.83 (3H, t, J = 6.7 Hz, Me- 18), 5.07 (1H, d, J = 7.2 Hz, H-1'), 4.32 (1H, m, H-2'), 3.79 (1H, m, H-4'), 3.62 (1H, m, H-3'), 3.29 (2H, m, H_2-5'), 4.98 (1H, d, J = 7.5 Hz, H-1"), 4.18 (1H, m, H-5"), 3.97 (1H, m, H-2"), 3.52 (1H, m, H-3"), 3.45 (1H, m, H-4"), 3.09 (2H, d, J = 8.6 Hz, H_2-6″), ^{13}C NMR (DMSO-d_6): δ 169.06 (C-1), 51.03 (C–2), 33.18 (C–3), 30.45 (C–4), 29.97 (C–5), 29.81 (C-6), 29.73 (C–7), 29.66 (C–8), 128.27 (C–9), 121.38 (C–10), 33.25 (C–11), 31.16 (C–12), 29.91 (C–13), 29.89 (C–14), 29.56 (C–15), 25.28 (C–16), 22.68 (C-17), 13.02 (C–18), 103.41 (C–1'), 81.29 (C–2'), 72.60 (C–3'), 71.16 (C–4'), 63.55 (C–5'), 98.83 (C-1"), 73.02 (C-2"), 72.21 (C-3"), 69.50 (C-4"), 76.38 (C-5"), 60.98 (C-6"); ESI-MS *m/z* (rel.int.): 592 $[M]^+$ ($C_{29}H_{52}O_{12}$) (11.8), 413 (12.1), 327 (4.8), 311 (9.1), 281 (6.3), 265 (10.3) 179 (6.7), 163 (3.1).

Isolation of phytoconstituents from the fruits of *Pyrus communis*

Gadoleic acid (7)

Elution of the column with chloroform produced a pale yellow powder of **7**, recrystallized from chloroform-methanol (1:1), yield 189 mg, m. p. 23 - 24 ^0C, IR γ_{max} (KBr): 3231, 2928, 2848, 1698, 1645, 1456, 1378, 1261, 935, 726 cm^{-1}; ^1H NMR ($CDCl_3$): δ 5.02 (1H, m, $w_{1/2}$ = 8.3 Hz, H-9), 4.96 (1H, m, $w_{1/2}$ = 8.6 Hz, H-10), 2.31 (2H, t, J = 7.2 Hz, H_2-2), 2.21 (2H, m, H_2-8), 2.02 (2H, m, H_2-11), 1.62 (2H, m, CH_2), 1.55 (2H, m, CH_2), 1.32 (2H, m, CH_2), 1.29 (20H, brs, 10 x CH_2), 0.88 (3H, t, J = 6.8 Hz, Me-20); ^{13}C NMR ($CDCl_3$): δ 180.21 (C-1), 33.82 (C-2), 30.04 (C-3), 29.69 (C-4), 29.58 (C-5), 29.51 (C-6), 29.46 (C-7), 31.93 (C-8), 139.28 (C-9), 114.06 (C-10), 31.62 (C-11), 29.36 (C-12), 29.25 (C-13), 29.20 (C-14), 29.16 (C-15), 28.96 (C-16), 25.91 (C-17), 23.58 (C-18), 22.69 (C-19), 14.11 (C-20); ESI MS *m/z* (rel. int.): 310 $[M]^+$ ($C_{20}H_{38}O_2$) (3.1).

Oleiyl β-D-tetraglucoside (8)

Elution of the column with chloroform - methanol (19:1) furnished light brown crystals of **8**, 218 mg, m. p. 209 °C; IR γ_{max} (KBr): 3511, 3445, 3327, 2928, 2847, 1723, 1643, 1451, 1267, 1034 cm^{-1}; ^1H NMR (DMSO d-$_6$): δ 5.51 (1H, m, H-9), 5.46 (1H, m, H-10), 2.58 (2H, t, J = 7.2 Hz, H_2-2), 2.20 (2H, m, H_2-8), 2.15 (2H, m, H_2-11), 1.88 (2H, m, CH_2), 1.68 (2H, m, CH_2), 1.41 (2H, m, CH_2), 1.29 (6H, brs, 3 x CH_2), 1.26 (10H, brs, 5 × CH_2), 0.86 (3H, t, J = 6.9 Hz, Me-18), 5.29 (1H, d, J = 9.3 Hz, H-1a), 4.90 (1H, m, H-5a), 4.35 (1H, m, H-2a), 4.21 (1H, m, H-3a), 4.08 (1H, m, H-4a), 3.25 (2H, d, J = 6.5 Hz, H_2-6a), 5.24 (1H, d, J = 7.5 Hz, H-1b), 4.87 (1H, m, H-5b), 4.32 (1H, m, H-2b), 4.19 (1H, m, H-3b), 4.05 (1H, m, H-4b), 3.22 (2H, d, J = 7.4 Hz, H_2-6b), 5.17 (1H, d, J = 8.4 Hz, H-1c), 4.45 (1H, m, H-5c), 4.27 (1H, m, H-2c), 4.17 (1H, m, H-3c), 3.93 (1H, m, H-4c), 3.19 (2H, d, J = 6.8 Hz, H_2-6c), 5.06 (1H, d, J = 9.9 Hz, H-2d), 4.41 (1H, m, H-5d), 4.23 (1H, m, H-2d), 4.13 (1H, m, H-3d), 3.91 (1H, m, H-4d), 3.10 (2H, d, J = 8.8 Hz, H_2-6d); ^{13}C NMR (DMSO d-$_6$): δ 170.34 (C-1), 33.79 (C-2), 31.41 (C-3), 29.66 (C-4), 29.64 (C-5), 29.58 (C-6), 29.52 (C-7), 31.90 (C-8), 139.26 (C-9), 114.04 (C-10), 31.60 (C-11), 29.48 (C-12), 29.48 (C-13), 29.33 (C-14), 29.13 (C-15), 25.28 (C-16), 22.68 (C-17), 14.16 (C-18), 100.25 (C-1a), 70.04 (C-2a), 69.40 (C-3a), 68.02 (C-4a), 71.34 (C-5a), 62.55 (C-6a), 99.03 (C-1b), 69.89 (C-2b), 69.27 (C-3b), 67.20 (C-4b), 71.11 (C-5b), 62.47 (C-6b), 95.18 (C-1c), 69.63 (C-2c), 68.66 (C-3c), 65.19 (C-4c), 70.68 (C-5c), 62.29 (C-6c), 90.15 (C-1d), 69.48 (C-2d), 68.52 (C-3d), 64.43 (C-4d), 70.62 (C-5d), 61.66 (C-6d); ESI MS *m/z* (rel.int.): 928 $[M]^+$ ($C_{42}H_{72}O_{22}$) (2.1).

Oleiyl β-D-hexaglucoside (9)

Elution of the column with chloroform - methanol (9:1) furnished light brown crystals of **9**, 334 mg, m. p. 253 °C; IR γ_{max} (KBr): 3516, 3452, 3332, 2925, 2841, 1725, 1646, 1441, 1262, 1045 cm^{-1}; ^1H NMR (DMSO d-$_6$): δ 5.48 (1H, m, H-9), 5.45 (1H, m, H-10), 2.70 (2H, m, H_2-2), 2.31 (2H, m, H_2-8), 2.13 (2H, m, H_2-11), 1.66 (2H, m, CH_2), 1.42 (2H, m, CH_2), 1.28 (6H, brs, 3 x CH_2), 1.25 (12H, brs, 6 × CH_2), 0.85 (3H, t, J = 6.5 Hz, Me-18); 5.38 (1H, d, J = 7.5 Hz, H-1a), 4.46 (1H, m, H-5a), 4.24 (1H, m, H-2a), 4.09 (1H, m, H-3a), 3.91 (1H, m, H-4a), 3.28 (2H, m, H_2-6a), 5.36 (1H, d, J = 7.3 Hz, H-1b), 4.40 (1H, m, H-5b), 4.22 (1H, m, H-2b), 4.07 (1H, m, H-3b), 3.89 (1H, m, H-4b), 3.25 (2H, m, H_2-6b), 5.27 (1H, d, J = 7.6 Hz, H-1c), 4.37 (1H, m, H-5c), 4.20 (1H, m, H-2c), 4.05 (1H, m, H-3c), 3.87 (1H, m, H-4c), 3.22 (2H, m, H_2-6c), 5.12 (1H, d, J = 7.2 Hz, H-2d), 4.34 (1H, m, H-5d), 4.18 (1H, m, H-2d), 4.03 (1H, m, H-3d), 3.85 (1H, m, H-4d), 3.19 (2H, m, H_2-6d), 5.02 (1H, d, J = 7.8 Hz, H-2e), 4.32 (1H, m, H-5e), 4.15 (1H, m, H-2e), 4.01 (1H, m, H-3e), 3.83 (1H, m, H-4e), 3.15 (2H, m, H_2-6e), 4.93 (1H, d, J = 8.8 Hz, H-2f), 4.30 (1H, m, H-5f), 4.12 (1H, m, H-2f), 3.99 (1H, m, H-3f), 3.81 (1H, m, H-4f), 3.10 (2H, m, H_2-6f); ^{13}C NMR (DMSO d-$_6$): δ 170.76 (C-1), 33.82 (C-2), 31.93 (C-3), 31.62 (C-4), 30.04 (C-5), 29.69 (C-6), 29.51 (C-7), 29.53 (C-8), 141.23 (C-9), 118.46 (C-10), 29.36 (C-11), 29.16 (C-12), 28.96 (C-13), 27.21 (C-14), 25.91 (C-15), 23.58 (C-16), 22.69 (C-17), 14.11 (C-18), 101.51 (C-1a), 71.16 (C-2a), 69.44 (C-3a), 68.25 (C-4a), 80.04 (C-5a), 62.74 (C-6a), 100.08 (C-1b), 70.94 (C-2b), 70.29 (C-3b), 65.70 (C-4b), 78.54 (C-5b), 62.65 (C-6b), 97.86 (C-1c), 71.44 (C-2c), 70.19 (C-3c), 65.47 (C-4c), 72.92 (C-5c), 62.53 (C-6c), 95.28 (C-1d), 71.28 (C-2d), 69.98 (C-3d), 65.18 (C-4d), 72.01 (C-5d), 62.39 (C-6d), 93.45 (C-1e), 71.16 (C-2e), 69.80 (C-3e), 64.93 (C-

4e), 71.64 (C-5e), 62.27 (C-6e), 86.29 (C-1f), 70.77 (C-2f), 69.52 (C-3f), 64.65 (C-4f), 71.50 (C-5f), 61.91 (C-6f); ESI MS *m/*z (rel.int.): 1254 $[M]^+$ ($C_{54}H_{94}O_3$) (2.3).

RESULTS AND DISCUSSION

Compound **1** showed its IR absorption bands for carbonyl group (1710 cm^{-1}), unsaturation (1637 cm^{-1}) and long aliphatic chain (721 cm^{-1}). Its mass spectrum displayed a molecular ion peak at *m/z* 756 corresponding to a molecular formula of an unsaturated aliphatic ketone, $C_{53}H_{104}O$. The ion fragments arising at *m/z* 127 [C_{44} – C_{45} fission, CH_3 $(CH_2)_8$] $^+$ and 153 [C_{42} – C_{43} fission, CH_3 $(CH_2)_8$-CH=CH] $^+$ suggested the existence of the vinylic linkage at C_{43} carbon. The ion peaks generating at *m/z* 323 [C_{22} – C_{23} fission, CH_3 $(CH_2)_{20}$CO] $^+$ and 295 [C_{22} – C_{21} fission, CH_3 $(CH_2)_{20}$] $^+$ suggested the presence of the carbonyl function at C_{22} carbon. The ^{1}H NMR spectrum of **1** exhibited two one -proton multiplets at δ 5.01 and 4.95 with half-widths of 8.7 Hz and 9.1 Hz, respectively, assigned correspondingly to *cis*-oriented vinylic H-43 and H-44 protons, methylene protons as four - proton multiplets at δ 2.30 (H_2-21, H_2-23), 1.35 (2 x CH_2) and 1.33 (2 x CH_2), as two-proton multiplets at δ 2.18 (H_2-42) and 2.15 (H_2-45) and as a broad singlet at δ 1.25 (80 H, 40 x CH_2). Two three-proton triplets at δ 0.88 (J = 6.3 Hz) and 0.84 (J = 6.5 Hz) were accounted to terminal C-1 and C-53 primary methyl protons, respectively.

The ^{13}C NMR spectrum of **1** showed signals for the carbonyl carbon at δ 207.63 (C-15), vinylic carbons at δ 139.27 (C-43) and 114.03 (C-44), methylene carbons between δ 50.56 - 19.69 and methyl carbons at δ 14.15 (C-1) and 14.09 (C-53). The absence of any signal between δ 4.95 - 2.30 in the ^{1}H NMR spectrum and from δ 114.03 to 50.56 in the ^{13}C NMR spectrum ruled out the presence of any carbinol function in the molecule. On the basis of foregoing spectral data analysis, the structure of **1** has been elucidated as (Z)-*n*- tripentacont-43-ene-22-one, a new aliphatic ketone (Fig. 1).

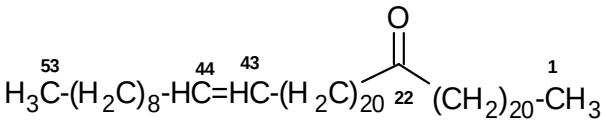


Fig 1. Structural formula of the chemical constituents 1 isolated from the leaves of *Ageratum conyzoides*

Compound **2** was a known monosaccharide identified as β-D-glucose.

Compound **3**, designated as 1-glyceroloxy glycerol, displayed IR absorption bands for hydroxyl groups (3396, 3292 cm^{-1}). On the basis of mass and ^{13}C NMR spectra its molecular ion peak was established at *m/z* 166 corresponding with a molecular formula of a diglycerol derivative, $C_6H_{14}O_5$. The ^{1}H NMR spectrum of **3** showed two one-proton multiplets at δ 4.43 and 4.34 assigned to hydroxymethine H-2 and H-2′ protons, respectively, and four two-proton doublets at δ 3.60 (J = 5.2 Hz), 3.53 (J = 5.2 H), 3.37 (J = 5.6 Hz) and 3.32 (J = 5.6 Hz) attributed correspondingly to oxymethylene H_2-1, H_2-1′, H_2-3 and H_2-3′ protons. The ^{13}C NMR spectrum of **3** exhibited signals for carbinol carbons at δ 71.25 (C-2) and 71.23 (C-2′) and oxymethylene carbons between δ 69.61 - 63.78. The existence of ^{1}H NMR signals from δ 4.43 to 3.32 and carbon signals in the range of δ 71.25 – 63.78 indicated saturated nature of the molecule and devoid of any aromatic or alkyl substituent. These evidences led to established the structure of compound **3** as 1-glyceroloxy glycerol (Fig. 2).

Compound **4**, named lauryl O-β-D-xyloside, responded for glycoside tests positively and exhibited IR absorption bands for hydroxyl groups (3420, 3352 cm^{-1}), ester function (1721 cm^{-1}) and long aliphatic chain (722 cm^{-1}). Its molecular ion peak was determined at *m/z* 332 on the basis of mass and ^{13}C NMR spectra consistent with a molecular formula of an acyl glycoside, $C_{17}H_{32}O_6$. The ion peaks arising at *m/z* 149 $[C_5H_9O_5]^+$ and 199 [$C_{1'}$ – O fission, CH_3-$(CH_2)_{10}$-COO]$^+$ indicated that lauric acid was esterified with a pentoside unit. The ^{1}H NMR spectrum of **4** displayed a one-proton doublet at δ 5.05 (J = 7.2 Hz) assigned to anomeric H-1′, other sugar protons as one-proton multiplets at δ 4.67 (H-2′), 4.41 (H-3′) and 3.61 (H-4′) and as a two-proton doublet at δ 3.57 (J = 6.1 Hz, H_2-5′), methylene protons between δ 2.51 – 1.22, and a three - proton triplet at δ 0.82 (J = 6.5 Hz) accounted to terminal C-12 primary methyl protons. The ^{13}C NMR spectrum of **4** displayed signals for ester carbon at δ 171.28 (C-1), anomeric carbon at δ 98.43 (C-1'), other sugar carbons from δ 76.43 to 63.62, methyl carbon at δ 13.04 (C-12) and methylene carbons between δ 56.21 - 18.29. Acid hydrolysis of **4** yielded lauric acid, R_f 0.14 (gl. AcOH, 85%), and D-xylose, R_f 0.76 (*n*-butanol-acetic acid – water, 4 : 1 : 1.6). On the basis of foregoing discussion, the structure of compound **4** has been characterized as lauryl O-β-D-xylopyranoside, a new acyl xyloside (Fig. 2).

Compound **5**, named *n*-tridecan-7β-olyl O-β-D-diarabinoside, $[M]^+$ at *m/z* 464 ($C_{23}H_{44}O_9$), gave positive tests for glycosides and showed IR absorption bands for hydroxyl groups (3430, 3357, 3261 cm^{-1}). The mass ion peaks arising at *m/z* 85 $[(CH_2)_5$-$CH_3]^+$, 133 $[C_5H_9O_4]^+$, 149 $[C_5H_9O_5]^+$, 265 [$C_5H_9O_4$- $C_5H_8O_4$]$^+$ and 199 [$C_{1'}$ – O fission, CH_3-$(CH_2)_5$-CH(O)-$(CH_2)_5$-CH_3]$^+$ indicated that a secondary tridecanol unit was linked with a dipentoside moiety. The ^{1}H NMR spectrum of **5** exhibited two one-proton doublets at δ 5.26 (J = 7.2 Hz) and 5.07 (J = 7.5 Hz) assigned to anomeric H-1′ and H-1″ protons, respectively, other sugar protons as one-proton multiplets between δ 4.25 - 3.49 due to oxymethine protons and as two-proton doublets at δ 3.45 (J = 7.6 Hz) and 3.39 (J = 8.8 Hz) attributed to oxymethylene H_2-5′ and H_2-5″, respectively. A one-proton multiplet at δ 3.84 with half-width of 8.0 Hz was accounted to α-oriented methine H-7 proton. Six multiplets between δ 2.21 – 1.53 and as a singlet at δ 1.16 (8H) were ascribed to methylene protons. Two three - proton triplets at δ 0.97 (J = 5.6 Hz)

and 0.91 (J = 6.3 Hz) were associated with terminal C-1 and C-13 primary methyl protons, respectively. The ^{13}C NMR spectrum of **5** displayed signals for anomeric carbons at δ 103.12 (C-1') and 98.25 (C-1"), other sugar carbons from δ 76.66 to 63.08, oxymethine carbon of the alkyl chain at δ 70.51 (C-7), methyl carbons at δ 18.30 (C-1) and 18.48 (C-13) and methylene carbons between δ 56.22 - 24.86. The absence of any signal beyond δ 5.26 in the ^{1}H NMR spectrum and δ 103.12 in the ^{13}C NMR spectrum indicated saturated nature of the compound. The presence of H-2′ signal in the deshielded region at δ 4.25 in the ^{1}H NMR spectrum and C-2′ signal at δ 76.66 in the ^{13}C NMR spectrum suggested (2′→1″) linkage of the sugar units. Acid hydrolysis of **5** yielded D-arabinose, R_f 0.70 (*n*-butanol- acetic acid – water, 4: 1 : 1.6). On the basis of these evidences the structure of **5** has been elucidated as *n*-tridecan-7β-olyl O-β-D-arabinopyranosyl-(2′→1″)-*O*-β-D-arabinopyranoside, a new alkyl diarabinoside (Fig. 2).

Compound **6**, designated as oleiyl O-β-D-arabinoglucoside, $[M]^+$ at *m/*z 592 ($C_{29}H_{52}O_{12}$), gave positive tests for glycosides and displayed characteristic IR absorption bands for hydroxyl groups (3510, 3437, 3386, 3241 cm^{-1}), ester function (1722 cm^{-1}), unsaturation (1631 cm^{-1}) and long chain aliphatic hydrocarbon (724 cm^{-1}). The mass ion fragments generated at *m/*z 163 $[C_6H_{11}O_5]^+$, 179 $[C_6H_{11}O_6]^+$ and 413 $[M – 179]^+$ indicated that a hexose unit was present at the terminal of the disaccharide chain. The ion peaks arising at *m/*z 265 $[CH_3(CH_2)_7 –CH=CH-(CH_7)_7-CO]^+$, 281 $[CH_3(CH_2)_7 –CH=CH-(CH_7)_7-COO]^+$, 327 $[M – 265]^+$ and 311 $[M – 281]^+$ suggested that oleic acid was esterified with a pentosyl hexose $[C_5H_8O_4-C_6H_{11}O_6]^+$ unit. The ^{1}H NMR spectrum of **6** exhibited two one-proton multiplets at δ 5.45 and 5.23 assigned to vinylic H-9 and H-10 protons, respectively, methylene protons between δ 2.62 – 1.19, a three-proton triplet at δ 0.83 (J = 6.7 Hz) ascribed to primary C-18 methyl protons, two one-proton doublets at δ 5.07 (J = 7.2 Hz) and 4.98 (J = 7.5 Hz) attributed correspondingly to anomeric H-1′ and H-1″ protons, other sugar protons as one-protons multiplets from δ 4.32 to 3.29 each assigned for carbinol protons and as a two-proton doublet at δ 3.09 (J = 5.6 Hz) accounted to hydroxymethylene H_2-6″ protons.

The ^{13}C NMR spectrum of **6** exhibited signals for the ester carbon at δ 169.06 (C-1), anomeric carbons at δ 103.41 (C-1′) and δ 98.83 (C-1″), other sugar carbons in the range from δ 81.29 to 60.98, methylene carbons between δ 51.03- 22.68 and methy1 carbon at 13.02 (C-24). The presence of ^{1}H NMR signal for H-2′ in the deshielded region at δ 4.32 and the respective carbon C-2′ signal at δ 81.29 suggested the attachment of another sugar by (2′→1″) linkage. Acid hydrolysis of **6** yielded oleic acid, R_f 0.34 (85% glacial acetic acid), D-arabinose, R_f 0.70 (*n*-butanol: acetic acid: water, 4:1:1.6) and D-glucose, R_f : 0.55 (*n*-butanol-acetic acid- water, 2:1:1). On the basis of these evidences the structure of **6** has been elucidated as oleiyl O-β-D-arabinopyranosyl-(2′→1″)-O-β-D- glucopyranoside, a new acyl arabinoglucoside (Fig. 2).

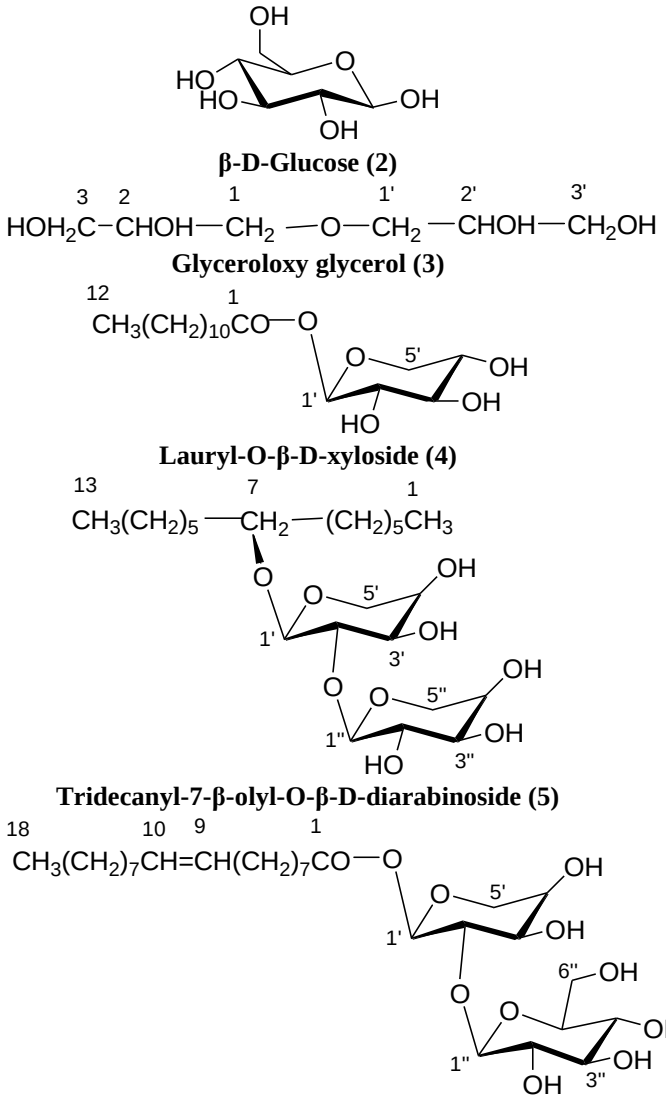


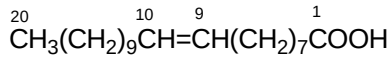
Fig 2: Structural formulae of the chemical constituents 2 - 6 isolated from the leaves of *Jasminum sambac*.

Compound 7 was a known fatty acid characterized as gadoleic acid.[50,51]

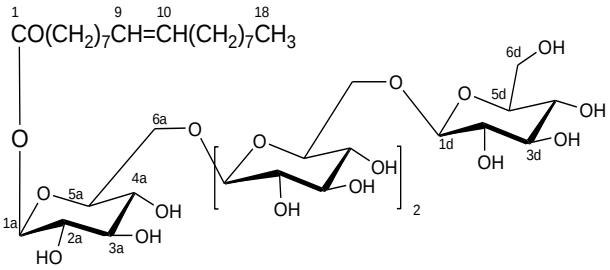
Compound **8**, named oleiyl β-D-tetraglucoside, gave confirmatory tests for glycosides and had characteristic IR absorption bands for hydroxyl groups (3511, 3445, 3327 cm^{-1}) and ester function (1723 cm^{-1}). The molecular ion peak of **8** was determined at *m/*z 928 on the basis of mass and ^{13}C NMR spectra corresponding to the molecular formula of an acyl tetraglucoside, $C_{42}H_{72}O_{22}$. The ^{1}H NMR spectrum of **8** displayed four one-proton anomeric H-1a to H-1d proton signals as doublets at δ 5.29 (J = 9.3 Hz), 5.24 (J = 7.5 Hz), 5.17 (J = 8.4 Hz) and 5.06 (J = 9.9 Hz) indicating β-glycosidic units of the tetraglycoside chain. Other sugar protons appeared as multiplets between δ 4.90 - 3.91 and as four two-proton

doublets at δ 3.25 (J = 6.5 Hz), 3.22 (J = 7.4 Hz), 3.19 (J = 6.8 Hz) and 3.10 (J = 8.8 Hz) due to hydroxymethylene H_2-6a to H_2-6d protons. Two one-proton multiplets at δ 5.51 and 5.46 were assigned to vinylic H-9 and H-10 protons, respectively. A three-proton triplet at δ 0.86 (J = 6.9 Hz) was accounted to C-18 primary methyl protons. The remaining methylene protons appeared as a two-proton triplet at δ 2.58 (J = 7.2 Hz, H_2-2), as two-proton multiplets from δ 2.20 to 1.41 and two broad singlets at δ 1.29 (6H) and 1.26 (10H). The ^{13}C NMR spectrum of compound **8** showed signals for anomeric carbons from δ 100.25 to 90.15, other sugar carbons between δ 71.34 - 61.66, ester carbon at δ 170.34 (C-1), vinylic carbons at δ 139.26 (C-9) and 114.04 (C-10), methyl carbon at δ 14.16 (C-18) and methylene carbons between δ 33.79 - 22.68. The presence of the sugar protons in the deshielded region at δ 3.25 (H_2-6a), 3.22 (H_2-6b) and 3.19 (H_2-6c) and the respective carbon signals at δ 62.55 (C-6a), 62.47 (C-6b) and 62.29 (C-6c) suggested (6→1) linkages of the sugar units. Acid hydrolysis of **8** yielded D-glucose, R_f 0.26 (*n*-butanol- acetic acid – water, 4 : 1 : 5). On the basis of above mentioned discussion, the structure of compound **8** has been characterized as oleiyl-O-β-D-glucopyranosyl-(6a→1b)-O-β(6d→1e)-O-β-D-glucopyranosyl- (6e→1f)-O-β -D-glucopyranoside, a new fatty acid hexaglucoside (Fig 3).

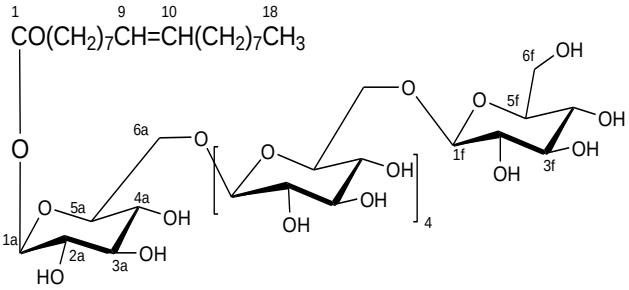
Compound **9**, named oleiyl β-D-hexaglucoside, $[M]^+$ at *m/*z 1254 ($C_{54}H_{94}O_3$), responded positively to glycoside tests and showed distinctive IR absorption bands for hydroxyl groups (3516, 3452, 3332 cm^{-1}) and ester function (1725 cm^{-1}). The ^{1}H NMR spectrum of **9** displayed six one-proton anomeric H-1a to H-1f proton signals as doublets correspondingly at δ 5.38 (J = 7.5 Hz), 5.36 (J = 7.3 Hz), 5.27 (J = 7.6 Hz), 5.12 (J = 7.2 Hz), 5.02 (J = 7.8 Hz) and 4.93 (J = 8.8 Hz) indicating β-glycosidic units of the hexaglycoside chain. The other sugar protons appeared as multiplets between δ 4.46 - 3.10. Two one-proton multiplets at δ 5.48 and 5.45 were assigned to vinylic H-9 and H-10 protons, respectively. A three-proton triplet at δ 0.85 (J = 6.5 Hz) was due to C-18 primary methyl protons. The remaining methylene protons resonated as two-proton multiplets from δ 2.70 to 1.42 and as broad singlets at δ 1.28 (6H) and 1.25 (12H). The ^{13}C NMR spectrum of compound **9** showed signals for anomeric carbons from δ 101.51 to 86.29, other sugar carbons between δ 80.04 - 61.91, ester carbon at δ 170.76 (C-1), vinylic carbons at δ 141.23 (C-9) and 118.46 (C-10), methyl carbon at δ 14.11 (C-18) and methylene carbons in the range of δ 33.82 - 22.69. The presence of the sugar protons in the deshielded region at δ 3.28 (H_2-6a), 3.25 (H_2-6b), 3.22 (H_2-6c), 3.19 (H_2-6d) and 3.15 (H_2-6e) and the respective carbon signals from δ 62.74 to 62.27 suggested (6→1) linkages of the sugar units. Acid hydrolysis of **9** yielded D-glucose, R_f 0.26 (*n*-butanol- acetic acid – water, 4 : 1 : 5). On the basis of these evidences the structure of compound **9** has been characterized as oleiyl-O-β-D-glucopyranosyl- (6a→1b)-O-β-D-glucopyranosyl-(6b→1c)-O-β-D- glucopyranosyl-(6c→1d)-O-β-D-glucopyranosyl- (6d→1e)-O-β-D-glucopyranosyl-(6e→1f)-O-□-D-glucopyranoside, a new fatty acid hexaglucoside (Fig 3).



Gadoleic acid (7)



Oleiyl β-D-tetraglucoside (8)



Oleiyl β-D-hexaglucoside (9)

Fig 3: Structural formulae of the chemical constituents 7 - 9 isolated from the fruits of *Pyrus communis.*

CONCLUSION

Phytochemical investigation of a methanolic extract of the leaves of *A. conyzoides* gave (Z)-*n*- tripentacont-43-ene-22-one. The leaves of *J. sambac* afforded β- D-glucose, glyceroloxy glycerol and three new acyl glycosides. The fruits of *P. communis* yielded gadoleic acid and two oleiyl polyglucosides. 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.

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CONFLICTS OF INTERESTS

The authors declare that they have no conflict of interest.

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