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FATTY ACID CONSTITUENTS FROM THE LEAVES OF *AMARANTHUS HYBRIDUS* L.

Mohammed Ali[1*], Sumitra Singh Dahiya[2], Shahnaz Sultana[1,3] and Kavita Munjal[1,4]

[1]Phytopharmaceuticals Research Laboratory, School of Pharmaceutical Education and Research, Jamia Hamdard, P.O. Hamdard Nagar, New Delhi – 110062, India.

[2]Department of Pharmaceutical Sciences, Guru Jambheshwar University of Science and Technology, Hisar - 125001, India.

[3]Present address: College of Pharmacy, Jazan University, Jazan, Saudi Arabia.

[4]Present address: Department of Pharmacy, M.M. College of Pharmacy, Mullana, Ambala-133207, India.

***Corresponding Author: Mohammed Ali**

Phytopharmaceuticals Research Laboratory, School of Pharmaceutical Education and Research, Jamia Hamdard, P.O. Hamdard Nagar, New Delhi - 110062, India.

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ABSTRACT

Amaranthus hybridus L. (family Amaranthaceae) is an annual, erect herb used to treat intestinal bleeding, diarrhoea, jaundice, excessive menstruation, scorpion sting, snake bites, swelling and mouth and throat ulcers. The leaves are eaten as a green vegetable and to prepare a soup. Our study was planned to isolate chemical constituents from a methanolic extract of the leaves of *A. hybridus* and to characterize their structures on the basis spectral data analysis. Phytochemical investigation of the leaves led to isolate three higher fatty acids characterized as (Z)-docos-11-enoic acid (cetoleic acid, **1**), *n*-tetracosanoic acid (lignoceric acid, **2**) and *n*-dotriacontanoic acid (lacceroic acid, **3**) and five fatty acid esters identified as 8′β-hydroxynonadecanyl caprate (8′β-hydroxynonadecanyl decanoate, **4**), tricosanyl palmitate **(5**), *n*-tricosanyl linoleate (**6**), *n*-tricosanyl *n*-octadec-9-en-1-oate (*n*-tricosanyl oleate, **7**) and *n*-pentacosanyl *n*-octadec-9-en-1-oate (*n*-pentacosanyl oleate, **8**).

KEYWORDS: *Amaranthus hybridus* L., leaves, phytoconstituents, isolation, spectral data analysis, structure characterization.

INTRODUCTION

Amaranthus hybridus L. (family Amaranthaceae), commonly known as green amaranth, slim amaranth, smooth amaranth, smooth pigweed, or red amaranth, is a native to eastern North America, Mexico and South America, introduced into Europe, Africa, south-eastern Asia and Australia. It is an annual, erect herb; stems stout, branched, angular, glabrous, with multicellular hairs; leaves glabrous, long-petiolate, lamina lanceolate to ovate; flowers in yellowish, reddish or purple, axillary and terminal spikes; capsules sub-globose to ovoid-urceolate, circumscissile, with a distinct ovoid beak, lid smooth; seeds black and shining, compressed, smooth. A leaf decoction is taken as an antioxidant, astringent, diuretic, laxative and to treat intestinal bleeding, diarrhoea, jaundice, excessive menstruation and swelling.[1,2] The leaves are eaten as spinach or a green vegetable and to prepare a soup. The boiled leaves mixed with a groundnut sauce are eaten as salad.[3, 4] The leaves are used as an antidote for snake bite and scorpion sting.[5] A leaf decoction is used as a wash for ulcers and sores and to treat mouth and throat ulcers. An inflorescence infusion is drunk by women to alleviate periodic pain.[2] The plant is useful to relieve diabetes, diarrhoea, dysentery, haemorrhage of the bowel, liver infections and ulcers.[6]

The amaranth leaves contained β-carotene, thiamine, riboflavin, niacin, pyridoxine, ascorbic acids, tocopherols, amino acids, flavonoid, saponin, tannins, phenols, hydrocyanic acid and phytic acid.[1] The plant yielded flavonoids, e.g., rutin, isoquercetin and nicotiflirin.[7] The plant showed the presence of tannins, phenols, quinones, steroids, flavonoids, triterpenoids, reducing sugars.[8-10] and vitamin A.[11] GCMS analysis of a methanolic extract of *A. hybridus* indicated the presence of squalene, palmitic acid, methyl oleate, chondrillasterol, 6-octadecenoic acid, methyl ester, 1,3-propanediol, pentacosane, tetracontane, pentatriacontane and benzenepropanoic acid.[12] The presence of herbal chemical constituents vary due to many factors such as geographic regions, soils, seasonal changes, plant species and application of fertilizers. Keeping in views the various therapeutic values and variation aspects of chemical constituents of the plants and development of ecofriendly, biodegradable and safer herbal preparations, it has been aimed to establish chemical structures of phytoconstituents isolated from the leaves of *Amaranthus hybridus*.

MATERIALS AND METHODS

The protocols of all methodologies (procedures, experimental designs and spectral data analysis) were adopted from the earlier published work.[15,20]

Collection and authentication of plant materials

The leaves of *Amaranthus hybridus* were collected from the campus of Guru Jambeshwar University of Science and Technology, Hisar, Haryana. The plant material was identified and authenticated by Prof. M. P. Sharma, Taxonomist, Department of Botany, Jamia Hamdard, New Delhi. A voucher specimen of the amaranth leaves was preserved in the herbarium of the Department of Pharmacognosy and Phytochemistry, Jamia Hamdard, New Delhi.

Extraction and isolation

The leaves of *Amaranthus hybridus* (1 kg each) were dried in air, coarsely powdered and extracted exhaustively with methanol in a Soxhlet apparatus. The extract was concentrated under reduced pressure to get a dark brown mass, 211.3 g. The dried residue (100 g) was dissolved in minimum amount of methanol and adsorbed on silica gel column grade (60-120 mesh) to obtain a slurry. It was air-dried and chromatographed over a silica gel column loaded in petroleum ether (b. p. 60 – 80 °C). The column was eluted with petroleum ether, petroleum ether - chloroform (9:1, 3:1, 1:1, 1:3, *v/v*) and chloroform. 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.

Cetoleic acid (1)

Elution of the column with petroleum ether-chloroform (3:1) gave yellow sticky mass of **1**, recrystallized from chloroform-methanol (1:1), 79.3 mg, R_f 0.48 (petroleum ether-chloroform, 9:1), m. p. 33 – 34 ^{o} C; IR υ_{max} (KBr): 3408, 2927, 2857, 1687, 1640, 1458, 1339, 1261, 1120, 725 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.48 (1H, m, $w_{1/2}$ = 5.8 Hz, H-11, 5.45 (1H, m, $w_{1/2}$ = 5.1 Hz, H-12), 2.59 (2H, t, J = 7.1 Hz, H_2-2), 2.03 (2H, m, H_2-10), 2.01 (2H, m, H_2-13), 1.51 (4H, m, H_2-3, H_2-4), 1.25 (26H, m, 13 × CH_2), 0.88 (3H, t, J = 7.8 Hz, Me-22); ^{13}C NMR ($CDCl_3$): δ 179.12 (C-1), 39.41 (C-2), 32.04 (C-3), 29.73 (C-4), 29.58 (C-5), 29.49 (C-6), 29.47 (C-7), 2841 (C-8), 29.38 (C-9), 34.41(C-10), 130.18 (C-11), 128.09 (C-12), 34.86 (C-13), 29.42 (C-14), 29.37 (C-15), 29.23 (C-16), 28.41 (C-17), 27.64 (C-18), 25.72 (C-19), 24.96 (C-20), 22.69 (C-21), 14.8 (C-22); +ve FAB MS *m/z* (rel. int.): 338 $[M]^+$ ($C_{22}H_{42}O_2$) (9.8).

Lignoceric acid (2)

Elution of column with petroleum ether - chloroform (2:3) yielded colourless amorphous powder of compound **2**, recrystallized from acetone-methanol (1:1), yield 71 mg; R_f 0.61 (petroleum ether - chloroform, 2:3), m. p. 83 - 84 °C; IR υ_{max} (KBr): 3426, 2923, 2845, 1705, 1465, 1384, 1235, 1122, 1037, 827, 728 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 2.29 (2H, t, J = 7.7 Hz, H_2-2), 2.03 (2H, m, H_2-3), 1.54 (4H, m, H_2-4, H_2-5), 1.38 (2H, m, H_2-6), 1.24 (36H, brs, 18 x CH_2), 0.85 (3H, t, J = 7.1 Hz, Me-24); ^{13}C NMR ($CDCl_3$): δ 177.18 (C-1), 33.82 (C-2), 31.94 (C-3), 32.11 (C-4), 29.53 (12 × CH_2), 29.64 (C-17), 29.52 (C-18), 29.28 (C-19), 27.78 (C-20), 26.25 (C-21), 24.93 (C-22), 22.71 (C-23), 14.24 (C-24); +ve FAB MS *m/z* (rel. int.): 368 $[M]^+$ ($C_{24}H_{48}O_2$) (14.8), 339 (32.6), 311 (11.5).

Dotriacontanoic acid (3)

Elution of the column with petroleum ether - chloroform (1:1) produced colourless crystals of **3**, recrystallized from acetone-methanol (1:1), 291 g, m. p. 87 – 88 ^{0}C; IR υ_{max} (KBr): 3427, 2923, 2853, 1705, 1471, 1334, 1180, 1021, 892 cm^{-1}; ^{1}H NMR ($CDCl_3$) : δ 2.27 (2H, t, J = 4.5 Hz, H_2-2), 1.54 (2H, m, H_2-3), 1.33 (2H, m, H_2-4), 1.28 (4H, m, H_2-5, H_2-6) 1.19 (50 H, brs, 25 × CH_2), 0.83 (3 H, t , J = 6.3 Hz, Me-32); ^{13}C NMR ($CDCl_3$): δ 179.23 (C-1), 34.08 (C-2), 31.91 (C-3), 29.74 (21 × CH_2), 29.49 (C-25, C-26), 29.33 (C-27), 29.25 (C-28), 29.14 (C-29), 24.76 (C-30), 22.69 (C-31), 14.08 (Me-32); +ve FAB MS *m/z* (rel. int.): 480 $[M]^+$ ($C_{32}H_{64}O_2$) (13.2).

8′β-Hydroxynonadecanyl caprate (4)

Further elution of the column with petroleum ether-chloroform (1:1) furnished colourless crystals of **4**, recrystallized from acetone-methanol (1:1), yield 211 mg, m. p. 72 - 73 °C; UV λ max (MeOH): 215 nm; IR υmax (KBr): 3414, 2923, 2856, 1735, 1649, 1461, 1381, 1229, 1023, 953, 713 cm^{-1}; ^{1}H NMR ($CDCl_3$) : δ 3.84 (2H, t, J = 7.2 Hz, H_2 -1′), 3.47 (1H, m, $w_{1/2}$ = 8.6 Hz, H-8′β), 2.04 (2H, t, J = 6.6 Hz, H_2 -2), 1.53 (2H, m, H_2 -3), 1.32 (2 H, m, H_2 -4), 1.25 (44 H, brs, 22 x CH_2), 0.88 (3H, t, J = 7.1 Hz, Me-10), 0.82 (3H, t, J = 7.6 Hz, Me-19′); ^{13}C NMR ($CDCl_3$): δ 171.42 (C-1), 67.58 (C-8′), 63.37 (C-1′), 35.47 (C-2), 32.71 (C-3), 32.65 (C-7′), 31.84 (C-9′), 31.38 (C-2′), 29.87 (C-3′), 29.61 (C-4′), 29.37 (14 x CH_2), 27.58 (C-8), 25.82 (C-9), 22.69 (C-18′), 14.19 (C-10), 14.16 (C-19′); +ve FAB MS *m/z* (rel. int.) : 454 $[M]^+$ ($C_{29}H_{58}O_3$) (21.5), 185 (100), 171 (35.6), 155 (85.3).

Tricosanyl palmitate (5)

Elution of the column with petroleum ether-chloroform (1:3) afforded colourless crystals of **5**, yield 211 mg, recrystallized from chloroform-methanol (1:1), m. p. 119 – 121 °C; R_f : 0.51 (petroleum ether - chloroform, 1 : 4); IR υ_{max} (KBr) : 2928, 2860, 1738, 1459, 1375, 1266, 1165, 1031, 721 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 3.94 (2H, t, J = 6.3 Hz, H_2 -1′), 2.34 (2H, t, J = 7.2 Hz, H_2 -2), 2.17 (2H, m, H_2-3), 2.03 (2H, m, H_2-2′), 1.67 (2H, m, H_2-4), 1.56 (4H, m, H_2-5, H_2-6), 1.41 (2H, m, H_2-3′), 1.25 (56H, brs, 28 x CH_2), 0.88 (3H, t, J = 6.8 Hz, Me-16), 0.82 (3H, t, J = 6.3 Hz, Me-23′); ^{13}C NMR ($CDCl_3$): δ 172.08 (C-1), 63.37 (C-1′), 34.39 (C-2), 33.71 (C-3), 32.82 (C-2′), 31.73 (C-4), 31.41 (C-5), 29.94 (C-3′), 29.68 (C-4′), 29.37 (24 x CH_2), 29.31 (C-21′), 28.28 (C-14), 25.89 (C-15), 22.67 (C-22′), 14.17 (C-16), 14.11 (C-23′); +ve

FAB MS *m/z* (rel. int.): 578 $[M]^+$ ($C_{39}H_{78}O_2$) (11.2), 255 (24.5), 239 (12.2).

***n*-Tricosanyl linoleate (6)**

Further elution of the column with petroleum ether – chloroform (1:3) produced a pale yellow mass of **6**, recrystallized from acetone-methanol (1:1), yield 114 mg , m. p. 74-75 ^{o} C; IR υ_{max} (KBr): 2926, 2859, 1742, 1655, 1461, 1377, 1169, 1045, 722 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.37 (1H, m, H-10), 5.34 (1H, m, H-12), 5.14 (1H, m, H-9), 5.06 (1H, m, H-13), 3.61 (2H, t, J = 6.9 Hz, H_2 -1′), 2.77 (2H, m, H_2-11), 2.36 (2H, t, J = 7.2 Hz, H_2 -2), 2.31 (2H, m, H_2 -8), 2.27 (2H, m, H_2 -14), 2.03 (2H, m, H_2 -3), 1.77 (2H, m, H_2-4), 1.62 (2H, m, H_2-7), 1.34 (4H, m, H_2-2′, H_2-3′), 1.25 (44H, brs, 22 x CH_2), 0.89 (3H, t, J = 6.5 Hz, Me-18), 0.85 (3H, t, J = 6.3 Hz, Me-23′); ^{13}C NMR ($CDCl_3$): δ 172.11 (C-1), 37.18 (C-2), 31.93 (C-3), 29.71 (C-4), 29.65 (C-5), 29.58 (C-6), 29.61 (C-7), 34.87 (C-8), 125.64 (C-9), 121.29 (C-10), 48.34 (C-11), 125.51 (C-12), 122.39 (C-13), 29.45 (C-14), 29.39 (C-15), 29.33 (C-16), 22.69 (C-17), 14.18 (C-18), 65.06 (C-1′), 33.18 (C-2′), 29.79 (C-3′), 29.69 (C-4′), 29.66 (C-5′), 29.63 (C-6′ to C-14′), 29.58 (C-15′), 29.52 (C-16′), 29.48 (C-17′), 29.35 (C-18′), 29.31 (C-19′), 28.81 (C-20′), 25.47 (C-21′), 22.71 (C-22′), 14.12 (C-23′); +ve FAB MS *m/z* (rel.int.): 602 $[M]^+$ ($C_{41}H_{80}O_2$) (31.8), 339 (100), 263 (18.3).

***n*-Tricosanyl oleate (7)**

Further elution of the column with petroleum ether – chloroform (1:3) afforded a pale yellow mass of **7**, recrystallized from acetone-methanol (1:1), yield 129 mg , R_f : 0.69 ($CHCl_3$); m. p. 79-80 ^{o} C; UV λmax (MeOH): 225 nm (log Ɛ 3.7); IR υ_{max} (KBr): 2927, 2857, 1742, 1649, 1457, 1371, 1168, 1072, 723 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.35 (1H, m, H-9), 5.33 (1H, m, H-10), 4.16 (2H, t, J = 6.5 Hz, H_2 -1′), 2.29 (2H, t, J = 7.5 Hz, H_2 -2), 2.05 (2H, m, H_2 -8), 2.01 (2H, m, H_2 -11), 1.77 (2H, m, H_2-3), 1.51 (4H, m, H_2-7, H_2-12), 1.31 (4H, brs, H_2-2′, H_2-3′), 1.25 (34H, brs, 17 x CH_2), 0.88 (3H, t, J = 6.9 Hz, Me-18), 0.80 (3H, t, J = 6.5 Hz, Me-23′); ^{13}C NMR ($CDCl_3$): δ 171.98 (C-1), 38.75 (C-2), 31.89 (C-3), 30.32 (C-4), 29.67 (C-5), 29.62 (C-6), 29.58 (C-7), 34.89 (C-8), 124.51 (C-9), 119.14 (C-10), 34.57 (C-11), 30.24 (C-12), 29.48 (C-13), 29.41 (C-14), 29.34 (C-15), 29.26 (C-16), 22.67 (C-17), 14.16 (C-18), 64.17 (C-1′), 31.47 (C-2′), 29.73 (C-3′), 29.71 (C-4′), 29.69 (C-5′), 29.66 (C-6′ to C-14′), 29.61 (C-15′), 29.56 (C-16′), 29.47 (C-17′), 29.39 (C-18′), 29.27 (C-19′), 28.88 (C-20′), 25.53 (C-21′), 22.99 (C-22′), 14.02 (C-23′); +ve FAB MS *m/z* (rel.int.): 604 $[M]^+$ ($C_{41}H_{80}O_2$) (31.8), 339 (21.21), 265 (18.3).

***n*-Pentacosanyl oleate (8)**

Elution of the column with chloroform furnished colourless crystals of **8**, recrystallized from chloroform-methanol (1:1), yield 197 mg; R_f : 0.56 ($CHCl_3$); m. p. 86-88 ^{o} C; UV λmax (MeOH): 221 nm (log Ɛ 3.1); IR υ_{max} (KBr): 2926, 2857, 1738, 1632,1462, 1378, 1251, 1179, 1036, 724 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 5.36 (1H, m, H-9), 5.34 (1H, m, H-10), 4.13 (2H, d, J = 6.9 Hz, H_2-1′), 2.31 (1H, t, J=7.5 Hz, H_2-2), 2.05 (2H, m, H_2-8), 1.85 (2H, m, H_2-11), 1.51 (6H, m, H_2-7, H_2-12, H_2-3), 1.30 (2H, m, H_2-4), 1.25 (60H, m, 30 x CH_2), 0,89 (3H, t, J=6.3 Hz, Me-18), 0.87 (3H, t, J=6.2 Hz, Me-25′); ^{13}C NMR ($CDCl_3$): δ 172.13 (C-1), 131.56 (C-9), 129.12 (C-10), 62.19 (C-1′), 34.55 (C-2), 34.49 (C-8), 31.95 (C-11), 31.04 (C-3), 30.47 (C-7), 29.73 (C-12, C-23), 29.73 (24 x CH_2), 29.25 (C-2′), 27.22 (C-22′), 25.64 (C-23′), 24.89 (C-16), 22.68 (C-17), 21.16 (C-24′), 13.05 (C-18), 13.02 (C-25′); +ve ion FAB MS *m/z* (rel. int.): 632 [M]+ ($C_{43}H_{84}O_2$) (1.5), 367 (29.8), 265 (31.5).

RESULTS AND DISCUSSION

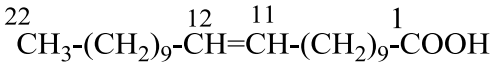
Compound **1** was a known unsaturated fatty acid identified as (*Z*)-docos-11-enoic acid (cetoleic acid, Fig. 1).[13] Compounds **2** and **3** were the familiar long chain saturated fatty acid identified as *n*-tetracosanoic acid (lignoceric acid).[14, 15] and dotriacontanoic acid (lacceroic acid, lacceric acid), respectively (Fig. 1).[16-18]

The IR spectrum of compound **4** showed absorption bands for a hydroxyl group (3414 cm^{-1}), ester function (1735 cm^{-1}) and long aliphatic chain (713 cm^{-1}). Its mass spectrum exhibited a molecular ion peak at *m/z* 454 corresponding to a hydroxyalkyl fatty acid ester, $C_{29}H_{58}O_3$. An ion fragment arising at *m/z* 171 [$C_{1'}$ – O fission, $CH_3(CH_2)_8$-$COO]^+$ indicated that capric acid was esterified with hydroxynonadecanol. The ion peaks produced at *m/z* 155 [$C_{8'}$ - $C_{9'}$ fission, $(CH_2)_{10}$-$CH_3]^+$ and 185 [$C_{7'}$ - $C_{8'}$ fission, HOCH-$(CH_2)_{10}$-$CH_3]^+$ suggested the attachment of the hydroxyl group at C-8′ carbon. The ^{1}H NMR spectrum of **4** displayed two two-proton triplets at δ 3.84 (J = 7.2 Hz) and 2.04 (J = 6.6 Hz) assigned to oxymethylene H_2 -1′ and methylene H_2 -2 respectively, adjacent to the ester group. A one-proton multiplet at δ 3.47 with half-width of 8.6 Hz was ascribed to alpha-oriented H-8′β carbinol proton. Two two-proton multiplets at δ 1.53 and 1.32 and a broad singlet at δ 1.25 (44 H) were attributed to other methylene protons. Two three- proton triplets at δ 0.88 (J = 7.1 Hz) and 0.82 (J = 7.6 Hz) were accounted to terminal C-10 and C-19′ primary methyl protons. The ^{13}C NMR spectrum of **4** exhibited signals for the ester carbon at δ 171.42 (C-1), carbinol carbon at δ 67.58 (C-8′), oxymethylene carbon at δ 63.37 (C-1′), methylene carbons from δ 35.47 to 22.69 and methyl carbons at δ 14.19 (C-10) and 14.16 (C-19′). The absence of any signal beyond δ 3.84 in the ^{1}H NMR spectrum and carbon signals between δ 171.42 - 67.58 in the ^{13}C NMR spectrum ruled out the existence of any vinylic linkage in the molecule. On the basis of these spectral data analysis, the structure of **4** has been established as 8′β-hydroxynonadecanyl caprate (8′β-hydroxynonadecanyl decanoate), a new hydroxyalkyl caprate (Fig. 1).

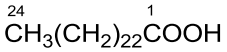
The compounds **5** was a known fatty acid ester identified as tricosanyl palmitate (Fig. 1).[19]

Compound **6** showed IR absorption bands for an ester group (1742 cm^{-1}) and long aliphatic chain (722 cm^{-1}). Its mass spectrum exhibited a molecular ion peak at *m/z* 602 consistent with the molecular formula of a fatty acid ester, $C_{41}H_{40}O_2$. The generation of the ion peaks at *m/z* 263 [C_1 - O fission, $CH_3(CH_2)_4$-CH=CH-CH_2-CH=CH-$(CH_2)_7$-$CO]^+$ and 339 [M – 263, O-CH_2-$(CH_2)_{21}$-$CH_3]^+$ indicated that linoleic acid was esterified with *n*-tricosanol. The ^{1}H NMR spectrum of **6** displayed four one-proton deshielded multiplets at δ 5.37, 5.34, 5.14 and 5.06 assigned to vinylic H-10, H-12, H-9 and H-13 protons, respectively. Two two-proton triplets at δ 3.61 (J = 6.9 Hz) and 2.36 (J = 7.2 Hz) were ascribed correspondingly to oxymethylene H_2-1′ and methylene H_2 -2 protons adjacent to the ester function. The remaining methylene protons appeared as multiplets from δ 2.77 to 1.34 and as a broad singlet at δ 1.25 (44H). Two three-proton triplets at δ 0.89 (J = 6.5 Hz) and 0.85 (J = 6.3 Hz) were accounted to C-18 and C-23′ primary methyl protons, respectively. The ^{13}C NMR spectrum of **6** showed signals for the ester carbon at δ 172.11 (C-1), vinylic carbons at δ 125.64 (C-9), 121.29 (C-10), 125.51 (C-12) and 122.39 (C-13), oxymethylene carbon at δ 65.06 (C-1′), other methylene carbons between δ 48.34 - 22.69 and methyl carbons at δ 14.18 (C-18) and 14.12 (C-23′). On the basis of these spectral data analysis, the structure of **6** has been elucidated as *n*-tricosanyl linoleate, a new fatty acid ester (Fig. 1).

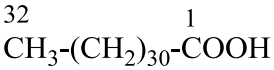
Compound **7** and **8** were the known fatty acid ester characterized as characterized as *n*-tricosanyl *n*-octadec-9-en-1-oate (*n*-tricosanyl oleate) and *n*-pentacosanyl *n*-octadec-9-en-1-oate (*n*-pentacosanyl oleate, Fig 1).[20]



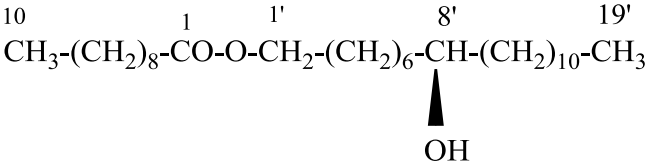
Cetoleic acid **(1)**



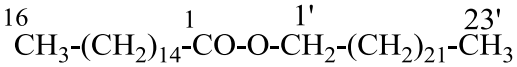
Lignoceric acid **(2)**



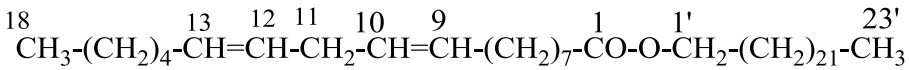
Lacceroic acid **(3)**



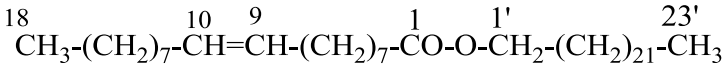
8′β-Hydroxynonadecanyl caprate (**4**)



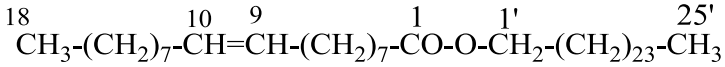
n-Tricosanyl palmitate **(5)**



n-Tricosanyl linoleate **(6)**



n-Tricosanyl oleate **(7)**



n-Pentacosanyl oleate **(8)**

Fig. 1: Chemical constituents 1 to 8 isolated from the leaves of *Amaranthus hybridus* L.

CONCLUSION

Phytochemical investigation of the leaves of *Amaranthus hybridus* L. led to isolate three higher fatty acids characterized as cetoleic acid (**1**), lignoceric acid (**2**) and lacceroic acid (**3**) and five fatty acid esters identified as 8′β-hydroxynonadecanyl caprate (8′β-hydroxynonadecanyl decanoate, **4**), *n*-tricosanyl palmitate **(5)**, *n*-tricosanyl linoleate (**6**), *n*-tricosanyl oleate (**7**) and *n*-pentacosanyl oleate (**8**). This work has enhanced understanding about the chemical constituents of the undertaken plant. Further research is recommended to screen bioactivities of the isolated chemical constituents with a view for supplementing

conventional drug development especially in developing countries.

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