SUPPLEMENTARY INFORMATION

Target-selective photo-degradation of verotoxin-1 and reduction of its cytotoxicity to Vero cells using porphyrin-globotriose hybrids.

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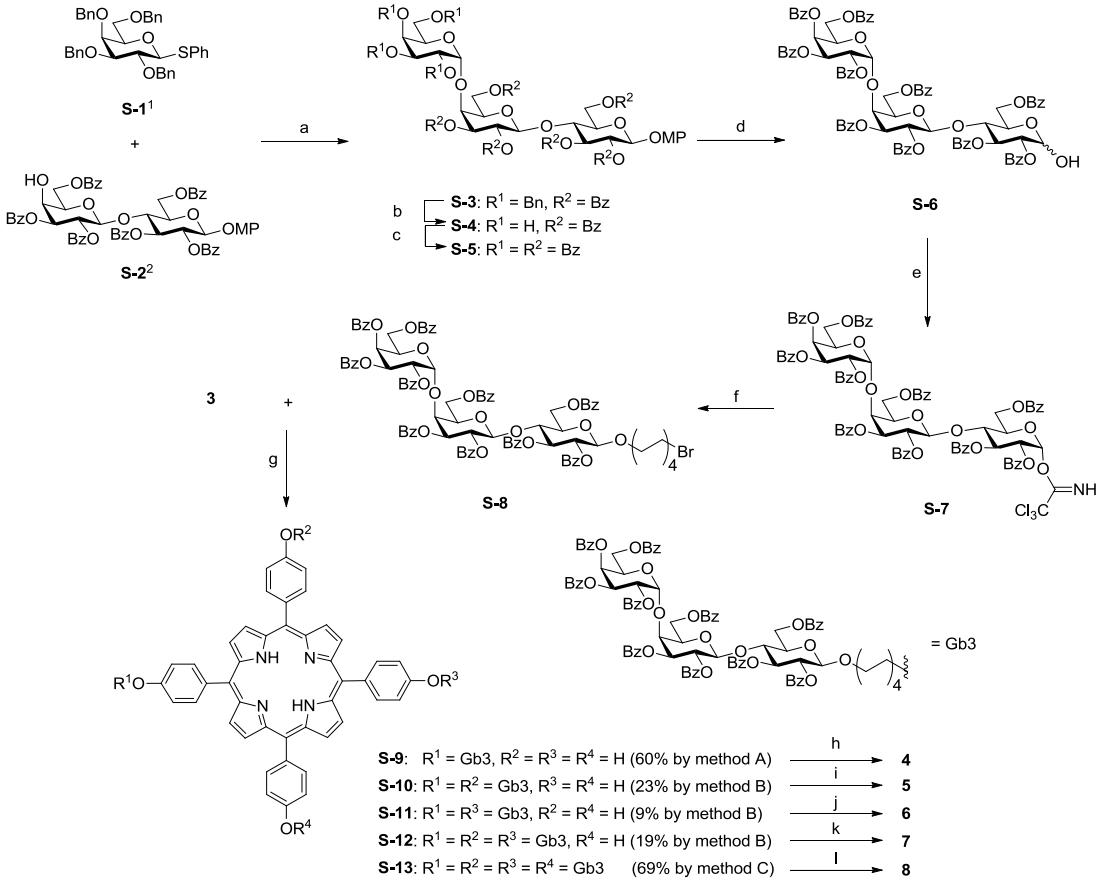
General Methods for Chemical Synthesis.

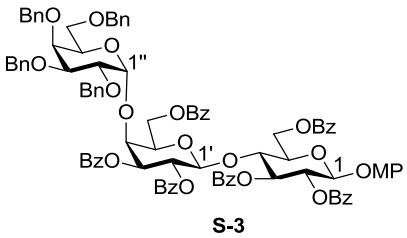
NMR spectra were recorded on a JEOL Lamda (300 MHz for ^{1}H) or JEOL ECA-500 (500 MHz for ^{1}H, 125 MHz for ^{13}C) spectrometer. ESI-TOF mass spectra were measured on a Waters LCT premier XE. Melting points were determined on a micro hot-stage (Yanako MP-S3) and were uncorrected. Optical rotations were measured on a JASCO P-2200 polarimeter. Silica gel TLC and column chromatography were performed using Merck TLC 60F-254 (0.25 mm) and Silica Gel 60 N (spherical, neutral) (Kanto Chemical Co., Inc.), respectively. Air- and/or moisture-sensitive reactions were carried out under an argon atmosphere using oven-dried glassware. In general, organic solvents were purified and dried using appropriate procedures, and evaporation and concentration were carried out under reduced pressure below 30 °C, unless otherwise noted.

Synthesis of compounds 4-8.



Scheme S1 a) NIS, TfOH, MS 5A, CH_2Cl_2, -40 ºC, 82%; b) $Pd(OH)_2$, H_2, MeOH/AcOH=2/1, rt, 97%; c) BzCl, DMAP, pyridine, 60 ºC, 97%; d) CAN, MeCN/H_2O=8/1, 0 ºC, 94%; e) Cl_3CCN, DBU, CH_2Cl_2, 0 ºC, 90%; f) 8-bromo-1-octanol, $Yb(OTf)_3$, MS5A, CH_2Cl_2, 0 ºC, 79%; g) Cs_2CO_3, NaI, DMF, 40 ºC; h) THF/H_2O=4/1, NaOH, 40 ºC, 70%; i) THF/H_2O=2/1, NaOH, 40 ºC, 80%; j) THF/H_2O=1/1, NaOH, 40 ºC, 31%; k) THF/H_2O=2/1, NaOH, 40 ºC, 80%; l) THF/H_2O=1/1, NaOH, 40 ºC, 92%.

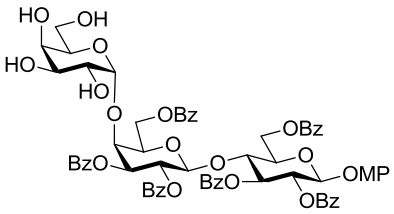
***p*-Methoxyphenyl 4-*O*-{4'-*O*-(2'',3'',4'',6''-tetra-*O*-benzyl-α-D-galactopyranosyl)-2',3',6'-tri-*O*-benzoyl-β-D-galactopyranosyl}-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (S-3).**



S-3

To a solution of **S-1**[1] (11.8 g, 18.7 mmol) and **S-2**[2] (5.00 g, 4.66 mmol) in CH_2Cl_2 (255 mL) was added MS 5A (21.0 g). The mixture was cooled to -40 ºC, and stirred for 30 min. Then NIS (4.20 g, 18.7 mmol) and TfOH (0.124 mL, 1.40 mmol) were added to the reaction mixture. After being stirred for 1 h at the same temperature, the reaction was quenched with triethylamine (3.90 mL, 27.5 mmol). The resultant mixture was filtered through Celite. The filtrate was washed with 30% $Na_2S_2O_3$ aq., saturated $NaHCO_3$ aq., and brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (PhMe/EtOAc=10/1) to give **S-3** (6.10 g, 3.82 mmol, 82% yield). White solid; R_f 0.55 (10/1 PhMe-EtOAc); m.p. 78.2-79.2 ºC; $[\alpha]^{29}_D$ +9.75º (*c* 0.502, $CHCl_3$); ^{1}H-NMR(500 MHz, $CDCl_3$) δ 8.03 (2H, d, *J* = 8.0 Hz, Ar-H), 7.97-7.92 (8H, m, Ar-H), 7.81 (2H, d, *J* = 8.3 Hz, Ar-H), 7.57-7.07 (38H, m, Ar-H), 6.84 (2H, d, *J* = 8.6 Hz, $CH_3OC_6O_4$-), 6.61 (2H, d, *J* = 8.6 Hz, $CH_3OC_6O_4$-), 5.84 (1H, dd, *J* = 9.2 Hz, H-3), 5.75 (1H, dd, *J* = 7.7, 10.6 Hz, H-2'), 5.59 (1H, t, *J* = 7.7, 9.2 Hz, H-2), 5.09 (1H, d, *J* = 7.7 Hz, H-1), 5.05 (1H, dd, *J* = 2.3, 10.6 Hz, H-3'), 4.89 (1H, d, *J* = 7.7 Hz, H-1'), 4.80 (1H, d, *J* = 10.9 Hz), 4.57-4.53 (3H, m, H-6'), 4.75-4.67 (4H, m), 4.49 (1H, dd, *J* = 5.7, 12.0 Hz, H-6), 4.45 (1H, d, *J* = 11.2 Hz, H-2''), 4.30 (1H, d, *J* = 8.9 Hz, H-4'), 4.25 (1H, m, H-4), 4.22-4.13 (3H, m, H-5''), 4.07 (1H, s), 3.99 (1H, m, H-5), 3.95 (1H, d, *J* = 2.3 Hz), 3.90 (1H, dd, *J* = 2.9, 10.0 Hz), 3.71 (1H, t, *J* = 6.3 Hz, H-5'), 3.68 (3H, s, CH_3O), 3.33 (1H, t, *J* = 9.5 Hz, H-6''), 2.97 (1H, dd, *J* = 4.8, 8.5 Hz, H-6''); ^{13}C-NMR ($CDCl_3$, 125 MHz) 166.7, 166.0, 165.9, 165.6, 165.5, 165.4, 155.9, 151.2, 139.2, 139.1, 138.7, 138.5, 133.5, 133.4, 130.1, 130.5, 130.0, 129.9, 129.8, 129.7, 129.5, 129.3, 129.2, 128.8, 128.7, 128.6, 128.6, 128.5, 128.5, 128.5, 128.3, 128.3, 127.9, 127.8, 127.7, 127.6, 119.2, 114.6, 101.5, 101.4, 101.7, 79.4, 76.8, 76.1, 75.8, 75.2, 75.0, 74.7, 73.7, 73.7, 73.6, 73.2, 72.9, 72.5, 70.2, 70.1, 67.7, 63.0, 62.6, 55.7; HRMS (ESI-TOF) *m/z* 1595.5625 (1595.5638 calcd. for $C_{95}H_{87}O_{23}$, $[M+H]^+$).

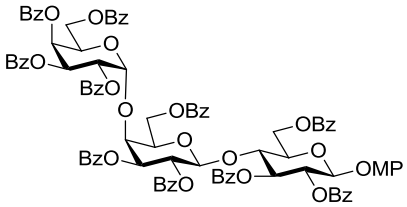
***p*-Methoxyphenyl 4-*O*-{4'-*O*-(α-D-galactopyranosyl)-2',3',6'-tri-*O*-benzoyl-β-D-galactopyranosyl}-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (S-4).**



S-4

To a solution of **S-3** (1.15 g, 0.721 mmol) in MeOH/AcOH (40.0 mL, 2/1) was added $Pd(OH)_2$ (0.580 g) under H_2 atmosphere. After being stirred for 24 h, the reaction mixture was filtered through Celite, and then filtrate was concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (10/1 $CHCl_3$-MeOH) to give **S-4** (0.864 g, 0.699 mmol, 97% yield). White solid; R_f 0.43 (10/1 $CHCl_3$-MeOH); m.p. 130-131 ºC; $[\alpha]^{28}_D$ +13.8º (*c* 0.500, $CHCl_3$); ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.07-7.86 (12H, m, Ar-H), 7.60-7.22 (18H, m, Ar-H), 6.85 (2H, d, *J* = 9.2 Hz, $CH_3OC_6O_4$-), 6.62 (2H, d, *J* = 9.2 Hz, $CH_3OC_6O_4$-), 5.71 (1H, dd, *J* = 7.7, 9.5 Hz, H-3), 5.65 (1H, dd, *J* = 7.7, 9.5 Hz, H-2), 5.17 (1H, dd, *J* = 2.6, 10.7 Hz, H-3'), 5.01 (1H, d, *J* = 7.7 Hz, H-1), 4.94 (1H, d, *J* = 2.6 Hz, H-1''), 4.87 (1H, d, *J* = 7.7 Hz, H-1'), 4.66 (1H, dd, *J* = 1.8, 11.9 Hz, H-6), 4.49 (1H, dd, *J* = 6.0, 11.9 Hz, H-6), 4.30 (1H, d, *J* = 2.6 Hz, H-4'), 4.23 (1H, t, *J* = 9.5 Hz, H-4), 4.12-4.08 (2H, m, H-6', H-3''), 4.02-3.97 (3H, m, H-5, H-4'', H-5''), 3.78 (3H, m, H-5', H-6', H-2''), 3.68 (3H, s, CH_3O), 3.36 (1H, dd, *J* = 3.4, 11.9 Hz, H-6''), 3.27 (1H, m, H-6''), 3.08-2.95 (2H, br, OH), 2.42 (1H, s, OH), 2.33 (1H, s, OH); ^{13}C-NMR ($CDCl_3$, 125 MHz) δ 166.0, 166.0, 165.9, 165.6, 165.4, 155.8, 151.0, 133.8, 133.8, 133.6, 133.4, 130.0, 129.9, 129.8×2, 129.8, 129.7, 129.5, 129.2, 128.9, 128.8, 128.7, 128.6, 128.6, 119.0, 114.5, 101.4, 100.5, 100.5, 77.2, 73.8, 73.7, 73.3, 71.9, 70.7, 70.5, 70.1, 69.6, 62.9, 62.5, 61.9, 55.6; HRMS (ESI-TOF) *m/z* 1235.3712 (1235.3760 calcd. for $C_{67}H_{63}O_{23}$, $[M+H]^+$).

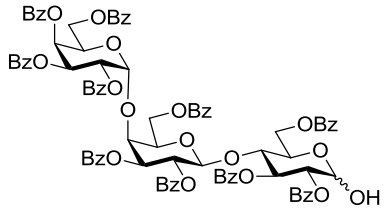
***p*-Methoxyphenyl 4-*O*-{4'-O-(2'',3'',4'',6''-tetra-*O*-bevzoyl-α-D-galactopyranosyl)-2',3',6'-tri-*O*-benzoyl-β-D-galactopyranosyl}-2,3,6-tri-*O*-benzoyl-β-D-glucopyranoside (S-5).**



S-5

To a solution of **S-4** (0.889 g, 0.721 mmol) in pyridine (26.7 mL) were added benzoyl chloride (0.837 mL, 7.21 mmol) and catalytic amount of 4-dimethylaminopyridine, and then the resultant mixture was stirred at 60 ºC for 22 h. After cooling to room temperature, the reaction mixture was poured into 1 N HCl aq. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (10/1 PhMe-EtOAc) to give **S-5** (1.16 g, 0.699 mmol, 97% yield). White solid; R_f 0.48 (10/1 PhMe-EtOAc); m.p. 122-123 ºC; $[\alpha]^{29}_D$ +12.4º (*c* 0.510, $CHCl_3$); ^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.14-8.07 (2H, m, Ar-H), 7.96-7.86 (16H, m, Ar-H), 7.77 (4H, t, *J* = 8.3 Hz, Ar-H), 7.71 (2H, d, *J* = 8.3 Hz, Ar-H), 7.55-7.14 (30H, m, Ar-H), 6.84 (2H, d, *J* = 9.2 Hz, $CH_3OC_6H_4$-), 6.60 (2H, d, *J* = 9.2 Hz, $CH_3OC_6H_4$-), 6.18 (1H, d, *J* = 3.2 Hz, H-4"), 6.04 (1H, dd, *J* =3.2, 10.9 Hz, H-3"), 5.85 (1H, t, *J* = 9.2 Hz, H-3), 5.82 (1H, dd, *J* = 7.8, 10.9 Hz, H-2'), 5.70 (1H, dd, *J* = 3.7, 10.9 Hz, H-2"), 5.63 (1H, dd, *J* = 7.5, 9.2 Hz, H-2), 5.48 (1H, d, *J* = 3.7 Hz, H-1"), 5.20 (1H, dd, *J* = 2.6, 10.9 Hz, H-3'), 5.11 (1H, d, *J* =7.5 Hz, H-1), 4.96 (1H, dd, *J* = 5.2, 8.6 Hz, H-5''), 4.94 (1H, d, *J* = 7.8 Hz, H-1'), 4.68 (1H, dd, *J* = 2.0, 11.8 Hz, H-6), 4.48 (1H, dd, *J* = 6.0, 11.8 Hz, H-6), 4.40 (1H, dd, *J* = 5.2, 10.9 Hz, H-6"), 4.36 (1H, d, *J* = 2.6 Hz, H-4'), 4.28 (1H, t, *J* = 9.2 Hz, H-4), 4.22 (1H, dd, *J* = 8.6, 10.9 Hz, H-6"), 4.09 (1H, dd, *J* = 7.7, 10.8 Hz, H-6'), 4.04 (1H, ddd, *J* = 2.0, 6.0 9.2 Hz, H-5), 4.02 (1H, dd, 7.7, 10.8 Hz, H-6'), 3.67 (3H, s, CH_3O), 3.64 (1H, t, *J* = 7.7 Hz, H-5'); ^{13}C-NMR (125 MHz, acetone-d_6): δ 165.7, 165.6, 165.4, 165.3, 165.2, 165.1×2, 165.0, 165.9, 155.6, 151.1, 133.6, 133.6×2, 133.5, 133.4, 133.5, 133.4 133.3 133.2×2. 133.2, 130.2, 130.0, 129.9, 129.8, 129.7, 129.6, 129.5×3, 129.3, 129.2, 128.9, 128.8, 128.7, 128.6, 128.6, 128.5, 128.5, 118.2, 114.4, 101.4, 99.5, 98.8, 77.5, 76.5, 73.6, 73.1, 72.7, 72.3, 70.45, 69.6, 69.2, 68.8, 67.7, 63.0, 61.4, 61.3; HRMS (ESI-TOF) *m/z* 1651.4874 (1651.4809 calcd. for $C_{95}H_{79}O_{27}$, $[M+H]^+$).

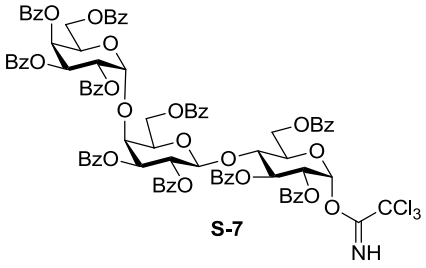
4-*O*-{4'-*O*-(2",3",4",6"-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2',3',6'-tri-*O*-benzoyl-β-D-galactopyranosyl}-2,3,6-tri-*O*-benzoyl-β-D-glucopyranose (S-6).



S-6

To a solution of **S-5** (1.13 g, 0.685 mmol) in acetonitrile/H_2O (113 mL, 8/1) was added ceric (IV) ammonium nitrate (3.00 g, 5.48 mmol). After being stirred for 2 h at 0 ^oC, the reaction mixture was poured into water. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (8/1 PhMe-acetone) to give **S-6** (0.955 g, 0.644 mmol, 94% yield). White solid; R_f 0.09 (8/1 PhMe-acetone); ^{1}H-NMR (500 MHz, $CDCl_3$) δ 8.25-7.67 (20H, m, Ar-H), 7.55-7.18 (30H, m, Ar-H), 6.19 (2/3H, d, *J* = 6.3 Hz), 6.16 (1H, d, *J* = 9.8 Hz), 6.07-6.01 (1H, m), 5.88-5.79 (4/3H, m), 5.71 (2/3H, dd, *J* = 3.4, 11,6 Hz), 5.68 (1/3H, dd, *J* = 3.4, 10.9 Hz), 5.57 (2/3H, t, *J* = 7.5 Hz), 5.49 (1H, d, *J* = 3.5 Hz), 5.25-5.14 (2H, m), 4.99 (2/3H, d, *J* = 7.8 Hz) 4.98-4.85 (5/3H, m), 4.65-4.59 (1H, m), 4.51-3.85 (8H, m), 3.64-3.57 (1H, m), 3.45 (1H, d, *J* = 3.2 Hz); ^{13}C-NMR (125 MHz, $CDCl_3$): 167.4, 166.4, 166.1, 166.0, 165.9, 165.8, 165.5, 165.2, 165.1×2, 165.1, 165.0, 133.7, 133.6, 133.5, 133.4, 133.4, 133.3, 133.2, 133.1×2, 133.0, 130.1, 130.0, 129.9, 129.9, 129.8×2, 129.7×3, 129.6, 129.5, 129.4×2, 129.3, 129.2, 128.9, 128.8, 128.7, 128.6, 128.5×2, 128.4, 128.3×3, 101.4, 101.3, 98.9, 98.8, 95.7, 90.3, 77.0, 76.9, 75.9, 75.5, 74.6, 73.8, 73.7, 73.4, 72.8, 72.7, 72.6, 72.5, 70.4, 70.1, 69.9, 69.8×2, 69.20, 69.1, 68.5, 68.1, 68.1, 67.8, 67.7, 62.4, 62.3, 61.6, 60.6×2; HRMS (ESI-TOF) *m/z* 1527.4299 (1527.4284 calcd. for $C_{88}H_{71}O_{25}$, $[M\text{-}OH]^+$).

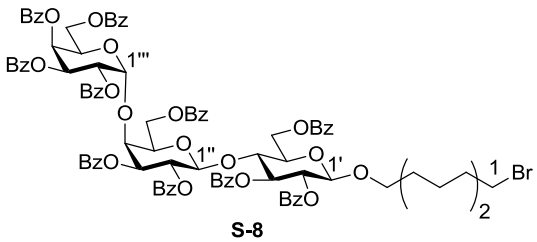
4-*O*-{4'-*O*-(2",3",4",6"-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2',3',6'-tri-*O*-benzoyl-β-D-galactopyranosyl}-2,3,6-tri-*O*-benzoyl-α-D-glucopyranosyl trichloroacetimidate (S-7).



S-7

To a solution of **S-6** (1.65 g, 1.07 mmol) in CH_2Cl_2 (48.0 mL) were added DBU (240 μL, 1.60 mmol) and trichloroacetonitrile (1.60 mL, 16.0 mmol) at 0 ºC. After being stirred for 22 h, the reaction mixture was poured into water. The resultant mixture was extracted with EtOAc, and the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (10/1 PhMe-EtOAc) to give **S-7** (1.63 g, 0.963 mmol, 90% yield). White solid; R_f 0.27 (10/1 PhMe-EtOAc); ; m.p. 118-119 ºC; $[\alpha]^{30}_D$ +37.4º (*c* 0.232, $CHCl_3$); ^{1}H-NMR(500 MHz, $CDCl_3$) δ 8.54 (1H, s, NH), 8.12 (2H, d, *J* = 7.2 Hz, Ar-H), 7.96-7.86 (12H, m, Ar-H), 7.80-7.71 (6H, m, Ar-H), 7.55-7.15 (30H, m, Ar-H), 6.69 (1H, d, *J* = 3.7 Hz, H-1), 6.20 (1H, dd, *J* = 9.0, 10.3 Hz, H-3), 6.15 (1H, dd, *J* = 1.1, 3.2 Hz, H-4”), 6.00 (1H, dd, *J* = 3.2, 11.2 Hz, H-3”), 5.84 (1H, dd, *J* = 7.7, 10.9 Hz, H-2’), 5.70 (1H, dd, *J* = 3.4, 11.2 Hz, H-2”), 5.47 (1H, dd, *J* = 3.7, 10.3 Hz, H-2), 5.44 (1H, d, *J* = 3.4 Hz, H-1”), 5.18 (1H, dd, *J* = 2.6, 10.9 Hz, H-3’), 4.98 (1H, d, *J* = 7.7 Hz, H-1’), 4.92 (1H, dd, *J* = 6.6, 8.4 Hz, H-5”), 4.63 (1H, dd, *J* = 1.7, 12.0 Hz, H-6), 4.49 (1H, dd, *J* = 3.8, 12.0 Hz, H-6), 4.44-4.41 (1H, m), 4.37-4.32 (2H, m, H-4, H-4’), 4.27 (1H, dd, *J* = 6.6, 11.2 Hz, H-6”), 4.13 (1H, dd, *J* = 8.4, 11.2 Hz, H-6’’), 4.06 (1H, dd, *J* = 5.4, 11.2 Hz, H-6’), 3.99 (1H, dd, *J* = 8.3, 11.2 Hz, H-6’), 3.55 (1H, dd, *J* = 5.4, 8.3 Hz, H-5’); ^{13}C NMR (125 MHz, $CDCl_3$): δ 166.4, 166.2, 165.8, 165.7, 165.6, 165.5, 165.3, 165.1, 164.8, 160.7, 133.7, 133.6, 133.5, 133.3, 133.2, 133.1, 132.9, 130.0, 129.9×2, 129.8×4, 129.7, 129.6, 129.5, 129.4, 129.3, 129.2, 128.7×2, 128.6×3, 128.5, 128.4×2, 128.3×2, 101.9, 99.0, 93.1, 90.7, 76.6, 75.5, 73.8, 72.6, 71.2, 70.8, 70.7, 69.8, 69.7, 69.1, 68.1, 67.7; HRMS (ESI-TOF) *m/z* 1688.3457 (1688.3486 calcd. for $C_{90}H_{73}N_1O_{26}Cl_3$, $[M+H]^+$).

1-Bromooctyl 4’-*O*-{4”-O-(2”’,3”’,4”’,6”’-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2”,3”,6”-tri-*O*-benzoyl-β-D-galactopyranosyl}-2’,3’,6’-tri-*O*-benzoyl-β-D-glucopyranoside (S-8).

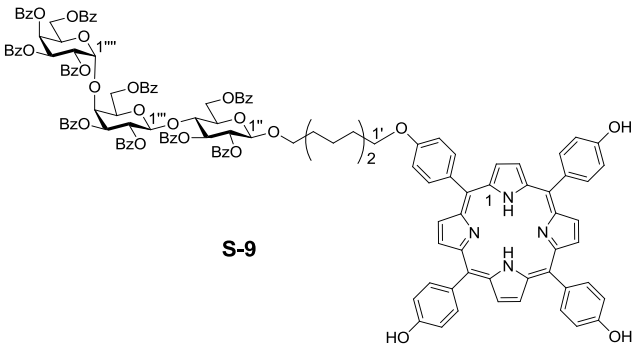


S-8

To a suspension of **S-7** (3.38 g, 2.00 mmol), 8-bromo-1-octanol (686 μL, 4.00 mmol) and MS 5A (3.15 g) in CH_2Cl_2 (21.0 mL) was added $Yb(OTf)_3$ (620 mg, 1.00 mmol) at 0 ºC.

After the reaction mixture was stirred for 3 h at the same temperature, the reaction was quenched with triethylamine (1.67 mL, 12.0 mmol). The resultant mixture was filtered using Celite, and then the filtrate was poured into saturated $NaHCO_3$ aq. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (10/1 PhMe-acetone) to give **S-8** (2.74 g, 1.58 mmol, 79% yield). White solid; R_f 0.66 (10/1 PhMe-acetone); m.p. 95.2-96.2 ºC; $[\alpha]^{27}_D$ +11.7º (*c* 0.508, $CHCl_3$); ^{1}H-NMR(500 MHz, $CDCl_3$) δ 8.10 (2H, d, *J* = 8.6 Hz, Ar-H), 7.90-7.67 (18H, m, Ar-H), 7.55-7.14 (30H, m, Ar-H), 6.17 (1H, dd, *J* = 1.5, 3.5 Hz, H-4'''), 6.02 (1H, dd, *J* = 3.5, 10.9 Hz, H-3'''), 5.83-5.75 (2H, m, H-3', H-2''), 5.70 (1H, dd, *J* = 3.5, 10.9 Hz, H-2'''), 5.48 (1H, d, *J* = 3.5 Hz, H-1'''), 5.39 (1H, dd, *J* = 8.0, 9.5 Hz, H-2), 5.17 (1H, d, *J* = 2.3, 10.6 Hz, H-3''), 4.96 (1H, dd, *J* = 5.7, 8.0 Hz, H-5'''), 4.91 (1H, d, *J* = 7.7 Hz, H-1''), 4.66 (1H, d, *J* = 8.0 Hz), 4.63 (1H, dd, *J* = 1.7, 10.9 Hz), 4.47 (1H, dd, *J* = 4.6, 12.0 Hz), 4.42 (1H, dd, *J* = 4.9, 10.9 Hz), 4.32 (1H, d, *J* = 2.3 Hz, H-4''), 4.27-4.21 (2H, m), 4.07 (1H, dd, *J* = 5.5 Hz, 11.0 Hz, H-6''), 4.00 (1H, dd, *J* = 7.9, 11.0 Hz, H-6''), 3.90 (1H, ddd, *J* = 1.7, 4.9, 9.8 Hz, H-5'), 3.78 (1H, dt, *J* = 6.3, 9.8 Hz), 3.60 (1H, t, *J* = 9.6 Hz), 3.42-3.38 (1H, dt, *J* = 6.3, 9.8 Hz), 3.30 (2H, t, *J* = 7.2 Hz), 1.70 (2H, tt, *J* = 7.2, 7.5 Hz), 1.50-1.34 (2H, m), 1.28-1.24 (2H, m), 1.18-0.97 (6H, m); ^{13}C-NMR (125 MHz, DMSO-d_6): δ 165.8, 165.8, 165.7, 165.6, 165.5, 165.4×2, 165.3, 165.2, 165.0, 134.4, 134.3, 134.1, 134.0, 133.9×2, 133.8, 133. 7, 130.0, 129.8×2, 129.7, 129.6×3, 129.5×3, 129.3, 129.2, 129.1×2, 128.9, 128.8, 128.7, 100.9, 100.0, 98.6, 77.5, 76.4, 73.7, 73.3, 72.7, 72.4, 72.2, 70.7, 69.6, 69.3, 68.8, 67.5, 61.8, 35.5, 32.6, 29.3, 28.8, 28.4, 27.8, 25.6; HRMS (ESI-TOF) *m/z* 1735.48 (1735.4747 calcd for $C_{96}H_{88}O_{26}Br$, $[M+H]^+$).

5,10,15-Tris(*p*-hydroxyphenyl)-20-[8'-*O*-{4"-*O*-(4'''-*O*-(2'''',3'''',4'''',6''''-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2''',3''',6'''-tri-*O*-benzoyl-β-D-galactopyranosyl)-2",3",6"-tri-*O*-benzoyl-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (S-9).

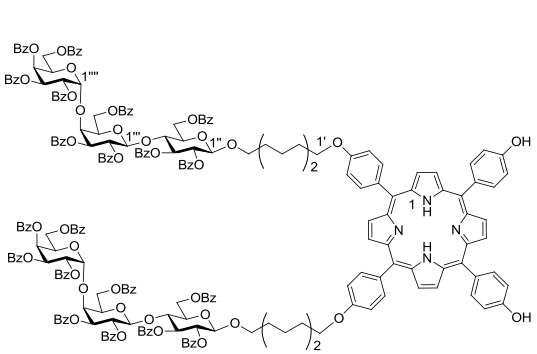


S-9

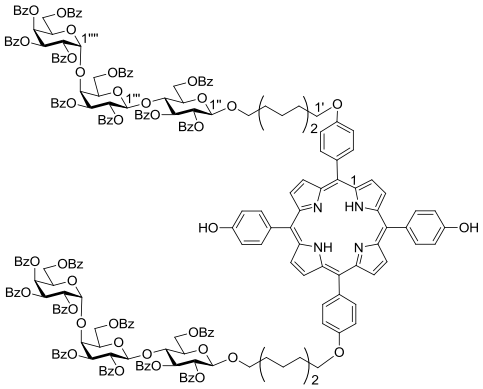
Method A: To a solution of **S-8** (3.17 g, 1.84 mmol) and **3** (4.94 g, 7.30 mmol) in dry

DMF (100 mL) were added Cs_2CO_3 (1.78 g, 5.47 mmol) and NaI (273 mg, 1.82 mmol), and then the resultant mixture was stirred at 40 ºC. After being stirred for 15 h, the reaction mixture was poured into water at room temperature. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (3/1 to 5/1 PhMe-EtOAc) to give **S-9** (2.58 g, 1.10 mmol, 60% yield). Purple solid; R_f 0.63 (3/1 PhMe-EtOAc) ; m.p. 174-175 ºC; ^{1}H-NMR (500 MHz, acetone-d_6) δ 8.95-8.78 (11H, m, pyrroles, Ar-OH), 8.18-7.80 (28H, m), 7.63-7.05 (38H, m), 6.31 (1H, dd, *J* =1.1, 3.1 Hz, H-4’’’’), 6.07 (1H, dd, *J* =3.3, 10.9 Hz), 5.93-5.86 (3H, m), 5.72 (1H, d, *J* =3.5 Hz), 5.57 (1H, dd, *J* = 2.8, 10.7 Hz), 5.44 (1H, dd, *J* = 7.9, 9.5 Hz), 5.42 (1H, d, *J* = 7.9 Hz), 5.14 (1H, dd, *J* = 5.9, 8.6 Hz), 4.97 (1H, d, *J* = 7.9 Hz), 4.49 (1H, dd, *J* = 1.8, 11.7 Hz), 4.66 (1H, d, *J* = 2.8 Hz, H-4’’’), 4.61-4.48 (3H, m), 4.42 (1H, dd, *J* = 8.6, 11.0 Hz), 4.24 (1H, dd, *J* = 6.5, 10.0 Hz), 4.14 (1H, ddd, *J* = 2.1, 5.5, 10.0 Hz), 4.12-4.03 (2H, m), 3.90 (2H, t, *J* = 6.4 Hz, Ar-OCH_2-), 3.77(1H, dt, *J* = 6.2, 10.0 Hz), 3.62 (1H, dt, *J* = 6.2, 10.0 Hz), 1.64 (2H, tt, *J* = 6.5, 7.3 Hz), 1.43 (2H, m), 1.31-1.22 (2H, m), 1.18-1.03 (6H, m), -2.64 (2H, s, NH_2); ^{13}C-NMR (125 MHz, $CDCl_3$) δ 166.6, 166.4, 166.3, 166.2, 165.9, 165.7, 165.6, 165.5, 165.4, 165.3, 158.7, 155.9, 155.8, 135.8, 135.5, 134.2×2, 133.9, 133.7, 133.5×2, 133.4×2, 133.3, 133.1, 131.8-131.4, 130.2, 130.0×2, 129.9, 129.8, 129.6, 129.4, 129.3×2, 129.1, 128.7×2, 128.5, 128.4×2, 120.1, 119.9, 113.8, 113.6, 112.6, 101.6, 101.0, 99.0, 76.1, 73.8, 73.6, 73.0, 72.7, 72.4, 70.3, 70.2, 70.1, 69.9, 69.4, 68.3, 67.9, 62.7, 61.9, 60.7, 29.8, 29.4, 29.2, 25.9, 25.7; HRMS (ESI-TOF) *m/z* 2333.7822 (2333.7753 calcd. for $C_{140}H_{117}N_4O_{30}$, $[M+H]^+$).

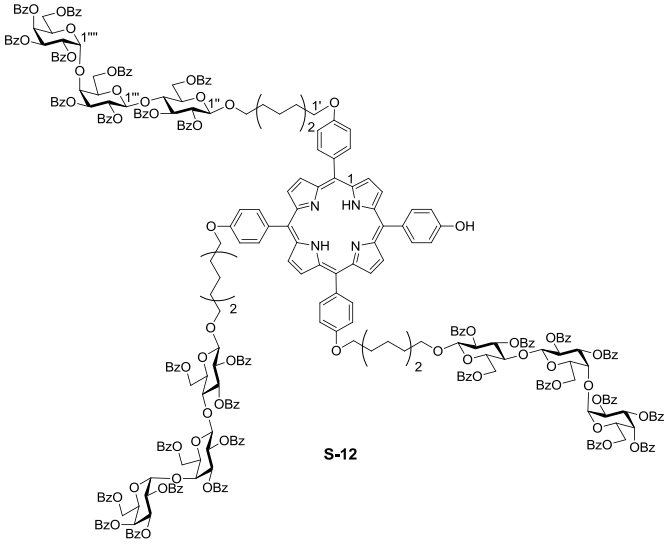
5,10-Bis(*p*-hydroxyphenyl)-15,20-bis[8’-*O*-{4”-*O*-(4”’-*O*-(2””,3””,4””,6””-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2”’,3”’,6”’-tri-*O*-benzoyl-β-D-galactopyranosyl)-2”,3”,6”-tri-*O*-benzoyl-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (**S-10**), **5,15-Bis(*p*-hydroxyphenyl)-10,20-bis[8’-*O*-{4”-*O*-(4”’-*O*-(2””,3””,4””,6””-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2”’,3”’,6”’-tri-*O*-benzoyl-β-D-galactopyranosyl)-2”,3”,6”-tri-*O*-benzoyl-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine** (**S-11**), **and 5-(*p*-hydroxyphenyl)-10,15,20-tris[8’-*O*-{4”-*O*-(4”’-*O*-(2””,3””,4””,6””-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2”’,3”’,6”’-tri-*O*-benzoyl-β-D-galactopyranosyl)-2”,3”,6”-tri-*O*-benzoyl-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (S-12).**



S-10



S-11



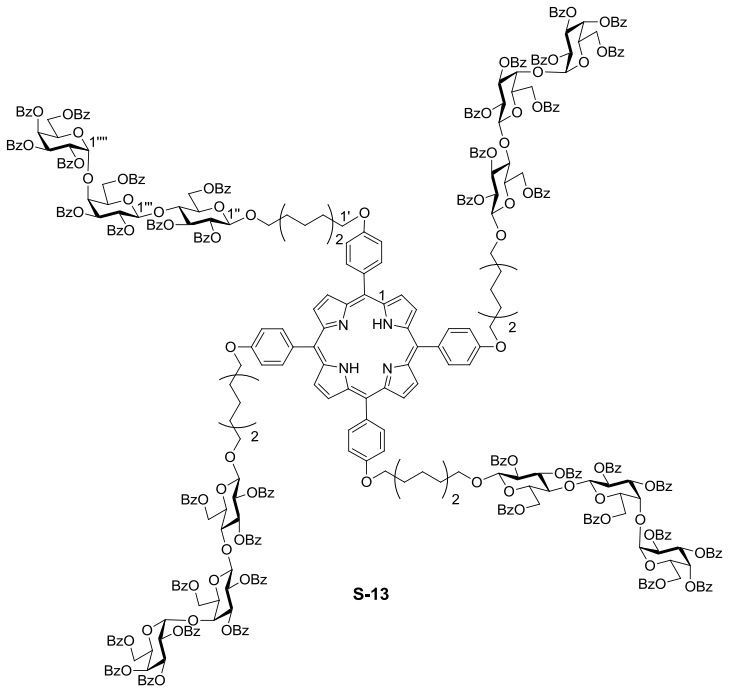
S-12

Method B: To a solution of **S-8** (2.81 g, 1.20 mmol) and **3** (271 mg, 0.400 mmol) in dry DMF (60.0 mL) were added Cs_2CO_3 (2.35 g, 7.22 mmol) and NaI (53.6 mg, 0.360 mmol), and then the resultant mixture was stirred at 40 ºC. After being stirred for 3 h at the same temperature, the reaction mixture was poured into water at room temperature. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel column chromatography (4/4/3 *n*-hexane-$CHCl_3$-acetone) to give **S-10** (367 mg, 0.092 mmol, 23% yield), **S-11** (145 mg, 0.036 mmol, 9% yield), and **S-12** (428 mg, 0.076 mmol, 19% yield). **S-10**: purple solid; R_f 0.24 (4/4/3 *n*-hexane-$CHCl_3$-acetone); m.p. 158-160 ºC; ^{1}H- NMR(500 MHz, $CDCl_3$) δ ^{1}H-NMR (500 MHz, acetone-d_6) δ 8.85-8.83 (8H, m, pyrroles), 8.13-7.70 (48H, m, Ar-H), 7.50-7.14 (56H, m, Ar-H), 6.21 (2H, dd, *J* = 1.5, 3.5 Hz, H-4’’’’), 6.05 (2H, dd, *J* = 3.5, 10.9 Hz, H-3’’’), 5.83 (4H, t, *J*=7.2 Hz), 5.70 (2H, dd, *J* = 3.5, 10.9 Hz), 5.49 (2H, d, *J* = 3.5 Hz, H-1’’’’), 5.43 (2H, dd, *J* = 8.0, 9.5 Hz), 5.19 (2H, d, *J* = 2.3, 10.6 Hz, H-3’’), 5.00

(1H, dd, *J* = 5.7, 8.0 Hz, H-5’’’), 4.93 (2H, d, *J* = 7.7 Hz, H-1’’), 4.69 (2H, d, *J* = 8.0 Hz, H-1’), 4.66 (2H, dd, *J* = 1.7, 10.9 Hz), 4.50-4.44 (4H, m), 4.36 (2H, d, *J* = 2.3 Hz, H-4’’), 4.27-4.21 (2H, m), 4.07 (2H, dd, *J* = 5.5 Hz, 11.0 Hz, H-6’’), 4.00 (2H, dd, *J* = 7.9, 11.0 Hz, H-6’’), 3.90 (2H, ddd, *J* = 1.7, 4.9, 9.8 Hz, H-5’), 3.78 (2H, dt, *J* = 6.3, 9.8 Hz), 3.60 (2H, t, *J* = 9.6 Hz), 3.30 (2H, t, *J* = 7.2 Hz), 3.44 (2H, dt, *J* = 6.3, 9.8 Hz), 1.80 (4H, tt, *J* = 7.2, 7.5 Hz), 1.54-1.38 (8H, m), 1.27-1.17 (12H, m), -2.72 (2H, s, NH_2); ^{13}C-NMR (125 MHz, $CDCl_3$): δ 166.4, 166.3, 166.0, 165.4, 165.3×2, 165.1×2, 159.0, 155.9, 135.8, 135.7, 134.6, 134.5, 133.7, 133.5, 133.4, 133.3, 133.2, 133.1, 132.9, 130.0×2, 129.9, 129.8×2, 129.7, 129.6, 129.4, 129.3, 129.2, 128.7, 128.6×3, 128.4×2, 128.3×2, 119.9, 119.8, 113.8, 112.8, 101.4, 101.0, 99.0, 77.2, 76.0, 73.8, 73.5, 73.0, 72.7, 72.3, 70.3, 70.1, 69.8, 69.3, 68.2×2, 67.8, 62.6, 61.7, 60.6, 29.5, 29.4, 29.3×2, 26.1, 25.8; HRMS (ESI-TOF) *m/z* 3988.3042 (3988.3160 calcd. for $C_{236}H_{203}N_4O_{56}$, $[M+H]^+$). **S-11**: purple solid; R_f 0.36 (4/4/3 *n*-hexane-$CHCl_3$-acetone); m.p. 156-158 ºC; ^{1}H-NMR (500 MHz, acetone-d_6) δ 8.86 (8H, s, pyrroles), 8.13-7.70 (48H, m, Ar-H), 7.50-7.14 (68H, m, Ar-H), 6.21 (2H, dd, *J* = 1.5, 3.5 Hz, H-4’’’), 6.05 (2H, dd, *J* = 3.5, 10.9 Hz, H-3’’’’), 5.83 (4H, t, *J*=7.2 Hz), 5.70 (2H, dd, *J* = 3.5, 10.9 Hz, H-2’’’’), 5.49 (2H, d, *J* = 3.5 Hz, H-1’’’’), 5.43 (2H, dd, *J* = 8.0, 9.5 Hz, H-2’’), 5.19 (2H, d, *J* = 2.3, 10.6 Hz, H-3’’’), 5.00 (1H, dd, *J* = 5.7, 8.0 Hz, H-5’’’’), 4.93 (2H, d, *J* = 7.7 Hz, H-1’’’), 4.69 (2H, d, *J* = 8.0 Hz, H-1’’), 4.66 (2H, dd, *J* = 1.7, 10.9 Hz), 4.50-4.44 (4H, m), 4.36 (2H, d, *J* = 2.3 Hz, H-4’’’), 4.27-4.21 (2H, m), 4.07 (2H, dd, *J* = 5.5 Hz, 11.0 Hz, H-6’’’), 4.00 (2H, dd, *J* = 7.9, 11.0 Hz, H-6’’’), 3.90 (2H, ddd, *J* = 1.7, 4.9, 9.8 Hz, H-5’’), 3.78 (2H, dt, *J* = 6.3, 9.8 Hz), 3.60 (2H, t, *J* = 9.6 Hz), 3.30 (2H, t, *J* = 7.2 Hz), 3.44 (2H, dt, *J* = 6.3, 9.8 Hz), 1.80 (4H, tt, *J* = 7.2, 7.5 Hz), 1.54-1.38 (8H, m), 1.27-1.17 (12H, m), -2.73 (2H, s, NH_2); ^{13}C-NMR (125 MHz, $CDCl_3$): δ 166.4×2, 166.3, 165.9, 165.7, 165.4, 165.3, 165.2, 165.1×2, 159.0, 155.9, 135.8, 135.7, 134.6, 133.7, 133.5, 133.4, 133.2, 133.1, 132.9, 130.0×3, 129.8×2, 129.6, 129.4, 129.3, 129.2, 128.7, 128.6×2, 128.4×2, 128.3, 119.9, 119.8, 113.8, 112.8, 101.4, 101.2, 101.0×2, 99.0, 73.8, 73.6, 73.5, 73.4, 73.0×2, 72.7, 72.4, 72.3, 70.3, 70.1, 69.8, 69.3, 68.2, 68.1, 67.8, 62.6, 61.7, 60.6; HRMS (ESI-TOF) *m/z* 3988.3176 (3988.3160 calcd. for $C_{236}H_{203}N_4O_{56}$, $[M+H]^+$). **S-12:** purple solid; R_f 0.55 (4/4/3 *n*-hexane-$CHCl_3$-acetone); m.p. 154-157 ºC; ^{1}H-NMR (500 MHz, acetone-d_6) δ 8.94-8.91 (8H, m, pyrroles), 8.21-7.77 (68H, m, Ar-H), 7.59-7.19 (98H, m, Ar-H), 6.31(3H, dd, *J* =1.1, 3.1 Hz, H-4’’’’), 6.07 (3H, dd, *J* =3.3, 10.9 Hz), 5.93-5.86 (9H, m), 5.72 (3H, d, *J* =3.5 Hz, H-1’’’’), 5.57 (3H, dd, *J* = 2.8, 10.7 Hz), 5.44 (3H, dd, *J* = 7.9, 9.5 Hz), 5.42 (3H, d, *J* = 7.9 Hz, H-1’’’), 5.14 (3H, dd, *J* = 5.9, 8.6 Hz), 4.97 (3H, d, *J* = 7.9 Hz, H-1’’), 4.94 (3H, dd, *J* = 1.8, 11.7 Hz), 4.66 (3H, d, *J* = 2.8 Hz, H-4’’’), 4.61-4.48 (9H, m), 4.42 (3H, dd, *J* = 8.6, 11.0 Hz), 4.24 (3H, dd, *J* = 6.5, 10.0 Hz), 4.14 (3H, ddd, *J* = 2.1,

5.5, 10.0 Hz), 4.12-4.03 (6H, m), 3.90 (6H, t, *J* = 6.4 Hz, Ar-OCH_2-), 3.77 (3H, dt, *J* = 6.2, 10.0 Hz), 3.62 (3H, dt, *J* = 6.2, 10.0 Hz), 1.87 (6H, tt, *J* = 6.5, 7.3 Hz), 1.58-1.47 (12H, m), 1.31-1.25 (18H, m), -2.63 (2H, s, NH_2); ^{13}C-NMR (125 MHz, $CDCl_3$): δ 166.4, 166.3, 165.9, 165.7, 165.4, 165.3×2, 165.1×2, 159.0, 155.9, 135.8, 135.7, 134.6, 134.5, 133.7, 133.5, 133.4, 133.3, 133.2, 133.1, 132.9, 130.0×2, 129.9, 129.8, 129.7, 129.6, 129.4, 129.3, 129.2, 128.7, 128.6×2, 128.4×2, 128.3×2, 119.9, 119.8, 113.8, 112.8, 101.4, 101.0, 99.0, 76.0, 73.8, 73.5, 73.0, 72.7, 72.3, 70.3, 70.1, 69.8, 69.3, 68.2×2, 67.8, 62.6, 61.7, 60.6, 29.8, 29.5, 29.4, 29.3×2, 26.1, 25.8; HRMS (ESI-TOF) *m/z* 2821.9277 (2821.9324 calcd. for $C_{332}H_{288}N_4O_{82}$, $[M+2H]^{2+}$).

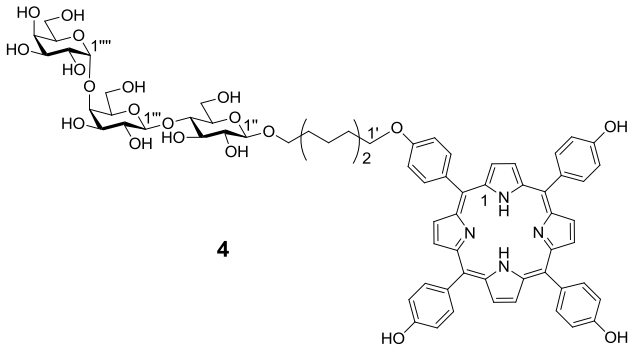
5,10,15-20-Tetrakis[8'-*O*-{4"-*O*-(4'''-*O*-(2'''',3'''',4'''',6''''-tetra-*O*-benzoyl-α-D-galactopyranosyl)-2''',3''',6'''-tri-*O*-benzoyl-β-D-galactopyranosyl)-2",3",6"-tri-*O*-benzoyl-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (S-13).



Method C: To a solution of **S-8** (138 mg, 0.079 mmol) and **3** (10.8 mg, 0.015 mmol) in dry DMF (2.80 mL) were added Cs_2CO_3 (61.8 mg, 0.190 mmol) and NaI (11.9 mg, 0.079 mmol), and then the resultant mixture was stirred at 40 ºC. After being stirred for 3 h, the reaction mixture was poured into water at room temperature. The resultant mixture was extracted with EtOAc, and then the extracts were washed with brine, dried over anhydrous Na_2SO_4, and concentrated in *vacuo*. The residue was subjected to silica gel

column chromatography (4/4/3 *n*-hexane-$CHCl_3$-acetone) to give **S-13** (80.3 mg, 0.011 mmol, 69% yield). Purple solid; R_f 0.79 (4/4/3 *n*-hexane-$CHCl_3$-acetone); m.p. 143-145 ºC; ^{1}H-NMR (500 MHz, acetone-d_6) δ 8.85 (8H, m, pyrroles), 8.10-7.69 (88H, m, Ar-H), 7.53-7.15 (128H, m, Ar-H), 6.17 (4H, d, *J* =2.5 Hz, H-4''''), 6.02 (4H, dd, *J* =3.3, 10.9 Hz), 5.83-5.79 (8H, m), 5.68 (4H, d, *J* =3.5 Hz, H-1''''), 5.46 (1H, d, *J* =3.45 Hz), 5.40 (4H, dd, *J* = 7.9, 9.5 Hz), 5.16 (4H, d, *J* = 7.9 Hz, H-1'''), 5.16 (4H, dd, *J* = 5.9, 8.6 Hz), 4.96 (4H, dd, *J* = 1.8, 11.7 Hz), 4.91 (4H, d, *J* = 7.6 Hz, H-1''), 4.69 (4H, d, *J* = 2.8 Hz, H-4'''), 4.61-4.48 (4H, m), 4.42 (4H, dd, *J* = 8.6, 11.0 Hz), 4.24 (4H, dd, *J* = 6.5, 10.0 Hz), 4.14 (4H, ddd, *J* = 2.1, 5.5, 10.0 Hz), 4.12-4.03 (8H, m), 3.90 (8H, t, *J* = 6.4 Hz, Ar-OCH_2-), 3.77 (4H, dt, *J* = 6.2, 10.0 Hz), 3.62 (4H, dt, *J* = 6.2, 10.0 Hz), 1.85 (8H, tt, *J* = 6.5, 7.3 Hz), 1.59-1.43 (16H, m), 1.27-1.20 (24H, m), -2.75 (2H, s, NH_2); ^{13}C-NMR (125 MHz, $CDCl_3$): δ 166.4, 166.3, 165.9×2, 165.5, 165.4, 165.3, 165.2, 165.1, 164.9, 159.0, 135.7, 134.5, 133.7, 133.5, 133.3×2, 133.2, 133.1, 132.9, 130.0, 129.9×2, 129.8×2, 129.7, 129.6, 129.4, 129.3, 129.2, 128.7×2, 128.5×2, 128.4×2, 128.3×2, 128.2, 119.9, 112.8, 101.4, 101.0, 99.0, 76.8, 76.0, 73.7, 73.4, 73.0, 72.7, 72.3, 70.3, 70.0, 69.8, 69.2, 68.4, 68.1, 67.8, 62.6, 61.6, 60.6, 29.8, 29.5, 29.4, 29.3, 26.2, 25.9; HRMS (ESI-TOF) *m/z* 3649.6982 (3649.7043 calcd. for $C_{428}H_{374}N_4O_{108}$, $[M+2H]^{2+}$).

5,10,15-Tris(*p*-hydroxyphenyl)-20-[8'-*O*-{4''-*O*-(4'''-*O*-(α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (4).

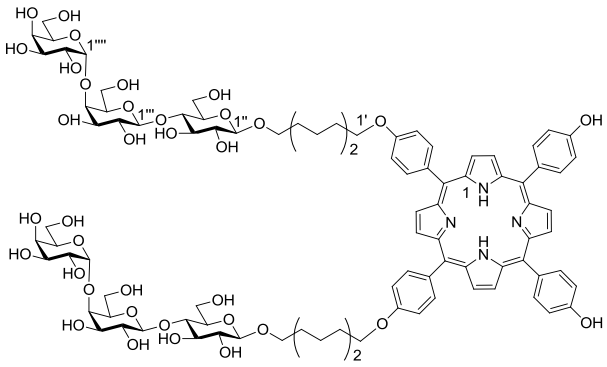


4

To a solution of **S-9** (120 mg, 51.4 μmol) in THF (9.60 mL) was added 2 N NaOH aq. (2.40 mL), and then the resultant mixture was stirred at 40 ºC. After being stirred for 18 h, the reaction mixture was allowed to be cooled to room temperature, and then the reaction mixture was neutralized by adding 2 N HCl aq. The resultant solution was concentrated in *vacuo*. The residue was subjected to reverse phase silica gel column chromatography (90/10 to 10/90 H_2O-MeOH) to give **4** (46.2 mg, 36 μmol, 70% yield). Purple solid; R_f

0.08 (3/1 $CHCl_3$-MeOH); m.p. 222-223 ºC; ^{1}H-NMR (500 MHz, CD_3OD) δ 9.00-8.55 (8H, br-s, pyrroles), 7.97 (6H, m, Ar-H), 7.78 (2H, d, *J* = 8.3 Hz, Ar-H), 7.18 (6H, m, Ar-H), 6.96 (2H, d, *J* = 8.3 Hz, Ar-H), 4.88 (1H, d, *J* = 3.8 Hz), 4.28-4.20 (3H, m), 3.95-3.64 (13H, m), 3.54-3.45 (5H, m), 3.39 (1H, dd, *J* = 2.9 Hz, 10.0 Hz), 3.33 (1H, m), 3.23 (1H, t, *J* = 8.2 Hz), 1.74 (2H, tt, *J* = 6.6 , 7.5 Hz), 1.61 (2H, tt, *J* =6.6, 7.7 Hz), 1.45-1.35 (8H, m); ^{13}C-NMR (125 MHz, DMSO-d_6): δ 159.1, 157.9, 136.0, 135.9, 133.9, 132.4, 132.4-130.5, 120.6, 120.6, 119.9, 104.3, 103.1, 101.2, 81.4, 77.6, 75.5×2, 75.2, 73.6, 73.3, 71.6, 71.4, 69.7, 69.3×2, 69.2, 68.2, 61.0, 60.9, 59.9, 29.8, 29.5×2, 26.2, 26.1; HRMS (ESI-TOF) *m/z* 1291.5037 (1291.4975 calcd. for $C_{70}H_{74}N_4O_{20}$, $[M-H]^-$).

5,10-Bis(*p*-hydroxyphenyl)-15,20-[8'-{4''-*O*-(4'''-*O*-(α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (5).

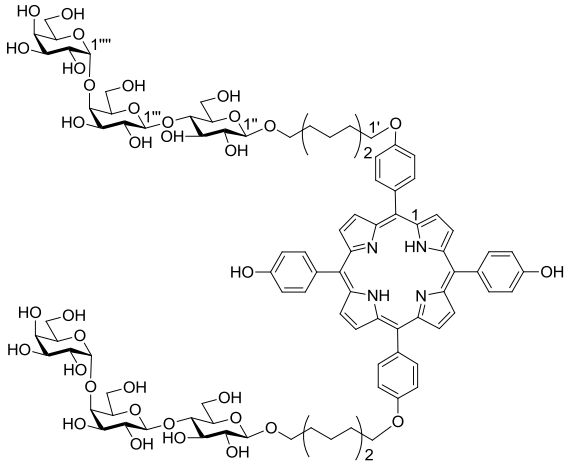


5

To a solution of **S-10** (568 mg, 0.142 mmol) in THF (23.3 mL) and H_2O (2.65 mL) was added 2 N NaOH aq. (9.00 mL), and then the resultant mixture was stirred at 40 ºC. After being stirred for 18 h at the same temperature, the reaction mixture was allowed to be cooled to room temperature, and then the reaction mixture was neutralized by adding 2 N HCl aq. The resultant solution was concentrated in *vacuo*. The residue was subjected to reverse phase silica gel column chromatography (90/10 to 10/90 H_2O-THF) to give **5** (217 mg, 0.113mmol, 80% yield). Purple solid; R_f 0.46 (1/1 H_2O-THF); m.p. 215-218 ºC; ^{1}H-NMR (300 MHz, 3/1 pyridine-d_5-D_2O) δ 9.24-9.15 (8H, m, pyrroles), 8.45 (4H, dd, *J* = 7.5 Hz, Ar-H), 8.36 (4H, d, *J* = 7.8 Hz, Ar-H), 7.89 (4H, d, *J* = 7.8 Hz, Ar-H), 7.48 (4H, d, *J* = 7.8 Hz, Ar-H), 5.60 (2H, d, *J* = 4.2 Hz), 5.18 (2H, d, *J* = 7.9 Hz), 4.94 (4H, m), 4.68-4.13 (40H, m), 3.90-3.86 (2H, m), 1.97 (4H, br-s), 1.85 (4H, br-s), 1.63-1.37 (16H, m); ^{13}C-NMR (125 MHz, DMSO-d_6): δ 159.2, 158.0, 136.0, 135.9, 133.9, 132.4, 120.7, 120.0, 114.5, 113.5, 104.4, 103.1, 101.2, 81.4, 77.7, 75.5×2, 75.3, 73.7, 73.4, 71.7, 71.3,

69.7, 69.3, 69.2, 68.3, 61.1, 60.9, 59.8, 29.8, 29.5×2; HRMS (ESI-TOF) *m/z* 1907.7850 (1907.7917 calcd. for $C_{96}H_{123}N_4O_{36}$, $[M+H]^+$).

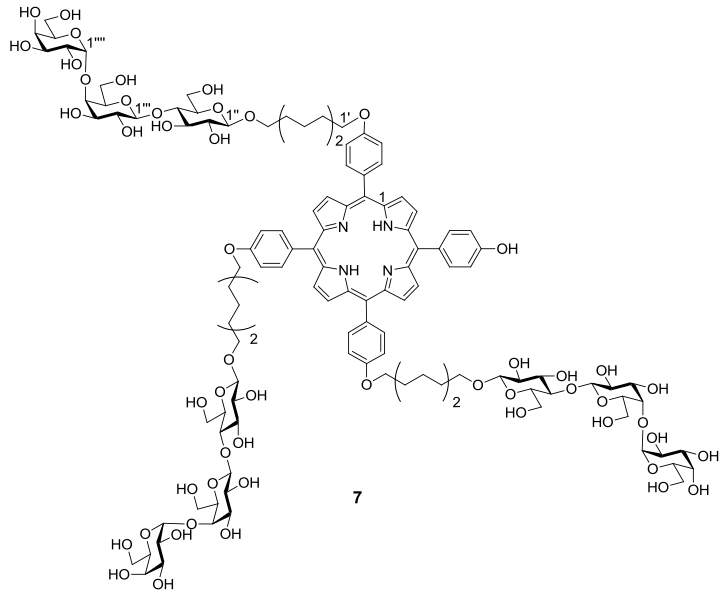
5,15-Bis(*p*-hydroxyphenyl)-10,20-bis[8'-*O*-{4''-*O*-(4'''-*O*-(α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (6).



6

To a solution of **S-11** (132 mg, 0.033 mmol) in THF (5.30 mL) and H_2O (2.70 mL) was added 2 N NaOH aq. (2.60 mL), and then the resultant mixture was stirred at 40 ºC. After being stirred for 24 h at the same temperature, the reaction mixture was allowed to be cooled to room temperature, and then the reaction mixture was neutralized by adding 2 N HCl aq. The resultant solution was concentrated in *vacuo*. The residue was subjected to reverse phase silica gel column chromatography (90/10 to 10/90 H_2O-THF) to give **6** (19.1 mg, 0.010 mmol, 31% yield). Purpule solid; R_f 0.44 (1/1 H_2O-THF); m.p. 223-224 ºC; ^{1}H-NMR (300 MHz, 3/1 pyridine-d_5-D_2O) δ 9.24 (8H, s, pyrroles), 8.36 (4H, d, *J* = 7.8 Hz, Ar-H), 8.28 (4H, d, *J* = 7.8 Hz, Ar-H), 7.87 (4H, d, *J* = 7.8 Hz, Ar-H), 7.71 (4H, d, *J* = 7.8 Hz, Ar-H), 5.62 (2H, d, *J* = 4.2 Hz), 5.19 (2H, d, *J* = 7.9 Hz), 4.94 (4H, m), 4.68-4.13 (40H, m), 3.90-3.86 (2H, m), 1.97 (4H, br-s), 1.85 (4H, br-s), 1.63-1.37 (16H, m); ^{13}C-NMR (125 MHz, DMSO-d_6): δ 159.0, 157.7, 136.0, 135.9, 133.7, 132.4, 120.6, 120.1, 114.4, 113.4, 104.3, 103.0, 101.1, 81.2, 77.6,75.4, 75.2×2, 73.5, 73.1, 71.5, 71.2, 69.5, 69.4, 69.2, 69.0, 68.2, 60.8, 59.8, 29.7, 29.4, 29.3, 26.1, 16.0; HRMS (ESI-TOF) *m/z* 1907.7953 (1907.7917 calcd. for $C_{96}H_{123}N_4O_{36}$, $[M+H]^+$).

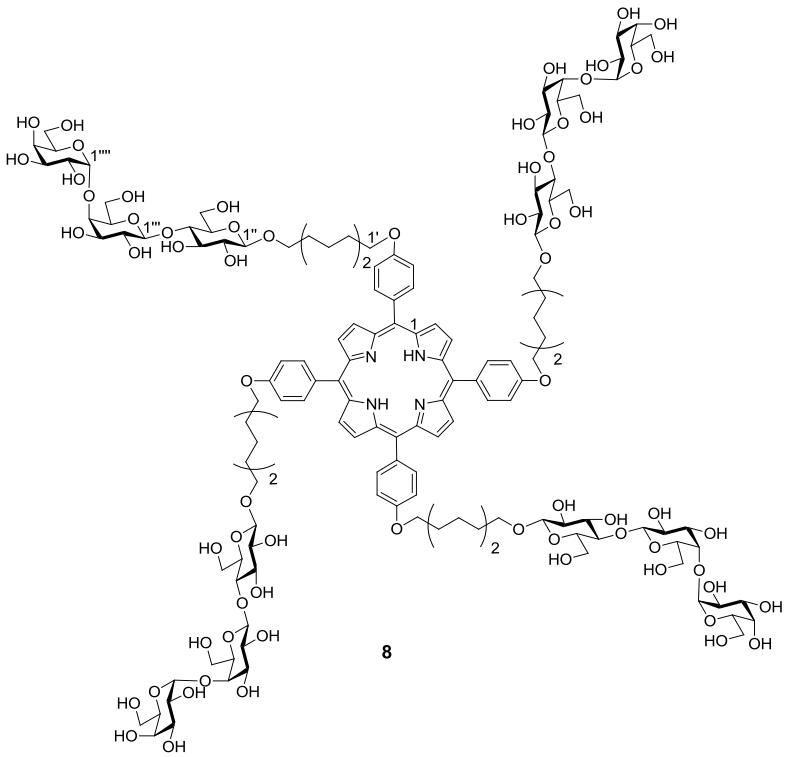
5-(*p*-Hydroxyphenyl)-10,15,20-tris[8'-*O*-{4''-*O*-(4'''-*O*-(α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (7).



7

To a solution of **S-12** (347 mg, 0.061 mmol) in THF (18.3 mL) and H_2O (2.15 mL) was added 2 N NaOH aq. (7.00 mL), and then the resultant mixture was stirred at 40 ºC. After being stirred for 24 h at the same temperature, the reaction mixture was allowed to be cooled to room temperature, and then the reaction mixture was neutralized by adding 2 N HCl aq. The resultant solution was concentrated in *vacuo*. The residue was subjected to reverse phase silica gel column chromatography (90/10 to 10/90 H_2O-THF) to give **7** (123 mg, 0.049 mmol, 80% yield). Purple solid; R_f 0.57 (1/1 H_2O-THF); m.p. 232-234 ºC; ^{1}H-NMR (300 MHz, 3/1 pyridine-d_5-D_2O) δ 9.24 (8H, s, pyrroles), 8.46 (6H, br-s, Ar-H), 8.37 (2H, d, *J* = 8.0 Hz, Ar-H), 7.85 (2H, d, *J* = 8.0 Hz, Ar-H), 7.71 (6H, br-s, Ar-H), 5.59 (3H, d, *J* = 4.1 Hz), 5.19 (3H, d, *J* = 7.5 Hz), 4.95-4.92 (6H, m), 4.68-4.13 (54H, m), 4.13 (3H, t, *J* = 8.3 Hz), 4.04 (3H, d, *J* = 7.9 Hz), 3.88 (3H, dd, *J* = 8.3 , 11.3 Hz), 2.07 (6H, br-s), 1.86 (6H, br-s), 1.65 (6H, br-s), 1.48-1.40 (18H, m); ^{13}C-NMR (125 MHz, pyridine-d_5-D_2O): δ 162.5, 161.0, 135.8, 116.4, 115.1, 106.2, 105.1, 103.4, 82.3, 80.2, 77.5, 77.3×2, 75.4, 75.2, 73.7, 73.6, 71.8, 71.6, 71.3, 70.1, 63.3, 62.6, 62.1, 31.4, 31.0, 30.9×2, 27.7, 27.5; HRMS (ESI-TOF) *m/z* 2522.0781 (2522.0703 calcd. for $C_{122}H_{169}N_4O_{52}$, $[M+H]^+$).

5,10,15,20-Tetrakis[8'-*O*-{4"-*O*-(4"'-*O*-(α-D-galactopyranosyl)-β-D-galactopyranosyl)-β-D-glucopyranosyl}octyloxyphenyl]-21H,23H-porphine (8).



8

To a solution of **S-13** (20.0 mg, 2.73 μmol) in THF (1.80 mL) and H_2O (1.00 mL) was added 2 N NaOH aq. (0.800 mL), and then the resultant mixture was stirred at 40 ºC. After being stirred for 14 h at the same temperature, the reaction mixture was allowed to be cooled to room temperature, and then the reaction mixture was neutralized by adding 2 N HCl aq. The resultant solution was concentrated in *vacuo*. The residue was subjected to reverse phase silica gel column chromatography (90/10 to 10/90 H_2O-THF) to give **8** (7.87 mg, 2.51 μmol, 92% yield). Purple solid; R_f 0.66 (1/1 H_2O-THF); m.p. 260-262 ºC; ^{1}H-NMR (500 MHz, 3/1 pyridine-d_5-D_2O) δ 9.23 (8H, s, pyrroles), 8.40 (8H, d, J = 6.6 Hz, Ar-H), 7.67 (8H, d, J = 6.6 Hz Ar-H), 5.58 (4H, d, J = 3.1 Hz), 5.18 (4H, d, J = 7.9 Hz), 4.94 (8H, m), 4.69 (8H, dd, J = 3.1, 9.3 Hz), 4.60-4.19 (60H, m), 4.12 (4H, t, J = 8.3 Hz), 4.03 (4H, d, J = 7.9 Hz), 3.88 (4H, dd, J = 8.3, 11.3 Hz), 3.78 (4H, t, J = 6.2 Hz), 2.09 (8H, br-s), 1.85 (8H, t, J = 6.9 Hz), 1.64 (8H, br-s), 1.48-1.40 (24H, m); ^{13}C-NMR (125 MHz, DMSO-d_6): δ 159.2, 159.1, 146.6, 143.8, 135.9, 133.8, 125.4, 120.2, 113.5, 104.4, 103.1, 101.2, 81.4, 77.7, 75.5, 75.4, 75.3, 73.7, 73.4, 71.6, 71.3, 69.7, 69.3, 69.1, 68.3, 61.0, 60.9, 59.8, 34.9, 34.8, 31.0, 29.8, 29.7, 29.5, 26.3, 26.1; HRMS (ESI-TOF) *m/z* 3136.3411 (3136.3489 calcd. for $C_{148}H_{215}N_4O_{68}$, $[M+H]^+$).

UV/vis spectra of 3-8.

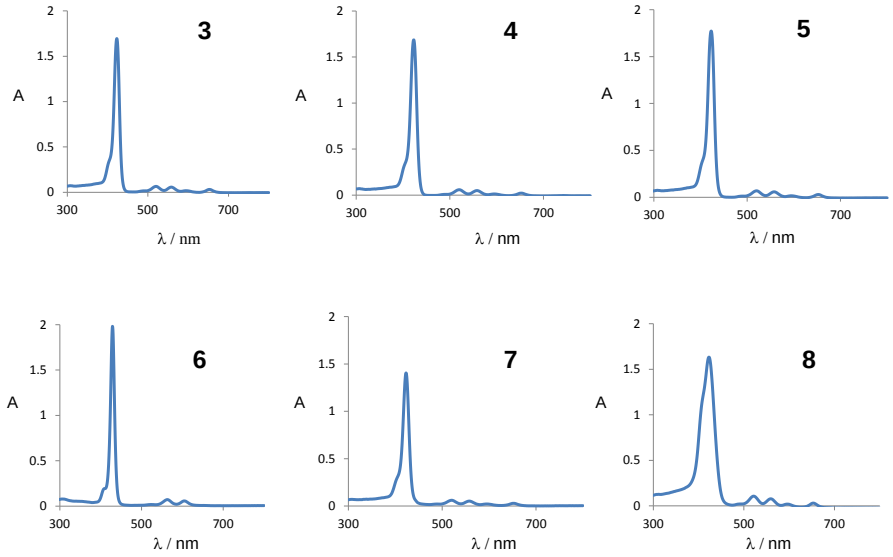


Fig. S1. UV-vis spectra of **3-8** (5 μM) in 60% DMF 0.1 M Tris-HCl buffer (pH 7.9, 0.1 M 0.1 M NaCl)

Photo-degradation of verotoxin-1 analyzed by SDS-PAGE.

The protein degradation experiments were performed with VT-1 (Nakarai Tesque) (0.5 μM), BSA (Sigma) (0.5 μM) and/or Lyso (Sigma) (0.5 μM) in a volume of 10 μL in 0.1 M Tris-HCl buffer (pH 7.9, 0.1 M NaCl) containing 3% DMF and indicated concentrations of each compound at 25 ºC for 2 h under irradiation of a UV lamp (365 nm, 100 W, Blak-ray (B-100A), UVP. Inc.) or a visible light lamp (100 W xenon lamp, SOLAX XC-100AF, SERIC LTD.) placed at 10 cm from the mixture. After irradiation, 4.80 μL of electrophoresis buffer consisted of SDS (5%, wt/vol), glycerol (27%, vol/vol), and bromophenol blue (0.007%, wt/vol) was added to the samples and the protein was separated by SDS-PAGE in 15% polyacrylamide gels. Gels were run by applying 60 V for 100 min. Then the gels were stained with SYPRO Ruby Protein Gel Stain (Bio-Rad Lab. Inc.) for 14 h, destained in acetic acid (7%, vol/vol) and methanol (10%, vol/vol) for 0.5 h, and then washed with water. The gels were scanned with a Molecular Imager FX (Bio-Rad Lab. Inc.).

Photo-degradation of verotoxin-1 analyzed by immunoblotting.

The protein degradation experiments were performed with VT-1 (List Biological

Laboratories) (70 nM) in a volume of 10 μL in 10 mM PBS (pH 7.4) containing 10% DMF and indicated concentrations of each compound at 25 ºC for 30 min under irradiation of a visible light lamp (100 W xenon lamp, SOLAX XC-100AF, SERIC LTD.) placed at 45 cm from the mixture. After irradiation, 4.80 μL of electrophoresis buffer consisted of SDS (5%, wt/vol), glycerol (27%, vol/vol), and bromophenol blue (0.007%, wt/vol) was added to the samples and the protein was separated by SDS-PAGE in 15% polyacrylamide gels. Gels were run by applying 60 V for 100 min. Then protein was transferred at 200 mA for 2 h onto Amersham Hybond ECL Nitrocellulose Membrane (GE Healthcare). Nonspecific binding sites were blocked for 2 h by immersing the membrane in a blocking solution, Tris-buffered saline with Tween 20 (TBST): 10 mM Tris-HCl, (pH 8.0), Tween 20 (0.1%, vol/vol). After a short wash in TBST, the membrane was incubated in a 1:1000 dilution of a primary antibody (Life Span Biosciences, Inc.) in TBST for 14 h at 4 ºC followed by 30 min of washing with TBST. The bound antibody was then detected with horseradish peroxidase-conjugated secondary antibody Anti-mouse IgG (GE healthcare) diluted at 1:3000 in TBST and 2% (wt/vol) nonfat dry milk by incubation with it for 2 h at 25 ºC. After having been washed for 30 min in TBST, the immunocomplexes were detected by using ECL reagent, Immobilon Western (Millipore, Billerica, MA). Exposure to RX-U films (Fuji Film, Kanagawa, Japan) was carried out for 30 s to 5 min.

Cell Culture.

The Vero cell line was routinely grown in MEM supplemented with phenol red, L-glutamine (2 mM), and 2% fetal bovine serum. The cells were maintained at 37 ºC in a humidified atmosphere containing 5% CO_2.

Vero cytotoxicity neutralization assays.[3]

1.0×10^4 cells in 90 μL of medium were cultured in 96-well microplates, and then incubated for 20 h at 37 ºC prior to the addition of experimental samples. Photo-degradation experiment was performed in a volume of 35 μL PBS solutions containing 1% DMSO, VT-1 (List Biological Laboratories) (2 nM), and indicated concentrations of each compound. The mixture was incubated at 25 ºC for 30 min under irradiation with a visible light lamp (100 W xenon lamp, SOLAX XC-100AF, SERIC LTD.) placed at 45 cm from the sample. Following photo-irradiation, the aliquots (10 μL) of the mixtures were added to appropriate wells, and then the cells were incubated at 37 ºC for 48 h. After incubation, medium were removed and the cells were washed with PBS. The Vero cell monolayers were fixed with 4% paraformaldehyde solution (50

μL) for 15min at 25 ºC, and then stained with 0.05% crystal violet solution (50 μL) for 5 min at 25 ºC. The cells were washed with deionized water until no further stain was eluted. Cytotoxicity was determined by eluting the dye from the stained cells with methanol (100 μL), and subsequent measurement of absorbance at 590 nm using Safire (TECAN) micro plate reader.

References

1. B. C. Liu, R. J. Roy, *J. Chem. Soc. Perkin Trans.*, *1*, 2001, **8**, 773.

2. L. Chen, X. E. Zhao, D. Lai, Z. Song, F. Kong, *Carbohydr. Res.*, 2006, **341**, 1174.

3. M. Noda, T. Yutsudo, N. Nakabayashi, T. Hirayama, Y. Takeda *Microb. Pathog.*, 1987, **2**, 339.

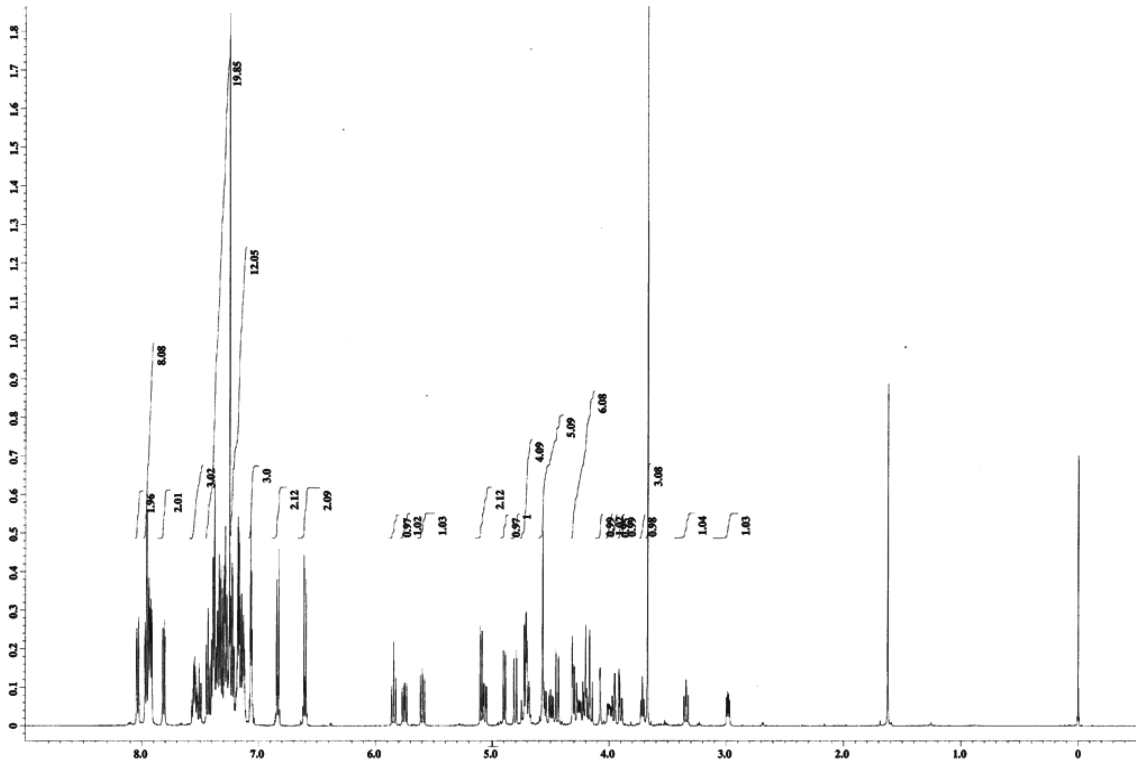


Fig. S2 ^{1}H-NMR spectrum of compound **S-3**.

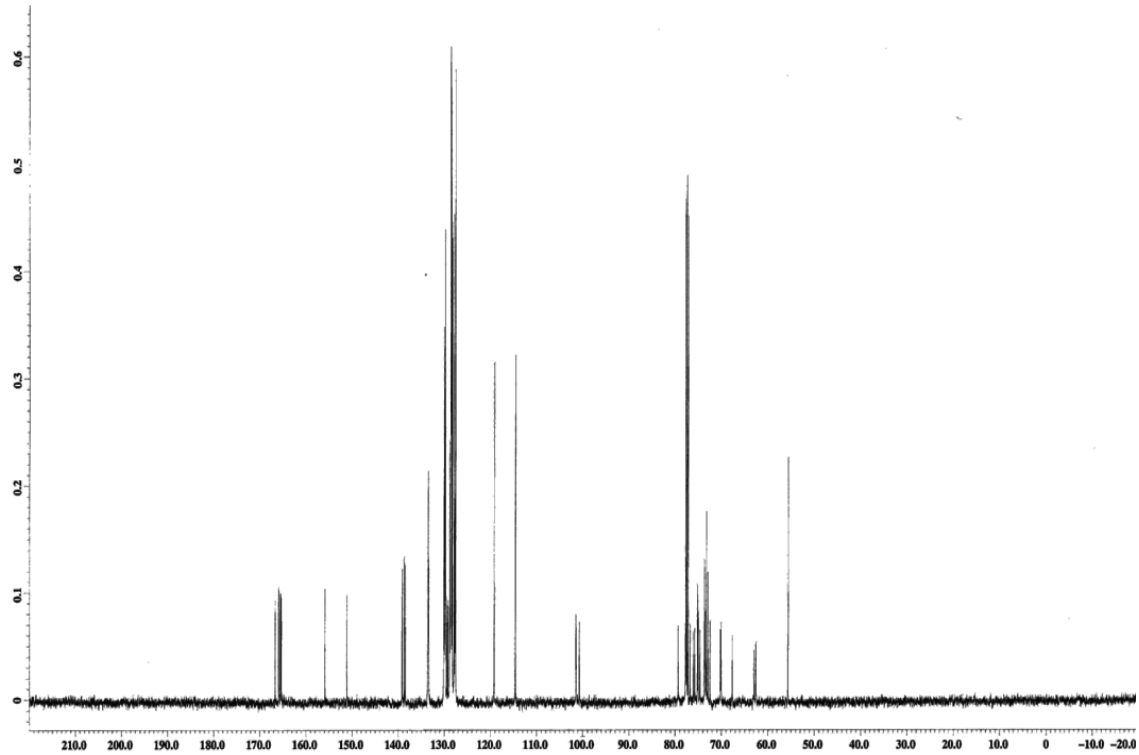


Fig. S3 ^{13}C-NMR spectrum of compound **S-3**.

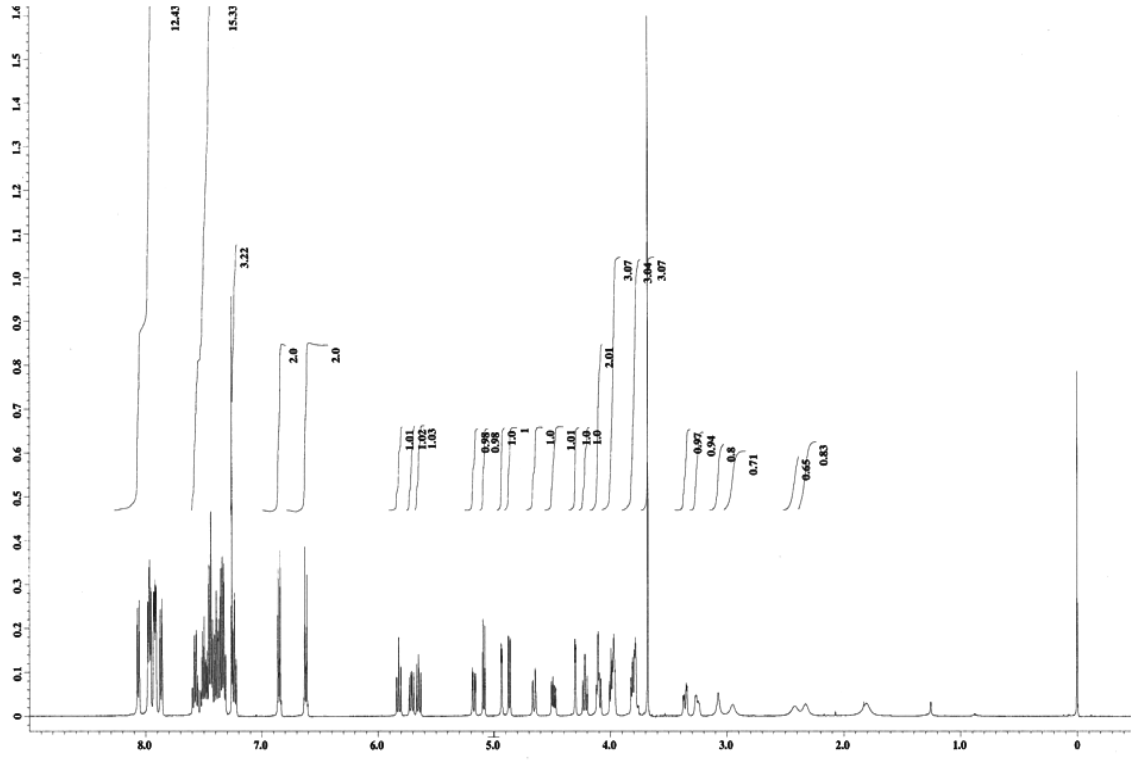


Fig. S4 ^{1}H-NMR spectrum of compound **S-4**.

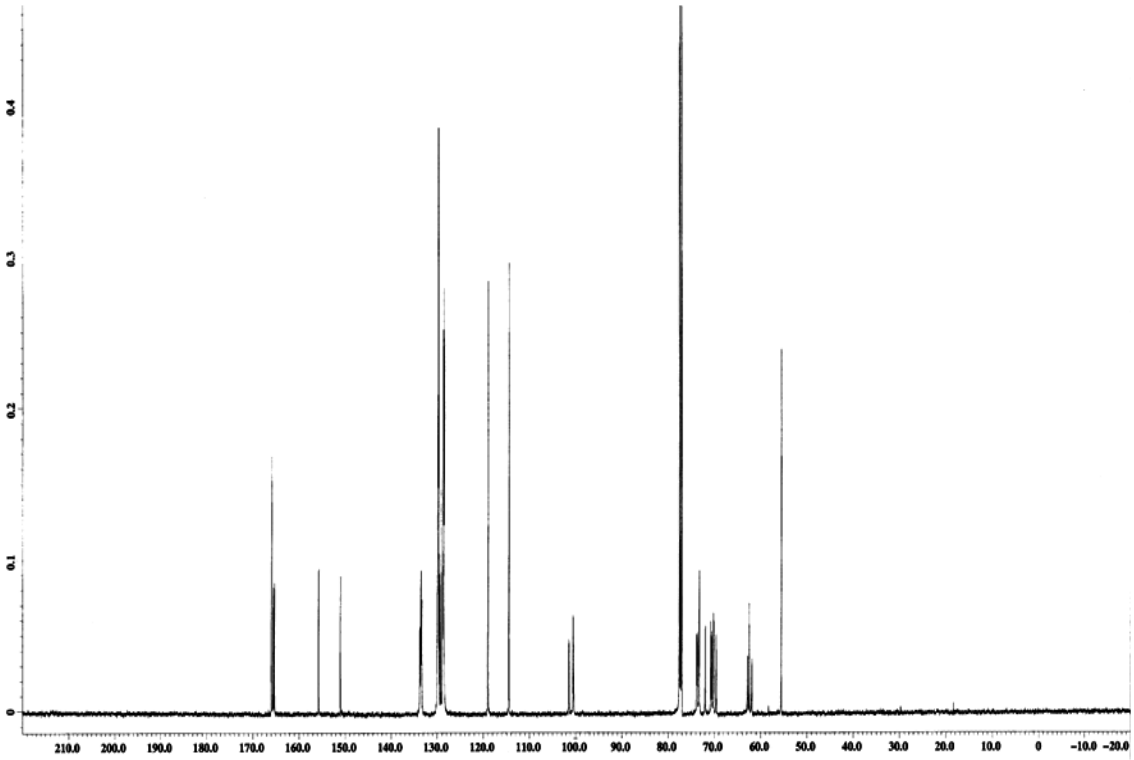


Fig. S5 ^{13}C-NMR spectrum of compound **S-4**.

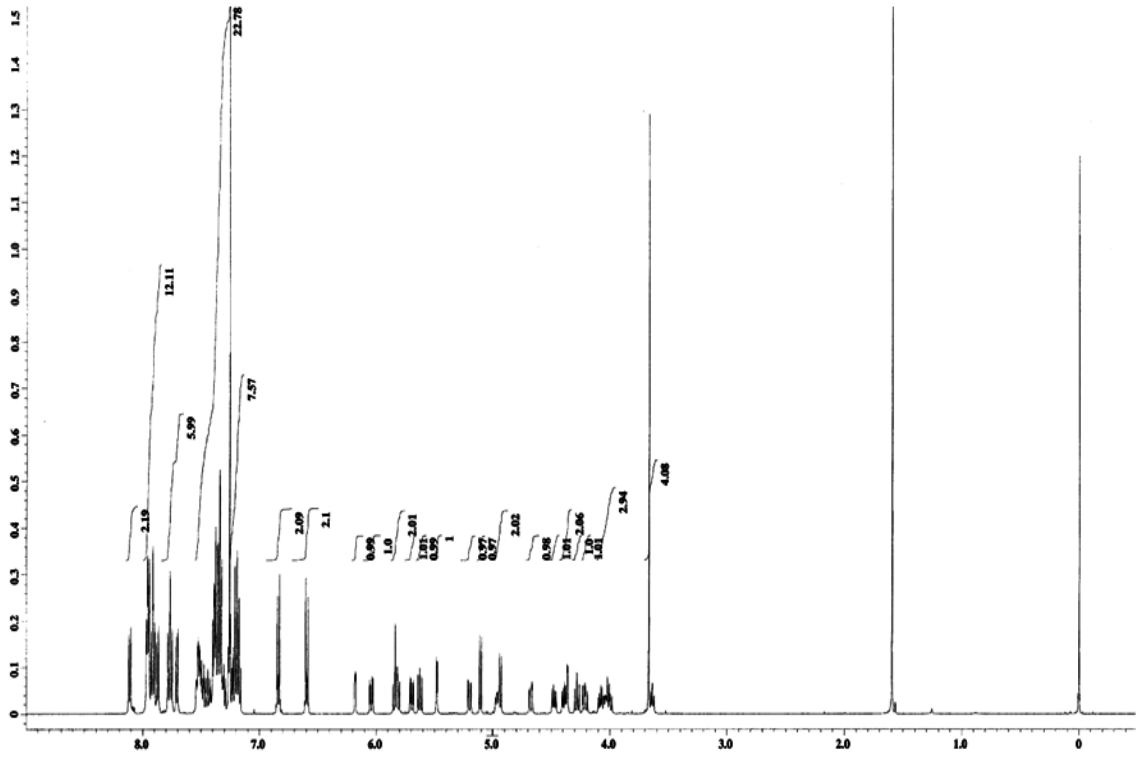


Fig. S6 ^{1}H-NMR spectrum of compound **S-5**.

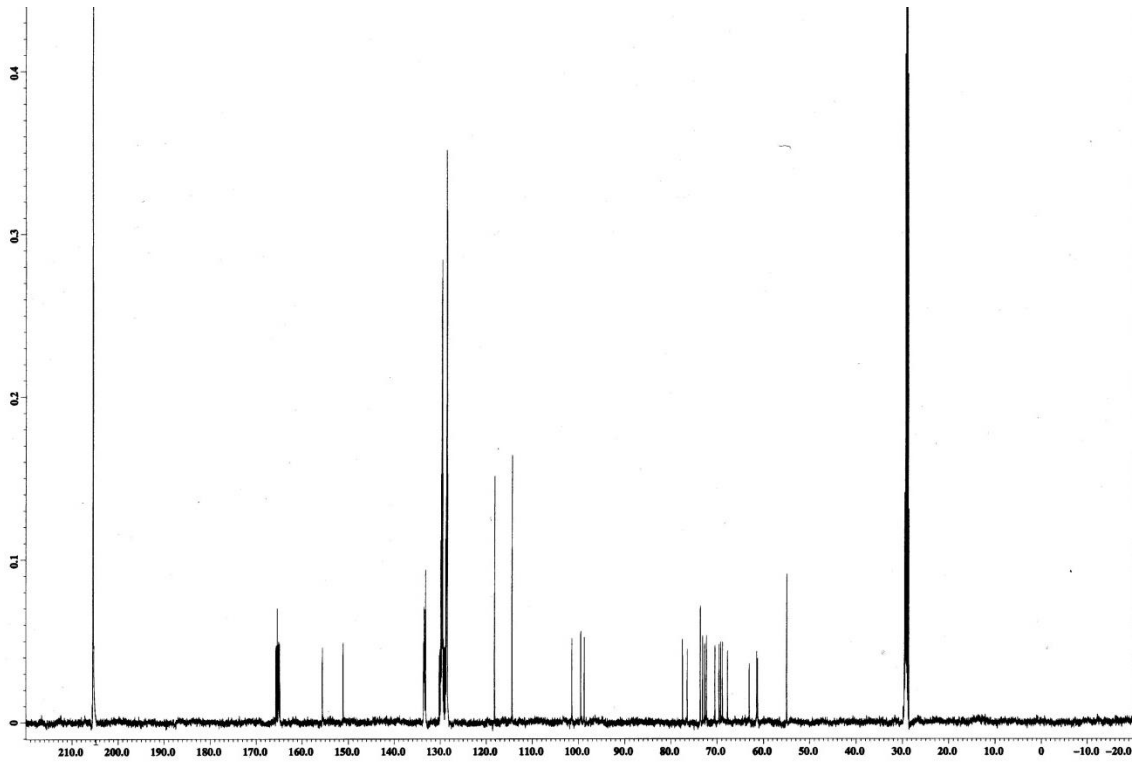


Fig. S7 ^{13}C-NMR spectrum of compound **S-5**.

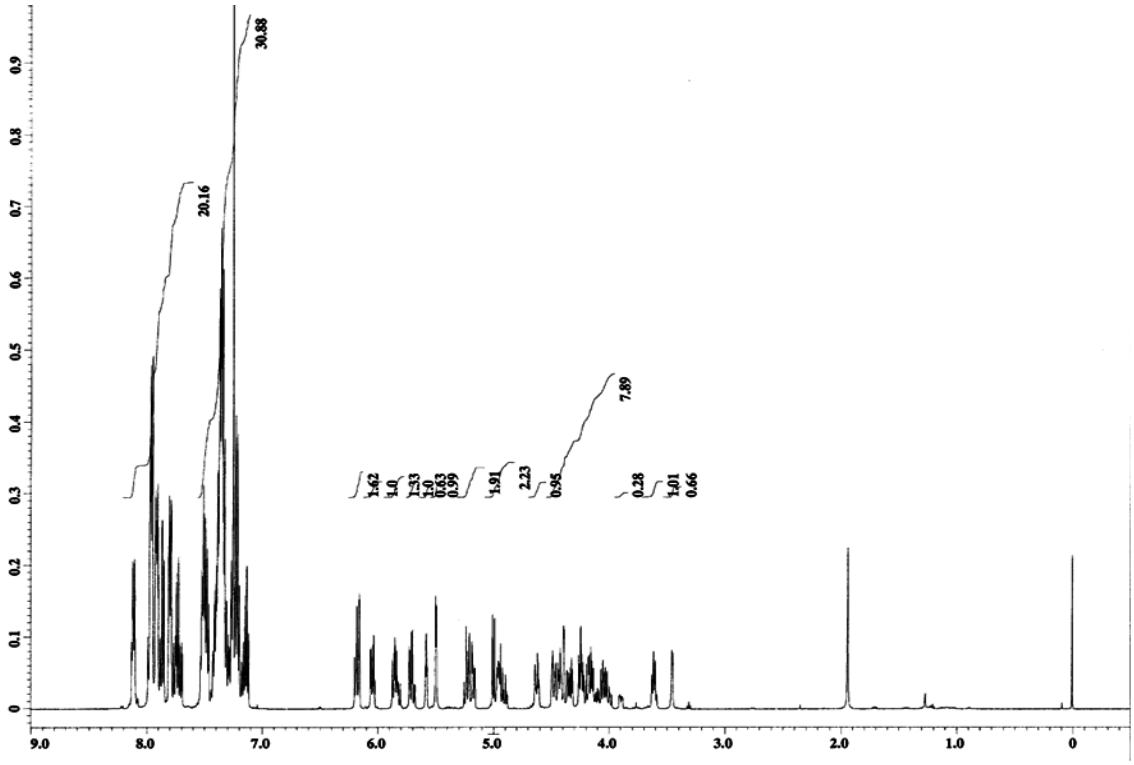


Fig. S8 ^{1}H-NMR spectrum of compound **S-6**.

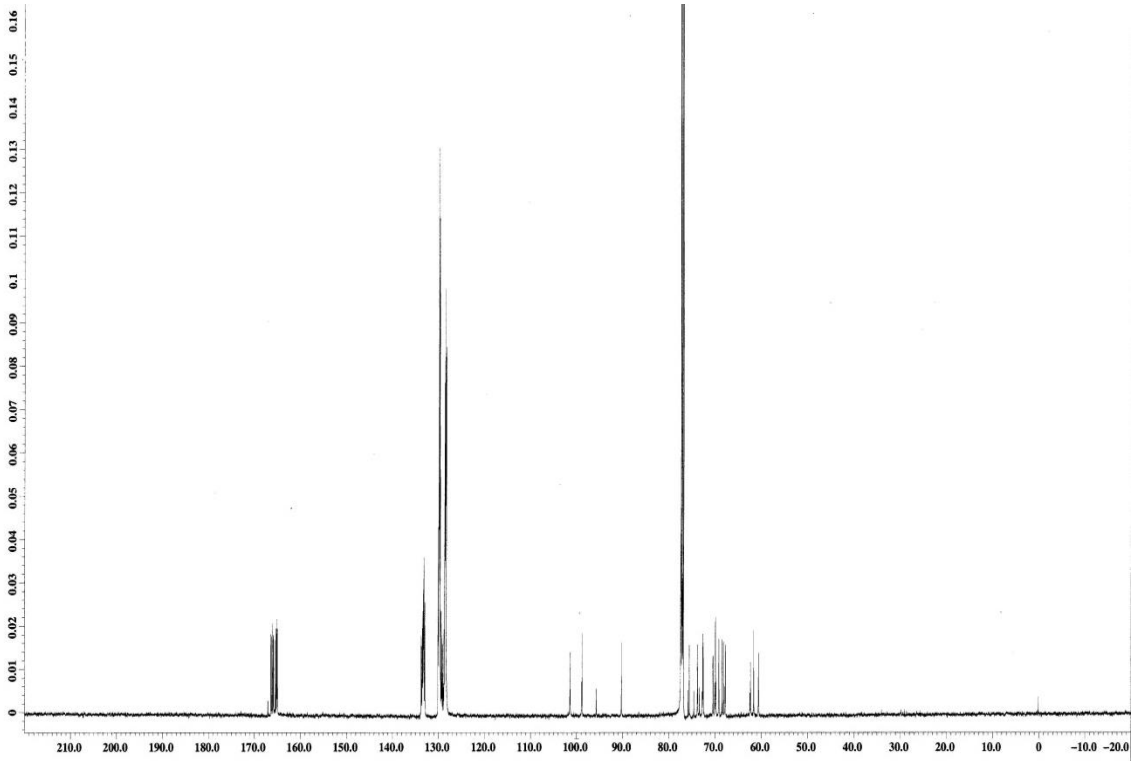


Fig. S9 ^{13}C-NMR spectrum of compound **S-6**.

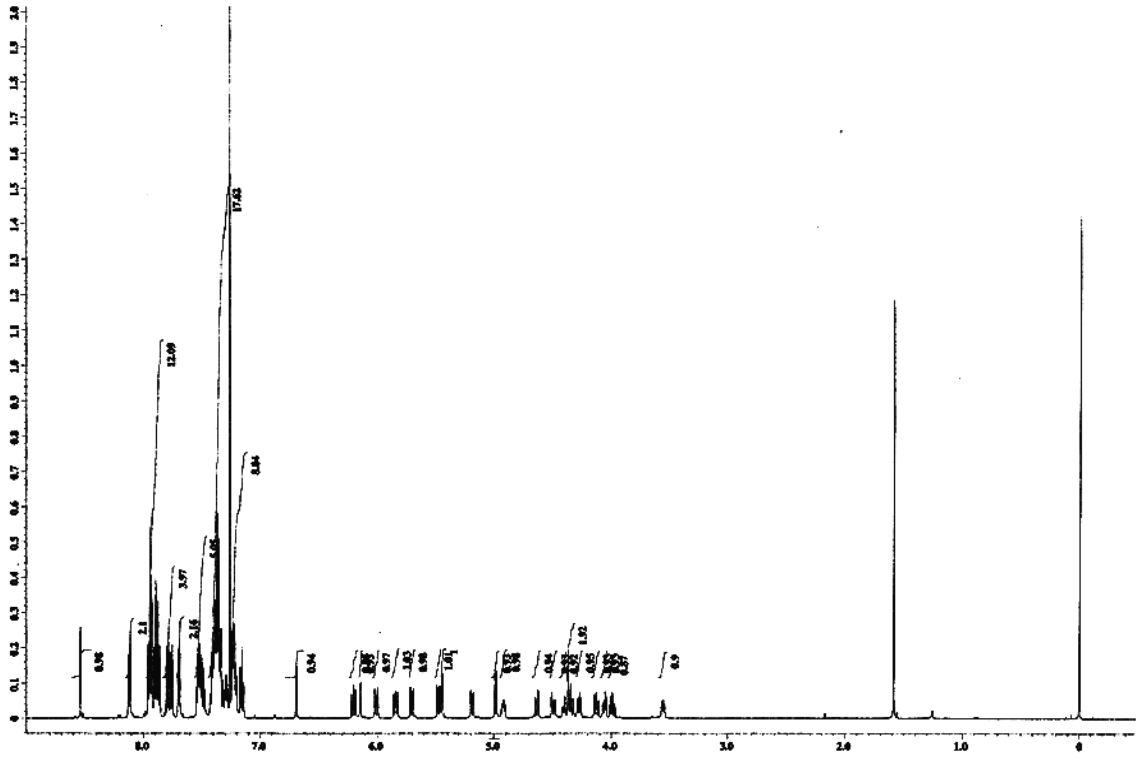


Fig. S10 ^{1}H-NMR spectrum of compound **S-7**.

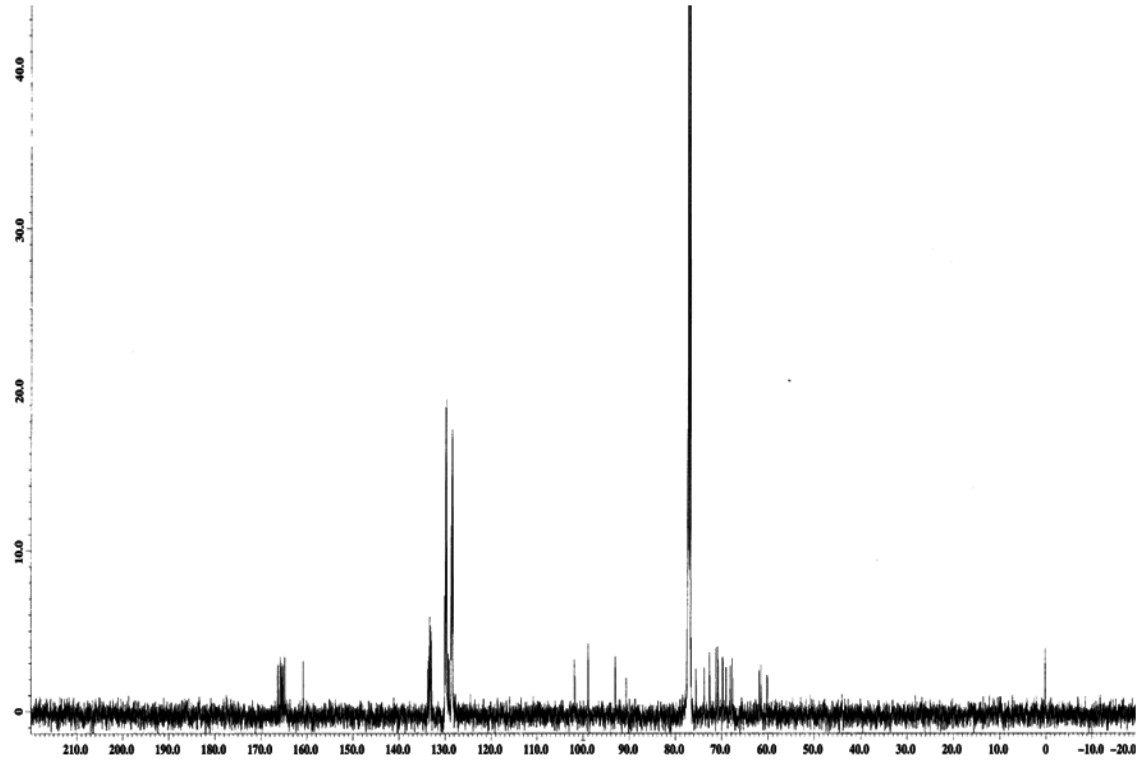


Fig. S11 ^{13}C-NMR spectrum of compound **S-7**.

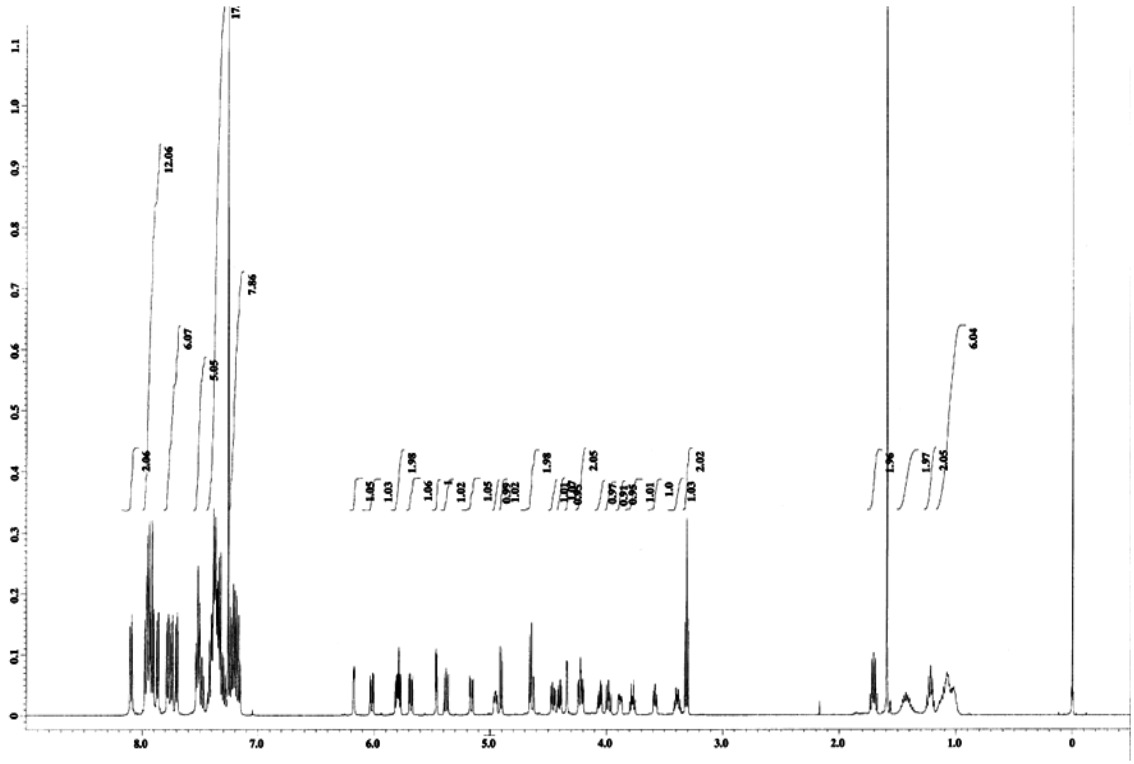


Fig. S12 ^{1}H-NMR spectrum of compound **S-8**.

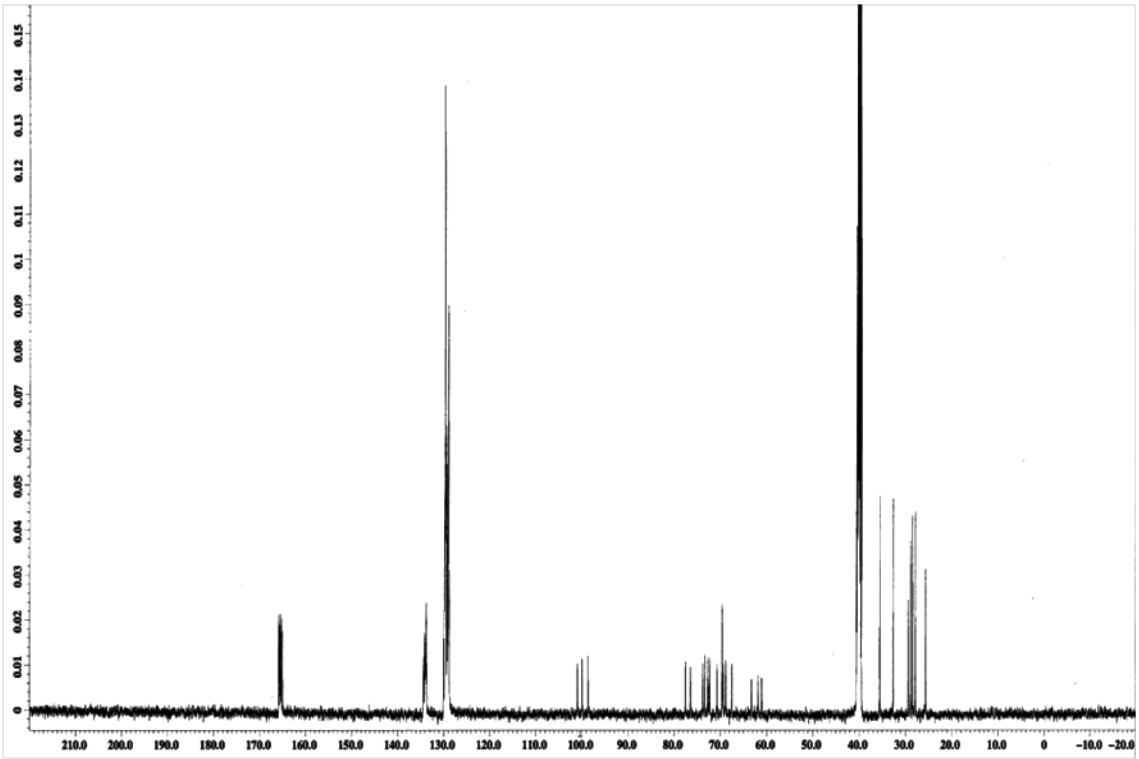


Fig. S13 ^{13}C-NMR spectrum of compound **S-8**.

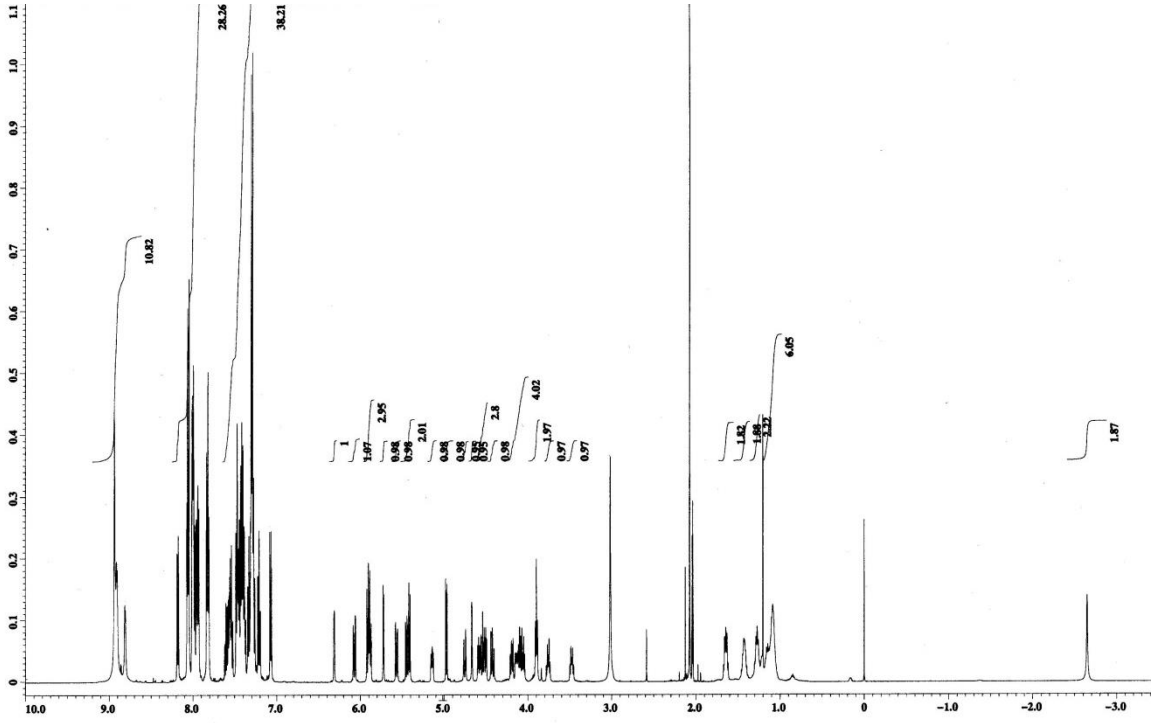


Fig. S14 ^{1}H-NMR spectrum of compound **S-9**.

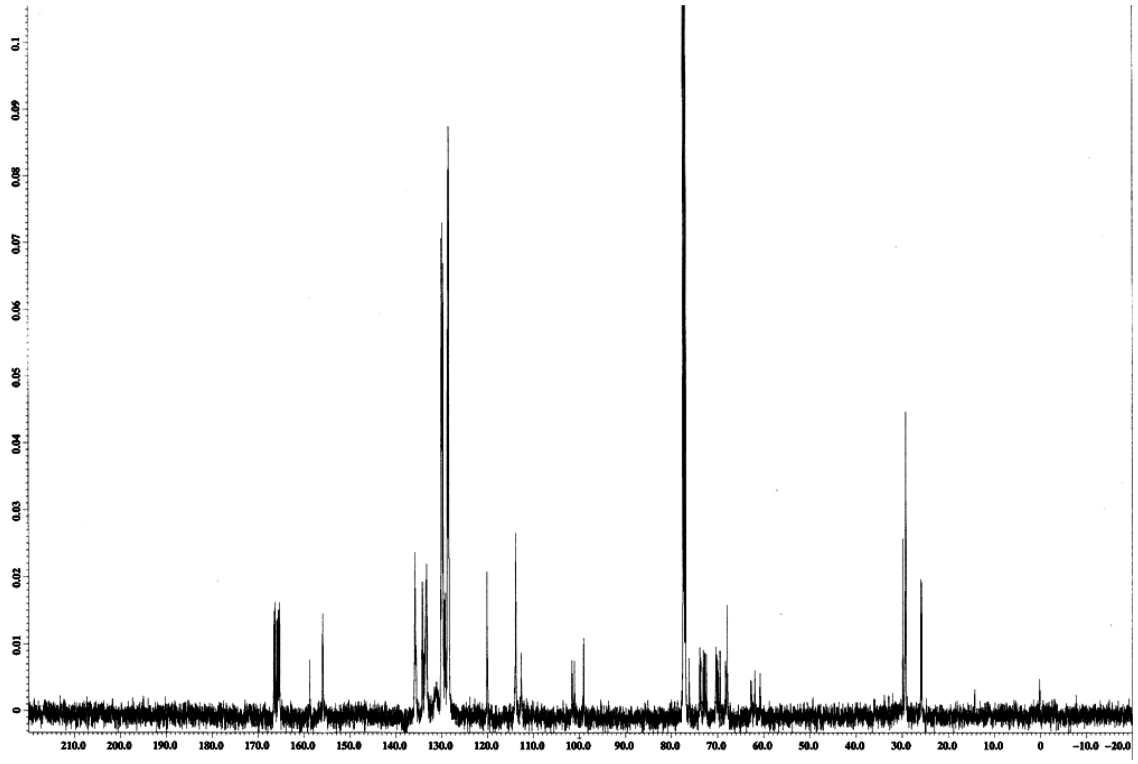


Fig. S15 ^{13}C-NMR spectrum of compound **S-9**.

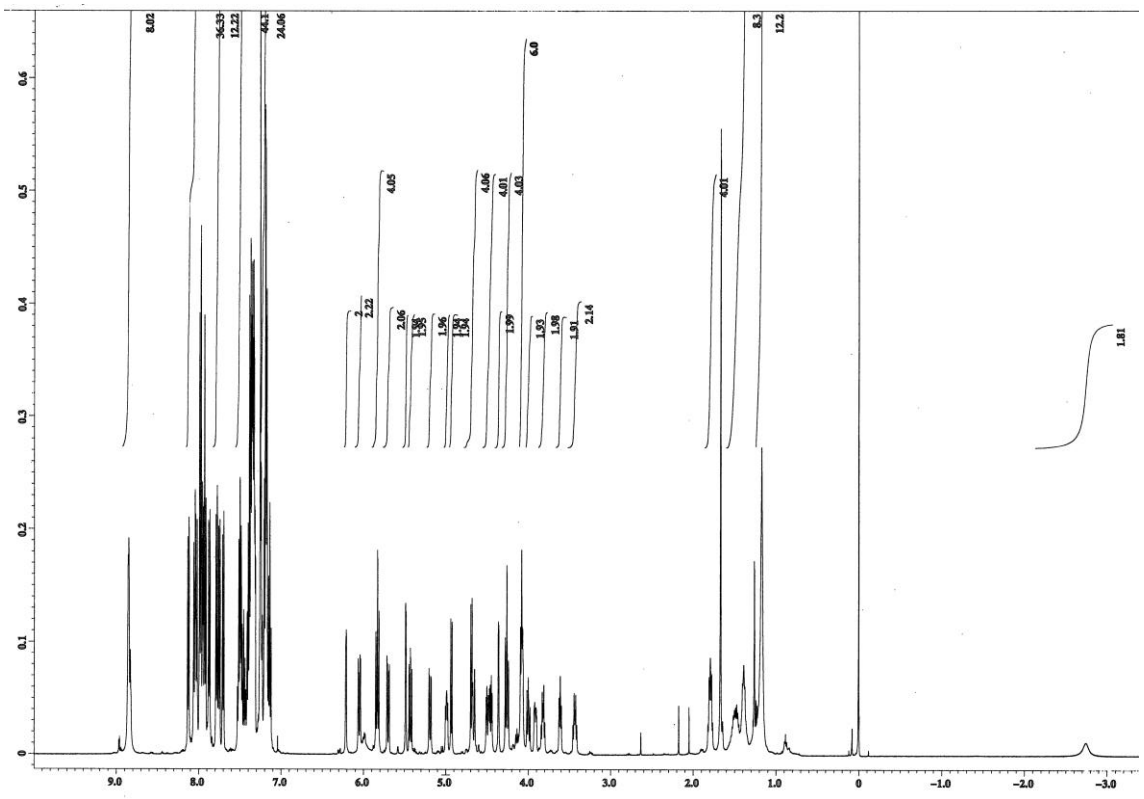


Fig. S16 ^{1}H-NMR spectrum of compound **S-10**.

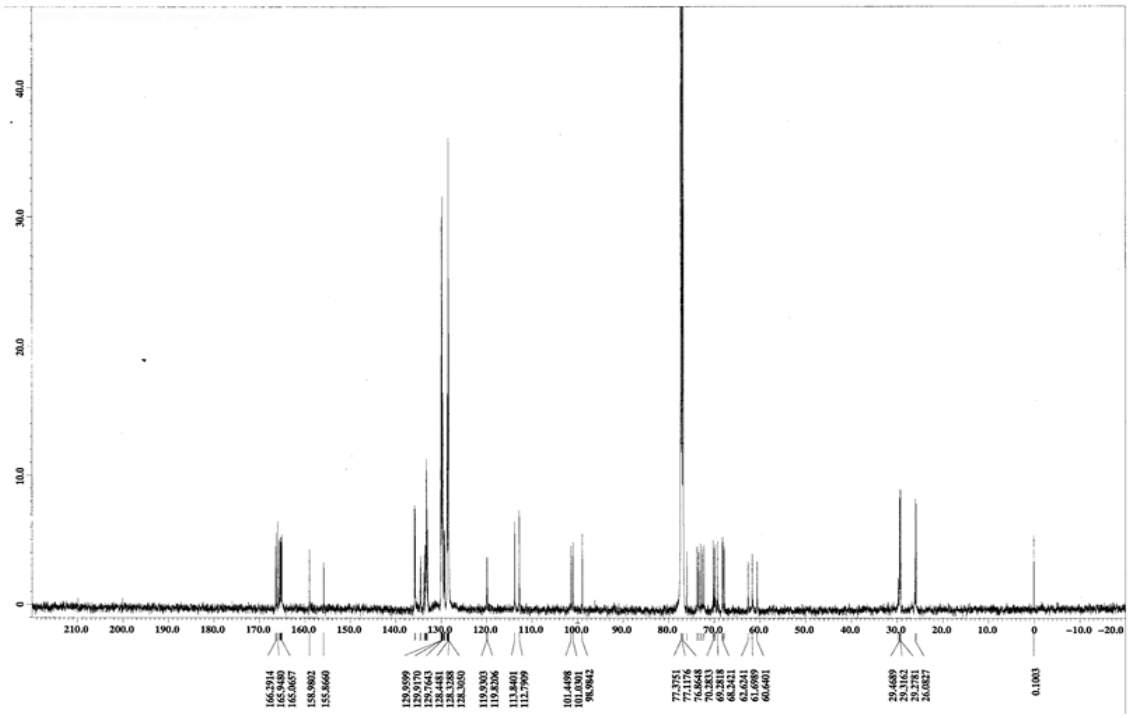


Fig. S17 ^{13}C-NMR spectrum of compound **S-10**

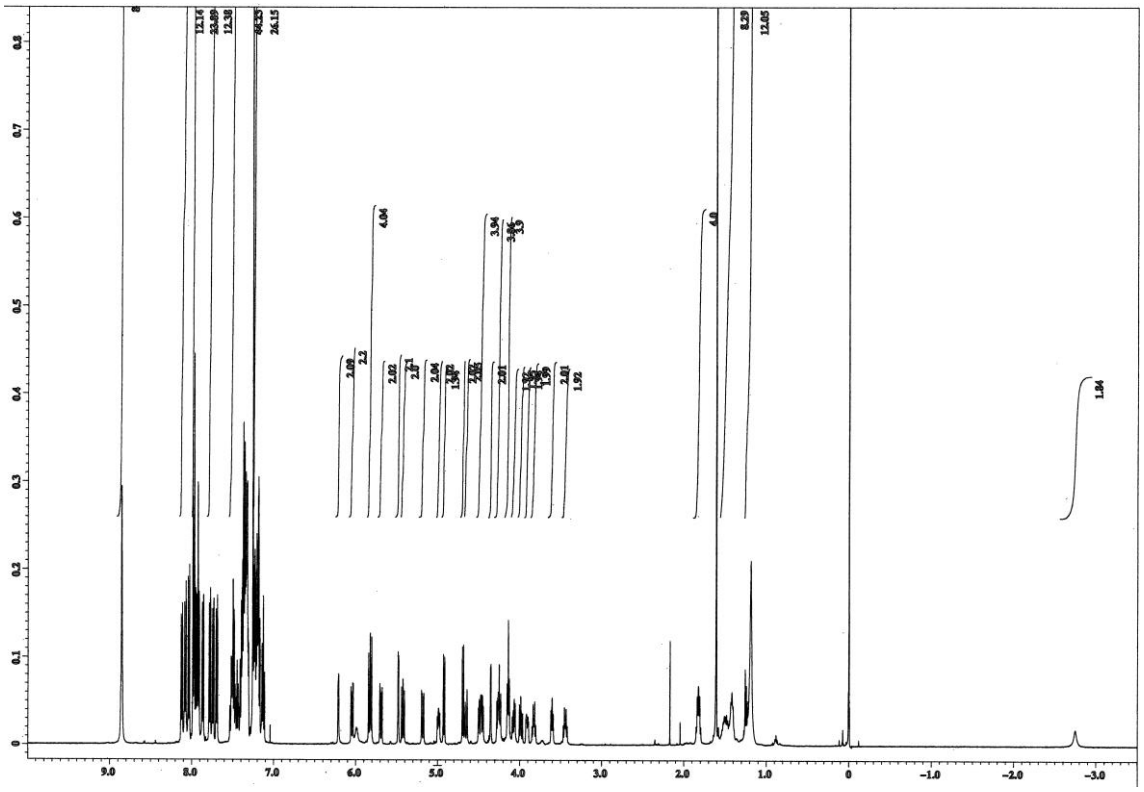


Fig. S18 ^{1}H-NMR spectrum of compound **S-11**.

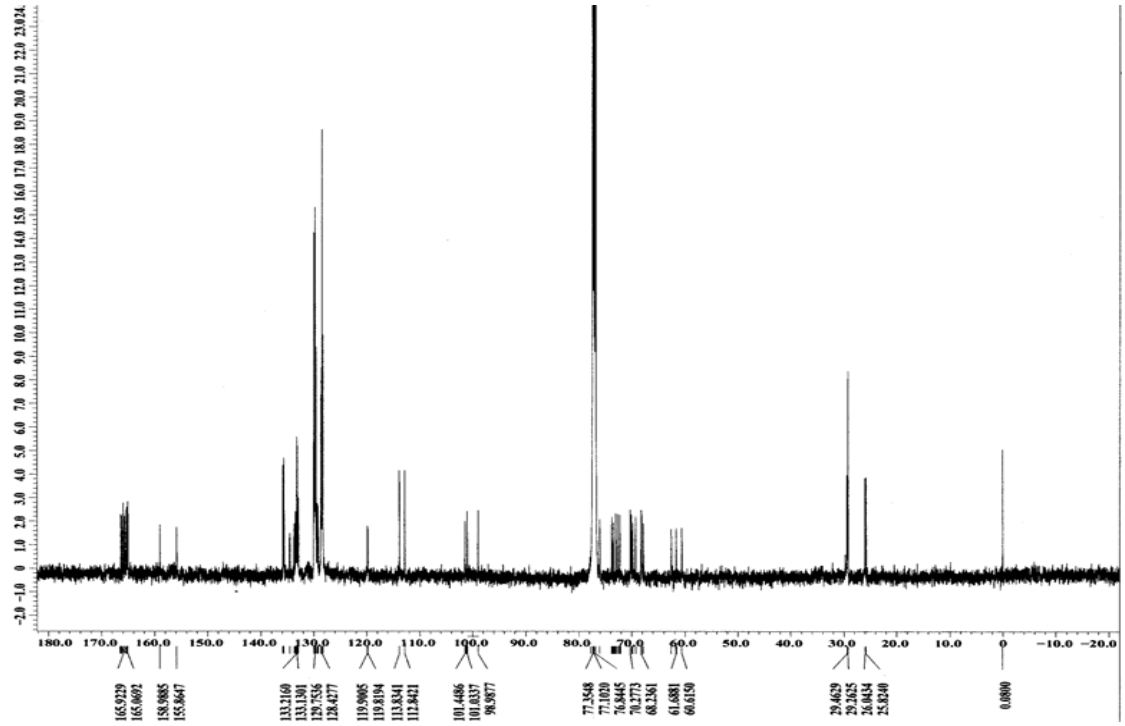


Fig. S19 ^{13}C-NMR spectrum of compound **S-11**.

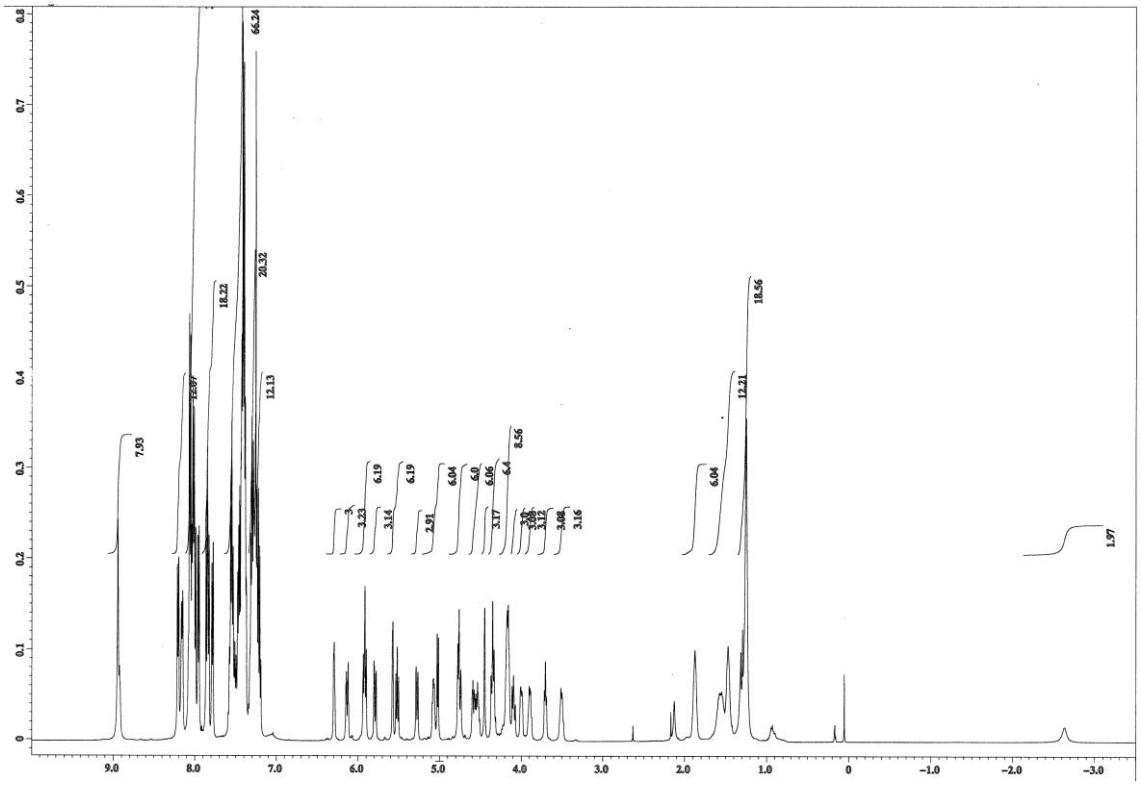


Fig. S20 ^{1}H-NMR spectrum of compound **S-12**.

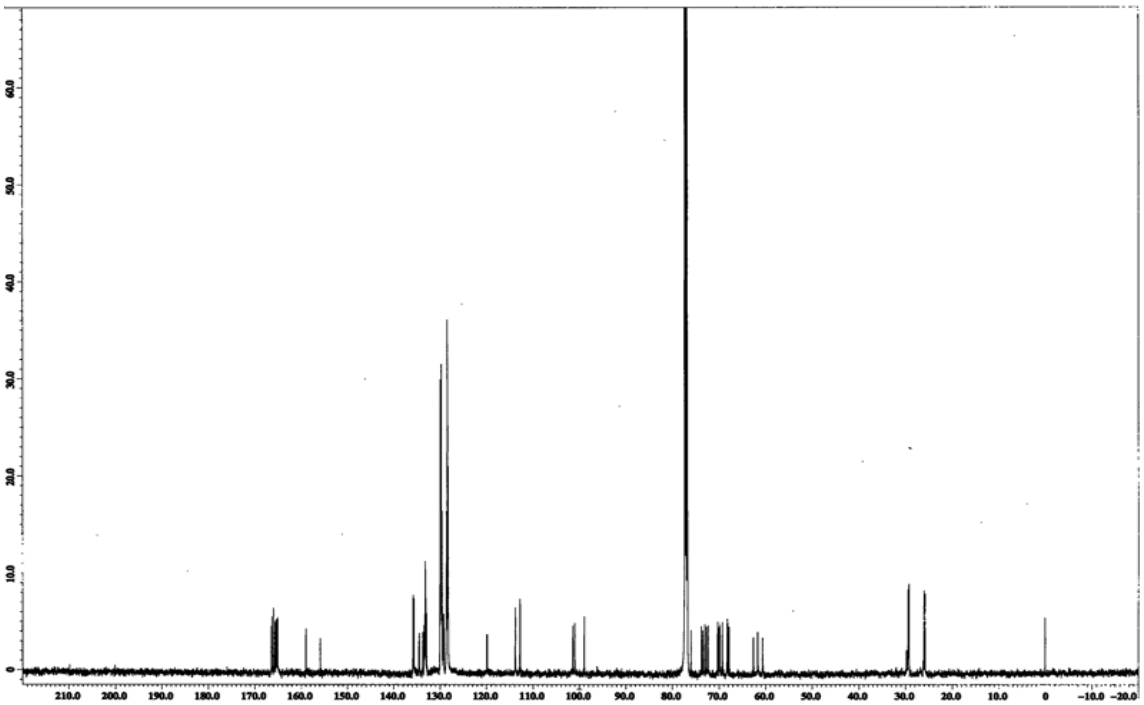


Fig. S21 ^{13}C-NMR spectrum of compound **S-12**.

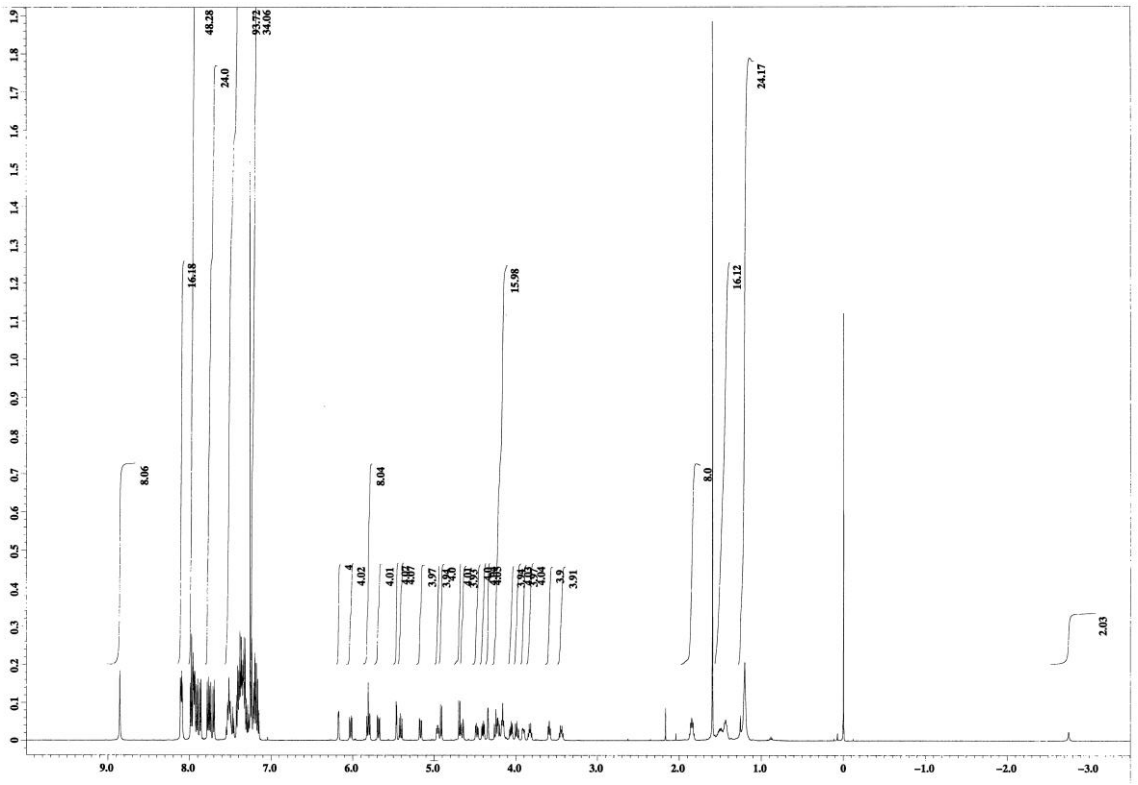


Fig. S22 ^{1}H-NMR spectrum of compound **S-13**.

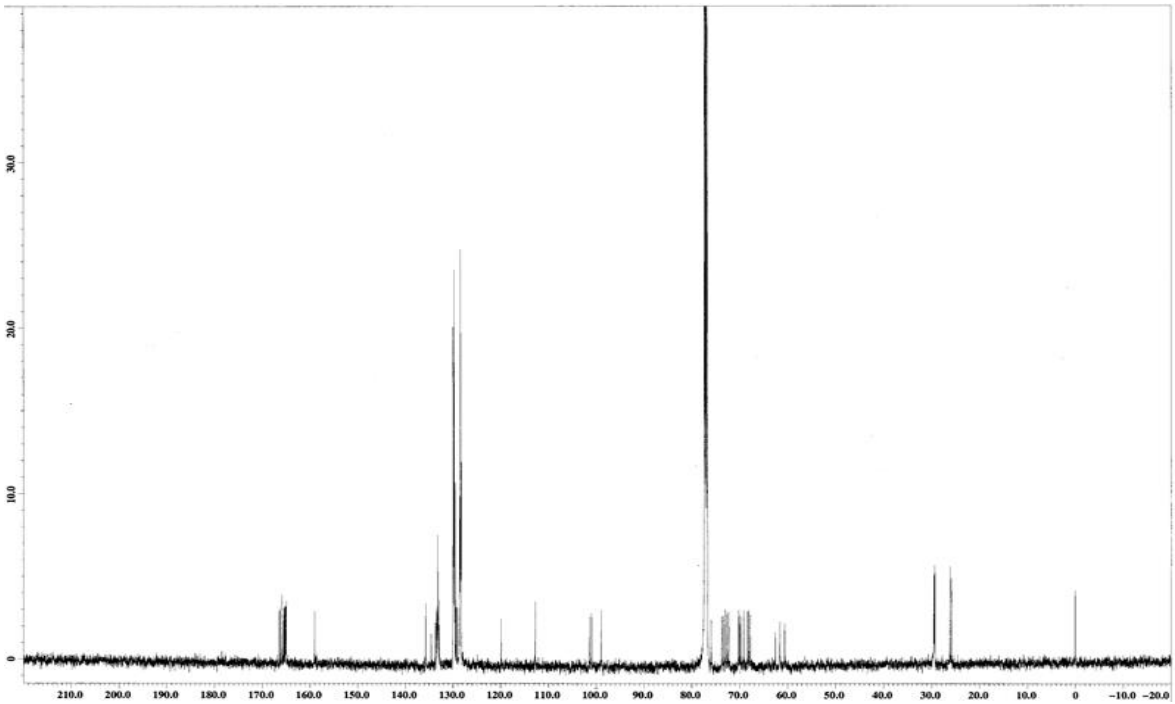


Fig. S23 ^{13}C-NMR spectrum of compound **S-13**.

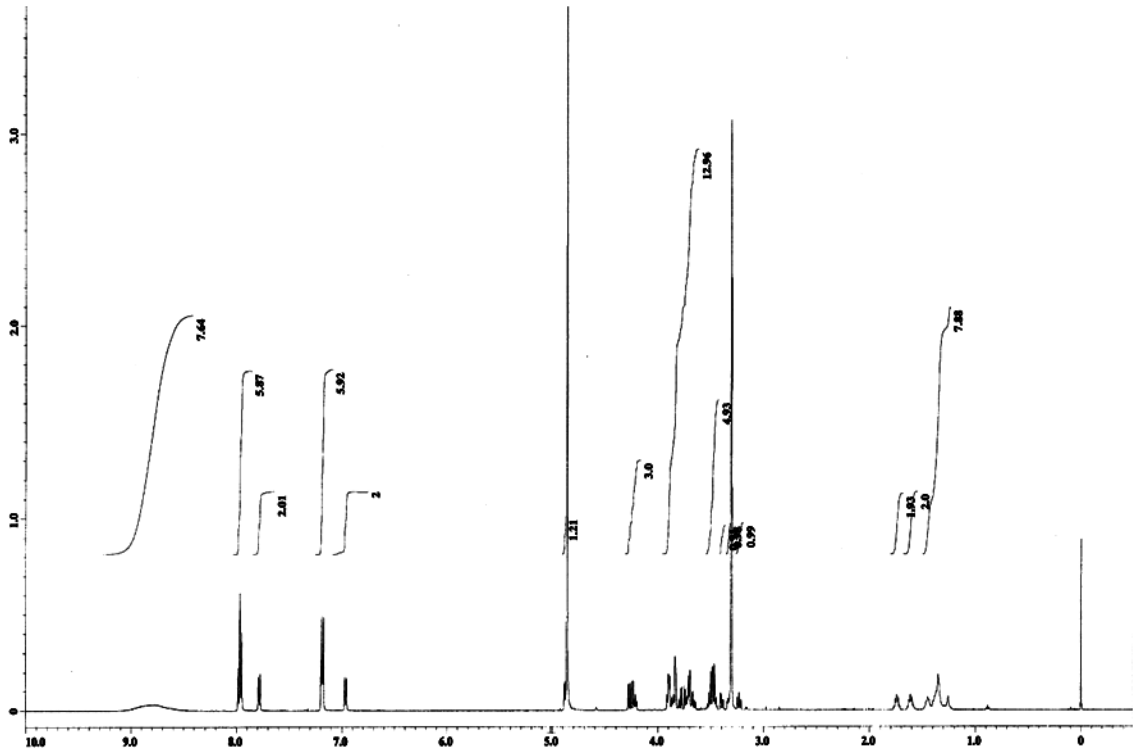


Fig. S24 ^{1}H-NMR spectrum of compound **4**.

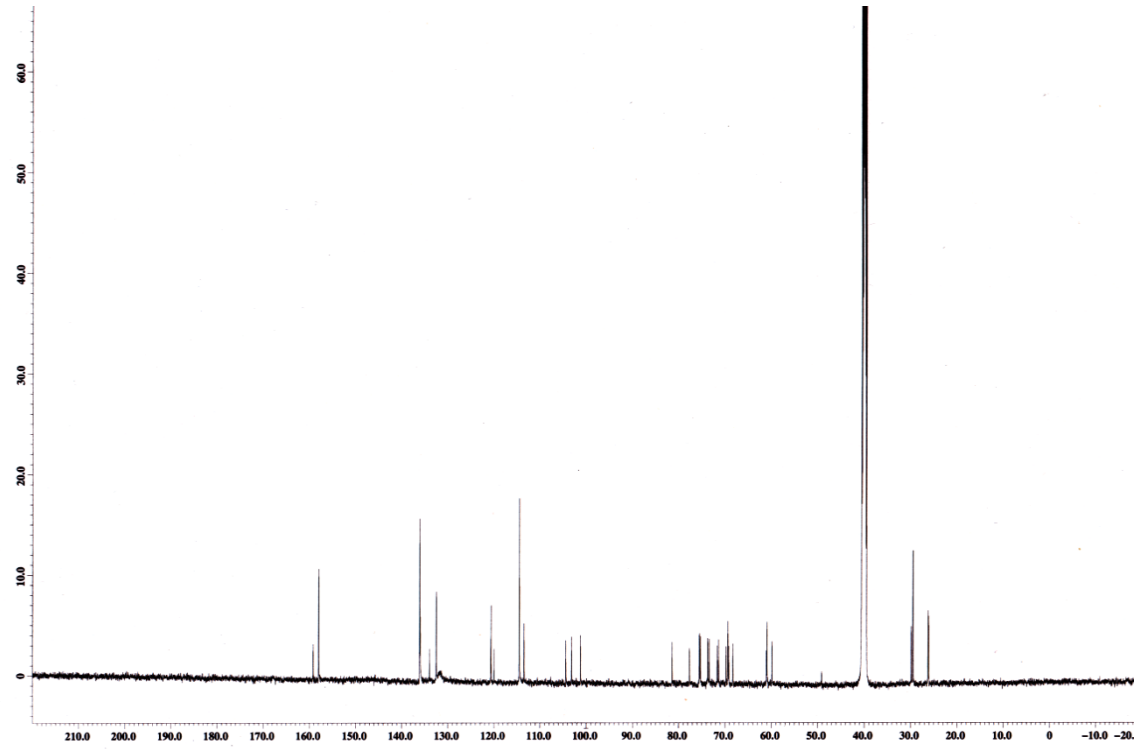


Fig. S25 ^{13}C-NMR spectrum of compound **4**.

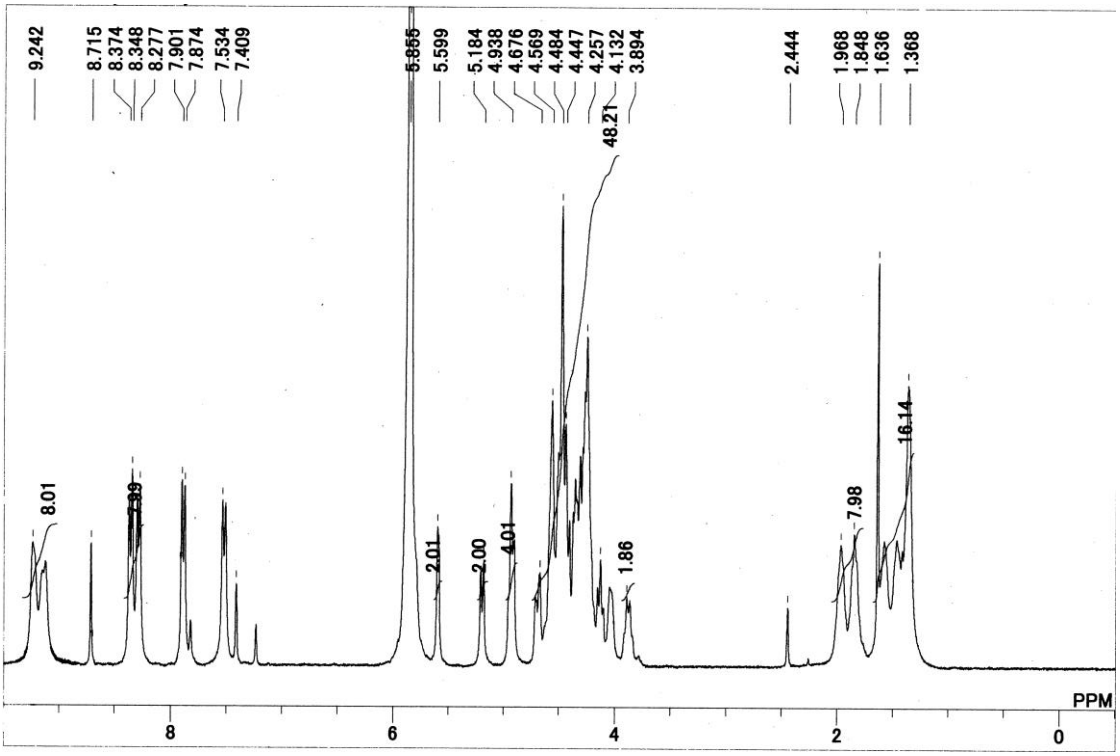


Fig. S26 ^{1}H-NMR spectrum of compound **5**.

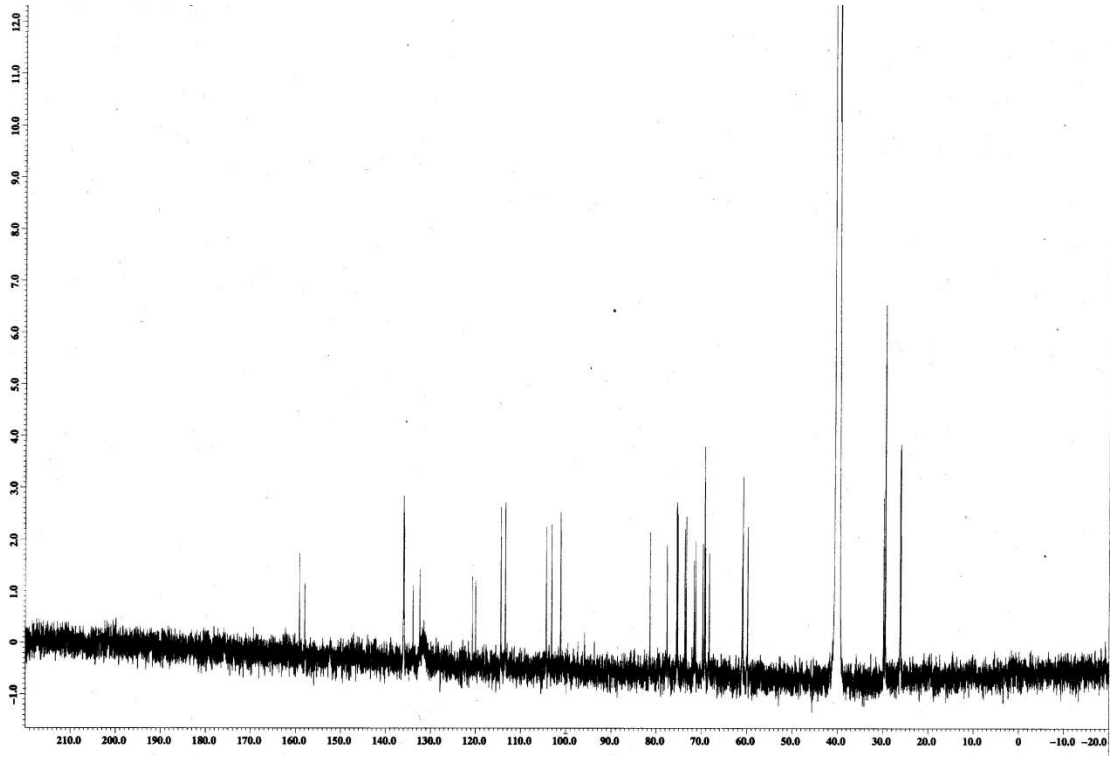


Fig. S27 ^{13}C-NMR spectrum of compound **5**.

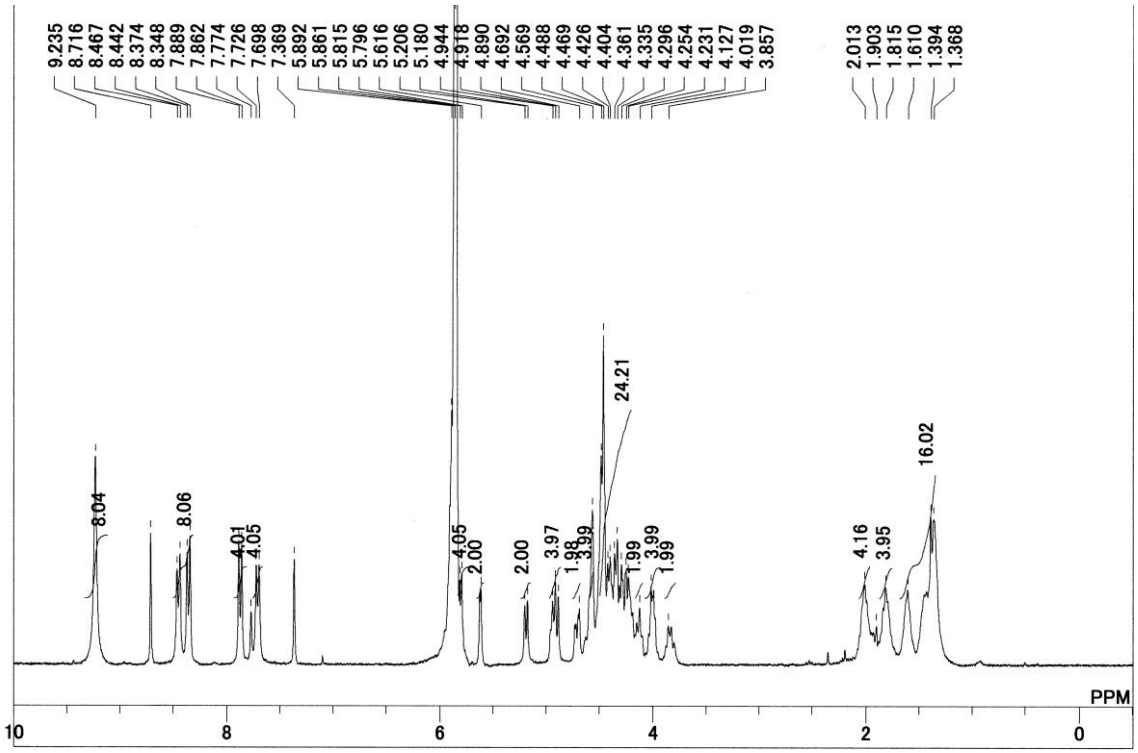


Fig. S28 ^{1}H-NMR spectrum of compound **6**.

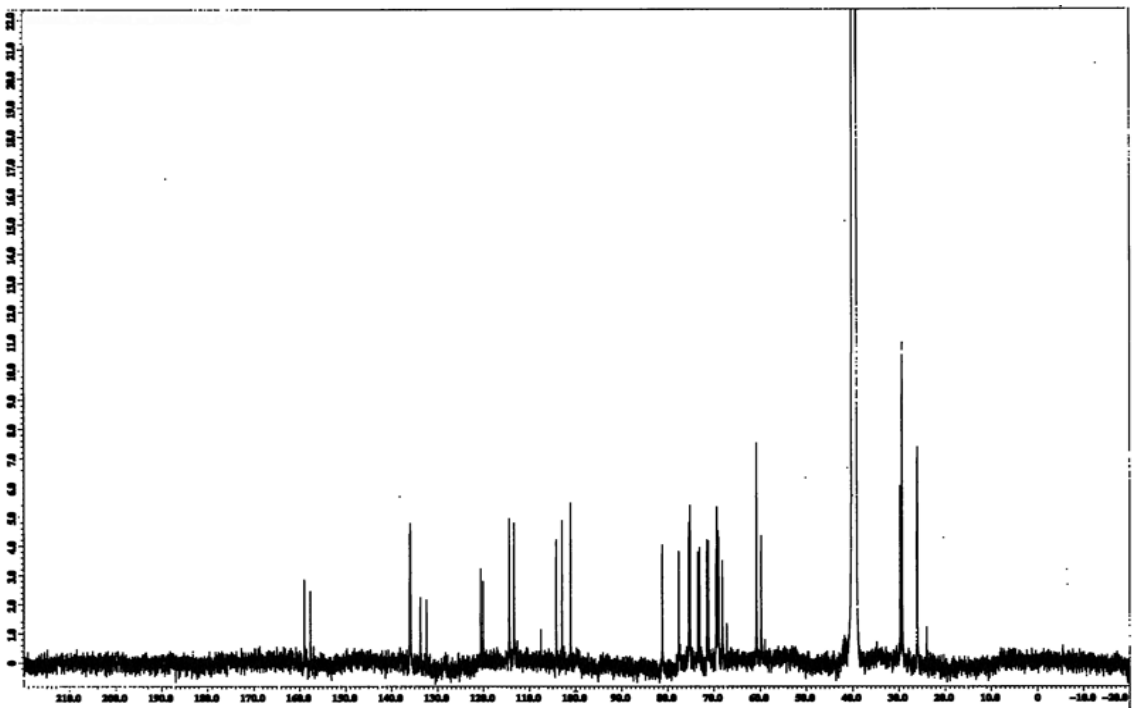


Fig. S29 ^{13}C-NMR spectrum of compound **6**.

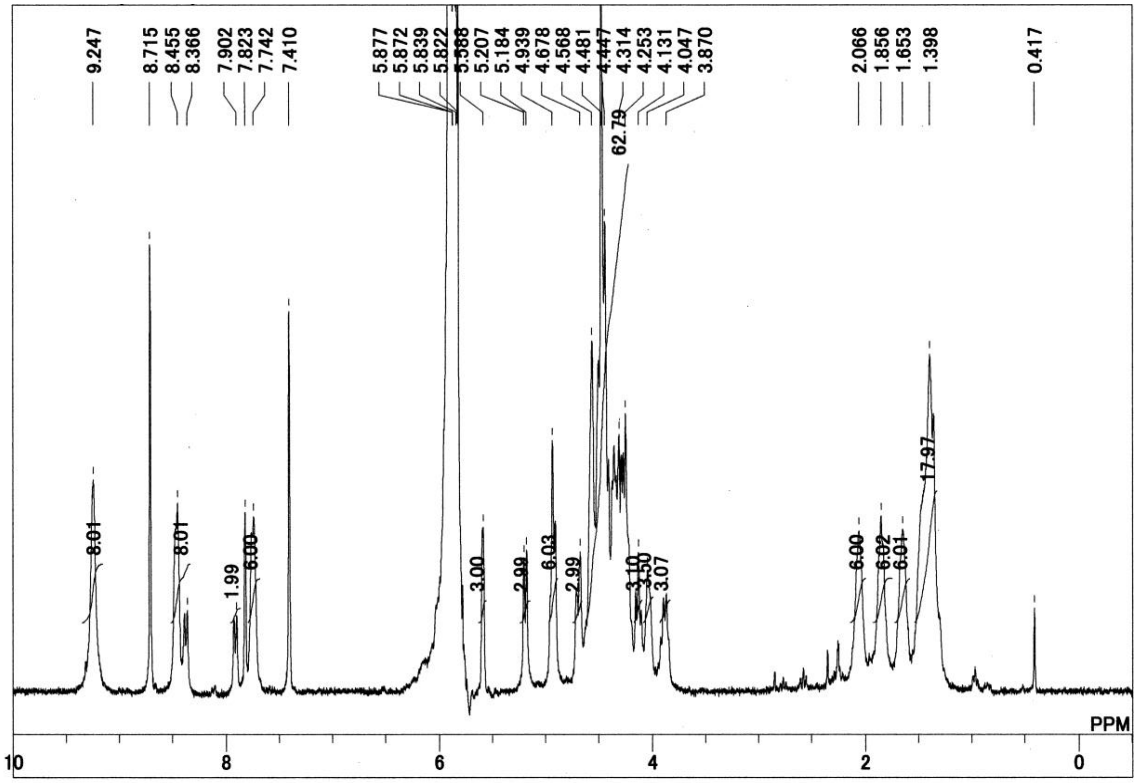


Fig. S30 ^{1}H-NMR spectrum of compound **7**.

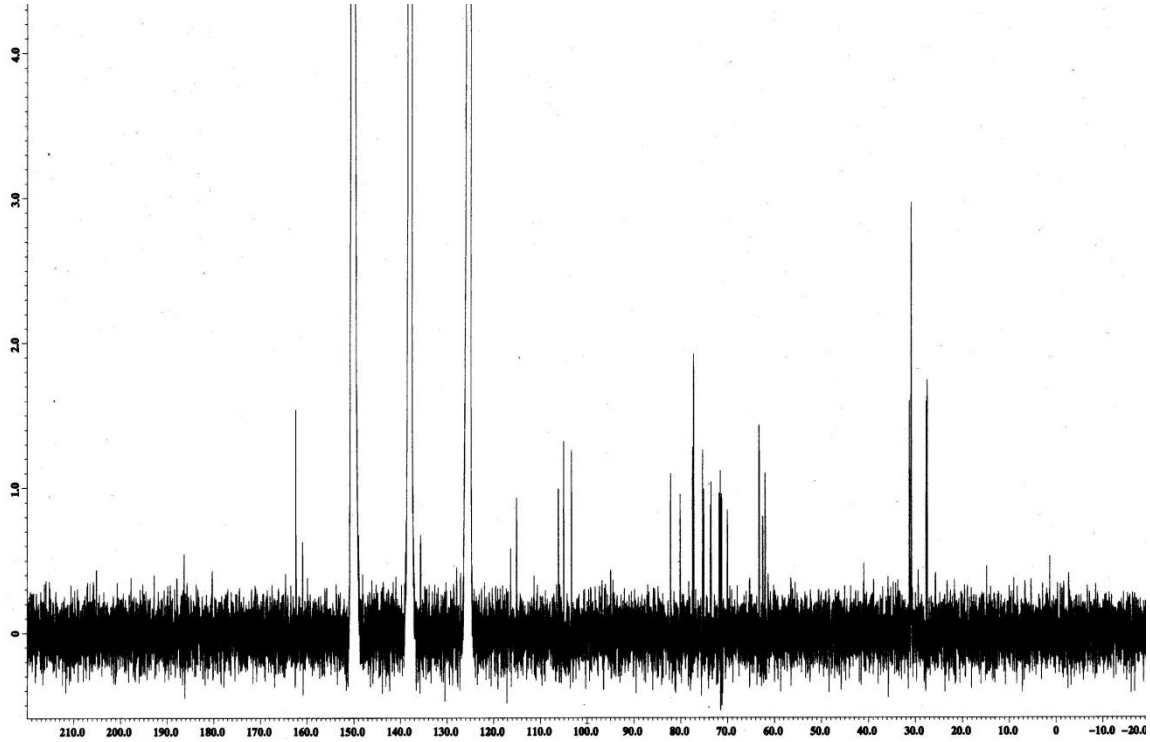


Fig. S31 ^{13}C-NMR spectrum of compound **7**.

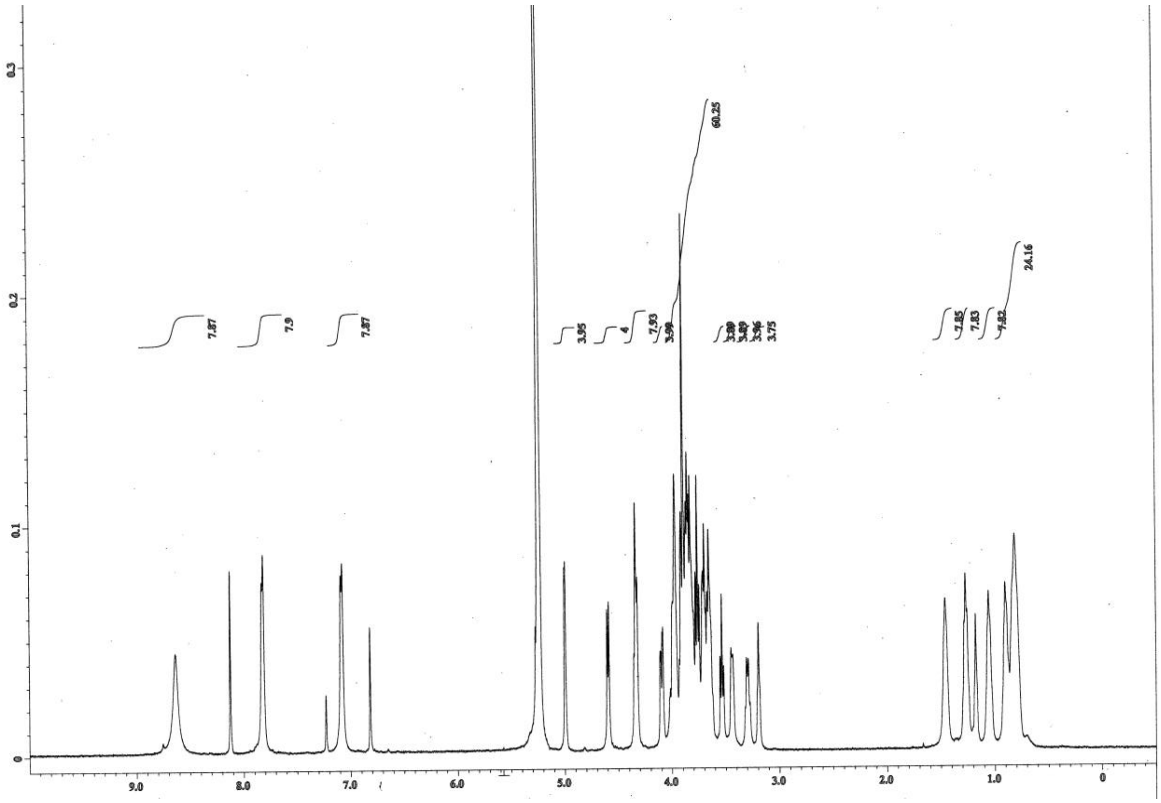


Fig. S32 ^{1}H-NMR spectrum of compound **8**.

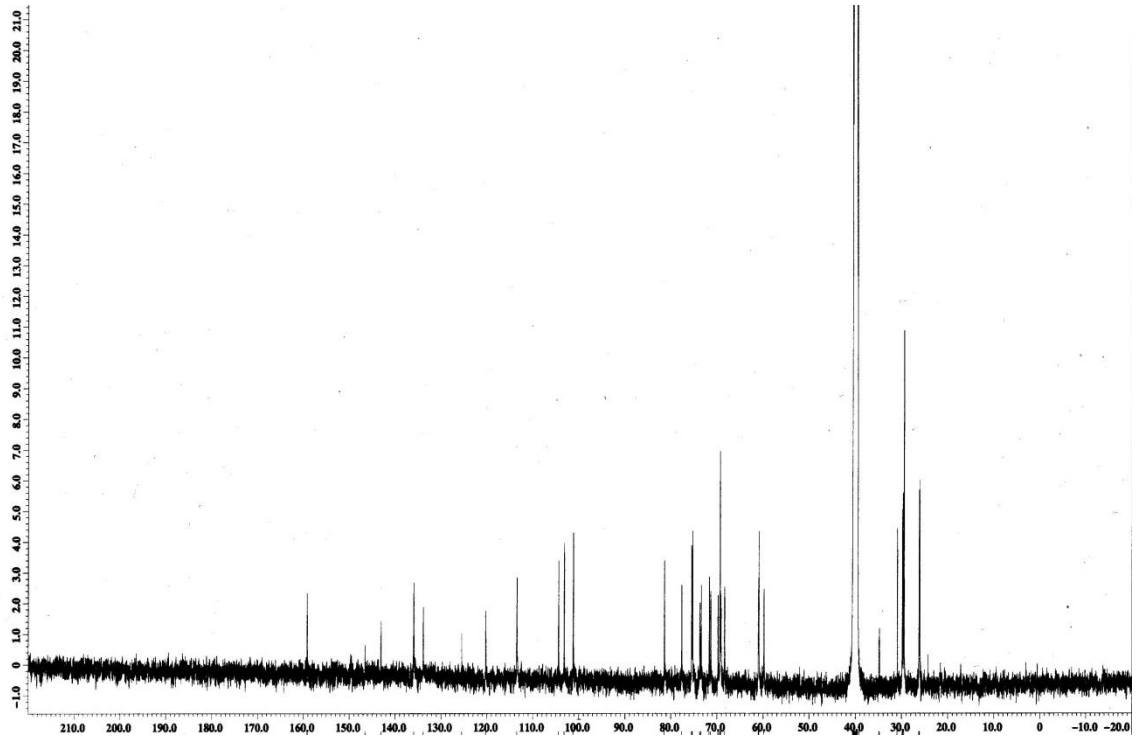


Fig. S33 ^{13}C-NMR spectrum of compound **8**.