Electronic Supplementary Material (ESI) for RSC Advances.

Novel cathepsin K inhibitors block osteoclasts *in vitro* and increase spinal bone density in zebrafish

Si-tu Xue, † Ya-li Wang,† Xiao-wan Han, Hong Yi, Wei Jiang, Shu-yi Si, Hui-fang Guo* and Zhuo-rong Li*

Institute of Medicinal Biotechnology, Chinese Academy of Medical Science and Peking Union Medical College, Beijing 100050, China

* Corresponding authors.

E-Mail addresses: l-z-r@263.net (Z. R. Li); guohuifang@imb.pumc.edu.cn (H. F. Guo).

Table of content

1. The characterization data for the compounds A1 to A61 ----------Page S2
2. The ^{1}H NMR, ^{13}C NMR spectra and HRMS of compounds A1 to A61----------Page S15

1. The characterization data for the compounds A1 to A61 are listed below.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(3-chloropyridin-2-yl)prop-2-en-1-one (**A1**): Yellow solid (Yield: 59%). m.p.: 257.8–259.6 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.57 (s, 1H), 8.69 (d, *J* = 3.8 Hz, 1H), 8.63 (d, *J* = 15.5 Hz, 1H), 8.21 (d, *J* = 15.5 Hz, 1H), 8.04 (d, *J* = 7.6 Hz, 1H), 7.74 (s, 2H), 7.54–7.51 (m, 1H), 7.39–7.36 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.39, 149.29, 149.12, 149.10, 138.71, 136.66, 132.95, 127.99, 127.10; HRMS calcd for $C_{15}H_{11}ON_3Cl^+$ $[M + H]^+$ 284.05852, found 284.05852.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(4-chloropyridin-2-yl)prop-2-en-1-one (**A2**): Yellow solid (Yield: 46%). m.p.: 218.3–219.7 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.70 (d, *J* = 5.2 Hz, 1H), 8.59 (d, *J* = 15.7 Hz, 1H), 8.04 (d, *J* = 1.6 Hz, 1H), 7.92 (d, *J* = 15.7 Hz, 1H), 7.75–7.73 (m, 2H), 7.62 (d, J_1 = 5.2 Hz, J_2 = 1.8 Hz, 1H), 7.37–7.35 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.76, 154.77, 151.92, 144.32, 141.46, 127.07, 126.18, 125.27, 124.89; HRMS calcd for $C_{15}H_{11}ON_3Cl^+$ $[M + H]^+$ 284.05852, found 284.05849.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(5-chloropyridin-2-yl)prop-2-en-1-one (**A3**): Yellow solid (Yield: 54%). m.p.: 238.6–240.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.51 (s, 1H), 8.75 (s, 1H), 8.49 (dd, J_1 = 15.7 Hz, J_2 = 1.0 Hz, 1H), 8.03 (d, *J* = 1.9 Hz, 1H), 7.95–7.89 (m, 2H), 7.73 (s, 2H), 7.37 (d, *J* = 2.5 Hz, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.53, 151.40, 149.33, 141.68, 137.43, 132.64, 127.35, 126.03; HRMS calcd for $C_{15}H_{11}ON_3Cl^+$ $[M + H]^+$ 284.05852, found 284.05833.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(6-chloropyridin-2-yl)prop-2-en-1-one (**A4**): Yellow solid (Yield: 51%). m.p.: 212.0–213.6 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.50 (s, 1H), 8.47 (d, *J* = 15.7 Hz, 1H), 7.97 (d, *J* = 7.4 Hz, 1H), 7.92–7.84 (m, 2H), 7.75 (s, 2H), 7.59 (d, *J* = 7.6 Hz, 1H), 7.39 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.44, 153.57, 151.18, 149.33, 141.48, 141.14, 126.52, 126.17, 125.71; HRMS calcd for $C_{15}H_{11}ON_3Cl^+$ $[M + H]^+$ 284.05852, found 284.05859.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(3-methylpyridin-2-yl)prop-2-en-1-one (**A5**): Yellow solid

(Yield: 50%). m.p.: 213.8–215.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.48 (s, 1H), 8.62 (d, *J* = 15.4 Hz, 1H), 8.57 (d, *J* = 4 Hz, 1H), 8.13 (d, *J* = 15.4 Hz, 1H), 7.75–7.71 (m, 3H), 7.39–7.36 (m, 3H), 2.51 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.85, 150.71, 149.78, 148.09, 139.37, 139.20, 134.79, 126.26, 125.53, 124.91, 18.47; HRMS calcd for $C_{16}H_{14}ON_3^+$ $[M + H]^+$ 264.11314, found 264.11305.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(6-methylpyridin-2-yl)prop-2-en-1-one (**A6**): Yellow solid (Yield: 44%). m.p.: 245.1–246.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.53 (s, 1H), 8.49 (d, *J* = 15.7 Hz, 1H), 7.94–7.90 (m, 2H), 7.79 (t, *J* = 7.6 Hz, 1H), 7.64–7.59 (m, 2H), 7.42 (t, *J* = 7.8 Hz, 1H), 7.34 (t, *J* = 7.7 Hz, 2H), 2.58 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.74, 159.15, 152.04, 149.43, 143.43, 137.96, 125.30, 124.95, 123.98, 121.75, 113.37; HRMS calcd for $C_{16}H_{14}ON_3^+$ $[M + H]^+$ 264.11314, found 264.11306.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(5-bromopyridin-2-yl)prop-2-en-1-one (**A7**): Yellow solid (Yield: 52%). m.p.: 239.4–241.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.84 (s, 1H), 8.55 (d, *J* = 15.8 Hz, 1H), 8.17 (d, *J* = 7.9 Hz, 1H), 7.90 (d, *J* = 15.8 Hz, 1H), 7.83 (d, J = 8.2 Hz, 1H), 7.74–7.72 (m, 2H), 7.35–7.33 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.93, 151.78, 151.46, 141.42, 140.35, 127.66, 126.48, 124.64, 122.01; HRMS calcd for $C_{15}H_{11}ON_3Br^+$ $[M + H]^+$ 328.00800, found 328.00802.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(6-bromopyridin-2-yl)prop-2-en-1-one (**A8**): Yellow solid (Yield: 51%). m.p.: 223.5–225.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.58 (s, 1H), 8.45 (d, *J* = 15.7 Hz, 1H), 7.90 (d, *J* = 2.5 Hz, 1H), 7.88 (d, *J* = 2.4 Hz, 2H), 7.87 (d, *J* = 1.6 Hz, 1H), 7.72 (dd, J_1 = 6.4 Hz, J_2 = 2.4 Hz, 2H), 7.39 (d, *J* = 2.8 Hz, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.39, 154.14, 149.25, 142.40, 141.14, 141.13, 129.86, 126.47, 126.04; HRMS calcd for $C_{15}H_{11}ON_3Br^+$ $[M + H]^+$ 328.00800, found 328.00801.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(3-fluoropyridin-2-yl)prop-2-en-1-one (**A9**): Yellow solid (Yield: 59%). m.p.: 226.7–228.6 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.56 (s, 1H), 8.59 (d, *J* = 4.4 Hz, 1H), 8.56 (d, *J* = 15.8 Hz, 1H), 8.02 (d, *J* = 15.8 Hz, 1H), 7.86 (t, *J* = 9.2 Hz, 1H), 7.74 (s, 2H), 7.62–7.57 (m, 1H), 7.39–7.36 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.35, 160.19, 157.58, 149.28, 146.93, 140.86, 140.75, 134.35, 127.86, 126.87,

125.14, 124.95; HRMS calcd for $C_{15}H_{11}ON_3F^+$ $[M + H]^+$ 268.08807, found 268.08798.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(6-methoxypyridin-2-yl)prop-2-en-1-one (**A10**): Yellow solid (Yield: 78%). m.p.: 184.4–185.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.52 (s, 1H), 8.42 (d, *J* = 15.6 Hz, 1H), 7.92 (d, *J* = 15.6 Hz, 2H), 7.80 (t, *J* = 7.4 Hz, 1H), 7.60 (s, 1H), 7.43 (d, *J* = 7.1 Hz, 1H), 7.38 (s, 2H), 6.92 (d, *J* = 8.3 Hz, 1H), 3.99 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.78, 163.77, 150.40, 149.37, 143.21, 140.46, 124.84, 120.86, 113.81, 53.51; HRMS calcd for $C_{16}H_{14}O_2N_3^+$ $[M + H]^+$ 280.10805, found 280.10801.

(*E*)-2-(3-(1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A11**): Yellow solid (Yield: 41%). m.p.: 255.1–257.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.74 (d, *J* = 4.2 Hz, 1H), 8.53 (d, *J* = 15.8 Hz, 1H), 7.96 (d, *J* = 15.7 Hz, 1H), 7.92 (d, J_1 = 7.6 Hz, J_2 = 1.8 Hz, 1H), 7.87 (d, J_1 = 7.7 Hz, 1H), 7.75 (s, 2H), 7.50–7.46 (m, 1H), 7.41–7.36 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.66, 152.72, 150.61, 149.35, 143.09, 137.97, 126.40, 125.68, 125.51; HRMS calcd for $C_{17}H_{12}ON_3^+$ $[M + H]^+$ 274.09749, found 274.09724.

(*E*)-3-(3-(1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A12**): Yellow solid (Yield: 50%). m.p.: 257.5–259.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.54 (s, 1H), 8.37 (s, 1H), 8.21 (d, *J* = 15.0 Hz, 2H), 7.98–7.86 (m, 3H), 7.66 (s, 1H), 7.59 (d, *J* = 6.6 Hz, 1H), 7.41 (s, 1H), 7.34 (d, *J* = 6.0 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.34, 149.22, 143.52, 142.23, 136.03, 135.32, 134.42, 133.48, 133.06, 130.67, 126.39, 124.25, 123.73, 121.66, 118.78, 113.41, 112.78; HRMS calcd for $C_{17}H_{12}ON_3^+$ $[M + H]^+$ 274.09749, found 274.09733.

(*E*)-4-(3-(1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A13**): Yellow solid (Yield: 43%). m.p.: 257.5–259.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.22 (d, *J* = 16.2 Hz, 1H), 8.05 (d, *J* = 8.2 Hz, 2H), 7.98 (d, *J* = 16.2 Hz, 1H), 7.91 (d, *J* = 8.2 Hz, 2H), 7.74 (s, 2H), 7.39–7.37 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.22, 149.16, 142.38, 139.21, 133.32, 129.93, 125.15, 119.00, 113.14; HRMS calcd for $C_{17}H_{12}ON_3^+$ $[M + H]^+$ 274.09749, found 274.09724.

(*E*)-1-(5-methyl-1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A14**): Yellow

solid (Yield: 46%). m.p.: 243.1–244.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.40 (s, 1H), 8.73 (d, *J* = 4.2 Hz, 1H), 8.50 (d, *J* = 15.8 Hz, 1H), 7.95–7.89 (m, 2H), 7.84 (d, *J* = 7.6 Hz, 1H), 7.76–7.65 (m, 1H), 7.48–7.37 (m, 2H), 7.17 (s, 1H), 2.45 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.55, 152.86, 150.71, 142.96, 137.79, 126.32, 125.57, 125.48, 121.35, 112.69, 22.01; HRMS calcd for $C_{16}H_{14}ON_3^+$ $[M + H]^+$ 264.11314, found 264.11320.

(*E*)-2-(3-(5-methyl-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A15**): Yellow solid (Yield: 42%). m.p.: 240.2–240.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.58 (d, *J* = 2.1 Hz, 1H), 8.26 (d, *J* = 16.1 Hz, 1H), 7.99 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.83 (d, *J* = 16.1 Hz, 1H), 7.72 (d, *J* = 9.0 Hz, 1H), 7.67 (s, 1H), 7.61 (d, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.6 Hz, 1H), 7.29 (d, *J* = 7.6 Hz, 1H), 2.39 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 184.78, 143.09, 142.05, 138.83, 135.14, 131.85, 129.45, 129.26, 126.62, 123.79, 118.33, 116.86, 115.99, 21.32; HRMS calcd for $C_{18}H_{14}ON_3^+$ $[M + H]^+$ 288.11314, found 288.11313.

(*E*)-3-(3-(5-methyl-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A16**): Yellow solid (Yield: 44%). m.p.: 261.3–271.1 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.40 (s, 1H), 8.37 (s, 1H), 8.19 (t, *J* = 7.2 Hz, 2H), 7.96–7.91 (m, 2H), 7.69 (s, 1H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.40–7.36 (m, 1H), 7.20 (s, 1H), 2.45 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.19, 149.01, 141.98, 136.07, 134.39, 133.46, 133.04, 130.69, 124.30, 118.80, 112.77, 21.93; HRMS calcd for $C_{18}H_{14}ON_3^+$ $[M + H]^+$ 288.11314, found 288.11337.

(*E*)-4-(3-(5-methyl-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A17**): Yellow solid (Yield: 59%). m.p.: 238.4–239.4 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.41 (s, 1H), 8.20 (d, *J* = 16.1 Hz, 1H), 8.05 (d, *J* = 8.1 Hz, 2H), 7.96 (d, *J* = 16.2 Hz, 1H), 7.92 (d, *J* = 8.1 Hz, 2H), 7.72–7.60 (m, 1H), 7.38 (s, 1H), 7.20 (s, 1H), 2.45 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.10, 148.99, 142.12, 139.27, 133.32, 129.90, 125.21, 119.02, 113.08, 21.93; HRMS calcd for $C_{18}H_{14}ON_3^+$ $[M + H]^+$ 288.11314, found 288.11310.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A18**): Yellow solid (Yield: 72%). m.p.: 252.3–254.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.73 (d, *J* = 4.1

Hz, 1H), 8.49 (d, *J* = 15.8 Hz, 1H), 7.95–7.89 (m, 2H), 7.83 (d, *J* = 7.6 Hz, 1H), 7.76 (s, 2H), 7.73 (d, *J* = 8.8 Hz, 1H), 7.46 (t, *J* = 5.3 Hz, 1H), 7.35 (d, *J* = 8.5 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.83, 152.80, 151.18, 150.72, 143.23, 137.80, 128.99, 126.38, 125.61, 125.47, 125.09; HRMS calcd for $C_{15}H_{11}ON_3Cl^+$ $[M + H]^+$ 284.05852, found 284.05843.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-chloropyridin-2-yl)prop-2-en-1-one (**A19**): Yellow solid (Yield: 52%). m.p.: 260.5–262.1 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.59 (d, *J* = 2.2 Hz, 1H), 8.21 (d, *J* = 16.2 Hz, 1H), 8.08–8.06 (m, 2H), 7.89 (s, 1H), 7.85 (d, *J* = 5.6 Hz, 1H), 7.77 (d, *J* = 9.0 Hz, 1H), 7.66 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 183.27, 142.13, 137.49, 133.73, 131.71, 131.61, 127.98, 124.64, 122.88, 118.17, 117.82, 115.80; HRMS calcd for $C_{15}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 318.01954, found 318.01957.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(4-chloropyridin-2-yl)prop-2-en-1-one (**A20**): Yellow solid (Yield: 44%). m.p.: 208.9–209.7 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.69 (d, *J* = 4.4 Hz, 1H), 8.66 (d, *J* = 6.0 Hz, 1H), 7.80 (s, 1H), 7.80 (d, *J* = 15.8 Hz, 1H), 7.67–7.64 (m, 2H), 7.59 (d, *J* = 4.8 Hz, 1H), 7.16 (d, *J* = 8.7 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 183.72, 155.26, 151.83, 144.24, 139.91, 128.76, 126.94, 125.69, 124.91, 122.96, 119.96, 117.76; HRMS calcd for $C_{15}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 318.01954, found 318.01938.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(5-chloropyridin-2-yl)prop-2-en-1-one (**A21**): Yellow solid (Yield: 38%). m.p.: 239.2–240.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.68 (s, 1H), 8.78 (s, 1H), 8.47 (d, *J* = 15.7 Hz, 1H), 8.07 (d, *J* = 8.3 Hz, 1H), 7.95 (d, *J* = 15.7 Hz, 1H), 7.90 (d, *J* = 8.3 Hz, 1H), 7.78–7.49 (m, 2H), 7.40 (d, *J* = 8.7 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.43, 151.32, 149.42, 142.00, 137.52, 132.74, 127.53, 125.83; HRMS calcd for $C_{15}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 318.01954, found 318.01933.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-methylpyridin-2-yl)prop-2-en-1-one (**A23**): Yellow solid (Yield: 56%). m.p.: 253.8–254.6 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.66 (s, 1H), 8.55 (d, *J* = 15.5 Hz, 2H), 8.13 (d, *J* = 15.3 Hz, 1H), 7.72 (d, *J* = 7.6 Hz, 3H), 7.39 (d, *J* = 7.8 Hz, 2H), 2.51 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.57, 150.56, 150.53, 148.13, 139.65, 139.41, 134.94, 125.77, 125.65, 18.45; HRMS calcd for $C_{16}H_{13}ON_3Cl^+$

$[M + H]^+$ 298.07417, found 298.07397.

(*E*)-3-(5-bromopyridin-2-yl)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A24**): Yellow solid (Yield: 56%). m.p.: 277.4–278.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.82 (d, J = 2.0 Hz, 1H), 8.76 (d, J = 15.9 Hz, 1H), 8.14 (dd, J_1 = 8.3 Hz, J_2 = 2.1 Hz, 1H), 7.80 (d, J = 8.4 Hz, 1H), 7.69 (d, J = 15.9 Hz, 1H), 7.58–7.56 (m, 2H), 7.16 (dd, J_1 = 8.7 Hz, J_2 = 1.2 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 185.92, 161.22, 152.75, 151.23, 148.38, 146.38, 140.18, 138.41, 129.72, 126.68, 124.83, 121.14, 120.75, 120.73, 118.49; HRMS calcd for $C_{15}H_{10}ON_3BrCl^+$ $[M + H]^+$ 361.96903, found 361.96991.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-fluoropyridin-2-yl)prop-2-en-1-one (**A25**): Yellow solid (Yield: 58%). m.p.: 241.3–242.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.84 (d, J = 15.9 Hz, 1H), 8.58 (d, J = 4.2 Hz, 1H), 7.87–7.81 (m, 2H), 7.58–7.54 (m, 3H), 7.47 (dd, J_1 = 8.6 Hz, J_2 = 1.7 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 185.49, 160.99, 159.79, 157.20, 148.25, 146.72, 146.25, 141.94, 141.83, 130.73, 130.71, 126.87, 124.87, 124.70, 120.80, 120.70, 118.45; HRMS calcd for $C_{15}H_{10}ON_3ClF^+$ $[M + H]^+$ 302.04909, found 302.04919.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(6-methoxypyridin-2-yl)prop-2-en-1-one (**A26**): Yellow solid (Yield: 48%). m.p.: 265.4–266.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.66 (s, 1H), 8.35 (d, J = 15.5 Hz, 1H), 7.91 (d, J = 15.5 Hz, 1H), 7.83–7.77 (m, 3H), 7.43 (d, J = 6.9 Hz, 1H), 7.38 (d, J = 8.4 Hz, 1H), 6.93 (d, J = 8.1 Hz, 1H), 3.99 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.62, 163.76, 150.40, 150.29, 143.55, 140.49, 124.58, 120.99, 113.91, 53.51; HRMS calcd for $C_{16}H_{13}O_2N_3Cl^+$ $[M + H]^+$ 314.06908, found 314.06870.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(2-chlorophenyl)prop-2-en-1-one (**A27**): Yellow solid (Yield: 56%). m.p.: 275.4–277.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.71 (s, 1H), 8.26 (d, J = 16.0 Hz, 1H), 8.13–8.19 (m, 2H), 7.88 (s, 1H), 7.61 (d, J = 7.7 Hz, 2H), 7.54–7.46 (m, 2H), 7.40 (d, J = 6.4 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.05, 139.57, 135.12, 133.00, 132.29, 130.70, 128.98, 128.49, 124.53; HRMS calcd for $C_{16}H_{11}ON_2Cl_2^+$ $[M + H]^+$ 317.02429, found 317.02400.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-chlorophenyl)prop-2-en-1-one (**A28**): Yellow solid (Yield: 65%). m.p.: 226.5–228.7 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.09 (d, *J* = 16.2 Hz, 1H), 7.92 (m, 2H), 7.82 (d, *J* = 6.8 Hz, 1H), 7.73 (d, *J* = 9.1 Hz, 2H), 7.50 (d, *J* = 10.0 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.29, 150.71, 143.09, 136.94, 134.35, 131.32, 131.06, 128.99, 127.73, 125.20, 123.44; HRMS calcd for $C_{16}H_{11}ON_2Cl_2^+$ $[M + H]^+$ 317.02429, found 317.02400.

(*E*)-3-(3-bromophenyl)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A29**): Yellow solid (Yield: 70%). m.p.: 220.3–221.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.65 (s, 1H), 8.08 (d, *J* = 15.6 Hz, 2H), 7.94–7.86 (m, 2H), 7.73 (d, *J* = 9.2 Hz, 2H), 7.67 (d, *J* = 7.8 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 1H), 7.38 (d, *J* = 8.6 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.14, 150.37, 143.19, 137.16, 134.01, 131.88, 131.60, 128.13, 123.30, 122.89; HRMS calcd for $C_{16}H_{11}ON_2Br^+$ $[M + H]^+$ 360.97378, found 360.97382.

(*E*)-1-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-methoxyphenyl)prop-2-en-1-one (**A30**): Yellow solid (Yield: 62%). m.p.: 216.7–217.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.61 (s, 1H), 8.06 (d, *J* = 16.1 Hz, 1H), 7.95 (d, *J* = 16.1 Hz, 1H), 7.75 (d, *J* = 10.4 Hz, 2H), 7.43–7.37 (m, 4H), 7.07 (d, *J* = 7.2 Hz, 1H), 3.84 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.36, 160.17, 150.64, 145.07, 136.11, 130.63, 122.13, 121.90, 117.84, 114.02, 55.76; HRMS calcd for $C_{17}H_{14}O_2N_2Cl^+$ $[M + H]^+$ 313.07383, found 313.07373.

(*E*)-2-(3-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A31**): Yellow solid (Yield: 37%). m.p.: 308.6–309.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.71 (d, *J* = 5.2 Hz, 1H), 8.59 (d, *J* = 15.8 Hz, 1H), 8.06 (d, *J* = 1.9 Hz, 1H), 7.94 (d, *J* = 15.7 Hz, 1H), 7.74 (s, 2H), 7.63 (d, J_1 = 5.2 Hz, J_2 = 2.0 Hz, 1H), 7.39–7.37 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.67, 154.74, 151.94, 149.58, 144.34, 141.59, 126.96, 126.24, 125.32; HRMS calcd for $C_{17}H_{11}ON_3Cl^+$ $[M + H]^+$ 308.05852, found 308.05824.

(*E*)-3-(3-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A32**): Yellow solid (Yield: 40%). m.p.: 241.2–242.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.67 (s, 1H), 8.39 (s, 1H), 8.21 (d, *J* = 7.9 Hz, 1H), 8.17 (d, *J* = 16.2 Hz, 1H), 7.97 (d, *J* = 16.2 Hz, 1H), 7.93 (d, *J* = 7.6 Hz, 2H), 7.68 (t, 1H), 7.59 (s, *J* = 7.8 Hz, 1H), 7.38 (s, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.19, 142.65, 135.94, 134.54, 133.54, 133.13, 130.72, 124.01,

118.77, 112.79; HRMS calcd for $C_{17}H_{11}ON_3Cl^+$ $[M + H]^+$ 308.05852, found 308.05917.

(*E*)-4-(3-(5-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A33**): Yellow solid (Yield: 46%). m.p.: 279.6–280.4 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.57 (s, 1H), 8.47 (d, *J* = 16.2 Hz, 1H), 8.01 (d, *J* = 7.9 Hz, 2H), 7.93–7.89 (m, 3H), 7.83 (d, *J* = 16.2 Hz, 1H), 7.68 (d, *J* = 8.9 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 185.89, 164.51, 152.62, 146.19, 141.30, 140.03, 139.75, 133.31, 129.57, 128.10, 119.14, 119.11, 116.41, 115.72, 112.49; HRMS calcd for $C_{17}H_{11}ON_3$ Cl^+ $[M + H]^+$ 308.05852, found 308.05812.

(*E*)-3-(3-(4-chloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A34**): Yellow solid (Yield: 37%). m.p.: 252.4–253.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.85 (s, 1H), 8.40 (s, 1H), 8.22 (d, *J* = 7.8 Hz, 1H), 8.17 (d, *J* = 16.1 Hz, 1H), 7.99 (d, *J* = 16.1 Hz, 1H), 7.94 (d, *J* = 7.7 Hz, 1H), 7.71–7.67 (m, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.43–7.39 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.16, 142.77, 135.91, 134.58, 133.59, 133.16, 131.33, 130.73, 123.98, 118.78, 112.79; HRMS calcd for $C_{17}H_{11}ON_3Cl^+$ $[M + H]^+$ 308.05852, found 308.05833.

(*E*)-1-(5,6-dichloro-1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A35**): Yellow solid (Yield: 37%). m.p.: 290.1–292.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.72 (d, *J* = 7.1 Hz, 1H), 8.70 (d, *J* = 4.1 Hz, 1H), 7.88 (t, *J* = 7.7 Hz, 1H), 7.80 (d, *J* = 9.9 Hz, 3H), 7.74 (d, *J* = 15.9 Hz, 1H), 7.44–7.41 (m, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 186.05, 162.12, 153.75, 150.54, 146.91, 140.28, 137.66, 128.62, 125.30, 124.90, 122.32, 120.03; HRMS calcd for $C_{15}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 318.01954, found 318.01932.

(*E*)-3-(3-(5,6-dichloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A36**): Yellow solid (Yield: 47%). m.p.: 228.6–229.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.34 (d, *J* = 16.3 Hz, 1H), 8.31 (s, 1H), 8.17 (d, *J* = 7.9 Hz, 1H), 7.90 (d, *J* = 7.6 Hz, 1H), 7.83–7.79 (m, 3H), 7.67 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 184.39, 159.25, 144.86, 139.90, 136.61, 133.89, 133.06, 132.76, 130.66, 126.49, 123.61, 119.66, 118.88, 112.70; HRMS calcd for $C_{17}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 342.01954, found 342.01939.

(*E*)-4-(3-(5,6-dichloro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A37**): Yellow solid (Yield: 55%). m.p.: 264.3–266.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.56 (d, *J* = 2.2 Hz, 1H), 8.24 (d, *J* = 16.0 Hz, 1H), 8.13 (d, *J* = 16.0 Hz, 1H), 8.05 (dd, J_1 = 7.9 Hz, J_2 = 1.5 Hz, 1H), 8.03 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.78–7.73 (m, 2H), 7.52 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 183.71, 140.66, 134.43, 133.88, 132.71, 128.97, 128.84, 126.48, 125.90, 115.96; HRMS calcd for $C_{17}H_{10}ON_3Cl_2^+$ $[M + H]^+$ 342.01954, found 342.01939.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A38**): Yellow solid (Yield: 71%). m.p.: 245.8–247.3 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.43 (s, 1H), 8.74 (d, *J* = 4.4 Hz, 1H), 8.48 (d, *J* = 15.7 Hz, 1H), 7.98–7.84 (m, 3H), 7.85 (d, *J* = 7.6 Hz, 1H), 7.70 (d, *J* = 8.6 Hz, 1H), 7.51–7.46 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.59, 152.71, 150.75, 150.30, 143.53, 137.84, 126.52, 125.71, 125.21; HRMS calcd for $C_{15}H_{11}ON_3Br^+$ $[M + H]^+$ 328.00800, found 328.00796.

(*E*)-1-(1*H*-benzo[*d*]imidazol-2-yl)-3-(3-chlorophenyl)prop-2-en-1-one (**A39**): Yellow solid (Yield: 68%). m.p.: 224.6–225.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.66 (s, 1H), 8.10 (d, *J* = 16.1 Hz, 1H), 7.97–7.93 (m, 2H), 7.91 (s, 1H), 7.85 (d, *J* = 7.2 Hz, 1H), 7.69 (d, *J* = 8.4 Hz, 1H), 7.56–7.49 (m, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.23, 150.19, 143.33, 136.92, 134.36, 131.38, 131.15, 129.07, 127.79, 123.37; HRMS calcd for $C_{16}H_{11}ON_2BrCl^+$ $[M + H]^+$ 360.97378, found 360.97351.

(*E*)-3-(3-(1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A40**): Yellow solid (Yield: 43%). m.p.: 263.4–265.4 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.65 (s, 1H), 8.36 (s, 1H), 8.19–8.12 (m, 2H), 7.97–7.91 (m, 2H), 7.67 (d, *J* = 6.0 Hz, 2H), 7.51 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.16, 142.61, 135.91, 134.51, 133.51, 133.10, 130.69, 123.98, 118.76, 112.79; HRMS calcd for $C_{17}H_{11}ON_3Br^+$ $[M + H]^+$ 352.00800, found 352.00754.

(*E*)-4-(3-(1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A41**): Yellow solid (Yield: 34%). m.p.: 271.3–273.0 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 13.67 (s, 1H), 8.16 (d, *J* = 16.2 Hz, 1H), 8.08–8.04 (m, 3H), 7.99 (d, *J* = 16.2 Hz, 1H), 7.92 (d, *J* = 8.1 Hz,

2H), 7.87–7.73 (m, 1H), 7.54 (s, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.12, 142.79, 139.12, 133.34, 129.97, 124.91, 118.99, 115.92, 113.24; HRMS calcd for $C_{17}H_{11}ON_3Br^+$ $[M + H]^+$ 352.00800, found 352.00876.

(*E*)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A42**): Yellow solid (Yield: 77%). m.p.: 265.7–267.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.74 (d, *J* = 15.8 Hz, 1H), 8.72 (s, 1H), 8.57 (d, *J* = 2.3 Hz, 1H), 7.91–7.87 (m, 2H), 7.82 (d, *J* = 7.8 Hz, 1H), 7.78 (d, *J* = 15.8 Hz, 1H), 7.67 (d, *J* = 8.9 Hz, 1H), 7.45–7.42 (m, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 186.51, 16.79, 153.65, 152.72, 150.57, 146.24, 141.22, 140.76, 137.69, 128.46, 125.48, 125.01, 119.09, 116.43, 115.65; HRMS calcd for $C_{15}H_{11}O_3N_4^+$ $[M + H]^+$ 295.08257, found 295.08282.

(*E*)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)-3-phenylprop-2-en-1-one (**A43**): Yellow solid (Yield: 47%). m.p.: 257.8–259.1 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 14.06 (s, 1H), 8.58 (s, 1H), 8.19 (dd, J_1 = 9.0 Hz, J_2 = 2.2 Hz, 1H), 8.00 (s, 2H), 7.86–7.81 (m, 3H), 7.51–7.48 (m, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.12, 152.88, 145.79, 134.54, 131.85, 129.62, 129.52, 121.43; HRMS calcd for $C_{16}H_{12}O_3N_3^+$ $[M + H]^+$ 294.08732, found 294.08749.

(*E*)-3-(2-chlorophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A44**): Yellow solid (Yield: 44%). m.p.: 238.1–239.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.59 (d, *J* = 2.2 Hz, 1H), 8.21 (s, 2H), 8.11–7.08 (m, 2H), 7.78 (d, *J* = 9.0 Hz, 1H), 7.62–7.59 (m, 1H), 7.54–7.46 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 182.78, 143.22, 138.69, 134.99, 132.74, 132.56, 130.66, 128.83, 128.46, 125.68, 118.52, 117.67, 115.76; HRMS calcd for $C_{16}H_{11}O_3N_3Cl^+$ $[M + H]^+$ 328.04835, found 328.04804.

(*E*)-3-(3-chlorophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A45**): Yellow solid (Yield: 90%). m.p.: 200.7–202.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.58 (d, *J* = 2.1 Hz, 1H), 8.30 (d, *J* = 16.2 Hz, 1H), 7.98 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.91 (s, 1H), 7.85–7.81 (m, 2H), 7.72 (d, *J* = 9.0 Hz, 1H), 7.52–7.51 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 184.73, 142.07, 141.19, 137.49, 134.30, 131.33, 130.58, 128.73, 127.45, 125.57, 118.46, 116.85, 116.08; HRMS calcd for $C_{16}H_{11}O_3N_3Cl^+$ $[M + H]^+$ 328.04835, found 328.04823.

(*E*)-3-(4-chlorophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A46**): Yellow solid (Yield: 59%). m.p.: 223.6–225.1 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.55 (s, 1H), 8.37 (d, *J* = 16.1 Hz, 1H), 7.90–7.86 (m, 3H), 7.79 (d, *J* = 16.1 Hz, 1H), 7.66 (d, *J* = 8.8 Hz, 1H), 7.54 (d, *J* = 7.6 Hz, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 186.03, 164.73, 152.68, 146.19, 141.16, 140.37, 135.20, 134.43, 130.64, 129.56, 125.68, 118.98, 116.30, 115.59; HRMS calcd for $C_{16}H_{11}O_3N_3Cl^+$ $[M + H]^+$ 328.04835, found 328.04739.

(*E*)-3-(2-bromophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A47**): Yellow solid (Yield: 55%). m.p.: 235.5–236.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.56 (d, *J* = 2.2 Hz, 1H), 8.24 (d, *J* = 16.0 Hz, 1H), 8.13 (d, *J* = 16.0 Hz, 1H), 8.05 (dd, J_1 = 7.9 Hz, J_2 = 1.5 Hz, 1H), 8.03 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.78–7.73 (m, 2H), 7.52 (t, *J* = 7.2 Hz, 1H), 7.44–7.39 (m, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 183.71, 142.56, 140.66, 134.43, 133.88, 132.71, 128.97, 128.84, 126.48, 125.90, 118.12, 117.58, 115.96; HRMS calcd for $C_{16}H_{11}O_3N_3Br^+$ $[M + H]^+$ 371.99783, found 371.99769.

(*E*)-3-(3-bromophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A48**): Yellow solid (Yield: 79%). m.p.: 220.3–221.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.59 (d, *J* = 2.2 Hz, 1H), 8.21 (d, *J* = 16.2 Hz, 1H), 8.08–8.06 (m, 2H), 7.89 (s, 1H), 7.85 (d, *J* = 5.6 Hz, 1H), 7.77 (d, *J* = 9.0 Hz, 1H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 183.27, 142.96, 142.13, 137.49, 133.73, 131.71, 131.61, 127.98, 124.64, 122.88, 118.17, 117.82, 115.80; HRMS calcd for $C_{16}H_{11}O_3N_3Br^+$ $[M + H]^+$ 371.99783, found 371.99751.

(*E*)-3-(4-bromophenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A49**): Yellow solid (Yield: 71%). m.p.: 232.1–234.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.55 (d, *J* = 2.2 Hz, 1H), 8.38 (d, *J* = 16.1 Hz, 1H), 7.89 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.81–7.74 (m, 3H), 7.69 (s, 1H), 7.67–7.65 (m, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 186.01, 164.75, 152.70, 146.20, 141.14, 140.41, 134.76, 132.48, 130.85, 125.75, 124.02, 118.97, 116.29, 115.57; HRMS calcd for $C_{16}H_{11}O_3N_3Br^+$ $[M + H]^+$ 371.99783, found 371.99698.

(*E*)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)-3-(m-tolyl)prop-2-en-1-one (**A50**): Yellow solid

(Yield: 68%). m.p.: 201.5–203.0 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.58 (d, *J* = 2.1 Hz, 1H), 8.26 (d, *J* = 16.1 Hz, 1H), 7.99 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.83 (d, *J* = 16.1 Hz, 1H), 7.72 (d, *J* = 9.0 Hz, 1H), 7.67 (s, 1H), 7.61 (d, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.6 Hz, 1H), 7.29 (d, *J* = 7.6 Hz, 1H), 2.39 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 184.78, 143.09, 142.05, 138.83, 135.14, 131.85, 129.45, 129.26, 126.62, 123.79, 118.33, 116.86, 115.99, 21.32; HRMS calcd for $C_{17}H_{14}O_3N_3^+$ [M + H]$^+$ 308.10297, found 308.10292.

(*E*)-3-(3-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)-3-oxoprop-1-en-1-yl)benzonitrile (**A51**): Yellow solid (Yield: 42%). m.p.: 235.3–236.7 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.55 (d, *J* = 2.0 Hz, 1H), 8.45 (d, *J* = 16.2 Hz, 1H), 8.33 (s, 1H), 8.19 (d, *J* = 7.9 Hz, 1H), 7.89 (d, *J* = 8.7 Hz, 2H), 7.81 (d, *J* = 16.2 Hz, 1H), 7.68 (t, *J* = 8.3 Hz, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 185.97, 164.59, 152.66, 146.20, 141.22, 139.48, 136.79, 133.79, 133.02, 132.71, 130.66, 127.20, 119.03, 118.91, 116.34, 115.65, 112.70; HRMS calcd for $C_{17}H_{11}O_3N_4^+$ [M + H]$^+$ 319.08257, found 319.08203.

(*E*)-3-(3-methoxyphenyl)-1-(5-nitro-1*H*-benzo[*d*]imidazol-2-yl)prop-2-en-1-one (**A52**): Yellow solid (Yield: 50%). m.p.: 218.7–212.0 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.59 (d, *J* = 2.1 Hz, 1H), 8.26 (d, *J* = 16.1 Hz, 1H), 7.99 (dd, J_1 = 9.0 Hz, J_2 = 2.3 Hz, 1H), 7.85 (d, *J* = 16.1 Hz, 1H), 7.72 (d, *J* = 9.0 Hz, 1H), 7.42–7.38 (m, 3H), 7.06–7.04 (m, 1H), 3.85 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 184.84, 160.17, 143.08, 142.08, 136.63, 130.58, 124.14, 121.56, 118.36, 117.24, 116.88, 116.02, 113.78, 55.73; HRMS calcd for $C_{17}H_{14}O_4N_3^+$ [M + H]$^+$324.09788, found 324.09789.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(pyridin-2-yl)prop-2-en-1-one (**A53**): Yellow solid (Yield: 46%). m.p.: 199.4–200.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.84 (s, 1H), 8.71 (d, *J* = 4.1 Hz, 1H), 8.48 (d, *J* = 15.8 Hz, 1H), 7.94–7.88 (m, 2H), 7.82 (d, *J* = 7.6 Hz, 1H), 7.75 (s, 2H), 7.72 (d, *J* = 8.8 Hz, 1H), 7.45 (t, *J* = 5.3 Hz, 1H), 7.34 (d, *J* = 8.5 Hz, 1H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 181.97, 152.94, 151.32, 150.86, 143.37, 137.94, 129.13, 126.53, 125.76, 125.62, 125.24; HRMS calcd for $C_{15}H_{13}ON_4^+$ [M + H]$^+$ 266.11676, found 266.13788.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-phenylprop-2-en-1-one (**A54**): Yellow solid

(Yield: 47%). m.p.: 219.4–220.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.83 (s, 1H), 8.09 (d, *J* = 16.1 Hz, 1H), 7.89–7.82 (m, 3H), 7.48–7.47 (m, 4H), 6.72 (d, *J* = 8.5 Hz, 1H), 6.63 (s, 1H), 5.51 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.97, 142.92, 135.04, 131.16, 129.56, 129.14, 122.42, 115.30; HRMS calcd for $C_{16}H_{14}ON_3^+$ $[M + H]^+$ 264.11314, found 264.11328.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(2-chlorophenyl)prop-2-en-1-one (**A55**): Yellow solid (Yield: 44%). m.p.: 218.7–219.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.88 (s, 1H), 8.13 (s, 2H), 8.07 (d, *J* = 7.0 Hz, 1H), 7.58 (d, *J* = 7.3 Hz, 1H), 7.52–7.45 (m, 3H), 6.74 (d, *J* = 8.6 Hz, 1H), 6.64 (s, 1H), 5.58 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.58, 147.34, 137.47, 134.81, 132.68, 132.47, 130.61, 128.75, 128.40, 125.22, 115.68; HRMS calcd for $C_{16}H_{13}ON_3Cl^+$ $[M + H]^+$ 298.07417, found 298.07389.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(3-chlorophenyl)prop-2-en-1-one (**A56**): Yellow solid (Yield: 59%). m.p.: 190.9–192.5 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.88 (s, 1H), 8.12 (d, *J* = 16.1 Hz, 1H), 7.90 (s, 1H), 7.85–7.80 (m, 2H), 7.53–7.48 (m, 3H), 6.75 (dd, J_1 = 8.8 Hz, J_2 = 1.9 Hz, 1H), 6.66 (s, 1H), 5.68 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.81, 147.49, 141.24, 137.30, 131.29, 130.65, 128.76, 127.48, 123.99, 115.69; HRMS calcd for $C_{16}H_{13}ON_3Cl^+$ $[M + H]^+$ 298.07417, found 298.07419.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(4-chlorophenyl)prop-2-en-1-one (**A57**): Yellow solid (Yield: 54%). m.p.: 215.3–217.0 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.84 (s,1H), 8.08 (d, *J* = 16.1 Hz, 1H), 7.87–7.82 (m, 3H), 7.52 (d, *J* = 8.4 Hz, 3H), 6.73 (d, *J* = 8.4 Hz, 1H),6.63 (s, 1H), 5.53 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.82, 147.47, 141.43, 135.60, 134.00, 130.81, 129.57, 123.17, 115.39; HRMS calcd for $C_{16}H_{13}ON_3Cl^+$ $[M + H]^+$ 298.07417, found 298.07465.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(2-bromophenyl)prop-2-en-1-one (**A58**): Yellow solid (Yield: 42%). m.p.: 235.4–237.2 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.89 (s, 1H), 8.10 (s, 2H), 8.05 (d, *J* = 7.9 Hz, 1H), 7.75 (dd, J_1 = 7.9 Hz, J_2 = 0.8 Hz, 1H), 7.53–7.48 (m, 2H), 7.42–7.38 (m, 1H), 6.75 (d, *J* = 7.9 Hz, 1H), 6.67 (s, 1H), 5.82 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.56, 147.43, 140.21, 134.35, 133.87, 132.67, 128.95,

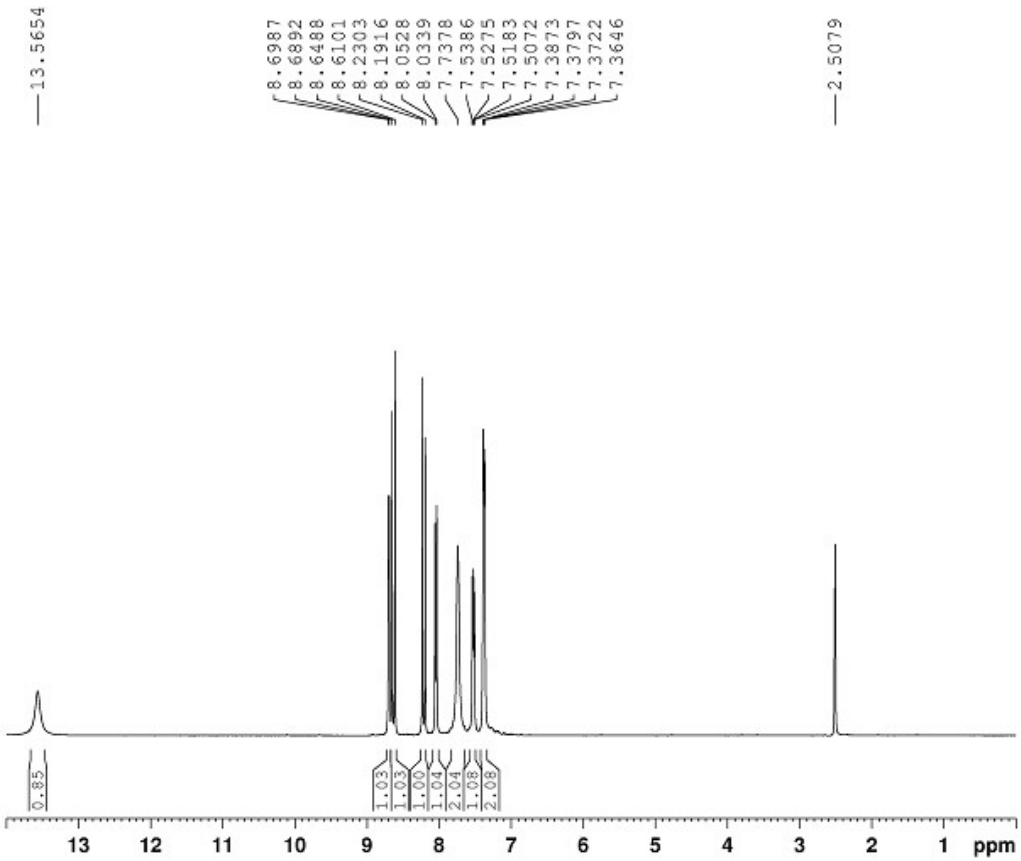
128.86, 125.84, 125.32, 115.82; HRMS calcd for $C_{16}H_{13}ON_3Br^+$ $[M + H]^+$ 342.02365, found 342.02354.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(2-bromophenyl)prop-2-en-1-one (**A59**): Yellow solid (Yield: 58%). m.p.: 216.4–218.8 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.85 (s, 1H), 8.08 (t, *J* = 16.1 Hz, 2H), 7.83 (t, *J* = 16.8 Hz, 2H), 7.64 (d, *J* = 7.9 Hz, 1H), 7.51 (d, *J* = 8.4 Hz, 1H), 7.42 (t, *J* = 7.9 Hz, 1H), 6.72 (d, *J* = 8.6 Hz, 1H), 6.62 (s, 1H), 5.53 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.70, 147.37, 141.06, 137.58, 133.55, 131.60, 129.12, 127.85, 123.98, 122.87, 115.40; HRMS calcd for $C_{16}H_{12}ON_3Br^+$ $[M + H]^+$ 342.02365, found 342.02362.

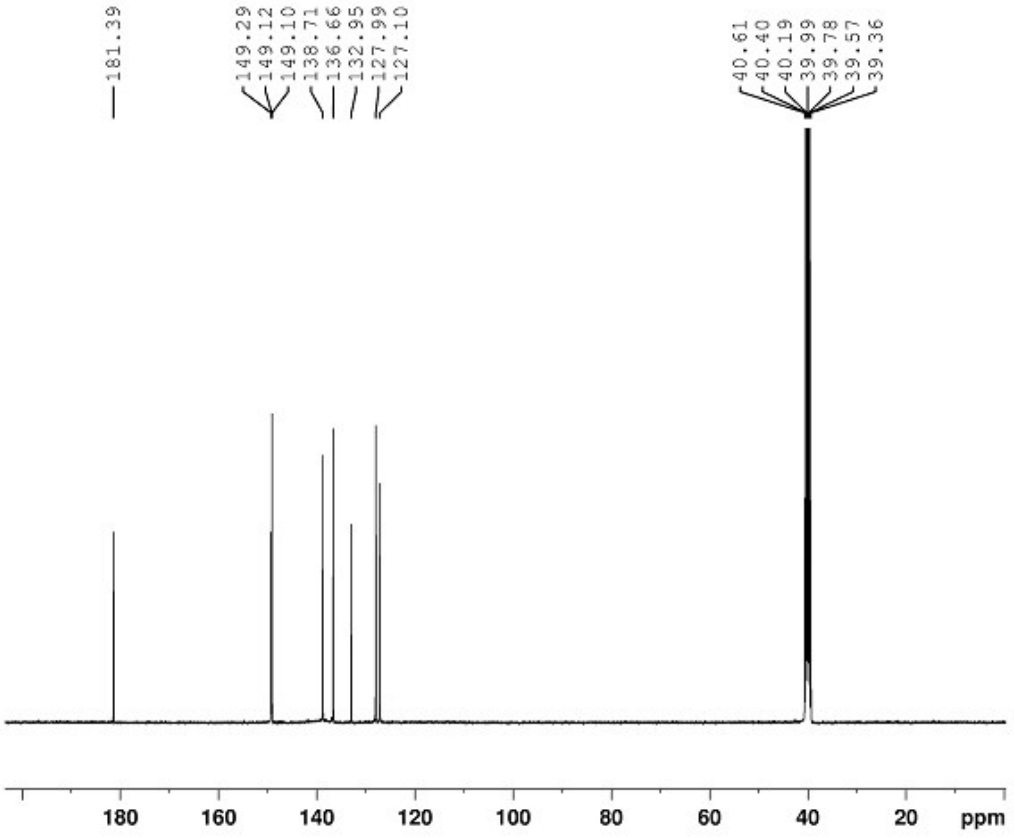
(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(4-bromophenyl)prop-2-en-1-one (**A60**): Yellow solid (Yield: 88%). m.p.: 228.7–230.6 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 12.84 (s, 1H), 8.09 (d, *J* = 16.1 Hz, 1H), 7.81 (t, *J* = 16.1 Hz, 3H), 7.66 (d, *J* = 8.5 Hz, 2H), 7.51 (d, *J* = 8.6 Hz, 1H), 6.73 (d, *J* = 8.8 Hz, 1H), 6.63 (s, 1H), 5.54 (s, 2H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 179.82, 147.48, 141.53, 134.33, 132.51, 131.02, 124.48, 123.21, 115.44; HRMS calcd for $C_{16}H_{13}ON_3Br^+$ $[M + H]^+$ 342.02365, found 342.02323.

(*E*)-1-(5-amino-1*H*-benzo[*d*]imidazol-2-yl)-3-(m-tolyl)prop-2-en-1-one (**A61**): Yellow solid (Yield: 49%). m.p.: 212.0–213.9 °C; ^{1}H NMR (400 MHz, d_6-DMSO) δ 8.07 (d, *J* = 16.1 Hz, 1H), 7.83 (d, *J* = 16.1 Hz, 1H), 7.66 (s, 1H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.36 (t, *J* = 7.6 Hz, 1H), 7.28 (d, *J* = 7.5 Hz, 1H), 6.77 (dd, J_1 = 8.8 Hz, J_2 = 1.2 Hz, 1H), 6.72 (s, 1H), 2.37 (s, 3H); ^{13}C NMR (101 MHz, d_6-DMSO) δ 180.05, 147.76, 143.23, 138.85, 134.95, 131.97, 129.45, 129.25, 126.72, 122.18, 115.74, 21.30; HRMS calcd for $C_{17}H_{16}ON_3^+$ $[M + H]^+$ 278.12879, found 278.12851.

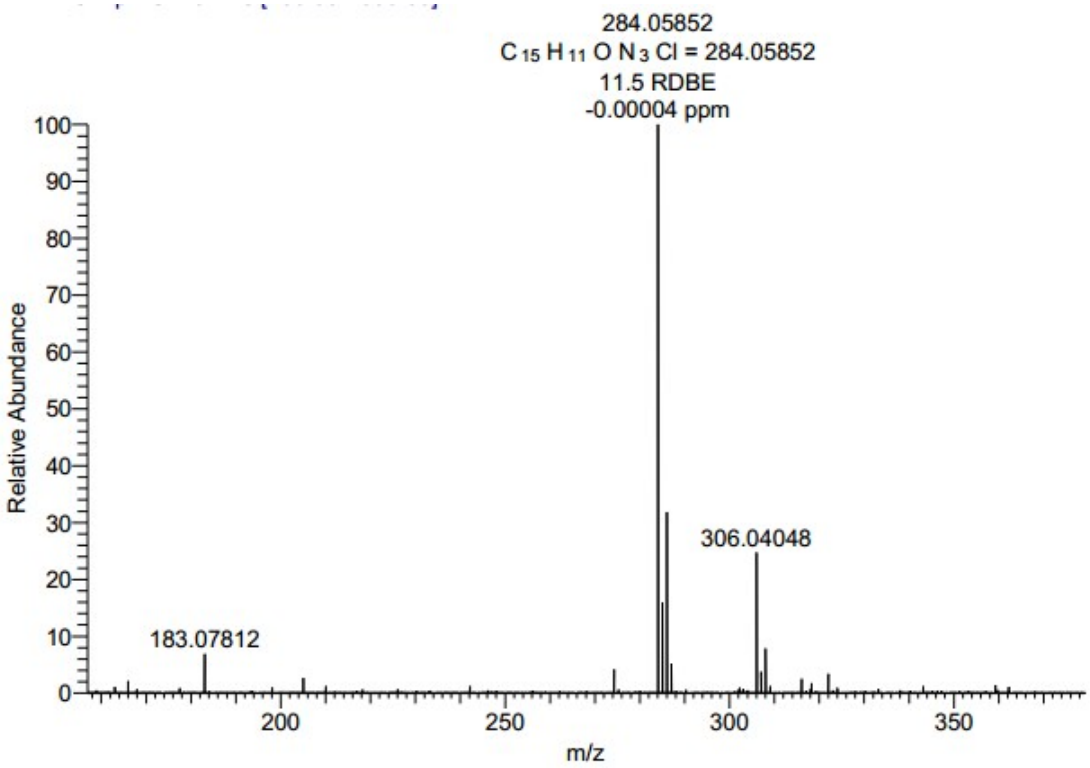
2. The ^{1}H NMR, ^{13}C NMR spectra and HRMS of compounds A1 to A61 are listed below.



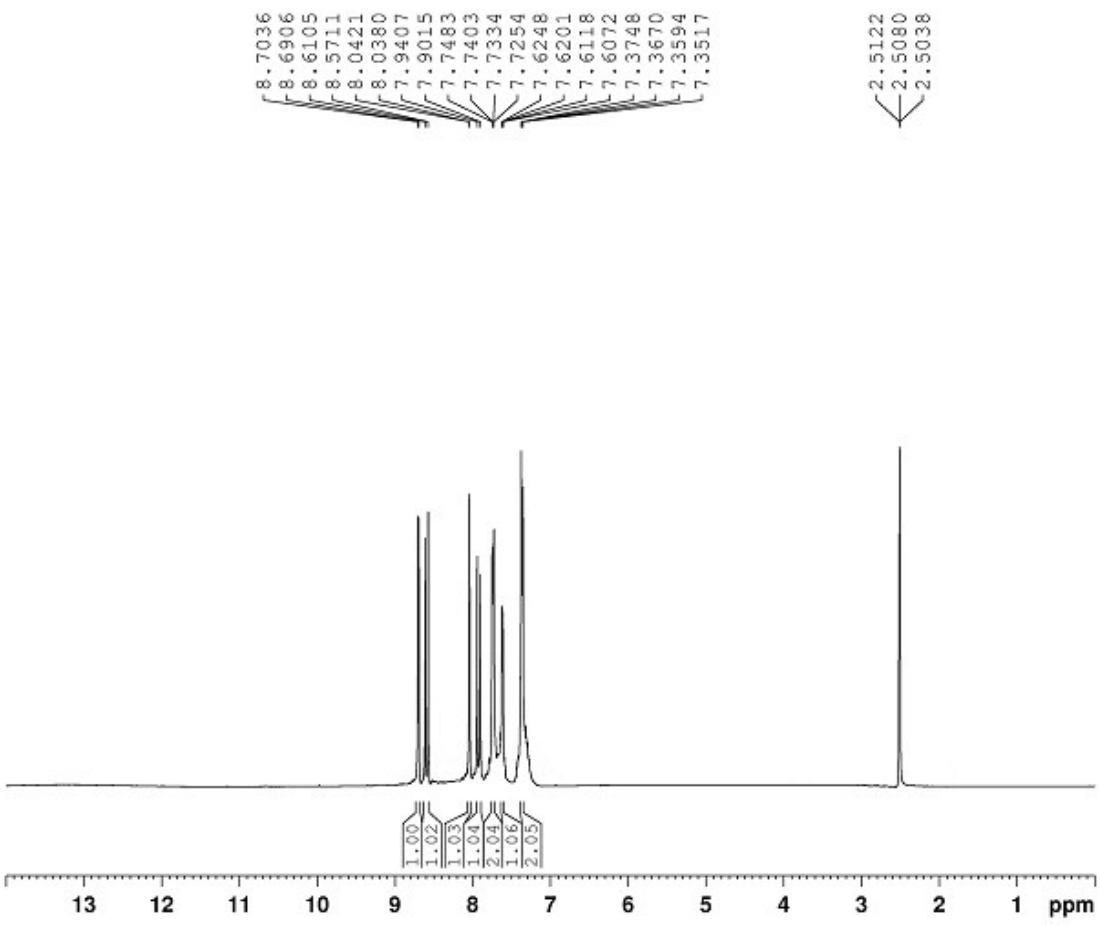
^{1}H NMR spectrum of compound **A1**



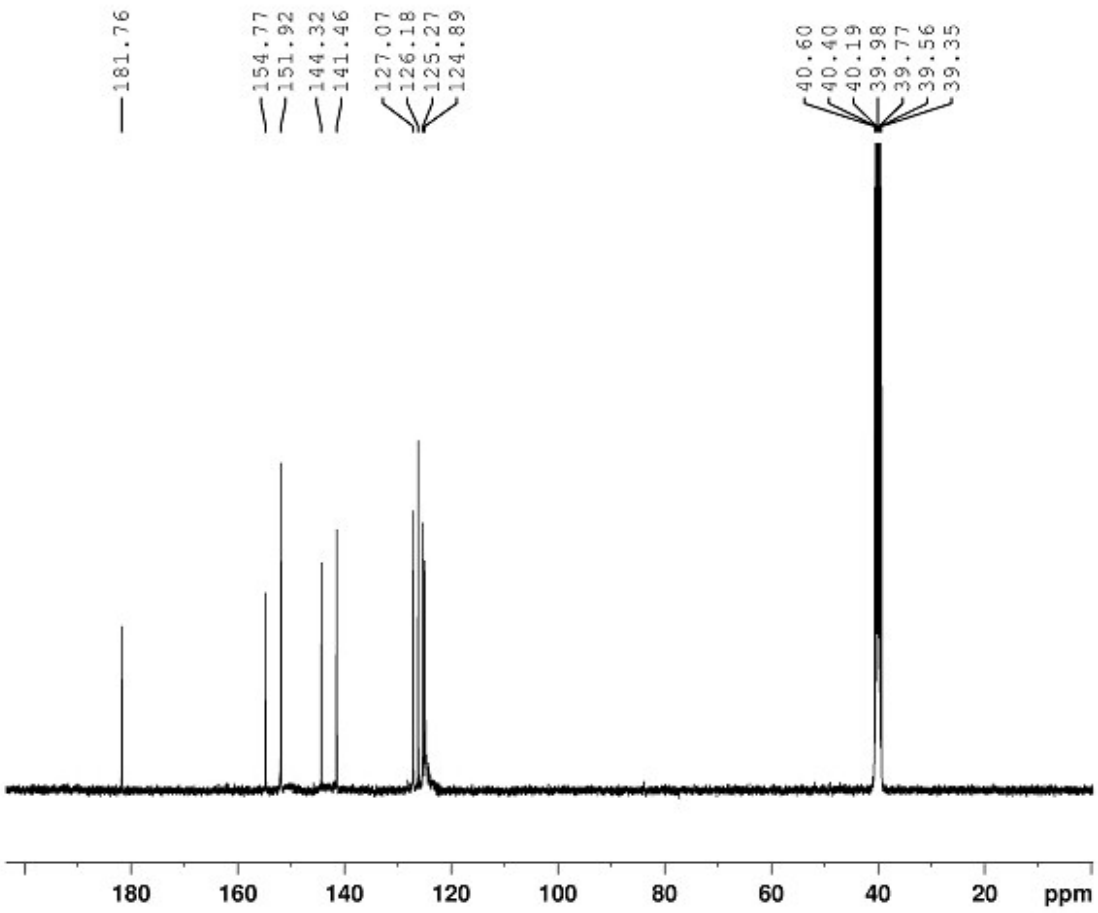
^{13}C NMR spectrum of compound **A1**



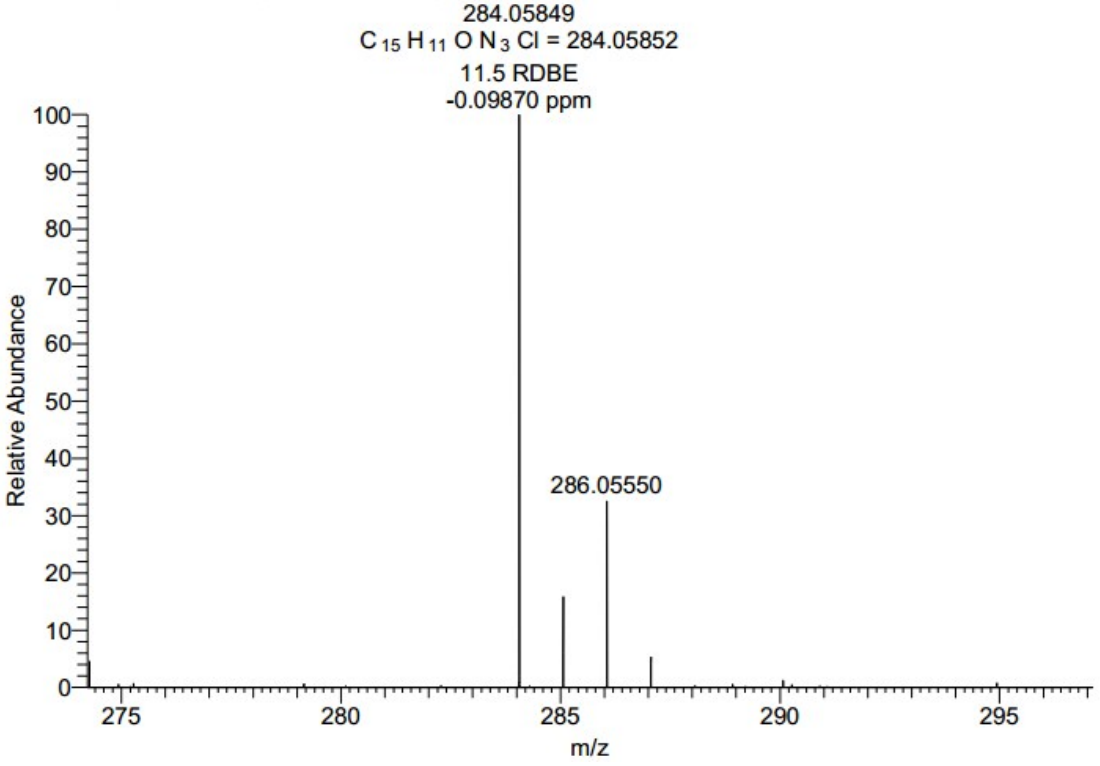
High resolution mass spectrum of compound **A1**



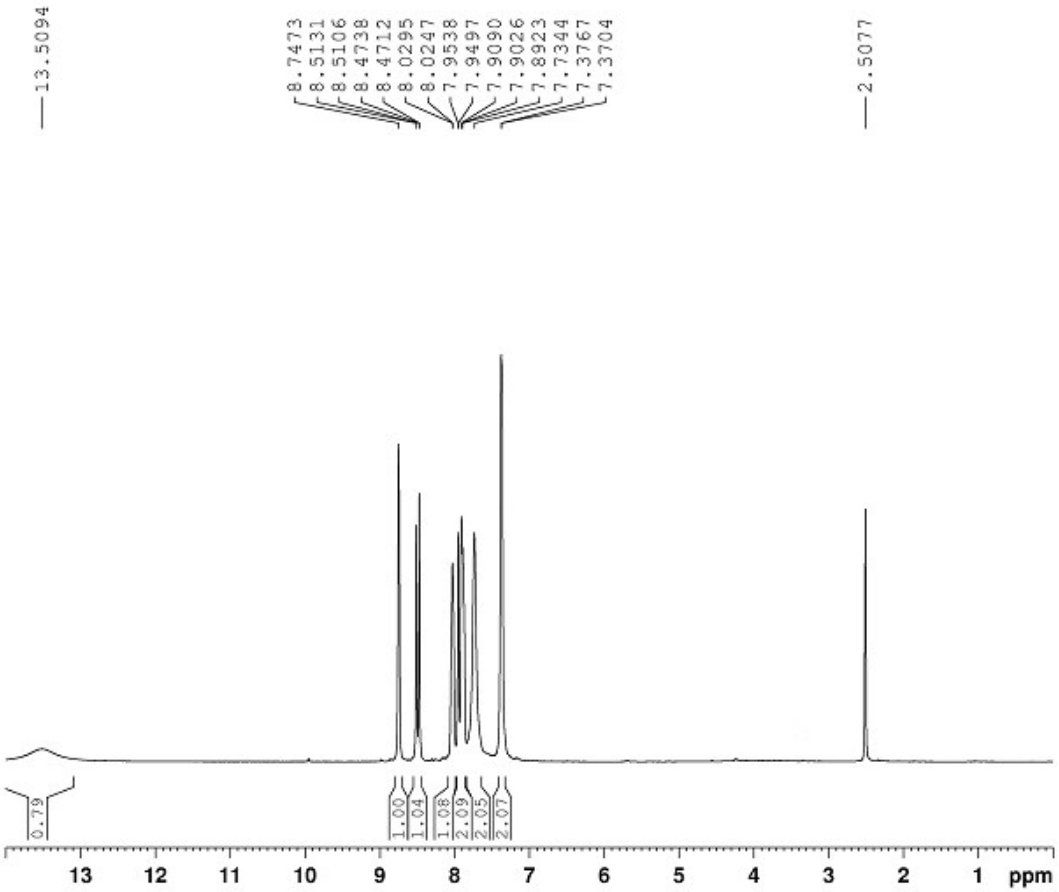
^{1}H NMR spectrum of compound **A2**



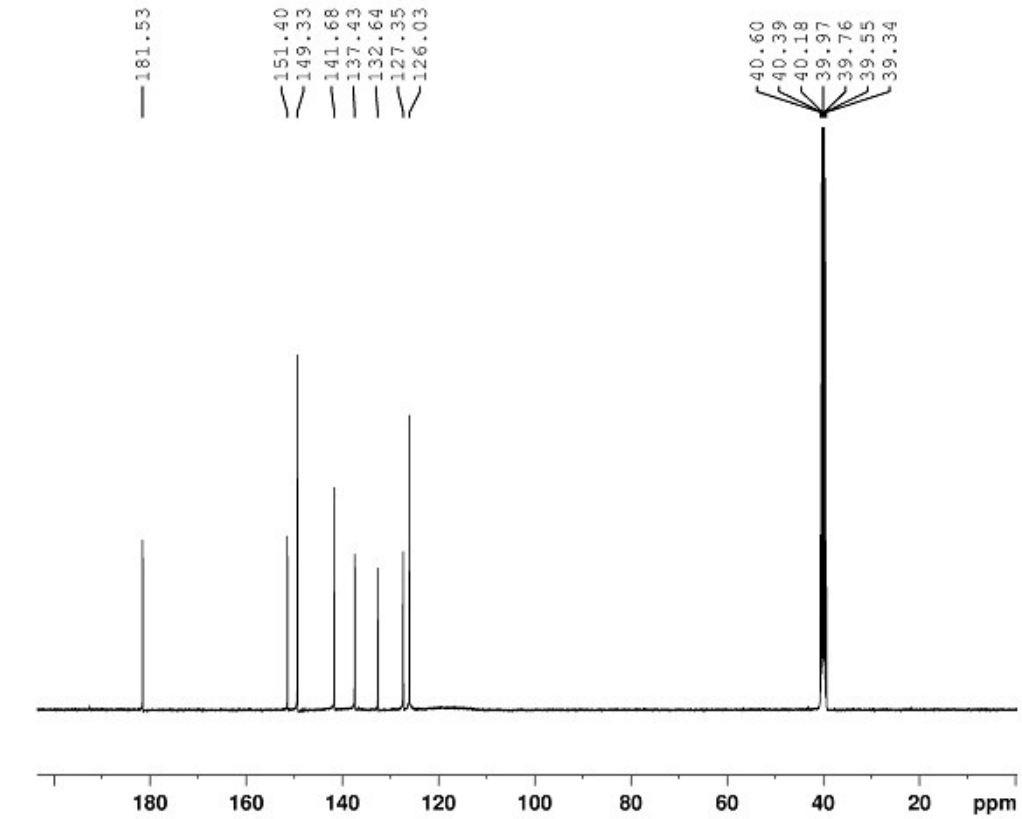
^{13}C NMR spectrum of compound **A2**



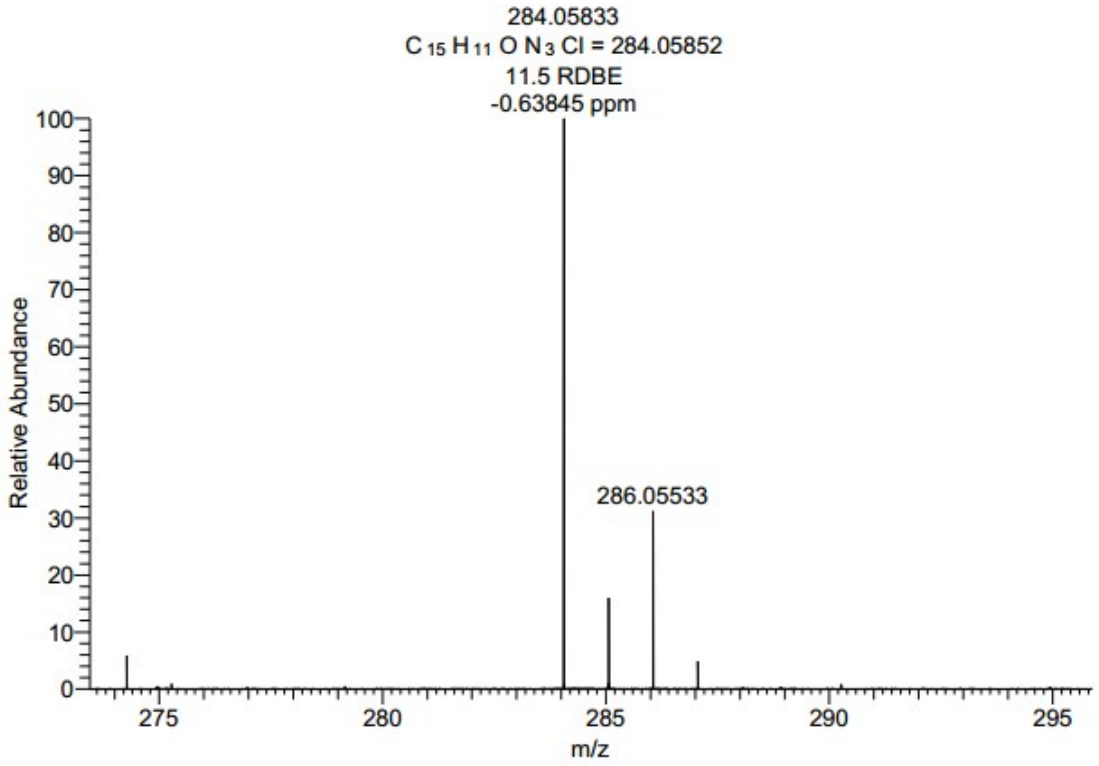
High resolution mass spectrum of compound **A2**



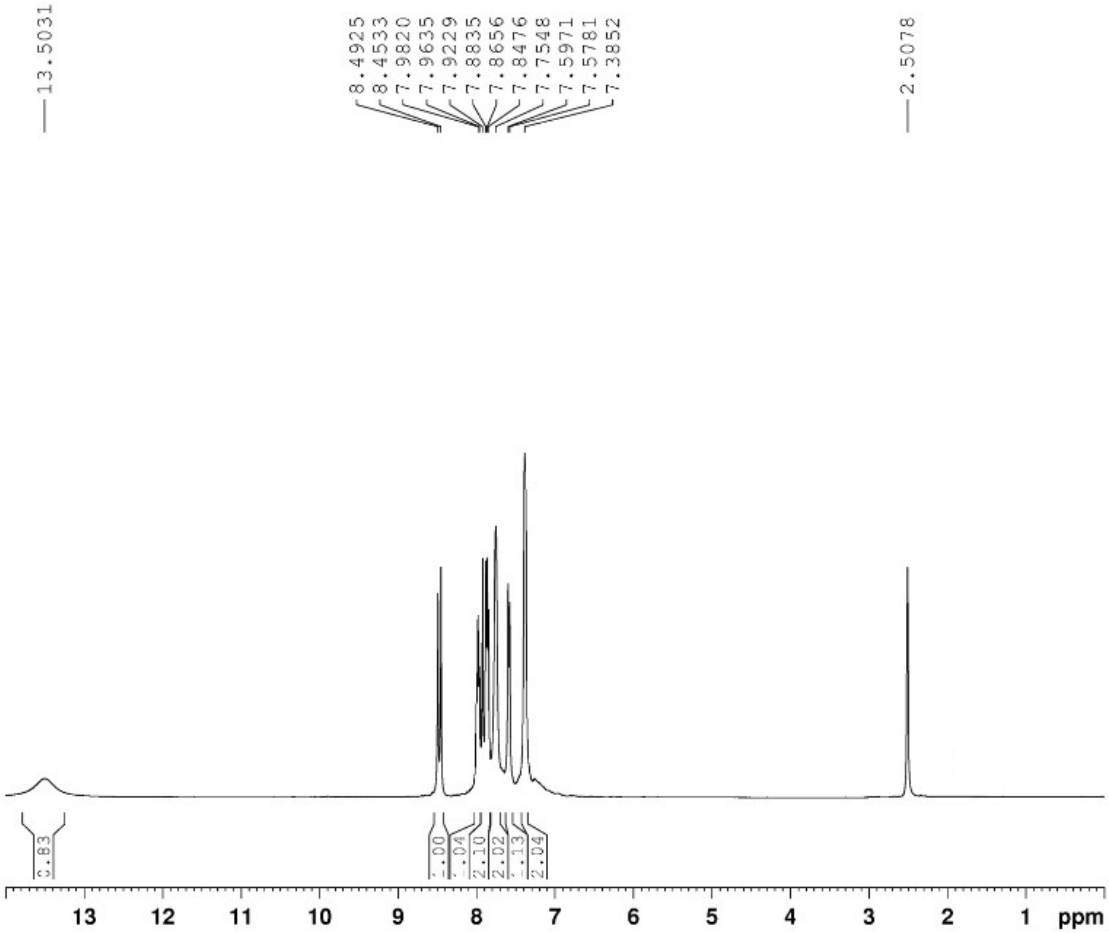
^{1}H NMR spectrum of compound **A3**



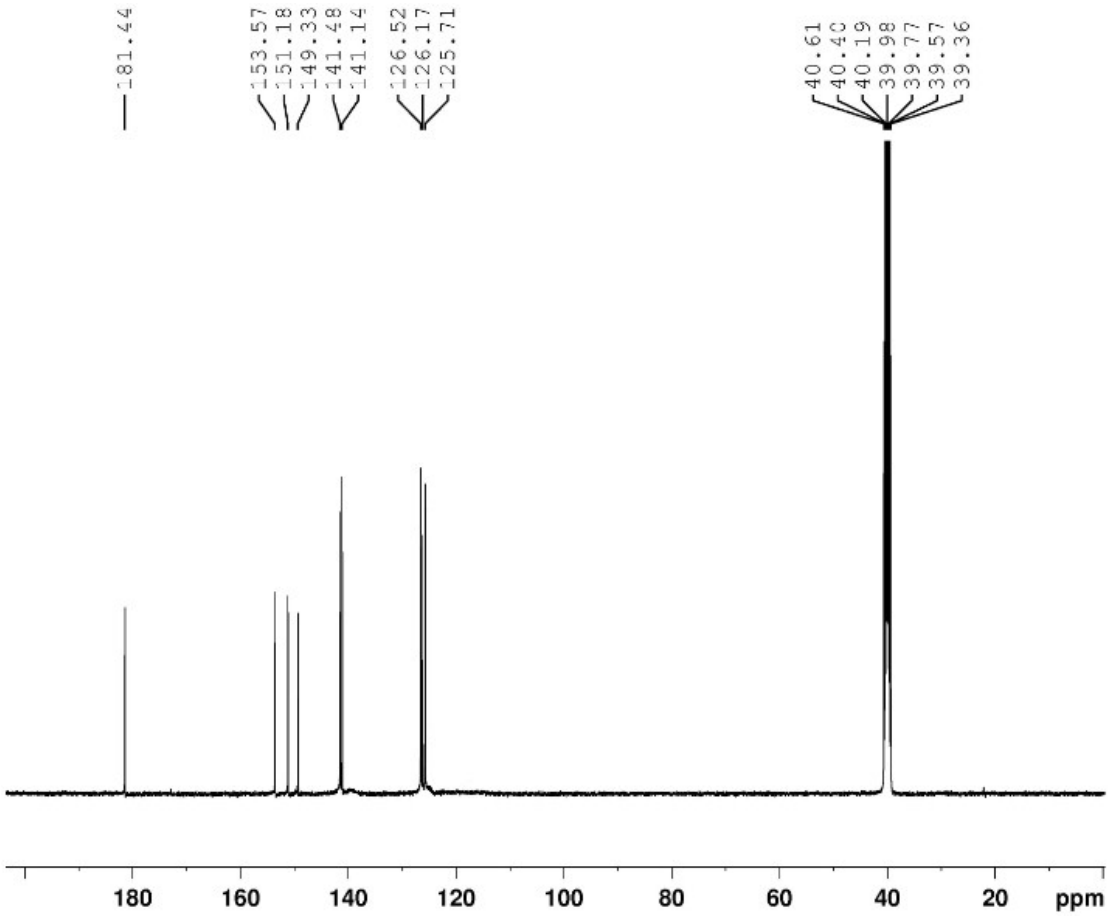
^{13}C NMR spectrum of compound **A3**



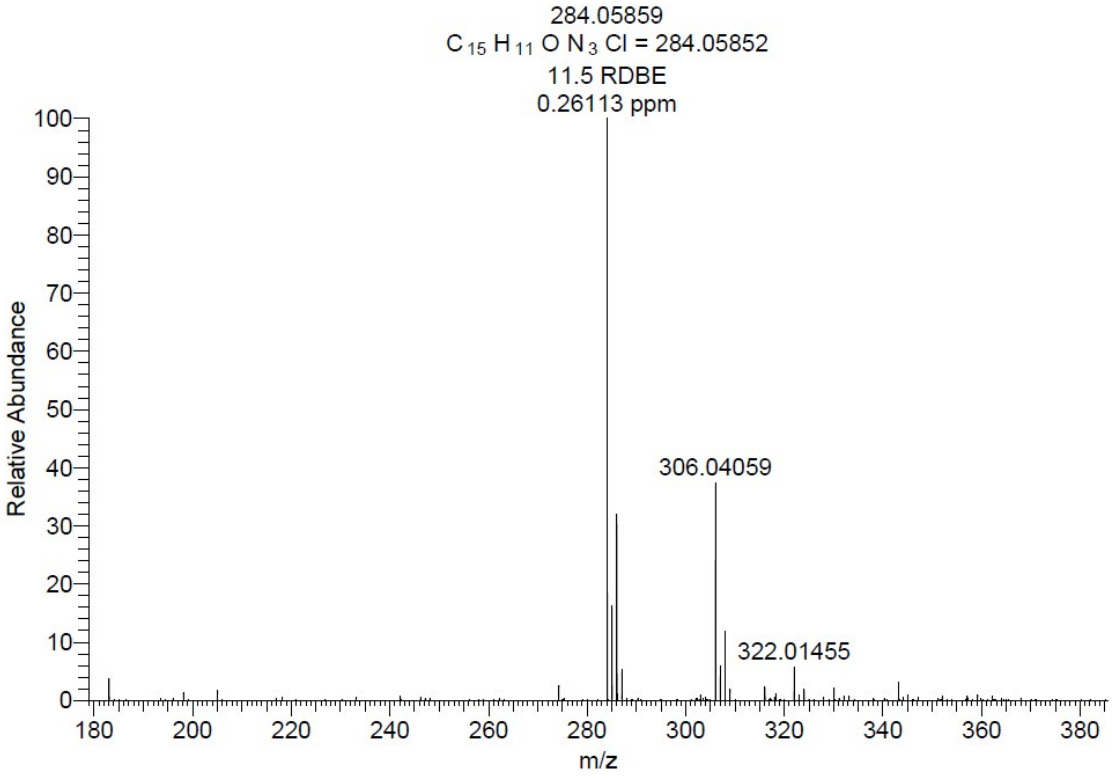
High resolution mass spectrum of compound **A3**



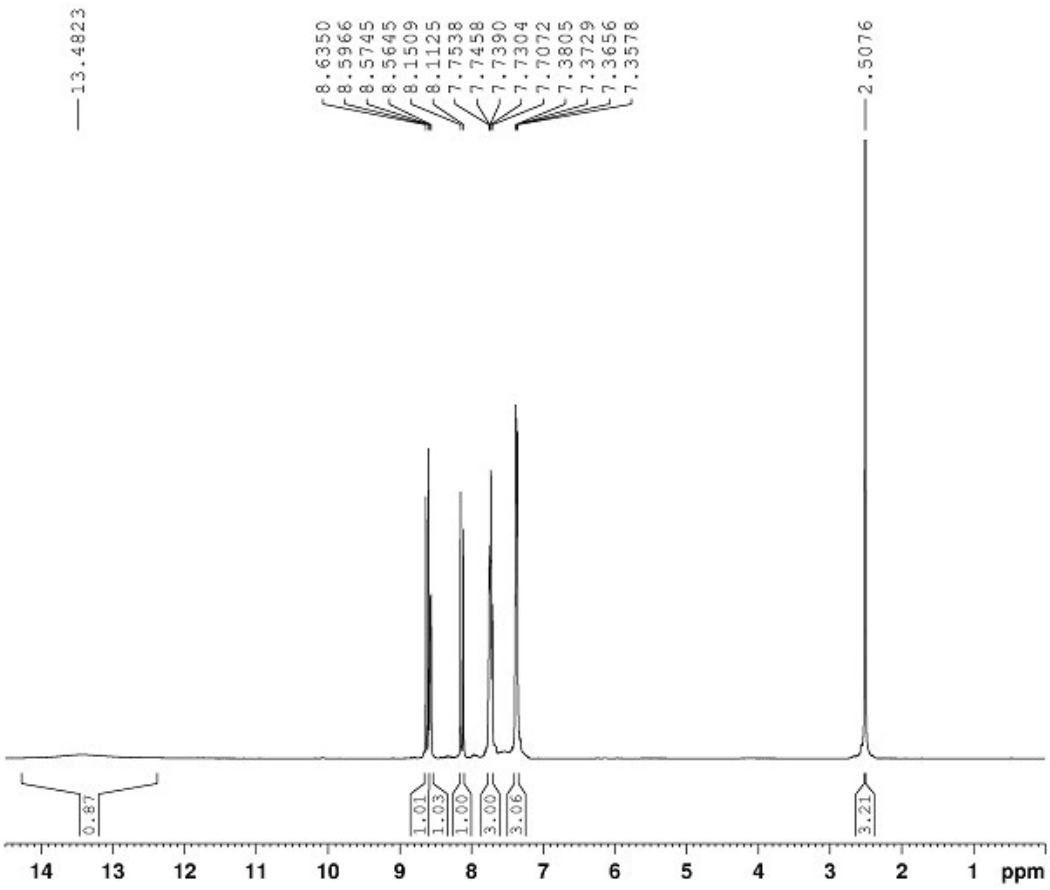
^{1}H NMR spectrum of compound **A4**



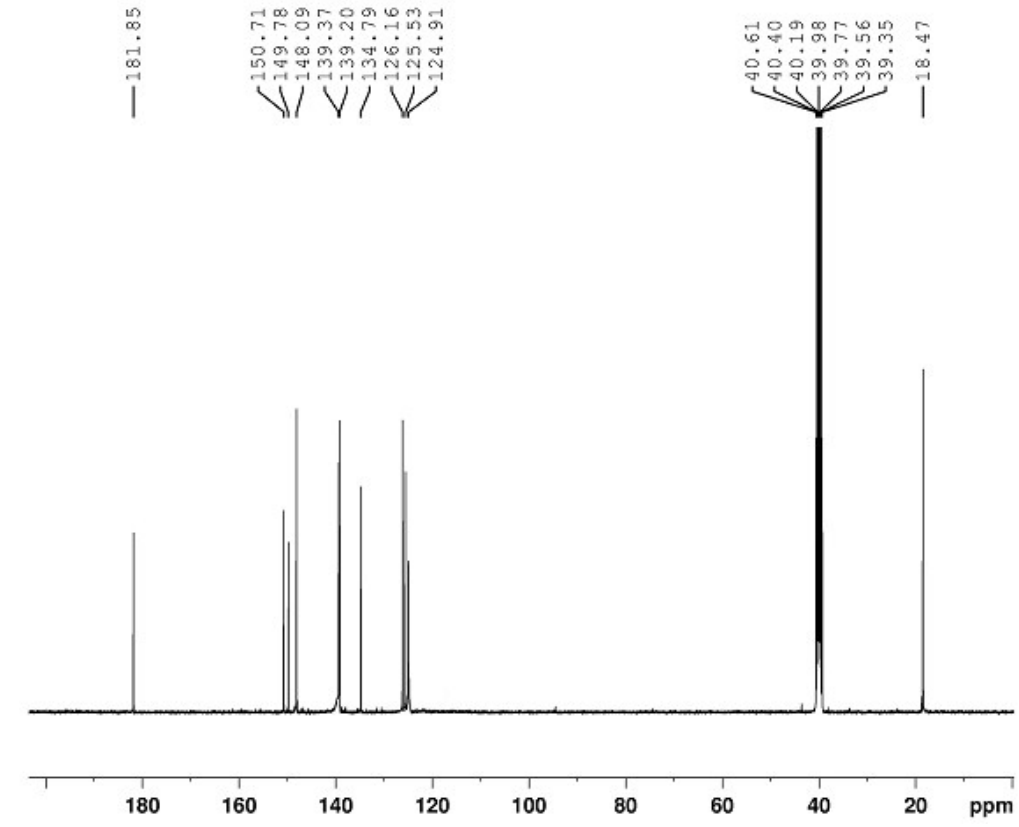
^{13}C NMR spectrum of compound **A4**



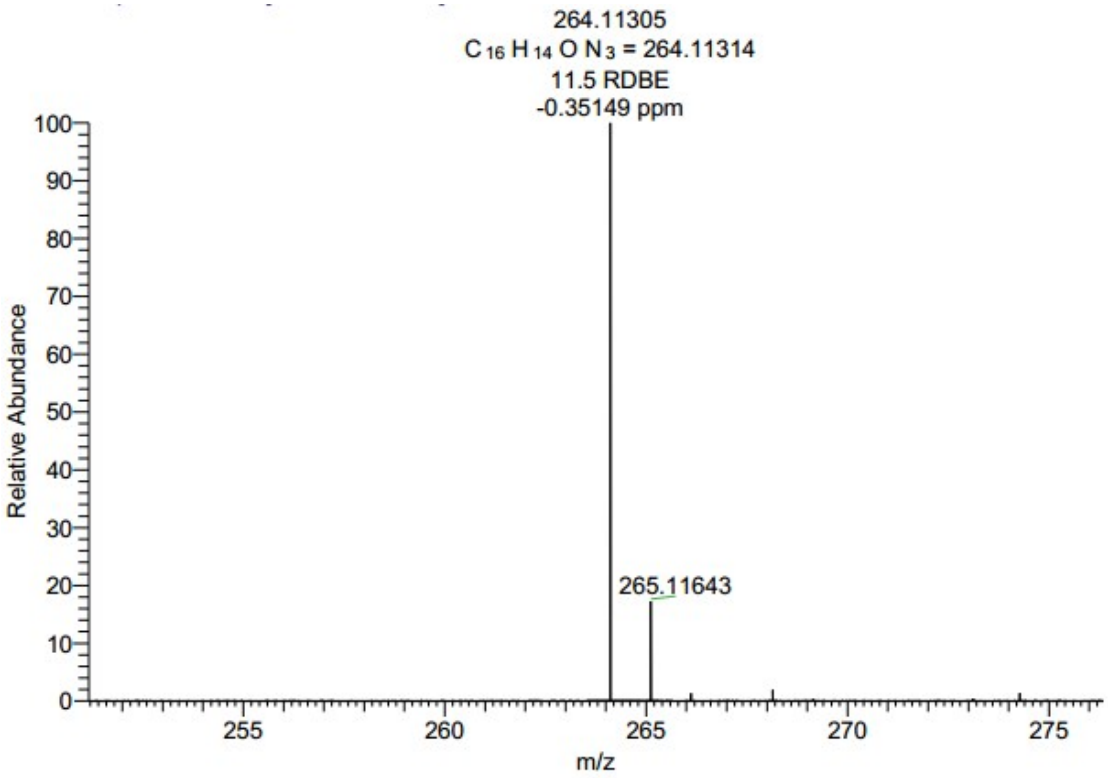
High resolution mass spectrum of compound **A4**



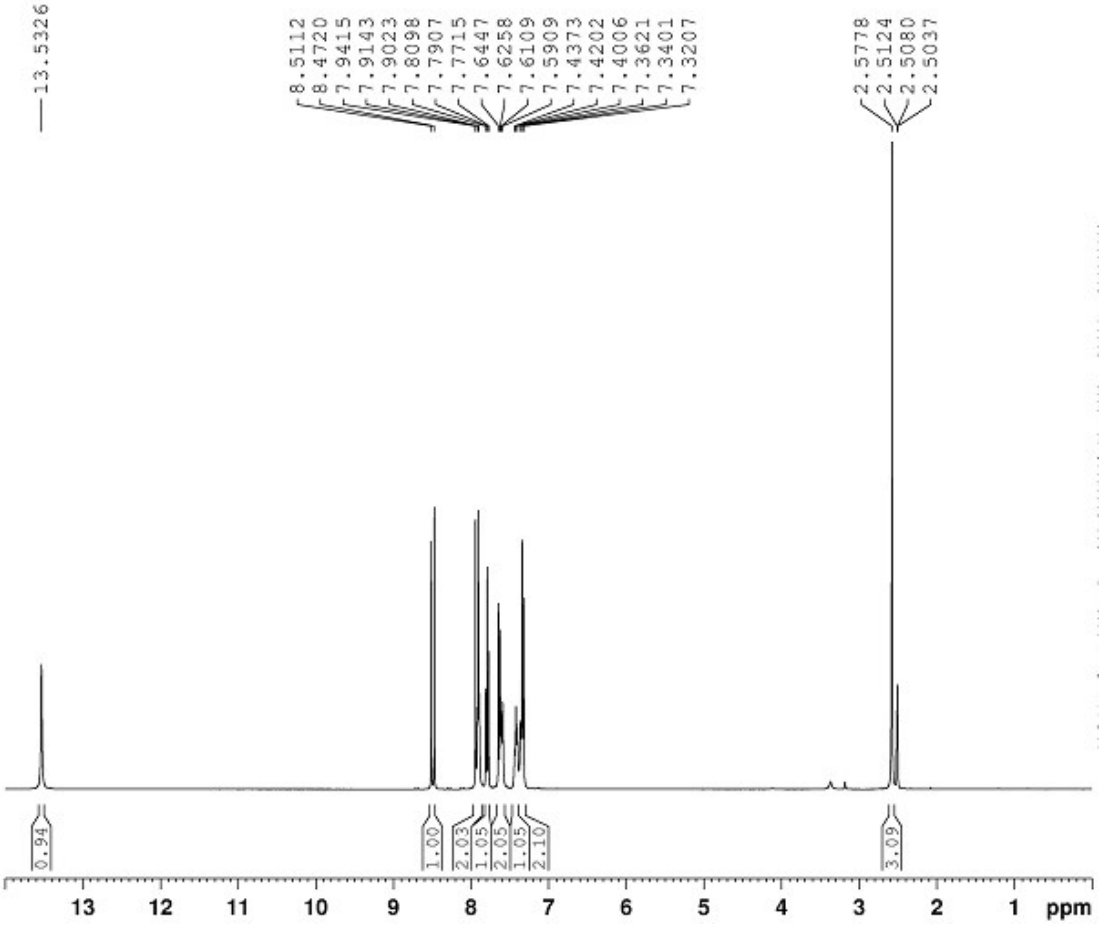
^{1}H NMR spectrum of compound **A5**



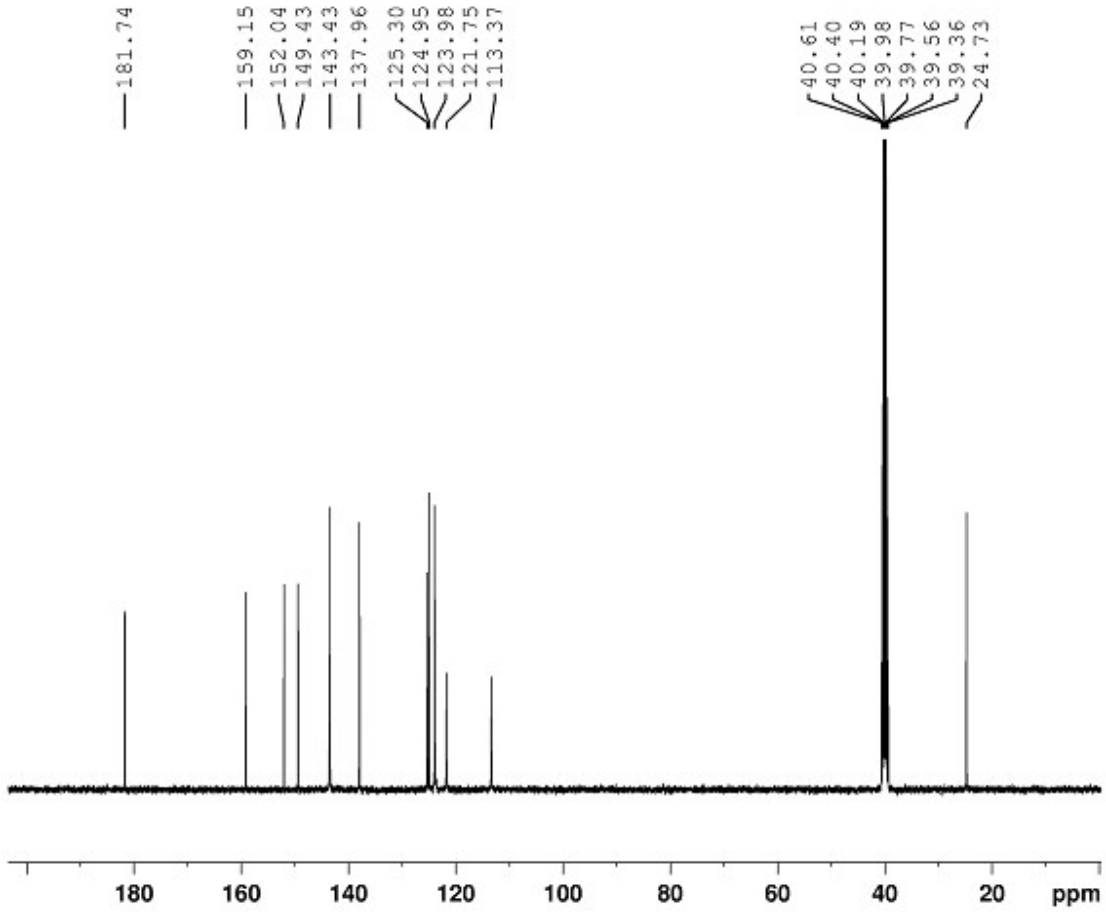
^{13}C NMR spectrum of compound **A5**



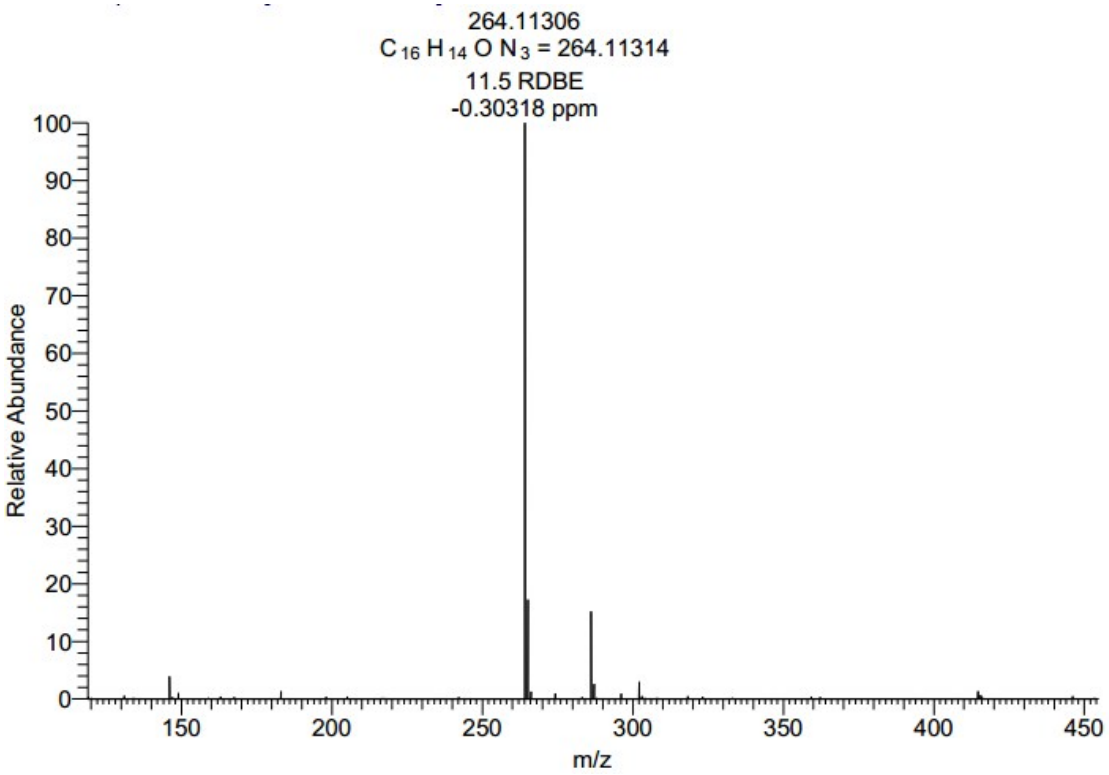
High resolution mass spectrum of compound **A5**



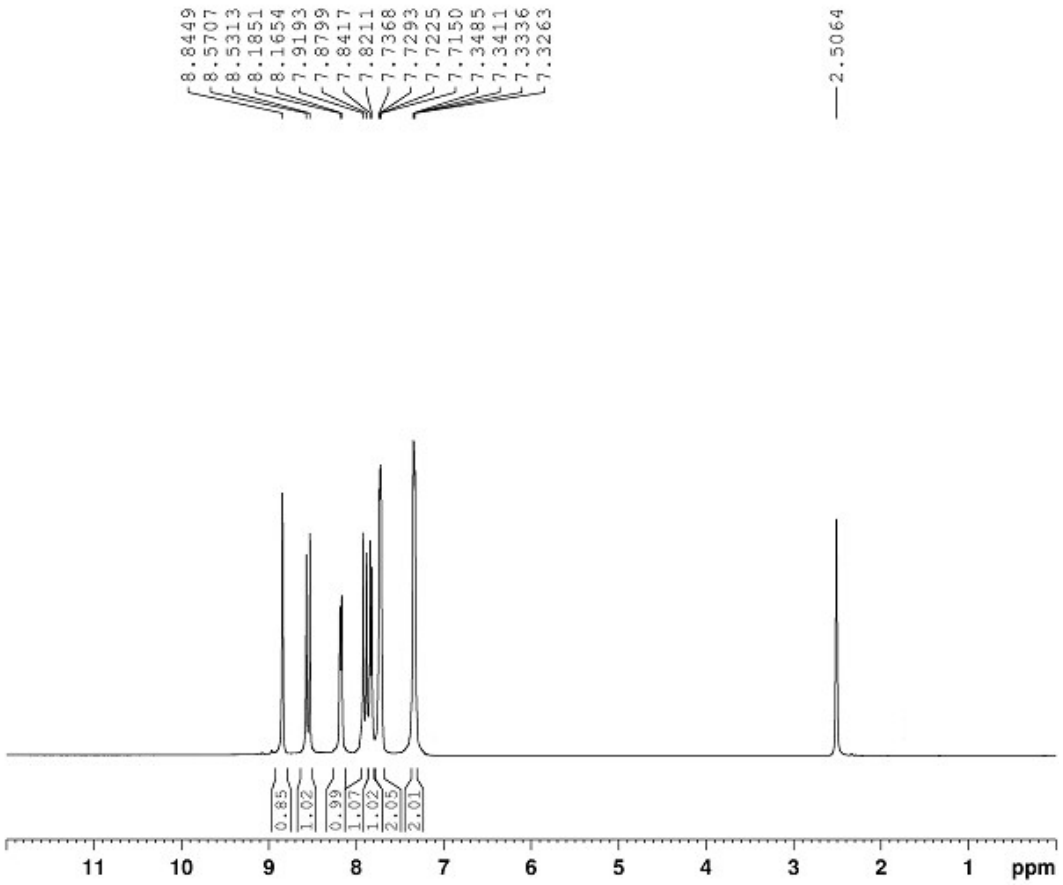
^{1}H NMR spectrum of compound **A6**



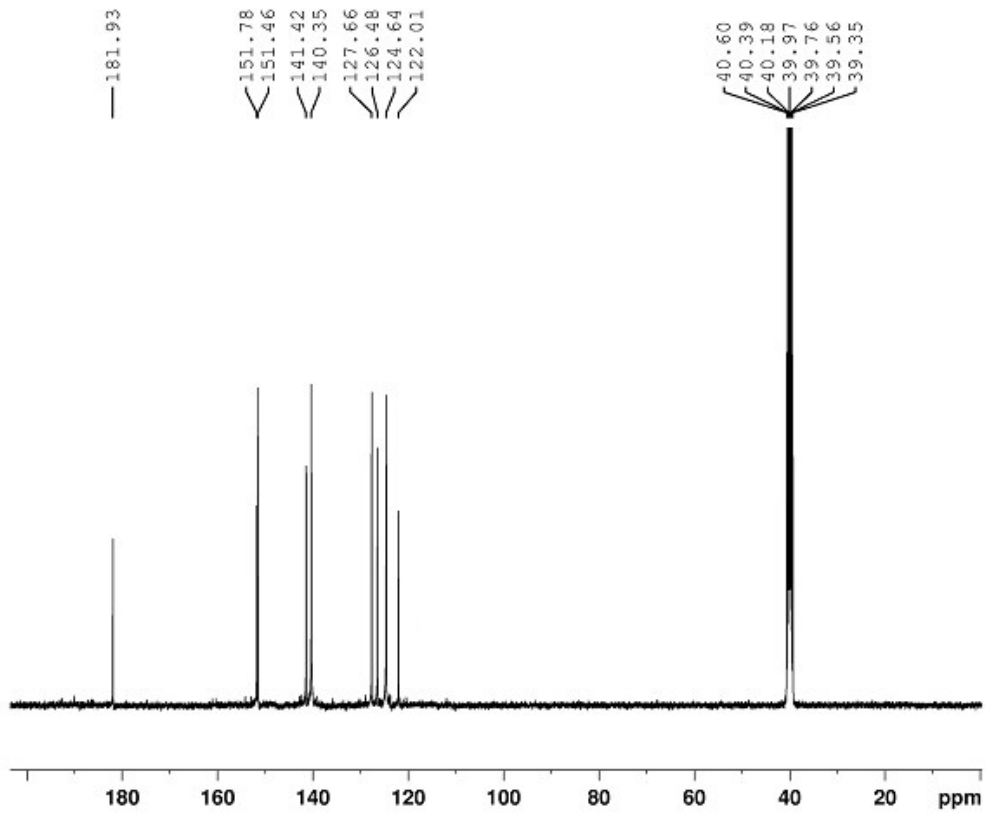
^{13}C NMR spectrum of compound **A6**



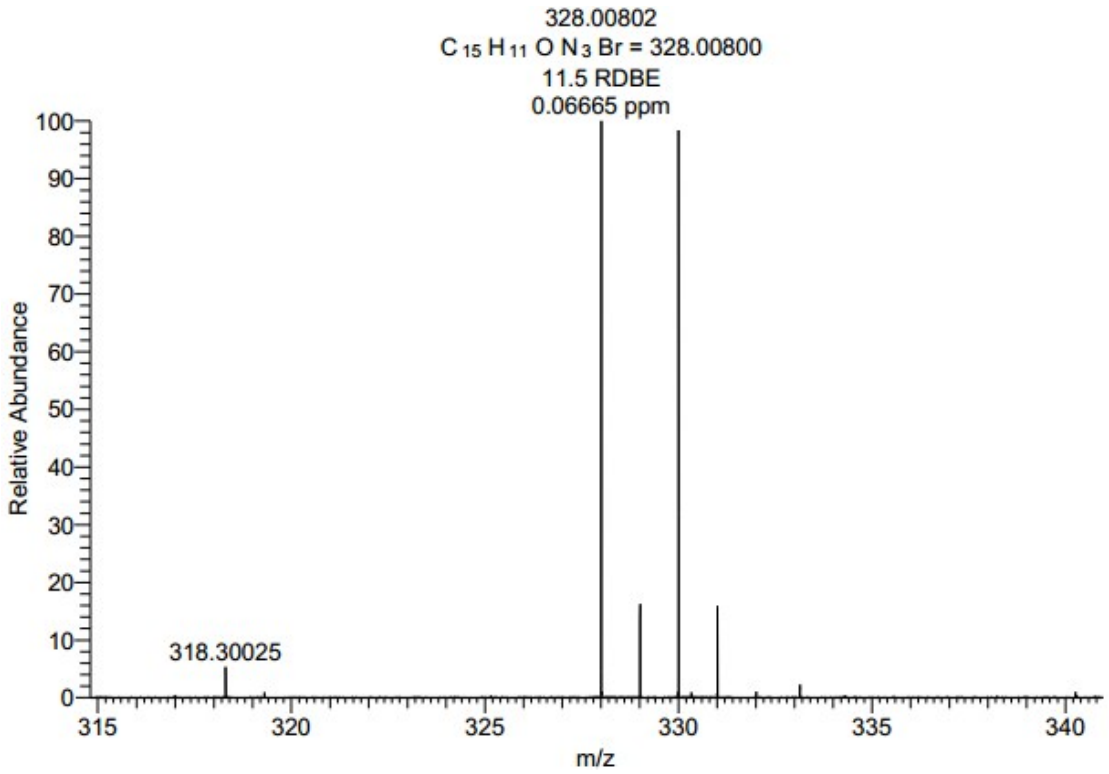
High resolution mass spectrum of compound **A6**



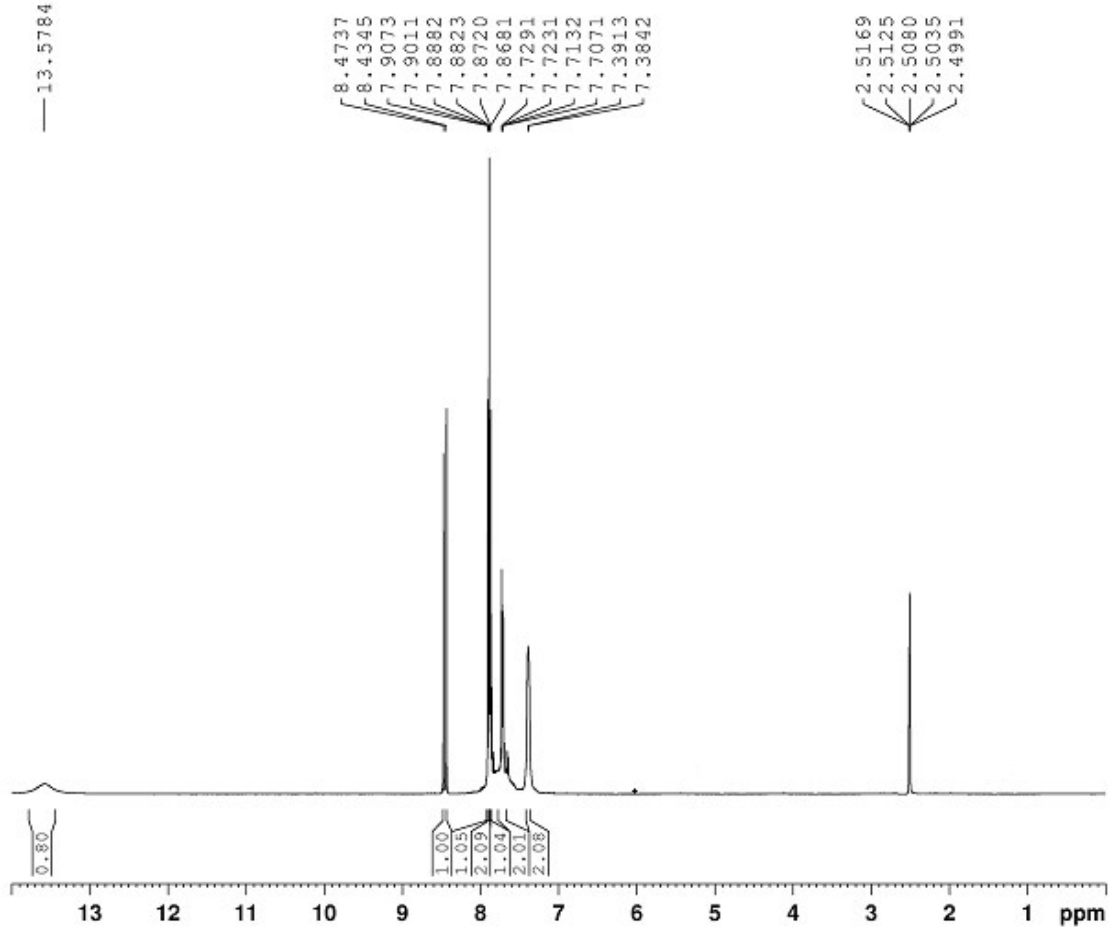
^{1}H NMR spectrum of compound **A7**



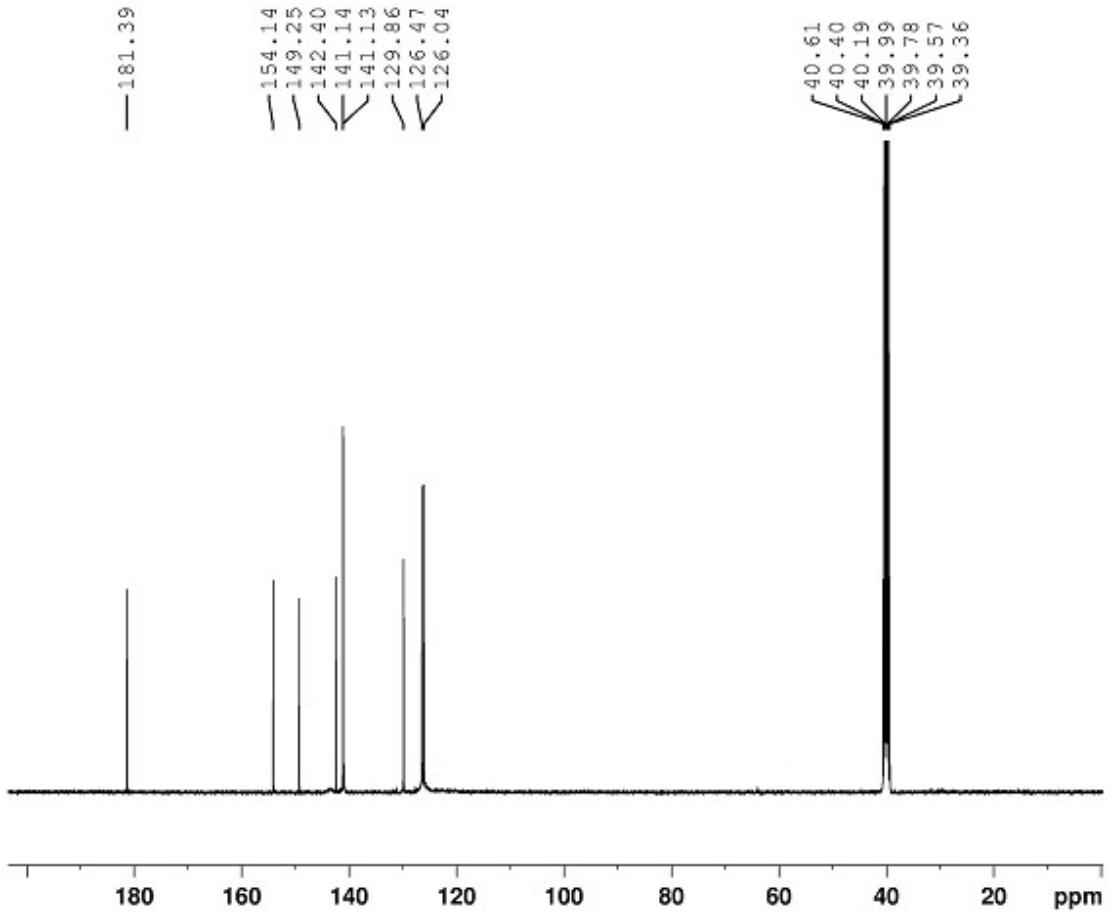
^{13}C NMR spectrum of compound **A7**



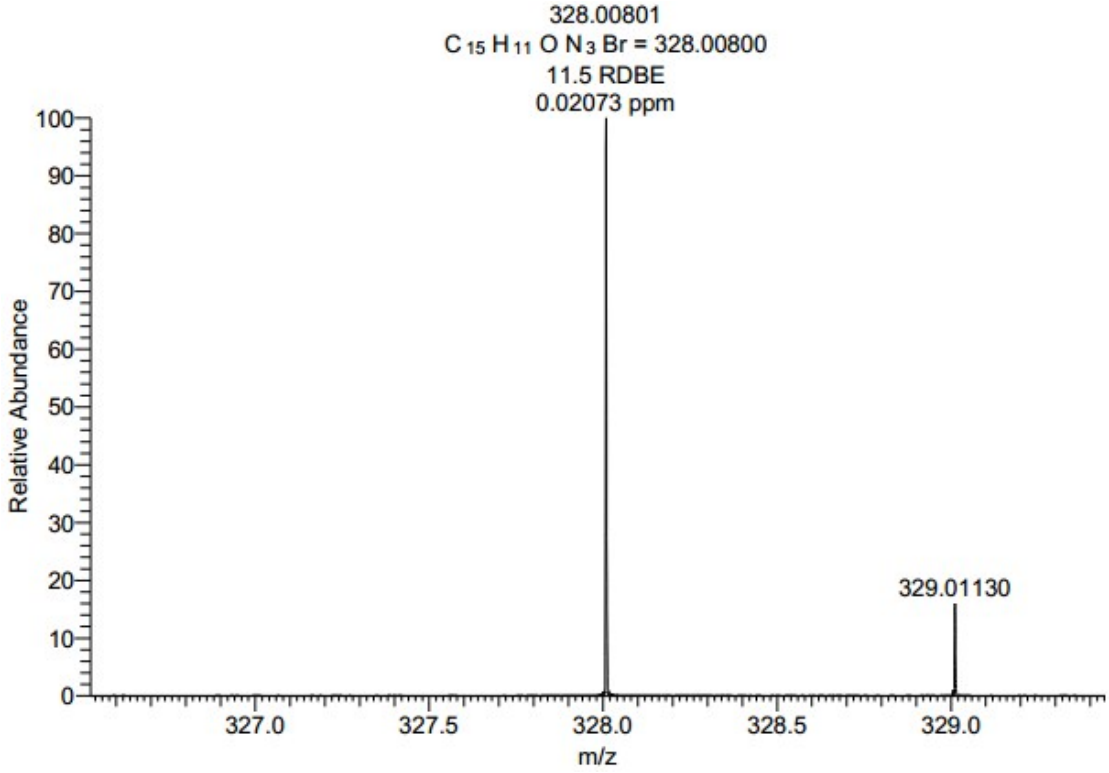
High resolution mass spectrum of compound **A7**



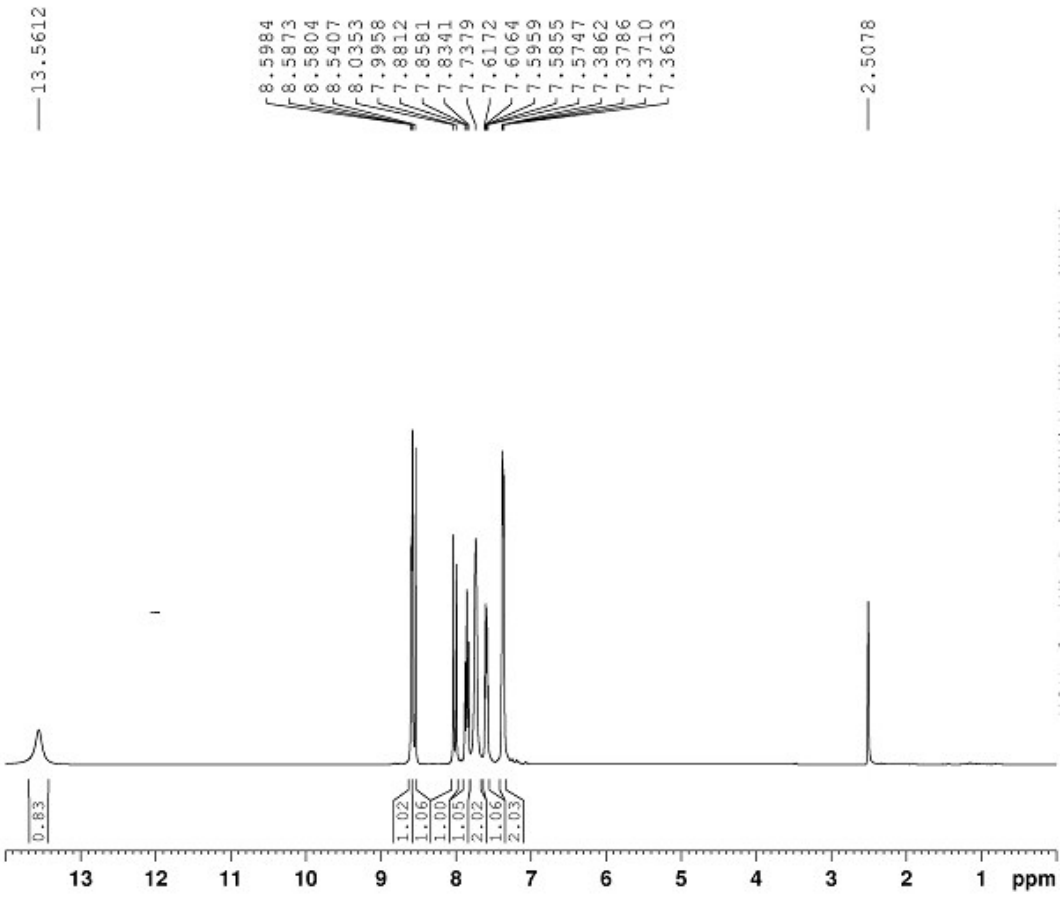
^{1}H NMR spectrum of compound **A8**



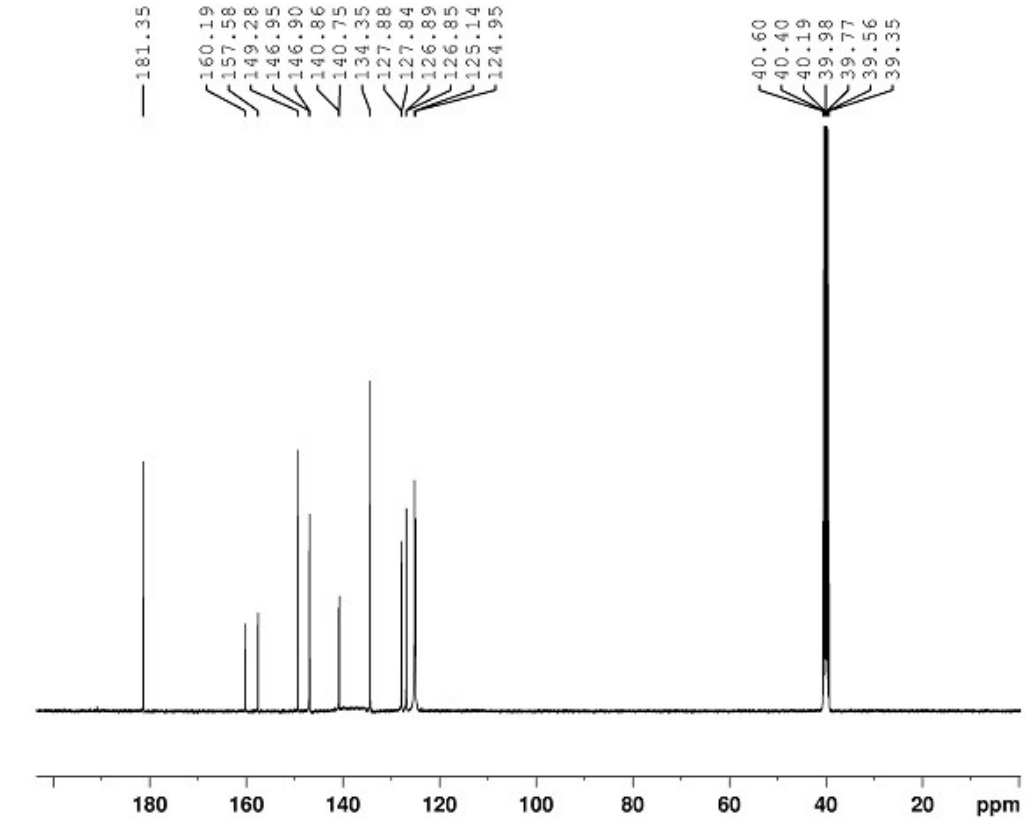
^{13}C NMR spectrum of compound **A8**



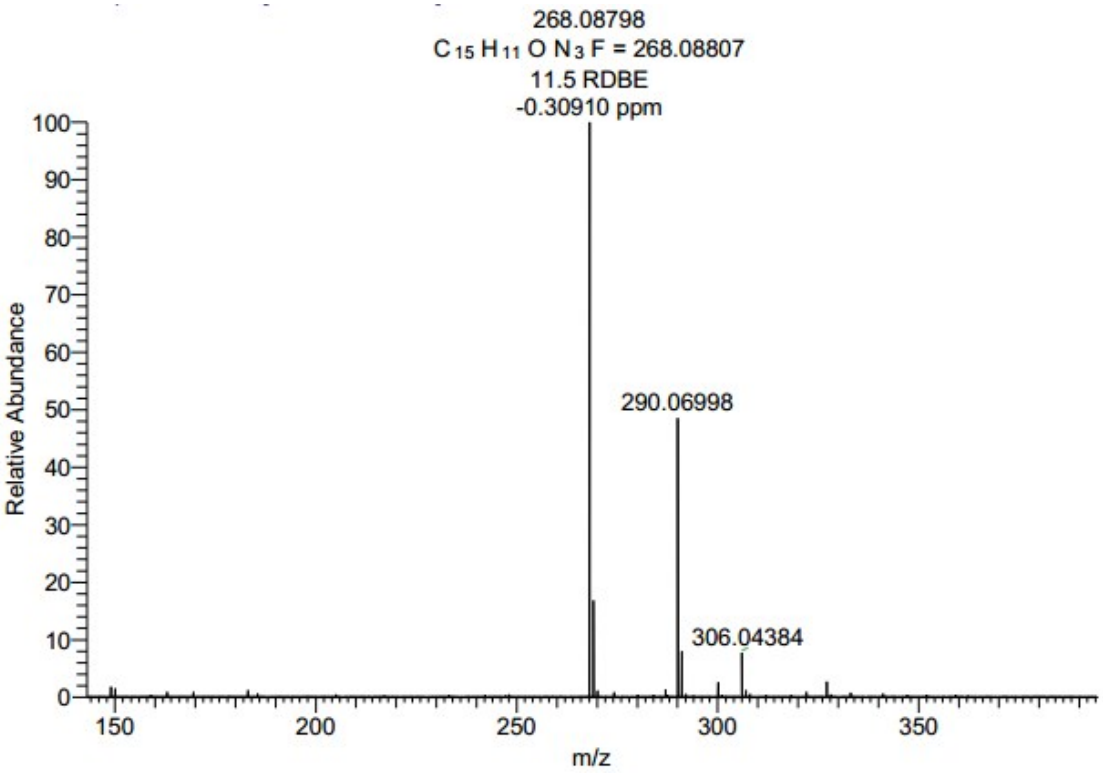
High resolution mass spectrum of compound **A8**



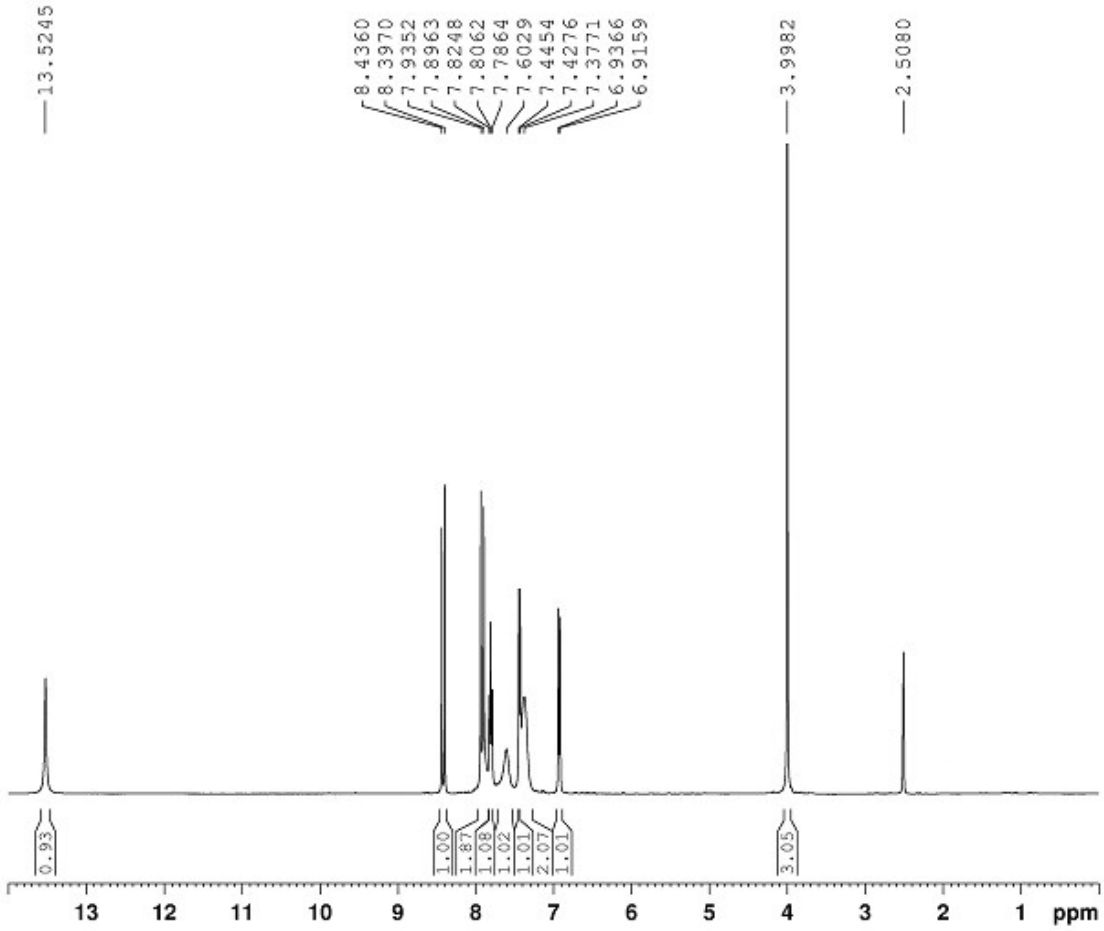
^{1}H NMR spectrum of compound **A9**



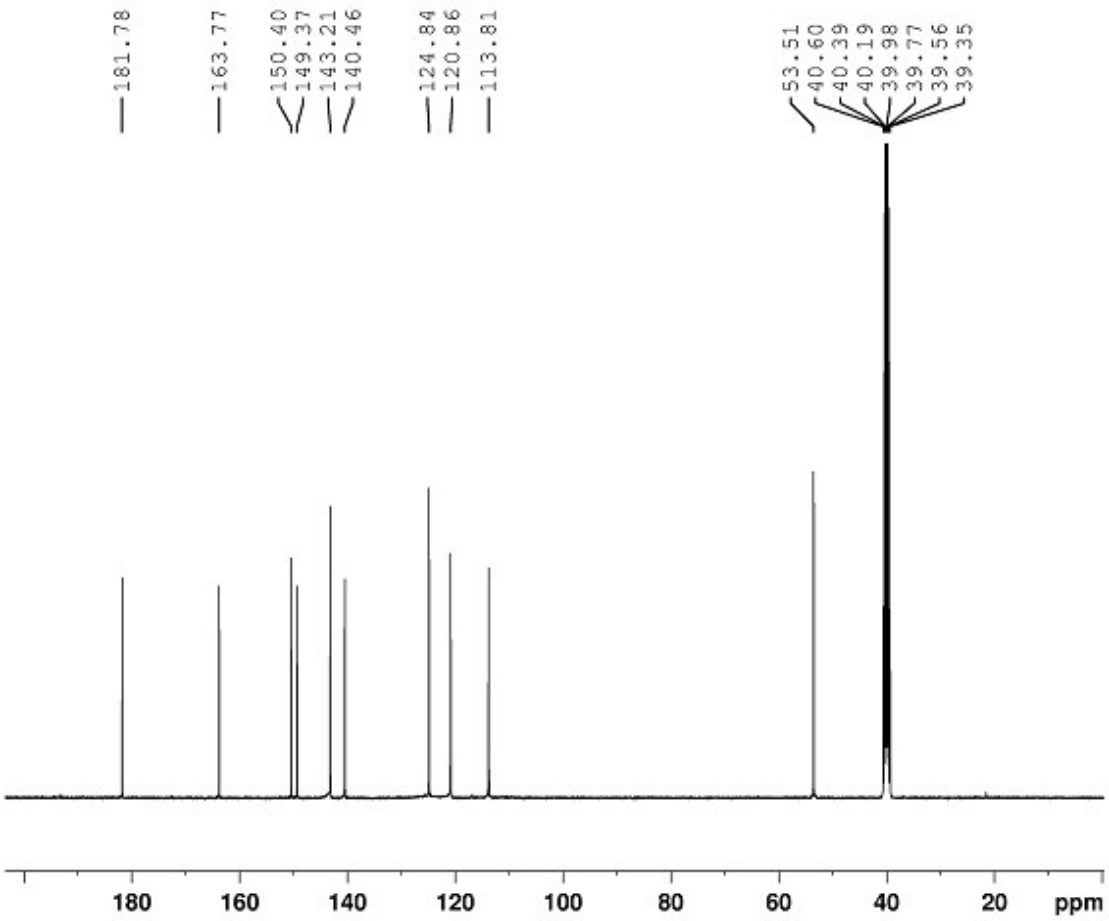
^{13}C NMR spectrum of compound **A9**



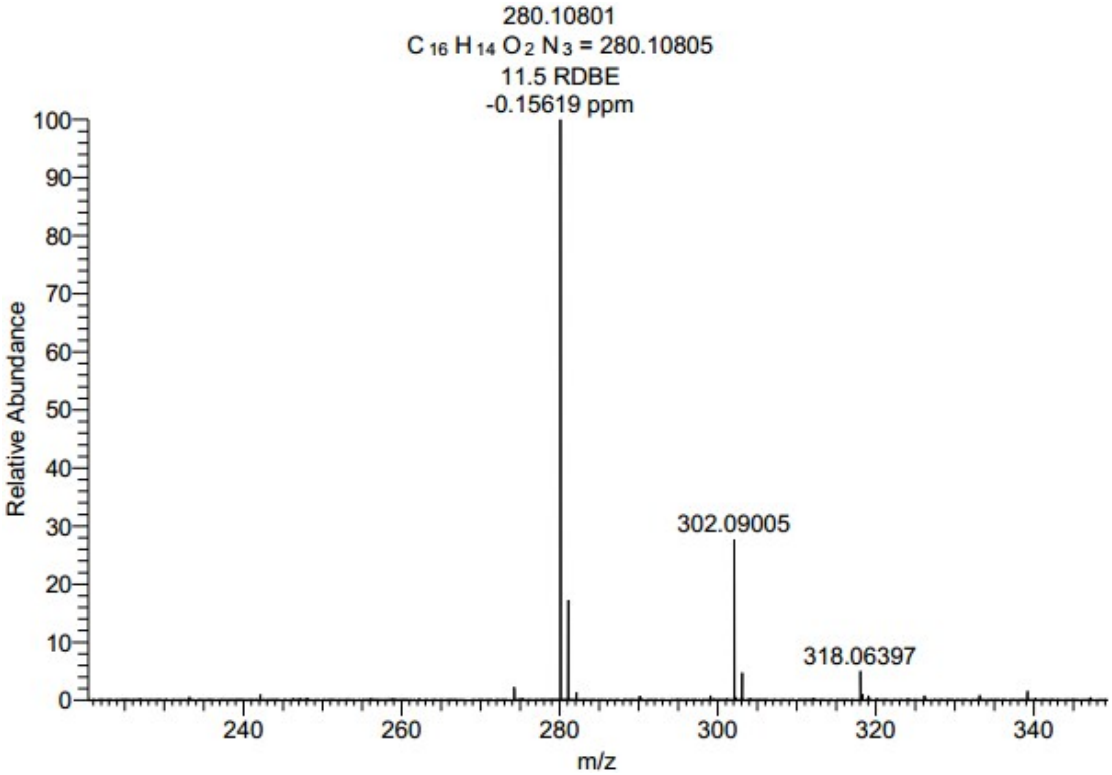
High resolution mass spectrum of compound **A9**



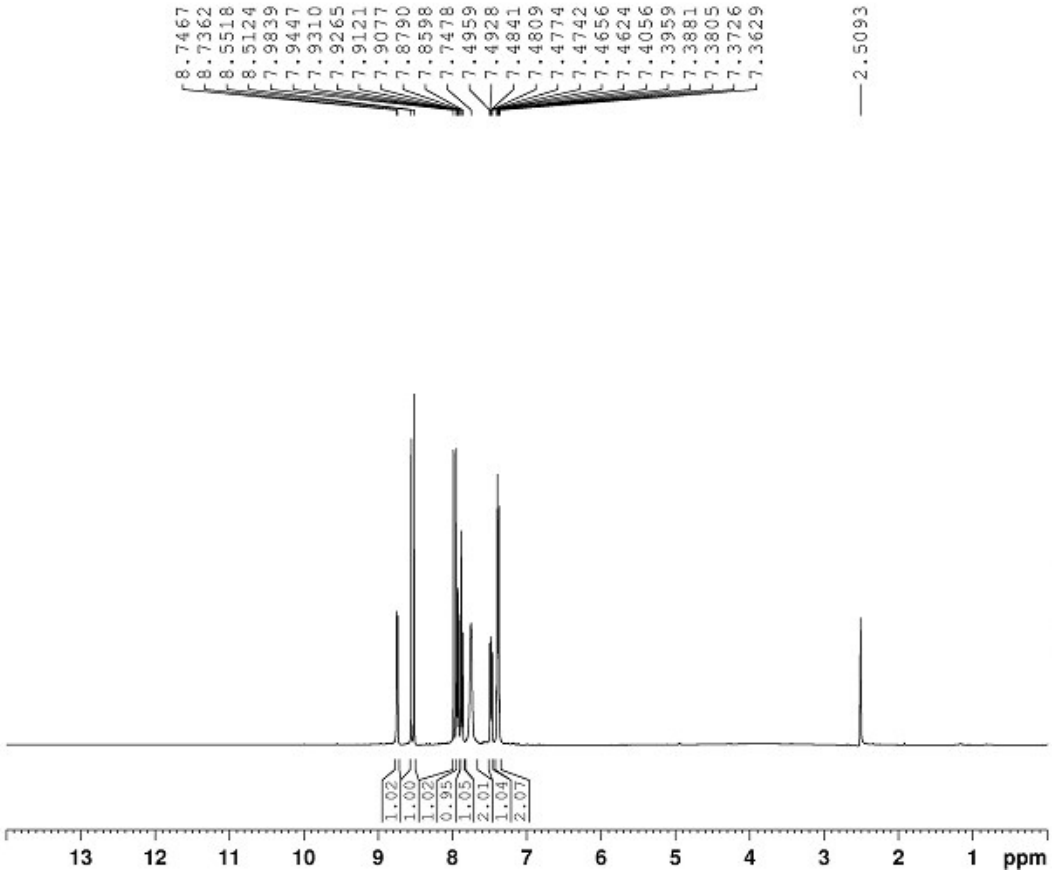
^{1}H NMR spectrum of compound **A10**



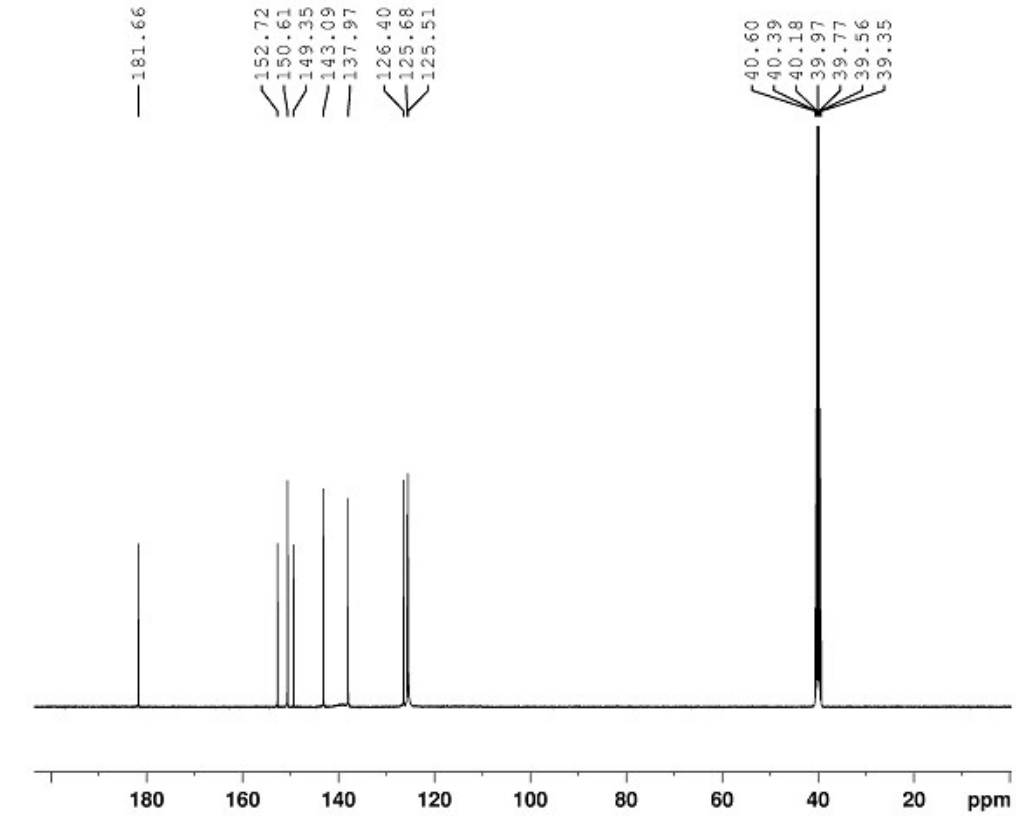
^{13}C NMR spectrum of compound **A10**



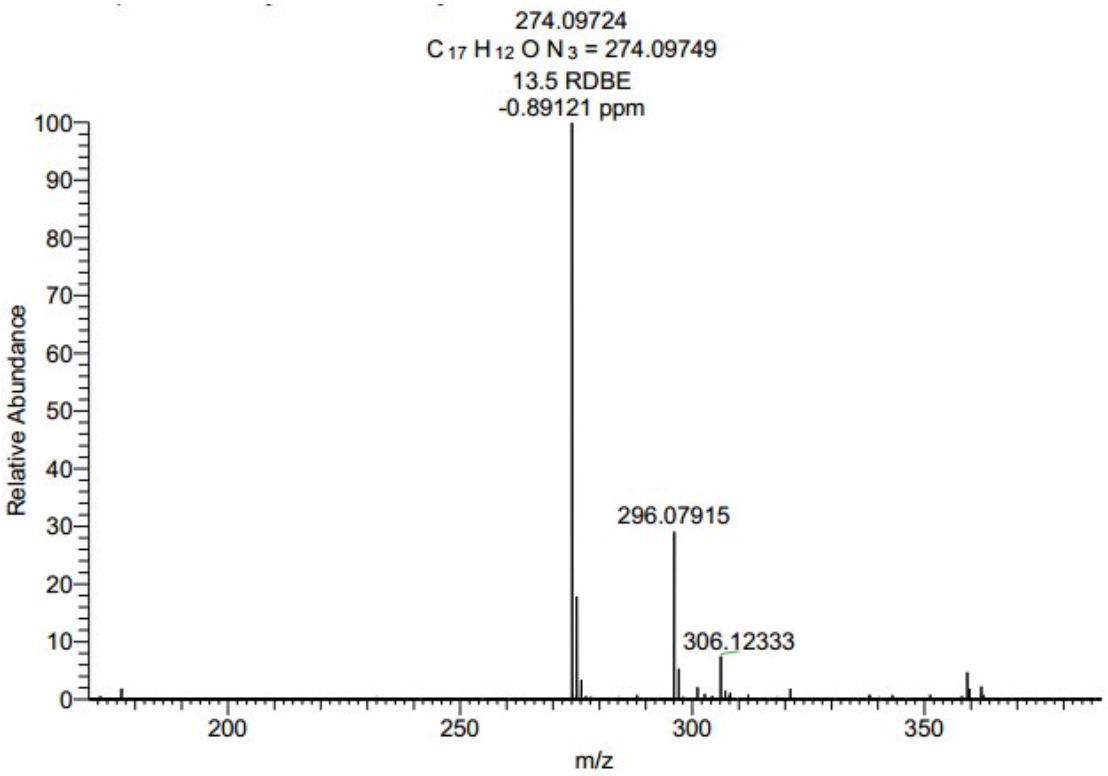
High resolution mass spectrum of compound **A10**



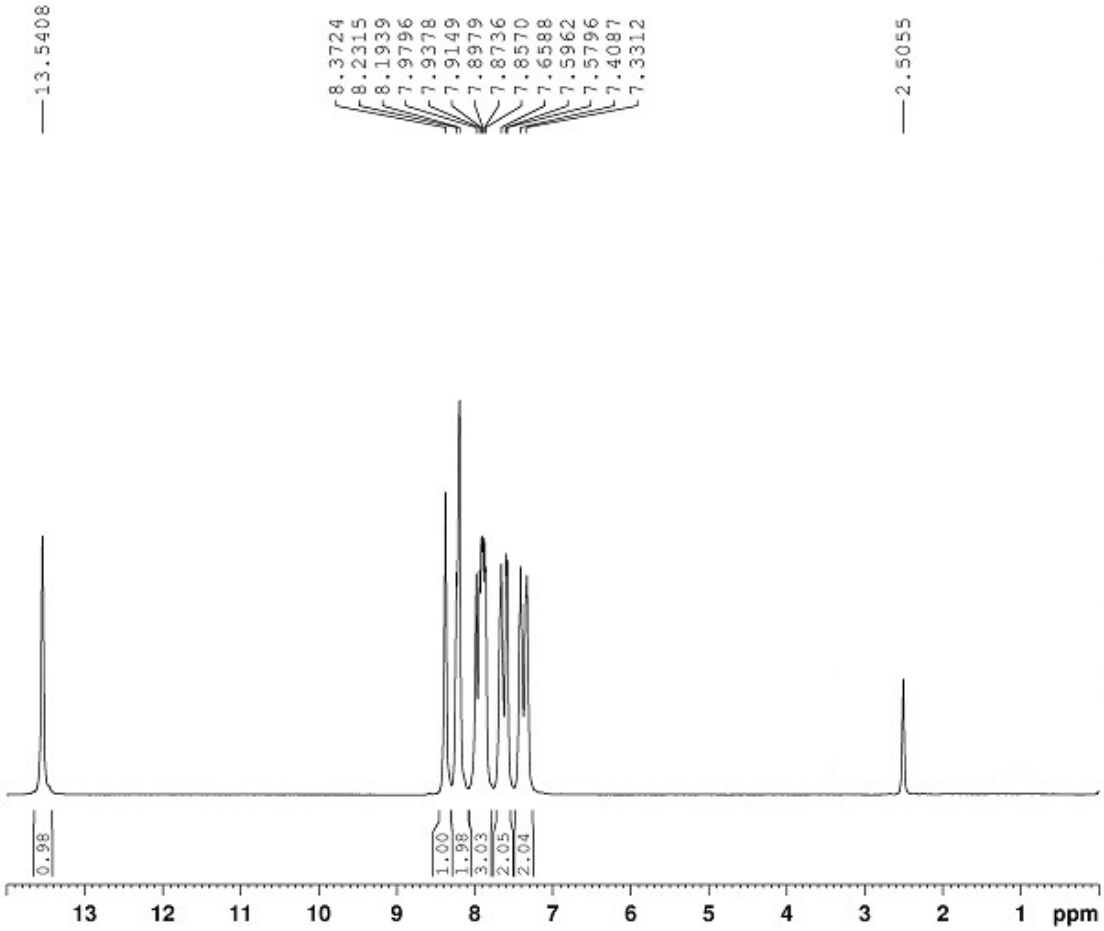
^{1}H NMR spectrum of compound **A11**



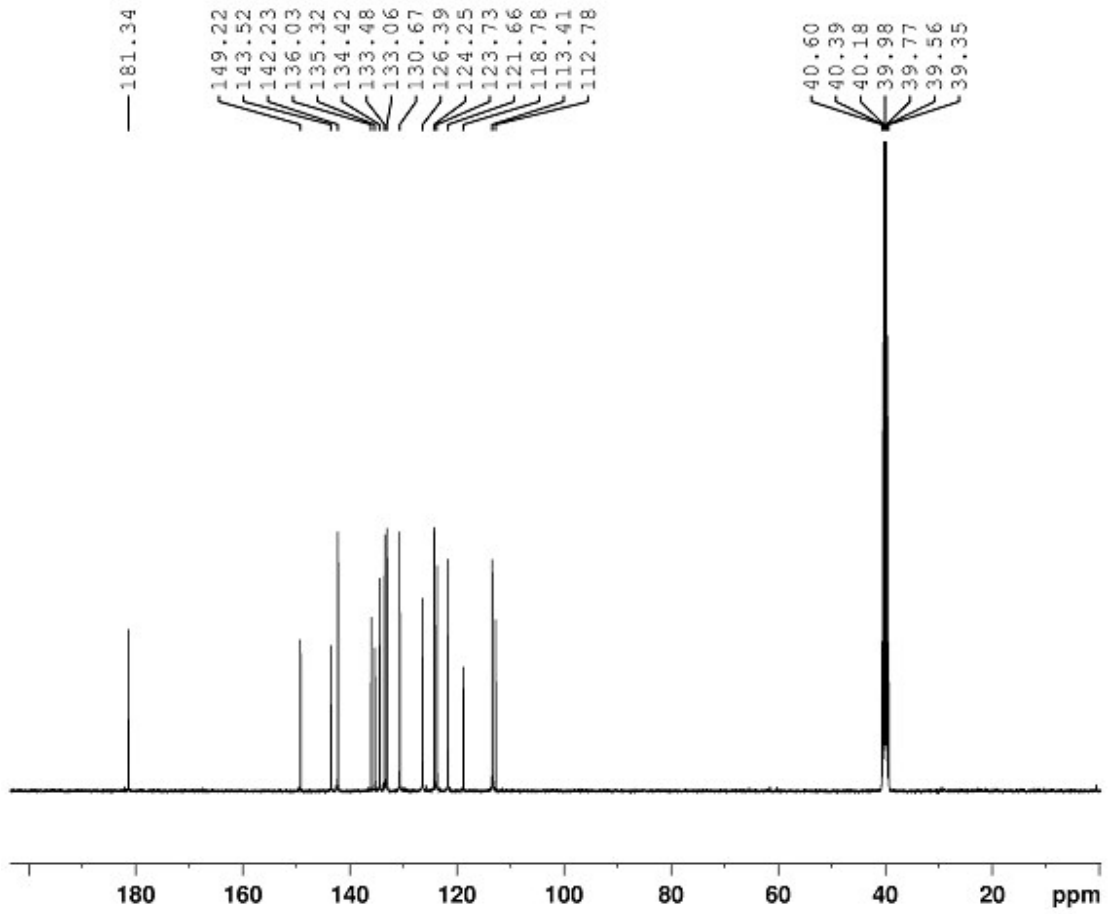
^{13}C NMR spectrum of compound **A11**



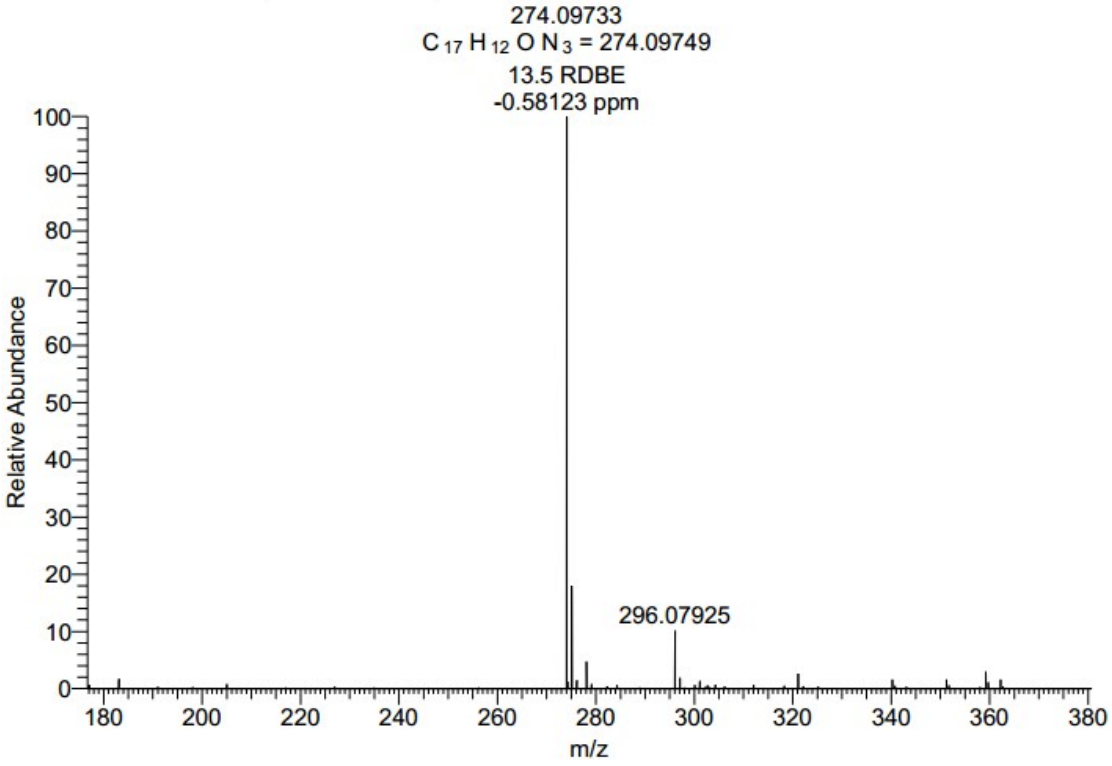
High resolution mass spectrum of compound **A11**



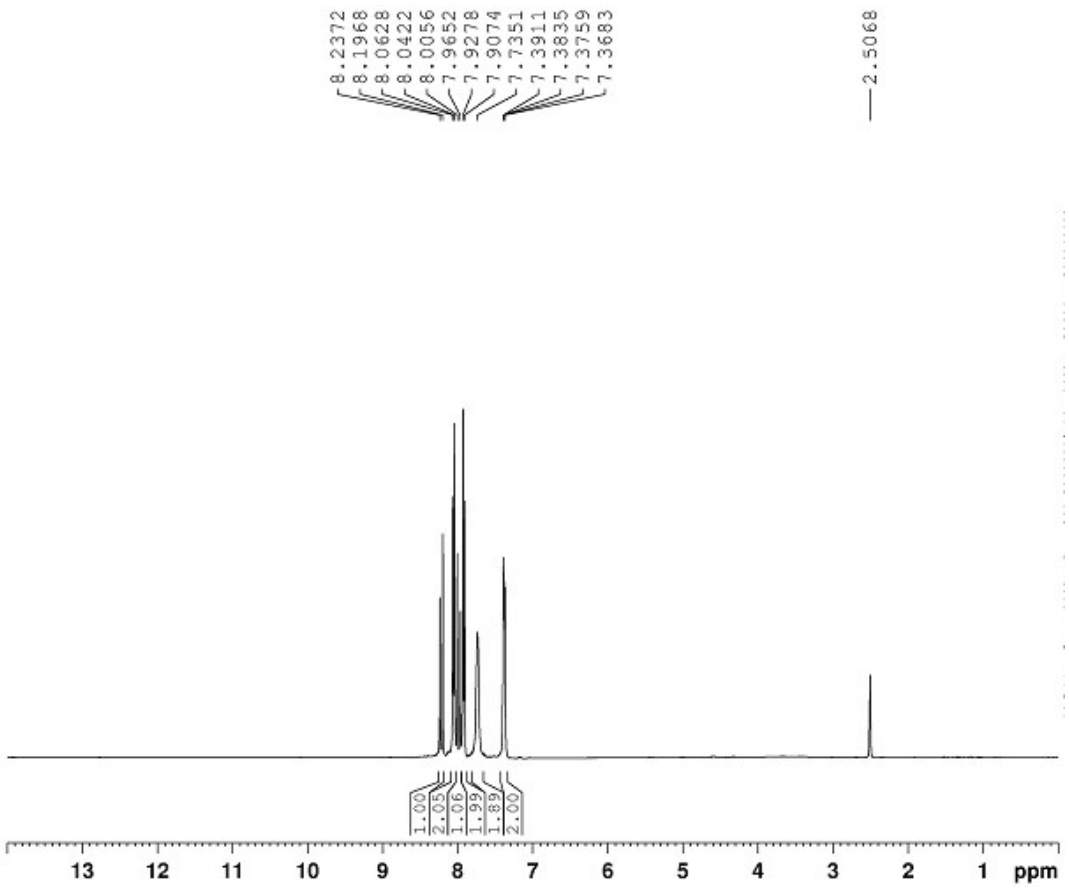
^{1}H NMR spectrum of compound **A12**



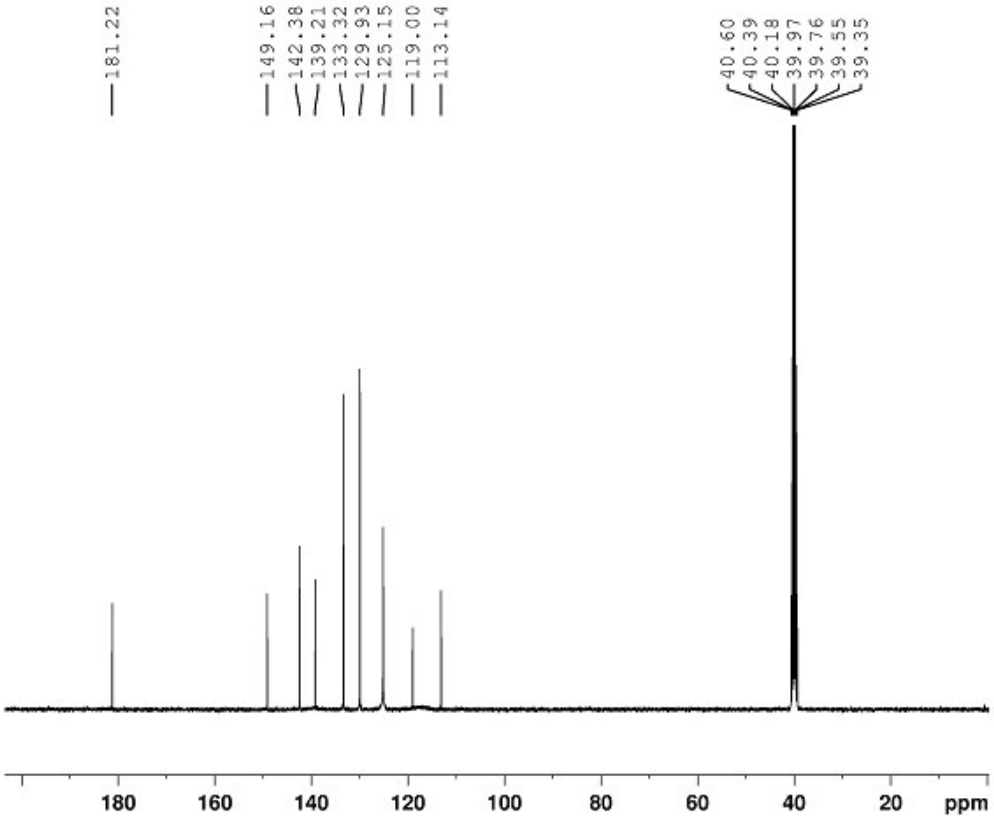
^{13}C NMR spectrum of compound **A12**



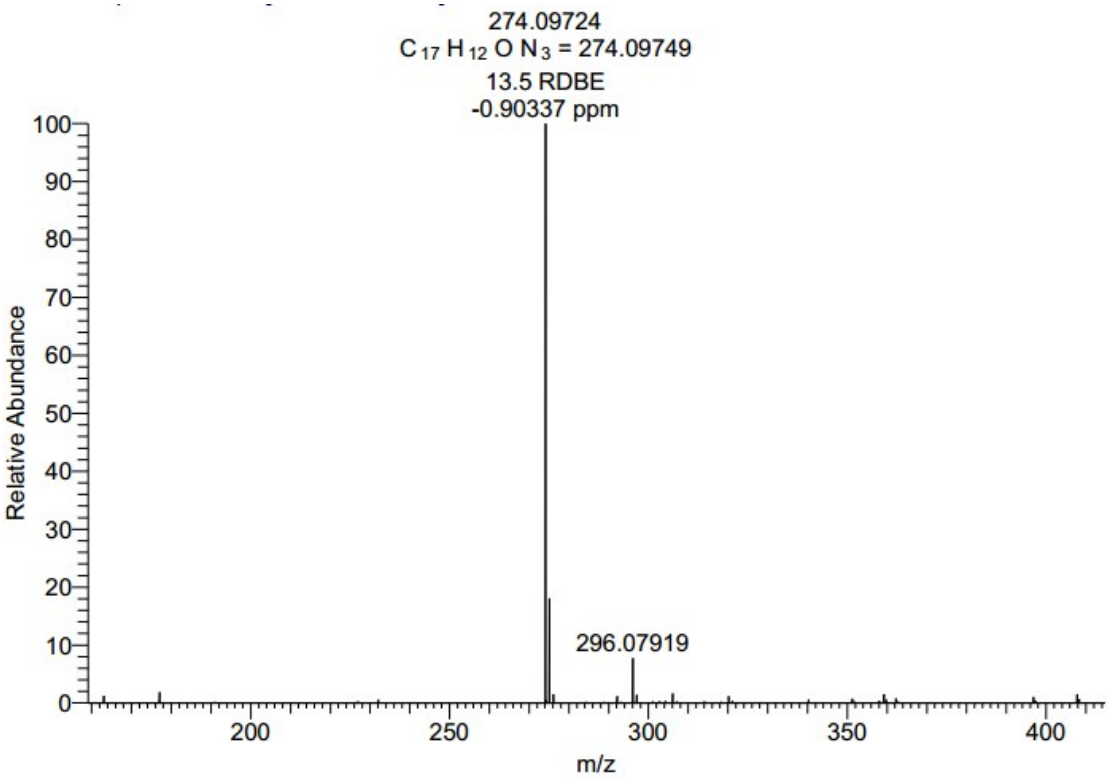
High resolution mass spectrum of compound **A12**



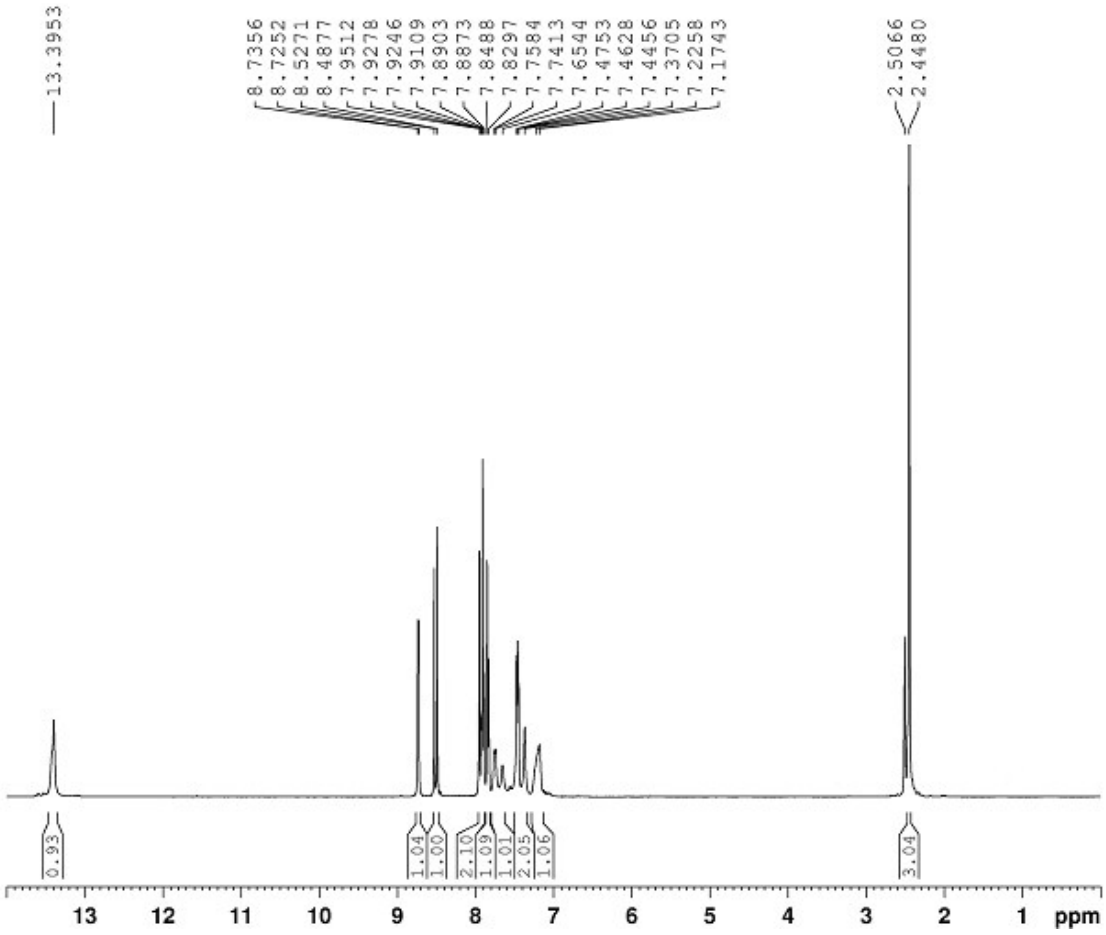
^{1}H NMR spectrum of compound **A13**



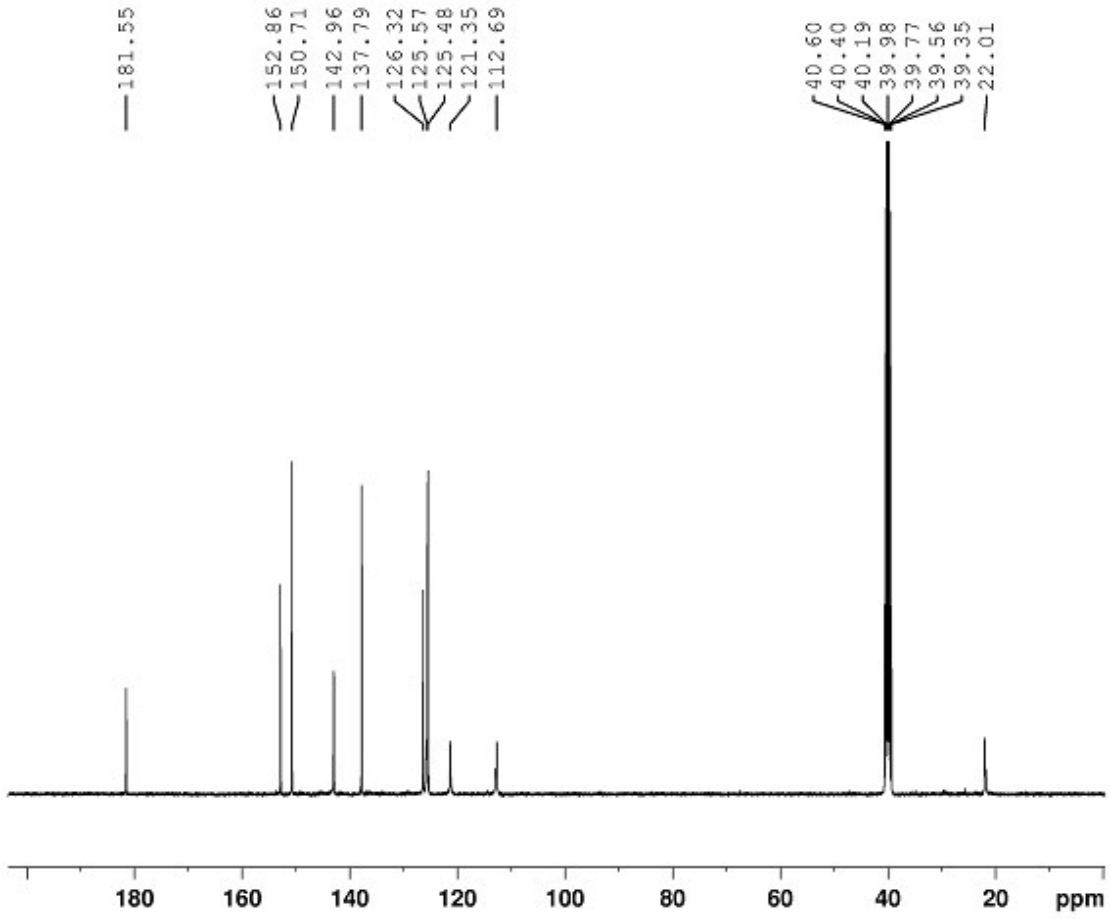
^{13}C NMR spectrum of compound **A13**



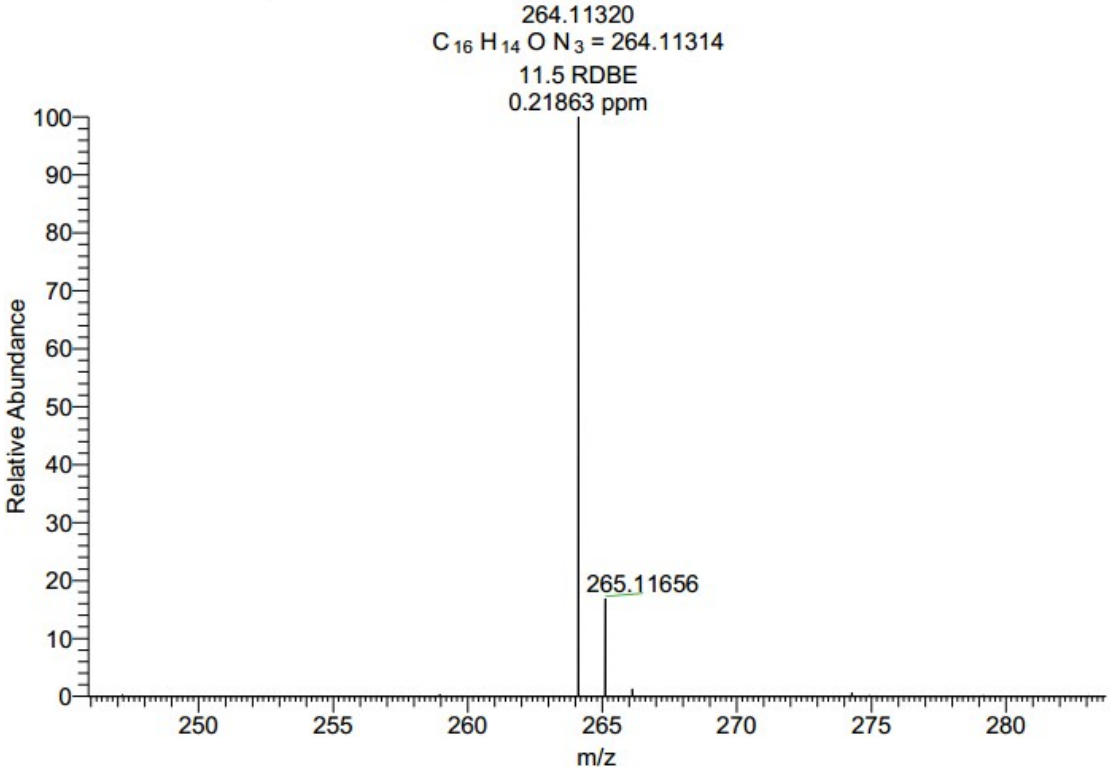
High resolution mass spectrum of compound **A13**



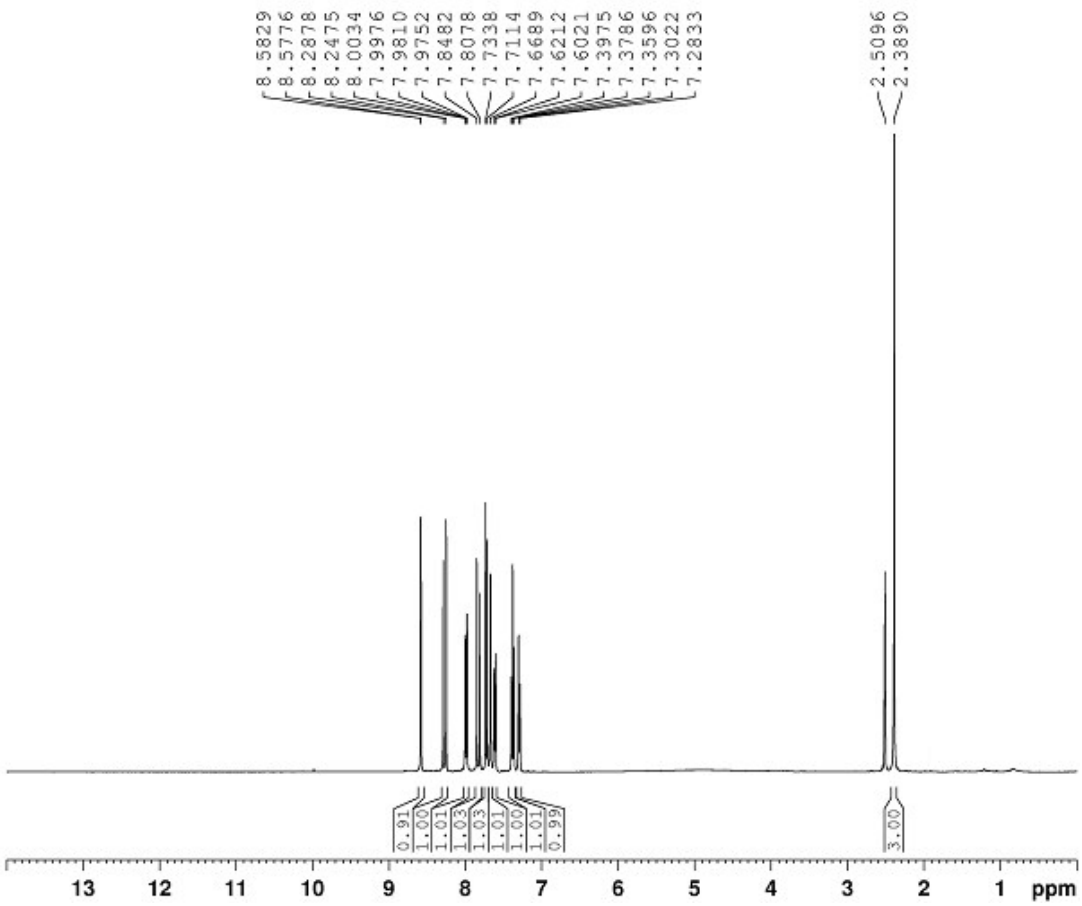
^{1}H NMR spectrum of compound **A14**



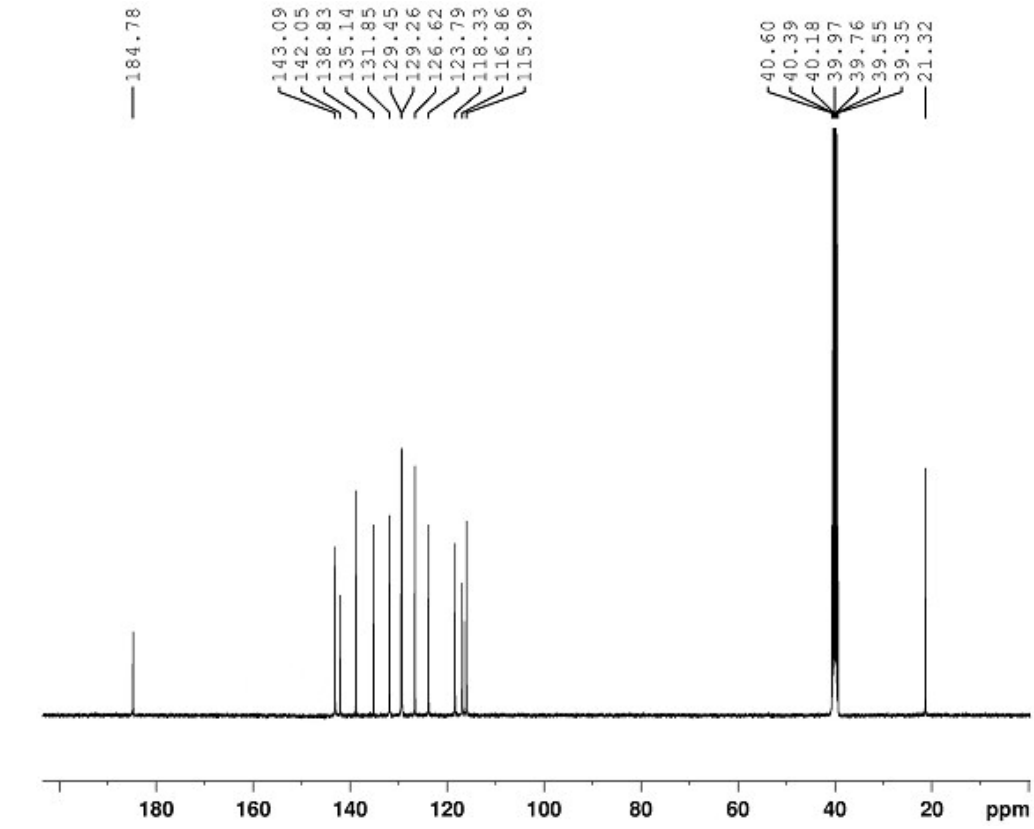
^{13}C NMR spectrum of compound **A14**



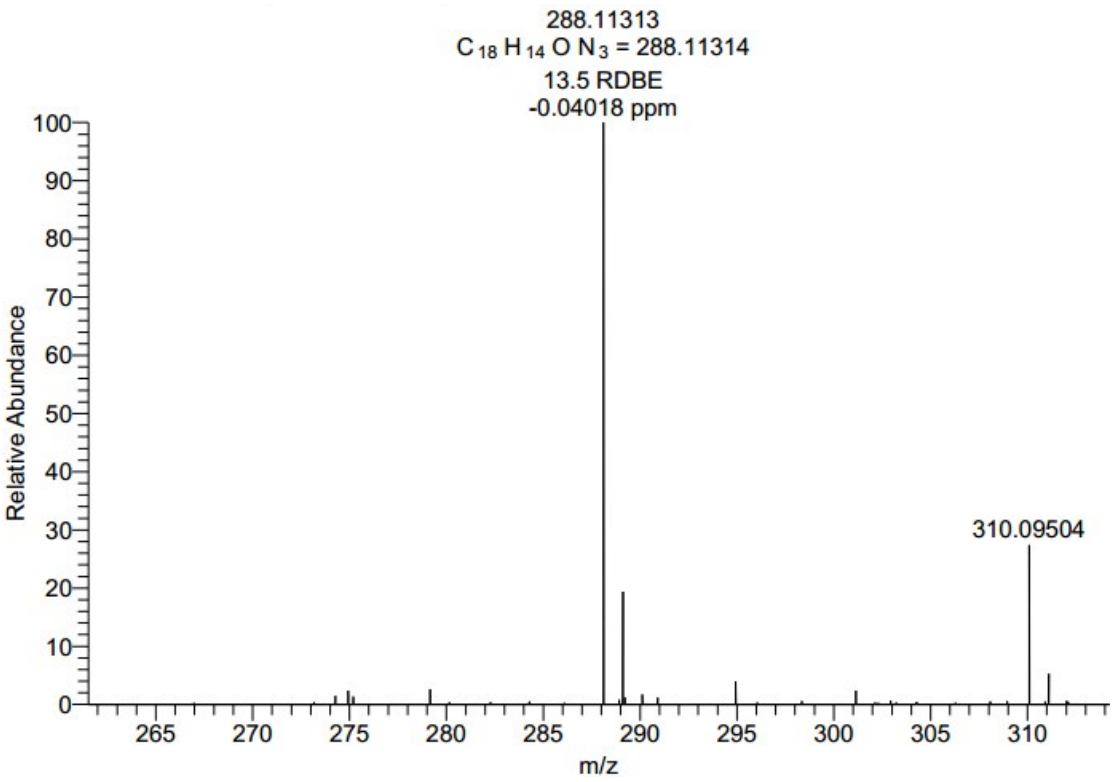
High resolution mass spectrum of compound **A14**



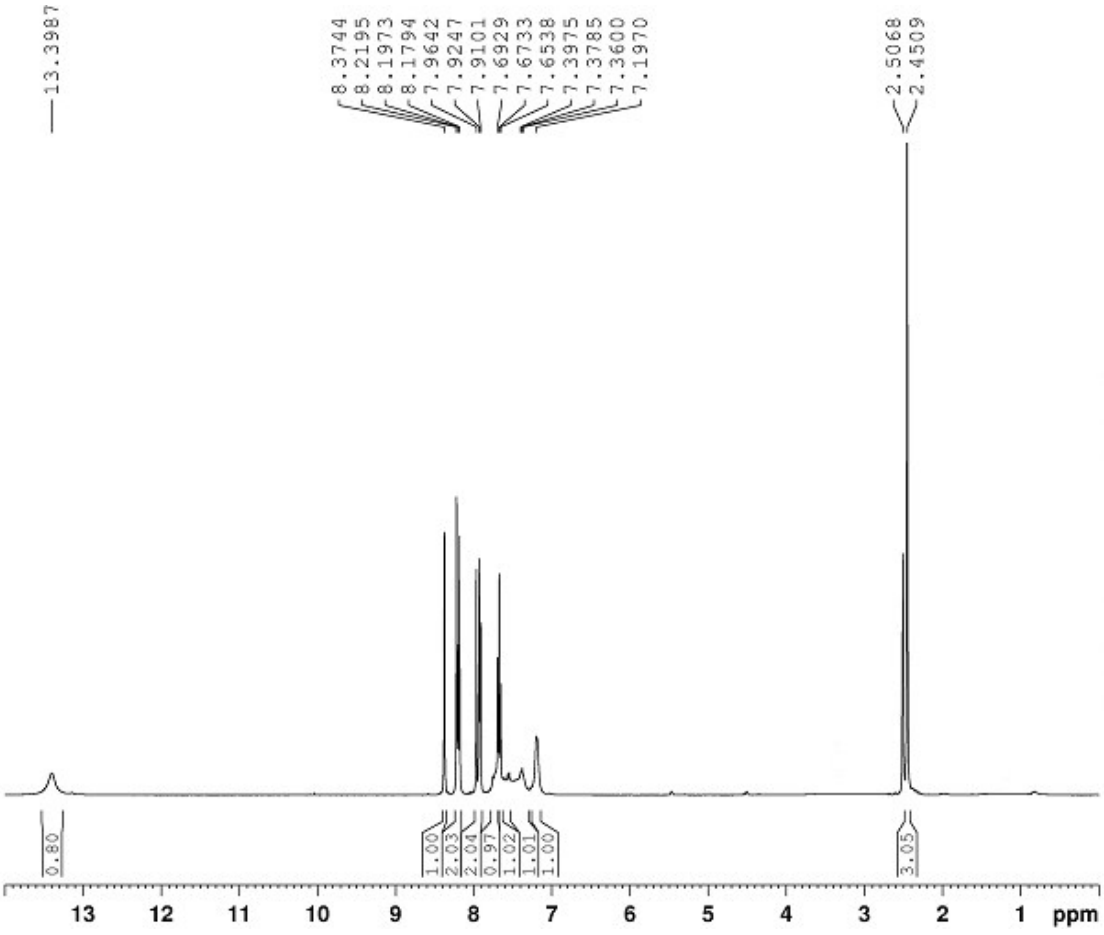
^{1}H NMR spectrum of compound **A15**



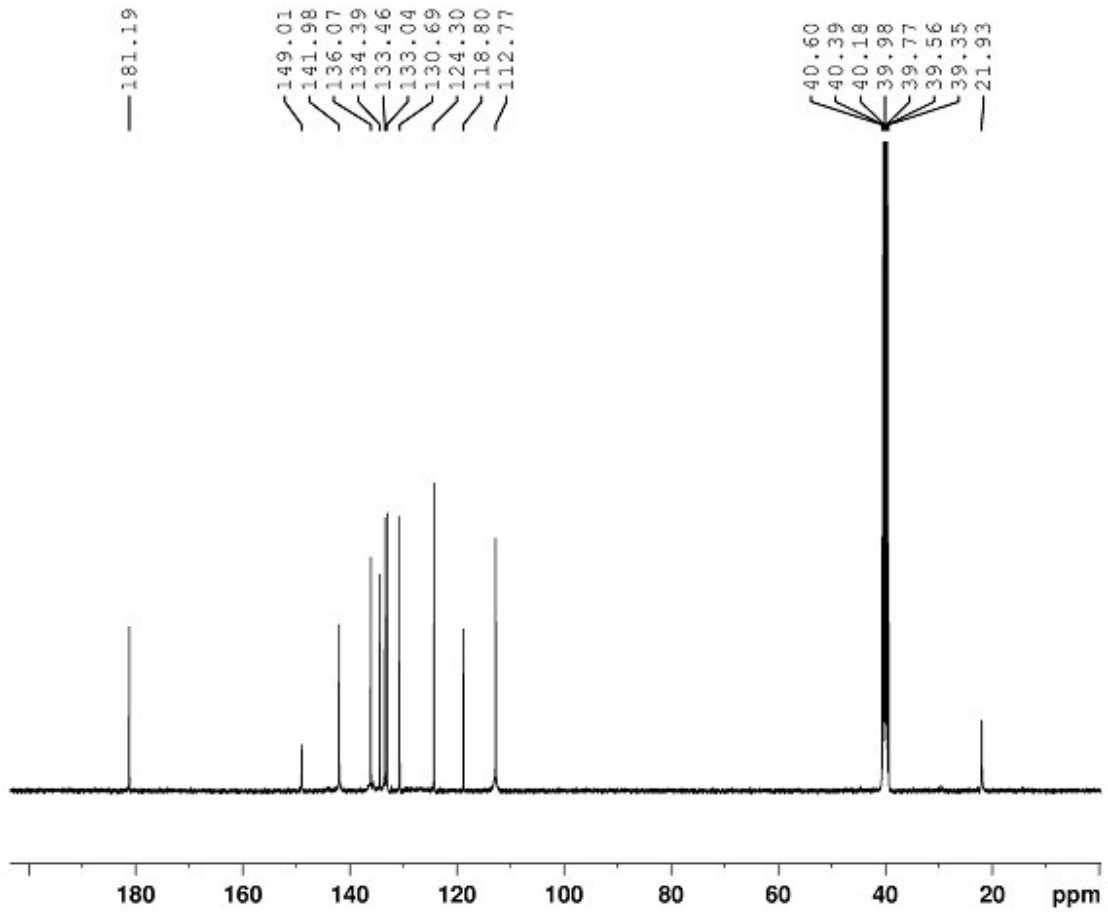
^{13}C NMR spectrum of compound **A15**



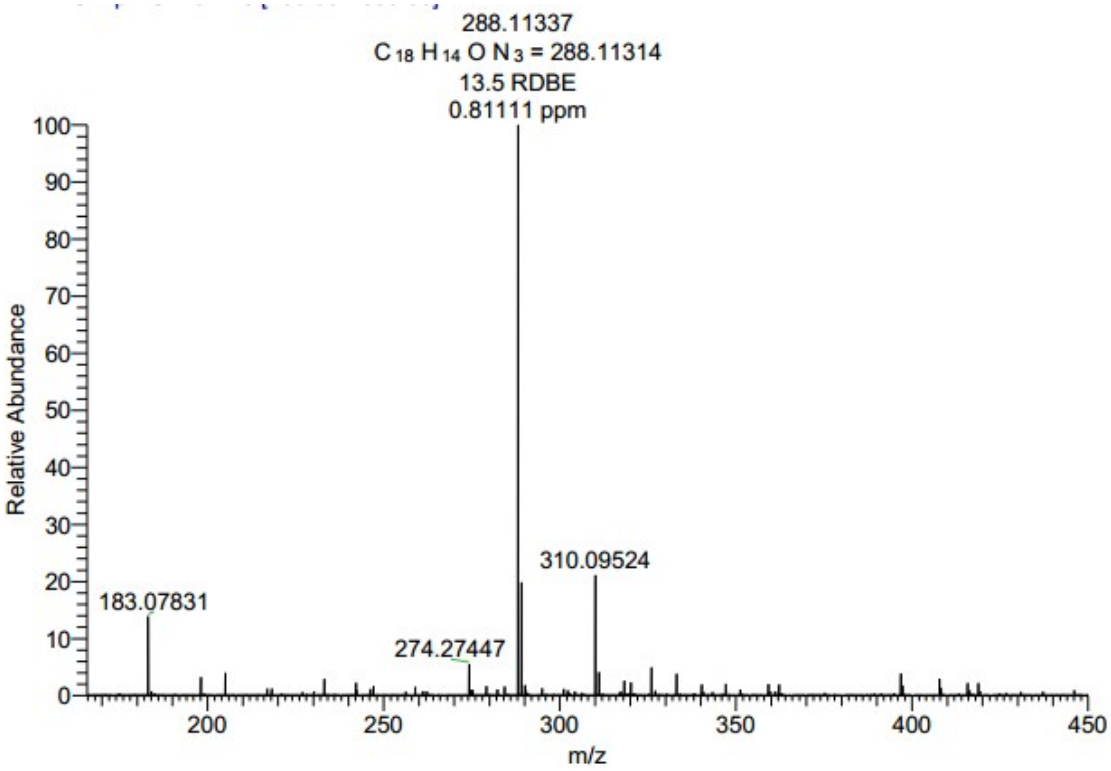
High resolution mass spectrum of compound **A15**



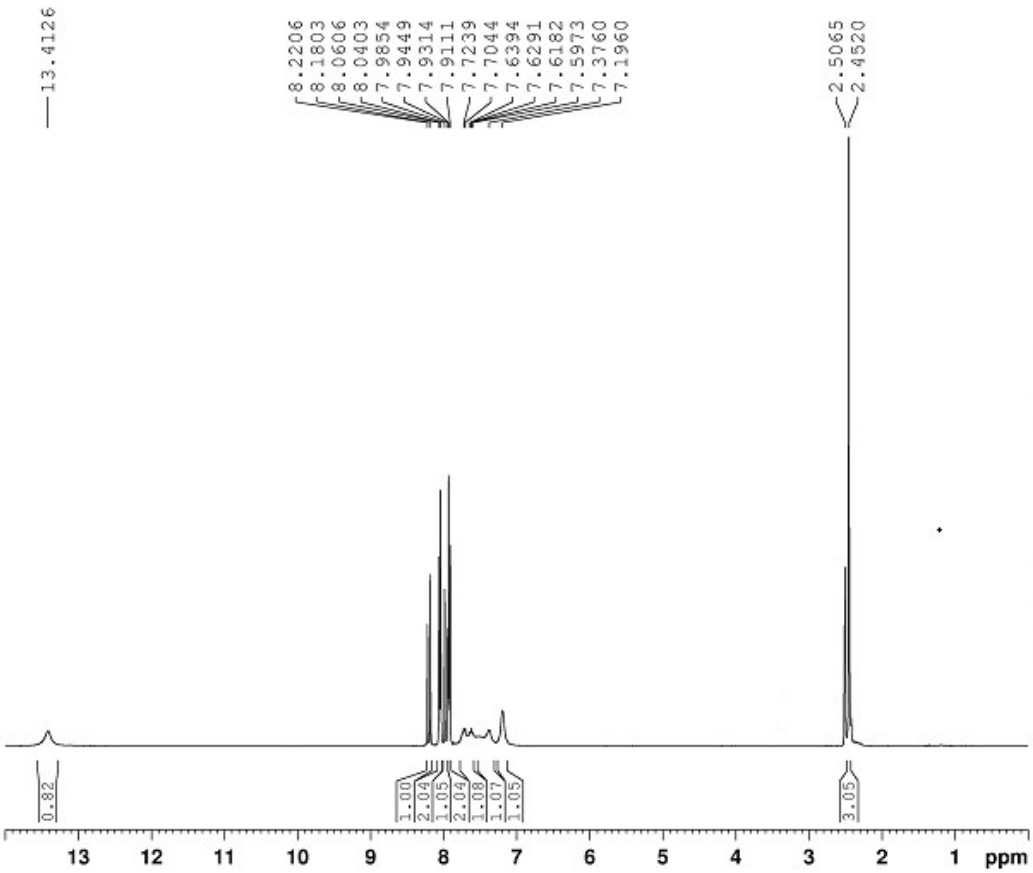
^{1}H NMR spectrum of compound **A16**



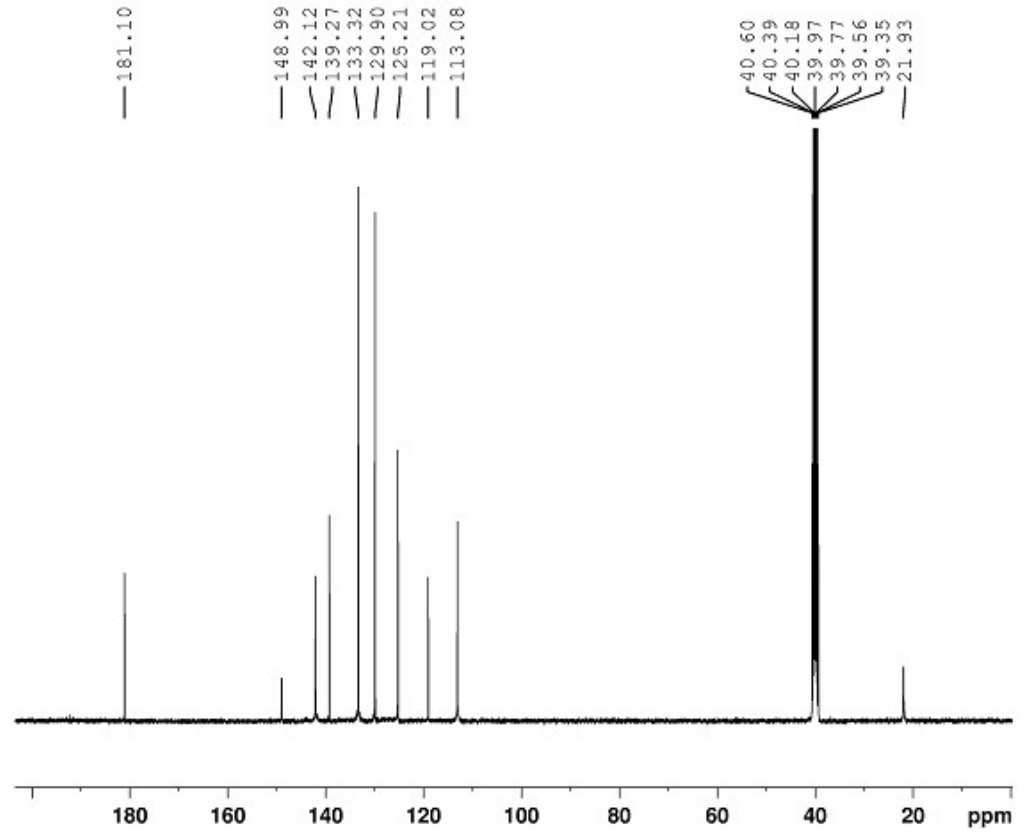
^{13}C NMR spectrum of compound **A16**



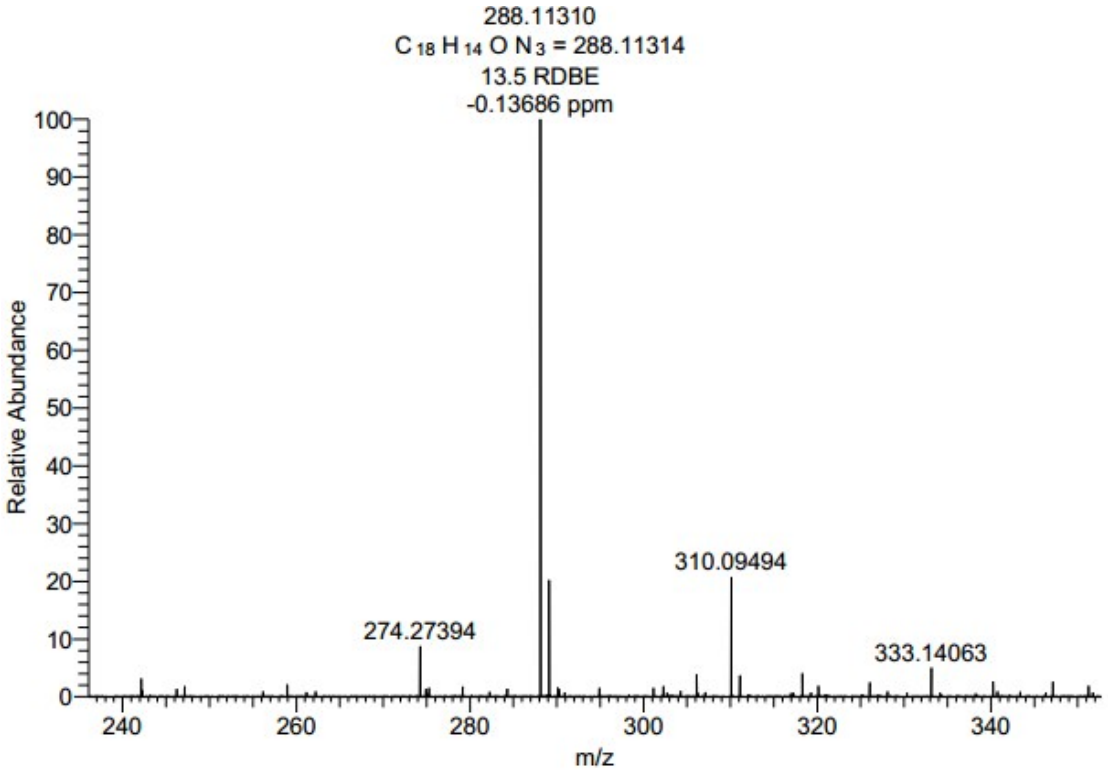
High resolution mass spectrum of compound **A16**



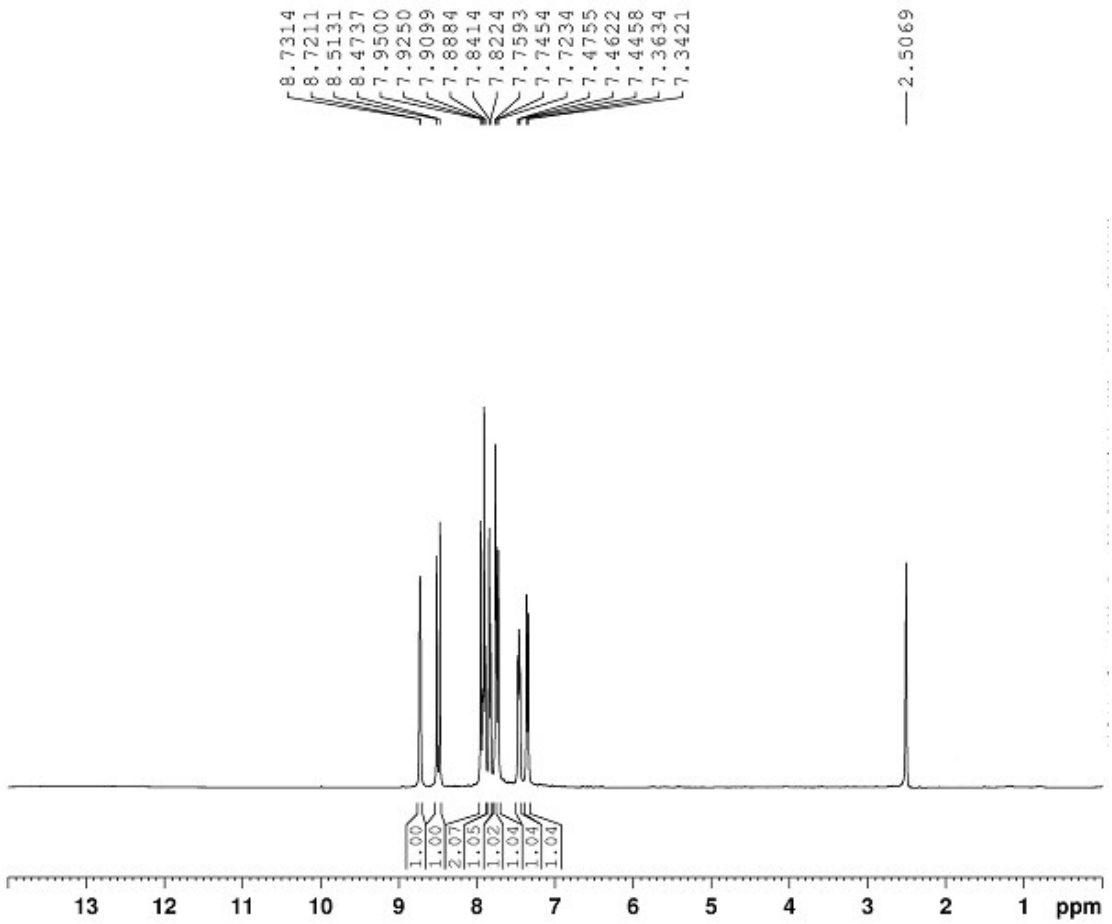
^{1}H NMR spectrum of compound **A17**



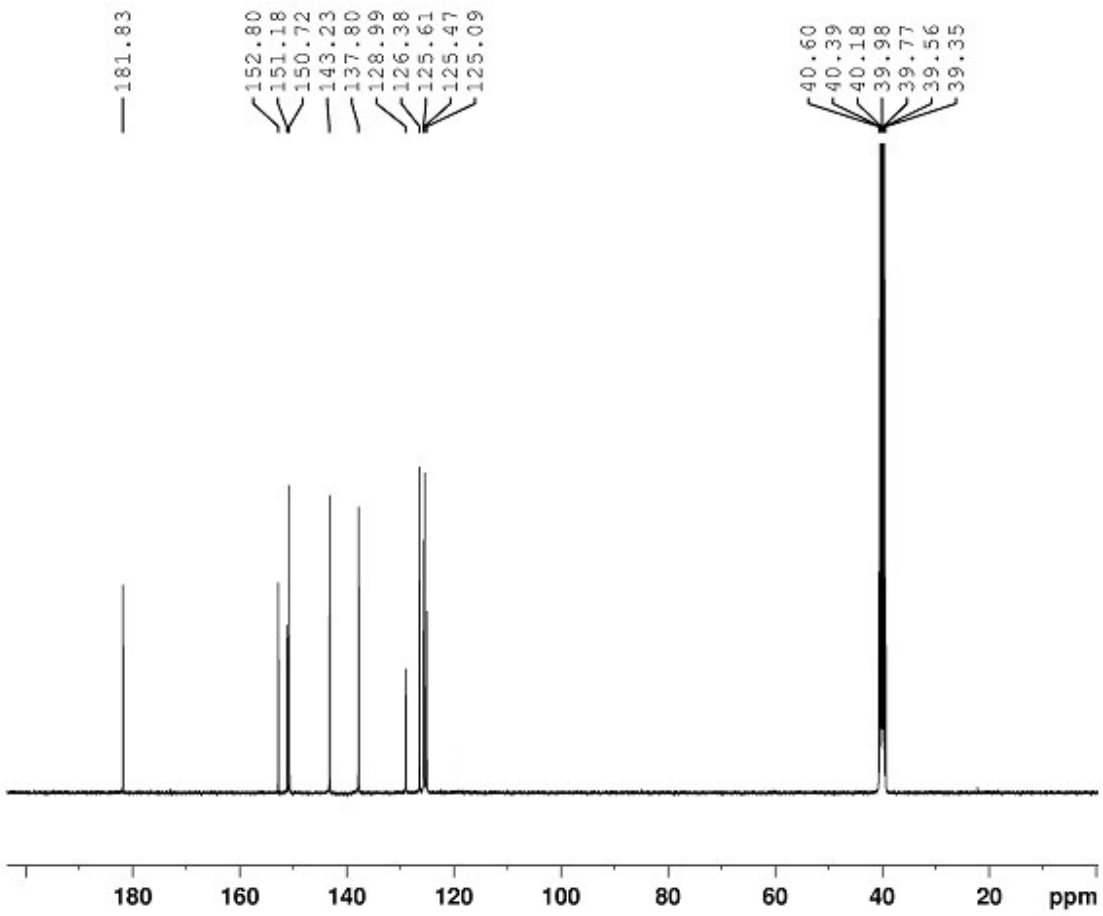
^{13}C NMR spectrum of compound **A17**



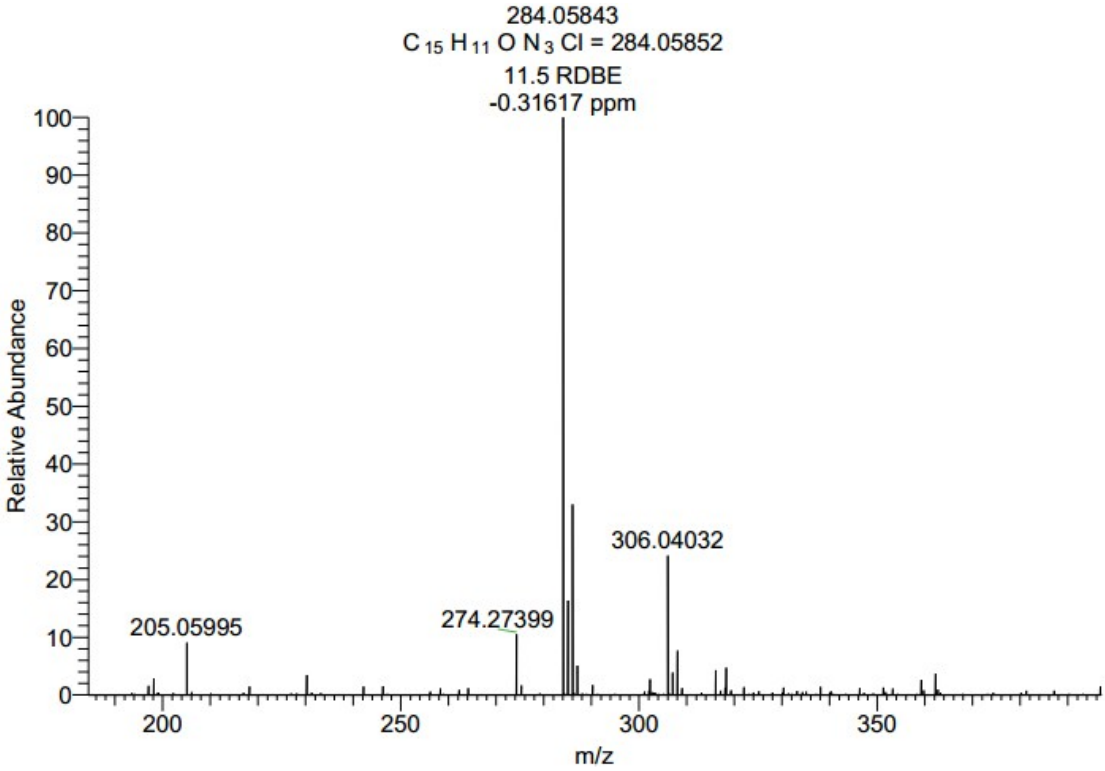
High resolution mass spectrum of compound **A17**



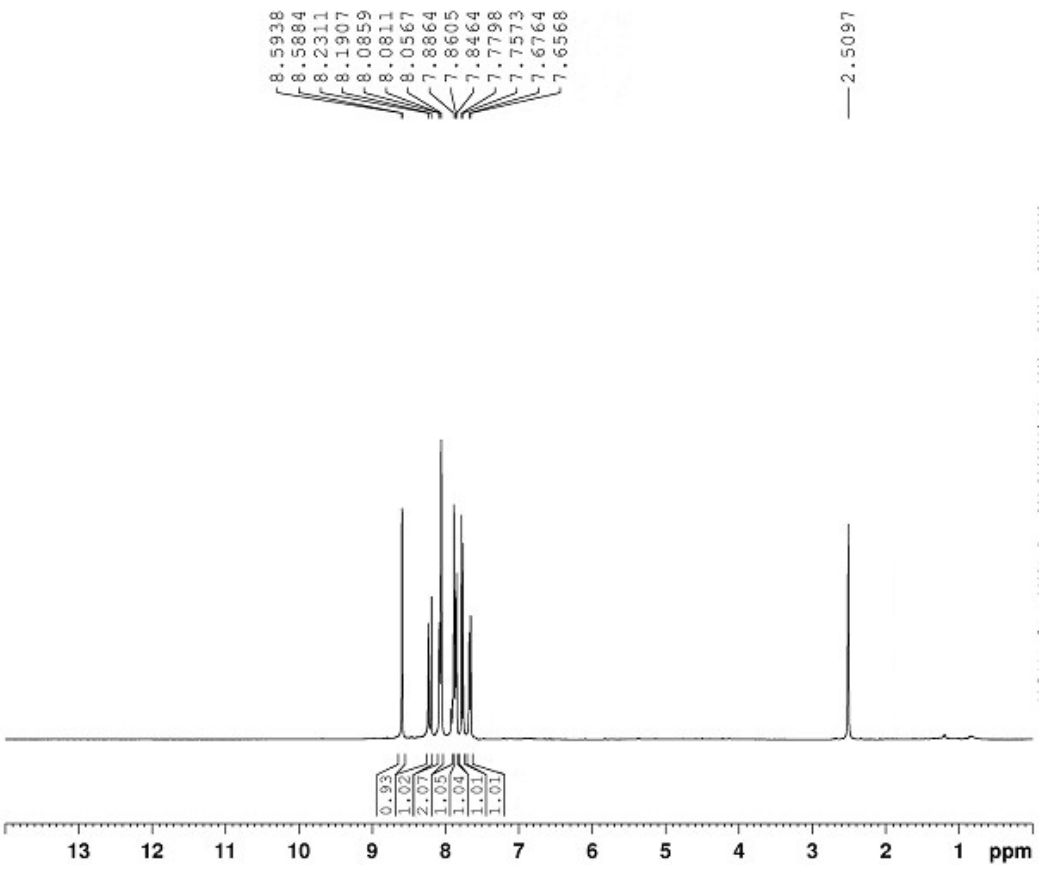
^{1}H NMR spectrum of compound **A18**



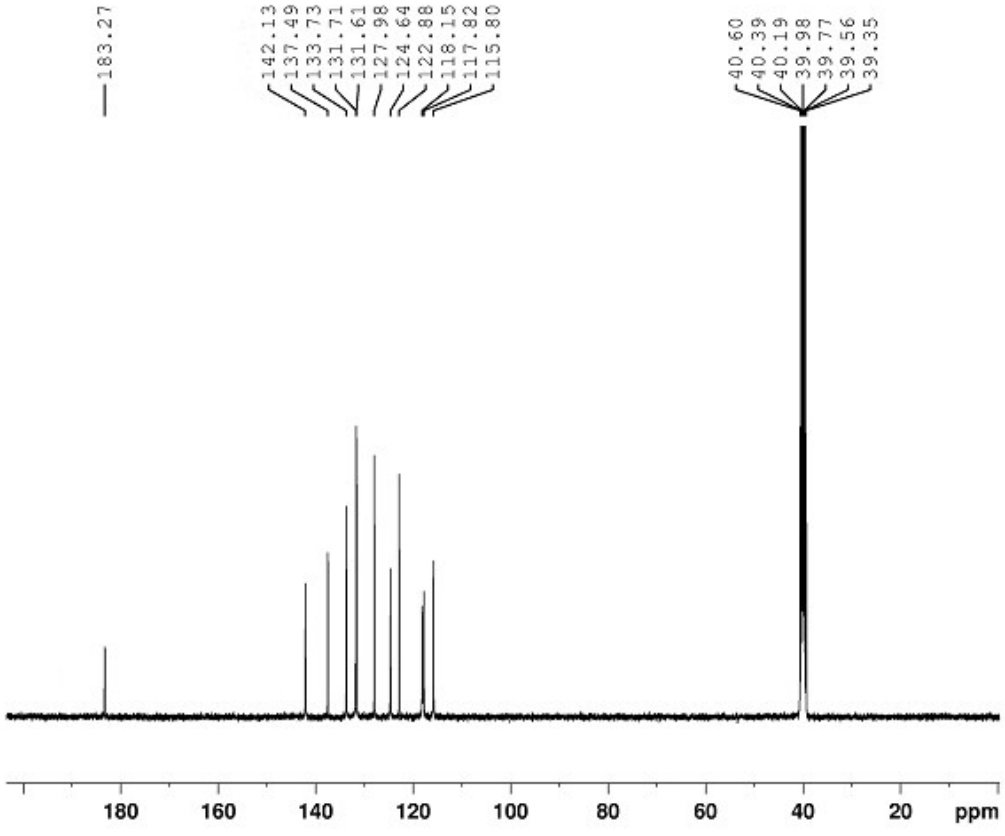
^{13}C NMR spectrum of compound **A18**



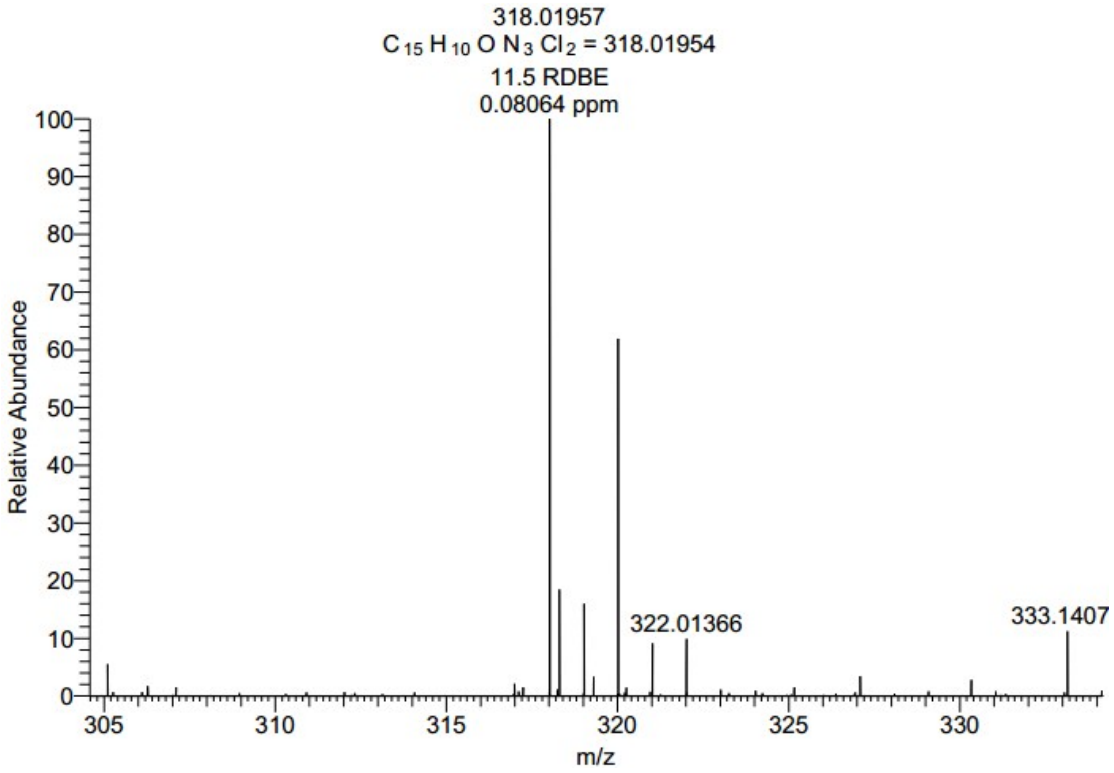
High resolution mass spectrum of compound **A18**



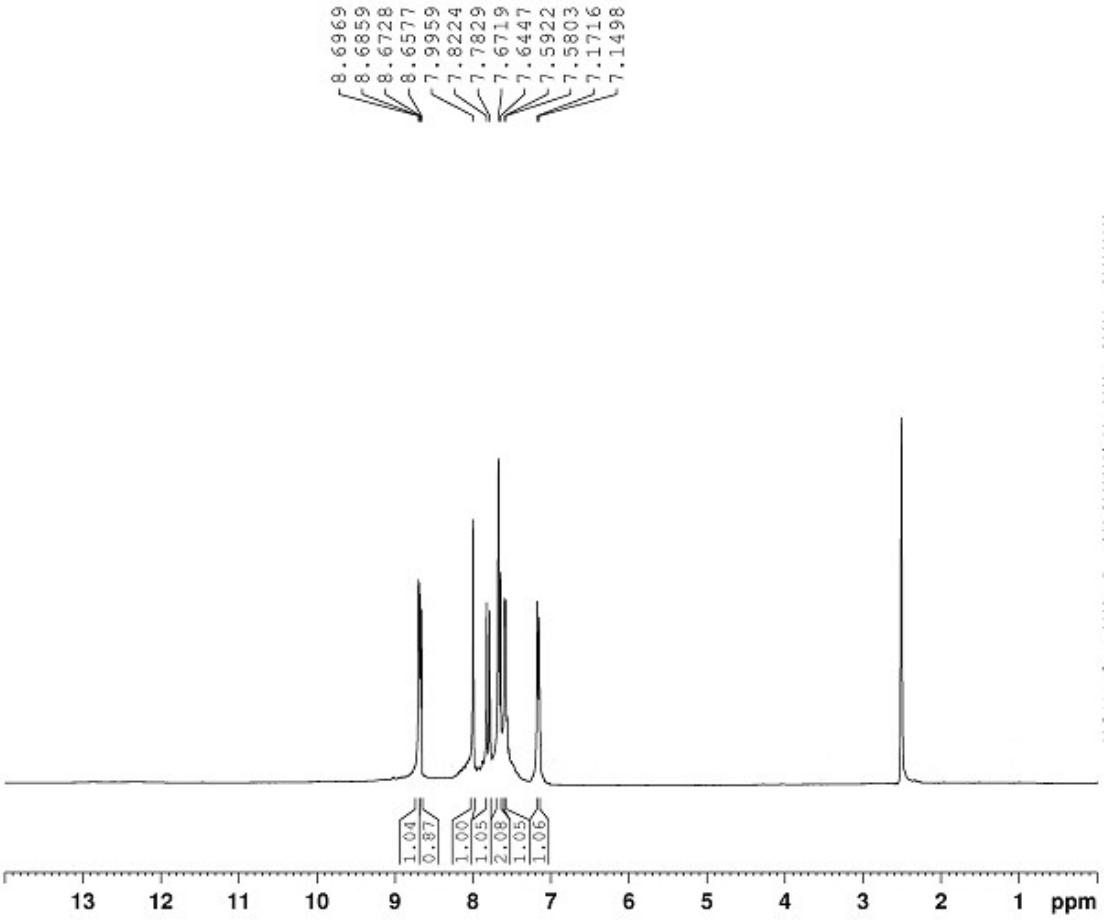
^{1}H NMR spectrum of compound **A19**



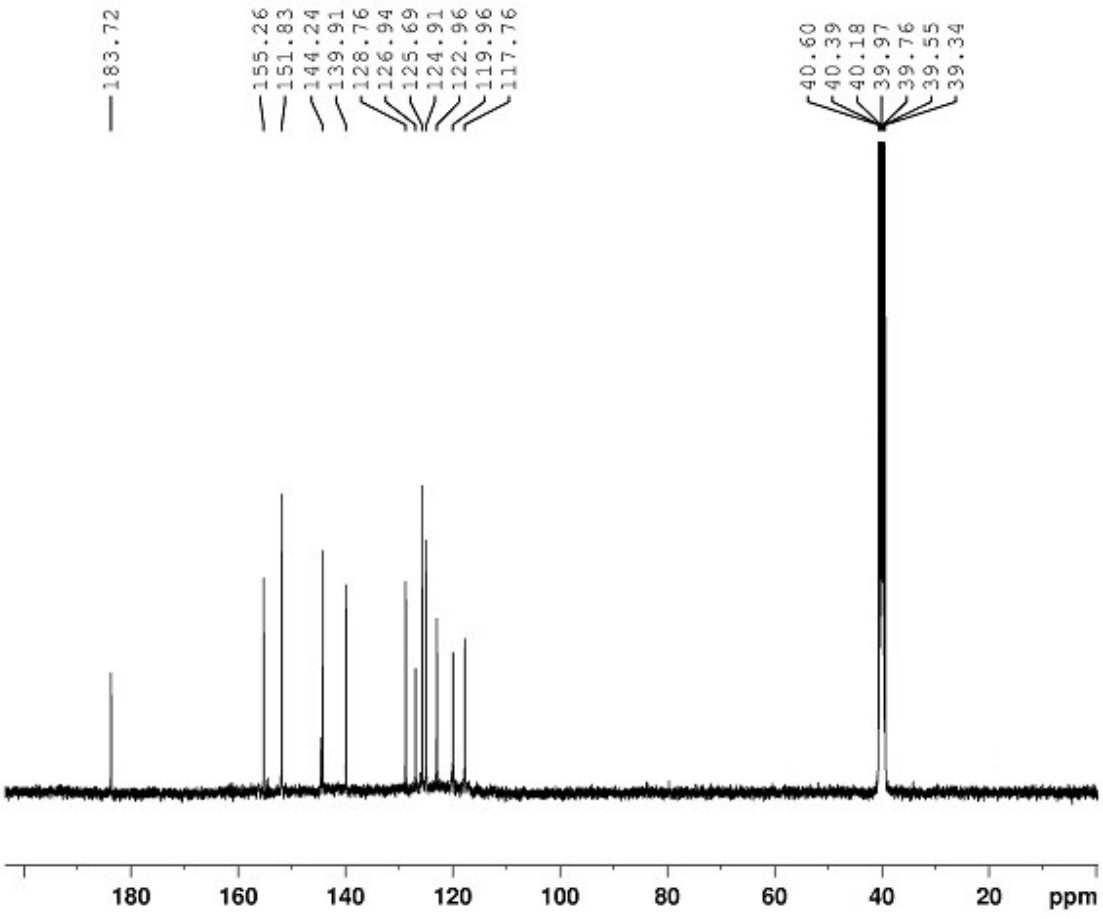
^{13}C NMR spectrum of compound **A19**



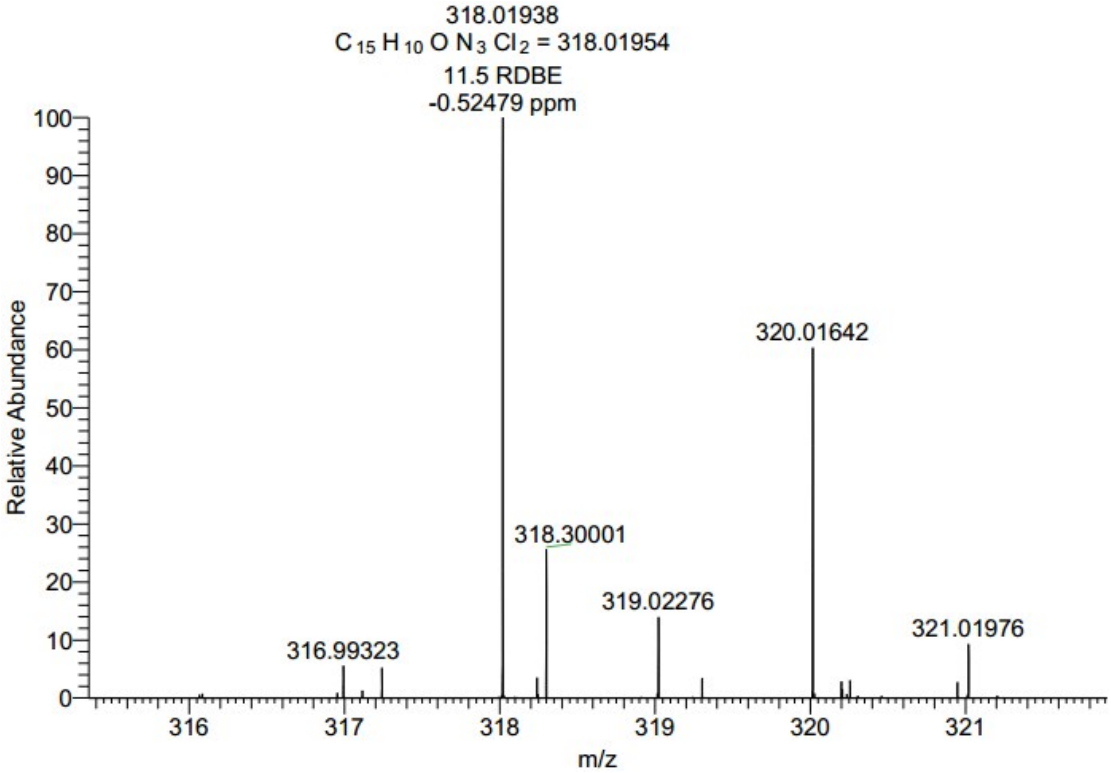
High resolution mass spectrum of compound **A19**



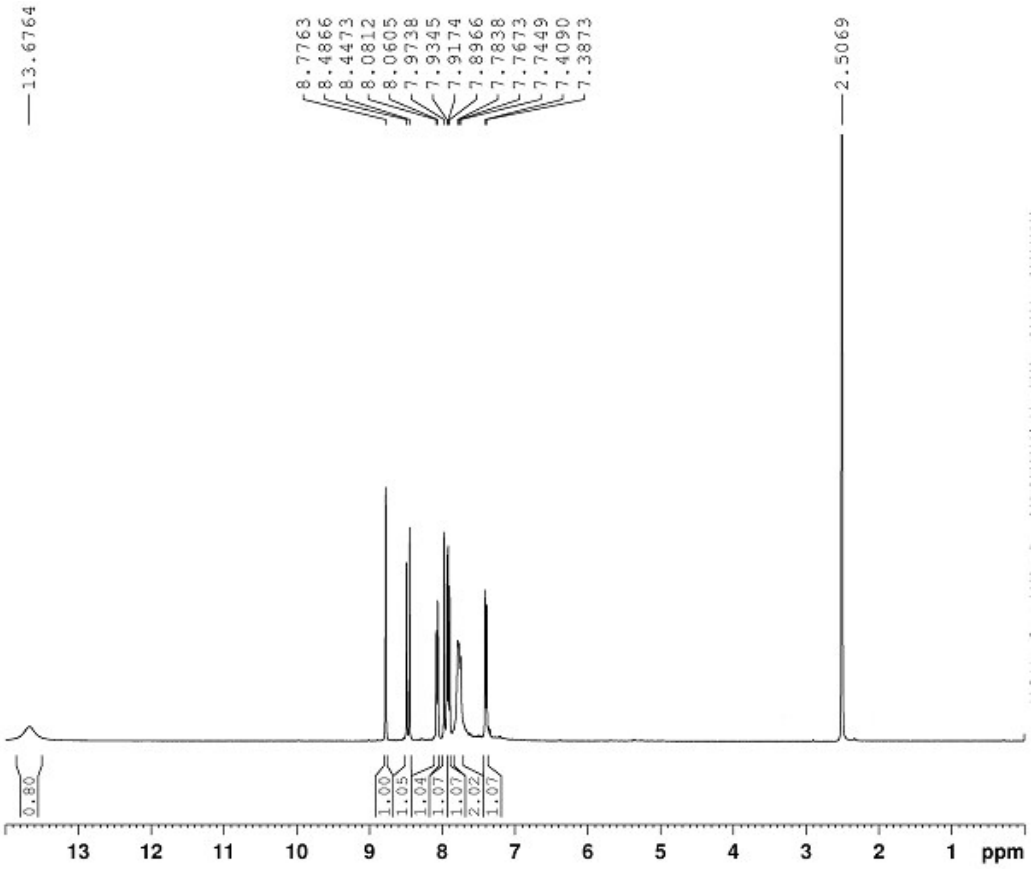
^{1}H NMR spectrum of compound **A20**



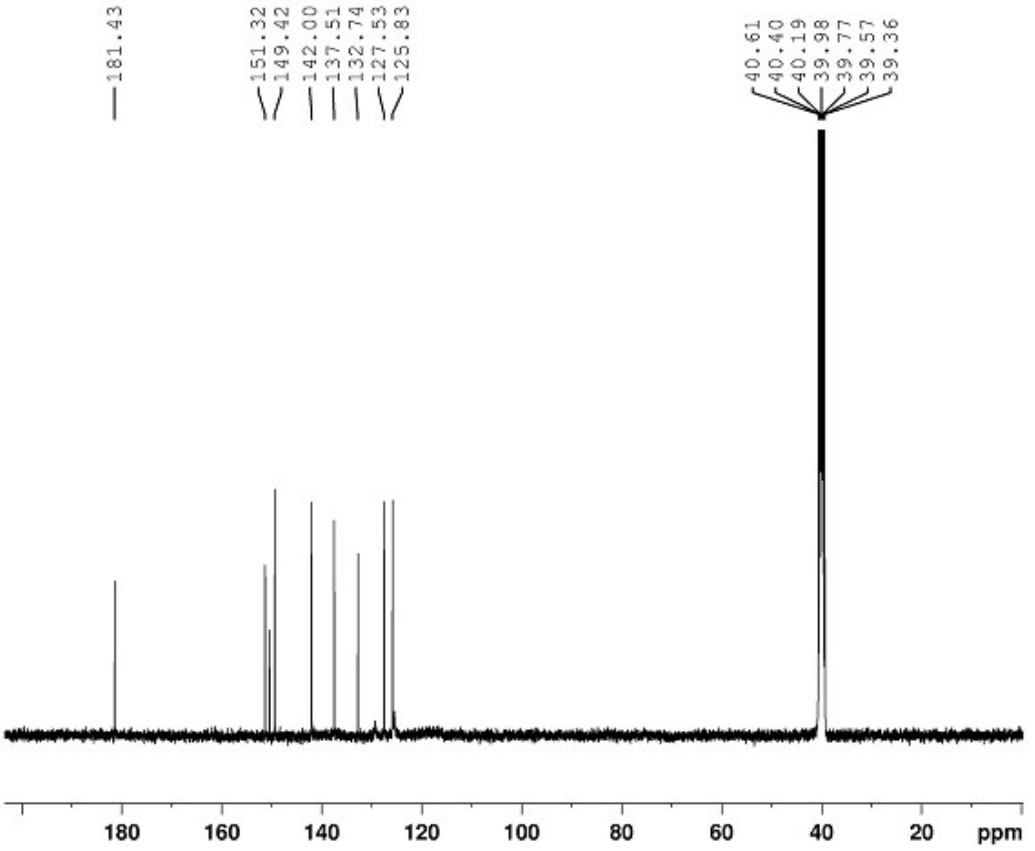
^{13}C NMR spectrum of compound **A20**



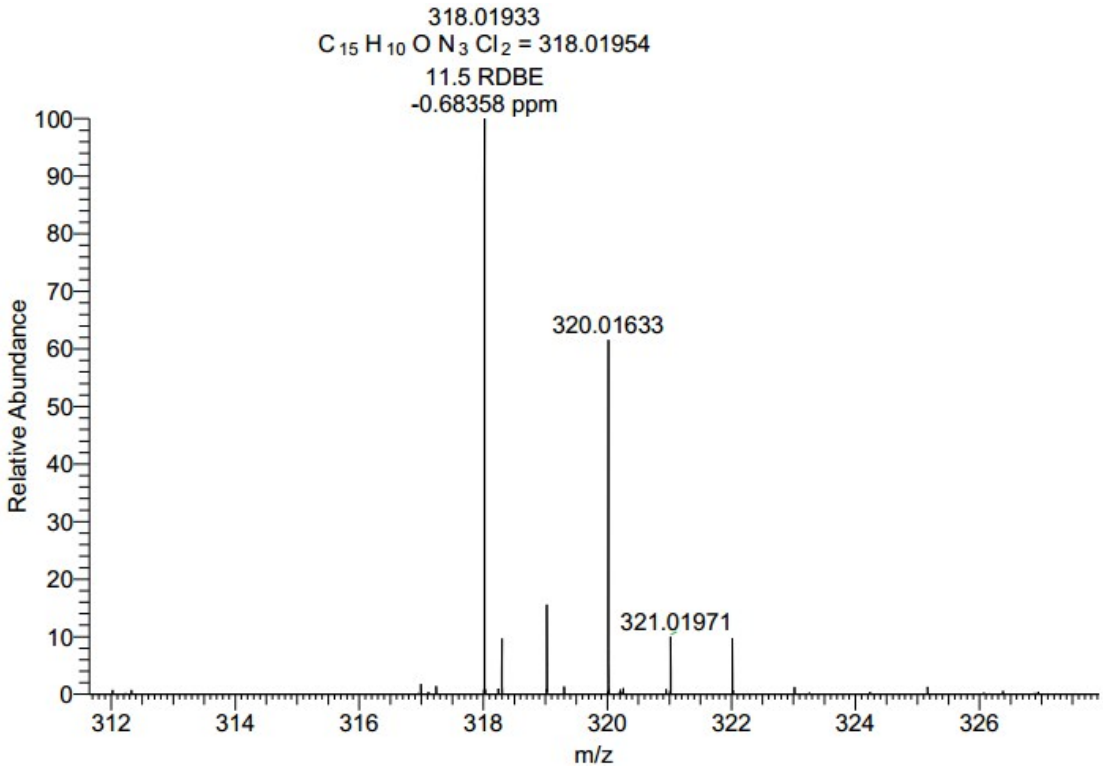
High resolution mass spectrum of compound **A20**



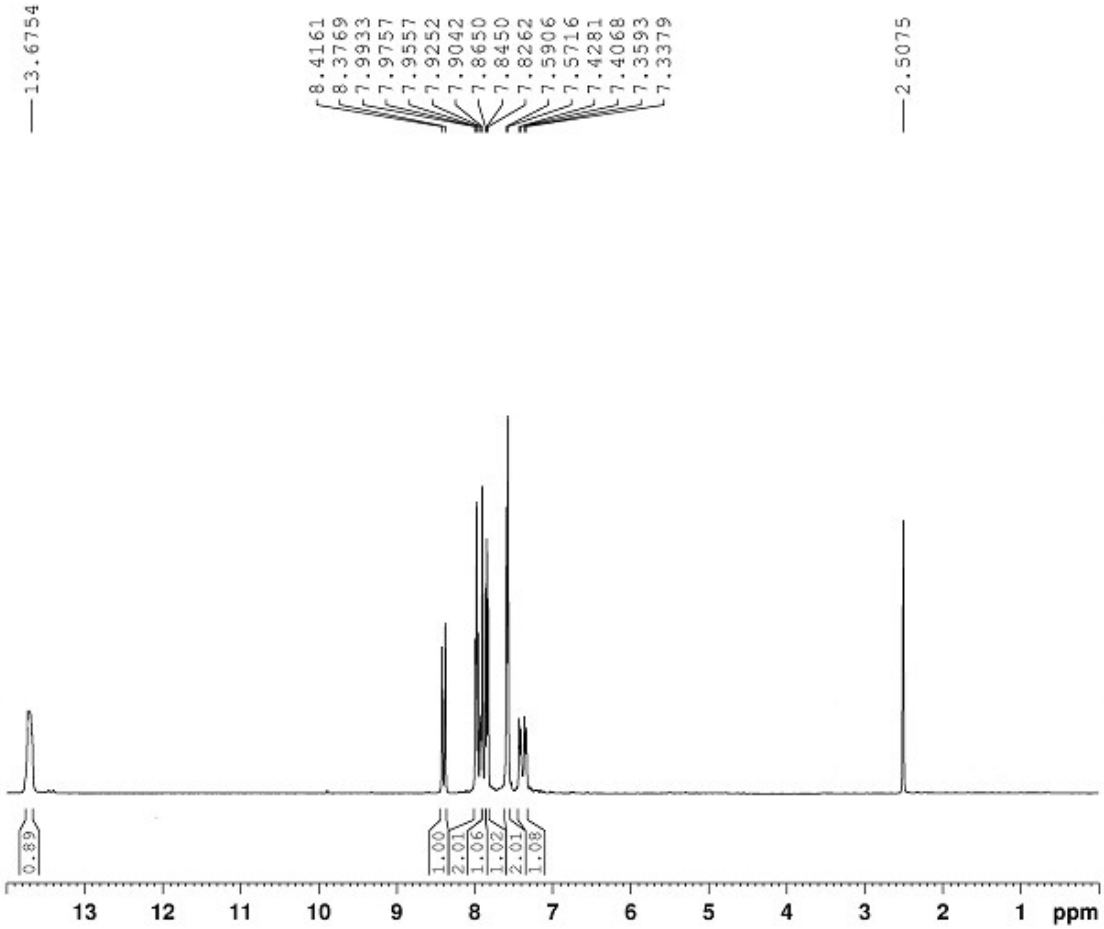
^{1}H NMR spectrum of compound **A21**



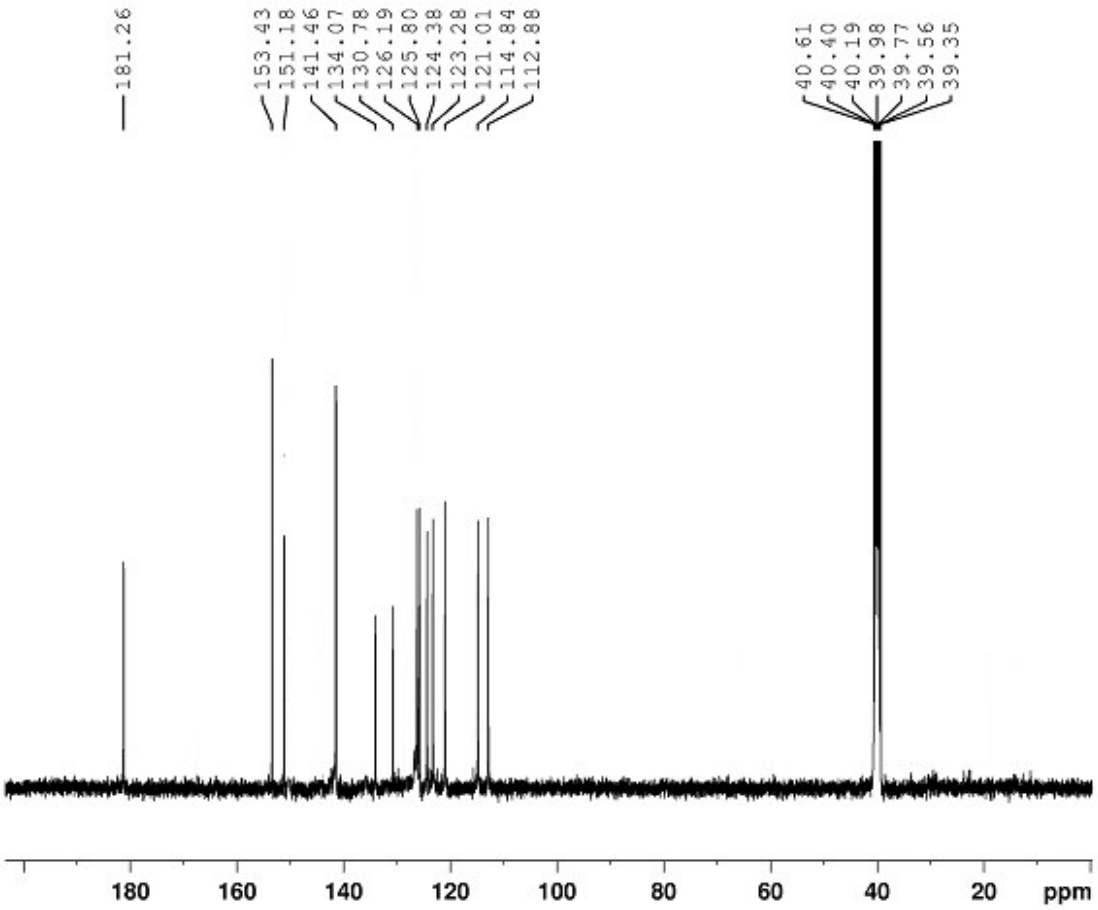
^{13}C NMR spectrum of compound **A21**



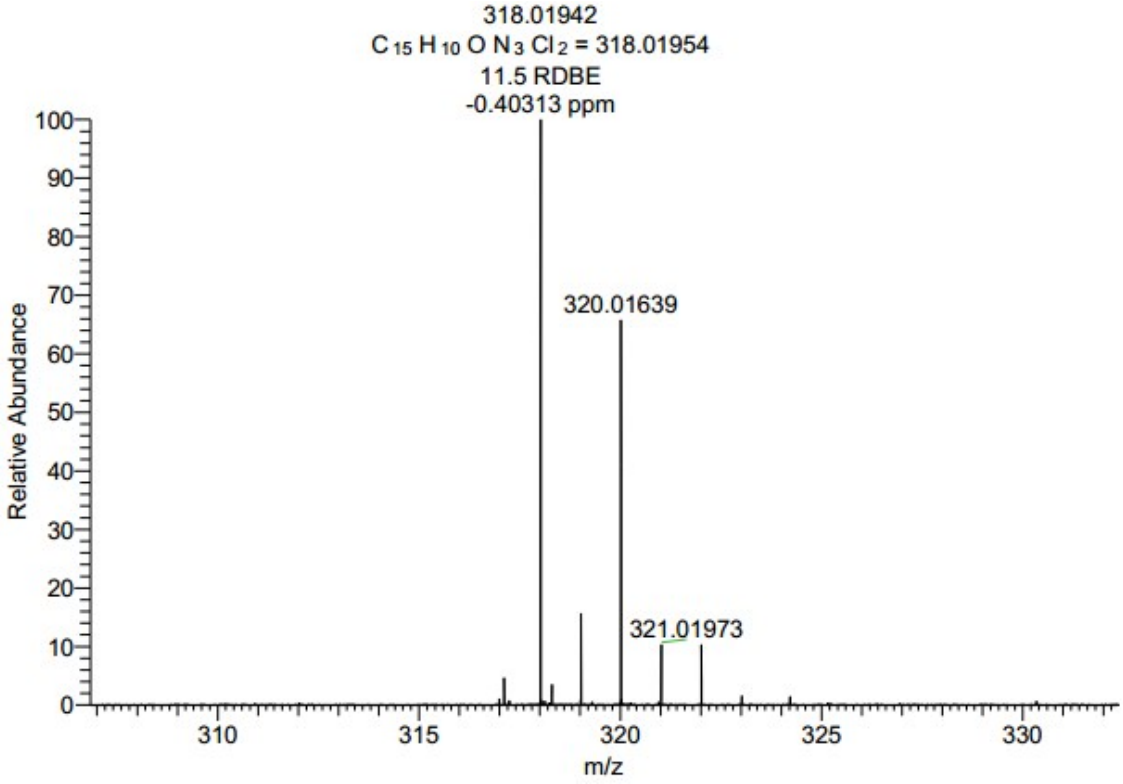
High resolution mass spectrum of compound **A21**



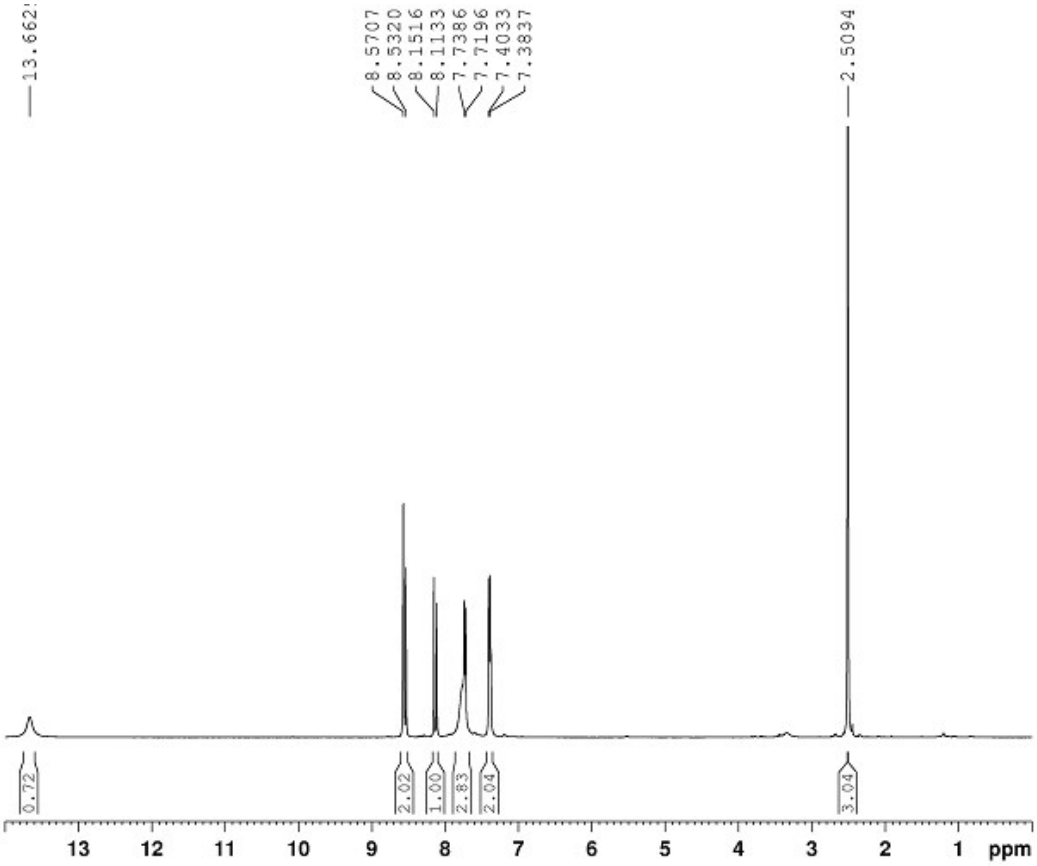
^{1}H NMR spectrum of compound **A22**



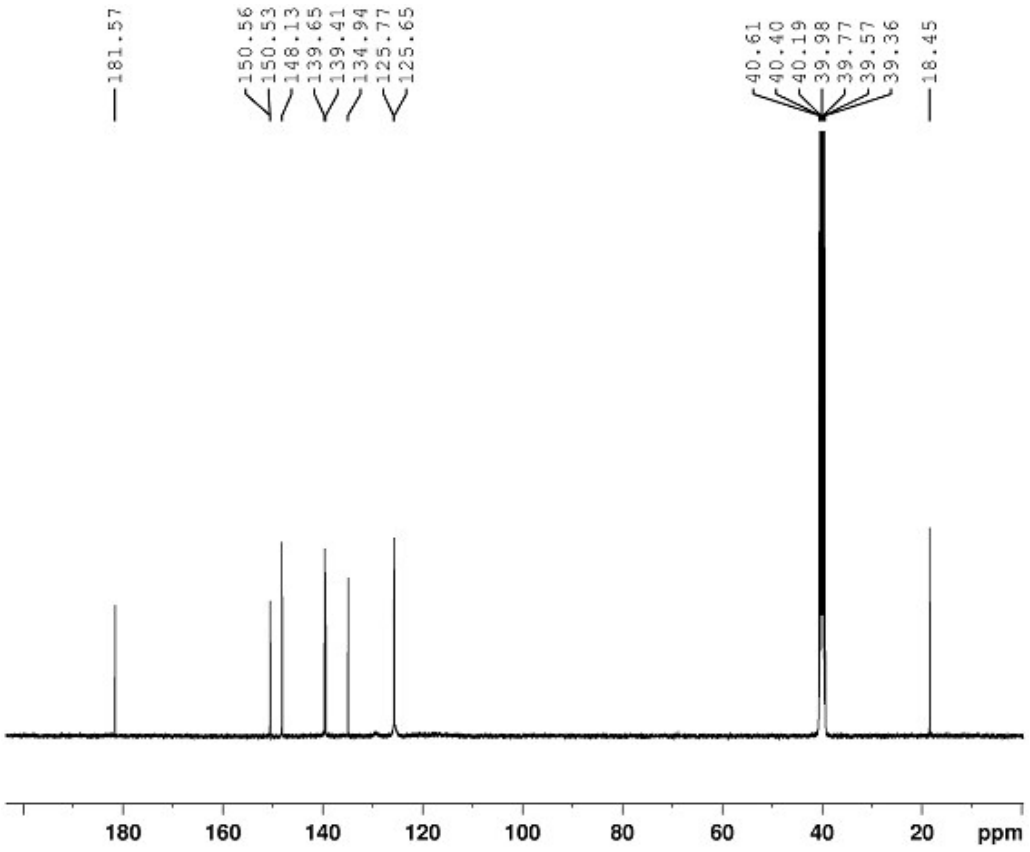
^{13}C NMR spectrum of compound **A22**



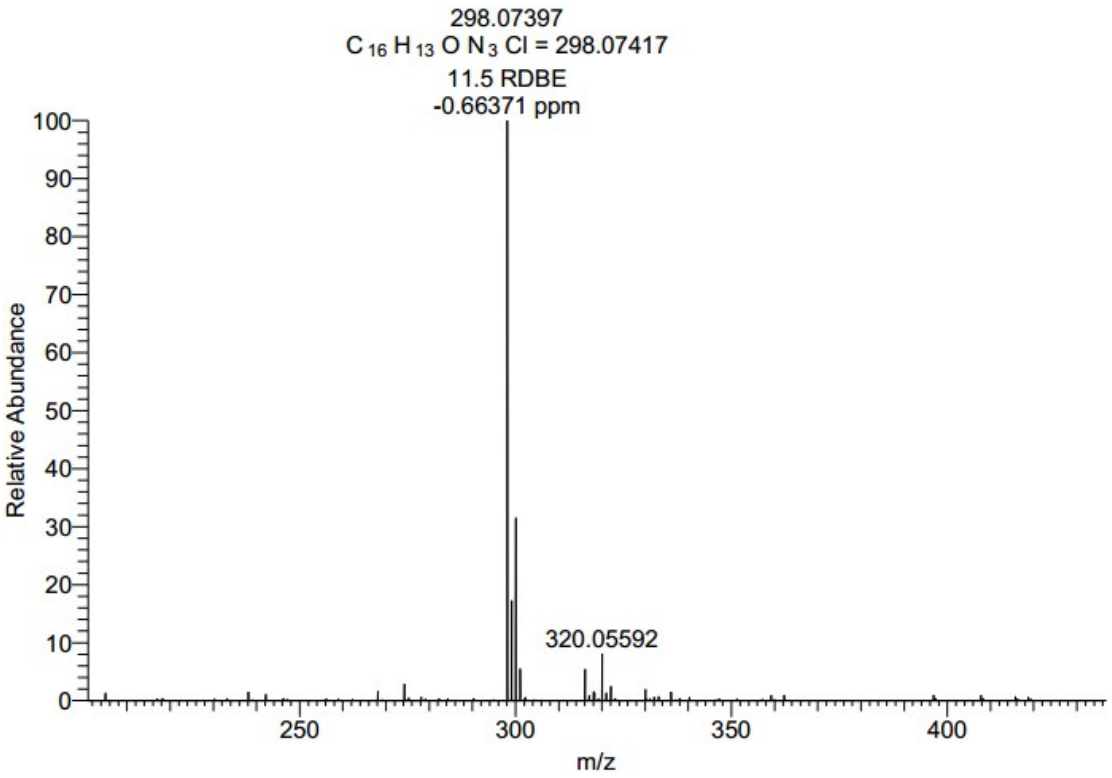
High resolution mass spectrum of compound **A22**



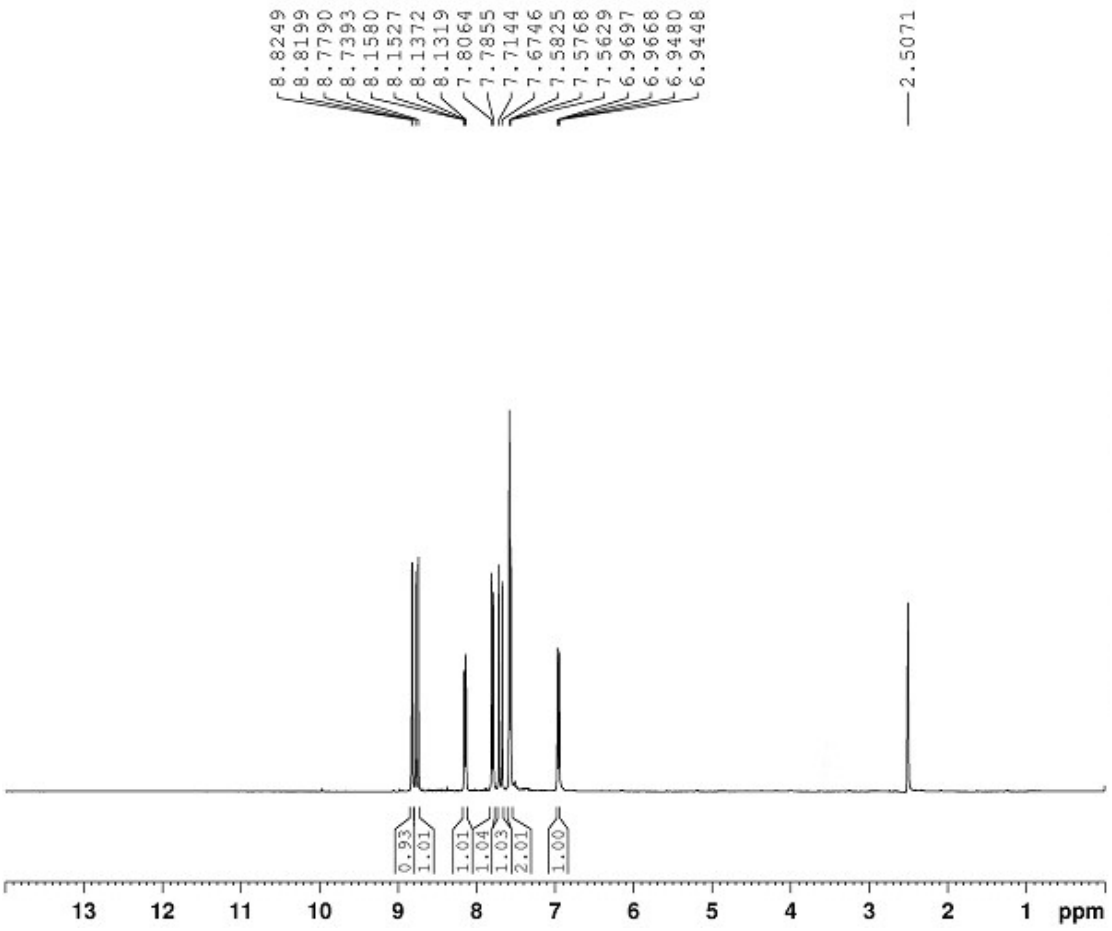
^{1}H NMR spectrum of compound **A23**



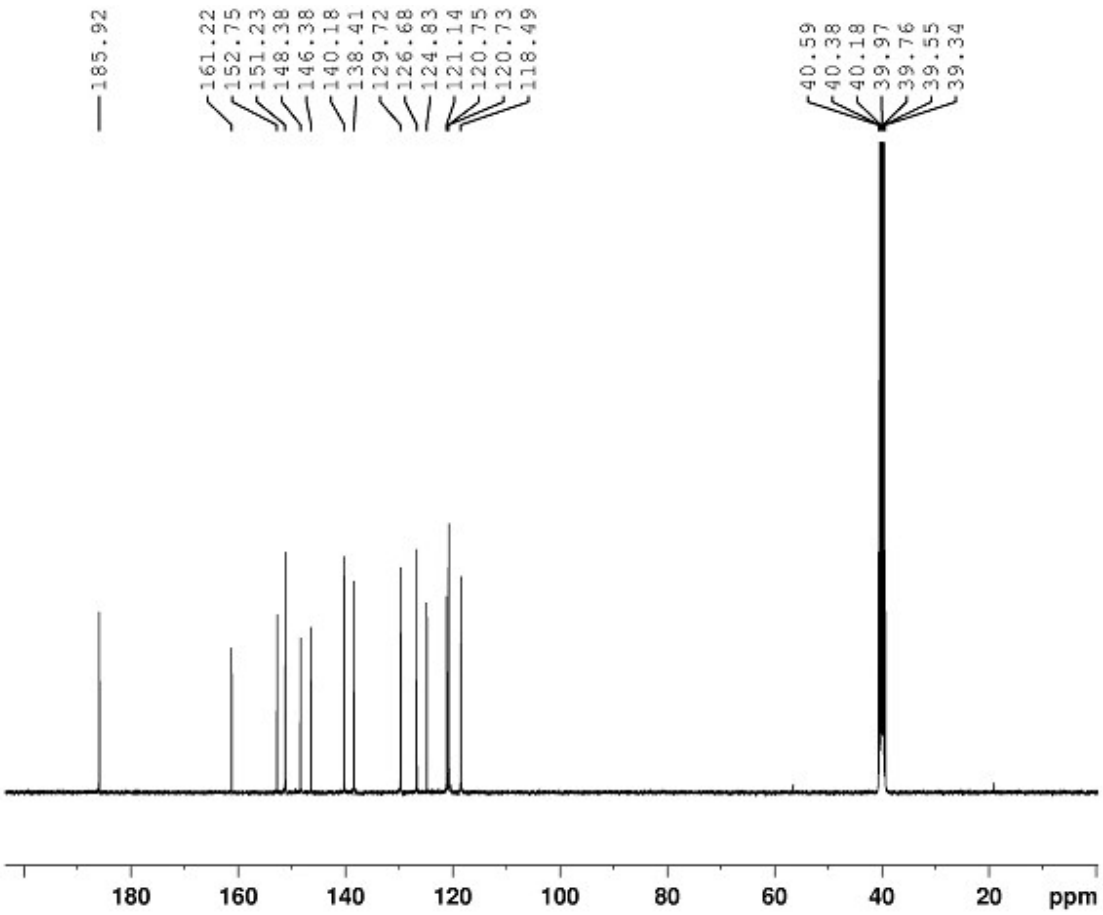
^{13}C NMR spectrum of compound **A23**



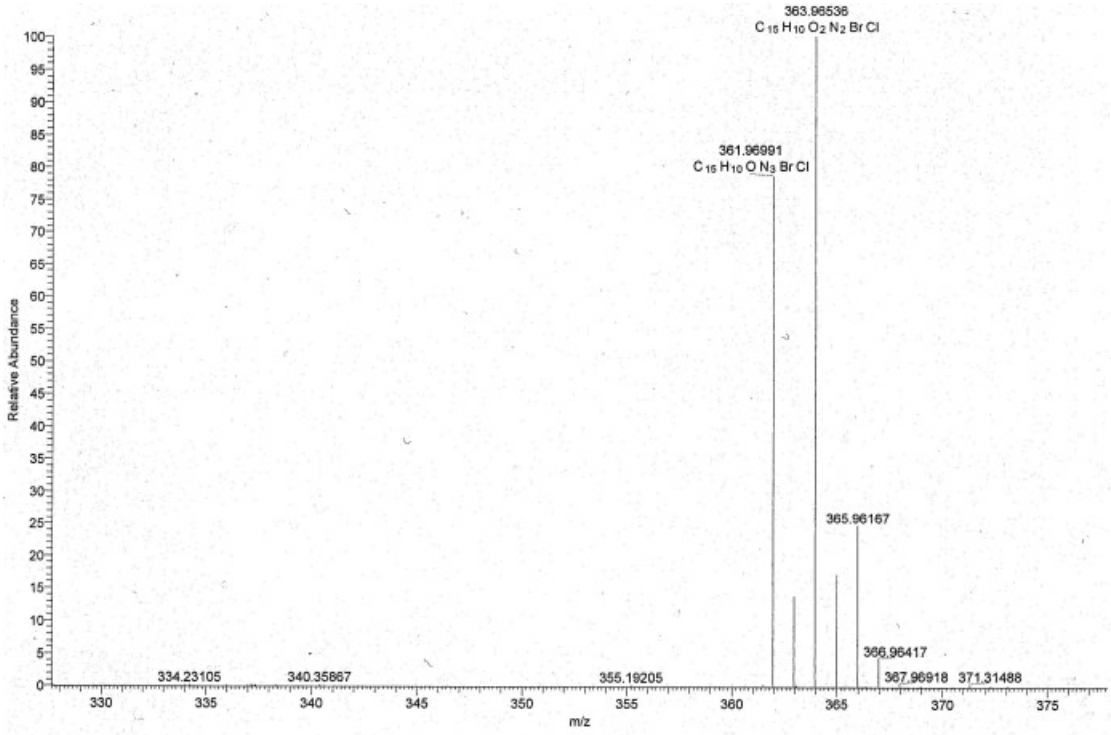
High resolution mass spectrum of compound **A23**



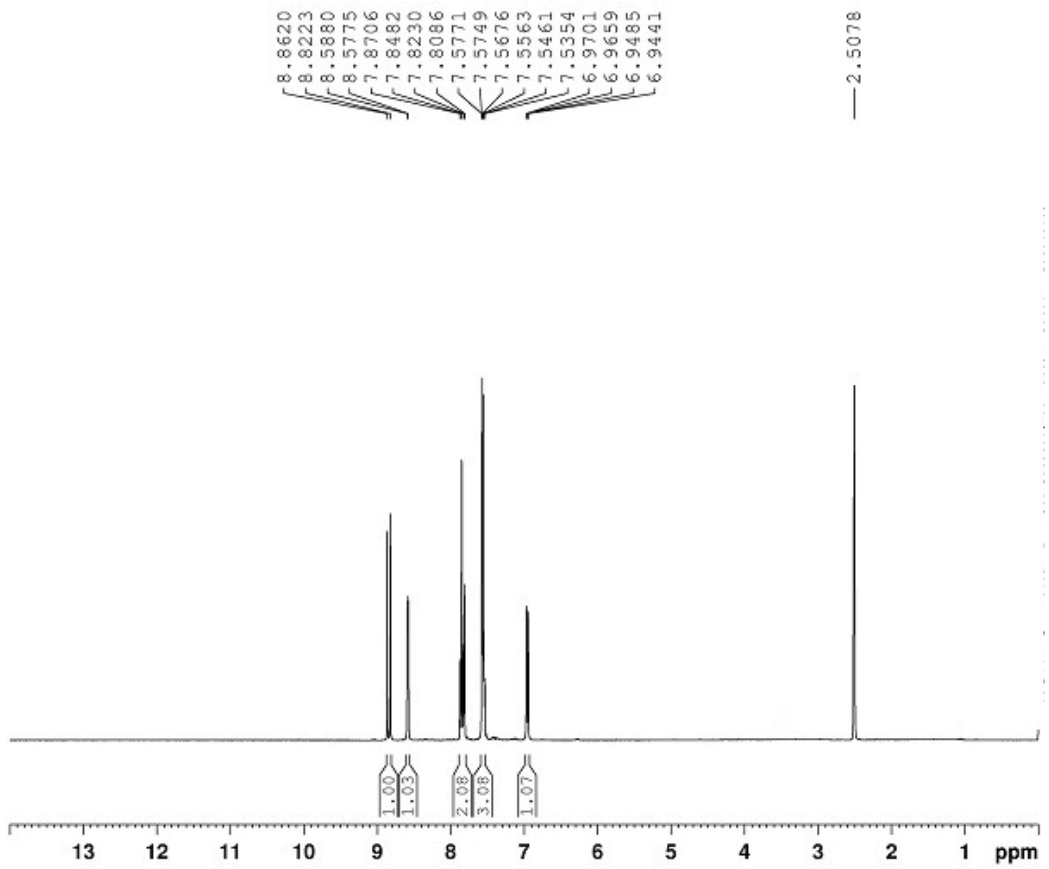
^{1}H NMR spectrum of compound **A24**



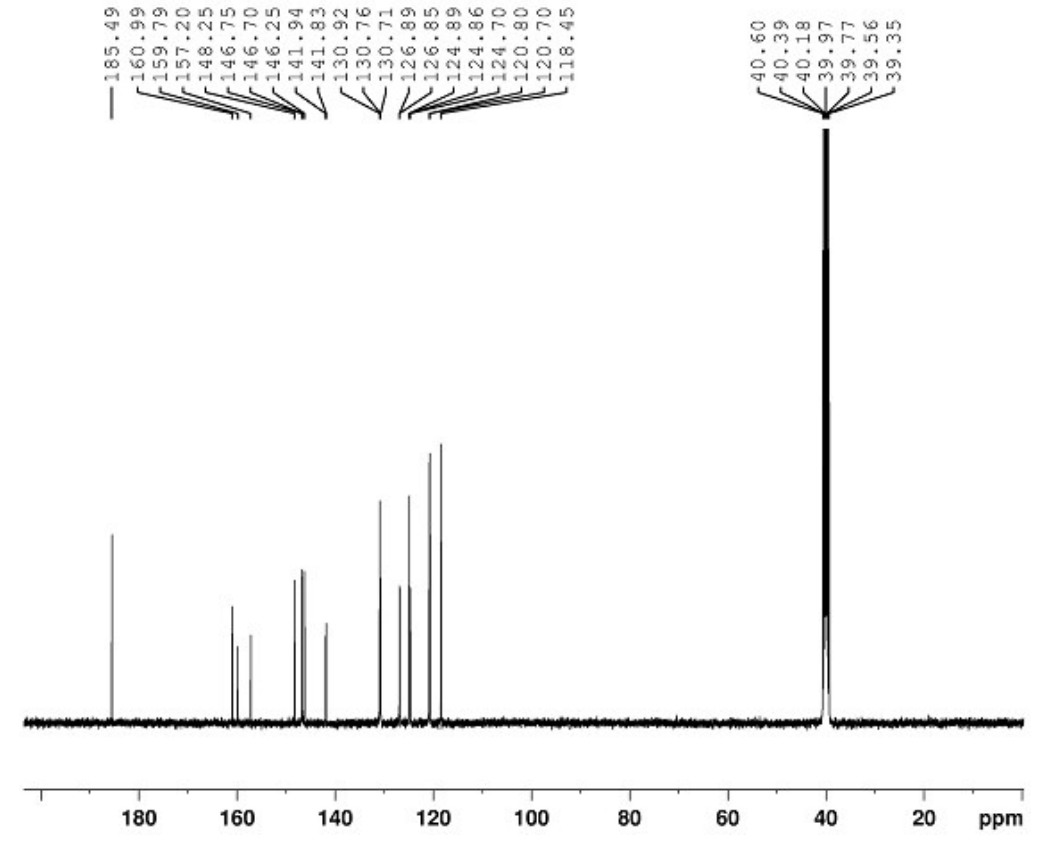
^{13}C NMR spectrum of compound **A24**



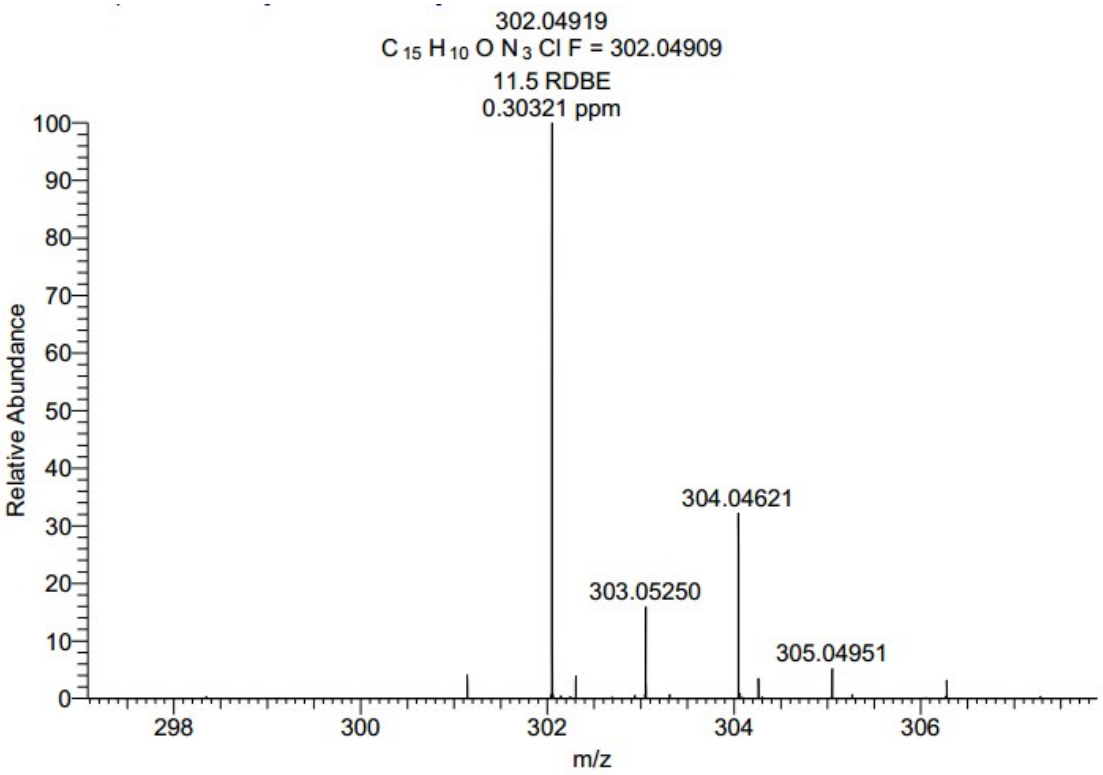
High resolution mass spectrum of compound **A24**



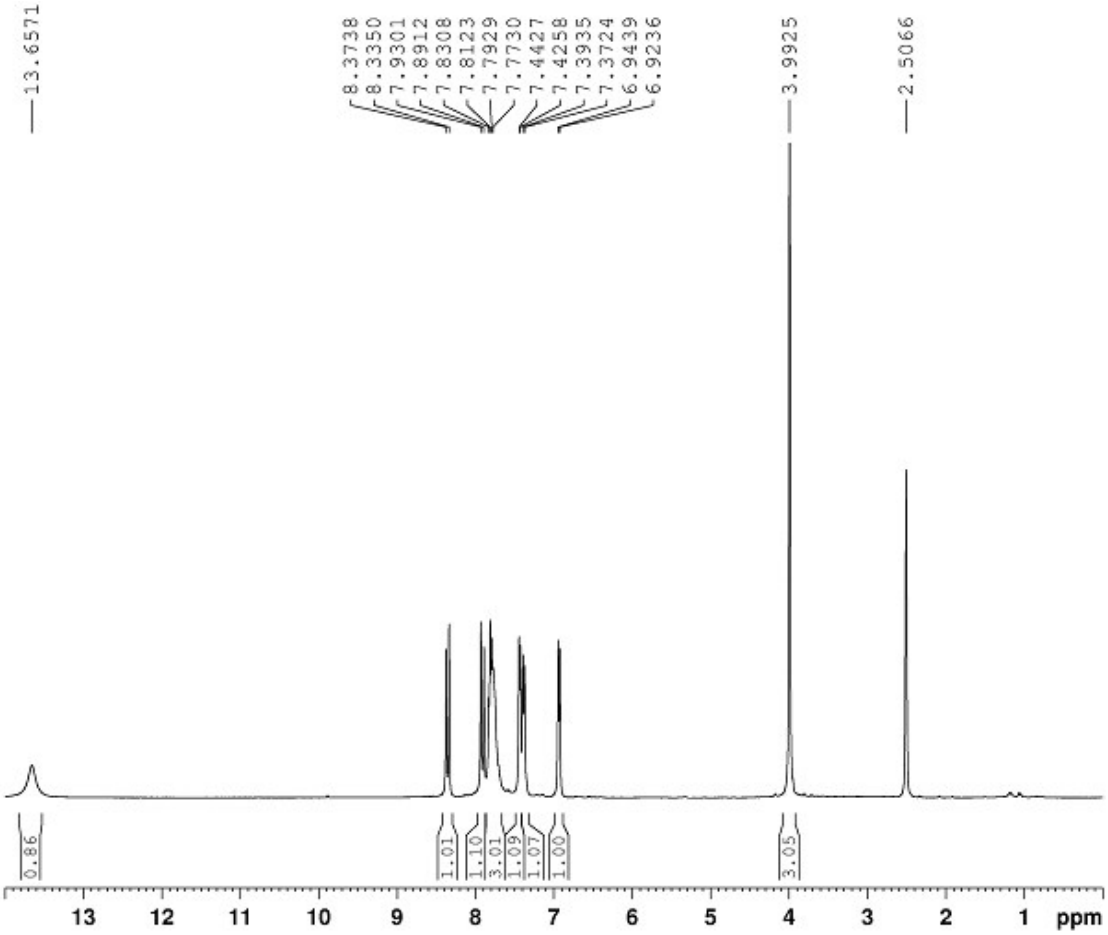
^{1}H NMR spectrum of compound **A25**



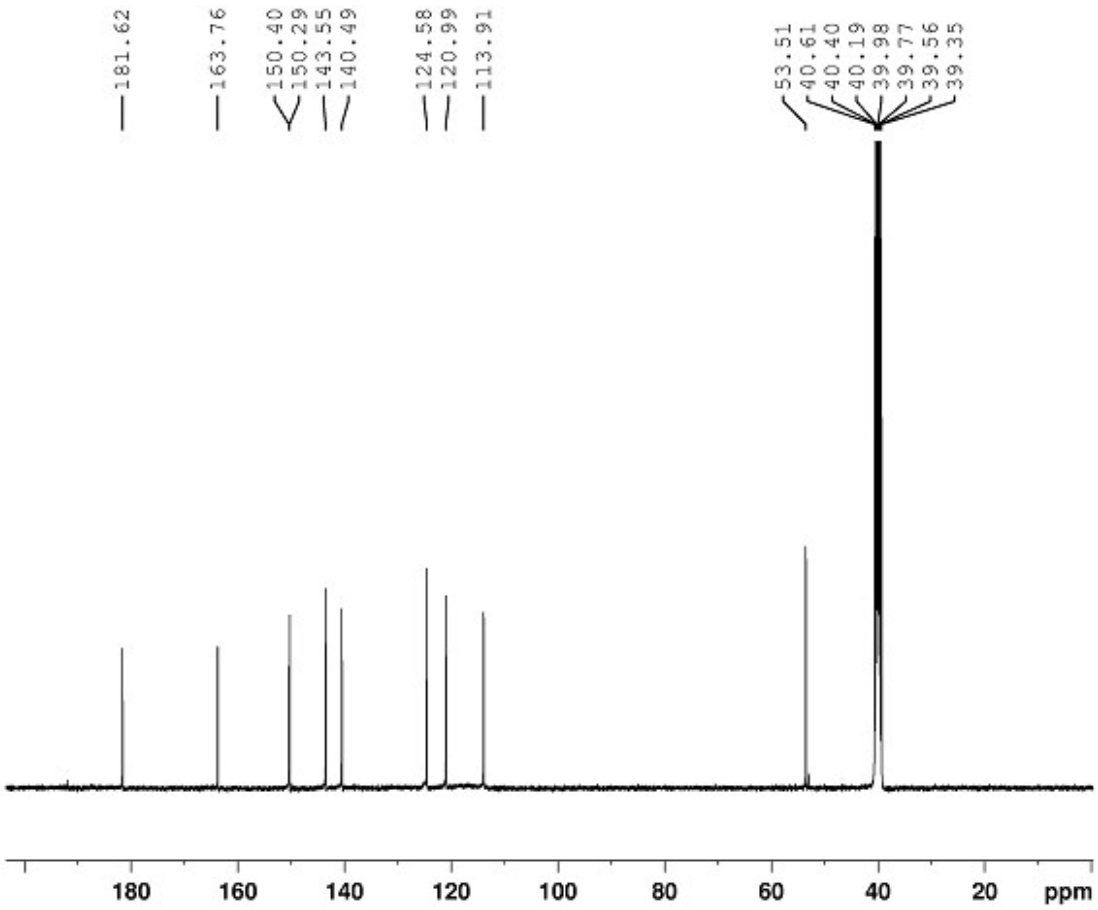
^{13}C NMR spectrum of compound **A25**



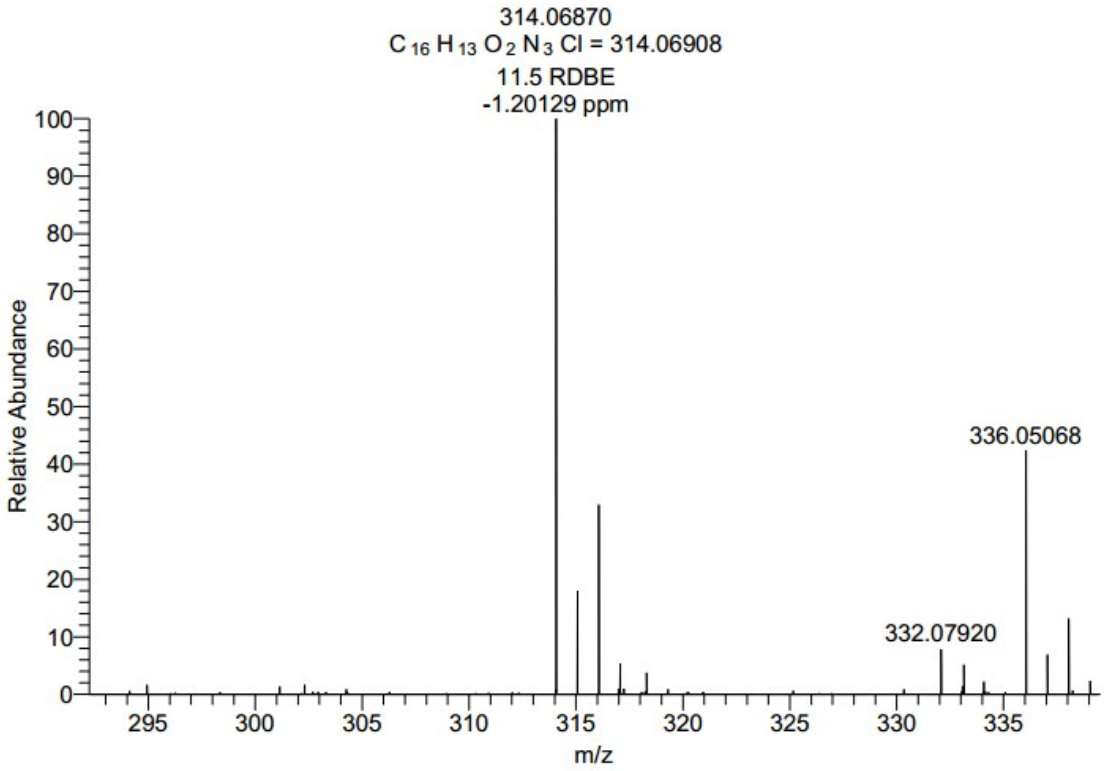
High resolution mass spectrum of compound **A25**



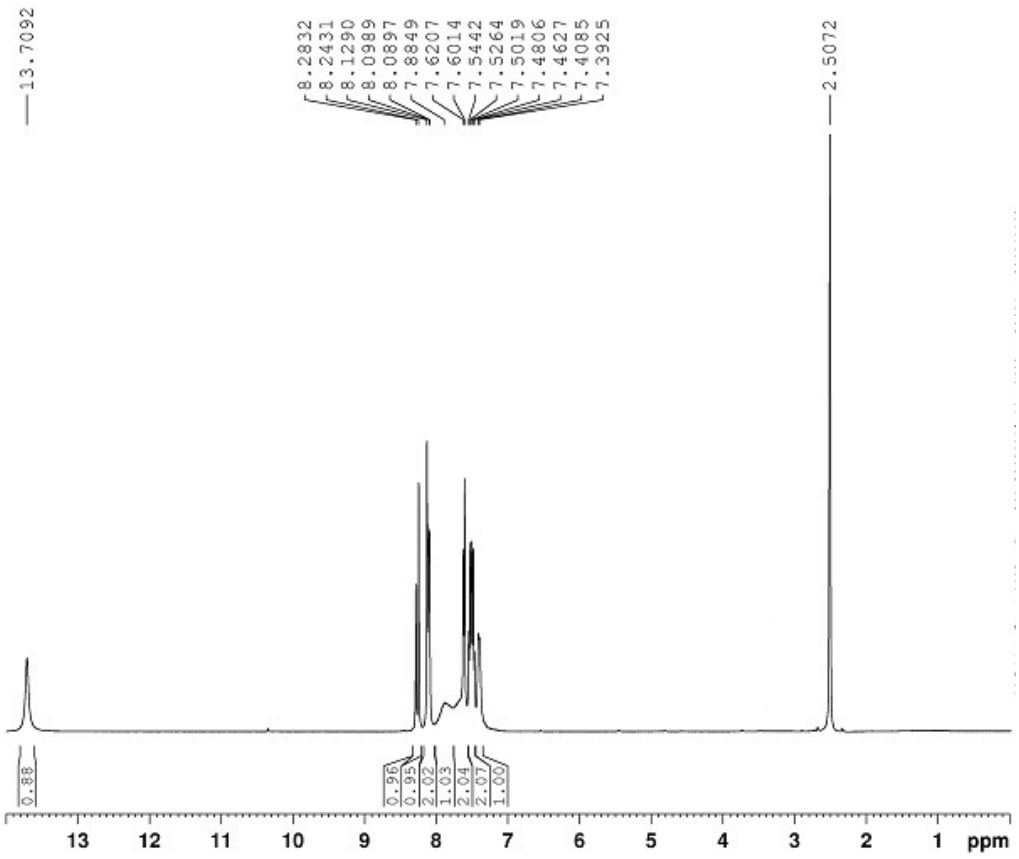
^{1}H NMR spectrum of compound **A26**



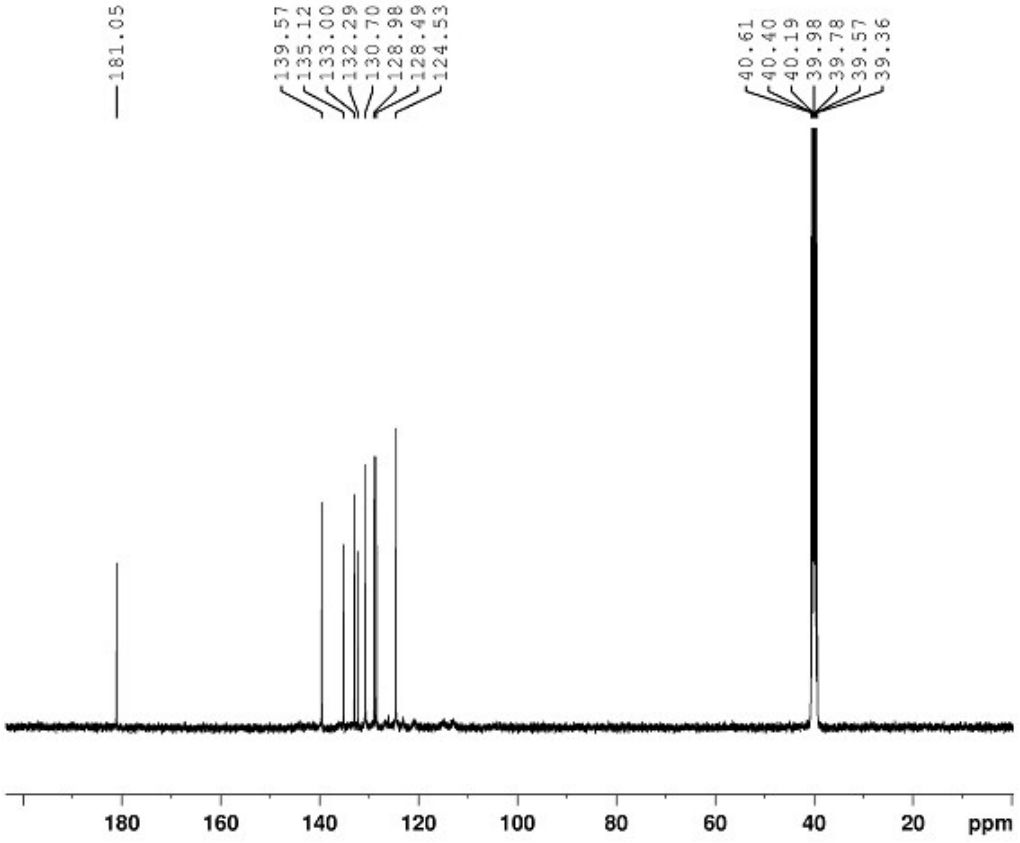
^{13}C NMR spectrum of compound **A26**



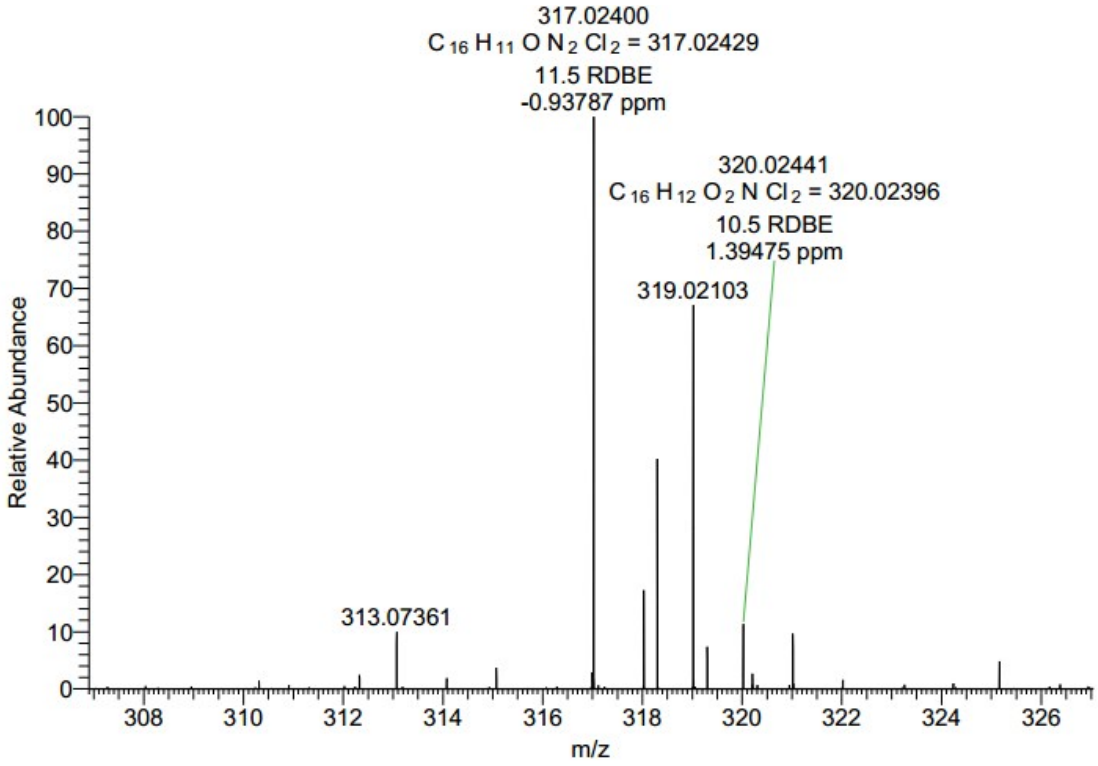
High resolution mass spectrum of compound **A26**



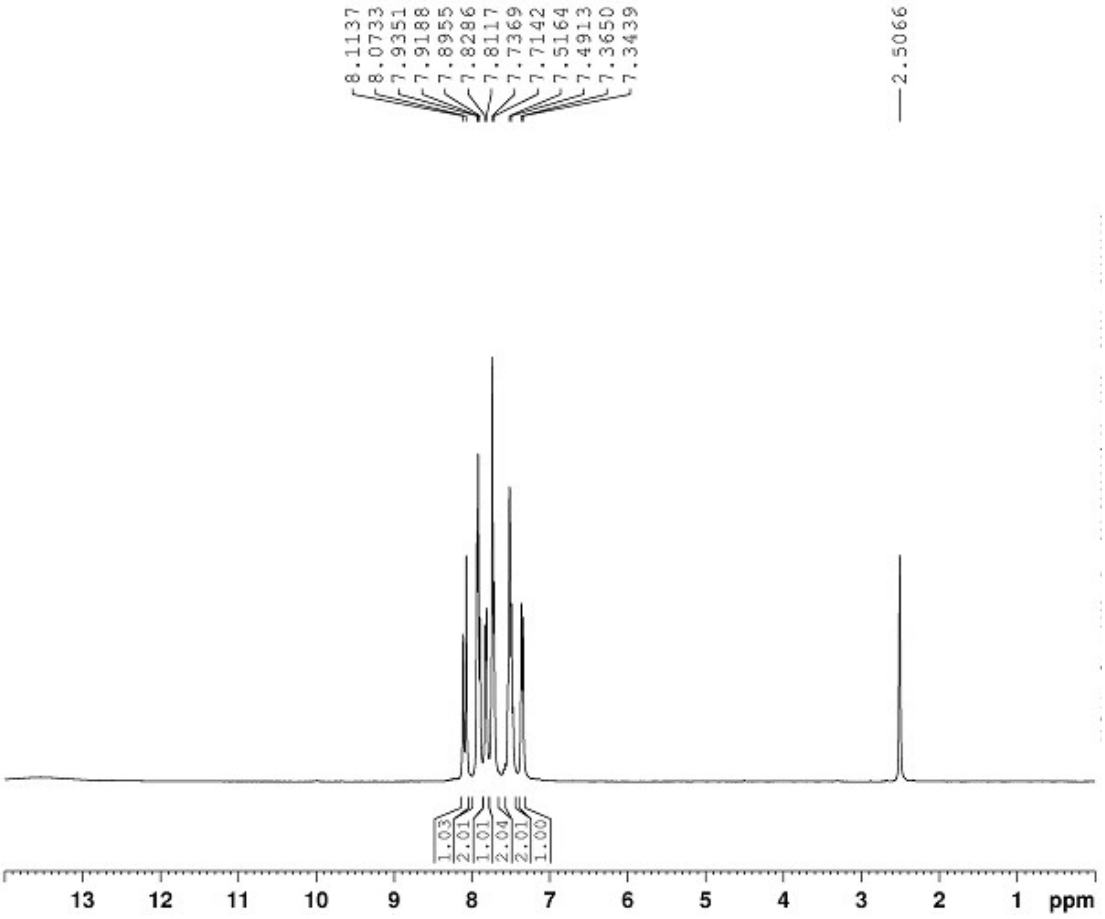
^{1}H NMR spectrum of compound **A27**



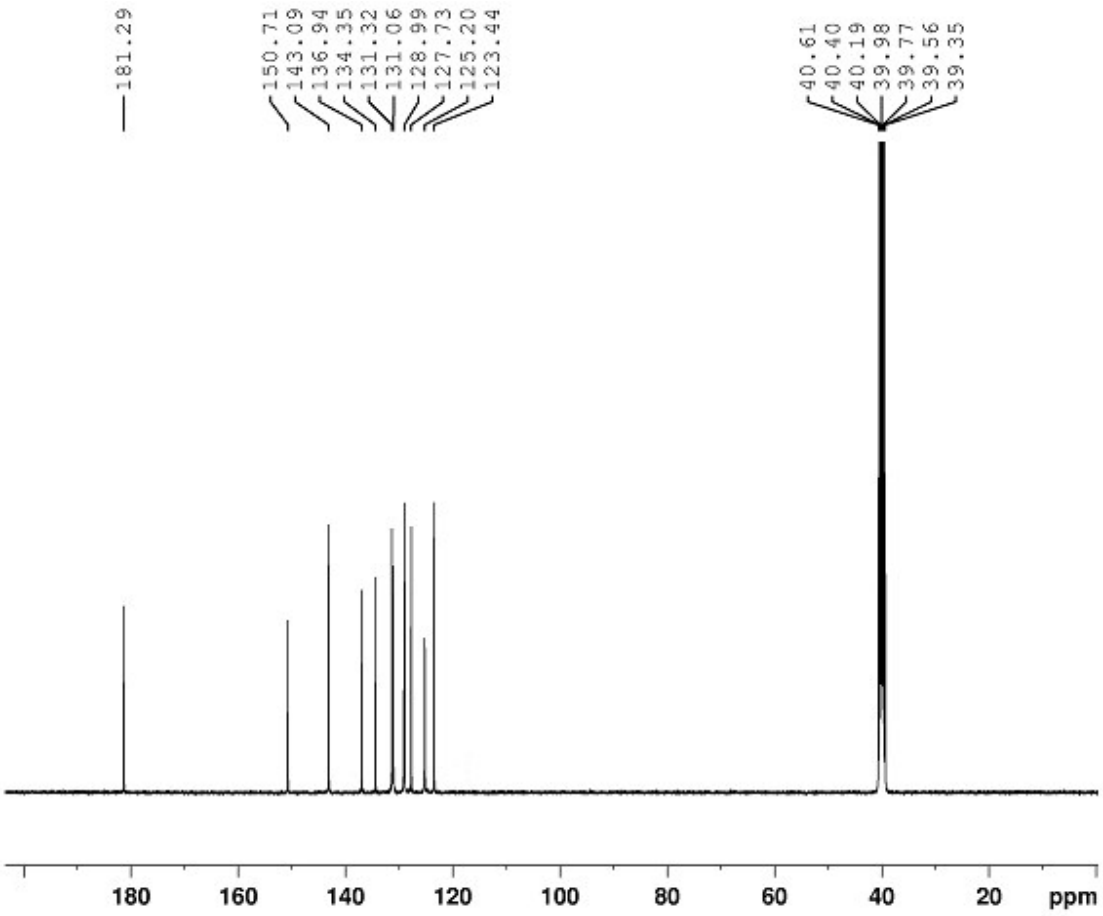
^{13}C NMR spectrum of compound **A27**



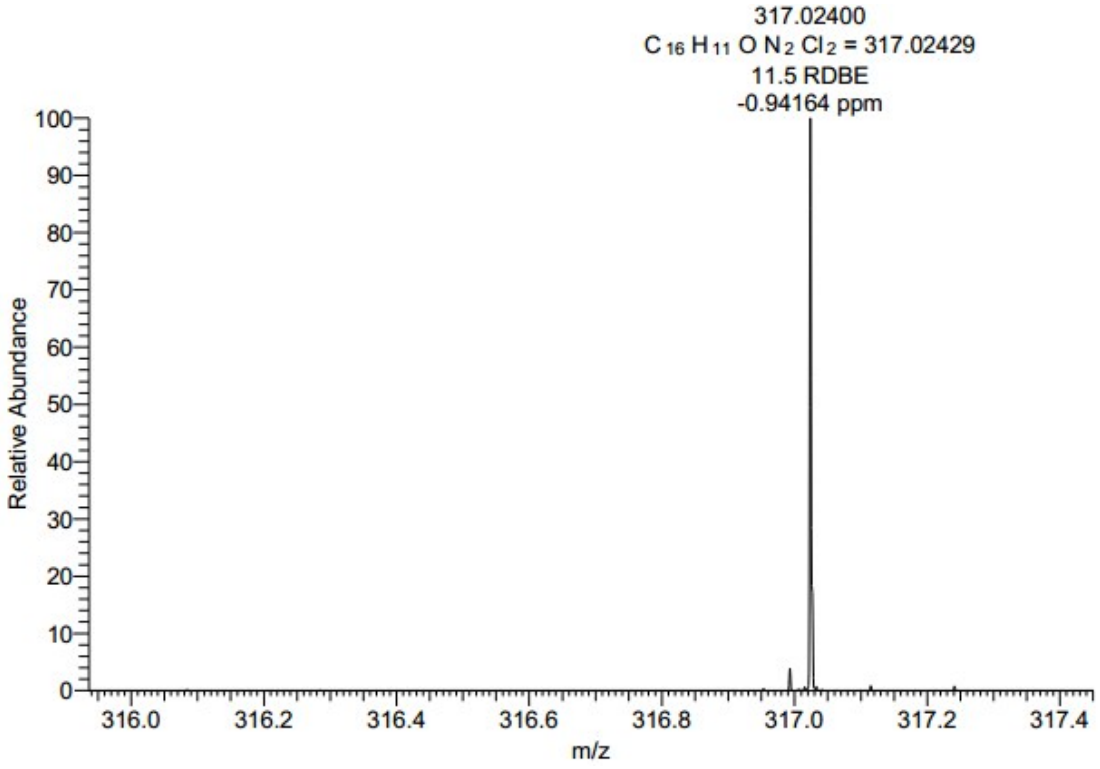
High resolution mass spectrum of compound **A27**



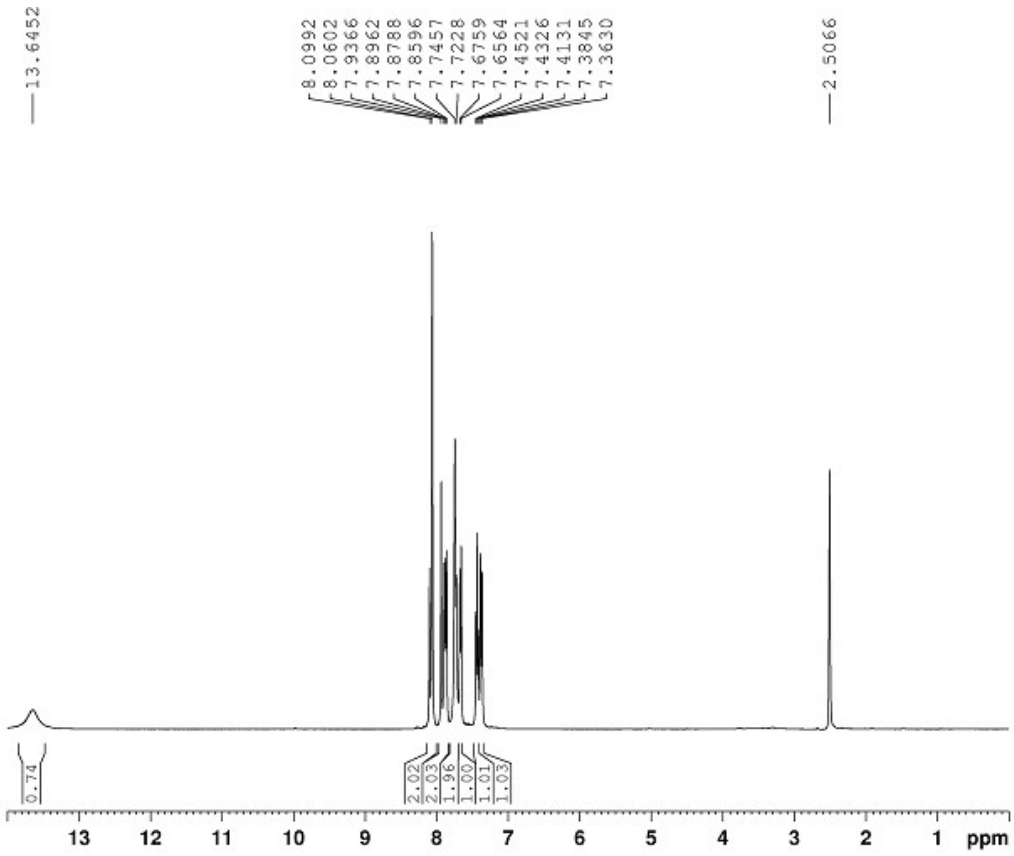
^{1}H NMR spectrum of compound **A28**



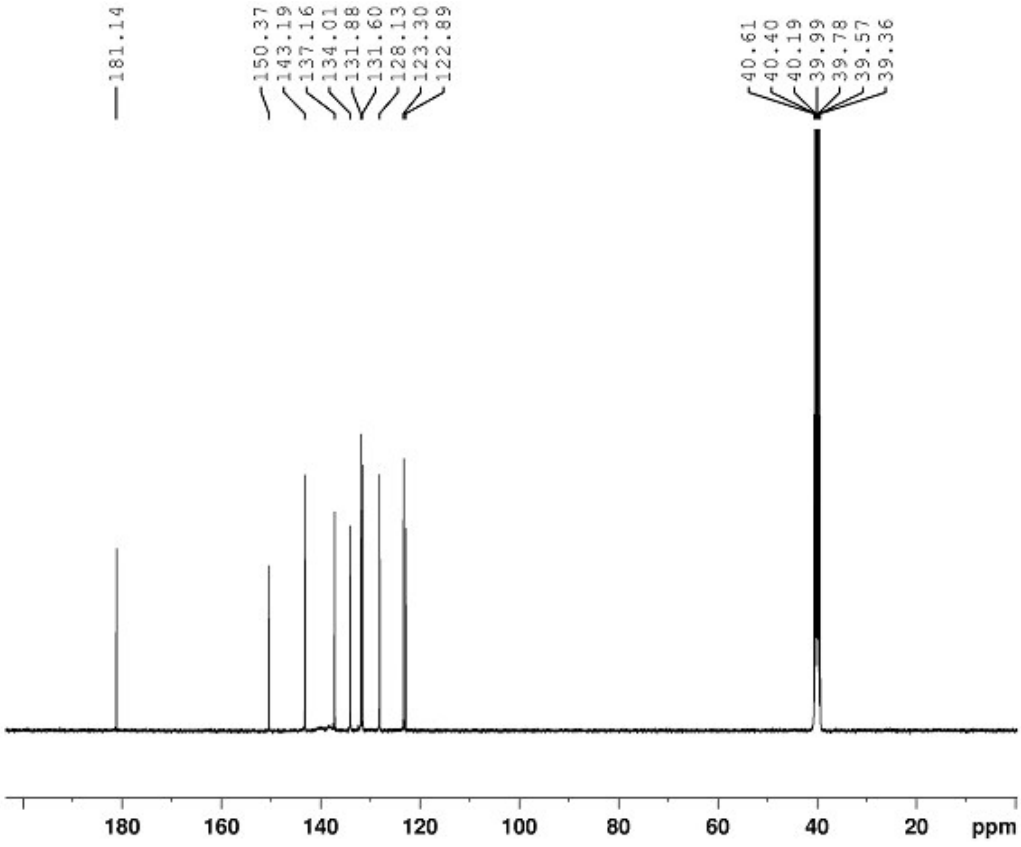
^{13}C NMR spectrum of compound **A28**



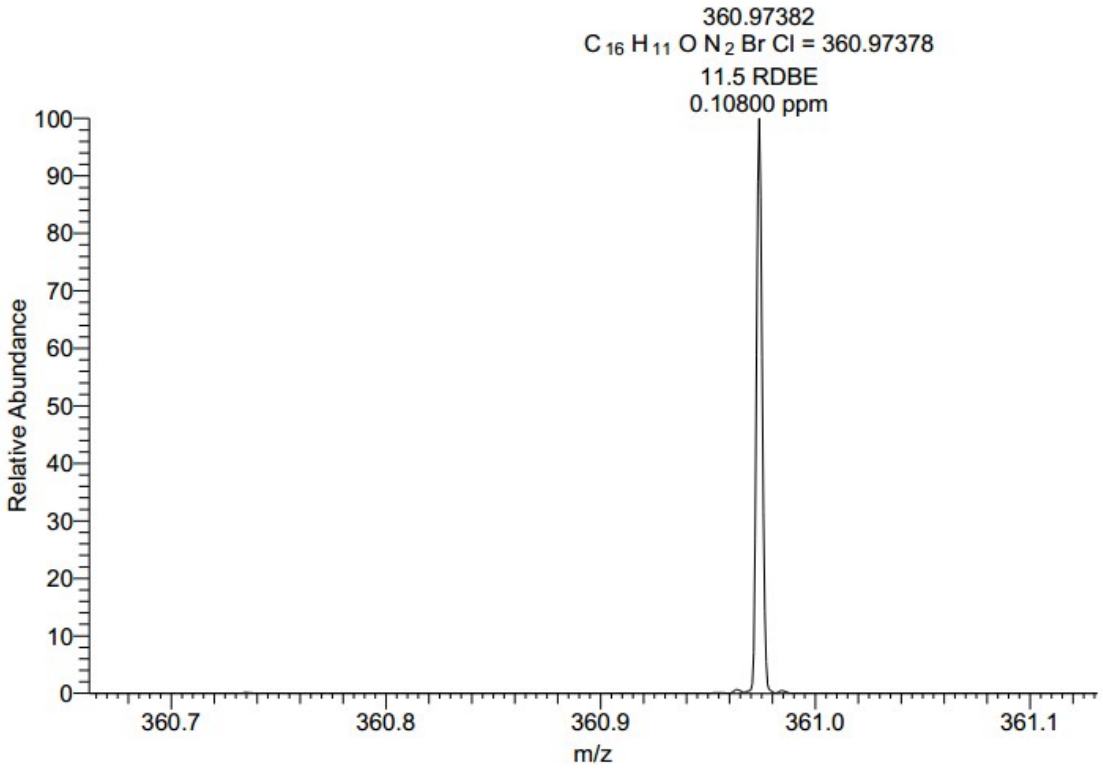
High resolution mass spectrum of compound **A28**



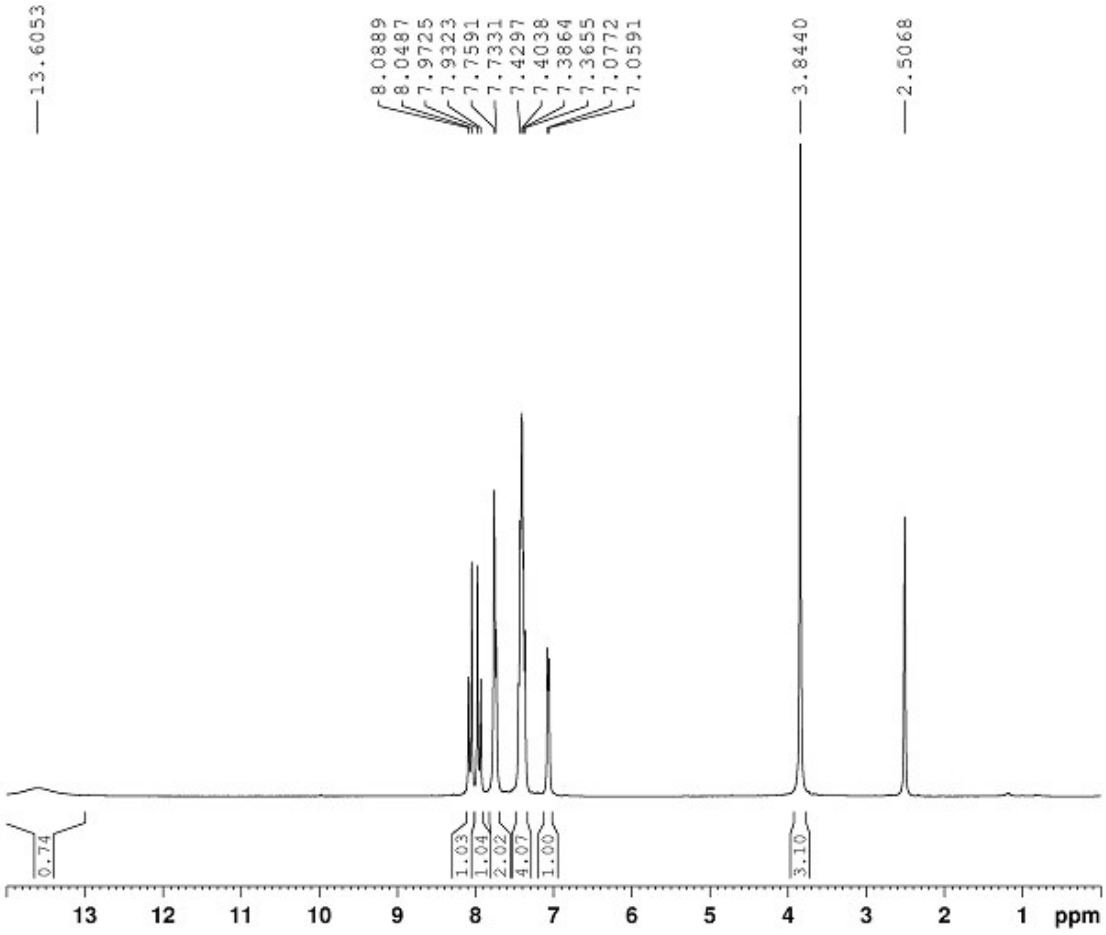
^{1}H NMR spectrum of compound **A29**



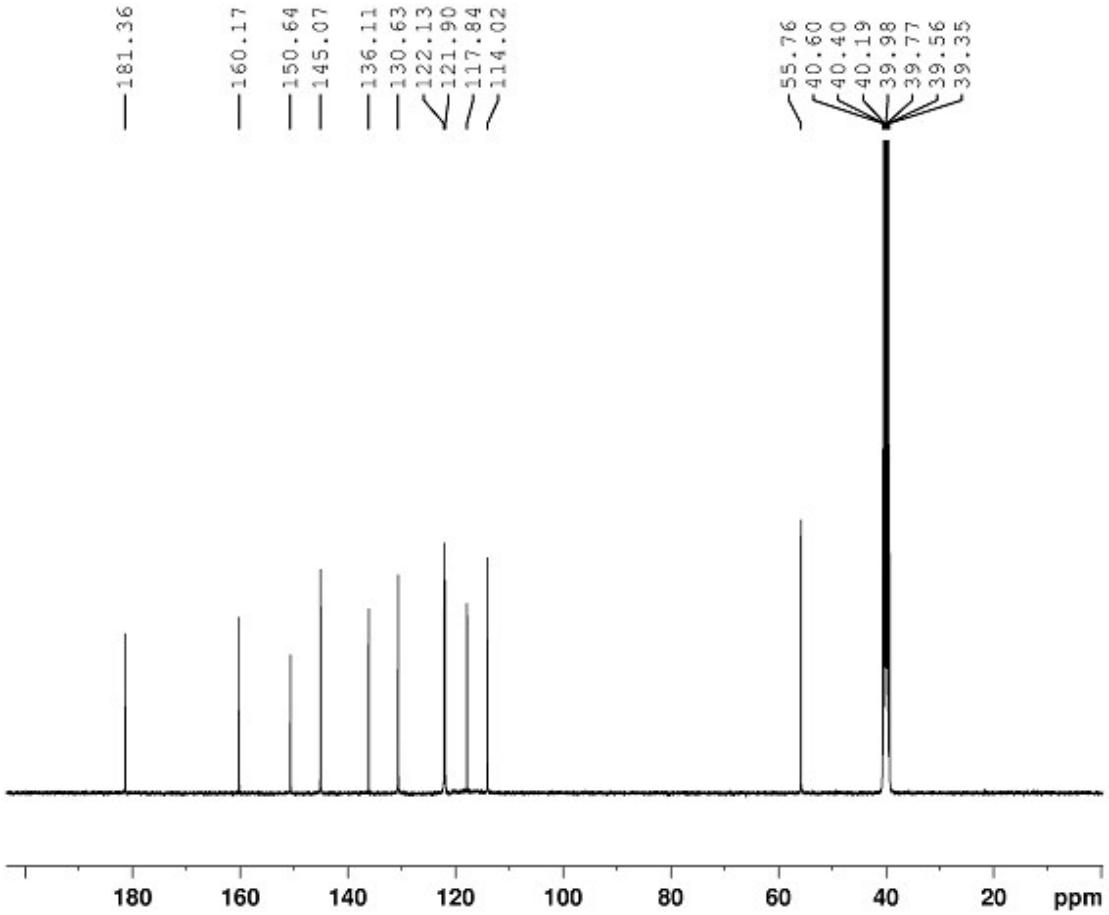
^{13}C NMR spectrum of compound **A29**



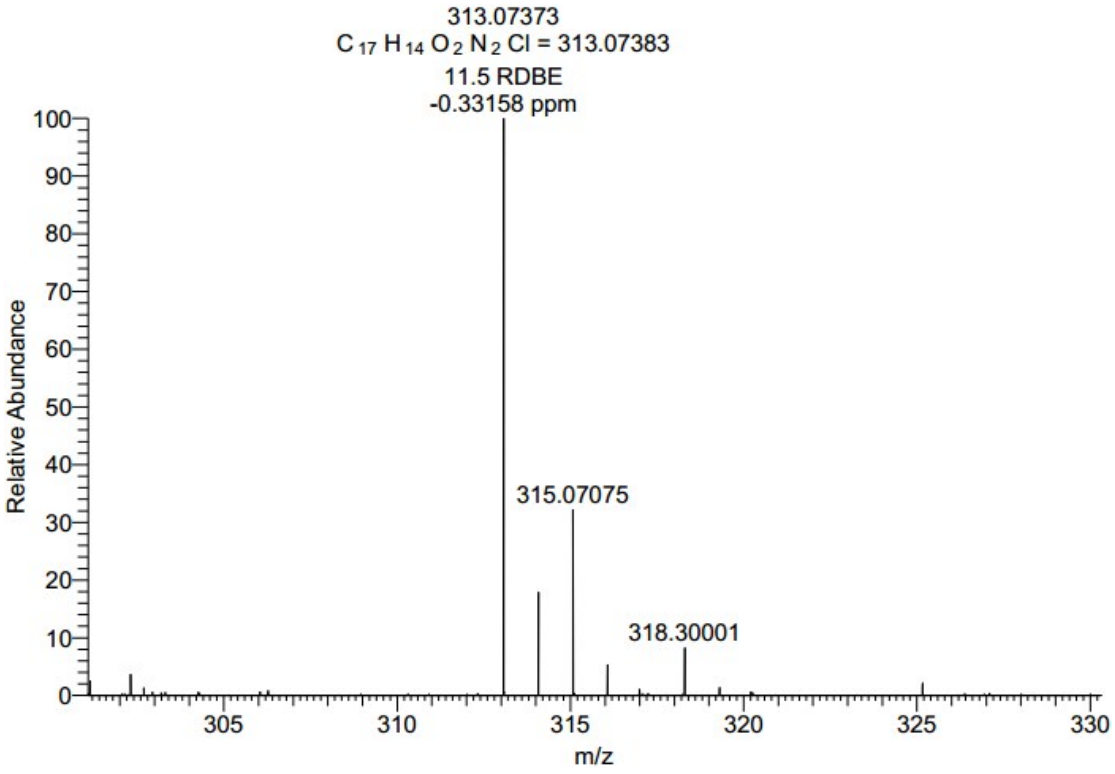
High resolution mass spectrum of compound **A29**



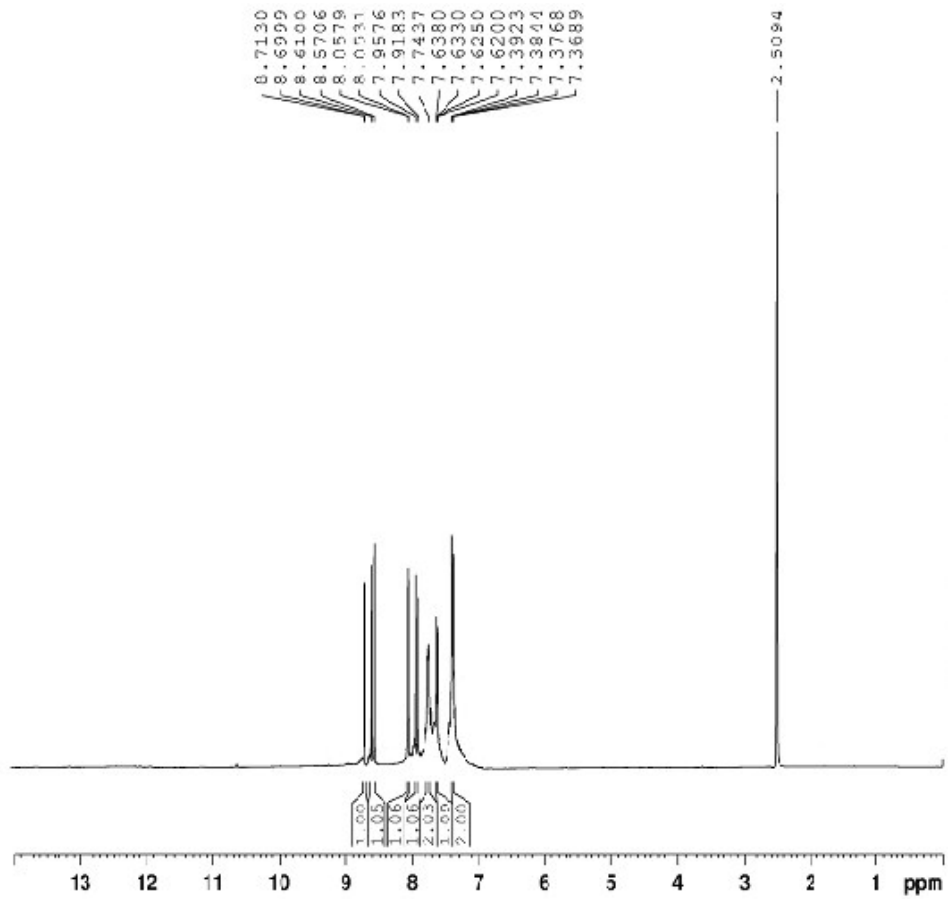
^{1}H NMR spectrum of compound **A30**



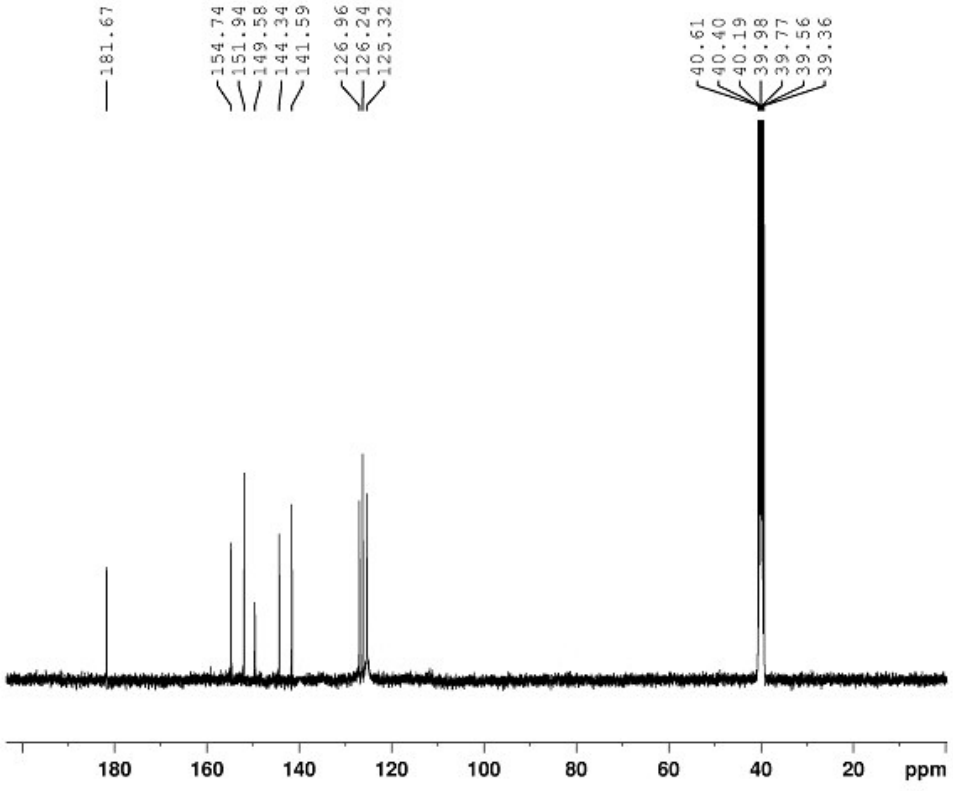
^{13}C NMR spectrum of compound **A30**



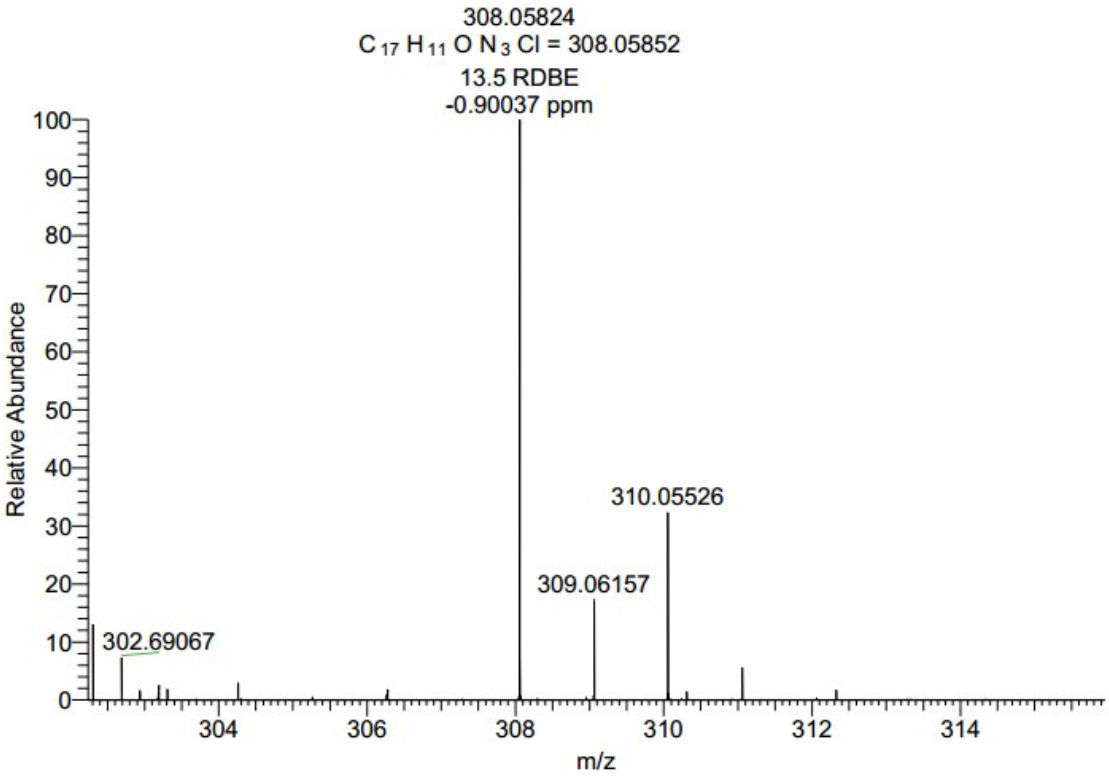
High resolution mass spectrum of compound **A30**



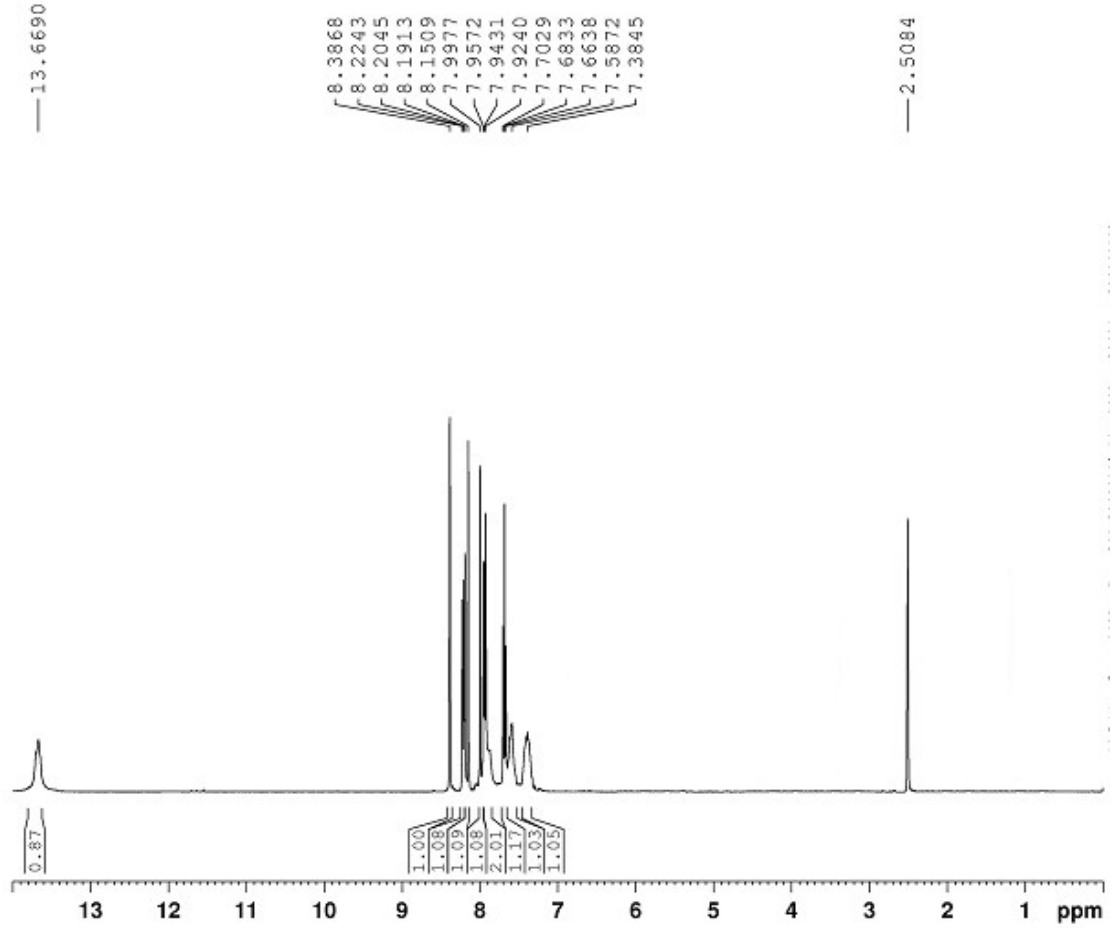
^{1}H NMR spectrum of compound **A31**



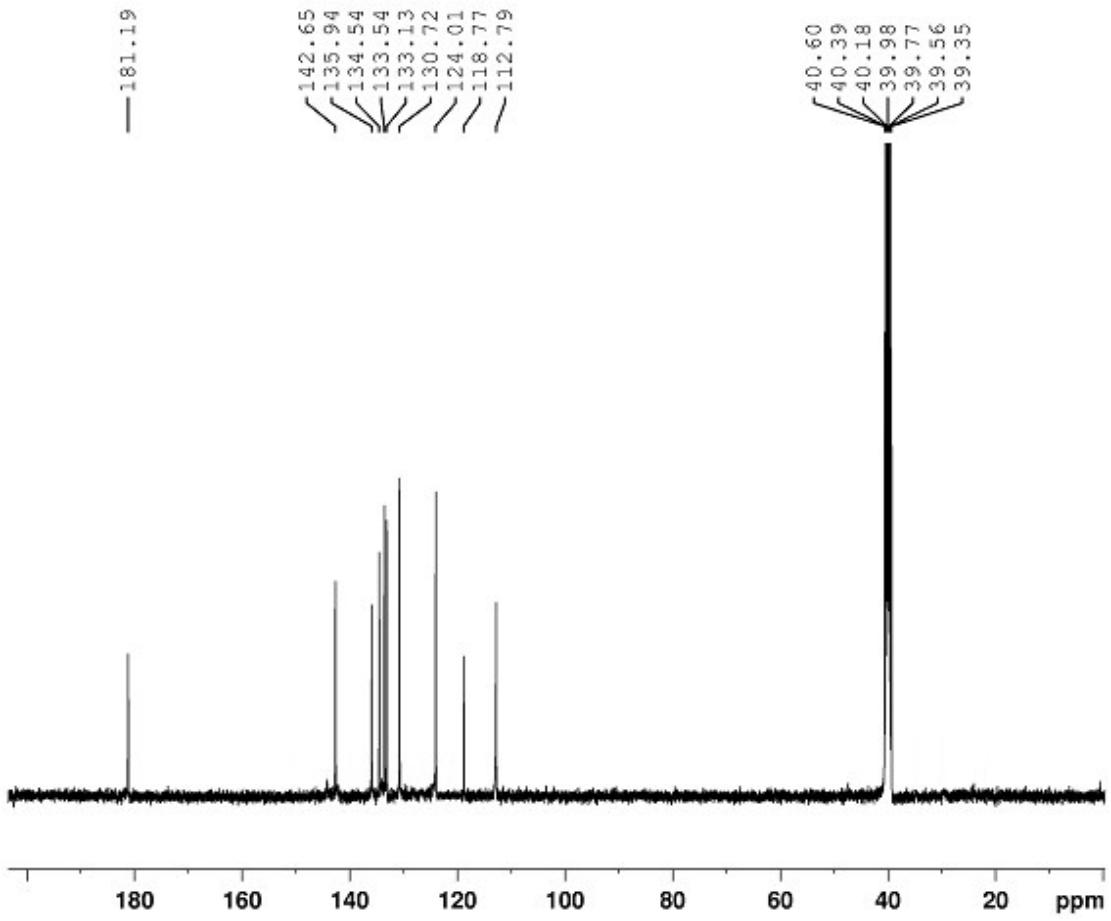
^{13}C NMR spectrum of compound **A31**



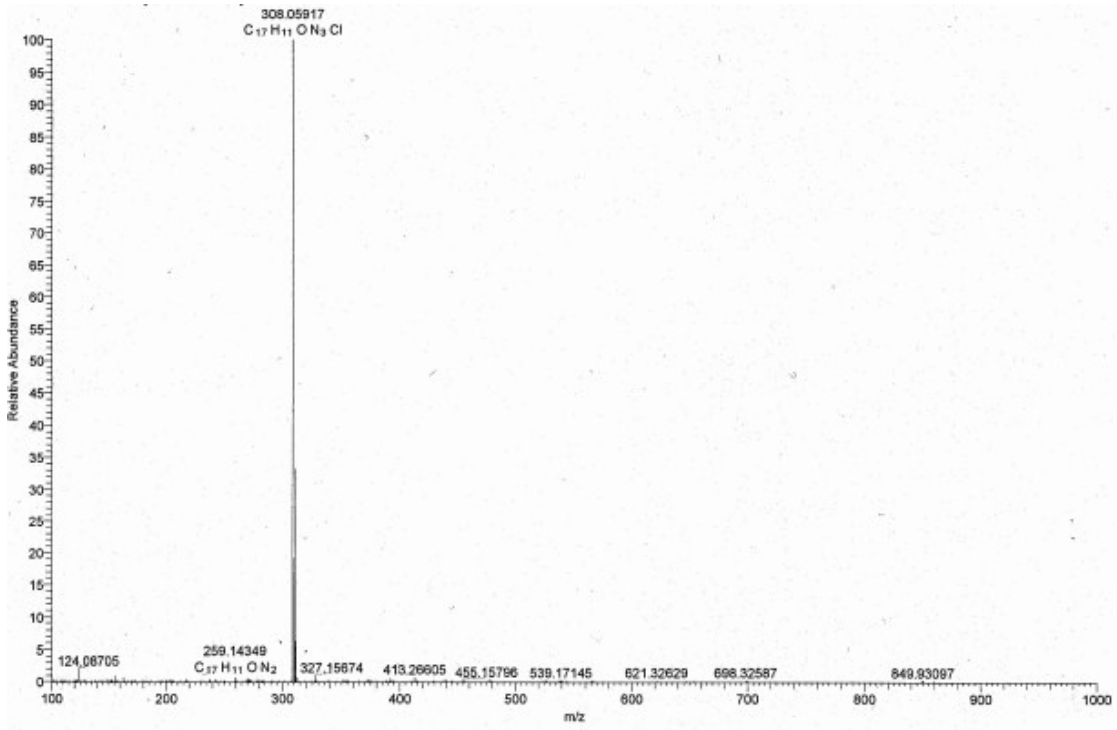
High resolution mass spectrum of compound **A31**



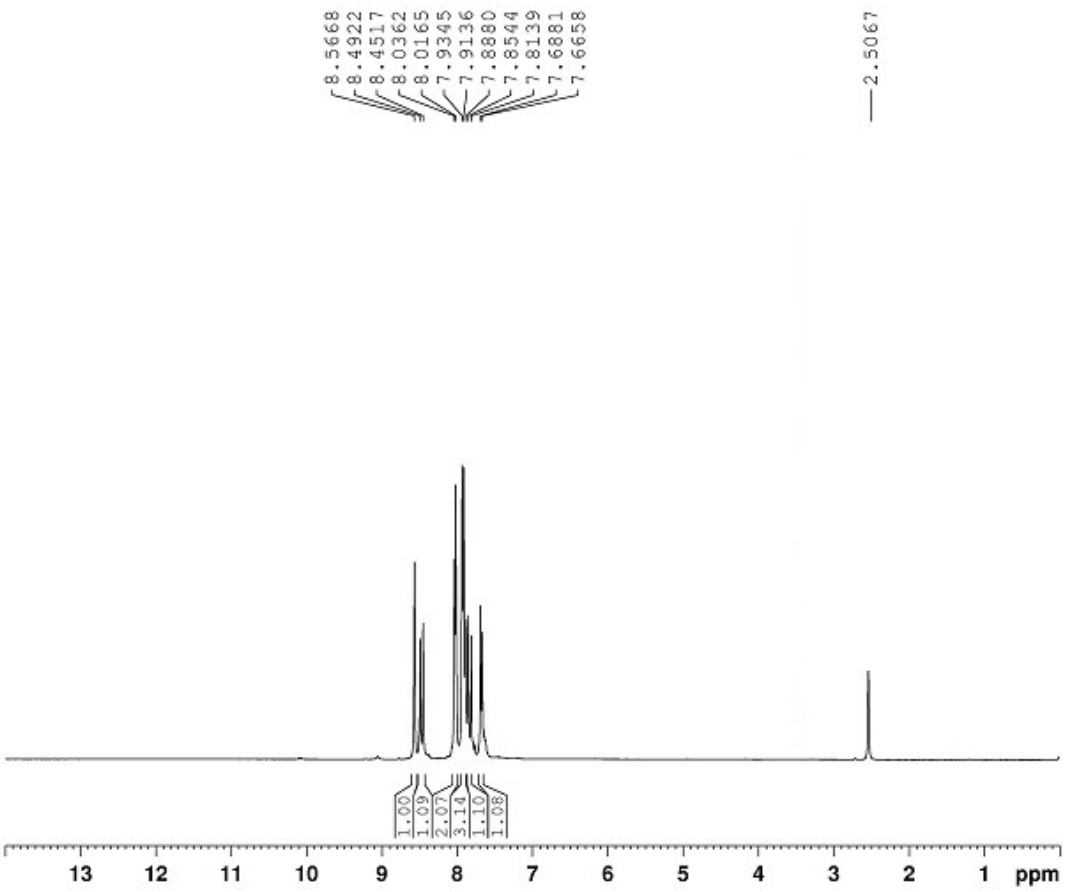
^{1}H NMR spectrum of compound **A32**



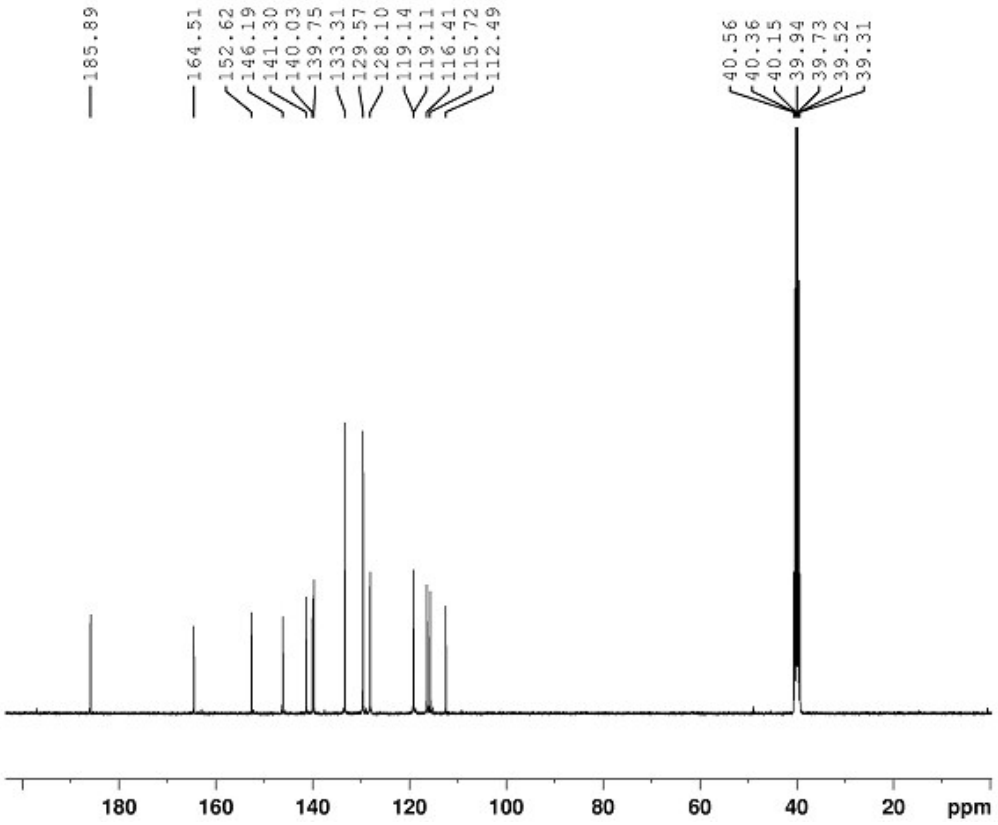
^{13}C NMR spectrum of compound **A32**



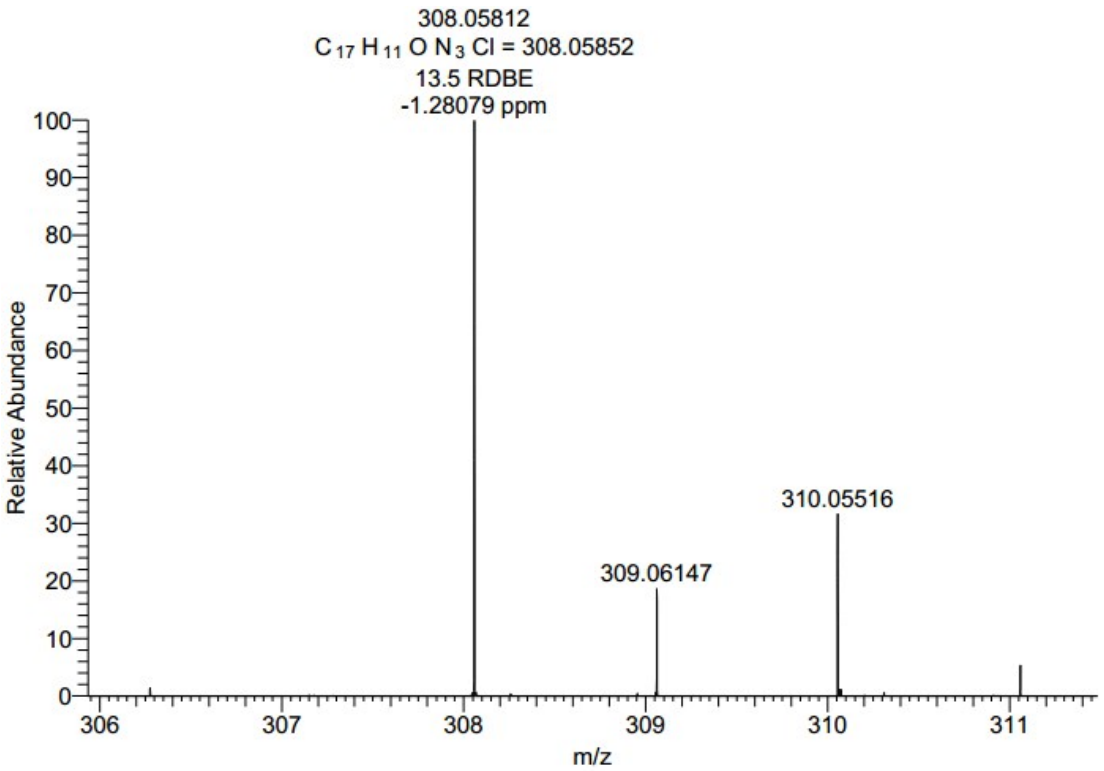
High resolution mass spectrum of compound **A32**



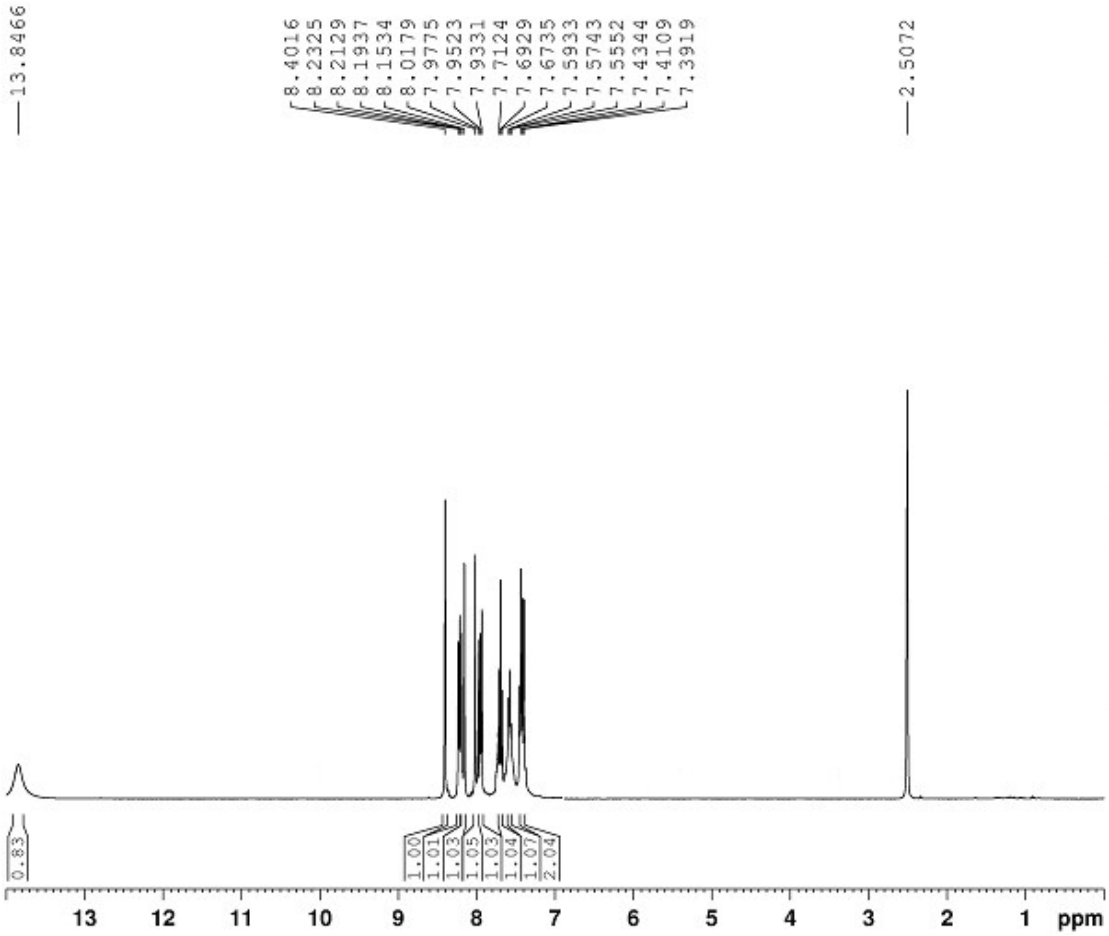
^{1}H NMR spectrum of compound **A33**



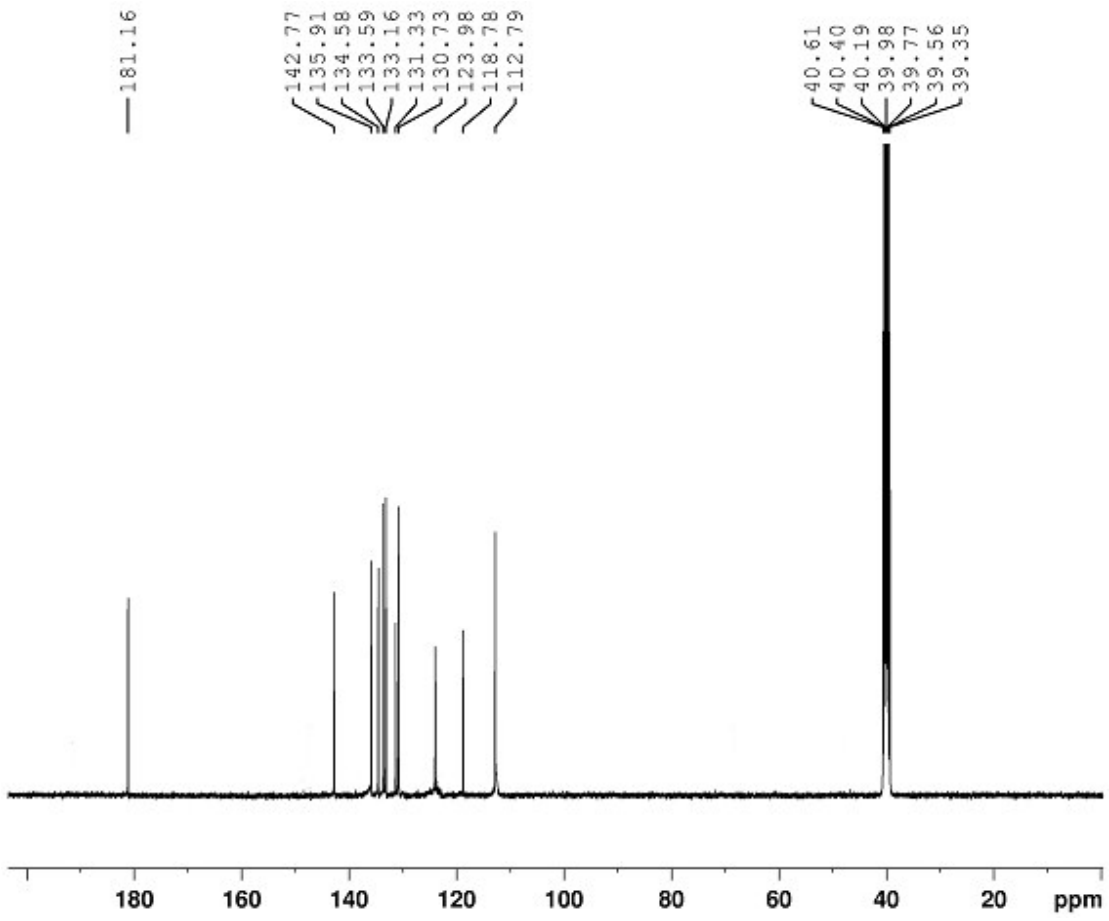
^{13}C NMR spectrum of compound **A33**



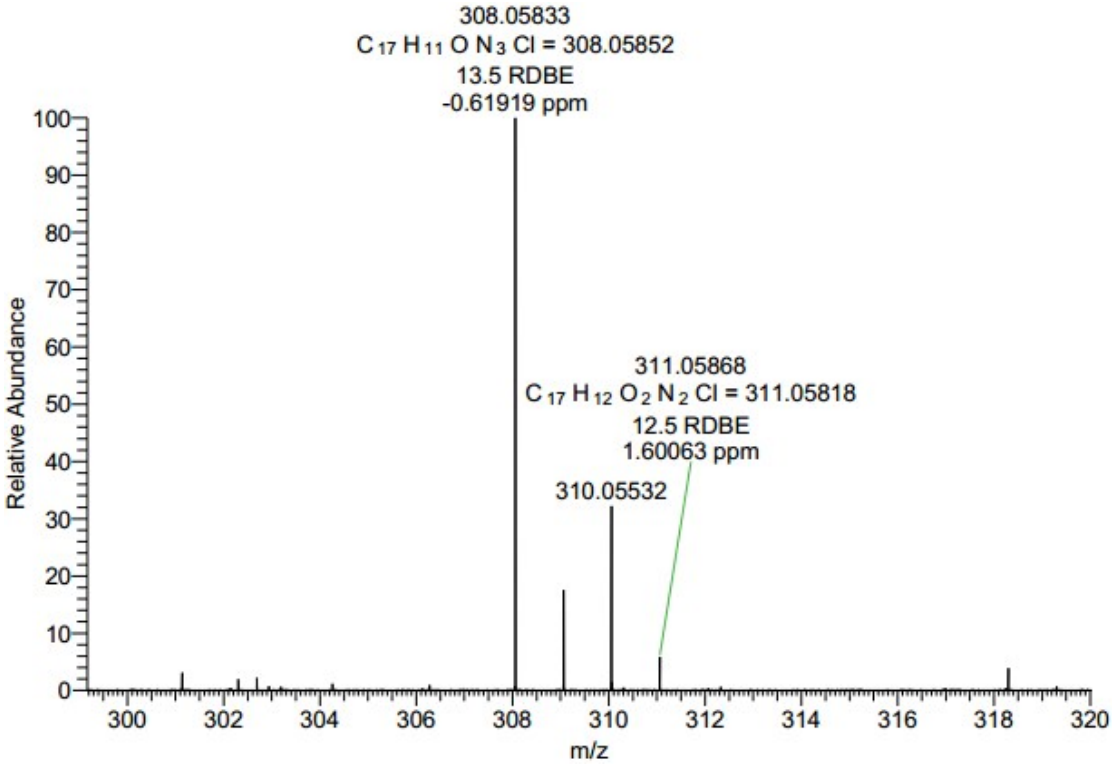
High resolution mass spectrum of compound **A33**



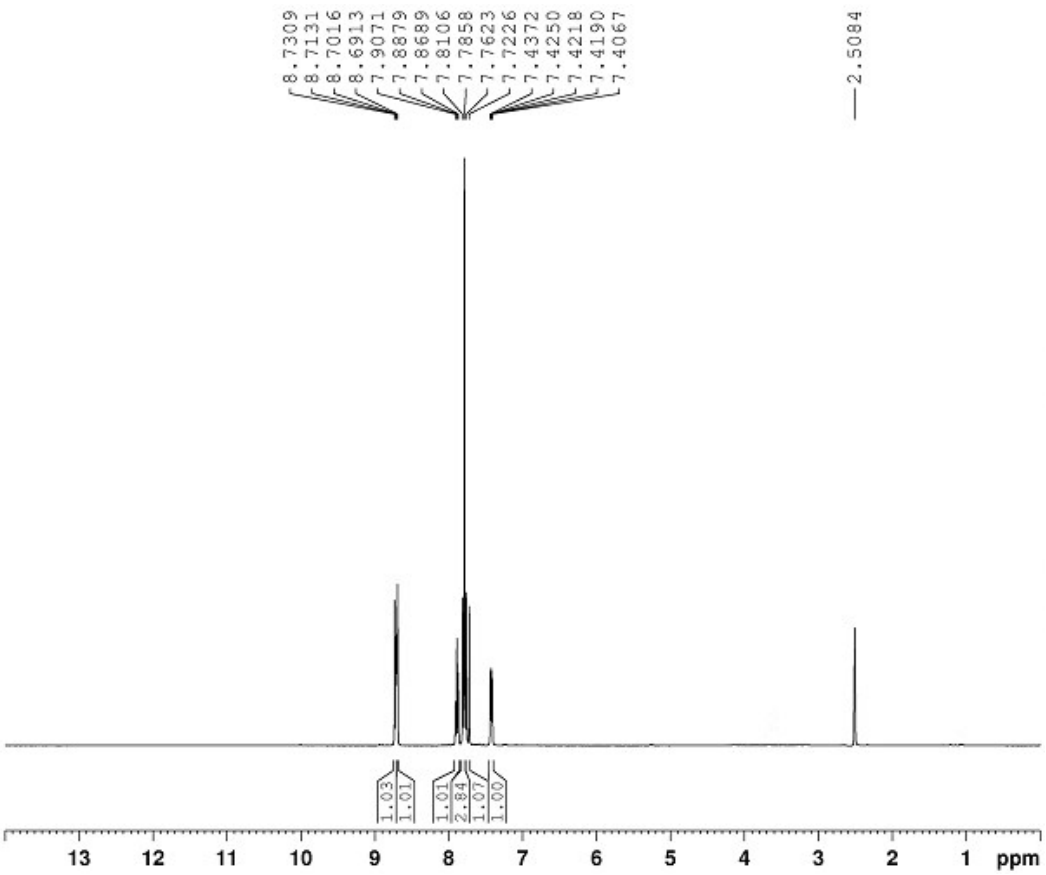
^{1}H NMR spectrum of compound **A34**



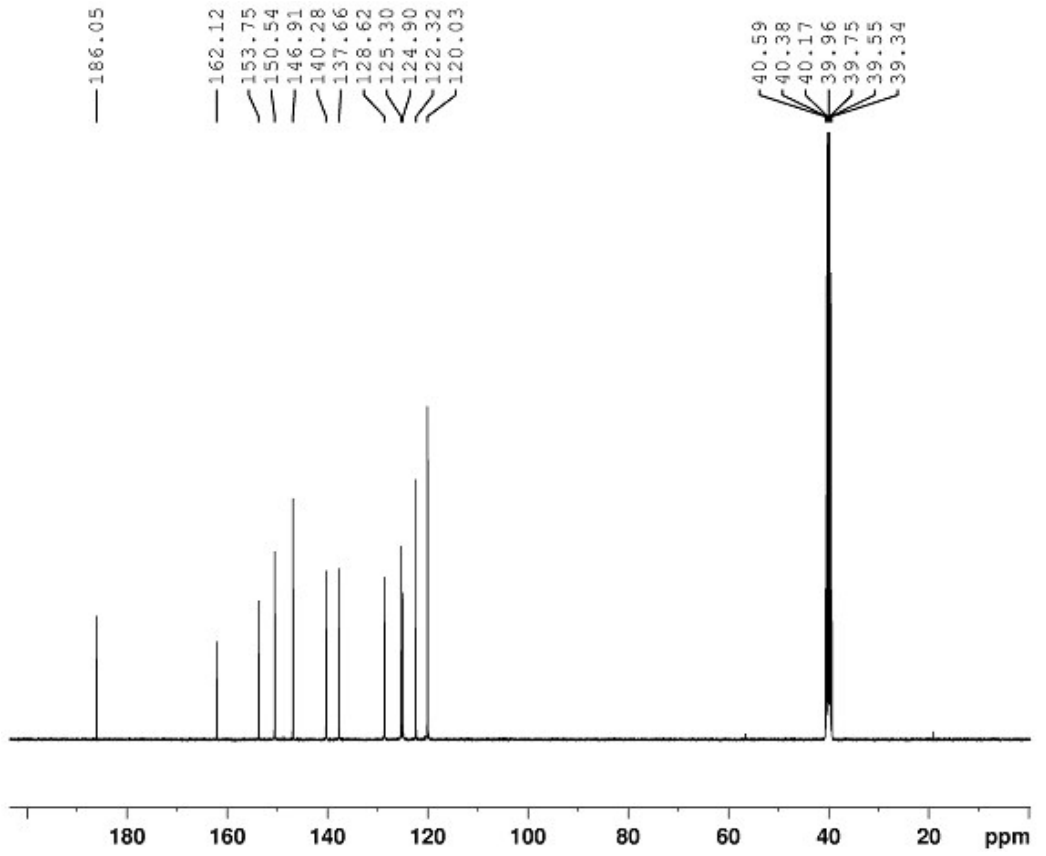
^{13}C NMR spectrum of compound **A34**



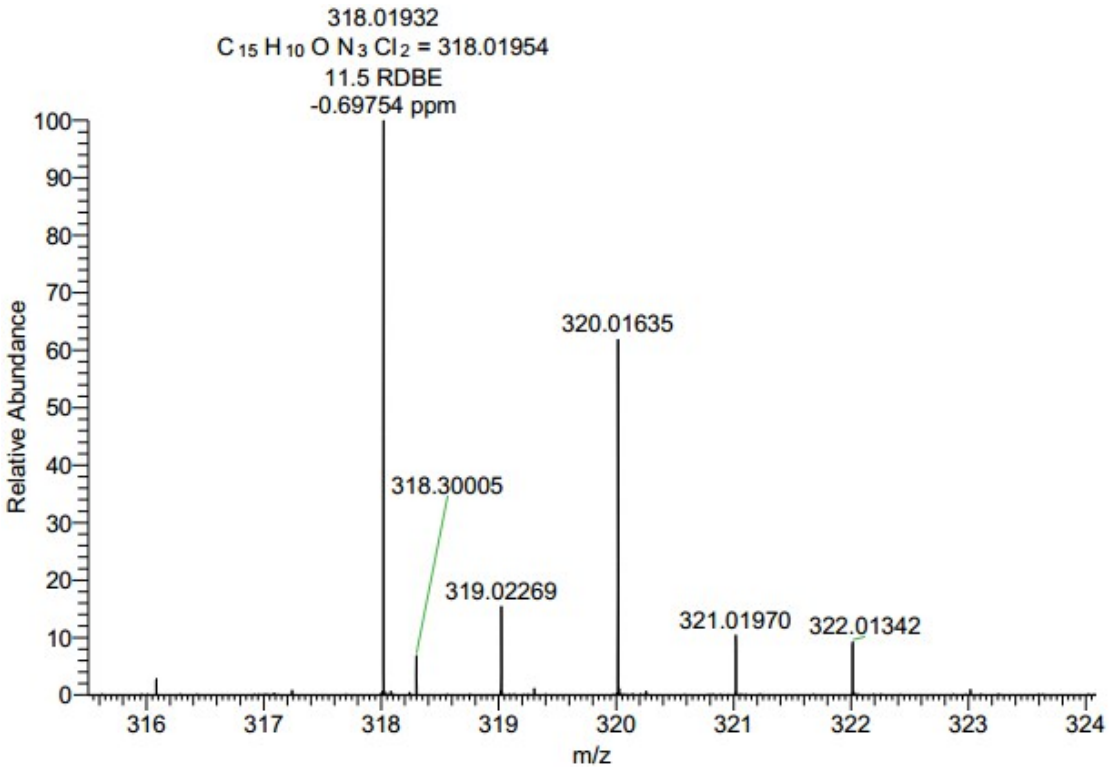
High resolution mass spectrum of compound **A34**



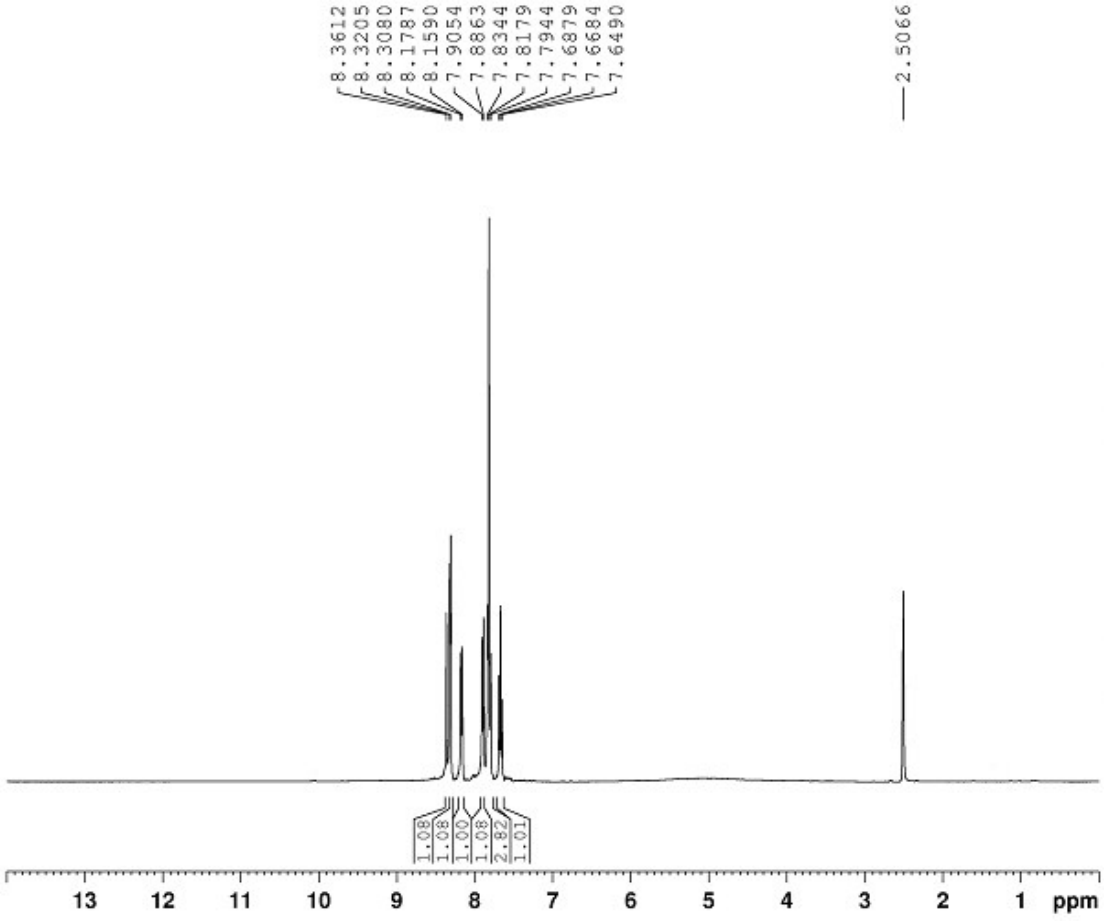
^{1}H NMR spectrum of compound **A35**



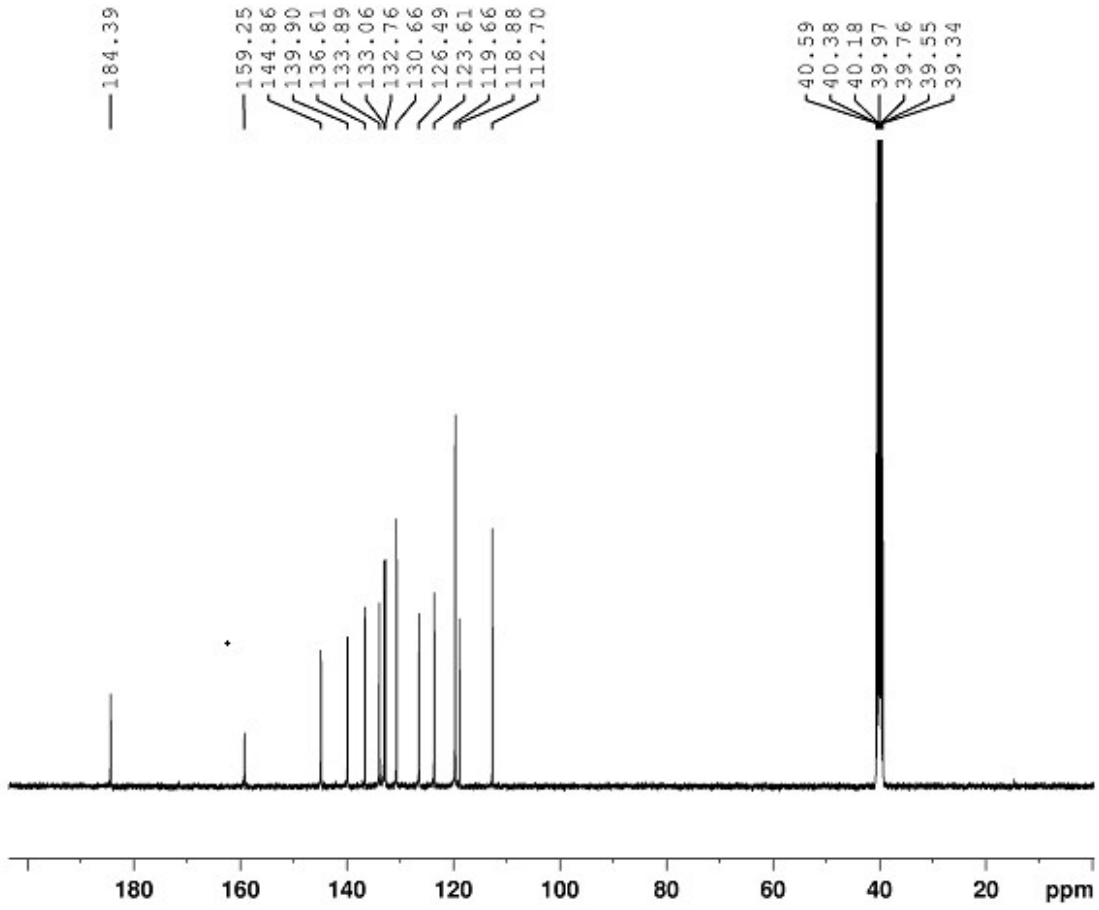
^{13}C NMR spectrum of compound **A35**



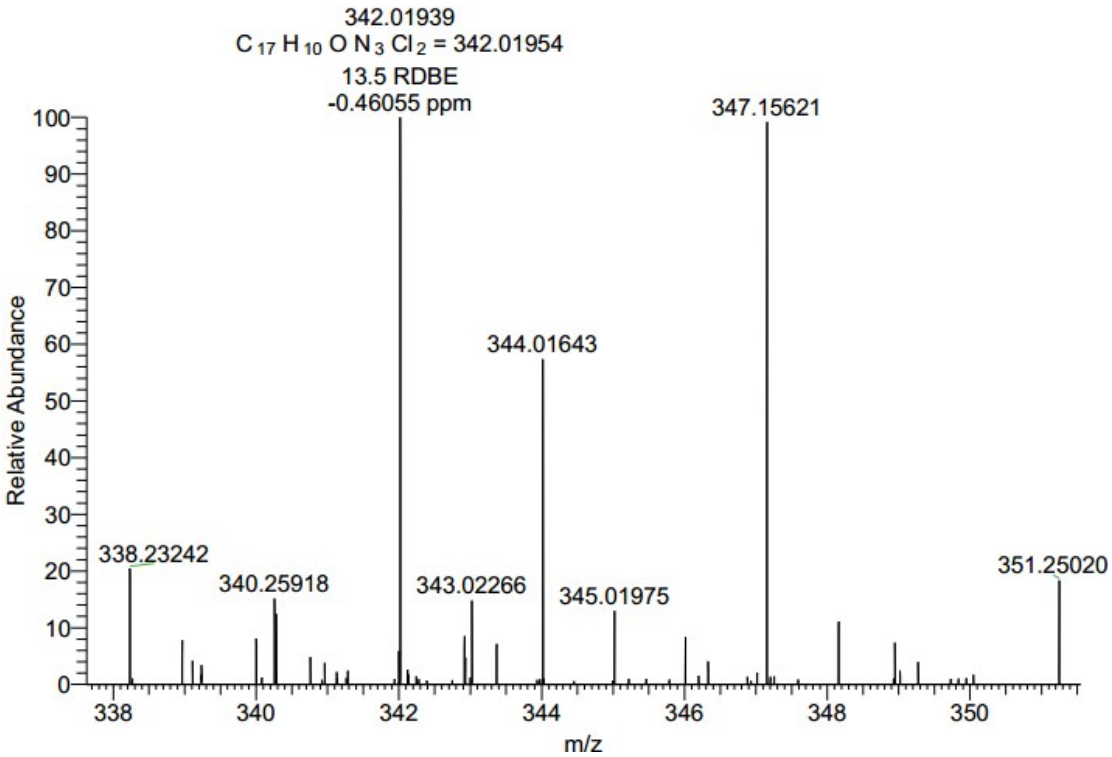
High resolution mass spectrum of compound **A35**



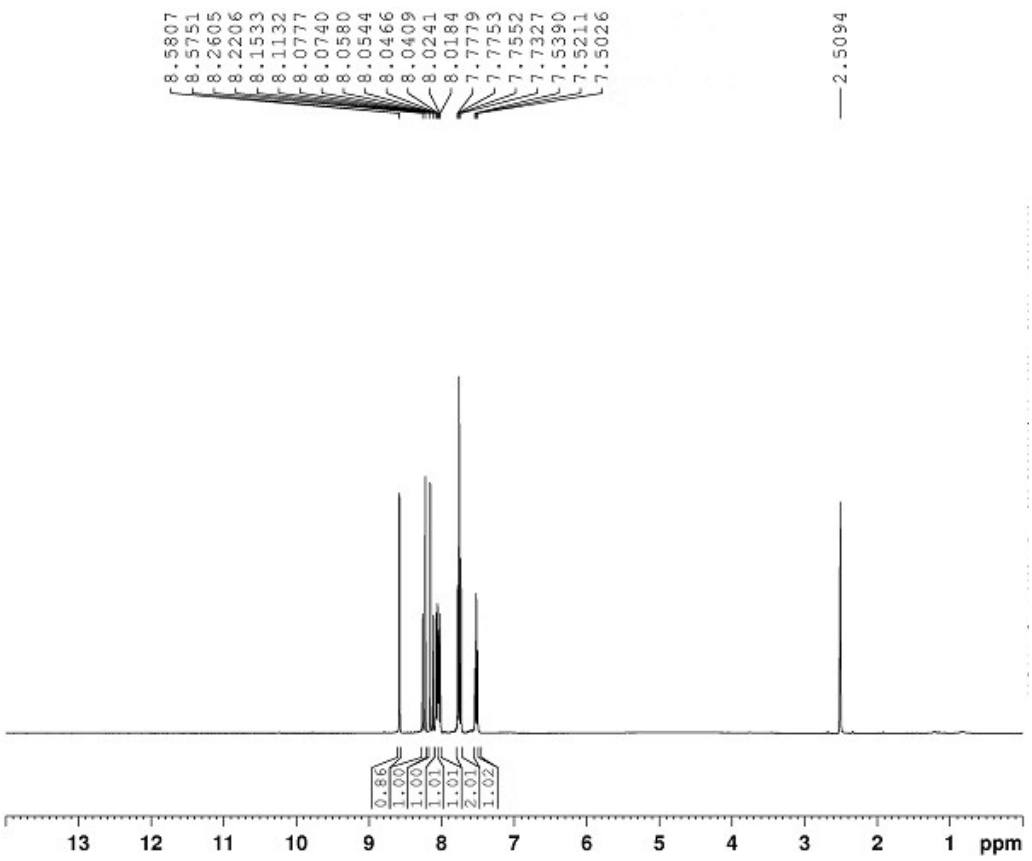
^{1}H NMR spectrum of compound **A36**



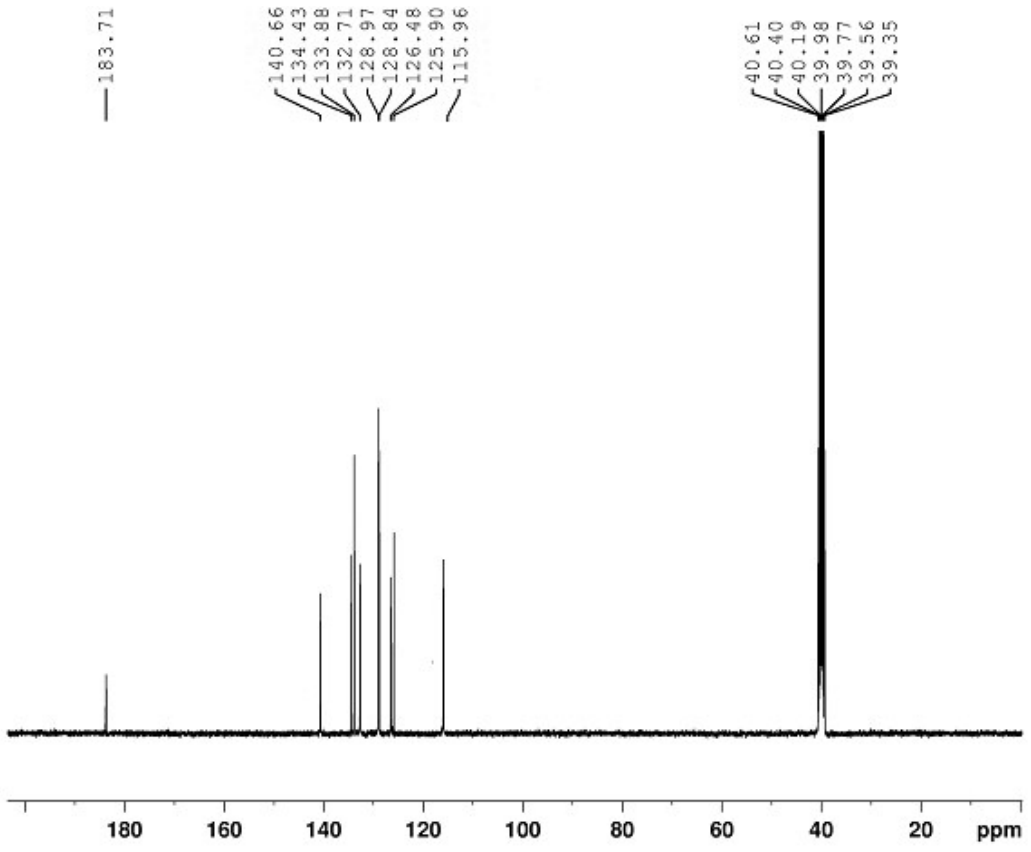
^{13}C NMR spectrum of compound **A36**



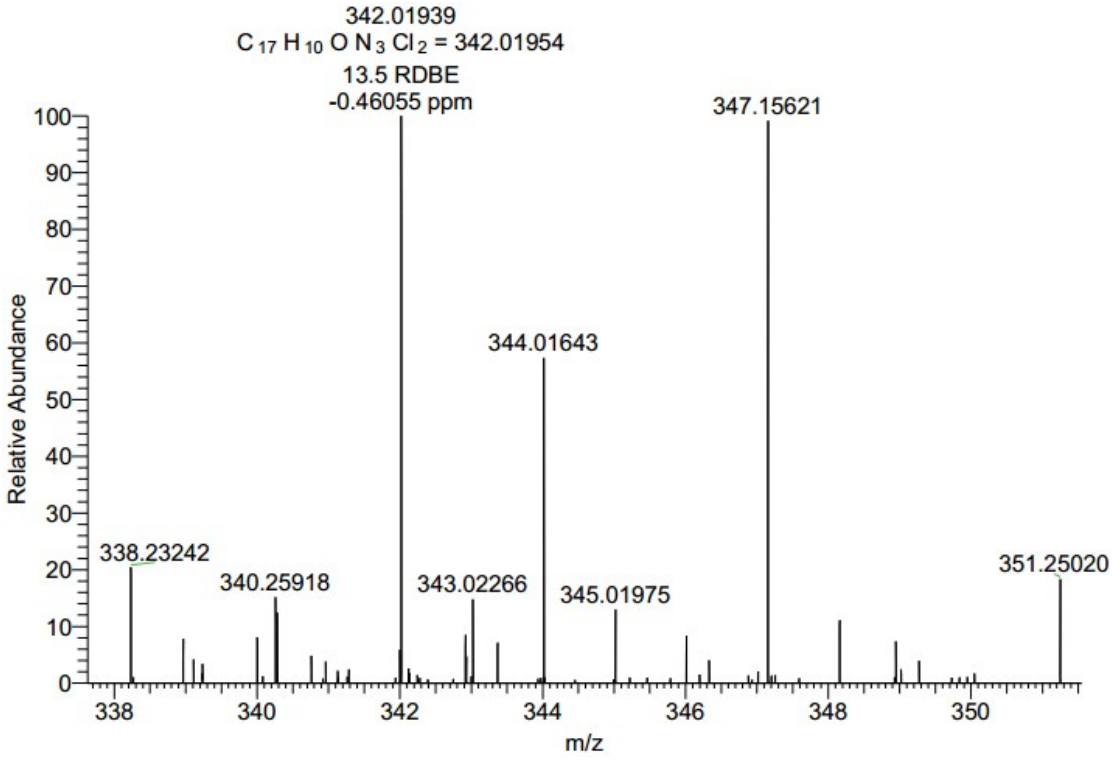
High resolution mass spectrum of compound **A36**



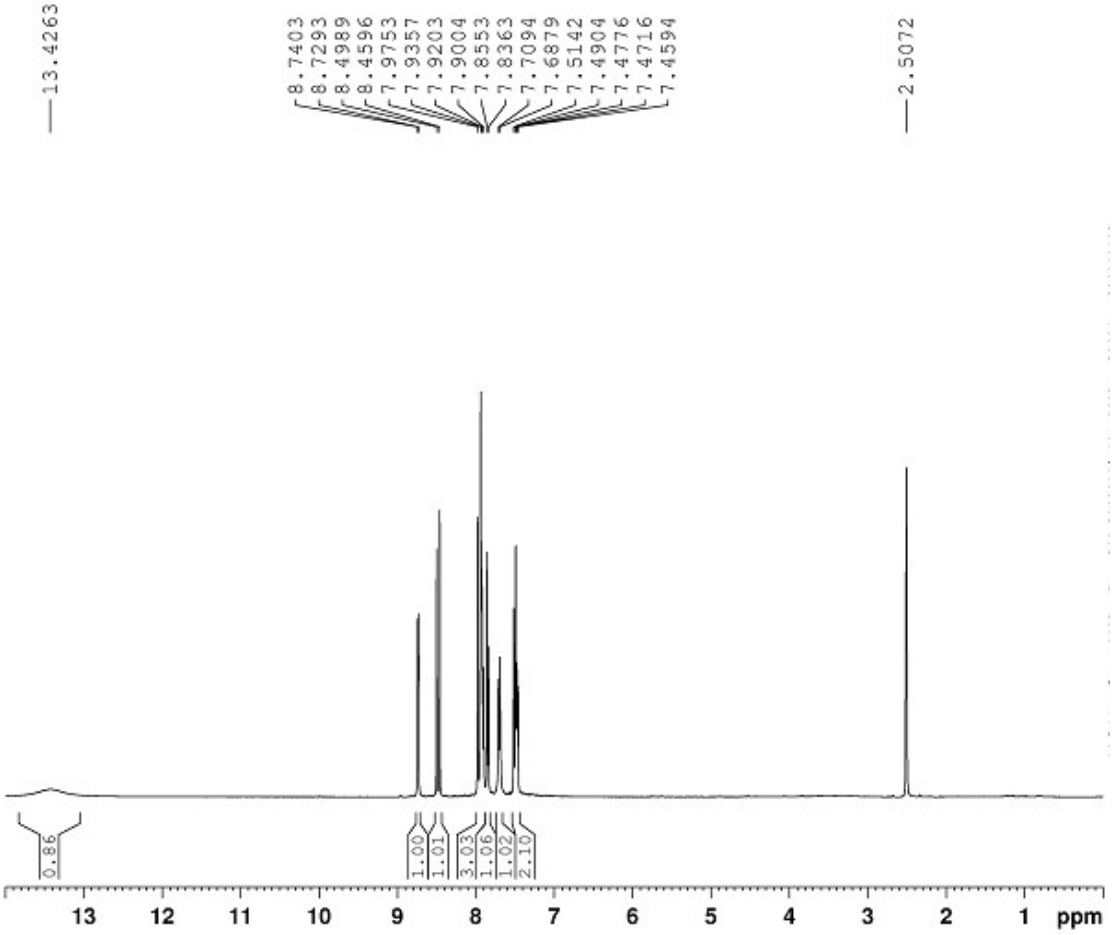
^{1}H NMR spectrum of compound **A37**



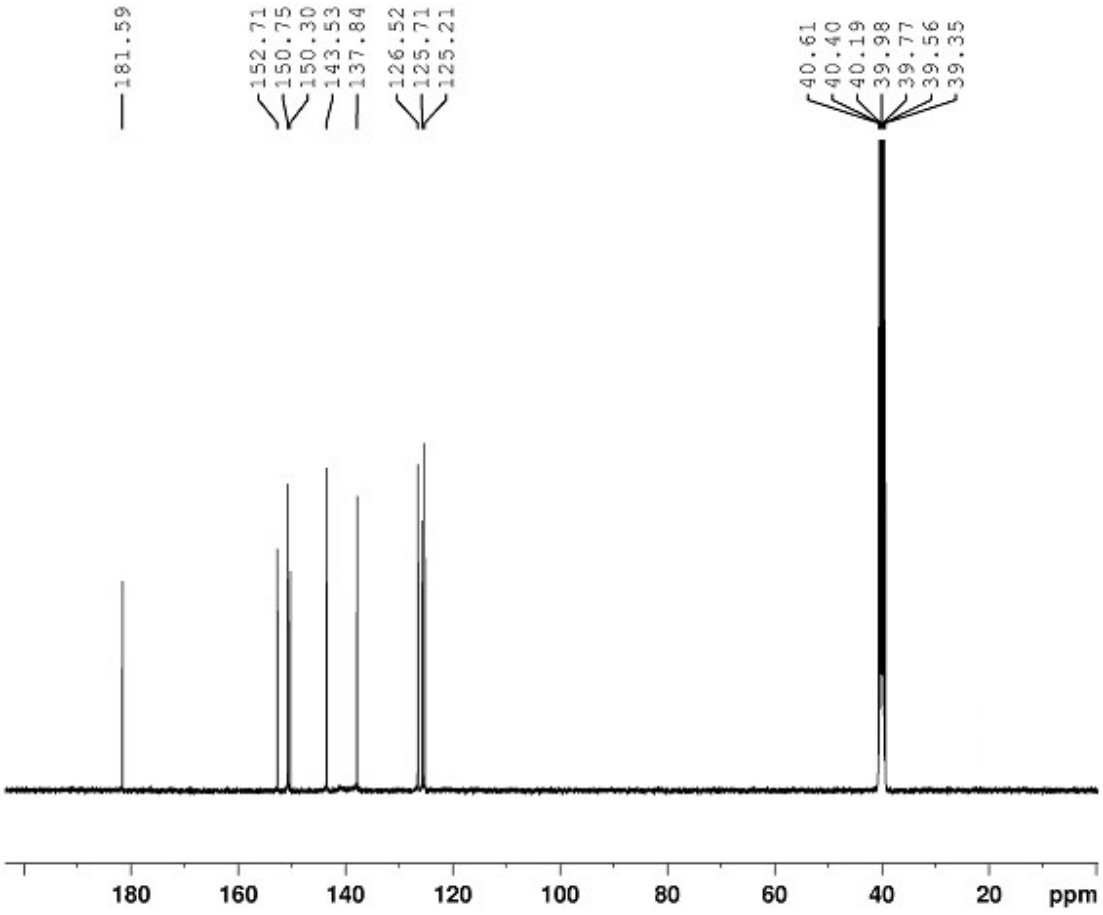
^{13}C NMR spectrum of compound **A37**



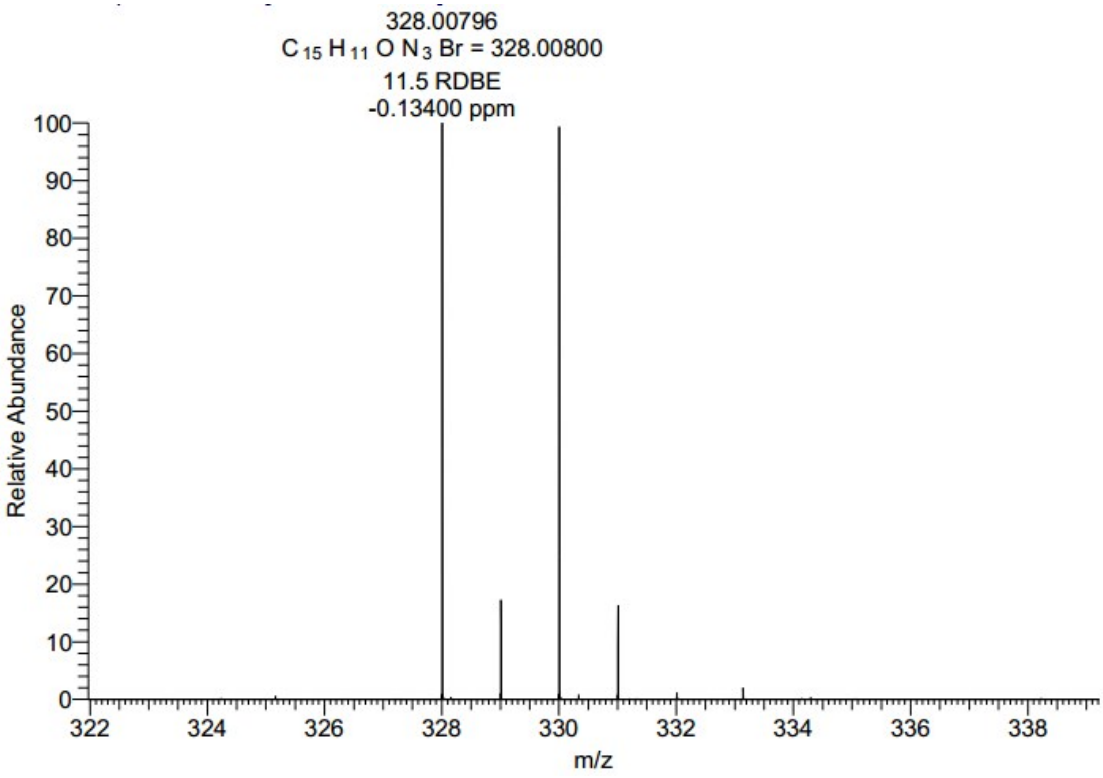
High resolution mass spectrum of compound **A37**



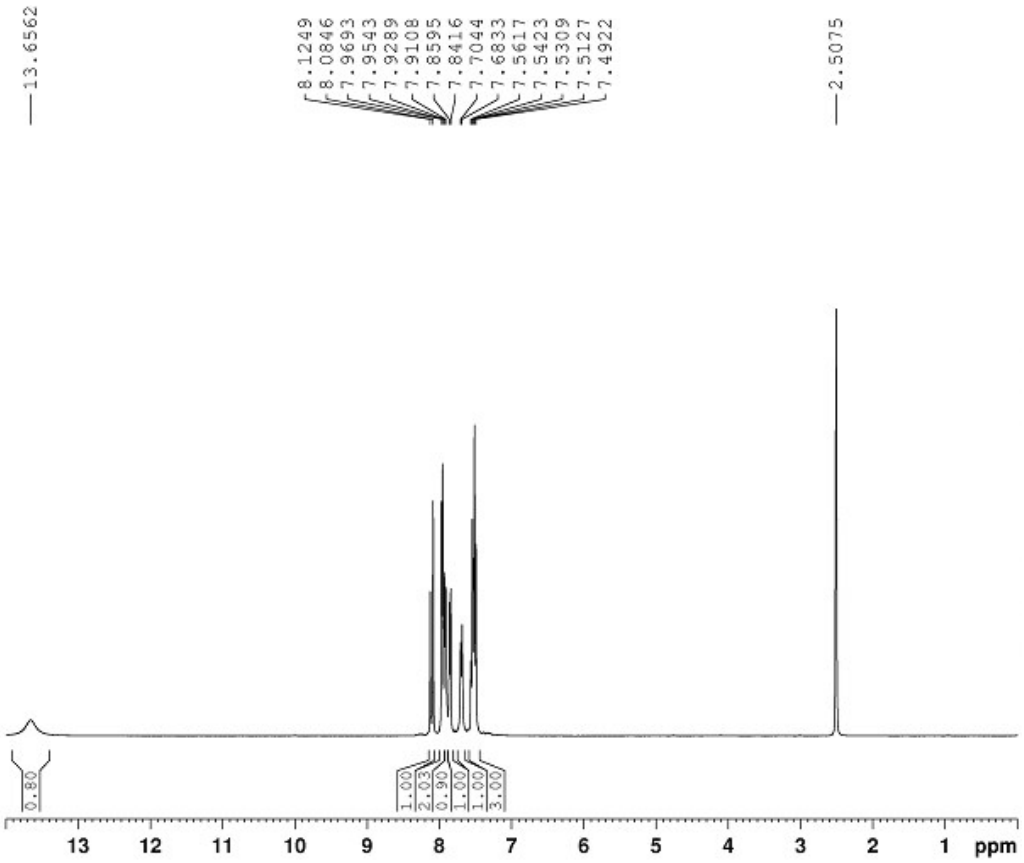
^{1}H NMR spectrum of compound **A38**



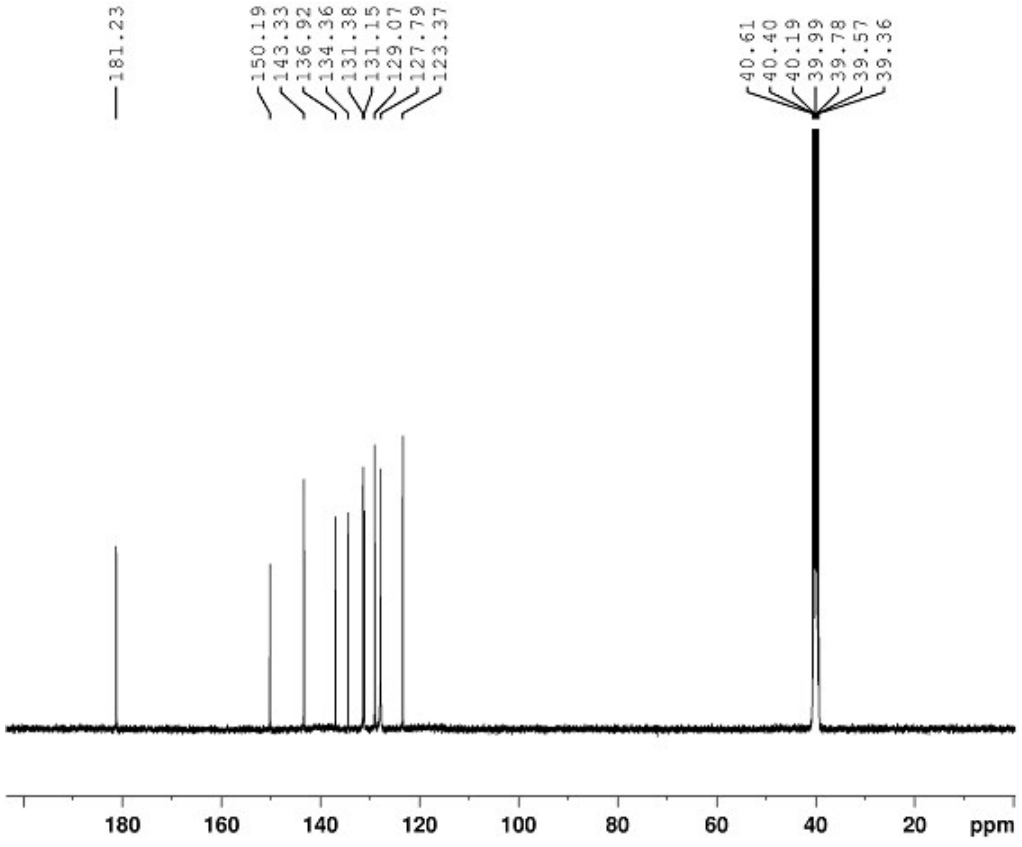
^{13}C NMR spectrum of compound **A38**



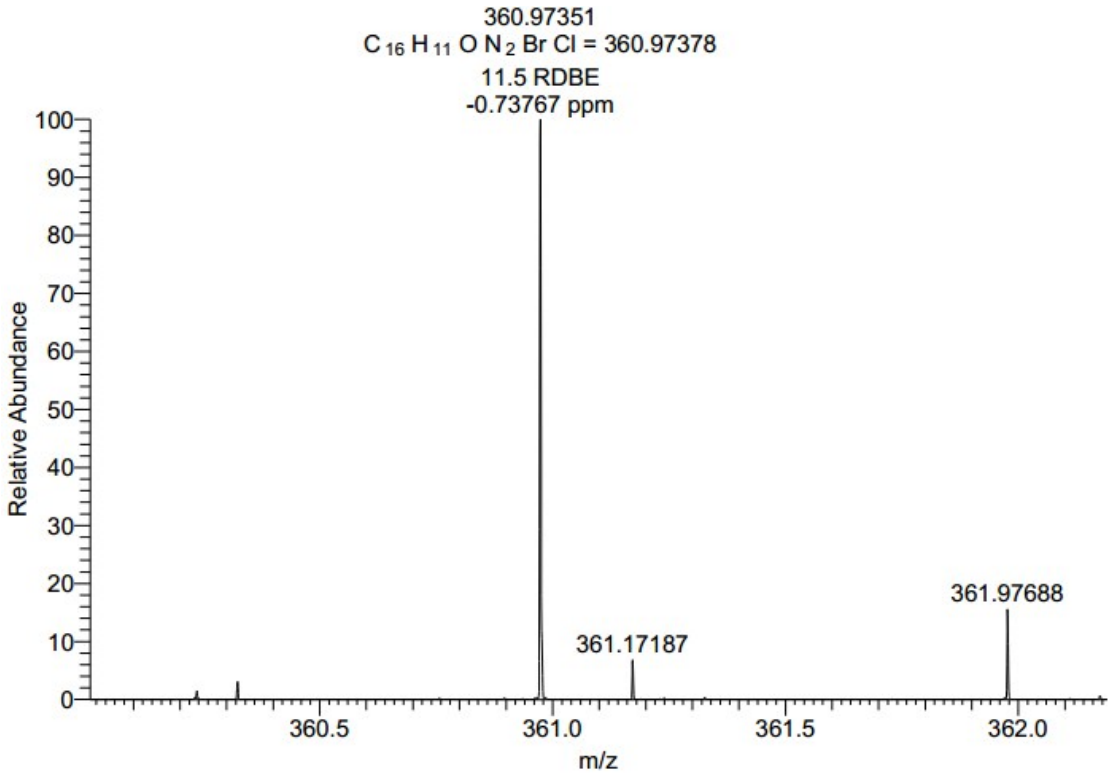
High resolution mass spectrum of compound **A38**



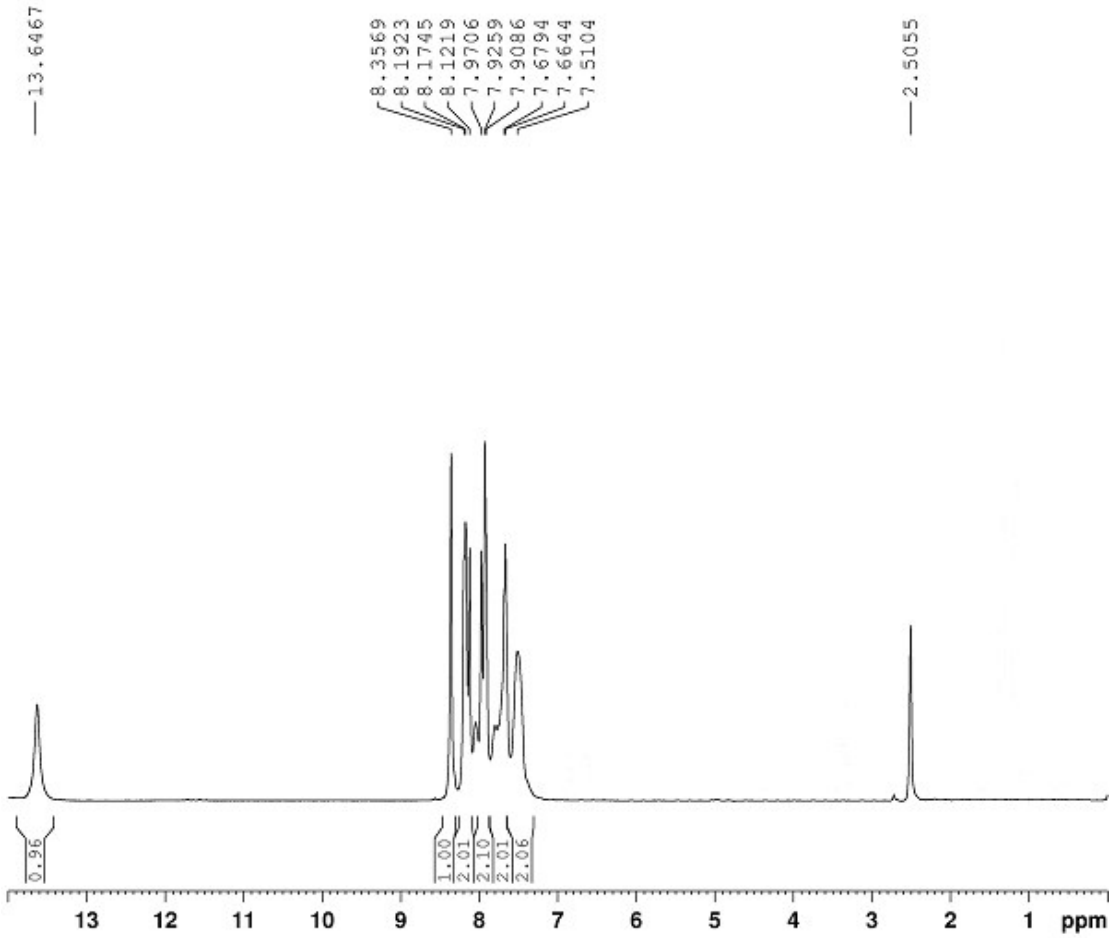
^{1}H NMR spectrum of compound **A39**



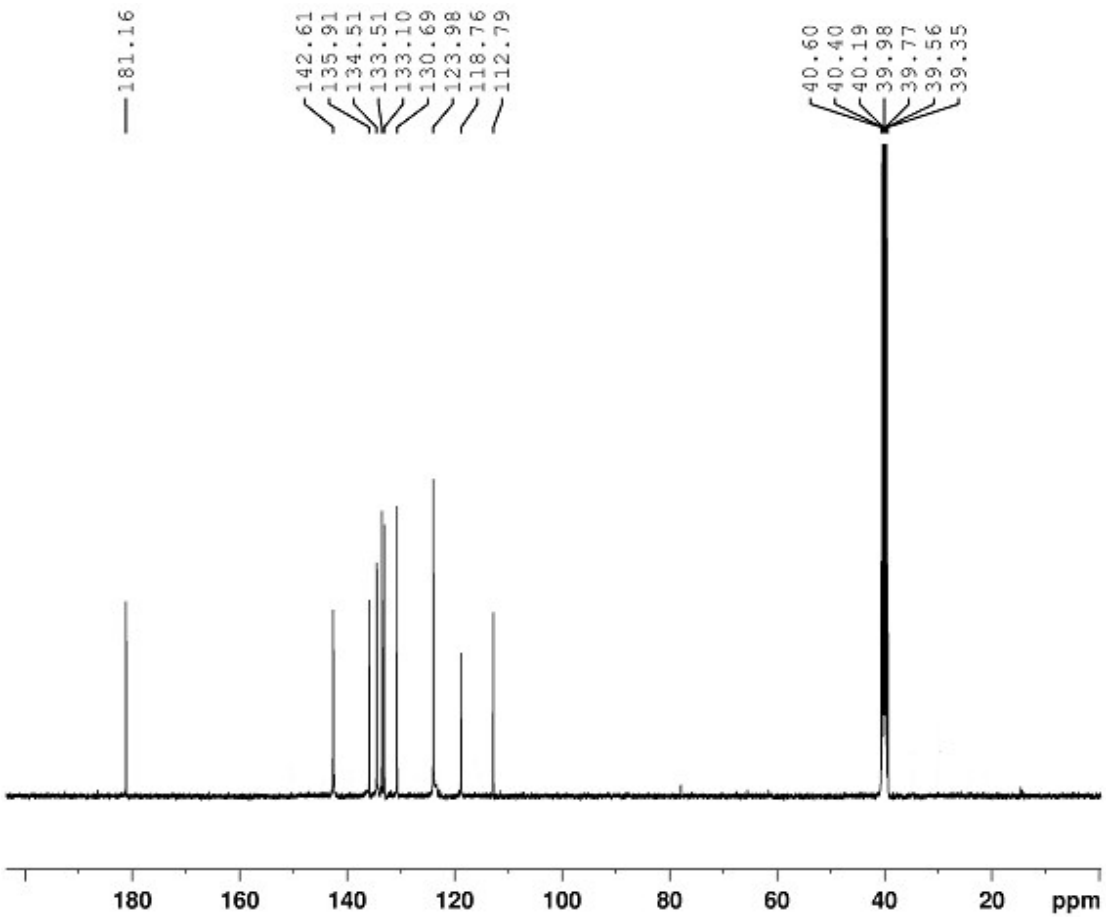
^{13}C NMR spectrum of compound **A39**



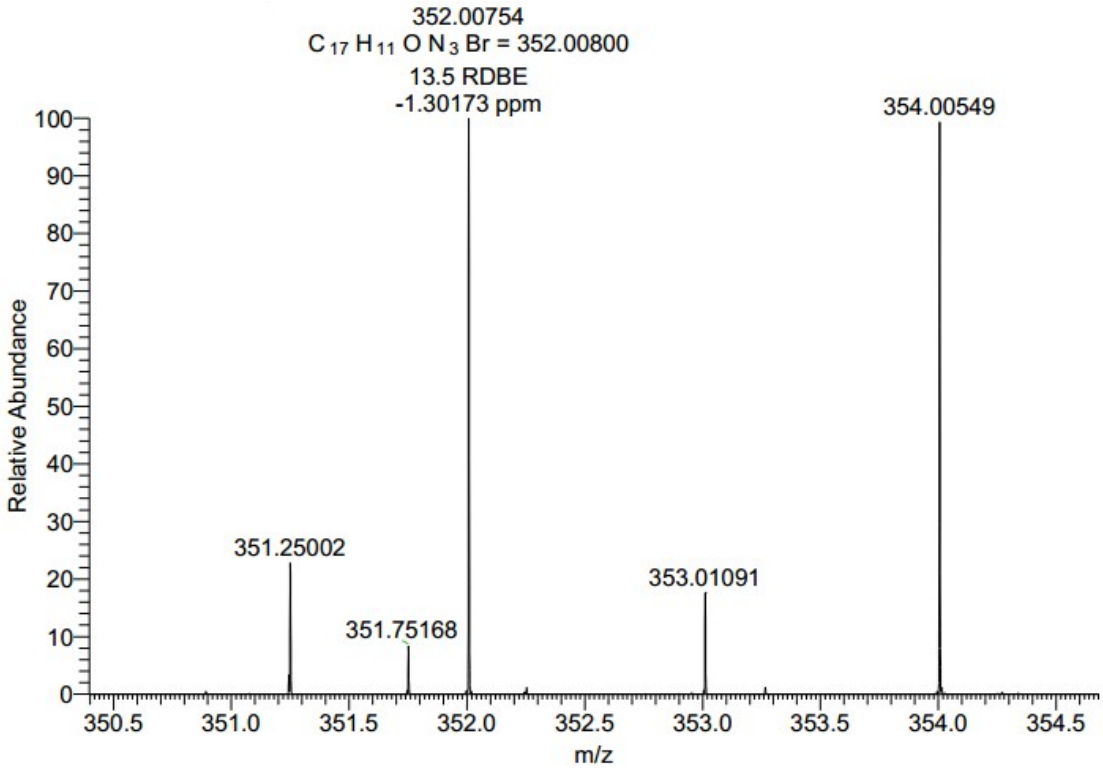
High resolution mass spectrum of compound **A39**



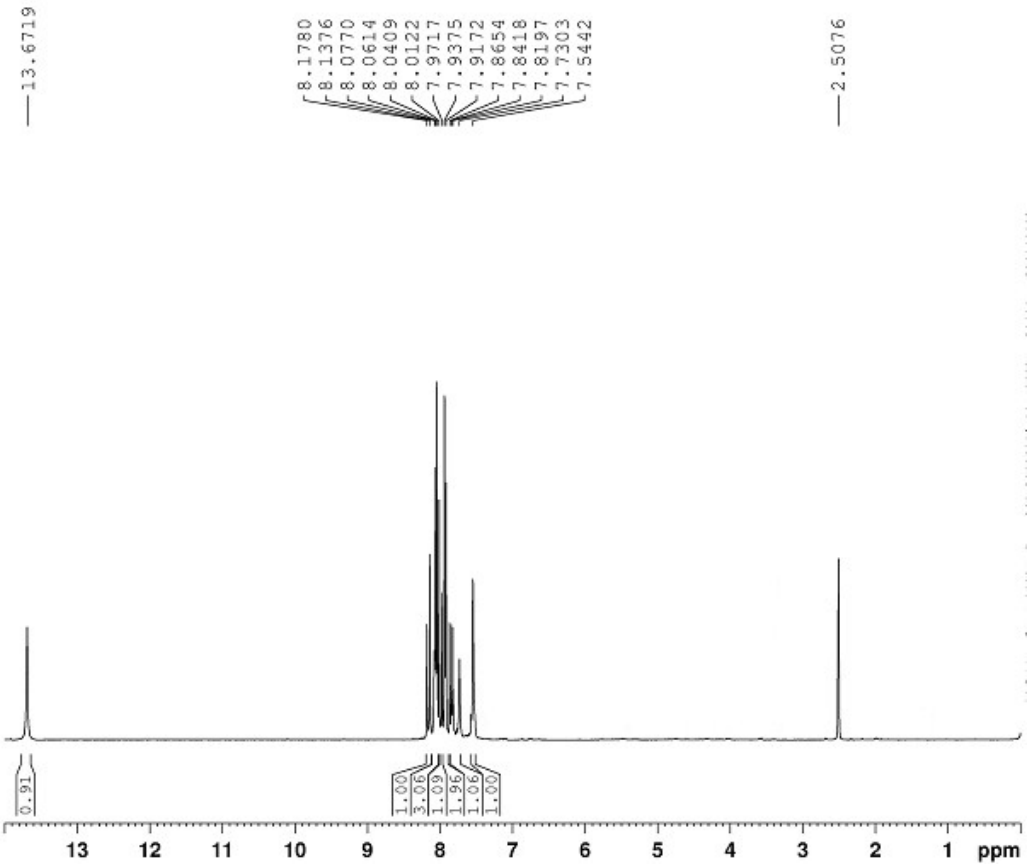
^{1}H NMR spectrum of compound **A40**



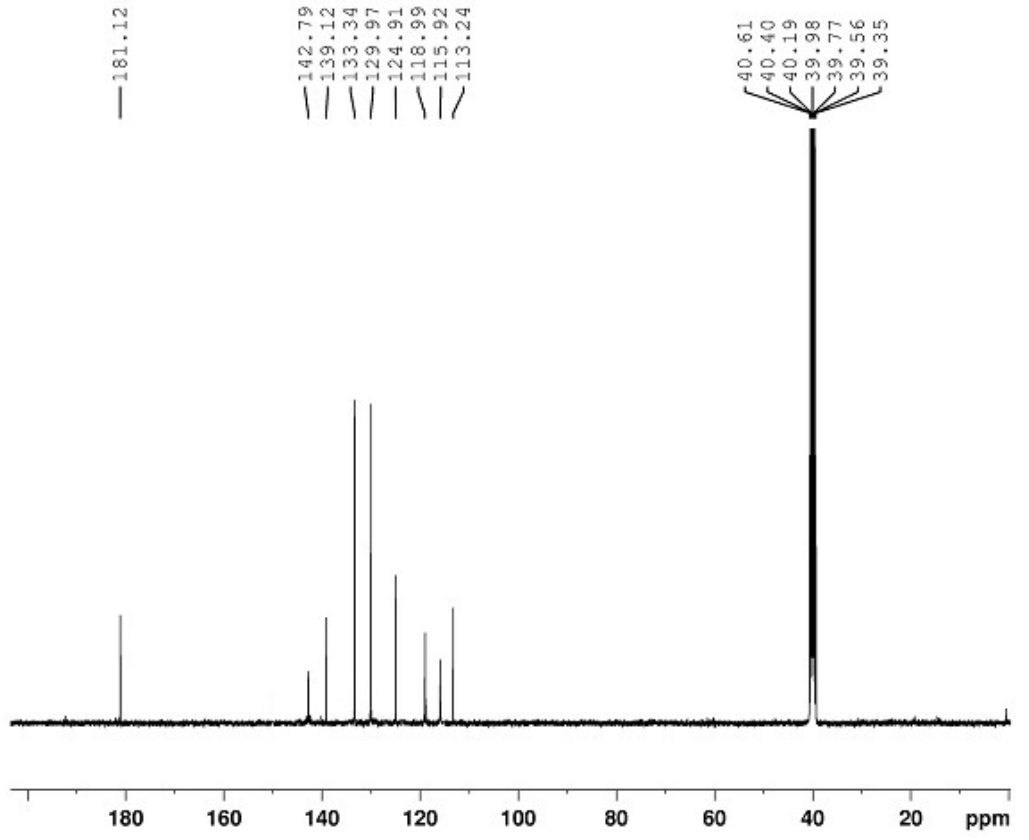
^{13}C NMR spectrum of compound **A40**



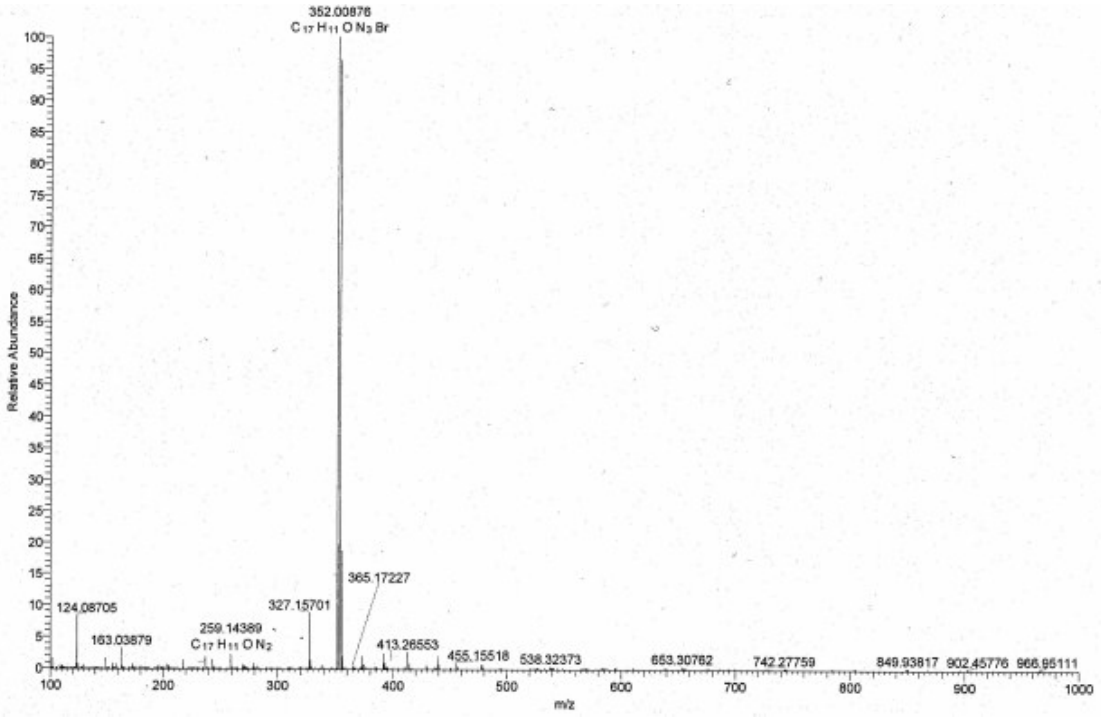
High resolution mass spectrum of compound **A40**



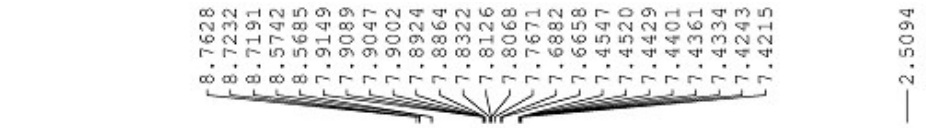
^{1}H NMR spectrum of compound **A41**

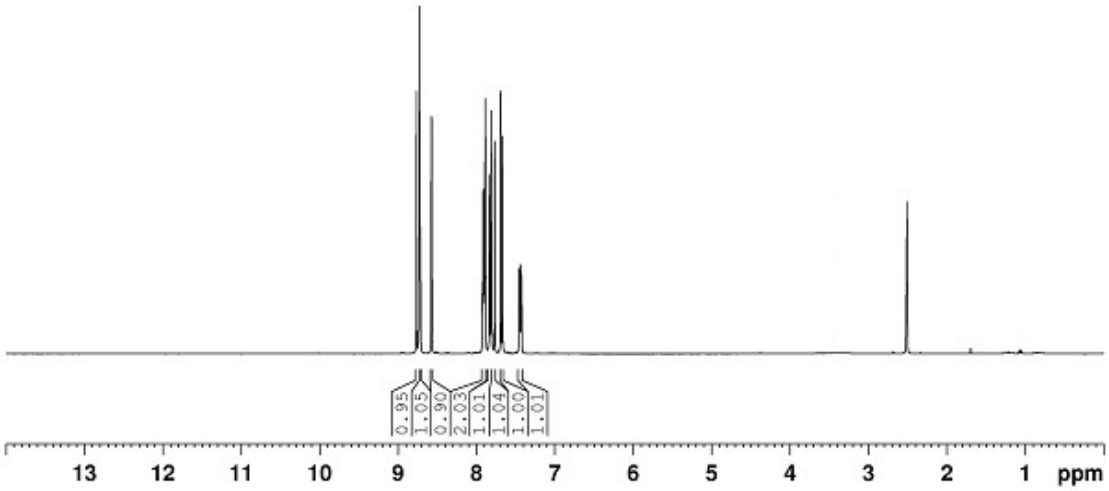


^{13}C NMR spectrum of compound **A41**

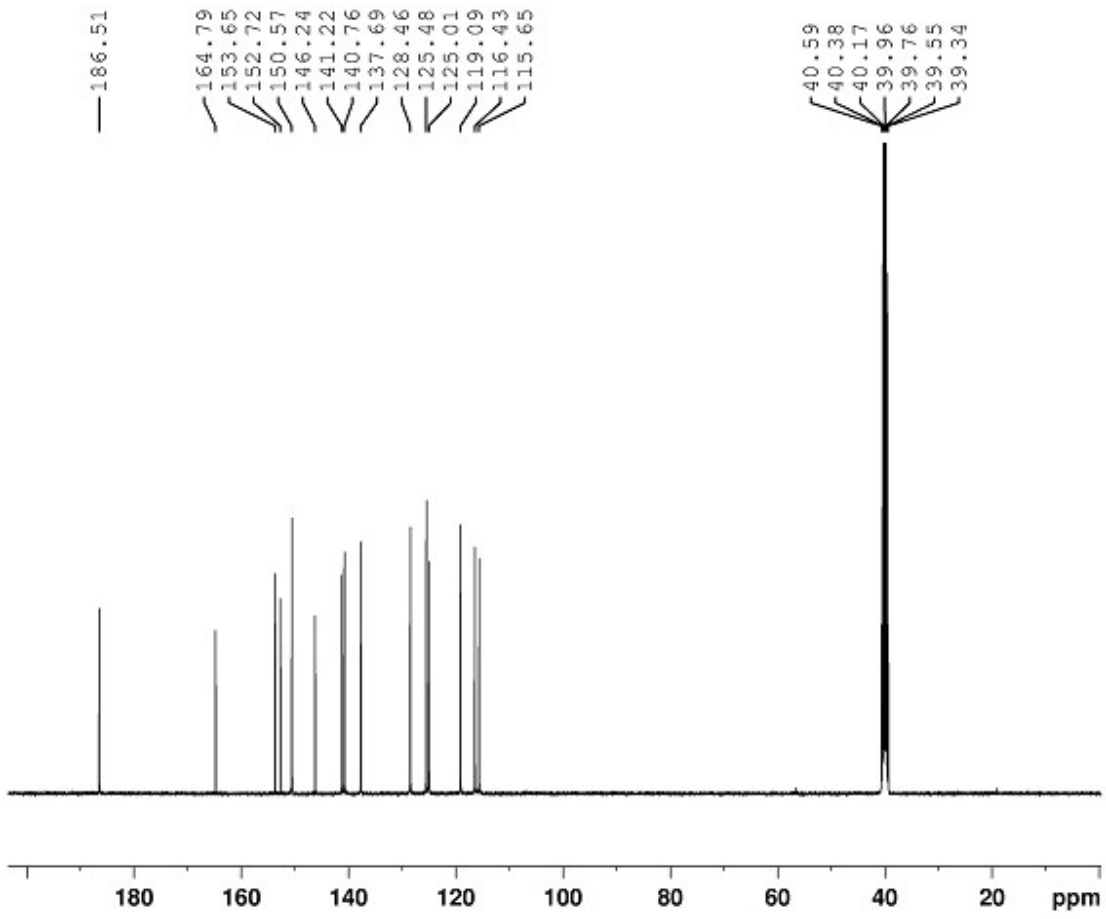


High resolution mass spectrum of compound **A41**

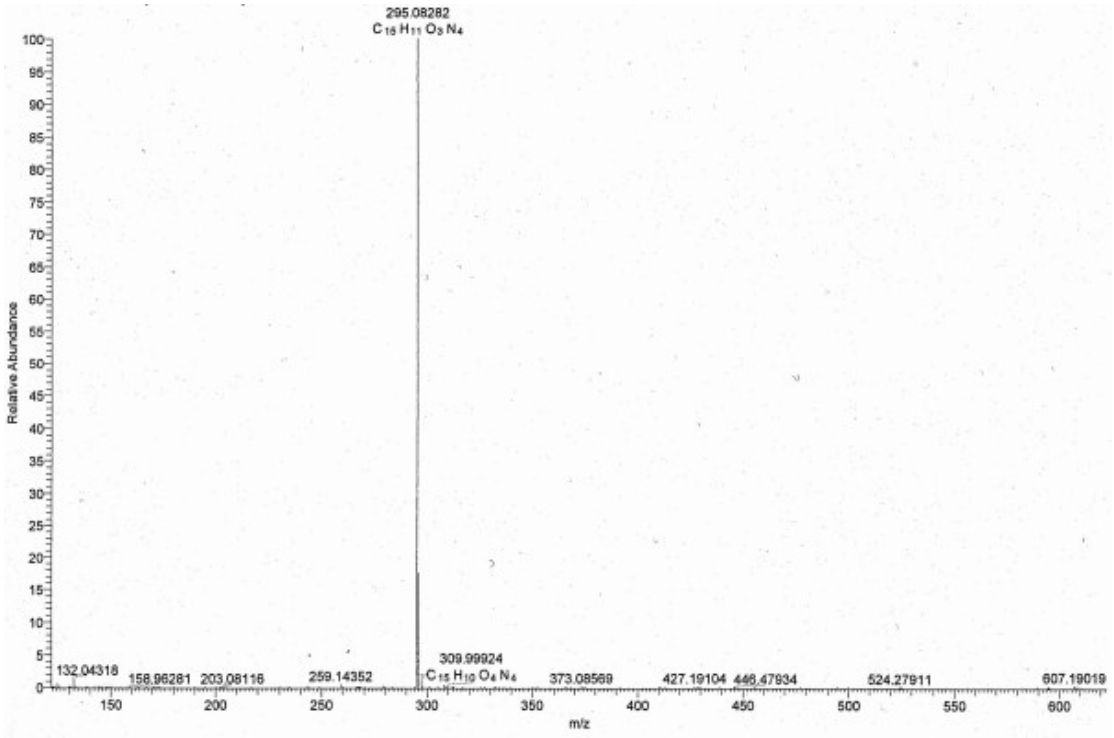




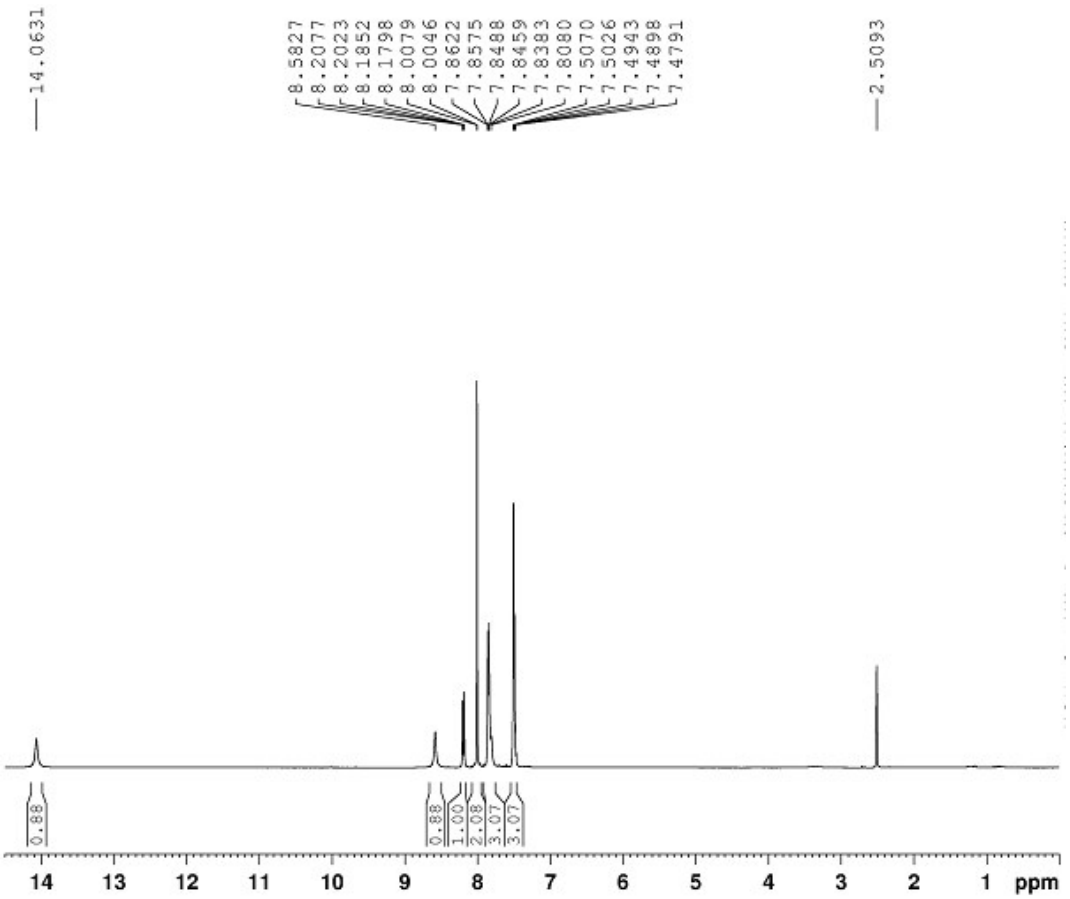
^{1}H NMR spectrum of compound **A42**



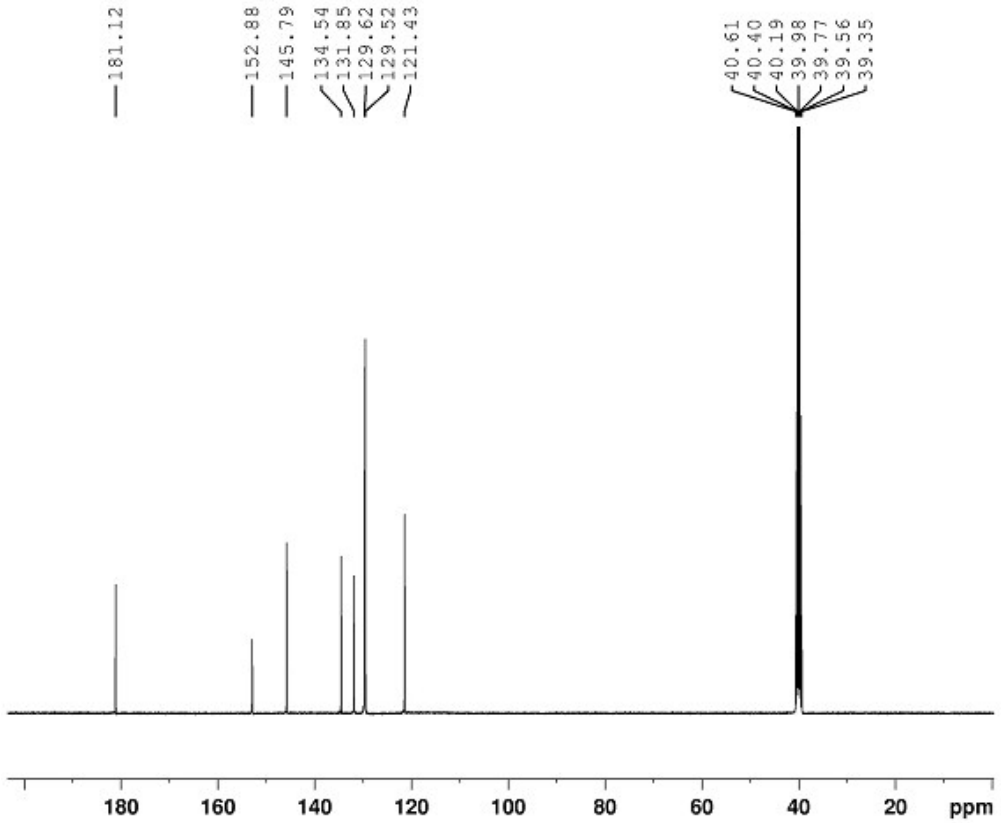
^{13}C NMR spectrum of compound **A42**



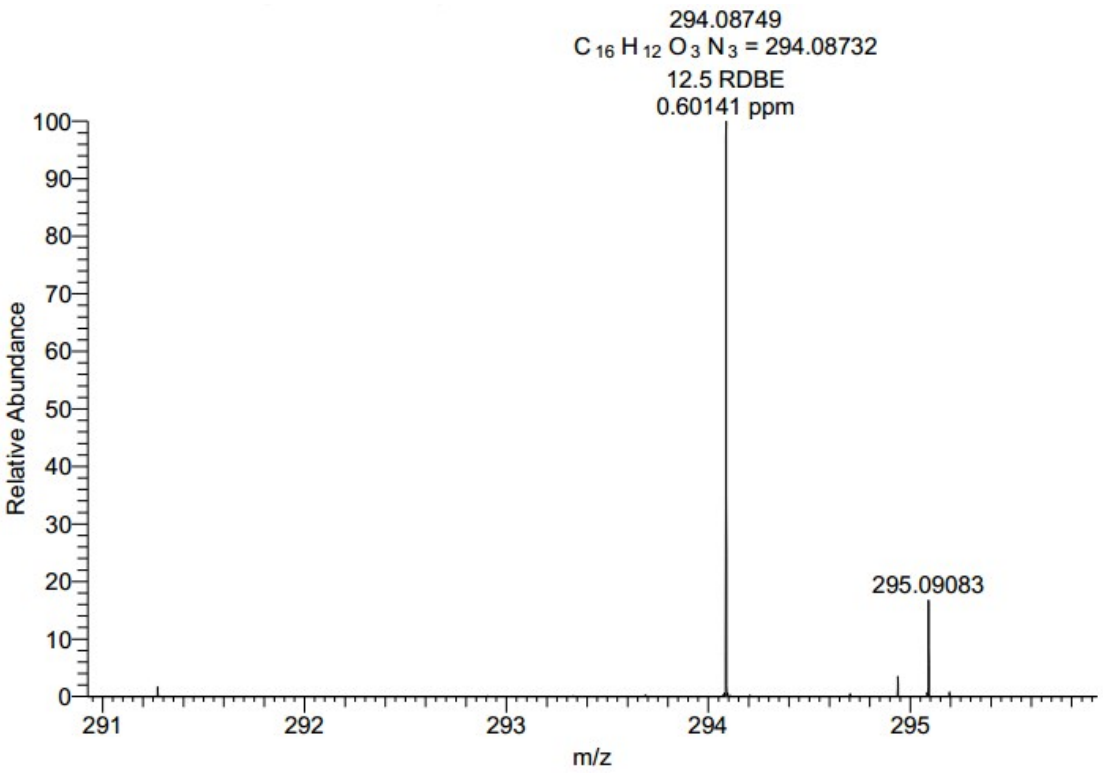
High resolution mass spectrum of compound **A42**



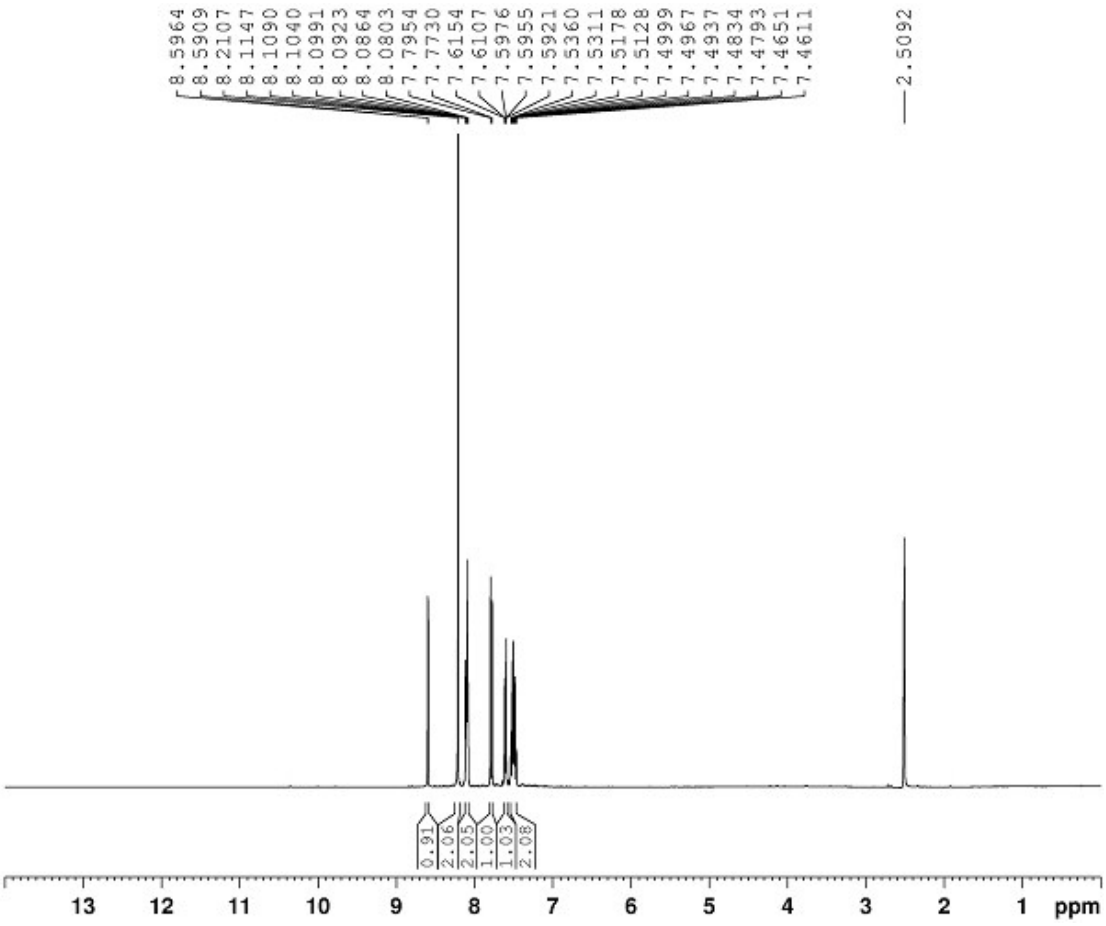
^{1}H NMR spectrum of compound **A43**



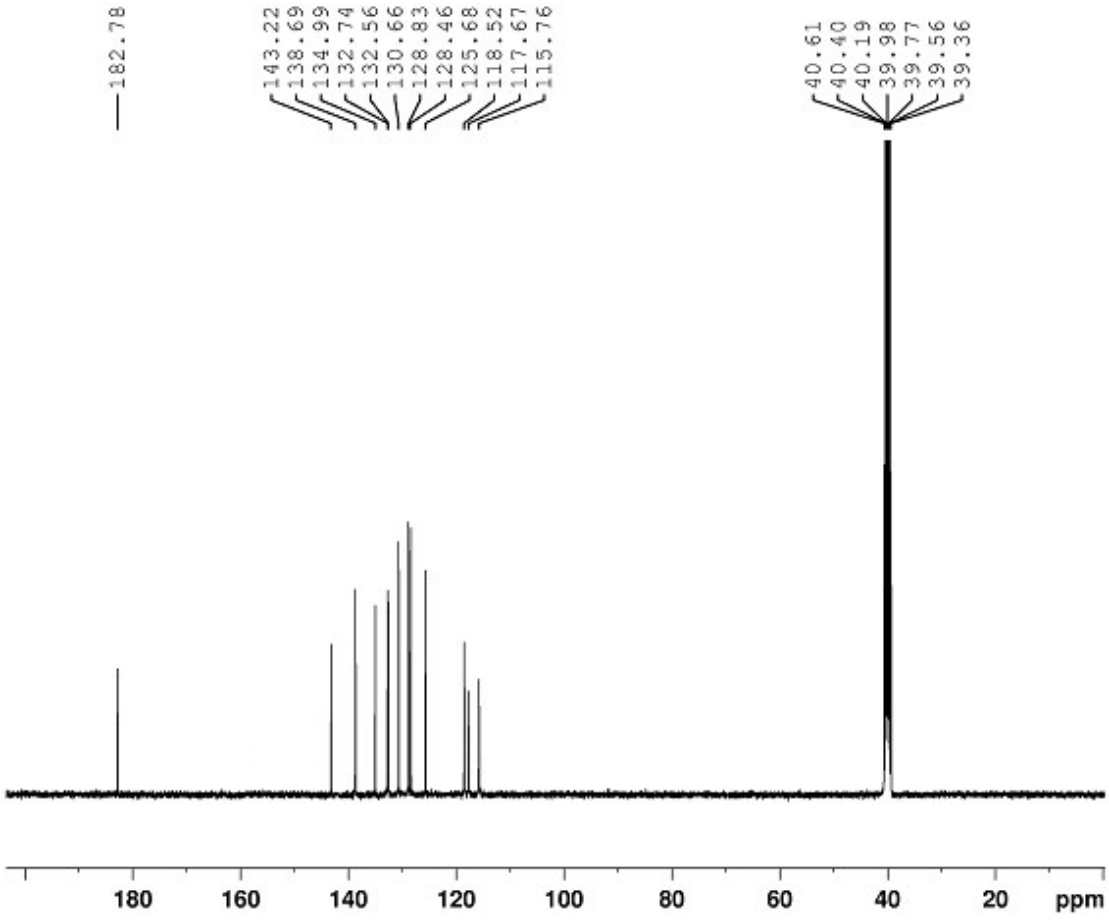
^{13}C NMR spectrum of compound **A43**



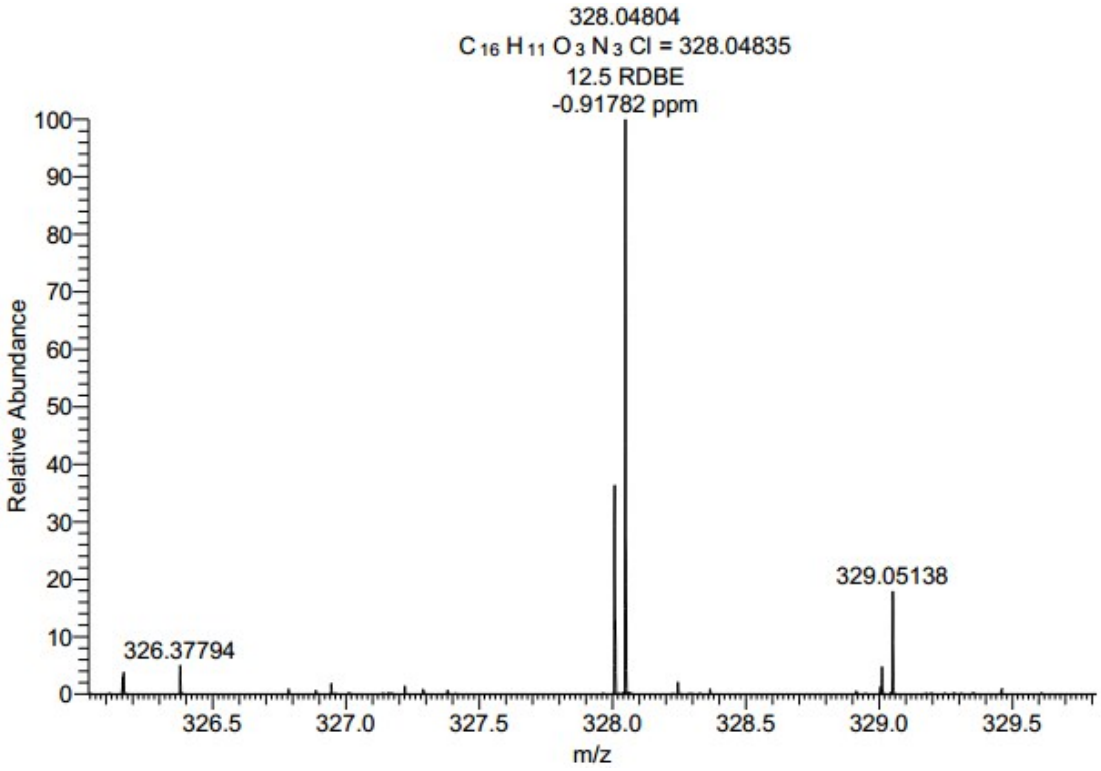
High resolution mass spectrum of compound **A43**



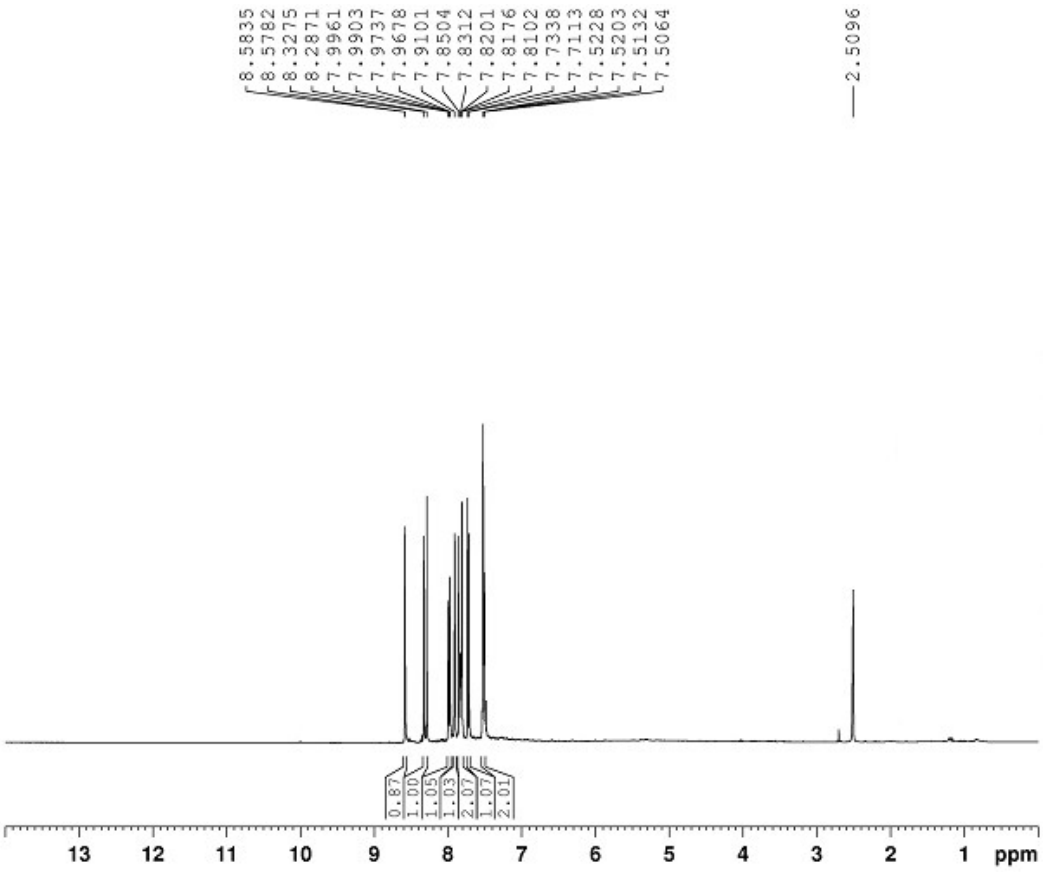
^{1}H NMR spectrum of compound **A44**



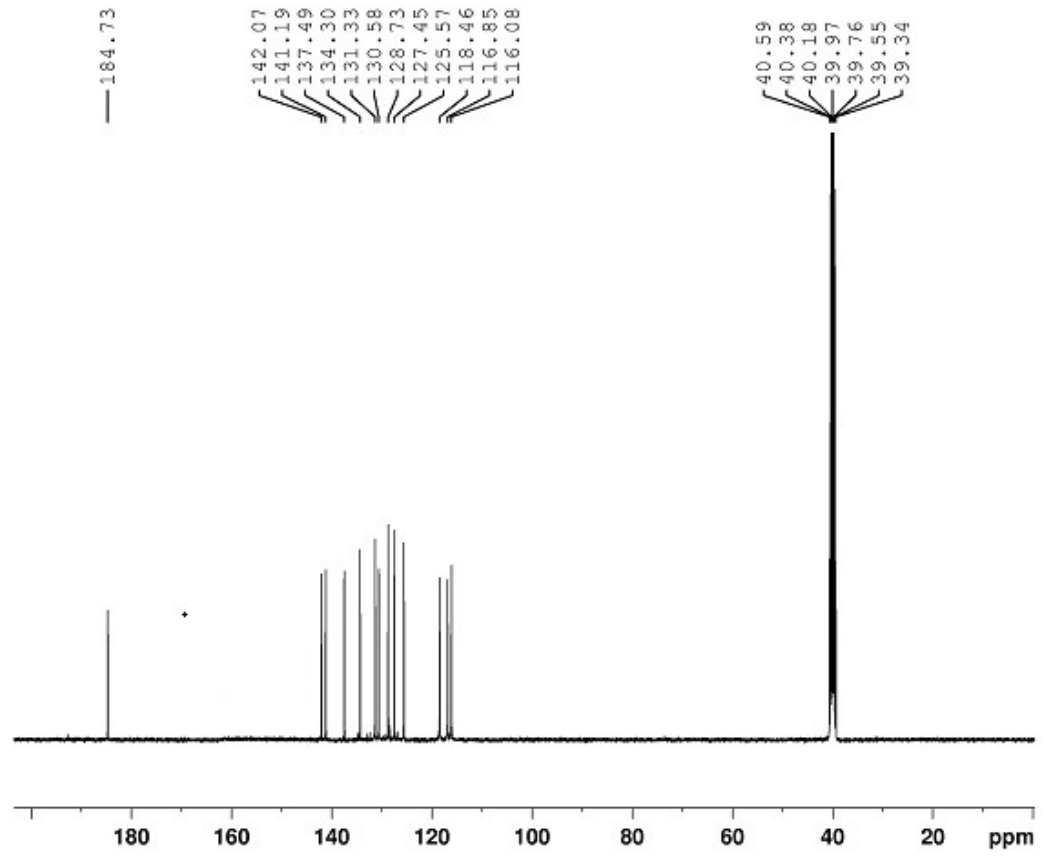
^{13}C NMR spectrum of compound **A44**



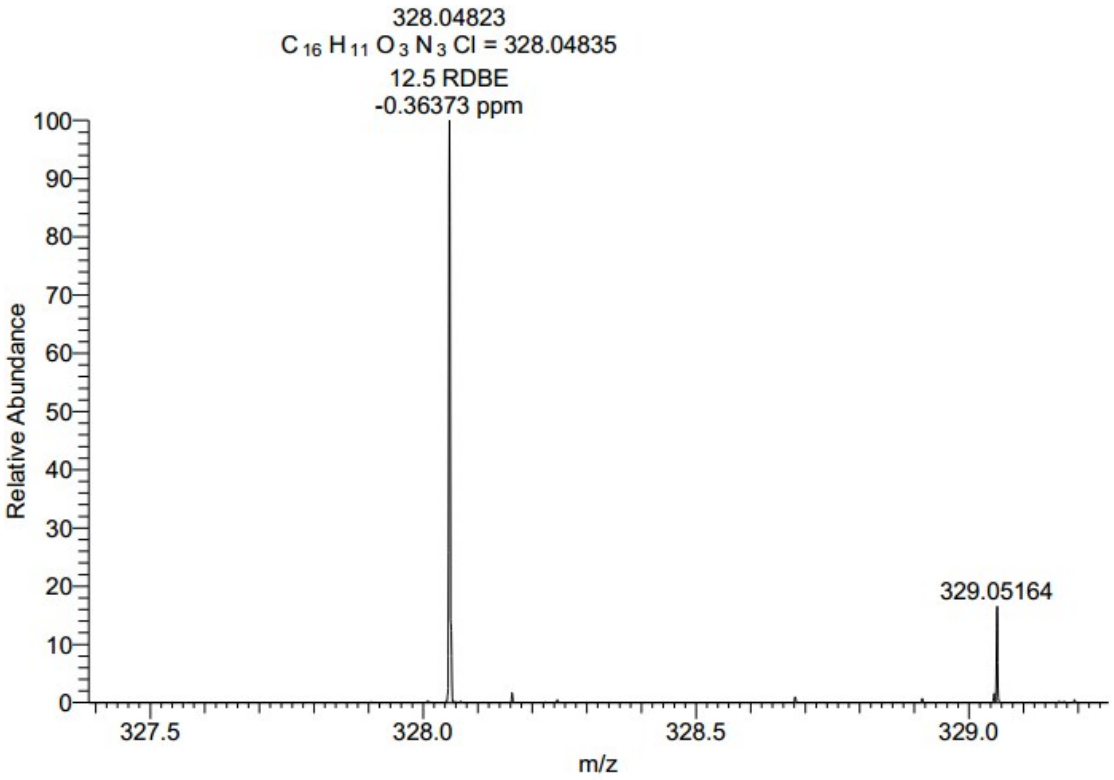
High resolution mass spectrum of compound **A44**



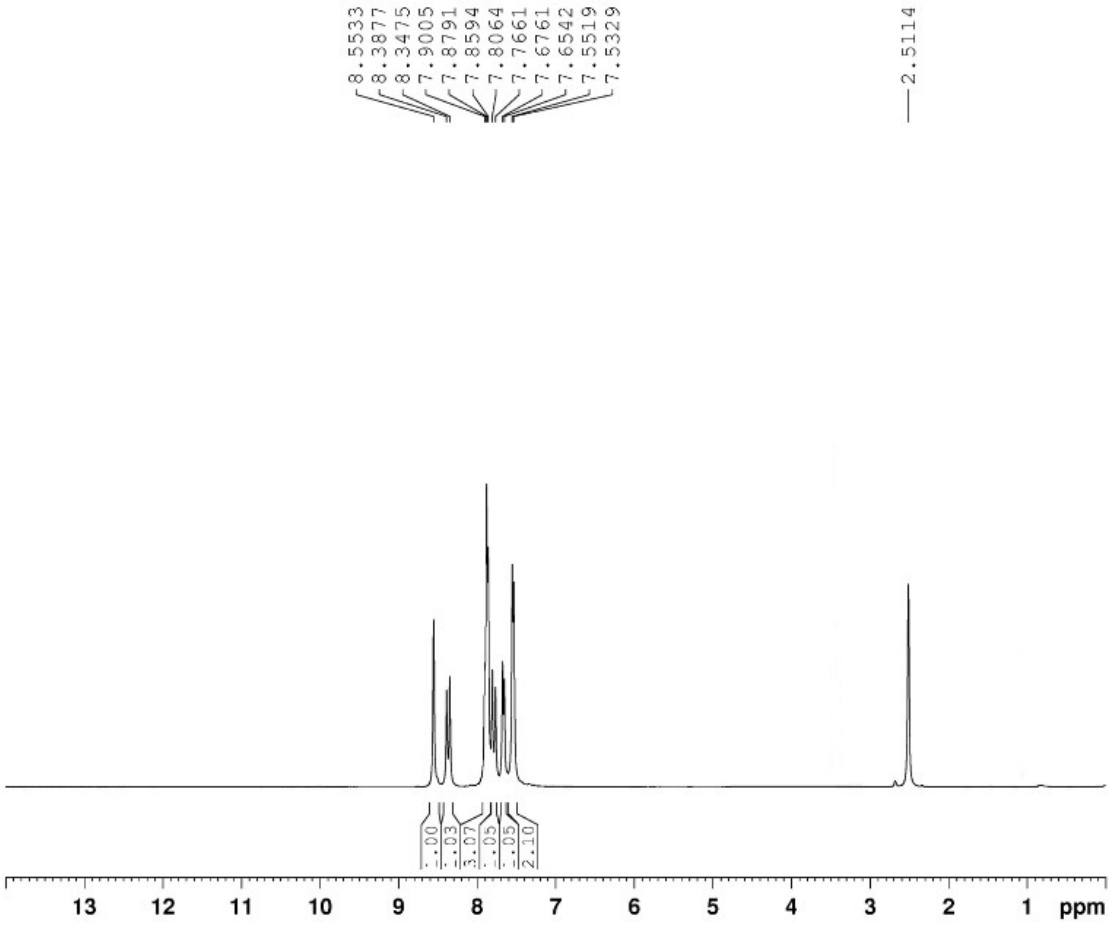
^{1}H NMR spectrum of compound **A45**



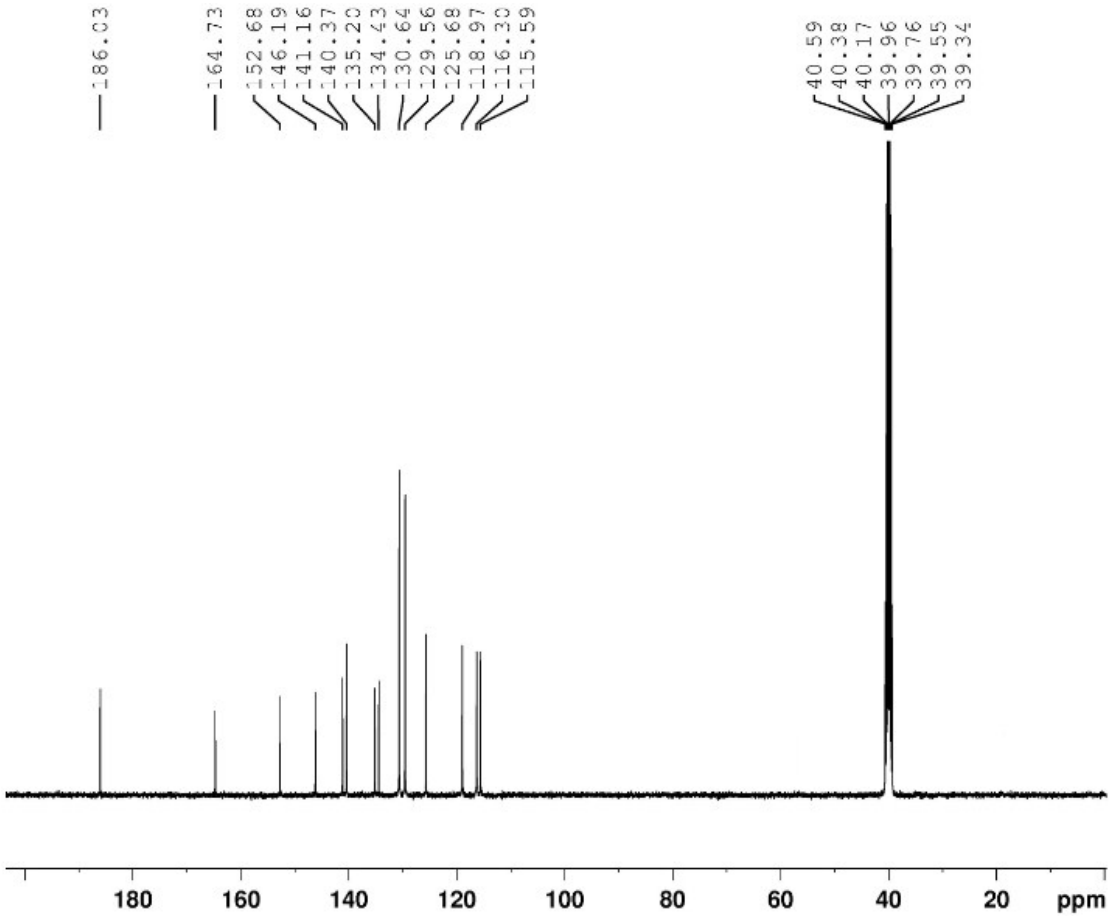
^{13}C NMR spectrum of compound **A45**



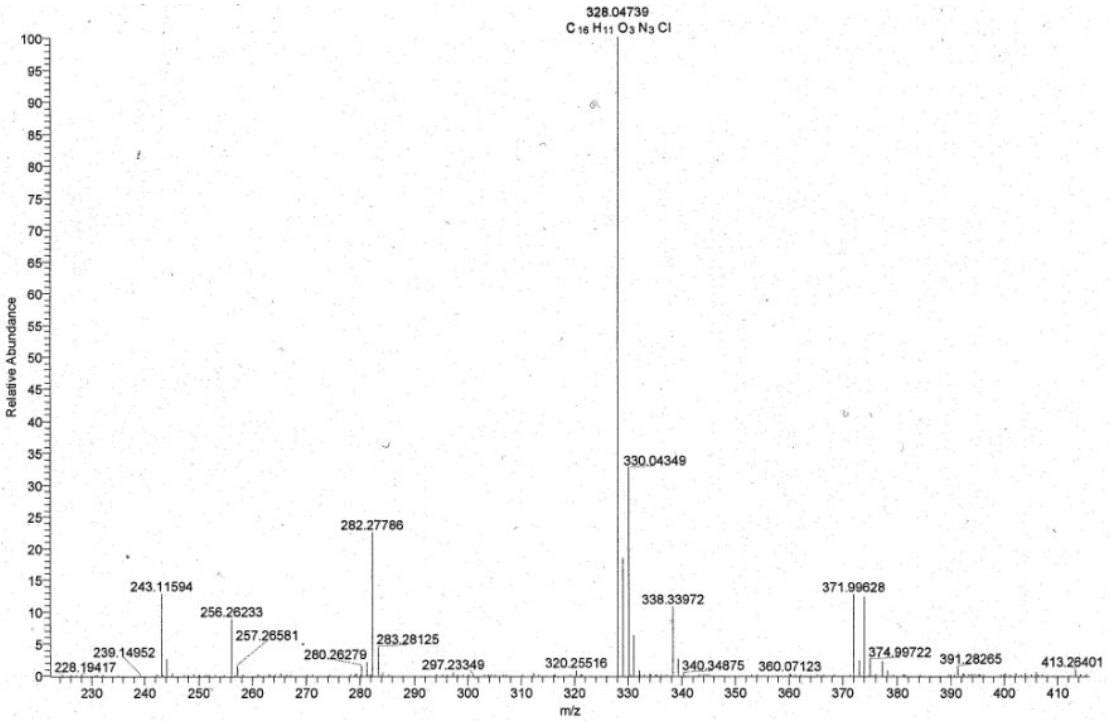
High resolution mass spectrum of compound **A45**



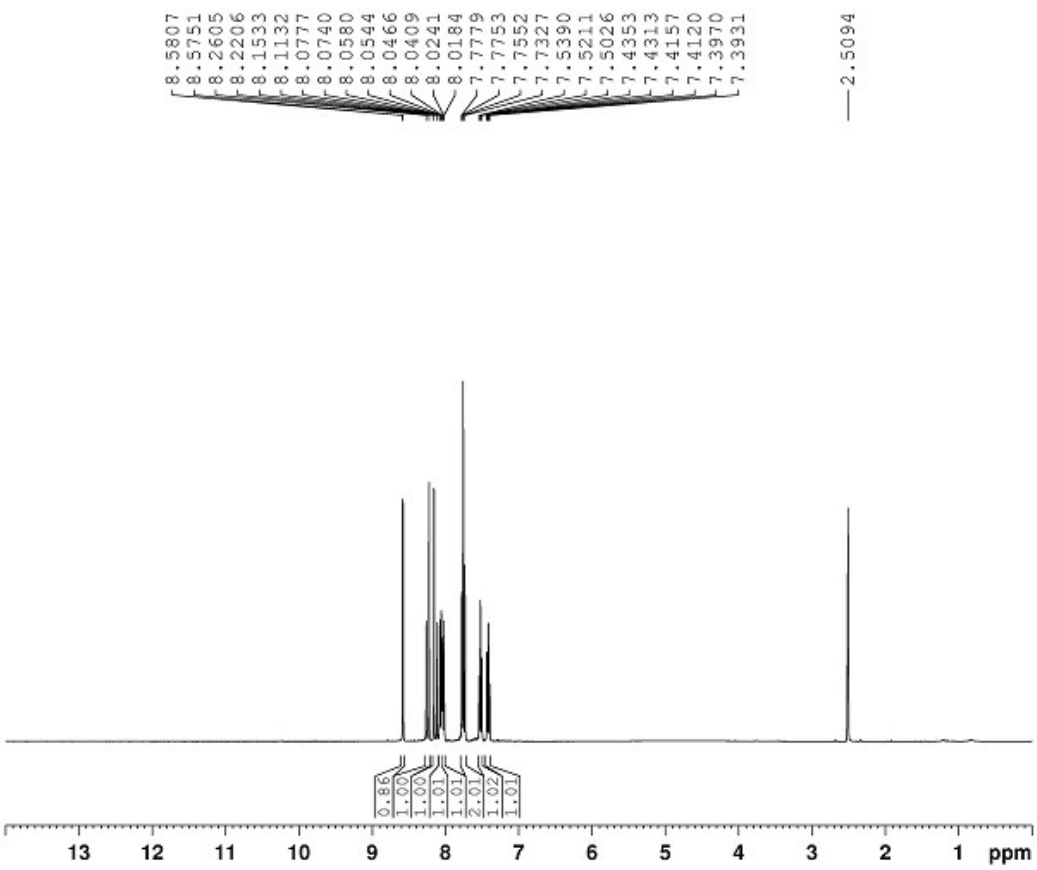
^{1}H NMR spectrum of compound **A46**



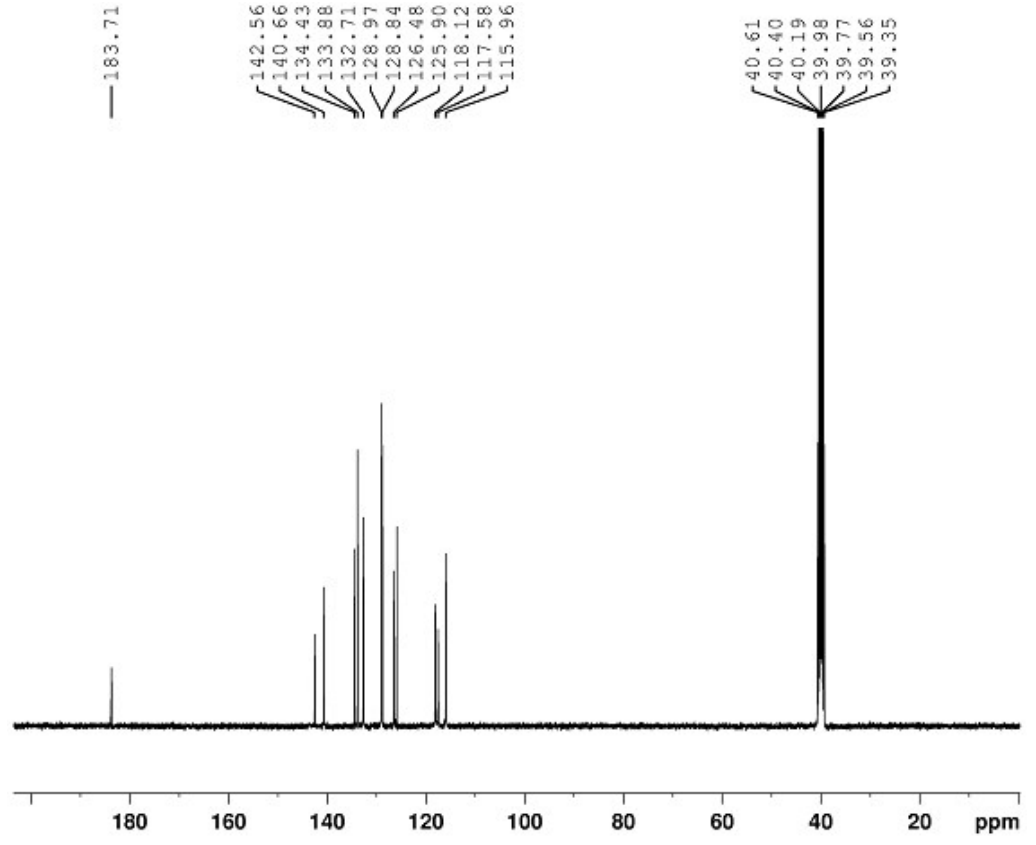
^{13}C NMR spectrum of compound **A46**



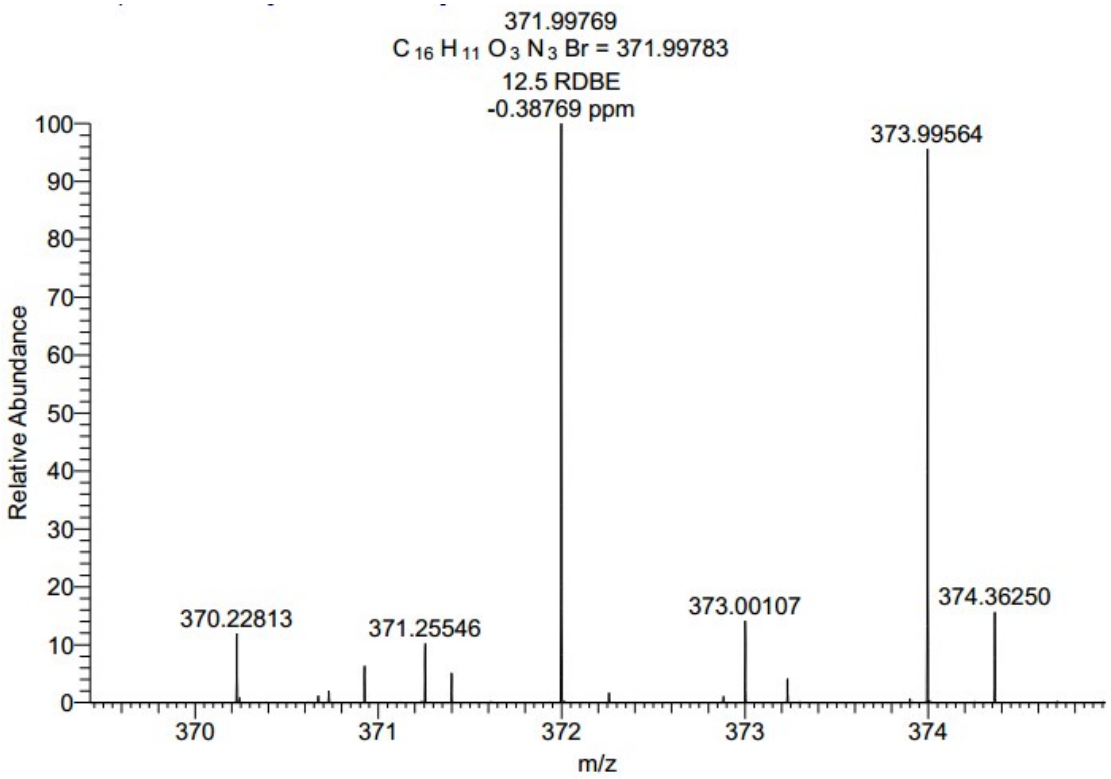
High resolution mass spectrum of compound **46**



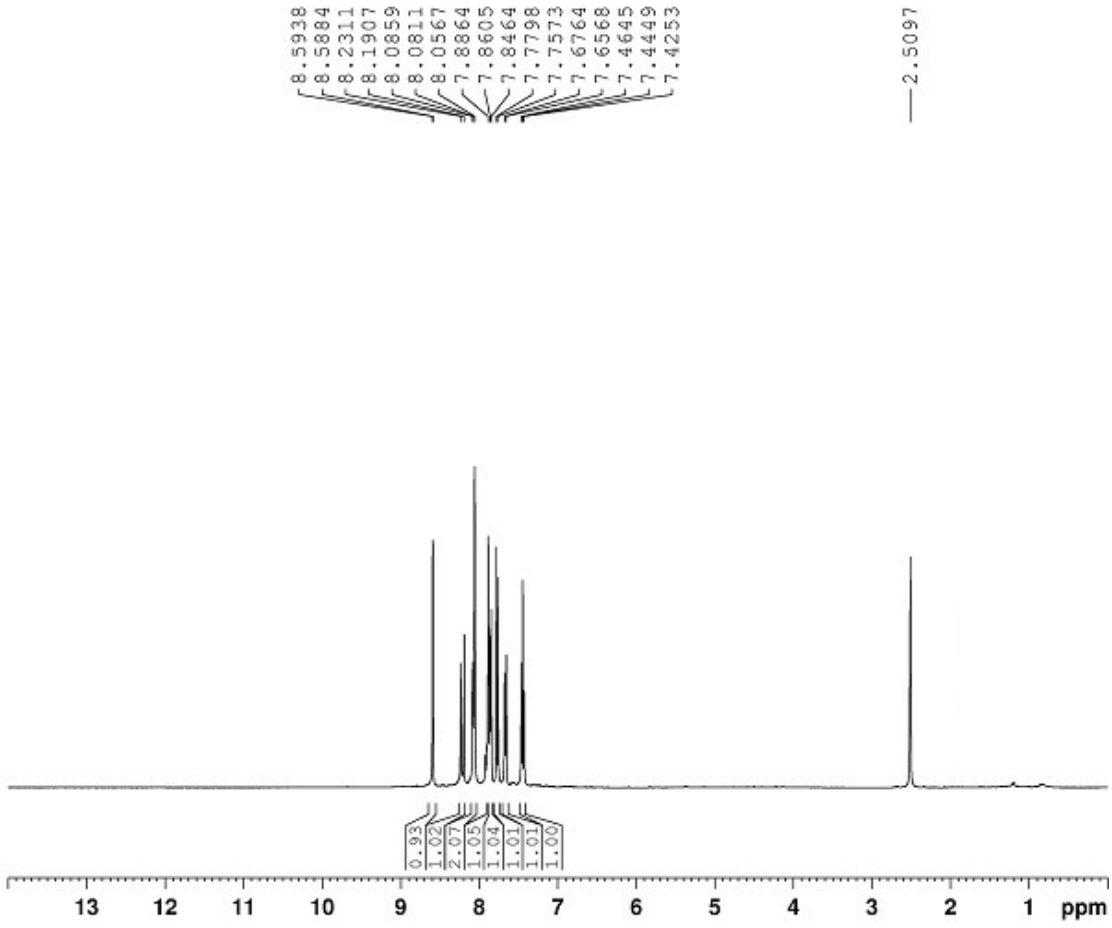
^{1}H NMR spectrum of compound **A47**



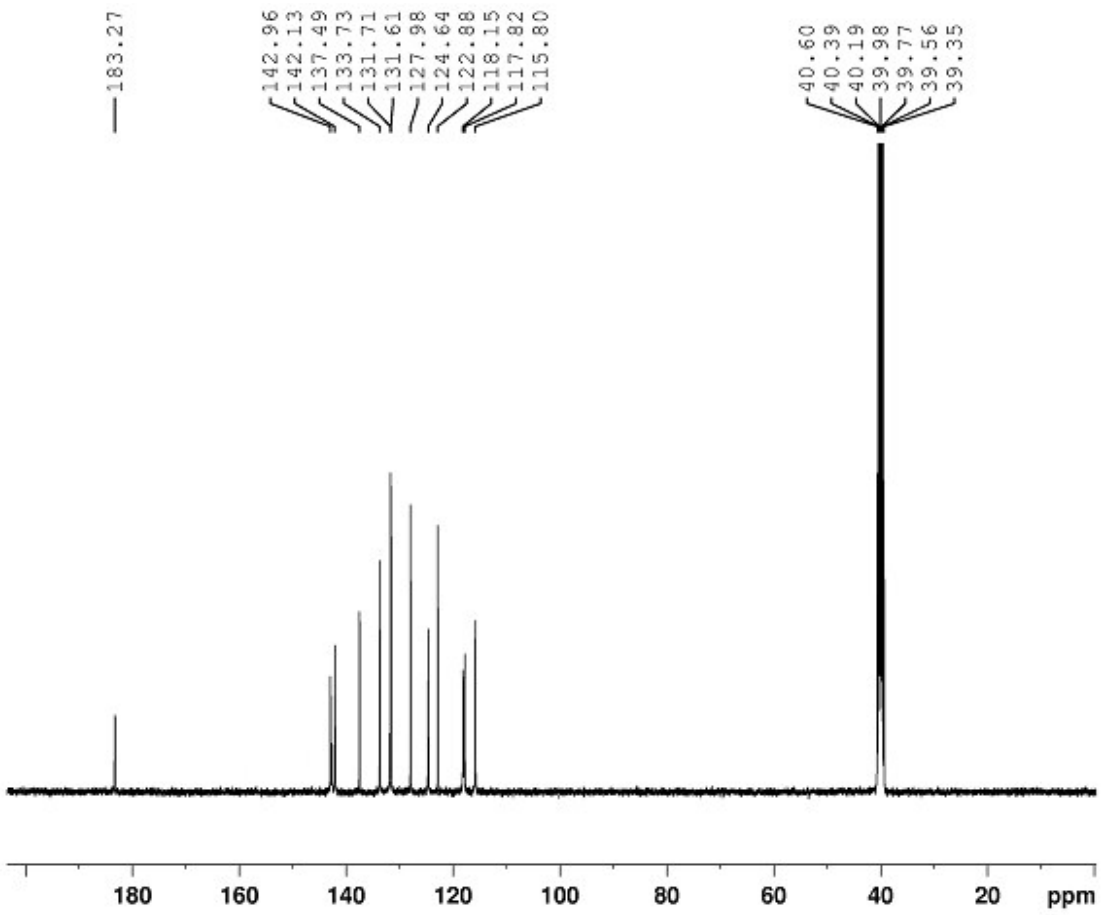
^{13}C NMR spectrum of compound **A47**



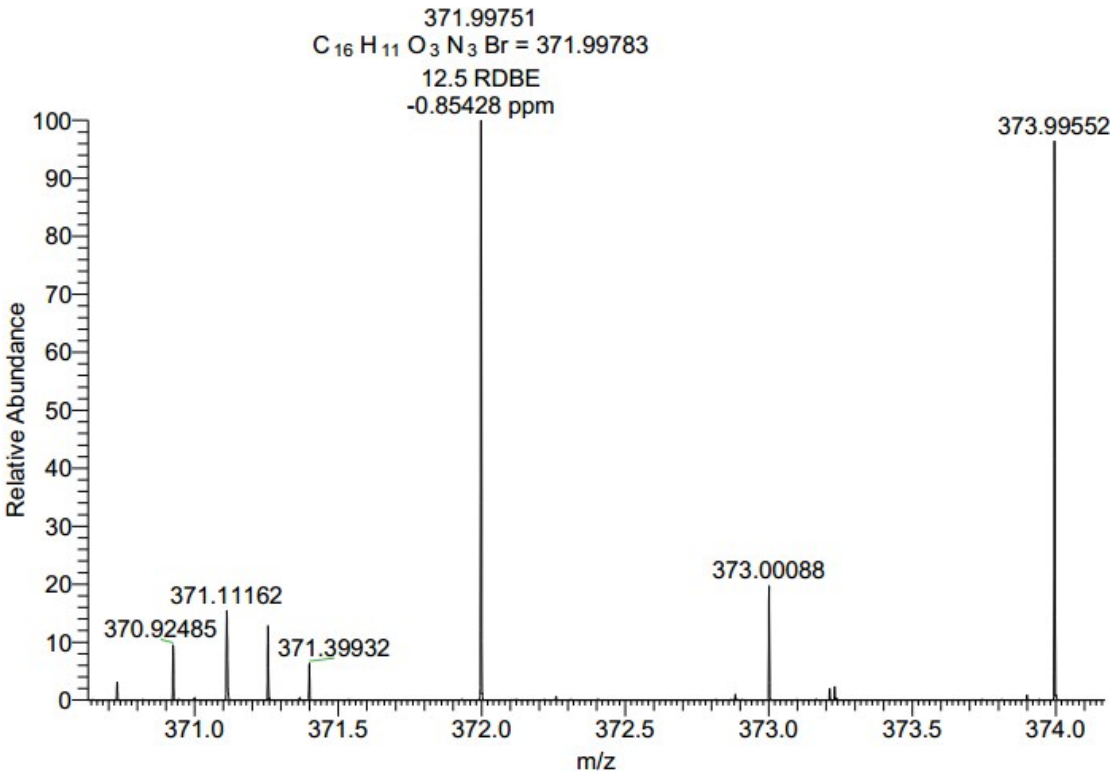
High resolution mass spectrum of compound **A47**



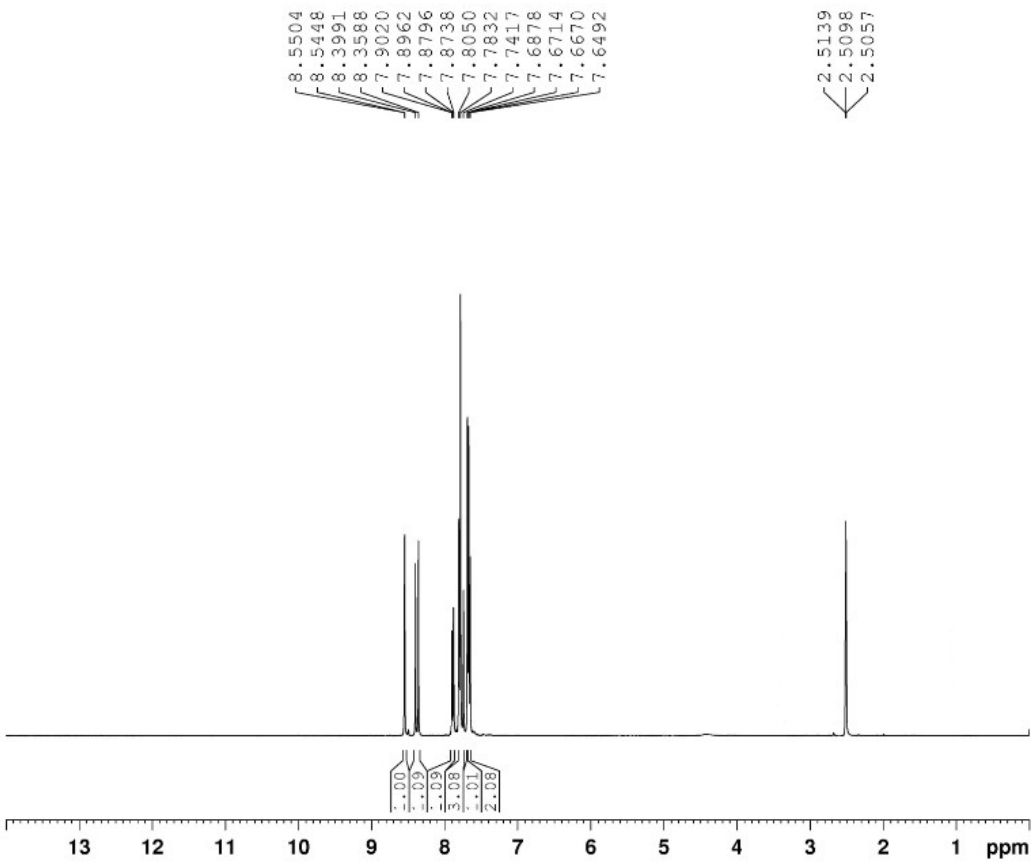
^{1}H NMR spectrum of compound **A48**



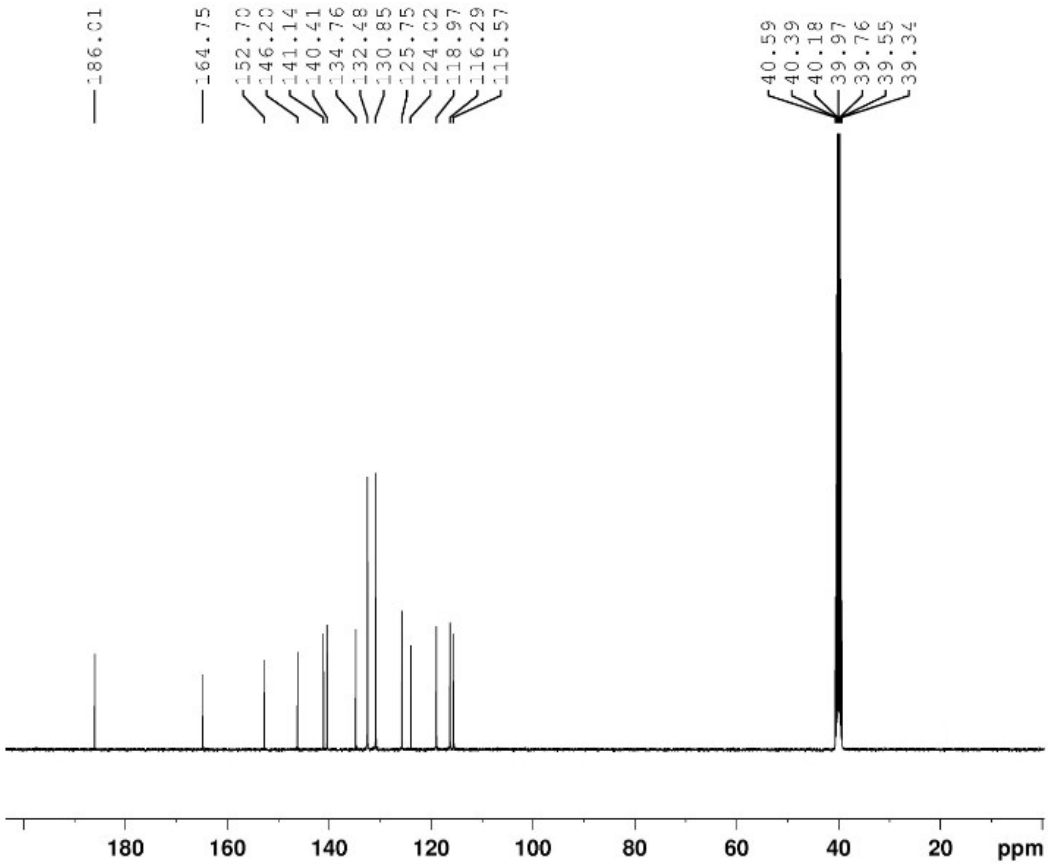
^{13}C NMR spectrum of compound **A48**



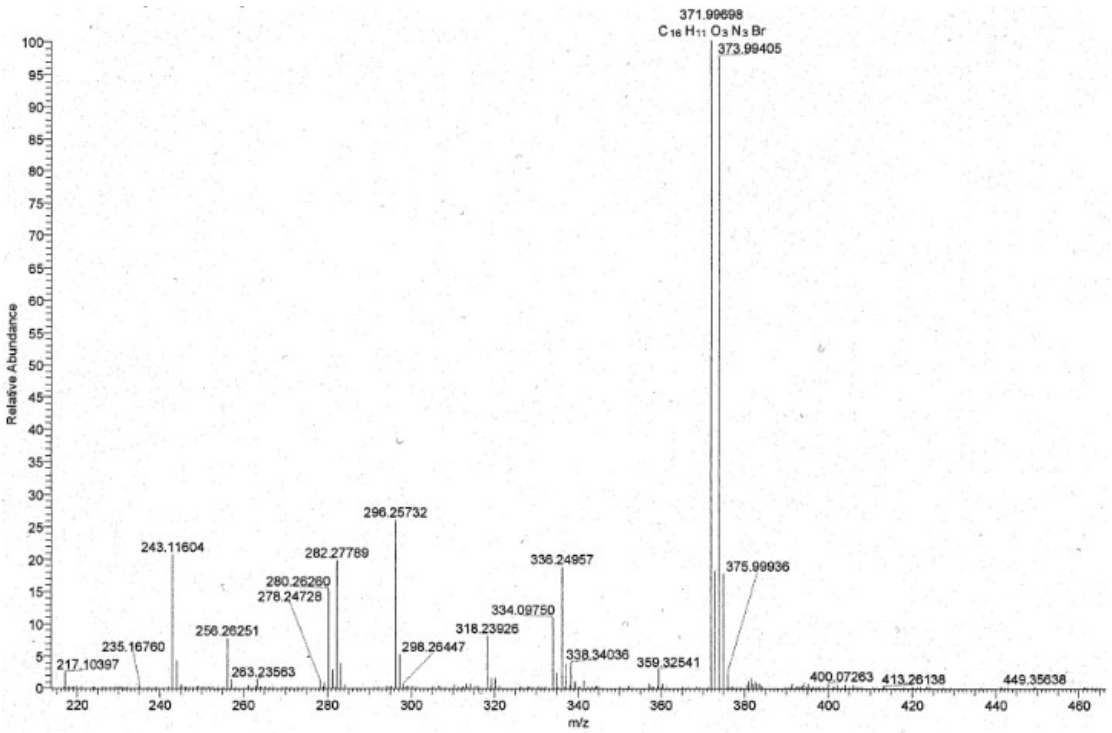
High resolution mass spectrum of compound **A48**



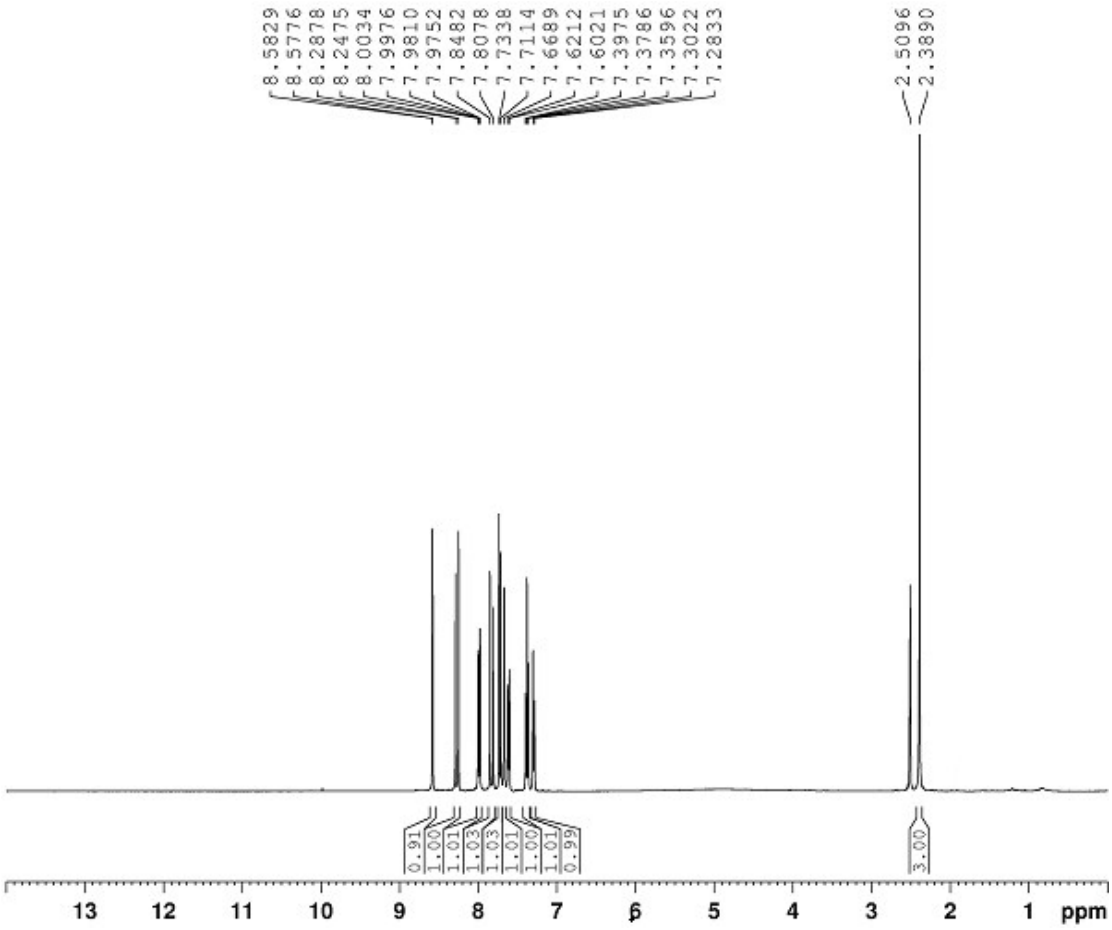
^{1}H NMR spectrum of compound **A49**



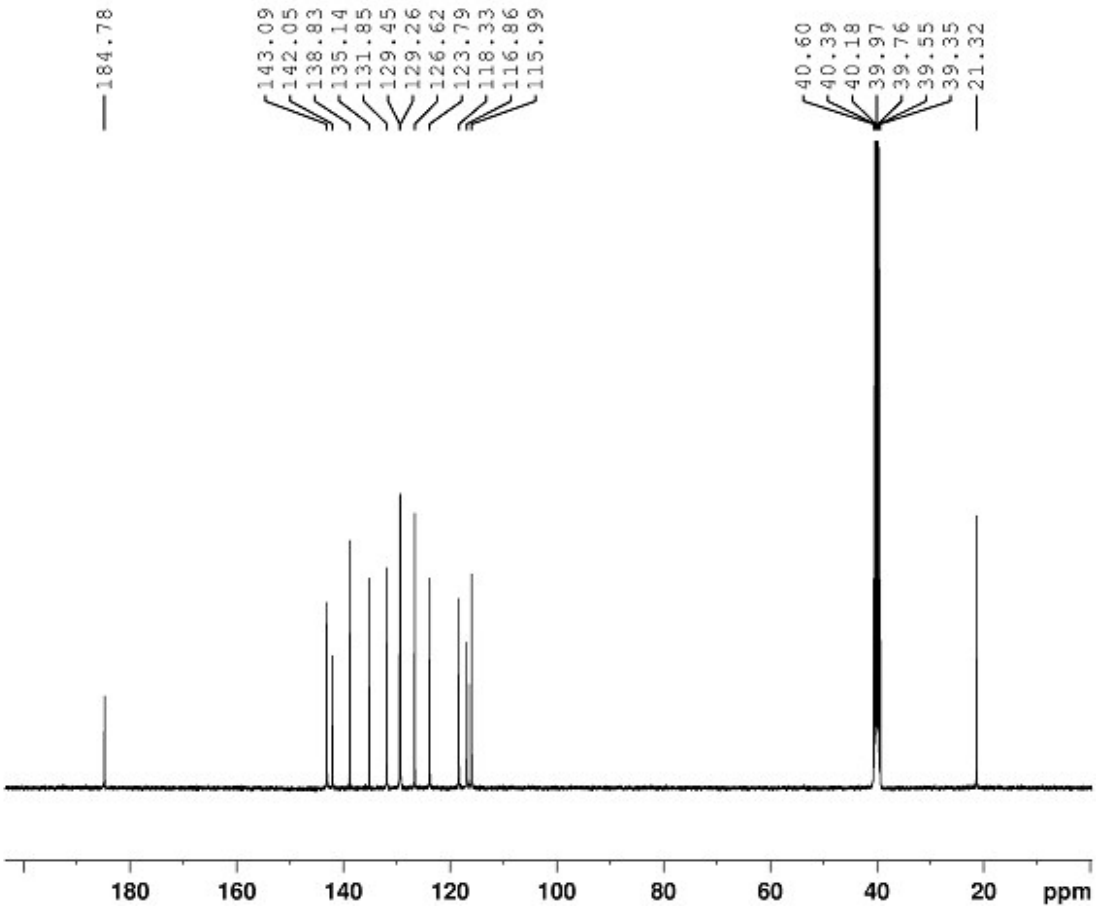
^{13}C NMR spectrum of compound **A49**



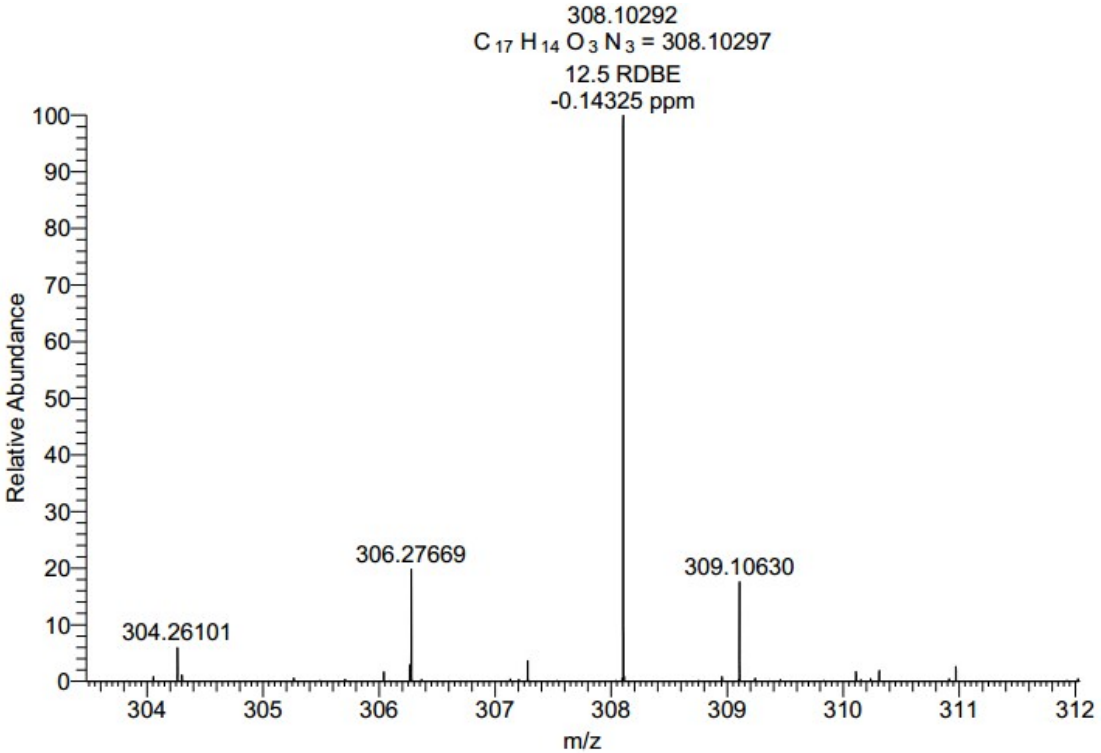
High resolution mass spectrum of compound **A49**



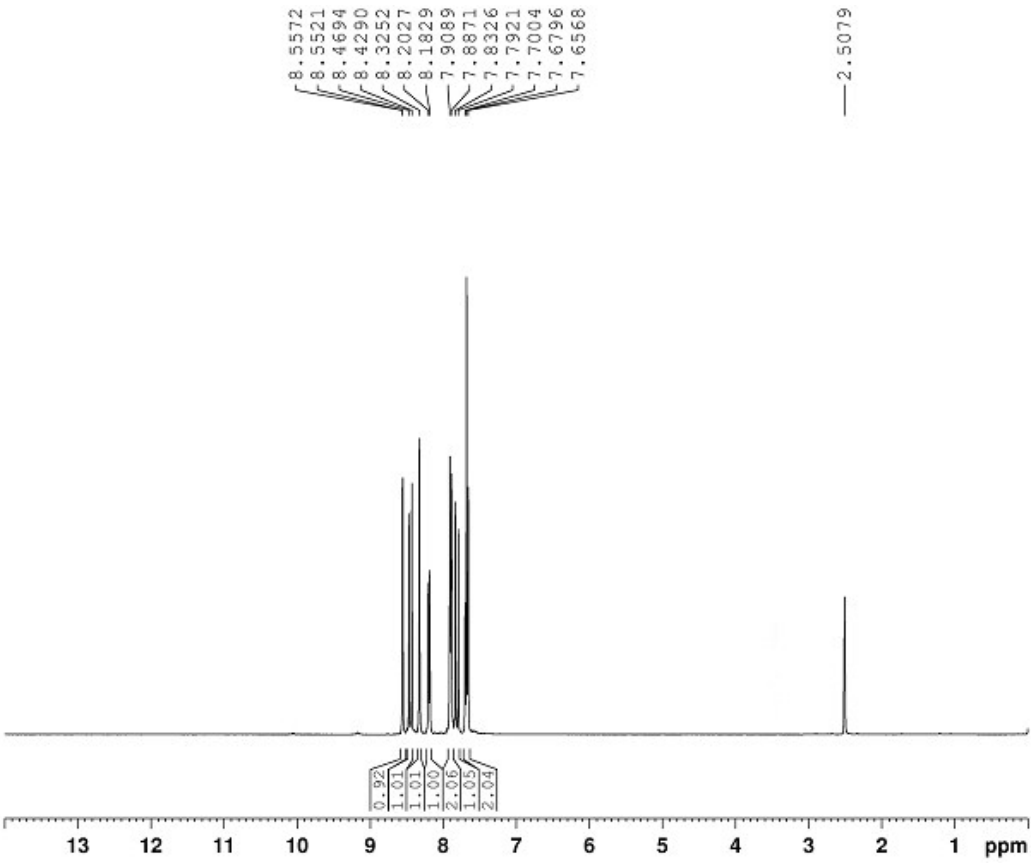
^{1}H NMR spectrum of compound **A50**



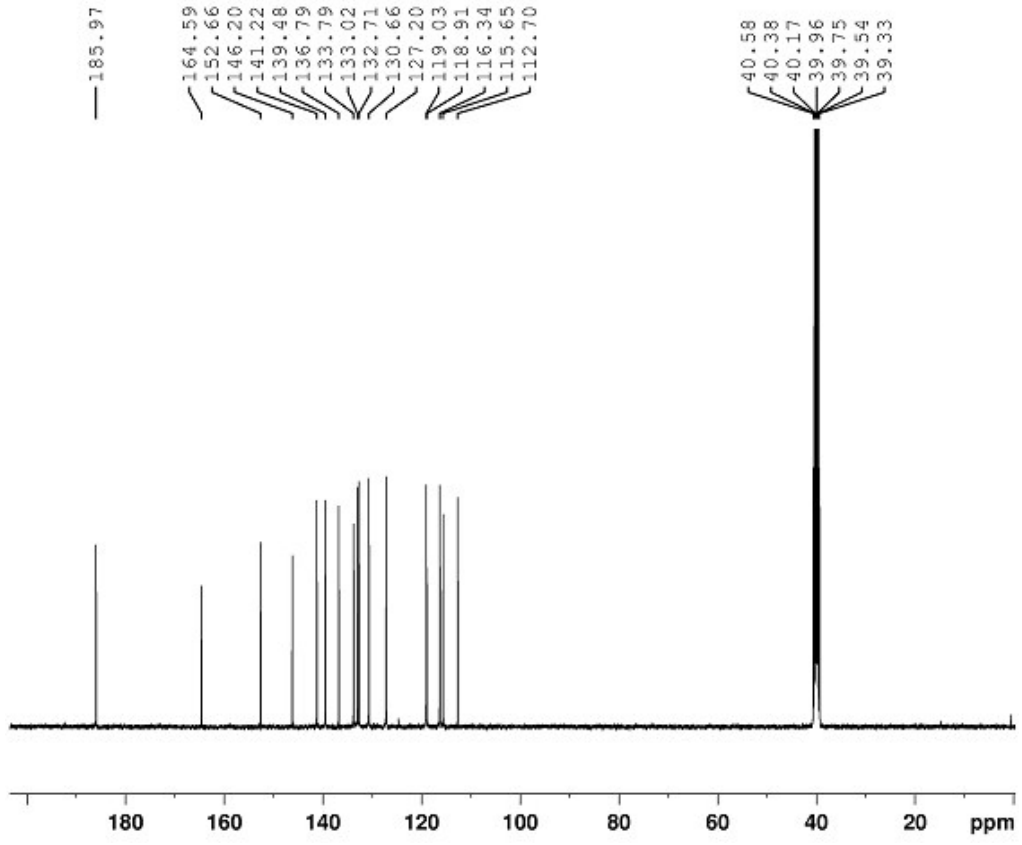
^{13}C NMR spectrum of compound **A50**



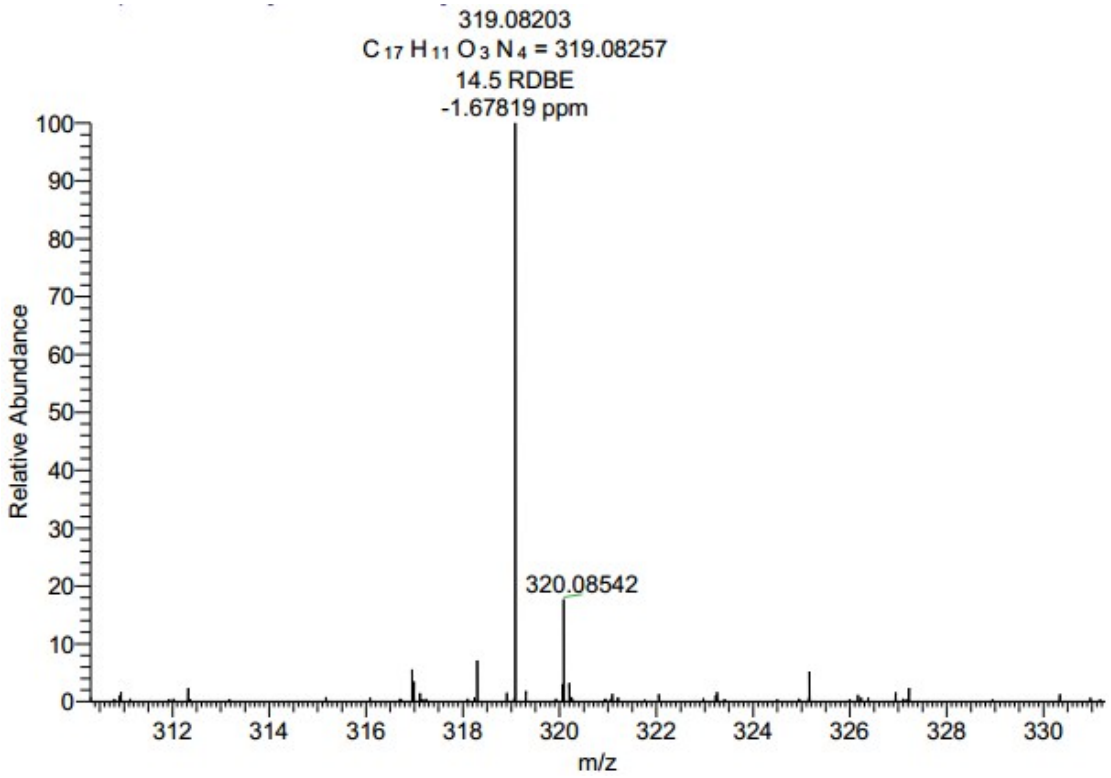
High resolution mass spectrum of compound **A50**



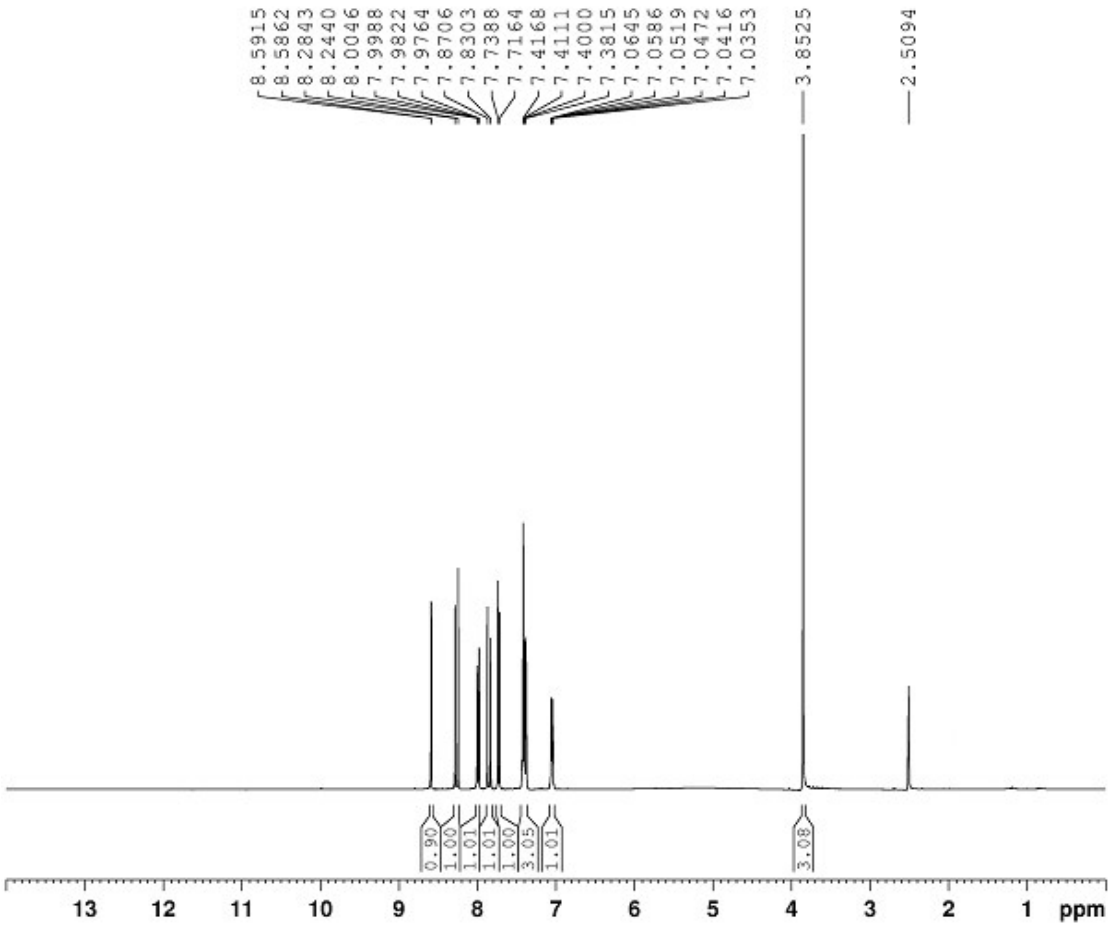
^{1}H NMR spectrum of compound **A51**



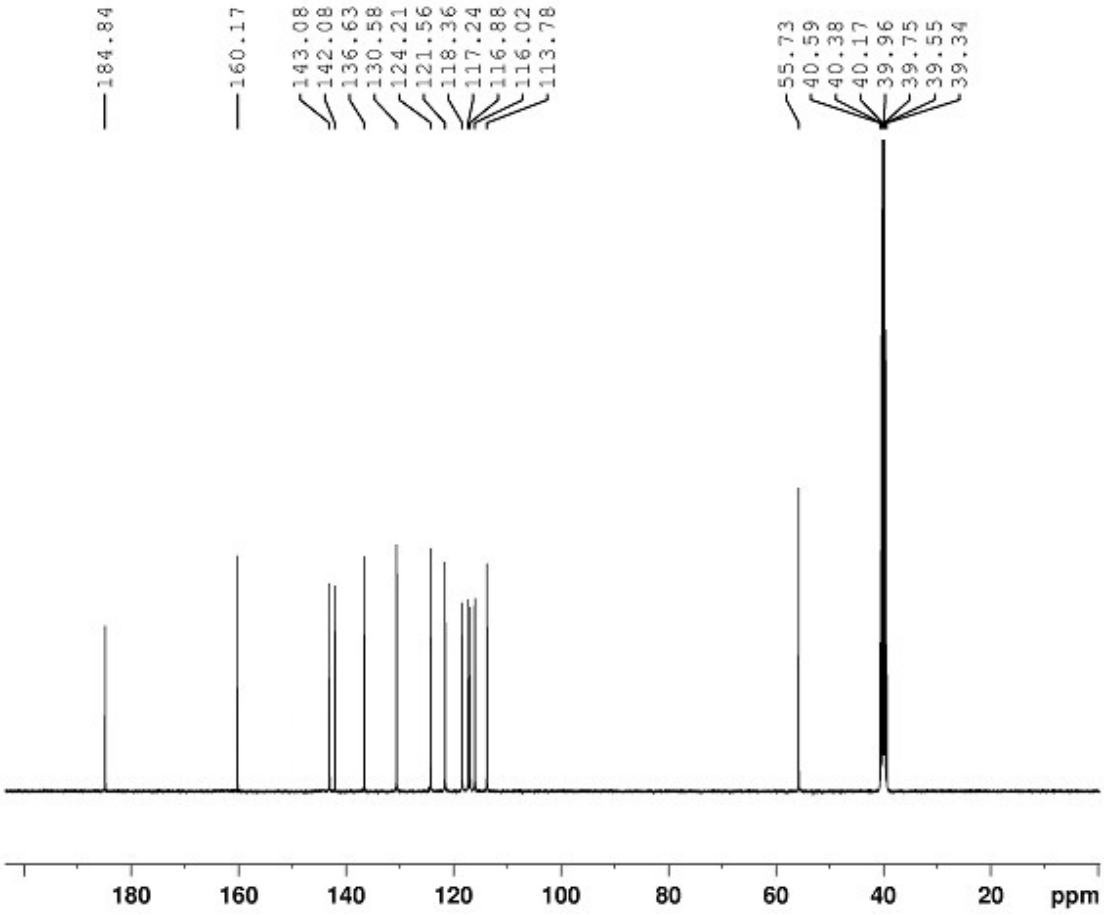
^{13}C NMR spectrum of compound **A51**



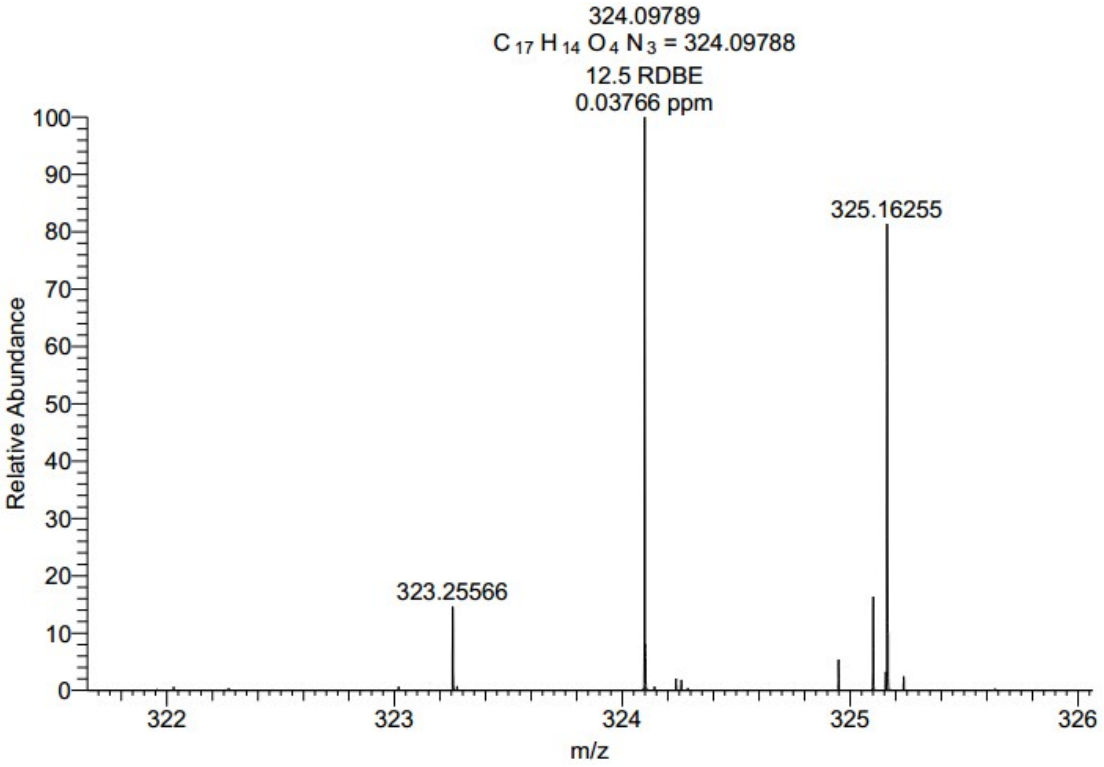
High resolution mass spectrum of compound **A51**



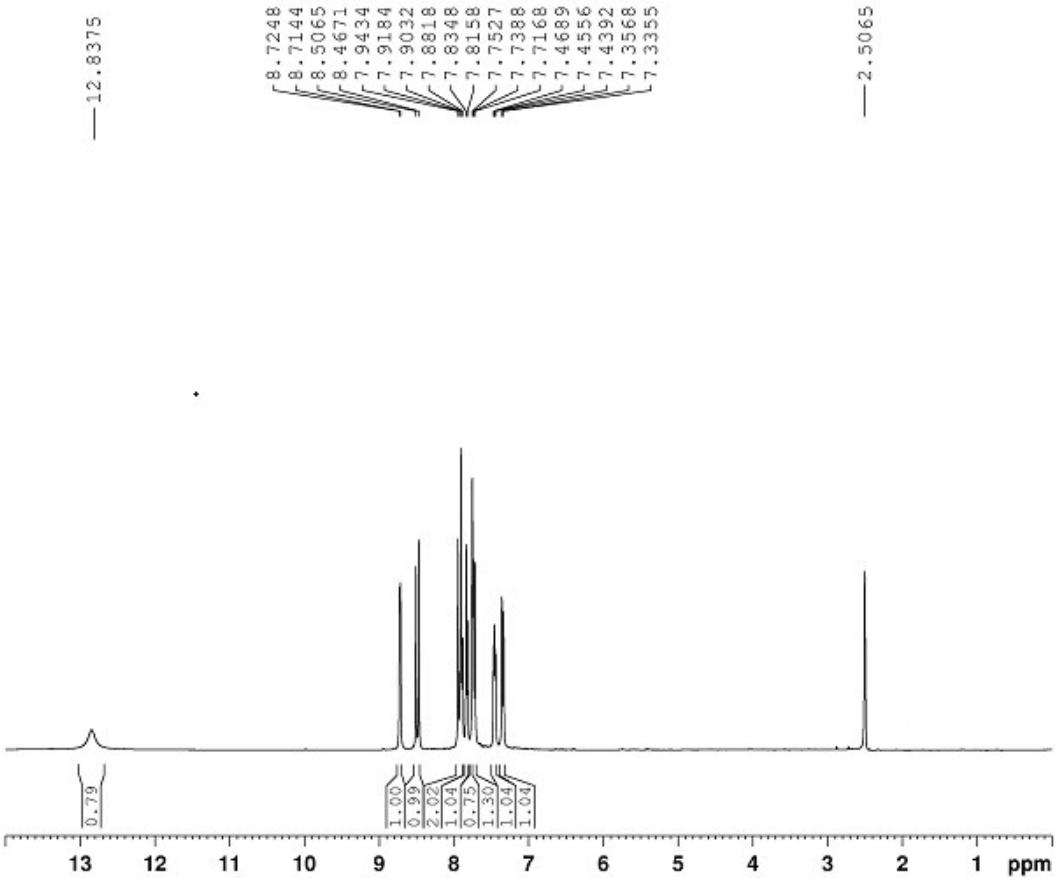
^{1}H NMR spectrum of compound **A52**



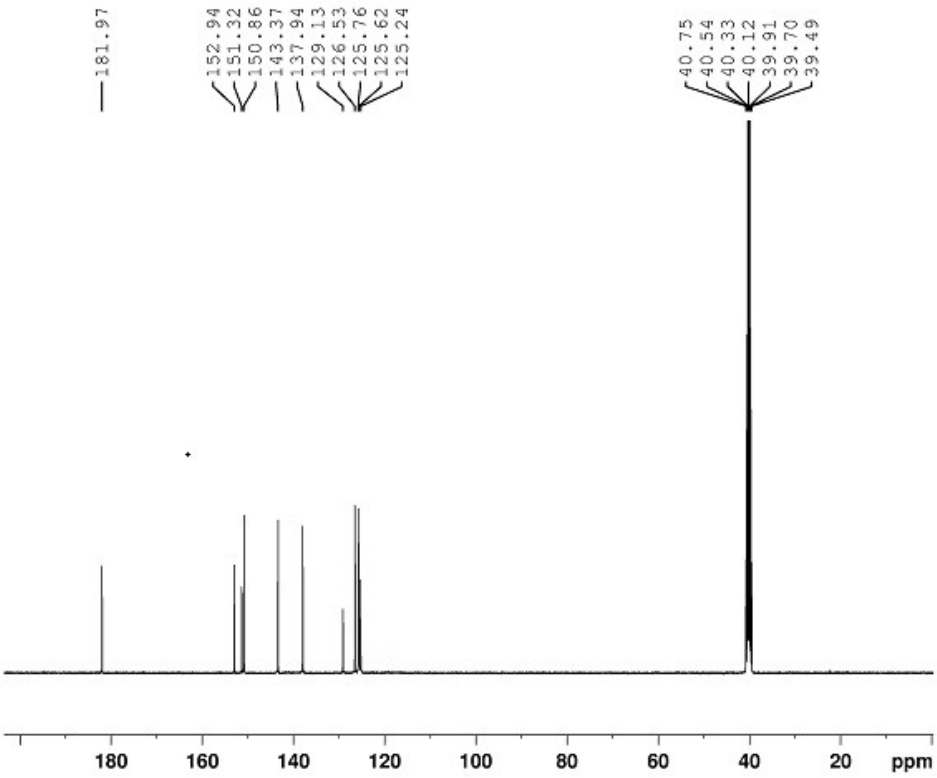
^{13}C NMR spectrum of compound **A52**



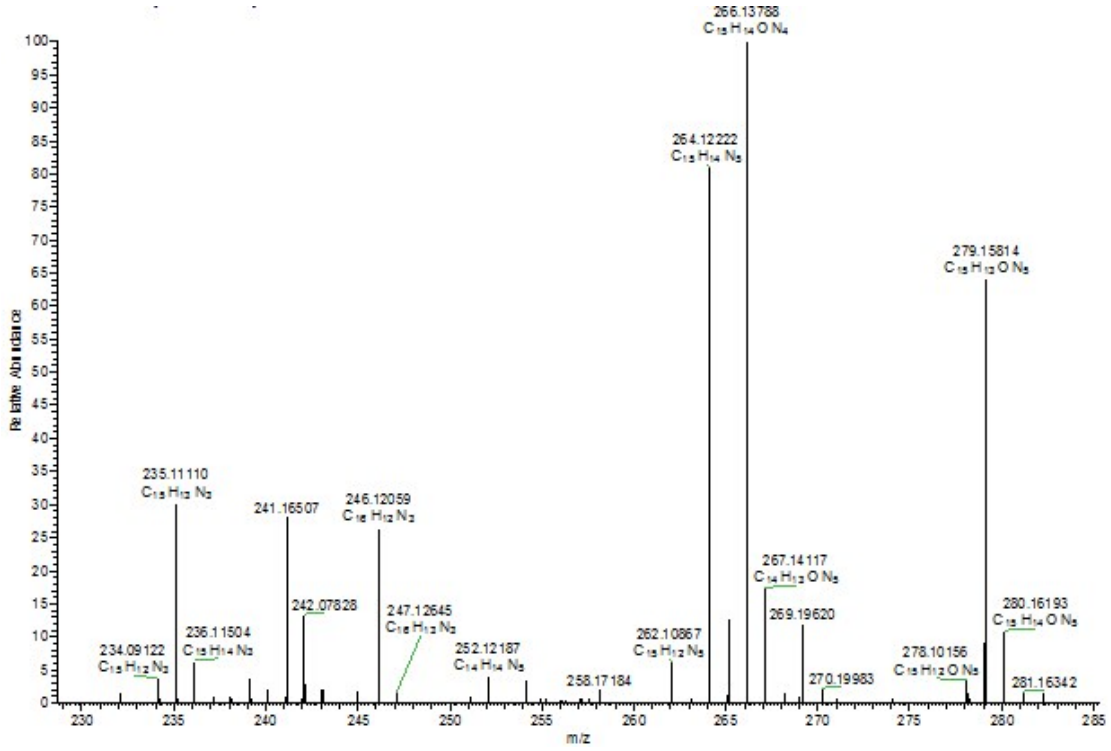
High resolution mass spectrum of compound **A52**



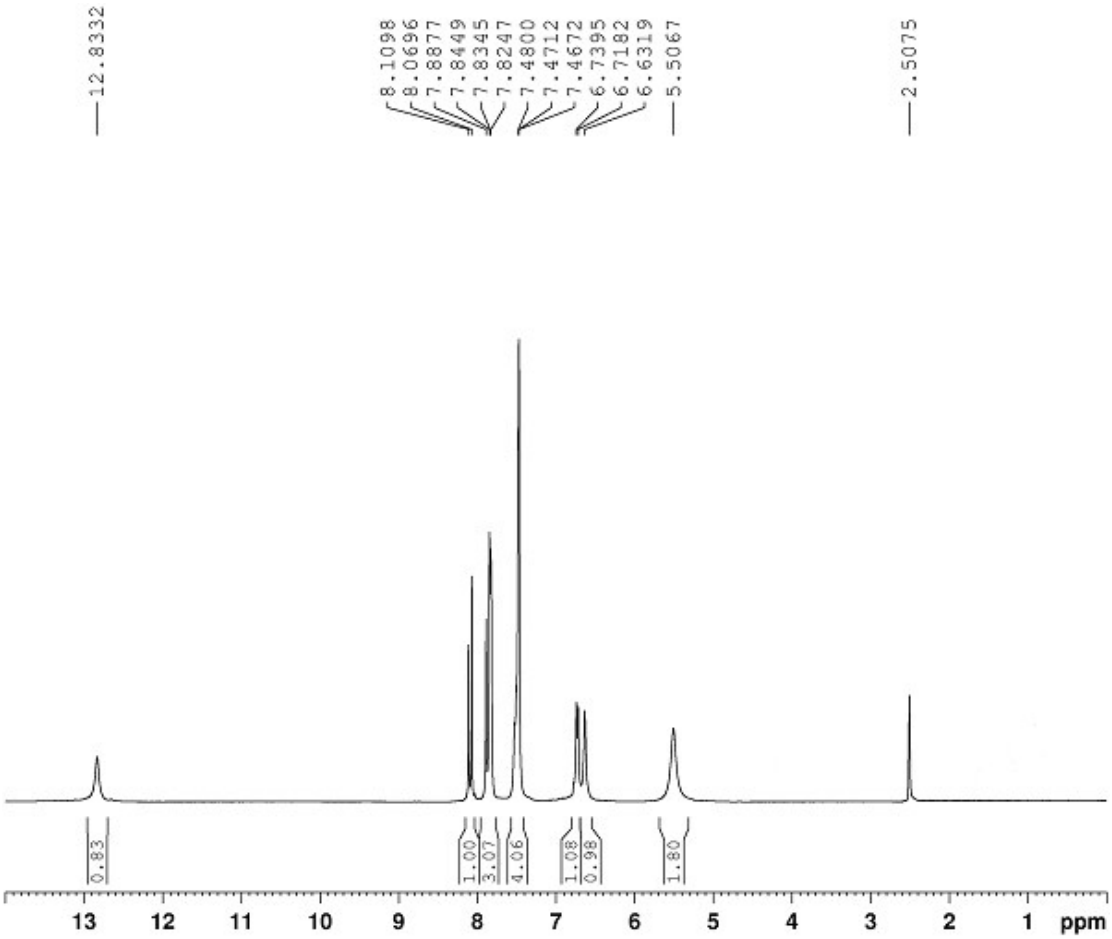
^{1}H NMR spectrum of compound **A53**



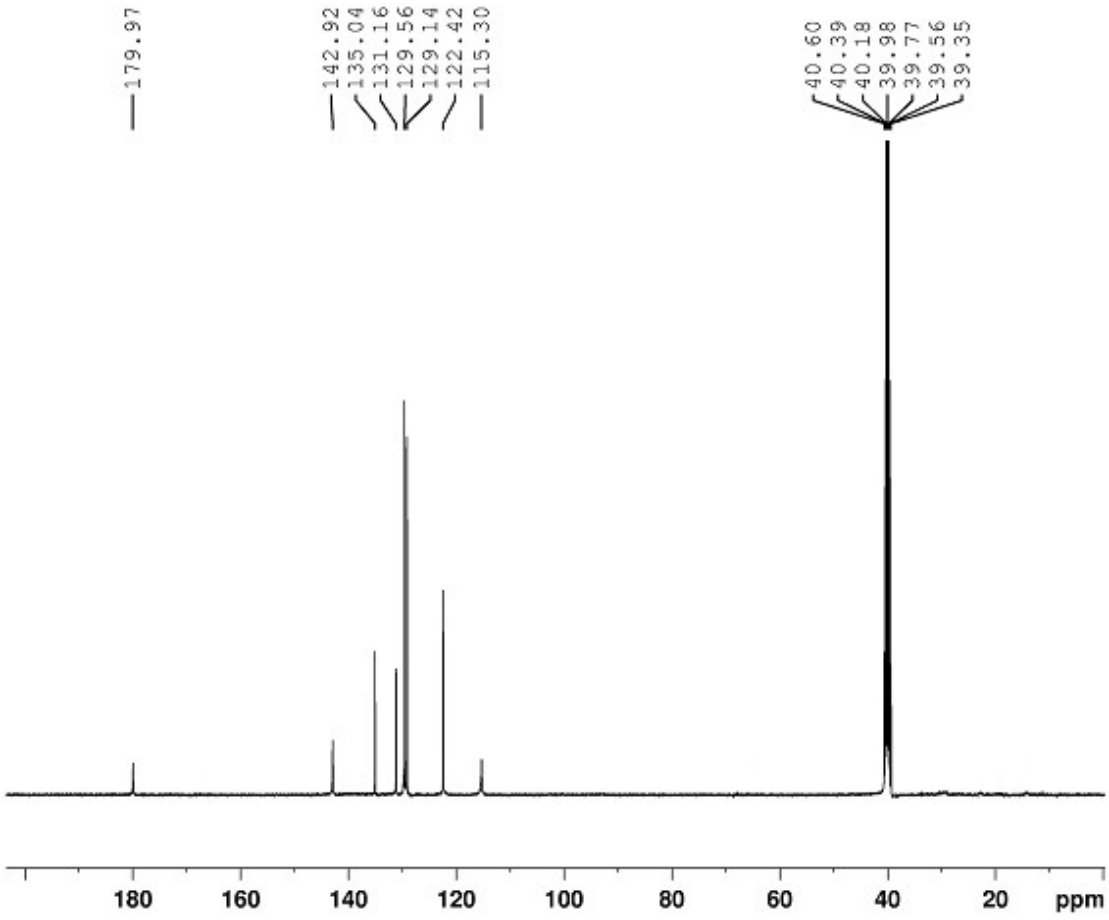
^{13}C NMR spectrum of compound **A53**



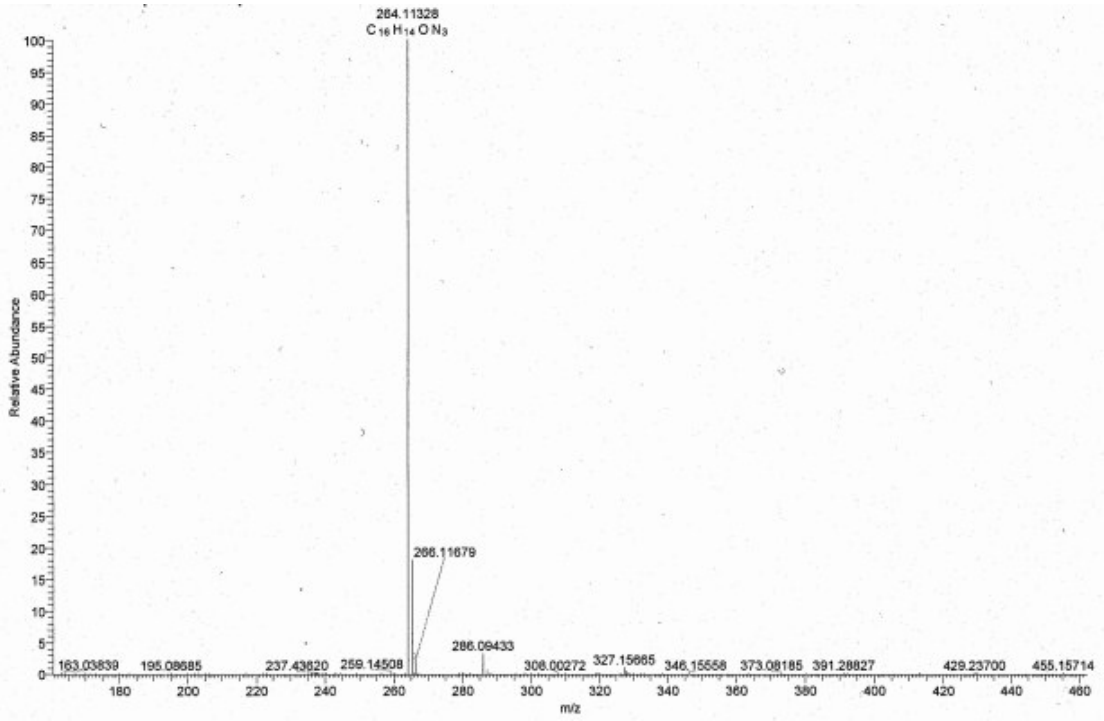
High resolution mass spectrum of compound **A53**



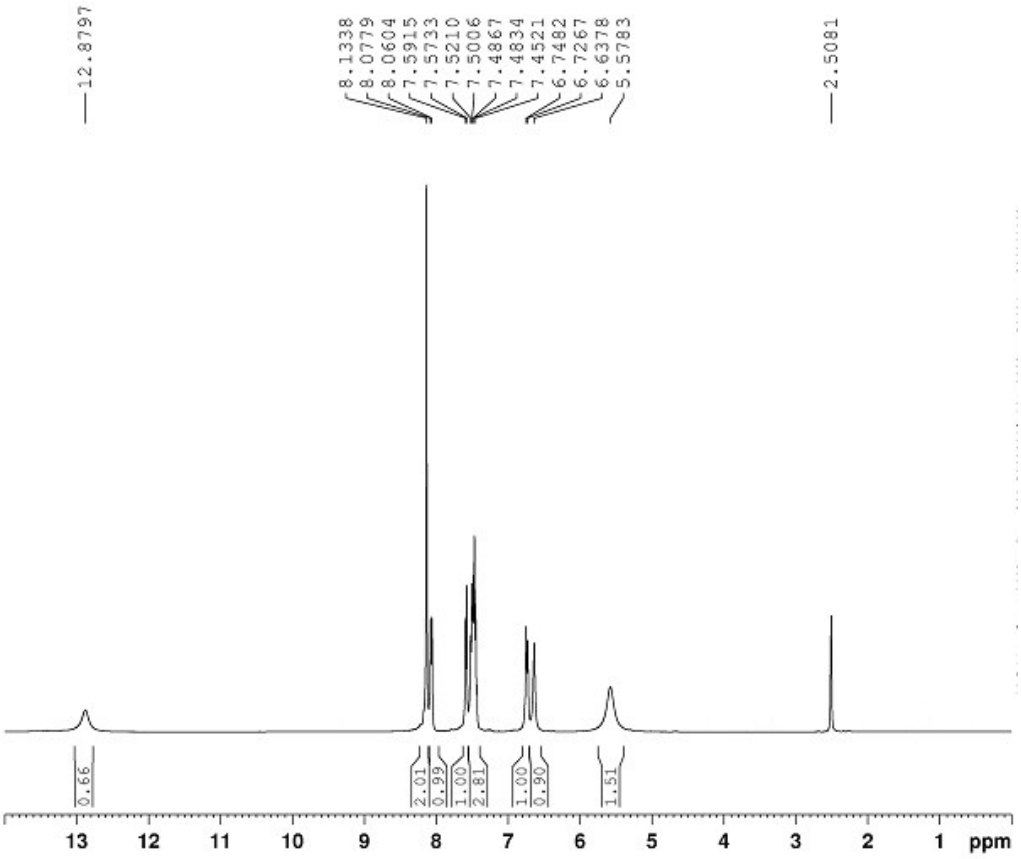
^{1}H NMR spectrum of compound **A54**



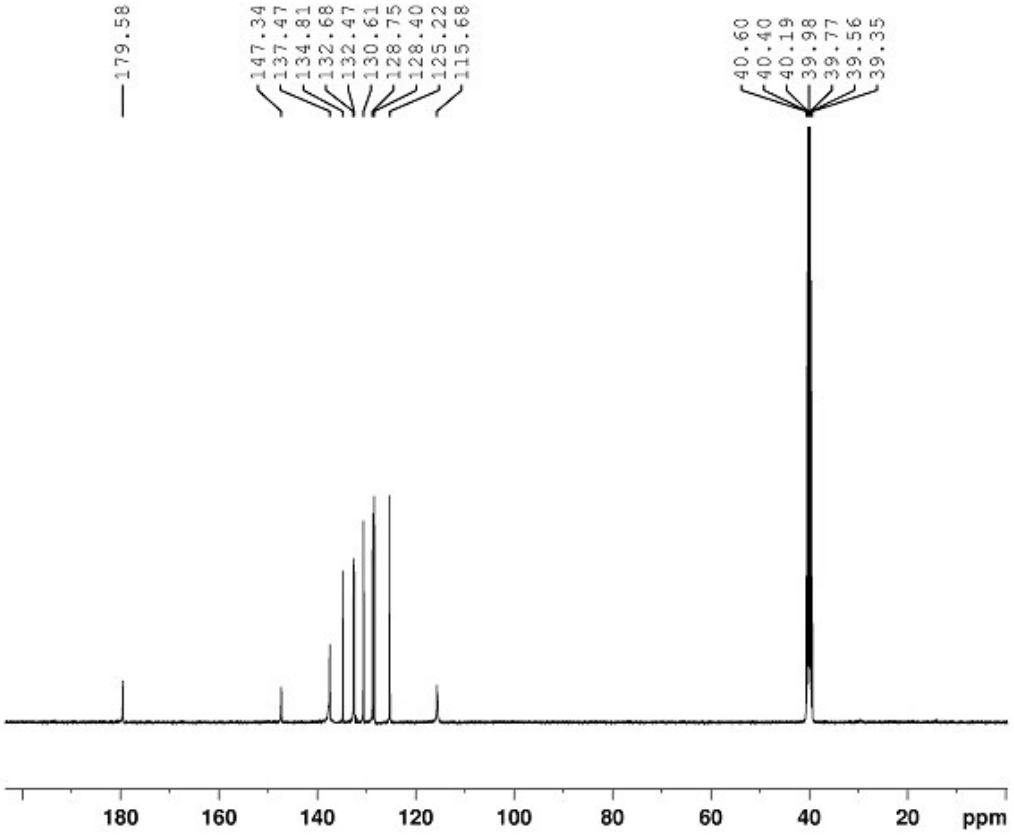
^{13}C NMR spectrum of compound **A54**



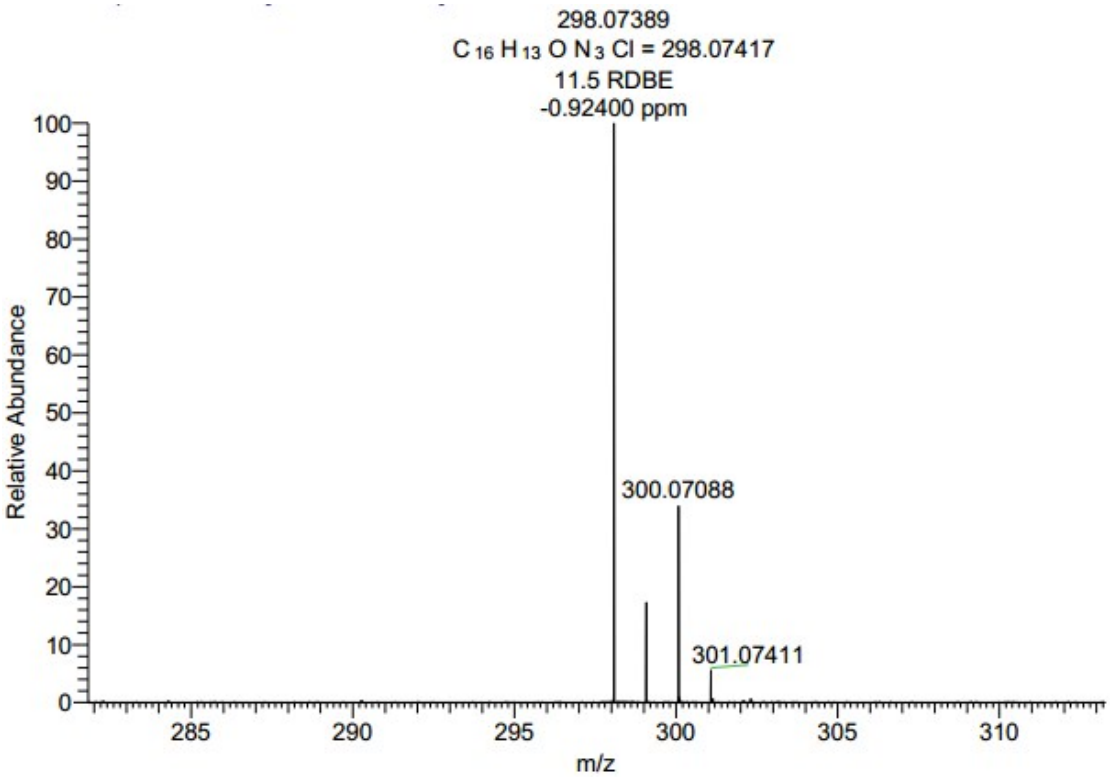
High resolution mass spectrum of compound **A54**



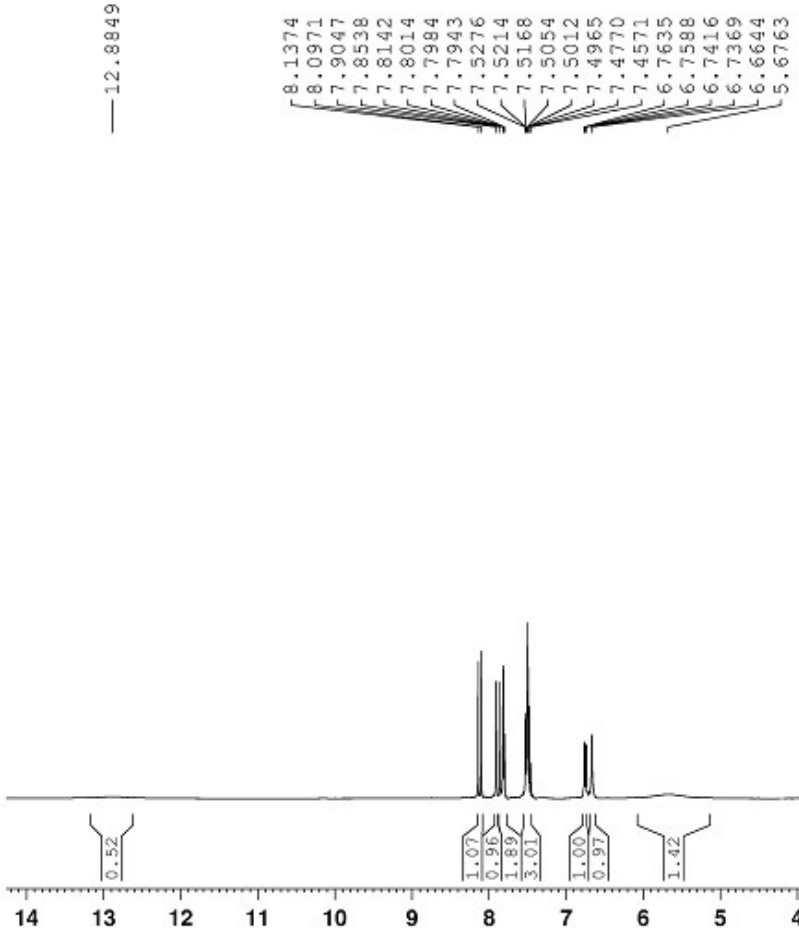
^{1}H NMR spectrum of compound **A55**



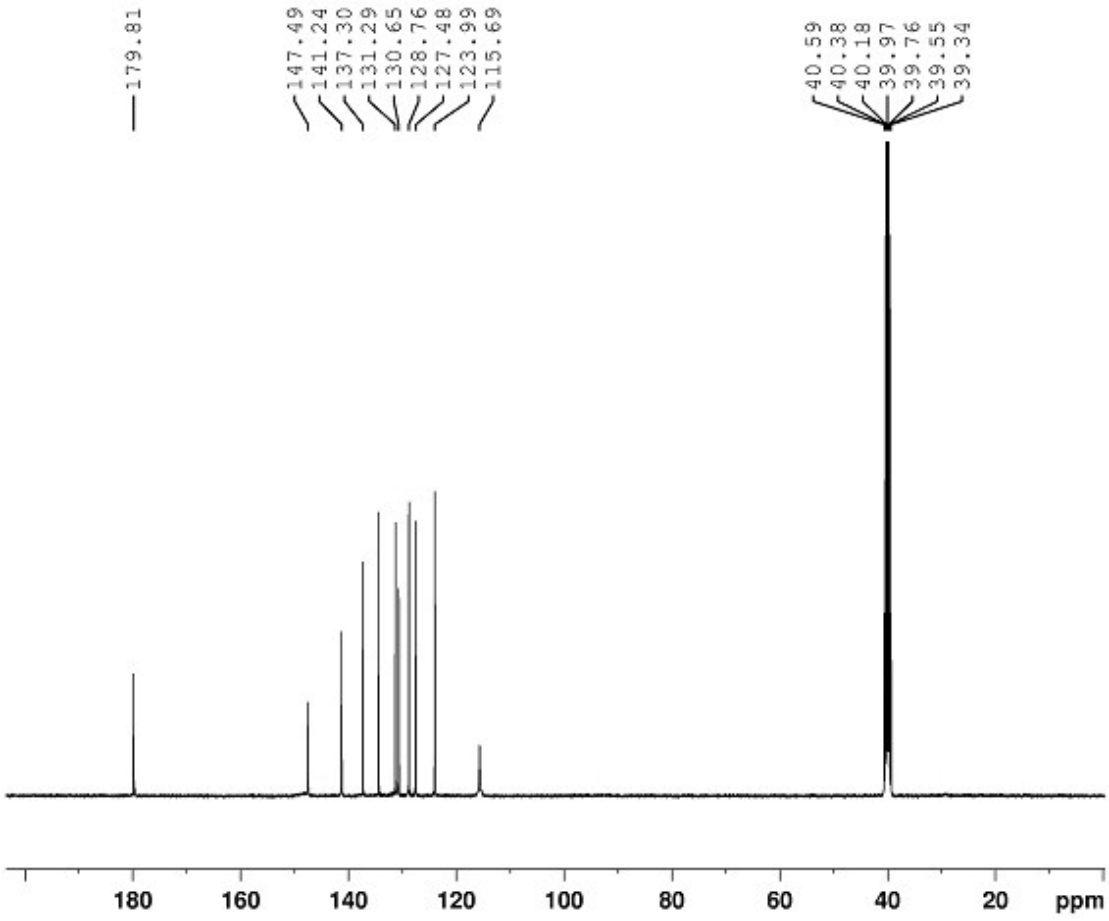
^{13}C NMR spectrum of compound **A55**



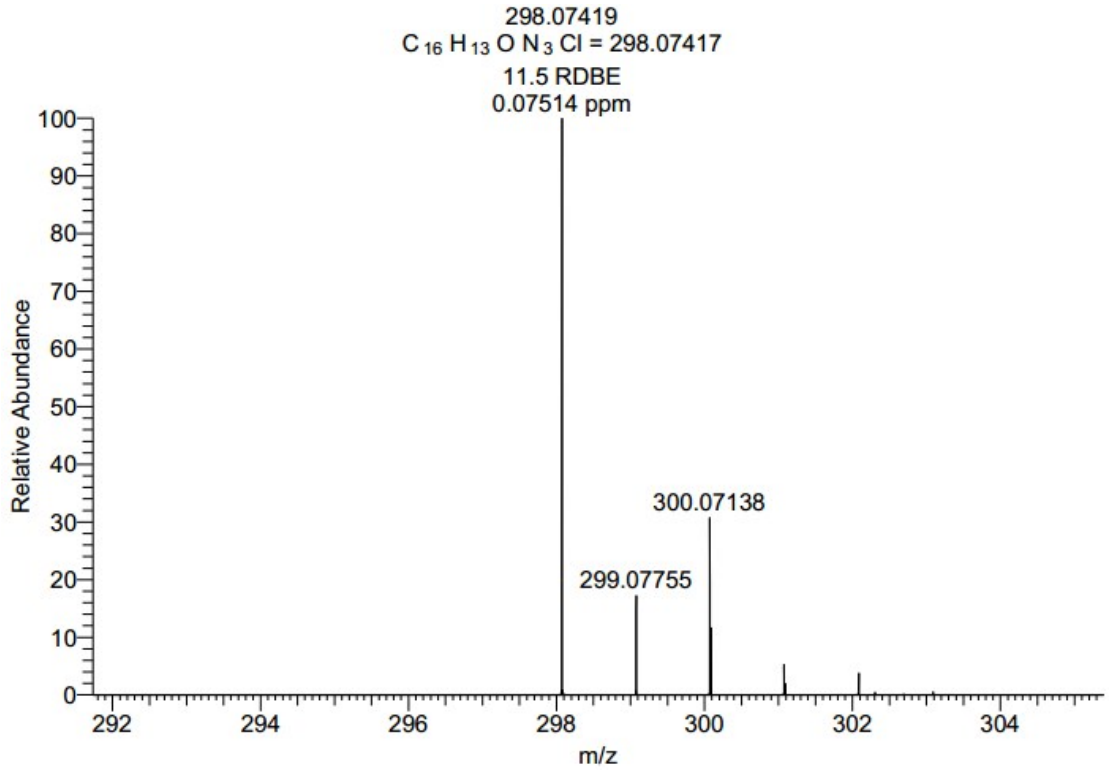
High resolution mass spectrum of compound **A55**



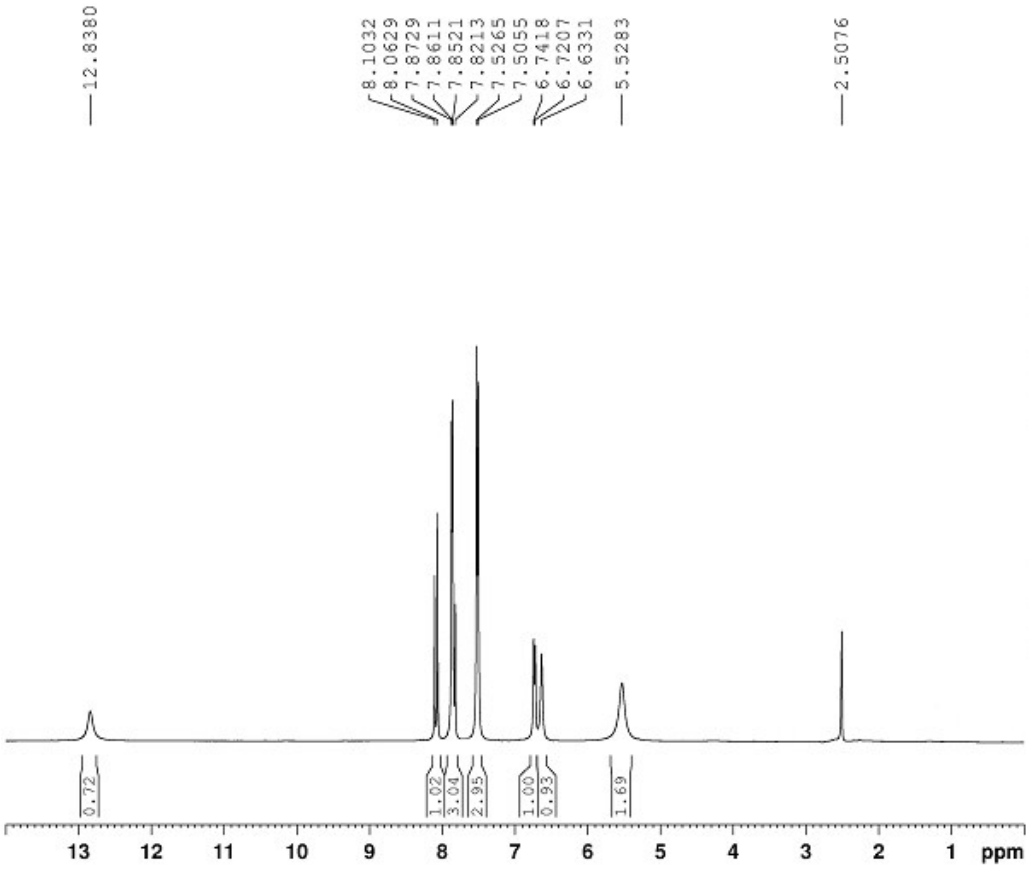
^{1}H NMR spectrum of compound **A56**



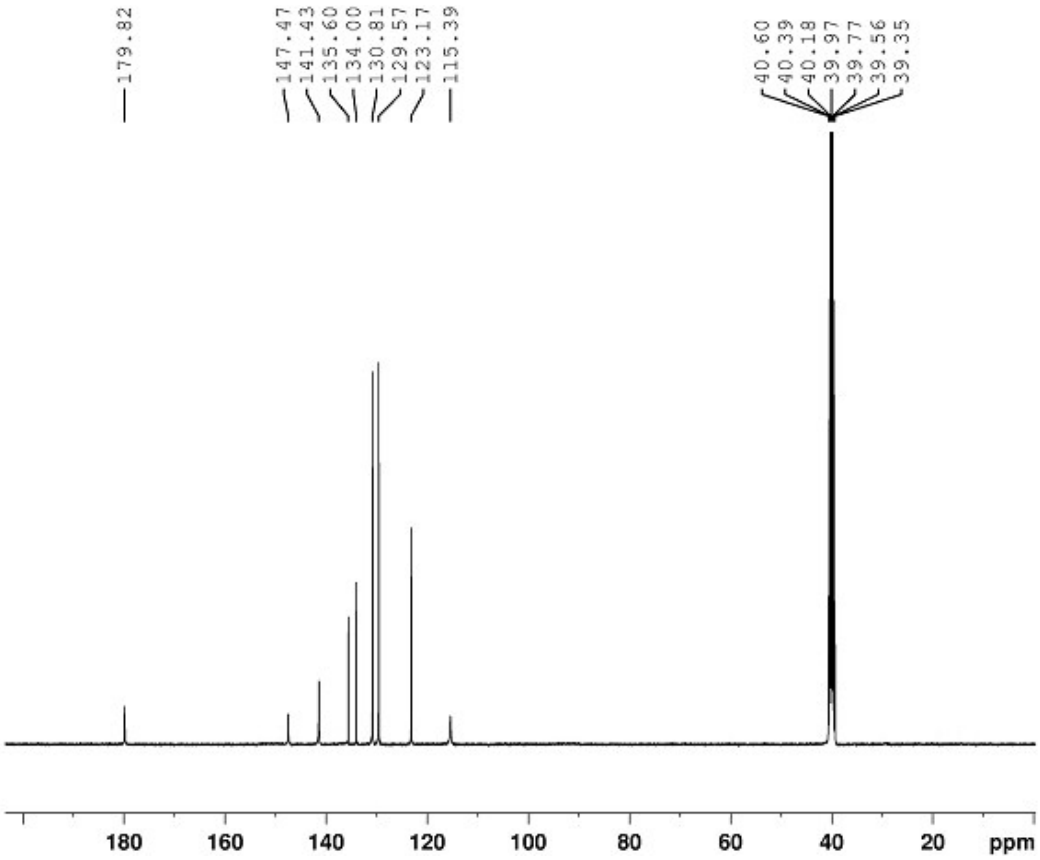
^{13}C NMR spectrum of compound **A56**



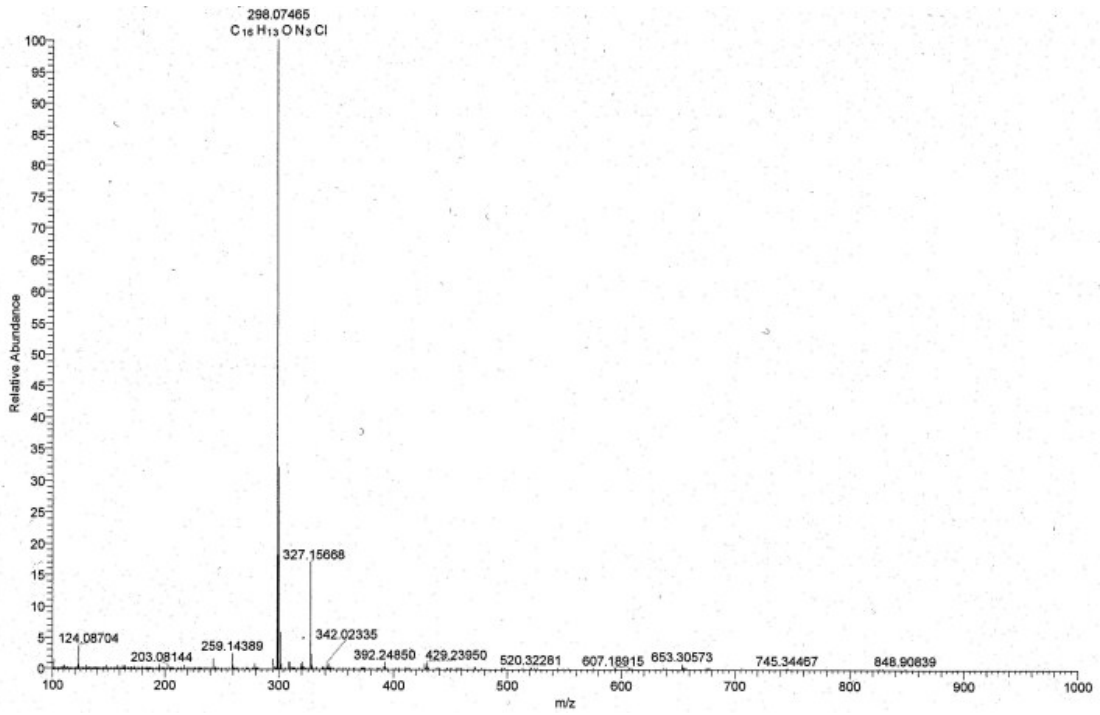
High resolution mass spectrum of compound **A56**



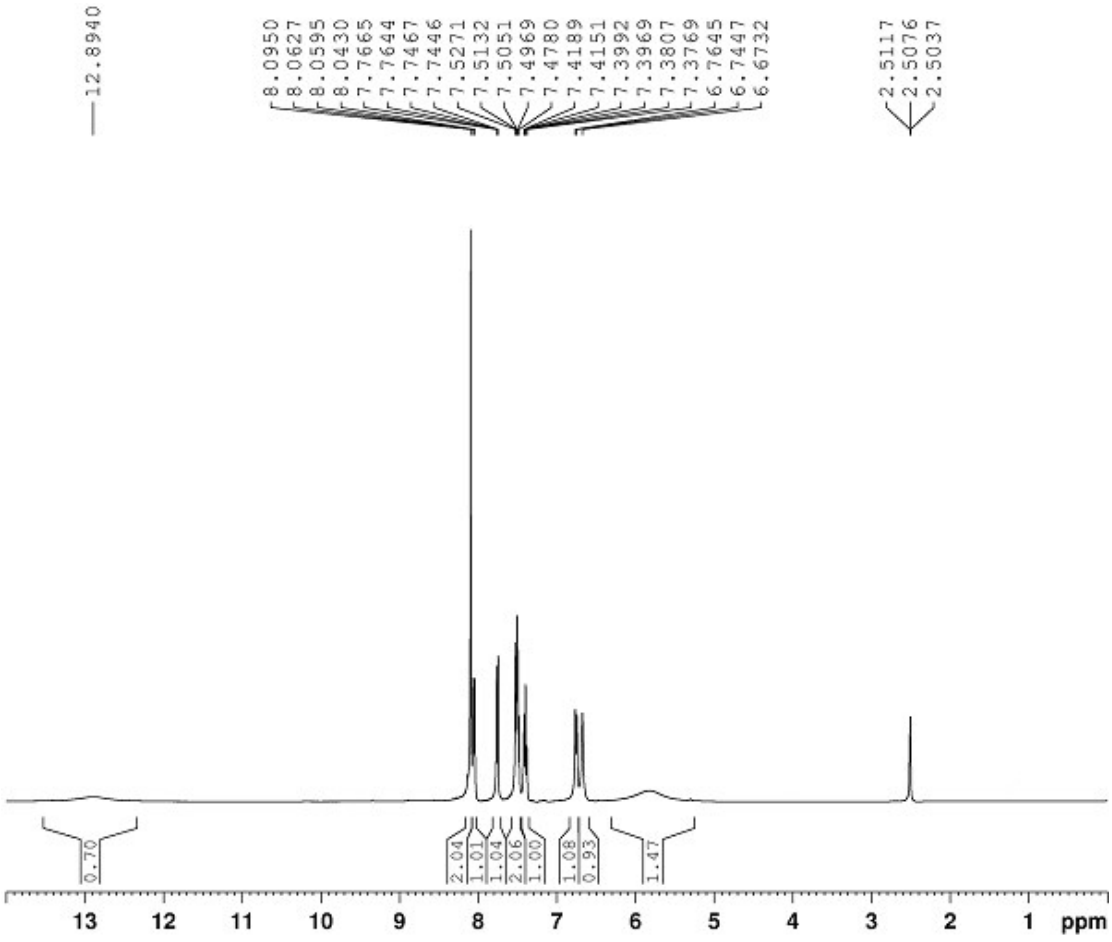
^{1}H NMR spectrum of compound **A57**



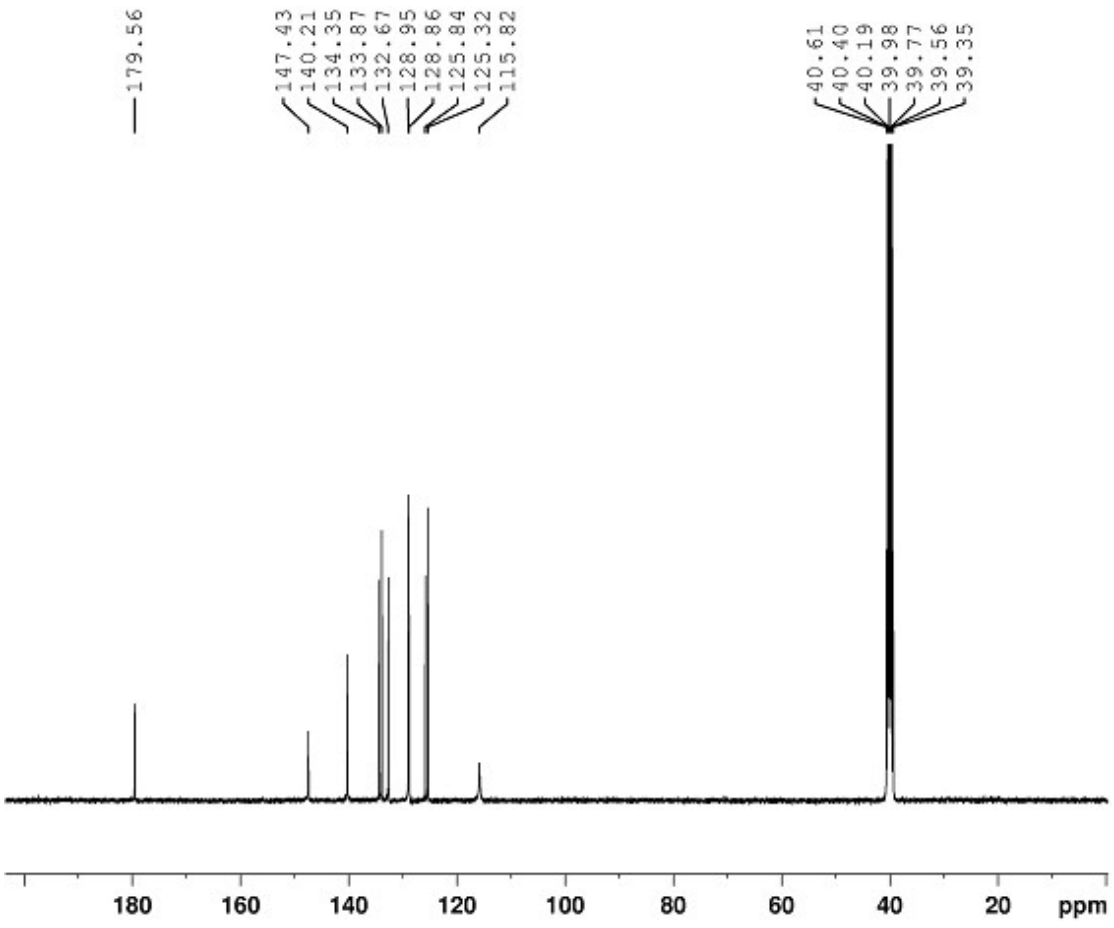
^{13}C NMR spectrum of compound **A57**



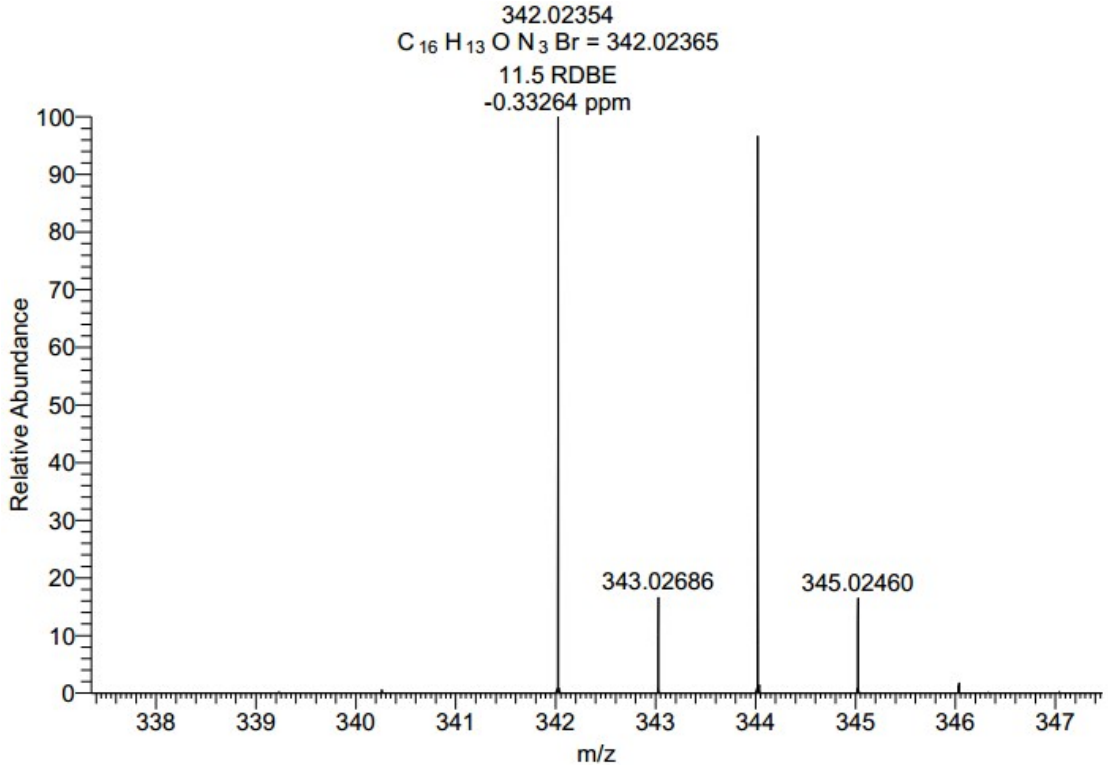
High resolution mass spectrum of compound **A57**



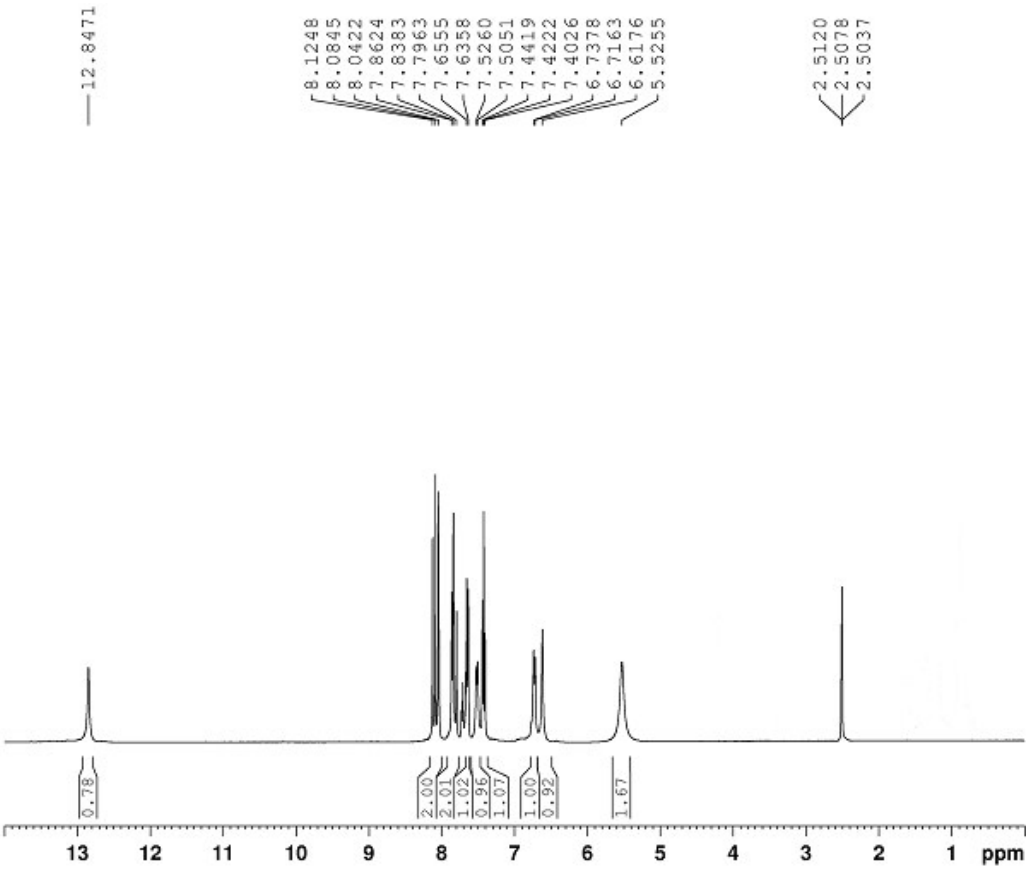
^{1}H NMR spectrum of compound **A58**



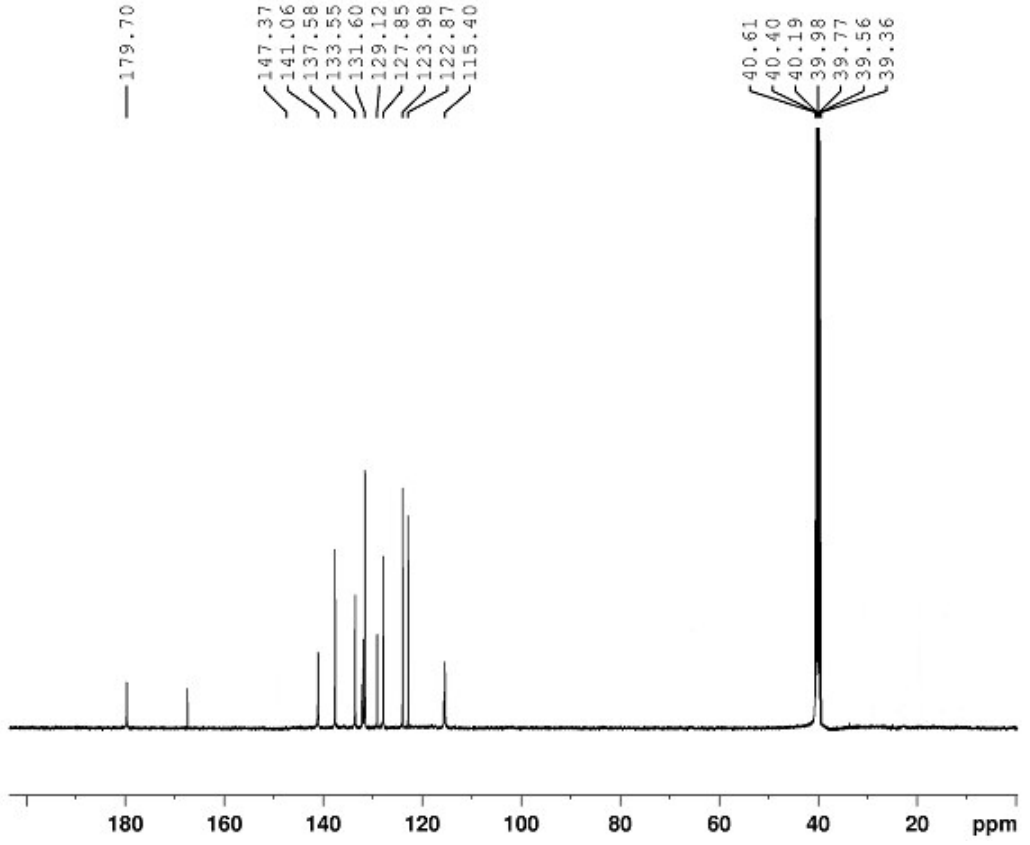
^{13}C NMR spectrum of compound **A58**



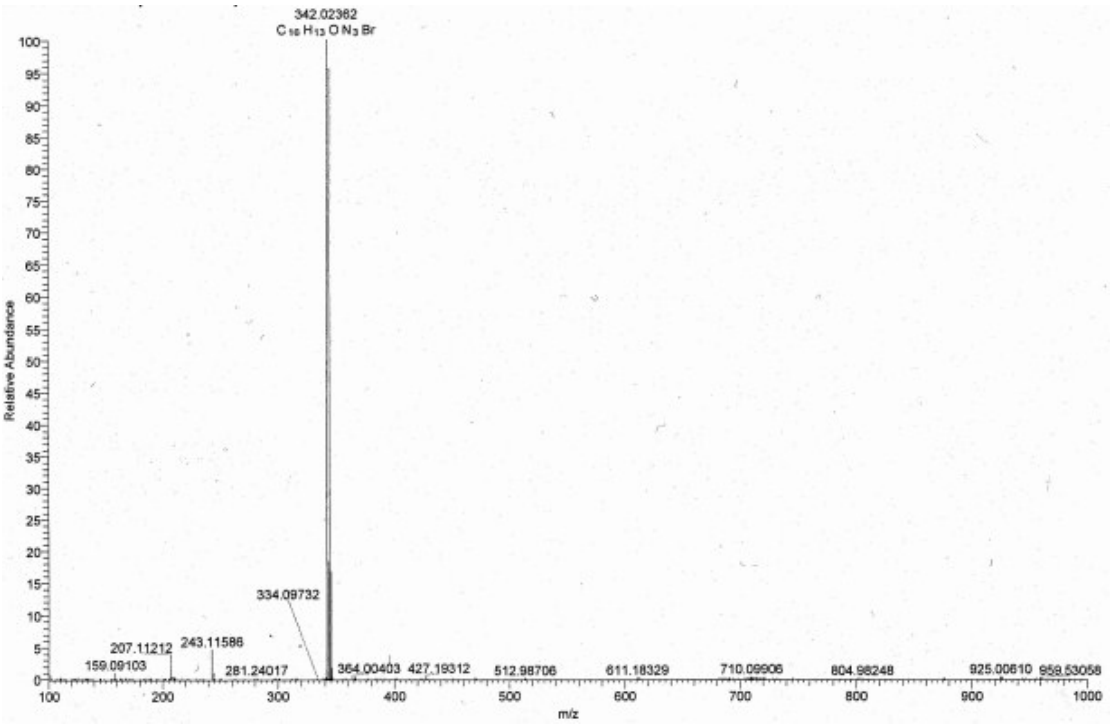
High resolution mass spectrum of compound **A58**



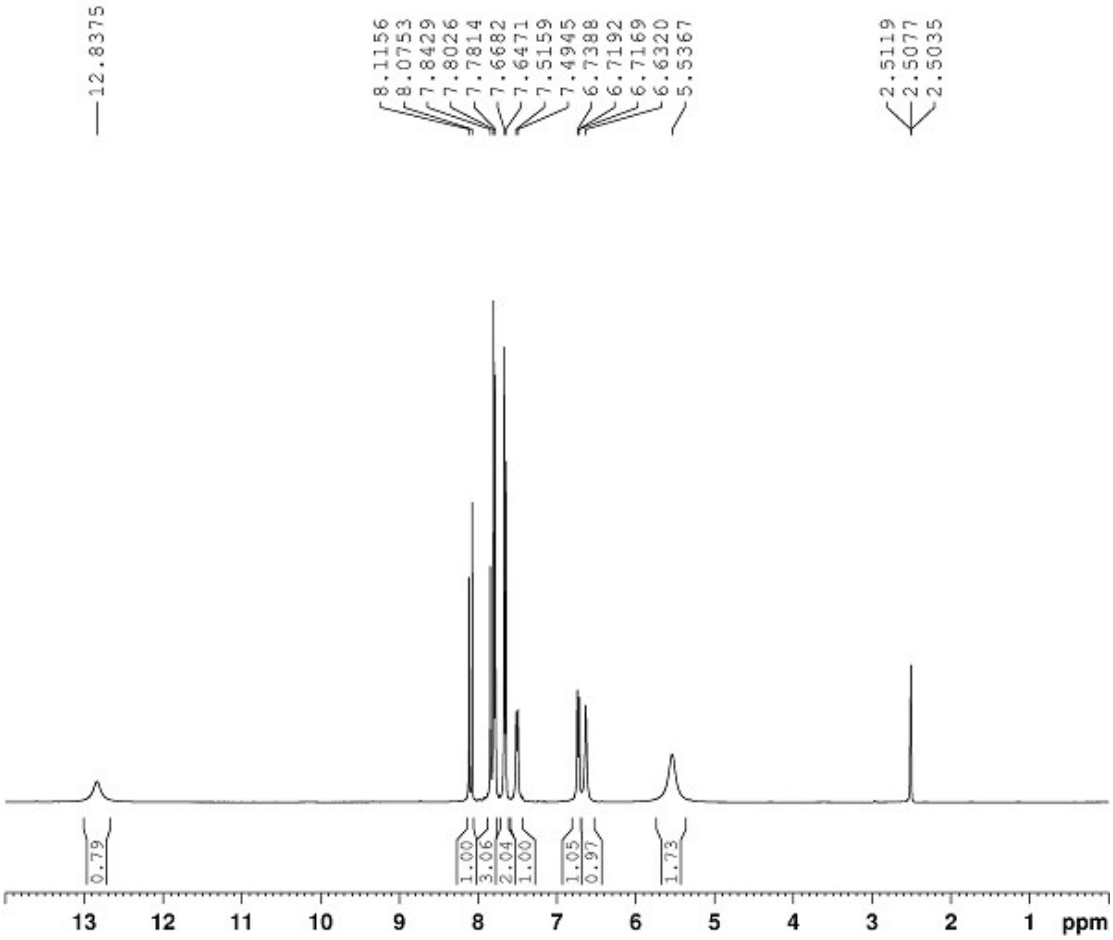
^{1}H NMR spectrum of compound **A59**



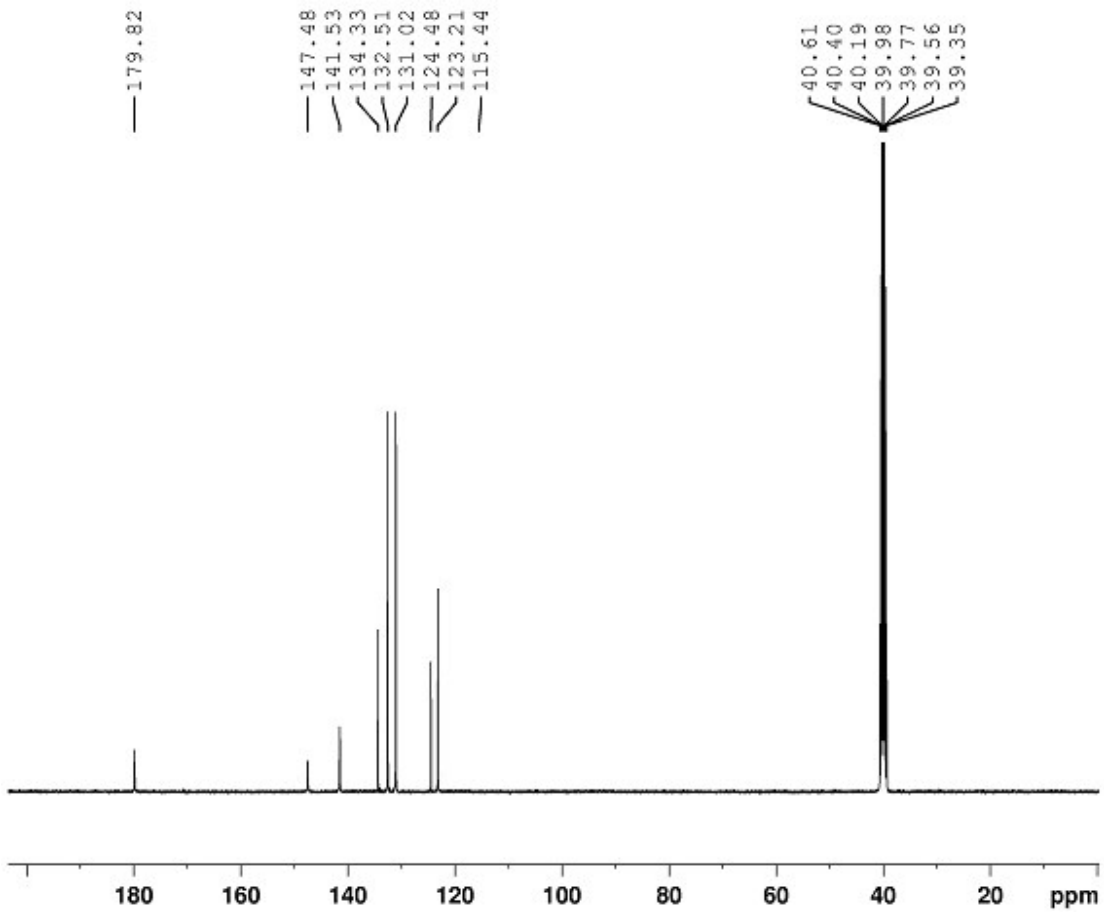
^{13}C NMR spectrum of compound **A59**



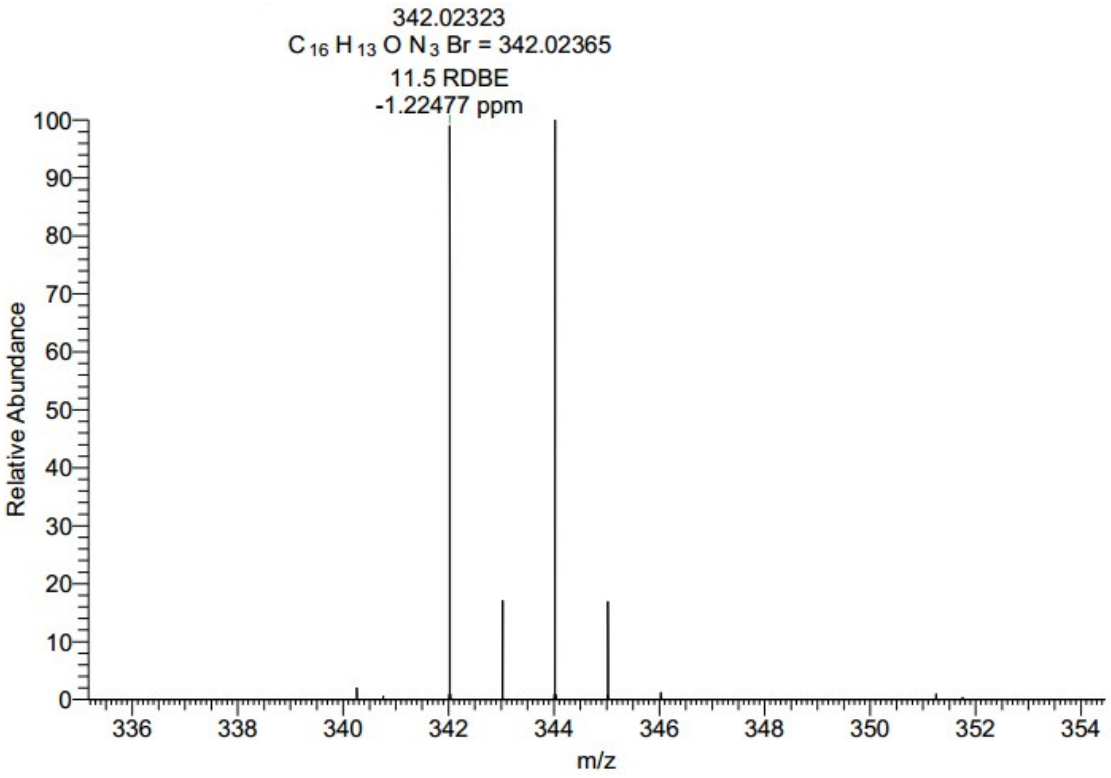
High resolution mass spectrum of compound **A59**



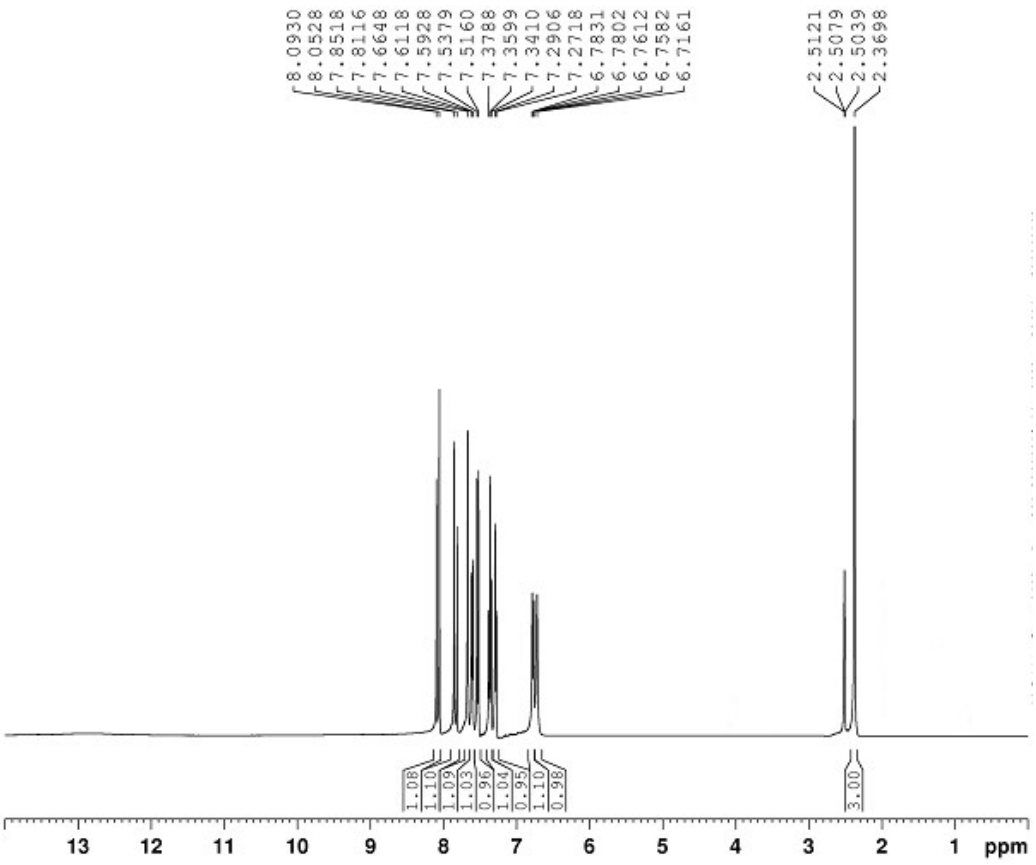
^{1}H NMR spectrum of compound **A60**



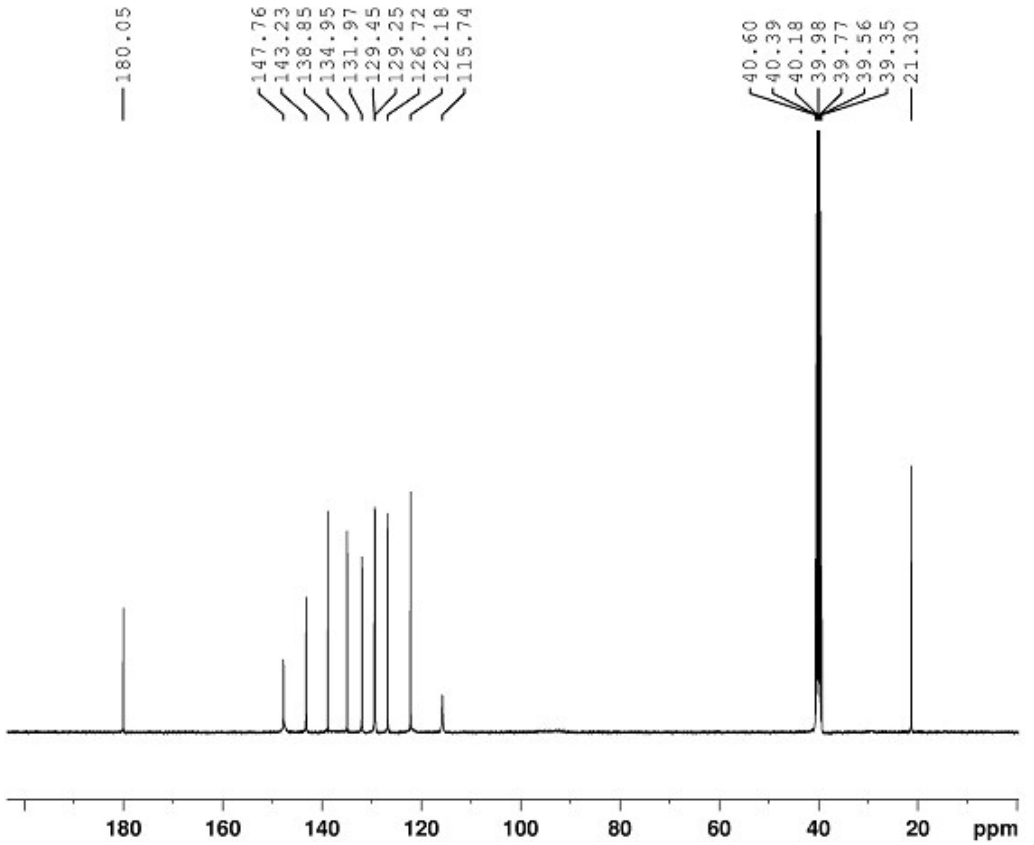
^{13}C NMR spectrum of compound **A60**



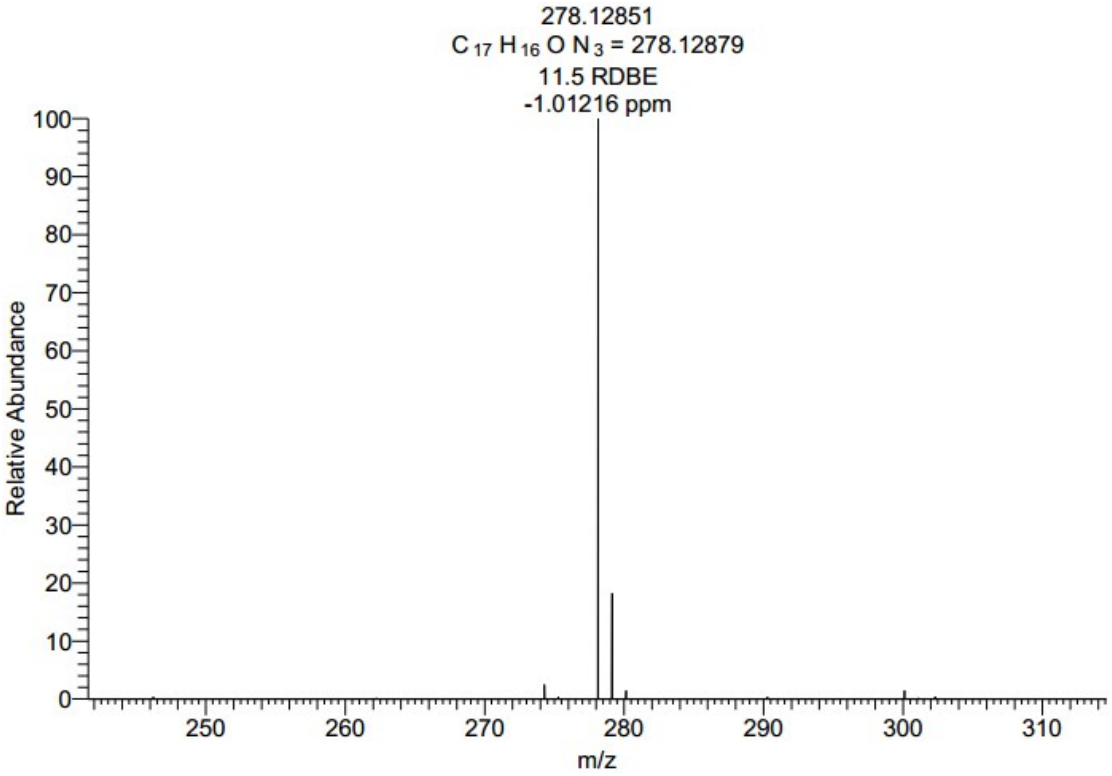
High resolution mass spectrum of compound **A60**



^{1}H NMR spectrum of compound **A61**



^{13}C NMR spectrum of compound **A61**



High resolution mass spectrum of compound **A61**