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Supporting Information

Copper(I)/Lewis Acid Triggered Ring-Opening Coupling Reaction of Cyclopropenes with Nitriles

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A. General method

Melting points were measured with a BÜCHI B-545 melting point instrument and were uncorrected. ^{1}H and ^{13}C NMR spectra were recorded using a Bruker Avance 400 MHz NMR spectrometer. The chemical shifts are referenced to signals at 7.26 and 77.0 ppm, respectively, chloroform is solvent with TMS as the internal standard. Mass spectra were recorded on a Shimadzu GCMS-QP5050A spectrometer at an ionization voltage of 70 eV equipped with a DB-WAX capillary column (internal diameter: 0.25 mm, length: 30 m). Elemental analyses were performed with a Vario EL elemental analyzer. IR spectra were obtained as potassium bromide pellets or as liquid films between two potassium bromide pellets with a Bruker Vector 22 spectrometer. High-resolution mass spectra were obtained with Shimadazu LCMS-IT-TOF mass spectrometer. TLC was performed by using commercially prepared 100–400 mesh silica gel plates (GF254) and visualization was effected at 254 nm. All the other chemicals were purchased without further purification.

B. General procedure

Procedure for the synthesis of γ-amino ketones from corresponding cyclopropyl ketones and nitriles. To the mixture of cyclopropyl ketone (0.2 mmol, 1.0 equiv) and nitrile (aryl-carbonitrile: 3 equiv; alkyl-carbonitrile: 1.5 equiv), CuBr (5 mol%), PBu_3 (10 mol%), $BF_3{\cdot}Et_2O$ (1.0 equiv), H_2O (1.0 equiv), and $MeNO_2$ (1.5 mL) were added successively. The mixture was stirred under 85 ^{o}C for 18 h. Upon completion, the crude product was directly separated by flash column chromatography on silica gel to give the pure product.

C. Analytical data for pruducts prepared

***N*-(4-Oxo-4-phenyl-butyl)-benzamide 4aa.** White solid, m.p: 118–120 ^{o}C. IR (KBr): 2970, 1643, 1406, 704 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 7.7 Hz, 2H), 7.78 (d, J = 7.5 Hz, 2H), 7.54 (t, J = 7.4 Hz, 1H), 7.46–7.36 (m, 5H), 6.90 (br. s, 1H), 3.53 (q, J = 6.5 Hz, 2H), 3.10 (t, J = 6.8 Hz, 2H), 2.08 (p, J = 6.7 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.33, 167.55, 136.58, 134.43, 133.19, 131.23, 128.55, 128.40, 127.98, 126.84, 39.85, 36.25, 23.47. MS (EI) m/z: 77, 105, 148, 162, 267. Anal. calcd.

for $C_{17}H_{17}NO_2$: C 76.38, H 6.41, found: C 76.51, H 6.36.

4-Methyl-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ab. White solid, m.p: 128–130 ^oC. IR (KBr): 2922, 1740, 1644, 1540, 1364, 685 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.67 (d, *J* = 8.0 Hz, 2H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.20 (d, *J* = 7.9 Hz, 2H), 6.71 (br. s, 1H), 3.53 (q, *J* = 6.4 Hz, 2H), 3.11 (t, *J* = 6.7 Hz, 2H), 2.36 (s, 3H), 2.08 (p, *J* = 6.7 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.37, 167.50, 141.64, 136.63, 133.21, 131.62, 129.11, 128.58, 128.02, 126.84, 39.81, 36.29, 23.54, 21.35. MS (EI) m/z: 77, 91, 119, 162, 281. Anal. calcd. for $C_{18}H_{19}NO_2$: C 76.84, H 6.81, found: C 76.98, H 6.70.

2-Methyl-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ac. White solid, m.p: 112–114 ^oC. IR (KBr): 2923, 1644, 1522, 1408, 1289, 691 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.9 Hz, 2H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.29 (t, *J* = 7.6 Hz, 2H), 7.19–7.14 (m, 2H), 6.20 (br. s, 1H), 3.52 (q, *J* = 6.6 Hz, 2H), 3.11 (t, *J* = 6.9 Hz, 2H), 2.41 (s, 3H), 2.06 (p, *J* = 6.9 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.85, 170.28, 136.64, 136.40, 135.93, 133.20, 130.92, 129.74, 128.61, 128.00, 126.61, 125.65, 39.46, 36.03, 23.87, 19.73. MS (EI) m/z: 77, 105, 119, 162, 281. Anal. calcd. for $C_{18}H_{19}NO_2$: C 76.84, H 6.81, found: C 76.95, H 6.75.

4-Methoxy-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ad. White solid, m.p: 138–140 ^oC. IR (KBr): 2923, 1741, 1624, 1502, 1250, 681 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.8 Hz, 2H), 7.74 (d, *J* = 8.7 Hz, 2H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 6.89 (d, *J* = 8.7 Hz, 2H), 6.69 (br. s, 1H), 3.82 (s, 3H), 3.53 (q, *J* = 6.4 Hz, 2H), 3.11 (t, *J* = 6.7 Hz, 2H), 2.08 (p, *J* = 6.7 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.48, 167.10, 162.01, 136.63, 133.22, 128.65, 128.59, 128.03, 126.76, 113.63, 55.32, 39.86, 36.34, 23.54. MS (EI) m/z: 77, 92, 107, 135, 297. Anal. calcd. for $C_{18}H_{19}NO_3$: C 72.71, H 6.44, found: C 72.88, H 6.31.

3-Bromo-4-methyl-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ae. White solid, m.p: 113–115 ^oC. IR (KBr): 2951, 1733, 1648, 1543, 1241, 1041, 689 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.7 Hz, 2H), 7.94 (s, H), 7.64–7.51 (m, 2H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.25 (d, *J* = 8.4 Hz, 1H), 6.78 (br. s, 1H), 3.53 (q, *J* = 6.5 Hz, 2H), 3.13 (t, *J* = 6.6 Hz, 2H), 2.41 (s, 3H), 2.09 (p, *J* = 6.7 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ

200.49, 166.08, 141.42, 136.56, 133.75, 133.32, 130.98, 130.73, 128.63, 128.06, 125.63, 124.98, 40.04, 36.33, 23.35, 22.90. MS (EI) m/z: 77, 105, 162, 197, 359. Anal. calcd. for $C_{18}H_{18}BrNO_2$: C 60.01, H 5.04, found: C 60.20, H 4.98.

4-Fluoro-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4af. White solid, m.p: 129–131 °C. IR (KBr): 2922, 1647, 1503, 1234, 686 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.6 Hz, 2H), 7.79 (dd, *J* = 8.6, 5.4 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.06 (t, *J* = 8.6 Hz, 2H), 6.86 (br. s, 1H), 3.53 (q, *J* = 6.4 Hz, 2H), 3.13 (t, *J* = 6.6 Hz, 2H), 2.09 (p, *J* = 6.6 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.59, 166.47, 164.58, 136.56, 133.33, 130.62, 129.18, 128.63, 128.02, 115.44, 40.09, 36.41, 23.29. MS (EI) m/z: 77, 105, 123, 166, 285. Anal. calcd. for $C_{17}H_{16}FNO_2$: C 71.56, H 5.65, found: C 71.58, H 5.57.

4-Chloro-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ag. White solid, m.p: 155–157 °C. IR (KBr): 2922, 1738, 1639, 1538, 1363, 686 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.5 Hz, 2H), 7.72 (d, *J* = 8.5 Hz, 2H), 7.56 (t, *J* = 7.3 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.37 (d, *J* = 8.4 Hz, 2H), 6.85 (br. s, 1H), 3.53 (q, 6.4 Hz, 2H), 3.14 (t, *J* = 6.6 Hz, 2H), 2.10 (p, *J* = 6.6 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.63, 166.44, 137.51, 136.55, 133.38, 132.83, 128.71, 128.66, 128.33, 128.04, 40.17, 36.47, 23.21. MS (EI) m/z: 77, 105, 139, 182, 301. Anal. calcd. for $C_{17}H_{16}ClNO_2$: C 67.66, H 5.34, found: C 67.52, H 5.41.

4-Bromo-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ah. White solid, m.p: 158–160 °C. IR (KBr): 2922, 1682, 1639, 1540, 1459, 686 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.1 Hz, 2H), 7.65 (d, *J* = 8.4 Hz, 2H), 7.59-7.53 (m, 3H), 7.45 (t, *J* = 7.6 Hz, 2H), 6.82 (br. s, 1H), 3.54 (q, *J* = 6.2 Hz, 2H), 3.14 (t, *J* = 6.5 Hz, 2H), 2.10 (p, *J* = 6.5 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.64, 166.50, 136.55, 133.39, 133.30, 131.70, 128.67, 128.52, 128.05, 125.97, 40.19, 36.49, 23.19. MS (EI) m/z: 77, 105, 183, 226, 345. Anal. calcd. for $C_{17}H_{16}BrNO_2$: C 58.97, H 4.66, found: C 58.68, H 4.71.

4-Iodo-*N*-(4-oxo-4-phenyl-butyl)-benzamide 4ai. White solid, m.p: 173–175 °C. IR (KBr): 2922, 1649, 1539, 1457, 1268, 690 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.3 Hz, 2H), 7.77–7.74 (m, 2H), 7.56 (t, *J* = 7.3 Hz, 1H), 7.51–7.43 (m, 4H),

6.87 (br. s, 1H), 3.52 (q, *J* = 6.3 Hz, 2H), 3.16–3.12 (m, 2H), 2.12 – 2.06 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.62, 166.72, 137.67, 136.54, 133.86, 133.38, 128.66, 128.53, 128.05, 98.25, 40.16, 36.46, 23.20. MS (EI) m/z: 77, 105, 127, 230, 273, 393. Anal. calcd. for $C_{17}H_{16}INO_2$: C 51.93, H 4.10, found: C 52.08, H 4.06.

Pentanoic acid [4-(4-fluoro-phenyl)-4-oxo-butyl]-amide 4bj. White solid, m.p: 100–102 °C. IR (KBr): 2951, 1637, 1541, 1464, 1234, 833, 679 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 8.5, 5.6 Hz, 2H), 7.11 (t, *J* = 8.5 Hz, 2H), 5.83 (br. s, 1H), 3.33 (q, *J* = 6.5 Hz, 2H), 3.00 (t, *J* = 6.9 Hz, 2H), 2.13 (t, *J* = 7.6 Hz, 2H), 1.95 (p, *J* = 6.9 Hz, 2H), 1.56 (p, *J* = 7.6 Hz, 2H), 1.35–1.25 (m, 2H), 0.87 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.37, 173.35, 165.77, 133.10, 130.64, 115.70, 39.04, 36.52, 35.93, 27.78, 23.80, 22.36, 13.72. MS (EI) m/z: 85, 95, 123, 164, 223, 265. Anal. calcd. for $C_{15}H_{20}FNO_2$: C 67.90, H 7.60, found: C 67.74, H 7.64.

Pentanoic acid [4-(4-chloro-phenyl)-4-oxo-butyl]-amide 4cj. White solid, m.p: 127–129 °C. IR (KBr): 2938, 1638, 1543, 1461, 1362, 820, 683 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.4 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 2H), 5.83 (br. s, 1H), 3.33 (q, *J* = 6.6 Hz, 2H), 2.99 (t, *J* = 6.9 Hz, 2H), 2.13 (t, *J* = 7.6 Hz, 2H), 1.94 (p, *J* = 6.9 Hz, 2H), 1.56 (p, *J* = 7.6 Hz, 2H), 1.34–1.25 (m, 2H), 0.87 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.72, 173.35, 139.63, 134.96, 129.41, 128.91, 38.99, 36.50, 35.97, 27.77, 23.77, 22.36, 13.72. MS (EI) m/z: 85, 128, 139, 180, 239, 281. Anal. calcd. for $C_{15}H_{20}ClNO_2$: C 63.94, H 7.15, found: C 63.80, H 7.22.

Pentanoic acid [4-(4-methoxy-phenyl)-4-oxo-butyl]-amide 4dj. White solid, m.p: 115–117 °C. IR (KBr): 2933, 1666, 1513, 1458, 1255, 1171, 1027, 833 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.8 Hz, 2H), 6.92 (d, *J* = 8.8 Hz, 2H), 5.87 (br. s, 1H), 3.86 (s, 3H), 3.33 (q, *J* = 6.5 Hz, 2H), 2.98 (t, *J* = 6.9 Hz, 2H), 2.13 (t, *J* = 7.6 Hz, 2H), 1.95 (p, *J* = 6.8 Hz, 2H), 1.56 (p, *J* = 7.6 Hz, 2H), 1.35-1.26 (m, 2H), 0.88 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.73, 173.36, 163.58, 130.32, 129.76, 113.75, 55.45, 39.24, 36.54, 35.72, 27.79, 23.85, 22.37, 13.73. MS (EI) m/z: 77, 92, 135, 150, 176, 235, 277. Anal. calcd. for $C_{16}H_{23}NO_3$: C 69.29, H 8.36, found: C 69.38, H 8.25.

Dodecanoic acid (4-oxo-4-phenyl-butyl)-amide 4ak. White solid, m.p: 91–93 °C. IR

(KBr): 2919, 1684, 1640, 1459, 1362, 683 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.1 Hz, 2H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 5.90 (br. s, 1H), 3.34 (q, *J* = 6.5 Hz, 2H), 3.03 (t, *J* = 6.9 Hz, 2H), 2.12 (t, *J* = 7.6 Hz, 2H), 1.96 (p, *J* = 6.8 Hz, 2H), 1.62–1.53 (m, 2H), 1.32–1.17 (m, 16H), 0.86 (t, *J* = 6.7 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.04, 173.36, 136.66, 133.17, 128.59, 127.98, 39.10, 36.80, 36.03, 31.84, 29.56, 29.54, 29.43, 29.30, 29.27, 29.26, 25.72, 23.74, 22.62, 14.05. MS (EI) m/z: 77, 105, 146, 205, 345. Anal. calcd. for $C_{22}H_{35}NO_2$: C 76.47, H 10.21, found: C 76.57, H 10.15.

Cyclopropanecarboxylic acid (4-oxo-4-phenyl-butyl)-amide 4al. White solid, m.p: 112–114 °C. IR (KBr): 2927, 1680, 1646, 1546, 1448, 1241, 691 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.6 Hz, 2H), 7.54 (t, *J* = 7.3 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 6.20 (br. s, 1H), 3.34 (q, *J* = 6.6 Hz, 2H), 3.03 (t, *J* = 7.0 Hz, 2H), 1.99–1.92 (m, 2H), 1.37–1.30 (m, 1H), 0.91–0.87 (m, 2H), 0.69–0.64 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.09, 173.72, 136.65, 133.11, 128.55, 127.96, 39.29, 35.97, 23.88, 14.59, 6.91. MS (EI) m/z: 69, 77, 105, 146, 185, 231. Anal. calcd. for $C_{14}H_{17}NO_2$: C 72.70, H 7.41, found: C 72.82, H 7.32.

Adamantane-1-carboxylic acid (4-oxo-4-phenyl-butyl)-amide 4am. White solid, m.p: 116–118 °C. IR (KBr): 2908, 1683, 1642, 1520, 1449, 1273, 745, 690 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.8 Hz, 2H), 7.54 (t, *J* = 7.3 Hz, 1H), 7.44 (t, *J* = 7.5 Hz, 2H), 5.94 (br. s, 1H), 3.33 (q, *J* = 6.2 Hz, 2H), 3.02 (t, *J* = 6.7 Hz, 2H), 2.00– 1.93 (m, 5H), 1.79 (s, 6H), 1.68 (q, *J* = 12.3 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.16, 178.11, 136.67, 133.13, 128.57, 128.01, 40.52, 39.16, 39.05, 36.47, 36.12, 28.09, 23.65. MS (EI) m/z: 77, 105, 135, 180, 206, 281, 325. Anal. calcd. for $C_{21}H_{27}NO_2$: C 77.50, H 8.36, found: C 77.44, H 8.39.

***N*-(4-Oxo-4-phenyl-butyl)-4-phenyl-butyramide 4an.** White solid, m.p: 72–74 °C. IR (KBr): 2933, 1679, 1543, 1449, 1247, 744, 695 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.0 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.25 (t, *J* = 7.4 Hz, 2H), 7.18–7.13 (m, 3H), 5.92 (br. s, 1H), 3.33 (q, *J* = 6.5 Hz, 2H), 3.03 (t, *J* = 6.9 Hz, 2H), 2.62 (t, *J* = 7.5 Hz, 2H), 2.15 (t, *J* = 7.5 Hz, 2H), 1.99–1.89 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.98, 172.87, 141.43, 136.61, 133.15, 128.57,

128.38, 128.28, 127.95, 125.84, 39.11, 35.98, 35.87, 35.15, 27.04, 23.72. MS (EI) m/z: 77, 91, 105, 146, 205, 309. Anal. calcd. for $C_{20}H_{23}NO_2$: C 77.64, H 7.49, found: C 77.75, H 7.46.

***N*-[4-(4-Fluoro-phenyl)-4-oxo-butyl]-2-phenyl-acetamide 4bo.** White solid, m.p: 96–98 ^{o}C. IR (KBr): 2922, 1676, 1627, 1550, 1459, 1357, 1239, 826, 691 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93–7.89 (m, 2H), 7.34–7.22 (m, 5H), 7.11 (t, *J* = 8.6 Hz, 2H), 5.80 (br. s, 1H), 3.53 (s, 2H), 3.30 (q, *J* = 6.7 Hz, 2H), 2.92 (t, *J* = 7.0 Hz, 2H), 1.88 (p, *J* = 6.9 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.01, 171.17, 165.70, 134.90, 133.02, 130.59, 129.29, 128.91, 127.23, 115.62, 43.79, 39.14, 35.62, 23.63. MS (EI) m/z: 77, 91, 125, 223, 299. Anal. calcd. for $C_{18}H_{18}FNO_2$: C 72.22, H 6.06, found: C 72.05, H 6.12.

***N*-(4-Oxo-4-phenyl-butyl)-acrylamide 4ap.** White solid, m.p: 68–70 ^{o}C. IR (KBr): 2930, 1673, 1543, 1449, 1243, 691 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.7 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 6.27–6.05 (m, 3H), 5.60 (dd, *J* = 10.2, 1.3 Hz, 1H), 3.43 (q, *J* = 6.7 Hz, 2H), 3.07 (t, *J* = 6.9 Hz, 2H), 2.01 (p, *J* = 6.8 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.15, 165.77, 136.63, 133.24, 130.89, 128.62, 128.01, 126.18, 39.28, 36.08, 23.59. MS (EI) m/z: 77, 105, 146, 217. Anal. calcd. for $C_{13}H_{15}NO_2$: C 71.87, H 6.96, found: C 71.64, H 7.07.

Hex-5-enoic acid (4-oxo-4-phenyl-butyl)-amide 4aq. Yellowish oil. IR (KBr): 2933, 1648, 1544, 1447, 1250, 1208, 994, 745, 691 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.9 Hz, 2H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 6.07 (br. s, 1H), 5.81–5.71 (m, 1H), 5.02–4.94 (m, 2H), 3.34 (q, *J* = 6.4 Hz, 2H), 3.04 (t, *J* = 6.9 Hz, 2H), 2.16 (t, *J* = 7.6 Hz, 2H), 2.06 (q, *J* = 7.1 Hz, 2H), 1.97 (p, *J* = 6.8 Hz, 2H), 1.71 (p, *J* = 7.5 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.97, 173.00, 137.78, 136.62, 133.11, 128.54, 127.92, 115.09, 39.06, 35.96, 35.83, 33.06, 24.67, 23.74. MS (EI) m/z: 77, 105, 146, 205, 259. Anal. calcd. for $C_{16}H_{21}NO_2$: C 74.10, H 8.16, found: C 74.23, H 8.14.

3-Methoxy-*N*-(4-oxo-4-phenyl-butyl)-propionamide 4ar. Yellowish oil. IR (KBr): 2930, 1680, 1546, 1448, 1209, 1113, 692 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.6 Hz, 2H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 6.41 (br. s, 1H),

3.59 (t, *J* = 5.8 Hz, 2H), 3.36–3.32 (m, 5H), 3.02 (t, *J* = 7.0 Hz, 2H), 2.41 (t, *J* = 5.8 Hz, 2H), 1.95 (p, *J* = 7.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.79, 171.49, 136.70, 133.08, 128.55, 127.96, 68.61, 58.70, 38.88, 36.97, 35.82, 23.84. MS (EI) m/z: 77, 105, 146, 205, 249. Anal. calcd. for $C_{14}H_{19}NO_3$: C 67.45, H 7.68, found: C 67.28, H 7.75.

***N*-[4-(4-Chloro-phenyl)-4-oxo-butyl]-3-methoxy-propionamide 4cr.** Yellowish oil. IR (KBr): 2936, 1672, 1553, 1403, 1115, 817, 753 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.5 Hz, 2H), 7.42 (d, *J* = 8.5 Hz, 2H), 6.36 (br. s, 1H), 3.60 (t, *J* = 5.8 Hz, 2H), 3.37–3.32 (m, 5H), 2.99 (t, *J* = 7.0 Hz, 2H), 2.42 (t, *J* = 5.8 Hz, 2H), 1.95 (p, *J* = 7.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.53, 171.61, 139.56, 135.05, 129.43, 128.90, 68.63, 58.76, 38.81, 37.00, 35.82, 23.88. MS (EI) m/z: 77, 105, 146, 205, 283. Anal. calcd. for $C_{14}H_{18}ClNO_3$: C 59.26, H 6.39, found: C 59.13, H 6.45.

4-Chloro-*N*-(4-oxo-4-phenyl-butyl)-butyramide 4as. Yellowish oil. IR (KBr): 2931, 1648, 1505, 1232, 833, 698 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.8 Hz, 2H), 7.56 (t, *J* = 7.3 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 6.00 (br. s, 1H), 3.56 (t, *J* = 6.2 Hz, 2H), 3.34 (q, *J* = 6.6 Hz, 2H), 3.04 (t, *J* = 6.9 Hz, 2H), 2.32 (t, *J* = 7.1 Hz, 2H), 2.07 ((p, *J* = 6.8 Hz, 2H), 1.97 (p, *J* = 6.9 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.99, 171.79, 136.62, 133.23, 128.62, 127.99, 44.47, 39.23, 35.98, 33.19, 28.07, 23.68. MS (EI) m/z: 77, 105, 146, 205, 233, 267. Anal. calcd. for $C_{14}H_{18}ClNO_2$: C 62.80, H 6.78, found: C 62,55, H 6.91.

Hex-5-ynoic acid (4-oxo-4-phenyl-butyl)-amide 4at. White solid, m.p: 77–79 ^{o}C. IR (KBr): 2933, 1678, 1545, 1447, 1366, 1248, 691 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.3 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 5.93 (br. s, 1H), 3.34 (q, *J* = 6.6 Hz, 2H), 3.04 (t, *J* = 6.9 Hz, 2H), 2.30–2.20 (m, 4H), 2.01–1.93 (m, 3H), 1.86–1.78 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.99, 172.35, 136.64, 133.20, 128.61, 127.99, 83.46, 69.11, 39.16, 35.97, 35.03, 24.09, 23.74, 17.79. MS (EI) m/z: 77, 95, 105, 138, 146, 257. Anal. calcd. for $C_{16}H_{19}NO_2$: C 74.68, H 7.44, found: C 74.53, H 7.50.

5-Cyano-pentanoic acid (4-oxo-4-phenyl-butyl)-amide 4au. Yellowish oil. IR (KBr): 2936, 1679, 1545, 1449, 1242, 693 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93

(d, *J* = 8.2 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 6.10 (br. s, 1H), 3.32 (q, *J* = 6.5 Hz, 2H), 3.03 (t, *J* = 6.8 Hz, 2H), 2.31 (t, *J* = 6.9 Hz, 2H), 2.18 (t, *J* = 7.1 Hz, 2H), 1.95 (p, *J* = 6.8 Hz, 2H), 1.77–1.61 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.05, 172.04, 136.56, 133.23, 128.61, 127.94, 119.47, 39.21, 36.00, 35.31, 24.82, 24.50, 23.57, 16.87. MS (EI) m/z: 77, 105, 110, 162, 272. Anal. calcd. for $C_{16}H_{20}N_2O_2$: C 70.56, H 7.40, found: C 70.62, H 7.35.

2-(4-Methoxy-phenyl)-*N*-(4-oxo-4-phenyl-butyl)-acetamide 4av. White solid, m.p: 109–111 °C. IR (KBr): 2925, 1648, 1448, 1203, 696 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 7.7 Hz, 2H), 7.57 (t, *J* = 7.3 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.14 (d, *J* = 8.3 Hz, 2H), 6.86 (d, *J* = 8.3 Hz, 2H), 5.64 (br. s, 1H), 3.79 (s, 3H), 3.48 (s, 2H), 3.30 (q, *J* = 6.5 Hz, 2H), 2.96 (t, *J* = 6.9 Hz, 2H), 1.89 (p, *J* = 6.8 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.67, 171.60, 158.76, 136.58, 133.12, 130.42, 128.55, 127.95, 126.82, 114.34, 55.19, 42.87, 39.18, 35.71, 23.61. MS (EI) m/z: 77, 105, 146, 205, 311. Anal. calcd. for $C_{19}H_{21}NO_3$: C 73.29, H 6.80, found: C 73.12, H 6.87.

8,9-Dimethoxy-10b-phenyl-1,2,3,10b-tetrahydropyrrolo[2,1-a]isoquinolin-5(6H)-one 4aw. White solid, m.p: 135–137 °C. IR (KBr): 2948, 1644, 1505, 1463, 1229, 834, 699 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30–7.17 (m, 5H), 7.07 (s, 1H), 6.59 (s, 1H), 4.00 (s, 3H), 3.90–3.81 (m, 4H), 3.69 (dd, *J* = 19.1, 11.0 Hz, 1H), 3.37 (q, *J* = 18.2 Hz, 2H), 2.69 (dd, *J* = 11.6, 6.1 Hz, 1H), 2.52–2.44 (m, 1H), 2.04–1.98 (m, 1H), 1.86–1.71 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.19, 148.48, 147.77, 142.78, 133.11, 128.41, 126.94, 125.08, 124.89, 110.50, 108.30, 71.11, 56.43, 55.92, 45.39, 40.43, 38.33, 20.87. HRMS (ESI) calc. $C_{20}H_{21}NO_3$ $[M+H]^+$: 324.1600, found: 324.1594.

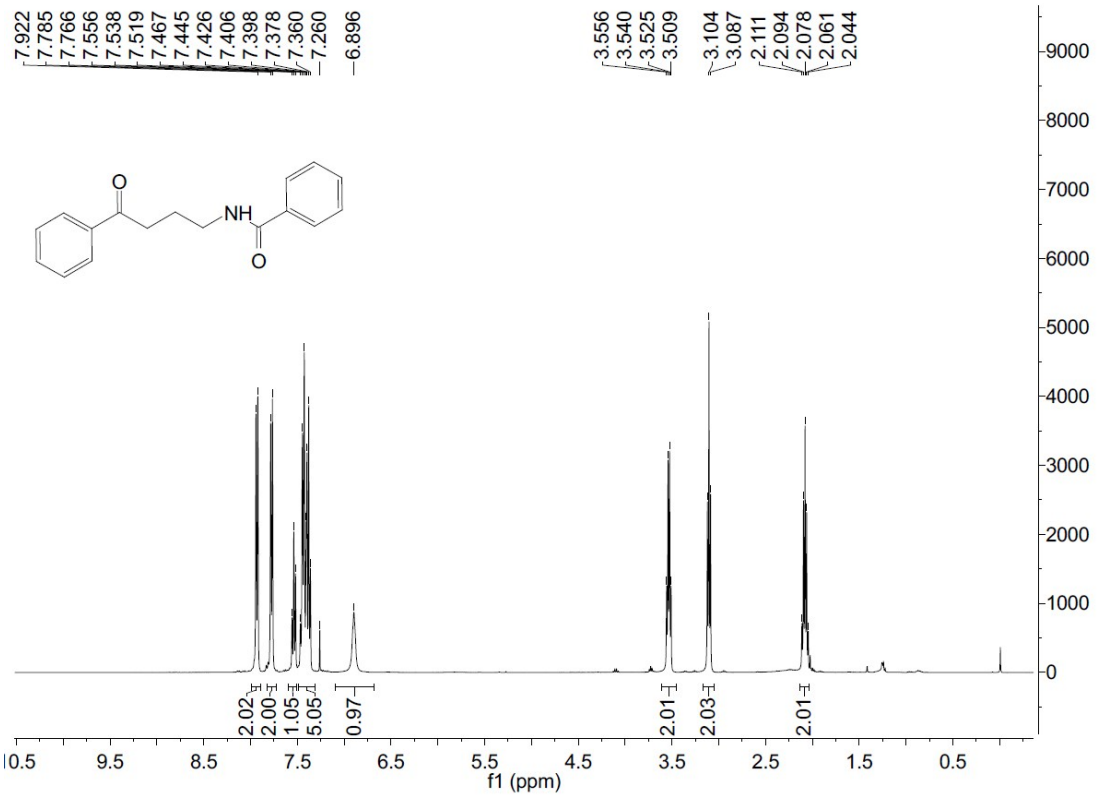
11b-Phenyl-1,2,3,11b-tetrahydrobenzo[4,5]thieno[3,2-g]indolizin-5(6H)-one 4ax. White solid, m.p: 175–177 °C. IR (KBr): 2923, 1646, 1508, 1407, 1231, 1160, 833, 671 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 7.9 Hz, 1H), 7.54 (d, *J* = 7.7 Hz, 1H), 7.42–7.28 (m, 6H), 7.23 (t, *J* = 7.2 Hz, 1H), 3.95–3.82 (m, 2H), 3.67 (t, *J* = 10.7 Hz, 1H), 3.55 (d, *J* = 19.5 Hz, 1H), 2.85 (dd, *J* = 11.8, 6.4 Hz, 1H), 2.45–2.36 (m, 1H), 2.08–2.01 (m, 1H), 1.78–1.65 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.03, 142.11, 139.29, 138.99, 136.93, 128.82, 127.45, 125.47, 124.93, 124.67, 124.66, 122.63, 121.25, 69.88, 44.67, 40.11, 32.38, 20.80. HRMS (ESI) calc. $C_{20}H_{17}NOS$ $[M+Na]^+$:

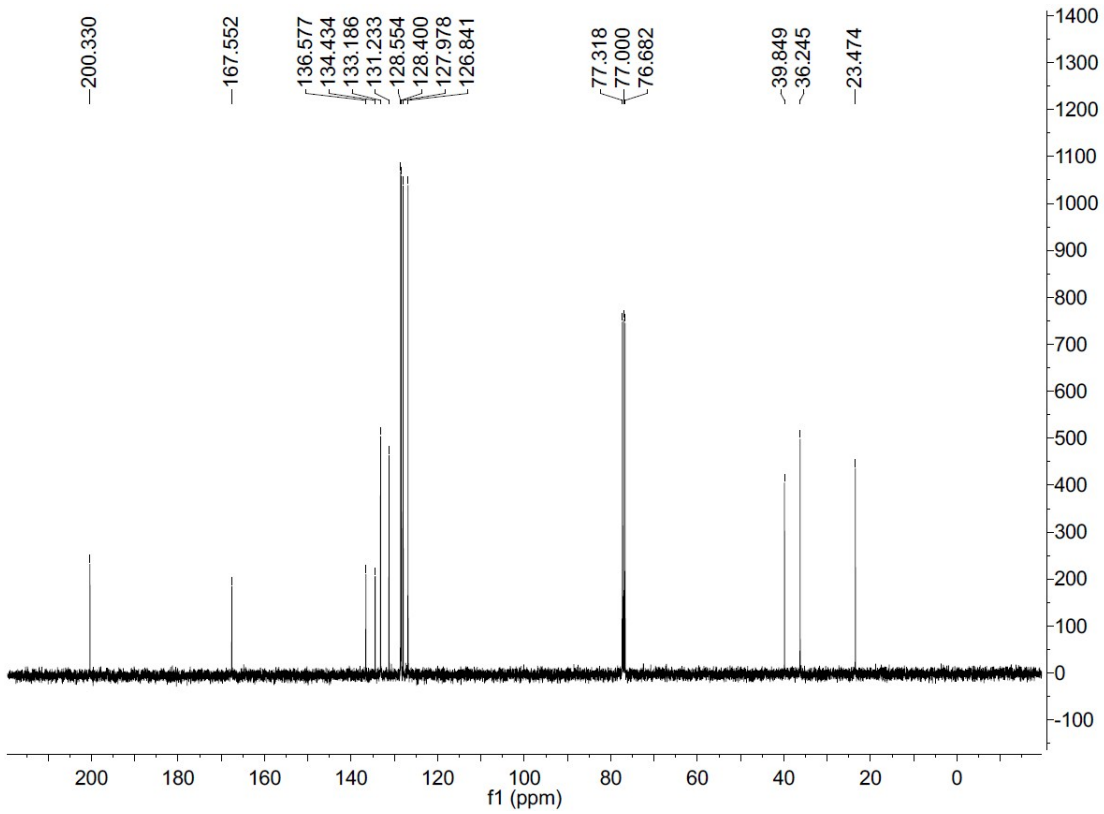
342.0929, found: 342.0923.

7,8a-Diphenylhexahydroindolizin-5(1H)-one 5. Yellowish oil. IR (KBr): 2930, 1647, 1418, 763, 701 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.5 Hz, 2H), 7.29–7.17 (m, 6H), 7.06 (d, *J* = 7.1 Hz, 2H), 4.01 (dd, *J* = 20.7, 8.6 Hz, 1H), 3.46 (t, *J* = 10.2 Hz, 1H), 2.70–2.62 (m, 2H), 2.52–2.38 (m, 2H), 2.28–2.21 (m, 1H), 2.16–2.06 (m, 1H), 1.90–1.84 (m, 2H), 1.58–1.48 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.15, 146.56, 143.13, 128.83, 128.62, 126.90, 126.75, 126.70, 124.47, 68.16, 44.69, 44.30, 40.75, 39.59, 37.74, 20.32. MS (EI) m/z: 77, 91, 103, 131, 186, 214, 262, 291. Anal. calcd. for $C_{20}H_{21}NO$: C 82.44, H 7.26, found: C 82.57, H 7.23.

D. ^{1}H and ^{13}C NMR spectra

4aa





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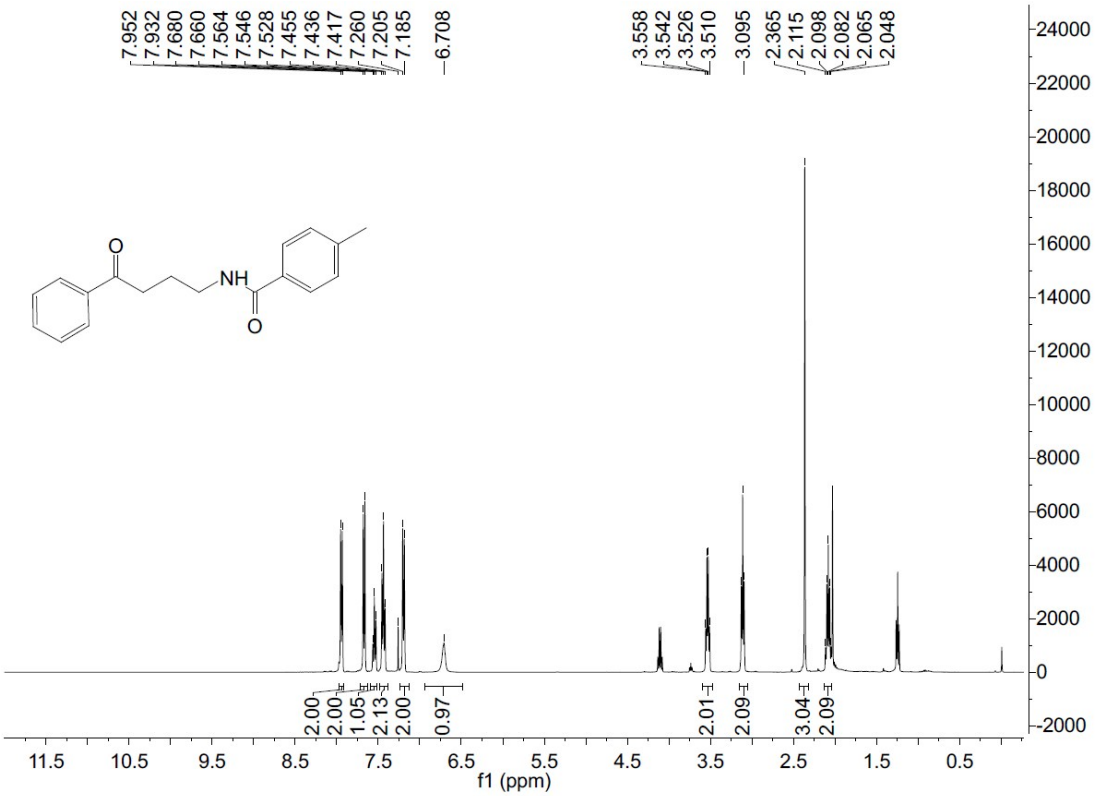
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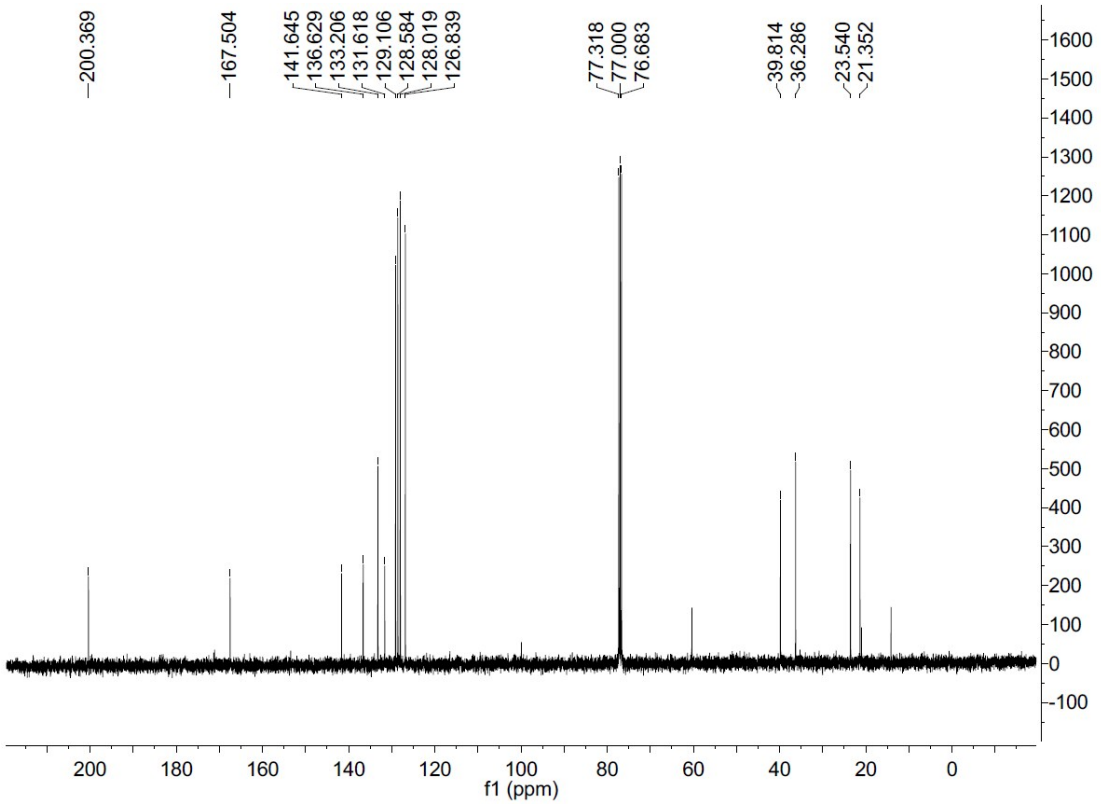
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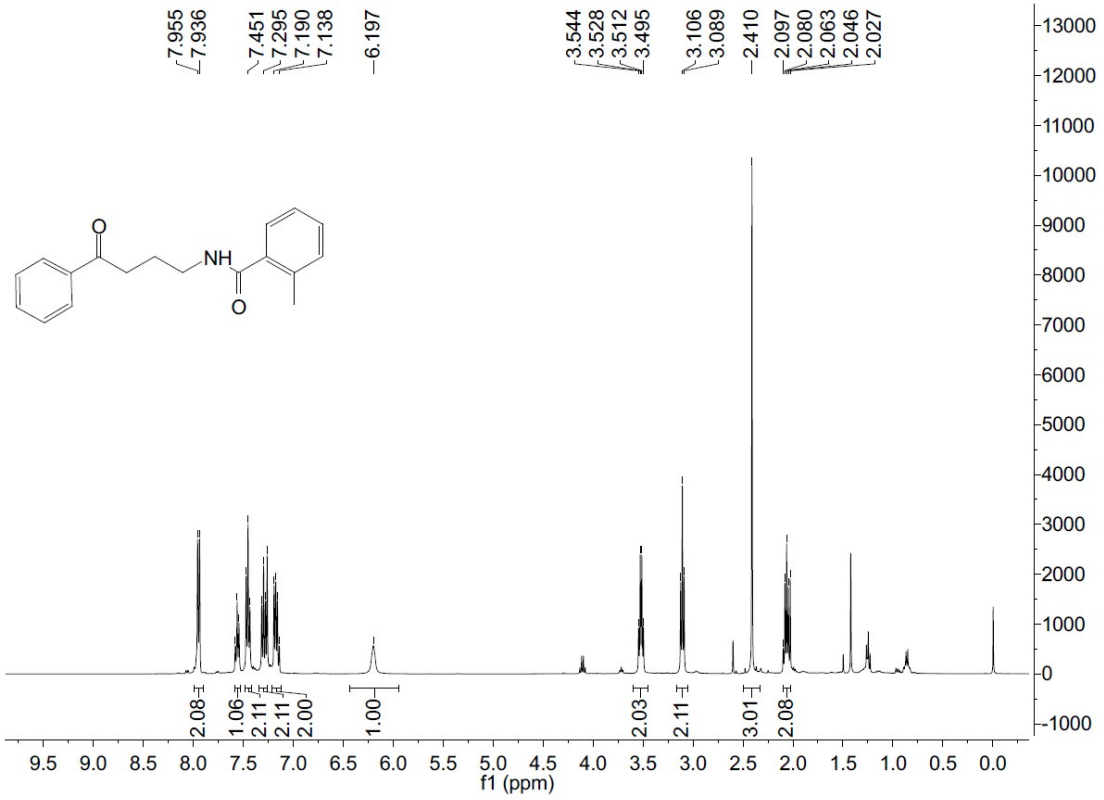
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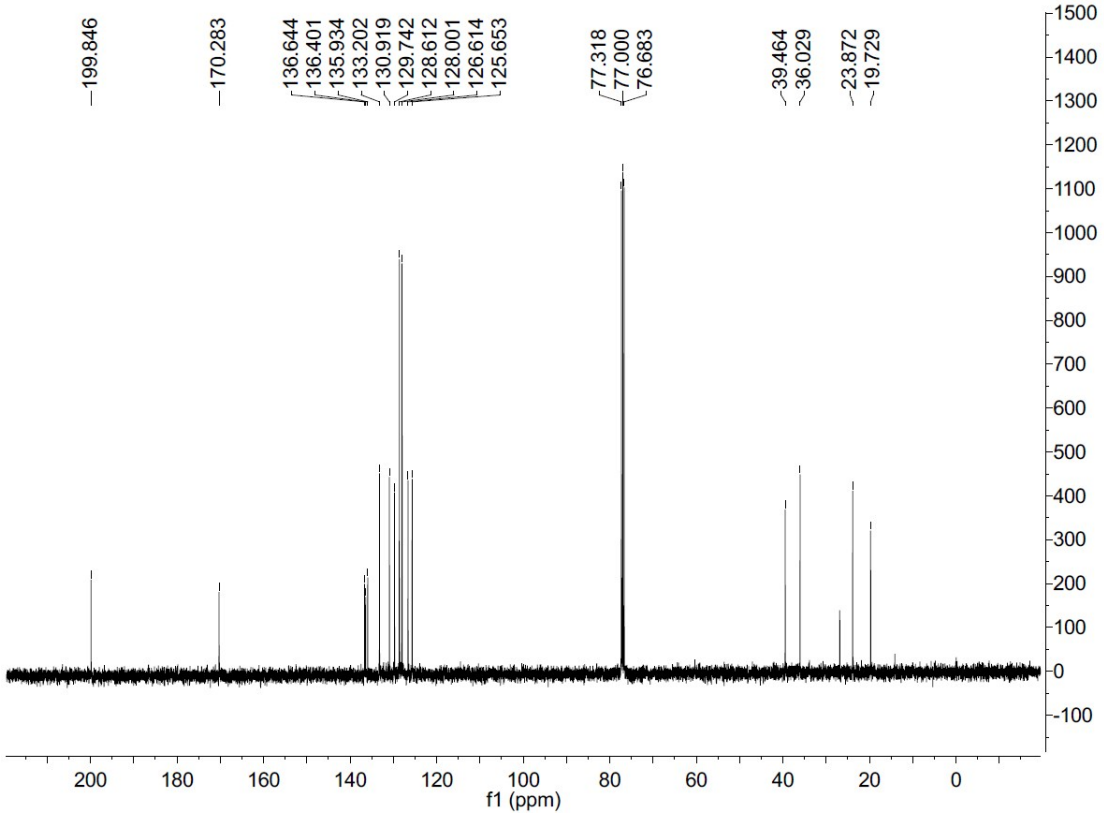
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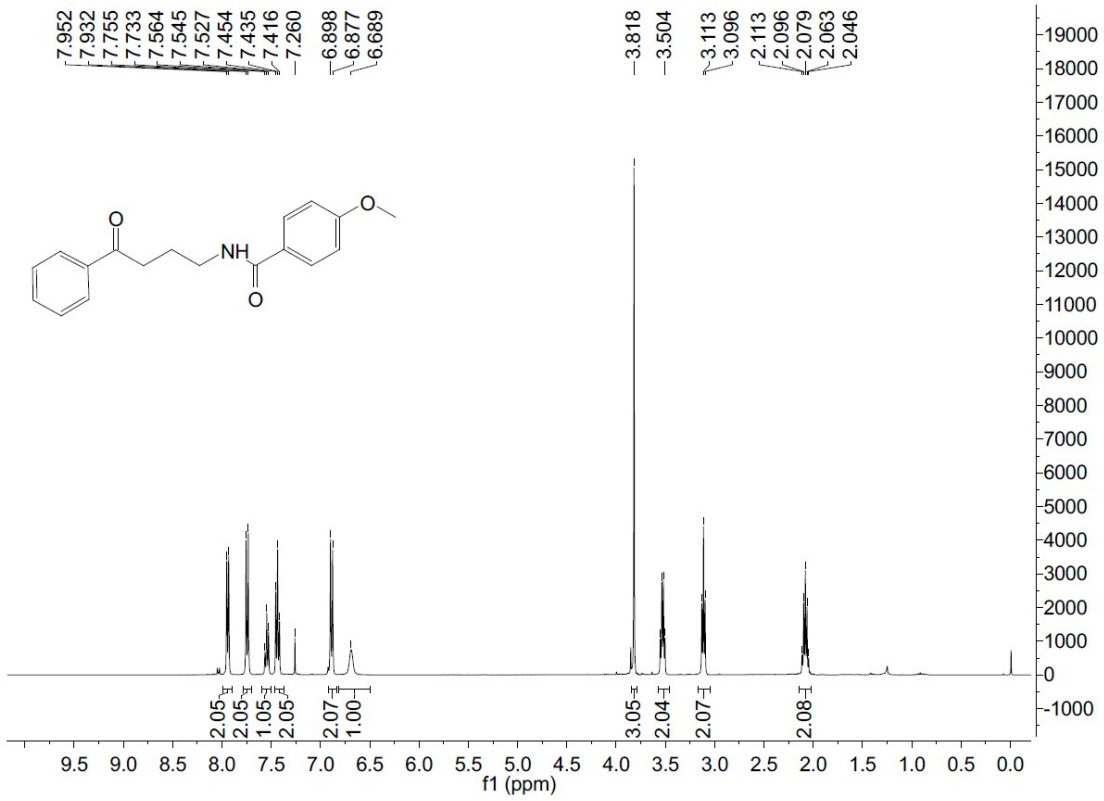
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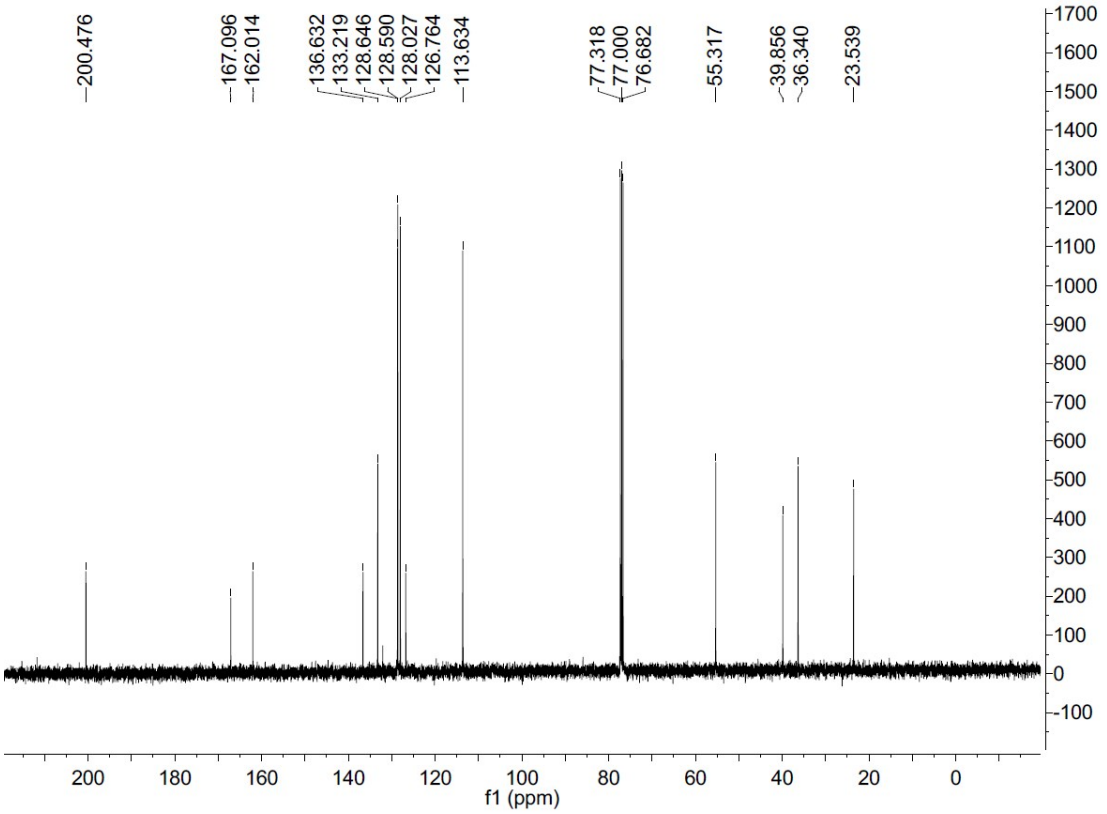
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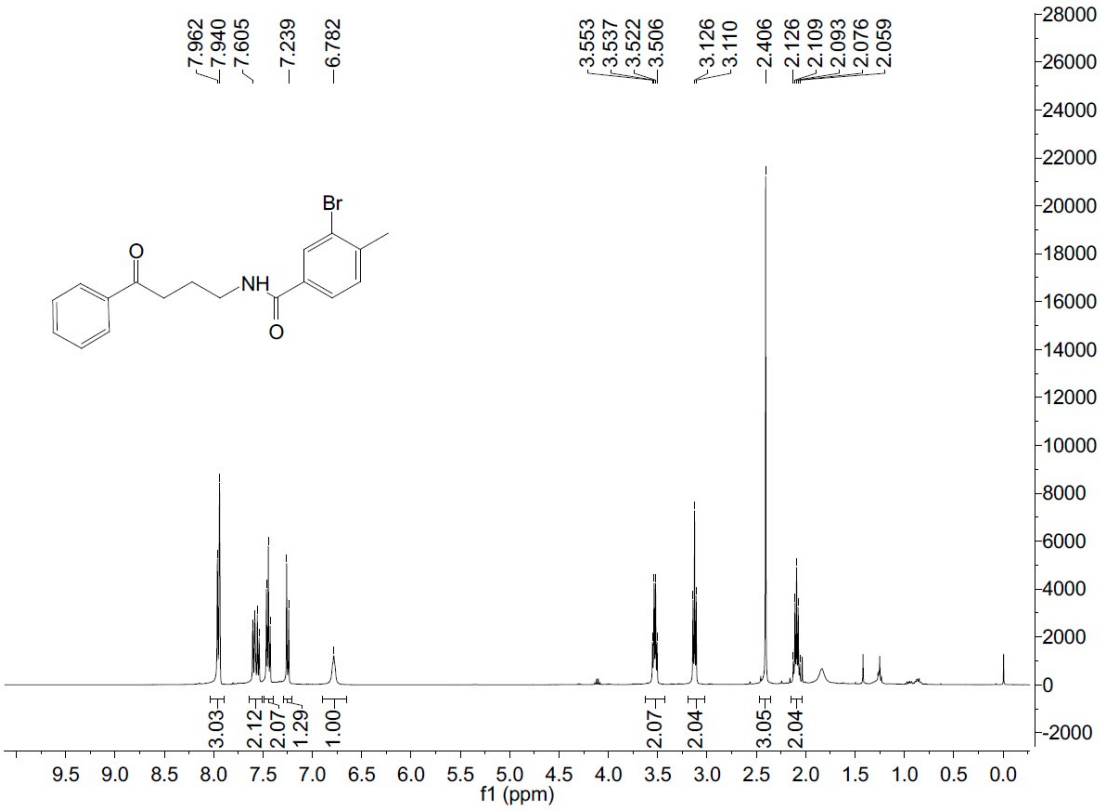
4ae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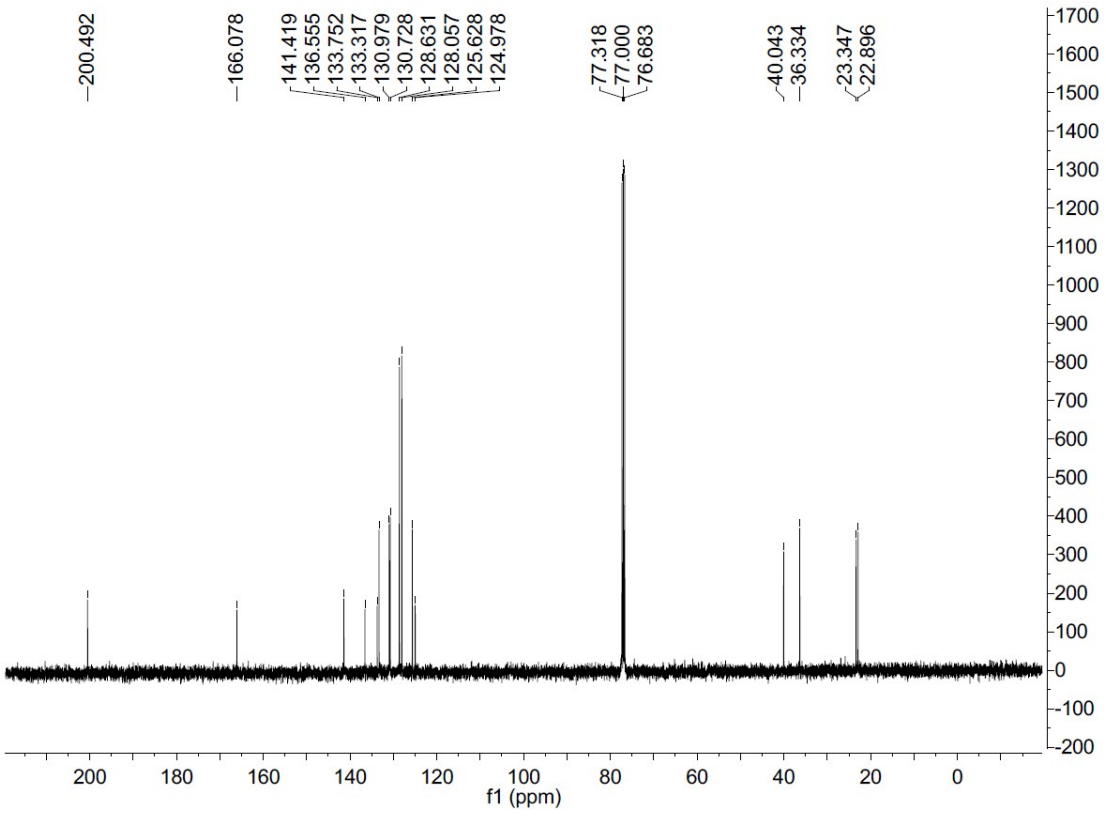
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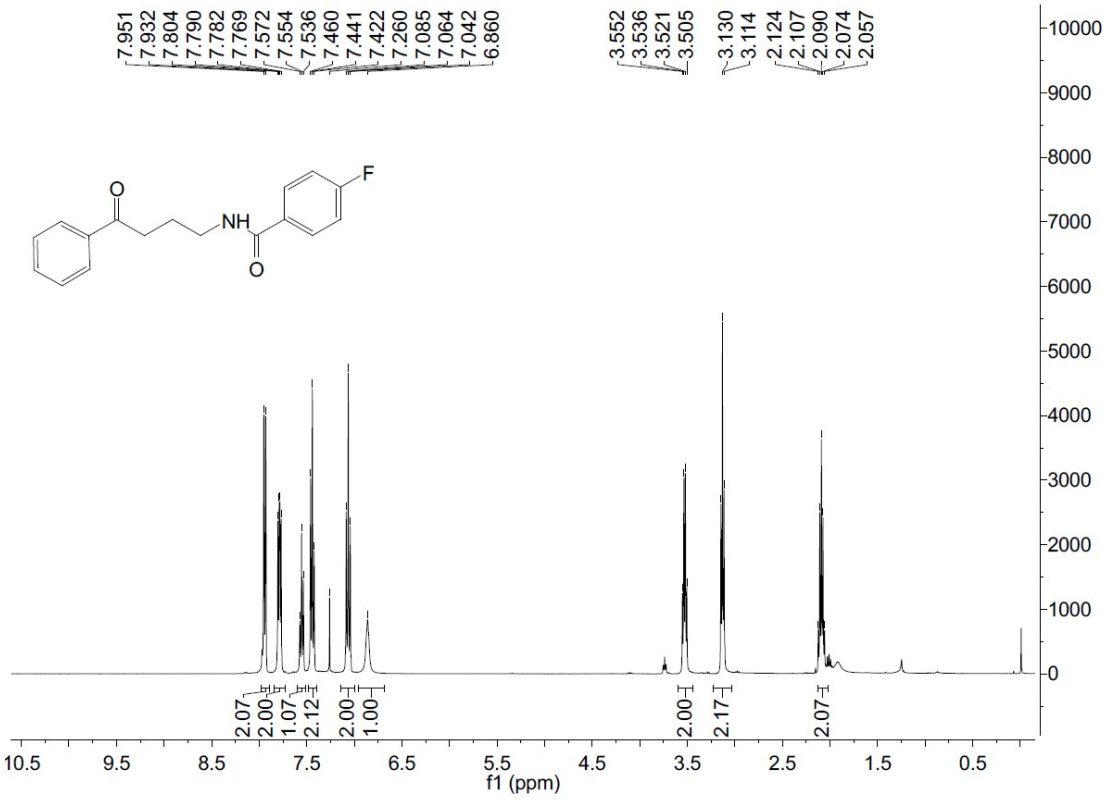
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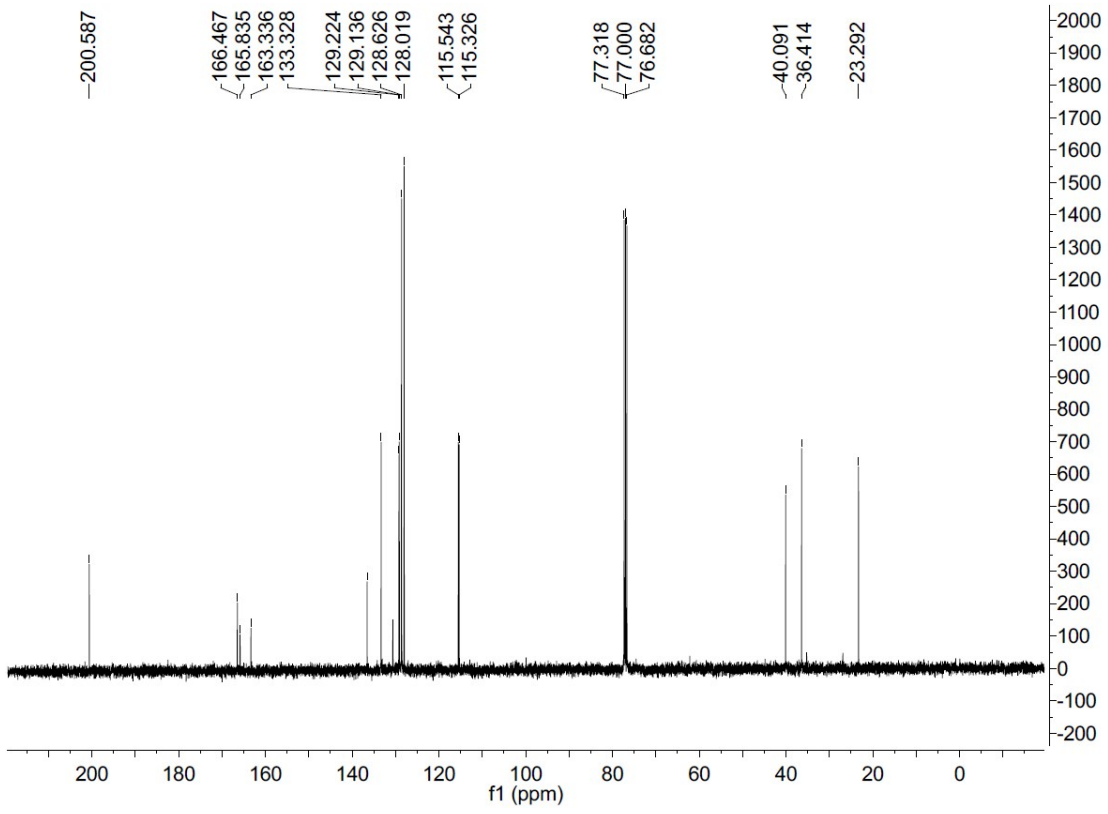
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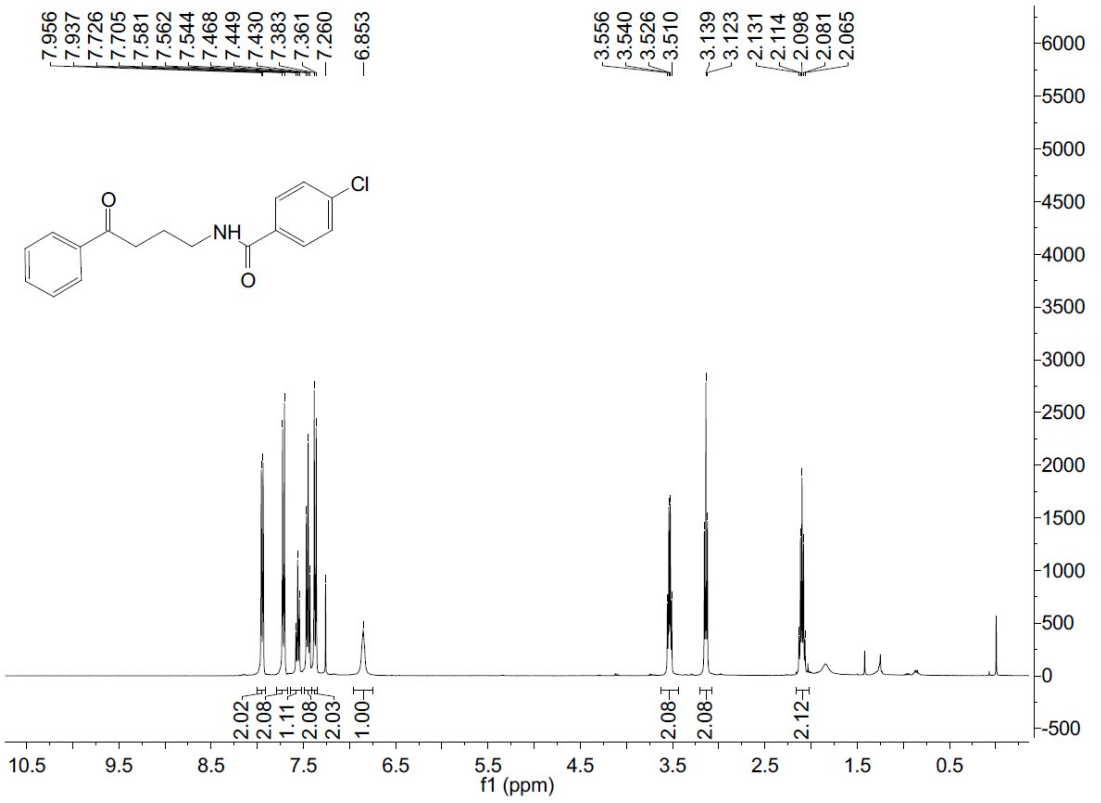
4ag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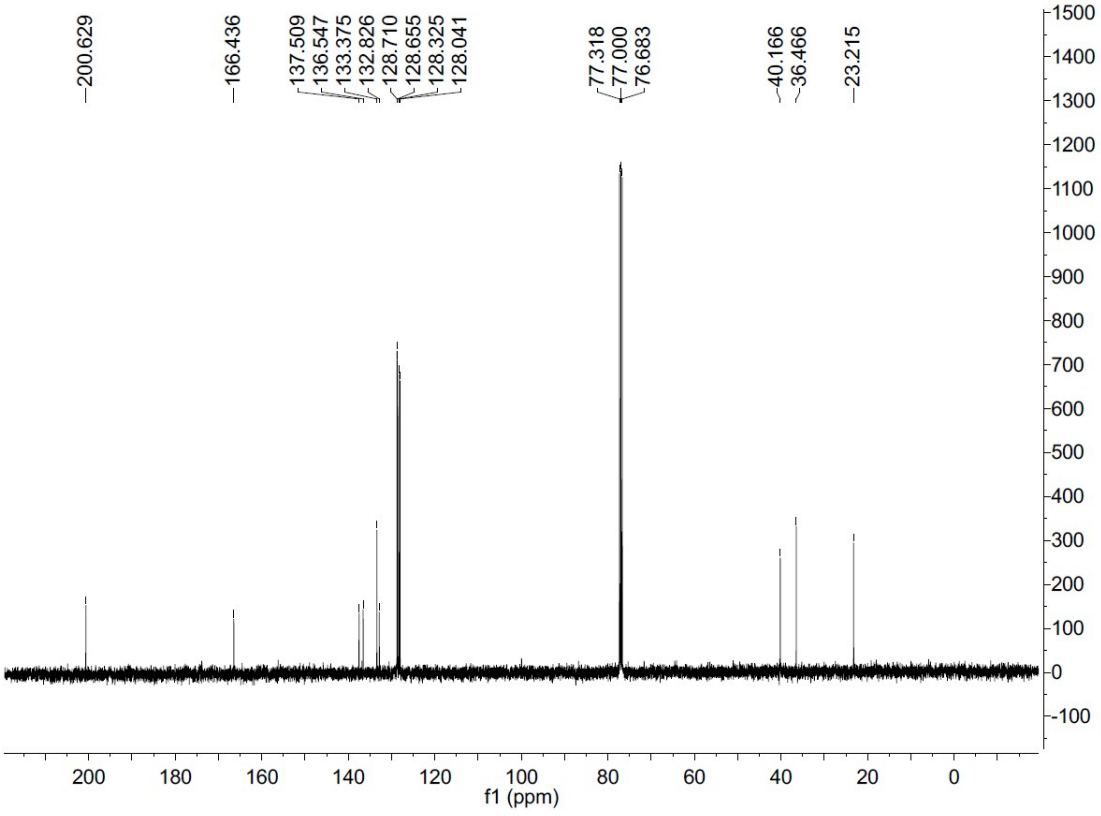
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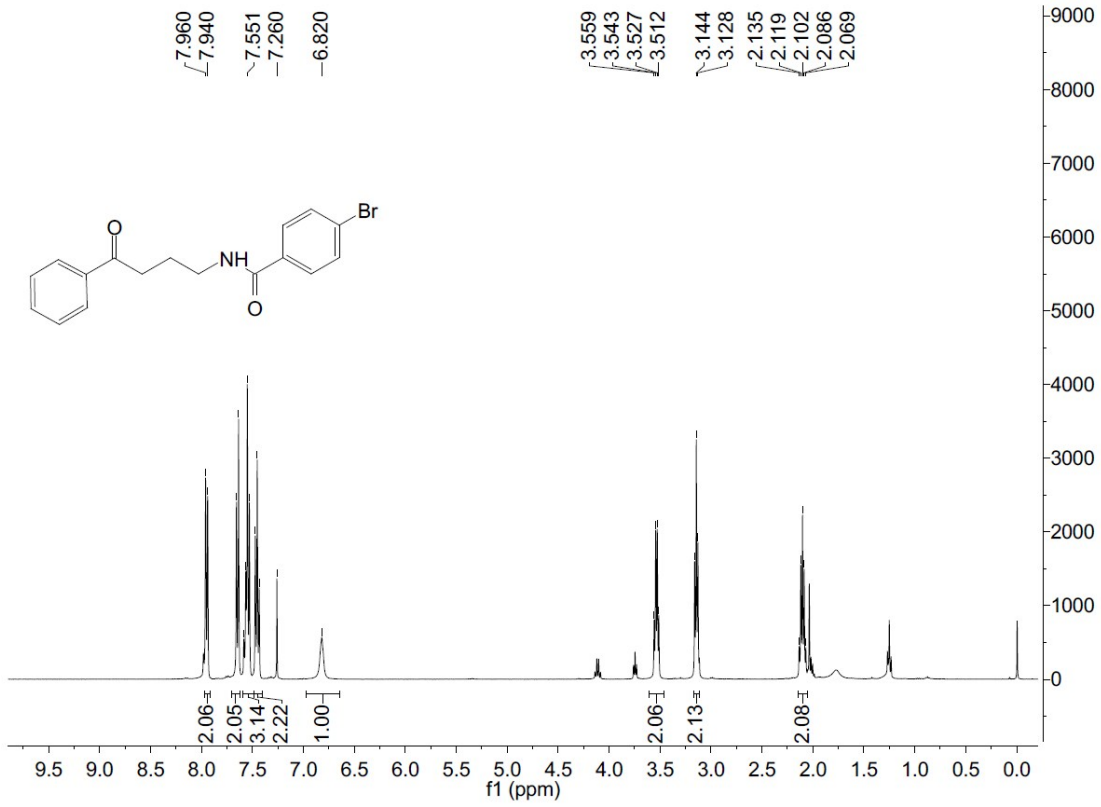
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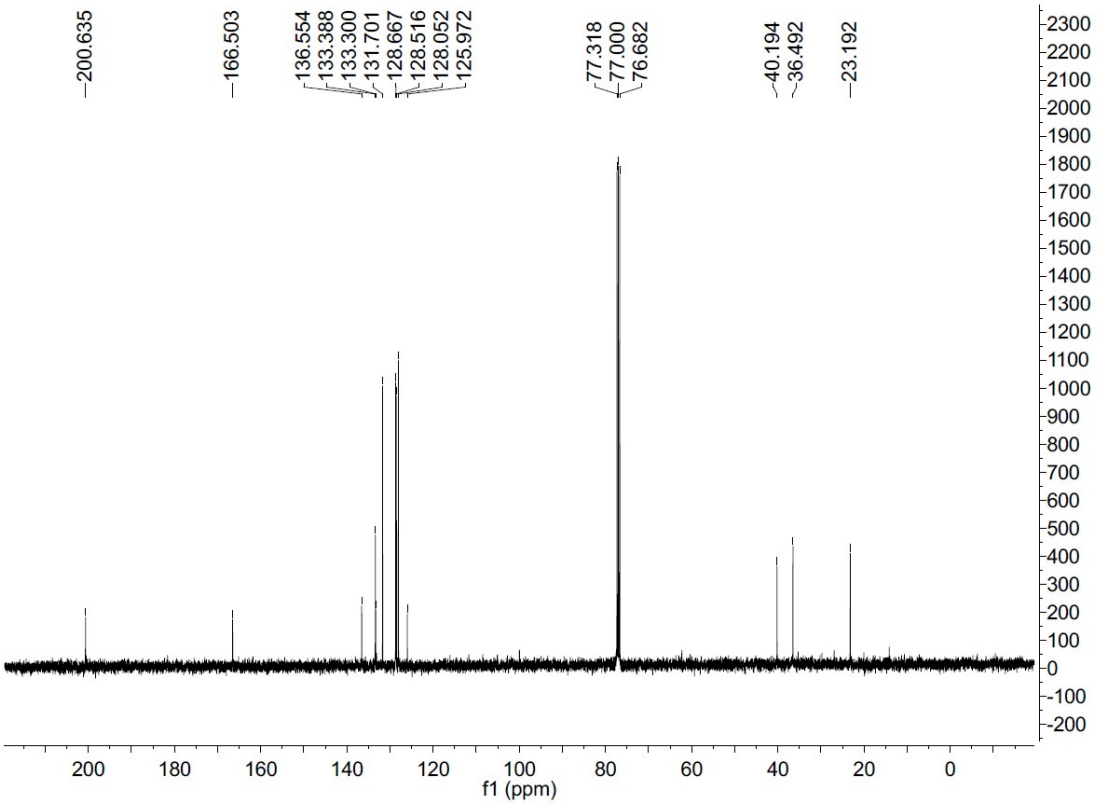
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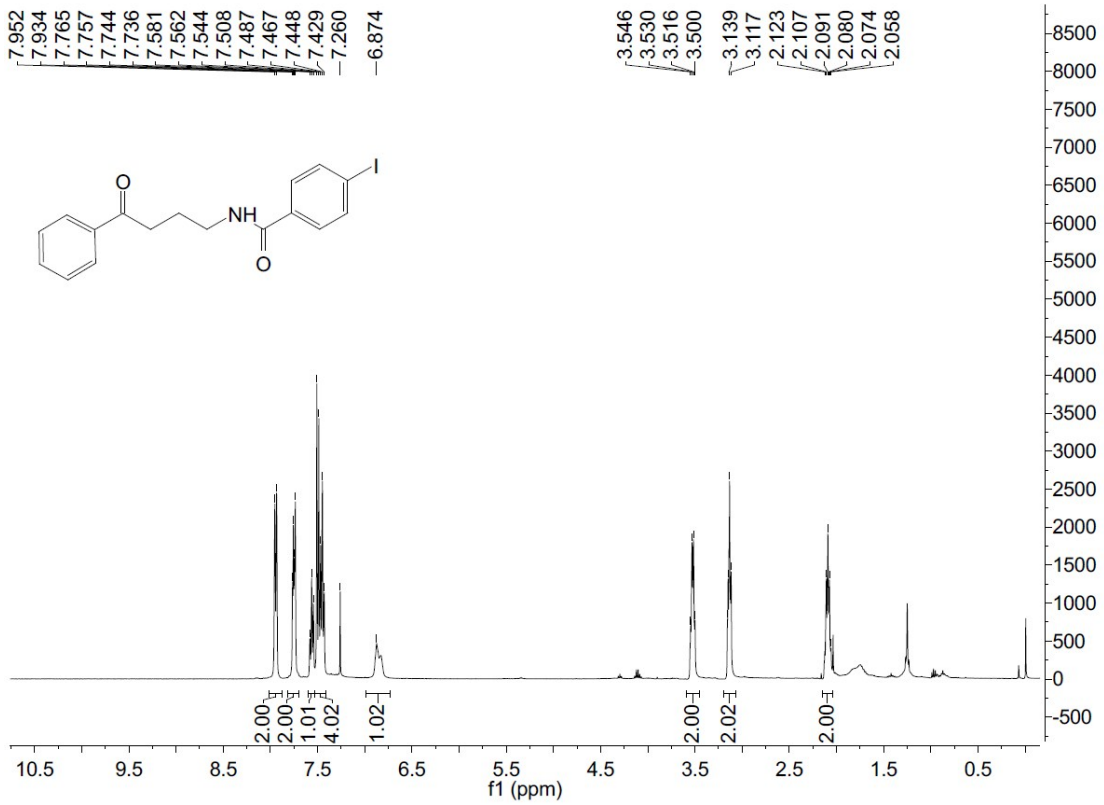
4ai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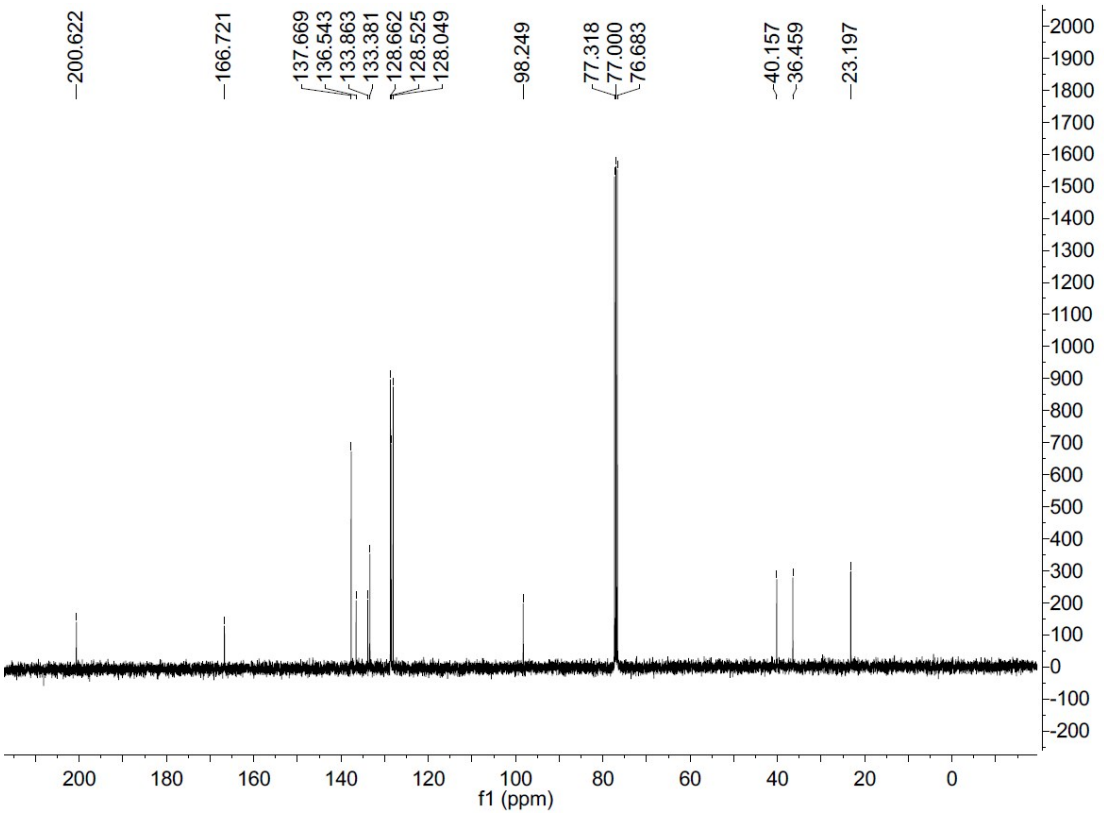
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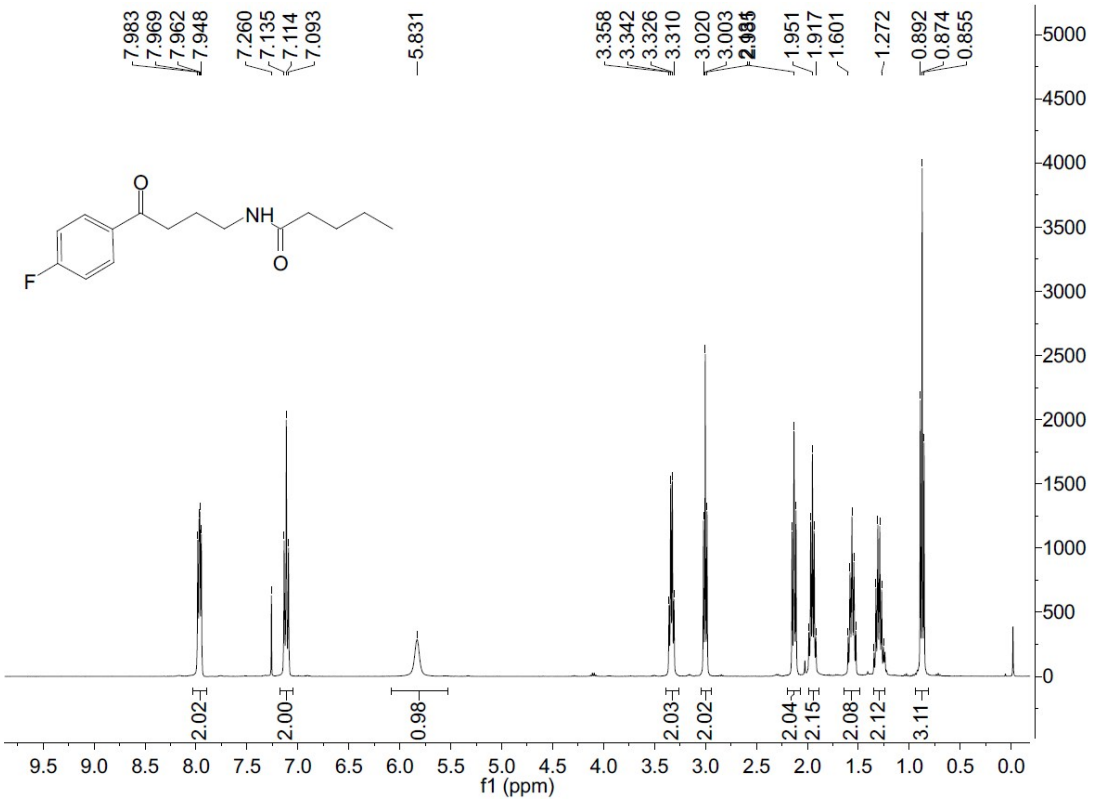
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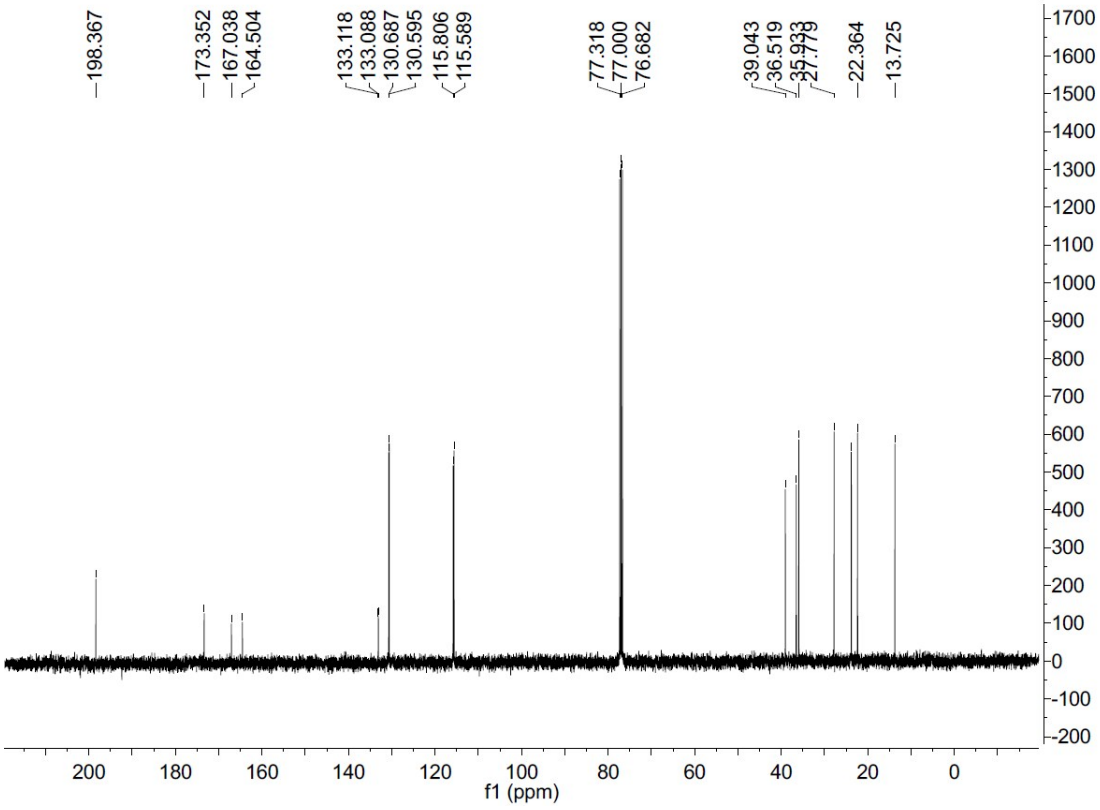
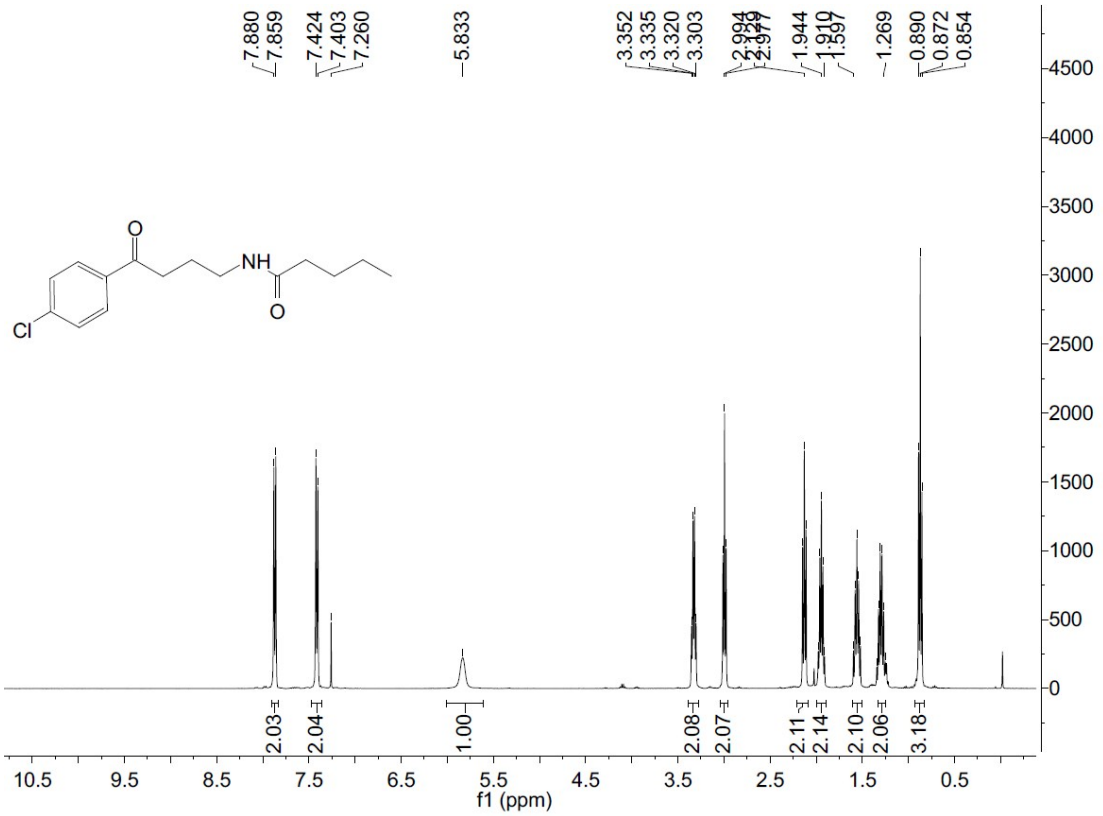
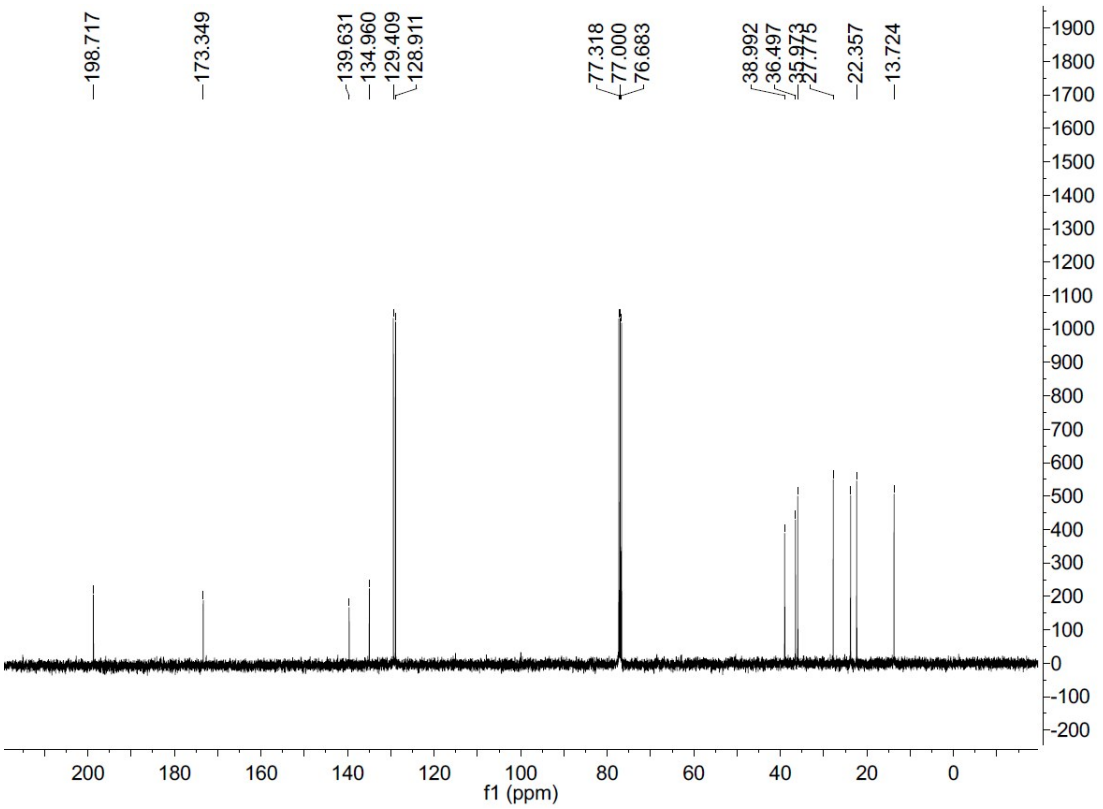
O
NH
O
F
2.02
2.00
0.98
2.03
2.02
2.04
2.15
2.08
2.12
3.11
f1 (ppm)

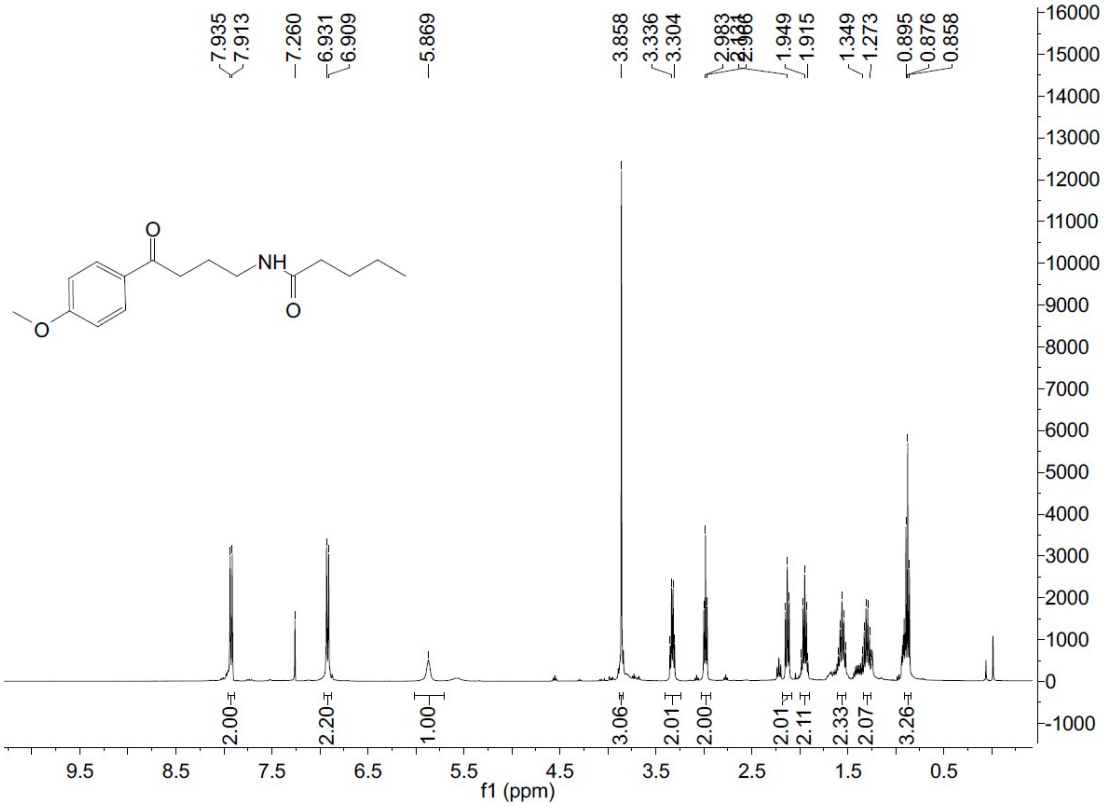

198.367
173.352
167.038
164.504
133.118
133.088
130.687
130.595
115.806
115.589
77.318
77.000
76.682
39.043
36.519
35.933
27.779
22.364
13.725
f1 (ppm)

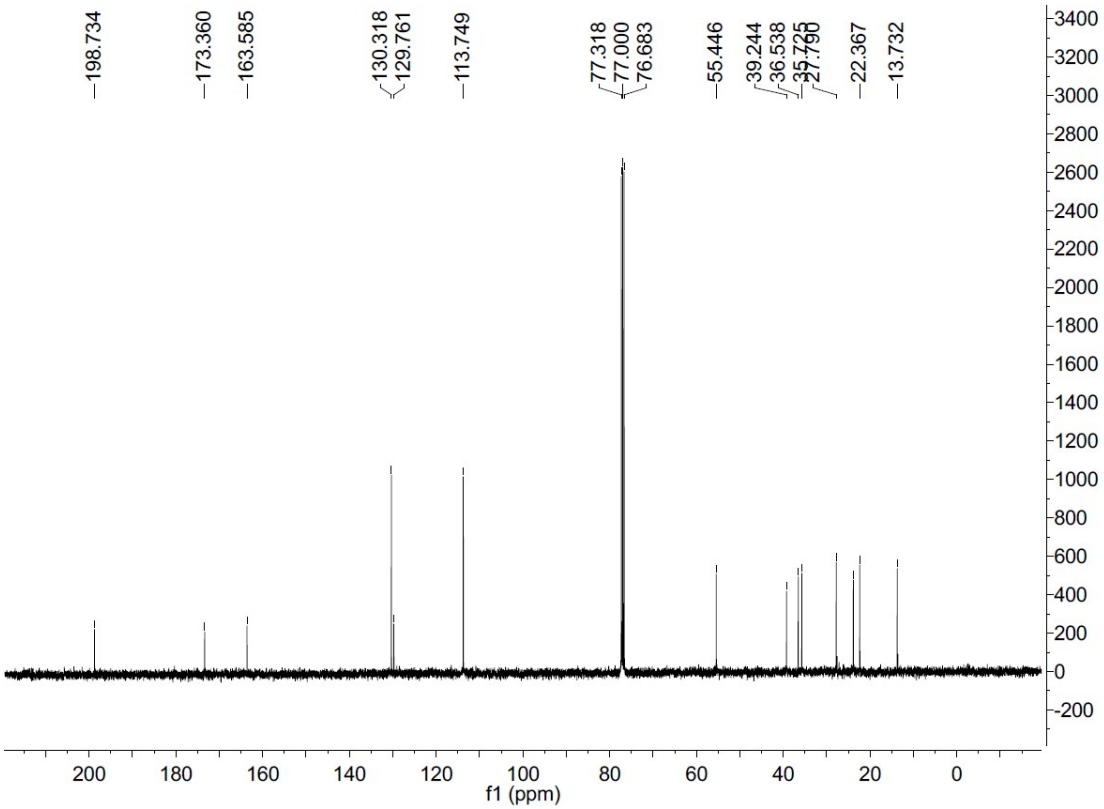
4cj


7.880
7.859
7.424
7.403
7.260
5.833
3.352
3.335
3.320
3.303
1.944
1.910
1.269
0.890
0.872
0.854
O
NH
O
Cl
2.03
2.04
1.00
2.08
2.07
2.11
2.14
2.10
2.06
3.18
f1 (ppm)

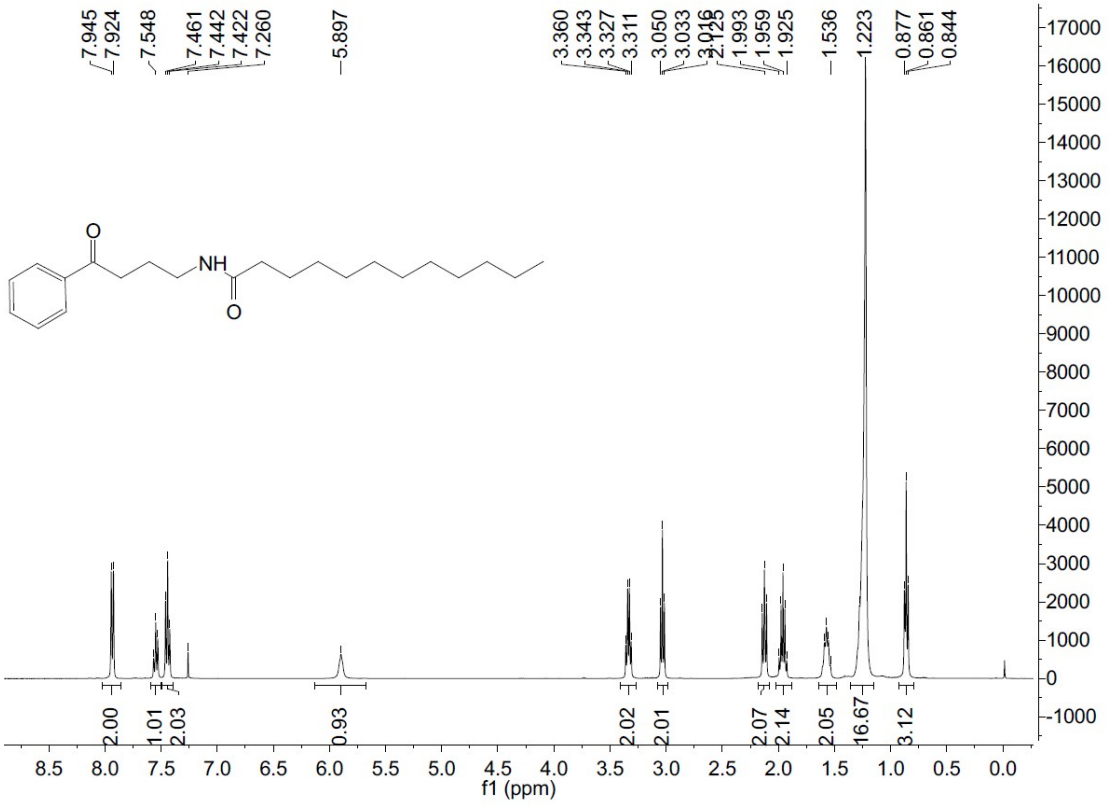

198.717
173.349
139.631
134.960
129.409
128.911
77.318
77.000
76.683
38.992
36.497
35.973
27.775
22.357
13.724
f1 (ppm)

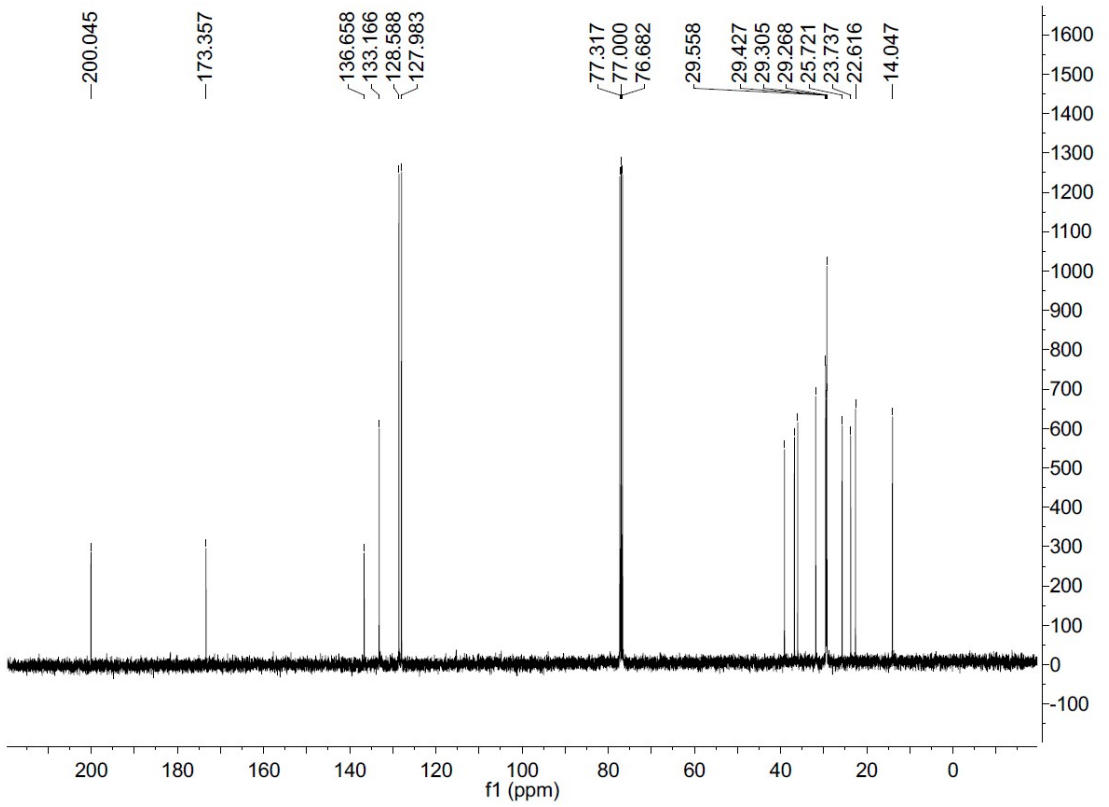
4dj


7.935
7.913
7.260
6.931
6.909
5.869
3.858
3.336
3.304
2.983
1.949
1.915
1.349
1.273
0.895
0.876
0.858
NH
O
O
O
2.00
2.20
1.00
3.06
2.01
2.00
2.01
2.11
2.33
2.07
3.26
f1 (ppm)

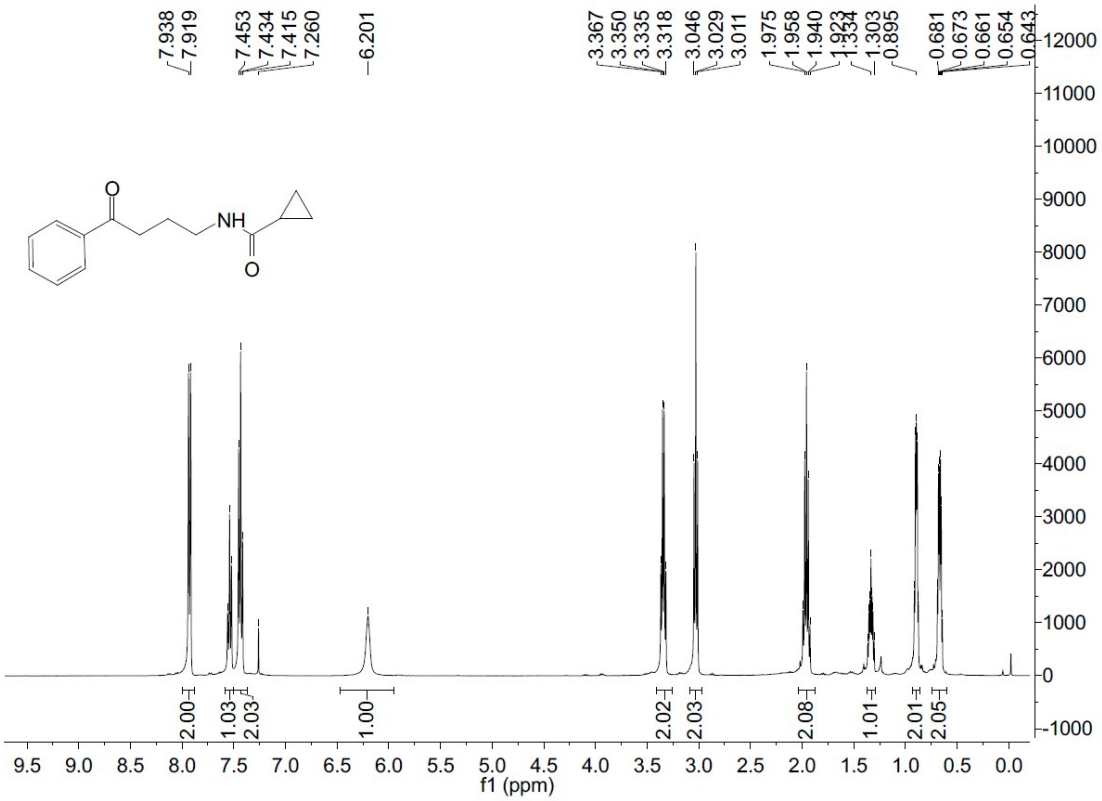

198.734
173.360
163.585
130.318
129.761
113.749
77.318
77.000
76.683
55.446
39.244
36.538
22.367
13.732
f1 (ppm)

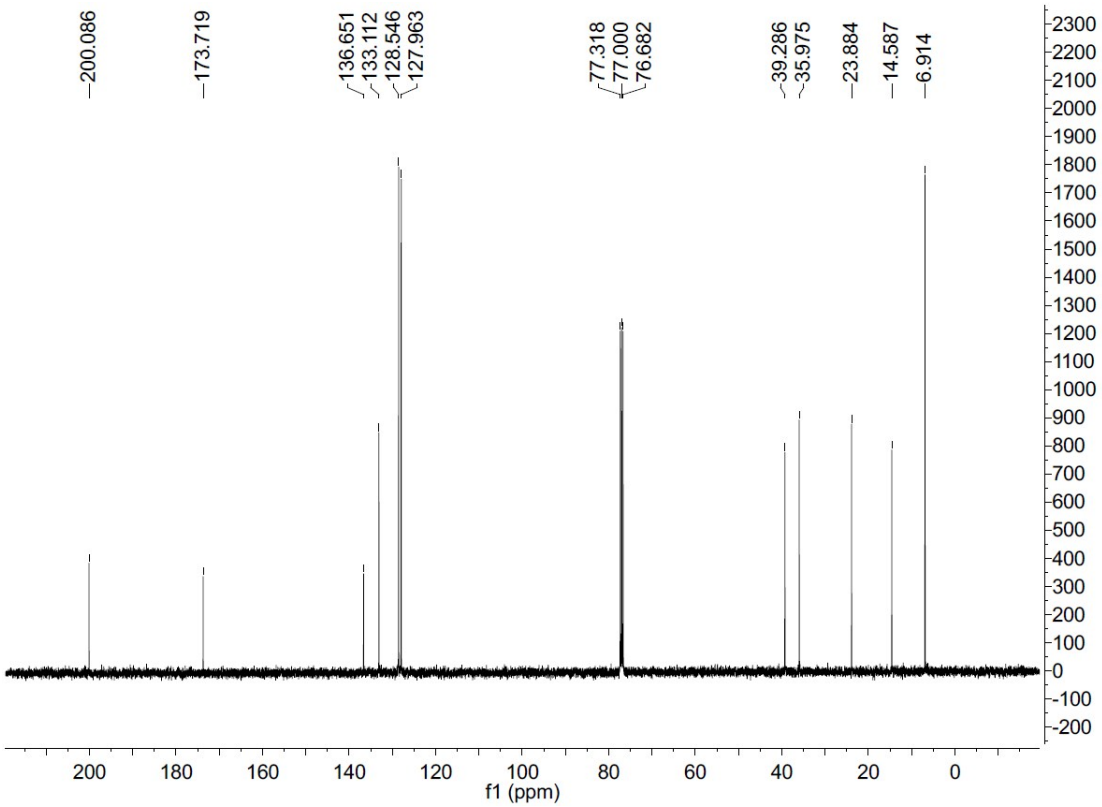
4ak


7.945
7.924
7.548
7.461
7.442
7.422
7.260
5.897
3.360
3.343
3.327
3.311
3.050
3.033
1.993
1.959
1.925
1.536
1.223
0.877
0.861
0.844
O
NH
O
2.00
1.01
2.03
0.93
2.02
2.01
2.07
2.14
2.05
16.67
3.12
f1 (ppm)

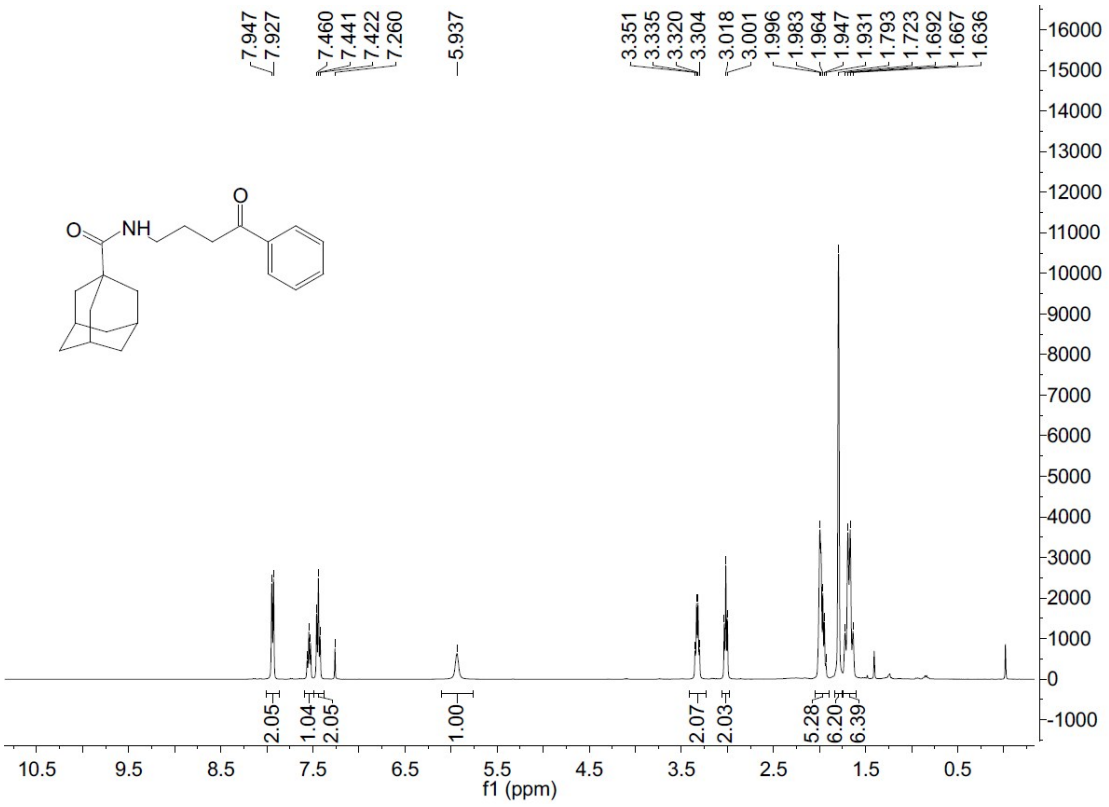

200.045
173.357
136.658
133.166
128.588
127.983
77.317
77.000
76.682
29.558
29.427
29.305
29.268
25.721
23.737
22.616
14.047
f1 (ppm)

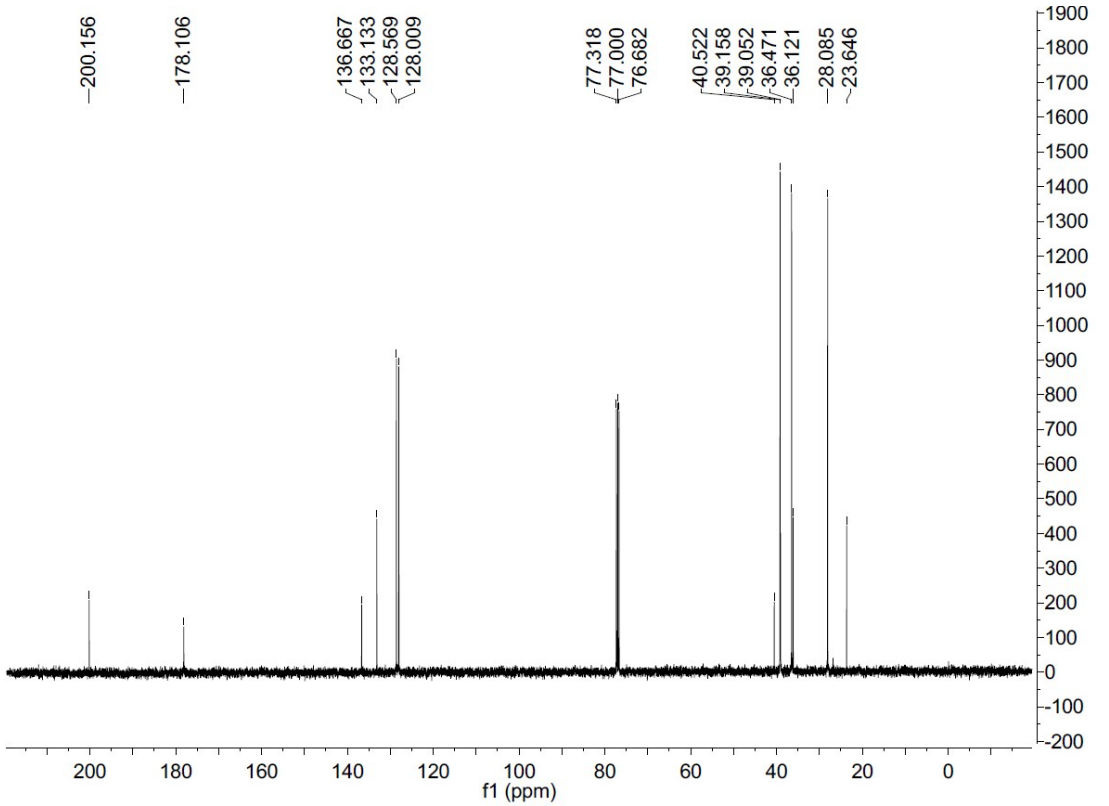
4al


7.938
7.919
7.453
7.434
7.415
7.260
6.201
3.367
3.350
3.335
3.318
3.046
3.029
3.011
1.975
1.958
1.940
1.923
1.334
1.303
0.895
0.681
0.673
0.661
0.654
0.643
O
NH
O
2.00
1.03
2.03
1.00
2.02
2.03
2.08
1.01
2.01
2.05
f1 (ppm)

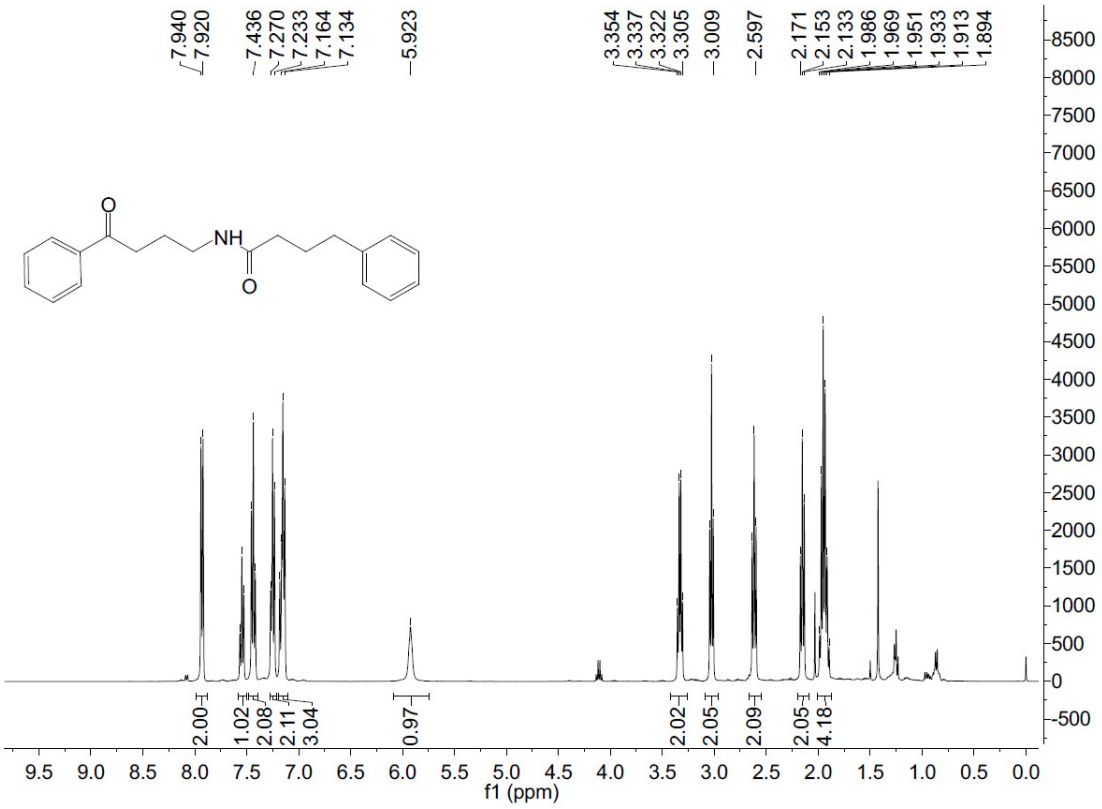

200.086
173.719
136.651
133.112
128.546
127.963
77.318
77.000
76.682
39.286
35.975
23.884
14.587
6.914
f1 (ppm)

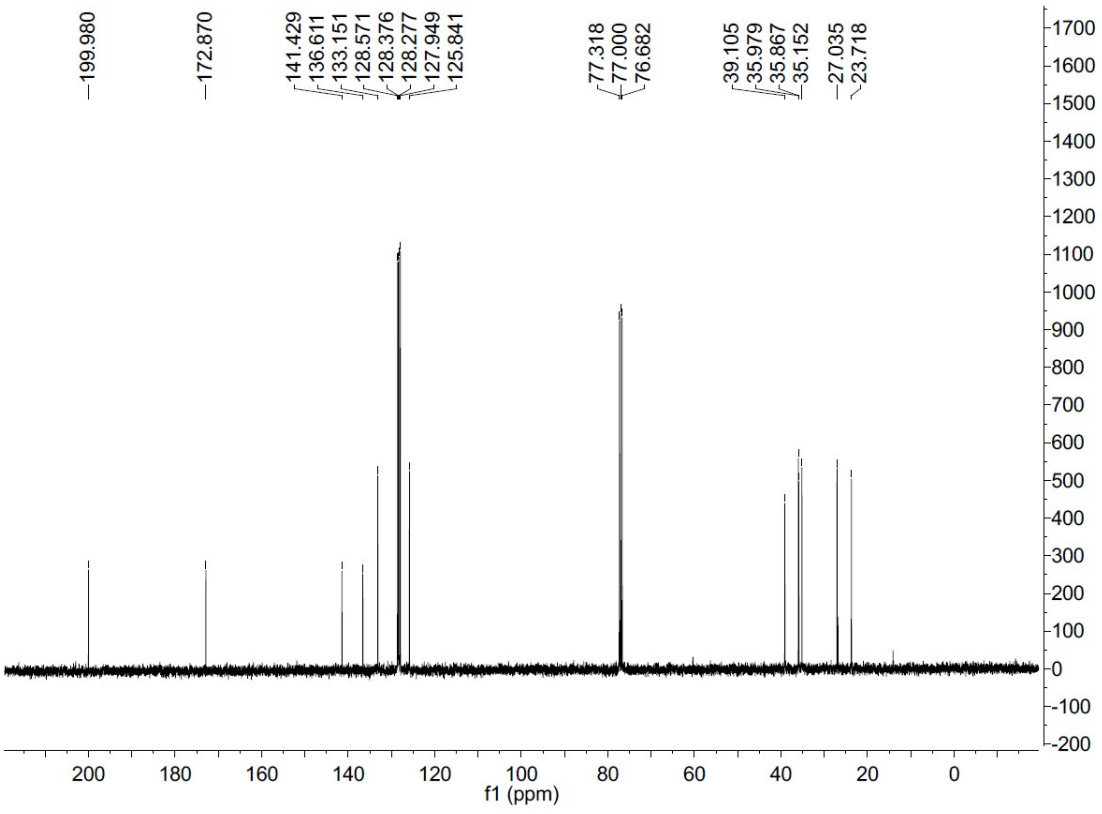
4am


7.947
7.927
7.460
7.441
7.422
7.260
5.937
3.351
3.335
3.320
3.304
3.018
3.001
1.996
1.983
1.964
1.947
1.931
1.793
1.723
1.692
1.667
1.636
O
NH
O
2.05
1.04
2.05
1.00
2.07
2.03
5.28
6.20
6.39
f1 (ppm)

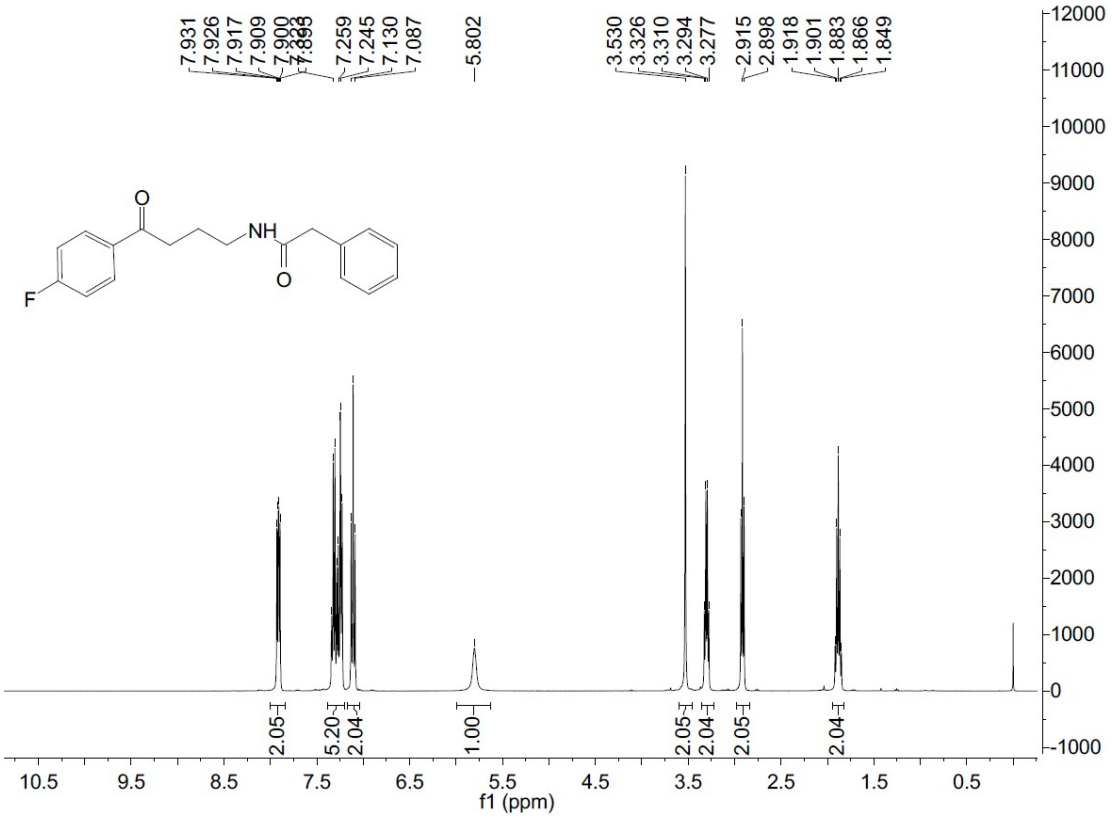

200.156
178.106
136.667
133.133
128.569
128.009
77.318
77.000
76.682
40.522
39.158
39.052
36.471
36.121
28.085
23.646
f1 (ppm)

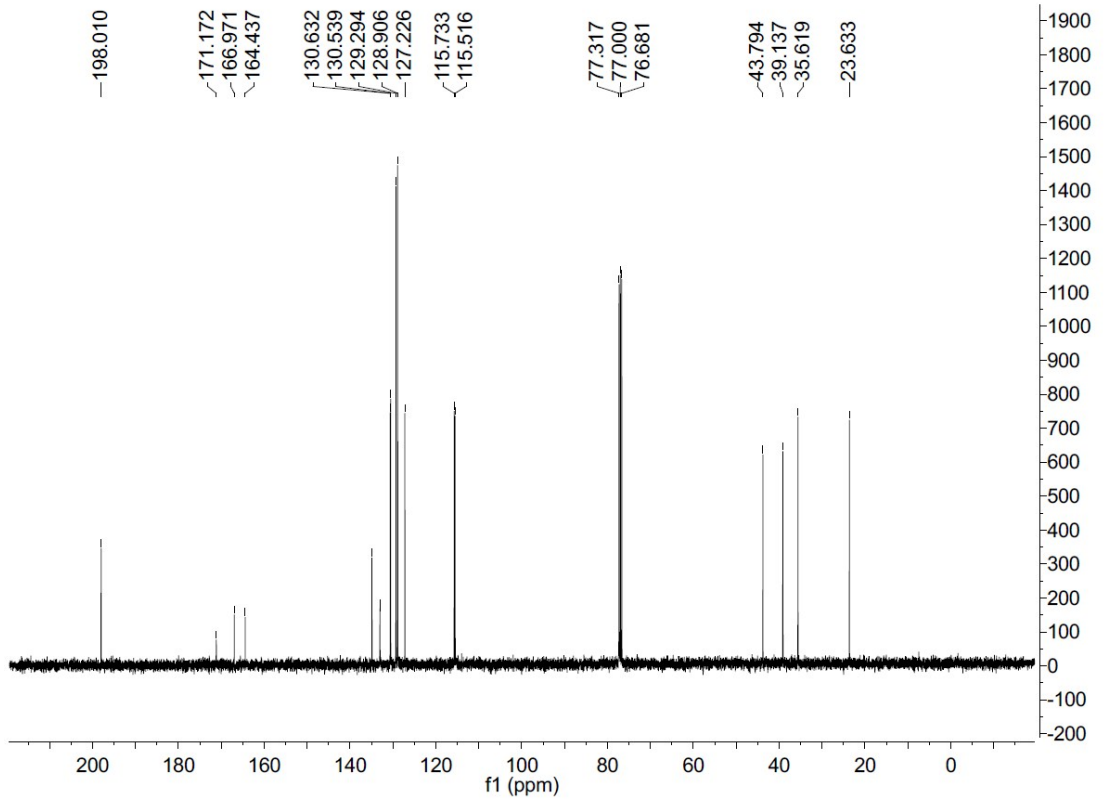
4an


7.940
7.920
7.436
7.270
7.233
7.164
7.134
5.923
3.354
3.337
3.322
3.305
3.009
2.597
2.171
2.153
2.133
1.986
1.969
1.951
1.933
1.913
1.894
O
NH
O
2.00
1.02
2.08
2.11
3.04
0.97
2.02
2.05
2.09
2.05
4.18
f1 (ppm)

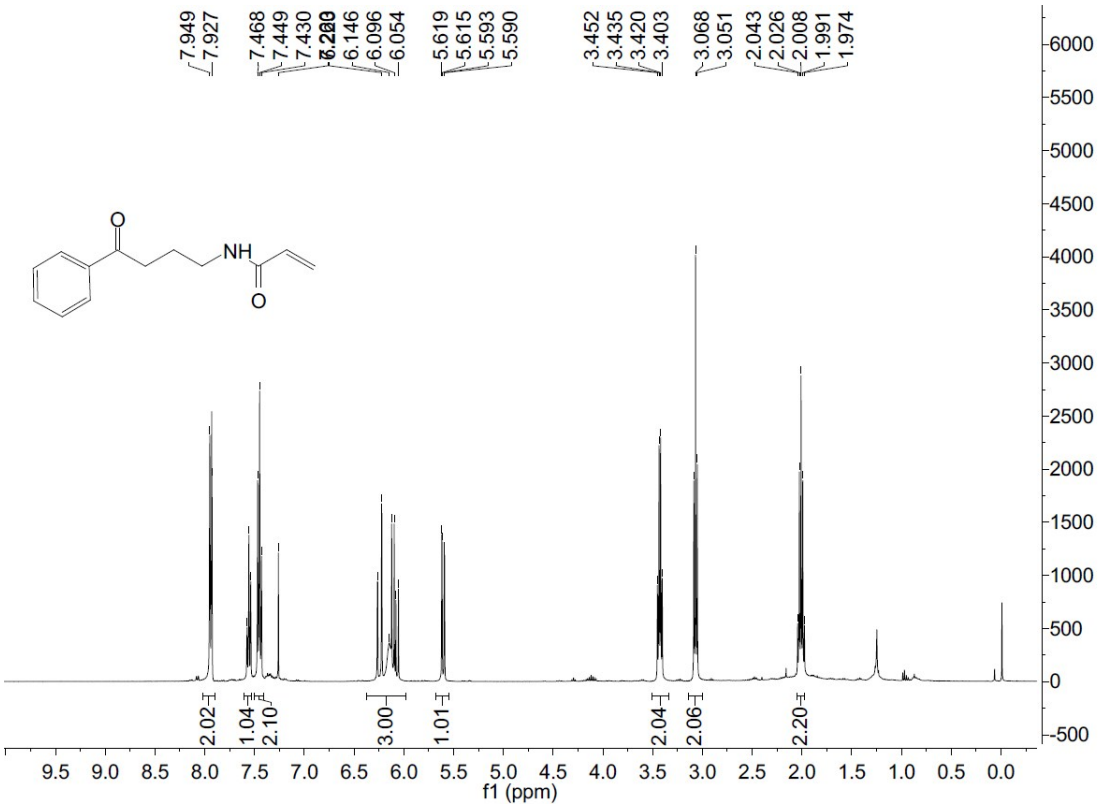

199.980
172.870
141.429
136.611
133.151
128.571
128.376
128.277
127.949
125.841
77.318
77.000
76.682
39.105
35.979
35.867
35.152
27.035
23.718
f1 (ppm)

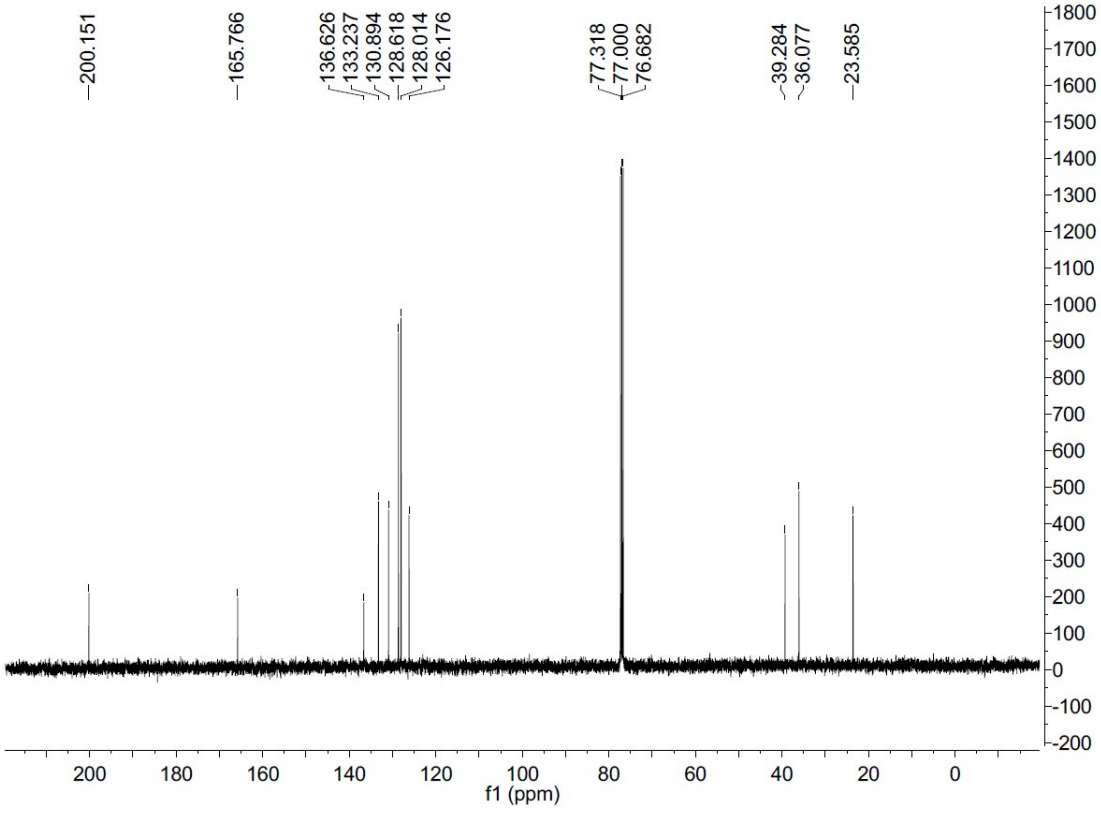
4bo


7.931
7.926
7.917
7.909
7.900
7.259
7.245
7.130
7.087
5.802
3.530
3.326
3.310
3.294
3.277
2.915
2.898
1.918
1.901
1.883
1.866
1.849
O
NH
O
F
2.05
5.20
2.04
1.00
2.05
2.04
2.05
2.04
f1 (ppm)

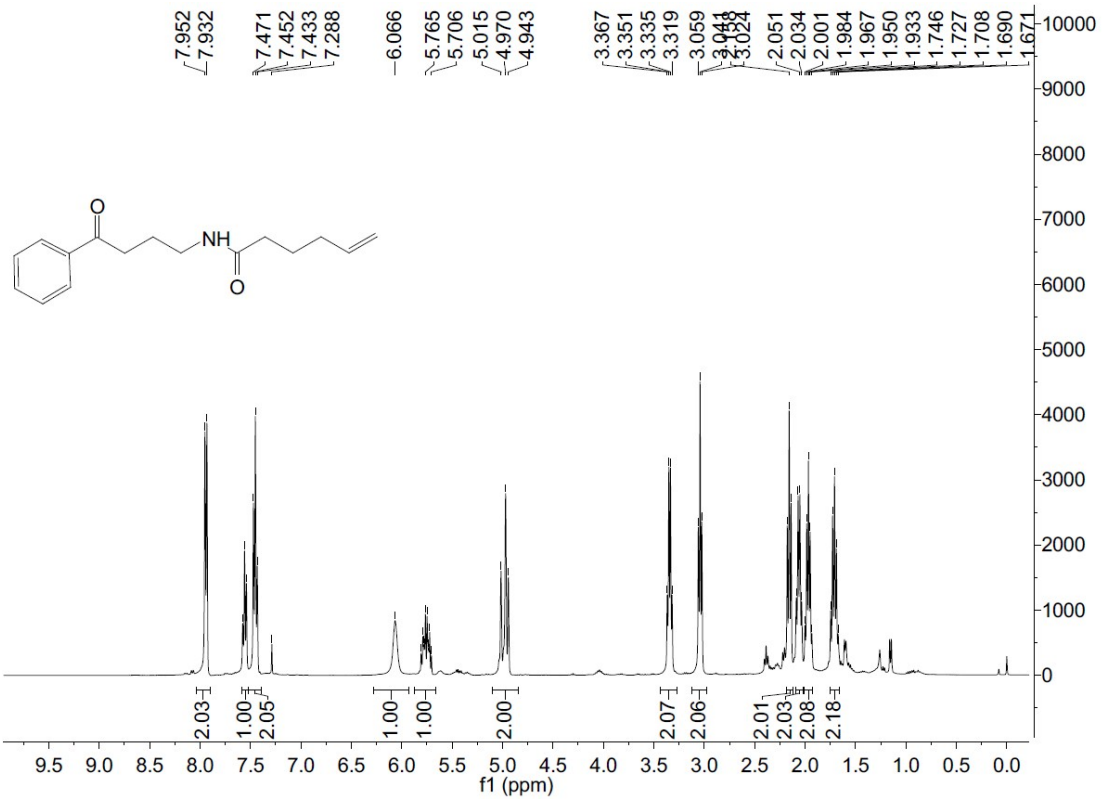

198.010
171.172
166.971
164.437
130.632
130.539
129.294
128.906
127.226
115.733
115.516
77.317
77.000
76.681
43.794
39.137
35.619
23.633
f1 (ppm)

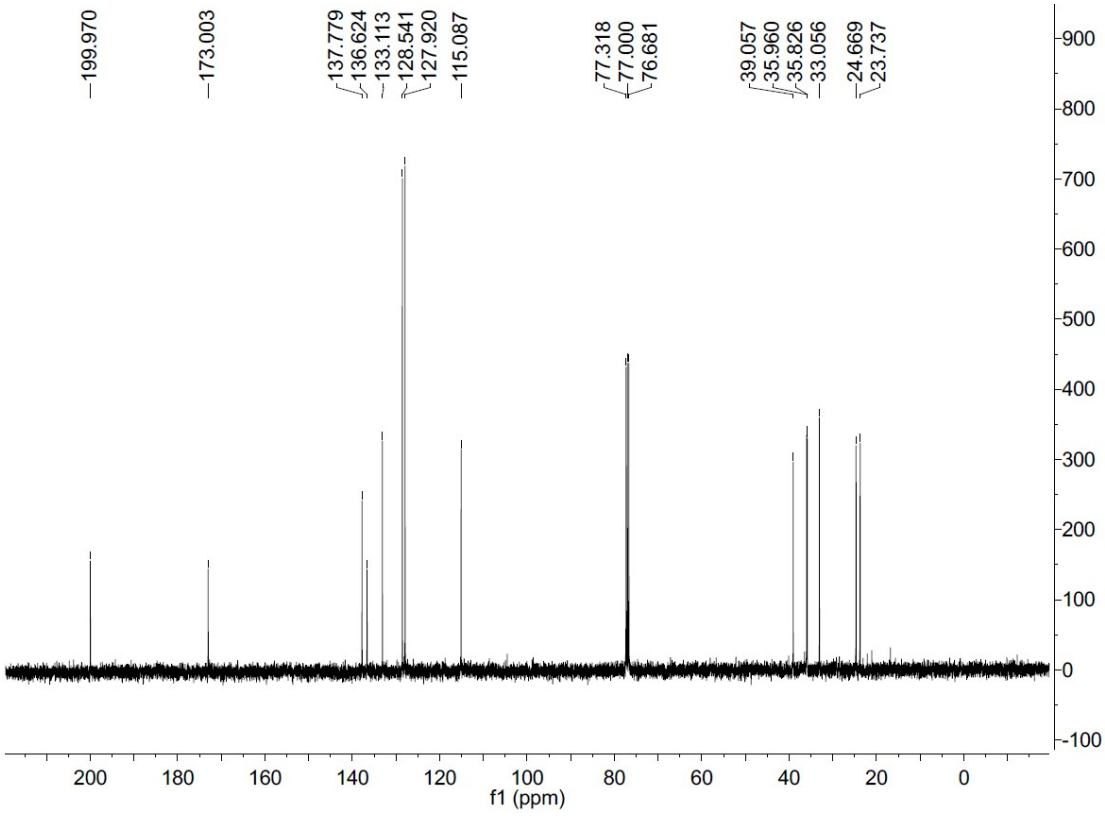
4ap


7.949
7.927
7.468
7.449
7.430
6.146
6.096
6.054
5.619
5.615
5.593
5.590
3.452
3.435
3.420
3.403
3.068
3.051
2.043
2.026
2.008
1.991
1.974
O
NH
O
2.02
1.04
2.10
3.00
1.01
2.04
2.06
2.20
f1 (ppm)

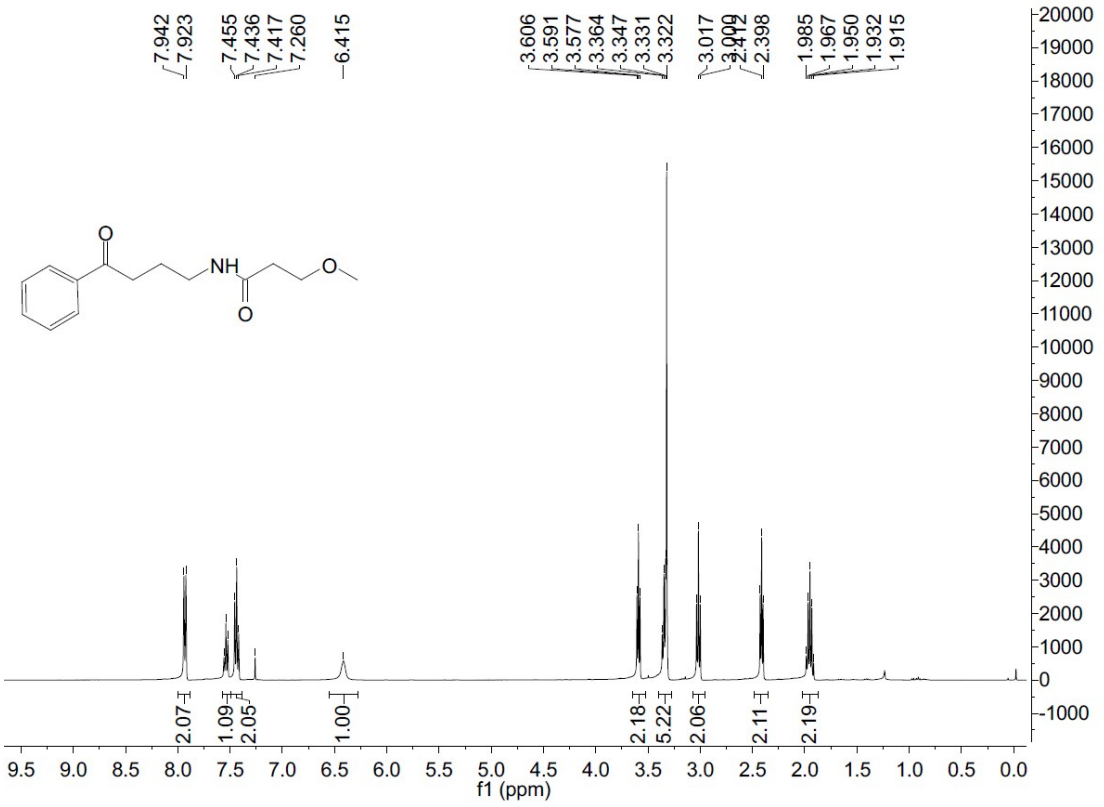

200.151
165.766
136.626
133.237
130.894
128.618
128.014
126.176
77.318
77.000
76.682
39.284
36.077
23.585
f1 (ppm)

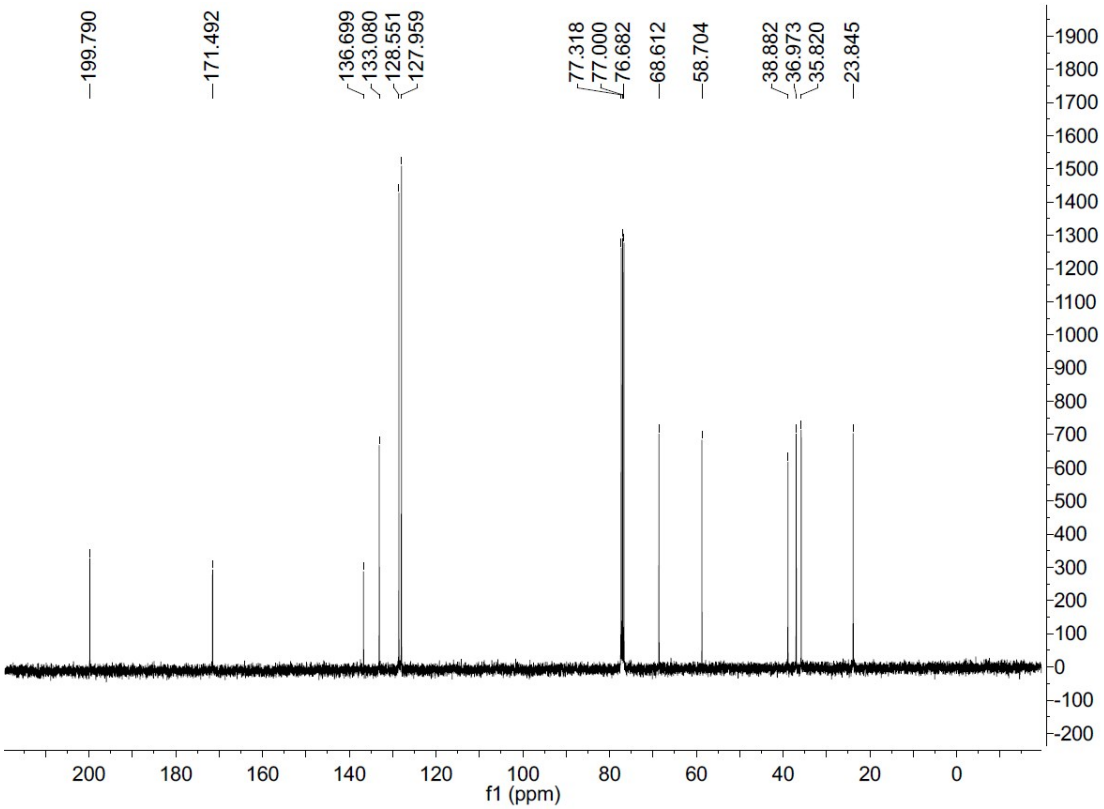
4aq


7.952
7.932
7.471
7.452
7.433
7.288
6.066
5.765
5.706
5.015
4.970
4.943
3.367
3.351
3.335
3.319
3.059
3.044
3.024
2.051
2.034
2.001
1.984
1.967
1.950
1.933
1.746
1.727
1.708
1.690
1.671
NH
O
O
2.03
1.00
2.05
1.00
1.00
2.00
2.07
2.06
2.01
2.03
2.08
2.18
f1 (ppm)

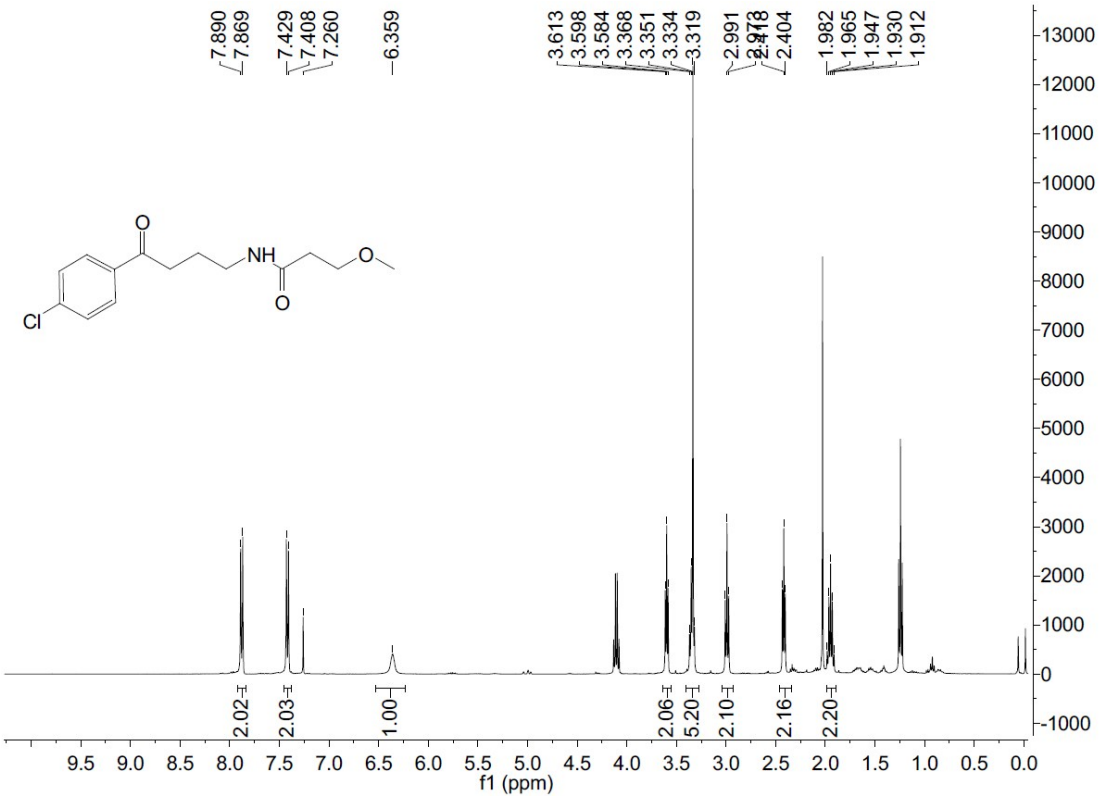

199.970
173.003
137.779
136.624
133.113
128.541
127.920
115.087
77.318
77.000
76.681
39.057
35.960
35.826
33.056
24.669
23.737
f1 (ppm)

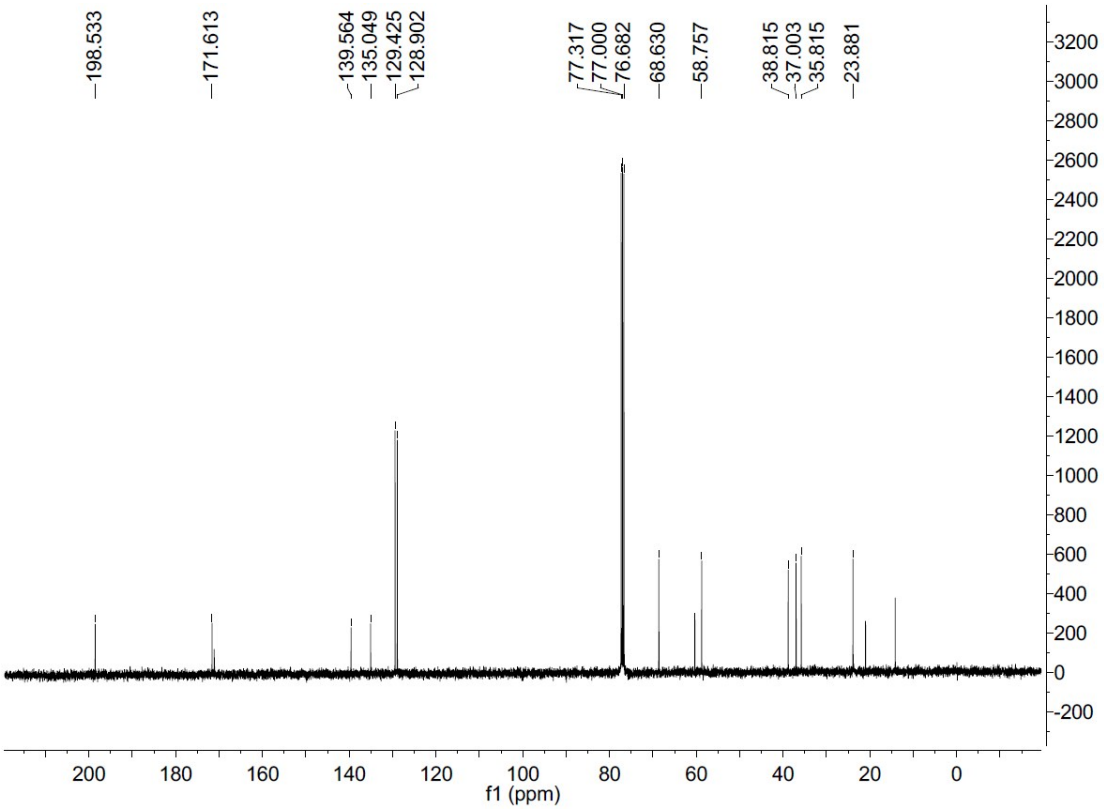
4ar


7.942
7.923
7.455
7.436
7.417
7.260
6.415
3.606
3.591
3.577
3.364
3.347
3.331
3.322
3.017
2.398
1.985
1.967
1.950
1.932
1.915
NH
O
O
O
2.07
1.09
2.05
1.00
2.18
5.22
2.06
2.11
2.19
f1 (ppm)

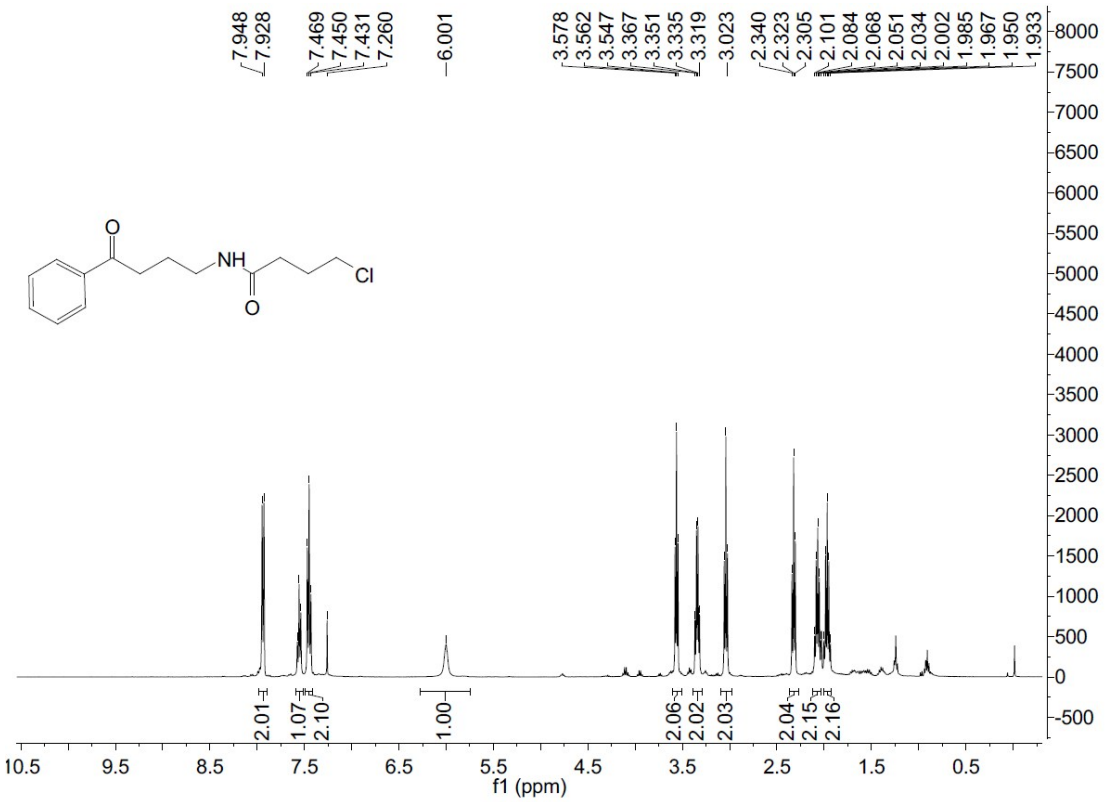

199.790
171.492
136.699
133.080
128.551
127.959
77.318
77.000
76.682
68.612
58.704
38.882
36.973
35.820
23.845
f1 (ppm)

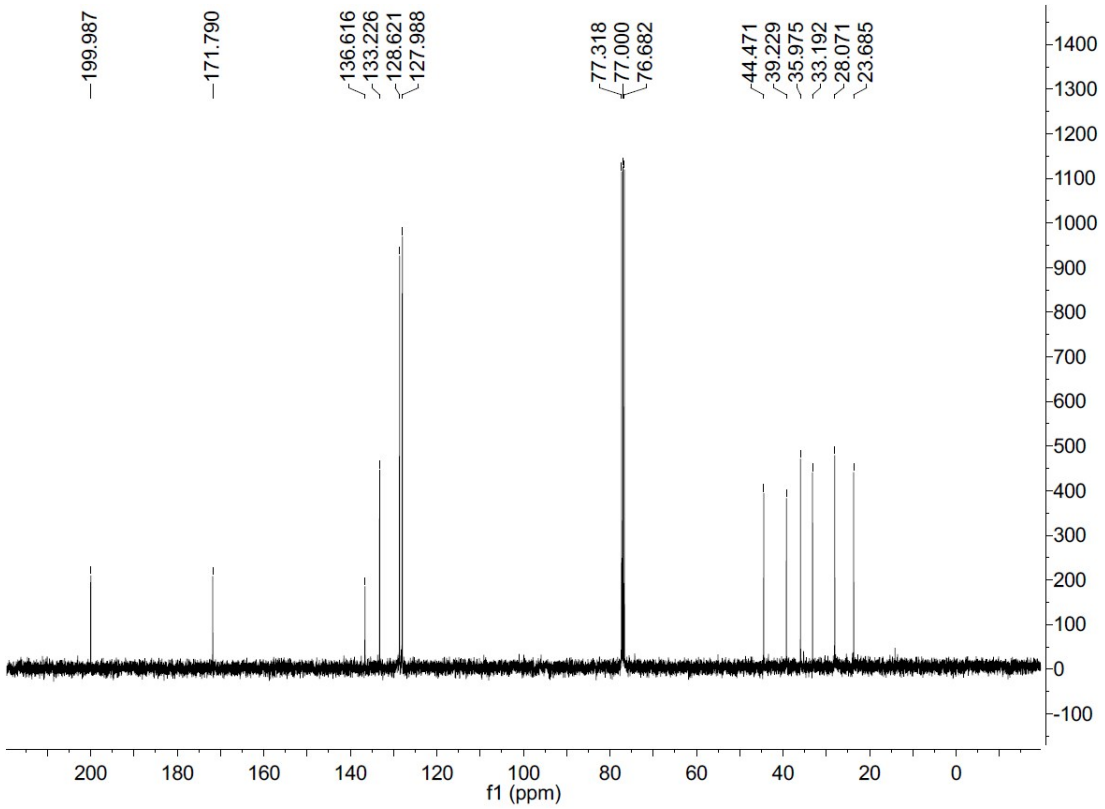
4cr


7.890
7.869
7.429
7.408
7.260
6.359
3.613
3.598
3.584
3.368
3.351
3.334
3.319
2.991
2.404
1.982
1.965
1.947
1.930
1.912
O
NH
O
O
Cl
2.02
2.03
1.00
2.06
5.20
2.10
2.16
2.20
f1 (ppm)

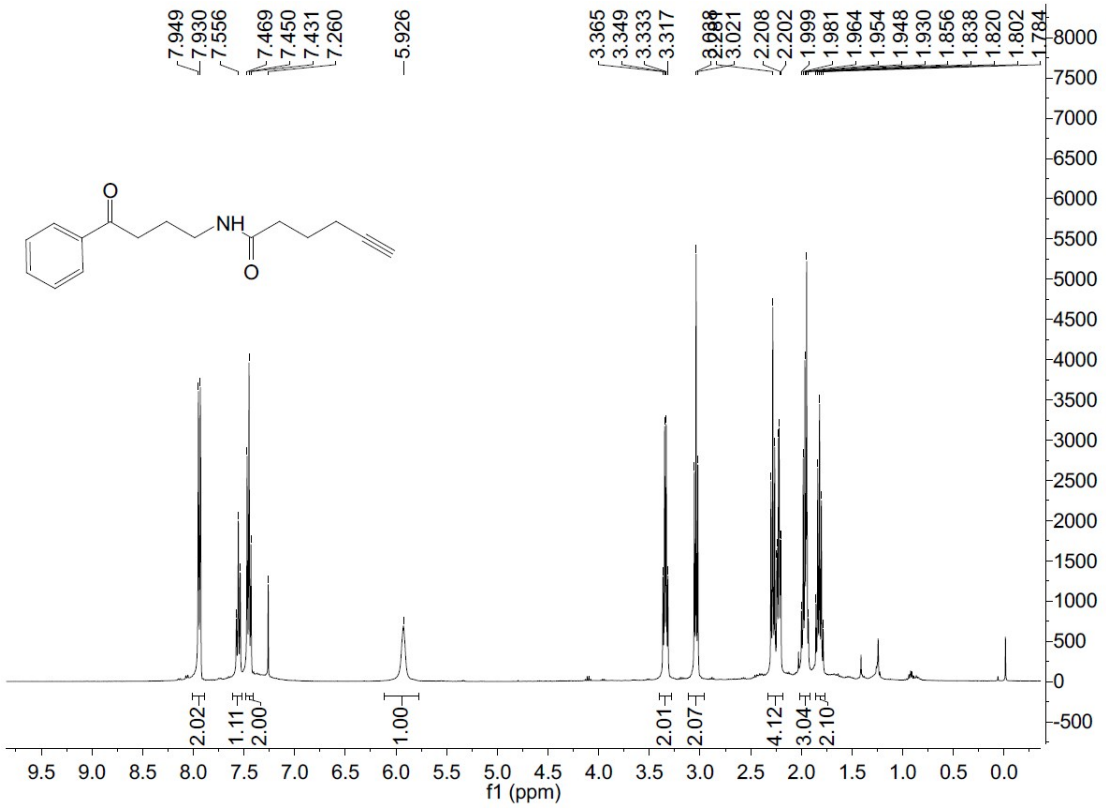

198.533
171.613
139.564
135.049
129.425
128.902
77.317
77.000
76.682
68.630
58.757
38.815
37.003
35.815
23.881
f1 (ppm)

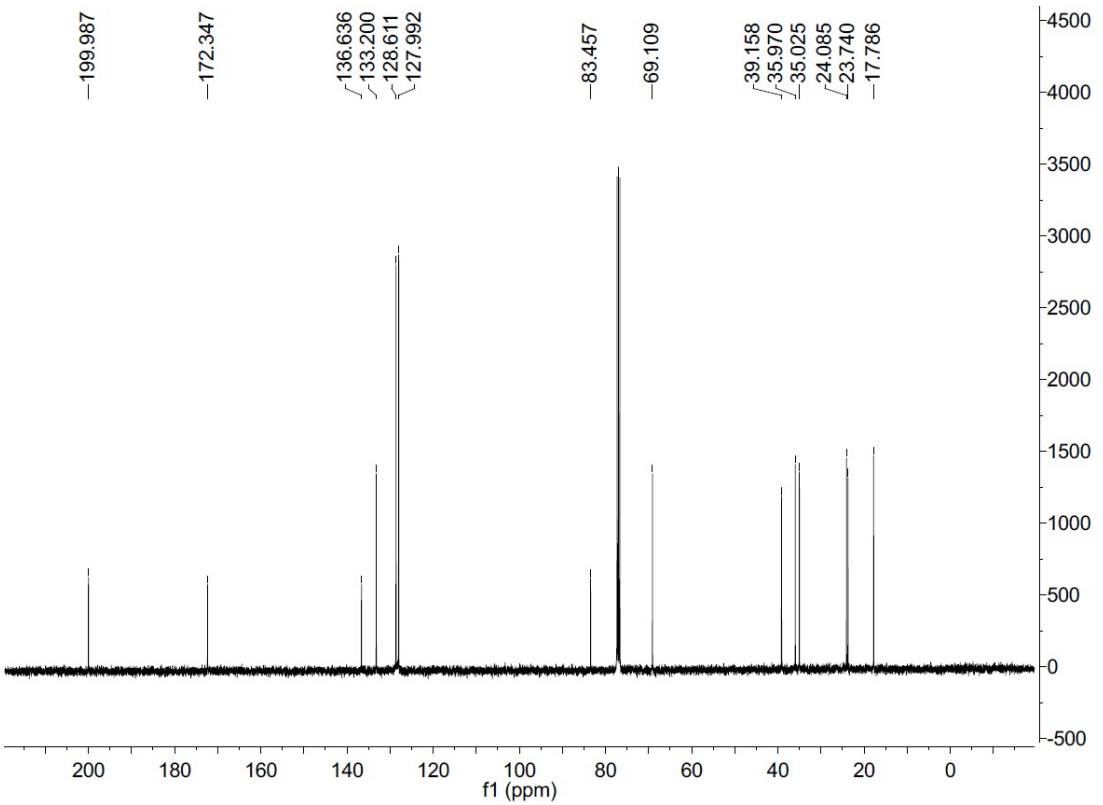
4as


7.948
7.928
7.469
7.450
7.431
7.260
6.001
3.578
3.562
3.547
3.367
3.351
3.335
3.319
3.023
2.340
2.323
2.305
2.101
2.084
2.068
2.051
2.034
2.002
1.985
1.967
1.950
1.933
O
NH
Cl
O
2.01
1.07
2.10
1.00
2.06
2.02
2.03
2.04
2.15
2.16
f1 (ppm)

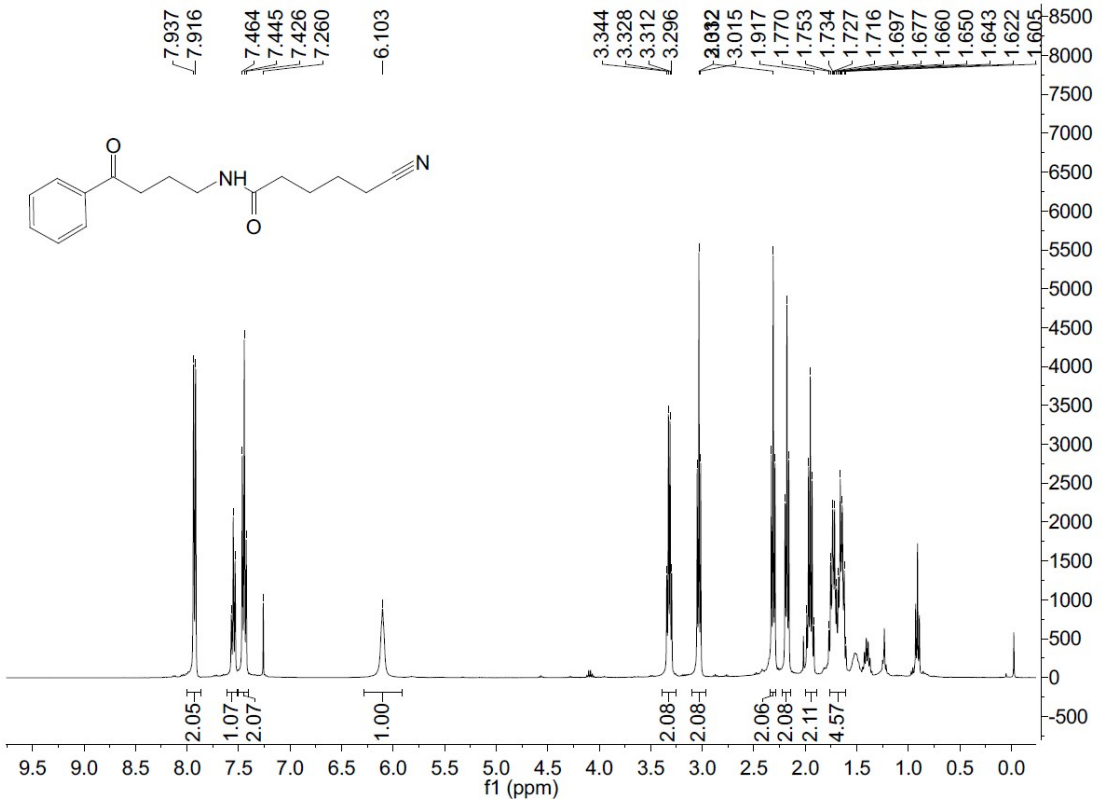

199.987
171.790
136.616
133.226
128.621
127.988
77.318
77.000
76.682
44.471
39.229
35.975
33.192
28.071
23.685
f1 (ppm)

4at


7.949
7.930
7.556
7.469
7.450
7.431
7.260
5.926
3.365
3.349
3.333
3.317
3.021
2.208
2.202
1.999
1.981
1.964
1.954
1.948
1.930
1.856
1.838
1.820
1.802
1.784
O
NH
O
2.02
1.11
2.00
1.00
2.01
2.07
4.12
3.04
2.10
f1 (ppm)


199.987
172.347
136.636
133.200
128.611
127.992
83.457
69.109
39.158
35.970
35.025
24.085
23.740
17.786
f1 (ppm)

4au


7.937
7.916
7.464
7.445
7.426
7.260
6.103
3.344
3.328
3.312
3.296
3.015
1.917
1.770
1.753
1.734
1.727
1.716
1.697
1.677
1.660
1.650
1.643
1.622
1.605
O
NH
O
N
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1.07
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1.00
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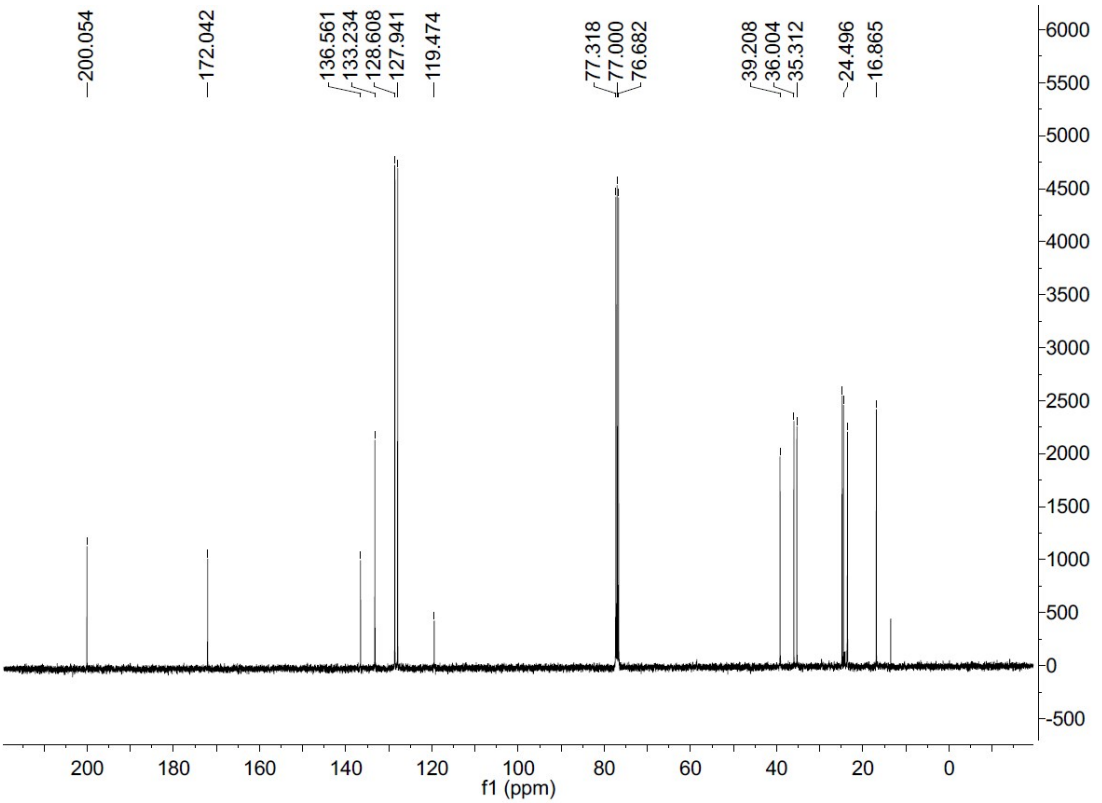
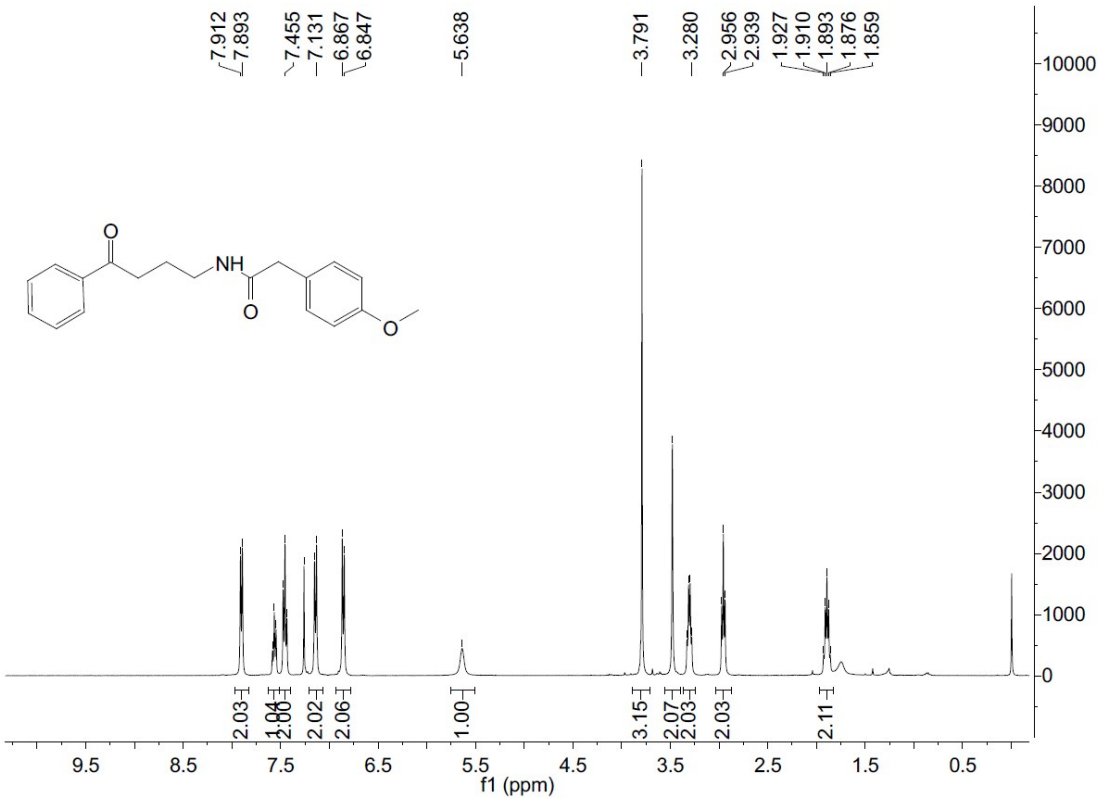
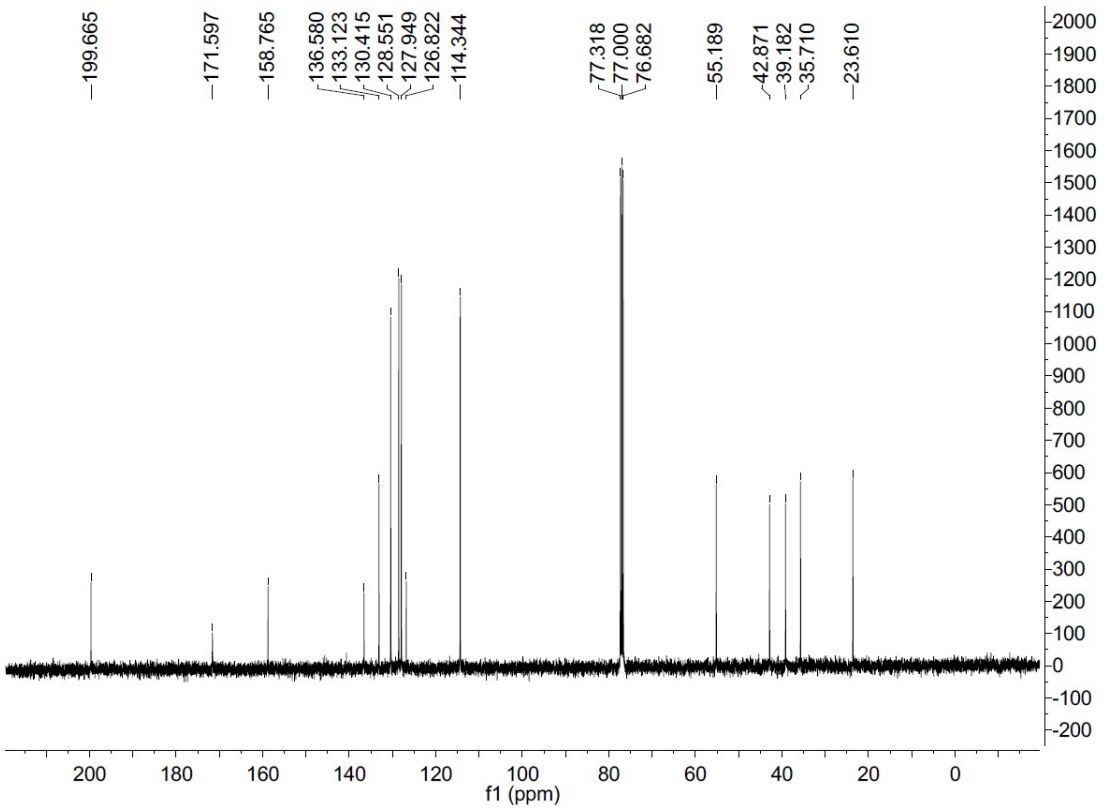
2.08
2.06
2.08
2.11
4.57
f1 (ppm)

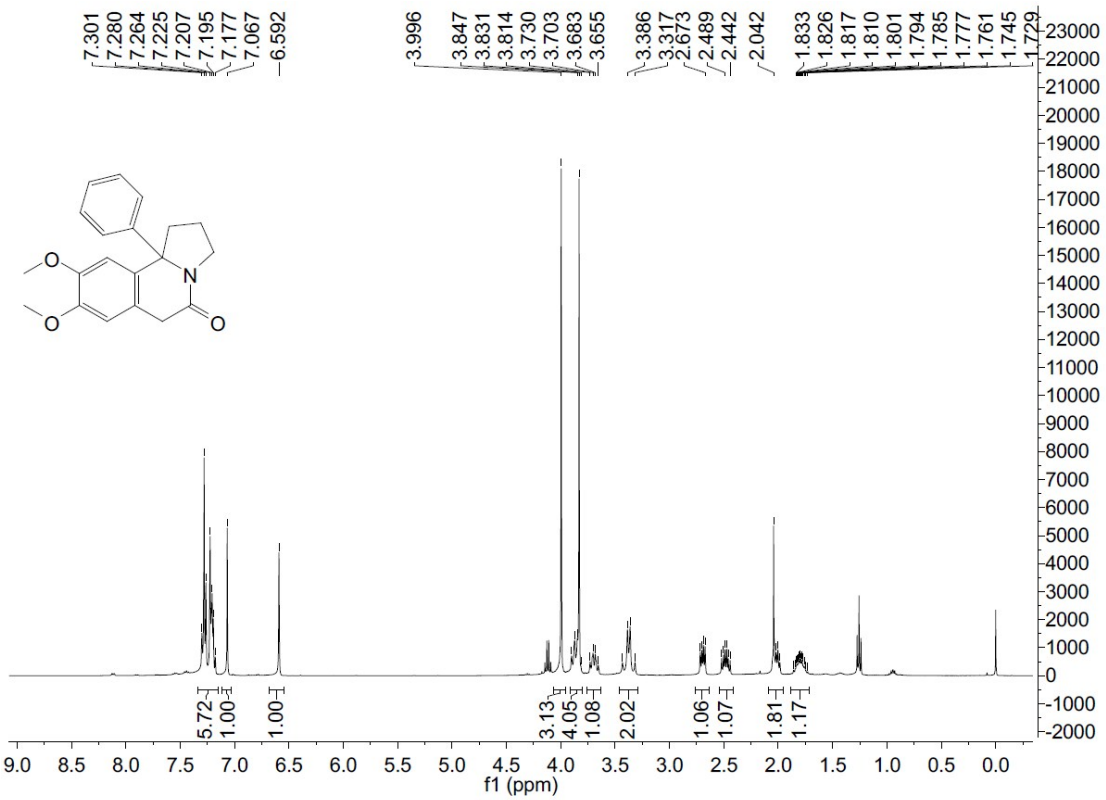

200.054
172.042
136.561
133.234
128.608
127.941
119.474
77.318
77.000
76.682
39.208
36.004
35.312
24.496
16.865
f1 (ppm)

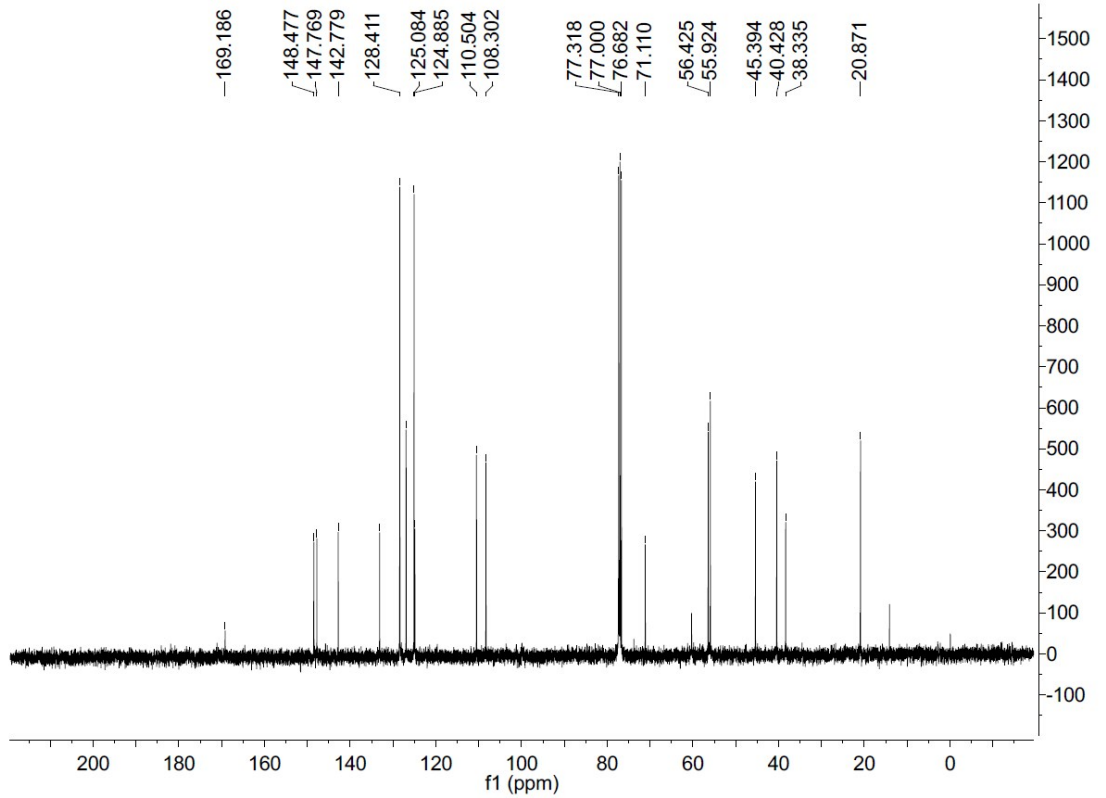
4av


7.912
7.893
7.455
7.131
6.867
6.847
5.638
3.791
3.280
2.956
2.939
1.927
1.910
1.893
1.876
1.859
NH
O
O
O
2.03
1.04
2.00
2.02
2.06
1.00
3.15
2.07
2.03
2.03
2.11
f1 (ppm)

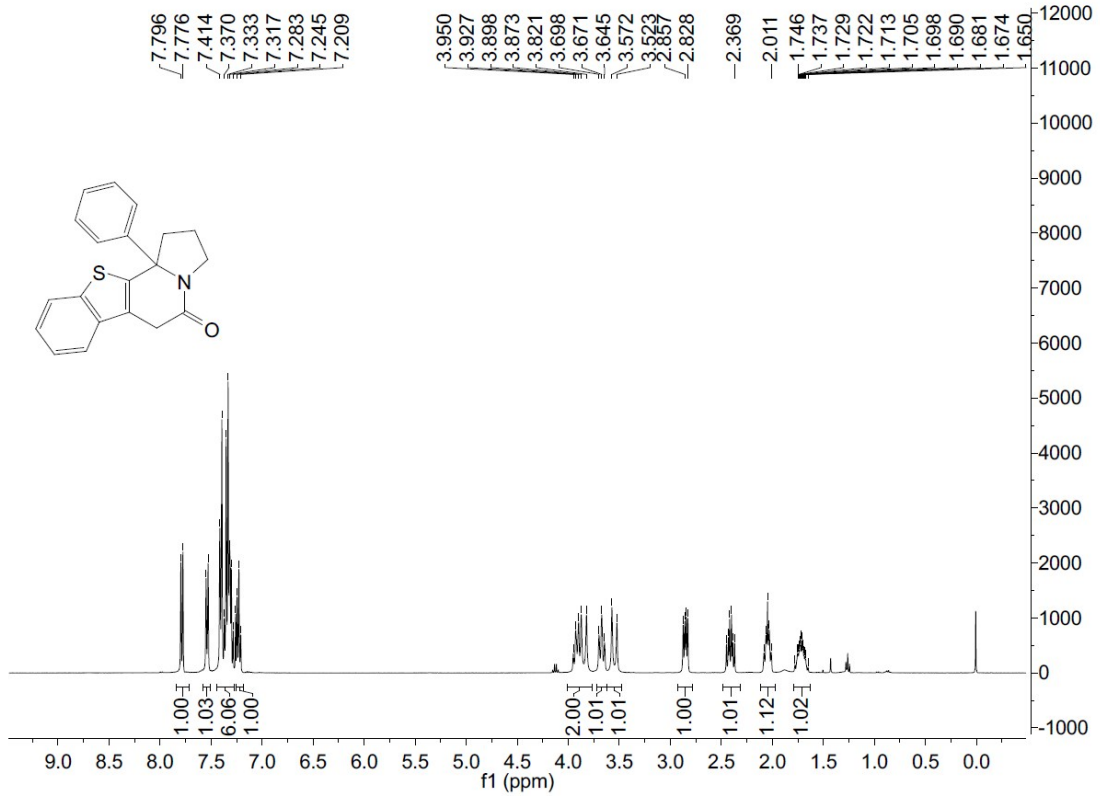

199.665
171.597
158.765
136.580
133.123
130.415
128.551
127.949
126.822
114.344
77.318
77.000
76.682
55.189
42.871
39.182
35.710
23.610
f1 (ppm)

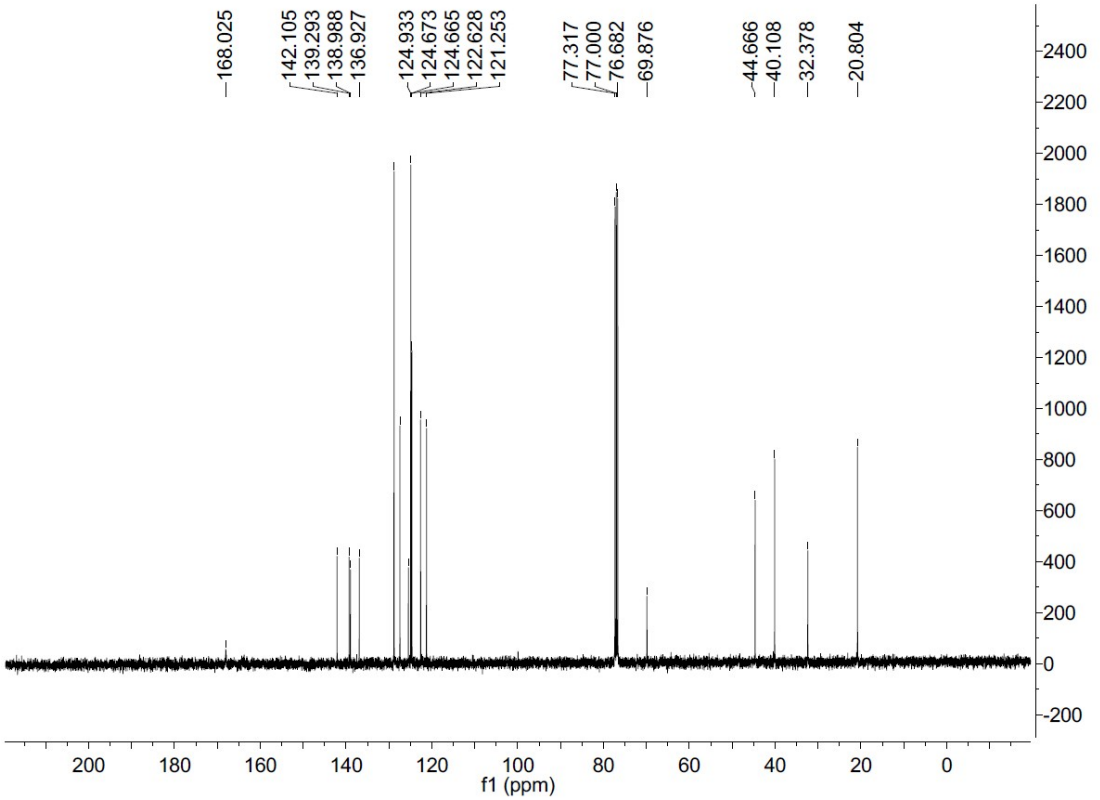
4aw


7.301
7.280
7.264
7.225
7.207
7.195
7.177
7.067
6.592
3.996
3.847
3.831
3.814
3.730
3.703
3.683
3.655
3.386
3.317
2.673
2.489
2.442
2.042
1.833
1.826
1.817
1.810
1.801
1.794
1.785
1.777
1.761
1.745
1.729
O
N
O
O
5.72
1.00
1.00
3.13
4.05
1.08
2.02
1.06
1.07
1.81
1.17
f1 (ppm)

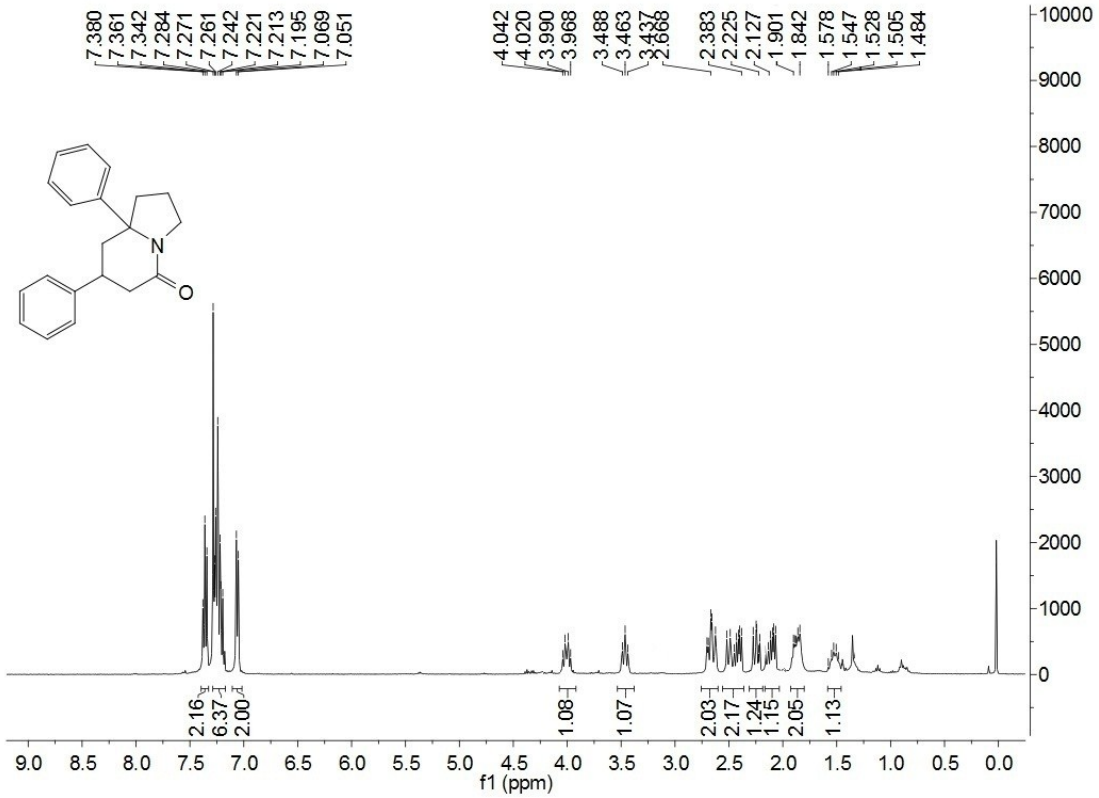

169.186
148.477
147.769
142.779
128.411
125.084
124.885
110.504
108.302
77.318
77.000
76.682
71.110
56.425
55.924
45.394
40.428
38.335
20.871
f1 (ppm)

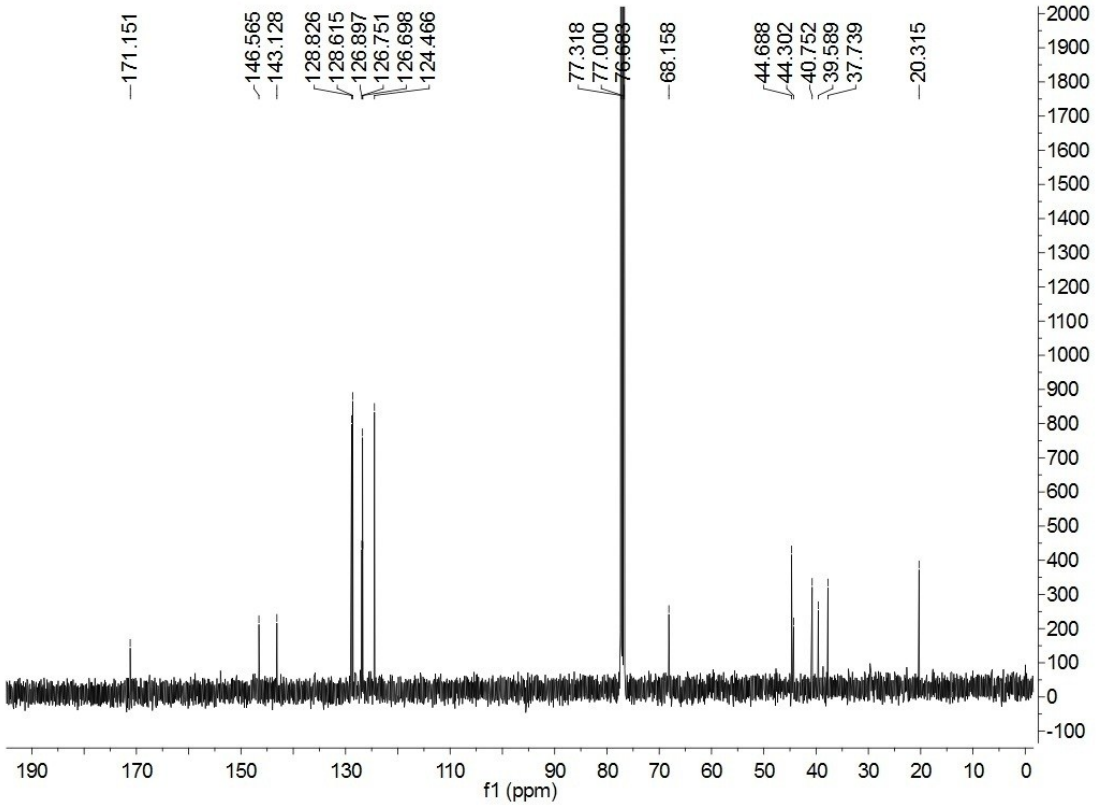
4ax


7.796
7.776
7.414
7.370
7.333
7.317
7.283
7.245
7.209
3.950
3.927
3.898
3.873
3.821
3.698
3.671
3.645
3.572
3.523
2.857
2.828
2.369
2.011
1.746
1.737
1.729
1.722
1.713
1.705
1.698
1.690
1.681
1.674
1.650
S
N
O
1.00
1.03
6.06
1.00
2.00
1.01
1.01
1.00
1.01
1.12
1.02
f1 (ppm)


168.025
142.105
139.293
138.988
136.927
124.933
124.673
124.665
122.628
121.253
77.317
77.000
76.682
69.876
44.666
40.108
32.378
20.804
f1 (ppm)

5


7.380
7.361
7.342
7.284
7.271
7.261
7.242
7.221
7.213
7.195
7.069
7.051
4.042
4.020
3.990
3.968
3.488
3.463
3.437
2.668
2.383
2.225
2.127
1.901
1.842
1.578
1.547
1.528
1.505
1.484
N
O
2.16
6.37
2.00
1.08
1.07
2.03
2.17
1.24
1.15
2.05
1.13
f1 (ppm)


171.151
146.565
143.128
128.826
128.615
126.897
126.751
126.698
124.466
77.318
77.000
76.683
68.158
44.688
44.302
40.752
39.589
37.739
20.315
f1 (ppm)