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Supporting Information

Versatile One-Pot Reductive Alkylation of Lactams/Amides via Amide Activation: Application to the Concise Syntheses of Bioactive Alkaloids (±)-Bgugaine, (±)-Coniine, (+)-Preussin, and (−)-Cassine

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General.

Melting points were determined on a Yanaco MP-500 micro melting point apparatus and were uncorrected. Infrared spectra were measured with a Nicolet Avatar 360 FT-IR spectrometer using film KBr pellet techniques. ^{1}H NMR spectra were recorded in $CDCl_3$ on a Bruker 400 spectrometer with tetramethylsilane as an internal standard. Chemical shifts are expressed in δ (ppm) units downfield from TMS. Mass spectra were recorded on a Bruker Dalton ESquire 3000 plus LC-MS apparatus. HRMS spectra were recorded on a Shimadzu LCMS-IT-TOF apparatus. Optical rotations were measured with a Perkin-Elmer 341 automatic polarimeter. Silica gel (300-400 mesh) was used for flash column chromatography (FC), eluting (unless otherwise stated) with ethyl acetate (EtOAc)/petroleum ether (PE) (60-90 °C) mixture. Diethyl ether and THF were distilled over sodium benzophenone ketyl under N_2. Dichloromethane was distilled over calcium hydride under N_2. All the Grignard reagents were diluted to 0.2-0.4 M and titrated immediately before use.[1]

1-Benzyl-2-ethylpyrrolidine (11a).

Tf_2O (138 μl, 0.82 mmol) was added dropwise to a cooled (–78 °C) solution of lactam **9** (120 mg, 0.69 mmol) and 2,6-di-*tert*-butyl-4-methylpyridine (169 mg, 0.82mmol) in CH_2Cl_2 and the resultant mixture was stirred at −78 °C for 45 min. A solution of ethylmagnesium bromide (0.39 M, 1.76 ml, 0.69 mmol) in Et_2O was added dropwise to the resultant mixture. The mixture was allowed to warm slowly to RT and stirred for 1 h. Then $LiAlH_4$ (38 mg, 2.06 mmol) was added in one portion. After stirring for 1 h, the reaction was quenched by careful addition of a 20% NaOH solution. After filtration, the filtrate was dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was purified by FC (eluent: EtOAc/PE= 1/20) to afford pyrrolidine **11a** (106 mg, yield: 82%), and reduced porduct **13** (10 mg, yield: 9%). **11a**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.93 (dd, *J* = 7.5, 7.5 Hz, 3H, CH_3), 1.35 (ddq, *J* = 13.3, 8.9, 7.5 Hz, 1H, CH_2CH_3), 1.50 (dddd, *J* = 12.4, 10.3, 7.8, 5.4 Hz, 1H, H-3), 1.58-1.84 (m, 2H, H-4), 1.78 (dqd, *J* = 13.3, 7.5, 2.9 Hz, 1H, CH_2CH_3), 1.93 (dddd, *J* = 12.4, 9.4, 7.7, 6.1 Hz, 1H, H-3), 2.12 (dd, *J* = 16.8, 9.2 Hz, 1H, H-5), 2.29 (ddd, *J* = 16.8, 8.2, 3.3 Hz, 1H, H-5), 2.92 (ddd, *J* = 9.4, 7.8, 2.9 Hz, 1H, H-2), 3.18 (d, *J* = 12.9 Hz, 1H, $PhCH_2$), 4.04 (d, *J* = 12.9 Hz, 1H, $PhCH_2$), 7.21-7.35 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 10.4, 21.8, 26.5, 29.8, 54.2, 58.5, 65.8, 126.8, 128.1 (2C), 129.0 (2C), 139.5 ppm; IR (KBr): ˜,ν = 3062, 3028, 2961, 2926, 2854, 1495, 1455, 1380, 1029, 747, 670 cm^{-1}; MS (ESI) *m/z* 190 ($M+H^+$, 100%); Anal. calcd for $C_{13}H_{19}N$: C, 82.48; H, 10.12; N, 7.40. Found: C, 82.57; H, 10.17; N, 7.37. **13**:[2] colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.75-1.82 (m, 4H, CH_2), 2.48-2.55 (m, 4H, NCH_2), 3.62 (s, 2H, $PhCH_2$), 7.21-7.35 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.4, 54.1, 60.7, 126.9, 128.2 (2C), 128.9 (2C), 139.3 ppm; IR (KBr): ˜,ν = 3062, 3027, 2965, 2927, 2784, 2732, 1493, 1453, 1375, 1348, 1125, 738, 698 cm^{-1}; MS (ESI) *m/z* 162 ($M+H^+$, 100%);

1-Benzyl-2-butylpyrrolidine (11b).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **9** (120 mg, 0.69 mmol) with *n*-butylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/30), pyrrolidine **11b** (118 mg, yield: 79%), and reduced porduct **13** (11 mg, yield: 10%). **11b**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.91 (t, *J* = 7.0Hz, 3H, CH_3), 1.24-1.40 (m, 5H), 1.49 (dddd, *J* = 12.4, 10.3, 7.7, 5.4 Hz, 1H, H-3), 1.58-1.78 (m, 3H), 1.93 (dddd, *J* = 12.4, 9.4, 7.6, 6.0 Hz, 1H, H-3), 2.09 (dd, *J* = 16.8, 9.1 Hz, 1H, H-5), 2.31 (ddd, *J* = 16.8, 8.0, 3.1 Hz, 1H, H-5), 2.91 (ddd, *J* = 9.4, 7.7, 2.5 Hz, 1H, H-2), 3.16 (d, *J* = 12.9 Hz, 1H, $PhCH_2$), 4.05 (d, *J* = 12.9 Hz, 1H, $PhCH_2$), 7.20-7.25 (m, 1H, Ar-H), 7.27-7.35 ppm (m, 1H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1, 21.9, 23.1, 28.6, 30.4, 33.8, 54.2, 58.6, 64.4, 126.7, 128.1 (2C), 129.1 (2C), 139.6 ppm; IR (KBr): ˜,ν = 3062, 3027, 2958, 2928, 2858, 2785, 1494, 1453, 1375, 1117, 736, 698 cm^{-1}; MS (ESI) *m/z* 218 ($M+H^+$, 100%); Anal. calcd for $C_{15}H_{23}N$: C, 82.89; H, 10.67; N, 6.44. Found: C, 83.27; H, 10.79; N, 6.61.

1, 2-Dibenzylpyrrolidine (11c).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **9** (120 mg, 0.69 mmol) with benzylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/40), pyrrolidine **11c** (119 mg, yield: 69%), and reduced porduct **13** (21 mg, yield: 19%). **11c**: colorless oil; IR (KBr): ˜,ν = 3061, 3026, 2963, 2873, 2787, 1494, 1452, 1122, 735, 698 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.52-1.63 (m, 2H), 1.65-1.78 (m, 2H), 2.17 (dd, *J* = 16.5, 9.0 Hz, 1H, H-5), 2.54 (dd, *J* =13.0, 9.2 Hz, 1H, $PhCH_2$), 2.65 (ddd, *J* = 16.5, 7.2, 4.1 Hz, 1H, H-5), 2.94 (ddd, *J* = 9.5, 7.3, 2.2 Hz, 1H, H-2), 3.07 (dd, *J* = 13.0, 4.0 Hz, 1H, $PhCH_2$), 3.28 (d, *J* = 12.9 Hz, 1H, $PhCH_2N$), 4.10 (d, *J* = 12.9 Hz, 1H, $PhCH_2N$), 7.16-7.38 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.9, 30.4, 41.0, 54.3, 58.9, 65.7, 125.9, 126.8, 128.2 (4C), 128.9 (2C), 129.2 (2C), 139.6, 140.0 ppm; IR (KBr): ˜,ν = 3062, 3027, 2958, 2928, 2858, 2785, 1494, 1453, 1375, 1117, 736, 698 cm^{-1}; MS (ESI) *m/z* 252 ($M+H^+$, 100%); Anal. calcd for $C_{18}H_{21}N$: C, 86.01; H, 8.42; N, 5.57. Found: C, 85.81; H, 8.64; N, 5.48.

1-Benzyl-2-phenylpyrrolidine (11d).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **9** (120 mg, 0.69 mmol) with phenylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/20), pyrrolidine **11d**[3] (94 mg, yield: 58%), and reduced porduct **13** (29 mg, yield: 26%). **11d**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.70-1.94 (m, 3H), 2.14-2.24 (m, 2H), 3.04 (d, *J* = 13.1 Hz, 1H, $PhCH_2$), 3.10 (ddd, *J* = 7.9, 7.9, 1.7 Hz, 1H, H-5), 3.37 (dd, *J* = 7.9, 7.9 Hz, 1H, H-5), 3.85 (d, *J* = 13.1 Hz, 1H, $PhCH_2$), 7.18-7.49 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.4, 35.2, 53.3, 58.1, 69.6, 126.7, 127.0, 127.6 (2C), 128.1 (2C), 128.4 (2C), 128.7 (2C), 139.7, 143.9 ppm; IR (KBr): ˜,ν = 3061, 3027, 2966, 2873, 2788, 1494, 1453, 1373, 1116, 757, 699 cm^{-1}; MS (ESI) *m/z* 238 ($M+H^+$, 100%).

1-Benzyl-2-ethylpiperidine (12a)

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **10** (130 mg, 0.69 mmol) with ethylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/20), piperidine **12a** (100 mg, yield: 72%), and reduced porduct **14** (19 mg, yield: 16%). **12a**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.92 (dd, *J* = 7.5, 7.5 Hz, 3H, CH_3), 1.26-1.34 (m, 1H), 1.38-1.52 (m, 3H), 1.58-1.72 (m, 4H), 2.02 (ddd, *J* = 11.9, 9.7, 4.0 Hz, 1H, H-6), 2.21 (ddd, *J* = 11.9, 7.1, 3.0 Hz, 1H, H-6), 2.75 (ddd, *J* = 11.6, 4.1, 4.1 Hz, 1H, H-2), 3.21 (d, *J* = 13.5 Hz, 1H, $PhCH_2$), 3.99 (d, *J* = 13.5 Hz, 1H, $PhCH_2$), 7.20-7.35 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 9.6, 23.8, 24.4, 25.3, 29.7, 51.9, 57.6, 61.9, 126.6, 128.1 (2C), 128.9 (2C), 139.9 ppm; IR (KBr): ˜,ν = 3062, 3028, 2931, 2875, 1496, 1453, 1384, 1029, 742, 700 cm^{-1}; MS (ESI) *m/z* 204 ($M+H^+$, 100%); Anal. calcd for $C_{14}H_{21}N$: C, 82.70; H, 10.41; N, 6.89. Found: C, 83.01; H, 10.44; N, 6.89. **14**:[2] colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.38-1.46 (m, 2H, CH_2), 1.53-1.60 (m, 4H, CH_2), 2.33-2.41 (m, 4H, NCH_2), 3.46 (s, 2H, $PhCH_2$), 7.20-7.33 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 24.4, 26.0, 54.5, 63.9, 126.8, 128.0 (2C), 129.2 (2C), 138.6 ppm; IR (KBr): ˜,ν = 3058, 3030, 2934, 2853, 2793, 2755, 1453, 1442, 1347, 1113, 735, 698 cm^{-1}; MS (ESI) *m/z* 176 ($M+H^+$, 100%);

1-Benzyl-2-propylpiperidine (12b).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **10** (130 mg, 0.69 mmol) with *n*-propylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/20), piperidine **12b** (101 mg, yield: 68%), and reduced porduct **14** (24 mg, yield: 20%). **12b**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.88 (t, *J* = 7.3 Hz, 3H, CH_3), 1.26-1.70 (m, 10H), 2.02 (ddd, *J* = 11.9, 8.9, 4.4 Hz, 1H, H-6), 2.28 (ddd, *J* = 11.5, 7.3, 3.0 Hz, 1H, H-6), 2.73 (ddd, *J* = 11.7, 4.0, 4.0 Hz, 1H, H-2), 3.22 (d, *J* = 13.5 Hz, 1H, $PhCH_2$), 3.97 (d, *J* = 13.5 Hz, 1H, $PhCH_2$), 7.19-7.35 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.6, 18.8, 23.7, 25.1, 30.3, 34.1, 51.7, 57.5, 60.6, 126.6, 128.1 (2C), 128.9 (2C), 139.9 ppm; IR (KBr): ˜,ν = 3062, 3025, 2961, 2928, 2853, 1493, 1451, 1140, 732, 698 cm^{-1}; MS (ESI) *m/z* 218 ($M+H^+$, 100%); Anal. calcd for $C_{15}H_{23}N$: C, 82.89; H, 10.67; N, 6.44. Found: C, 82.89; H, 10.35; N, 6.47.

1,2-Dibenzylpiperidine (12c).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **10** (130 mg, 0.69 mmol) with benzylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/40), piperidine **12c** (113 mg, yield: 62%), and reduced porduct **14** (27 mg, yield: 23%). **12c**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.24-1.36 (m, 2H), 1.48-1.56 (m, 3H), 1.58-1.66 (m, 1H), 2.22 (ddd, *J* = 11.9, 6.0, 5.9 Hz, 1H, H-6), 2.60 (d, *J* = 9.8 Hz, $PhCH_2$), 2.64-2.69 (m, 1H, H-6), 2.77 (ddd, *J* = 10.9, 5.0, 5.9 Hz, 1H, H-2), 3.17 (d, *J* = 9.8 Hz, 1H, $PhCH_2$), 3.49 (d, *J* = 13.6 Hz, 1H, $PhCH_2N$), 4.05 (d, *J* = 13.6 Hz, 1H, $PhCH_2N$), 7.16-7.38 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.4, 25.4, 29.3, 36.4, 50.9, 58.5, 61.7, 125.7, 126.7, 128.1 (2C), 128.2 (2C), 128.8 (2C), 129.3 (2C), 139.7, 140.5 ppm; IR (KBr): ˜,ν = 3061, 3025, 2930, 2855, 2791, 1494, 1452, 1129, 732, 698 cm^{-1}; MS (ESI) *m/z* 266 ($M+H^+$, 100%); Anal. calcd for $C_{19}H_{23}N$: C, 85.99; H, 8.74; N, 5.28. Found: C, 86.16; H, 8.94; N, 5.32.

***N,N*-Dibenzylbutan-2-amine (16a).**

Following the same procedure as for compound **11a**, the reductive alkylation of amide **15a** (164 mg, 0.69 mmol) with ethylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/80), amine **16a** (135 mg, yield: 78%), and reduced porduct **17a** (20 mg, yield: 13%). **16a**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.89 (dd, *J* = 7.3, 7.3 Hz, 3H, CH_3), 1.00 (d, *J* = 6.6 Hz, 3H, CH_3), 1.29 (dqd, *J* = 14.6, 7.3, 6.8 Hz, 1H, CH_2), 1.63 (dqd, *J* = 14.6, 7.3, 7.0 Hz, 1H, CH_2), 2.60 (ddq, *J* = 7.0, 6.8, 6.6 Hz, 1H, CH), 3.42 (d, *J* = 13.9 Hz, 2H, $PhCH_2$), 3.69 (d, *J* = 13.9 Hz, 2H, $PhCH_2$), 7.17-7.41 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 11.7, 13.1, 26.6, 29.7, 53.2, 54.3, 126.5 (2C), 128.1 (4C), 128.6 (4C), 140.9 (2C) ppm; IR (KBr): ˜,ν = 3062, 3026, 2961, 2928, 2873, 2798, 1494, 1453, 1162, 743, 697 cm^{-1}; MS (ESI) *m/z* 254 ($M+H^+$, 100%); Anal. calcd for $C_{18}H_{23}N$: C, 85.32; H, 9.15; N, 5.53. Found: C, 85.04; H, 9.44; N, 5.50. **17a**:[2] colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.06 (t, *J* = 7.1 Hz, 3H, CH_3), 2.49 (q, *J* = 7.1 Hz, 2H, CH_2), 3.56 (s, 4H, $PhCH_2$), 7.18-7.40 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 11.9, 47.1, 57.7, 126.7 (2C), 128.1 (4C), 128.7 (4C), 140.0 (2C) ppm; IR (KBr): ˜,ν = 3084, 3062, 3027, 2968, 2932, 2795, 1493, 1453, 1364, 1130, 1028, 745, 731, 698 cm^{-1}; MS (ESI) *m/z* 226 ($M+H^+$, 100%);

***N,N*-Dibenzyl-3-methylbutan-2-amine (16b).**

Following the same procedure as for compound **11a**, the reductive alkylation of *i*-propylmagnesium bromide to lactam **15a**[4] (239 mg, 1.00 mmol) gave, after FC (eluent: EtOAc/PE= 1/100), amine **16b** (194 mg, yield: 73%), and reduced porduct **17a** (14 mg, yield: 9%). **16b**: colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.81 (d, *J* = 9.9 Hz, 3H, CH_3), 0.99 (d, *J* = 6.9 Hz, 3H, CH_3), 1.01 (d, *J* =, 6.9 Hz, 3H, CH_3), 1.70 (qqd, *J* = 6.9, 6.9, 6.5 Hz, 1H, $CHCH_3$), 2.24 (qd, *J* = 9.9, 6.5 Hz, 1H, NCH), 3.31 (d, *J* = 13.8 Hz, 2H, $PhCH_2$), 3.77 (d, *J* = 13.8 Hz, 2H, $PhCH_2$), 7.16-7.40 ppm (m, 10H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 9.6, 20.6, 21.1, 29.7, 31.7, 53.7, 59.0, 126.6 (2C), 128.1 (4C),

128.8 (4C), 140.8 (2C) ppm; IR (KBr): ˜,ν = 3062, 3027, 2959, 2926, 2872, 1494, 1453, 1113, 745, 697 cm^{-1}; MS (ESI) *m/z* 268 ($M+H^+$, 100%).

***N,N*-Dibenzyl-1-phenylpropan-1-amine (16c).**

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **15b** (301 mg, 1.00 mmol) with ethylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/100), amine **16c**[5] (255 mg, 81%), and reduced porduct **17b** (29 mg, yield: 10%). **16c**: colorless oil; ^1H NMR (400 MHz, $CDCl_3$) δ 0.91 (t, *J* = 7.3 Hz, 3H, CH_3), 1.79 (ddq, *J* = 14.6, 7.5, 7.3 Hz, 1H, CH_2CH_3), 2.07 (ddq, *J* = 14.6, 7.4, 7.3 Hz, 1H, CH_2CH_3), 3.15 (d, *J* = 13.9 Hz, 2H, $PhCH_2$), 3.58 (dd, *J* = 7.5, 7.4 Hz, 1H, CH), 3.81 (d, *J* = 13.9 Hz, 2H, $PhCH_2$), 7.19-7.41 ppm (m, 15H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 11.7, 24.2, 53.7 (2C), 63.8 126.7 (2C), 126.9, 127.9 (2C), 128.2 (4C), 128.7 (4C), 129.0 (2C), 139.0, 140.5 (2C) ppm; IR (KBr): ˜,ν = 3083, 3061, 3026, 2962, 2930, 2802, 1493, 1453, 1125, 743, 698 cm^{-1}; MS (ESI) *m/z* 316 ($M+H^+$, 100%). **17b**:[2] white solid; mp 87~88 °C (EtOAc/PE); ^1H NMR (400 MHz, $CDCl_3$) *d* 3.55 (s, 6H, CH_2), 7.18-7.42 ppm (m, 15H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) *d* 58.0 (3C), 126.9 (3C), 128.3 (6C), 128.8 (6C), 139.7 (3C) ppm; IR (KBr): ˜,ν = 3062, 3028, 2925, 2881, 2837, 2802, 1493, 1452, 1366, 1247, 1122, 745, 699 cm^{-1}; MS (ESI) *m/z* 288 ($M+H^+$, 100%).

(±)-1-Methyl-2-tetradecylpyrrolidine ((±)-bgugaine) (2).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **18** (68 mg, 0.69 mmol) with tetradecylmagnesium bromide gave, after FC (eluent: EtOAc/MeOH= 20/1), (±)-bgugaine **2**[6] (145 mg, yield: 75%) as a colorless oil. ^1H NMR (400 MHz, $CDCl_3$) δ 0.88 (t, *J* = 6.9 Hz, 3H, CH_3), 1.20-1.36 (m, 25H), 1.38-1.48 (m, 1H), 1.60-1.82 (m, 3H), 1.87-2.01 (m, 2H), 2.12 (dd, *J* = 17.7, 9.4 Hz, 1H, H-5), 2.31 (s, 3H, NCH_3), 3.07 ppm (ddd, *J* = 9.5, 7.5, 2.0 Hz, 1H, H-2); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1, 21.8, 22.7, 26.7, 29.3, 29.6, 29.6, 29.7, 30.0, 30.8, 31.9, 33.8, 40.4, 57.4, 66.5 ppm; IR (KBr): ˜,ν = 2924, 2854, 2797, 1465, 1280, 1225, 1162 cm^{-1}; MS (ESI) *m/z* 282 ($M+H^+$, 100%); HRESIMS calcd for $[C_8H_{17}N+H]^+$: 282.3155; found: 282.3166.

(±)-2-Propylpiperidine hydrochloride ((±)-coniine hydrochloride) (3).

Compound **12c** (61 mg, 0.28 mmol) was dissolved in MeOH (3 mL) and then 10% Pd/C was added (30 mg). The mixture was stirred under H_2 (1 atm) for 1 h, after which concentrated HCl (0.1 mL, 16.7 mmol) was added. After stirring for 48 h, the solution was filtered through a pad of celite, and the filtrate was concentrated under reduced pressure. The residue was crystallized from MeOH/Et_2O to afford **(±)**-coniine hydrochloride salt **3**[7] (39 mg, yield: 85%) as a white solid. Mp 212~213 °C (MeOH/Et_2O); ^1H NMR (400 MHz, $CDCl_3$) δ 0.95 (t, *J* = 7.1 Hz, 3H, CH_3), 1.36-1.52 (m, 3H), 1.58-2.04 (m, 7H), 2.75-2.88 (m, 1H), 2.89-3.02 (m, 1H), 3.38-3.52 (m, 1H), 9.16 (br s, 1H), 9.44 ppm (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.7, 18.6, 22.2, 22.4, 28.2, 35.4, 44.8, 57.2 ppm; IR (KBr): ˜,ν = 3404, 2953, 2933, 2814, 2709, 1453, 1310 cm^{-1}; MS *m/z* (ESI) 128 ($M-Cl^+$, 100%); HRESIMS calcd for $[C_8H_{17}N-Cl]^+$: 128.1434; found: 128.1433.

Total synthesis of (+)-preussin (4)

(2*S*,3*S*,5*R*)-1-(4-Methoxybenzyl)-2-benzyl-3-(benzyloxy)-5-nonylpyrrolidine (21).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **19**[8] (200 mg, 0.50 mmol) with *n*-nonylmagnesium bromide gave, after FC (eluent: EtOAc/PE= 1/5), pyrrolidine **21** (181 mg, yield: 71%) (*cis*/*trans* = 7.2/1, determined by HPLC) as a colorless oil. $[a]^{20}_D$ +30.2 (*c* = 1.0, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$) δ 0.89 (t, *J* = 6.8 Hz, 3H, CH_2CH_3), 1.20-1.36 (m, 15H), 1.59 (ddd, *J* = 13.3, 6.8, 3.7 Hz, 1H, H-4), 1.62-1.68 (m, 1H), 1.97 (ddd, *J* = 13.3, 7.8, 6.6 Hz, 1H, H-4), 2.62 (dddd, *J* = 10.1, 6.6, 3.7, 3.3 Hz, 1H, H-5), 2.82 (dd, *J* = 12.6, 4.3 Hz, 1H, $PhCH_2$), 2.90 (dd, *J* = 9.2, 4.3 Hz, 1H, H-2), 3.00 (dd, *J* = 12.6, 9.2 Hz, 1H, $PhCH_2$), 3.62 (dd, *J* = 9.7, 5.4 Hz, 1H, H-3), 3.77 (d, *J* = 14.4 Hz, 1H, NCH_2), 3.79 (d, *J* = 14.4 Hz, 1H, NCH_2), 3.79 (s, 3H, OCH_3), 4.21 (d, *J* = 11.7 Hz, 1H, OCH_2), 4.42 (d, *J* = 11.7 Hz, 1H, OCH_2), 6.84 (d, *J* = 6.8 Hz, 2H, Ar-H), 7.12-7.34 ppm (m, 12H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.1, 22.7, 26.4, 29.3, 29.5, 29.6, 29.9, 31.9, 35.0, 35.1, 35.6, 55.1, 55.2, 61.6, 68.7, 70.8, 77.6, 113.4 (2C), 125.5, 127.3, 127.8 (2C), 128.0 (2C), 128.2 (2C), 129.5 (3C), 130.5 (2C), 138.6, 140.6, 158.5 ppm; IR (KBr): ˜,ν = 3062, 3028, 2925, 2853, 1511, 1453, 1247,1099, 1037, 735, 698 cm^{-1}; MS (ESI) *m/z* 514 ($M+H^+$, 100); HRESIMS calcd for $[C_{35}H_{47}NO_2+H]^+$: 514.3685; found: 514.3698.

***tert*-Butyl (2*S*,3*S*,5*R*)-2-benzyl-3-(benzyloxy)-5-nonylpyrrolidine-1-carboxylate (22).**

A suspension of **21** (65 mg, 0.13 mmol), 20% $Pd(OH)_2/C$ (30 mg), and Boc_2O (0.09 mL, 0.38 mmol) in EtOH (4 mL) was stirred under an atmosphere of H_2 for 48 h. After the catalyst was filtered off, the filtrate was concentrated under reduced pressure. The residue was purified by FC (eluent: EtOAc/PE= 1/5) to afford **22** (43 mg, yield: 84%) as a colorless oil. $[a]^{20}_D$ –64.9 (*c* = 1.0, CH_2Cl_2) {lit.[9] $[a]^{20}_D$ – 2.6 (*c* = 1.0, CH_2Cl_2)}; ^1H NMR (400 MHz, $CDCl_3$): δ 0.89 (t, *J* = 6.8 Hz, 3H, CH_3), 1.20-1.48 (m, 25H), 1.67 (dt, *J* = 12.7, 7.4 Hz, 1H, $CHCH_2$), 1.88-1.98 (m, lH), 2.02-2.12 (m, lH), 2.22-2.32 (m, lH), 2.92-3.00 (m, lH), 3.66-3.76 (m, lH), 4.13 (dd, *J* = 13.5, 6.6 Hz, 1H), 4.28 (dd, *J* = 13.9, 7.0 Hz, 1H), 7.16-7.21 (m, 1H, Ar-H), 7.26-7.32 ppm (m, 4H, Ar-H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 14.1, 22.6, 26.5, 28.3 (3C), 29.3, 29.5, 29.6, 29.7, 36.0, 36.9, 37.5, 56.4, 62.5, 71.3, 79.2, 125.9, 128.3 (2C), 129.5 (2C), 139.6, 154.9 ppm; IR (KBr): ˜,ν = 3439, 3028, 2957, 2925, 2855, 1691, 1663, 1454, 1399, 1173, 1123, 1078, 745, 699cm^{-1}; MS (ESI) *m/z* 404 ($M+H^+$, 100%). HRESIMS calcd for $[C_{25}H_{41}NO_3+H]^+$: 404.3165; found: 404.3176.

(2*S*,3*S*,5*R*)-2-Benzyl-1-methyl-5-nonylpyrrolidin-3-ol, (+)-preussin (4).

To a solution of **22** (38 mg, 0.094 mmol) in dry THF (4 mL) was added $LiAlH_4$ (36 mg, 0.94 mmol) in one portion. The resulting reaction mixture was stirred at 60 ºC for 4 h. After being diluted with 4 mL of Et_2O, filtration and removal of the solvent under reduced pressure, the crude was purified by FC (eluent: EtOAc/PE= 1/2) to give preussin **4** (28 mg, yield: 93%) as a colorless oil. $[a]^{20}_D$ +22.3 (*c* 1.0, $CHCl_3$) {lit.[10] $[a]^{20}_D$ +22.0 (*c* = 1.0, $CHCl_3$) for the natural product}; ^{1}H NMR (400 MHz, $CDCl_3$) d 0.88 (t, *J*= 6.8 Hz, 3H, CH_3), 1.16-1.37 (m, 15H), 1.42 (ddd, *J*= 13.5, 6.2, 1.3 Hz, 1H, H-4), 1.66-1.78 (m, 1H), 1.97 (br s, 1H, OH), 2.12 (dddd, *J*= 11.9, 6.4, 6.2, 2.8 Hz, 1H, H-5), 2.18 (ddd, *J*= 13.5, 9.2, 6.4 Hz, 1H, H-4), 2.27 (ddd, *J*= 9.7, 5.0, 3.8 Hz, 1H, H-2), 2.34 (s, 3H, NCH_3), 2.84 (dd, *J*= 13.1, 4.9 Hz, 1H, $PhCH_2$), 2.89 (dd, *J*= 13.1, 9.7 Hz, 1H, $PhCH_2$), 3.76-3.85 (m, 1H, H-3), 7.14-7.32 ppm (m, 5H, Ar-H). ^{13}C NMR (100 MHz, $CDCl_3$): d 14.1, 22.6, 26.3, 29.3, 29.5, 29.6, 29.9, 31.9, 33.7, 34.9, 38.6, 39.3, 65.8, 70.5, 73.6, 126.0, 128.3 (2C), 129.3 (2C), 139.4 ppm. IR (KBr): ˜,ν = 3428, 2958, 2924, 2853, 1488, 1455, 1241, 1170, 1024, 820, 734, 698 cm^{-1}; MS (ESI) *m/z* 318 ($M+H^+$, 100). HRESIMS calcd for $[C_{21}H_{35}NO+H]^+$: 318.2797; found: 318.2805.

Total synthesis of (–)-cassine (5).

(5*R*,6*S*)-1-(4-Methoxybenzyl)-5-(benzyloxy)-6-methylpiperidin-2-one (20).

Following the reported method,[11] compound **20** was prepared, after FC (eluent: EtOAc/PE= 1/2), as a colorless oil. $[a]^{20}_D$ +52.3 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.21 (d, *J* = 6.6 Hz, 3H, CH_3), 1.88-2.02 (m, 2H, H-4), 2.46 (ddd, *J* = 18.2, 9.4, 8.2 Hz, 1H, H-3), 2.61 (ddd, *J* = 18.2, 7.3, 3.7 Hz, 1H, H-3), 3.54 (m, 1H, H-5), 3.60 (qd, *J* = 6.6, 4.6 Hz, 1H, H-6), 3.79 (s, 3H, OCH_3), 3.86 (d, *J* = 14.8 Hz 1H, NCH_2), 4.42 (d, *J* = 11.8 Hz, 1H, OCH_2), 4.46 (d, *J* = 11.8 Hz, 1H, OCH_2), 5.25 (d, *J* = 14.8 Hz, 1H, NCH_2), 6.84 (d, *J* = 8.6 Hz, 2H, Ar-H), 7.14 (d, *J* = 8.6 Hz, 2H, Ar-H), 7.20-7.32 ppm (m, 5H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.3, 21.9, 29.1, 47.1, 52.4, 55.1, 70.6, 74.0, 113.9 (2C), 127.4 (2C), 127.6, 128.3 (2C), 129.1 (2C), 129.4, 137.7, 158.8, 168.9 ppm; IR (KBr): ˜,ν = 3063, 3031, 2966, 2929, 2864, 1659, 1513, 1455, 1248, 1100, 1032, 738, 699 cm^{-1}; MS (ESI) *m/z* 340 ($M+H^+$, 100%).

(2*R*,3*R*,6*S*)-1-(4-Methoxybenzyl)-3-(benzyloxy)-2-methyl-6-(10-(2-methyl-1,3-dioxolan-2-yl)decyl)piperidine (24a).

Following the same procedure as for compound **11a**, the reductive alkylation of lactam **20** (350 mg, 1.03 mmol) with Grignard reagent **23** gave, after FC (eluent: EtOAc/PE= 1/5), *cis*-diastereomer **24a** (274 mg, yield: 48%) and *trans*-diastereomer **24b** (78 mg, yield: 14%) (combined yield 62%, *cis*/*trans* = 3.5/1). **24a**: colorless oil. $[a]^{20}_D$ +6.0 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.09 (d, *J* = 6.7 Hz, 3H, $CHCH_3$), 1.15-1.43 (m, 20H), 1.50-1.70 (m, 6H), 1.76-1.87 (m, 1H), 2.50-2.60 (m, 1H, H-6), 3.04-3.12 (m, 1H, H-2), 3.45-3.52 (m, 1H, H-3), 3.74 (d, *J* = 14.8 Hz, 1H, NCH_2), 3.79 (s, 3H, OCH_3), 3.84 (d, *J* = 14.8 Hz, 1H, NCH_2), 3.88-3.97 (m, 4H, OCH_2CH_2), 4.44 (d, *J* = 12.0 Hz, 1H, OCH_2), 4.52 (d, *J* = 12.0 Hz, 1H, OCH_2), 6.83 (d, *J* = 8.5 Hz, 2H, Ar-H), 7.20-7.32 ppm (m, 7H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.4, 23.4, 23.7, 24.1, 25.6, 27.9, 29.5, 29.6, 29.6, 29.8, 29.9, 31.4, 39.2, 53.6, 55.2, 55.8, 58.3, 64.6, 70.3, 110.2, 113.4 (2C), 127.3, 127.5 (2C), 128.2 (2C), 129.3 (2C), 133.0, 139.1, 158.3 ppm; IR (KBr): ˜,ν = 2980, 2929, 2853, 1510, 1463, 1375, 1247, 1098, 1039, 735, 698 cm^{-1}; MS (ESI) *m/z* 552 ($M+H^+$, 100%); HRESIMS calcd for $[C_{35}H_{53}NO_4+H]^+$: 552.4053; found: 552.4068. **24b**: colorless oil; $[a]^{20}_D$ -8.6 (*c* = 1.0, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.99 (d, *J* = 6.7 Hz, 3H, $CHCH_3$), 1.17-1.42 (m, 21H), 1.46-1.56 (m, 1H), 1.58-1.72 (m, 4H), 1.75-1.83 (m, 1H), 2.66-2.74 (m, 1H, H-6), 3.14 (qd, *J* = 11.4, 6.7 Hz, 1H, H-2), 3.48 (d, *J* = 13.9 Hz, 1H, NCH_2), 3.54 (dt, *J* = 10.7, 4.5 Hz, 1H, H-3), 3.77 (d, *J* = 13.9 Hz, 1H, NCH_2), 3.81 (s, 3H, OCH_3), 3.88-3.97 (m, 4H, OCH_2CH_2), 4.39 (s, 2H, OCH_2), 6.84 (d, *J* = 8.7 Hz, 2H, Ar-H), 7.20-7.34 ppm (m, 7H, Ar-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 6.8, 23.7, 24.1, 25.3, 25.5, 28.1, 29.5, 29.6, 29.6, 29.9, 30.0, 33.2, 39.2, 51.1, 52.6, 55.2, 64.6, 69.9, 75.8, 110.2, 113.5 (2C), 127.2, 127.4 (2C), 128.2 (2C), 129.2 (2C), 133.0, 139.0, 158.3 ppm; MS (ESI) *m/z* 552 ($M+H^+$, 100%).

(2*S*,5*R*,6*R*)-12-(5-Hydroxy-6-methylpiperidin-2-yl)-dodecan-2-one, (–)-cassine (5).

A suspension of **24a** (30 mg, 0.05 mmol) and 20% $Pd(OH)_2$/C (15 mg) in EtOH (4 mL) was stirred under an atmosphere of H_2 for 48h. To the resulting solution was added a few drops of conc. HCl. After being stirred for 12 h, the mixture was filtrated and concentrated under reduced pressure. The residue was dissolved in 2 mL of H_2O, washed with Et_2O (3 × 2 mL), basified with a 10% NaOH solution to reach pH 10 and extracted with CH_2Cl_2 (3 × 2 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered and concentrated to afford (–)-cassine (**5**) (14 mg, yield: 88%) as a white solid. M.p. 56-57 °C (EtOH) [lit.[12] mp 57-58 °C]; $[a]^{20}_D$ - 1.2 (*c* = 0.5, EtOH); $[\alpha]_D^{20}$ - 15.4 (*c* = 0.5, $CHCl_3$) {lit.[12] $[a]^{20}_D$ - 0.6 (*c* = 8.0, EtOH)}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.11 (d, *J* = 6.5 Hz, 3H, $CHCH_3$), 1.24-1.35 (m, 16H), 1.44-1.65 (m, 5H), 1.86-1.93 (m, 1H), 2.14 (s, 3H, $COCH_3$), 2.42 (t, *J* = 7.5 Hz, 2H, $COCH_2$), 2.54 (dddd, *J* = 2.5, 5.6, 5.8, 11.4 Hz, 1H, H-6), 2.76 (qd, *J* = 6.5, 1.2 Hz, 1H, H-2), 3.55 ppm (br s, 1H, H-3); ^{13}C NMR (100 MHz, $CDCl_3$) δ 18.6, 23.8, 25.8, 26.1, 29.2, 29.4, 29.4, 29.5, 29.5, 29.7, 29.8, 32.0, 37.0, 43.8, 55.8, 57.2, 68.0, 209.4 ppm; IR (KBr): ˜,ν = 3404, 2926, 2853, 1716, 1463, 1365, 1175, 1146, 1071, 720 cm^{-1}; MS (ESI) *m/z* 298 ($M+H^+$, 100%); HRESIMS calcd for $[C_{18}H_{35}NO_2+H]^+$: 298.2746; found: 298.2754.

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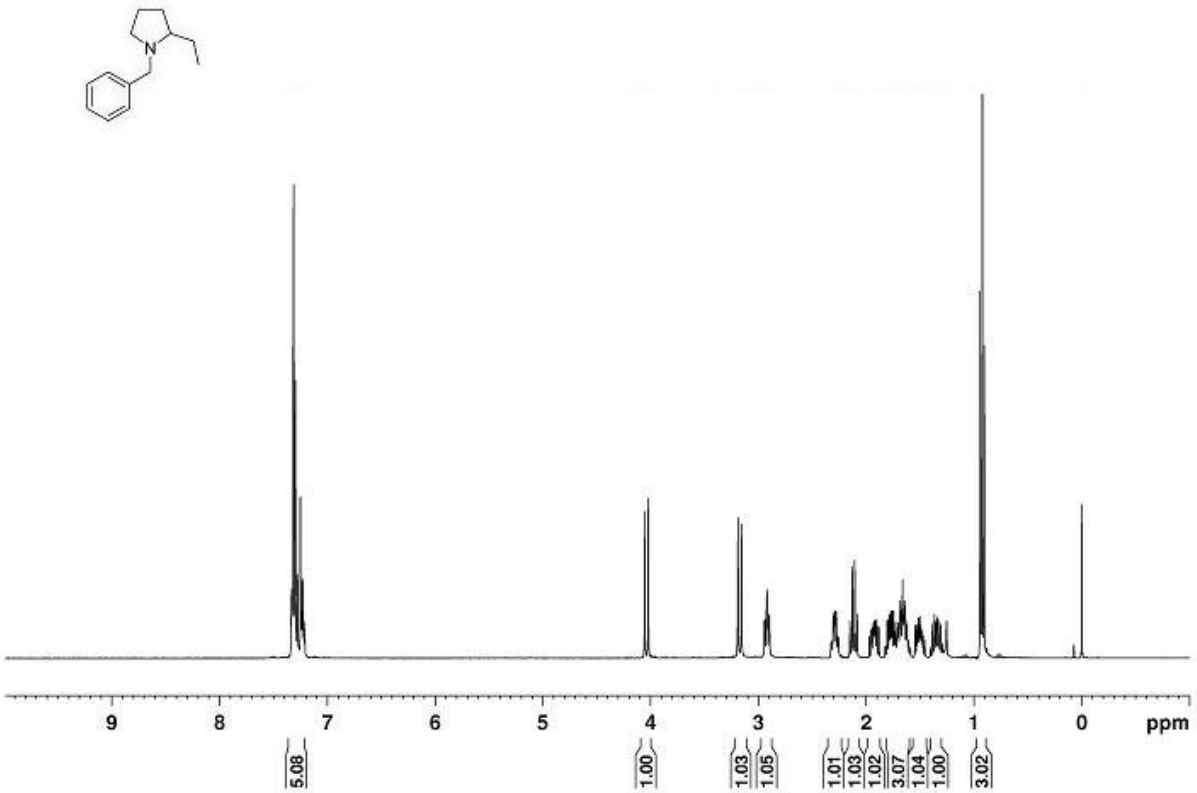
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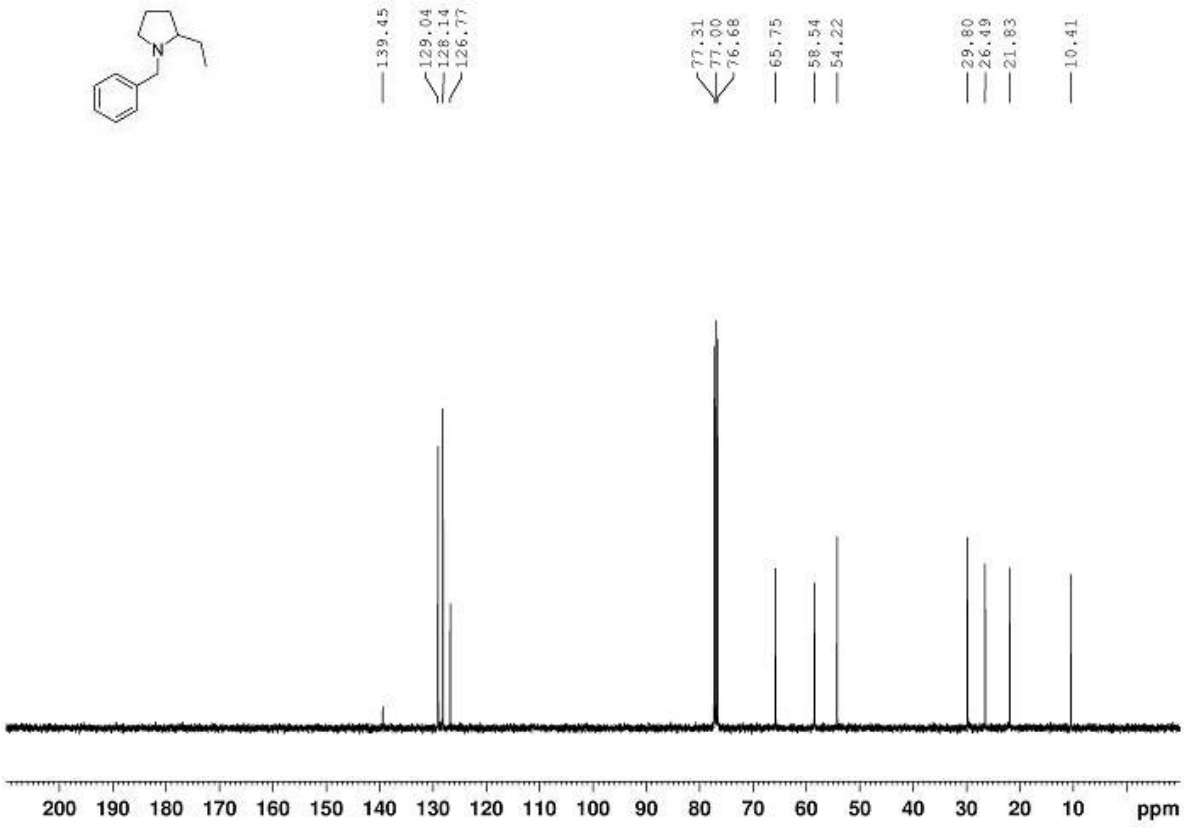
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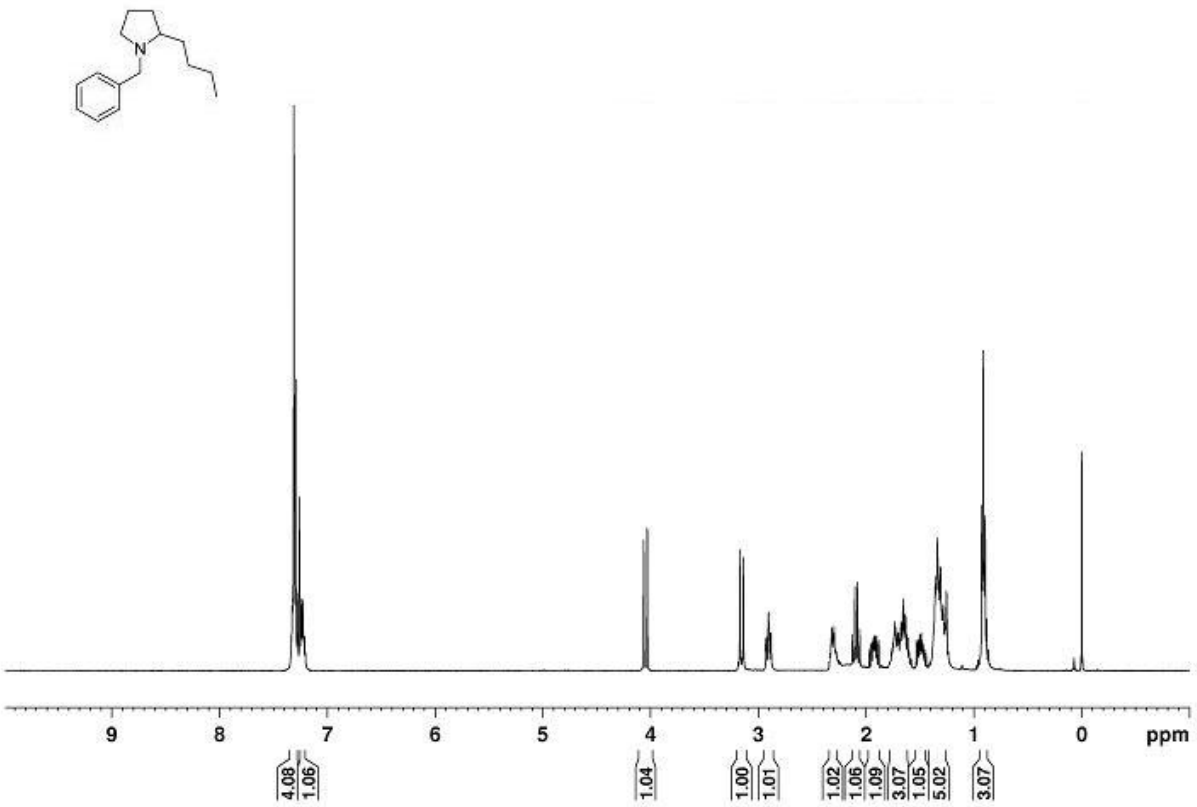
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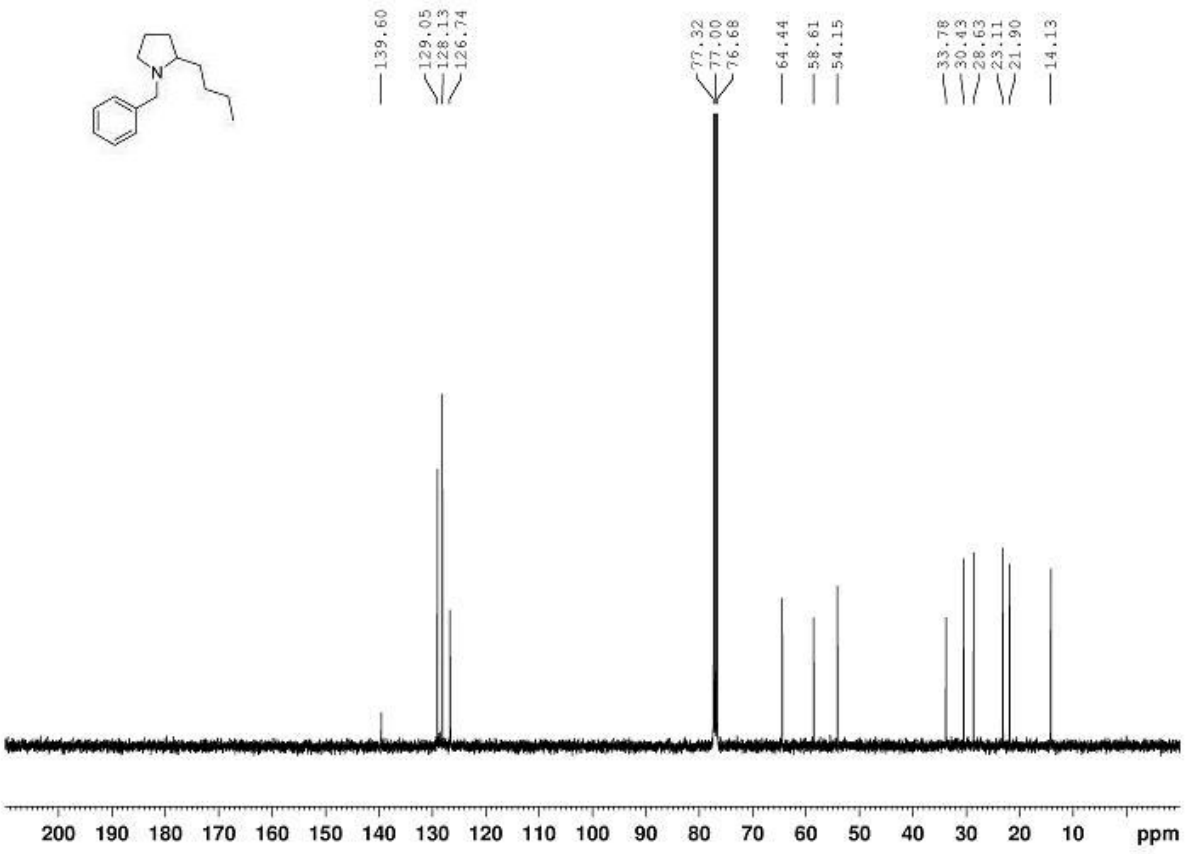
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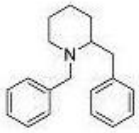

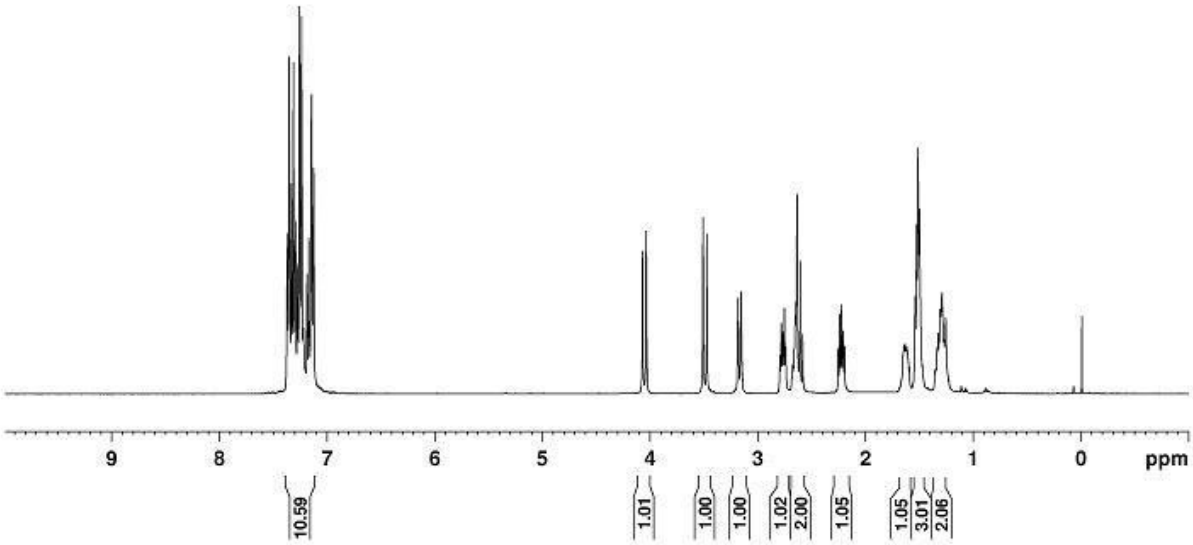
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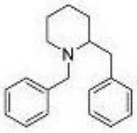

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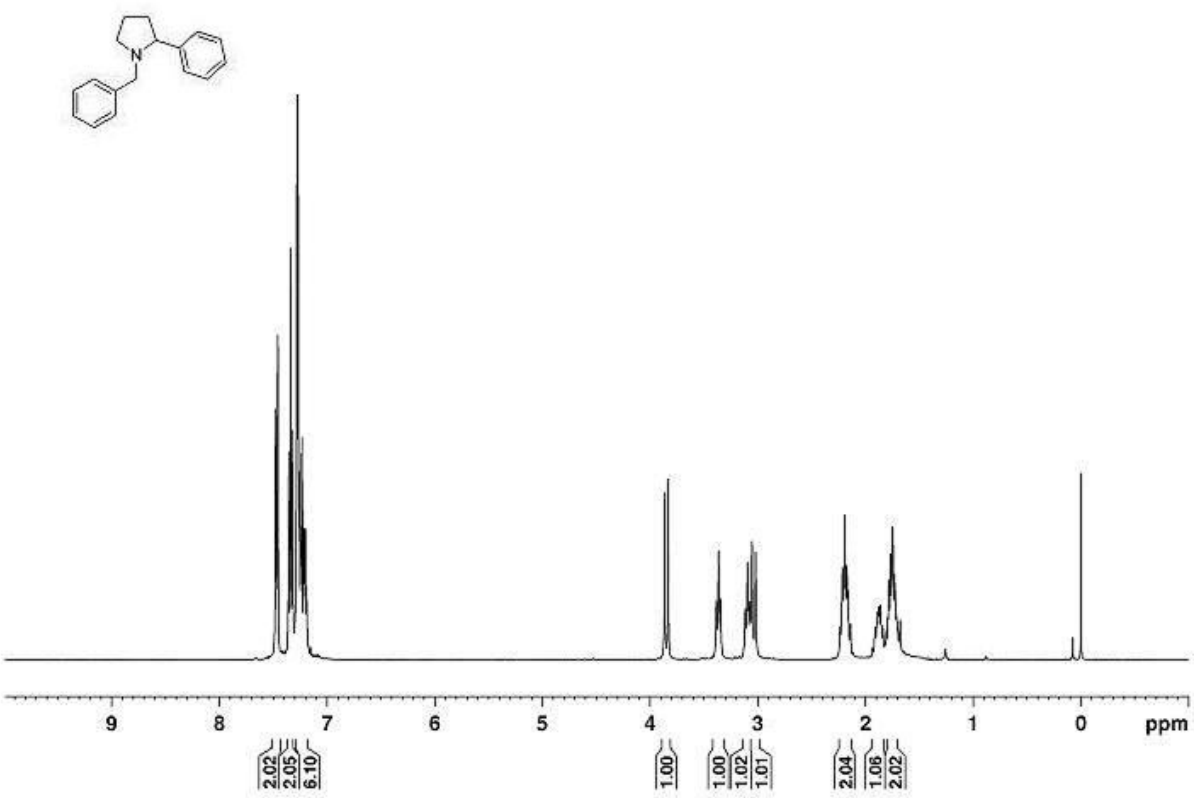
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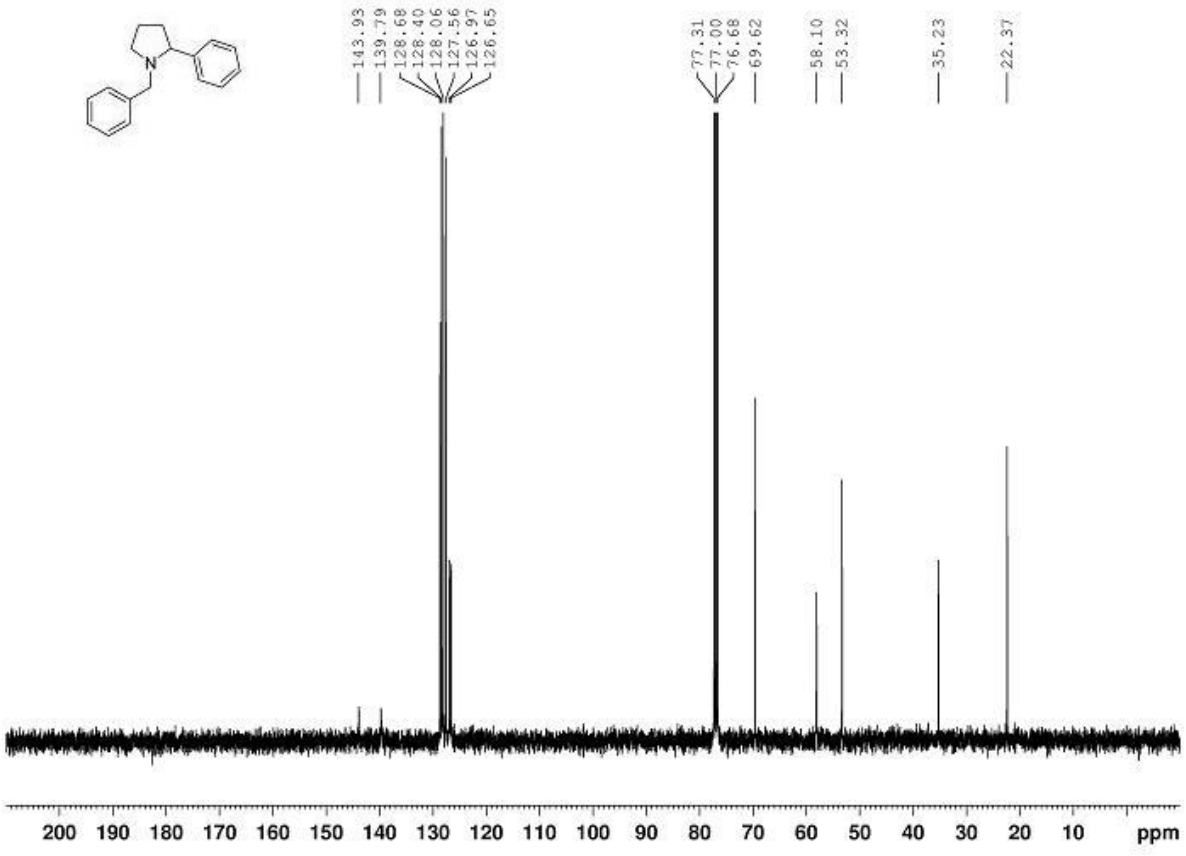
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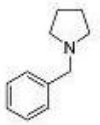

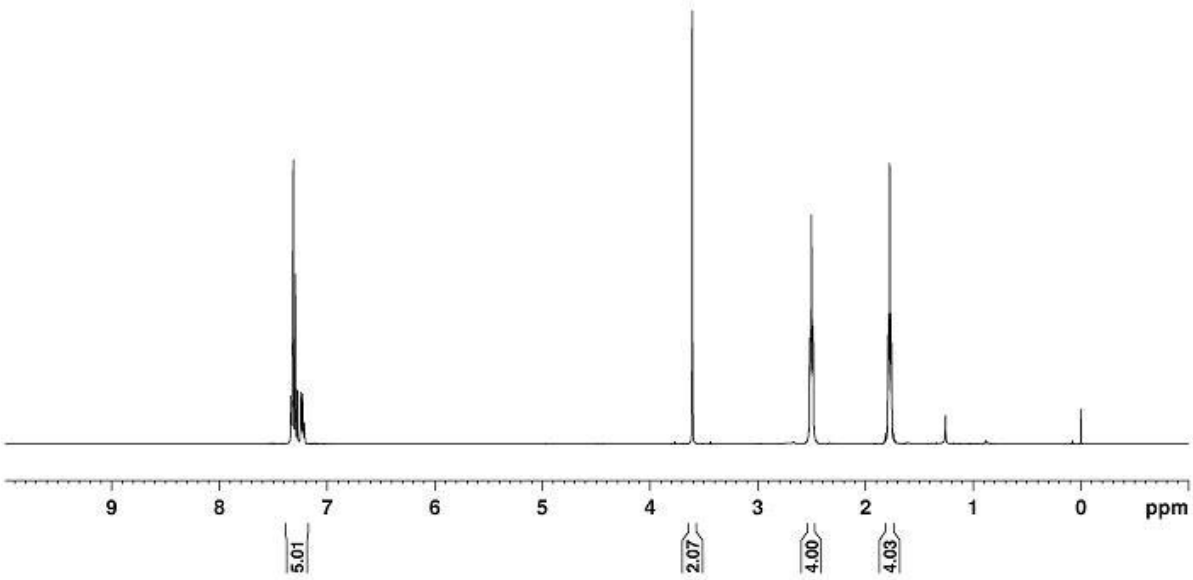
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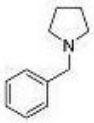

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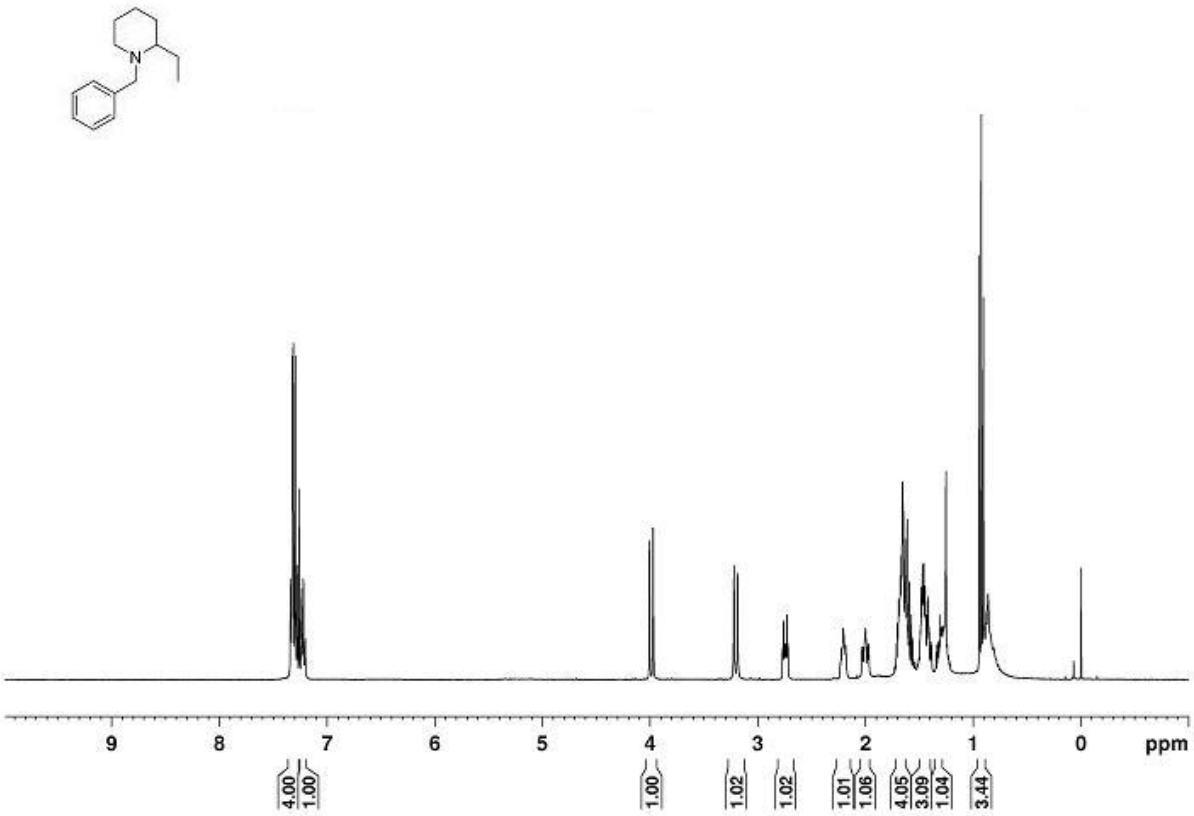
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5
4
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1.00
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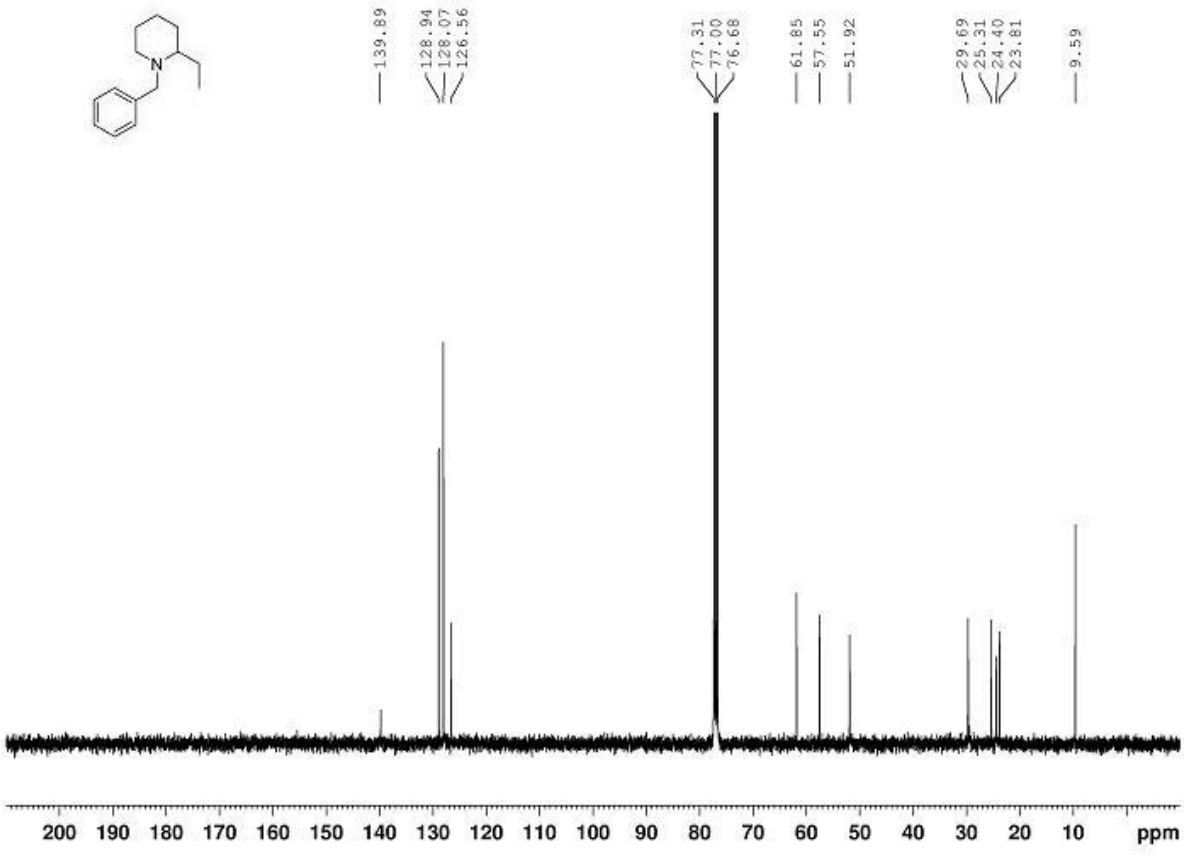
1.02
1.01
1.06
4.05
3.09
1.04
3.44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77.00
76.68
61.85
57.55
51.92
29.69
25.31
24.40
23.81
9.59
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150
140
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110
100
90
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70
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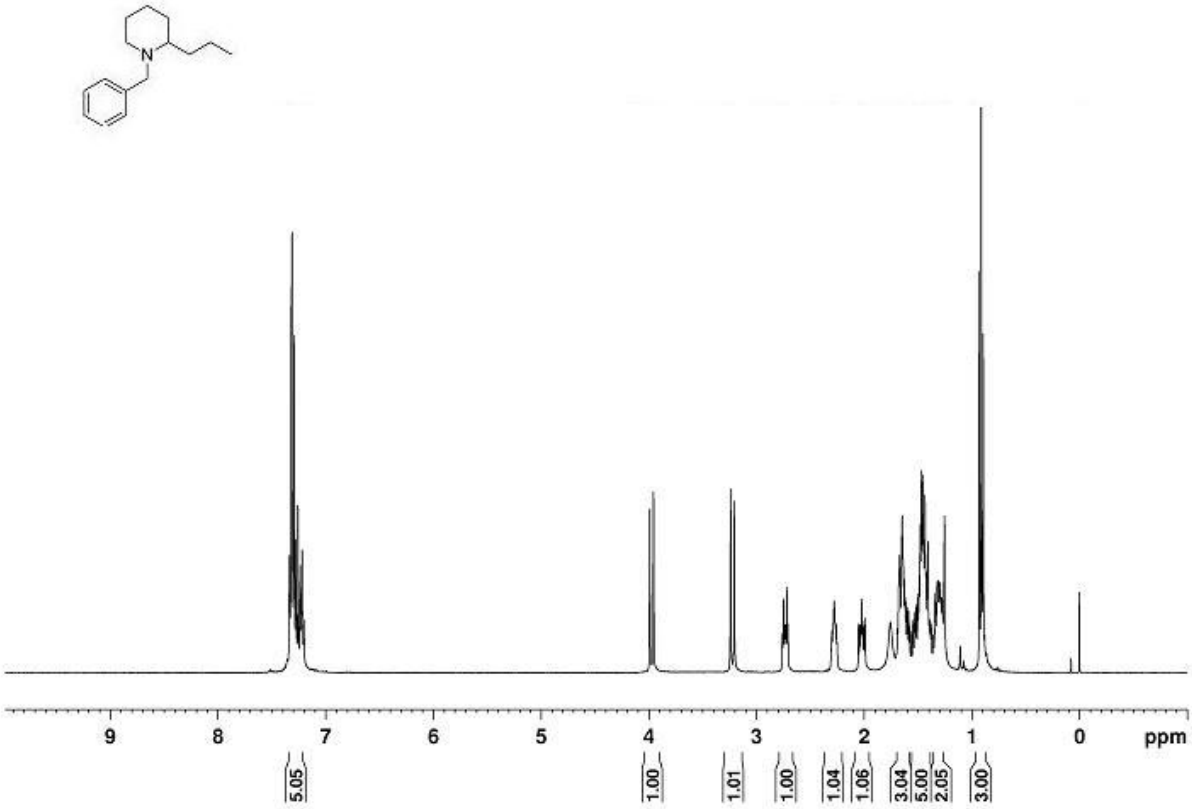
30
20
10
ppm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8
7
6
5
4
3
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0
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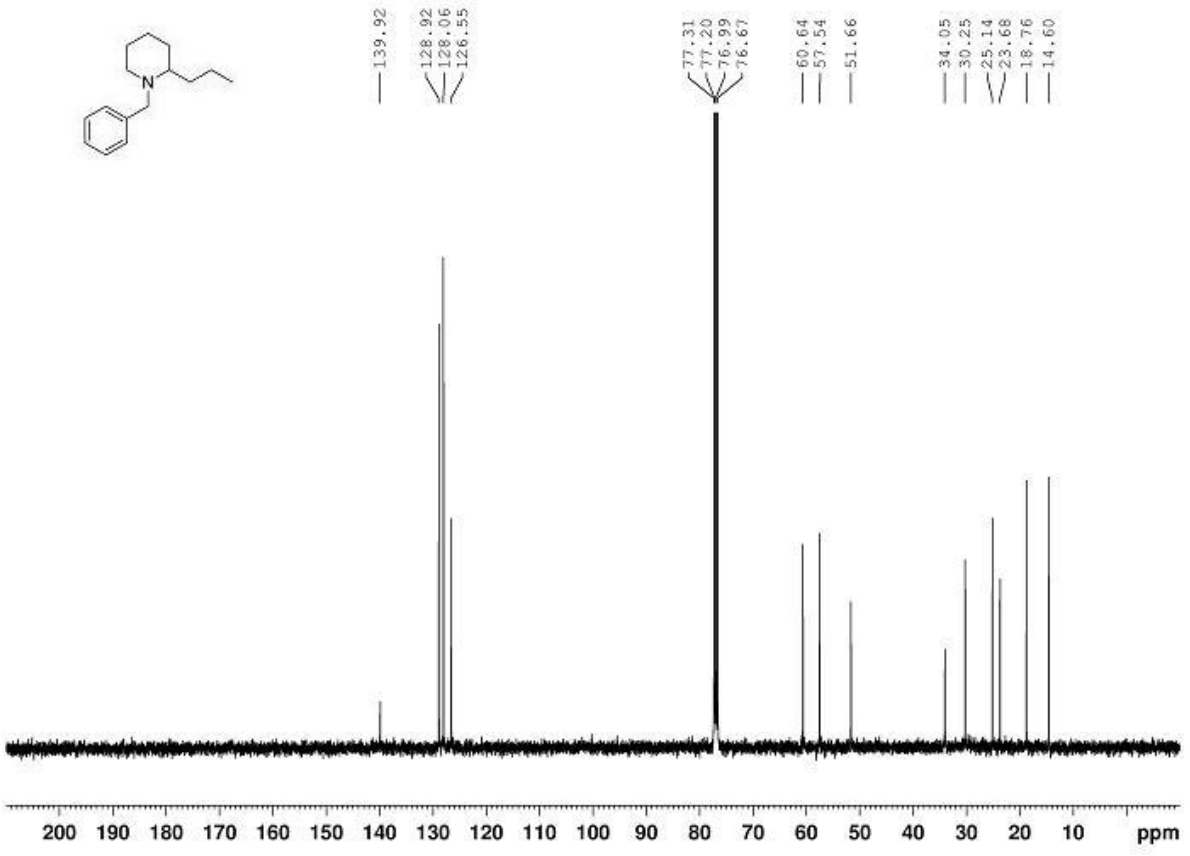
1.00
1.01
1.00
1.04
1.06
3.04
5.00
2.05
3.00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77.20
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76.67
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57.54
51.66
34.05
30.25
25.14
23.68
18.76
14.60
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150
140
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120
110
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90
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70
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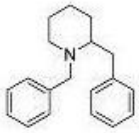
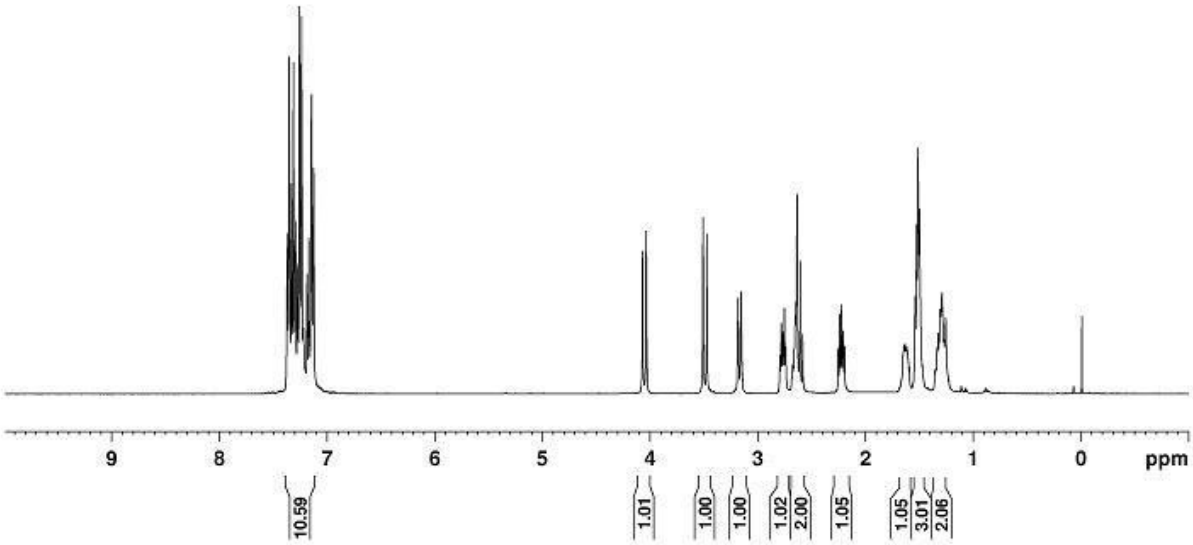
30
20
10
ppm

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8
7
6
5
4
3
2
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0
ppm
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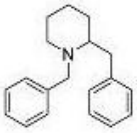
1.00
1.00
1.02
2.00
1.05
1.05
3.01
2.06



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128.13
126.69
125.71
77.31
76.99
76.67
61.69
58.50
50.85
36.44
29.29
25.35
22.41
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150
140
130
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110
100
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70
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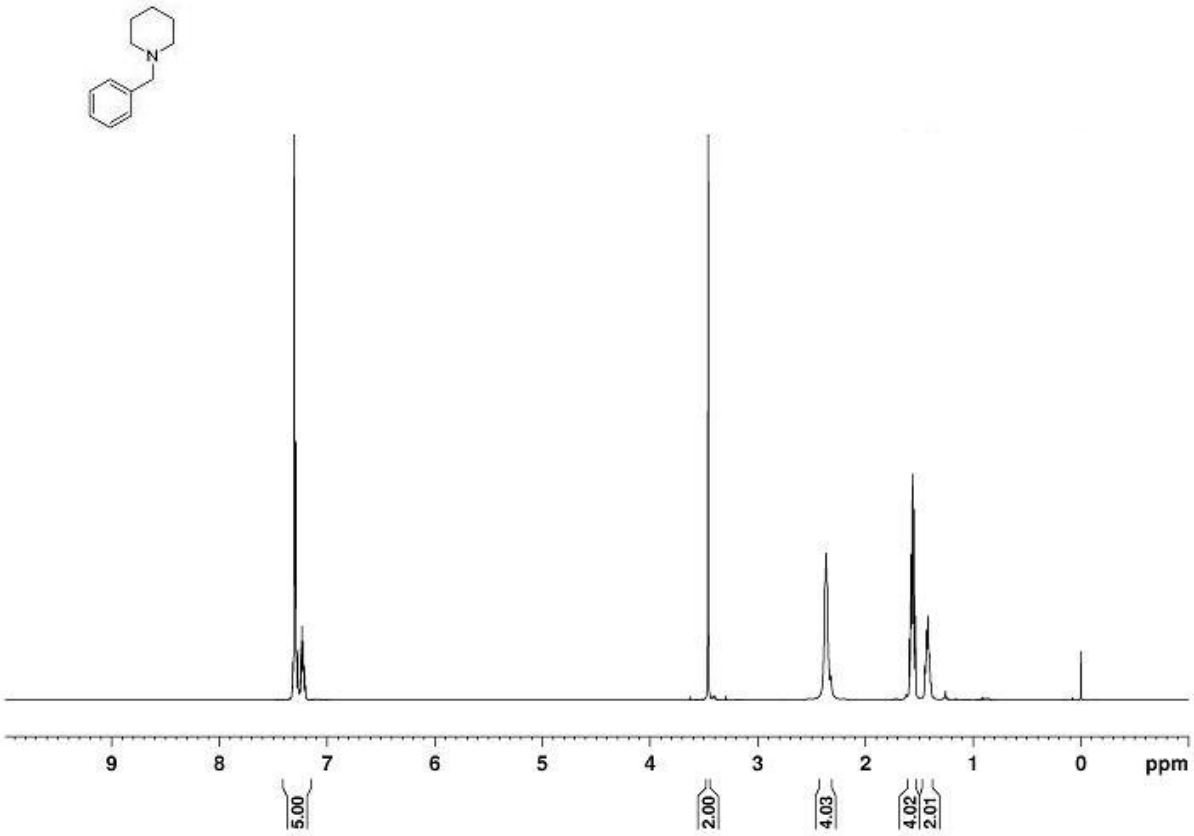
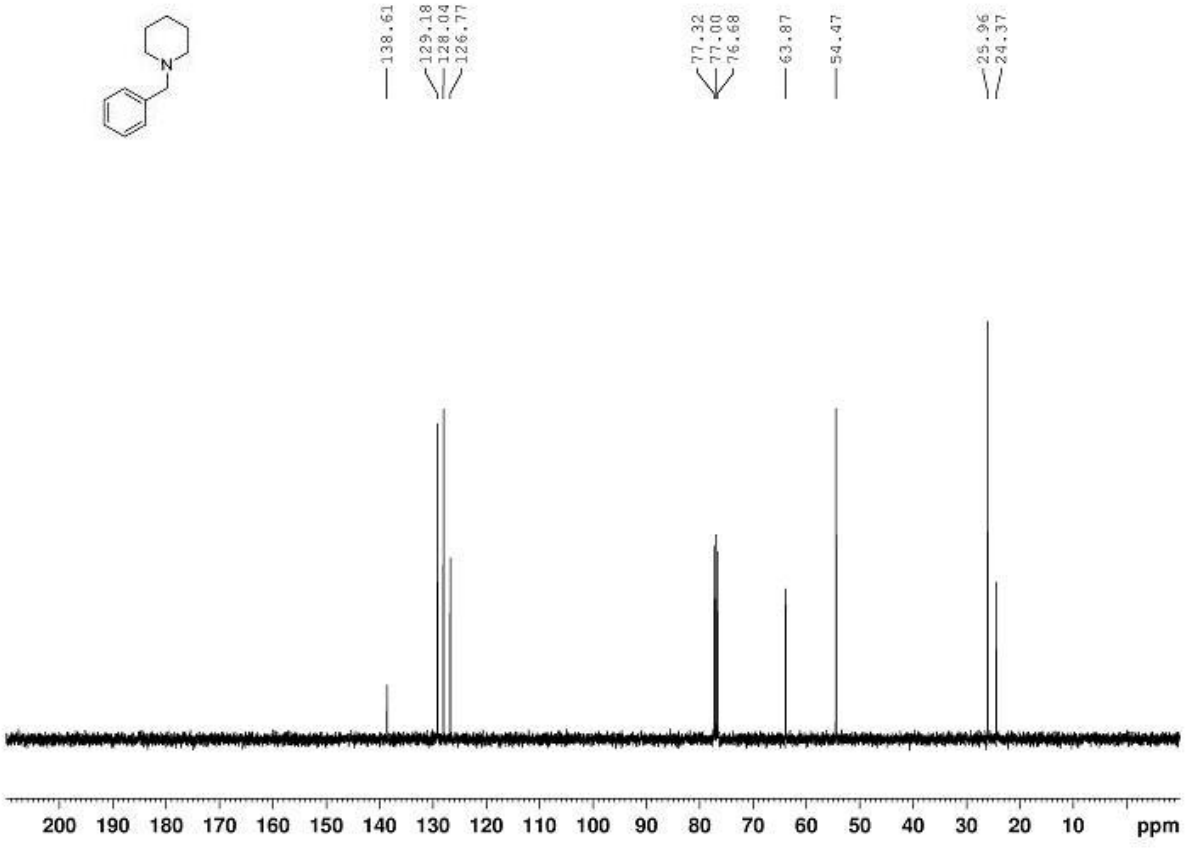
30
20
10
ppm


9
8
7
6
5
4
3
2
1
0
ppm
5.00
2.00
4.03
4.02
2.01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128.04
126.77
77.32
77.00
76.68
63.87
54.47
25.96
24.37
200
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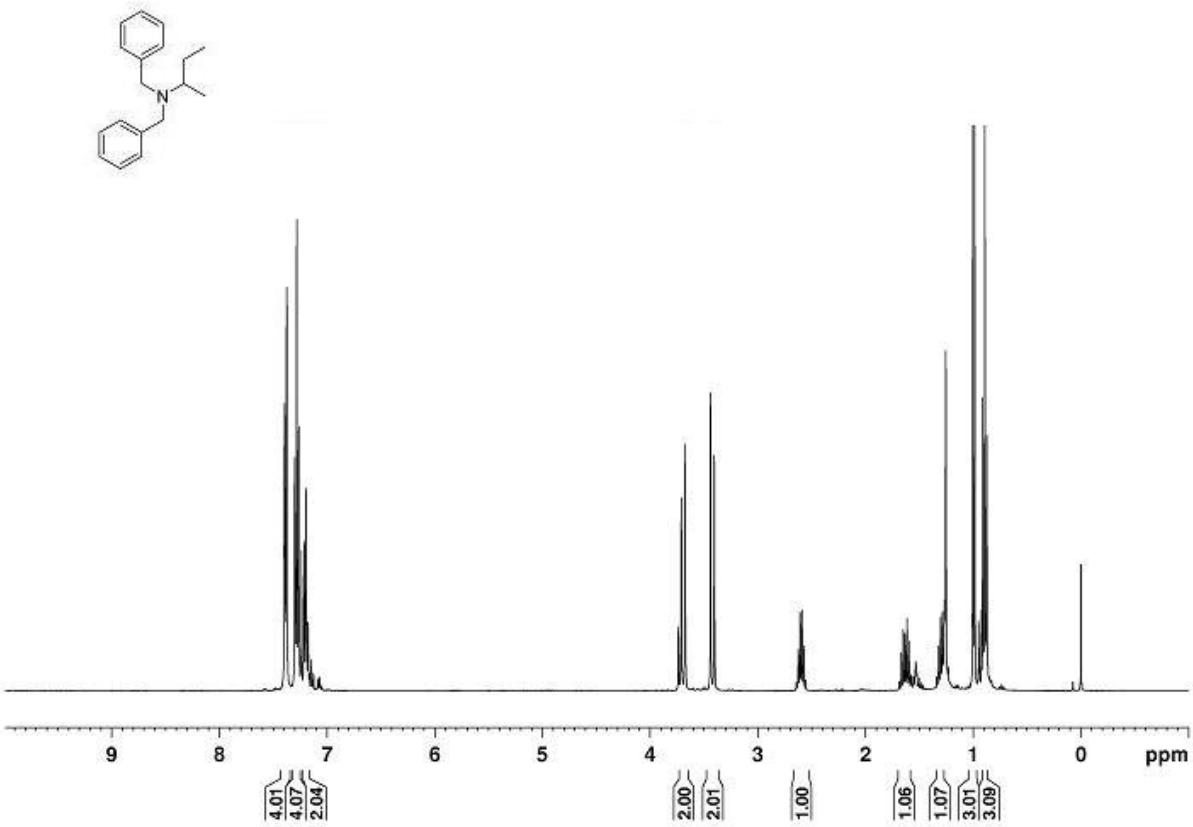
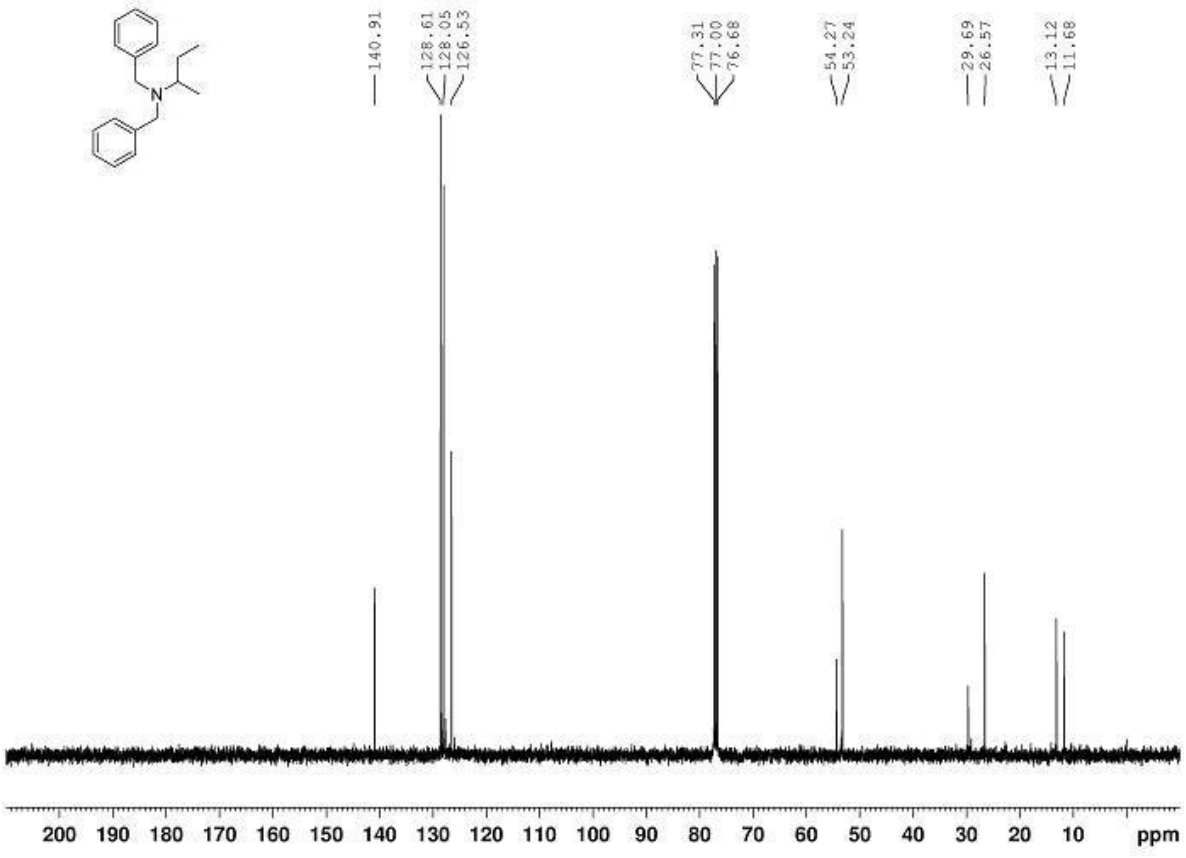
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


9
8
7
6
5
4
3
2
1
0
ppm
4.01
4.07
2.04
2.00
2.01
1.00
1.06
1.07
3.01
3.09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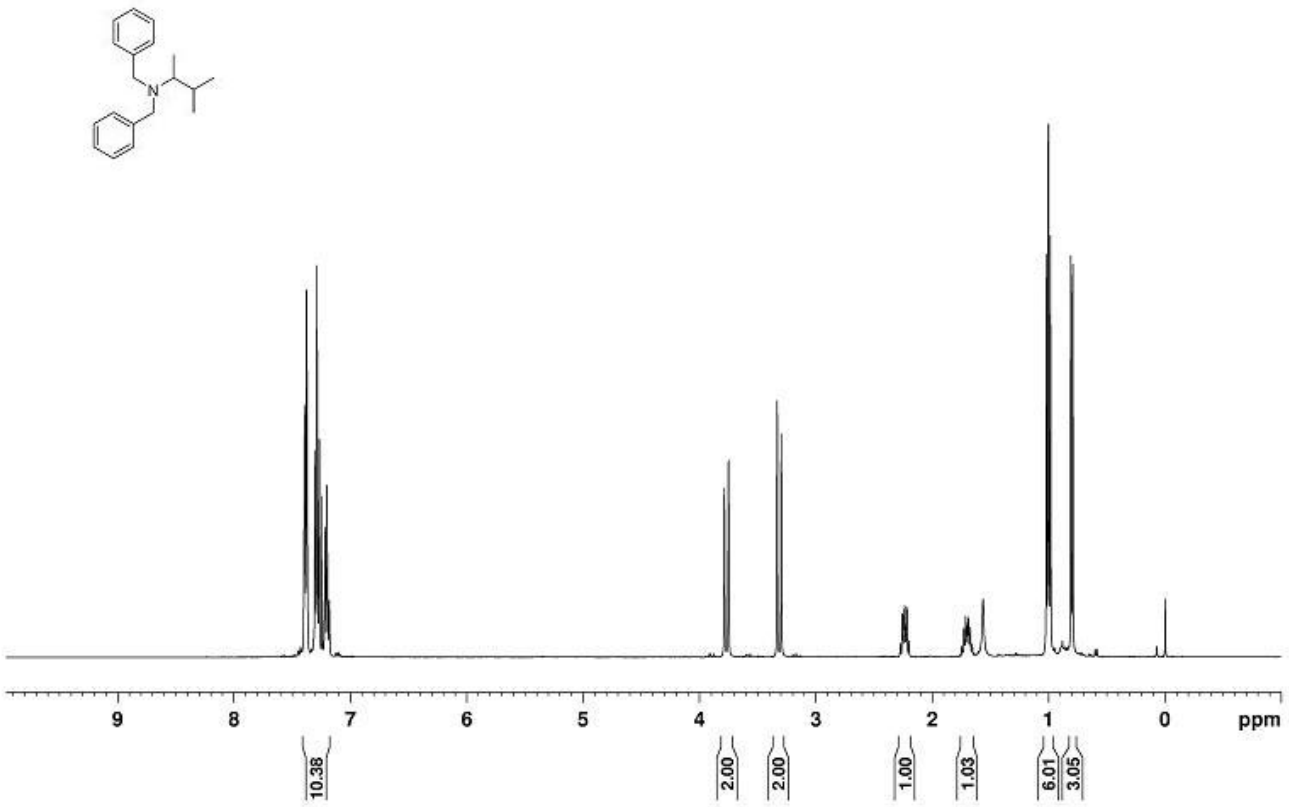
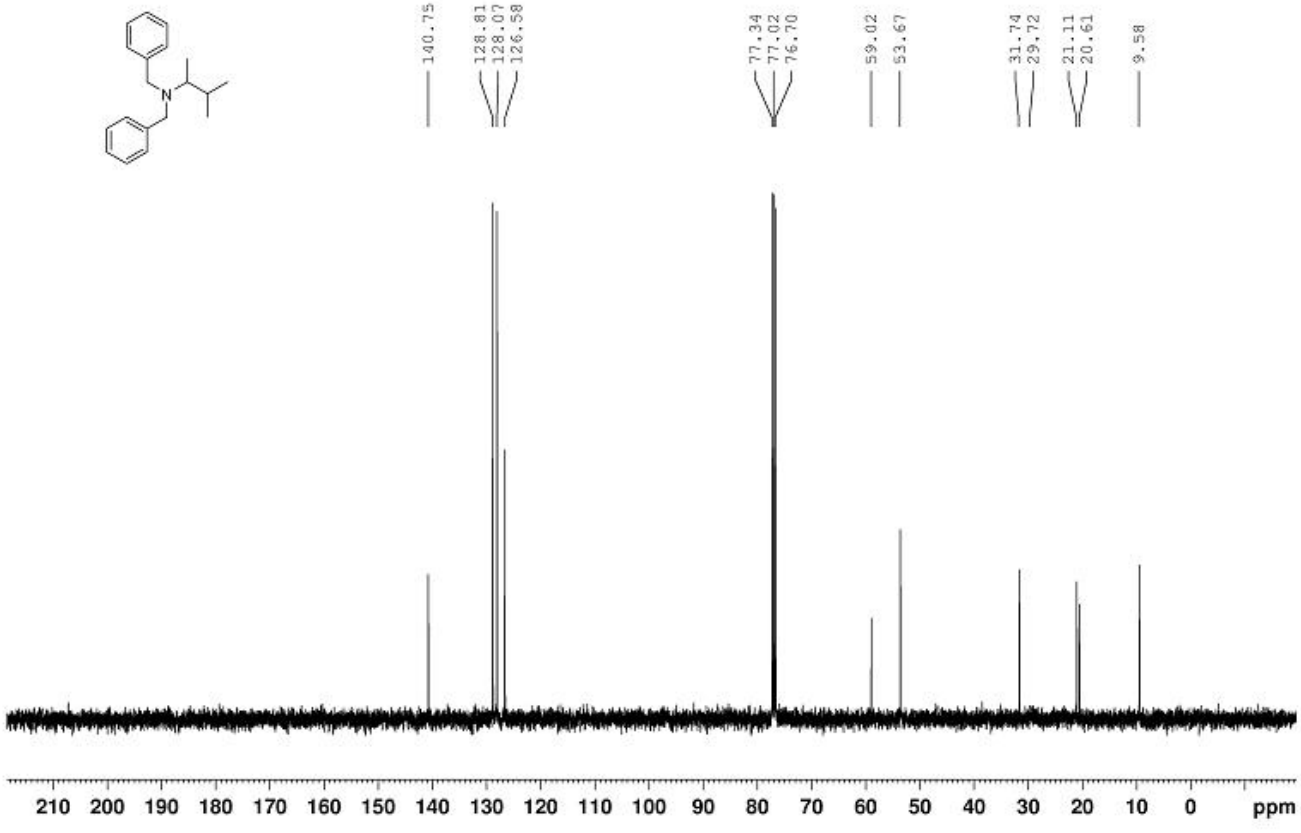
128.61
128.05
126.53
77.31
77.00
76.68
54.27
53.24
29.69
26.57
13.12
11.68
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


9
8
7
6
5
4
3
2
1
0
ppm
10.38
2.00
2.00
1.00
1.03
6.01
3.05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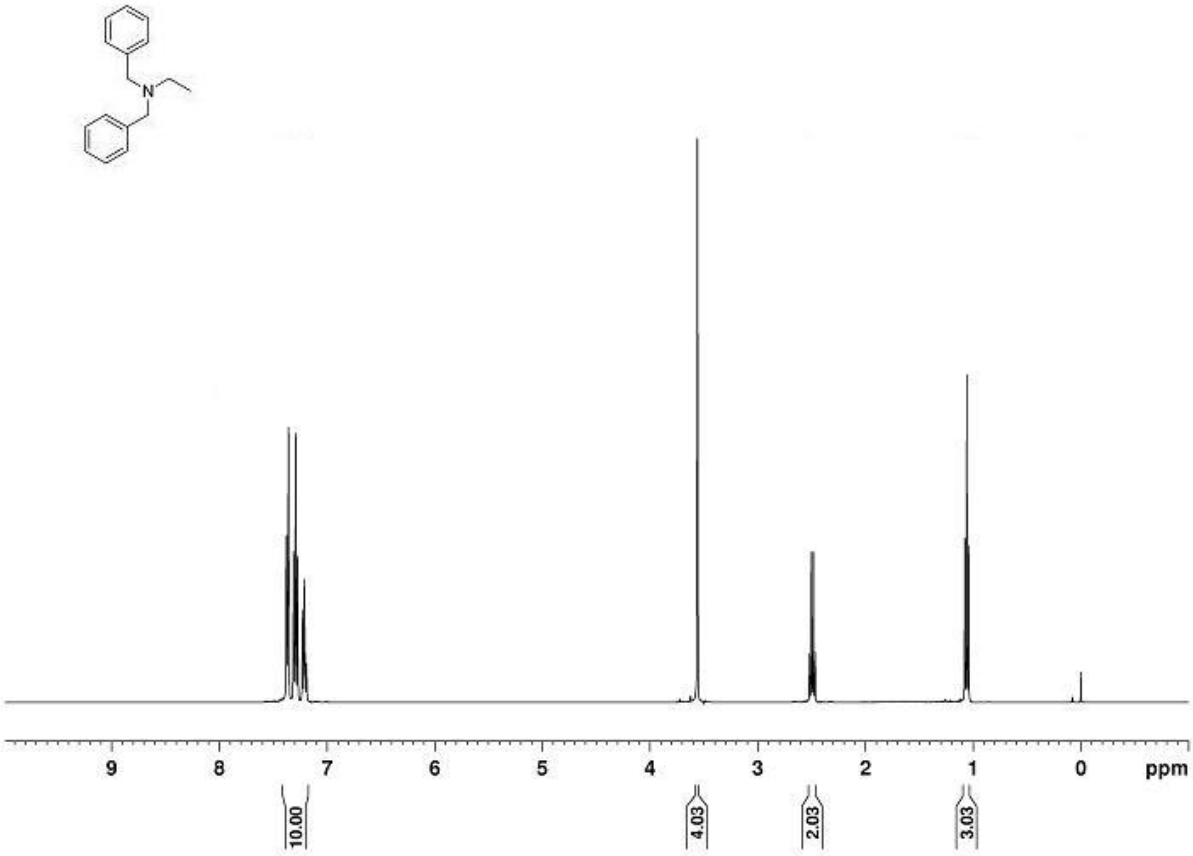
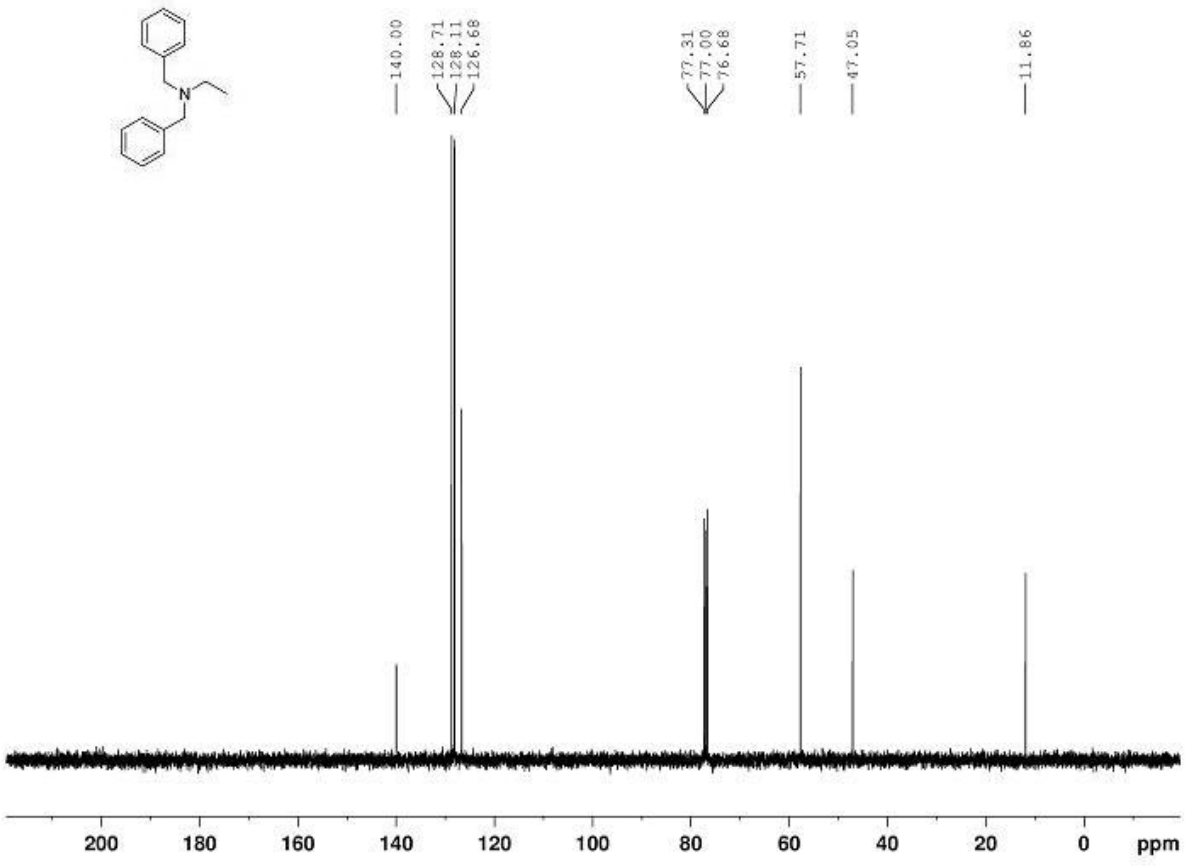
128.81
128.07
126.58
77.34
77.02
76.70
59.02
53.67
31.74
29.72
21.11
20.61
9.58
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


9
8
7
6
5
4
3
2
1
0
ppm
10.00
4.03
2.03
3.03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128.71
128.11
126.68
77.31
77.00
76.68
57.71
47.05
11.86
200
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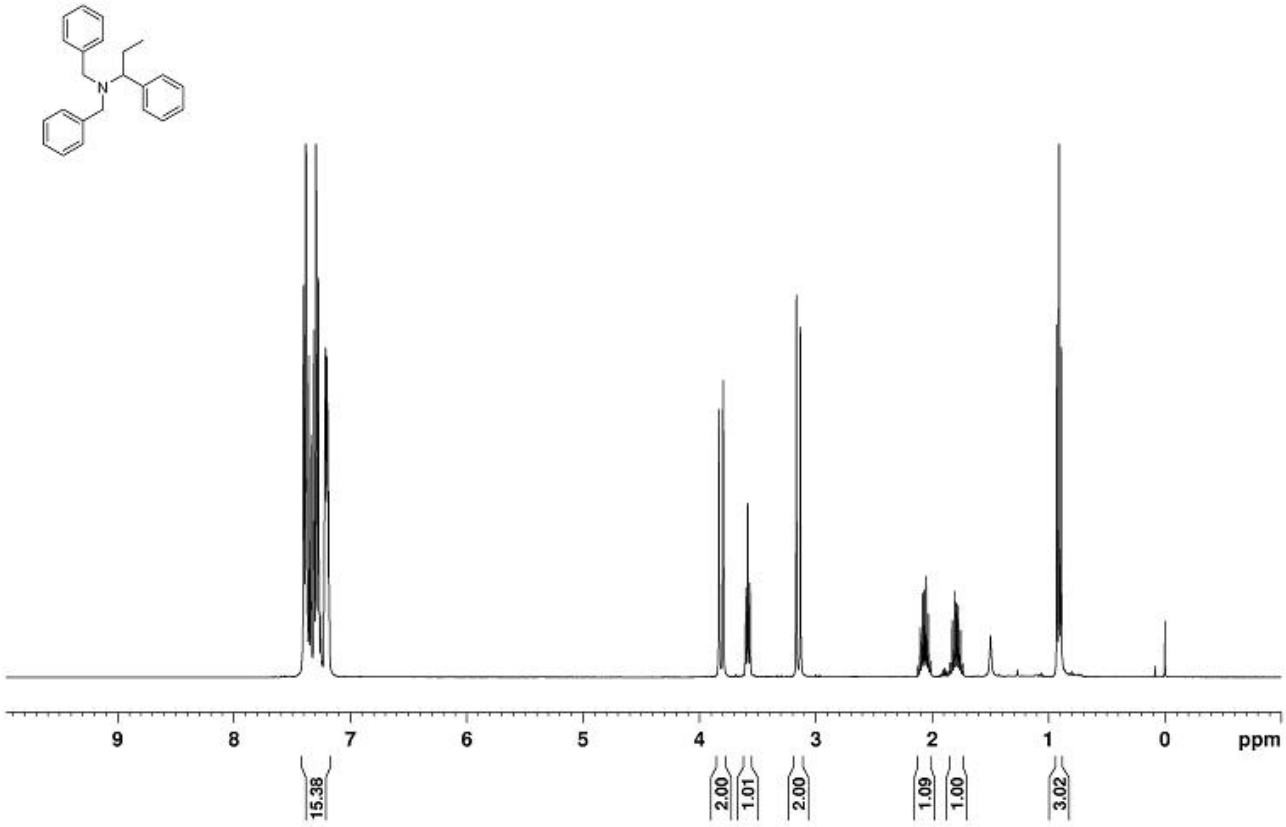
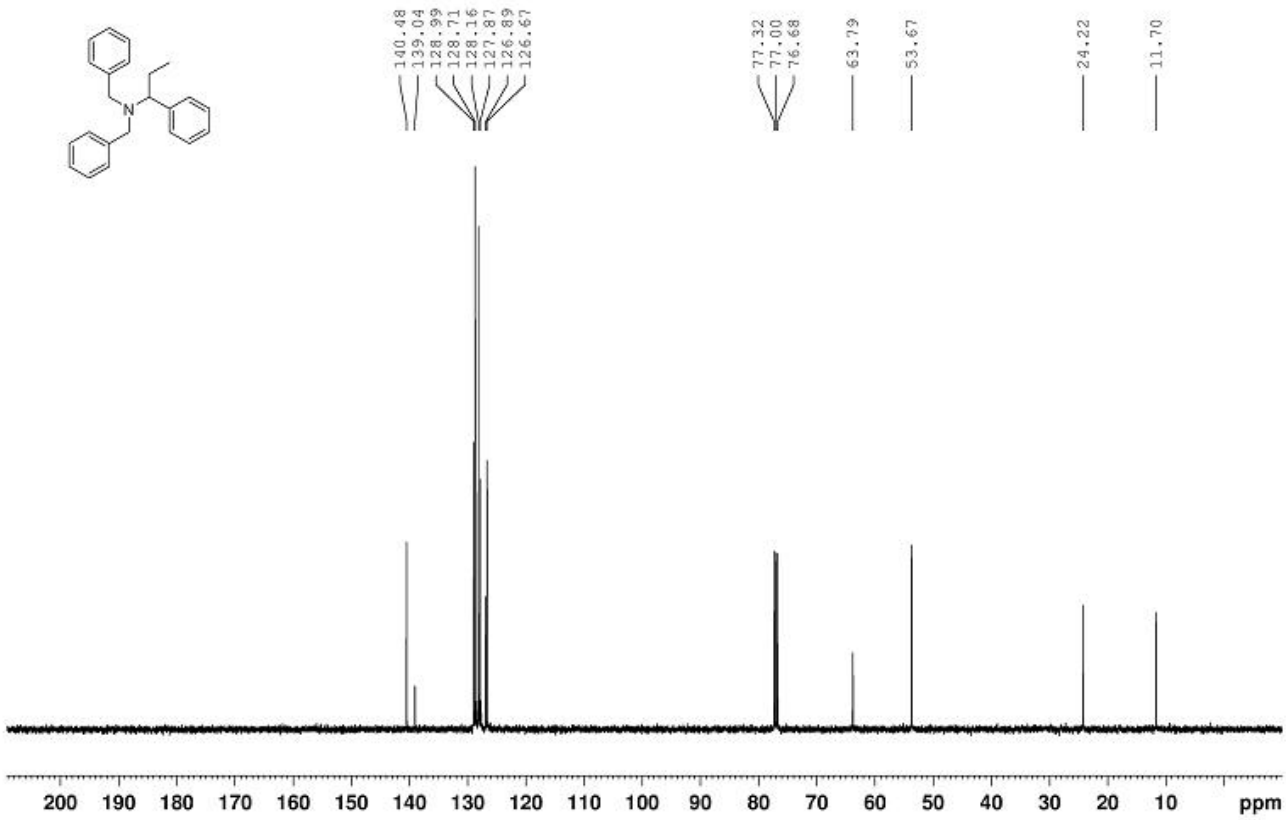
160
140
120
100
80
60
40
20
0
ppm


9
8
7
6
5
4
3
2
1
0
ppm
15.38
2.00
1.01
2.00
1.09
1.00
3.02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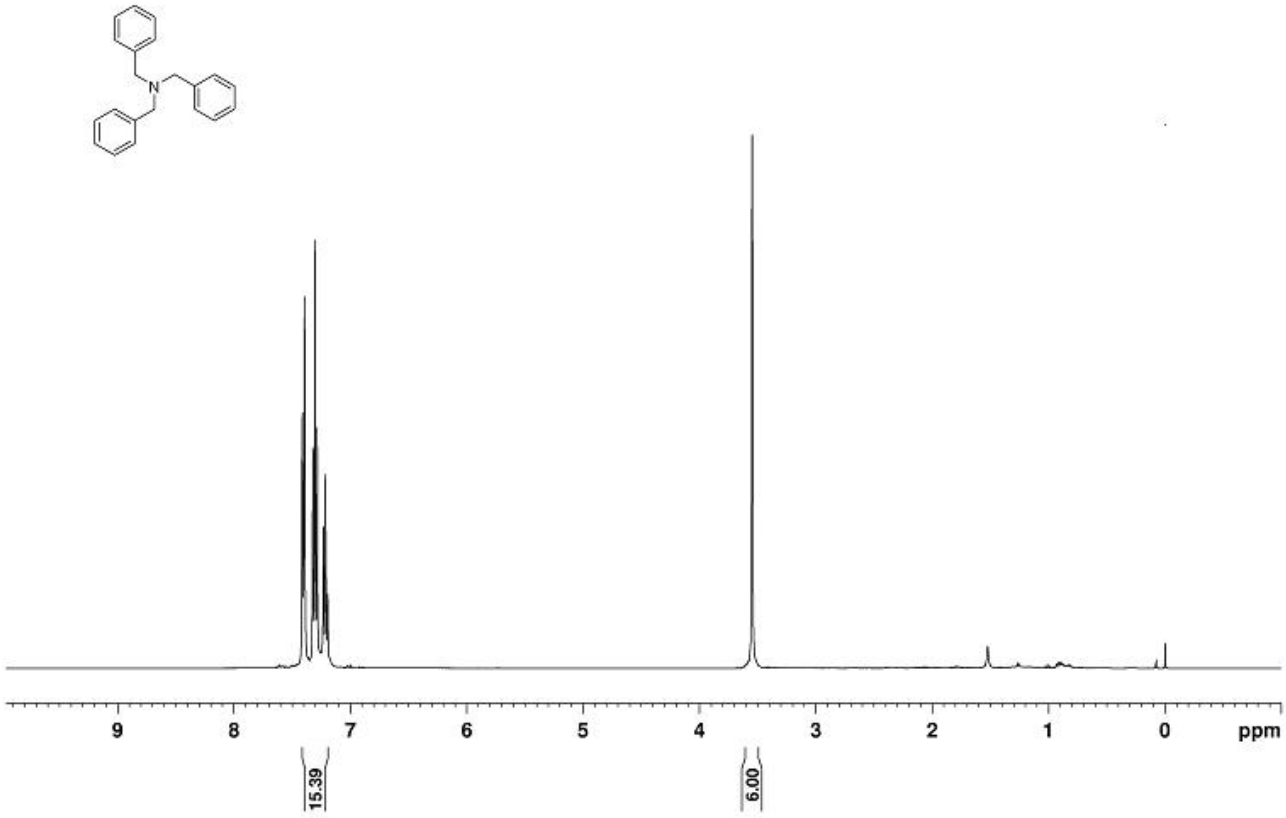
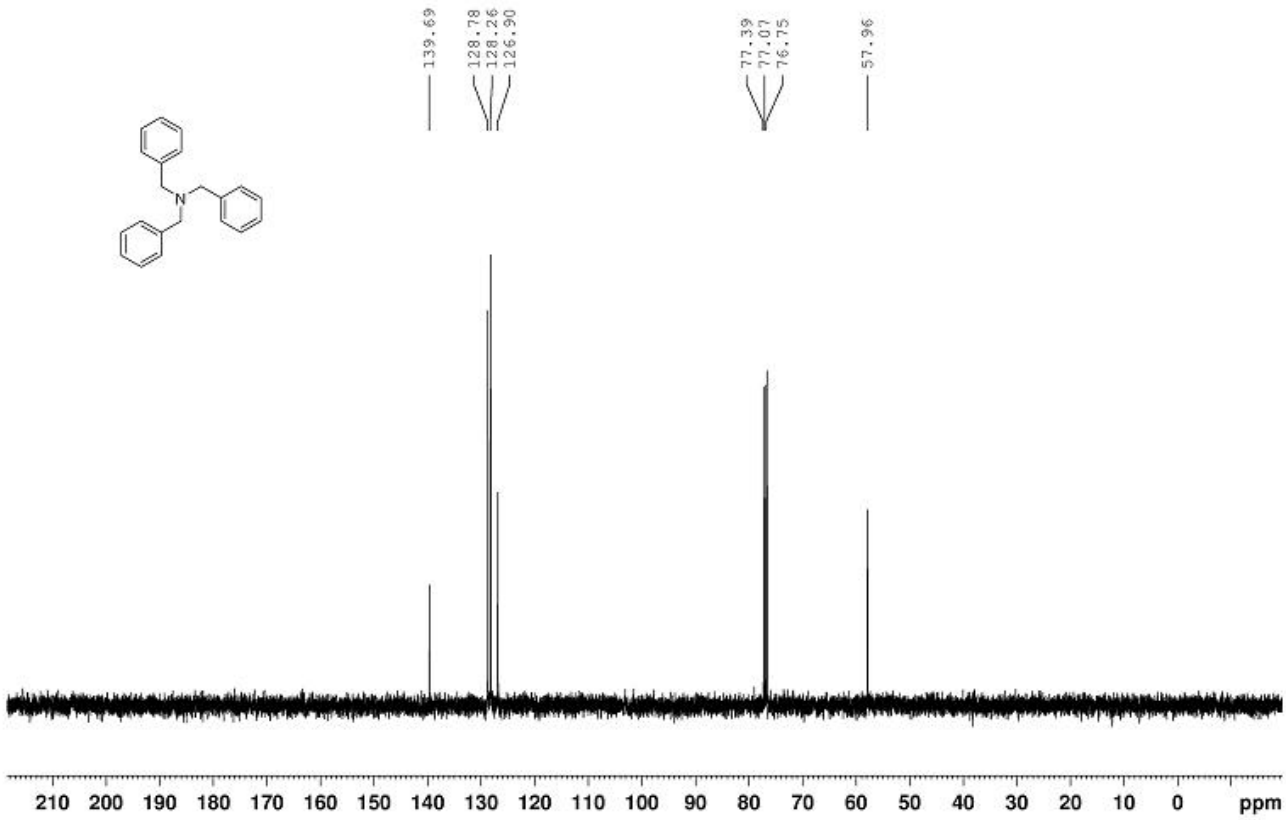
139.04
128.99
128.71
128.16
127.87
126.89
126.67
77.32
77.00
76.68
63.79
53.67
24.22
11.70
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


9
8
7
6
5
4
3
2
1
0
ppm
15.39
6.00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128.78
128.26
126.90
77.39
77.07
76.75
57.96
210
200
190
180
170
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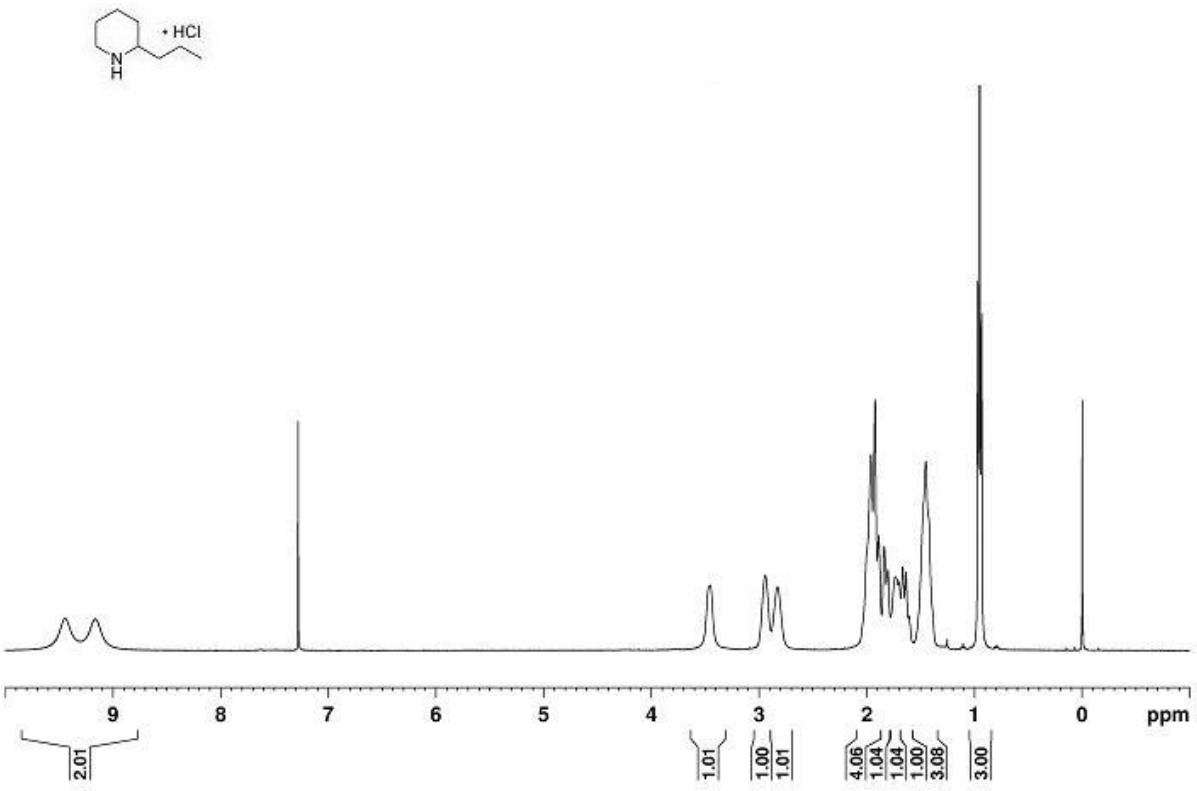
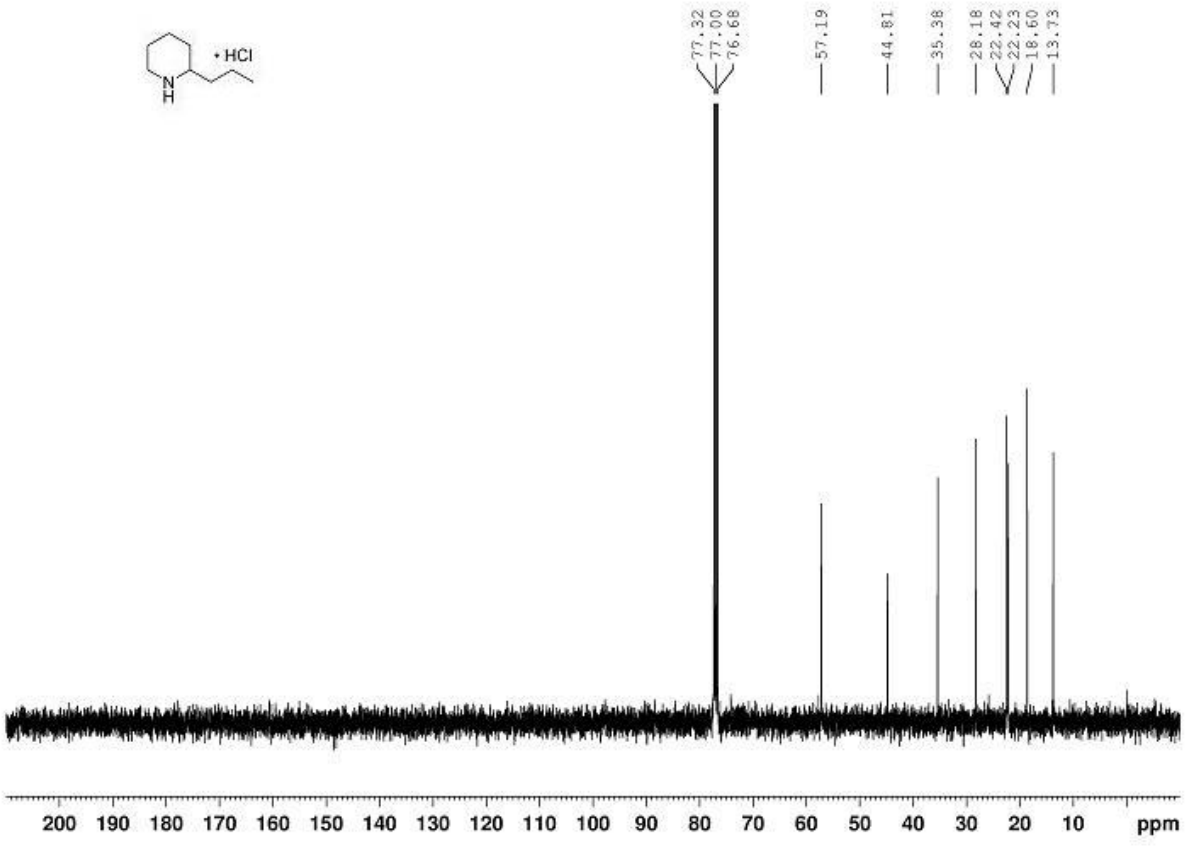
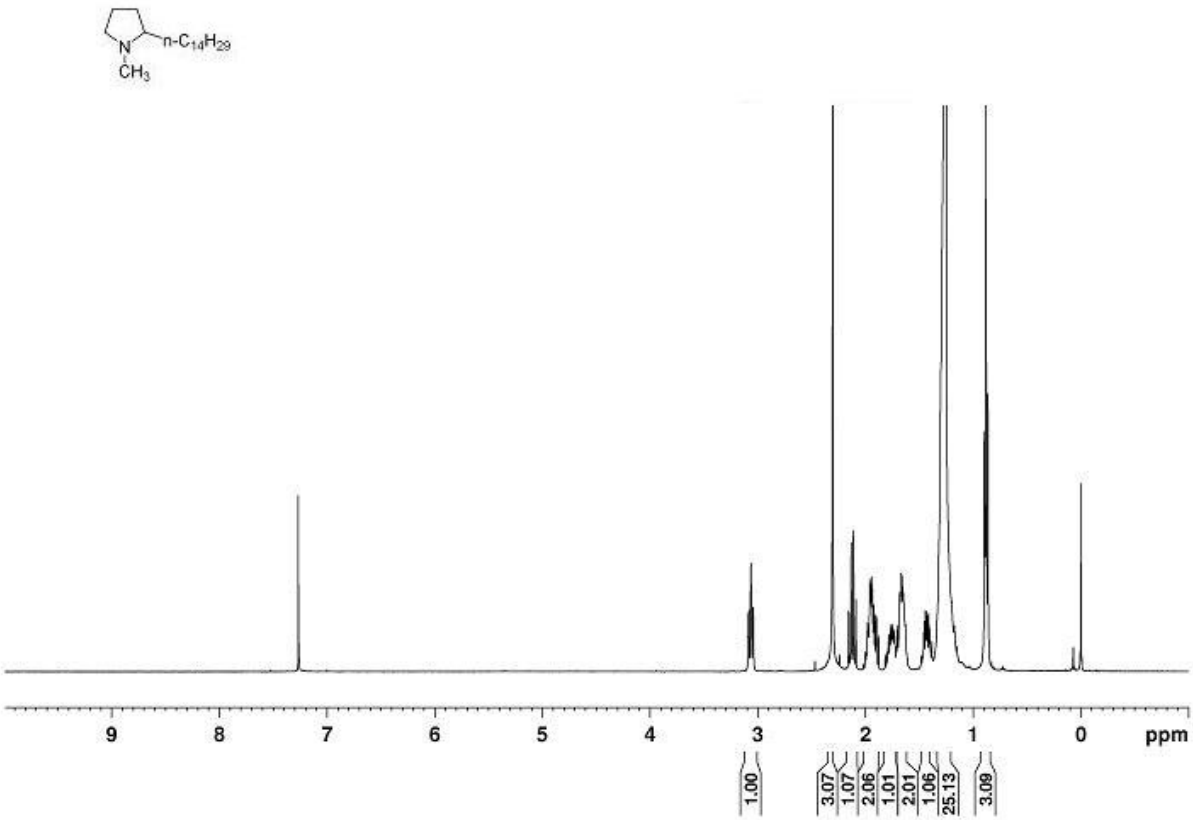
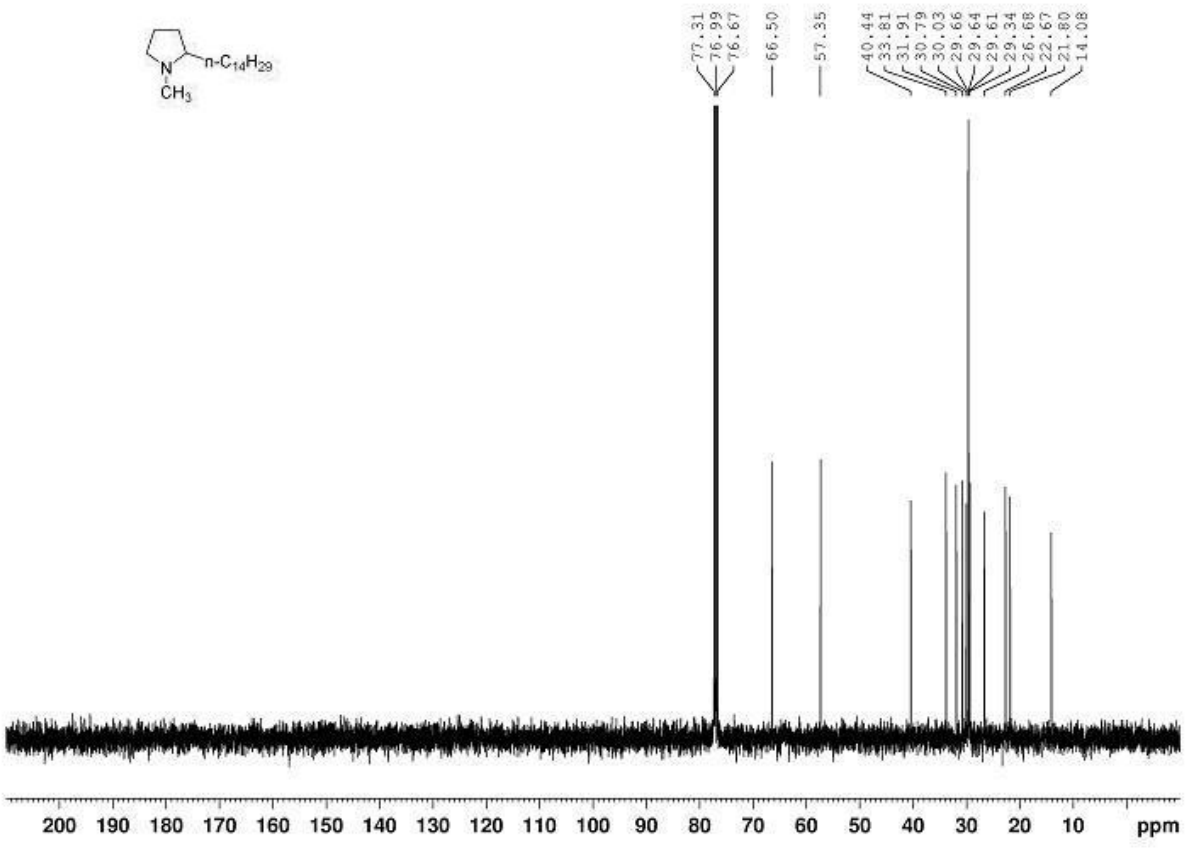
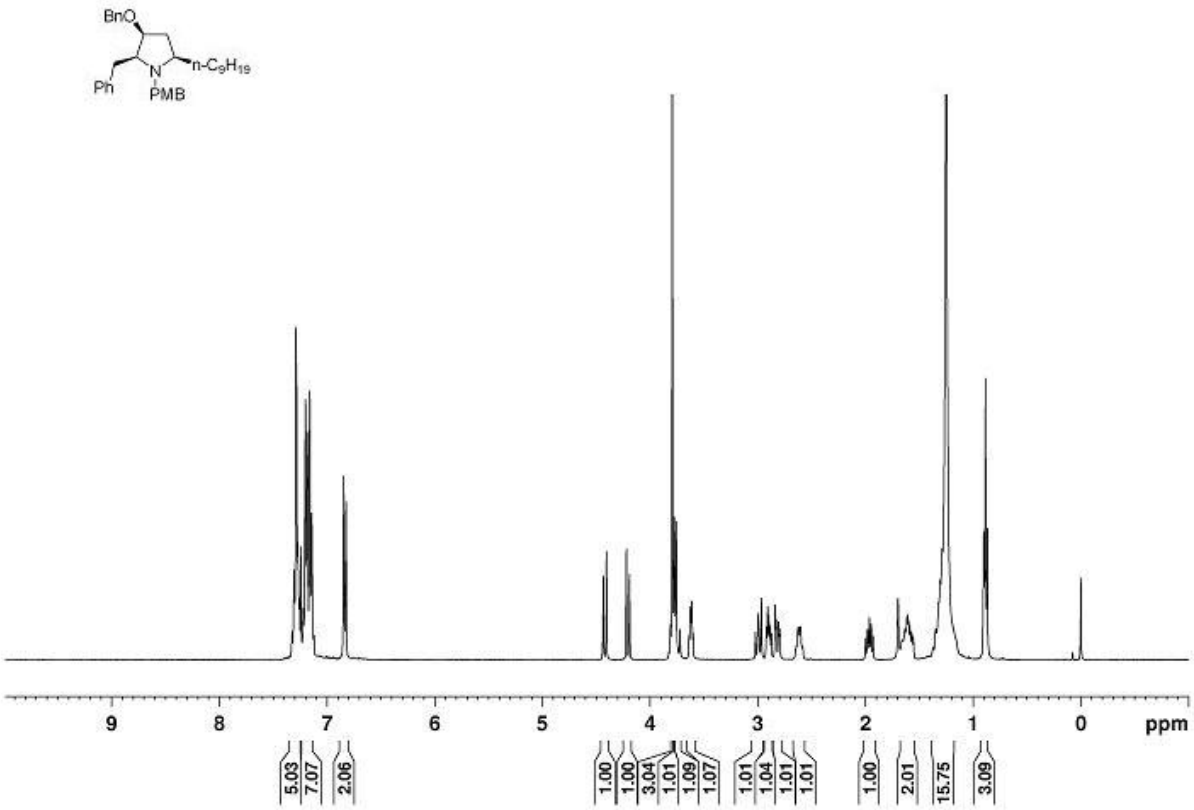
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

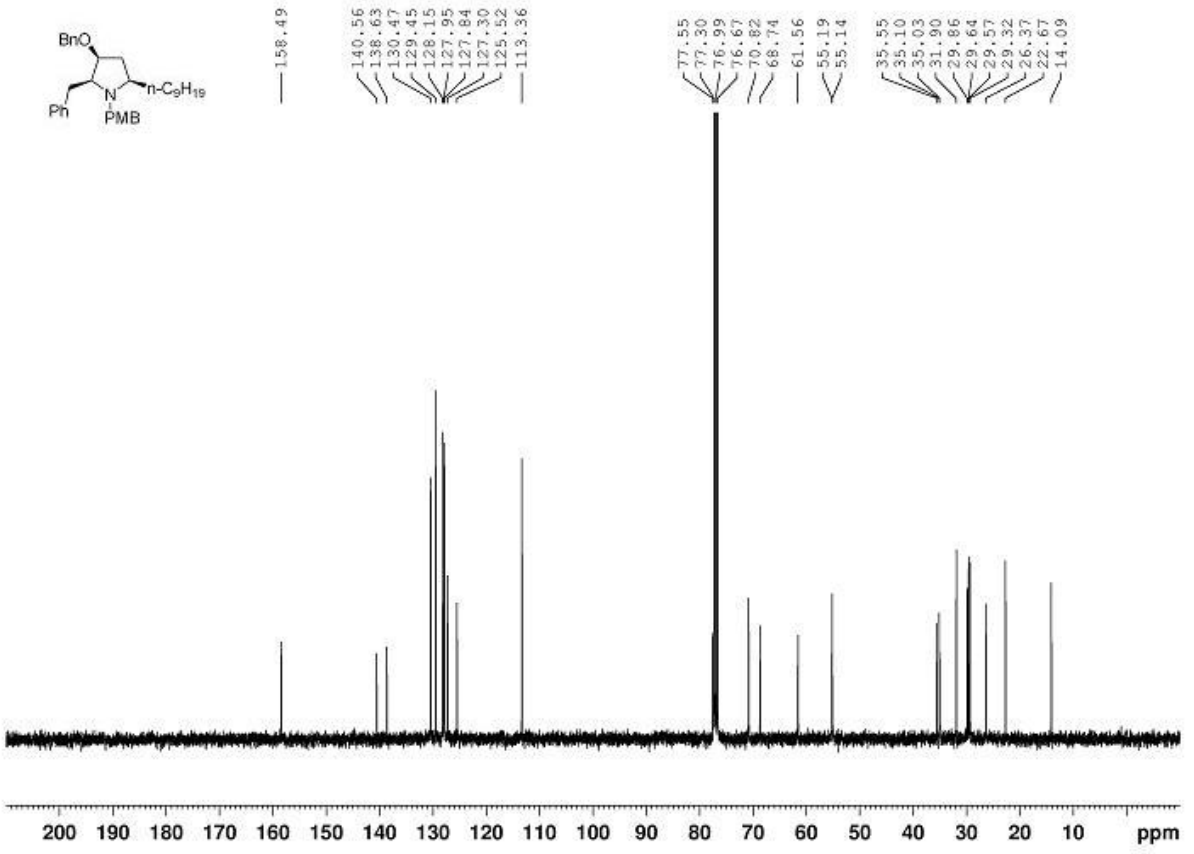

• HCl
N
H
9
8
7
6
5
4
3
2
1
0
ppm
2.01
1.01
1.00
1.01
4.06
1.04
1.04
1.00
3.08
3.00

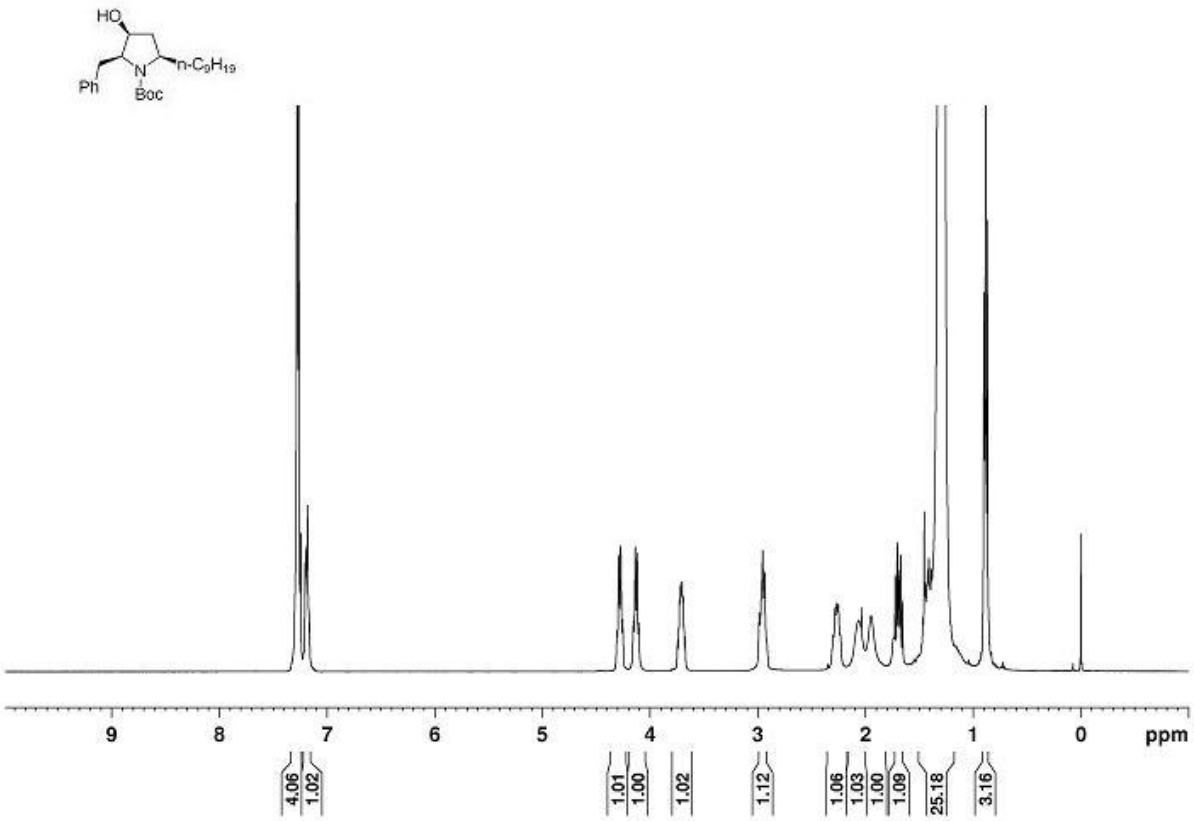

• HCl
N
H
77.32
77.00
76.68
57.19
44.81
35.38
28.18
22.42
22.23
18.60
13.73
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

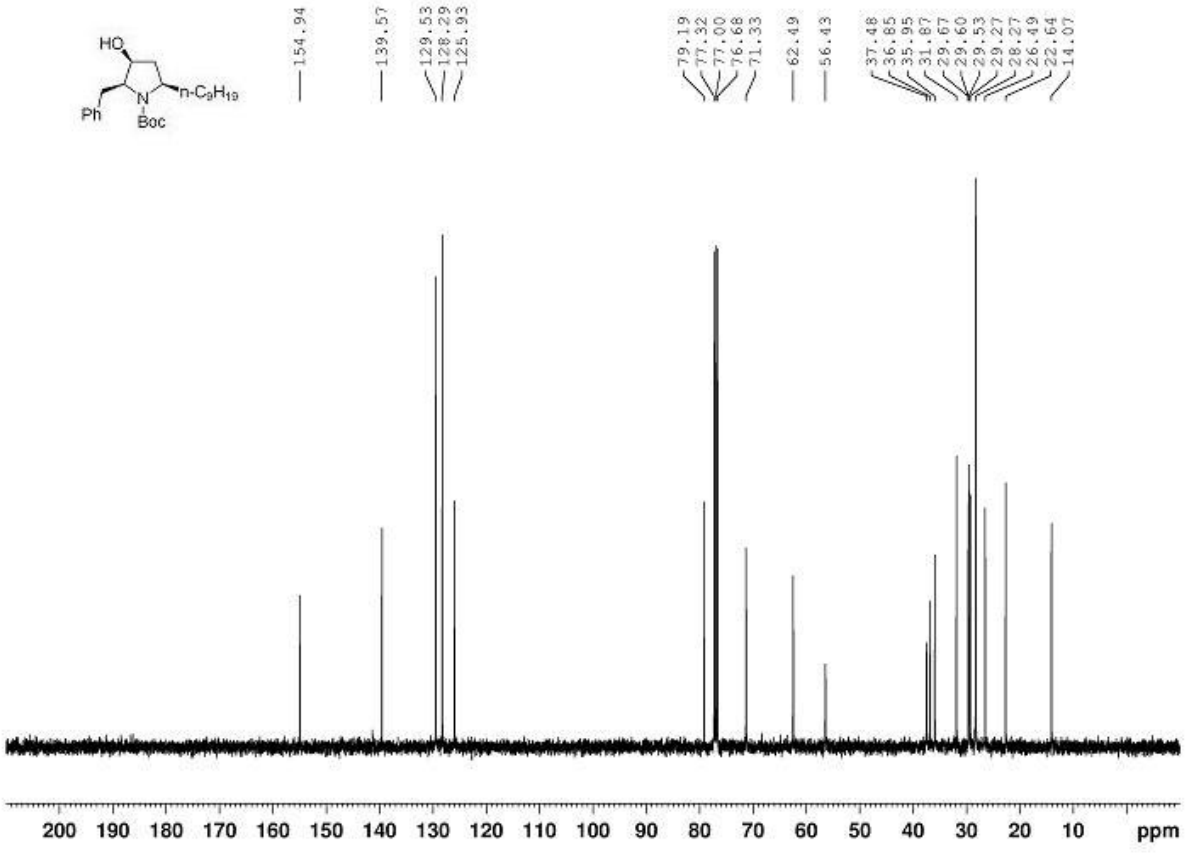

n-C14H29
N
CH3
9
8
7
6
5
4
3
2
1
0
ppm
1.00
3.07
1.07
2.06
1.01
2.01
1.06
25.13
3.09

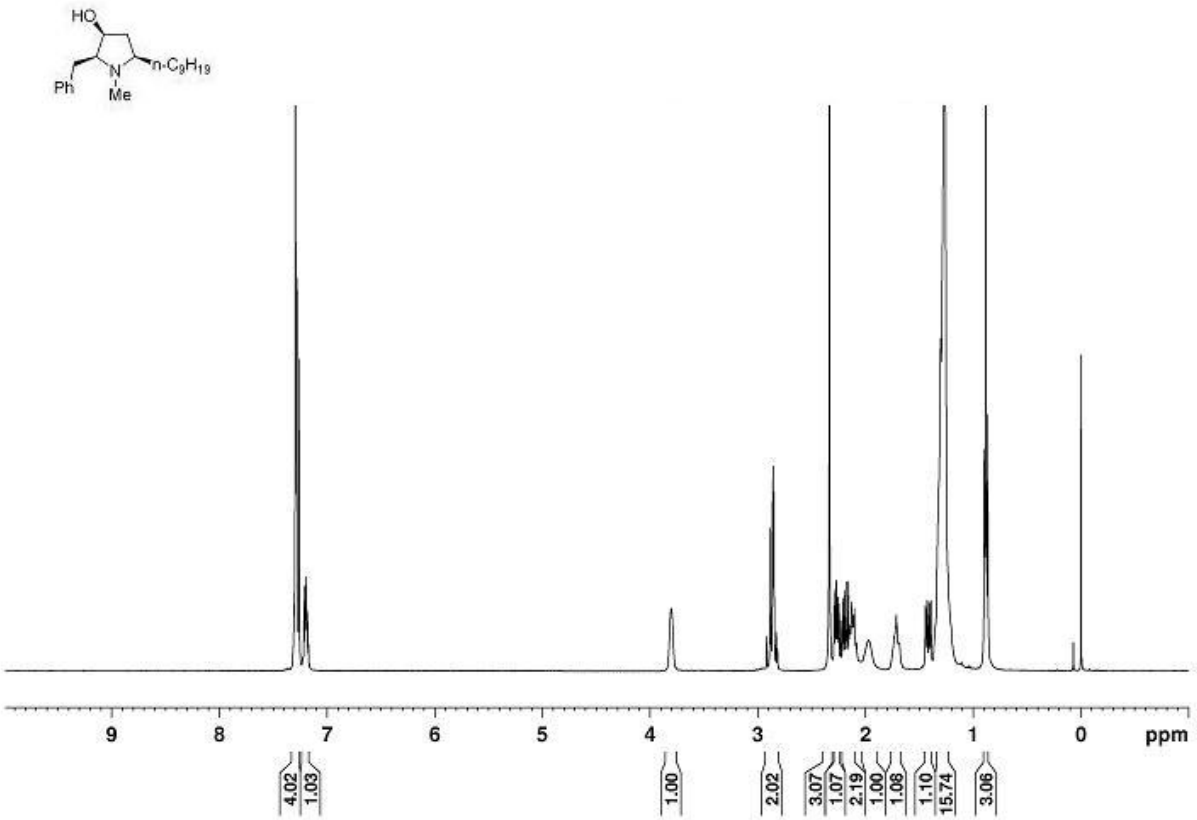

n-C14H29
N
CH3
77.31
76.99
76.67
66.50
57.35
40.44
33.81
31.91
30.79
30.03
29.66
29.64
29.61
29.34
26.68
22.67
21.80
14.08
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

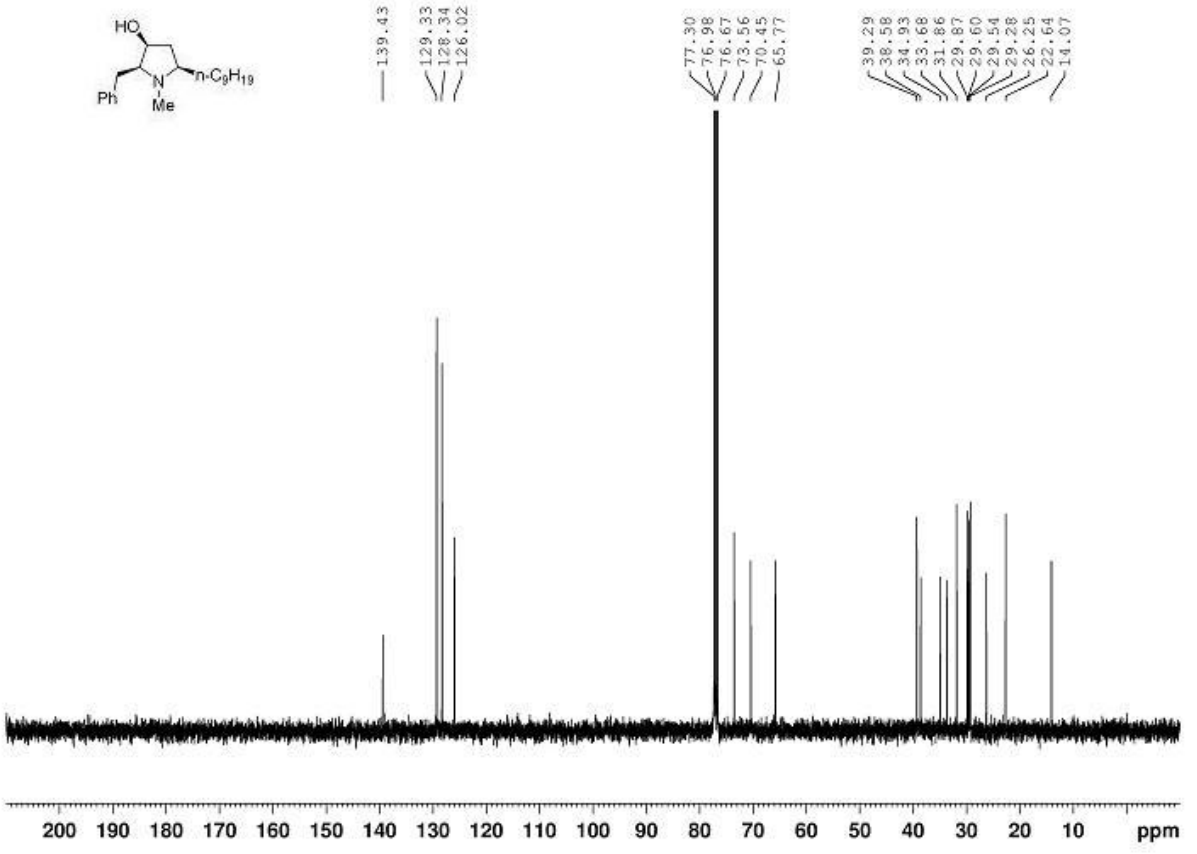

BnO
n-C9H19
Ph
N
PMB
9
8
7
6
5
4
3
2
1
0
ppm
5.03
7.07
2.06
1.00
1.00
3.04
1.01
1.09
1.07
1.01
1.04
1.01
1.01
1.00
2.01
15.75
3.09

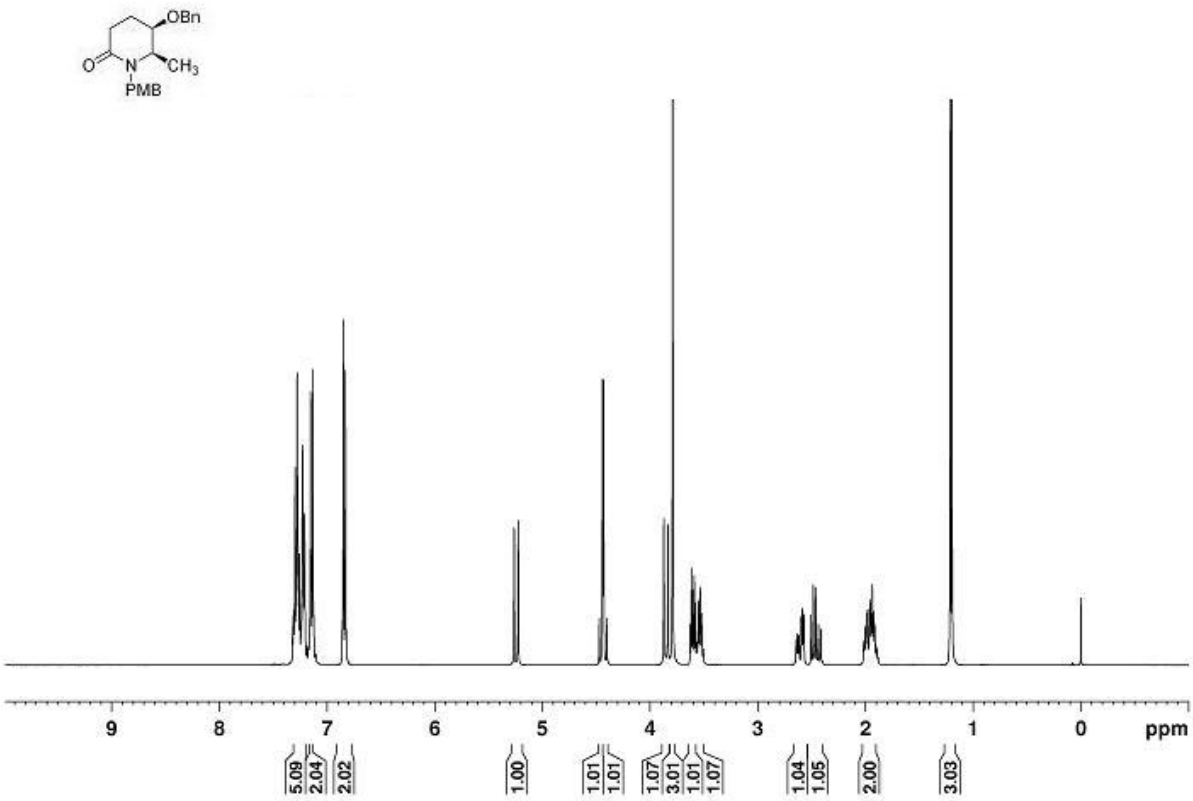

BnO
n-C9H19
Ph
N
PMB
158.49
140.56
138.63
130.47
129.45
128.15
127.95
127.84
127.30
125.52
113.36
77.55
77.30
76.99
76.67
70.82
68.74
61.56
55.19
55.14
35.55
35.10
35.03
31.90
29.86
29.64
29.57
29.32
26.37
22.67
14.09
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

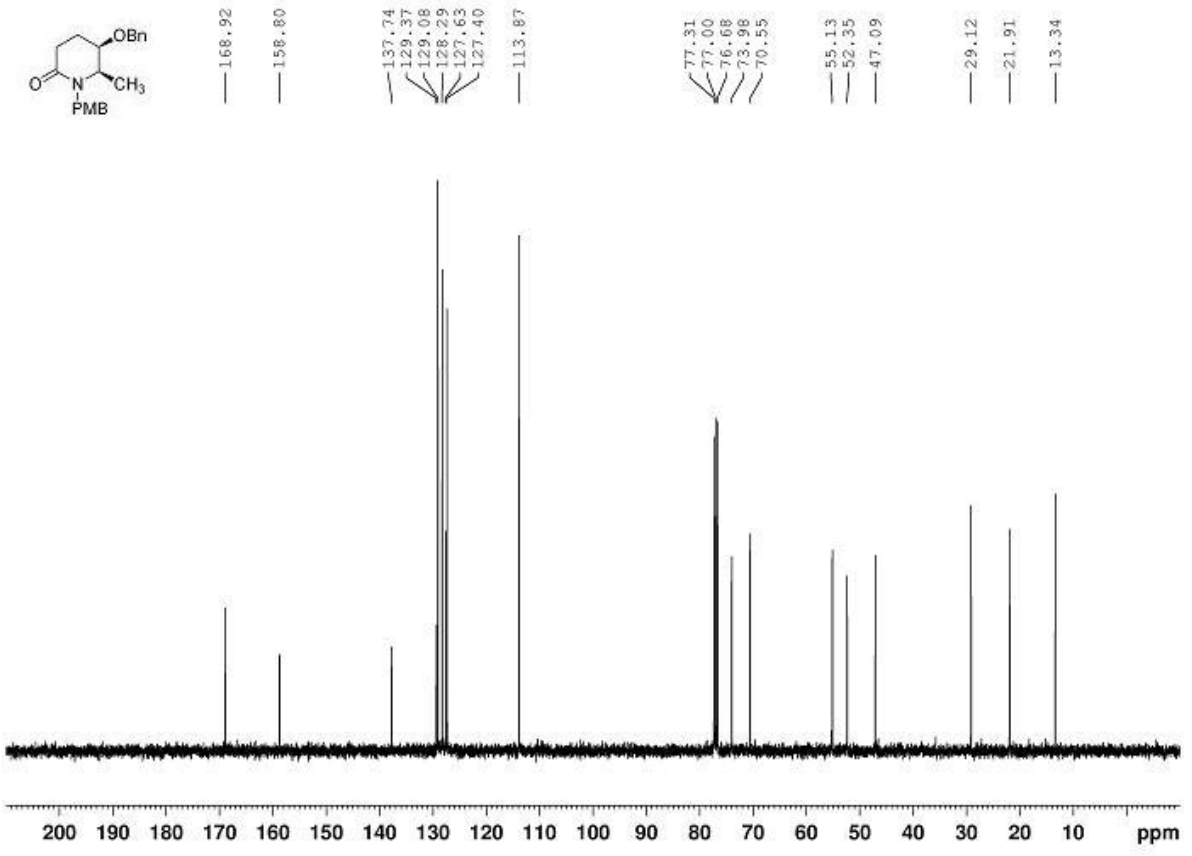

HO
n-C9H19
Ph
N
Boc
9
8
7
6
5
4
3
2
1
0
ppm
4.06
1.02
1.01
1.00
1.02
1.12
1.06
1.03
1.00
1.09
25.18
3.16

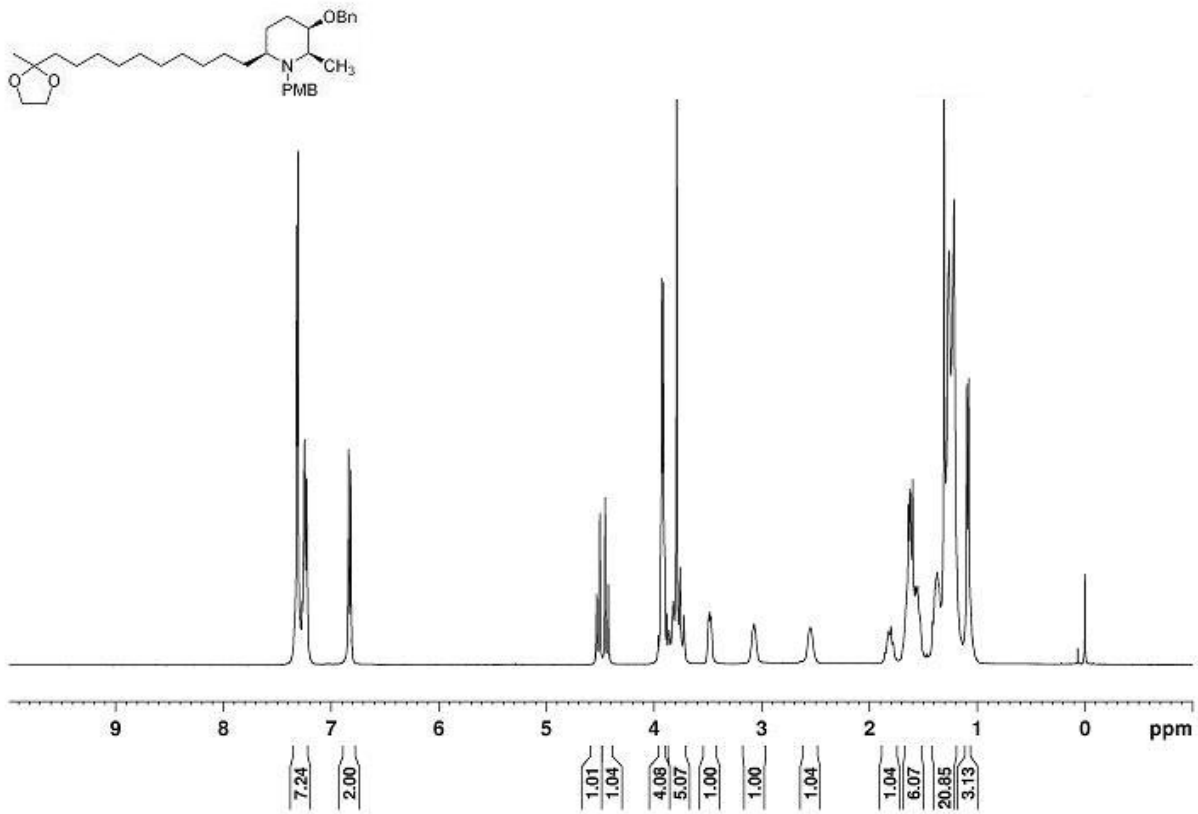

HO
n-C9H19
Ph
N
Boc
154.94
139.57
129.53
128.29
125.93
79.19
77.32
77.00
76.68
71.33
62.49
56.43
37.48
36.85
35.95
31.87
29.67
29.60
29.53
29.27
28.27
26.49
22.64
14.07
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

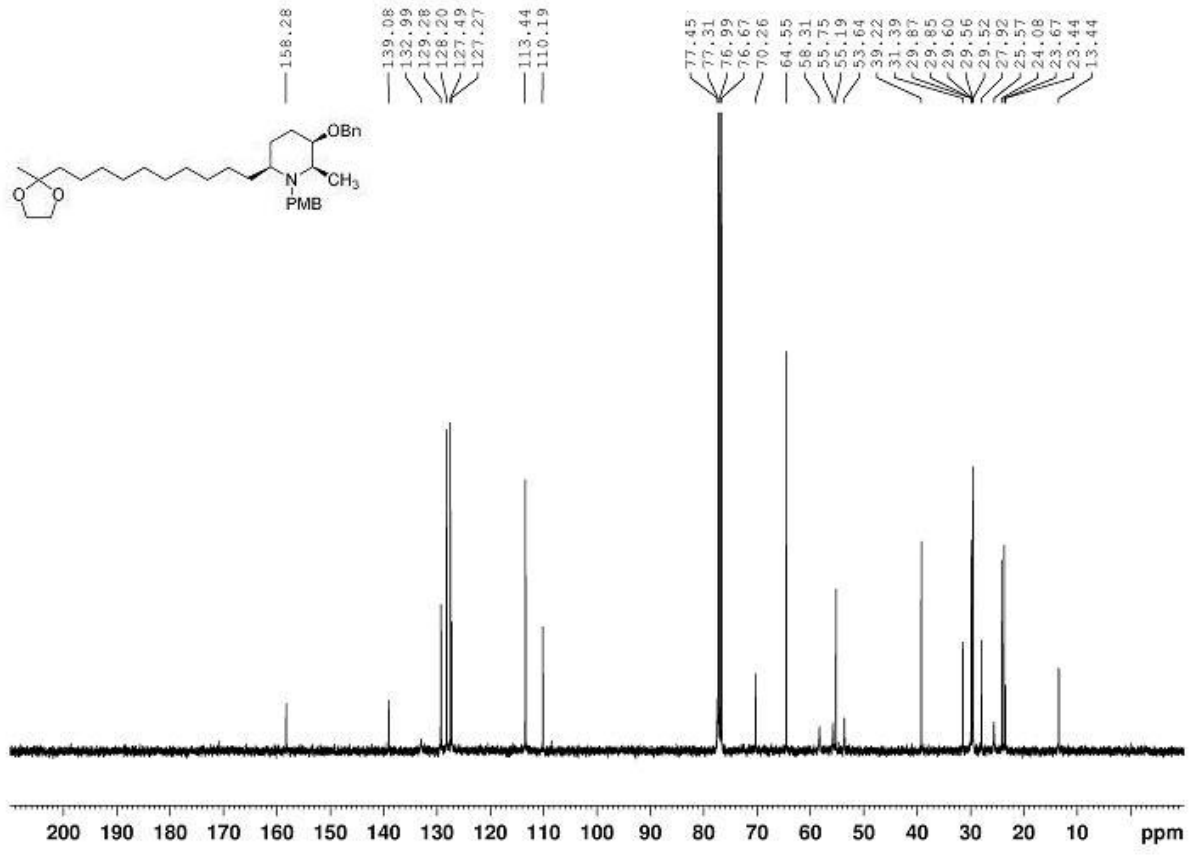

HO
n-C9H19
Ph
N
Me
9
8
7
6
5
4
3
2
1
0
ppm
4.02
1.03
1.00
2.02
3.07
1.07
2.19
1.00
1.08
1.10
15.74
3.06


HO
n-C9H19
Ph
N
Me
139.43
129.33
128.34
126.02
77.30
76.98
76.67
73.56
70.45
65.77
39.29
38.58
34.93
33.68
31.86
29.87
29.60
29.54
29.28
26.25
22.64
14.07
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


OBn
CH3
N
PMB
O
9
8
7
6
5
4
3
2
1
0
ppm
5.09
2.04
2.02
1.00
1.01
1.01
1.07
3.01
1.01
1.07
1.04
1.05
2.00
3.03


OBn
CH3
N
PMB
O
168.92
158.80
137.74
129.37
129.08
128.29
127.63
127.40
113.87
77.31
77.00
76.68
73.98
70.55
55.13
52.35
47.09
29.12
21.91
13.34
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


OBn
CH3
N
PMB
9
8
7
6
5
4
3
2
1
0
ppm
7.24
2.00
1.01
1.04
4.08
5.07
1.00
1.00
1.04
1.04
6.07
20.85
3.13


158.28
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129.28
128.20
127.49
127.27
113.44
110.19
77.45
77.31
76.99
76.67
70.26
64.55
58.31
55.75
55.19
53.64
39.22
31.39
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29.56
29.52
27.92
25.57
24.08
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23.44
13.44
OBn
CH3
N
PMB
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110
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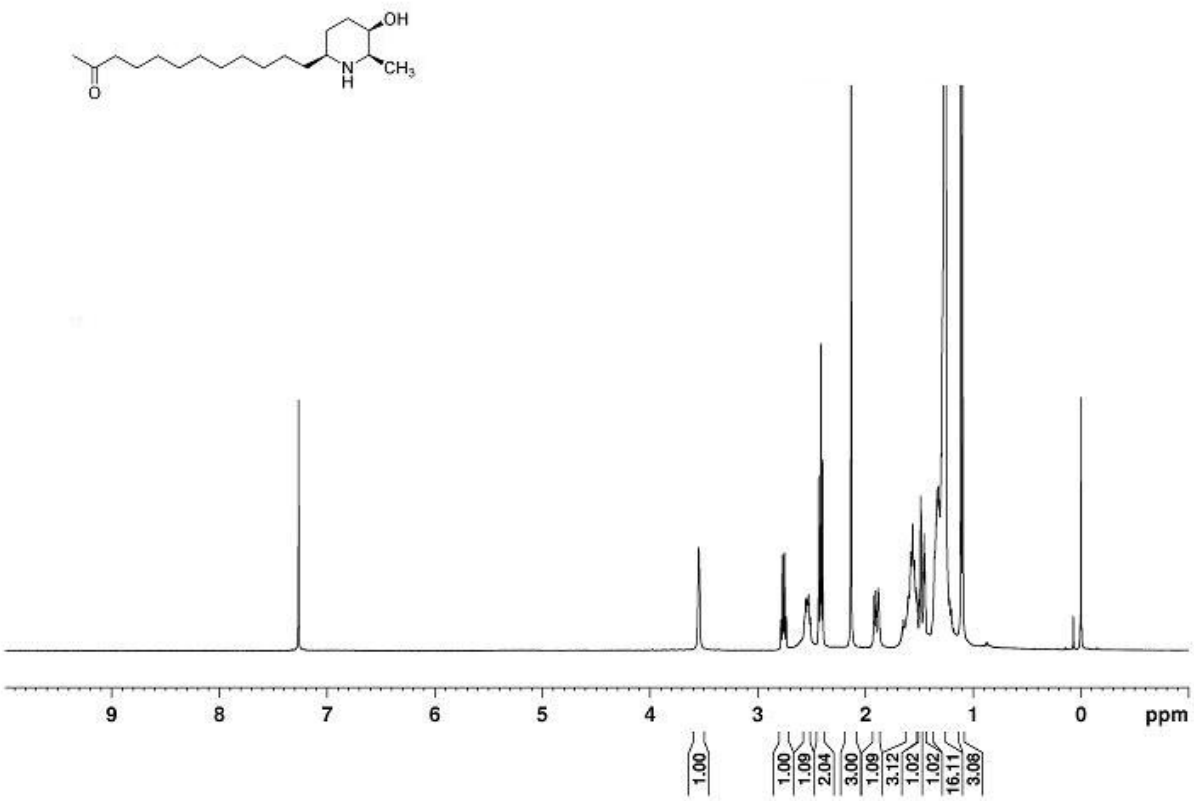
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O
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6
5
4
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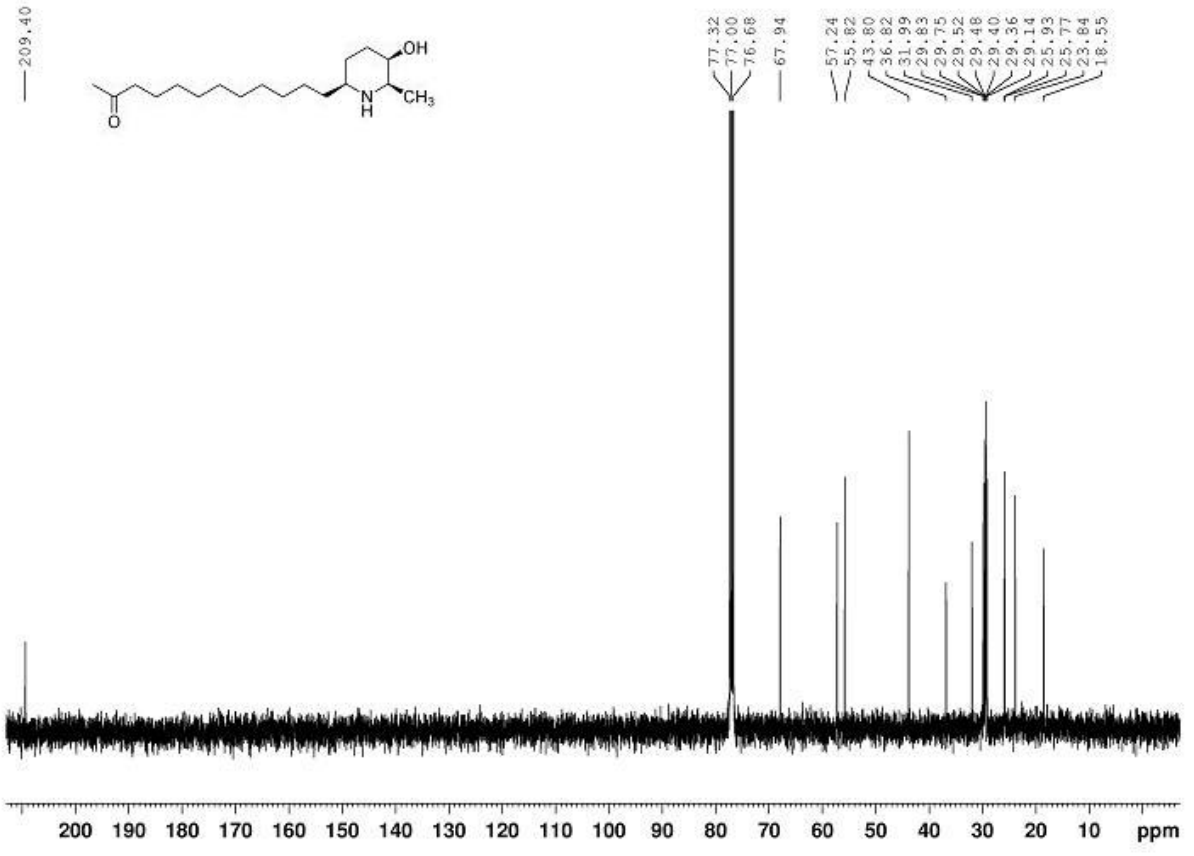
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CH3
O
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29.40
29.36
29.14
25.93
25.77
23.84
18.55
200
190
180
170
160
150
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30
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10
ppm