Electronic Supplementary Material (ESI) for New Journal of Chemistry.


*Supplementary Information*

# *N*-Arylation of (Hetero)arylamines Using Aryl Sulfamates and Carbamates *via* C−O Bond Activation Enabled by Reusable and Durable Nickel (0) Catalyst

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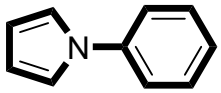
## 1. Experimental

### 1.1 General experimental methods

The products were characterized by comparison of their spectral and physical data such as NMR and CHNS with available literature data. $^{1}H$ and $^{13}C$ NMR spectra were recorded with Bruker Avance DPX 250MHz instruments with $Me_4Si$ or solvent resonance as the internal standard. $^{1}H$ NMR spectroscopic data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q= quartet, quint = quintet, sext = sextet, sept = septet, br. = broad, m = multiplet), coupling constants (Hz), and integration. $^{19}F$ NMR spectra were recorded with a Bruker DPX 400 MHz spectrometer in $CDCl_3$ that operating at 376 MHz for $^{19}F$ acquisitions. Elemental analysis was performed using Thermofinigan Flash EA-1112 CHNSO rapid elemental analyzer. Determination of the purity of the substrate and monitoring of the reaction were accomplished by thin-layer chromatography (TLC) on a silica-gel polygram SILG/UV 254 plates.

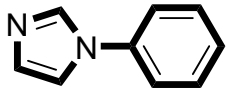
### 1.2 Chemicals

All starting materials and solvents were purchased from the Merck, Flucka and Aldrich Chemical Companies in high purity.



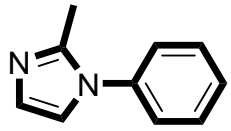
**1-Phenyl-1*H*-pyrrole (C1):**[1]

Dark brown oil, $^{1}H$ NMR (250 MHz, $CDCl_3$): $\delta$= 7.28-7.33 (m, 4H), 7.12-7.18 (m, 1H), 7.00 (t, $J$= 4.5 Hz, 2H), 6.27 (t, $J$= 4.5 Hz, 2H); $^{13}C$ NMR (63 MHz, $CDCl_3$): $\delta$= 110.4, 119.3, 120.5, 125.6, 129.5, 140.8; Anal. Calcd for $C_{10}H_9N$: C, 83.88; H, 6.34; N, 9.78%. Found: C, 83.64; H, 6.43; N, 9.93%.



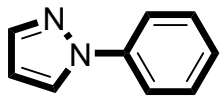
**1-Phenyl-1*H*-imidazole (C2):**[1]

Dark brown oil, $^{1}H$ NMR (250 MHz, $CDCl_3$): $\delta$= 7.80 (s, 1H), 7.14-7.45 (m, 7H); $^{13}C$ NMR (63 MHz, $CDCl_3$): $\delta$= 118.2, 121.4, 127.5, 129.9, 130.4, 135.5, 137.4; Anal. Calcd for $C_9H_8N_2$: C, 74.98; H, 5.59; N, 19.43%. Found: C, 74.93; H, 5.56; N, 19.51%.



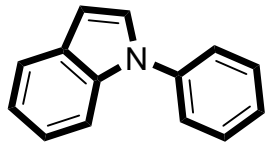
**2-Methyl-1-phenyl-1*H*-imidazole (C3):**[1]

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.51-7.35 (m, 3H), 7.26 (d, $J$ = 7.0 Hz, 2H), 7.01 (s, 1H), 6.98 (s, 1H), 2.35(s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 13.7, 120.6, 125.5, 127.5, 128.2, 129.5, 137.8, 144.6; Anal. Calcd for $C_{10}H_{10}N_2$: C, 75.92; H, 6.37; N, 17.71%. Found: C, 75.86; H, 6.35; N, 17.79%.



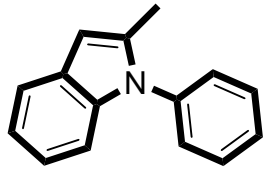
**1-Phenyl-1*H*-pyrazole (C4):**[1]

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.85 (d, $J$ = 7.5 Hz, 1H), 7.74-7.62 (m, 3H), 7.46-7.40 (m, 2H), 7.33-7.27 (m, 2H), 6.45 (t, $J$ = 7.5 Hz, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 107.7, 119.3, 126.1, 126.5, 129.9, 140.8, 141.8; Anal. Calcd for $C_9H_8N_2$: C, 74.98; H, 5.59; N, 19.43%. Found: C, 74.92; H, 5.54; N, 19.54%.



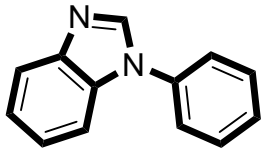
**1-Phenyl-1*H*-indole (C5):**[2]

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.59-7.64 (m, 1H), 7.41-7.52 (m, 5H), 7.25-7.30 (m, 2H), 7.06–7.17 (m, 2H), 6.59-6.63 (m, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 103.6, 110.5, 120.4, 121.1, 122.4, 124.4, 126.4, 128.0, 129.3, 129.6, 135.8, 139.8; Anal. Calcd for $C_{14}H_{11}N$: C, 87.01; H, 5.75; N 7.25%. Found: C, 86.91; H, 5.86; N, 7.23%.



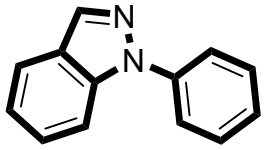
**2-Methyl-1-phenyl-1*H*-indole (C6):**[3]

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.36-7.51 (m, 4H), 7.25-7.29 (m, 2H), 7.00-7.07 (m, 3H), 6.32 (s, 1H), 2.22 (s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 13.4, 101.3, 110.0, 119.6, 120.0, 121.0, 127.7, 128.0, 128.2, 129.4, 137.0, 138.2; Anal. Calcd for $C_{15}H_{13}N$: C, 86.92; H, 6.32; N, 6.76%. Found: C, 86.72; H, 6.45; N, 6.83%.



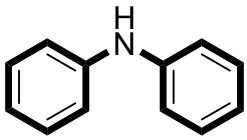
**1-Phenyl-1*H*-benzimidazole (C7):**[1]

Brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.17 (s, 1H), 7.89-7.90 (m, 1H), 7.44-7.61 (m, 6H), 7.32-7.36 (m, 2H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 110.5, 120.6, 122.8, 123.7, 124.0, 128.0, 130.0, 136.3, 142.8, 144.2; Anal. Calcd for $C_{13}H_{10}N_2$: C, 80.39; H, 5.19; N, 14.42%. Found: C, 80.51; H, 5.01; N, 14.48%.



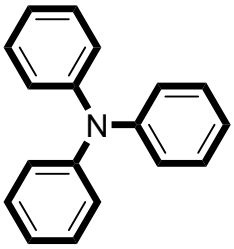
**1-phenyl-1*H*-indazole (C8):**[4]

Colorless crystals; mp = 76-77 $^o$C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.19 (s, 1H), 7.85-7.65 (m, 4H), 7.51 (t, $J$ = 7.0 Hz, 2H), 7.39 (t, $J$ = 7.0 Hz, 1H), 7.33 (t, $J$ = 7.0 Hz, 1H), 7.20 (t, $J$ = 7.0 Hz, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 110.5, 121.4, 121.6, 122.8, 125.4, 126.7, 127.2, 129.5, 135.5, 138.8, 140.2; Anal. Calcd for $C_{13}H_{10}N_2$: C, 80.39; H, 5.19; N, 14.42%. Found: C, 80.51; H, 4.99; N, 14.50%.



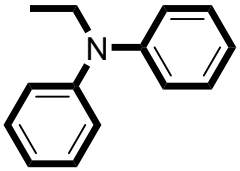
**Diphenylamine (C9):**[5]

Colorless crystals; mp = 52-54 $^o$C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.39-7.34 (m, 4H), 7.22-7.15 (m, 4H), 7.89-7.83 (m, 2H), 5.81 (s, 1H, NH); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 116.9, 120.3, 129.0, 145.9; Anal. Calcd for $C_{12}H_{11}N$: C, 85.17; H, 6.55; N, 8.28%. Found: C, 85.13; H, 6.53; N, 8.34%.



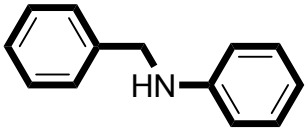
**Triphenylamine (C10)**

Colorless crystals; mp = 126-128 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.46-7.41 (m, 6H), 7.29-7.22 (m, 6H), 6.96-6.99 (m, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 121.7, 123.1, 129.0, 149.0; Anal. Calcd for $C_{18}H_{15}N$: C, 88.13; H, 6.16; N, 5.71%. Found: C, 88.07; H, 6.10; N, 5.83%.



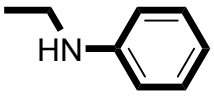
***N*-Ethyl-*N*-phenylaniline (C11)**

Brown oil, $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.39-7.34 (m, 4H), 7.22-7.15 (m, 4H), 6.89-6.83 (m, 2H), 3.03 (q, $J$ = 7.5 Hz, 2H), 1.17 (t, $J$ = 7.5 Hz, 2H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 14.5, 40.7, 121.3, 124.7, 129.0, 141.8; Anal. Calcd for $C_{14}H_{15}N$: C, 85.24; H, 7.66; N, 7.10%. Found: C, 85.18; H, 7.61; N, 7.21%.



***N*-Benzylaniline (C12):**[5]

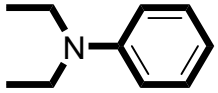
Colorless oil; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.38-7.23 (m, 7H), 6.75-6.67 (m, 3H), 4.08 (s, 3H), 3.93 (s, 1H, NH); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 48.8, 112.4, 117.5, 128.2, 128.5, 128.8, 129.0, 139.7, 148.5; Anal. Calcd for $C_{13}H_{13}N$: C, 85.21; H, 7.15; N, 7.64%. Found: C, 85.16; H, 7.13; N, 7.71%.



***N*-Ethylaniline (C13):**[5]

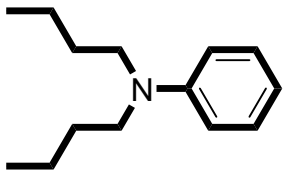
Colorless oil; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.32-7.17 (m, 4H), 7.00-6.94 (m, 1H), 3.49 (s, 1H, NH), 3.13 (q, $J$ = 7.5 Hz, 2H), 1.23 (d, $J$ = 7.5 Hz, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 15.8, 38.7,

112.8, 117.2, 129.2, 148.7; Anal. Calcd for $C_8H_{11}N$: C, 79.29; H, 9.15; N, 11.56%. Found: C, 79.22; H, 9.11; N, 11.67%.



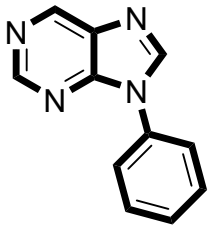
***N,N*-Diethylaniline (C14)**

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.20-7.27 (m, 2H), 6.63-6.73 (m, 3H), 3.37 (q, $J$ = 7.5 Hz, 4H), 1.18 (t, $J$ = 7.5 Hz, 6H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 12.6, 44.3, 111.8, 115.3, 129.3, 147.8; Anal. Calcd for $C_{10}H_{15}N$: C, 80.48; H, 10.13; N, 9.39%. Found: C, 80.25; H, 10.03; N, 9.72%.



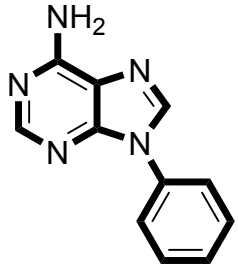
***N,N*-Dibutylaniline (C15)**

Black oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.09-7.17 (m, 2H), 6.54-6.58 (m, 3H), 3.18 (t, $J$= 7.5 Hz, 4H), 1.46-1.55 (m, 4H), 1.20-1.32 (m, 4H), 0.88 (t, $J$= 7.5 Hz, 6H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 14.0, 20.4, 29.4, 50.8, 111.6, 115.0, 129.2, 148.2; Anal. Calcd for $C_{14}H_{23}N$: C, 81.89; H, 11.29; N, 6.82%. Found: C, 81.84; H, 11.25; N, 6.91%.



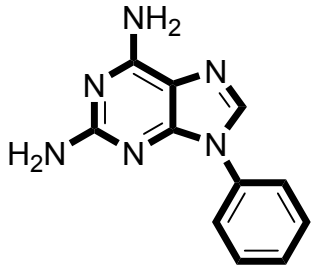
**9-Phenylpurine (C16):**

Colorless crystals; mp = 160-162 $^o$C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 9.21 (s, 1H), 9.06 (s, 1H), 8.34 (s, 1H), 7.84–7.76 (m, 2H), 7.69–7.61 (m, 2H), 7.30–7.22 (m, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 153.3, 151.4, 149.4, 144.6, 135.0, 134.3, 130.2, 128.8, 123.7; Anal. Calcd for $C_{11}H_8N_4$: C, 67.34; H, 4.11; N, 28.55%. Found: C, 74.45; H, 5.22; N, 28.69%.



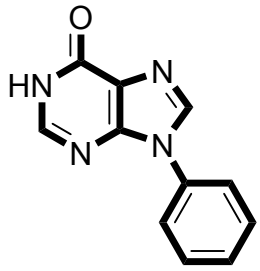
**9-Phenyladenine (C17):**

Colorless crystals; mp = 245-247 $^{o}$C; $^{1}$H NMR (250 MHz, DMSO-$d_6$): $\delta$= 8.59 (s, 1H), 8.22 (s, 1H), 7.87-7.84 (m, 2H), 7.62-7.57 (m, 2H), 7.45-7.39 (m, 1H), 7.34 (s, 2H); $^{13}$C NMR (63 MHz, DMSO-$d_6$): $\delta$= 156.3, 152.9, 149.2, 139.6, 135.2, 129.7, 127.3, 122.5, 119.8; Anal. Calcd for $C_{11}H_9N_5$: C, 62.55; H, 4.29; N, 33.16%. Found: C, 62.45; H, 4.24; N, 33.31%.



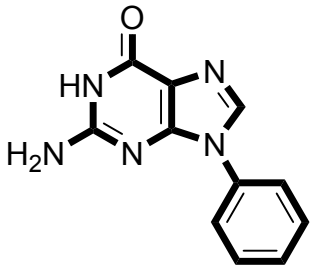
**9-Phenylpurine-2,6-diamine (C18):**

Colorless crystals; mp = 285-286 $^{o}$C; $^{1}$H NMR (250 MHz, DMSO-$d_6$): $\delta$= 8.20 (s, 1H), 7.92-7.84 (m, 2H), 7.63-7.54 (m, 2H), 7.38-7.31 (m, 1H), 6.81 (s, 2H), 5.91 (s, 2H); $^{13}$C NMR (63 MHz, DMSO-$d_6$): $\delta$= 160.8, 156.2, 151.5, 136.1, 135.9, 129.4, 126.1, 122.8, 113.3; Anal. Calcd for $C_{11}H_{10}N_6$: C, 58.40; H, 4.46; N, 37.15%. Found: C, 58.31; H, 4.42; N, 37.28%.



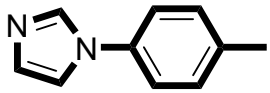
**9-Phenylhypoxanthine (C19):**

Colorless crystals; mp = 317-319 $^{o}$C; $^{1}$H NMR (250 MHz, DMSO-$d_6$): $\delta$= 12.47 (br, 1H), 8.47 (s, 1H), 8.09 (s, 1H), 7.79-7.76 (m, 2H), 7.61-7.58 (m, 2H), 7.49-7.44 (m, 1H); $^{13}$C NMR (63 MHz, DMSO-$d_6$): $\delta$= 156.8, 147.8, 146.1, 139.4, 134.5, 129.6, 128.1, 124.9, 123.9; Anal. Calcd for $C_{11}H_8N_4O$: C, 62.26; H, 3.80; N, 26.40%. Found: C, 62.23; H, 3.76; N, 26.49%.



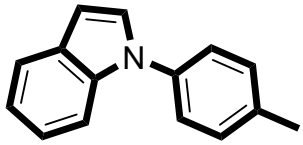
**9-Phenylguanine (C20):**

Colorless crystals; mp = 341-343 $^{o}$C; $^{1}$H NMR (250 MHz, DMSO-$d_6$): $\delta$= 10.76 (br, 1H), 8.04 (s, 1H), 7.78-7.73 (m, 2H), 7.55-7.52 (m, 2H), 7.43-7.40 (m, 1H), 6.51 (br, 2H); $^{13}$C NMR (63 MHz, DMSO-$d_6$): $\delta$= 156.7, 153.9, 150.9, 136.6, 135.1, 129.7, 127.6, 123.8, 117.8; Anal. Calcd for $C_{11}H_9N_5O$: C, 58.14; H, 3.99; N, 30.82%. Found: C, 58.07; H, 4.39; N, 30.93%.



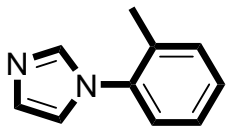
**1-(*p*-Tolyl)-1*H*-imidazole (C22):[3]**

Colorless crystals; mp = 61-63 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.88 (s, 1H), 7.39-7.34 (m, 5H), 7.19-7.14 (m, 1H), 2.30 (s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 20.1, 118.8, 120.5, 130.0, 131.1, 135.5, 135.9, 137.9; Anal. Calcd for $C_{10}H_{10}N_2$: C, 75.92; H, 6.37; N, 17.71%. Found: C, 75.85; H, 6.31; N, 17.84%.



**1-(*p*-Tolyl)-1*H*-indole (C23):**[2]

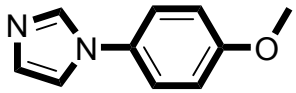
Dark brown oil, $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.58-7.62 (m, 1H), 7.43-7.47 (m, 1H), 7.04-7.32 (m, 7H), 6.58 (dd, $J$= 4.2 Hz, 1H), 2.35 (s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 21.1, 103.2, 110.5, 120.1, 121.1, 122.2, 124.3, 128.1, 129.2, 130.1, 136.3, 137.3; Anal. Calcd for $C_{15}H_{13}N$: C, 86.92; H, 6.32; N, 6.76%. Found: C, 86.57; H, 6.55; N, 6.88%.



**1-(*o*-Tolyl)-1*H*-imidazole (C24)**

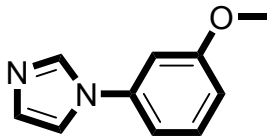
Pale yellow oil; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.68 (s, 1H), 7.45-7.33 (m, 5H), 7.18-7.13 (m, 1H), 2.04 (s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 17.5, 120.6, 125.2, 125.8, 128.5, 128.7, 131.2, 134.0,

136.3, 137.7; Anal. Calcd for $C_{10}H_{10}N_2$: C, 75.92; H, 6.37; N, 17.71%. Found: C, 75.83; H, 6.30; N, 17.87%.



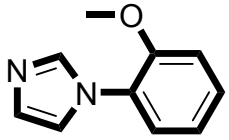
**1-(4-Methoxyphenyl)-1*H*-imidazole (C25):**[1]

Colorless crystals; mp = 59-60 °C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.54 (s, 1H), 7.37-7.32 (m, 2H), 7.19-7.14 (m, 2H), 7.00-6.92 (m, 2H), 3.83 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 55.8, 114.2, 118.3, 123.4, 129.2, 130.2, 135.3, 158.6; Anal. Calcd for $C_{10}H_{10}N_2O$: C, 68.95; H, 5.79; N, 16.08%. Found: C, 68.88; H, 5.75; N, 16.19%.



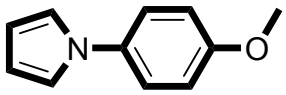
**1-(3-Methoxyphenyl)-1*H*-imidazole (C26):**[6]

Pale yellow oil; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.84 (s, 1H), 7.35 (t, $J$ = 7.5 Hz, 1H), 7.26 (s, 1H), 7.18 (s, 1H), 6.95 (d, $J$ = 8.0 Hz, 1H), 6.93-6.84 (m, 2H), 3.83 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 55.7, 107.6, 112.6, 113.5, 118.2, 130.2, 130.6, 135.5, 138.4,160.6; Anal. Calcd for $C_{10}H_{10}N_2O$: C, 68.95; H, 5.79; N, 16.08%. Found: C, 68.87; H, 5.75; N, 16.20%.



**1-(2-Methoxyphenyl)-1*H*-imidazole (C27):**[4]

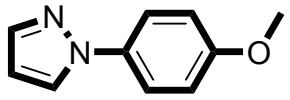
Pale yellow oil; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.77 (s, 1H), 7.33 (t, $J$ = 8.0 Hz, 1H), 7.23 (dd, $J1$ = 7.0 Hz, $J2$ = 1.2 Hz, 1H), 7.18 (s, 1H), 7.14 (s, 1H), 7.09-6.95 (m, 2H), 3.79 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 55.7, 112.3, 120.2, 121.0, 125.4, 126.3, 128.6, 128.9, 137.7, 152.5; Anal. Calcd for $C_{10}H_{10}N_2O$: C, 68.95; H, 5.79; N, 16.08%. Found: C, 68.86; H, 5.74; N, 16.22%.



**1-(4-Methoxyphenyl)-1*H*-pyrrole (C28):**[2]

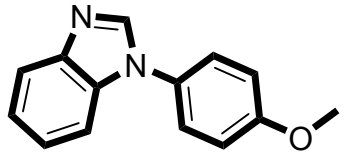
Colorless crystals; mp = 111-113 °C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.32 (d, $J$ = 7.0 Hz, 2H), 7.03-7.00 (m, 2H), 6.96 (d, $J$ = 7.0 Hz, 2H), 6.37-6.33 (m, 2H), 3.85 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$):

$\delta$= 55.5, 109.8, 114.6, 119.7, 122.2, 134.5, 157.6; Anal. Calcd for $C_{11}H_{11}NO$: C, 76.28; H, 6.40; N, 8.06%. Found: C, 76.28; H, 6.37; N, 8.15%.



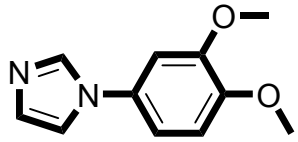
**1-(4-methoxyphenyl)-1*H*-pyrazole (C29):**[2]

Colorless crystals; mp = 43-44 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.80 (d, $J$ = 2.0 Hz, 1H), 7.69 (d, $J$ = 1.0 Hz, 1H), 7.57 (d, $J$ = 8.0 Hz, 2H), 6.95 (d, $J$ =8.0 Hz, 2H), 6.41 (t, $J$ = 2.0 Hz, 1H), 3.81 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 55.5, 107.2, 114.5, 120.8, 126.8, 134.0, 140.6, 158.2; Anal. Calcd for $C_{10}H_{10}N_2O$: C, 68.95; H, 5.79; N, 16.08%. Found: C, 68.87; H, 5.74; N, 16.21%.



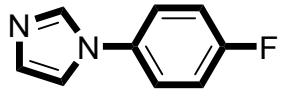
**1-(4-Methoxyphenyl)-1*H*-benzoimidazole (C30):**[3]

Colorless crystals; mp = 94-96 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.97 (s, 1H), 7.79-7.76 (m, 1H), 7.39-7.17 (m, 5H), 7.01-6.96 (m, 2H), 3.81 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 55.5, 107.3, 109.8, 114.6, 115.9, 119.7, 122.2, 136.0, 163.2; Anal. Calcd for $C_{14}H_{12}N_2O$: C, 74.98; H, 5.39; N, 12.49%. Found: C, 74.94; H, 5.36; N, 12.55%.



**1-(3,4-Dimethoxyphenyl)-1*H*-imidazole (C31)**

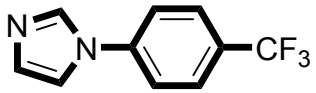
Colorless crystals; mp = 73-75 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.91 (s, 1H), 7.58-7.53 (m, 2H), 7.09-7.04 (m, 2H), 6.53 (s, 1H), 4.02 (s, 3H), 4.01 (s, 3H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 53.4, 54.7, 113.1, 118.6, 122.3, 124.4, 126.5, 129.1, 134.7, 155.1, 155.5; Anal. Calcd for $C_{11}H_{12}N_2O_2$: C, 64.69; H, 5.92; N, 13.72%. Found: C, 64.62; H, 5.87; N, 13.81%.



**1-(4-Fluorophenyl)-1*H*-imidazole (C32):**[6]

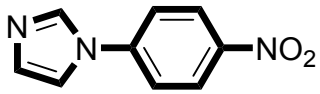
Pale yellow oil; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.94 (s, 1H), 7.44-7.40 (m, 2H), 7.28-7.12 (m, 4H); $^{13}$C NMR (63MHz, $CDCl_3$): $\delta$= 116.6 (d, $J$ = 22.7 Hz), 118.5, 123.4 (d, $J$ = 8.2 Hz), 130.3, 133.5 (d,

$J$ = 2.2 Hz), 135.6, 161.5 (d, $J$ = 246.7 Hz); $^{19}$F NMR (376 MHz, $CDCl_3$): $\delta$= –117.3. Anal. Calcd for $C_9H_7FN_2$: C, 66.66; H, 4.35; N, 17.27%. Found: C, 66.62; H, 4.31; N, 17.39%.



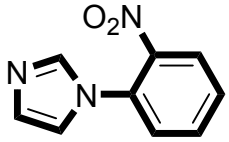
**1-(4-(*tri*Fluoromethyl)phenyl)-1*H*-imidazole (C33):**[7]

Colorless crystals; mp = 66-68 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.99 (s, 1H), 7.83 (d, $J$ = 8.0 Hz, 2H), 7.54 (d, $J$ = 8.0 Hz, 2H), 7.40 (s, 1H), 7.23 (s, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 117.7, 121.5, 122.4, 125.2, 127.4 (d, $J$ = 14.8 Hz), 127.7, 129.9, 131.9, 135.3, 141.1; $^{19}$F NMR (376 MHz, $CDCl_3$): $\delta$= –62.3. Anal. Calcd for $C_{10}H_7F_3N_2$: C, 56.61; H, 3.33; N, 13.20%. Found: C, 56.54; H, 3.31; N, 13.29%.



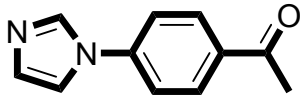
**1-(4-Nitrophenyl)-1*H*-imidazole (C34):**[1]

Yellow crystals; mp = 207-209 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.39 (d, $J$ = 7.5 Hz, 2H), 8.02 (s, 1H), 7.49 (d, $J$ = 7.5 Hz, 2H), 7.33 (s, 1H), 7.07 (s, 2H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 117.7, 121.7, 125.2, 130.9, 136.3, 142.9, 147.0; Anal. Calcd for $C_9H_7N_3O_2$: C, 57.14; H, 3.73; N, 22.21%. Found: C, 57.08; H, 3.67; N, 22.32%.



**1-(2-Nitrophenyl)-1*H*-imidazole (C35)**

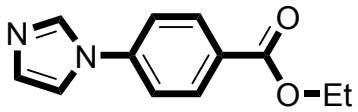
Yellow crystals; mp = 108-110 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.81-7.73 (m, 2H), 7.61-7.50 (m, 1H), 7.44-7.32 (m, 3H), 6.51 (s, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 108.4, 125.8, 126.8, 128.7, 129.9, 232.9, 133.6, 142.5; Anal. Calcd for $C_9H_7N_3O_2$: C, 57.14; H, 3.73; N, 22.21%. Found: C, 57.07; H, 3.64; N, 22.34%.



**1-(4-(1*H*-imidazol-1-yl)phenyl)ethan-1-one (C36):**[1]

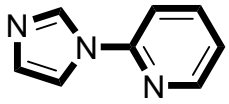
Yellow crystals; mp = 110-112 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.09 (d, $J$ = 8.0 Hz, 2H), 7.97 (s, 1H), 7.51 (d, $J$ = 8.0 Hz, 2H), 7.38 (s, 1H), 7.24 (s, 1H), 2.64 (s, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$):

$\delta$= 26.6, 117.7, 120.6, 130.3, 131.1, 135.3, 135.7, 140.7, 196.5; Anal. Calcd for $C_{11}H_{10}N_2O$: C, 70.95; H, 5.41; N, 15.04%. Found: 70.90; H, 5.38; N, 15.12%.



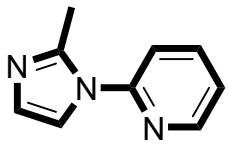
**Ethyl 4-(1*H*-imidazol-1-yl)benzoate (C37):**[6]

Yellow crystals; mp = 102-104 $^oC$; $^1H$ NMR (250 MHz, $CDCl_3$): $\delta$= 8.17 (d, $J$ = 8.0 Hz, 2H), 7.97 (s, 1H), 7.48 (d, $J$ = 8.0 Hz, 2H), 7.37 (s, 1H), 7.25 (s, 1H), 4.41 (q, $J$ = 7.0 Hz, 2H), 1.42 (t, $J$ = 7.0 Hz, 3H); $^{13}C$ NMR (63 MHz, $CDCl_3$): $\delta$= 14.3, 61.3, 117.8, 120.5, 129.3, 131.0, 131.4, 135.4, 140.6, 165.5; Anal. Calcd for $C_{12}H_{12}N_2O_2$: C, 66.65; H, 5.59; N, 12.96%. Found: C, 66.61; H, 5.56; N, 13.06%.



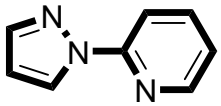
**2-Imidazol-1-ylpyridine (C38):**[1]

Dark brown oil, $^1H$ NMR (250 MHz, $CDCl_3$): $\delta$= 8.41-8.43 (m, 1H), 8.28 (s, 1H), 7.73-7.80 (m, 1H), 7.58 (s, 1H), 7.25-7.34 (m, 1H), 7.28-7.34 (m, 1H), 7.14-720 (m, 2H);$^{13}C$ NMR (63 MHz, $CDCl_3$): $\delta$= 112.3, 116.7, 122.0, 130.6, 132.2, 134.9, 139.0, 149.1; Anal. Calcd for $C_8H_7N_3$: C, 66.19; H, 4.86; N, 28.95%. Found: C, 65.89; H, 4.97; N, 29.14%.



**2-Methyl-1-phenyl-1*H*-imidazole (C39):**[6]

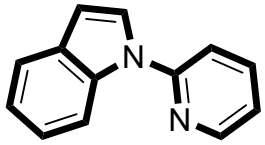
Yellow crystals; mp = 91-93 $^oC$; $^1H$ NMR (250 MHz, $CDCl_3$): $\delta$= 7.51-7.35 (m, 3H), 7.26 (d, $J$ = 7.0 Hz, 2H), 7.01 (s, 1H), 6.98 (s, 1H), 2.35 (s, 3H); $^{13}C$ NMR (63 MHz, $CDCl_3$): $\delta$= 13.6, 120.5, 125.4, 127.5, 128.1, 129.4, 137.9, 144.5; Anal. Calcd for $C_9H_9N_3$: C, 67.90; H, 5.70; N, 26.40%. Found: C, 67.84; H, 5.67; N, 26.49%.



**2-(1*H*-Pyrazol-1-yl)pyridine (C40):**[7]

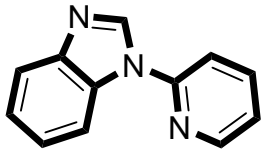
Dark brown oil, $^1H$ NMR (250 MHz, $CDCl_3$): $\delta$= 8.57 (d, $J$ = 2.1 Hz, 1H), 8.38 (d, $J$ = 4.0 Hz, 1H), 7.97 (d, $J$ = 7.5 Hz 1H), 7.83-7.67 (m, 2H), 7.14 (d, $J$ = 6.5 Hz, 1H), 6.45 (t, $J$ = 1.5 Hz, 1H); $^{13}C$

NMR (63 MHz, $CDCl_3$): $\delta$= 107.8, 112.4, 121.3, 127.0, 138.6, 142.0, 148.0, 151.6; Anal. Calcd for $C_8H_7N_3$: C, 66.19; H, 4.86; N, 28.95%. Found: C, 66.10; H, 4.80; N, 29.11%.



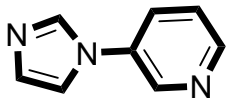
**1-Pyridin-2-yl-1*H*-indole (C41):**[3]

Dark brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.36-8.39 (m, 1H), 8.09 (d, *J*= 8.2 Hz, 1H), 7.49-7.56 (m, 3H), 7.00-7.25 (m, 3H), 6.97 (t, *J*= 6.0 Hz, 1H), 6.56 (d, *J*= 3.5 Hz, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 105.7, 113.3, 114.6, 120.2, 121.2, 121.5, 123.3, 126.1, 130.6, 135.2, 138.5, 149.0, 152.5; Anal. Calcd for $C_{13}H_{10}N_2$: C, 80.39; H, 5.19; N, 14.42%. Found: C, 80.57; H, 5.09; N, 14.34%.



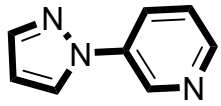
**1-Pyridin-2-yl-1*H*-benzimidazole (C42):**[3]

Brown oil, $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.58-8.62 (m, 2H), 8.06 (d, *J*= 7.8 Hz, 1H), 7.86-7.93 (m, 2H), 7.58 (d, *J*= 8.2 Hz, 1H), 7.26-7.39 (m, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 112.6, 114.3, 120.6, 121.8, 123.3, 124.2, 132.1, 138.9, 141.3, 144.7, 149.5, 149.9; Anal. Calcd for $C_{12}H_9N_3$: C, 73.83; H, 4.65; N, 21.52%. Found: C, 73.62; H, 4.76; N, 21.62%.



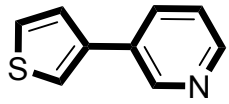
**3-(1*H*-Imidazol-1-yl)pyridine (C43):**[6]

Yellow crystals; mp = 57-58 $^o$C; $^1$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.76 (d, *J* = 2.3 Hz, 1H), 8.64 (d, *J* = 6.5 Hz, 1H), 7.92 (s, 1H), 7.82-7.72 (m, 1H), 7.47 (d, *J*= 7.5 Hz, 1H), 7.34 (s, 1H), 7.26 (s, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 118.1, 124.3, 128.9, 130.9, 133.8, 135.4, 142.7, 148.7; Anal. Calcd for $C_8H_7N_3$: C, 66.19; H, 4.86; N, 28.95%. Found: C, 66.11; H, 4.81; N, 29.08%.



**3-(1*H*-Pyrazol-1-yl)pyridine (C44):**[6]

Yellow crystals; mp = 48-49 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 8.99 (d, $J$ = 1.5 Hz, 1H), 8.54 (d, $J$ = 4.0 Hz, 1H), 8.12-8.03 (m, 1H), 7.97 (d, $J$ = 2.0 Hz, 2H), 7.77 (d, $J$ =1.0 Hz, 2H), 7.41 (d, $J$ = 7.5 Hz, 1H), 6.52 (d, $J$ = 1.5 Hz, 1H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 108.4, 123.9, 126.5, 126.8, 136.5, 140.5, 141.9, 147.5; Anal. Calcd for $C_8H_7N_3$: C, 66.19; H, 4.86; N, 28.95%. Found: C, 66.12; H, 4.82; N, 29.06%.



**1-(Thiophen-3-yl)-1*H*-imidazole (C45):**[6]

Yellow crystals; mp = 73-75 $^{o}$C; $^{1}$H NMR (250 MHz, $CDCl_3$): $\delta$= 7.81 (s, 1H), 7.42 (d, $J$ = 5.0 Hz, 1H), 7.23 (s, 1H), 7.23-7.13 (m, 3H); $^{13}$C NMR (63 MHz, $CDCl_3$): $\delta$= 113.2, 118.5, 121.4, 127.2, 130.0, 135.8, 136.3; Anal. Calcd for $C_9H_7NS$: C, 67.35; H, 4.38; N, 8.69; S, 19.89%. Found: C, 67.31; H, 4.35; N, 8.72; S, 19.94%.

**Notes and references**


1 Q. Yang, Y. Wang, L. Yang, M. Zhang, *Tetrahedron*, 2013, **69**, 6230-6233.

2 D. Nandi, S. Siwal, K. Mallick, *New J. Chem.*, 2017, **41**, 3082-3088.

3 S. Zahmatkesh, M. Esmaeilpour, A. Mollaiy Poli, *Inorg. Nano-Met. Chem.*, 2019, **49**, 323-334.

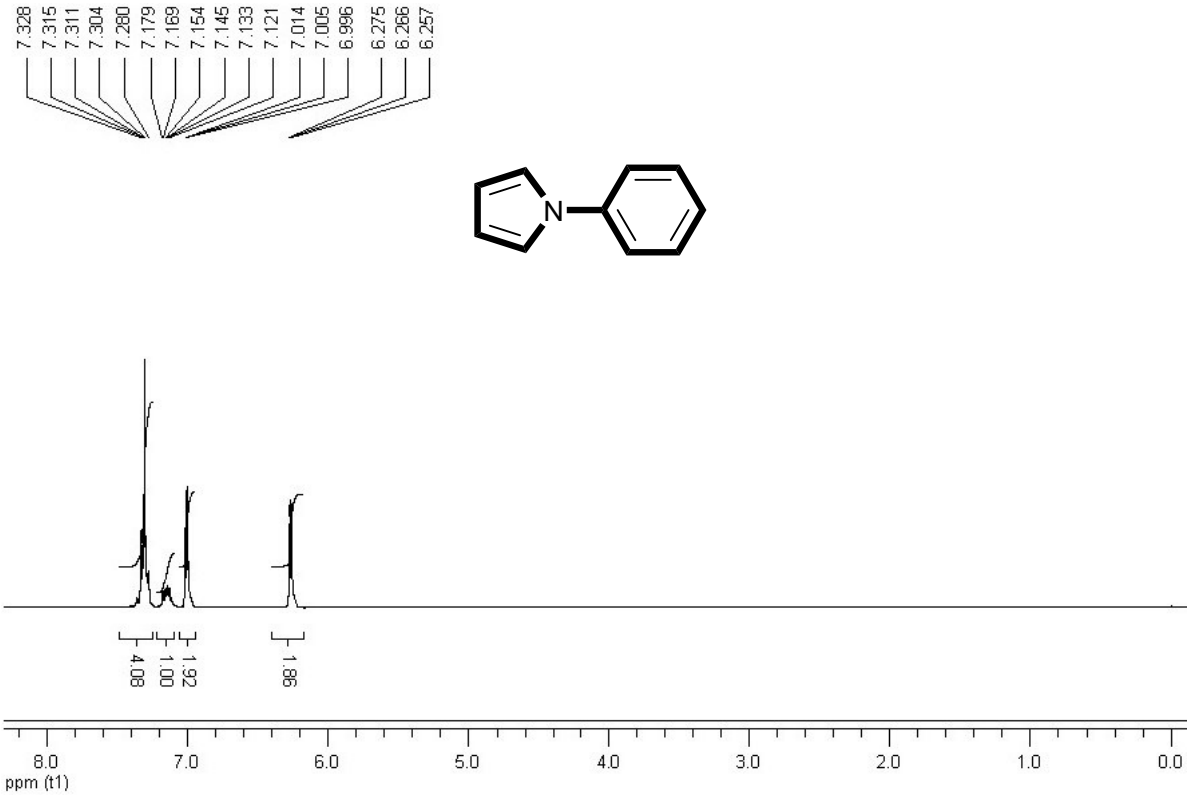
4 G. Pai, A. P. Chattopadhyay, *Tetrahedron Lett.*, 2016, **57**, 3140-3145.

5 X. Zhu, L. Su, L. Huang, G. Chen, J. Wang, H. Song, Y. Wan, *Eur. J. Org. Chem.*, 2009, 635-642.

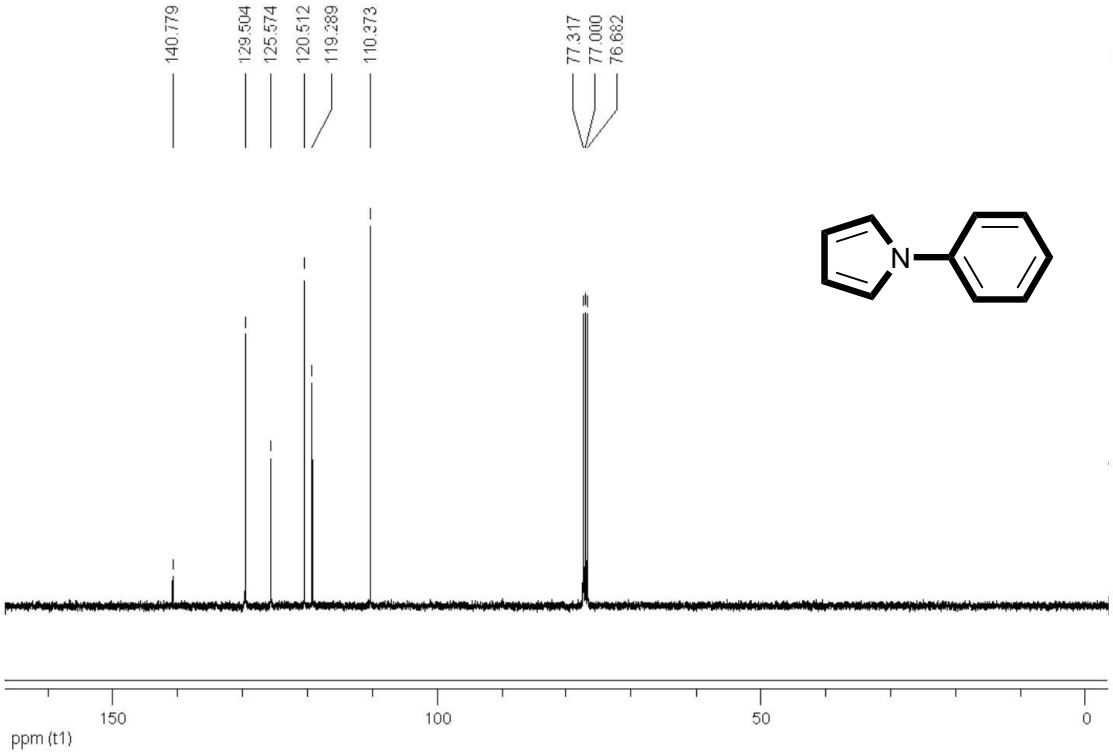
6 Y. Wang, Y. Zhang, B. Yang, A. Zhang, Q. Yao, *Org. Biomol. Chem.*, 2015, **13**, 4101-4114.

7 L. Li, L. Zhu, D. Chen, X. Hu, R. Wang, *Eur. J. Org. Chem.*, 2011, 2692-2696.

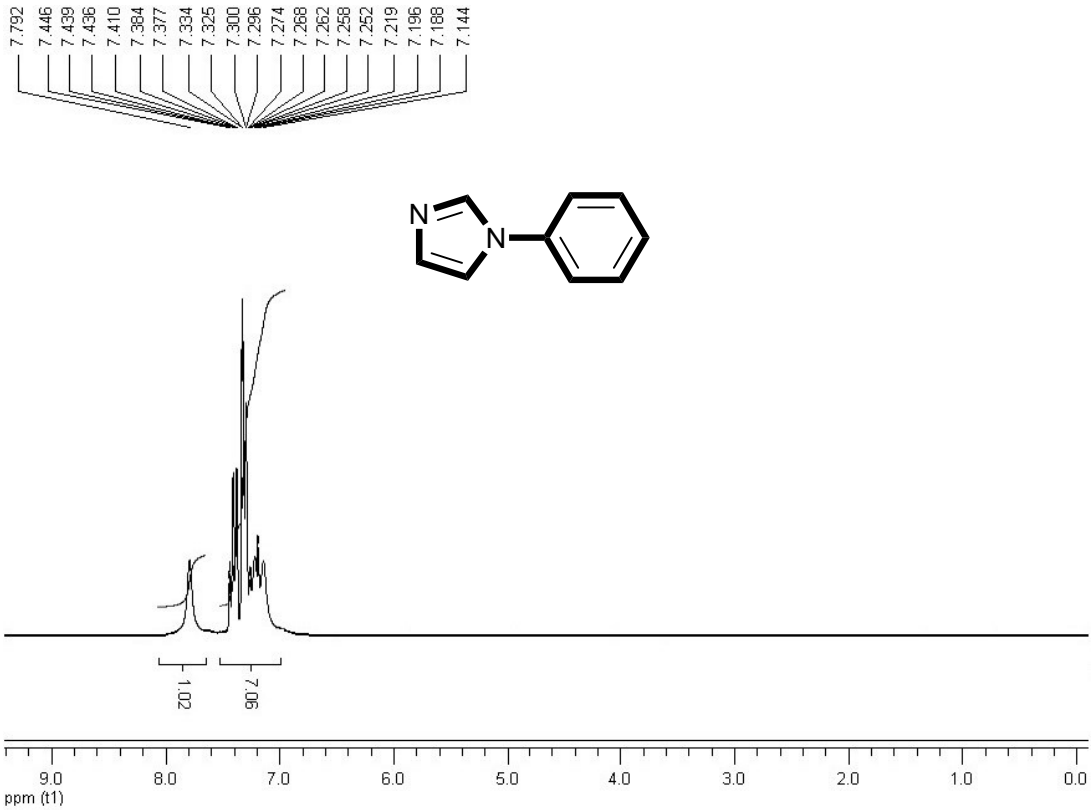
## 2 Product Characterizations:



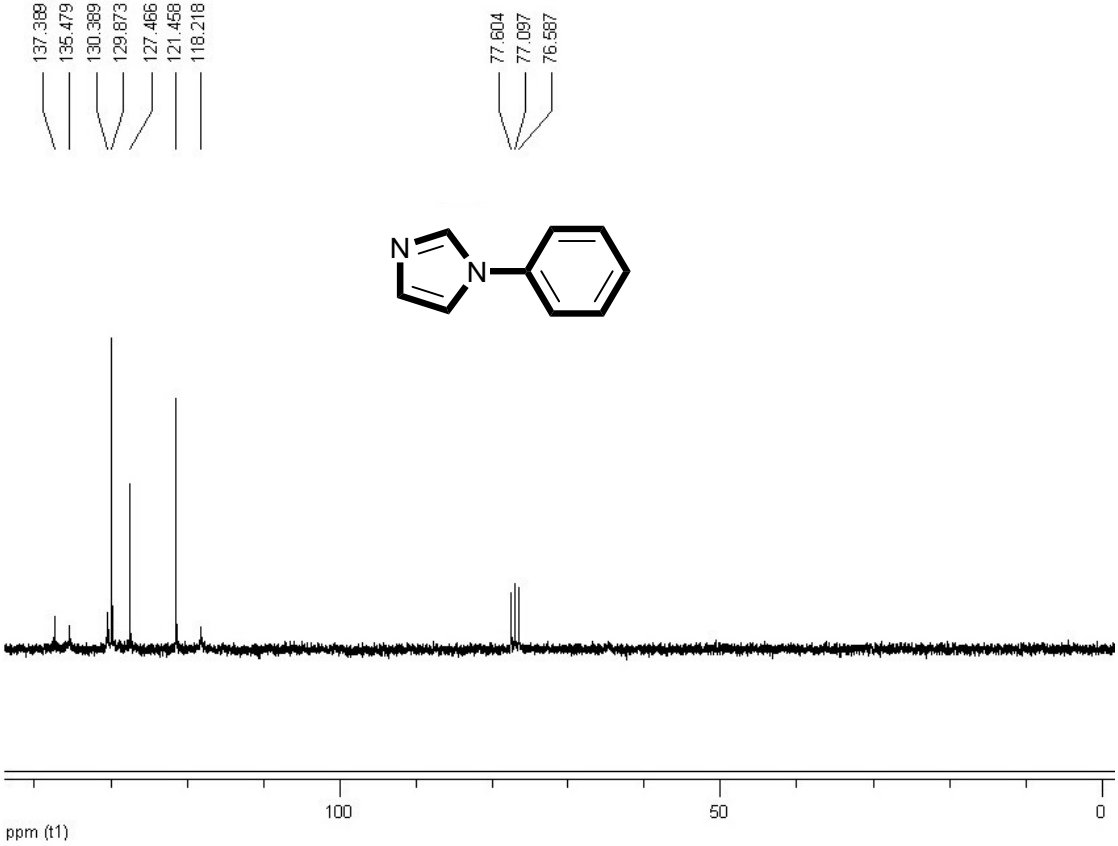

$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-pyrrole (**C1**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-pyrrole (**C1**) in $CDCl_3$.

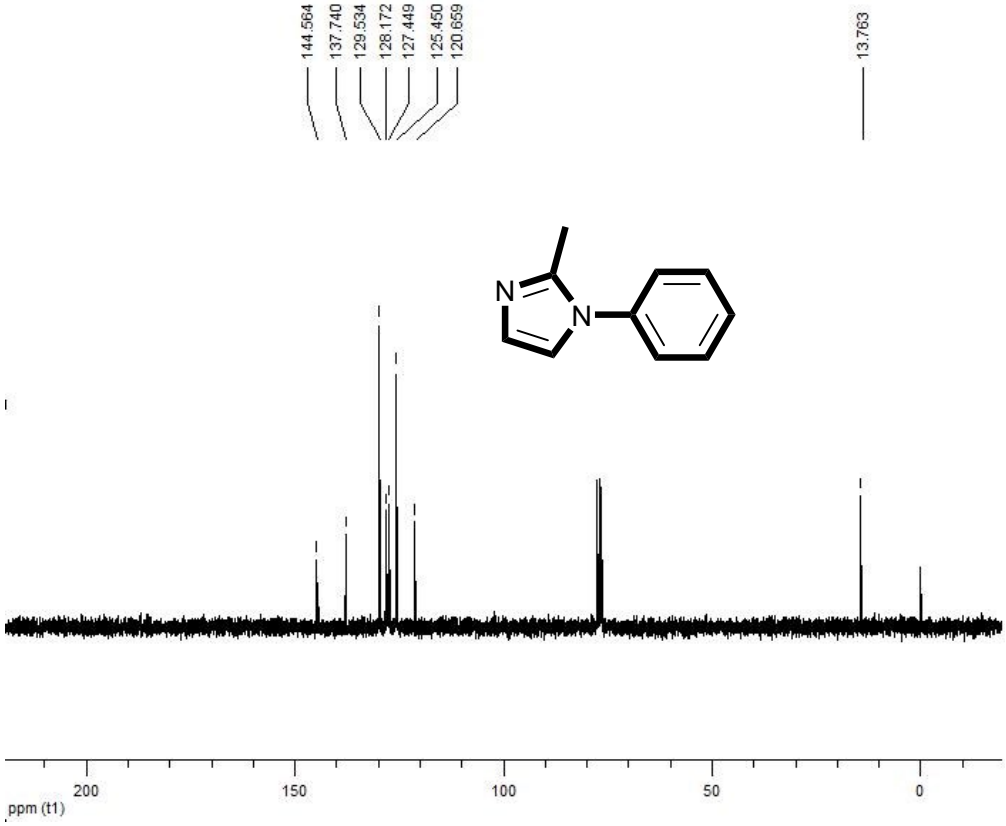



$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-imidazole (**C2**) in $CDCl_3$.

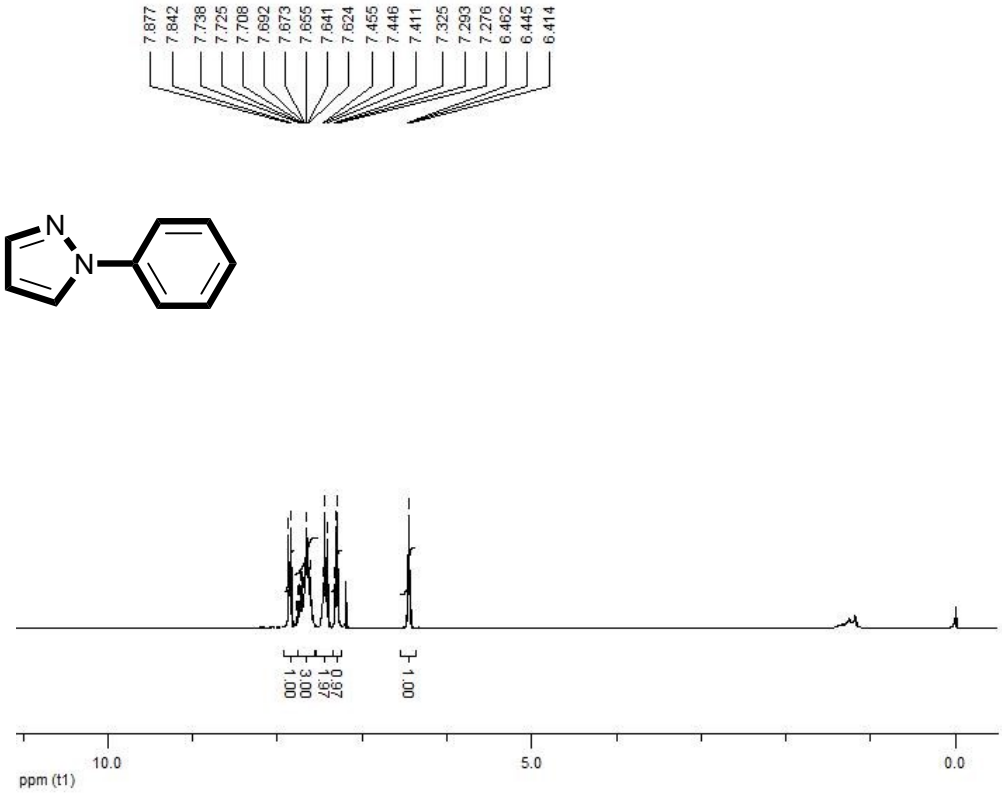



$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-imidazole (**C2**) in $CDCl_3$.

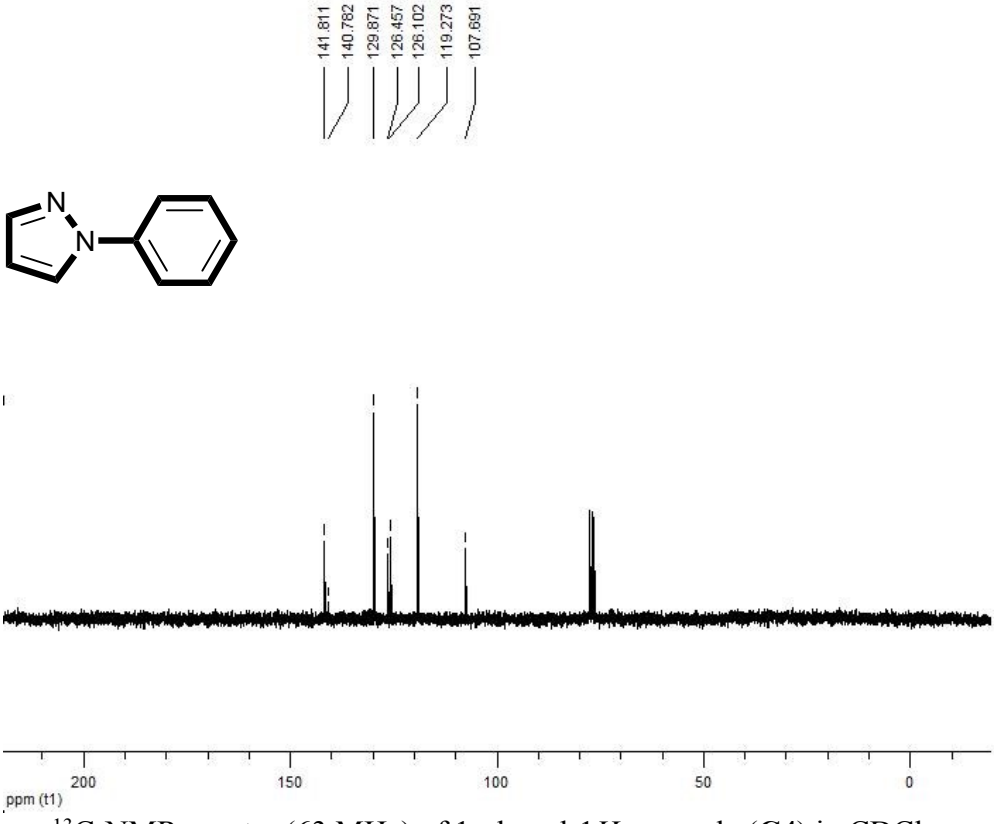

$^{1}$H-NMR spectra (250 MHz) of 2-methyl-1-phenyl-1*H*-imidazole (**C3**) in $CDCl_3$.



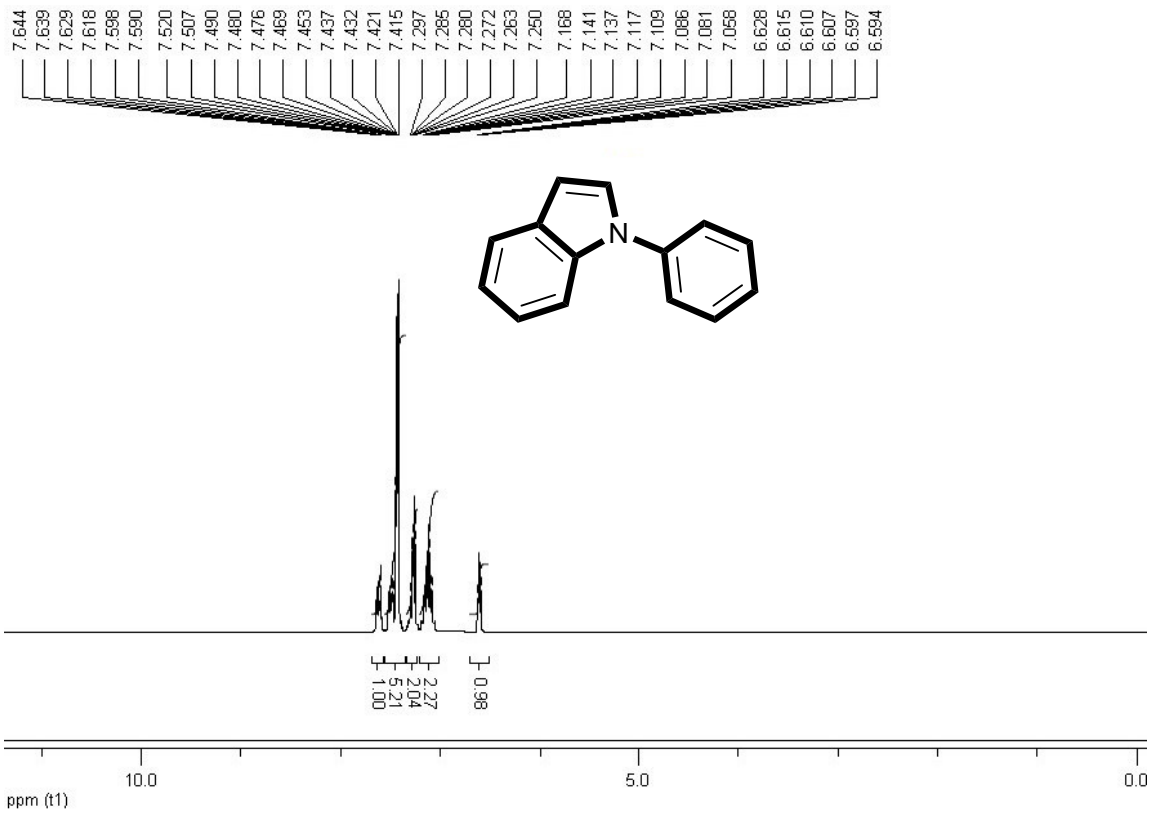

$^{13}$C-NMR spectra (63 MHz) of 2-methyl-1-phenyl-1*H*-imidazole (**C3**) in $CDCl_3$.



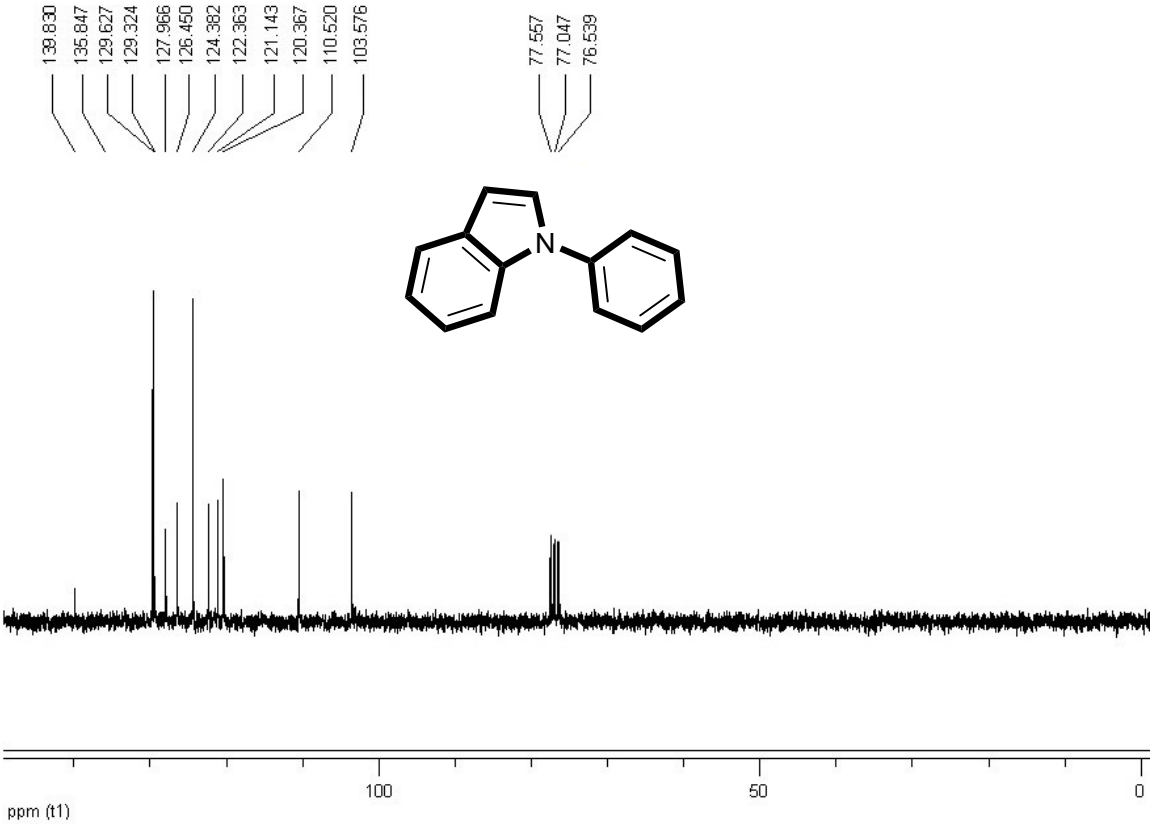

$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-pyrazole (**C4**) in $CDCl_3$.



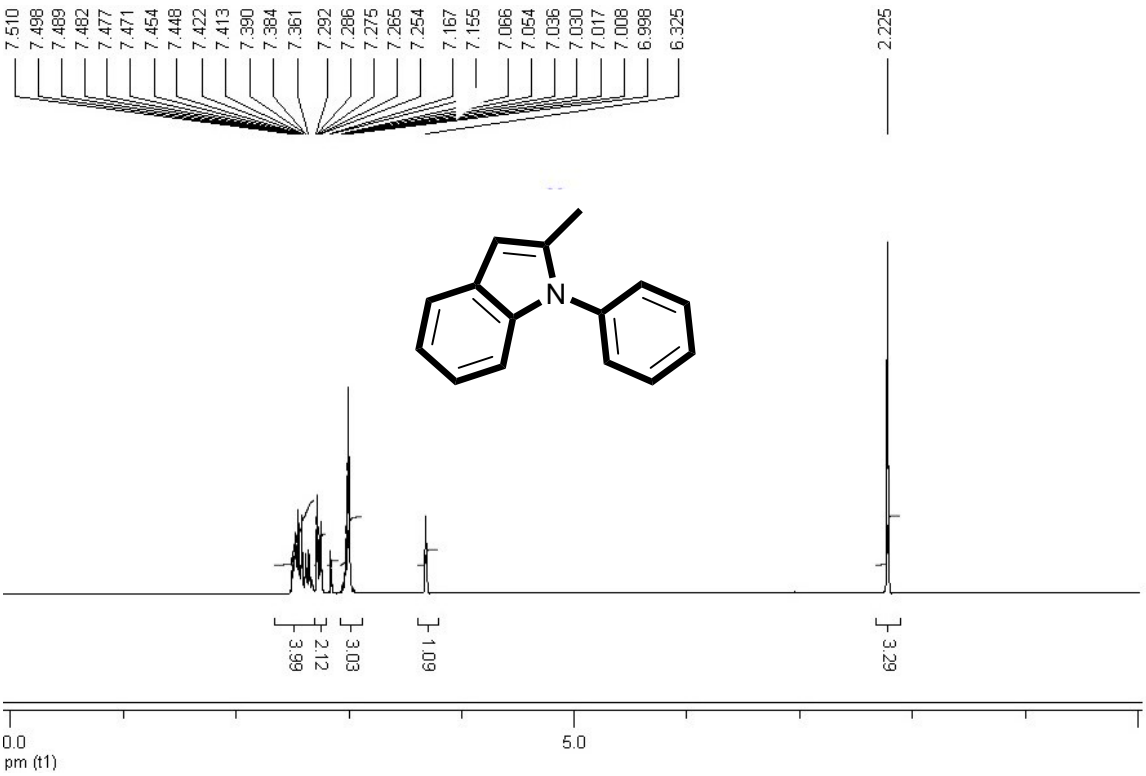

$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-pyrazole (**C4**) in $CDCl_3$.



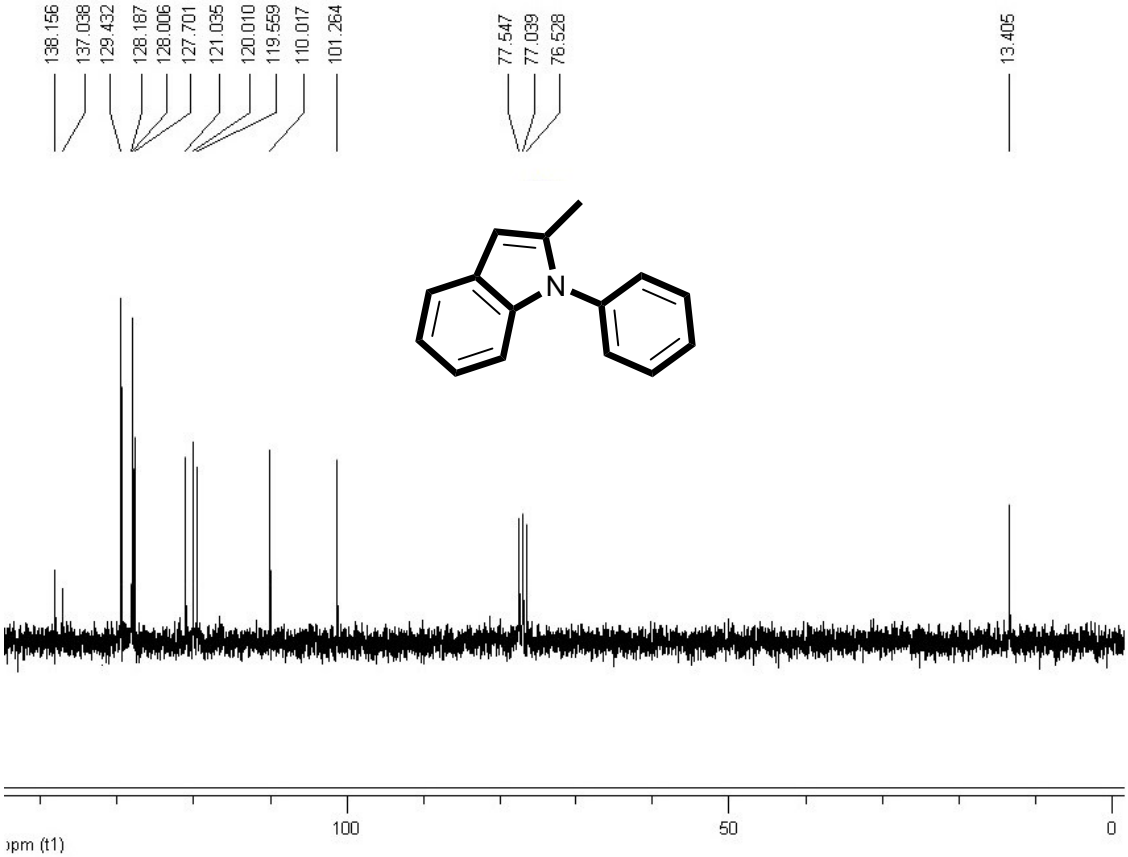

$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-indole (**C5**) in $CDCl_3$.



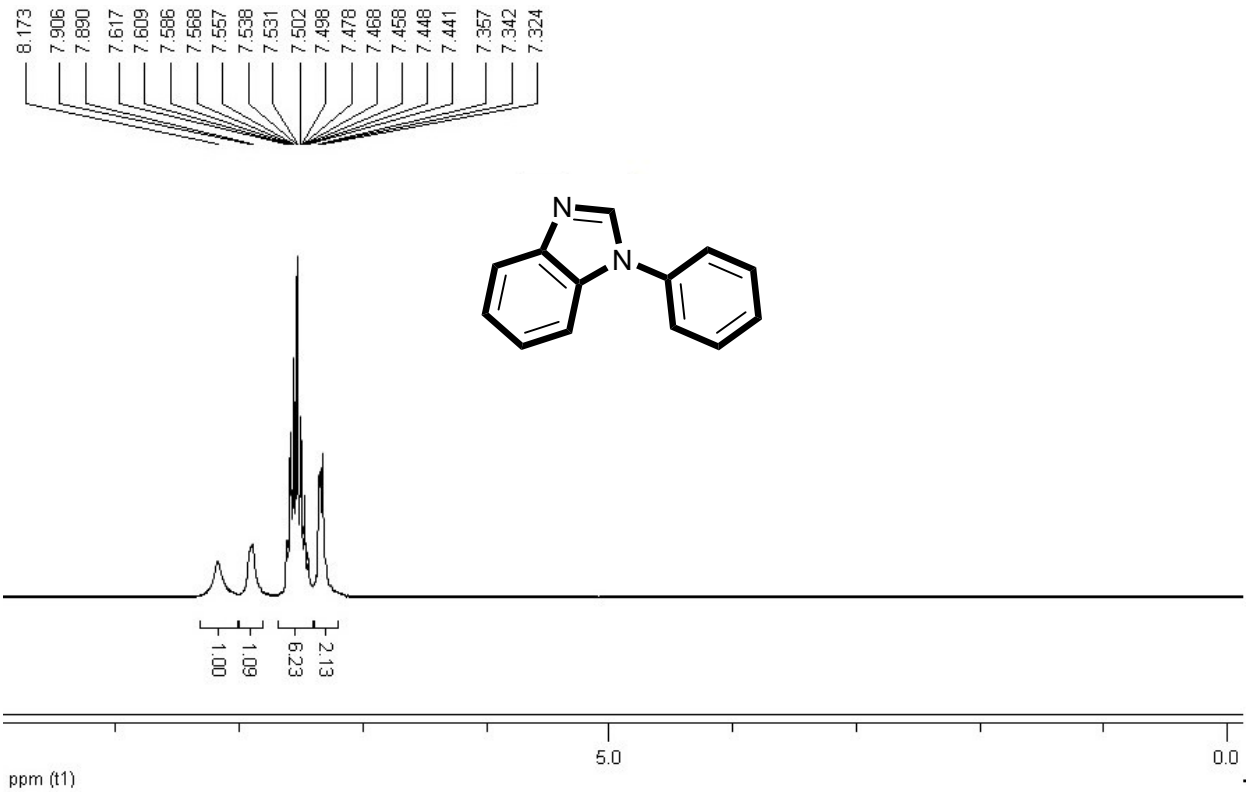

$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-indole (**C5**) in $CDCl_3$.



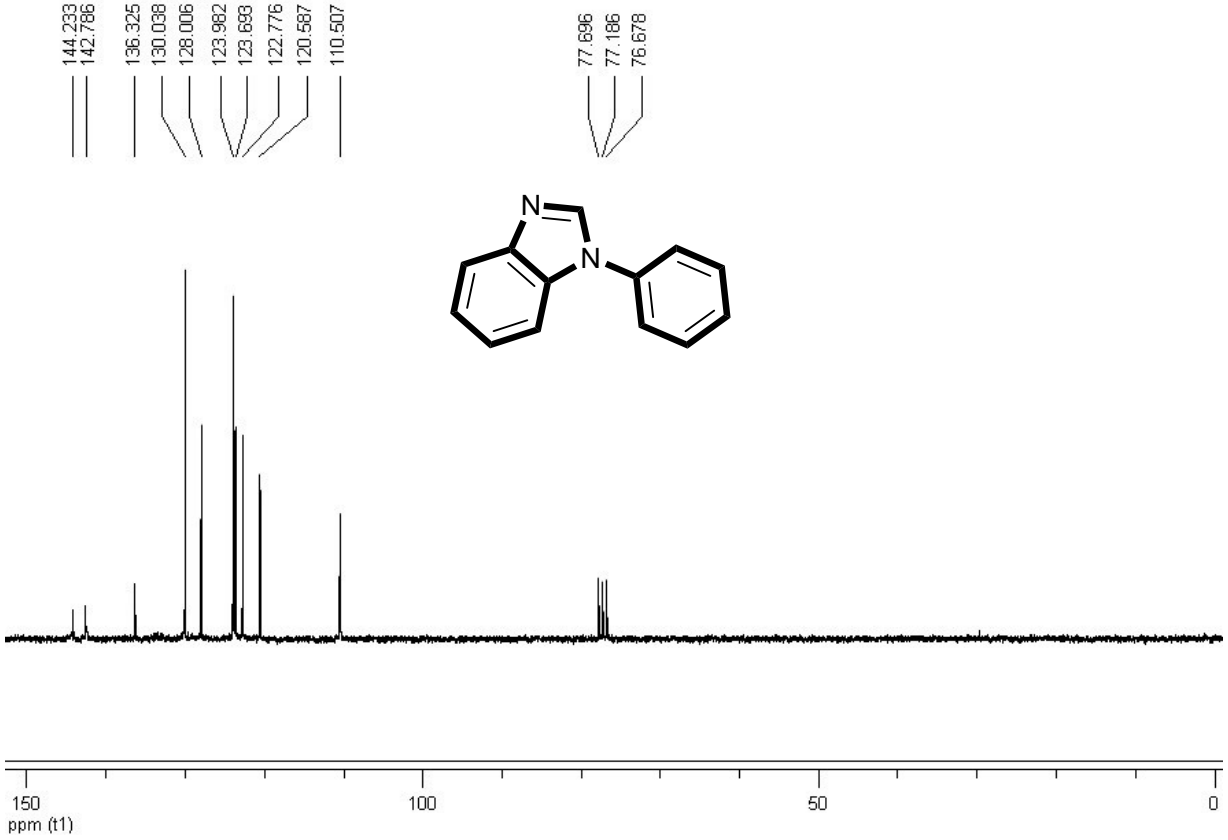

$^{1}$H-NMR spectra (250 MHz) of 2-methyl-1-phenyl-1*H*-indole (**C6**) in $CDCl_3$.



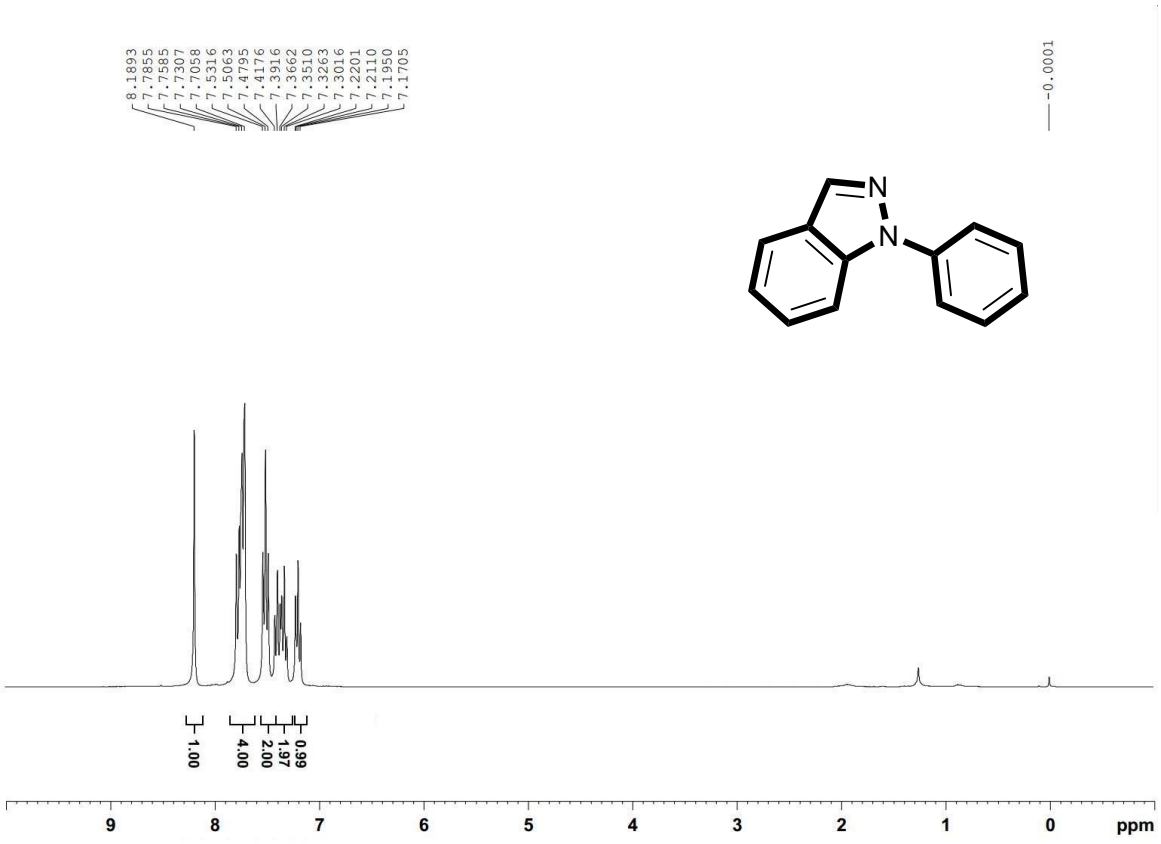

$^{13}$C-NMR spectra (63 MHz) of 2-methyl-1-phenyl-1*H*-indole (**C6**) in $CDCl_3$.



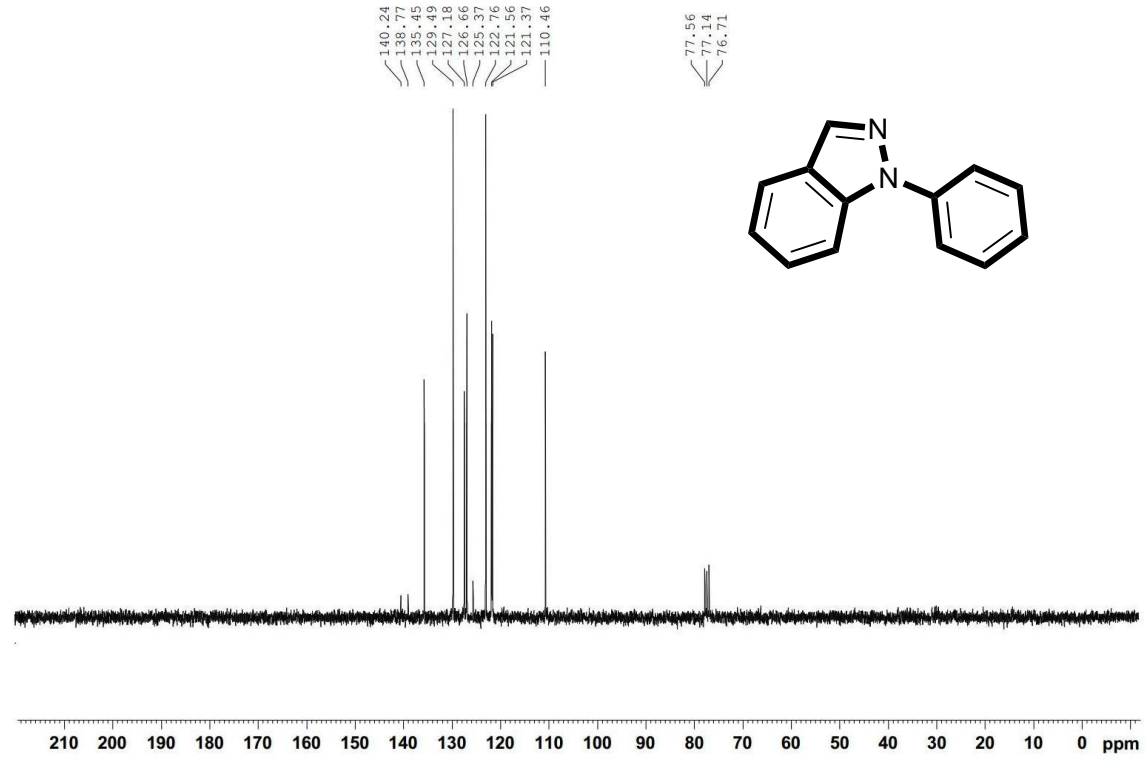

$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-benzimidazole (**C7**) in $CDCl_3$.



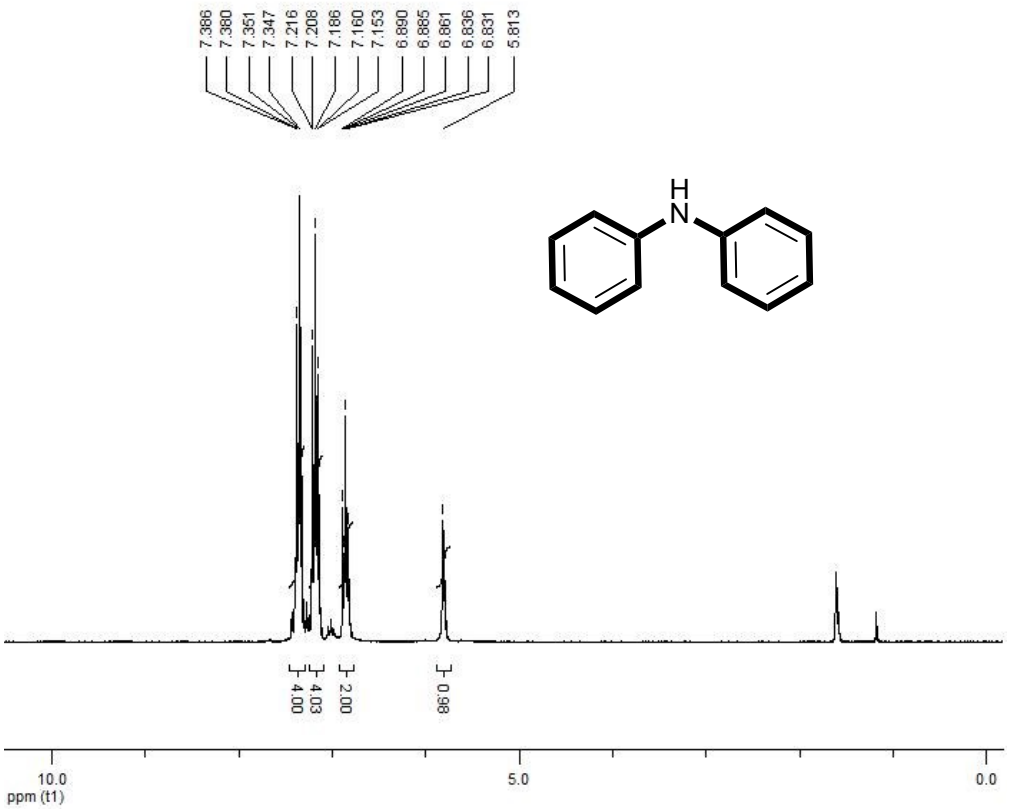

$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-benzimidazole (**C7**) in $CDCl_3$.



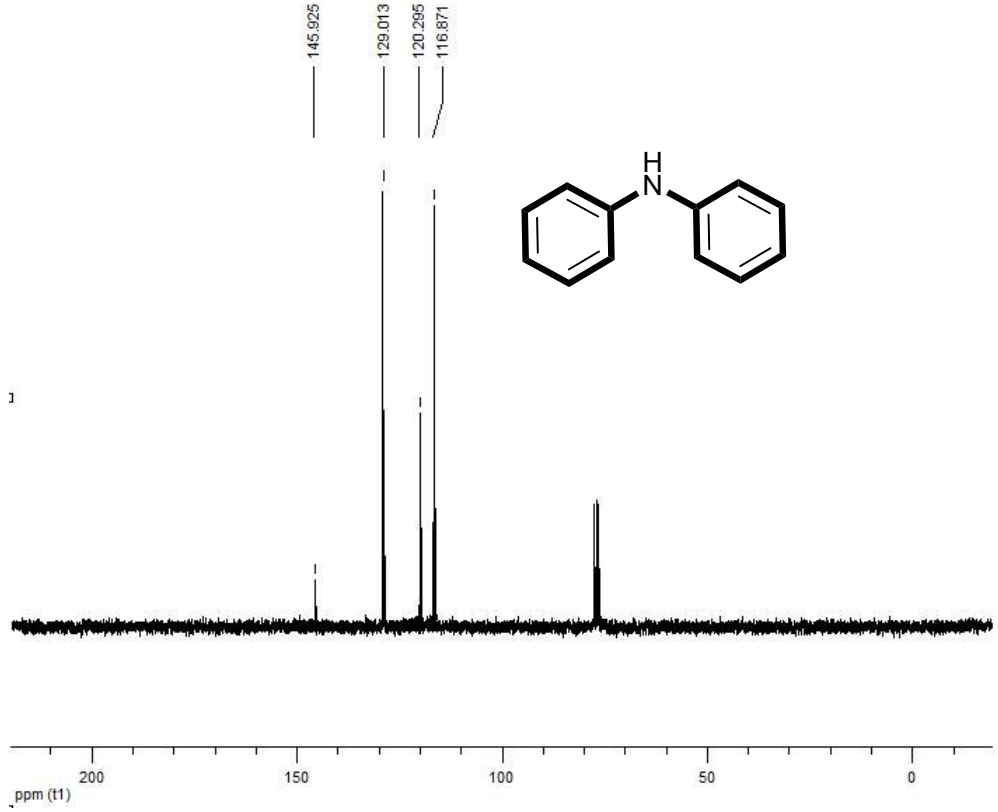

$^{1}$H-NMR spectra (250 MHz) of 1-phenyl-1*H*-indazole (**C8**) in $CDCl_3$.



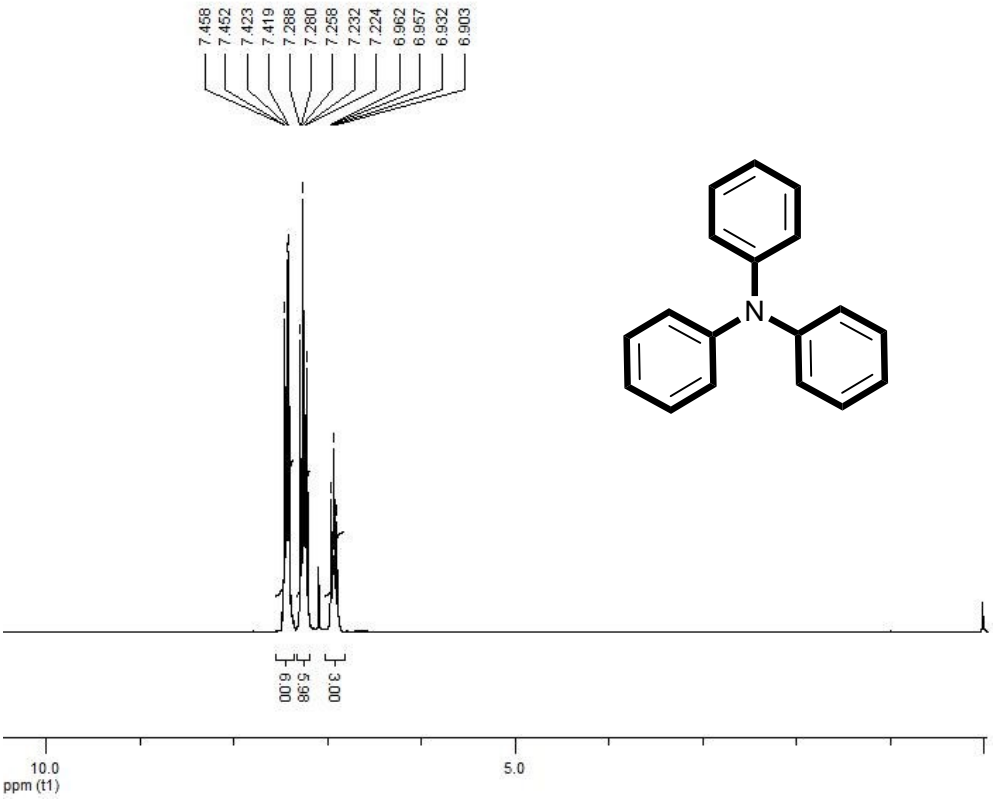

$^{13}$C-NMR spectra (63 MHz) of 1-phenyl-1*H*-indazole (**C8**) in $CDCl_3$.




$^{1}$H-NMR spectra (250 MHz) of diphenylamine (**C9**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of diphenylamine (**C9**) in $CDCl_3$.

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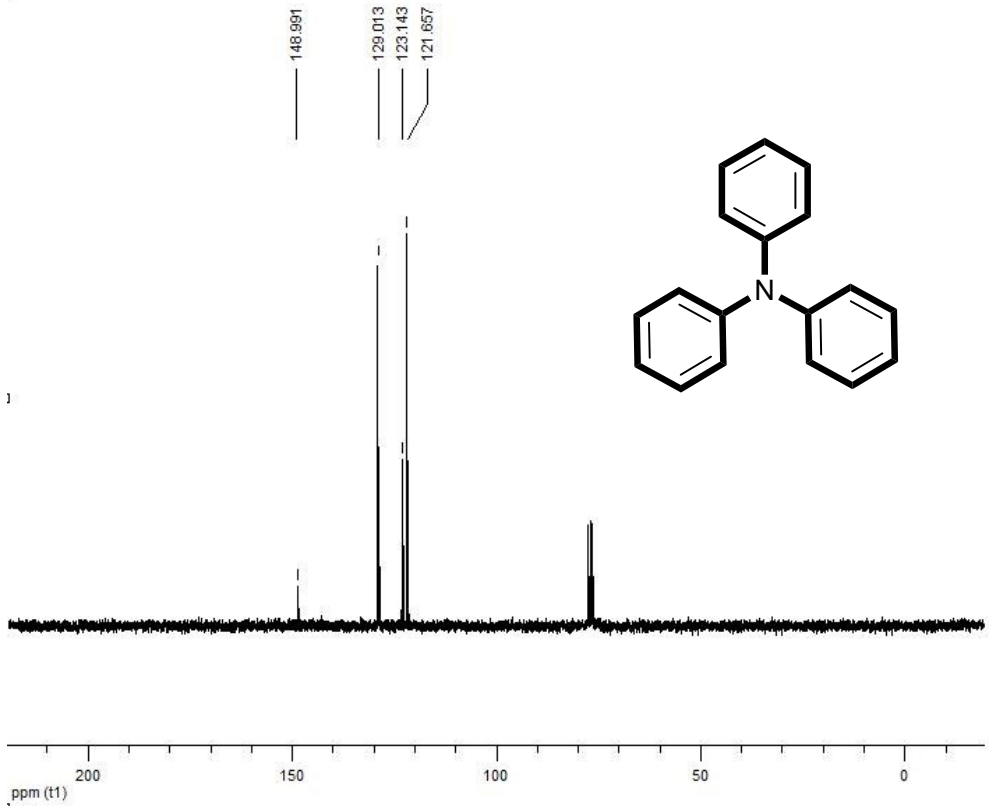


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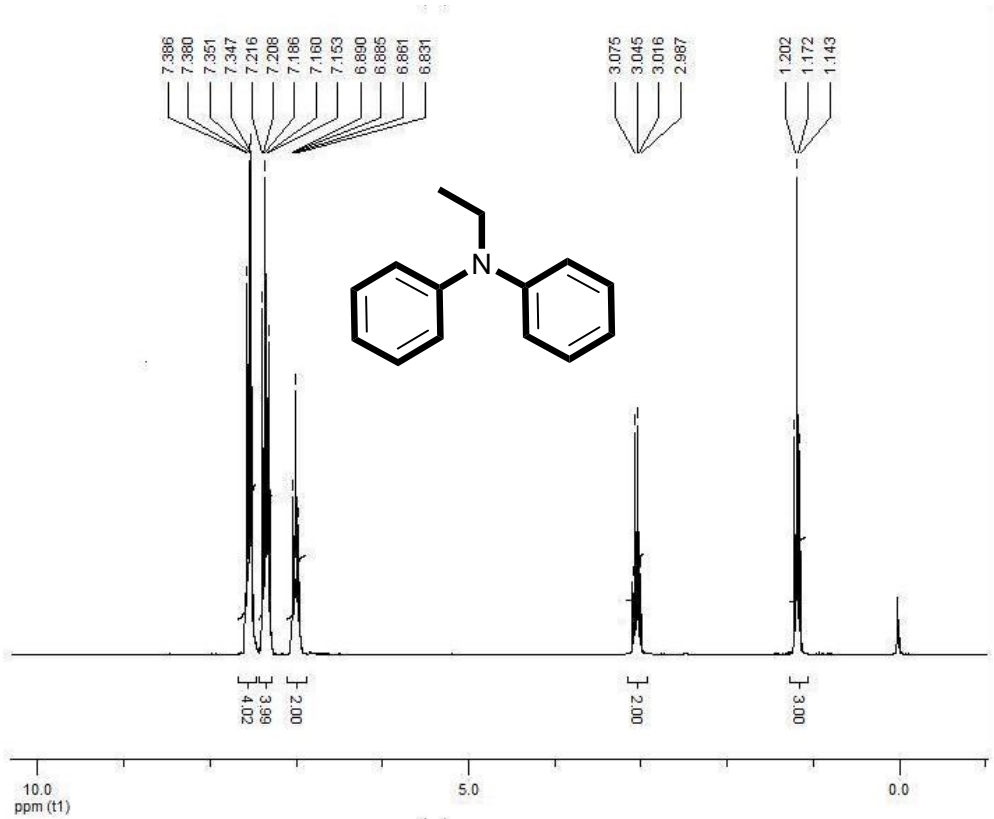
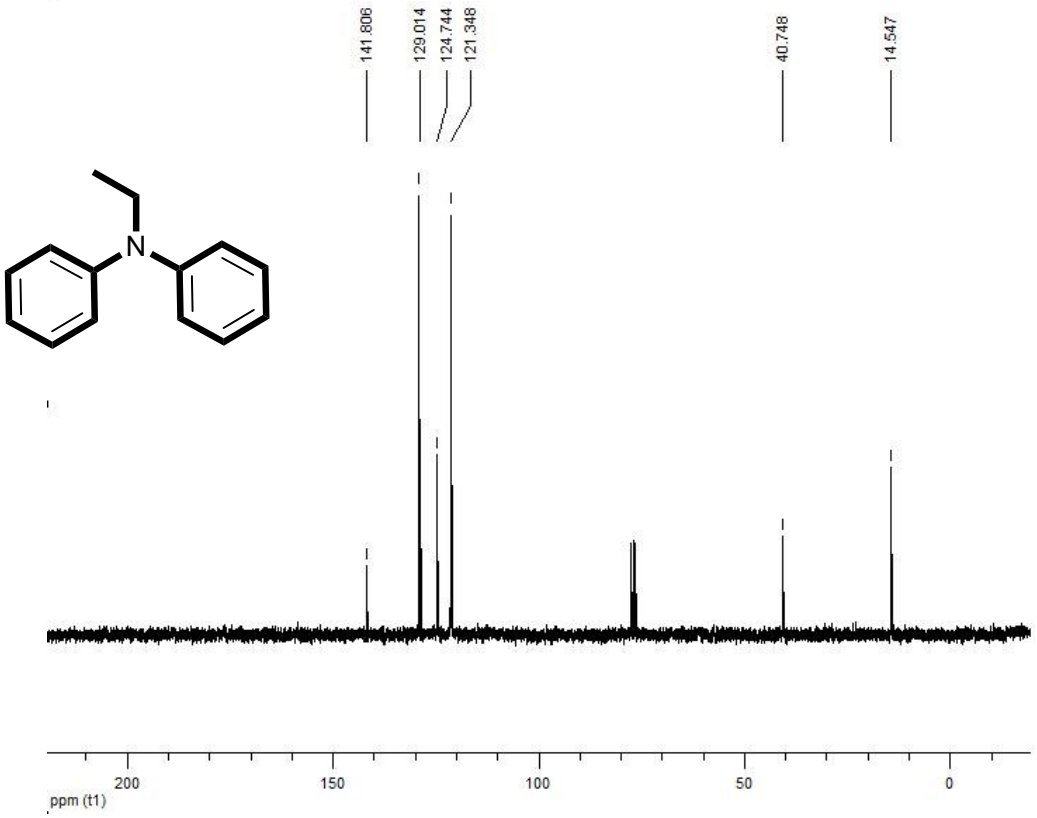
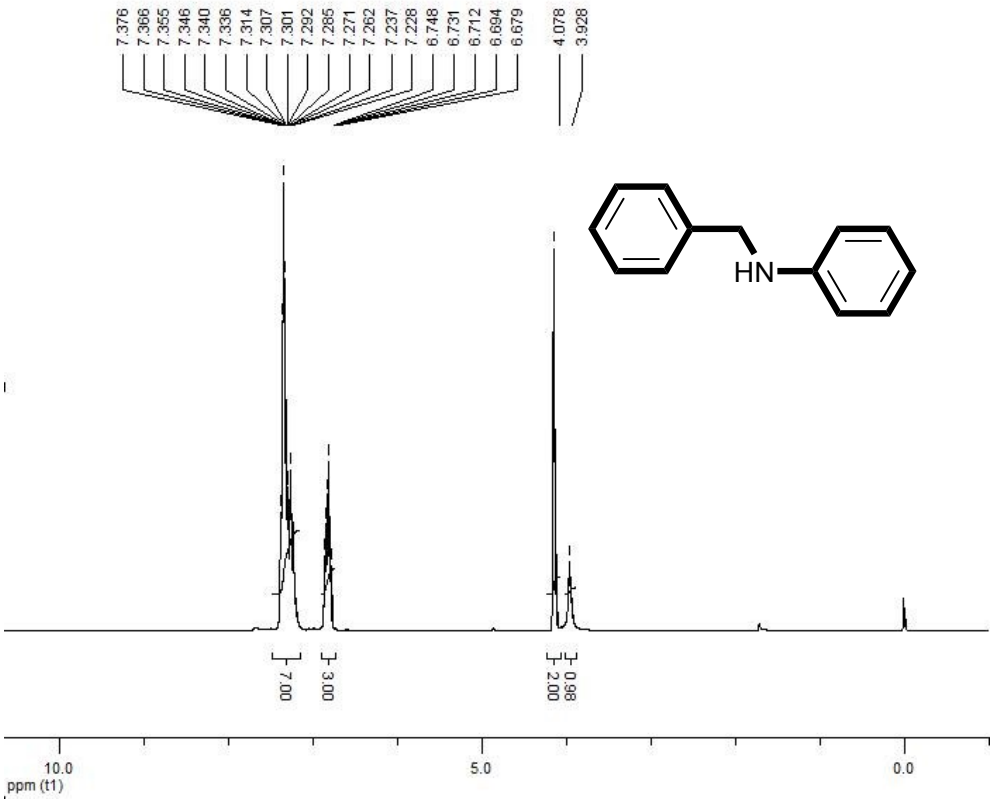



$^{1}$H-NMR spectra (250 MHz) of *N*-ethyl-*N*-phenylaniline (**C11**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of *N*-ethyl-*N*-phenylaniline (**C11**) in $CDCl_3$.

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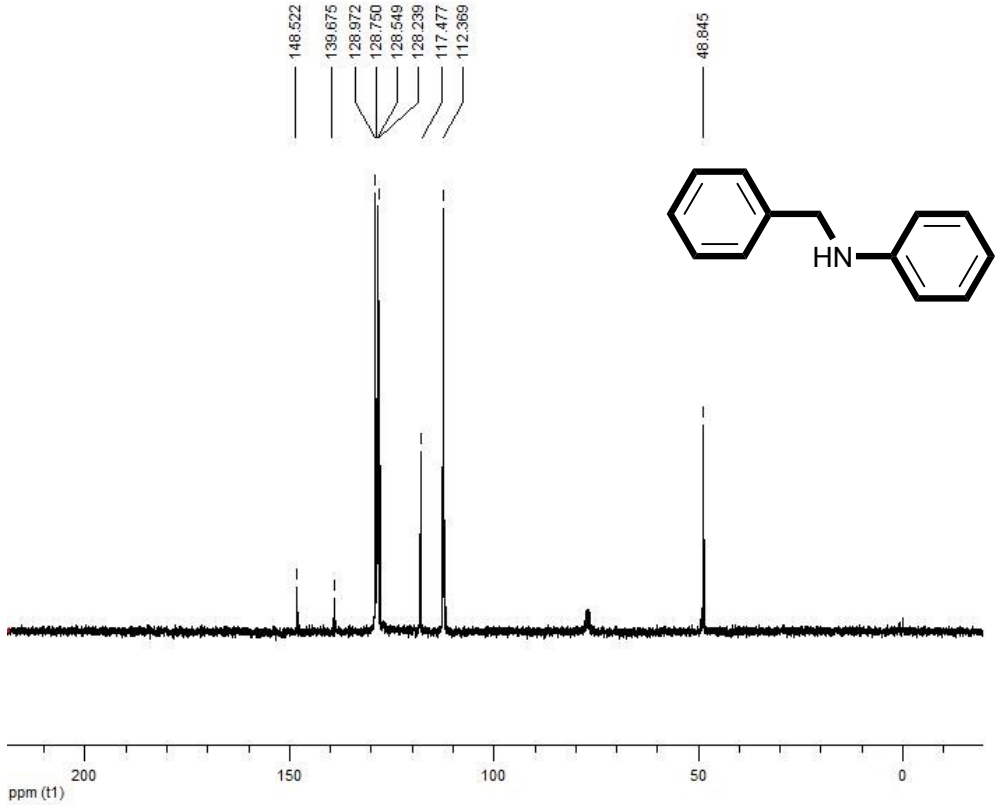
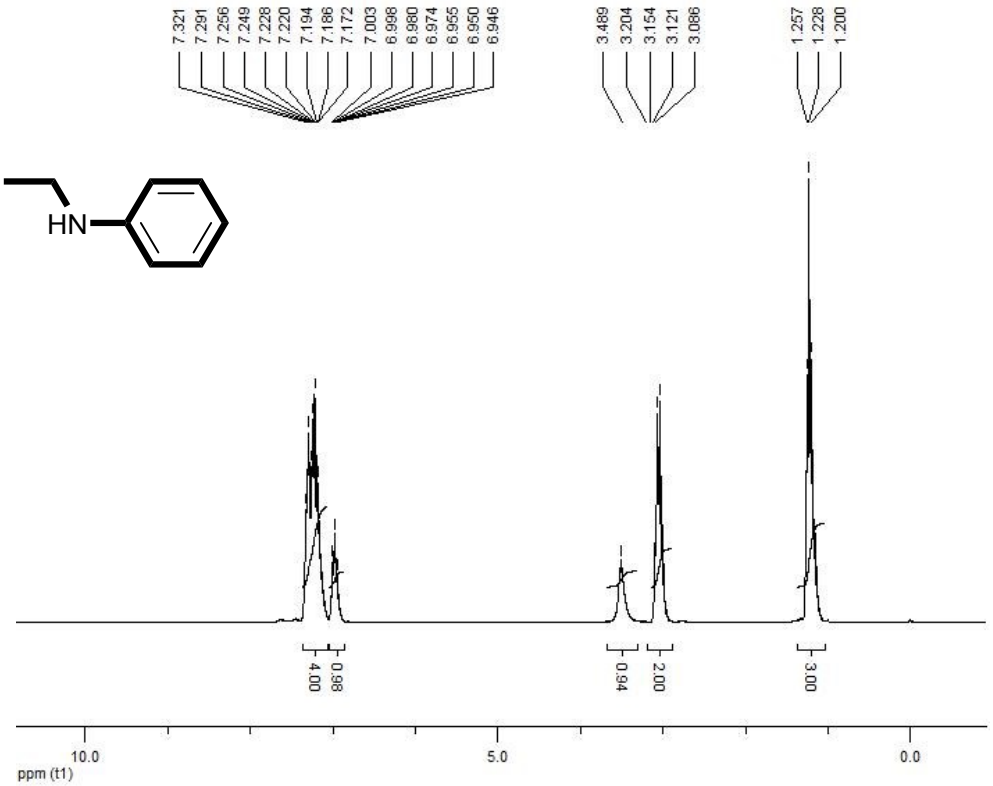
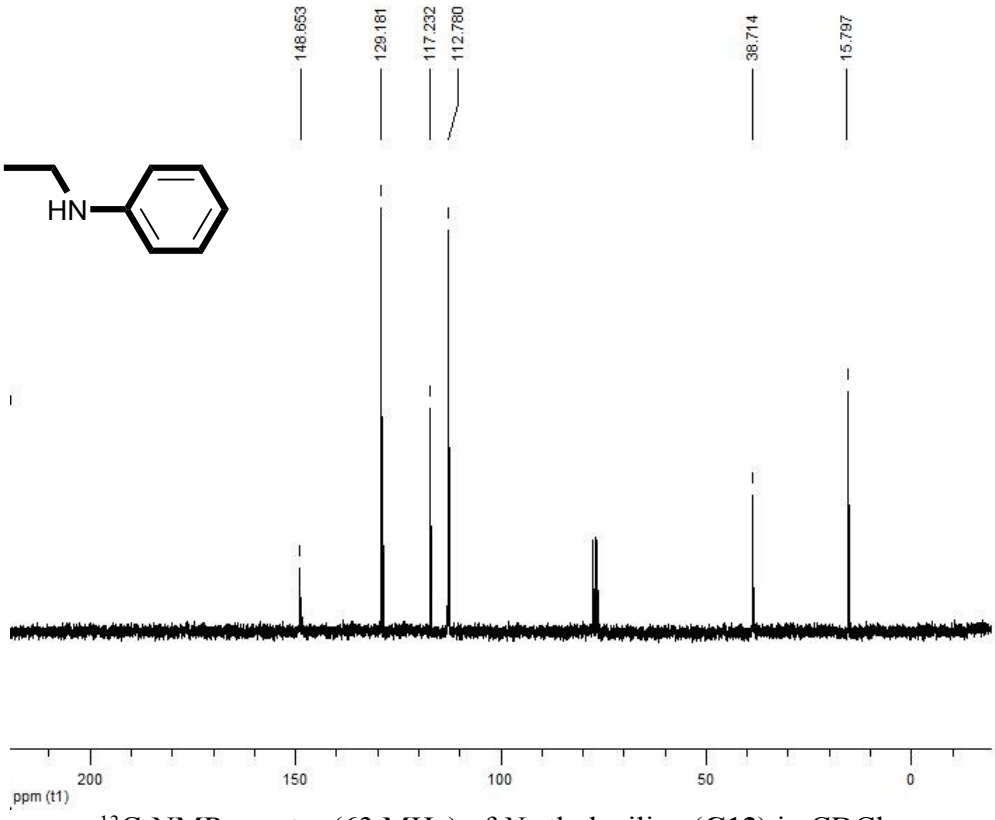



$^{13}$C-NMR spectra (63 MHz) of *N*-benzylaniline (**C12**) in $CDCl_3$.




$^{1}$H-NMR spectra (250 MHz) of *N*-ethylaniline (**C13**) in $CDCl_3$.

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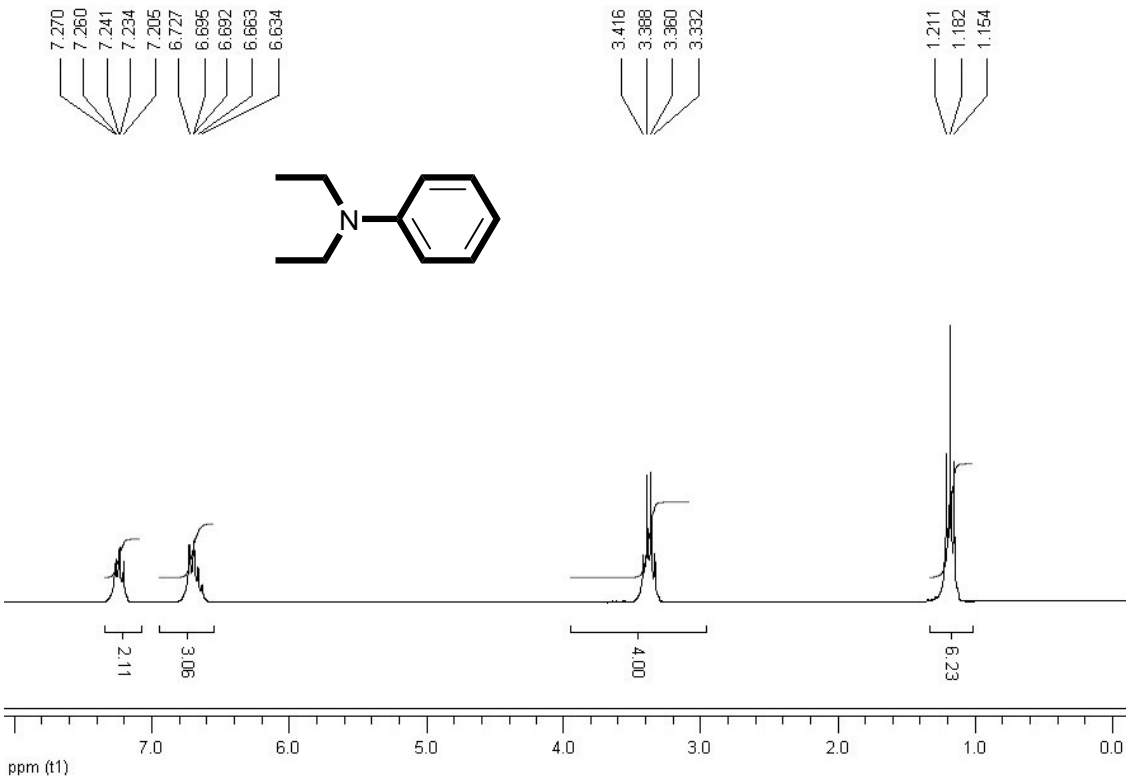
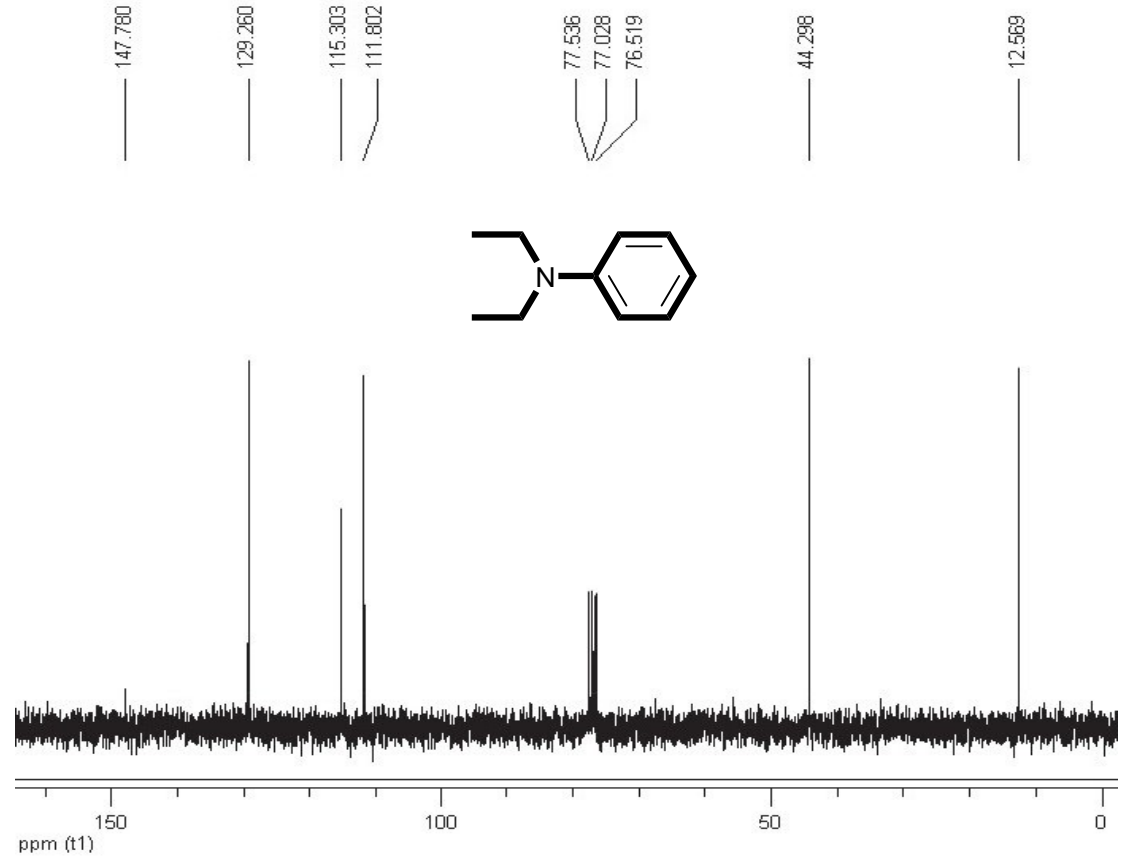
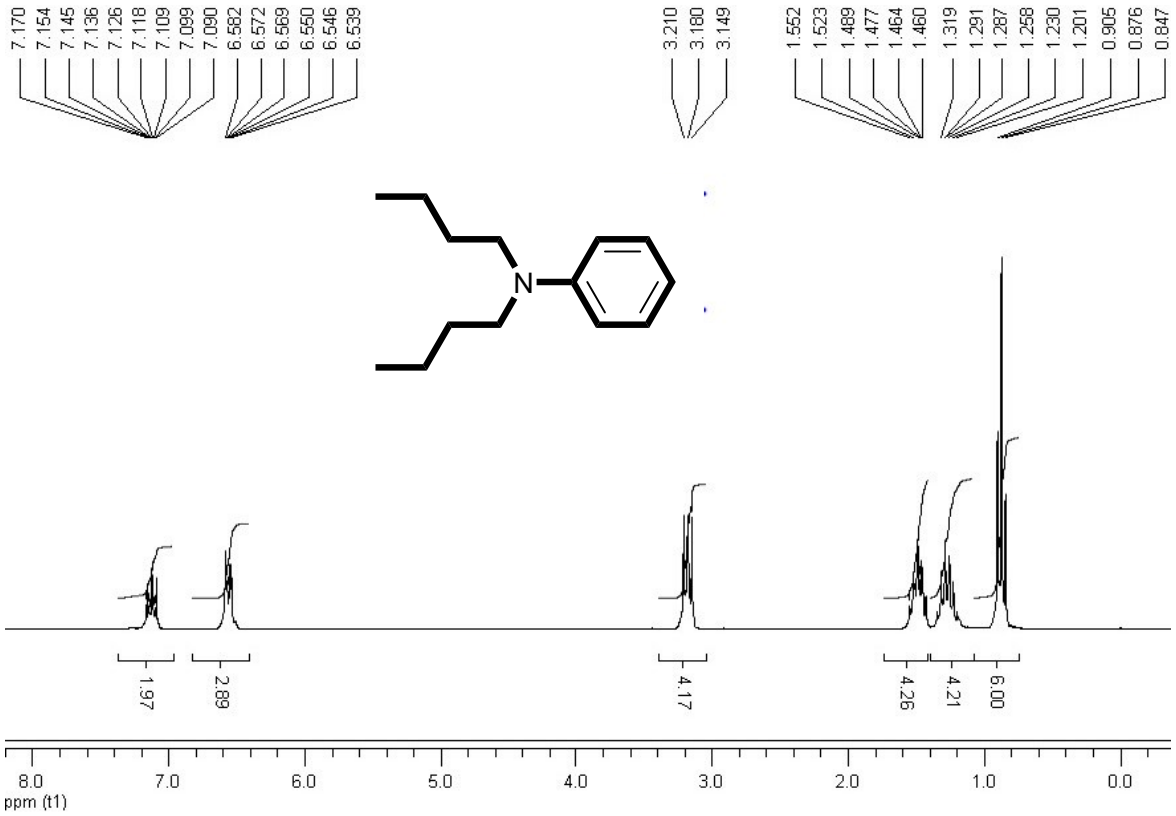


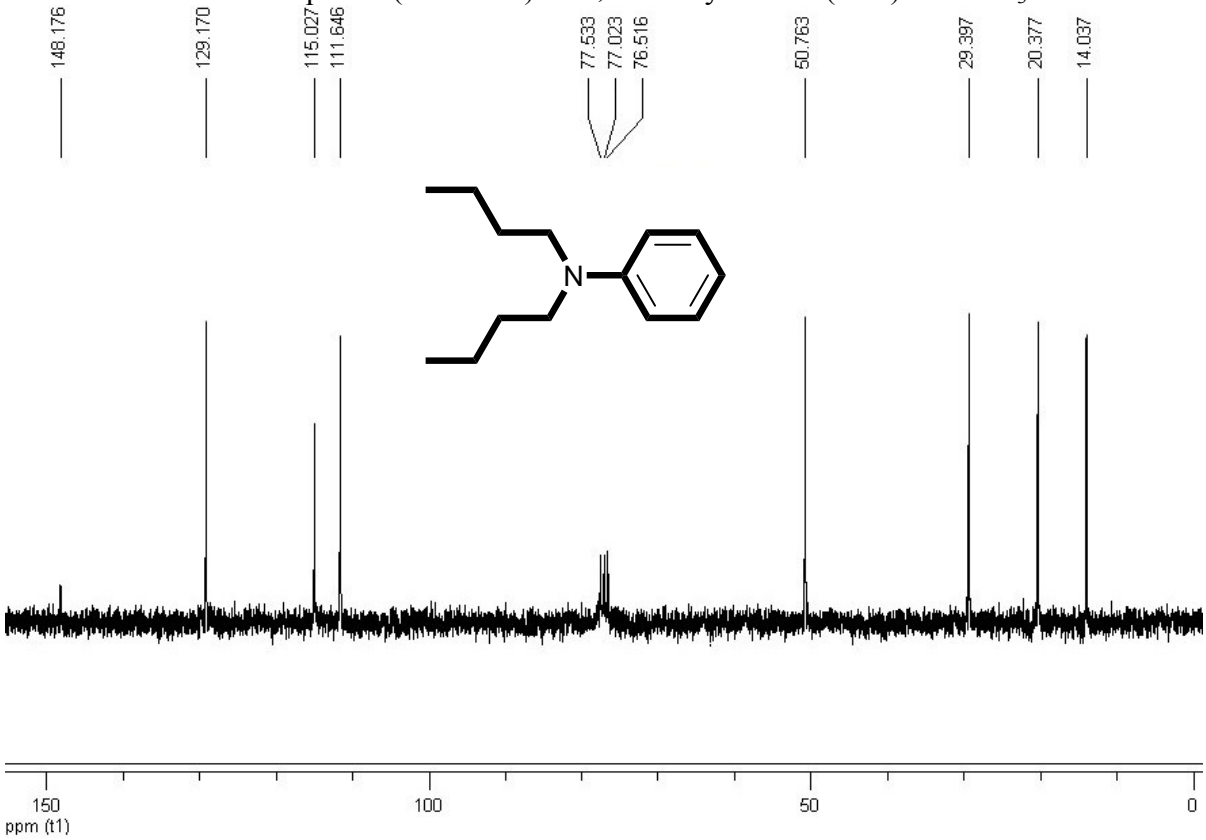

$^{1}$H-NMR spectra (250 MHz) of *N,N*-diethylaniline (**C14**) in $CDCl_3$.



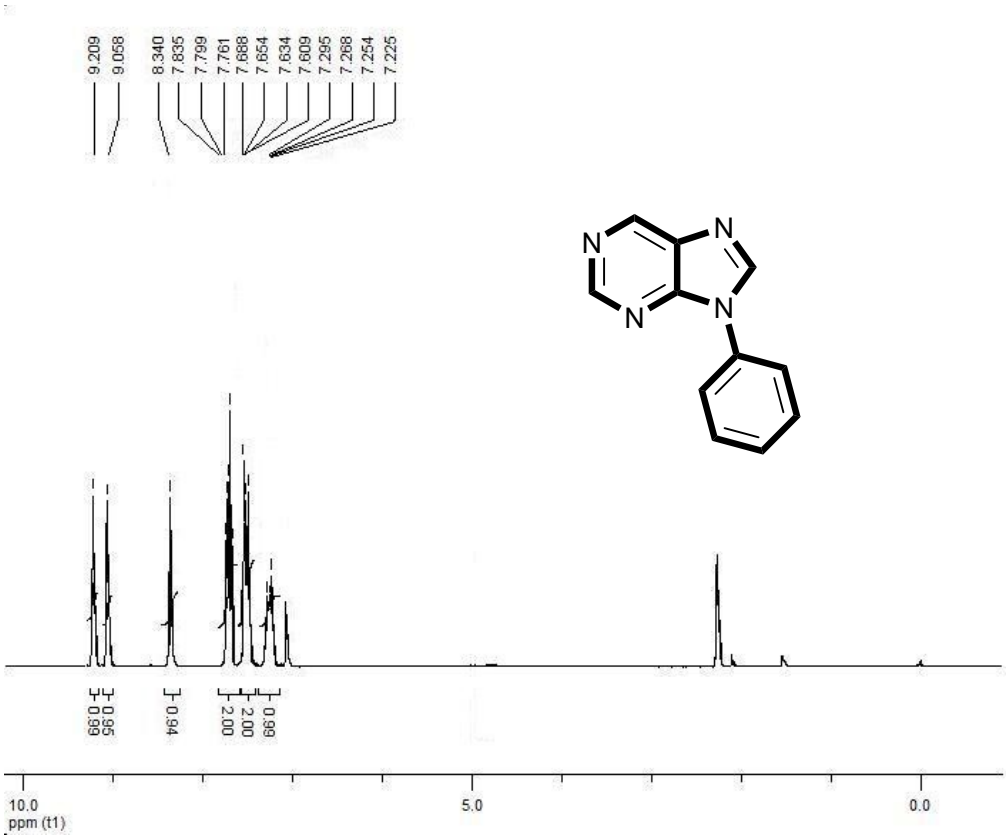

$^{13}$C-NMR spectra (63 MHz) of *N,N*-diethylaniline (**C14**) in $CDCl_3$.



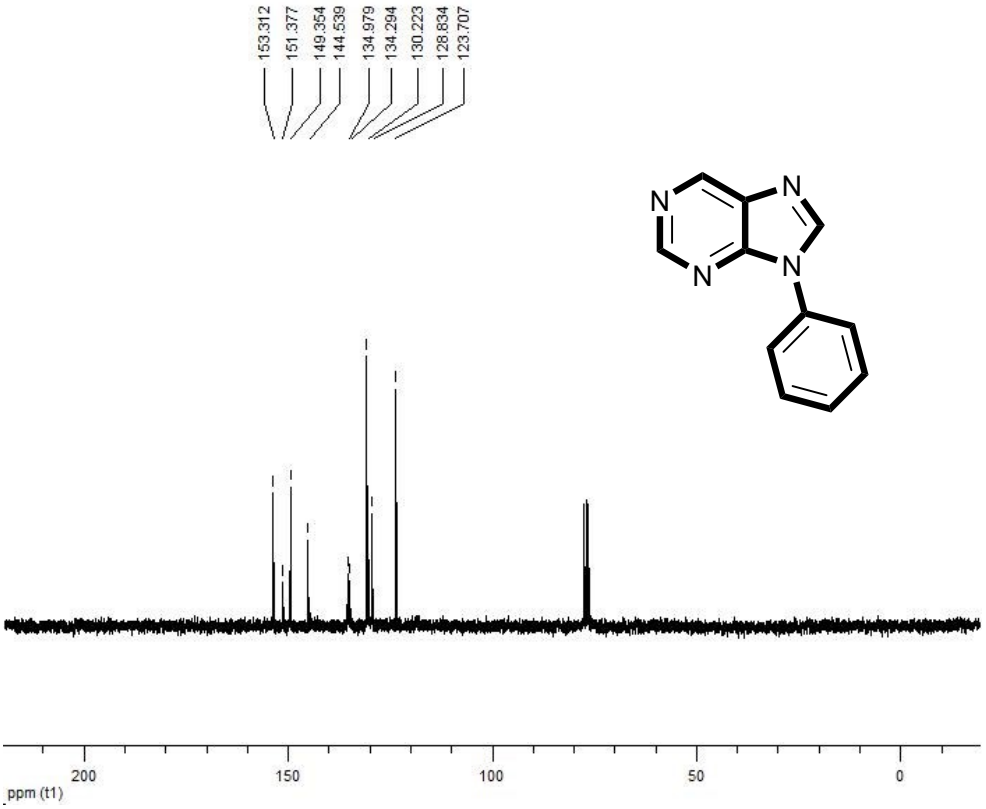

$^{1}$H-NMR spectra (250 MHz) of *N,N*-dibutylaniline (**C15**) in $CDCl_3$.



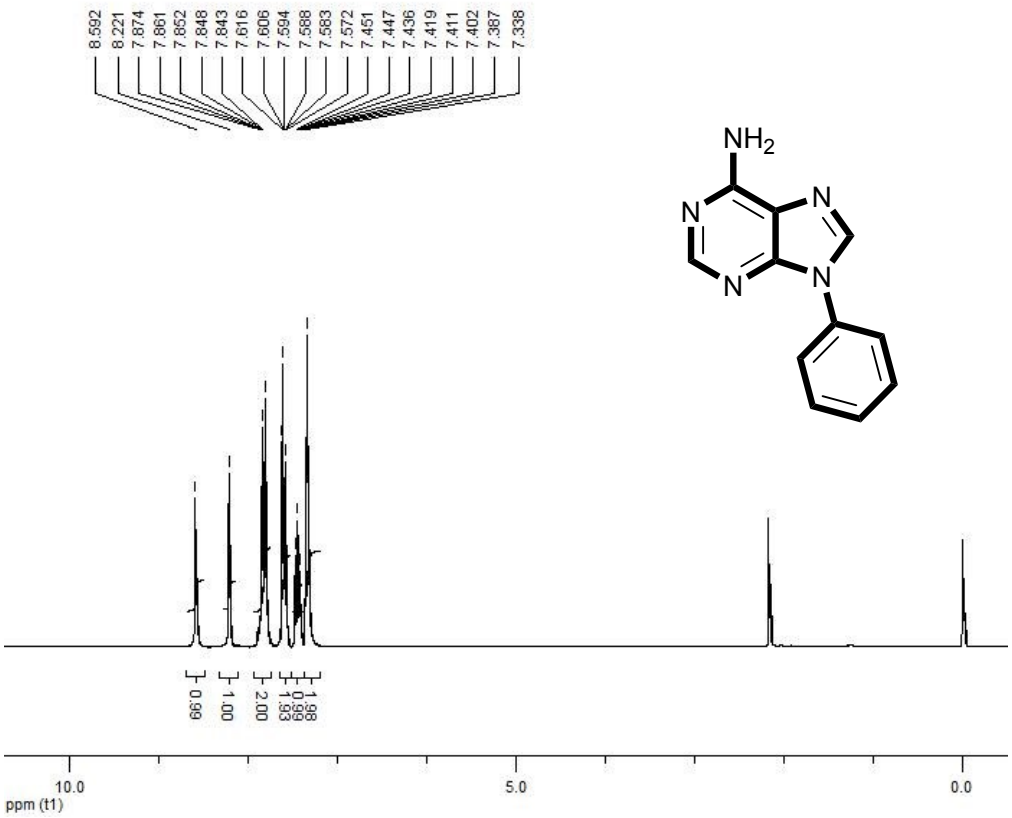

$^{13}$C-NMR spectra (63 MHz) of *N,N*-dibutylaniline (**C15**) in $CDCl_3$.



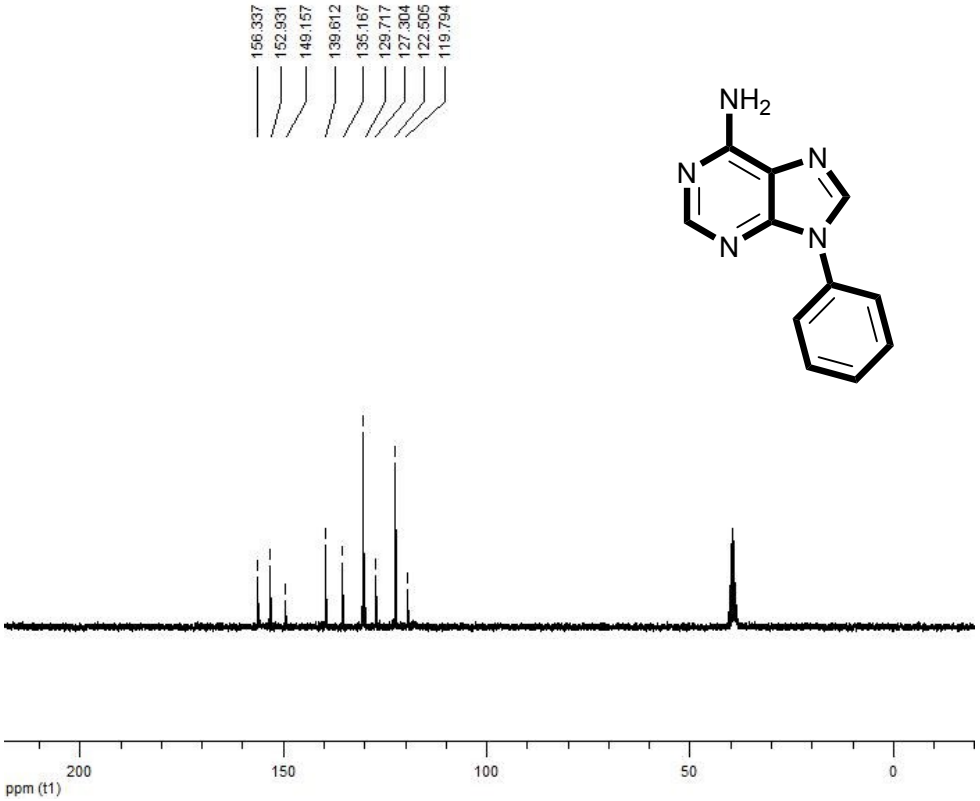

$^{1}$H-NMR spectra (250 MHz) of 9-phenylpurine **(C16)** in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of 9-phenylpurine **(C16)** in $CDCl_3$.




$^{1}$H-NMR spectra (250 MHz) of 9-phenyladenine **(C17)** in DMSO-$d_6$.

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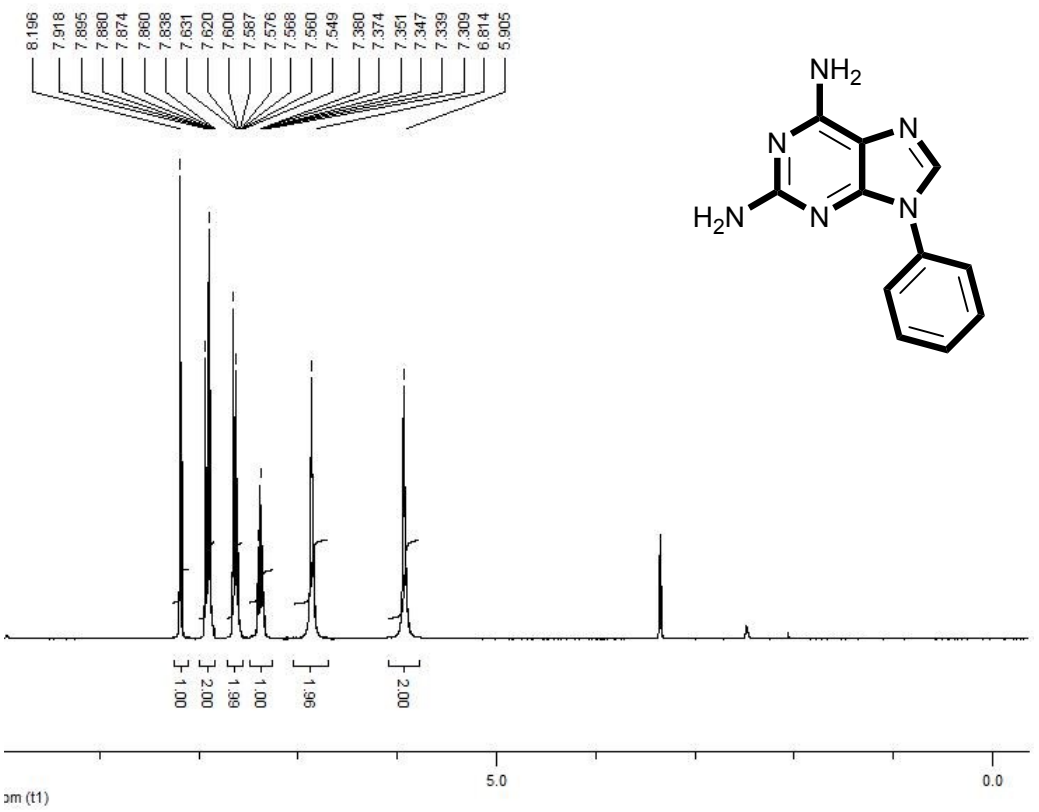
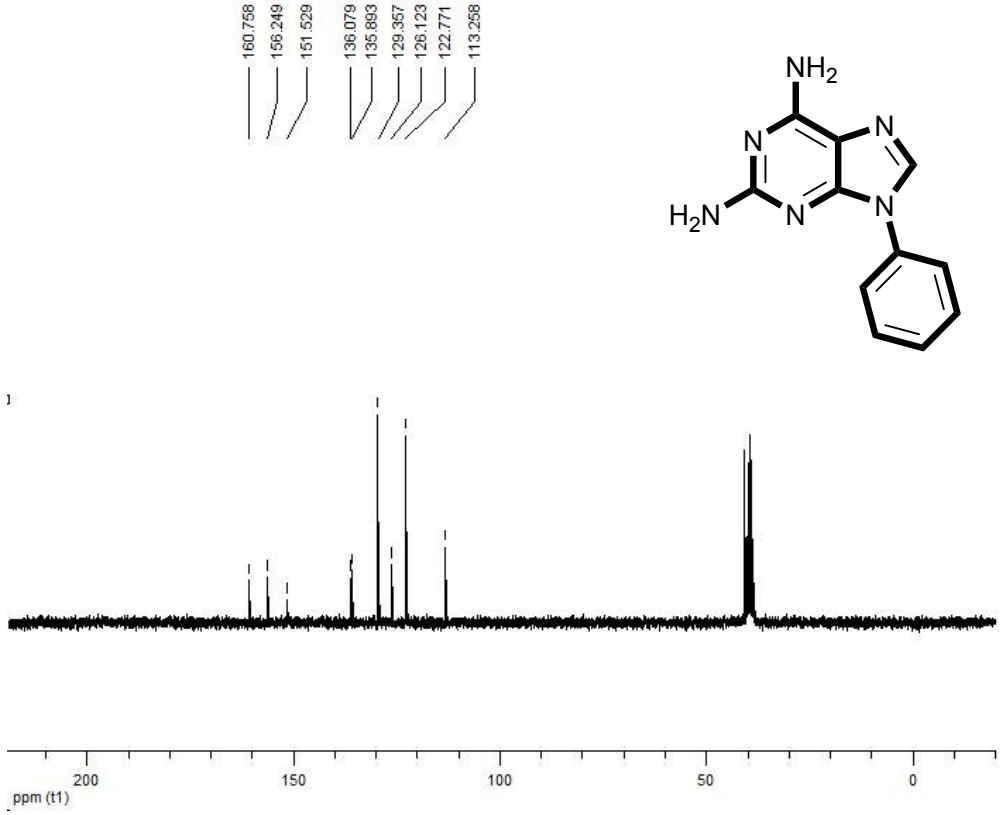
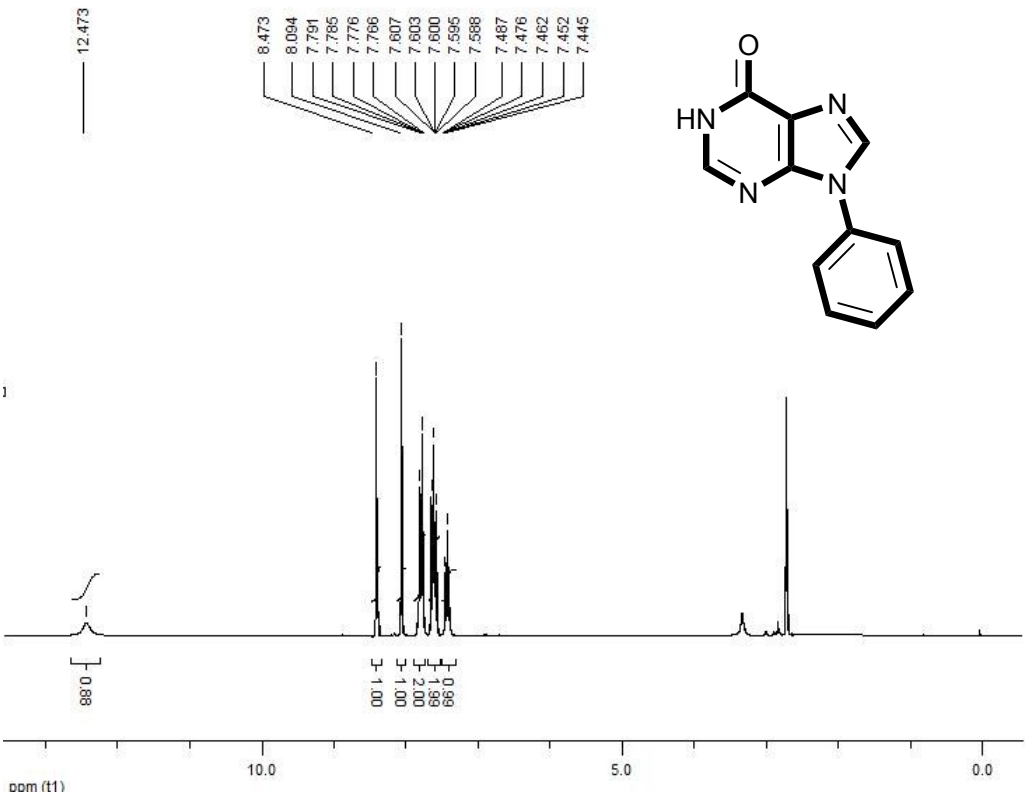


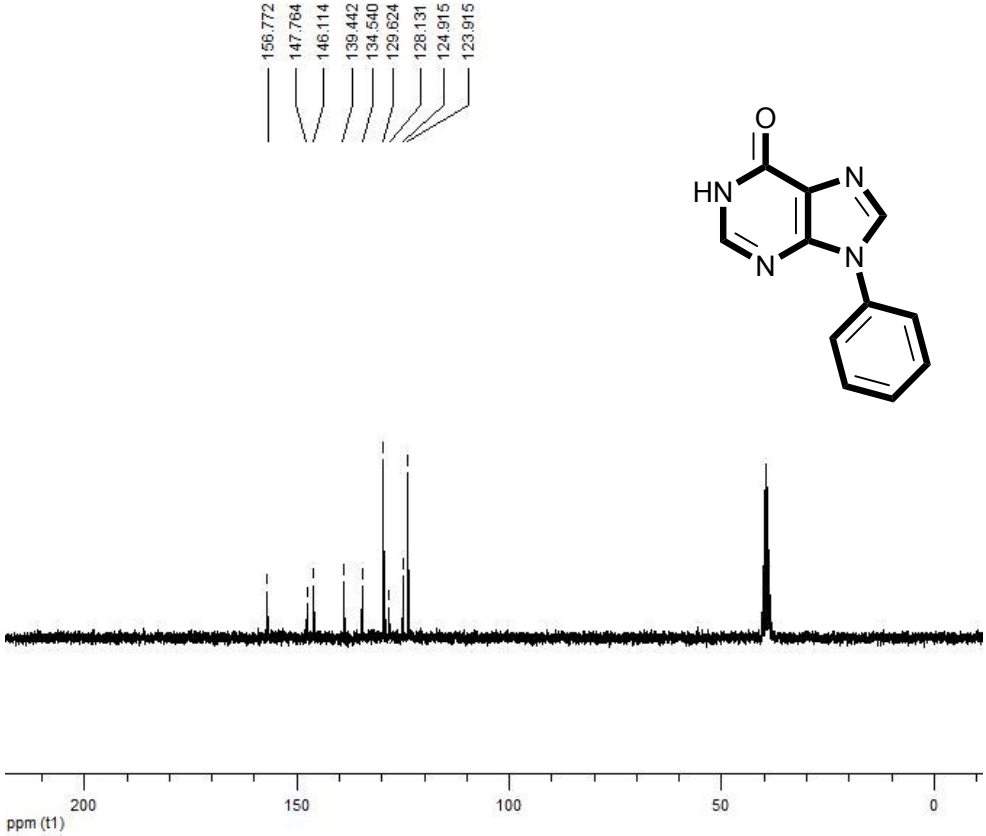

$^{1}$H-NMR spectra (250 MHz) of 9-phenylpurine-2,6-diamine **(C18)** in DMSO-$d_6$.



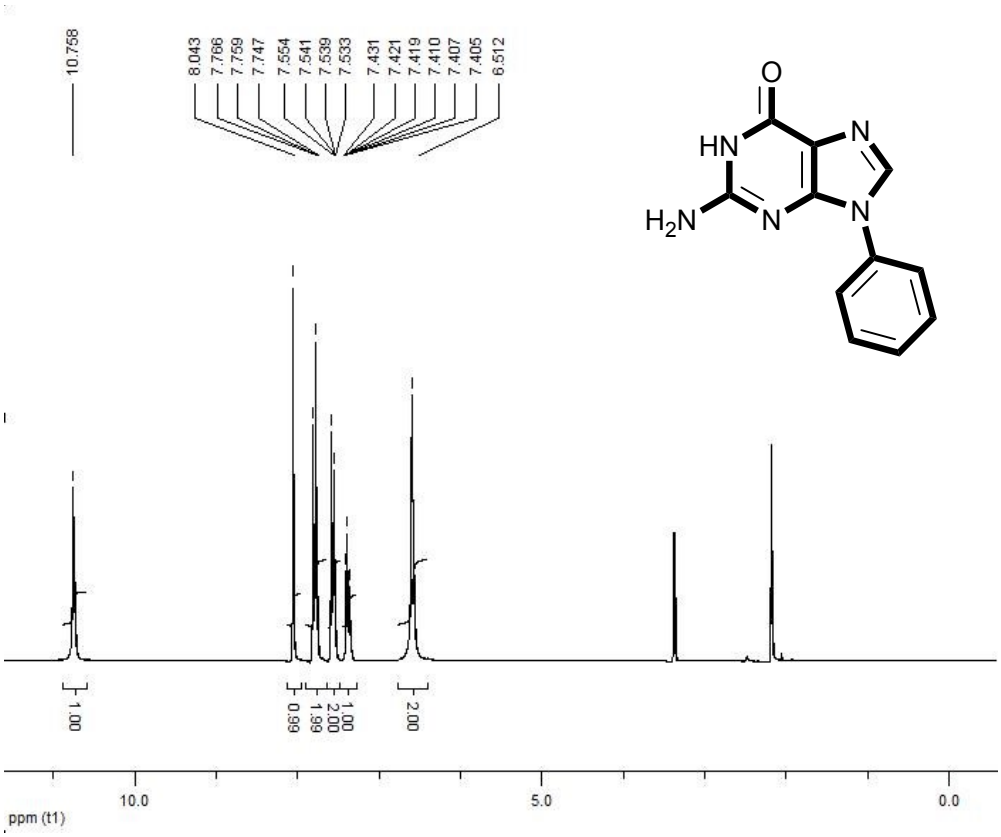

$^{13}$C-NMR spectra (63 MHz) of 9-phenylpurine-2,6-diamine **(C18)** in DMSO-$d_6$.



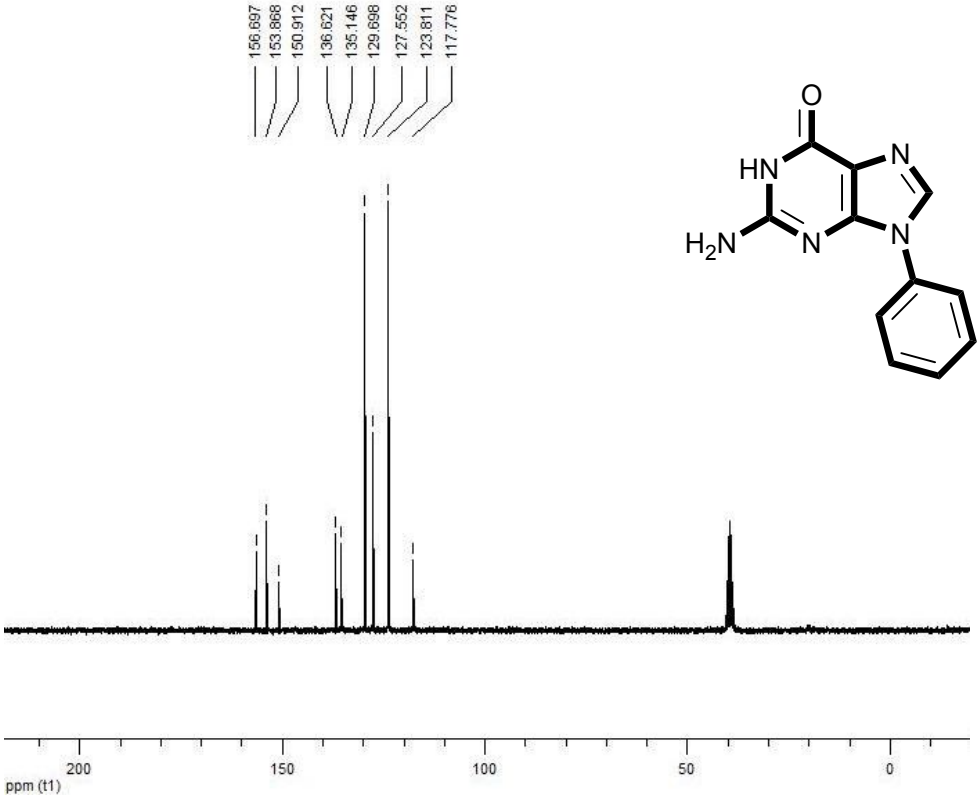

$^{1}$H-NMR spectra (250 MHz) of 9-phenylhypoxanthine **(C19)** in DMSO-$d_6$.



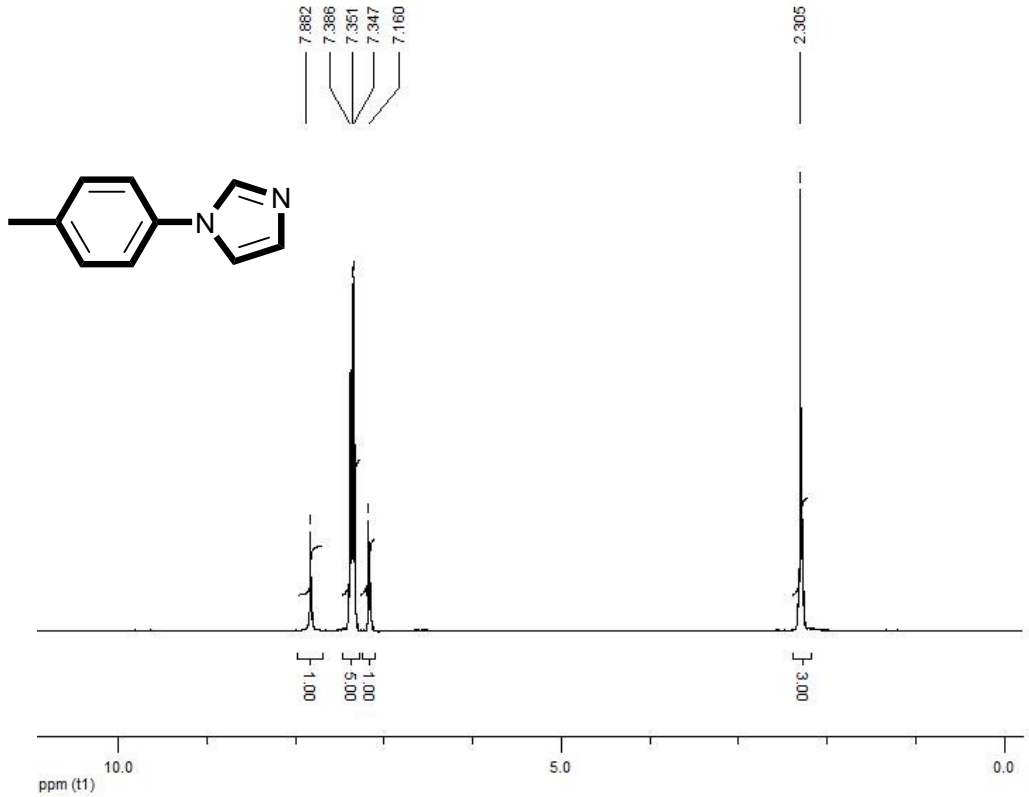

$^{13}$C-NMR spectra (63 MHz) of 9-phenylhypoxanthine **(C19)** in DMSO-$d_6$.




$^{1}$H-NMR spectra (250 MHz) of 9-phenylguanine **(C20)** in DMSO-$d_6$.




$^{13}$C-NMR spectra (63 MHz) of 9-phenylguanine **(C20)** in DMSO-$d_6$.

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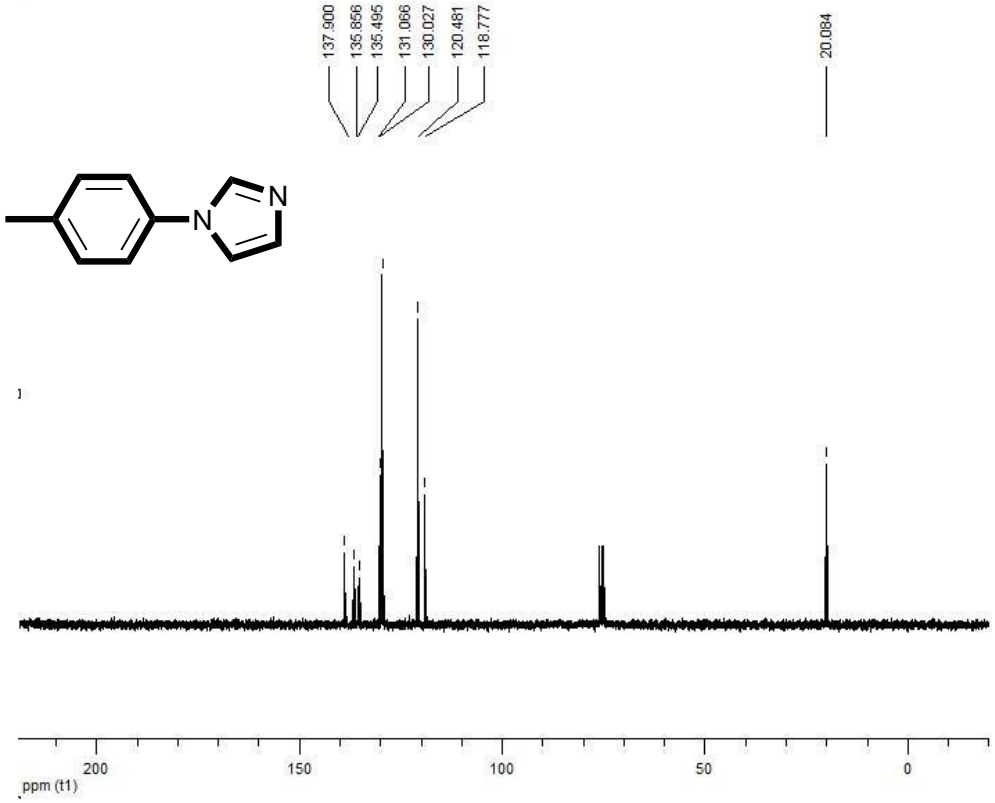
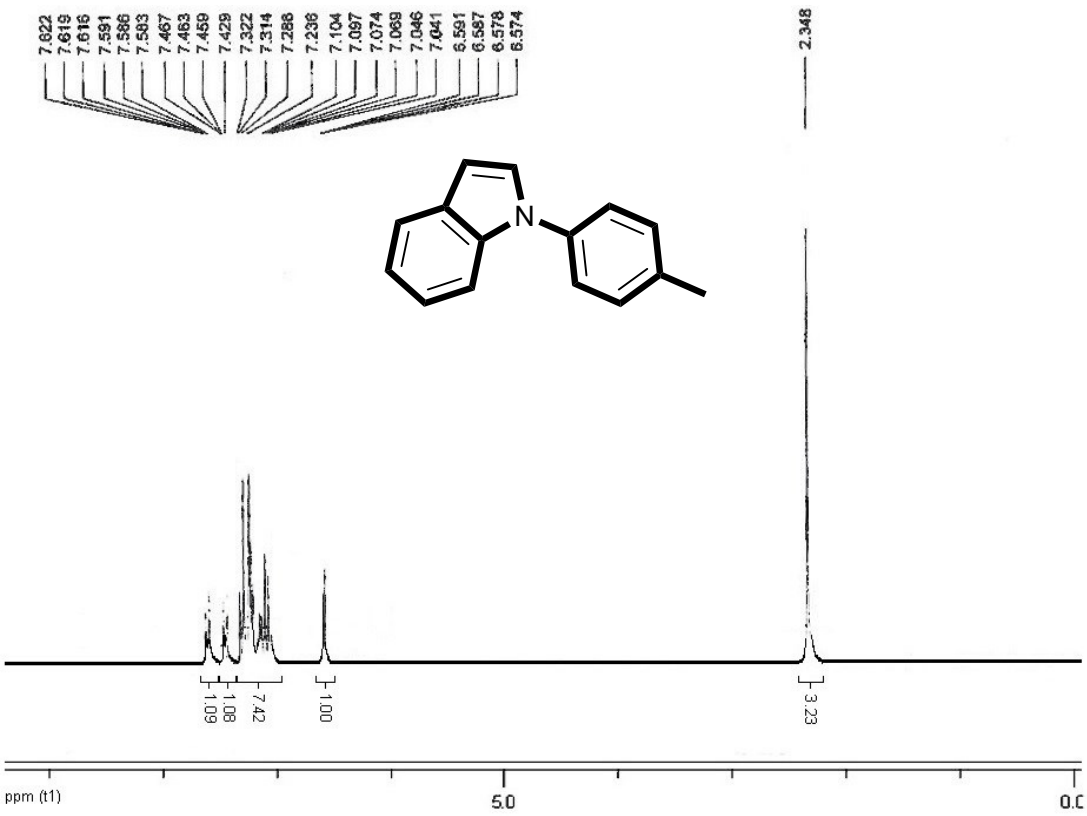
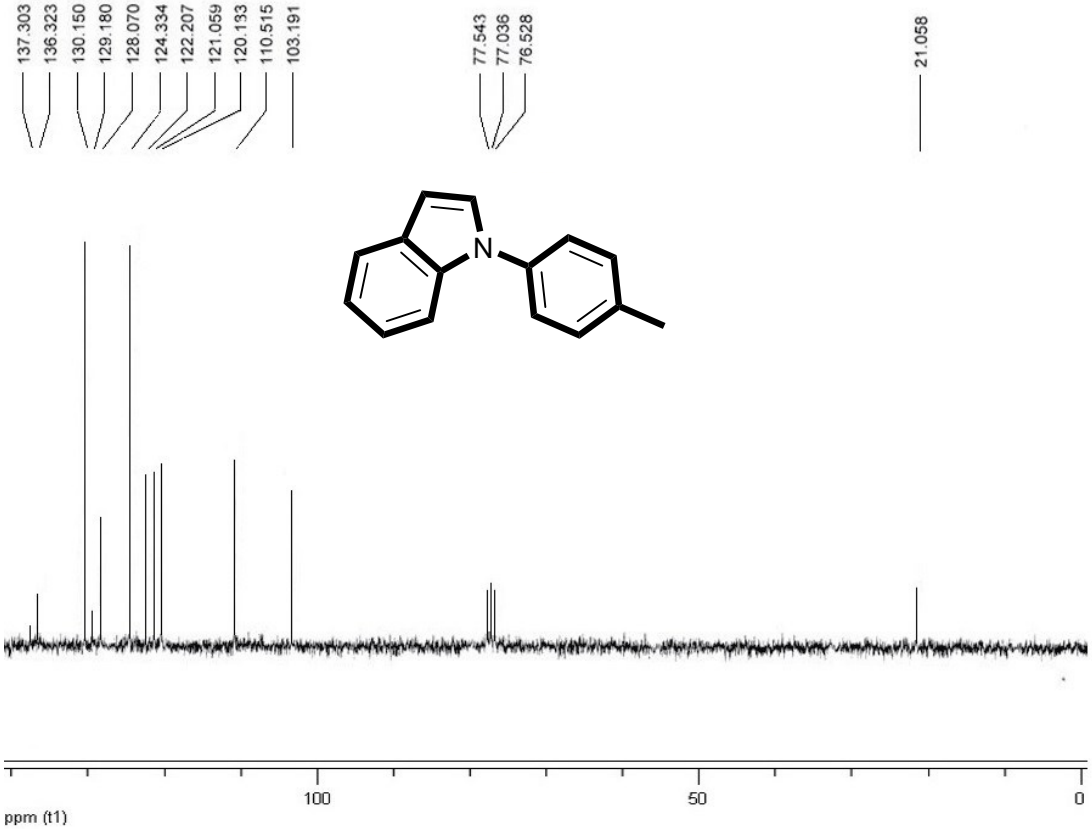


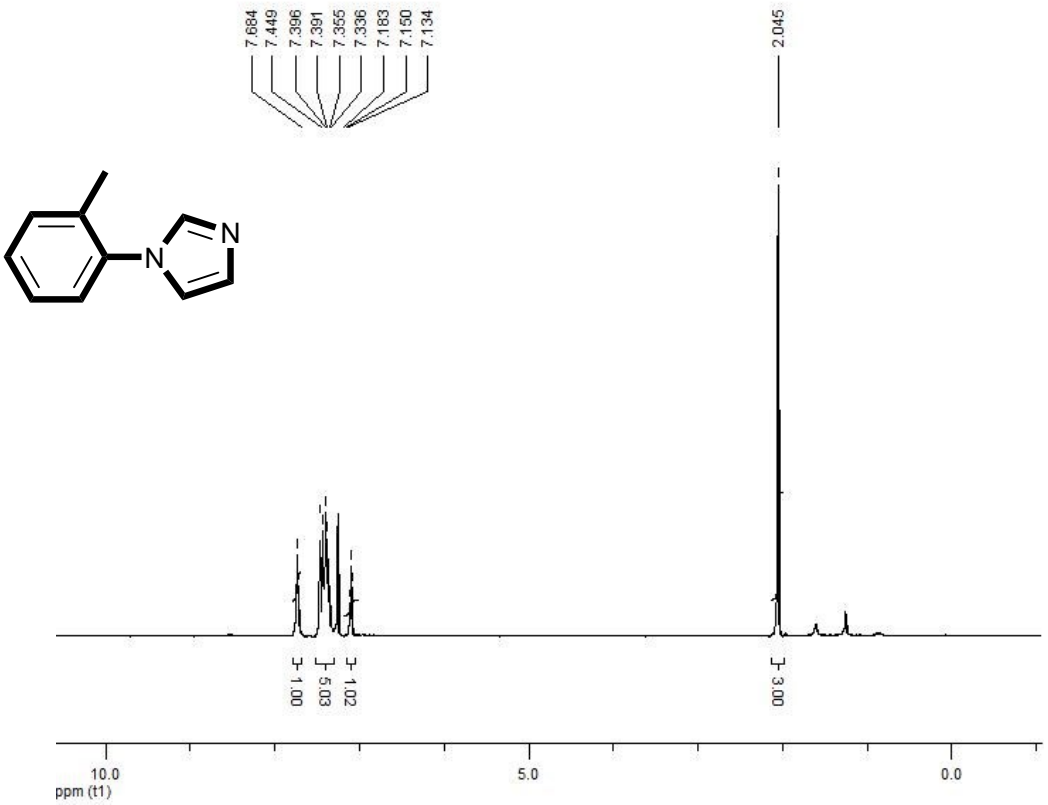

$^{13}$C-NMR spectra (63 MHz) of 1-(*p*-tolyl)-1*H*-imidazole (**C22**) in $CDCl_3$.



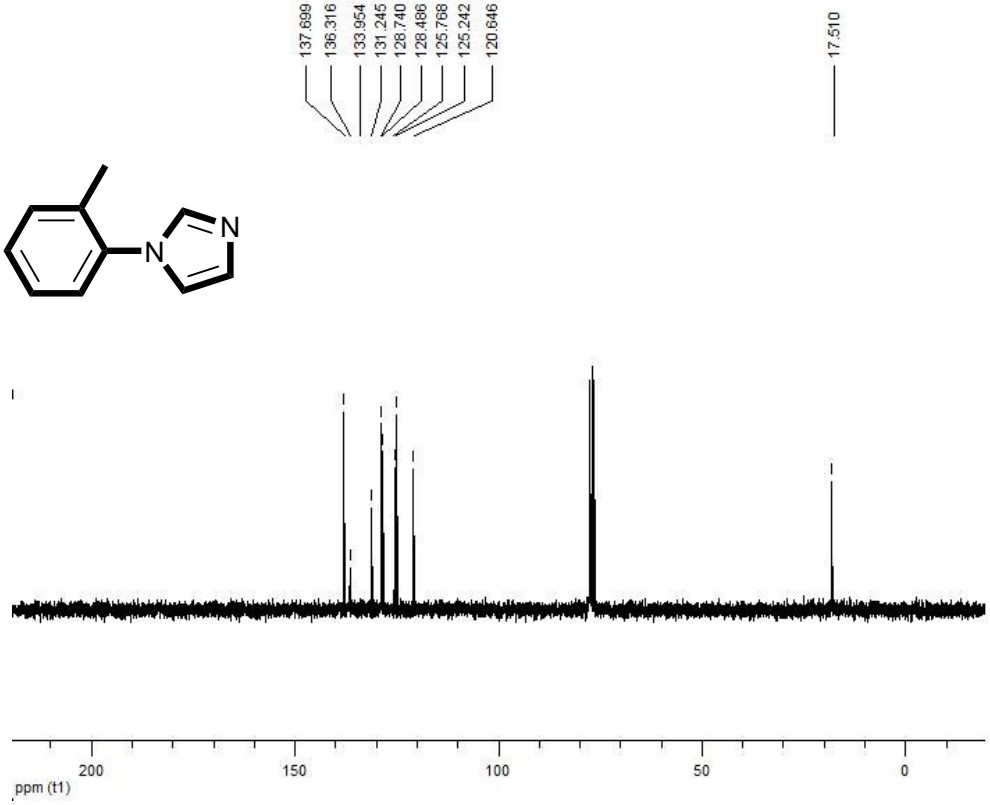

$^{1}$H-NMR spectra (250 MHz) of 1-(*p*-tolyl)-1*H*-indole (**C23**) in $CDCl_3$.



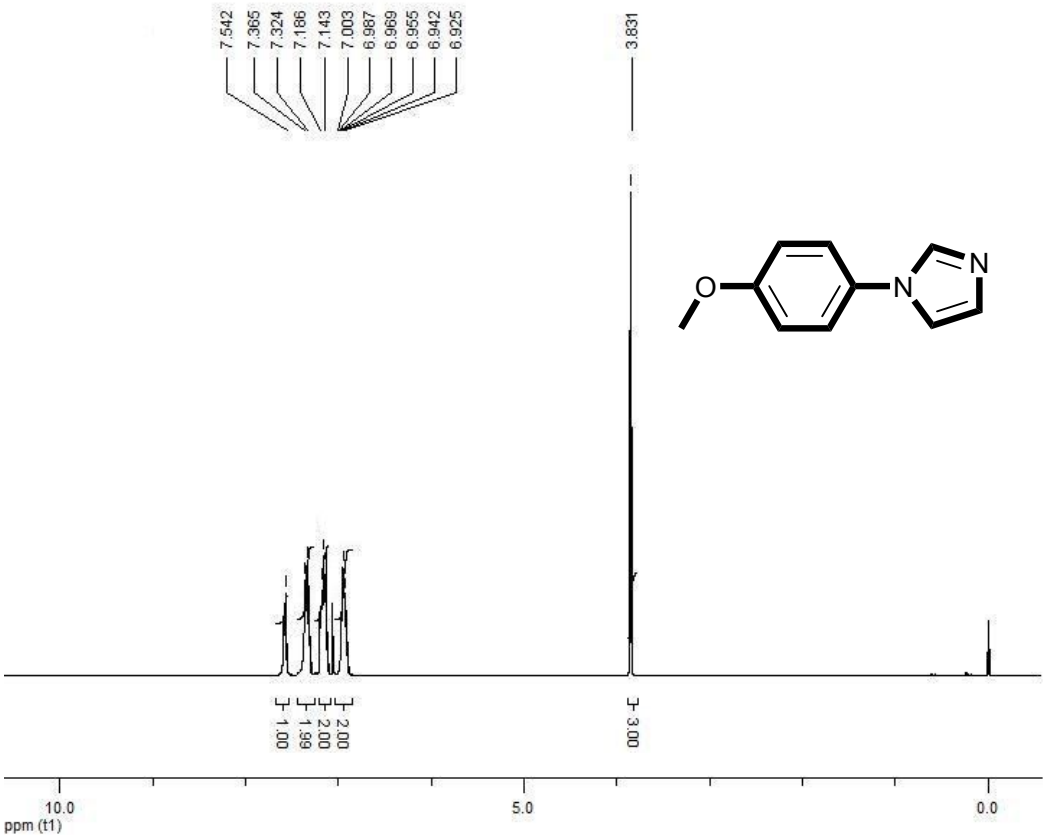

$^{13}$C-NMR spectra (63 MHz) of 1-(*p*-tolyl)-1*H*-indole (**C23**) in $CDCl_3$.



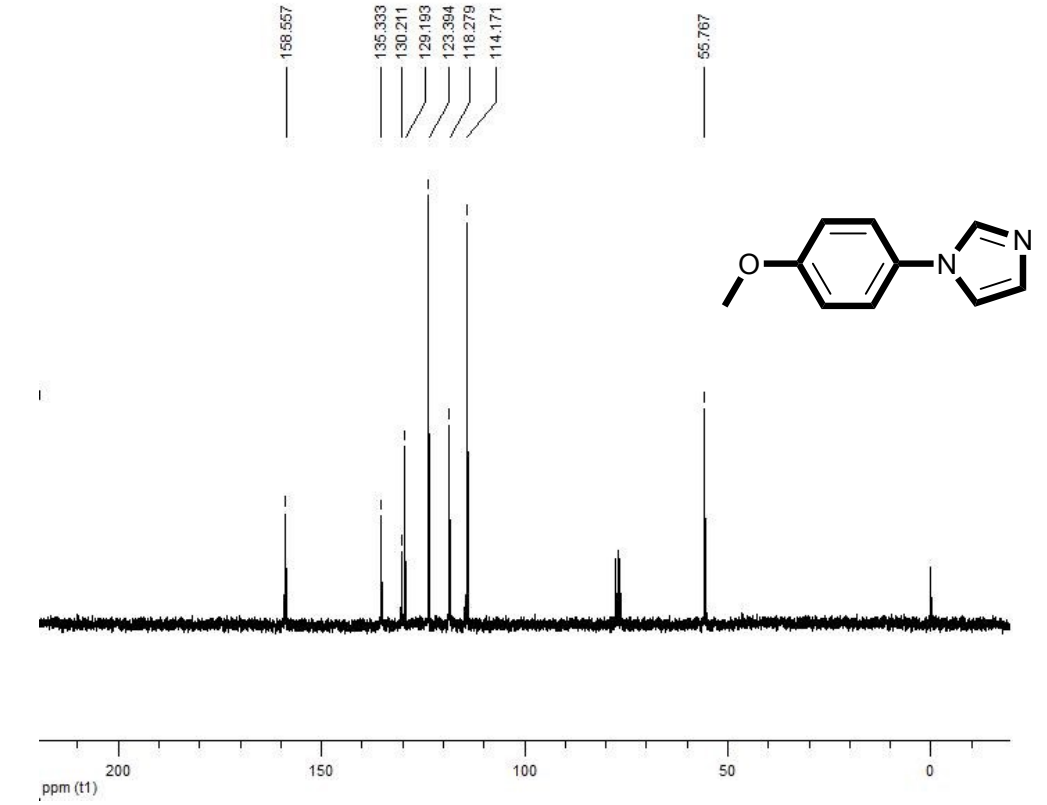

$^{1}$H-NMR spectra (250 MHz) of 1-(*o*-tolyl)-1*H*-imidazole (**C24**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of 1-(*o*-tolyl)-1*H*-imidazole (**C24**) in $CDCl_3$.

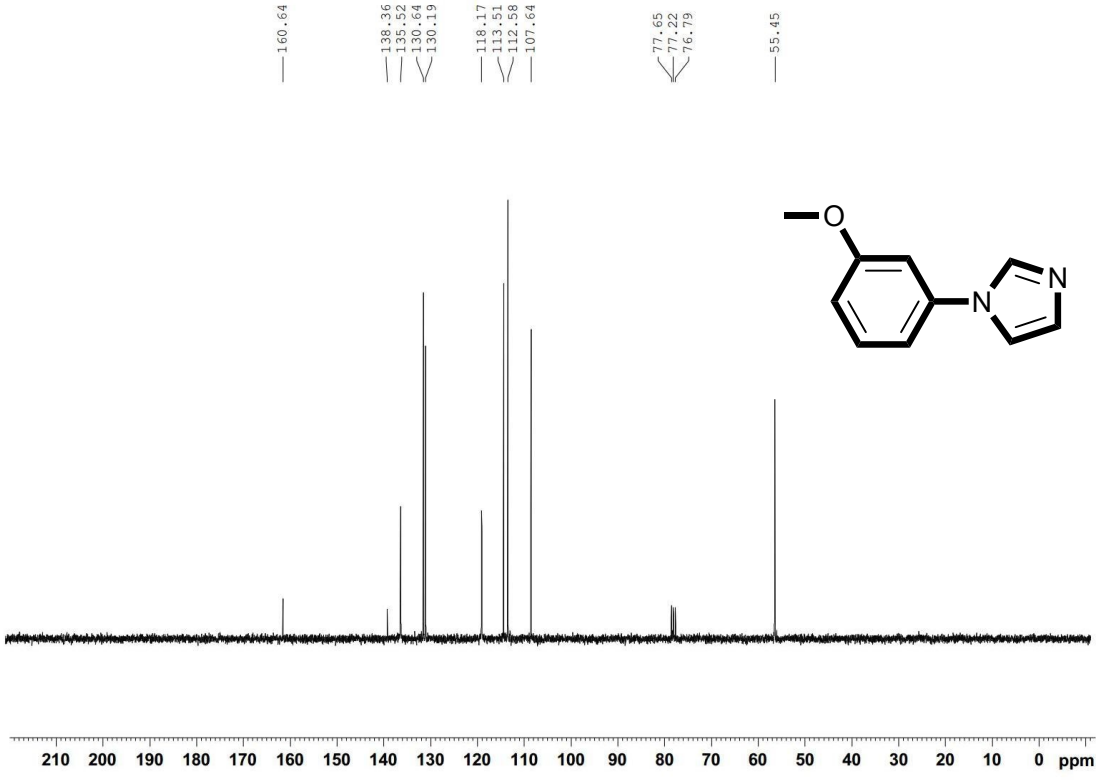



$^{1}$H-NMR spectra (250 MHz) of 1-(4-methoxyphenyl)-1*H*-imidazole (**C25**) in $CDCl_3$.

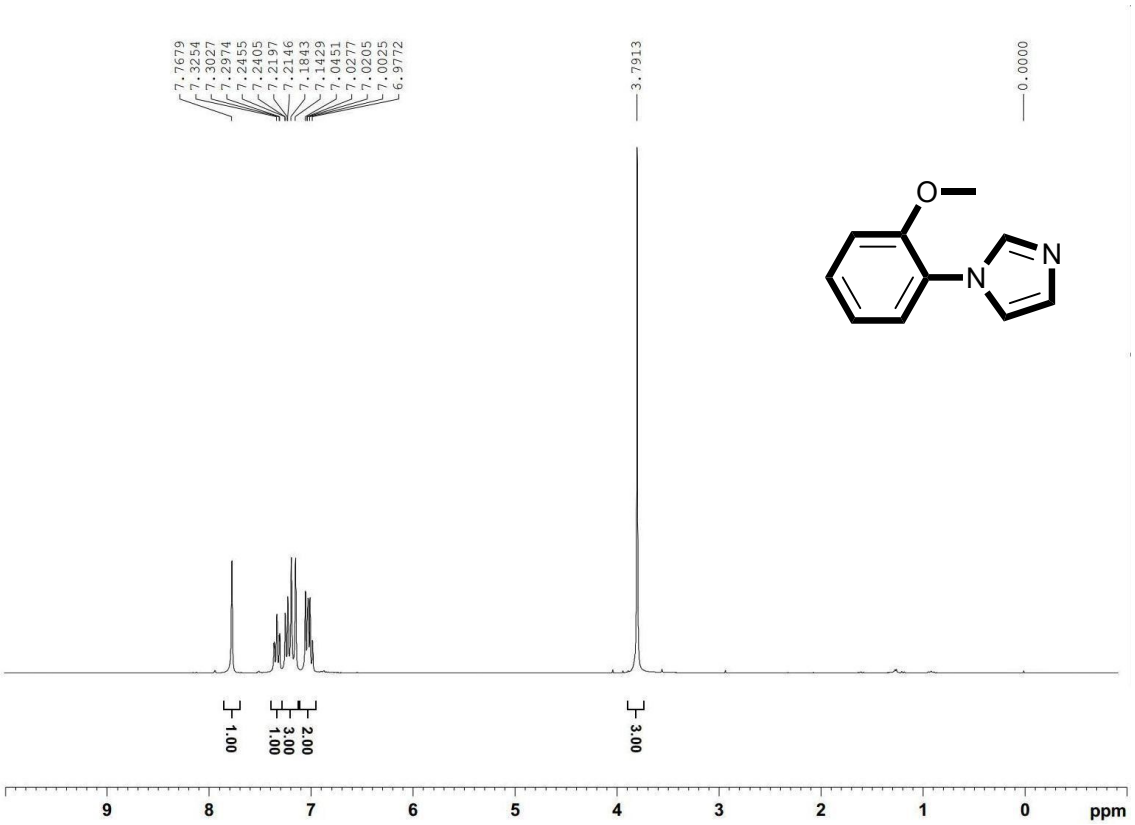



$^{13}$C-NMR spectra (63 MHz) of 1-(4-methoxyphenyl)-1*H*-imidazole (**C25**) in $CDCl_3$.

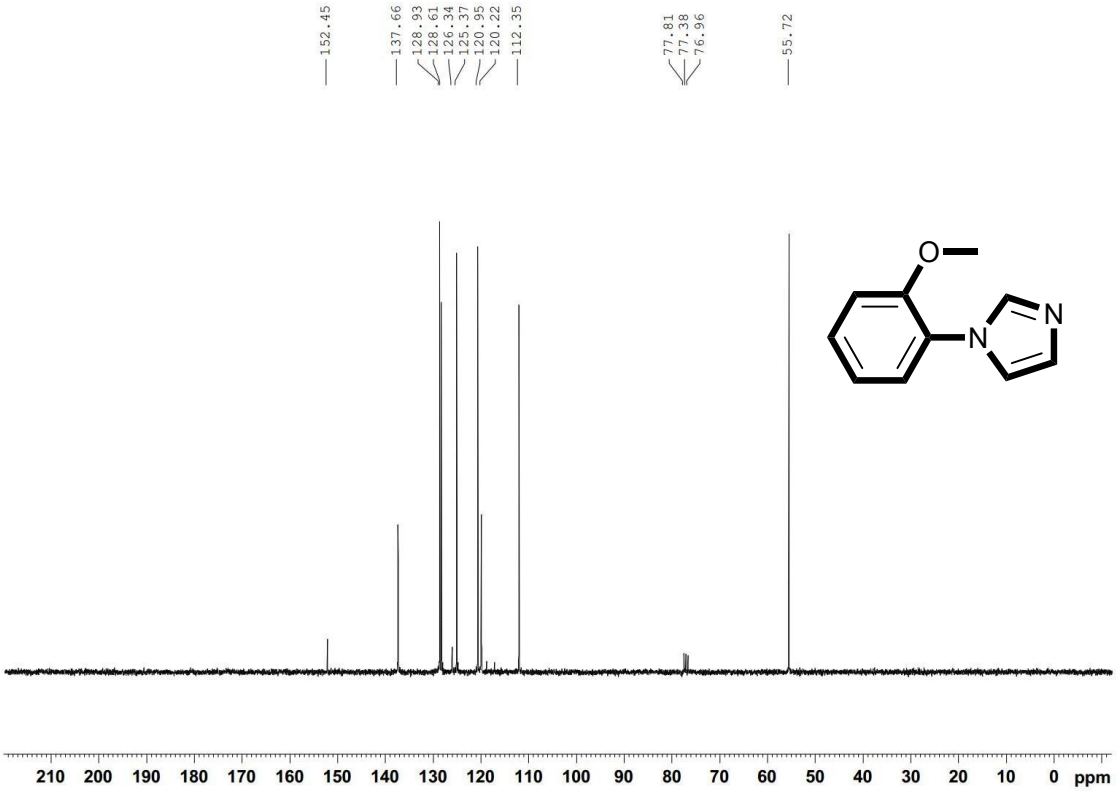

$^{1}$H-NMR spectra (250 MHz) of 1-(3-methoxyphenyl)-1*H*-imidazole (**26**) in $CDCl_3$.



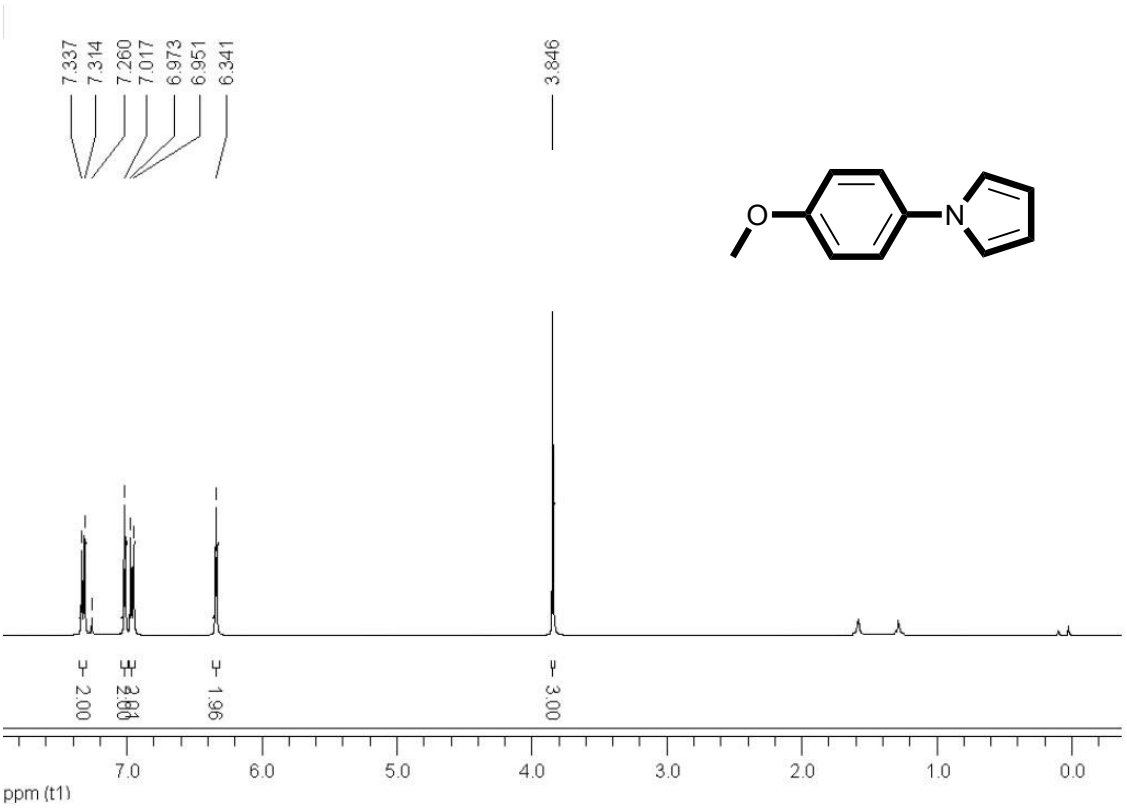

$^{13}$C-NMR spectra (63 MHz) of 1-(3-methoxyphenyl)-1*H*-imidazole (**26**) in $CDCl_3$.



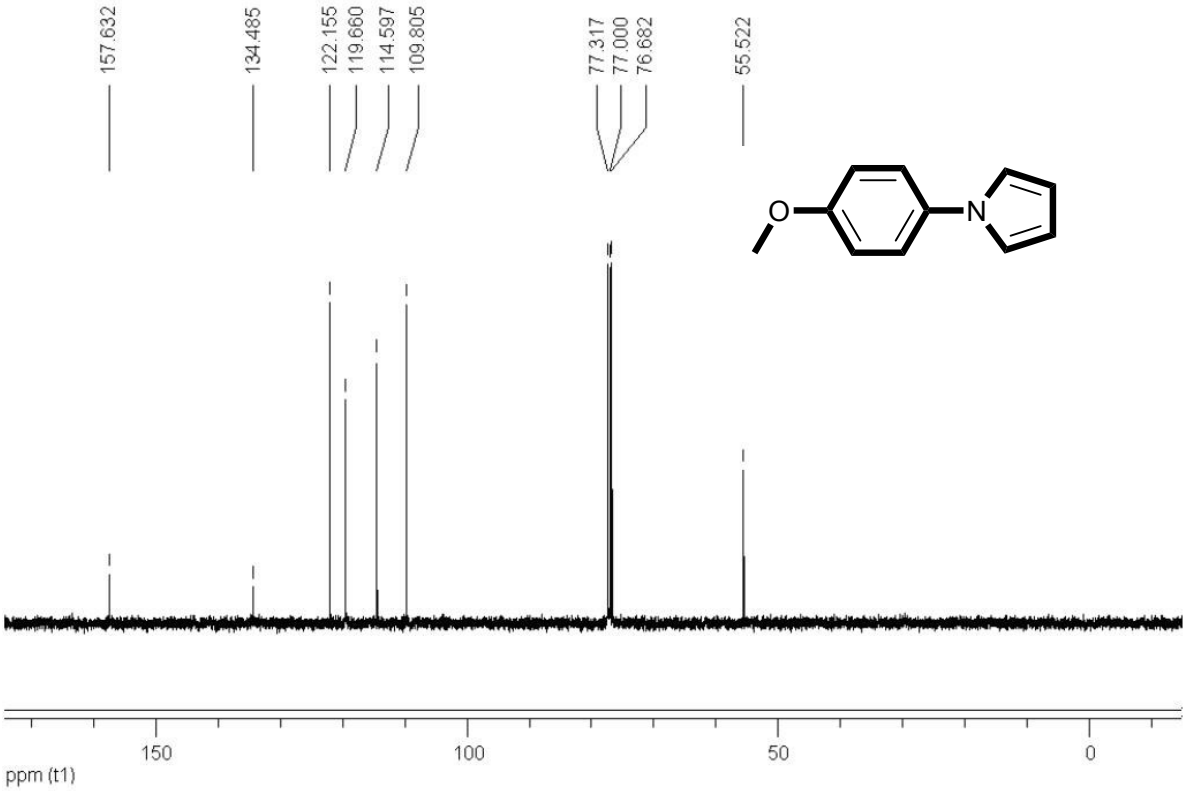

$^{1}$H-NMR spectra (250 MHz) of 1-(2-methoxyphenyl)-1*H*-imidazole (**27**) in $CDCl_3$.



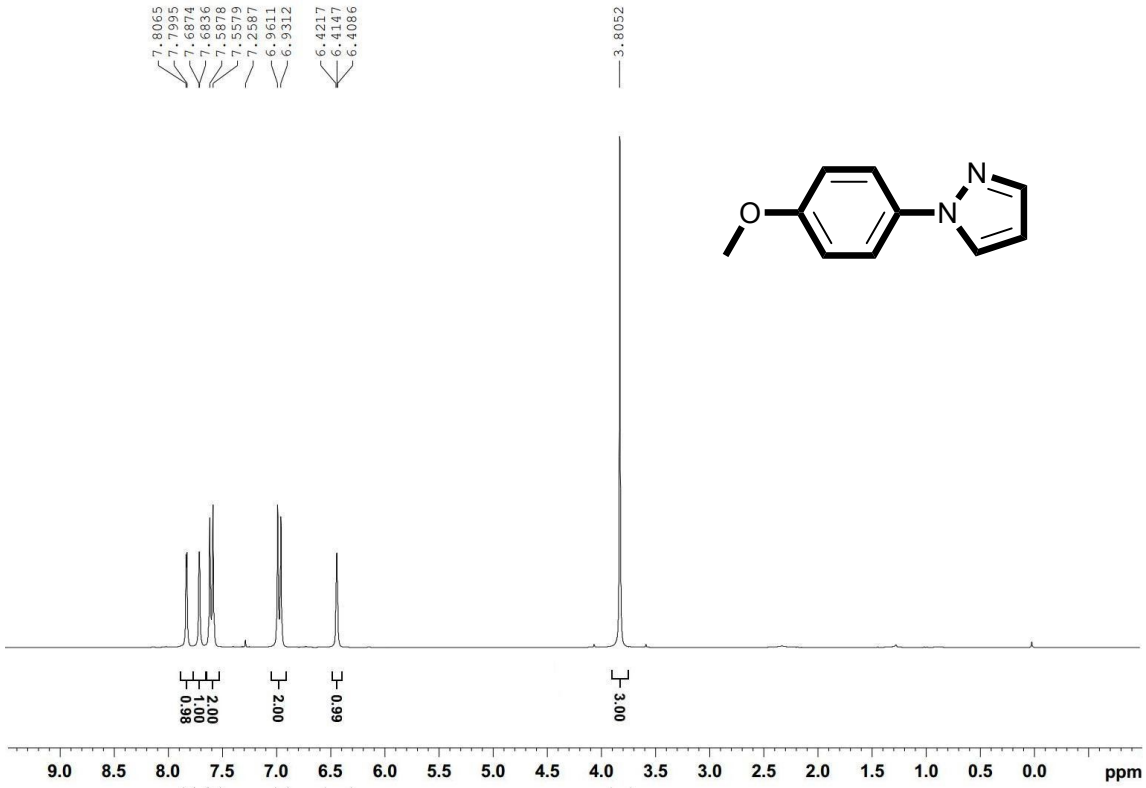

$^{13}$C-NMR spectra (63 MHz) of 1-(2-methoxyphenyl)-1*H*-imidazole (**27**) in $CDCl_3$.



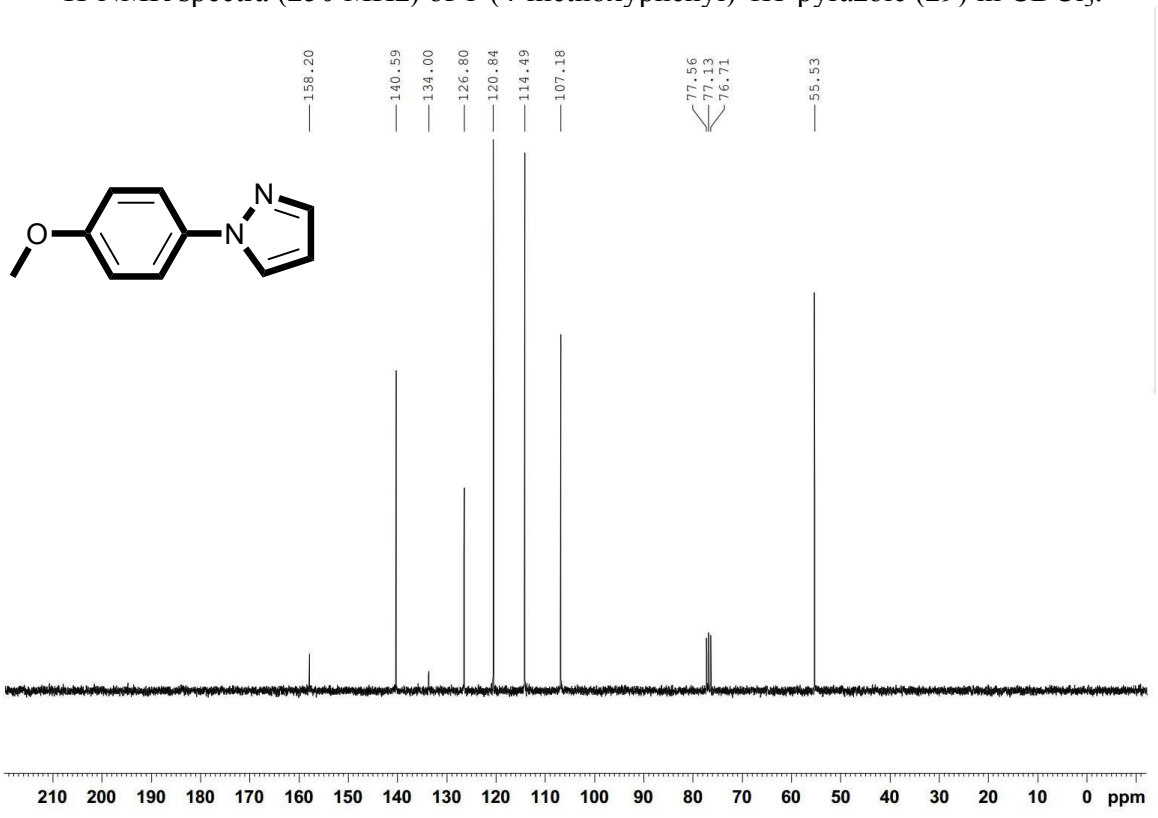

$^{1}$H-NMR spectra (250 MHz) of 1-(4-methoxyphenyl)-1*H*-pyrrole (**28**) in $CDCl_3$.



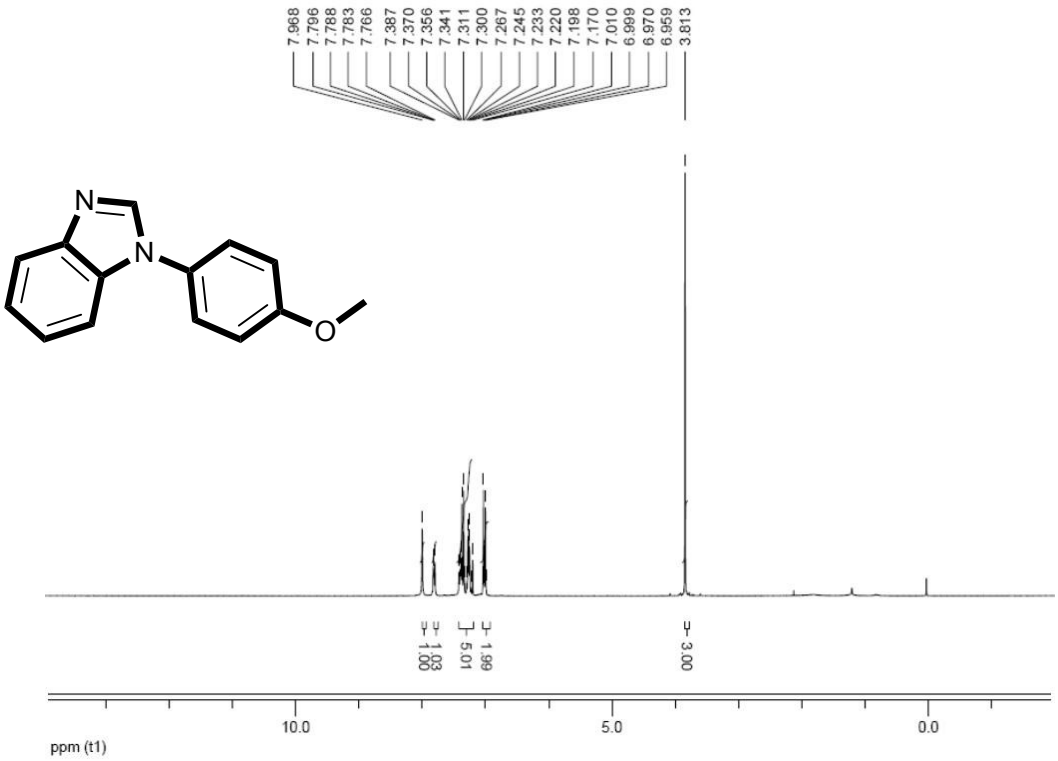

$^{13}$C-NMR spectra (63 MHz) of 1-(4-methoxyphenyl)-1*H*-pyrrole (**28**) in $CDCl_3$.



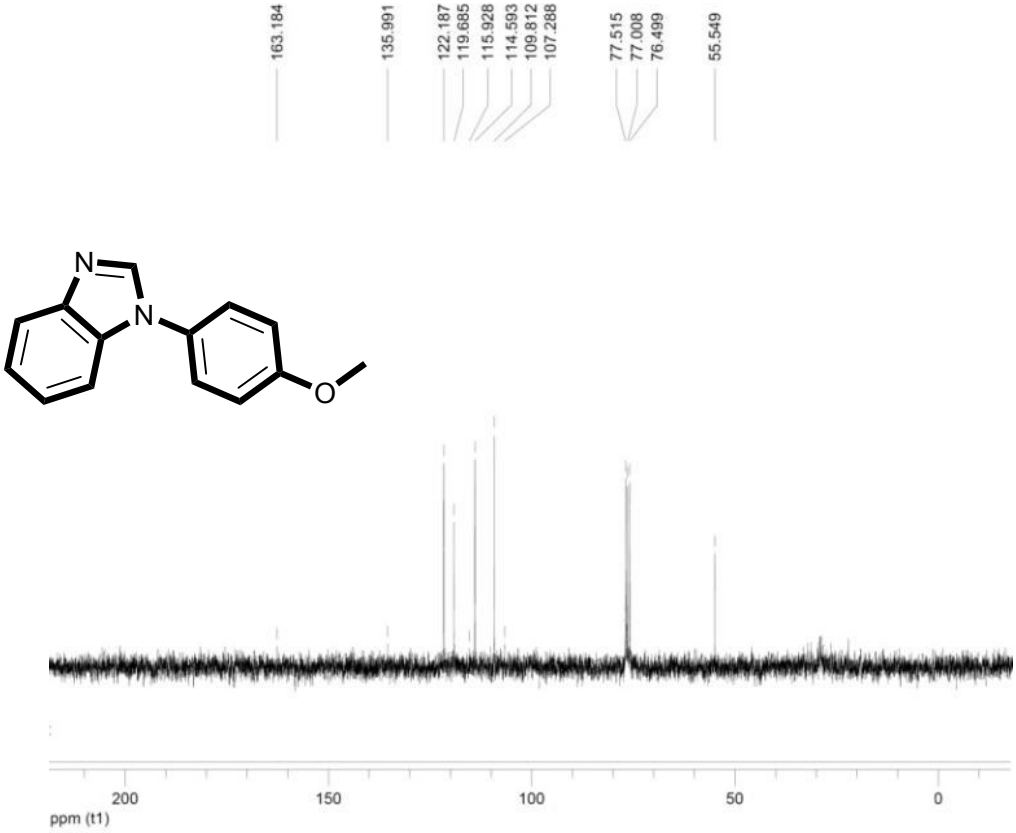

$^{1}$H-NMR spectra (250 MHz) of 1-(4-methoxyphenyl)-1*H*-pyrazole (**29**) in $CDCl_3$.



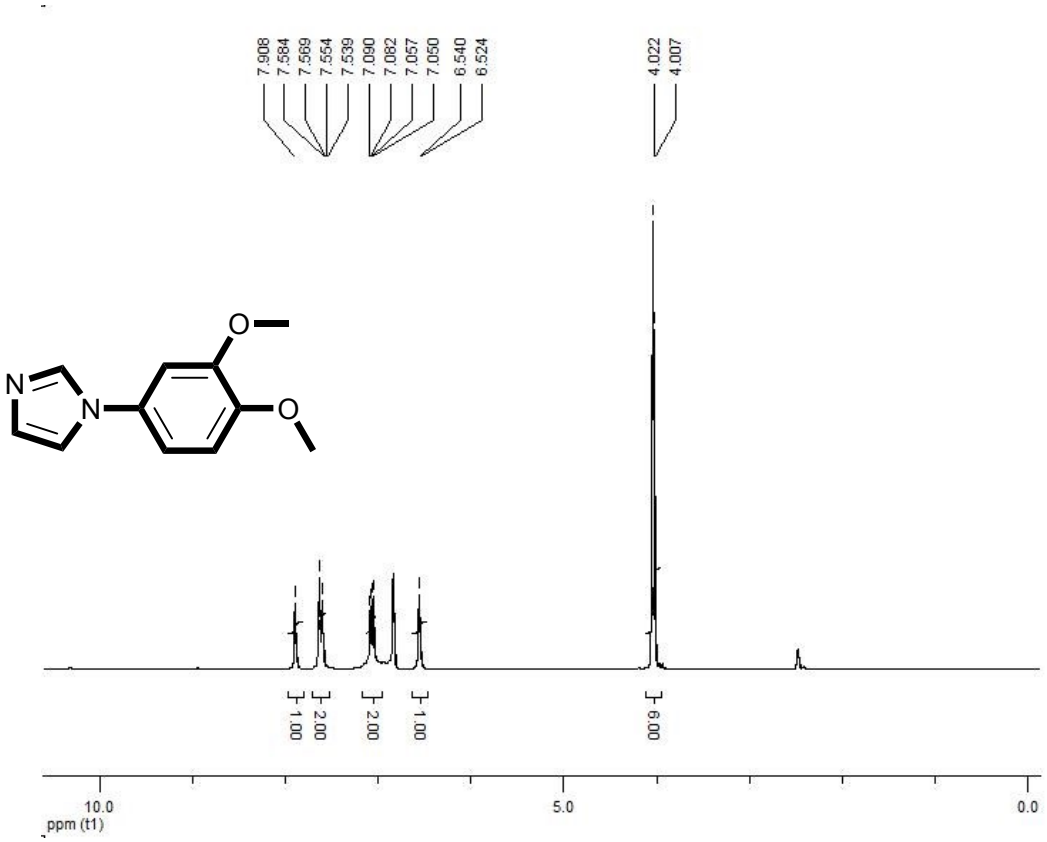

$^{13}$C-NMR spectra (63 MHz) of 1-(4-methoxyphenyl)-1*H*-pyrazole (**29**) in $CDCl_3$.



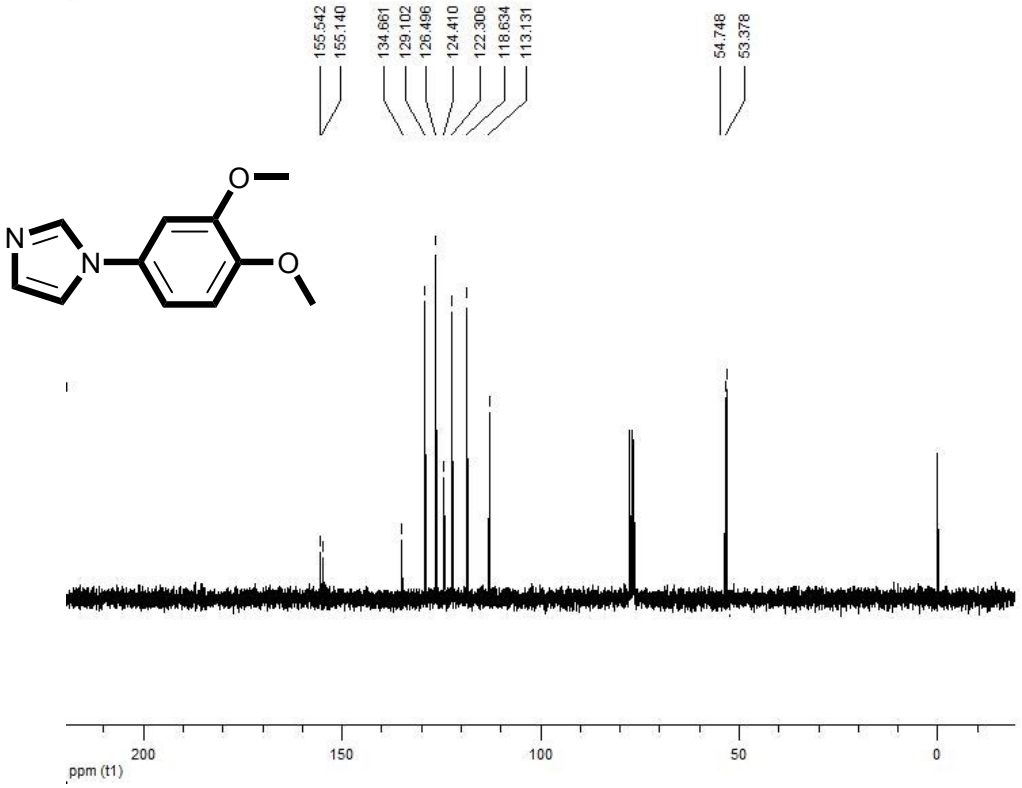

$^{1}$H-NMR spectra (250 MHz) of 1-(4-methoxyphenyl)-1*H*-benzoimidazole (**C30**) in $CDCl_3$.



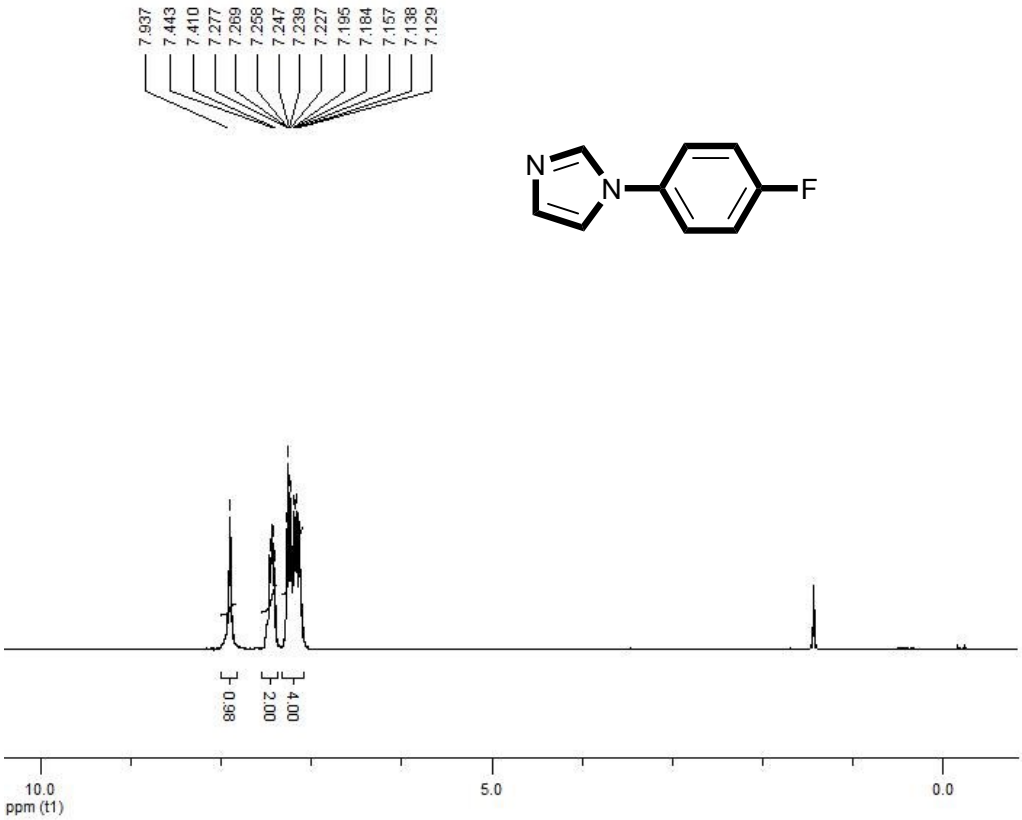

$^{13}$C-NMR spectra (63 MHz) of 1-(4-methoxyphenyl)-1*H*-benzoimidazole (**C30**) in $CDCl_3$.



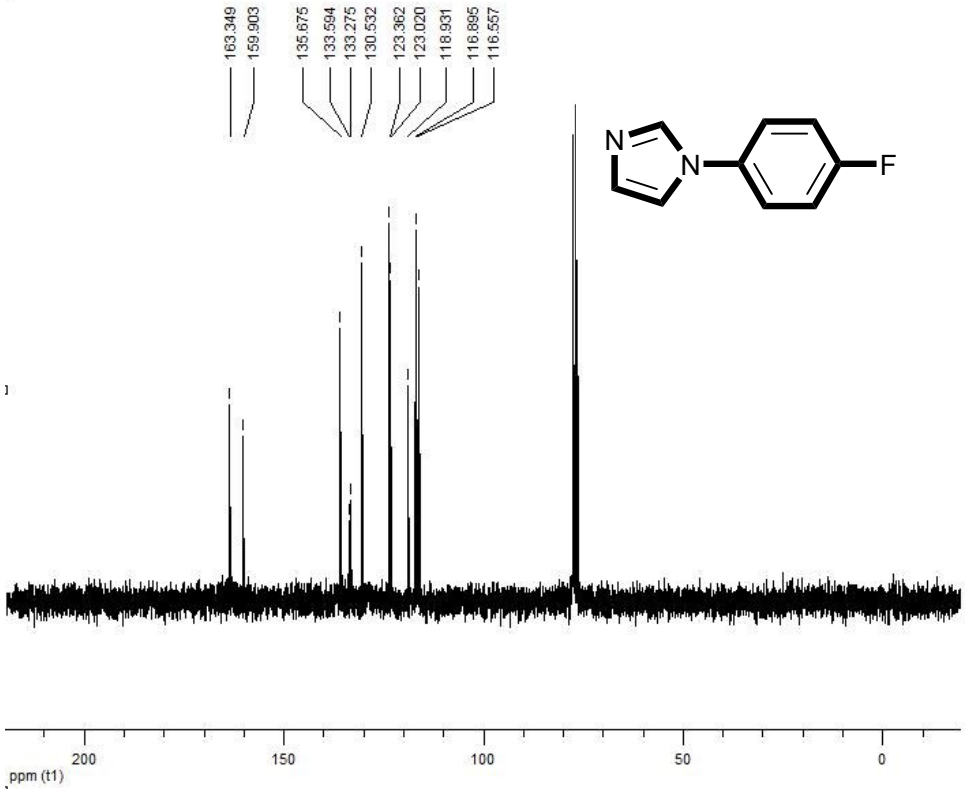

$^{1}$H-NMR spectra (250 MHz) of 1-(3,4-dimethoxyphenyl)-1*H*-imidazole (**C31**) in $CDCl_3$.



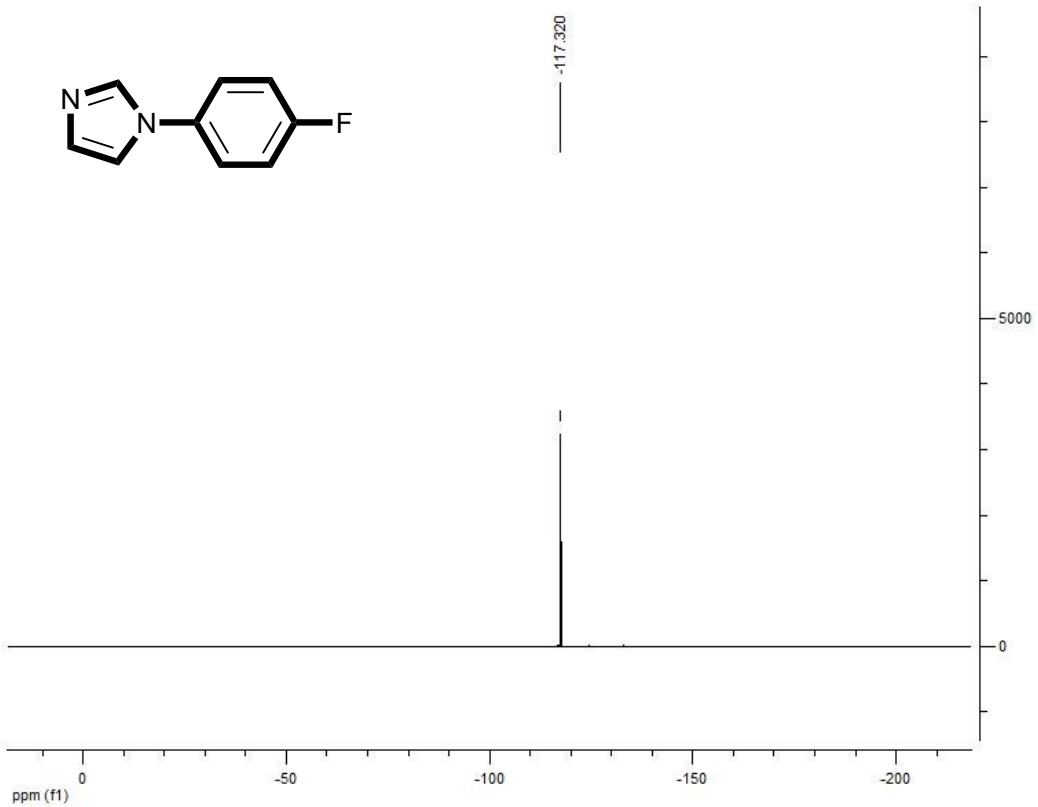

$^{13}$C-NMR spectra (63 MHz) of 1-(3,4-dimethoxyphenyl)-1*H*-imidazole (**C31**) in $CDCl_3$.



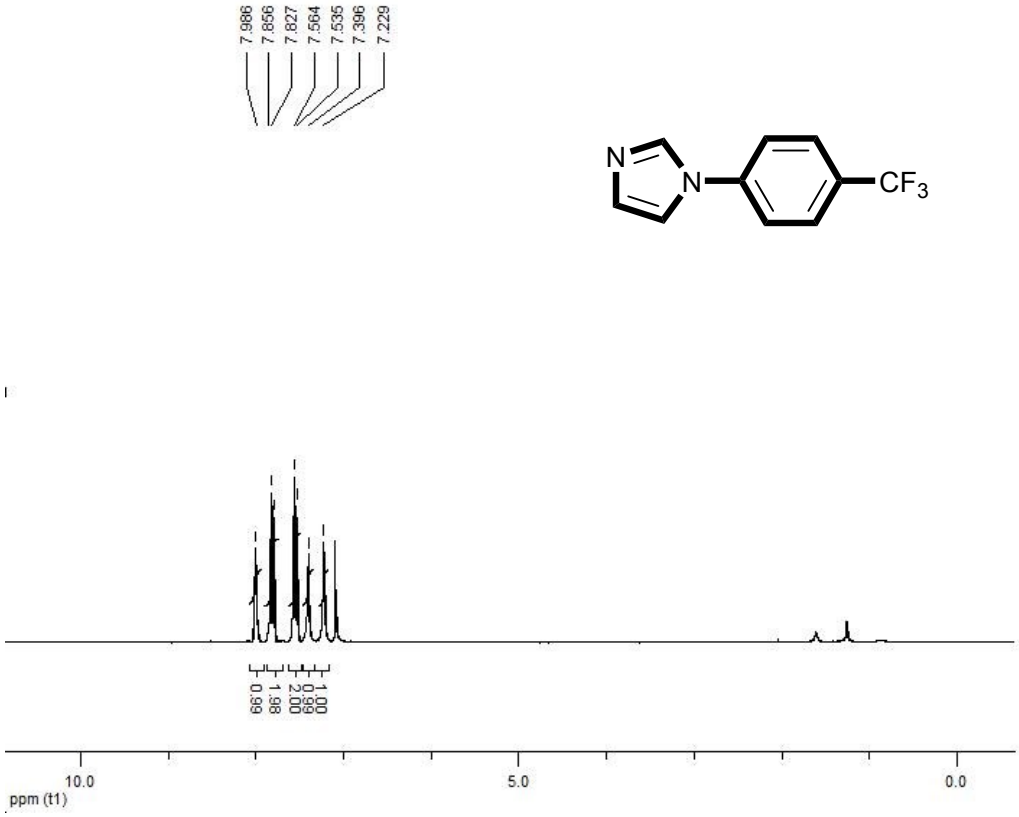

$^{1}$H-NMR spectra (250 MHz) of 1-(4-fluorophenyl)-1*H*-imidazole (**C32**) in $CDCl_3$.



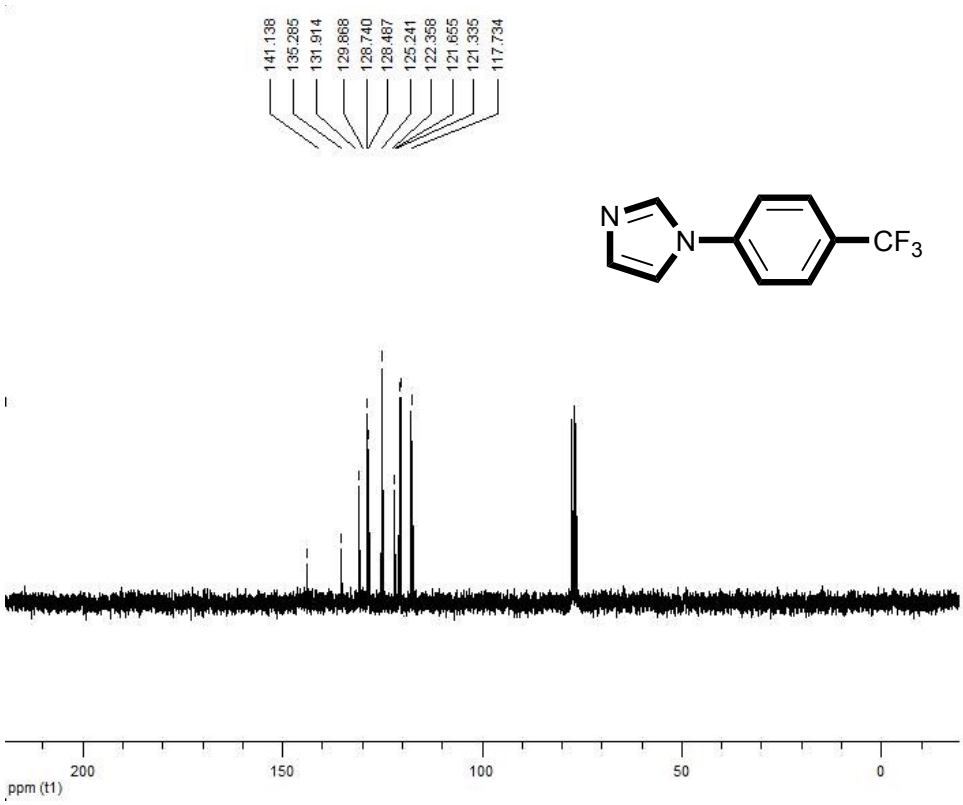

$^{13}$C-NMR spectra (63 MHz) of 1-(4-fluorophenyl)-1*H*-imidazole (**C32)** in $CDCl_3$.



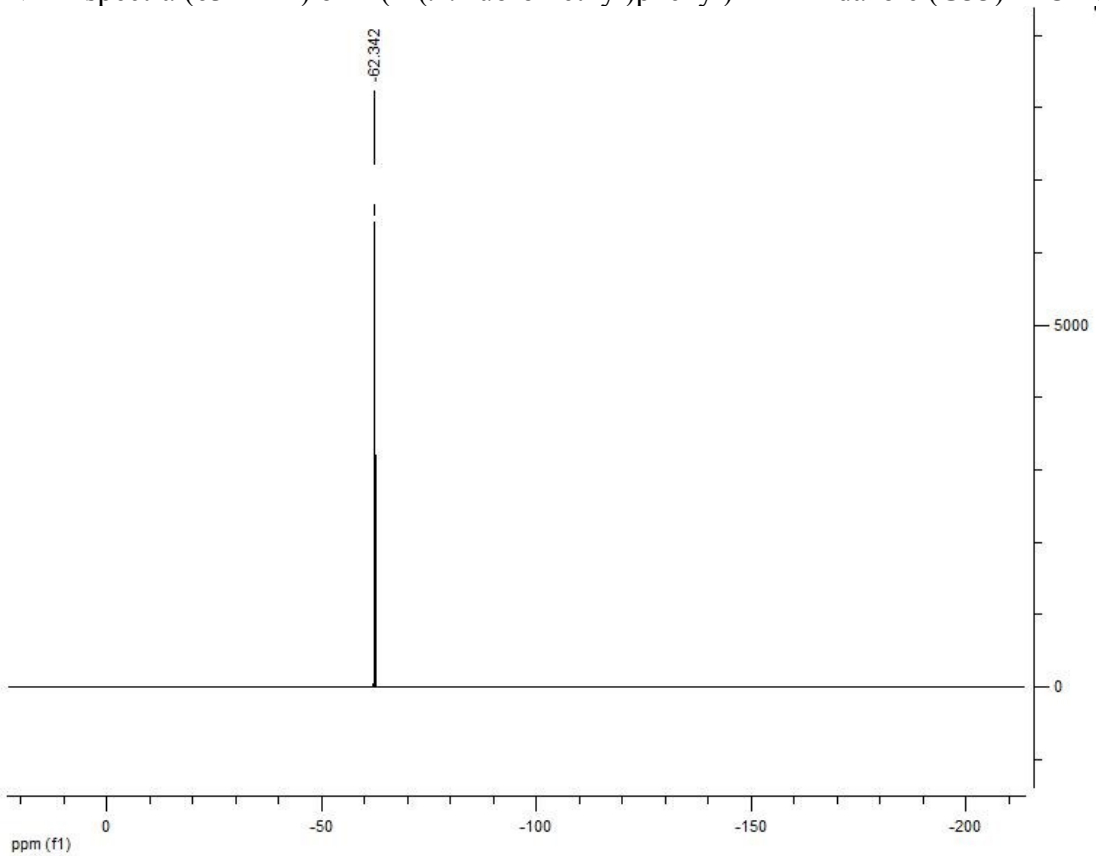

$^{19}$F-NMR spectra (376 MHz) of 1-(4-fluorophenyl)-1*H*-imidazole (**C32)** in $CDCl_3$.



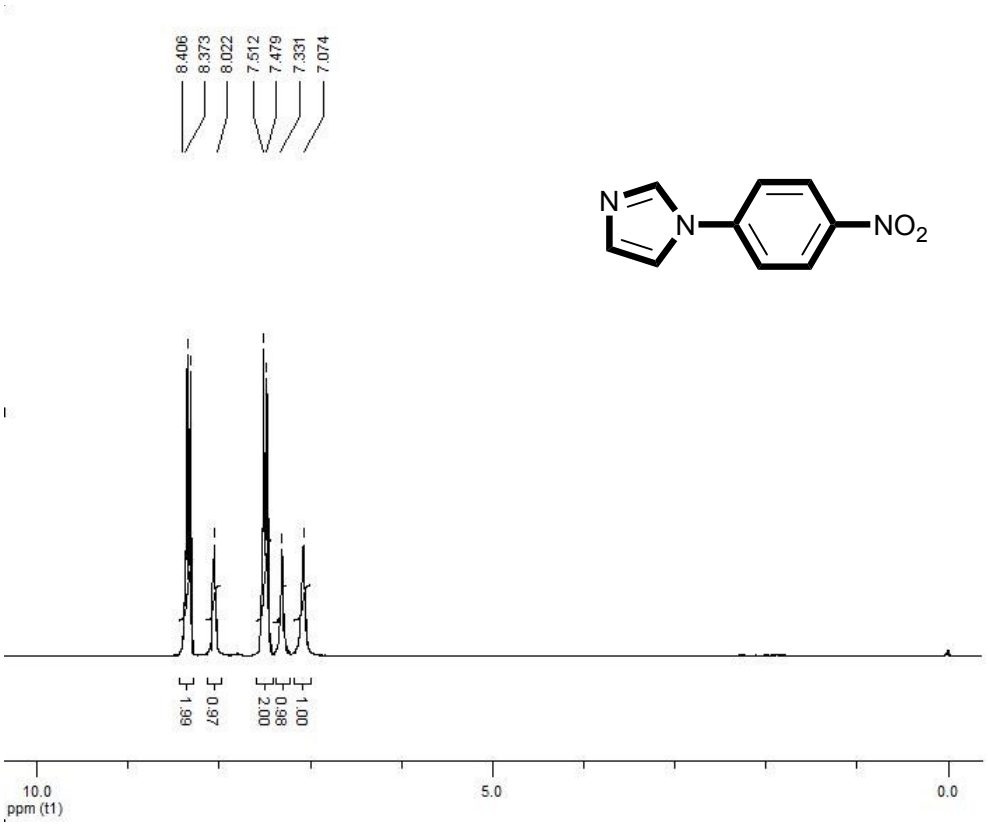

$^{1}$H-NMR spectra (250 MHz) of 1-(4-(*tri*fluoromethyl)phenyl)-1*H*-imidazole (**C33**) in $CDCl_3$.



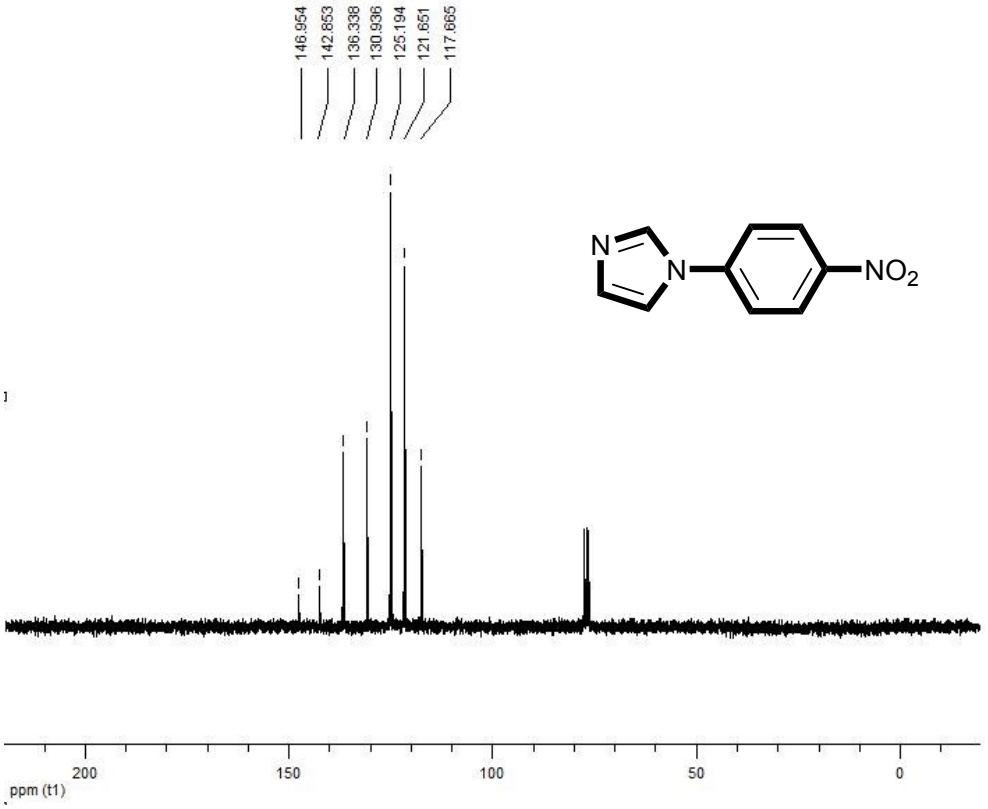

$^{13}$C-NMR spectra (63 MHz) of 1-(4-(*tri*fluoromethyl)phenyl)-1*H*-imidazole (**C33**) in $CDCl_3$.



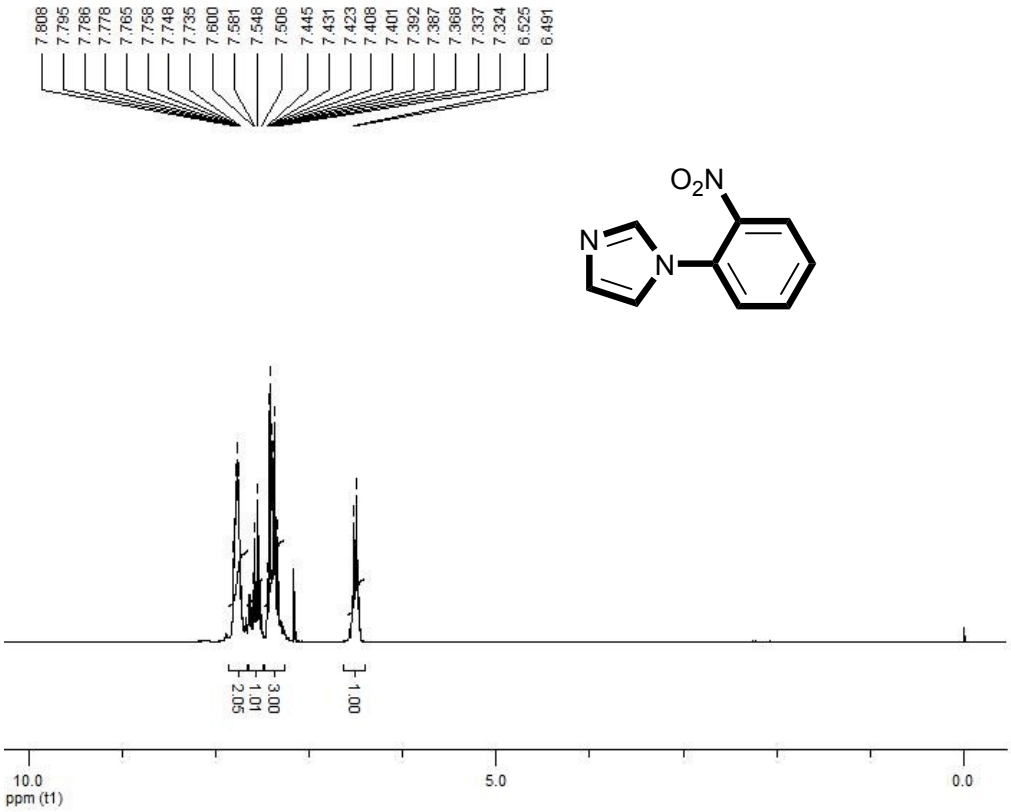

$^{19}$F-NMR spectra (376 MHz) of 1-(4-(*tri*fluoromethyl)phenyl)-1*H*-imidazole (**C33**) in $CDCl_3$.



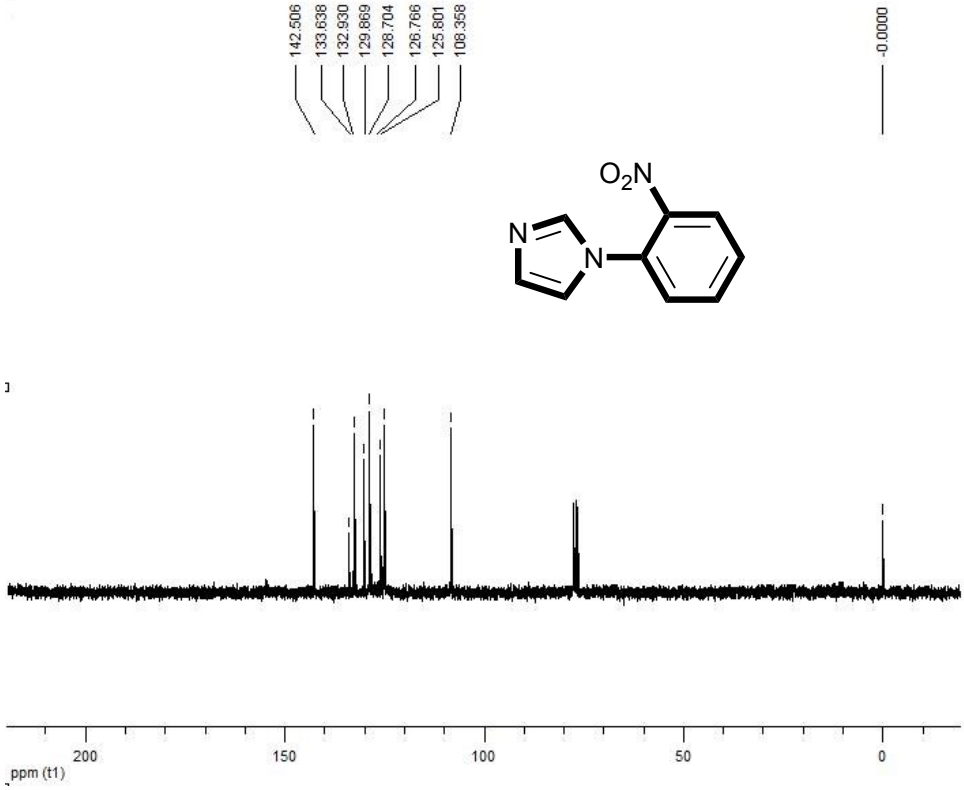

$^{1}$H-NMR spectra (250 MHz) of 1-(4-nitrophenyl)-1*H*-imidazole (**C34**) in $CDCl_3$.



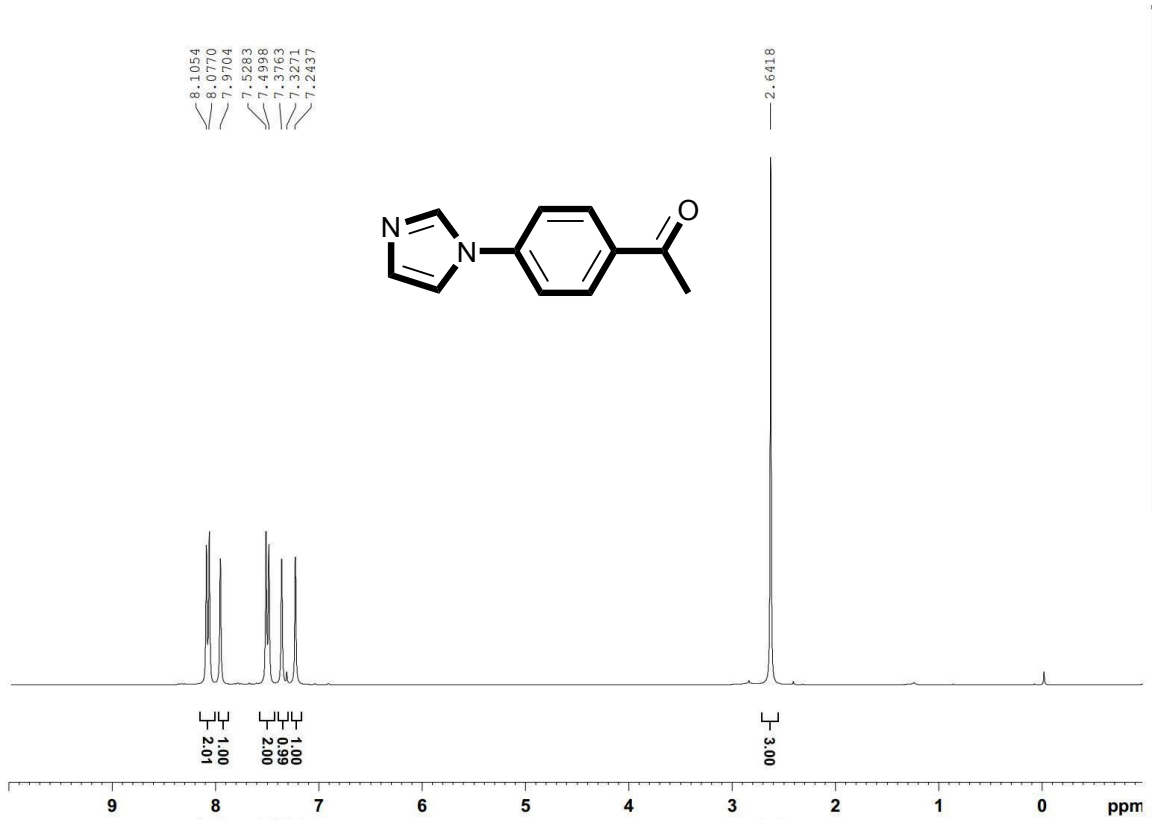

$^{13}$C-NMR spectra (63 MHz) of 1-(4-nitrophenyl)-1*H*-imidazole (**C34**) in $CDCl_3$.



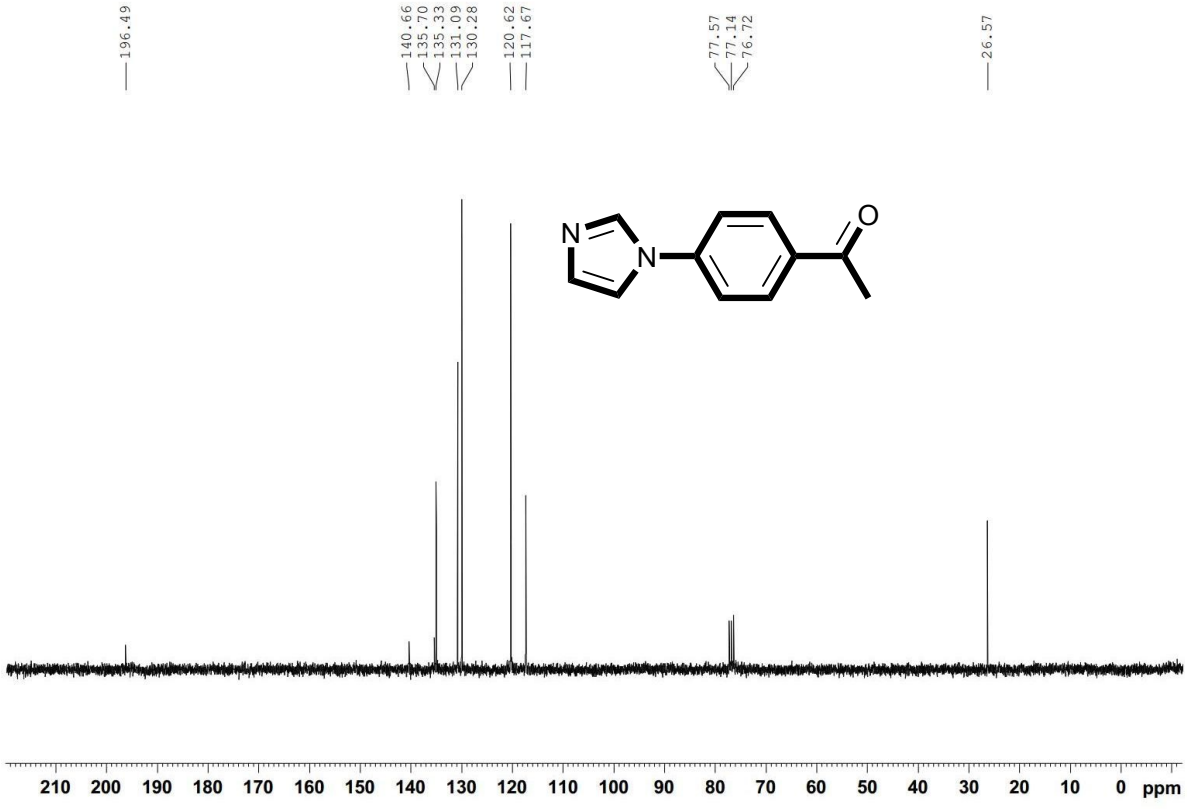

$^{1}$H-NMR spectra (250 MHz) of 1-(2-nitrophenyl)-1*H*-imidazole (**C35**) in $CDCl_3$.



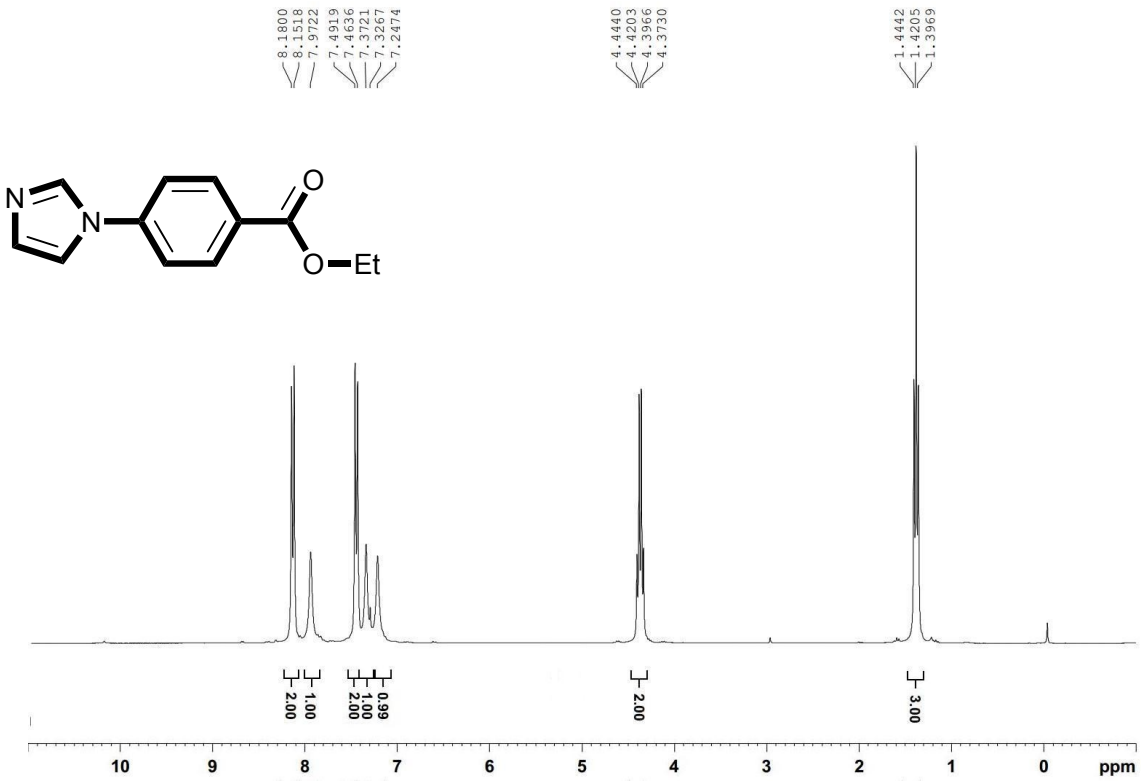

$^{13}$C-NMR spectra (63 MHz) of 1-(2-nitrophenyl)-1*H*-imidazole (**C35**) in $CDCl_3$.



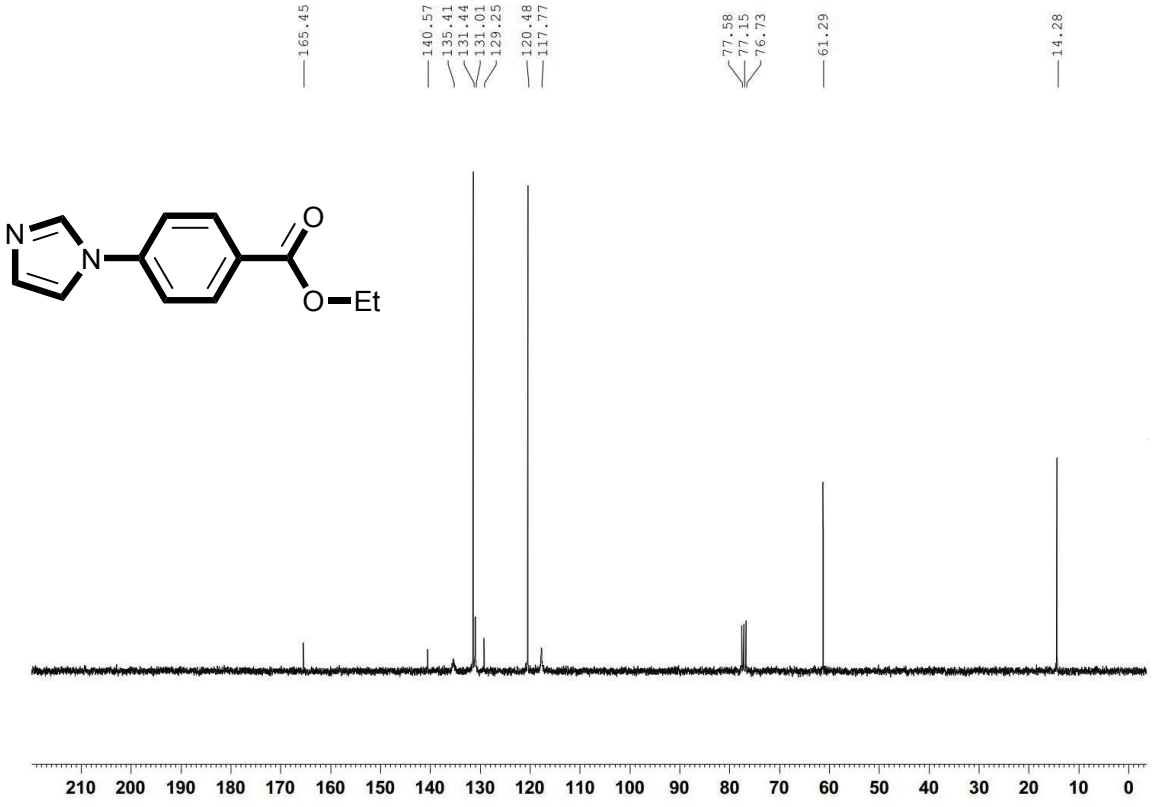

$^{1}$H-NMR spectra (250 MHz) of 1-(4-(1*H*-imidazol-1-yl)phenyl)ethan-1-one (**C36**) in $CDCl_3$.



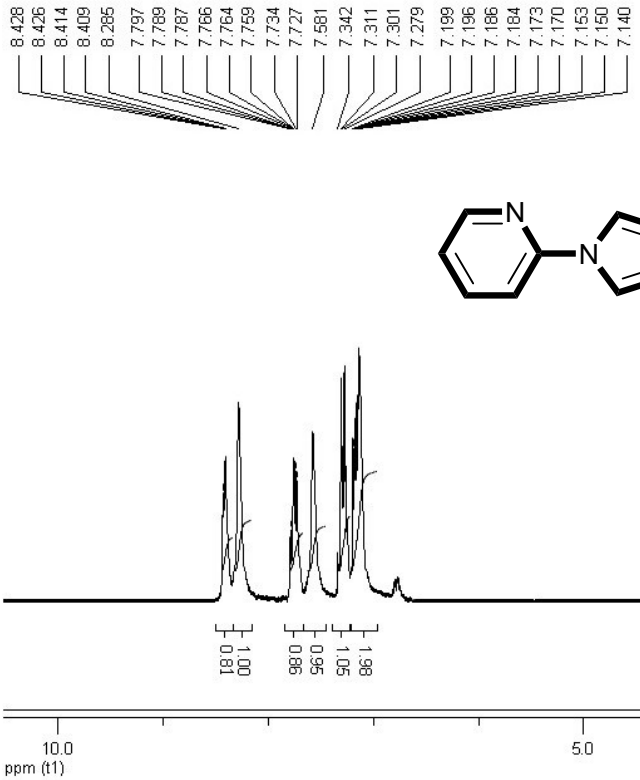

$^{13}$C-NMR spectra (63 MHz) of 1-(4-(1*H*-imidazol-1-yl)phenyl)ethan-1-one (**C36**) in $CDCl_3$.



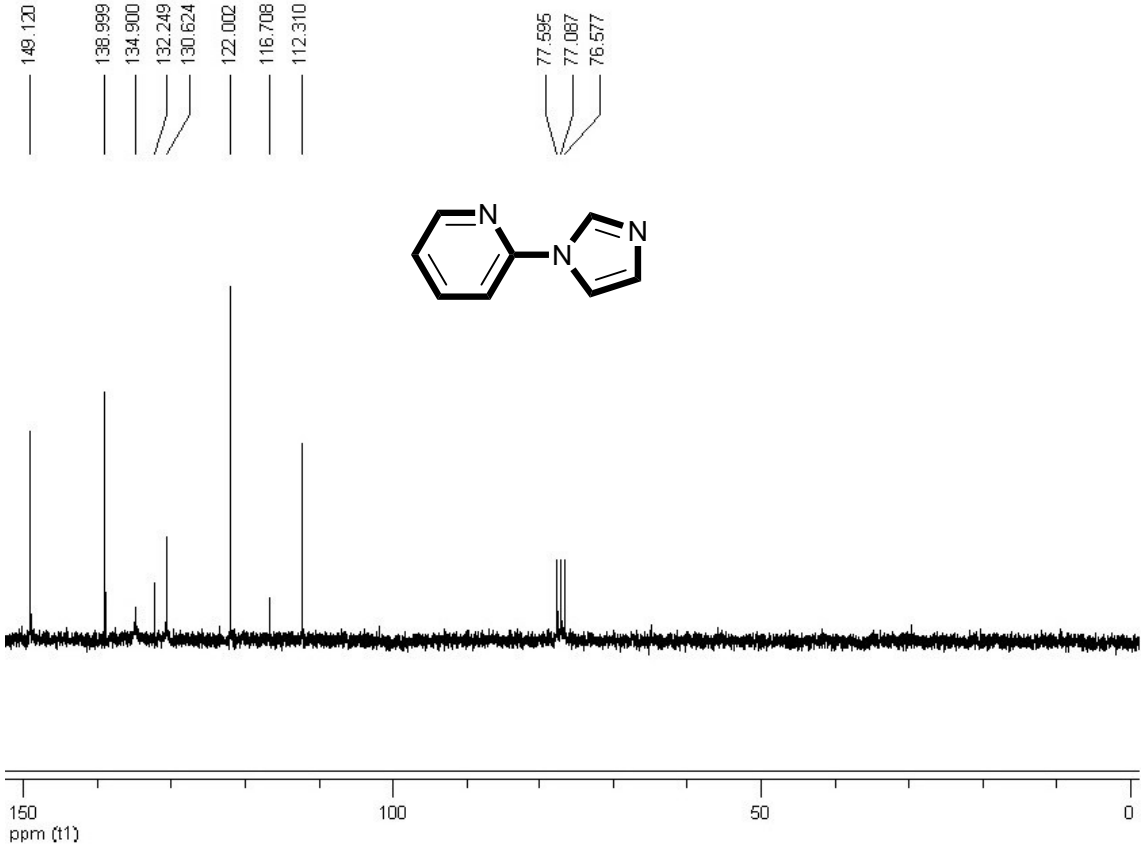

$^{1}$H-NMR spectra (250 MHz) of ethyl 4-(1*H*-imidazol-1-yl)benzoate (**C37**) in $CDCl_3$.



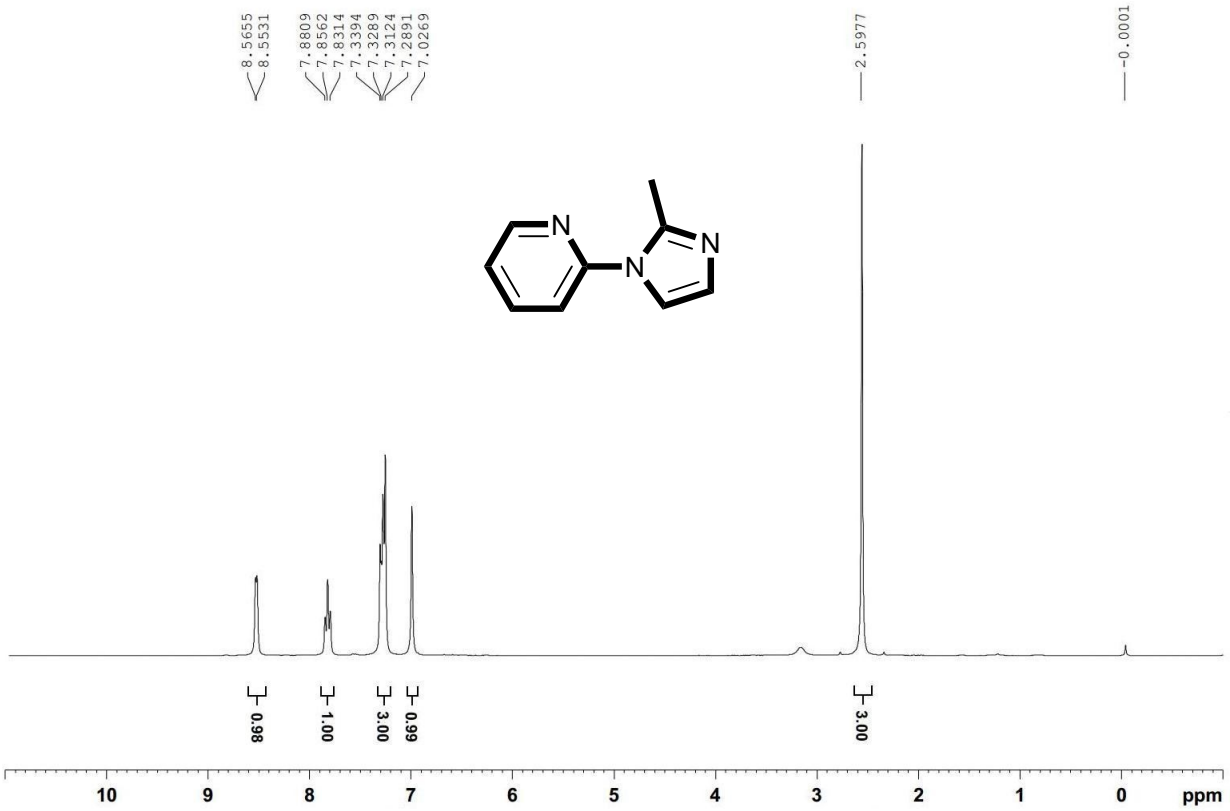

$^{13}$C-NMR spectra (63 MHz) of ethyl 4-(1*H*-imidazol-1-yl)benzoate (**C37**) in $CDCl_3$.



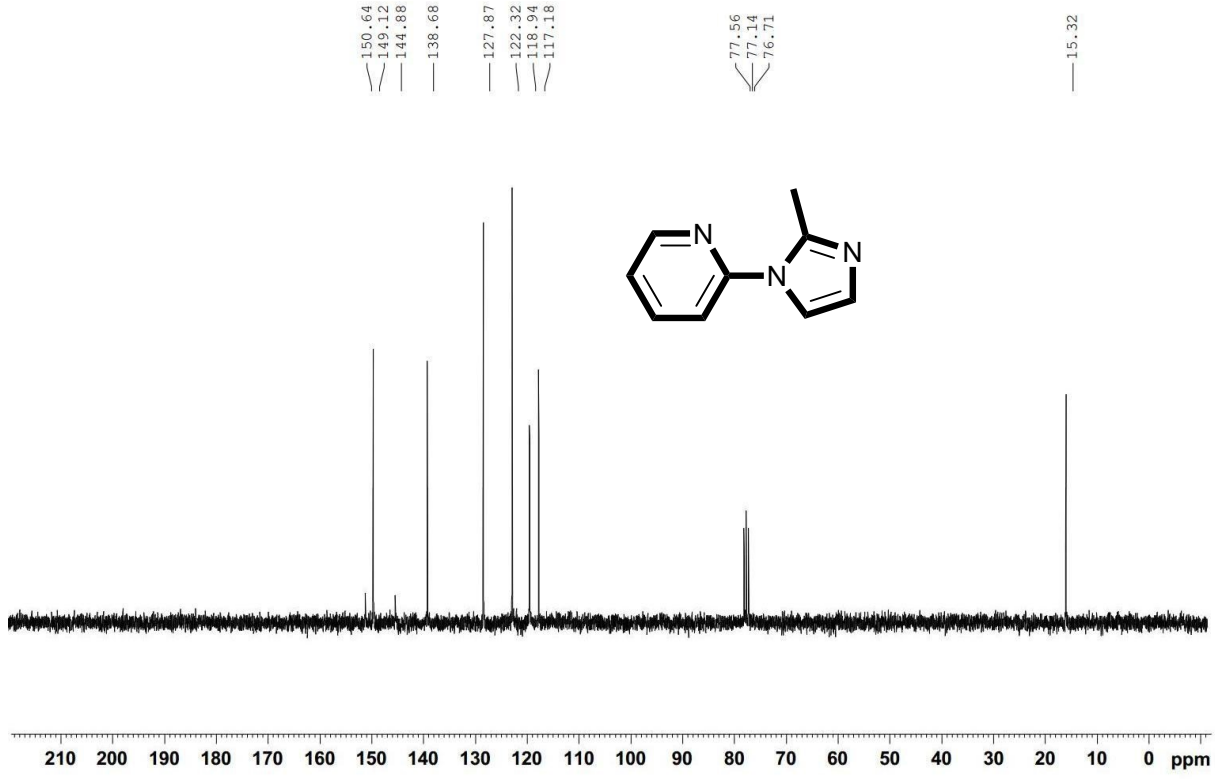

$^{1}$H-NMR spectra (250 MHz) of 2-imidazol-1-ylpyridine (**C38**) in $CDCl_3$.



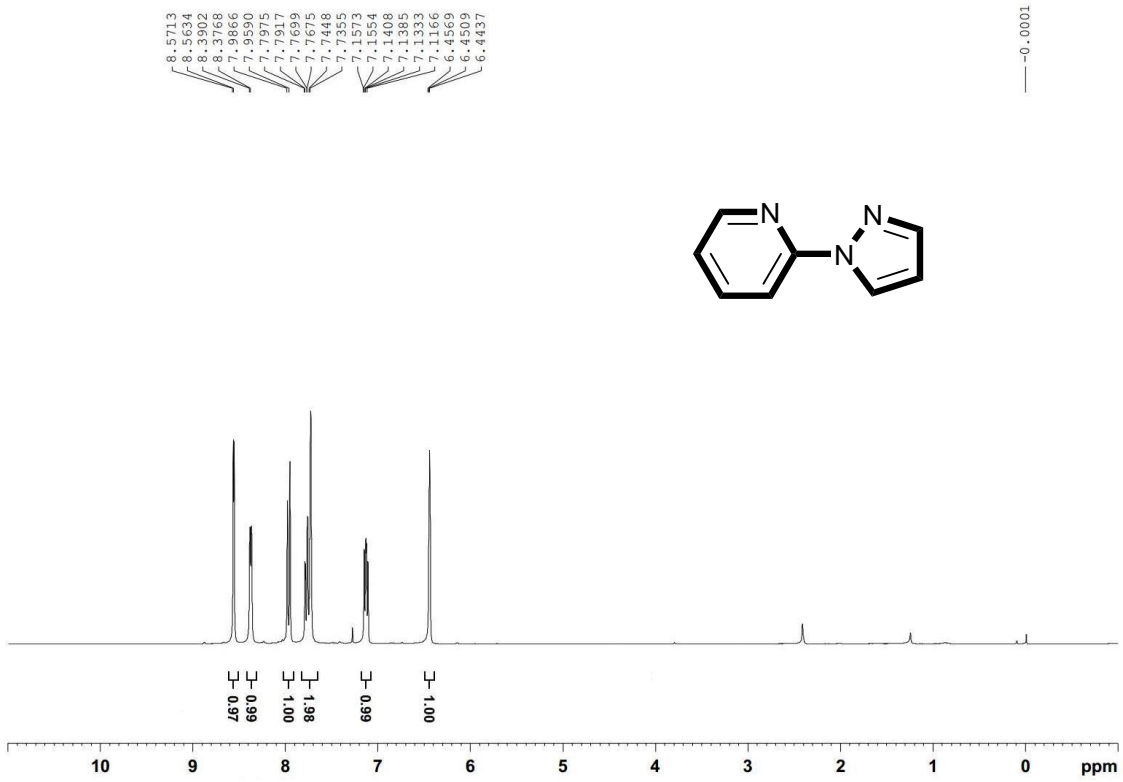

$^{13}$C-NMR spectra (63 MHz) of 2-imidazol-1-ylpyridine (**C38**) in $CDCl_3$.



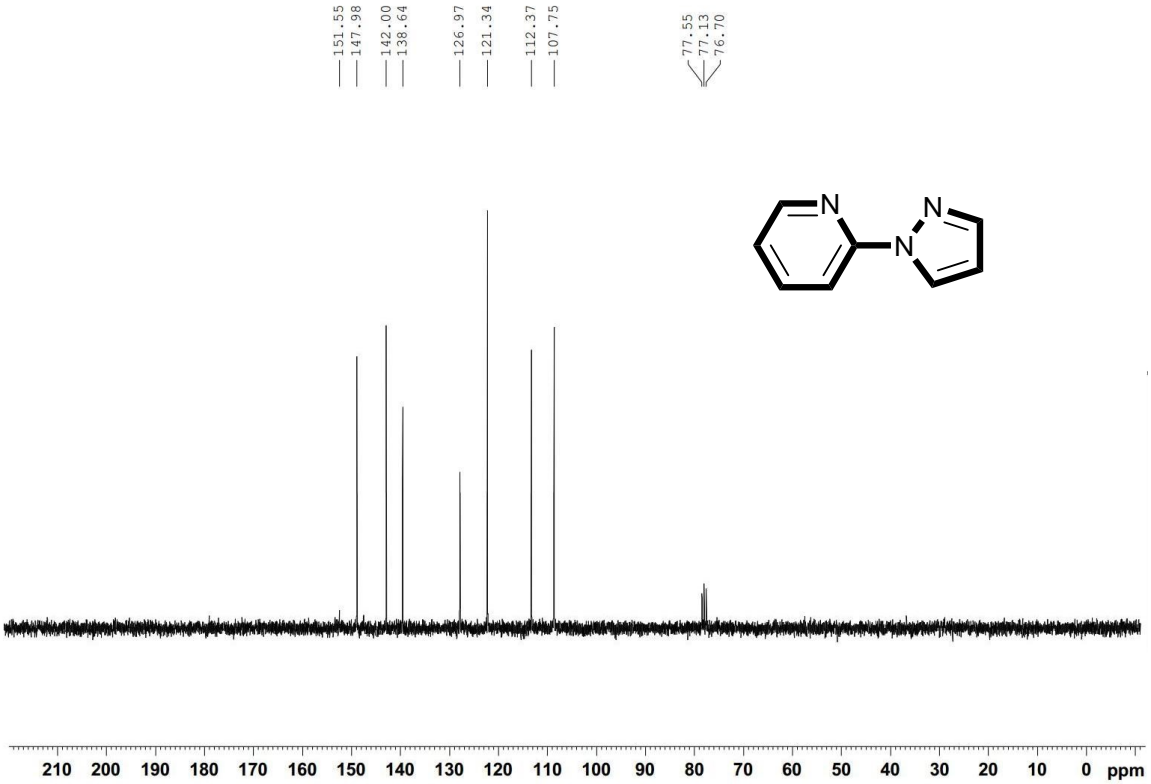

$^{1}$H-NMR spectra (250 MHz) of 2-(2-methyl-1*H*-imidazol-1-yl)pyridine (**C39**) in $CDCl_3$.



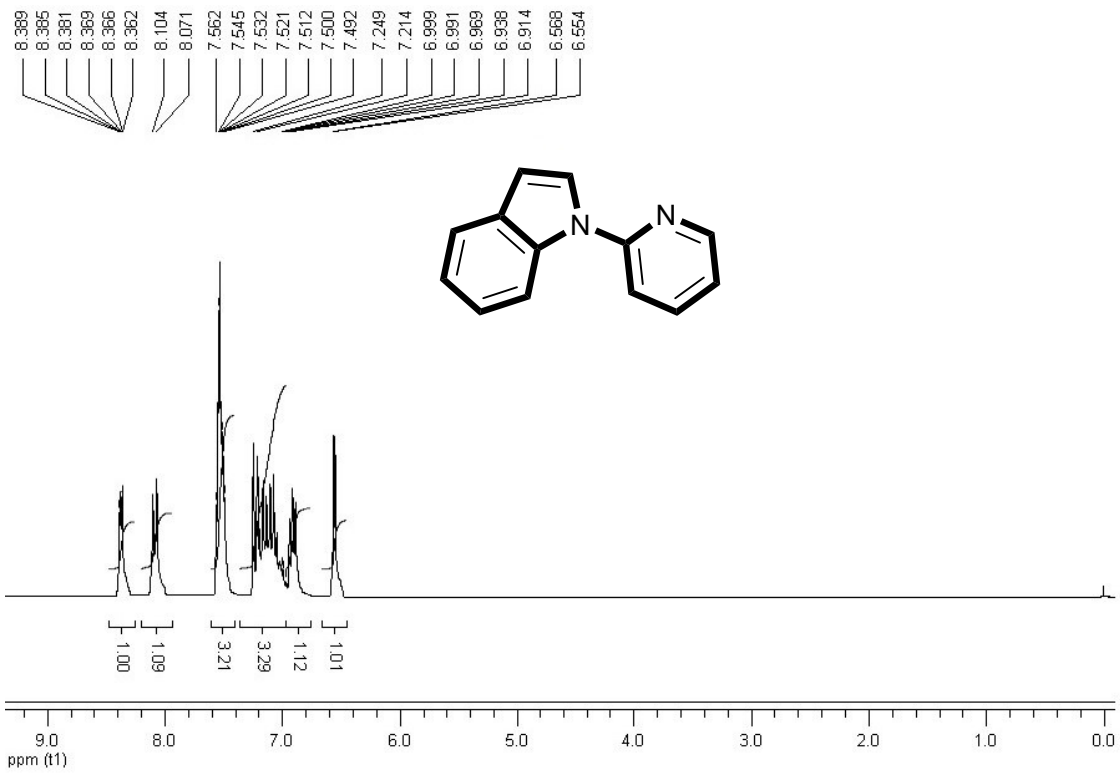

$^{13}$C-NMR spectra (63 MHz) of 2-(2-methyl-1*H*-imidazol-1-yl)pyridine (**C39**) in $CDCl_3$.



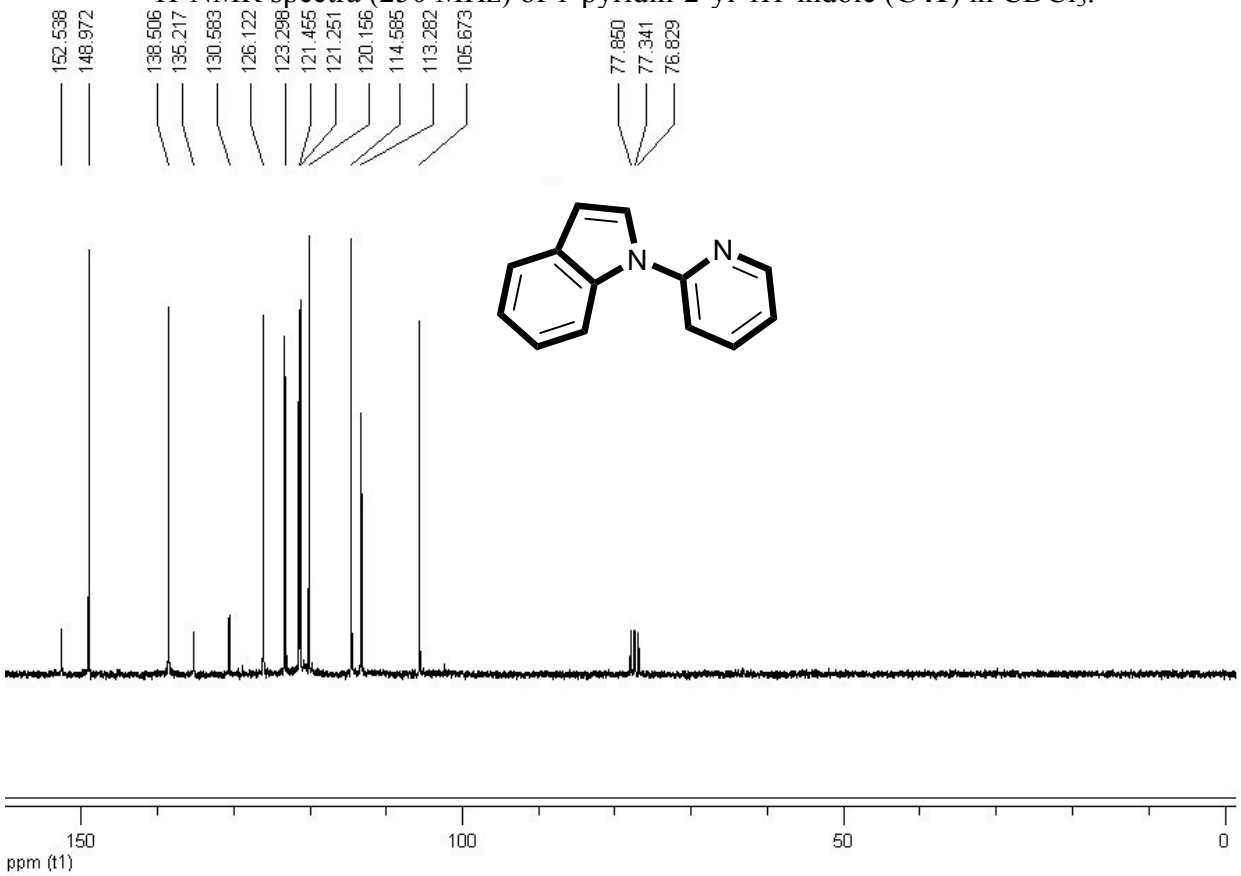

$^{1}$H-NMR spectra (250 MHz) of 2-(1*H*-pyrazol-1-yl)pyridine (**C40**) in $CDCl_3$.



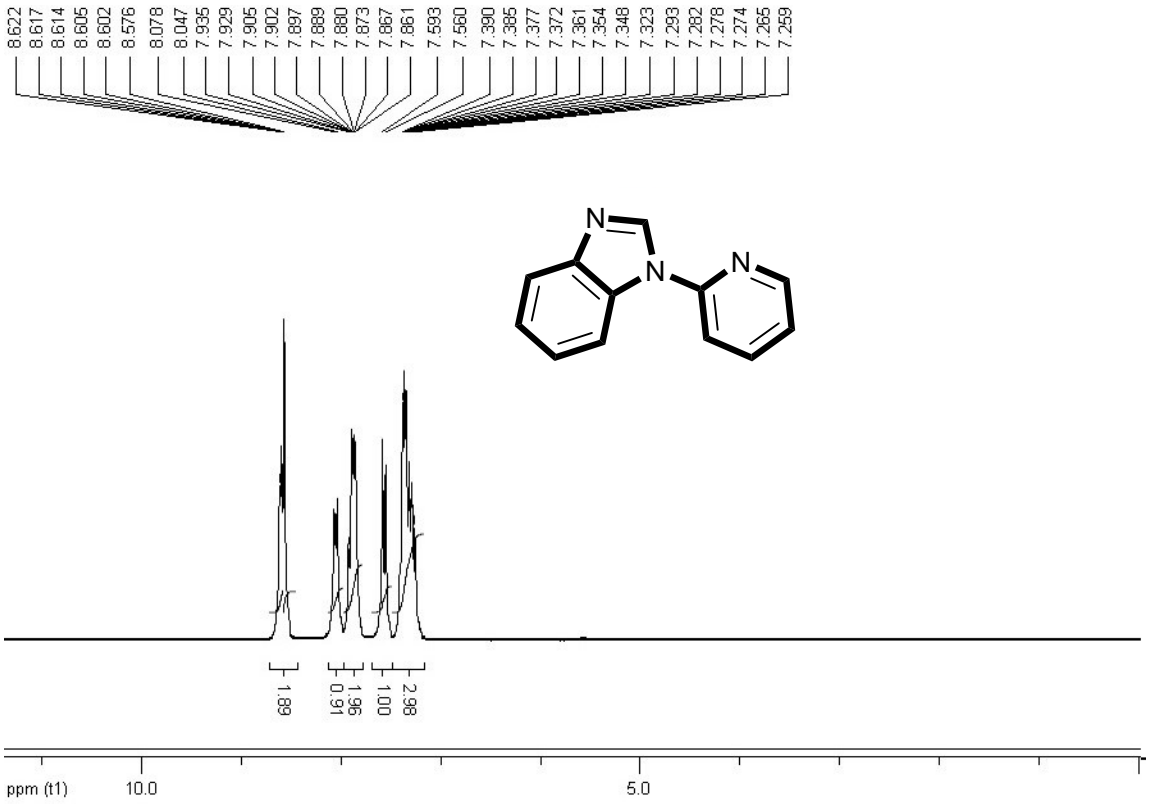

$^{13}$C-NMR spectra (63 MHz) of 2-(1*H*-pyrazol-1-yl)pyridine (**C40**) in $CDCl_3$.



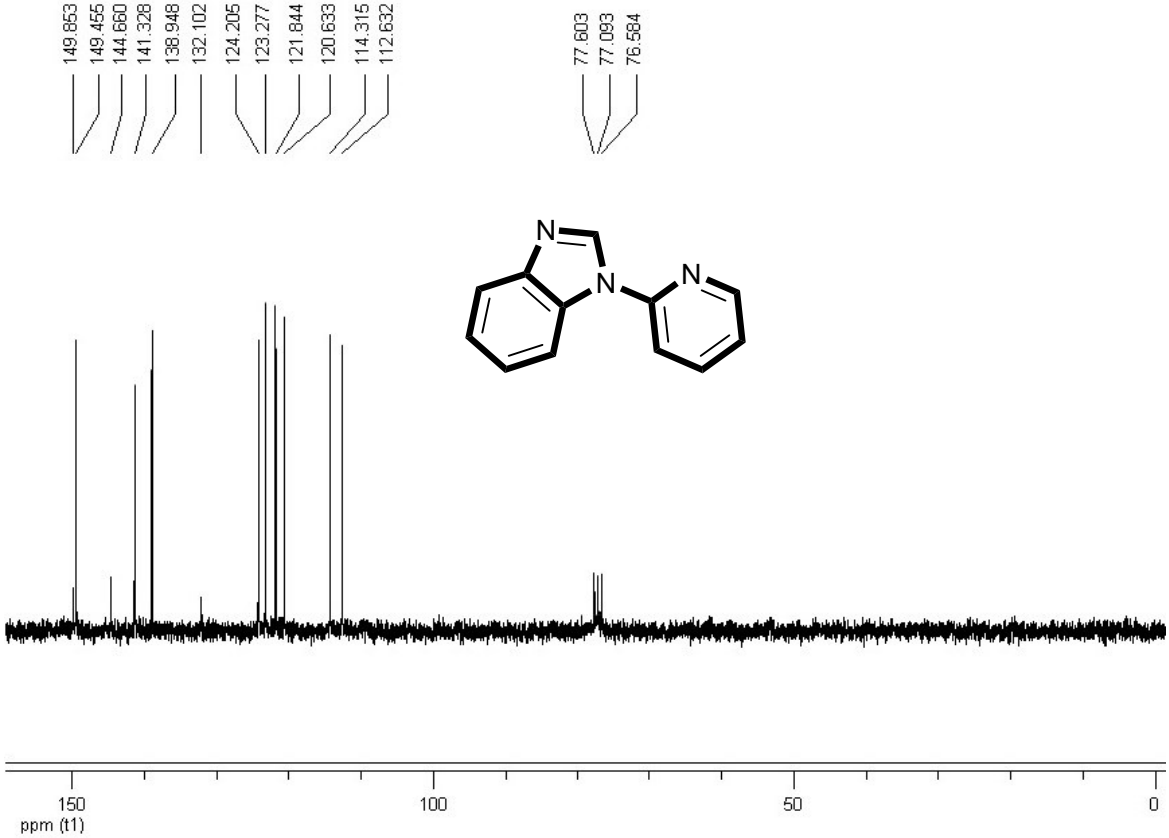

$^{1}$H-NMR spectra (250 MHz) of 1-pyridin-2-yl-1*H*-indole (**C41**) in $CDCl_3$.



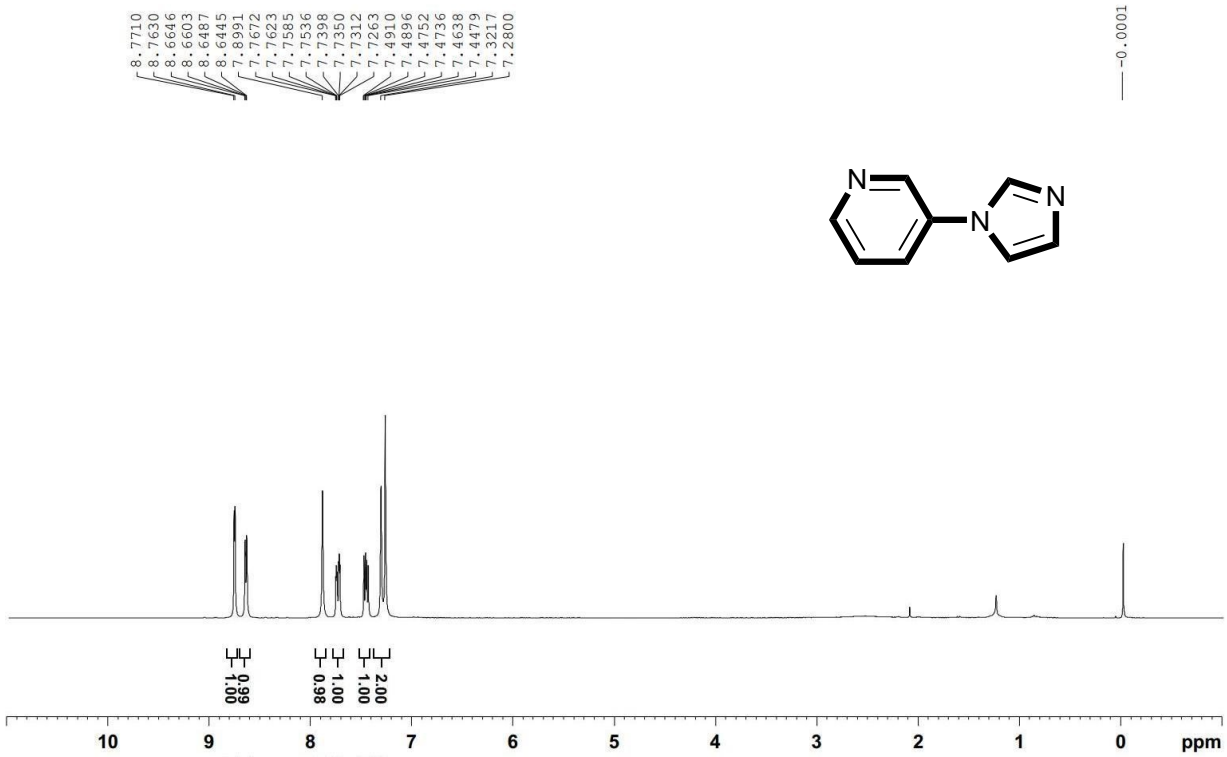

$^{13}$C-NMR spectra (63 MHz) of 1-pyridin-2-yl-1*H*-indole (**C41**) in $CDCl_3$.



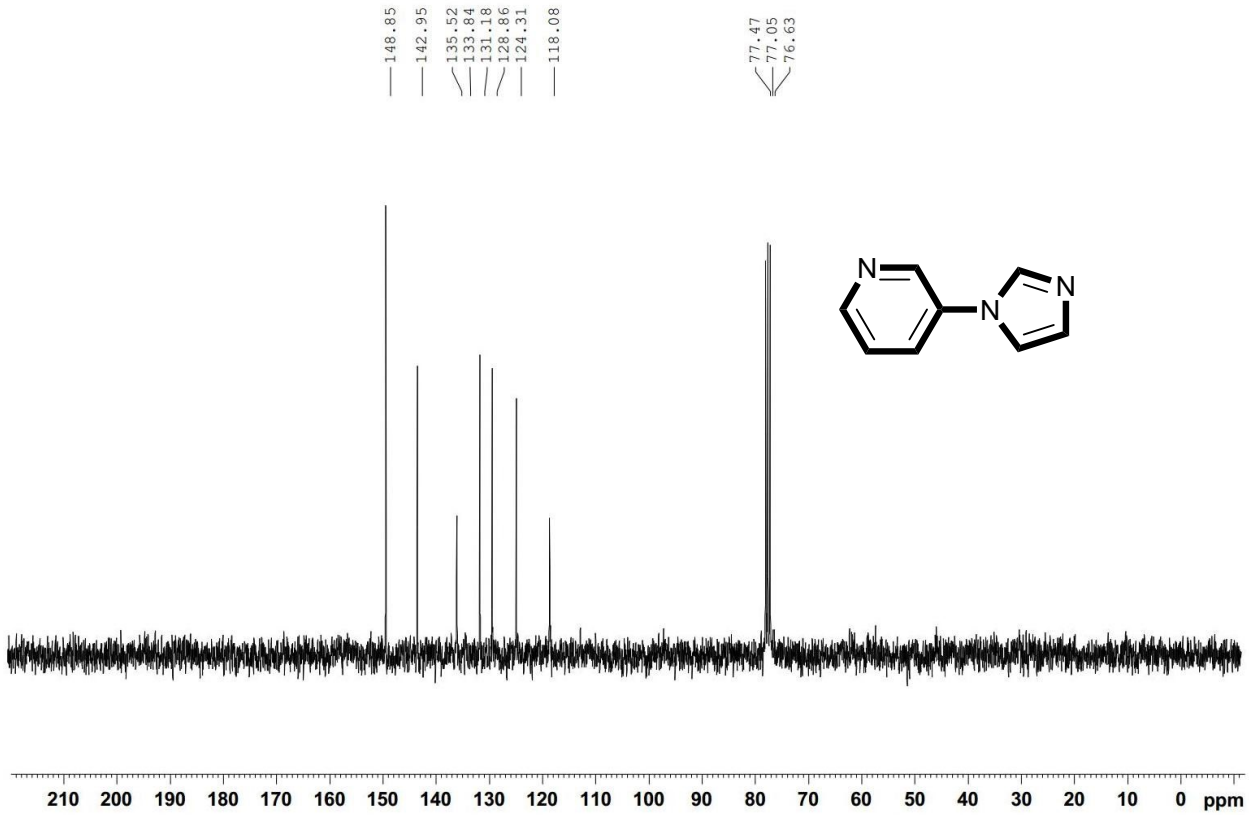

$^{1}$H-NMR spectra (250 MHz) of 1-pyridin-2-yl-1*H*-benzimidazole (**C42**) in $CDCl_3$.



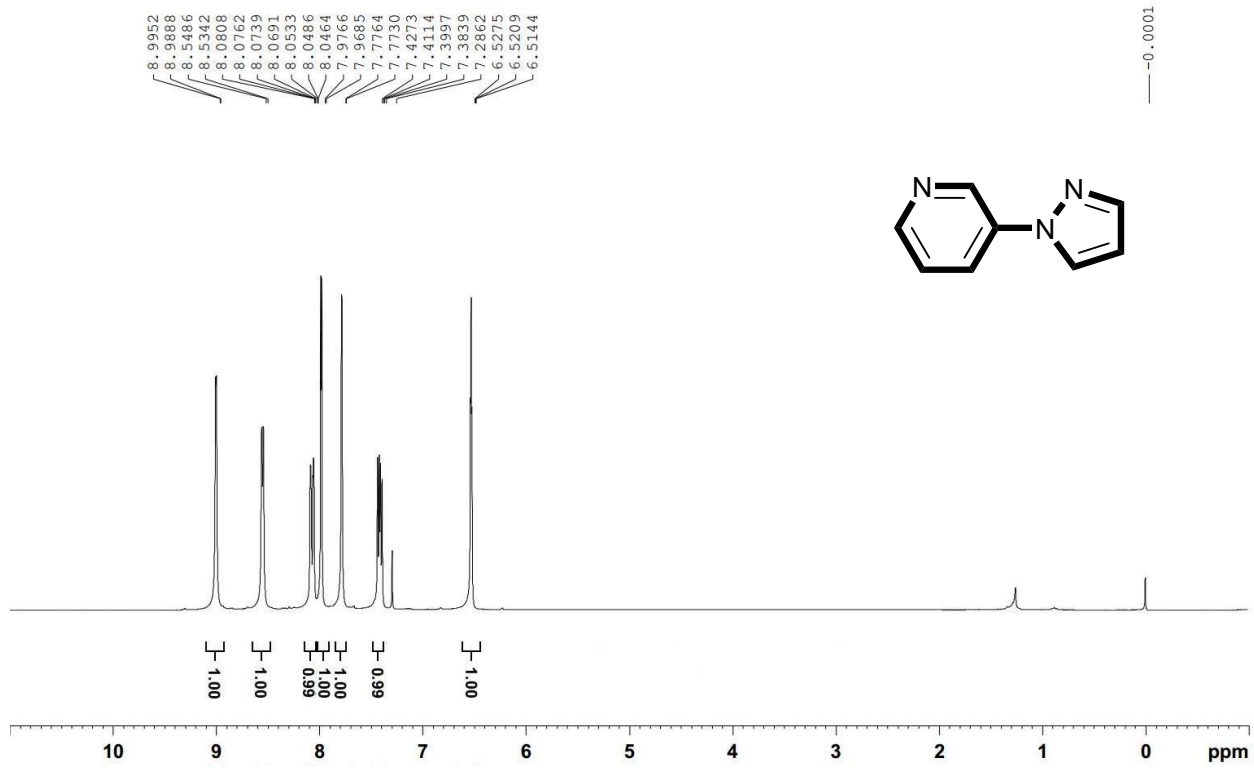

$^{13}$C-NMR spectra (63 MHz) of 1-pyridin-2-yl-1*H*-benzimidazole (**C42**) in $CDCl_3$.



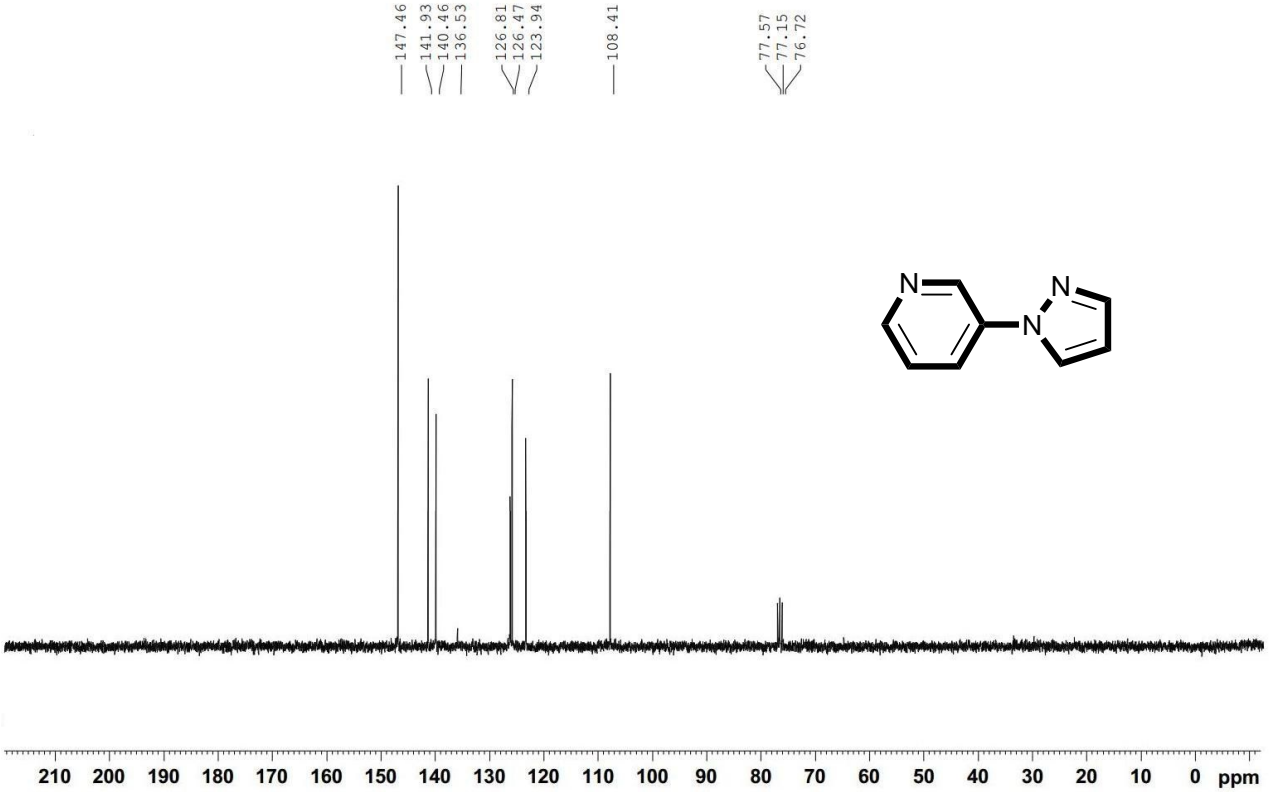

$^{1}$H-NMR spectra (250 MHz) of 3-(1*H*-imidazol-1-yl)pyridine (**C43**) in $CDCl_3$.



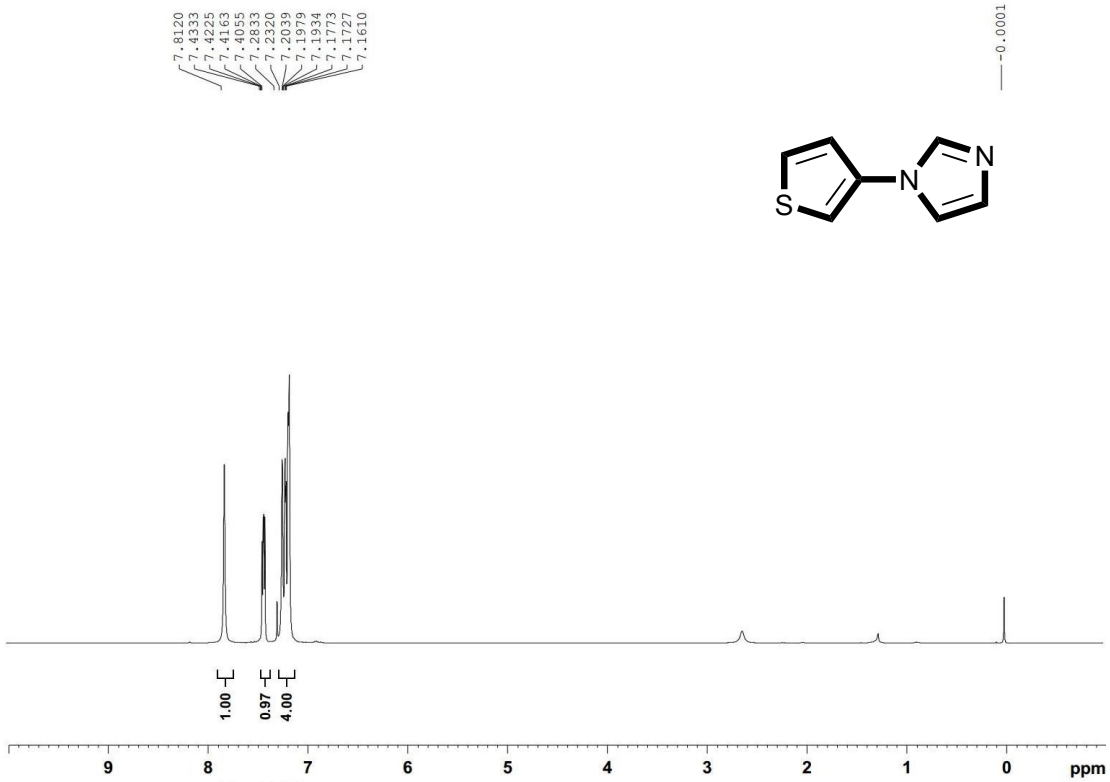

$^{13}$C-NMR spectra (63 MHz) of 3-(1*H*-imidazol-1-yl)pyridine (**C43**) in $CDCl_3$.



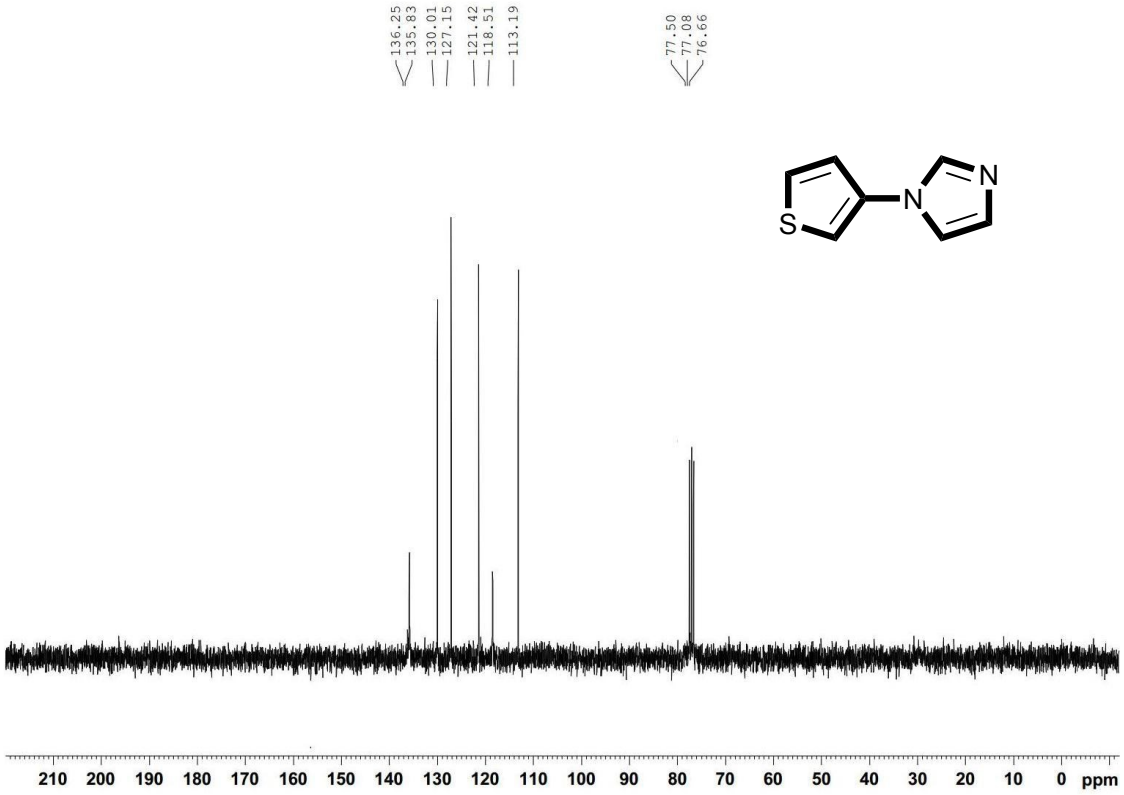

$^{1}$H-NMR spectra (250 MHz) of 3-(1*H*-pyrazol-1-yl)pyridine (**C44**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of 3-(1*H*-pyrazol-1-yl)pyridine (**C44**) in $CDCl_3$.




$^{1}$H-NMR spectra (250 MHz) of 1-(thiophen-3-yl)-1*H*-imidazole (**C45**) in $CDCl_3$.




$^{13}$C-NMR spectra (63 MHz) of 1-(thiophen-3-yl)-1*H*-imidazole (**C45**) in $CDCl_3$.