Electronic Supplementary Information

for

Electrochemical primary amination of imidazopyridines with azidotrimethylsilane under mild conditions

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Contents

1 General information

All reagents were obtained from commercial suppliers and used without further purification. Reactions were monitored by thin layer chromatography. Column chromatography was performed using silica gel (300−400 mesh). The NMR spectra were recorded on a Bruker Avance 400 spectrometer at 400 MHz (^{1}H) and 100 MHz (^{13}C) in DMSO-d_6 using tetramethylsilane as the internal standard. The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, q = quartet. High-resolution mass spectra were obtained with an AB Triple 5600 mass spectrometer by ESI on a TOF mass analyzer. Melting points are uncorrected.

2 Experimental procedures

2.1 General procedure for the electrochemical reaction

An oven-dried undivided three-necked flask (25 mL) was charged with 2-phenylimidazo[1,2-*a*]pyridine (**1a**, 97.1 mg, 0.5 mmol), ^{n}Bu$_4$NPF$_6$ (193.7 mg, 0.5 mmol). The flask was evacuated and backfilled with argon for 3 times. Then CH_3CN (10 mL) and $TMSN_3$ (115.2 mg, 1.0 mmol, 131.5μL, 2.0 equiv.) were added. The flask was equipped with graphite felt electrode as the anode and platinum plate electrode (10 mm × 10 mm) as the cathode. The reaction mixture was stirred and electrolyzed at a constant current (10 mA) at room temperature for 4 h. After the reaction was completed, the mixture was diluted with water (30 mL) and then extracted with CH_2Cl_2 (20 mL × 3). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in *vacuo*. The resulting residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (2:1, v/v) as eluent to afford the desired product **2a**.

2.2 General procedure for the gram-scale experiment

The electrolysis was carried out at a constant current of 15 mA using a flow electrolytic cell equipped with a carbon rod anode and a carbon rod cathode. The 2-phenylimidazo[1,2-*a*]pyridine (0.1 M in CH_3CN), $TMSN_3$ (0.2 M in CH_3CN), ^{n}Bu$_4$NPF$_6$ (0.1 M in CH_3CN) were pushed via syringe pump into the flow electrolytic cell at a flow rate of 0.025 mL/min (Figure S1). After 66 h, 100 mL of the reaction solution was collected. It was concentrated under reduced pressure on rotary evaporator. The residue was diluted with water (80 mL) and then extracted with CH_2Cl_2 (60 mL × 3). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated

in *vacuo*. The resulting residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (2:1, v/v) as eluent to afford the desired product **2a**. (1.47g, yield 70%).

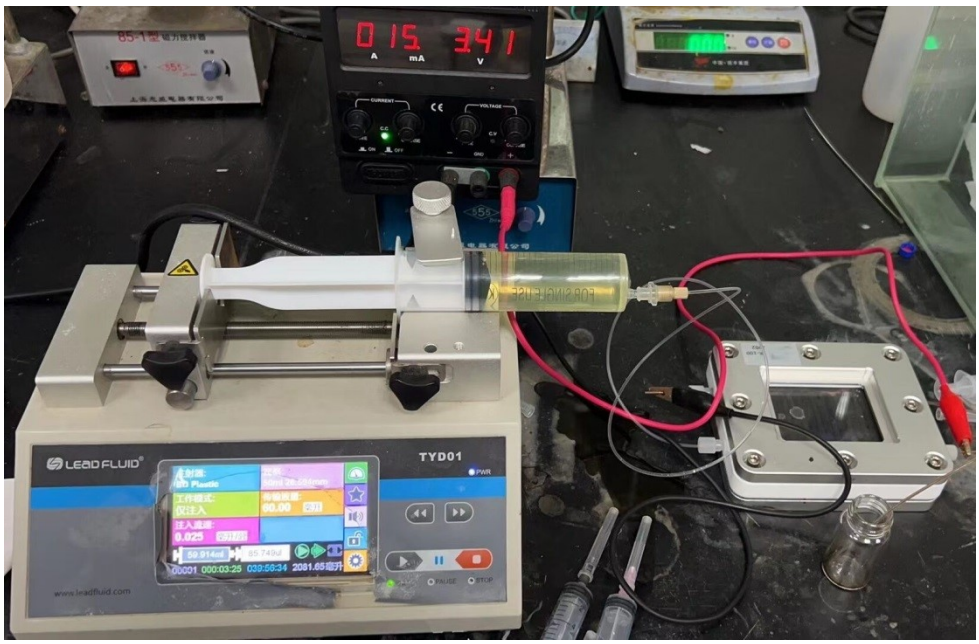
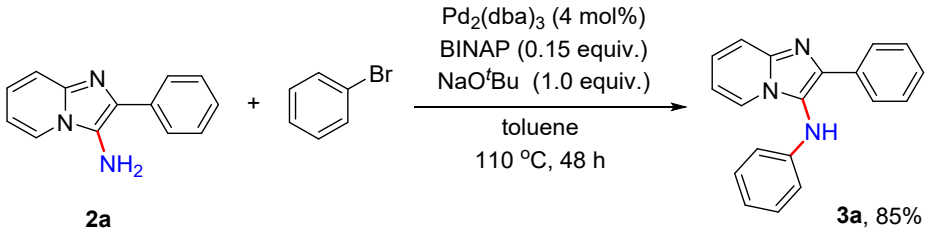


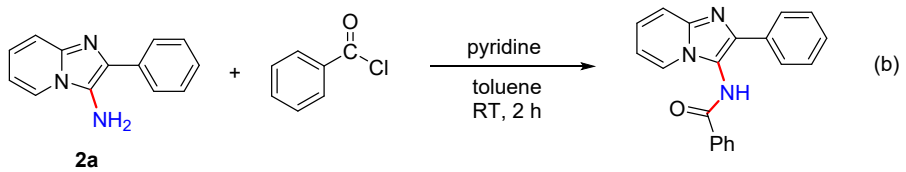
Figure S1 Reaction setup for scale up experiment.

2.3 General procedure for the preparation of 3a



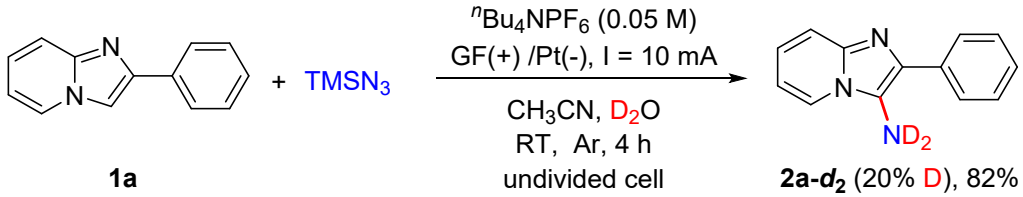
An oven-dried Schlenk tube (10 mL) was charged with 2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2a**, 100.0 mg, 0.48 mmol), $Pd_2(dba)_3$ (17.5 mg, 0.019 mmol, 4 mol%), BINAP (44.8 mg, 0.07 mmol, 0.15 equiv.), and sodium *tert*-butoxide (46.1 mg, 0.48 mmol, 1.0 equiv.). The flask was evacuated and backfilled with argon for 3 times. Then toluene (3 mL) and PhBr (150.7 mg, 0.96 mmol, 101.2 μL, 2.0 equiv.) were added. The reaction mixture was stirred under 110 °C for 48 hours. After the reaction was completed, the mixture was diluted with water (30 mL) and then extracted with CH_2Cl_2 (20 mL × 3). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in *vacuo*. The resulting residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (2:1) as eluent to afford the desired product **3a**.

2.4 General procedure for the preparation of 3b



To a solution of 2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2a**, 100.0 mg, 0.48 mmol) in toluene (4 mL) and pyridine (2 mL) in a Schlenk flask was added benzoyl chloride (105.5 mg, 87.9 μL, 1.5 equiv.). The reaction mixture was stirred at room temperature for 2 hours. After the reaction was completed, water (3 mL) was added, and the solution was stirred for 15 min. The reaction mixture was cooled in an ice bath, and the precipitate was collected by vacuum filtration and then washed several times with ice water. The filtrate was diluted with water (30 mL) and then extracted with CH_2Cl_2 (20 mL × 3), and the combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in *vacuo*. The resulting residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (1:1, v/v) as eluent to afford the desired product **3b**.

3 Control experiments



An oven-dried undivided three-necked flask (25 mL) was charged with 2-phenylimidazo[1,2-*a*]pyridine (**1a**, 97.1 mg, 0.5 mmol), $^{n}Bu_4NPF_6$ (193.7 mg, 0.5 mmol). The flask was evacuated and backfilled with argon for 3 times. Then dry CH_3CN (10 mL), D_2O (200.3 mg, 180.1 μL, 20 equiv.) and $TMSN_3$ (115.2 mg, 131.5μL, 1.0 mmol, 2.0 equiv.) were added. The flask was equipped with graphite felt electrode as the anode and platinum plate electrode (10 mm × 10 mm) as the cathode. The reaction mixture was stirred and electrolyzed at a constant current (10 mA) at room temperature for 4 h. After the reaction was completed, the mixture was diluted with water (30 mL) and then extracted with CH_2Cl_2 (20 mL × 3). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in *vacuo*. The resulting residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (2:1, v/v) as eluent to afford the desired product **2a-*d*$_2$**.

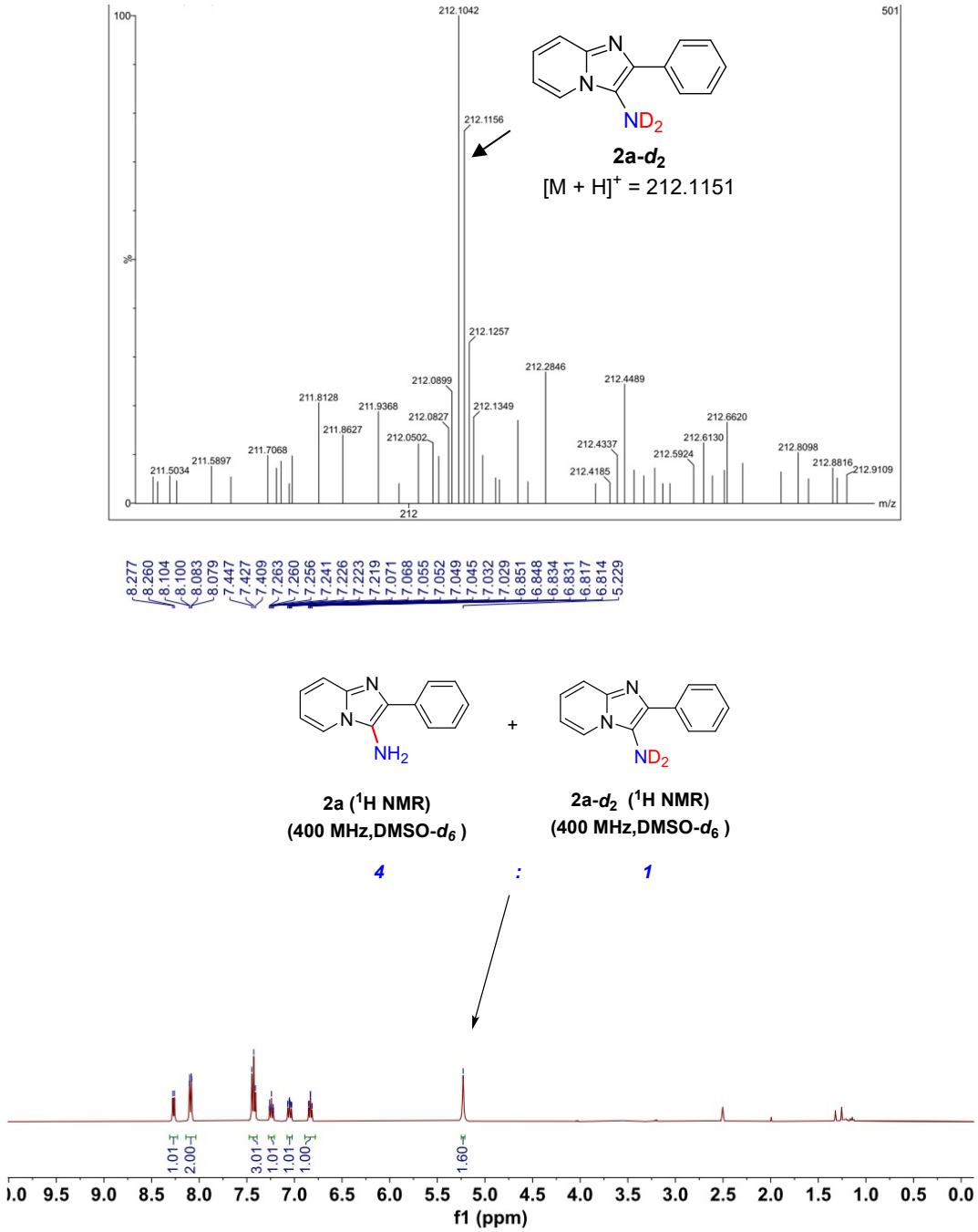


Figure S2 HR-MS analysis and ^{1}H NMR of the mixture of **2a** and **2a-*d*$_2$**.

4 Cyclic voltammetry analysis

Cyclic voltammetry was performed in a three electrode cell in a three-necked flask. The working electrode was a Pt electrode, the counter electrode was Pt wire. The reference was saturated calomel electrode (SCE) submerged in saturated aqueous KCl solution. As shown in the Figure S2, 2-phenylimidazo[1,2-*a*]pyridine (**1a**) had lower oxidation potential (1.40 V vs SCE) than $TMSN_3$ (no distinct oxidation peak), indicating that the initial step maybe the oxidation of imidazopyridine **1a**.

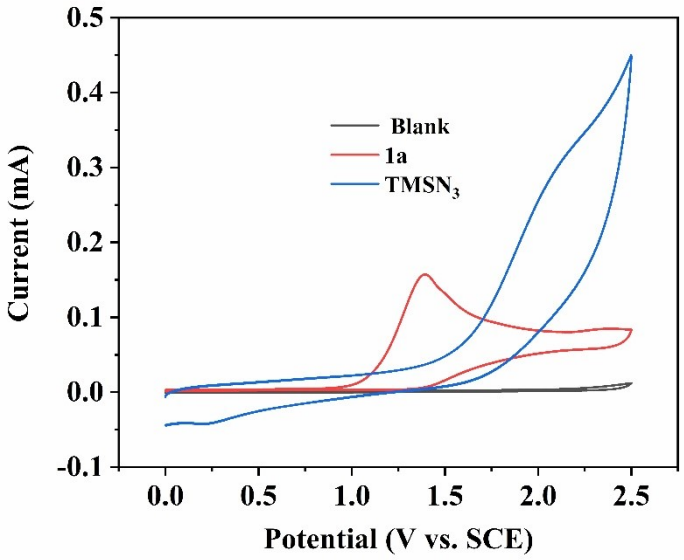
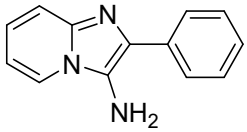
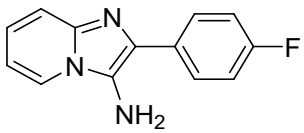


Figure S3 CV scans (scan rate 100 mv·s^{-1}) of substrates. (a) Blank (^{n}Bu$_4$NPF$_6$ (0.02 M) in MeCN); (b) $TMSN_3$ (0.01 M) in blank. (c) 2-Phenylimidazo[1,2-*a*]pyridine (**1a**, 0.01 M) in blank.

5 Experimental data for the products 2, 3a and 3b.

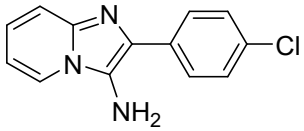


2-Phenylimidazo[1,2-*a*]pyridin-3-amine (**2a**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (93.0 mg, 89% yield). m.p. 209−210 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.25–8.23 (m, 1H), 8.06–8.03 (m, 2H), 7.43–7.40 (m, 3H), 7.25–7.21 (m, 1H), 7.07–7.03 (m, 1H), 6.85–6.82 (m, 1H), 5.19 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.1, 135.3, 128.8, 127.2, 127.0, 126.6, 126.4, 123.1, 122.7, 116.8, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{12}N_3^+$ 210.1026; Found 210.1027.

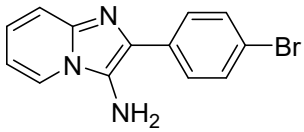


2-(4-Fluorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2b**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (92.0 mg, 81% yield). m.p. 150−151 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.28 (d, J = 6.9 Hz, 1H), 8.17–8.12 (m, 2H), 7.44 (d, J = 9.1 Hz, 1H), 7.29–7.23 (m, 2H), 7.08–7.04 (m, 1H), 6.85–6.82 (m, 1H),

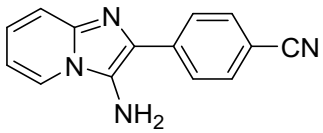
5.19 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 161.2 (d, J = 243.0 Hz), 160.0, 139.4, 132.2 (d, J = 2.9 Hz), 128.5 (d, J = 7.9 Hz). 127.6, 126.5, 123.0, 122.6, 117.0, 115.5 (d, J = 21.1 Hz), 111.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}FN_3^+$ 228.0932; Found 228.0936.



2-(4-Chlorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2c**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (104.5 mg, 86% yield). m.p. 151−152 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.29–8.27 (m, 1H), 8.13–8.10 (m, 2H), 7.48–7.42 (m, 3H), 7.08–7.04 (m, 1H), 6.85–6.82 (m, 1H), 5.29 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 134.5, 130.7, 128.7, 128.2, 127.3, 126.8, 123.1, 122.7, 117.1, 111.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}ClN_3^+$ 244.0636; Found 244.0644.

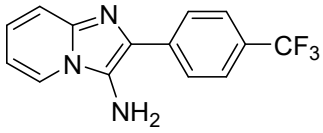


2-(4-Bromophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2d**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (126.2 mg, 88% yield). m.p. 147−148 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.30–8.28 (m, 1H), 8.09–8.06 (m, 2H), 7.62–7.58 (m, 2H), 7.46–7.43 (m, 1H), 7.08–7.04 (m, 1H), 6.85–6.81 (m, 1H), 5.32 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 134.9, 131.6, 128.5, 127.4, 126.8, 123.1, 122.7, 119.3, 117.1, 111.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}BrN_3^+$ 288.0131; Found 288.0136.

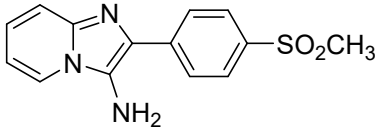


4-(3-Aminoimidazo[1,2-*a*]pyridin-2-yl)benzonitrile (**2e**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (97.1 mg, 83% yield). m.p. 184−185 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.28 (d, J = 6.9 Hz, 1H), 8.22–8.20 (m, 2H), 7.84–7.82 (m, 2H), 7.42 (d, J = 9.1 Hz, 1H), 7.10–7.06 (m, 1H), 6.86–6.83 (m, 1H), 5.63 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 140.3, 139.5, 132.7, 129.5, 126.5, 124.7, 123.3, 123.2, 119.9, 117.4, 111.8, 107.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{11}N_4^+$

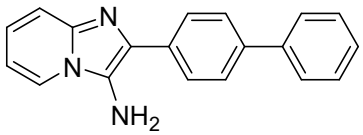
235.0978; Found 235.0985.



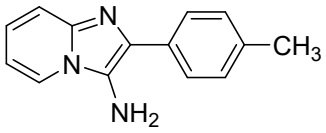
2-(4-(Trifluoromethyl)phenyl)imidazo[1,2-*a*]pyridin-3-amine (**2f**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (121.9 mg, 88% yield). m.p. 189−190 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.30–8.25 (m, 3H), 7.74 (d, J = 8.3 Hz, 2H), 7.45–7.42 (m, 1H), 7.10–7.06 (m, 1H), 6.87–6.83 (m, 1H), 5.49 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.8, 139.4, 128.7, 126.6, 126.1 (q, J = 31.4 Hz), 125.6 (q, J = 3.9 Hz), 125.1 (q, J = 271.5 Hz), 125.5, 123.2, 123.0, 117.3, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{11}F_3N_3^+$ 278.0900; Found 278.0907.



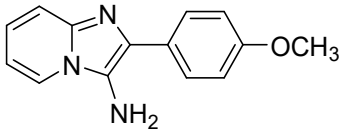
2-(4-(Methylsulfonyl)phenyl)imidazo[1,2-*a*]pyridin-3-amine (**2g**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (124.8 mg, 87% yield). m.p. 232−233 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.29 (d, J = 8.0 Hz, 3H), 7.94 (d, J = 8.1 Hz, 2H), 7.44 (d, J = 9.1 Hz, 1H), 7.10–7.06 (m, 1H), 6.87–6.84 (m, 1H), 5.60 (s, 2H), 3.25 (s, 3H). ^{13}C NMR ((100 MHz, DMSO) δ (ppm) 140.8, 139.5, 137.6, 129.3, 127.6, 126.5, 124.9, 123.2, 123.2, 117.4, 111.7, 44.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3O_2S^+$ 288.0801; Found 288.0806.



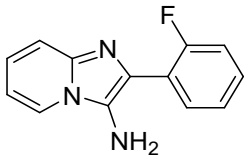
2-([1,1'-Biphenyl]-4-yl)imidazo[1,2-*a*]pyridin-3-amine (**2h**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (111.1 mg, 78% yield). m.p. 206−207 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.28 (d, J = 6.9 Hz, 1H), 8.18 (d, J = 8.1 Hz, 2H), 7.75–7.72 (m, 4H), 7.49–7.43 (m, 3H), 7.38–7.34 (m, 1H), 7.08–7.04 (m, 1H), 6.86–6.83 (m, 1H), 5.30 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 140.4, 139.3, 137.8, 134.9, 129.4, 127.7, 127.3, 127.1, 127.0, 126.8, 123.0, 122.5, 117.0, 111.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{16}N_3^+$ 286.1339; Found 286.1346.



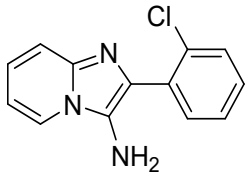
2-(*p*-Tolyl)imidazo[1,2-*a*]pyridin-3-amine (**2i**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (92.5 mg, 83% yield). m.p. 105−106 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.27–8.24 (m, 1H), 8.00–7.98 (m, 2H), 7.44–7.41 (m, 1H), 7.24 (d, J = 8.0 Hz, 2H), 7.06–7.02 (m, 1H), 6.85–6.81 (m, 1H), 5.15 (s, 2H), 2.33 (s, 3H). ^{13}C NMR (101 MHz, DMSO) δ (ppm) 139.2, 135.5, 132.8, 129.4, 128.2, 126.6, 126.4, 122.9, 122.2, 116.9, 111.3, 21.3. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3^+$ 224.1182; Found 224.1182.



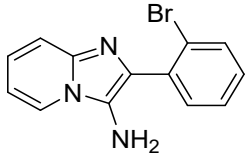
2-(4-Methoxyphenyl)imidazo[1,2-*a*]pyridin-3-amine (**2j**). The product was purified by silica gel column chromatography with ether/ethyl acetate (2:1, v/v). Yellow solid (100.4 mg, 84% yield). m.p. 152−153 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.25 (d, J = 6.9 Hz, 1H), 8.05 (d, J = 8.7 Hz, 2H), 7.43 (d, J = 9.0 Hz, 1H), 7.07–7.00 (m, 3H), 6.85–6.81 (m, 1H), 5.06 (s, 2H), 3.79 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 158.2, 139.3, 128.8, 128.2, 128.0, 125.6, 122.9, 122.2, 116.7, 114.2, 111.2, 55.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3O^+$ 240.1131; Found 240.1136.



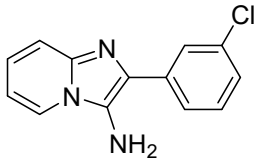
2-(2-Fluorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2k**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (85.1 mg, 75% yield). m.p. 232−233 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.18 (d, J = 6.9 Hz, 1H), 7.81–7.77 (m, 1H), 7.44 (d, J = 9.1 Hz, 1H), 7.38–7.26 (m, 3H), 7.08–7.04 (m, 1H), 6.86–6.83 (m, 1H), 5.10 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 159.4 (d, J = 245.8 Hz), 139.5, 131.6 (d, J = 4.6 Hz), 128.9 (d, J = 8.1 Hz), 128.5, 124.9 (d, J = 3.3 Hz), 123.2 (d, J = 14.5 Hz), 123.0, 122.2, 122.2, 117.1, 116.3 (d, J = 22.2 Hz), 111.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}FN_3^+$ 228.0932; Found 228.0927.



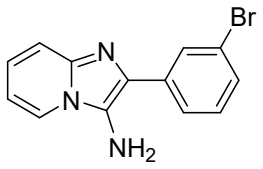
2-(2-Chlorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2l**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow oil (64.4 mg, 53% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.18–8.16 (m, 1H), 7.59–7.54 (m, 2H), 7.44–7.37 (m, 3H), 7.09–7.05 (m, 1H), 6.88–6.85 (m, 1H), 4.97 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 138.9, 134.3, 133.1, 132.9, 130.1, 129.3, 128.1, 127.3, 125.7, 123.0, 122.2, 117.1, 111.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}ClN_3^+$ 244.0636; Found 244.0642.



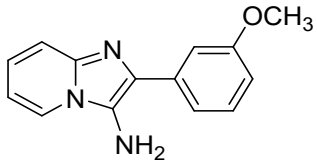
2-(2-Bromophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2m**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (111.9 mg, 78% yield). m.p. 167−168 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.30–8.28 (m, 2H), 8.10–8.08 (m, 1H), 7.45–7.35 (m, 3H), 7.10–7.05 (m, 1H), 6.86–6.83 (m, 1H), 5.35 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 138.1, 130.9, 128.9, 128.8, 127.7, 126.1, 125.2, 123.1, 123.0, 122.5, 117.2, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}BrN_3^+$ 288.0131; Found 288.0138.



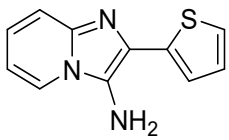
2-(3-Chlorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2n**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (70.5 mg, 58% yield). m.p. 172−173 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.30–8.27 (m, 1H), 8.13–8.12 (m, 1H), 8.06–8.03 (m, 1H), 7.45–7.41 (m, 2H), 7.29–7.26 (m, 1H), 7.09–7.05 (m, 1H), 6.86–6.83 (m, 1H), 5.35 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 137.8, 133.7, 130.6, 127.7, 126.2, 126.0, 125.9, 124.8, 123.1, 122.9, 117.2, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}ClN_3^+$ 244.0636; Found 244.0644.



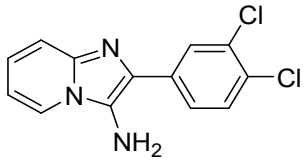
2-(3-Bromophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2o**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (124.8 mg, 87% yield). m.p. 133−134 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.29 (d, J = 6.0 Hz, 2H), 8.10–8.08 (m, 1H), 7.45–7.35 (m, 3H), 7.09–7.05 (m, 1H), 6.86–6.83 (m, 1H), 5.34 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 138.1, 130.9, 128.9, 128.8, 127.7, 126.2, 125.2, 123.1, 122.9, 122.5, 117.2, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}BrN_3^+$ 288.0131; Found 288.0141.



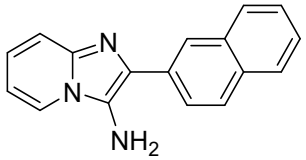
2-(3-Methoxyphenyl)imidazo[1,2-*a*]pyridin-3-amine (**2p**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow oil (62.1 mg, 52% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.27–8.24 (m, 1H), 7.65–7.61 (m, 2H), 7.44–7.41 (m, 1H), 7.35–7.30 (m, 1H), 7.09–7.04 (m, 1H), 6.86–6.79 (m, 2H), 5.20 (s, 2H), 3.83 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 159.8, 139.1, 136.9, 129.8, 127.4, 127.1, 123.0, 122.6, 119.0, 117.0, 112.3, 111.7, 111.5, 55.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3O^+$ 240.1131; Found 240.1140.



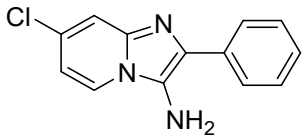
2-(Thiophen-2-yl)imidazo[1,2-*a*]pyridin-3-amine (**2q**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (91.4 mg, 85% yield). m.p. 170−171 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.23–8.21 (m, 1H), 7.57–7.56 (m, 1H), 7.42–7.38 (m, 2H), 7.13–7.11 (m, 1H), 7.08–7.03 (m, 1H), 6.86–6.83 (m, 1H), 5.33 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.0, 138.9, 128.3, 126.0, 124.1, 123.4, 122.9, 122.6, 122.4, 116.6, 111.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{11}H_{10}N_3S^+$ 216.0590; Found 216.0599.



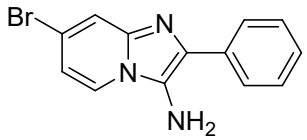
2-(3,4-Dichlorophenyl)imidazo[1,2-*a*]pyridin-3-amine (**2r**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (84.5 mg, 61% yield). m.p. 184−185 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.29–8.26 (m, 2H), 8.06–8.03 (m, 1H), 7.64 (d, J = 8.5 Hz, 1H), 7.43–7.40 (m, 1H), 7.10–7.06 (m, 1H), 6.87–6.83 (m, 1H), 5.40 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.5, 136.4, 131.6, 130.9, 128.2, 128.0, 127.7, 126.3, 125.2, 123.2, 117.2, 111.7. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{10}Cl_2N_3^+$ 278.0246; Found 278.0255.



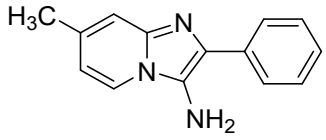
2-(Naphthalen-2-yl)imidazo[1,2-*a*]pyridin-3-amine (**2s**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (112.7 mg, 87% yield). m.p. 178−179 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.60 (d, J = 1.4 Hz, 1H), 8.39–8.33 (m, 2H), 8.00–7.88 (m, 3H), 7.53–7.44 (m, 3H), 7.10–7.06 (m, 1H), 6.88–6.85 (m, 1H), 5.48 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.4, 133.9, 133.3, 132.1, 128.4, 128.1, 128.0, 127.7, 127.4, 126.6, 125.8, 125.6, 124.5, 123.0, 122.5, 117.1, 111.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{14}N_3^+$ 260.1182; Found 260.1184.



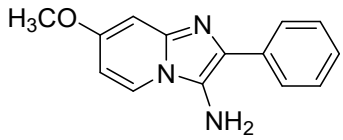
7-Chloro-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2t**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (98.4 mg, 81% yield). m.p. 220−221 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.28 (d, J = 7.4 Hz, 1H), 8.05–8.03 (m, 2H), 7.57 (d, J = 2.1 Hz, 1H), 7.44–7.40 (m, 2H), 7.27–7.22 (m, 1H), 6.93–6.91 (m, 1H), 5.36 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 138.6, 135.2, 128.8, 128.1, 127.6, 127.2, 126.6, 126.6, 123.9, 115.6, 112.5. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}ClN_3^+$ 244.0636; Found 244.0634.



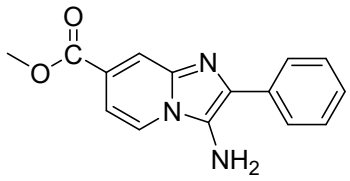
7-Bromo-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2u**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (123.4 mg, 86% yield). m.p. 238−239 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.22 (d, J = 7.3 Hz, 1H), 8.04–8.02 (m, 2H), 7.72 (d, J = 1.9 Hz, 1H), 7.44–7.40 (m, 2H), 7.27–7.23 (m, 1H), 7.01–6.99 (m, 1H), 5.36 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.1, 135.2, 128.8, 127.9, 127.7, 126.6, 126.6, 123.9, 118.8, 114.9, 114.7. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}BrN_3^+$ 288.0131; Found 288.0135.



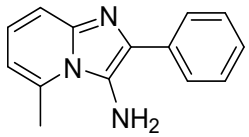
7-Methyl-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2v**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Red oil (78.0 mg, 70% yield). m.p. 201−202 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.16 (d, J = 7.1 Hz, 1H), 8.08–8.06 (m, 2H), 7.43–7.39 (m, 2H), 7.24–7.19 (m, 2H), 6.69–6.67 (m, 1H), 5.10 (s, 2H), 2.32 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.7, 135.8, 132.7, 128.7, 127.6, 126.5, 126.4, 126.2, 122.4, 115.2, 113.9, 21.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3^+$ 224.1182; Found 224.1187.



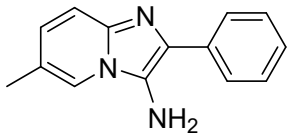
7-Methoxy-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2w**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (10:1, v/v). Yellow solid (87.2 mg, 73% yield). m.p. 161−162 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.14–8.12 (m, 1H), 8.05–8.03 (m, 2H), 7.41–7.36 (m, 2H), 7.22–7.17 (m, 1H), 6.81 (d, J = 2.5 Hz, 1H), 6.59–6.56 (m, 1H), 4.96 (s, 2H), 3.81 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 156.4, 140.6, 135.9, 128.7, 127.4, 126.3, 125.9, 125.7, 123.9, 106.1, 94.5, 55.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3O^+$ 240.1131; Found 240.1138.



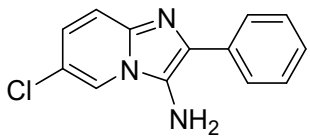
Methyl 3-amino-2-phenylimidazo[1,2-*a*]pyridine-7-carboxylate (**2x**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (104.1 mg, 78% yield). m.p. 207−208 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.30 (d, J = 7.3 Hz, 1H), 8.05–8.02 (m, 3H), 7.47–7.43 (m, 2H), 7.30–7.23 (m, 2H), 5.81 (s, 2H), 3.85 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 166.0, 137.4, 134.9, 130.0, 129.9, 128.9, 127.0, 126.8, 122.2, 121.2, 119.4, 110.1, 52.6. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}N_3O_2^+$ 268.1081; Found 268.1077.



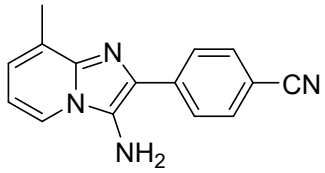
5-Methyl-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2y**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (40.1 mg, 36% yield). m.p. 78−79 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.11–8.08 (m, 2H), 7.45–7.40 (m, 2H), 7.29–7.25 (m, 2H), 6.97–6.93 (m, 1H), 6.47–6.44 (m, 1H), 4.55 (s, 2H), 2.99 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 141.8, 137.0, 135.6, 133.4, 128.7, 127.7, 127.4, 126.8, 123.7, 115.6, 112.7, 20.1. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3^+$ 224.1182; Found 224.1192.



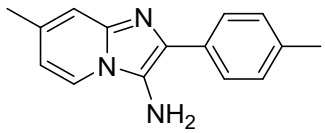
6-Methyl-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2z**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (55.8 mg, 50% yield). m.p. 197−198 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.08 (d, J = 9.3 Hz, 3H), 7.43–7.33 (m, 3H), 7.24–7.21 (m, 1H), 6.90 (d, J = 9.2 Hz, 1H), 5.15 (s, 2H), 2.27 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 138.5, 135.8, 128.7, 128.0, 126.7, 126.5, 126.2, 125.4, 120.3, 116.5, 18.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_3^+$ 224.1182; Found 224.1190.



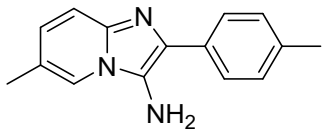
6-Chloro-2-phenylimidazo[1,2-*a*]pyridin-3-amine (**2aa**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Red oil (49.8 mg, 41% yield). m.p. 199−200 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.48 (d, J = 2.0 Hz, 1H), 8.03–8.01 (m, 2H), 7.48–7.40 (m, 3H), 7.27–7.23 (m, 1H), 7.07–7.05 (m, 1H), 5.42 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 137.3, 135.1, 128.9, 128.2, 128.0, 126.6, 126.6, 122.7, 120.7, 118.7, 117.9. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{11}ClN_3^+$ 244.0636; Found 244.0639.



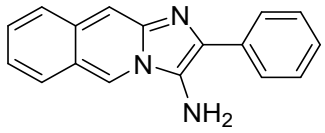
4-(3-Amino-8-methylimidazo[1,2-*a*]pyridin-2-yl)benzonitrile (**2ab**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow oil (45.9 mg, 37% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.24–8.21 (m, 2H), 8.14 (d, J = 7.0 Hz, 1H), 7.84–7.81 (m, 2H), 6.90–6.88 (m, 1H), 6.77–6.74 (m, 1H), 5.58 (s, 2H), 2.46 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 140.5, 140.0, 132.6, 129.9, 126.7, 126.5, 124.3, 121.8, 121.1, 120.0, 111.7, 107.6, 16.7. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{13}N_4^+$ 249.1135; Found 249.1139.



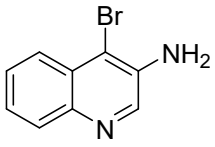
7-Methyl-2-(*p*-tolyl)imidazo[1,2-*a*]pyridin-3-amine (**2ac**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow oil (69.9 mg, 59% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.13 (d, J = 7.0 Hz, 1H), 7.96–7.94 (m, 2H), 7.22–7.17 (m, 3H), 6.68–6.66 (m, 1H), 4.98 (s, 2H), 2.33 (s, 3H), 2.32 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.7, 135.2, 133.0, 132.6, 129.3, 128.1, 126.5, 125.8, 122.3, 115.1, 113.7, 21.3, 21.2. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{16}N_3^+$ 238.1339; Found 238.1350.



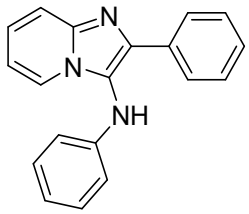
6-Methyl-2-(*p*-tolyl)imidazo[1,2-*a*]pyridin-3-amine (**2ad**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (15:1, v/v). Yellow solid (53.3 mg, 45% yield). m.p. 208−209 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.06–8.05 (m, 1H), 7.93–7.91 (m, 2H), 7.34–7.32 (m, 1H), 7.22 (d, J = 8.0 Hz, 2H), 6.95–6.92 (m, 1H), 5.05 (s, 2H), 2.33 (s, 3H), 2.29 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 138.2, 135.4, 132.6, 129.4, 127.8, 126.5, 126.2, 125.6, 120.5, 120.4, 116.1, 21.3, 18.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{16}N_3^+$ 238.1339; Found 238.1347.



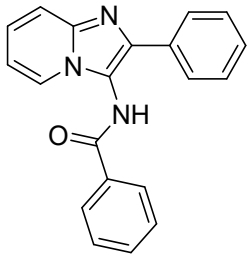
2-Phenylimidazo[1,2-*b*]isoquinolin-3-amine (**2ae**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (2:1, v/v). Yellow solid (93.2 mg, 72% yield). m.p. 119−120 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 9.37 (d, J = 8.6 Hz, 1H), 8.05 (d, J = 7.0 Hz, 2H), 7.88–7.85 (m, 1H), 7.64–7.59 (m, 1H), 7.50–7.42 (m, 5H), 7.31–7.28 (m, 1H), 5.17 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 139.0, 135.3, 134.8, 131.5, 130.9, 129.0, 128.9, 127.8, 127.2, 126.7, 125.0, 124.7, 124.6, 117.7, 117.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{14}N_3^+$ 260.1182; Found 260.1191.



4-Bromoquinolin-3-amine (**2af**).[1] The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (5:1, v/v). Yellow solid (75.5 mg, 68% yield). m.p. 187−188 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.50 (s, 1H), 8.30 (d, J = 8.5 Hz, 1H), 7.80 (d, J = 8.4 Hz, 1H), 7.67–7.64 (m, 1H), 7.49–7.46 (m, 1H), 7.01 (s, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 151.5, 148.3, 147.5, 129.8, 129.4, 125.4, 123.0, 119.3, 98.6.



***N*,2-diphenylimidazo[1,2-*a*]pyridin-3-amine** (**3a**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (3:1, v/v). Brown solid (121.1 mg, 85% yield). m.p. 235−236 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 8.28 (s, 1H), 8.08 (d, J = 7.7 Hz, 2H), 7.94 (d, J = 6.8 Hz, 1H), 7.64 (d, J = 9.0 Hz, 1H), 7.40–7.37 (m, 2H), 7.32–7.25 (m, 2H), 7.15–7.12 (m, 2H), 6.92–6.88 (m, 1H), 6.74–6.70 (m, 1H), 6.52 (d, J = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 146.0, 142.3, 137.9, 134.2, 130.0, 128.9, 128.0, 126.9, 125.6, 123.5, 119.4, 119.0, 117.6, 113.4, 112.7. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{16}N_3^+$ 286.1339; Found 286.1342.

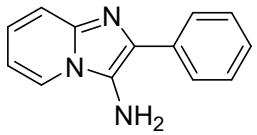


***N*-(2-phenylimidazo[1,2-*a*]pyridin-3-yl)benzamide** (**3b**). The product was purified by silica gel column chromatography with petroleum ether/ethyl acetate (1:1, v/v). Brown solid (109.6 mg, 70% yield). m.p. 244−245 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 10.75 (s, 1H), 8.16–8.12 (m, 3H), 8.03–8.00 (m, 2H), 7.72–7.60 (m, 4H), 7.47–7.43 (m, 2H), 7.37–7.31 (m, 2H), 6.98–6.95 (m, 1H). ^{13}C NMR (100 MHz, DMSO) δ (ppm) 167.2, 142.6, 138.3, 134.0, 133.4, 132.9, 129.2, 129.1, 128.5, 128.2, 127.1, 125.8, 124.3, 117.4, 115.9, 112.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{16}N_3O^+$ 314.1288; Found 314.1285.

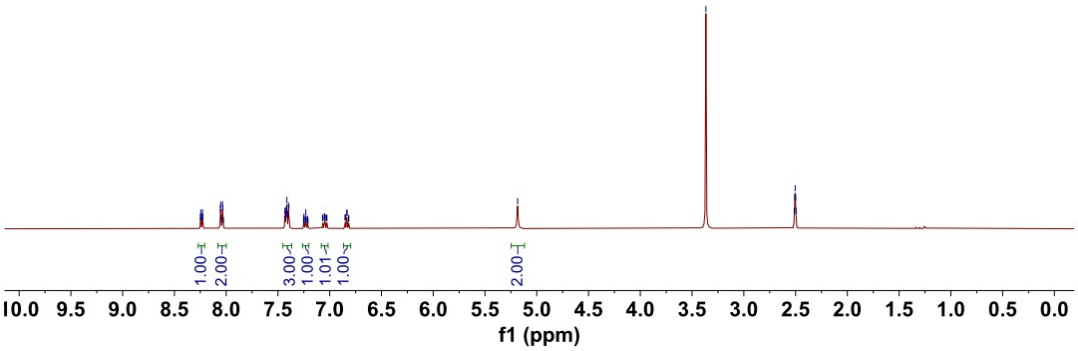
6 References

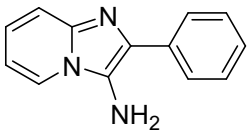
1 D. A. Scott, J. M. Hatcher, H. Liu, M. Fu, G. Du, L. Fontán, I. Us, G. Casalena, Q. Qiao, H. Wu, A. Melnick and N. S. Gray, *Bioorg. Med. Chem. Lett*., 2019, **29**, 1694–1698.

7 ^{1}H and ^{13}C NMR spectra of the products

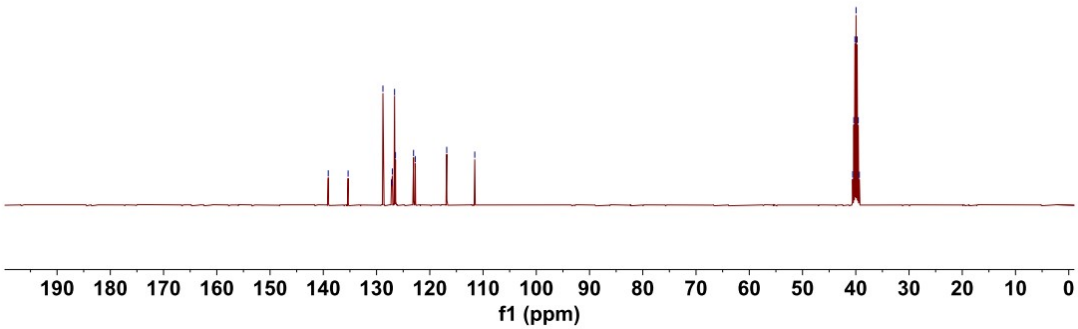


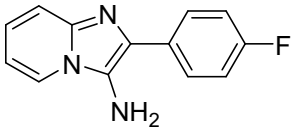
2a (^{1}H NMR) (400 MHz,DMSO-d_6)





2a (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)





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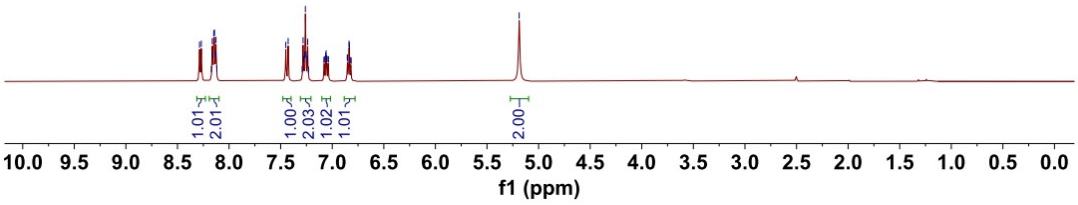
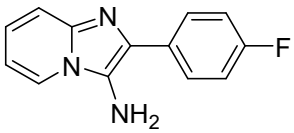
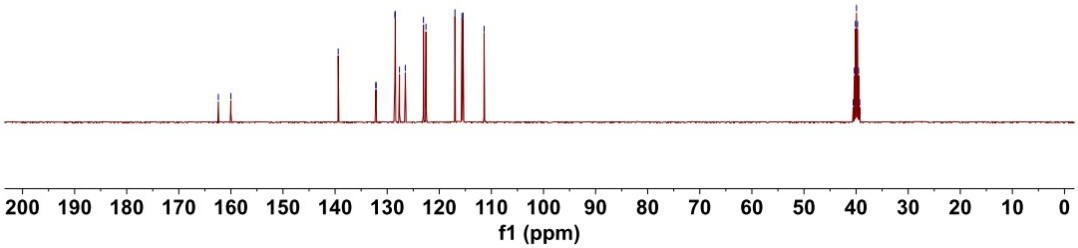
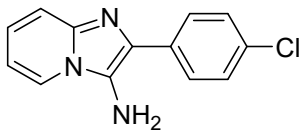




2b (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)





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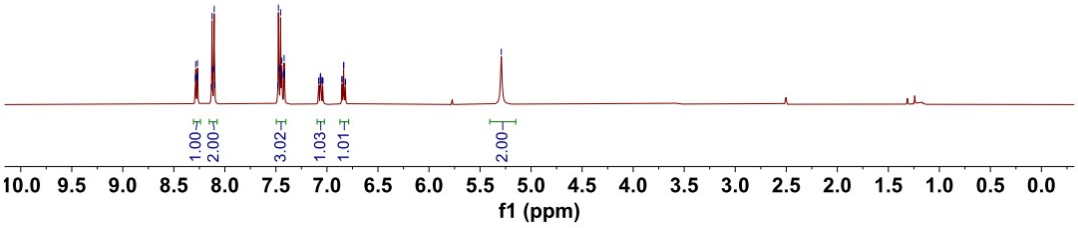
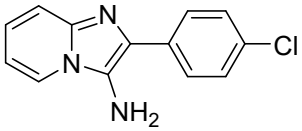
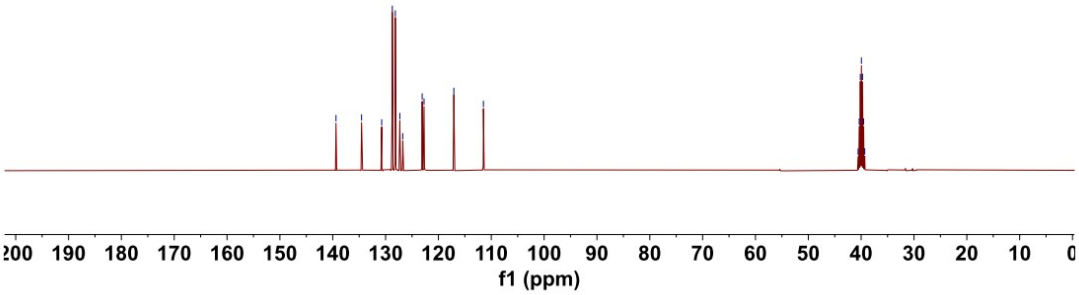
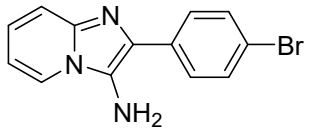




2c (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)





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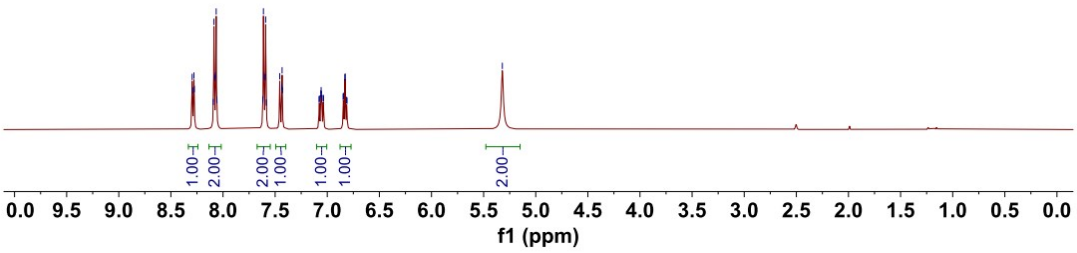

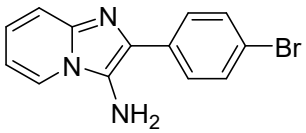

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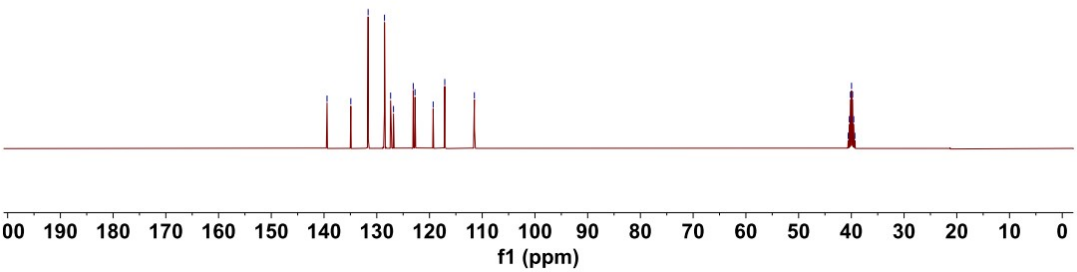

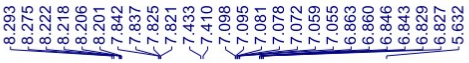

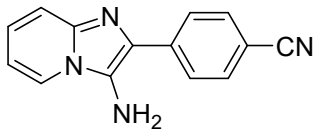

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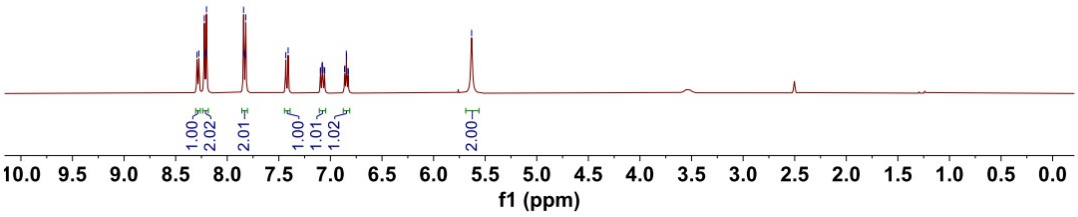

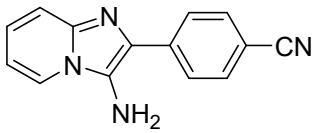

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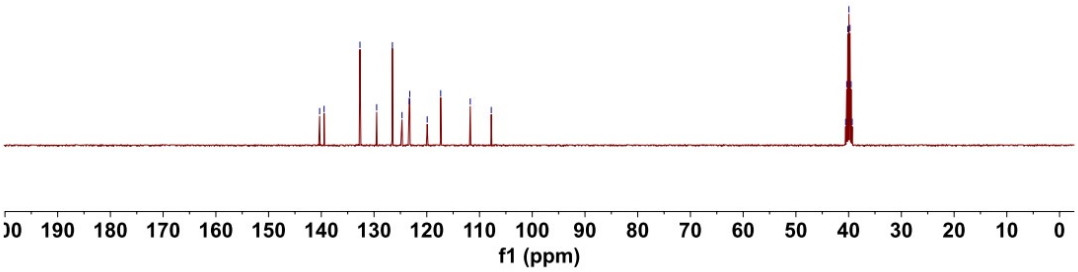

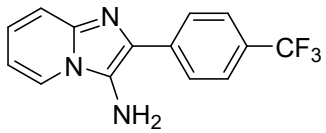

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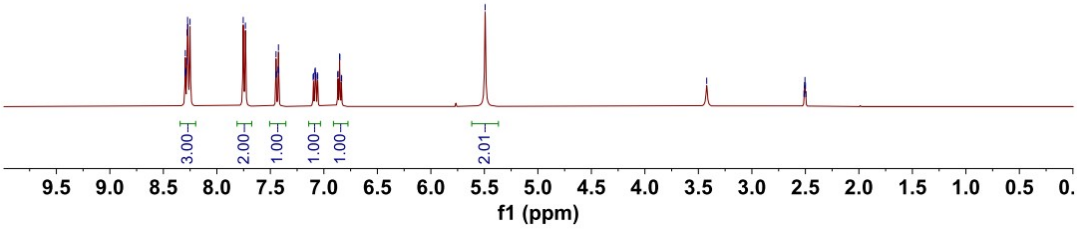

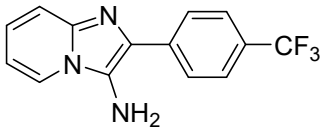

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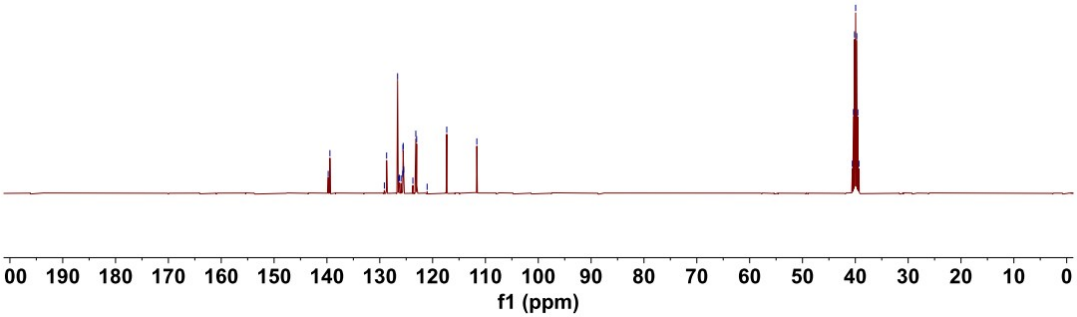

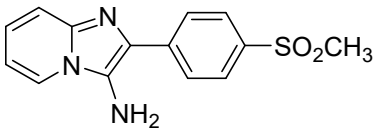

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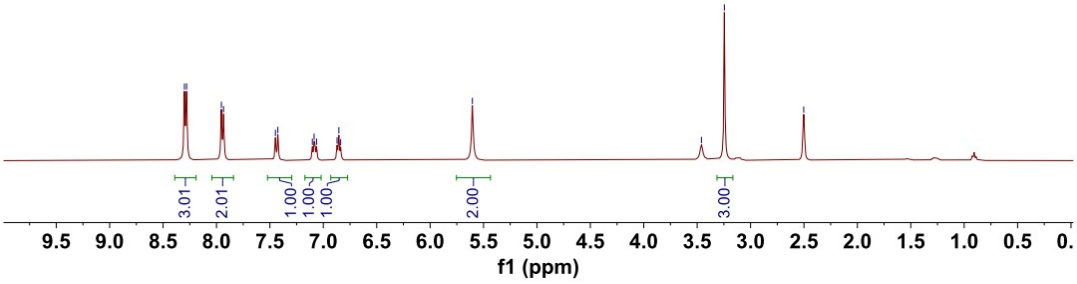

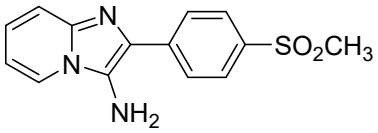

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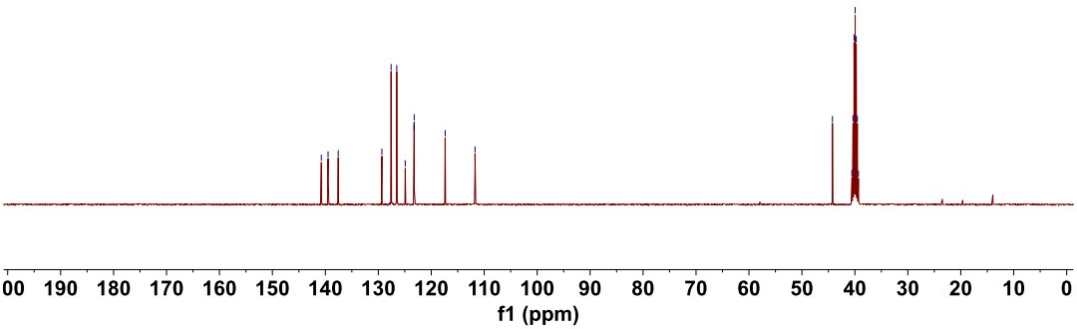

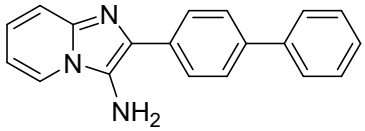

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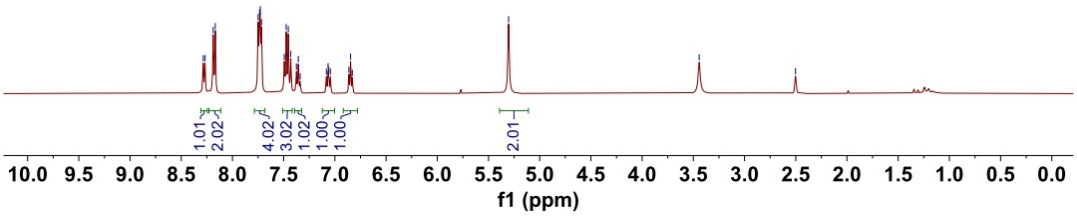

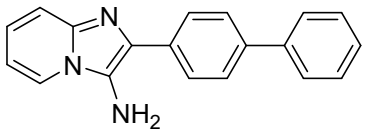

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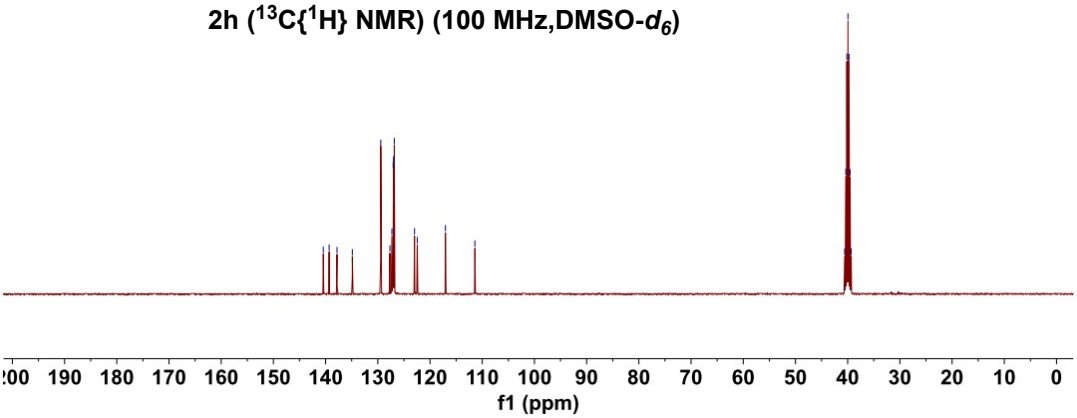

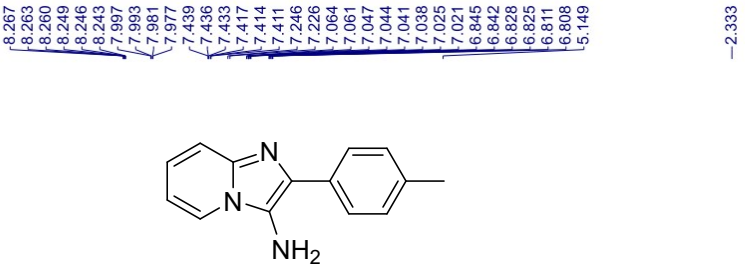

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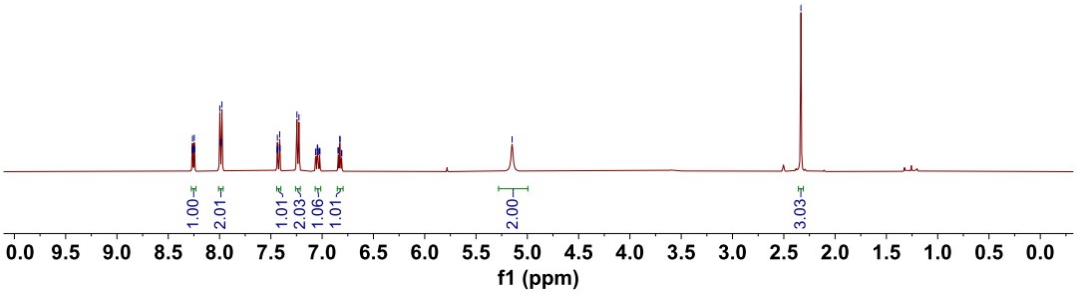

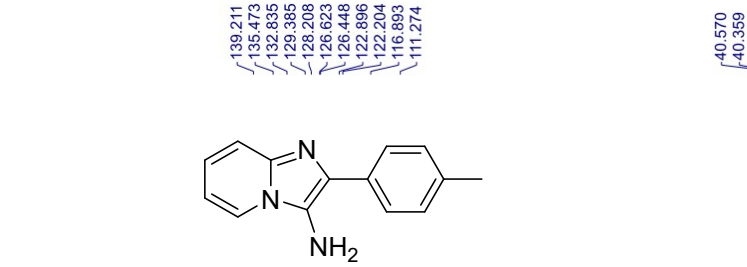

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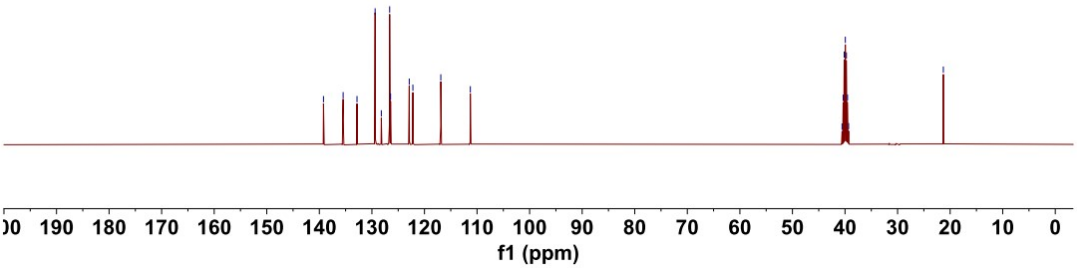

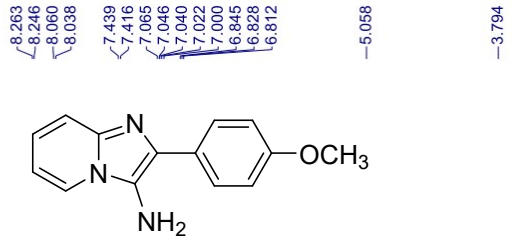

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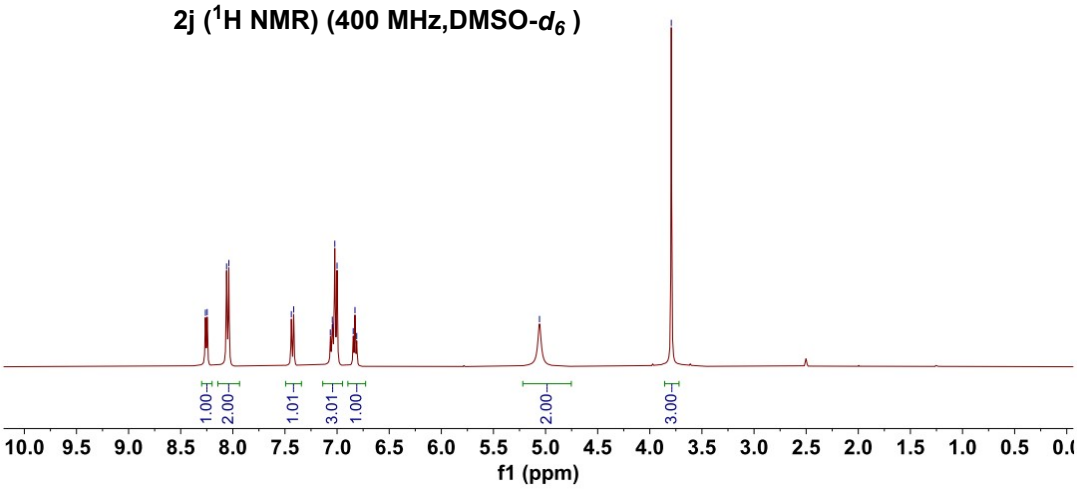

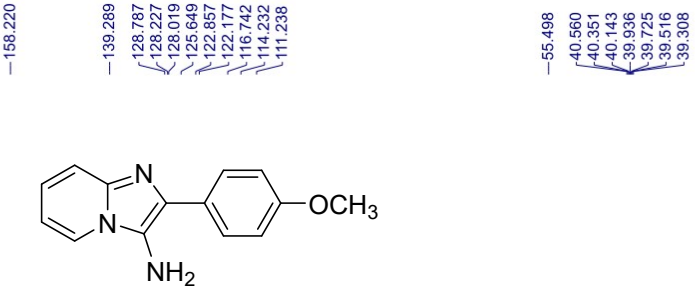

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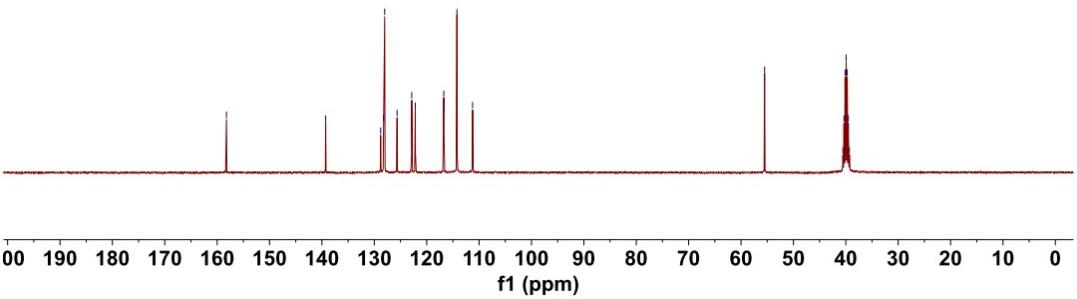
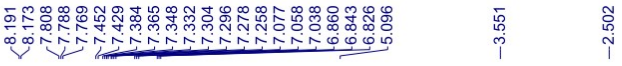
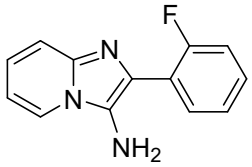
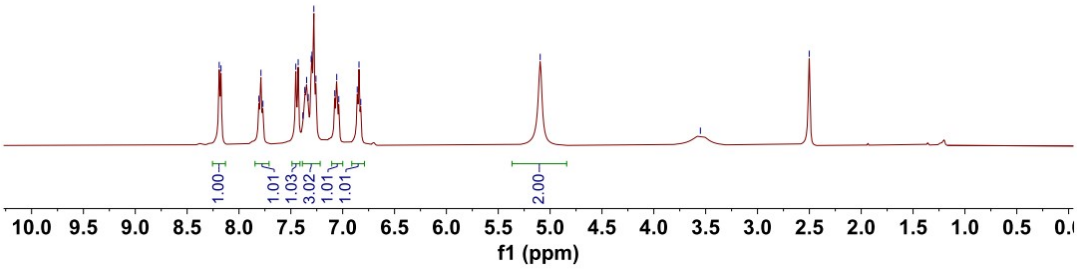
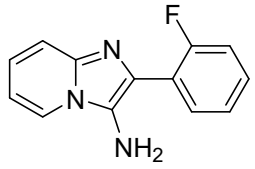




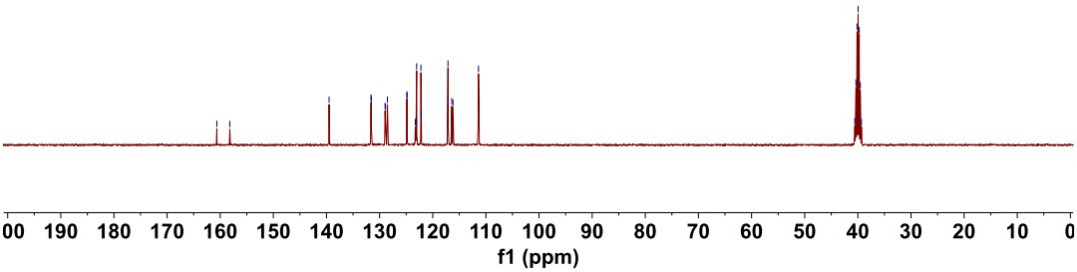


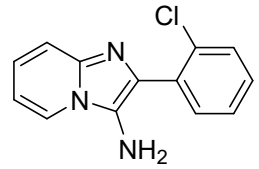
2k (^{1}H NMR) (400 MHz,DMSO-d_6)



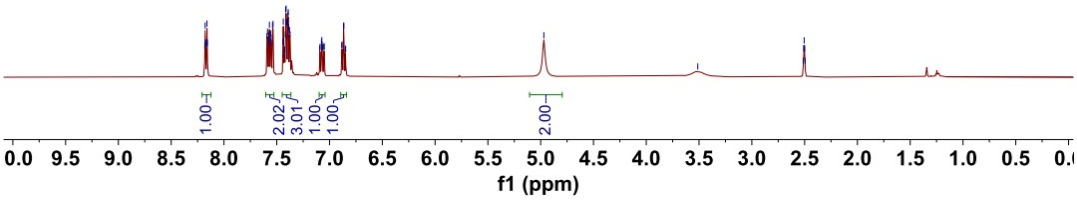


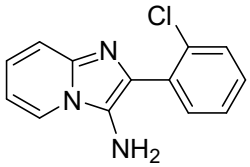
2k (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



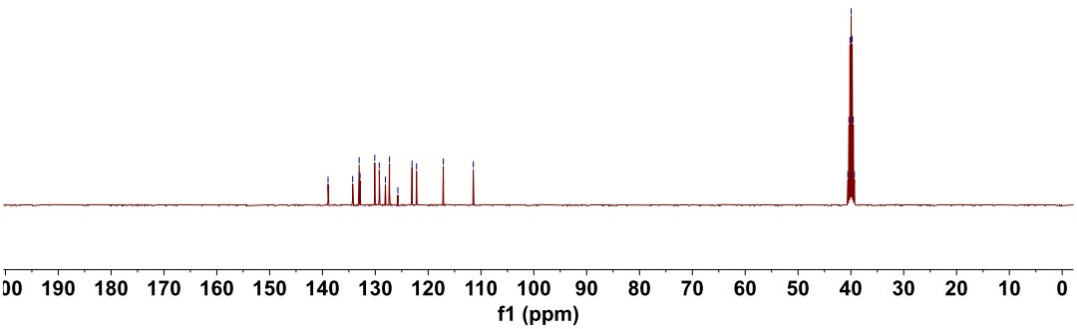


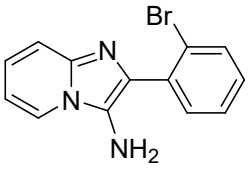
2l (^{1}H NMR) (400 MHz,DMSO-d_6)



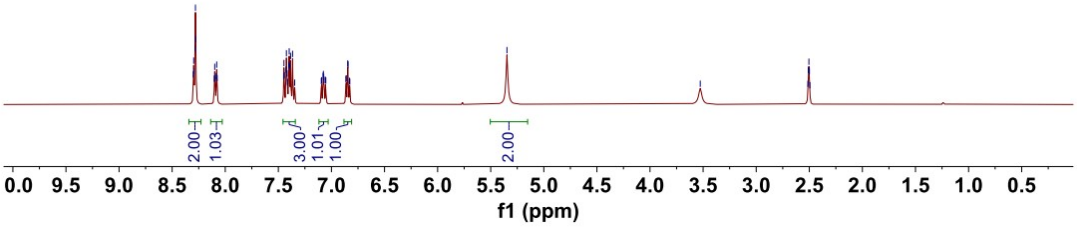


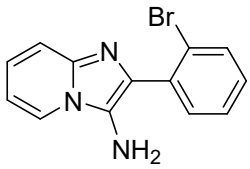
2l (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



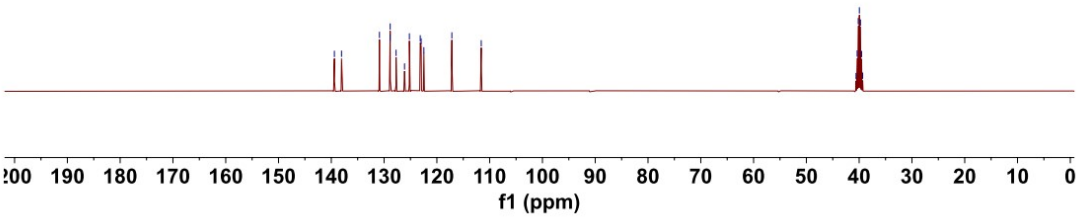


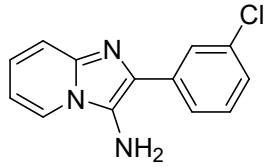
2m (^{1}H NMR) (400 MHz,DMSO-d_6)



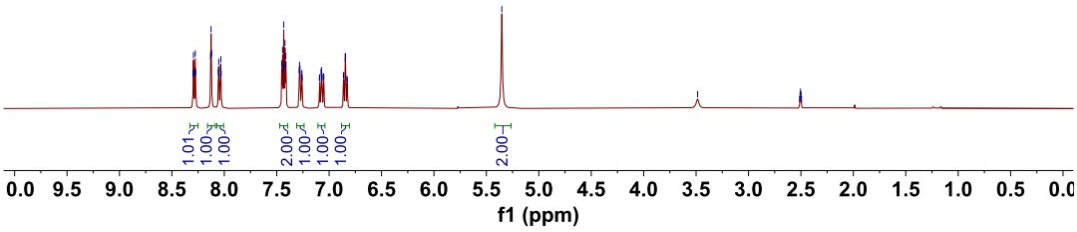


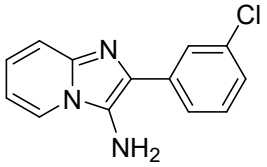
2m (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



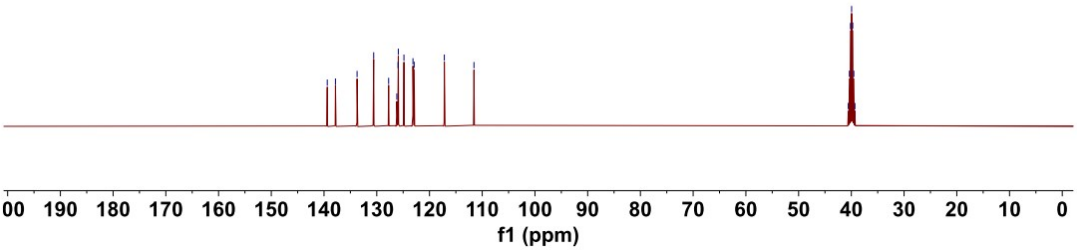


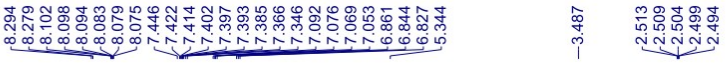
2n (^{1}H NMR) (400 MHz,DMSO-d_6)

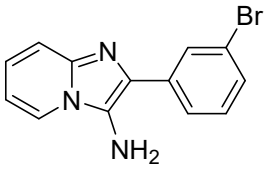




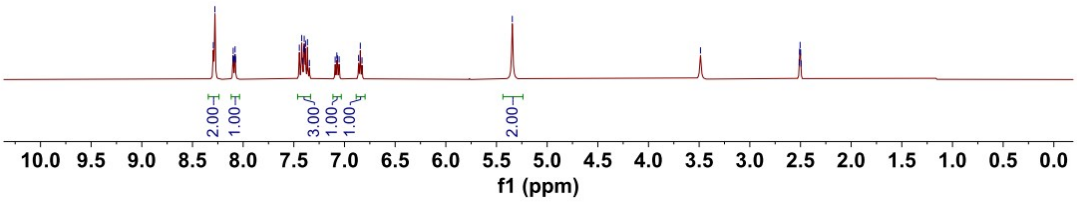
2n (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)

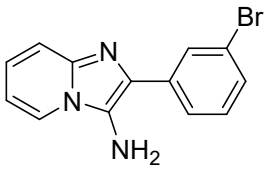




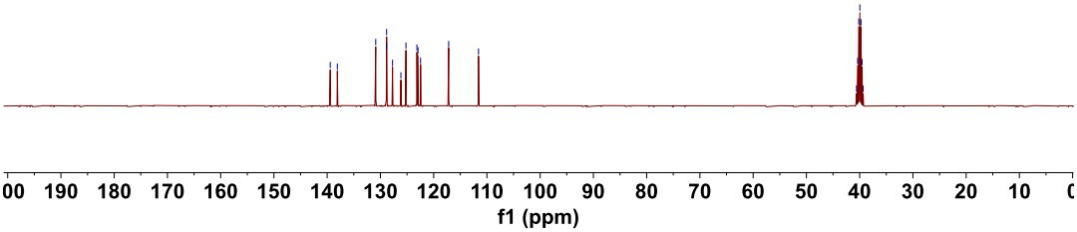


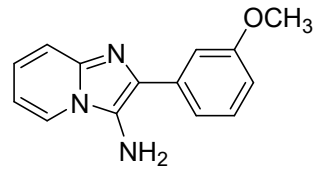
2o (^{1}H NMR) (400 MHz,DMSO-d_6)



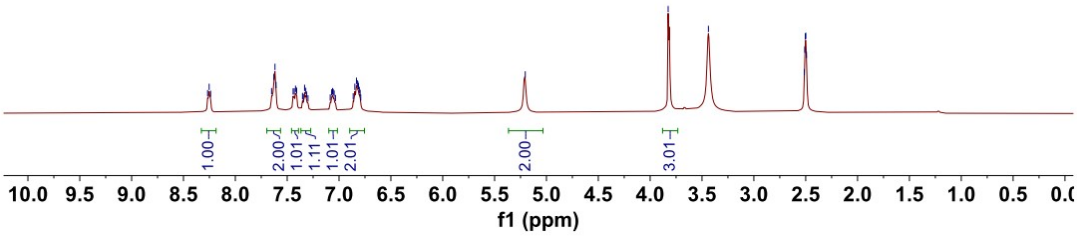


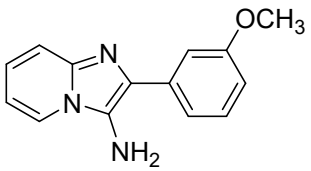
2o (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



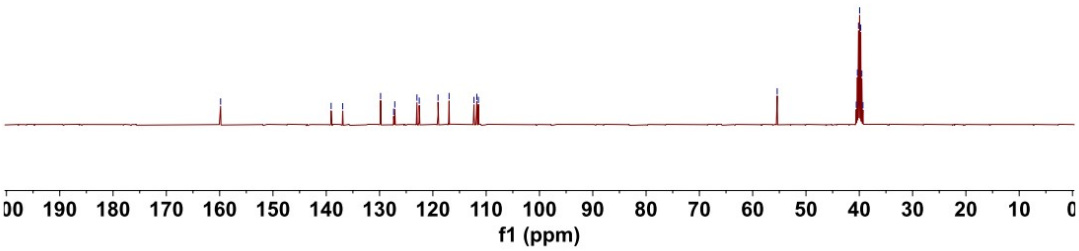


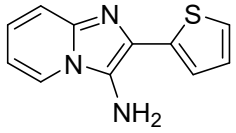
2p (^{1}H NMR) (400 MHz,DMSO-d_6)



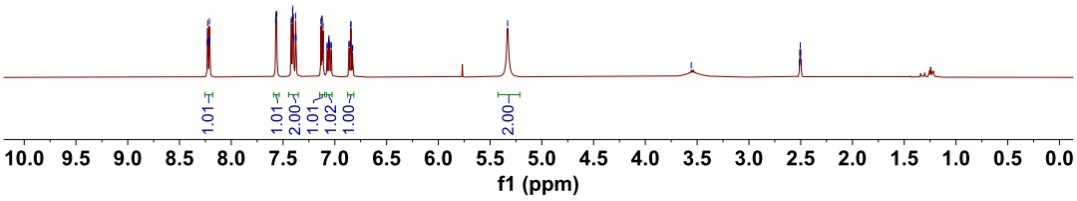


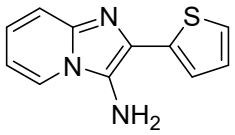
2p (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



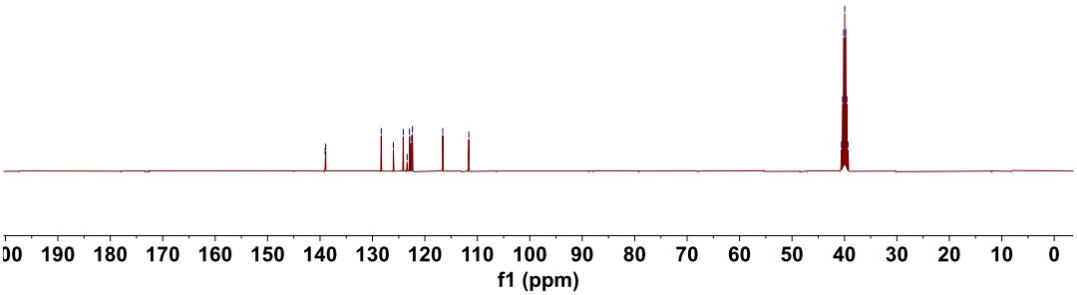


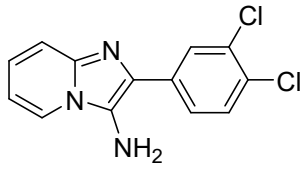
2q (^{1}H NMR) (400 MHz,DMSO-d_6)





2q (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)





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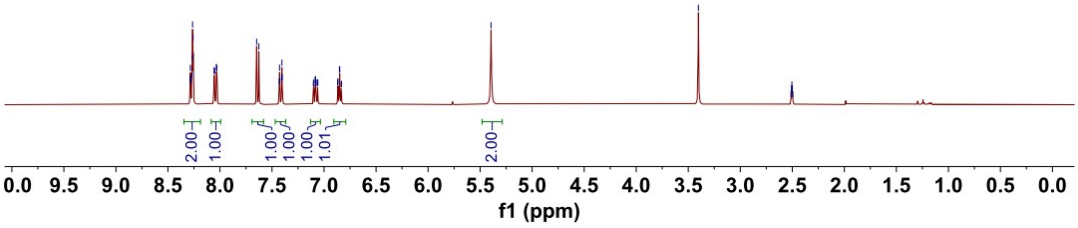
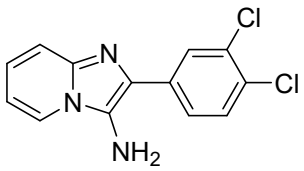
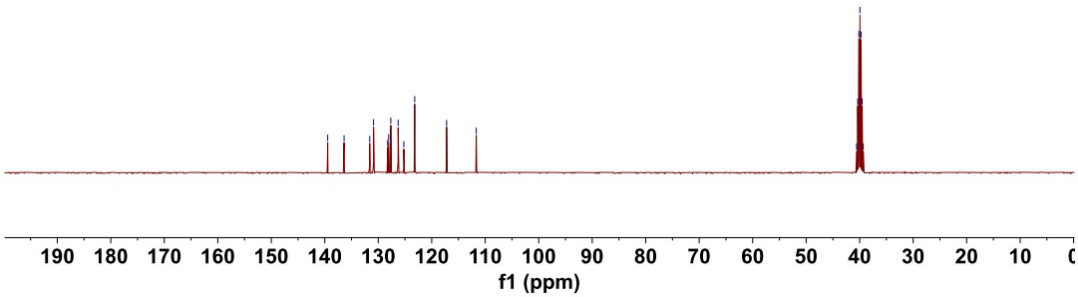
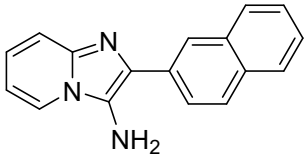


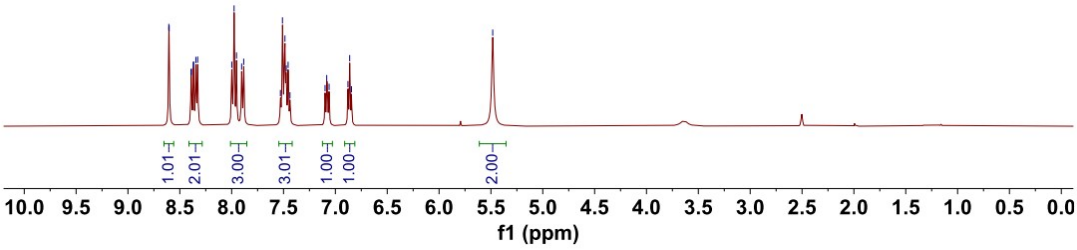


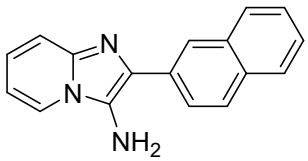
2r (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



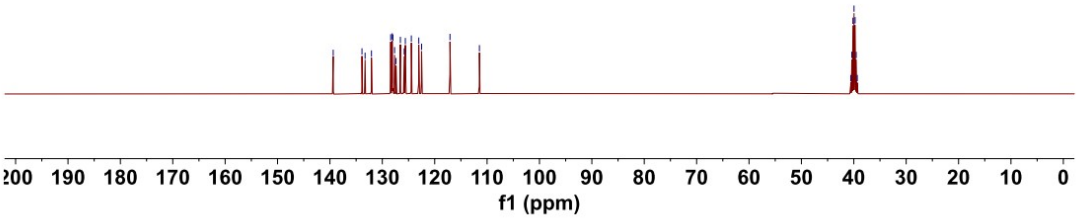


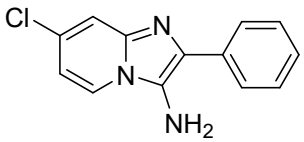
2s (^{1}H NMR) (400 MHz,DMSO-d_6)



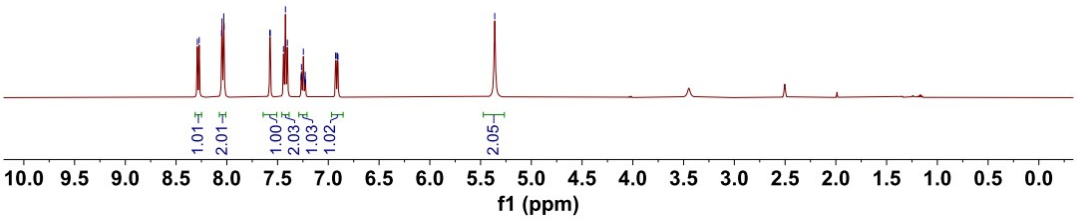


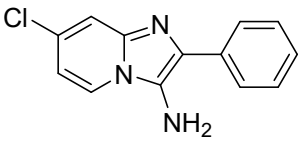
2s (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



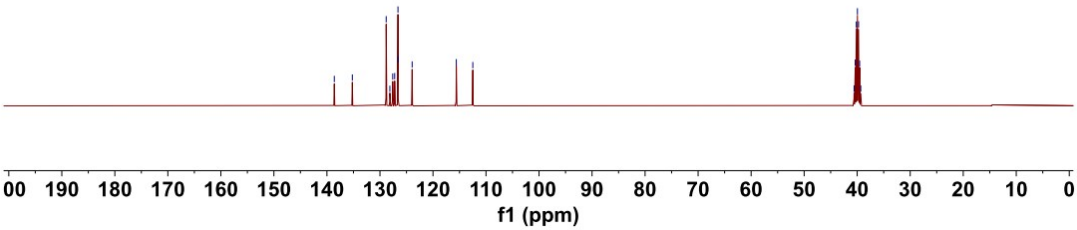


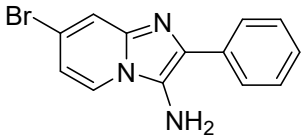
2t (^{1}H NMR) (400 MHz,DMSO-d_6)



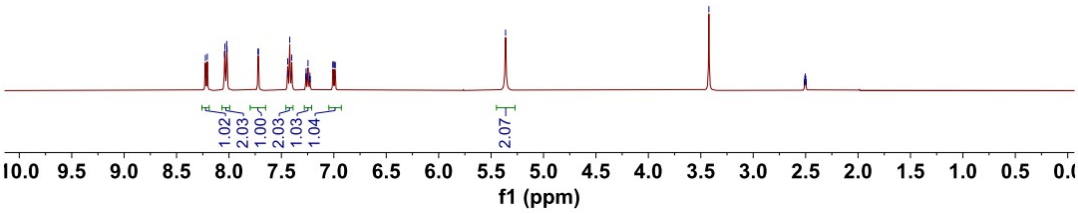


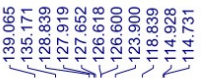
2t (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)

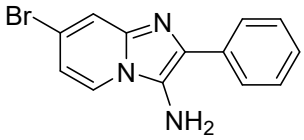




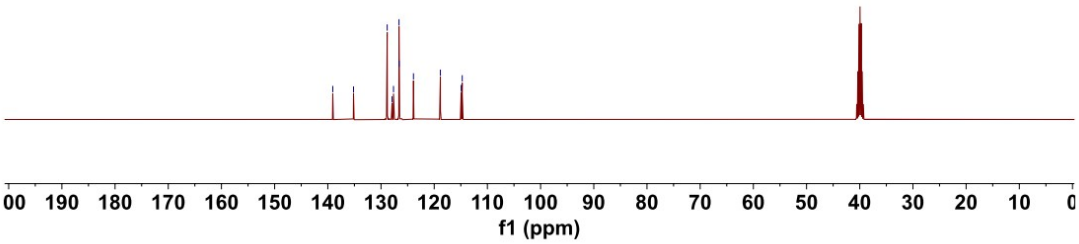
2u (^{1}H NMR) (400 MHz,DMSO-d_6)

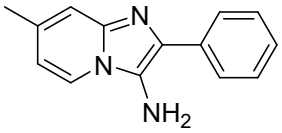




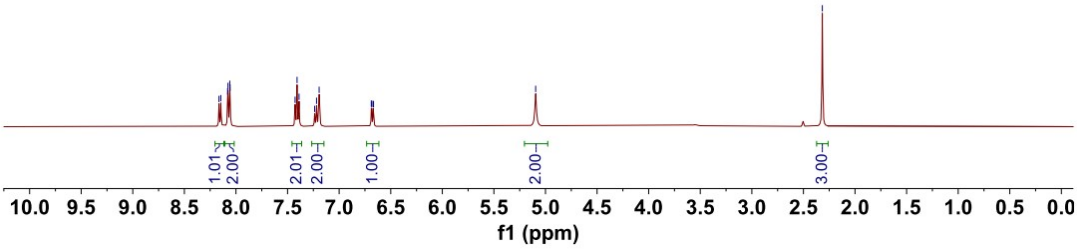


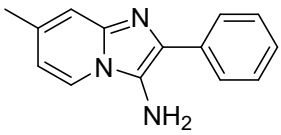
2u (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



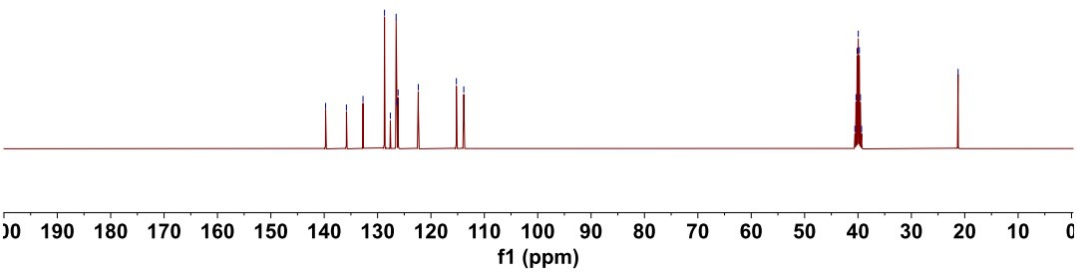


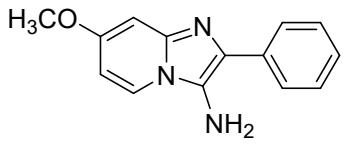
2v (^{1}H NMR) (400 MHz,DMSO-d_6)



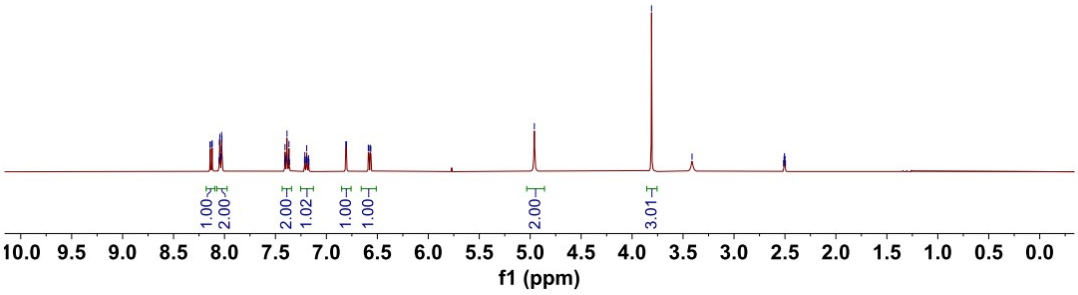


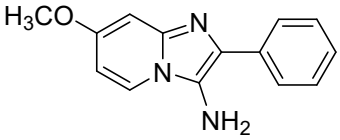
2v (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



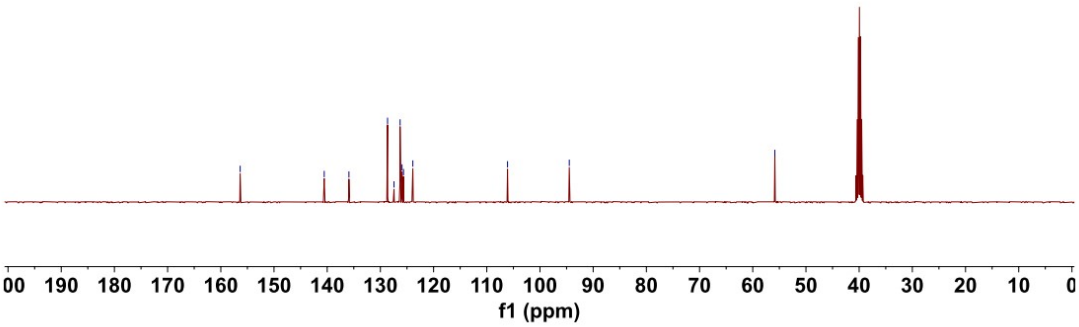


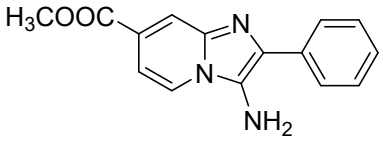
2w (^{1}H NMR) (400 MHz,DMSO-d_6)



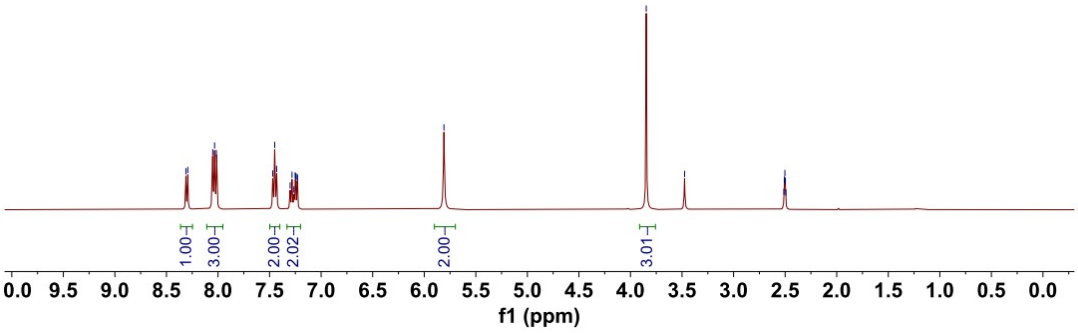


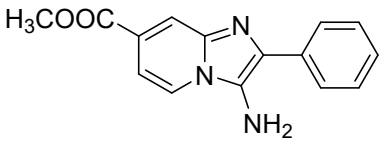
2w (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



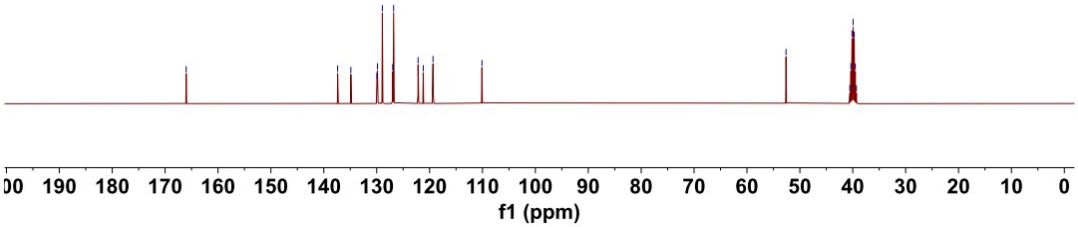


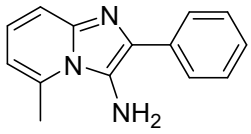
2x (^{1}H NMR) (400 MHz,DMSO-d_6)



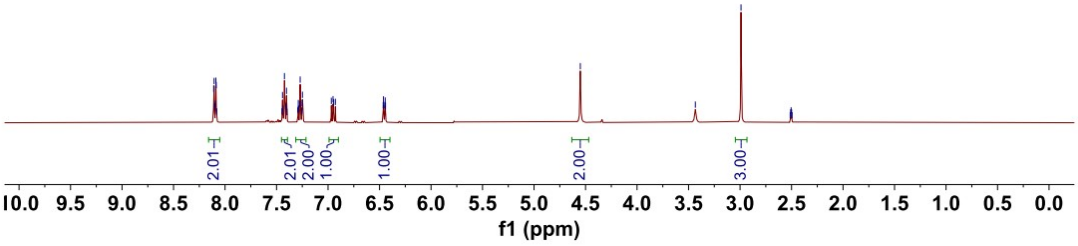


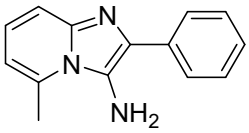
2x (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



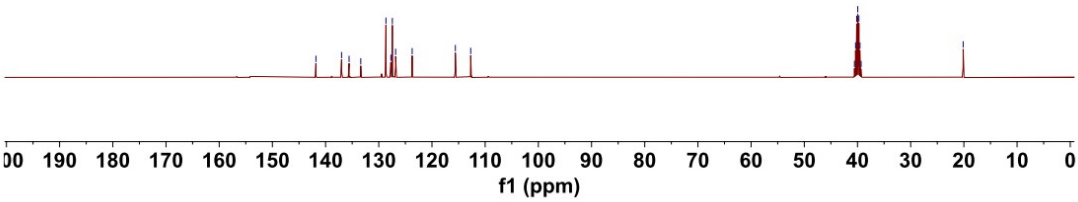


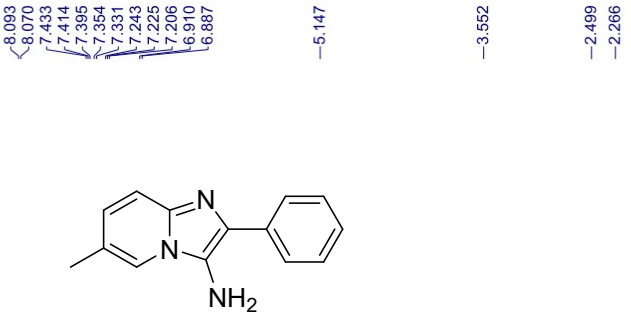
2y (^{1}H NMR) (400 MHz,DMSO-d_6)



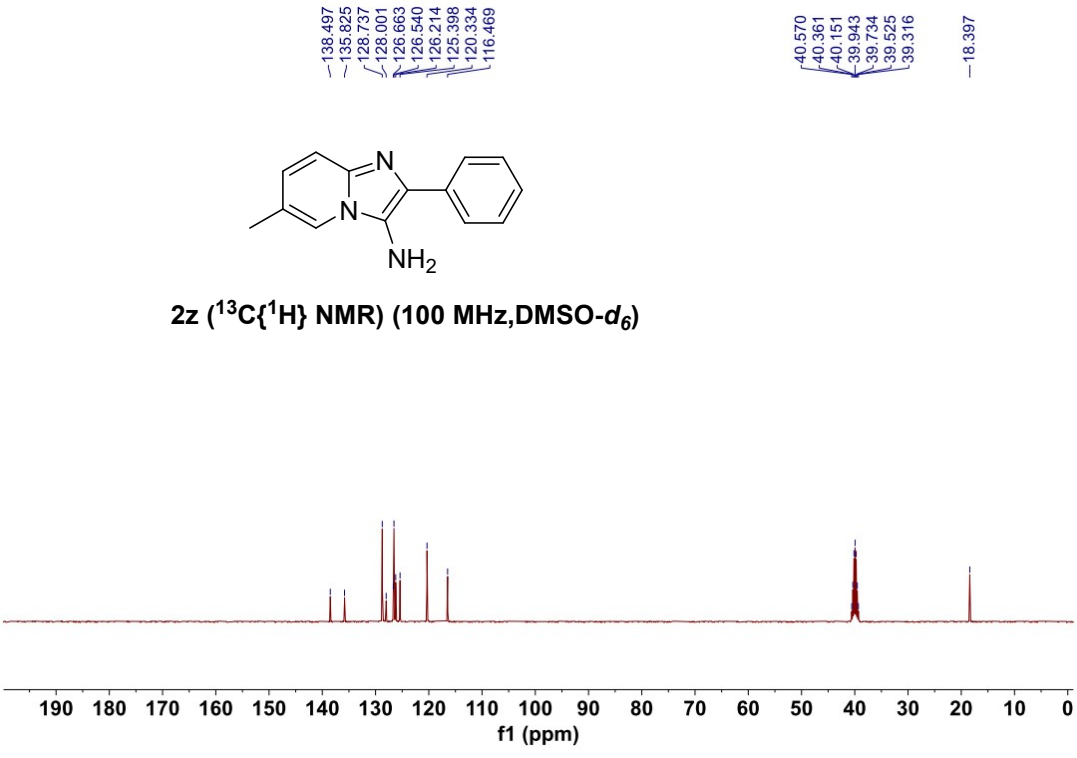


2y (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)

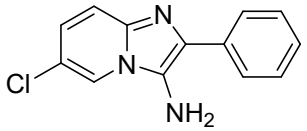




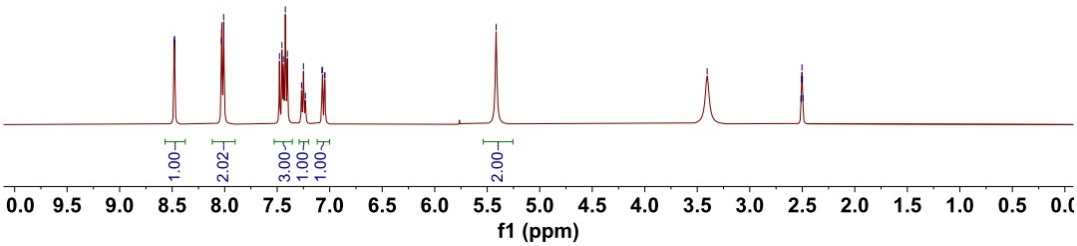
2z (^{1}H NMR) (400 MHz,DMSO-d_6)

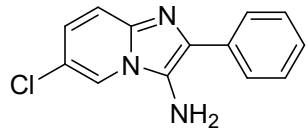


2z (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)

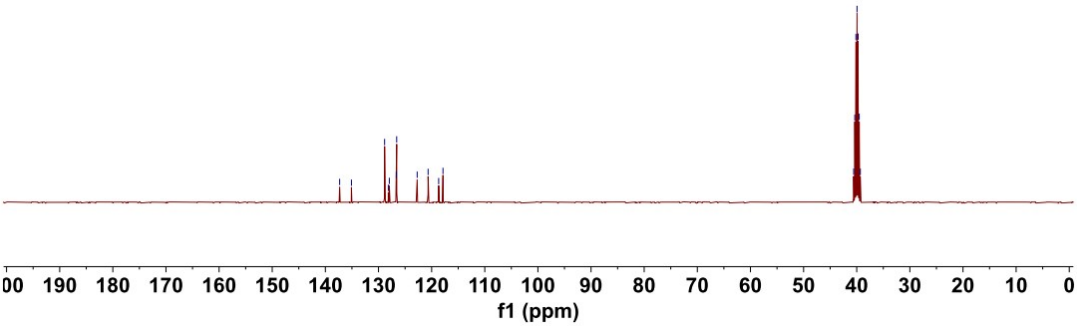


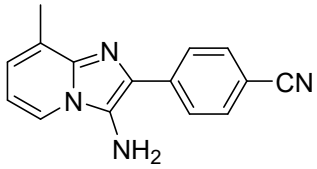
2aa (^{1}H NMR) (400 MHz,DMSO-d_6)



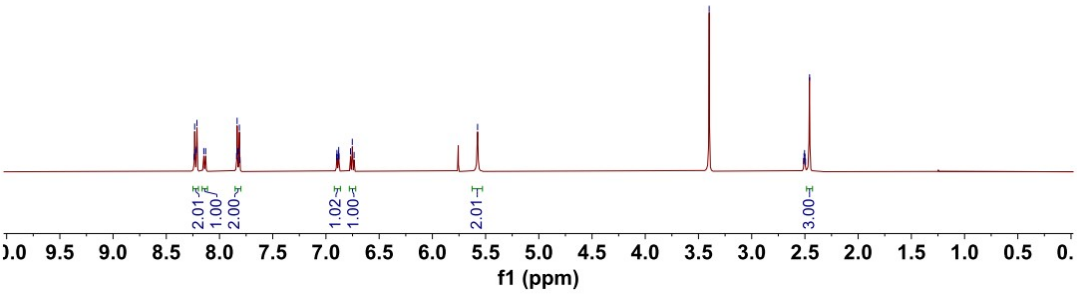


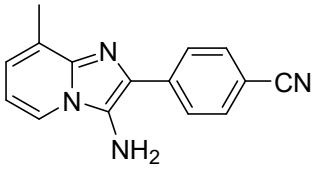
2aa (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



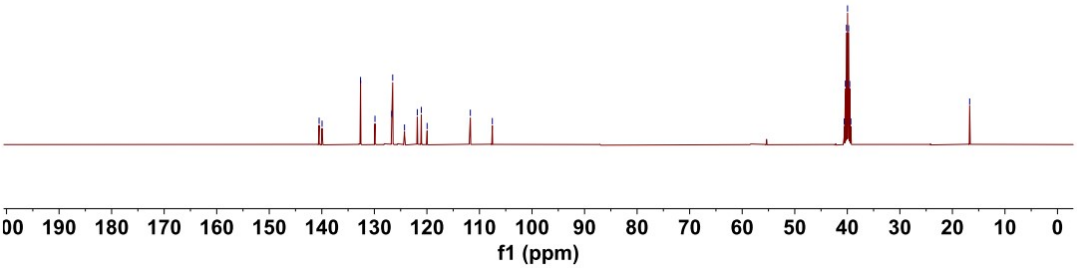


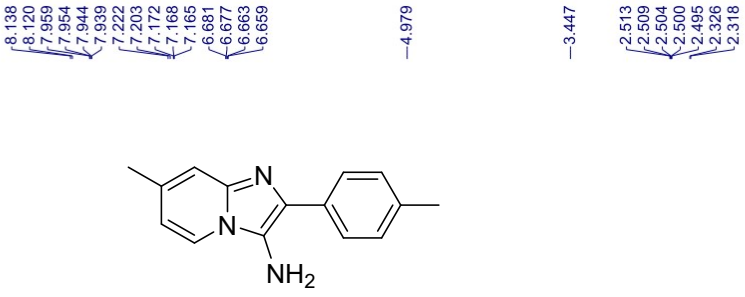
2ab (^{1}H NMR) (400 MHz,DMSO-d_6)



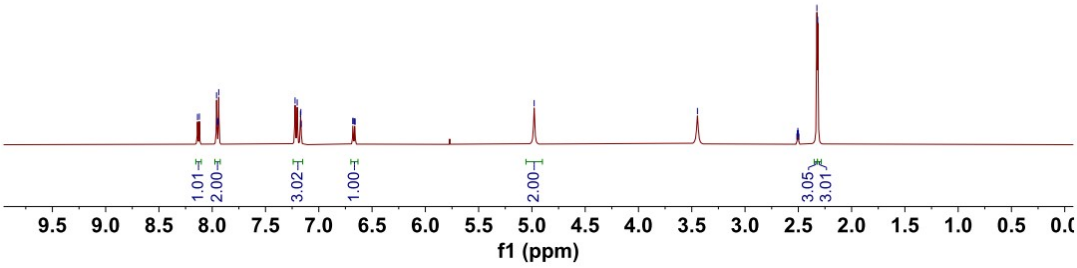


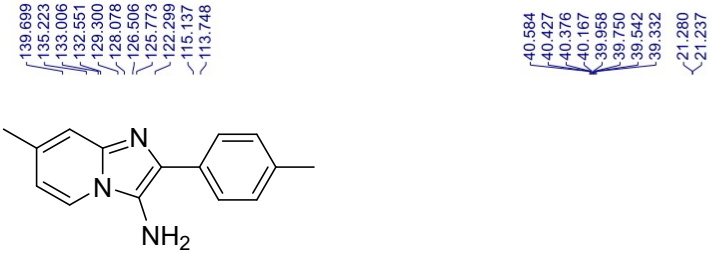
2ab (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



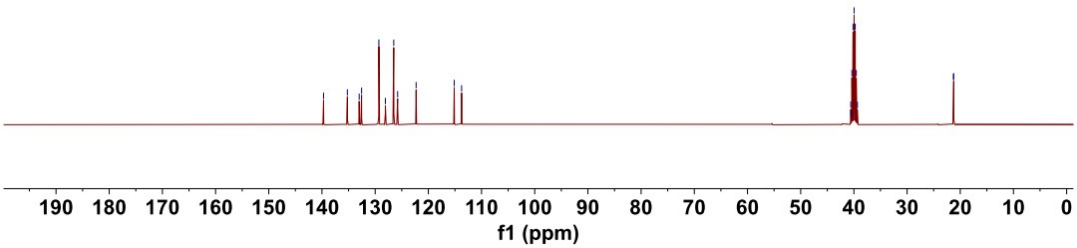


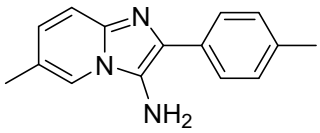
2ac (^{1}H NMR) (400 MHz,DMSO-d_6)



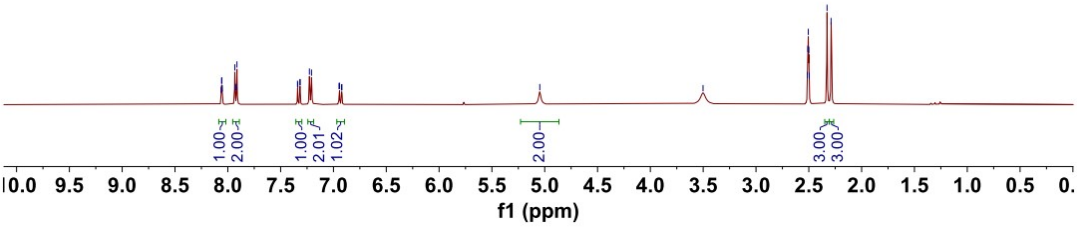


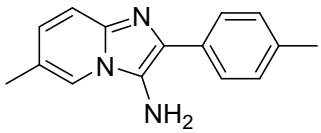
2ac (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



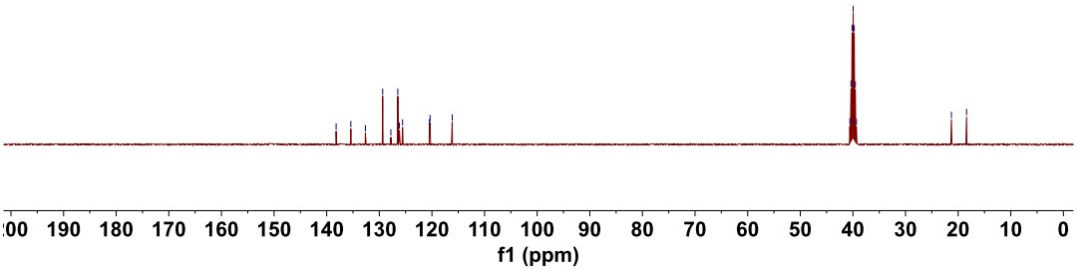


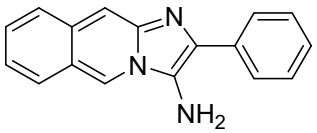
2ad (^{1}H NMR) (400 MHz,DMSO-d_6)



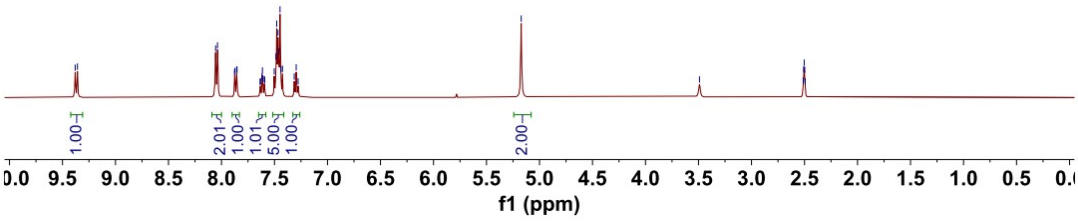


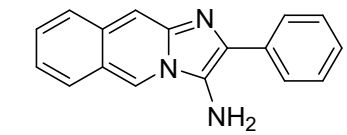
2ad (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)



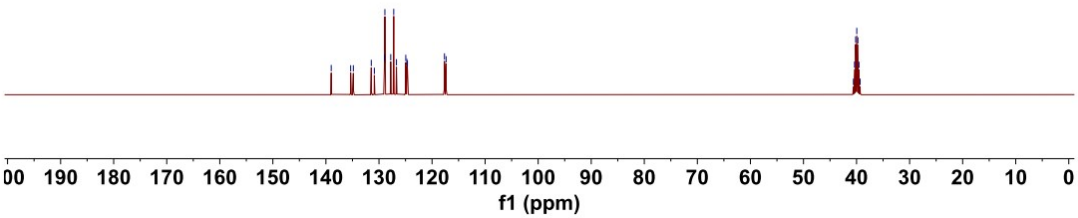


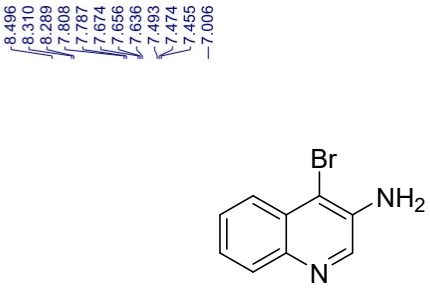
2ae (^{1}H NMR) (400 MHz,DMSO-d_6)



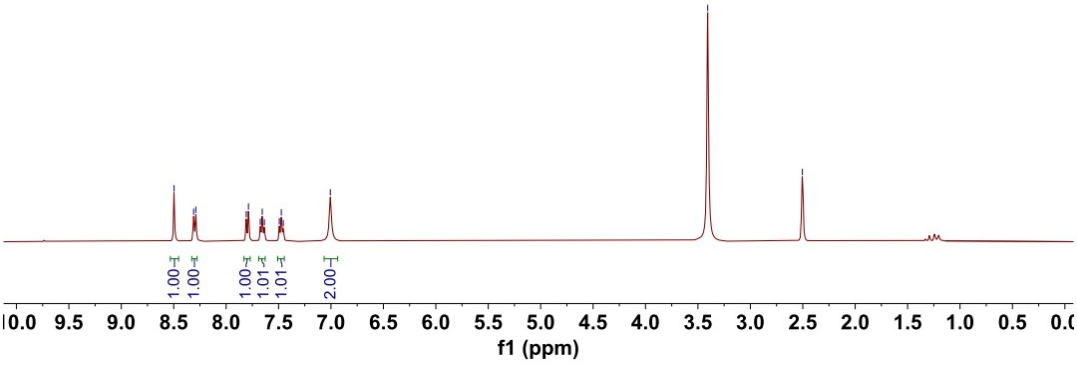


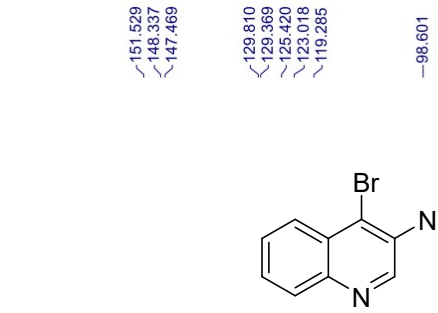
2ae (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)





2af (^{1}H NMR) (400 MHz,DMSO-d_6)





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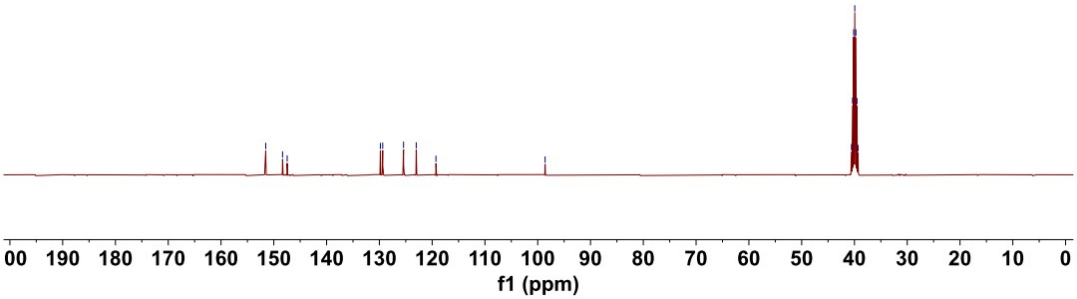
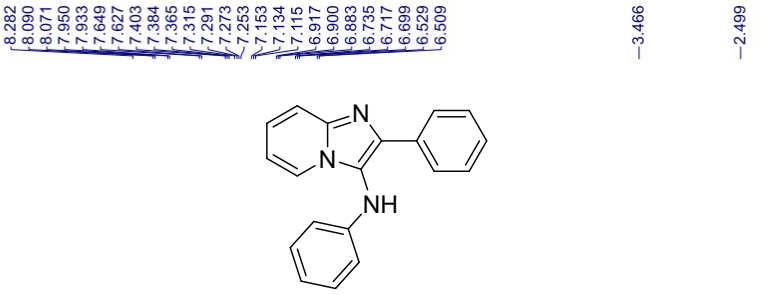
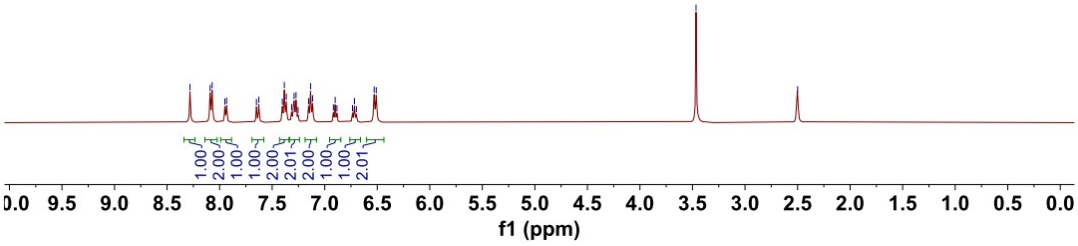
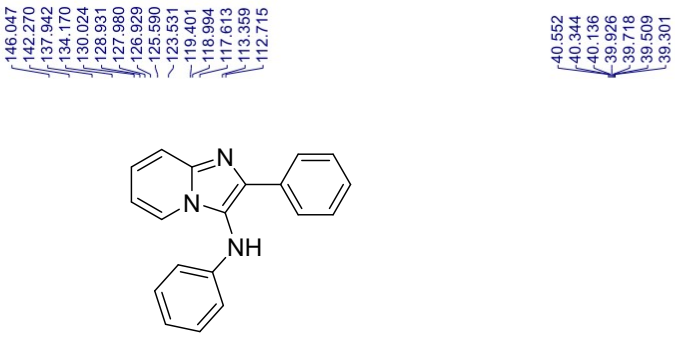




3a (^{1}H NMR) (400 MHz,DMSO-d_6)





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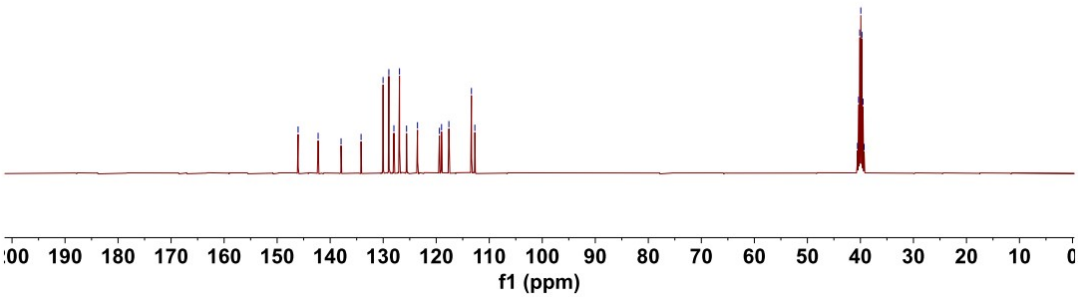
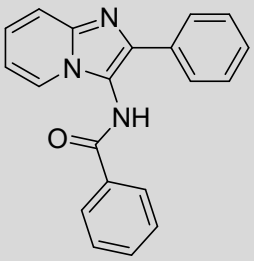
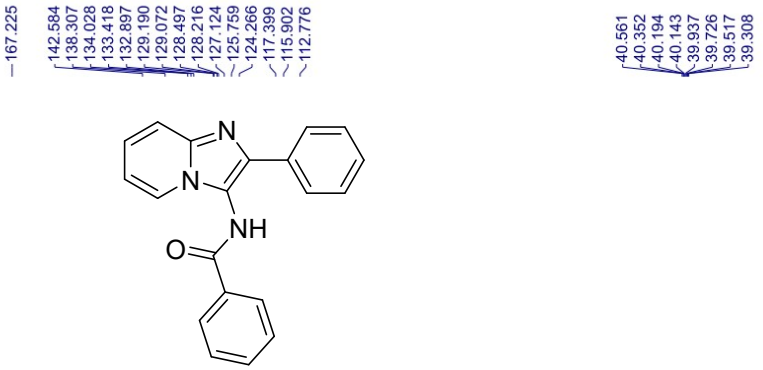




3b (^{1}H NMR) (400 MHz,DMSO-d_6)



3b (^{13}C{^{1}H} NMR) (100 MHz,DMSO-d_6)