Supplementary Information

Visible-light-induced catalyst-free reductive coupling of aldehydes, ketones, and imines with cyanopyridines

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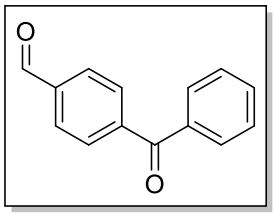
I. General Methods

All reagents and solvents were purchased from commercial sources and used without further purification unless otherwise stated. Silica gel (300-400 mesh) was used for flash column chromatograph. Preparative thin-layer chromatography (TLC) and flash column chromatograph were used to obtain purified products that are suitable for NMR spectroscopic characterization. Chloroform, acetone, dichloromethane, methanol, diethyl ether, acetonitrile, petroleum ether, tetrahydrofuran, ethyl acetate, hexane, toluene, and triethylamine were used as the eluents, and the ratio of volume were provided. The NMR yields were determined using ^{1}H NMR analysis (^{1}H NMR spectra were recorded with D1 = 10 s to ensure reproducibility in the quantification of crude NMR yields) of the crude mixture with dibromomethane as the internal standard. ^{1}H, ^{19}F and ^{13}C NMR spectra obtained using a Bruker AVANCE III 400 (^{1}H 400 MHz, ^{13}C 101 MHz), Bruker AVANCE III HD 400 (^{1}H 400 MHz, ^{13}C 101 MHz, ^{19}F 376 MHz), JEOL JNM-ECS 400M (^{1}H 400 MHz, ^{13}C 101 MHz, ^{19}F 376 MHz), Bruker AVANCE NEO 600 (^{1}H 600 MHz, ^{13}C 151 MHz), and Agilent INOVA 600 (^{1}H 600 MHz, ^{13}C 151 MHz). Chemical shifts of ^{1}H NMR spectra were reported using either a residual solvent signal or TMS (δ = 0.00 ppm) as an internal standard. Chemical shifts of ^{13}C NMR spectra were reported using the solvent signal of $CDCl_3$ (δ = 77.16 ppm), DMSO-d_6 (δ = 39.52 ppm) or MeOH-d_4 (δ = 49.00 ppm) as an internal standard. Chemical shifts of ^{19}F NMR spectra were reported using $CFCl_3$ (δ = 0.00 ppm) as an internal standard. HR-MS analyses were performed with Thermo Fisher Scientific Q Exactive LC-MS/MS (ESI and APCI) and Agilent 1290 Infinity II UHPLC-IM-QTOF (ESI). Diastereomeric ratio (dr) values were determined by chiral HPLC with chiral AD-H, OD-H columns with hexane and *i*-PrOH as solvents.

II. General procedures for preparation of starting materials

1. General procedures for preparation of complex aldehydes

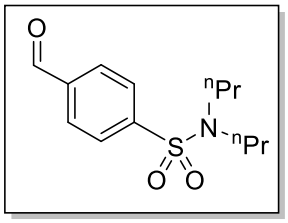


4-Benzoylbenzaldehyde (2n)

The synthesis of starting material **2n** was following the procedure according to literature[1]. Data was consistent with literature precedent[2].

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.13 (s, 1H), 8.00 (d, *J* = 8.0 Hz, 2H), 7.92 (d, *J* = 8.0 Hz, 2H), 7.85 – 7.76 (m, 2H), 7.63 (t, *J* = 7.5 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 195.9, 191.7, 142.7, 138.6, 136.8, 133.2, 130.4, 130.2, 129.6, 128.6.

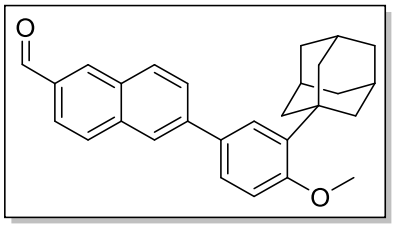


4-Formyl-*N*,*N*-dipropylbenzenesulfonamide (2aa)

The synthesis of starting material **2aa** was following the procedure according to literature[1]. Data was consistent with literature precedent[1].

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.11 (s, 1H), 8.09 – 7.92 (m, 4H), 3.19 – 3.02 (m, 4H), 1.56 (h, *J* = 7.4 Hz, 4H), 0.88 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 191.0, 145.5, 138.6, 130.2, 127.6, 49.9, 21.9, 11.1.



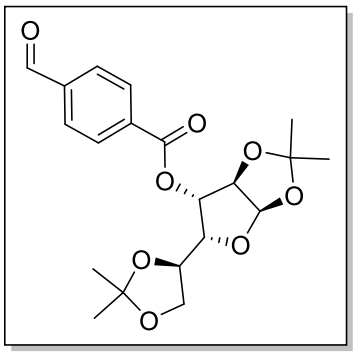
6-(3-((3*r*,5*r*,7*r*)-Adamantan-1-yl)-4-methoxyphenyl)-2-naphthaldehyde (2ac)

The synthesis of starting material **2ac** was following the procedure according to literature[1]. Data was consistent with literature precedent[1].

^{1}H NMR (600 MHz, $CDCl_3$) δ 10.15 (s, 1H), 8.33 (s, 1H), 8.06 – 8.01 (m, 2H), 7.96 (s, 2H), 7.83 (dd, *J* = 8.5, 1.8 Hz, 1H), 7.61 (d, *J* = 2.4 Hz, 1H), 7.55 (dd, *J* = 8.4, 2.3 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 1H), 3.90 (s, 3H), 2.19 (d, *J* = 2.9 Hz, 6H), 2.11 (s, 3H), 1.81 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 192.3, 159.3, 142.5, 139.3, 137.1, 134.4, 133.9, 132.5, 131.5, 130.0, 129.3, 127.0, 126.1, 125.9, 125.1, 123.3, 112.3, 55.3, 40.8, 37.4, 37.3, 29.3.

The synthesis of starting materials **2ab, 2ad and 2ae** were following the general according to literature[3].

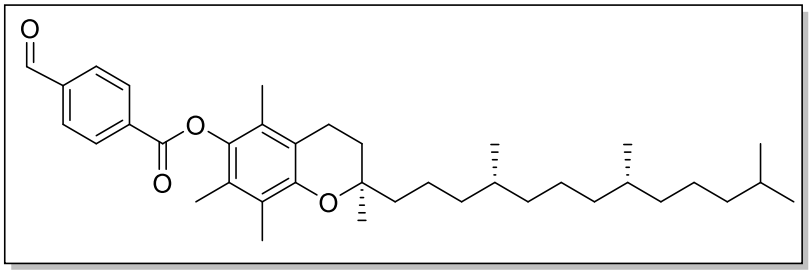


(3a*R*,5*R*,6*S*,6a*R*)-5-((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-6-yl 4-formylbenzoate (2ab)

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.13 (s, 1H), 8.21 (d, *J* = 8.5 Hz, 2H), 8.04 – 7.98 (m, 2H), 5.89 (d, *J* = 4.1 Hz, 1H), 5.35 (t, *J* = 6.0 Hz, 1H), 4.96 (dd, *J* = 5.8, 4.2 Hz, 1H), 4.76 (dd, *J* = 15.4, 6.9 Hz, 1H), 4.23 – 4.12 (m, 2H), 3.67 (t, *J* = 7.8 Hz, 1H), 1.52 (s, 3H), 1.47 (s, 3H), 1.43 (s, 3H), 1.35 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 191.5, 164.7, 139.8, 134.1, 130.5, 129.8, 115.2, 109.8, 105.3, 81.1, 79.3, 75.2, 73.0, 66.5, 27.1, 26.8, 25.5.

HRMS (ESI, m/z) Calcd. for $C_{20}H_{24}NaO_8^+$ $[M+Na]^+$: 415.1363; Found: 415.1364.

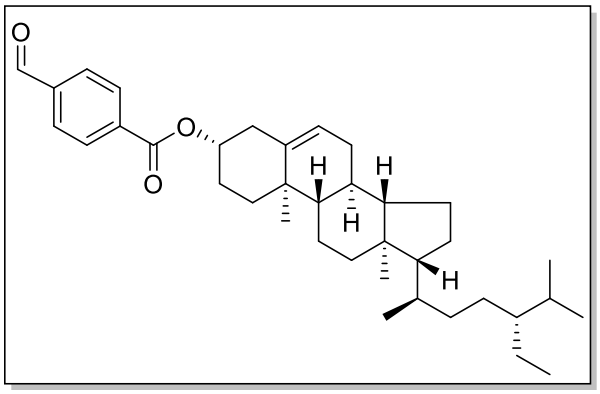


(*R*)-2,5,7,8-Tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl 4-formylbenzoate (2ad)

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.15 (s, 1H), 8.41 (d, *J* = 8.0 Hz, 2H), 8.03 (d, *J* = 8.2 Hz, 2H), 2.62 (t, *J* = 6.8 Hz, 2H), 2.13 (s, 3H), 2.06 (s, 3H), 2.02 (s, 3H), 1.89 – 1.67 (m, 2H), 1.63 – 1.01 (m, 24H), 0.86 (t, *J* = 6.5 Hz, 12H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 191.7, 164.3, 149.9, 140.7, 139.7, 134.8, 130.9, 129.8, 126.8, 125.1, 123.5, 117.8, 75.3, 39.5, 37.61, 37.58, 37.4, 33.0, 32.9, 28.1, 24.9, 24.6, 22.9, 22.8, 21.2, 20.8, 19.9, 19.8, 13.2, 12.4, 12.0.

HRMS (ESI, m/z) Calcd. for $C_{37}H_{54}NaO_4^+$ $[M+Na]^+$: 585.3914; Found: 585.3915.



(3*S*,8*S*,9*S*,10*R*,13*R*,14*S*,17*R*)-17-((2*R*,5*R*)-5-Ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1*H*-cyclopenta[*a*]phenanthren-3-yl 4-formylbenzoate (2ae)

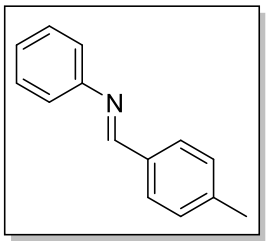
^{1}H NMR (400 MHz, $CDCl_3$) 10.10 (s, 1H), 8.19 (d, *J* = 8.0 Hz, 2H), 7.94 (d, *J* = 7.9 Hz, 2H), 5.43 (s, 1H), 4.89 (d, *J* = 10.2 Hz, 1H), 2.48 (d, *J* = 8.4 Hz, 2H), 2.11 – 0.34 (m, 46H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 191.8, 165.1, 139.6, 139.2, 136.0, 130.3, 129.6, 123.2, 75.5, 56.9, 56.2, 50.2, 46.0, 42.5, 39.9, 38.3, 37.2, 36.8, 36.3, 34.1, 33.9, 32.1, 32.0, 29.3, 28.4, 28.0, 26.3, 24.5, 23.2, 21.2, 20.0, 19.5, 19.2, 18.9, 12.1, 12.0.

HRMS (APCI, m/z) Calcd. for $C_{37}H_{55}O_3^+$ $[M+H]^+$: 547.4146; Found: 547.4140.

2. General procedures for preparation of imines

In accordance with the literature known procedure[4], aniline (10 mmol) was added to a solution of corresponding aldehyde (10 mmol) in toluene (15 mL). To this, acetic acid (10 μL) was added, and the solution was allowed to reflux in toluene with removal of water via Dean-Stark trap under detected by TLC. After cooling, the toluene was removed under vacuum to obtain the pure imine.



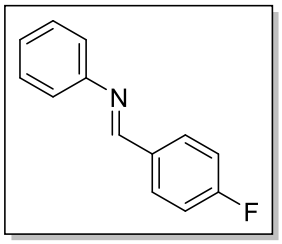
(*E*)-*N*-Phenyl-1-(*p*-tolyl)methanimine (4b)

Prepared according to the general procedure using 4-methylbenzaldehyde (1.12 mL, 10 mmol) and aniline (915 μL, 10 mmol) to afford the imine **4b** (1.89 g) as a pale-brown solid. The purity of **4b** was detected by ^{1}H NMR data and it can be used directly

without further purify. Data was consistent with literature precedent.[5]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (s, 1H), 7.71 (d, *J* = 7.8 Hz, 2H), 7.29 (t, *J* = 7.7 Hz, 2H), 7.13 (t, *J* = 7.3 Hz, 5H), 2.26 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.0, 152.0, 141.5, 133.5, 129.3, 129.0, 128.7, 125.6, 120.8, 21.4.



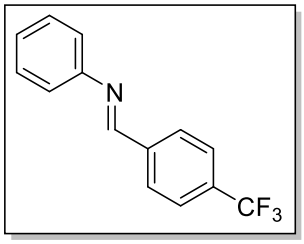
(*E*)-1-(4-Fluorophenyl)-*N*-phenylmethanimine (4c)

Prepared according to the general procedure using 4-fluorobenzaldehyde (1.08 mL, 10 mmol) and aniline (915 μL, 10 mmol) to afford the imine **4c** (2.02 g) as a pale-brown solid. The purity of **4c** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[6]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (s, 1H), 7.85 (dd, *J* = 8.6, 5.6 Hz, 2H), 7.40 – 7.31 (m, 2H), 7.24 – 7.14 (m, 3H), 7.13 – 7.05 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 164.7 (d, *J* = 252.0 Hz), 158.8, 151.8, 132.6 (d, *J* = 3.0 Hz), 130.8 (d, *J* = 8.7 Hz), 129.2, 126.1, 120.9, 115.9 (d, *J* = 22.0 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -108.36 – -108.58 (m).



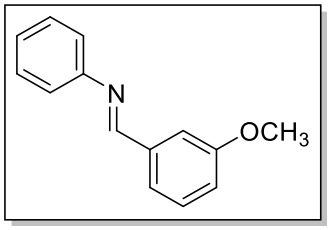
(*E*)-*N*-Phenyl-1-(4-(trifluoromethyl)phenyl)methanimine (4d)

Prepared according to the general procedure using 4-(trifluoromethyl)benzaldehyde (1.37 mL, 10 mmol) and aniline (915 μL, 10 mmol) to afford the imine **4d** (2.72 g) as a white solid. The purity of **4d** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[7]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (s, 1H), 7.96 (d, *J* = 8.0 Hz, 2H), 7.67 (d, *J* = 8.1 Hz, 2H), 7.42 – 7.34 (m, 2H), 7.28 – 7.18 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.6, 151.4, 139.4, 132.8 (q, *J* = 32.5 Hz), 129.4, 129.0, 126.7, 125.8 (q, *J* = 3.8 Hz), 124.0 (q, *J* = 272.4 Hz), 121.0.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.22(s).

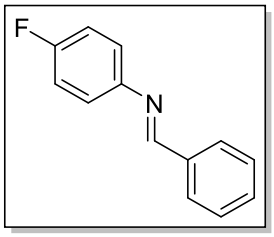


(*E*)-1-(3-Methoxyphenyl)-*N*-phenylmethanimine (4e)

Prepared according to the general procedure using 3-methoxybenzaldehyde (1.22 mL, 10 mmol) and aniline (915 μL, 10 mmol) to afford the imine **4e** (1.63 g) as a yellow oil. The purity of **4e** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[7]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (s, 1H), 7.54 – 7.49 (m, 1H), 7.41 – 7.30 (m, 4H), 7.26 – 7.16 (m, 3H), 7.06 – 6.98 (m, 1H), 3.84 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.2, 159.9, 151.9, 137.6, 129.7, 129.1, 126.0, 122.3, 120.9, 118.2, 111.7, 55.3.



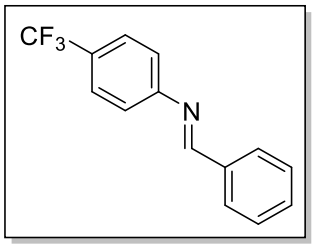
(*E*)-*N*-(4-Fluorophenyl)-1-phenylmethanimine (4f)

Prepared according to the general procedure using benzaldehyde (1.02 mL, 10 mmol) and 4-fluoroaniline (950 μL, 10 mmol) to afford the imine **4f** (1.55 g) as a pale-yellow solid. The purity of **4f** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[8]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (s, 1H), 7.91 – 7.81 (m, 2H), 7.50 – 7.36 (m, 3H), 7.23 – 7.11 (m, 2H), 7.10 – 6.98 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.3 (d, *J* = 244.5 Hz), 160.3, 148.1 (d, *J* = 2.9 Hz), 136.2, 131.6, 128.89, 128.92, 122.4 (d, *J* = 8.2 Hz), 116.0 (d, *J* = 22.5 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -117.70 – -117.83 (m).



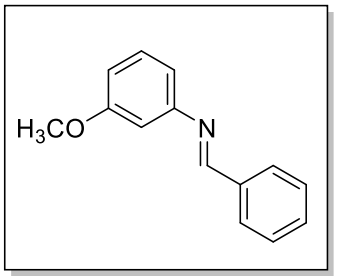
(*E*)-1-Phenyl-*N*-(4-(trifluoromethyl)phenyl)methanimine (4g)

Prepared according to the general procedure using benzaldehyde (1.02 mL, 10 mmol) and 4-(trifluoromethyl)aniline (1.26 mL, 10 mmol) to afford the imine **4g** (2.44 g) as a white solid. The purity of **4g** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[9]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (s, 1H), 7.96 – 7.87 (m, 2H), 7.65 (d, *J* = 8.2 Hz, 2H), 7.57 – 7.45 (m, 3H), 7.25 (d, *J* = 8.1 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.1, 155.3 (q, *J* = 2.8, 1.2 Hz), 135.8, 132.1, 129.2, 129.0, 127.8 (q, *J* = 32.7 Hz), 126.5 (q, *J* = 3.7 Hz), 124.5 (q, *J* = 271.7 Hz), 121.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.48 (s).



(*E*)-*N*-(3-Methoxyphenyl)-1-phenylmethanimine (4h)

Prepared according to the general procedure using benzaldehyde (1.02 mL, 10 mmol) and 3-methoxyaniline (1.12 mL, 10 mmol) to afford the imine **4h** (2.11 g) as a dark-brown liquid. The purity of **4h** was detected by ^{1}H NMR data and it can be used directly without further purify. Data was consistent with literature precedent.[10]

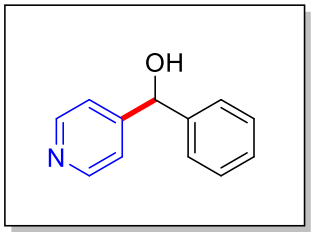
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.91 – 7.82 (m, 2H), 7.48 – 7.39 (m, 3H), 7.30 – 7.22 (m, 1H), 6.80 – 6.74 (m, 3H), 3.78 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.5, 160.3, 153.5, 136.1, 131.5, 129.9, 128.9, 128.8, 112.9, 111.8, 106.7, 55.3.

III. General procedures for coupling of aldehydes, ketones, and imines with cyanopyridines

1. General procedures for coupling of aldehydes, ketones with cyanopyridines

The cyanopyridine **1** (0.2 mmol), aldehyde or ketone **2** (0.25 mmol), Hantzsch ester (0.28 mmol) and tetrahydrofuran (1.0 mL) were added to a 20 mL tube with a magnetic stir-bar. Then the tube was evacuated by three freeze-pump-thaw cycles and back-filled with ultra-purified argon. The reaction mixture was stirred at room temperature under 405 nm (3 W × 2) LED for 3 h. The crude product was purified by preparative TLC or flash column chromatograph to afford the pure product (see each compound for detail).

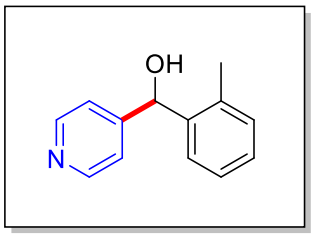


Phenyl(pyridin-4-yl)methanol (3a)

Prepared according to the general procedure described above by using 4-cyanopyridine **1a** (0.2 mmol) and benzaldehyde **2a** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : acetone = 3 : 1) to afford the corresponding **3a** as a white solid (36.7 mg, 99% yield). Data was consistent with literature precedent.[11]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 5.1 Hz, 2H), 7.40 – 7.28 (m, 7H), 5.79 (s, 1H), 3.21 (br, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 152.8, 149.8, 142.9, 129.0, 128.4, 127.0, 121.4, 75.1.



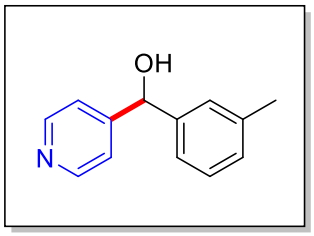
Pyridin-4-yl(*o*-tolyl)methanol (3b)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 2-methylbenzaldehyde **2b** (0.25 mmol) as substrates. The crude product was

purified by preparative TLC (chloroform : acetone = 3 : 1) to afford the corresponding **3b** as a pale-yellow solid (28.7 mg, 72% yield). Data was consistent with literature precedent.[12]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.42 (d, *J* = 4.6 Hz, 2H), 7.30 (dd, *J* = 7.0, 2.2 Hz, 1H), 7.27 (d, *J* = 5.0 Hz, 2H), 7.24 – 7.18 (m, 2H), 7.16 (dd, *J* = 6.8, 2.2 Hz, 1H), 5.98 (s, 1H), 2.30 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$)δ 152.9, 149.3, 140.7, 135.8, 131.0, 128.2, 127.4, 126.5, 121.9, 72.1, 19.5.

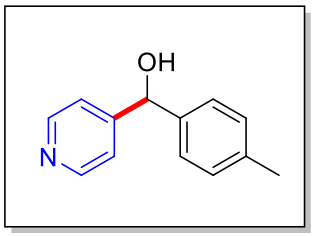


Pyridin-4-yl(*m*-tolyl)methanol (3c)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 3-methylbenzaldehyde **2c** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (petroleum ether : ethyl acetate = 1 : 4) to afford the corresponding **3c** as a white solid (28.3 mg, 71% yield). Data was consistent with literature precedent.[13]

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.51 – 8.44 (m, 2H), 7.37 (d, *J* = 6.0 Hz, 2H), 7.24 – 7.12 (m, 3H), 7.04 (d, *J* = 6.7 Hz, 1H), 6.11 (d, *J* = 4.0 Hz, 1H), 5.66 (d, *J* = 3.9 Hz, 1H), 2.26 (s, 3H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 154.2, 149.5, 144.4, 137.5, 128.3, 127.9, 127.0, 123.6, 121.2, 73.1, 21.1.



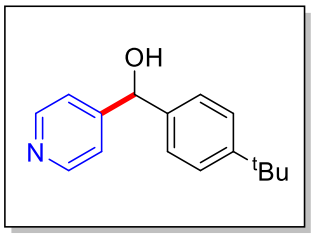
Pyridin-4-yl(*p*-tolyl)methanol (3d)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-methylbenzaldehyde **2d** (0.25 mmol) as substrates. The crude product was

purified by preparative TLC (dichloromethane : acetone = 3 : 1) to afford the corresponding **3d** as a pale-yellow solid (36.3 mg, 91% yield). Data was consistent with literature precedent.[14]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.48 (d, *J* = 5.0 Hz, 2H), 7.32 (d, *J* = 5.1 Hz, 2H), 7.22 (d, *J* = 7.6 Hz, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 5.76 (s, 1H), 2.33 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.6, 149.3, 140.2, 138.1, 129.5, 126.9, 121.5, 74.7, 21.2.

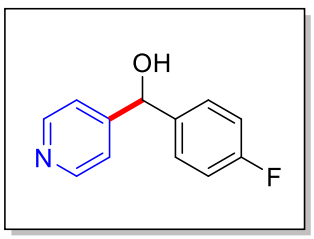


(4-(Tert-butyl)phenyl)(pyridin-4-yl)methanol (3e)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-tert-butylbenzaldehyde **2e** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (petroleum ether : ethyl acetate = 1 : 4 with 1% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3e** as a pale-yellow solid (35.2 mg, 73% yield). Data was consistent with literature precedent.[13]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.36 – 8.32 (m, 2H), 7.36 – 7.32 (m, 2H), 7.32 – 7.28 (m, 2H), 7.26 – 7.21 (m, 2H), 5.73 (s, 1H), 1.29 (s, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.6, 151.2, 149.4, 140.1, 126.7, 125.7, 121.5, 74.6, 34.6, 31.4.



(4-Fluorophenyl)(pyridin-4-yl)methanol (3f)

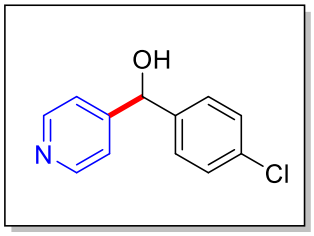
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-fluorobenzaldehyde **2f** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (dichloromethane : acetone = 3 : 1 with 1% triethylamine).

The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3f** as a white solid (33.3 mg, 82% yield). Data was consistent with literature precedent.[14]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.51 – 8.45 (m, 2H), 7.34 – 7.28 (m, 4H), 7.07 – 7.01 (m, 2H), 5.79 (s, 1H), 3.36 (br, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 162.6 (d, *J* = 246.7 Hz), 153.1, 149.6, 138.9 (d, *J* = 2.3 Hz), 128.7 (d, *J* = 8.1 Hz), 121.4, 115.8 (d, *J* = 21.6 Hz), 74.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -114.04 – -114.23 (m).

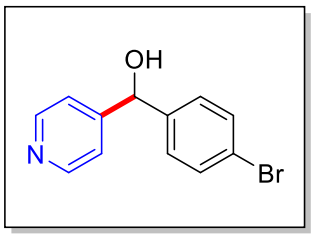


(4-Chlorophenyl)(pyridin-4-yl)methanol (3g)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-chlorobenzaldehyde **2g** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetonitrile : acetone = 1 : 1 : 1, second, dichloromethane : acetone = 1 : 3, third, chloroform : acetone = 1 : 3) to afford the corresponding **3g** as a white solid (34.7 mg, 79% yield). Data was consistent with literature precedent.[15]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.47 (d, *J* = 5.1 Hz, 2H), 7.37 – 7.22 (m, 6H), 5.77 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 152.7, 149.7, 141.4, 134.1, 129.1, 128.3, 121.4, 74.3.



(4-Bromophenyl)(pyridin-4-yl)methanol (3h)

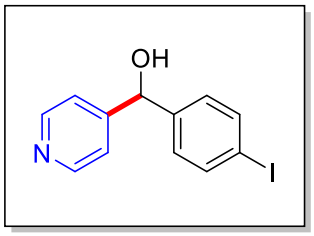
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-bromobenzaldehyde **2h** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : acetone = 1 : 1) to afford the

corresponding **3h** as a white solid (38.0 mg, 72% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.54 – 8.43 (m, 2H), 7.51 – 7.46 (m, 2H), 7.30 – 7.27 (m, 2H), 7.25 – 7.21 (m, 2H), 5.76 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 151.6, 148.7, 140.9, 131.0, 127.6, 121.3, 120.4, 73.4.

HRMS (ESI, m/z) Calcd. for $C_{12}H_{11}BrNO^+$ $[M+H]^+$: 264.0019; Found: 264.0021.



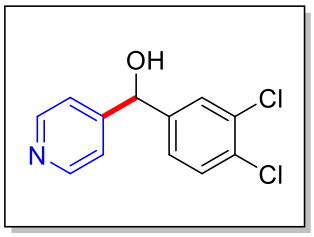
(4-Iodophenyl)(pyridin-4-yl)methanol (3i)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-iodobenzaldehyde **2i** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetonitrile : acetone = 3 : 1 : 1, second, dichloromethane : acetone = 3 : 1, third, chloroform : acetone = 3 : 1) to afford the corresponding **3i** as a white solid (45.4 mg, 73% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.56 – 8.49 (m, 2H), 7.73 – 7.66 (m, 2H), 7.31 – 7.27 (m, 2H), 7.13 – 7.08 (m, 2H), 5.75 (s, 1H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 153.6, 149.5, 144.2, 137.1, 128.7, 121.1, 93.2, 72.4.

HRMS (ESI, m/z) Calcd. For $C_{12}H_{11}INO^+$ $[M+H]^+$: 311.9880; Found: 311.9878.



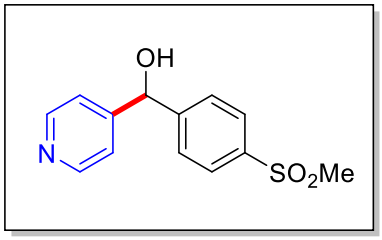
(3,4-Dichlorophenyl)(pyridin-4-yl)methanol (3j)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 3,4-dichlorobenzaldehyde **2j** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetonitrile : acetone = 5 : 1 : 1, second, dichloromethane : acetone = 3 : 1) to afford the corresponding **3j** as a white solid (50.3 mg, 99% yield).

^{1}H NMR (600 MHz, DMSO-d_6) δ 8.50 (d, J = 5.7 Hz, 2H), 7.66 (d, J = 2.0 Hz, 1H), 7.58 (d, J = 8.3 Hz, 1H), 7.42 – 7.38 (m, 2H), 7.37 (dd, J = 8.3, 2.0 Hz, 1H), 6.37 (d, J = 4.1 Hz, 1H), 5.77 (d, J = 4.0 Hz, 1H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 153.0, 149.6, 145.5, 131.0, 130.6, 129.7, 128.2, 126.6, 121.1, 71.7.

HRMS (ESI, m/z) Calcd. for $C_{12}H_{10}Cl_2NO^+$ $[M+H]^+$: 254.0134; Found: 254.0134.



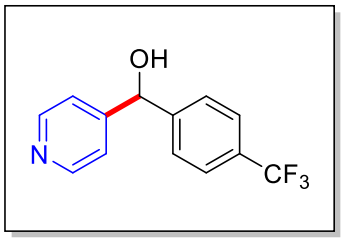
(4-(Methylsulfonyl)phenyl)(pyridin-4-yl)methanol (3k)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-methylsulphonyl benzaldehyde **2k** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetonitrile : acetone = 1 : 1 : 1, second, dichloromethane : acetone = 1 : 3) to afford the corresponding **3k** as a yellow viscous liquid (49.5 mg, 94% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.38 – 8.32 (m, 2H), 7.84 – 7.78 (m, 2H), 7.55 (d, J = 8.4 Hz, 2H), 7.32 – 7.27 (m, 2H), 5.85 (s, 1H), 3.01 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 152.6, 149.4, 149.3, 139.8, 127.8, 127.6, 121.6, 73.9, 44.5.

HRMS (ESI, m/z) Calcd. for $C_{13}H_{14}NO_3S^+$ $[M+H]^+$: 264.0689; Found: 264.0689.



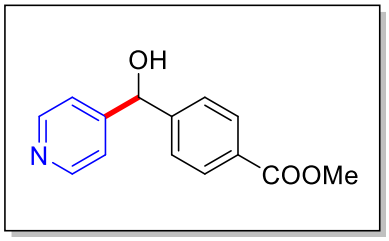
Pyridin-4-yl(4-(trifluoromethyl)phenyl)methanol (3l)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-(trifluoromethyl)benzaldehyde **2l** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : acetone = 1 : 1) to afford the corresponding **3l** as a white solid (41.5 mg, 82% yield). Data was consistent with literature precedent.[12]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.33 (d, *J* = 5.1 Hz, 2H), 7.58 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 7.9 Hz, 2H), 7.30 (d, *J* = 5.1 Hz, 2H), 5.81 (s, 1H), 5.35 (br, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.0, 149.4, 146.9, 130.4 (q, *J* = 32.8 Hz), 127.1, 125.8 (q, *J* = 3.9 Hz), 124.1 (q, *J* = 272.2 Hz), 121.6, 74.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.08 (s).

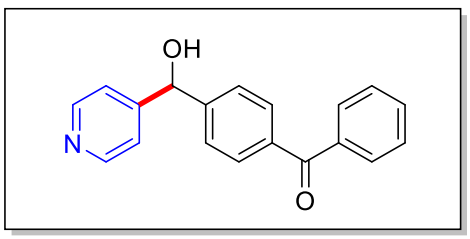


Methyl 4-(hydroxy(pyridin-4-yl)methyl)benzoate (3m)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and methyl 4-formylbenzoate **2m** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (first, chloroform : acetone = 3 : 1 with 1% triethylamine, second, dichloromethane : methanol = 20 : 1). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3m** as a white solid (43.3 mg, 89% yield). Data was consistent with literature precedent.[16]

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.54 – 8.46 (m, 2H), 7.97 – 7.88 (m, 2H), 7.55 (d, *J* = 8.1 Hz, 2H), 7.44 – 7.35 (m, 2H), 6.32 (d, *J* = 4.0 Hz, 1H), 5.81 (d, *J* = 3.9 Hz, 1H), 3.83 (s, 3H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 166.1, 153.4, 149.7, 149.6, 129.3, 128.6, 126.6, 121.3, 72.6, 52.1.



(4-(Hydroxy(pyridin-4-yl)methyl)phenyl)(phenyl)methanone (3n)

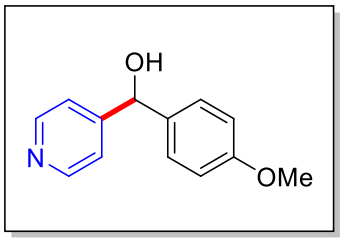
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-benzoylbenzaldehyde **2n** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : acetone = 3 : 1) to afford the corresponding

3n as a yellow solid (44.6 mg, 77% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (d, *J* = 5.3 Hz, 2H), 7.74 (d, *J* = 6.4 Hz, 4H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.50 – 7.41 (m, 4H), 7.34 (d, *J* = 5.1 Hz, 2H), 5.85 (s, 1H), 4.92 (br, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 196.5, 153.1, 149.4, 147.5, 137.4, 137.2, 132.7, 130.6, 130.1, 128.4, 126.7, 121.6, 74.4.

HRMS (ESI, m/z) Calcd. for $C_{19}H_{16}NO_2^+$ $[M+H]^+$: 290.1176; Found: 290.1177.



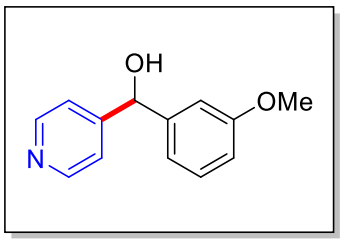
(4-Methoxyphenyl)(pyridin-4-yl)methanol (3o)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-methoxybenzaldehyde **2o** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : acetone = 3 : 1) to afford the corresponding **3o** as a white solid (23.2 mg, 54% yield).

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.49 – 8.44 (m, 2H), 7.37 – 7.33 (m, 2H), 7.31 – 7.24 (m, 2H), 6.91 – 6.83 (m, 2H), 6.05 (d, *J* = 4.0 Hz, 1H), 5.66 (d, *J* = 4.0 Hz, 1H), 3.71 (s, 3H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 158.5, 154.5, 149.4, 136.6, 127.7, 121.1, 113.7, 72.7, 55.1.

HRMS (ESI, m/z) Calcd. for $C_{13}H_{14}NO_2^+$ $[M+H]^+$: 216.1019; Found: 216.1019.



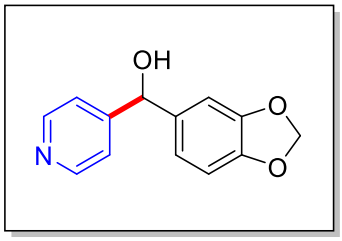
(3-Methoxyphenyl)(pyridin-4-yl)methanol (3p)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 3-methoxybenzaldehyde **2p** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (dichloromethane : acetonitrile : acetone = 3 : 1 : 1 with 1% triethylamine). The crude product was then diluted with ethyl acetate and washed

with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3p** as a white solid (34.0 mg, 79% yield). Data was consistent with literature precedent.[15]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.49 (d, *J* = 5.1 Hz, 2H), 7.32 (d, *J* = 5.1 Hz, 2H), 7.27 (t, *J* = 7.9 Hz, 1H), 6.92 (d, *J* = 7.6 Hz, 1H), 6.90 (s, 1H), 6.84 (dd, *J* = 8.2, 2.5 Hz, 1H), 5.76 (s, 1H), 3.78 (s, 3H), 3.17 (br, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 160.0, 153.0, 149.6, 144.6, 129.9, 121.4, 119.2, 113.6, 112.5, 74.7, 55.4.



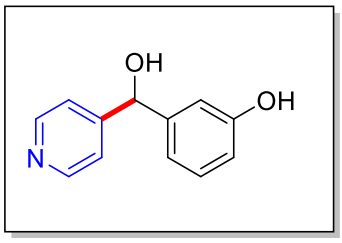
Benzo[*d*][1,3]dioxol-5-yl(pyridin-4-yl)methanol (3q)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and piperonyl aldehyde **2q** (0.25 mmol) as substrates. The crude product was purified by flash chromatography eluted (dichloromethane : tetrahydrofuran = 12 : 1) to afford the corresponding **3q** as a white solid (19.7 mg, 43% yield).

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.47 (d, *J* = 4.1 Hz, 2H), 7.35 (d, *J* = 5.0 Hz, 2H), 6.90 (s, 1H), 6.89 – 6.82 (m, 2H), 6.06 (d, *J* = 4.1 Hz, 1H), 5.96 (d, *J* = 4.5 Hz, 2H), 5.63 (d, *J* = 3.9 Hz, 1H).

^{13}C NMR (151 MHz, DMSO-d_6) δ 154.3, 149.5, 147.3, 146.4, 138.6, 121.1, 119.7, 108.0, 106.8, 100.9, 72.8.

HRMS (ESI, m/z) Calcd. for $C_{13}H_{12}NO_3^+$ $[M+H]^+$: 230.0812; Found: 230.0813.



3-(Hydroxy(pyridin-4-yl)methyl)phenol (3r)

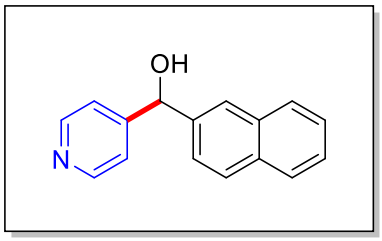
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 3-hydroxybenzaldehyde **2r** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : acetone = 3 : 1) to afford the corresponding

3r as a white solid (29.0 mg, 72% yield).

^{1}H NMR (600 MHz, MeOH-d_4) δ 8.48 – 8.37 (m, 2H), 7.44 – 7.40 (m, 2H), 7.14 (t, *J* = 8.1 Hz, 1H), 6.87 – 6.82 (m, 2H), 6.72 (ddd, *J* = 8.1, 2.4, 1.1 Hz, 1H), 5.70 (s, 1H), 4.95 (br, 1H).

^{13}C NMR (151 MHz, MeOH-d_4) δ 158.7, 156.3, 149.7, 146.0, 130.7, 123.0, 119.1, 115.8, 114.6, 75.4.

HRMS (ESI, m/z) Calcd. for $C_{12}H_{12}NO_2^+$ $[M+H]^+$: 202.0863; Found: 202.0871.



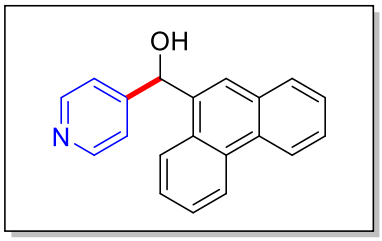
Naphthalen-2-yl(pyridin-4-yl)methanol (3s)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 2-naphthaldehyde **2s** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetone = 1 : 1, second, chloroform : acetone = 1 : 1) to afford the corresponding **3s** as a white solid (43.8 mg, 93% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.54 – 8.50 (m, 2H), 7.86 – 7.79 (m, 4H), 7.53 – 7.47 (m, 2H), 7.40 (dd, *J* = 8.6, 1.8 Hz, 1H), 7.38 – 7.34 (m, 2H), 5.96 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.0, 149.5, 140.2, 133.3, 133.2, 128.9, 128.1, 127.9, 126.6, 126.5, 125.9, 124.7, 121.6, 75.1.

HRMS (ESI, m/z) Calcd. for $C_{16}H_{14}NO^+$ $[M+H]^+$: 236.1070; Found: 236.1071.



Phenanthren-9-yl(pyridin-4-yl)methanol (3t)

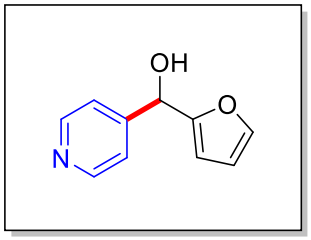
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 9-phenanthrenecarbaldehyde **2t** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (first, chloroform : acetone = 3 : 1 with 1% triethylamine, second, dichloromethane : acetonitrile : acetone = 3 : 1 : 1 with 1% triethylamine). The crude product was then diluted with ethyl acetate and washed with

20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3t** as a white solid (56.5 mg, 99% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 (d, *J* = 8.3 Hz, 1H), 8.67 (d, *J* = 8.3 Hz, 1H), 8.50 – 8.46 (m, 2H), 8.04 (d, *J* = 8.4 Hz, 1H), 7.85 (d, *J* = 7.8 Hz, 1H), 7.77 (s, 1H), 7.68 (t, *J* = 7.3 Hz, 1H), 7.66 – 7.59 (m, 2H), 7.52 (t, *J* = 7.6 Hz, 1H), 7.37 (d, *J* = 6.3 Hz, 2H),, 6.43 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 152.3, 149.7, 136.0, 131.3, 131.2, 130.6, 129.5, 129.1, 127.4, 127.1, 127.0, 126.9, 126.8, 125.2, 123.4, 122.7, 121.9, 73.5.

HRMS (ESI, m/z) Calcd. for $C_{20}H_{16}NO^+$ $[M+H]^+$: 286.1226; Found: 286.1227.

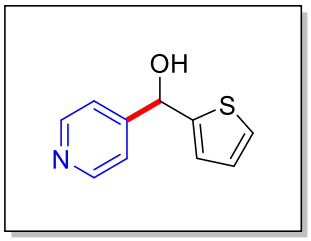


Furan-2-yl(pyridin-4-yl)methanol (3u)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 2-furanaldehyde **2u** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, dichloromethane : acetonitrile : acetone = 1 : 1 : 1, second, dichloromethane : acetone = 1 : 3, third, chloroform : acetone = 1 : 3) to afford the corresponding **3u** as a brown solid (31.9 mg, 91% yield). Data was consistent with literature precedent.[13]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 – 8.36 (m, 2H), 7.44 – 7.33 (m, 3H), 6.31 (dd, *J* = 3.3, 1.9 Hz, 1H), 6.15 (d, *J* = 3.3 Hz, 1H), 5.81 (s, 1H), 5.07 (br, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 155.1, 151.1, 149.2, 142.9, 121.7, 110.4, 107.8, 68.3.



Pyridin-4-yl(thiophen-2-yl)methanol (3v)

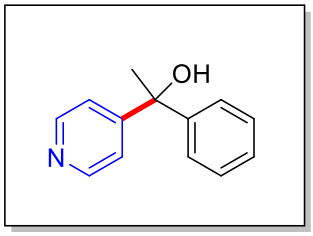
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 2-thenaldehyde **2v** (0.25 mmol) as substrates. The crude product was purified by

preparative TLC (dichloromethane : methanol = 25 : 1) to afford the corresponding **3v** as a yellow solid (32.5 mg, 85% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.5 Hz, 2H), 7.38 (d, *J* = 5.1 Hz, 2H), 7.29 (d, *J* = 5.0 Hz, 1H), 7.00 – 6.89 (m, 2H), 6.04 (s, 1H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 152.4, 149.7, 146.8, 126.9, 126.2, 125.5, 121.3, 70.7.

HRMS (ESI, m/z) Calcd. for $C_{10}H_{10}NOS^+$ $[M+H]^+$: 192.0478; Found: 192.0479.

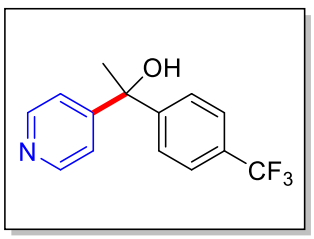


1-Phenyl-1-(pyridin-4-yl)ethan-1-ol (3w)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and acetophenone **2w** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (first, dichloromethane : ethyl acetate = 1 : 1 with 2% triethylamine, second, hexane : acetone = 1 : 1 with 1% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3w** as a white solid (23.5 mg, 59% yield). Data was consistent with literature precedent.[13]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.1 Hz, 2H), 7.41 (d, *J* = 7.7 Hz, 2H), 7.36 – 7.31 (m, 4H), 7.30 – 7.25 (m, 1H), 3.07 (br, 1H), 1.94 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.3, 149.6, 146.7, 128.6, 127.7, 126.0, 121.0, 75.4, 30.3.



1-(Pyridin-4-yl)-1-(4-(trifluoromethyl)phenyl)ethan-1-ol (3x)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 1-(4-trifluoromethyl-phenyl)-ethanone **2x** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : acetone = 3 : 2 with 1%

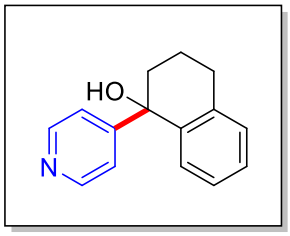
triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **3x** as a white solid (50.3 mg, 94% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.46 – 8.23 (m, 2H), 7.65 – 7.49 (m, 4H), 7.35 – 7.31 (m, 2H), 4.31 (br, 1H), 1.95 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 156.7, 150.7, 149.5, 129.8 (q, *J* = 32.7 Hz), 126.3, 125.5 (q, *J* = 3.8 Hz), 124.1 (q, *J* = 272.1 Hz), 121.0, 75.0, 30.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.03(s).

HRMS (ESI, m/z) Calcd. for $C_{14}H_{13}F_3NO^+$ $[M+H]^+$: 268.0944; Found: 268.0945.



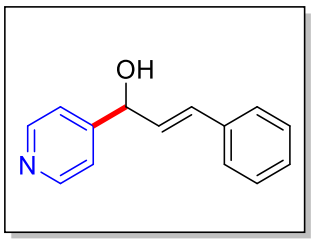
1-(Pyridin-4-yl)-1,2,3,4-tetrahydronaphthalen-1-ol (3y)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 1-tetralone **2y** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, chloroform : acetone = 3 : 1, second, chloroform : diethyl ether = 1 : 1) to afford the corresponding **3y** as a white solid (26.6 mg, 59% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 6.1 Hz, 2H), 7.31 – 7.23 (m, 2H), 7.24 – 7.12 (m, 2H), 7.09 (t, *J* = 7.4 Hz, 1H), 6.93 (d, *J* = 7.8 Hz, 1H), 2.89 (t, *J* = 5.6 Hz, 2H), 2.20 – 2.08 (m, 1H), 2.08 – 1.93 (m, 2H), 1.87 – 1.72 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 149.1, 140.7, 137.7, 129.20, 129.16, 128.0, 126.7, 121.7, 74.6, 41.1, 29.9, 19.4.

HRMS (ESI, m/z) Calcd. for $C_{15}H_{16}NO^+$ $[M+H]^+$: 226.1226; Found: 226.1228.



(*E*)-3-Phenyl-1-(pyridin-4-yl)prop-2-en-1-ol (3z)

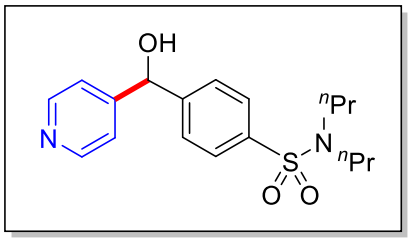
Prepared according to the general procedure described above by using **1a** (0.2 mmol)

and (*E*)-3-phenylpropenal **2z** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : diethyl ether = 1 : 4) to afford the corresponding **3z** as a pale-yellow solid (18.2 mg, 43% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.61 – 8.50 (m, 2H), 7.41 – 7.35 (m, 4H), 7.35 – 7.29 (m, 2H), 7.31 – 7.22 (m, 1H), 6.71 (d, *J* = 15.8 Hz, 1H), 6.29 (dd, *J* = 15.8, 7.1 Hz, 1H), 5.38 (d, *J* = 7.1 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 151.8, 149.9, 136.1, 132.3, 130.3, 128.8, 128.4, 126.8, 121.3, 73.9.

HRMS (ESI, m/z) Calcd. for $C_{14}H_{14}NO^+$ $[M+H]^+$: 212.1070; Found: 212.1078.



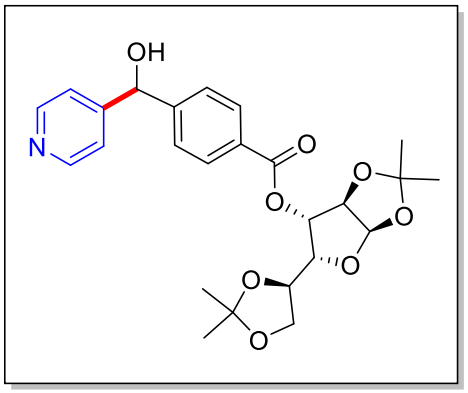
4-(Hydroxy(pyridin-4-yl)methyl)-*N*,*N*-dipropylbenzenesulfonamide (3aa)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 4-formyl-*N*,*N*-dipropylbenzenesulfonamide **2aa** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : methanol = 20 : 1) to afford the corresponding **3aa** as a pale-yellow solid (69.0 mg, 99% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 5.2 Hz, 2H), 7.69 (d, *J* = 8.1 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.34 – 7.28 (m, 2H), 5.82 (s, 1H), 5.45 (br, 1H), 3.02 (t, *J* = 7.7 Hz, 4H), 1.53 (h, *J* = 7.3 Hz, 4H), 0.84 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 153.0, 149.3, 147.6, 139.4, 127.4, 127.3, 121.6, 73.9, 50.2, 22.1, 11.2.

HRMS (ESI, m/z) Calcd. for $C_{18}H_{25}N_2O_3S^+$ $[M+H]^+$: 349.1580; Found: 349.1581.



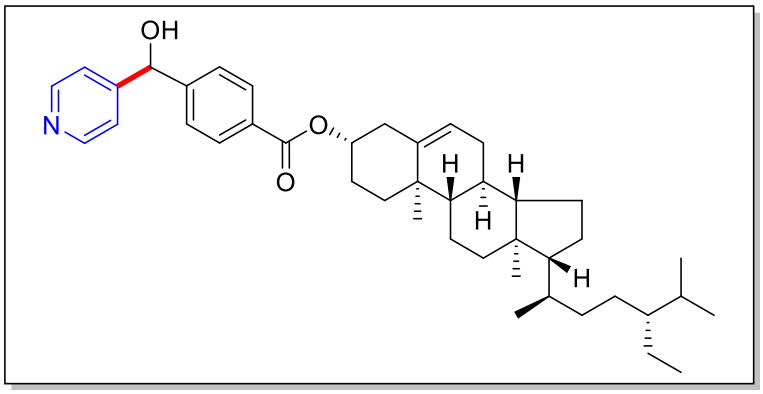
(3a*R*,5*R*,6*S*,6a*R*)-5-((*R*)-2,2-Dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydro furo[2,3-d][1,3]dioxol-6-yl 4-(hydroxy(pyridin-4-yl)methyl)benzoate (3ab)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (3a*R*,5*R*,6*S*,6a*R*)-5-((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydro furo[2,3-d][1,3]dioxol-6-yl 4-formylbenzoate **2ab** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (first, chloroform : diethyl ether = 4 : 1, second, chloroform : acetone = 9 : 1) to afford the corresponding **3ab** as a yellow solid (92.4 mg, 98% yield), dr value (1:1) was determined by HPLC analysis with Chiralpak OD-H column, hexane/i-PrOH, 65:35 v/v, flow rate 1 mL/min, λ = 254 nm, 30 °C).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 5.4 Hz, 2H), 7.99 (d, *J* = 7.9 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* = 5.2 Hz, 2H), 5.85 (s, 2H), 5.31 (t, *J* = 6.0 Hz, 1H), 4.91 (t, *J* = 4.9 Hz, 1H), 4.73 (q, *J* = 7.4 Hz, 1H), 4.13 (dt, *J* = 21.8, 7.4 Hz, 2H), 3.59 (t, *J* = 7.8 Hz, 1H), 1.51 (s, 3H), 1.44 (s, 3H), 1.39 (s, 3H), 1.32 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 153.0, 149.3, 148.9, 130.2, 128.5, 126.9, 121.5, 109.6, 105.1, 81.1, 79.0, 75.2, 74.1, 72.3, 66.3, 27.0, 26.9, 26.7, 25.3.

HRMS (ESI, m/z) Calcd. for $C_{25}H_{30}NO_8^+$ $[M+H]^+$: 472.1966; Found: 472.1966.



(3*S*,8*S*,9*S*,10*R*,13*R*,14*S*,17*R*)-17-((2*R*,5*R*)-5-Ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[*a*]phenanthren-3-yl 4-(hydroxy(pyridin-4-yl)methyl)benzoate (3ac)

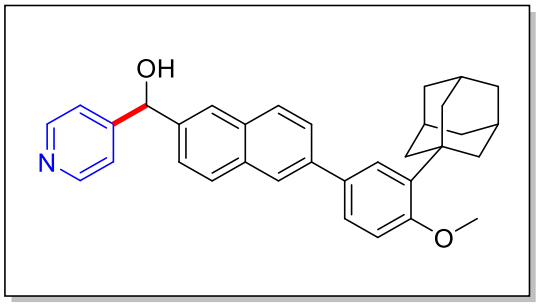
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (3*S*,8*S*,9*S*,10*R*,13*R*,14*S*,17*R*)-17-((2*R*,5*R*)-5-ethyl-6-methylheptan-2-yl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[*a*]phe nanthren-3-yl 4-formylbenzoate **2ac** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : methanol = 20 : 1) to afford the corresponding **3ac** as a yellow solid (123.9 mg, 99% yield). dr value (1.1:1) was determined by HPLC analysis with Chiralpak AD-H column, hexane/i-PrOH, 95:5 v/v,

flow rate 1 mL/min, λ = 254 nm, 30 °C).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 – 8.40 (m, 2H), 8.03 – 7.95 (m, 2H), 7.46 – 7.39 (m, 2H), 7.33 – 7.27 (m, 2H), 5.81 (s, 1H), 5.41 (d, *J* = 4.2 Hz, 1H), 4.90 – 4.76 (m, 1H), 2.44 (d, *J* = 8.0 Hz, 2H), 2.08 – 0.88 (m, 33H), 0.88 – 0.74 (m, 9H), 0.69 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 152.8, 149.6, 147.8, 139.7, 130.5, 130.1, 126.7, 123.0, 121.5, 74.8, 74.4, 56.8, 56.1, 50.1, 45.9, 42.4, 39.8, 38.3, 37.1, 36.7, 36.3, 34.0, 32.03, 31.96, 29.2, 28.4, 28.0, 26.2, 24.4, 23.2, 21.1, 19.9, 19.5, 19.1, 18.9, 12.1, 12.0.

HRMS (ESI, m/z) Calcd. for $C_{42}H_{60}NO_3^+$ $[M+H]^+$: 626.4568; Found: 626.4561.



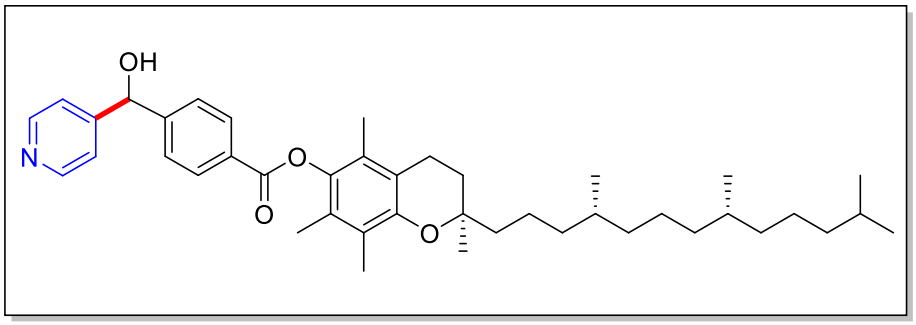
(6-(3-((3*r*,5*r*,7*r*)-Adamantan-1-yl)-4-methoxyphenyl)naphthalen-2-yl)(pyridin-4-yl)methanol (3ad)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 6-(3-(adamantan-1-yl)-4-methoxyphenyl)-2-naphthaldehyde **2ad** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : acetone = 6 : 1) to afford the corresponding **3ad** as a pale-yellow solid (94.2 mg, 99% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.45 – 8.40 (m, 2H), 7.94 (s, 1H), 7.83 (dd, *J* = 8.5, 3.3 Hz, 2H), 7.80 (s, 1H), 7.73 (dd, *J* = 8.6, 1.8 Hz, 1H), 7.57 (d, *J* = 2.4 Hz, 1H), 7.50 (dd, *J* = 8.3, 2.3 Hz, 1H), 7.37 (dd, *J* = 8.6, 1.8 Hz, 1H), 7.36 – 7.31 (m, 2H), 6.97 (d, *J* = 8.4 Hz, 1H), 5.90 (s, 1H), 3.88 (s, 3H), 2.17 (d, *J* = 3.0 Hz, 6H), 2.09 (s, 3H), 1.79 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.8, 153.0, 149.6, 140.0, 139.6, 139.0, 133.6, 133.0, 132.1, 129.0, 128.5, 126.4, 126.0, 125.7, 125.6, 125.0, 124.9, 121.6, 112.2, 75.0, 55.3, 40.7, 37.3, 37.2, 29.2.

HRMS (ESI, m/z) Calcd. for $C_{33}H_{34}NO_2^+$ $[M+H]^+$: 476.2584; Found: 476.2586.



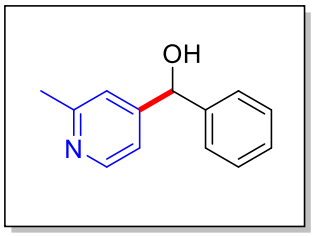
(*R*)-2,5,7,8-Tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl 4-(hydroxy(pyridin-4-yl)methyl)benzoate (3ae)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (*R*)-2,5,7,8-tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl 4-formylbenzoate **2ae** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (chloroform : methanol = 20 : 1) to afford the corresponding **3ae** as a pale-yellow solid (105.3 mg, 82% yield), dr value (1.2:1) was determined by HPLC analysis with Chiralpak AD-H column, hexane/i-PrOH, 80:20 v/v, flow rate 1 mL/min, λ = 254 nm, 30 °C).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, *J* = 5.1 Hz, 2H), 8.19 (d, *J* = 8.1 Hz, 2H), 7.50 (d, *J* = 8.1 Hz, 2H), 7.38 – 7.28 (m, 2H), 5.80 (s, 1H), 2.60 (t, *J* = 6.7 Hz, 2H), 2.11 (s, 3H), 2.03 (s, 3H), 1.99 (s, 3H), 1.89 – 1.70 (m, 2H), 1.65 – 0.95 (m, 24H), 0.92 – 0.80 (m, 12H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 164.9, 152.7, 149.7, 149.6, 148.4, 140.7, 130.8, 129.4, 126.9 (126.92, 126.94), 125.2, 123.3, 121.5, 117.7, 75.2, 74.5, 39.5, 37.6, 37.4, 32.9, 28.1, 24.9, 24.6, 22.9, 22.8, 21.2, 20.8, 19.9, 19.8, 13.2, 12.3, 12.0.

HRMS (ESI, m/z) Calcd. for $C_{42}H_{60}NO_4^+$ $[M+H]^+$: 642.4517; Found: 642.4521.



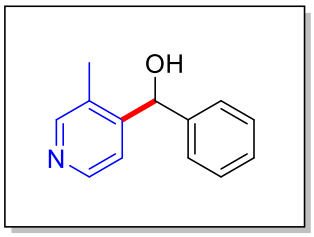
(2-Methylpyridin-4-yl)(phenyl)methanol (6a)

Prepared according to the general procedure described above by using 4-cyano-2-methylpyridine **1b** (0.2 mmol) and **2a** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (chloroform : diethyl ether = 1 : 1 with 2% triethylamine). The crude product was then diluted with ethyl acetate and washed with

20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **6a** as a yellow solid (35.5 mg, 89% yield). Data was consistent with literature precedent.[17]

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.13 (d, *J* = 5.2 Hz, 1H), 7.33 – 7.21 (m, 5H), 7.17 (s, 1H), 7.06 (d, *J* = 3.6 Hz, 1H), 5.69 (s, 1H), 5.21 (br, 1H), 2.41 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.4, 153.7, 148.8, 143.3, 128.8, 128.1, 126.9, 121.0, 118.7, 74.8, 24.2.



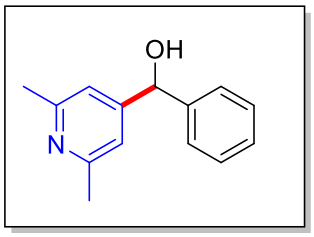
(3-Methylpyridin-4-yl)(phenyl)methanol (6b)

Prepared according to the general procedure described above by using 4-cyano-3-methylpyridine **1c** (0.2 mmol) and **2a** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (chloroform : diethyl ether = 1 : 1 with 2% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **6b** as a white solid (24.7 mg, 62% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.1 Hz, 1H), 8.27 (s, 1H), 7.61 (d, *J* = 5.0 Hz, 1H), 7.37 – 7.27 (m, 5H), 5.90 (s, 1H), 2.12 (s, 3H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 151.5, 150.5, 147.5, 142.8, 130.0, 128.2, 127.3, 127.2, 120.6, 70.8, 15.8.

HRMS (ESI, m/z) Calcd. for $C_{13}H_{14}NO^+$ $[M+H]^+$: 200.1070; Found: 200.1079.



(2,6-Dimethylpyridin-4-yl)(phenyl)methanol (6c)

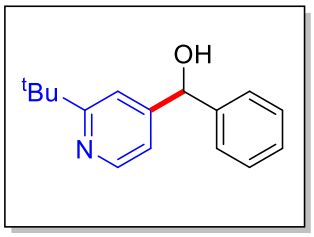
Prepared according to the general procedure described above by using 2,6-dimethyl-4-cyanopyridine **1d** (0.2 mmol) and **2a** (0.25 mmol) as substrates. The crude product

was purified by preparative TLC (petroleum ether : ethyl acetate = 1 : 3) to afford the corresponding **6c** as a white solid (34.6 mg, 81% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 – 7.23 (m, 5H), 6.96 (s, 2H), 5.67 (s, 1H), 2.40 (s, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 157.7, 153.8, 143.3, 128.7, 128.0, 126.8, 118.1, 74.8, 24.2.

HRMS (ESI, m/z) Calcd. for $C_{14}H_{16}NO^+$ $[M+H]^+$: 214.1226; Found: 214.1228.



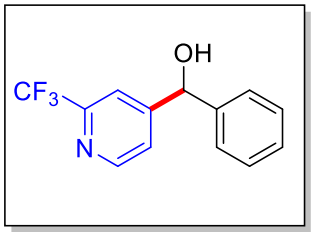
(2-(Tert-butyl)pyridin-4-yl)(phenyl)methanol (6d)

Prepared according to the general procedure described above by using 2-tert-butylisonicotinonitrile **1e** (0.2 mmol) and **2a** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : methanol = 100 : 1) to afford the corresponding **6d** as a white solid (34.8 mg, 72% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, J = 5.1 Hz, 1H), 7.41 (s, 1H), 7.37 – 7.23 (m, 5H), 7.03 (dd, J = 5.0, 1.6 Hz, 1H), 5.75 (s, 1H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 152.8, 148.6, 143.1, 128.8, 128.2, 126.9, 118.6, 116.8, 75.5, 37.6, 30.3.

HRMS (ESI, m/z) Calcd. for $C_{16}H_{20}NO^+$ $[M+H]^+$: 242.1539; Found: 242.1539.



Phenyl(2-(trifluoromethyl)pyridin-4-yl)methanol (6e)

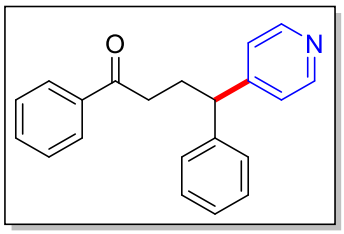
Prepared according to the general procedure described above by using 2-trifluoromethyl-isonicotinonitrile **1f** (0.2 mmol) and **2a** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : methanol = 80 : 1) to afford the corresponding **6e** as a pale-yellow solid (40.5 mg, 80% yield).

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.53 (d, *J* = 5.1 Hz, 1H), 7.75 (s, 1H), 7.46 (d, *J* = 5.0 Hz, 1H), 7.39 – 7.29 (m, 5H), 5.82 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.9, 149.9, 148.4 (q, *J* = 34.7 Hz), 142.1, 129.2, 128.8, 127.0, 124.0, 121.6 (q, *J* = 274.6 Hz), 118.1, 74.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -68.34(s).

HRMS (ESI, m/z) Calcd. for $C_{13}H_{11}F_3NO^+$ $[M+H]^+$: 254.0787; Found: 254.0788.



1,4-Diphenyl-4-(pyridin-4-yl)butan-1-one (3af)

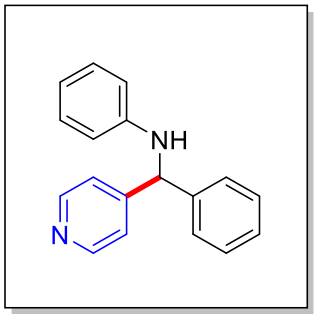
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and phenyl(2-phenylcyclopropyl)methanone **2af** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (*n*-hexane : acetone = 4 : 1) to afford the corresponding **3af** as a pale-yellow solid (34.4 mg, 57% yield). Data was consistent with literature precedent.[18]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 – 8.48 (m, 2H), 7.88 – 7.82 (m, 2H), 7.57 – 7.50 (m, 1H), 7.45 – 7.39 (m, 2H), 7.35 – 7.29 (m, 2H), 7.26 – 7.18 (m, 5H), 4.02 (t, *J* = 7.9 Hz, 1H), 2.93 (t, *J* = 7.2 Hz, 2H), 2.58 – 2.43 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 199.5, 153.5, 150.1, 142.5, 136.9, 133.3, 129.0, 128.7, 128.1, 128.0, 127.1, 123.3, 49.9, 36.5, 29.1.

2. General procedures for coupling of imines with cyanopyridines

The cyanopyridine **1a** (0.2 mmol), imine **4** (0.25 mmol), Hantzsch ester (0.28 mmol) and tetrahydrofuran (1.0 mL) were added to a 20 mL tube with a magnetic stir-bar. Then the tube was evacuated by three freeze-pump-thaw cycles and back-filled with ultra-purified argon. The reaction mixture was stirred at room temperature under 405 nm LED (3 W × 2) for 3 h. The crude product was purified by preparative TLC to afford the pure product (see each compound for detail).

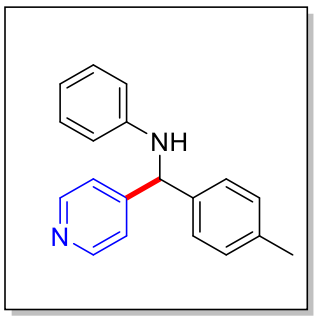


***N*-(Phenyl(pyridin-4-yl)methyl)aniline (5a)**

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (*E*)-*N*-benzylideneaniline **4a** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : acetone = 6 : 1 with 6% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5a** as a pale-yellow solid (50.8 mg, 98% yield). Data was consistent with literature precedent.[19]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 – 8.45 (m, 2H), 7.39 – 7.25 (m, 7H), 7.12 (t, *J* = 7.8 Hz, 2H), 6.72 (t, *J* = 7.3 Hz, 1H), 6.51 (d, *J* = 8.0 Hz, 2H), 5.45 (d, *J* = 3.9 Hz, 1H), 4.26 (d, *J* = 4.0 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 151.7, 150.3, 146.9, 141.7, 129.3, 129.2, 128.2, 127.8, 122.4, 118.4, 113.6, 62.4.



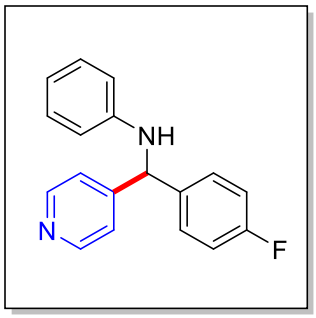
***N*-(Pyridin-4-yl(*p*-tolyl)methyl)aniline (5b)**

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (*E*)-*N*-phenyl-1-(*p*-tolyl)methanimine **4b** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : acetone = 6 : 1 with 6% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5b** as a pale-yellow solid (53.8 mg, 98% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.57 – 8.45 (m, 2H), 7.36 – 7.25 (m, 2H), 7.20 – 7.06 (m, 6H), 6.71 (t, *J* = 7.3 Hz, 1H), 6.50 (d, *J* = 8.0 Hz, 2H), 5.40 (d, *J* = 3.4 Hz, 1H), 4.25 (d, *J* = 4.0 Hz, 1H), 2.32 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 152.0, 150.2, 146.9, 138.8, 138.0, 129.8, 129.3, 127.7, 122.3, 118.2, 113.6, 62.1, 21.2.

HRMS (ESI, m/z) Calcd. for $C_{19}H_{19}N_2^+$ $[M+H]^+$: 275.1543; Found: 275.1546.



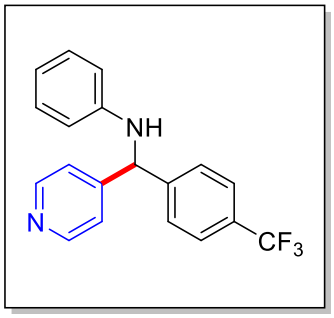
***N*-((4-Fluorophenyl)(pyridin-4-yl)methyl)aniline (5c)**

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and (*E*)-1-(4-fluorophenyl)-*N*-phenylmethanimine **4c** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : chloroform = 1 : 1 with 6% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5c** as a pale-yellow solid (48.9 mg, 89% yield). Data was consistent with literature precedent.[20]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 – 8.40 (m, 2H), 7.37 – 7.20 (m, 4H), 7.18 – 7.08 (m, 2H), 7.07 – 6.96 (m, 2H), 6.73 (t, *J* = 7.4 Hz, 1H), 6.59 – 6.45 (m, 2H), 5.44 (d, *J* = 3.5 Hz, 1H), 4.26 (d, *J* = 3.9 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.4 (d, *J* = 247.2 Hz), 151.5, 150.3, 146.7, 137.4 (d, *J* = 3.3 Hz), 129.4 (d, *J* = 8.1 Hz), 129.3, 122.3, 118.5, 116.0 (d, *J* = 21.6 Hz), 113.6, 61.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -114.23 – -114.35 (m).



***N*-(Pyridin-4-yl(4-(trifluoromethyl)phenyl)methyl)aniline (5d)**

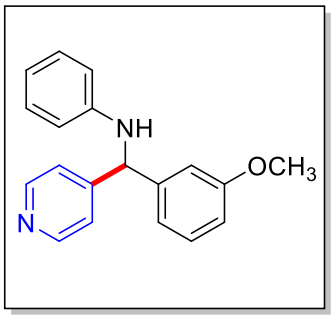
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and *N*-phenyl-1-(4-(trifluoromethyl)phenyl)methanimine **4d** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : acetone = 6 : 1 with 6% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5d** as a pale-yellow solid (43.9 mg, 67% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 (d, *J* = 5.2 Hz, 2H), 7.61 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 7.9 Hz, 2H), 7.28 (d, *J* = 5.1 Hz, 2H), 7.14 (t, *J* = 7.7 Hz, 2H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.53 (d, *J* = 8.0 Hz, 2H), 5.53 (d, *J* = 3.9 Hz, 1H), 4.29 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.8, 150.5, 146.5, 145.3, 130.4 (q, *J* = 32.6 Hz), 129.4, 128.0, 126.2 (q, *J* = 3.9 Hz), 124.0 (q, *J* = 271.9 Hz), 122.5, 118.8, 113.7, 62.0.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.06 (s).

HRMS (ESI, m/z) Calcd. for $C_{19}H_{16}F_3N_2^+$ $[M+H]^+$: 329.1260; Found: 329.1262.



***N*-((3-Methoxyphenyl)(pyridin-4-yl)methyl)aniline (5e)**

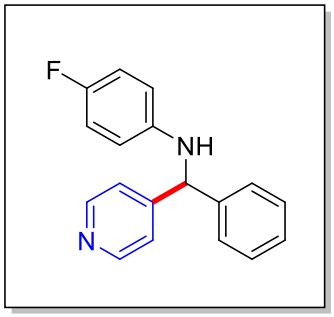
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 1-(3-methoxyphenyl)-*N*-phenylmethanimine **4e** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (toluene : triethylamine = 10 : 1). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced

pressure to afford the corresponding **5e** as a pale-yellow solid (46.1 mg, 79% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.60 – 8.44 (m, 2H), 7.34 – 7.29 (m, 2H), 7.28 – 7.21 (m, 1H), 7.17 – 7.07 (m, 2H), 6.91 – 6.79 (m, 3H), 6.72 (t, *J* = 7.3 Hz, 1H), 6.51 (d, *J* = 7.4 Hz, 2H), 5.40 (d, *J* = 3.6 Hz, 1H), 4.31 (d, *J* = 3.9 Hz, 1H), 3.75 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.1, 151.6, 150.2, 146.9, 143.2, 130.2, 129.3, 122.3, 119.9, 118.3, 113.61, 113.57, 113.2, 62.3, 55.3.

HRMS (ESI, m/z) Calcd. for $C_{19}H_{19}N_2O^+$ $[M+H]^+$: 291.1492; Found: 291.1494.



4-Fluoro-*N*-(phenyl(pyridin-4-yl)methyl)aniline (5f)

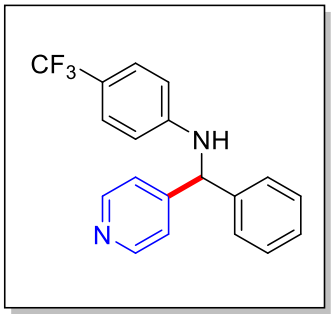
Prepared according to the general procedure described above by using **1a** (0.2 mmol) and *N*-(4-fluorophenyl)-1-phenylmethanimine **4f** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (hexane : chloroform = 1 : 1 with 10% triethylamine). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5f** as a pale-yellow solid (50.3 mg, 91% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, *J* = 5.2 Hz, 2H), 7.64 – 7.01 (m, 7H), 6.82 (t, *J* = 8.5 Hz, 2H), 6.44 (dd, *J* = 8.9, 4.4 Hz, 2H), 5.38 (d, *J* = 3.3 Hz, 1H), 4.23 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 156.2 (d, *J* = 236.2 Hz), 151.6, 150.3, 143.2 (d, *J* = 2.0 Hz), 141.5, 129.2, 128.2, 127.7, 122.3, 115.8 (d, *J* = 22.4 Hz), 114.4 (d, *J* = 7.5 Hz), 62.9.

^{19}F NMR (376 MHz, $CDCl_3$) δ -127.34 (tt, *J* = 8.6, 4.5 Hz).

HRMS (ESI, m/z) Calcd. for $C_{18}H_{16}FN_2^+$ $[M+H]^+$: 279.1292; Found: 279.1300.



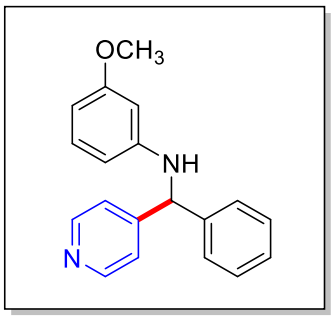
***N*-(phenyl(pyridin-4-yl)methyl)-4-(trifluoromethyl)aniline (5g)**

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and 1-phenyl-*N*-(4-(trifluoromethyl)phenyl)methanimine **4g** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (first, petroleum ether : ethyl acetate = 2 : 1, second, dichloromethane : petroleum ether : triethylamine = 1 : 1 : 1). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5g** as a white solid (63.7 mg, 97% yield). Data was consistent with literature precedent.[20]

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 (d, *J* = 5.4 Hz, 2H), 7.45 – 7.27 (m, 9H), 6.54 (d, *J* = 8.3 Hz, 2H), 5.50 (d, *J* = 4.3 Hz, 1H), 4.62 (d, *J* = 4.3 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.8, 150.5, 149.2, 140.8, 129.4, 128.5, 127.8, 126.7 (q, *J* = 3.8 Hz), 124.9 (q, *J* = 270.5 Hz), 122.3, 120.0 (q, *J* = 32.7 Hz), 112.9, 62.0.

^{19}F NMR (376 MHz, $CDCl_3$) δ -61.68 (s).



3-methoxy-*N*-(phenyl(pyridin-4-yl)methyl)aniline (5h)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and *N*-(3-methoxyphenyl)-1-phenylmethanimine **4h** (0.25 mmol) as substrates. The reaction mixture was purified by preparative TLC (dichloromethane : petroleum ether : triethylamine = 1 : 1 : 1). The crude product was then diluted with ethyl acetate and washed with 20% aq NaOH. The organic layer was then dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the corresponding **5h** as a white solid

(56.8 mg, 98% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 – 8.49 (m, 2H), 7.39 – 7.26 (m, 7H), 7.04 (t, *J* = 8.1 Hz, 1H), 6.30 (dd, *J* = 8.1, 2.4 Hz, 1H), 6.15 (dd, *J* = 8.0, 2.3 Hz, 1H), 6.10 – 6.04 (m, 1H), 5.45 (d, *J* = 3.9 Hz, 1H), 4.26 (s, 1H), 3.69 (s, 3H).

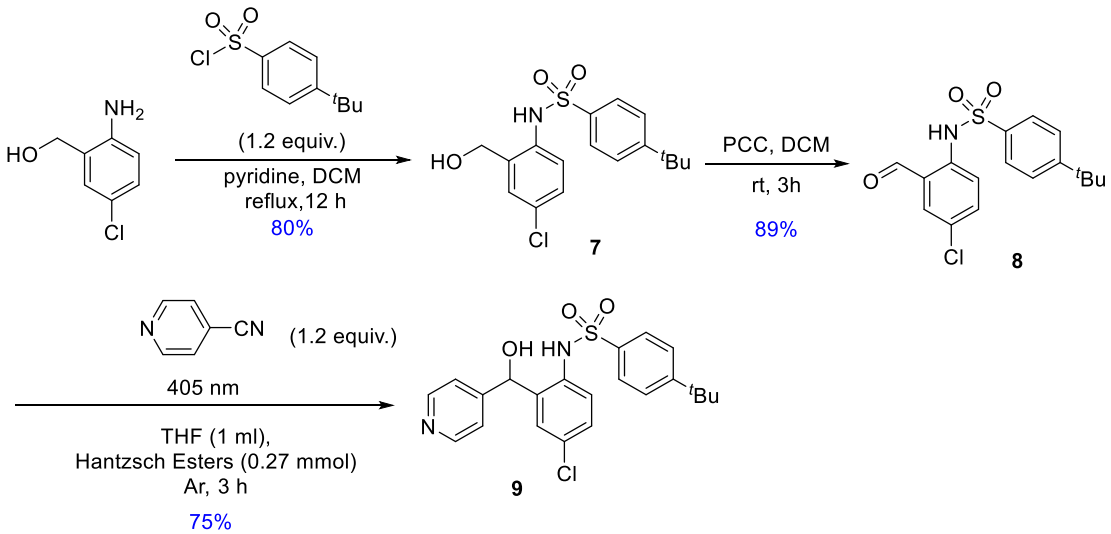
^{13}C NMR (101 MHz, $CDCl_3$) δ 160.7, 151.7, 150.2, 148.2, 141.5, 130.1, 129.2, 128.2, 127.8, 122.4, 106.6, 103.3, 99.8, 62.4, 55.1.

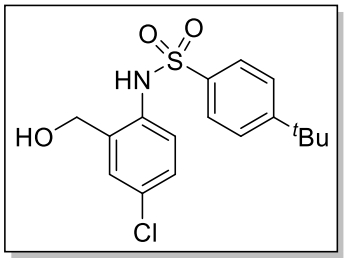
HRMS (ESI, m/z) Calcd. for $C_{19}H_{19}N_2O^+$ $[M+H]^+$: 291.1492; Found: 291.1497.

IV. Gram scale reaction

The 4-cyanopyridine **1a** (6 mmol, 624.7mg) and benzaldehyde **2a** (7.5 mmol, 765 μL), Hantzsch ester (8.4 mmol, 2.13 g) and tetrahydrofuran (30 mL) were added to a 100 mL round-bottom flask with a magnetic stir-bar. Then it was evacuated by three freeze-pump-thaw cycles and back-filled with ultra-purified argon. The reaction mixture was stirred at room temperature under 405nm (3 W × 8) for 3 h. The crude product was purified by flash column chromatograph (chloroform : acetone = 20 : 1) to afford the pure product **3a** (0.867 g, 78% yield).

V. General procedure for the synthesis of drug molecules





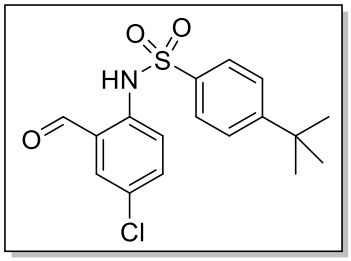
4-(Tert-butyl)-*N*-(4-chloro-2-(hydroxymethyl)phenyl)benzenesulfonamide (7)

Prepared according to the literature[21]. (2-amino-5-chlorophenyl)methanol (793.4 mg, 5 mmol, 1 equiv.) was dissolved in dichloromethane (5 mL), and pyridine (530 μL, 6.5 mmol) was added to the solution. Then 4-(tert-butyl)benzenesulfonyl chloride(1.40 g, 6 mmol, 1.2 equiv.) was added and the solution was refluxed for 12 h. The solution was allowed to cool to room temperature and washed with 1 M HCl (20 mL), brine (3 × 10 mL), and dried over Na_2SO_4. After removal of the solvent, the residue was crystallized from CH_2Cl_2/toluene to give **7** (1.42 g, 80%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.64 (m, 2H), 7.48 – 7.42 (m, 2H), 7.38 (d, *J* = 8.6 Hz, 1H), 7.22 (dd, *J* = 8.6, 2.5 Hz, 1H), 7.10 (d, *J* = 2.4 Hz, 1H), 4.35 (s, 2H), 1.31 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.3, 136.8, 135.1, 133.5, 130.8, 129.2, 129.1, 127.0, 126.3, 124.9, 63.5, 35.3, 31.2.

HRMS (ESI, m/z) Calcd. for $C_{17}H_{20}ClNNaO_3S^+$ $[M+Na]^+$: 376.0745; Found: 376.0743.



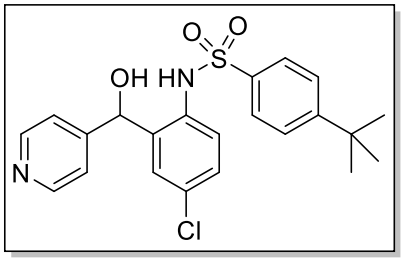
4-(Tert-butyl)-*N*-(4-chloro-2-formylphenyl)benzenesulfonamide (8)

A suspension of PCC (1.96 g, 9 mmol) in dry CH_2Cl_2 (10 mL) was added into **7** (1.07 g, 3.0 mmol) in the same solvent (20 mL). The reaction mixture was stirred at room temperature for 5 h. The raw product was crystallized from $CHCl_3$/EtOH (1:5) to yield **8** (928.9 mg, 88% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.68 (s, 1H), 9.78 (s, 1H), 7.84 – 7.76 (m, 2H), 7.70 (d, *J* = 8.9 Hz, 1H), 7.57 (d, *J* = 2.5 Hz, 1H), 7.53 – 7.42 (m, 3H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 193.9, 157.5, 138.6, 136.2, 135.8, 135.2, 128.3, 127.1, 126.4, 122.8, 119.4, 35.3, 31.1.

HRMS (ESI, m/z) Calcd. for $C_{17}H_{18}ClNNaO_3S^+$ $[M+Na]^+$: 374.0588; Found: 374.0595.



4-(Tert-butyl)-*N*-(4-chloro-2-(hydroxy(pyridin-4-yl)methyl)phenyl)-benzenesulfonamide (9)

Prepared according to the general procedure described above by using **1a** (0.2 mmol) and **8** (0.25 mmol) as substrates. The crude product was purified by preparative TLC (dichloromethane : acetone = 3 : 1) to afford the corresponding **9** as a pale-yellow solid (64.6 mg, 75% yield).

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.46 (d, J = 5.5 Hz, 2H), 7.57 (q, J = 8.5 Hz, 4H), 7.32 (d, J = 2.6 Hz, 1H), 7.25 (dd, J = 8.6, 2.6 Hz, 1H), 7.17 (d, J = 5.8 Hz, 2H), 6.90 (d, J = 8.6 Hz, 1H), 6.10 (s, 1H), 1.28 (s, 9H).

^{13}C NMR (101 MHz, DMSO-d_6) δ 156.1, 152.1, 149.5, 140.8, 136.7, 133.3, 130.5, 128.1, 128.0, 126.7, 126.2, 126.2, 121.4, 68.6, 34.9, 30.8.

HRMS (ESI, m/z) Calcd. for $C_{22}H_{24}ClN_2O_3S^+$ $[M+H]^+$: 431.1191; Found: 431.1197.

VI. UV-Vis absorption spectrum

UV-vis absorption spectra were recorded using a Lengguang Technology UV1901 Dual-Beam UV-Visible Spectrophotometer. The samples were measured in UV quartz cuvettes (chamber volume = 4 mL, H × W × D = 40 mm × 10 mm, 10 mm) fitted with a PTFE stopper. The solution of reactants was prepared in 0.1 mM, and THF was used as solvent.

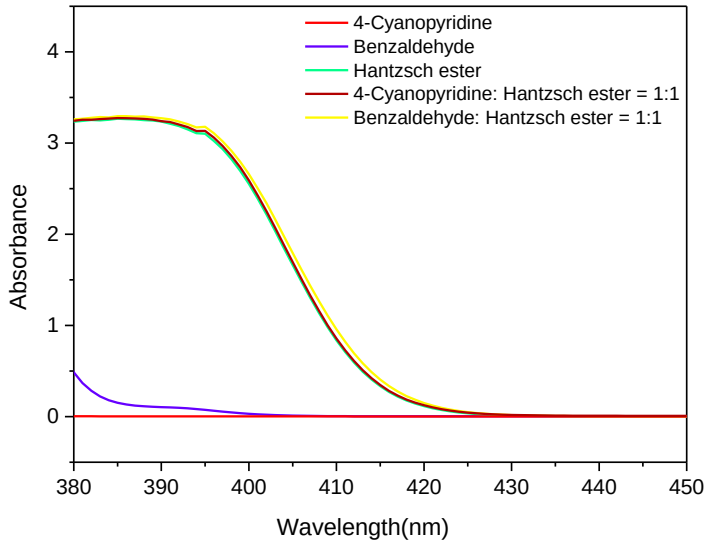
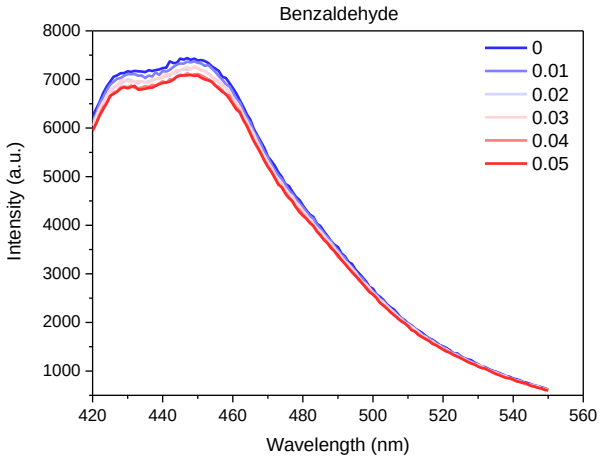


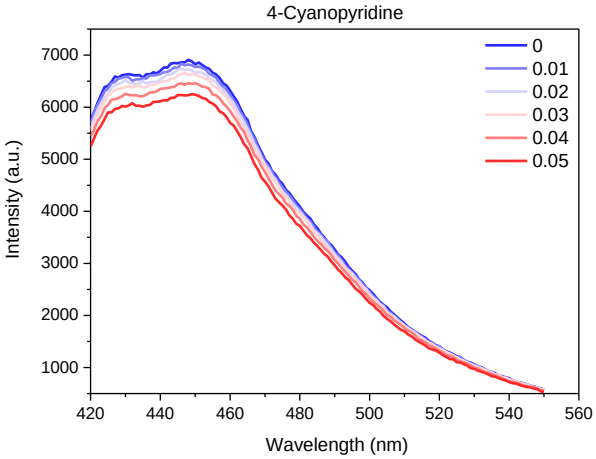
Figure S1. UV-vis absorption spectra of reactants.

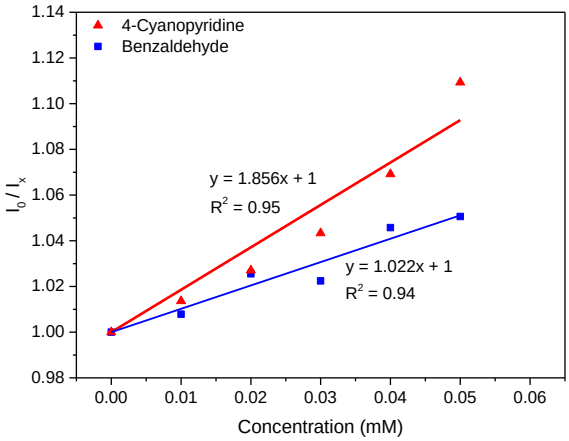
VII. Fluorescence quenching studies

The quenching experiment for the fluorescence of Hantzsch ester by 4-cyanopyridine and benzaldehyde was performed on SHIMADZU RF-6000 spectro fluorophotometer.

A stock solution of Hantzsch ester (0.05 mM, in THF) was prepared for the quenching experiment. A quartz cuvette (1 cm ×1 cm ×3 cm) was filled with the above mentioned 0.05 mM THF solution and its fluorescence was recorded with excitation at 405 nm in the spectrometer. Quenching experiments were performed with the injection of 20 μL, 40 μL, 60 μL, 80 μL and 100 μL 1.5 mM 4-cyanopyridine or benzaldehyde respectively by auto-pipette.

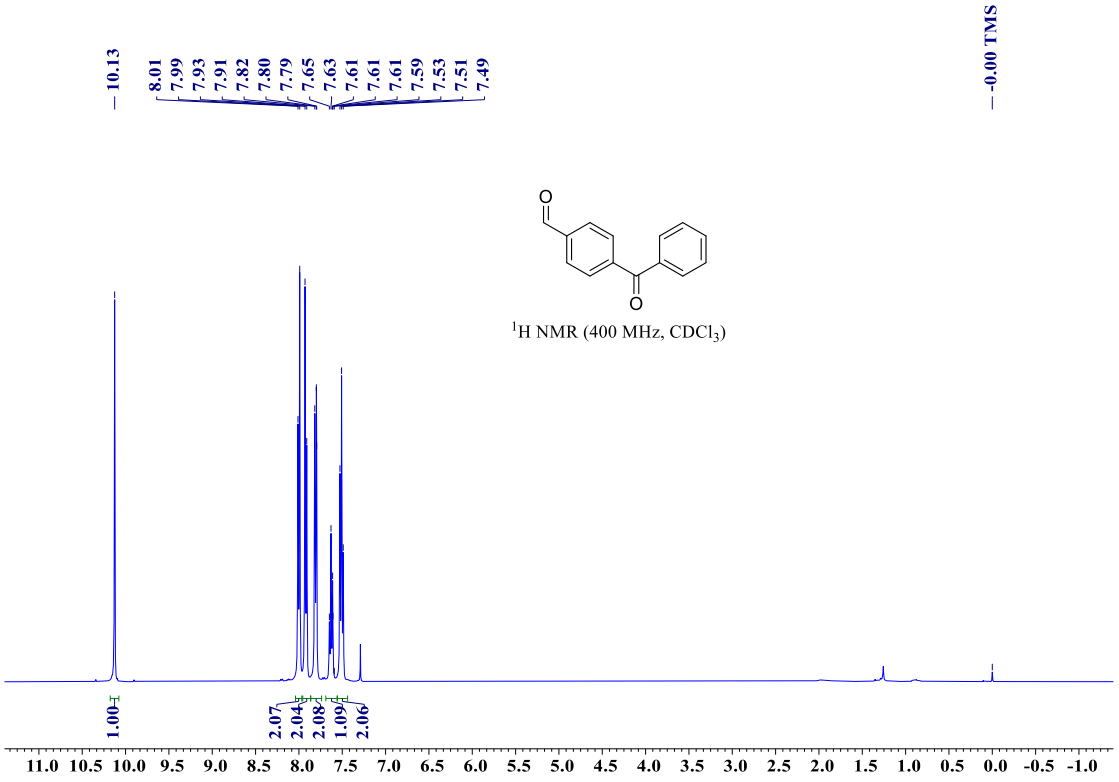



4-Cyanopyridine
Intensity (a.u.)
Wavelength (nm)
0
0.01
0.02
0.03
0.04
0.05

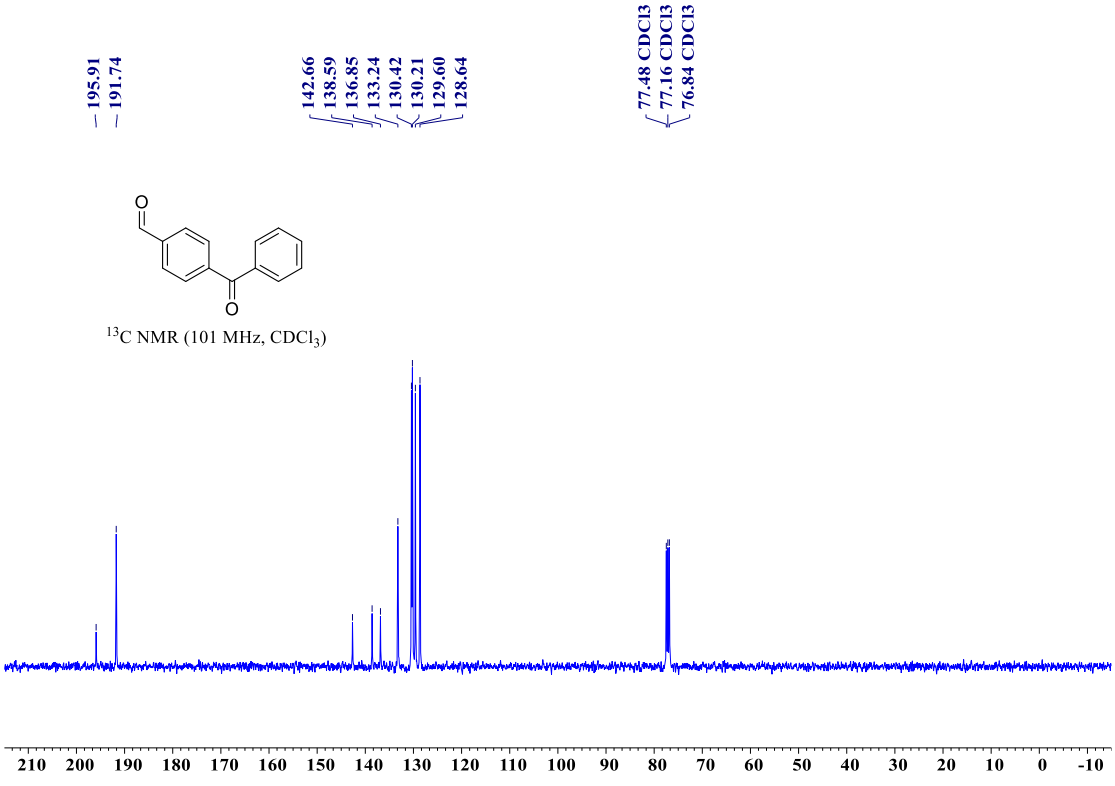

4-Cyanopyridine
Benzaldehyde
y = 1.856x + 1
R2 = 0.95
y = 1.022x + 1
R2 = 0.94
I0 / Ix
Concentration (mM)

VIII. Copies of ^{1}H, ^{13}C, and ^{19}F NMR Spectra

^{1}H and ^{13}C NMR spectra of compound 2n

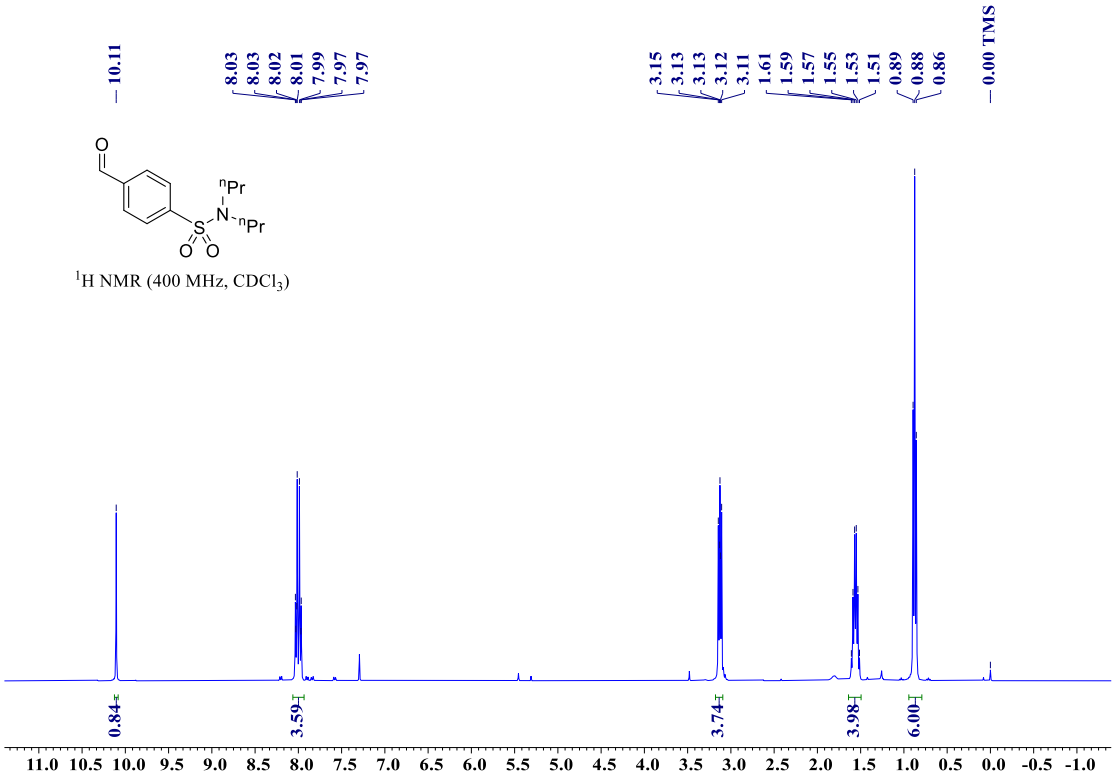


^{1}H NMR (400 MHz, $CDCl_3$)

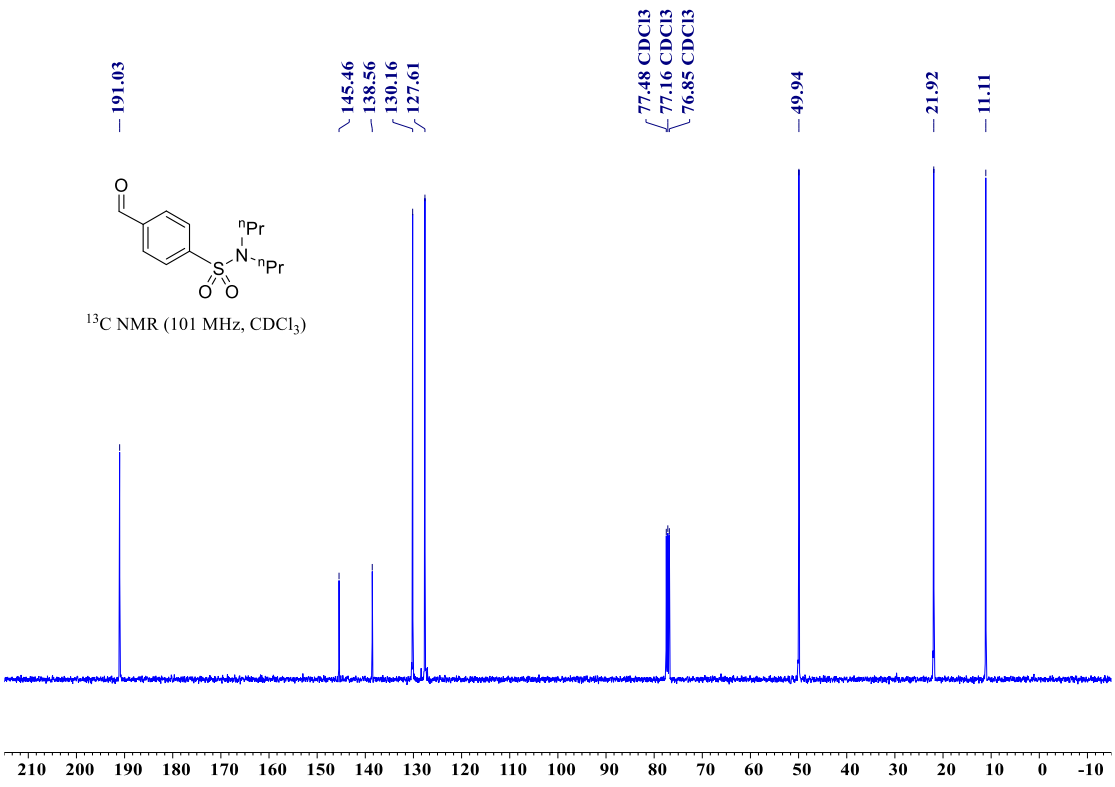


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 2aa

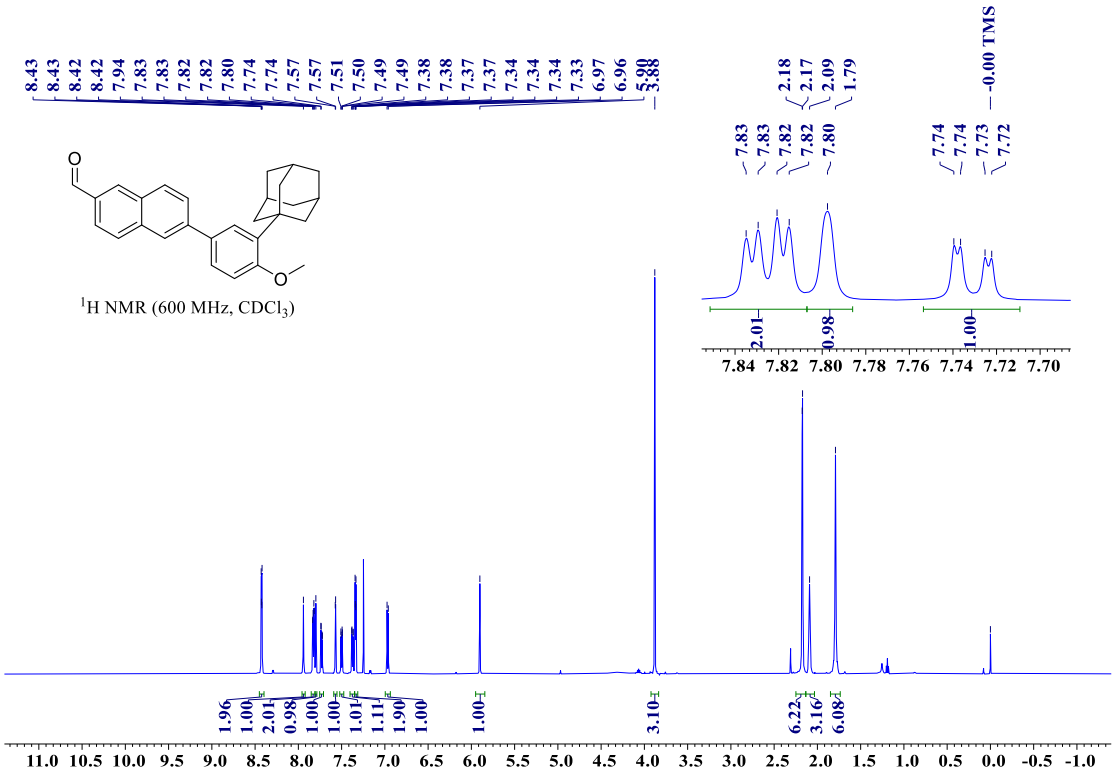


^{1}H NMR (400 MHz, $CDCl_3$)

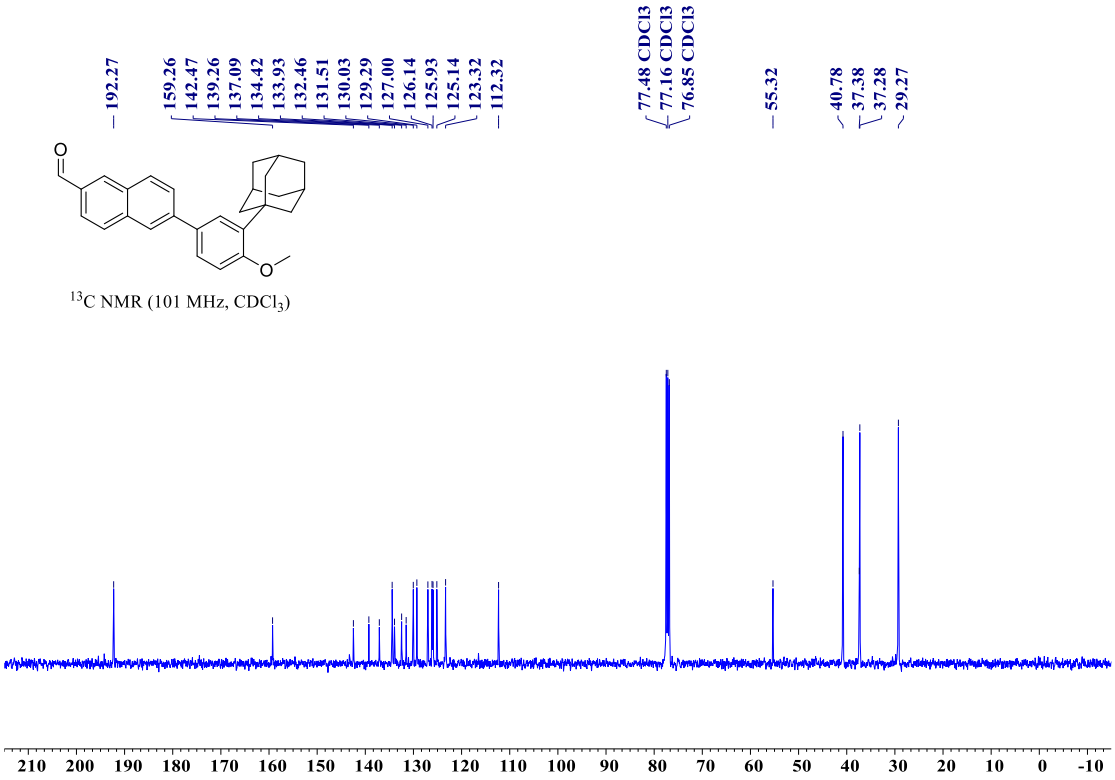


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 2ac

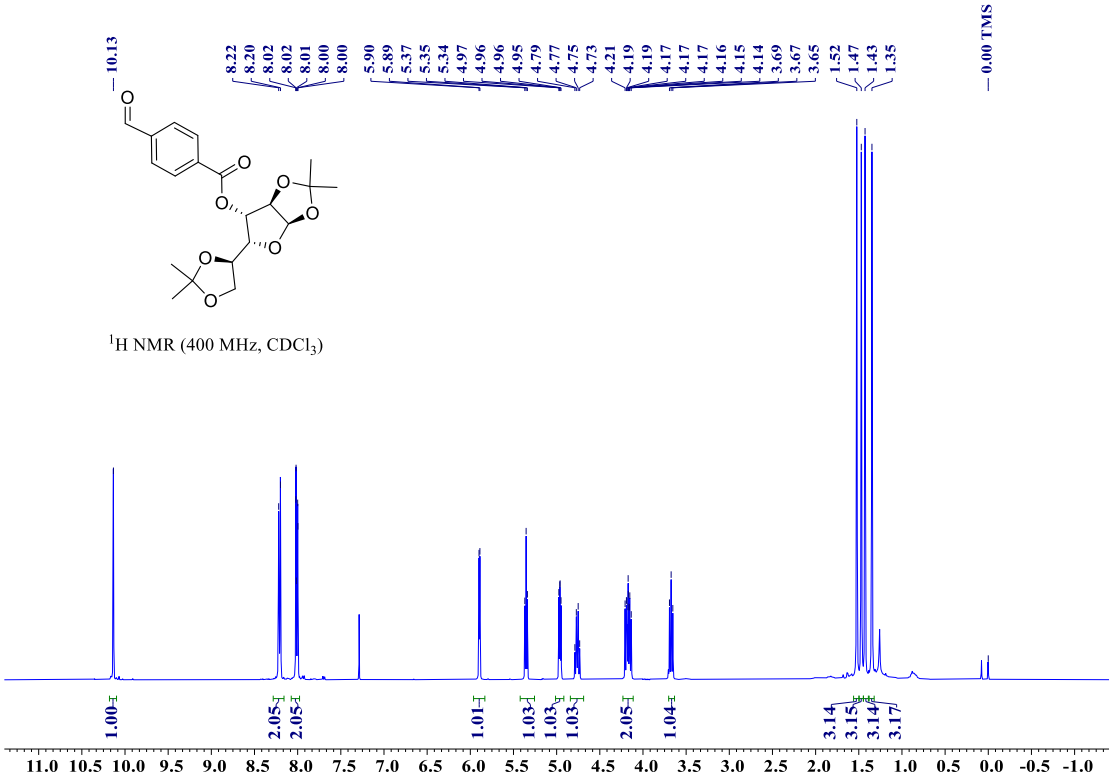


^{1}H NMR (600 MHz, $CDCl_3$)

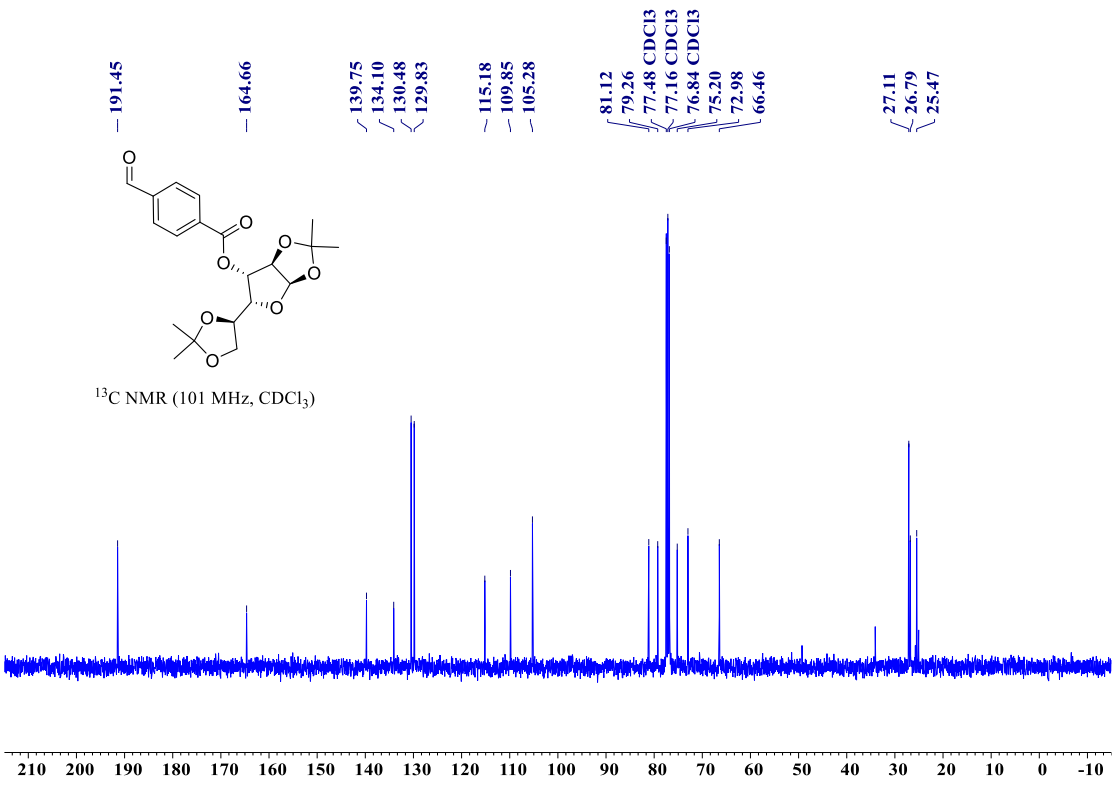


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 2ab

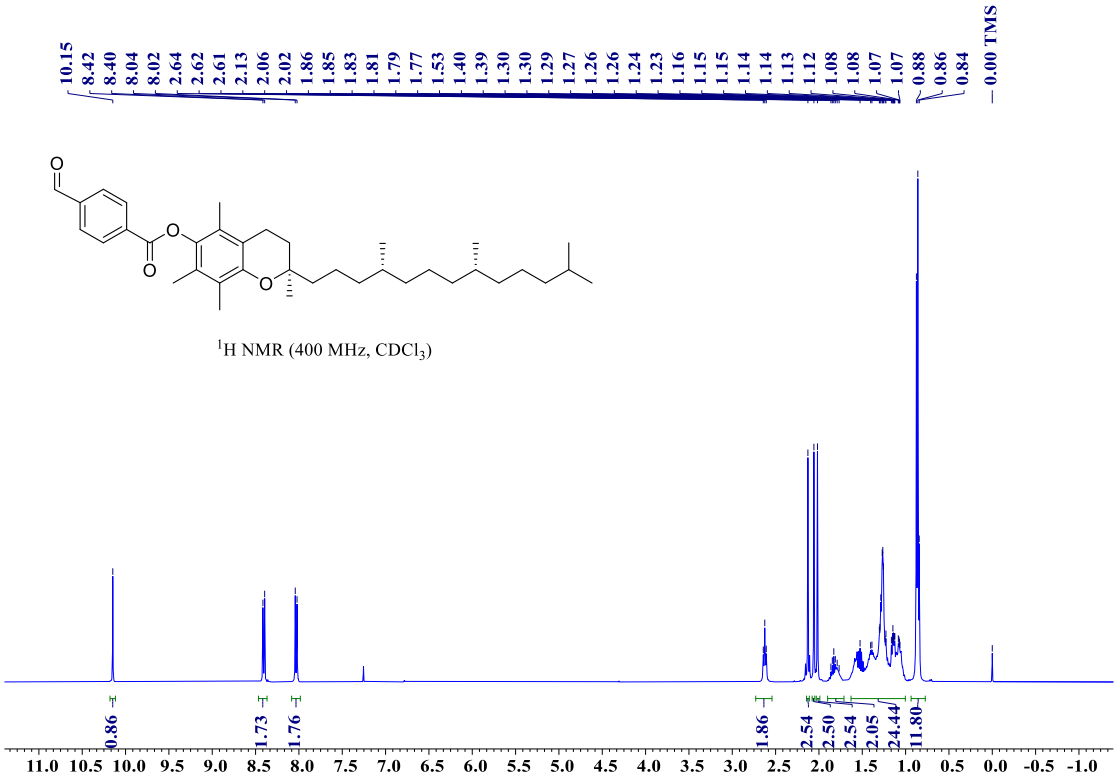


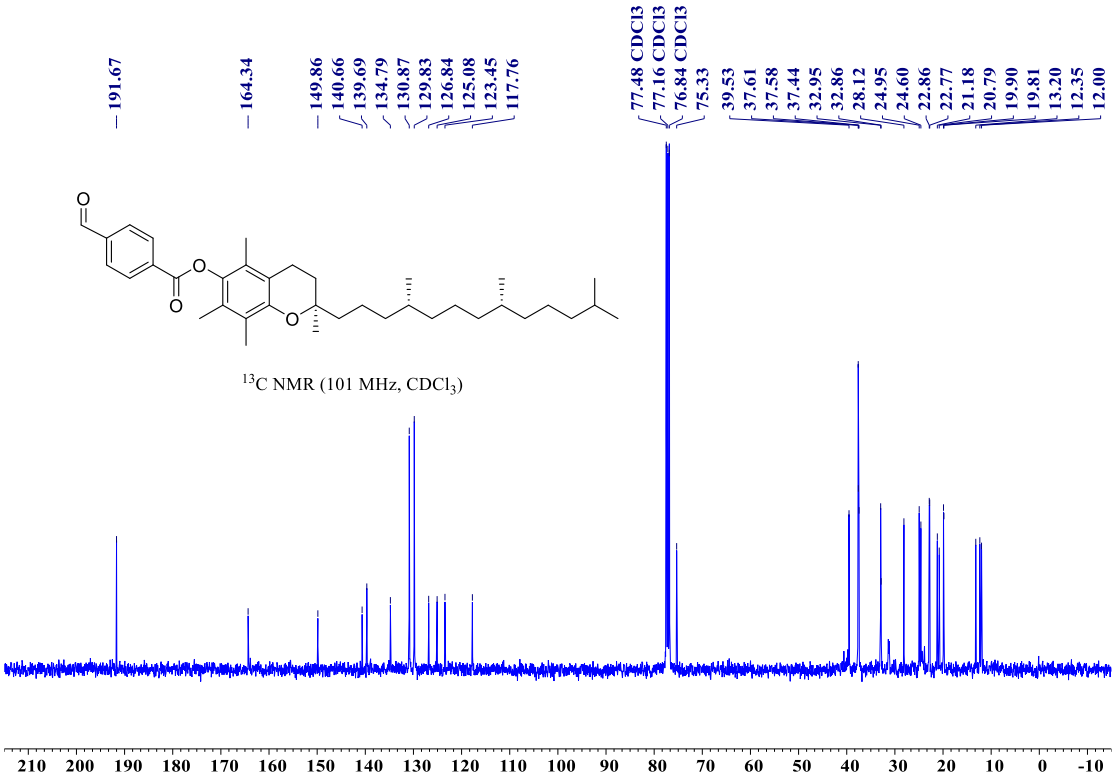
^{1}H NMR (400 MHz, $CDCl_3$)



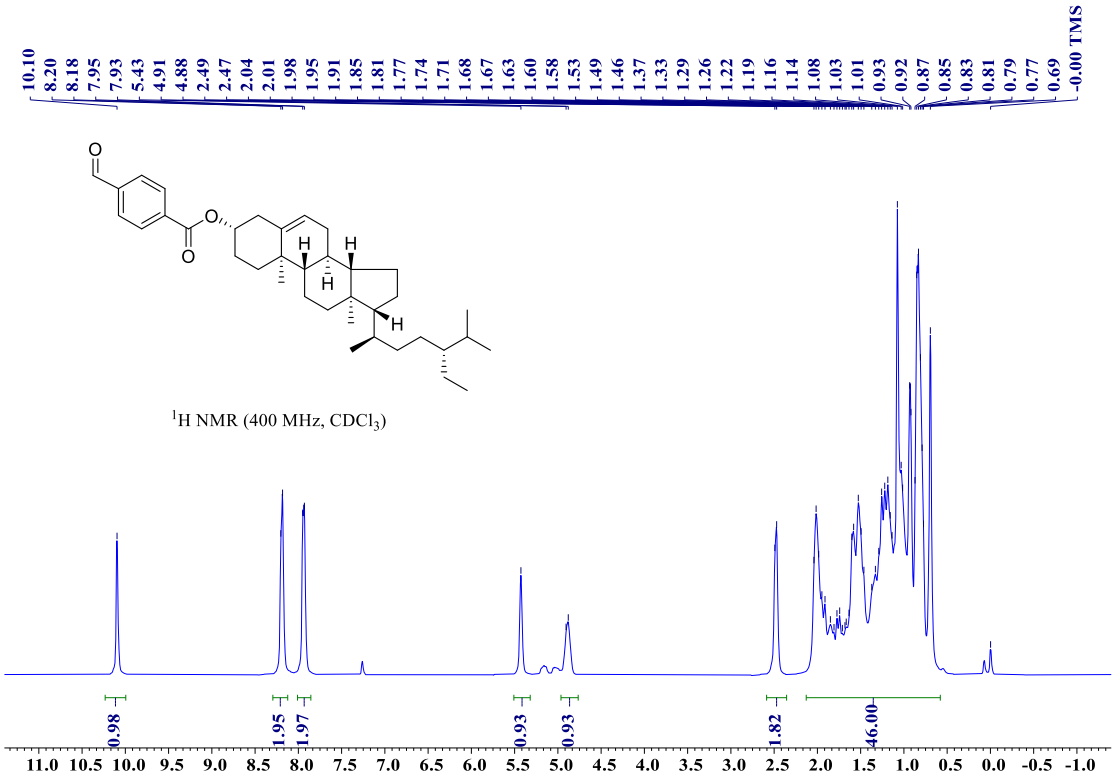
^{13}C NMR (101 MHz, $CDCl_3$)

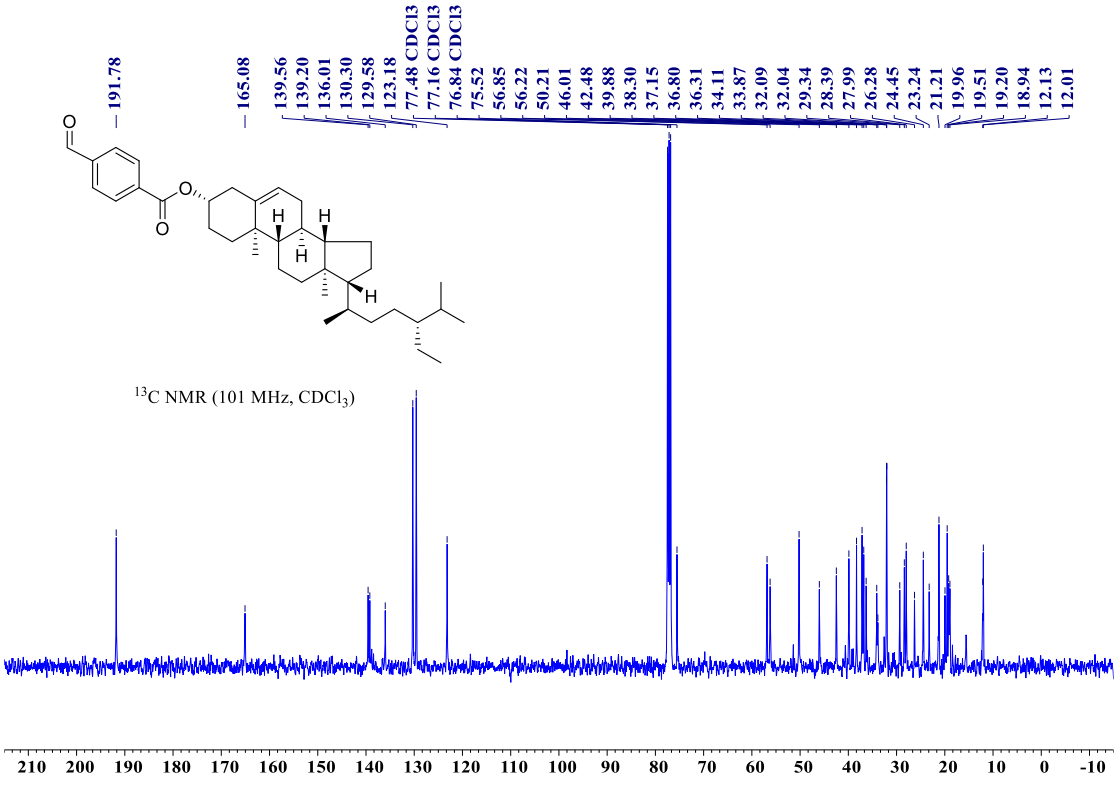
^{1}H and ^{13}C NMR spectra of compound 2ad



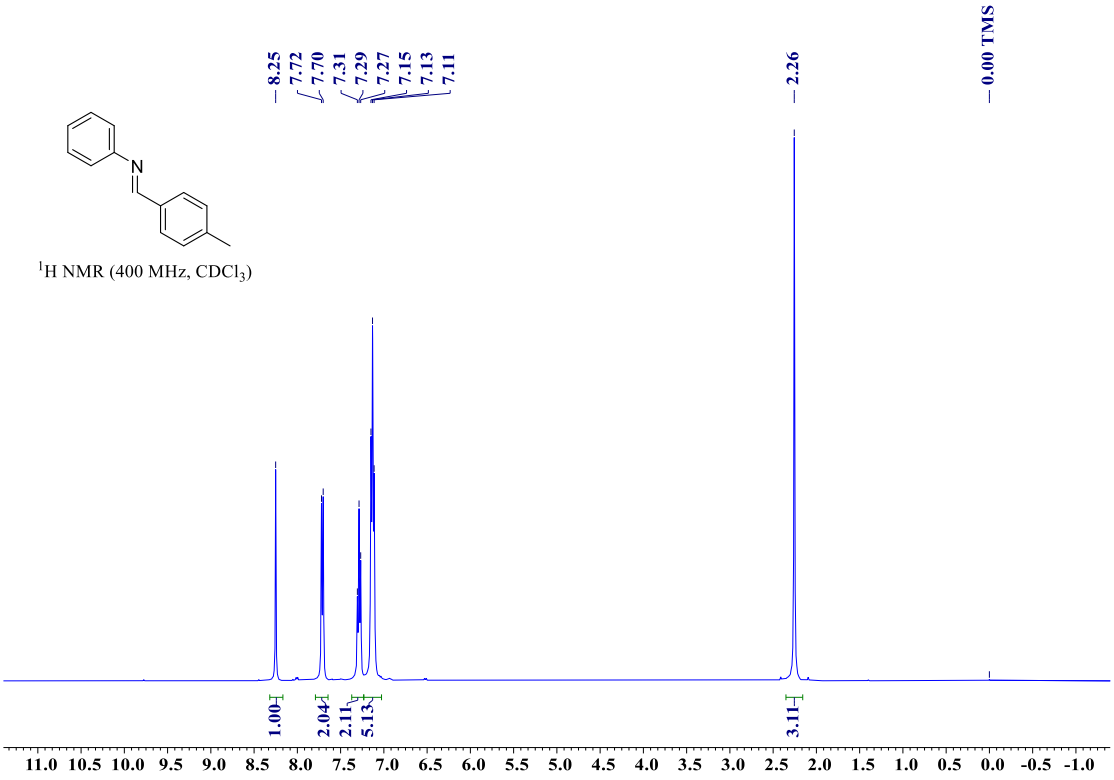


^{1}H and ^{13}C NMR spectra of compound 2ae

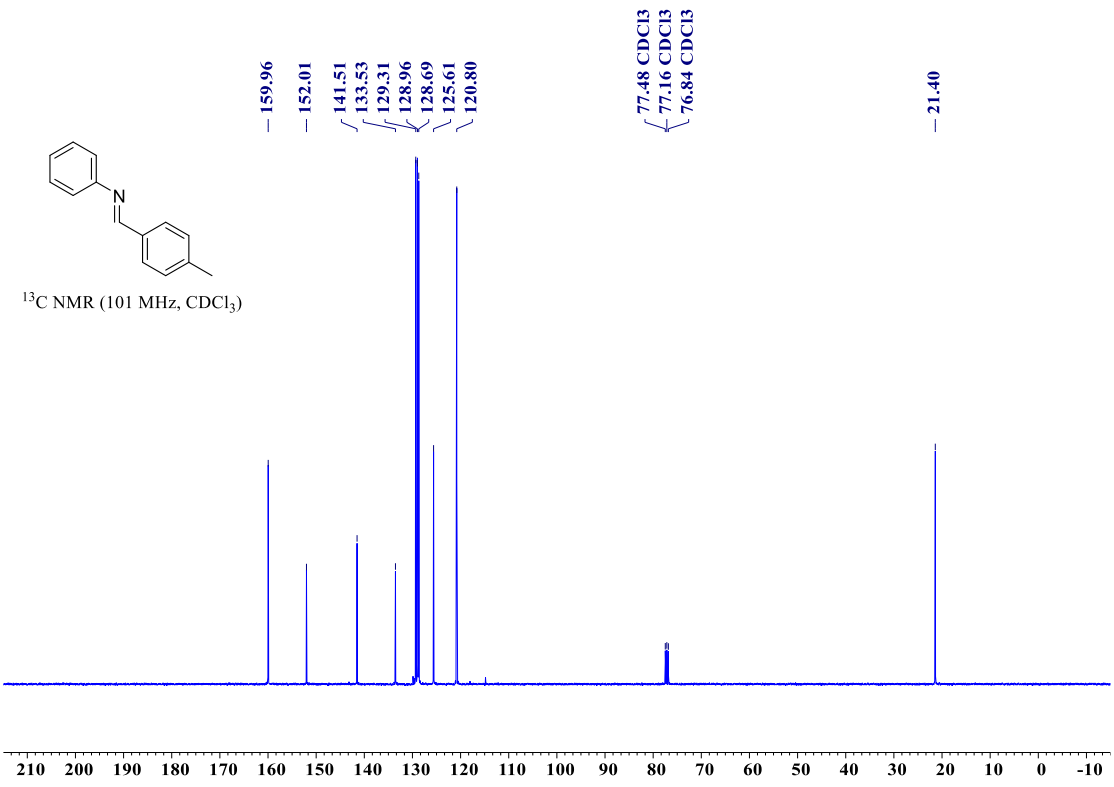




^{1}H and ^{13}C NMR spectra of compound 4b

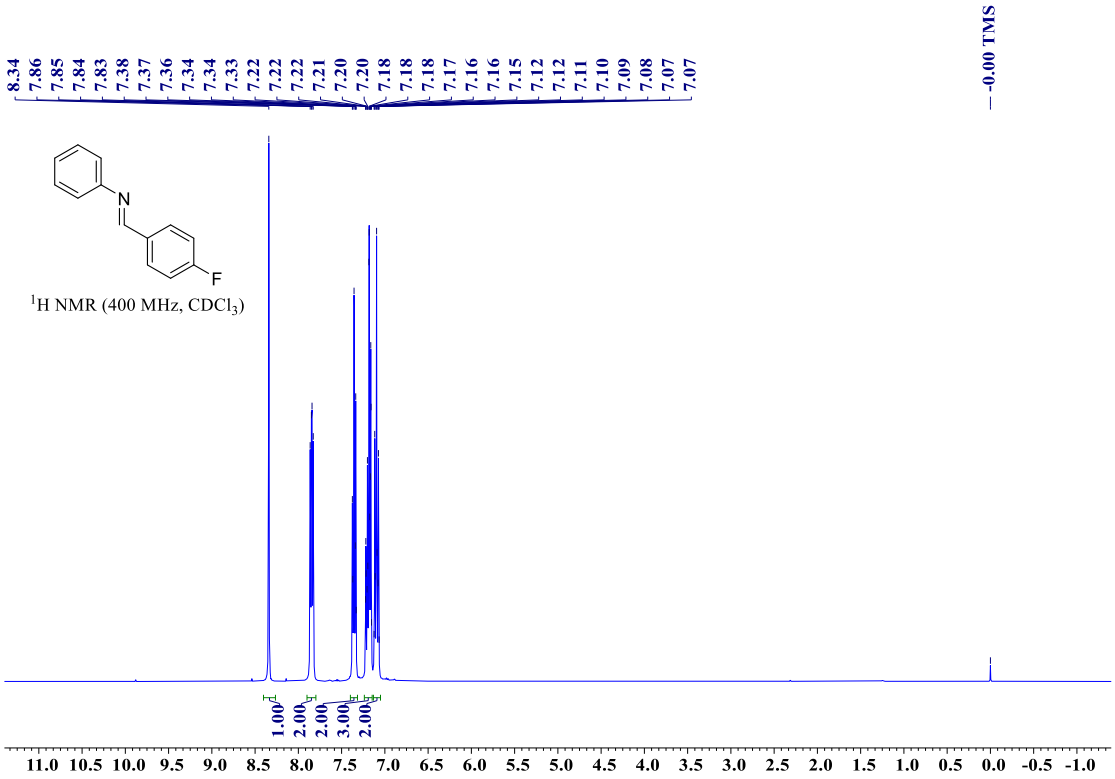


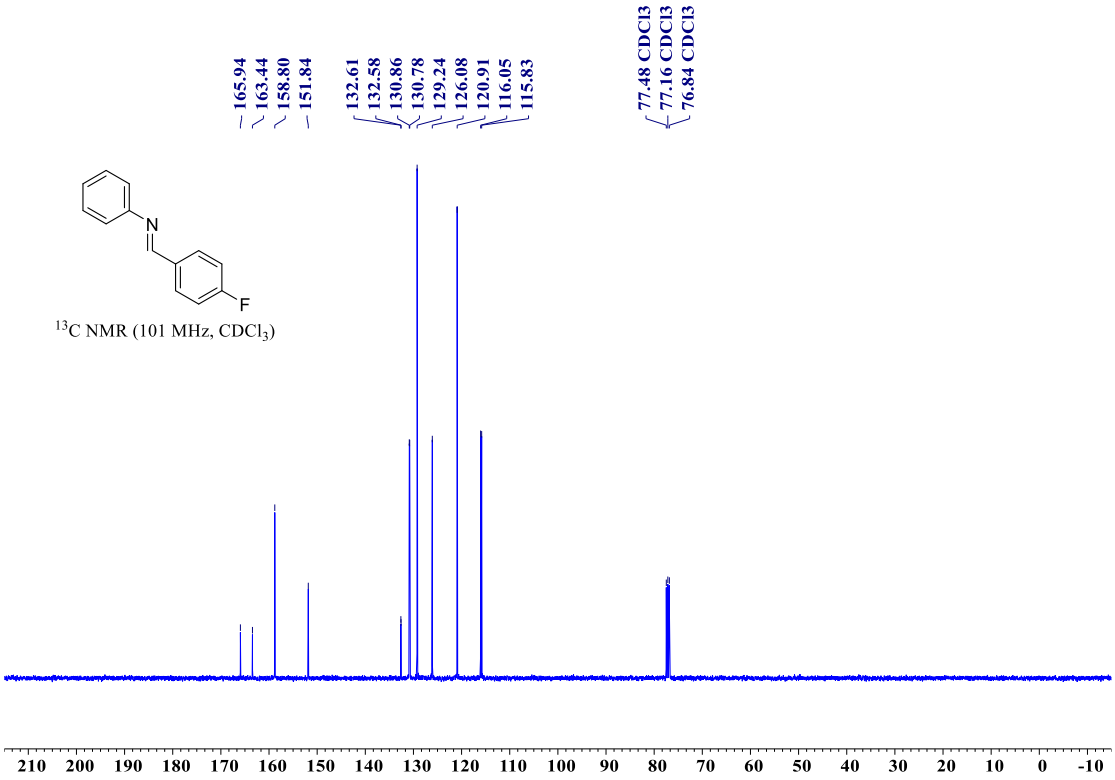
^{1}H NMR (400 MHz, $CDCl_3$)

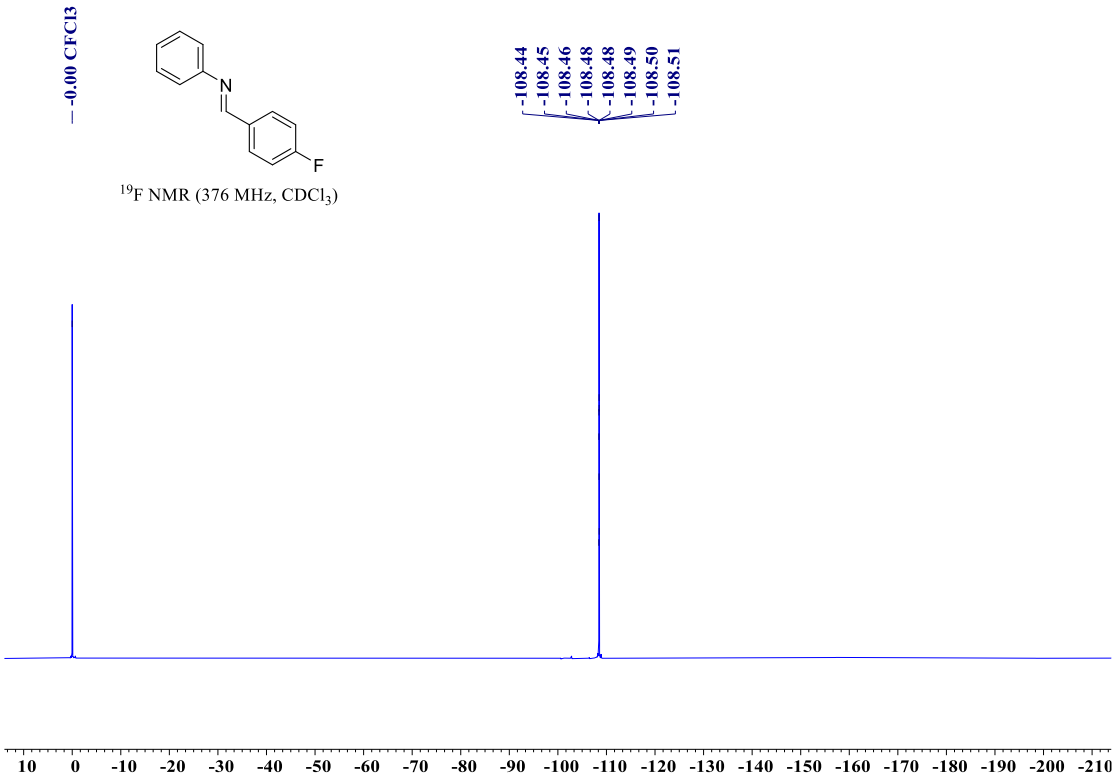


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 4c

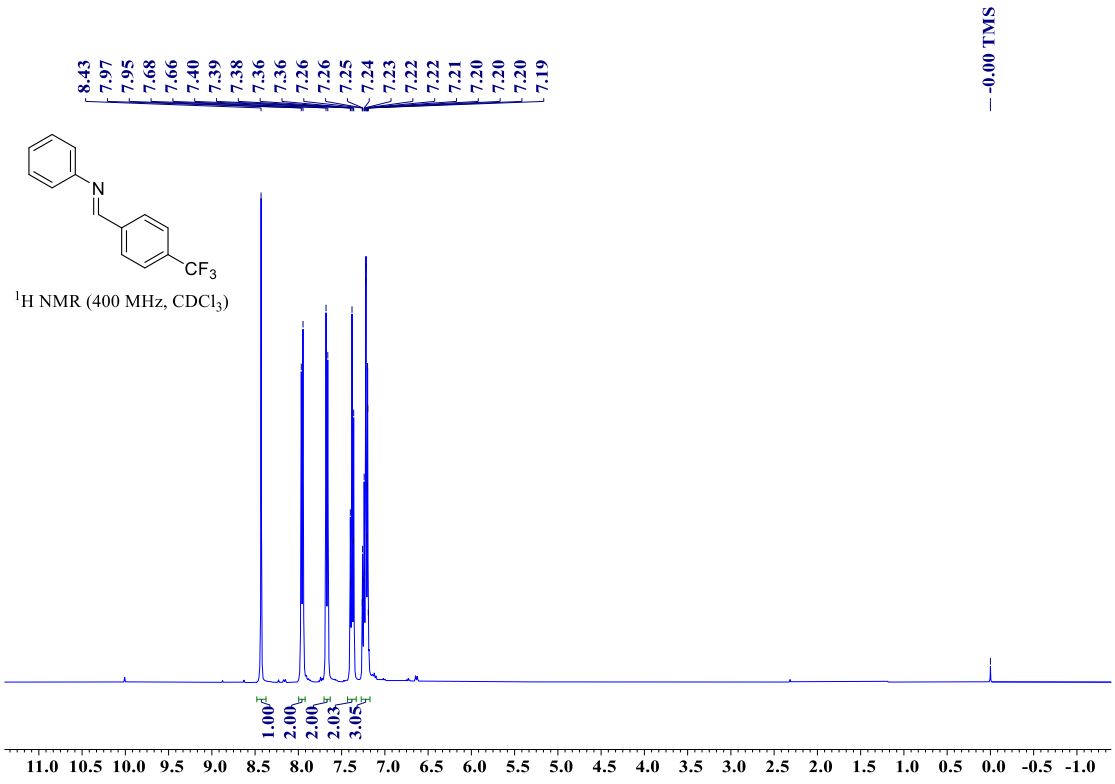




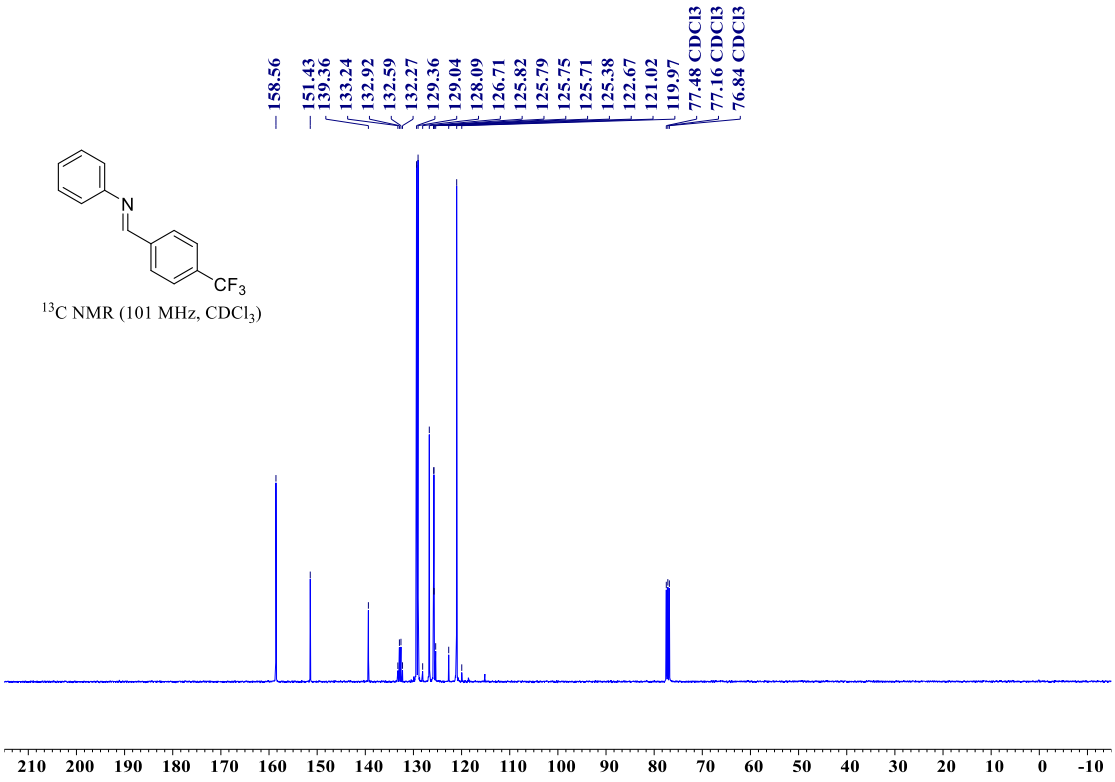


^{19}F NMR (376 MHz, $CDCl_3$)

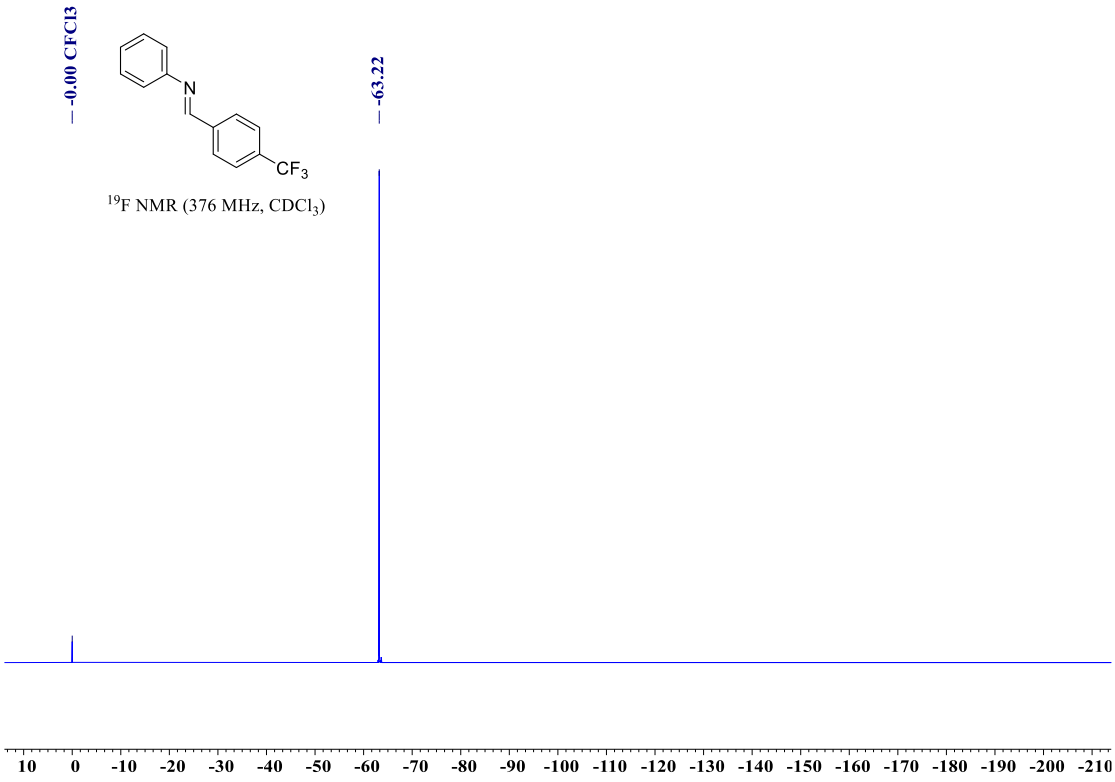
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 4d



^{1}H NMR (400 MHz, $CDCl_3$)

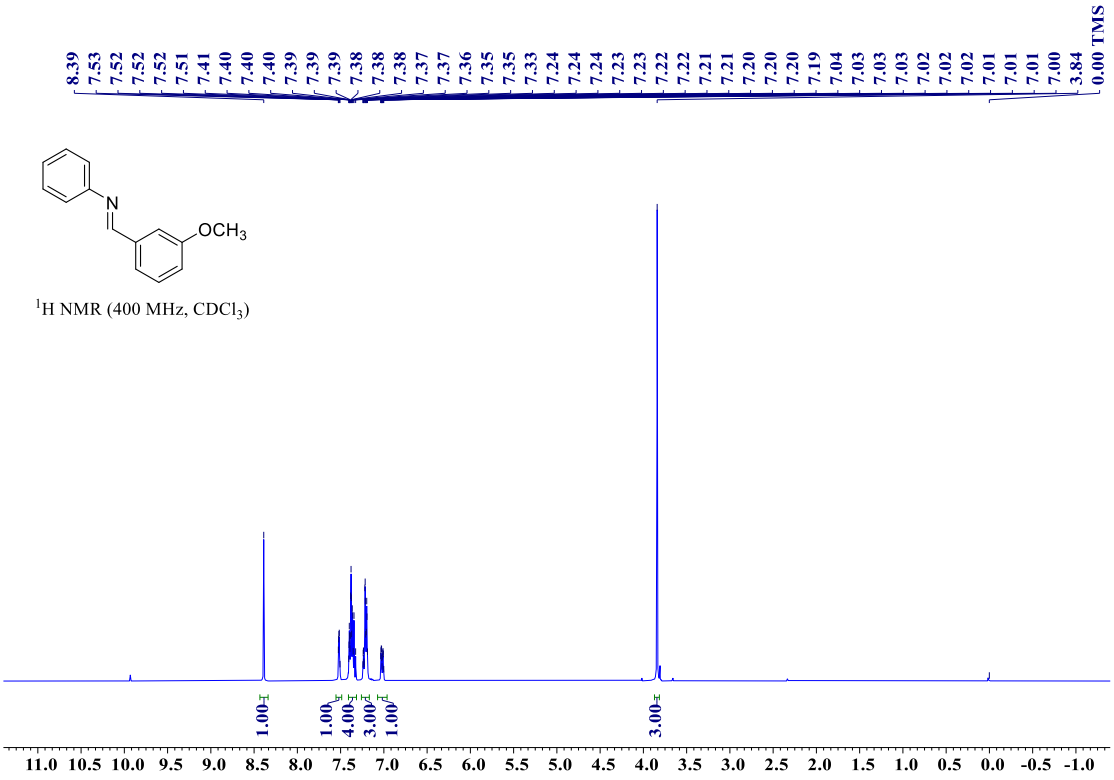


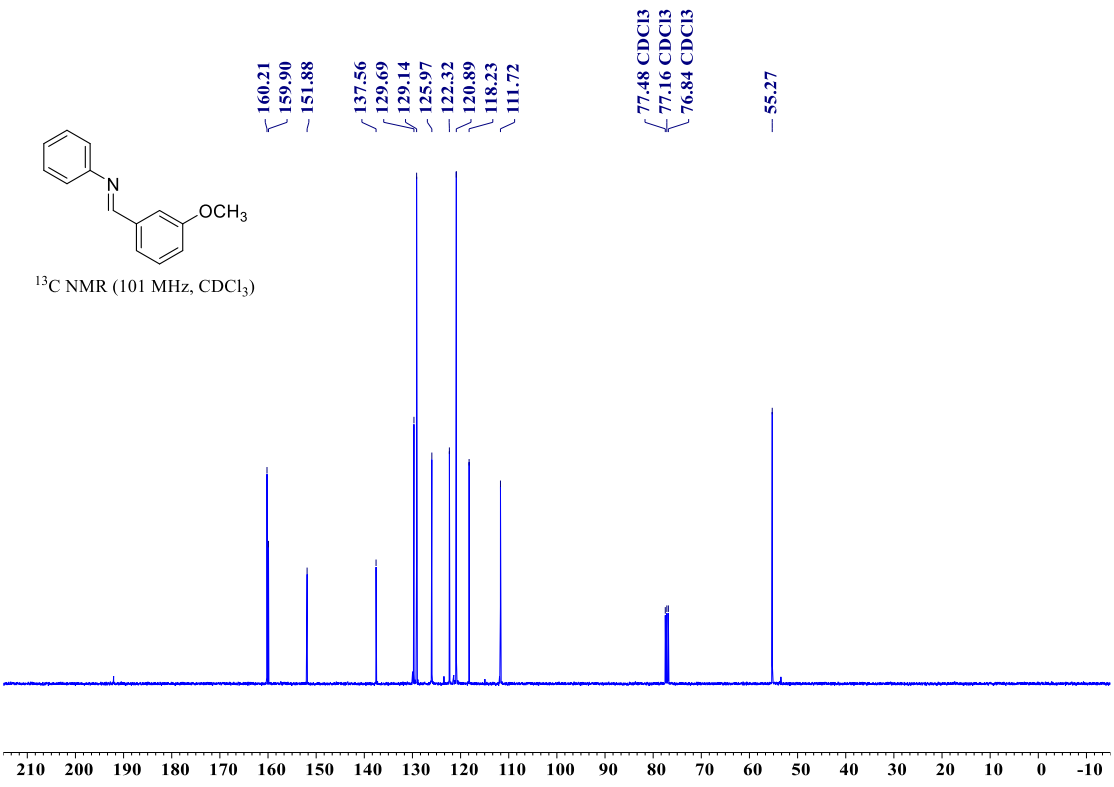
^{13}C NMR (101 MHz, $CDCl_3$)



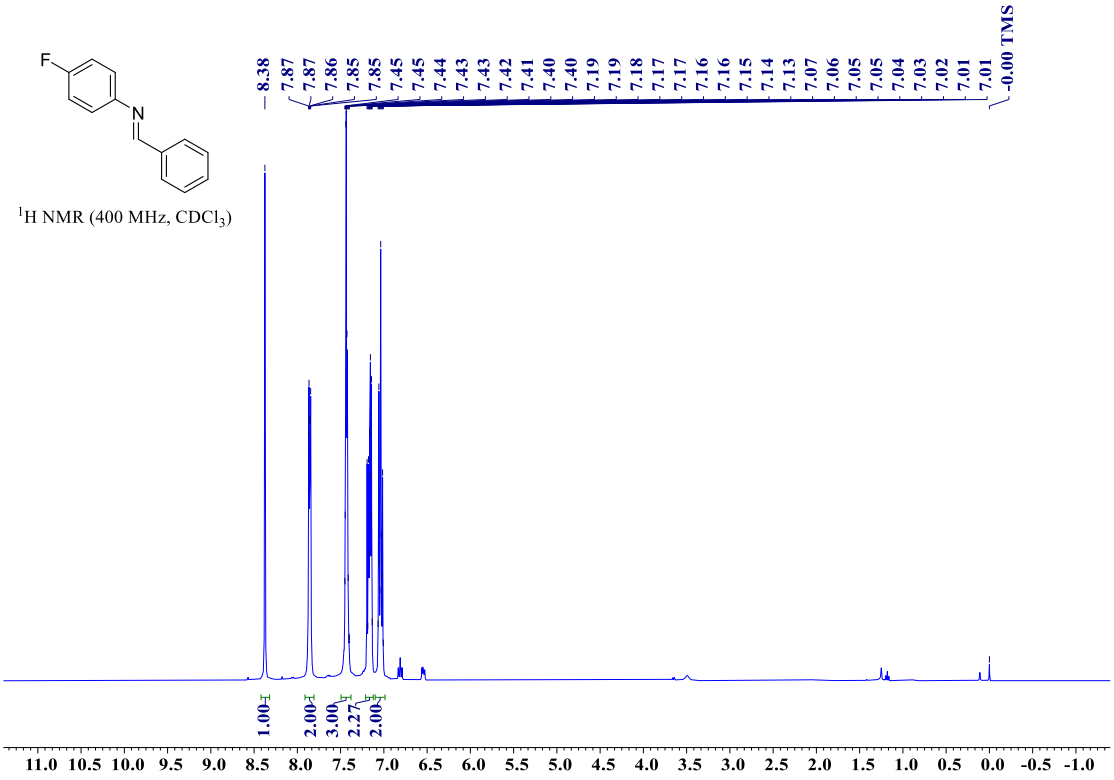
^{19}F NMR (376 MHz, $CDCl_3$)

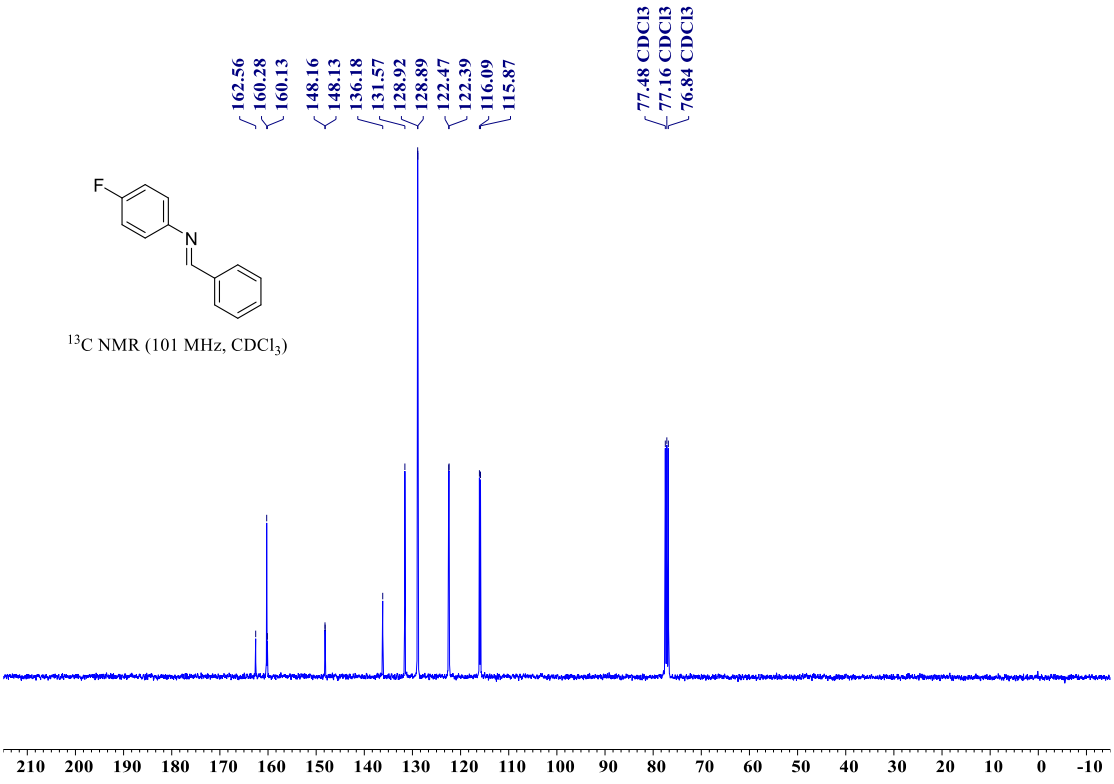
^{1}H and ^{13}C NMR spectra of compound 4e

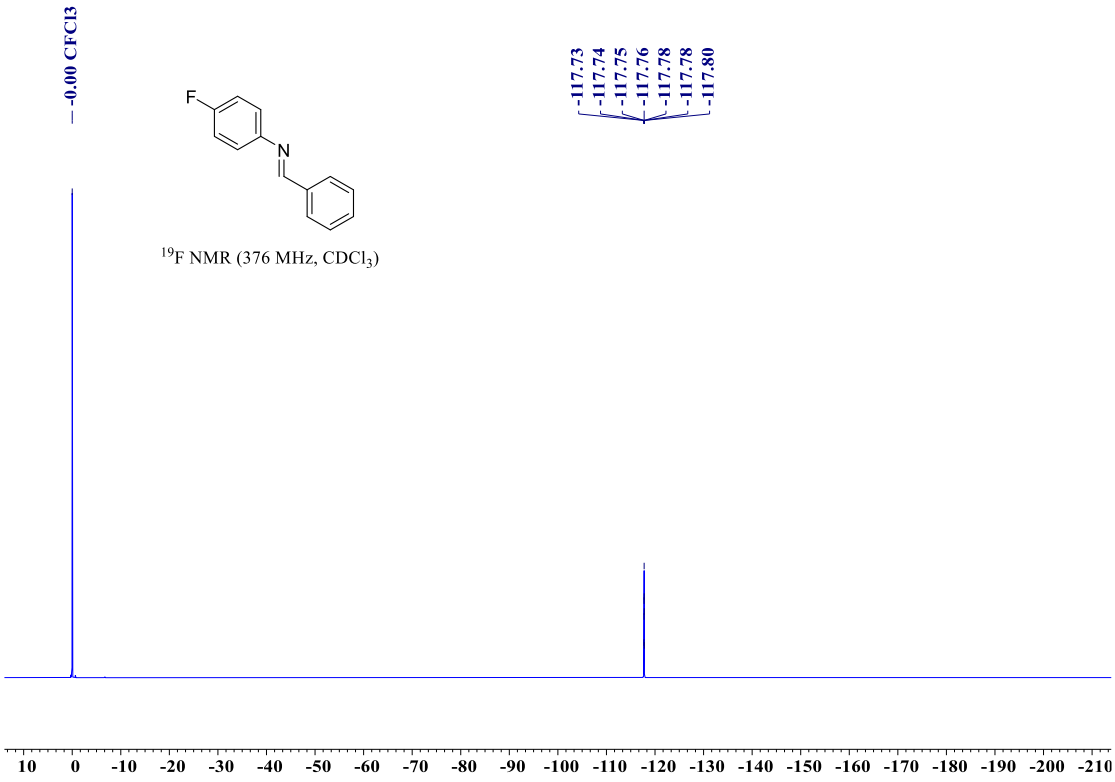




^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 4f

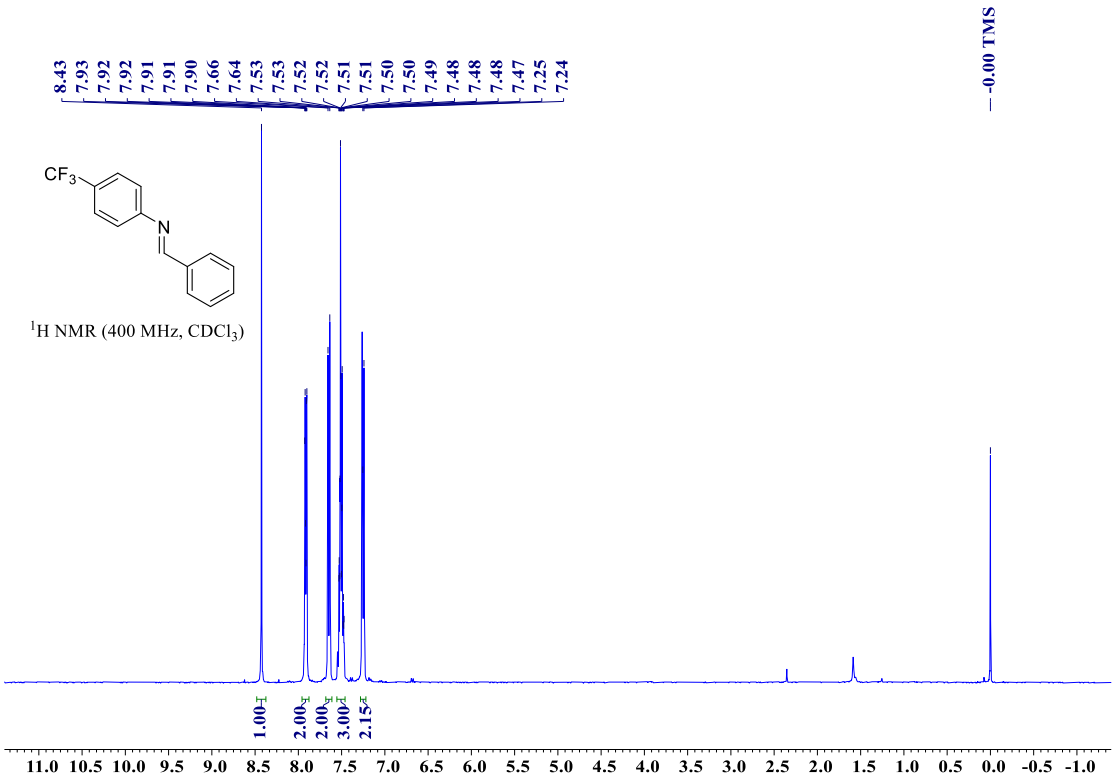




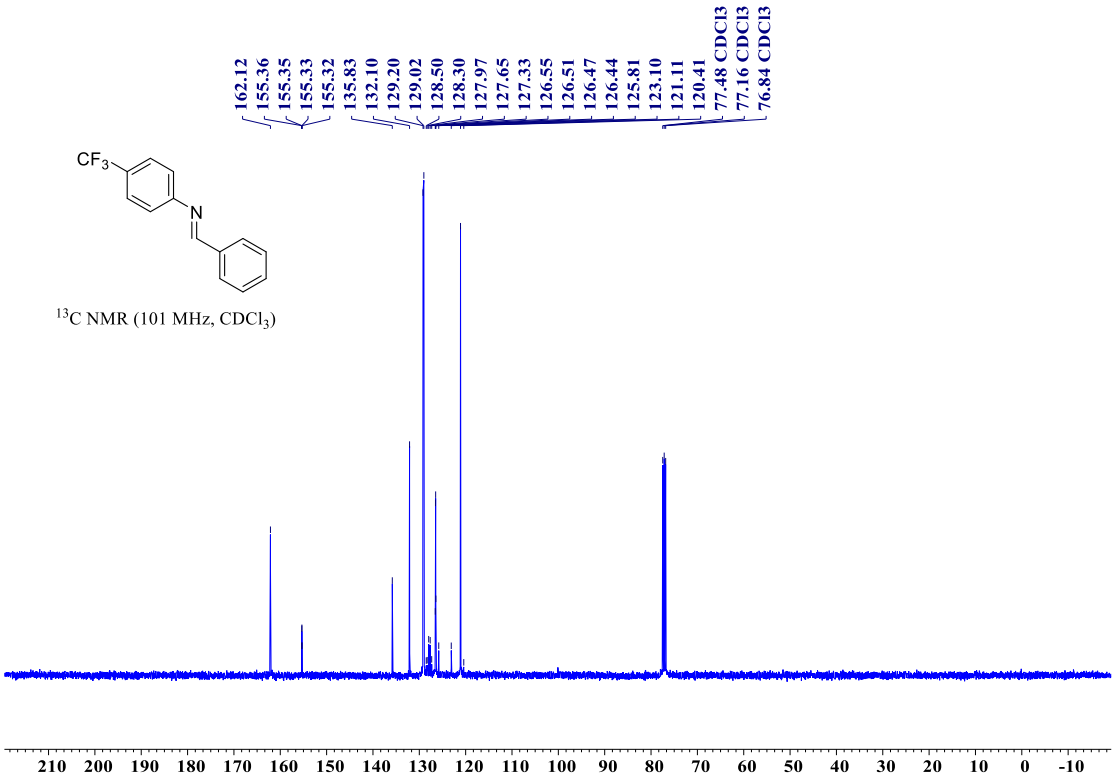


^{19}F NMR (376 MHz, $CDCl_3$)

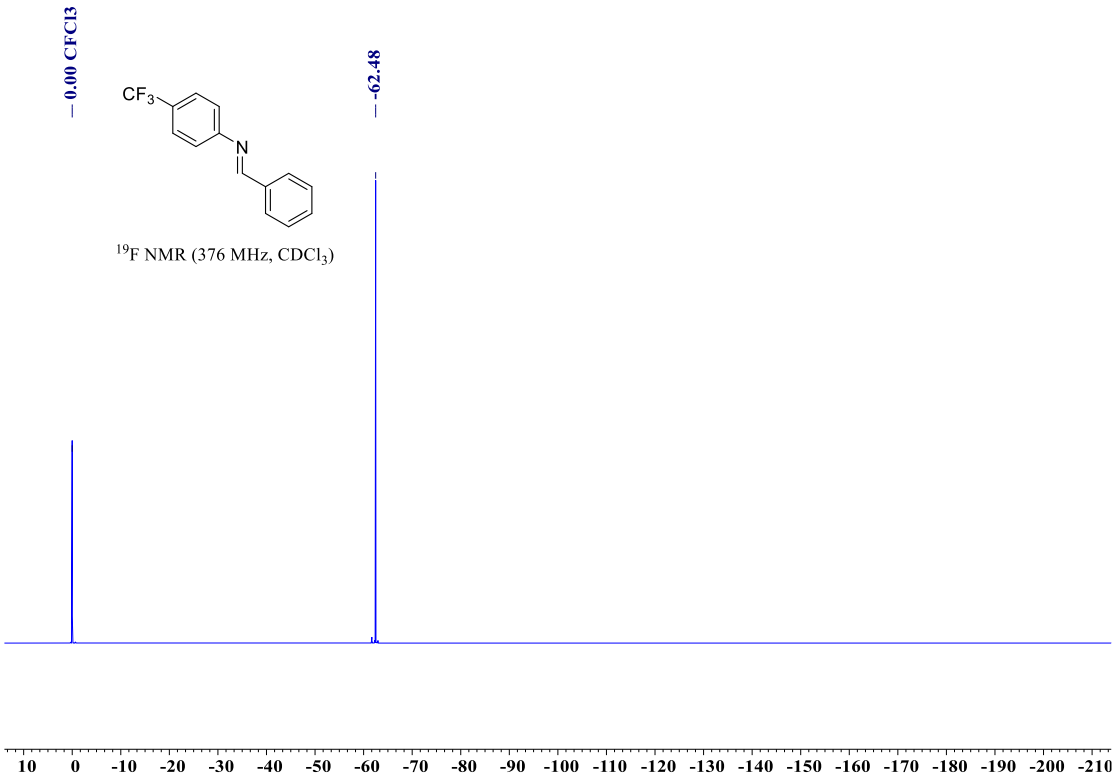
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 4g



^{1}H NMR (400 MHz, $CDCl_3$)

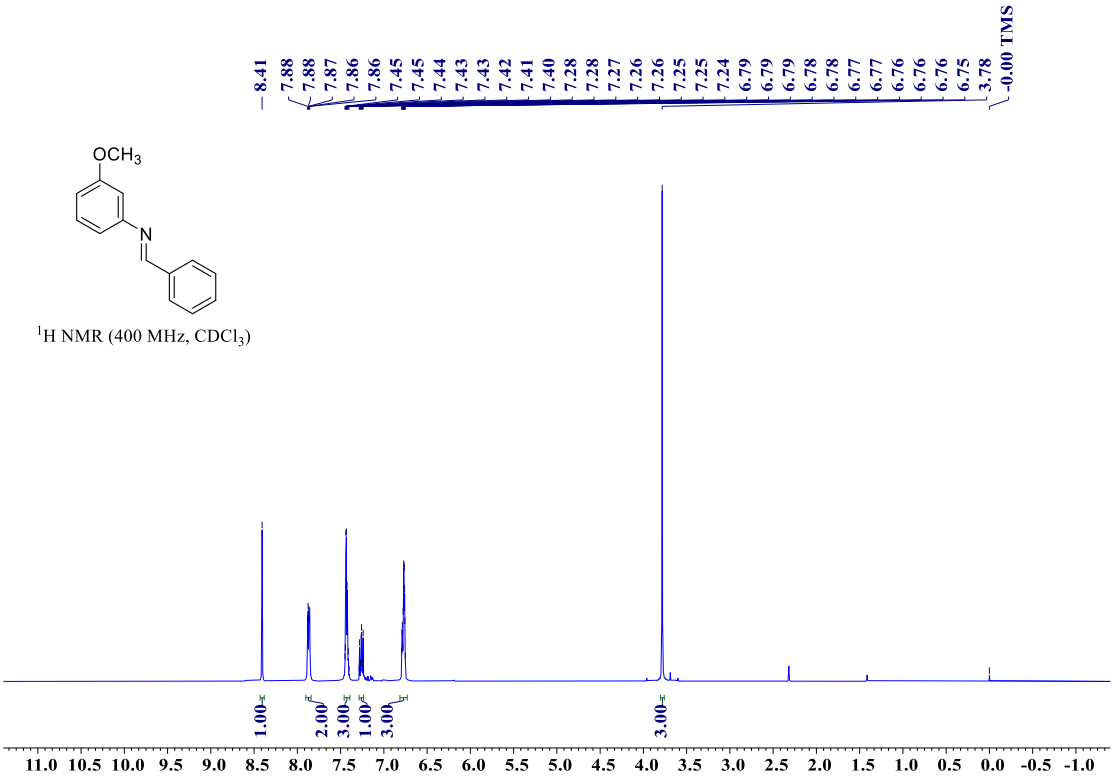


^{13}C NMR (101 MHz, $CDCl_3$)

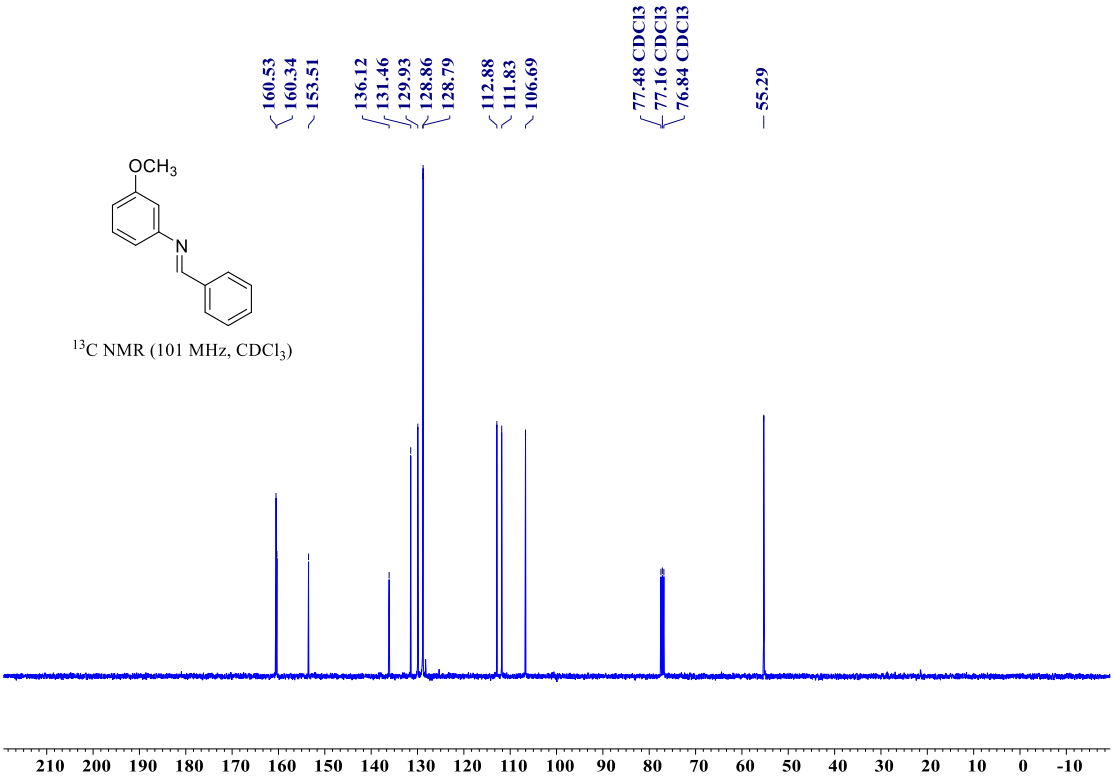


^{19}F NMR (376 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 4h

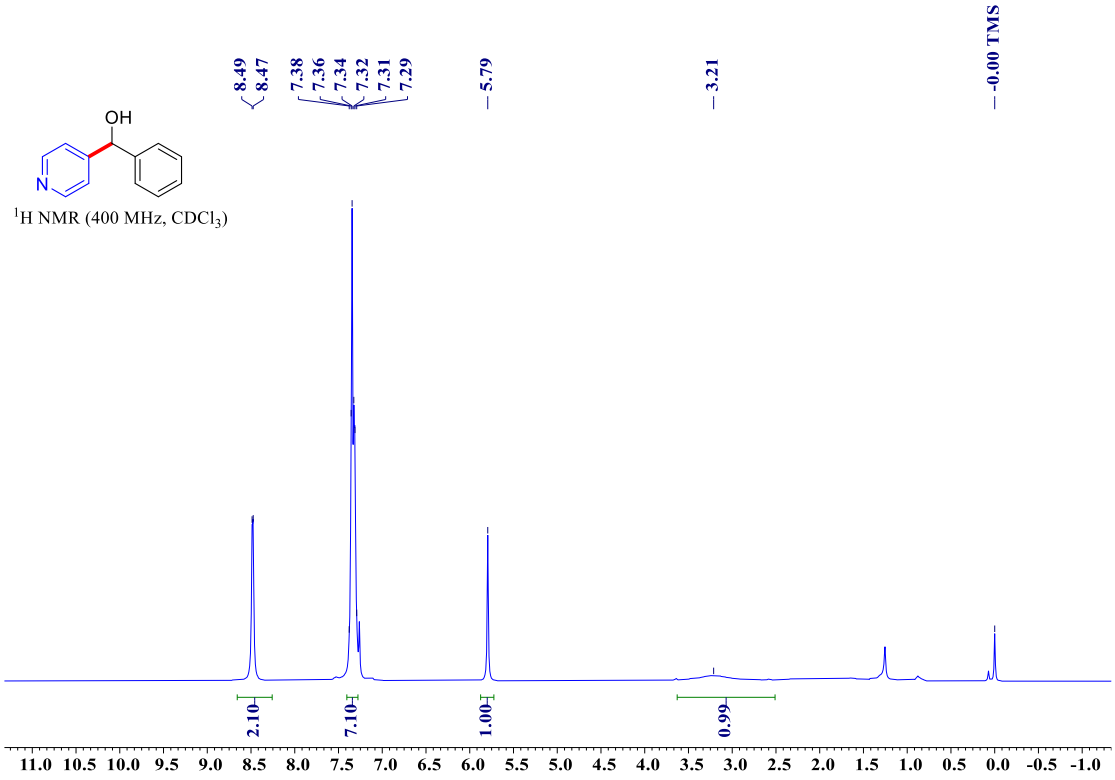


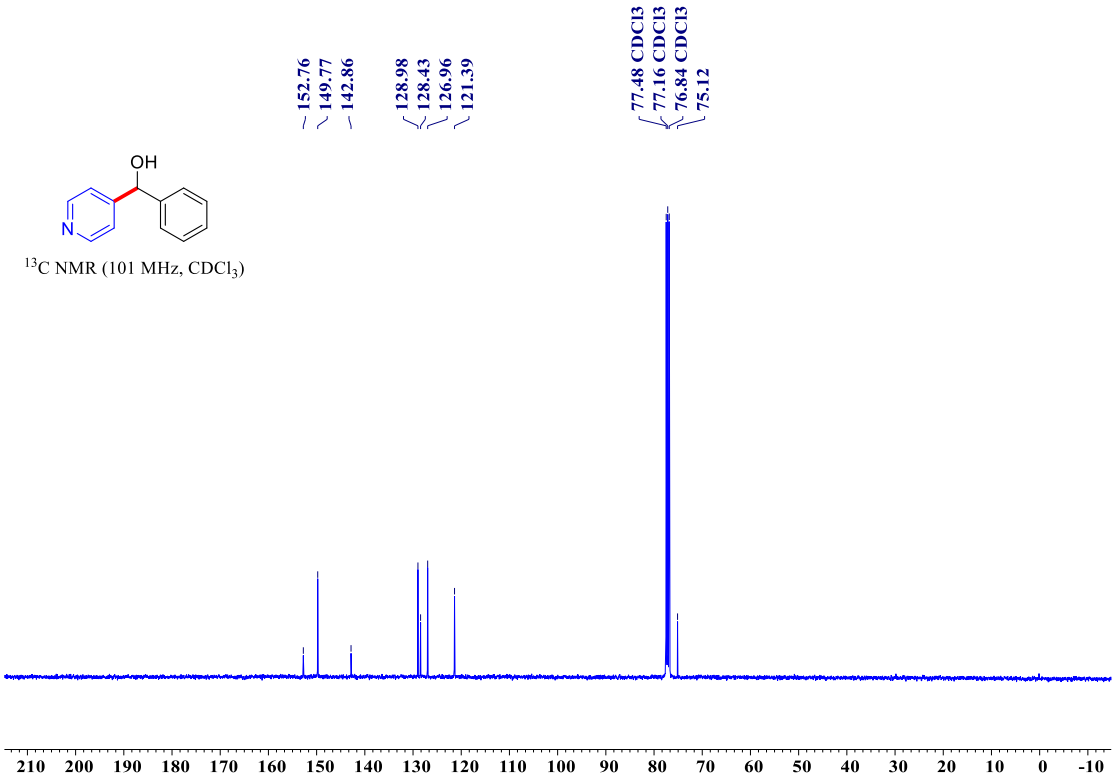
^{1}H NMR (400 MHz, $CDCl_3$)



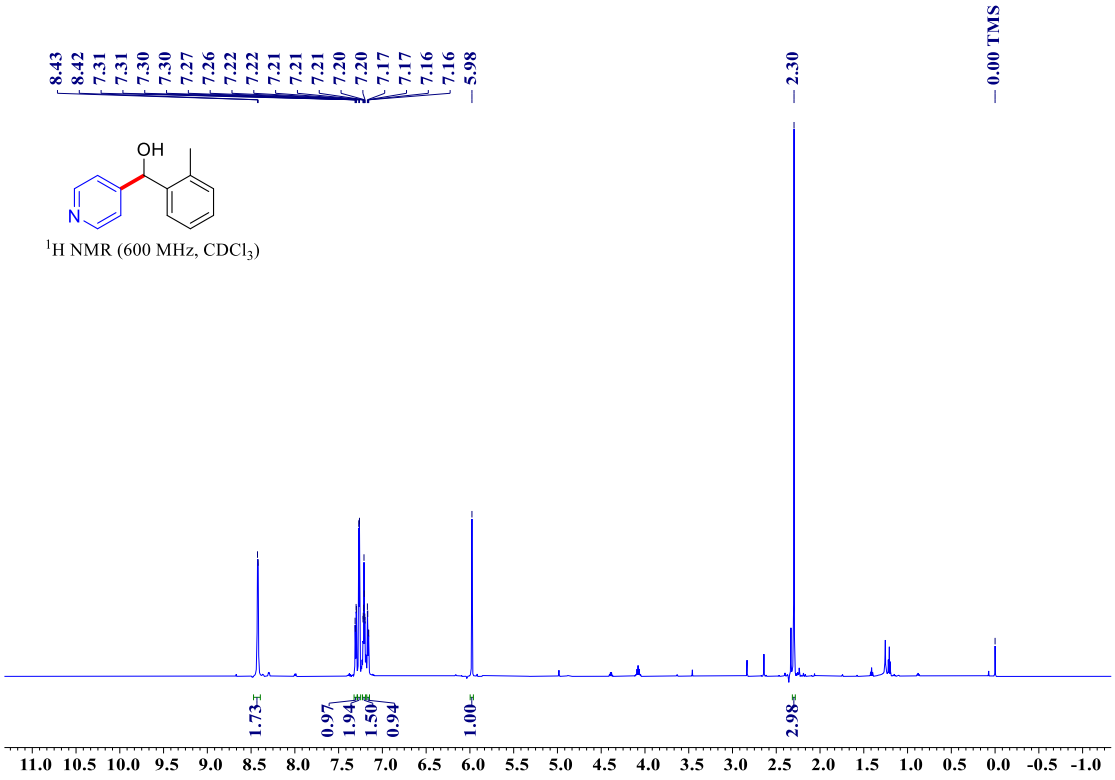
^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3a

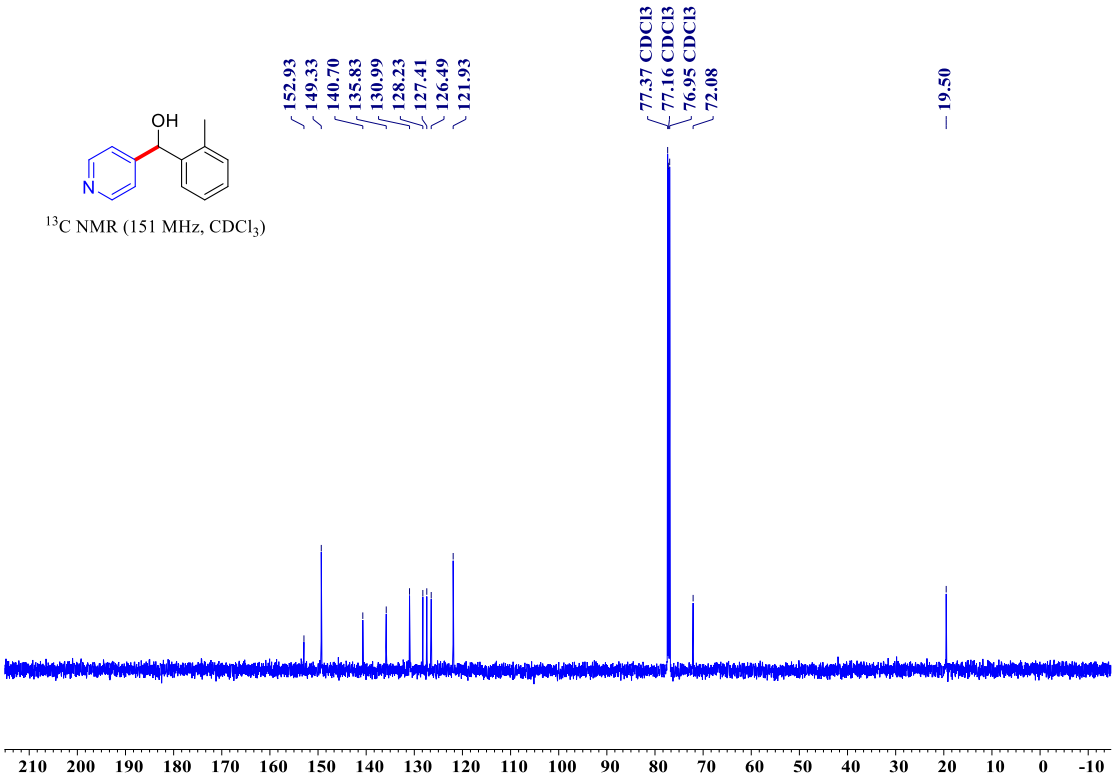




^{1}H and ^{13}C NMR spectra of compound 3b

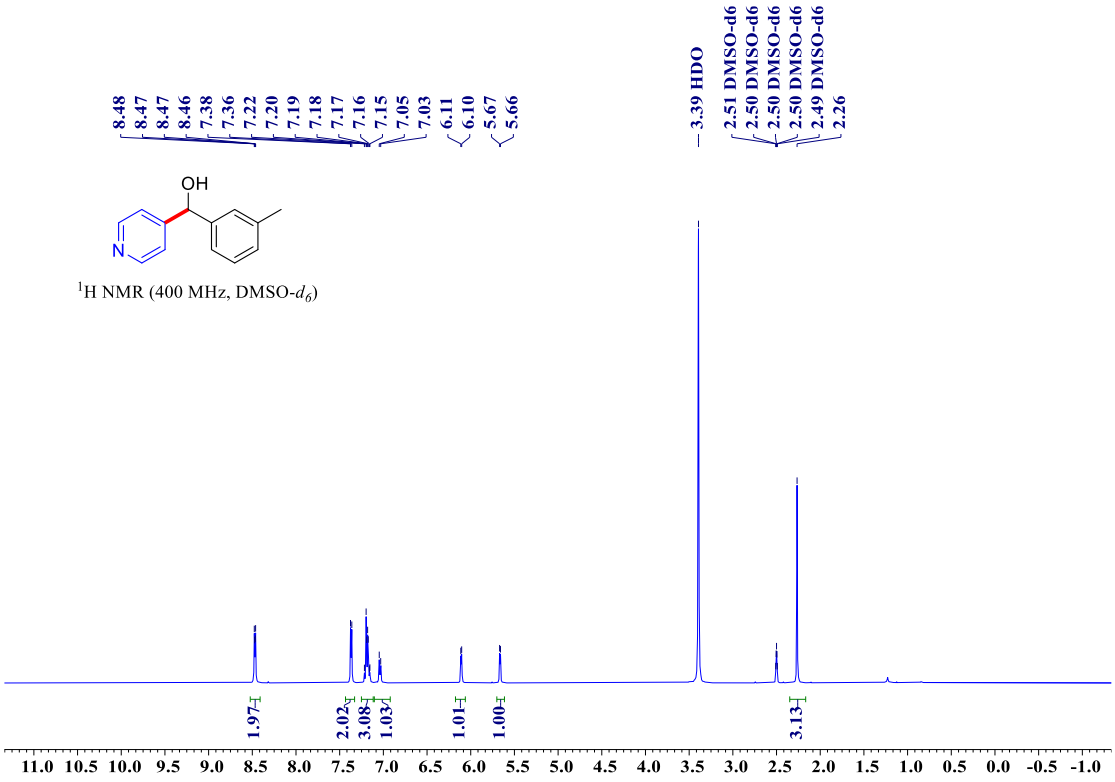


^{1}H NMR (600 MHz, $CDCl_3$)

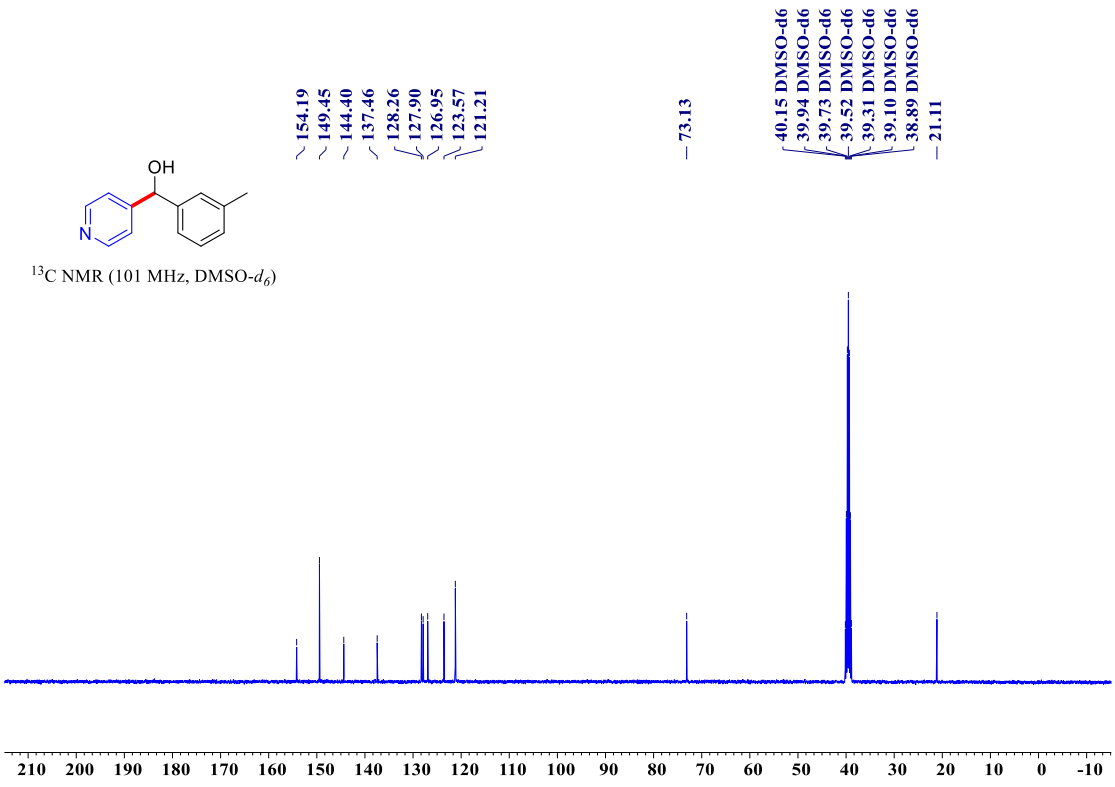


^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3c

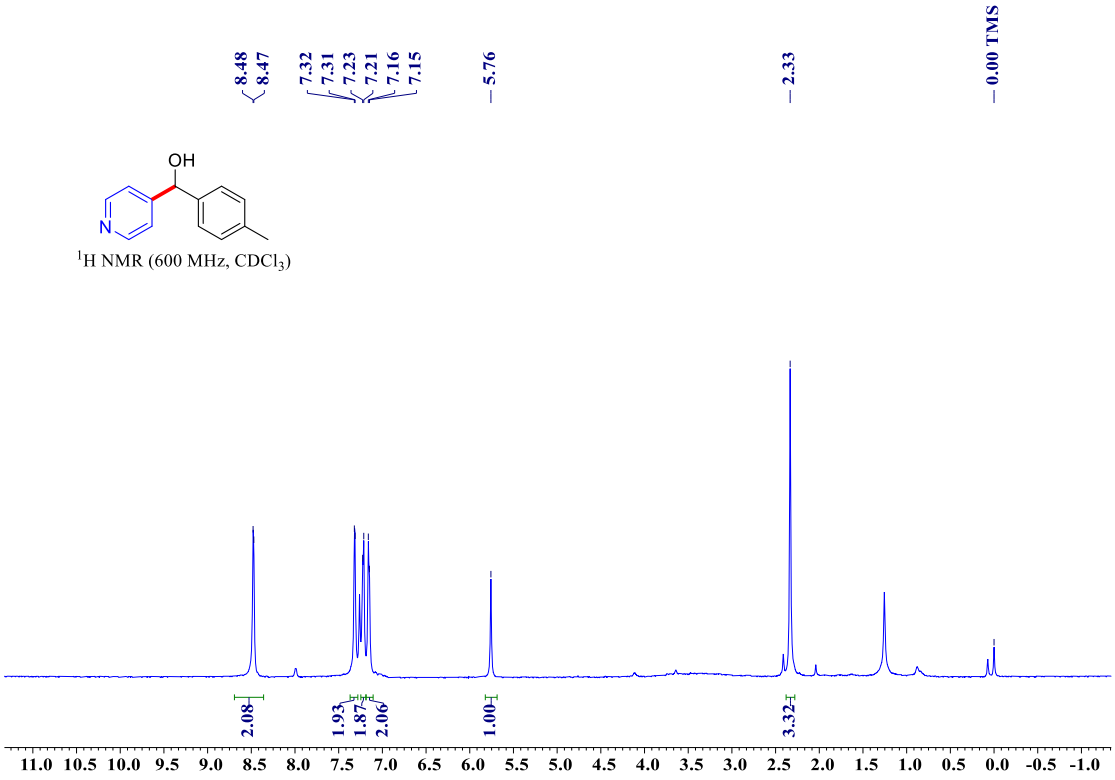


^{1}H NMR (400 MHz, DMSO-d_6)

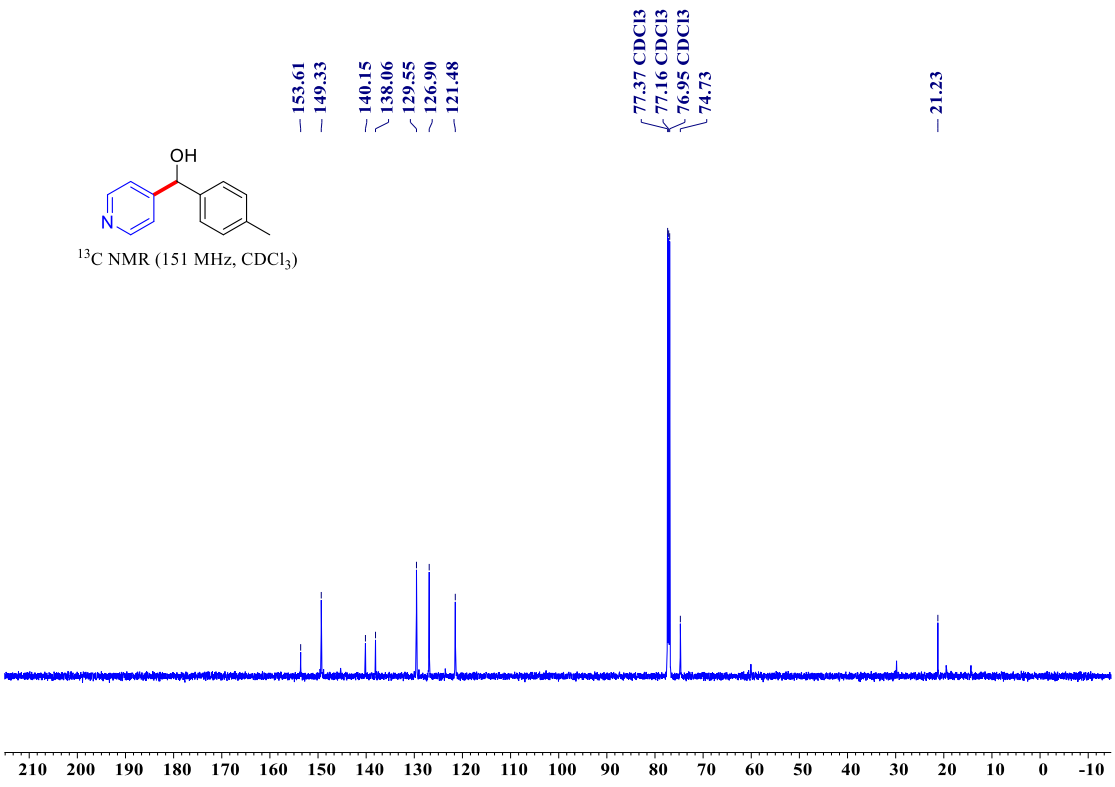


^{13}C NMR (101 MHz, DMSO-d_6)

^{1}H and ^{13}C NMR spectra of compound 3d

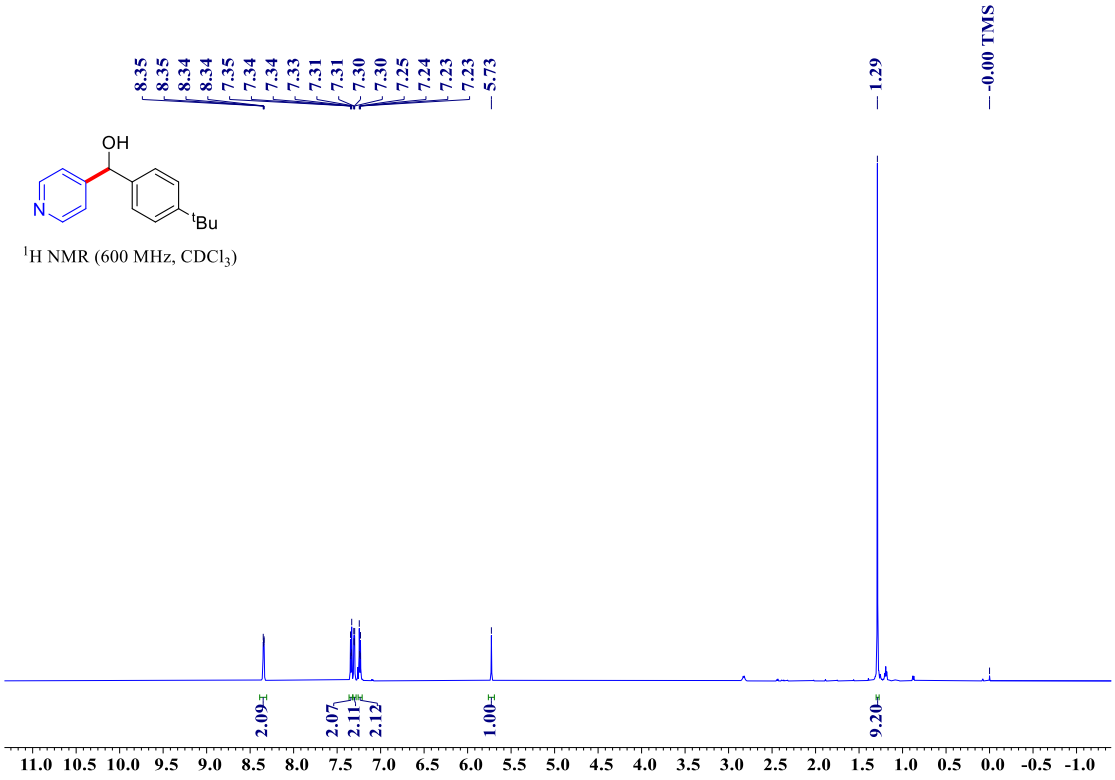


^{1}H NMR (600 MHz, $CDCl_3$)

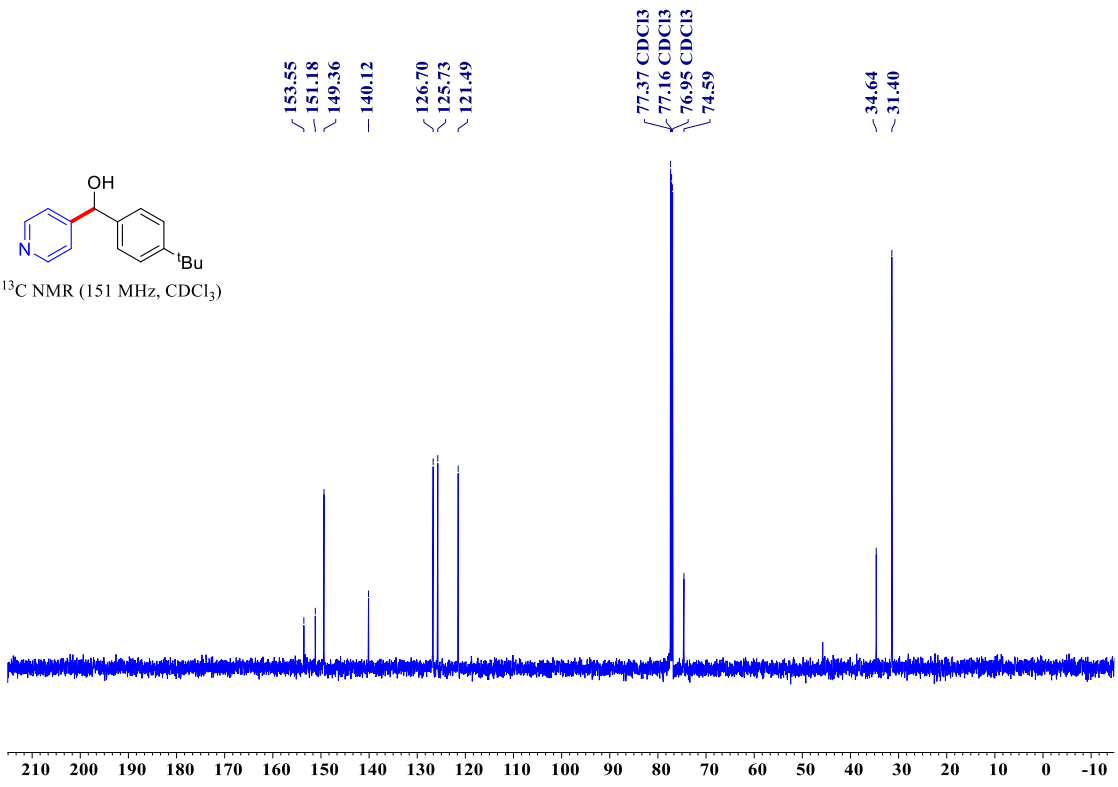


^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3e

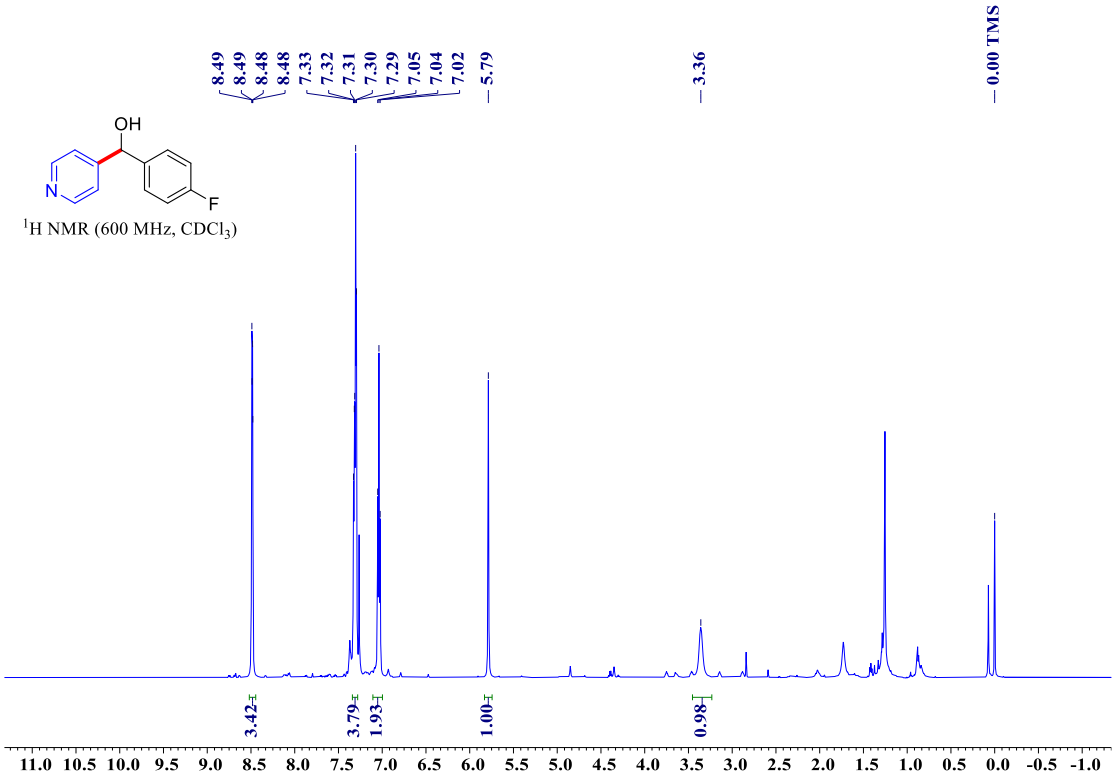


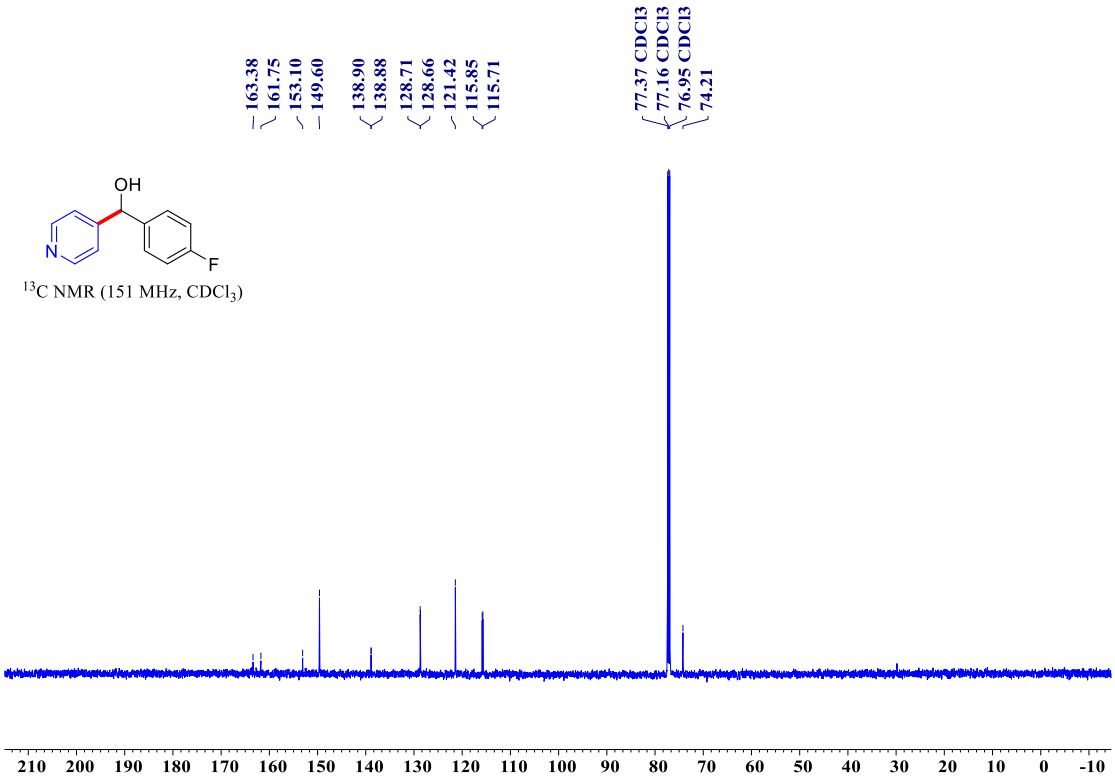
^{1}H NMR (600 MHz, $CDCl_3$)

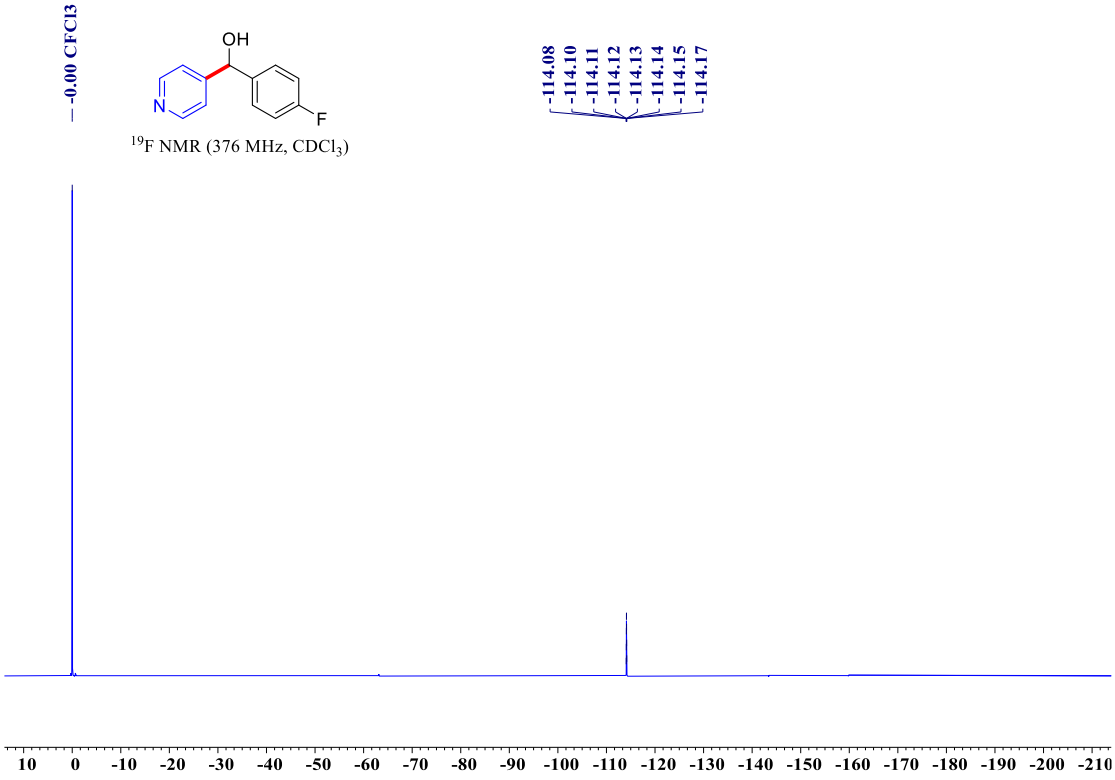


^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 3f

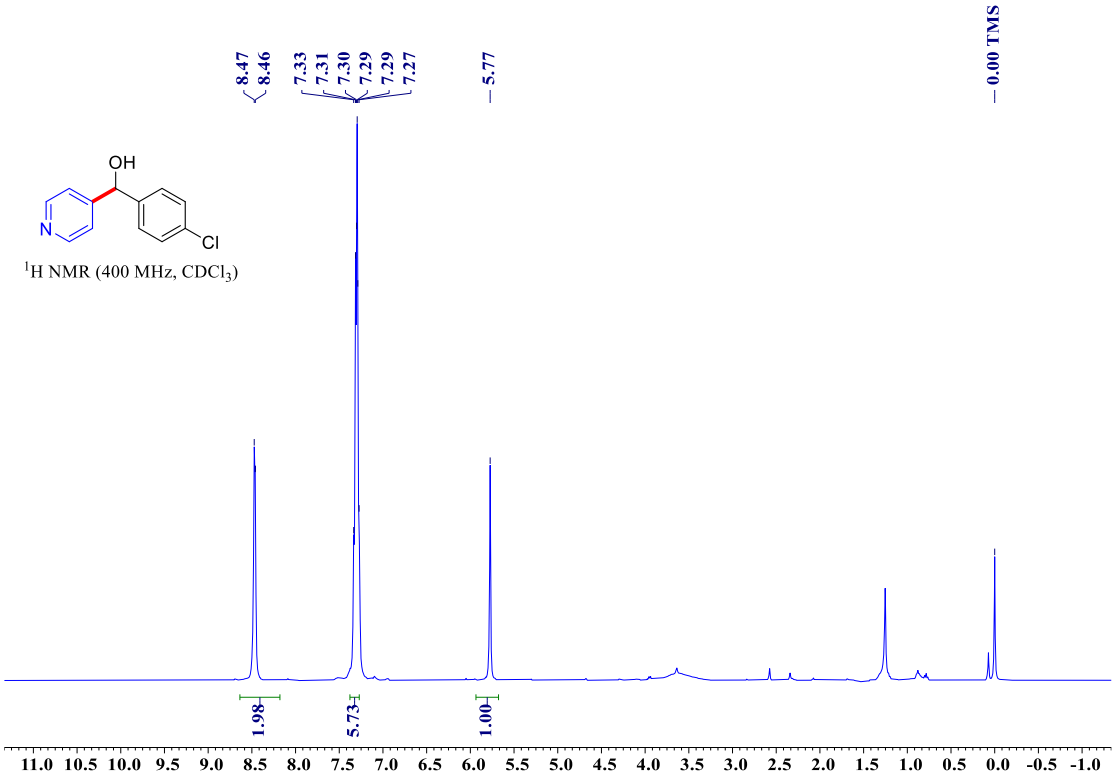




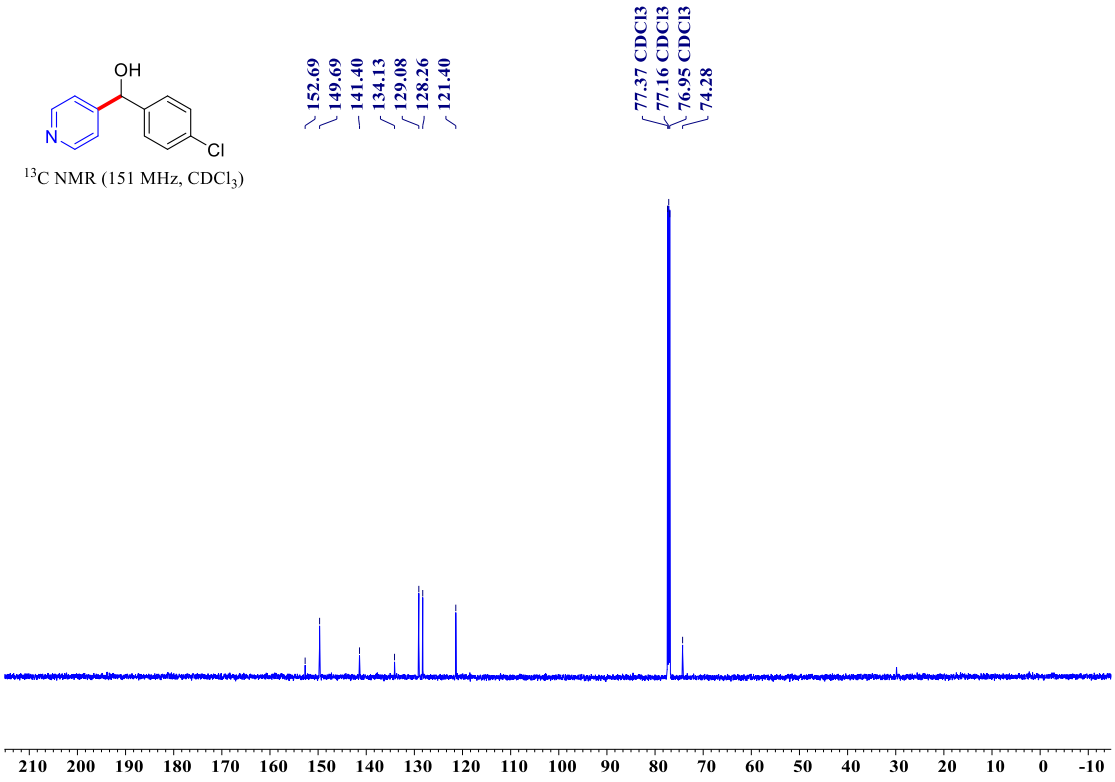


^{19}F NMR (376 MHz, $CDCl_3$)

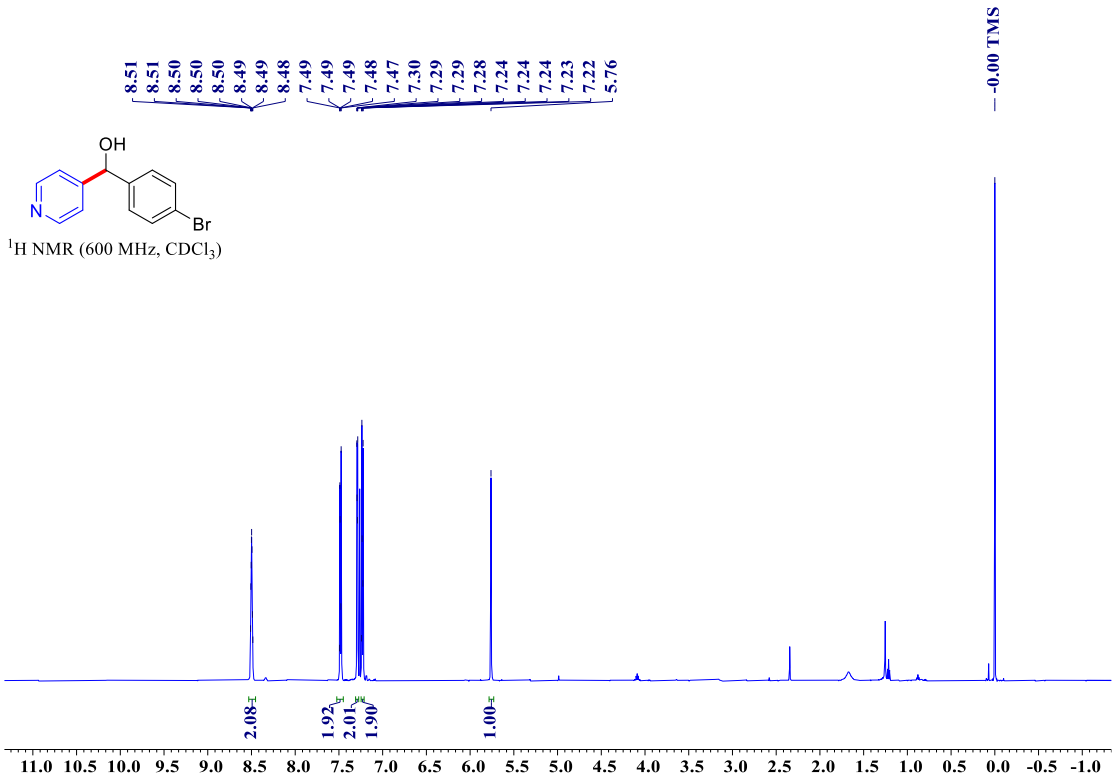
^{1}H and ^{13}C NMR spectra of compound 3g

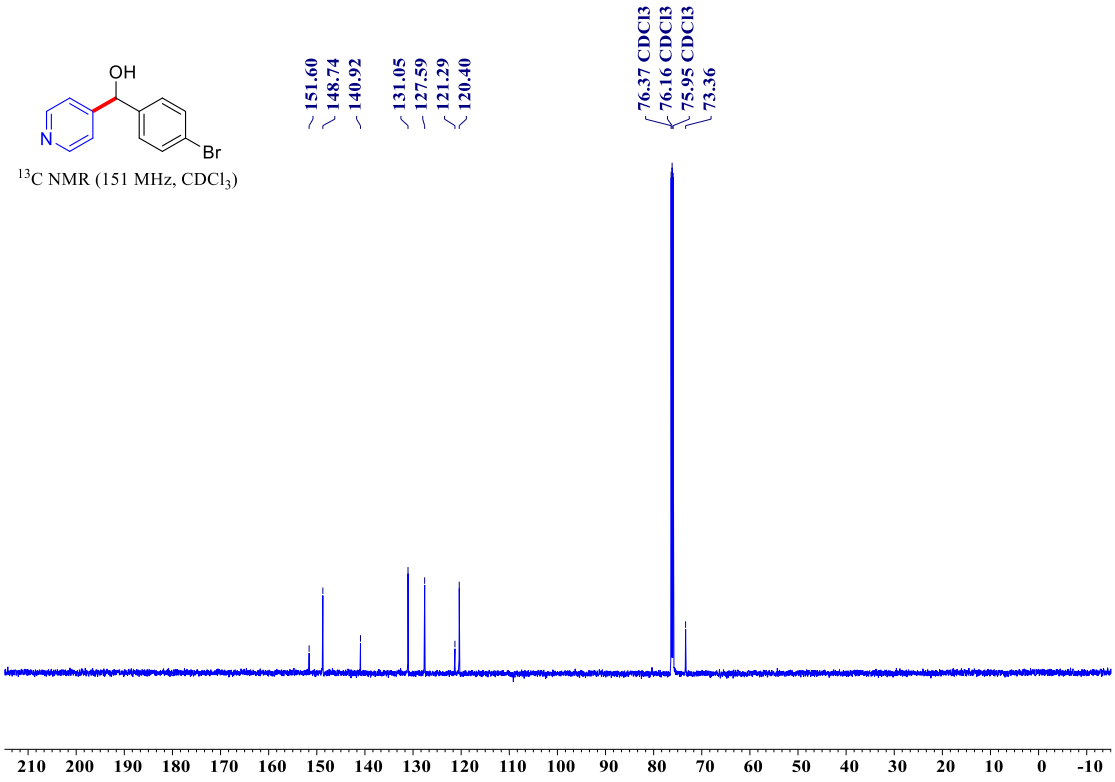


^{1}H NMR (400 MHz, $CDCl_3$)

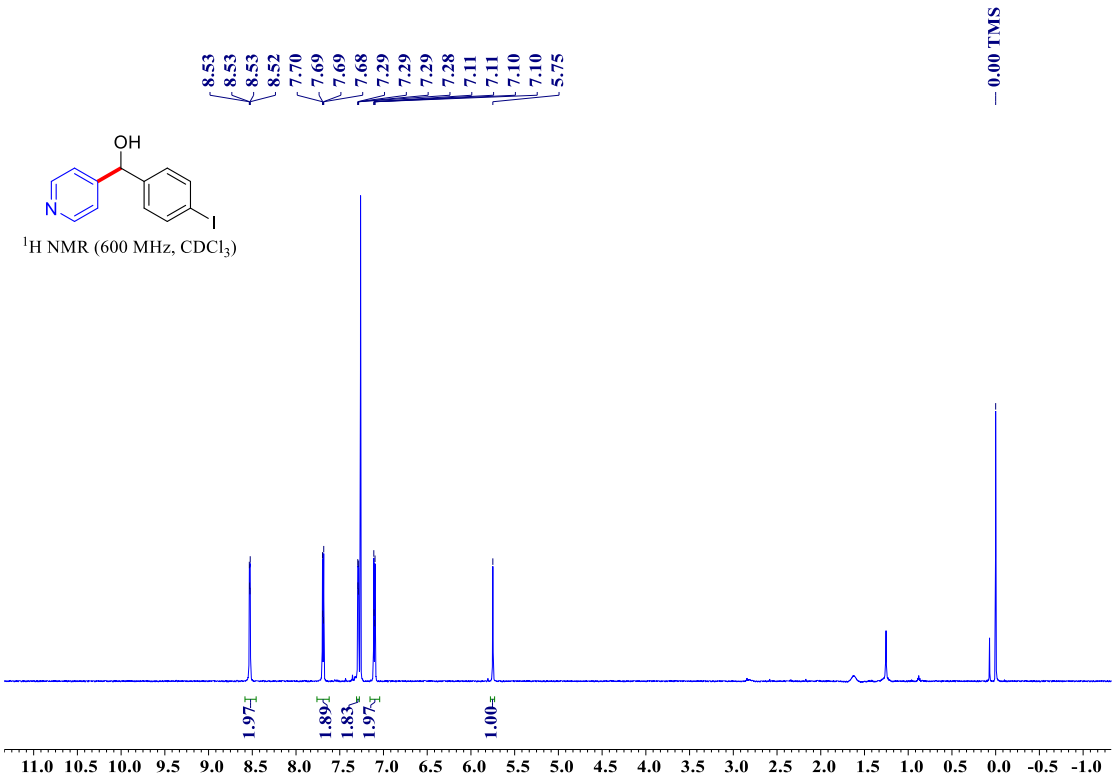


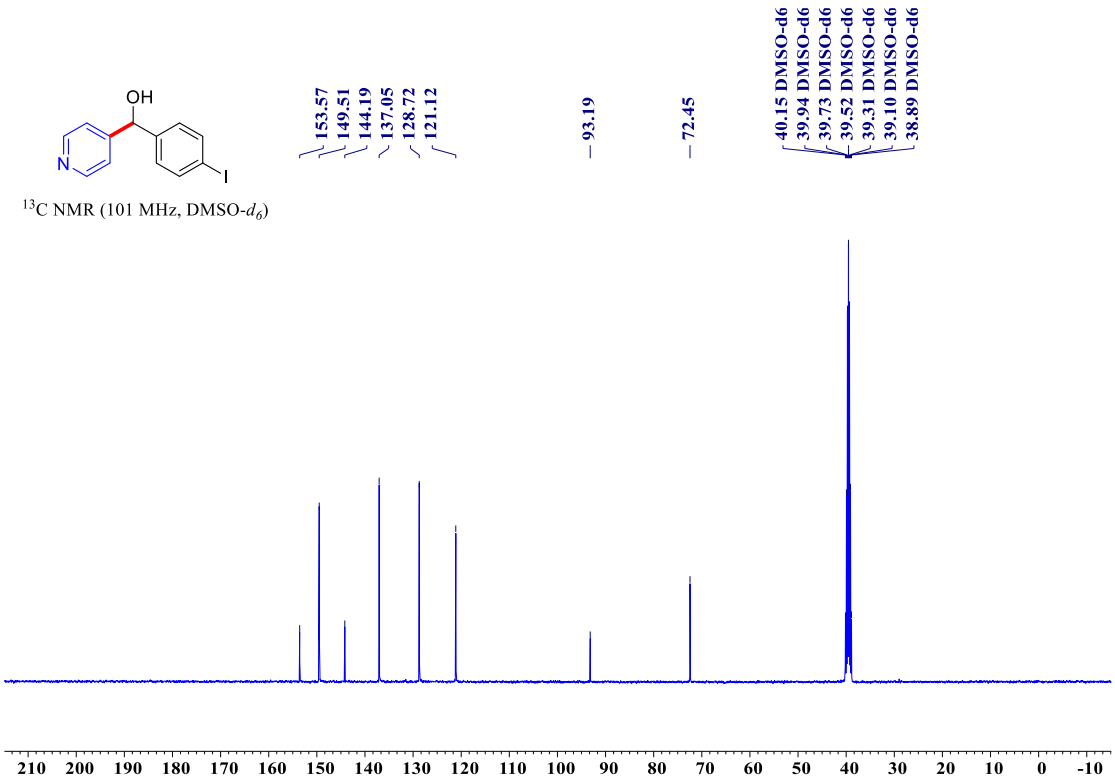
^{1}H and ^{13}C NMR spectra of compound 3h





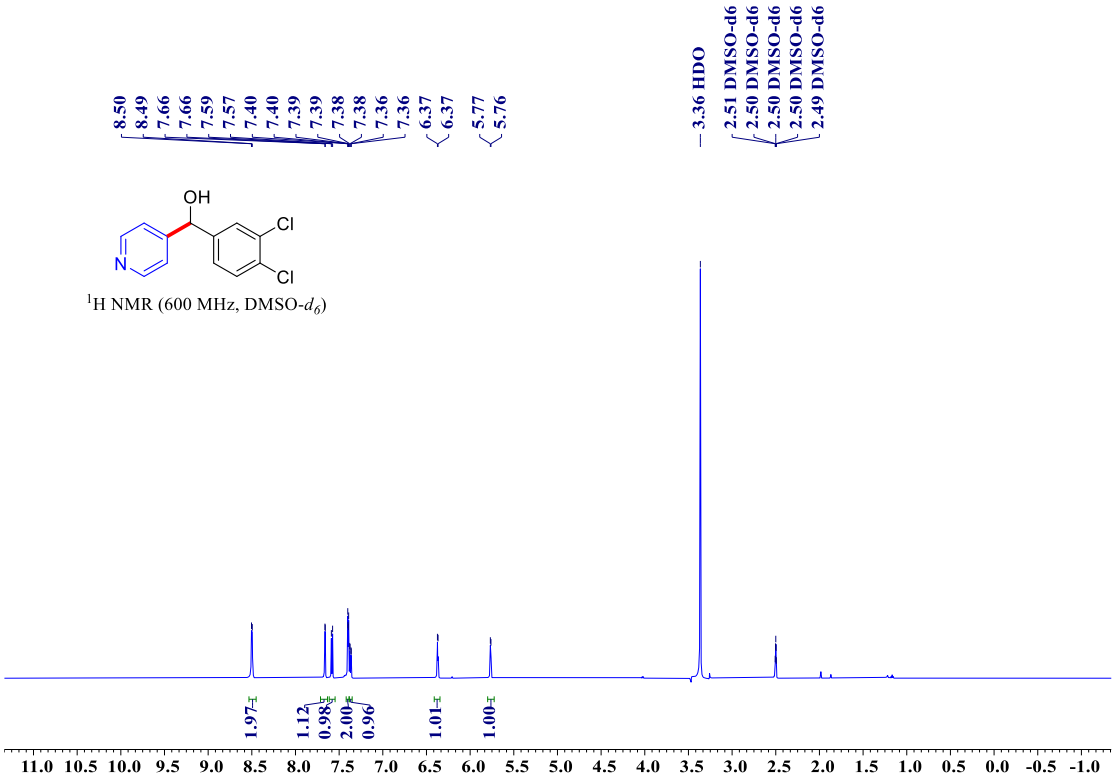
^{1}H and ^{13}C NMR spectra of compound 3i



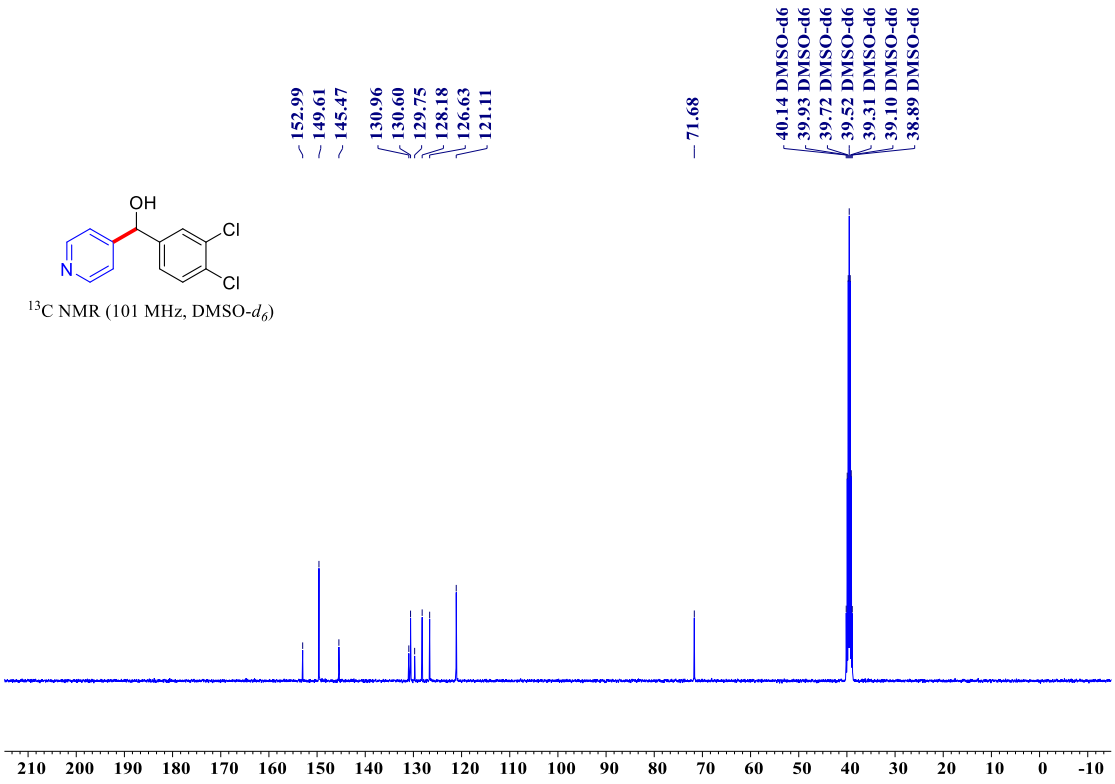


^{13}C NMR (101 MHz, DMSO-d_6)

^{1}H and ^{13}C NMR spectra of compound 3j

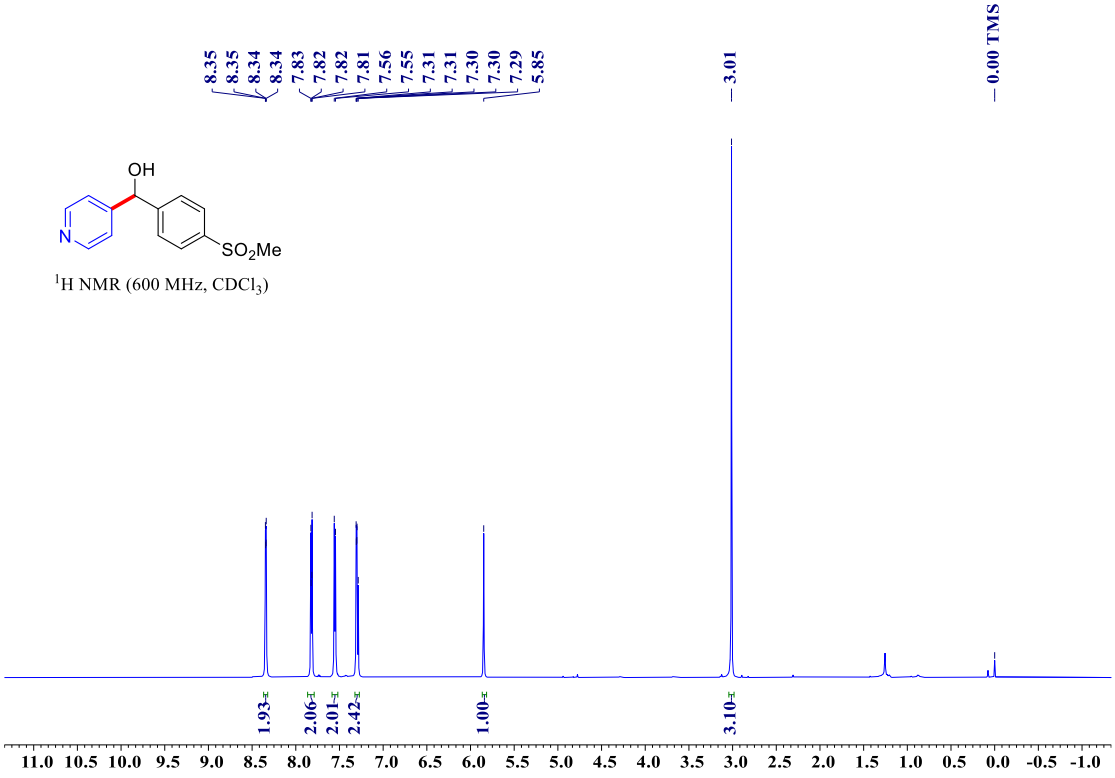


^{1}H NMR (600 MHz, DMSO-d_6)

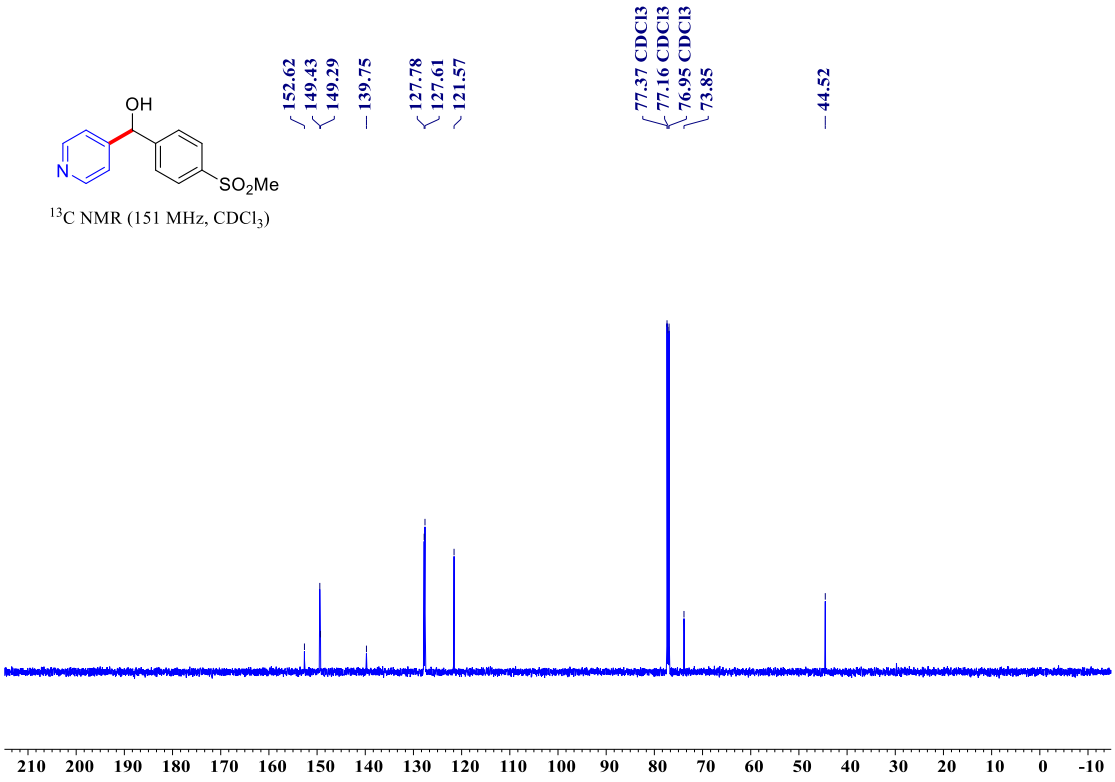


^{13}C NMR (101 MHz, DMSO-d_6)

^{1}H and ^{13}C NMR spectra of compound 3k

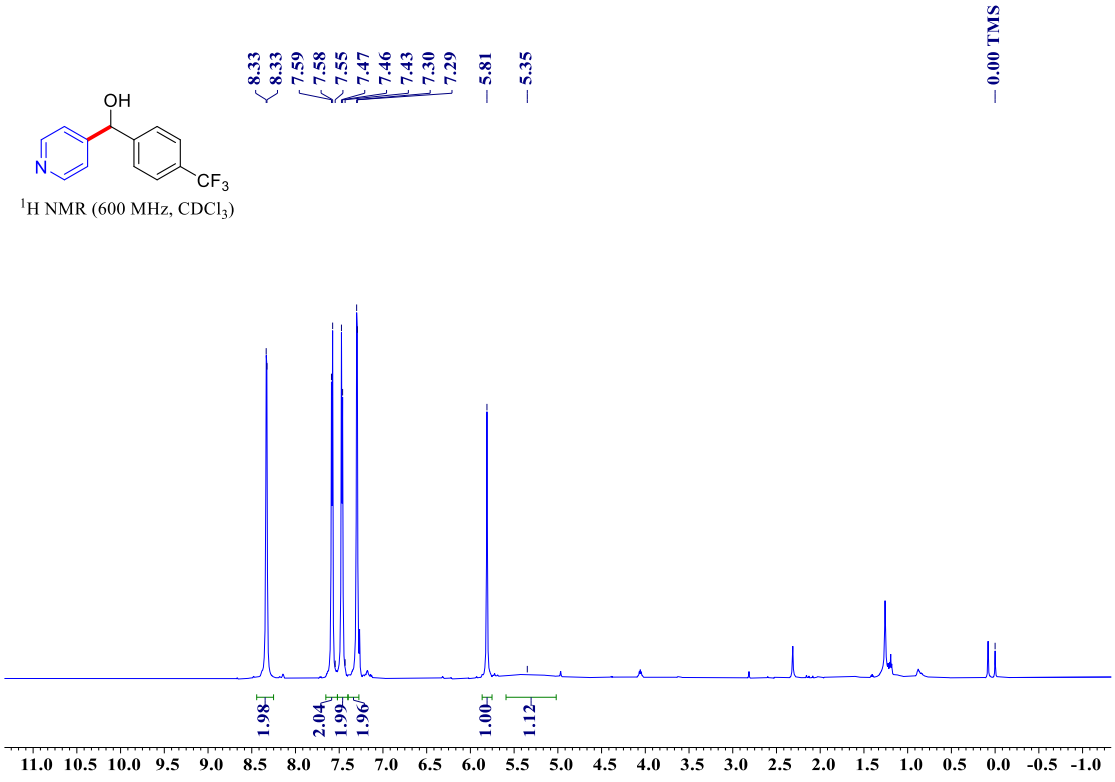


^{1}H NMR (600 MHz, $CDCl_3$)

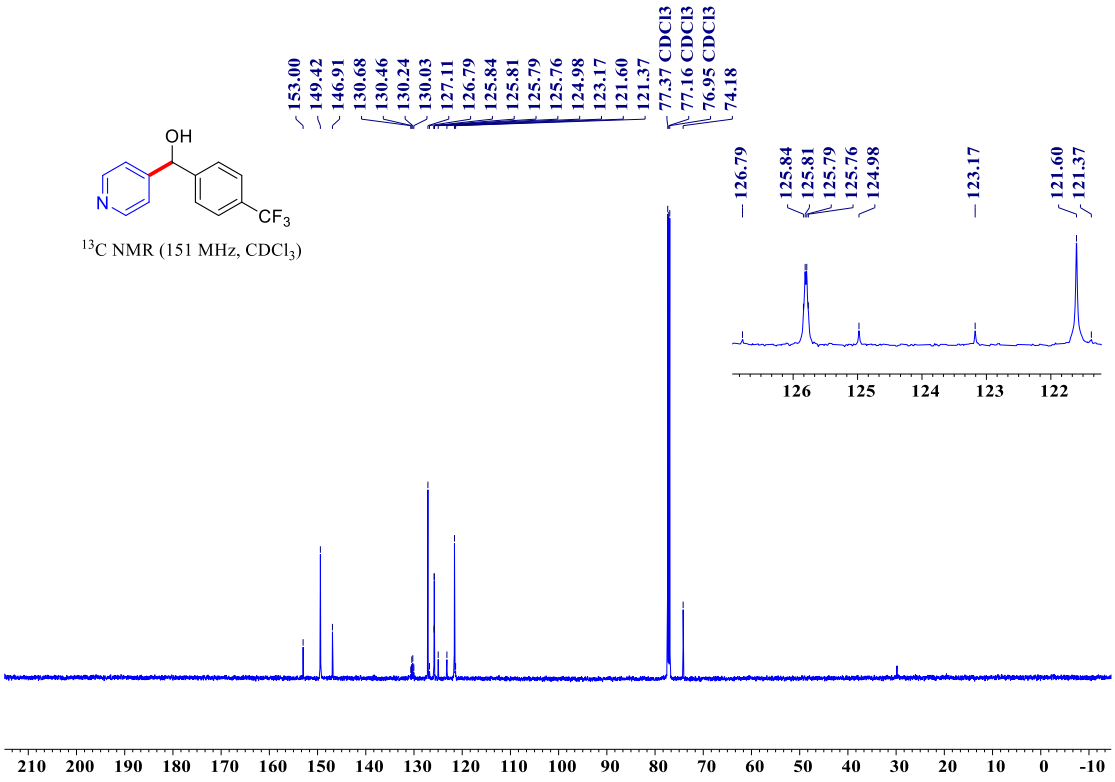


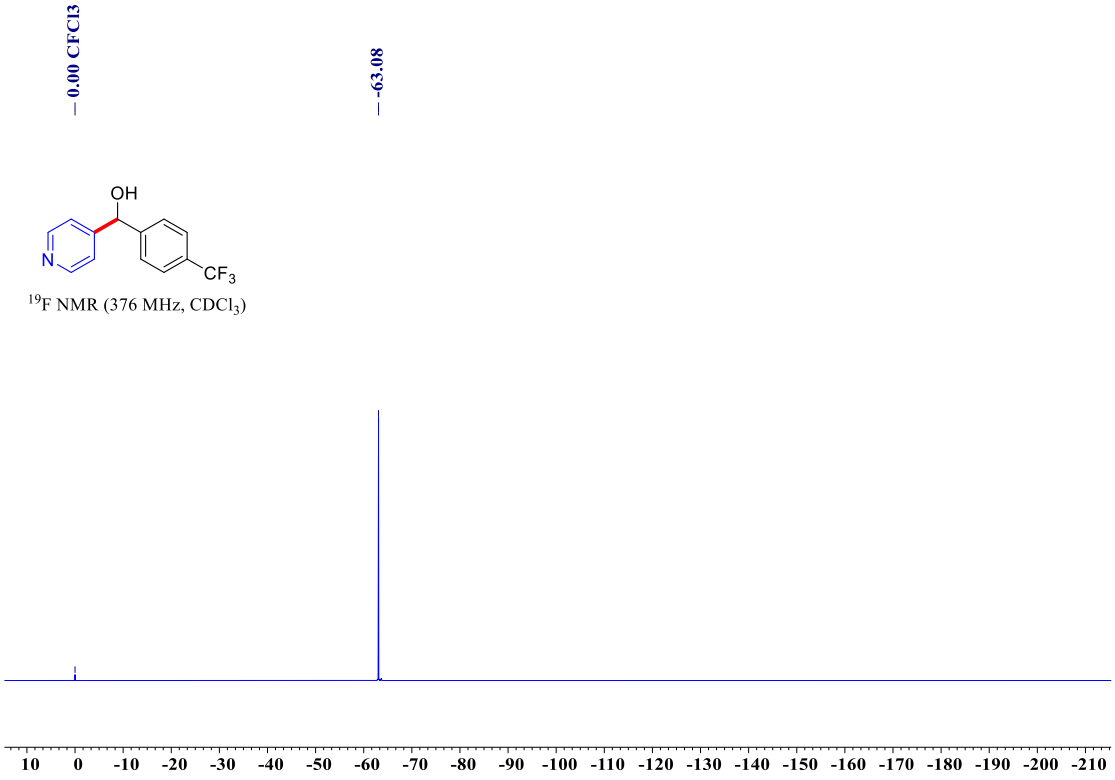
^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 3l

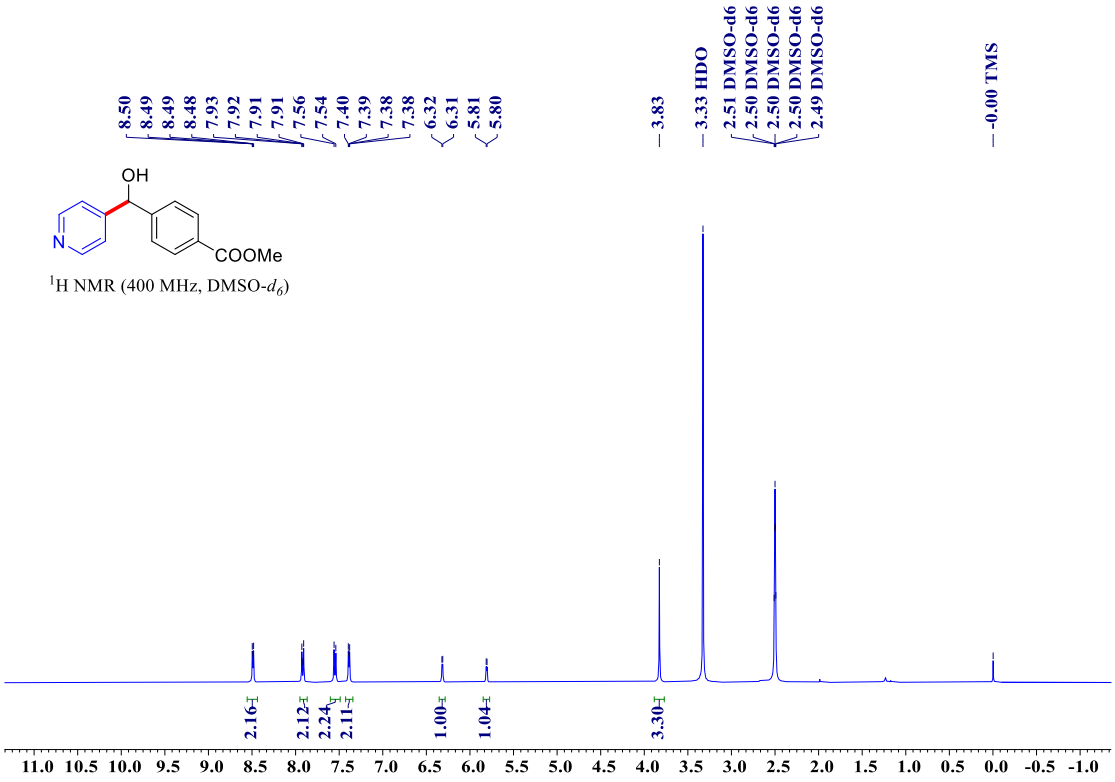


^{1}H NMR (600 MHz, $CDCl_3$)

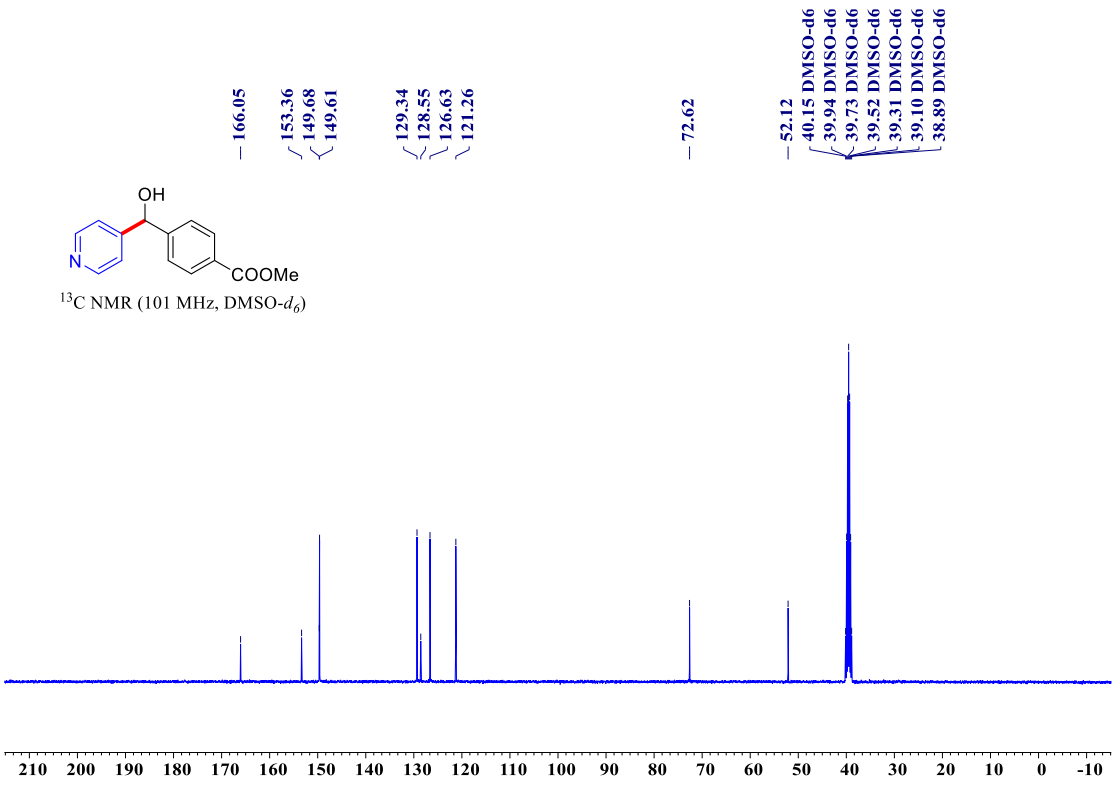

153.00
149.42
146.91
130.68
130.46
130.24
130.03
127.11
126.79
125.84
125.81
125.79
125.76
124.98
123.17
121.60
121.37
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
74.18
126.79
125.84
125.81
125.79
125.76
124.98
123.17
121.60
121.37
OH
N
CF3
13C NMR (151 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
126 125 124 123 122


0.00 CFCl3
-63.08
OH
N
CF3
19F NMR (376 MHz, CDCl3)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

^{1}H and ^{13}C NMR spectra of compound 3m

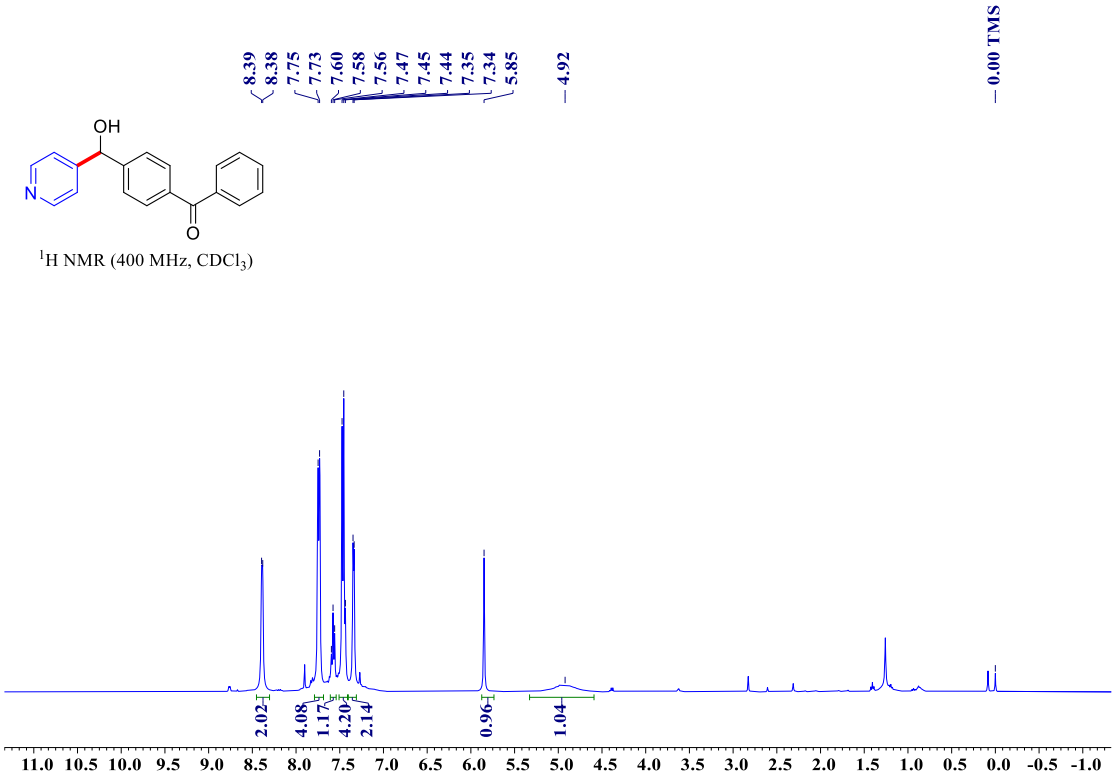


^{1}H NMR (400 MHz, DMSO-d_6)

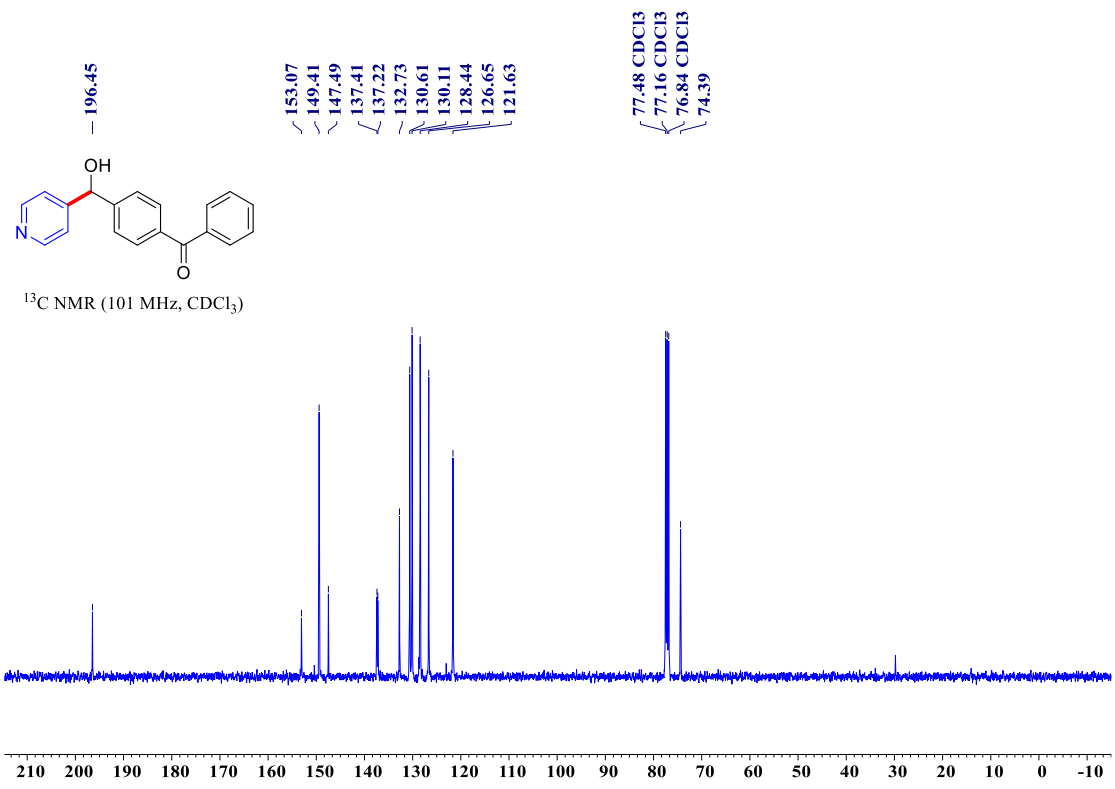


^{13}C NMR (101 MHz, DMSO-d_6)

^{1}H and ^{13}C NMR spectra of compound 3n

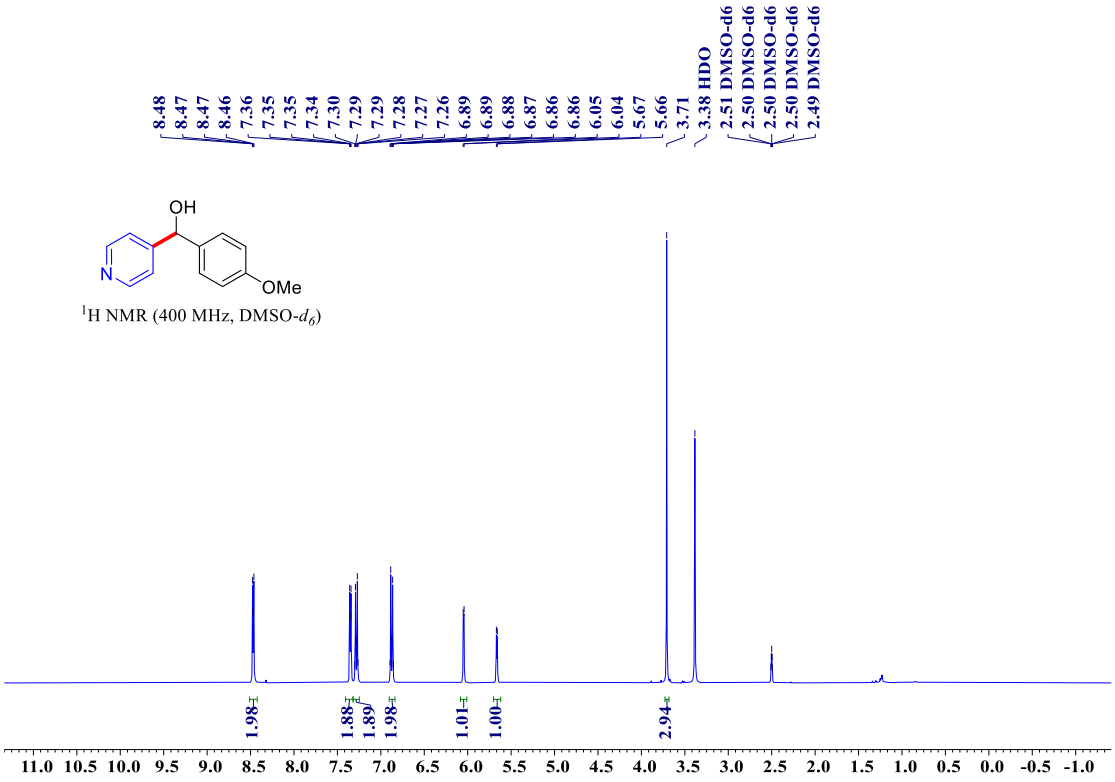


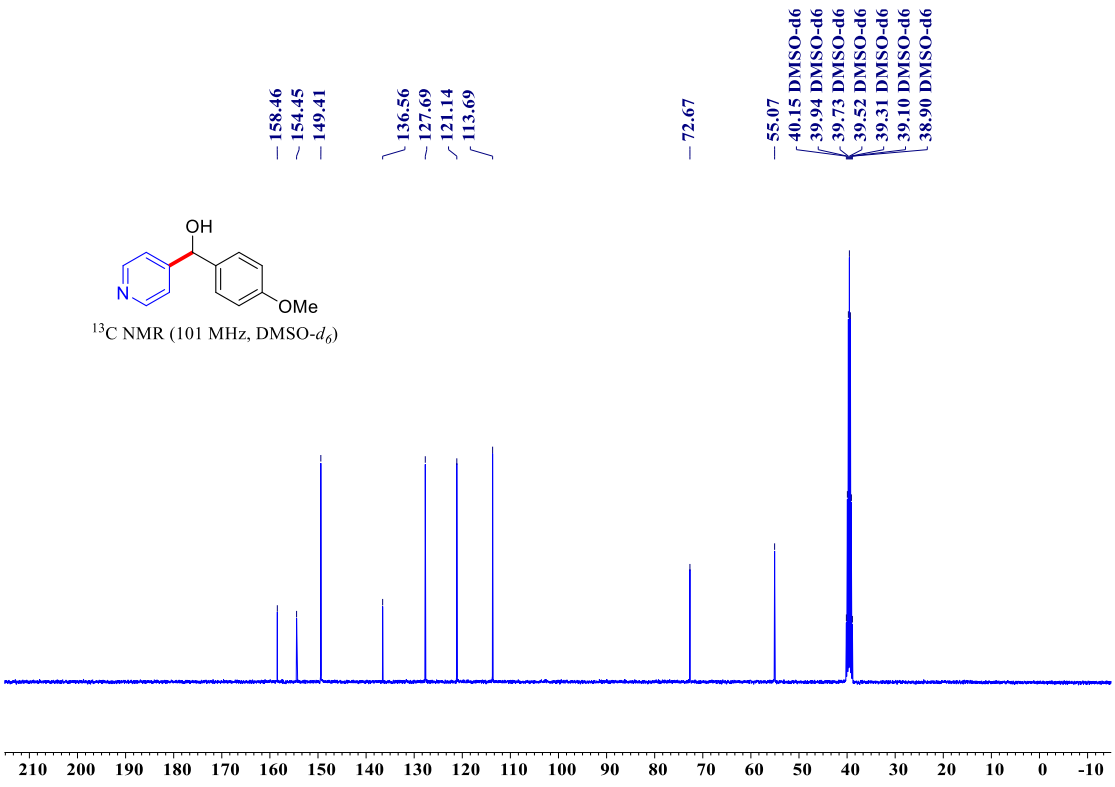
^{1}H NMR (400 MHz, $CDCl_3$)



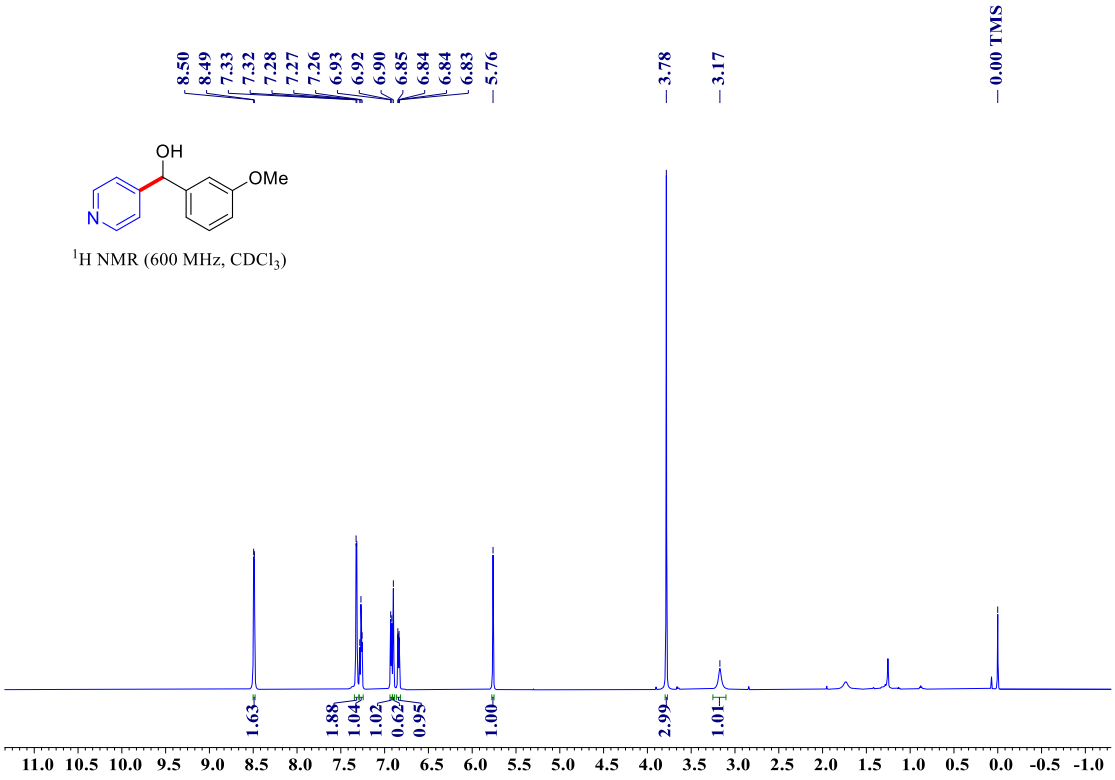
^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3o

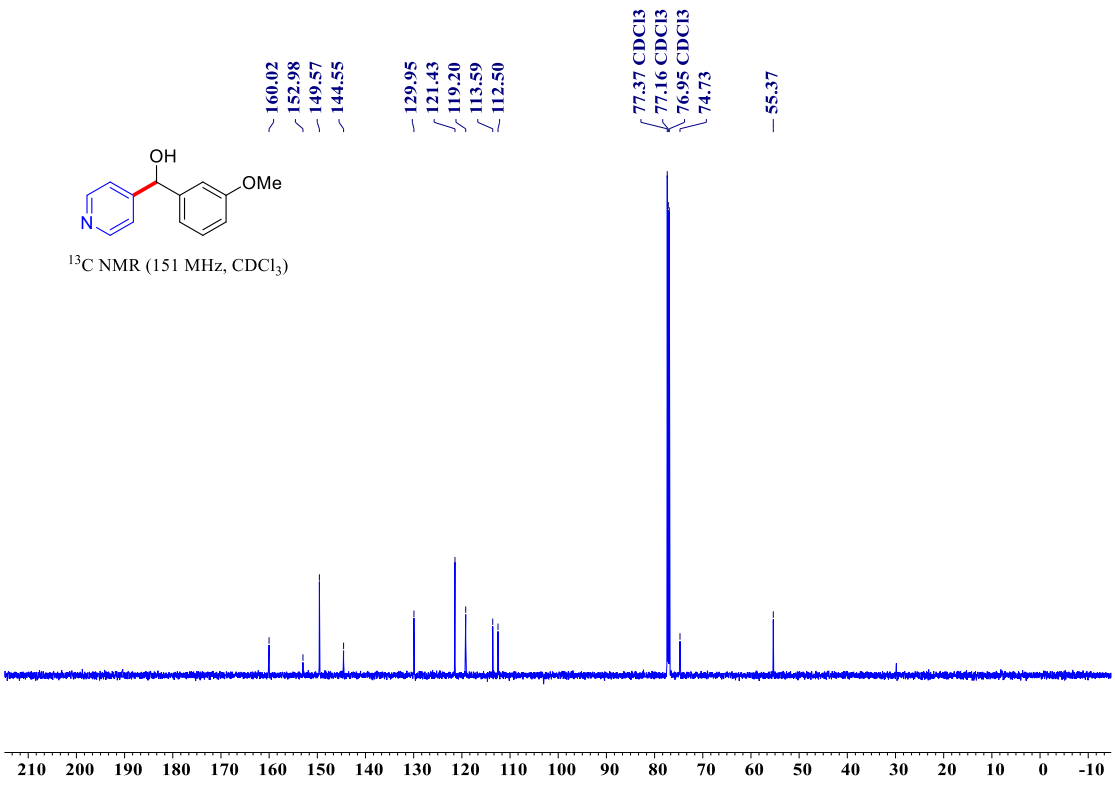




^{1}H and ^{13}C NMR spectra of compound 3p

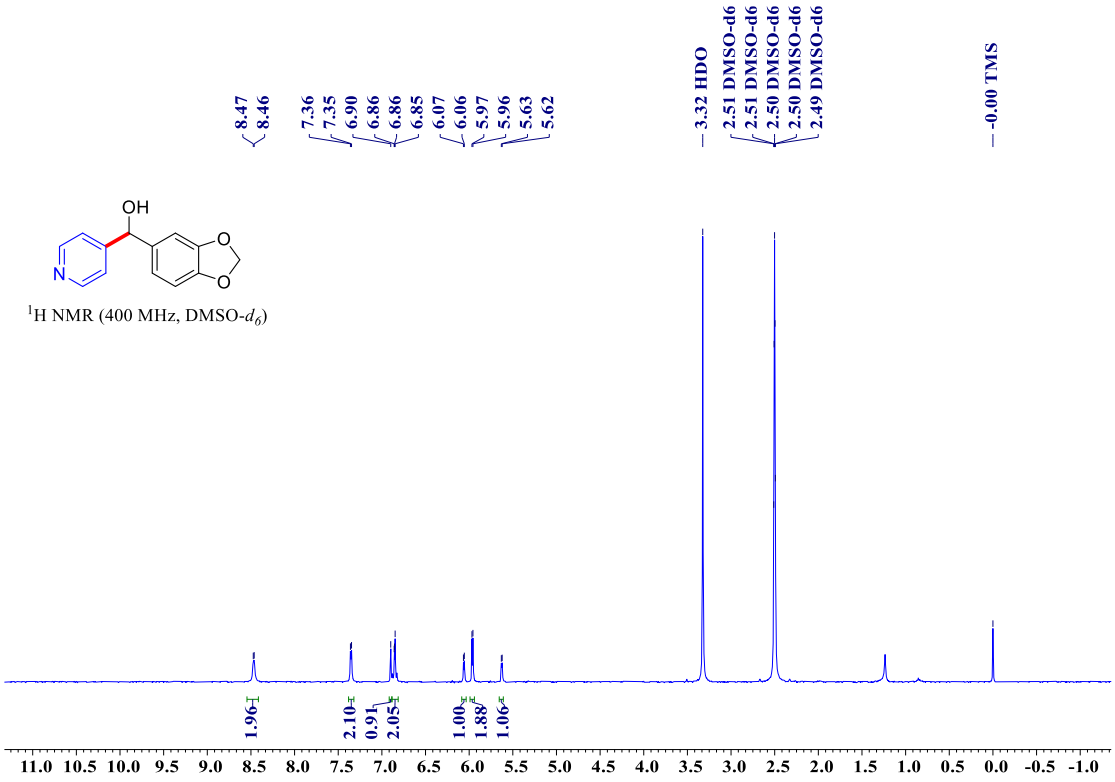


^{1}H NMR (600 MHz, $CDCl_3$)

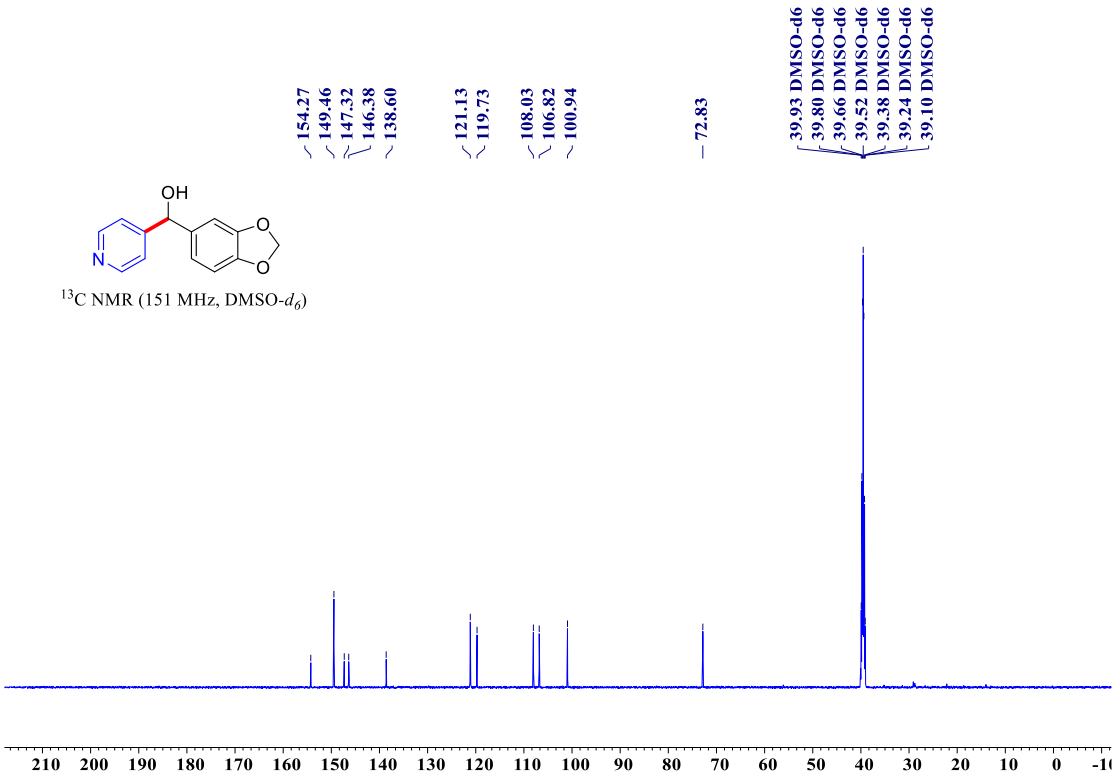


^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3q

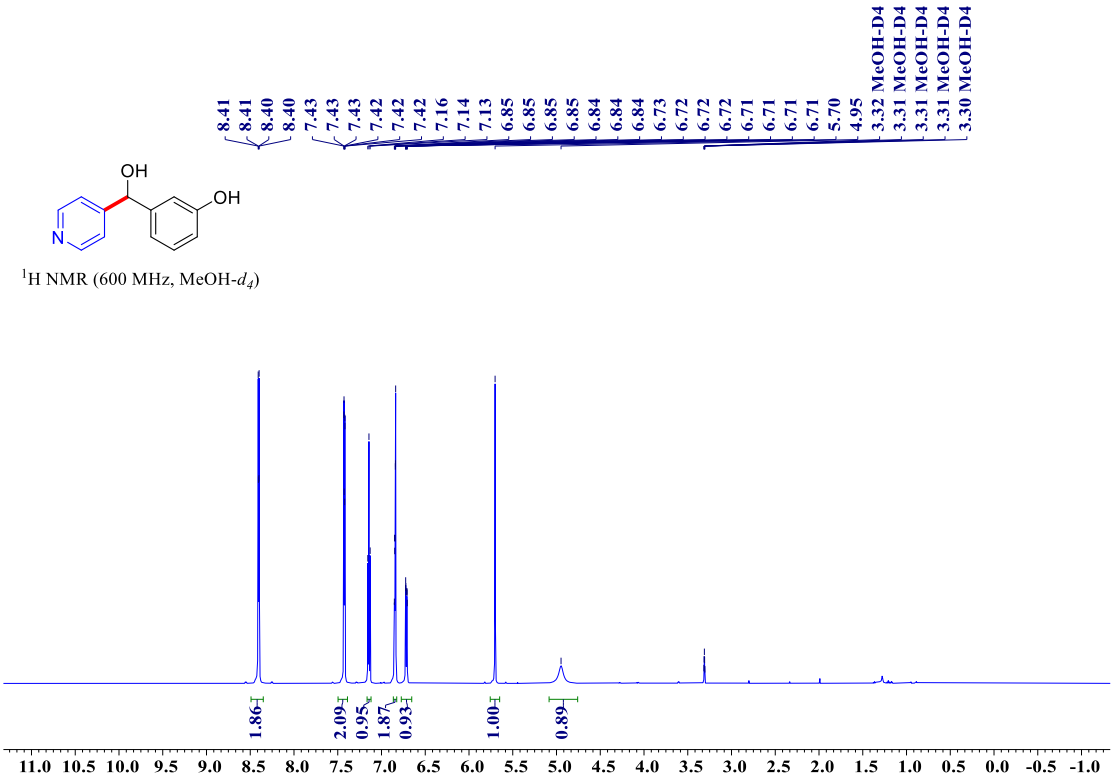


^{1}H NMR (400 MHz, DMSO-d_6)

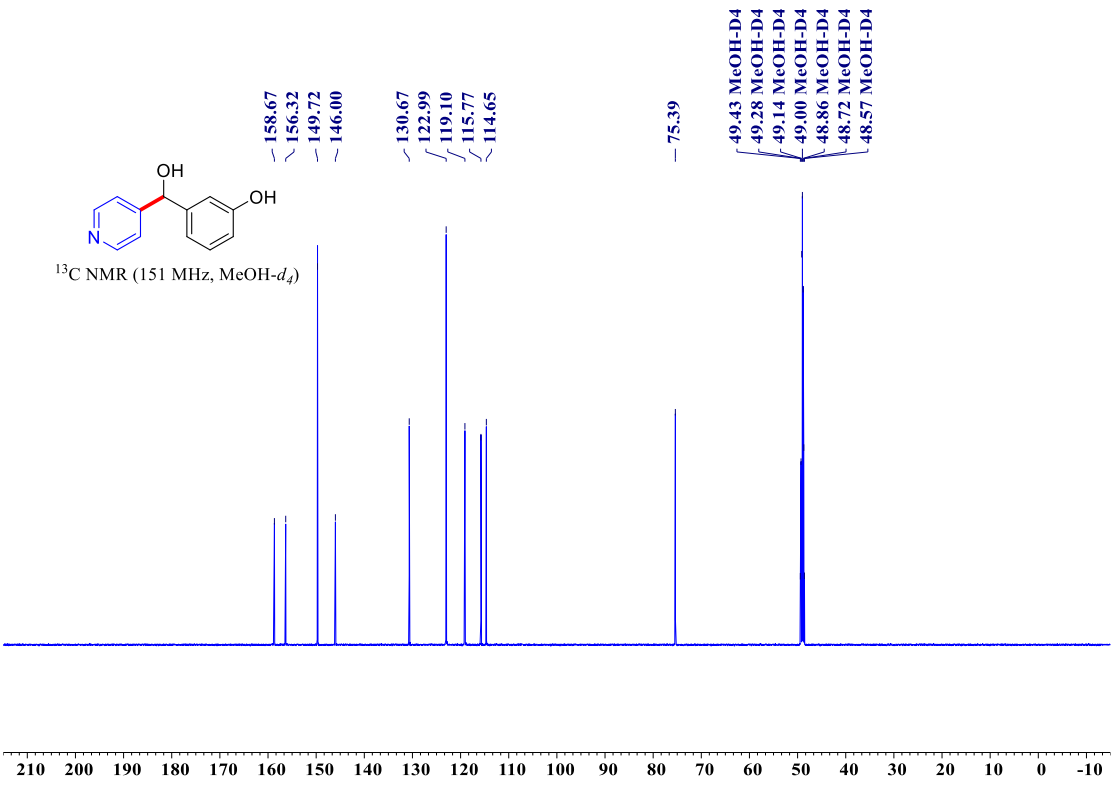


^{13}C NMR (151 MHz, DMSO-d_6)

^{1}H and ^{13}C NMR spectra of compound 3r

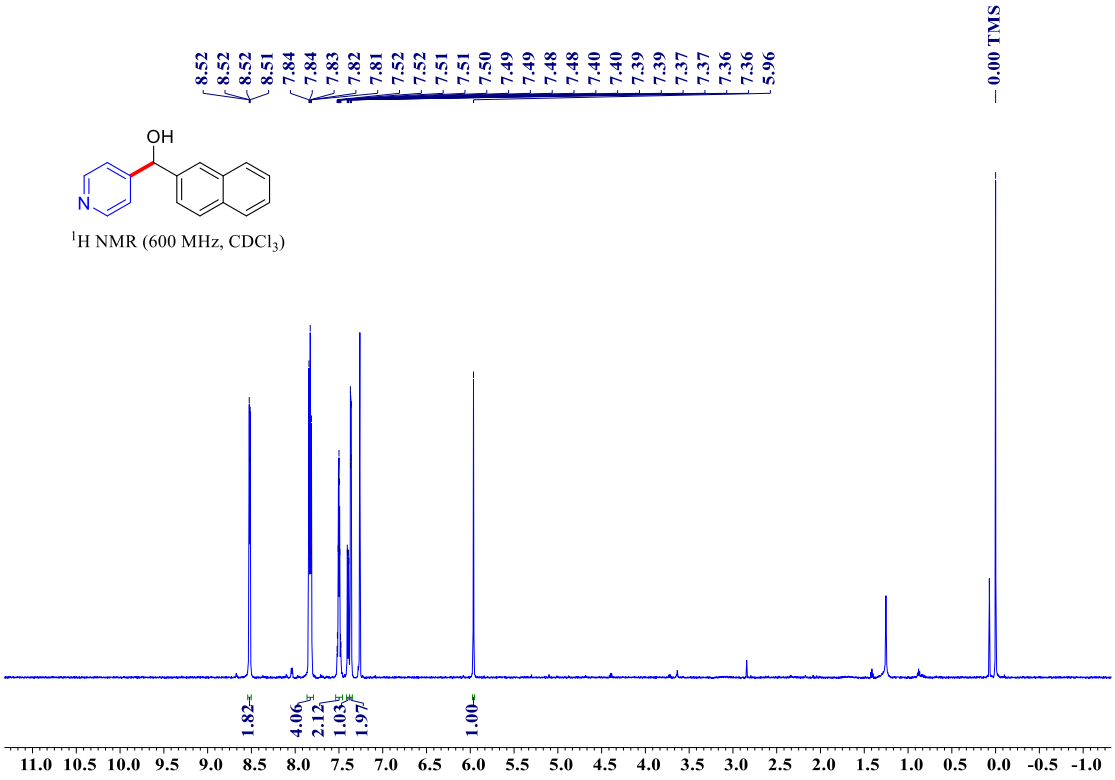


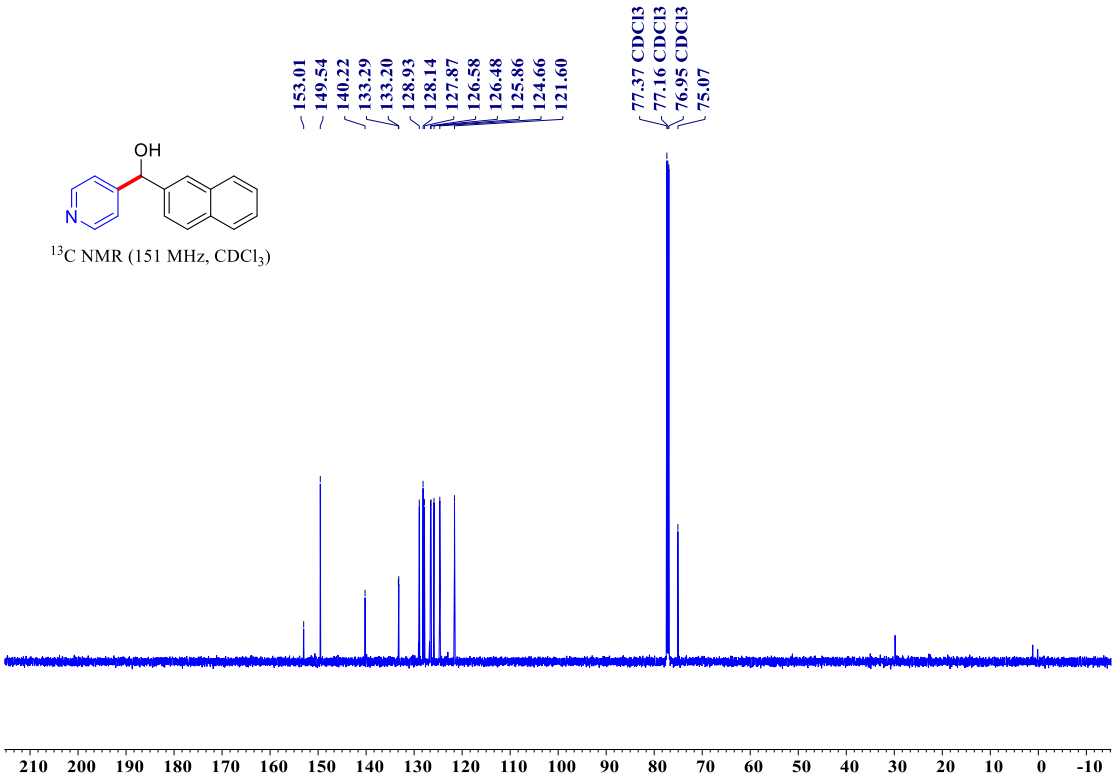
^{1}H NMR (600 MHz, MeOH-d_4)



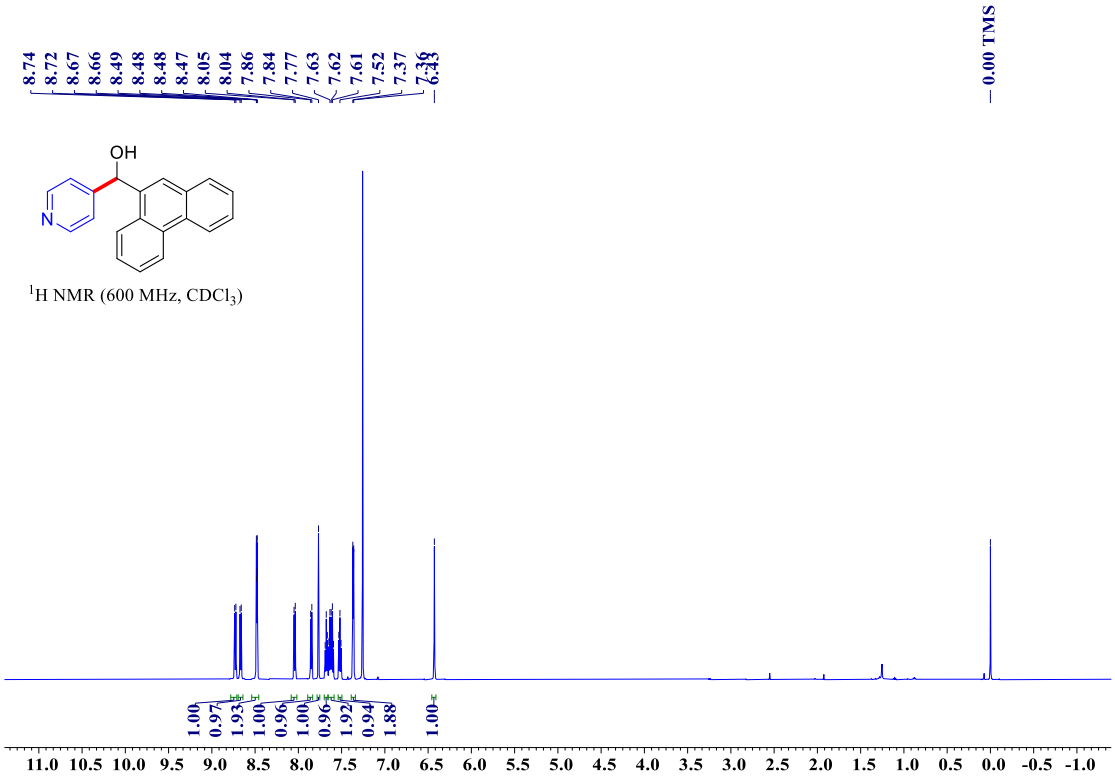
^{13}C NMR (151 MHz, MeOH-d_4)

^{1}H and ^{13}C NMR spectra of compound 3s

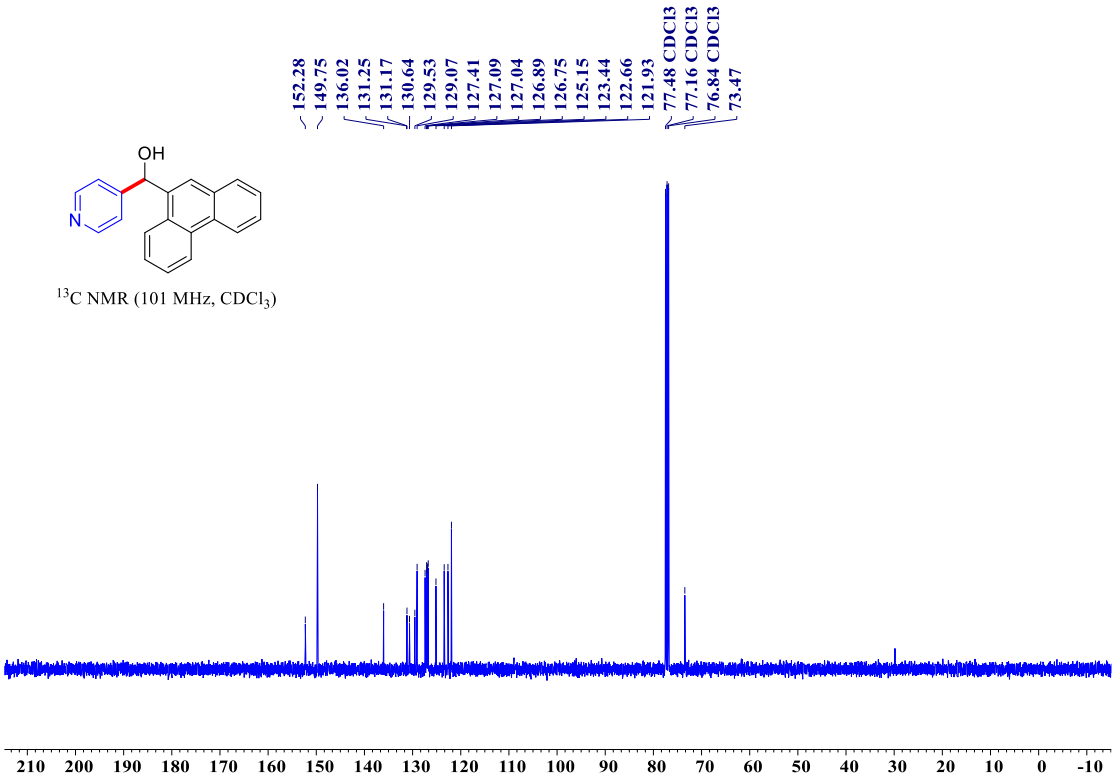




^{1}H and ^{13}C NMR spectra of compound 3t

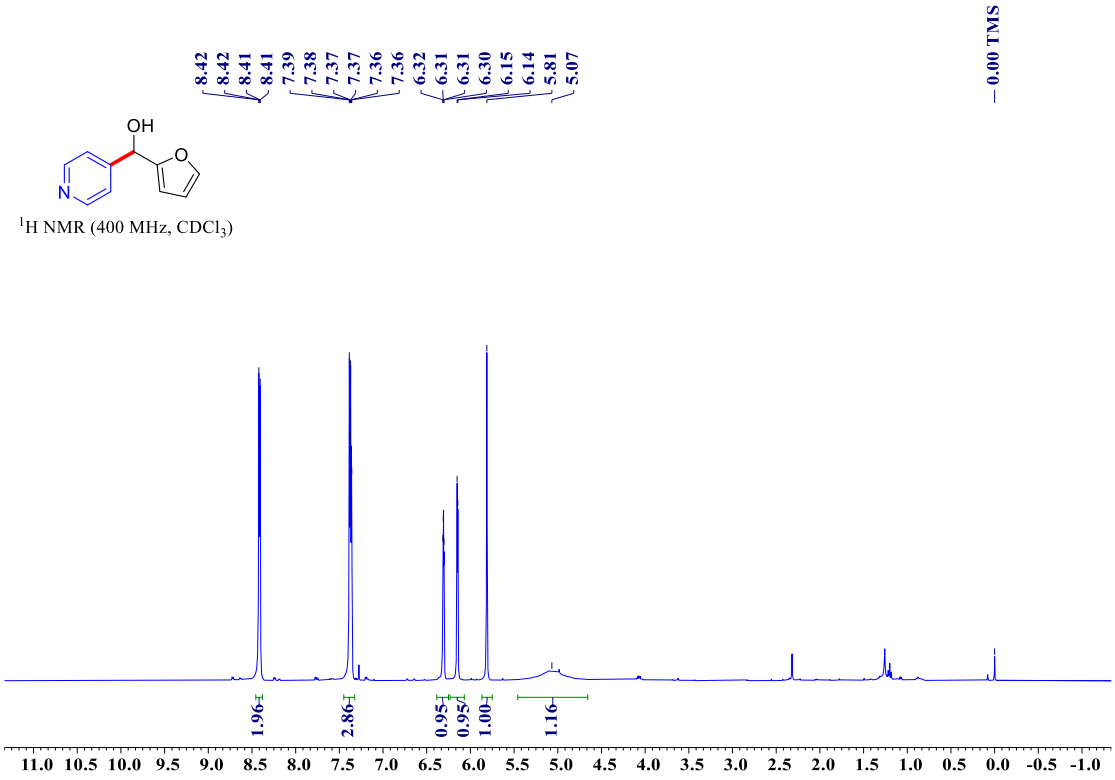


^{1}H NMR (600 MHz, $CDCl_3$)

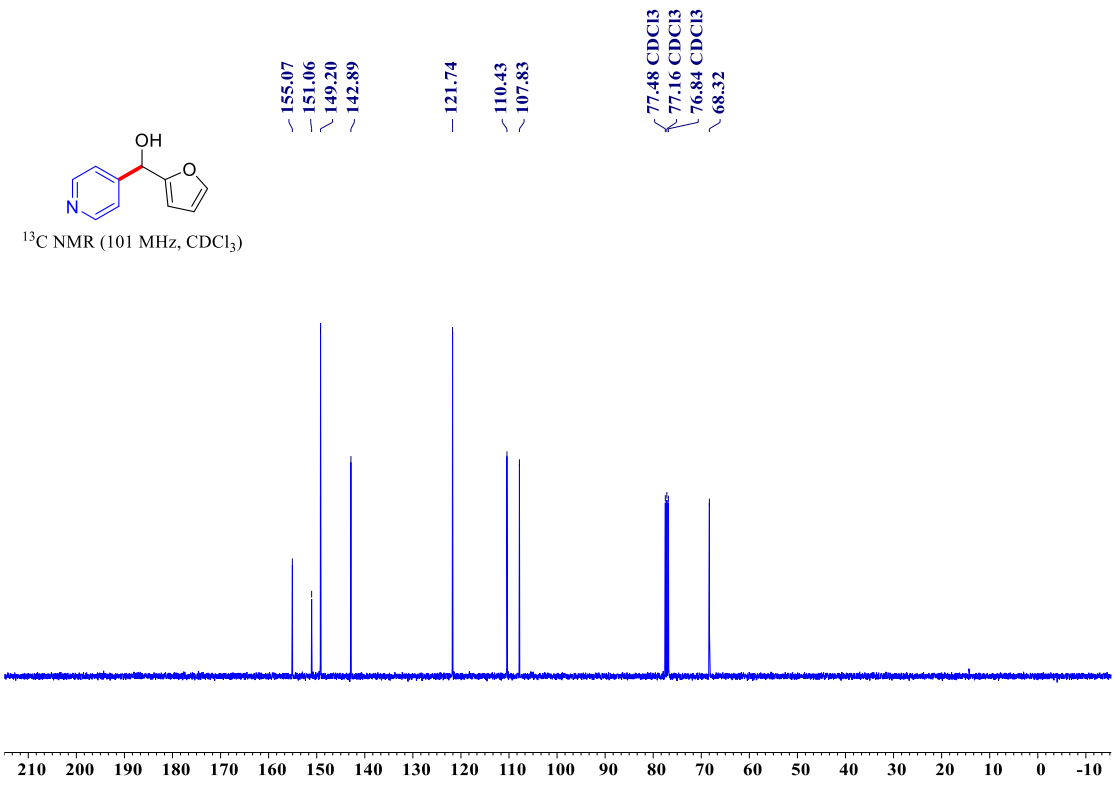


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3u

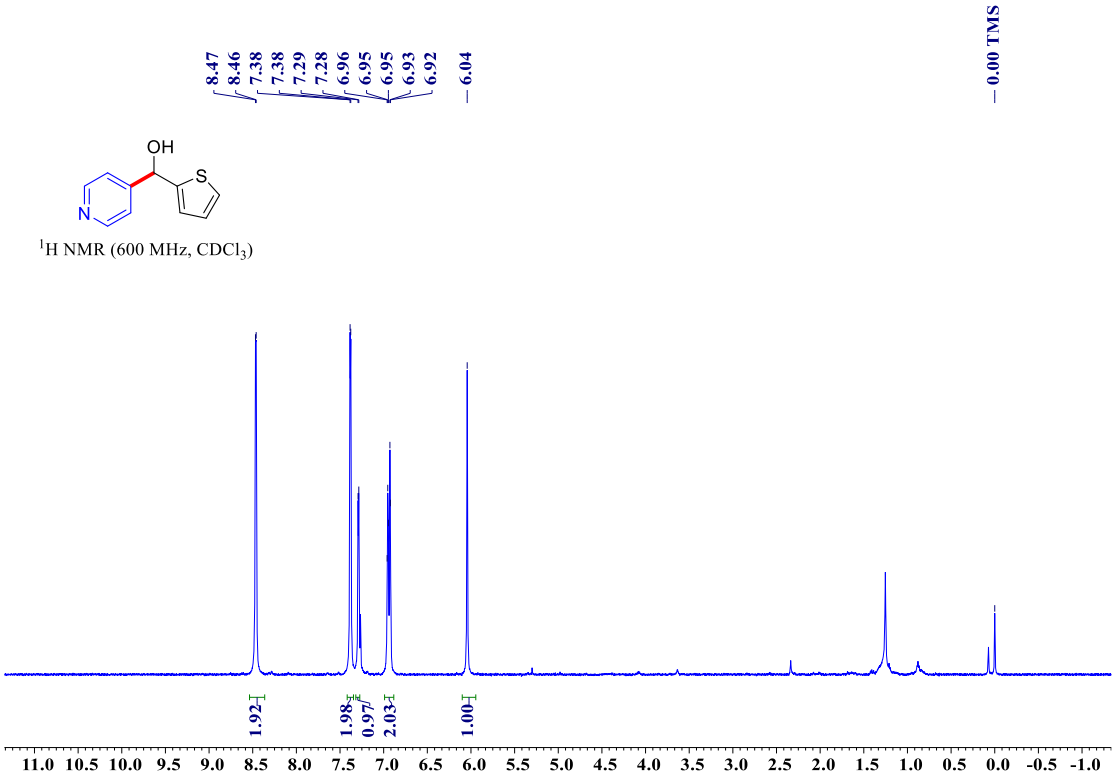


^{1}H NMR (400 MHz, $CDCl_3$)

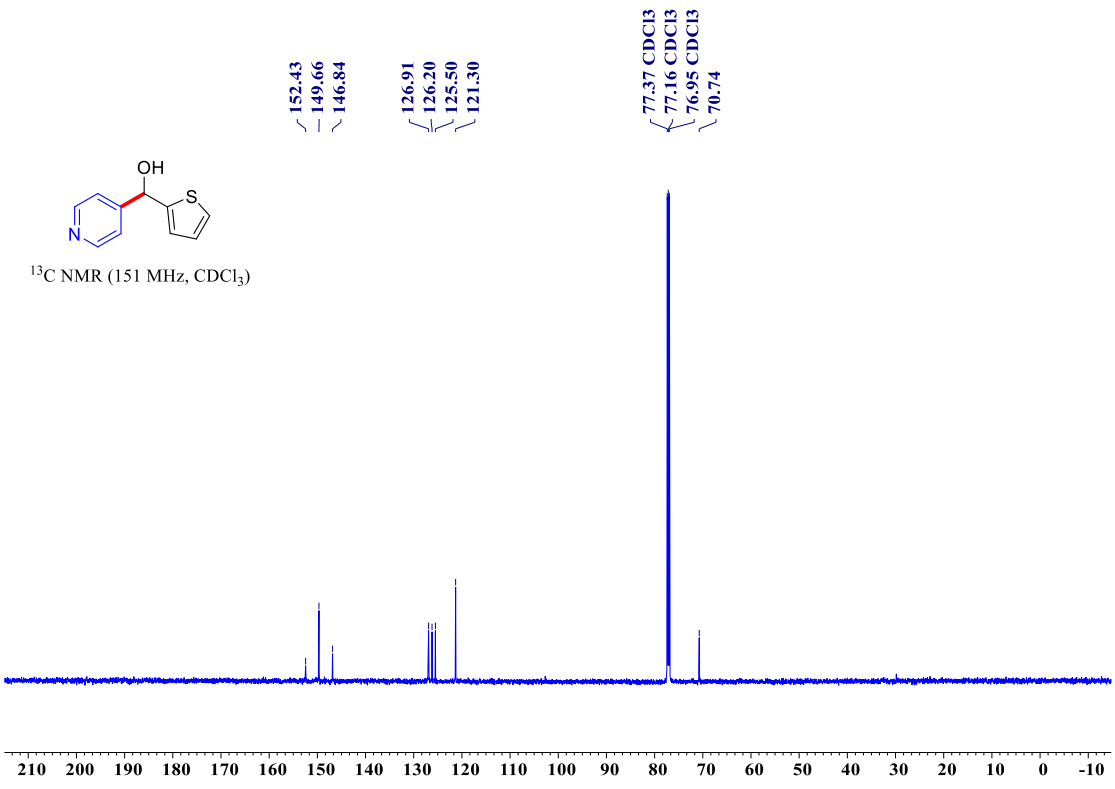


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3v

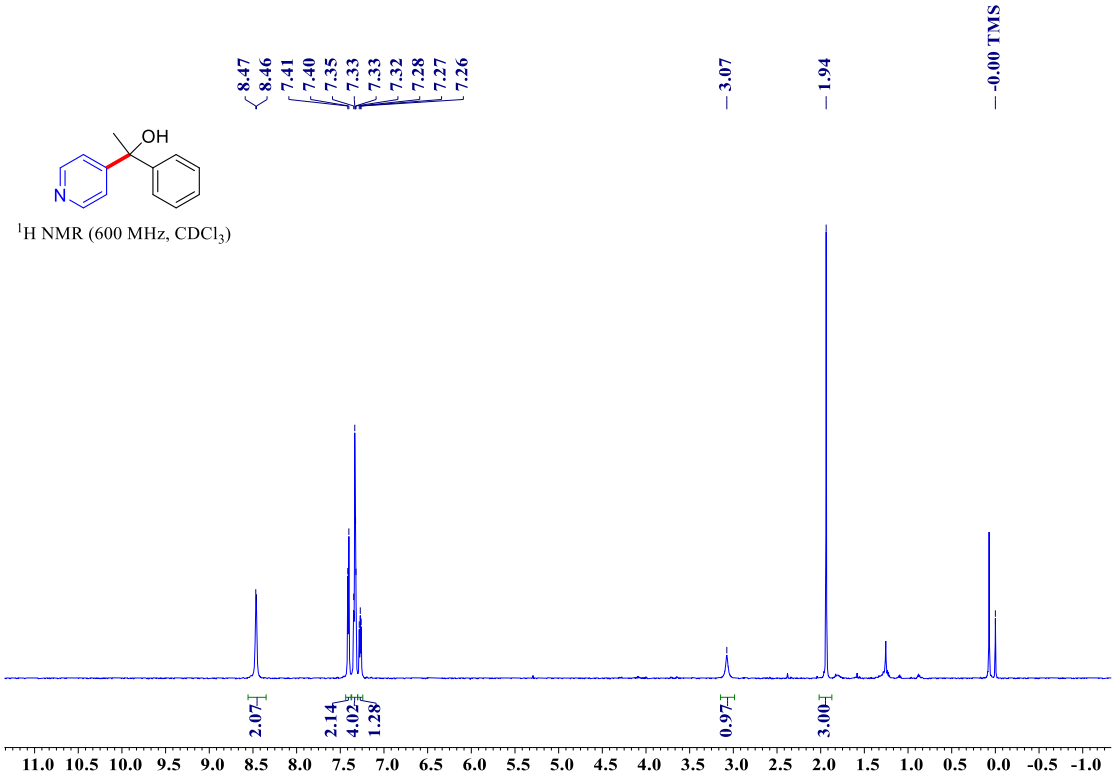


^{1}H NMR (600 MHz, $CDCl_3$)

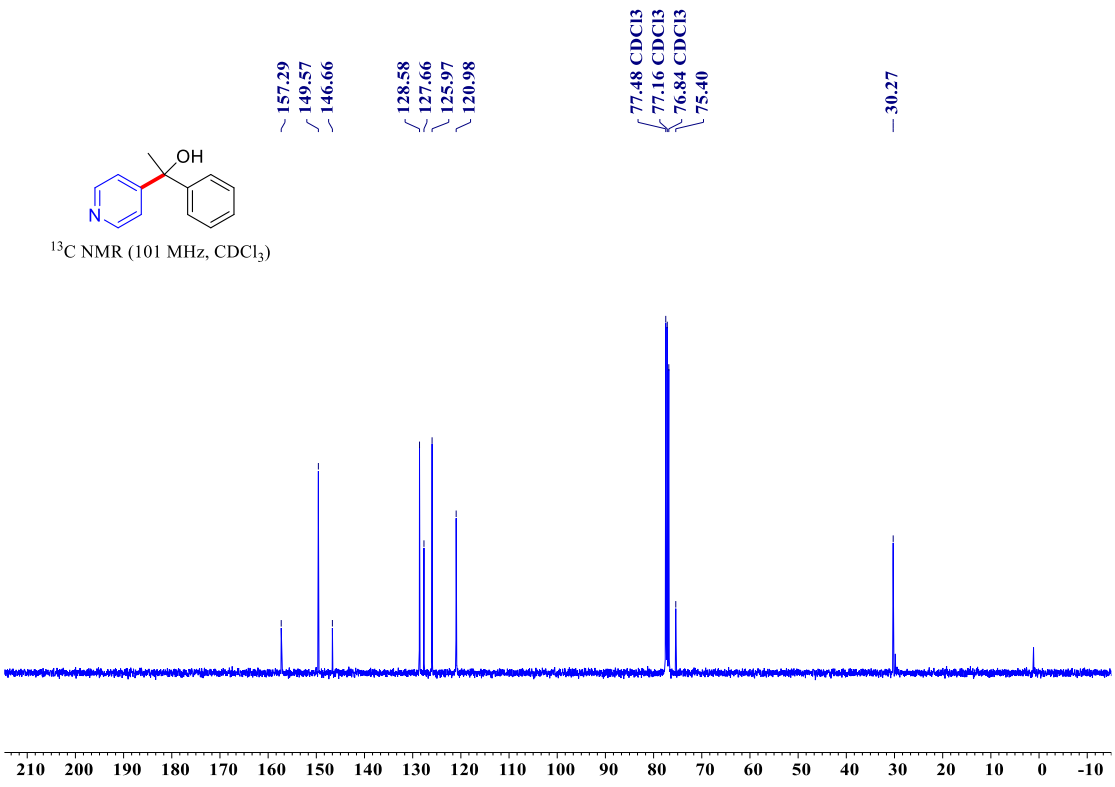


^{13}C NMR (151 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 3w

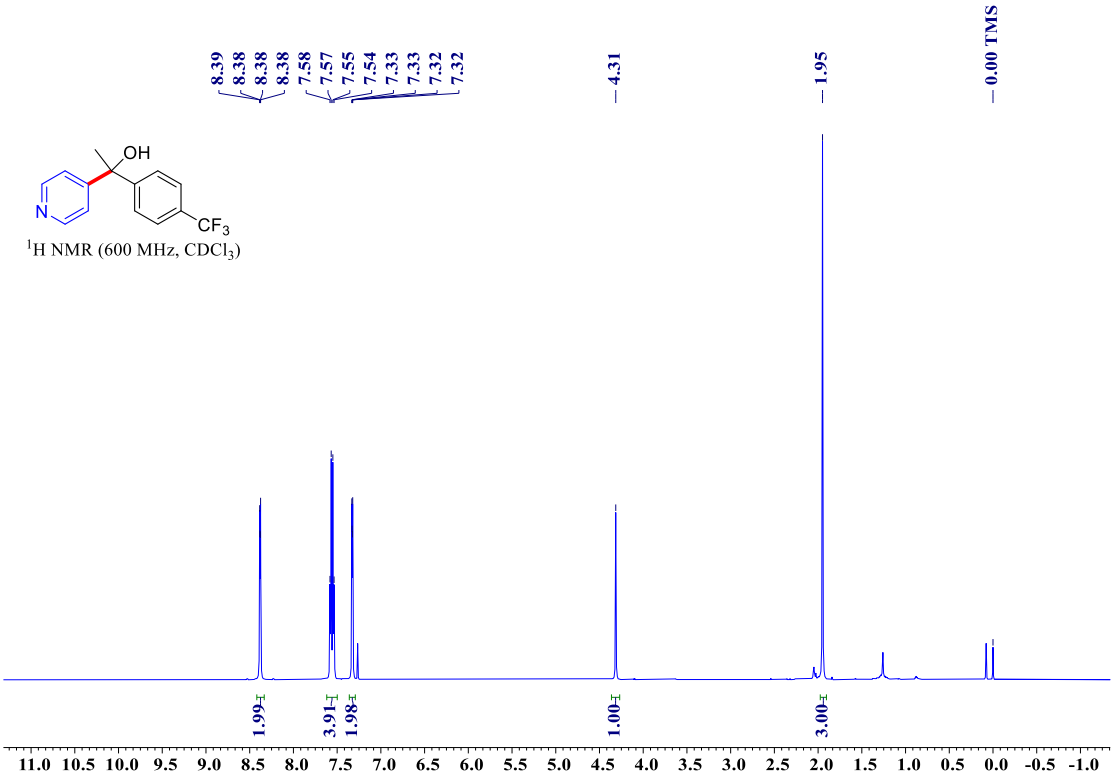


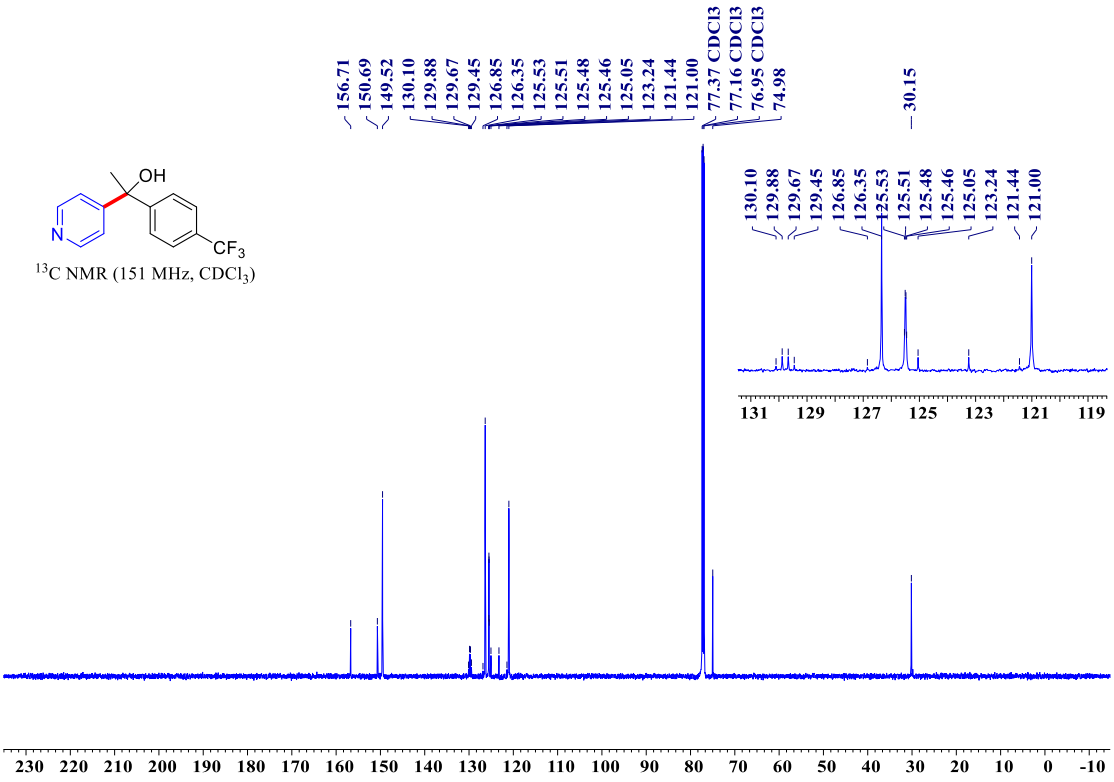
^{1}H NMR (600 MHz, $CDCl_3$)

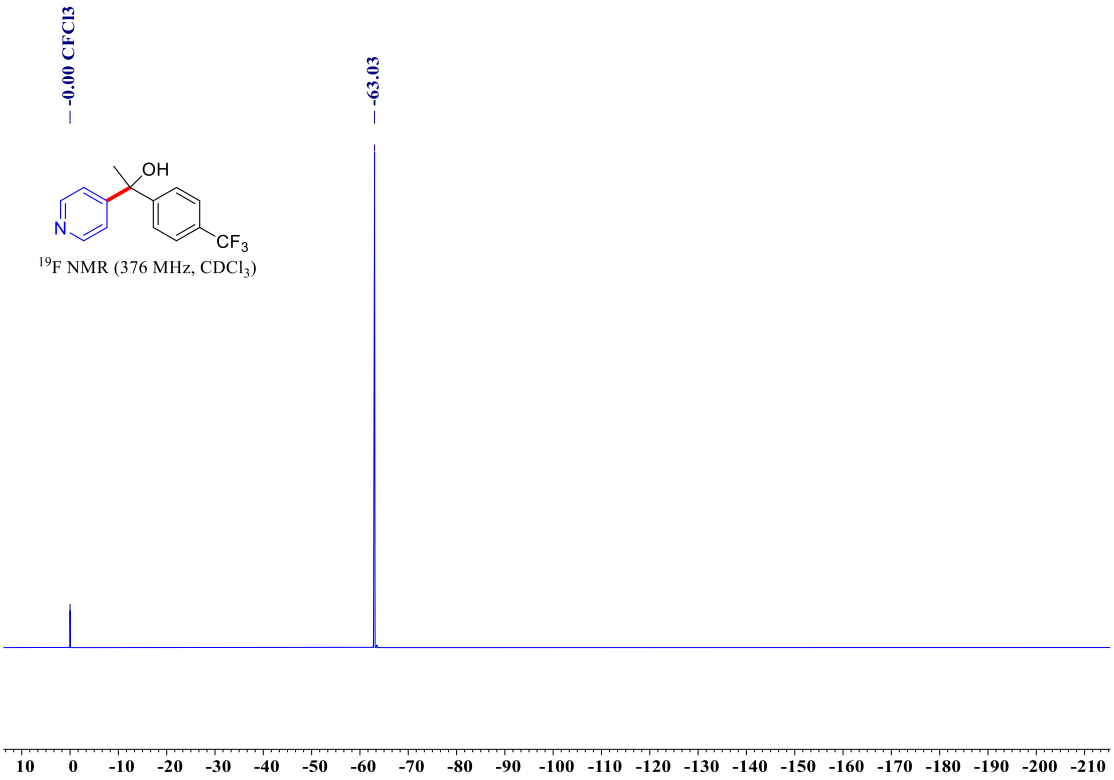


^{13}C NMR (101 MHz, $CDCl_3$)

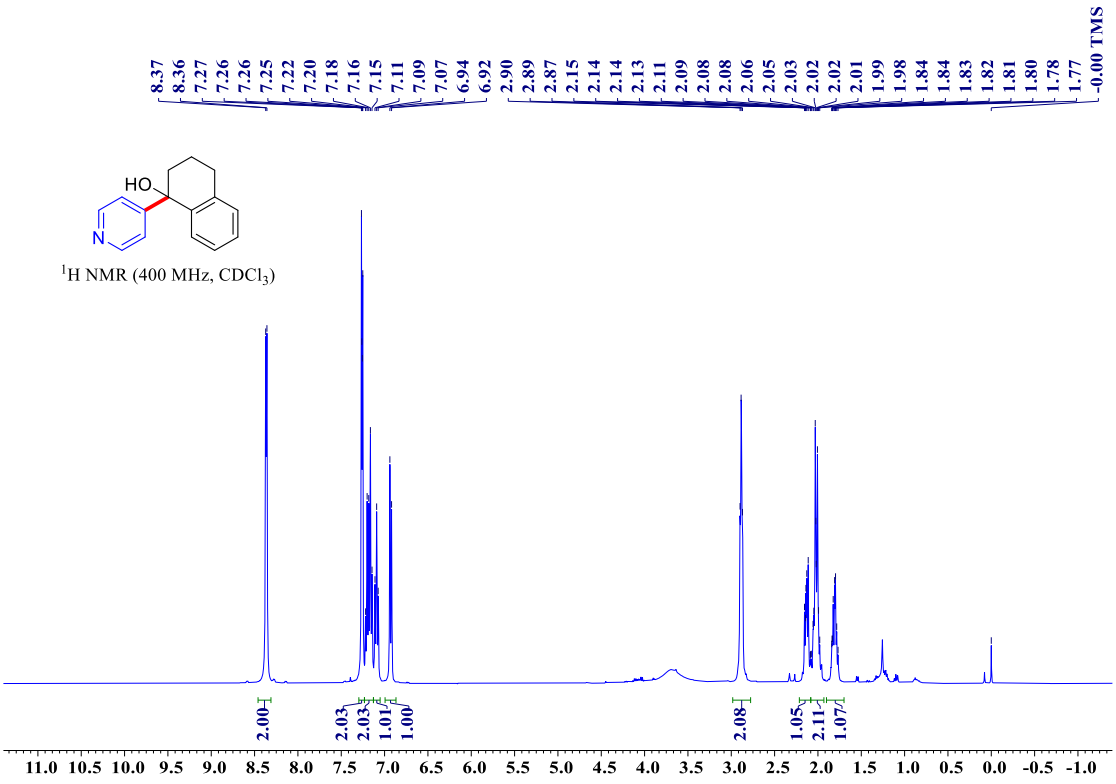
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 3x

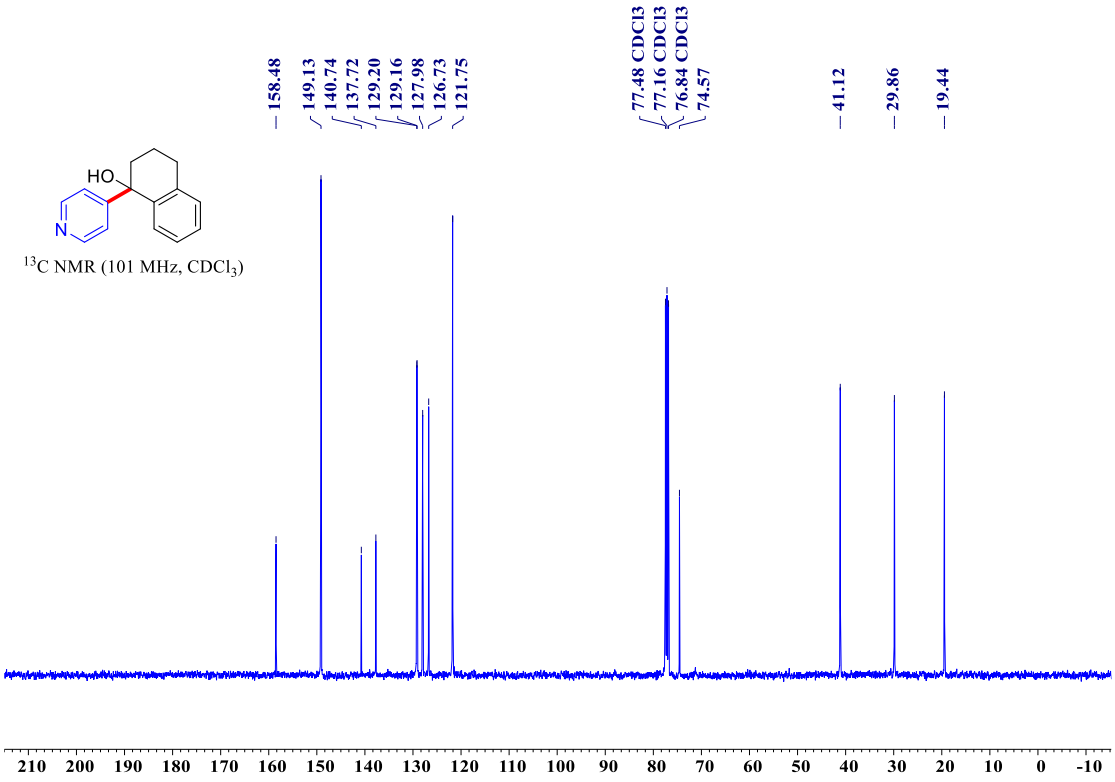




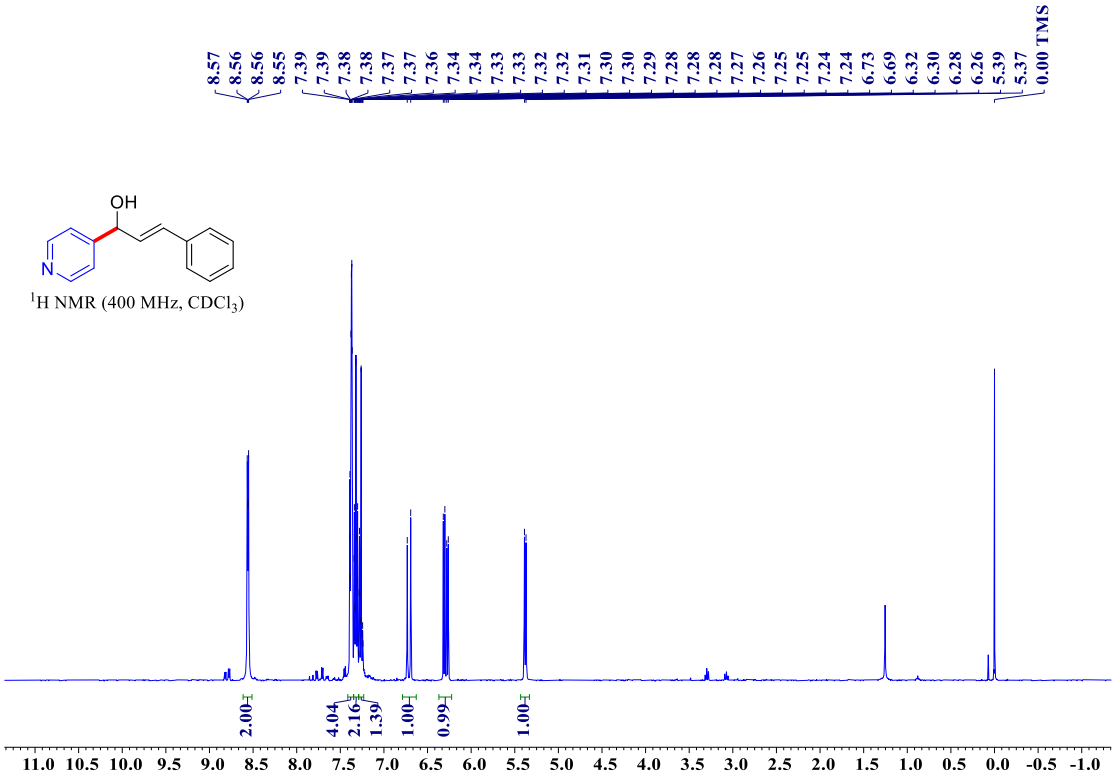


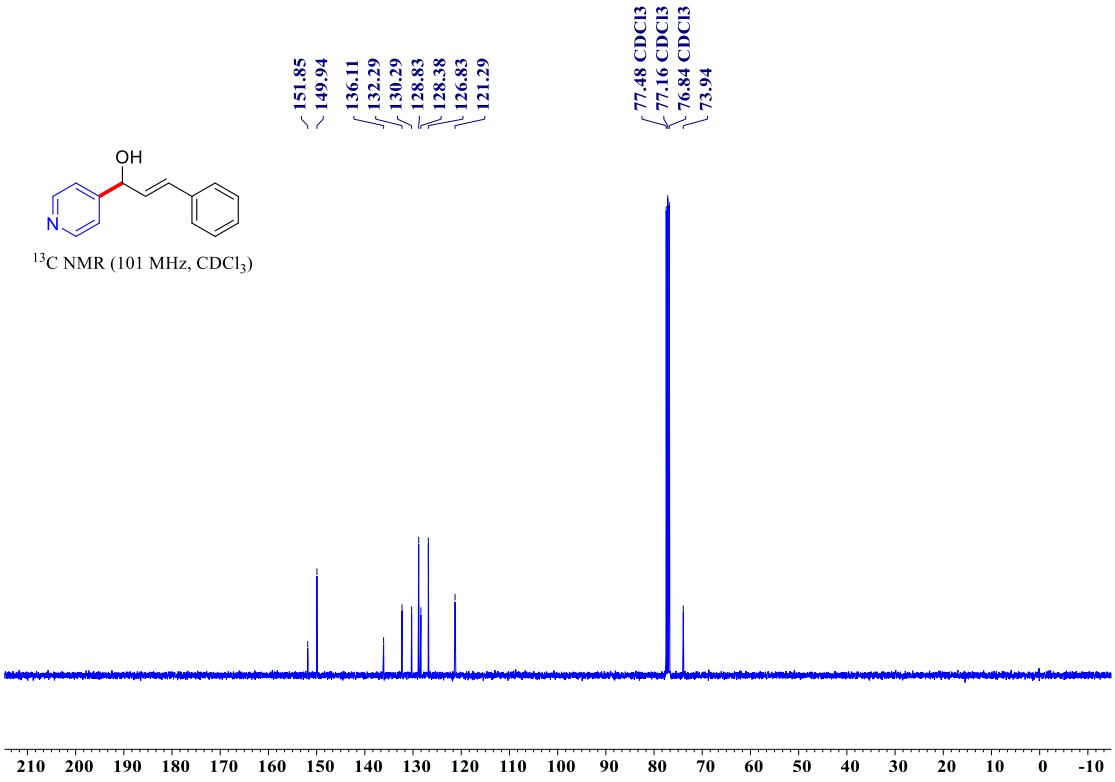
^{1}H and ^{13}C NMR spectra of compound 3y





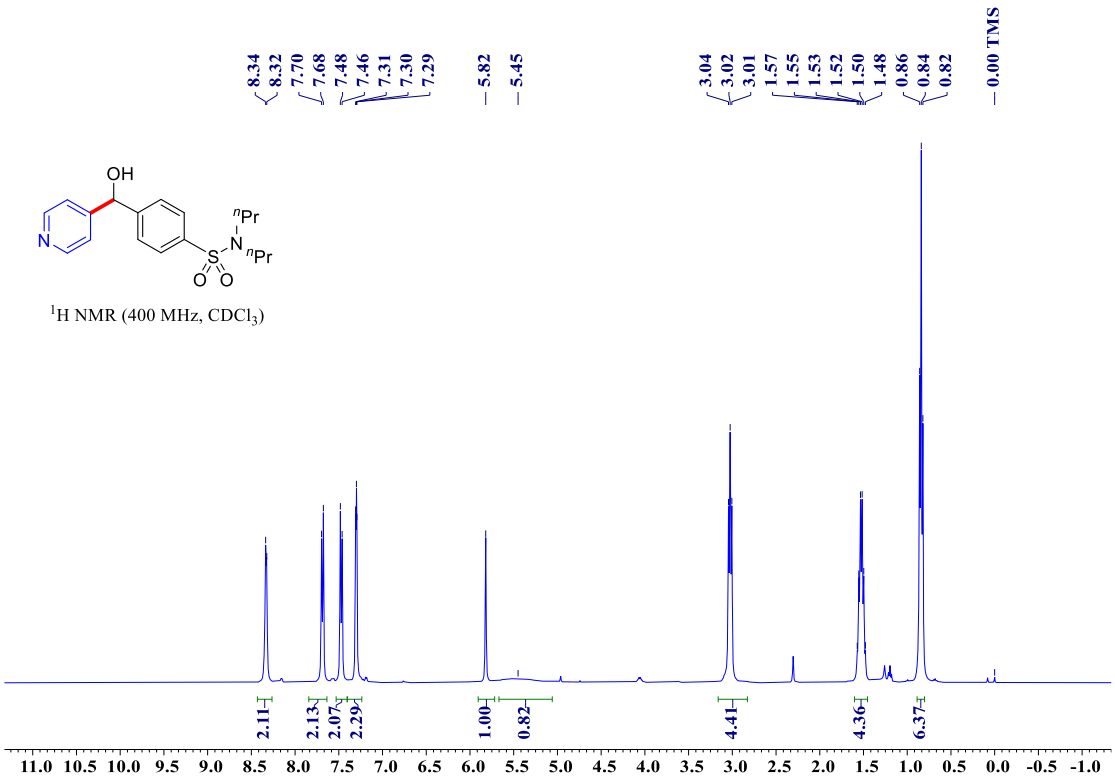
^{1}H and ^{13}C NMR spectra of compound 3z



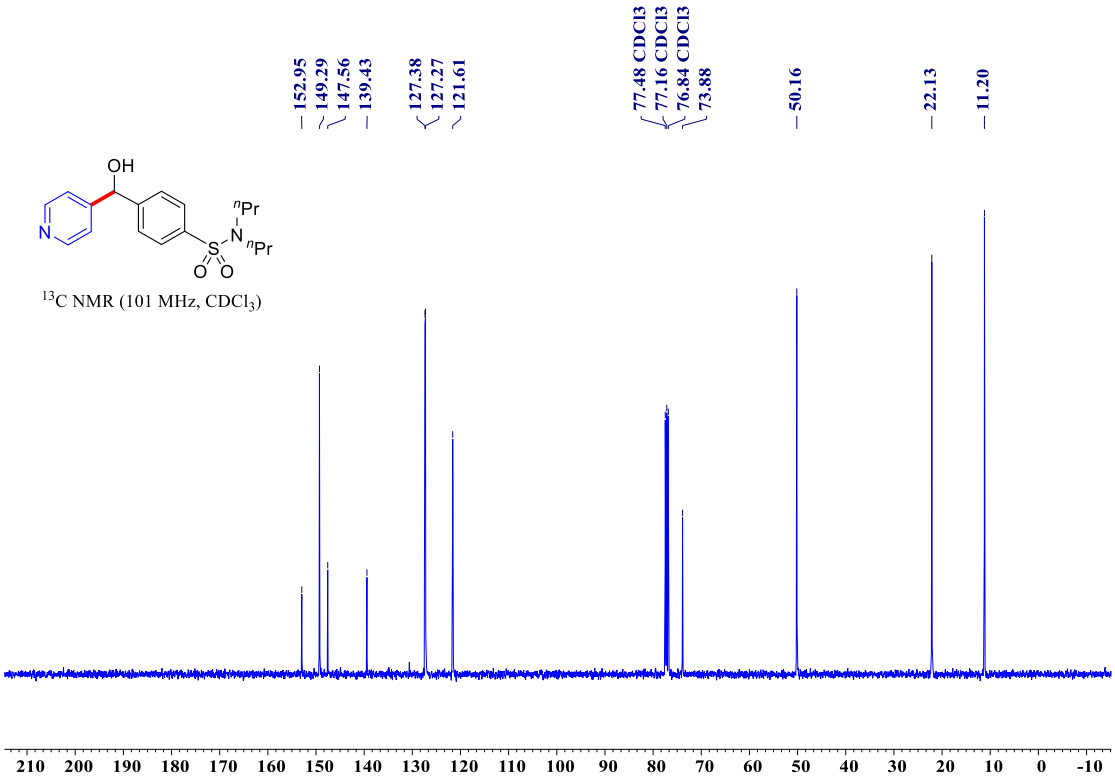


^{13}C NMR (101 MHz, $CDCl_3$)

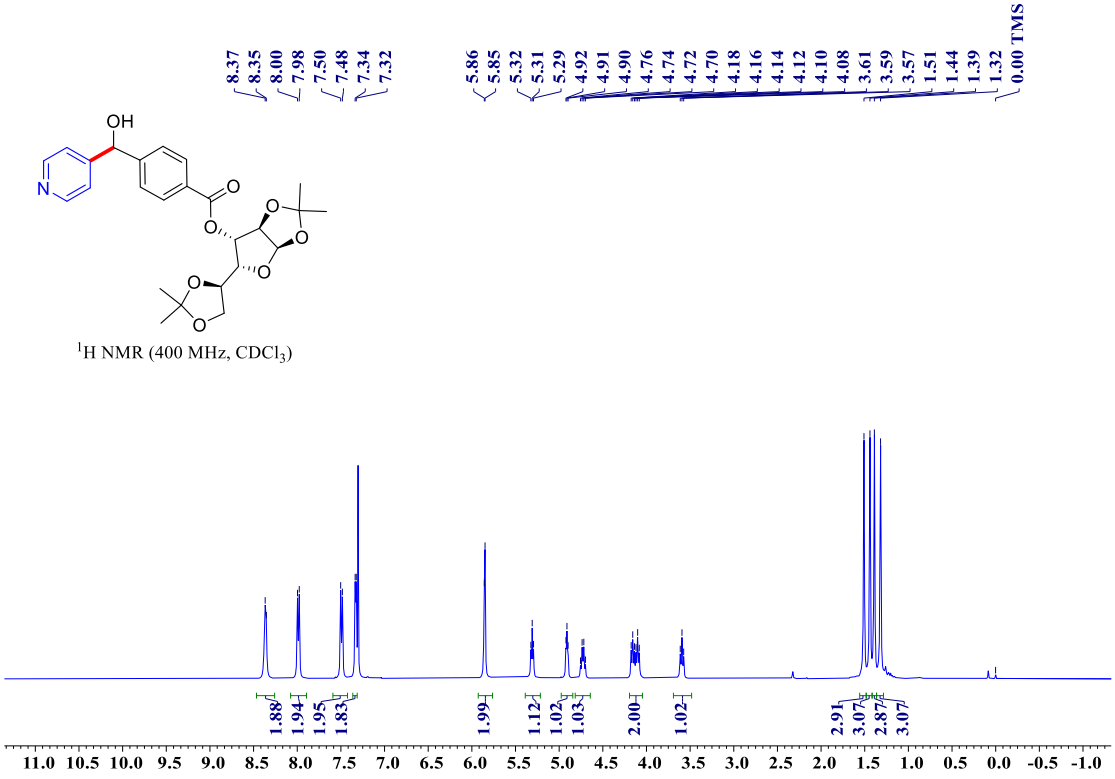
^{1}H and ^{13}C NMR spectra of compound 3aa

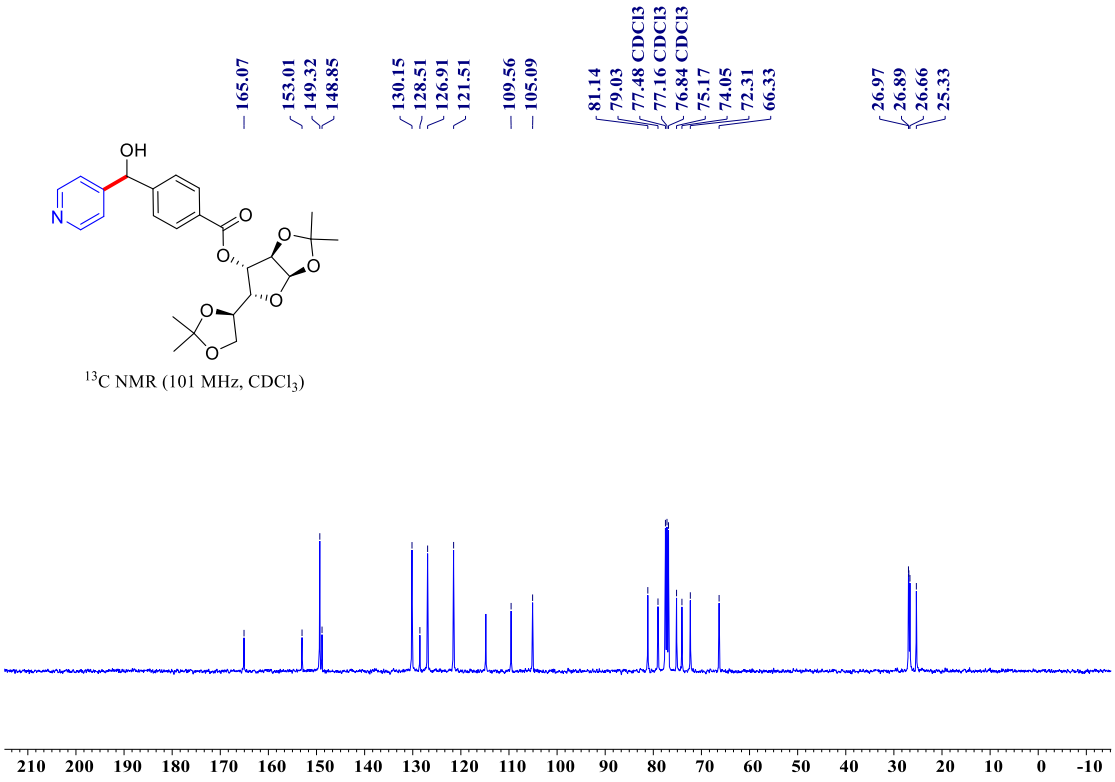


^{1}H NMR (400 MHz, $CDCl_3$)



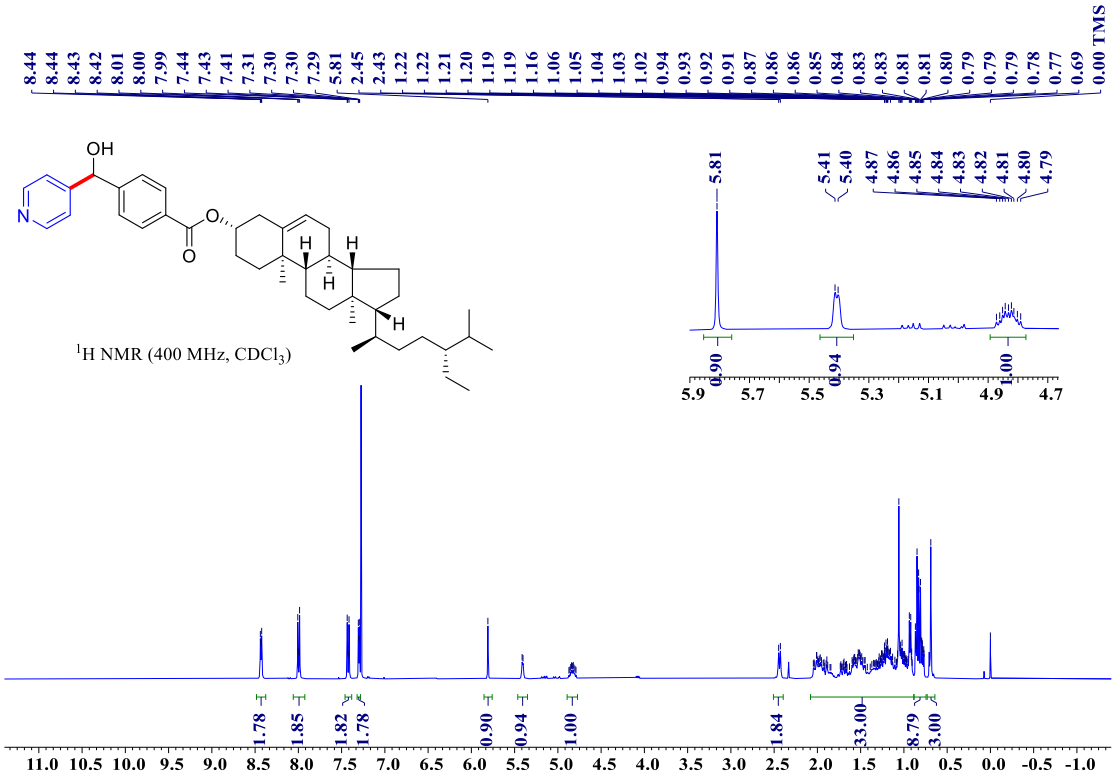
^{1}H and ^{13}C NMR spectra of compound 3ab



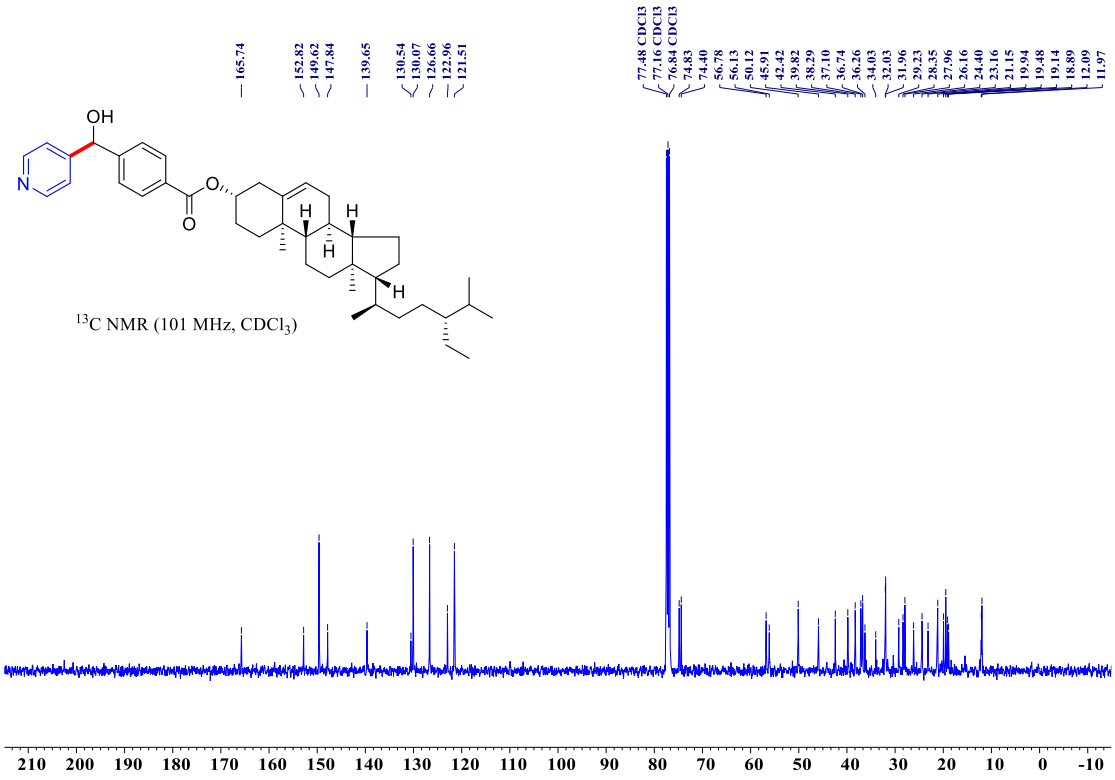


^{13}C NMR (101 MHz, $CDCl_3$)

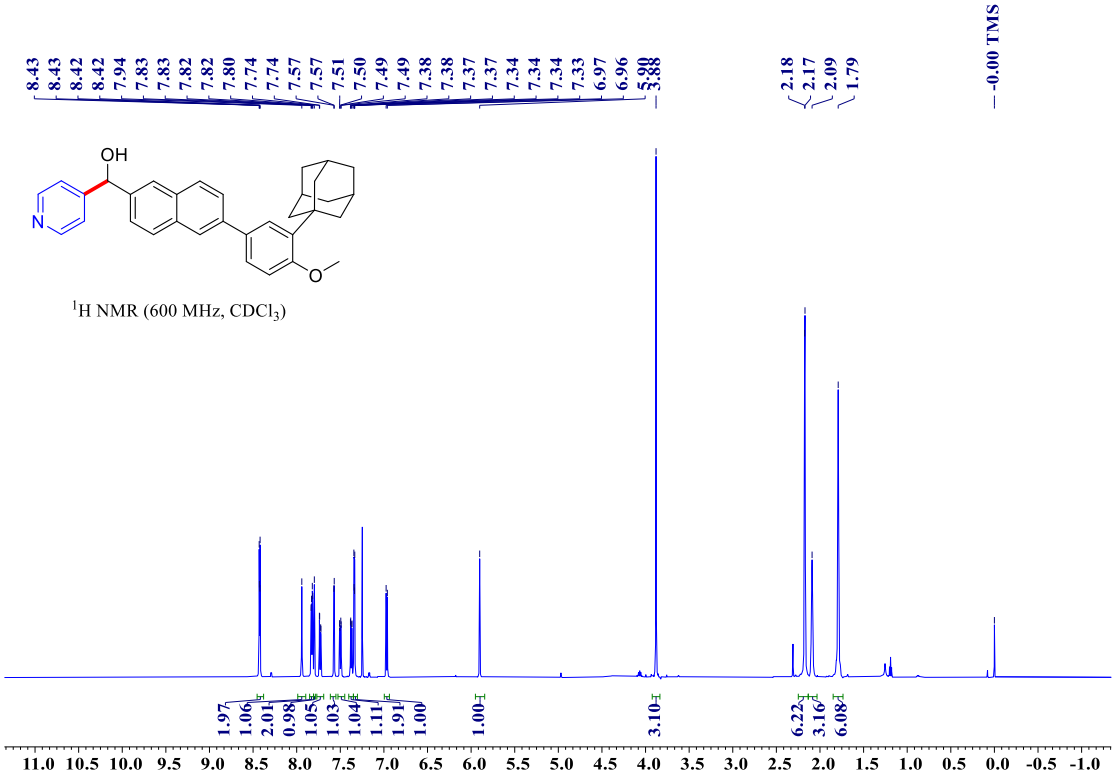
^{1}H and ^{13}C NMR spectra of compound 3ac

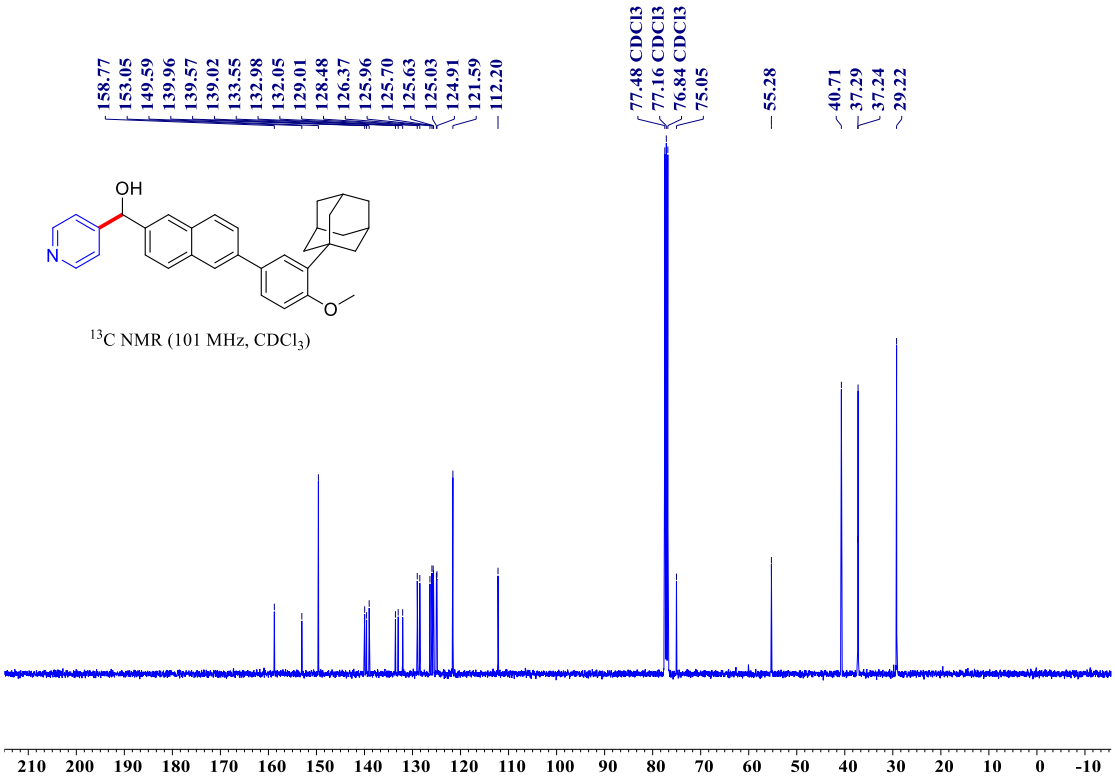


^{1}H NMR (400 MHz, $CDCl_3$)



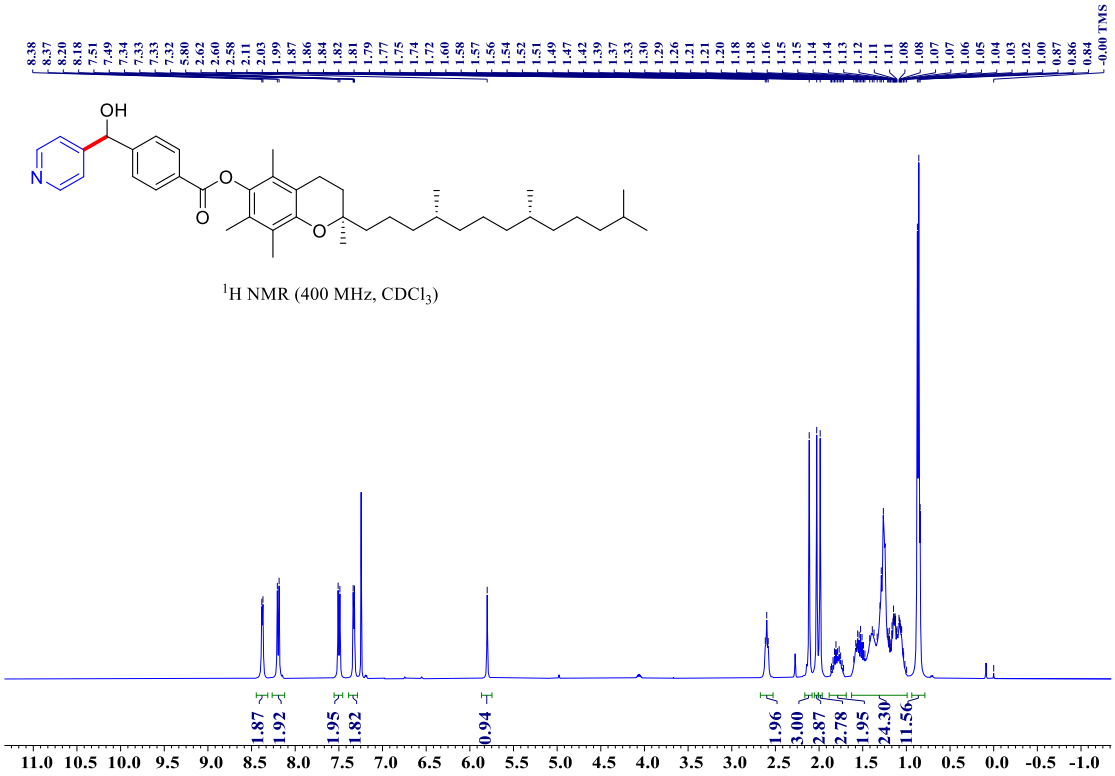
^{1}H and ^{13}C NMR spectra of compound 3ad



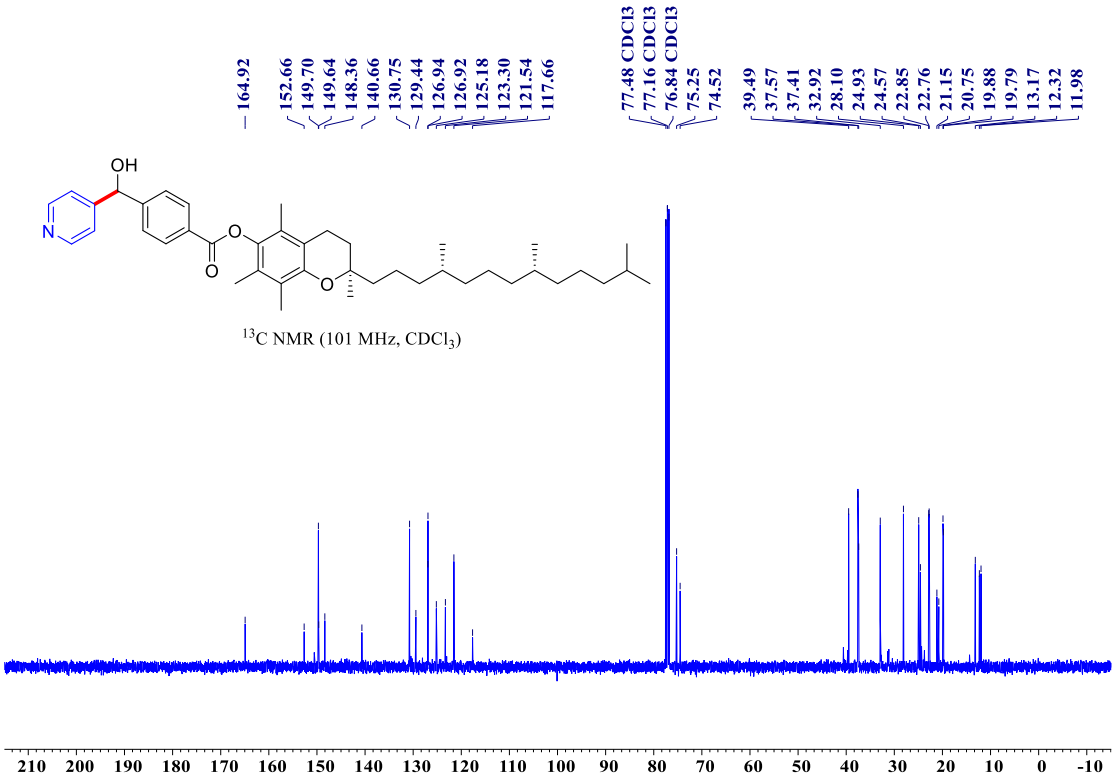


^{13}C NMR (101 MHz, $CDCl_3$)

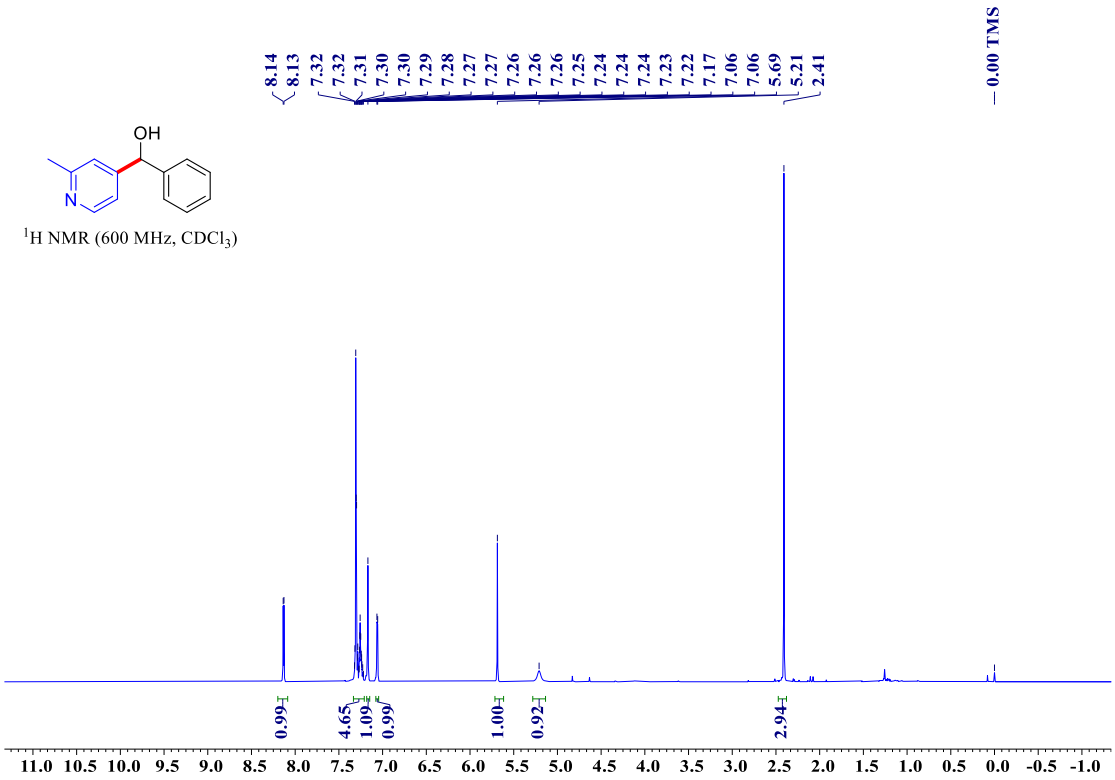
^{1}H and ^{13}C NMR spectra of compound 3ae

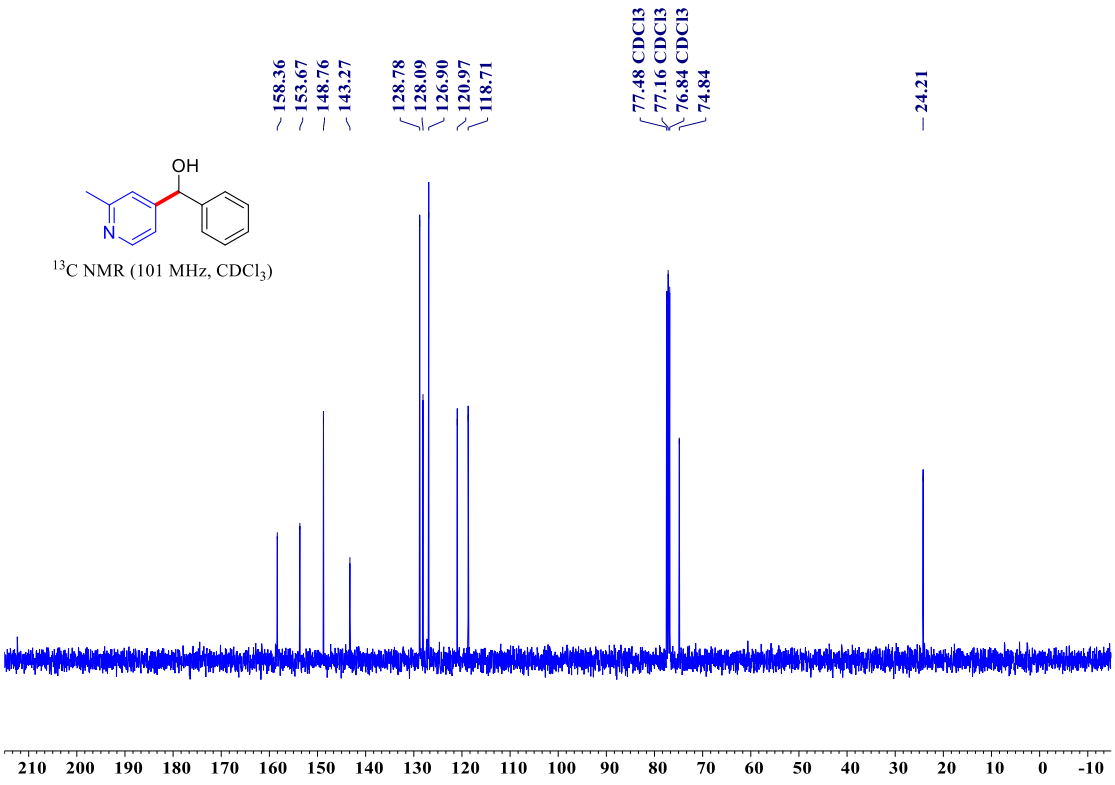


^{1}H NMR (400 MHz, $CDCl_3$)

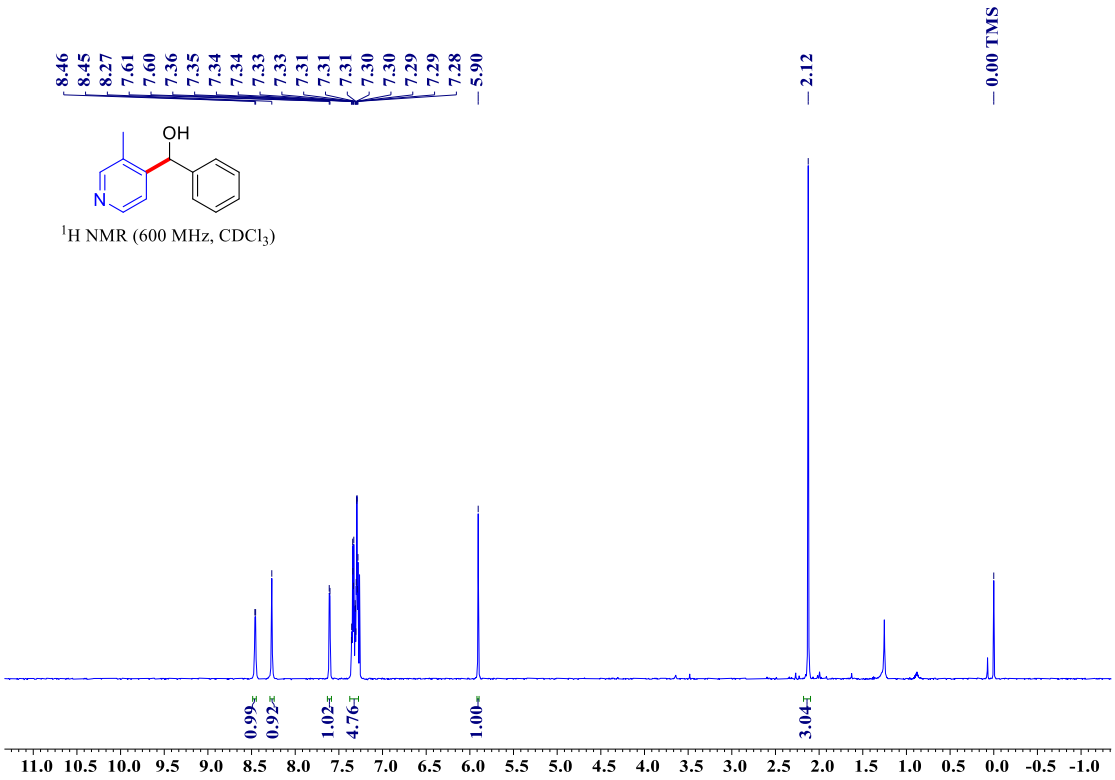


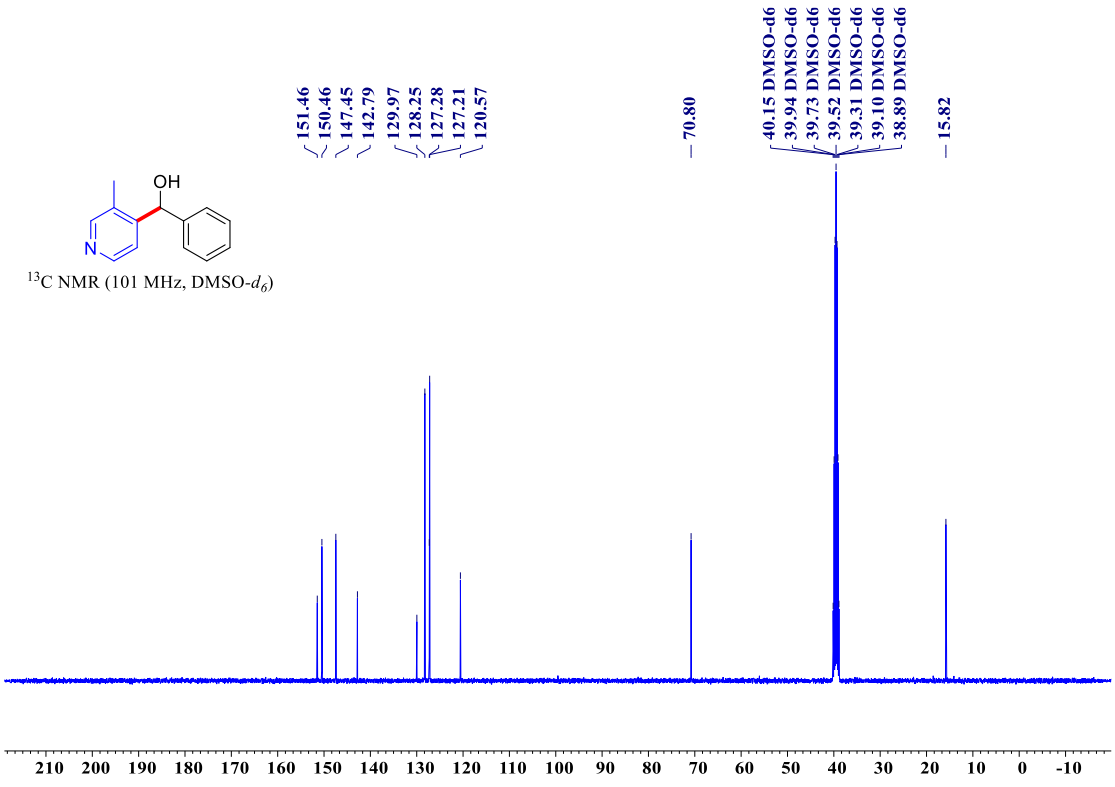
^{1}H and ^{13}C NMR spectra of compound 6a





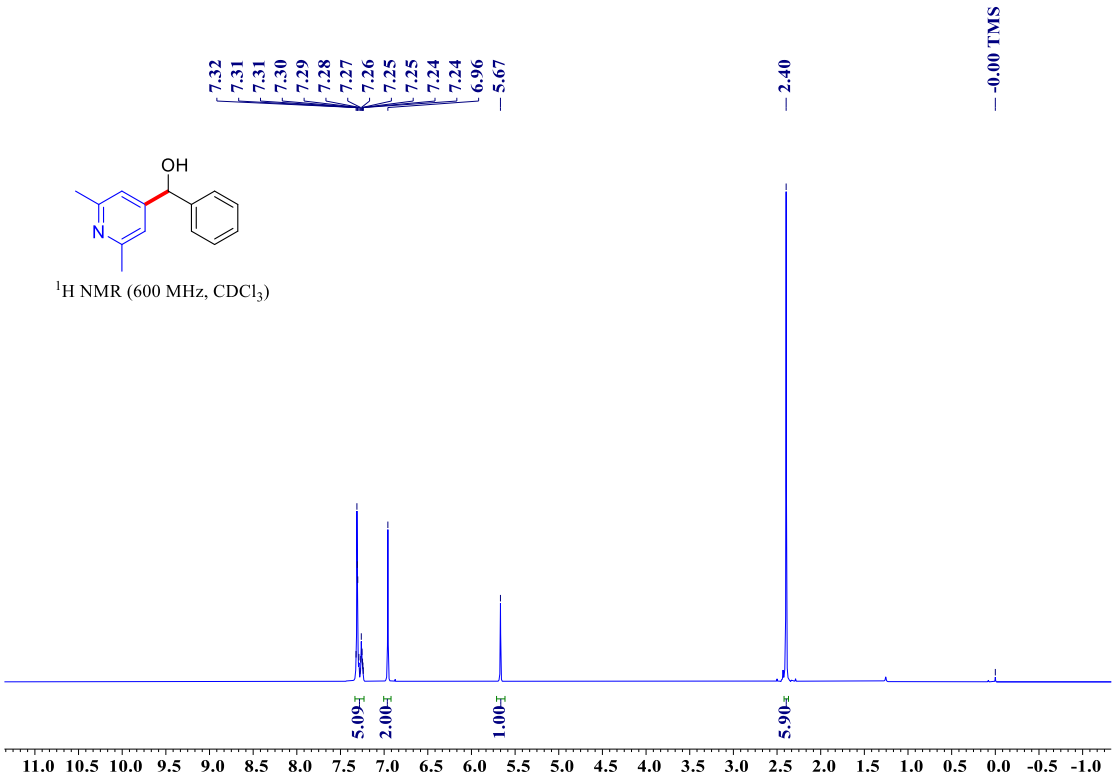
^{1}H and ^{13}C NMR spectra of compound 6b



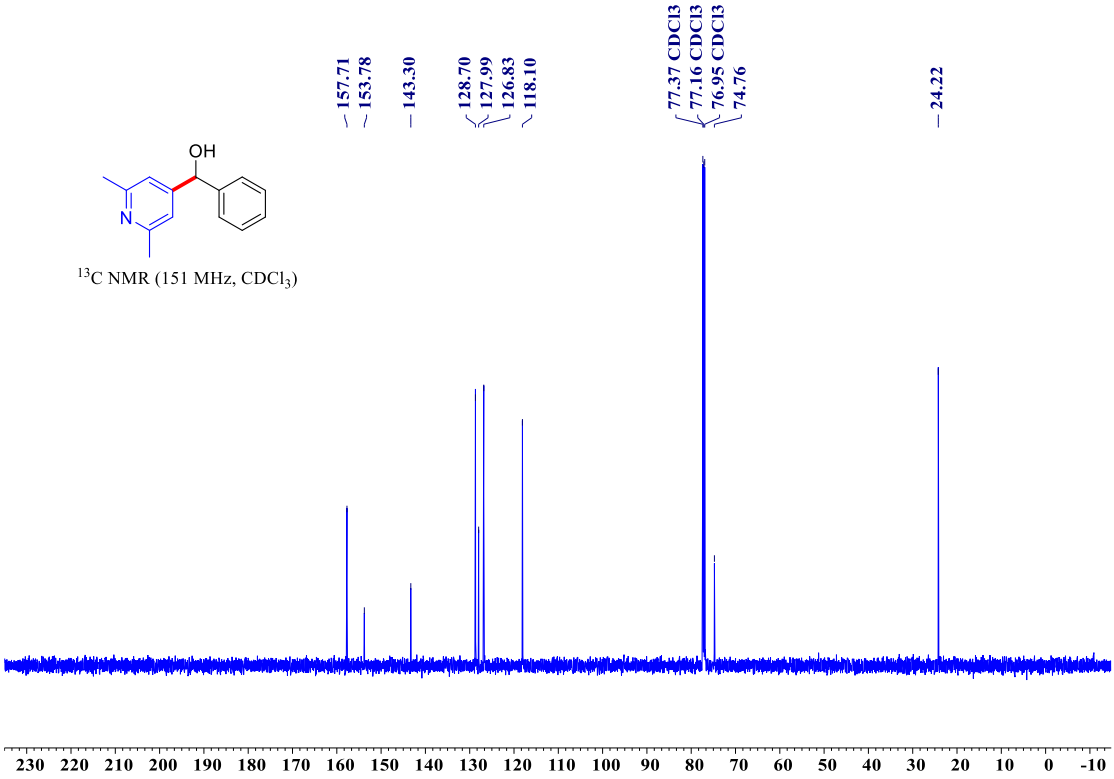


^{13}C NMR (101 MHz, DMSO-d_6)

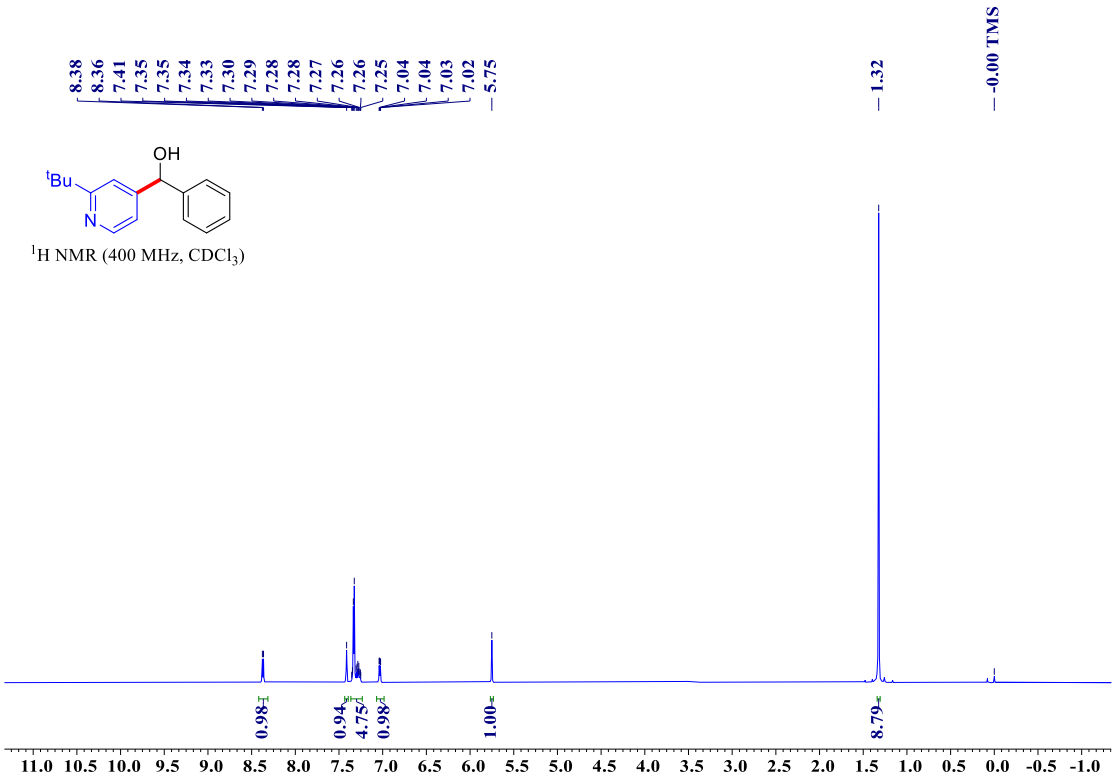
^{1}H and ^{13}C NMR spectra of compound 6c

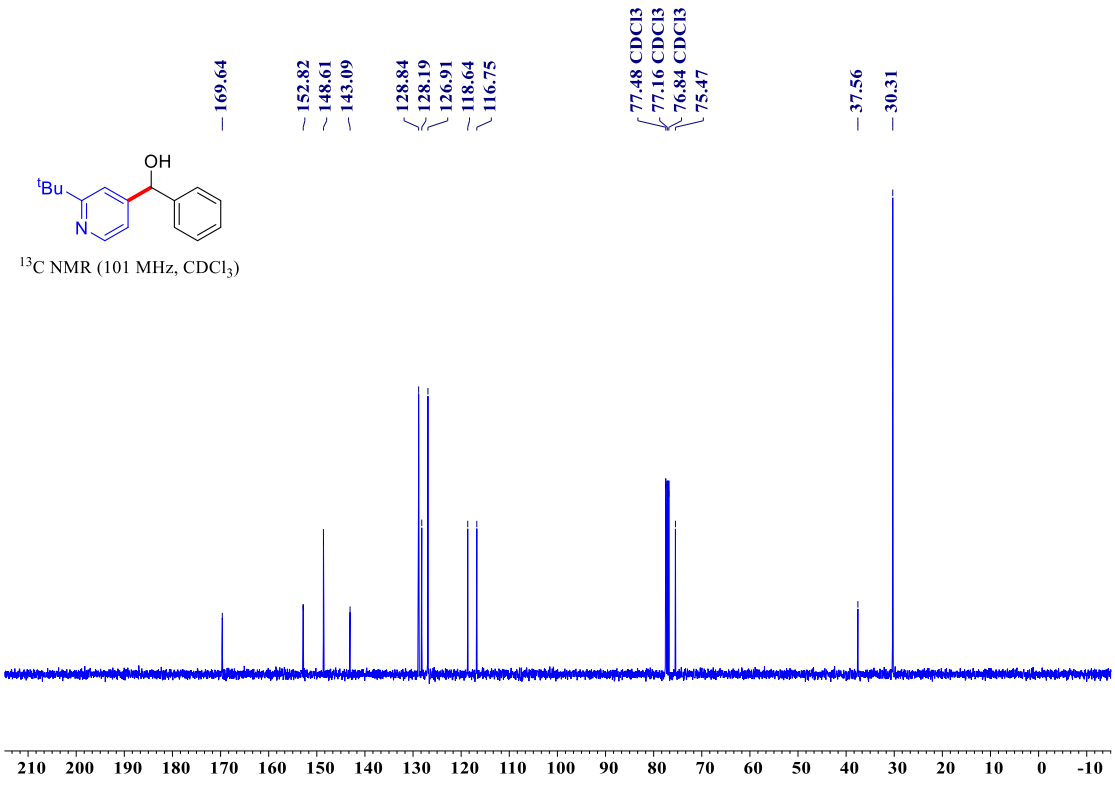


^{1}H NMR (600 MHz, $CDCl_3$)

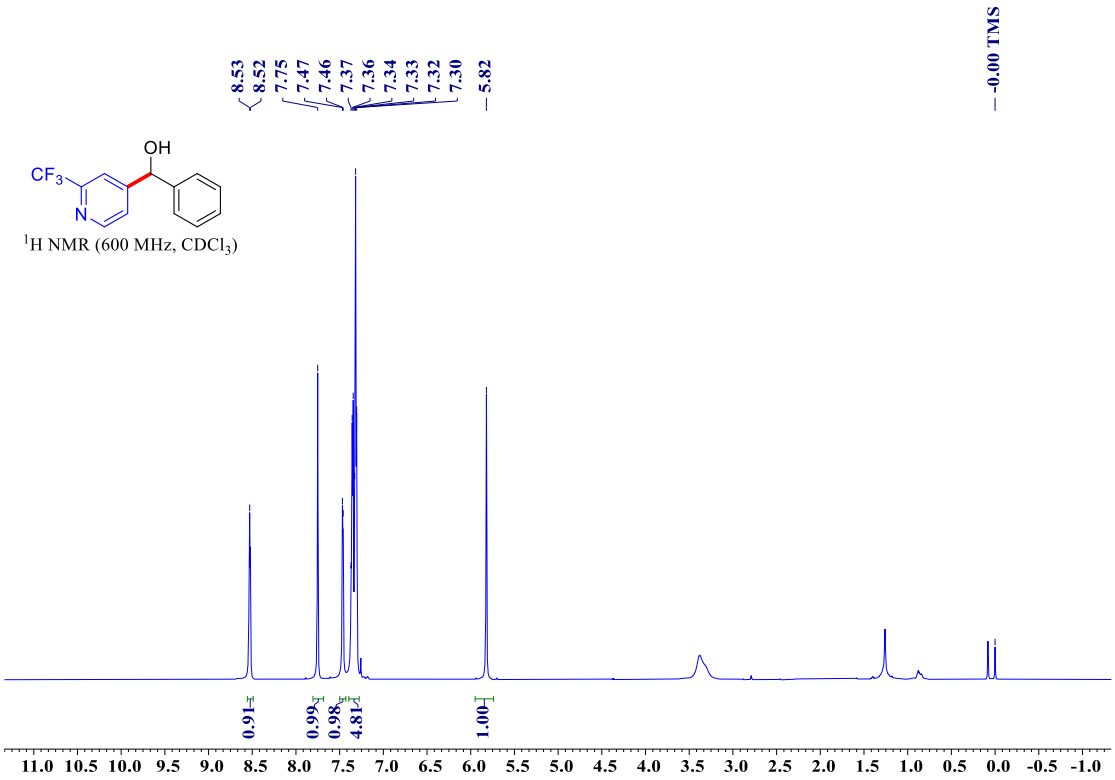


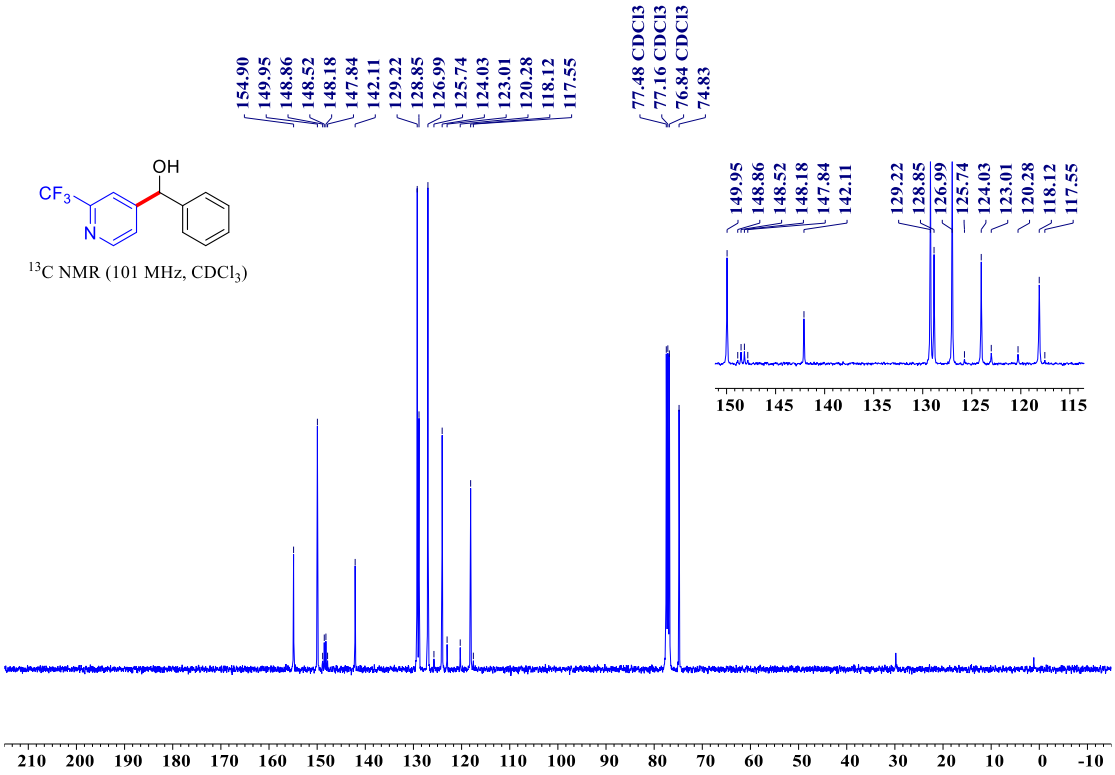
^{1}H and ^{13}C NMR spectra of compound 6d

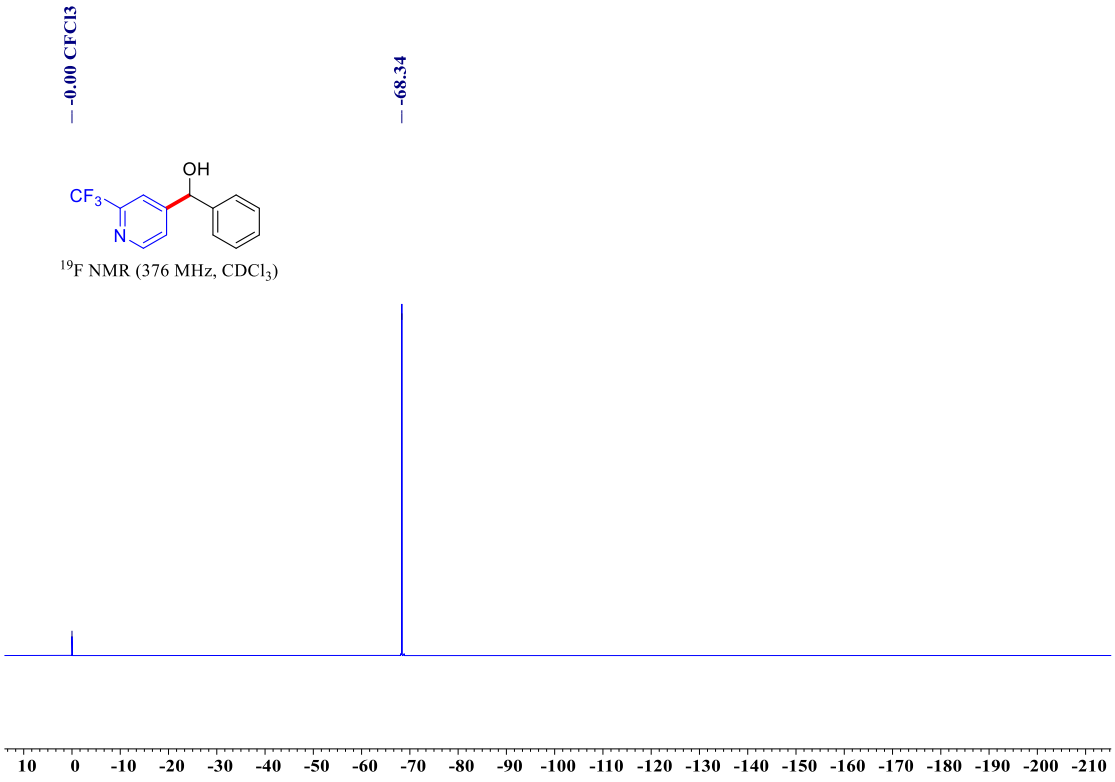




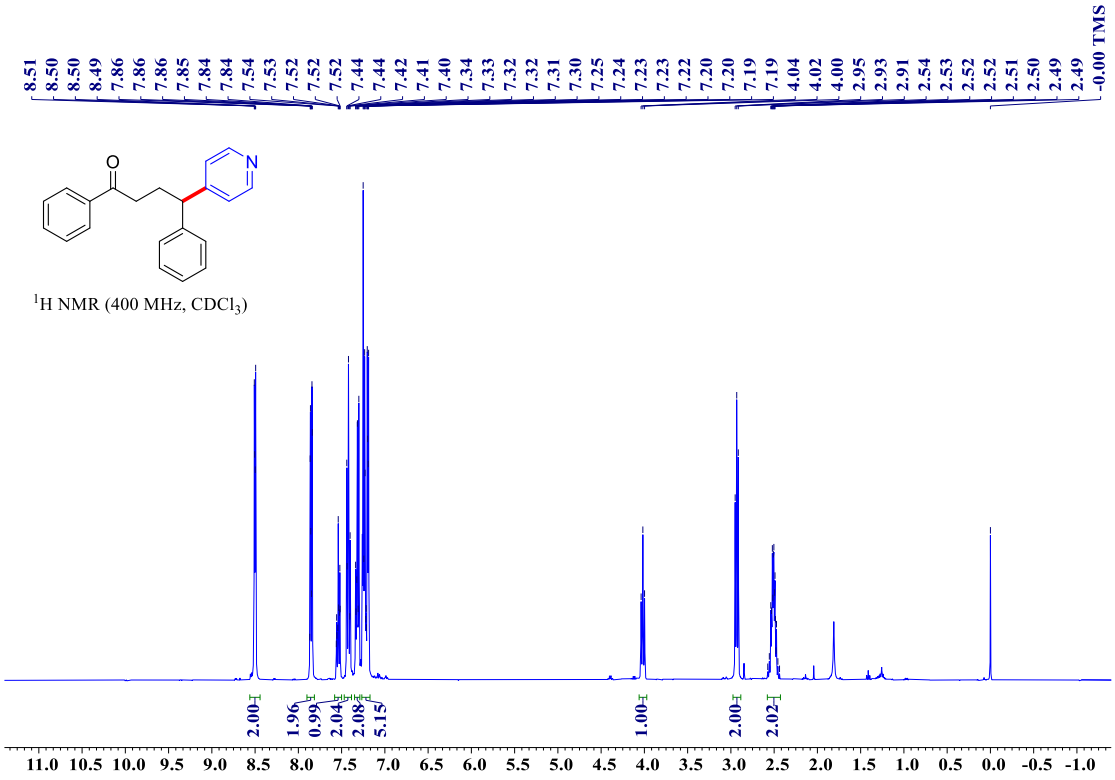
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 6e

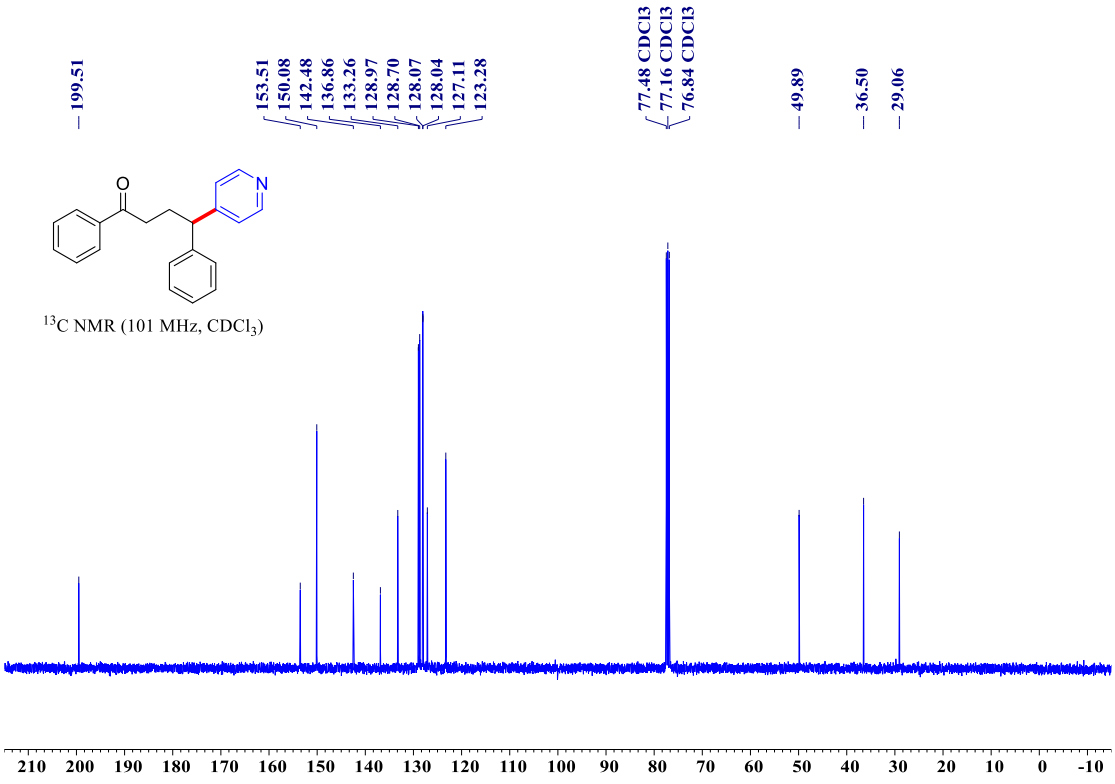



154.90
149.95
148.86
148.52
148.18
147.84
142.11
129.22
128.85
126.99
125.74
124.03
123.01
120.28
118.12
117.55
77.48 CDCl3
77.16 CDCl3
76.84 CDCl3
74.83
OH
CF3
N
13C NMR (101 MHz, CDCl3)
149.95
148.86
148.52
148.18
147.84
142.11
129.22
128.85
126.99
125.74
124.03
123.01
120.28
118.12
117.55
150 145 140 135 130 125 120 115
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

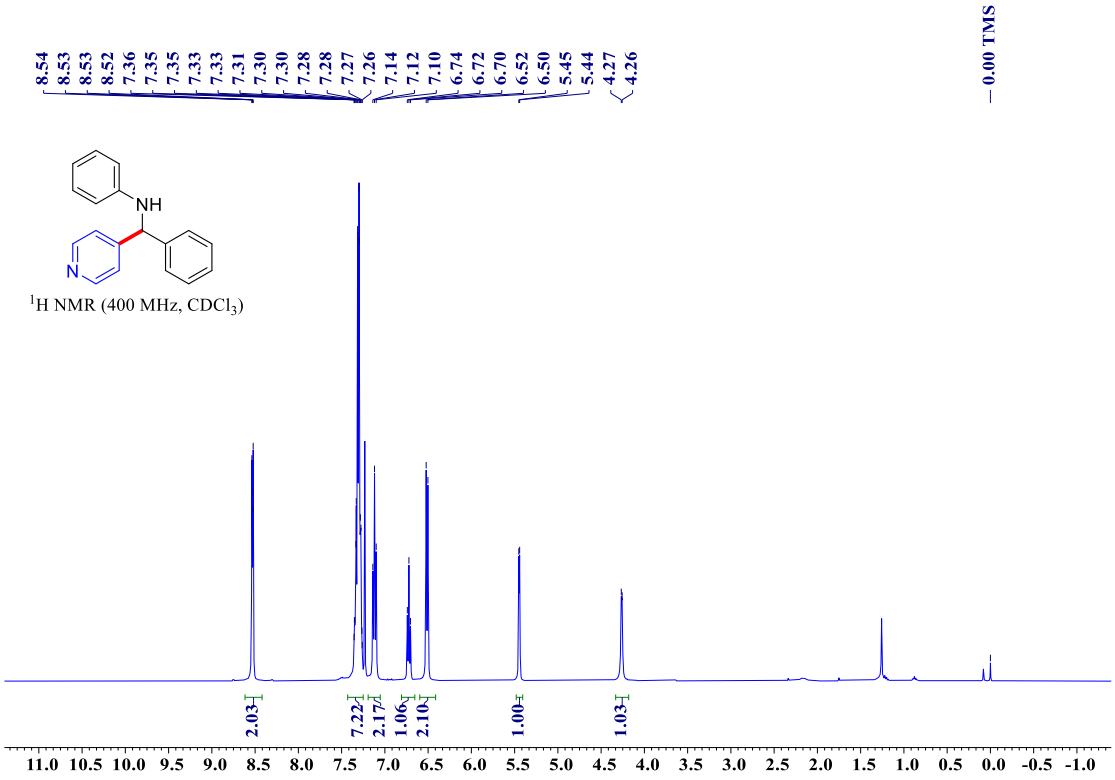

-0.00 CFCl3
-68.34
OH
CF3
N
19F NMR (376 MHz, CDCl3)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

^{1}H and ^{13}C NMR spectra of compound 3af

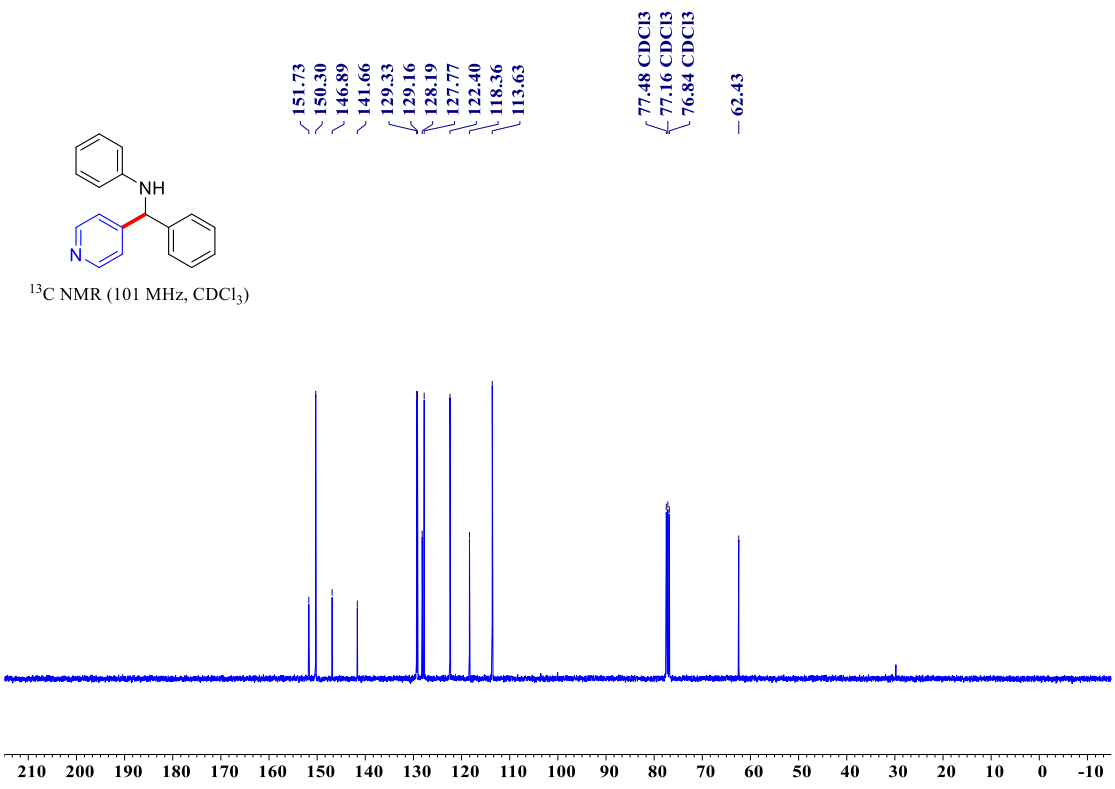




^{1}H and ^{13}C NMR spectra of compound 5a

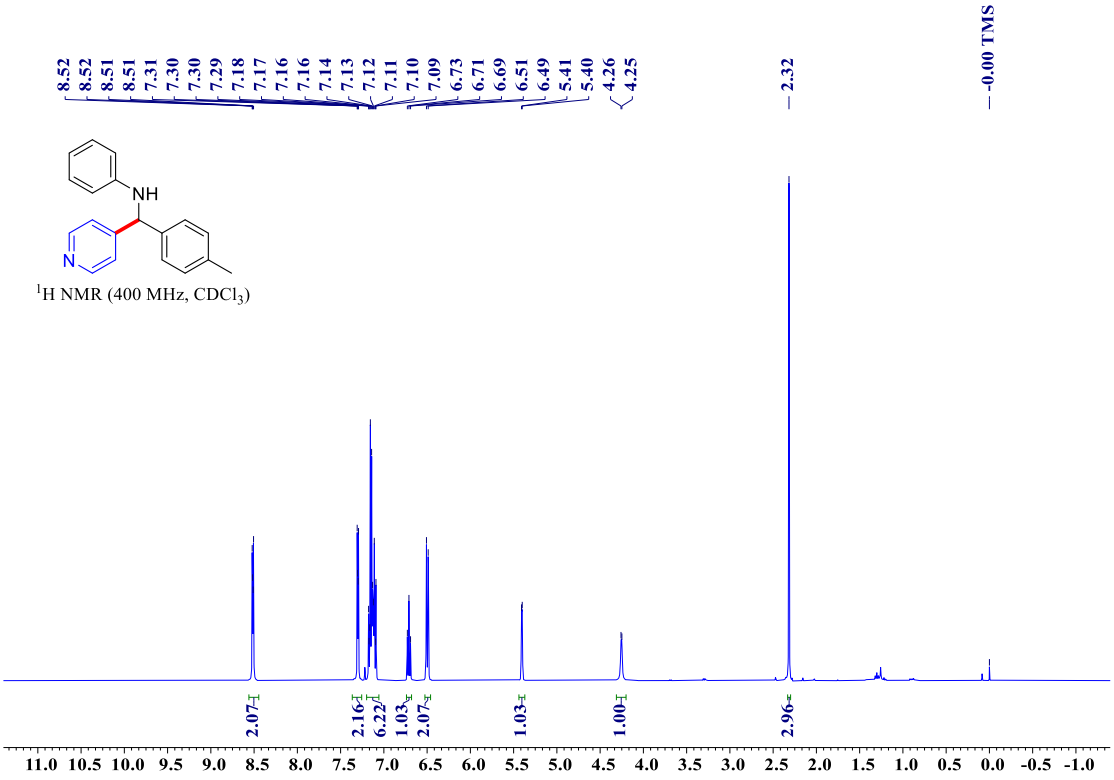


^{1}H NMR (400 MHz, $CDCl_3$)

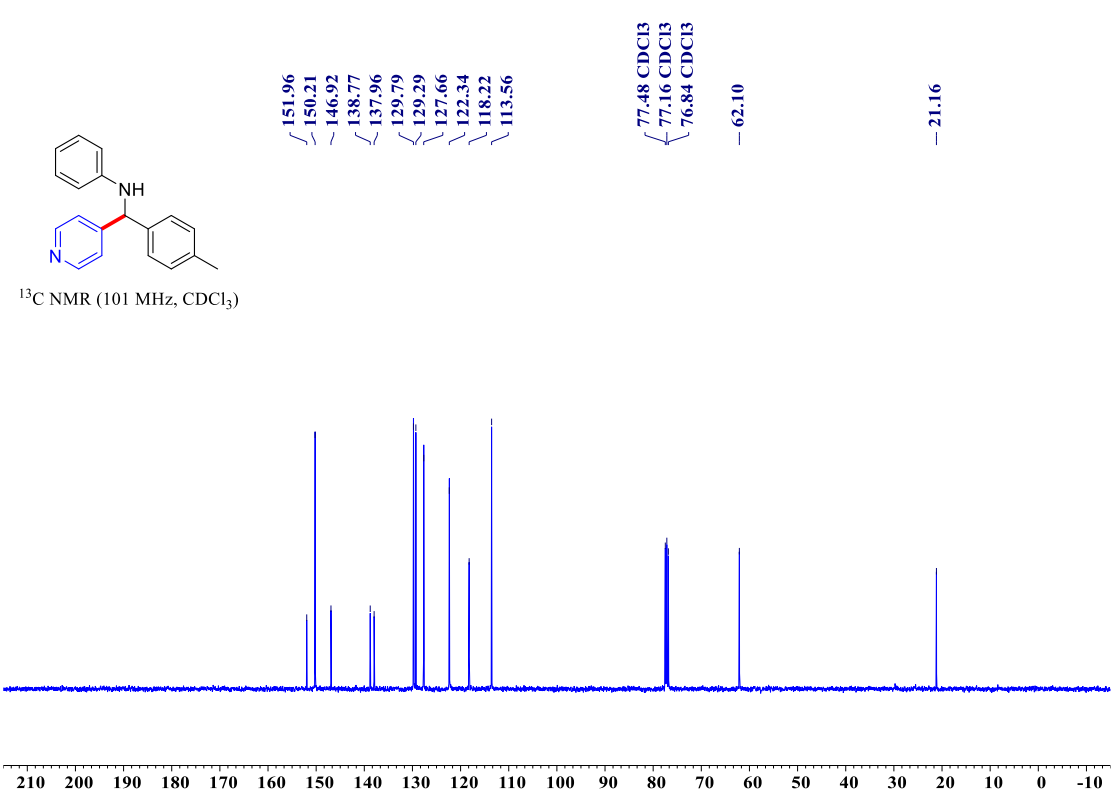


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 5b

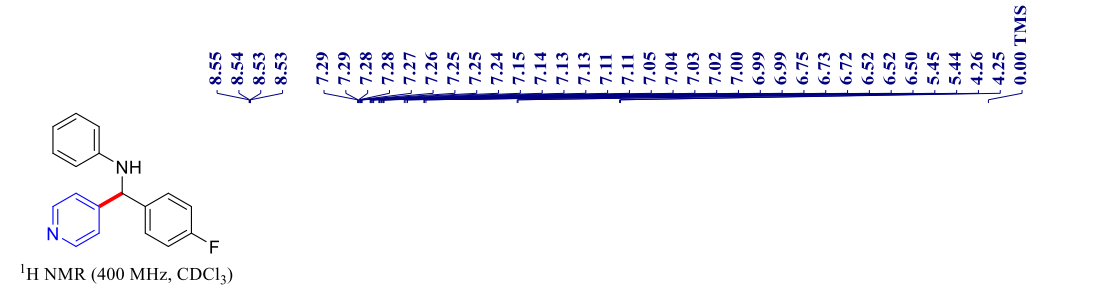


^{1}H NMR (400 MHz, $CDCl_3$)

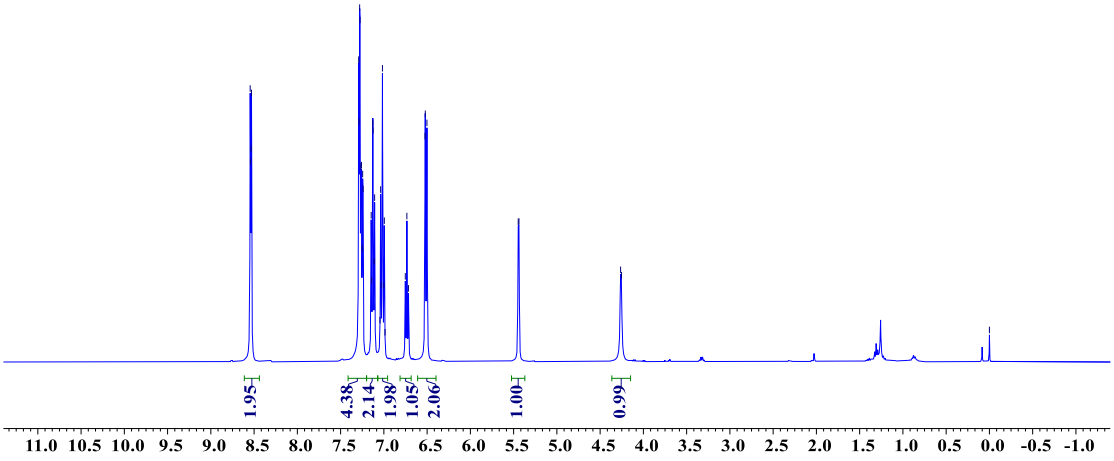


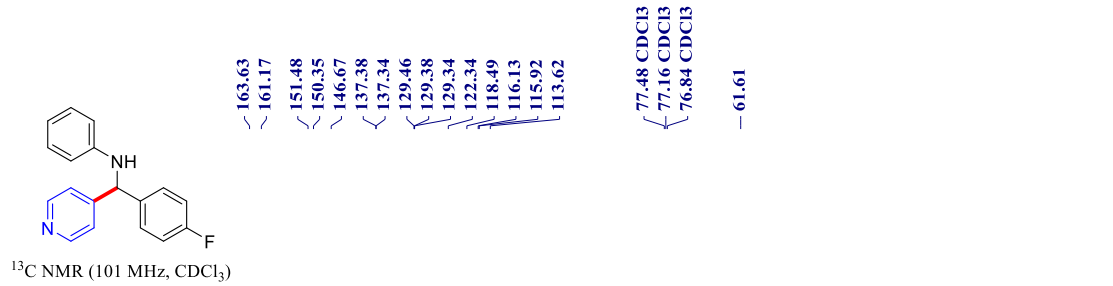
^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 5c

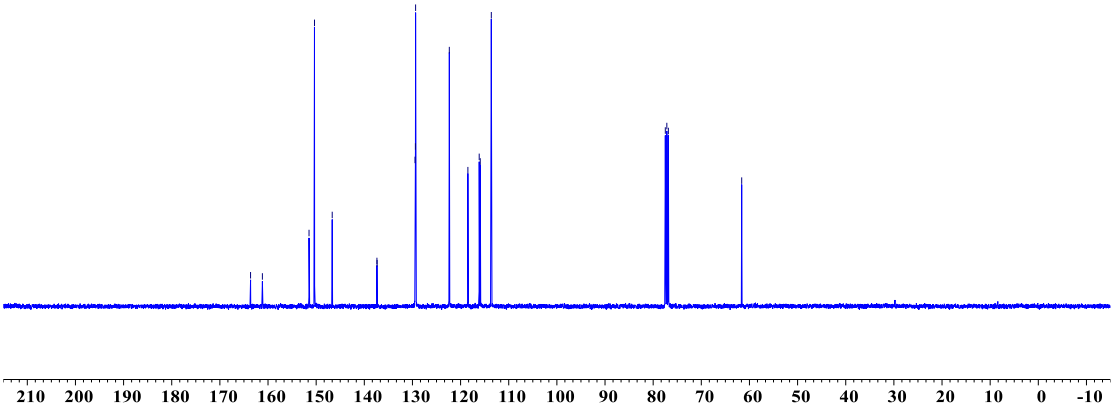


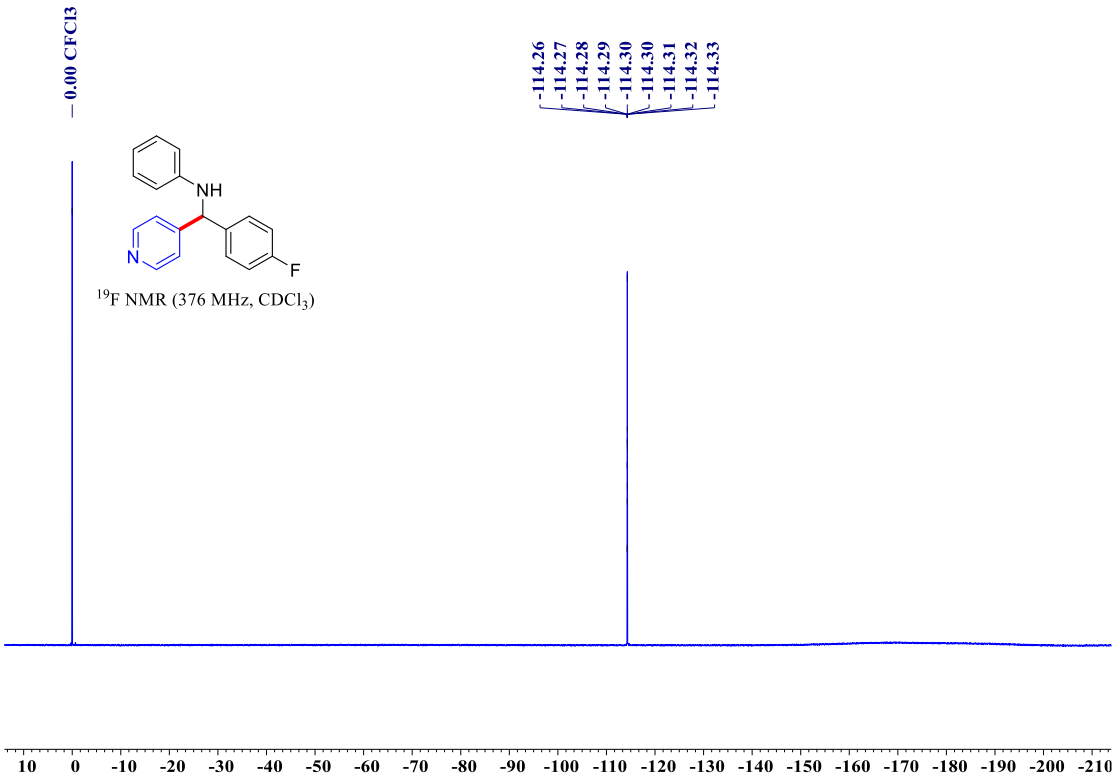
^{1}H NMR (400 MHz, $CDCl_3$)



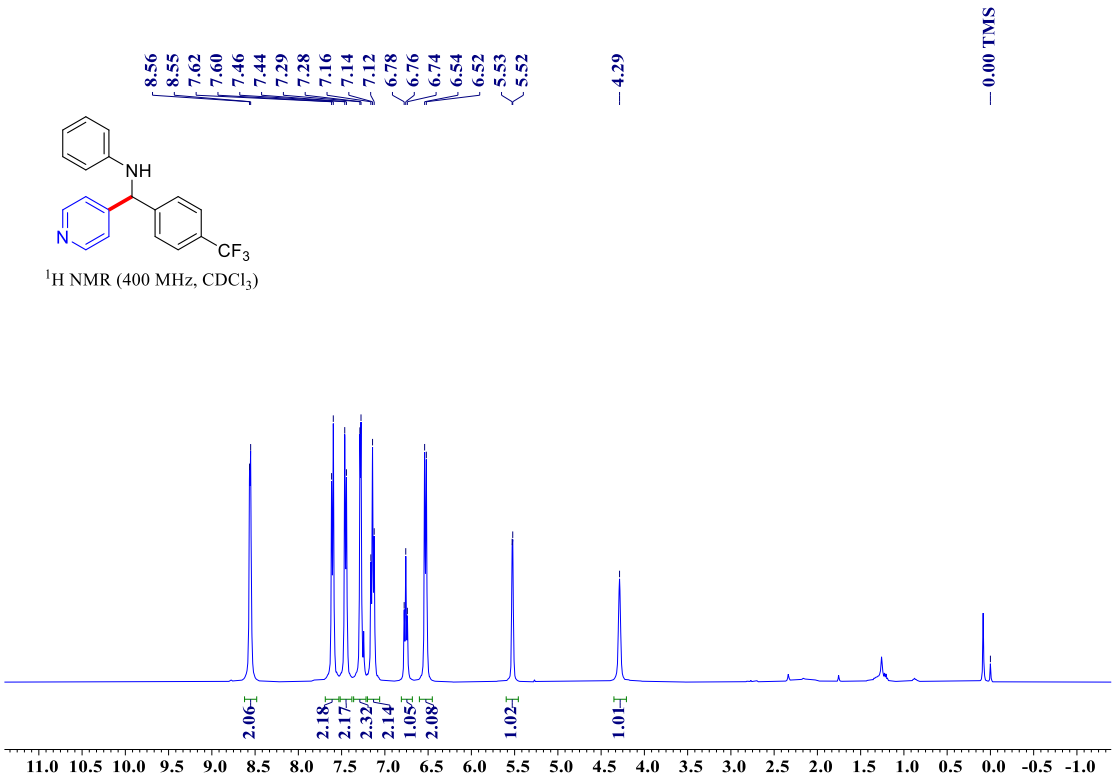


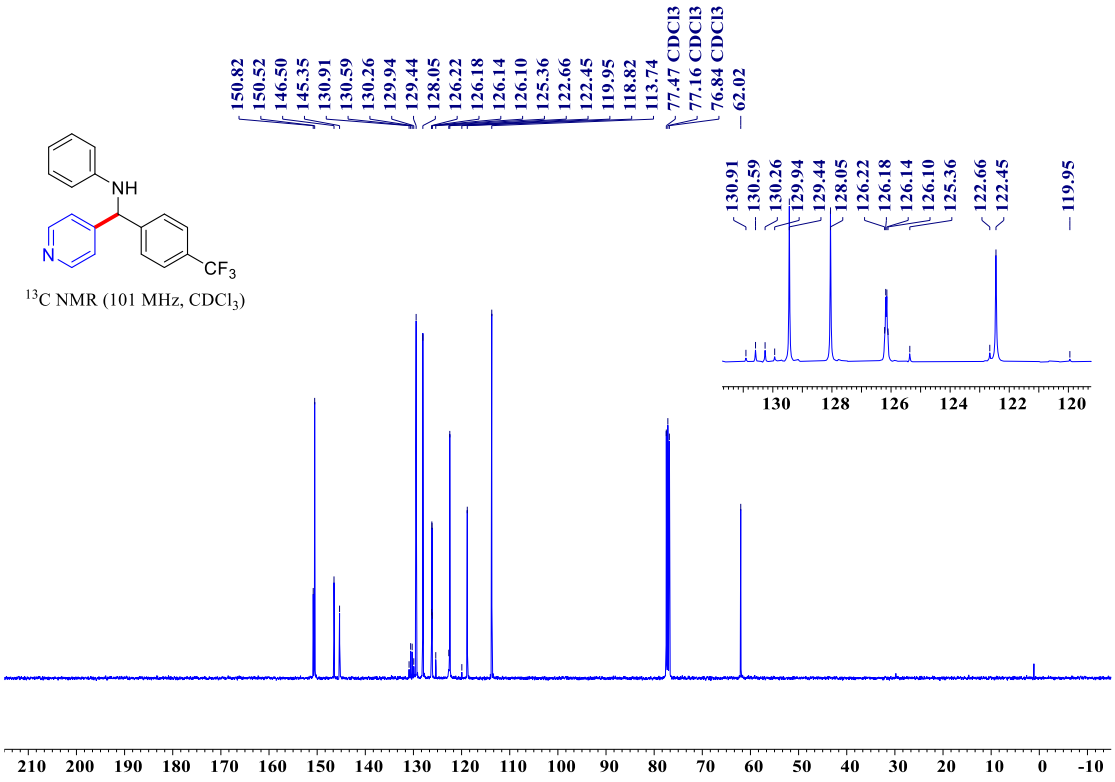
^{13}C NMR (101 MHz, $CDCl_3$)



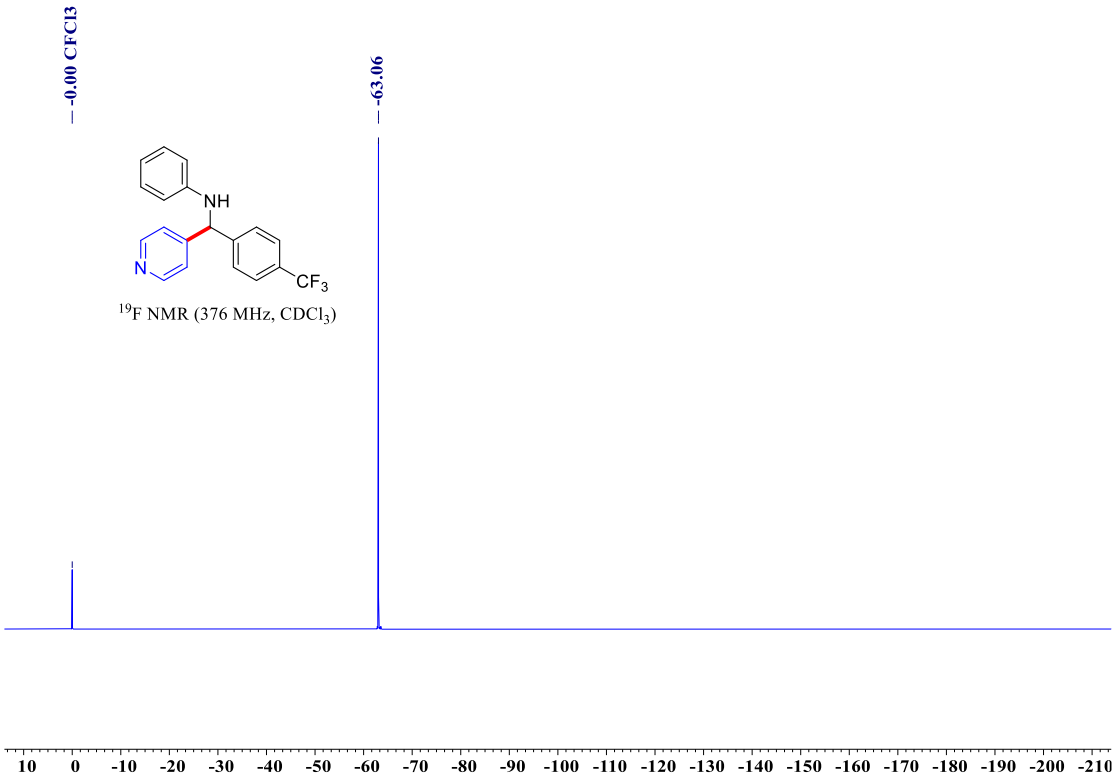


^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 5d



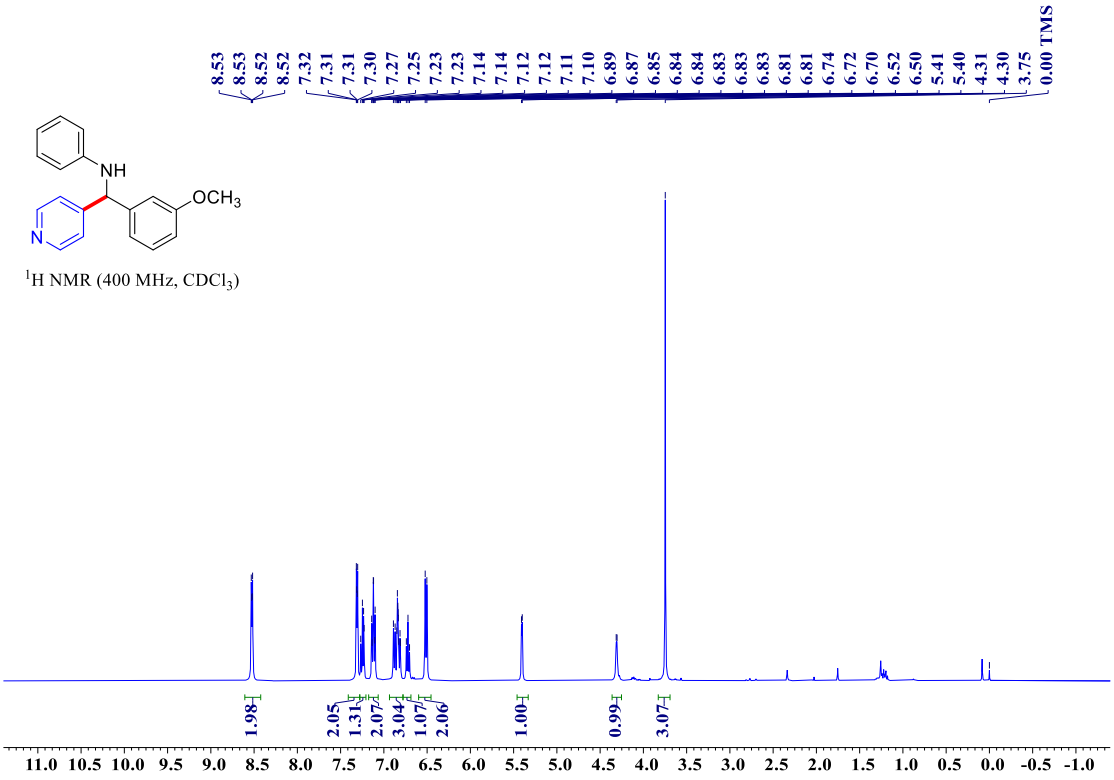


^{13}C NMR (101 MHz, $CDCl_3$)

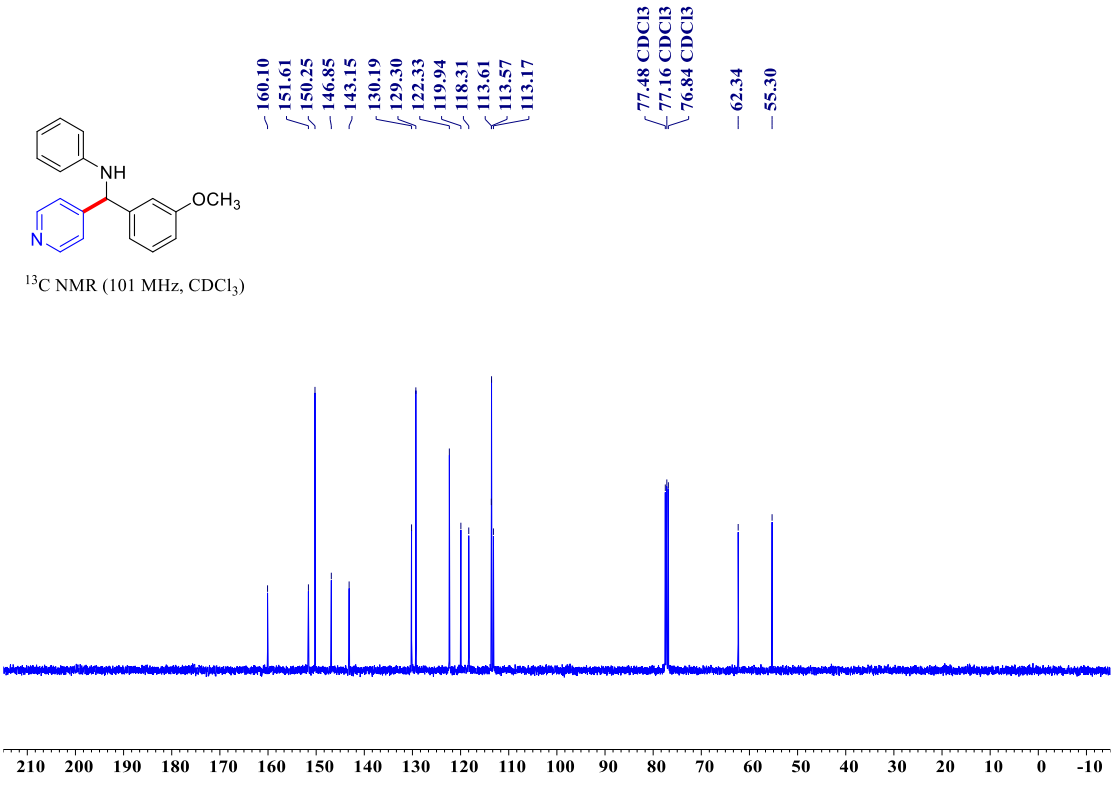


^{19}F NMR (376 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 5e

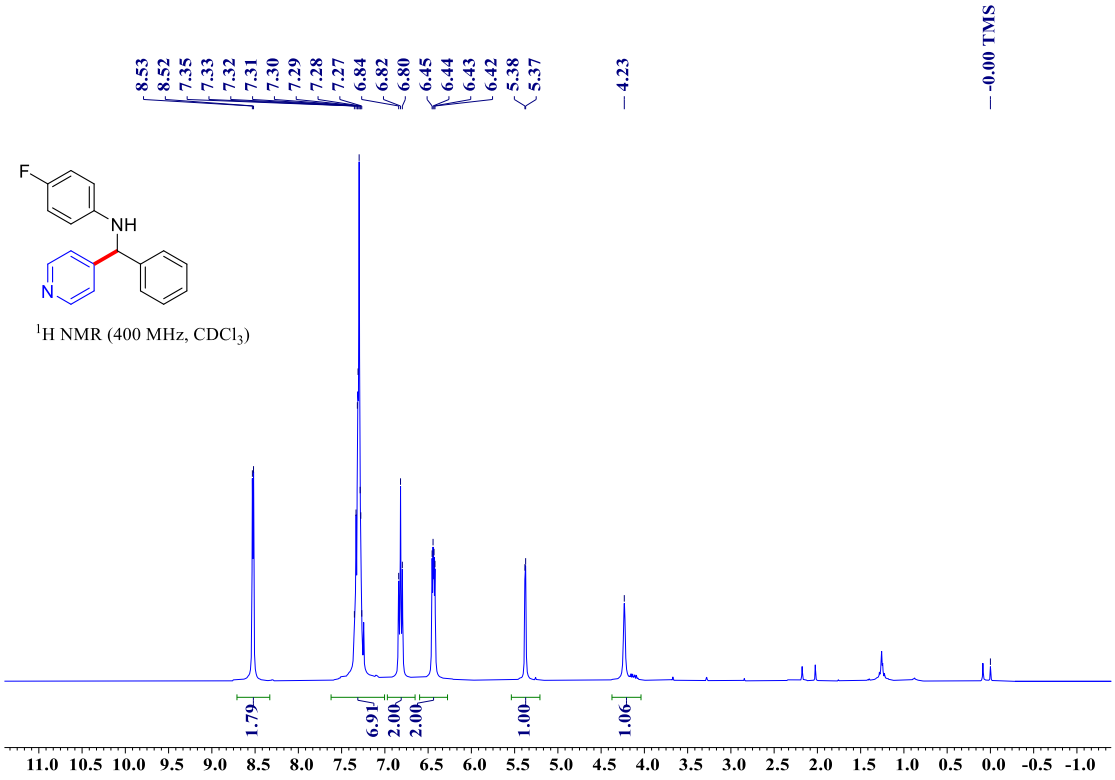


^{1}H NMR (400 MHz, $CDCl_3$)

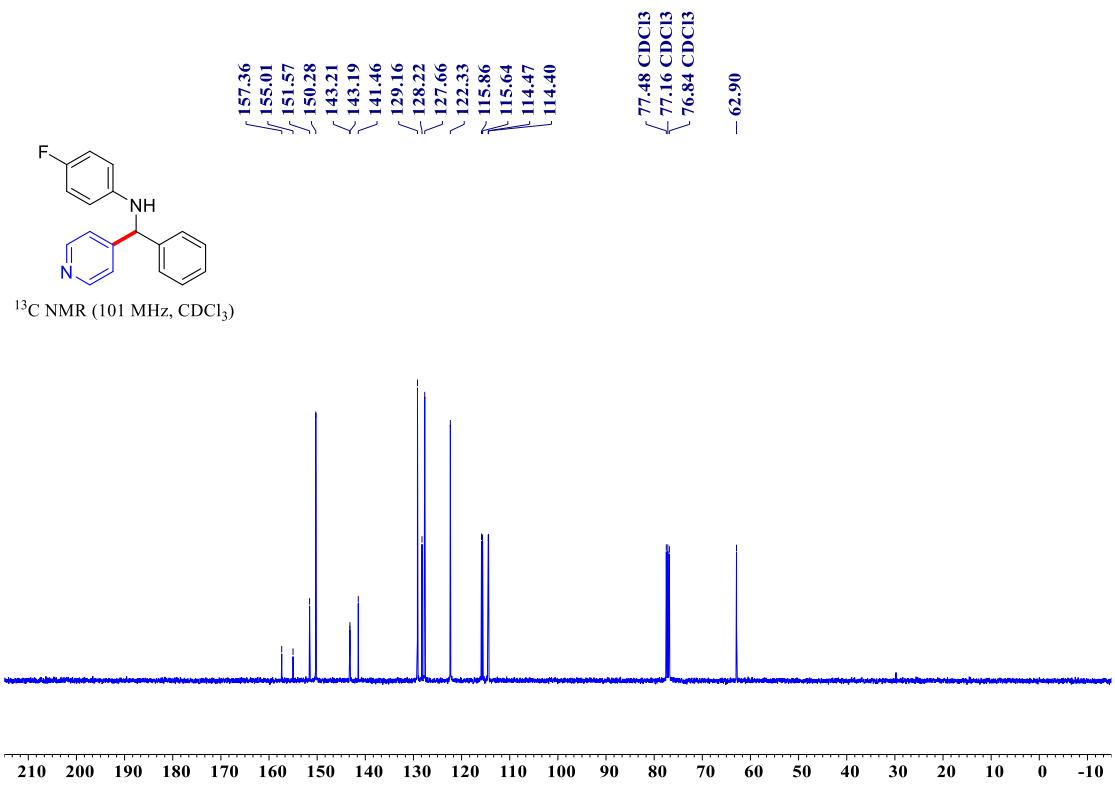


^{13}C NMR (101 MHz, $CDCl_3$)

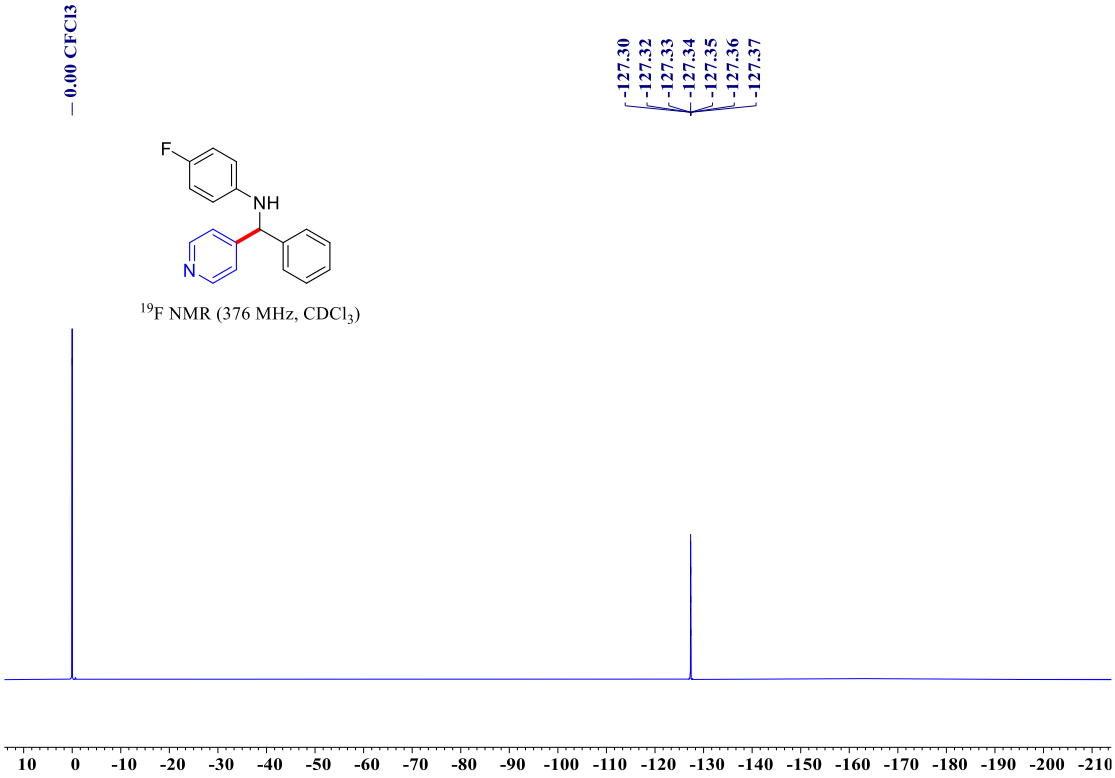
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 5f



^{1}H NMR (400 MHz, $CDCl_3$)

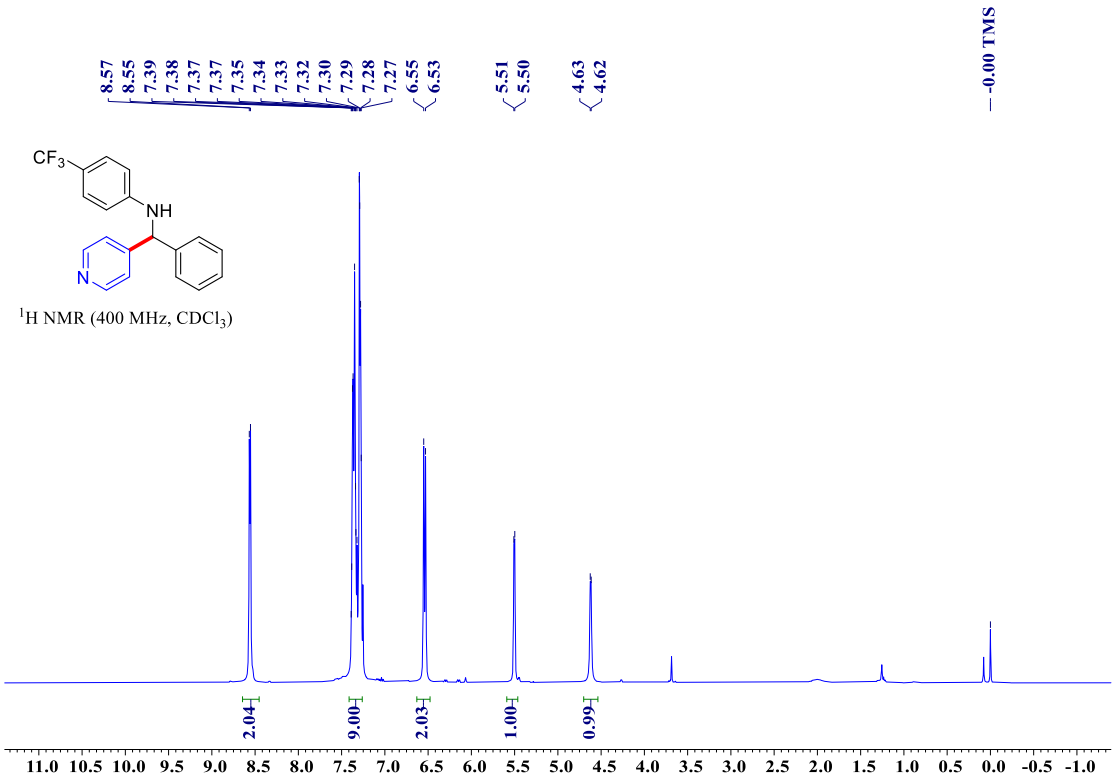


^{13}C NMR (101 MHz, $CDCl_3$)

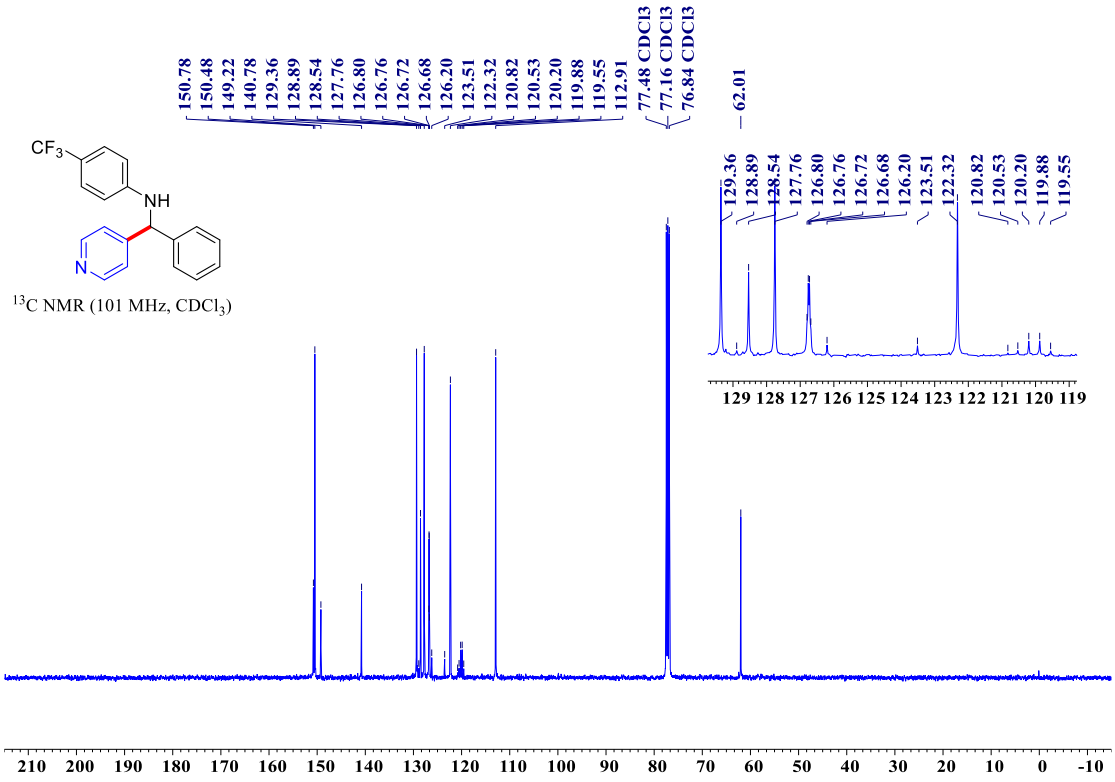


^{19}F NMR (376 MHz, $CDCl_3$)

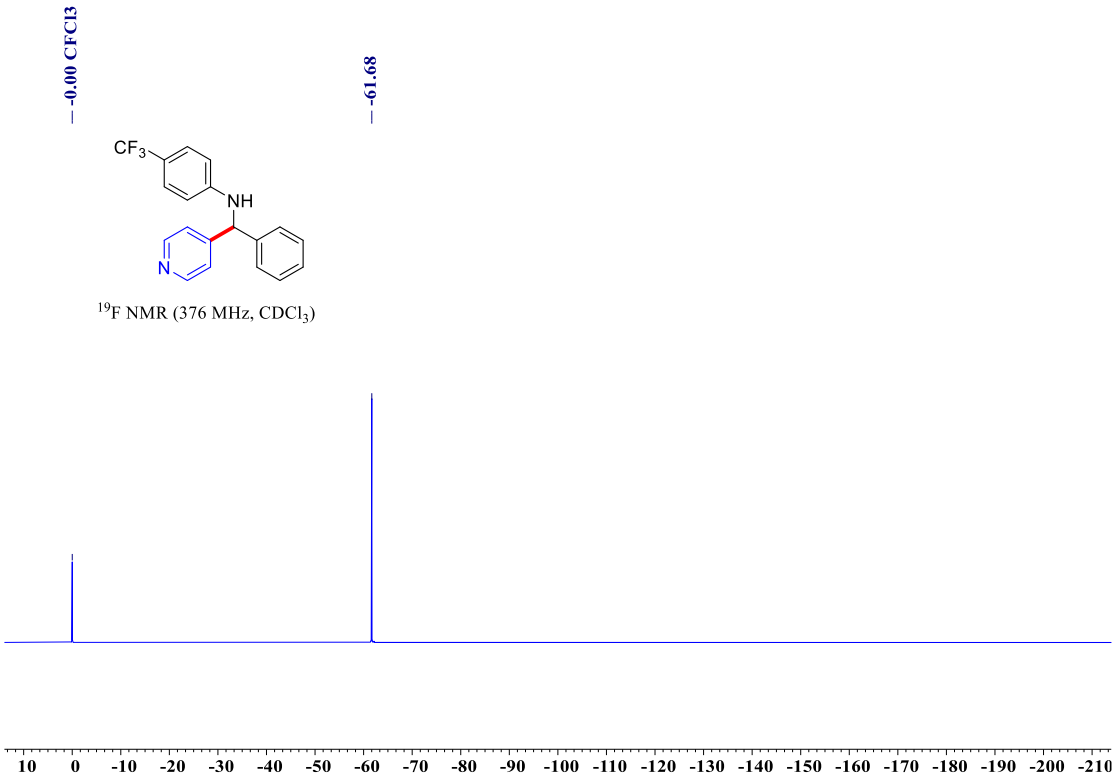
^{1}H, ^{13}C, and ^{19}F NMR spectra of compound 5g



^{1}H NMR (400 MHz, $CDCl_3$)

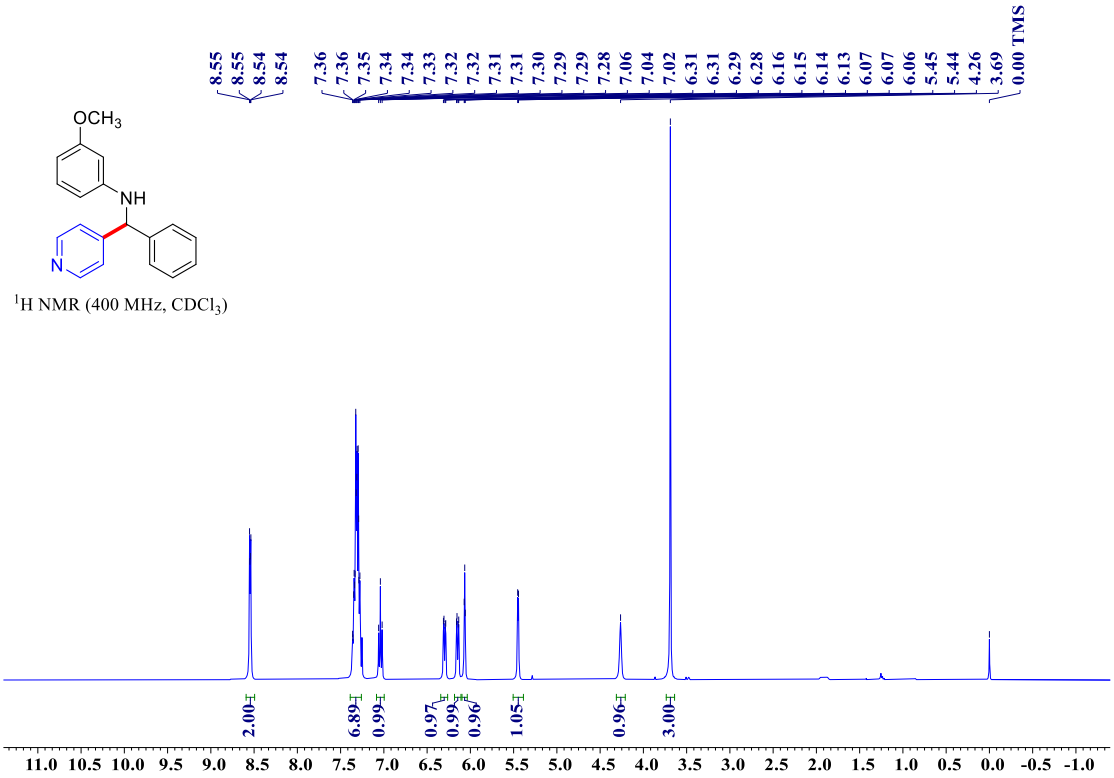


^{13}C NMR (101 MHz, $CDCl_3$)

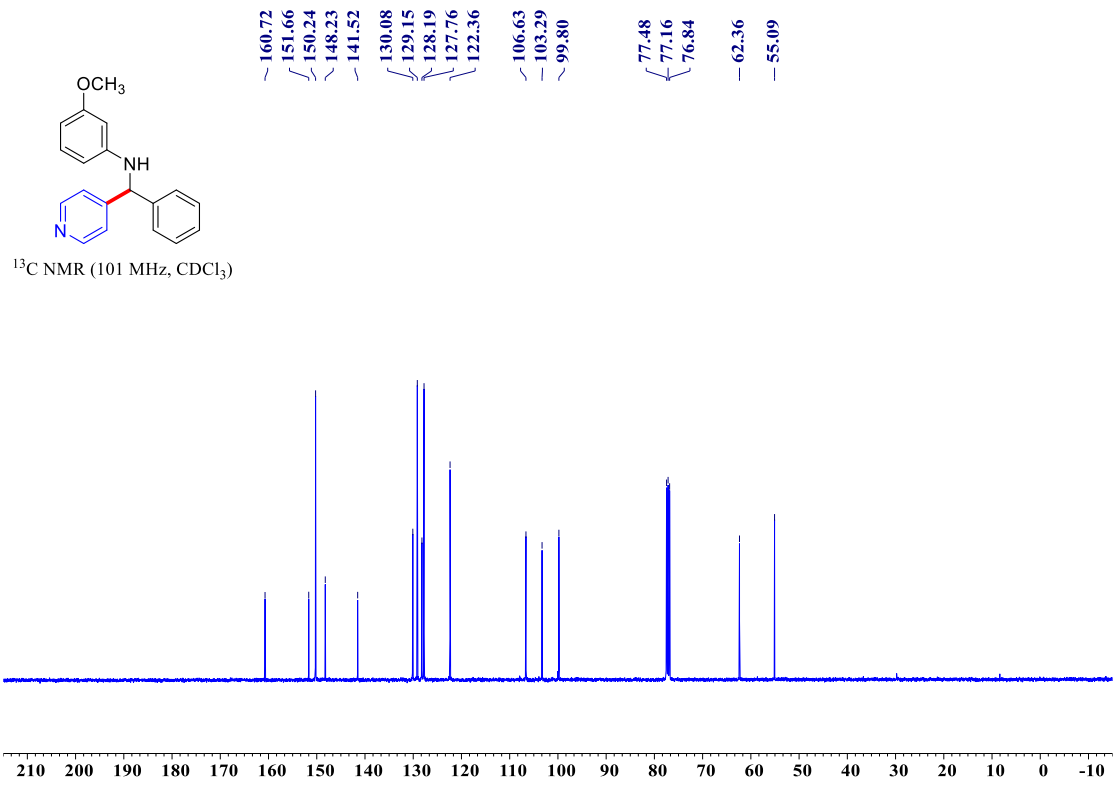


^{19}F NMR (376 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 5h

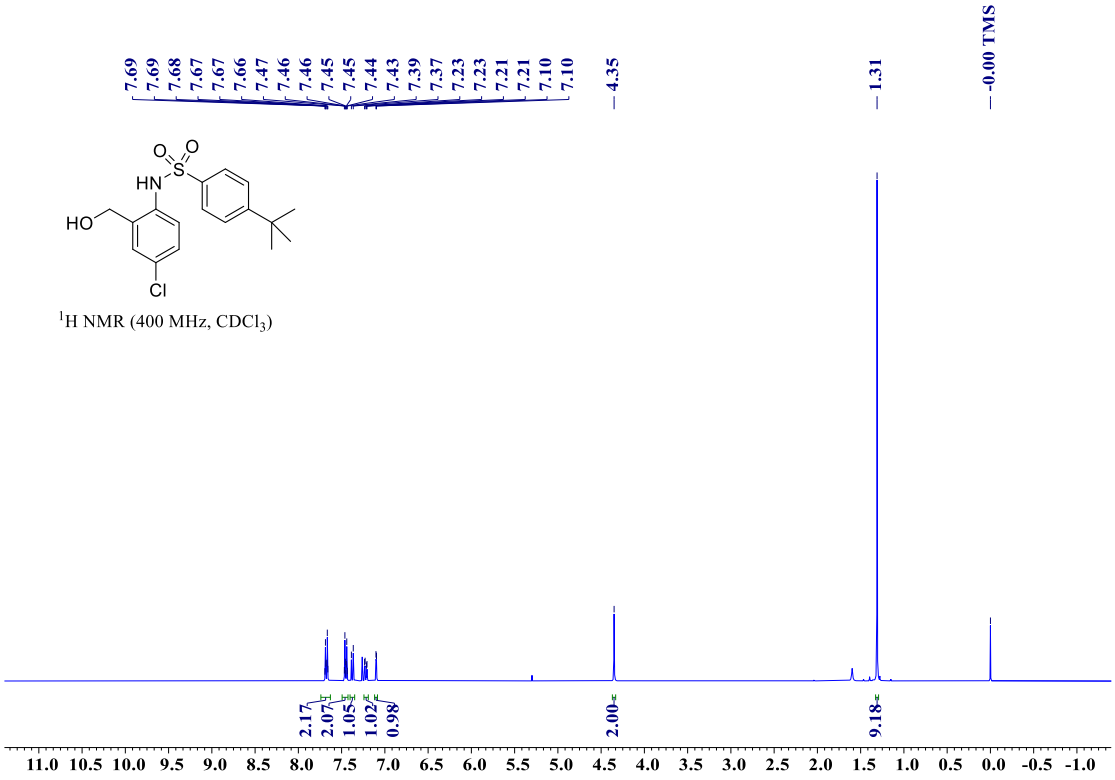


^{1}H NMR (400 MHz, $CDCl_3$)

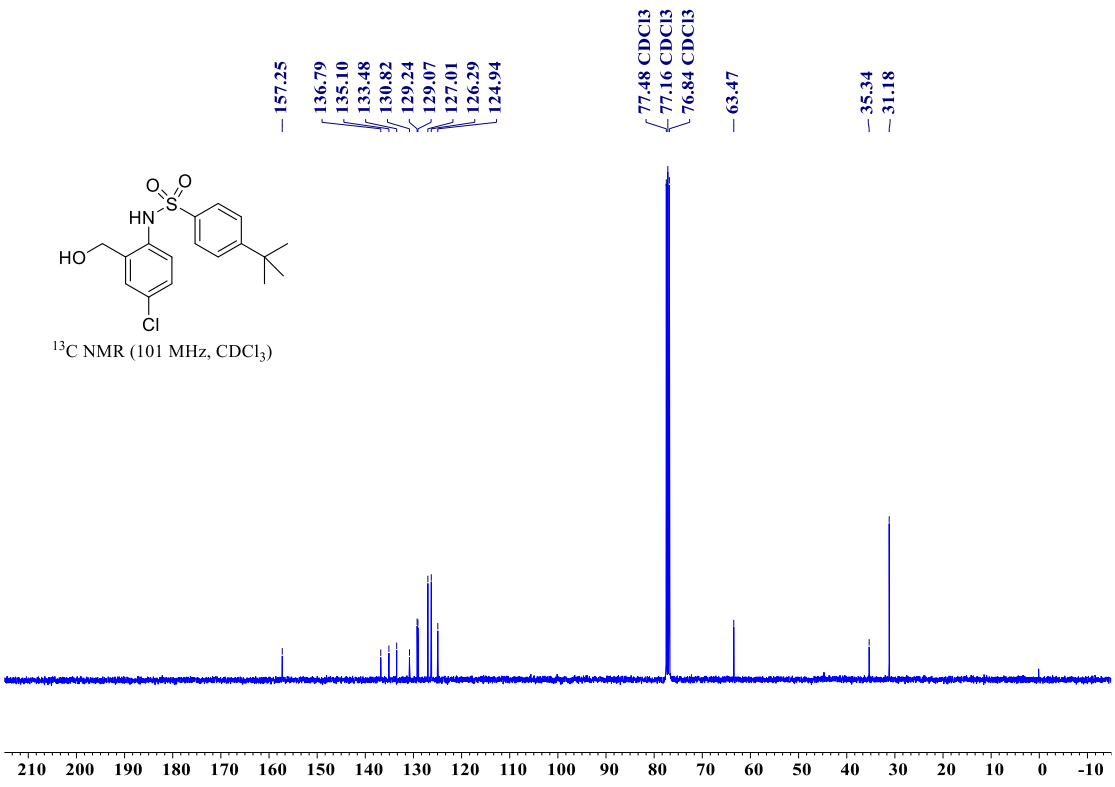


^{13}C NMR (101 MHz, $CDCl_3$)

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

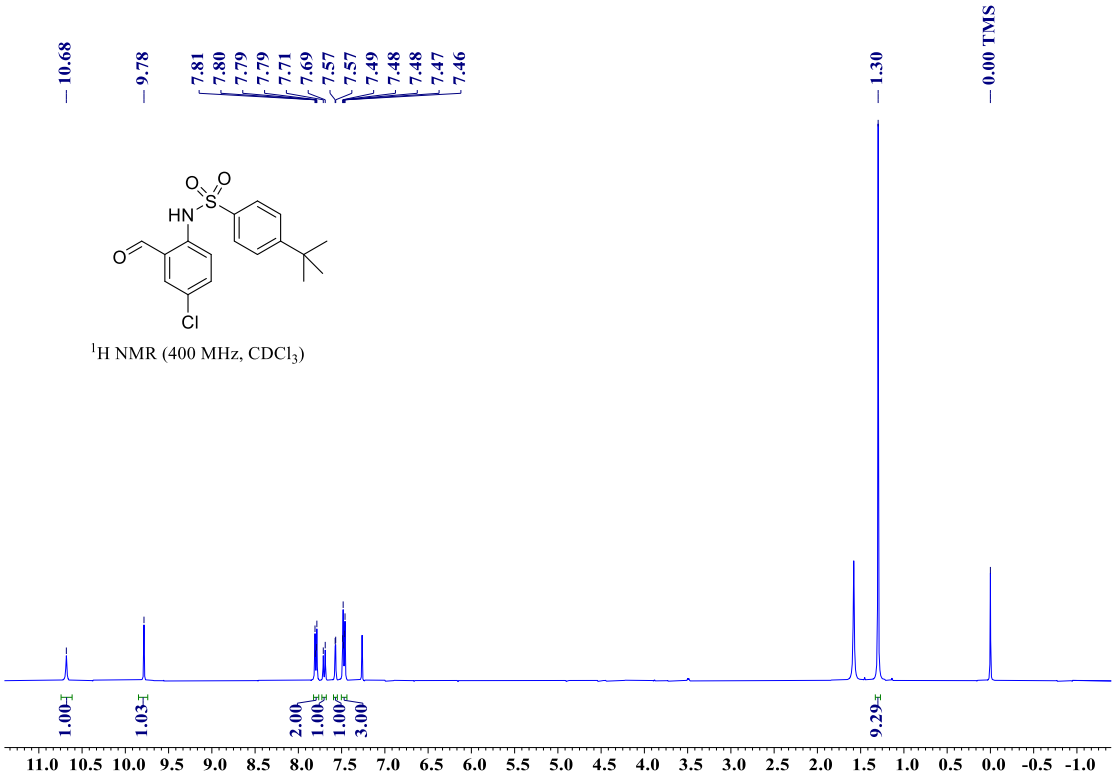


^{1}H NMR (400 MHz, $CDCl_3$)

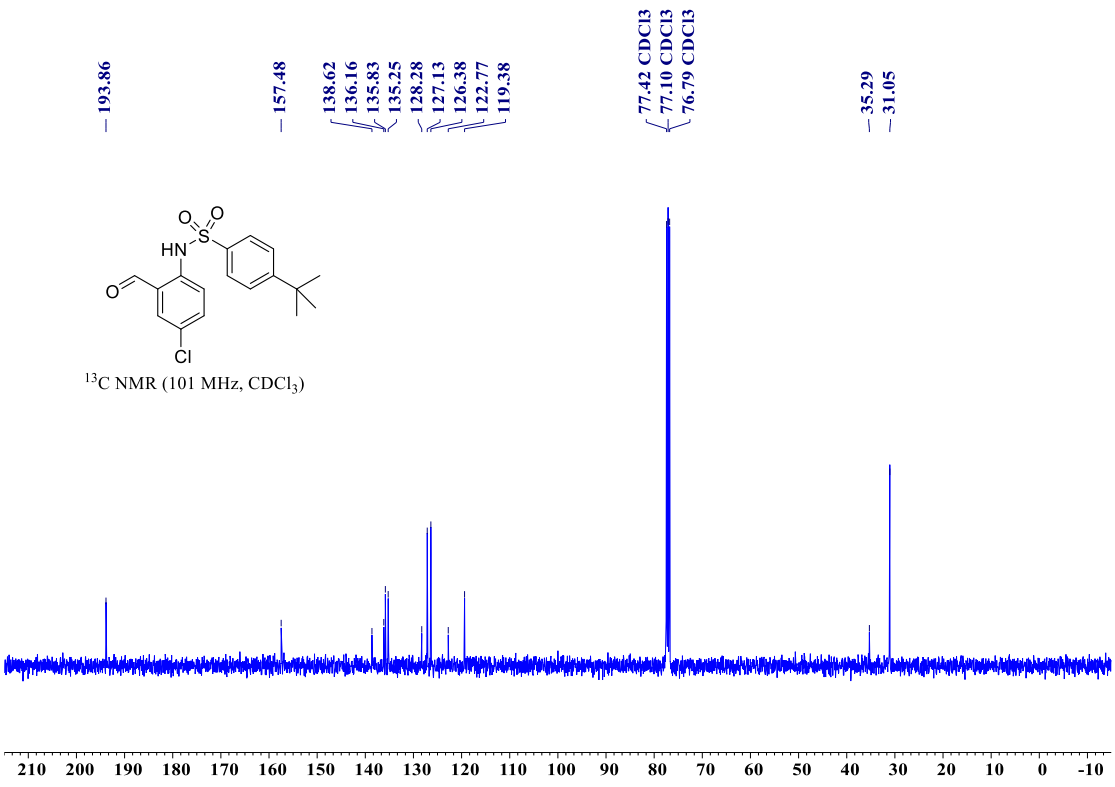


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 8

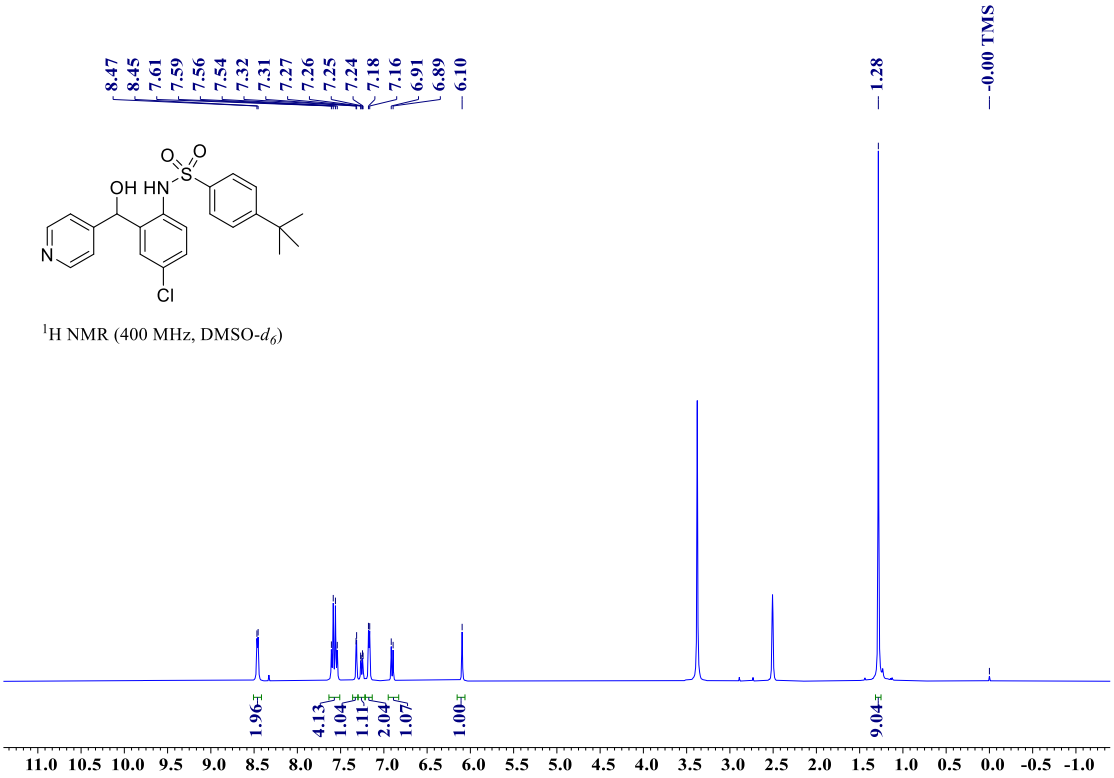


^{1}H NMR (400 MHz, $CDCl_3$)

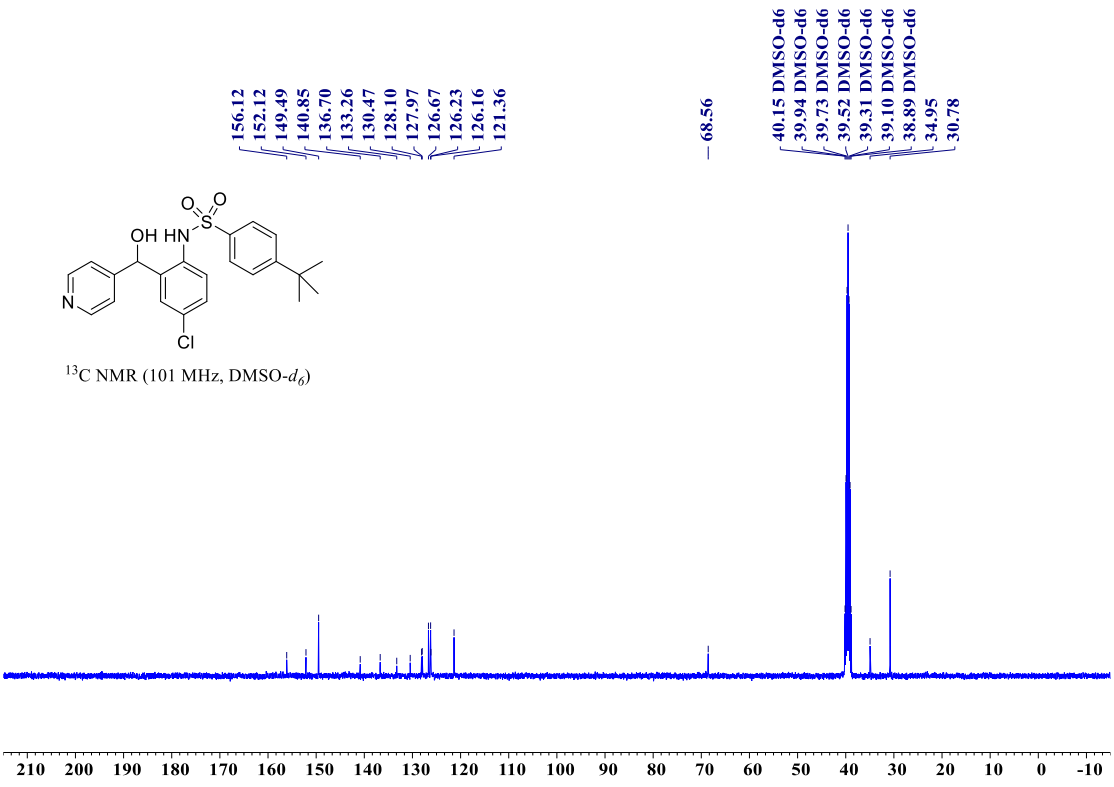


^{13}C NMR (101 MHz, $CDCl_3$)

^{1}H and ^{13}C NMR spectra of compound 9



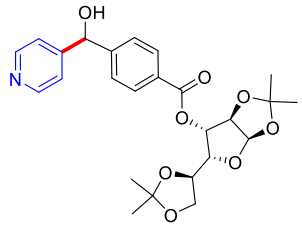
^{1}H NMR (400 MHz, DMSO-d_6)

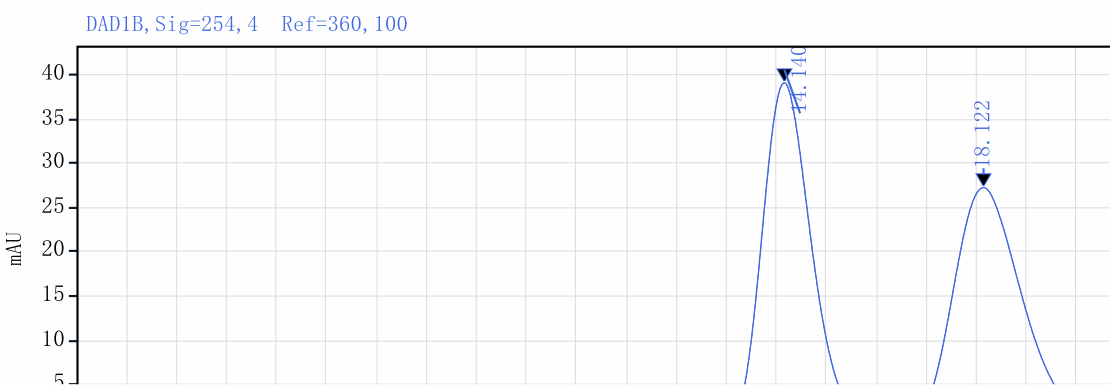


^{13}C NMR (101 MHz, DMSO-d_6)

IX. Copies of HPLC Spectra

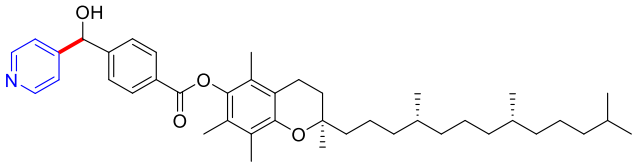
Chiral HPLC spectrum of compound **3ab**

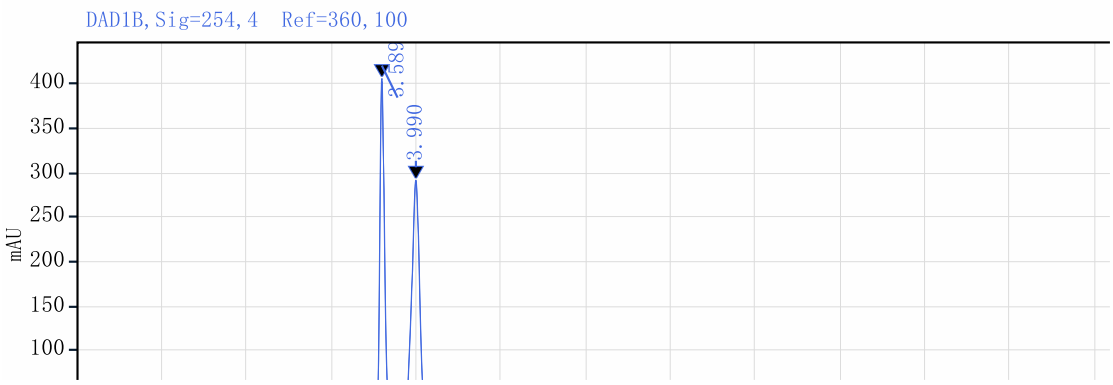




	RT (min)	Height	Area	Area%
1	14.140	39.45	2739.47	50.17
2	18.122	27.48	2720.64	49.83

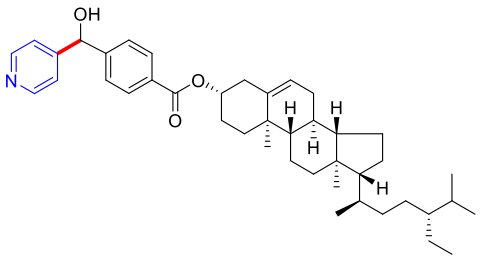
Chiral HPLC spectrum of compound **3ae**



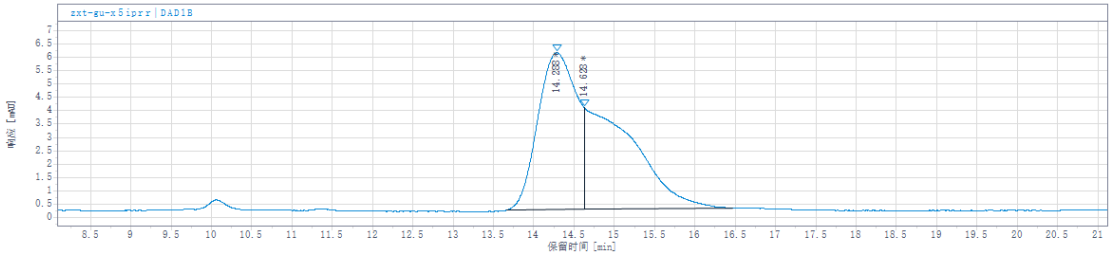


	RT (min)	Height	Area	Area%
1	3.589	402.04	1686.08	44.72
2	3.990	287.81	2084.63	55.28

Chiral HPLC spectrum of compound **3ac**



Despite our attempts to utilize various chiral columns (Chiralpak AD-H, OD-H, OJ-H, AS-H column) and solvents for the separation of this pair of diastereomeric isomers, due to their poor solubility and low polarity, we were consistently unable to achieve effective separation. Therefore, we resorted to estimating their diastereomeric ratio.



	RT (min)	Height	Area	Area%
1	14.288	5.875	195.405	53.3
2	14.628	3.796	171.452	46.7

X. References

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