SUPPORTING INFORMATION

for

Chemoselective Reduction of α-Keto Amides by Nickel Catalyst

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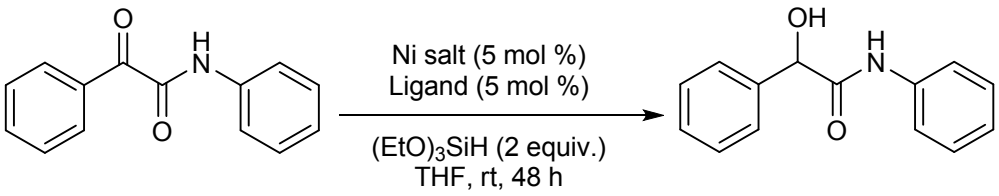
Table of contents

- Optimization Table 2
- General considerations 3
- General experimental procedure for synthesis of α-keto amides and their spectral data 3
- General experimental procedure for chemo selective reduction of α-keto amides and their spectral data 5
- General experimental procedure for complete reduction of α-keto amides and their spectral data 8
- References 11
- ^{1}H and ^{13}C spectra for all compounds 12

Table 1: Optimization of ligands and nickel salts in the reduction of α-keto amides[a]



Entry	Ligand	Nickel salt	Yiled (%)
1	L1	$Ni(OAc)_2$	30
2	L2	$Ni(OAc)_2$	32
3	L3	$Ni(OAc)_2$	16
4	L4	$Ni(OAc)_2$	20
5	L5	$Ni(OAc)_2$	10
6	L6	$Ni(OAc)_2$	22
7	L7	$Ni(OAc)_2$	18
8	L8	$Ni(OAc)_2$	5
9	L9	$Ni(OAc)_2$	12
10	L2	$NiCl_2$	10
11	L2	$NiBr_2$	8
12	L2	$Ni(acac)_2$	10
13	L2	$Ni(OAc)_2.4H_2O$	8
14	L2	$NiCl_2.6H_2O$	6
15	L2	$NiBr_2.3H_2O$	4

[a]Reaction condition. 0.5 mmol of **1a** in THF. [b]Isolated yield.

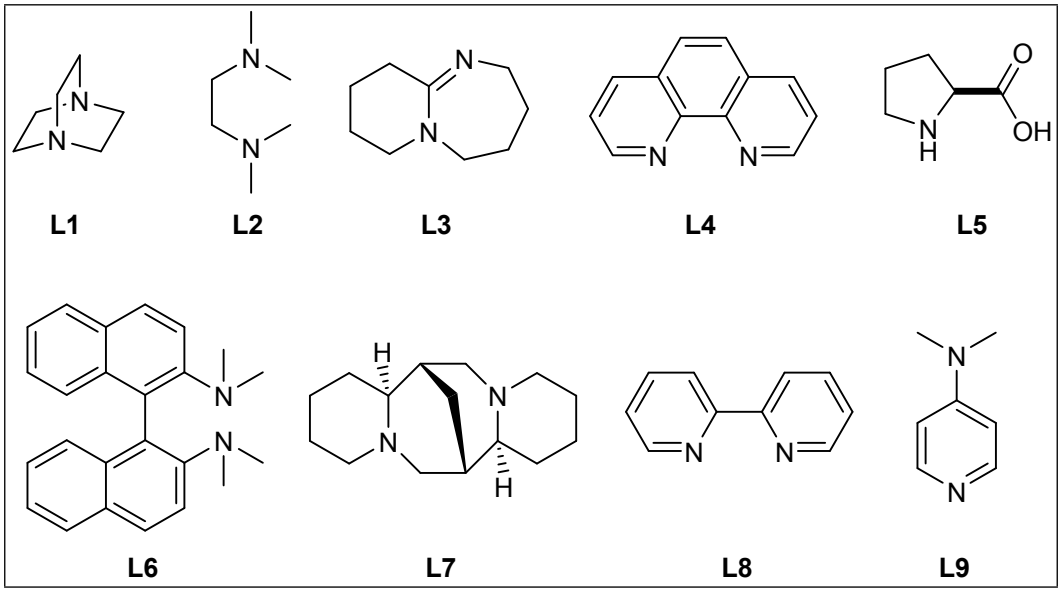


Figure 1: Ligands screened for the reduction of α-ketoamides

General considerations

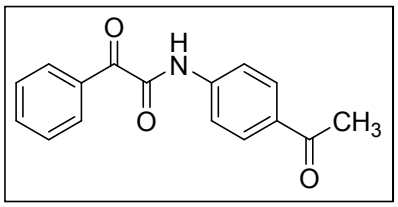
Nickel(II) acetate (98% pure), TMEDA (99% pure), DBU (99% pure), NaOAc (99% pure), NaOtBu (97% pure) and KOtBu (98% pure) were purchased from SpectrochemPvt. Ltd. India. Hydrosilanes, nickel(II) bromide (98% pure), nickel(II) chloride (98%), DABCO (>99% pure) and 1,10-phenanthroline (≥99% pure) werepurchesed from Sigma aldrich chemicals, USA. Thin-layer chromatography (TLC) was performed using Merck silica gel 60 F254 precoated plates (0.25 mm) and visualized by UV fluorescence quenching. Silica gel for column chromatography (particle size 100-200 mesh) was purchased from SRL India. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker 400 MHz instrument. ^{1}H NMR spectra were reported relative to residual $CHCl_3$ (δ 7.26 ppm) or DMSO (δ 2.50 ppm). ^{13}C NMR were reported relative to $CDCl_3$ (δ 77.16 ppm) or DMSO-d_6 (δ 39.52 ppm). FTIR spectra were recorded on aJASCOspectrometer and are reported in frequency of absorption (cm^{-1}). High resolution mass spectra (HRMS) were recorded on Q-Tof Micro mass spectrometer.

General experimental procedure for synthesis of α-keto amides

Thionyl chloride (0.3 ml, 4 mmol) was added dropwise to a stirred mixture of benzyl formic acid (0.300 g, 2 mmol) and Et_3N (0.5 ml, 4 mmol) in CH_2Cl_2 (10 mL) at 0^{o}C under nitrogen atmosphere. The stirring was continued for 20 min. and then a suspension of corresponding amine (2 mmol) in CH_2Cl_2 (10 mL) was added slowly to the reaction mixture at 0 ^{o}C under nitrogen flow. The stirring was continued in the room temperature and the completion of the reaction manitored through TLC. A saturated aqueous solution of $NaHCO_3$ (20 mL) was added slowly under stirring to the reaction mixture. The organic layer separated, washed with water (3 × 15 mL) and evaporated under reduced pressure. The solid residue purified through silica gel cloumn chromatography.

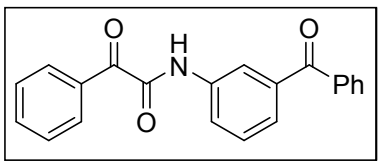
Spectral data for α-keto amides

N-(4-acetylphenyl)-2-oxo-2-phenylacetamide



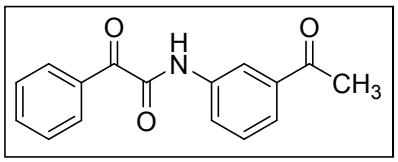
Green colure solid, mp = 163-162 ^{o}C R_f 0.36; (hexanes : ethyl acetate, 90:10 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.18 (bs, 1H), 8.41 (d, J = 7.6 Hz, 2H), 8.01 (d, J = 8.8 Hz, 2H), 7.81 (d, J = 8.8 Hz, 2H), 7.67 (t, J = 7.6 Hz, 1H), 7.52 (t, J = 7.6 Hz, 2H), 2.60 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 197.0, 186.9, 159.1, 140.9, 135.0, 133.9, 132.9, 131.6, 130.0, 128.8, 119.5, 26.6; IR (neat) 3315, 1675, 1597, 1526, 1442, 1167 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{16}H_{14}NO_3$, 268.0974; found, 268.0966.

N-(3-benzoylphenyl)-2-oxo-2-phenylacetamide



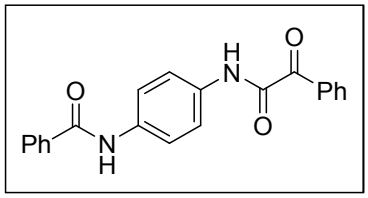
Yellow colure solid, mp = 148-149 ^{o}C R_f 0.35; (hexanes : ethyl acetate, 90:10 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.11 (bs, 1H), 8.40 (dd, J = 7.2, 1.2 Hz, 2H), 8.05 (dd, J = 9.8, 2.0 Hz, 2H), 7.83 (dd, J = 7.2, 1.6 Hz, 2H), 7.66 (t, J = 7.6, 1.2 Hz, 1H), 7.60 (t, J = 7.6, 1.2 Hz, 2H), 7.54-7.47 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 196.1, 187.2, 159.2, 138.8, 137.3, 136.9, 134.9, 133.0, 131.6, 130.2, 129.4, 128.8, 128.5, 126.9, 123.8, 121.4; IR (neat) 3252, 1676, 1636, 1591, 1552, 1169 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{21}H_{16}NO_3$, 330.1130; found, 330.1119.

N-(3-acetylphenyl)-2-oxo-2-phenylacetamide



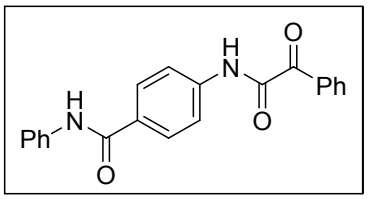
Pale yellow colure solid, mp = 88-89 °C R_f 0.36; (hexanes : ethyl acetate, 90:10 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.12 (bs, 1H), 8.42 (d, J = 7.6 Hz, 2H), 8.28 (s, 1H), 7.97 (d, J = 8.0 Hz, 1H), 7.78 (t, J = 7.6 Hz, 1H), 7.67 (t, J = 7.6 Hz, 1H), 7.56-7.46 (m, 3H), 2.63 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 197.6, 187.1, 159.2, 138.2, 137.3, 134.9, 133.1, 131.6, 129.7, 128.8, 125.2, 124.4, 119.8, 26.8; IR (neat) 3291, 1672, 1599, 1543, 1486, 1170 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{16}H_{14}NO_3$, 268.0974; found, 268.0967.

N-(4-(2-oxo-2-phenylacetamido)phenyl)benzamide



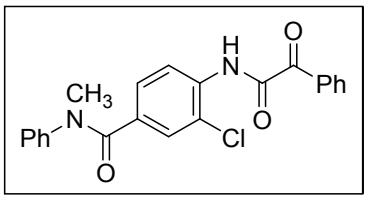
Lite Green colure solid, mp = 195-196 °C ; R_f 0.35; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$:DMSO-d_6, 8:2): δ 9.61 (bs, 1H), 9.26 (bs, 1H), 8.20 (dd, J = 17.2, 8.0 Hz, 2H), 7.84 (t, J = 8.0 Hz, 2H), 7.60-7.75 (m, 4H), 7.59-7.49 (m, 1H), 7.48-7.30 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$:DMSO-d_6, 8:2): δ 188.1, 165.8, 160.5, 135.6, 134.9, 134.1, 133.0, 132.9, 131.1, 130.5, 128.2, 128.0, 127.3, 120.7, 120.3; IR (KBr) 3989, 1659, 1537, 1402 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{16}N_2O_3Na_1$, 367.1059; found, 367.1057.

4-(2-oxo-2-phenylacetamido)-N-phenylbenzamide



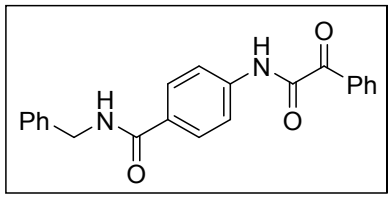
Green colure solid, mp = 180-181 °C ; R_f 0.49; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 11.20 (bs, 1H), 10.17 (bs, 1H), 8.07 (d, J = 7.6 Hz, 2H), 8.01 (d, J = 8.0 Hz, 2H), 7.89 (d, J = 8.0 Hz, 2H), 7.78 (d, J = 8.0 Hz, 3H), 7.62 (t, J = 7.6 Hz, 2H) 7.35 (t, J = 7.6 Hz, 2H) 7.10 (t, J = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 189.1, 164.8, 163.5, 140.5, 139.2, 134.9, 132.5, 130.7, 130.0, 129.1, 128.7, 128.6, 123.6, 120.4, 119.5; IR (KBr) 3333, 1671, 1650, 1595, 1525, 1180 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{15}H_{12}N_2O_3Na_1$, 291.0746; found, 291.0759.

3-chloro-N-methyl-4-(2-oxo-2-phenylacetamido)-N-phenylbenzamide



Pale Green colure solid, mp = 155-156 °C ; R_f 0.55; (hexanes : ethyl acetate, 50:50 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 10. 56 (bs, 1H), 8.05 (d, J = 8.0, 2H), 7.76 (dd, J = 8.0, 13.2 Hz, 2H), 7.60 (t, J = 8.0 Hz, 2H), 7.46 (bs, 1H), 7.32 (t, J = 7.6 Hz, 2H), 7.29-7.18 (m, 4H), 3.38 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 188.7, 167.4 163.5, 144.2, 135.0, 134.8, 134.2, 132.6, 130.0, 129.7, 129.3, 129.0, 127.7, 126.9, 125.9, 124.7, 38.0; IR (KBr) 3358, 1705, 1678, 1637, 1600, 1569, 1525, 1054 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{22}H_{18}N_2O_3Cl$, 393.1006; found, 393.1016.

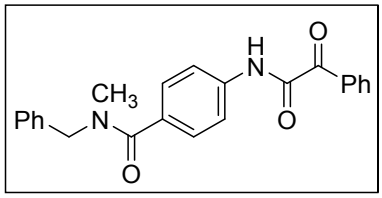
N-benzyl-4-(2-oxo-2-phenylacetamido)benzamide



Pale Green colure solid, mp = 142-143 °C ; R_f 0.55; (hexanes : ethyl acetate, 50:50 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 11.17 (bs, 1H), 9.00 (t, J = 5.6 1H), 8.06 (d, J = 7.6 Hz, 2H), 7.94 (d, J = 8.0 Hz, 2H), 7.83 (d, J = 8.0 Hz, 2H), 7.77 (t, J = 7.2, 1H), 7.62 (t, J = 7.6 Hz, 2H), 7.32 (bs, 4H), 7.25 (d, J = 4.4 Hz, 1H), 4.49 (d, J = 5.6 Hz,

2H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 189.2, 165.6, 163.5, 140.3, 139.8, 135.0, 132.5, 130.2, 130.0, 129.1, 128.3, 127.3, 126.8, 126.3, 119.5, 42.7; IR (KBr) 3326, 1803, 1666, 1630, 1168 cm^{-1}; HRMS (*m/z*): $[M+H]^+$ calcd for $C_{22}H_{19}N_2O_3$, 359.1396; found, 359.1390.

N-benzyl-N-methyl-4-(2-oxo-2-phenylacetamido)benzamide



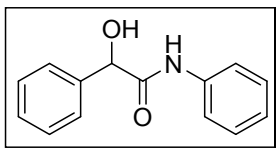
Pale Green colure solid, mp = 120-121 ^{o}C ; R_f 0.40; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 10.85 (bs, 1H), 8.07 (dd, *J* = 1.2 Hz, 5.6 Hz, 2H), 7.81 (d, *J* = 6.4 Hz, 2H), 7.74 (t, *J* = 6.0 Hz, 1H), 7.60 (t, J= 6.4 Hz, 2H), 7.49 (d, *J* = 6.8 Hz, 2H), 7.38 (t, *J* = 6.4 Hz, 2H), 7.29 (t, *J* = 5.2 Hz,3H), 4.62 (s, 2H), 2.90 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6, temp. 90 ^{o}C): δ 188.6, 169.8, 162.9 138.1, 136.9, 134.0, 132.6, 132.2, 129.3, 128.4, 128.0, 127.2, 126.8, 126.6, 119.6, 51.7, 34.7; IR (KBr) 3069, 1694, 1688, 1682, 1632, 1612, 1071 cm^{-1}; HRMS (*m/z*): $[M+H]^+$ calcd for $C_{23}H_{21}N_2O_3$, 373.1552; found, 367.1569.

General experimental procedure for chemo selective reduction of α-keto amides

A mixture of TMEDA (4 µL, 0.025 mmol), nickel(II)acetate (4.4 mg, 0.025 mmol), NaOAc (4 mg, 0.05 mmol) and α-keto amide (0.5 mmol) in 1.5 mL of dry THF were taken in a reaction tube fitted with rubber septum under nitrogen atmosphere. The reaction mixture was stirred at room temperature for 10 min., then PMHS (120 µL, 2 mmol) was slowly added to the reaction mixture. Then the rubber septum was replaced with glass stopper under nitrogen flow and the reaction was stirred at 60 °C. The progress of the reaction was monitered by TLC. After complete disappearance of starting material, 5 mL of 2N aq. NaOH was added and the resulting reaction mixture was stirred for 30 min. Then the reaction mixture was extracted with ethyl acetate (2x10 mL). The combined organic layers was washed with brine, dried over anhydrous $MgSO_4$, filtered off and the solvent was removed under reduced pressure. The resulting residue was purified by silica gel column chromatography (eluents: hexanes-ethyl acetate, 80:20) to get pure α-hydroxy amide.

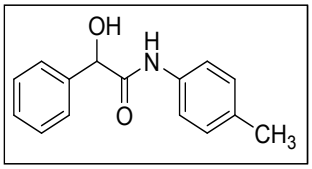
Spectral data for α-hydroxy amides

2-Hydroxy-N, 2-diphenylacetamide[1]



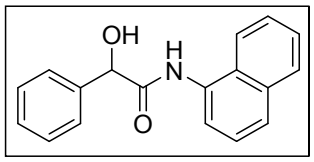
Colorless solid, mp = 152-153 ^{o}C (Lit.[1] mp = 150-151 ^{o}C); R_f 0.56; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (bs, 1H), 7.55-7.46 (m, 4H), 7.43-7.35 (m, 3H), 7.32 (t, *J*= 7.6 Hz, 2H), 7.12 (t, *J* = 7.6 Hz, 2H), 5.19 (s, 1H), 3.42 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.1, 139.1, 137.2, 129.2, 129.1, 129.00, 127.0, 124.9, 120.0, 74.9; IR (KBr) 3675, 3409, 1655, 1602, 1544, 1191 cm^{-1}; HRMS (*m/z*): $[M+Na]^+$ calcd for $C_{14}H_{13}NO_2Na_1$, 250.0844; found, 250.0833

2-Hydroxy-2-phenyl-N-p-tolylacetamide[2]



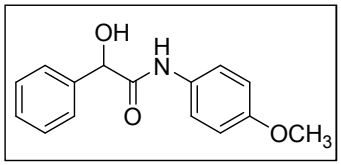
Colorless solid, mp = 168-169 ^{o}C (Lit.[2] mp = 169-170 ^{o}C); R_f 0.46; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 (bs, 1H), 7.48 (dd, *J* = 8.0 Hz, 1.6 Hz, 2H), 7.43-7.31 (m, 5H), 7.11 (d, *J* = 8.4 Hz, 2H), 5.17 (d, *J* = 3.2 Hz, 1H), 3.44 (d, *J* = 3.2 Hz 1H), 2.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.9, 139.2, 134.6, 134.5, 129.7, 129.2, 129.1, 127.1, 120.0, 74.8, 21.0; IR (KBr) 3322, 1646, 1602, 1546, 1527, 1495 cm^{-1}; HRMS (*m/z*): $[M+H]^+$ calcd for $C_{15}H_{16}NO_2$, 242.1181; found, 242.1192

2-Hydroxy-N-(naphthalen-1-yl)-2-phenylacetamide



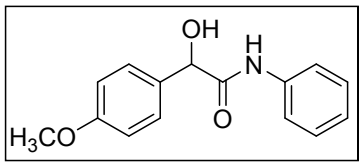
Colorles solid, mp = 114-115 °C ; R_f 0.55; (hexanes : ethyl acetate, 90:10 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.72 (bs, 1H), 7.96 (d, *J*= 7.6, 1H), 7.84 (d, *J* = 5.2 Hz, 1H), 7.67 (d, *J*= 8.4 Hz, 2H), 7.64 (d, *J*= 3.2 Hz 1H), 7.56-7.34 (m, 8H), 5.26 (d, *J*= 3.2 Hz, 1H), 3.92 (d, *J*= 3.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.1, 139.3, 134.1, 131.5, 129.0, 128.9, 126.9, 126.8, 126.6, 126.1, 126.0, 125.8, 120.3, 120.1, 74.9; IR (KBr) 3360, 3265, 1659, 1592, 1523, 1514, 1497 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{18}H_{15}NO_2$, 300.1000; found, 300.1001.

2-Hydroxy-N-(4-methoxyphenyl)-2-phenylacetamide[3]



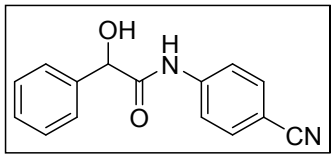
Colorless solid, mp = 154-155 °C (Lit.[3] mp= 153-154 °C); R_f 0.34; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.01 (bs, 1H), 7.48 (d, *J* = 7.2 Hz, 3H), 7.45-7.33 (m, 5H), 6.84 (d, *J* = 2.8 Hz, 1H), 5.17 (d, *J* = 2.8 Hz, 1H), 3.77 (s, 3H), 3.49 (d, *J* = 3.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.0, 156.8, 139.2, 130.3, 129.0, 128.9, 127.0, 121.7, 114.3, 74.7, 55.6; IR (KBr) 3655, 1644, 1599, 1556, 1545, 1192 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{16}NO_3$, 258.1130; found, 258.1133.

2-Hydroxy-2-(4-methoxyphenyl)-N-phenylacetamide



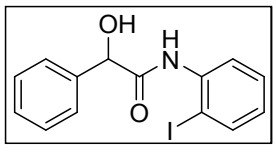
Colorless solid, mp = 94-95 °C; R_f 0.32; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.25 (bs, 1H), 7.51 (d, *J*= 7.6 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 1H), 7.30 (t, *J*= 8.4 Hz, 2H), 7.11 (t, *J* = 7.6 Hz, 1H), 6.89 (d, *J*= 8.4 Hz, 2H), 5.07 (d, *J* = 2.8 Hz, 1H), 3.79 (s, 1H), 3.65 (d, *J*= 3.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 160.0, 137.2, 131.3, 129.1, 128.3, 124.7, 119.9, 114.4, 74.3, 55.4; IR (KBr) 3359, 2923, 1662, 1602, 1530, 1523, 1513 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{15}H_{15}NO_3Na_1$, 280.0950; found, 280.0954.

N-(4-Cyanophenyl)-2-hydroxy-2-phenylacetamide



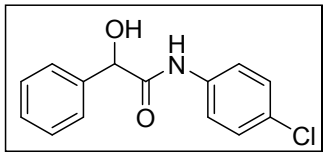
Colorless solid, mp= 130-131°C; R_f 0.37; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.53 (s, 1H), 7.70 (d, *J* = 8.8 Hz 2H), 7.61 (d, *J* = 8.8 Hz, 2H), 7.49 (dd, *J* = 8.0, 1.6 Hz 2H), 7.45-7.37 (m, 3H), 5.26 (d, *J* = 3.2 Hz, 1H), 3.13 (d, *J* = 3.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.3, 141.3, 138.6, 133.5, 131.3, 129.3, 129.2, 126.9, 119.8, 119.6, 75.0; IR (KBr) 3289, 3109, 2227, 1744, 1703, 1667, 1604, 1597 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{13}O_2N_2$, 253.0977; found, 253.0978

2-Hydroxy-N-(2-iodophenyl)-2-phenylacetamide



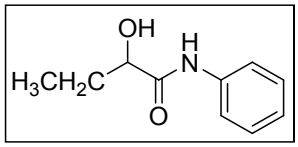
Colorless solid, mp = 75-76 °C ; R_f 0.35; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.57 (bs, 1H), 8.22 (dd, *J*= 8.4, 1.2 Hz, 1H), 7.76 (dd, *J* = 8.0,1.6 Hz, 1H), 7.52 (d, *J*= 7.2 Hz, 2H), 7.45-7.35 (m, 3H), 7.35-7.29(m, 1H), 6.84 (td, *J*= 7.8, 0.8 Hz, 1H), 5.21 (d, *J* = 1.2 Hz, 1H), 3.69 (d, *J* = 2.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 139.0, 138.0, 137.7, 129.4, 129.2, 129.1, 127.1, 126.4, 121.6, 89.8, 75.1; IR (KBr) 3445, 2958, 1731, 1183, 1067 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{14}H_{13}NO_2I$, 353.9991; found, 354.0004.

_N_-(4-Chlorophenyl)-2-hydroxy-2-phenylacetamide[4]



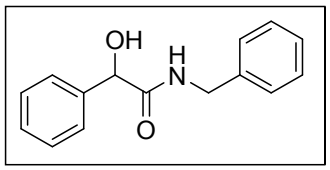
Colorless solid, mp = 160-161 °C (Lit.[4] mp = 161-164 °C); R_f 0.58; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (bs, 1H),7.49-7.42 (m, 4H), 7.41-7.32 (m, 3H), 7.25 (d, J = 2.4 Hz, 2H), 5.18 (d, J = 2.8 Hz 1H), 3.24 (d, J = 2.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.9, 138.9, 135.8, 129.9, 129.2, 129.19, 127.0, 121.2, 74.9; IR (KBr) 3297, 1650, 1596, 1540, 1068 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{14}H_{12}NO_2Na_1Cl$, 284.0454; found, 284.0443.

2-Hydroxy-N-phenylpentanamide



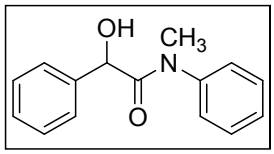
Colorless solid mp = 129-130 °C; R_f 0.30; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.38 (bs, 1H), 7.57 (dd, J = 8.4, 1.2 Hz, 2H), 7.31-7.37 (m, 2H), 7.15-7.37 (m, 1H), 4.23 (m, 1H), 2.58 (d, J = 4.4 Hz, 1H), 2.05-1.93 (m, 1H), 1.87-1.74 (m, 1H), 1.04 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.3, 137.2, 129.2, 124.7, 120.0, 73.6, 30.0, 9.3; IR (KBr) 3402, 3392, 1647, 1601, 1531, 1444, 1120 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{10}H_{14}NO_2$, 180.1025; found, 180.1033.

N-Benzyl-2-hydroxy-2-phenylacetamide[5]



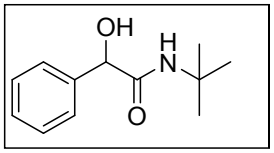
Colorless solid, mp = 133-134 °C (Lit.[5] mp = 133-135 °C); R_f 0.35; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.43-7.33 (m, 5H),7.33-7.27 (m, 3H), 7.18 (dd, J = 6.8, 1.2 Hz, 1H), 6.47 (bs, 1H), 5.08 (d, J = 3.2 Hz, 1H), 4.52-4.38 (m, 2H), 3.60 (d, J = 3.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.2, 139.5, 137.8, 129.0, 128.9, 127.7, 127.0, 74.4, 43.7; IR (KBr) 3568, 3281, 2921, 1626, 1534, 1348, 1028 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{14}H_{11}NO_2Na_1$, 248.0687; found, 248.0691.

2-Hydroxy-N-methyl-N, 2-diphenylacetamide



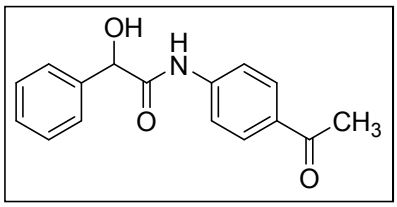
Colorless solid, mp = 89-90 °C; R_f 0.40; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34-7.22 (m, 3H), 7.22-7.10 (m, 3H), 6.86-6.77 (m, 4H), 5.01 (d, J= 6.8 Hz, 1H), 4.49 (d, J = 7.2 Hz, 1H), 3.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.9, 141.6, 139.3, 129.7, 128.4, 128.2, 128.1, 127.4, 71.7, 38.4; IR (KBr) 3423, 2952, 1655, 1596, 1585, 1496, 1020 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{15}H_{15}NO_2Na_1$, 264.1010; found, 264.1000.

N-tert-Butyl-2-hydroxy-2-phenylacetamide[6]



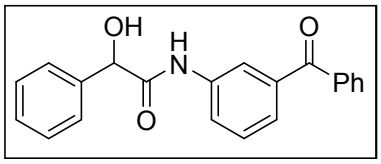
Colorless solid, mp = 103-104 °C; R_f 0.31; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39-7.31 (m, 5H), 5.76 (s, 1H), 4.90 (d, J = 3.6 Hz, 1H), 3.64 (s, 1H), 1.32 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.4, 140.0, 129.0, 128.6, 127.0, 74.3, 51.6, 28.8; IR (KBr) 3225, 1645, 1538, 1409, 1452, 1065 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{12}H_{17}NO_2Na_1$, 230.1157; found, 230.1167

N-(4-Acetylphenyl)-2-hydroxy-2-phenylacetamide



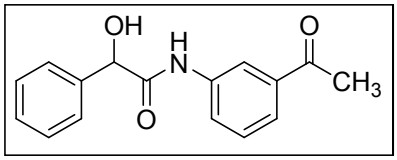
Colourless solid, mp = 148-149 °C R_f 0.39; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 10.78 (bs, 1H), 8.42 (d, J = 8.8 Hz, 2H), 8.37 (d, J = 8.8 Hz, 2H), 8.04 (d, J = 8.0 Hz, 2H), 7.87 (t, J = 7.2 Hz, 2H), 7.84-7.78 (m, 1H), 7.02 (d, J = 4.4 Hz, 1H), 5.66 (d, J = 4.4 Hz, 1H), 3.03 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 196.6, 171.8, 142.9, 140.6, 132.0, 129.3, 128.2, 127.8, 126.6, 119.0, 74.1, 26.5; IR (neat) 3285, 1674, 1657, 1598, 1543, 1183 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{16}H_{16}NO_3$, 270.1130; found, 270.1118.

N-(3-Benzoylphenyl)-2-hydroxy-2-phenylacetamide



Colurless solid, mp = 126-127 °C R_f 0.35; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.52 (bs, 1H), 7.94-7.90 (m 1H), 7.81 (t, J = 1.6, Hz, 1H), 7.77 (dd, J = 7.2, 1.6 Hz, 2H), 7.61-7.55 (m 1H), 7.51-7.41 (m, 5H), 7.41-7.32 (m, 4H), 5.17 (d, J = 3.6 Hz, 1H), 3.76 (d, J = 3.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 196.5, 170.5, 138.9, 138.5, 137.5, 137.3, 132.9, 130.2, 129.2, 129.1, 129.0, 128.5, 126.9, 126.4, 123.9, 121.1, 74.8; IR (neat) 3324, 1659, 1591, 1532, 1499, 1180 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{21}H_{18}NO_3$, 332.1287; found, 332.1286.

N-(3-Acetylphenyl)-2-hydroxy-2-phenylacetamide



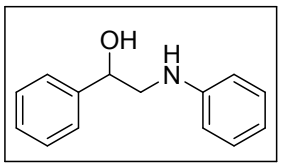
Yellow colure solid, mp = 118-119 °C, R_f 0.38; (hexanes : ethyl acetate, 70:30 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 10.16 (bs, 1H), 8.32 (t, J = 1.6 Hz, 1H), 7.98 (dd, J = 8.2, 1.2 Hz, 1H), 7.65 (d, J = 8.0 Hz, 1H), 7.53 (d, J = 7.2 Hz, 2H), 7.44 (t, J = 8.0 Hz, 1H), 7.36 (t, J = 7.2 Hz, 2H), 7.33-7.26 (m 1H), 6.48 (d, J = 4.8 Hz, 1H), 5.13 (d, J = 4.4 Hz, 1H), 2.54 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 197.7, 171.6, 140.8, 139.0, 137.3, 129.1, 128.2, 127.7, 126.6, 124.2, 123.4, 119.3, 74.1, 26.8; IR (neat) 3335, 1674, 1604, 1542, 1485, 1192 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{16}H_{16}NO_3$, 270.1130; found, 270.1130.

General experimental procedure for complete reduction of α-keto amides.

A mixture of TMEDA (4 µL, 0.025 mmol), nickel(II)acetate (4.4 mg, 0.025 mmol), KO^{t}Bu (6 mg, 0.05 mmol) in 1.5 mL of dry THF were taken in a reaction tube fitted with rubber septum under nitrogen atmosphere. The reaction mixture was stirred at room temperature for 10 min. Then the α-keto amide (0.5 mmol) was added to the reaction mixture and stirred for 10 min. then Ph_2SiH_2 (370 µL, 2 mmol) was added slowly to the reaction mixture. After that, the rubber septum was replaced with glass stopper under nitrogen flow. The resulting reaction mixture was stirred at room temperature. The progress of the reaction was monitered by TLC. After complete disappearance of substrate, 5 mL of 2N aq. NaOH was added to the reaction and the resulting mixture was stirred for 30 min. The reaction mixture was extracted with ethyl acetate (2x10 mL). The combined organic layers was washed with brine, dried over anhydrous $MgSO_4$, filtered off and the solvents was removed under reduced pressure and the resulting residue was purified by neutral aluminium oxide column chromatography (eluents: hexanes-ethyl acetate, 90:10) to obtain pure β-amino alcohol.

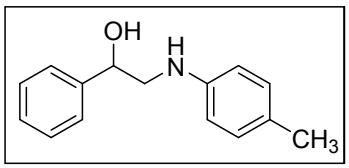
Spectral data for *β*-amino alchols

1-Phenyl-2-(phenylamino)ethanol[7]



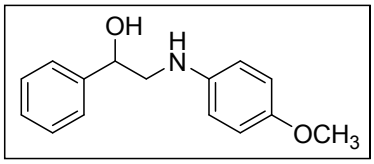
Colourless oily liqued; R_f 0.36; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45-7.37 (m, 4H), 7.36-7.31 (m, 1H), 7.21 (t, J = 8.4 Hz, 2H), 6.77 (t, J = 7.6 Hz, 1H), 6.69 (d, J = 7.6 Hz, 2H), 4.93 (dd, J = 8.8, 4.0 Hz, 1H), 3.44 (dd, J = 13.2, 4.0 Hz, 1H), 3.30 (dd, J = 13.2, 8.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 148.0, 142.1, 129.5, 128.8, 128.1, 126.0, 118.3, 113.6, 72.6, 51.9; IR (Neat) 3395, 3113, 1603, 1559, 1508, 1454 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{14}H_{16}NO$, 214.1232; found, 214.1240

1-Phenyl-2-(p-tolylamino)ethanol[8]



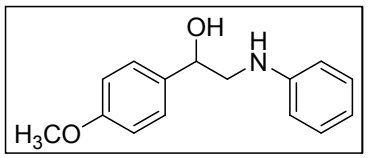
Colourless oil; R_f 0.39; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45-7.30 (m, 5H), 7.02 (d, J = 8.0 Hz, 2H), 6.62 (t, J = 8.0 Hz, 2H), 4.91 (dd, J = 8.6, 3.6 Hz, 1H), 3.41 (dd, J = 13.2, 4.0 Hz, 1H) 3.27 (dd, J = 13.2, 8.4 Hz, 1H), 2.26 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 145.6, 142.2, 130.0, 128.7, 128.0, 127.6, 126.0, 113.8, 72.5, 52.4, 20.5; IR (Neat) 3451, 3444, 1646, 1547, 1407, 1258 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{18}NO$, 228.1388; found, 228.1378

2-(4-Methoxyphenylamino)-1-phenylethanol[9]



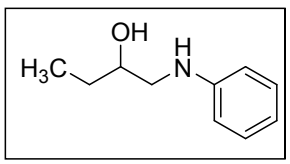
Pale yellow oil; R_f 0.34; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.44-7.36 (m, 4H), 7.35-7.29 (m, 1H), 6.80 (d, J = 9.2 Hz, 2H), 6.66 (d, J = 8.8 Hz, 2H), 4.92 (dd, J = 8.8, 3.6 Hz, 1H), 3.75 (s, 3H), 3.38 (dd, J = 12.8, 4.0 Hz, 1H), 3.25 (dd, J = 13.2, 8.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 152.8, 142.2, 142.1, 128.8, 128.1, 126.0, 115.2, 115.1, 72.6, 55.9, 53.1; IR (Neat) 3363, 3061, 1653, 1510, 1450, 1034 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{18}NO_2$, 244.1338; found, 244.1332

2-(Methyl(phenyl)amino)-1-phenylethanol[7]



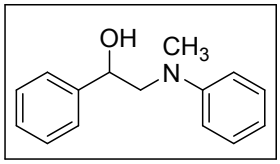
Pale yellow oil; R_f 0.37; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.33 (d, J = 7.6 Hz 2H), 7.20 (t, J = 7.6 Hz, 2H), 6.92 (d, J = 7.6 Hz, 1H), 6.76 (t, J = 7.2 Hz, 1H), 6.67 (d, J = 7.6 Hz, 2H), 4.86 (dd, J = 8.4, 3.6 Hz, 1H), 3.82 (s, 3H), 3.38 (dd, J = 13.0, 4.0 Hz, 1H), 3.29 (dd, J = 12.6, 8.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.5, 148.0, 134.3, 129.4, 127.3, 118.2, 114.1, 113.6, 72.2, 55.4, 51.8; IR (Neat) 3395, 3113, 1603, 1559, 1508, 1454 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{18}NO_2$, 244.1338; found, 244.1340

1-(Phenylamino)butan-2-ol[10]



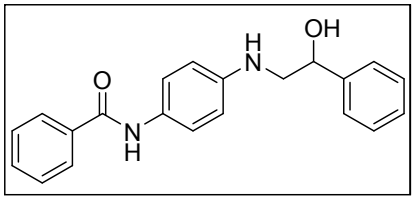
Colourless oil; R_f 0.40; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21-7.16 (m, 2H), 6.74 (tt, J = 6.0, 0.8 Hz, 1H), 6.66 (dd, J = 8.5, 1.0 Hz, 2H), 3.80-3.74 (m, 1H), 3.28 (dd, J = 13.0, 3.0 Hz, 1H), 3.01 (dd, J = 13.0, 8.5 Hz, 1H), 1.65-1.50 (m, *2*H), 1.02 (t, J = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 148.4, 129.4, 118.0, 113.4, 71.9, 50.0, 28.1, 10.1; IR (Neat) 3281, 3054, 1677, 1605, 1503, 1461 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{10}H_{16}NO$, 166.1232; found, 166.1235

2-(methyl(phenyl)amino)-1-phenylethanol



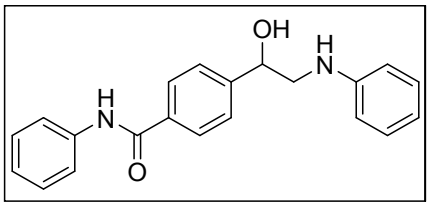
Colourless oily liqued; R_f 0.62; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.47-7.38 (m, 4H), 7.37-7.27 (m, 3H), 6.89 (d, J = 8.0 Hz, 2H), 6.82 (t, J = 7.2 Hz, 1H), 5.01 (dd, J = 8.8, 4.4 Hz, 1H), 3.54 (dd, J = 14.6, 8.4 Hz, 1H), 3.46 (dd, J = 14.8, 4.4 Hz, 1H), 2.96 (s, 3H), 2.66 (bs, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.0, 142.1, 129.4, 128.7, 127.9, 126.0, 117.7, 113.4, 71.8, 62.1, 39.6; IR (Neat) 3405, 3043, 1598, 1498, 1357, 1043 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{15}H_{18}NO$, 228.1388; found, 228.1385

***N*-(4-(1-Hydroxy-2-(phenylamino)ethyl)phenyl)benzamide**



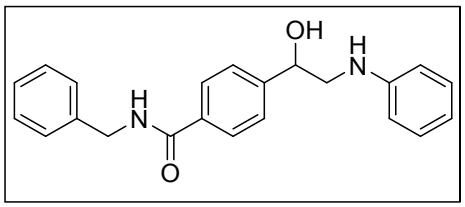
Colourless oil; R_f 0.33; (hexanes : ethyl acetate, 80:20 v/v): ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (s, 1H), 7.82 (d, J = 6.8 Hz, 2H), 7.50 (t, J = 7.2 Hz, 1H), 7.42 (t, J = 7.6 Hz, 2H), 7.39-7.33 (m, 6H), 7.33-7.29 (m, 1H), 6.58 (d, J = 8.8 Hz, 2H), 4.85 (dd, J = 8.9, 3.6 Hz, 1H), 3.35 (dd, J = 13.2, 4.8 Hz, 1H), 3.23 (dd, J = 13.2, 8.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.0, 145.4, 142.3, 135.1, 131.7, 128.8, 128.7, 128.6, 128.0, 127.2, 126.0, 122.9, 113.8, 72.3, 52.1; IR (Neat) 3385, 3060, 1643, 1523, 1474, 1407, 1061 cm^{-1}; HRMS (*m*/*z*): $[M+Na]^+$ calcd for $C_{21}H_{20}N_2O_2$, 355.1422; found, 355.1429

4-(1-Hydroxy-2-(phenylamino)ethyl)-N-phenylbenzamide



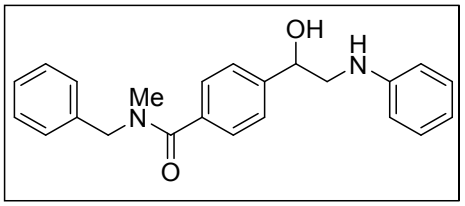
Pale yellow oil; R_f 0.40; (hexanes : ethyl acetate, 60:40 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 9.76 (s, 1H), 7.77 (t, J = 8.8 Hz, 4H), 7.42 (d, J = 7.6 Hz, 2H), 7.38-7.24 (m, 5H), 7.04 (t, J = 7.6 Hz, 1H), 6.69 (d, J = 8.0 Hz, 2H), 4.77 (t, J = 6.8 Hz, 1H), 3.31 (dd, J = 13.2, 4.4 Hz, 2H), 3.22 (dd, J = 13.0, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 165.3, 151.6, 144.0, 139.8, 129.3, 128.5, 128.1, 127.1, 126.1, 122.9, 121.2, 120.2, 111.0, 70.8, 50.9; IR (Neat) 3548, 3412, 3344, 1645, 1603, 1516, 1063 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{21}H_{21}N_2O_2$, 333.1615; found, 333.1603

N-Benzyl-4-(1-hydroxy-2-(phenylamino)ethyl)benzamide



Colourless oil; R_f 0.32; (hexanes : ethyl acetate, 60:40 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 8.62 (t, J = 6.0Hz, 1H), 7.68 (d, J = 8.4 Hz, 2H), 7.41 (d, J = 7.2 Hz, 2H), 7.37-7.26 (m, 8H), 6.65 (d, J = 8.4 Hz, 6H), 4.74 (dd, J = 7.8, 4.8 Hz, 1H), 4.43 (d, J = 6.0 Hz, 1H), 3.27 (dd, J = 13.0, 4.4 Hz, 1H), 3.18 (dd, J = 13.0, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 166.2, 151.1, 144.0, 140.4, 128.8, 128.2, 128.1, 127.2, 127.1, 126.6, 126.1, 121.2, 111.2, 70.8, 51.0, 42.4; IR (Neat) 3361, 3062, 3032, 1728, 1608, 1512, 1059 cm^{-1}; HRMS (*m*/*z*): $[M+H]^+$ calcd for $C_{22}H_{23}N_2O_2$, 347.1760; found, 347.1756

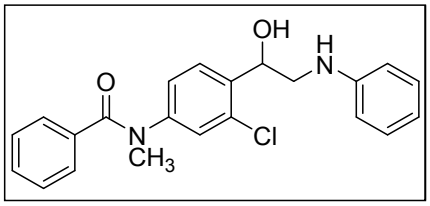
N-Benzyl-4-(1-hydroxy-2-(phenylamino)ethyl)-N-methylbenzamide



Yellow oil; R_f 0.35; (hexanes : ethyl acetate, 60:40 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.42-7.29 (m, 7H), 7.28-7.22 (m, 5H), 6.64 (d, J = 8.4 Hz, 2H), 4.74 (dd, J = 7.8, 4.8 Hz, 1H), 4.60 (s, 2H), 3.25 (dd, J = 13.2, 4.4 Hz, 1H) 3.15

(dd, J = 13.2, 8.0 Hz, 1H), 2.87 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 170.9, 149.6, 143.5, 137.4, 128.3, 128.1, 127.6, 126.8, 126.6, 126.5, 125.7, 122.8, 111.1, 70.7, 51.9, 50.8, 35.0; IR (Neat) 3489, 3402, 1610, 1529, 1491, 1070 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{23}H_{25}N_2O_2$, 361.1916; found, 361.1911

N-(3-Chloro-4-(1-hydroxy-2-(phenylamino)ethyl)phenyl)-N-methylbenzamide



Colourless oil; R_f 0.43; (hexanes : ethyl acetate, 60:40 v/v): ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.47 (d, J = 7.6 Hz, 2H), 7.38 (d, J = 7.6 Hz, 2H), 7.33 (t, J = 6.8 Hz, 3H), 7.15 (t, J = 7.6 Hz, 4H), 7.00 (d, J = 8.4 Hz 1H), 6.55 (d, J = 8.4 Hz 1H), 5.64 (d, J = 4.4 Hz, 1H), 5.44 (t, J = 5.2 Hz, 1H), 4.79-4.71 (m, 1H), 3.45 (s, 3H), 3.20-3.10 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.1, 145.3, 145.0, 143.5, 136.0, 134.8, 134.0, 129.2, 128.1, 127.5, 126.9, 126.0, 123.4, 116.4, 110.0, 70.5, 50.4, 38.3; IR (Neat) 3404, 3064, 1600, 1526, 1495, 1459, 1060 cm^{-1}; HRMS (m/z): $[M+H]^+$ calcd for $C_{22}H_{22}N_2O_2Cl$, 381.1370; found, 381.1355.

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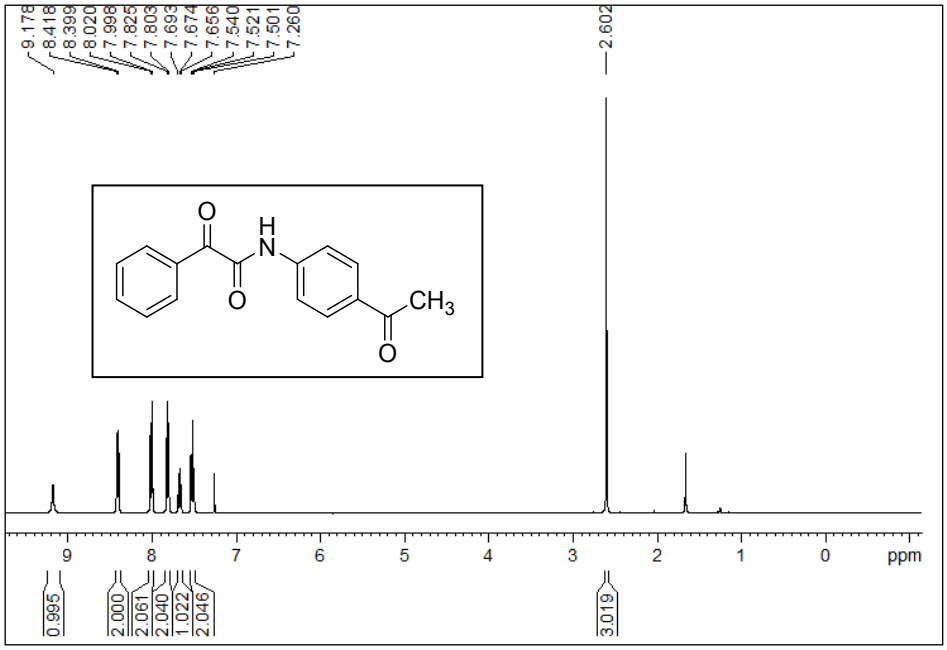
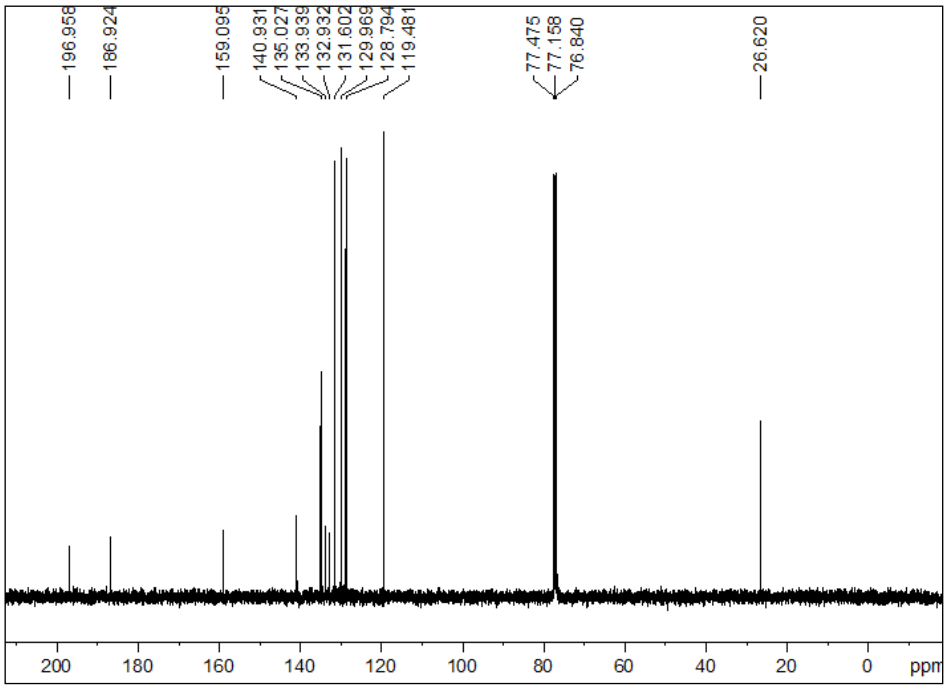
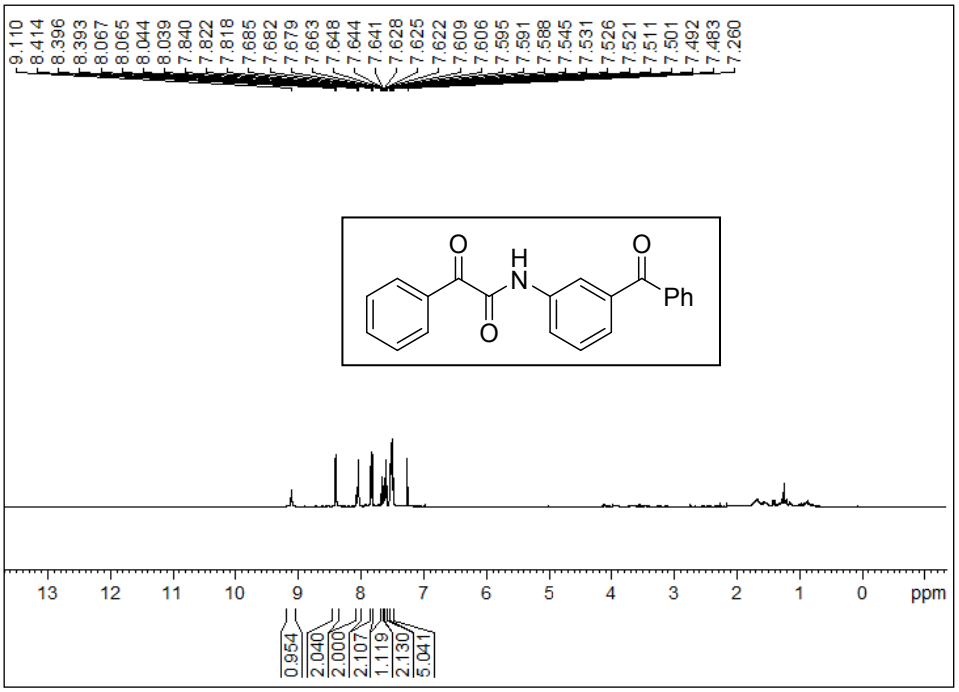


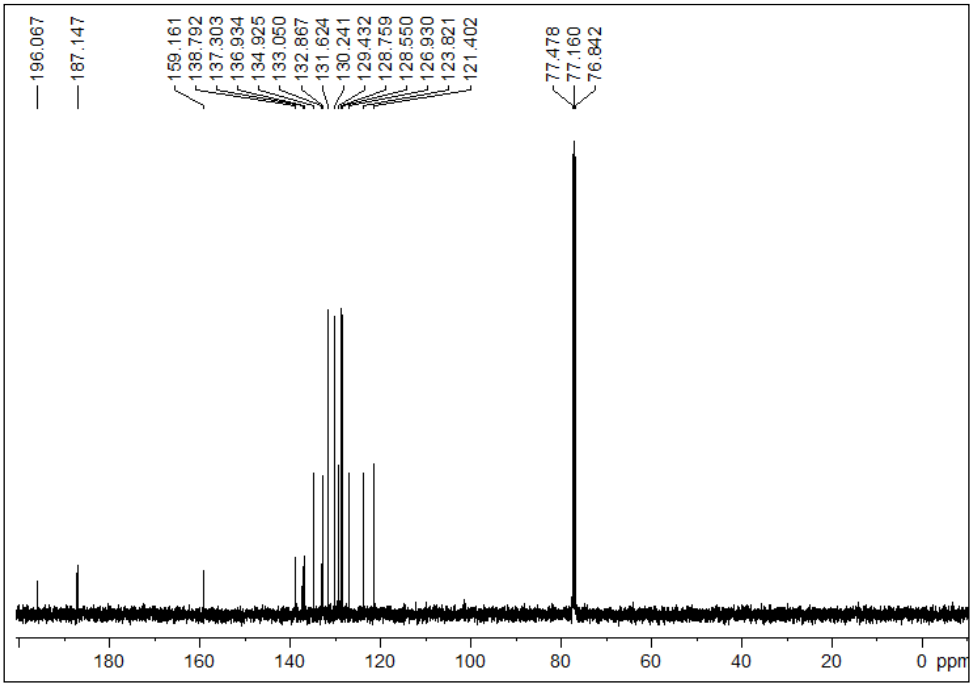
400 Mz ^{1}H-NMR spectra of **4a** in $CDCl_3$



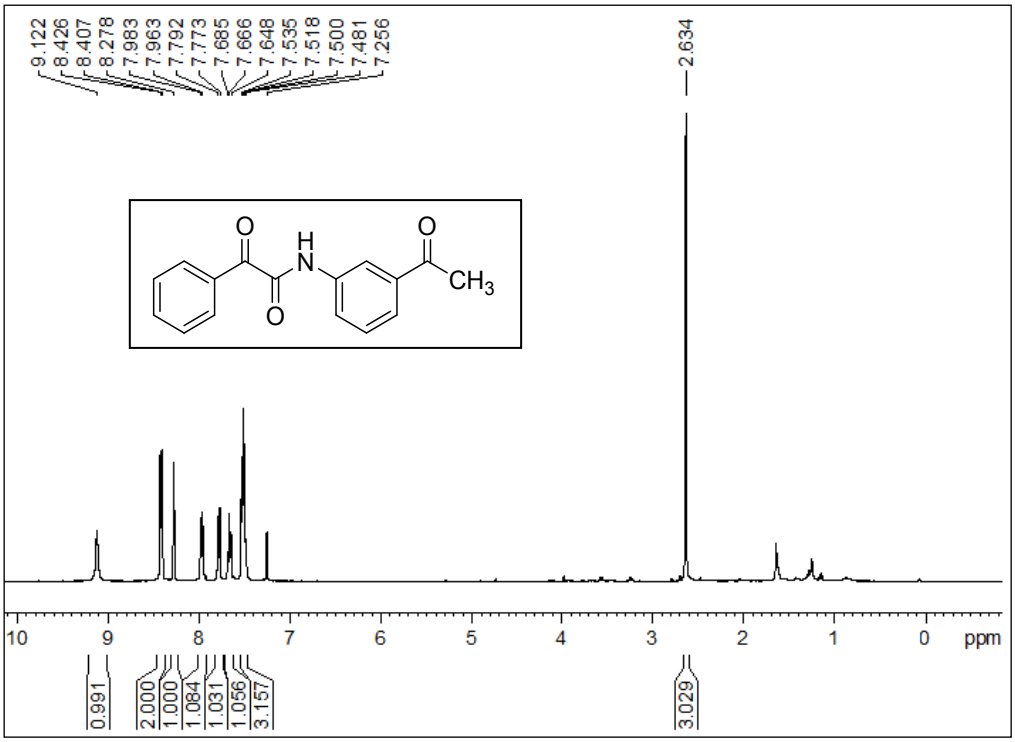
100 Mz ^{13}C-NMR spectra of **4a** in $CDCl_3$



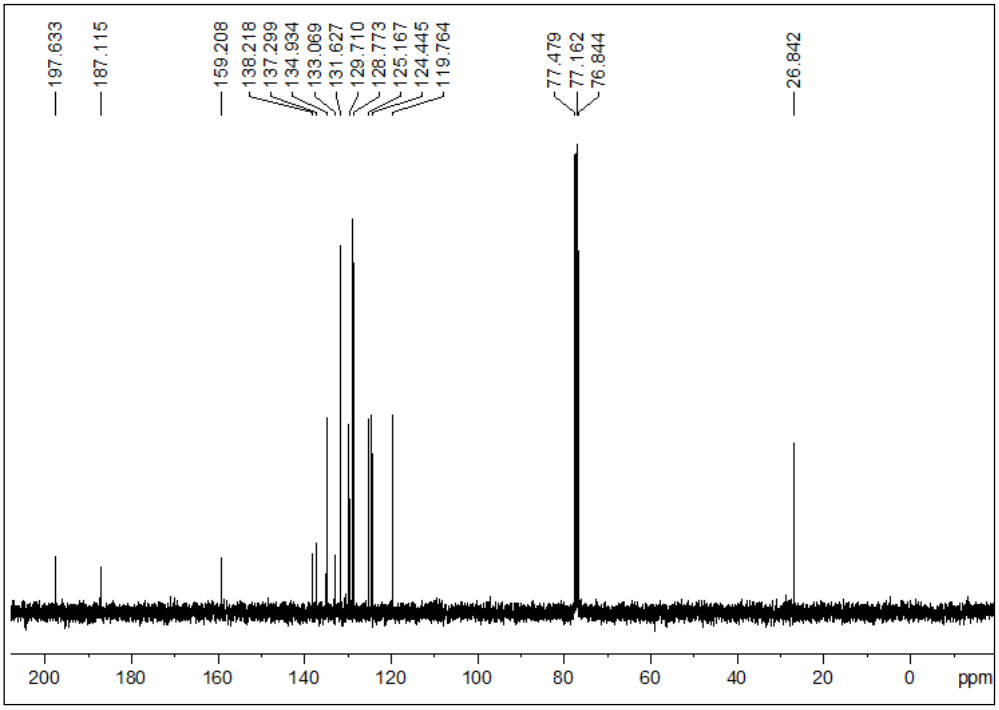
400 Mz ^{1}H-NMR spectra of **4b** in $CDCl_3$



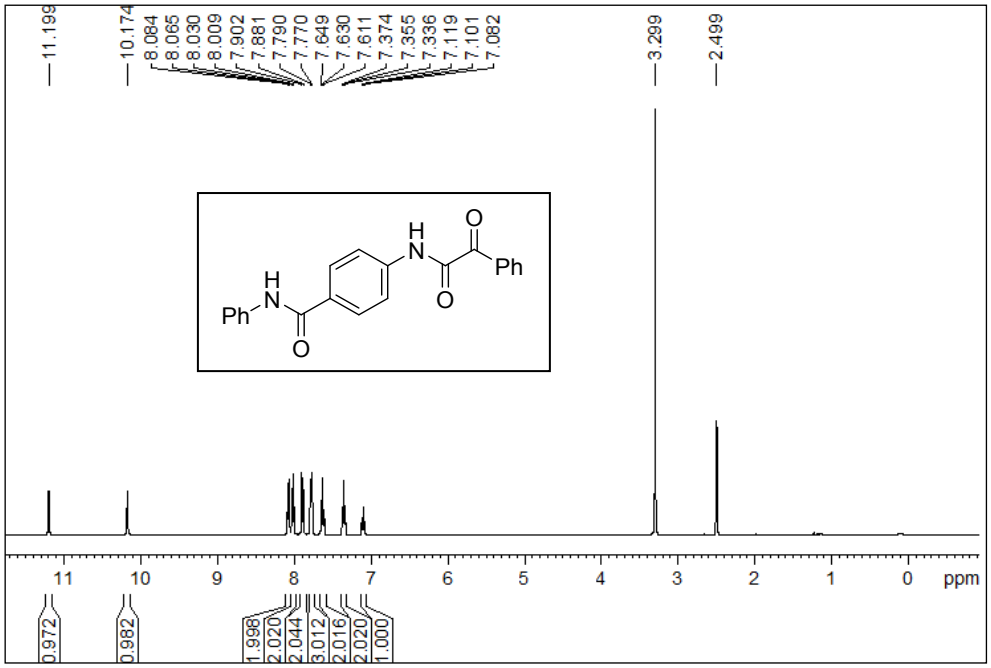
100 Mz ^{13}C-NMR spectra of **4b** in $CDCl_3$



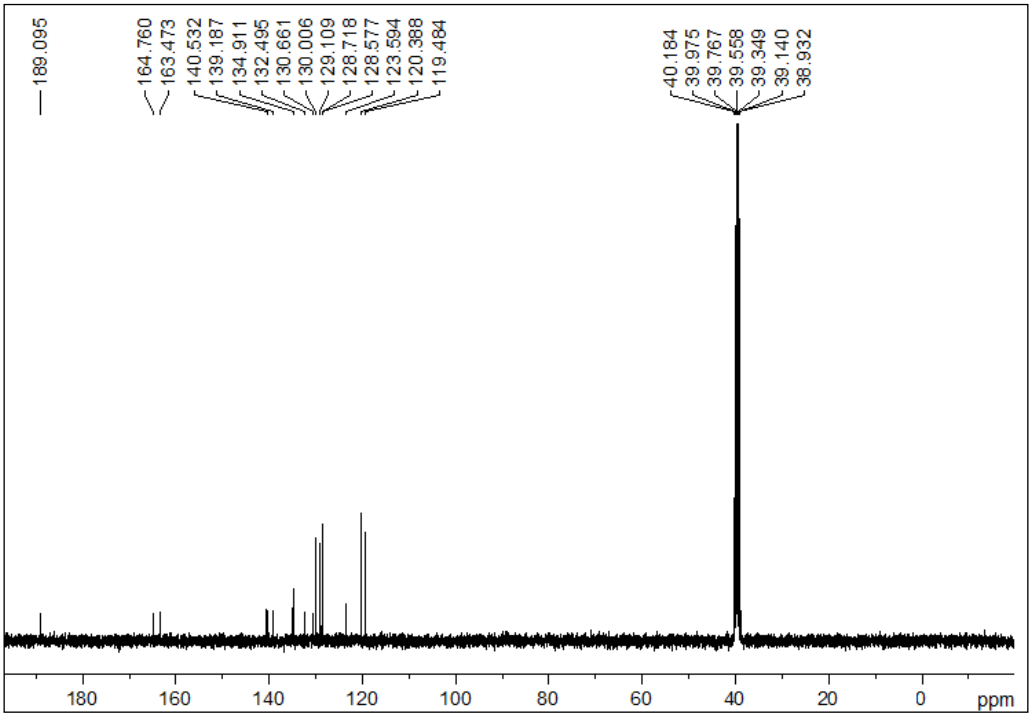
400 Mz ^{1}H-NMR spectra of **4c** in $CDCl_3$



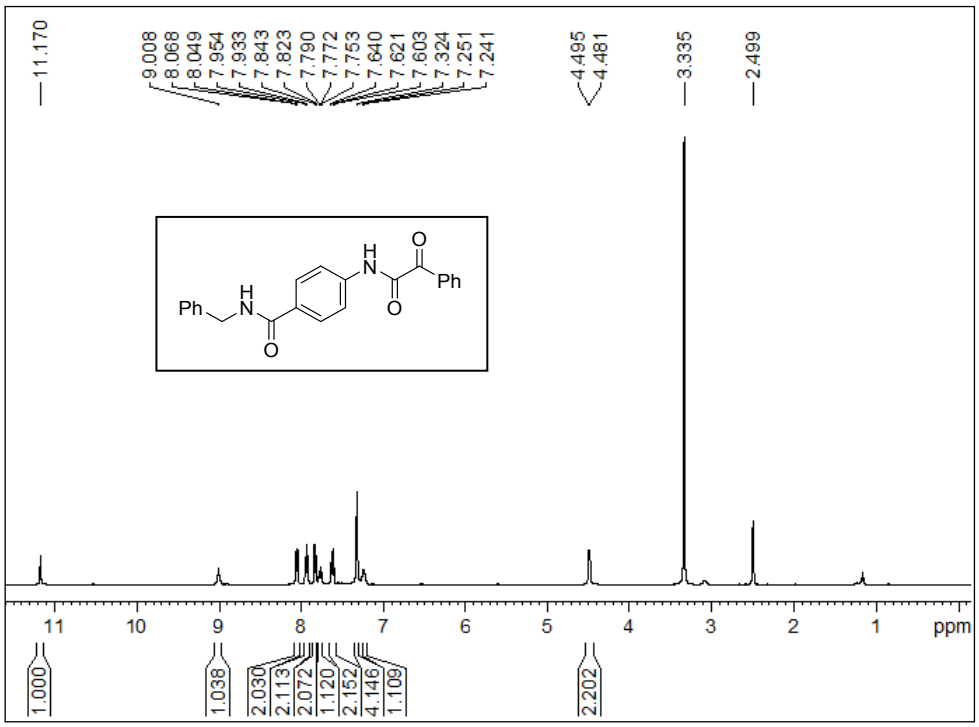
100 Mz ^{13}C-NMR spectra of **4c** in $CDCl_3$



400 Mz ^{1}H-NMR spectra of **6a** in DMSO-d_6



100 Mz ^{13}C-NMR spectra of **6a** in DMSO-d_6



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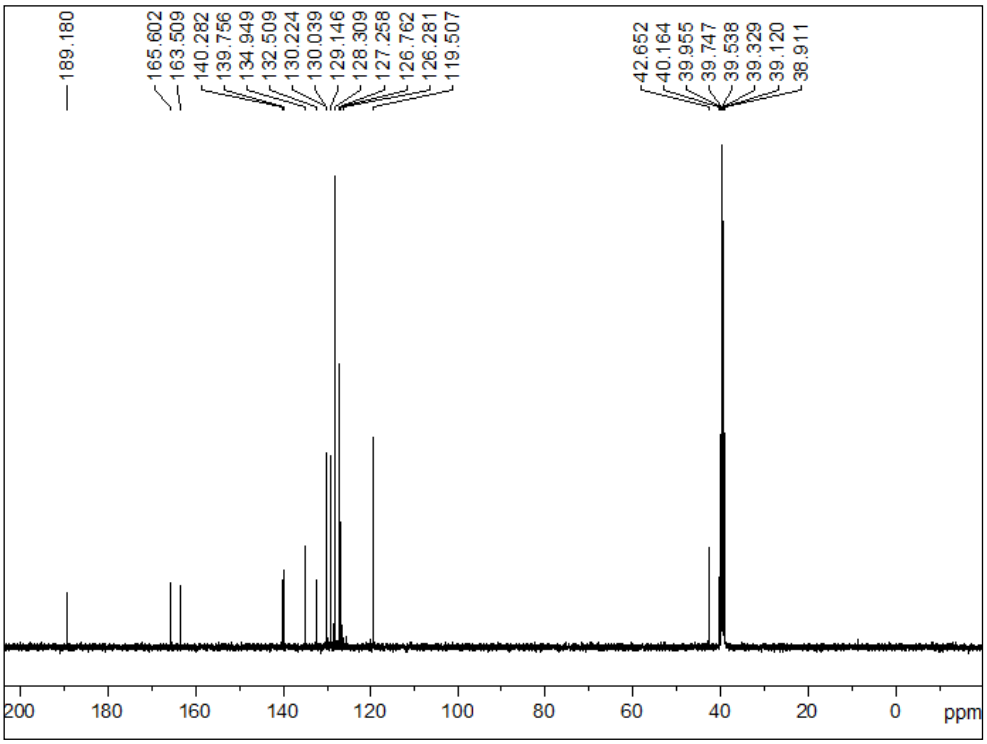

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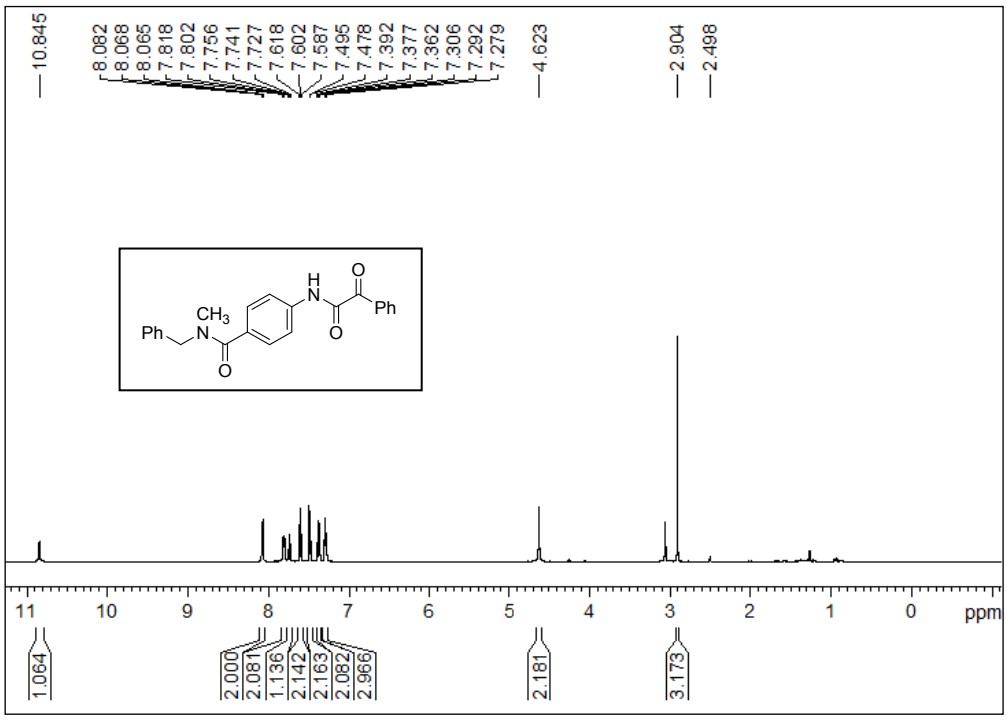
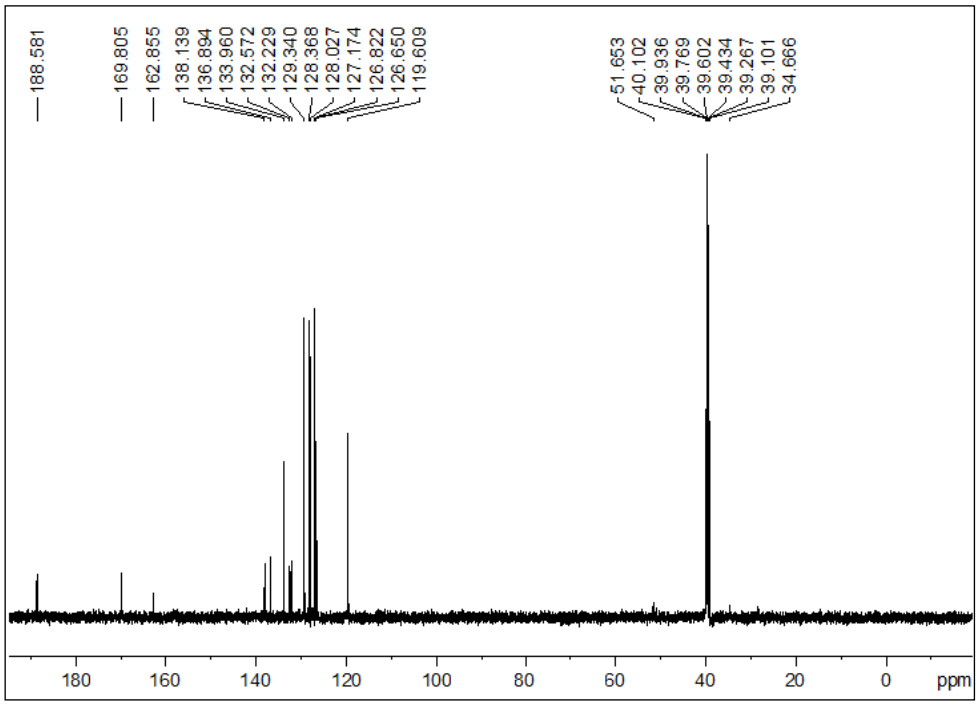
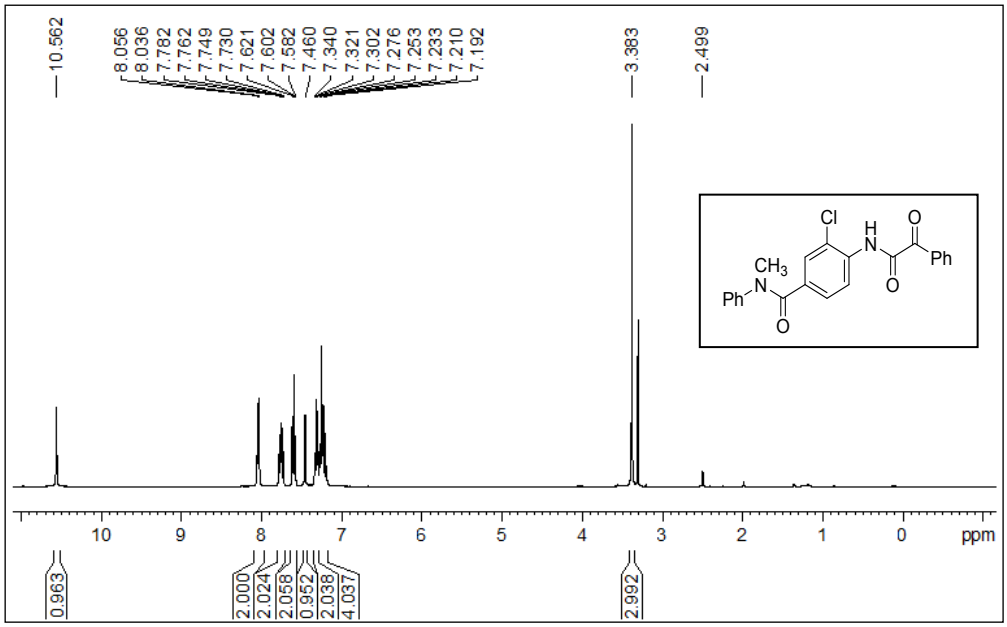


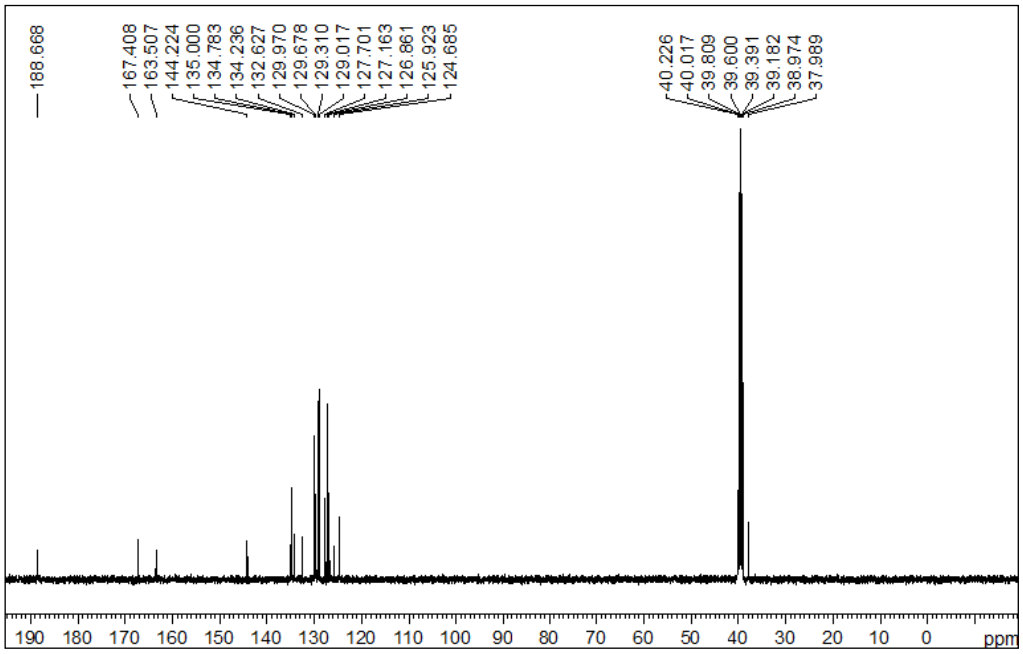
400 Mz ^{1}H-NMR spectra of **6c** in DMSO-d_6



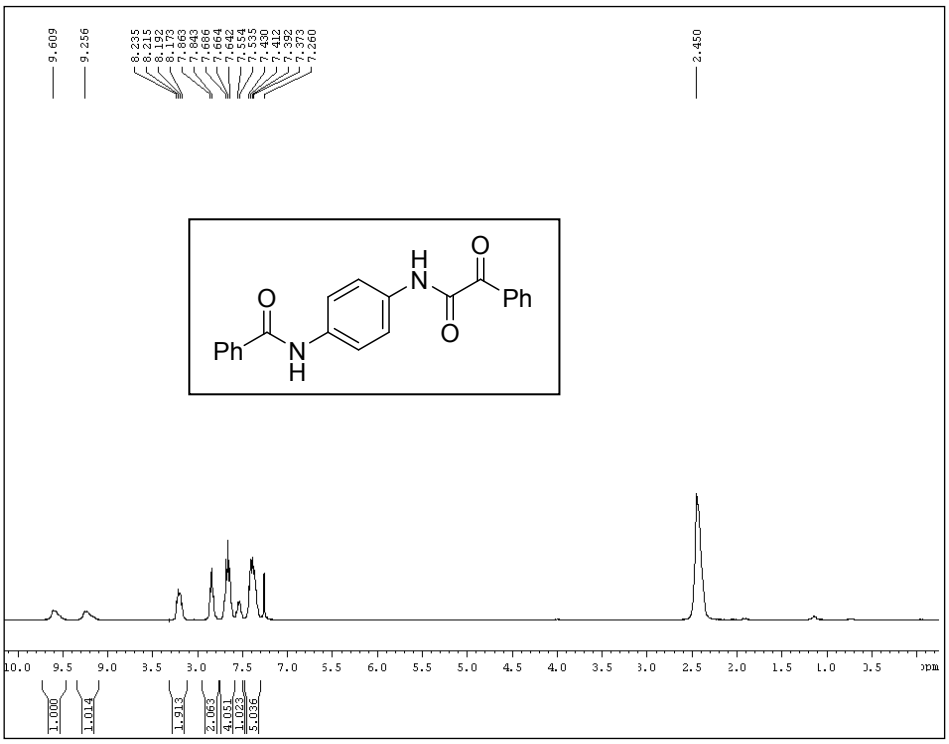
100 Mz ^{13}C-NMR spectra of **6c** in DMSO-d_6



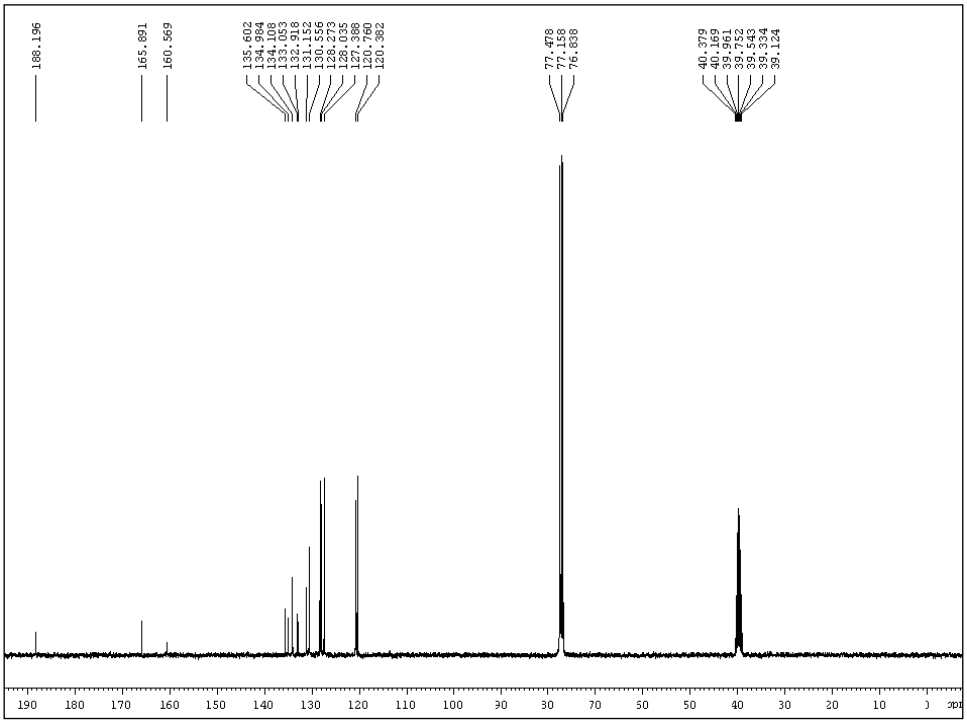
400 Mz ^{1}H-NMR spectra of **6d** in DMSO-d_6



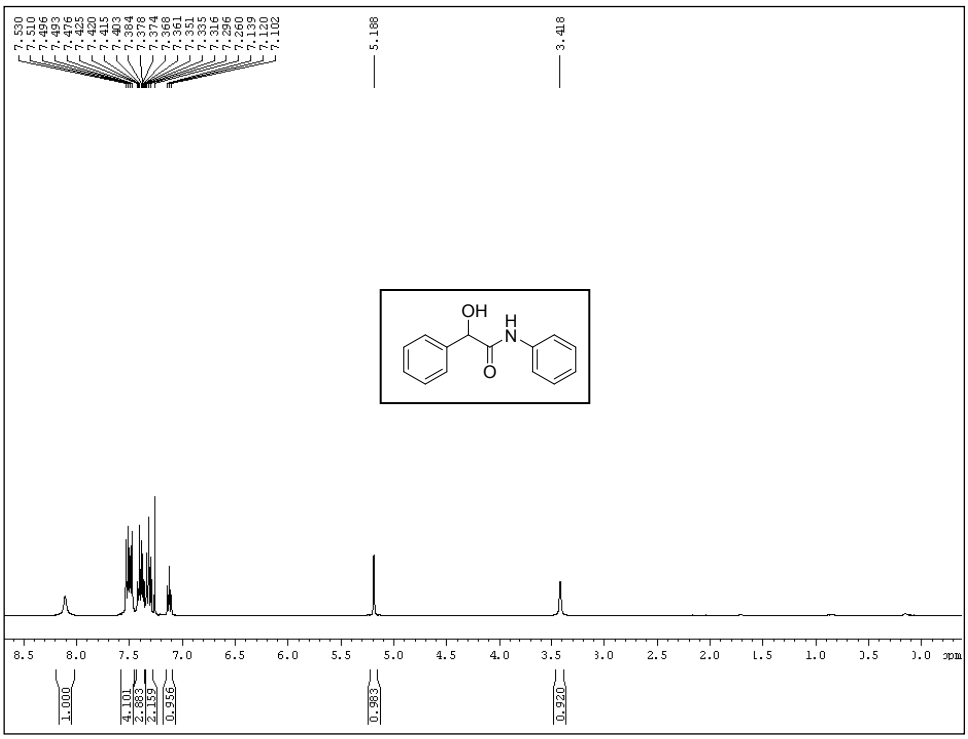
100 Mz ^{13}C-NMR spectra of **6d** in DMSO-d_6



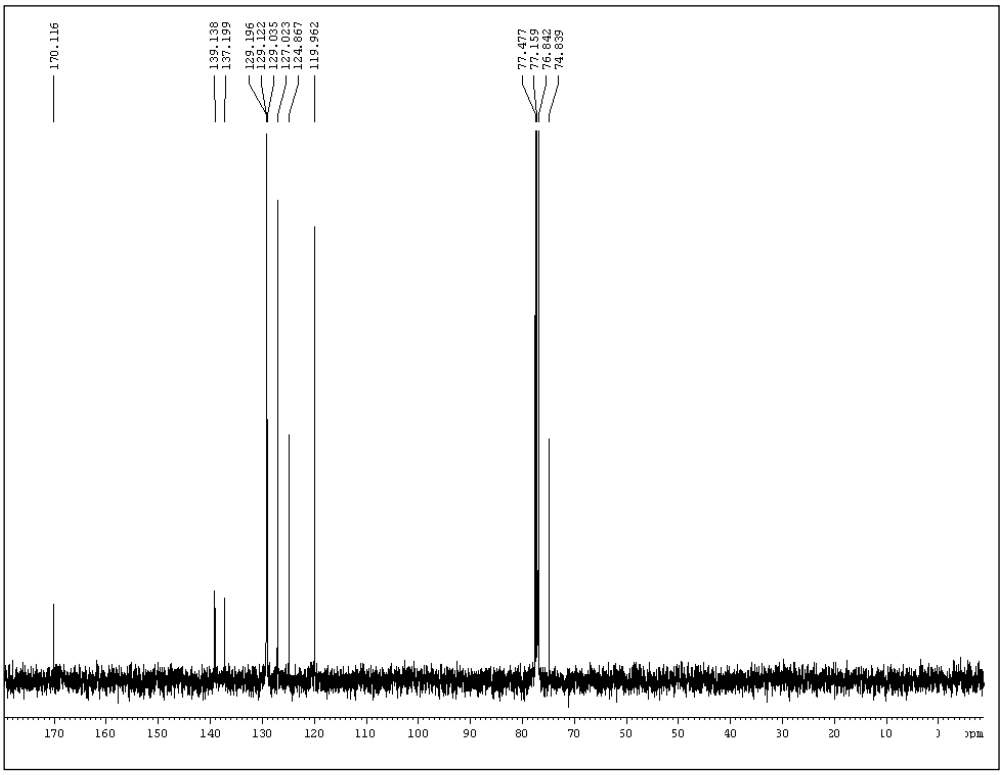
400 Mz ^{1}H-NMR spectra of **6e** in $CDCl_3$+DMSO-d_6



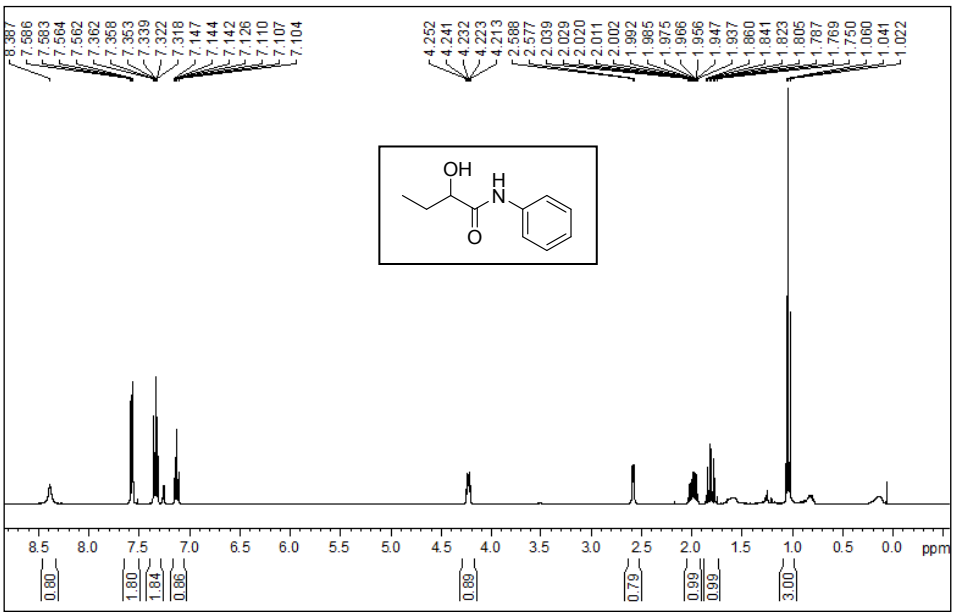
100 Mz ^{13}C-NMR spectra of **6e** in $CDCl_3$+DMSO-d_6



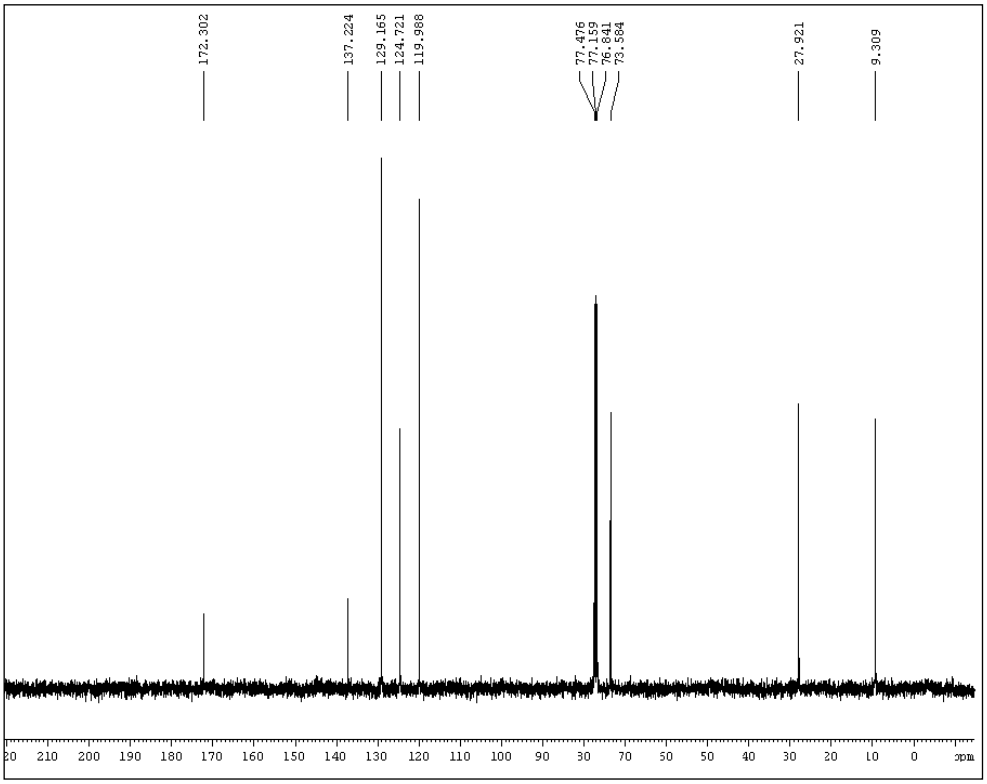
400 Mz ^{1}H-NMR spectra of **2a** in $CDCl_3$



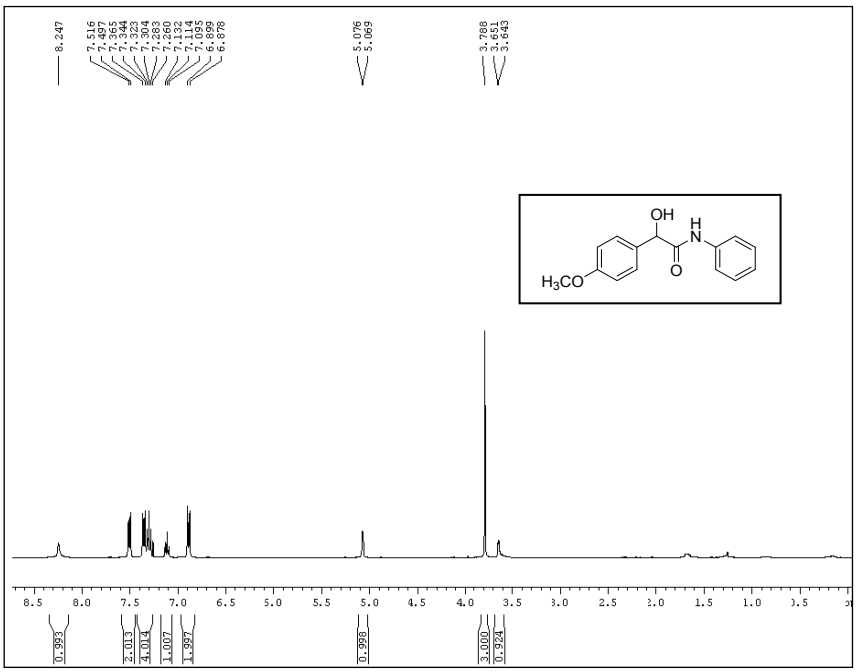
100 Mz ^{13}C-NMR spectra of **2a** in $CDCl_3$



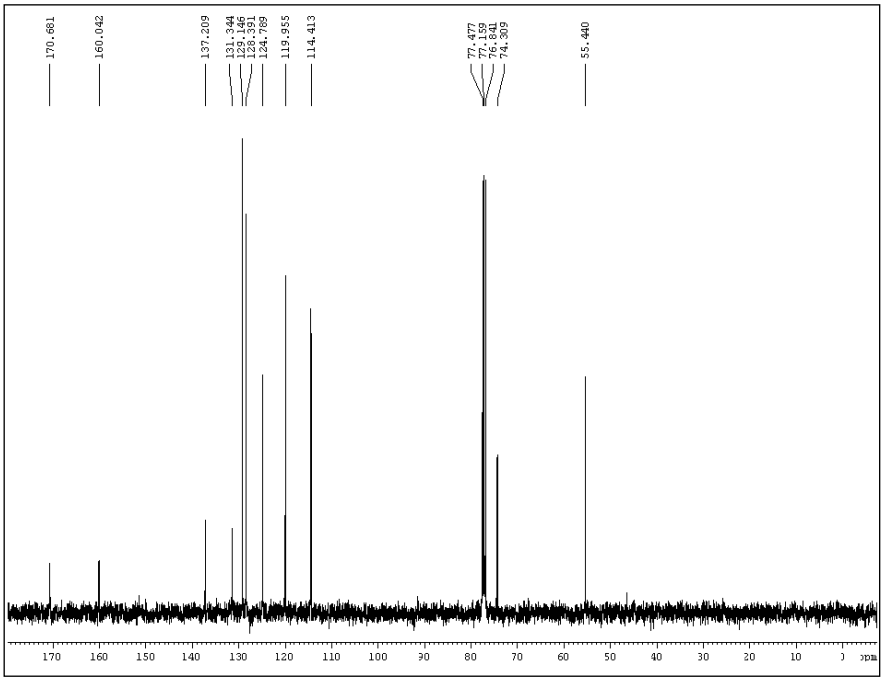
400 Mz ^{1}H-NMR spectra of **2b** in $CDCl_3$



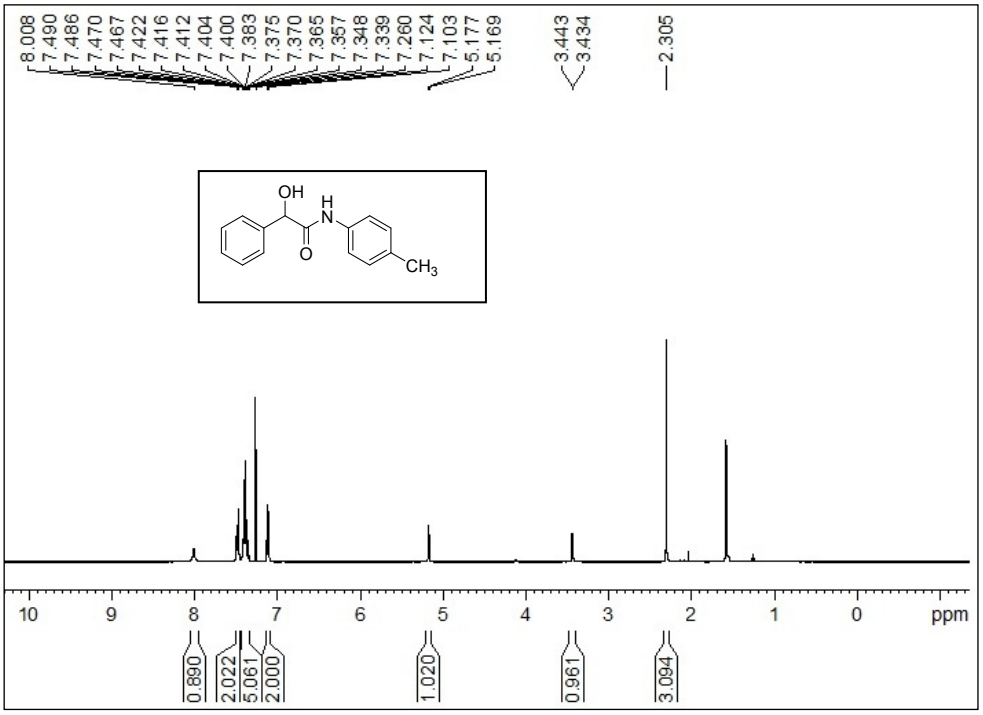
100 Mz ^{13}C-NMR spectra of **2b** in $CDCl_3$



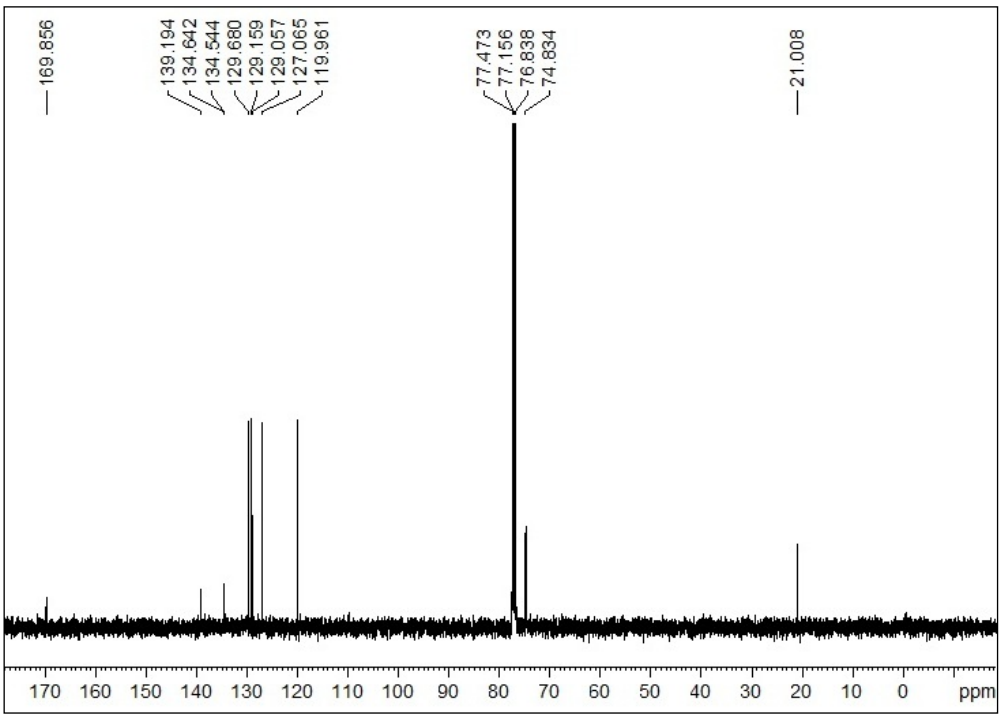
400 Mz ^{1}H-NMR spectra of **2c** in $CDCl_3$



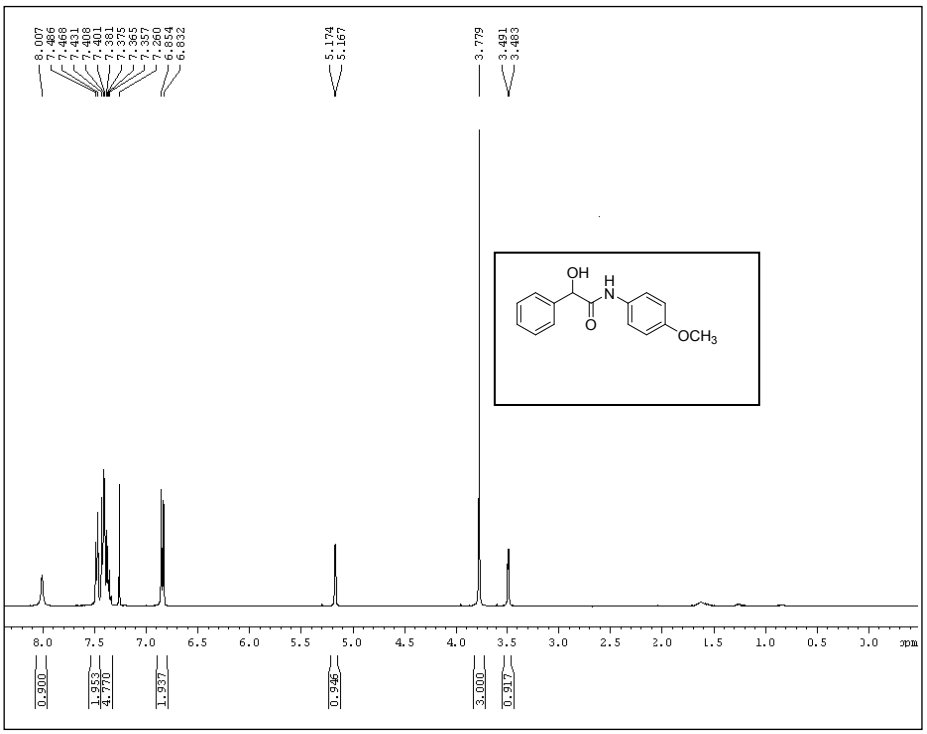
100 Mz ^{13}C-NMR spectra of **2c** in $CDCl_3$



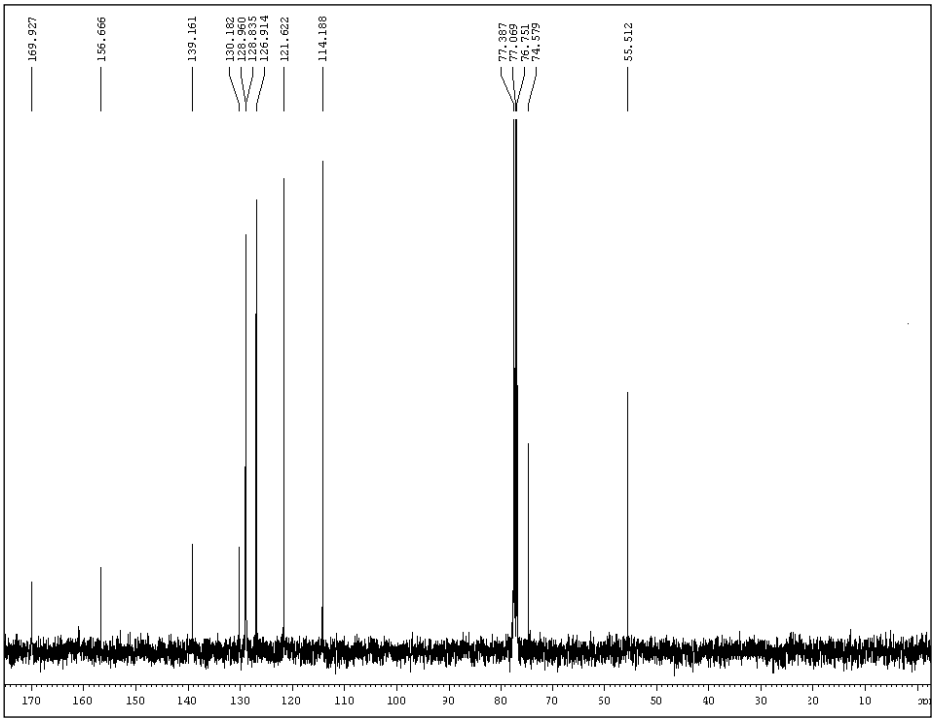
400 Mz ^{1}H-NMR spectra of **2d** in $CDCl_3$



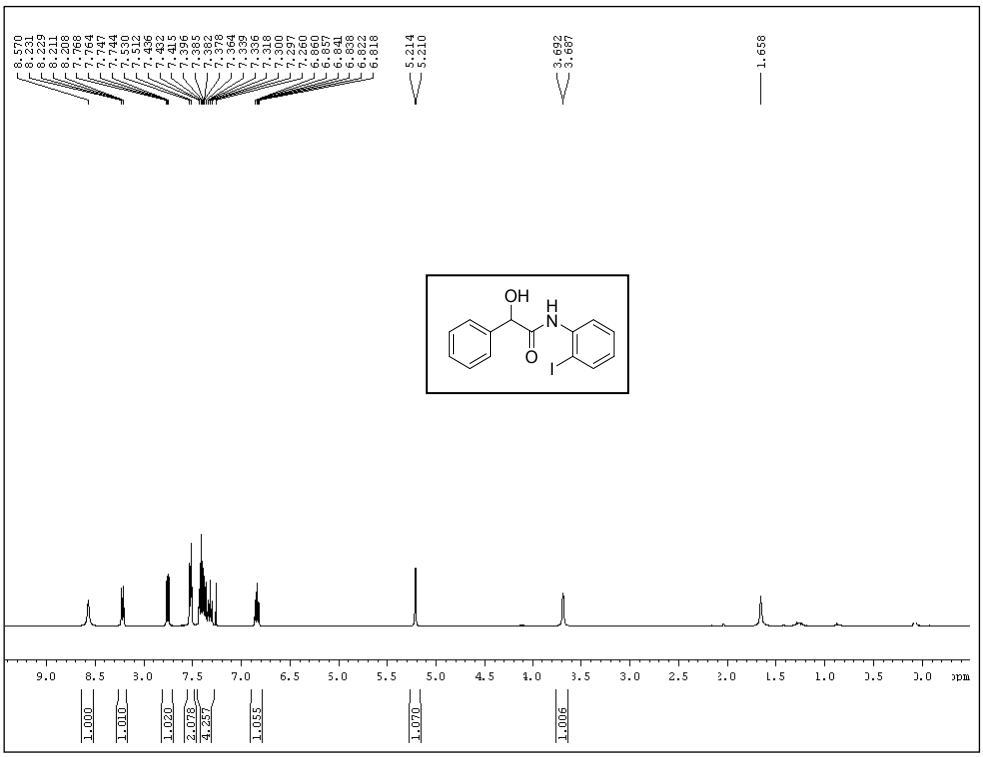
100 Mz ^{13}C-NMR spectra of **2d** in $CDCl_3$



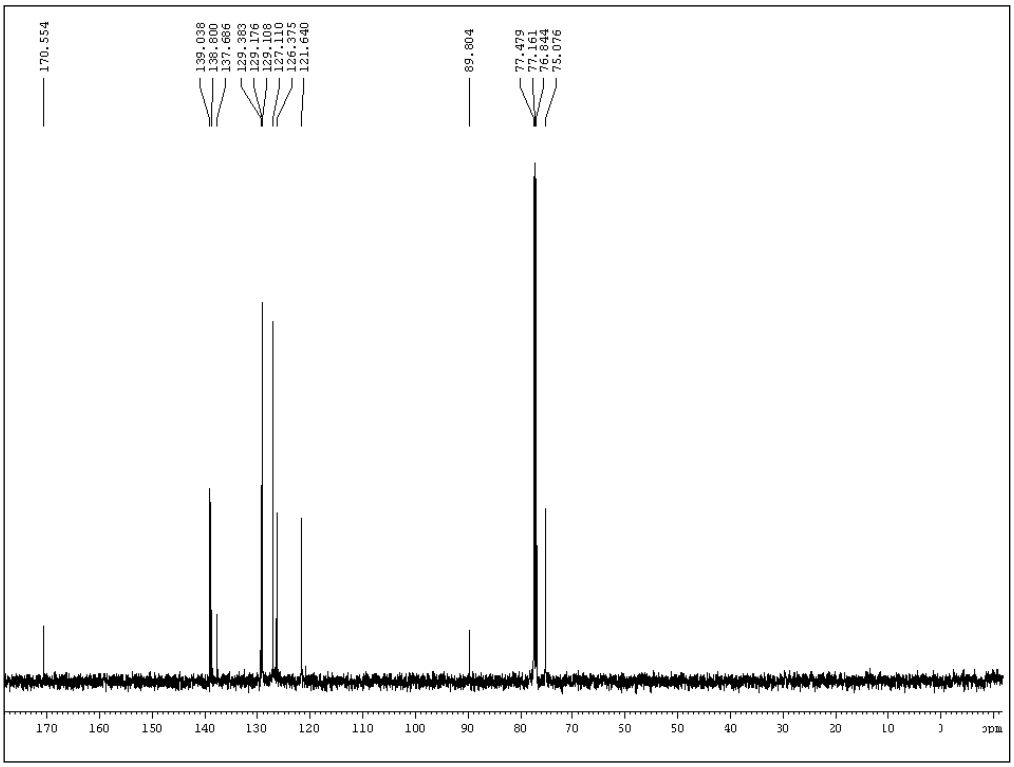
400 Mz ^{1}H-NMR spectra of **2e** in $CDCl_3$



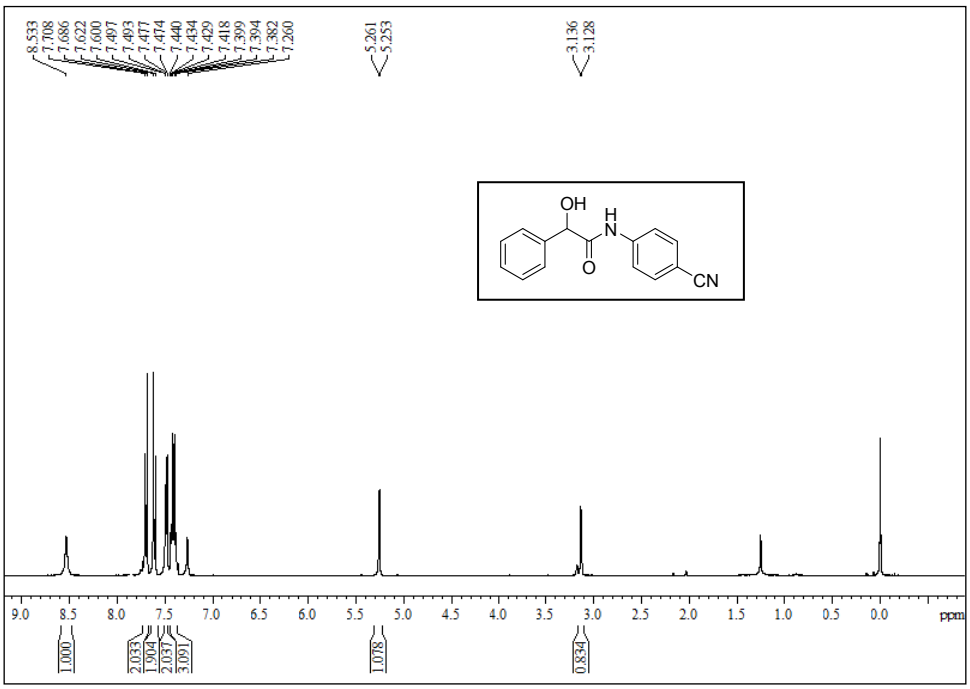
100 Mz ^{13}C-NMR spectra of **2e** in $CDCl_3$



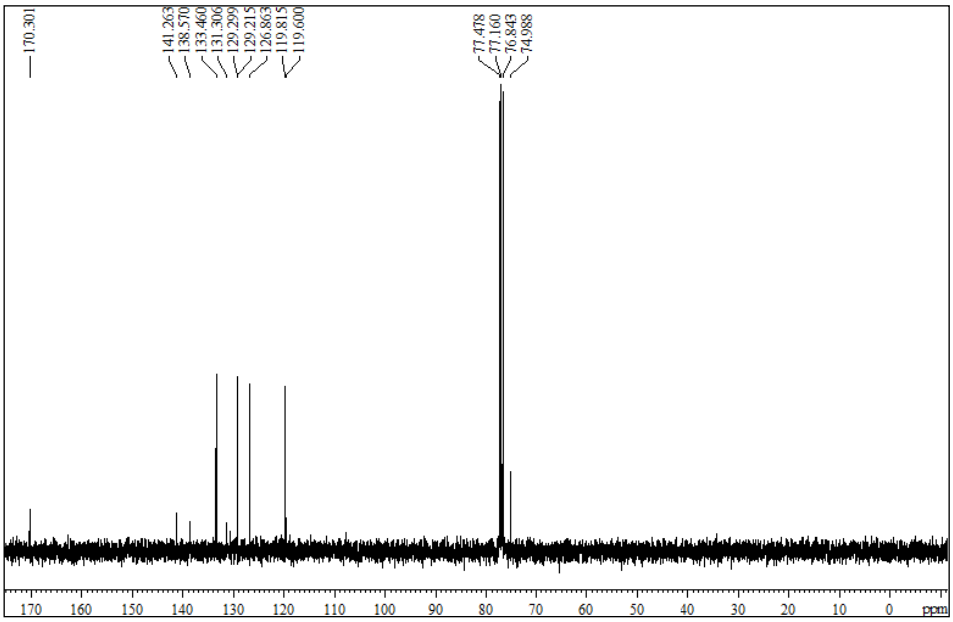
400 Mz ^{1}H-NMR spectra of **2f** in $CDCl_3$



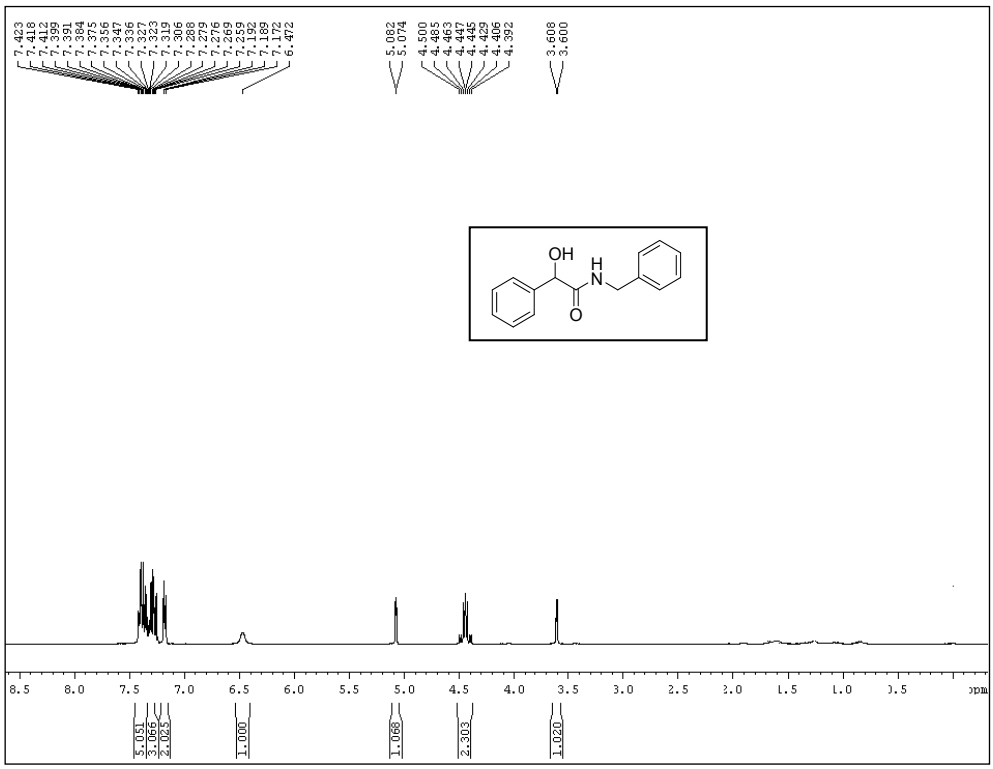
100 Mz ^{13}C-NMR spectra of **2f** in $CDCl_3$



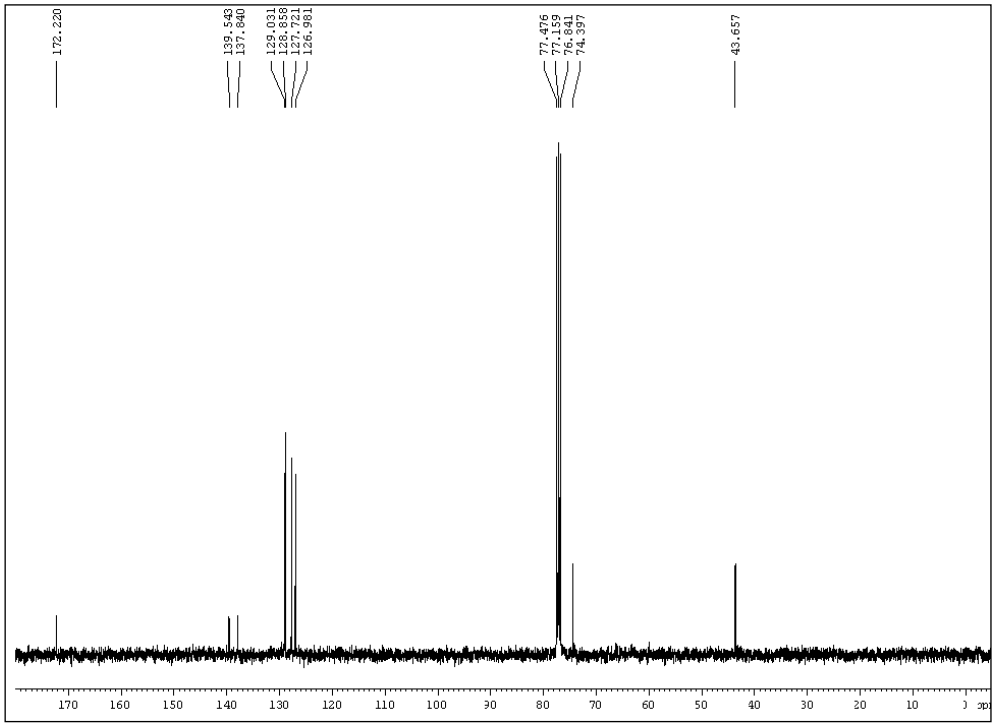
400 Mz ^{1}H-NMR spectra of **2g** in $CDCl_3$



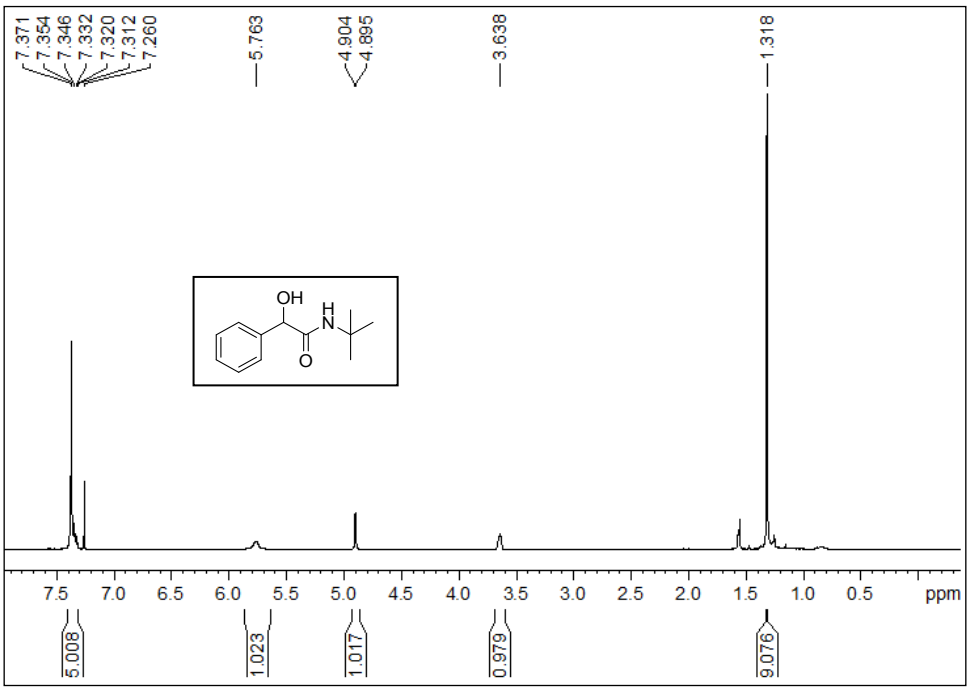
100 Mz ^{13}C-NMR spectra of **2g** in $CDCl_3$



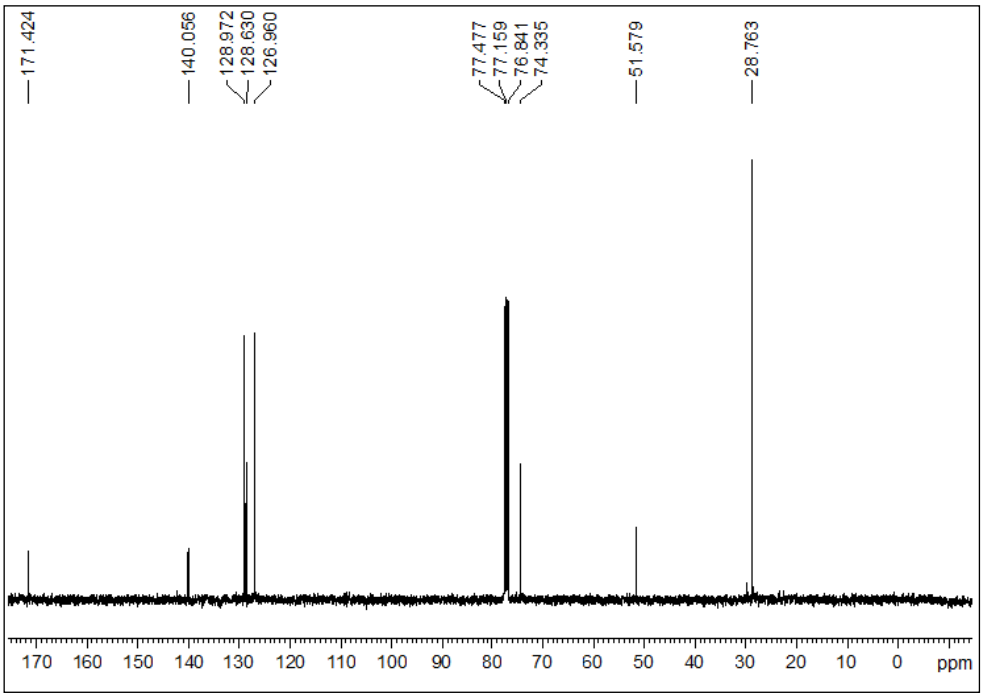
400 Mz ^{1}H-NMR spectra of **2h** in $CDCl_3$



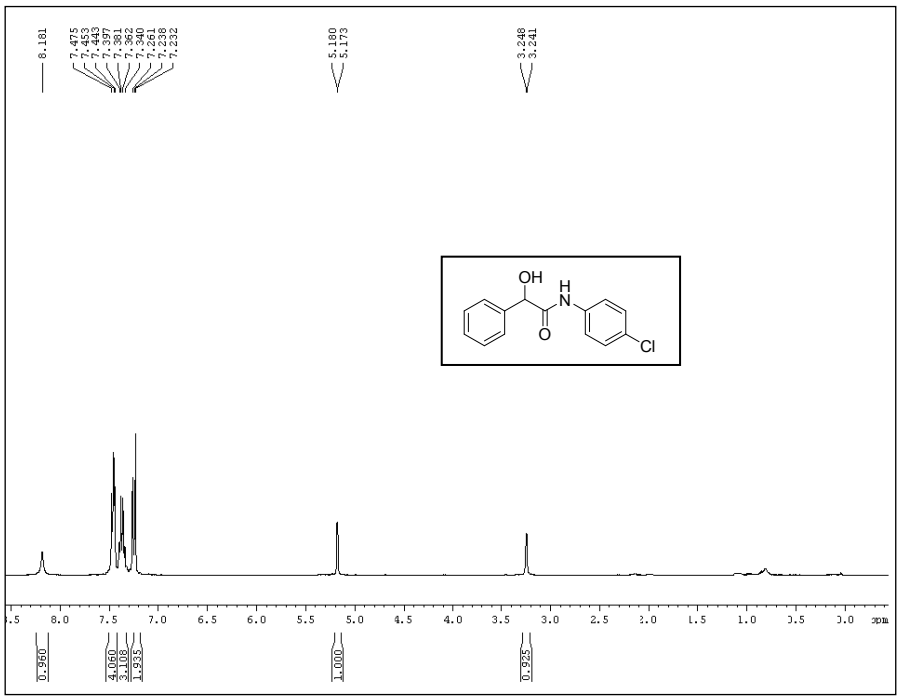
100 Mz ^{13}C-NMR spectra of **2h** in $CDCl_3$



400 Mz ^{1}H-NMR spectra of **2i** in $CDCl_3$



100 Mz ^{13}C-NMR spectra of **2i** in $CDCl_3$



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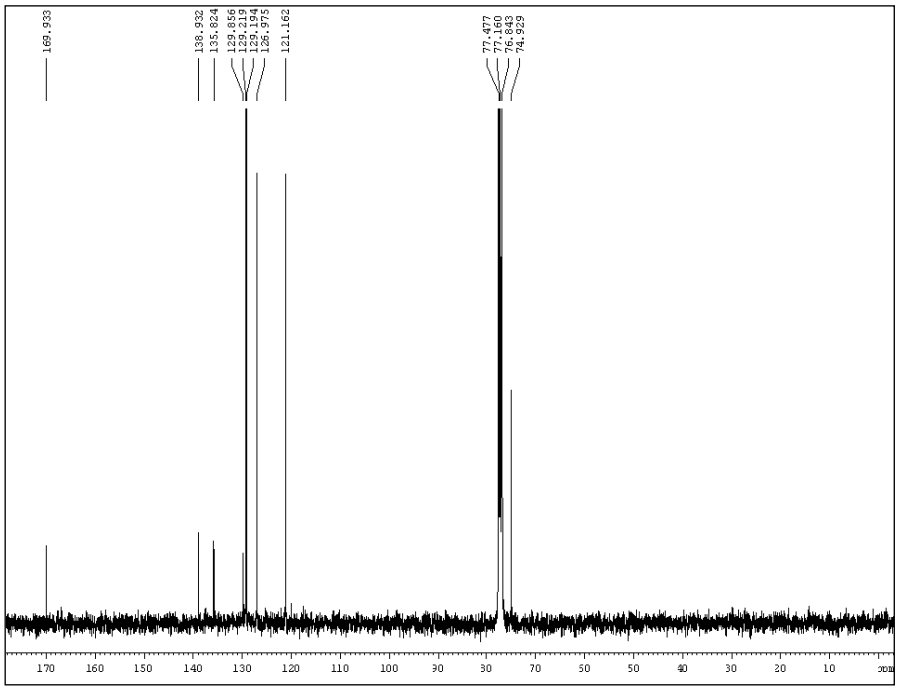
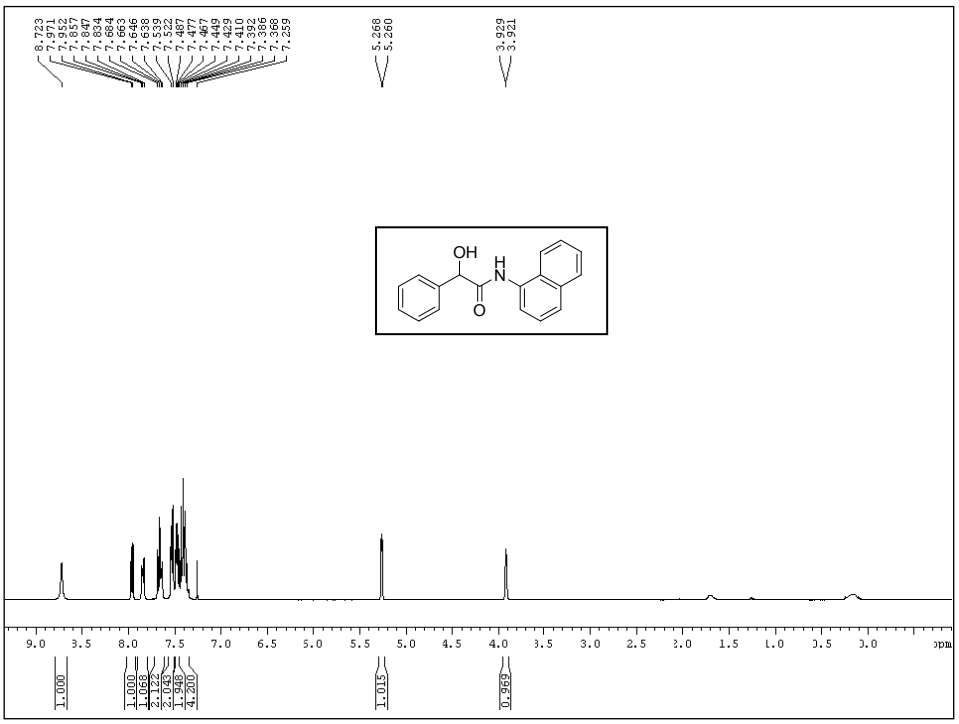
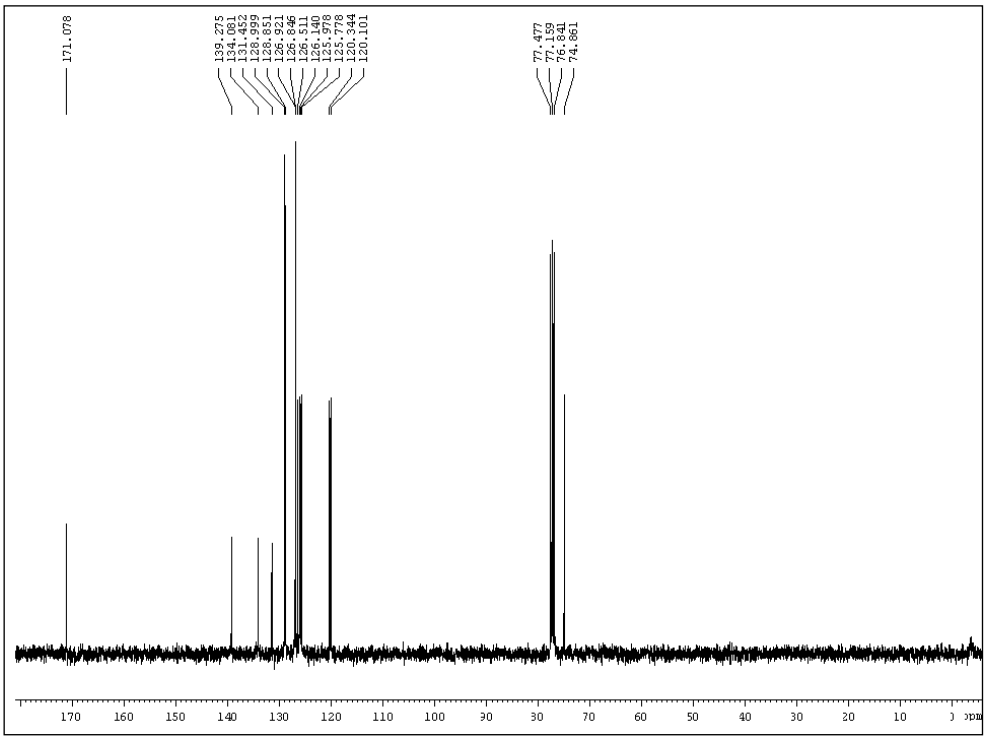


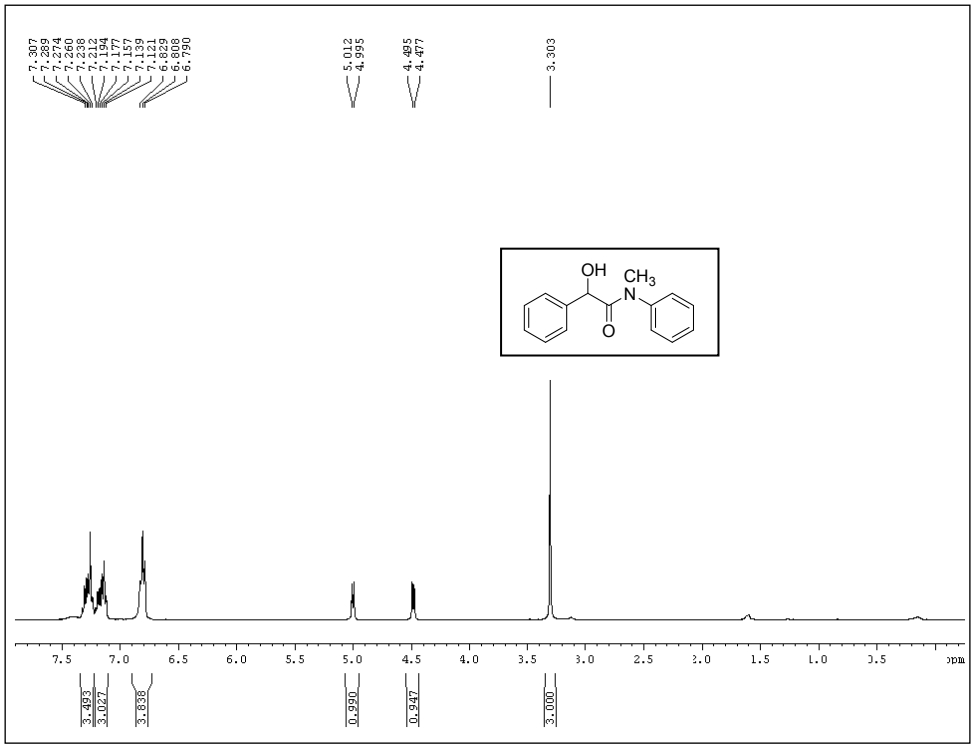
100 Mz ^{13}C-NMR spectra of **2j** in $CDCl_3$



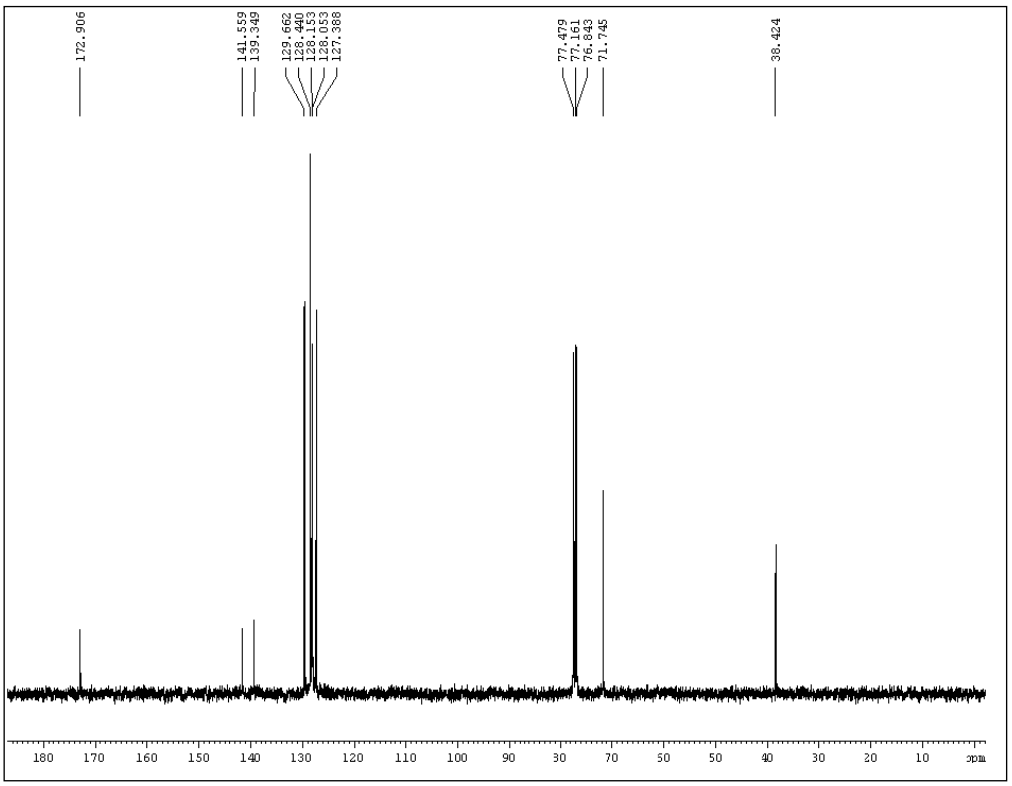
400 Mz ^{1}H-NMR spectra of **2k** in $CDCl_3$



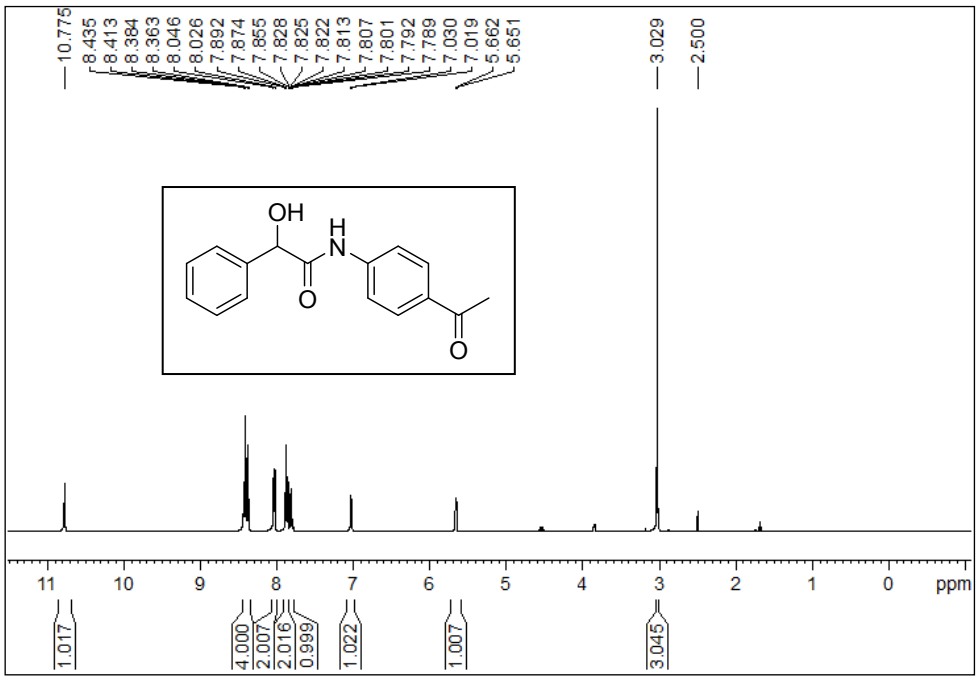
100 Mz ^{13}C-NMR spectra of **2k** in $CDCl_3$



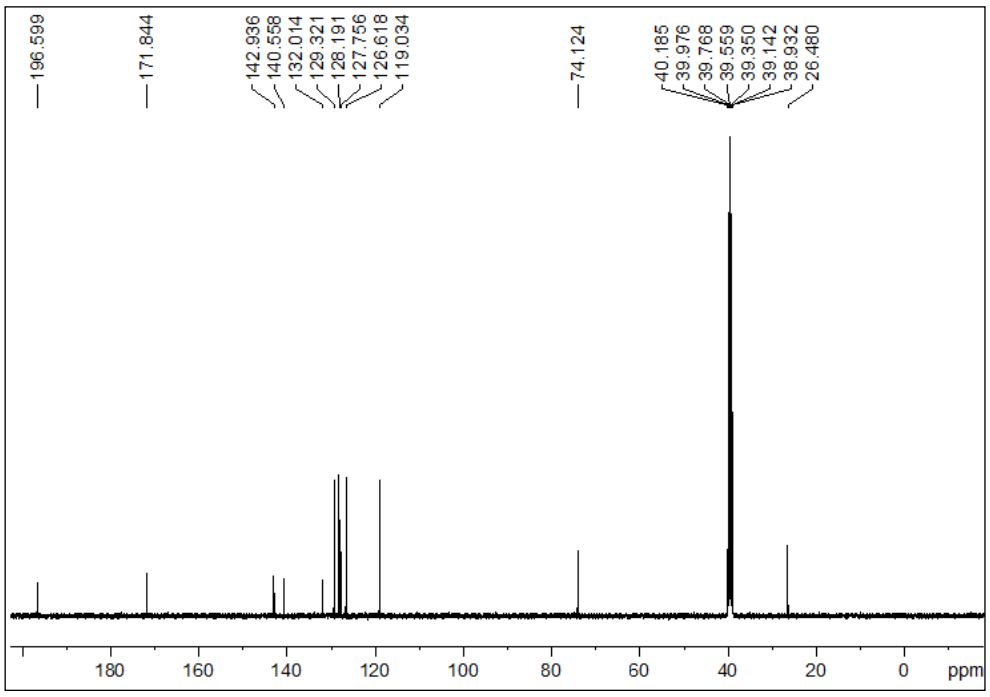
400 Mz ^{1}H-NMR spectra of **2l** in $CDCl_3$



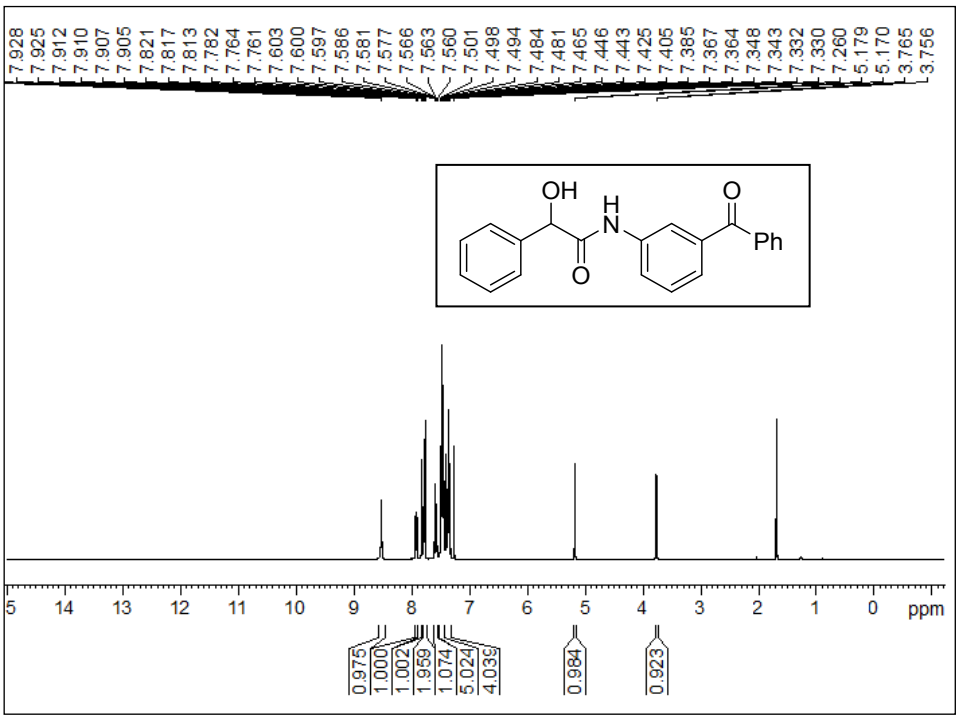
100 Mz ^{13}C-NMR spectra of **2l** in $CDCl_3$



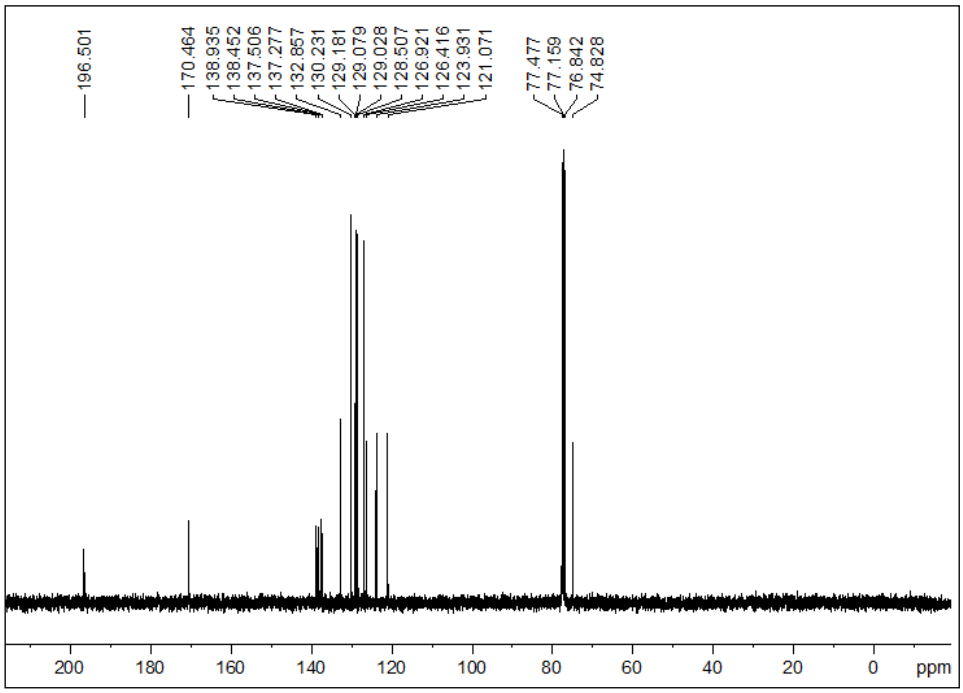
400 Mz ^{1}H-NMR spectra of **5a** in $CDCl_3$



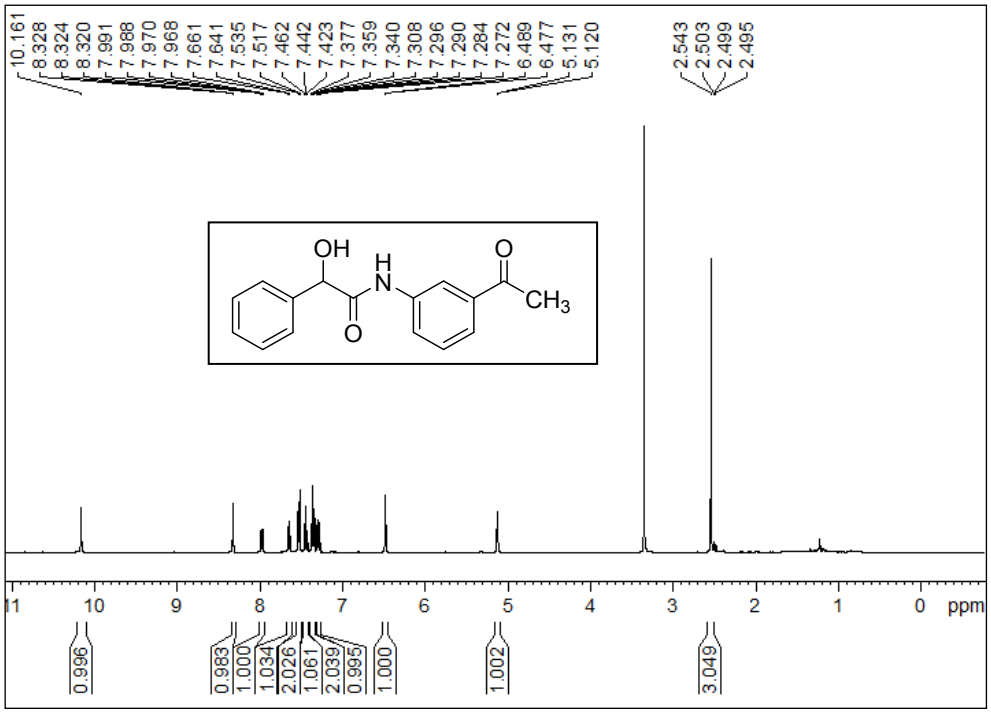
100 Mz ^{13}C-NMR spectra of **5a** in $CDCl_3$



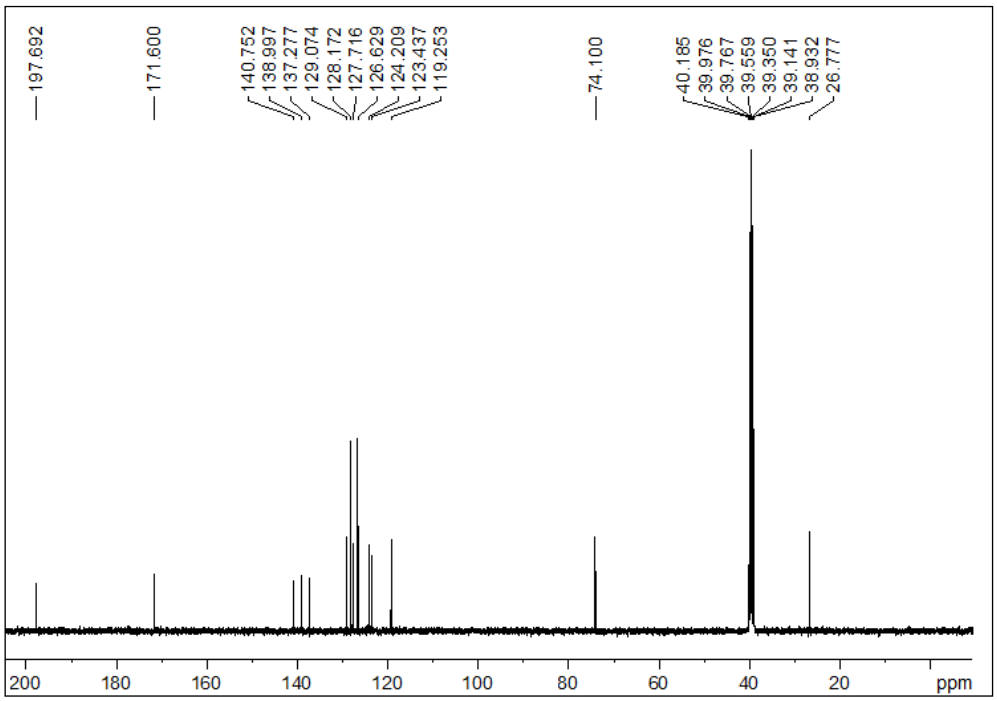
400 Mz ^{1}H-NMR spectra of **5b** in $CDCl_3$



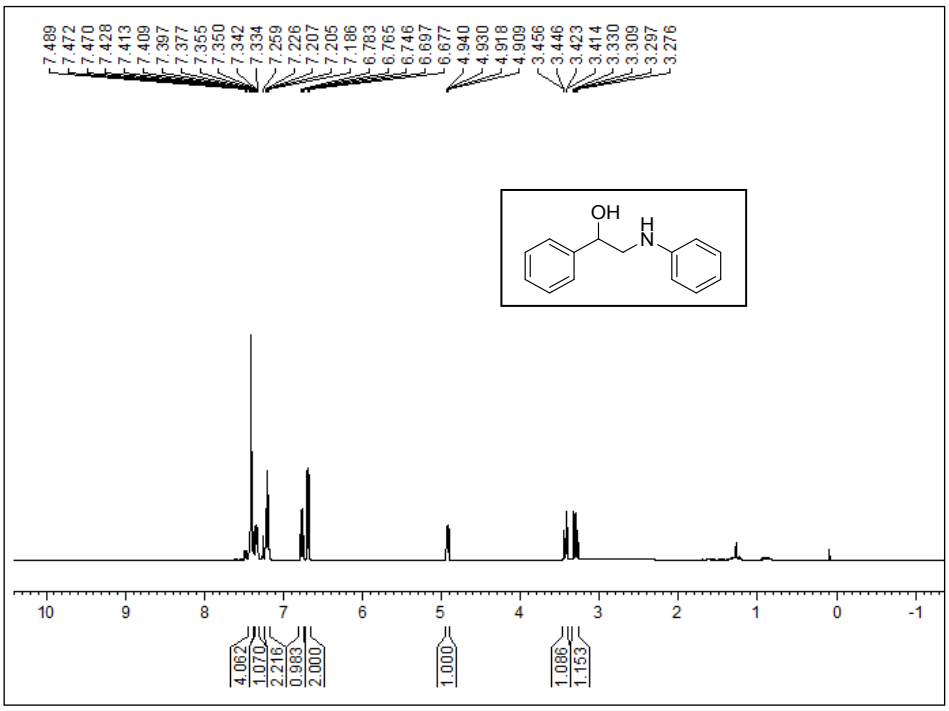
100 Mz ^{13}C-NMR spectra of **5b** in $CDCl_3$



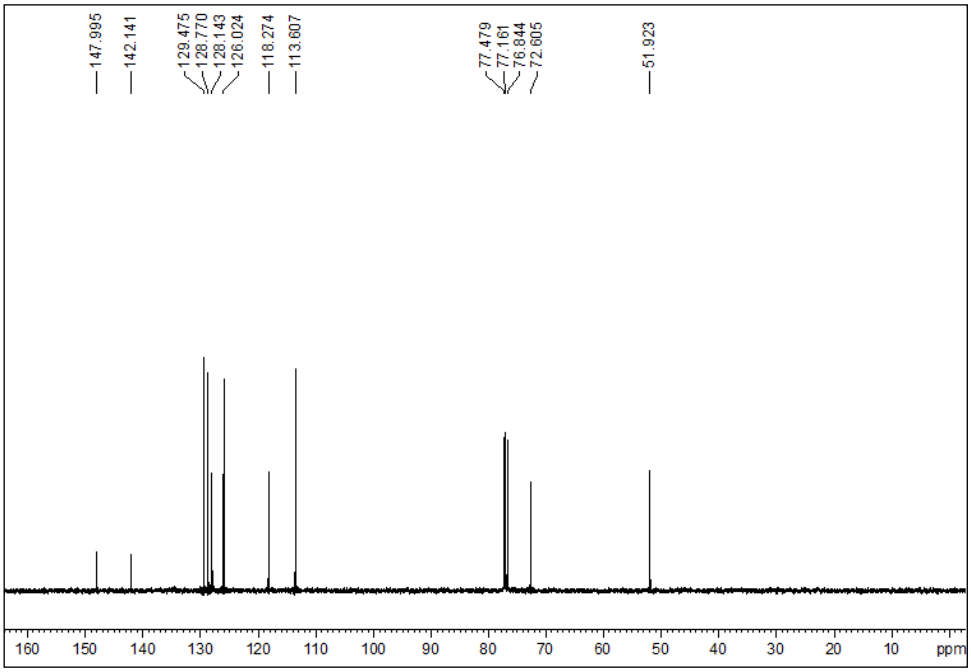
400 Mz ^{1}H-NMR spectra of **5c** in $CDCl_3$



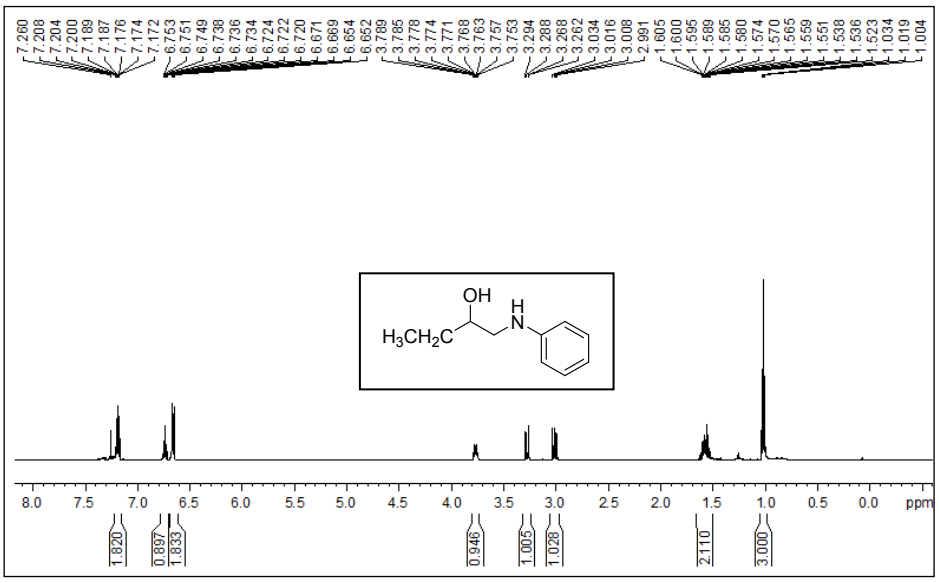
100 Mz ^{13}C-NMR spectra of **5c** in $CDCl_3$



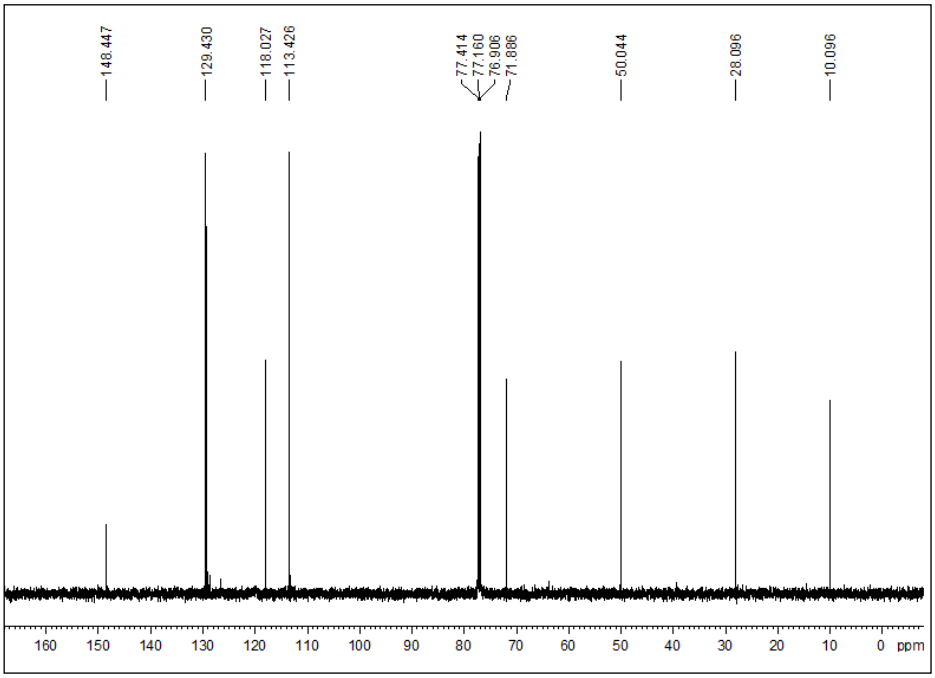
400 MHz ^{1}H-NMR spectra of **3a** in $CDCl_3$



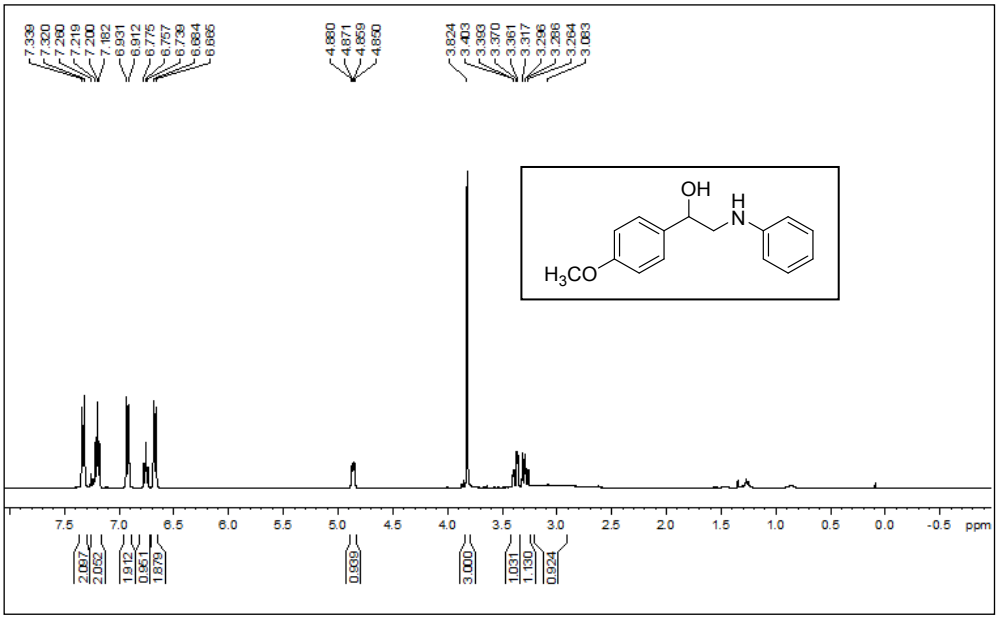
100 MHz ^{13}C-NMR spectra of **3a** in $CDCl_3$



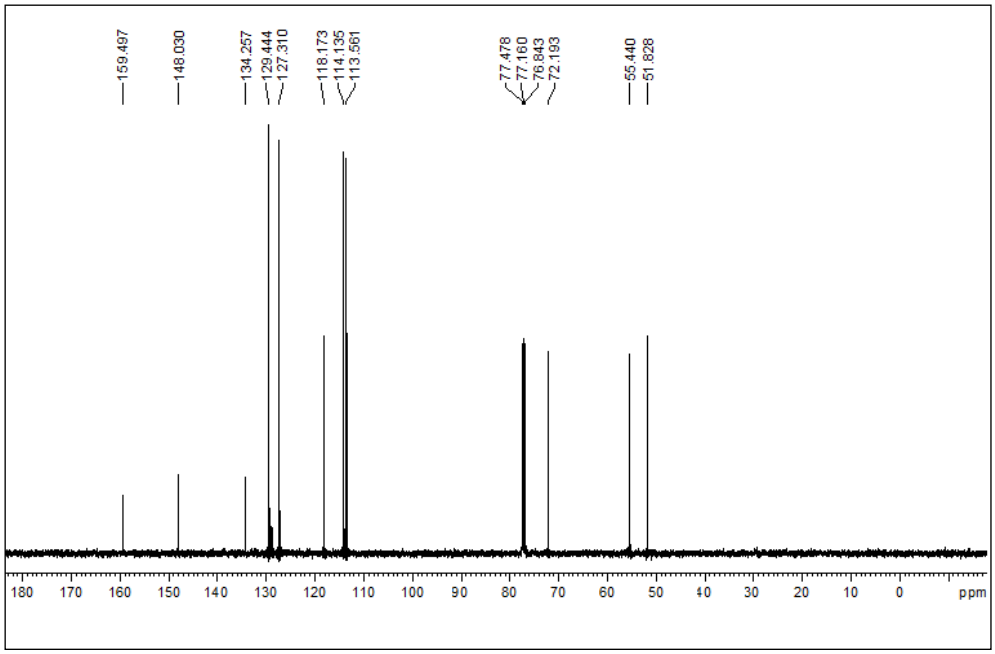
400 MHz ^{1}H-NMR spectra of **3b** in $CDCl_3$



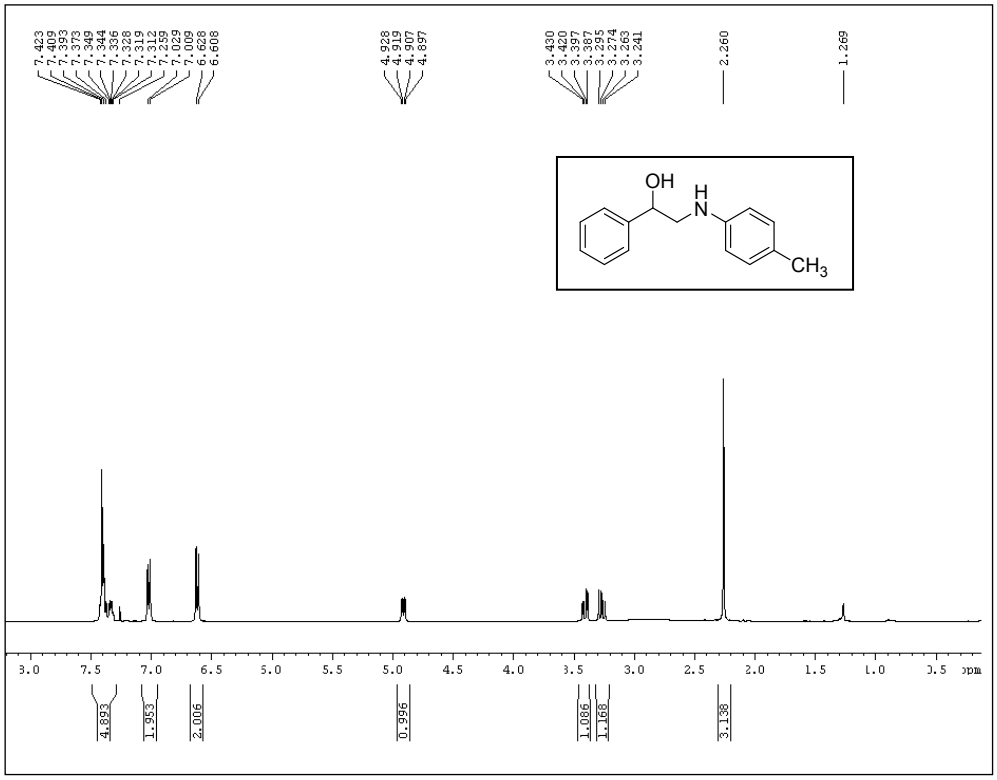
100 MHz ^{13}C-NMR spectra of **3b** in $CDCl_3$



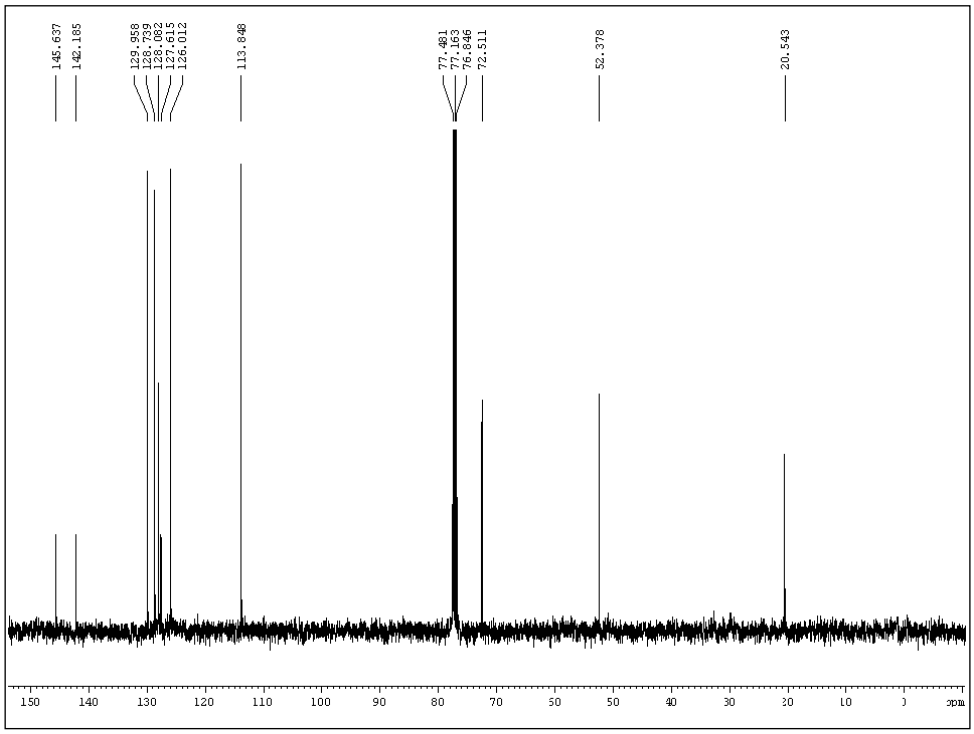
400 MHz ^{1}H-NMR spectra of **3c** in $CDCl_3$



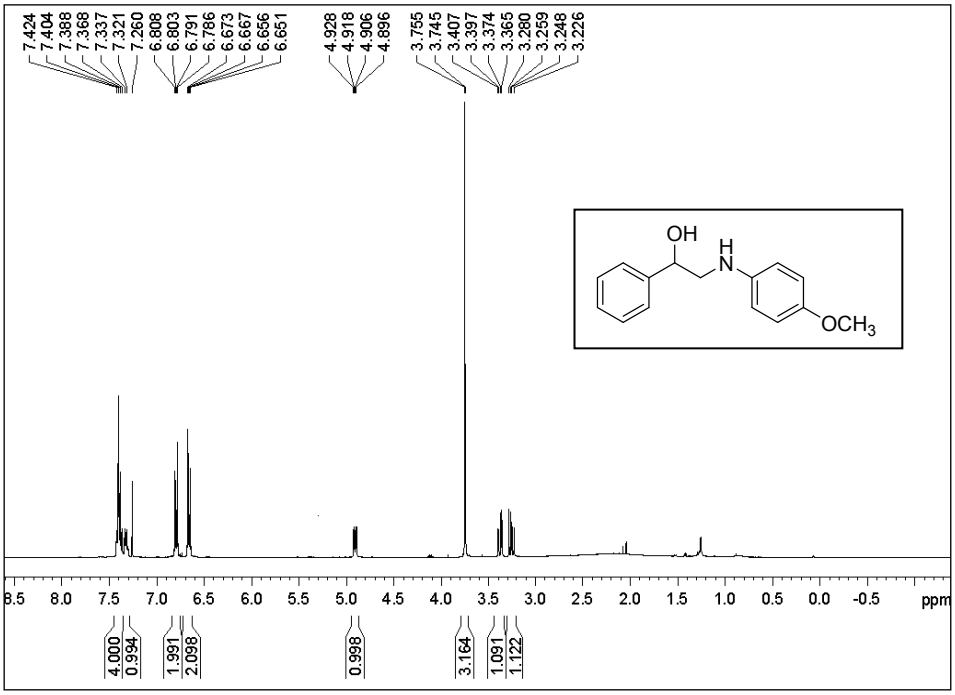
100 MHz ^{13}C-NMR spectra of **3c** in $CDCl_3$



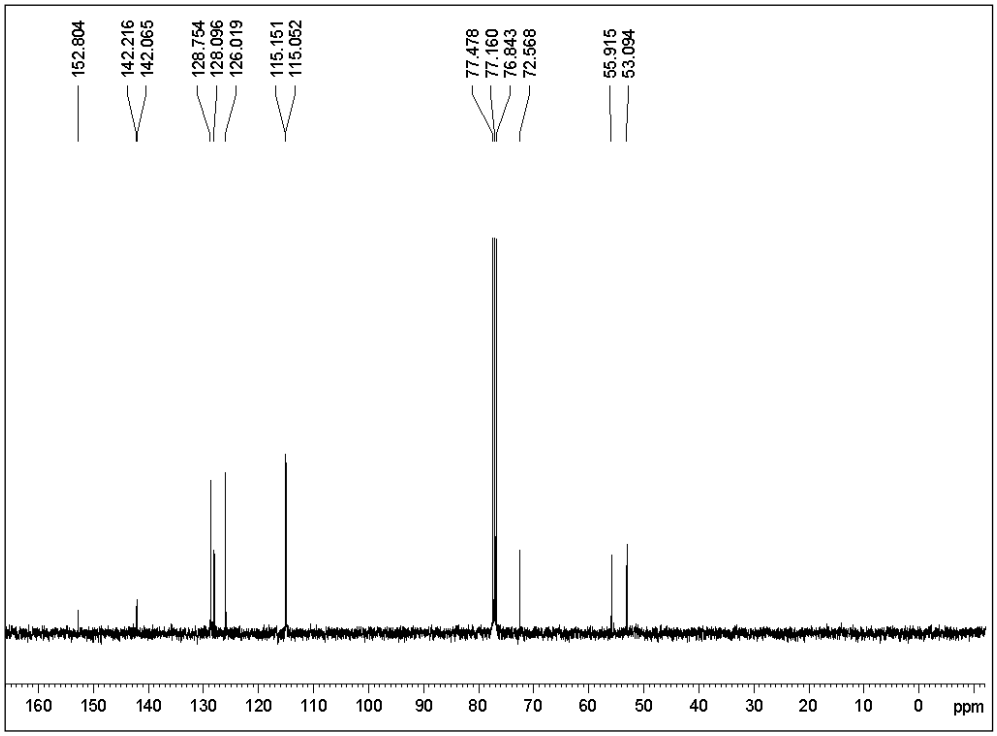
400 MHz ^{1}H-NMR spectra of **3d** in $CDCl_3$



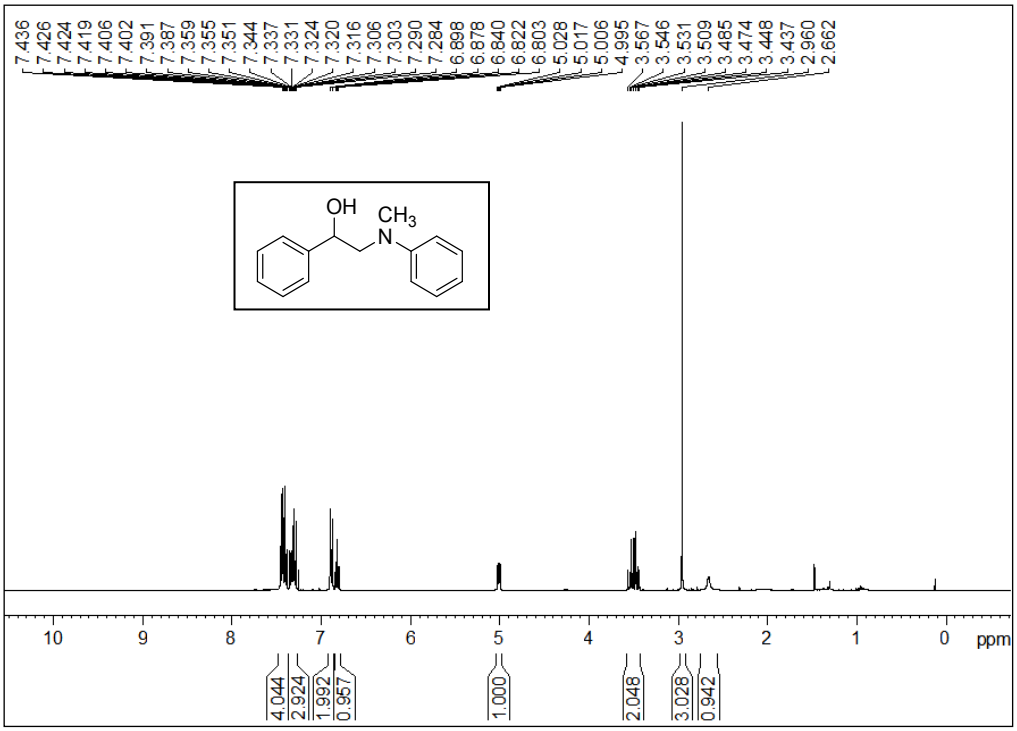
100 MHz ^{13}C-NMR spectra of **3d** in $CDCl_3$



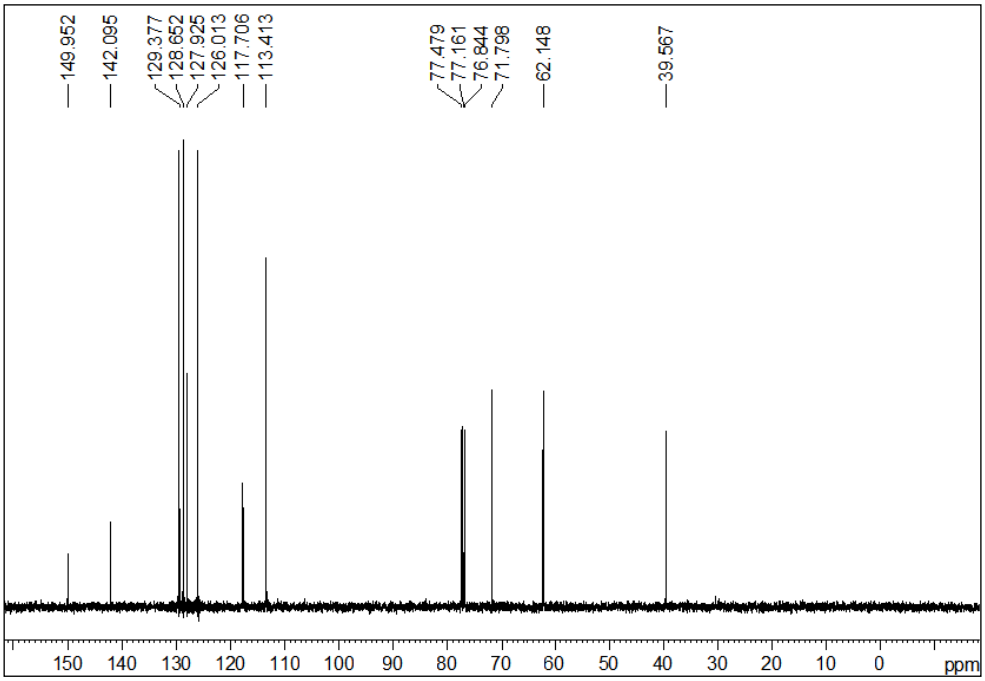
400 MHz ^{1}H-NMR spectra of **3e** in $CDCl_3$



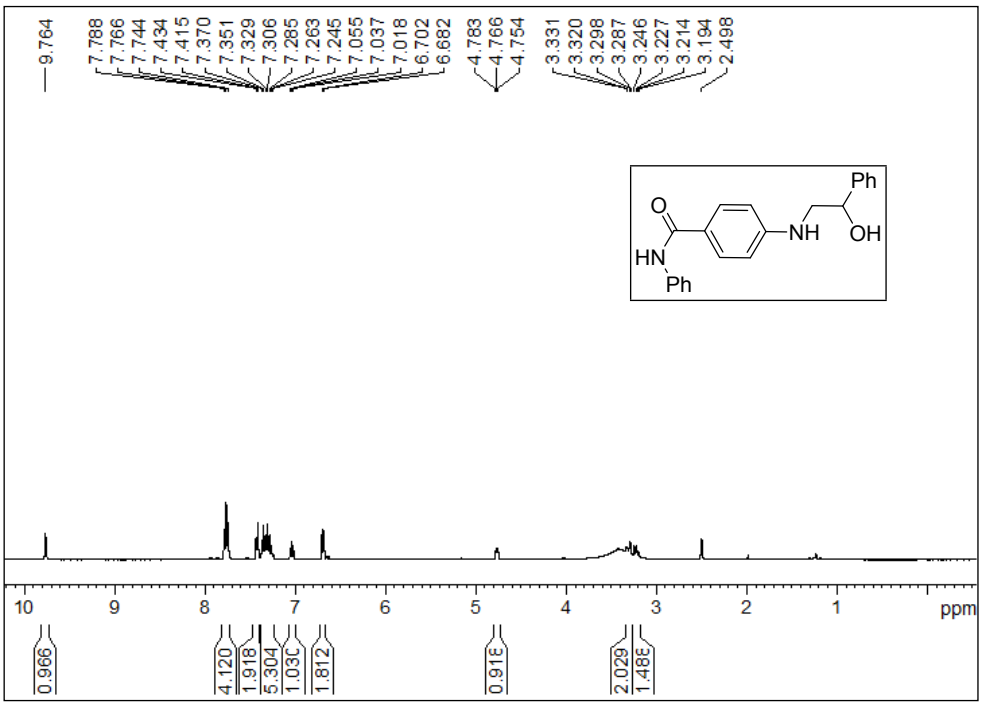
100 MHz ^{13}C-NMR spectra of **3e** in $CDCl_3$



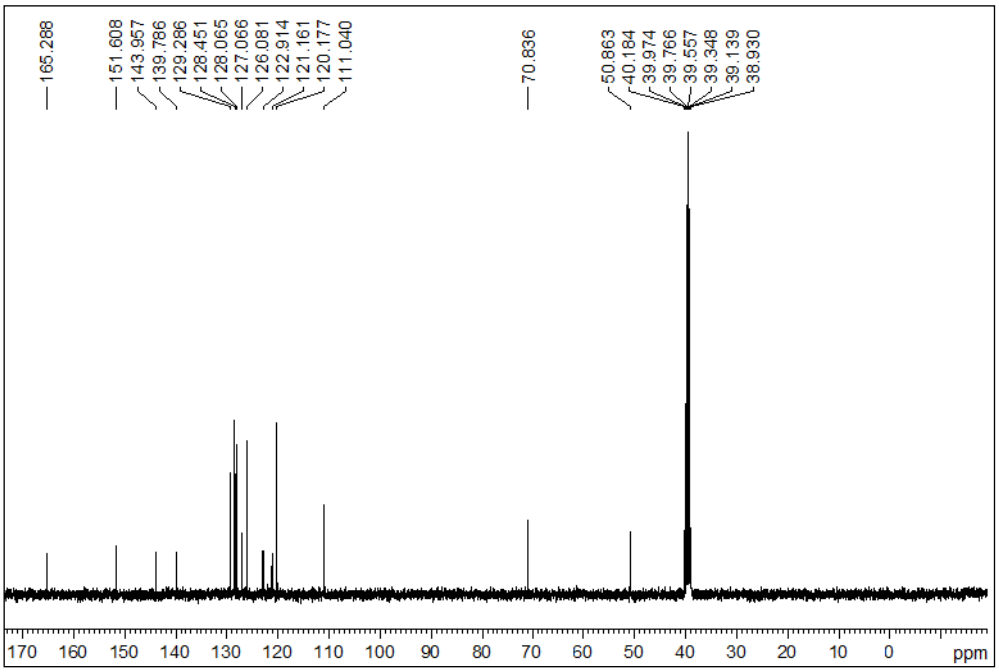
400 MHz ^{1}H-NMR spectra of **3l** in $CDCl_3$



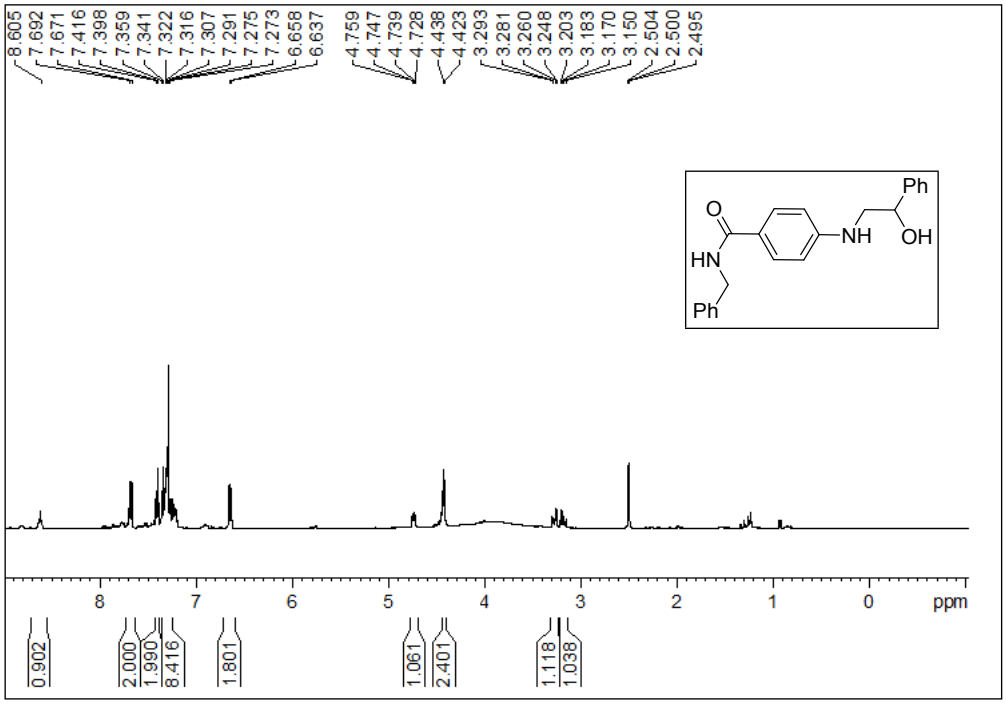
100 MHz ^{13}C-NMR spectra of **3l** in $CDCl_3$



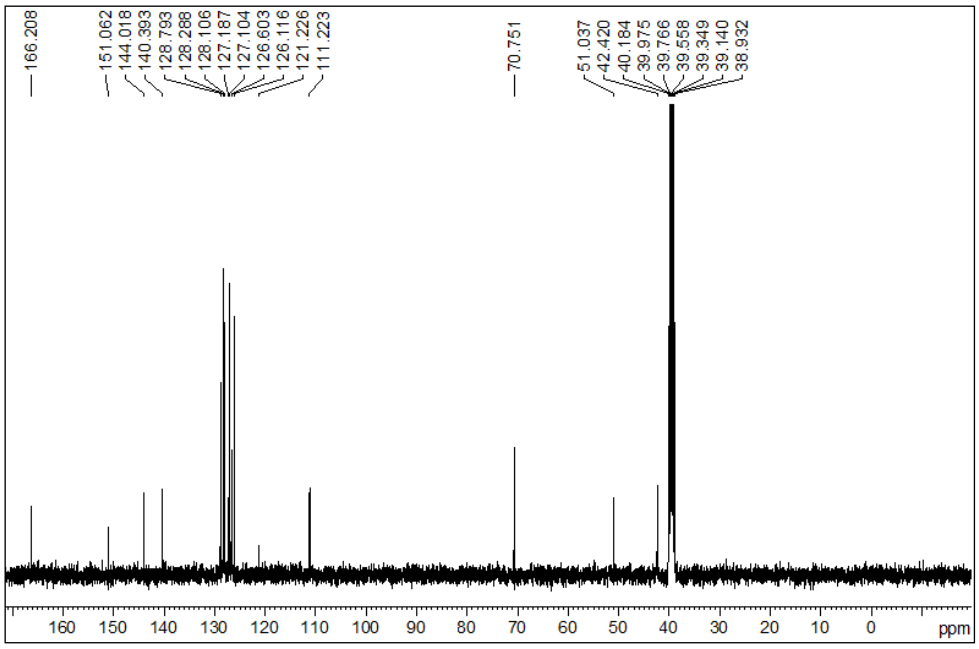
400 MHz ^{1}H-NMR spectra of **7a** in DMSO-d_6



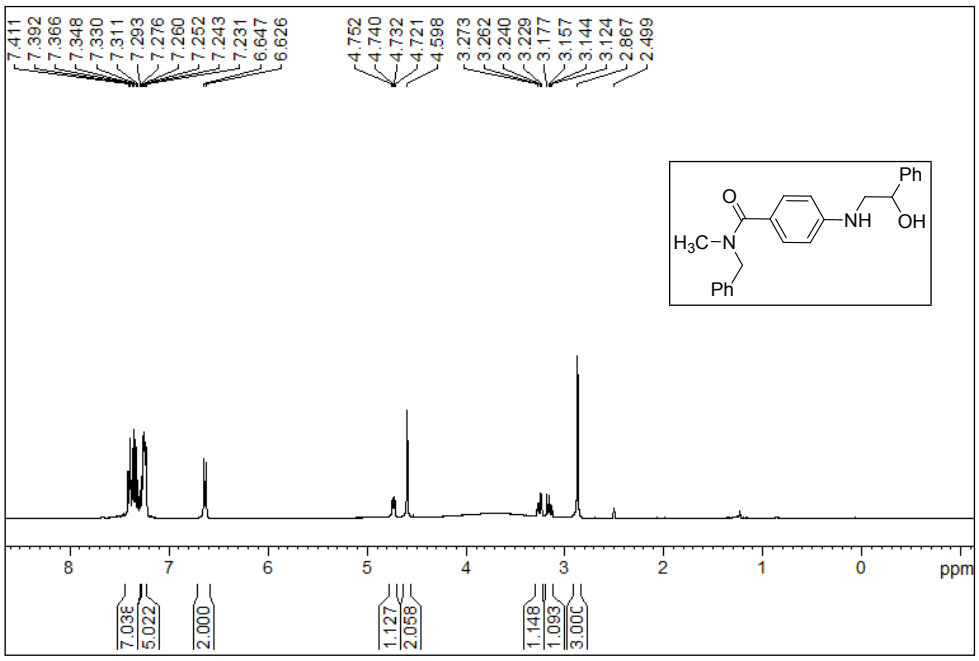
100 MHz ^{1}H-NMR spectra of **7a** in DMSO-d_6



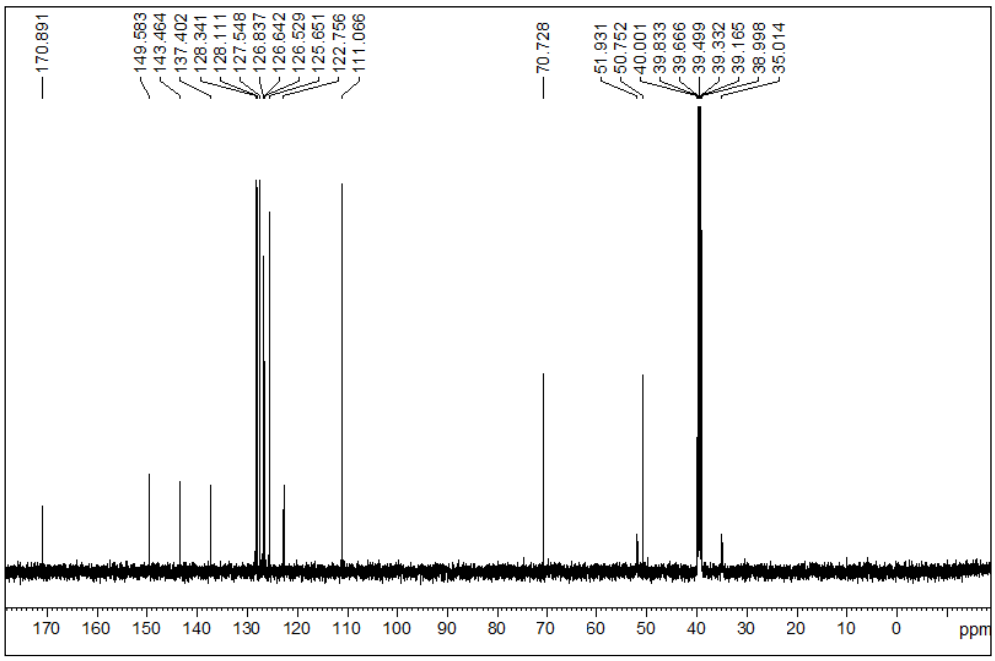
400 MHz ^{1}H-NMR spectra of **7b** in DMSO-d_6



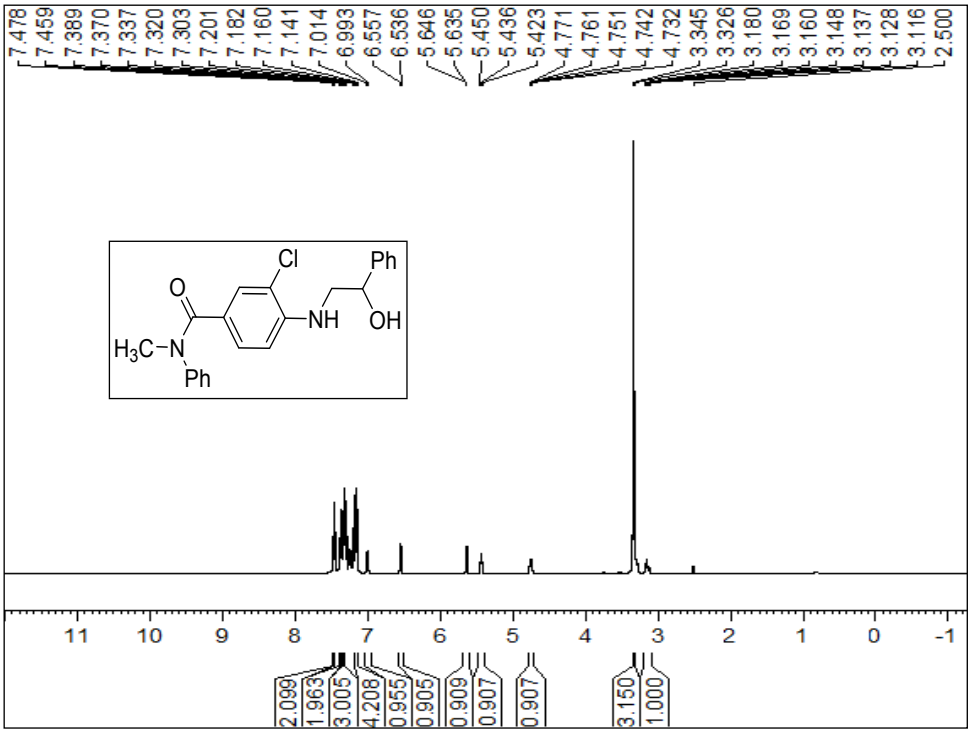
100 MHz ^{13}C-NMR spectra of **7b** in DMSO-d_6



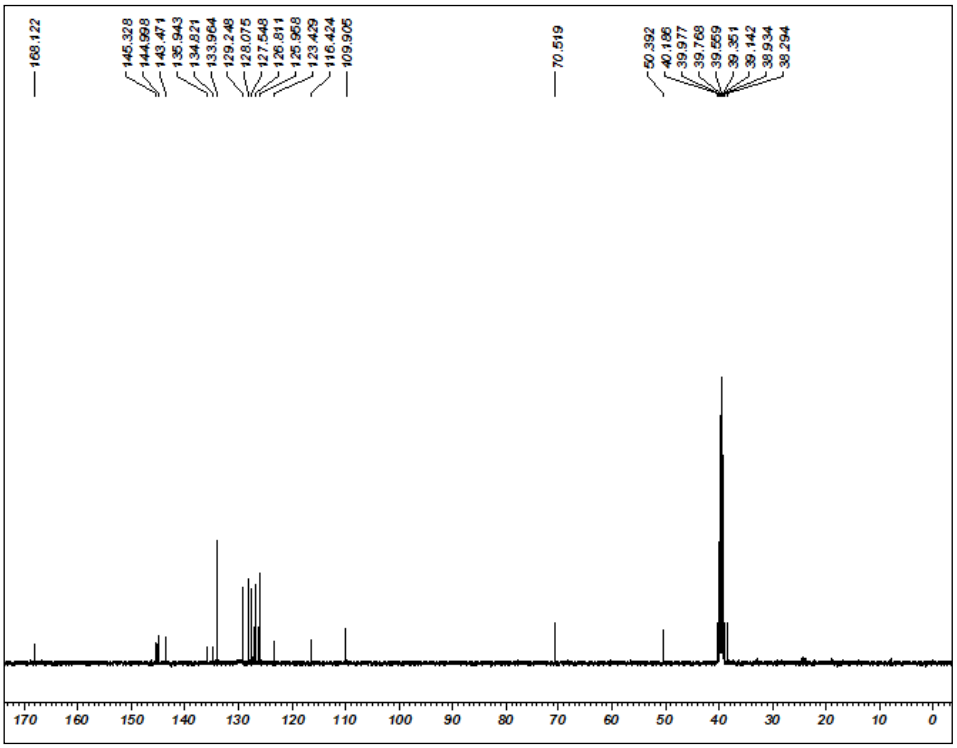
400 MHz ^{1}H-NMR spectra of **7c** in DMSO-d_6



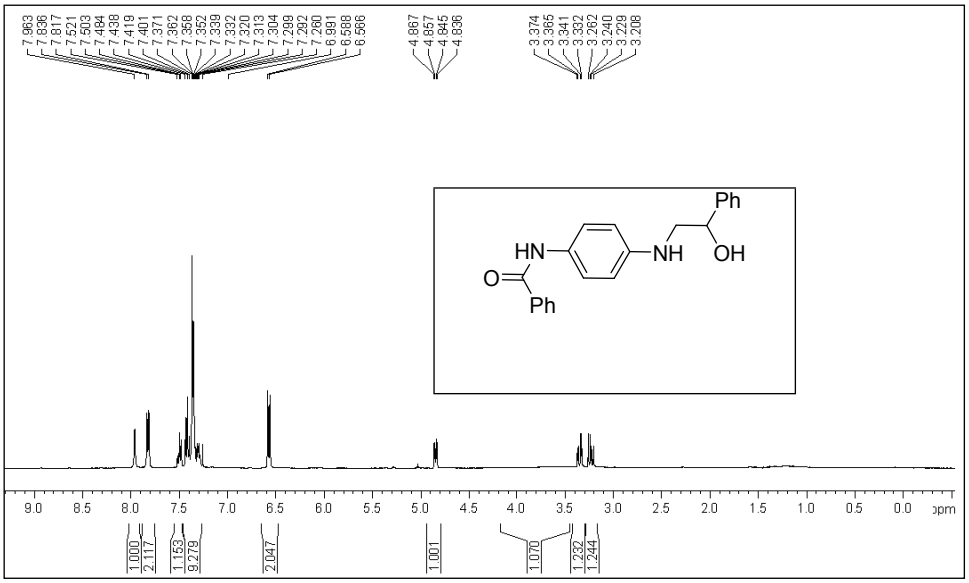
100 MHz ^{13}C-NMR spectra of **7c** in DMSO-d_6



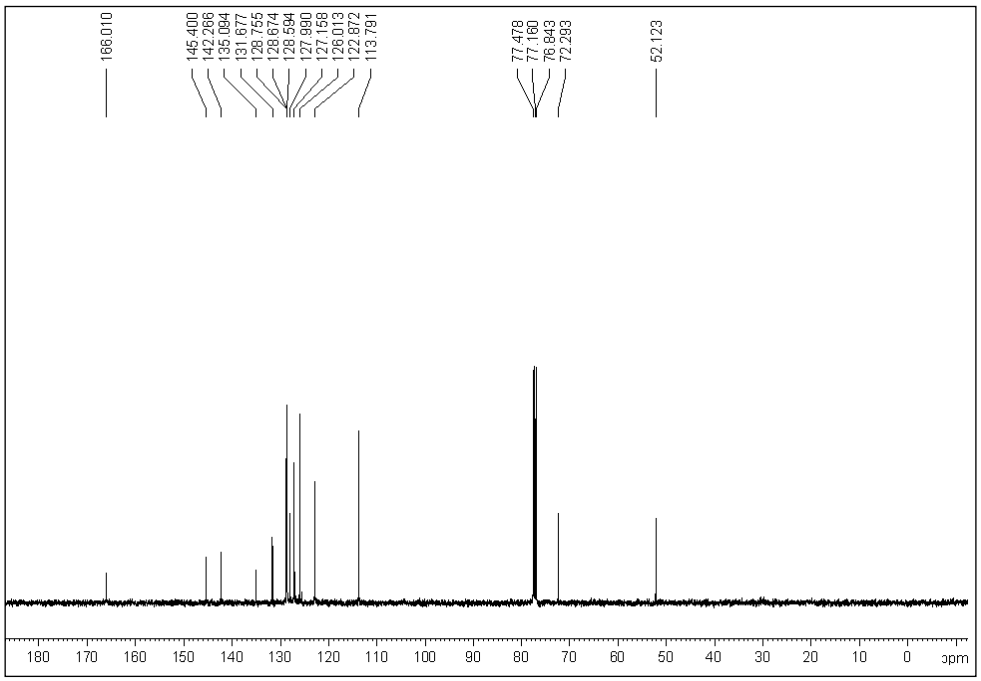
400 MHz ^{1}H-NMR spectra of **7d** in DMSO-d_6



100 MHz ^{13}C-NMR spectra of **7d** in DMSO-d_6



400 MHz ^{1}H-NMR spectra of **7e** in $CDCl_3$



100 MHz ^{13}C-NMR spectra of **7e** in $CDCl_3$