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

Ru–g-C_3N_4 as highly active heterogeneous catalyst for transfer hydrogenation of α–keto amide into β–aminol or α–hydroxyl amide

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General material and methods for the synthesis of catalyst:

For the preparation of g-C_3N_4, Ni-g-C_3N_4, Pd-g-C_3N_4, Ru-g-C_3N_4 various chemicals used as: Urea, $RuCl_3$, $NiCl_2$, $PdCl_2$ were procured from Oxford Product Pvt. Ltd., Spectrochem, Sigma Aldrich, Distilled water purchased from High Purity Laboratory Chemicals, Conc. HCl from Advent. For the preparation of α-keto amide SeO_2 and $NaBH_4$ were purchased from Oxford Product Pvt. Ltd. and s.d. fine chemical limited, and acetophenone derivatives were purchased from Alfa Aesar & Sigma Aldrich. Thin Layer Chromatography Silica Gel 60 F254 was purchased from Merck Specialities Pvt. Ltd., Silica gel for column chromatography (100-200 mesh) was purchased from SRL, India. NMR spectra were recorded with 500 MHz for ^{1}H NMR and 126 MHz for ^{13}C NMR spectrometer. The chemical shifts are reported in parts per million related to tetramethyl silane as an internal standard and the coupling constant *J* in hertz. 1H NMR spectra are reported relative to residual $CDCl_3$ (d= 7.26 ppm), DMSO-d_6 (d=2.50 ppm). 13C NMR are reported relative to $CDCl_3$ (d=77.02 ppm), DMSO-d_6 (d=39.52 ppm). The reaction was monitored by GC and TLC. The products were analysed by GC-MS and NMR-Spectroscopy.

Preparation of catalyst:

Preparation of g-C_3N_4 catalyst [1]: C_3N_4 was synthesized by using pyrolytic method disclosed by Wei Chen. Typically, 20 gm of urea was first heated at 80^{o}C for 8 h to remove the presence of moisture in the urea. It is then kept in covered crucible and then heated under static air at heating rate of 3^{o}C/min until it reaches the temperature at 520^{o}C and then kept at this temperature for 4 hr so that complete polymerization of urea takes place. After 4 hr pale yellow colour powder was obtained.

Preparation of Ru-g-C_3N_4 catalyst: For the preparation of Ru-g-C_3N_4 catalyst Ultrasonic deposition method was used to increase the effectiveness of loading of Ru on g-C_3N_4 support [2]. Typically, 500 mg of yellow colour powder (g-C_3N_4) obtained in previous step was dispersed in 60ml of H_2O and ultrasonicated for 2h. Further 12 mg of $RuCl_3$ was added into mixture and again kept for ultrasonication for another 30 min. To the resultant mixture, 10 ml $NaBH_4$ solution was added with continuous stirring. The grey-blue product was filtered, washed with water and ethanol. Process of washing is repeated twice to thrice, further it is dried at 60 ^{o}C and used for the application. Similarly, Ni-g-C_3N_4 and Pd-g-C_3N_4 also has been prepared just like above mentioned method.

Characterization of g-C_3N_4:

1. SEM IMAGES and Electron Microscopy/Energy Dispersive X-ray Spectroscopy

Morphology of Ru-g- C_3N_4 was investigated using field emission gun-scanning electron microscopy (FEG-SEM, Tescan MIRA 3 model) at 10 eV. The compositions of Ru-C_3N_4 were characterized by energy dispersive X-ray spectroscopy (EDS) scans in oxford X-act model.

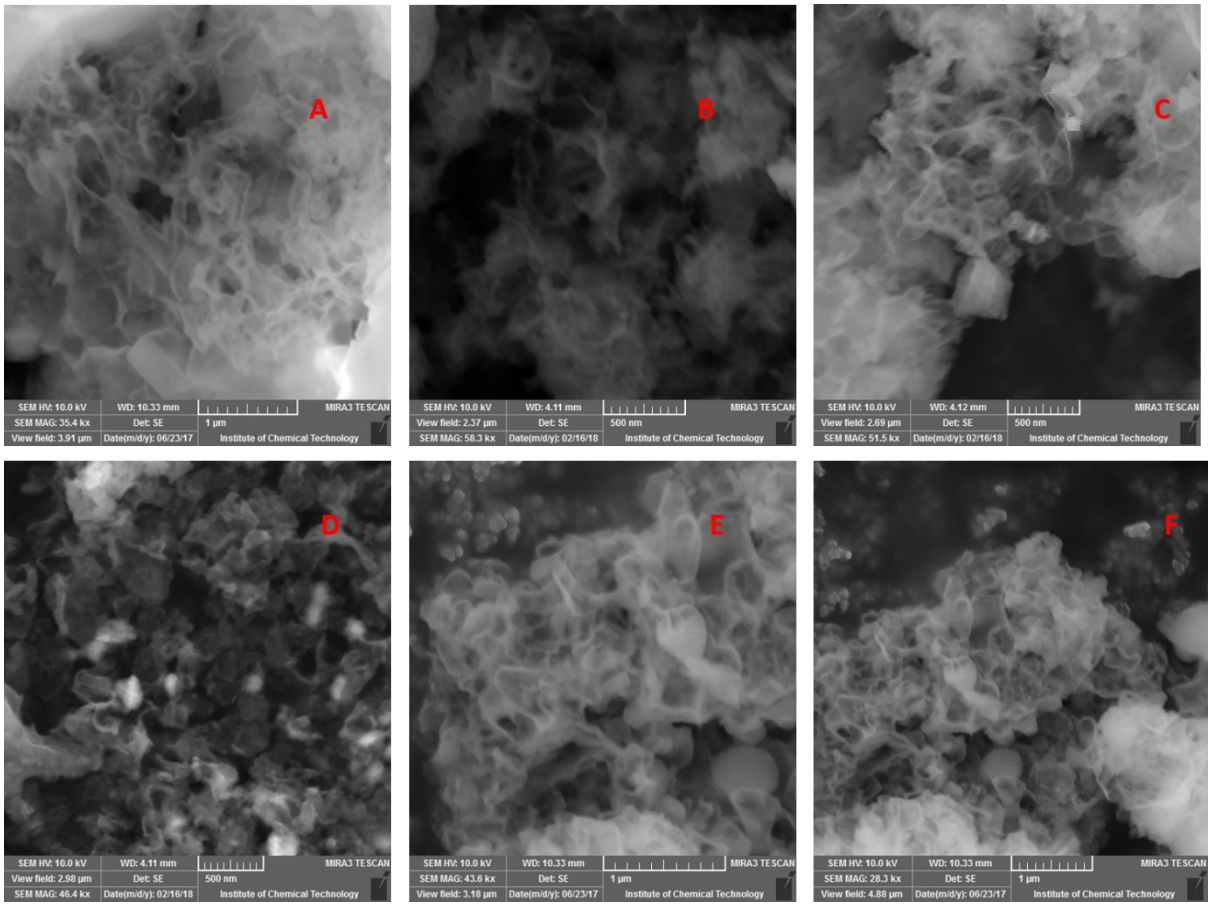


Figure S1: SEM images: A), B), C) g-C_3N_4; D), E), F) Ru-g-C_3N_4

2. X-Ray Photoelectron Spectroscopy (XPS) SPECTRA OF Ru-g-C_3N_4 material: [3]

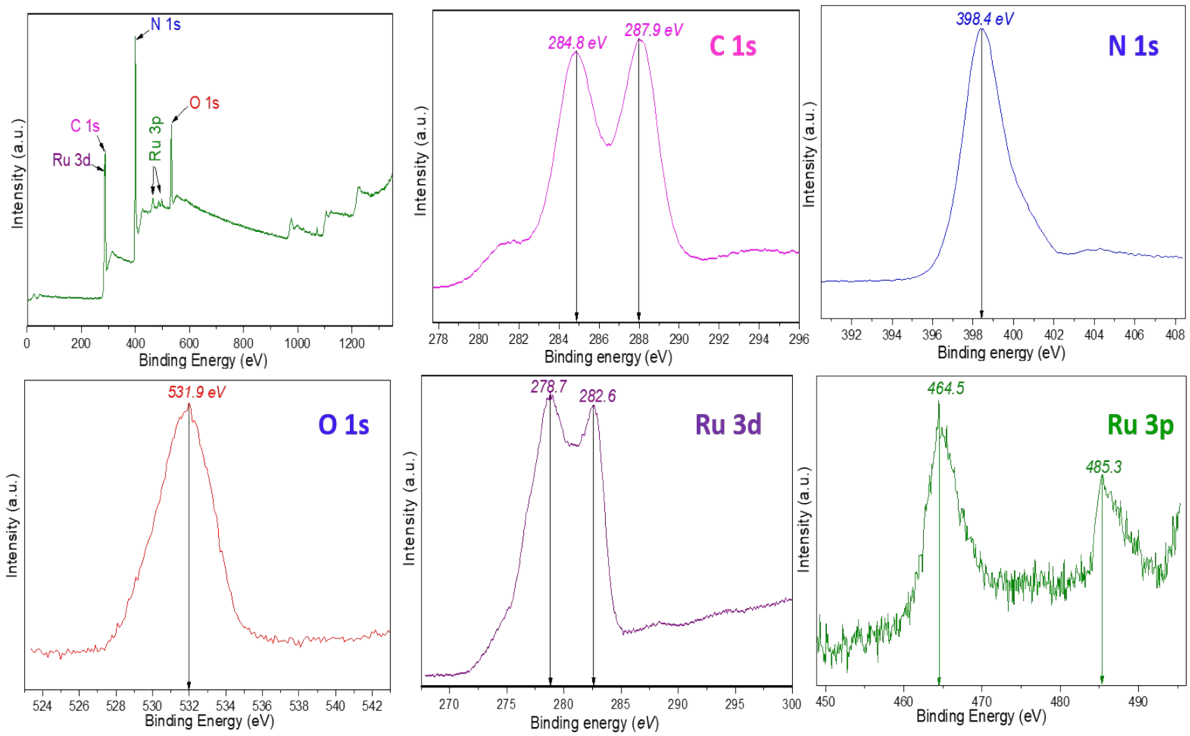


Figure S2: XPS spectra: a) full scan of Ru-g-C_3N_4 ; b) C 1s region of Ru-g-C_3N_4; c) N 1s region of Ru-g-C_3N_4; d) O 1s region of Ru-g-C_3N_4; 5) Ru 3d region of Ru-g-C_3N_4; 6) Ru 3p region of Ru-g-C_3N_4

3. EDX Spectra of catalyst Ru-g-C_3N_4

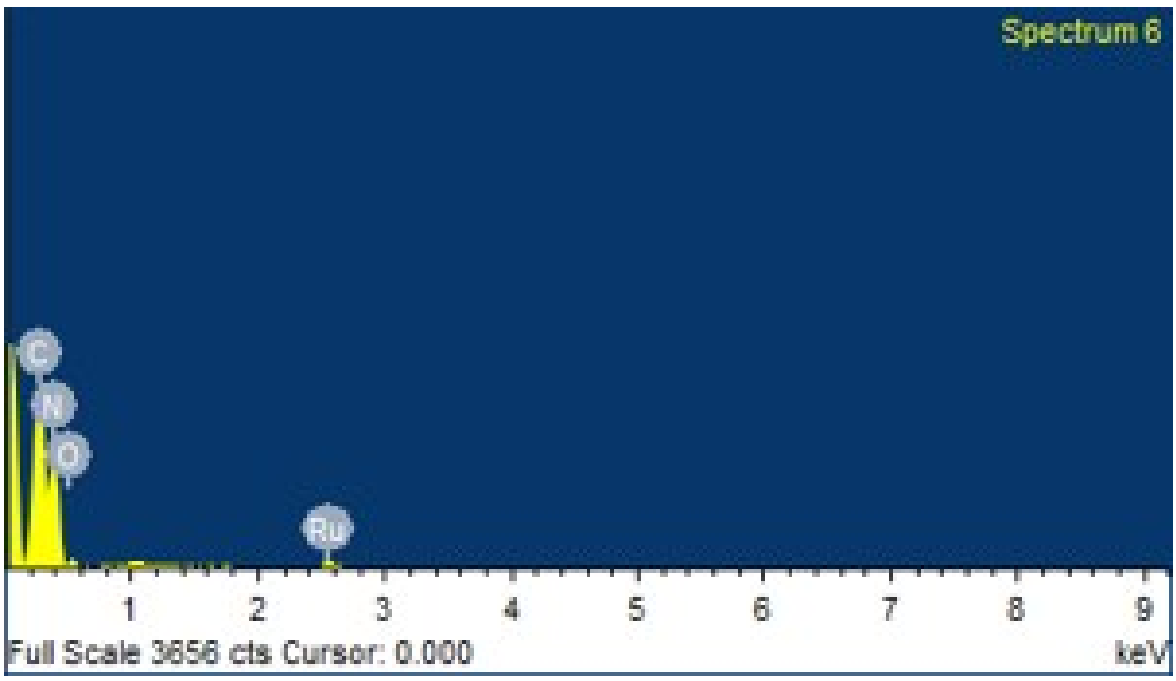


Figure S3: EDX spectra of catalyst Ru-g-C_3N_4

4. **Powder X-Ray Diffraction pattern of g-C_3N_4 [3], Ni-g-C_3N_4 [4], Pd-g-C_3N_4 [4], Ru-g-C_3N_4 [3] material:**

XRD patterns were collected using Shimadzu XRD-6100 (Cu $K_{\alpha1}$ radiations, λ_{avg} = 1.5405 A˚) with scanning rate 2° per min and 2 theta (2θ) angle ranging from 10° to 80°. Powder XRD samples were prepared by placing sample onto a glass sample holder. Crystallite sizes were calculated using the Scherrer equation $D_{hkl} = K\lambda/ \beta\cos\theta$; where K is the shape factor (0.9) of the average crystallite, λ is the X- ray wavelength (1.5405 A˚), β is the full width at half-maximum (radians), and θ is the Bragg angle (radians).

Typical X-Ray Diffraction (XRD) patterns of g-C_3N_4, Ni-g-C_3N_4, Pd-g-C_3N_4, Ru-g-C_3N_4 can be shown in Figure S4. From the XRD spectra two peaks observed in all the materials one at nearly 27.18° and other at 13.38°. For g-C_3N_4 peak observed at 13.67 ° and at 27.08 ° and for Ni- g-C_3N_4 peaks observed at 11.89° and 27.14° similarly Pd-g-C_3N_4 shows peak at 13.30° and 27.04° and Ru-g-C_3N_4 at 13.39° and 27.18°. The intense peak observed at 27.18° is corresponds to characteristic interlayer stacking structure of conjugated aromatic systems with interlayer distance of 0.326 nm. The other weak peak at 13.38° is due to an in-plane structural packing, such as the hole-to-hole distance of the nitride pores. The average size of the Ru-g-C_3N_4 crystallites was calculated to be 4.29 nm with lattice strain 0.036 having peak width 1.989 degree at 2θ value 27.18 °.

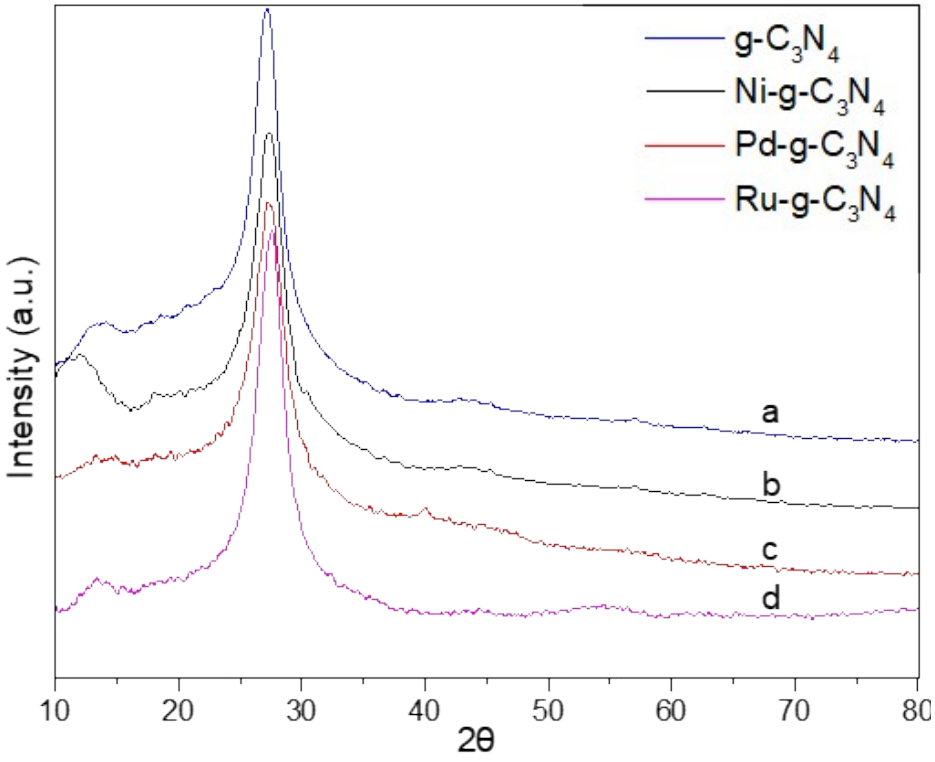


Figure S4: XRD Pattern: a) g-C_3N_4; b) Ni-g-C_3N_4; c) Pd-g-C_3N_4; d) Ru-g-C_3N_4

5. XRD-PATTERN; SEM IMAGES AND EDX SPECTRA OF RECYCLED Ru-g-C_3N_4 material:

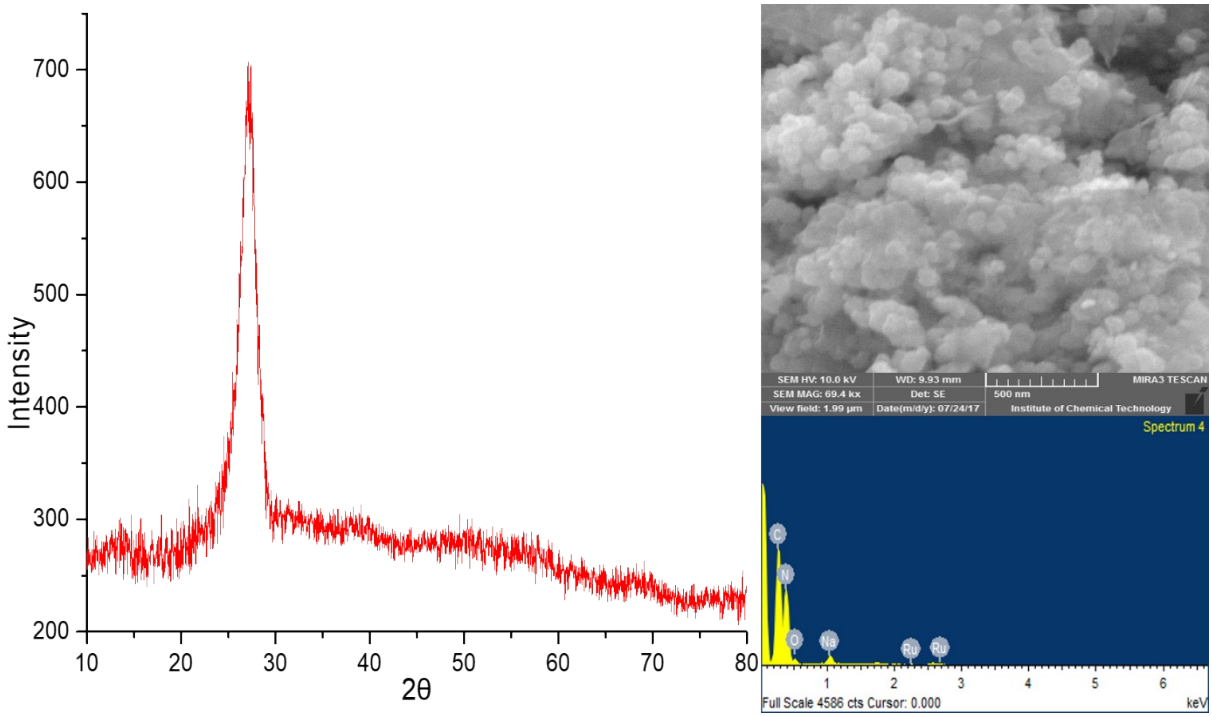


Figure S5: XRD pattern of 4th recycled Ru-g-C_3N_4, SEM-Images and EDX spectra of 4th recycled Ru-g-C_3N_4

6. Recycle study of Ru-g-C_3N_4 catalyst

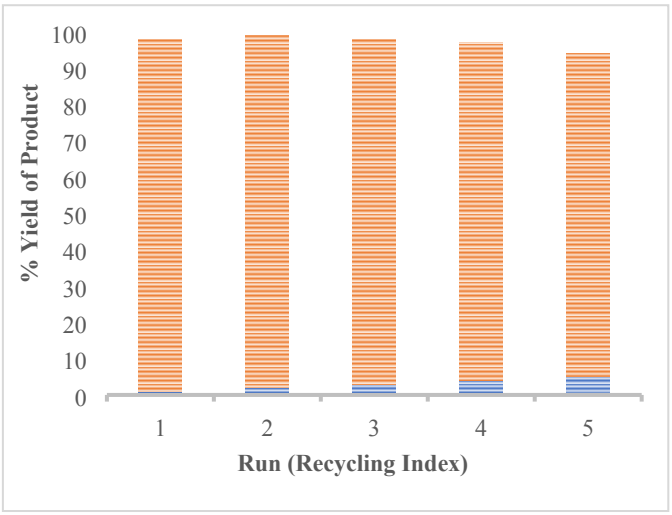


Figure S6: Recycling study of Ru-g-C_3N_4 catalyst under the optimised condition for complete transfer hydrogenation of α-ketoamide into β-aminol

7) COMPARATIVE DATA [3]:

a) AT-IR SPECTRA OF SYNTHESIZED g-C_3N_4; Ru-g-C_3N_4; Pd-g-C_3N_4; Ni-g-C_3N_4

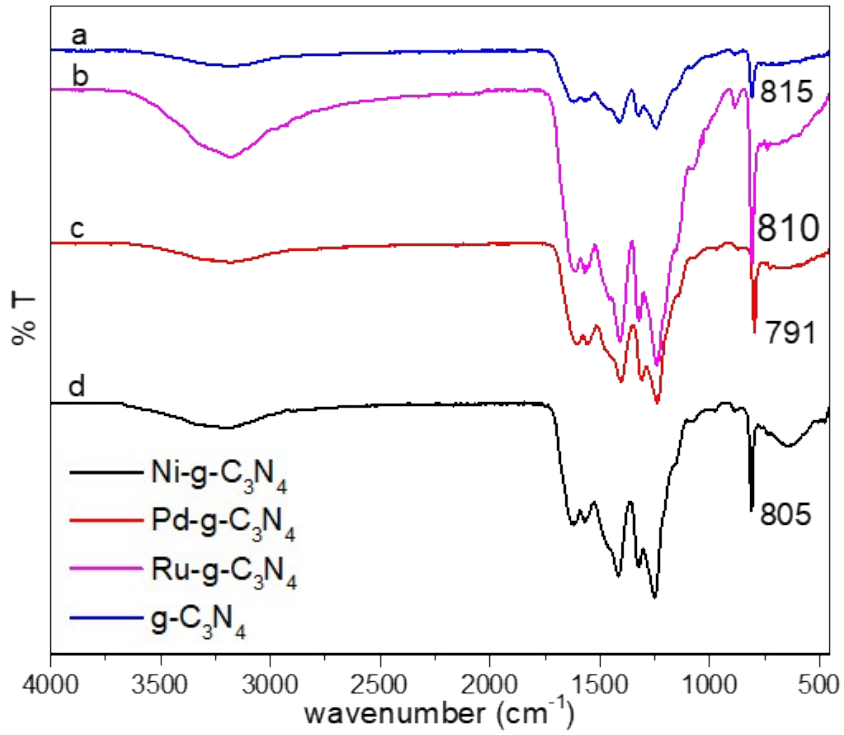


Figure S7: AT-IR spectra: From top a) g-C_3N_4, b) Ru-g-C_3N_4, c) Pd-g-C_3N_4, d) Ni-g-C_3N_4

b) TGA GRAPH OF SYNTHESIZED Ru-g-C_3N_4; Pd-g-C_3N_4; Ni-g-C_3N_4

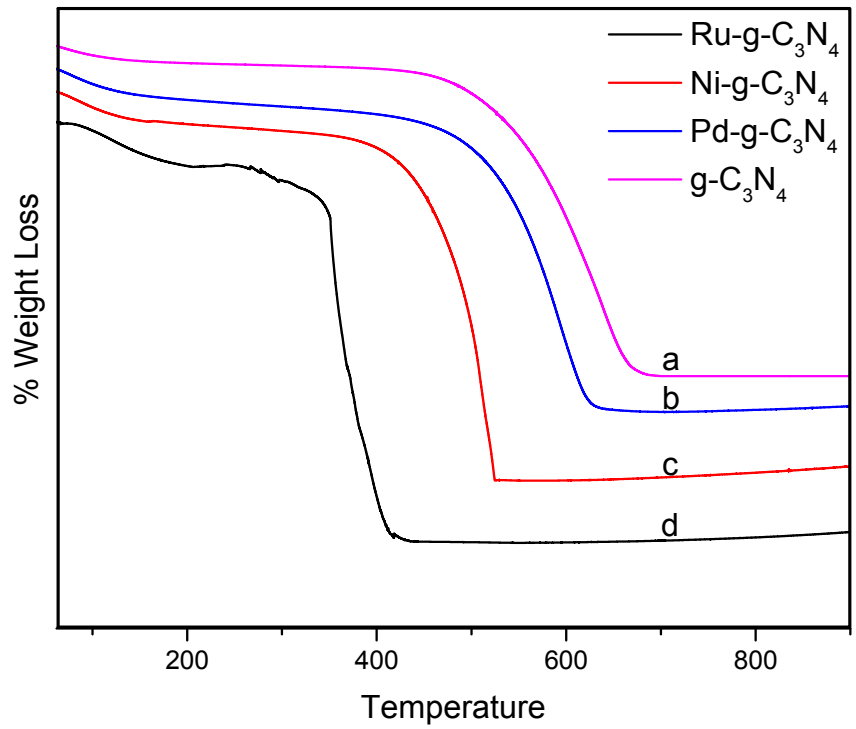


Figure S8: TGA graph: From top a) g-C_3N_4, b) Pd-g-C_3N_4, c) Ni-g-C_3N_4, d) Ru-g-C_3N_4

8. Control Experiment drawn based on optimization pattern:

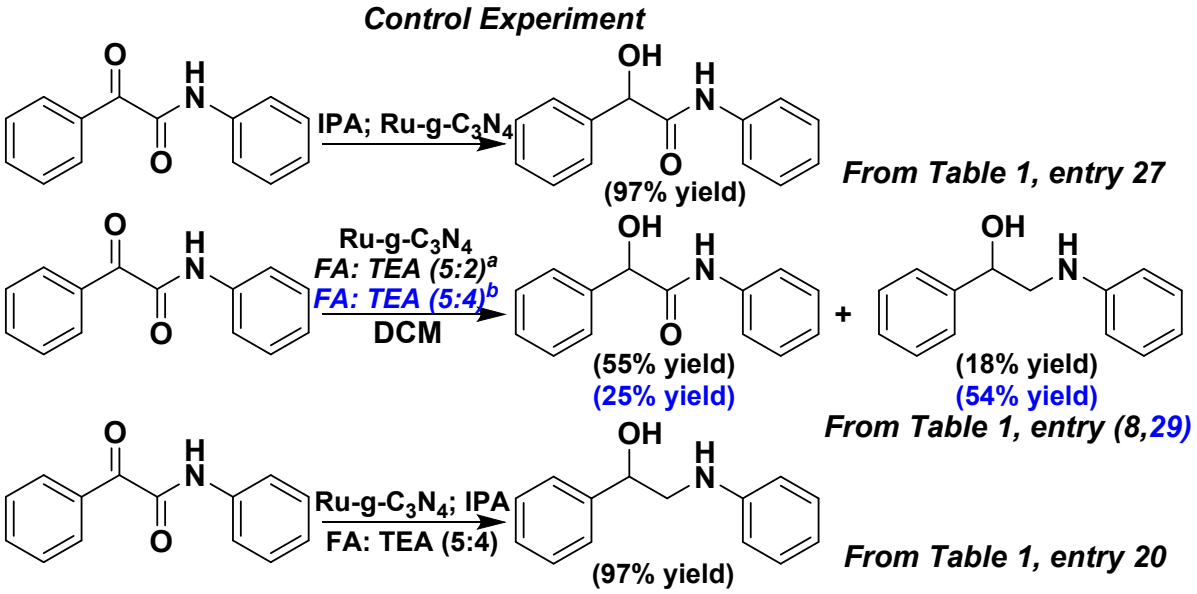


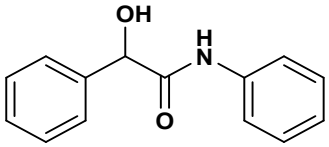
Figure S9: Control experiment for partial and complete transfer hydrogenation of α-ketoamide.

Preparation of α-keto amide: [5]

100 ml round bottom flask employed with 5 mmol of ketone and its derivatives which is dissolved in 20 ml of acetonitrile in which 10 mmol (1.1 g) anhydrous SeO_2 is added and stirred thoroughly. Slowly into which 5 mmol of primary amine and 10 mmol of pyridine is added at 80 °C for 10-15 h. Synthesis of product determined by the help of Thin Layer Chromatography (TLC) after which solution is extracted with DCM, water. For removal of extra base, conc. HCl is added in portion (3 x 5 ml) after which organic layer is washed with brine solution and dried over anhydrous Na_2SO_4, filtered and solvent removed under vacuum on rotary evaporator. Resulting mixture then purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure α-keto amide.

Analytical data of α-hydroxyl amide:

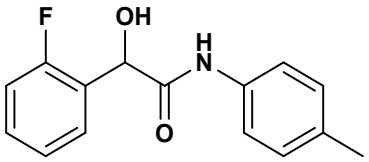
2-hydroxy-*N*,2-diphenylacetamide [2a]



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is heated at 50 °C for 3 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with ethyl acetate and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Final mixture then purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-hydroxy-*N*,2-diphenylacetamide.

White solid; Yield = 222 mg (97%); mp = 150–152 °C; R_f = 0.50 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6): δ 9.93 (s, 1H), 7.67 (d, *J* = 8.1 Hz, 2H), 7.50 (d, *J* = 7.5 Hz, 2H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.26 (t, *J* = 7.8 Hz, 3H), 7.02 (t, *J* = 7.3 Hz, 1H), 6.51 (s, 1H), 5.09 (s, 1H); **^{13}C NMR** (126 MHz, DMSO-d_6): δ 171.64, 141.31, 138.97, 129.04, 128.51, 128.02, 127.01, 123.96, 120.11, 74.41.

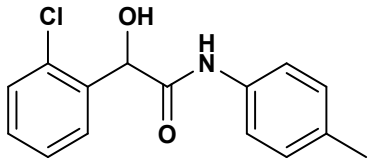
2-(2-fluorophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2b]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2-fluorophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 254 mg (98%); mp = 127–128 °C; R_f = 0.49 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6): δ 9.86 (s, 1H), 7.56 (d, *J* = 8.3 Hz, 2H), 7.50 (t, *J* = 6.9 Hz, 1H), 7.33 (dd, *J* = 14.1, 6.9 Hz, 1H), 7.17 (dt, *J* = 14.1, 8.3 Hz, 2H), 7.08 (d, *J* = 8.2 Hz, 2H), 6.59 (s, 1H), 5.31 (s, 1H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6): δ 170.43, 161.30, 159.35, 136.33, 133.01, 130.18, 130.12, 129.56, 129.53, 129.42, 128.77, 128.65, 124.74, 124.72, 120.21, 115.76, 115.59, 70.20, 68.58, 20.88.

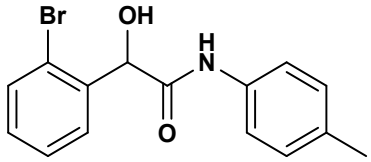
2-(2-chlorophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2c]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2-chlorophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 260 mg (95%); mp = 136–138 °C; R_f = 0.51 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6): δ 9.96 (s, 1H), 7.55 (dd, *J* = 14.1, 8.6 Hz, 3H), 7.41 (dd, *J* = 7.5, 1.0 Hz, 1H), 7.37 – 7.26 (m, 2H), 7.08 (d, *J* = 8.1 Hz, 2H), 6.69 (s, 1H), 5.44 (s, 1H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6): δ 170.22, 139.20, 136.43, 133.00, 132.97, 129.77, 129.59, 129.54, 129.41, 127.59, 120.19, 71.50, 20.89.

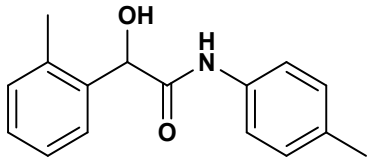
2-(2-bromophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2d]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2-bromophenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 301 mg (94%); mp = 149–150 °C; R_f = 0.52 (toluene: ethyl acetate, 80:20 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 10.01 (s, 1H), 7.57 (t, *J* = 8.1 Hz, 2H), 7.56 (s, 1H) 7.52 (d, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.4 Hz, 1H), 7.22 (t, *J* = 7.6 Hz, 1H), 7.08 (d, *J* = 8.1 Hz, 2H), 6.82 (s, 1H), 5.40 (s, 1H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 170.22, 140.86, 136.48, 132.93, 132.80, 130.04, 129.61, 129.40, 128.13, 123.55, 120.17, 73.63, 20.89.

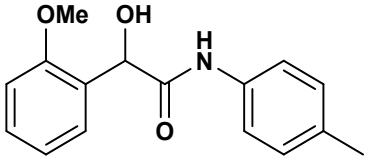
2-hydroxy-2-(o-tolyl)-*N*-(*p*-tolyl)acetamide [2e]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-hydroxy-2-(*o*-tolyl)-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 227 mg (89%); mp = 150–151 °C; R_f = 0.55 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.79 (s, 1H), 7.56 (d, *J* = 8.3 Hz, 2H), 7.42 – 7.35 (m, 1H), 7.14 (d, *J* = 3.2 Hz, 3H), 7.06 (d, *J* = 8.3 Hz, 2H), 6.44 (s, 1H), 5.25 (s, 1H), 2.38 (s, 3H), 2.21 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.50, 139.98, 136.52, 136.42, 132.85, 130.53, 129.38, 127.86, 127.51, 126.07, 120.18, 71.77, 20.86, 19.62.

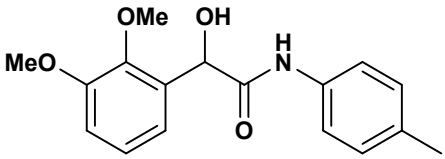
2-hydroxy-2-(2-methoxyphenyl)-*N*-(*p*-tolyl)acetamide [2f]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-hydroxy-2-(2-methoxyphenyl)-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 248 mg (90%); mp = 100–102 °C; R_f = 0.50 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.68 (s, 1H), 7.54 (d, *J* = 8.3 Hz, 2H), 7.34 (d, *J* = 7.6 Hz, 1H), 7.25 (t, *J* = 7.8 Hz, 1H), 7.06 (d, *J* = 8.2 Hz, 2H), 6.97 (d, *J* = 8.2 Hz, 1H), 6.90 (t, *J* = 7.4 Hz, 1H), 6.12 (s, 1H), 5.33 (s, 1H), 3.75 (s, 3H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.32, 157.17, 136.58, 132.72, 129.80, 129.39, 129.35, 128.53, 120.67, 120.05, 111.60, 69.01, 56.02, 20.86.

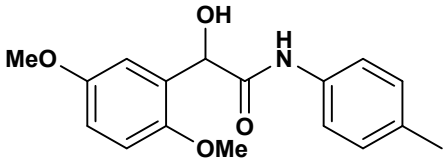
2-(2,3-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2g]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2,3-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 280 mg (93%); mp = 104–105 °C; R_f = 0.56 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.72 (s, 1H), 7.55 (d, *J* = 8.3 Hz, 2H), 7.07 (d, *J* = 8.3 Hz, 2H), 6.98 (d, *J* = 3.0 Hz, 1H), 6.89 (d, *J* = 8.9 Hz, 1H), 6.80 (dd, *J* = 8.9, 3.0 Hz, 1H), 6.20 (s, 1H), 5.33 (s, 1H), 3.70 (s, 3H), 3.66 (s, 3H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.13, 153.61, 151.26, 136.59, 132.75, 130.97, 129.40, 120.07, 114.55, 113.56, 112.90, 69.06, 56.70, 55.81, 20.85.

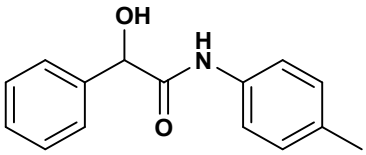
2-(2,5-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2h]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2,5-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 274 mg (91%); mp = 91–92 °C; R_f = 0.56 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.73 (s, 1H), 7.56 (d, *J* = 8.3 Hz, 2H), 7.08 (d, *J* = 8.2 Hz, 2H), 6.99 (d, *J* = 2.9 Hz, 1H), 6.90 (d, *J* = 8.9 Hz, 1H), 6.81 (dd, *J* = 8.9, 3.0 Hz, 1H), 6.21 (s, 1H), 5.34 (s, 1H), 3.71 (s, 3H), 3.67 (s, 3H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.15, 153.58, 151.24, 136.61, 132.75, 130.94, 129.41, 120.06, 114.53, 113.52, 112.84, 69.04, 56.67, 55.80, 20.87.

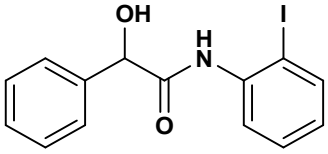
2-hydroxy-2-phenyl-*N*-(*p*-tolyl)acetamide [2i]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-hydroxy-2-phenyl-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 224 mg (93%); mp = 168-169 °C; R_f = 0.47 (toluene: ethyl acetate, 80:20 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.77 (s, 1H), 7.51 (d, *J* = 8.3 Hz, 2H), 7.47 (d, *J* = 7.5 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.23 (t, *J* = 7.3 Hz, 1H), 7.04 (d, *J* = 8.3 Hz, 2H), 6.40 (s, 1H), 5.06 (s, 1H), 2.17 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.37, 141.36, 136.45, 132.87, 129.42, 128.50, 128.04, 126.99, 120.09, 74.38, 20.89.

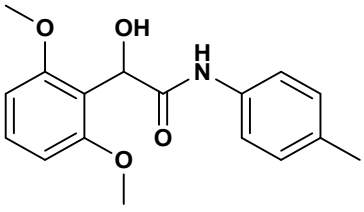
2-hydroxy-*N*-(2-iodophenyl)-2-phenylacetamide [2j]



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 35 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is heated at 60 °C for 5 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with ethyl acetate and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 80-20) to obtain pure 2-hydroxy-*N*-(2-iodophenyl)-2-phenylacetamide.

Yellow solid; Yield = 307 mg (87%); mp = 47–48 °C; R_f = 0.45 (toluene: ethyl acetate, 70:30 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.52 (s, 1H), 8.01 (d, *J* = 8.2 Hz, 1H), 7.87 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.51 (d, *J* = 7.7 Hz, 2H), 7.39 – 7.34 (m, 3H), 7.33 – 7.29 (m, 1H), 6.99 (d, *J* = 4.3 Hz, 1H), 6.90 (td, *J* = 7.7, 1.5 Hz, 1H), 5.15 (d, *J* = 4.3 Hz, 1H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 171.30, 140.87, 139.39, 138.58, 129.42, 128.64, 128.26, 127.19, 126.75, 122.16, 92.07, 74.13.

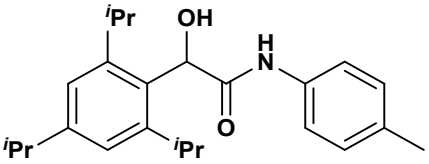
2-(2,6-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide [2k]



Synthesis of this product is parallel to synthesis of 2a and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-(2,6-dimethoxyphenyl)-2-hydroxy-*N*-(*p*-tolyl)acetamide.

White solid; Yield = 288 mg (96%); mp = 104–105 °C; R_f = 0.50 (toluene: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 9.38 (s, 1H), 7.55 (d, *J* = 8.2 Hz, 2H), 7.21 (t, *J* = 8.3 Hz, 1H), 7.07 (d, *J* = 8.1 Hz, 2H), 6.60 (d, *J* = 8.4 Hz, 2H), 6.00 (s, 1H), 5.42 (s, 1H), 3.66 (s, 6H), 2.22 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 172.50, 158.86, 136.68, 132.45, 129.87, 129.39, 120.02, 117.98, 104.95, 64.93, 56.33, 20.87.

2-hydroxy-*N*-(*p*-tolyl)-2-(2,4,6-triisopropylphenyl)acetamide [2l]



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is heated at 70 °C for 4 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with ethyl acetate and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 85-15) to obtain pure 2-hydroxy-*N*-(*p*-tolyl)-2-(2,4,6-triisopropylphenyl) acetamide.

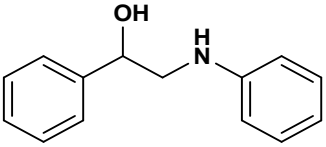
White solid; Yield = 355 mg (98%); Colourless solid; mp = 285–286 °C; R_f = 0.45 (toluene: ethyl acetate, 90:10 v/v)

^{1}H NMR (500 MHz, DMSO-d_6) δ 9.73 (s, 1H), 7.57 (d, *J* = 8.3 Hz, 2H), 7.07 (d, *J* = 8.2 Hz, 2H), 6.95 (s, 2H), 6.53 (s, 1H), 5.55 (s, 1H), 3.29 (dd, *J* = 13.4, 6.8 Hz, 2H), 2.82 (dt, *J* = 13.8, 6.9 Hz, 1H), 2.22 (s, 3H), 1.17 (dd, *J* = 6.6, 3.8 Hz, 12H), 1.08 (s, 6H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 172.54, 147.76, 136.56, 133.96, 132.75, 129.33, 120.45, 68.27, 34.01, 29.36, 25.06, 24.46, 24.40, 24.17, 20.89.

 # All the α-hydroxyl amide synthesised are less soluble in $CDCl_3$ so best solvent for NMR analysis is DMSO-d_6 solvent.

Analytical data of β-aminol:

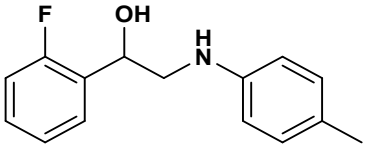
1-phenyl-2-(phenylamino)ethan-1-ol [2aa]



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is stirred for 3 h then 0.2 ml (200 µl) of FA:TEA (5:4) is added into it hence after heated at 80 °C for 5 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with DCM and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Final mixture then purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-phenyl-2-(phenylamino)ethan-1-ol.

Yellow liquid; Yield = 207 mg (97%); R_f = 0.65 (*n*-hexane: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.43 – 7.31 (m, 5H), 7.18 (t, *J* = 7.0 Hz, 2H), 6.74 (t, *J* = 7.3 Hz, 1H), 6.67 (d, *J* = 7.7 Hz, 2H), 4.91 (dd, *J* = 8.6, 3.8 Hz, 1H), 3.42 (dd, *J* = 12.7, 3.8 Hz, 1H), 3.28 (dd, *J* = 12.7, 8.6 Hz, 1H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 147.87, 142.04, 129.34, 128.63, 127.99, 125.89, 118.13, 113.48, 72.46, 51.79.

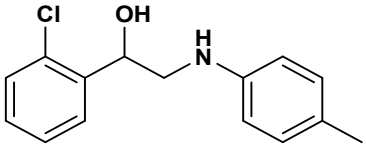
1-(2-fluorophenyl)-2-(*p*-tolylamino)ethan-1-ol [2ab]



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is stirred for 3 h then 0.2 ml (200 µl) of FA:TEA (5:4) is added into it hence after heated at 80 ^oC for 6 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with DCM and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Final mixture then purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(2-fluorophenyl)-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 227 mg (93%); R_f = 0.59 (n-hexane: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.60 – 7.52 (m, 1H), 7.33 – 7.27 (m, 1H), 7.18 (dd, *J* = 10.8, 4.0 Hz, 1H), 7.10 – 7.04 (m, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.65 (d, *J* = 8.3 Hz, 2H), 5.24 (dd, *J* = 8.9, 2.9 Hz, 1H), 3.52 (dd, *J* = 13.3, 2.9 Hz, 1H), 3.22 (dd, *J* = 13.3, 8.9 Hz, 1H), 2.26 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 160.76, 158.81, 145.37, 129.83, 129.19, 129.13, 127.53, 127.31, 127.28, 124.41, 124.39, 115.37, 115.19, 113.65, 66.67, 51.02, 20.37.

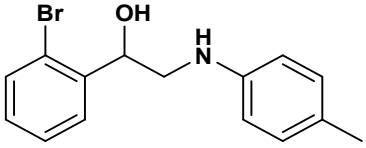
1-(2-chlorophenyl)-2-(*p*-tolylamino)ethan-1-ol [2ac]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(2-chlorophenyl)-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 240 mg (92%); R_f = 0.59 (n-hexane: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.64 (dd, *J* = 7.6, 1.3 Hz, 1H), 7.36 (dd, *J* = 7.9, 1.1 Hz, 1H), 7.33 (td, *J* = 7.5, 0.9 Hz, 1H), 7.28 – 7.22 (m, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.68 (d, *J* = 8.3 Hz, 2H), 5.32 (dd, *J* = 9.0, 2.9 Hz, 1H), 3.58 (dd, *J* = 13.4, 3.0 Hz, 1H), 3.11 (dd, *J* = 13.4, 9.0 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.39, 139.39, 131.80, 129.81, 129.42, 128.79, 127.57, 127.26, 127.19, 113.74, 69.07, 50.52, 20.37.

1-(2-bromophenyl)-2-(*p*-tolylamino)ethan-1-ol [2ad]

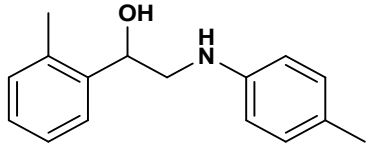


Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 85-15) to obtain pure 1-(2-bromophenyl)-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 184 mg (90%); R_f = 0.58 (n-hexane: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.64 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.55 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.37 (td, *J* = 7.7, 0.7 Hz, 1H), 7.17 (td, *J* = 7.9, 1.7 Hz, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.70 (d, *J* = 8.4 Hz, 2H), 5.26 (dd, *J* =

9.1, 3.0 Hz, 1H), 3.58 (dd, *J* = 13.4, 3.0 Hz, 1H), 3.09 (dd, *J* = 13.4, 9.1 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 145.39, 140.99, 132.69, 129.80, 129.17, 127.80, 127.61, 127.58, 121.81, 113.82, 71.23, 50.58, 20.38.

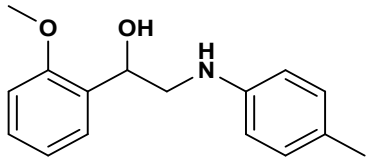
1-(*o*-tolyl)-2-(*p*-tolylamino)ethan-1-ol [2ae]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(*o*-tolyl)-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 205 mg (85%); R_f = 0.65 (n-hexane: ethyl acetate, 90:10 v/v). **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.55 (d, *J* = 7.2 Hz, 1H), 7.27 (t, *J* = 6.6 Hz, 1H), 7.22 (td, *J* = 7.3, 1.3 Hz, 1H), 7.17 (d, *J* = 6.9 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.62 (d, *J* = 8.3 Hz, 2H), 5.15 (dd, *J* = 9.0, 3.3 Hz, 1H), 3.40 (dd, *J* = 13.2, 3.3 Hz, 1H), 3.20 (dd, *J* = 13.2, 9.1 Hz, 1H), 2.38 (s, 3H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 145.62, 140.07, 134.68, 130.48, 129.81, 127.64, 127.44, 126.41, 125.44, 113.65, 69.11, 51.03, 20.38, 19.12.

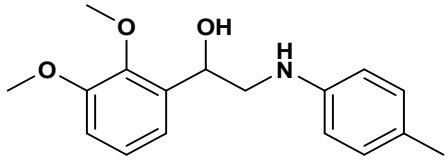
1-(2-methoxyphenyl)-2-(*p*-tolylamino)ethan-1-ol [2af]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(2-methoxyphenyl)-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 224 mg (87%); R_f = 0.60 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.33 (d, *J* = 8.4 Hz, 2H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.92 (d, *J* = 8.7 Hz, 2H), 6.61 (d, *J* = 8.3 Hz, 2H), 4.86 (dd, *J* = 8.6, 3.9 Hz, 1H), 3.82 (s, 3H), 3.37 (dd, *J* = 13.0, 4.0 Hz, 1H), 3.27 (dd, *J* = 13.0, 8.6 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 159.35, 145.60, 134.18, 129.79, 127.76, 127.37, 127.16, 114.20, 114.00, 113.67, 72.06, 55.31, 52.18, 20.38.

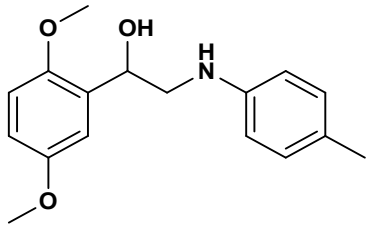
1-(2,3-dimethoxyphenyl)-2 -(*p*-tolylamino)ethan-1-ol [2ag]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(2,3-dimethoxyphenyl)-2 -(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 256 mg (89%); R_f = 0.62 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.01 (dd, *J* = 7.2, 5.7 Hz, 3H), 6.81 (dt, *J* = 8.9, 5.9 Hz, 2H), 6.65 (d, *J* = 8.4 Hz, 2H), 5.11 (dd, *J* = 8.8, 3.5 Hz, 1H), 3.84 (s, 3H), 3.78 (s, 3H), 3.49 (dd, *J* = 13.0, 3.5 Hz, 1H), 3.20 (dd, *J* = 13.0, 8.8 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 153.89, 150.57, 145.78, 131.07, 129.72, 127.02, 113.55, 112.99, 112.94, 111.45, 68.94, 55.79, 55.76, 50.49, 20.36.

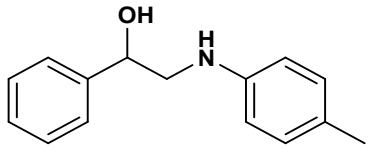
1-(2,5-dimethoxyphenyl)-2 -(*p*-tolylamino)ethan-1-ol [2ah]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-(2,5-dimethoxyphenyl)-2 -(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 259 mg (88%); R_f = 0.59 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.04 – 6.96 (m, 3H), 6.81 (dt, *J* = 8.9, 5.9 Hz, 2H), 6.65 (d, *J* = 8.4 Hz, 2H), 5.11 (dd, *J* = 8.4, 2.9 Hz, 1H), 3.84 (s, 3H), 3.78 (s, 3H), 3.49 (dd, *J* = 13.0, 3.4 Hz, 1H), 3.20 (dd, *J* = 13.0, 8.8 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 153.89, 150.57, 145.78, 131.07, 129.72, 127.02, 113.55, 112.99, 112.94, 111.44, 68.95, 55.79, 55.76, 50.49, 20.36.

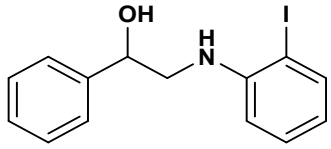
1-phenyl-2-(*p*-tolylamino)ethan-1-ol [2ai]



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 1-phenyl-2-(*p*-tolylamino)ethan-1-ol.

Colourless liquid; Yield = 198 mg (87%); R_f = 0.59 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.35 (dd, *J* = 25.2, 5.7 Hz, 5H), 7.00 (d, *J* = 6.2 Hz, 2H), 6.60 (d, *J* = 6.8 Hz, 2H), 4.90 (dd, *J* = 7.4, 3.9 Hz, 1H), 3.40 (dd, *J* = 12.7, 3.8 Hz, 1H), 3.25 (dt, *J* = 12.7, 7.4 Hz, 1H), 2.24 (d, *J* = 5.5 Hz, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.55, 142.12, 129.82, 128.59, 127.92, 127.46, 125.89, 113.74, 72.41, 52.26, 20.40.

2-((2-iodophenyl)amino)-1-phenylethan-1-ol (2aj)

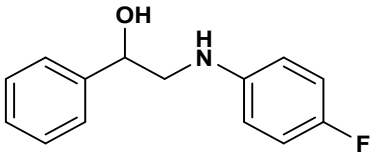


In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C_3N_4 dissolved in 5 ml of IPA and reaction mixture is stirred for 5 h then 0.2 ml (200 µl) of FA:TEA (5:4) is added into it hence after heated at 100 ^{o}C for 6 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with DCM and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Final mixture then purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 75-25) to obtain pure 2-((2-iodophenyl)amino)-1-phenylethan-1-ol.

Dark Yellow liquid; Yield = 295 mg (87%); R_f = 0.59 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.43 – 7.38 (m, 4H), 7.34 (ddd, *J* = 7.2, 5.9, 3.2 Hz, 1H), 7.13 (dd, *J* = 6.8, 2.1 Hz, 2H), 6.58 (d, *J* = 8.7 Hz, 2H), 4.91 (dd, *J* = 8.0, 3.7 Hz, 1H), 3.38 (dd, *J* = 13.0, 3.7 Hz, 1H), 3.28

(dd, *J* = 12.9, 8.0 Hz, 1H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 145.85, 141.55, 138.00, 129.19, 128.74, 128.26, 125.86, 122.44, 111.23, 85.30, 72.36, 51.80.

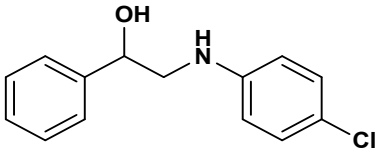
2-((4-fluorophenyl)amino)-1-phenylethan-1-ol (2ak)



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-((4-fluorophenyl)amino)-1-phenylethan-1-ol.

Yellow liquid; Yield = 215 mg (93%); R_f = 0.68 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.40 (d, *J* = 6.0 Hz, 1H), 7.35 (d, *J* = 4.1 Hz, 3H), 7.28 (dd, *J* = 8.4, 4.3 Hz, 1H), 6.93 – 6.78 (m, 2H), 6.63 – 6.47 (m, 2H), 4.43 (dd, *J* = 7.2, 4.1 Hz, 1H), 3.93 (dd, *J* = 11.1, 4.1 Hz, 1H), 3.74 (dd, *J* = 11.1, 7.2 Hz, 1H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 143.54, 139.92, 128.84, 128.65, 128.07, 127.68, 126.70, 125.86, 115.82, 115.81, 115.64, 115.46, 114.77, 114.72, 114.44, 114.38, 72.48, 67.31, 60.53, 52.45.

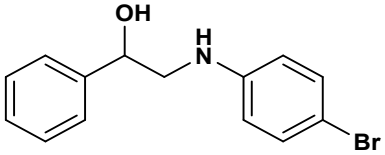
2-((4-chlorophenyl)amino)-1-phenylethan-1-ol (2al)



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-((4-fluorophenyl)amino)-1-phenylethan-1-ol.

Yellow liquid; Yield = 228 mg (92%); R_f = 0.69 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.38 (d, *J* = 4.1 Hz, 4H), 7.34 – 7.26 (m, 1H), 7.11 (d, *J* = 8.6 Hz, 2H), 6.56 (d, *J* = 8.4 Hz, 2H), 4.88 (dd, *J* = 8.5, 3.8 Hz, 1H), 3.36 (dd, *J* = 13.0, 3.8 Hz, 1H), 3.25 (dd, *J* = 13.0, 8.5 Hz, 1H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 146.47, 141.85, 129.13, 128.69, 128.13, 125.86, 122.60, 114.49, 72.46, 51.72.

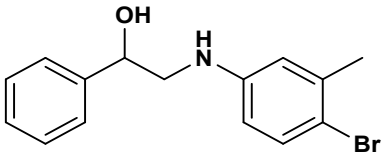
2-((4-bromophenyl)amino)-1-phenylethan-1-ol (2am)



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain pure 2-((4-bromophenyl)amino)-1-phenylethan-1-ol.

Yellow liquid; Yield = 266 mg (91%); R_f = 0.67 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) *δ* 7.37 (d, *J* = 4.3 Hz, 4H), 7.34 – 7.30 (m, 1H), 7.24 (d, *J* = 8.8 Hz, 2H), 6.51 (d, *J* = 8.8 Hz, 2H), 4.87 (dd, *J* = 8.5, 3.9 Hz, 1H), 3.35 (dd, *J* = 13.1, 3.9 Hz, 1H), 3.25 (dd, *J* = 13.1, 8.5 Hz, 1H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 146.91, 141.85, 132.00, 128.69, 128.13, 125.87, 114.98, 109.60, 72.41, 51.58.

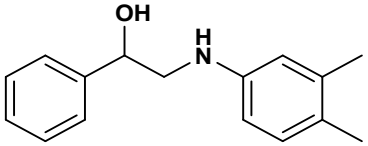
2-((4-bromo-3-methylphenyl)amino)-1-phenylethan-1-ol (2an)



In 100 ml of round bottom flask 1 mmol of α-keto amide is added along with 30 mg of Ru-g-C3N4 dissolved in 5 ml of IPA and reaction mixture is stirred for 3 h then 0.2 ml (200 µl) of FA:TEA (5:4) is added into it hence after heated at 100 °C for 4 h. Synthesis of product determined by repeated checking with Thin Layer Chromatography (TLC) further compound is extracted with DCM and water, after this organic layer is dried over anhydrous Na_2SO_4 filtered and solvent removed under vacuum on rotary evaporator. Finally it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 90-10) to obtain 2-((4-bromo-3-methylphenyl)amino)-1-phenylethan-1-ol.

Yellow liquid; Yield = 263 mg (86%); R_f = 0.62 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.43 (d, *J* = 7.6 Hz, 1H), 7.29 (d, *J* = 7.5 Hz, 1H), 7.23 (d, *J* = 7.6 Hz, 1H), 7.00 (d, *J* = 7.9 Hz, 2H), 6.59 (d, *J* = 8.1 Hz, 2H), 4.83 (dd, *J* = 8.8, 3.3 Hz, 1H), 3.36 (dd, *J* = 13.2, 3.5 Hz, 1H), 3.18 (dd, *J* = 13.2, 8.8 Hz, 1H), 2.25 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.23, 144.40, 130.92, 130.14, 129.87, 128.95, 127.74, 124.48, 122.73, 113.78, 71.61, 52.24, 20.42.

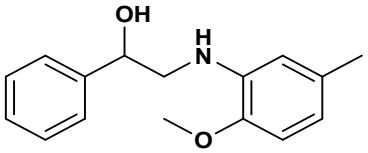
2-((3,4-dimethylphenyl)amino)-1-phenylethan-1-ol (2ao)



Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 80-20) to obtain pure 2-((3,4-dimethylphenyl)amino)-1-phenylethan-1-ol.

Yellow liquid; Yield = 193 mg (80%); R_f = 0.58 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.40 (dd, *J* = 8.2, 4.1 Hz, 4H), 7.34 (dd, *J* = 7.8, 4.5 Hz, 1H), 6.98 (d, *J* = 8.0 Hz, 1H), 6.52 (s, 1H), 6.47 (dd, *J* = 7.9, 2.2 Hz, 1H), 4.90 (dd, *J* = 8.6, 3.7 Hz, 1H), 3.41 (dd, *J* = 12.9, 3.7 Hz, 1H), 3.26 (dd, *J* = 12.9, 8.8 Hz, 1H), 2.22 (s, 3H), 2.19 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.92, 142.15, 137.43, 130.34, 128.58, 127.90, 126.30, 125.90, 115.53, 111.03, 72.35, 52.27, 20.07, 18.75.

2-((2-methoxy-5-methylphenyl)amino)-1-phenylethan-1-ol (2ap)

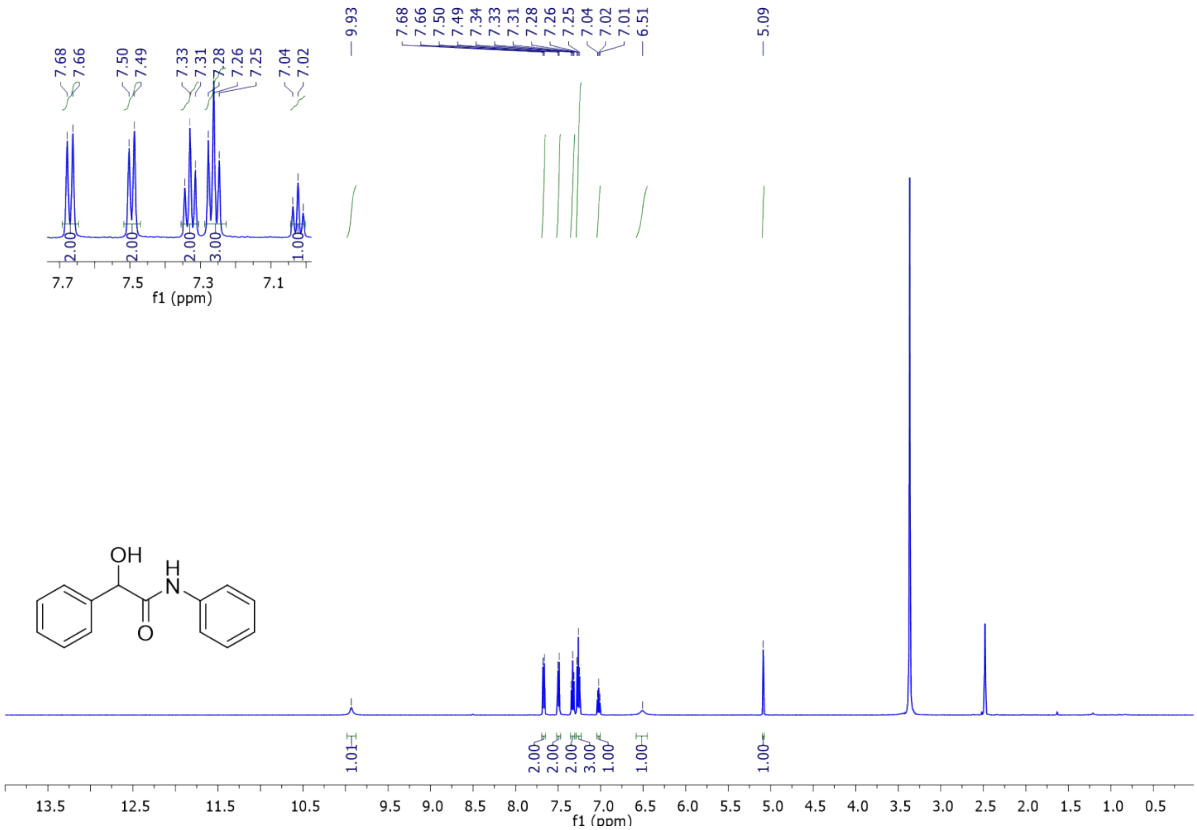


Synthesis of this product is parallel to synthesis of 2aa and then it is purified using silica gel column chromatography (eluent: *n*-hexane-ethyl acetate, 80-20) to obtain pure 2-((2-methoxy-5-methylphenyl)amino)-1-phenylethan-1-ol.

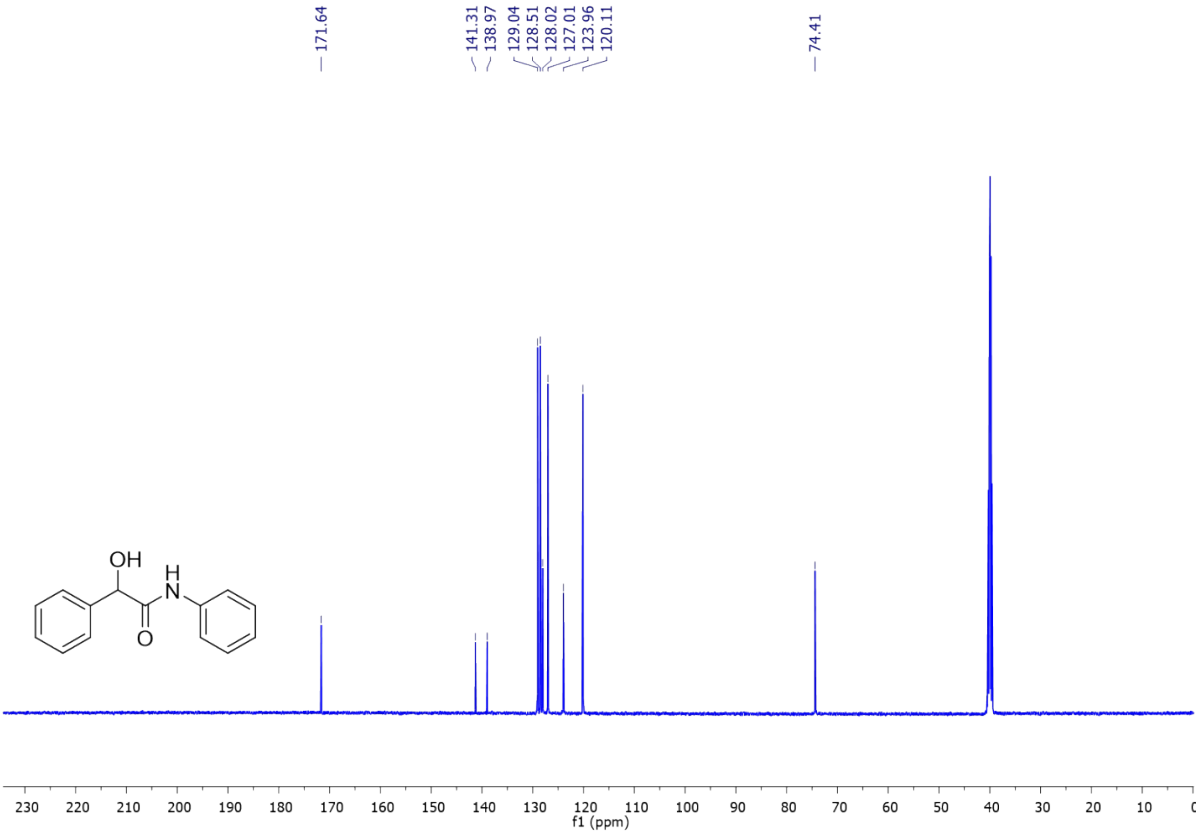
Yellow liquid; Yield = 211 mg (82%); R_f = 0.65 (n-hexane: ethyl acetate, 90:10 v/v) **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.46 – 7.36 (m, 4H), 7.33 (dd, *J* = 11.4, 4.3 Hz, 1H), 6.68 (d, *J* = 8.5 Hz, 1H), 6.51 (d, *J* = 5.4 Hz, 2H), 4.95 (dd, *J* = 8.8, 3.6 Hz, 1H), 3.82 (s, 3H), 3.43 (dd, *J* = 13.1, 3.6 Hz, 1H), 3.31

(dd, *J* = 13.1, 8.9 Hz, 1H), 2.27 (s, 3H); **^{13}C NMR** (126 MHz, $CDCl_3$) *δ* 145.28, 140.49, 133.56, 129.85, 128.71, 127.71, 127.24, 113.74, 71.66, 52.27, 20.40.

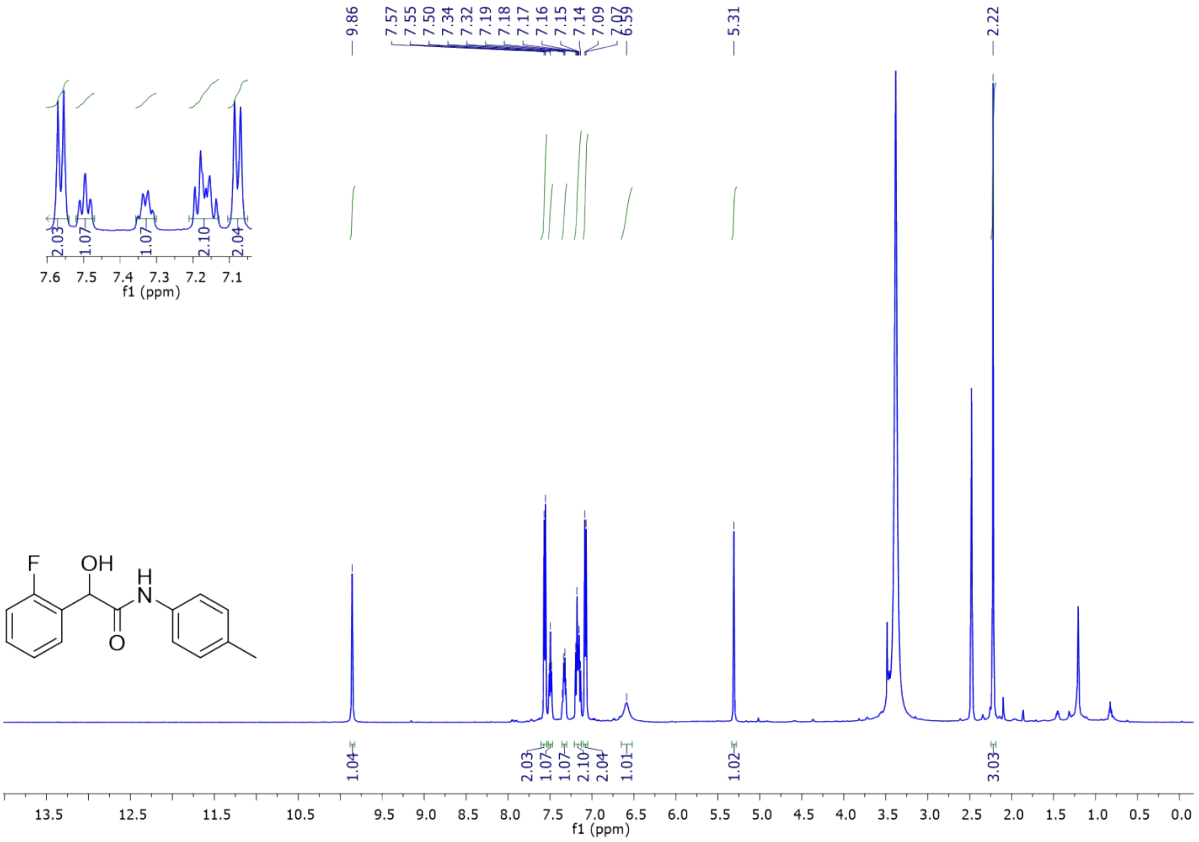
^{1}H and ^{13}C NMR of α–hydroxyl amide:



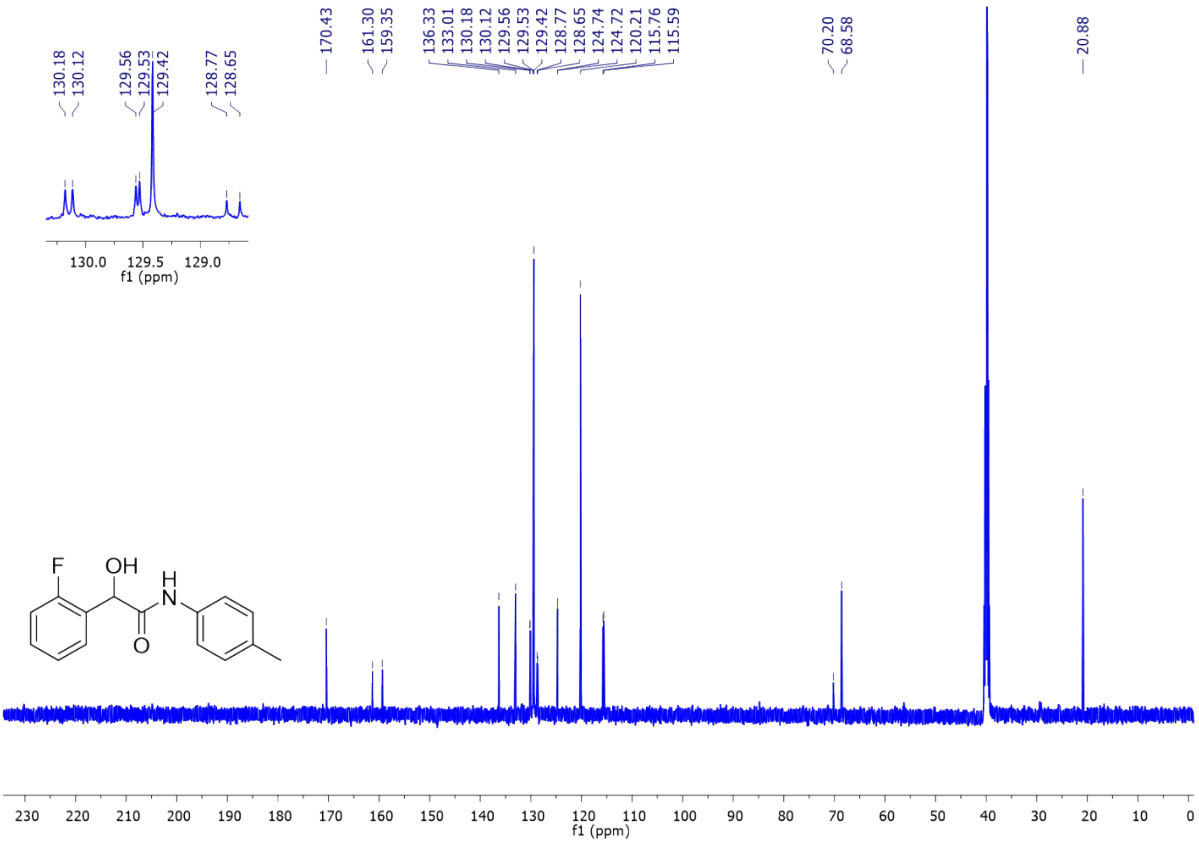
500 MHz ^{1}H-NMR spectra of 2a in DMSO-d_6



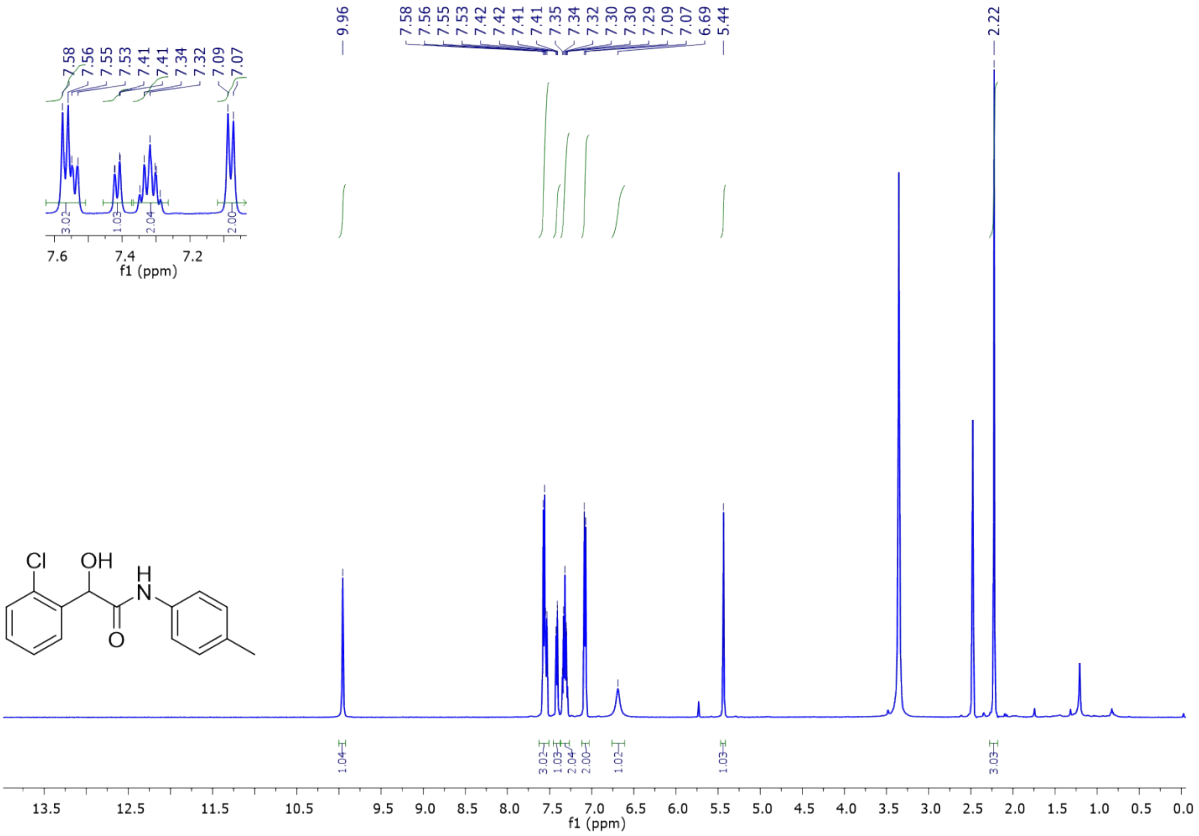
126 MHz ^{13}C-NMR spectra of 2a in DMSO-d_6



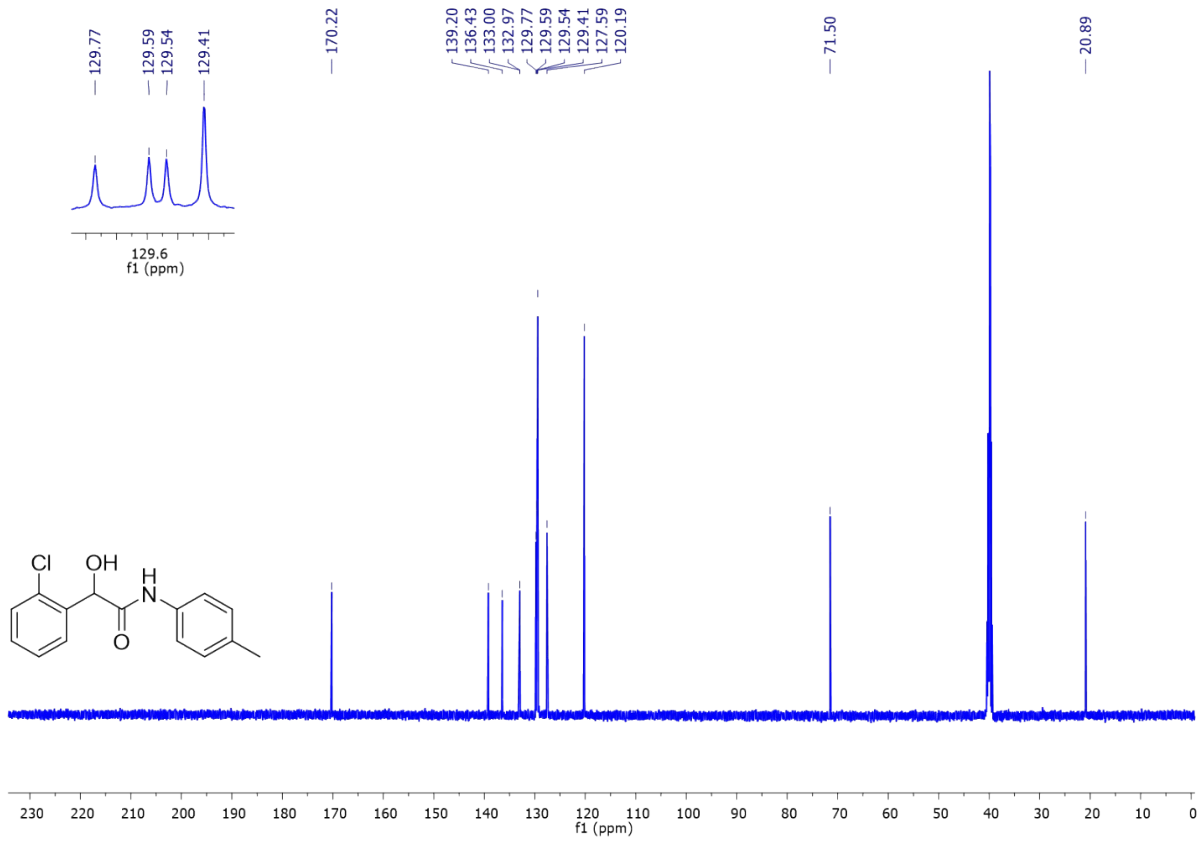
500 MHz ^{1}H-NMR spectra of 2b in DMSO-d_6



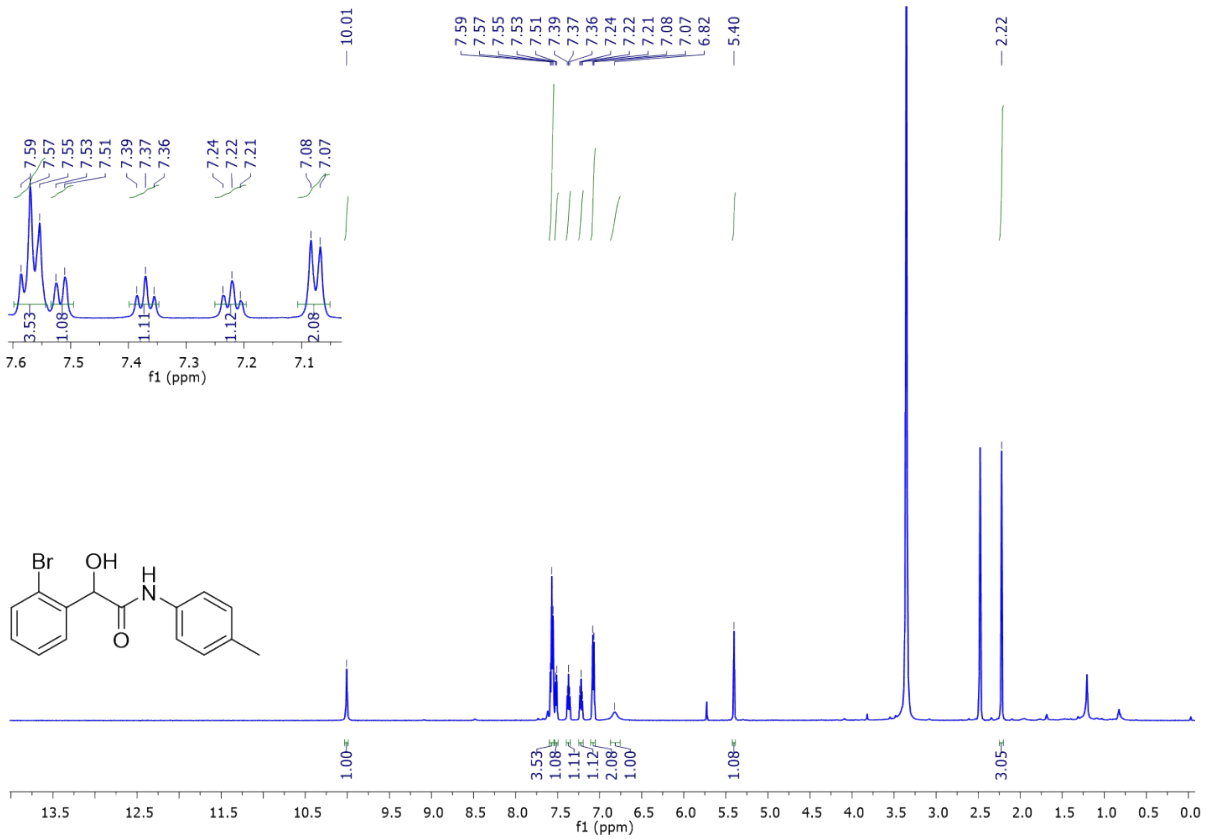
126 MHz ^{13}C-NMR spectra of 2b in DMSO-d$_6$



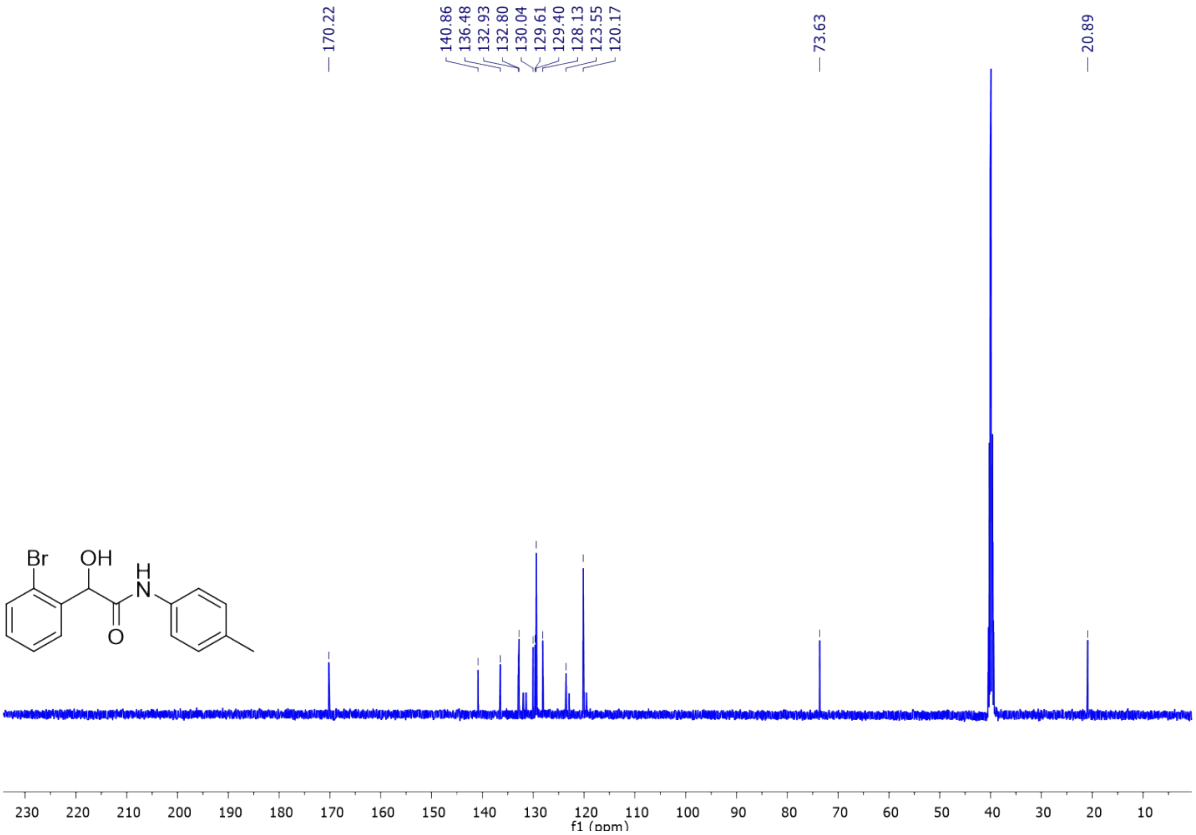
500 MHz ^{1}H-NMR spectra of 2c in DMSO-d$_6$



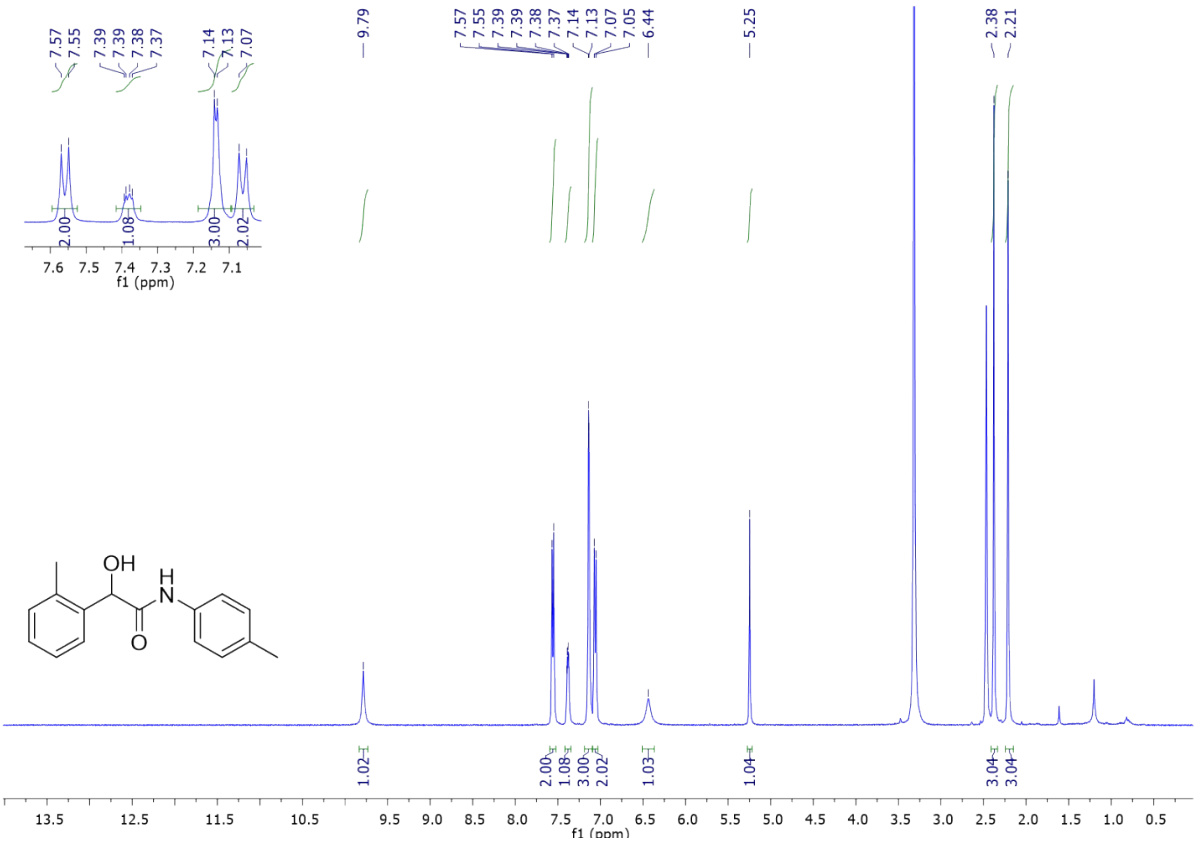
126 MHz ^{13}C-NMR spectra of 2c in DMSO-d$_6$



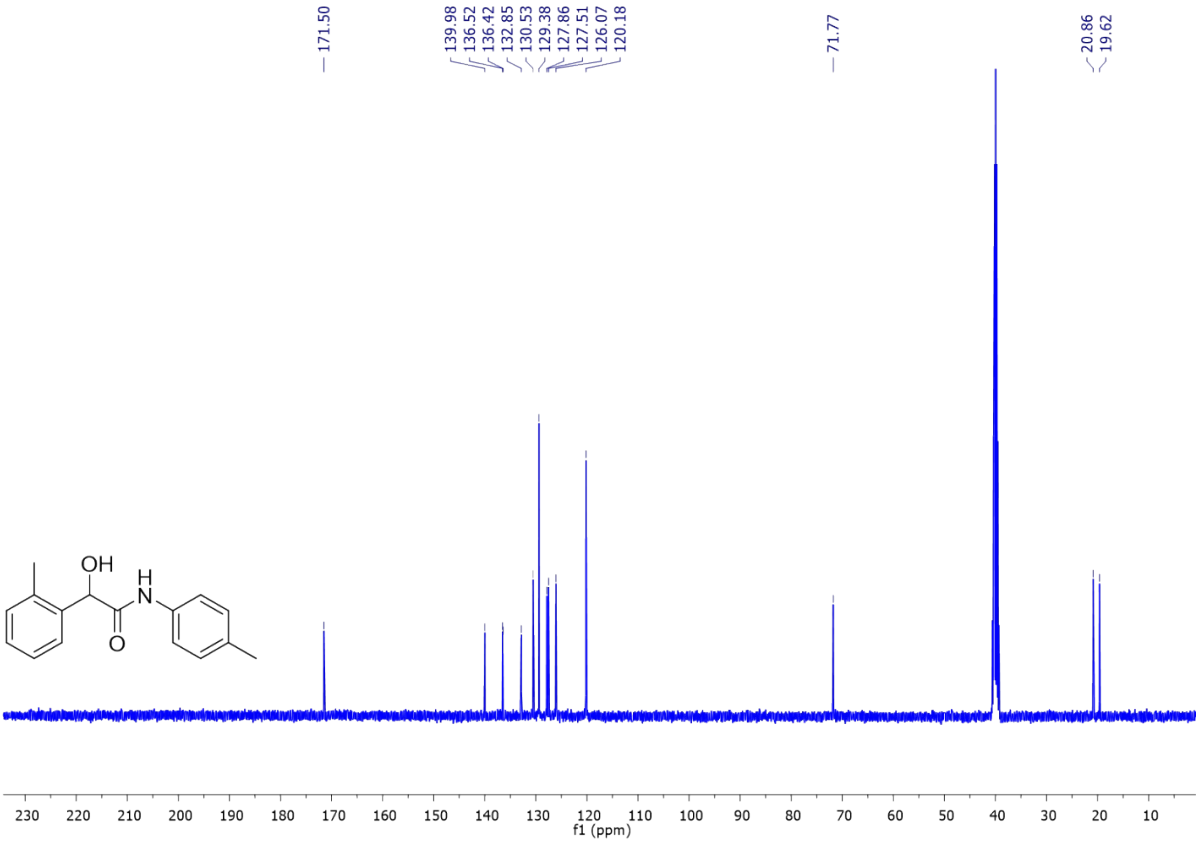
500 MHz ^{1}H-NMR spectra of 2d in DMSO-d$_6$



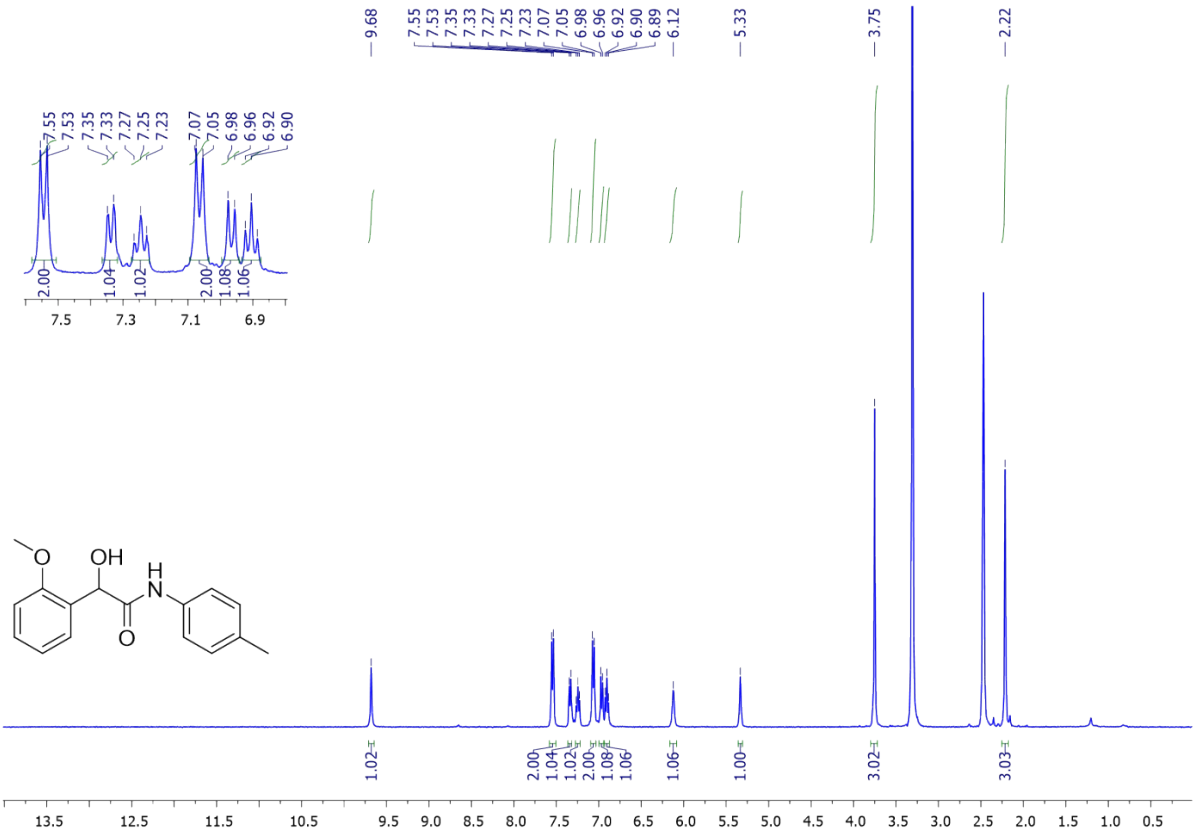
126 MHz ^{13}C-NMR spectra of 2d in DMSO-d$_6$



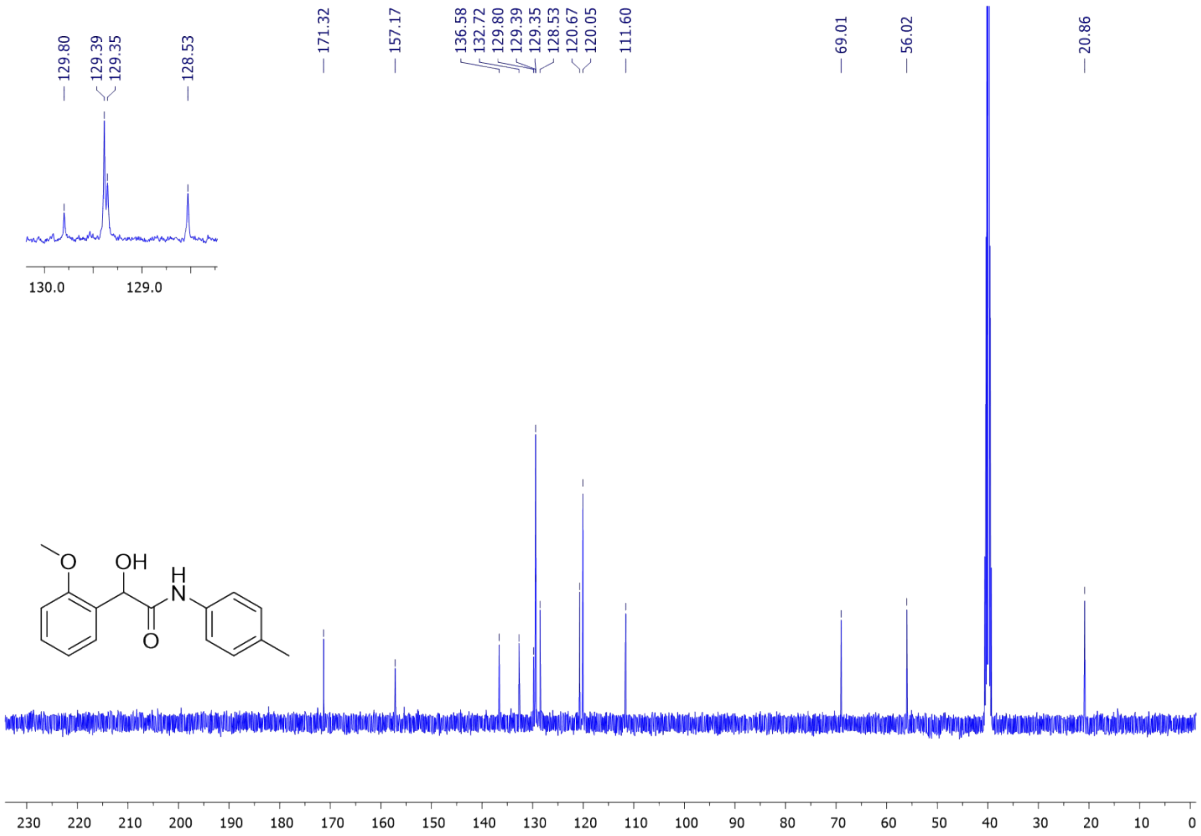
500 MHz ^{1}H-NMR spectra of 2e in DMSO-d$_6$



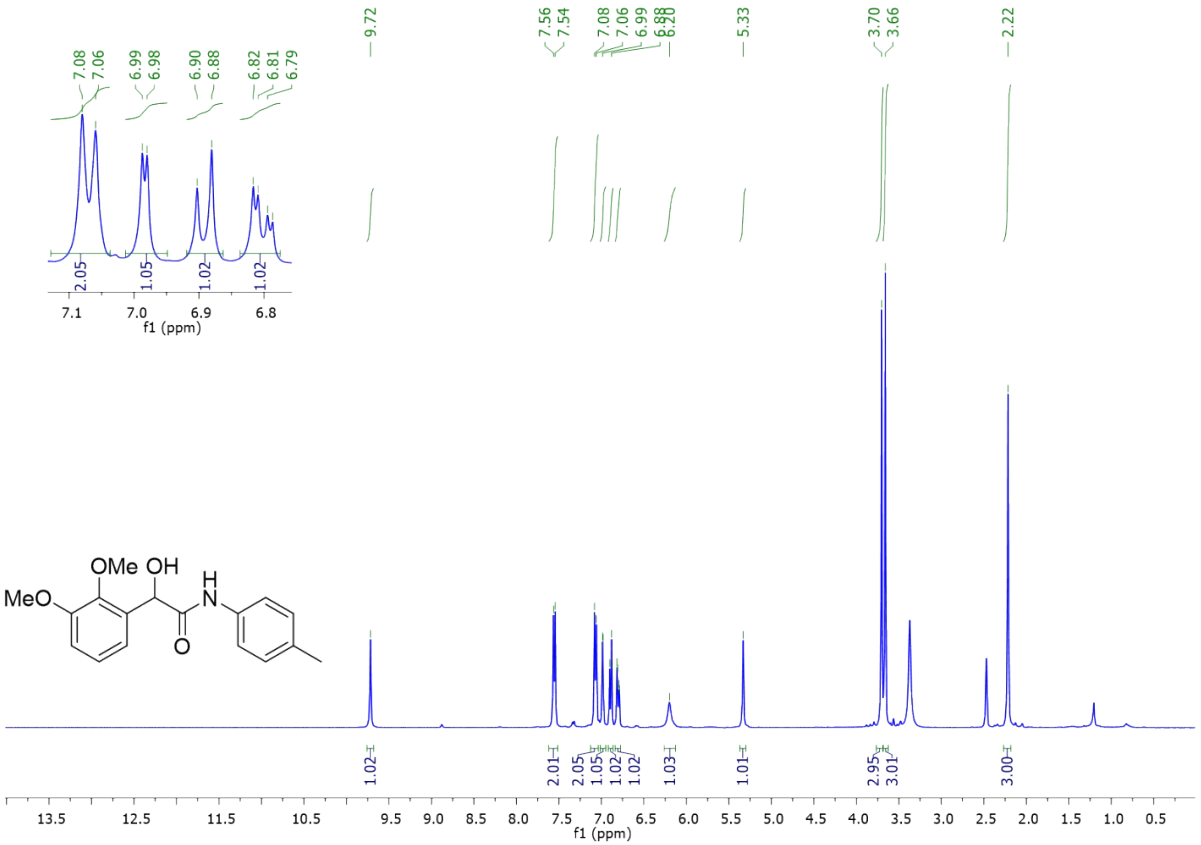
126 MHz ^{13}C-NMR spectra of 2e in DMSO-d$_6$



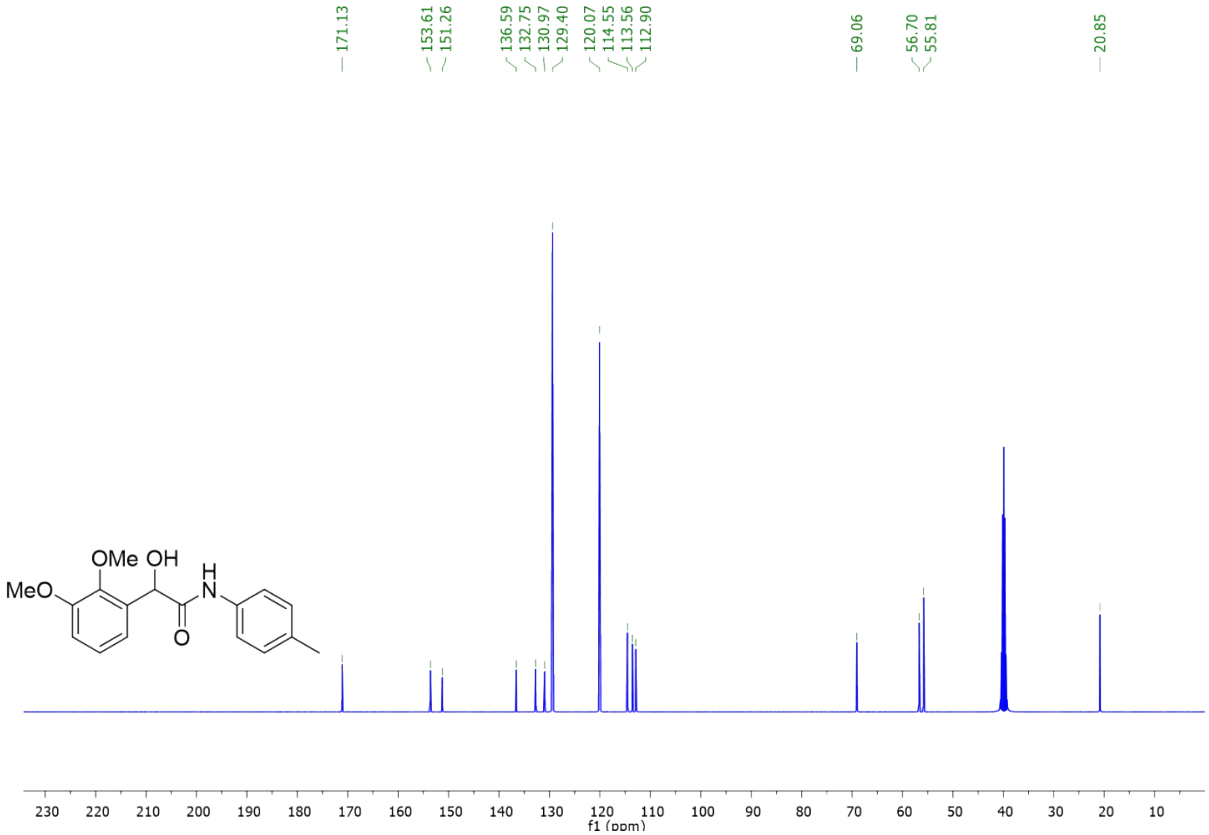
500 MHz ^{1}H-NMR spectra of 2f in DMSO-d$_6$



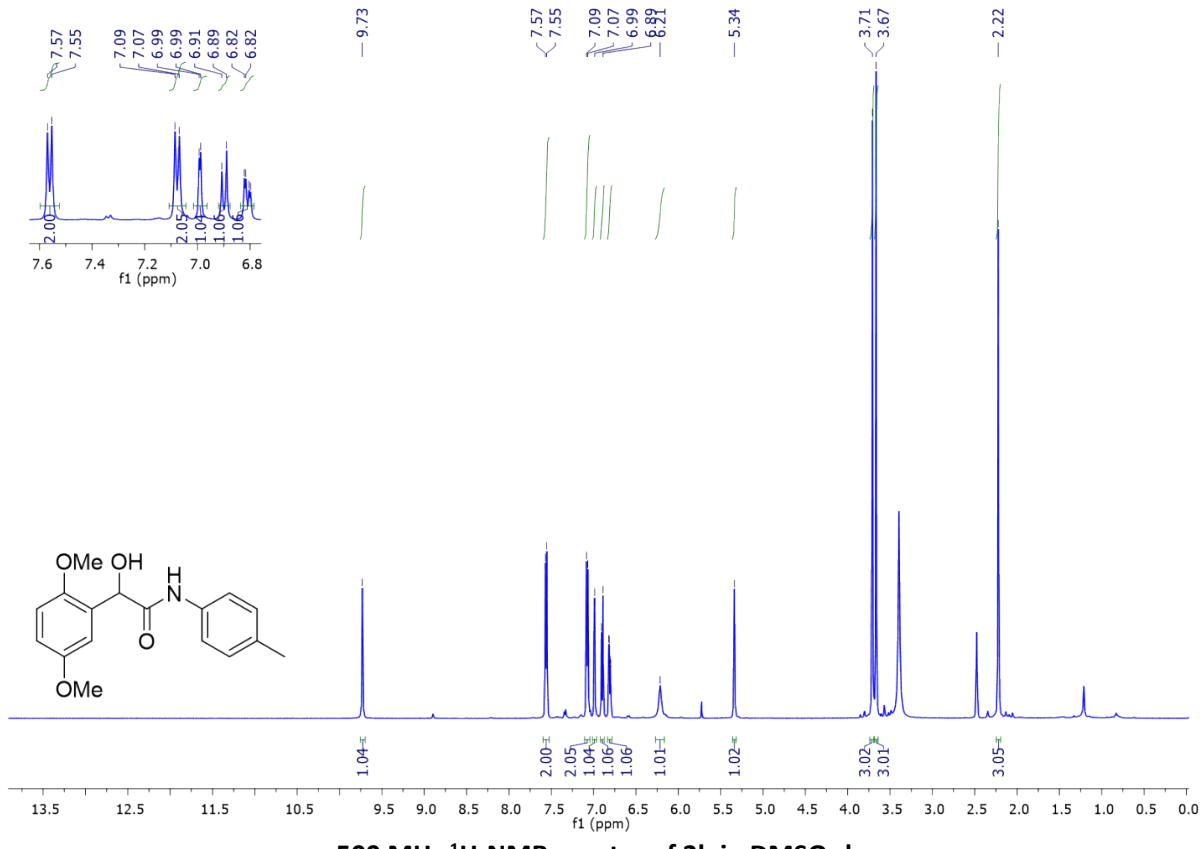
126 MHz ^{13}C-NMR spectra of 2f in DMSO-d$_6$



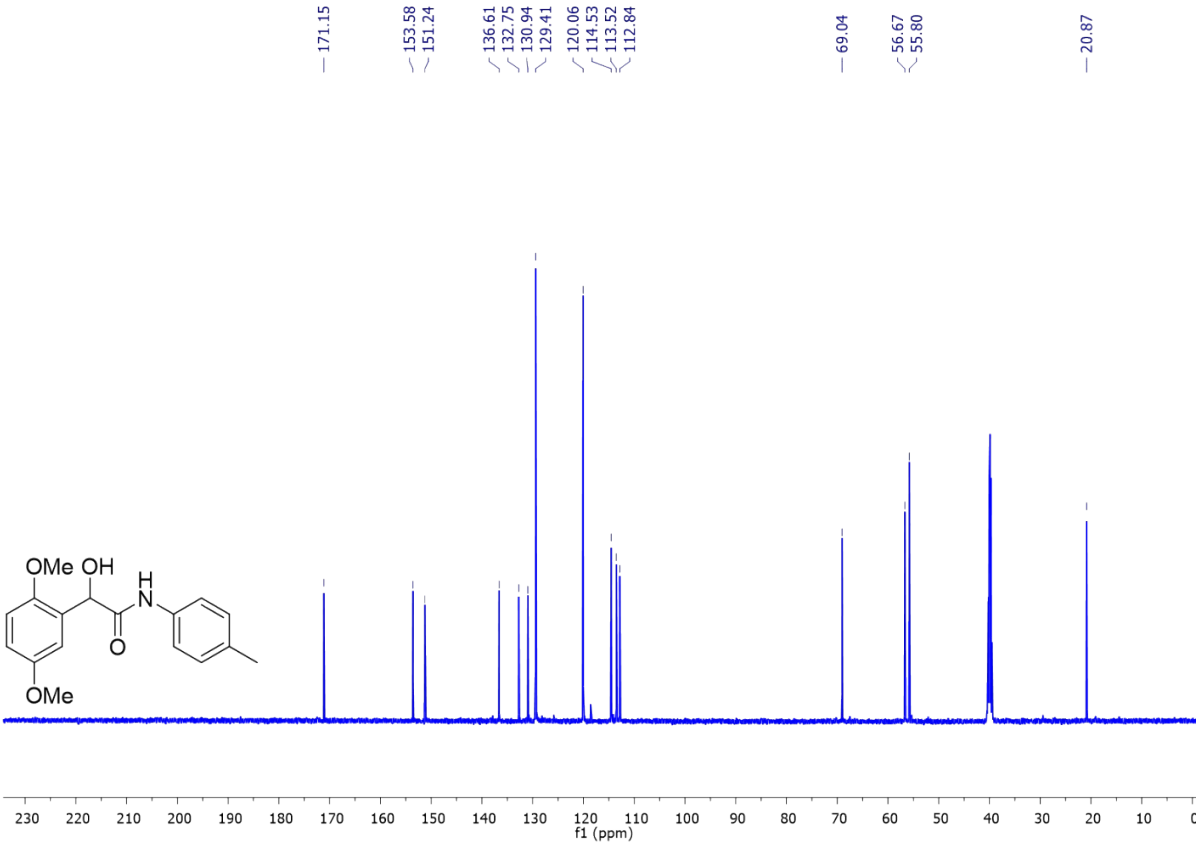
500 MHz ^{1}H-NMR spectra of 2g in DMSO-d$_6$



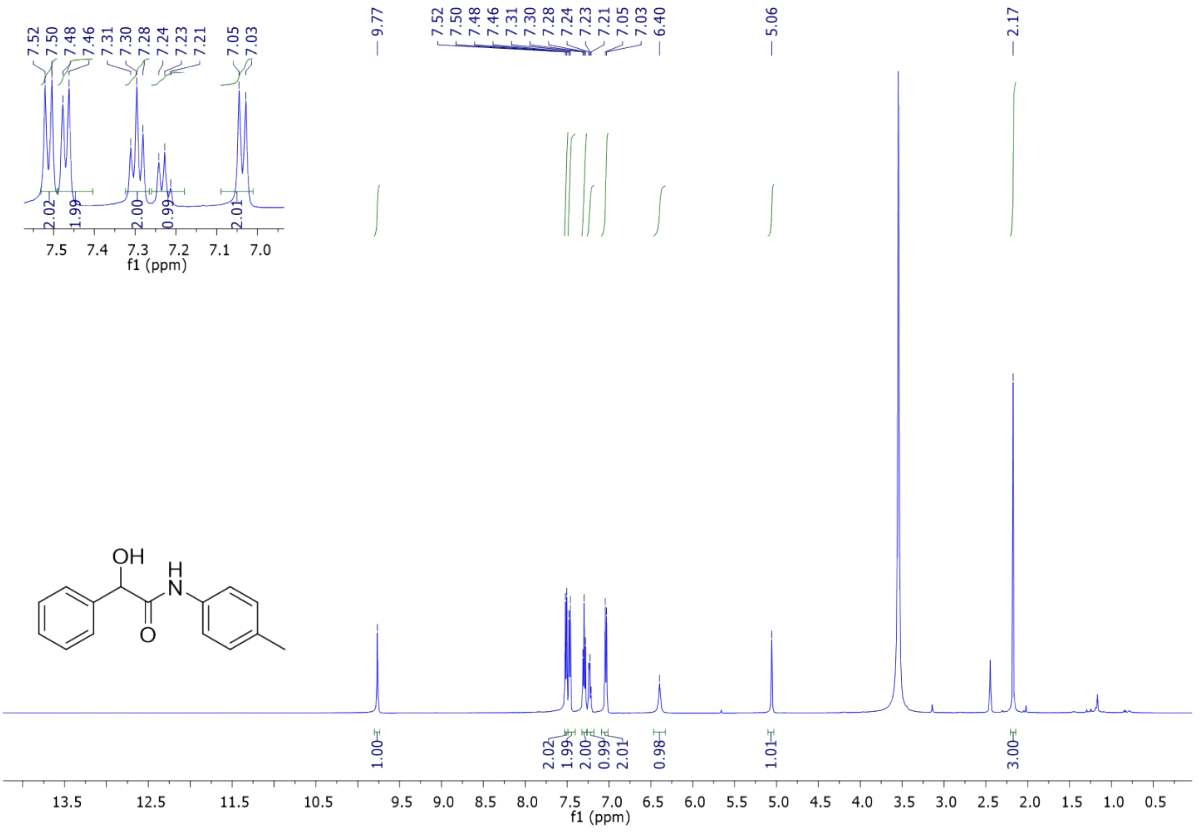
126 MHz ^{13}C-NMR spectra of 2g in DMSO-d$_6$



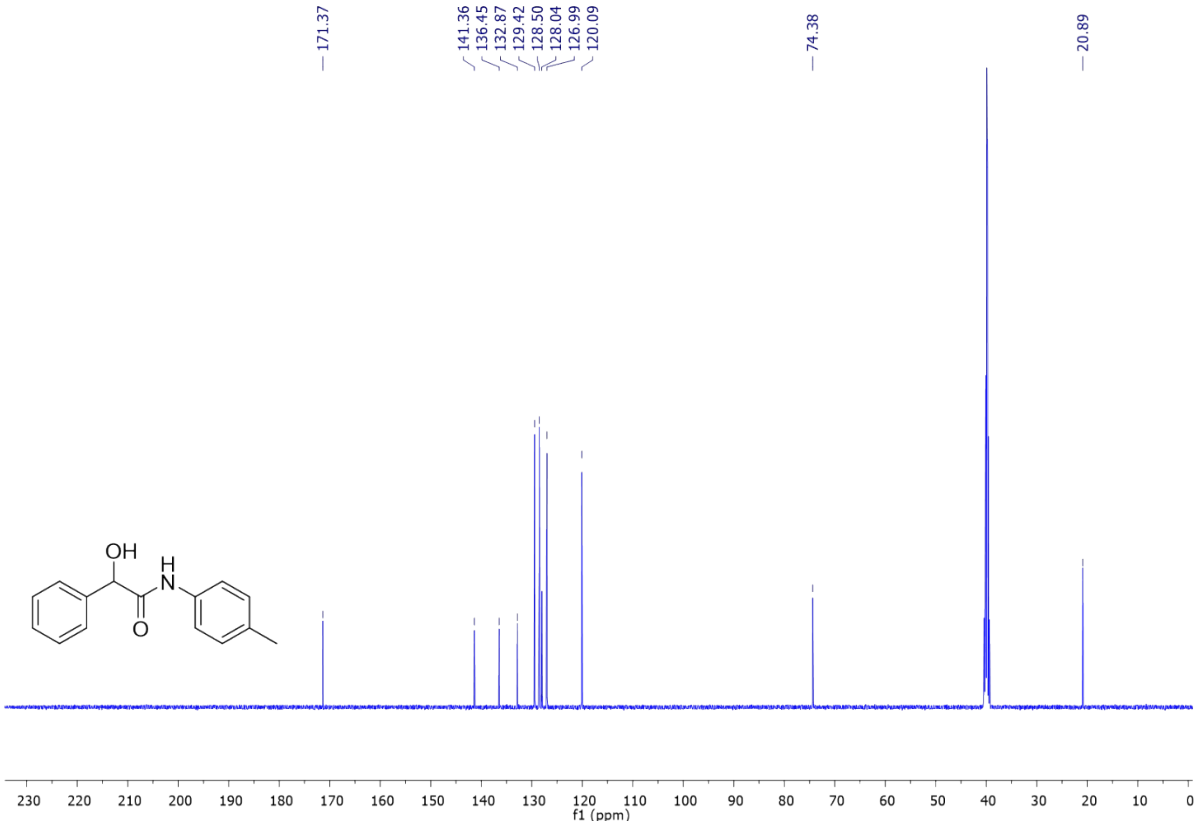
500 MHz ^{1}H-NMR spectra of 2h in DMSO-d$_6$



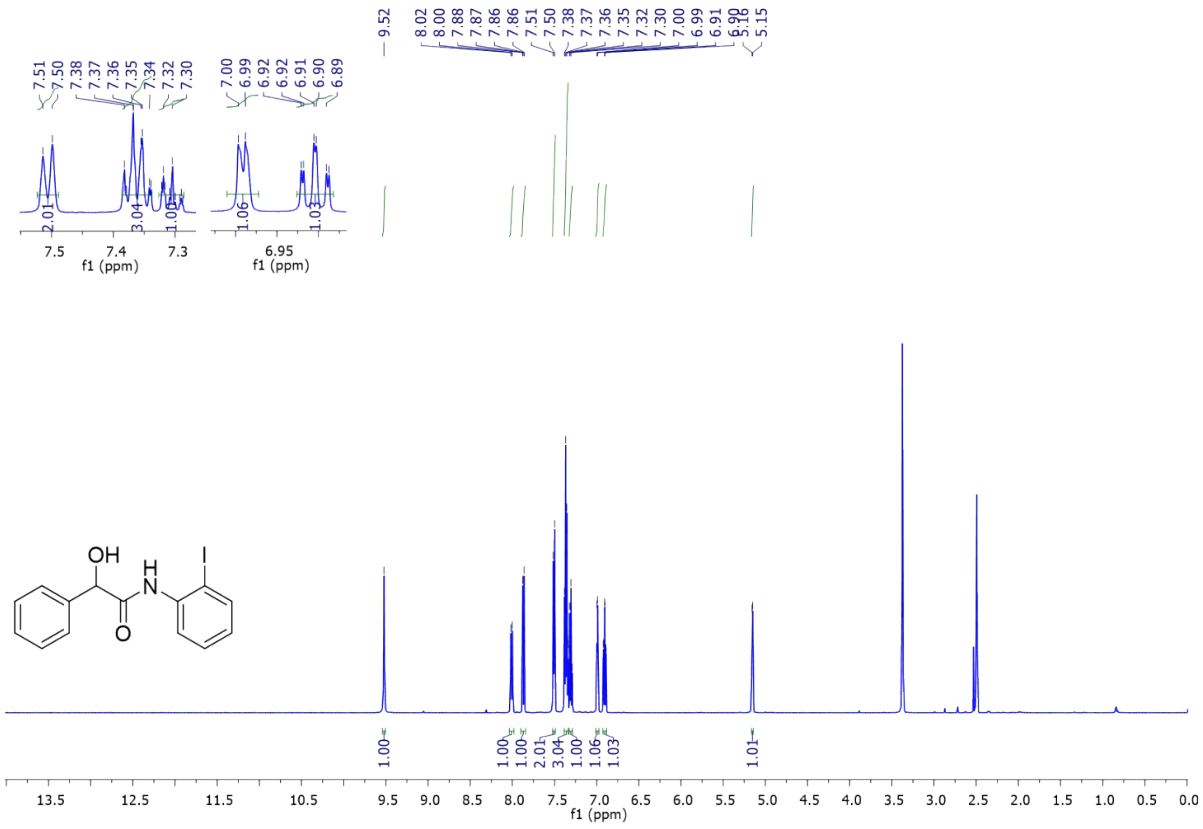
126 MHz ^{13}C-NMR spectra of 2h in DMSO-d$_6$



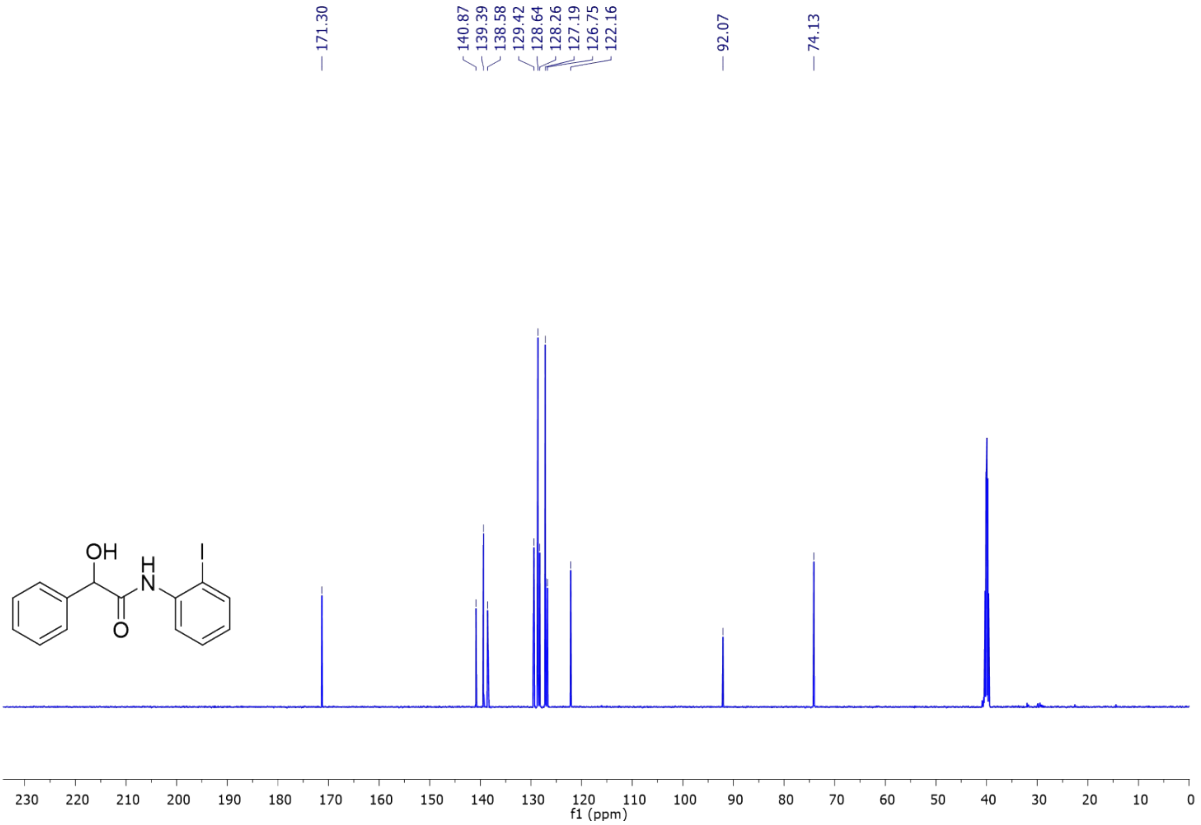
500 MHz ^{1}H-NMR spectra of 2i in DMSO-d$_6$



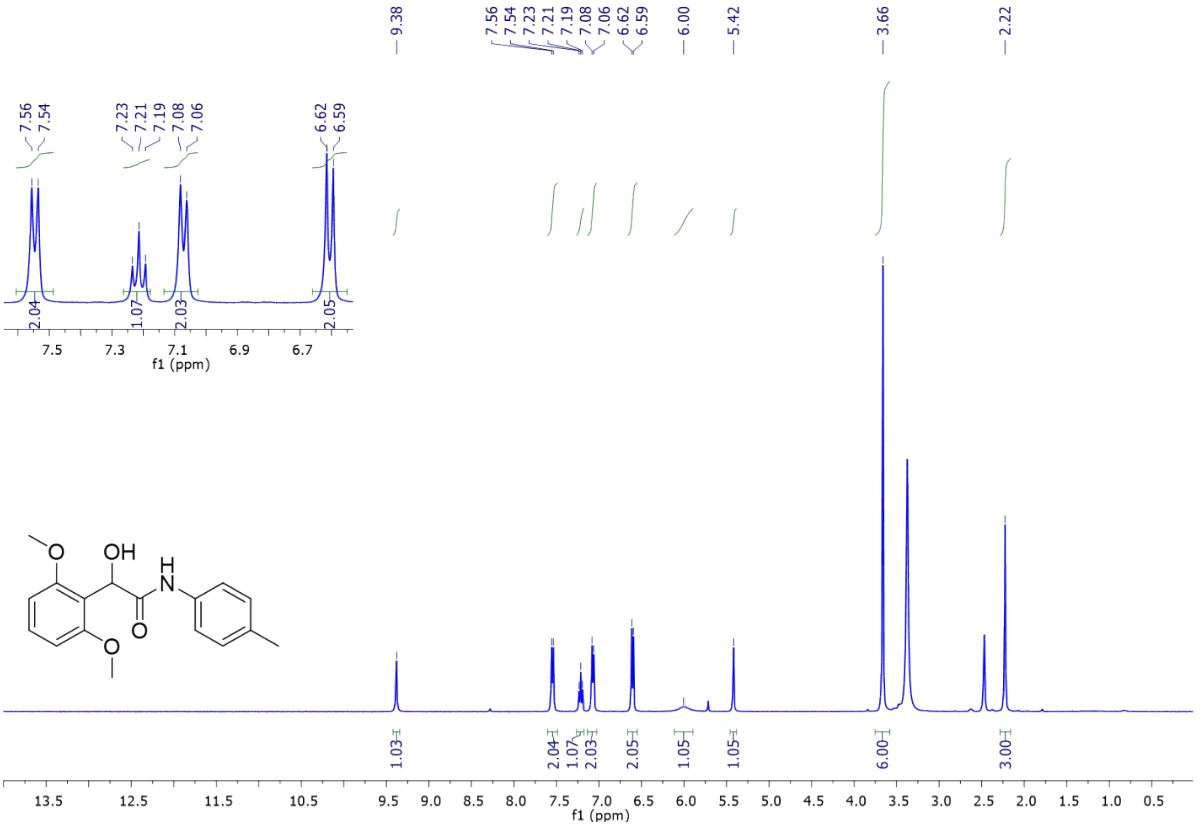
126 MHz ^{13}C-NMR spectra of 2i in DMSO-d$_6$



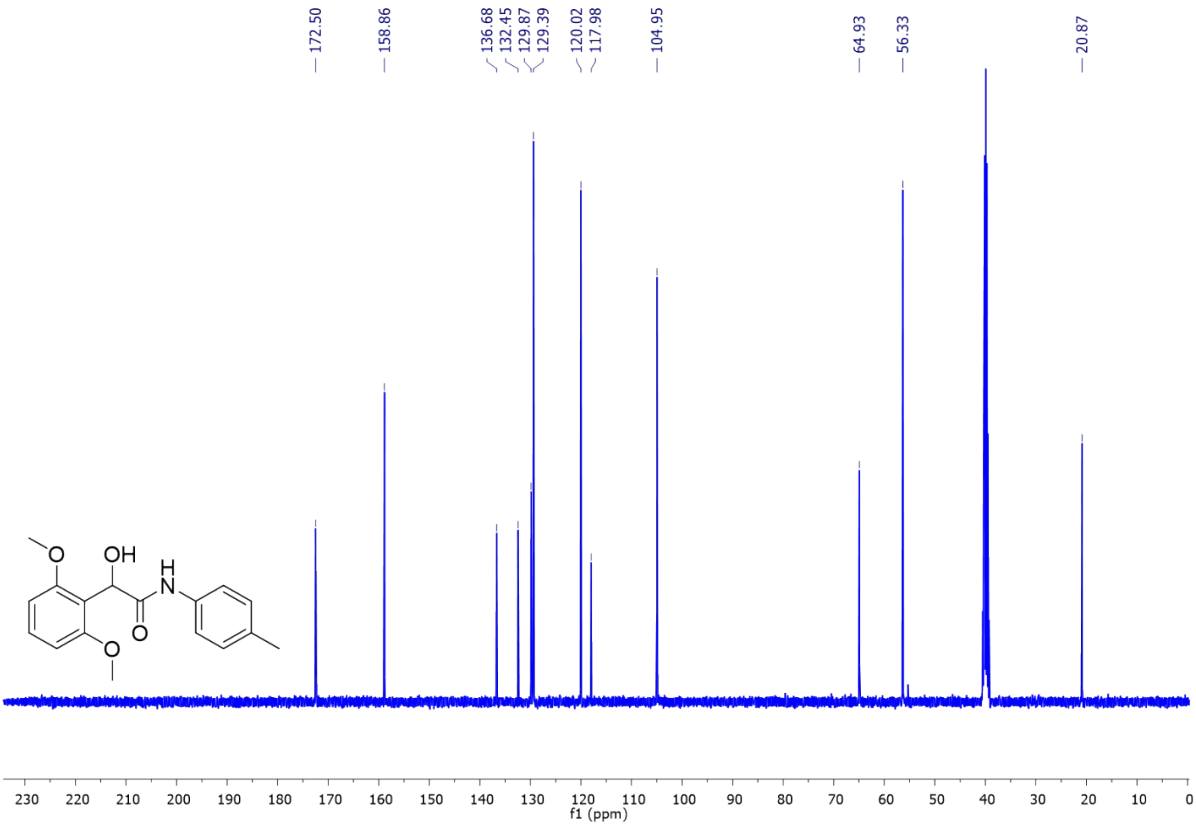
500 MHz ^{1}H-NMR spectra of 2j in DMSO-d$_6$



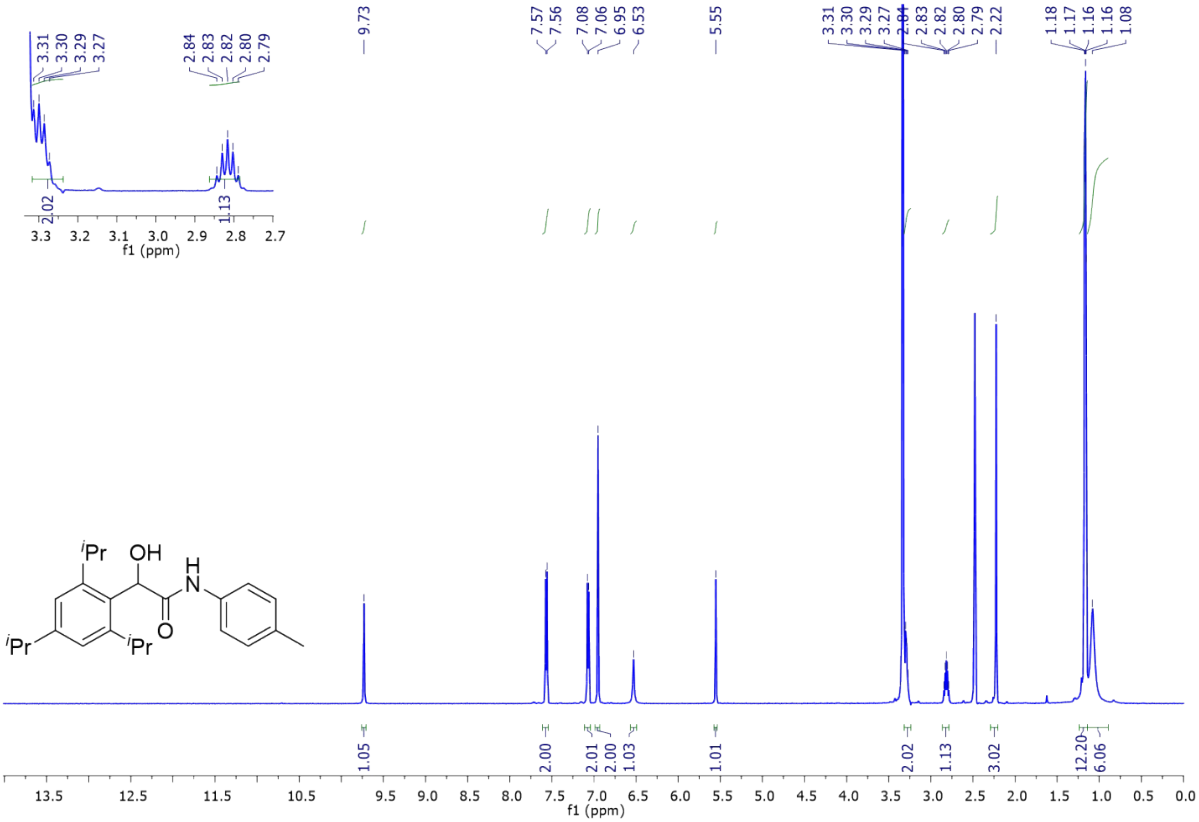
126 MHz ^{13}C-NMR spectra of 2j in DMSO-d$_6$



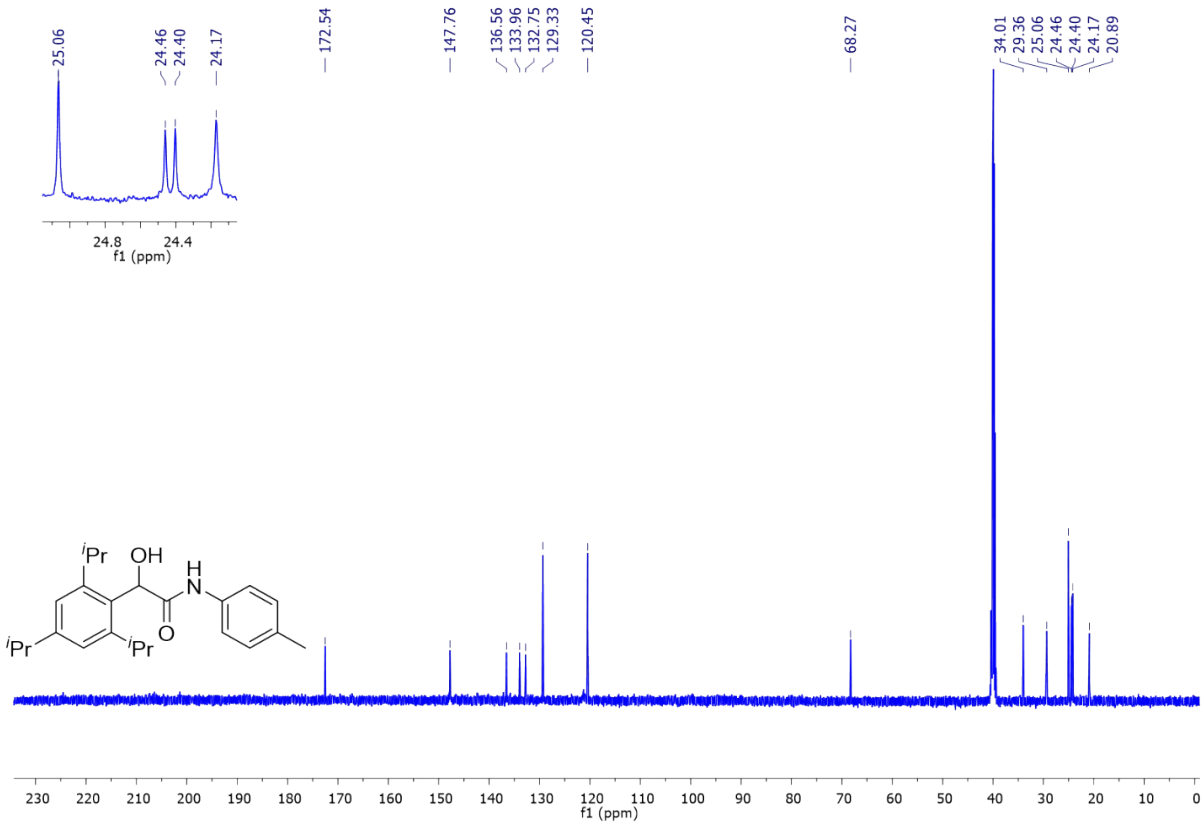
500 MHz ^{1}H-NMR spectra of 2k in DMSO-d$_6$



126 MHz ^{13}C-NMR spectra of 2k in DMSO-d$_6$

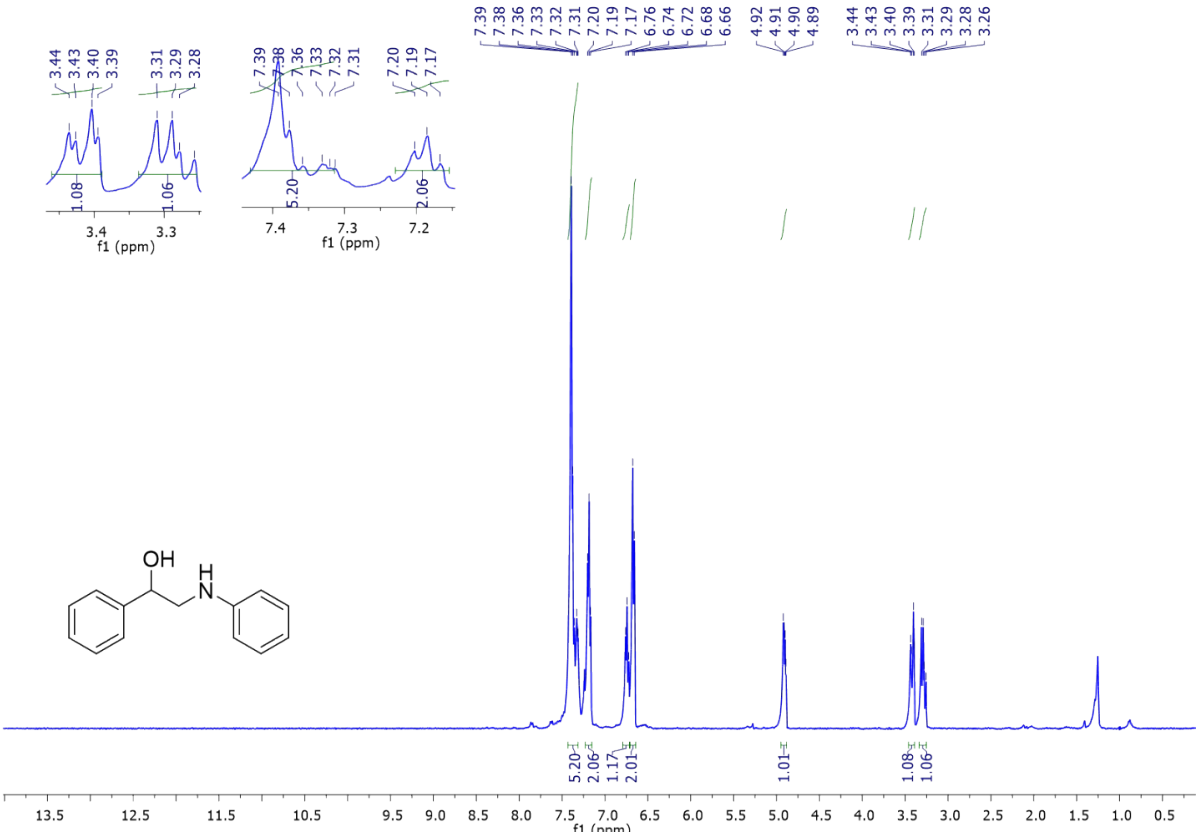


500 MHz ^{1}H-NMR spectra of 2l in DMSO-d$_6$

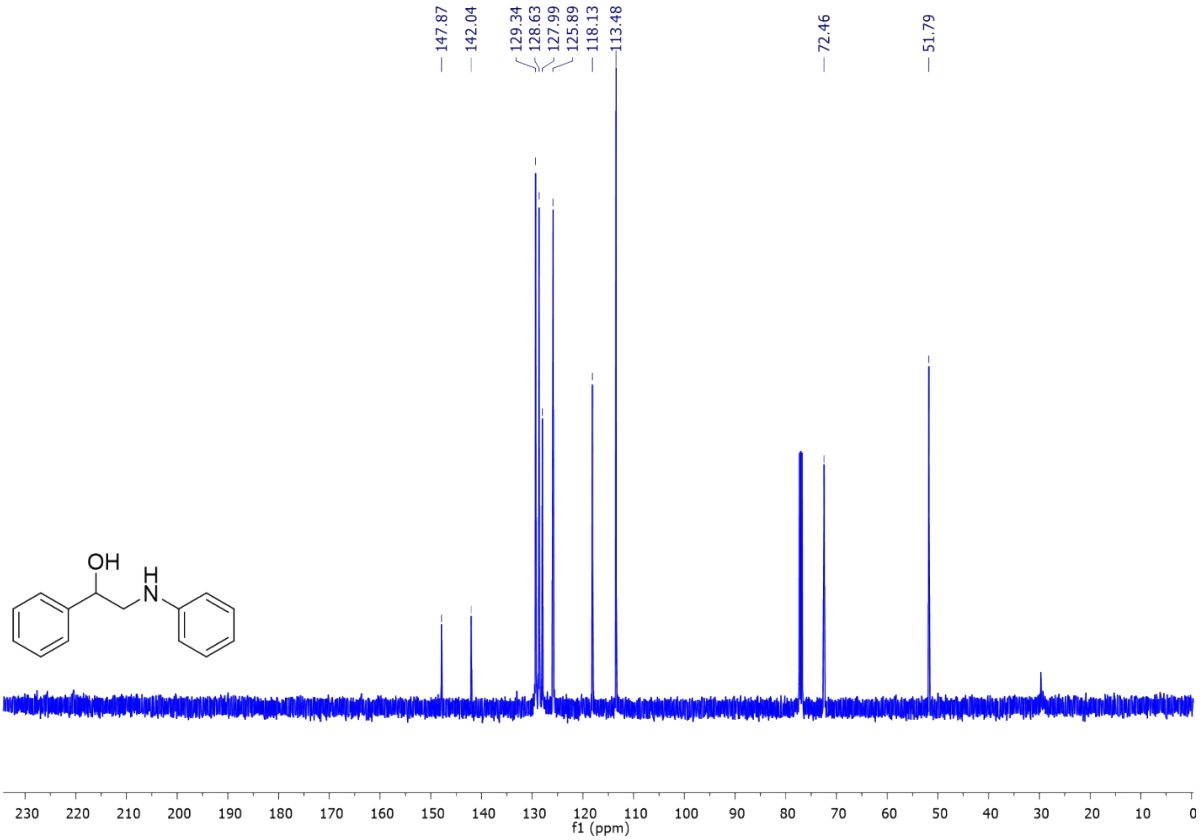


126 MHz ^{13}C-NMR spectra of 2l in DMSO-d_6

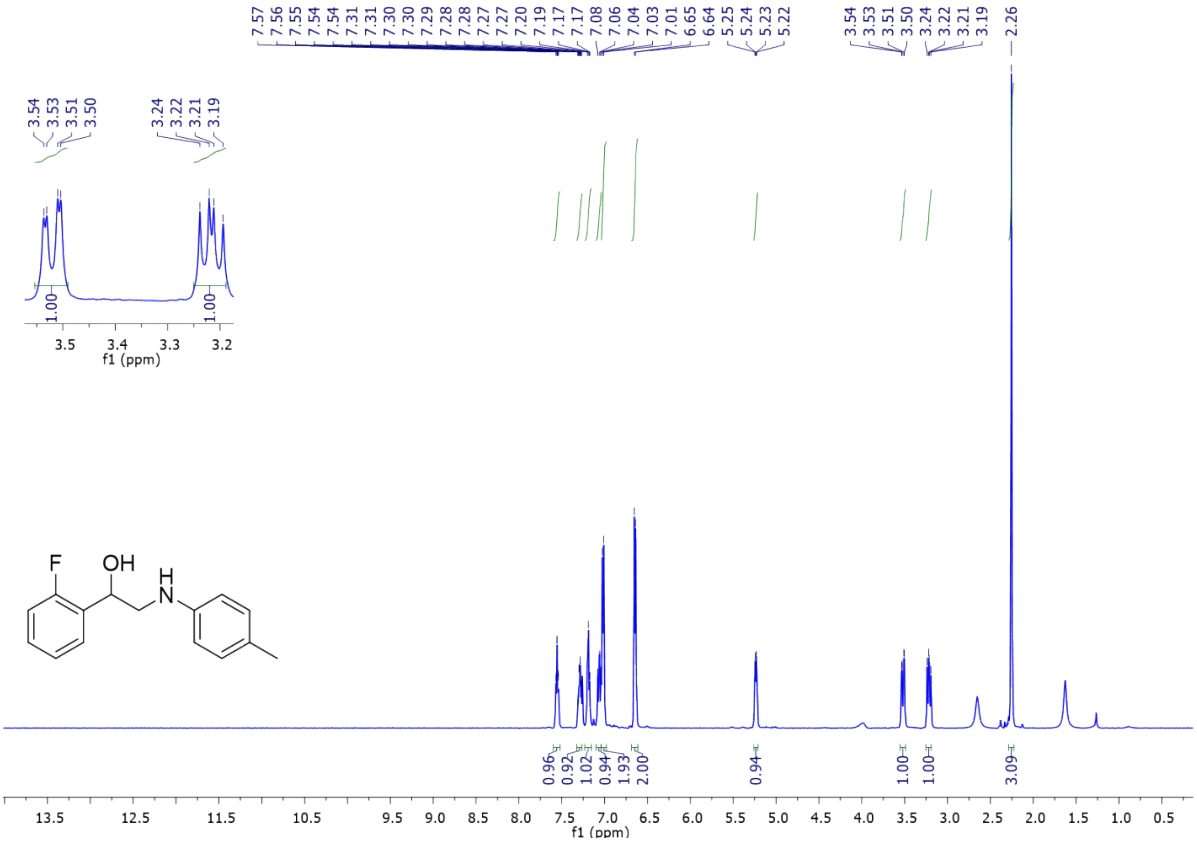
^{1}H and ^{13}C NMR of β-aminol:



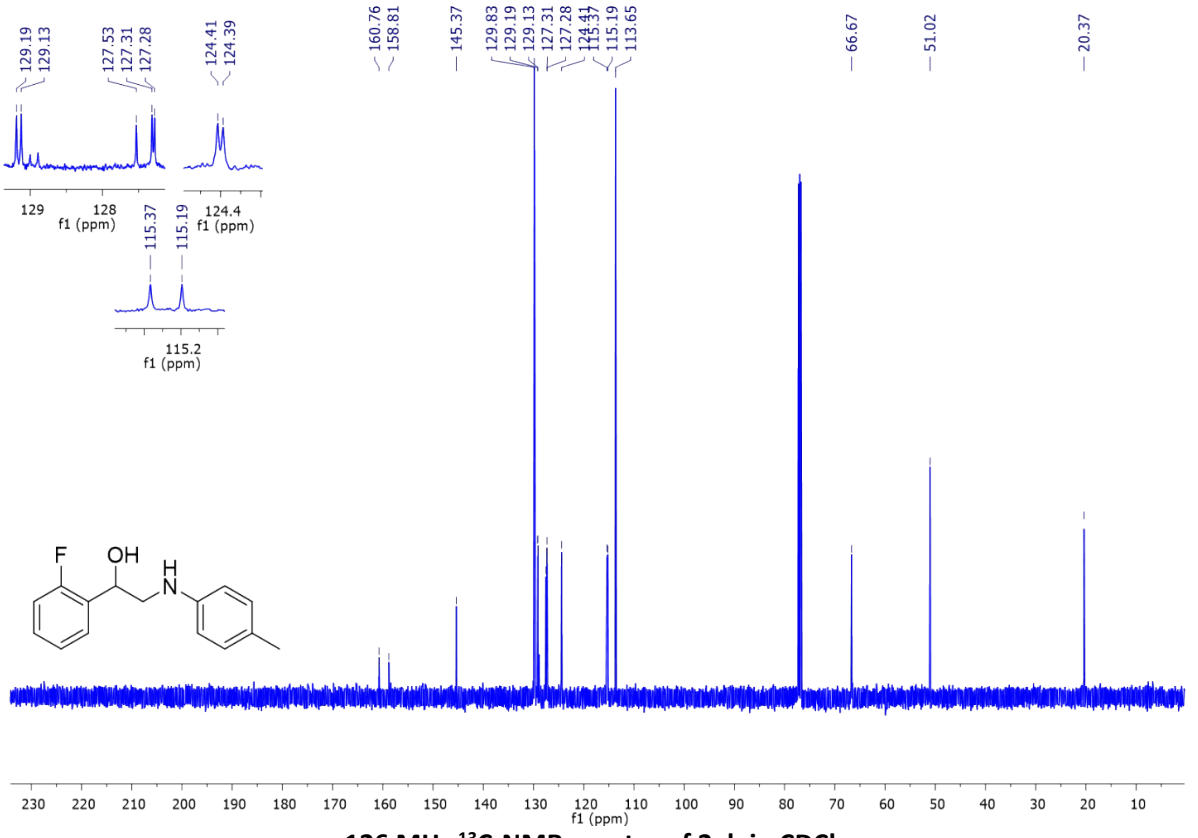
500 MHz ^{1}H-NMR spectra of 2aa in $CDCl_3$



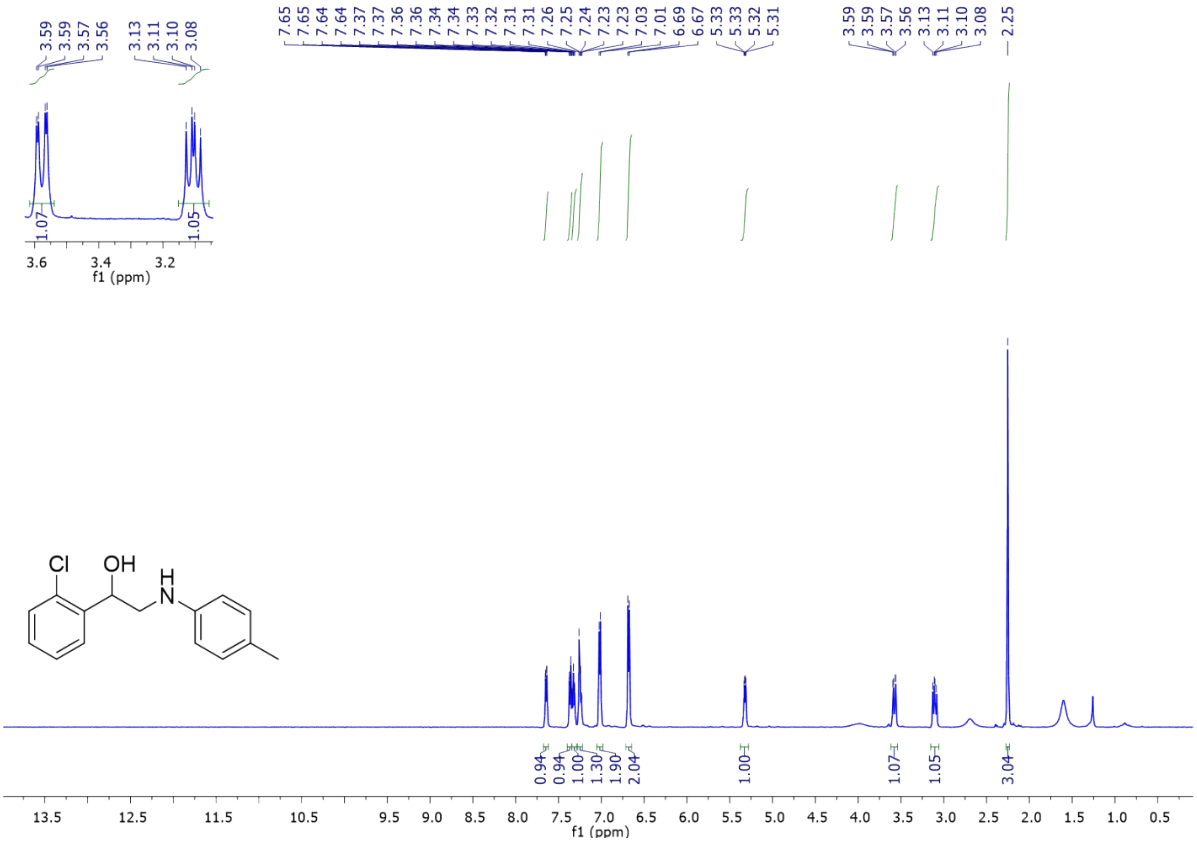
126 MHz ^{13}C-NMR spectra of 2aa in $CDCl_3$



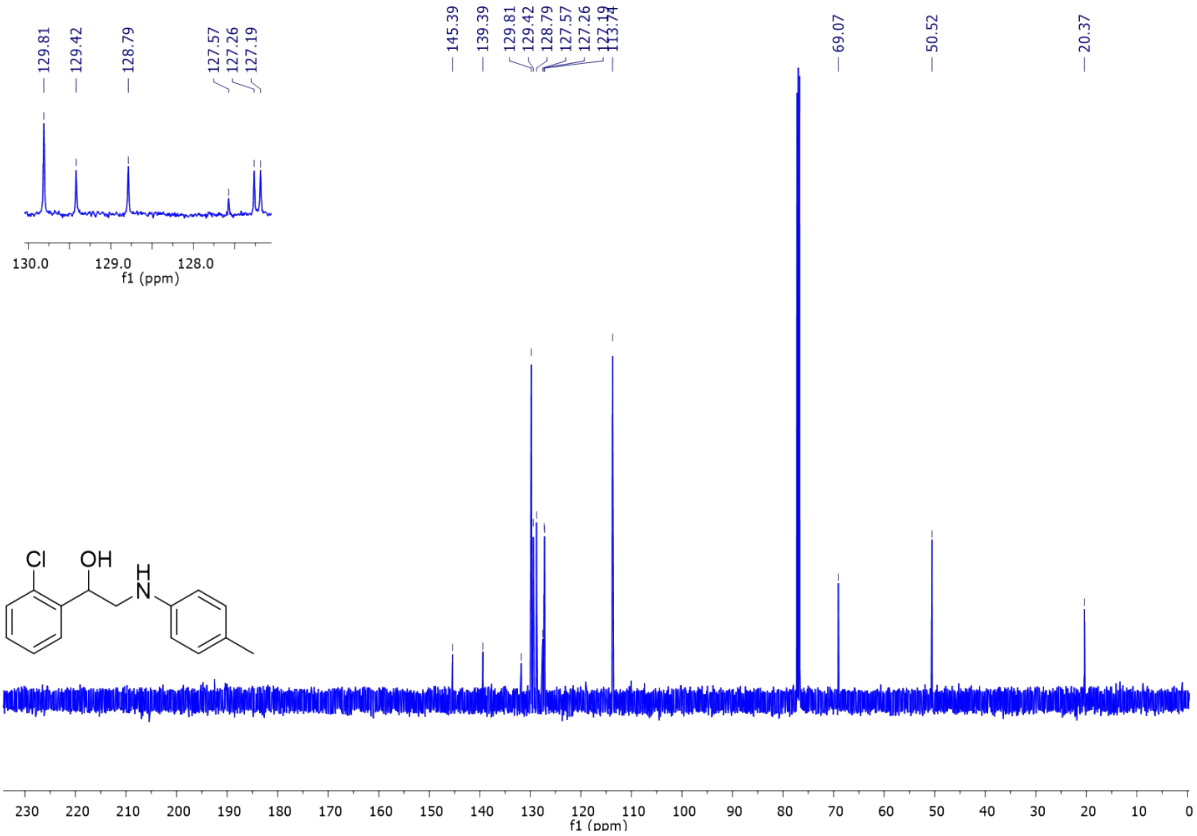
500 MHz ^{1}H-NMR spectra of 2ab in $CDCl_3$



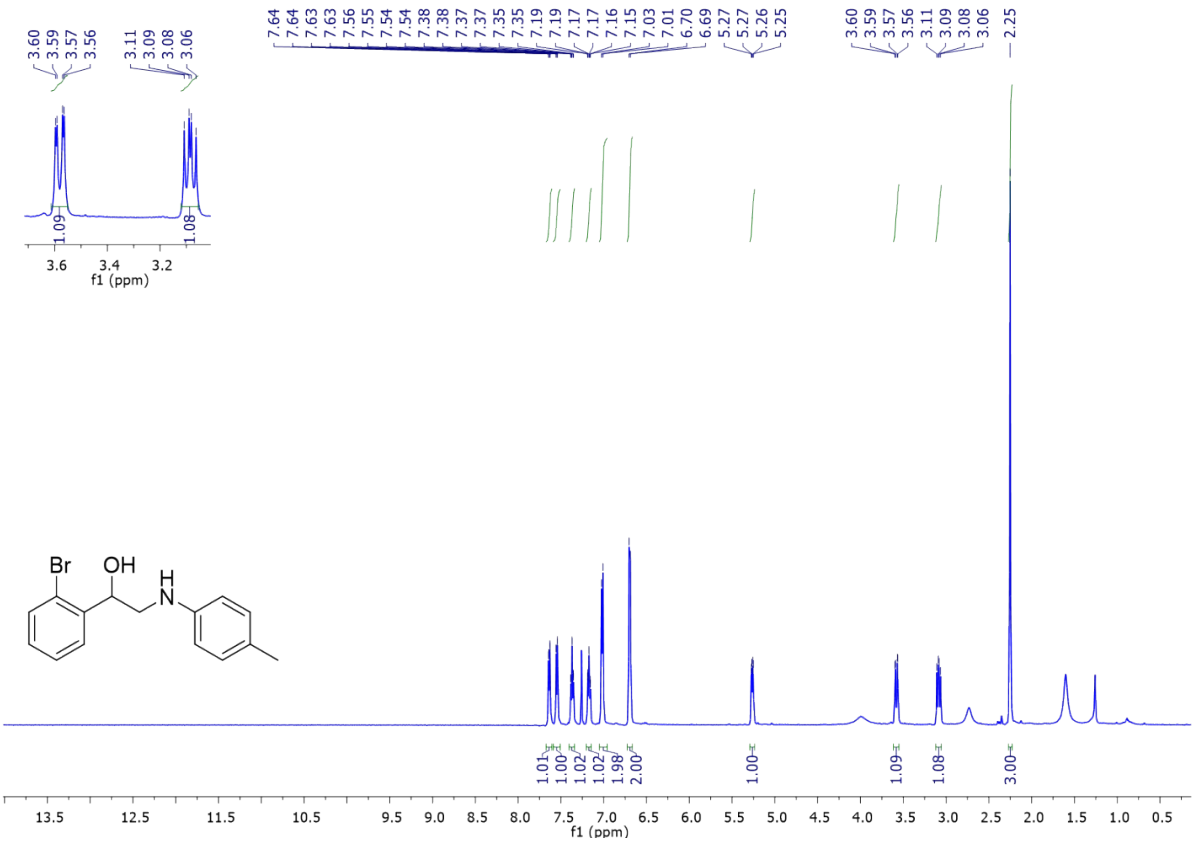
126 MHz ^{13}C-NMR spectra of 2ab in $CDCl_3$



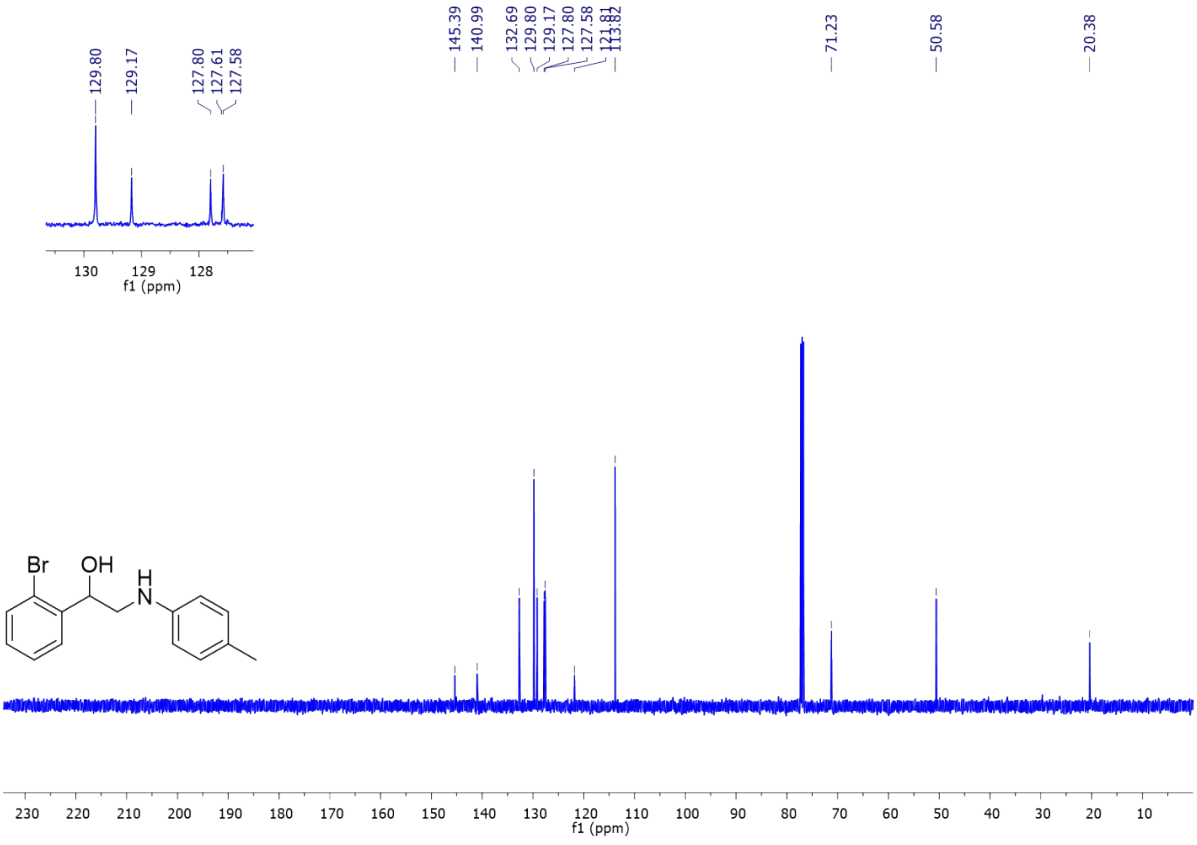
500 MHz ^{1}H-NMR spectra of 2ac in $CDCl_3$



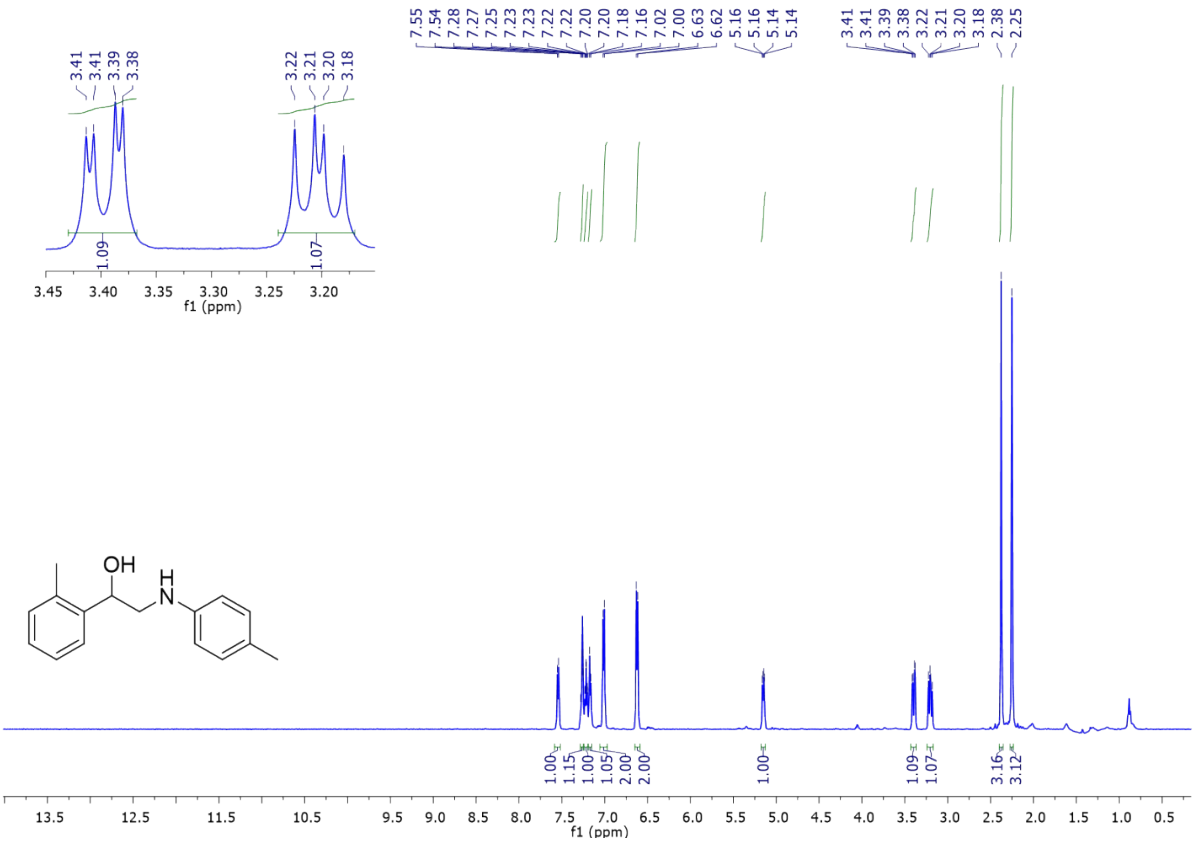
126 MHz ^{13}C-NMR spectra of 2ac in $CDCl_3$



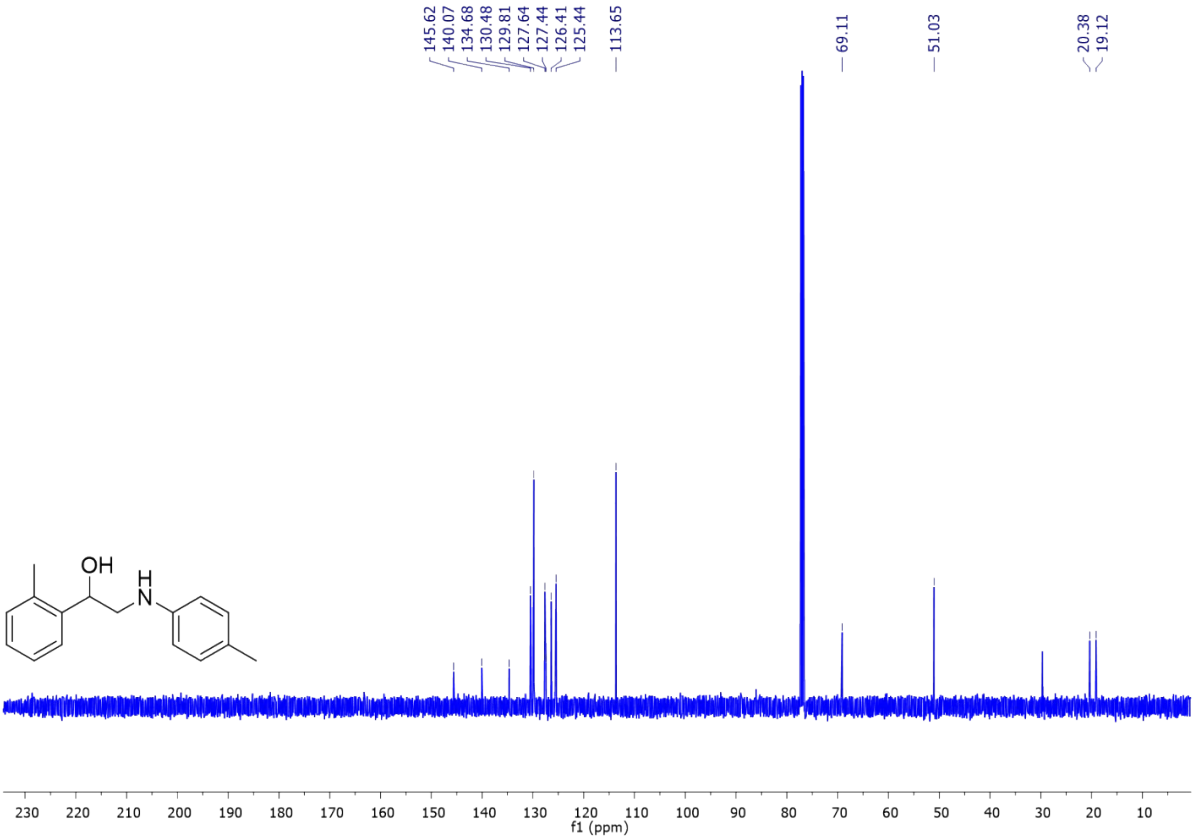
500 MHz ^{1}H-NMR spectra of 2ad in $CDCl_3$



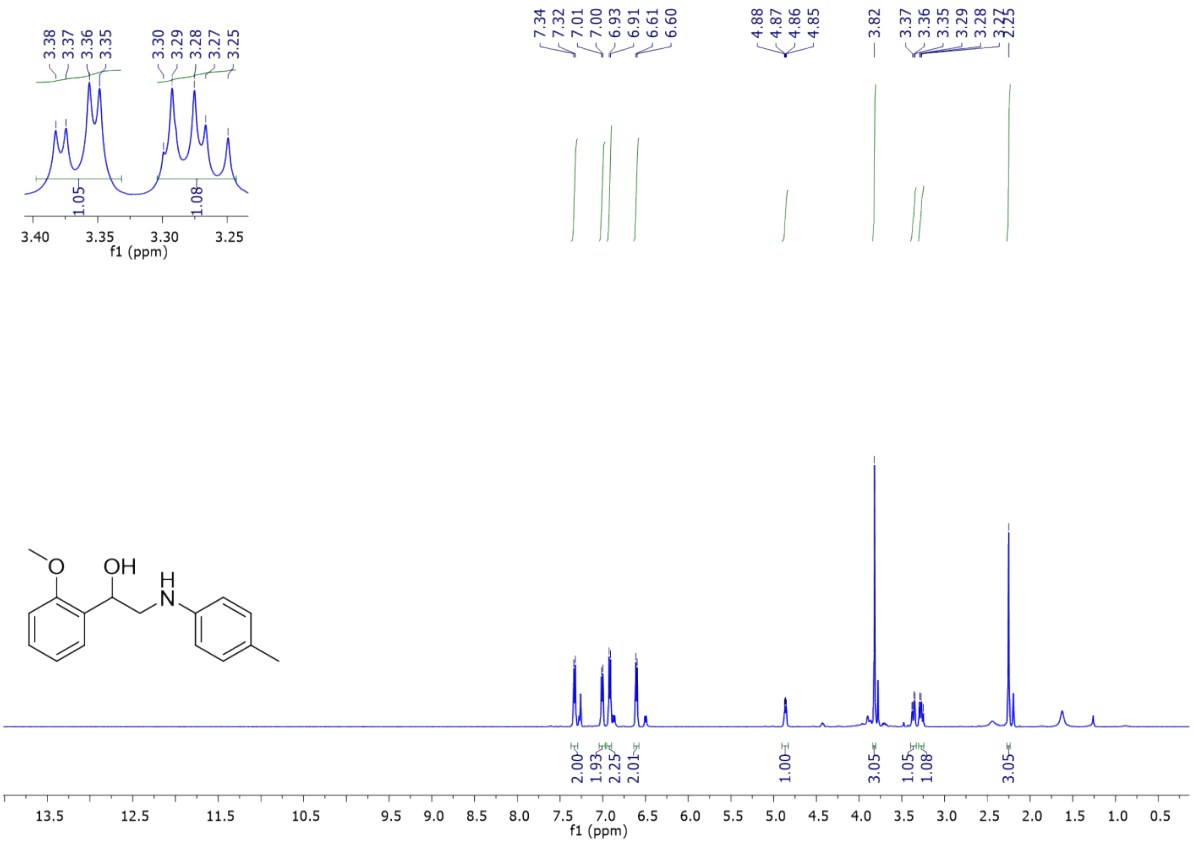
126 MHz ^{13}C-NMR spectra of 2ad in $CDCl_3$



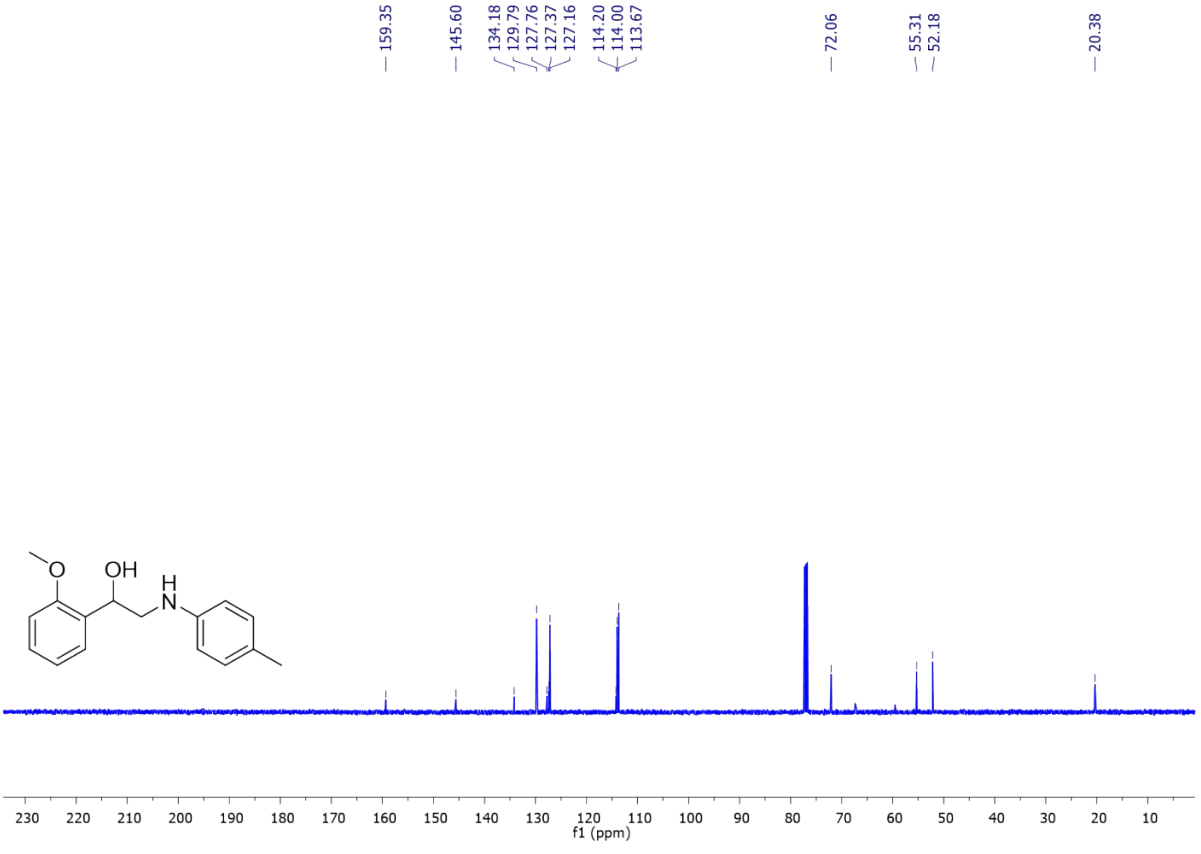
500 MHz ^{1}H-NMR spectra of 2ae in $CDCl_3$



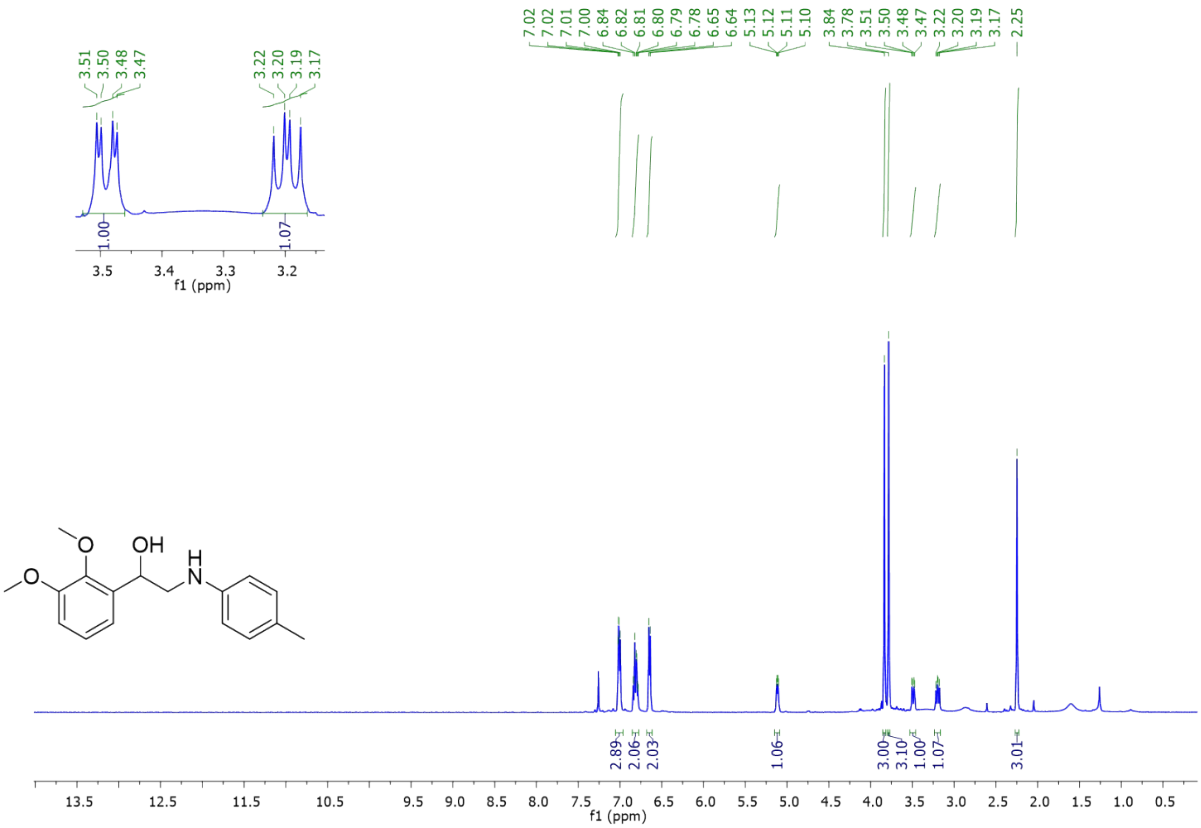
126 MHz ^{13}C-NMR spectra of 2ae in $CDCl_3$



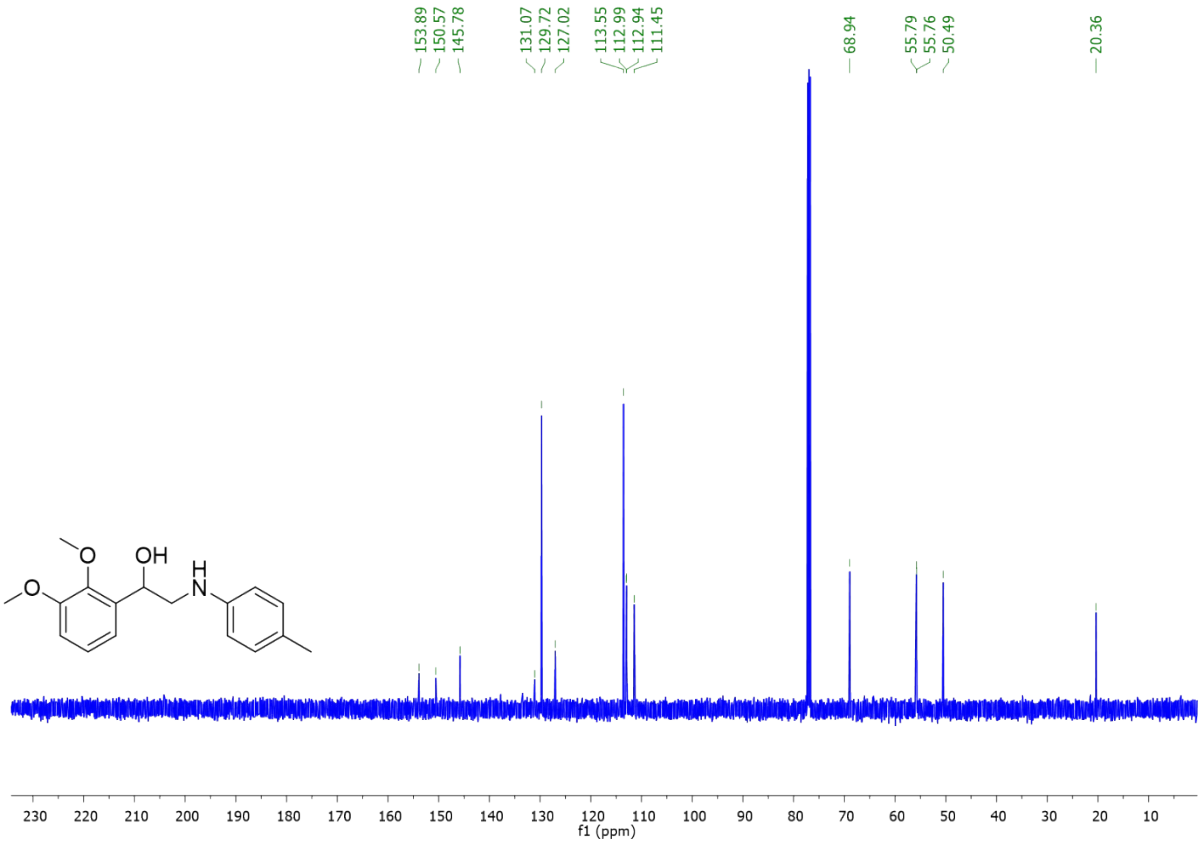
500 MHz ^{1}H-NMR spectra of 2af in $CDCl_3$



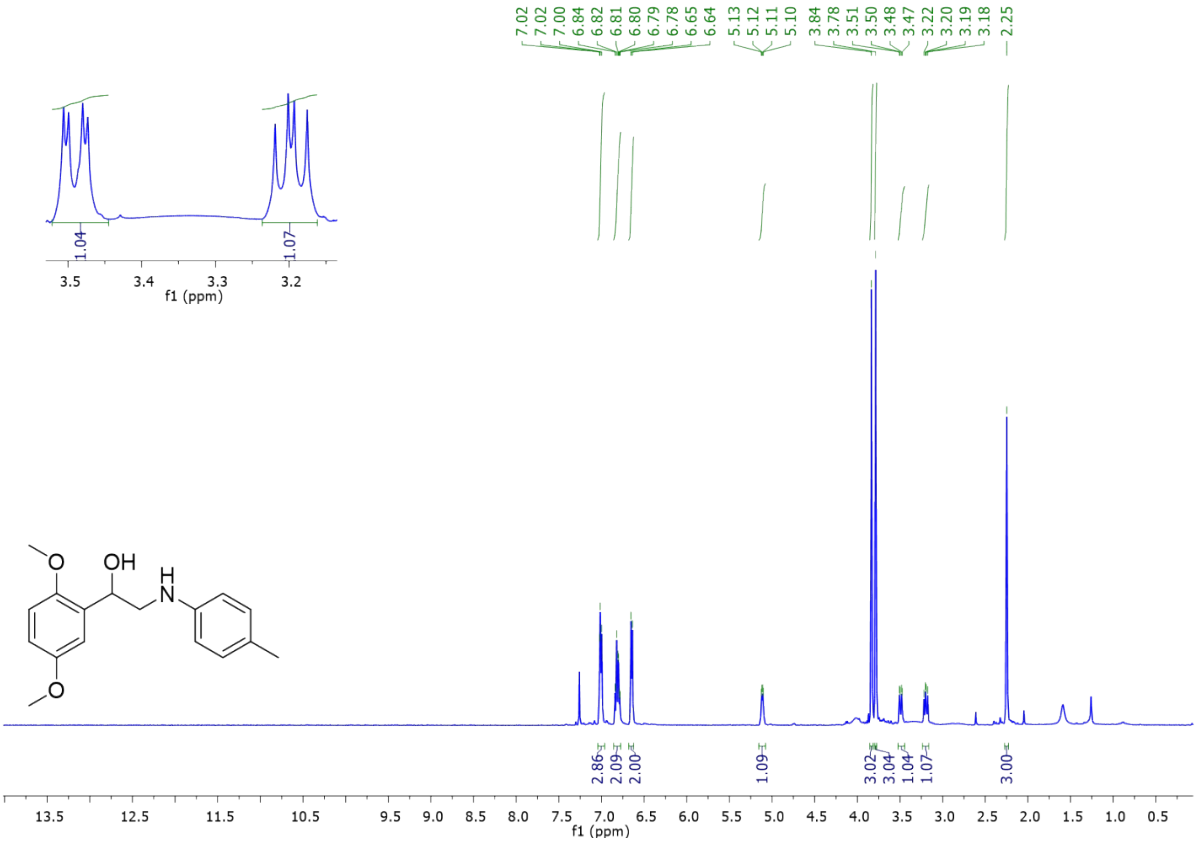
126 MHz ^{13}C-NMR spectra of 2af in $CDCl_3$



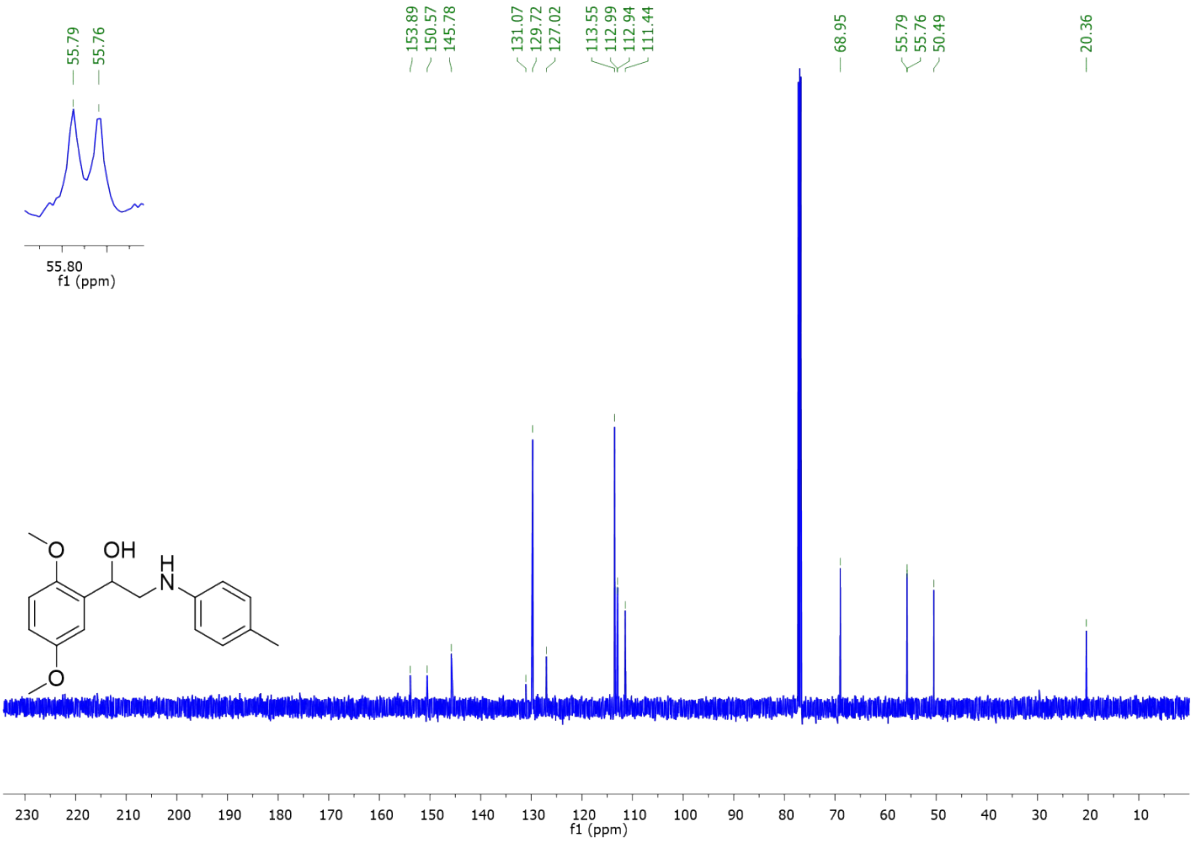
500 MHz ^{1}H-NMR spectra of 2ag in $CDCl_3$



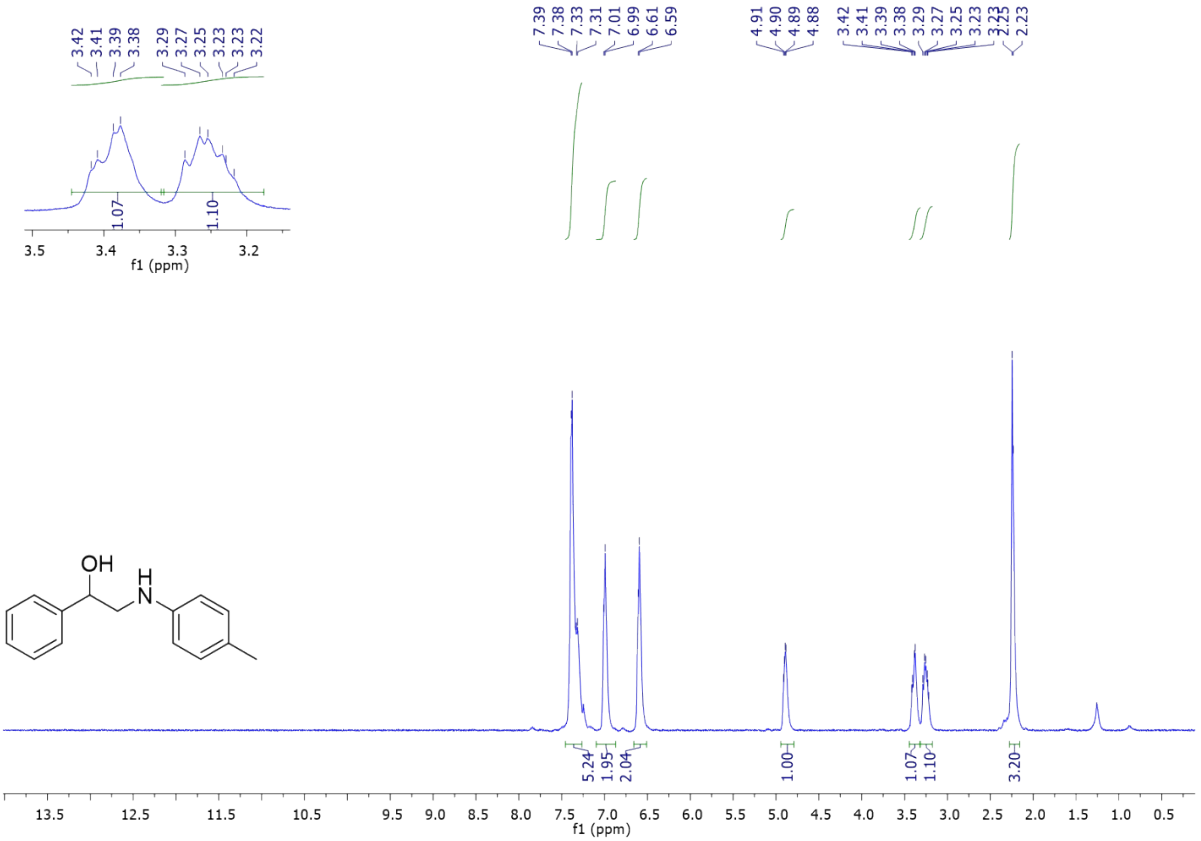
126 MHz ^{13}C-NMR spectra of 2ag in $CDCl_3$



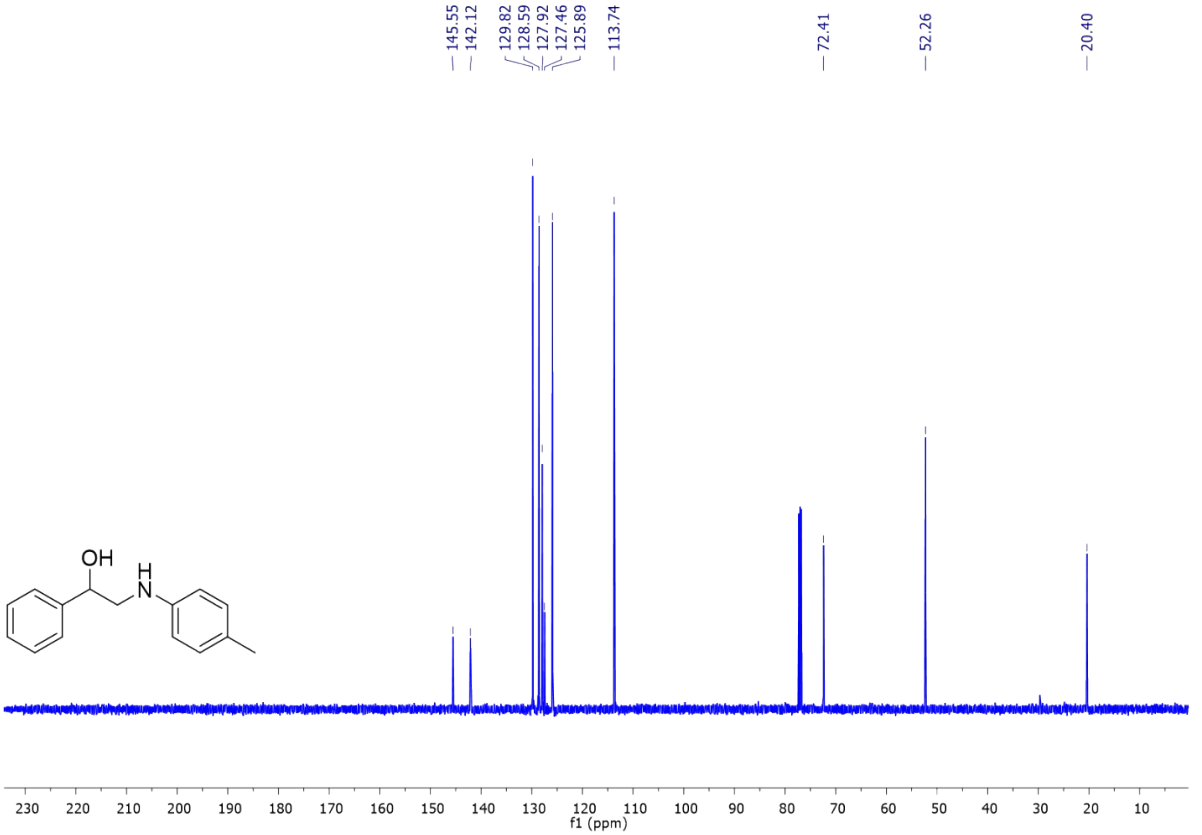
500 MHz ^{1}H-NMR spectra of 2ah in $CDCl_3$



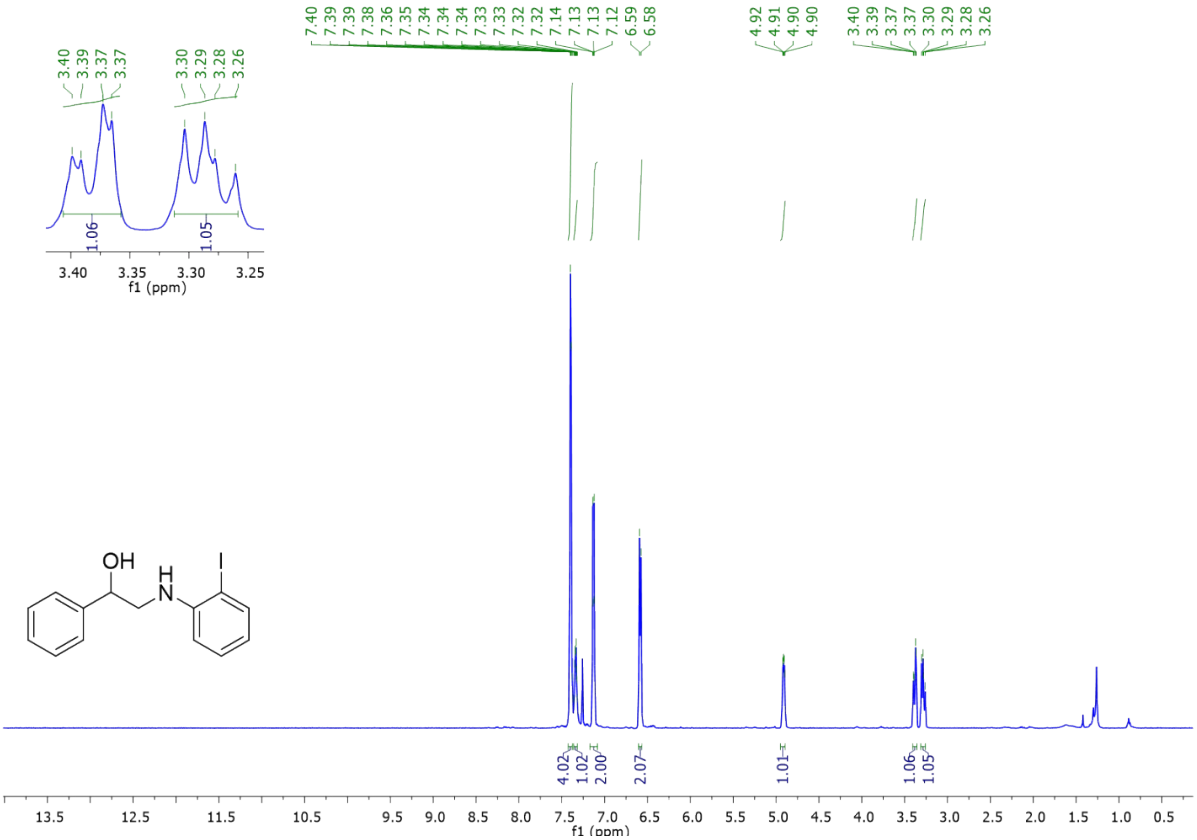
126 MHz ^{13}C-NMR spectra of 2ah in $CDCl_3$



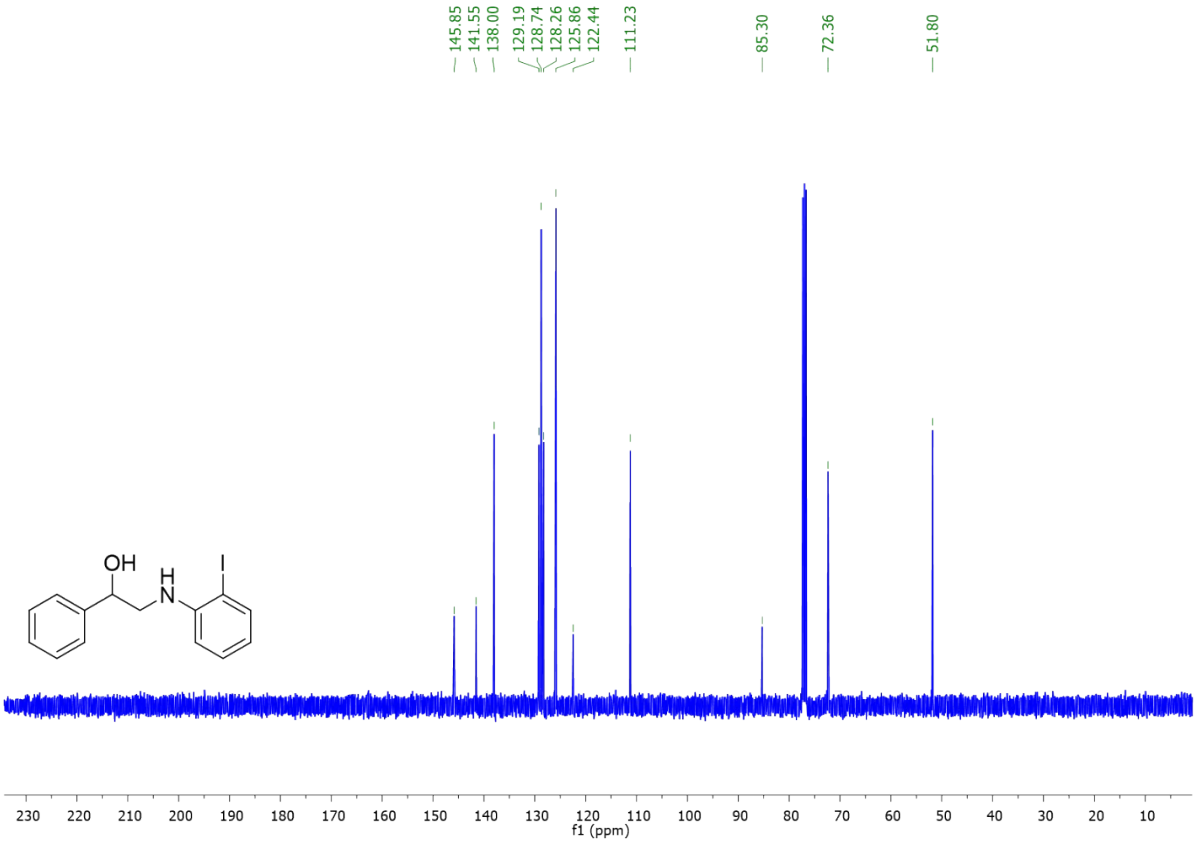
500 MHz ^{1}H-NMR spectra of 2ai in $CDCl_3$



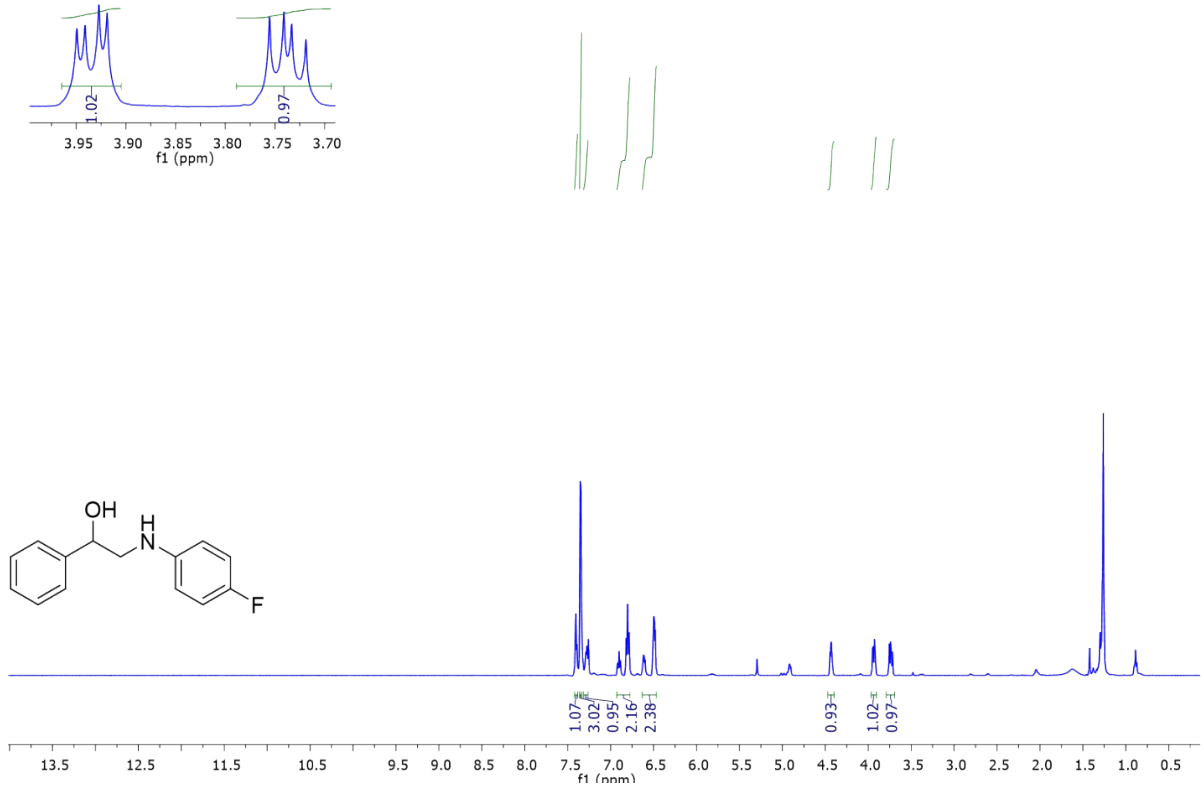
126 MHz ^{13}C-NMR spectra of 2ai in $CDCl_3$



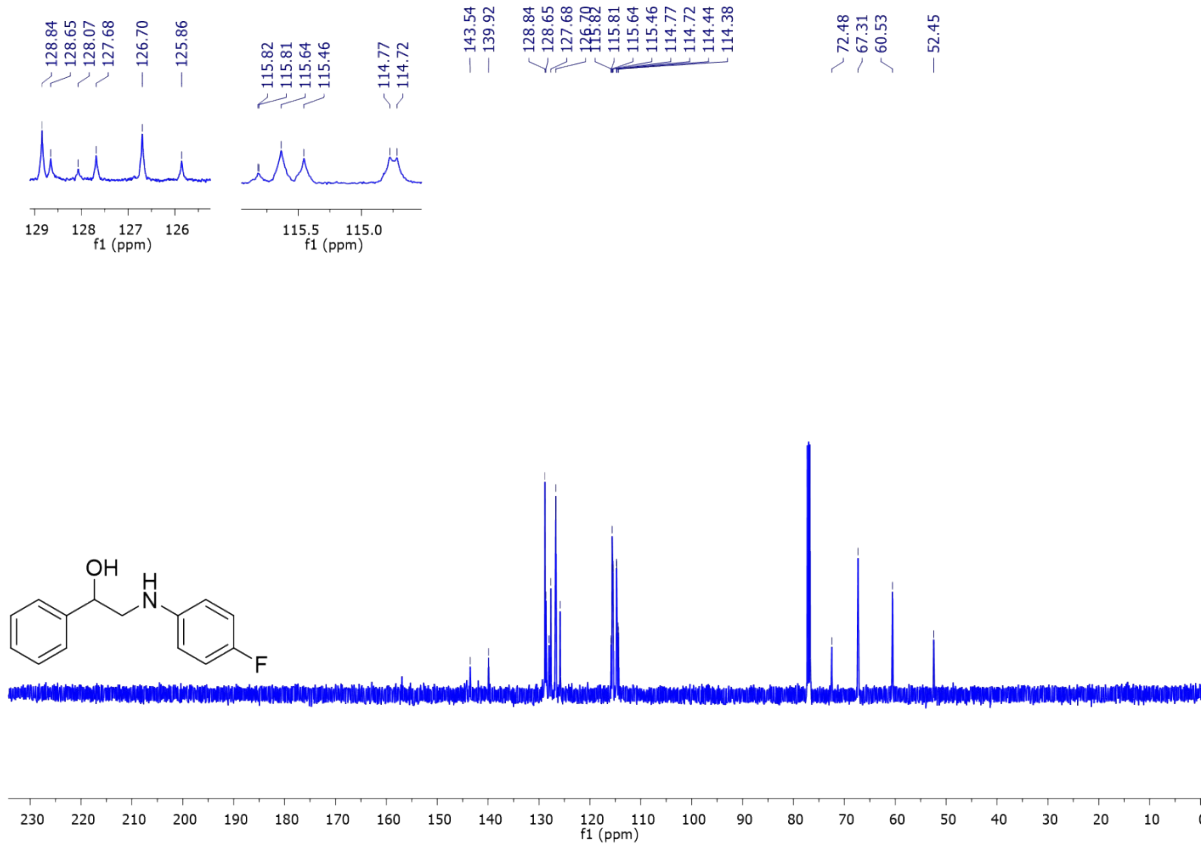
500 MHz ^{1}H-NMR spectra of 2aj in $CDCl_3$



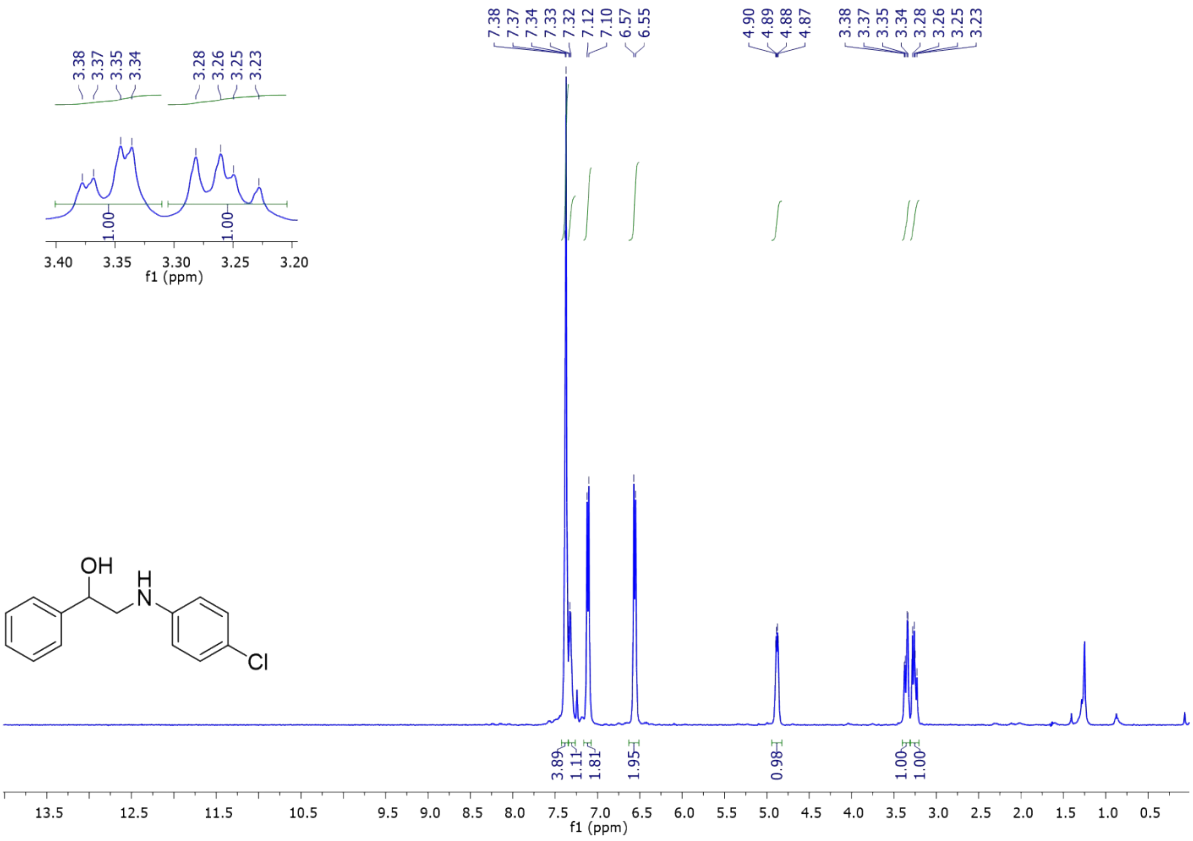
126 MHz ^{13}C-NMR spectra of 2aj in $CDCl_3$



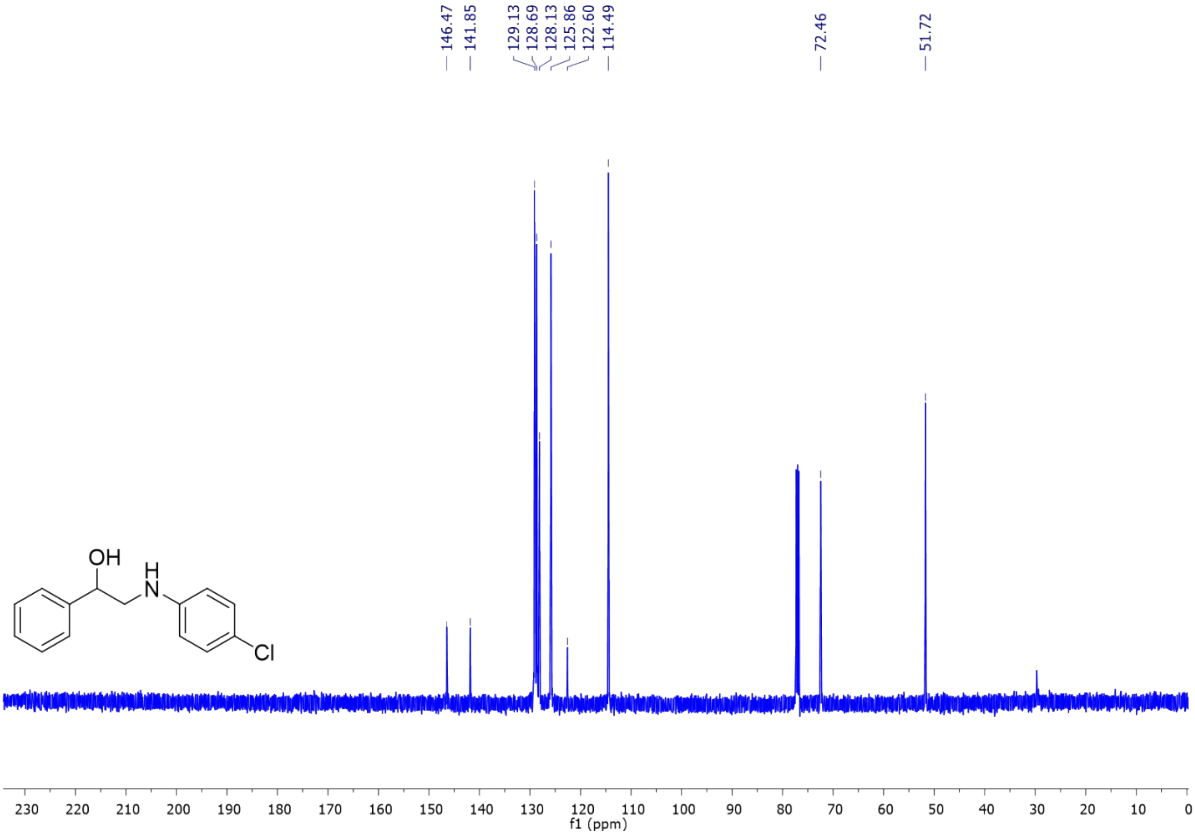
500 MHz ^{1}H-NMR spectra of 2ak in $CDCl_3$



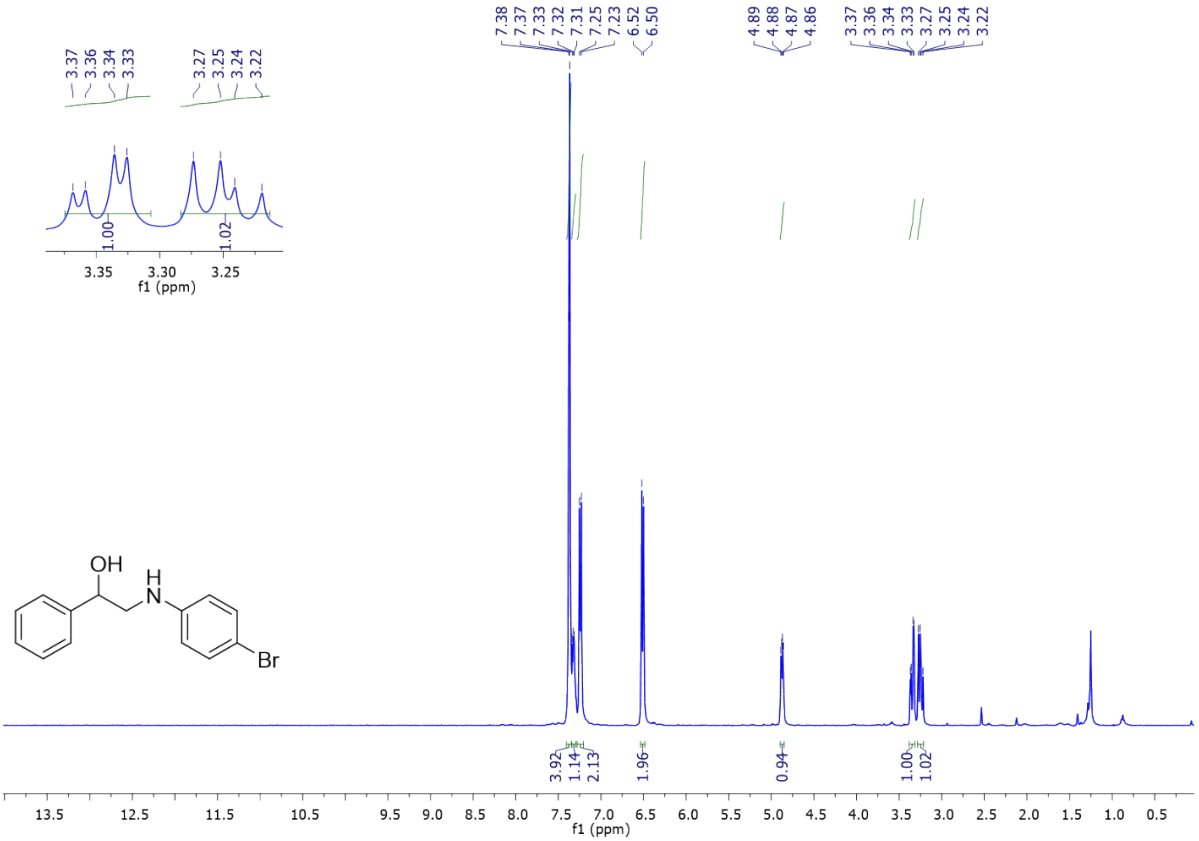
126 MHz ^{13}C-NMR spectra of 2ak in $CDCl_3$



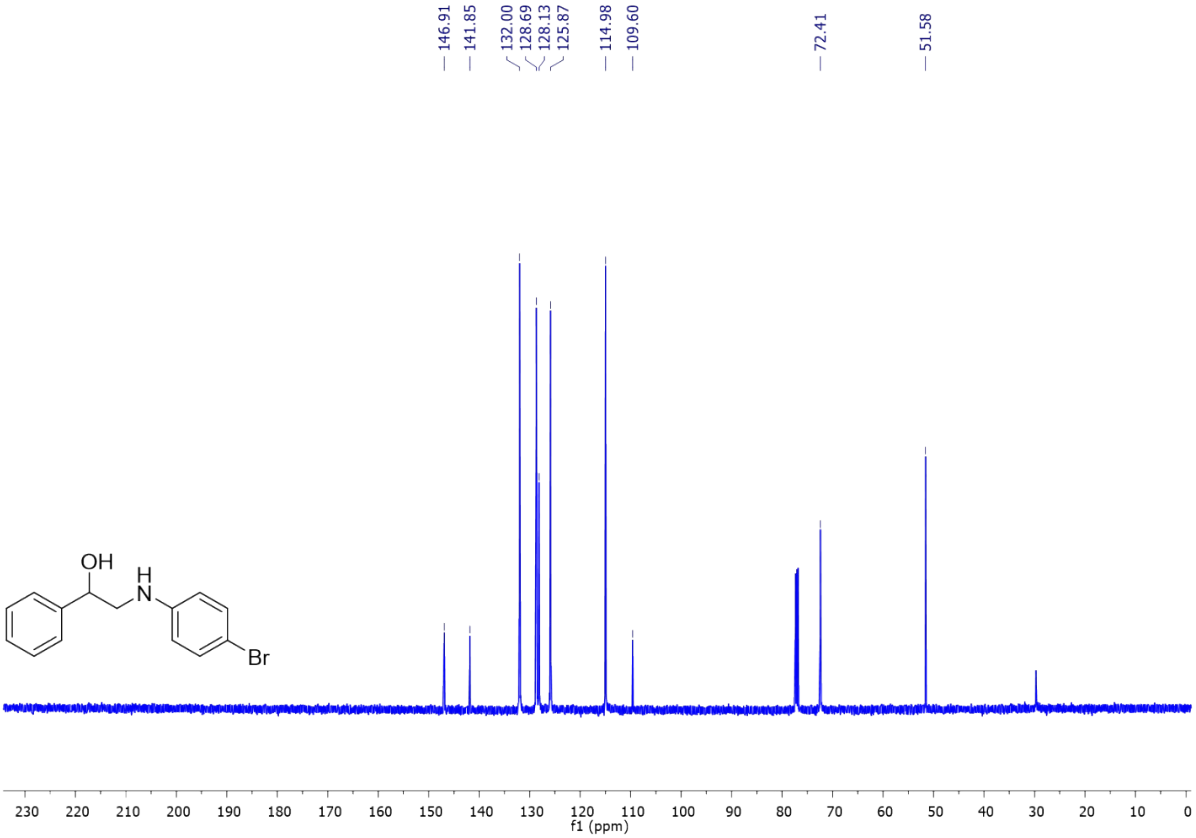
500 MHz ^{1}H-NMR spectra of 2al in $CDCl_3$



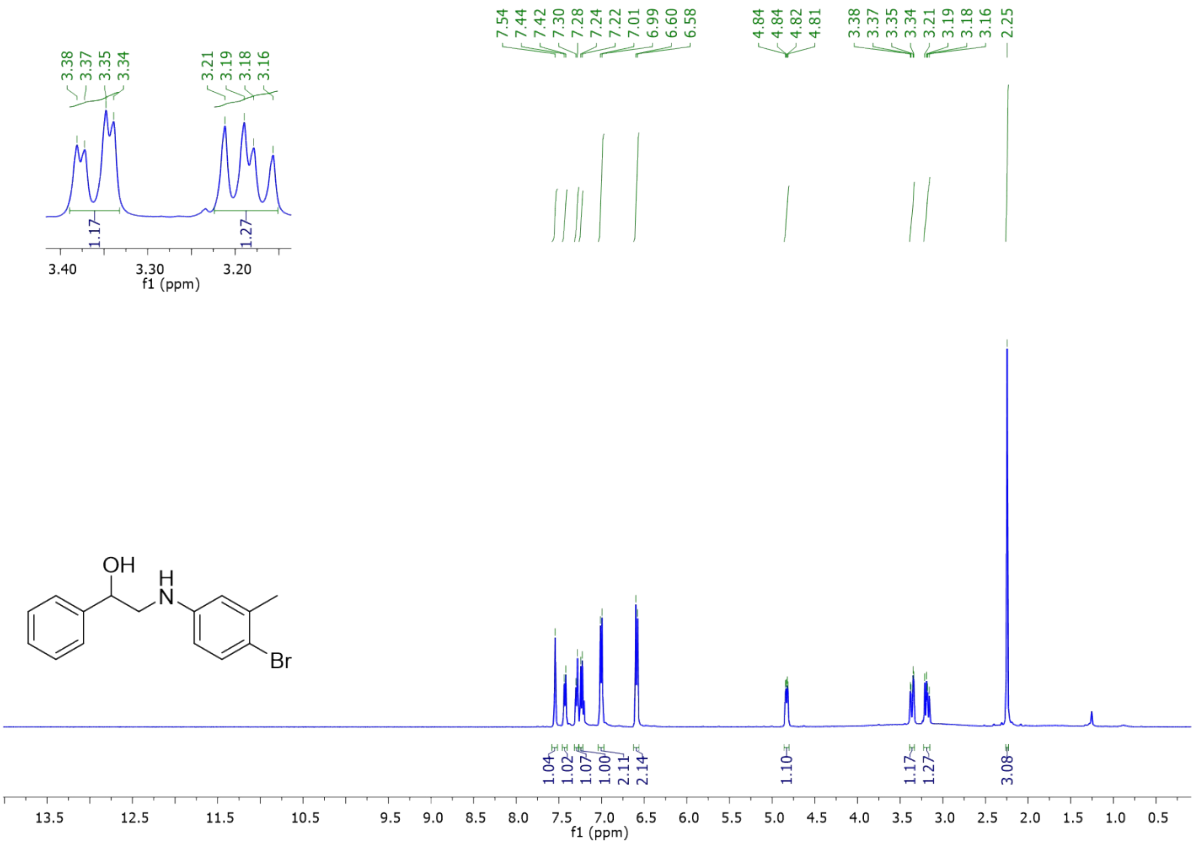
126 MHz ^{13}C-NMR spectra of 2al in $CDCl_3$



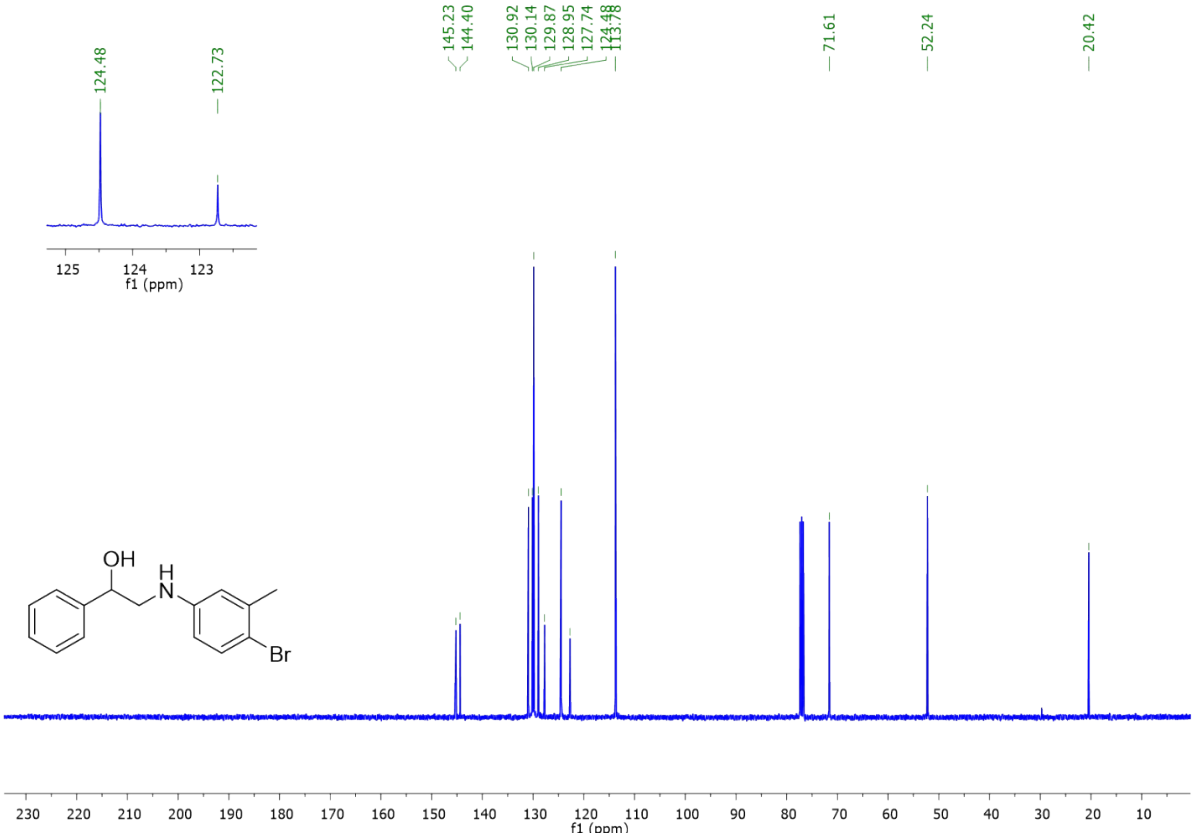
500 MHz ^{1}H-NMR spectra of 2am in $CDCl_3$



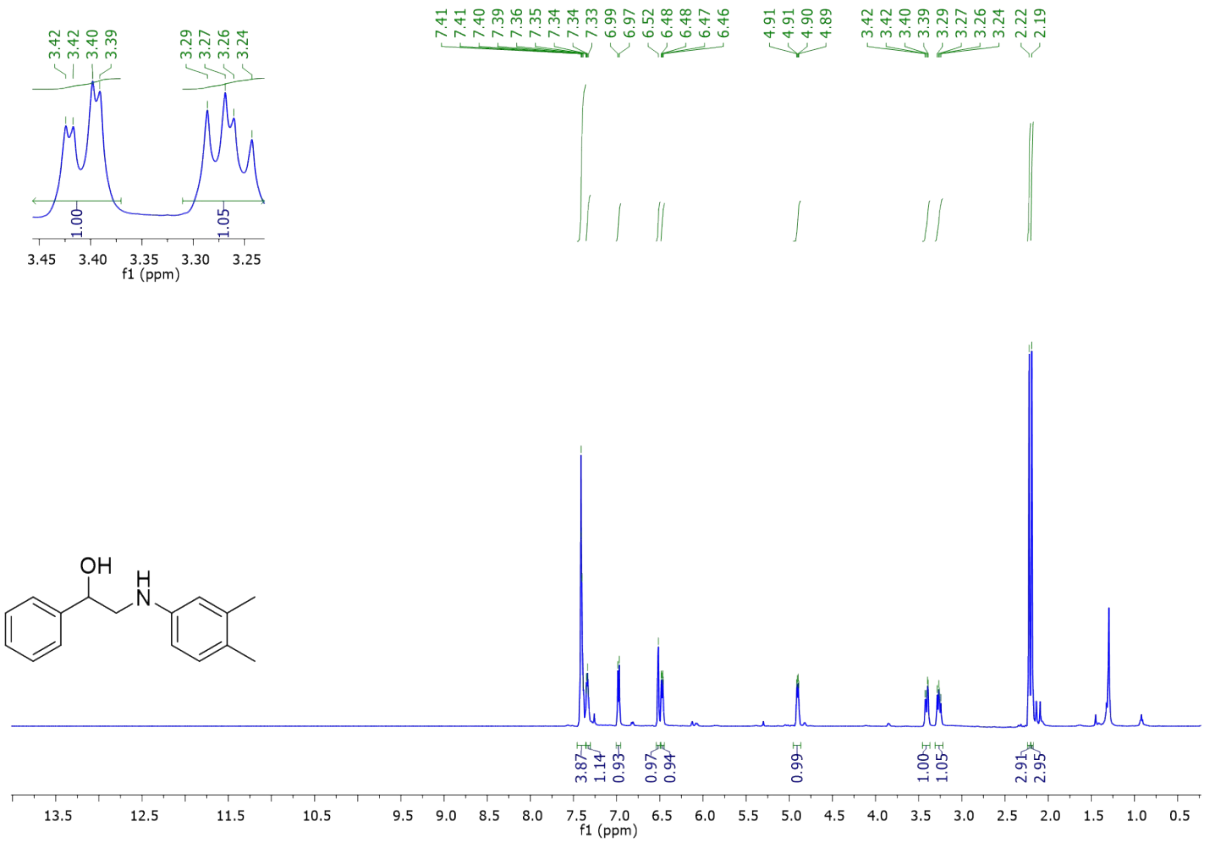
126 MHz ^{13}C-NMR spectra of 2am in $CDCl_3$



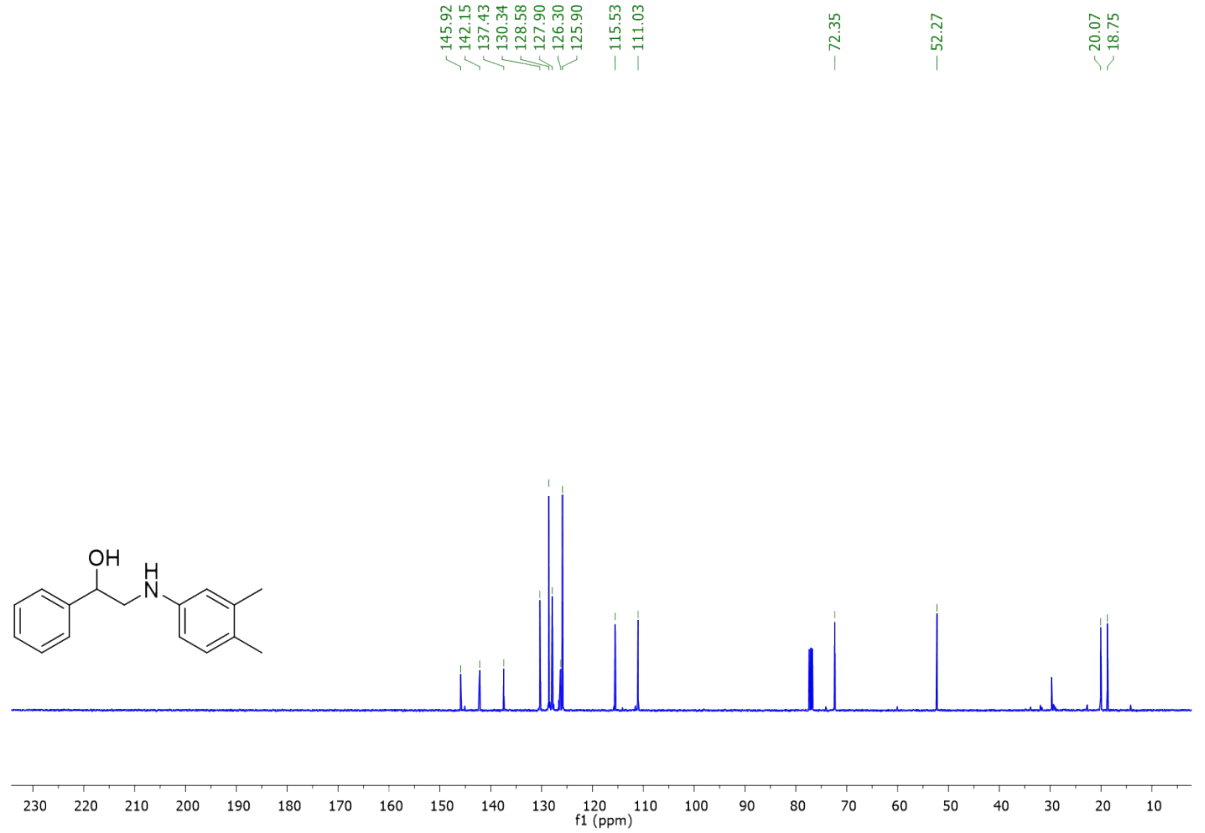
500 MHz ^{1}H-NMR spectra of 2an in $CDCl_3$



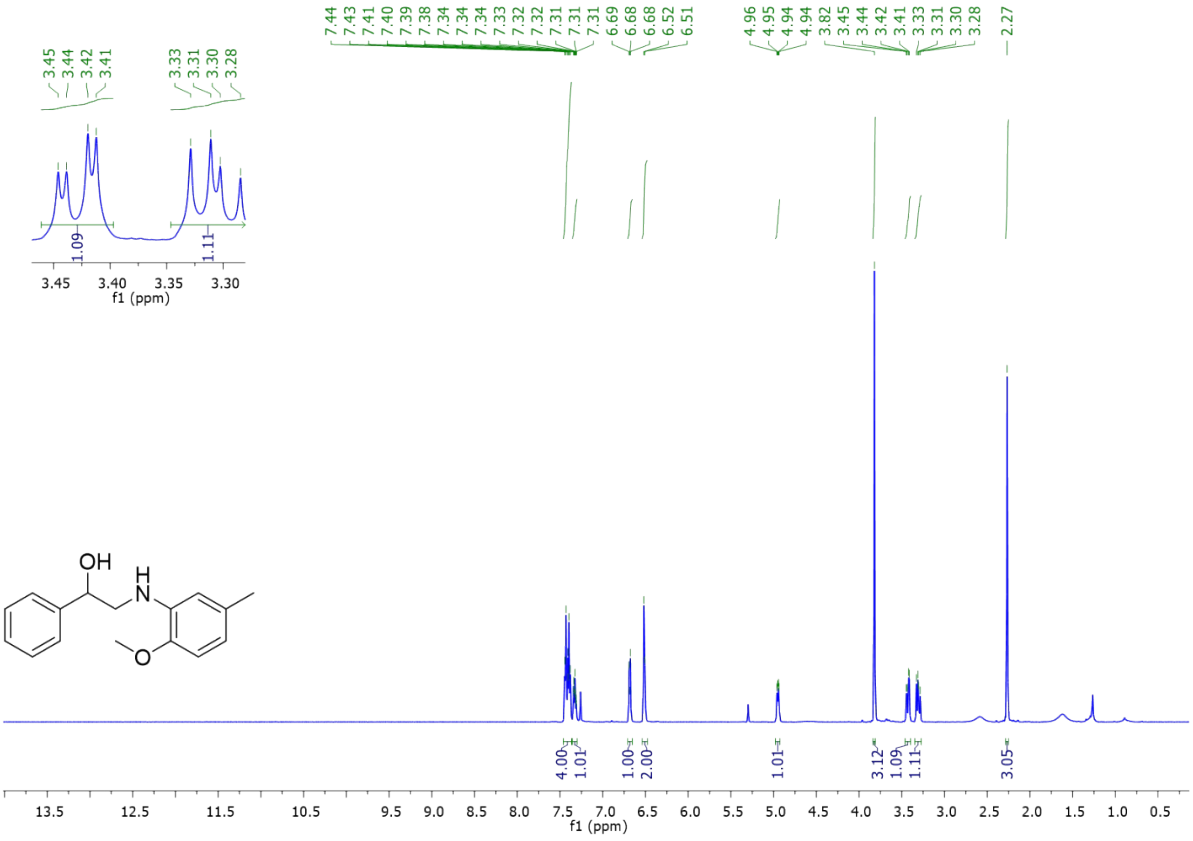
126 MHz ^{13}C-NMR spectra of 2an in $CDCl_3$



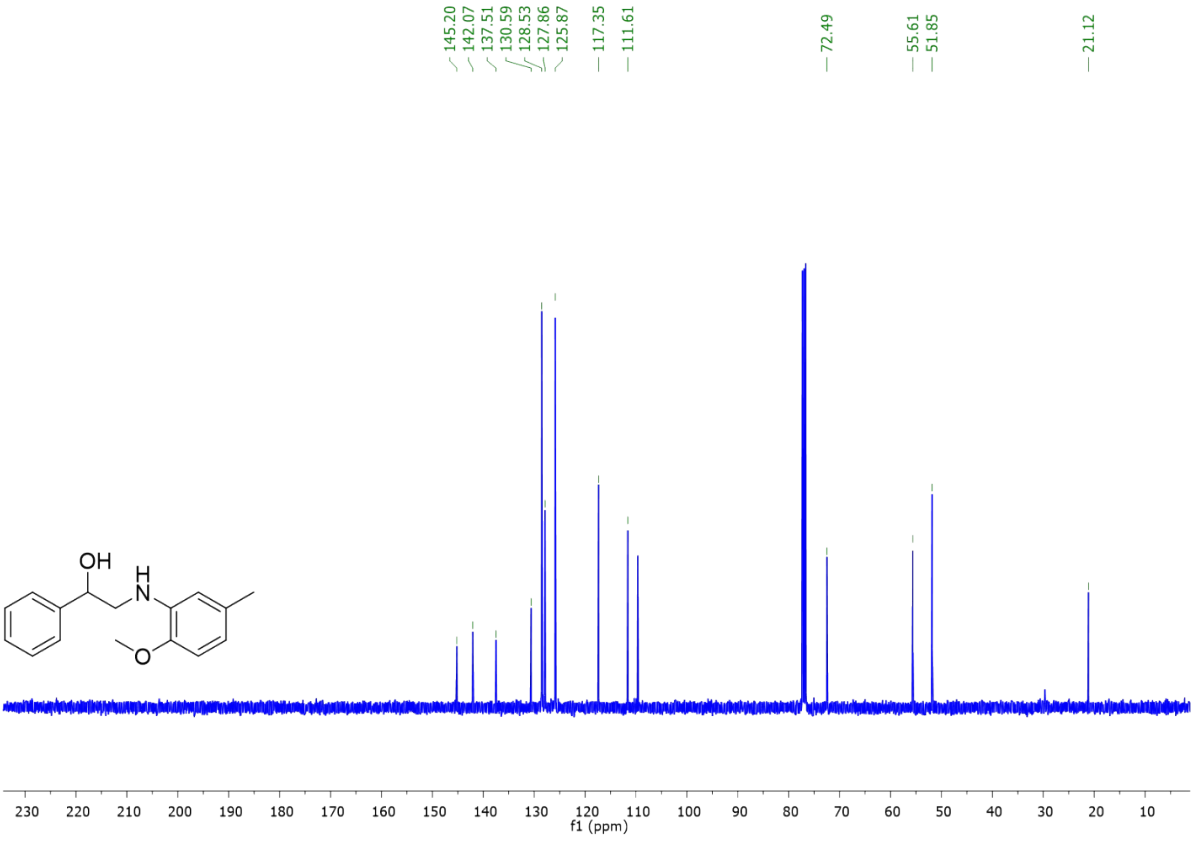
500 MHz ^{1}H-NMR spectra of 2ao in $CDCl_3$



126 MHz ^{13}C-NMR spectra of 2ao in $CDCl_3$



500 MHz ^{1}H-NMR spectra of 2ap in $CDCl_3$



126 MHz ^{13}C-NMR spectra of 2ap in $CDCl_3$

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