Supporting Information

Nano-particle Catalyzed Reaction (NPCR) : ZnO-NP catalyzed Ugi-reaction in aqueous medium

Atul Kumar,* Deepti Saxena and Maneesh Kumar Gupta

Medicinal and Process Chemistry Division, CSIR-Central Drug Research Institute, Lucknow-226001, India
dratulsax@gmail.com

General: All the reagents and solvents were purchased from Sigma-Aldrich or Merck chemical Co. Column chromatography was performed using Spectrochem siliga gel (100-200). Organic solvents were concentrated under reduced pressure on Ika rotary evaporator. The progress of reaction was checked by thin-layer chromatography. The plates were visualized first with UV illumination followed by iodine. ^{1}H and ^{13}C NMR spectra were obtained using either a Bruker DRX-200 or AV-300 spectrometer. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard and ^{1}H NMR Spectra are reported in the order: multiplicity, coupling constant (J value) in hertz (Hz) and no of protons; signals were characterized as s (singlet), d (doublet), t (triplet), m (multiplet). ^{13}C NMR spectra were recorded at 50 or 75 MHz. Mass spectra were obtained using JEOL SX-102 (ESI) instrument. Elemental analysis was performed using a Perkin-Elmer Autosystem XL Analyzer.

General experiment procedure for the synthesis of compound (5)

Aldehyde (1 mmol), aniline (2 mmol), isocyanide (1 mmol) and ZnO <50 nm (15 mol %) were placed into a flask .Water (3 mL) was added to the mixture and stirred for 5 min at room temperature. Progress of reaction was monitored by TLC, after completion of the reaction, the reaction mixture was diluted with water and extracted with ethyl acetate, dried over sodium sulphate and evaporated under vacuum to give crude product, which was purified by silica gel (100-200 mesh) coloum chromatography to afford the corresponding product.

General procedure for the synthesis of compound (6)

In a 50-mL round-bottom flask, iodine (0.2 mmol), 2-arylamino-2-phenylacetimidamide (1 mmol), and surfactant (sodium dodecyl sulfate, 10 mol %) were added in H_2O (5 mL) and stirred for 6h at 80°C and reaction was monitored by TLC. The aqueous part was diluted and extracted with ethyl acetate, the organic layer was washed with brine and dried over anhydrous Na_2SO_4. Evoperation of solvent gave a crude product which was purified by column chromatography (silica gel, ethyl acetate:hexane).

General procedure for the synthesis of α-Amino Acid (7)

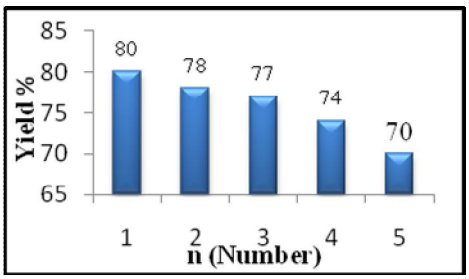
In a 50-mL round-bottom flask, 2-arylamino-2-phenylacetimidamide (1 mmol) was added in 1:3 ratio of H_2O**:** EtOH with 20 mol% NaOH and stirred for 3h at 70°C. After completion of reaction as evidenced by TLC, solvent was removed in vacuum. The aqueous part was diluted and extracted with ethyl acetate, the organic layer was washed with brine and dried over anhydrous Na_2SO_4. Evoperation of solvent gave a crude product which was purified by column chromatography (silica gel, ethyl acetate:hexane).

ZnO-NPs purchase from Sigma-Aldrich

Catlog No. 677450. <50 nm particle size.

Table 2. Recovery and Reuse of ZnO-Nanoparticle for the Synthesis of **5a**.

	Cycle				
Entry	1	2	3	4	5
Yield (%)	80	78	77	74	70



Characterization data for synthesized compounds:

N-Tert-butyl-N',2-diphenyl-2-(phenylamino)acetimidamide (5a)

Solid, ESI MS (*m/z*) = 358 (M+H), IR (KBr) ν_{max} : 3289, 3027, 2966, 2906, 1634, 1601, 1591, 1485, 1310, 1253, 1185, 1166, 1070, 745 cm $^{-1}$. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H **:** 1.48 (s, 9H), 4.22 (s, 1H, NH), 4.92 (s, 1H, CH), 6.16 (s, 1H, NH), 6.51 (d, *J* = 5.7 Hz, 2H), 6.66 (t, *J* = 1.0 Hz, 1H), 6.96 (d, *J* = 5.1 Hz, 2H), 7.08-7.13 (m, 5H), 7.29 (t, *J* = 4.2 Hz, 1H), 7.40 (q, *J* = 1.3 Hz, 4H). ^{13}C NMR (50 MHz; $CDCl_3$) δ_C : 29.6, 52.1, 56.5, 112.1, 119.0, 120.0, 123.4, 127.4, 128.8, 128.9, 128.9, 139.9, 146.0, 148.9, 158.8. Analysis calculated for : $C_{24}H_{27}N_3$, C 80.63, H 7.61, N 11.75, Found : C 80.58, H 7.53, N 11.82.

2-(4-Chlorophenyl)-N-cyclohexyl-N'-(4-methoxyphenyl)-2-((4-methoxyphenyl)amino)acetimidamide (5b)

Solid, ESI MS (*m/z*) = 478 (M+H), IR (KBr) ν_{max} : 3319, 3030, 2860, 2730, 2140, 1650, 747 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H :1.27-1.59 (m, 8H), 1.60 (br, s, 2H), 1.91 (br, s, 1H), 3.80 (s, 3H, OCH_3), 3.95 (s, 3H, OCH_3), 4.67 (s, 1H, NH), 5.32 (s, 1H, CH), 6.11 (s, 1H, NH), 6.44 (d, *J* = 8.5 Hz, 2H), 6.94 (d, *J* = 8.6 Hz, 2H), 7.04 (d, *J* = 6.4 Hz, 4H), 7.28-7.37(m, 4H).^{13}C NMR (50 MHz; $CDCl_3$) δ_C : 25.4, 26.5, 33.9, 53.9, 55.3, 56.6, 113.9, 114.4, 114.9, 122.9, 128.2, 128.5, 132.6, 136.4, 141.3, 141.5, 141.7, 154.3, 154.7, 158.2. Analysis calculated for : $C_{28}H_{32}ClN_3O_2$, C 70.35, H 6.75, N 8.79 Found : C 70.23, H 6.87, N 8.66.

N'-(4-Chlorophenyl)-2-(4-chlorophenylamino)-N-cyclohexyl-2-(4-methoxyphenyl)acetimidamide (5c)

Solid, ESI MS (*m/z*) = 482 (M+H), IR (KBr) ν_{max} : 3384, 2967, 2901, 1641, 1491, 1482, 1284, 746 cm-^{1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H **:** 1.10-1.37 (m, 4H), 1.49 (t, *J* = 4.7 Hz, 2H), 1.67 (t, *J* = 14.5 Hz, 4H), 2.01 (t, *J* = 13.5 Hz, 1H), 3.74 (s, 3H, OCH_3), 4.33 (s, 1H, NH), 4.61 (s, 1H, CH), 5.85 (s, 1H, NH), 6.11 (s, 1H), 6.75 (d, *J* = 8.4 Hz, 4H), 7.08 (s, 1H), 7.18 (d, *J* = 8.6 Hz, 4H), 7.28 (d, *J* = 3.5 Hz, 2H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 24.6, 24.7, 25.3, 29.6, 32.7, 32.9, 48.4, 55.3, 58.8, 113.1, 114.7, 120.4, 122.9, 127.7, 128.3, 128.8, 130.1, 141.4, 159.8. Analysis calculated for : $C_{27}H_{29}Cl_2N_3O$, C 67.22, H 6.06, N 8.71 Found : C 67.13, H 5.96, N 8.83.

N-Tert-butyl-N'-(3-chlorophenyl)-2-(3-chlorophenylamino)-2-(3 methoxyphenyl)acetimidamide (5d)

Solid, ESI MS (*m/z*) = 456 (M+H), IR (KBr) ν_{max} : 3373, 2966, 1719, 1669, 1633, 1588, 1492, 1373, 1212, 1127, 1033, 749 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H :1.46 (s, 9H), 3.74 (s, 3H, OCH_3), 4.76 (s, 1H, NH), 5.31(s, 1H, CH), 5.89 (s, 1H, NH), 6.40 (d, *J* = 8.3 Hz, 2H), 6.58 (d, *J* = 7.3 Hz, 2H), 6.84 (d, *J* = 5.7 Hz, 2H), 7.12-7.18 (m, 4H), 7.19 (d, *J* = 8.4

Hz, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ_C : 29.6, 51.9, 55.2, 58.1, 111.1, 112.5, 114.6, 115.3, 118.8, 119.4, 119.6, 121.4, 123.9, 129.1, 130.2, 130.9, 133.4, 134.2, 141.1, 148.1, 149.2, 157.2, 160.1. Analysis calculated for : $C_{25}H_{27}Cl_2N_3O$, C 65.79, H 5.96, N 9.21 Found : C 65.88, H 6.08, N 9.12.

N-Tert-butyl-N'-(3-methoxyphenyl)-2-(3-methoxyphenylamino)-2-phenylacetimidamide (5e)

Solid, ESI MS (*m/z*) = 418 (M+H), IR (KBr) ν_{max} **:** 3375, 2976, 1720, 1668, 1589, 1482, 1383, 1128, 1071, 746 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.51 (s, 9H), 3.75 (s, 3H, OCH_3), 3.79 (s, 3H, OCH_3), 4.34 (s, 1H, NH), 4.70 (s, 1H, CH), 6.01 (s,1H, NH), 6.20 (d, *J* = 1.2 Hz, 1H), 6.55 (t, *J* = 1.3 Hz, 1H), 6.74-6.87 (m, 4H), 6.95 (t, *J* = 4.9 Hz, 1H), 7.10 (d, *J* = 5.9 Hz, 3H), 7.13 (d, *J* = 2.6 Hz, 3H).^{13}C NMR (50 MHz; $CDCl_3$) δ_C : 29.6, 51.9, 55.1, 55.4, 57.9, 100.9, 104.9, 105.8, 106.0, 106.0, 106.3, 106.9, 116.3, 127.4, 127.5, 128.9, 129.6, 130.1, 140.1, 147.9, 149.6, 157.3, 159.9. Analysis calculated for : $C_{26}H_{31}N_3O_2$, C 74.79, H 7.48, N 10.06, Found : C 74.68, H 7.57, N 9.93.

2-(4-Chlorophenyl)-N'-(4-fluorophenyl)-2-(4-fluorophenylamino)-N-(tosylmethyl)acetimidamide (5f)

Solid, ESI MS (*m/z*) = 540 (M+H), IR (KBr) ν_{max} : 3469, 2989, 1730, 1678, 1589, 1482, 1383, 1128, 1089, 751 cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 2.42 (s, 3H, CH_3), 4.36 (s, 1H, NH), 4.46 (s, 2H), 4.93 (s, 1H, CH), 6.35 (s, 1H, NH), 6.50 (t, *J* = 6.0 Hz, 2H), 6.75 (d, *J* = 6.1 Hz, 2H), 7.01-7.09 (m, 4H), 7.17-7.20 (m, 6H), 7.80 (d, *J* = 6.4 Hz, 2H), ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 21.0, 46.2, 57.8, 114.8, 114.8, 115.6, 115.8, 116.0, 116.2, 123.6, 123.6, 128.2, 128.3, 128.4, 130.1, 132.6, 133.1, 136.5, 143.1, 143.1, 143.3, 143.4, 143.5, 143.7, 156.9, 159.8. Analysis calculated for : $C_{28}H_{24}ClF_2N_3O_2S$, C 62.28, H 4.48, N 7.78, Found: C 62.18, H 4.32, N 7.89.

N-Tert-butyl-2-(4-chlorophenyl)-N'-(3-methoxyphenyl)-2-(3-methoxyphenylamino)acetimidamide (5g)

Solid, ESI MS (*m/z*) = 452 (M+H), IR (KBr) ν_{max} : 3359, 2965, 2828, 1616, 1590, 1495, 1291, 1214, 1170, 1099, 748 cm^{-1}.^{1}H NMR (300 MHz: $CDCl_3$) δ_H **:** 1.51 (s, 9H), 3.67 (s, 3H, OCH_3), 3.80 (s, 3H, OCH_3), 4.39 (s, 1H, NH), 4.50 (s, 1H, CH), 5.99 (s, 1H, NH), 6.29 (d, *J* = 8.6 Hz, 1H), 6.47 (d, *J* = 7.9 Hz, 1H), 6.64 (s, 1H), 6.74 (d, *J* = 7.6 Hz, 1H), 6.82-6.88 (m, 2H), 7.20 (dd, *J* = 7.2, 16.0, Hz, 4H), 7.31 (t, *J* = 5.3 Hz, 2H), ^{13}C NMR (50 MHz: $CDCl_3$) δ_C : 29.6, 52.9, 55.1, 55.4, 58.1, 100.7, 104.9, 105.8, 106.0, 106.0, 106.3, 106.9, 116.3, 127.8,

128.1, 128.2, 128.4, 129.6, 130.0, 132.8, 137.4, 147.3, 149.9, 157.5, 158.9. Analysis calculated for : $C_{26}H_{30}ClN_3O_2$, C 69.09, H 6.69, N 9.30, Found : C 69.18, H 6.78, N 9.18.

2-(4-Bromophenyl)-N-*tert*-butyl-N'-(3-methoxyphenyl)-2-(3-methoxyphenylamino)acetimidamide (5h)

Solid, ESI MS (*m/z*) = 496 (M+H), IR (KBr) ν_{max} : 3380, 3362, 2958, 1637, 1595, 1508, 1481, 1329, 749 cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.49 (s, 9H), 3.67 (s, 3H, OCH_3), 3.84 (s, 3H, OCH_3), 4.31 (s, 1H, NH), 4.48 (s, 1H, CH), 6.04 (s, 1H, NH), 6.27 (d, *J* = 5.0 Hz, 1H), 6.47 (d, *J* = 6.9 Hz, 1H), 6.64 (s, 1H), 6.74 (d, *J* = 6.0 Hz, 1H), 6.81-6.88 (m, 2H), 7.21 (d, *J* = 6.5 Hz, 2H), 7.33 (t, *J* = 6.5 Hz, 2H), 7.51 (d, *J* = 6.7 Hz, 2H). ^{13}C NMR (50 MHz; $CDCl_3$) δ_C : 29.8, 52.9, 55.2, 55.5, 57.9, 101.7, 105.9, 105.8, 106.0, 106.0, 106.3, 106.9, 116.3, 122.7, 128.4, 129.6, 130.0, 131.5, 138.2, 147.3, 150.1, 159.9. Analysis calculated for : $C_{26}H_{30}BrN_3O_2$, C 62.90, H 6.09, N 8.46, Found: C 62.98, H 5.99, N 8.34.

N-Tert-butyl-2-(4-chlorophenyl)-N'-(4-methoxyphenyl)-2-(4-methoxyphenylamino)acetimidamide (5i)

Solid, ESI MS (*m/z*) = 452 (M+H), IR (KBr) ν_{max} **:** 3319, 3050, 2870, 2760, 2150,1630, 752 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H **:** 1.51 (s, 9H), 3.75 (s, 3H, OCH_3), 3.80 (s, 3H, OCH_3), 4.38 (s, 1H, NH), 4.70 (s, 1H, CH), 6.03 (s, 1H, NH), 6.20 (d, *J* = 3.2 Hz, 1H), 6.71 (t, *J* = 1.3 Hz, 1H), 6.74-6.87 (m, 4H), 6.98-7.23 (m, 4H), 7.26 (t, *J* = 2.6 Hz, 2H).^{13}C NMR (75 MHz: $CDCl_3$) δ_C : 29.9, 52.1, 55.3, 56.1, 113.8, 113.9, 114.1, 122.7, 127.7, 128.1, 128.1, 128.4, 132.6, 137.4, 139.1, 142.9, 154.7, 155.1, 158.6. Analysis calculated for : $C_{26}H_{30}ClN_3O_2$, C 69.09, H 6.69, N 9.30; Found : C 68.97, H 6.76, N 9.21.

N-Cyclohexyl-2-(4-fluorophenyl)-N'-(4-methoxyphenyl)-2-(4-methoxyphenylamino)acetimidamide (5j)

Solid, ESI MS (*m/z*) = 462 (M+H), IR (KBr) ν_{max} : 3356, 2935, 2852, 1640, 1428, 1255, 1095, 1012, 747 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.11-1.14 (m, 5H), 1.15 (t, *J* = 5.6 Hz, 2H), 1.17(t, *J* = 11.9 Hz, 3H), 2.12 (t, *J* = 5.4 Hz, 1H), 3.72 (s, 3H, OCH_3), 3.79 (s, 3H, OCH_3), 4.25 (s, 1H, NH), 4.71 (s, 1H, CH), 6.10 (br, s, 1H, NH), 6.34 (br, s, 1H), 6.74 (t, *J* = 6.3 Hz, 1H), 6.72-6.94 (m, 4H), 6.97 (d, *J* = 6.8 Hz, 4H), 7.29 (d, *J* = 5.4 Hz, 2H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 25.2, 26.8, 33.8, 53.9, 55.3, 56.8, 113.9, 114.1, 114.7, 114.9, 122.9, 128.2, 128.3, 134.1, 134.1, 141.3, 141.5, 141.7, 154.7, 158.2. Analysis calculated for : $C_{28}H_{32}FN_3O_2$, C 72.86, H 6.99, N 9.10, Found : C 72.76, H 7.09, N 9.21.

N-Cyclohexyl-N'-(2,4-dimethylphenyl)-2-(2,4dimethylphenylamino)-2-phenylacetimidamide (5k)

Solid, ESI MS (*m/z*) = 440 (M+H), IR (KBr) ν_{max} **:** 3355, 2934, 2855, 2870,1640, 1600, 14292, 1256, 1091, 1013, 754 cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.28-1.60 (m, 6H), 1.68 (t, *J* = 6.3 Hz, 5H), 2.16 (s, 6H, CH_3), 2.30 (s, 6H, CH_3), 4.08 (br, s, 1H, NH), 4.33 (br, s, 1H, CH), 5.32 (br, s, 1H, NH), 6.25 (d, *J* = 7.5 Hz, 1H), 6.51 (d, *J* = 7.2 Hz, 1H), 6.68 (s, 1H), 6.74 (d, *J* = 7.7 Hz, 1H), 6.84 (d, *J* = 9.2 Hz, 2H), 7.01 (s, 1H), 7.45 (d, *J* = 8.5 Hz, 2H), 8.01(d, *J* = 8.4 Hz, 2H). ^{13}C NMR (50 MHz; $CDCl_3$) δ_C : 17.7, 18.1, 20.5, 20.9, 25.4, 26.5, 33.3, 53.8, 56.3, 112.8, 119.6, 122.6, 125.3, 127.1, 127.4, 127.6, 127.7, 128.9, 130.3, 131.8, 132.1, 133.2, 140.6, 142.2, 142.5, 154.5, 159.6. Analysis calculated for : $C_{30}H_{37}N_3$, C 81.96, H 8.48, N 9.56, Found : C 82.04, H 8.41, N 9.49.

N'-(4-Chlorophenyl)-2-(4-chlorophenylamino)-N-cyclohexyl-2-(pyridin-4-yl)acetimidamid (5l)

Solid, ESI MS (*m/z*) = 453 (M+H), IR (KBr) ν_{max} : 3356, 2939, 2850, 2875,1645, 1430, 1255, 1093, 1013, 756 cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.22-1.55 (m, 5H), 1.67 (d, *J* = 13.9 Hz, 3H), 1.72 (br, s, 2H), 2.12 (t, *J* = 5.4 Hz, 1H), 4.36 (s, 1H, NH), 4.55 (s, 1H, CH), 6.24 (s, 1H, NH), 6.48 (d, *J* = 6.1 Hz, 2H), 6.79 (d, *J* = 6.1 Hz, 2H), 7.08 (d, *J* = 6.1 Hz, 2H), 7.23-7.28 (m, 4H), 8.50 (d, *J* = 4.5 Hz, 2H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 25.4, 26.4, 32.8, 53.9, 55.9, 114.0, 122.6, 123.6, 125.0, 129.3, 129.4, 130.4, 144.8, 146.5, 146.6, 149.9, 159.9. Analysis calculated for : $C_{25}H_{26}Cl_2N_4$, C 66.23, H 5.78, N 12.36, Found : C 66.31, H 5.67, N 12.45.

N-Tert-butyl-N'-phenyl-2-(phenylamino)-2-(pyridin-4-yl)acetimidamide (5m)

Solid, ESI MS (*m/z*) = 359 (M+H), IR (KBr) ν_{max} : 3360, 2940, 2853, 2870,1648, 1435, 1260, 1093, 1019, 752 cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.51, (s, 9H), 4.28 (s, 1H, NH), 4.69 (s, 1H, CH), 6.10 (s, 1H, NH), 6.51 (d, *J* = 5.7 Hz, 2H), 6.68 (t, *J* = 5.6 Hz, 1H), 6.94 (d, *J* = 1.0 Hz, 2H), 7.08-7.12 (m, 3H), 7.28 (d, *J* = 4.4 Hz, 2H), 7.41 (t, *J* = 5.6 Hz, 2H), 8.50 (d, *J* = 4.5 Hz, 2H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 29.6, 52.0, 56.3, 112.1, 118.9, 120.0, 123.4, 128.8, 128.9, 146.0, 146.8, 148.3, 149.8, 158.8. Analysis calculated for : $C_{23}H_{26}N_4$, C 77.06, H 7.31, N 15.63, Found : C 76.98, H 7.38, N 15.58.

N,2-Bis(4-chlorophenyl)-2-(4-chlorophenylamino)-N-(2-morpholinoethyl)acetimidamide (5n)

Solid, ESI MS (*m/z*) = 517 (M+H), IR (KBr) ν_{max} : 3359, 2947, 2855, 2868,1640, 1433, 1261, 1019, 754 cm^{-1}. ^{1}H NMR (300 MHz; DMSO-d_6) δ_H : 2.19 (t, *J* = 5.1 Hz, 2H), 2.29 (s, 4H), 3.51 (t, *J* = 4.3 Hz, 2H), 3.70 (s, 4H), 4.45 (s, 1H, NH), 5.10 (s, 1H, CH), 5.94 (s, 1H, NH), 6.51 (d, *J* = 5.7 Hz, 2H), 6.66 (t, *J* = 4.6 Hz, 2H), 6.91 (d, *J* = 5.0 Hz, 2H), 7.08 (d, *J* = 5.2 Hz, 2H), 7.29 (t, *J* = 3.9 Hz, 1H), 7.40 (t, *J* = 1.3 Hz, 3H). ^{13}C NMR (75 MHz; DMSO-d_6) δ_C : 59.6, 62.0, 62.5, 69.3, 114.2, 122.6, 125.0, 128.3, 128.6, 129.0, 129.3, 130.4, 132.6, 137.0, 144.8, 146.2, 157.9. Analysis calculated for : $C_{26}H_{27}Cl_3N_4O$, C 60.30, H 5.26, N 10.82, Found : C 60.42, H 5.14, N 10.76.

N-Tert-butyl-2-phenyl-2-(phenylamino)acetamide (6a)

Oily**,** ESI MS (*m/z*) = 283 (M+H), IR (KBr) ν_{max} : 3382, 1641, 1531, 1473, 749, cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.49 (s, 9H), 4.49 (s, 1H, NH) 4.95 (s, 1H, CH), 6.06 (s, 1H, NH), 6.57 (d, *J* = 5.7 Hz, 2H), 6.66 (t, *J* = 5.5 Hz, 1H), 6.98 (d, *J* = 3.7 Hz, 2H), 7.14 (t, *J* = 5.8 Hz, 2H), 7.28 (m, 3H).^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 29.0, 49.6, 63.3, 113.7, 119.4, 127.4, 127.8, 127.8, 128.0, 128.8, 128.9, 139.2, 146.8, 169.7. Analysis calculated for: $C_{18}H_{22}N_2O$: C 76.56, H 7.85, N 9.92, Found : C 76.42, H 7.97, N 9.81.

N-Cyclohexyl-2-(2,4-dimethylphenylamino)-2-phenylacetamide (6k)

Solid, ESI MS (*m/z*) = 337 (M+H), IR (KBr) ν_{max} : 3374, 1633, 1531, 1475, 749 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.18-1.49 (m, 6H), 1.58 (d, *J* = 16.8 Hz, 4H), 2.28 (s, 6H, CH_3), 3.59-3.79 (m, 1H), 4.07 (s, 1H, NH), 4.53 (s, 1H, CH), 6.03 (s, 1H, NH), 6.35 (d, *J* =3.4 Hz, 1H), 6.76 (s, 1H), 6.84 (d, *J* = 6.09 Hz, 1H), 7.01 (d, *J* = 4.71 Hz, 2H), 7.32 (t, *J* = 5.52 Hz, 3H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 18.3, 20.5, 25.2, 26.3, 32.8, 49.8, 62.4, 113.2, 122.4, 127.7, 127.8, 128.0, 128.9, 130.8, 132.0, 139.1, 143.6, 170.1. Analysis calculated for: $C_{22}H_{28}N_2O$, C 78.53, H 8.39, N 8.33, Found : C 78.68, H 8.47, N 8.21.

N-Tert-butyl-2-(4-chlorophenyl)-2-(4-methoxyphenylamino)acetamide (6i)

Solid, ESI MS (*m/z*) = 347 (M+H), IR (KBr) ν_{max} : 3383, 1639, 1535, 1478, 751cm^{-1}. ^{1}H NMR (300 MH; $CDCl_3$) δ_H : δ_H :1.49 (s, 9H), 3.69 (s, 3H, OCH_3), 4.45 (s. 1H, NH), 4.91 (s, 1H, CH), 6.03 (s, 1H, NH), 6.74 (dd, *J* = 6.6, 6.6 Hz, 4H), 7.06 (dd, *J* = 6.4, 6.3 Hz, 4H). ^{13}C NMR (75MHz; $CDCl_3$) δ_C : 29.9, 49.8, 55.3, 63.1, 114.1, 114.5, 128.3, 128.5, 133.1, 137.0, 140.6, 153.8, 168.8. Analysis calculated for: $C_{19}H_{23}ClN_2O_2$, C 65.79, H 6.68, N 8.08, Found : C 65.86, H 6.78, N 7.98.

2-(4-Chlorophenyl)-N-cyclohexyl-2-(4-methoxyphenylamino)acetamide (6b)

Solid, ESI MS (*m/z*) = 373 (M+H), IR (KBr) ν_{max}: 3381, 1635, 1528, 1469, 756 cm^{-1}. ^{1}H NMR (300 MHz; $CDCl_3$) δ_H : 1.13-1.28 (m, 5H), 1.45 (t, *J* = 4.31 Hz, 3H), 1.65 (t, *J* = 10.6 Hz, 2H), 3.39-3.61 (m, 1H), 3.67 (s, 3H, OCH_3), 4.14 (s, 1H, NH), 4.43 (s, 1H, CH), 6.03 (s, 1H, NH), 6.76 (q, *J* = 6.6 Hz, 4H), 7.06 (d, *J* = 6.2 Hz, 2H), 7.16 (d, *J* = 6.3 Hz, 2H). ^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 25.2, 26.3, 32.8, 49.6, 55.3, 61.6, 114.1, 115.1, 128.6, 129.0, 133.1, 135.8, 140.9, 153.8, 169.5. Analysis calculated for: $C_{21}H_{25}ClN_2O_2$, C 67.64, H 6.76, N 7.51, Found : C 67.77, H 6.52, N 7.40.

2-(4-Bromophenyl)-N-*tert*-butyl-2-(3-methoxyphenylamino)acetamide (6h)

Solid, ESI MS (*m/z*) = 391(M+H), IR (KBr) ν_{max} : 3389, 1638, 1533, 1479, 747, cm^{-1}.^{1}H NMR (300 MHz; $CDCl_3$) δ_H: 1.49 (s, 9H), 3.67 (s, 3H, OCH_3), 4.39 (s, 1H, NH), 4.93 (s, 1H, CH), 6.01 (s, 1H, NH), 6.11 (s, 1H), 6.28 (d, *J* = 5.1 Hz, 1H), 6.45 (d, *J* = 4.6 Hz, 1H), 6.87 (d, *J* = 5.8 Hz, 3H), 7.44 (d, *J* = 6.3 Hz, 2H).^{13}C NMR (75 MHz; $CDCl_3$) δ_C : 28.9, 49.4, 55.3, 63.1, 111.1, 114.3, 116.3, 122.4, 128.6, 129.6, 132.1, 138.2, 147.7, 141.8, 159.8, 169.5. Analysis calculated for : $C_{19}H_{23}BrN_2O_2$, C 58.32, H 5.92, N 7.16, Found : C 58.42, H 5.81, N 7.27.

2-Phenyl-2-(phenylamino)acetic acid (7a)

Solid, ESI MS (*m/z*) = 228 (M+H). IR (KBr) ν_{max} : 3400, 3331, 1671, 749 cm^{-1}.^{1}H NMR (300 MHz DMSO-d_6) δ_H **:** 4.33 (s, 1H, NH), 4.92 (s, 1H, CH), 6.29 (d, *J* = 5.7 Hz, 2H), 6.69 (t, *J* = 1.0 Hz, 1H), 7.14 (t, *J* = 5.7 Hz, 2H), 7.30-7.35 (m, 5H), 8.31 (s, 1H). ^{13}C NMR (75 MHz, DMSO-d_6) δ_C **:** 60.3, 114.2, 119.4, 127.19, 127.7, 128.1, 128.3, 128.9, 129.3, 137.5, 145.8, 169.4. Analysis calculated for : $C_{14}H_{13}NO_2$, C 73.99, H 5.77, N 6.16, Found : C 74.09, H 5.62, N 6.25.

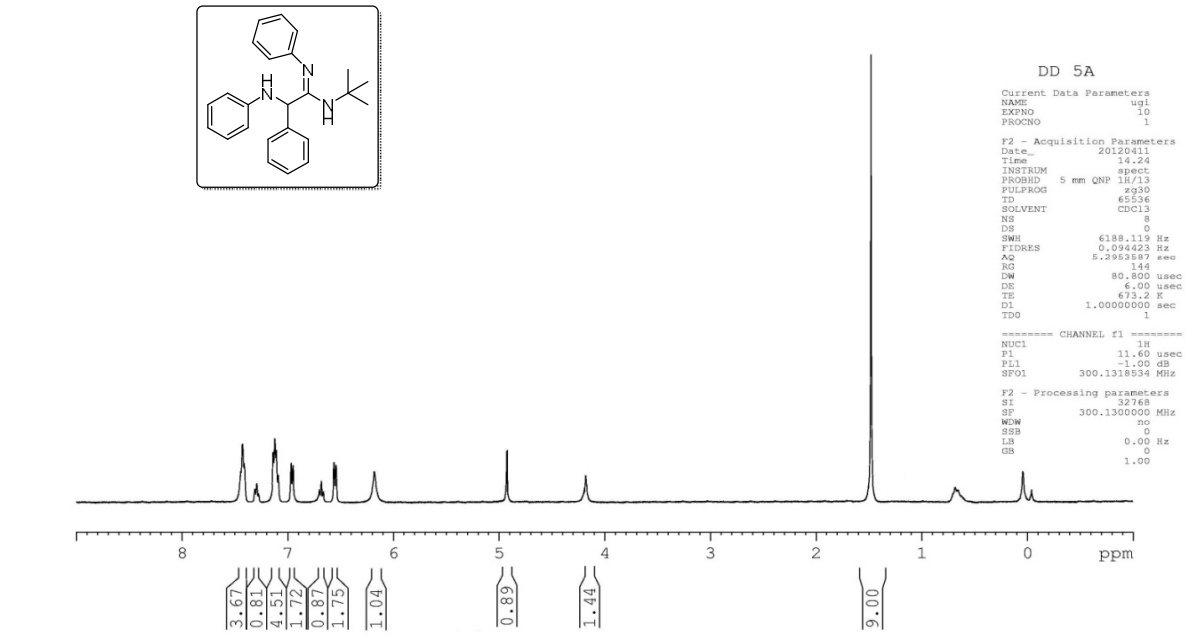
2-(2,4-Dimethylphenylamino)-2-phenylacetic acid (7k)

Solid, ESI MS (*m/z*) = 256 (M+H), ^{1}H NMR (300 MHz, DMSO-d_6) δ_H : 2.25 (s, 6H, CH_3), 4.30 (s, 1H, NH), 4.90 (s, 1H, CH), 6.04 (d, *J* = 6.0 Hz, 1H), 6.76 (s, 1H), 6.84 (d, *J* = 6.0 Hz, 1H), 7.30-7.35 (m, 5H), 8.29 (s, 1H). ^{13}C NMR (50 MHz, DMSO-d_6) δ_C : 18.2, 20.5, 60.7, 113.8, 121.7, 127.9, 128.1, 128.8, 129.0, 130.8, 132.7, 137.94, 143.8, 169.7. Analysis calculated for : $C_{16}H_{17}NO_2$, C 75.27, H 6.71, N 5.49, Found : C 75.37, H 6.62, N 5.58.

2-(4-Chlorophenylamino)-2-(4-methoxyphenyl)acetic acid (7b)

Solid, ESI MS (*m/z*) = 292 (M+H), IR (KBr) ν_{max} : 3419, 3292, 1678, 748 cm^{-1}. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H **:** 3.67 (s, 3H, OCH_3), 4.48 (s, 1H, NH), 4.83 (s, 1H, CH), 6.51 (d, *J* = 6.5 Hz, 2H), 6.80 (d, *J* = 6.5 Hz, 2H), 7.26 (d, *J* = 6.4 Hz, 2H), 7.42 (d, *J* = 6.4 Hz, 2H), 8.30 (s, 1H).^{13}C NMR (50 MHz, DMSO-d_6) δ_C : 55.3, 59.6, 115.3, 116.1, 128.5, 128.8, 129.2,

130.3, 133.6, 135.7, 141.4, 154.8, 170.3. Analysis calculated for : $C_{15}H_{14}ClNO_3$, C 61.76, H 4.84, N 4.80, Found : C 61.85, H 4.73, N 4.93.


DD 5A
Current Data Parameters
NAME ugi
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20120411
Time 14.24
INSTRUM spect
PROBHD 5 mm QNP 1H/13
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 8
DS 0
SWH 6188.119 Hz
FIDRES 0.094423 Hz
AQ 5.2953587 sec
RG 144
DW 80.800 usec
DE 6.00 usec
TE 673.2 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 11.60 usec
PL1 -1.00 dB
SFO1 300.1318534 MHz
F2 - Processing parameters
SI 32768
SF 300.1300000 MHz
WDW no
SSB 0
LB 0.00 Hz
GB 0
1.00
8 7 6 5 4 3 2 1 0 ppm
3.67 0.81 4.51 1.72 0.87 1.75 1.04 0.89 1.44 9.00

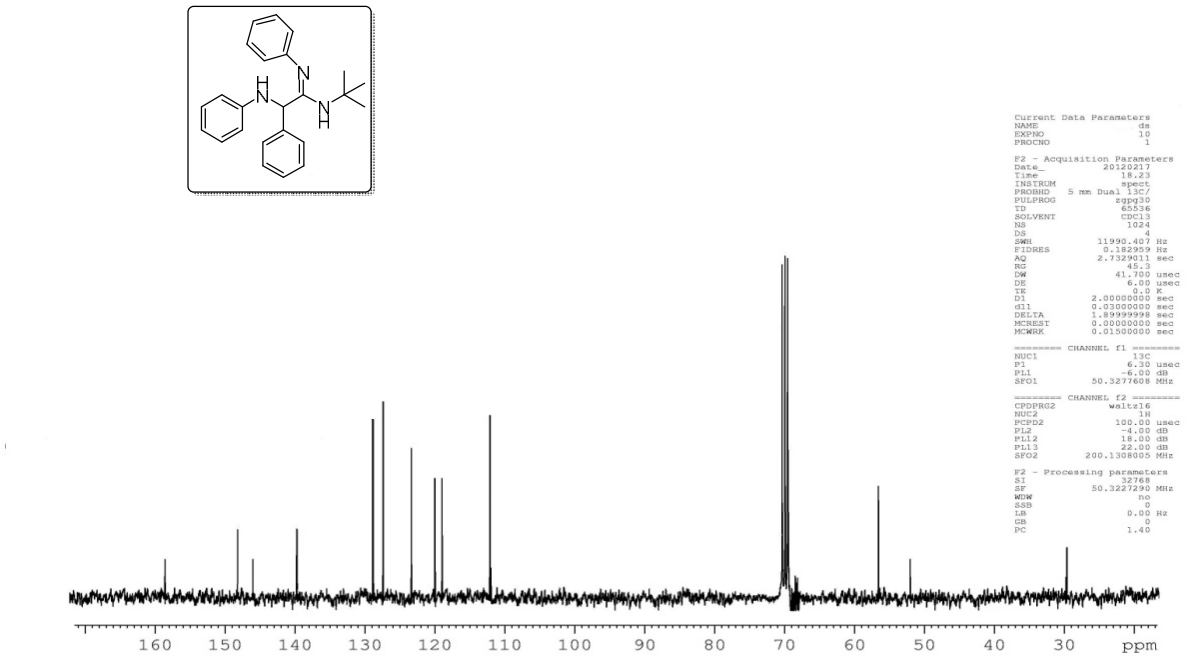
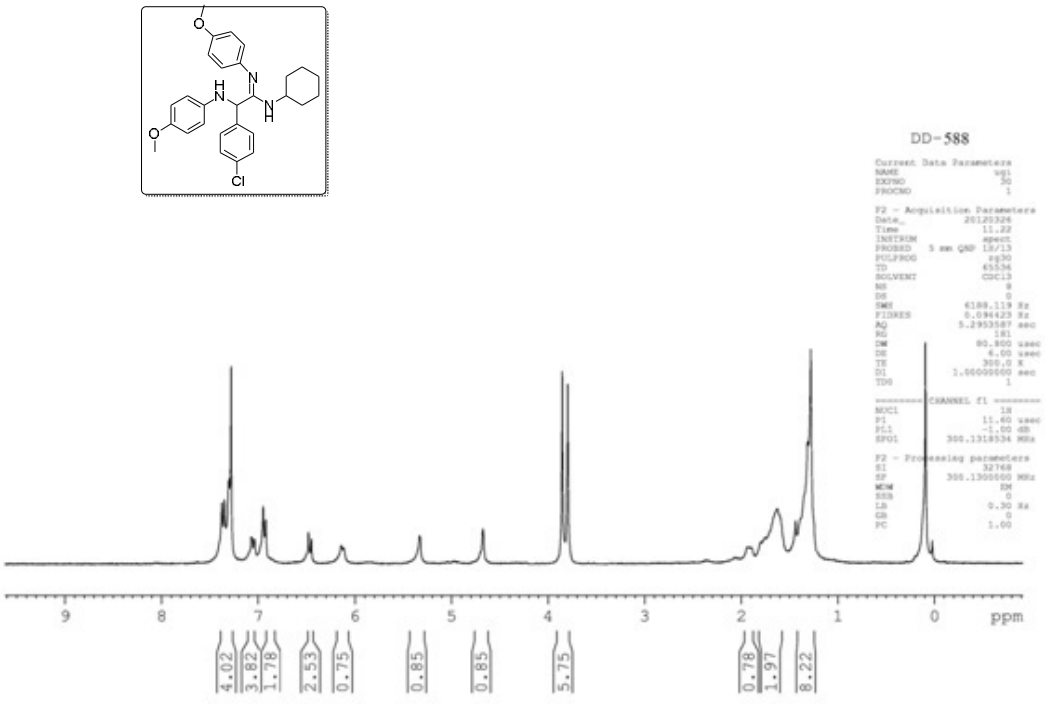

Current Data Parameters
NAME ds
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20120217
Time 18.23
INSTRUM spect
PROBHD 5 mm Dual 13C/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1024
DS 4
SWH 11990.407 Hz
FIDRES 0.182959 Hz
AQ 2.7329011 sec
RG 45.3
DW 41.700 usec
DE 6.00 usec
TE 0.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
MCREST 0.00000000 sec
MCWRK 0.01500000 sec
======== CHANNEL f1 ========
NUC1 13C
P1 6.30 usec
PL1 -6.00 dB
SFO1 50.3277608 MHz
======== CHANNEL f2 ========
CPDPRG2 waltz16
NUC2 1H
PCPD2 100.00 usec
PL2 -4.00 dB
PL12 18.00 dB
PL13 22.00 dB
SFO2 200.1308005 MHz
F2 - Processing parameters
SI 32768
SF 50.3227290 MHz
WDW no
SSB 0
LB 0.00 Hz
GB 0
PC 1.40
160 150 140 130 120 110 100 90 80 70 60 50 40 30 ppm

Fig. 1 (5a)



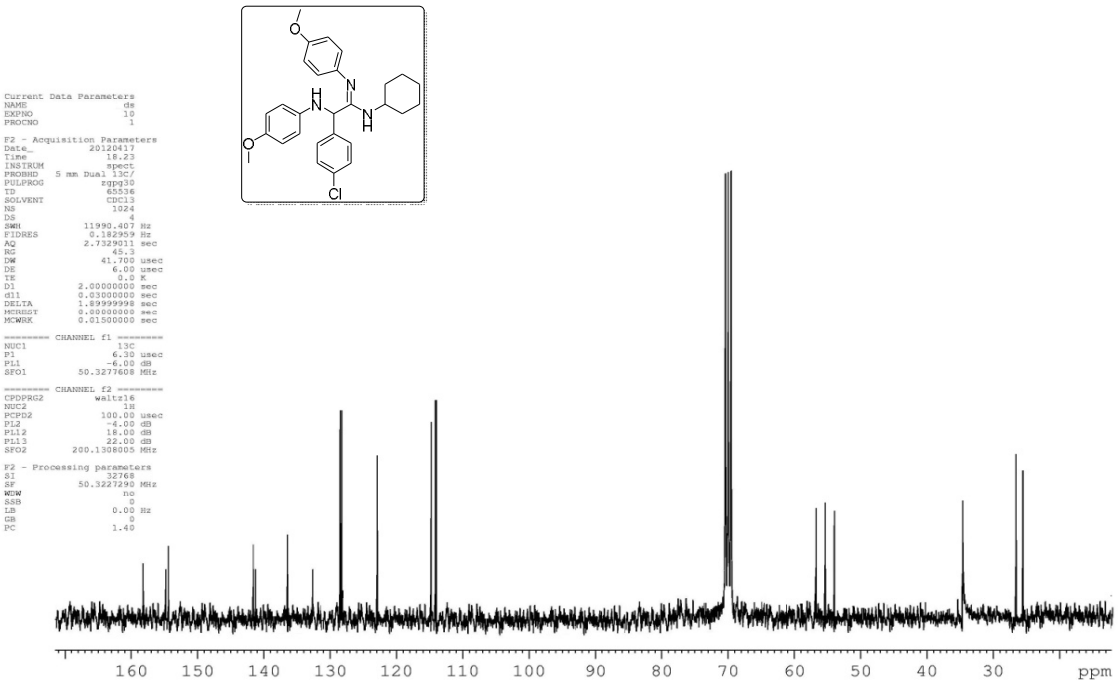
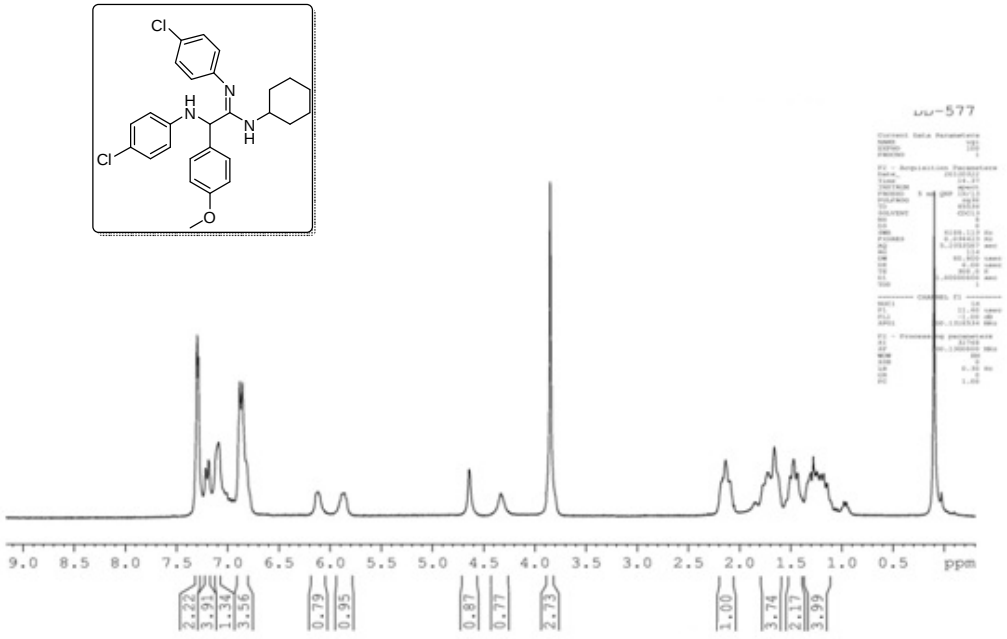


Fig. 2 (5b)



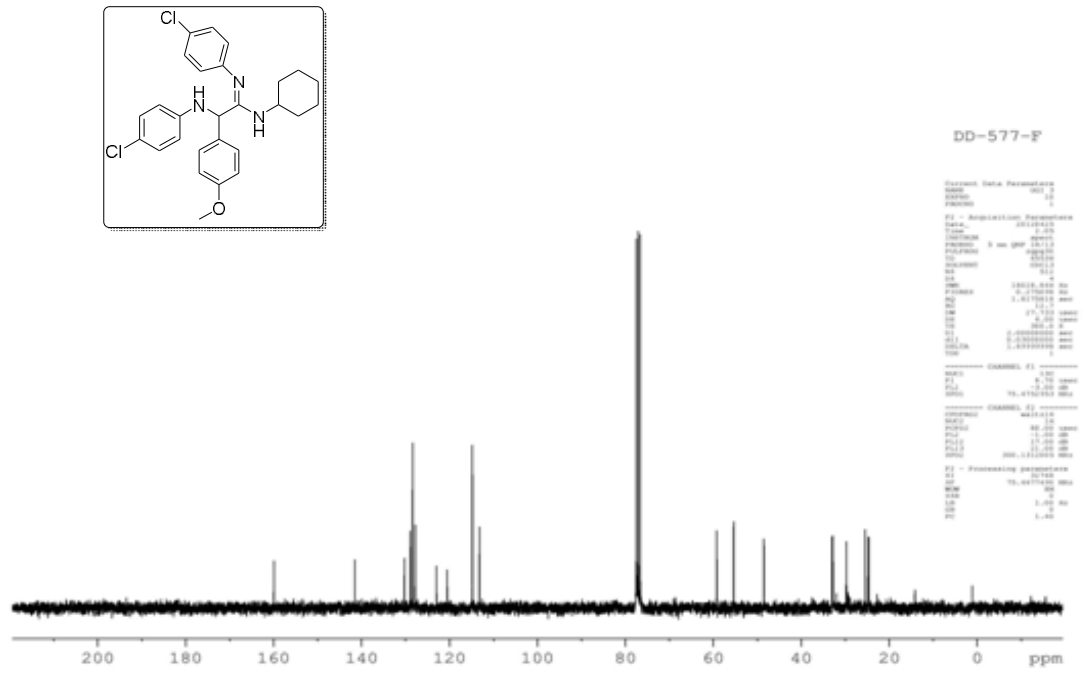
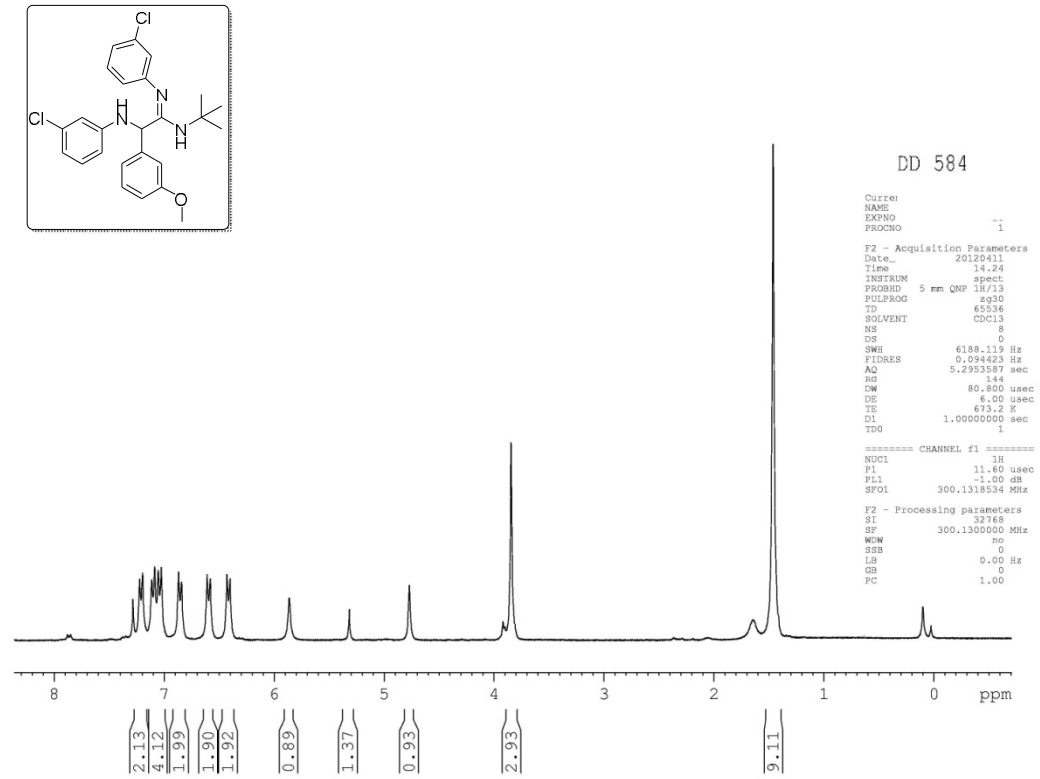


Fig. 3 (5c)


Cl
N
H
Cl
N
N
H
O
DD 584
8
7
6
5
4
3
2
1
0
ppm
2.13
4.12
1.99
1.90
1.92
0.89
1.37
0.93
2.93
9.11

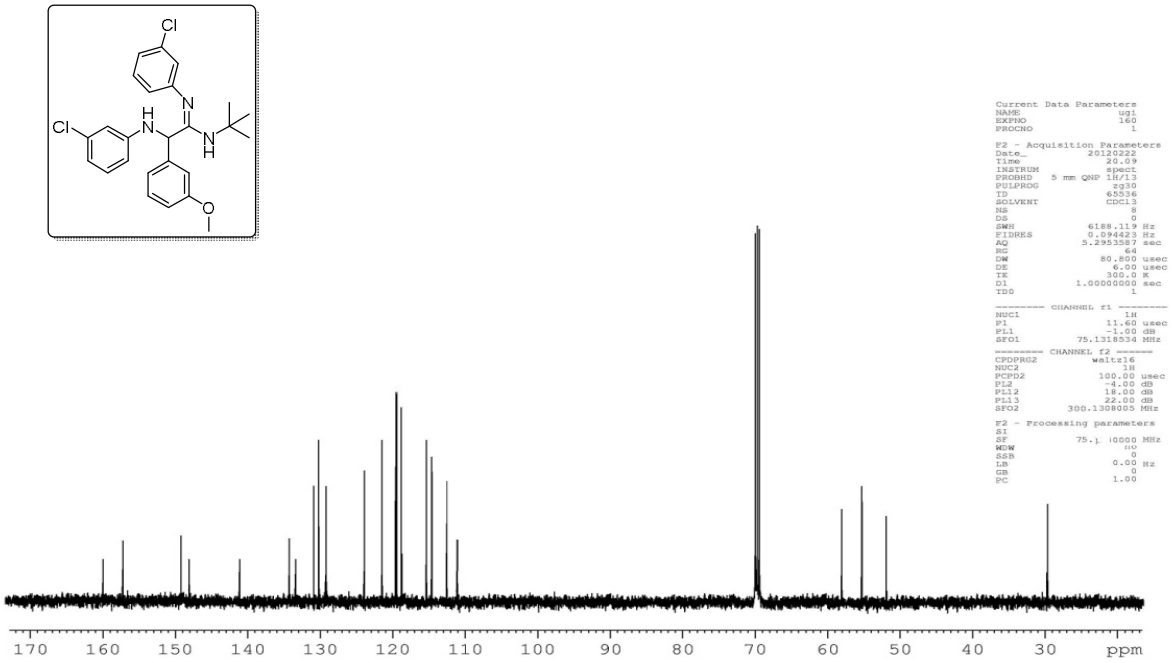
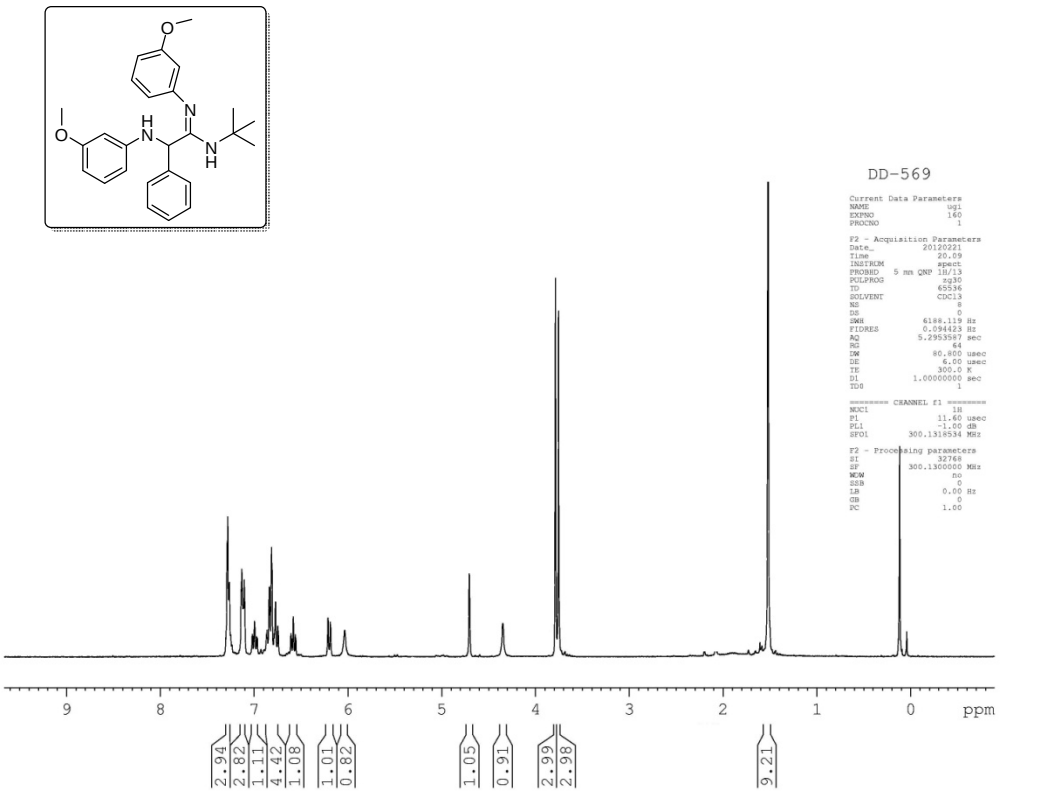

Cl
N
H
Cl
N
N
H
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
ppm

Fig. 4 (5d)


DD-569
9
8
7
6
5
4
3
2
1
0
ppm
2.94
2.82
1.11
4.42
1.08
1.01
0.82
1.05
0.91
2.99
2.98
9.21

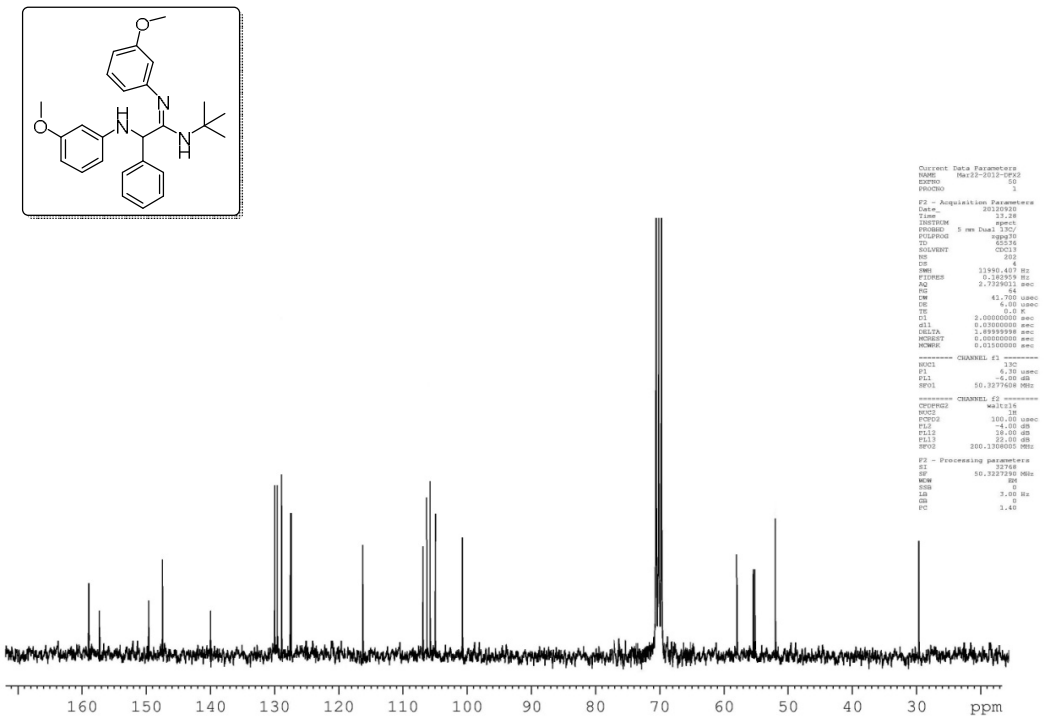
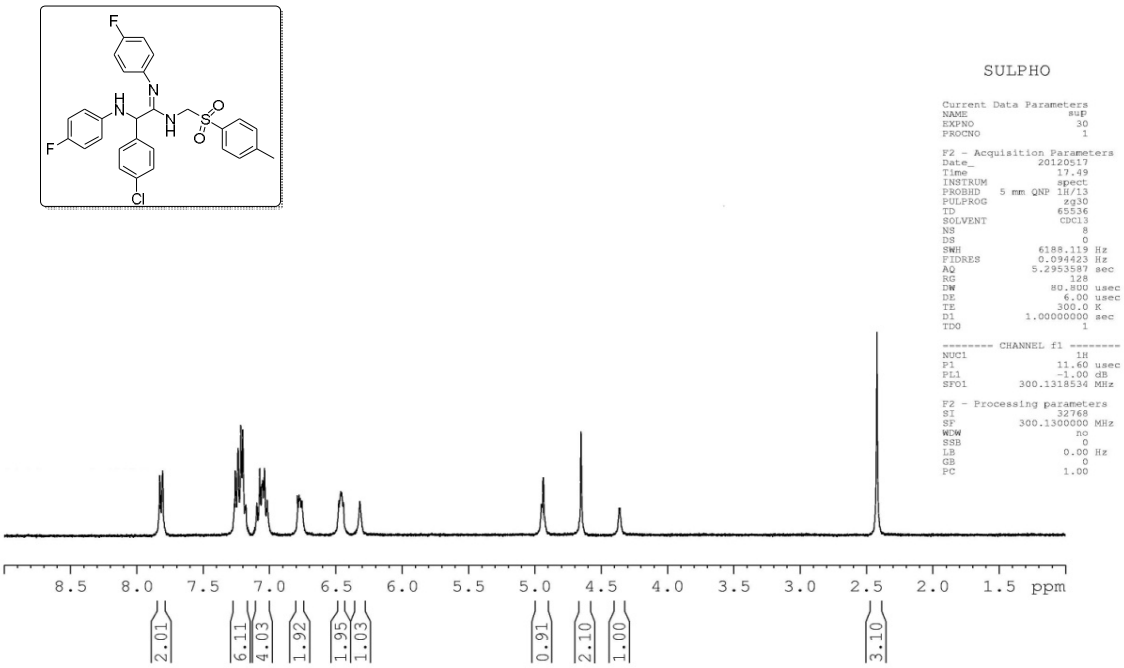

160
150
140
130
120
110
100
90
80
70
60
50
40
30
ppm

Fig. 5 (5e)



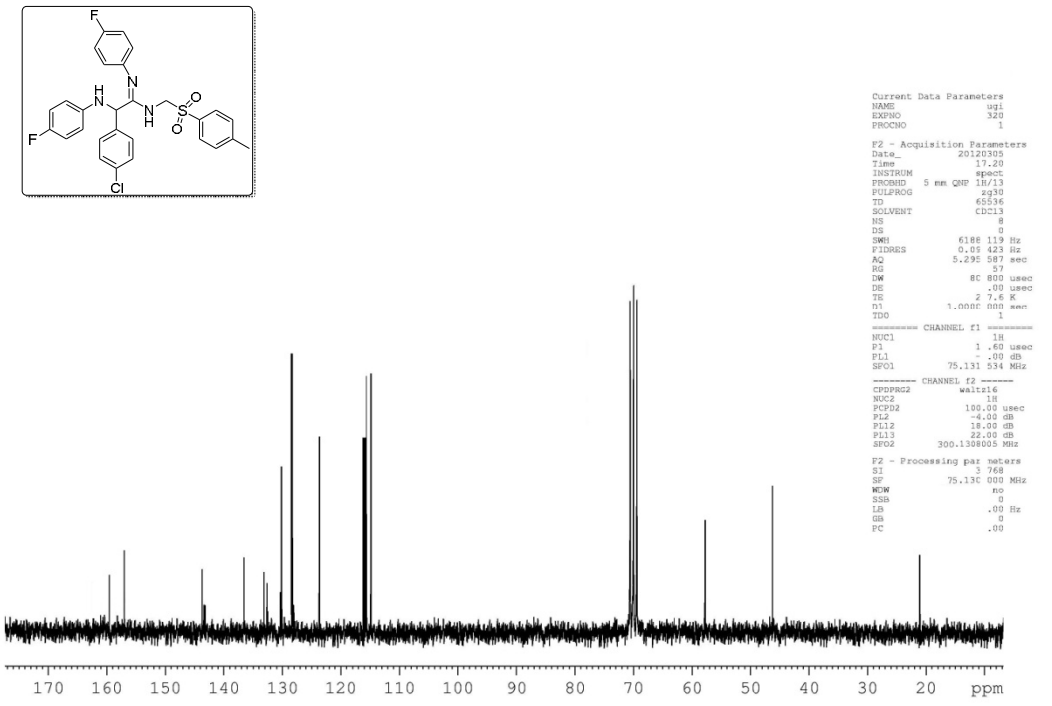
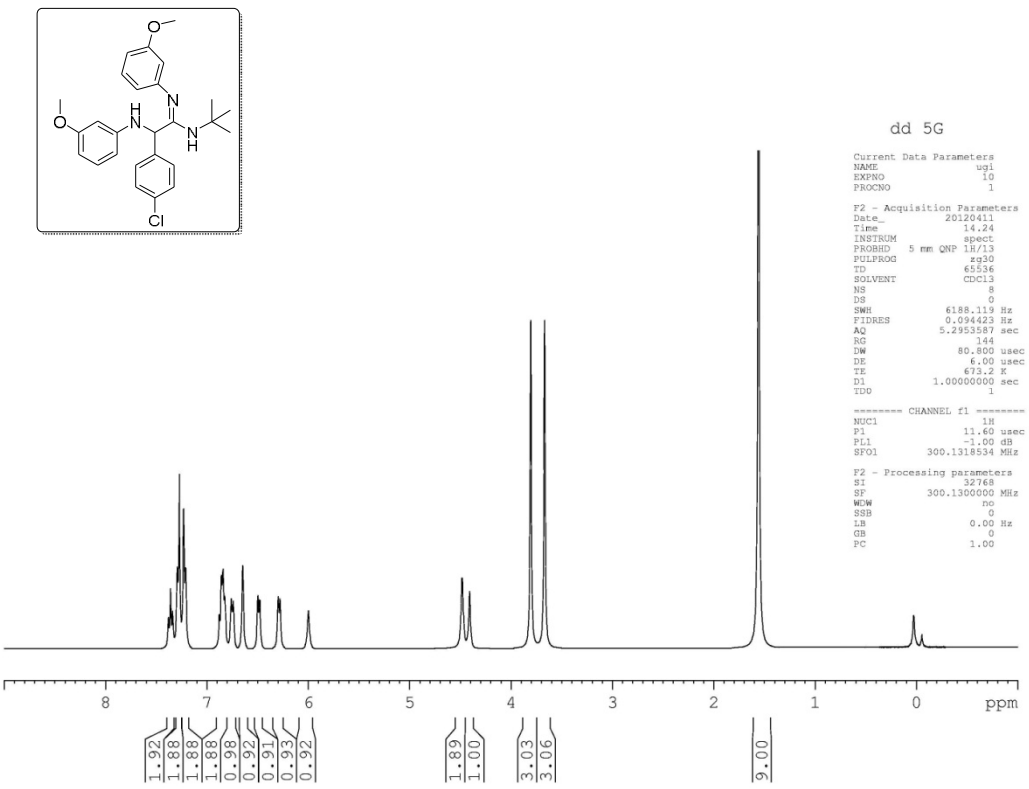


Fig. 6 (5f)



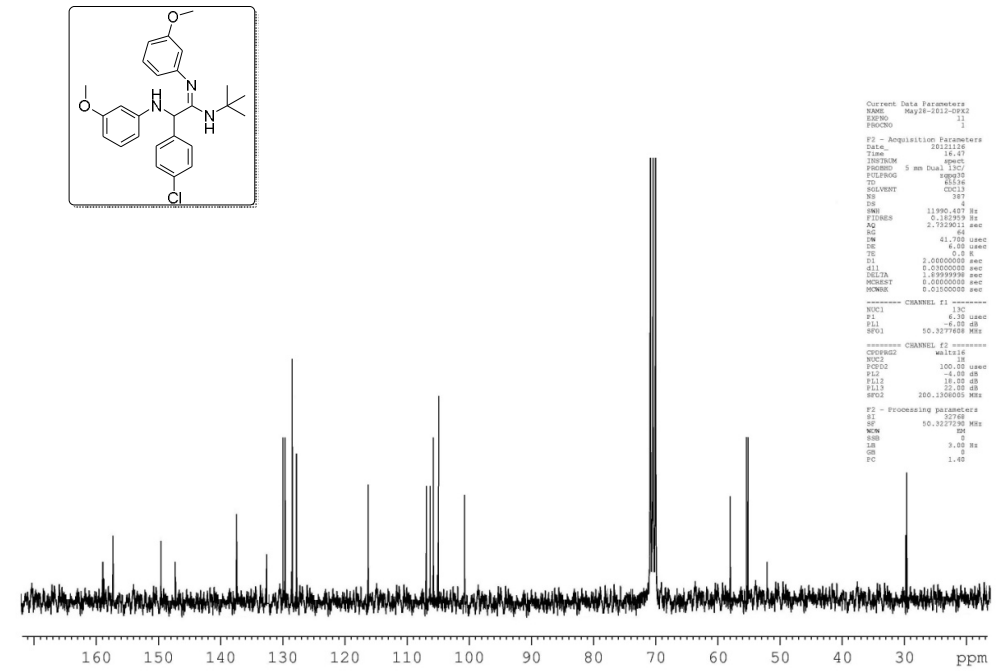
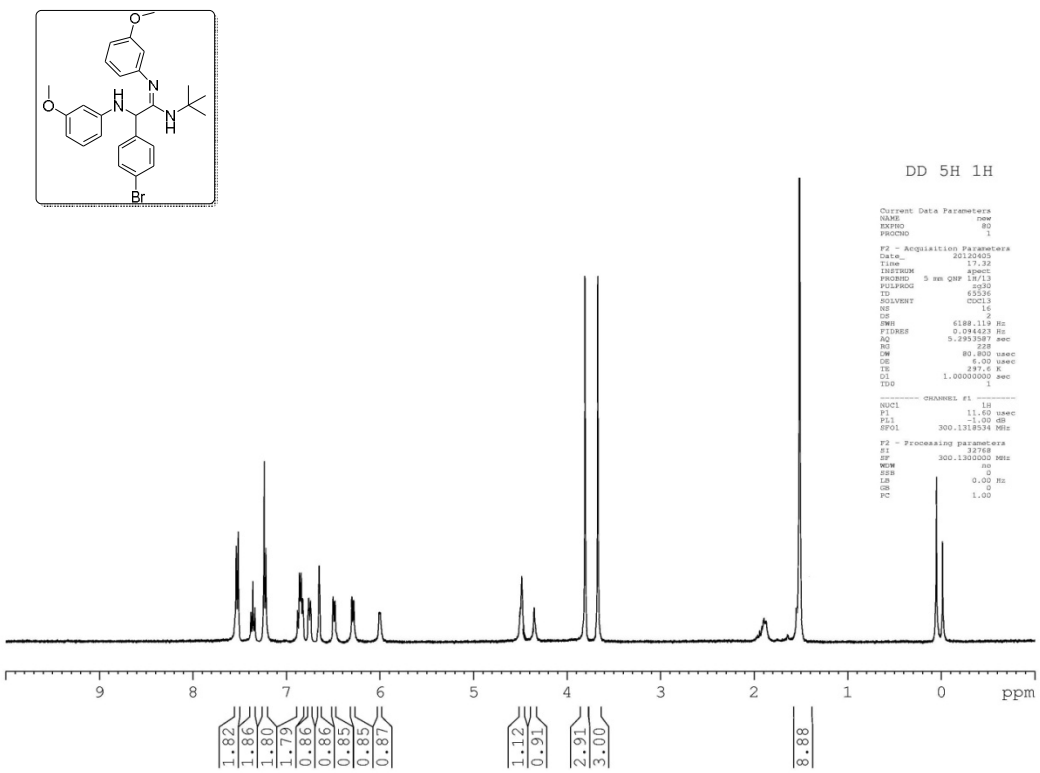


Fig. 7 (5g)



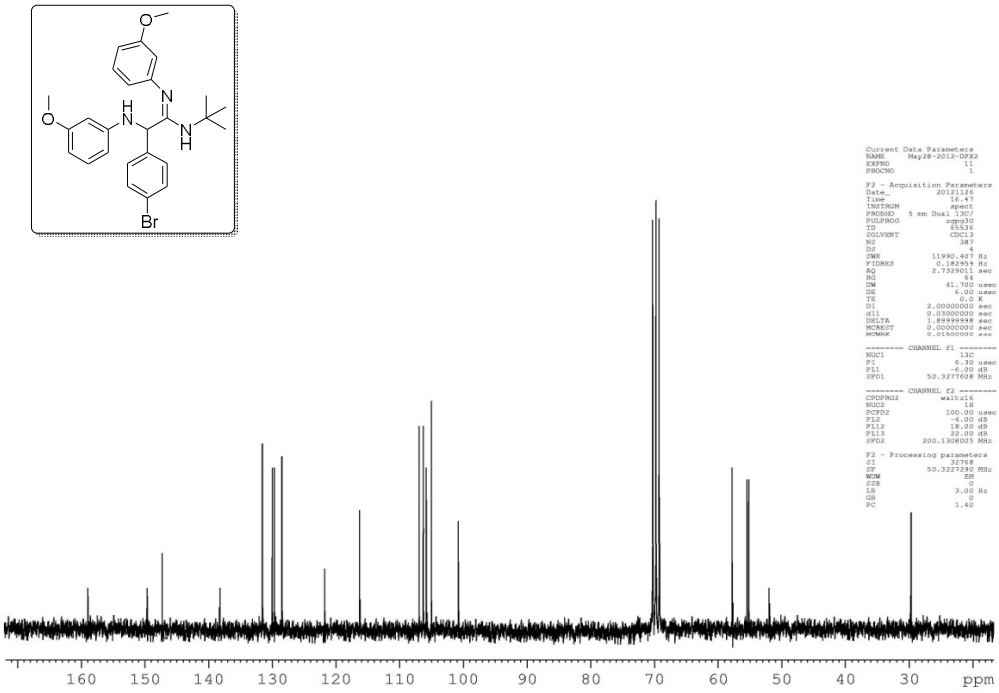
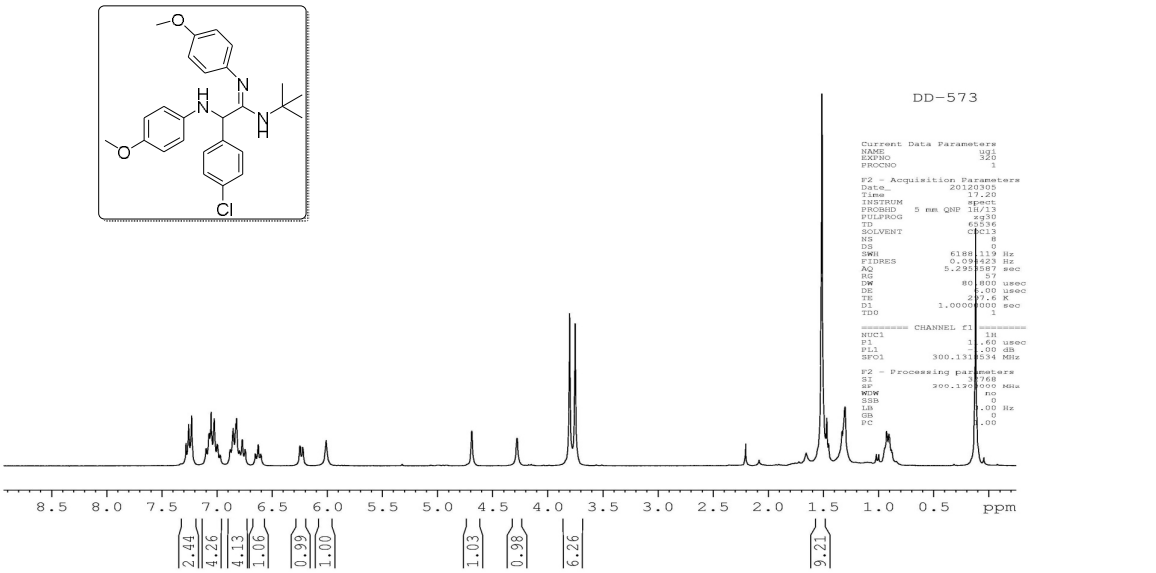


Fig. 8 (5h)



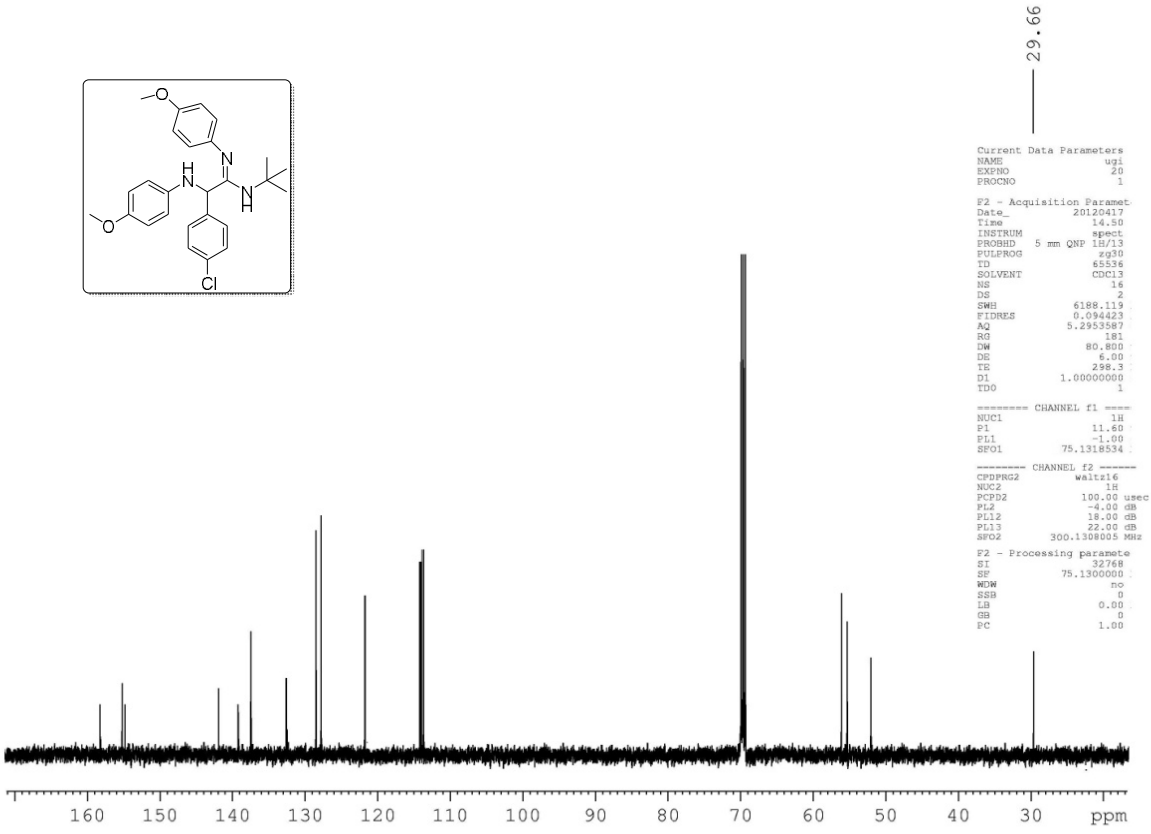
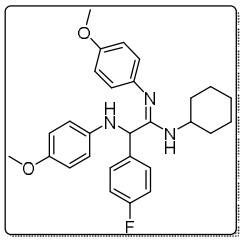
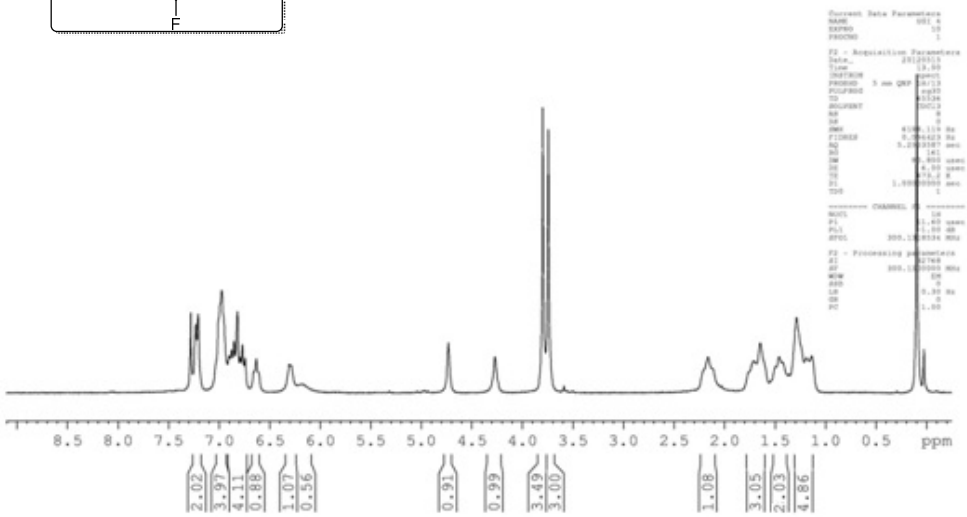


Fig. 9 (5i)





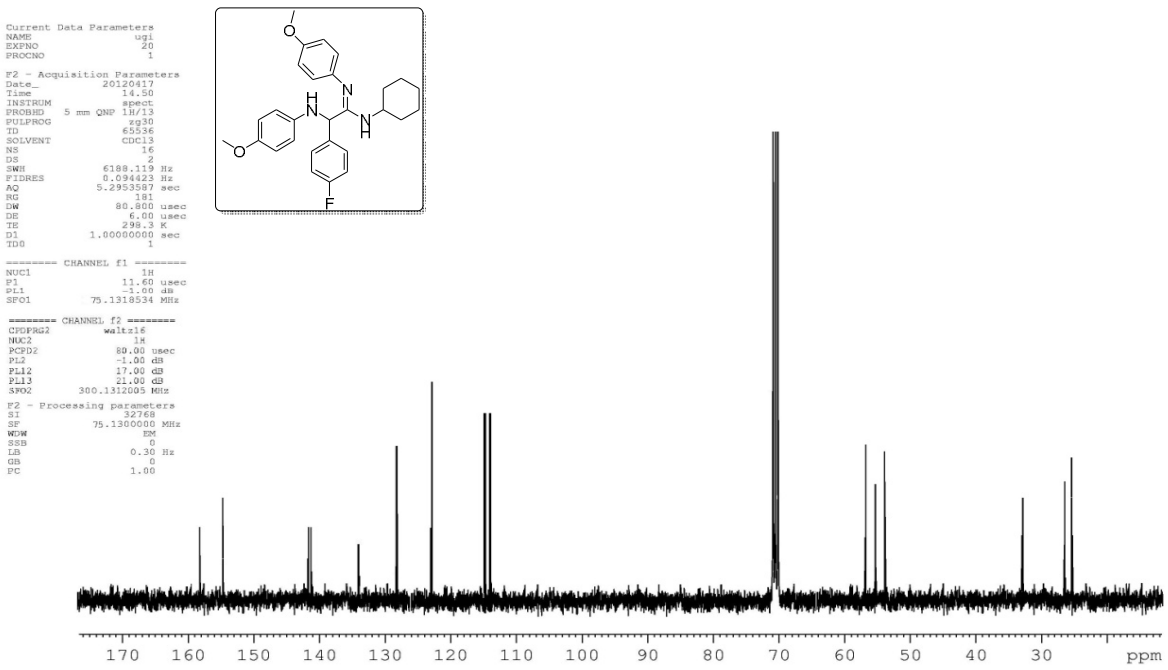
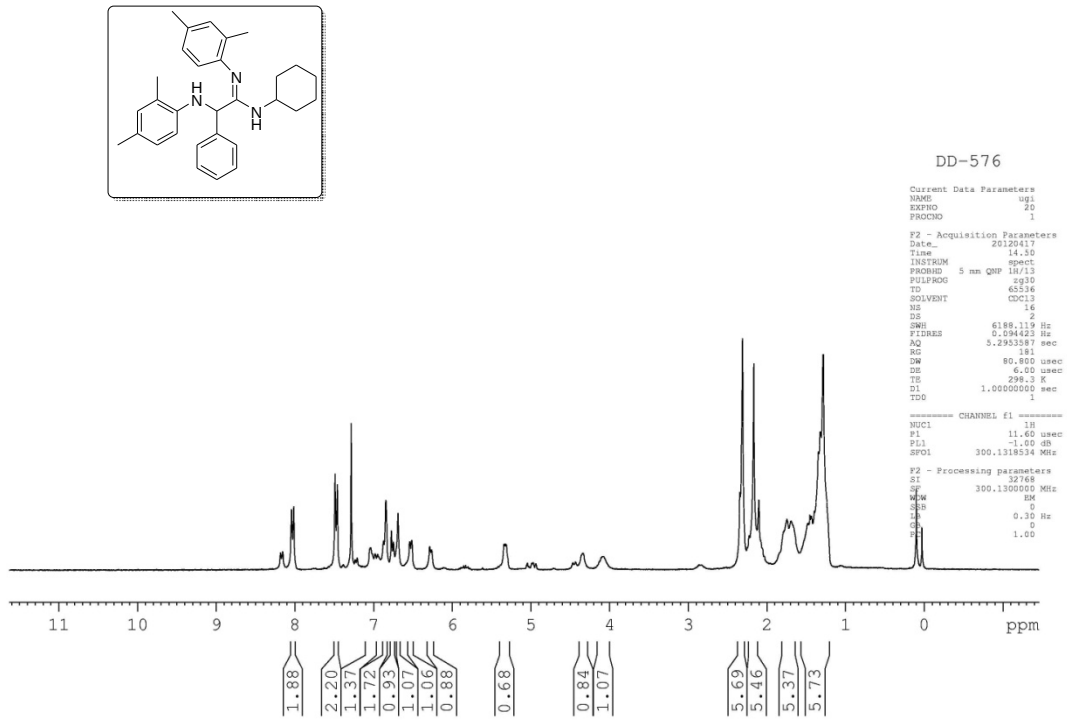


Fig. 10 (5j)


DD-576
ppm
1.88
2.20
1.37
1.72
0.93
1.07
1.06
0.88
0.68
0.84
1.07
5.69
5.46
5.37
5.73

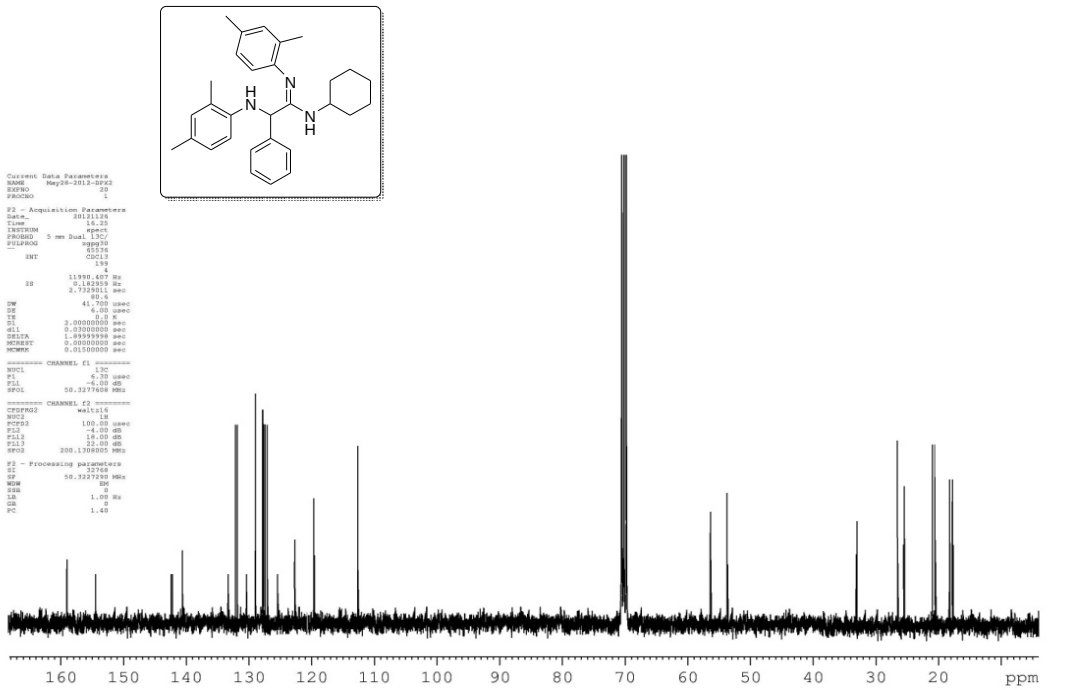
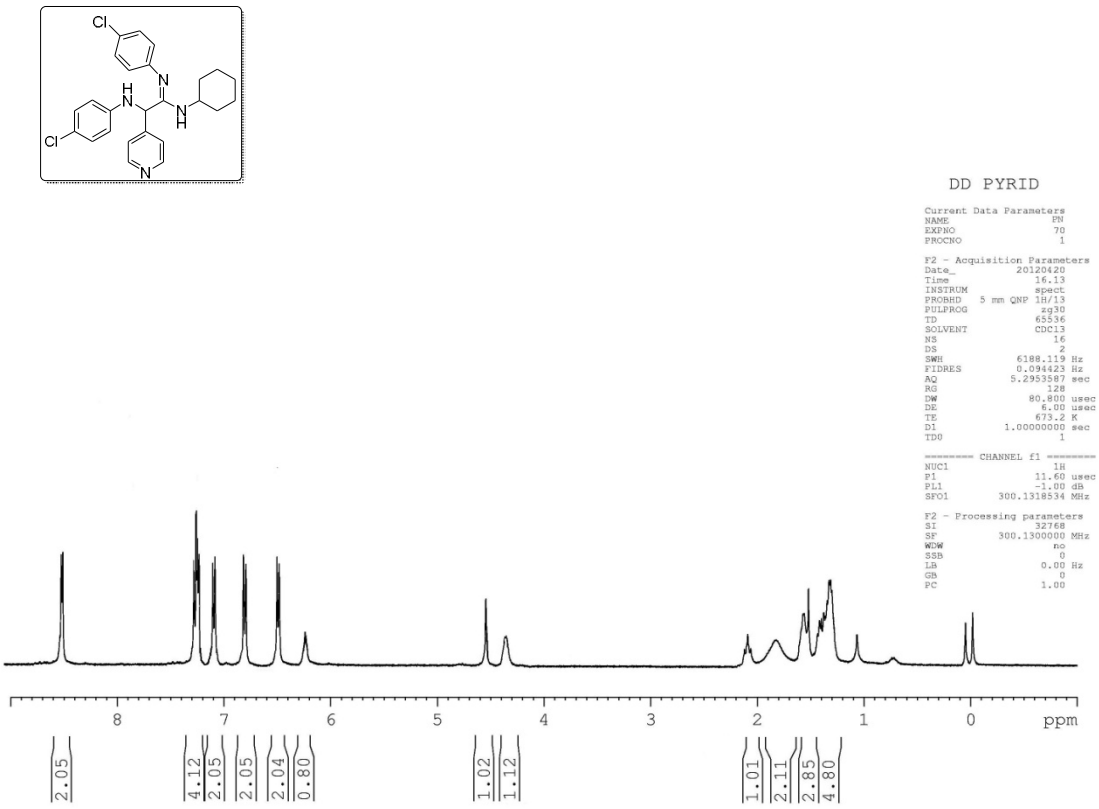

ppm

Fig. 11 (5k)



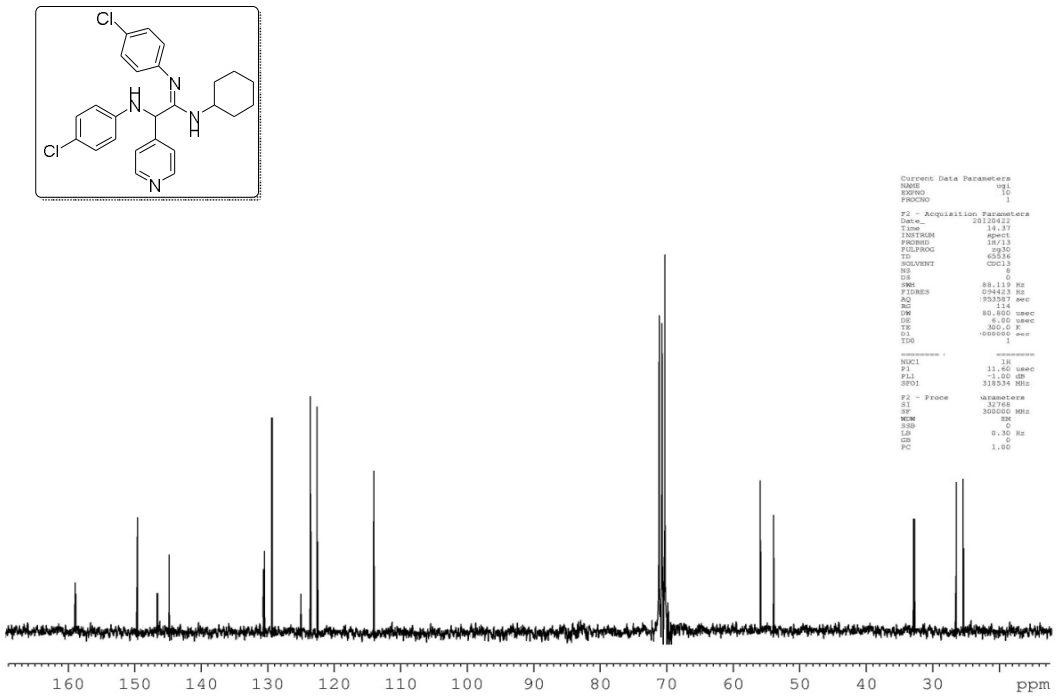
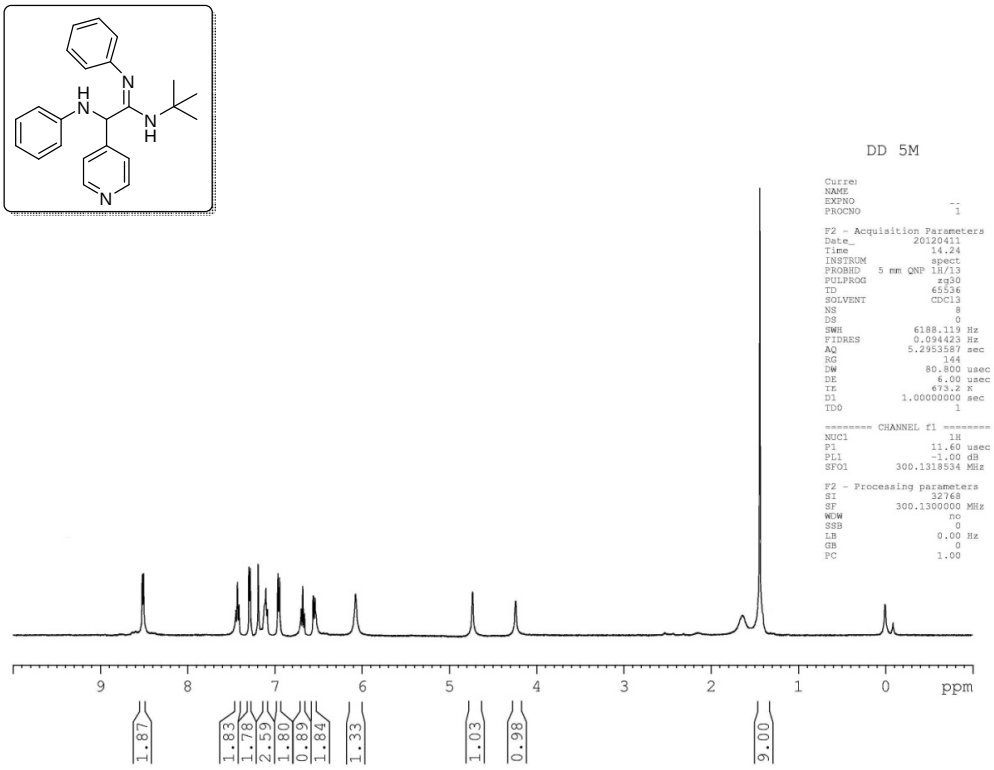


Fig. 12(5l)



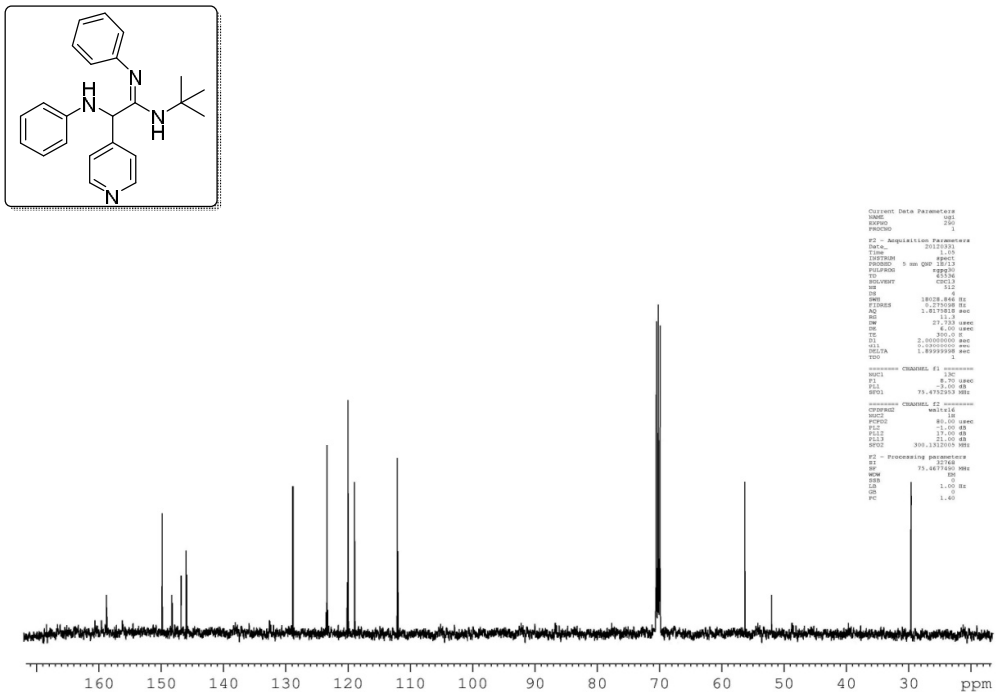
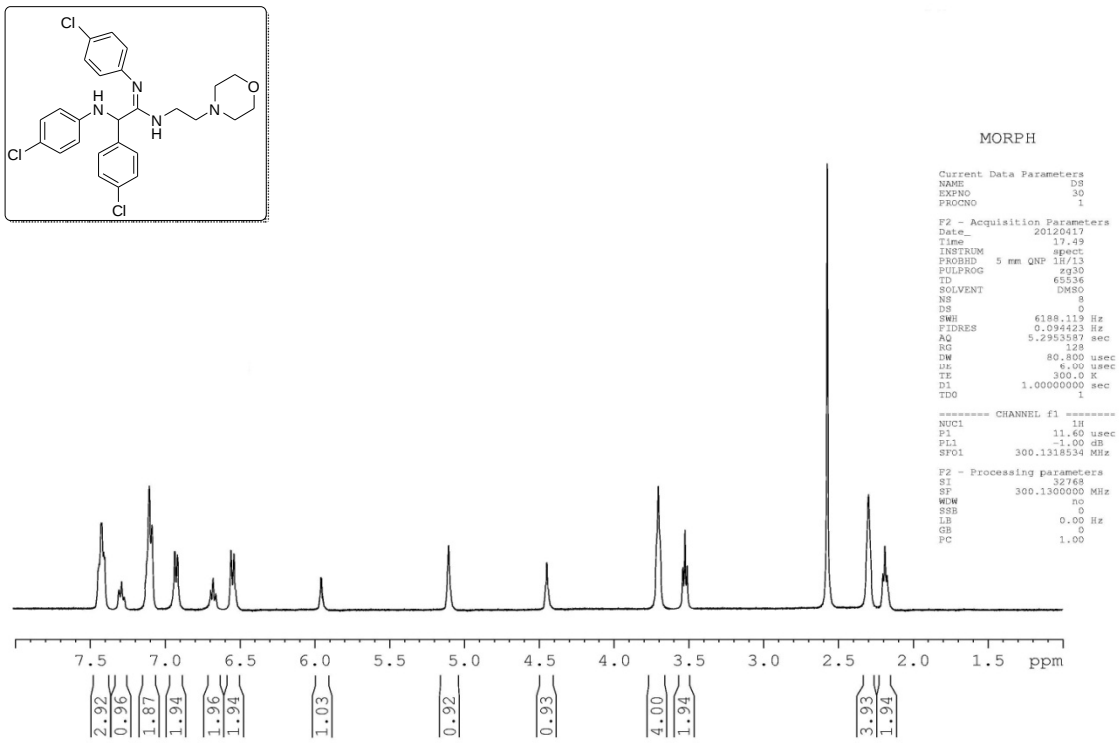


Fig. 13 (5m)


MORPH
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
ppm
2.92
0.96
1.87
1.94
1.96
1.94
1.03
0.92
0.93
4.00
1.94
3.93
1.94

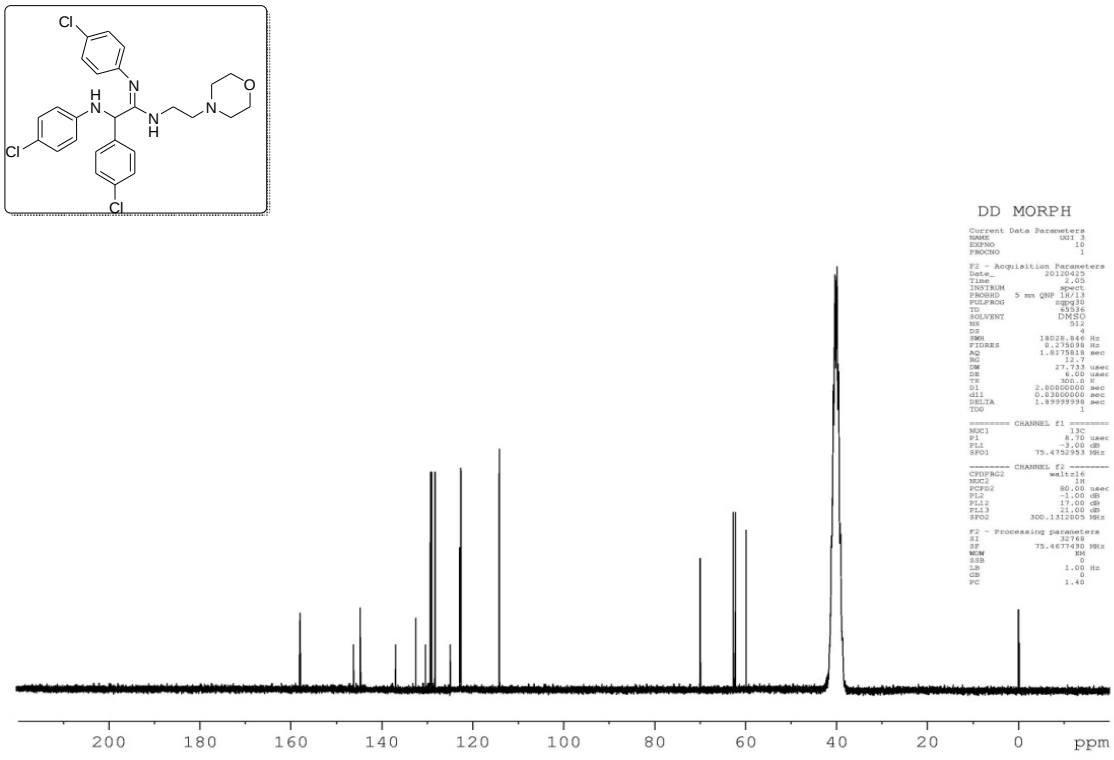
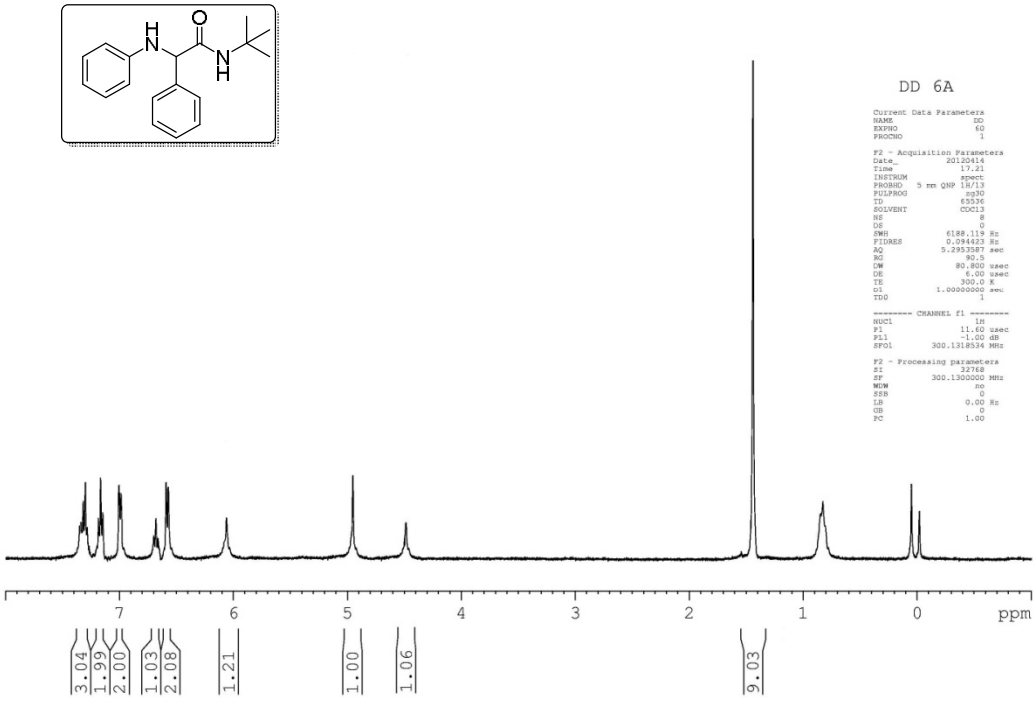

DD MORPH
200
180
160
140
120
100
80
60
40
20
0
ppm

Fig. 14 (5n)


DD 6A
7
6
5
4
3
2
1
0
ppm
3.04
1.99
2.00
1.03
2.08
1.21
1.00
1.06
9.03

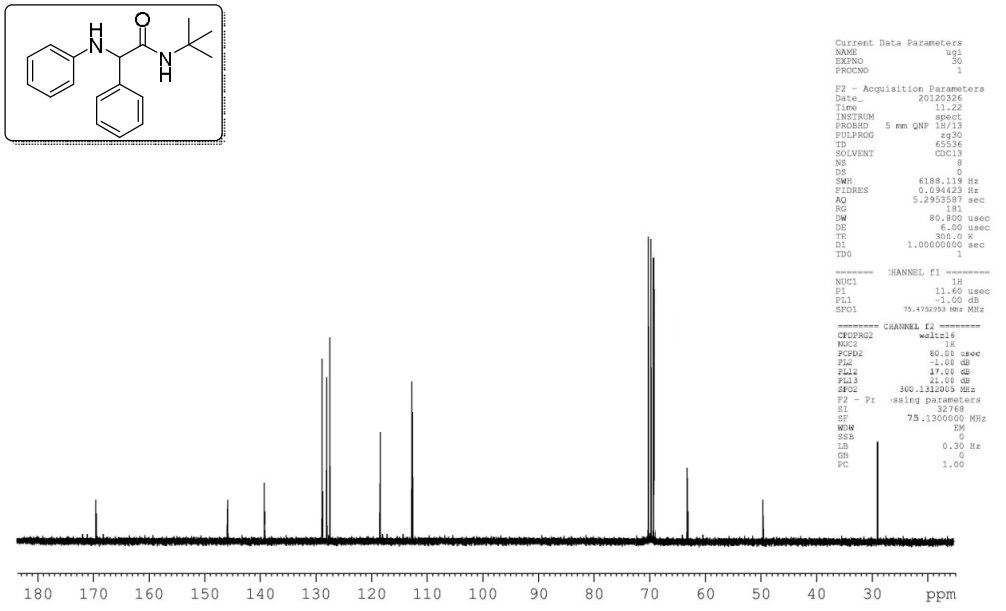
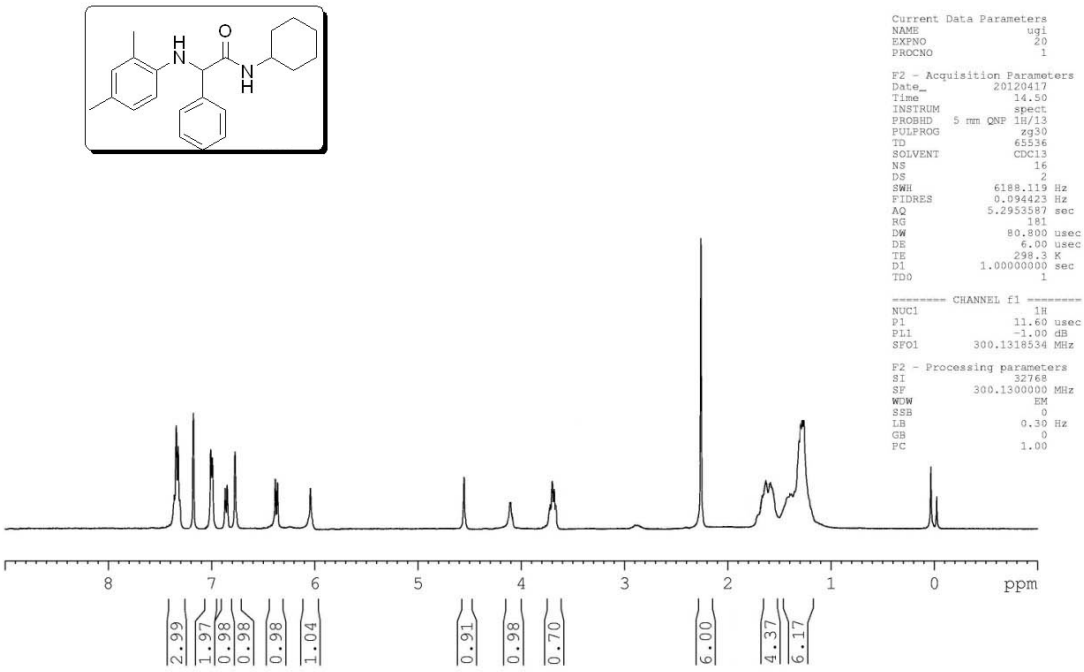

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
ppm

Fig 15 (6a)


Current Data Parameters
NAME ug1
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20120417
Time 14.50
INSTRUM spect
PROBHD 5 mm QNP 1H/13
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 6188.119 Hz
FIDRES 0.094423 Hz
AQ 5.2953587 sec
RG 181
DW 80.800 usec
DE 6.00 usec
TE 298.3 K
D1 1.00000000 sec
TD0 1
CHANNEL f1
NUC1 1H
P1 11.60 usec
PL1 -1.00 dB
SFO1 300.1318534 MHz
F2 - Processing parameters
SI 32768
SF 300.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
8 7 6 5 4 3 2 1 0 ppm
2.99 1.97 0.98 0.98 0.98 1.04 0.91 0.98 0.70 6.00 4.37 6.17

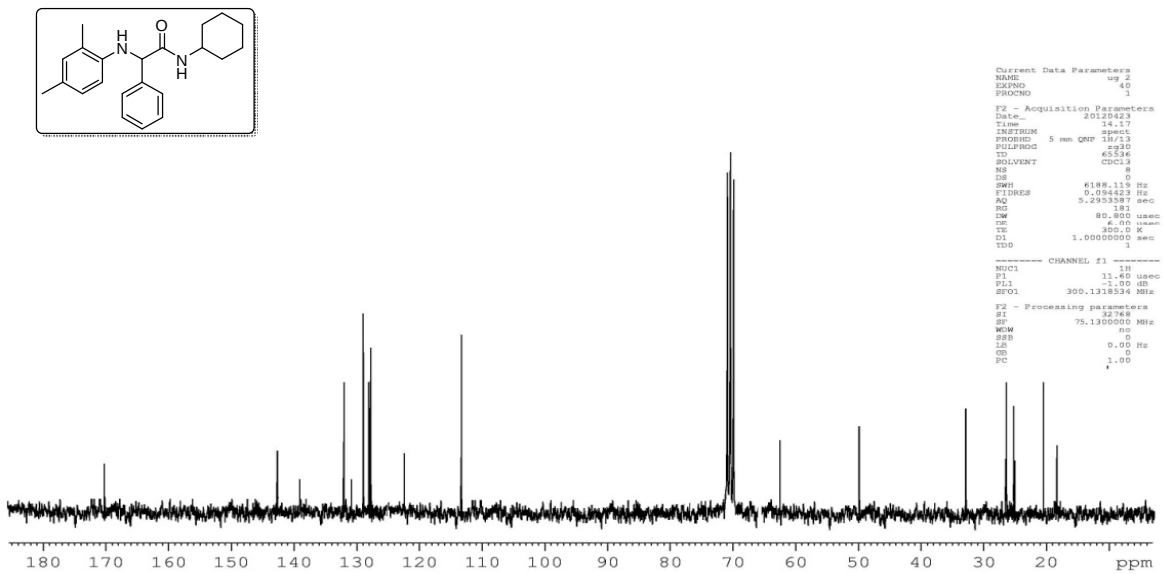
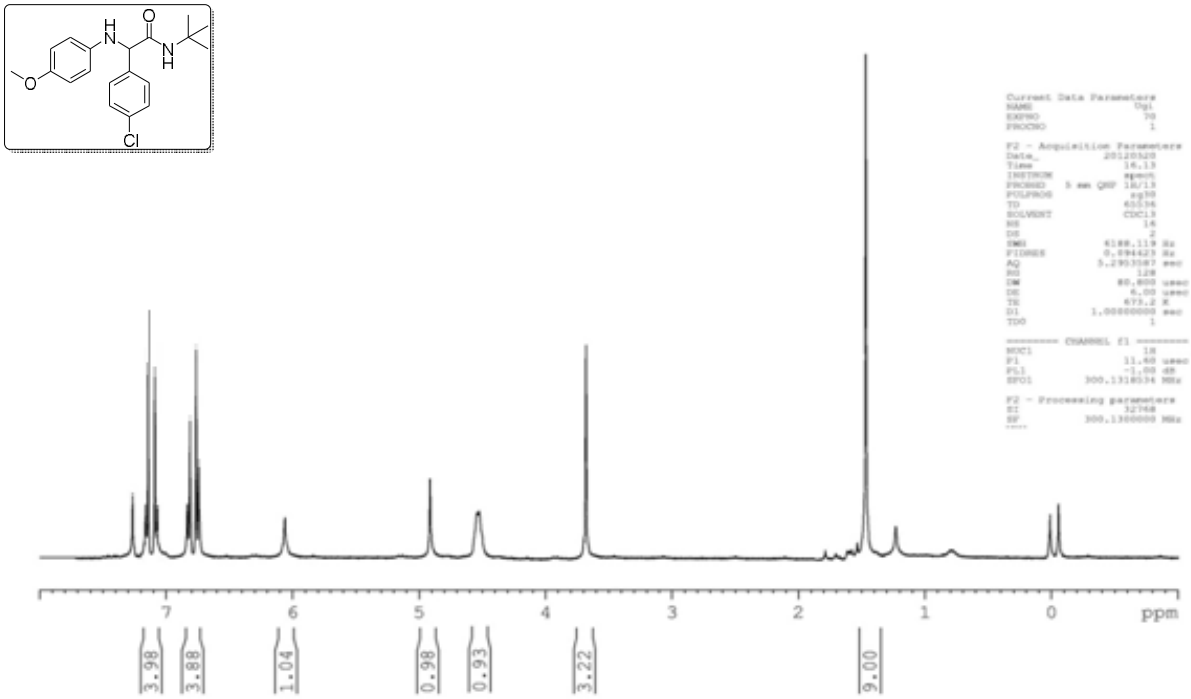

Current Data Parameters
NAME ug 2
EXPNO 40
PROCNO 1
F2 - Acquisition Parameters
Date_ 20120423
Time 14.17
INSTRUM spect
PROBHD 5 mm QNP 1H/13
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 8
DS 0
SWH 6188.119 Hz
FIDRES 0.094423 Hz
AQ 5.2953587 sec
RG 181
DW 80.800 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1
CHANNEL f1
NUC1 1H
P1 11.60 usec
PL1 -1.00 dB
SFO1 300.1318534 MHz
F2 - Processing parameters
SI 32768
SF 75.1300000 MHz
WDW no
SSB 0
LB 0.00 Hz
GB 0
PC 1.00
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

Fig. 16 (6k)



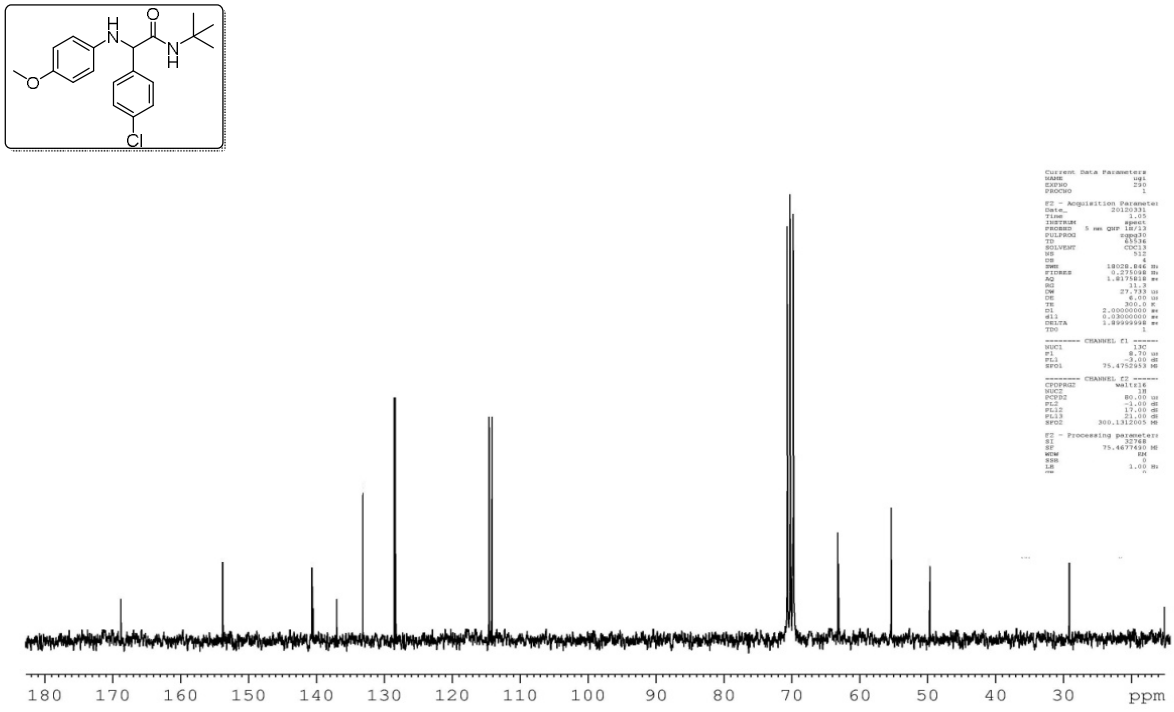


Fig. 17 (6i)

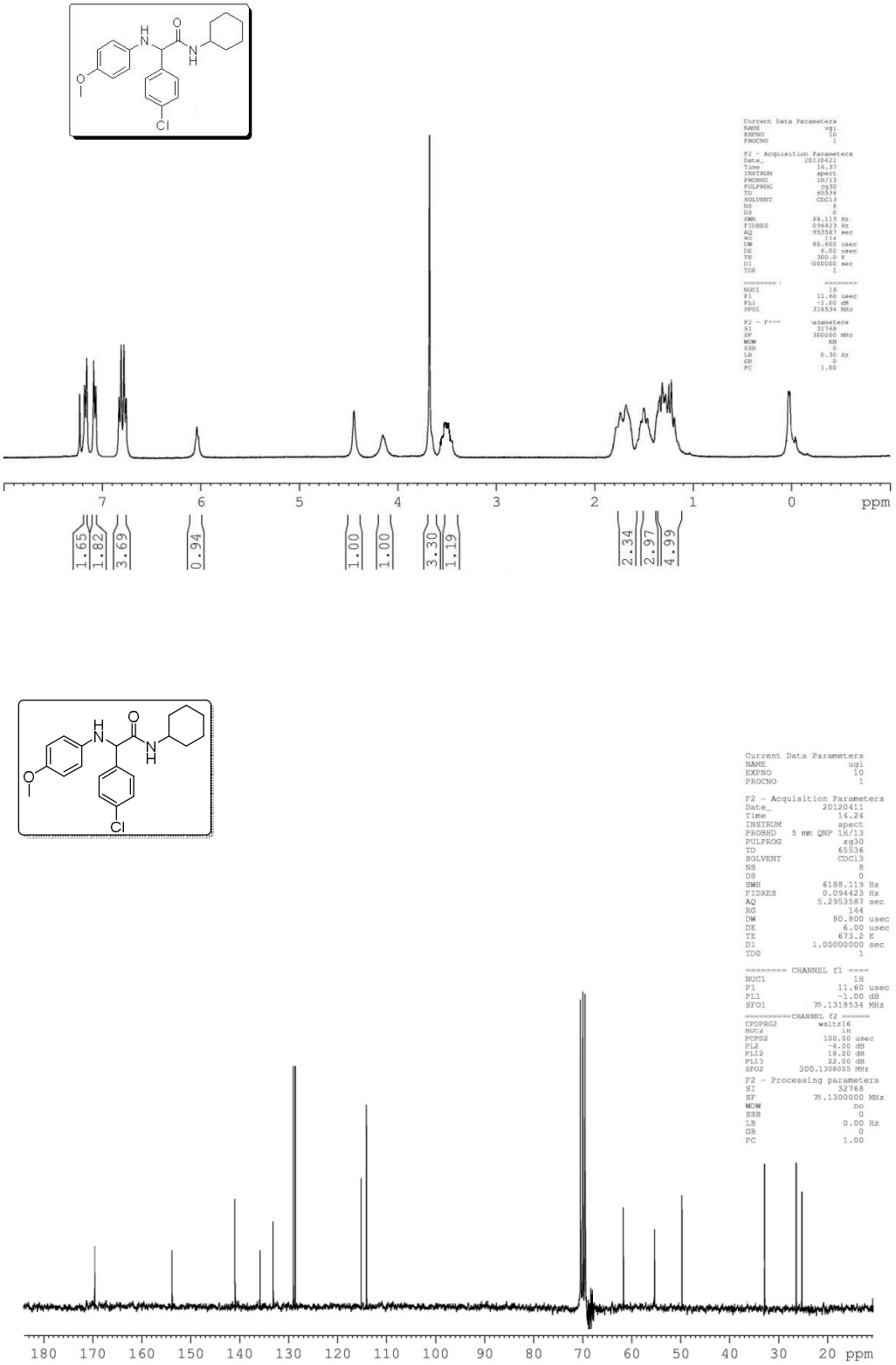
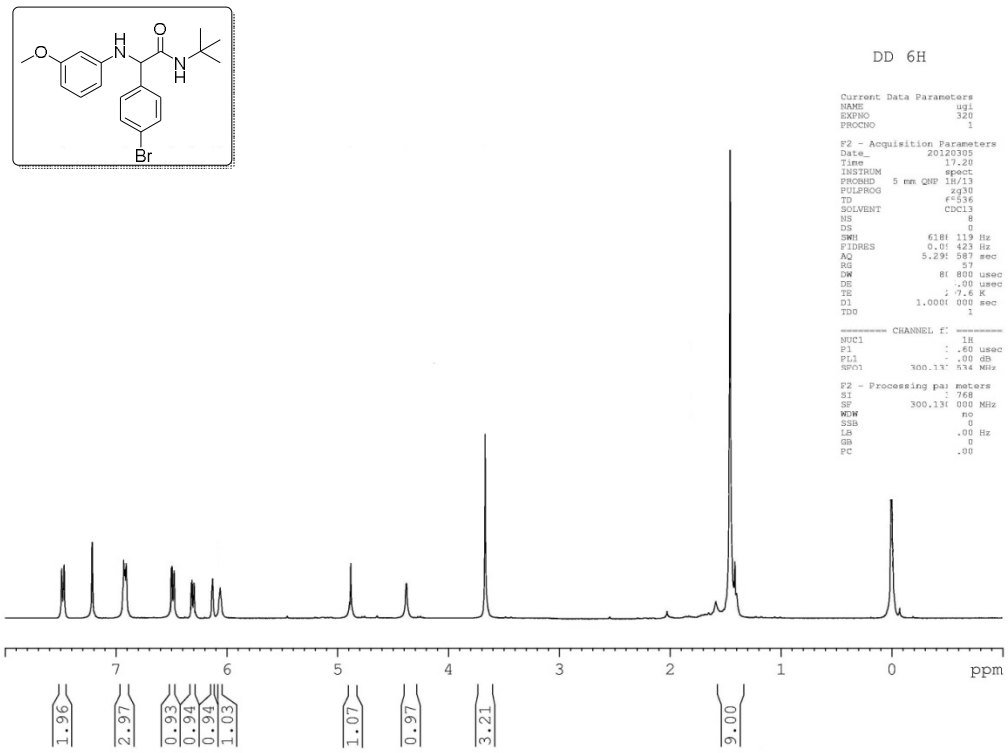


Fig. 18 (6b)



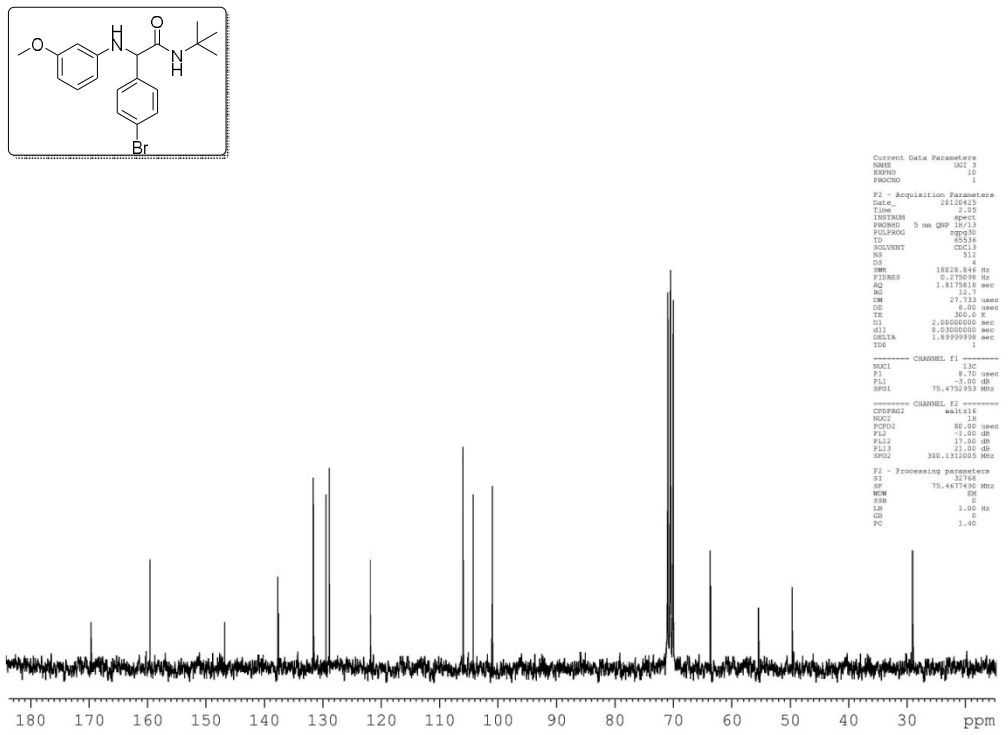
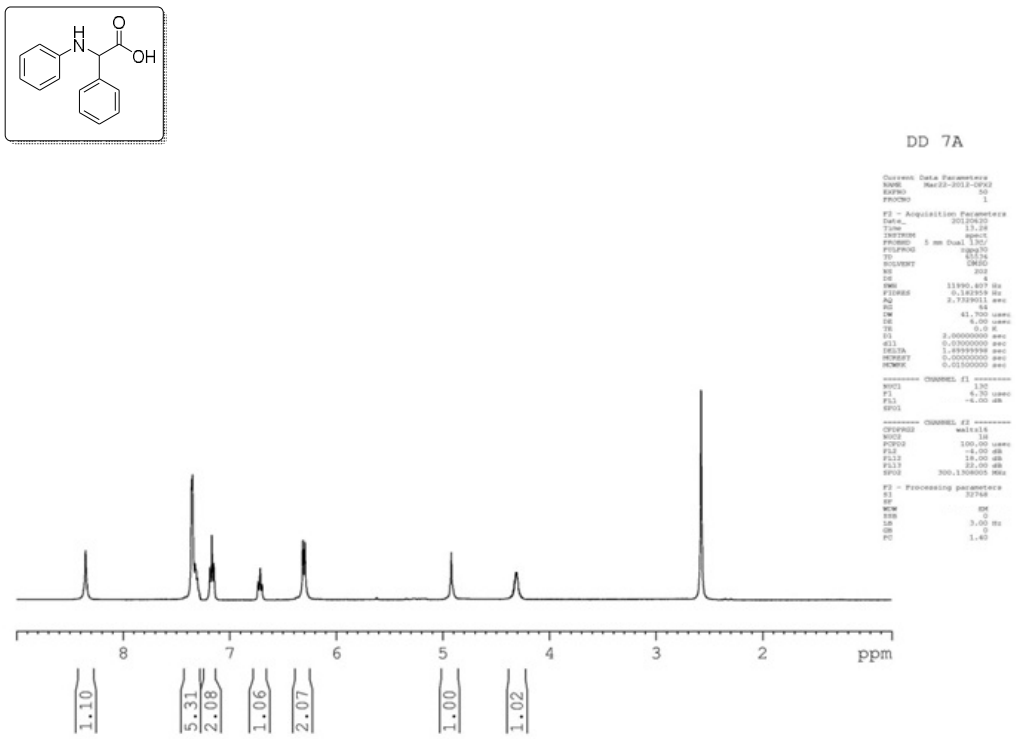


Fig. 19 (6h)



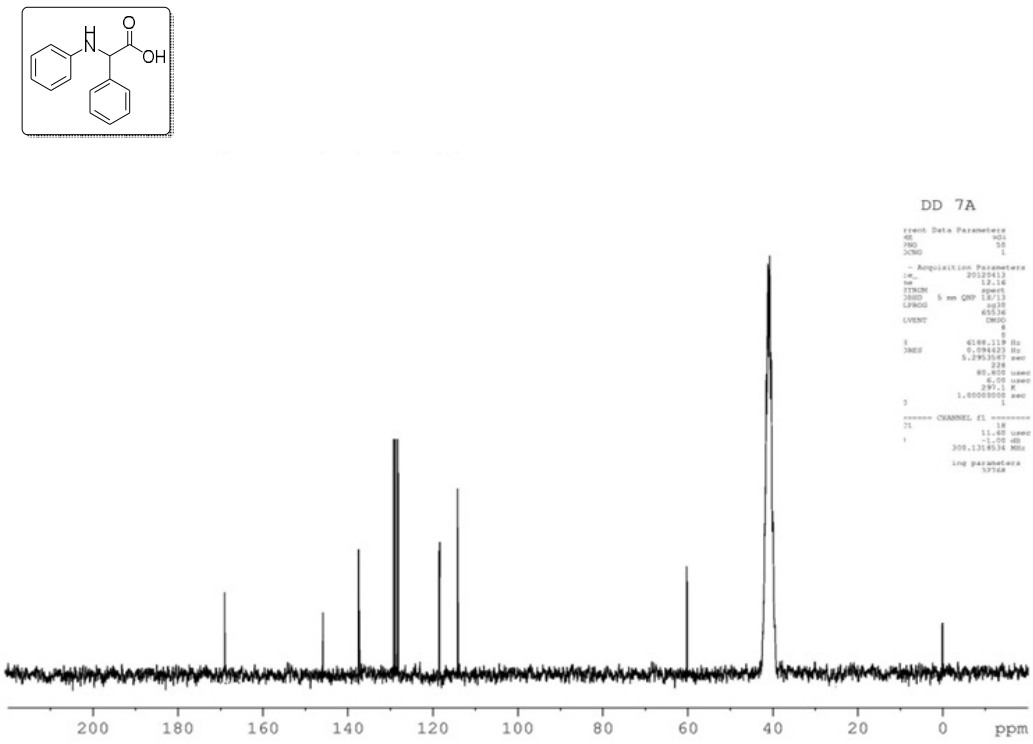


Fig. 20 (7a)

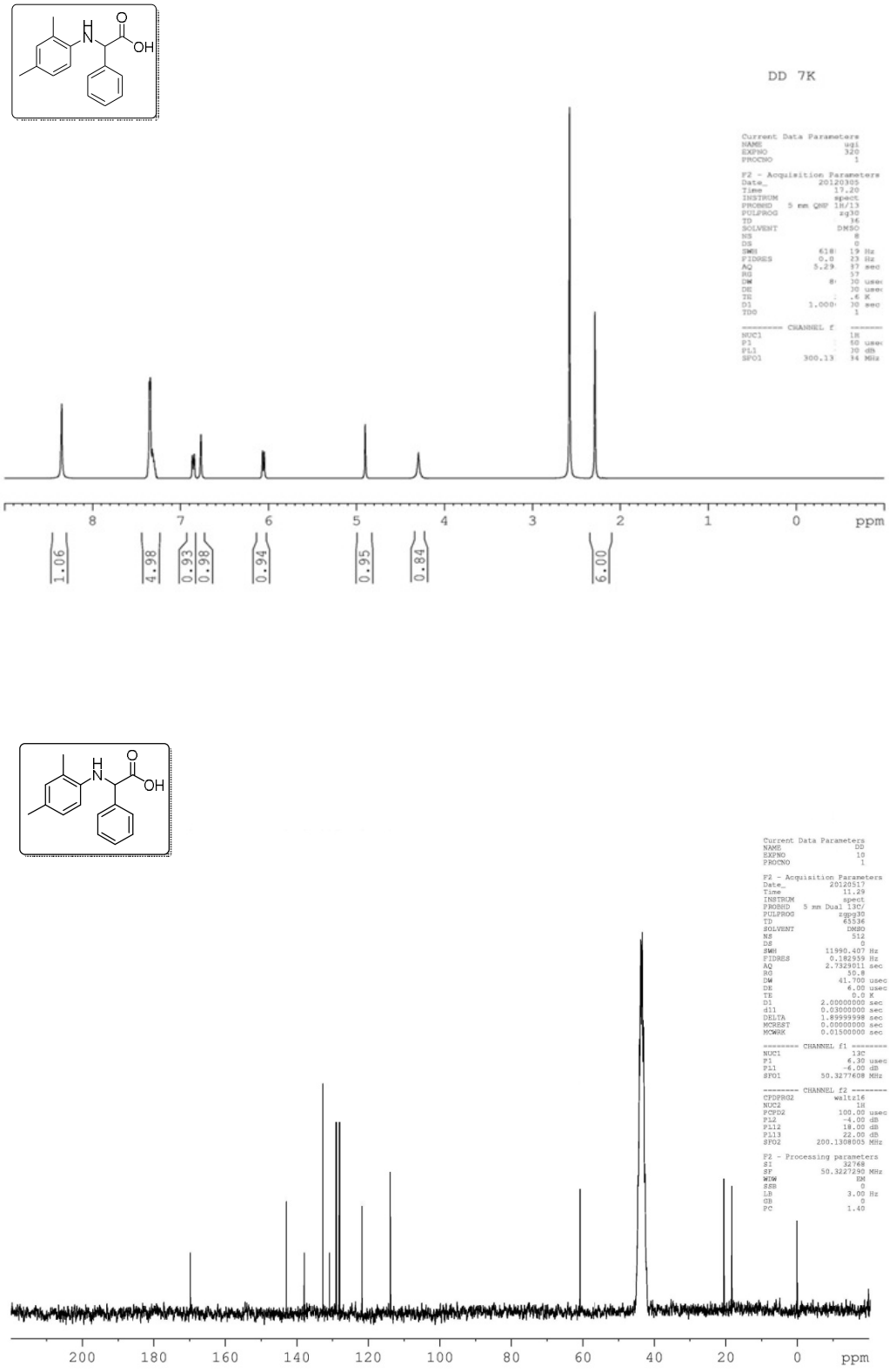
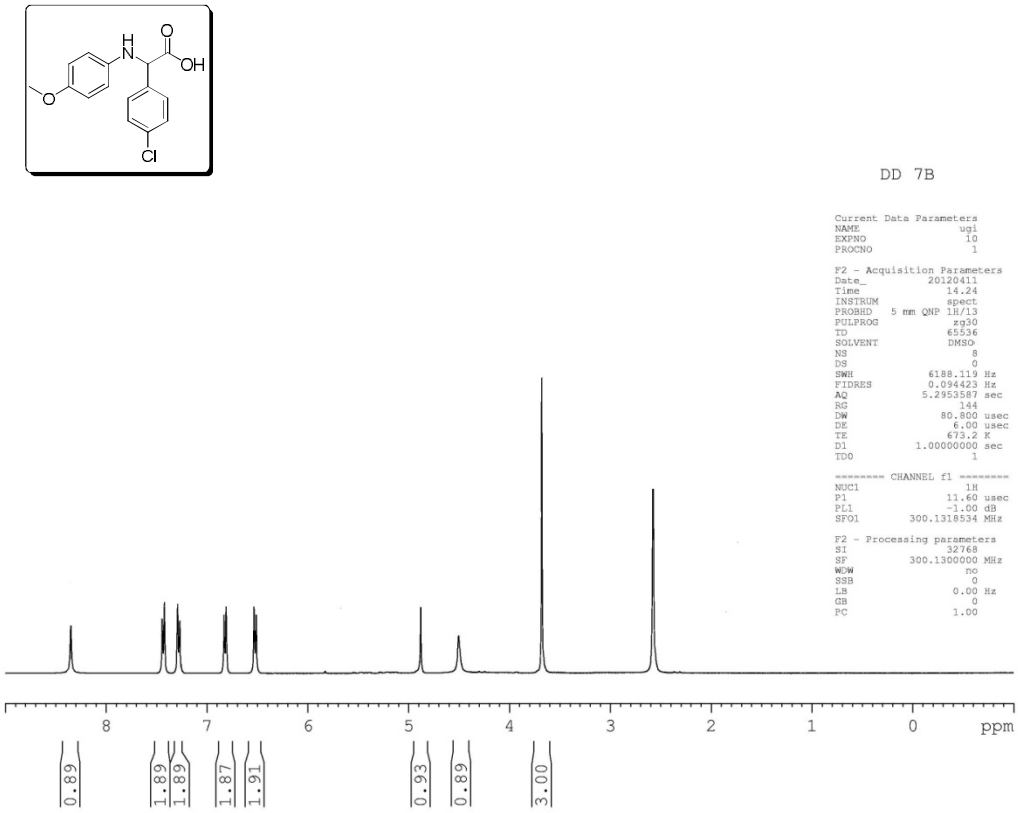


Fig. 21 (7k)



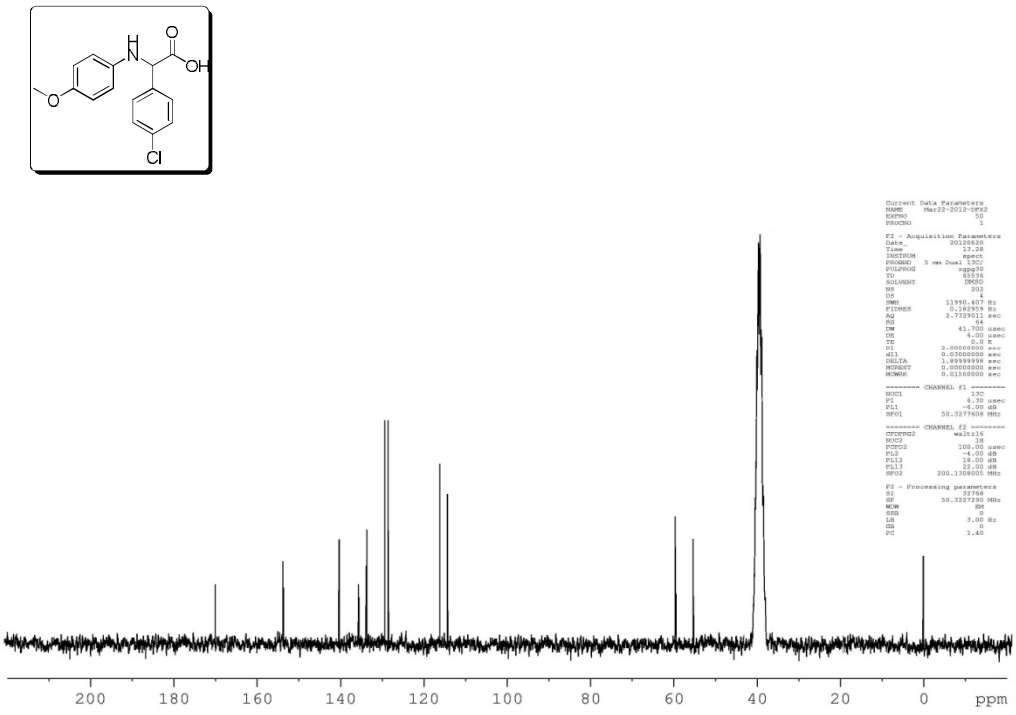


Fig. 23 (7b)