A facile four component protocol for the synthesis of dihydropyridine derivatives

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General remarks

Melting points were recorded on a Büchi melting point apparatus and are uncorrected. NMR spectra were recorded at 300/500 (^{1}H) and 75/ 125 (^{13}C) MHz respectively on Bruker Avance DPX-300/500S MHz NMR spectrometers. Chemical shifts (δ) are reported relative to TMS (^{1}H) and $CDCl_3$ (^{13}C) as the internal standards. Coupling constant (*J*) is reported in Hertz (Hz). Mass spectra were recorded under LRMS (FAB) using JEOL JMS 600H mass spectrometer. Elemantal analysis was carried out on Perkin Elmer Series II CHNS Analyser 2400. IR spectra were recorded on a Bruker Alpha-T FT-IR spectrophotometer. Allenoates were prepared using known literature procedures.[1] Gravity column chromatography was performed using silica gel and mixtures of petroleum ether-ethyl acetate were used for elution.

General Procedure for the Synthesis of dihydropyridines.

The aldehyde (1 mmol) and malononitrile (1 mmol) were taken in a round bottom flask in ethanol (3 ml) under argon atmosphere. Triethylamine (1.2 mmol) was added and stirred for 10 min. To this reaction mass, mixture of aniline (1.2 mmol) and allenoate (1.2 mmol) was added as a solution in ethanol (3 ml) and stirred the reaction for 12 h at room temperature. After the completion of the reaction as monitored by TLC, the reaction mixture was

[1] (a) For the synthesis of dialkyl penta-2,3-dienedioates, see T. A. Bryson and T. M. Dolak, *Org. Syn. Coll. Vol.*, 1988, **6**, 505; 1977, **57**, 62; (b) For the synthesis of ethyl penta-2,3-dienoate, see R. W. Lang and H.-J. Hansen, *Org. Syn. Coll. Vol.*, 1990, **7**, 232; 1984, **62**, 202.

concentrated and the crude product was purified by column chromatography on silica gel (100-200 mesh) and hexane: ethylacetate (70: 30) as the eluent to afford the product as a crystalline solid.

Characterization data for compounds

(*E*)-Ethyl2-(6-amino-5-cyano-4-(4-fluorophenyl)-3-methyl-1-phenyl-3,4-dihydropyridin-2(1H)-ylidene) acetate (10a)

Yield: 242 mg (0.62 mmol, 62%), colourless solid, M.P: 184-186 ^{o}C.

IR (film) ν_{max}: 3471, 3337, 2179, 1702, 1614, 1587, 1392, 1141 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57-7.50 (m, 3H), 7.25 – 7.22 (m, 2H), 7.16 (d, 2H, *J*= 7.5 Hz), 7.00 (t, 2H, *J*= 8.5 Hz), 4.64-4.60 (m, 1H), 4.33 (s, 1H), 4.19 (s, 2H), 3.97-3.90 (m, 2H), 3.49 (s, 1H), 1.47 (d, 3H, *J*= 6.5 Hz), 1.10 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.2, 161.7 (d, $^{1}J_{CF}$= 243.8 Hz), 158.9, 151.2, 138.5 7 (d, $^{4}J_{CF}$= 2.5Hz), 136.9, 130.8, 130.0, 129.4, 128.3, (d,$^{3}J_{CF}$=7.5 Hz) 121.7, 115.5 (d,$^{2}J_{CF}$=21.3 Hz), 99.2, 59.4, 57.8, 42.4, 34.1, 19.9, 14.2 ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{22}FN_3O_2$ $(M+H)^+$ 392.17; Found: 392.69.

Anal. Calcd for $C_{23}H_{22}FN_3O_2$: C, 70.57; H, 5.66; N, 10.73. Found: C, 70.71; H, 5.83; N, 10.94.

(*E*)-Ethyl 2-(6-amino-5-cyano-3-methyl-1-phenyl-4-p-tolyl-3,4-dihydropyridin-2(1H)-ylidene)acetate (10b)

Yield: 217 mg (0.56 mmol, 56%), colourless solid, M.P: 176-178 ^{o}C

IR (film) ν_{max}: 3470, 3336, 2178, 1702, 1613, 1588, 1393, 1138 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57-7.54 (m, 2H), 7.52-7.50 (m, 1H), 7.18-7.16 (m, 3H) 7.14-7.10 (m, 3H), 4.62 (m, 1H), 4.32 (s, 1H), 4.10 (s, 2H), 3.97-3.91 (m, 2H), 3.47 (s, 1H), 2.32 (s, 3H), 1.47 (d, 3H, *J*= 7 Hz), 1.10 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.3, 159.3, 150.9, 139.7, 137.1, 136.2, 130.7, 129.9, 129.4, 126.6, 98.8, 59.3, 58.5, 42.6, 34.1, 21.1, 20.0, 14.2 ppm.

LRMS (+FAB) m/z calcd for $C_{24}H_{25}N_2O_3$ $(M+H)^+$ 388.19; Found: 388.99.

Anal. Calcd for $C_{24}H_{25}N_2O_3$: C, 74.39; H, 6.50; N, 10.84. Found: C, 73.83; H, 6.85; N, 10.78.

(*E*)-Ethyl2-(6-amino-4-(4-bromophenyl)-5-cyano-3-methyl-1-phenyl-3,4-dihydropyridin -2(1H)-ylidene) acetate (10c).

Yield: 222 mg (0.49 mmol, 49%), colourless solid, M.P: 148-150 ^{o}C

IR (film) ν_{max}: 3463, 3333, 2178, 1699, 1615, 1586, 1389, 1139 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.58-7.51 (m, 3H), 7.45 (d, 2H, *J*= 8 Hz), 7.16 (d, 4H, *J*= 8.5 Hz), 4.64 (q, 1H, *J*= 7 Hz), 4.33 (s, 1H), 4.15 (s, 2H), 3.96-3.93 (m, 2H), 3.47 (s, 1H), 1.48 (d, 3H, *J*= 7 Hz), 1.11 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.2, 158.6, 151.1, 141.8, 131.7, 130.8, 130.7, 129.9, 129.3, 128.5, 120.7, 99.5, 59.5, 59.4, 42.8, 33.8, 19.8, 14.1ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{22}BrN_3O_2$ $(M+H)^+$ 453.09; Found: 452.89.

Anal. Calcd for $C_{23}H_{22}BrN_3O_2$: C, 61.07; H, 4.90; N, 9.29. Found: C, 61.38; H, 5.07; N, 9.00.

(*E*)-Ethyl 2-(6-amino-5-cyano-4-(4-methoxyphenyl)-3-methyl-1-phenyl-3,4-dihydropy-ridin-2(1H)-ylidene)acetate (10d)

Yield: 182 mg (0.45 mmol, 45%), colourless solid, M.P: 210-214 ^{o}C

IR (film) ν_{max}: 3458, 3354, 2177, 1700, 1610, 1586, 1391, 1139 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.56-7.49 (m, 3H), 7.17 (d, 4H, *J*= 8 Hz), 6.83 (d, 2H, *J*= 8.5 Hz), 4.61 (q, 1H, *J*= 7 Hz), 4.30 (s, 1H), 4.11 (s, 2H), 3.98-3.89 (m, 2H), 3.78 (s, 3H), 3.45 (s, 1H), 1.46 (d, 3H, *J*= 6.5 Hz), 1.11 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.3, 159.4, 158.4, 151.0, 137.1, 134.8, 130.7, 129.9, 129.44, 127.7, 121.8, 114.0, 98.8, 59.3, 58.5, 55.1, 42.3, 34.2, 19.9, 14.2 ppm.

LRMS (+FAB) m/z calcd for $C_{24}H_{25}N_3O_3$ $(M+H)^+$ 404.19; Found: 404.56.

Anal. Calcd for $C_{24}H_{25}N_3O_3$: C, 71.44; H, 6.25; N, 10.41. Found: C, 71.40; H, 6.46; N, 10.46.

(*E*)-Ethyl 2-(6-amino-5-cyano-3-methyl-1-phenyl-4-o-tolyl-3,4-dihydropyridin-2(1H)-ylidene)acetate (10e)

Yield: 178 mg (0.46 mmol, 46%), colourless solid, M.P: 218-220 ^{o}C.

IR (film) ν_{max}: 3472, 3333, 2174, 1705, 1613, 1581, 1394, 1144 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57-7.54 (m, 2H), 7.52-7.49 (m, 1H), 7.23 (s, 2H), 7.19-7.09 (m, 4H), 4.48 (q, 1H, *J*= 6 Hz), 4.30 (s, 1H), 4.22 (s, 2H), 3.93-3.84 (m, 2H), 3.67 (s, 1H), 2.43 (s, 3H), 1.49 (d, 3H, *J*= 6.5 Hz), 1.05 (t, 3H, *J*= 7.5 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.2, 158.9, 151.6, 140.2, 137.1, 135.4, 131.0, 130.8, 129.9, 129.4, 126.8, 126.0, 125.7, 99.3, 59.3, 57.8, 40.1, 32.8, 20.1, 19.2, 14.1 ppm.

LRMS (+FAB) m/z calcd for $C_{24}H_{25}N_3O_2$ $(M+H)^+$ 388.19; Found: 388.94.

Anal. Calcd for $C_{24}H_{25}N_3O_2$: C, 74.39; H, 6.50; N, 10.84. Found: C, 74.58; H, 6.45; N, 10.64.

(*E*)-Ethyl 2-(6-amino-5-cyano-3-methyl-1,4-diphenyl-3,4-dihydropyridin-2(1H)-ylidene) acetate (10f)

Yield: 157 mg (0.42 mmol, 42%), colourless solid, M.P: 130-134 ^oC

IR (film) ν_{max}: 3469, 3335, 2178, 1701, 1614, 1587, 1392, 1139 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57-7.51 (m, 3H), 7.34-7.31 (m, 2H), 7.27 (d, 2H, *J*= 7.5 Hz) 7.23-7.18 (m, 3H), 4.66-4.61 (m, 1H), 4.34 (s, 1H), 4.15 (s, 2H), 3.96-3.90 (m, 2H), 3.51 (s, 1H), 1.49 (d, 3H, *J*= 6.5 Hz), 1.09 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 166.2, 159.2, 151.0, 142.7, 137.0, 130.8, 129.9, 128.6, 126.8, 126.7, 98.9, 59.3, 58.3, 43.0, 34.1, 20.0, 14.2 ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{23}N_3O_2$ $(M+H)^+$ 374.19**;** Found: 374.34.

Anal. Calcd for $C_{23}H_{23}N_3O_2$: C, 73.97; H, 6.21; N, 11.25. Found: C, 73.62; H, 6.54; N, 10.92.

(*E*)-Methyl 6-amino-5-cyano-4-(4-fluorophenyl)-2-(2-methoxy-2-oxoethylidene)-1-phenyl-1,2,3,4-tetrahyd- ropyridine-3-carboxylate (10g)

Yield: 236 mg (0.56 mmol, 56%), colourless solid, M.P: 178-180 ^oC

IR (film) ν_{max}: 3464, 3351, 2180, 1736, 1703, 1621, 1580, 1426, 1386, 1149 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.54 (s, 4H), 7.29-7.27 (m, 3H), 7.06-7.01 (m, 2H), 5.65 (s, 1H), 4.59 (s, 1H), 4.31 (s, 1H), 4.27 (s, 2H), 3.88 (s, 3H), 3.48 (s, 3H) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 169.9, 166.7, 162.0 (d, $^1J_{CF}$=245 Hz), 152.2, 151.3, 136.8, 136.1, 130.2, 129.3, 128.4 (d, $^3J_{CF}$= 8.8Hz), 115.7 (d, $^2J_{CF}$= 21.3 Hz), 102.1, 57.6, 53.0, 52.9, 50.9, 45.8, 38.4 ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{20}FN_3O_4$ $(M+H)^+$ 422.14; Found: 422.96.

Anal. Calcd for $C_{23}H_{20}FN_3O_4$: C, 65.55; H, 4.78; N, 9.97. Found: C, 65.47; H, 4.80; N, 10.05.

(*E*)-Methyl 6-amino-4-(4-chlorophenyl)-5-cyano-2-(2-methoxy-2-oxoethylidene)-1-phenyl-1,2,3,4-tetra- hydropyridine-3-carboxylate (10h)

Yield: 254 mg (0.58 mmol, 58%), colourless solid, M.P: 184-186 ^oC

IR (film) ν_{max}: 3466, 3351, 2180, 1736, 1620, 1581, 1491, 1385, 1151 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.57-7.54 (m, 4H), 7.34-7.26 (m, 5H), 5.66 (d, 1H, *J*= 2.1 Hz), 4.59 (s, 1H), 4.31 (s, 1H), 4.24 (s, 2H), 3.88 (s, 3H), 3.49 (s, 3H) ppm.

^{13}C NMR (75 MHz, $CDCl_3$): δ 169.9, 166.7, 152.3, 151.2, 139.0, 136.7, 133.1, 131.0, 130.2, 129.3, 129.0, 128.3, 120.7, 102.1, 57.0, 53.0, 50.9, 45.6, 38.5 ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{20}ClN_3O_4$ $(M+H)^+$ 438.11; Found: 438.61.

Anal. Calcd for $C_{23}H_{20}ClN_3O_4$: C, 63.09; H, 4.60; N, 9.60. Found: C, 62.73; H, 4.79; N, 9.76.

(*E*)-Methyl 6-amino-4-(4-bromophenyl)-5-cyano-2-(2-methoxy-2-oxoethylidene)-1-phenyl-1,2,3,4-tetra- hydropyridine-3-carboxylate (10i)

Yield: 203 mg (0.42 mmol, 42%), colourless solid, M.P**:** 177-179 ^oC

IR (film) ν_{max}: 3469, 3360, 2182, 1736, 1624, 1581, 1460, 1380, 1154 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57- 7.51 (m, 3H), 7.47 (d, 2H, *J*= 8.5 Hz), 7.21 (d, 3H, *J*= 8.5 Hz), 7.16 (s, 1H), 5.66 (d, 1H, *J*= 2 Hz), 4.58 (s, 1H), 4.29 (s, 1H), 4.22 (s, 2H), 3.88 (s, 3H), 3.49 (s, 3H) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 169.8, 166.7, 152.5, 151.2, 139.6, 136.8, 131.9, 130.2, 129.3, 128.7, 121.3, 120.7, 102.1, 56.9, 53.0, 50.9, 45.6, 38.7 ppm.

LRMS (+FAB) m/z calcd for $C_{23}H_{20}BrN_3O_4$ $(M+H)^+$ 482.06; Found: 482.87.

Anal. Calcd for $C_{23}H_{20}BrN_3O_4$: C, 57.27; H, 4.18; N, 8.71. Found: C, 57.53; H, 4.33; N, 8.92.

(*E*)-Methyl6-amino-5-cyano-2-(2-methoxy-2-oxoethylidene)-4-(4-methoxyphenyl)-1-phenyl-1,2,3,4-tetra- hydropyridine-3-carboxylate (10j)

Yield: 165 mg (0.38 mmol, 38%), colourless solid, M.P**:** 167-169 ^oC

IR (film) ν_{max}: 3461, 3348, 2179, 1734, 1618, 1579, 1384, 1143 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.56- 7.50 (m, 3H), 7.46 (s, 1H), 7.23 (d, 2H, *J*= 9 Hz), 7.19 (s, 1H), 6.86 (d, 2H, *J*= 8.5 Hz), 5.62 (d, 1H, *J*= 2.5 Hz), 4.57 (s, 1H), 4.27 (s, 1H), 4.17 (s, 2H), 3.88 (s, 3H), 3.80 (s, 3H), 3.48 (s, 3H) ppm.

^{13}C NMR (75 MHz, $CDCl_3$): δ 170.2, 166.8, 158.8, 152.0, 151.8, 137.0, 132.4, 130.0, 129.4, 127.9, 120.8, 114.2, 101.8, 58.3, 55.1, 52.8, 50.8, 46.1, 38.4 ppm.

LRMS (+FAB) m/z calcd for $C_{24}H_{23}N_3O_5$ $(M+H)^+$ 434.16; Found: 435.04.

Anal. Calcd for $C_{24}H_{23}N_3O_5$: C, 66.50; H, 5.35; N, 9.69. Found: C, 66.15; H, 5.35; N, 9.32.

(*E*)-Methyl6-amino-5-cyano-2-(2-methoxy-2-oxoethylidene)-1-phenyl-4-o-tolyl-1,2,3,4-tetrahydropyridine -3-carboxylate (10k)

Yield: 221 mg (0.53 mmol, 53%), colourless solid, M.P: 210-214 ^oC

IR (film) ν_{max}: 3466, 3355, 2180, 1735, 1620, 1585, 1386, 1148 cm^{-1}**.**

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.59-7.56 (m, 2H), 7.53-7.50 (m, 1H), 7.47 (s, 1H), 7.29 (s, 1H), 7.19-7.14 (m, 4H), 5.54 (d, 1H, *J*= 2 Hz), 4.54 (s, 1H), 4.47 (s, 1H), 4.26 (s, 2H), 3.90 (s, 3H), 3.42 (s, 3H), 2.53 (s, 3H) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 170.3, 166.7, 152.6, 151.4, 137.8, 137.0, 135.8, 131.2, 130.1, 129.4, 127.4, 126.1, 120.7, 102.0, 57.6, 53.0, 50.8, 44.2, 36.6, 19.0 ppm.

LRMS (+FAB) m/z calcd for $C_{24}H_{23}N_3O_4$ $(M+H)^+$ 418.17; Found: 419.03**.**

Anal. Calcd for $C_{24}H_{23}N_3O_4$: C, 69.05; H, 5.55; N, 10.07. Found: C, 68.68; H, 5.72; N, 10.36.

(*E*)-Ethyl6-amino-5-cyano-2-(2-ethoxy-2-oxoethylidene)-4-(4-fluorophenyl)-1-phenyl-1,2,3,4-tetrahydrop- yridine-3-carboxylate (10l)

Yield: 319 mg (0.71 mmol, 71%), light yellow solid, M.P**:** 156-160 ^oC

IR (film) ν_{max}: 3463, 3385, 2180, 1732, 1623, 1578, 1382, 1138 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57- 7.51 (m, 3H), 7.47 (s, 1H), 7.31-7.29 (m, 2H), 7.16 (s, 1H), 7.03 (t, 2H, *J*= 8.5 Hz), 5.64 (d, 1H, *J*= 2.5 Hz), 4.57 (s, 1H), 4.35-4.31 (m, 3H), 4.22 (s, 2H), 3.94 (q, 2H, *J*= 7 Hz), 1.39 (t, 3H, *J*= 7 Hz), 1.10 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 169.4, 166.3, 161.9 (d, $^1J_{CF}$= 243.8 Hz), 152.4, 151.3, 136.9, 136.2, 130.4, 130.1, 129.3, 128.5 (d, $^3J_{CF}$=7.5 Hz), 120.8, 115.6 (d, $^2J_{CF}$=21.3 Hz), 102.4, 61.8, 59.7, 57.3, 45.9, 38.6, 14.3, 14.1 ppm.

LRMS (+FAB) m/z calcd for $C_{25}H_{24}FN_3O_4$ $(M+H)^+$ 450.18; Found: 451.05.

Anal. Calcd for $C_{25}H_{24}FN_3O_4$: C, 66.80; H, 5.38; N, 9.35. Found: C, 66.57; H, 5.77; N, 9.40.

(*E*)-Ethyl 6-amino-4-(4-chlorophenyl)-5-cyano-2-(2-ethoxy-2-oxoethylidene)-1-phenyl-1,2,3,4-tetrahydro-pyridine-3-carboxylate (10m)

Yield: 303 mg (0.65 mmol, 65%), colourless solid, M.P**:** 168-170 ^oC

IR (film) ν_{max}: 3460, 3358, 2180, 1731, 1618, 1588, 1385, 1143 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.56- 7.50 (m, 3H), 7.47 (s, 1H), 7.32-7.26 (m, 4H), 7.15 (s, 1H), 5.65 (d, 1H, *J*= 2 Hz), 4.55 (s, 1H), 4.35-4.31 (m, 2H), 4.29 (s, 1H), 4.26 (s, 2H), 3.94 (q, 2H, *J*= 7 Hz), 1.39 (t, 3H, *J*= 7 Hz), 1.11 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 169.3, 166.3, 152.4, 151.1, 139.0, 136.9, 133.1, 130.1, 129.4, 128.9, 128.3, 120.6, 102.5, 61.8, 59.7, 57.1, 45.7, 38.7, 14.3, 14.1 ppm.

LRMS (+FAB) m/z calcd for $C_{25}H_{24}ClN_3O_4$ $(M+H)^+$ 466.15; Found: 466.86.

Anal. Calcd for $C_{25}H_{24}ClN_3O_4$: C, 64.44; H, 5.19; N, 9.02. Found: C, 64.71; H, 5.11; N, 9.32.

(*E*)-Ethyl 6-amino-4-(4-bromophenyl)-5-cyano-2-(2-ethoxy-2-oxoethylidene)-1-phenyl-1,2,3,4-tetrahydro- pyridine-3-carboxylate (10n)

Yield: 291 mg (0.57 mmol, 57%), light yellow solid, M.P: 190-192 ^oC

IR (film) ν_{max}: 3463, 3347, 2180, 1731, 1621, 1587, 1384, 1143 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.57-7.51 (m, 3H), 7.47 (d, 3H, *J*= 8 Hz), 7.22 (d, 2H, *J*= 8.5 Hz), 7.15 (s, 1H), 5.66 (d, 1H, *J*= 2 Hz), 4.56 (s, 1H), 4.36-4.30 (m, 2H), 4.28 (s, 1H), 4.22 (s, 2H), 3.94 (q, 2H, *J*= 7 Hz), 1.39 (t, 3H, *J*= 7 Hz), 1.11 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (75 MHz, $CDCl_3$): δ 169.4, 166.3, 152.6, 151.1, 139.6, 136.8, 131.9, 130.4, 130.1, 129.3, 128.7, 121.2, 120.8, 102.5, 61.9, 59.7, 56.8, 45.7, 38.8, 14.3, 14.1 ppm.

LRMS (+FAB) m/z calcd for $C_{25}H_{24}BrN_3O_4$ $(M+H)^+$ 510.10; Found: 510.82.

Anal. Calcd for $C_{25}H_{24}BrN_3O_4$: C, 58.83; H, 4.74; N, 8.23. Found: C, 59.03; H, 4.88; N, 8.64.

(*E*)-Ethyl 6-amino-5-cyano-2-(2-ethoxy-2-oxoethyli dene)-1-phenyl-4-o-tolyl-1,2,3,4-tetrahydropyridine- 3-carboxylate (10o)

Yield: 214 mg (0.48 mmol, 48%), light yellow solid, M.P: 138-140 ^oC

IR (film) ν_{max}: 3467, 3366, 2180, 1733, 1623, 1590, 1394, 1148 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.60-7.57 (m, 2H), 7.54-7.49 (m, 2H), 7.30 (s, 1H), 7.20-7.13 (m, 4H), 5.51 (d, 1H, *J*= 2 Hz), 4.53 (s, 1H), 4.47 (d, 1H, *J*= 2 Hz), 4.37-4.30 (m, 2H), 4.22 (s, 2H), 3.93-3.82 (m, 2H), 2.53 (s, 3H), 1.40 (t, 3H, *J*= 7 Hz), 1.05 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (125 MHz, $CDCl_3$): δ 169.8, 166.3, 152.8, 151.3, 137.9, 137.0, 135.7, 131.1, 130.5, 130.0, 129.4, 127.3, 126.2, 126.1, 120.9, 102.4, 61.7, 59.6, 57.2, 44.4, 36.8, 18.9, 14.3, 14.1 ppm.

LRMS (+FAB) m/z calcd for $C_{26}H_{27}N_3O_4$ $(M+H)^+$ 446.20; Found: 446.85.

Anal. Calcd for $C_{26}H_{27}N_3O_4$: C, 70.09; H, 6.11; N, 9.43. Found: C, 69.78; H, 6.17; N, 9.62.

(*E*)-Ethyl 2-(6-amino-5-cyano-4-(4-fluorophenyl)-3-methyl-1-p-tolyl-3,4-dihydropyridin-2(1H)-ylidene) acetate (12)

Yield: 227 mg (0.56 mmol, 56%), colourless solid, M.P: 150-152^{o}C

IR (film) ν_{max}: 3471, 3345, 2177, 1701, 1600, 1581, 1501, 1385, 1139 cm^{-1}.

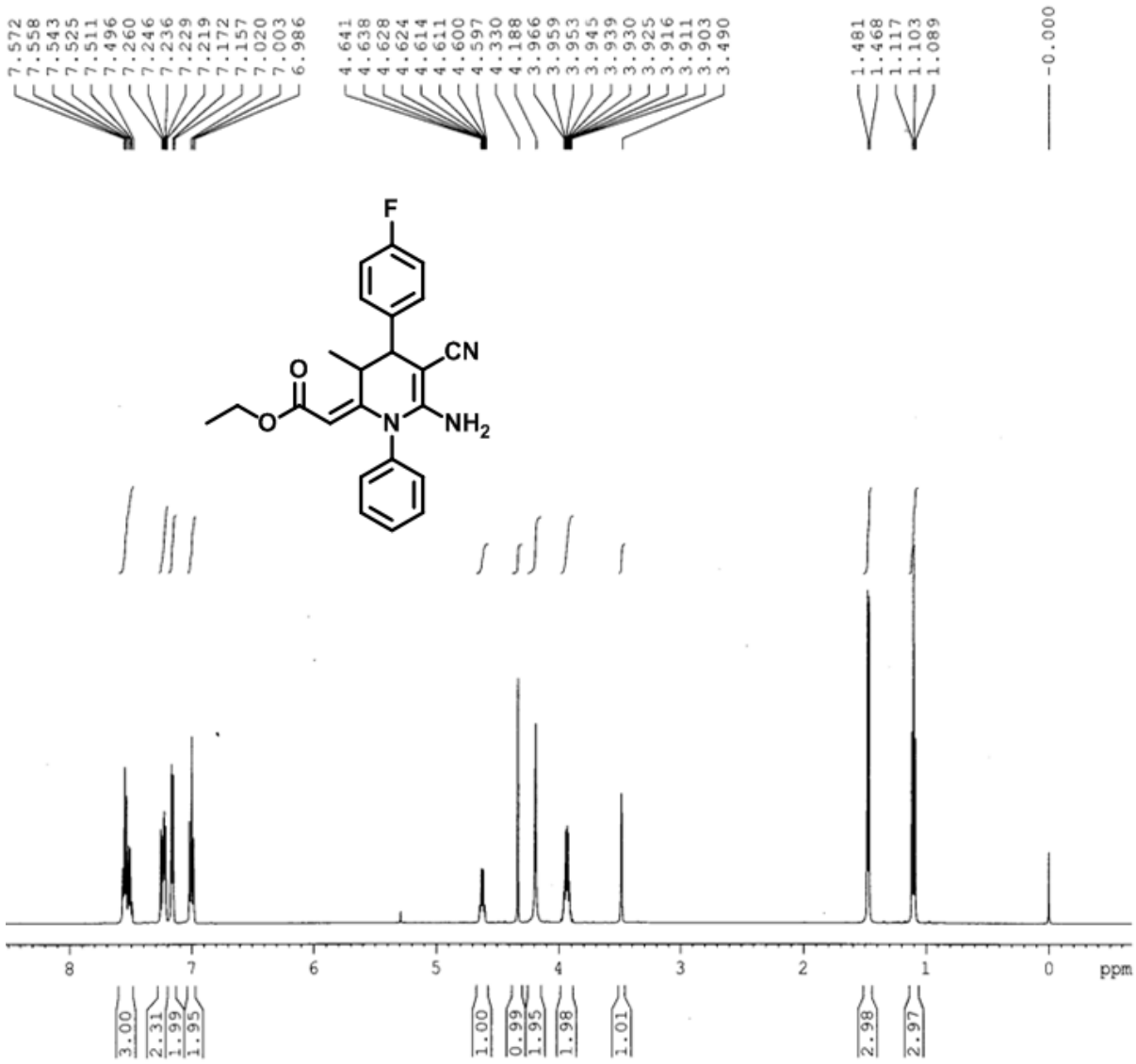
^{1}H NMR (500 MHz, $CDCl_3$): δ 7.34 (d, 2H, *J*= 8 Hz), 7.24 – 7.21 (m, 2H), 7.04-6.98 (m, 4H), 4.61 (q, 1H, *J*= 6.5 Hz), 4.37 (s, 1H), 4.16 (s, 2H), 3.97-3.92 (m, 2H), 3.48 (s, 1H), 2.44 (s, 3H), 1.46 (d, 3H, *J*= 6.5 Hz), 1.11 (t, 3H, *J*= 7 Hz) ppm.

^{13}C NMR (75 MHz, $CDCl_3$): δ 166.3, 161.7 (d, $^{1}J_{CF}$= 243 Hz), 159.0, 151.6, 140.2, 138.7 (d, $^{4}J_{CF}$= 3 Hz) , 134.2, 131.4, 129.1, 128.3 (d, $^{3}J_{CF}$=7.5 Hz), 121.9, 115.4 (d, $^{2}J_{CF}$=21 Hz), 99.0, 59.3, 57.3, 42.5, 34.1, 21.3, 19.9, 14.2 ppm.

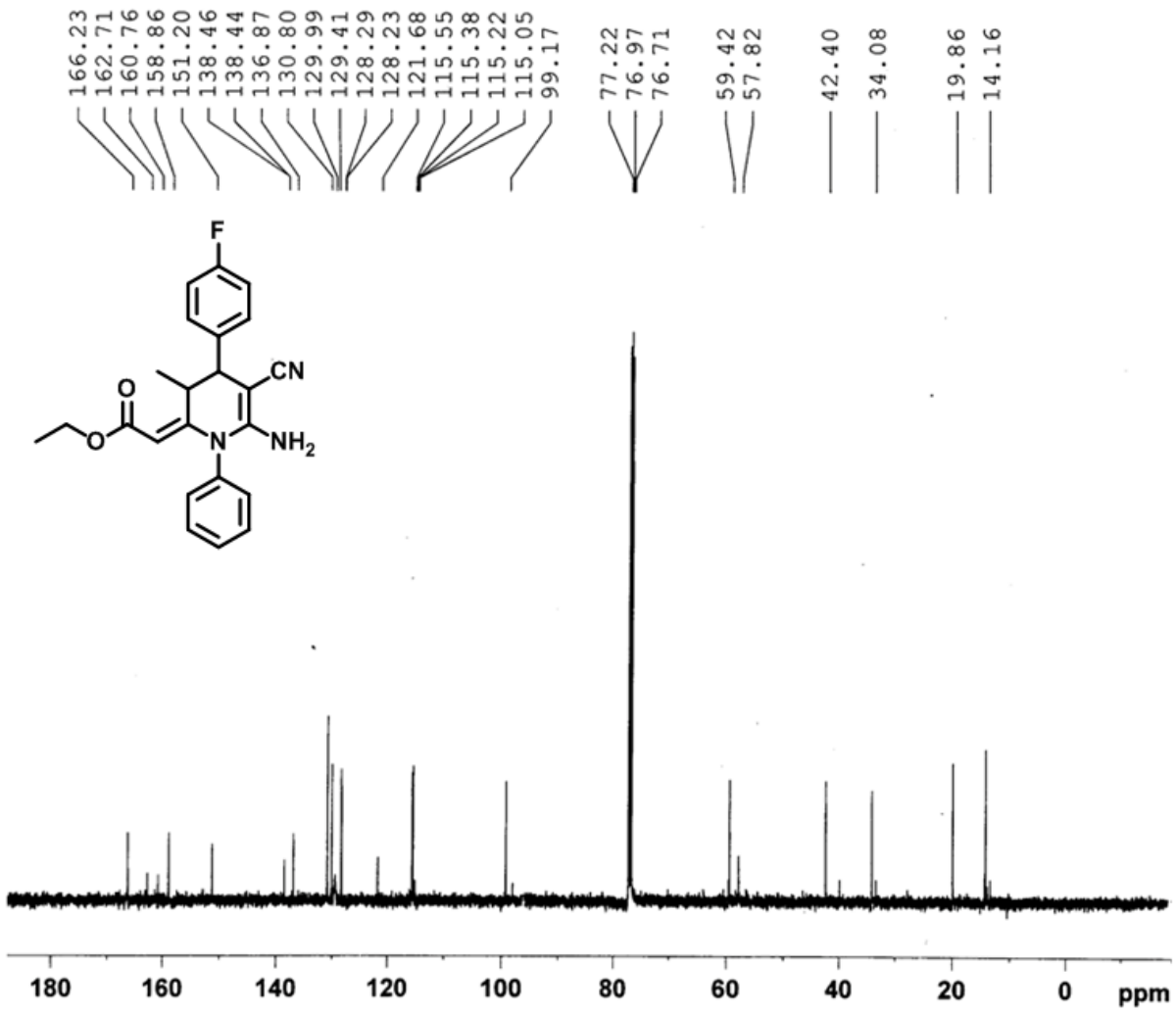
LRMS (+FAB) m/z calcd for $C_{24}H_{24}FN_3O_2$ $(M+H)^+$ 406.19; Found: 406.38.

Anal. Calcd for $C_{24}H_{24}FN_3O_2$: C, 71.09; H, 5.97; N, 10.36. Found: C, 70.40; H, 5.83; N, 10.54.

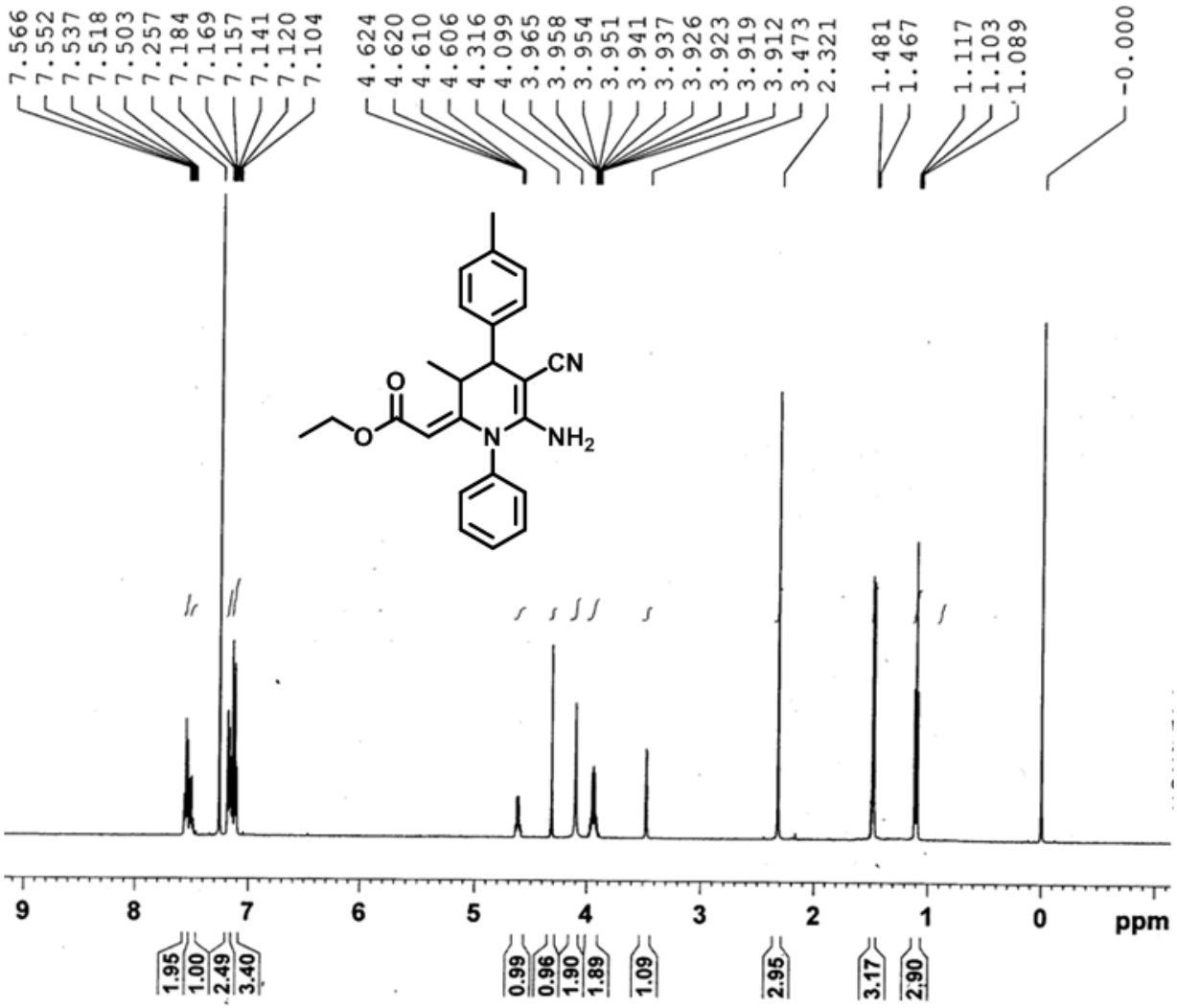
Compound 10a ^{1}H NMR (500 MHz)



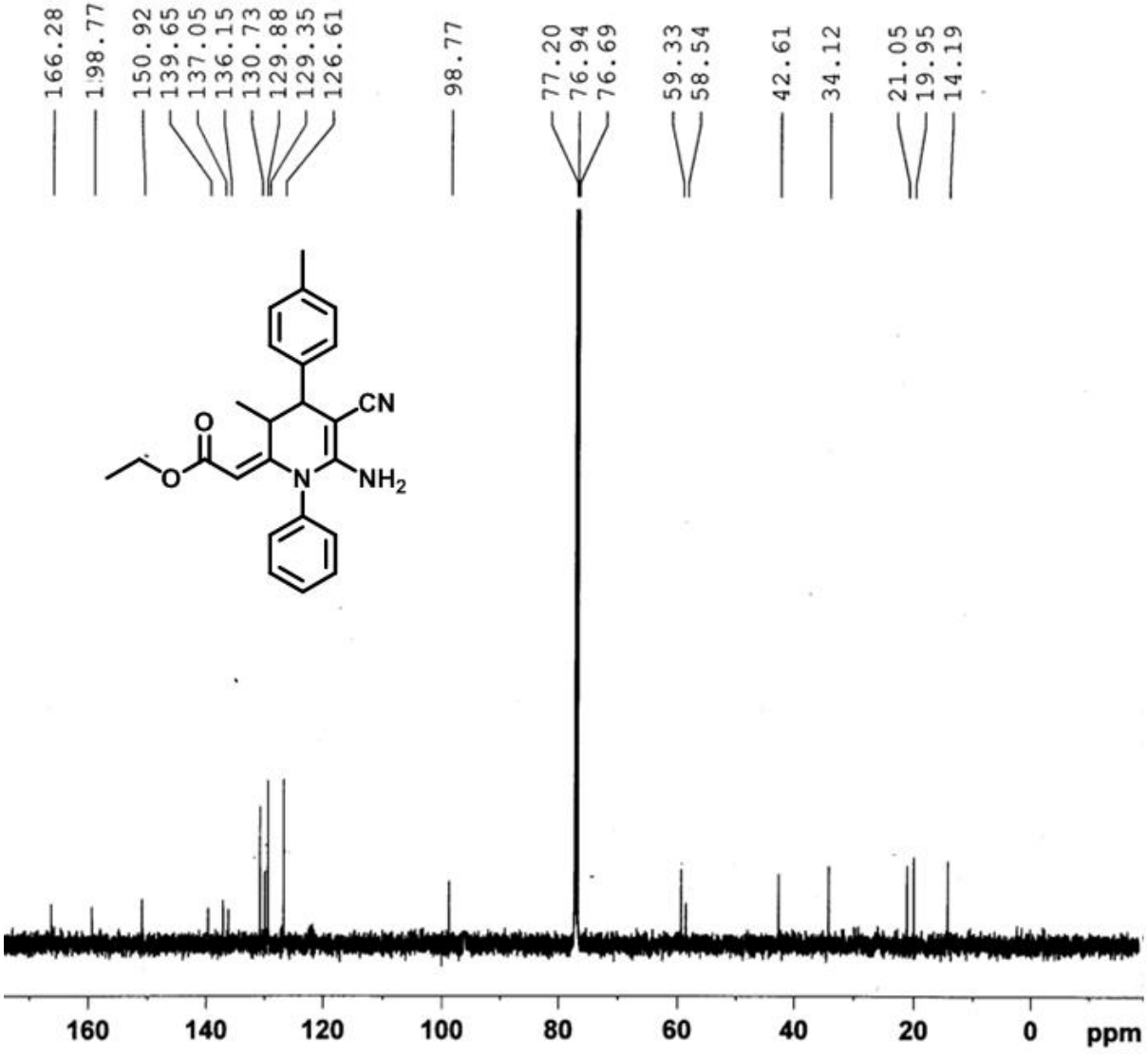
Compound 10a ^{13}C NMR (125 MHz)



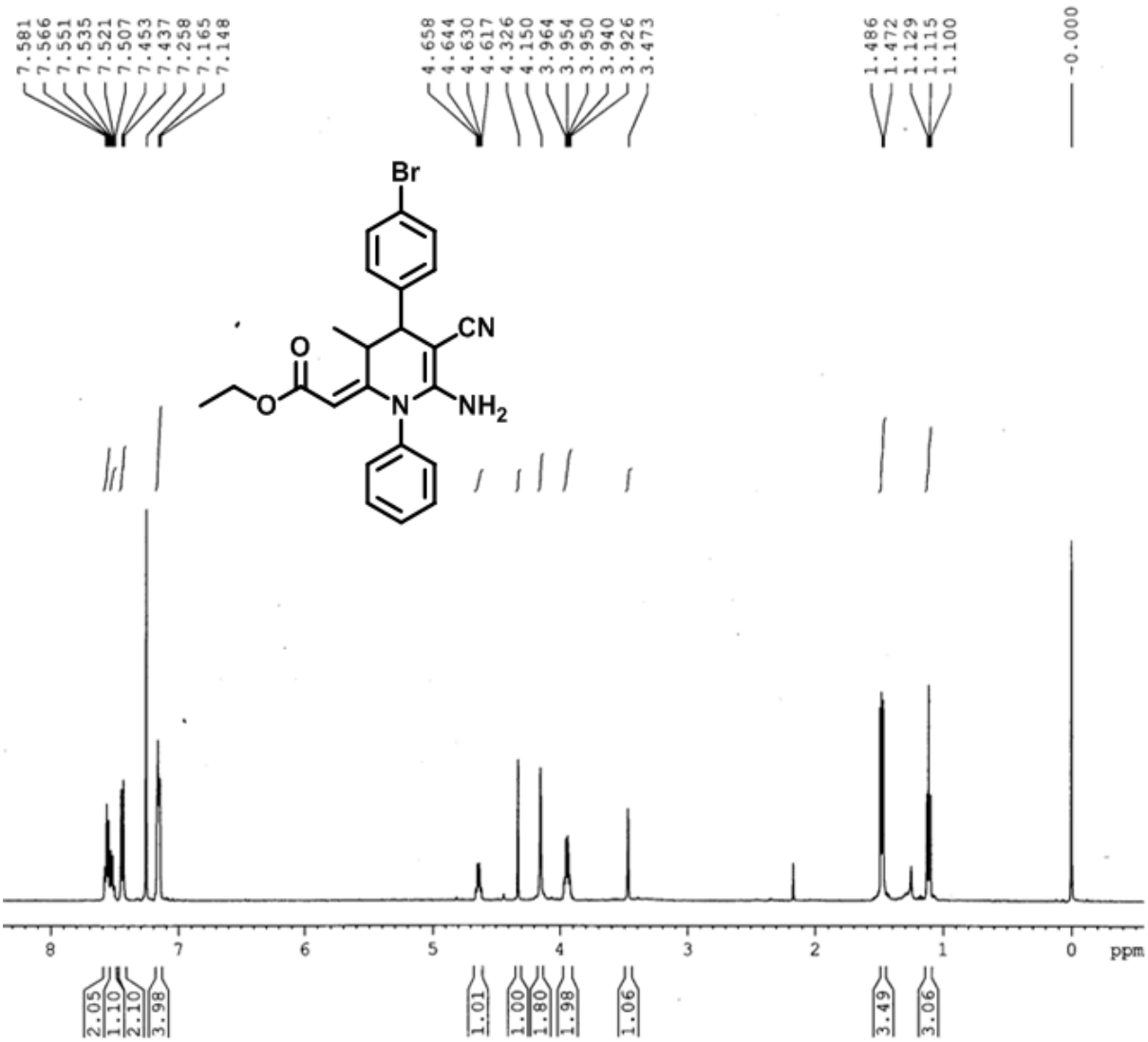
Compound 10b ^{1}H NMR (500 MHz)



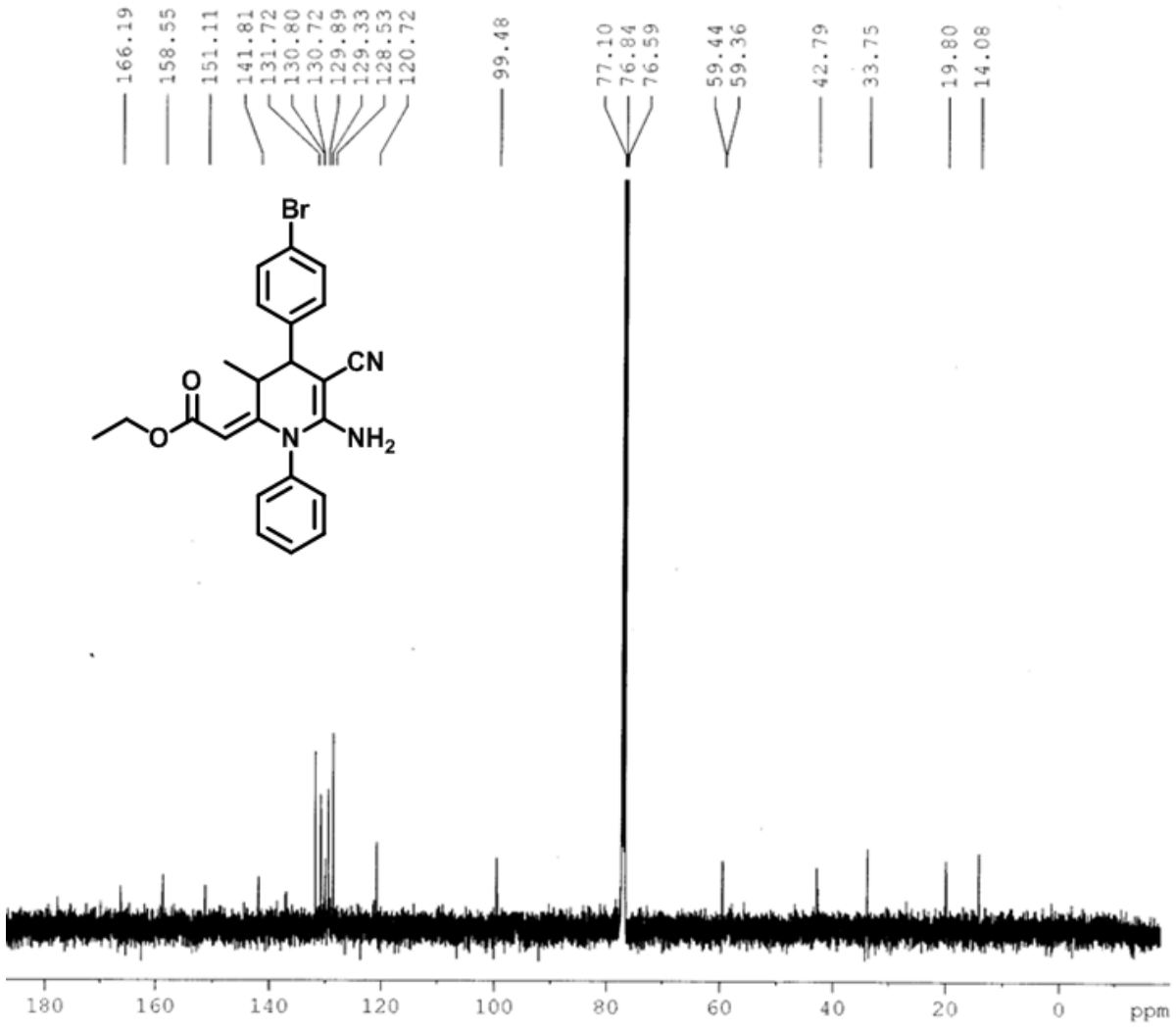
Compound 10b ^{13}C NMR (125 MHz)



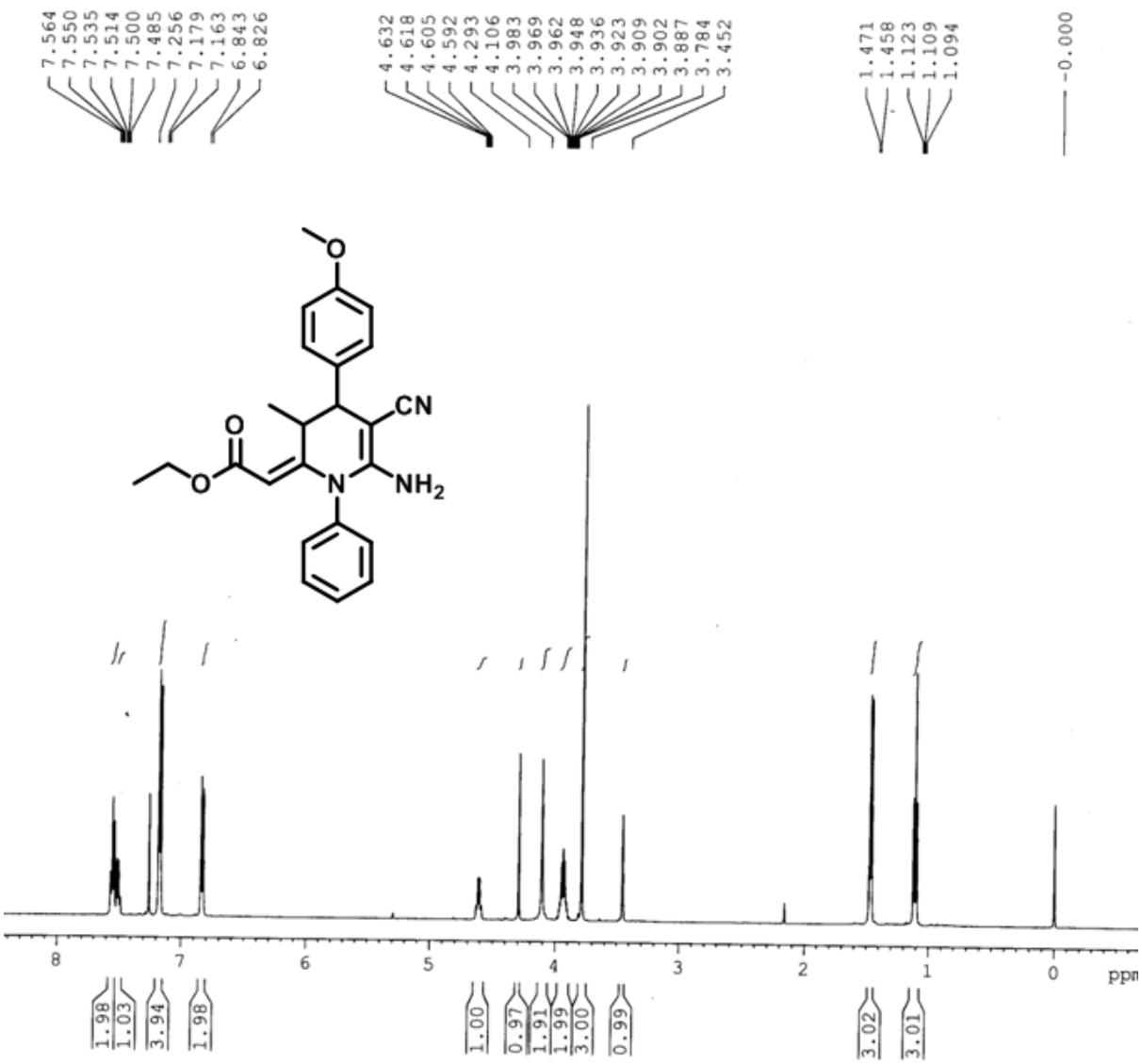
Compound 10c ^{1}H NMR (500 MHz)



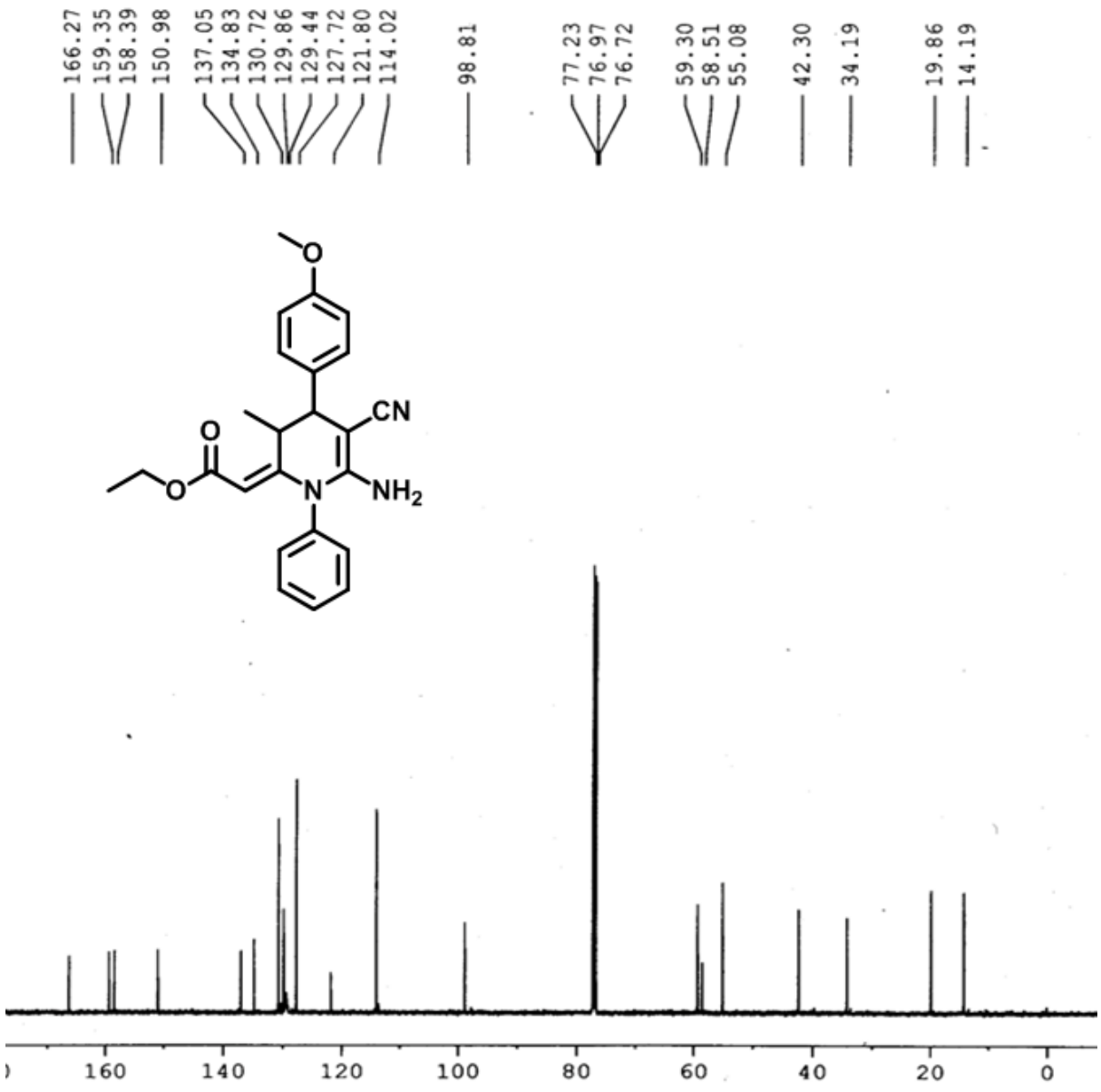
Compound 10c ^{13}C NMR (125 MHz)



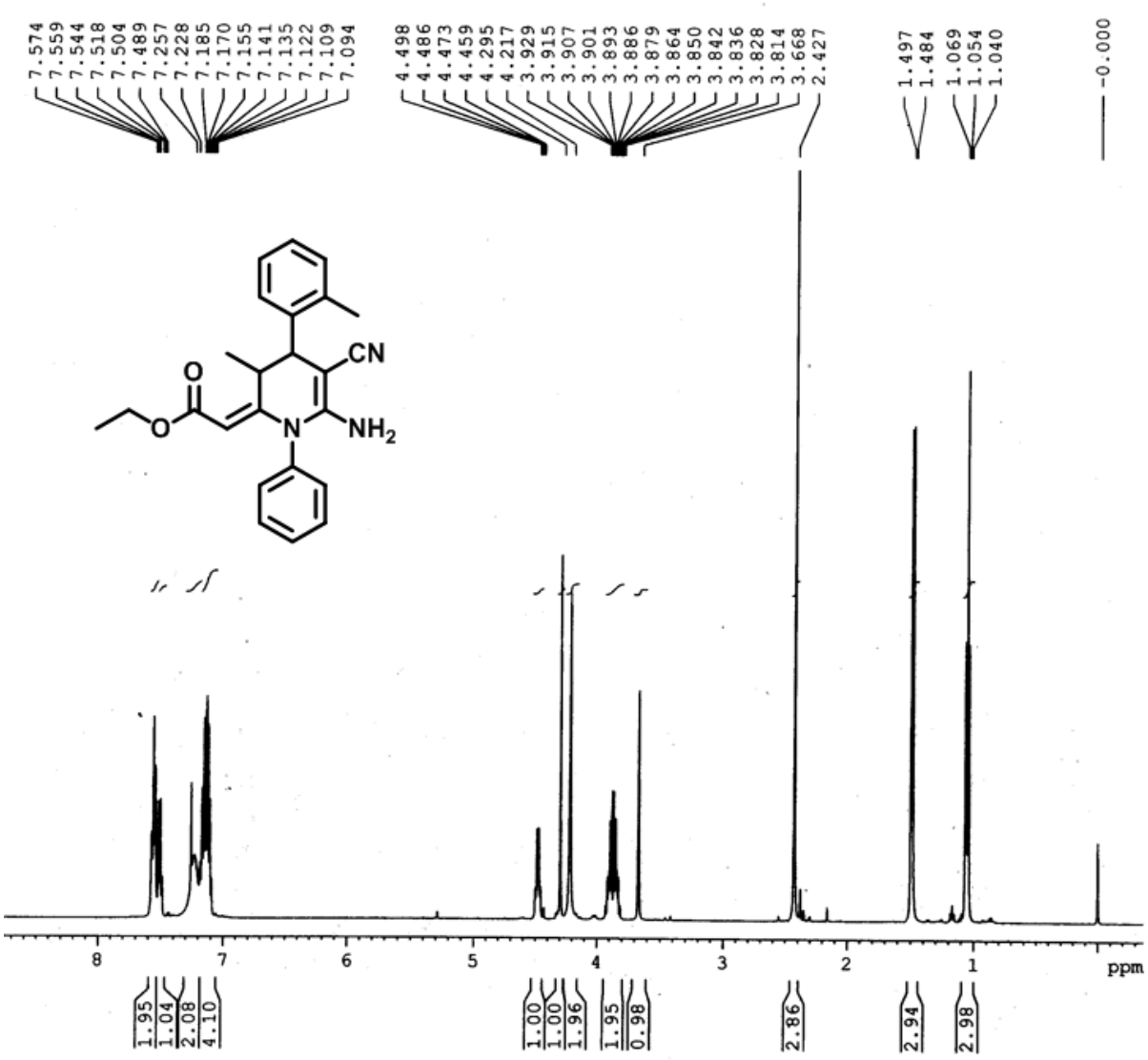
Compound 10d ^{1}H NMR (500 MHz)



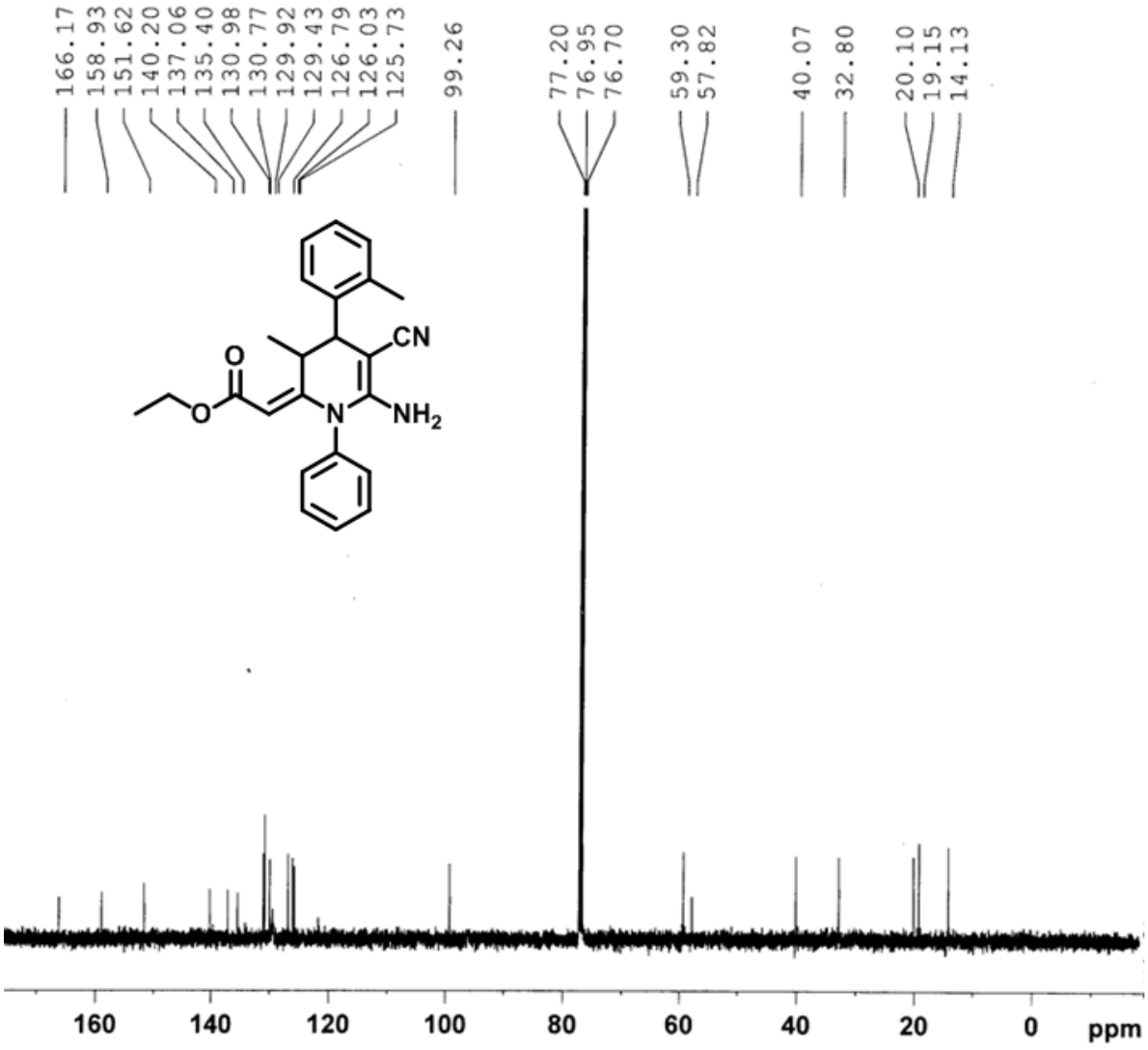
Compound 10d ^{13}C NMR (125 MHz)



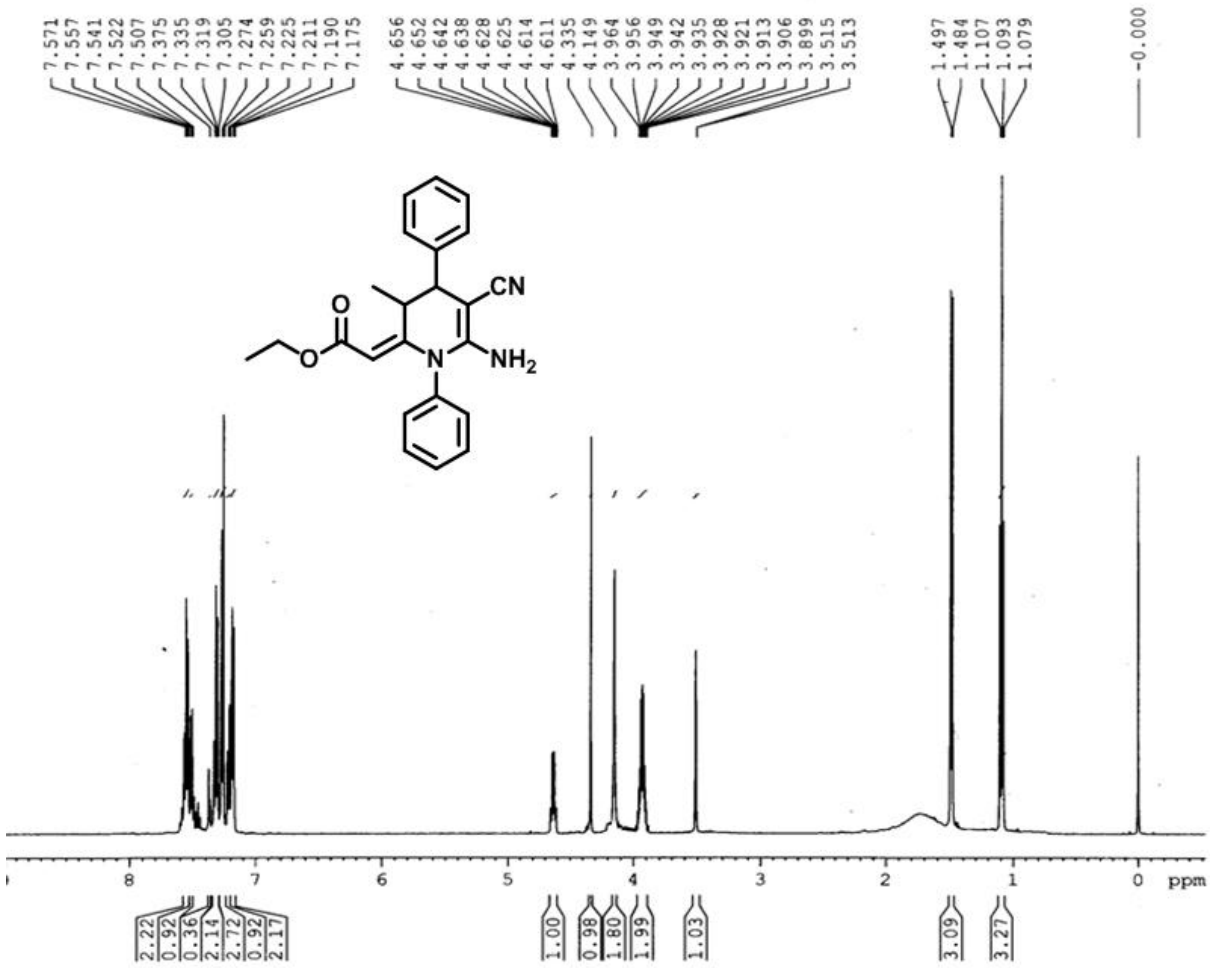
Compound 10e 1H NMR (500 MHz)



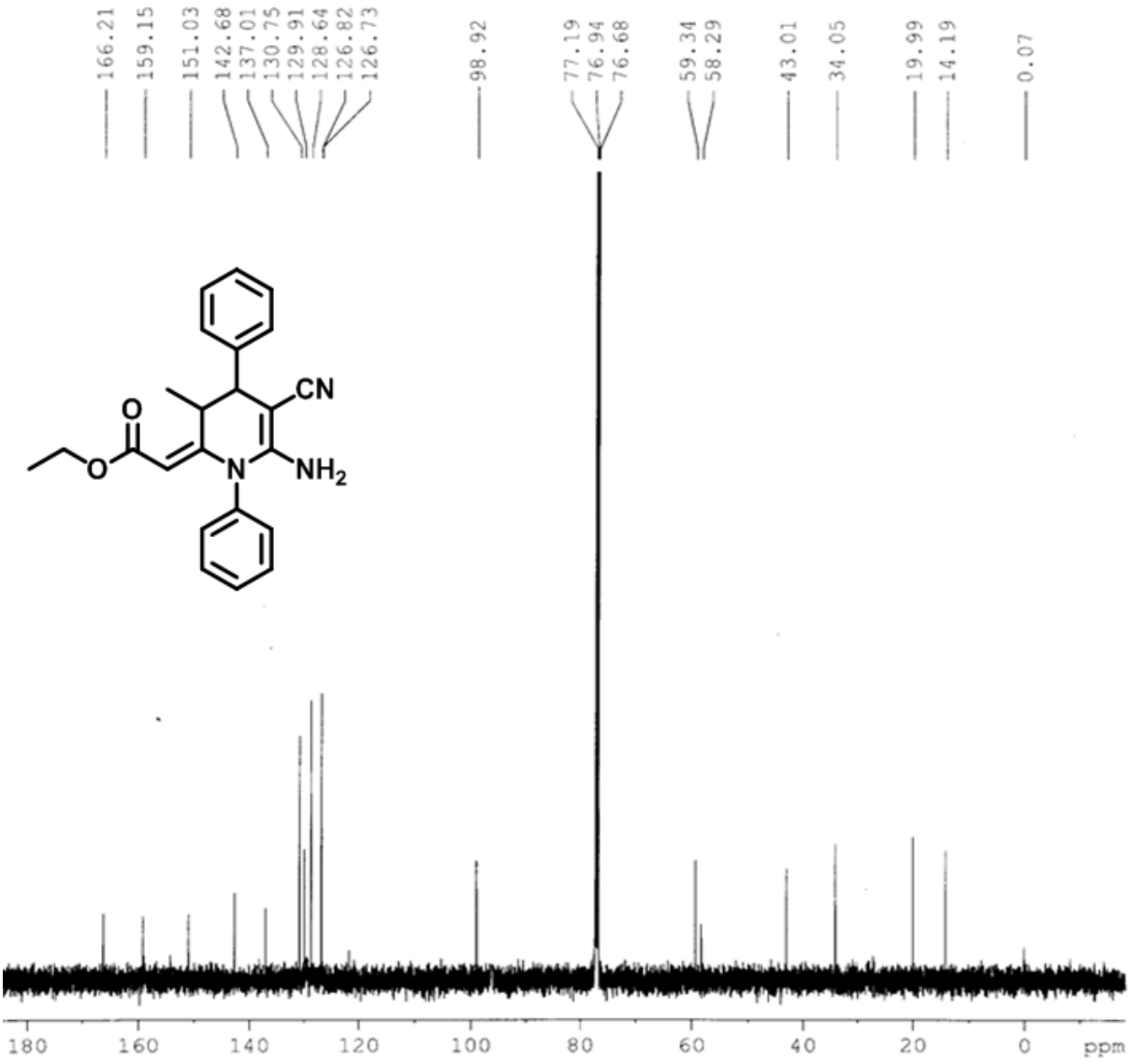
Compound 10e ^{13}C NMR (125 MHz)



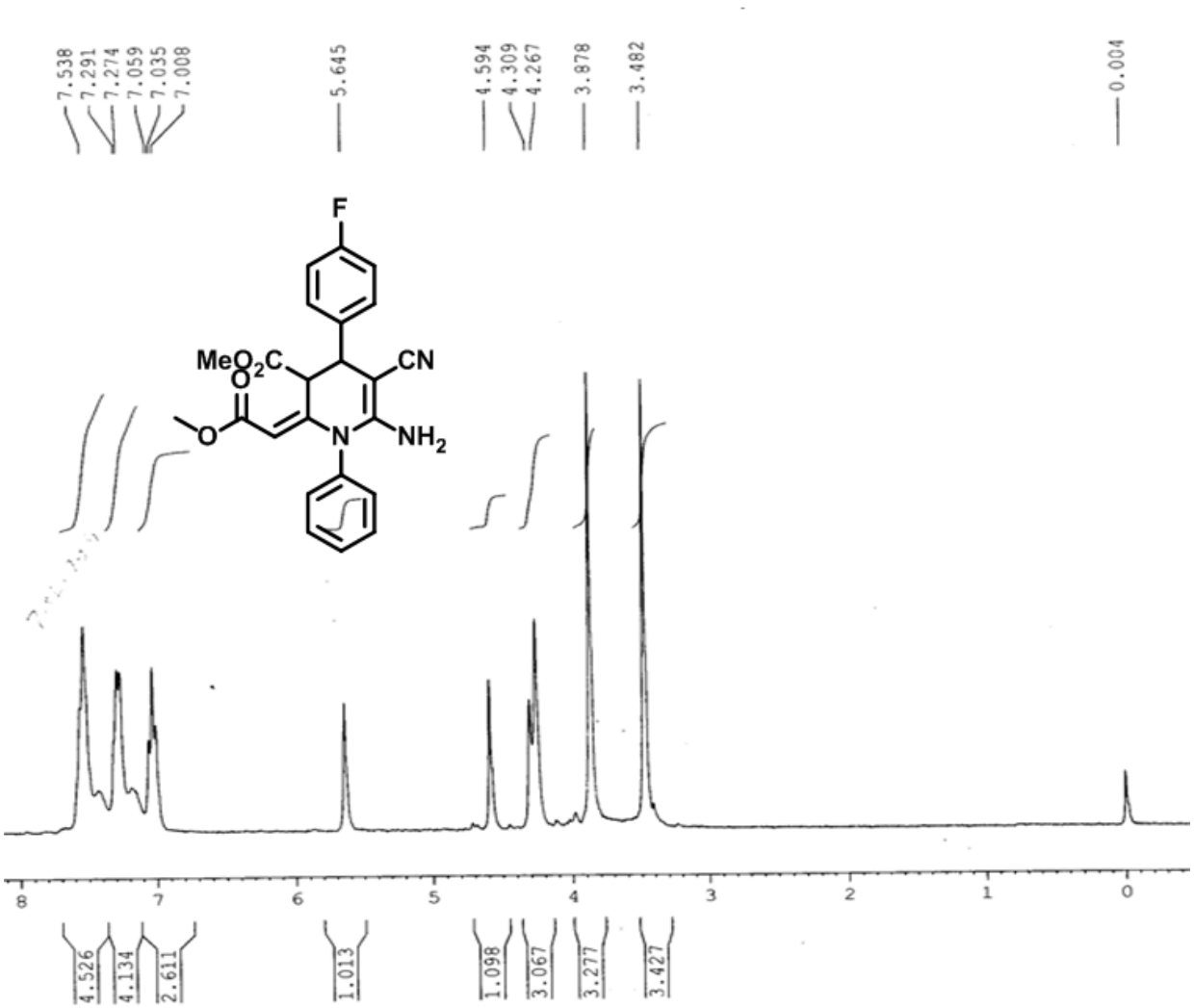
Compound 10f ^{1}H NMR (500 MHz)



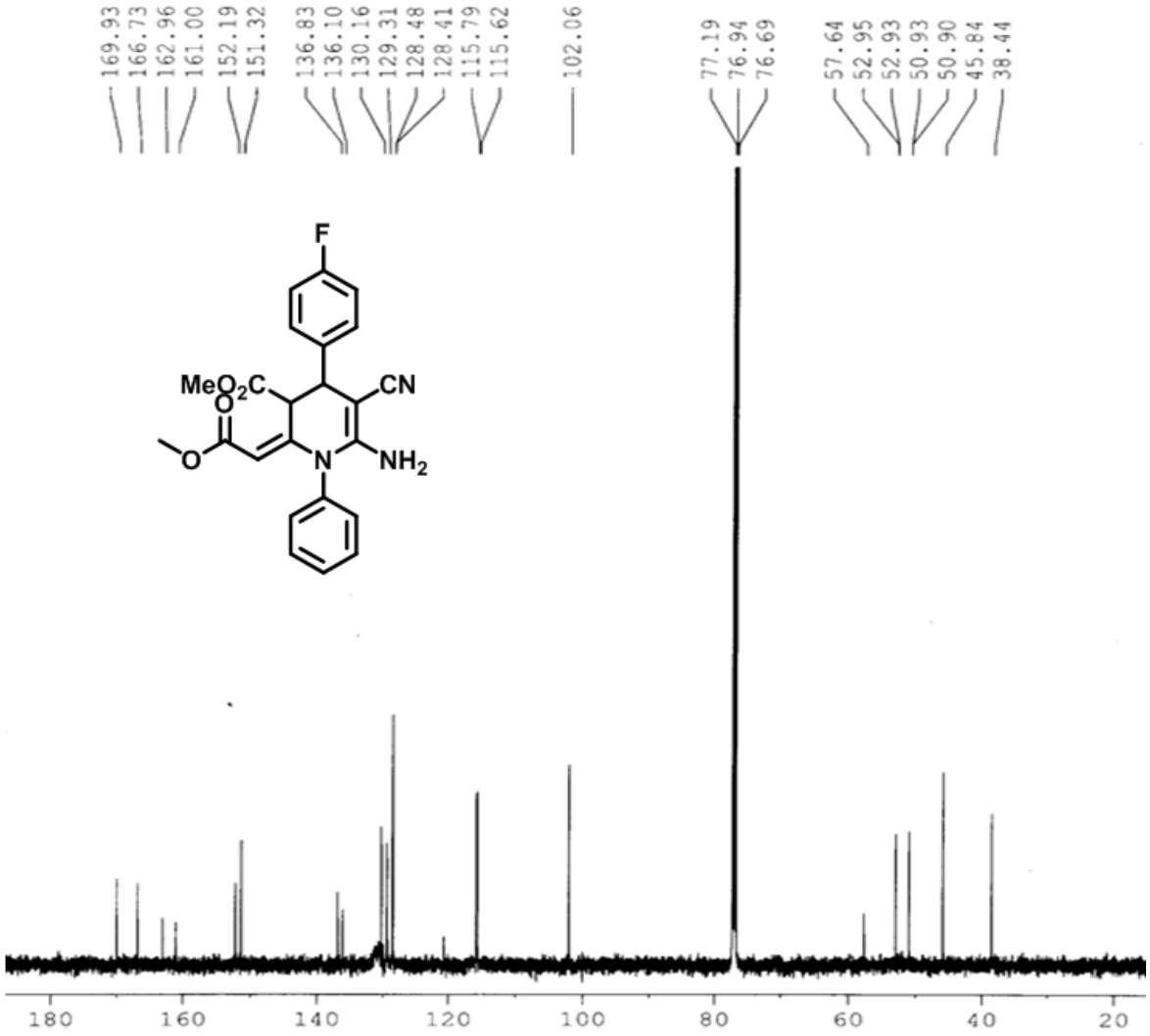
Compound 10f ^{13}C NMR (125 MHz)



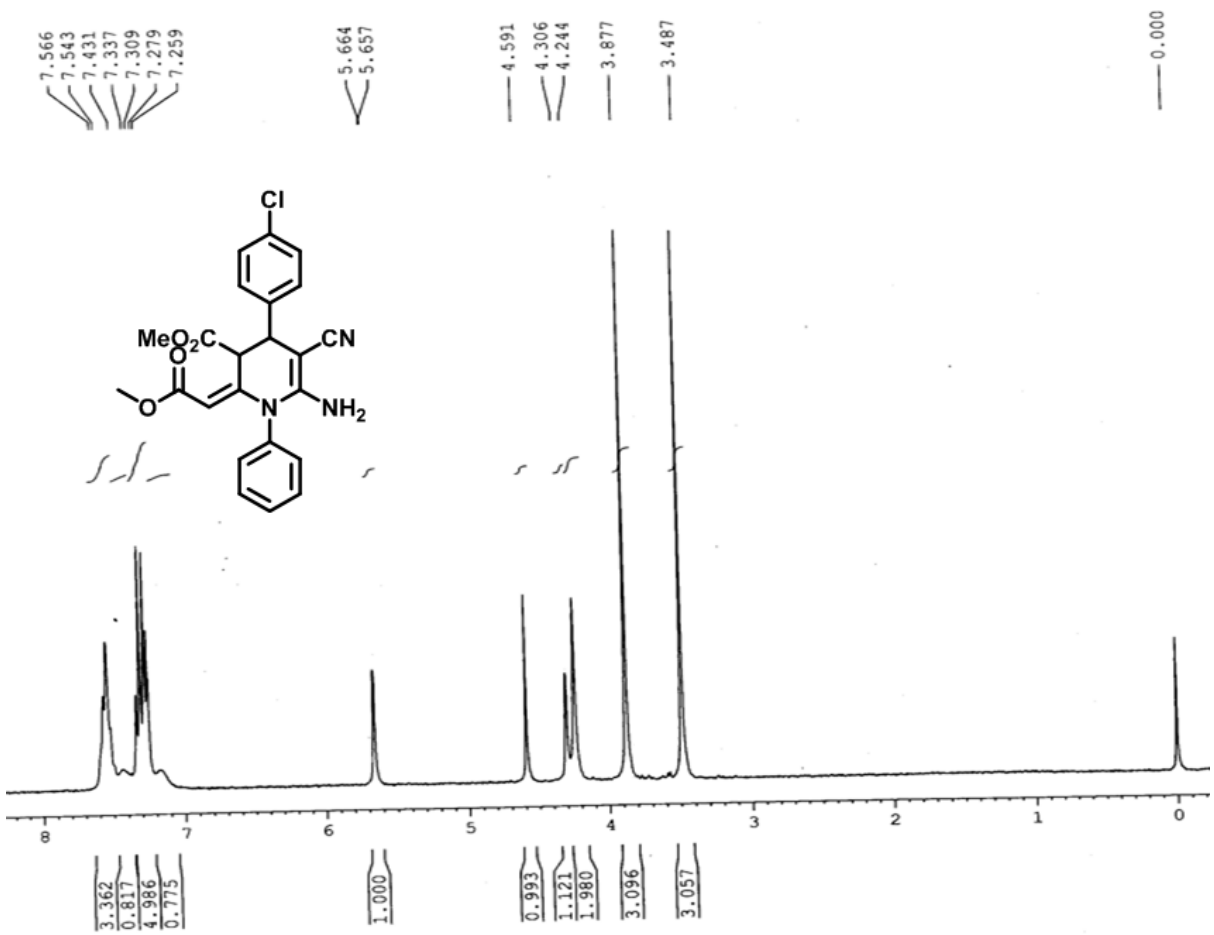
Compound 10g ^{1}H NMR (300 MHz)



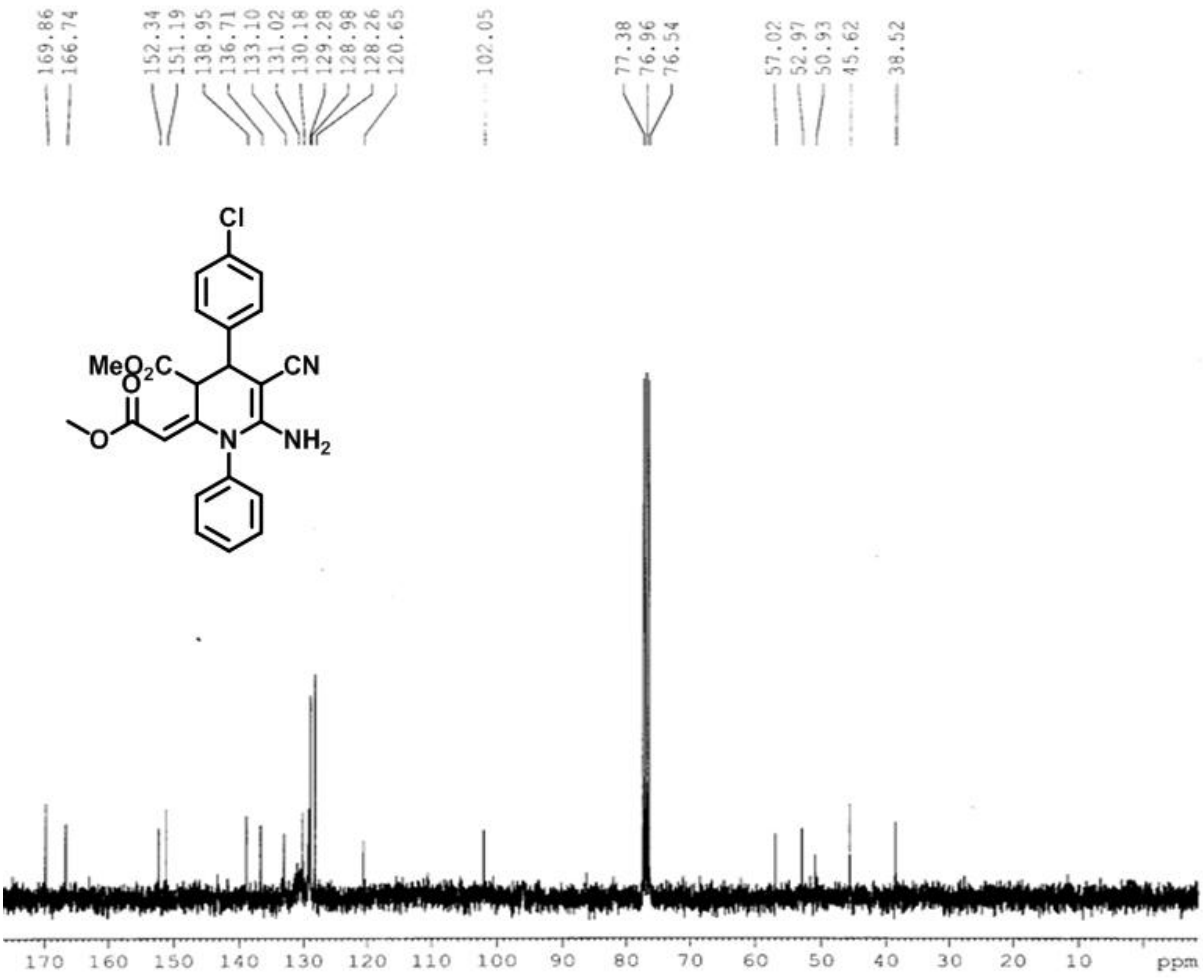
Compound 10g ^{13}C NMR (125 MHz)



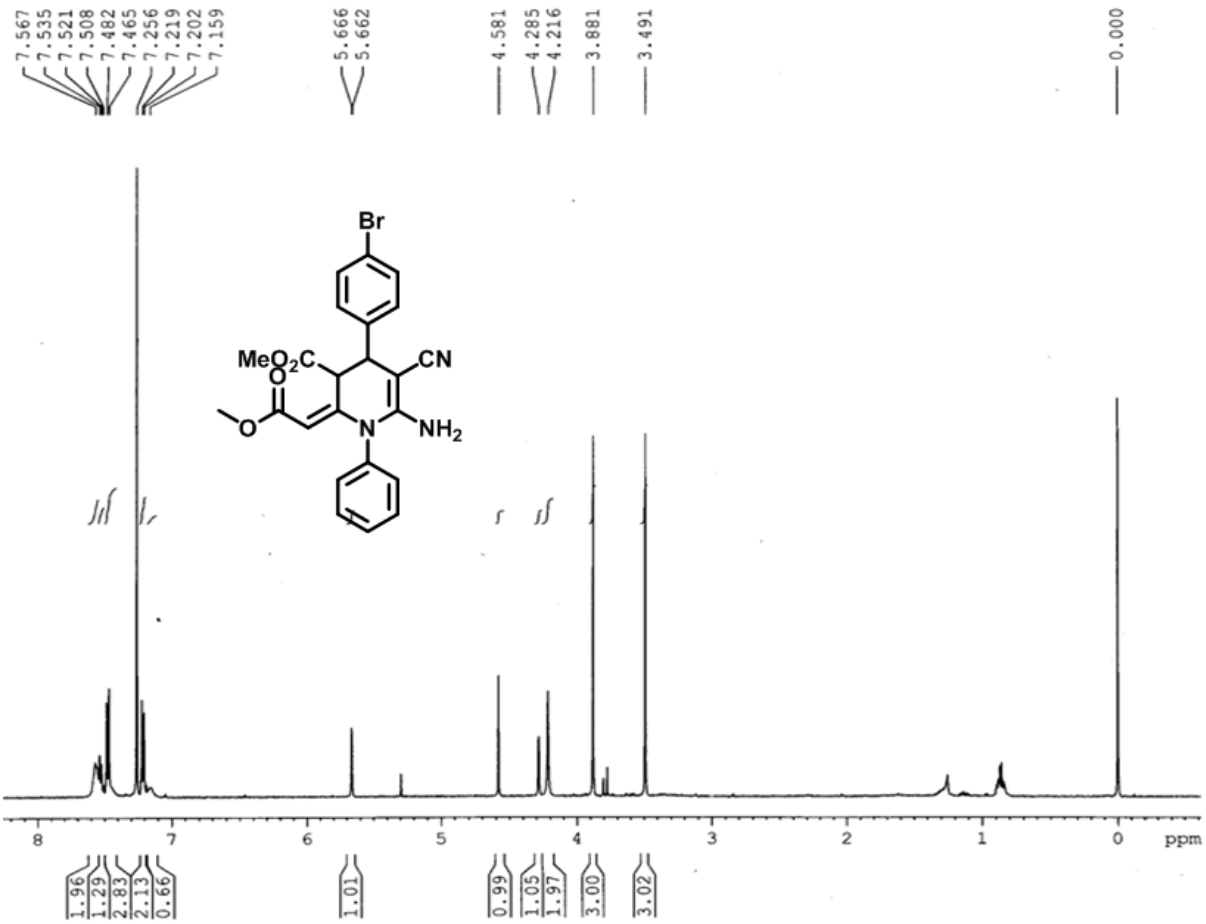
Compound 10h ^{1}H NMR (300 MHz)



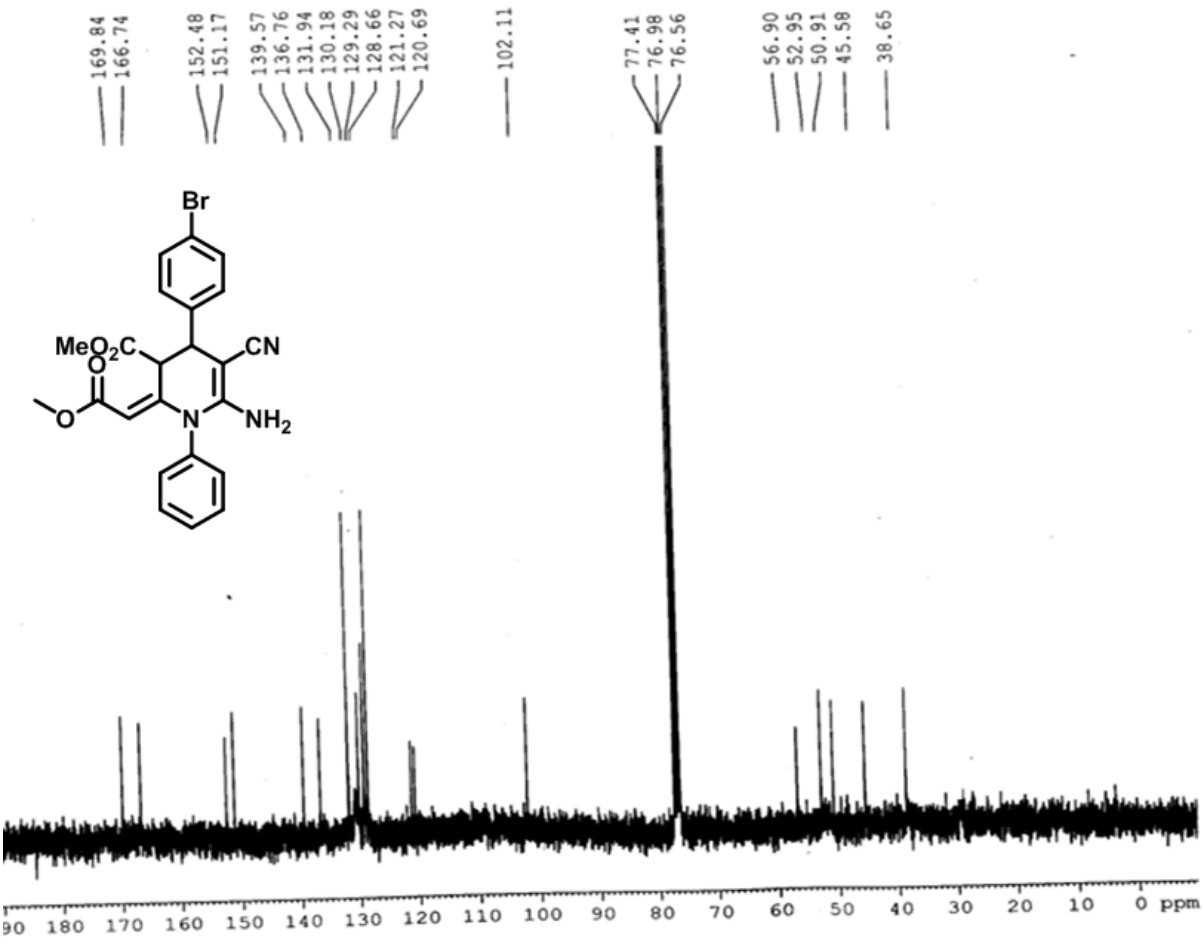
Compound 10h ^{13}C NMR (75 MHz)



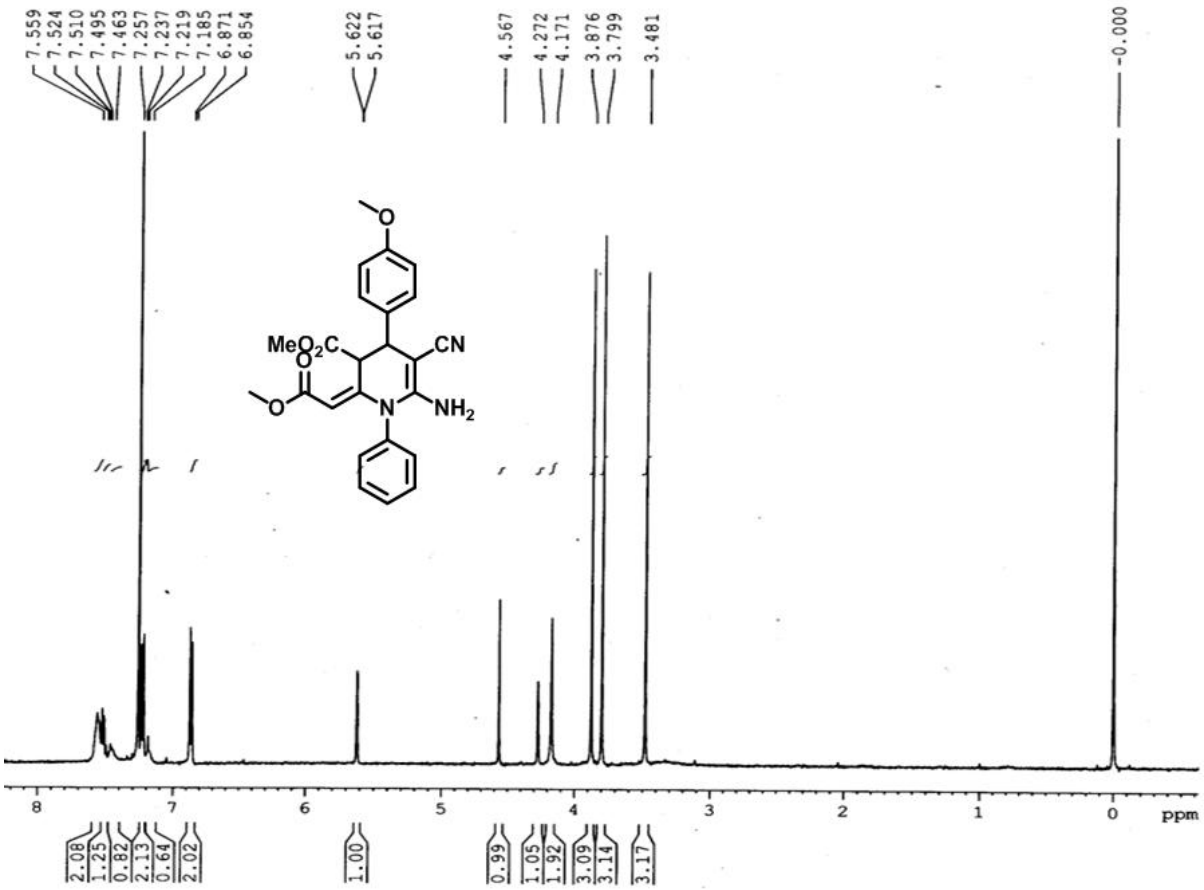
Compound 10i ^{1}H NMR (500 MHz)



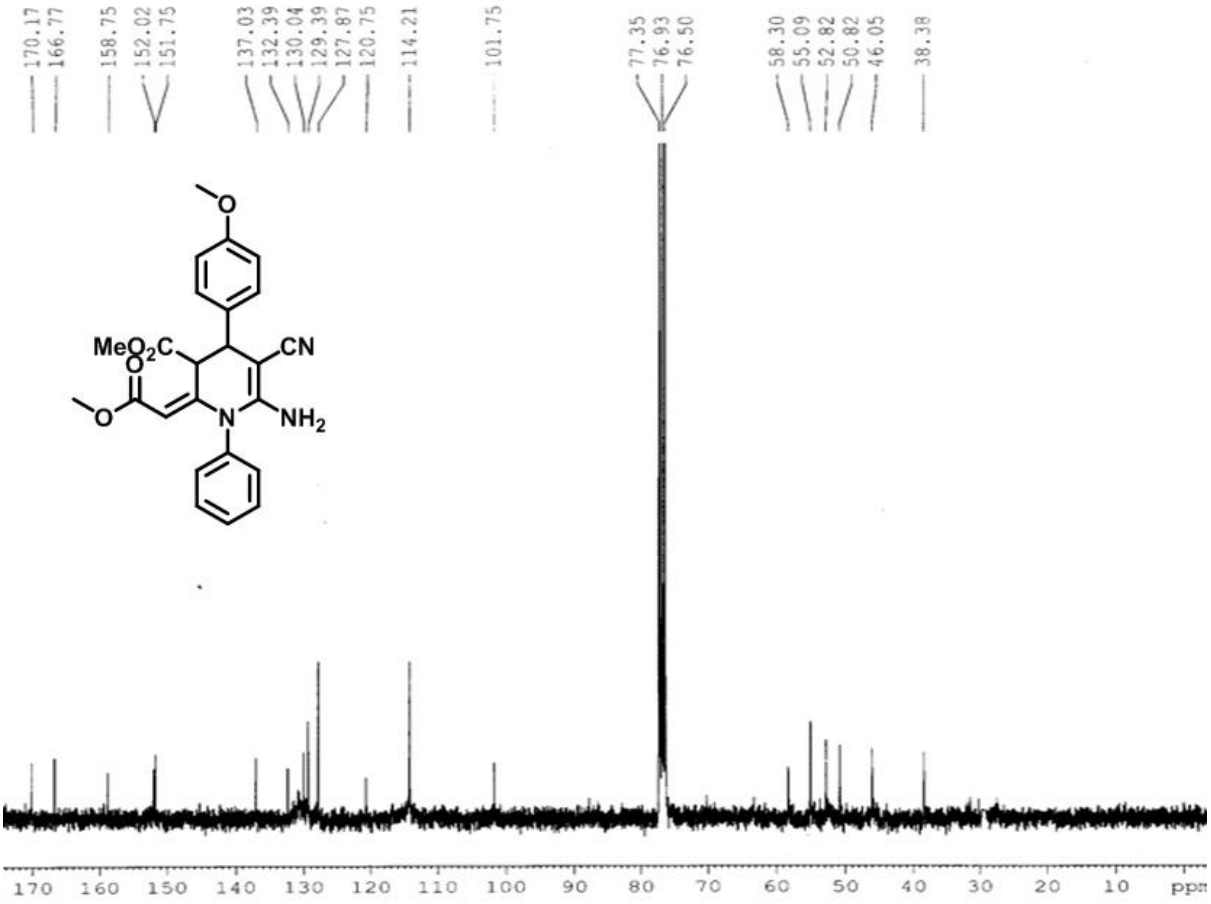
Compound 10i ^{13}C NMR (75 MHz)



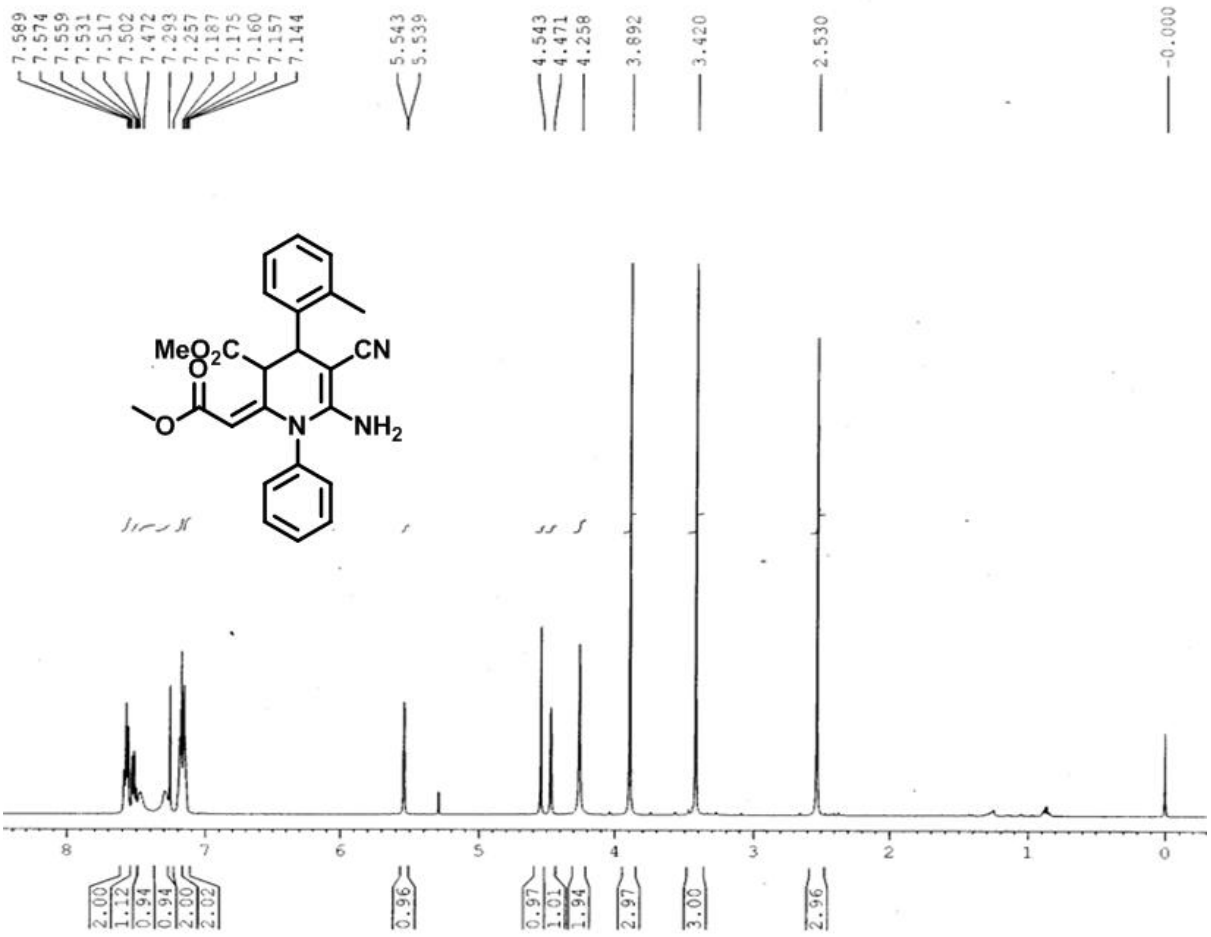
Compound 10j ^{1}H NMR (500 MHz)



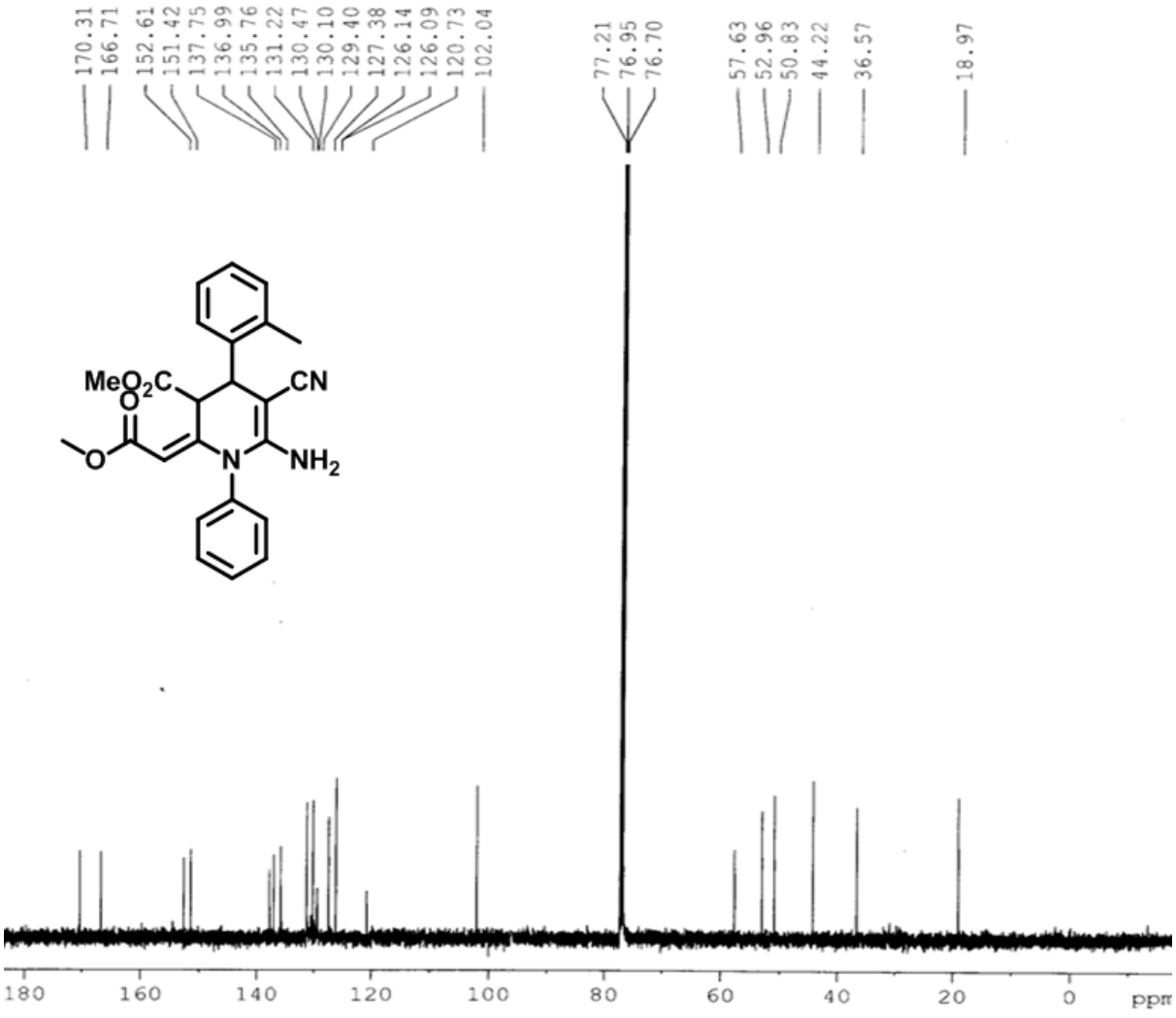
Compound 10j ^{13}C NMR (75 MHz)



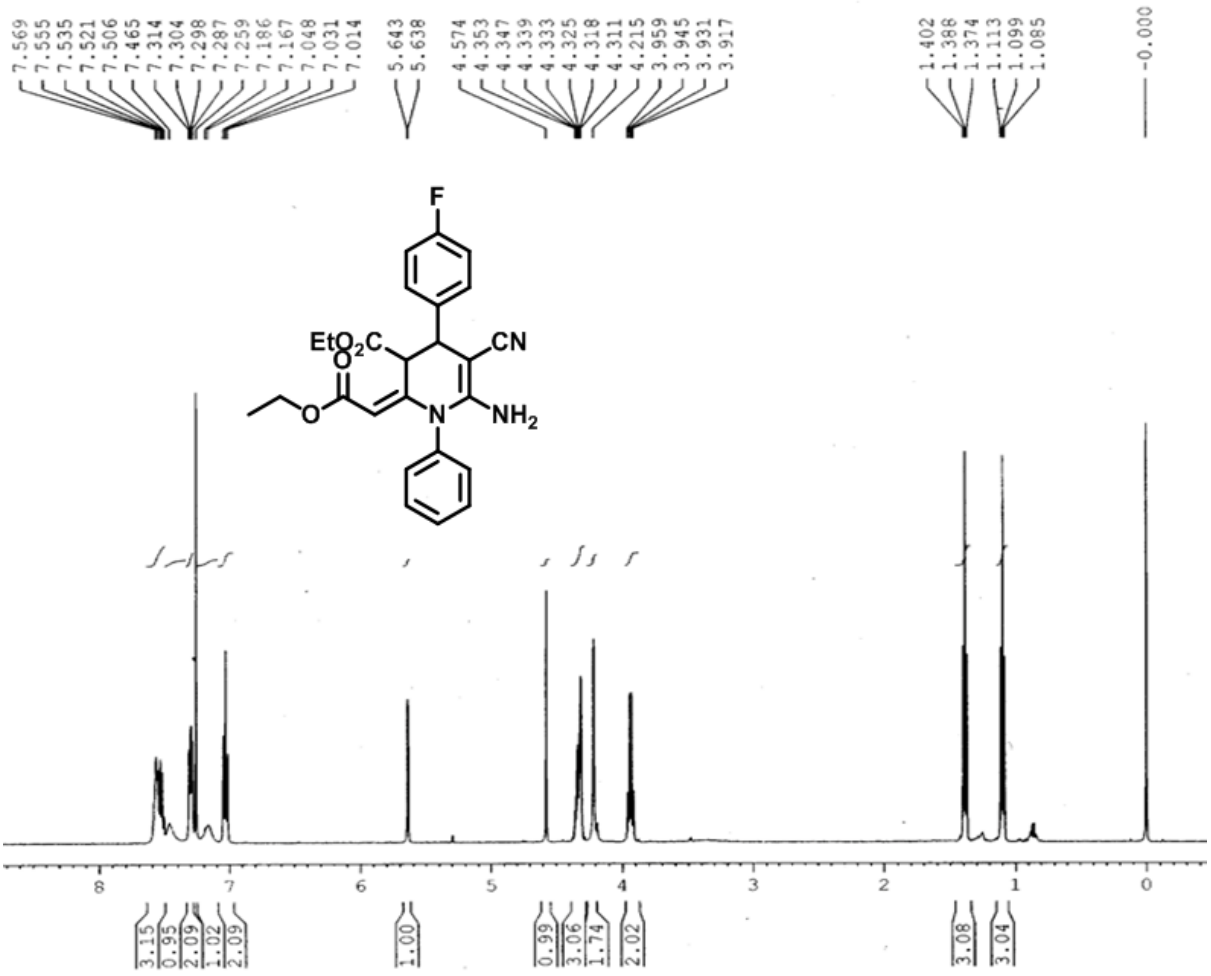
Compound 10k ^{1}H NMR (500 MHz)



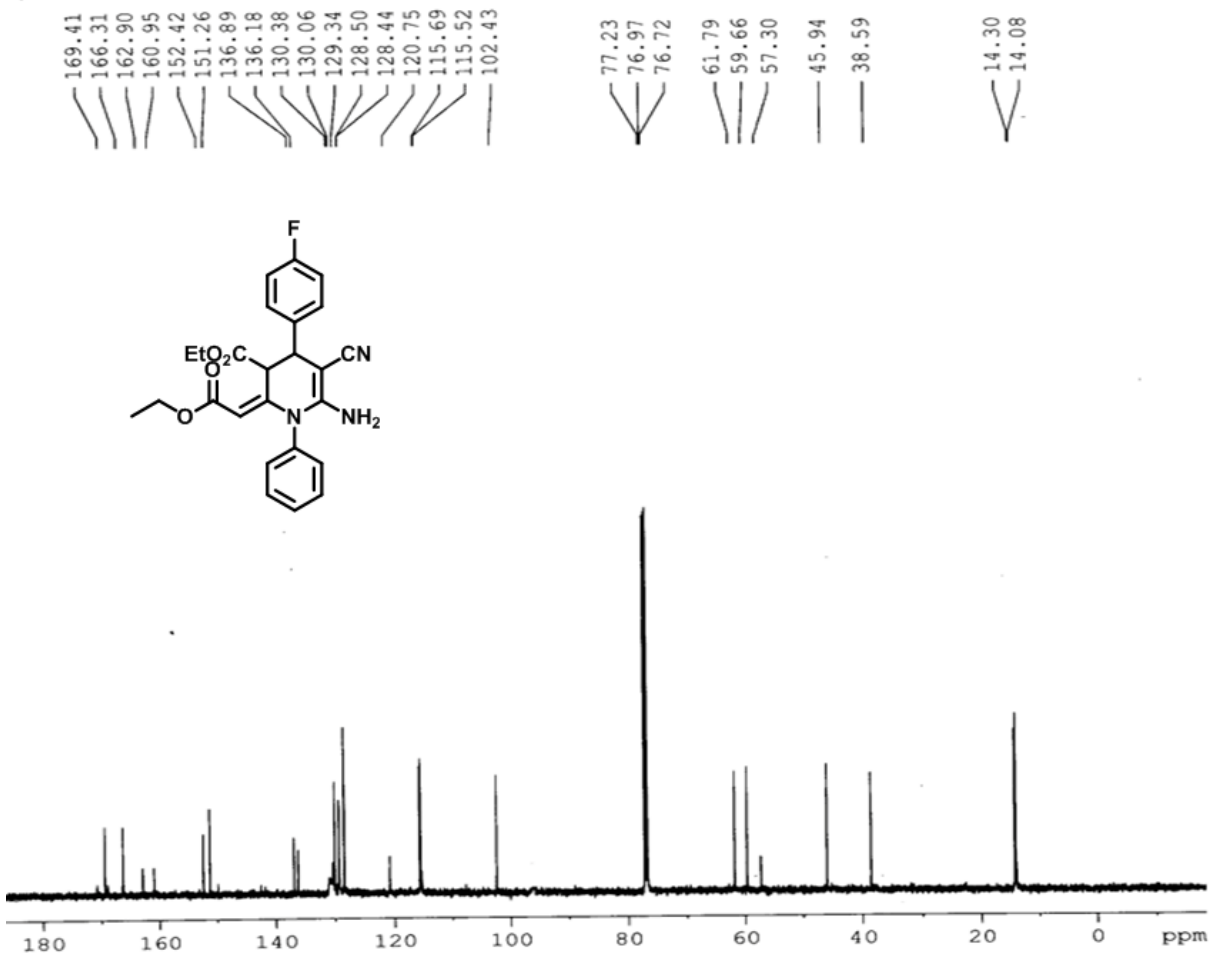
Compound 10k ^{13}C NMR (125 MHz)



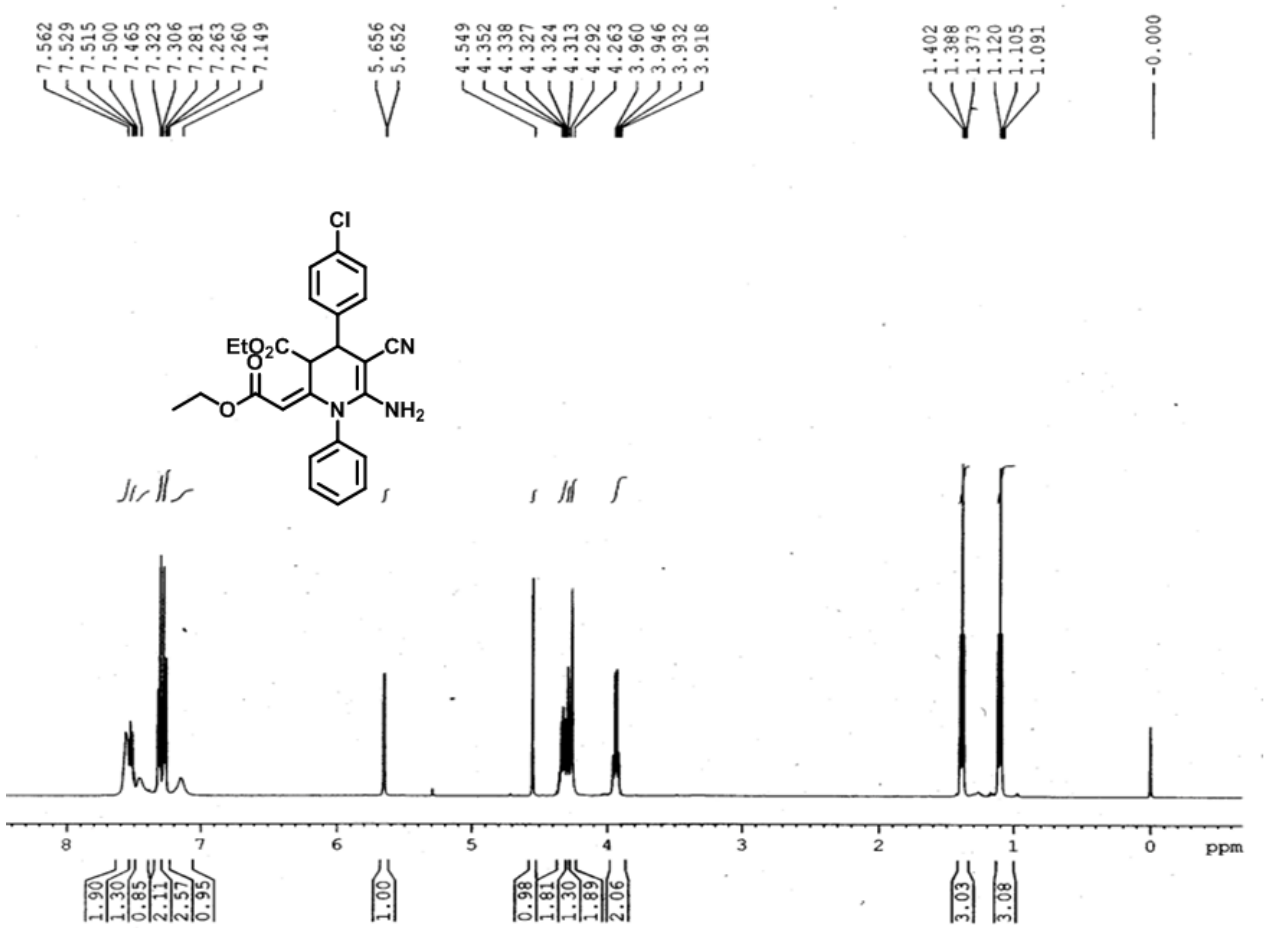
Compound 10l ^{1}H NMR (500 MHz)



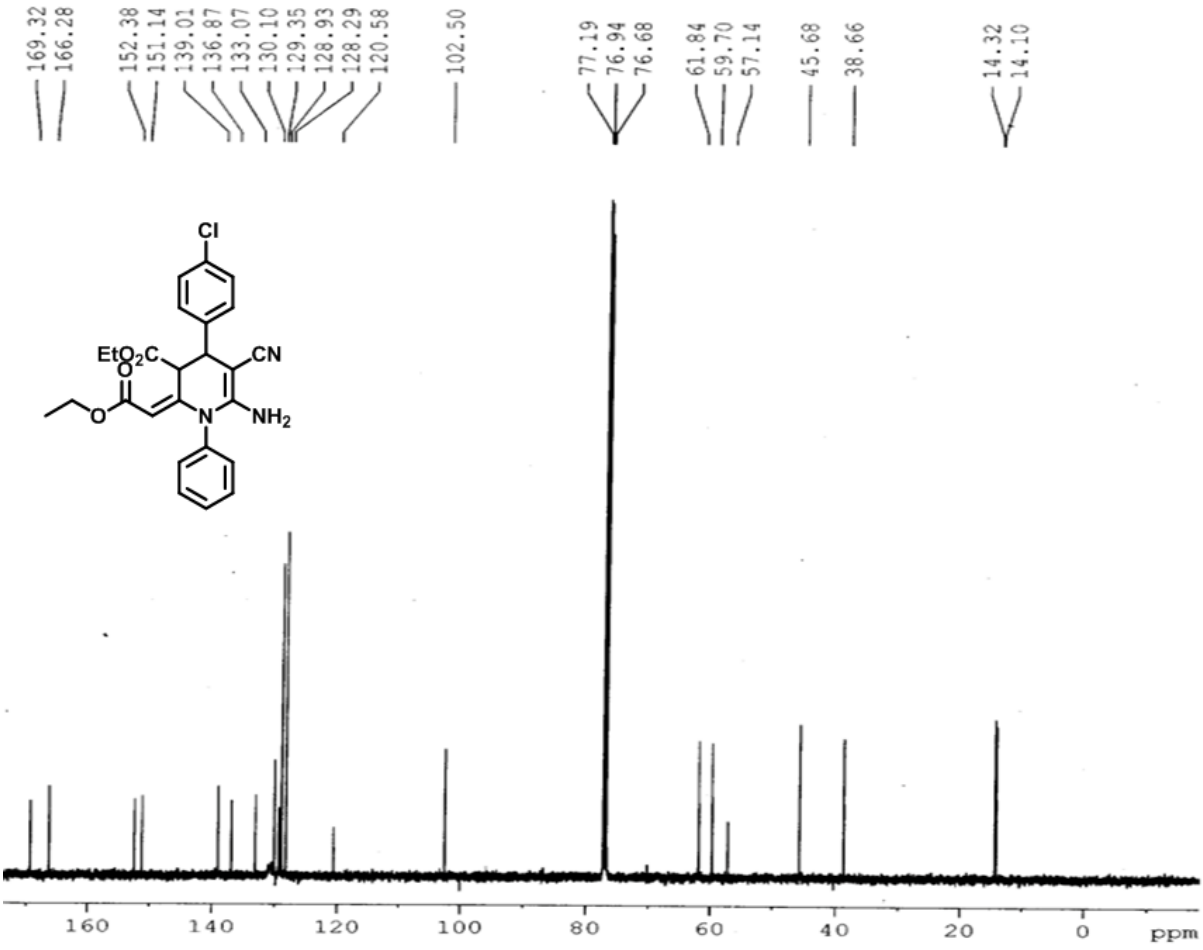
Compound 10l ^{13}C NMR (125 MHz)



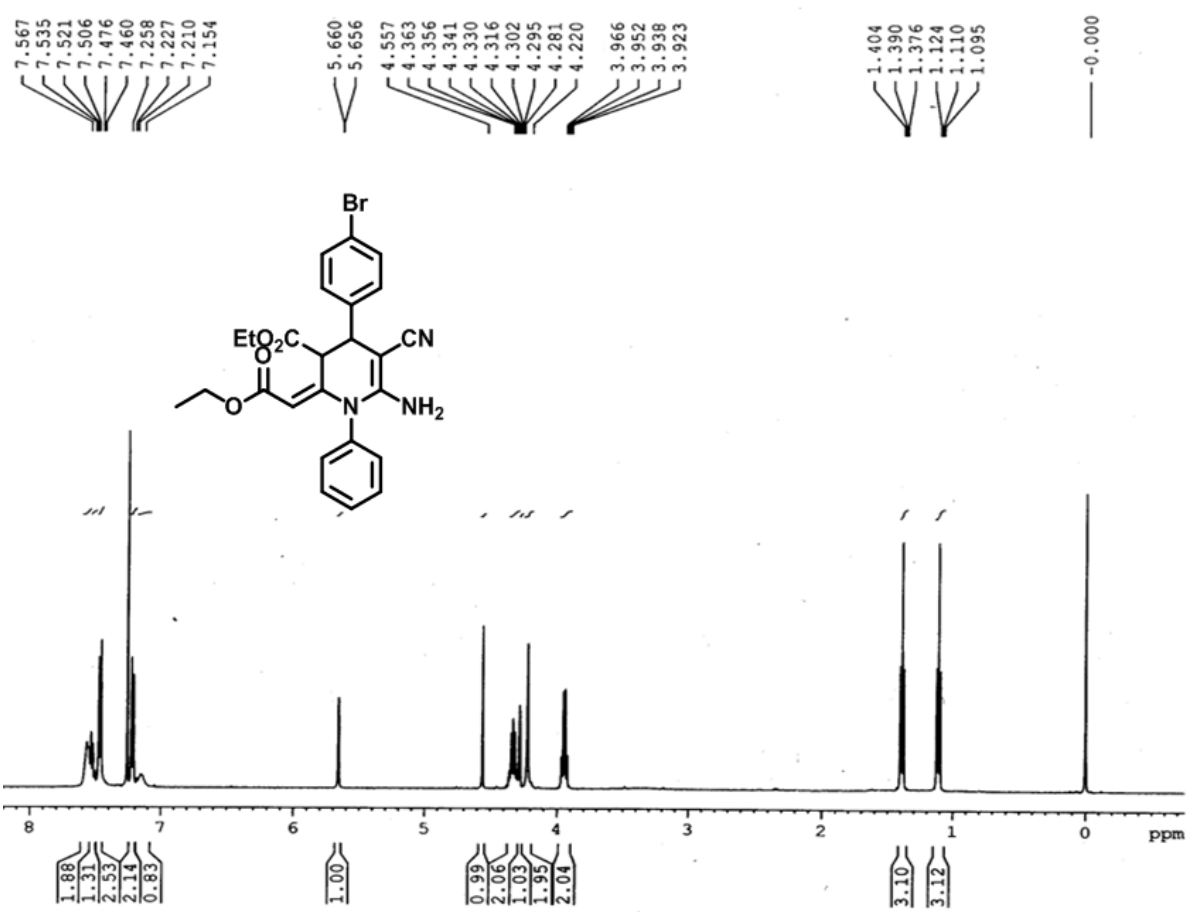
Compound 10m ^{1}H NMR (500 MHz)



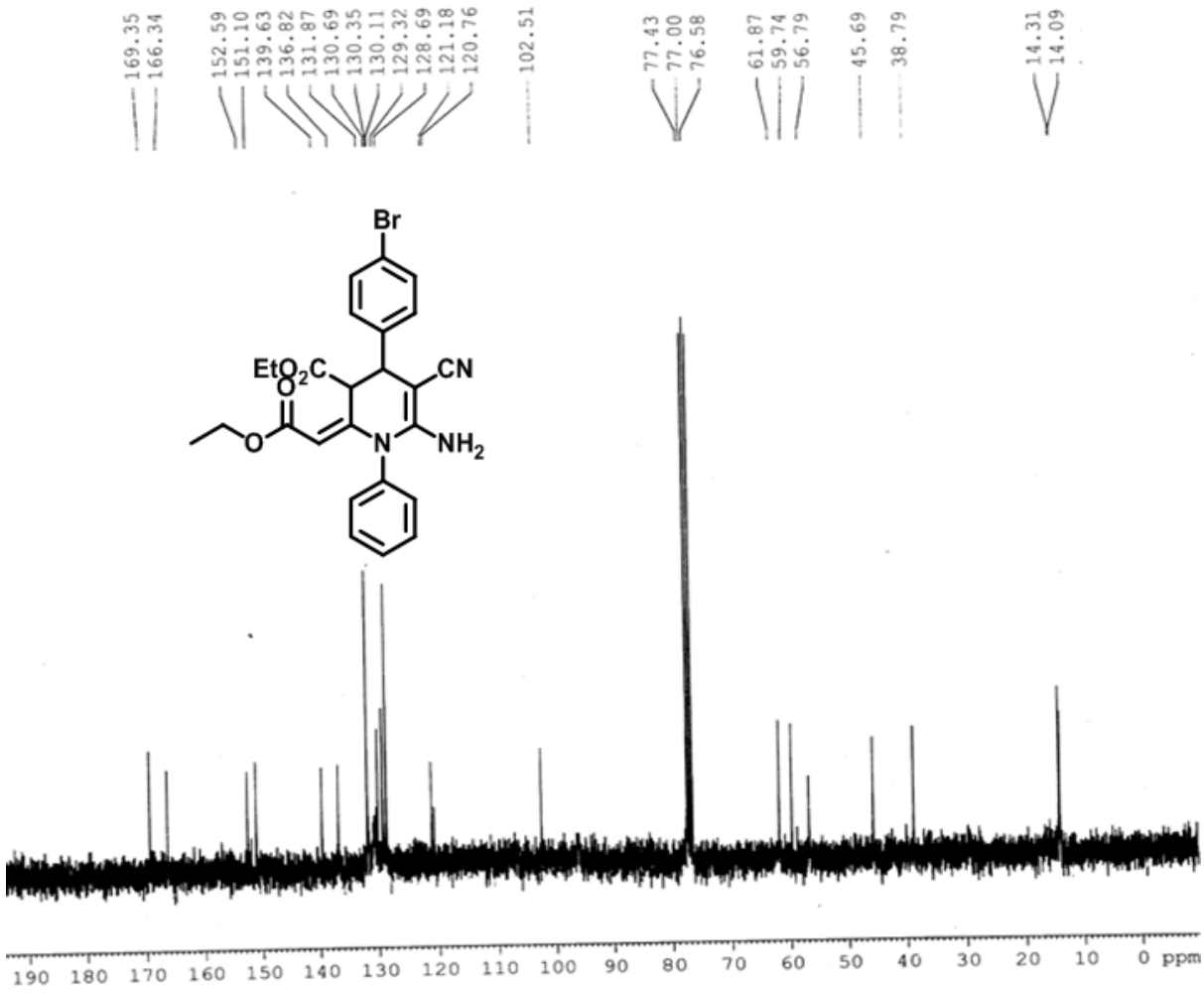
Compound 10m ^{13}C NMR (125 MHz)



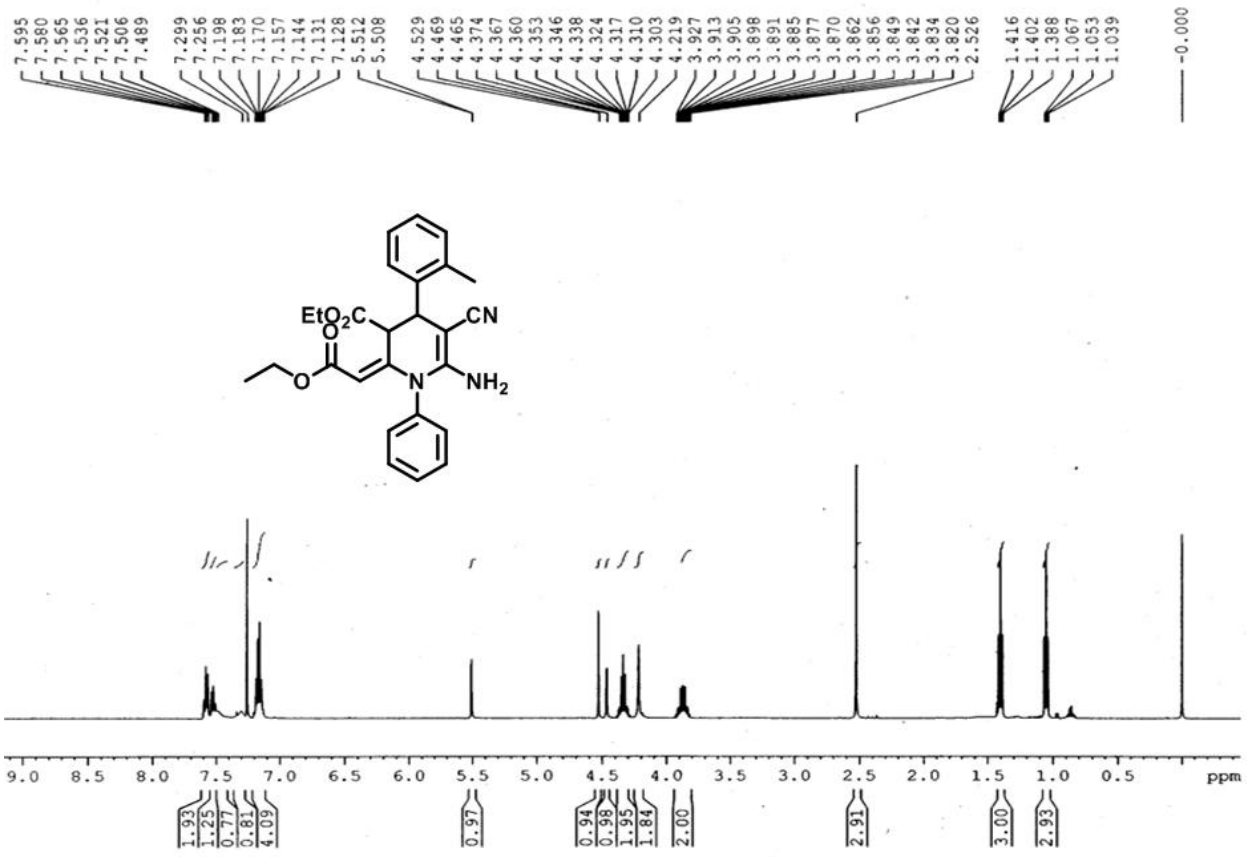
Compound 10n ^{1}H NMR (500 MHz)



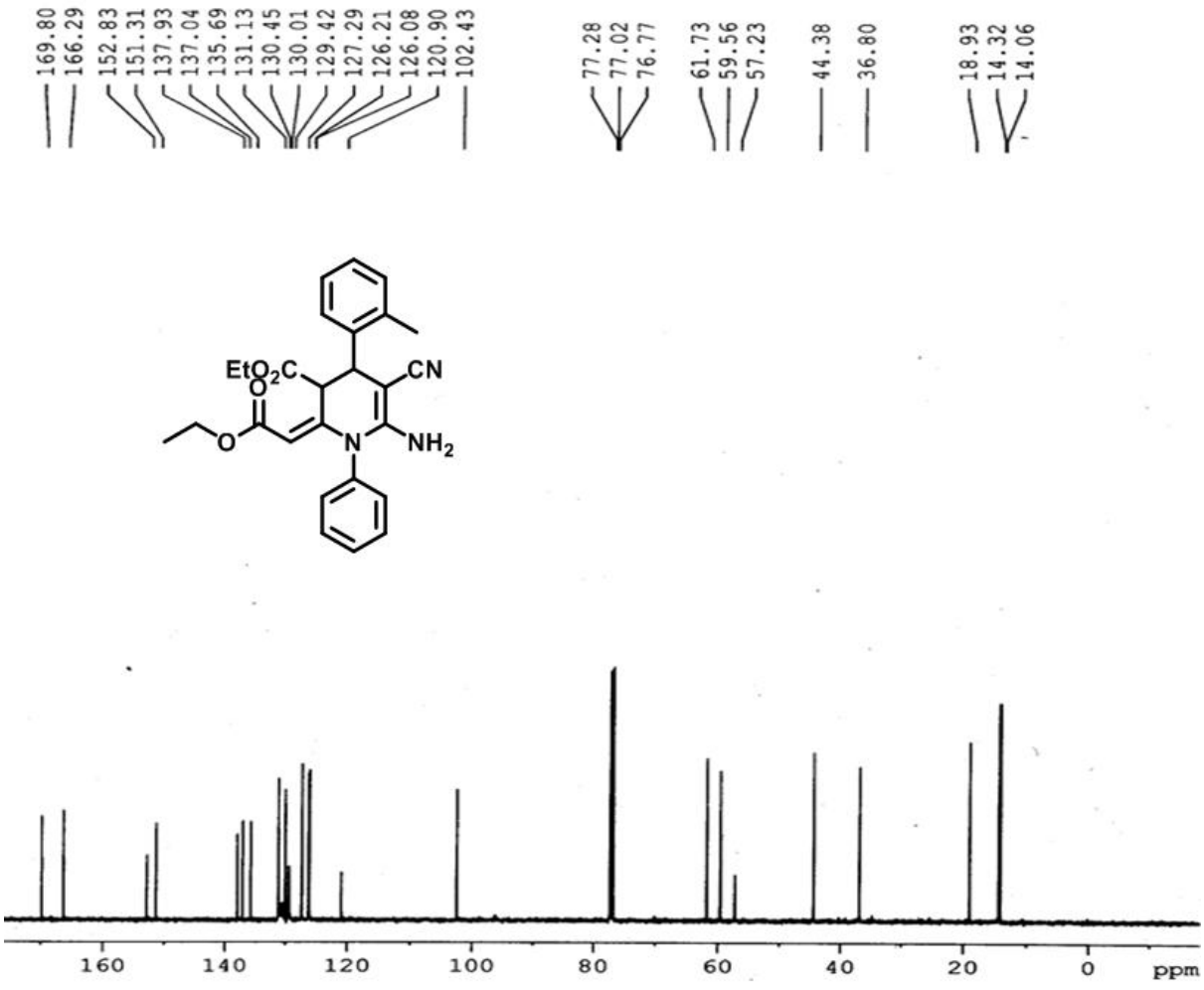
Compound 10n ^{13}C NMR (75 MHz)



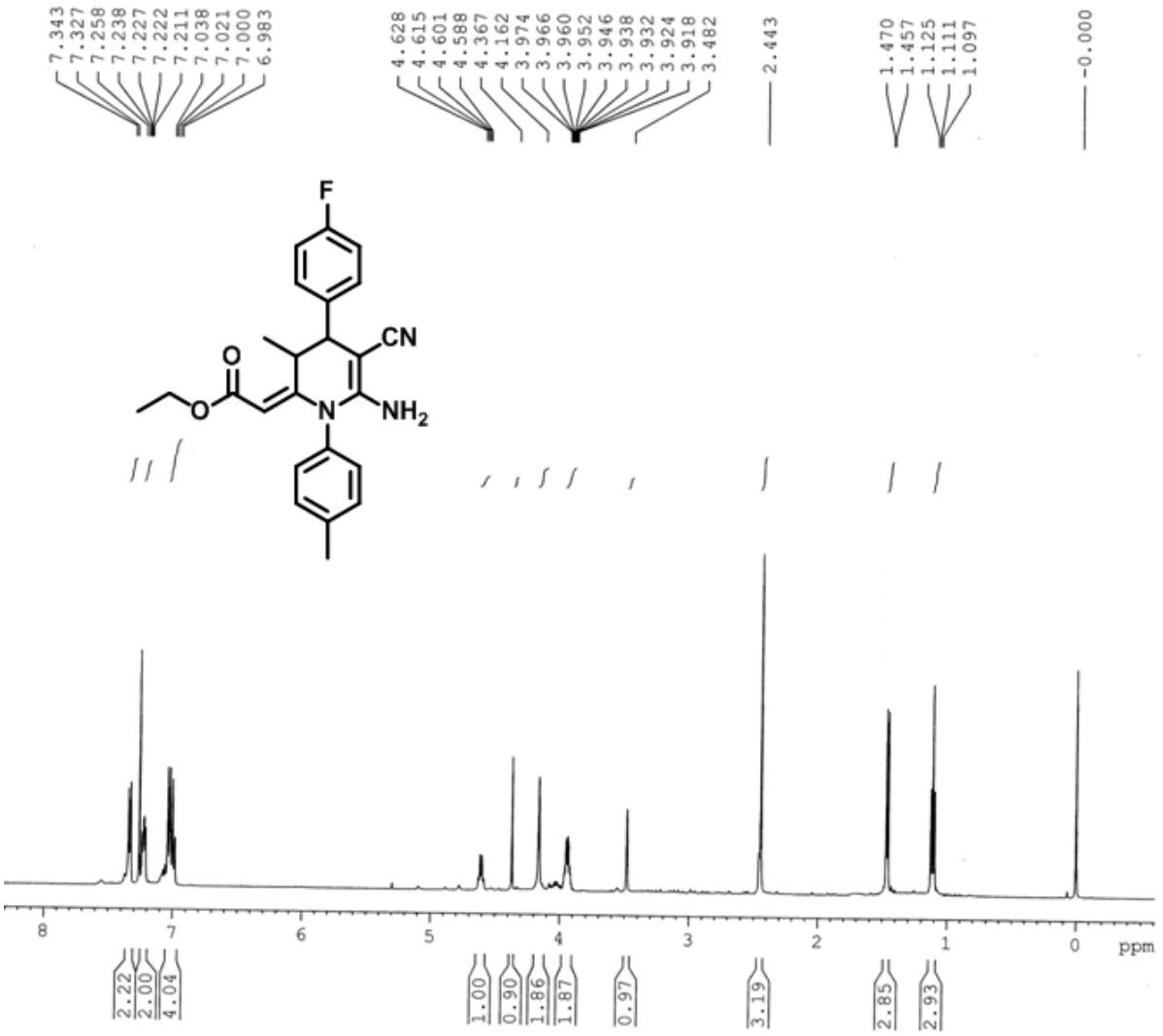
Compound 10o ^{1}H NMR (500 MHz)



Compound 10o ^{13}C NMR (125 MHz)



Compound 12 ^{1}H NMR (500 MHz)



Compound 12 ^{13}C NMR (75MHz)