Supporting Information

A direct metal-free C2-H functionalization of quinoline *N*-oxides: highly selective amination and alkylation strategy towards 2-substituted quinolines

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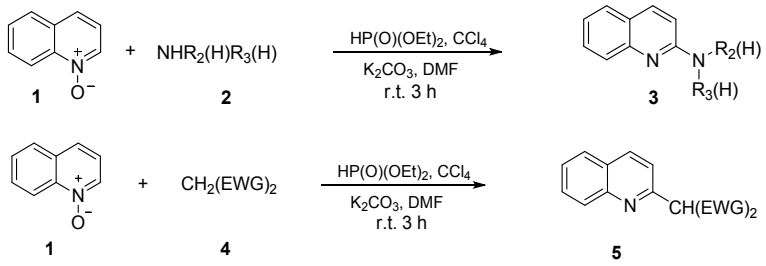
Table of Contents

1. General information

All the chemicals were obtained from Tianjin Kermel Chemical Reagent Co., Ltd. and used as received. All reactions were monitored by TLC and Silica gel was purchased from Qing Dao Hai Yang Chemical Industry Co. ^{1}H, ^{13}C, ^{19}F spectra were recorded on a Bruker Avance 400 MHz spectrometer operating at 400.1, 100.6, and 376.4 MHz, respectively. NMR spectra were recorded in $CDCl_3$ or DMSO-d6 at room temperature (20 ± 2 °C). High resolution mass spectra (HRMS) of the products were obtained on a Bruker Daltonics micro TOF-QII spectrometer.

2. General experimental procedures for the synthesis of 2-substituted quinolines



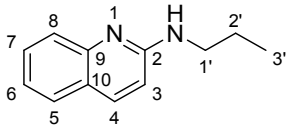
Quinoline *N*-oxide **1** (0.058 g, 0.4 mmol), diethyl *H*-phosphonates (0.110 g, 0.8 mmol), CCl_4 (0.5 mL), K_2CO_3 (0.110 g, 0.8 mmol) in DMF (2 mL) and amines **2** (0.4 mmol) or active methylene compounds **4** (0.4 mmol) were stirred at room temperature for 3 h. The mixture was quenched with water (5 mL), extracted with CH_2Cl_2 (3 × 5 mL). The combined organic layers were washed with brine (15 mL) and dried over anhydrous Na_2SO_4. After filtration, the solvent was evaporated in vacuo. The crude product was purified by silica gel chromatography (petroleum ether : ethyl acetate = 5:1) to give the desired products.

3. General experimental procedures for the 0.5 gram scale products

Quinoline *N*-oxide **1** (0.580 g, 4.0 mmol), diethyl *H*-phosphonates (1.102 g, 8.0 mmol), CCl_4 (5 mL), K_2CO_3 (1.102 g, 8.0 mmol) in DMF (20 mL) and amines **2** (4.0 mmol) or active methylene compounds **4** (4.0 mmol) were stirred at room temperature for 3 h. The mixture was quenched with water (25 mL), extracted with CH_2Cl_2 (3 × 25 mL). The combined organic layers were washed with brine (25 mL) and dried over anhydrous Na_2SO_4. After filtration, the solvent was evaporated in vacuo. The crude product was purified by silica gel chromatography (petroleum ether : ethyl acetate = 5:1) to give the desired products. ^{1}H NMR copies of the 0.5 gram scale products were provided in pages S90-S93.

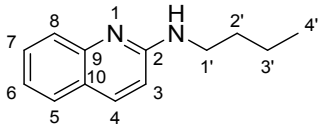
4. Characterization data for products (3a-3av)

***N*-propylquinolin-2-amine (3a)**



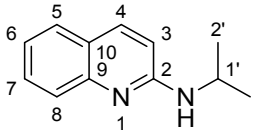
Yellow oil, yield: 83%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.02 (t, J =7.6 Hz, 3H, 3'-H), 1.69 (m, 2H, 2'-H), 3.43 (m, 2H, 1'-H), 4.85 (br,1H, -NH-), 6.63 (d, J = 8.8 Hz, 1H, 3-H), 7.19 (m, 1H, 6-H), 7.51 (m,1H, 7-H), 7.57 (m, 1H, 5-H), 7.67 (d, J = 8.4 Hz, 1H, 8-H), 7.81 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 11.6 (3'-C), 23.0 (2'-C), 43.7 (1'-C), 110.9 (3-C), 121.9 (10-C), 123.3 (6-C), 125.9 (8-C), 127.4 (5-C), 129.6 (7-C), 137.4 (4-C), 148.0 (9-C), 157.1 (2-C). HRMS Calcd for $C_{12}H_{14}N_2$ $[M + H]^+$: m/z 187.1230, Found 187.1234.

***N*-butylquinolin-2-amine (3b)**



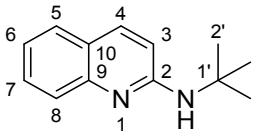
Yellow oil, yield: 82%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.97 (t, J =7.6 Hz, 3H, 4'-H), 1.46 (m, 2H, 3'-H), 1.66 (m, 2H, 2'-H), 3.46 (m, 2H, 1'-H), 5.12 (br, 1H, -NH-), 6.65 (d, J = 8.8 Hz, 1H, 3-H), 7.18 (m, 1H, 6-H), 7.20 (m, 1H, 7-H), 7.51 (m, 1H, 5-H), 7.54 (d, J = 6.4 Hz, 1H, 8-H), 7.83 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 13.9 (4'-C), 20.2 (3'-C), 29.7 (2'-C), 41.7 (1'-C), 110.8 (3-C), 122.1 (10-C), 123.1 (6-C), 125.4 (8-C), 127.5 (5-C), 129.8 (7-C), 137.8 (4-C), 147.2 (9-C), 156.9 (2-C). HRMS Calcd for $C_{13}H_{16}N_2$ $[M + H]^+$: m/z 201.1386, Found 201.1392.

***N*-isopropylquinolin-2-amine (3c)**



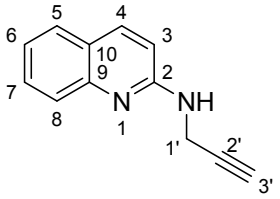
Yellow oil, yield: 79%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.27 (d, J =6.4 Hz, 6H, 2'-H), 4.17 (m, 1H, 1'-H), 5.03 (br, 1H, -NH-), 6.62 (d, J = 8.8 Hz, 1H, 3-H), 7.18 (m, 1H, 6-H), 7.21 (m, 1H,7-H), 7.56 (d, J = 7.6 Hz, 1H, 5-H), 7.66 (d, J = 8.4 Hz, 1H, 8-H), 7.81 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 23.1 (2'-C), 43.1 (1'-C), 110.1 (3-C), 122.1 (10-C), 123.1 (6-C), 125.4 (8-C), 127.5 (5-C), 129.8 (7-C), 137.8 (4-C), 147.3 (9-C), 156.1 (2-C). HRMS Calcd for $C_{12}H_{14}N_2$ $[M + H]^+$: m/z 187.1230, Found 187.1226.

***N*-(tert-butyl)quinolin-2-amine (3d)**



Yellow oil, yield: 84%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.52 (s, 9H, 2'-H), 4.72 (br, 1H, -NH-), 6.58 (d, J = 8.8 Hz, 1H, 3-H), 7.17 (m, 1H, 6-H), 7.51 (m,1H, 7-H), 7.53 (d, J = 8.0 Hz, 1H, 5-H), 7.66 (d, J = 8.4 Hz, 1H, 8-H), 7.73 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 29.5 (2'-C), 58.4 (1'-C), 112.9 (3-C), 121.8 (10-C), 122.9 (6-C), 126.4 (8-C), 127.3 (5-C), 129.3 (7-C), 136.6 (4-C), 147.9 (9-C), 156.5 (2-C). HRMS Calcd for $C_{13}H_{16}N_2$ $[M + H]^+$: m/z 201.1386, Found 201.1392.

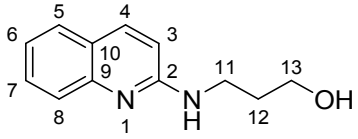
***N*-(prop-2-yn-1-yl)quinolin-2-amine (3e)**



Yellow oil, yield: 79%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.24 (s, 1H, 3'-H), 4.35 (d, 2H, J = 1.6 Hz, 1'-H), 4.94 (br, 1H, -NH-), 6.66 (d, J = 8.8 Hz, 1H, 3-H), 7.23 (m, 1H, 6-H), 7.54 (m,1H, 7-H), 7.59 (d, J = 8.0 Hz, 1H, 5-H), 7.73 (d, J = 8.4 Hz, 1H, 8-H), 7.83 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 31.3 (1'-C), 71.1 (3'-C),

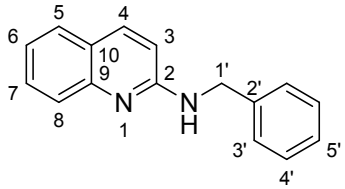
81.1 (2'-C), 111.6 (3-C), 122.6 (10-C), 123.7 (6-C), 126.5 (8-C), 127.4 (5-C), 129.6 (7-C), 137.5 (4-C), 147.7 (9-C), 155.8 (2-C). HRMS Calcd for $C_{12}H_{10}N_2$ $[M + H]^+$: m/z 183.0917, Found 183.0922.

3-(quinolin-2-ylamino)propan-1-ol (3f)



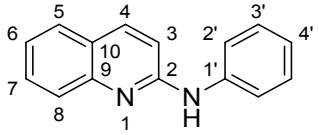
Yellow oil, yield: 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.76 (m, 2H, 12-H), 3.62 (m, 2H, 11-H), 3.73 (m, 2H, 13-H), 5.05 (br, 1H, -OH), 6.58 (d, J = 8.8 Hz, 1H, 3-H), 7.23 (m, 1H, 6-H), 7.50-7.57 (m, 2H, 7, 5-H), 7.64 (d, J = 8.4 Hz, 1H, 8-H), 7.46 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 34.1 (12-C), 37.2 (11-C), 57.8 (13-C), 112.5 (3-C), 122.4 (10-C), 123.2 (6-C), 125.3 (8-C), 127.4 (5-C), 129.9 (7-C), 137.6 (4-C), 147.0 (9-C), 157.4 (2-C). HRMS Calcd for $C_{12}H_{14}N_2O$ $[M + H]^+$: m/z 203.1179, Found 203.1178.

***N*-benzylquinolin-2-amine (3g)**



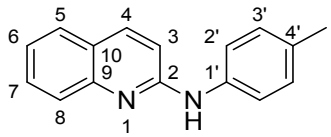
Yellow solid, yield: 83%. M. p. 91-93 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 4.70 (d, J = 5.2 Hz, 2H, 1'-H), 5.13 (br, 1H, -NH-), 6.60 (d, J = 8.8 Hz, 1H, 3-H), 7.19 (m, 1H, 5'-H), 7.27 (m, 1H, 6-H), 7.33 (t, 2H, 3'-H), 7.39 (d, J = 7.2 Hz, 2H, 4'-H), 7.51 (m, 1H, 7-H), 7.57 (d, J = 8.0 Hz, 1H, 5-H), 7.71 (d, J = 8.4 Hz, 1H, 8-H) , 7.79 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 45.9 (1'-C), 111.3 (3-C), 122.2 (9-C), 123.6 (6-C), 126.2 (8-C), 127.3 (5-C), 127.4 (5'-C), 127.8 (3'-C), 128.7 (4'-C), 129.6 (7-C), 137.5 (4-C), 139.4 (2'-C) , 147.9 (10-C), 156.7 (2-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1229.

***N*-phenylquinolin-2-amine (3h)**



Yellow solid, yield: 80%. M. p. 102-104 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.87 (d, J = 9.2 Hz, 1H, 3-H), 7.03 (m, 1H, 6-H), 7.22 (m, 1H, 7-H), 7.29 (m, 2H, 4'-H, 5-H),7.49 (m, 2H, 2'-H), 7.53 (m, 2H, 3'-H), 7.78 (m, 2H, 8-H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 111.9 (3-C), 120.7 (9-C), 123.1 (6-C), 123.2 (8-C), 124.2 (5-C), 126.7 (4'-C), 127.6 (2'-C), 129.3 (3'-C), 129.8 (7-C), 137.8 (4-C), 140.3 (1'-C), 147.7 (10-C), 154.7 (2-C). HRMS Calcd for $C_{15}H_{12}N_2$ $[M + H]^+$: m/z 221.1073, Found 221.1078.

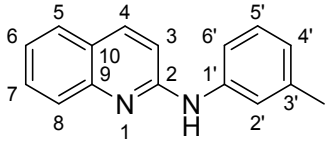
***N*-(p-tolyl)quinolin-2-amine (3i)**



Yellow solid, yield: 83%. M. p. 87-89 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.32 (s, 3H, -CH$_3$), 6.91 (d, J = 9.2 Hz,

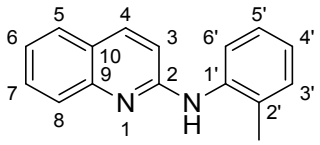
1H, 3-H), 7.13 (d, *J* = 8.0 Hz, 2H, 2'-H), 7.24 (t, 1H, 6-H), 7.37 (d, *J* = 8.4 Hz, 2H, 3'-H), 7.53 (m, 1H, 7-H), 7.58 (d, *J* = 8.0 Hz, 1H, 5-H), 7.74 (d, *J* = 8.4 Hz, 1H, 8-H), 7.82 (d, *J* = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 20.8 (-$\underline{C}H_3$), 111.4 (3-C), 121.4 (2'-C), 122.9 (9-C), 124.0 (6-C), 126.3 (8-C), 127.5 (5-C), 129.8 (7-C), 133.1 (3'-C), 137.4 (4'-C), 137.8 (4-C), 147.6 (1'-C), 155.7 (10-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1232.

***N*-(m-tolyl)quinolin-2-amine (3j)**



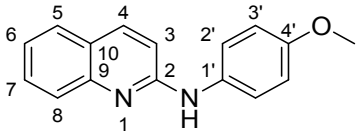
Yellow solid, yield: 80%. M. p. 107-108 °C. ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 2.29 (s, 3H, -C$\underline{H}_3$), 6.85 (d, *J* = 7.6 Hz, 1H, 4'-H), 6.91 (d, *J* = 8.8 Hz, 1H, 3-H), 7.17-7.25 (m, 3H, 2'-H, 5'-H, 6'-H), 7.32 (m, 1H, 6-H), 7.52 (m, 1H, 7-H), 7.56 (m, 1H, 5-H), 7.78 (t, 2H, 8-H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 21.6 (-$\underline{C}H_3$), 111.8 (3-C), 117.9 (6'-C), 121.5 (4'-C), 123.1 (2'-C), 124.1 (10-C), 124.2 (6-C), 126.7 (8-C), 127.5 (5-C), 129.1 (7-C), 129.8 (5'-C), 137.8 (4-C), 139.1 (3'-C), 140.2 (1'-C), 147.8 (9-C), 154.8 (2-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1237.

***N*-(o-tolyl)quinolin-2-amine (3k)**



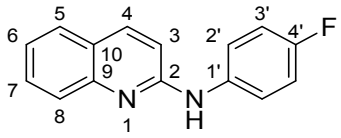
Yellow solid, yield: 81%. M. p. 97-98 °C. ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 2.29 (s, 3H, -C$\underline{H}_3$), 6.83 (d, *J* = 8.8 Hz, 1H, 3-H), 7.11 (t, 1H, 6-H), 7.24 (m, 3H, 4'-H, 6'-H, 5'-H), 7.52 (t, 1H, 7-H), 7.54 (m, 1H, 3'-H), 7.59 (t, 1H, 5-H), 7.69 (d, *J* = 8.4 Hz, 1H, 8-H), 7.85 (d, *J* = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 18.1 (-$\underline{C}H_3$), 110.7 (3-C), 122.9 (2'-C), 123.8 (10-C), 124.1 (6-C), 124.9 (4'-C), 126.3 (6'-C), 126.9 (8-C), 127.5 (5'-C), 129.8 (5-C), 131.0 (7-C), 131.9 (2'-C) , 137.9 (3'-C), 154.7 (4-C), 138.2 (1'-C), 147.9 (9-C), 155.6 (2-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1237.

***N*-(4-methoxyphenyl)quinolin-2-amine (3l)**



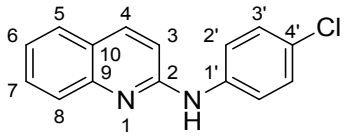
Yellow solid, yield: 85%. M. p. 108-110 °C. ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 3.78 (s, 3H, -OC$\underline{H}_3$), 6.82 (d, *J* = 8.8 Hz, 1H, 3-H), 6.88 (d, *J* = 8.8 Hz, 2H, 3'-H), 7.22 (t, 1H, 6-H), 7.39 (d, *J* = 8.0 Hz, 2H, 2'-H), 7.52 (t, 1H, 7-H), 7.58 (d, *J* = 8.0 Hz, 1H, 5-H), 7.71 (d, *J* = 8.4 Hz, 1H, 8-H) , 7.81 (d, *J* = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 55.6 (-O$\underline{C}H_3$), 111.1 (3-C), 114.6 (3'-C), 122.7 (10-C), 123.9 (2'-C), 124.0 (6-C), 126.4 (8-C), 127.5 (5-C), 129.8 (7-C), 133.1 (1'-C), 137.7 (4-C), 147.8 (9-C), 155.6 (4'-C), 156.4 (2-C). HRMS Calcd for $C_{16}H_{14}N_2O$ $[M + H]^+$: m/z 251.1179, Found 251.1181.

***N*-(4-fluorophenyl)quinolin-2-amine (3m)**



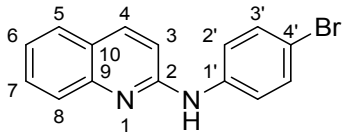
Yellow solid, yield: 63%. M. p. 106-109 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.88 (d, J = 8.8 Hz, 1H, 3-H), 7.07 (m, 2H, 2'-H), 7.30 (m, 1H, 6-H), 7.53-7.61 (m, 3H, 3'-H, 7-H), 7.64 (d, J = 8.0 Hz, 1H, 5-H), 7.77 (d, J = 8.4 Hz, 1H, 8-H) , 7.92 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 111.4 (3-C), 115.9 (d, J = 22.2 Hz, 3'-C), 122.7 (d, J = 8.7 Hz, 2'-C), 123.2 (6-C), 124.1 (10-C), 126.5 (8-C), 127.5 (5-C), 129.9 (7-C), 136.1 (1'-C), 138.0 (4-C), 147.4 (9-C), 154.5 (2-C), 159.0 (d, J = 240 Hz, 4'-C). ^{19}F NMR (376 MHz, $CDCl_3$) δ: -121.5. HRMS Calcd for $C_{15}H_{11}FN_2$ $[M + H]^+$: m/z 239.0979, Found 239.0981.

***N*-(4-chlorophenyl)quinolin-2-amine (3n)**



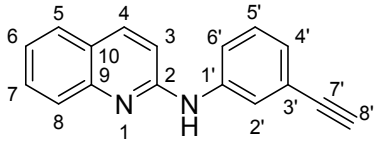
Yellow solid, yield: 71%. M. p. 127-129 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.89 (d, J = 9.2 Hz, 1H, 3-H), 7.29-7.33 (m, 3H, 6-H, 2'-H), 7.58-7.61 (m, 3H, 3'-H, 7-H), 7.64 (d, J = 8.0 Hz, 1H, 5-H), 7.79 (d, J = 8.4 Hz, 1H, 8-H) , 7.92 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 112.0 (3-C), 121.3 (4'-C), 123.4 (2'-C), 124.2 (10-C), 126.8 (6-C), 127.5 (8-C), 127.6 (5-C), 129.1 (7-C), 129.9 (3'-C), 137.9 (4-C), 138.9 (1'-C), 147.4 (9-C), 153.8 (2-C). HRMS Calcd for $C_{15}H_{11}ClN_2$ $[M + H]^+$: m/z 255.0684, Found 255.0693.

***N*-(4-bromophenyl)quinolin-2-amine (3o)**



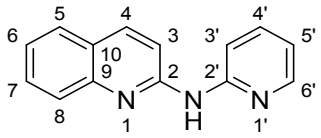
Yellow solid, yield: 78%. M. p. 146-148 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.85 (d, J = 9.2 Hz, 1H, 3-H), 7.30 (t, 1H, 6-H), 7.42 (m, J = 8.8 Hz, 2H, 2'-H), 7.52 (d, J = 9.2 Hz, 2H, 3'-H), 7.57 (m, 1H, 7-H), 7.62 (d, J = 8.0 Hz, 1H, 5-H), 7.78 (d, J = 8.4 Hz, 1H, 8-H) , 7.88 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 112.1 (3-C), 115.0 (4'-C), 121.5 (2'-C), 123.5 (10-C), 124.2 (6-C), 126.8 (8-C), 127.5 (5-C), 129.9 (7-C), 132.0 (3'-C), 137.9 (4-C), 139.5 (1'-C), 147.4 (9-C), 153.8 (2-C). HRMS Calcd for $C_{15}H_{11}BrN_2$ $[M + H]^+$: m/z 299.0178, Found 299.0179.

***N*-(3-ethynylphenyl)quinolin-2-amine (3p)**



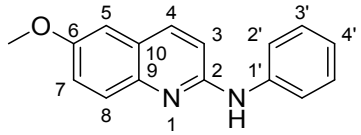
Yellow solid, yield: 71%. M. p. 137-140 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 3.12 (s, 1H, 8'-H), 7.01 (d, J = 9.2 Hz, 1H, 3-H), 7.31-7.41 (m, 3H, 2'-H, 4'-H, 5'-H), 7.52 (d, J = 8.0 Hz, 1H, 6-H), 7.64-7.71 (m, 3H, 6'-H, 7-H, 8-H), 7.86 (d, J = 8.0 Hz, 1H, 5-H) , 8.03 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 78.0 (8'-C), 83.0 (7'-C), 111.1 (3-C), 122.8 (6'-C), 123.1 (2'-C), 123.4 (10-C), 123.5 (6-C), 124.5 (4'-C), 125.5 (3'-C), 127.8 (8-C), 128.7 (5-C), 129.6 (7-C), 131.5 (5'-C), 138.2 (4-C), 140.5 (1'-C), 142.8 (9-C), 153.4 (2-C). HRMS Calcd for $C_{17}H_{12}N_2$ $[M + H]^+$: m/z 245.1073, Found 245.1082.

***N*-(pyridin-2-yl)quinolin-2-amine (3q)**



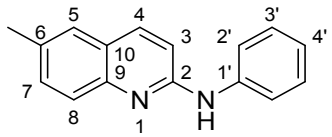
Yellow solid, yield: 61%. M. p. 157-160 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.91 (m, 1H, 5'-H), 7.32 (m, 2H, 3-H, 3'-H), 7.60 (m, 1H, 6-H), 7.68 (m, 2H, 4'-H, 7-H), 7.85 (d, J = 8.4 Hz, 1H, 5-H), 7.95 (d, J = 8.8 Hz, 1H, 8-H), 8.30 (m, 1H, 6'-H), 8.38 (d, J = 8.4 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 112.9 (3'-C), 113.9 (3-C), 117.2 (5'-C), 123.7 (10-C), 124.5 (6-C), 126.9 (8-C), 127.5 (5-C), 129.7 (7-C), 137.7 (4-C) , 138.1 (4'-C), 147.5 (6'-C), 152.9 (2'-C). HRMS Calcd for $C_{14}H_{11}N_3$ $[M + H]^+$: m/z 222.1026, Found 222.1022.

6-methoxy-*N*-phenylquinolin-2-amine (3r)



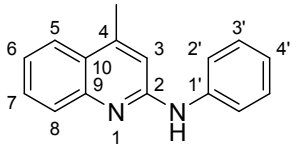
Yellow solid, yield: 84%. M. p. 107-110 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 3.88 (s, 3H, 6-OC<u>H</u>$_3$), 6.88 (d, J = 8.8 Hz, 1H, 3-H), 7.03 (m, 1H, 5-H), 7.30-7.38 (m, 4H, 3'-H, 4'-H, 7-H), 7.50 (d, J = 8.4 Hz, 2H, 2'-H), 7.68 (d, J = 8.4 Hz, 1H, 8-H), 7.74 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 55.5 (6-O<u>C</u>H$_3$), 105.8 (3-C), 112.9 (9-C), 121.1 (6-C), 121.8 (8-C), 124.5 (5-C), 126.4 (4'-C), 129.2 (2'-C), 129.6 (3'-C), 138.7 (7-C), 142.0 (4-C) , 154.3 (1'-C), 156.7 (10-C), 160.2 (2-C). HRMS Calcd for $C_{16}H_{14}N_2O$ $[M + H]^+$: m/z 251.1179, Found 251.1184.

6-methyl-*N*-phenylquinolin-2-amine (3s)



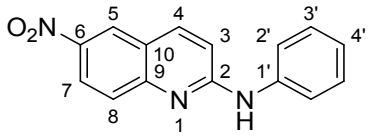
Yellow solid, yield: 85%. M. p. 109-111 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.42 (s, 3H, 6-C<u>H</u>$_3$), 6.88 (d, J = 8.8 Hz, 1H, 3-H), 7.03 (m, 1H, 6-H), 7.30 (m, 2H, 4'-H, 5-H), 7.35 (m, 2H, 3'-H), 7.50 (m, 2H, 2'-H), 7.68 (d, J = 8.4 Hz, 1H, 7-H) 7.74 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 21.3 (6-<u>C</u>H$_3$), 111.8 (3-C), 120.4 (9-C), 122.9 (6-C), 124.2 (8-C), 126.5 (5-C), 126.7 (4'-C), 127.6 (2'-C), 129.3 (3'-C), 131.9 (7-C), 137.2 (4-C) , 140.5 (1'-C), 146.0 (10-C), 154.1 (2-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1232.

4-methyl-*N*-phenylquinolin-2-amine (3t)



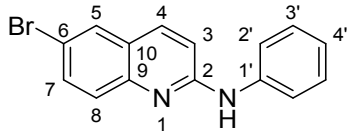
Yellow solid, yield: 85%. M. p. 105-108 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.46 (s, 3H, 4-C<u>H</u>$_3$), 6.72 (s, 1H, 3-H), 7.02 (m, 1H, 6-H), 7.23-7.31 (m, 3H, 3'-H, 7-H), 7.50-7.54 (m, 3H, 2'-H, 4'-H), 7.73 (dd, J = 8.4 Hz, J = 0.8 Hz, 1H, 5-H), 7.78 (d, J = 8.4 Hz, 1H, 8-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 21.3 (4-<u>C</u>H$_3$), 111.8 (3-C), 120.4 (9-C), 122.9 (6-C), 124.2 (8-C), 126.5 (5-C), 126.7 (4'-C), 127.6 (2'-C), 129.3 (3'-C), 131.9 (7-C), 137.2 (4-C), 140.5 (1'-C), 146.0 (10-C), 154.1 (2-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1227.

6-nitro-*N*-phenylquinolin-2-amine (3u)



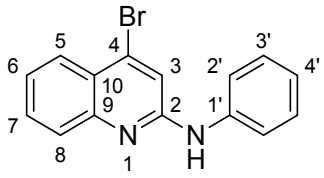
Yellow solid, yield: 78%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 7.13 (m, 1H, 4'-H), 7.38 (m, 2H, 3'-H), 7.57 (t, J = 8.0 Hz, 1H, 8-H), 7.65 (m, 1H, 3-H), 7.79 (d, J = 8.0 Hz, 2H, 2'-H), 7.93 (m, 1H, 7-H), 8.03 (t, J = 0.2 Hz, 1H, 4-H), 10.4 (s, 1H, 5-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 120.9 (3-C), 124.4 (2'-C), 126.9 (10-C), 127.9 (7-C), 129.1 (4'-C), 130.8 (5-C), 131.8 (3'-C), 133.7 (8-C), 137.4 (4-C), 139.3 (6-C), 146.0 (1'-C), 146.0 (9-C), 164.5 (2-C). HRMS Calcd for $C_{15}H_{11}N_3O_2$ [M + H]$^+$: m/z 266.0924, Found 266.0930.

6-bromo-*N*-phenylquinolin-2-amine (3v)



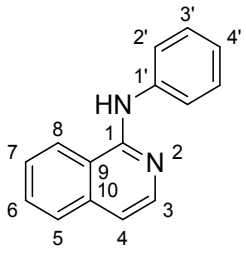
Yellow solid, yield: 83%. M. p. 147-150 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.94 (d, J = 9.2 Hz, 1H, 3-H), 7.06 (br, 1H, -NH-), 7.10 (m, 1H, 7-H), 7.36 (m, 2H, 3'-H), 7.55 (m, 2H, 2'-H), 7.61 (m, 2H, 4', 7-H) 7.75-7.78 (m, 2H, 8, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 112.6 (3-C), 116.1 (9-C), 120.7 (6-C), 123.5 (8-C), 125.3 (5-C), 128.4 (4'-C), 129.3 (2'-C), 129.5 (3'-C), 133.0 (7-C), 136.7 (4-C) , 139.8 (1'-C), 146.4 (10-C), 154.6 (2-C). HRMS Calcd for $C_{15}H_{11}BrN_2$ [M + H]$^+$: m/z 299.0178, Found 299.0185.

4-bromo-*N*-phenylquinolin-2-amine (3w)



Yellow solid, yield: 80%. M. p. 139-142 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 6.95 (br, 1H, -NH-), 7.12 (m, 1H, 6-H), 7.29 (s, 1H, 3-H), 7.34-7.39 (m, 3H, 3', 4'-H), 7.52 (m, 2H, 2'-H), 7.60 (m, 1H, 7-H), 7.74 (d, J = 8.4 Hz, 1H, 5-H) 7.99 (d, J = 8.4 Hz, 1H, 8-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 115.1 (3-C), 121.0 (9-C), 123.7 (6-C), 123.8 (8-C), 124.1 (5-C), 126.7 (4'-C), 127.0 (2'-C), 129.4 (3'-C), 130.8 (7-C), 134.8 (4-C) , 139.5 (1'-C), 148.1 (10-C), 154.1 (2-C). HRMS Calcd for $C_{15}H_{11}BrN_2$ [M + H]$^+$: m/z 299.0178, Found 299.0184.

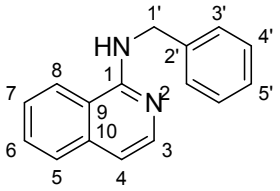
***N*-phenylisoquinolin-1-amine (3x)**



Yellow solid, yield: 73%. M. p. 117-120 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.05 (t, J = 7.2 Hz,1H, 4'-H), 7.12 (d,

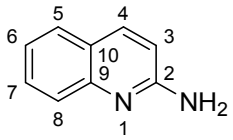
J = 5.6 Hz, 1H, 4-H), 7.35 (t, *J* = 7.6 Hz, 2H, 3'-H), 7.51(t, *J* = 8.0 Hz, 1H, 7'-H), 7.62 (t, *J* = 6.0 Hz, 1H, 6'-H), 7.65 (d, *J* = 7.6 Hz, 2H, 2'-H), 7.73 (d, *J* = 8.0 Hz, 1H, 5-H), 7.91 (d, *J* = 8.4 Hz, 1H, 8-H) , 8.08(d, *J* = 5.6 Hz, 1H, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 113.5 (4-C), 118.9 (9-C), 120.3 (2'-C), 121.5 (4'-C), 122.7 (8-C), 126.5 (7-C), 127.5 (5-C), 129.0 (3'-C), 129.9 (6-C), 137.5 (10-C), 140.5 (1'-C), 140.9 (3-C), 152.3 (1-C). HRMS Calcd for $C_{12}H_{15}N_2$ $[M + H]^+$: m/z 221.1073, Found 221.1076.

_N_-benzylisoquinolin-1-amine (3y)



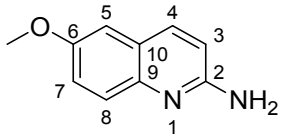
Yellow solid, yield: 70%. M. p. 97-100 °C. ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 4.82 (d, *J* = 4.8 Hz, 2H, 1'-H), 5.45 (br, 1H, -NH-), 6.97 (d, *J* = 6.0 Hz, 1H, 4-H), 7.31 (m, 1H, 7-H), 7.36 (m, 2H, 4'-H), 7.43 (m, 3H, 7-H, 3'-H), 7.58 (m, 1H, 6-H), 7.69 (d, *J* = 8.0 Hz, 1H, 5'-H), 7.73 (d, *J* = 8.4 Hz, 1H, 8-H) , 8.03 (d, *J* = 6.0 Hz, 1H, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 46.1 (1'-C), 111.3 (4-C), 118.1 (9-C), 121.4 (8-C), 125.9 (7-C), 127.2 (5'-C), 127.4 (3'-C), 128.1 (5-C), 128.7 (4'-C), 129.7 (6-C), 137.1 (10-C), 139.4 (2'-C), 141.3 (3-C), 154.9 (1-C). HRMS Calcd for $C_{16}H_{14}N_2$ $[M + H]^+$: m/z 235.1230, Found 235.1235.

quinolin-2-amine (3z)



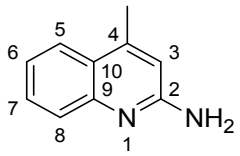
Light yellow solid, yield: 61%. M. p. 128-130 °C. ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 5.00 (br, 2H, -NH$_2$-), 6.70 (d, *J* = 8.8 Hz, 1H, 3-H), 7.26 (m, 1H, 6-H), 7.55 (m, 1H, 7-H), 7.61 (dd, *J* = 0.8 Hz, *J* = 8.0 Hz, 1H, 5-H), 7.66 (d, *J* = 8.4 Hz, 1H, 8-H), 7.86 (d, *J* = 8.4 Hz, 1H, 8-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 111.8 (3-C), 122.7 (10-C), 123.6 (6-C), 125.9 (8-C), 127.5 (5-C), 130.0 (7-C), 138.1 (4-C), 147.6 (9-C), 157.1 (2-C). HRMS Calcd for $C_9H_8N_2$ $[M + H]^+$: m/z 145.0760, Found 145.0761.

6-methoxyquinolin-2-amine (3aa)



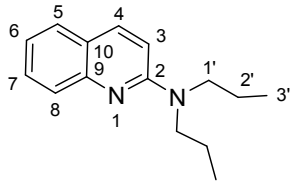
Light yellow oil, yield: 71%. M. p. 120-126 °C.^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 3.88 (s, 3H, 6-OCH_3), 4.75 (br, 2H, -NH$_2$-), 6.71 (d, *J* = 8.8 Hz, 1H, 3-H), 6.97 (d, *J* = 2.8 Hz, 1H, 5-H), 7.24 (m, 1H, 7-H), 7.59 (d, *J* = 9.2 Hz, 1H, 8-H), 7.80 (d, *J* = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 55.5 (6-OCH_3), 106.4 (3-C), 112.0 (10-C), 121.3 (6-C), 124.0 (8-C), 127.2 (5-C), 137.2 (7-C), 142.8 (4-C), 155.2 (9-C), 155.5 (2-C). HRMS Calcd for $C_{10}H_{10}N_2O$ $[M + H]^+$: m/z 175.0866, Found 175.0871.

4-methylquinolin-2-amine (3ab)



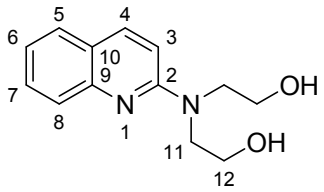
Light yellow oil, yield: 69%. M. p. 127-130 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.53 (s, 3H, 4-CH_3), 4.94 (br, 2H, -$N\underline{H}_2$-), 6.53 (s, 1H, 3-H), 7.27 (m, 1H, 6-H), 7.53 (m, 1H, 7-H), 7.66 (d, J = 8.4 Hz, 1H, 8-H), 7.76 (d, J = 8.4 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.7 (4- CH_3), 112.0 (3-C), 122.4 (10-C), 123.6 (6-C), 123.9 (8-C), 126.3 (5-C), 129.5 (7-C), 146.0 (4-C), 147.5 (9-C), 157.0 (2-C). HRMS Calcd for $C_{10}H_{10}N_2$ $[M + H]^+$: m/z 159.0917, Found 159.0919.

***N*, *N*-dipropylquinolin-2-amine (3ac)**



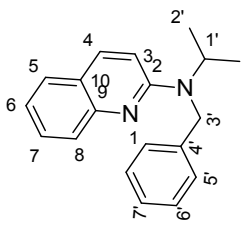
Yellow oil; Yield: 90%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.95 (t, 6H, 3'-H); 1.67 (m, 4H, 2'-H); 3.52 (m, 4H, 1'-H); 6.77 (d, J = 9.2 Hz, 1H, 3-H); 7.12 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.53 (dd, J = 1.2 Hz, J = 8.0 Hz, 1H, 5-H); 7.65 (d, J = 8.4 Hz, 1H, 8-H); 7.77 (d, J = 9.2 Hz, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 11.54 (C-3'); 21.26 (C-2'); 50.50 (C-1'); 109.23 (C-3); 121.23 (C-6); 122.37 (C-10); 126.40 (C-5); 127.16 (C-8); 129.21 (C-7); 136.85 (C-4); 148.51 (C-9); 156.41 (C-2). HRMS Calcd for $C_{15}H_{20}N_2$ $[M + H]^+$: m/z 229.1699, Found 229.1703.

2, 2'-(quinolin-2-ylazanediyl)diethanol (3ad)



Yellow oil, yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 3.66 (m, 2H, 12-H), 3.79 (m, 2H, 11-H), 5.56 (br, 2H, -O$\underline{H}$), 6.87 (d, J = 9.2 Hz, 1H, 3-H), 7.18 (m, 1H, 6-H), 7.46-7.58 (m, 3H, 7, 5, 8-H), 7.74 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 53.2 (13-C), 61.8 (12-C), 109.9 (3-C), 122.4 (10-C), 122.8 (6-C), 125.3 (8-C), 127.3 (5-C), 129.9 (7-C), 137.8 (4-C), 146.6 (9-C), 157.6 (2-C). HRMS Calcd for $C_{13}H_{16}N_2O_2$ $[M + H]^+$: m/z 233.1285, Found 233.1281.

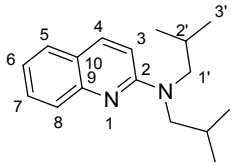
***N*-benzyl-*N*-isopropylquinolin-2-amine (3ae)**



Yellow oil; Yield: 75%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.23 (d, J = 6.8 Hz, 6H, 2'-H); 4.67 (s, 2H, 3'-H); 5.39 (m, 1H, 1'-H); 6.63 (d, J = 9.2 Hz, 1H, 3-H); 7.16 (m, 1H, 7'-H); 7.17 (m, 1H, 6-H); 7.17 (m, 1H, 7-H); 7.18 (d, J = 8.0 Hz, 1H, 5-H); 7.20 (d, J = 8.4 Hz, 1H, 8-H); 7.21 (d, J = 8.0 Hz, 1H, 4-H); 7.52 (m, 2H, 5'-H); 7.71 (m, 2H, 6'-H);

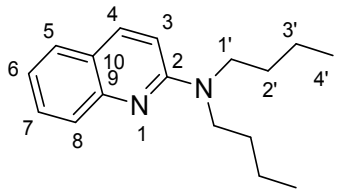
^{13}C NMR (100 MHz, $CDCl_3$) δ: 20.4 (C-2'); 46.0 (C-3'); 46.3 (C-1'); 110.4 (C-3); 121.8 (C-6); 122.9 (C-10); 126.4 (5'-C); 126.6 (C-5); 126.7 (C-8); 127.2 (6'-C); 128.6 (7'-C); 129.4 (C-7); 137.2 (4'-C); 140.2 (C-4); 148.2 (C-9); 157.1 (C-2). HRMS Calcd for $C_{19}H_{20}N_2$ [M + H]$^+$: m/z 277.1699, Found 277.1706.

***N*, *N*- diisobutylquinolin-2-amine (3af)**



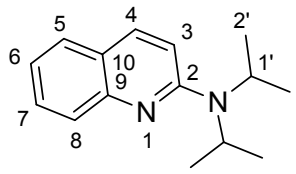
Yellow oil; Yield: 82%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.92 (d, J = 6.4 Hz, 12H, 3'-H); 2.18 (m, 2H, 2'-H); 3.44 (d, J = 7.6 Hz, 4H, 1'-H); 6.81 (d, J = 9.2 Hz, 1H, 3-H); 7.12 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.52 (d, J = 8.0 Hz, 1H, 5-H); 7.64 (d, J = 8.0 Hz, 1H, 8-H); 7.76 (d, J = 9.2 Hz, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 20.4 (C-3'); 27.3 (C-2'); 57.5 (C-1'); 109.7 (C-3); 121.3 (C-6); 122.3 (C-10); 126.4 (C-5); 127.1 (C-8); 129.2 (C-7); 136.6 (C-4); 148.4 (C-9); 156.8 (C-2). HRMS Calcd for $C_{17}H_{24}N_2$ [M + H]$^+$: m/z 257.2012, Found 257.2016.

***N*, *N*-dibutylquinolin-2-amine (3ag)**



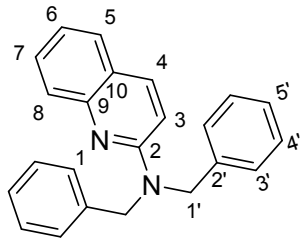
Yellow oil; Yield: 89%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.97 (t, 6H, 4'-H); 1.38 (m, 4H, 3'-H); 1.63 (m, 4H, 2'-H); 3.57 (m, 4H, 1'-H); 6.78 (d, J = 9.2 Hz, 1H, 3-H); 7.12 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.53 (dd, J = 1.2 Hz, J = 8.0 Hz, 1H, 5-H); 7.64 (d, J = 8.4 Hz, 1H, 8-H); 7.78 (d, J = 9.2 Hz, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.06 (C-4'); 20.36 (C-3'); 30.23 (C-2'); 48.32 (C-1'); 109.19 (C-3); 121.18 (C-6); 122.33 (C-10); 126.36 (C-5); 127.14 (C-8); 129.19 (C-7); 136.83 (C-4); 148.50 (C-9); 156.34 (C-2). HRMS Calcd for $C_{17}H_{24}N_2$ [M + H]$^+$: m/z 257.2012, Found 257.2015.

***N*, *N*- diisopropylquinolin-2-amine (3ah)**



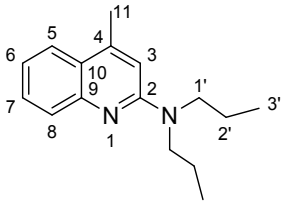
Yellow oil; Yield: 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.38 (d, J = 6.8 Hz, 12H, 2'-H); 4.40 (m, 2H, 1'-H); 6.87 (d, J = 9.2 Hz, 1H, 3-H); 7.13 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.53 (dd, J = 1.2 Hz, J = 8.0 Hz, 1H, 5-H); 7.64 (d, J = 8.4 Hz, 1H, 8-H); 7.75 (d, J = 9.2 Hz, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 21.1 (C-2'); 45.9 (C-1'); 111.9 (C-3); 121.3 (C-6); 122.4 (C-10); 126.5 (C-5); 127.1 (C-8); 129.0 (C-7); 136.9 (C-4); 148.3 (C-9); 156.3 (C-2). HRMS Calcd for $C_{15}H_{20}N_2$ [M + H]$^+$: m/z 229.1699, Found 229.1701.

***N*, *N*- dibenzylquinolin-2-amine (3ai)**



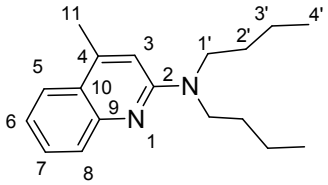
Yellow oil; Yield: 60%; ^{1}H NMR (400 MHz, CDCl3) δ: 4.93 (s, 4H, 1'-H); 6.80 (d, *J* = 8.8 Hz, 1H, 3-H); 7.17-7.29 (m, 11H, 3', 4', 5', 6-H); 7.50-7.58 (m, 2H, 7, 5-H); 7.72 (d, *J* = 8.4 Hz, 1H, 8-H); 7.79 (d, *J* = 9.2 Hz, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 50.7 (C-1'); 109.2 (C-3); 121.9 (C-6); 123.0 (C-10); 126.7 (C-5); 127.1 (C-5'); 127.2 (C-2'); 127.4 (C-3'); 128.6 (C-4'); 129.5 (C-8); 137.6 (C-7); 138.5 (C-4); 148.1 (C-9); 157.0 (C-2). HRMS Calcd for $C_{23}H_{20}N_2$ $[M + H]^+$: m/z 325.1699, Found 325.1703.

***N*, *N*-dipropyl-4-methylquinolin-2-amine (3aj)**



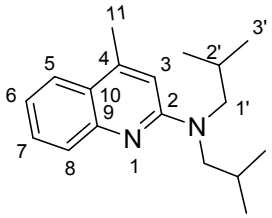
Yellow oil; Yield: 85%; ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 0.96 (t, 6H, 3'-H); 1.67 (m, 4H, 2'-H); 2.56 (d, *J* = 0.8 Hz, 1H, 11-H); 3.53 (m, 4H, 1'-H); 6.64 (d, *J* = 0.8 Hz, 1H, 3-H); 7.15 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.66 (dd, *J* = 0.4 Hz, *J* = 8.4 Hz, 1H, 5-H); 7.72 (dd, *J* = 1.2 Hz, *J* = 8.0 Hz, 1H, 8-H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 11.54 (C-3'); 19.32 (C-11); 21.29 (C-2'); 50.36 (C-1'); 109.43 (C-6); 121.01 (C-3); 122.72 (C-10); 123.39 (C-5); 126.75 (C-8); 129.00 (C-7); 144.30 (C-4); 148.39 (C-9); 156.25 (C-2). HRMS Calcd for $C_{16}H_{22}N_2$ $[M + H]^+$: m/z 243.1856, Found 243.1856.

***N*, *N*-dibutyl-4-methylquinolin-2-amine (3ak)**



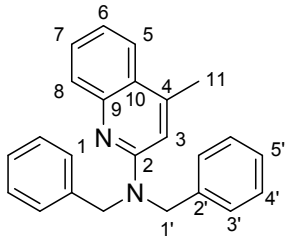
Yellow oil; Yield: 91%; ^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 0.97 (t, 6H, 4'-H); 1.38 (m, 4H, 3'-H); 1.63 (m, 4H, 2'-H); 2.56 (s, 3H, 11-H); 3.56 (m, 4H, 1'-H); 6.64 (s, 1H, 3-H), 7.15 (m, 1H, 6-H); 7.48 (m, 1H, 7-H); 7.65 (d, *J* = 8.4 Hz, 1H, 5-H); 7.71 (d, *J* = 8.0 Hz, 1H, 8-H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 14.09 (C-4'); 19.36 (C-11); 20.37 (C-3'); 30.31 (C-2'); 48.18 (C-1'); 109.40 (C-6); 120.98 (C-3); 122.73 (C-10); 123.40 (C-5); 126.83 (C-8); 128.98 (C-7); 144.23 (C-4); 148.50 (C-9); 156.23 (C-2). HRMS Calcd for $C_{18}H_{26}N_2$ $[M + H]^+$: m/z 271.2169, Found 271.2172.

***N*, *N*- diisopropyl-4-methylquinolin-2-amine (3al)**



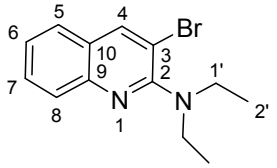
Yellow oil; Yield: 62%; ^{1}H NMR (400 MHz, $CDCl_3$) 0.92 (d, J = 6.8 Hz, 12H, 3'-H); 2.17 (m, 2H, 2'-H); 2.56 (d, J = 0.8 Hz, 3H, 11-H); 3.43 (d, J = 7.2 Hz, 4H, 1'-H); 6.67 (s, 1H, 3-H); 7.15 (m, 1H, 6-H); 7.47 (m, 1H, 7-H); 7.65 (d, J = 8.4 Hz, 1H, 8-H); 7.71 (dd, J = 1.2 Hz, J = 8.0 Hz, 1H, 5-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 19.4 (C-11); 20.4 (C-3'); 27.3 (C-2'); 57.3 (C-1'); 109.9 (C-6); 121.1 (C-3); 122.7 (C-10); 123.4 (C-5); 126.9 (C-8); 129.0 (C-7); 144.0 (C-4); 148.4 (C-9); 156.6 (C-2). HRMS Calcd for $C_{18}H_{26}N_2$ [M + H]+: m/z 271.2169, Found 271.2152.

***N*, *N*- dibenzyl-4-methylquinolin-2-amine (3am)**



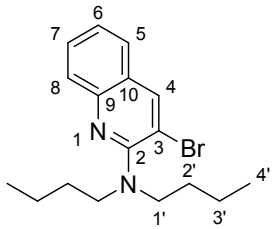
Yellow oil; Yield: 63%; ^{1}H NMR (400 MHz, CDCl3) δ: 2.49 (s, 3H, 11-H); 4.90 (s, 4H, 1'-H); 6.69 (s, 1H, 3-H); 7.18-7.28 (m, 11H, 3', 4', 5', 6-H); 7.51 (m, 1H, 7-H); 7.74 (d, J = 8.0 Hz, 2H, 8, 5-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 19.4 (C-11); 50.5 (1'-C); 109.3 (C-3); 121.8 (C-6); 123.4 (C-10); 123.6 (C-5); 127.1 (5'-C); 127.2 (C-8); 127.5 (3'-C); 128.7 (4'-C); 129.4 (C-7); 138.8 (2'-C); 145.4 (C-4); 148.2 (C-9); 157.0 (C-2). HRMS Calcd for $C_{24}H_{22}N_2$ $[M + H]^+$: m/z 339.1856, Found 339.1859.

3-Bromo-*N*, *N*-diethylquinolin-2-amine (3an)



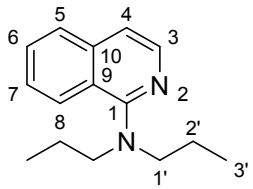
Yellow oil; Yield: 45%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.09 (m, 6H, 2'-H); 3.47 (d, J = 6.8 Hz, 1H, 1'-H); 7.55 (m, 1H, 6-H); 7.71 (m, 2H, 5, 7-H); 7.96 (s, 1H, 4-H); 8.62 (d, J = 8.8 Hz, 1H, 8-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.2 (C-2'); 45.3 (C-1'); 119.5 (C-6); 120.1 (C-3); 126.8 (C-10); 127.4 (C-5); 128.1 (C-8); 129.1 (C-7); 130.1 (C-4); 142.0 (C-9); 149.2 (C-2). HRMS Calcd for $C_{13}H_{15}BrN_2$ $[M + H]^+$: m/z 279.0491, Found 279.0493.

3-Bromo-*N*, *N*-dibutylquinolin-2-amine (3ao)



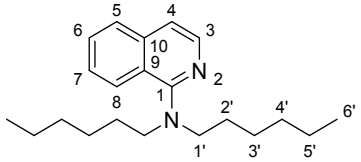
Yellow oil; Yield: 50%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.91 (t, 6H, 4'-H); 1.33 (m, 4H, 3'-H); 1.62 (m, 4H, 2'-H); 3.44 (m, 4H, 1'-H); 7.31 (m, 1H, 6-H); 7.55-7.59 (m, 2H, 7, 5-H); 7.77 (d, J = 9.2 Hz, 1H, 8-H); 8.21 (s, 1H, 4-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.03 (C-4'); 20.40 (C-3'); 30.11 (C-2'); 51.00 (C-1'); 112.72 (C-6); 124.11 (C-3); 125.69 (C-10); 126.20 (C-5); 127.32 (C-8); 129.44 (C-7); 141.41 (C-4); 145.74 (C-9); 157.24 (C-2). HRMS Calcd for $C_{17}H_{23}BrN_2$ $[M + H]^+$: m/z 335.1118, Found 335.1119.

***N*, *N*-dipropylisoquinolin-2-amine (3ap)**



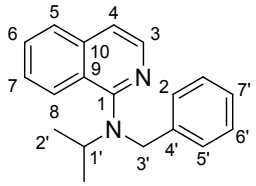
Yellow oil; Yield: 75%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.87 (t, 6H, 3'-H); 1.64 (m, 4H, 2'-H); 3.39 (m, 4H, 1'-H); 7.16 (d, J = 6.0 Hz, 1H, 4-H); 7.45 (m, 1H, 7-H); 7.55 (m, 1H, 6-H); 7.69 (d, J = 8.0 Hz, 1H, 5-H); 8.14 (m, 2H, 3-H, 8-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 11.74 (C-3'); 21.02 (C-2'); 54.12 (C-1'); 114.80 (C-4); 122.86 (C-9); 125.60 (C-8); 125.73 (C-7); 126.92 (C-5); 129.39 (C-6); 138.40 (C-10); 140.59 (C-3); 161.57 (C-1). HRMS Calcd for $C_{15}H_{20}N_2$ [M + H]$^+$: m/z 229.1699, Found 229.1698.

***N*, *N*-dihexylisoquinolin-2-amine (3aq)**



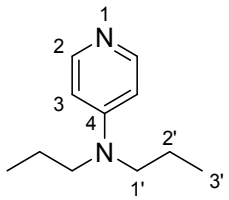
Yellow oil; Yield: 50%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.84 (m, 6H, 6'-H); 1.26 (m, 12H, 3',4',5'-H); 1.61 (m, 4H, 2'-H); 3.42 (m, 4H, 1'-H); 7.16 (d, J = 5.6 Hz, 1H, 4-H); 7.46 (m, 1H, 6-H); 7.56 (m, 1H, 7-H); 7.70 (d, J = 8.0 Hz, 1H, 5-H); 8.13 (m, 2H, 3-H, 8, 3-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.0 (C-6'); 22.6 (C-5'); 27.0 (C-4'); 27.8 (C-3'); 31.7 (C-2'); 52.3 (C-1'); 114.7 (C-4); 122.9 (C-9); 125.6 (C-8); 125.9 (C-7); 126.9 (C-5); 129.4 (C-6); 138.4 (C-10); 140.5 (C-3); 161.6 (C-1). HRMS Calcd for $C_{21}H_{32}N_2$ [M + H]$^+$: m/z 313.2638, Found 313.2643.

***N*-benzyl-*N*-isopropylisoquinolin-2-amine (3ar)**



Yellow oil; Yield: 63%; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.31 (d, J = 6.8 Hz, 6H, 2'-H); 4.06 (m, 1H, 1'-H)； 4.65 (s, 2H, 3'-H); 7.08 (d, J = 6.4 Hz, 1H, 4-H); 7.16 (m, 3H, 6', 7'-H); 7.40 (m, 2H, 5'-H); 7.48-7.58 (m, 2H, 6, 7-H); 7.68 (d, J = 8.0 Hz, 1H, 5-H); 8.07 (d, J = 5.6 Hz, 1H, 8-H); 8.24 (d, J = 8.0 Hz, 1H, 3-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 20.0 (2'-C); 45.9 (3'-C); 55.4 (1'-C); 115.7 (C-4); 123.8 (C-9); 125.6 (C-7); 126.0 (5'-C); 126.1 (C-5); 127.0 (C-8); 127.88 (6'-C); 127.90 (7'-C); 129.5 (C-2); 138.4 (4'-C); 140.5 (C-6); 141.2 (C-3); 160.8 (C-1). HRMS Calcd for $C_{19}H_{20}N_2$ [M + H]$^+$: m/z 277.1699, Found 277.1702.

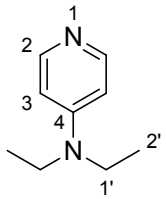
***N*, *N*-dipropylpyridin-4-amine (3au)**



Yellow oil. Yield 30%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 0.94 (t, 6H, 3'-H); 1.61 (m, 4H, 2'-H); 3.24 (m, 4H, 1'-H); 6.43 (d, J = 5.2 Hz, 2H, 3-H); 8.15 (d, J = 5.2 Hz, 2H, 2-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 11.3 (C-3'); 20.1 (C-2');

52.1 (C-1'); 106.4 (C-3); 147.2 (C-2); 153.4 (C-4). HR MS Calcd for $C_{11}H_{18}N_2$ $[M + H]^+$: m/z 179.1543, Found 179.1543.

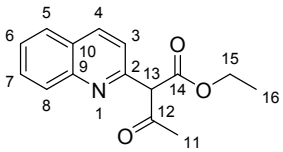
***N*, *N*-diethylpyridin-4-amine (3av)**



Yellow oil. Yield 37%. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.92 (m, 6H, 2'-H); 3.37 (m, 4H, 1'-H); 6.47 (d, J = 5.2 Hz, 2H, 3-H); 8.15 (d, J= 5.2 Hz, 2H, 2-H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 12.6 (C-2'); 44.0 (C-1'); 106.5 (C-3); 149.8 (C-2); 155.8 (C-4). HR MS Calcd for $C_9H_{14}N_2$ $[M + H]^+$: m/z 151.1230, Found 151.1229.

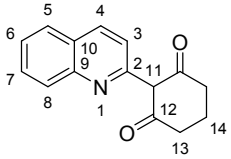
5. Characterization data for products (5a-5v)

Ethyl 3-oxo-2-(quinolin-2-yl)butanoate (5a)



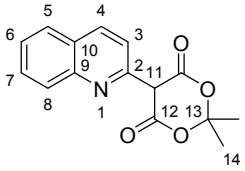
Yellow solid, yield: 60%. M. p. 147-149 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.39 (t, 3H, 16-H), 2.48 (s, 3H, 11-H), 4.34 (q, 2H, 15-H), 7.36 (m, 1H, 3-H), 7.56 (m, 1H, 6-H), 7.59 (m,1H, 7-H), 7.62 (m, 1H, 5-H), 7.88 (d, J = 9.6 Hz, 1H, 8-H), 7.95 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.4 (16-C), 29.7 (11-C), 60.1 (15-C), 98.4 (13-C), 118.7 (3-C), 120.3 (6-C), 123.2 (10-C), 124.9 (8-C), 127.5 (5-C), 131.3 (7-C), 136.4 (9-C), 137.6 (4-C), 154.6 (2-C), 169.5 (14-C), 195.2 (12-C). HRMS Calcd for $C_{15}H_{15}NO_3$ $[M + H]^+$: m/z 258.1125, Found 258.1128.

2-(quinolin-2-yl)cyclohexane-1,3-dione (5b)



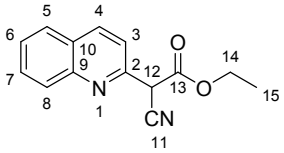
Yellow solid, yield: 71%. M. p. 154-155 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.00 (m, 2H, 14-H), 2.64 (m, 4H, 13-H), 7.46-7.50 (m, 1H, 3-H), 7.67-7.76 (m, 2H, 6, 7-H), 8.15 (d, J = 9.6 Hz, 1H, 8-H), 9.19 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 19.8 (16-C), 29.7 (11-C), 38.9 (15-C), 98.4 (13-C), 104.6 (3-C), 119.3 (3-C), 121.8 (6-C), 124.4 (10-C), 125.8 (8-C), 127.7 (5-C), 131.7 (7-C), 135.8 (9-C), 139.6 (4-C), 155.2 (2-C). HRMS Calcd for $C_{15}H_{13}NO_2$ $[M + H]^+$: m/z 240.1019, Found 240.1022.

2,2-dimethyl-5-(quinolin-2-yl)-1,3-dioxane-4,6-dione (5c)



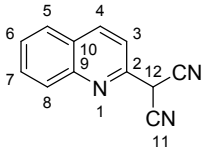
Yellow solid, yield: 75%. M. p. 157-160 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.77 (s, 6H, 14-H), 7.52 (m, 1H, 3-H), 7.68-7.80 (m, 3H, 6, 7, 5-H), 8.15 (d, J = 9.2 Hz, 1H, 8-H), 8.95 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (14-C), 26.4 (13-C), 58.4 (11-C), 102.9 (3-C), 118.6 (6-C), 121.2 (10-C), 123.5 (8-C), 126.0 (5-C), 128.0 (7-C), 132.2 (9-C), 135.8 (4-C), 140.0 (2-C), 154.9 (12-C). HRMS Calcd for $C_{15}H_{13}NO_4$ $[M + H]^+$: m/z 272.0917, Found 272.0924.

Ethyl 2-cyano-2-(quinolin-2-yl)acetate (5d)



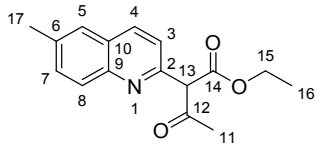
Yellow solid, yield: 61%. M. p. 177-179 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.38 (t, 3H, 15-H), 4.30 (q, 2H, 14-H), 7.31-7.42 (m, 3H, 3, 6, 7-H), 7.59-7.64 (m, 2H, 5, 8-H), 7.84 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.5 (15-C), 60.6 (14-C), 66.5 (12-C), 117.1 (3-C), 118.7 (11-C), 119.3 (6-C), 122.2 (10-C), 124.9 (8-C), 128.2 (5-C), 132.0 (7-C), 136.3 (9-C), 138.5 (4-C), 155.1 (2-C), 169.9 (13-C). HRMS Calcd for $C_{14}H_{12}N_2O_2$ $[M + H]^+$: m/z 241.0972, Found 241.0975.

2-(quinolin-2-yl)malononitrile (5e)



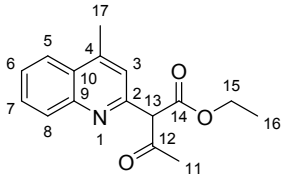
Yellow solid, yield: 76%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 7.17 (d, J = 9.2 Hz, 1H, 3-H), 7.42 (m, 1H, 6-H), 7.59 (m,1H, 7-H), 7.82 (d, J = 7.2 Hz, 1H, 5-H), 7.94 (d, J = 8.0 Hz, 1H, 8-H), 8.13 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 19.0 (12-C), 117.2 (11-C), 118.0 (3-C), 118.0 (10-C), 122.4 (6-C), 125.3 (8-C), 128.8 (5-C), 132.6 (7-C), 138.1 (9-C), 140.1 (4-C), 156.0 (2-C). HRMS Calcd for $C_{12}H_7N_3$ $[M + H]^+$: m/z 194.0713, Found 194.0716.

Ethyl 2-(6-methylquinolin-2-yl)-3-oxobutanoate (5f)



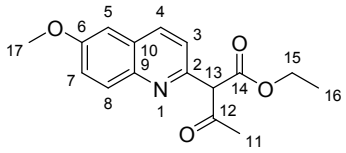
Yellow solid, yield: 53%. M. p. 189-191 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.39 (t, 3H, 16-H), 2.45-2.47 (m, 6H, 11, 17-H), 4.33 (q, 2H, 15-H), 7.40-7.46 (m, 3H, 3, 5, 7-H), 7.81 (d, J = 9.2 Hz, 1H, 8-H), 7.95 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.4 (16-C), 21.2 (17-C), 29.7 (11-C), 60.0 (15-C), 98.0 (13-C), 118.5 (3-C), 120.2 (6-C), 123.3 (10-C), 126.9 (8-C), 133.0 (5-C), 134.5 (7-C), 134.8 (9-C), 137.3 (4-C), 154.3 (2-C), 169.5 (14-C), 194.7 (12-C). HRMS Calcd for $C_{16}H_{17}NO_3$ $[M + H]^+$: m/z 272.1281, Found 272.1283.

Ethyl 2-(4-methylquinolin-2-yl)-3-oxobutanoate (5g)



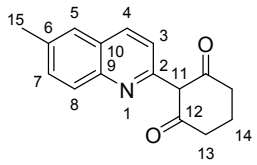
Yellow solid, yield: 61%. M. p. 167-169 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.40 (t, 3H, 16-H), 2.46 (s, 3H, 11-H), 2.59 (q, 2H, 17-H), 4.34 (q, 2H, 15-H), 7.38 (t, 1H, 6-H), 7.51 (d, J = 8.0 Hz, 1H, 5-H), 7.59 (m,1H, 7-H), 7.76 (m, 1H, 8-H), 7.83 (s, 1H, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.4 (16-C), 19.7 (17-C), 30.1 (11-C), 60.1 (15-C), 97.7 (13-C), 119.0 (3-C), 119.7 (6-C), 123.5 (10-C), 124.0 (8-C), 124.6 (5-C), 131.0 (7-C), 136.0 (9-C), 146.4 (4-C), 154.2 (2-C), 169.6 (14-C), 195.1 (12-C). HRMS Calcd for $C_{16}H_{17}NO_3$ $[M + H]^+$: m/z 272.1281, Found 272.1285.

Ethyl 2-(6-methoxyquinolin-2-yl)-3-oxobutanoate (5h)



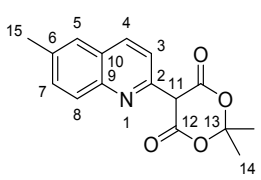
Yellow solid, yield: 51%. M. p. 171-173 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.39 (m, 3H, 16-H), 2.47 (s, 3H, 11-H), 3.87 (s, 3H, 17-H), 4.33 (q, 2H, 15-H), 6.98 (s, 1H, 5-H), 7.24 (m, 1H, 3-H), 7.45 (m,1H, 7-H), 7.82 (m, 1H, 8-H), 8.01 (d, J = 7.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.4 (16-C), 29.7 (17-C), 55.6 (15-C), 59.9 (11-C), 97.7 (13-C), 107.1 (3-C), 120.4 (6-C), 120.6 (10-C), 122.1 (8-C), 124.3 (5-C), 131.5 (9-C), 136.9 (7-C), 153.7 (4-C), 156.8 (2-C), 169.4 (14-C), 193.7 (12-C). HRMS Calcd for $C_{16}H_{17}NO_4$ $[M + H]^+$: m/z 288.1230, Found 288.1234.

2-(6-methylquinolin-2-yl)cyclohexane-1,3-dione (5i)



Yellow solid, yield: 78%. M. p. 197-199 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.99 (m, 2H, 14-H), 2.49 (s, 3H, 15-H), 2.62 (m, 4H, 13-H), 7.33-7.56 (m, 3H, 3, 5, 7-H), 8.04 (d, J = 9.6 Hz, 1H, 8-H), 9.13 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (14-C), 19.8 (15-C), 21.2 (13-C), 58.1 (11-C), 104.4 (3-C), 119.0 (5-C), 121.6 (10-C), 124.5 (8-C), 126.8 (7-C), 133.5 (6-C), 133.9 (4-C), 135.9 (9-C), 139.2 (2-C), 154.5 (12-C). HRMS Calcd for $C_{16}H_{15}NO_2$ $[M + H]^+$: m/z 254.1176, Found 254.1186.

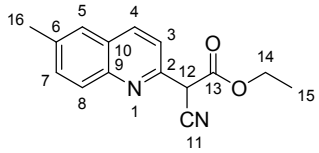
2,2-dimethyl-5-(6-methylquinolin-2-yl)-1,3-dioxane-4,6-dione (5j)



Yellow solid, yield: 71%. M. p. 175-179 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.76 (s, 6H, 14-H), 2.52 (s, 3H, 15-H), 7.55-7.60 (m, 3H, 3, 7, 5-H), 8.08 (d, J = 9.6 Hz, 1H, 8-H), 8.90 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (15-C), 21.3 (13-C), 26.4 (14-C), 58.4 (11-C), 79.1 (3-C), 102.8 (6-C), 118.3 (10-C), 121.0 (8-C), 123.6 (5-C), 127.2 (7-C), 134.0 (9-C), 136.2 (4-C), 139.6 (2-C), 154.2 (12-C). HRMS Calcd for $C_{16}H_{15}NO_4$ [M +

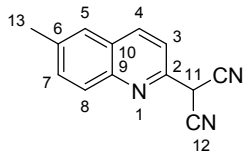
H]$^+$: m/z 286.1074, Found 286.1080.

Ethyl 2-cyano-2-(6-methylquinolin-2-yl)acetate (5k)



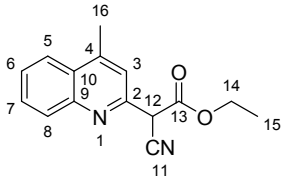
Yellow solid, yield: 41%. M. p. 177-179 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.37 (t, 3H, 15-H), 2.44 (s, 3H, 16-H), 4.29 (q, 2H, 14-H), 7.25-7.29 (m, 2H, 3, 7-H), 7.38-7.43 (m, 2H, 8, 4-H), 7.74 (d, J = 9.2 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.5 (15-C), 21.0 (16-C), 60.5 (14-C), 65.8 (12-C), 116.9 (3-C), 118.9 (11-C), 119.1 (5-C), 122.2 (10-C), 127.7 (8-C), 133.5 (7-C), 134.4 (6-C), 134.9 (4-C), 138.3 (9-C), 154.7 (2-C), 170.0 (13-C). HRMS Calcd for $C_{15}H_{14}N_2O_2$ [M + H]$^+$: m/z 255.1128, Found 255.1131.

2-(6-methylquinolin-2-yl)malononitrile (5l)



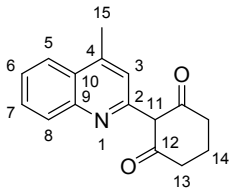
Yellow solid, yield: 71%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 2.59 (s, 3H, 13-H), 7.03 (s, 1H, 5-H), 7.44 (m, 1H, 3-H), 7.69 (m, 1H, 7-H), 7.88 (d, J = 7.6 Hz, 1H, 8-H), 7.95 (d, J = 8.4 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 19.2 (13-C), 42.5 (12-C), 117.1 (11-C), 117.5 (3-C), 118.3 (6-C), 122.6 (10-C), 125.2 (8-C), 125.4 (5-C), 132.4 (7-C), 137.8 (9-C), 149.2 (4-C), 155.4 (2-C). HRMS Calcd for $C_{13}H_9N_3$ [M + H]$^+$: m/z 208.0869, Found 208.0874.

Ethyl 2-cyano-2-(4-methylquinolin-2-yl)acetate (5m)



Yellow solid, yield: 53%. M. p. 171-173 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.37(t, 3H, 15-H), 2.56 (s, 3H, 16-H), 4.27 (q, 2H, 14-H), 7.11 (s, 1H, 3-H), 7.34-7.40 (m, 2H, 5, 6-H), 7.60 (m, 1H, 7-H), 7.74 (d, J = 8.4 Hz, 1H, 8-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.5 (15-C), 19.3 (16-C), 60.4 (14-C), 65.2 (12-C), 117.4 (11-C), 118.5 (3-C), 119.0 (5-C), 122.6 (10-C), 124.6 (6-C), 124.7 (8-C), 131.7 (7-C), 135.9 (4-C), 147.7 (9-C), 154.5 (2-C), 170.0 (13-C). HRMS Calcd for $C_{15}H_{14}N_2O_2$ [M + H]$^+$: m/z 255.1128, Found 255.1131.

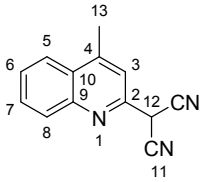
2-(4-methylquinolin-2-yl)cyclohexane-1,3-dione (5n)



Yellow solid, yield: 75%. M. p. 195-197 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 2.00 (m, 2H, 14-H), 2.62 (m, 4H, 13-H), 2.68 (s, 3H, 15-H), 7.46 (m, 1H, 6-H), 7.60-7.68 (m, 2H, 5, 7-H), 7.85 (d, J = 8.4 Hz, 1H, 8-H), 9.03 (s, 1H, 3-

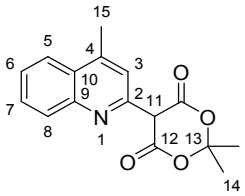
H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (14-C), 19.8 (13-C), 38.9 (15-C), 58.1 (11-C), 104.2 (3-C), 119.6 (5-C), 121.3 (10-C), 124.1 (6-C), 124.5 (8-C), 125.5 (7-C), 131.3 (4-C), 135.3 (9-C), 149.1 (2-C), 154.4 (12-C). HRMS Calcd for $C_{16}H_{15}NO_2$ $[M + H]^+$: m/z 254.1176, Found 254.1180.

2-(4-methylquinolin-2-yl)malononitrile (5o)



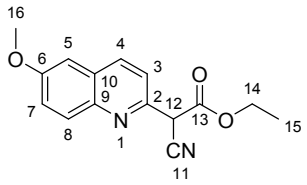
Yellow solid, yield: 72%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 2.59 (s, 3H, 13-H), 7.03 (s, 1H, 3-H), 7.44 (m, 1H, 6-H), 7.69 (m, 1H, 7-H), 7.88 (d, J = 7.6 Hz, 1H, 8-H), 7.95 (d, J = 8.4 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 19.2 (13-C), 42.5 (12-C), 117.1 (11-C), 117.5 (3-C), 118.3 (5-C), 122.7 (10-C), 125.2 (6-C), 125.4 (8-C), 132.4 (7-C), 137.8 (4-C), 149.2 (9-C), 155.4 (2-C). HRMS Calcd for $C_{13}H_9N_3$ $[M + H]^+$: m/z 208.0869, Found 208.0875.

2,2-dimethyl-5-(4-methylquinolin-2-yl)-1,3-dioxane-4,6-dione (5p)



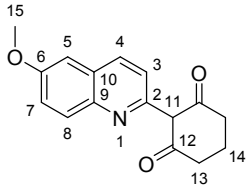
Yellow solid, yield: 75%. M. p. 175-177 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.76 (s, 6H, 15-H), 2.74 (s, 3H, 15-H), 7.53 (m, 1H, 6-H), 7.65 (d, J = 8.0 Hz, 1H, 5-H), 7.72 (m,1H, 7-H), 7.91 (d, J = 8.4 Hz, 1H, 8-H), 8.80 (s, 1H, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (15-C), 19.8 (13-C), 26.4 (14-C), 58.4 (11-C), 102.7 (3-C), 119.0 (6-C), 120.7 (10-C), 123.7 (8-C), 124.5 (5-C), 125.8 (7-C), 131.9 (9-C), 135.4 (4-C), 149.6 (2-C), 154.1 (12-C). HRMS Calcd for $C_{16}H_{15}NO_4$ $[M + H]^+$: m/z 286.1074, Found 286.1088

Ethyl 2-cyano-2-(6-methoxyquinolin-2-yl)acetate (5q)



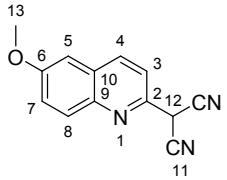
Yellow solid, yield: 65%. M. p. 184-186 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.36 (t, 3H, 15-H), 3.89 (s, 3H, 16-H), 4.27 (q, 2H, 14-H), 7.00 (d, J = 2.4 Hz, 1H, 5-H), 7.21-7.31 (m, 3H, 3, 7, 8-H), 7.75 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.5 (15-C), 55.7 (16-C), 60.4 (14-C), 65.1 (12-C), 108.4 (5-C), 118.4 (3-C), 119.1 (11-C), 119.4 (7-C), 122.2 (8-C), 123.1 (10-C), 130.9 (9-C), 138.0 (4-C), 153.8 (6-C), 156.7 (2-C), 170.0 (13-C). HRMS Calcd for $C_{15}H_{14}N_2O_3$ $[M + H]^+$: m/z 271.1077, Found 271.1081.

2-(6-methoxyquinolin-2-yl)cyclohexane-1,3-dione (5r)



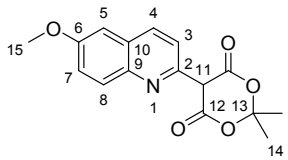
Yellow solid, yield: 71%. M. p. 200-202 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.98 (m, 2H, 14-H), 2.61 (m, 4H, 13-H), 3.89 (s, 3H, 15-H), 7.04 (m, 1H, 5-H), 7.28-7.32 (m, 1H, 3-H), 7.55 (m,1H, 7-H), 8.03 (m, 1H, 8-H), 9.11 (m, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 19.8 (14-C), 38.6 (13-C), 55.7 (15-C), 65.2 (11-C), 106.5 (5-C), 120.7 (7-C), 121.9 (3-C), 123.2 (8-C), 125.5 (10-C), 130.8 (9-C), 138.7 (4-C), 153.3 (6-C), 157.4 (2-C), 197.7 (12-C). HRMS Calcd for $C_{16}H_{15}NO_3$ $[M + H]^+$: m/z 270.1125, Found 270.1129.

2-(6-methoxyquinolin-2-yl)malononitrile (5s)



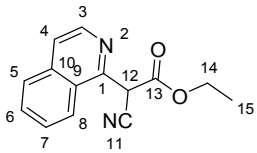
Yellow solid, yield: 79%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 3.83 (s, 3H, 13-H), 7.15 (d, J = 9.6 Hz, 1H, 3-H), 7.31-7.35 (m, 2H, 5, 7-H), 7.88 (d, J = 9.2 Hz, 1H, 8-H), 8.07 (d, J = 8.8 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 19.0 (13-C), 41.8 (12-C), 56.1 (11-C), 109.2 (3-C), 118.3 (6-C), 119.8 (10-C), 122.3 (8-C), 123.6 (5-C), 133.2 (7-C), 139.5 (9-C), 154.8 (4-C), 156.5 (2-C). HRMS Calcd for $C_{13}H_9N_3O$ $[M + H]^+$: m/z 224.0818, Found 224.0821.

5-(6-methoxyquinolin-2-yl)-2,2-dimethyl-1,3-dioxane-4,6-dione (5t)



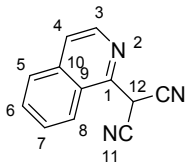
Yellow solid, yield: 73%. M. p. 201-203 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.76 (s, 6H, 14-H), 3.93 (s, 3H, 15-H), 7.12 (d, J = 2.4 Hz, 1H, 5-H), 7.37 (m, 1H, 7-H), 7.61 (d, J = 9.2 Hz, 1H, 3-H), 8.09 (d, J = 9.6 Hz, 1H, 8-H), 8.92 (d, J = 9.6 Hz, 1H, 4-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 18.4 (15-C), 26.3 (14-C), 55.8 (13-C), 58.3 (11-C), 102.8 (3-C), 107.2 (6-C), 120.0 (10-C), 121.4 (8-C), 123.4 (5-C), 124.6 (7-C), 130.8 (9-C), 139.2 (4-C), 153.1 (2-C), 157.6 (12-C). HRMS Calcd for $C_{16}H_{15}NO_5$ $[M + H]^+$: m/z 302.1023, Found 302.1038.

Ethyl 2-cyano-2-(isoquinolin-1-yl)acetate (5u)



Yellow solid, yield: 72%. M. p. 181-183 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 1.39 (t, 3H, 15-H), 4.32 (q, 2H, 14-H), 6.90 (d, J = 5.4 Hz, 1H, 4-H), 7.37 (m, 1H, 5-H), 7.54-7.62 (m, 2H, 6, 7-H), 7.72 (m, 1H, 8-H), 9.44 (d, J = 8.4 Hz, 1H, 3-H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 14.5 (15-C), 60.9 (14-C), 64.2 (12-C), 112.8 (4-C), 121.7 (11-C), 123.6 (9-C), 126.5 (5-C), 127.3 (7-C), 127.4 (8-C), 127.8 (6-C), 133.1 (10-C), 136.4 (3-C), 155.0 (1-C), 171.5 (13-C). HRMS Calcd for $C_{14}H_{12}N_2O_2$ $[M + H]^+$: m/z 241.0972, Found 241.0975.

2-(isoquinolin-1-yl)malononitrile (5v)



Yellow solid, yield: 63%. M. p. > 300 °C. ^{1}H NMR (400 MHz, DMSO-d6) δ: 7.15 (d, J = 6.8 Hz, 1H, 4-H), 7.55 (d, J = 6.4 Hz, 1H, 5-H), 7.70 (s,1H, 6-H), 7.88 (s, 2H, 7, 8-H), 8.94 (d, J = 8.4 Hz, 1H, 3-H). ^{13}C NMR (100 MHz, DMSO-d6) δ: 41.7 (12-C), 112.9 (4-C), 119.3 (11-C), 122.7 (5-C), 126.2 (7-C), 128.4 (8, 9-C), 129.9 (6-C), 134.4 (10-C), 136.7 (3-C), 155.0 (1-C). HRMS Calcd for $C_{12}H_7N_3$ $[M + H]^+$: m/z 194.0713, Found 194.0716.

6. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR copies of products (3a-3av)

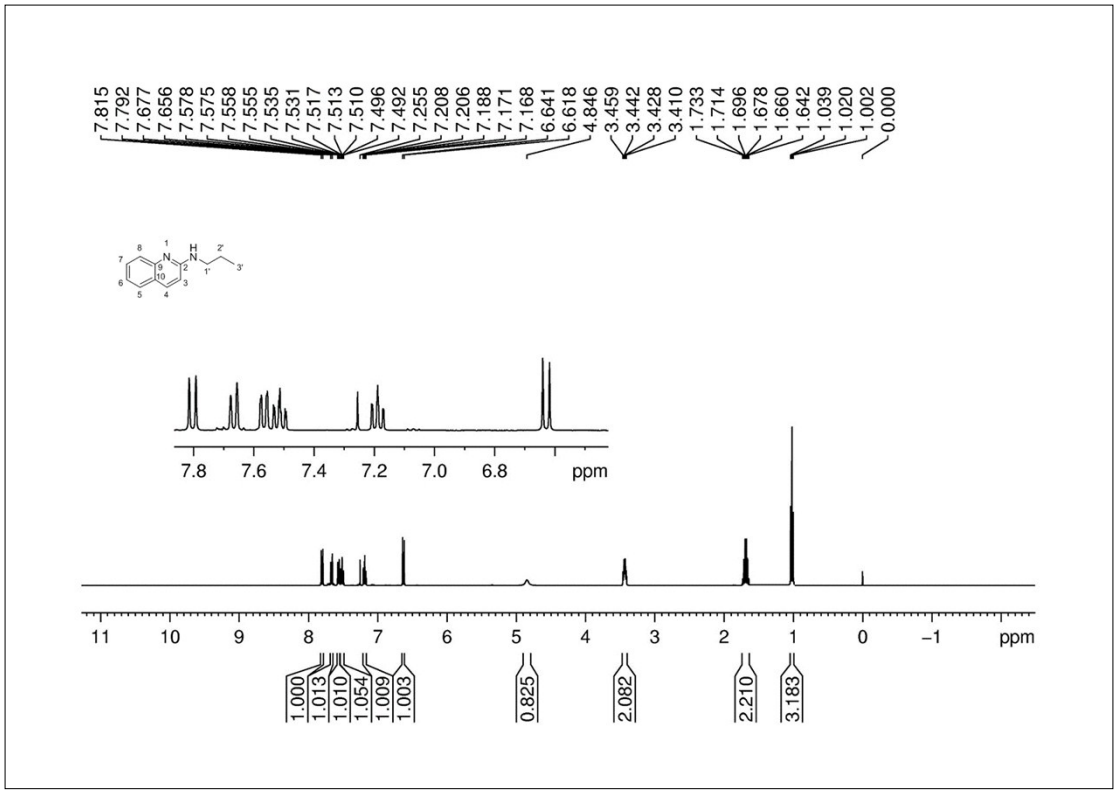


Fig.1 ^{1}H NMR spectrum of compound **3a**

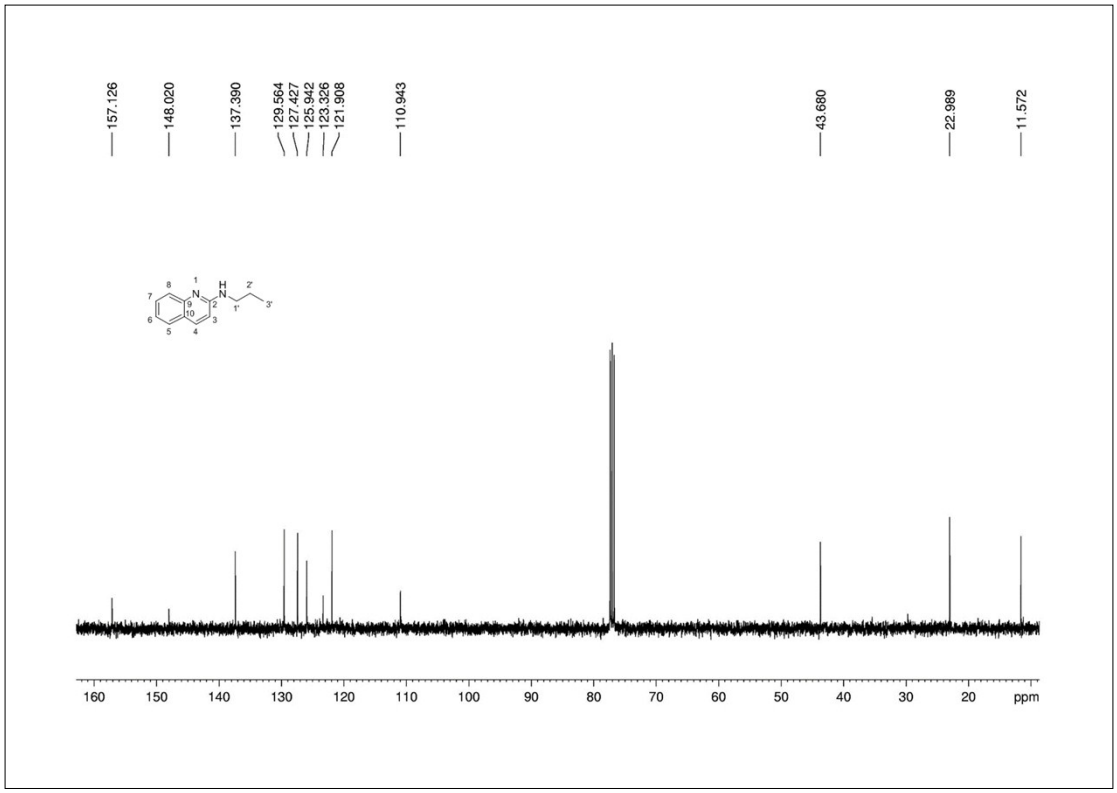


Fig.2 ^{13}C NMR spectrum of compound **3a**

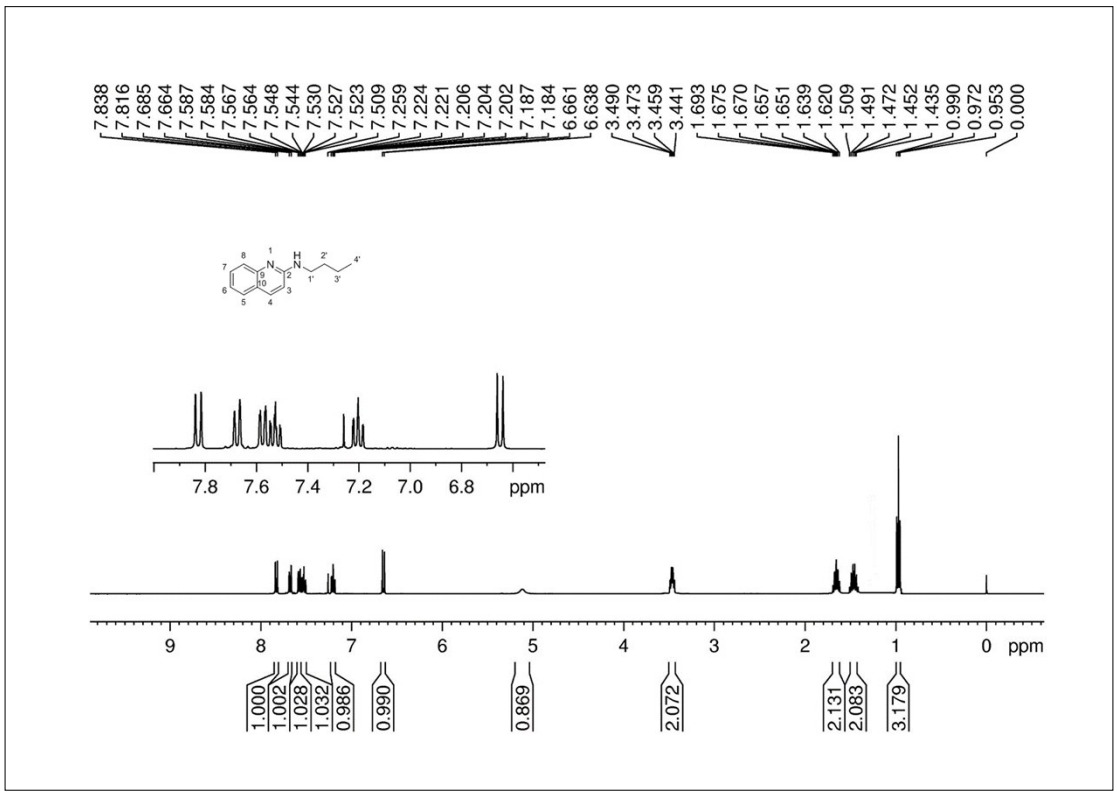


Fig.3 ^{1}H NMR spectrum of compound **3b**

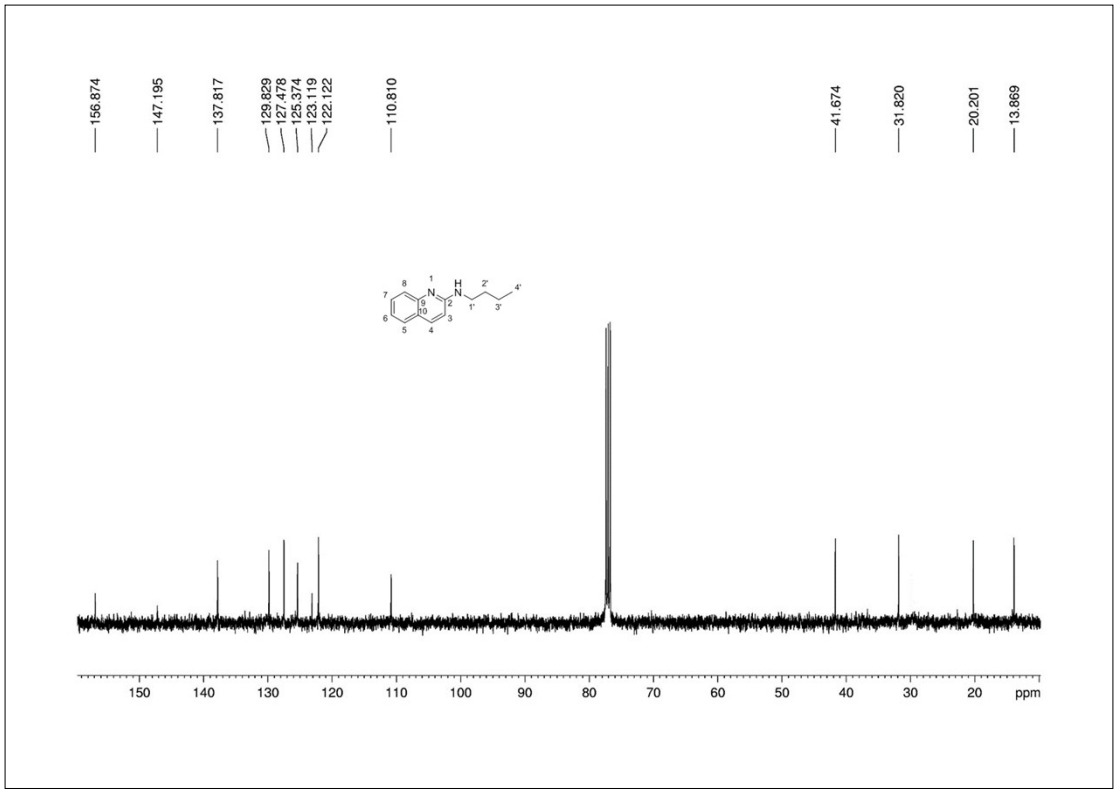


Fig.4 ^{13}C NMR spectrum of compound **3b**

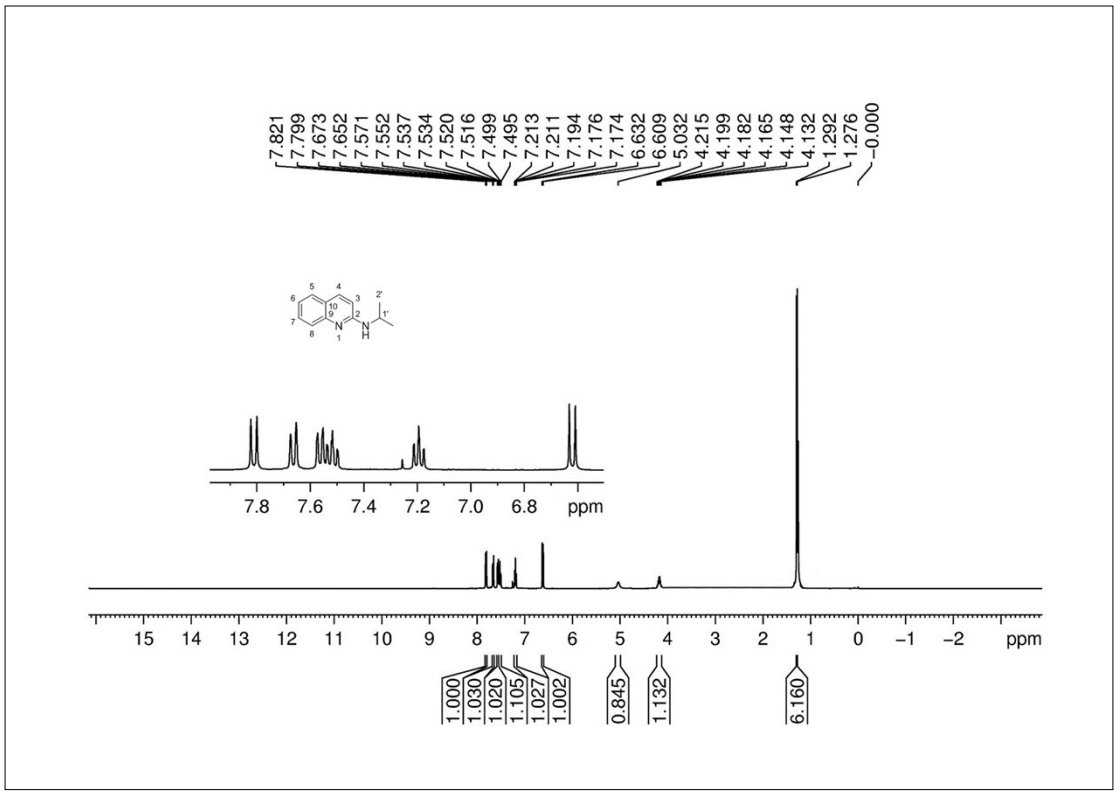


Fig.5 ^{1}H NMR spectrum of compound **3c**

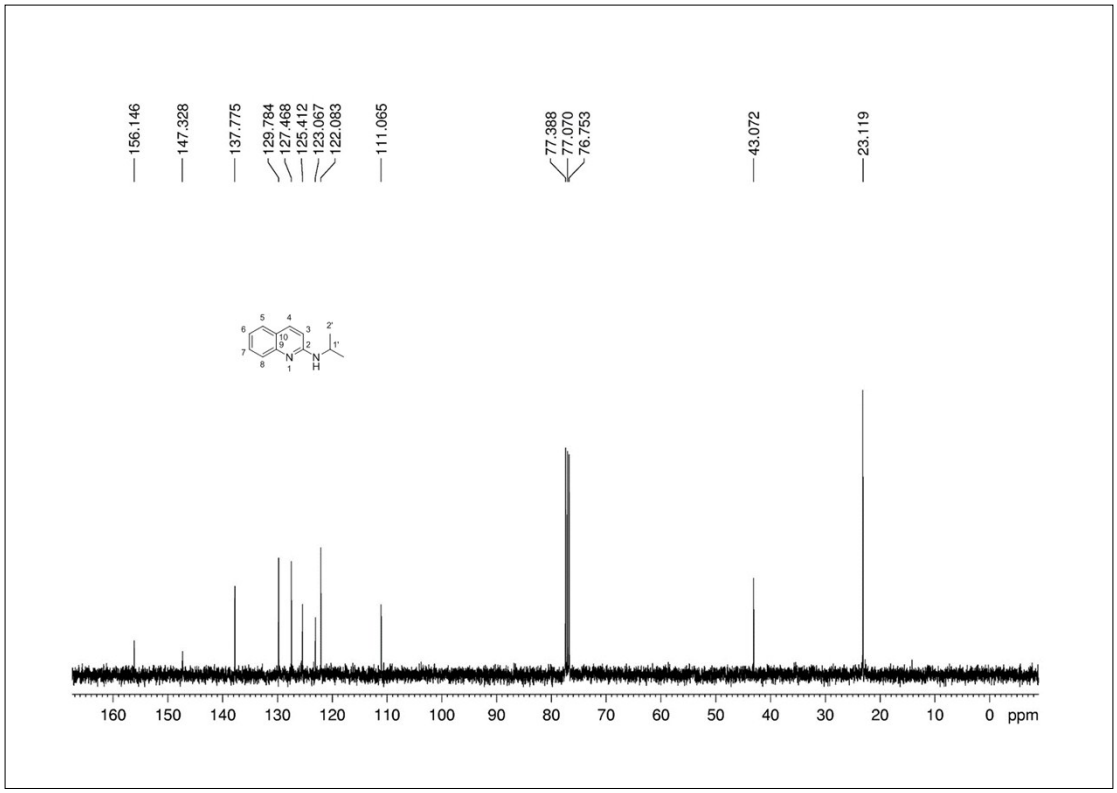


Fig.6 ^{13}C NMR spectrum of compound **3c**

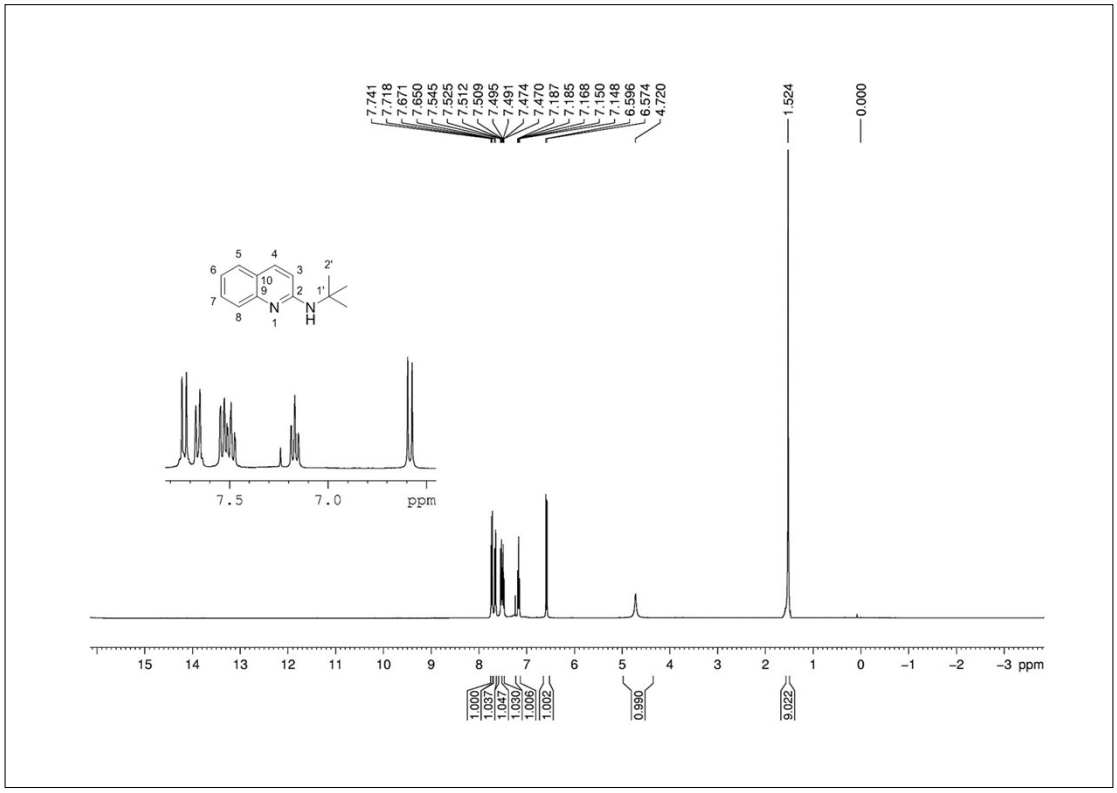


Fig.7 ^{1}H NMR spectrum of compound **3d**

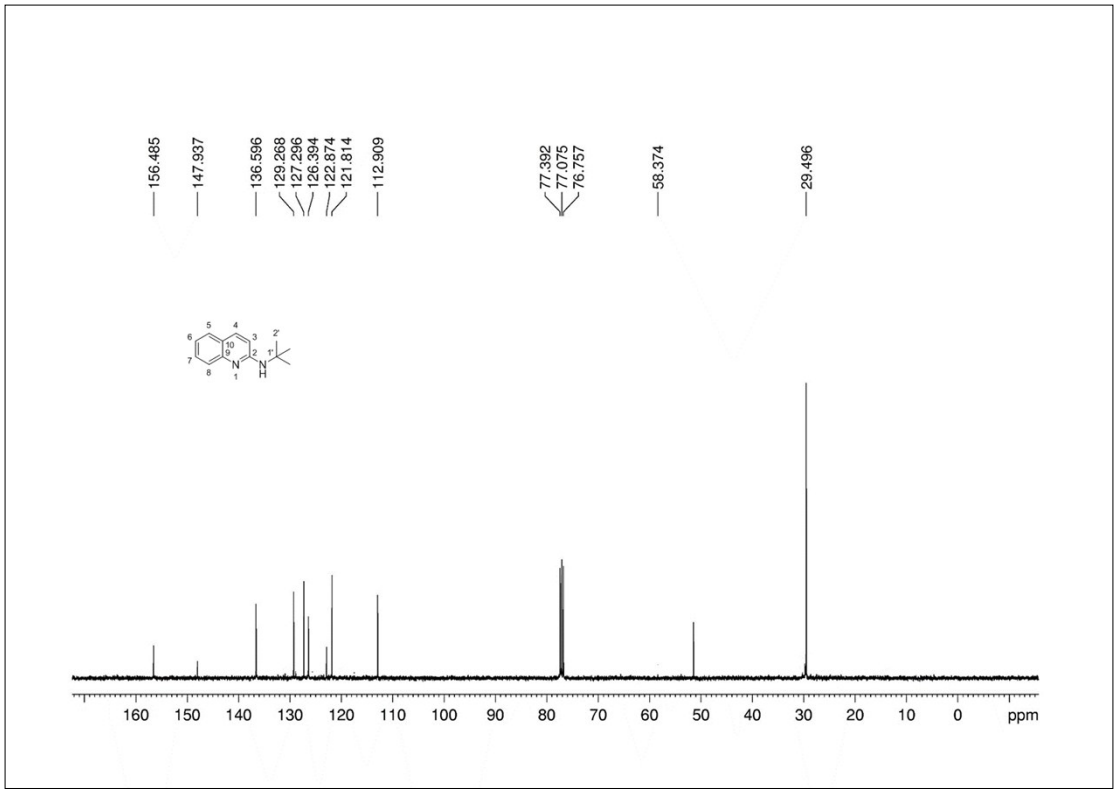


Fig.8 ^{13}C NMR spectrum of compound **3d**

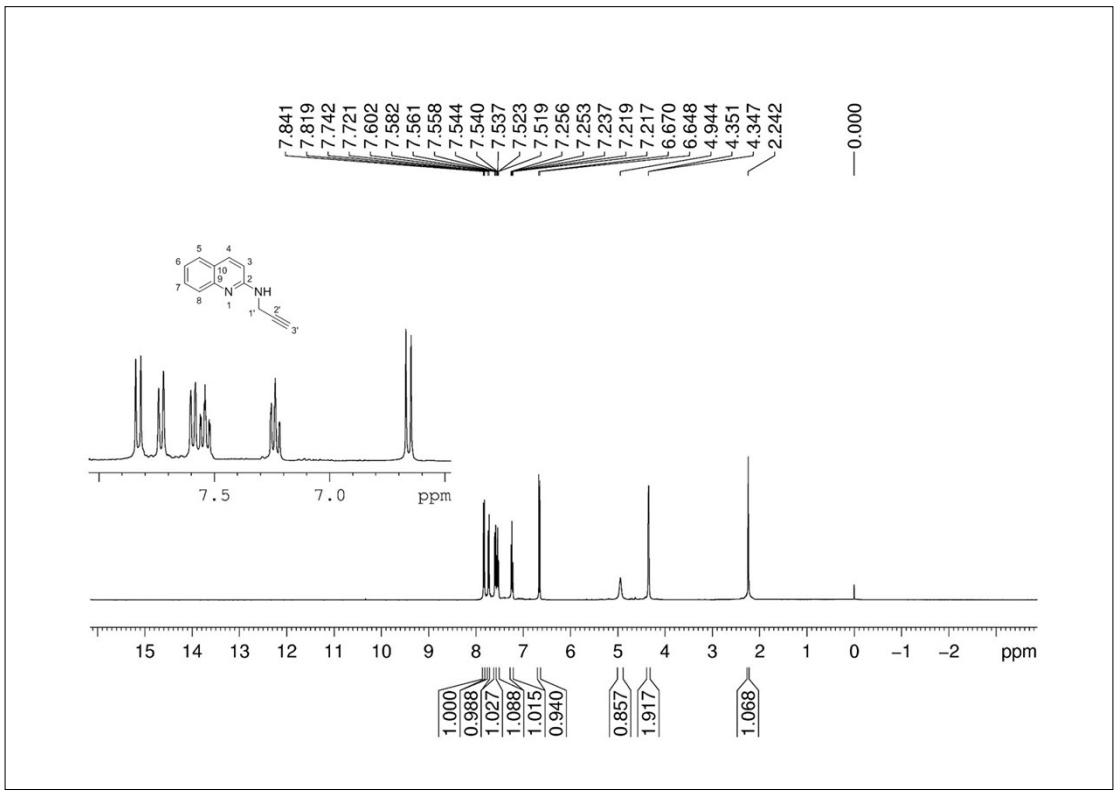


Fig.9 ^{1}H NMR spectrum of compound **3e**

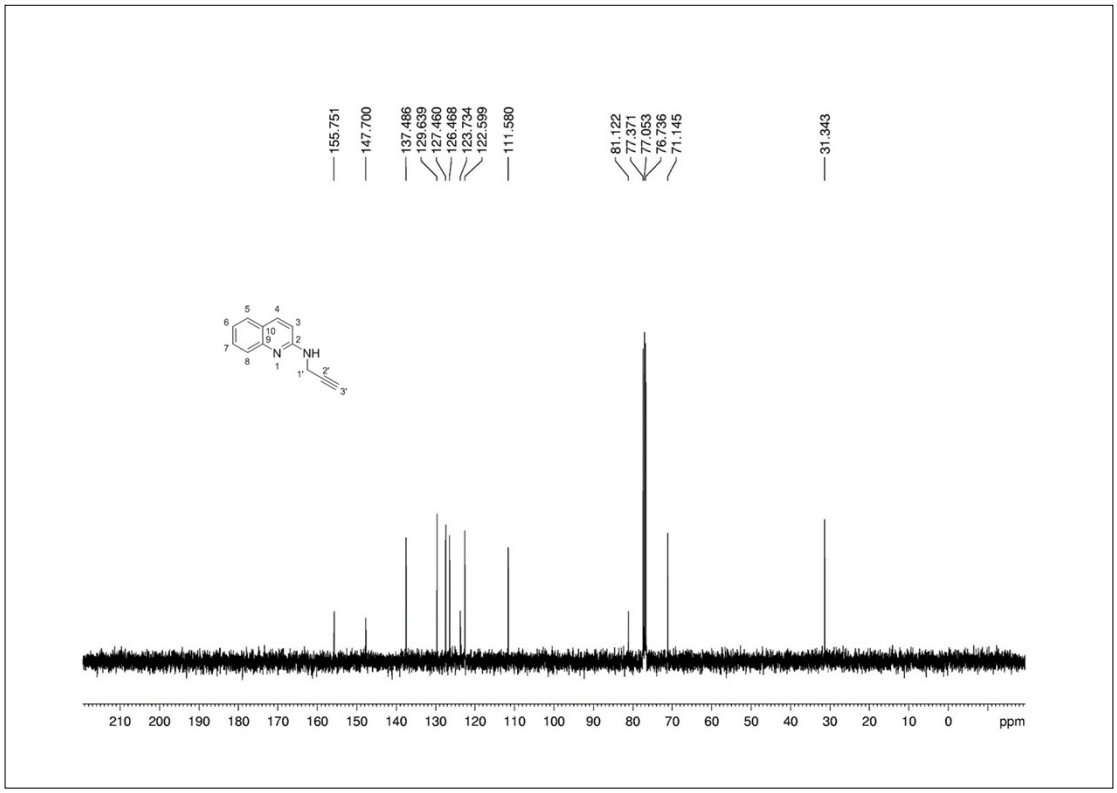


Fig.10 ^{13}C NMR spectrum of compound **3e**

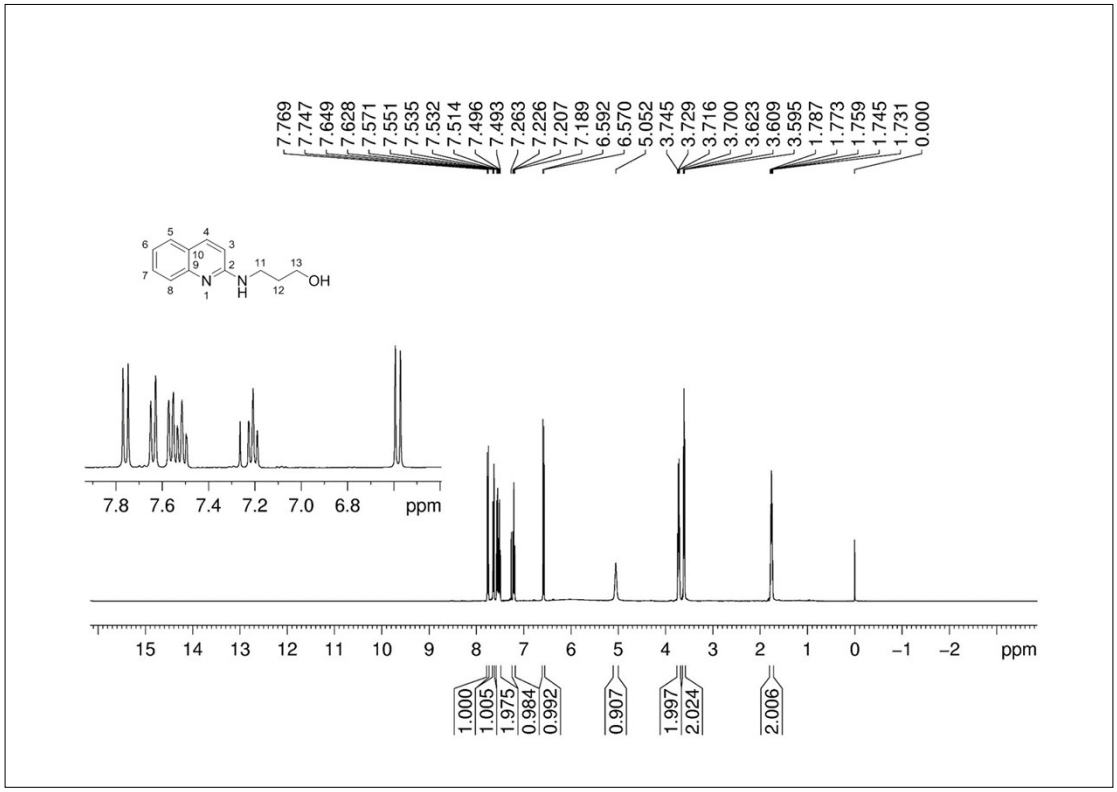


Fig.11 ^{1}H NMR spectrum of compound **3f**

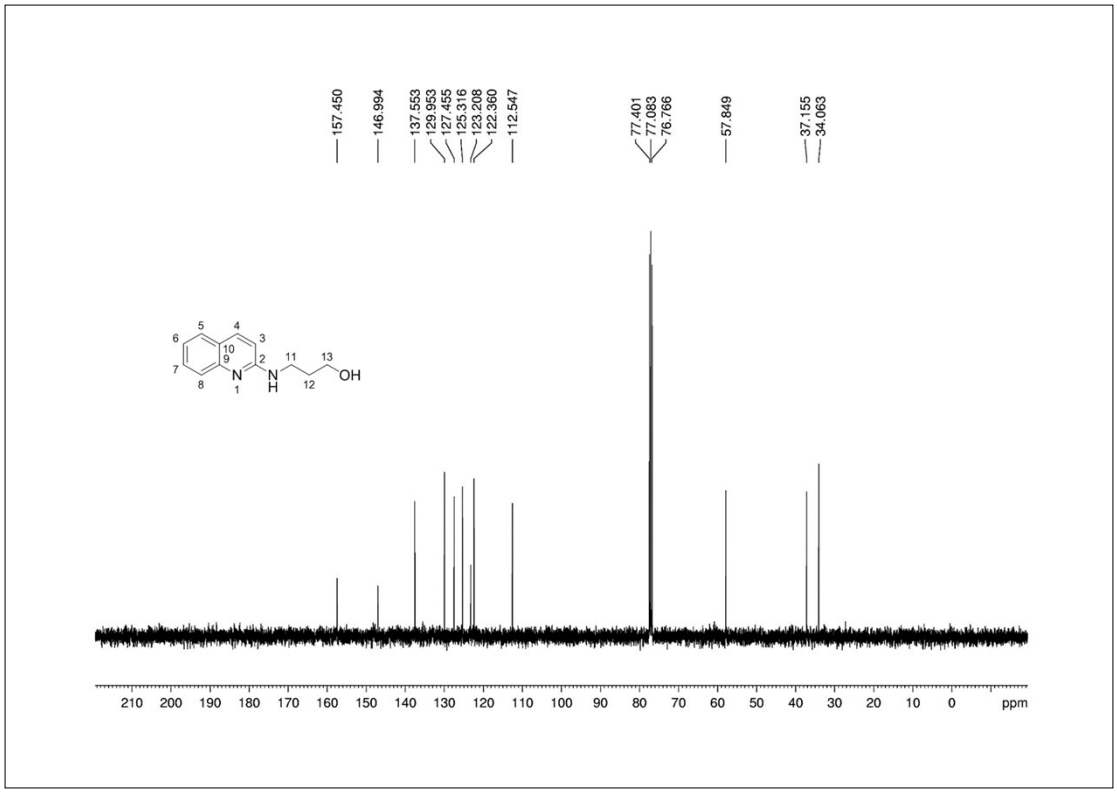


Fig.12 ^{13}C NMR spectrum of compound **3f**

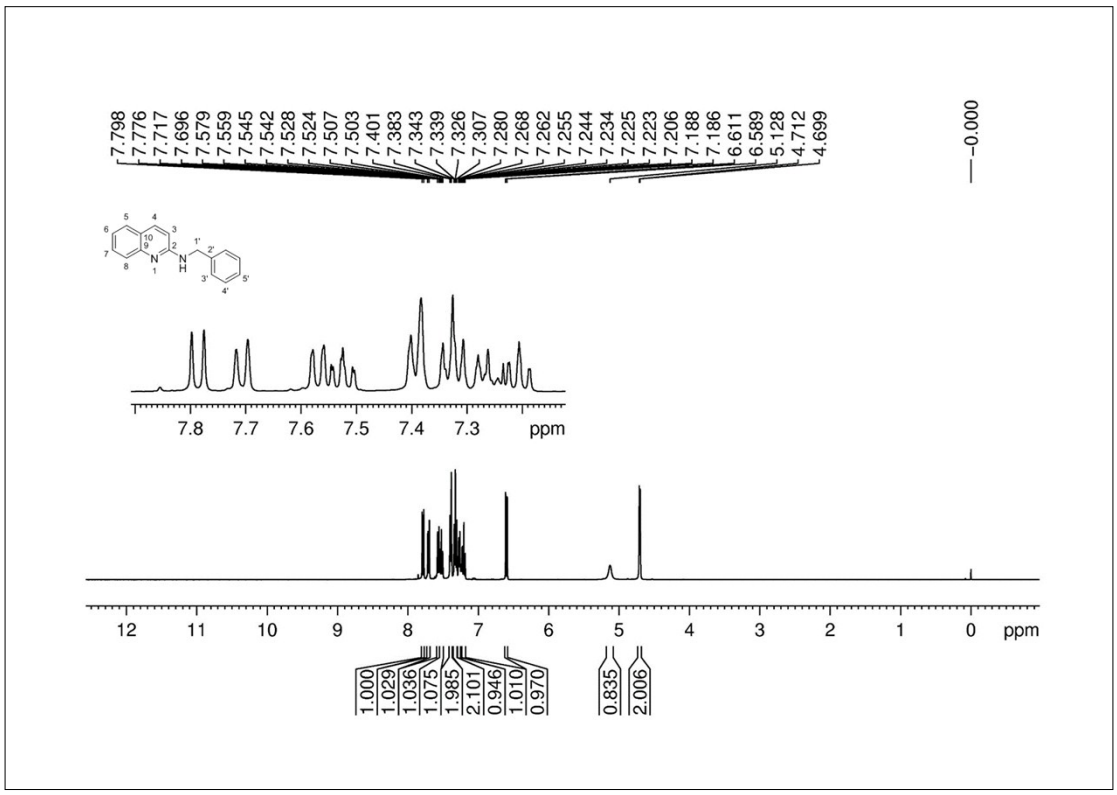


Fig.13 ^{1}H NMR spectrum of compound **3g**

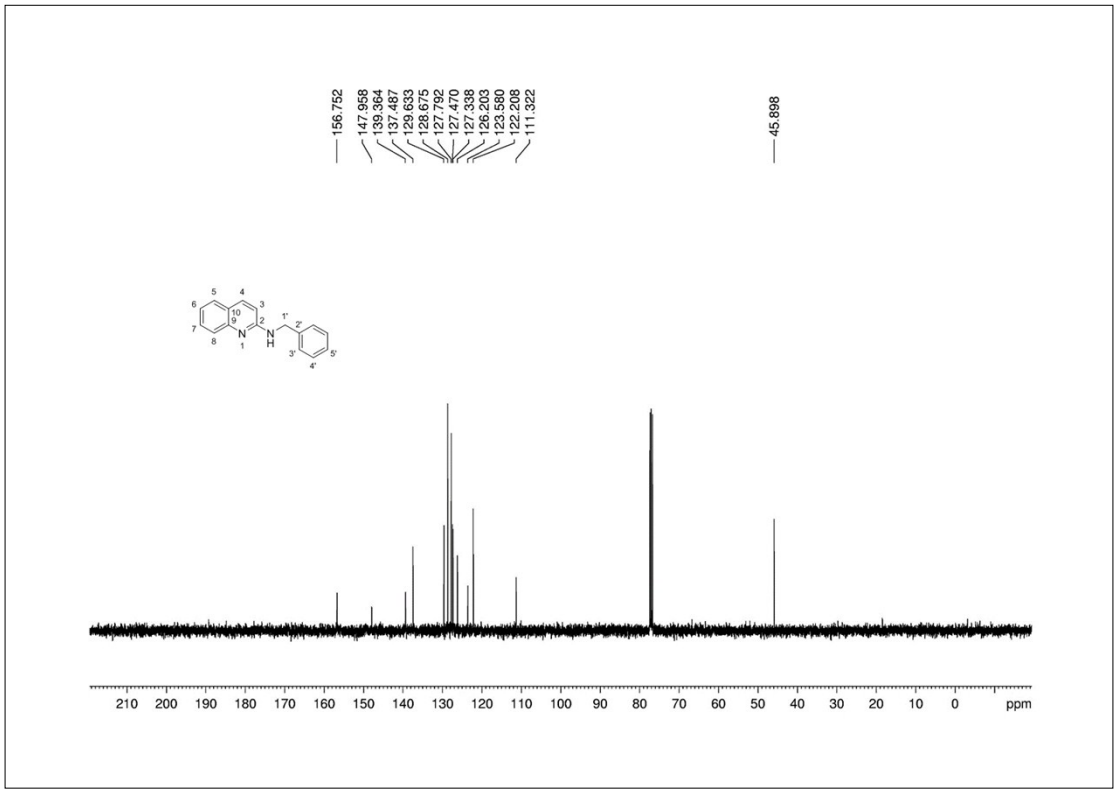


Fig.14 ^{13}C NMR spectrum of compound **3g**

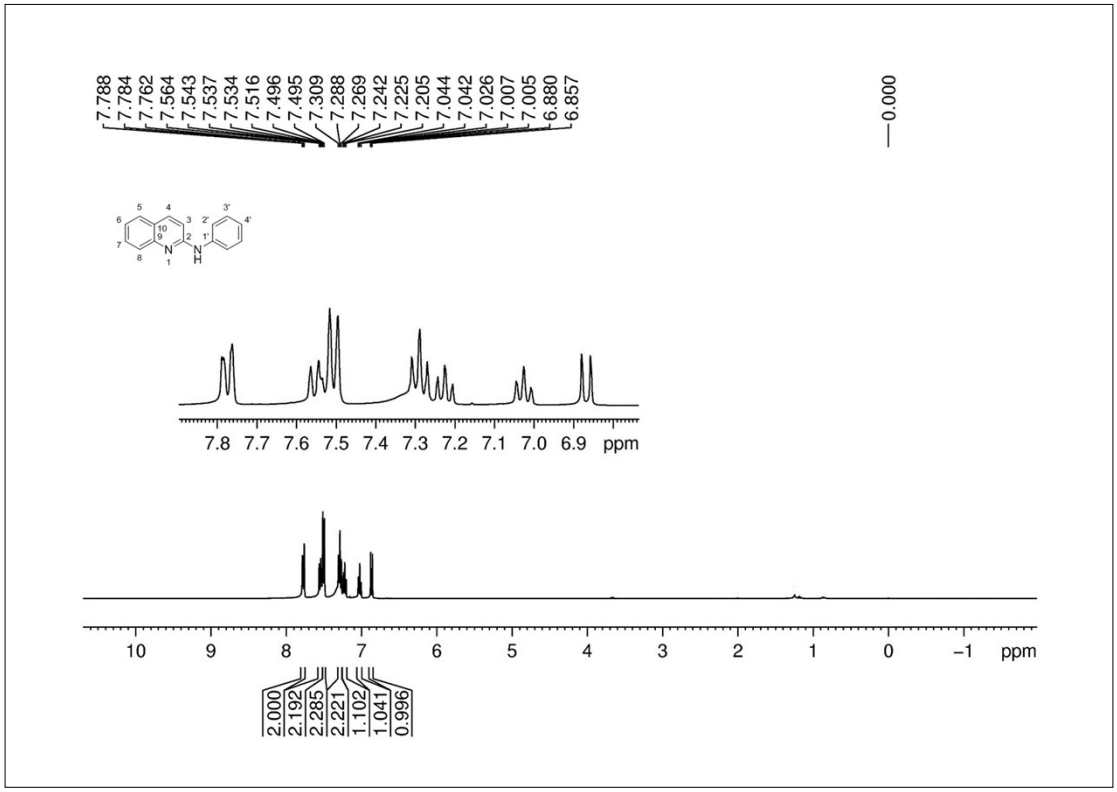


Fig.15 ^{1}H NMR spectrum of compound **3h**

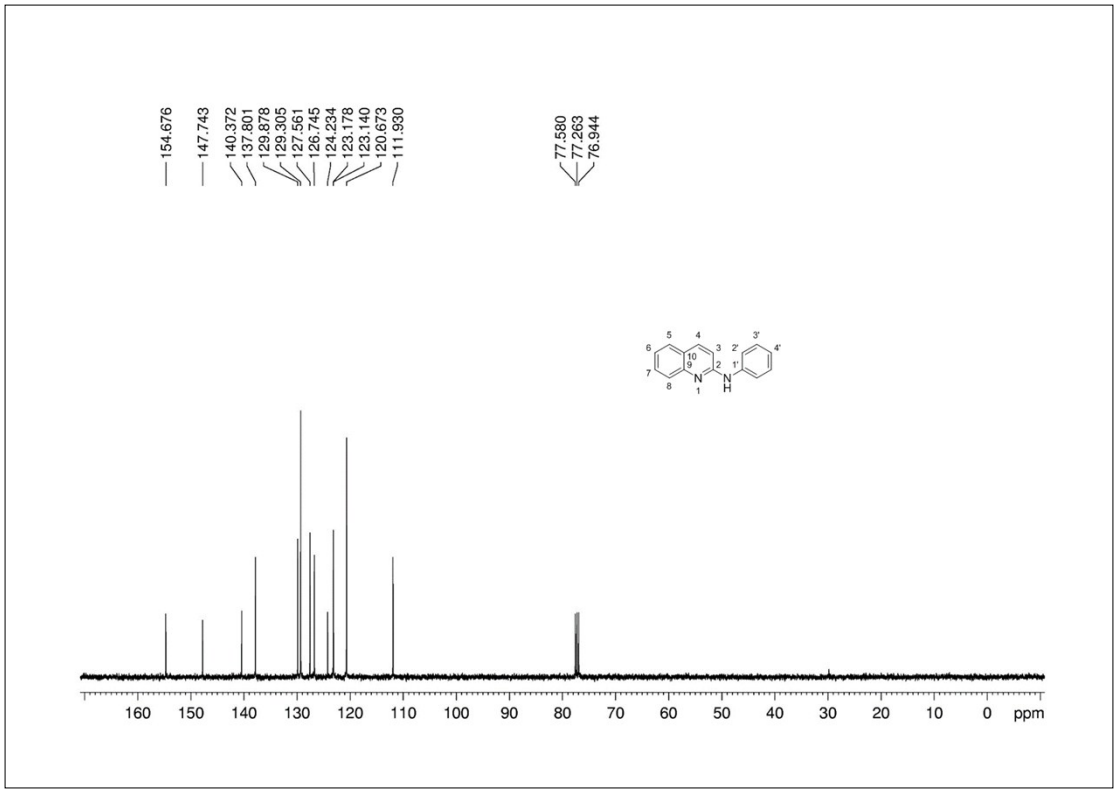


Fig.16 ^{13}C NMR spectrum of compound **3h**

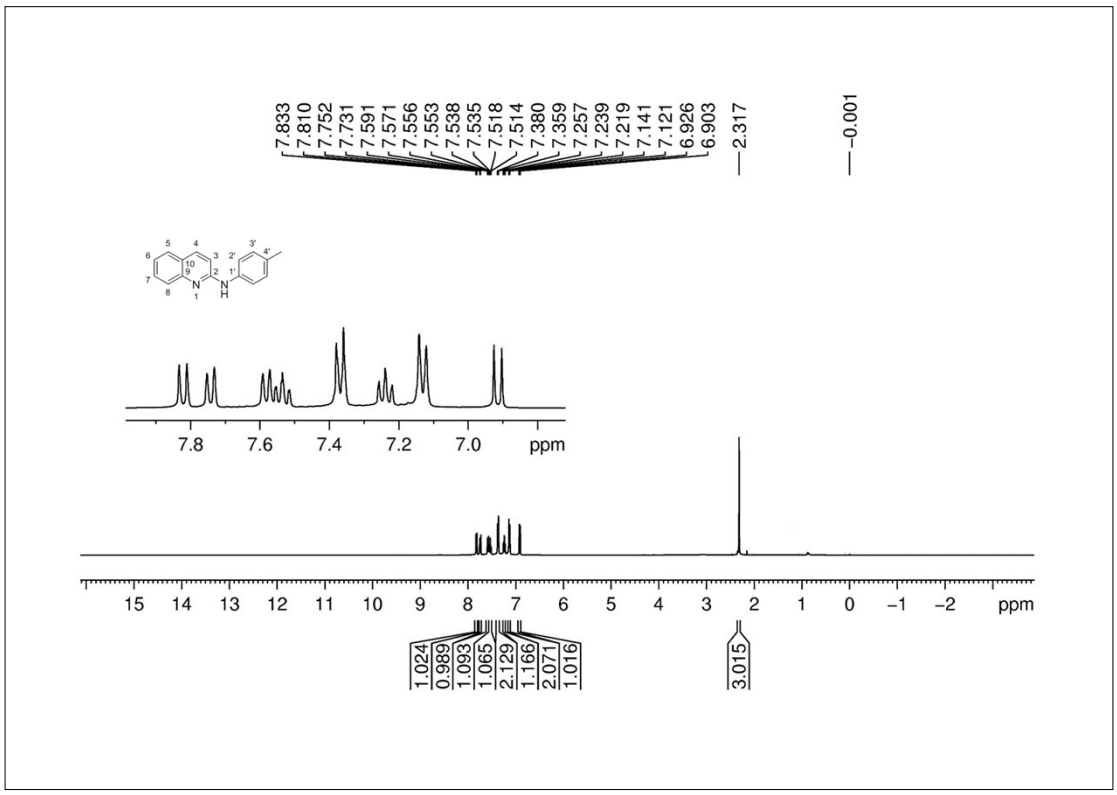


Fig.17 ^{1}H NMR spectrum of compound **3i**

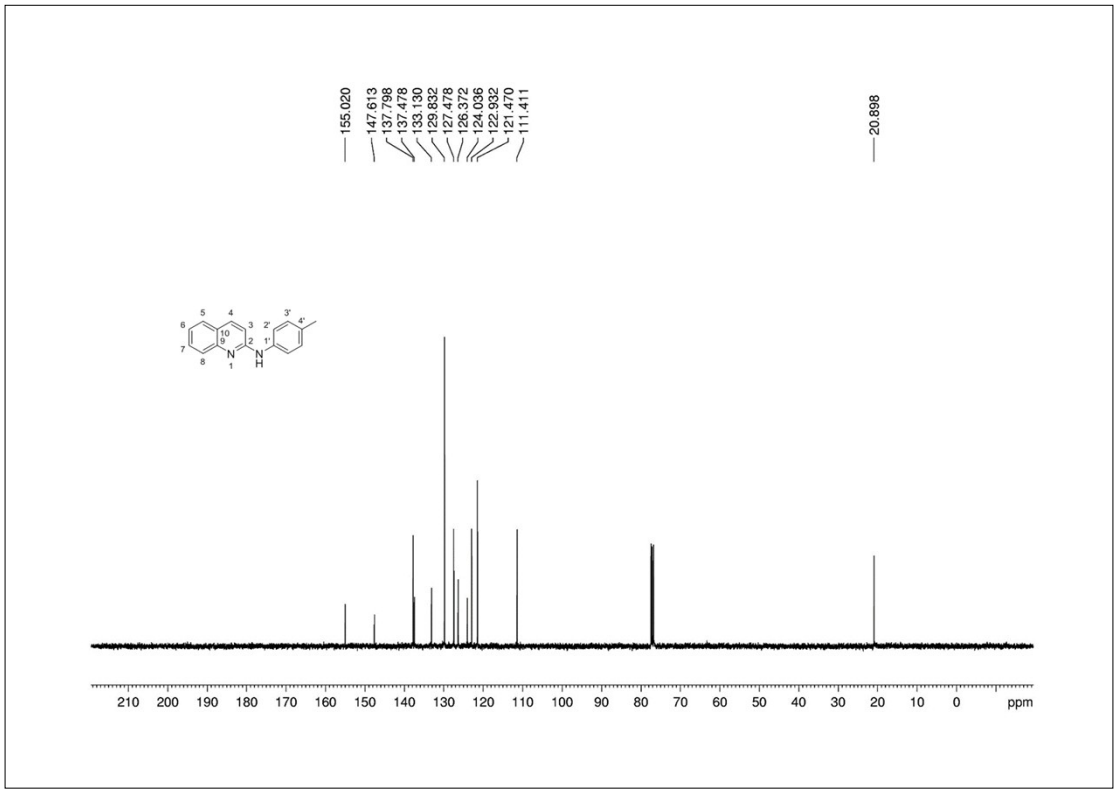


Fig.18 ^{13}C NMR spectrum of compound **3i**

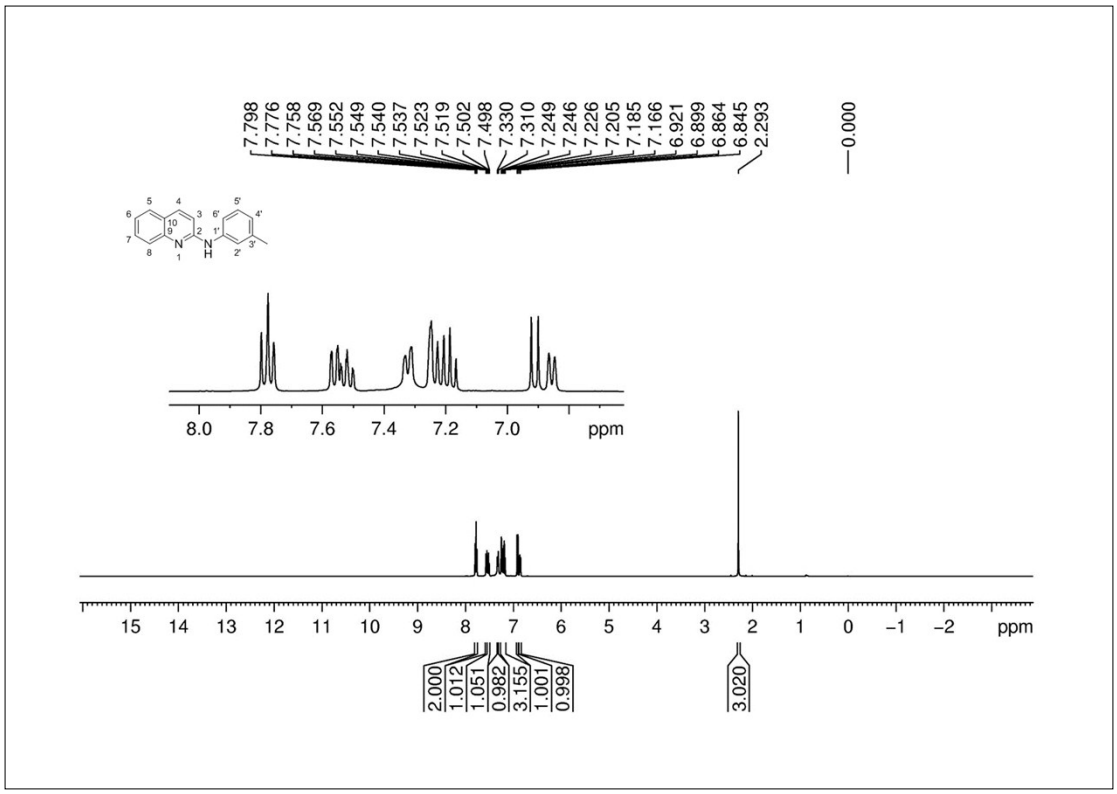


Fig.19 ^{1}H NMR spectrum of compound **3j**

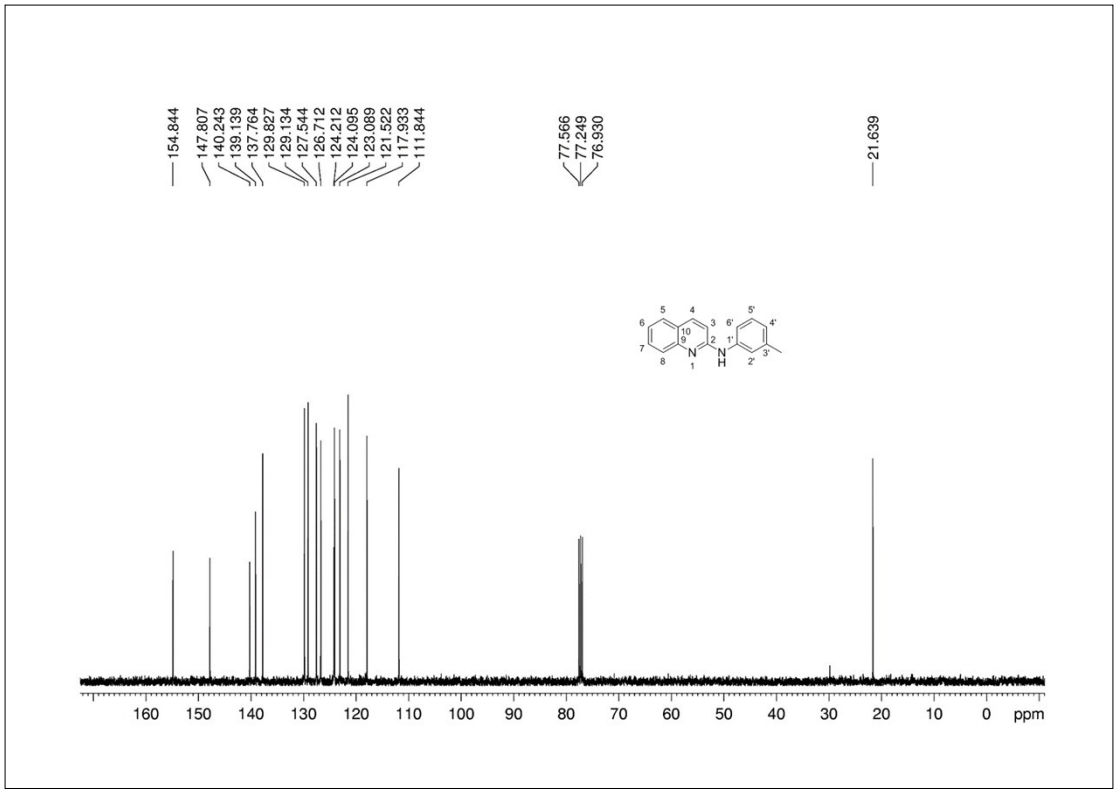


Fig.20 ^{13}C NMR spectrum of compound **3j**

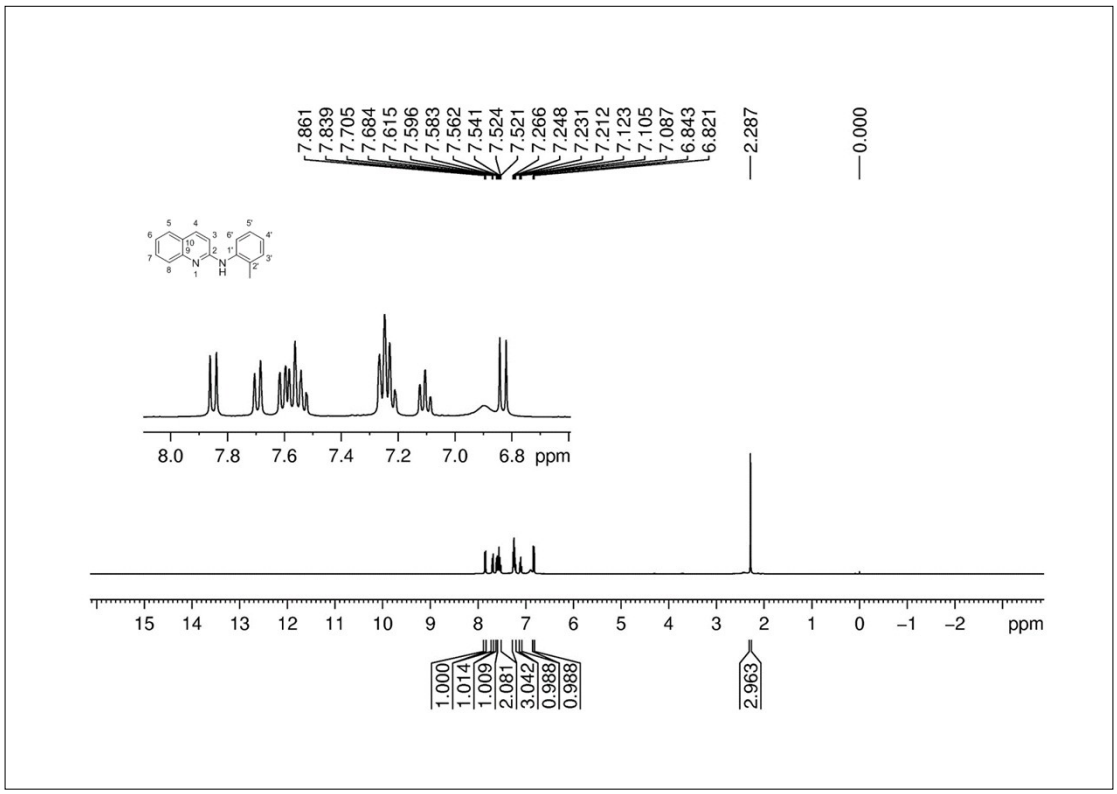


Fig.21 ^{1}H NMR spectrum of compound **3k**

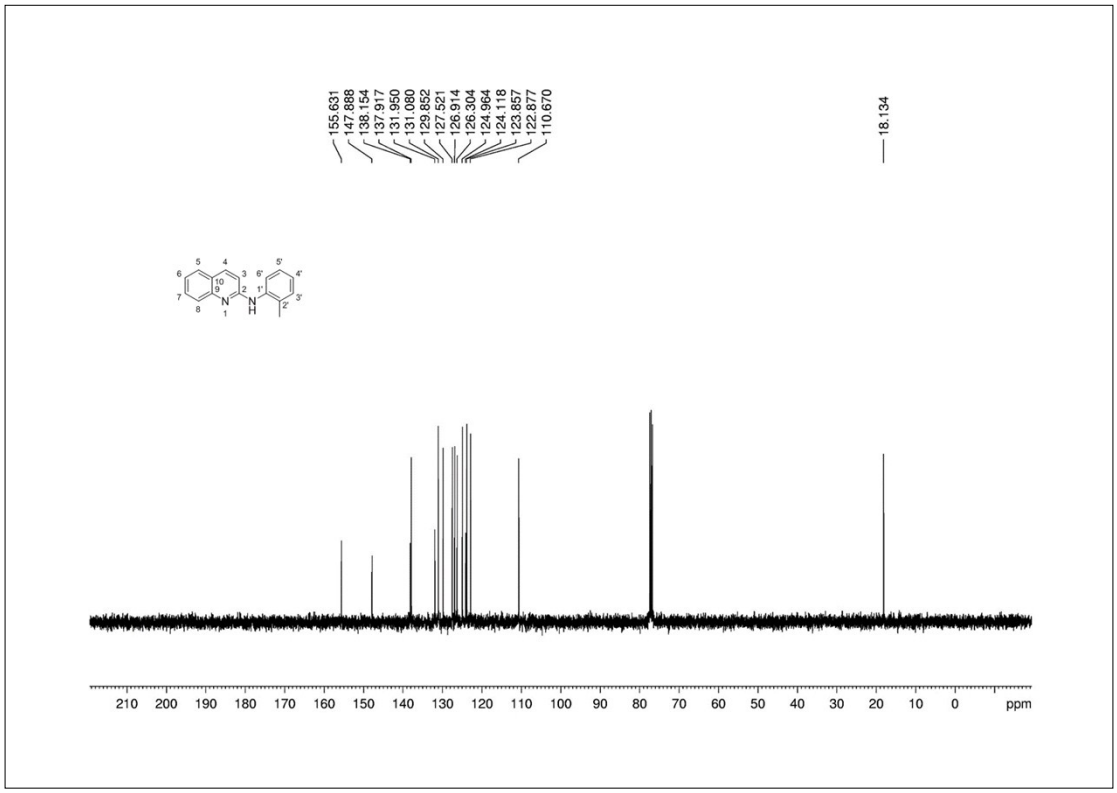


Fig.22 ^{13}C NMR spectrum of compound **3k**

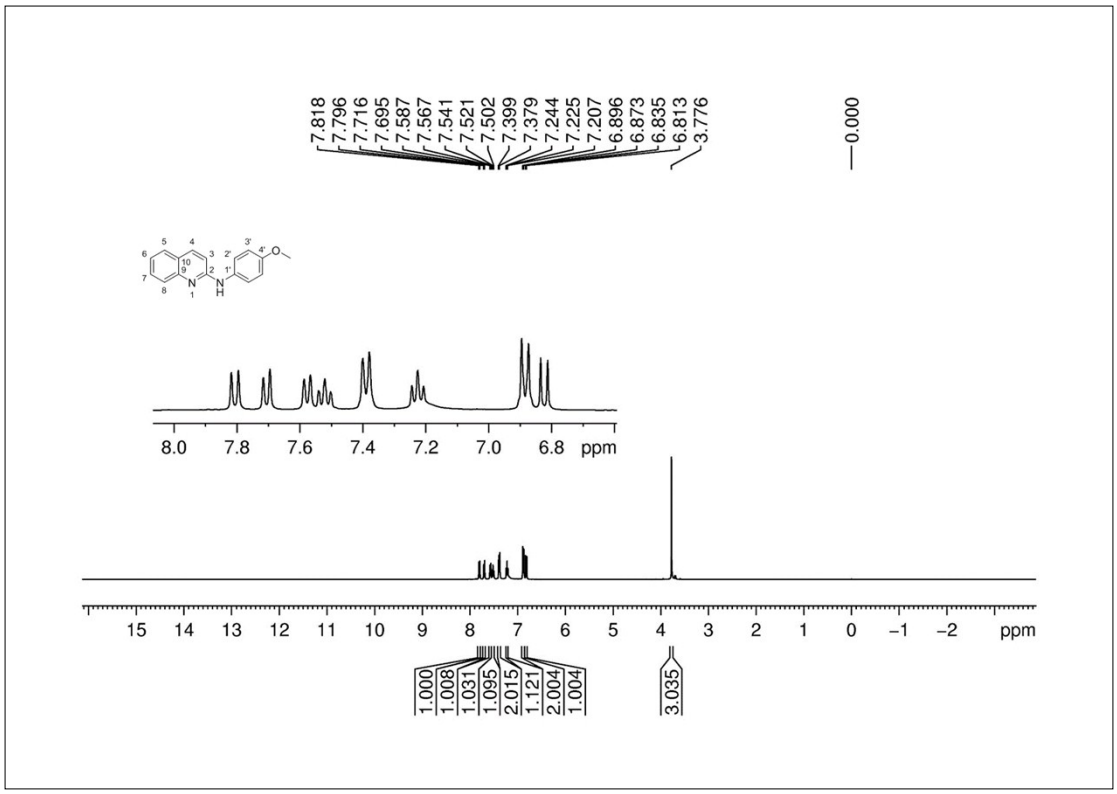


Fig.23 ^{1}H NMR spectrum of compound **3l**

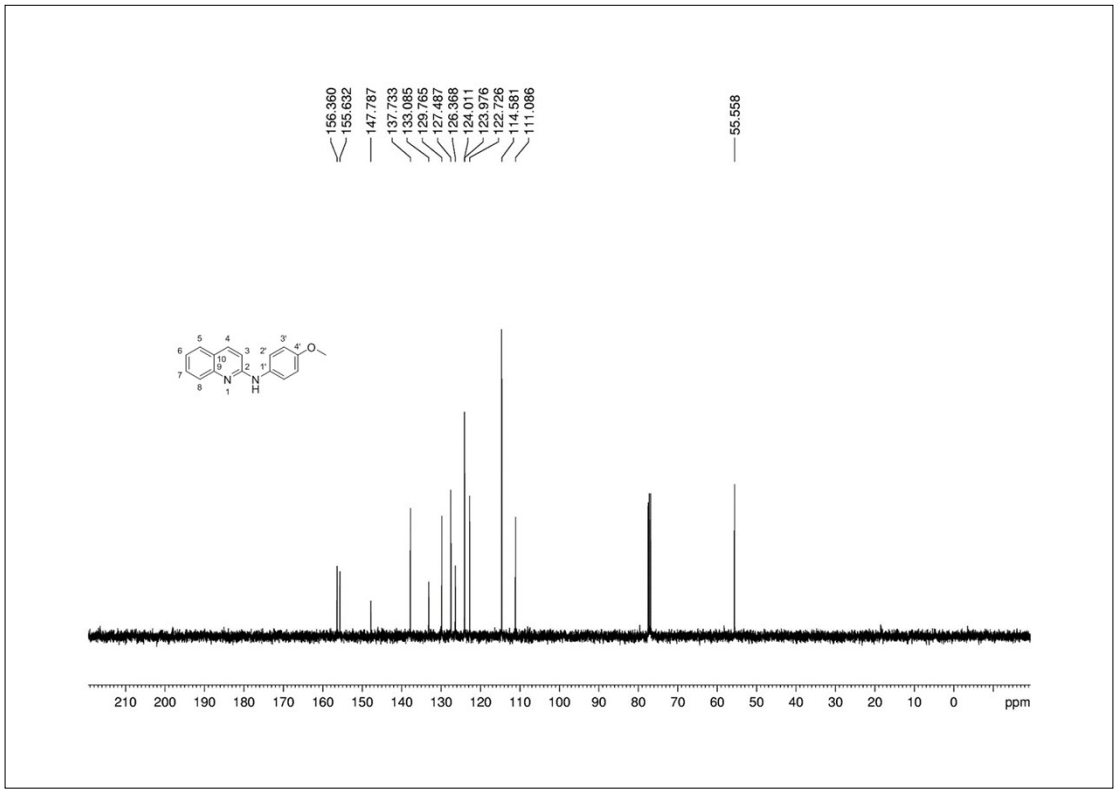


Fig.24 ^{13}C NMR spectrum of compound **3l**

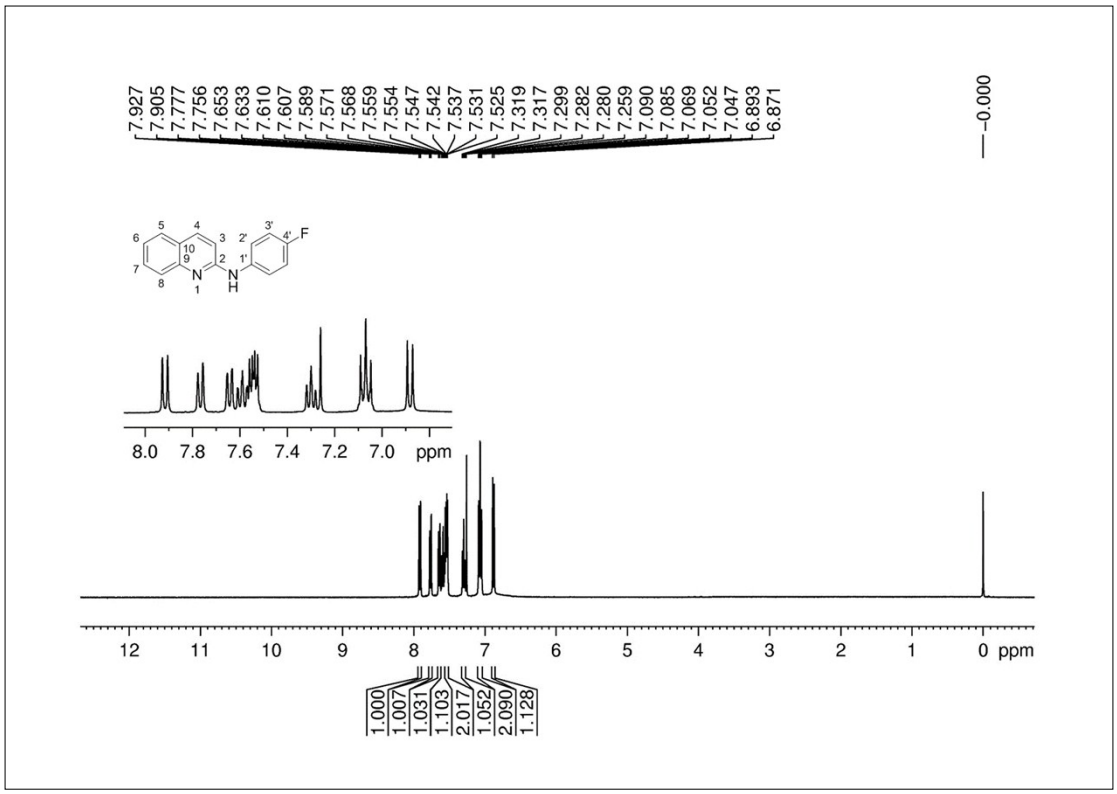


Fig.25 ^{1}H NMR spectrum of compound **3m**

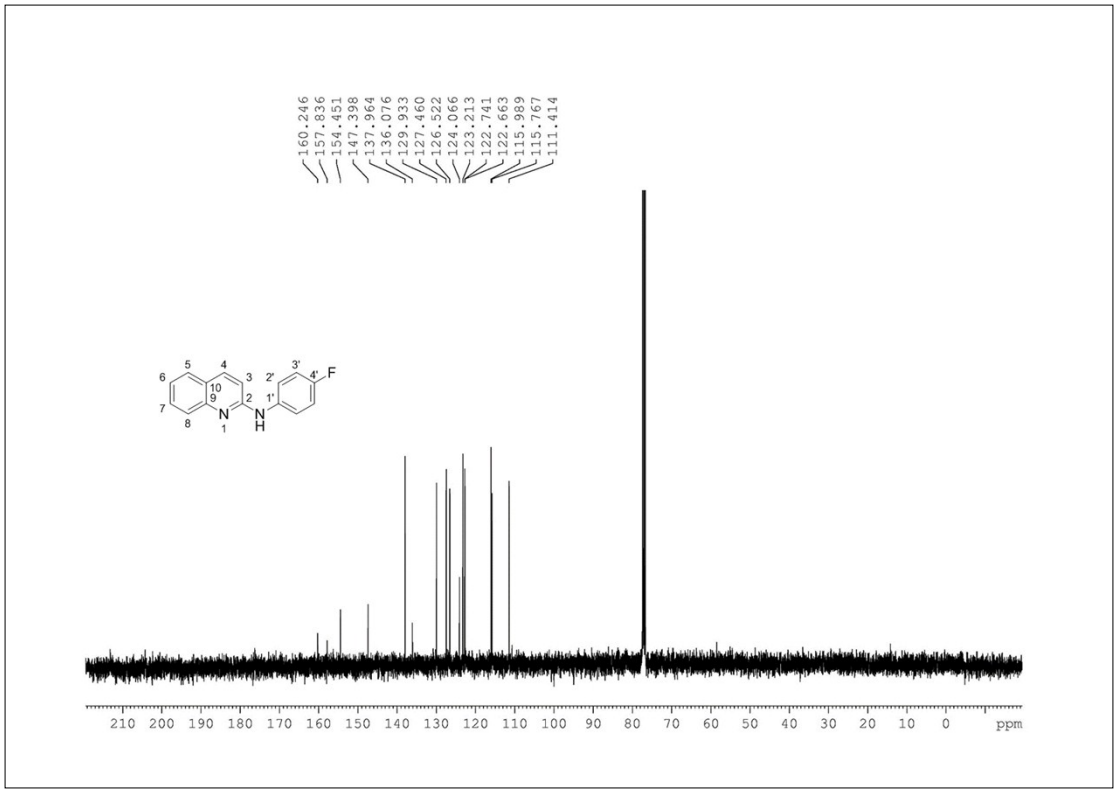


Fig.26 ^{13}C NMR spectrum of compound **3m**

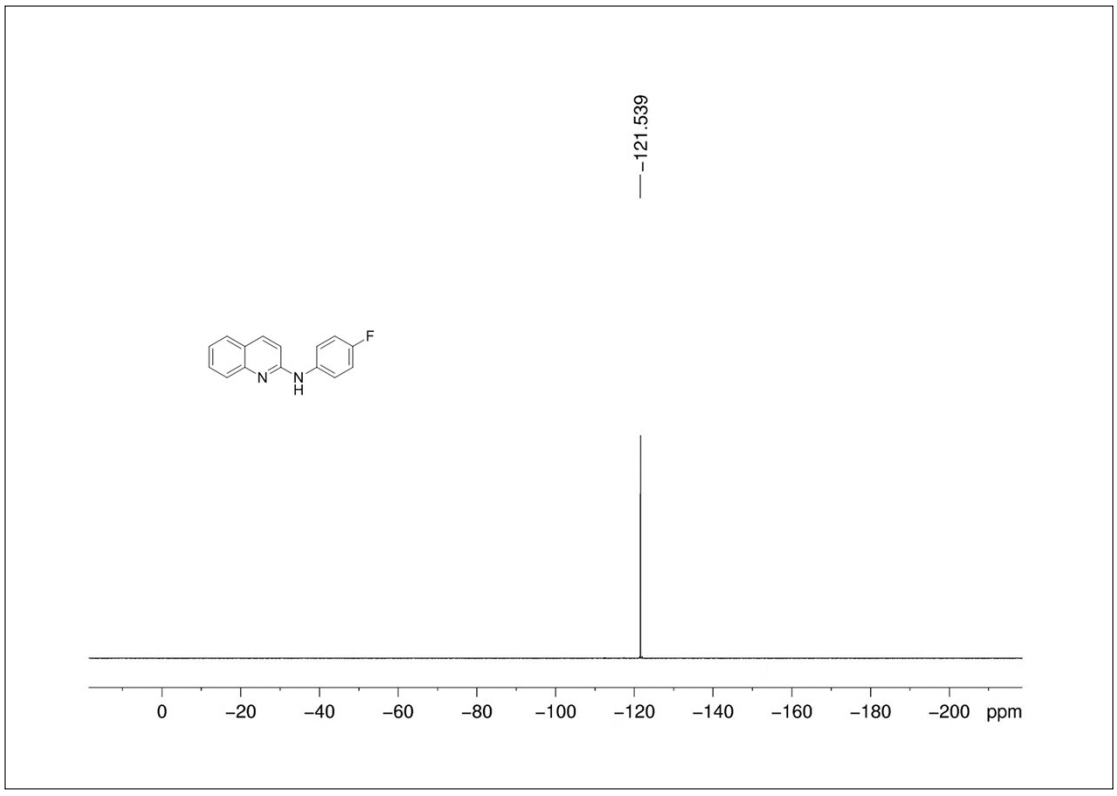


Fig.27 ^{19}F NMR spectrum of compound **3m**

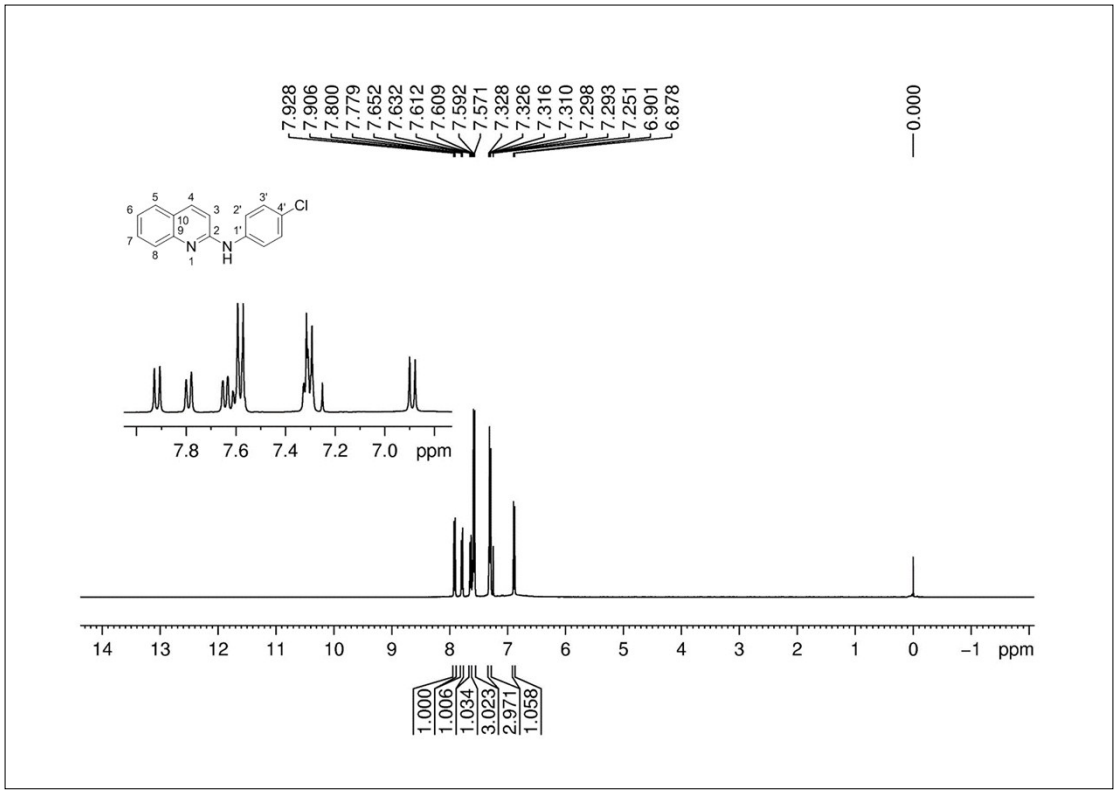


Fig.28 ^{1}H NMR spectrum of compound **3n**

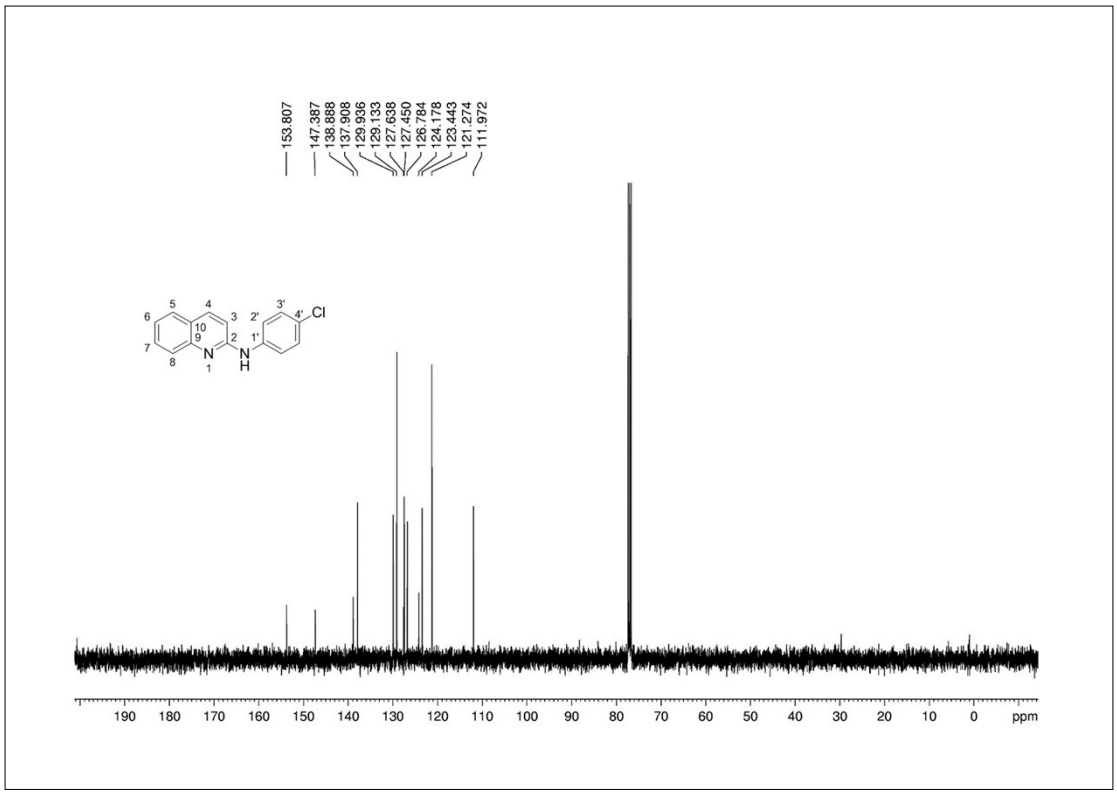


Fig.29 ^{13}C NMR spectrum of compound **3n**

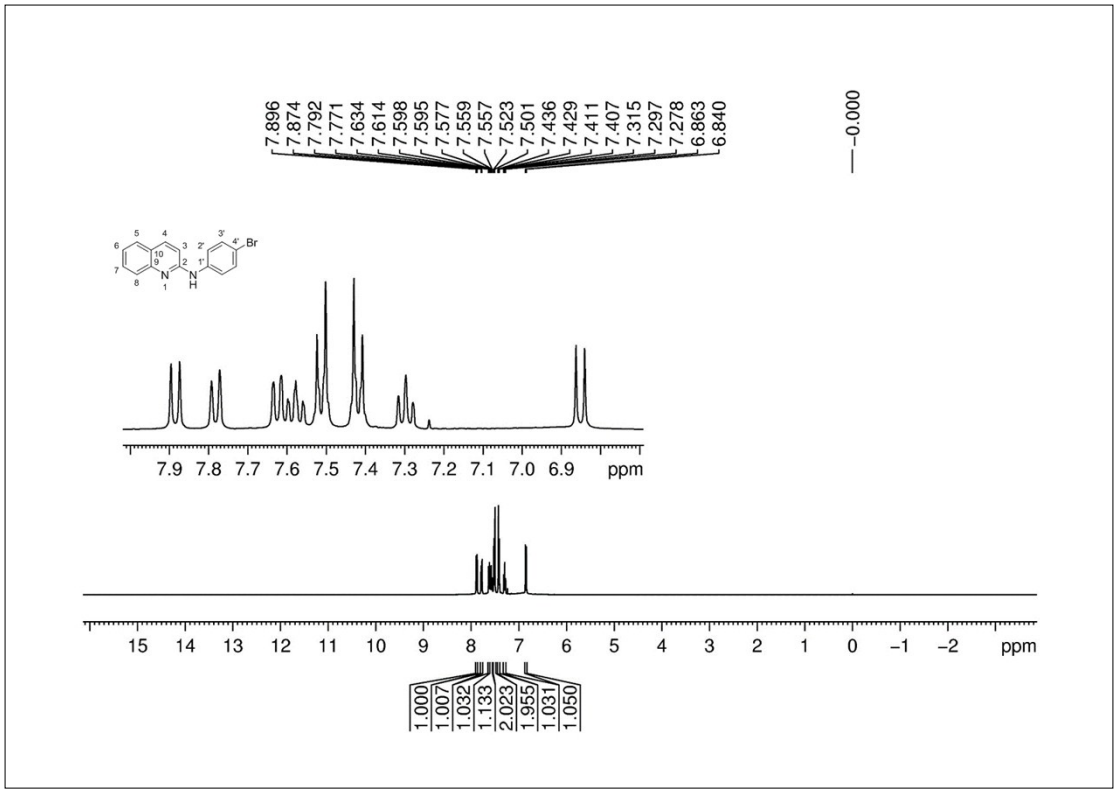


Fig.30 ^{1}H NMR spectrum of compound **3o**

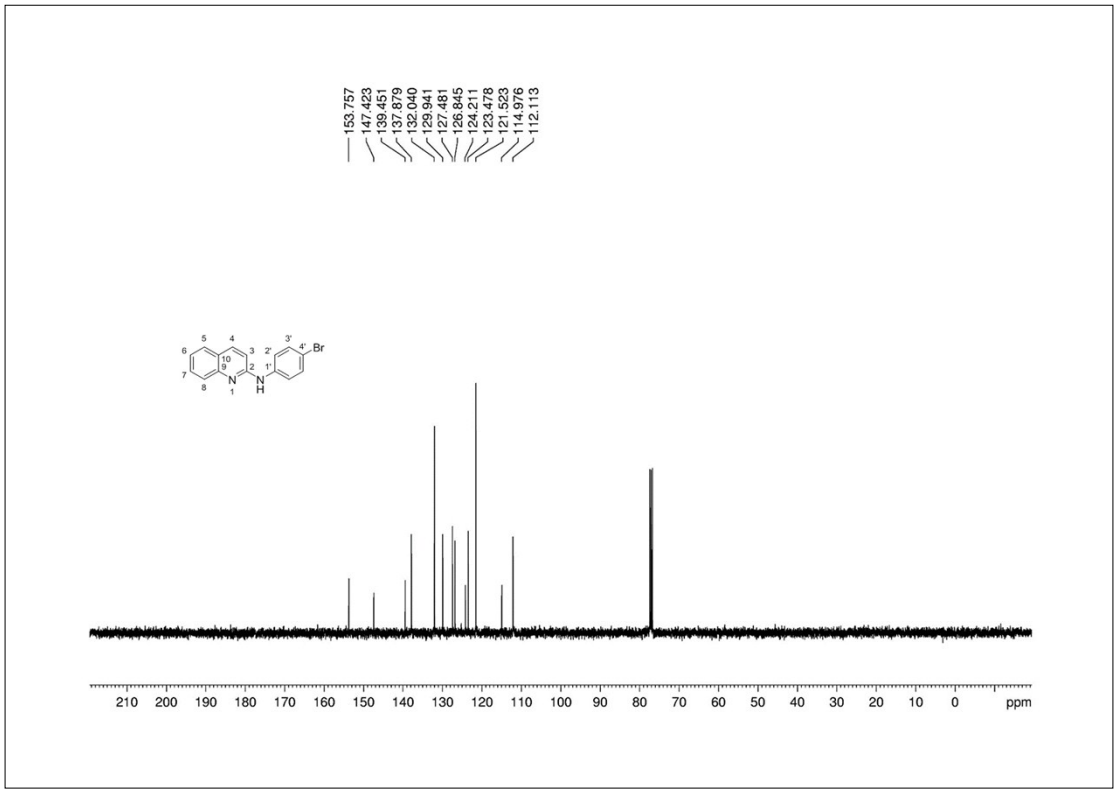


Fig.31 ^{13}C NMR spectrum of compound **3o**

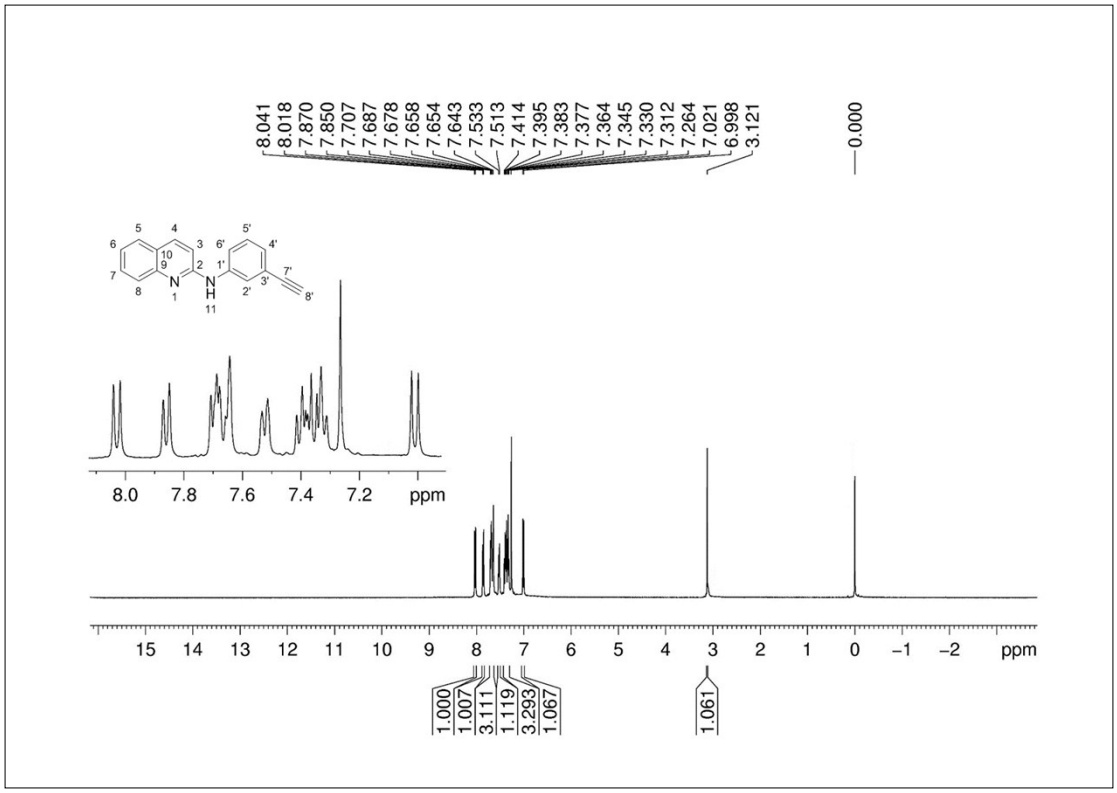


Fig.32 ^{1}H NMR spectrum of compound **3p**

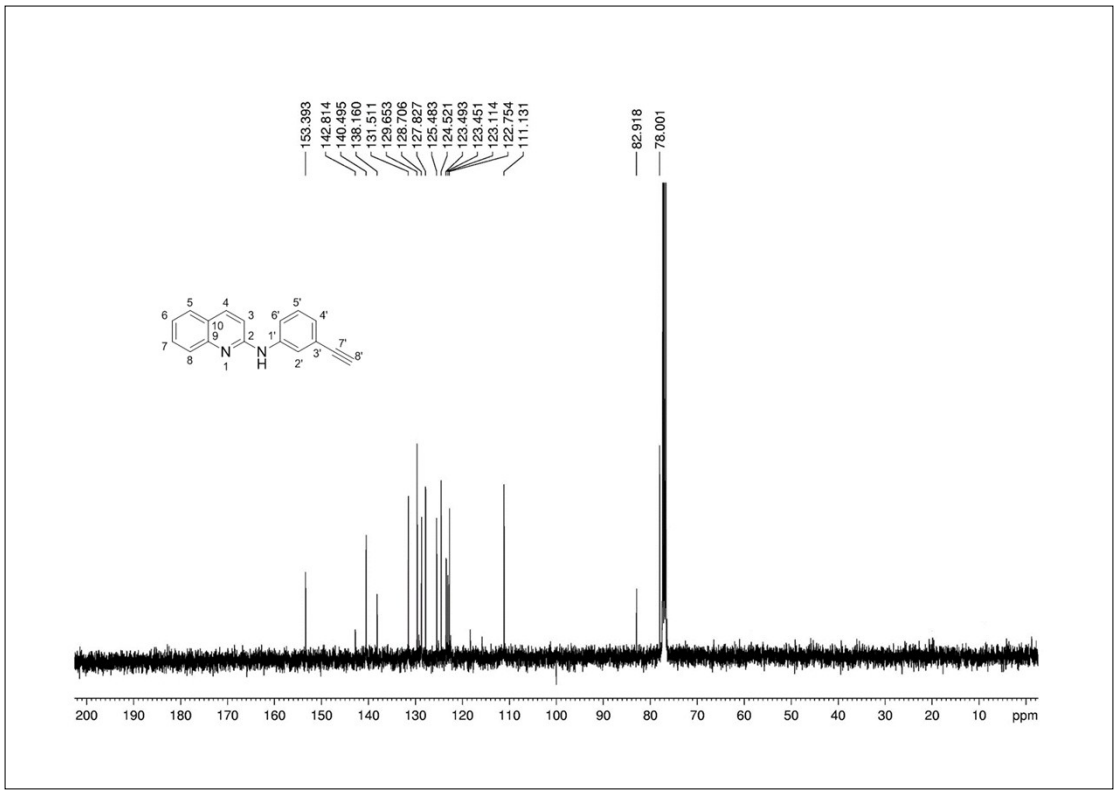


Fig.33 ^{13}C NMR spectrum of compound **3p**

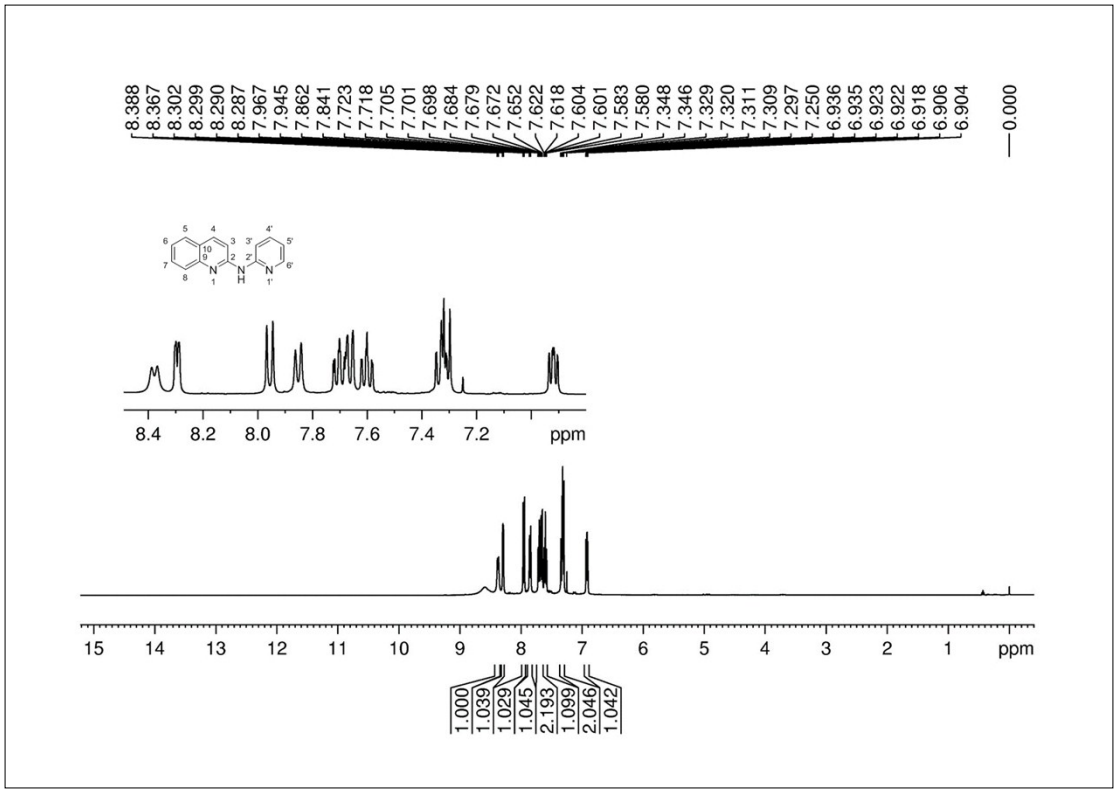


Fig.34 ^{1}H NMR spectrum of compound **3q**

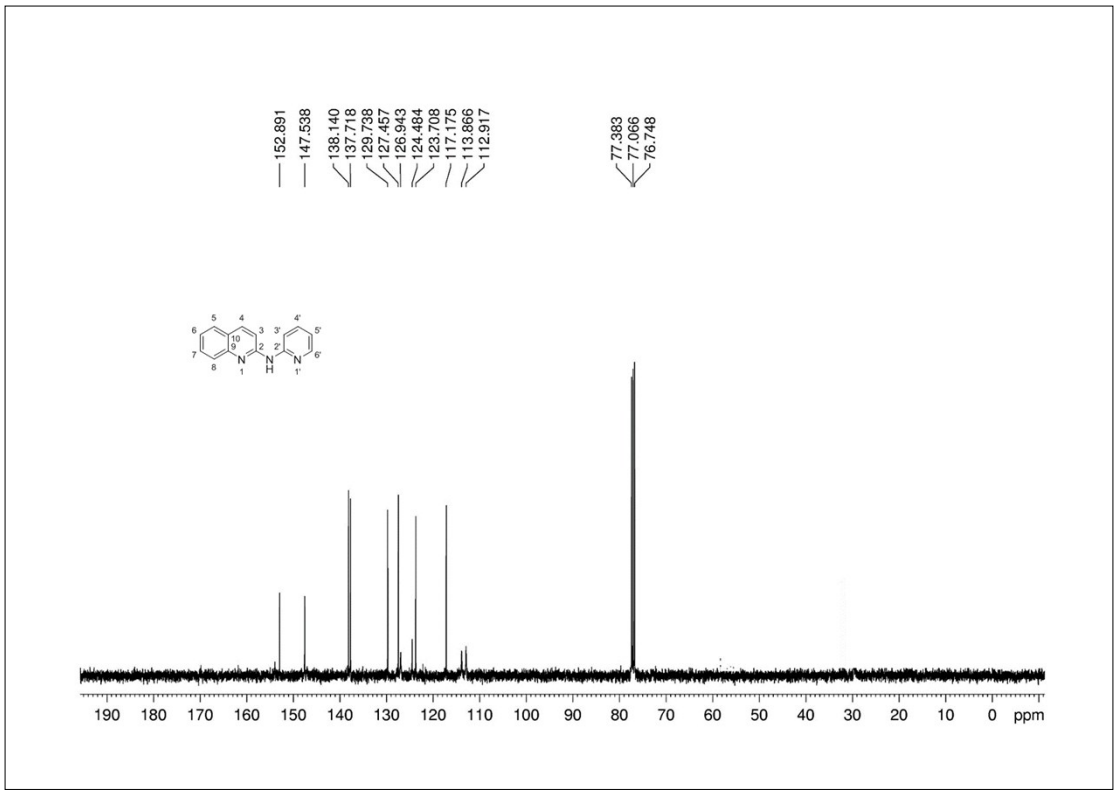


Fig.35 ^{13}C NMR spectrum of compound **3q**

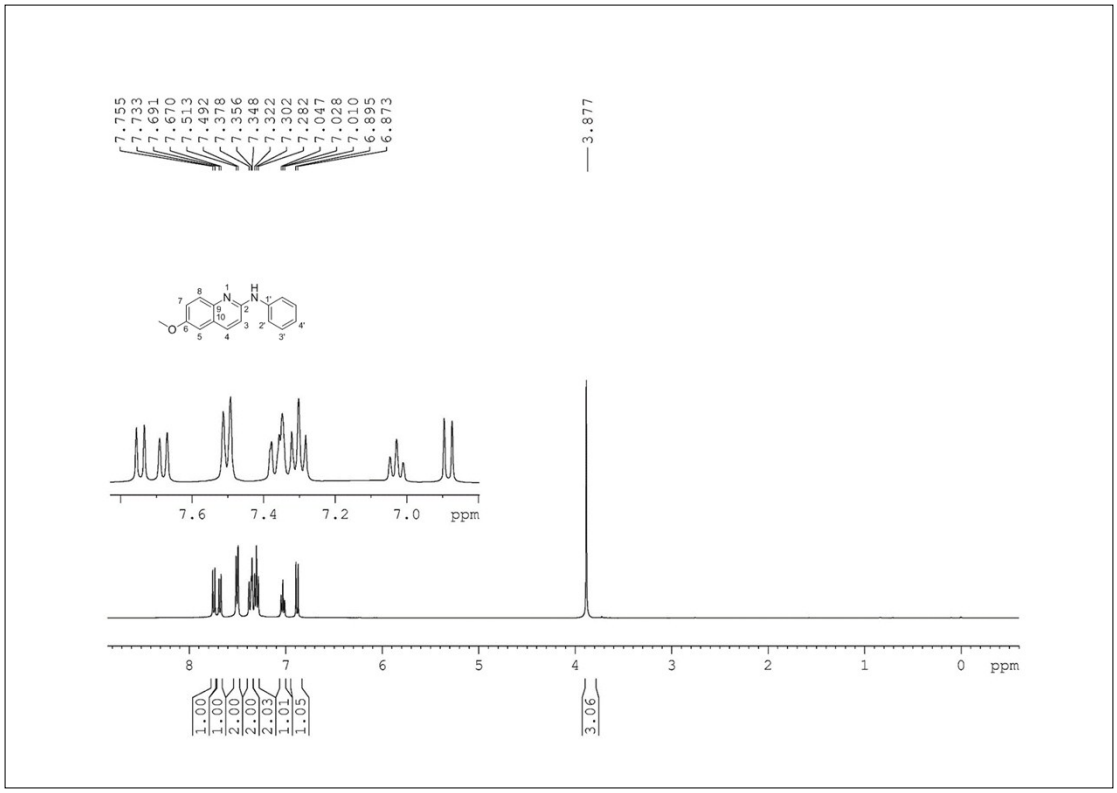


Fig.36 ^{1}H NMR spectrum of compound **3r**

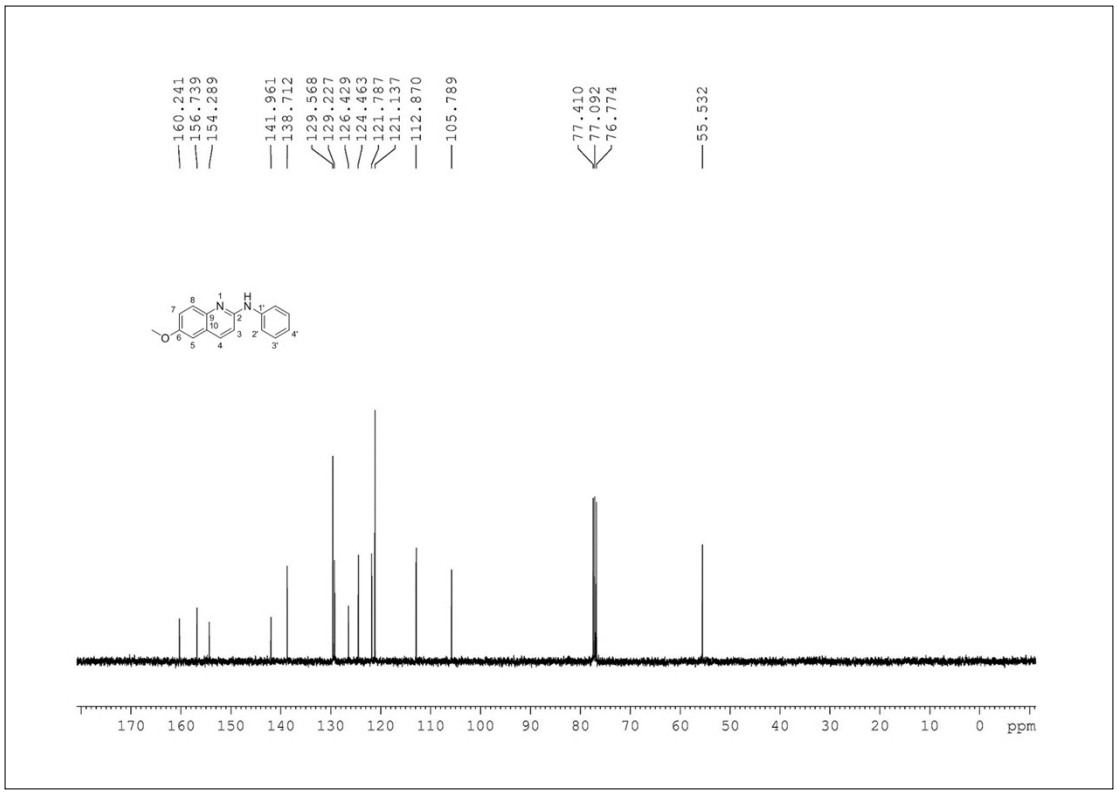


Fig.37 ^{13}C NMR spectrum of compound **3r**

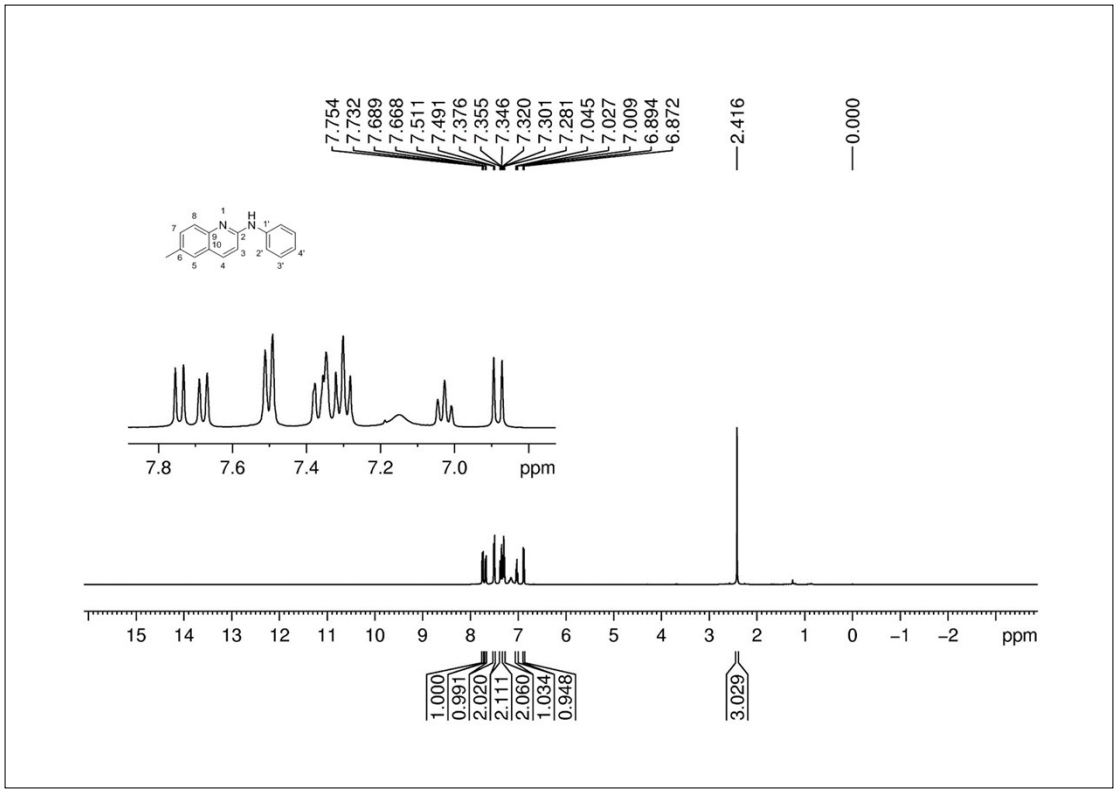


Fig.38 ^{1}H NMR spectrum of compound **3s**

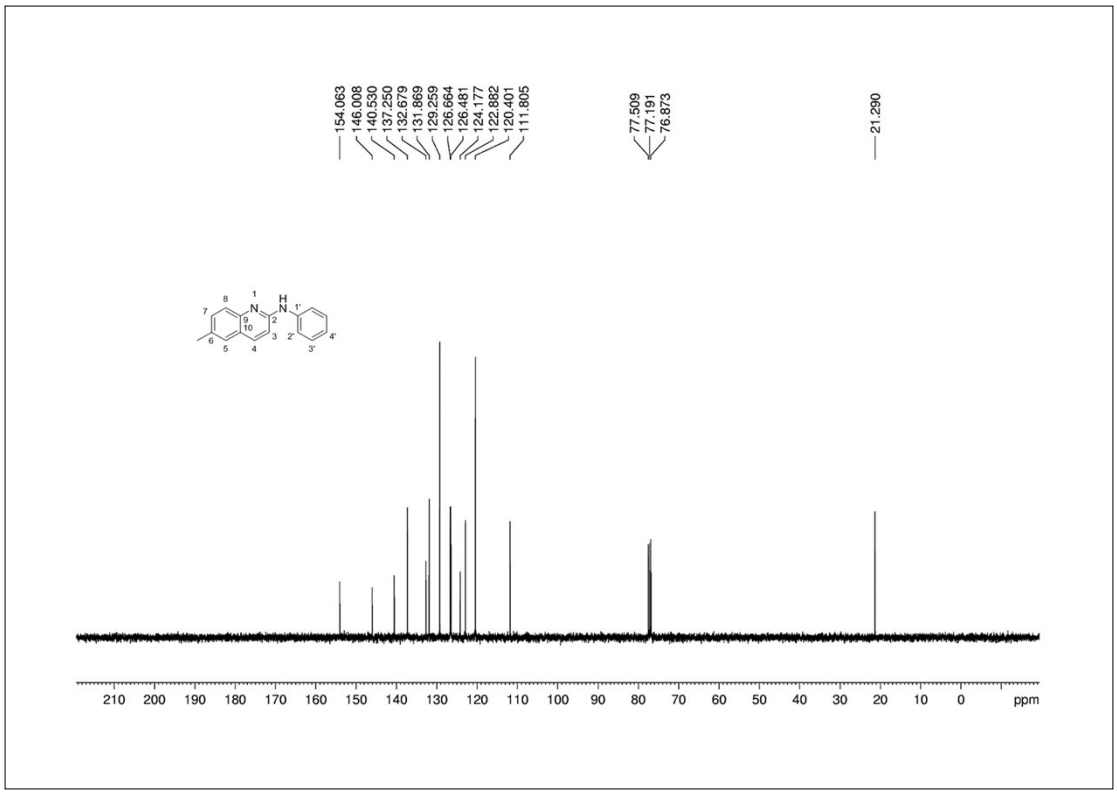


Fig.39 ^{13}C NMR spectrum of compound **3s**

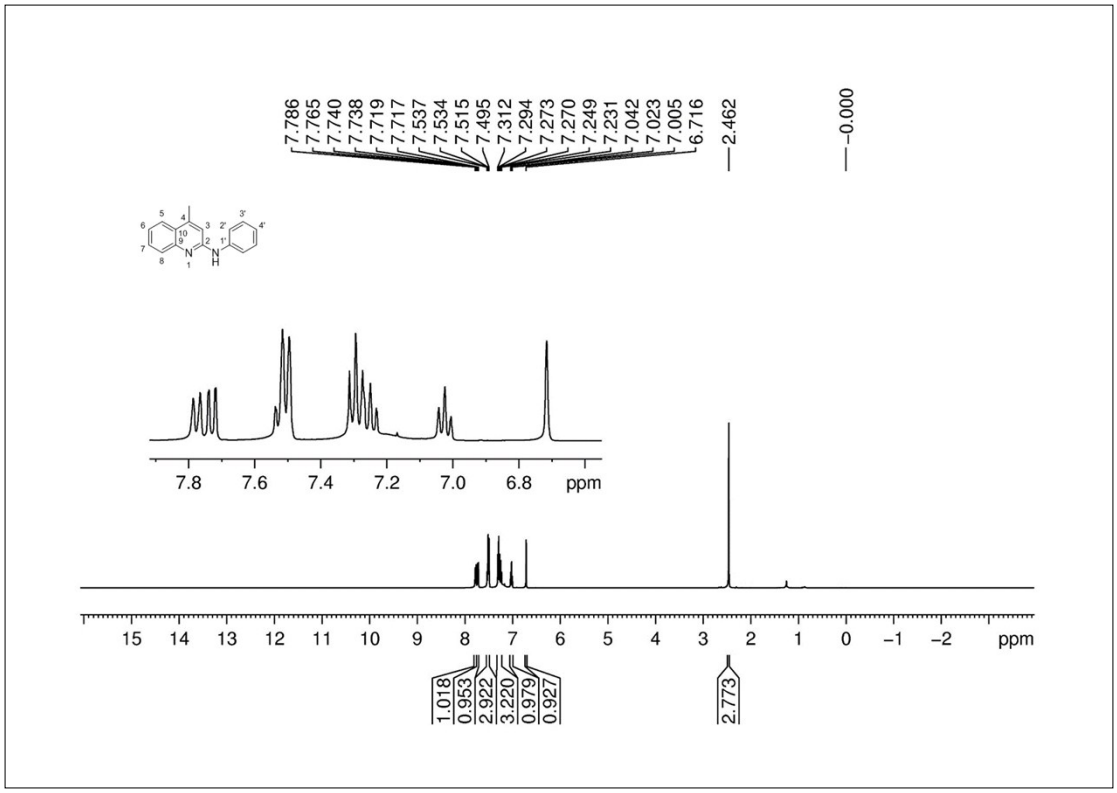


Fig.40 ^{1}H NMR spectrum of compound **3t**

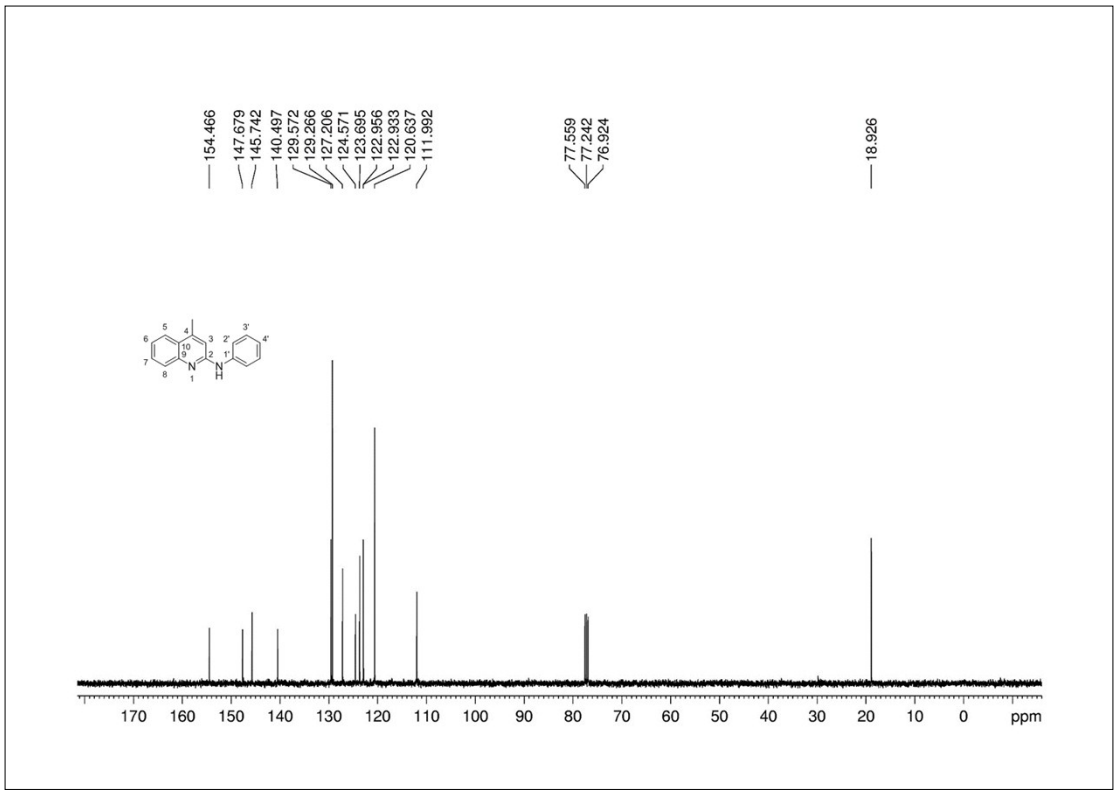


Fig.41 ^{13}C NMR spectrum of compound **3t**

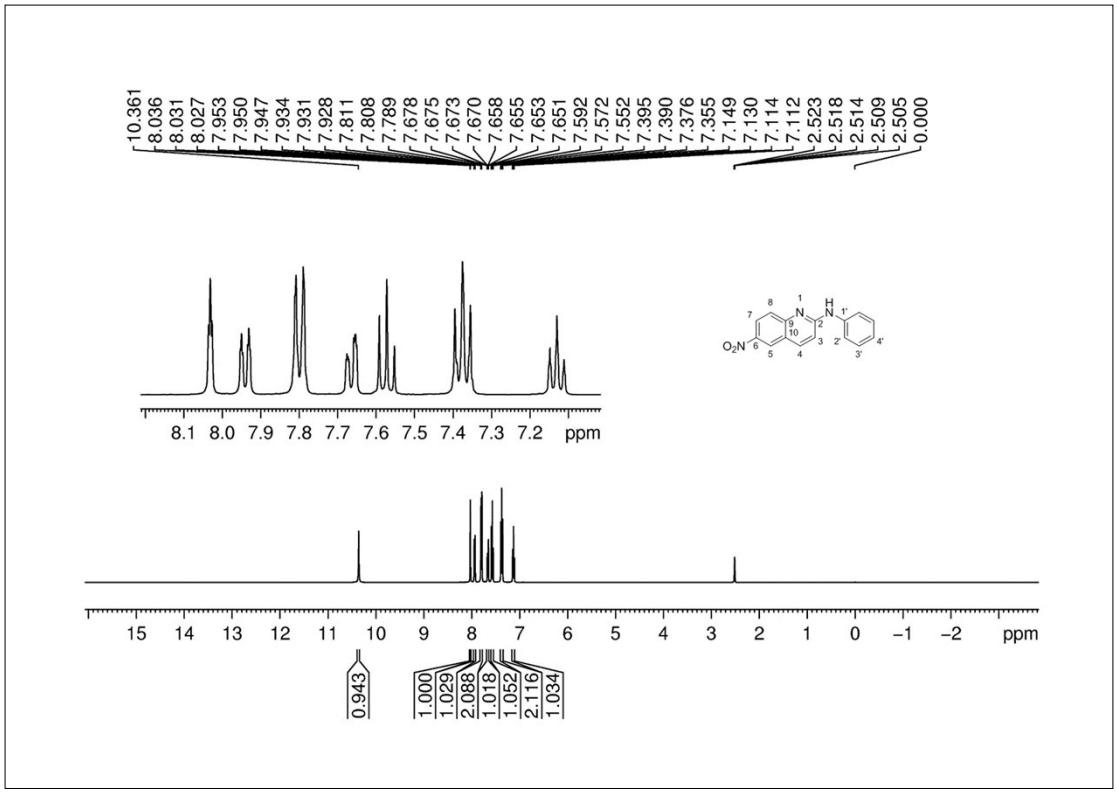


Fig.42 ^{1}H NMR spectrum of compound **3u**

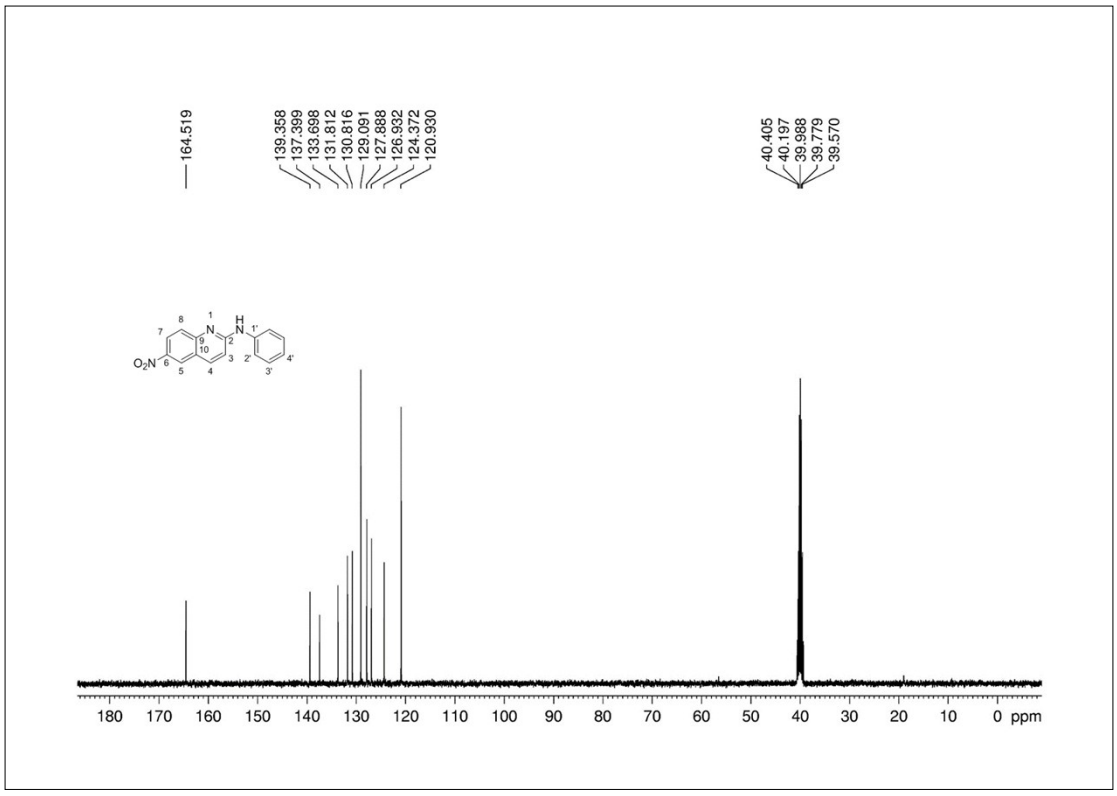


Fig.43 ^{13}C NMR spectrum of compound **3u**

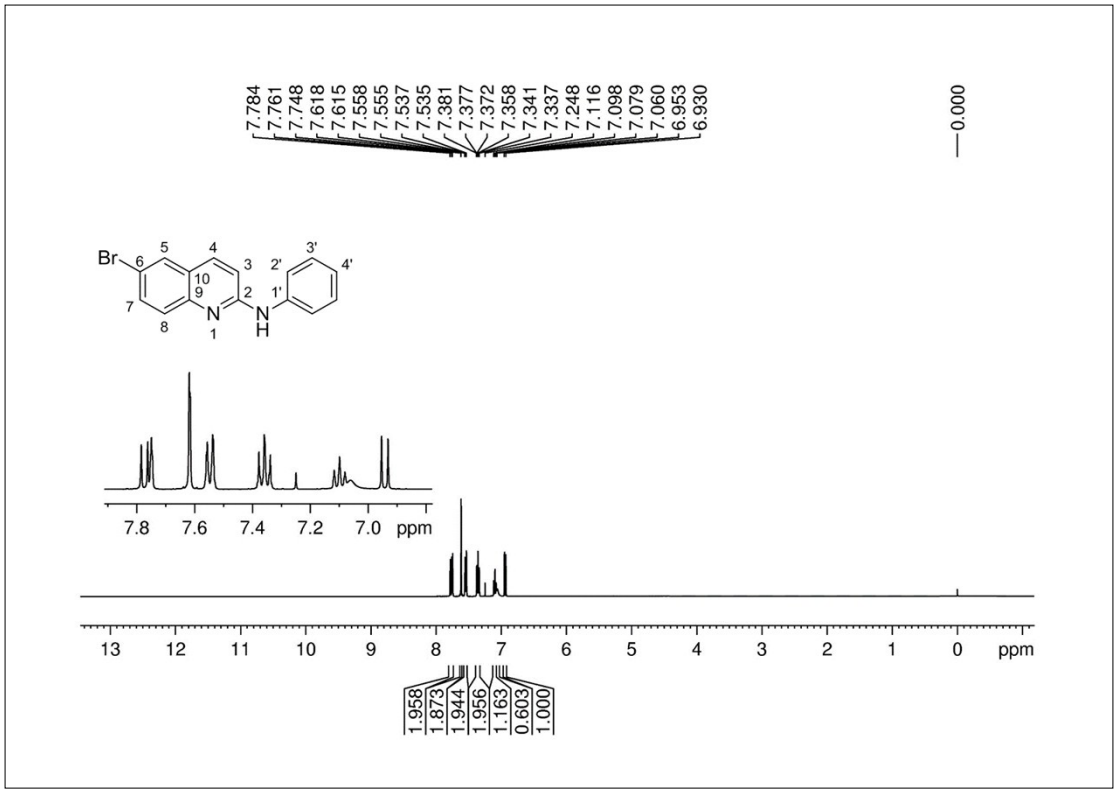


Fig.44 ^{1}H NMR spectrum of compound **3v**

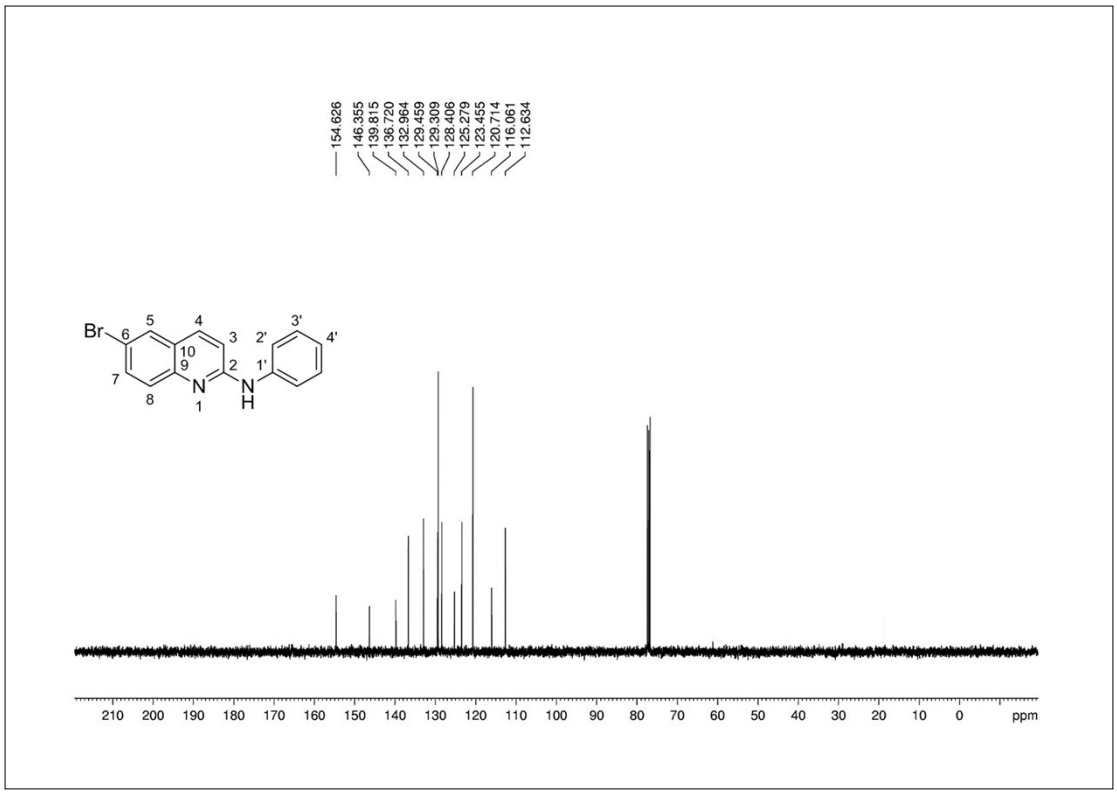


Fig.45 ^{13}C NMR spectrum of compound **3v**

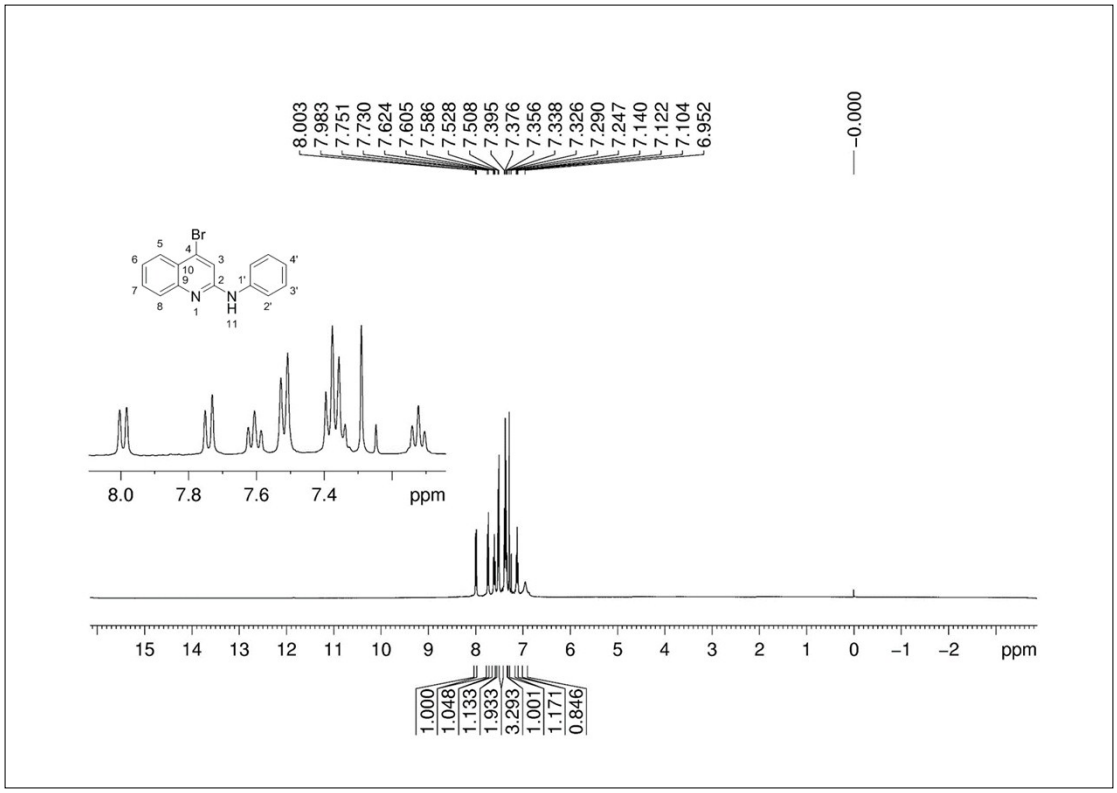


Fig.46 ^{1}H NMR spectrum of compound **3w**

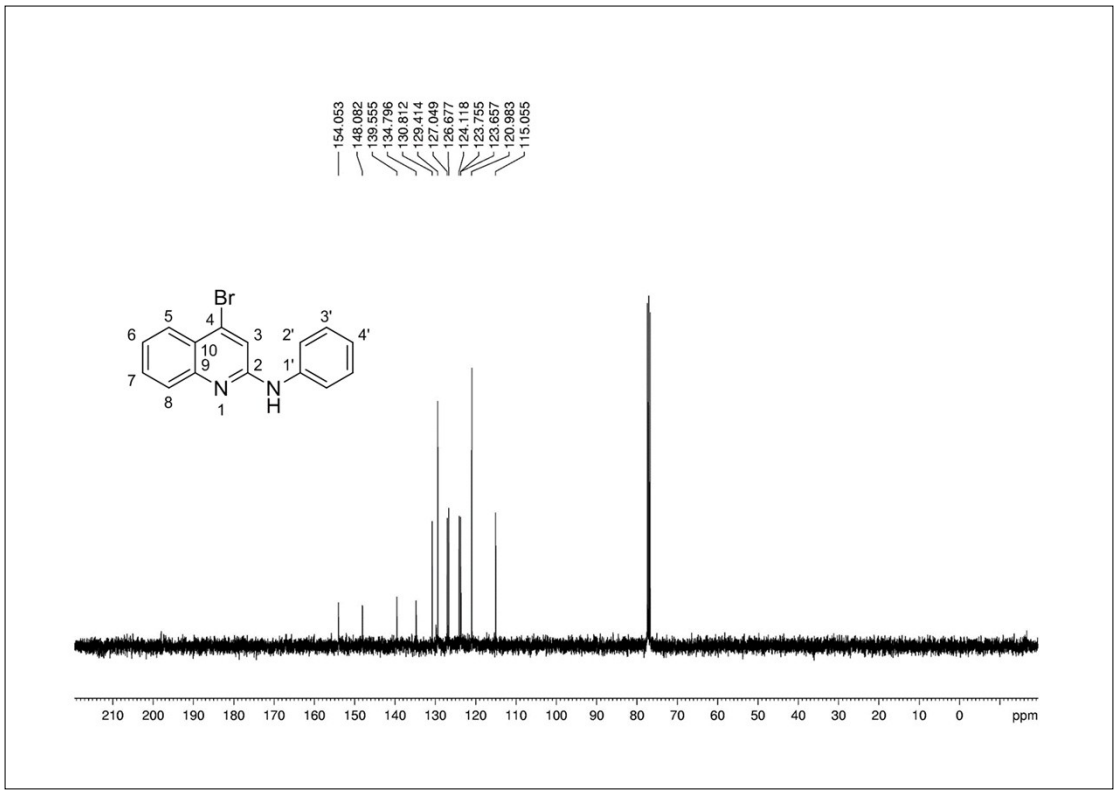


Fig.47 ^{13}C NMR spectrum of compound **3w**

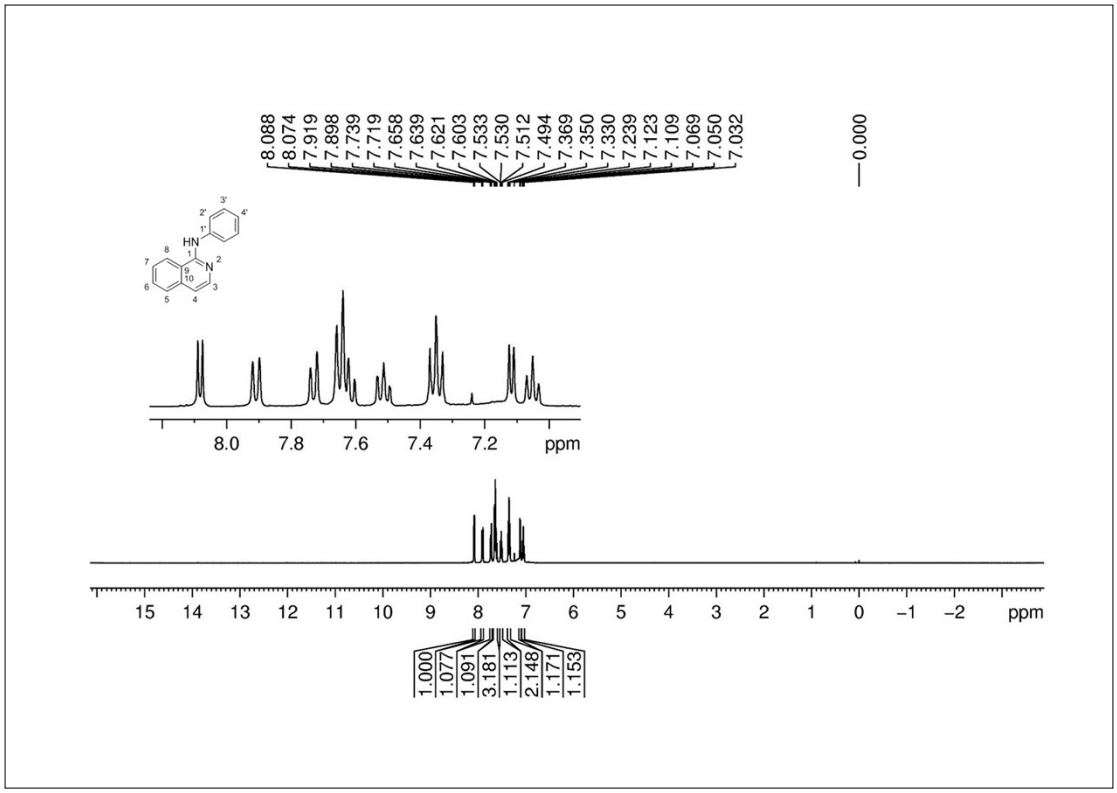


Fig.48 ^{1}H NMR spectrum of compound **3x**

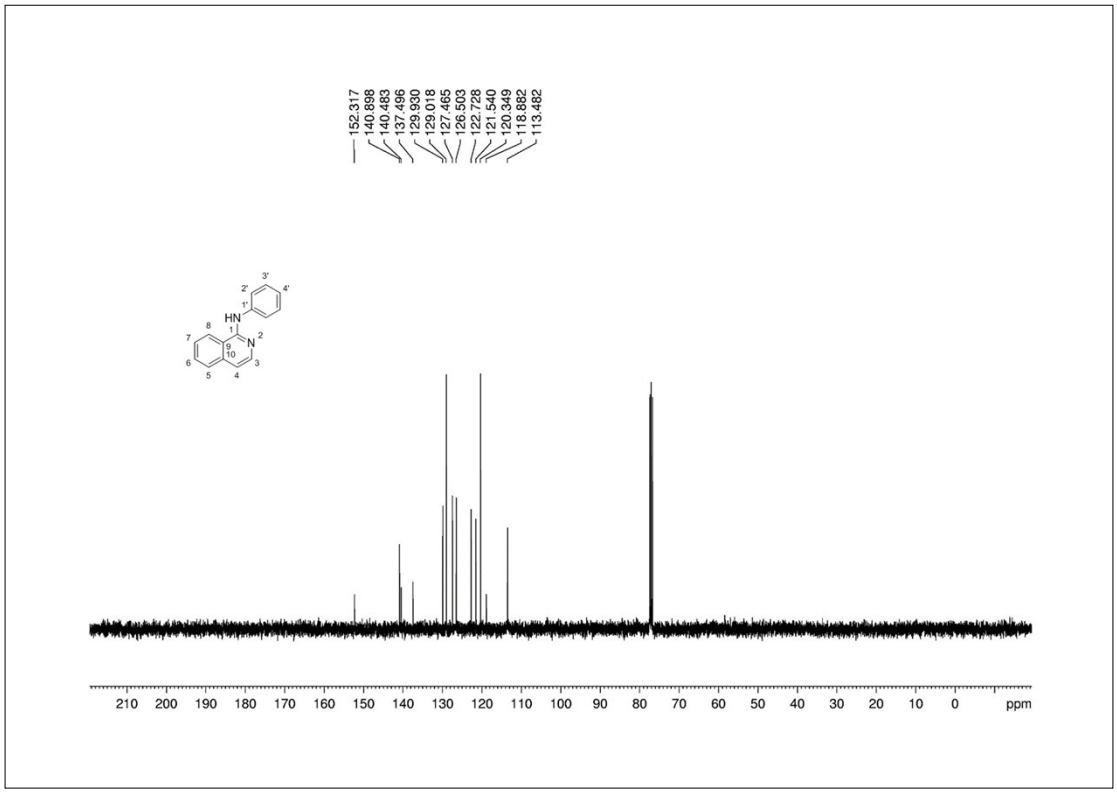


Fig.49 ^{13}C NMR spectrum of compound **3x**

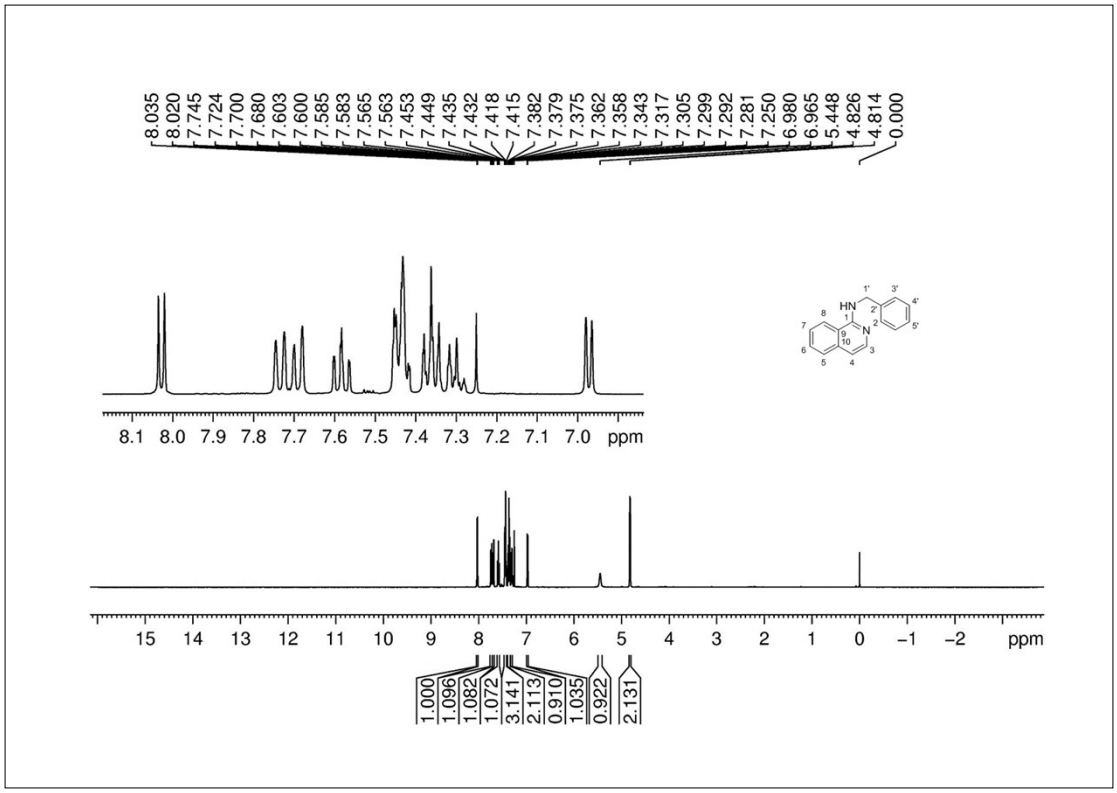


Fig.50 ^{1}H NMR spectrum of compound **3y**

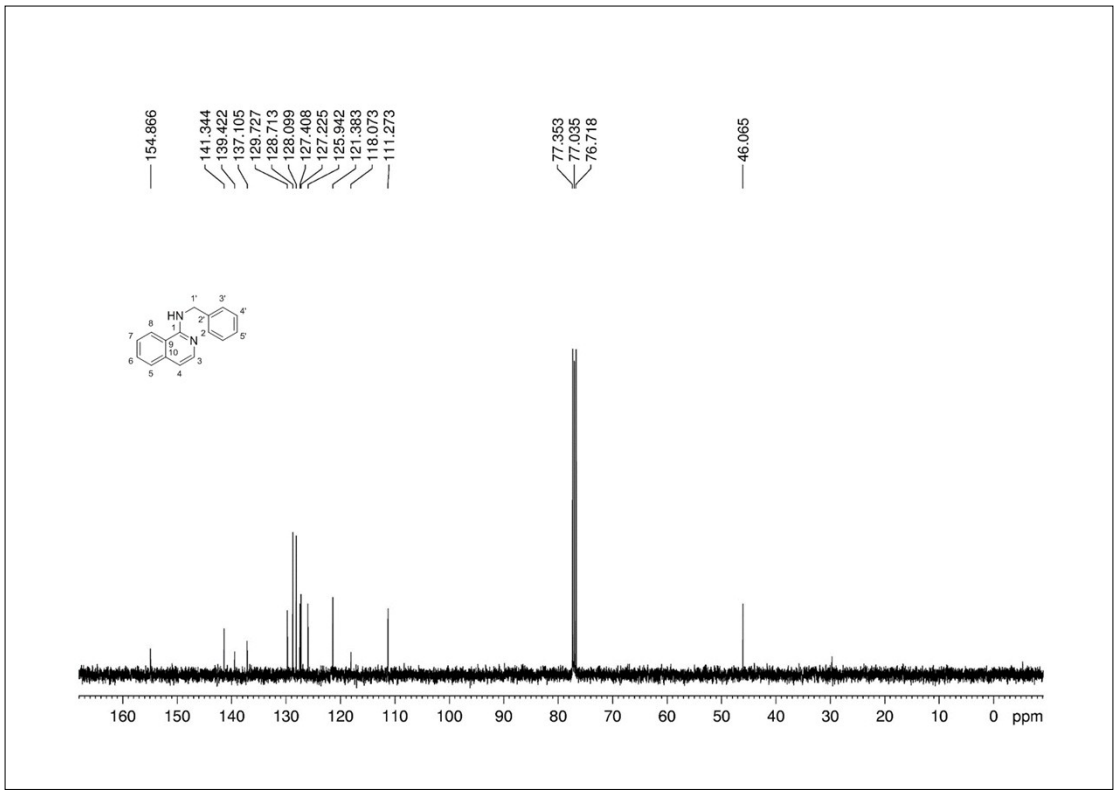


Fig.51 ^{13}C NMR spectrum of compound **3y**

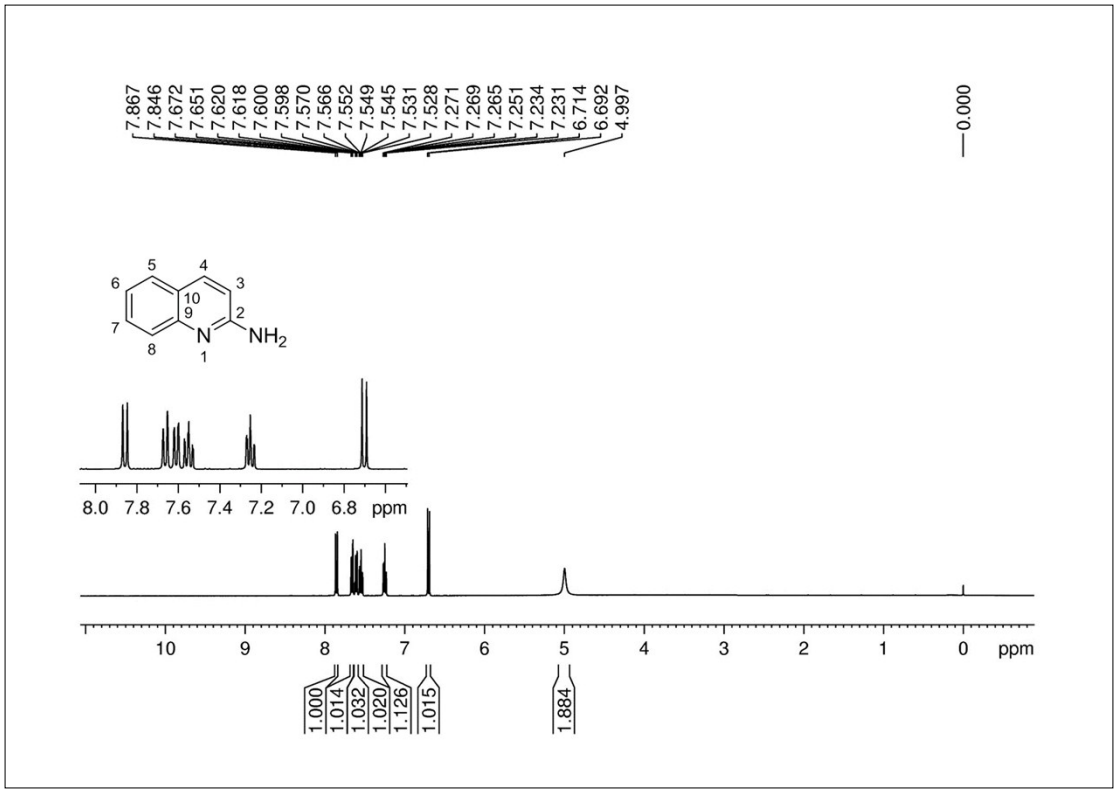


Fig.52 ^{1}H NMR spectrum of compound **3z**

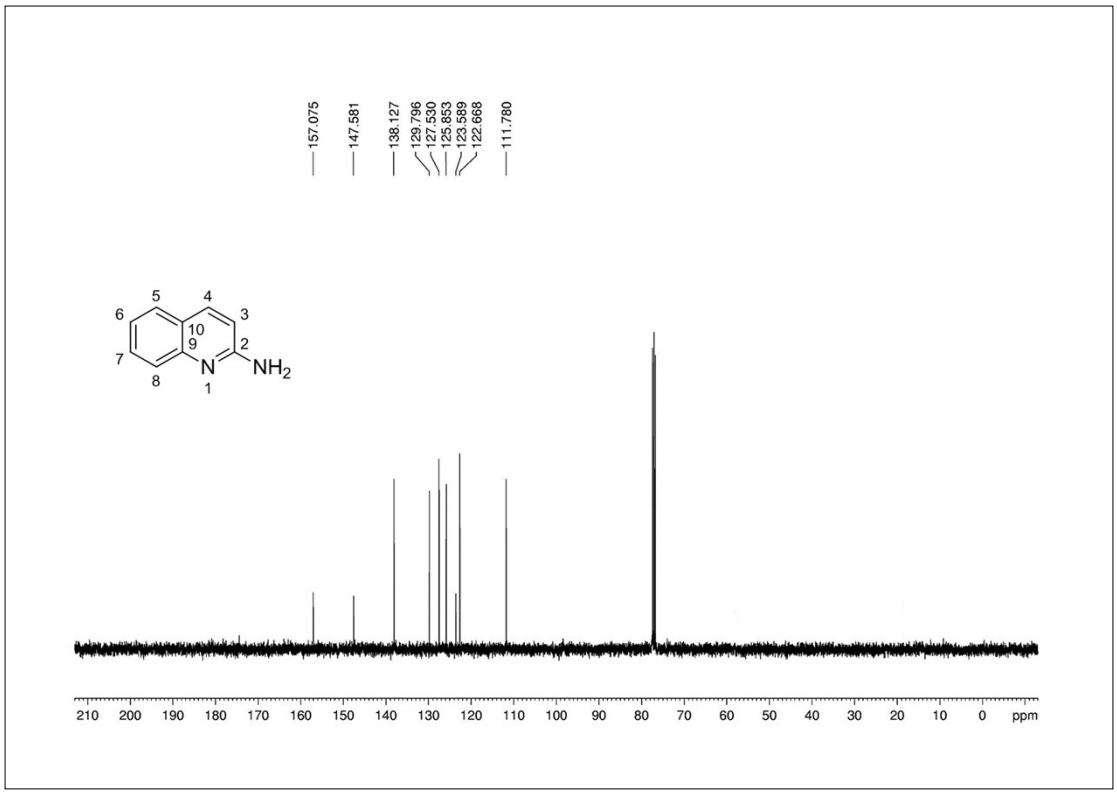


Fig.53 ^{13}C NMR spectrum of compound **3z**

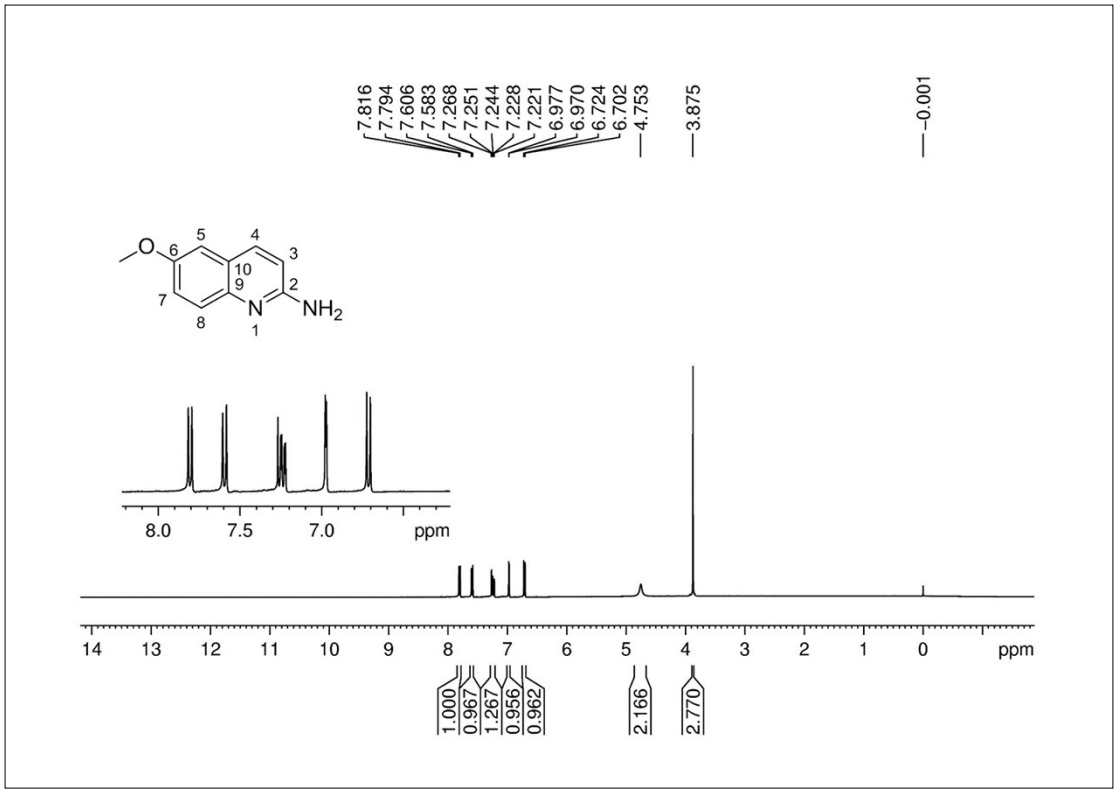


Fig.54 ^{1}H NMR spectrum of compound **3aa**

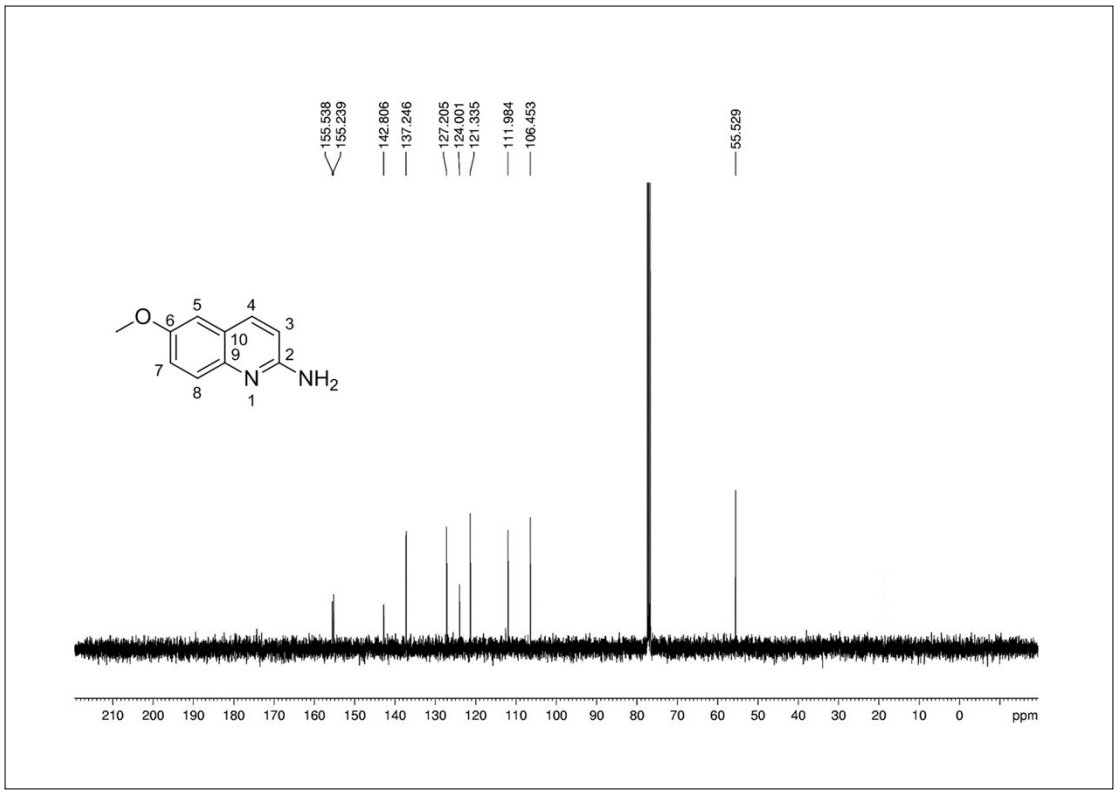


Fig.55 ^{13}C NMR spectrum of compound **3aa**

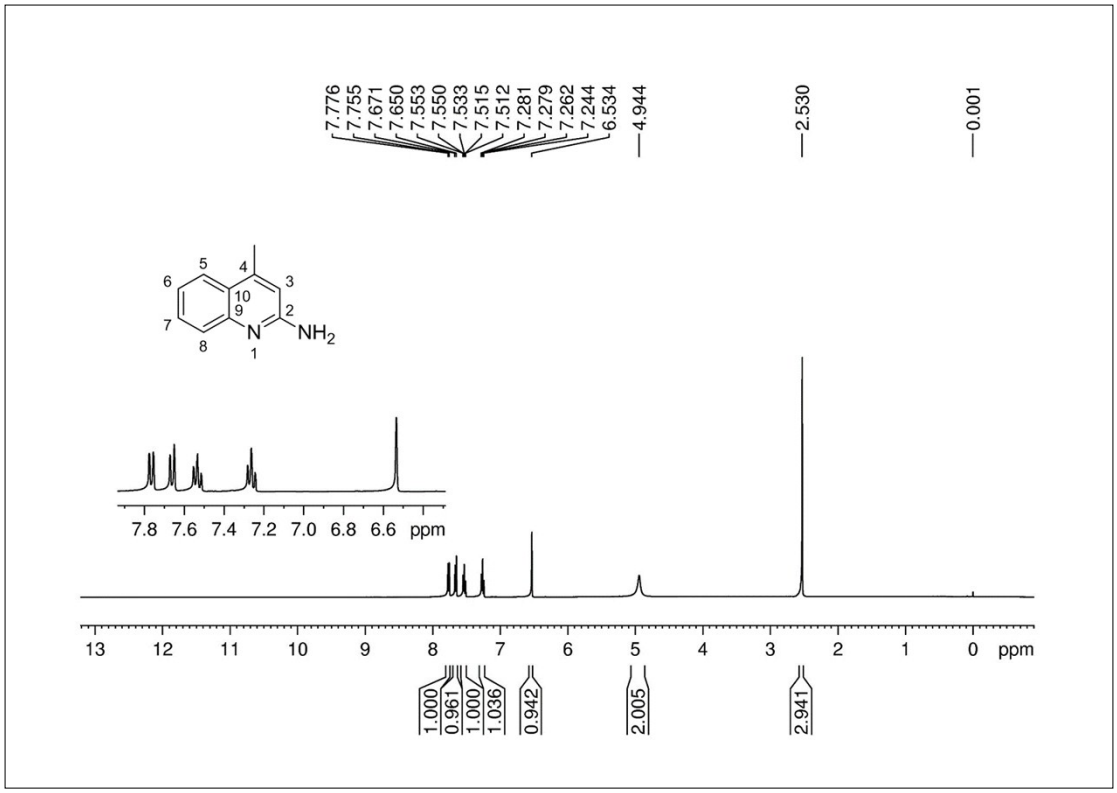


Fig.56 ^{1}H NMR spectrum of compound **3ab**

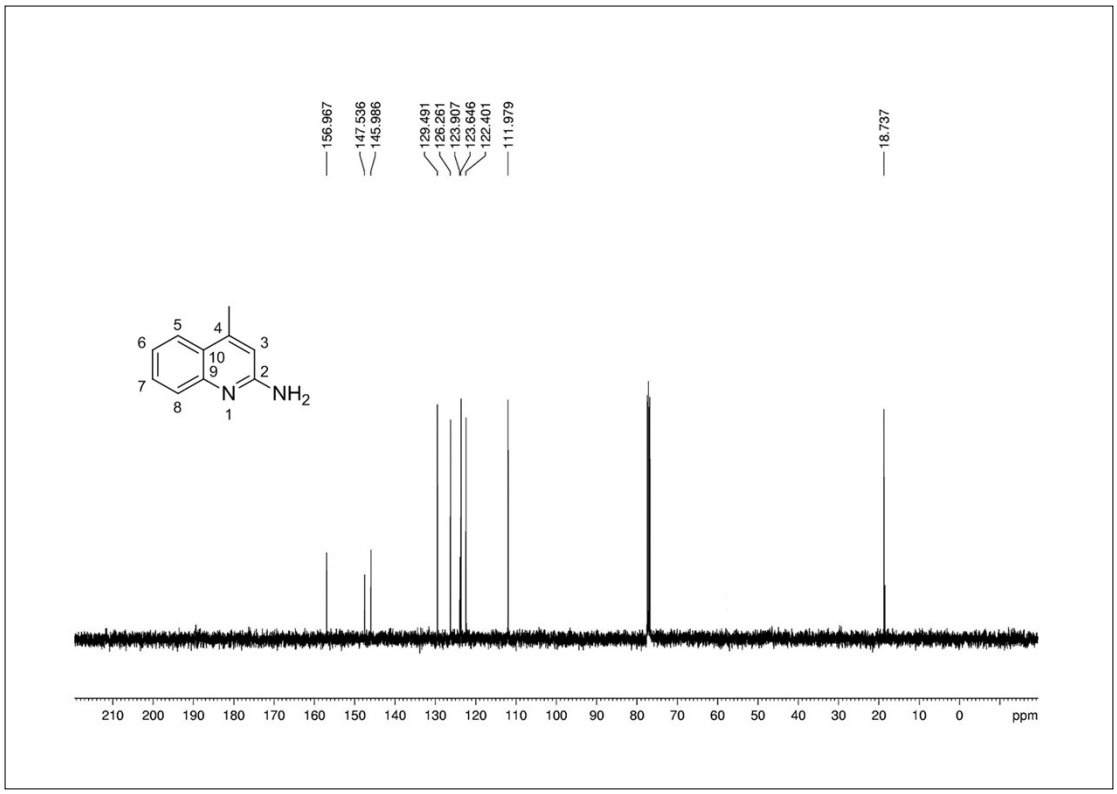


Fig.57 ^{13}C NMR spectrum of compound **3ab**

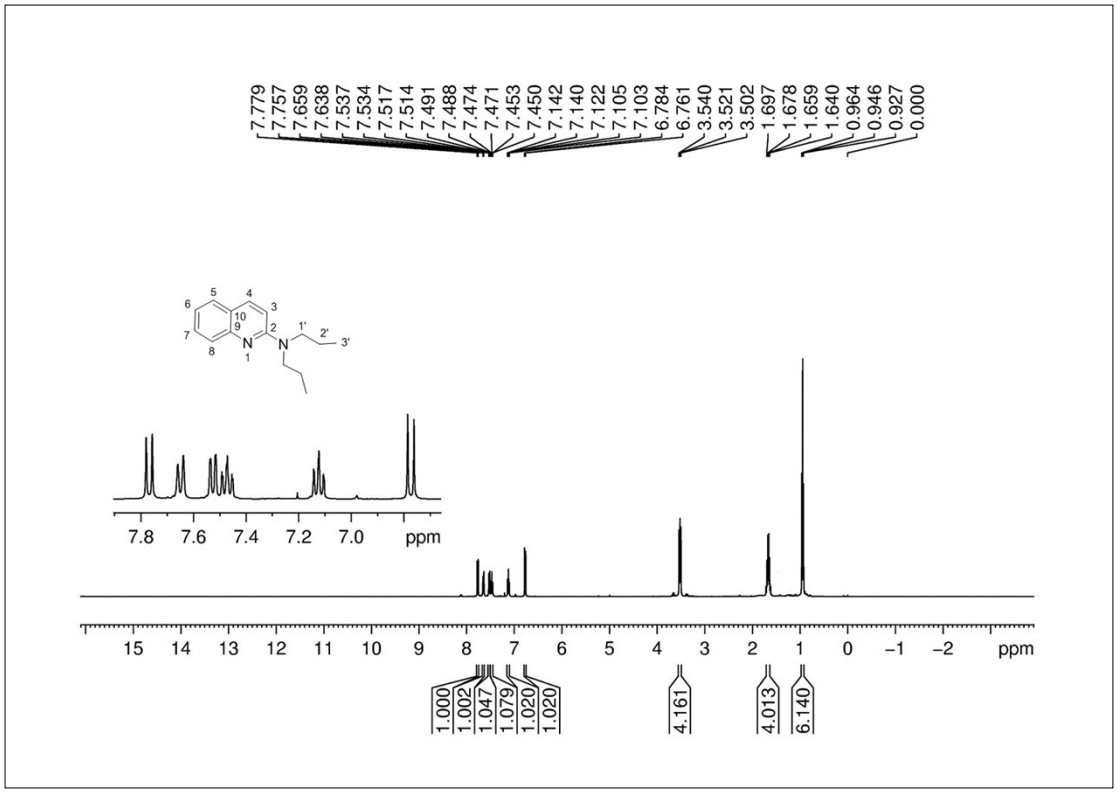


Fig.58 ^{1}H NMR spectrum of compound **3ac**

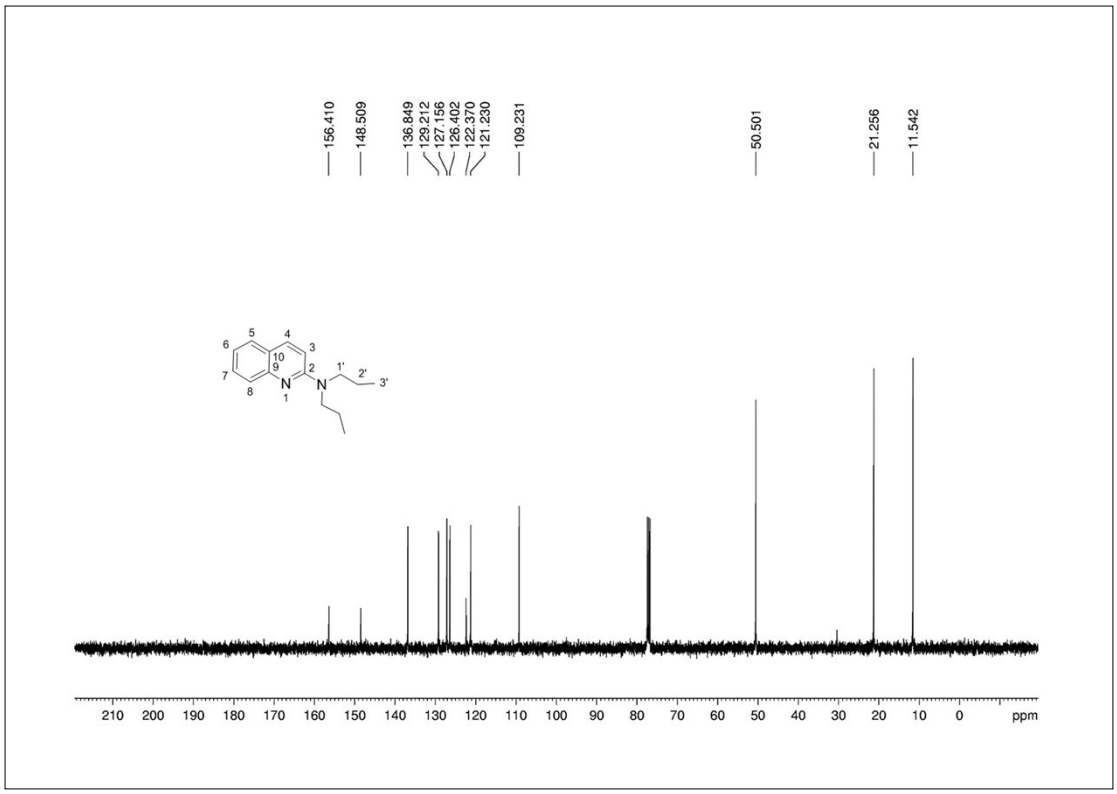


Fig.59 ^{13}C NMR spectrum of compound **3ac**

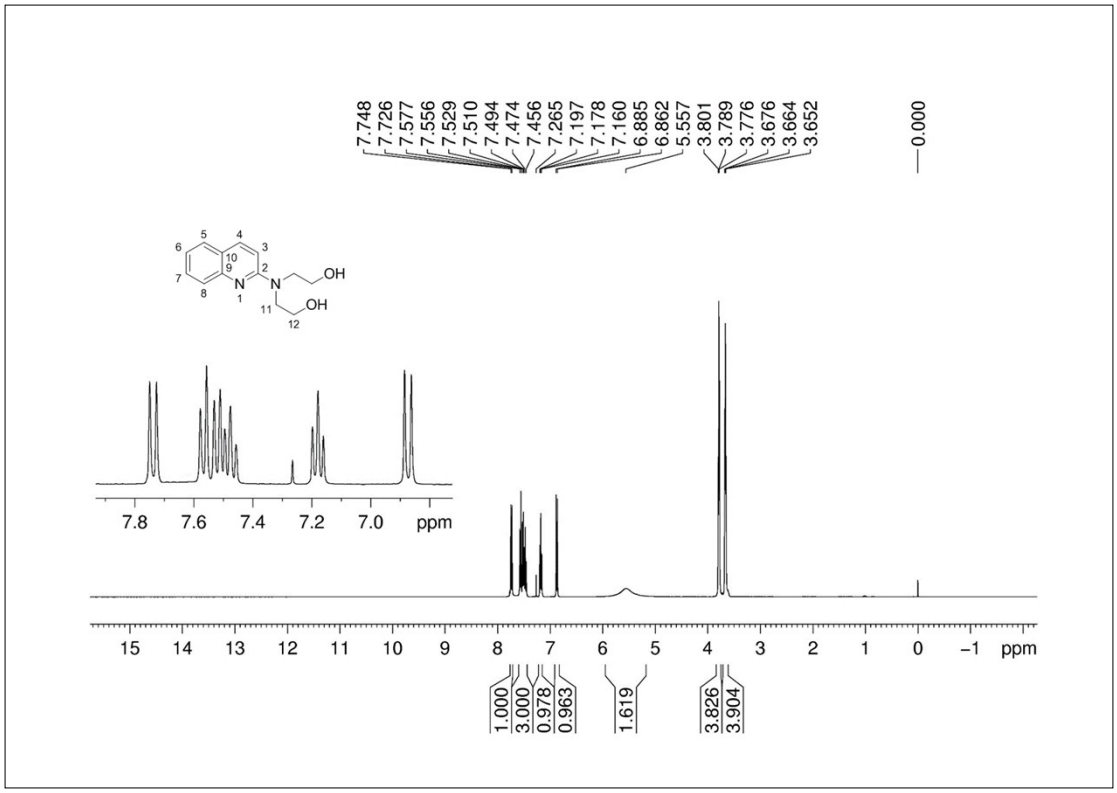


Fig.60 ^{1}H NMR spectrum of compound **3ad**

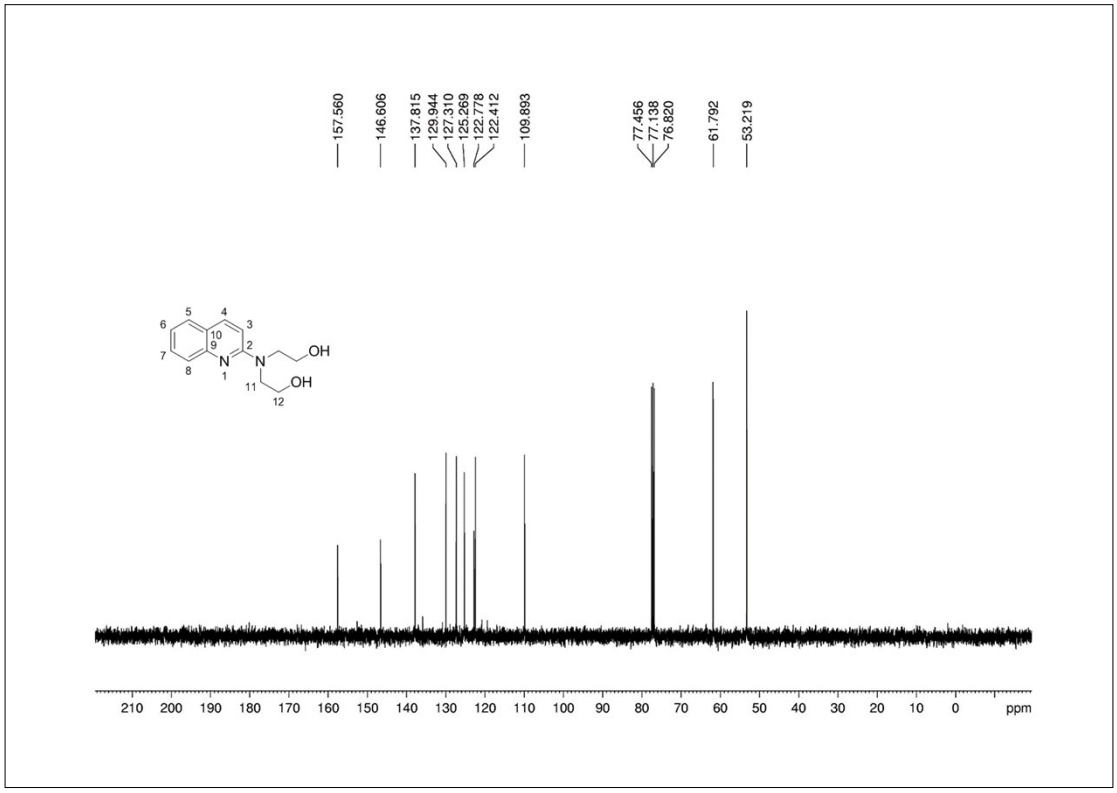


Fig.61 ^{13}C NMR spectrum of compound **3ad**

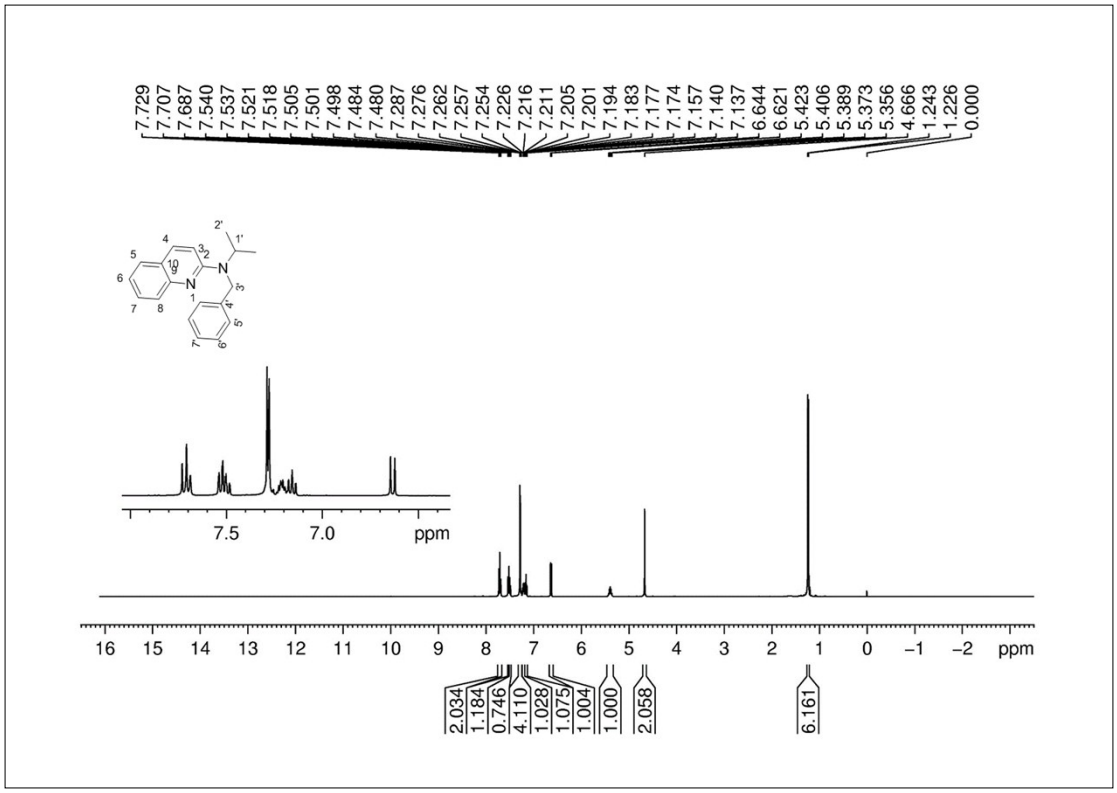


Fig.62 ^{1}H NMR spectrum of compound **3ae**

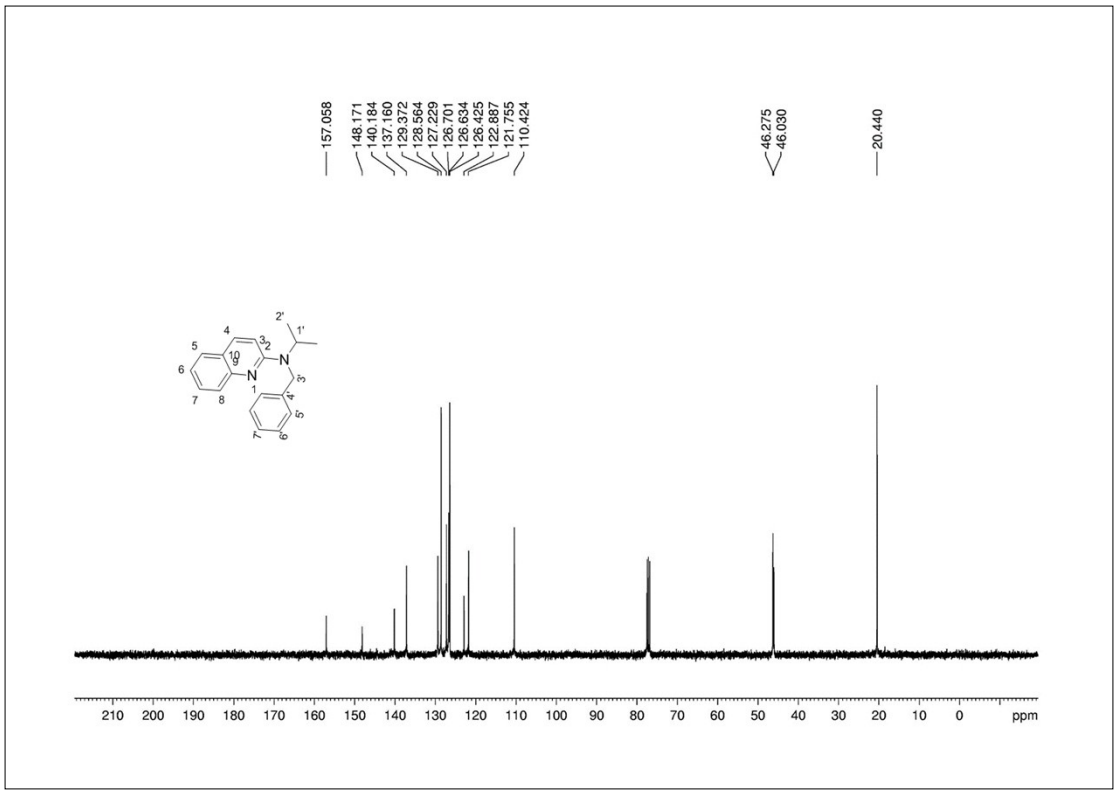


Fig.63 ^{13}C NMR spectrum of compound **3ae**

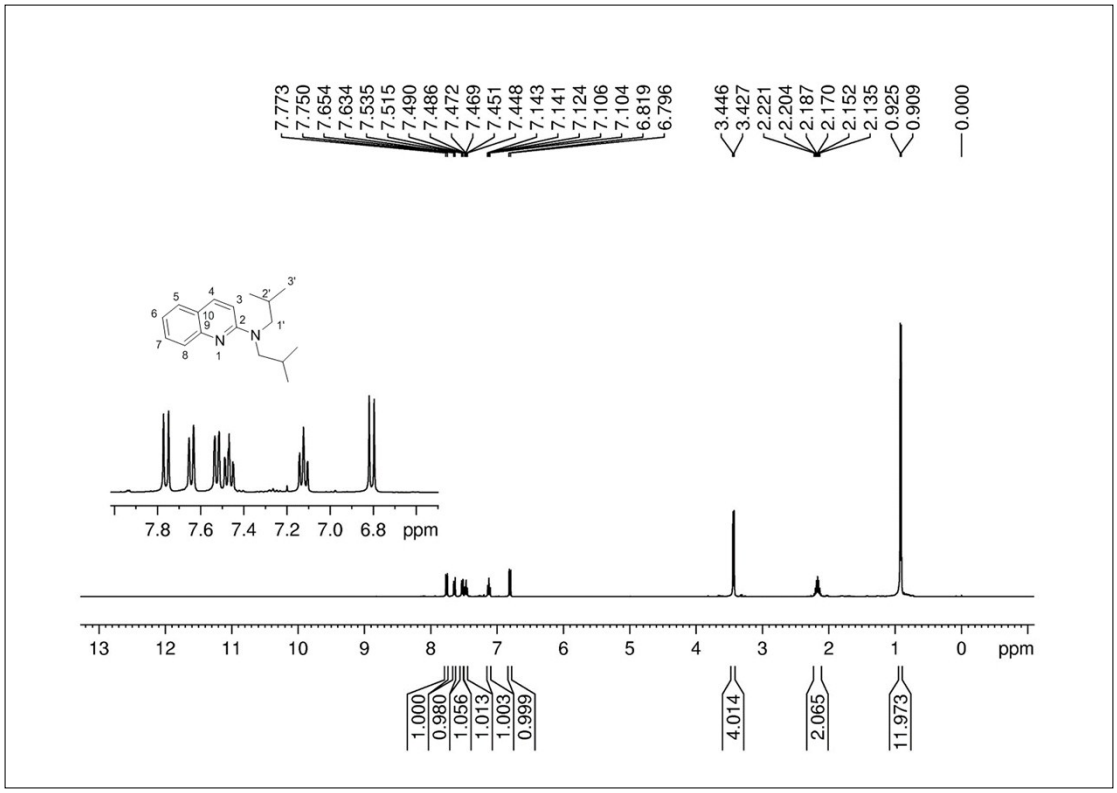


Fig.64 ^{1}H NMR spectrum of compound **3af**

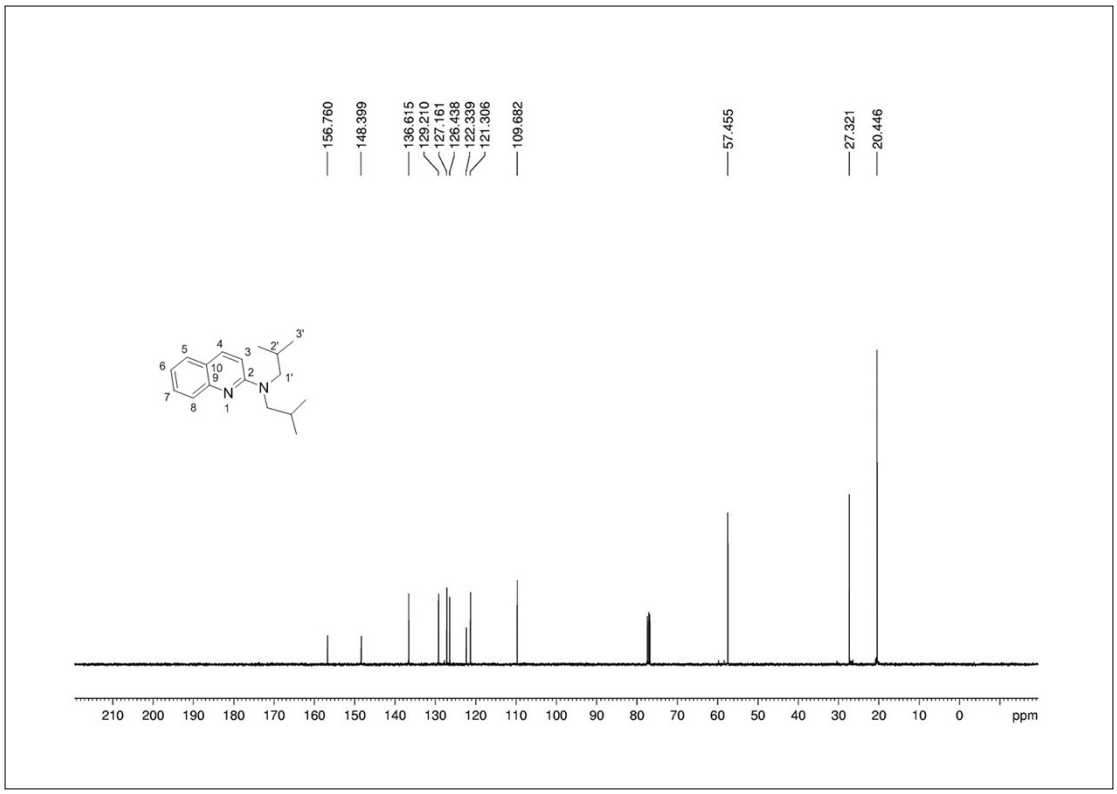


Fig.65 ^{13}C NMR spectrum of compound **3af**

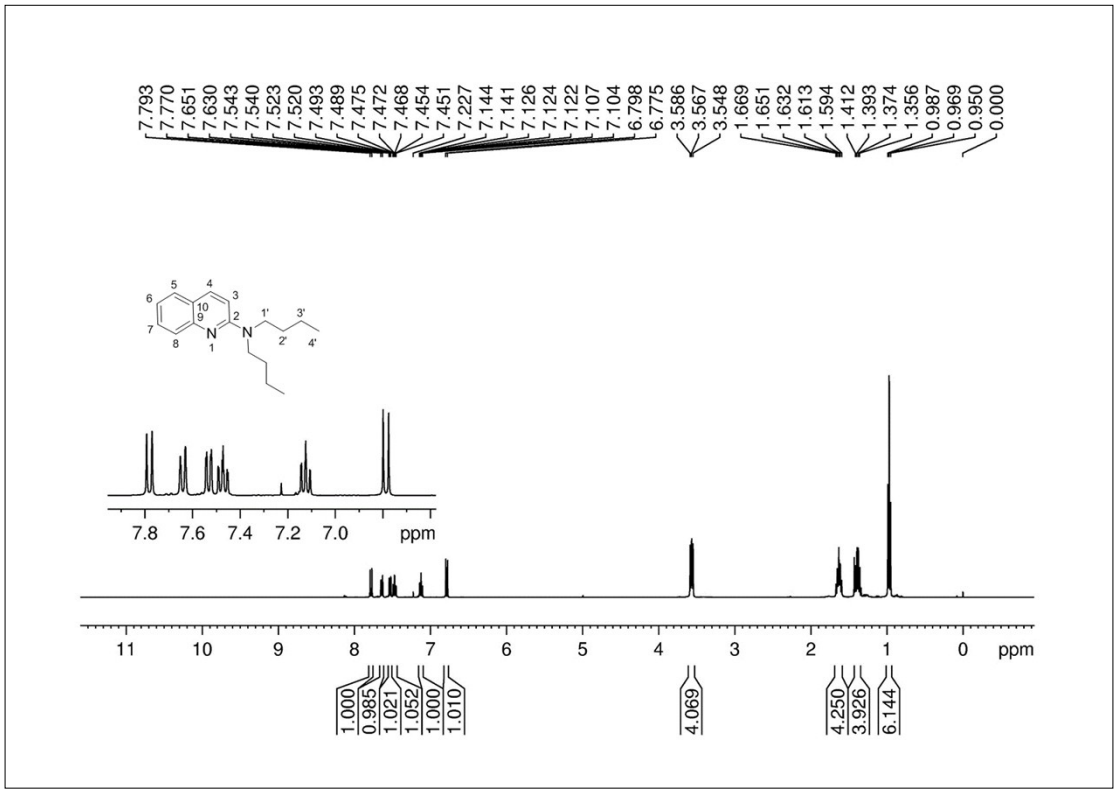


Fig.66 ^{1}H NMR spectrum of compound **3ag**

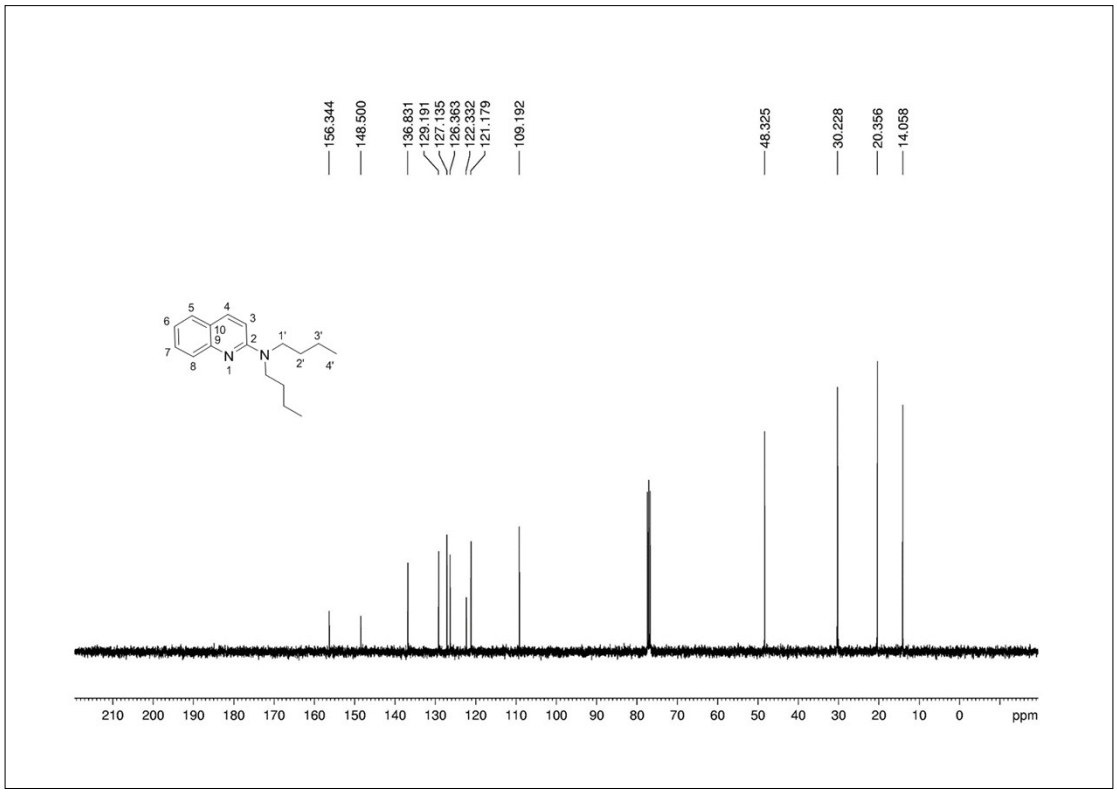


Fig.67 ^{13}C NMR spectrum of compound **3ag**

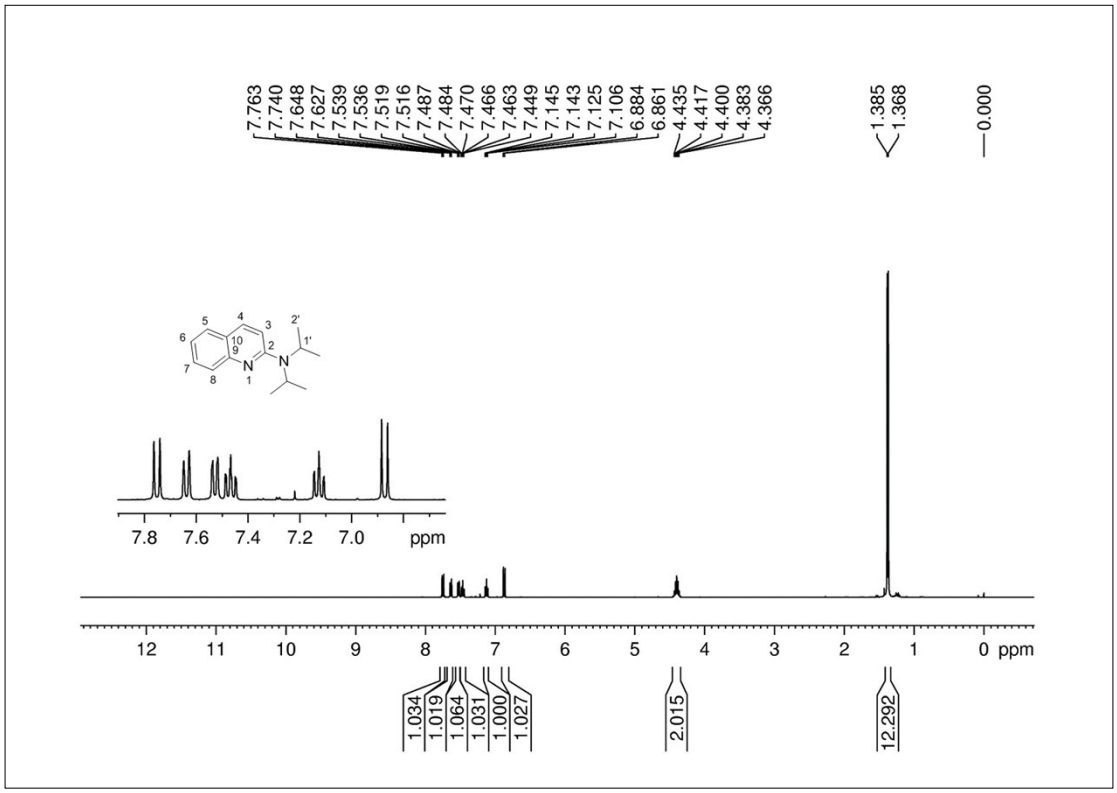


Fig.68 ^{1}H NMR spectrum of compound **3ah**

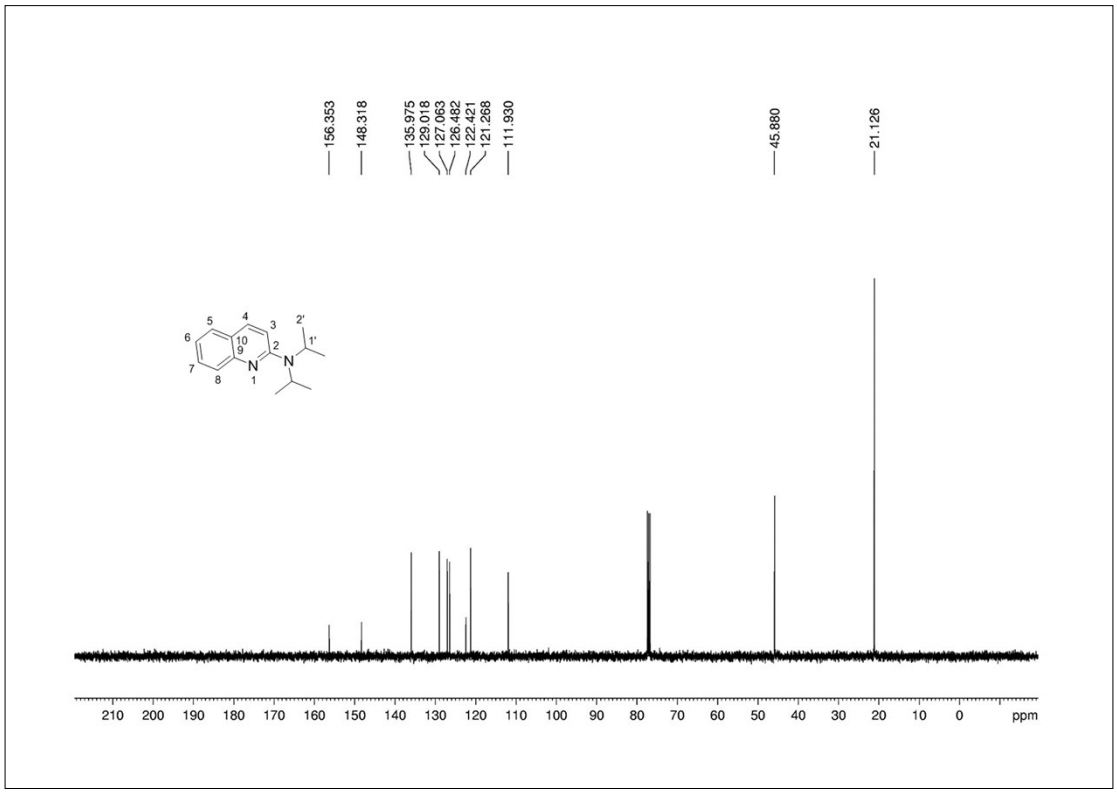


Fig.69 ^{13}C NMR spectrum of compound **3ah**

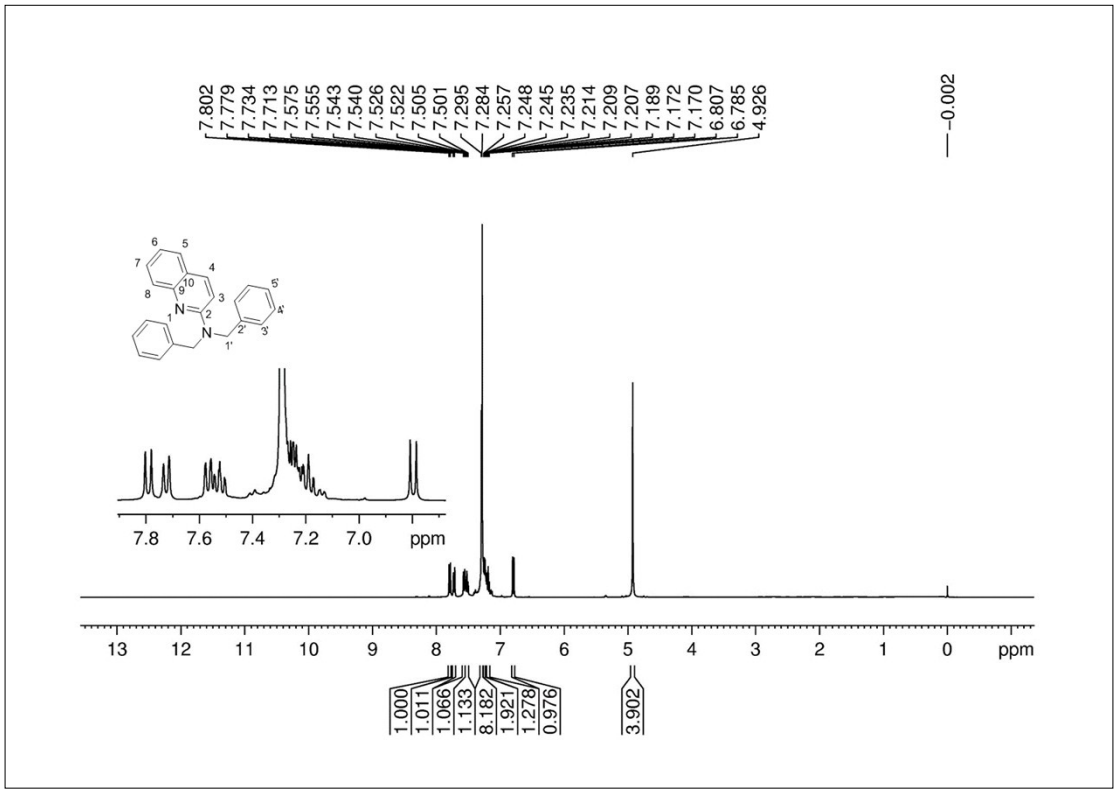


Fig.70 ^{1}H NMR spectrum of compound **3ai**

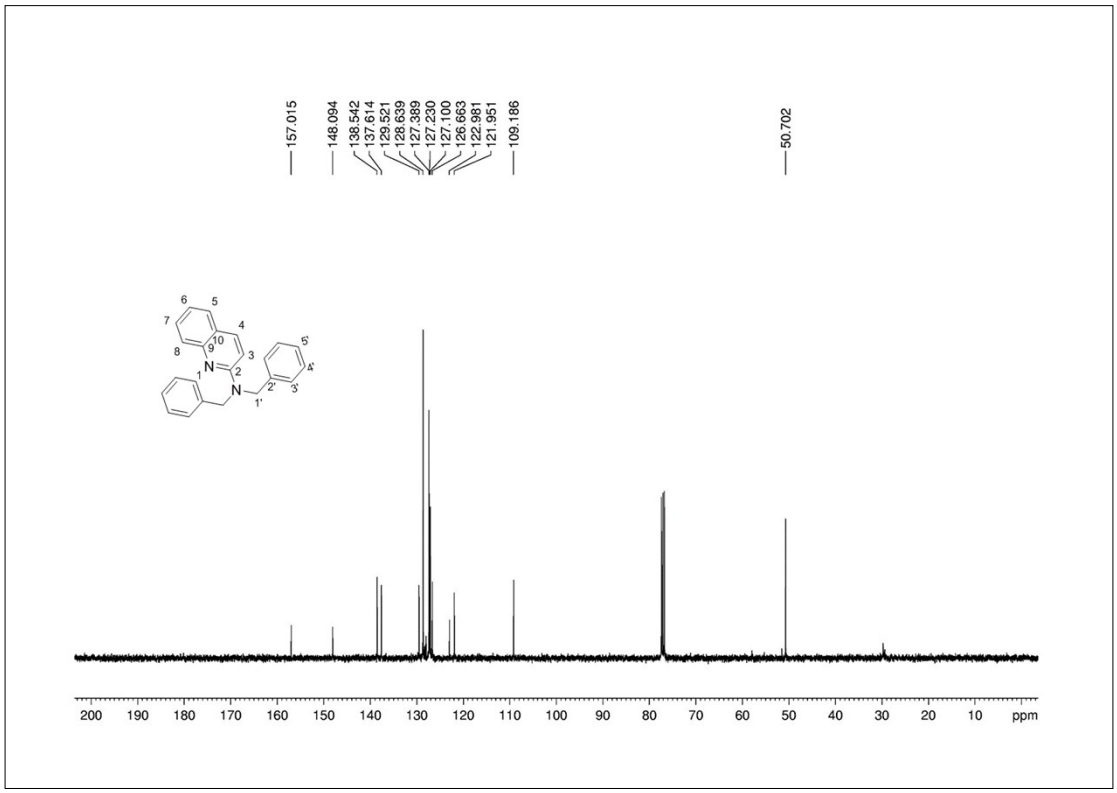


Fig.71 ^{13}C NMR spectrum of compound **3ai**

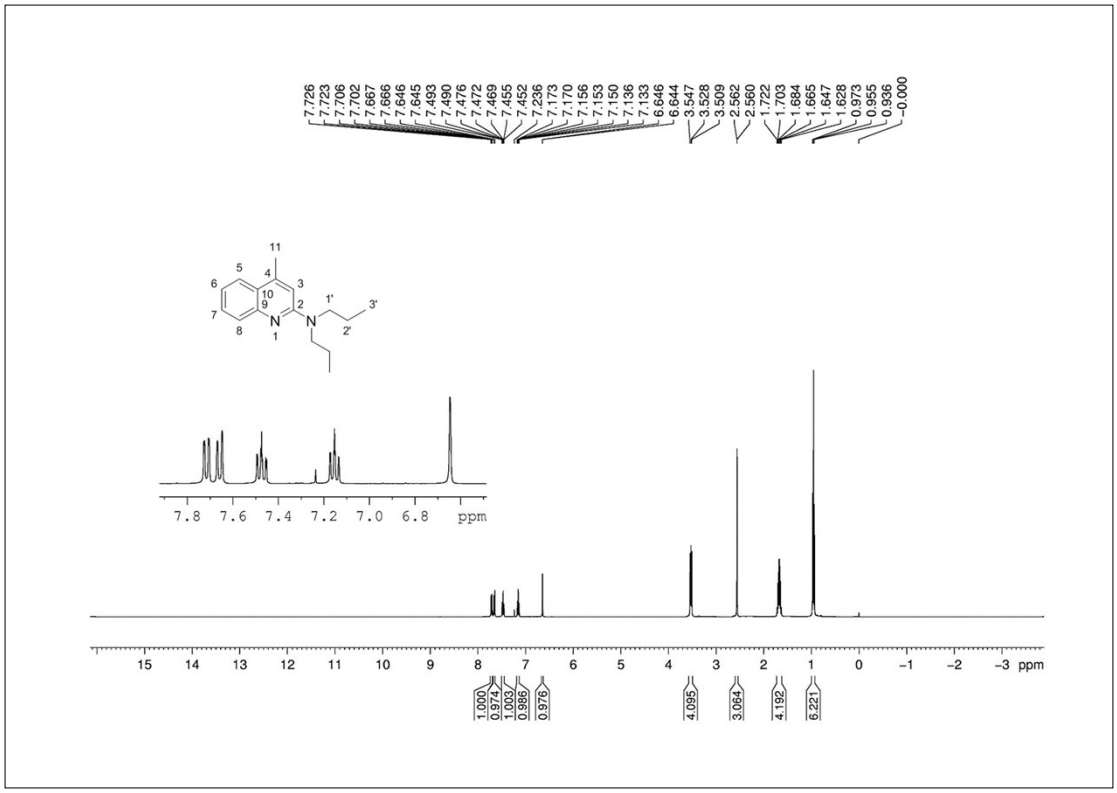


Fig.72 ^{1}H NMR spectrum of compound **3aj**

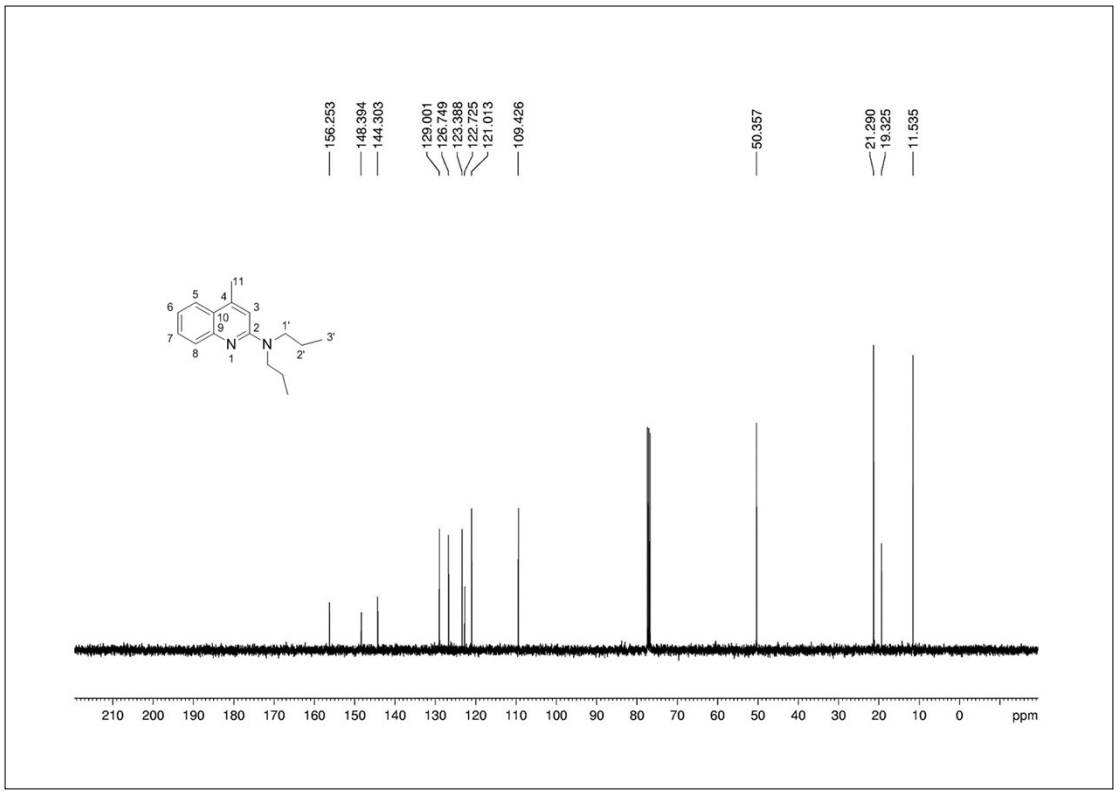


Fig.73 ^{13}C NMR spectrum of compound **3aj**

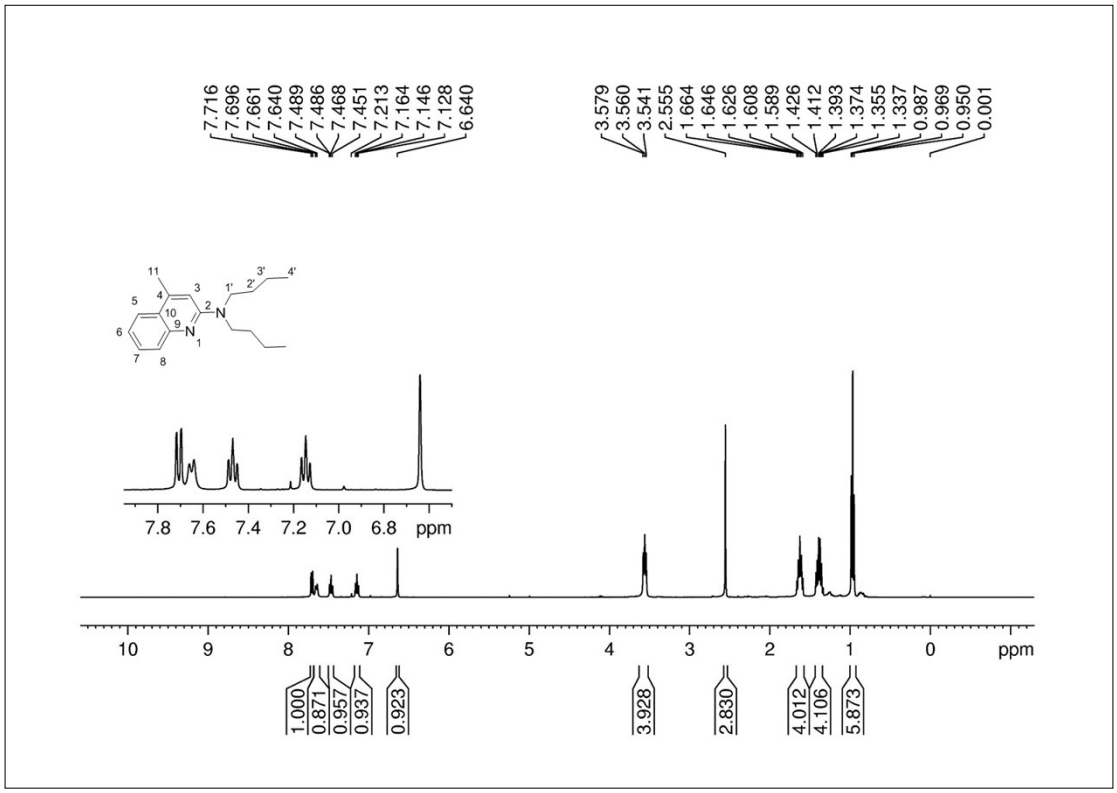


Fig.74 ^{1}H NMR spectrum of compound **3ak**

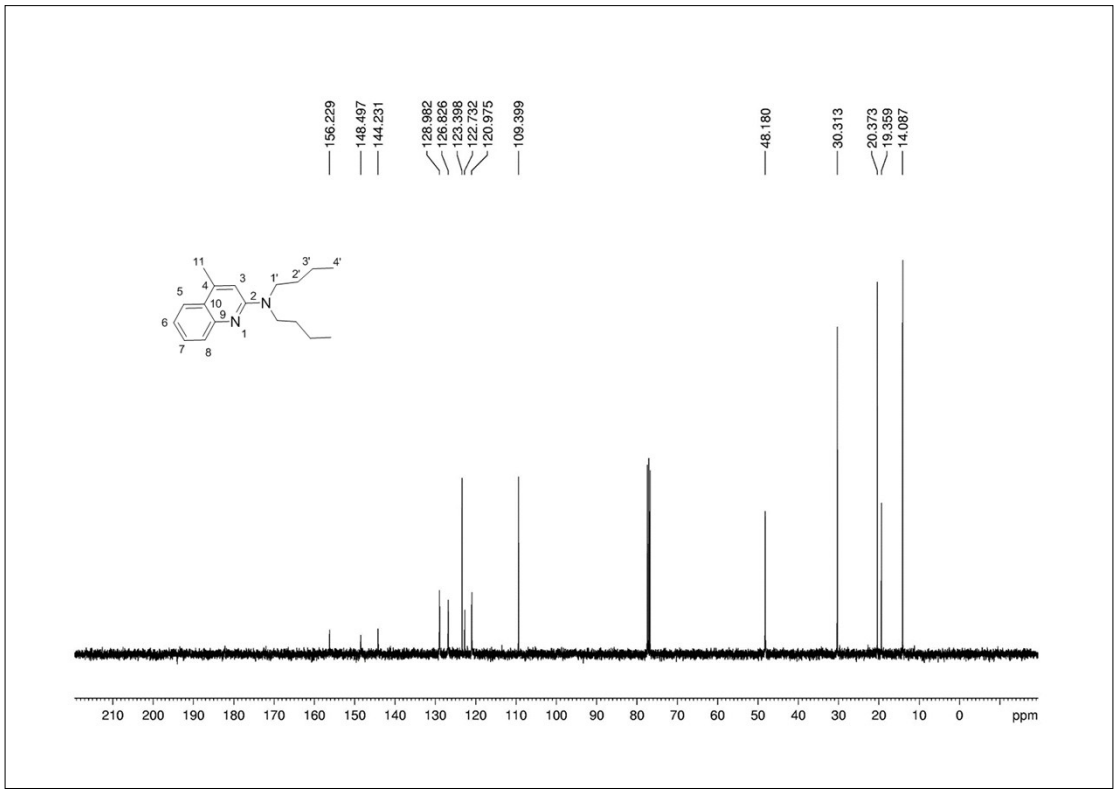


Fig.75 ^{13}C NMR spectrum of compound **3ak**

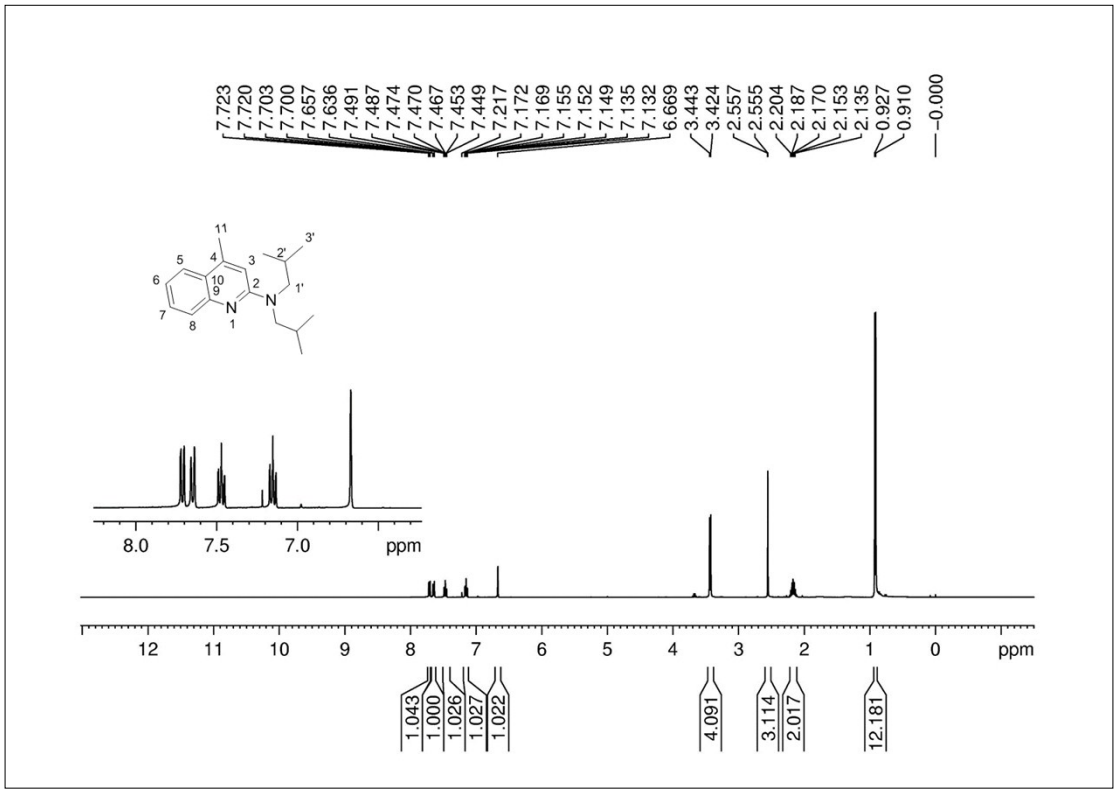


Fig.76 ^{1}H NMR spectrum of compound **3al**

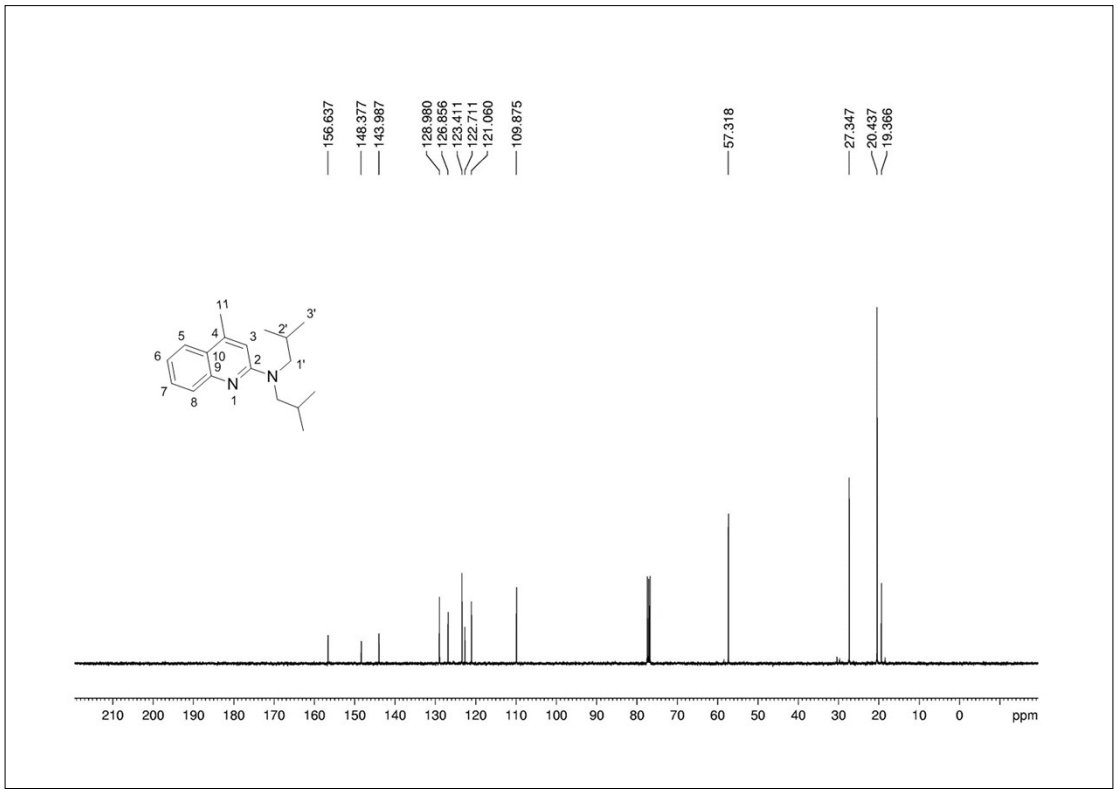


Fig.77 ^{13}C NMR spectrum of compound **3al**

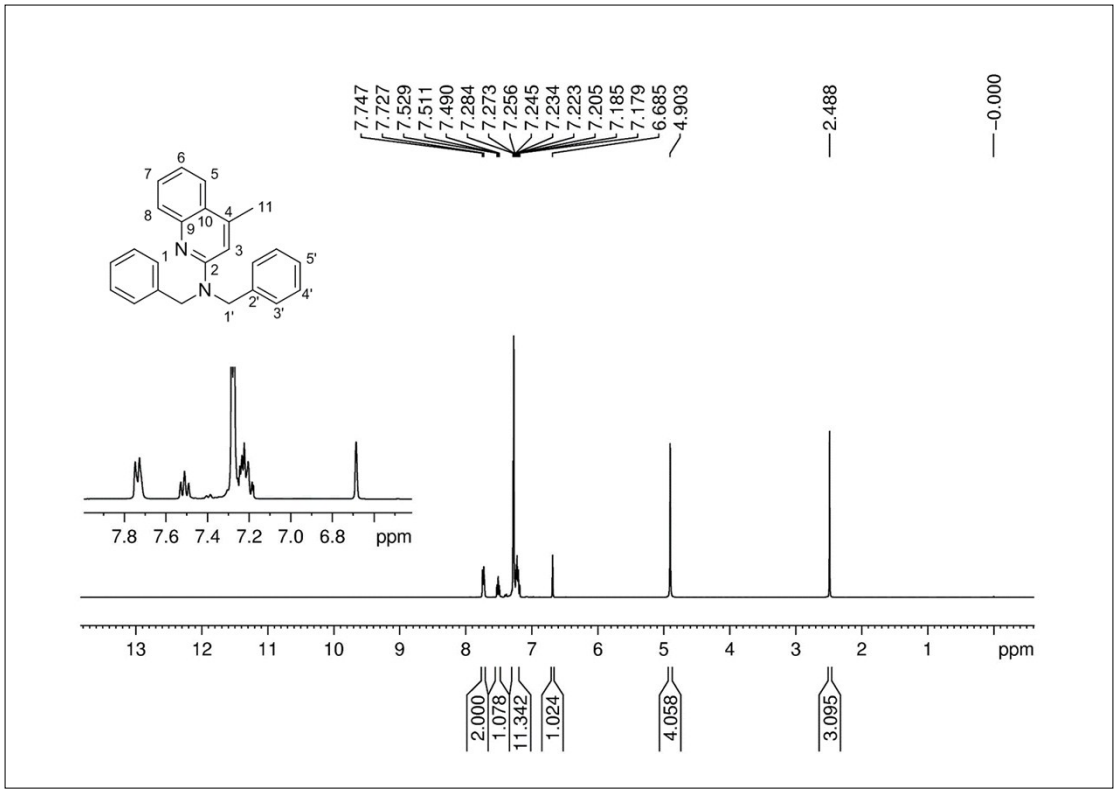


Fig.78 ^{1}H NMR spectrum of compound **3am**

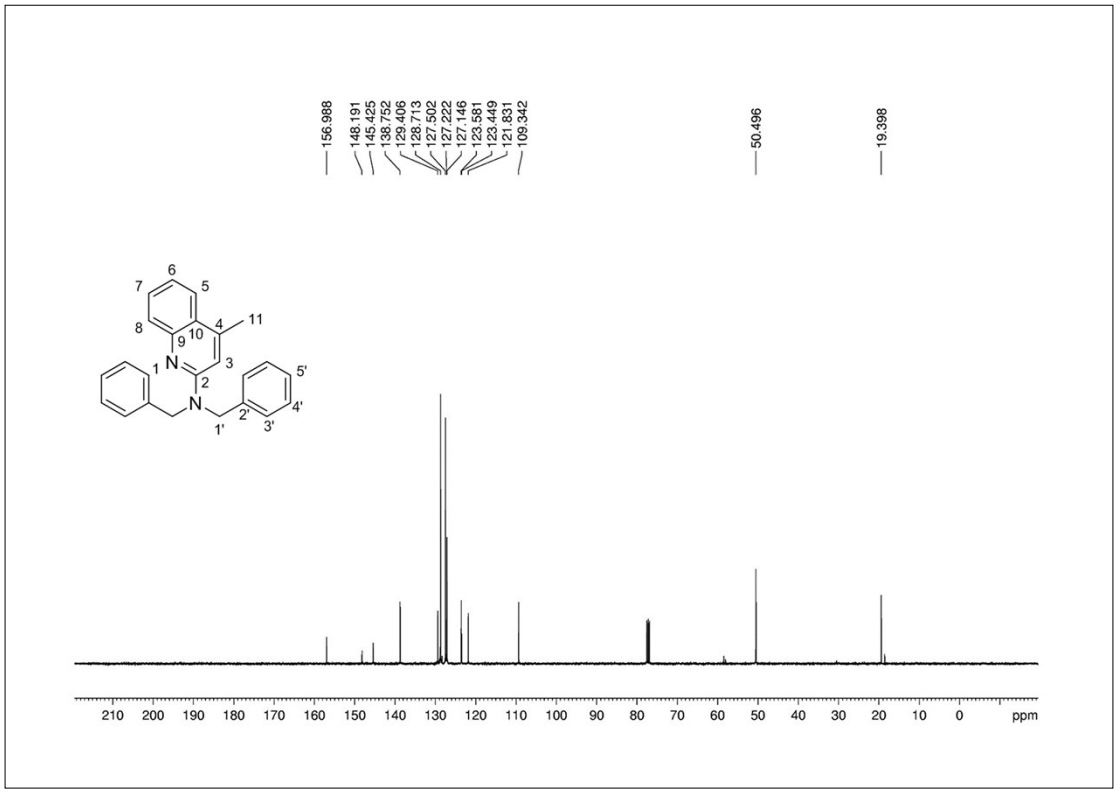


Fig.79 ^{13}C NMR spectrum of compound **3am**

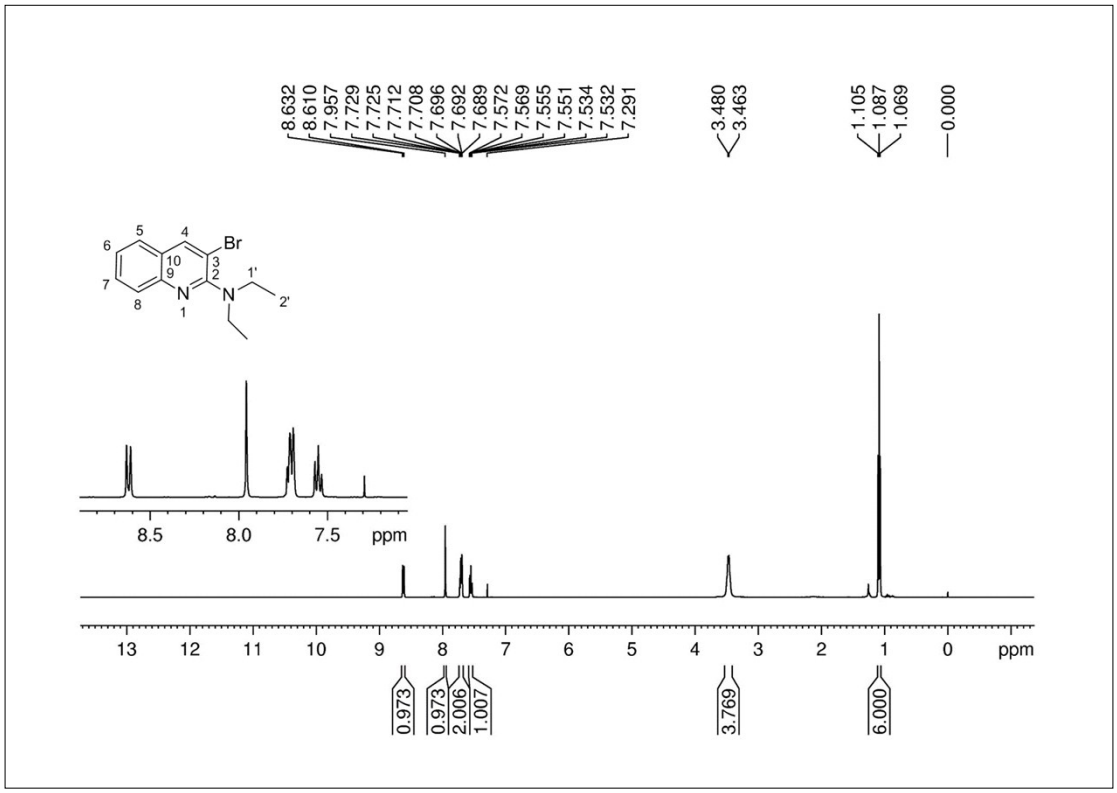


Fig.80 ^{1}H NMR spectrum of compound **3an**

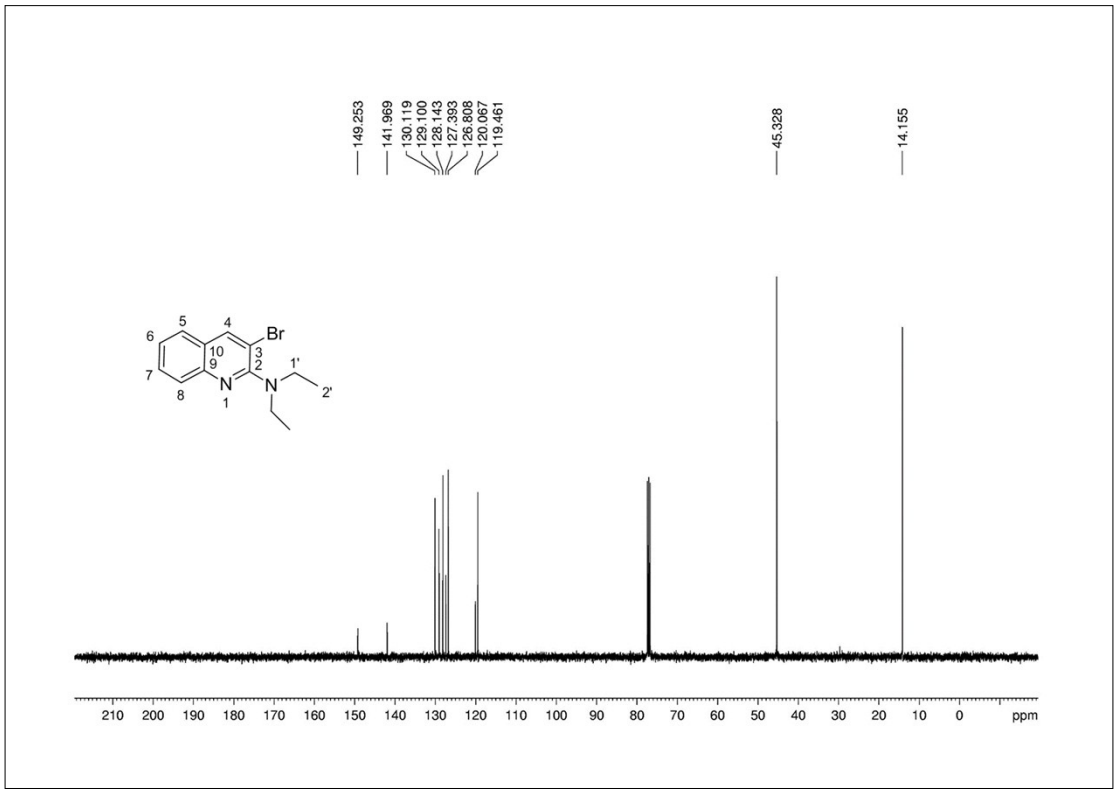


Fig.81 ^{13}C NMR spectrum of compound **3an**

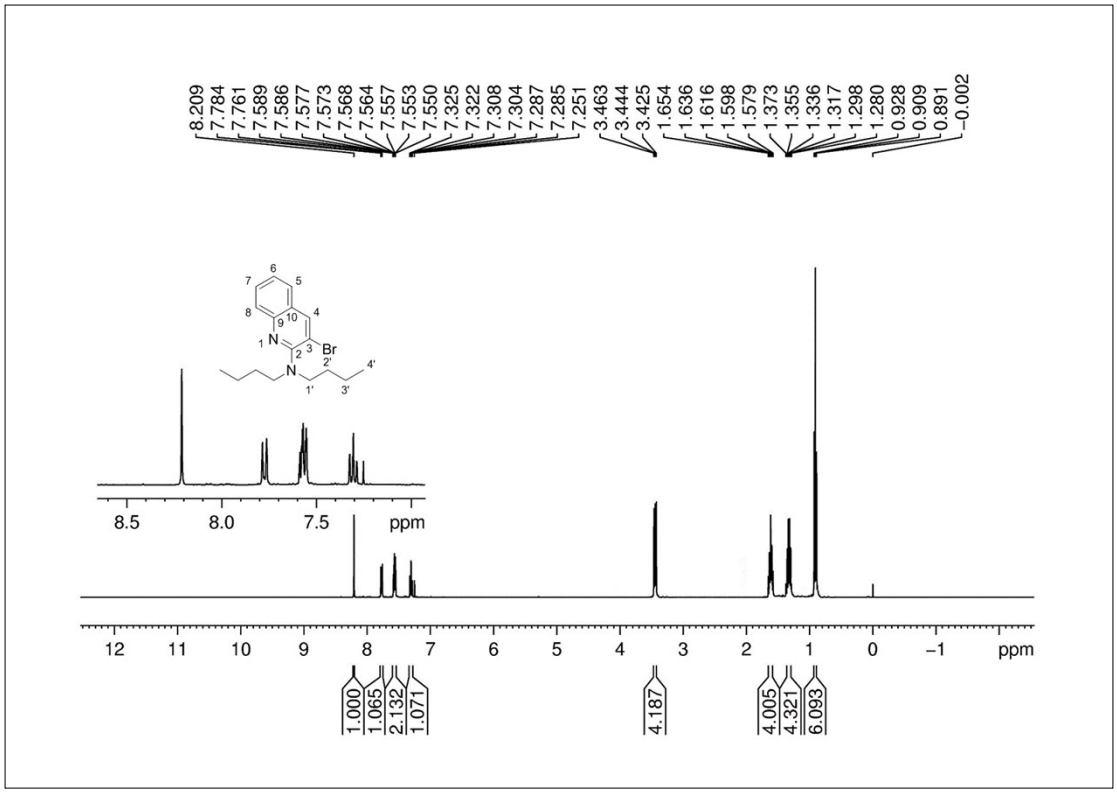


Fig.82 ^{1}H NMR spectrum of compound **3ao**

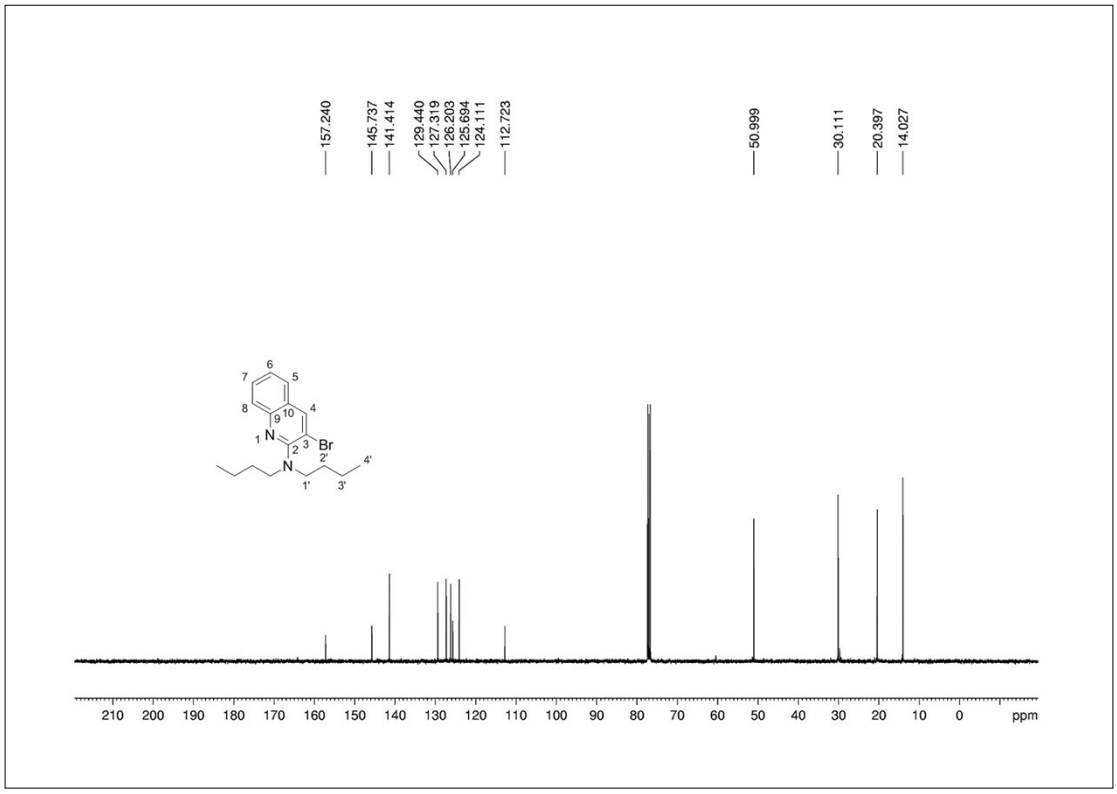


Fig.83 ^{13}C NMR spectrum of compound **3ao**

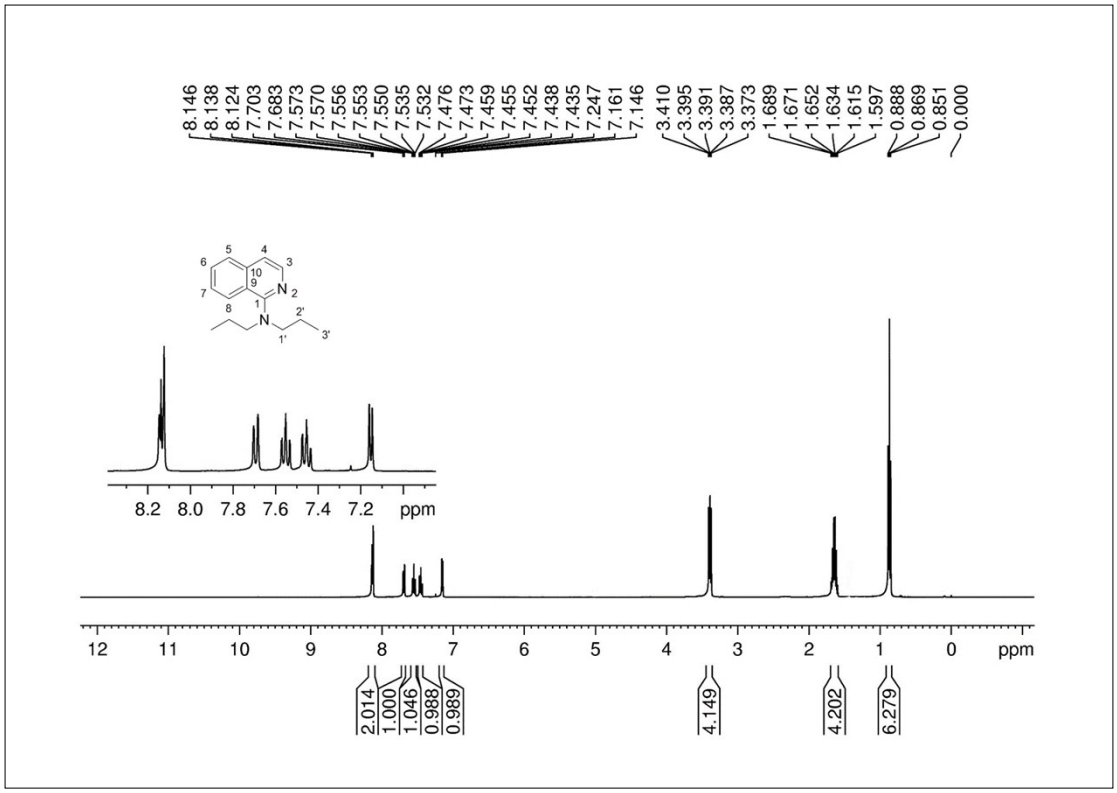


Fig.84 ^{1}H NMR spectrum of compound **3ap**

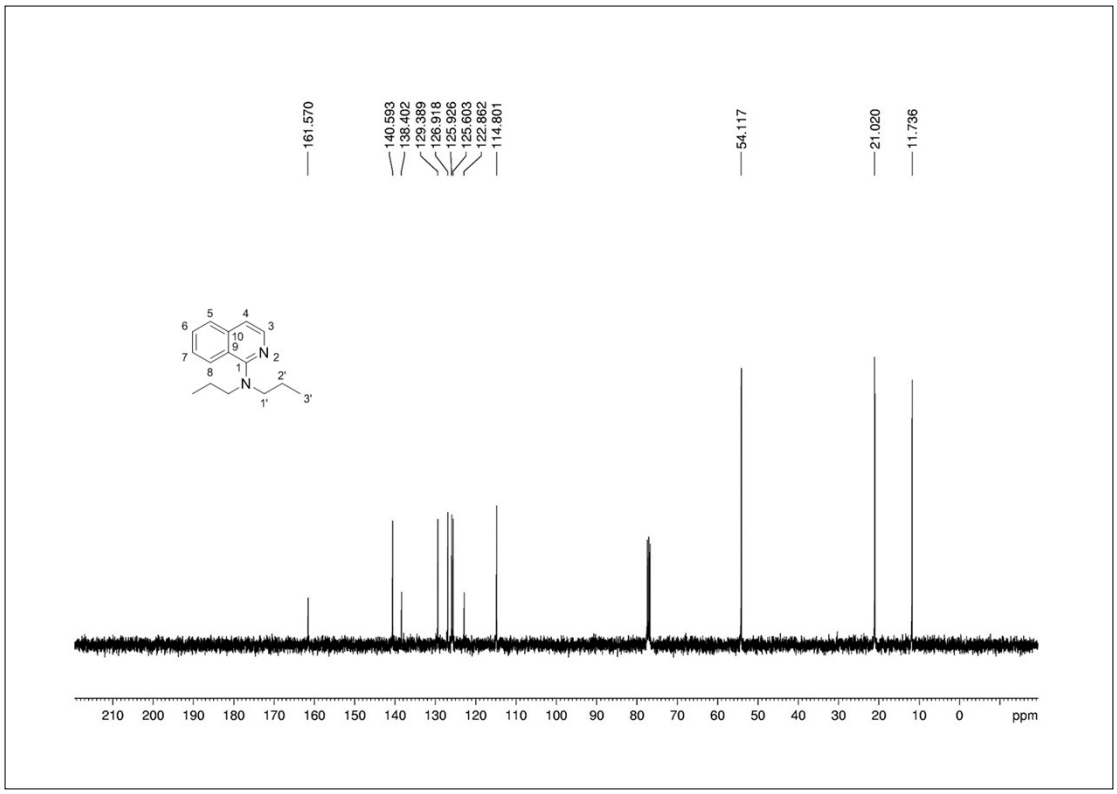


Fig.85 ^{13}C NMR spectrum of compound **3ap**

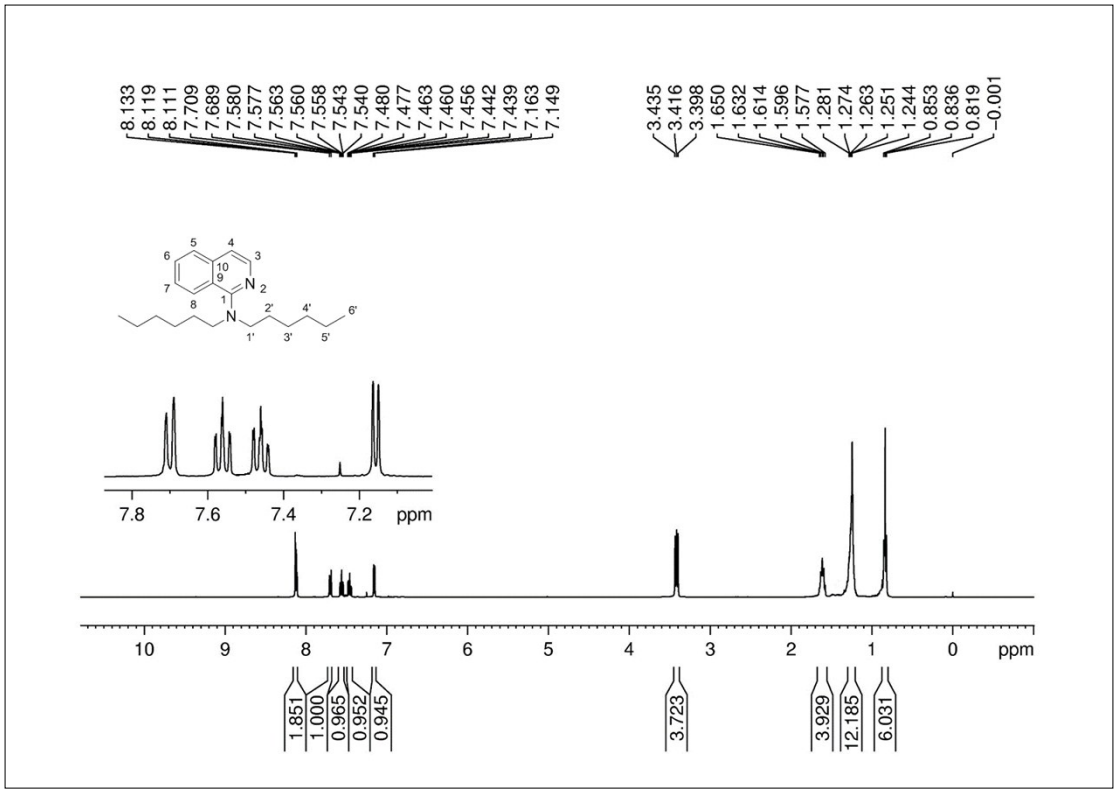


Fig.86 ^{1}H NMR spectrum of compound **3aq**

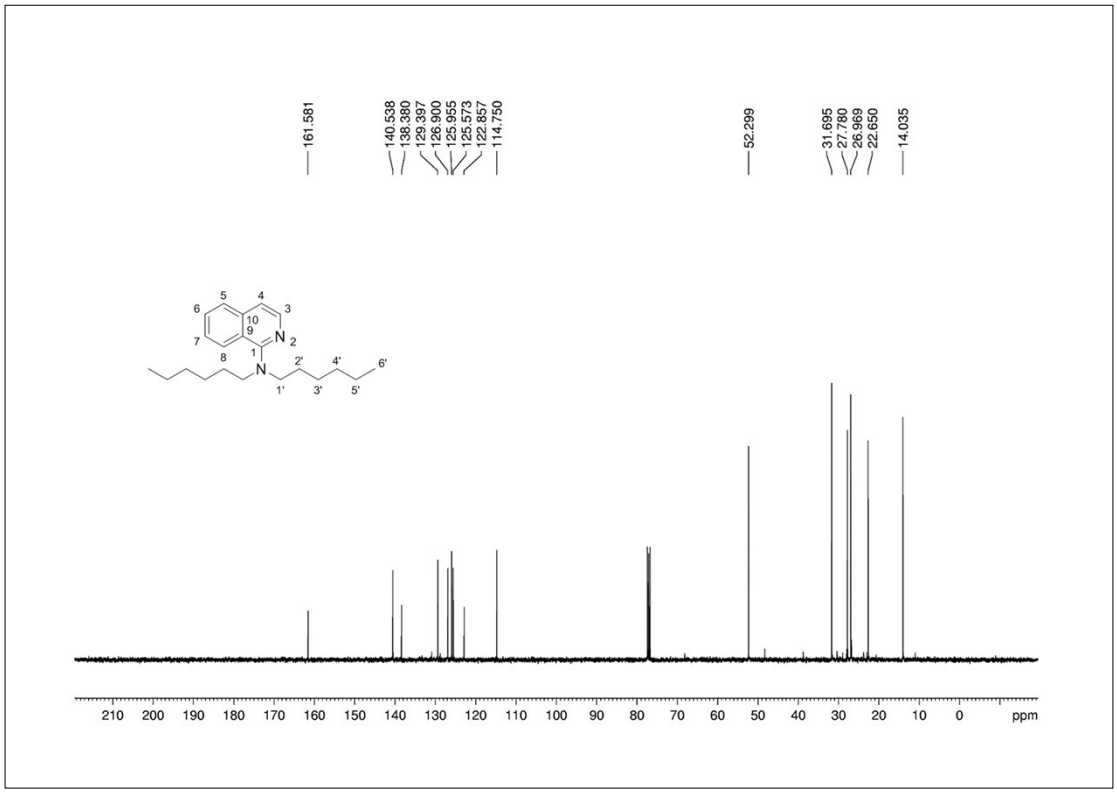


Fig.87 ^{13}C NMR spectrum of compound **3aq**

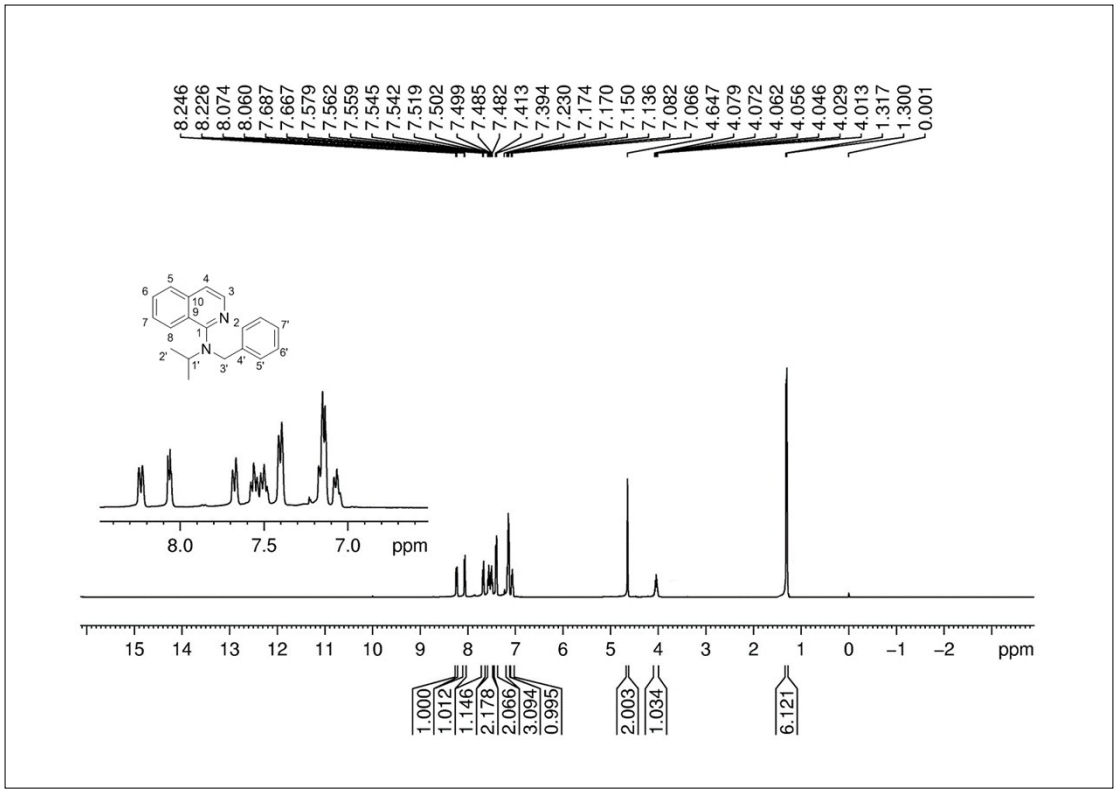


Fig.88 [1]H NMR spectrum of compound **3ar**

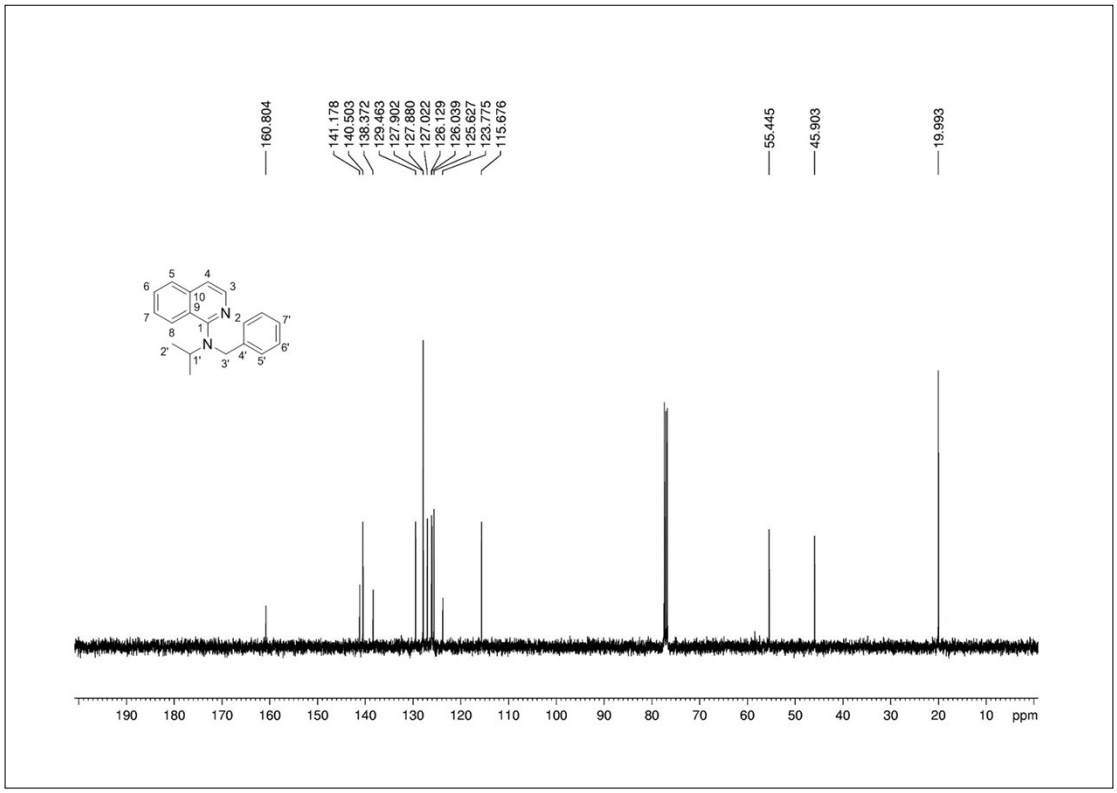


Fig.89 [13]C NMR spectrum of compound **3ar**

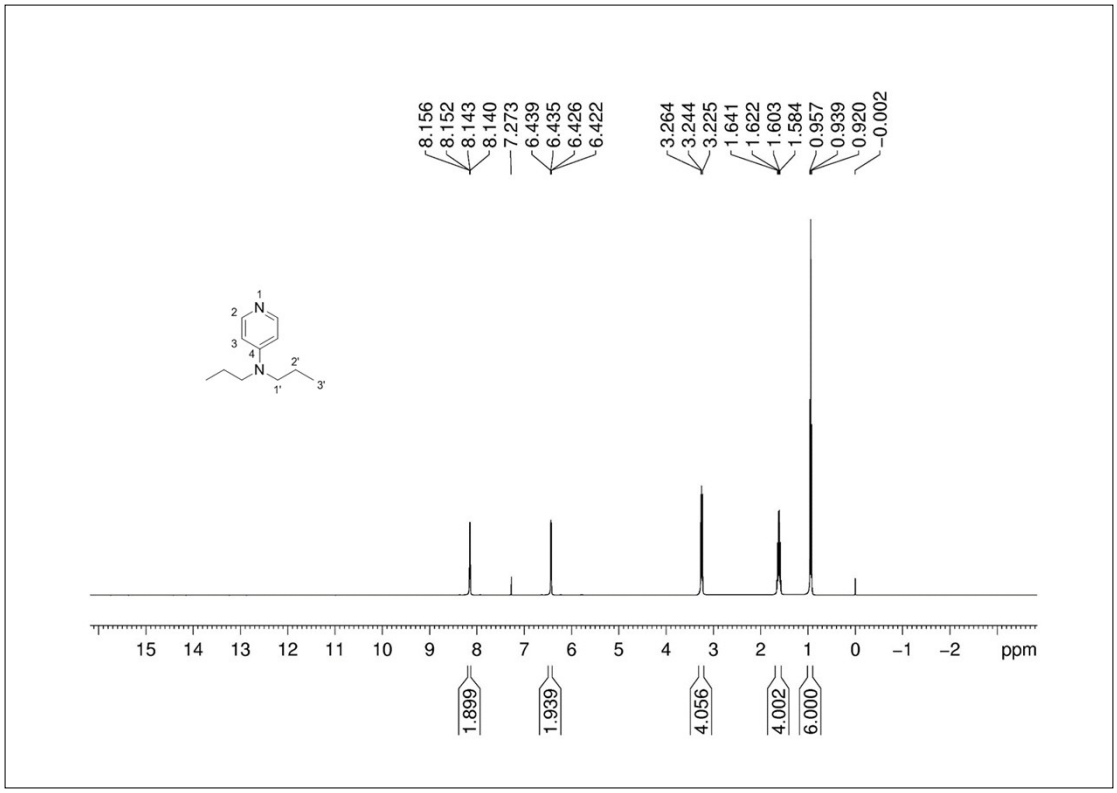


Fig.90 ^{1}H NMR spectrum of compound **3au**

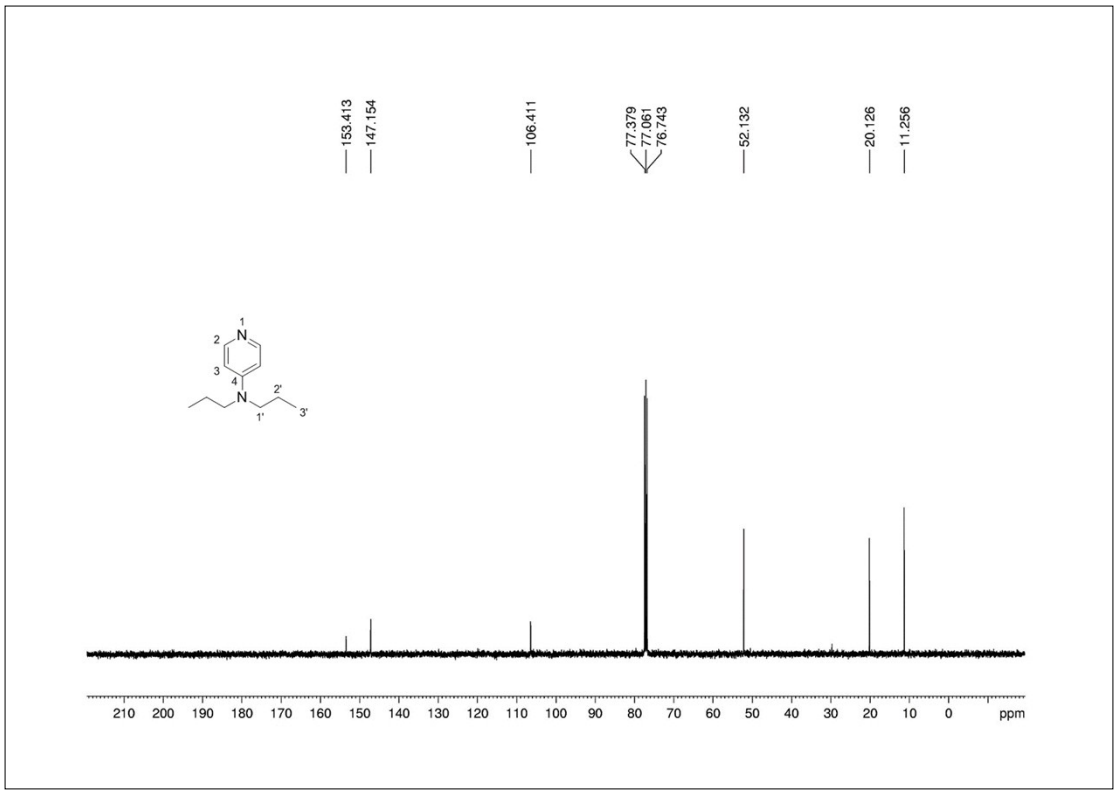


Fig.91 ^{13}C NMR spectrum of compound **3au**

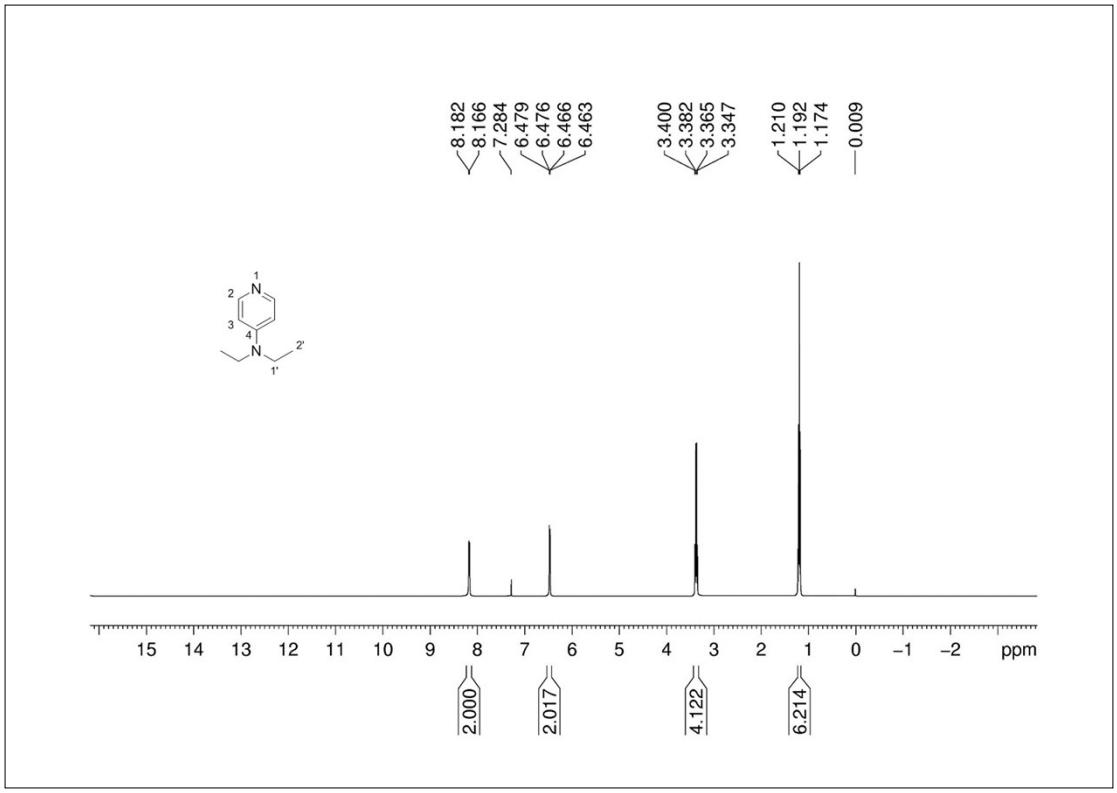


Fig.92 ^{1}H NMR spectrum of compound **3av**

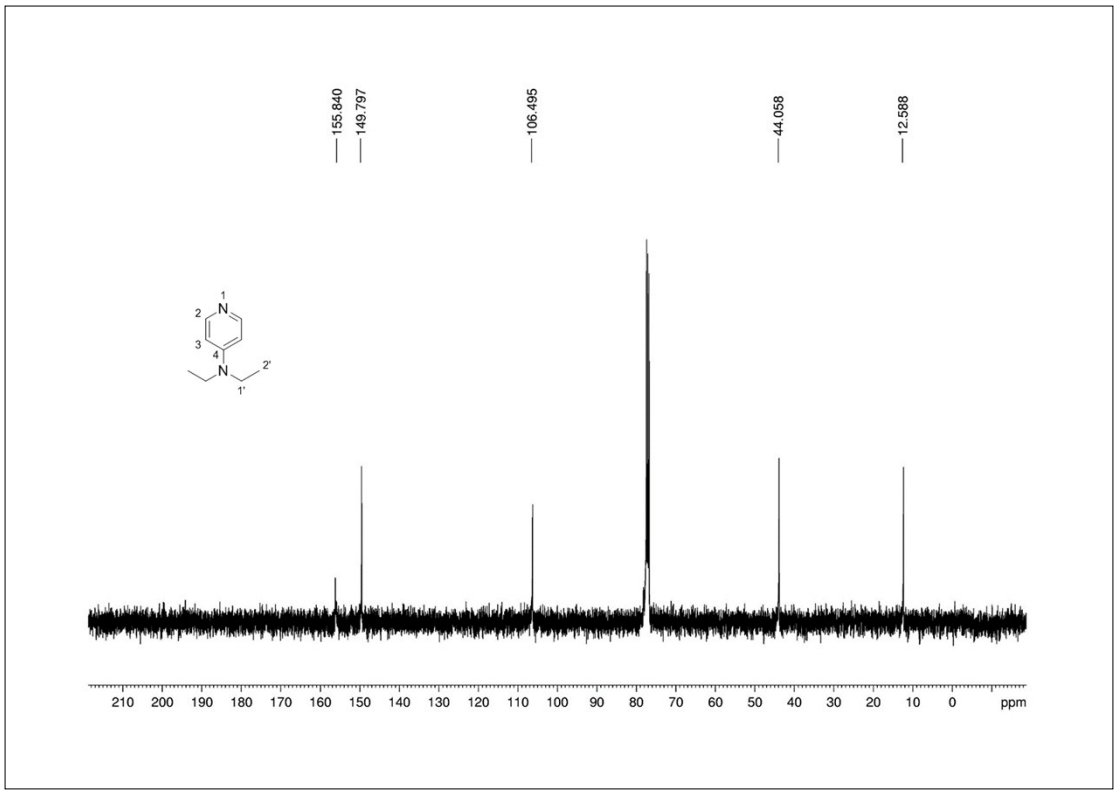


Fig.93 ^{13}C NMR spectrum of compound **3av**

7. ^{1}H NMR and ^{13}C NMR copies of products (5a-5v)

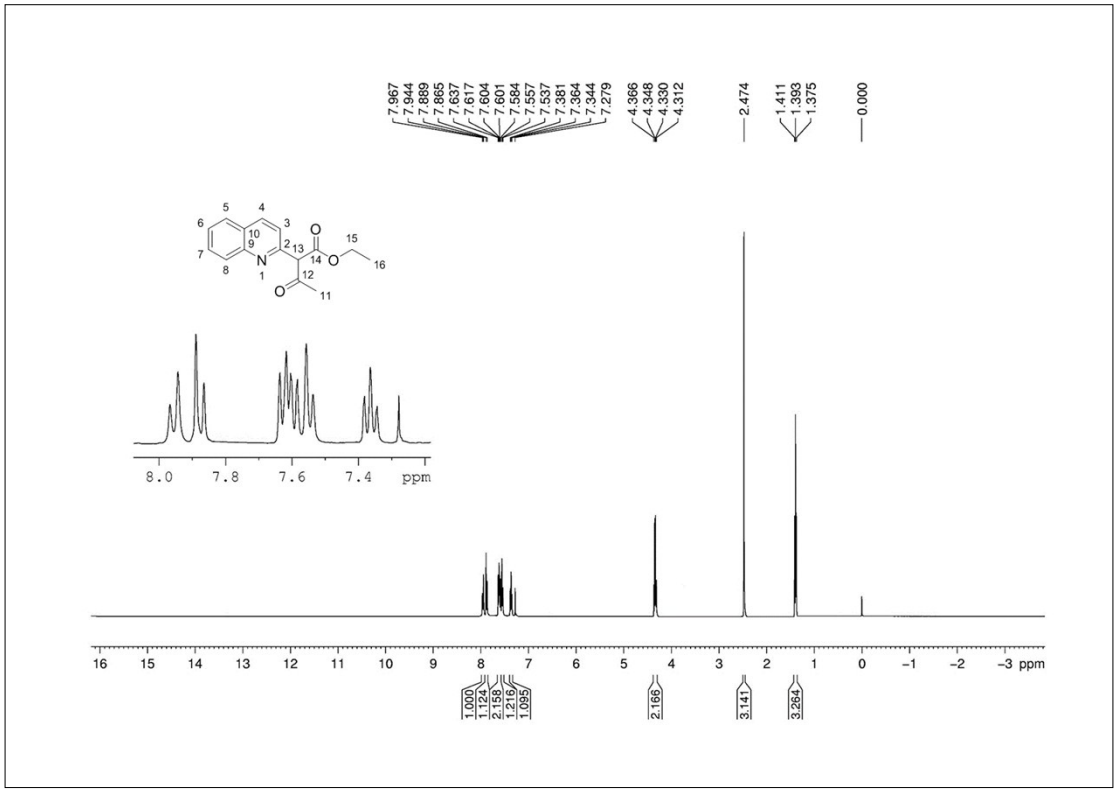


Fig.94 ^{1}H NMR spectrum of compound **5a**

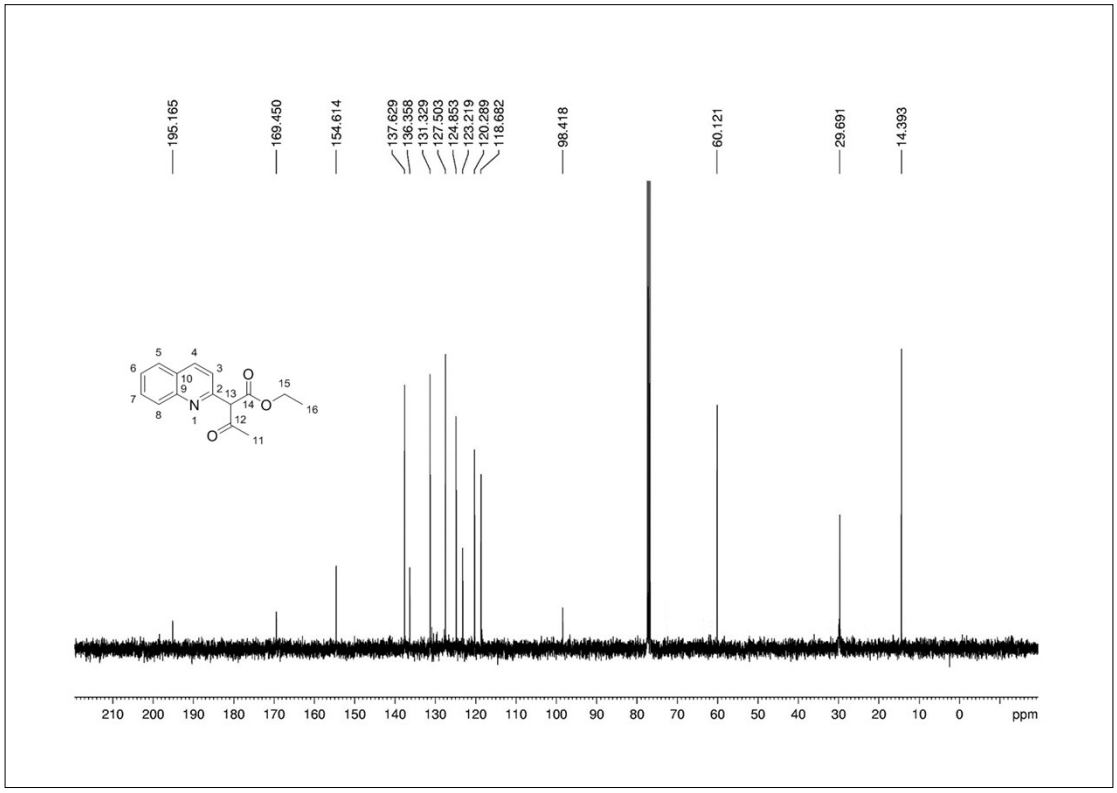


Fig.95 ^{13}C NMR spectrum of compound **5a**

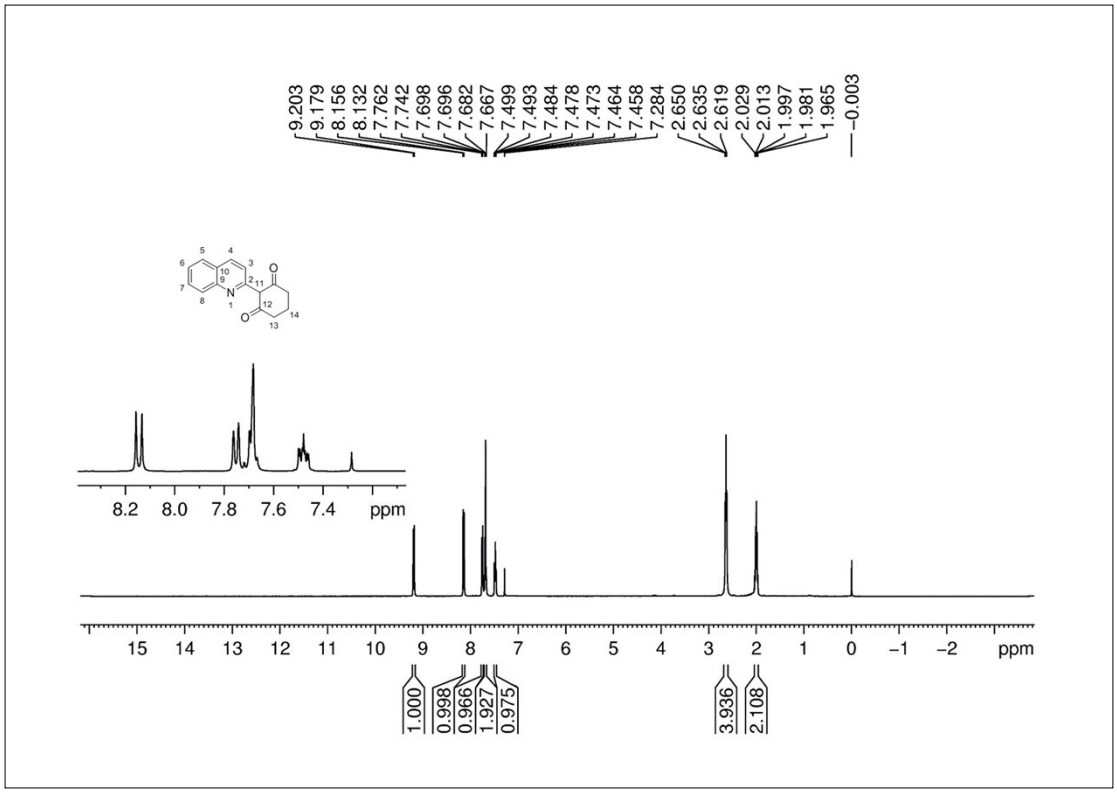


Fig.96 ^{1}H NMR spectrum of compound **5b**

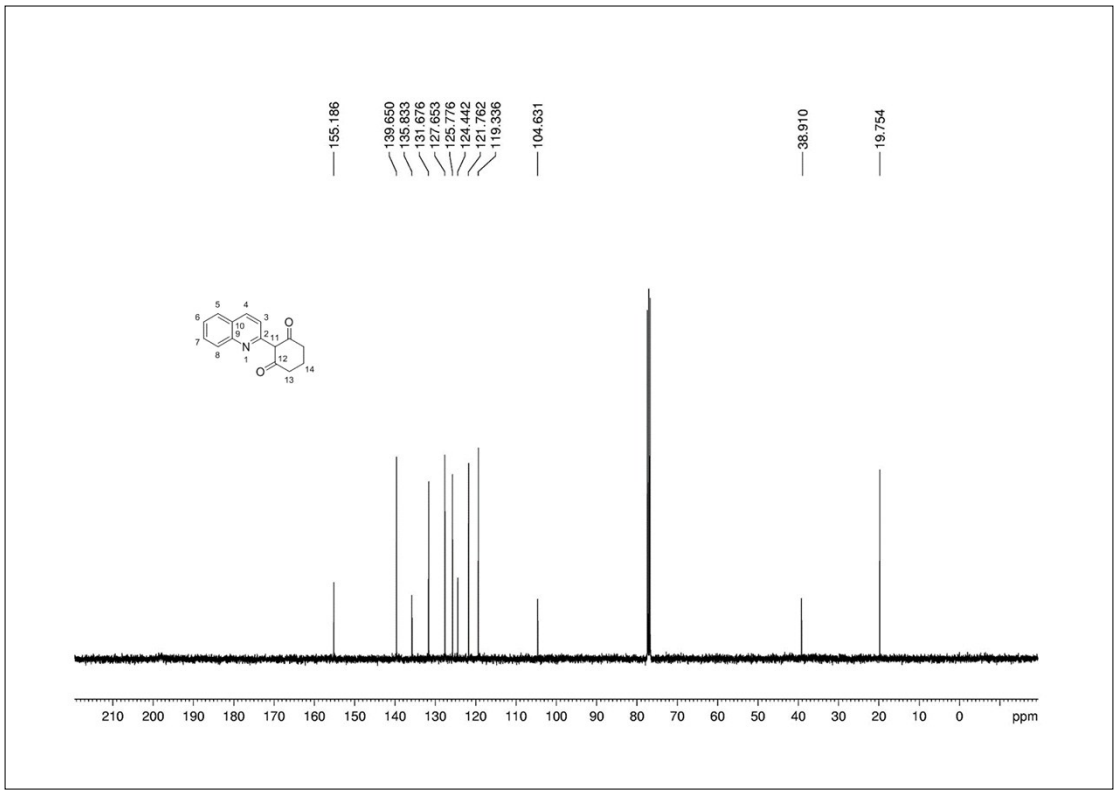


Fig.97 ^{13}C NMR spectrum of compound **5b**

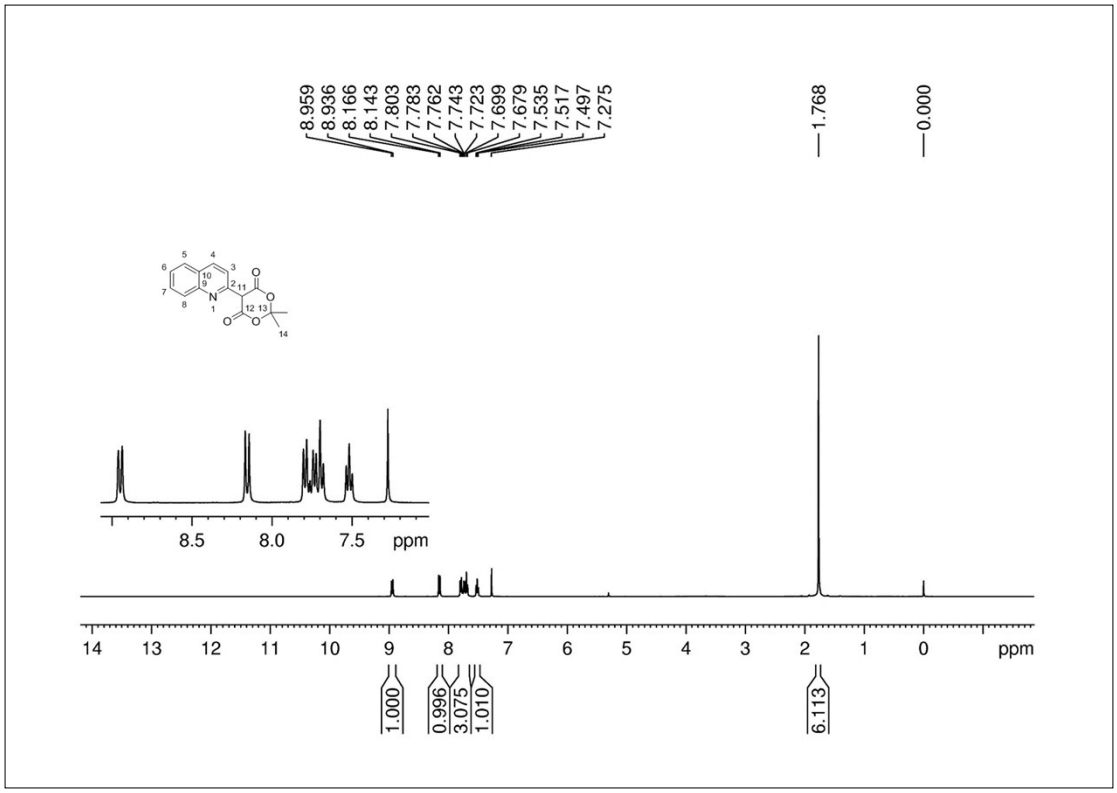


Fig.98 [1]H NMR spectrum of compound **5c**

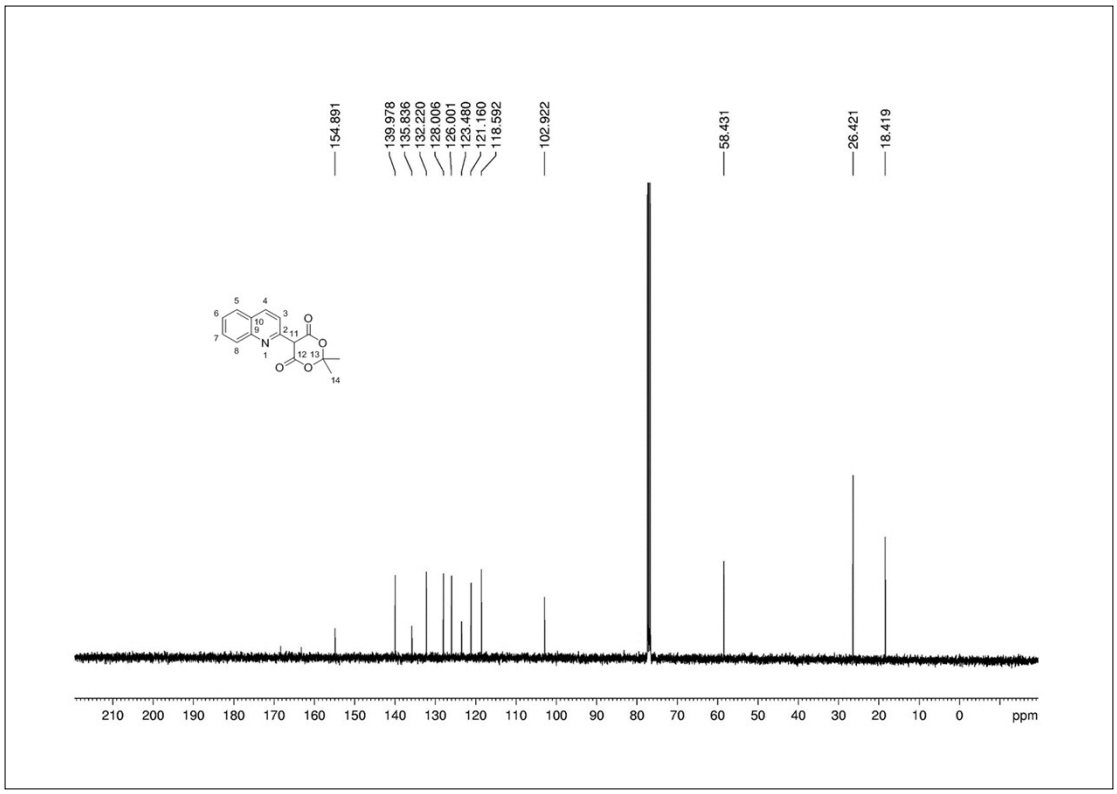


Fig.99 [13]C NMR spectrum of compound **5c**

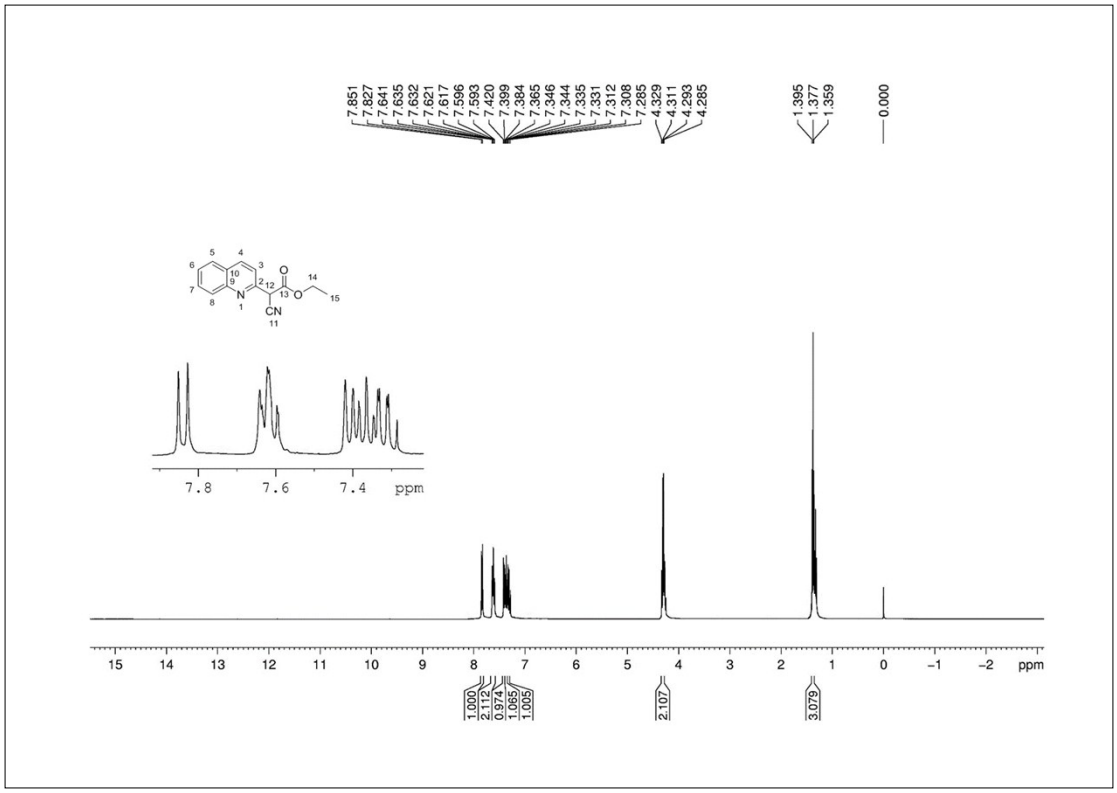


Fig.100 [1]H NMR spectrum of compound **5d**

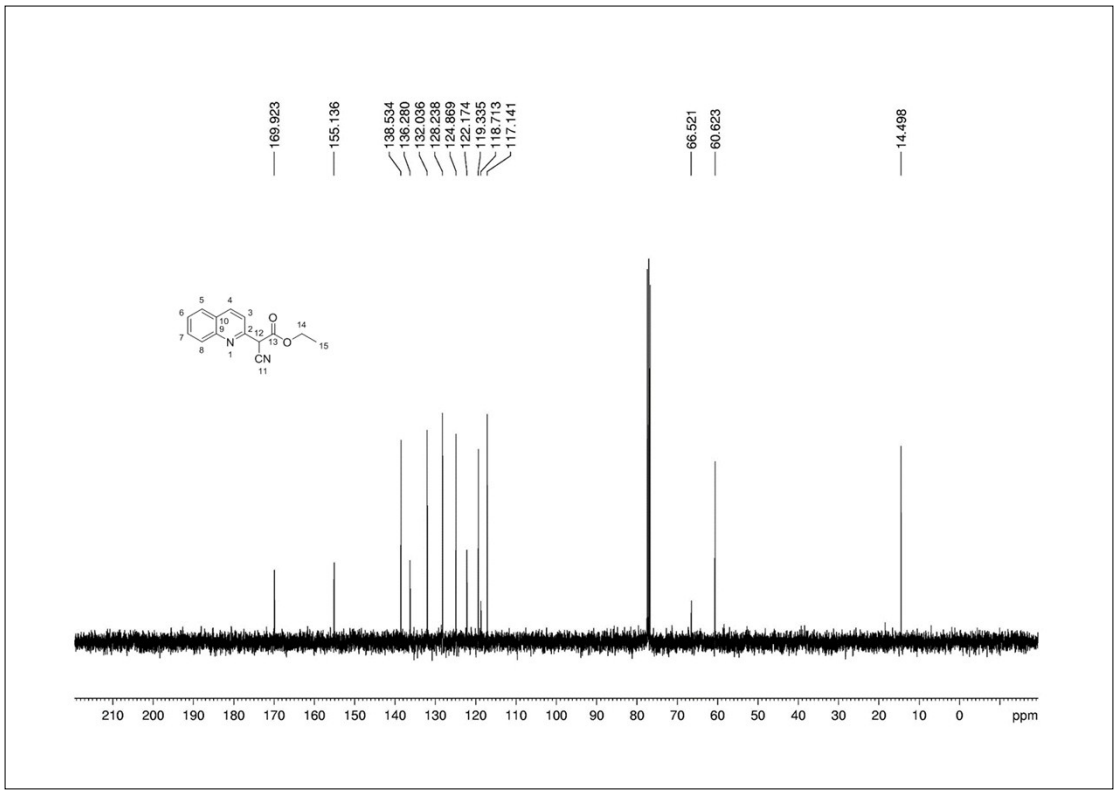


Fig.101 [13]C NMR spectrum of compound **5d**

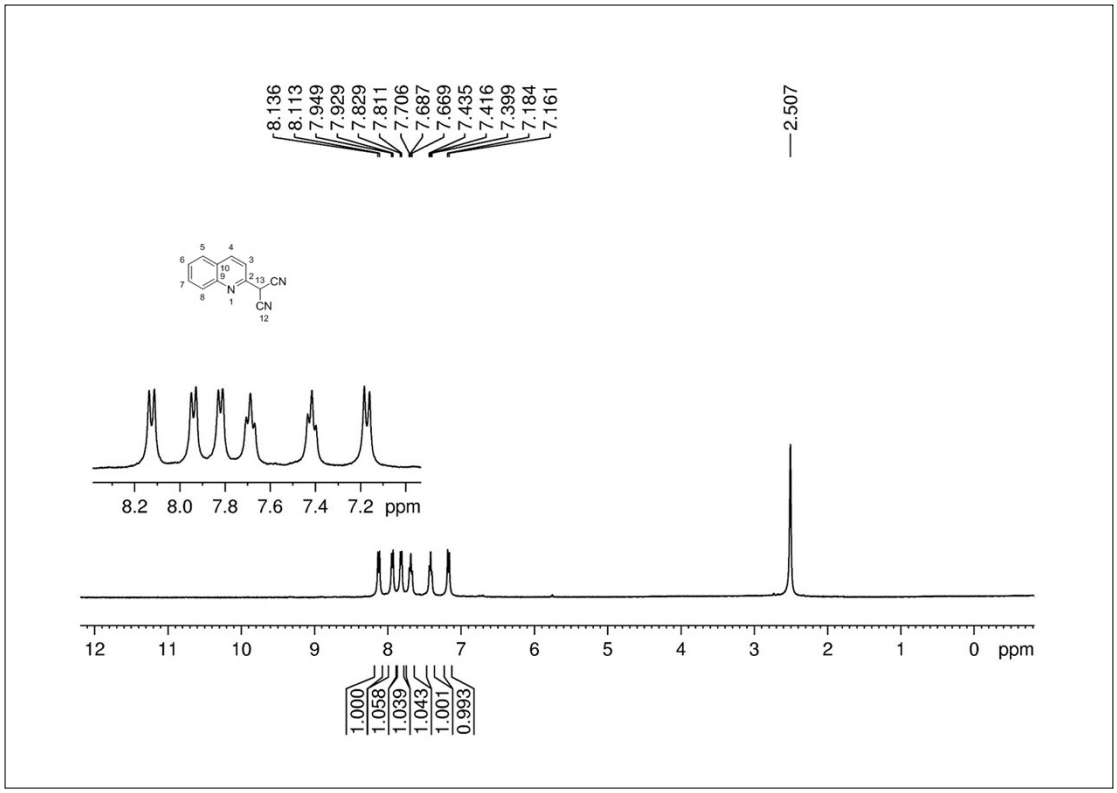


Fig.102 [1]H NMR spectrum of compound **5e**

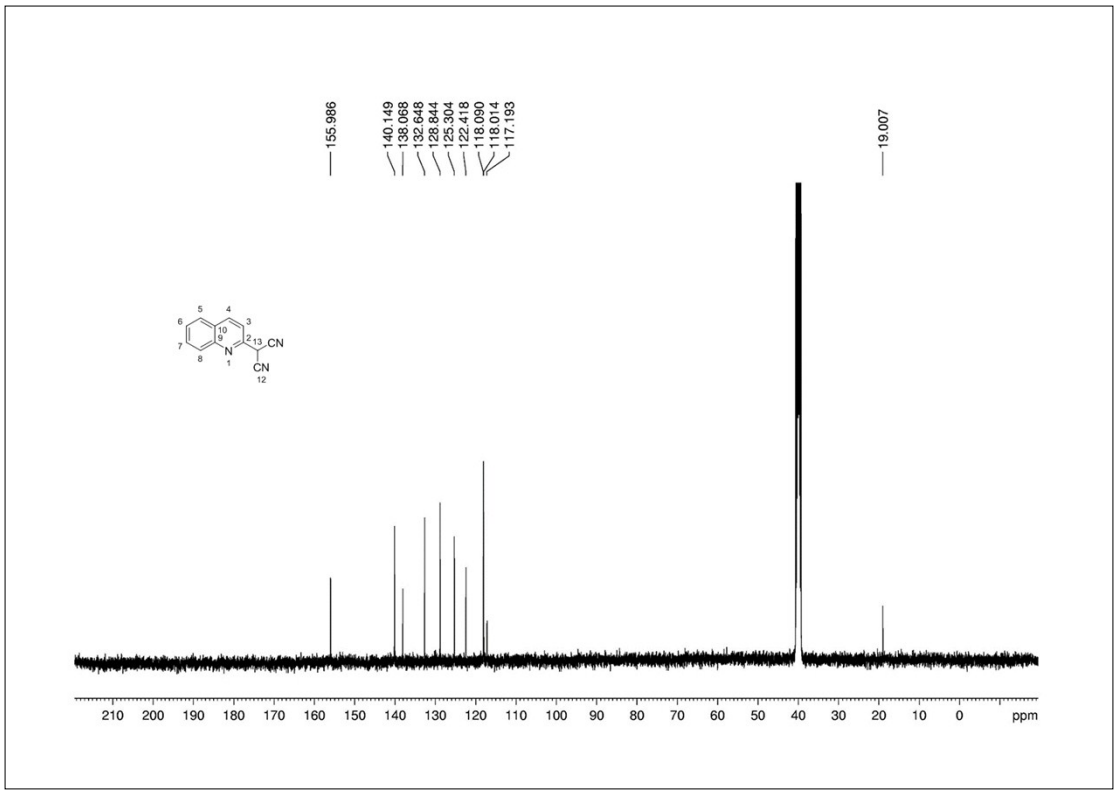


Fig.103 [13]C NMR spectrum of compound **5e**

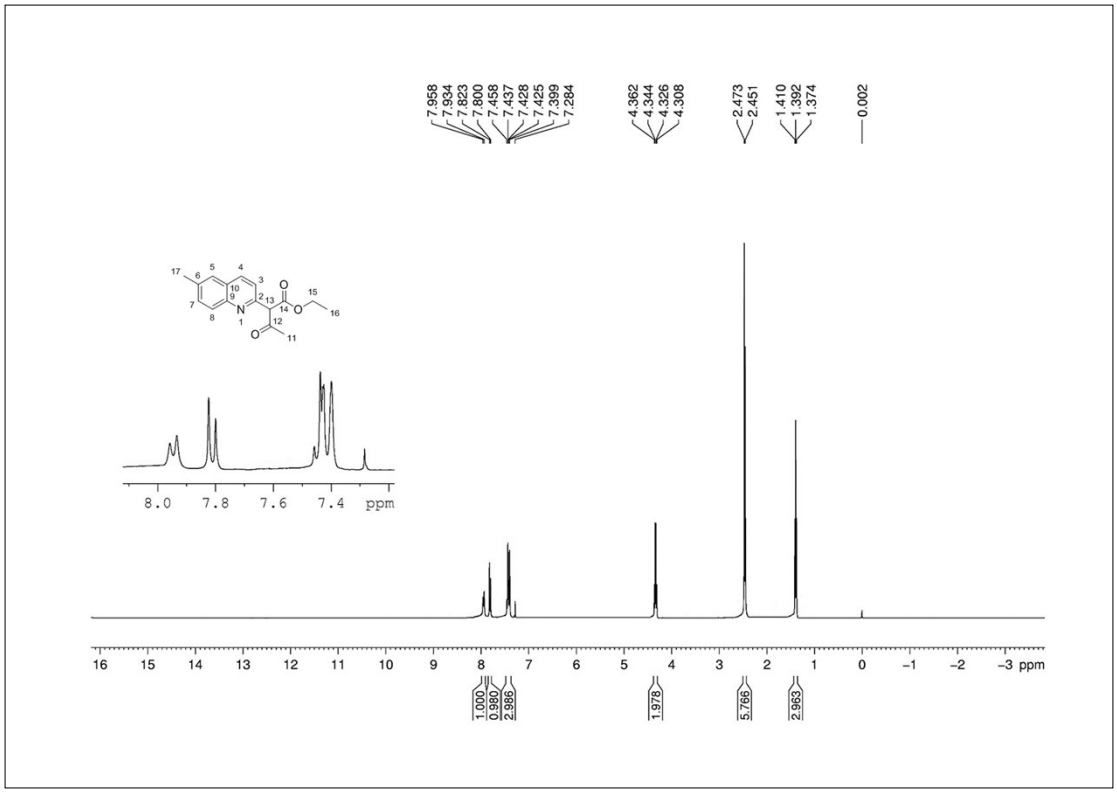


Fig.104 ^{1}H NMR spectrum of compound **5f**

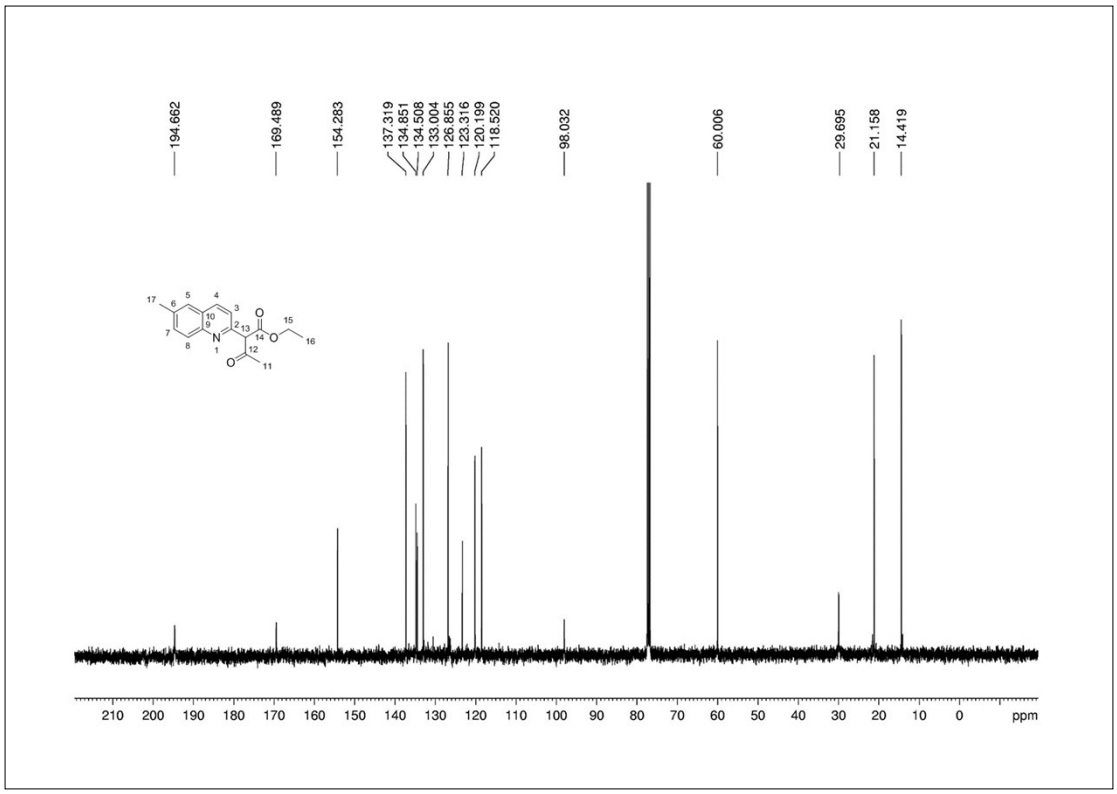


Fig.105 ^{13}C NMR spectrum of compound **5f**

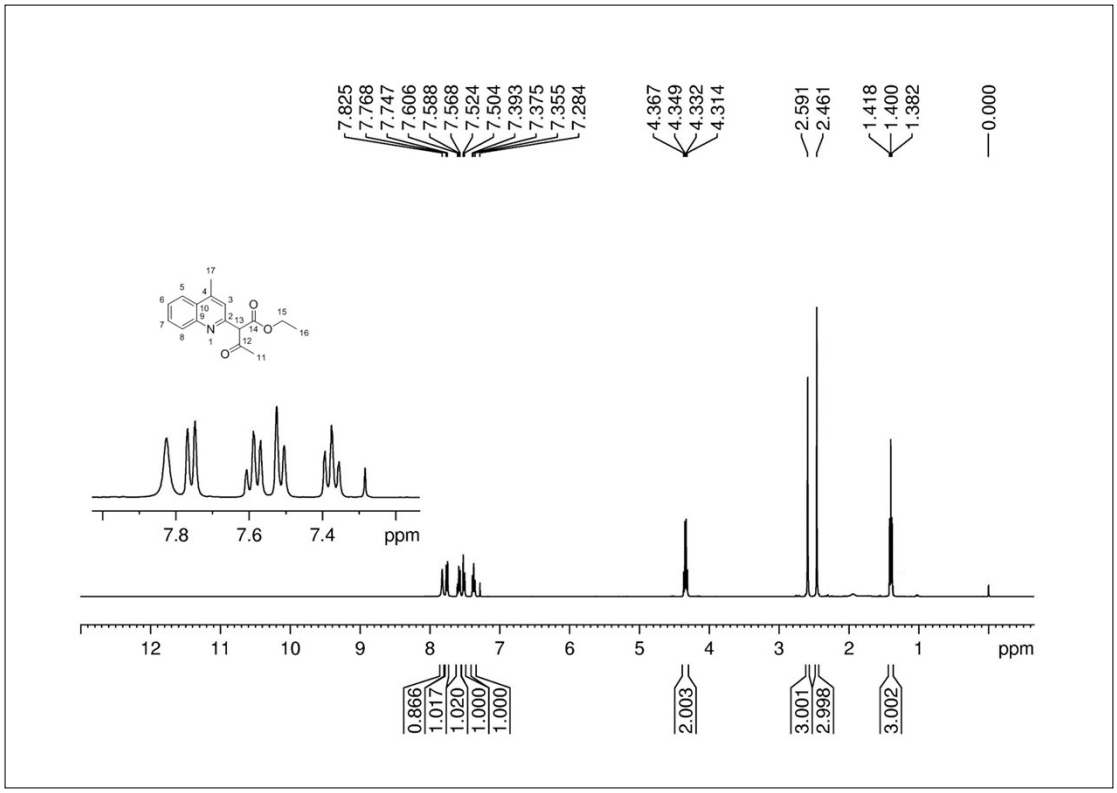


Fig.106 [1]H NMR spectrum of compound **5g**

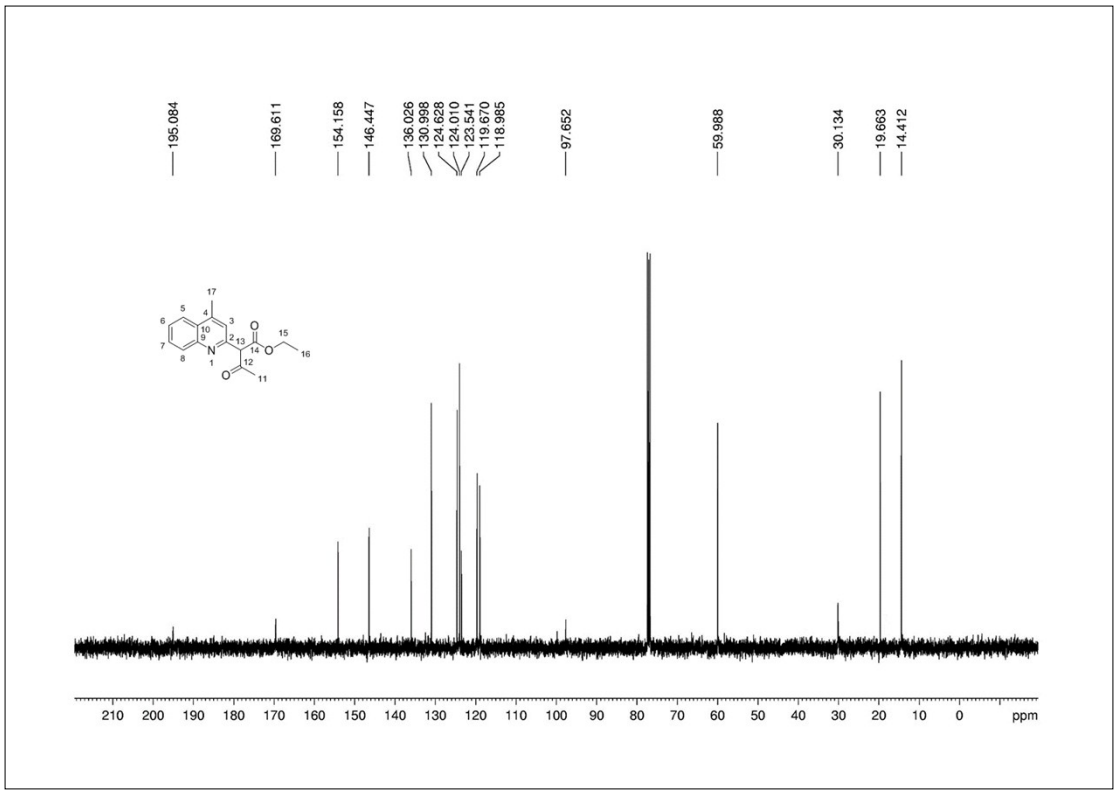


Fig.107 [13]C NMR spectrum of compound **5g**

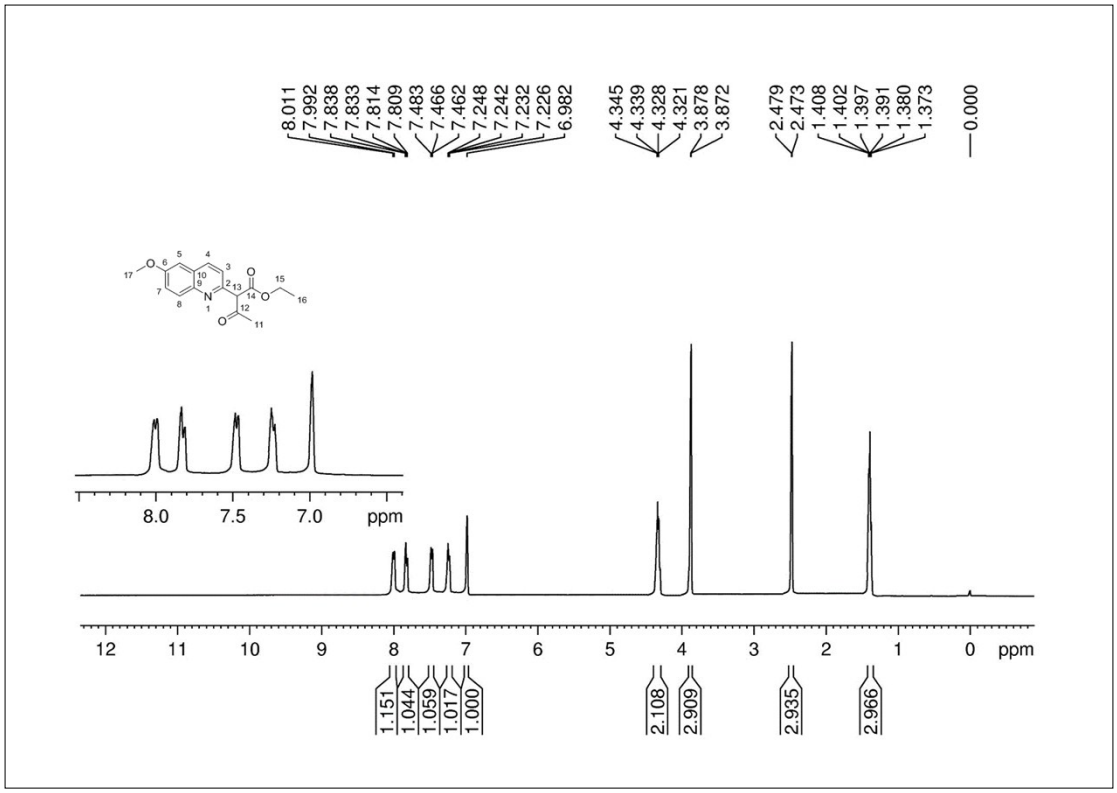


Fig.108 [1]H NMR spectrum of compound **5h**

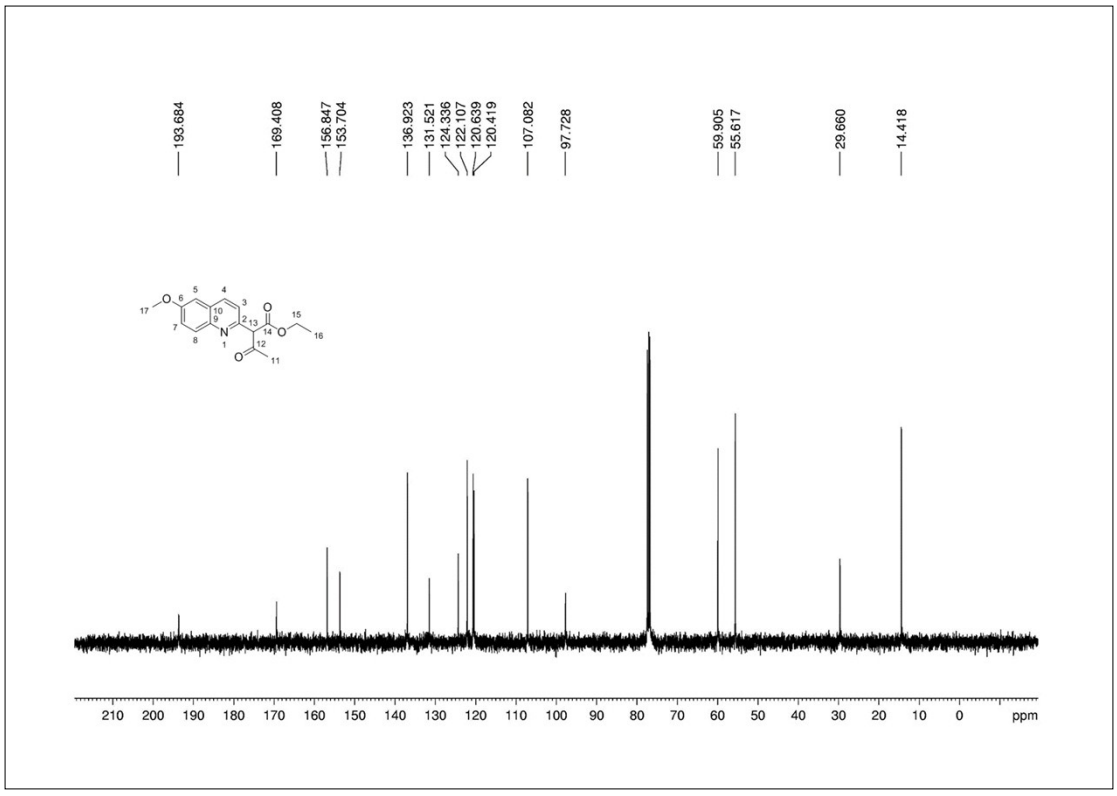


Fig.109 [13]C NMR spectrum of compound **5h**

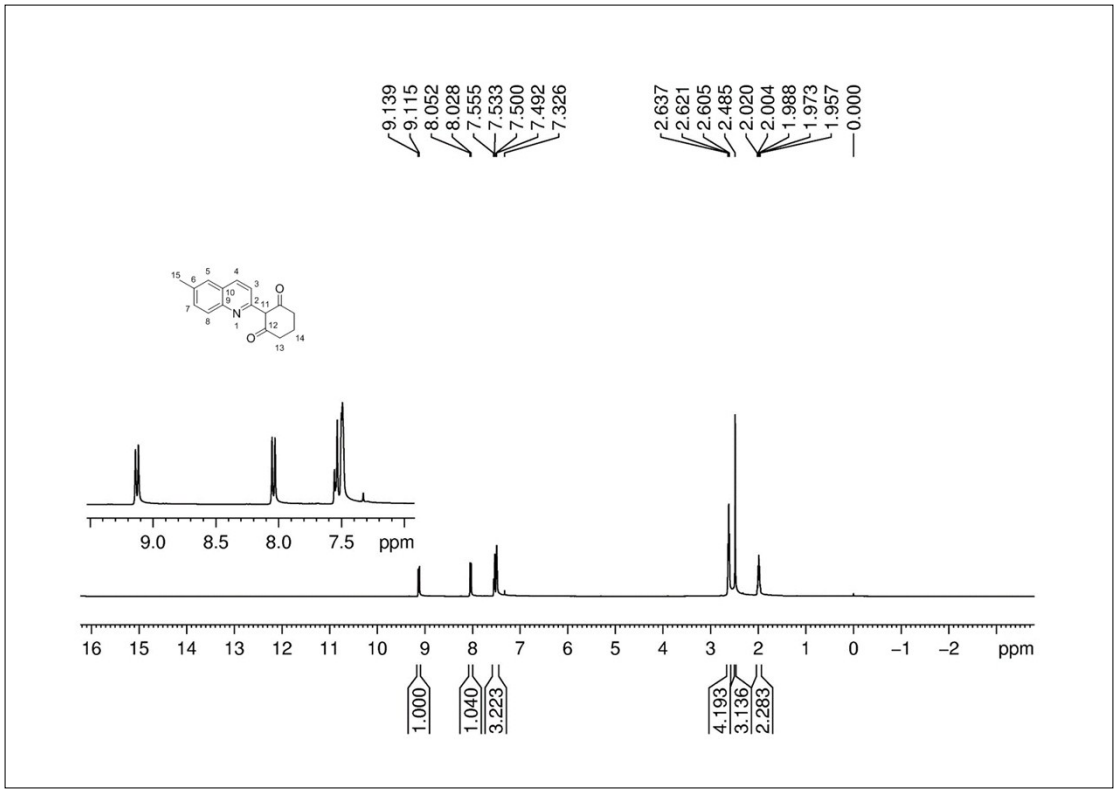


Fig.110 [1]H NMR spectrum of compound **5i**

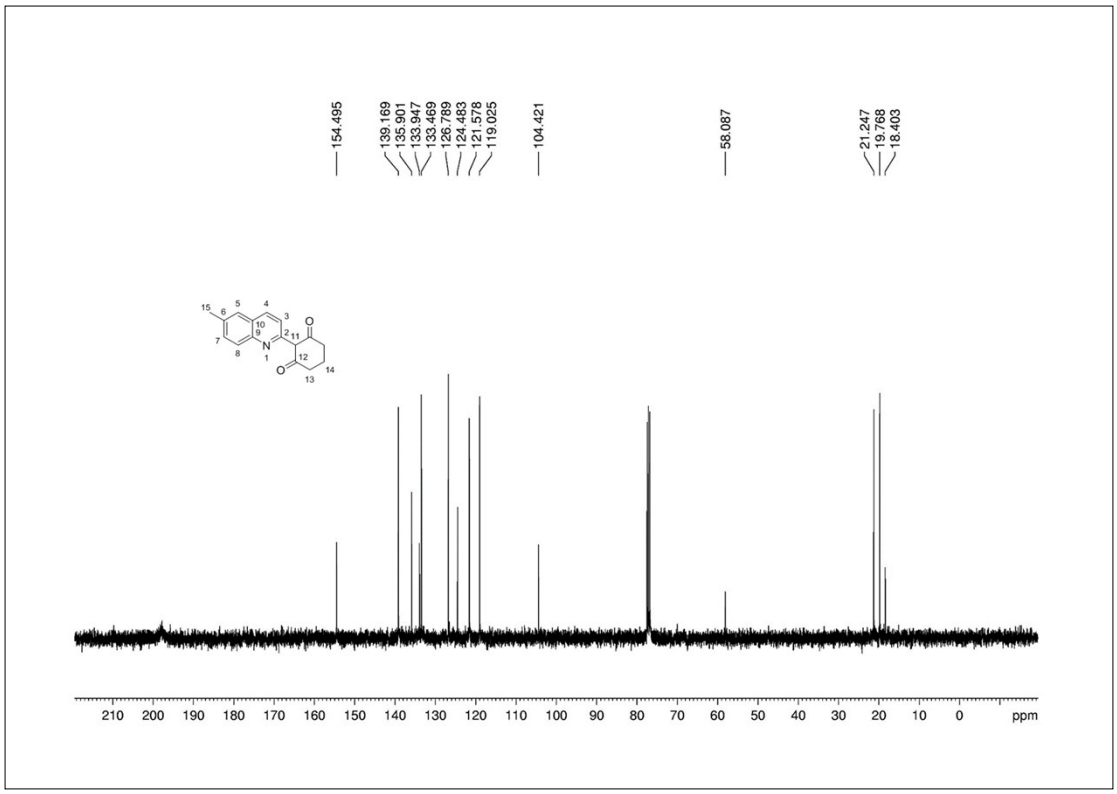


Fig.111 [13]C NMR spectrum of compound **5i**

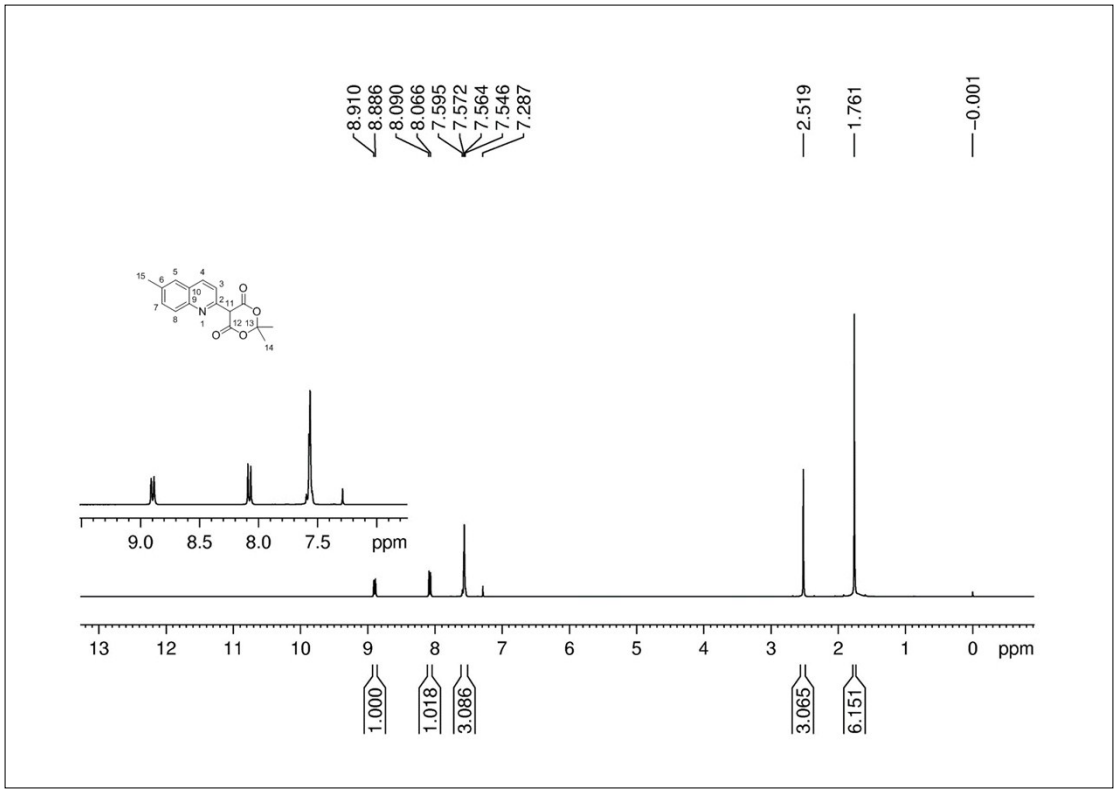


Fig.112 [1]H NMR spectrum of compound **5j**

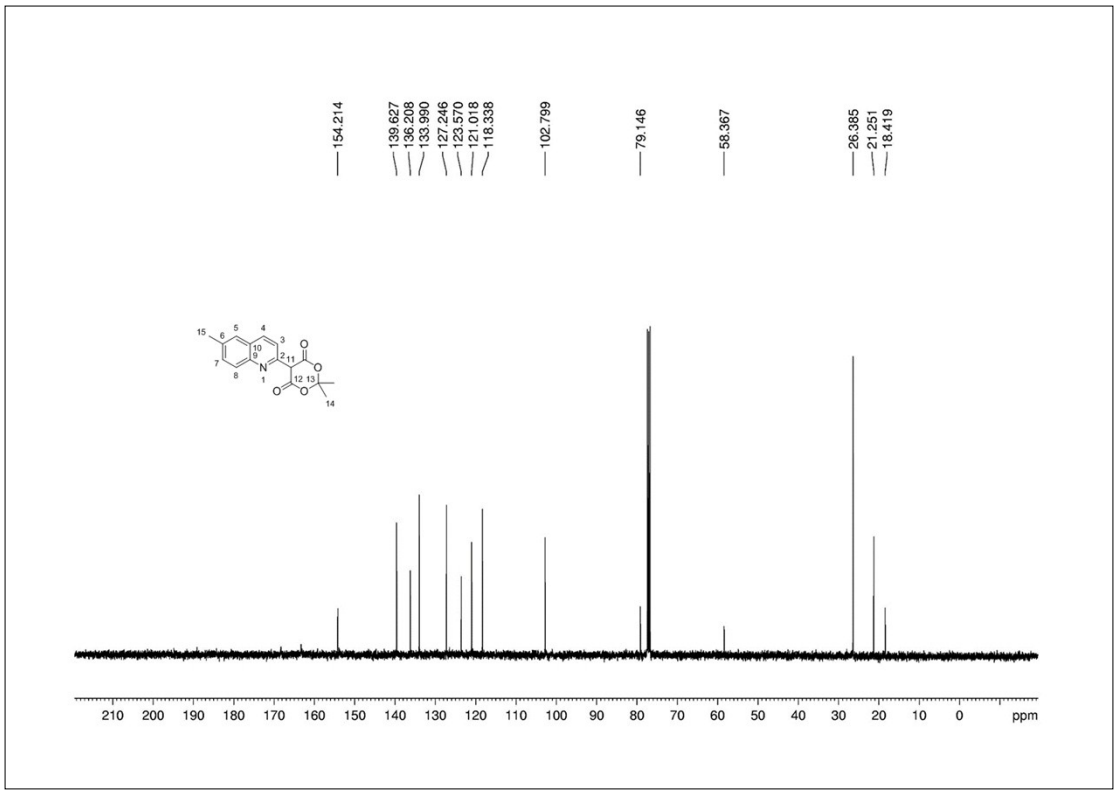


Fig.113 [13]C NMR spectrum of compound **5j**

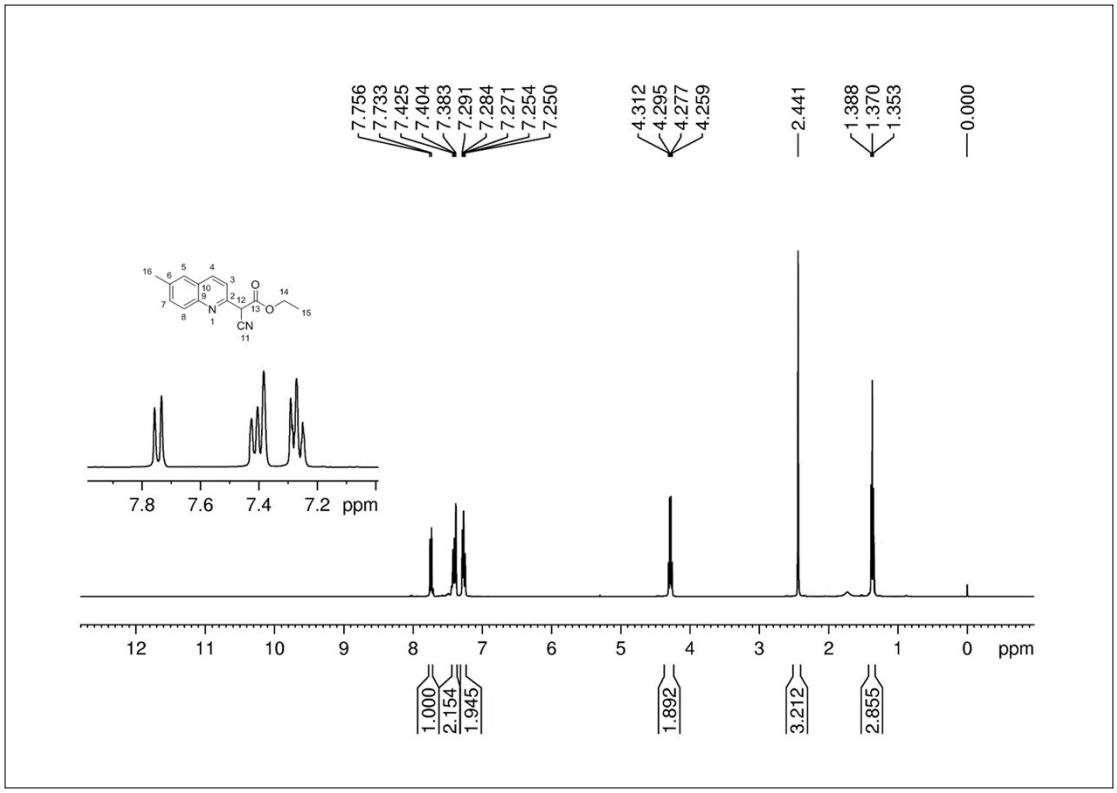


Fig.114 [1]H NMR spectrum of compound **5k**

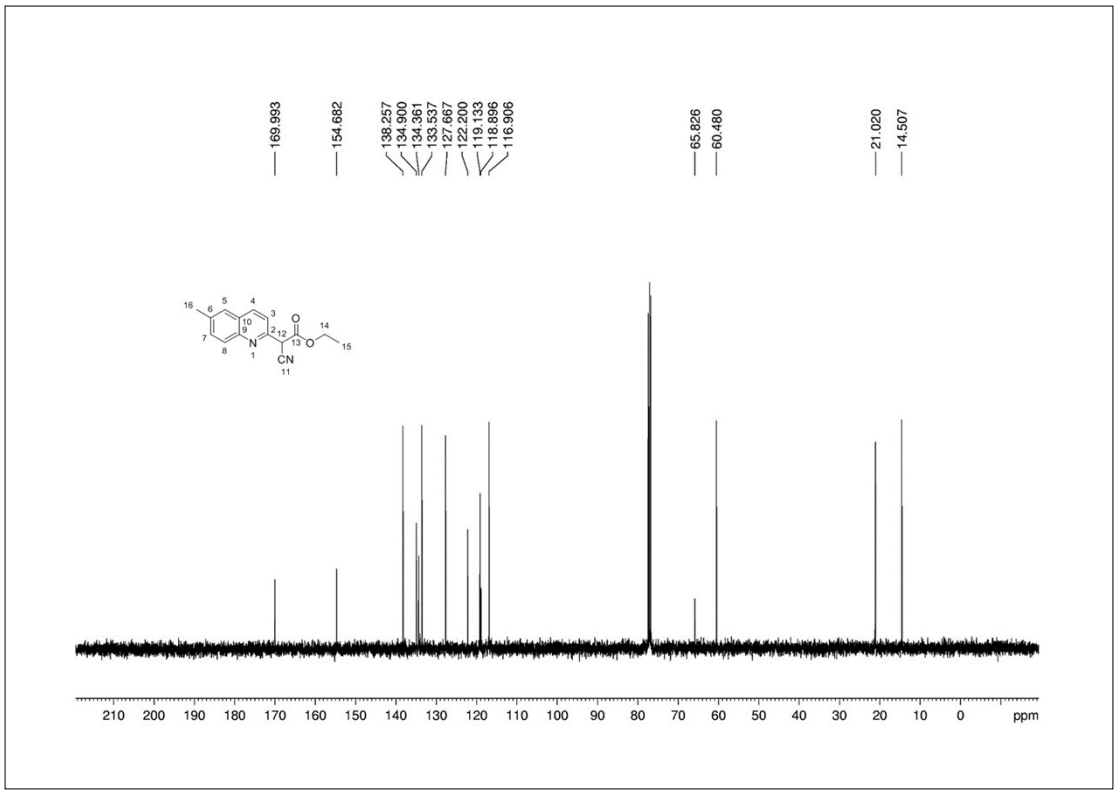


Fig.115 [13]C NMR spectrum of compound **5k**

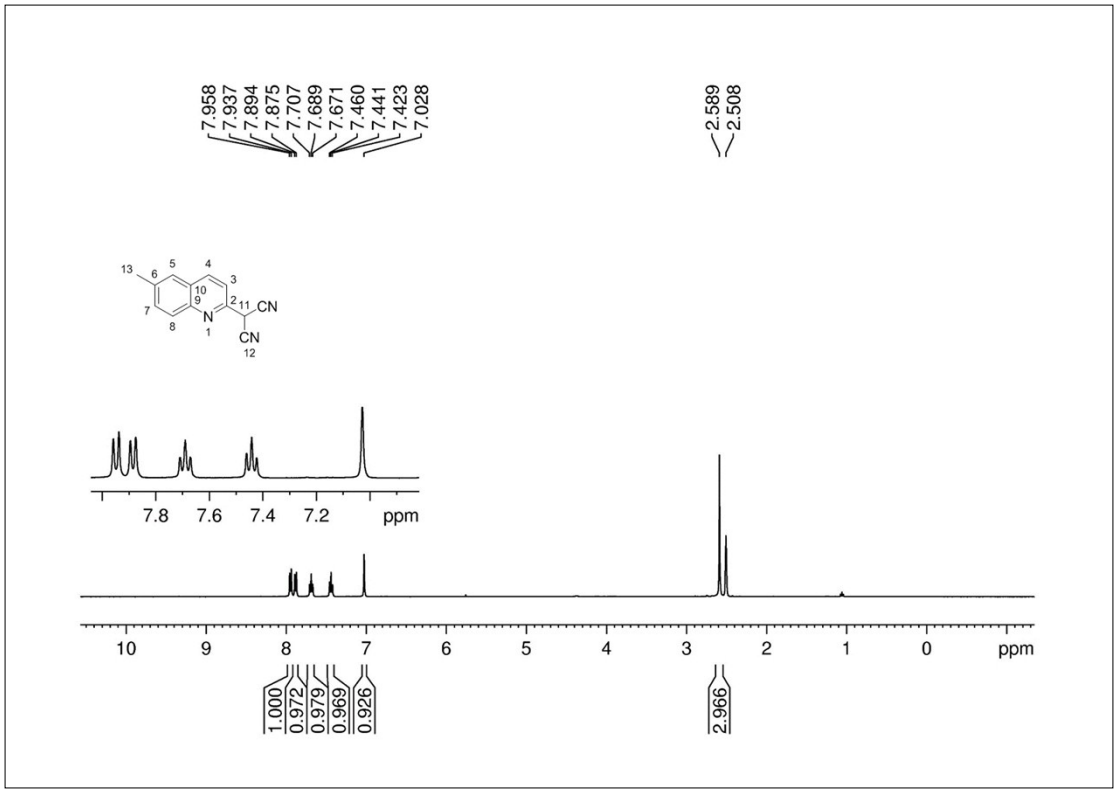


Fig.116 ^{1}H NMR spectrum of compound **5l**

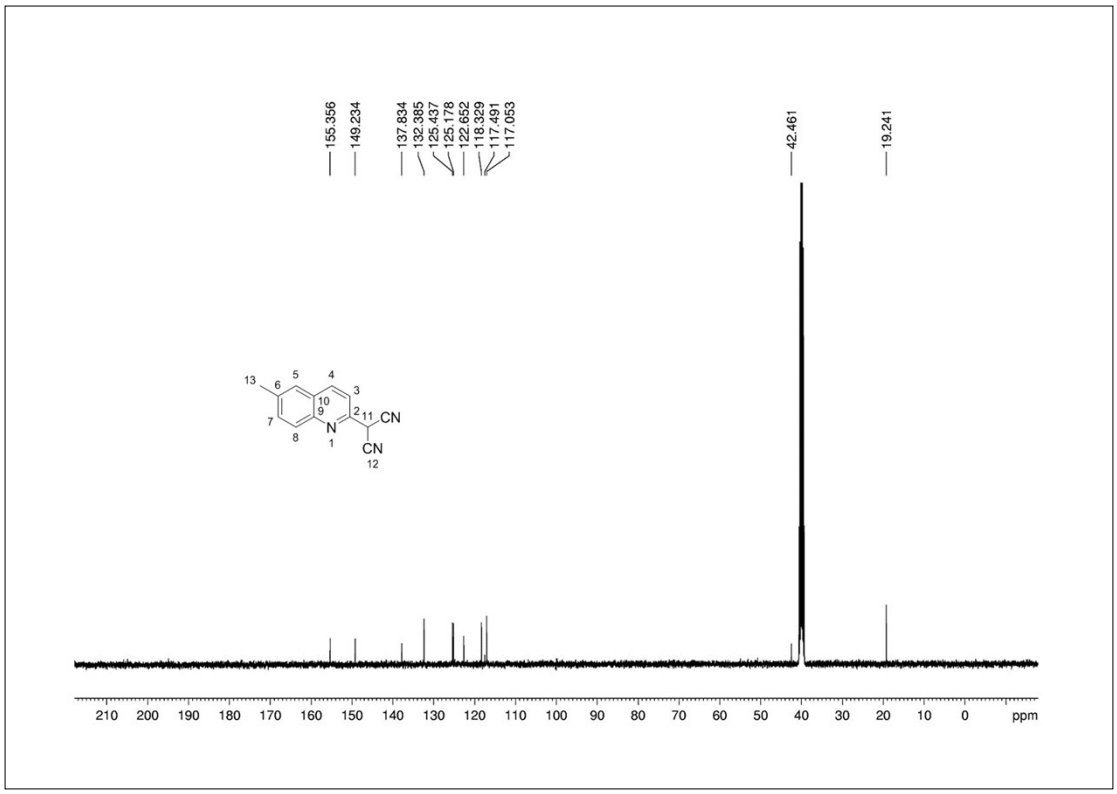


Fig.117 ^{13}C NMR spectrum of compound **5l**

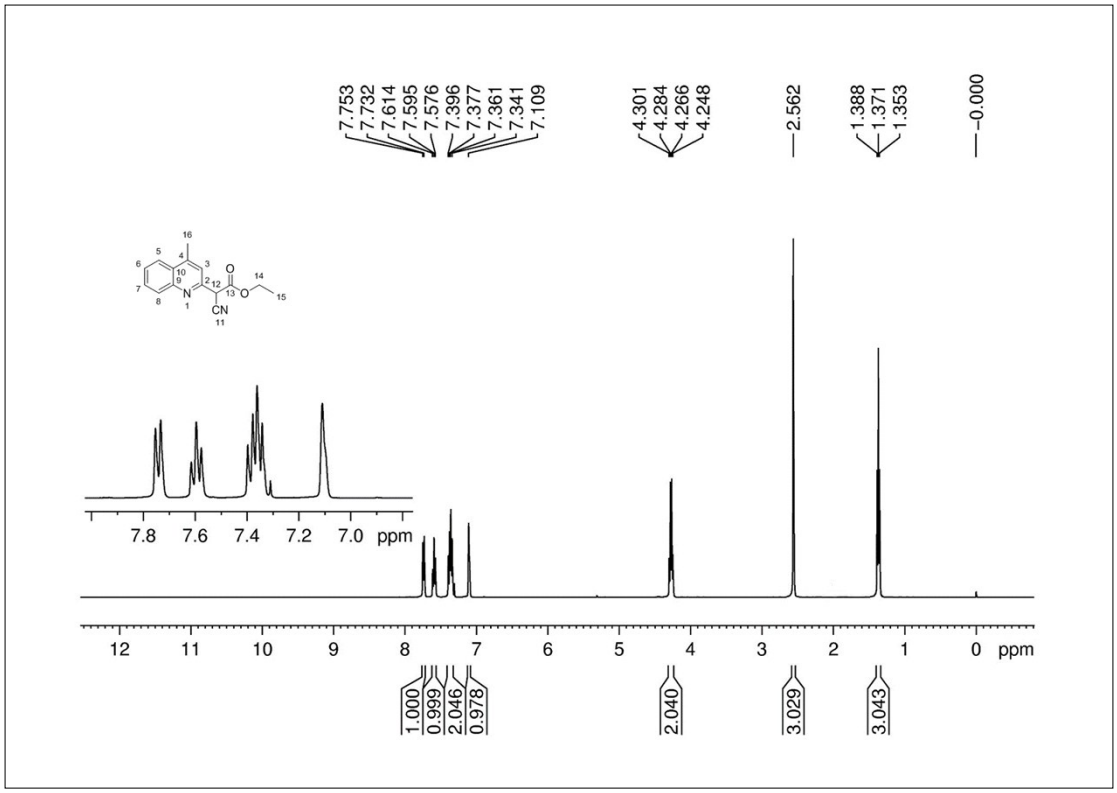


Fig.118 [1]H NMR spectrum of compound **5m**

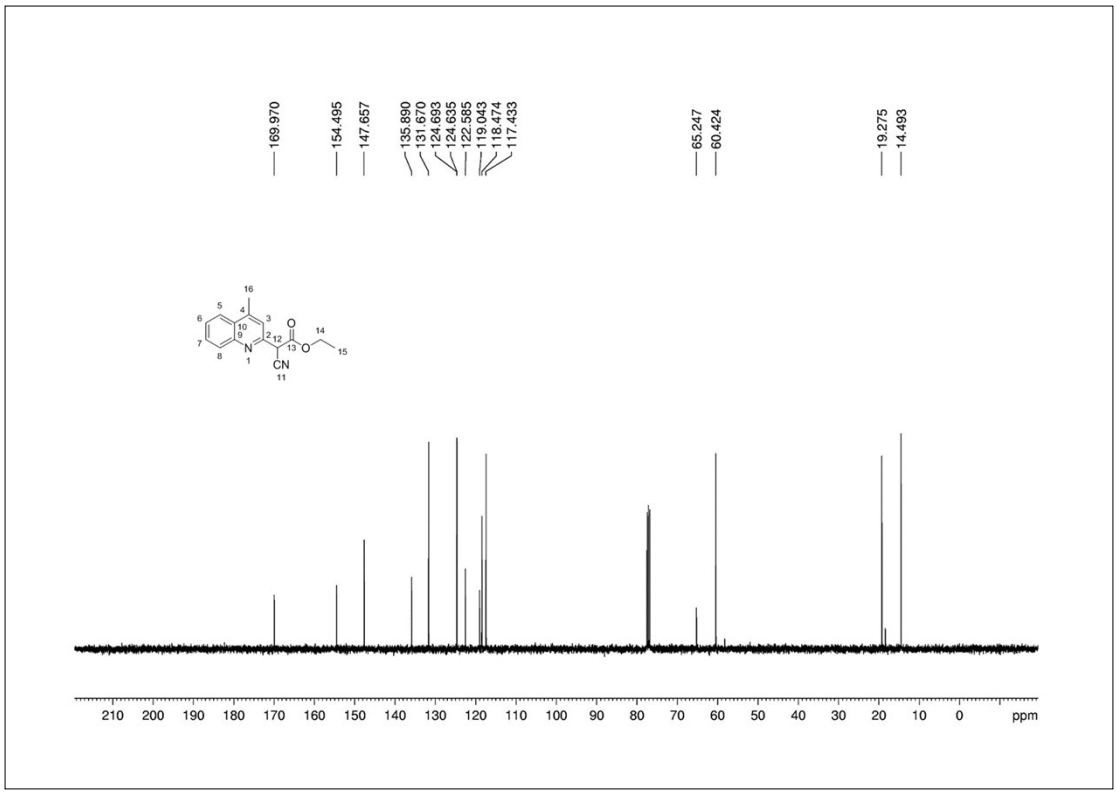


Fig.119 [13]C NMR spectrum of compound **5m**

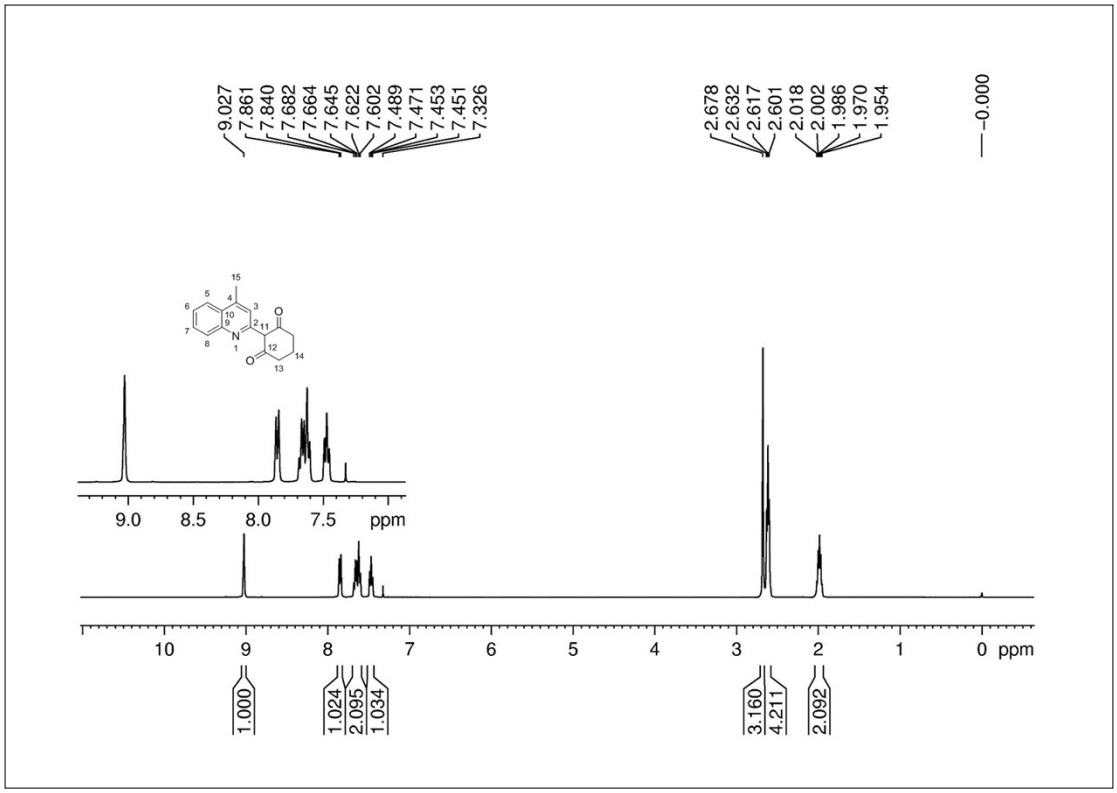


Fig.120 [1]H NMR spectrum of compound **5n**

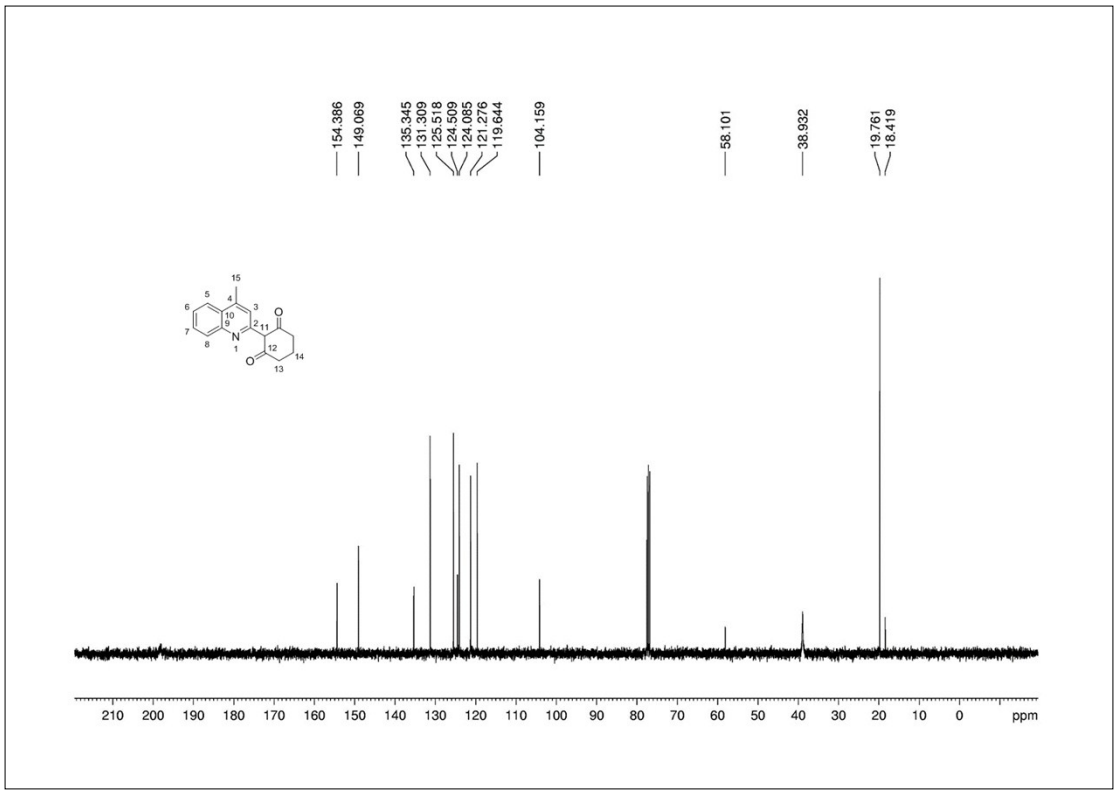


Fig.121 [13]C NMR spectrum of compound **5n**

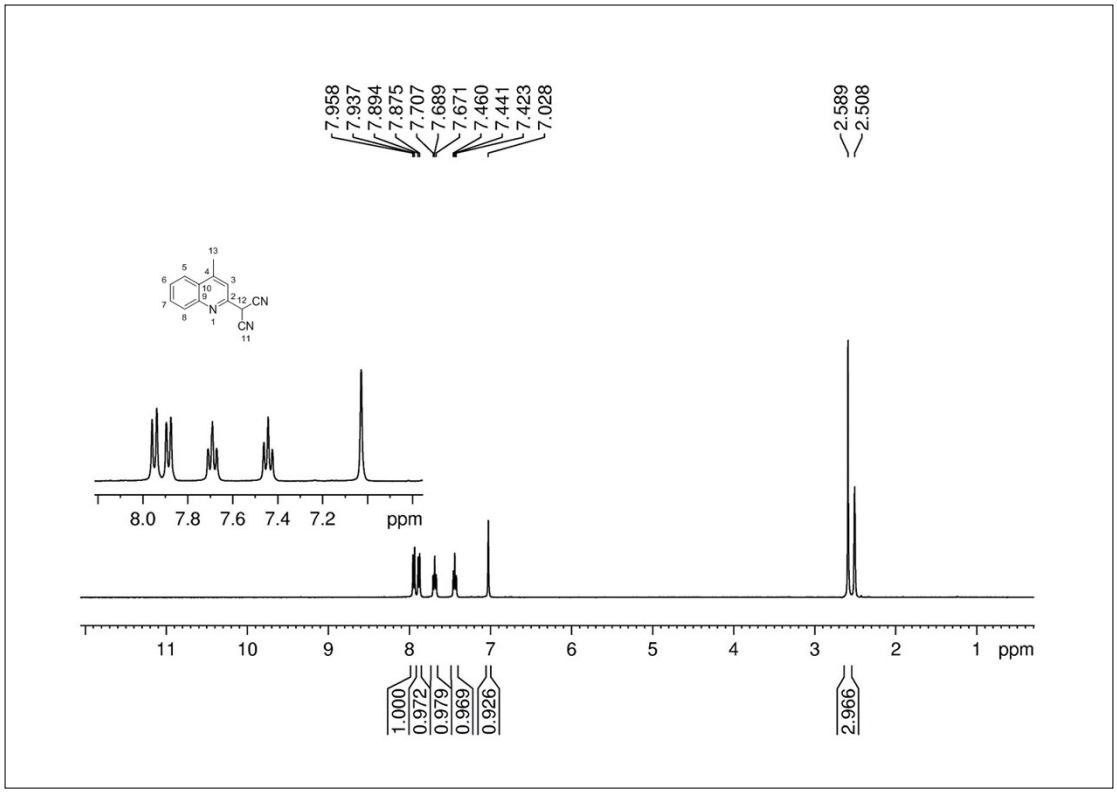


Fig.122 [1]H NMR spectrum of compound **5o**

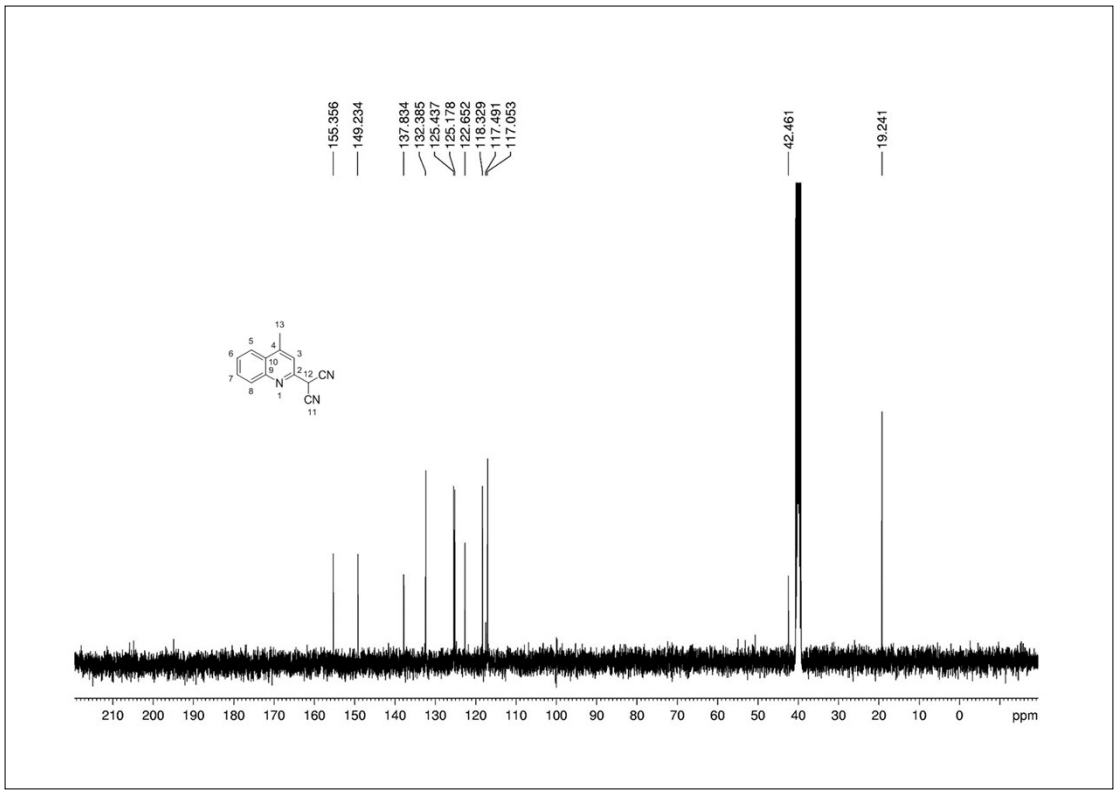


Fig.123 [13]C NMR spectrum of compound **5o**

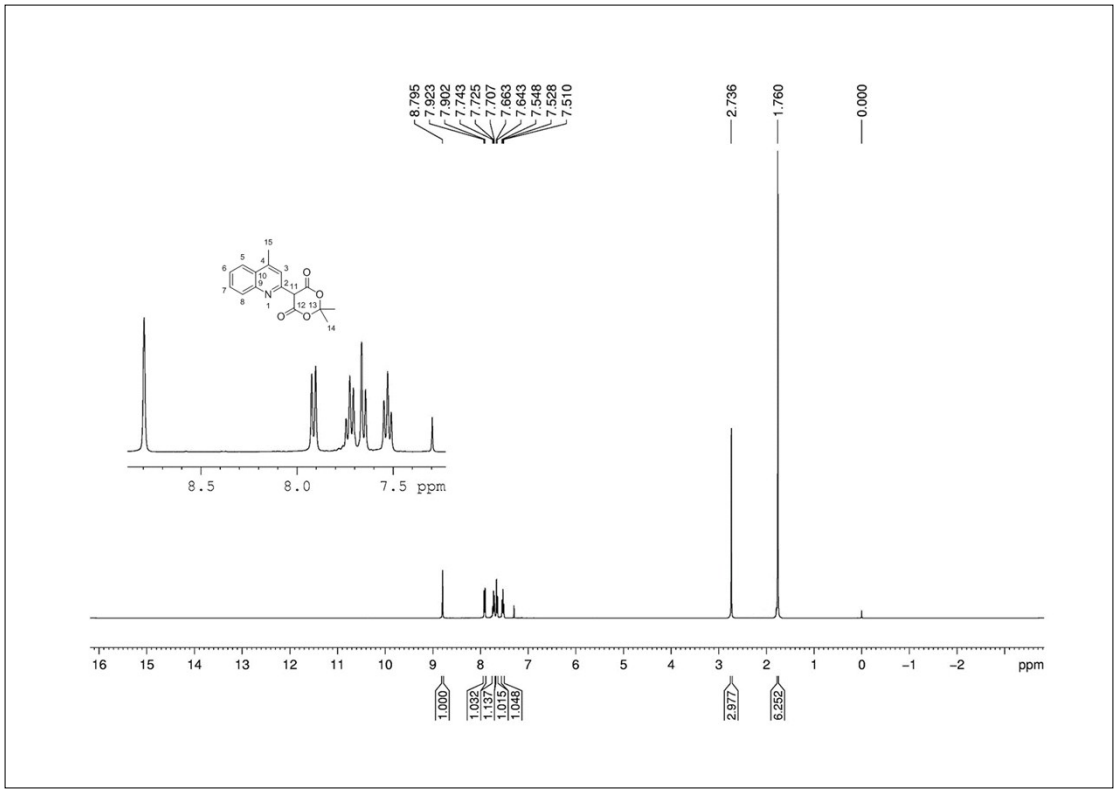


Fig.124 [1]H NMR spectrum of compound **5p**

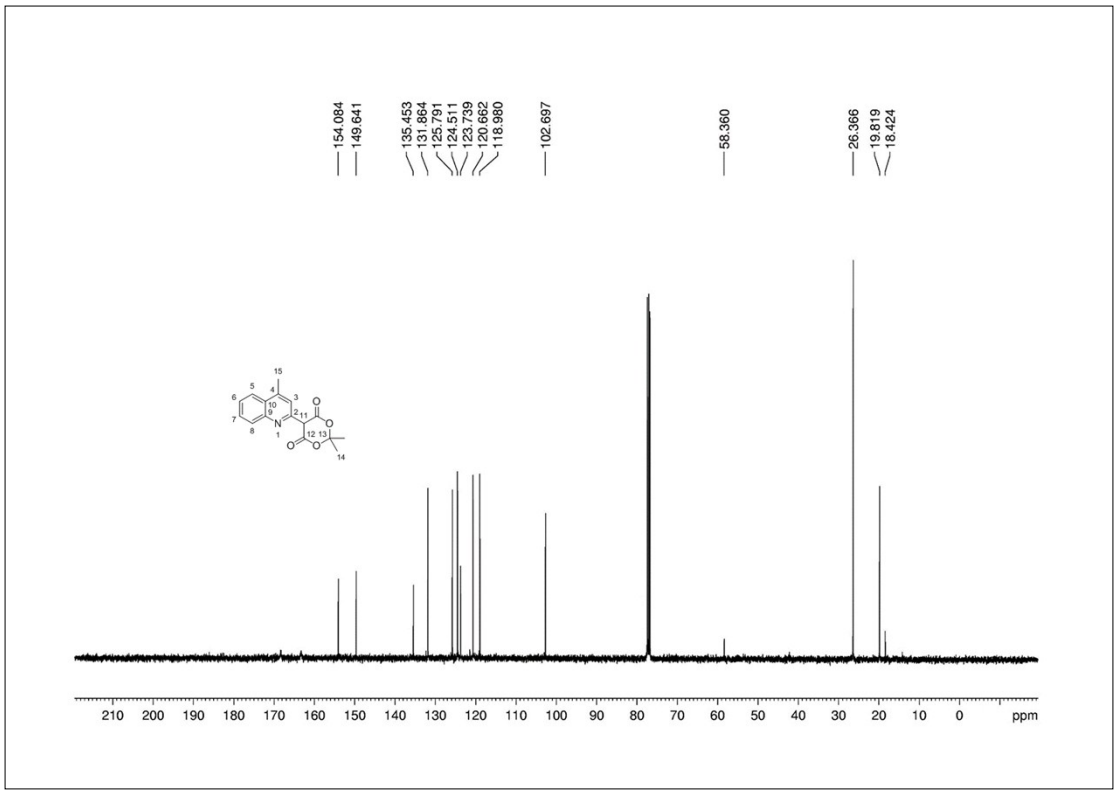


Fig.125 [13]C NMR spectrum of compound **5p**

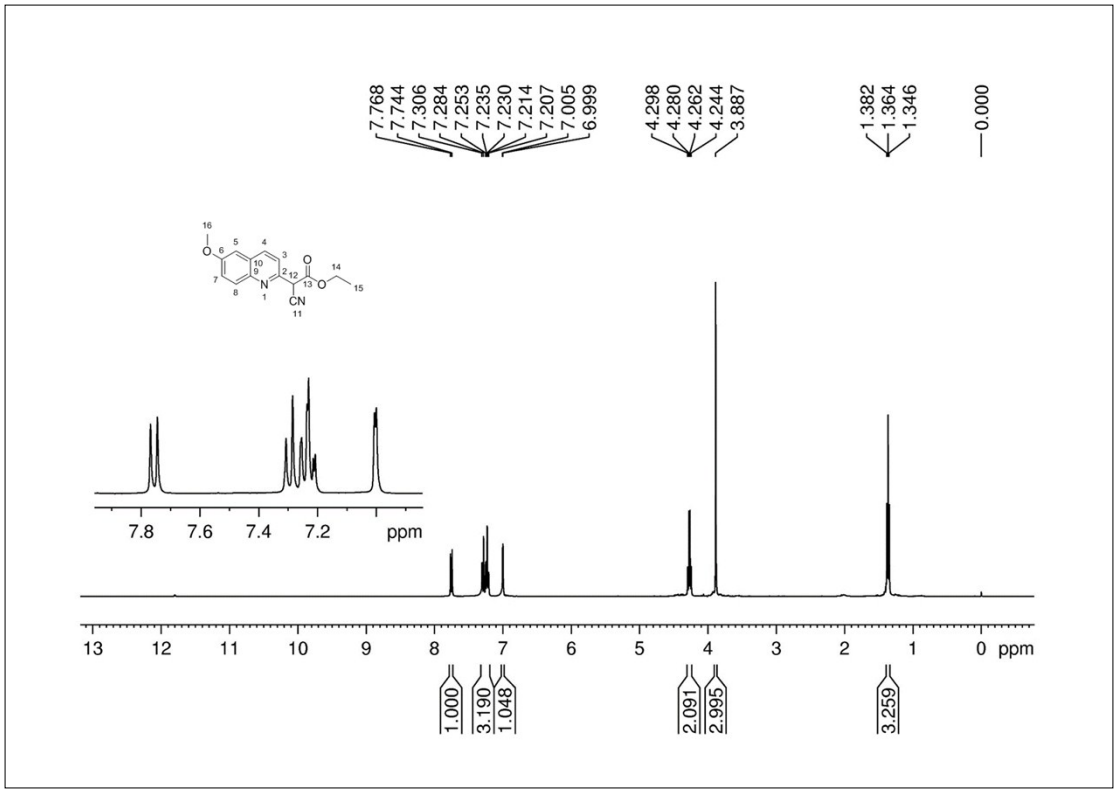


Fig.126 [1]H NMR spectrum of compound **5q**

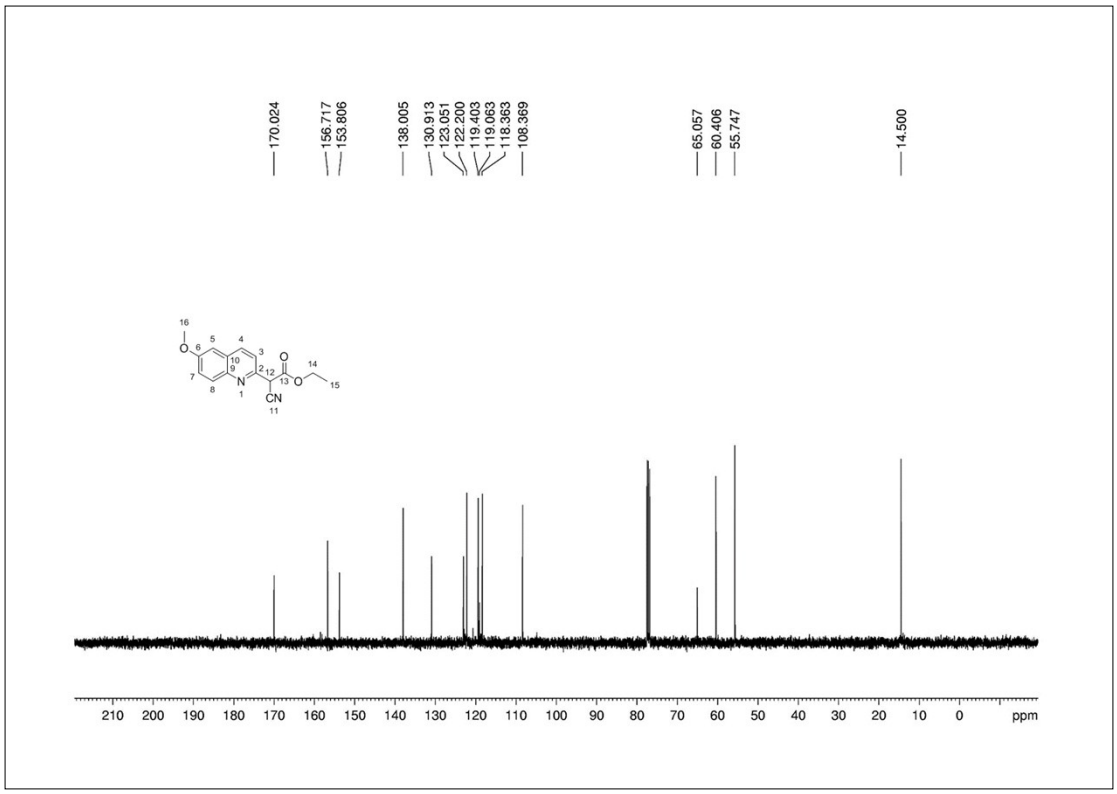


Fig.127 [13]C NMR spectrum of compound **5q**

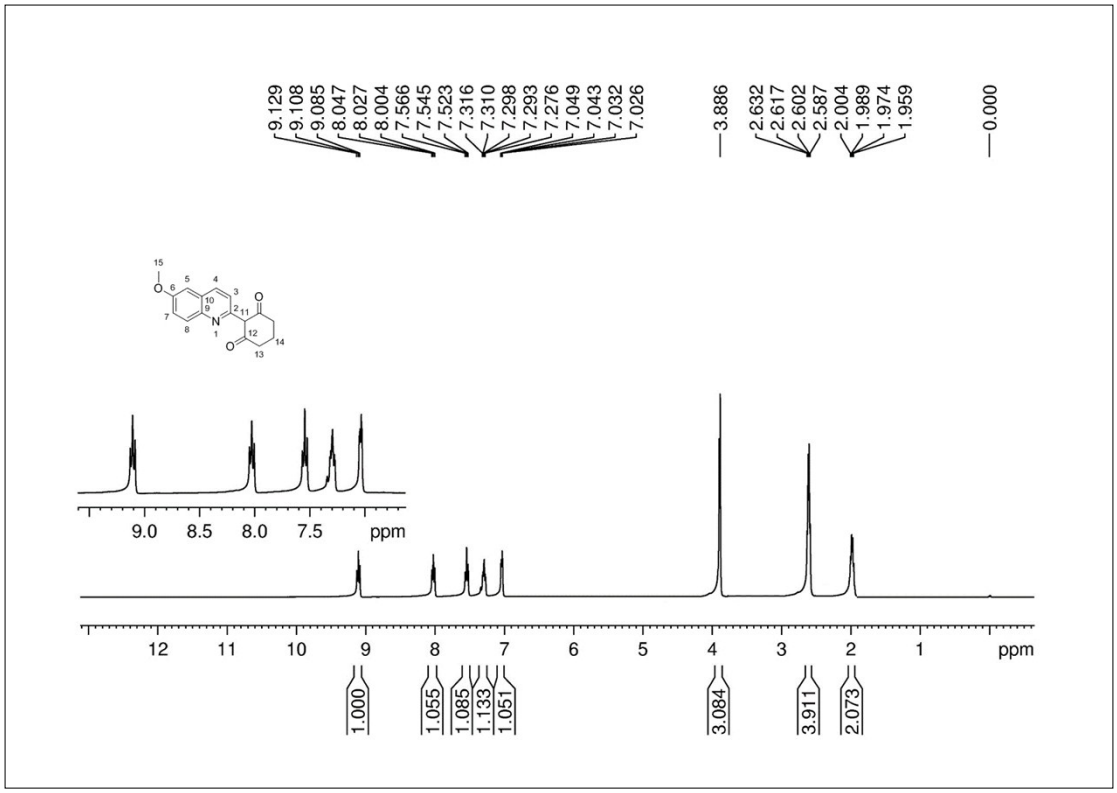


Fig.128 [1]H NMR spectrum of compound **5r**

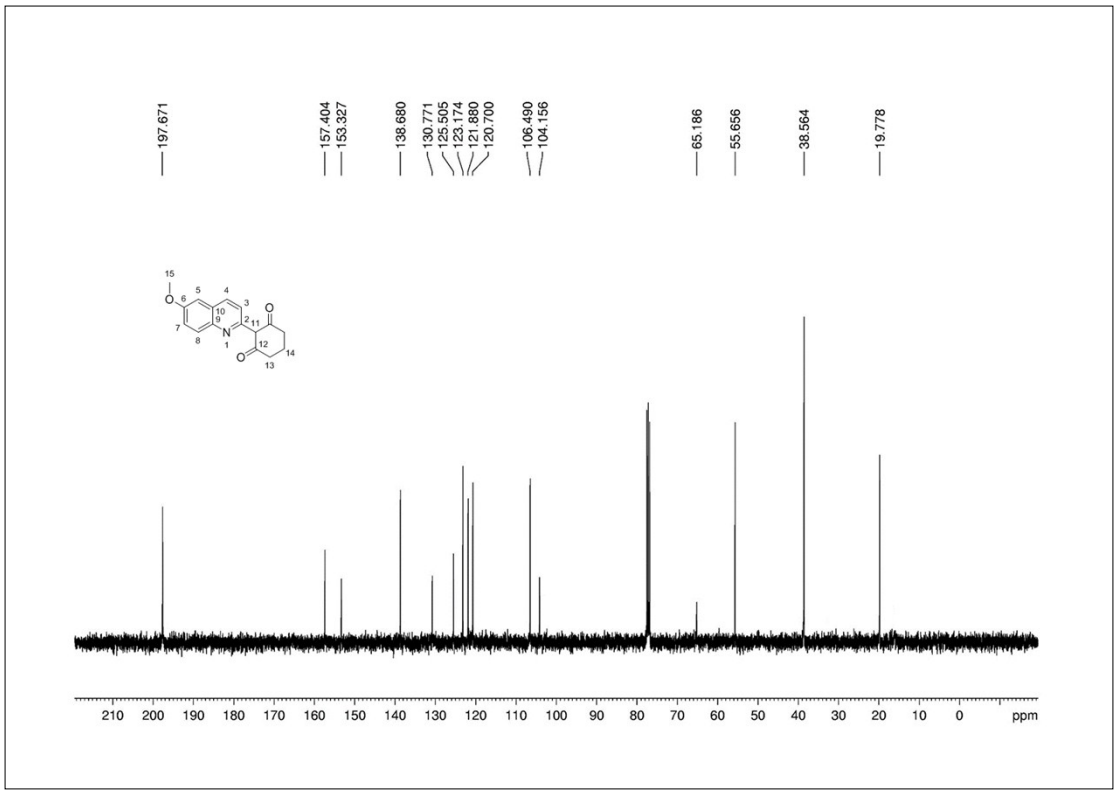


Fig.129 [13]C NMR spectrum of compound **5r**

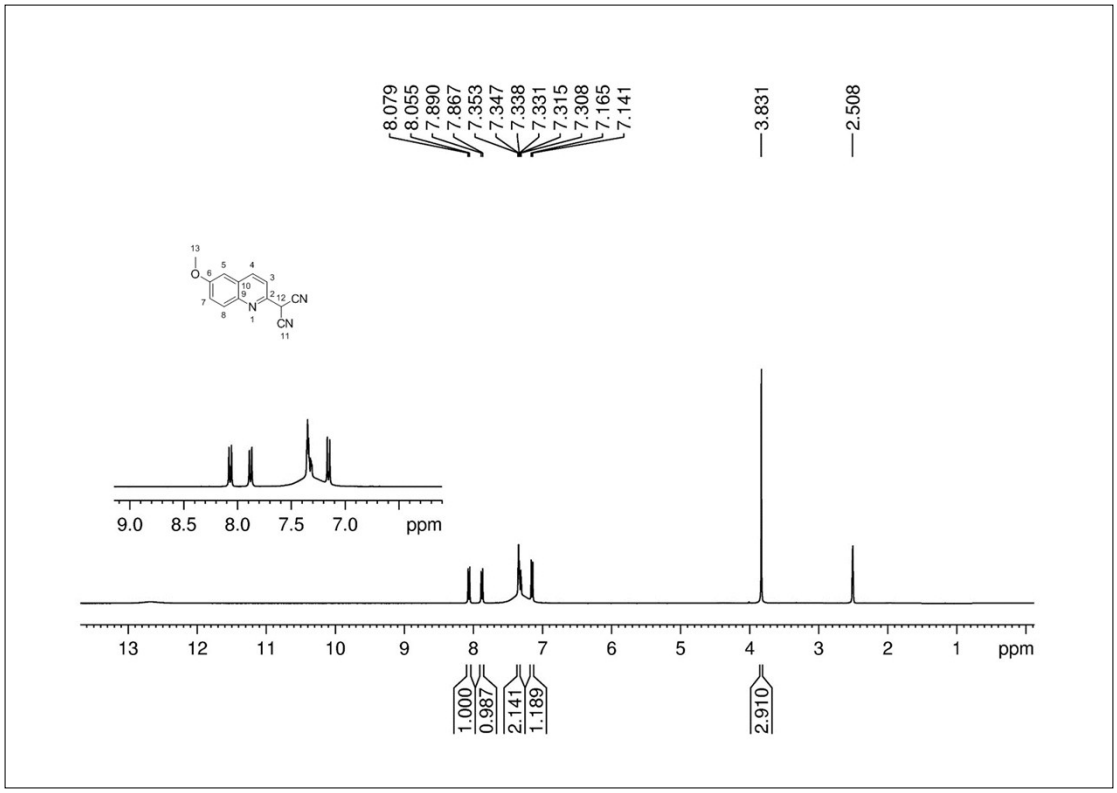


Fig.130 ^{1}H NMR spectrum of compound **5s**

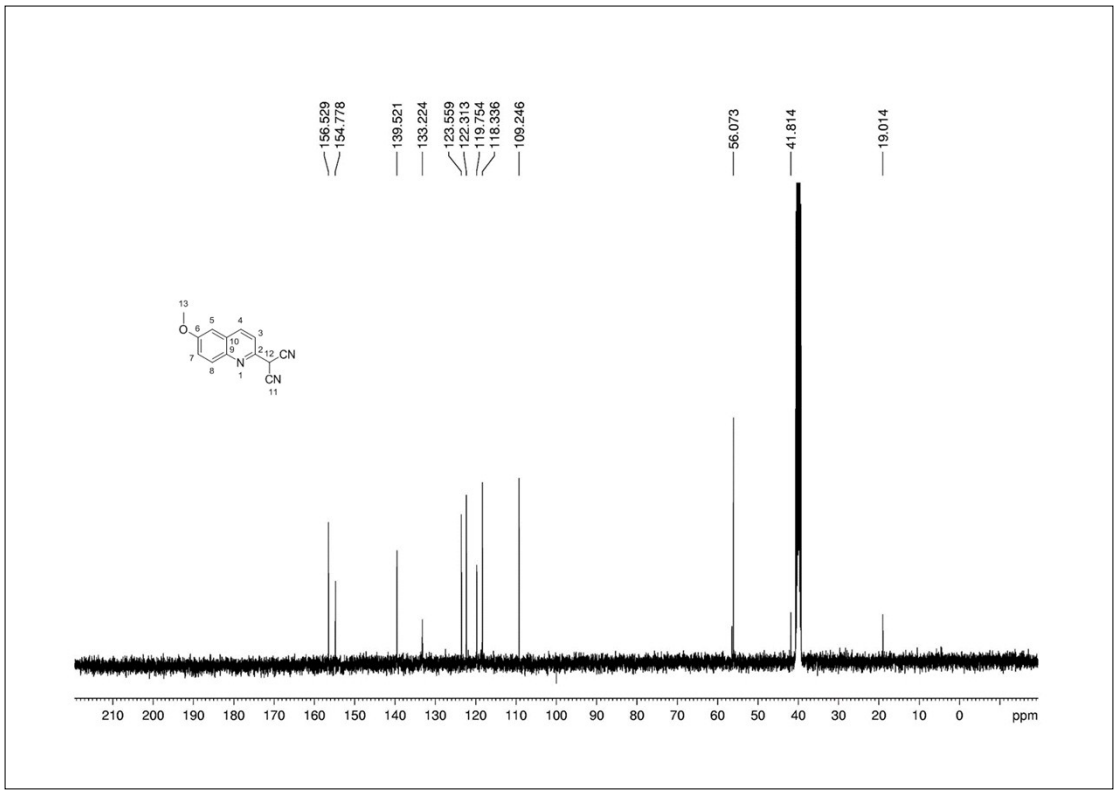


Fig.131 ^{13}C NMR spectrum of compound **5s**

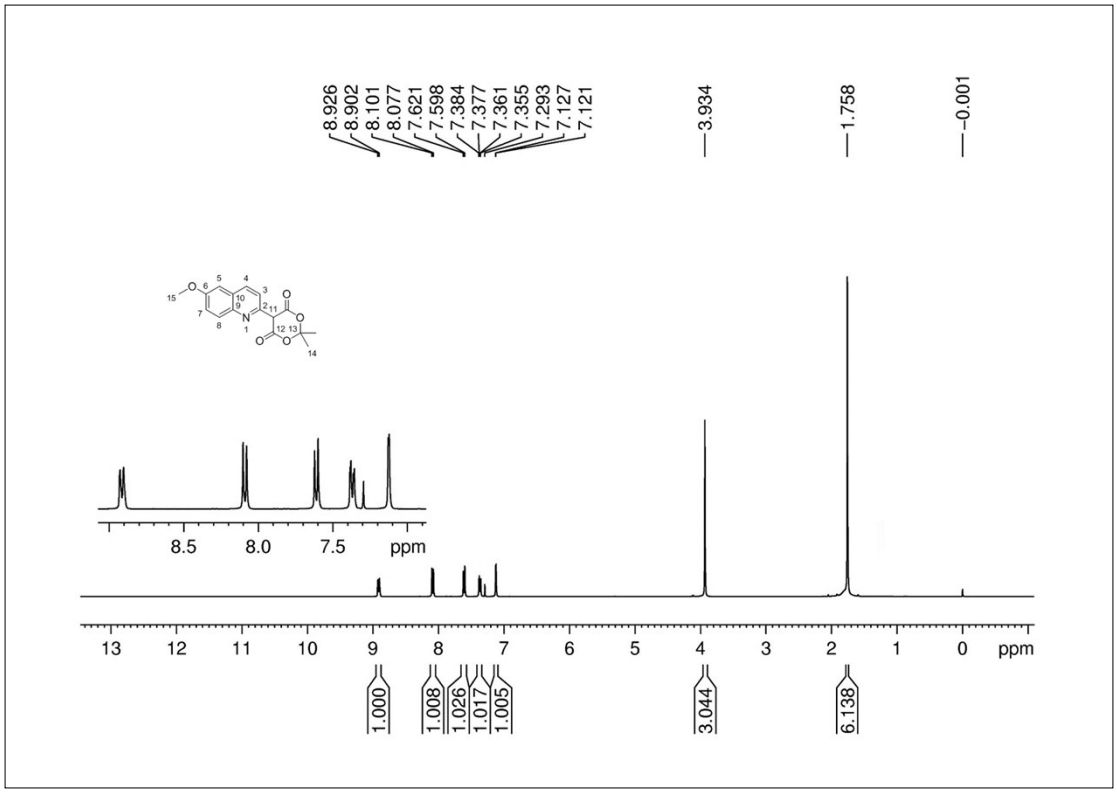


Fig.132 ^{1}H NMR spectrum of compound **5t**

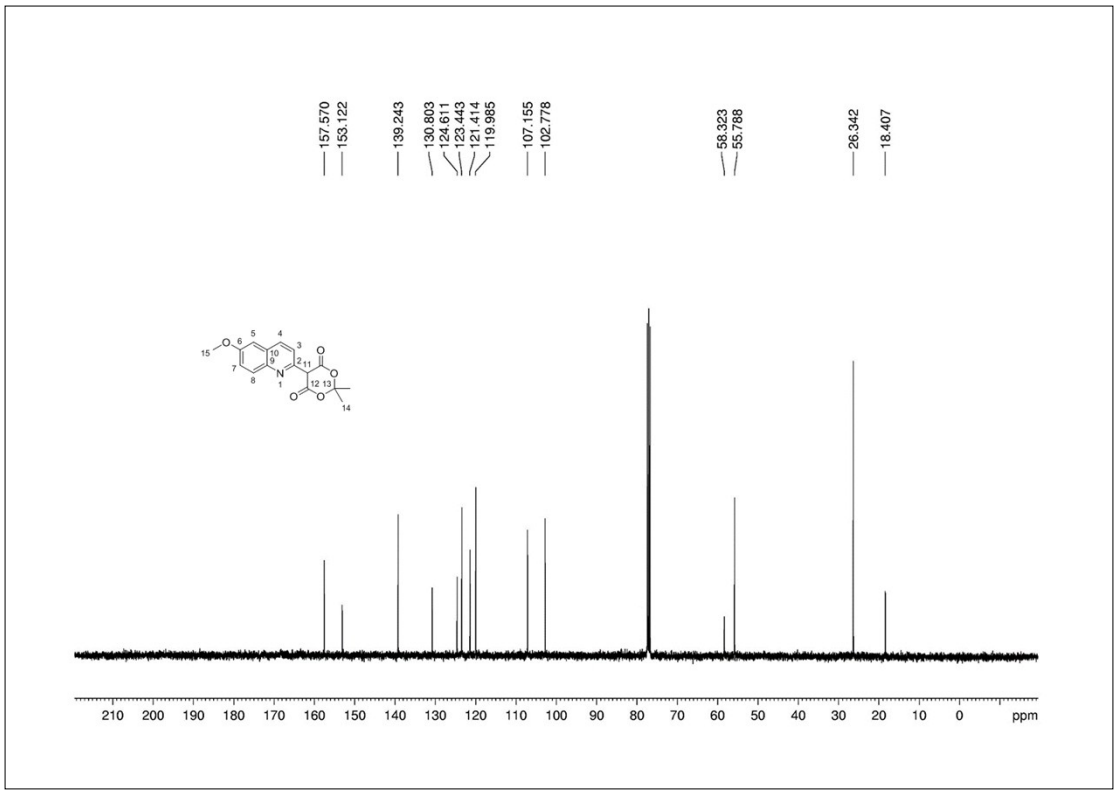


Fig.133 ^{13}C NMR spectrum of compound **5t**

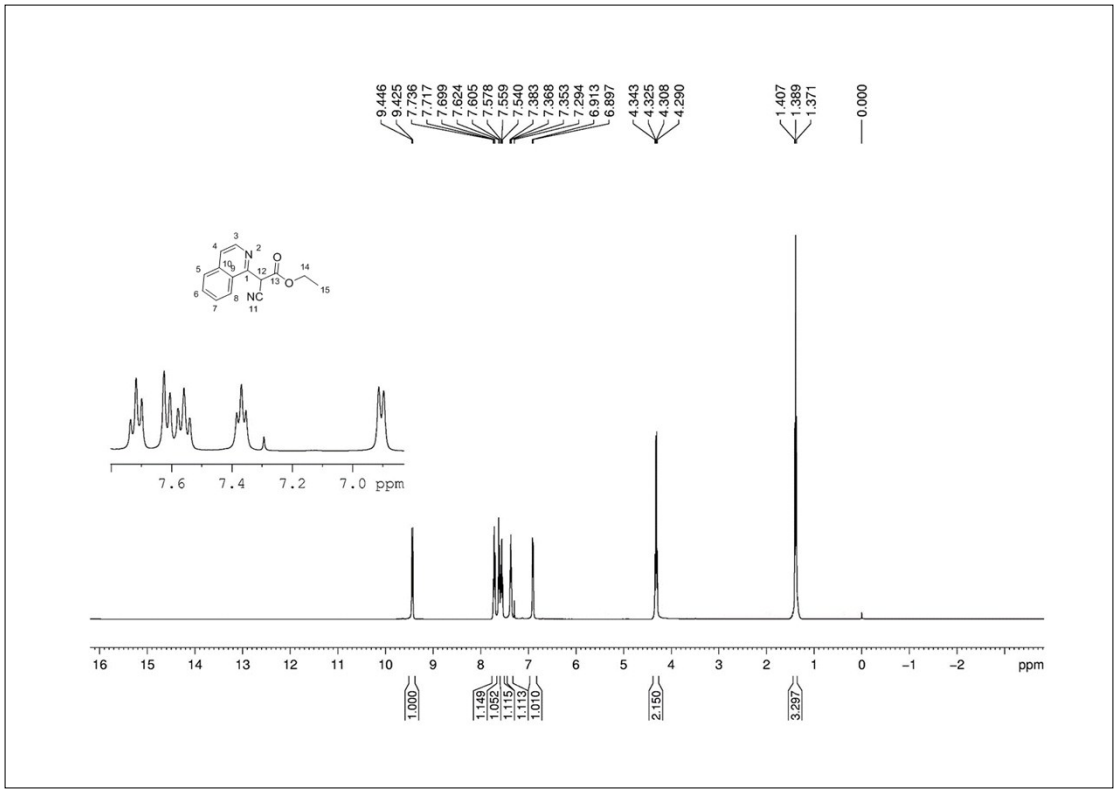


Fig.134 [1]H NMR spectrum of compound **5u**

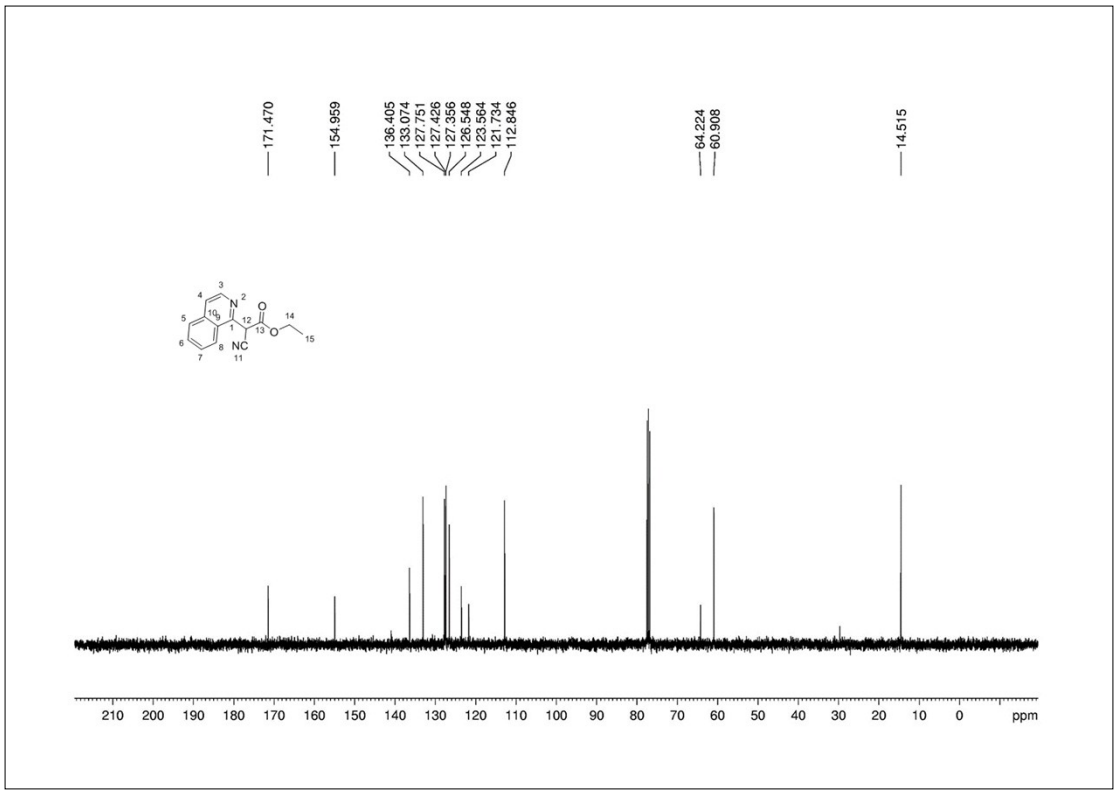


Fig.135 [13]C NMR spectrum of compound **5u**

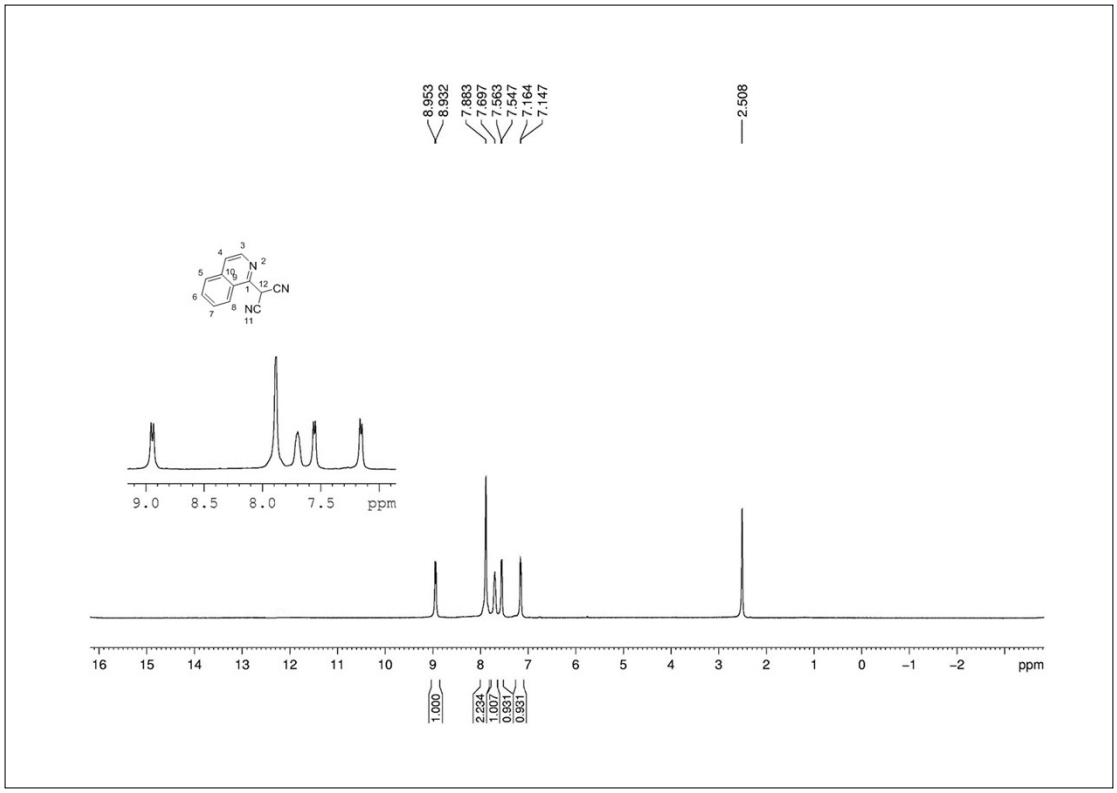


Fig.136 [1]H NMR spectrum of compound **5v**

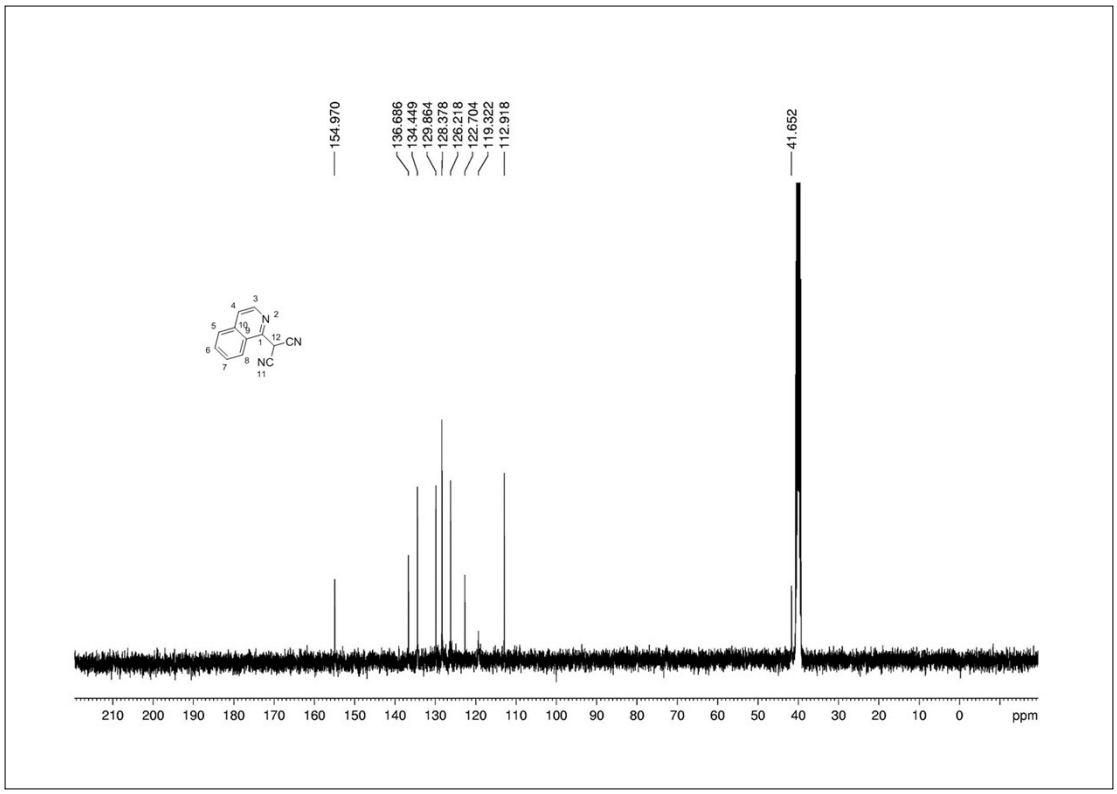


Fig.137 [13]C NMR spectrum of compound **5v**

8. ^{1}H NMR copies of the 0.5 gram scale products

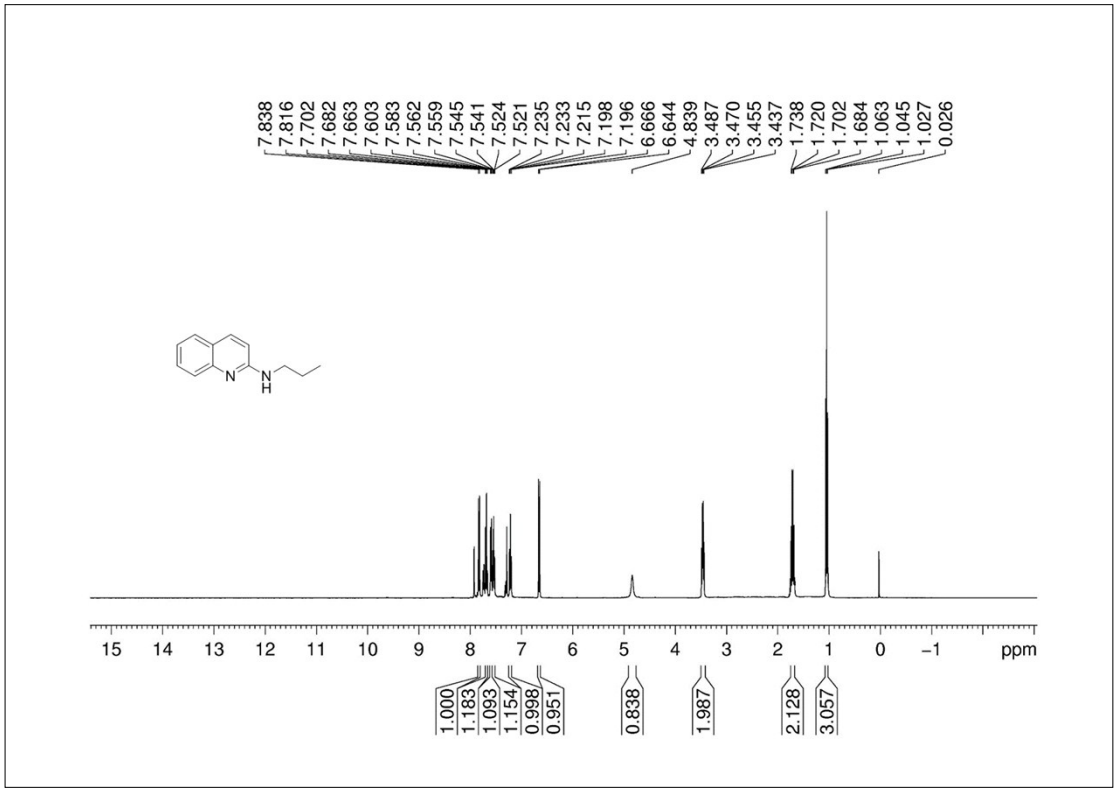


Fig.138 ^{1}H NMR spectrum of compound **3a**

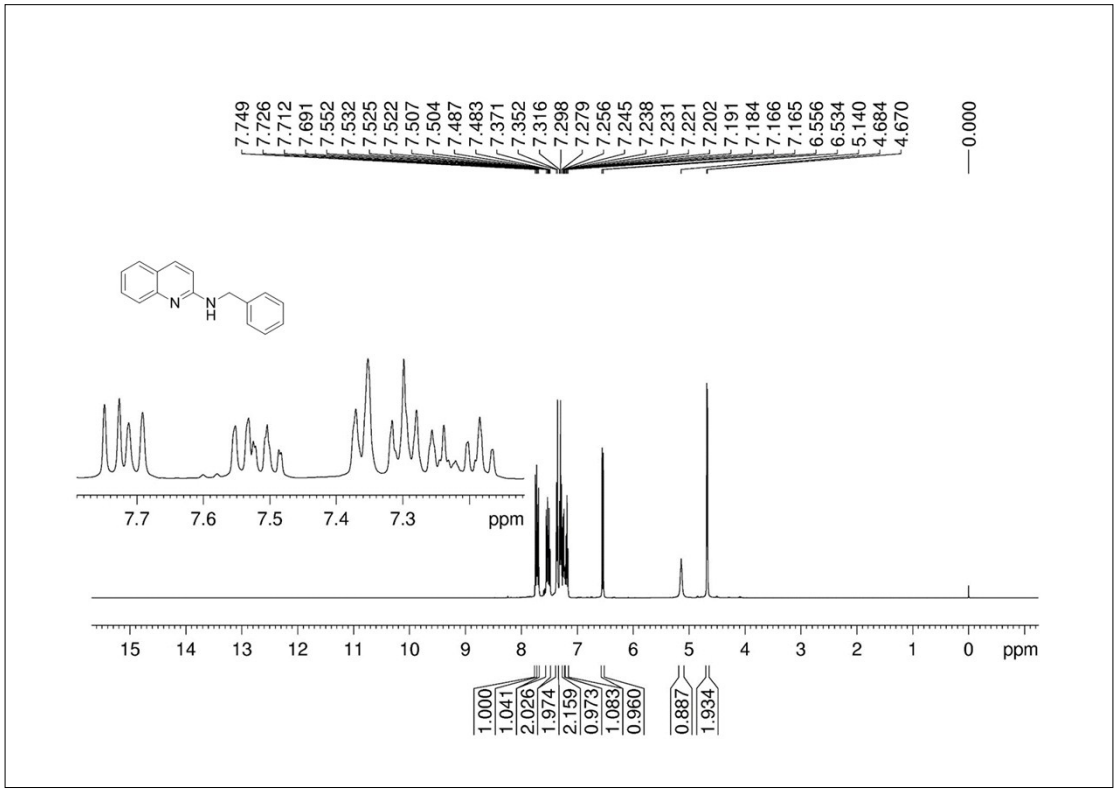


Fig.139 ^{1}H NMR spectrum of compound **3g**

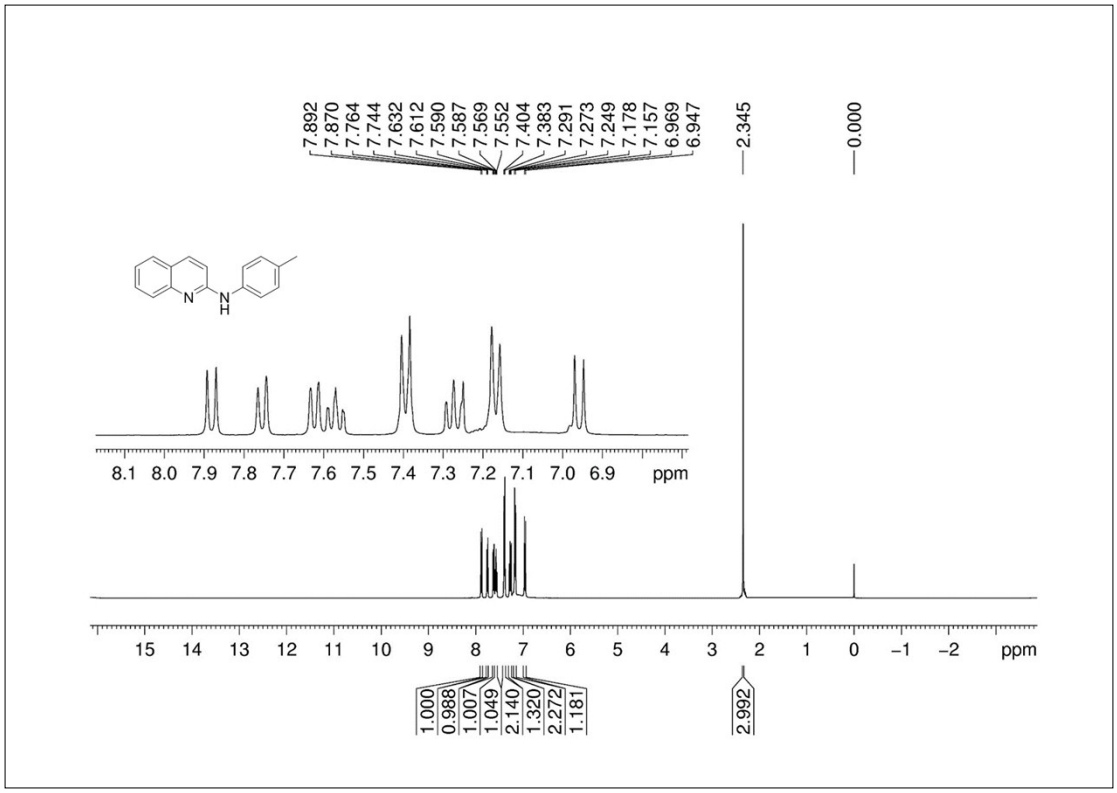


Fig.140 [1]H NMR spectrum of compound **3l**

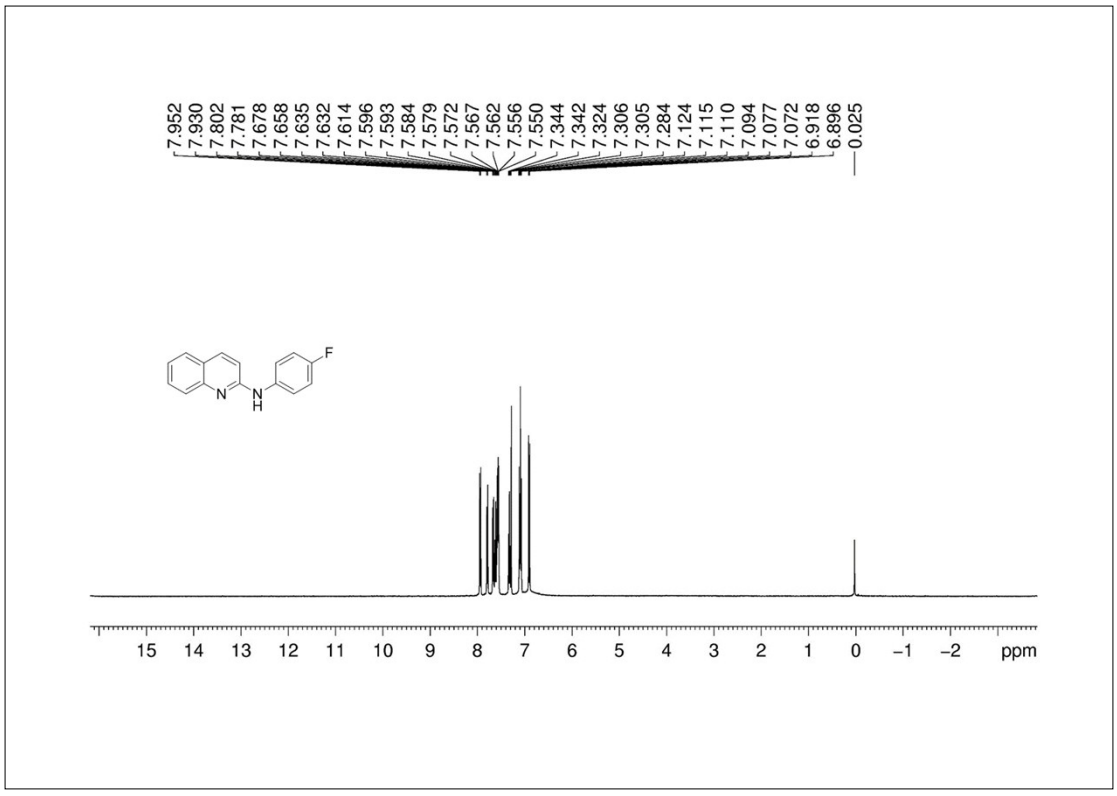


Fig.141 [1]H NMR spectrum of compound **3m**

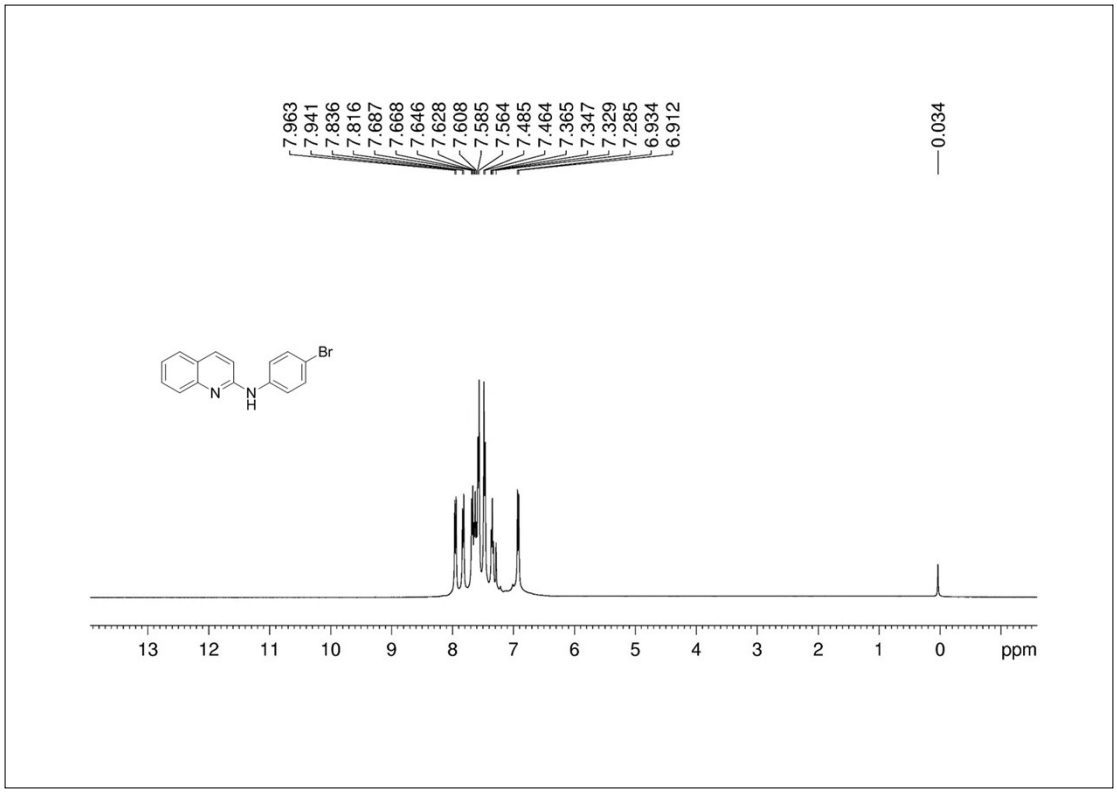


Fig.142 [1]H NMR spectrum of compound **3o**

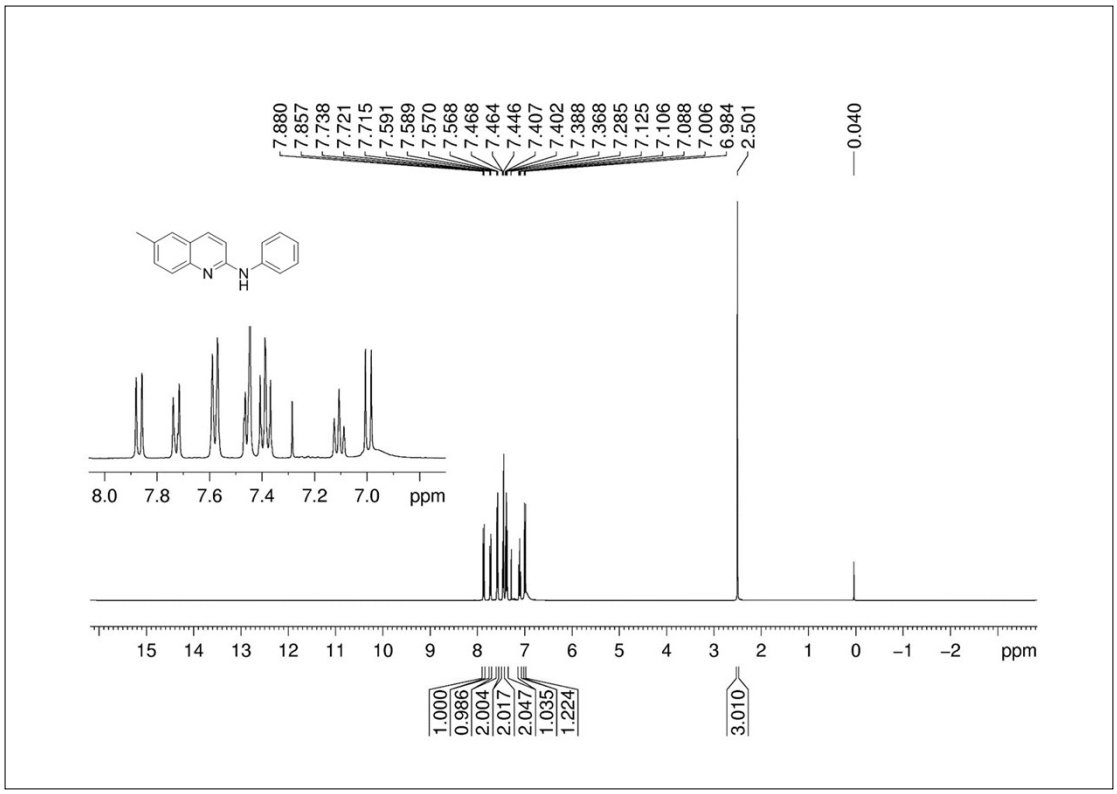


Fig.143 [1]H NMR spectrum of compound **3s**

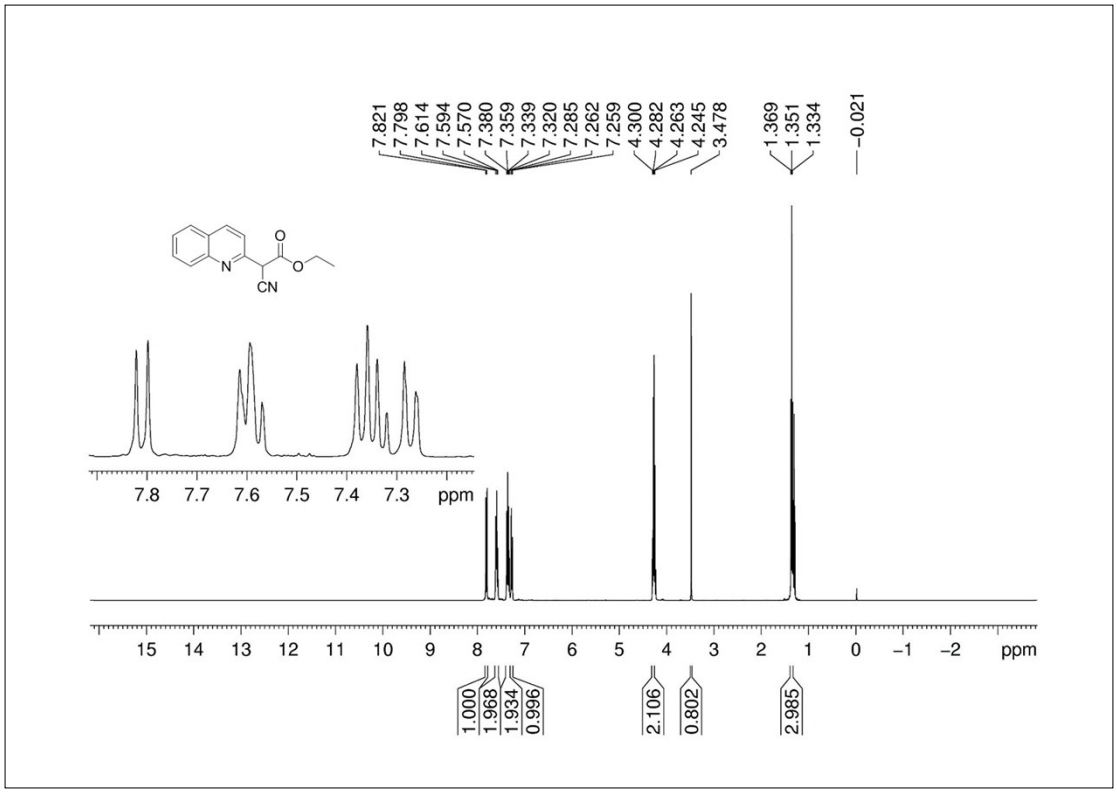


Fig.144 [1]H NMR spectrum of compound **5d**

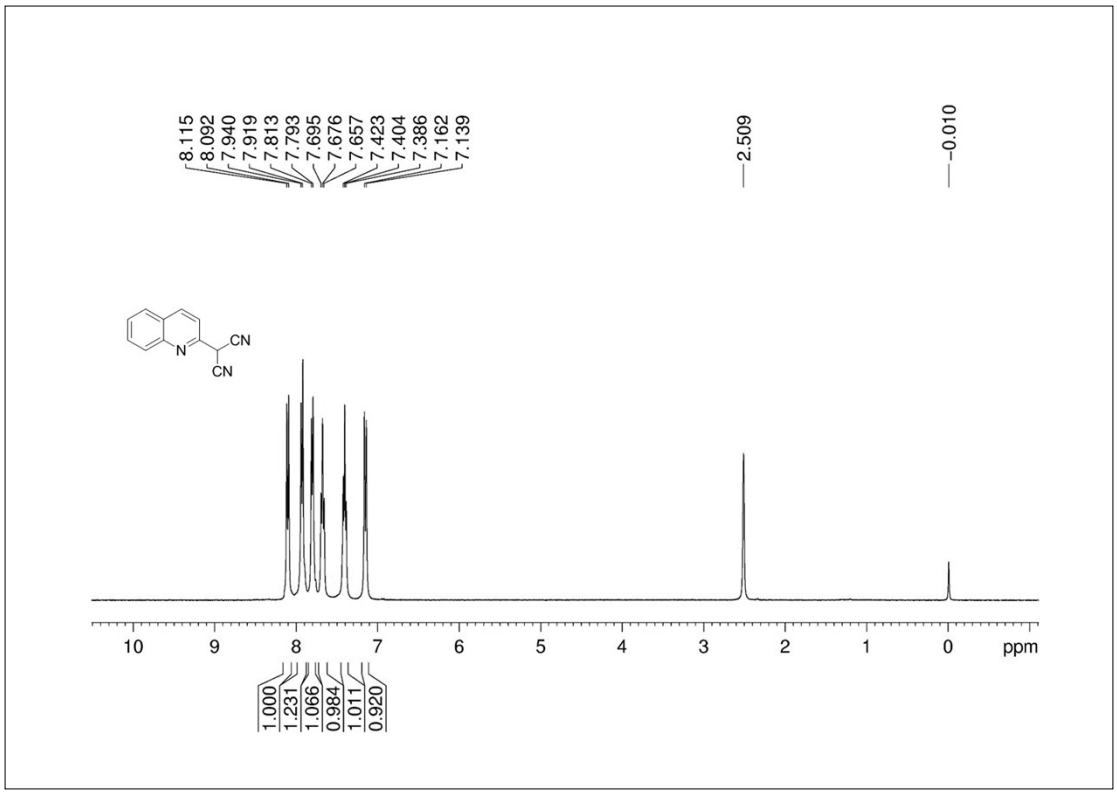


Fig.145 [1]H NMR spectrum of compound **5e**