MOF-5 as a highly efficient and recyclable catalyst for one pot synthesis of 2,4-disubstituted quinoline derivatives

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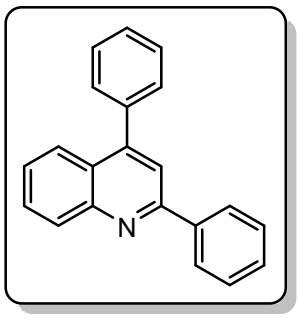
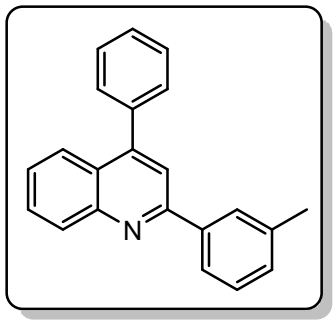
2,4-Diphenylquinoline (4a)[1]



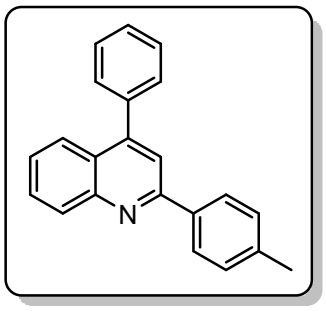
Colorless solid, Mp = 105-106 °C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.28 (d, *J* = 8.5 Hz, 1H), 8.22 (d, *J* = 7.0 Hz, 2H), 7.93 (d, *J* = 8.5 Hz, 1H), 7.84 (s, 1H), 7.75(t, *J* = 7.5 Hz, 1H), 7.59-7.46 (m, 9H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 156.9, 149.3, 148.7, 139.5, 138.4, 130.1, 129.6, 129.4, 128.9, 128.6, 128.5, 127.6, 126.4, 125.8, 125.7, 119.4 ppm; IR (KBr): 3063, 1589, 1488, 1405, 768, 694 cm^{-1}; EI-MS: m/z = 282 $(M+1)^+$.

4-Phenyl-2-(*m*-tolyl)quinoline (4b)[2]



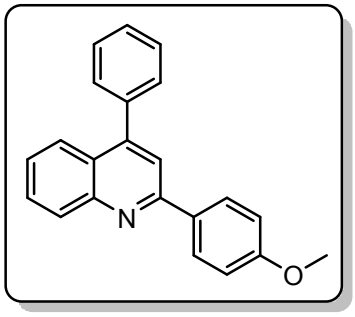
Pale yellow oil; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.33 (d, *J* = 8.5 Hz, 1H), 8.11 (s, 1H), 8.03 (d, *J* = 7.5 Hz, 1H), 7.95 (d, *J* = 8.0 Hz, 1H), 7.87 (s, 1H), 7.78 (t, *J* = 8.0 Hz, 1H), 7.62-7.55 (m, 5H), 7.51 (t, *J* = 7.5 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.33 (d, *J* = 7.5 Hz, 1H), 2.54 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 157.1, 149.2, 148.8, 139.6, 138.5, 138.4, 130.2, 130.1, 129.6, 129.5, 128.8, 128.6, 128.5, 128.3, 126.3, 125.8, 125.7, 124.8, 119.5, 21.7 ppm; IR (KBr): 3048, 1603, 1543, 1445, 893, 821, 779, 721, 701 cm^{-1}; EI-MS: m/z = 296 $(M+1)^+$.

4-Phenyl-2-(*p*-tolyl)quinoline (4c)[1]



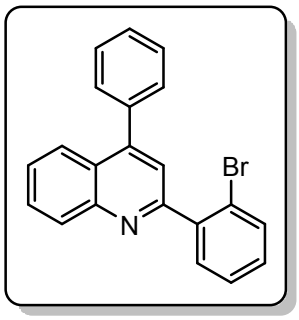
Colorless solid, Mp = 116-117°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.28 (d, *J* = 8.0 Hz, 1H), 8.14 (d, *J* = 8.0 Hz, 2H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.83 (s, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.59-7.53 (m, 5H), 7.48 (t, *J* = 7.5 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 2H), 2.46 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 156.9, 149.1, 148.9, 139.5, 138.5, 136.9, 130.1, 129.6, 129.5, 128.6, 128.4, 127.5, 126.2, 125.7, 125.6, 119.2, 21.4 ppm; IR (KBr): 3050, 1601, 1541, 1442, 895, 820, 773, 725, 704 cm^{-1}; EI-MS: m/z =296 $(M+1)^+$.

2-(4-Methoxyphenyl)-4-phenylquinoline (4d)[1]



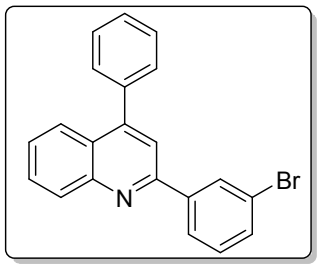
Yellow solid, Mp = 74-75°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.22 (d, *J* = 8.0 Hz, 1H), 8.18 (d, *J* = 9.0 Hz, 2H), 7.88 (d, *J* = 8.0 Hz, 1H), 7.78 (s, 1H), 7.72 (t, *J* = 7.5 Hz, 1H), 7.57-7.51 (m, 5H), 7.45 (t, *J* = 7.5 Hz, 1H), 7.05 (d, *J* = 9.0 Hz, 2H), 3.89 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 160.9, 156.4, 149.0, 148.8, 138.5, 132.2, 129.9, 129.6, 129.5, 128.9, 128.6, 128.4, 126.0, 125.6, 125.5, 118.9, 114.3, 55.4 ppm; IR (KBr): 2919, 1606, 1544, 1489, 1112, 842, 772, 703 cm^{-1}; EI-MS: m/z = 312 $(M+1)^+$.

2-(2-Bromophenyl)-4-phenylquinoline (4e)[3]



Pale yellow oil; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.27 (d, *J* = 8.5 Hz, 7H), 8.00 (d, J = 8.5 Hz, 1H), 7.77 (t, *J* = 7.5 Hz, 1H), 7.72-7.69 (m, 3H), 7.60-7.45 (m, 7H), 7.31 (t, *J* = 7.5 Hz, 1H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 158.3, 148.5, 148.0, 141.6, 138.1, 133.3, 131.7, 130.1, 130.0, 129.7, 129.6, 128.6, 128.5, 127.8, 126.9, 125.7, 125.6, 123.0, 122.0 ppm; IR (KBr): 3035, 1593, 1548, 1093, 875, 809, 768, 727 cm^{-1}; EI-MS: m/z = 360 $(M+1)^+$.

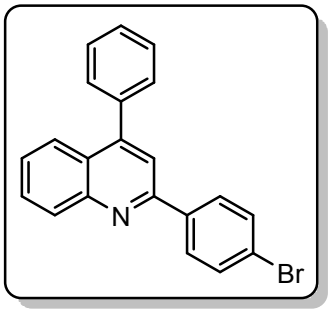
2-(3-Bromophenyl)-4-phenylquinoline (4f)[4]



Yellow solid, Mp = 89-90°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.44 (s, 1H), 8.27 (d, *J* = 8.5 Hz, 1H), 8.13 (d, *J* = 8.0 Hz, 1H), 7.92 (d, *J* = 8.5 Hz, 1H), 7.78 (s, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.60-7.48 (m, 7H), 7.38 (t, *J* = 8.0 Hz, 1H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 155.1, 149.5, 148.8, 141.7, 138.2, 132.3, 130.7, 130.4, 130.2, 129.8, 129.6, 128.7, 128.6, 126.8, 126.1, 126.0, 125.7, 123.2, 119.0 ppm; IR (KBr): 3069, 1588, 1544, 1086, 876, 792, 773, 701 cm^{-1}; EI-MS: m/z = 360 $(M+1)^+$.

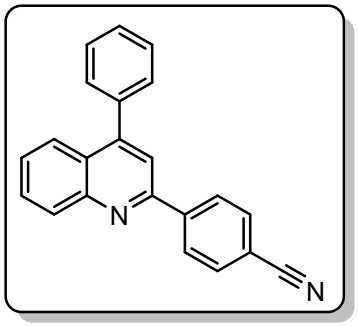
2-(4-Bromophenyl)-4-phenylquinoline (4g)[1]

Colorless solid, Mp = 122-123°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.26 (d, *J* = 5.0 Hz, 1H), 8.10 (d, *J* = 8.5 Hz, 2H), 7.91 (d, *J* = 8.5 Hz, 1H), 7.79 (s, 1H), 7.75 (t, *J* = 7.0



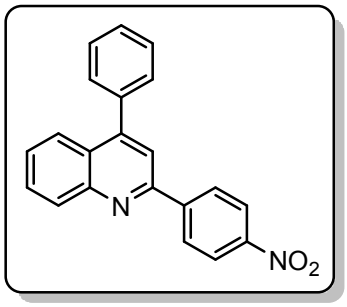
Hz, 1H), 7.66 (d, J = 8.5 Hz, 2H), 7.57-7.49 (m, 6H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 155.6, 149.6, 148.7, 138.2, 132.0, 130.0, 129.8, 129.6, 129.2, 128.7, 128.6, 126.6, 125.9, 125.7, 124.0, 118.9, 112.9 ppm; IR (KBr): 2922, 1602, 1543, 1071, 885, 810, 736, 701 cm^{-1}; EI-MS: m/z = 360 (M+1)$^+$.

4-(4-Phenylquinolin-2-yl)benzonitrile (4h)[1]



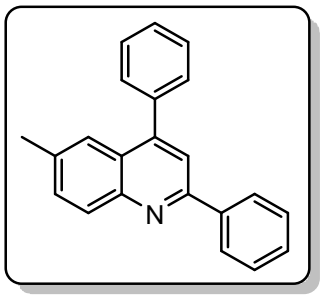
Pale yellow solid, Mp = 169-170°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.34 (d, J = 8.5 Hz, 2H), 8.29 (s, 1H), 7.95 (d, J = 8.5 Hz, 1H), 7.83-7.78 (m, 4H), 7.58-7.53 (m, 6H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 154.5, 149.9, 148.8, 143.7, 137.9, 132.6, 130.3, 130.0, 129.5, 128.7, 128.1, 127.2, 126.2, 125.8, 118.9, 118.8, 112.8 ppm; IR (KBr): 3423, 2221, 1589, 1491, 1418, 1356, 775, 701 cm^{-1}; EI-MS: m/z = 307 (M+1)$^+$.

2-(4-Ditrophenyl)-4-phenylquinoline (4i)[3]



Yellow solid, Mp = 164-165 °C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.43-8.38 (m, 5H), 7.97 (d, J = 8.5 Hz, 1H), 7.88 (s, 1H), 7.82 (t, J = 7.5 Hz, 1H), 7.59-7.56 (m, 6H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 154.1, 150.0, 148.8, 148.4, 145.4, 137.9, 130.3, 130.1, 129.5, 128.8, 128.4, 127.4, 126.2, 125.8, 124.1, 119.1 ppm; IR (KBr): 3060, 1613, 1591, 1492, 1346, 746, 635 cm^{-1}; EI-MS: m/z = 327 (M+1)$^+$.

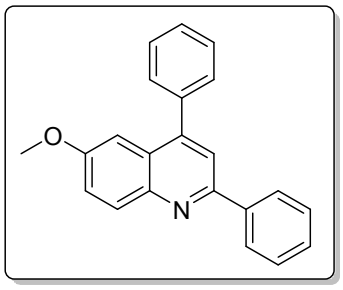
6-Methyl-2,4-diphenylquinoline (4j)[1]



Yellow solid, Mp = 119-120°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.23-8.18 (m, 3H), 7.81 (s, 1H), 7.69 (s, 1H), 7.59-7.46 (m, 9H) ppm, 2.49 (s, 3H); ^{13}C NMR ($CDCl_3$, 125MHz) δ 150.8, 143.3, 142.2, 134.6, 133.4, 131.1, 126.6, 124.7, 124.4, 124.0, 123.6, 123.4, 123.1, 122.3, 120.5,

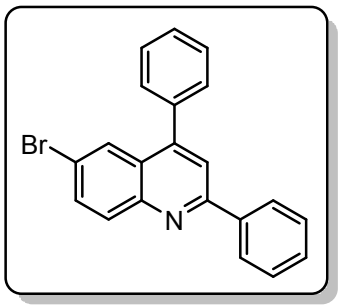
119.2, 114.2, 16.6 ppm; IR (KBr): 3045, 1587, 1544, 1448, 1026, 826, 756, 711, 700 cm^{-1}; EI-MS: m/z = 296 $(M+1)^+$.

6-Methoxy-2,4-diphenylquinoline (4k)[1]



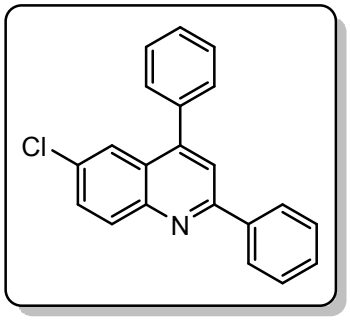
Yellow solid, Mp = 115-116°C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.20-8.18 (m, 3H), 7.79 (s, 1H), 7.59-7.50 (m, 7H), 7.45-7.39 (m, 2H), 7.21 (d, *J* = 2.5 Hz, 1H), 3.76(s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 157.9, 154.6, 147.8, 145.0, 139.8, 138.8, 131.7, 129.5, 129.1, 128.9, 128.8, 128.4, 127.4, 126.7, 121.9, 119.7, 103.7, 55.4 ppm; IR (KBr): 2926, 1616, 1546, 1487, 1112, 854, 772, 694 cm^{-1}; EI-MS: m/z = 312 $(M+1)^+$.

6-Bromo-2,4-diphenylquinoline (4l)[1]



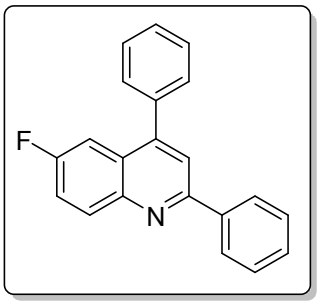
Yellow solid, Mp = 155-156°C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.19 (d, *J* = 7.5 Hz, 2H), 8.11 (d, *J* = 9.0 Hz, 1H), 7.04 (s, 1H), 7.84 (s, 1H), 7.81-7.79 (m, 1H), 7.60-7.47 (m, 8H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 157.2, 148.4, 147.4, 139.2, 137.7, 133.0, 131.9, 130.9, 129.7, 129.5, 128.9, 128.8, 128.7, 127.8, 127.6, 127.0, 120.5, 120.1 ppm; IR (KBr): 2843, 1586, 1547, 1075, 876, 796, 771, 703 cm^{-1}; EI-MS: m/z = 360 $(M+1)^+$.

6-Chloro-2,4-diphenylquinoline (4m)[1]



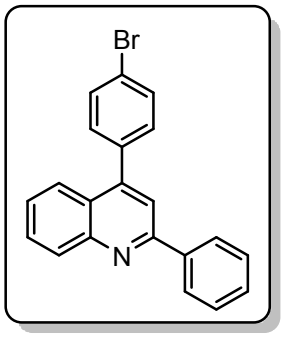
Yellow solid, Mp = 131-132°C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.19 (d, *J* = 7.5 Hz, 3H), 7.87 (d, *J* = 2.0 Hz, 1H), 7.85 (s, 1H), 7.68 (dd, *J* = 2.5, 9.0 Hz, 1H), 7.59-7.47 (m, 8H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 157.1, 148.5, 147.2, 139.2, 137.8, 132.2, 131.7, 130.5, 129.6, 129.5, 128.9, 128.8, 128.7, 127.6, 126.5, 124.5, 120.1 ppm; IR (KBr): 2923, 1617, 1588, 1541, 1027, 883, 779, 698 cm^{-1}; EI-MS: m/z = 316 $(M+1)^+$.

6-Fluoro-2,4-diphenylquinoline (4n)[1]



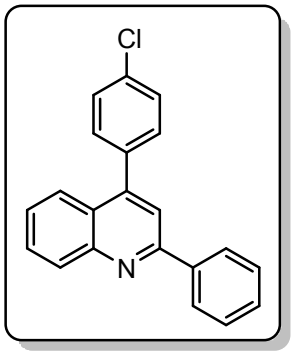
Yellow solid, Mp = 103-104°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.28 (dd, J = 5.5, 9.0 Hz, 1H), 8.23 (d, J = 7.5 Hz, 2H), 7.86 (s, 1H), 7.59-7.48 (m, 10H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 155.4(d, $^1J_{CF}$ = 245.6 Hz), 151.0 (d, $^4J_{CF}$ = 2.4 Hz), 143.4, 140.7, 134.1, 132.8, 127.4 (d, $^3J_{CF}$ = 9.0 Hz), 124.3, 124.2, 123.7, 123.6, 123.5, 122.3, 121.3 (d, $^3J_{CF}$ = 9.3 Hz), 114.6, 114.5 (d, $^2J_{CF}$ = 25.6 Hz), 103.9 (d, $^2J_{CF}$ = 22.8 Hz) ppm; IR (KBr): 3024, 1591, 1546, 1228, 1028, 888, 833, 769 cm^{-1}; EI-MS: m/z = 300 (M+1)$^+$.

4-(4-Bromophenyl)-2-phenylquinoline (4o)[5]



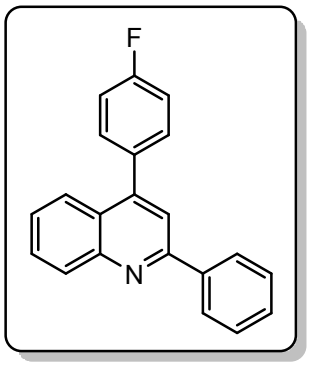
Yellow solid, Mp = 74-75°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.27 (d, J = 8.0 Hz, 1H), 8.19 (d, J = 7.5 Hz, 2H), 7.85 (d, J = 8.5 Hz, 1H), 7.79 (s, 1H), 7.75 (t, J = 7.5 Hz, 1H), 7.69 (d, J = 8.0 Hz, 2H), 7.55-7.48 (m, 4H), 7.44 (d, J = 8.5 Hz, 2H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 156.9, 148.7, 148.0, 139.4, 137.3, 131.9, 131.2, 130.2, 129.8, 129.5, 128.9, 127.6, 126.6, 125.5, 125.3, 122.9, 119.2 ppm; IR (KBr): 2923, 1596, 1545, 1069, 885, 829, 770, 693 cm^{-1}; EI-MS: m/z = 360 (M+1)$^+$.

4-(4-Chlorophenyl)-2-phenylquinoline (4p)[5]



Yellow solid, Mp = 93-94°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.26 (d, J = 8.5 Hz, 1H), 8.20 (d, J = 8.0 Hz, 2H), 7.85 (d, J = 8.5 Hz, 1H), 7.79 (s, 1H), 7.75 (t, J = 7.5 Hz, 1H), 7.55-7.46 (m, 8H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 156.9, 148.8, 147.9, 139.5, 136.8, 134.7, 130.9, 130.3, 129.7, 129.5, 128.9, 127.6, 126.6, 125.5, 125.3, 119.3 ppm; IR (KBr): 2926, 1615, 1578, 1539, 1025, 885, 747, 692 cm^{-1}; EI-MS: m/z = 316 (M+1)$^+$.

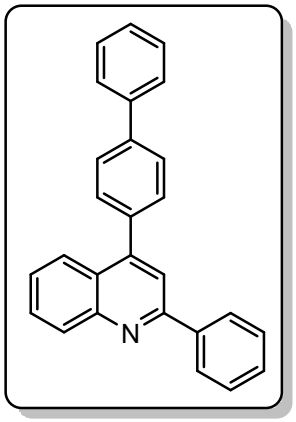
4-(4-Fluorophenyl)-2-phenylquinoline (4q)[1]



Yellow solid, Mp = 70-71°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.26 (d, J = 8.5 Hz, 1H), 8.19 (d, J = 7.5 Hz, 2H), 7.85 (d,

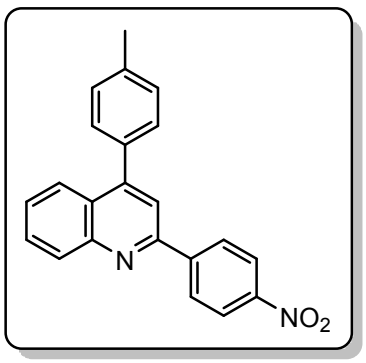
J = 8.5 Hz, 1H), 7.79 (s, 1H), 7.74 (t, *J* = 7.5 Hz, 1H), 7.54-7.45 (m, 6H), 7.25 (d, *J* = 8.5 Hz, 2H) ppm; ^{13}C NMR ($CDCl_3$, 125MHz) δ 162.9 (d, $^{1}J_{CF}$ = 246.7 Hz), 156.9, 148.48, 139.5, 134.3 (d, $^{4}J_{CF}$ = 3.1 Hz), 131.3 (d, $^{3}J_{CF}$ = 8.1 Hz), 130.2, 129.7, 129.5, 128.9, 127.6, 126.5, 125.8, 125.4, 119.4, 115.7 (d, $^{2}J_{CF}$ = 21.5 Hz) ppm; IR (KBr): 2922, 1606, 1545, 1224, 1028, 884, 838, 770 cm^{-1}; EI-MS: m/z = 300 (M+1)$^{+}$.

4-([1,1'-Biphenyl]-4-yl)-2-phenylquinoline (4r)[5]



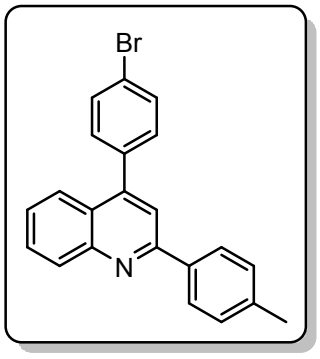
Yellow solid, Mp = 128-129°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.30 (d, *J* = 8.5 Hz, 1H), 8.24 (d, *J* = 7.5 Hz, 2H), 8.01 (d, *J* = 8.5 Hz, 1H), 7.89 (s, 1H), 7.81-7.75 (m, 3H), 7.72 (d, *J* = 7.5 Hz, 2H), 7.66 (d, *J* = 8.0 Hz, 2H), 7.57-7.49 (m, 6H), 7.43 (t, *J* = 7.5 Hz, 1H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 156.9, 148.9, 148.9, 141.4, 140.5, 139.6, 137.3, 130.2, 130.1, 129.6, 129.4, 129.0, 128.9, 127.7, 127.6, 127.4, 127.2, 126.4, 125.8, 125.7, 119.4 ppm; IR (KBr): 3065, 1585, 1487, 1408, 765, 690 cm^{-1}; EI-MS: m/z = 358 (M+1)$^{+}$.

2-(4-Nitrophenyl)-4-(*p*-tolyl)quinoline (4s)[6]



Yellow solid, Mp = 144-145°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.41-8.37 (m, 4H), 8.28 (d, *J* = 8.0 Hz, 1H), 7.98 (d, *J* = 8.5 Hz, 1H), 7.85 (s, 1H), 7.79 (t, *J* = 7.5 Hz, 1H), 7.55 (t, *J* = 7.5 Hz, 1H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.39 (d, *J* = 8.0 Hz, 2H), 2.49 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 154.1, 148.4, 138.8, 134.9, 130.3, 130.1, 129.5, 128.4, 127.3, 126.3, 125.9, 124.1, 119.1, 21.4 ppm; IR (KBr): 2923, 1596, 1546, 1348, 1105, 856, 760, 698 cm^{-1}; EI-MS: m/z = 341 (M+1)$^{+}$.

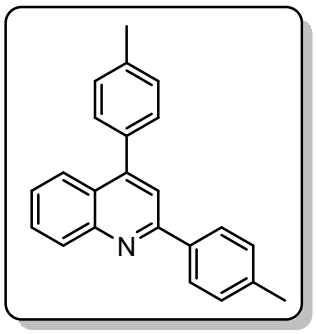
4-(4-Bromophenyl)-2-(*p*-tolyl)quinoline (4t)



Yellow solid, Mp = 103-104°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.25 (d, *J* = 8.5 Hz, 1H), 8.11 (d, *J* = 8.0 Hz, 2H), 7.83 (d, *J* = 8.5 Hz, 1H), 7.76 (s, 1H), 7.73 (t, *J* = 7.5 Hz, 1H), 7.68 (d, *J* = 8.5 Hz, 2H), 7.47 (t, *J* = 7.5 Hz, 1H), 7.42

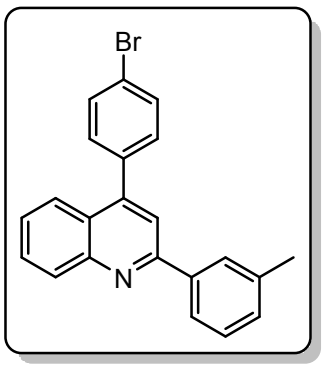
(d, J = 8.0 Hz, 2H), 7.34 (d, J = 7.5 Hz, 2H), 2.45 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 156.8, 148.8, 147.8, 139.6, 137.4, 136.6, 131.8, 131.2, 130.2, 129.6, 127.5, 126.4, 125.3, 122.8, 119.0, 21.4 ppm; IR (KBr): 2928, 1596, 1544, 1485, 1011, 819, 763, 713 cm^{-1}; EI-MS: m/z = 374 (M+1) $^+$; HRMS (ESI) m/z: [M + H]$^+$ calcd for $C_{22}H_{17}BrN$, 374.0544; found, 374.0548.

2,4-Di-*p*-tolylquinoline (4u)[7]



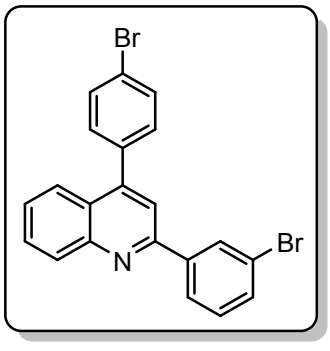
Colorless solid, Mp = 114-115°C; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 8.25 (d, J = 8.5 Hz,1H), 8.11 (d, J = 8.0 Hz, 2H), 7.93 (d, J = 8.0 Hz, 1H), 7.80 (s, 1H), 7.74-7.71 (m, 1H), 7.48-7.45 (m, 3H), 7.35 (m, 4H), 2.49 (s, 3H), 2.44 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 156.8, 149.1, 148.8, 139.4, 138.3, 136.8, 135.5, 129.9, 129.6, 129.5, 129.4, 129.3, 127.5, 126.0, 125.8, 125.7, 119.2, 21.4, 21.3 ppm; IR (KBr): 3029, 1592, 1541, 1495, 1018, 818, 774, 763, 720 cm^{-1}; EI-MS: m/z = 310 (M+1) $^+$.

4-(4-Bromophenyl)-2-(*m*-tolyl)quinoline (4v)



Yellow solid, Mp = 72-73°C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.28 (d, J = 8.5 Hz, 1H), 8.05 (s, 1H), 7.98 (d, J = 7.5 Hz, 1H), 7.92 (d, J = 8.0 Hz, 1H), 7.83 (s, 1H), 7.75 (t, J = 7.6 Hz, 1H), 7.58 – 7.47 (m, 5H), 7.43 (t, J = 7.6 Hz, 1H), 7.30 (d, J = 7.6 Hz, 1H), 2.49 (s, 3H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 157.1, 149.2, 148.7, 139.5, 138.6, 138.4, 130.2, 130.1, 129.6, 128.8, 128.6, 128.5, 128.3, 126.4, 125.8, 125.7, 124.80 119.6, 21.7 ppm; IR (KBr): 2920, 1590, 1547, 1490, 1029, 812, 770, 700 cm^{-1}; EI-MS: m/z = 374 (M+1) $^+$; HRMS (ESI) m/z: [M + H]$^+$ calcd for $C_{22}H_{17}BrN$, 374.0544; found, 374.0548.

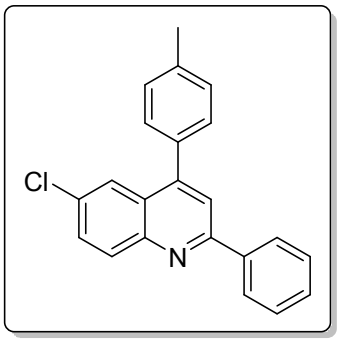
2-(3-Bromophenyl)-4-(4-bromophenyl)quinoline (4w)



Yellow solid, Mp = 83-84°C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.39 (s, 1H), 8.25 (d, J = 8.6 Hz, 1H), 8.12 (d, J = 7.6 Hz, 1H), 7.92 (d, J = 8.0 Hz, 1H), 7.78 – 7.73 (m, 2H), 7.54 (m, 6H), 7.39 (t, J = 8.0 Hz, 1H). ^{13}C NMR

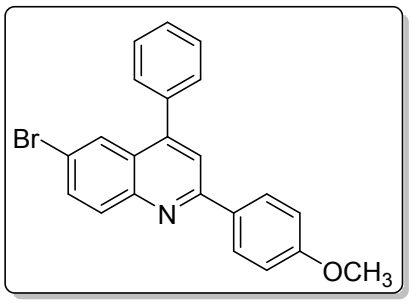
($CDCl_3$, 100 MHz) δ 155.2, 149.6, 148.8, 141.7, 138.2, 132.3, 130.7, 130.4, 130.2, 129.8, 129.6, 128.7, 128.6, 126.8, 126.2, 125.9, 125.8, 123.2, 119.1 ppm; IR (KBr): 2849, 1587, 1544, 1070, 877, 792, 773, 700 cm^{-1}; EI-MS: m/z = 437 $(M+1)^+$; HRMS (ESI) m/z: $[M + H]^+$ calcd for $C_{21}H_{14}Br_2N$, 437.9493; found, 437.9498.

6-Chloro-2-phenyl-4-(*p*-tolyl)quinoline (4x)[3]



Yellow solid, Mp = 128-129°C; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.19-8.17 (m, 3H), 7.91 (d, *J* = 2.5 Hz, 1H), 7.83 (s, 1H), 7.66 (dd, *J* = 2.0, 9.0 Hz, 1H), 7.54 (t, *J* = 7.5 Hz, 2H), 7.49 (d, *J* = 7.0 Hz, 1H), 7.45 (d, *J* = 8.0 Hz, 2H), 7.39 (d, *J* = 7.5 Hz, 2H), 2.50 (s, 3H) ppm; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 151.8, 143.3, 142.0, 134.0, 133.5, 129.6, 126.9, 126.5, 125.2, 124.3, 124.1, 123.7, 122.3, 121.4, 119.3, 114.8, 16.1 ppm; IR (KBr): 2917, 1589, 1542, 1355, 885, 824, 779, 688 cm^{-1}; EI-MS: m/z = 330 $(M+1)^+$.

6-Bromo-2-(4-methoxyphenyl)-4-phenylquinoline (4y)[8]



Yellow oil; ^1H NMR ($CDCl_3$, 500 MHz) δ 8.16 (d, *J* = 8.5 Hz, 2H), 8.08 (d, *J* = 9.0 Hz, 1H), 8.00 (d, *J* = 2.0 Hz, 1H), 7.77 (m, 2H) ppm, 7.56 (m, 5H), 7.05 (d, *J* = 9.0 Hz, 2H), 3.89(s, 3H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 161.1, 156.7, 148.3, 147.4, 137.8, 132.9, 131.6, 131.5, 129.5, 128.9, 128.8, 128.7, 127.8, 126.8, 120.0, 119.6, 114.3, 55.4 ppm; IR (KBr): 2901, 1585, 1539, 1103, 873, 795, 773, 705 cm^{-1}; EI-MS: m/z = 390 $(M+1)^+$.

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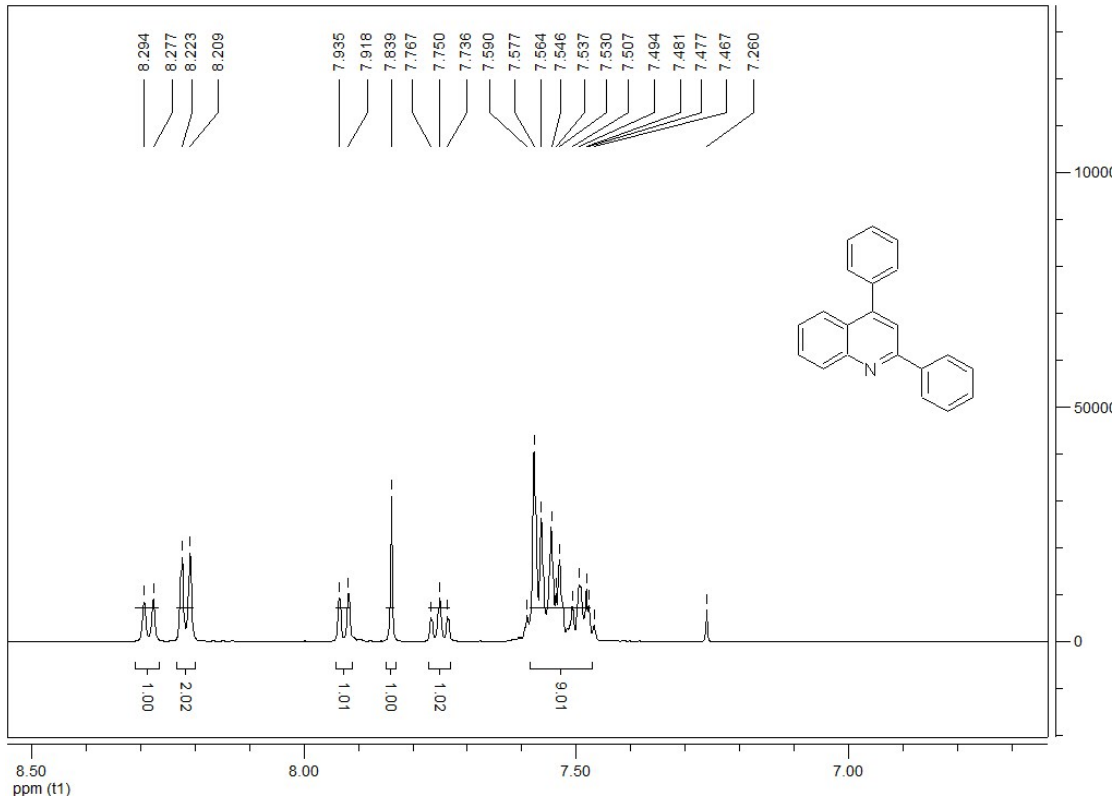
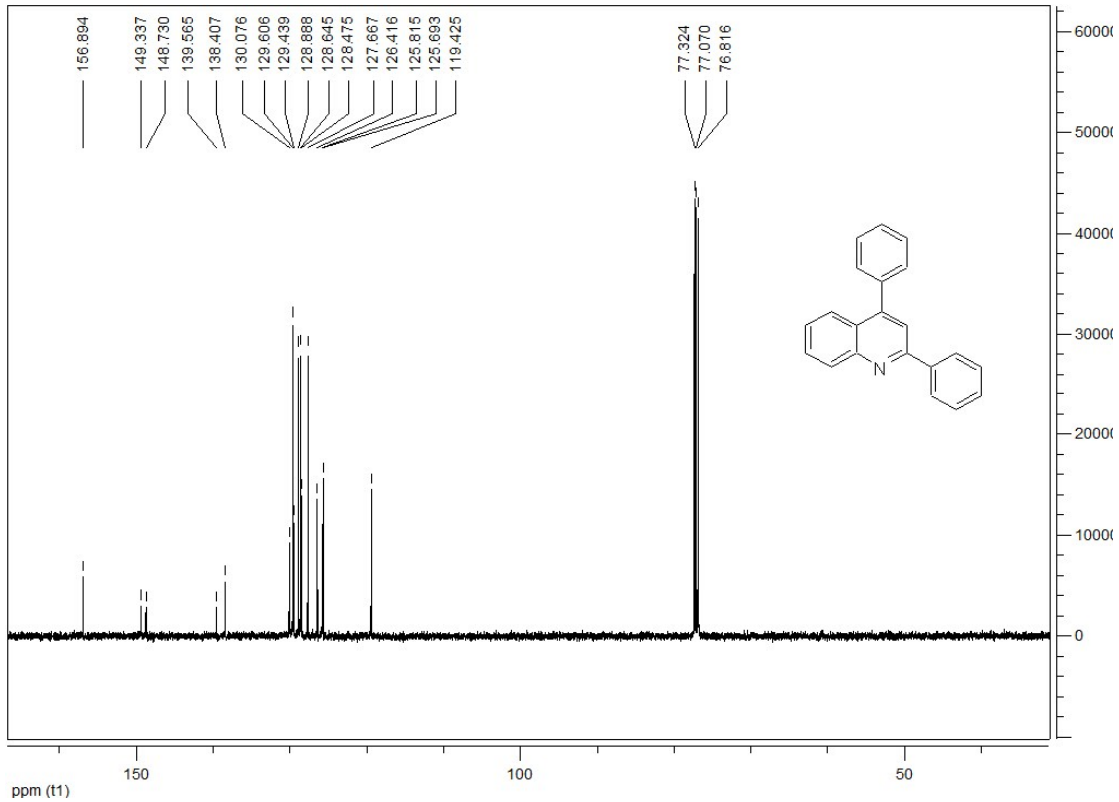
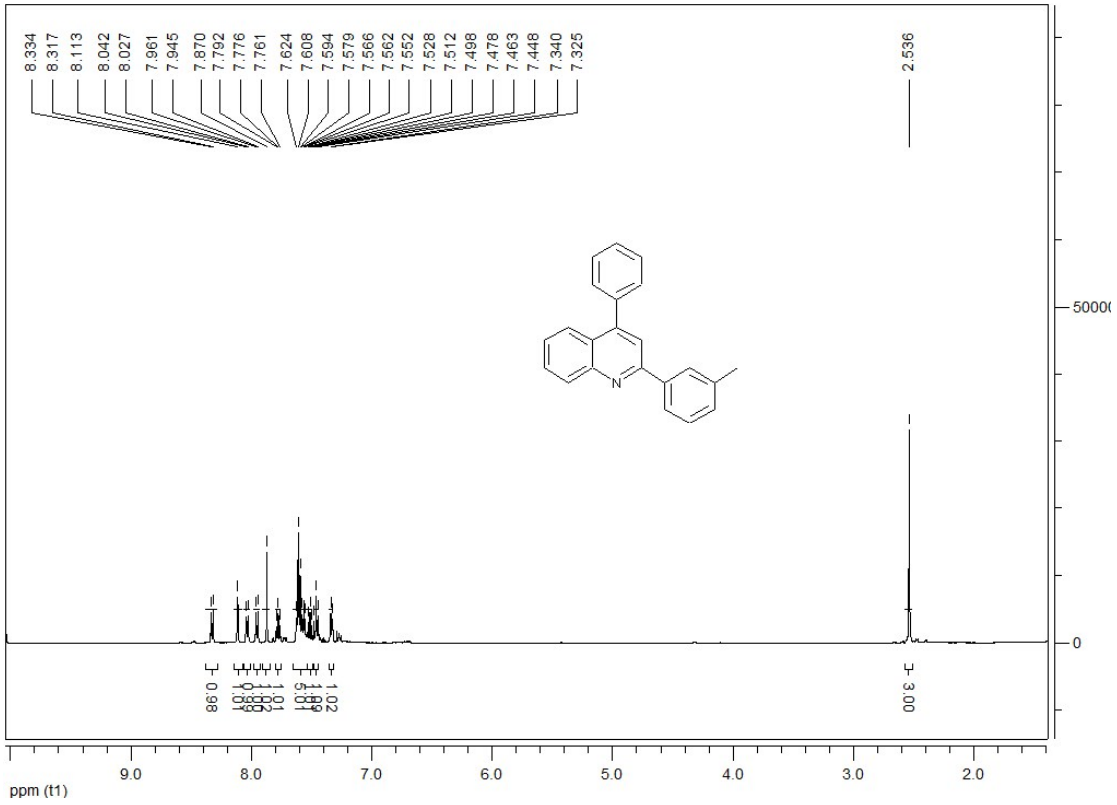
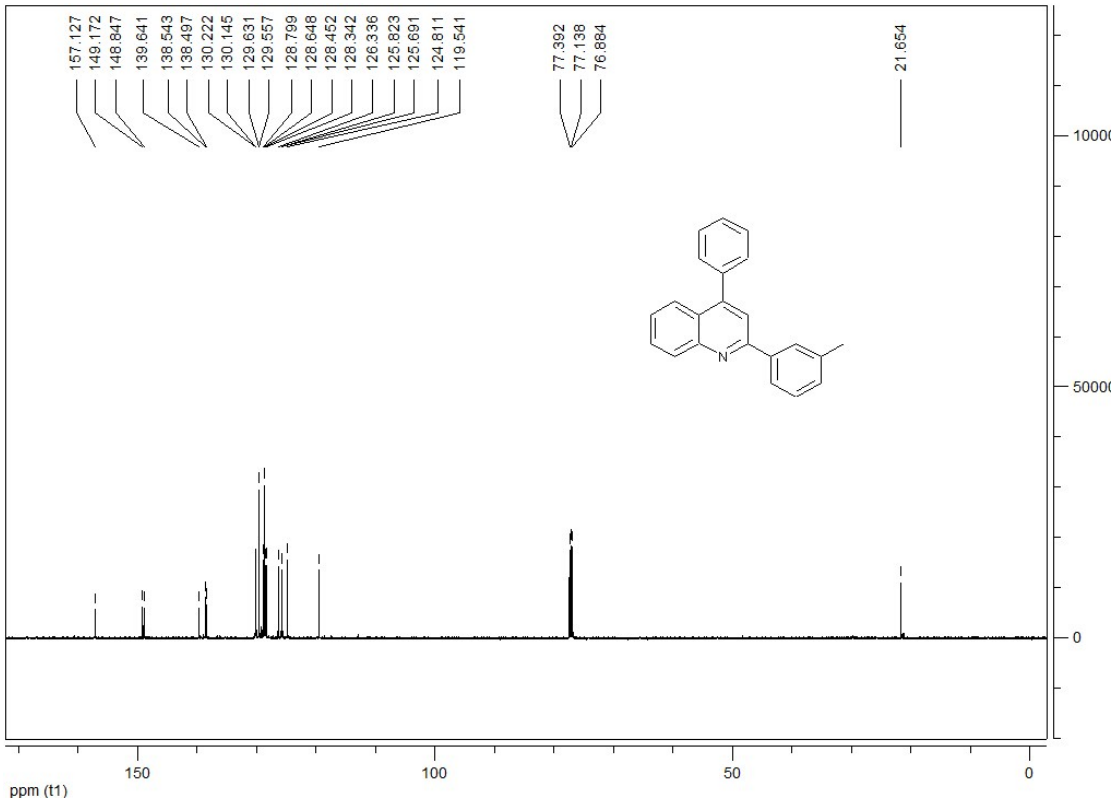
^{1}H NMR and ^{13}C NMR of compound **4a**



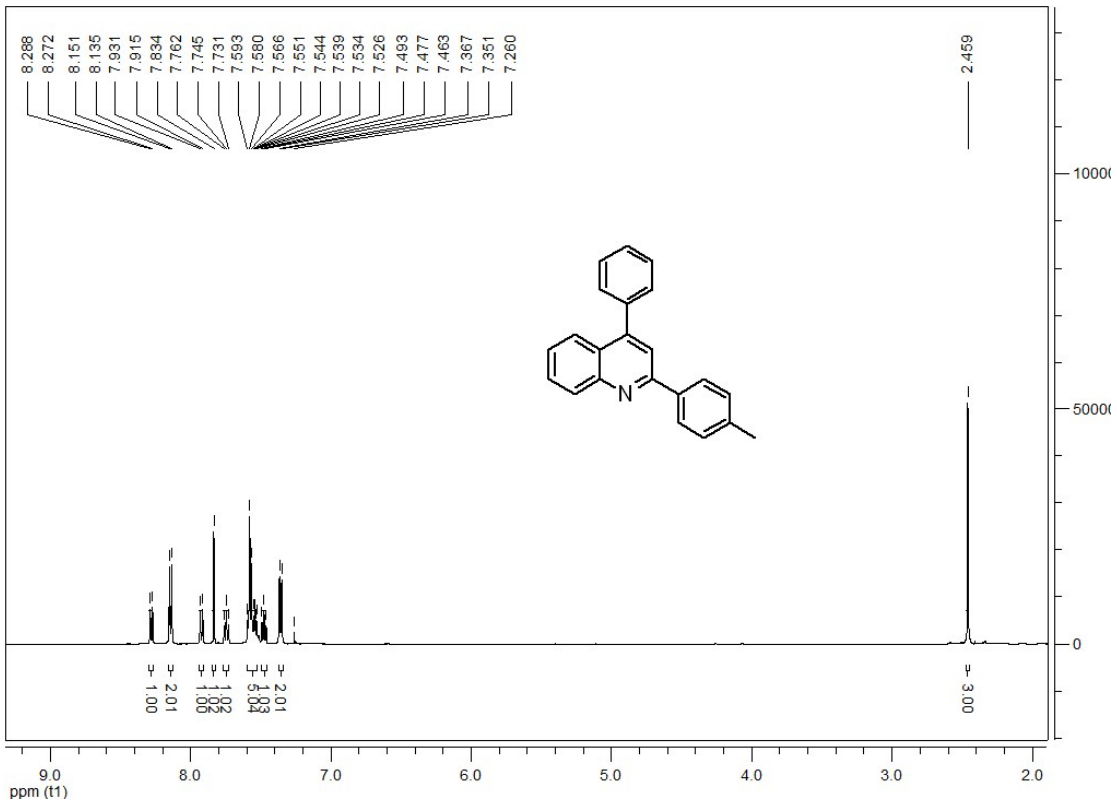


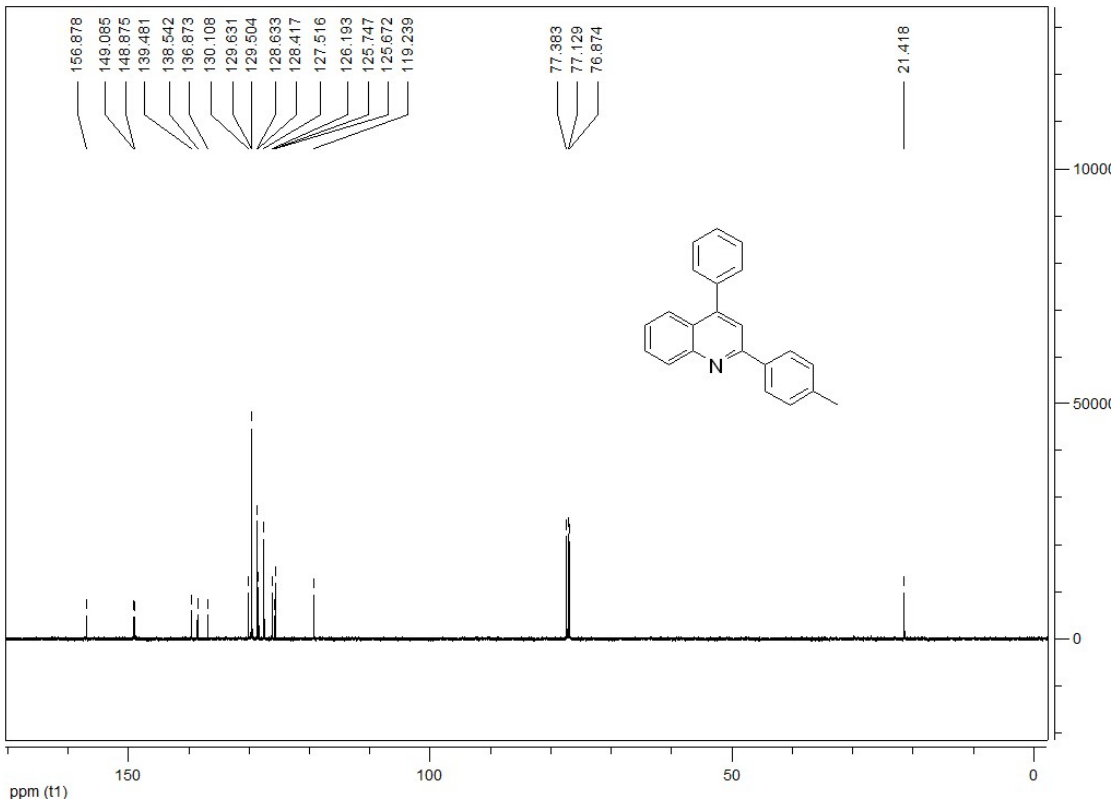
^{1}H NMR and ^{13}C NMR of compound **4b**



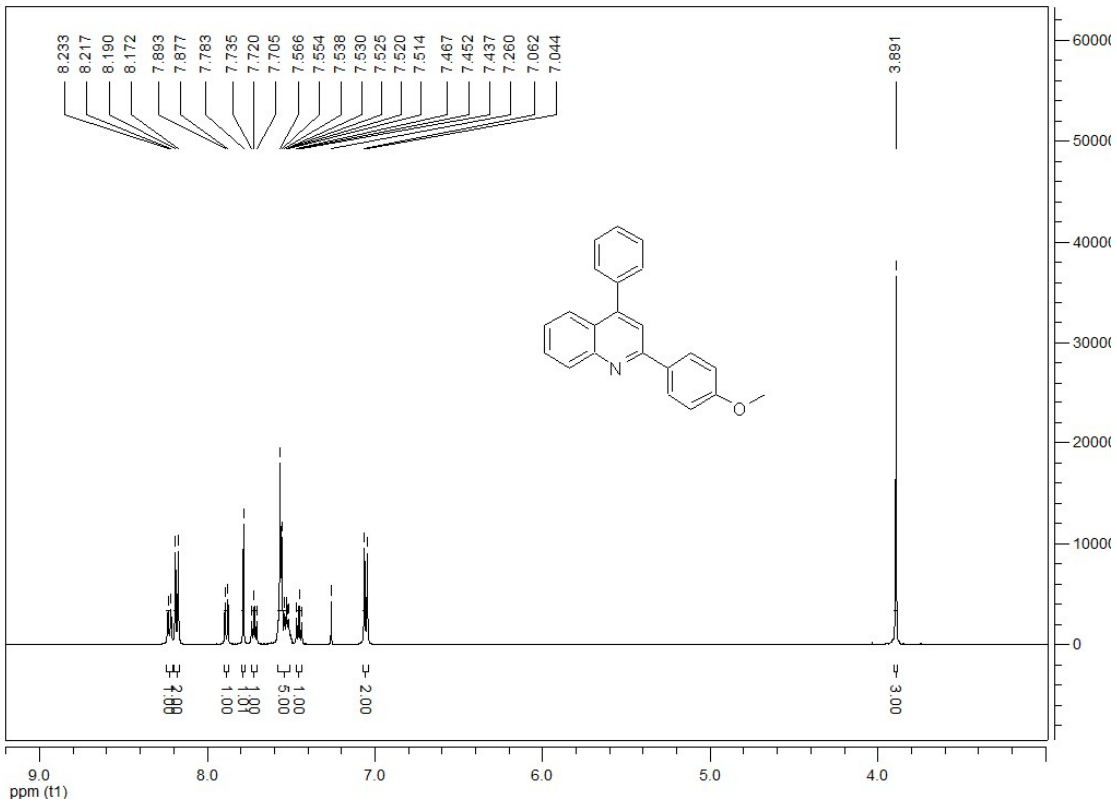


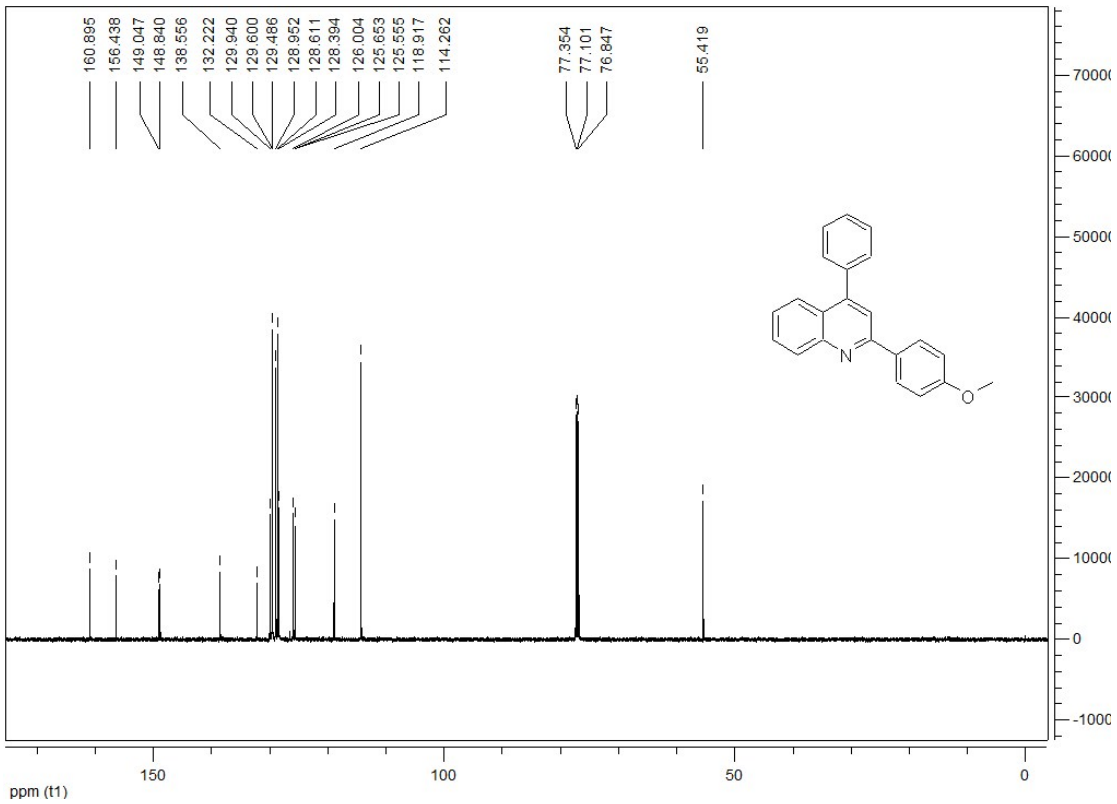
^{1}H NMR and ^{13}C NMR of compound **4c**



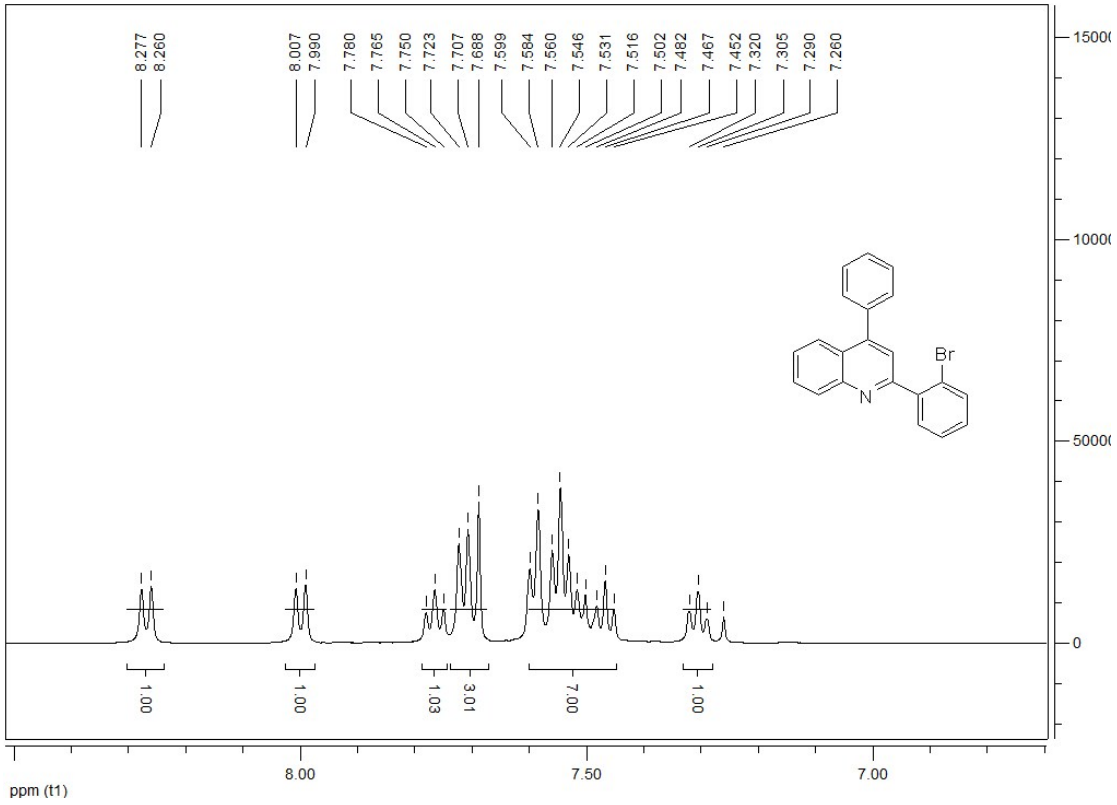


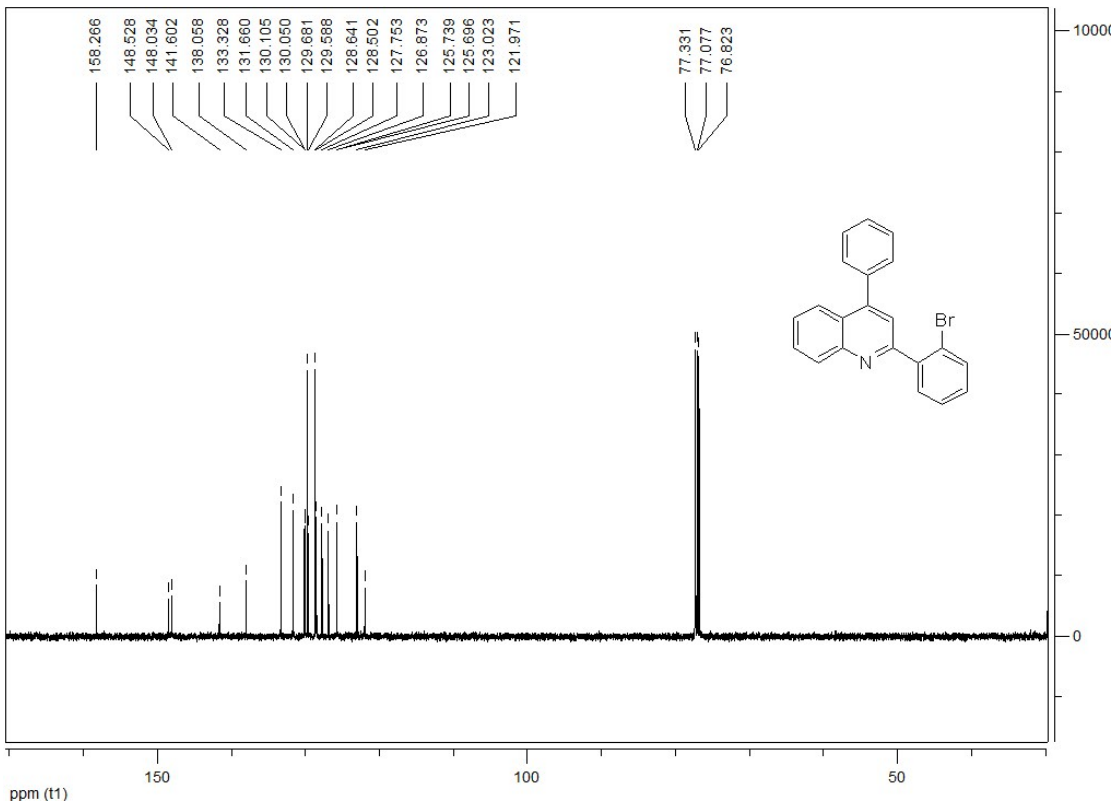
^{1}H NMR and ^{13}C NMR of compound **4d**



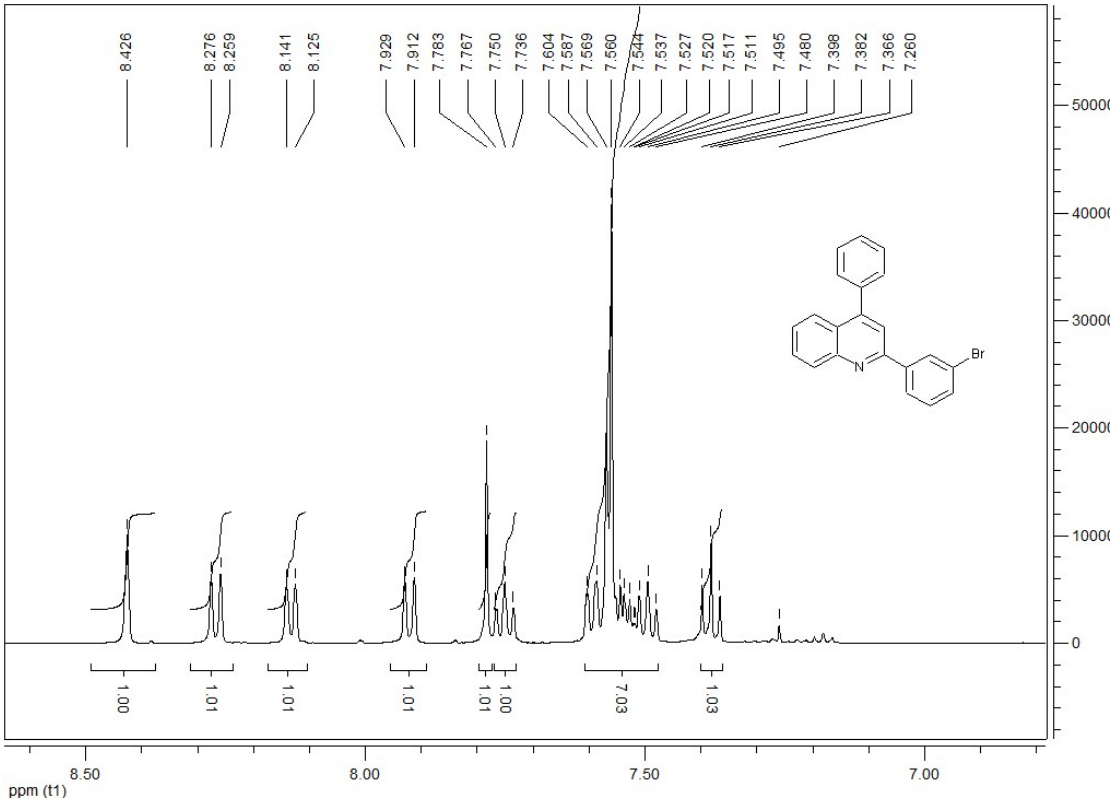


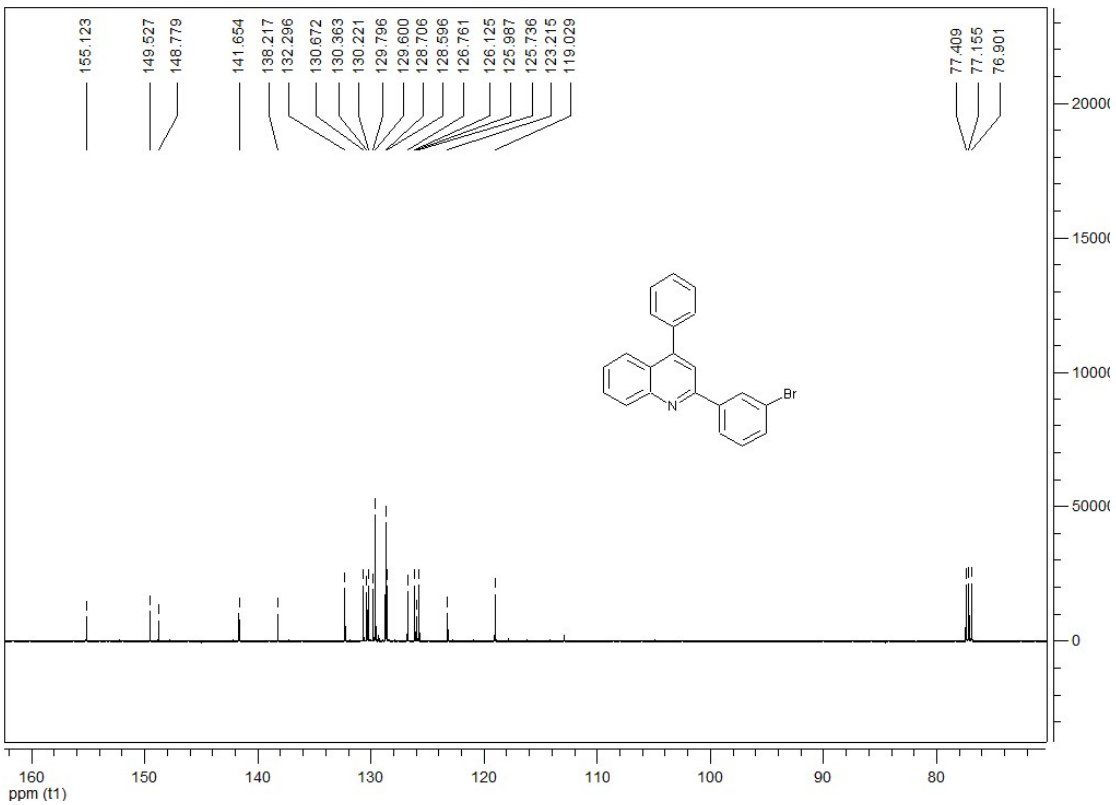
^{1}H NMR and ^{13}C NMR of compound **4e**



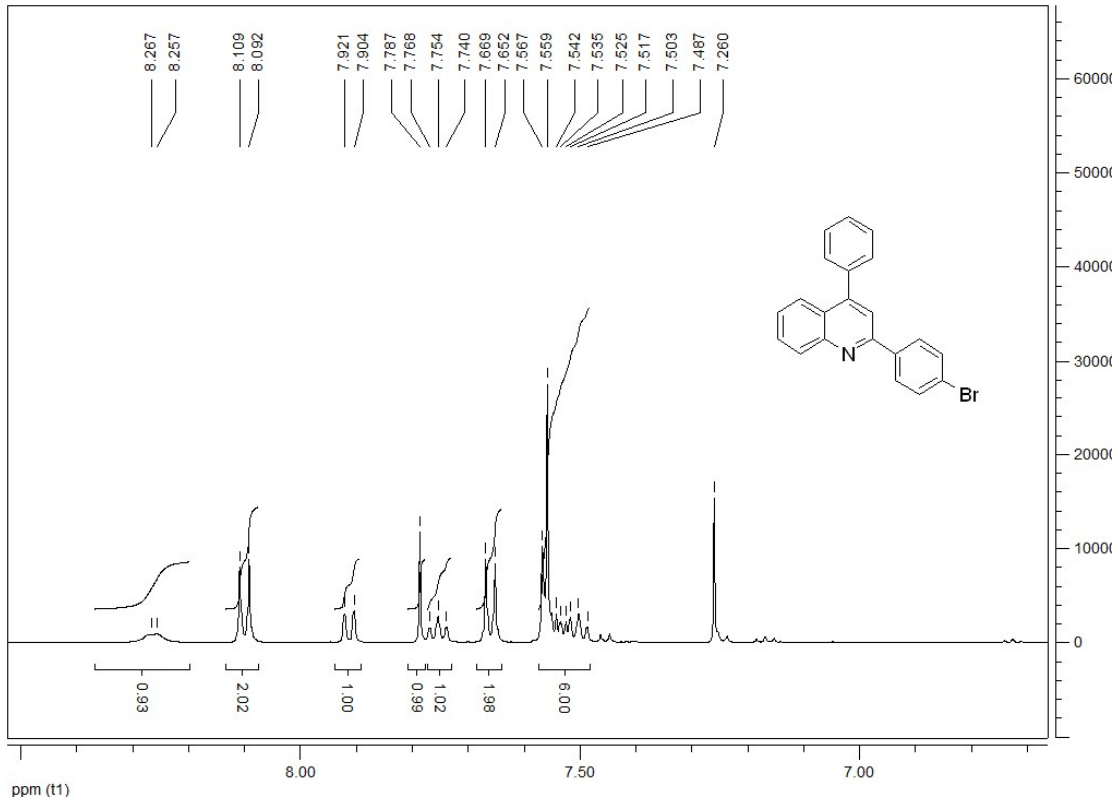


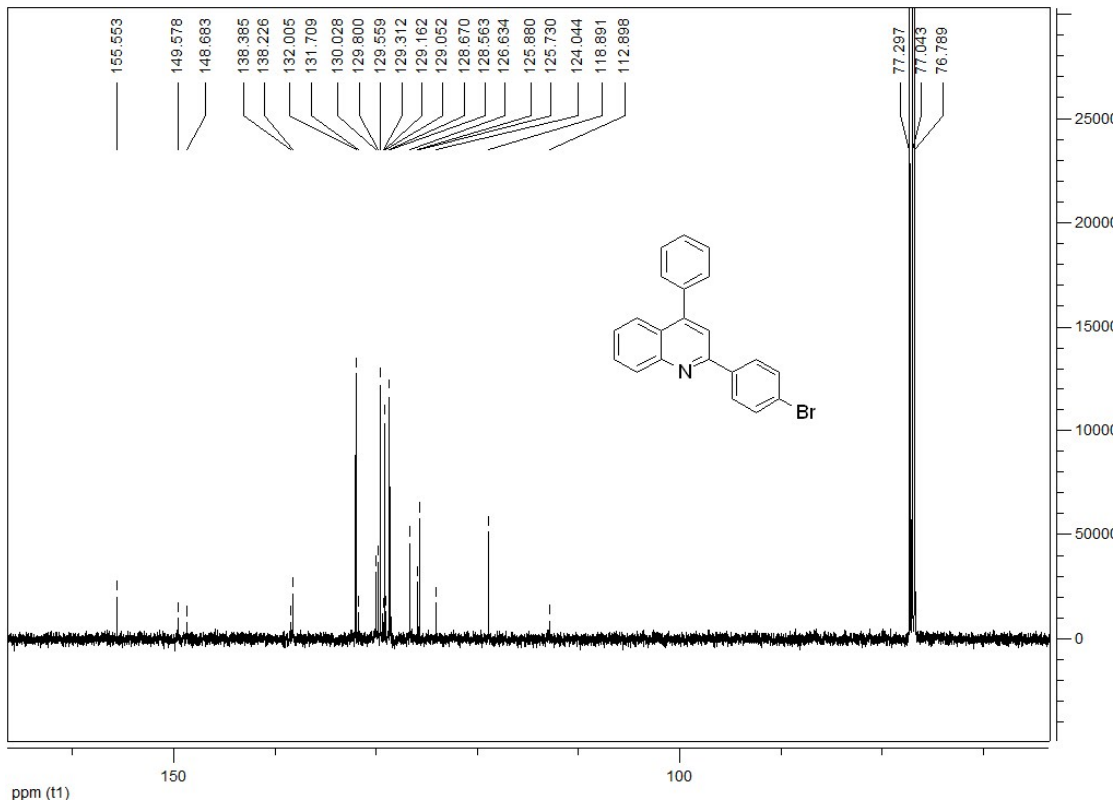
^{1}H NMR and ^{13}C NMR of compound **4f**



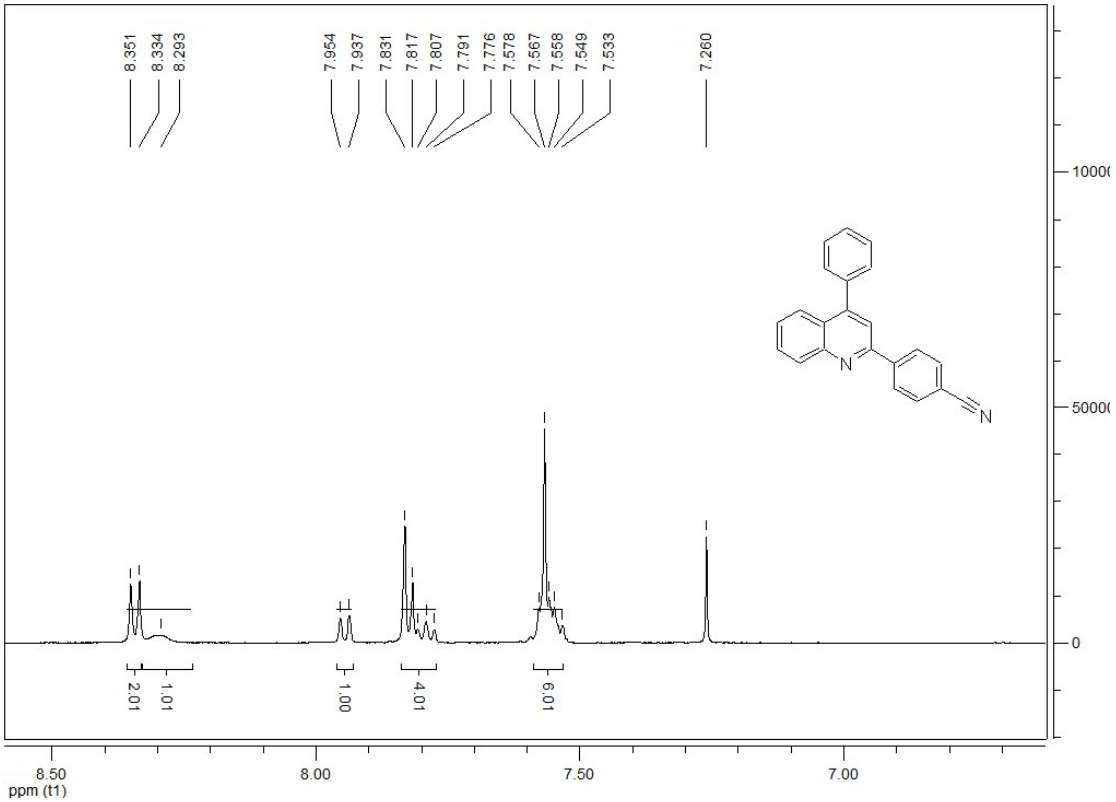


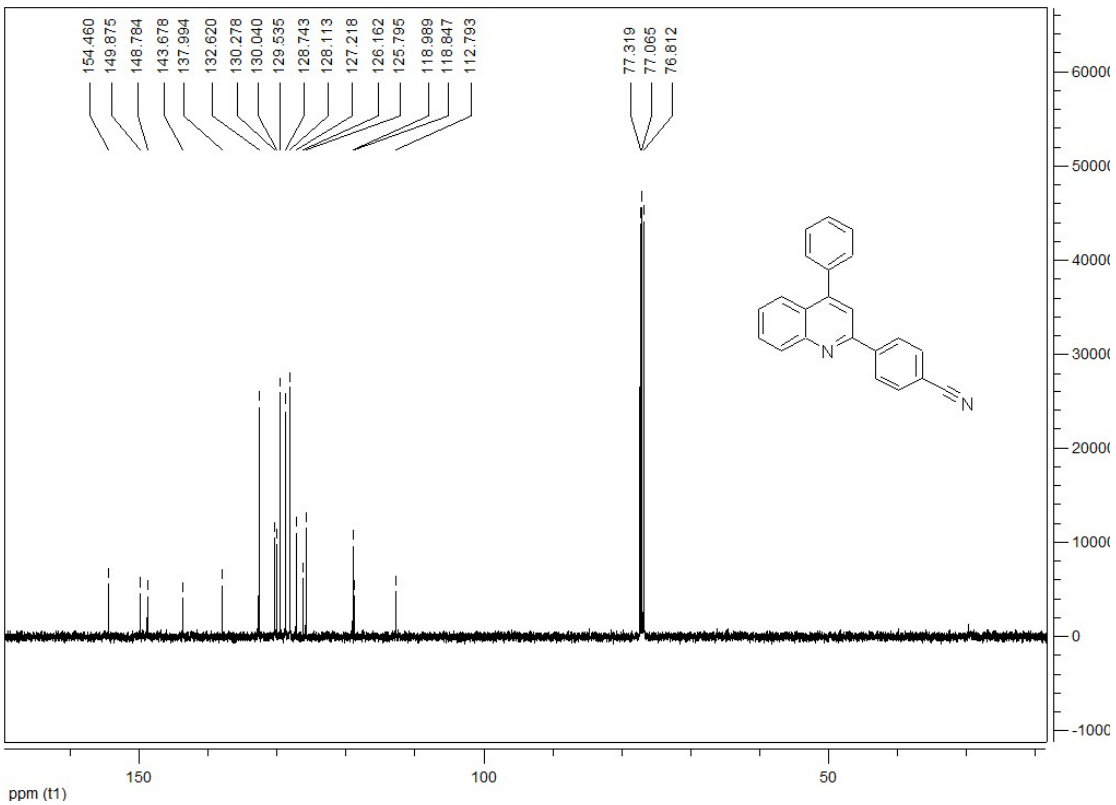
^{1}H NMR and ^{13}C NMR of compound **4g**



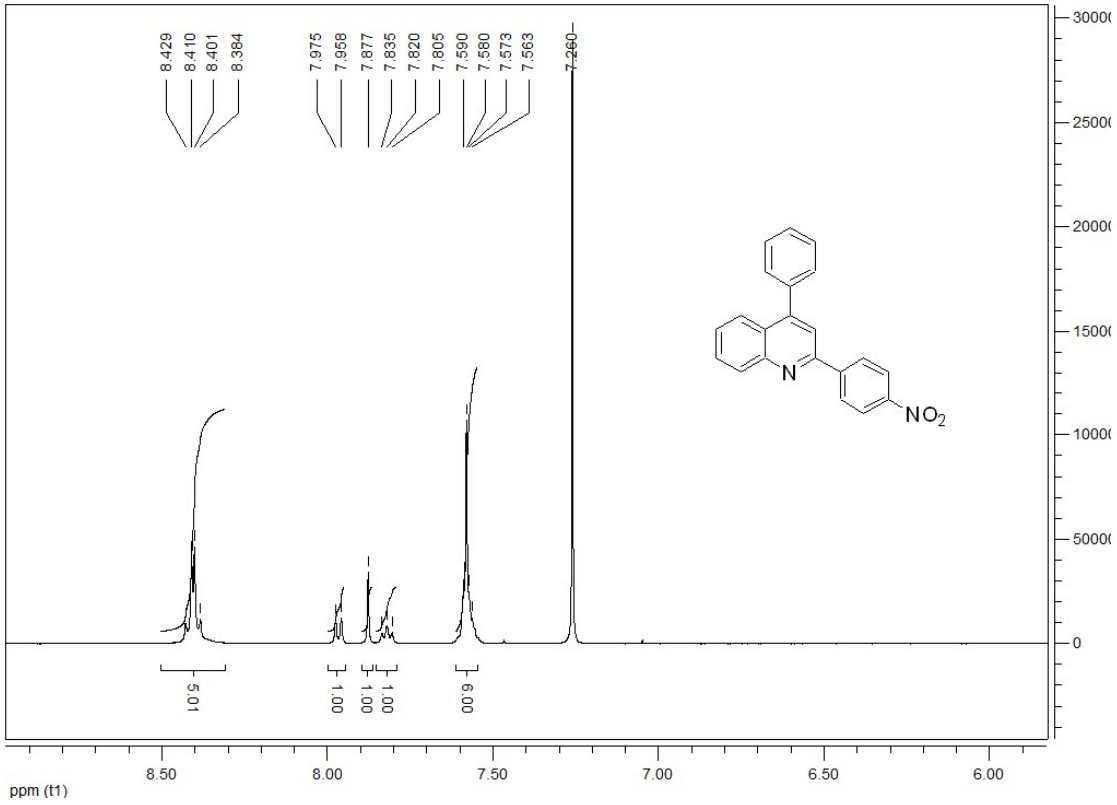


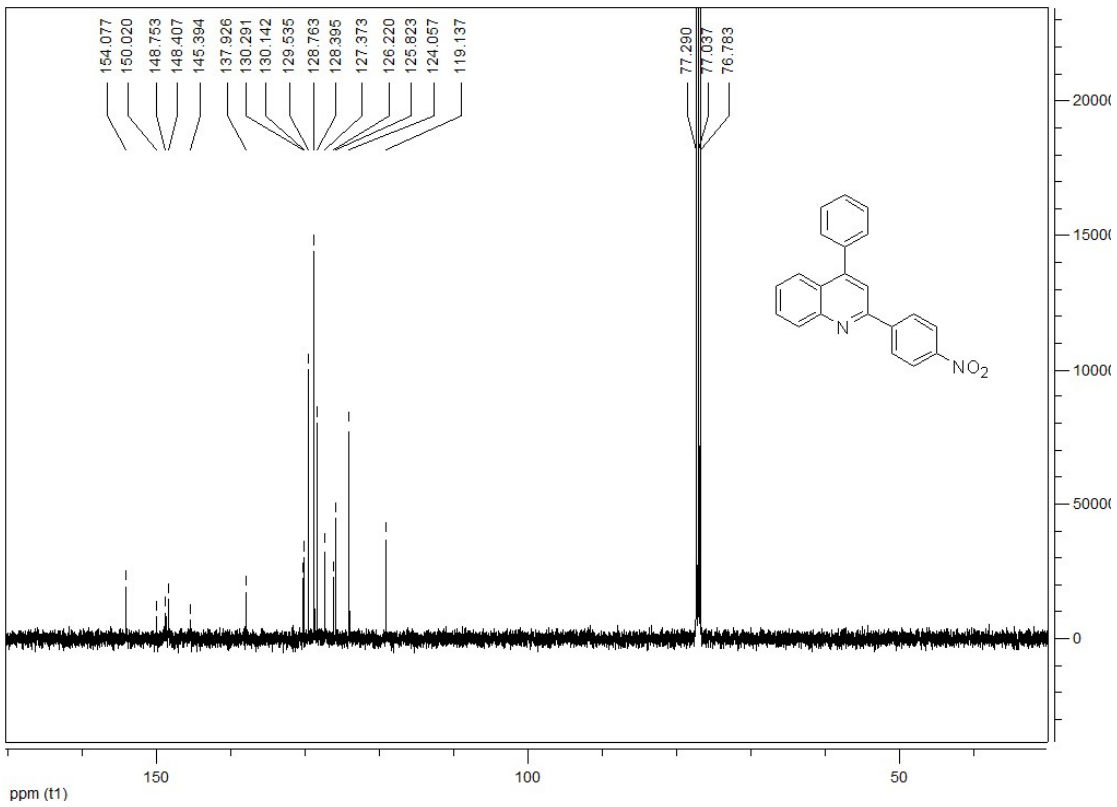
^{1}H NMR and ^{13}C NMR of compound **4h**



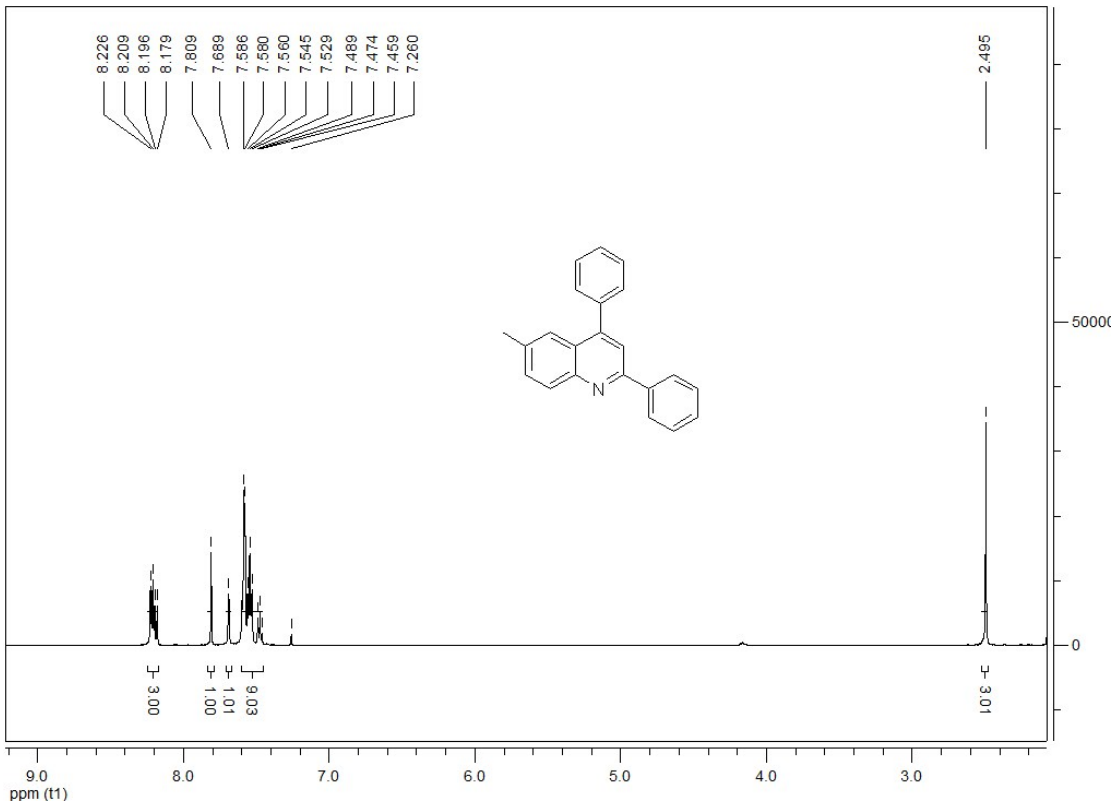


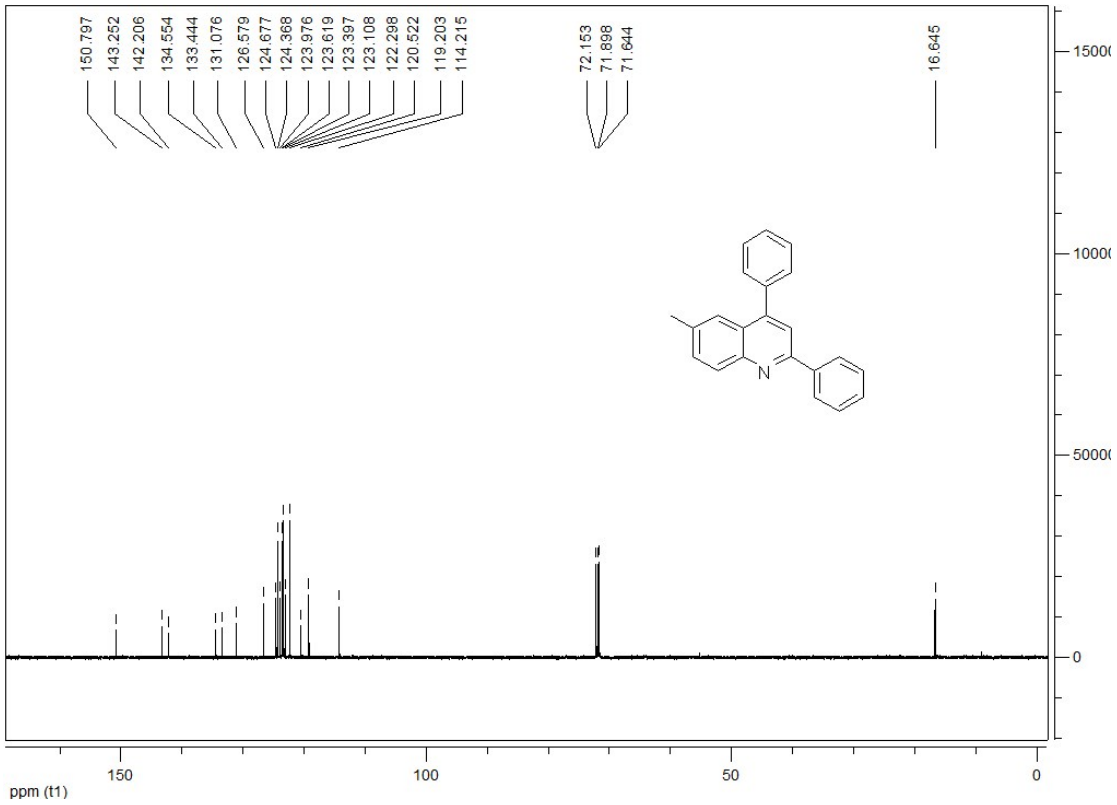
^{1}H NMR and ^{13}C NMR of compound **4i**



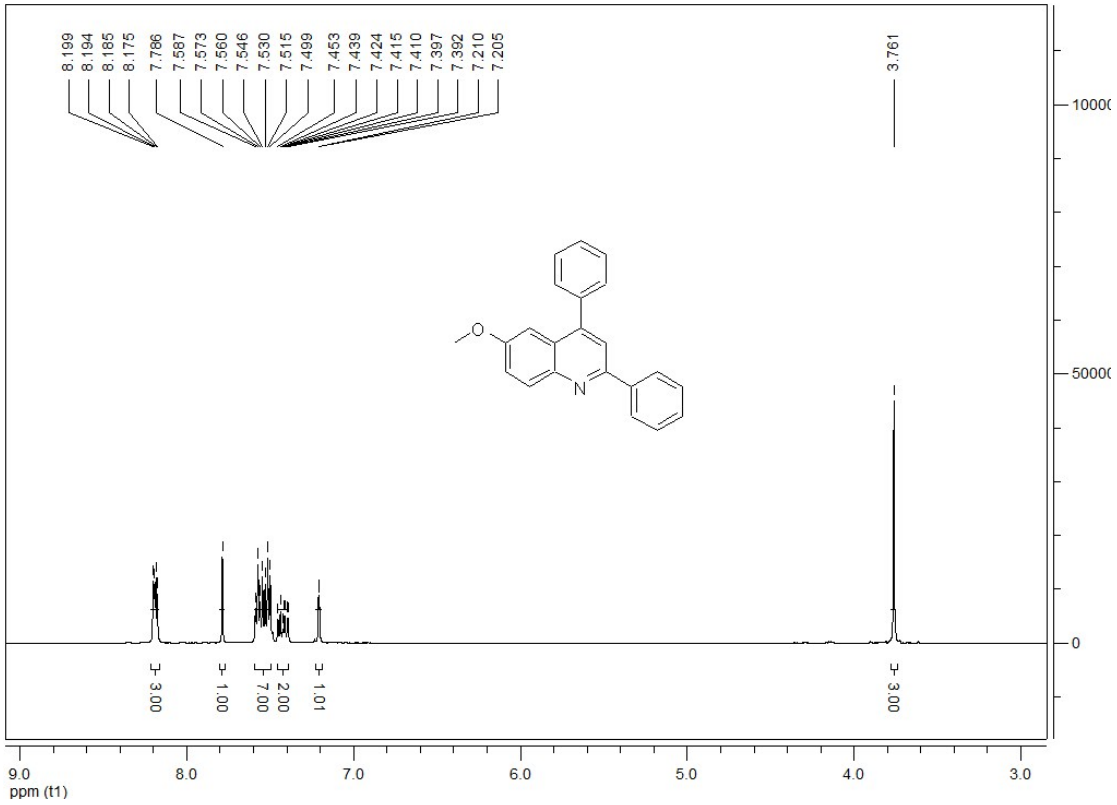


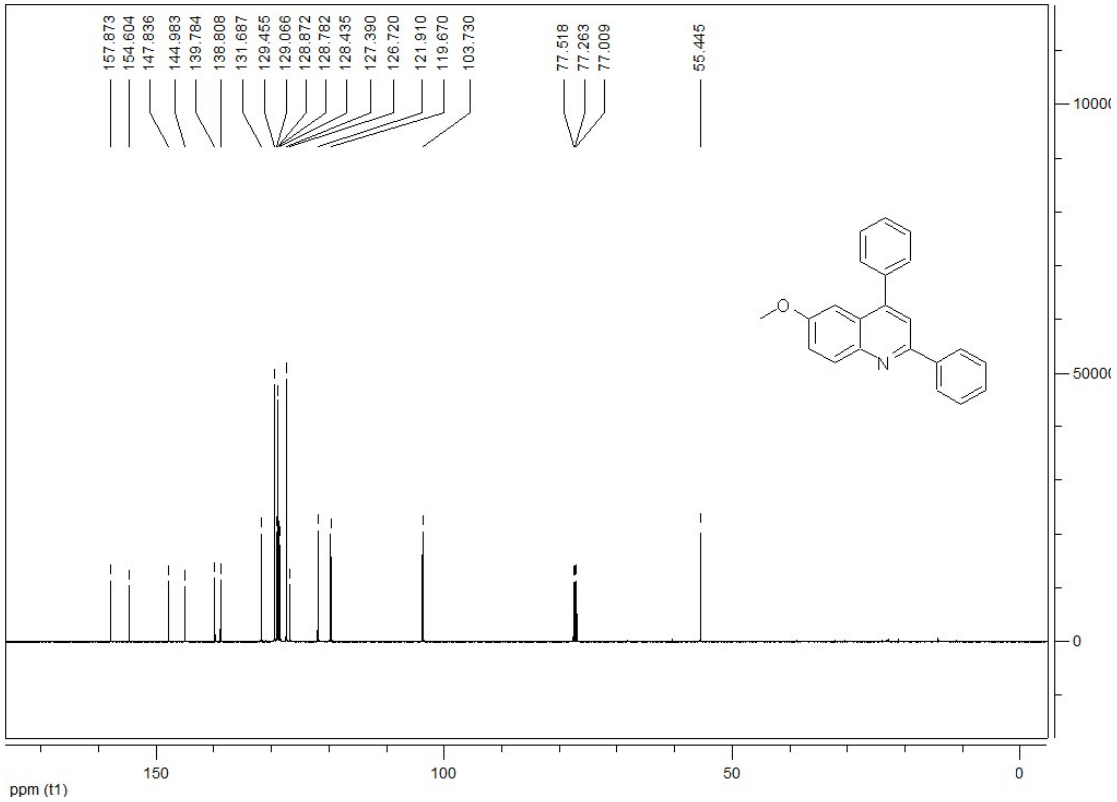
^{1}H NMR and ^{13}C NMR of compound **4j**



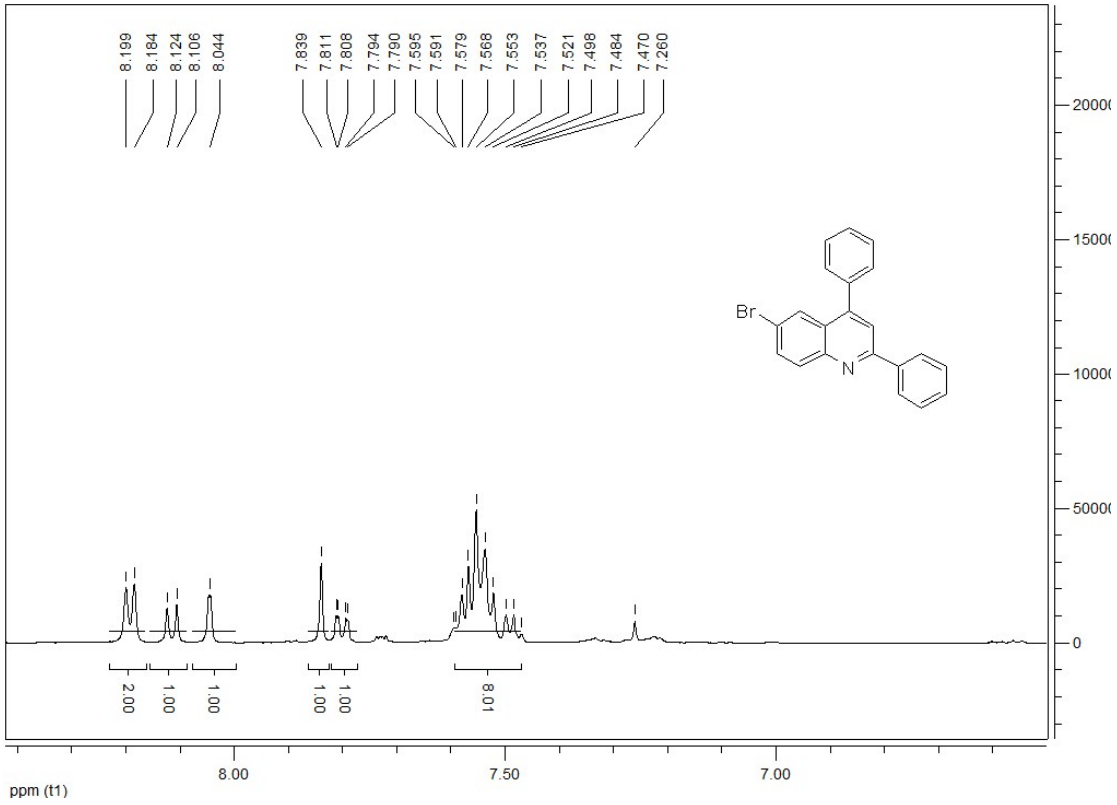


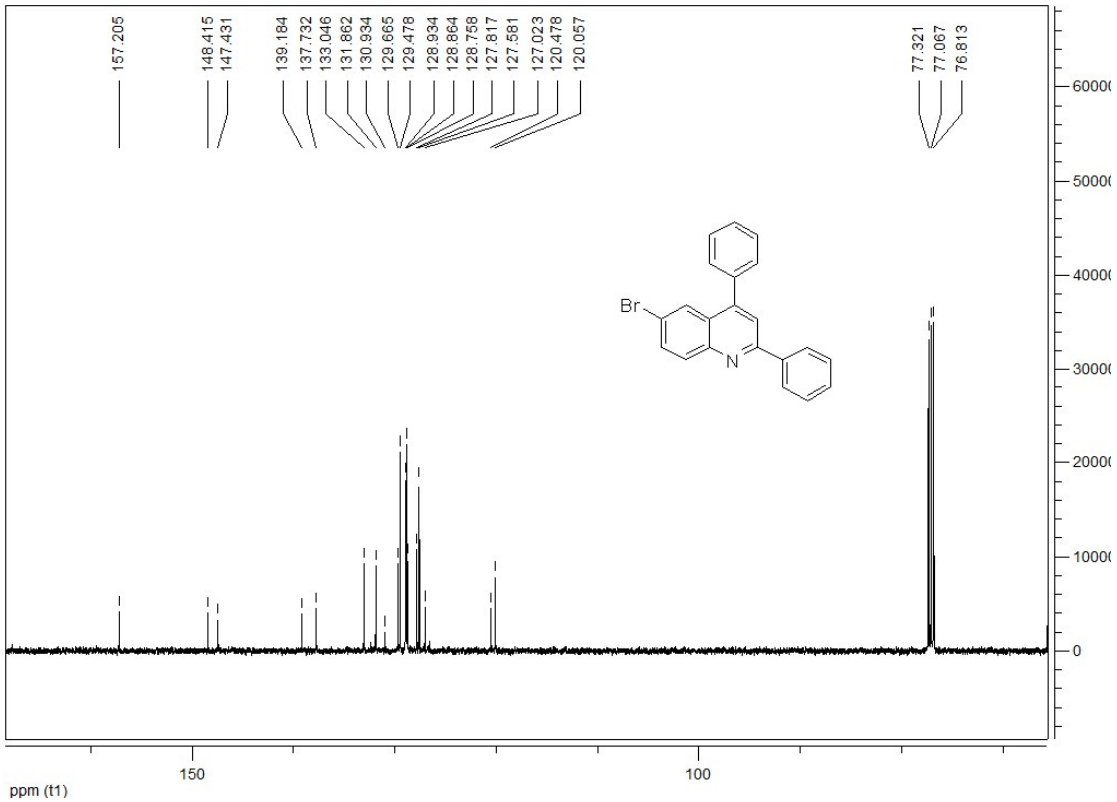
^{1}H NMR and ^{13}C NMR of compound **4k**



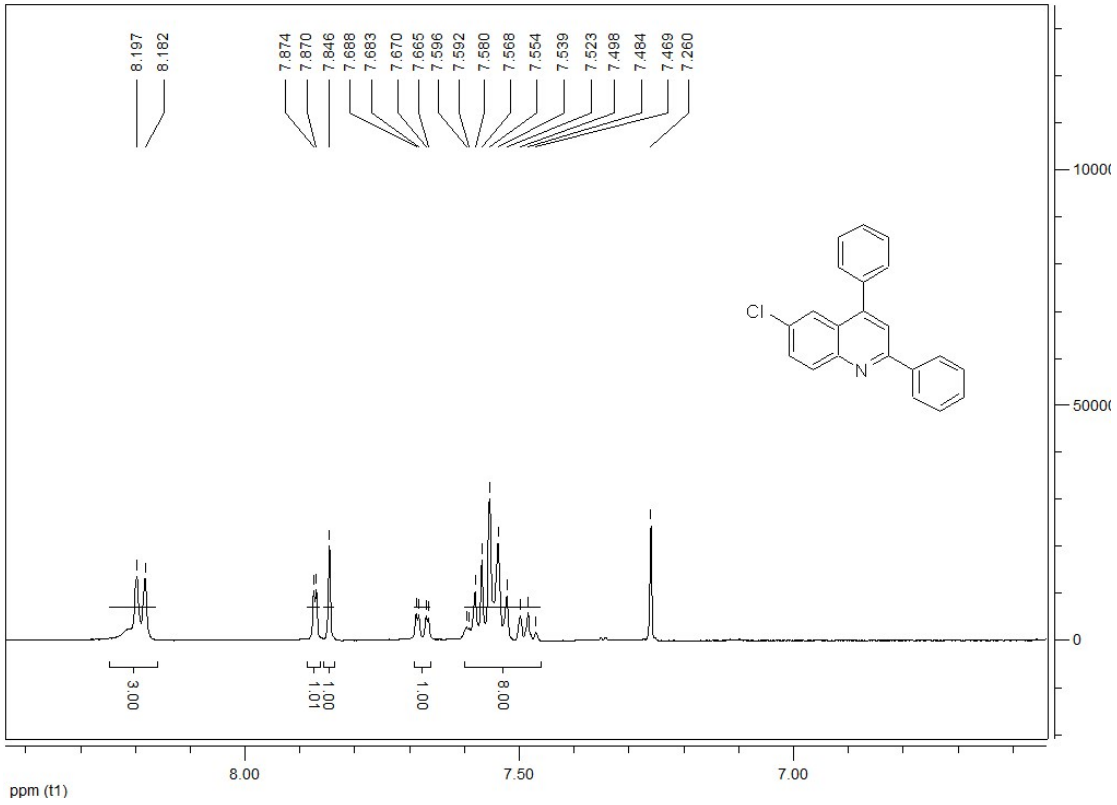


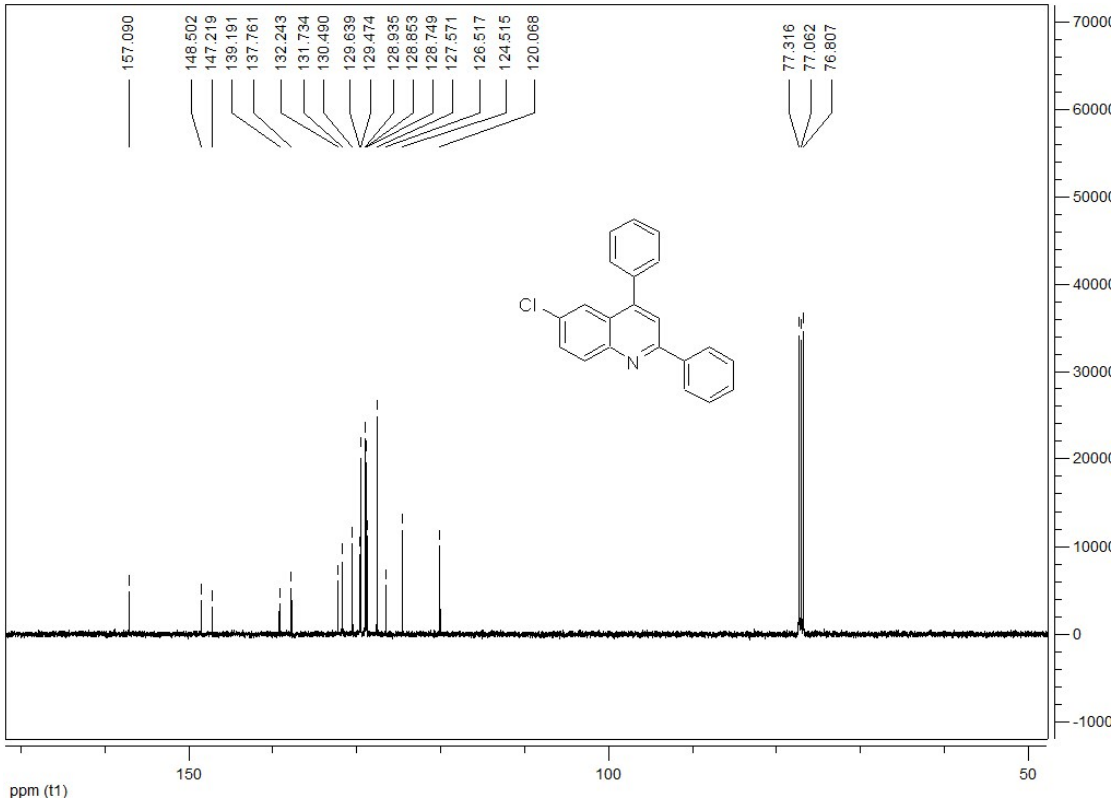
^{1}H NMR and ^{13}C NMR of compound **4l**



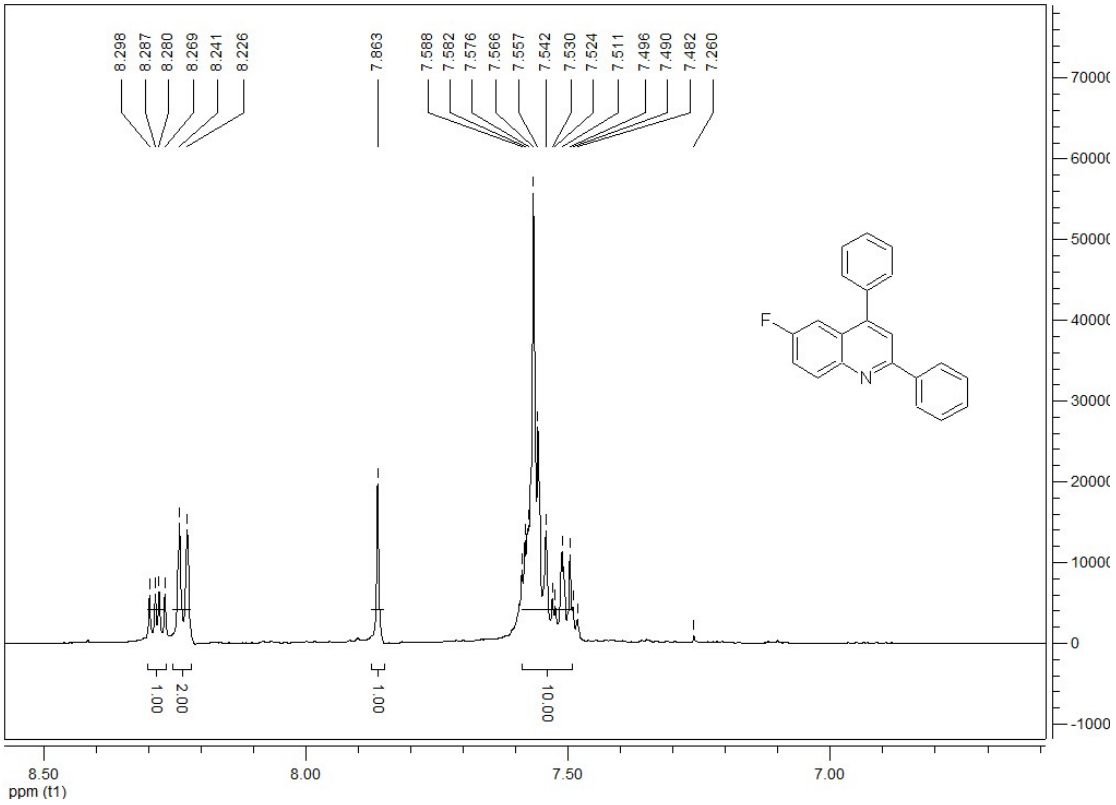


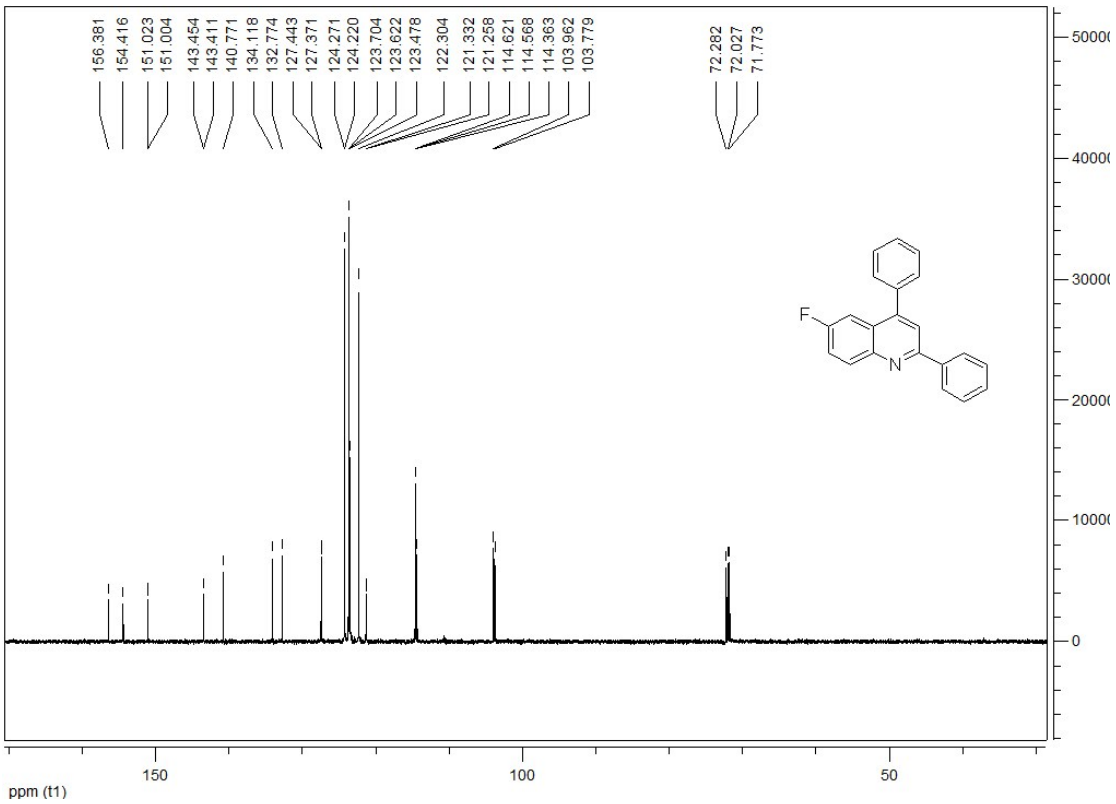
^{1}H NMR and ^{13}C NMR of compound **4m**



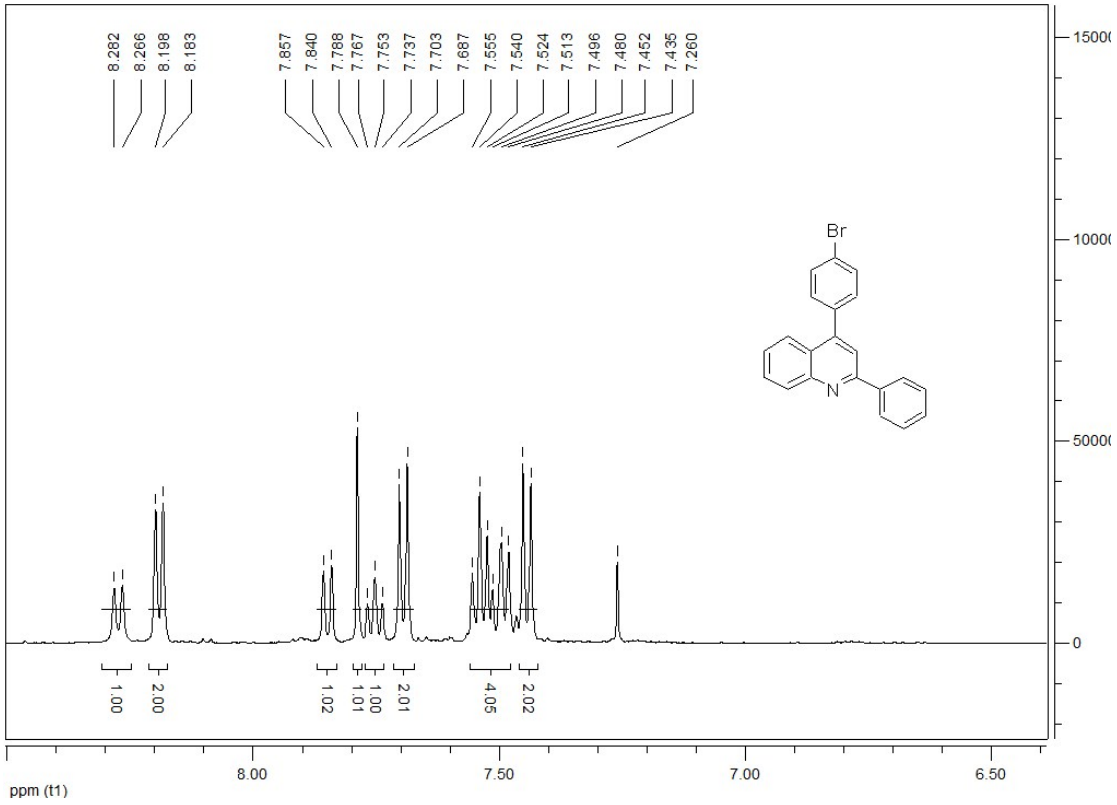


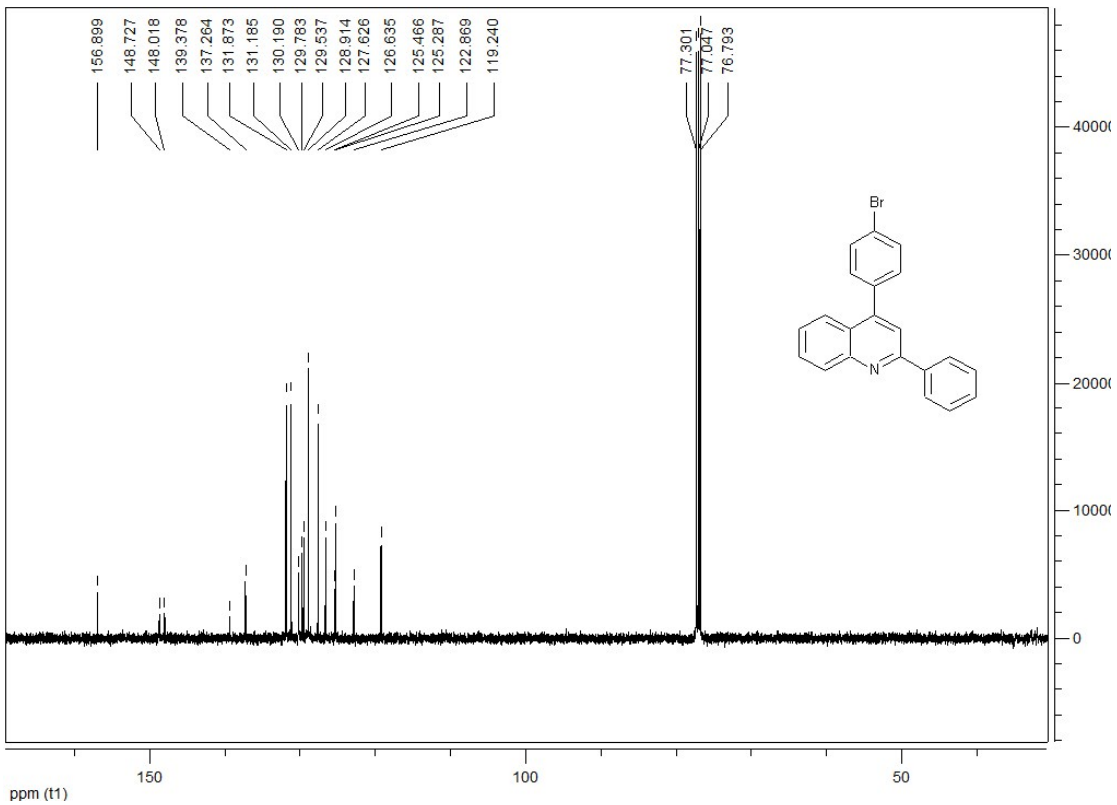
^{1}H NMR and ^{13}C NMR of compound **4n**



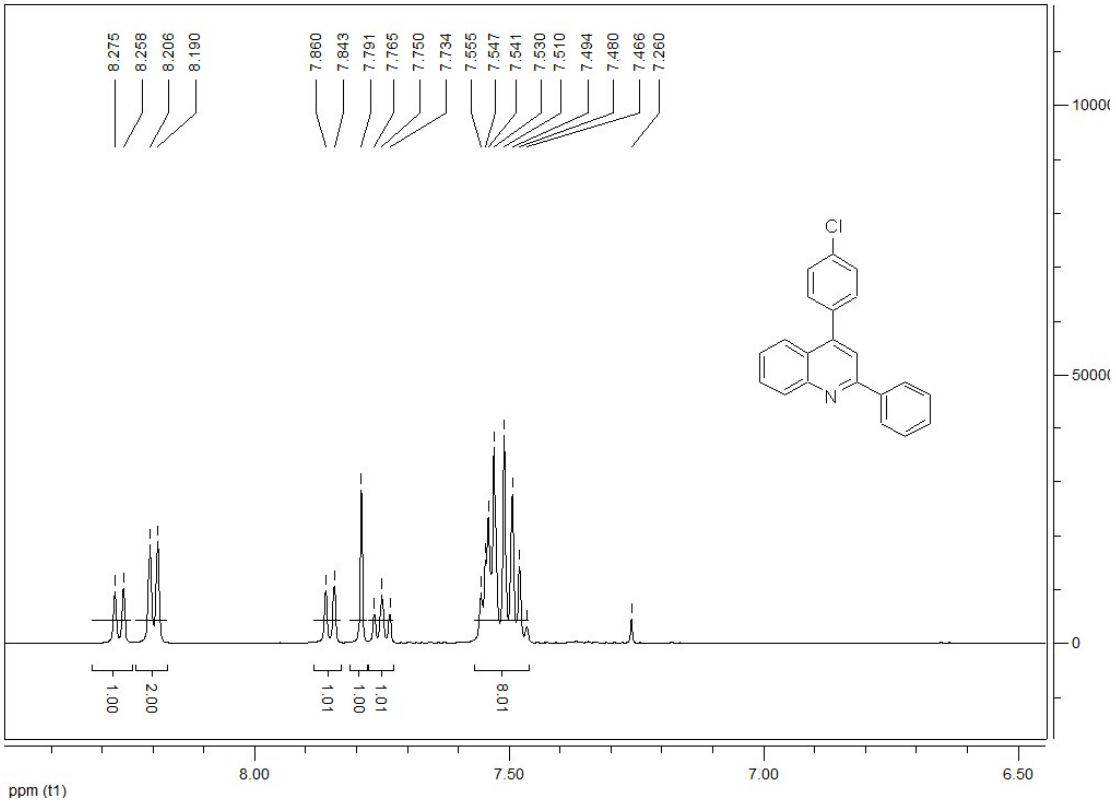


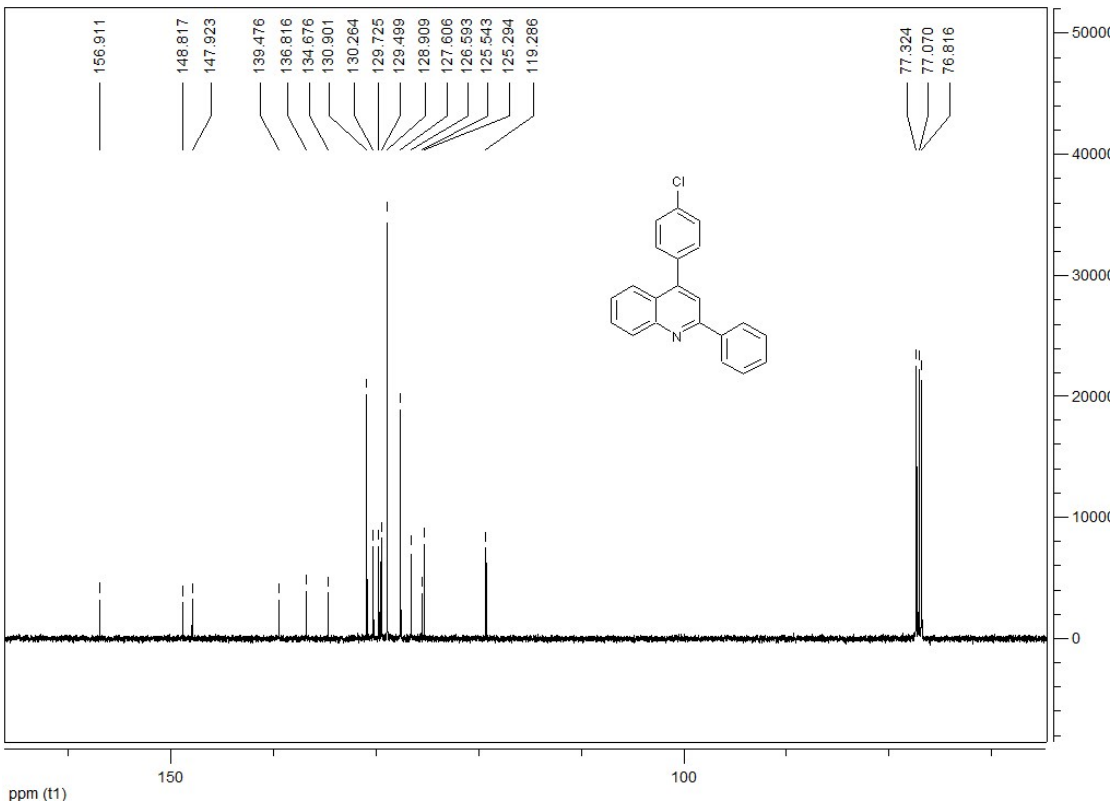
^{1}H NMR and ^{13}C NMR of compound **4o**



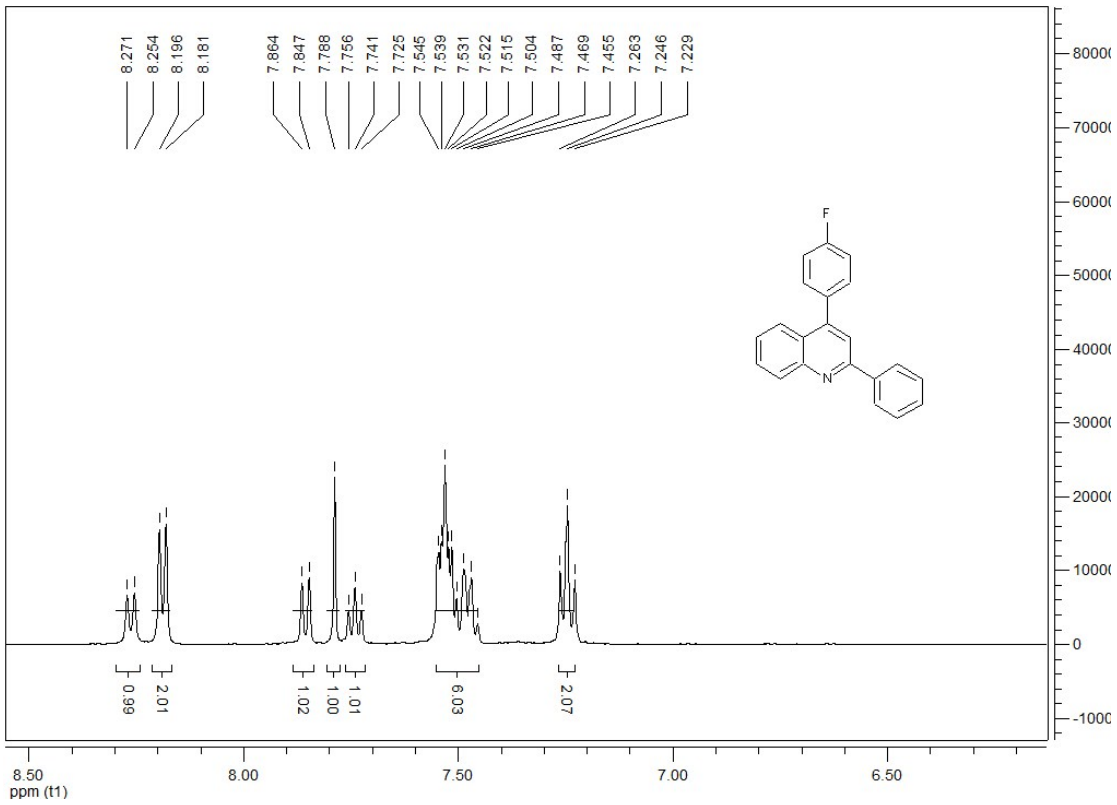


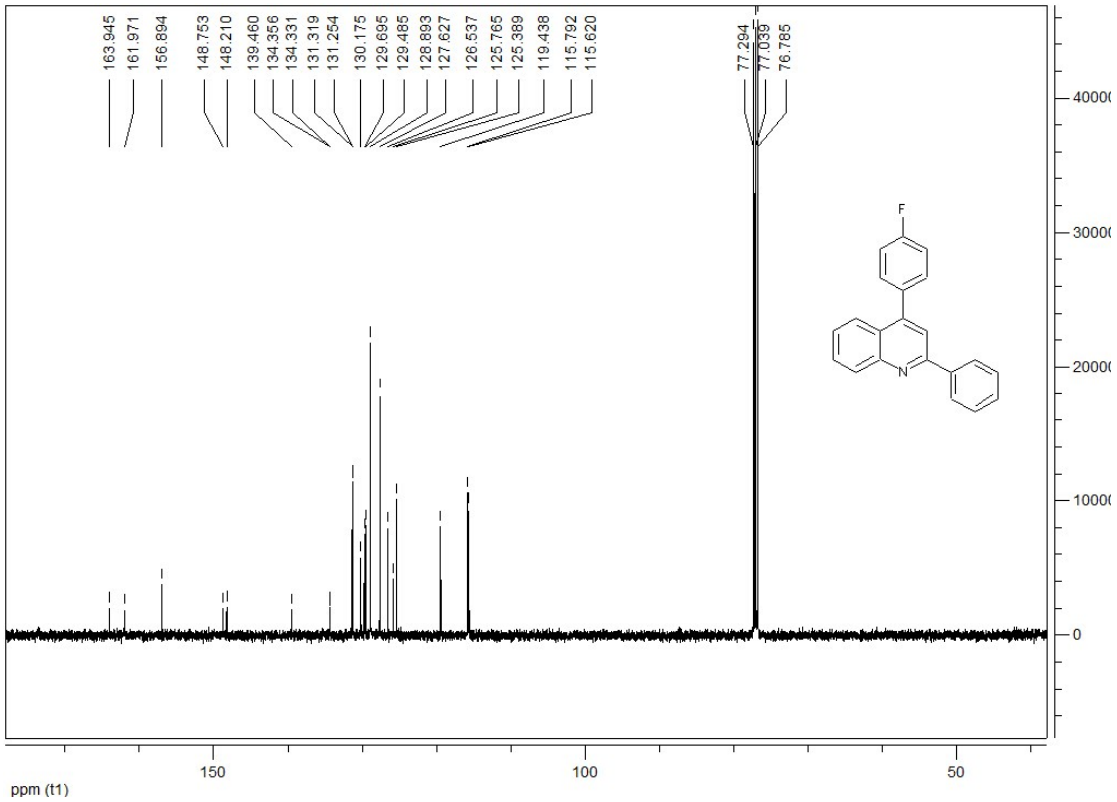
^{1}H NMR and ^{13}C NMR of compound **4p**



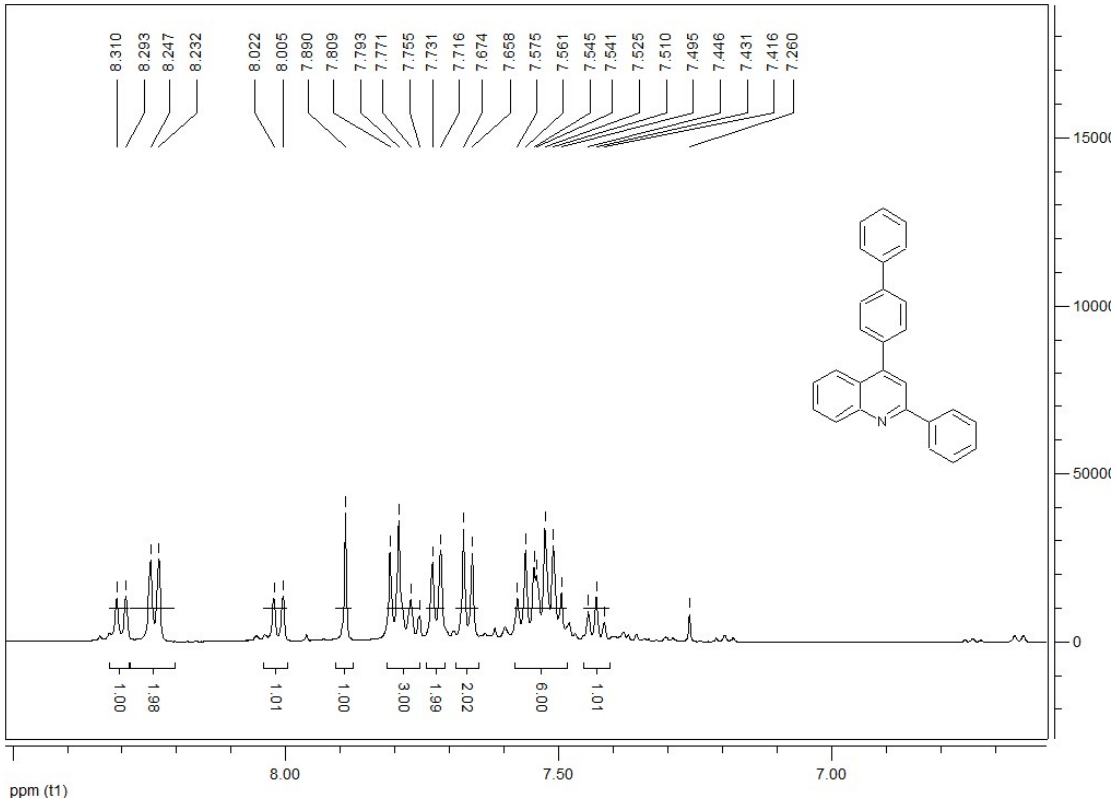


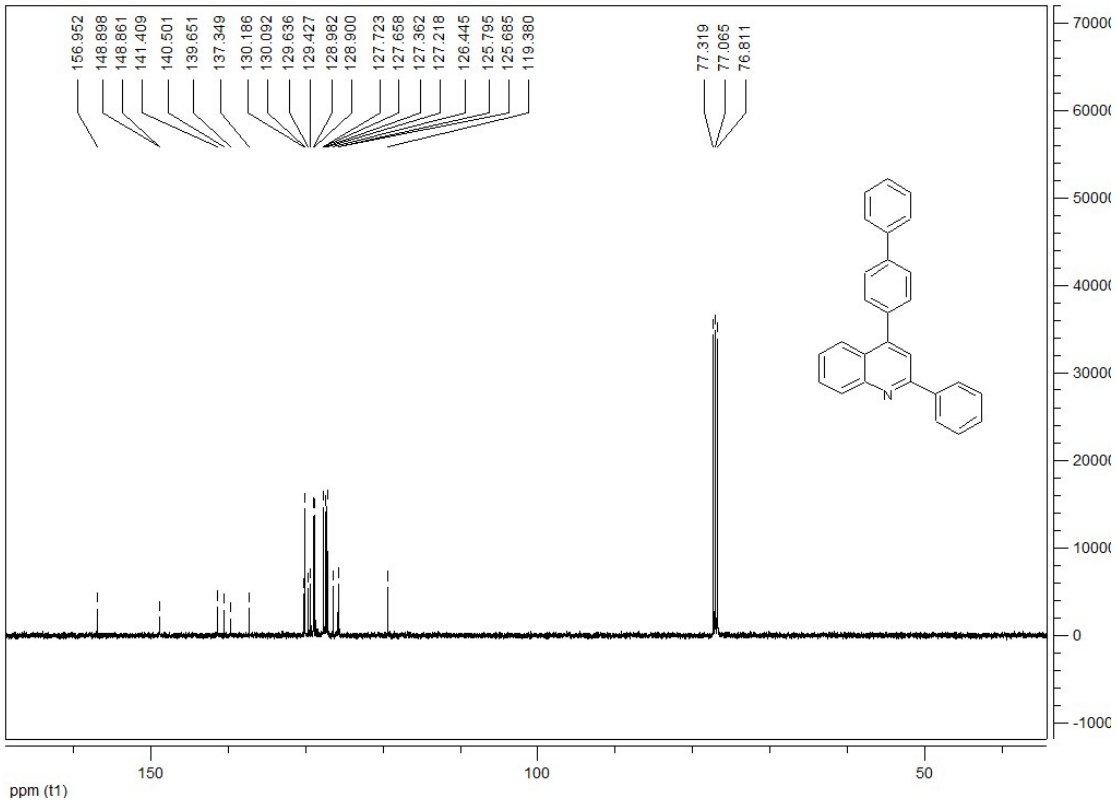
^{1}H NMR and ^{13}C NMR of compound **4q**



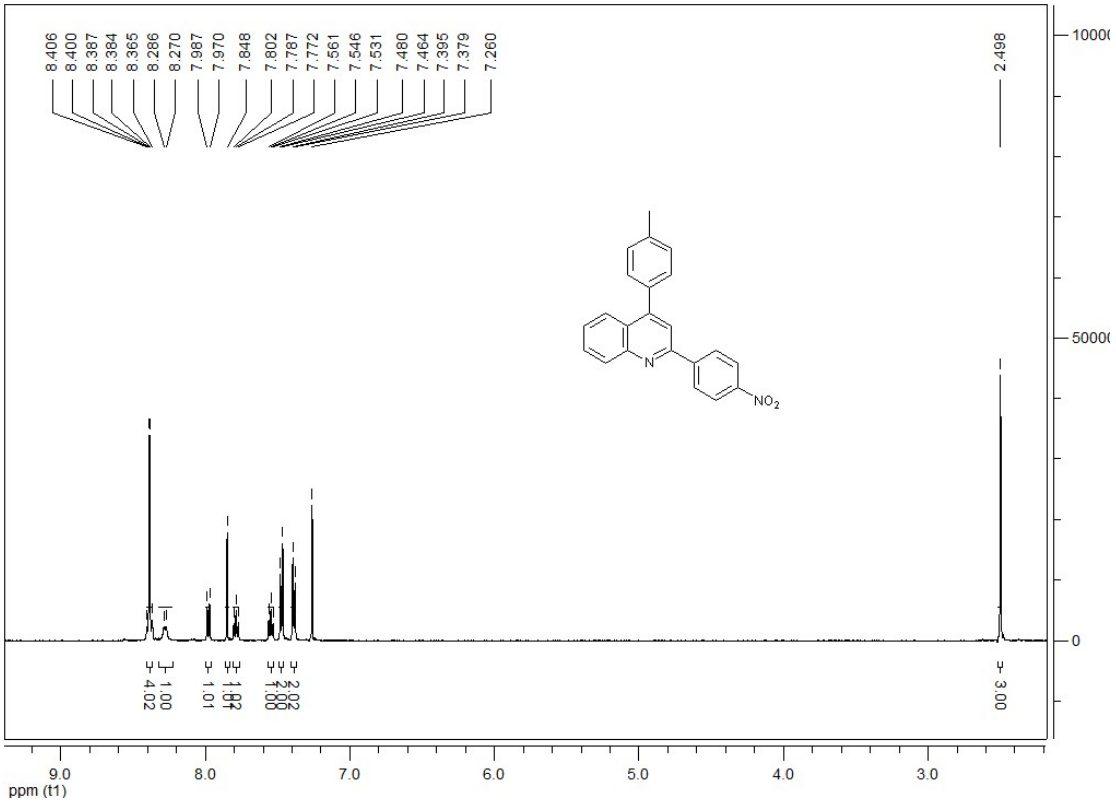


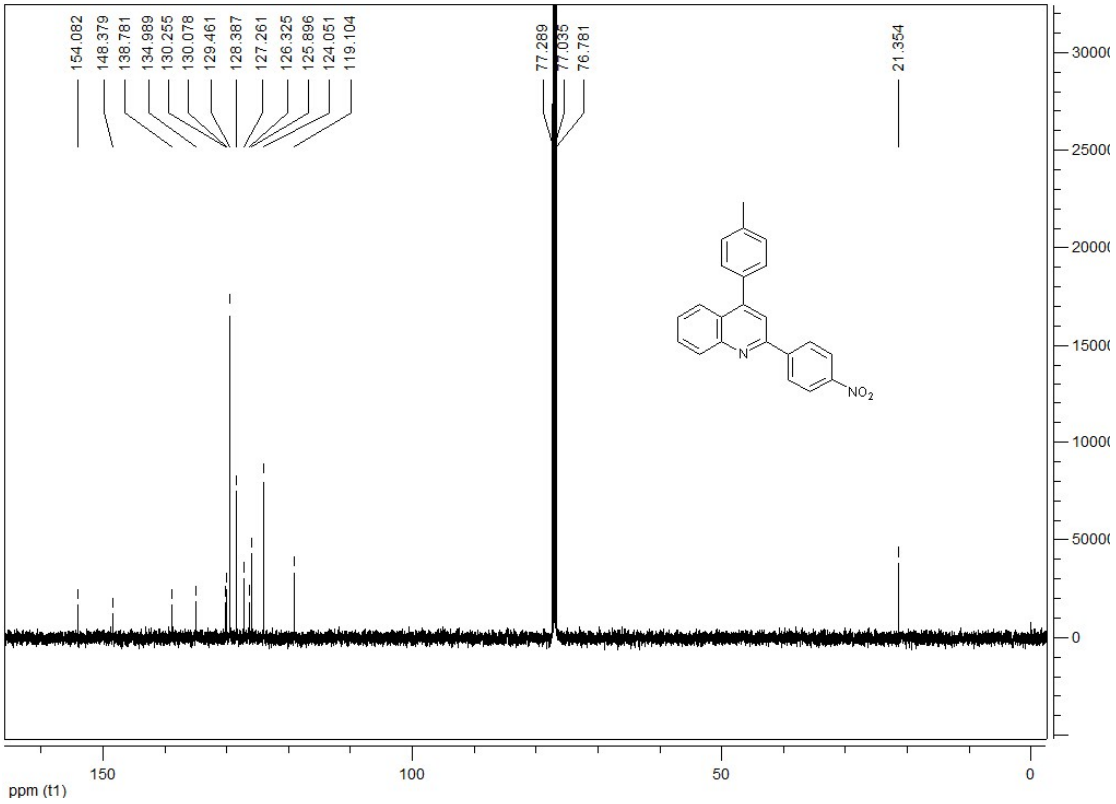
^{1}H NMR and ^{13}C NMR of compound **4r**



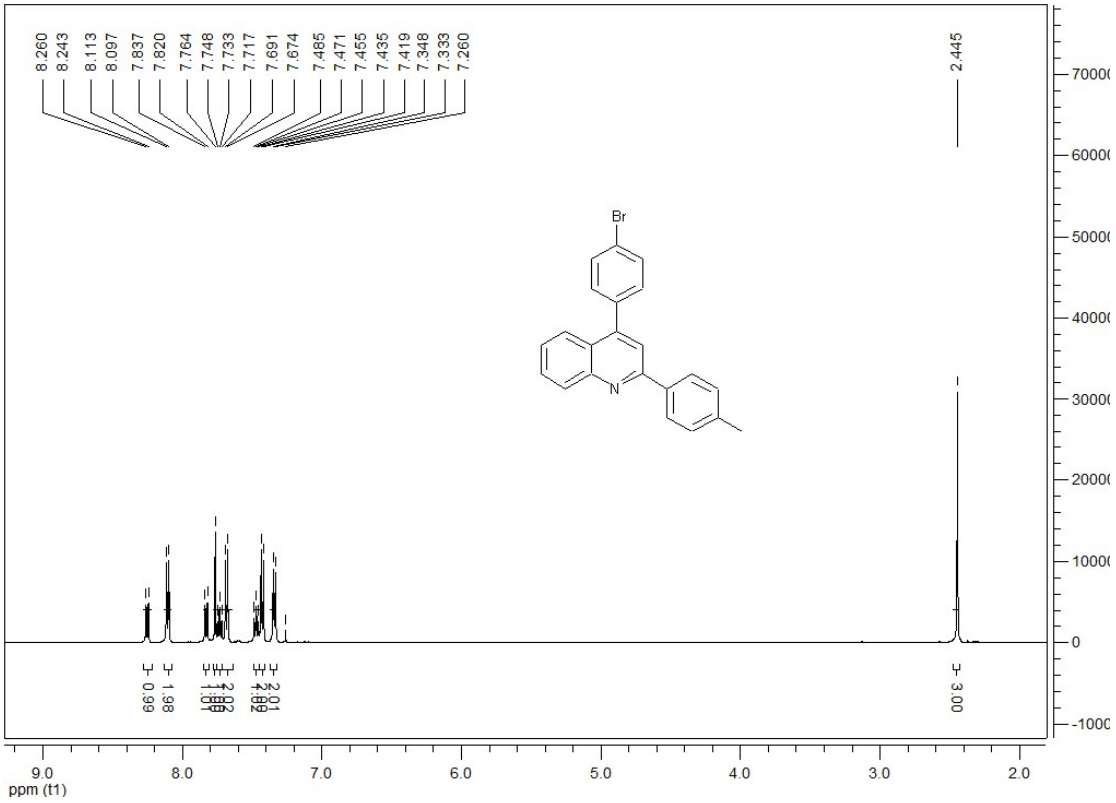


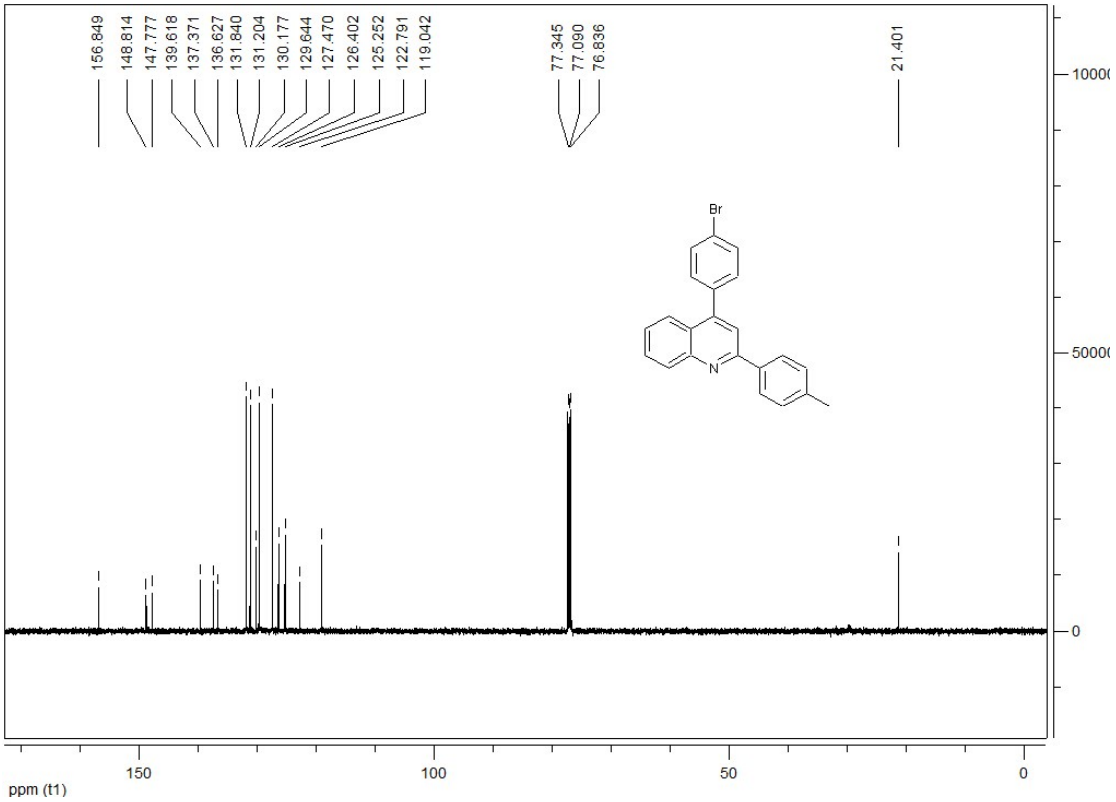
^{1}H NMR and ^{13}C NMR of compound **4s**



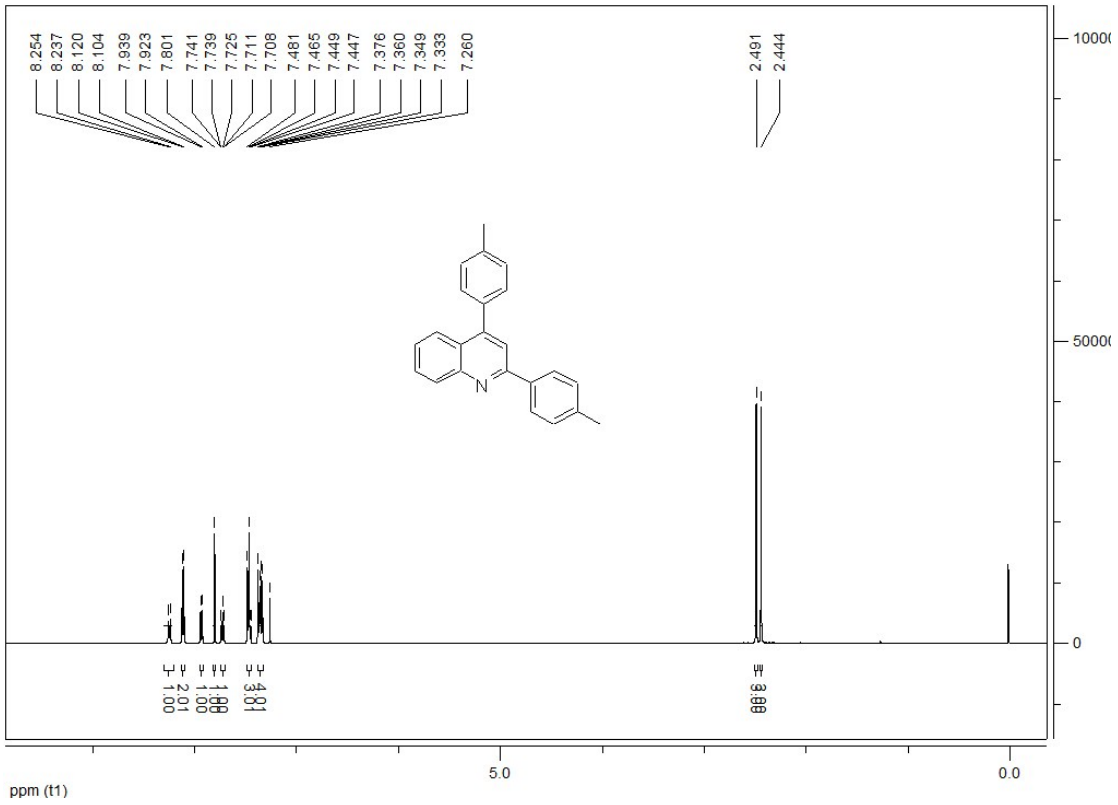


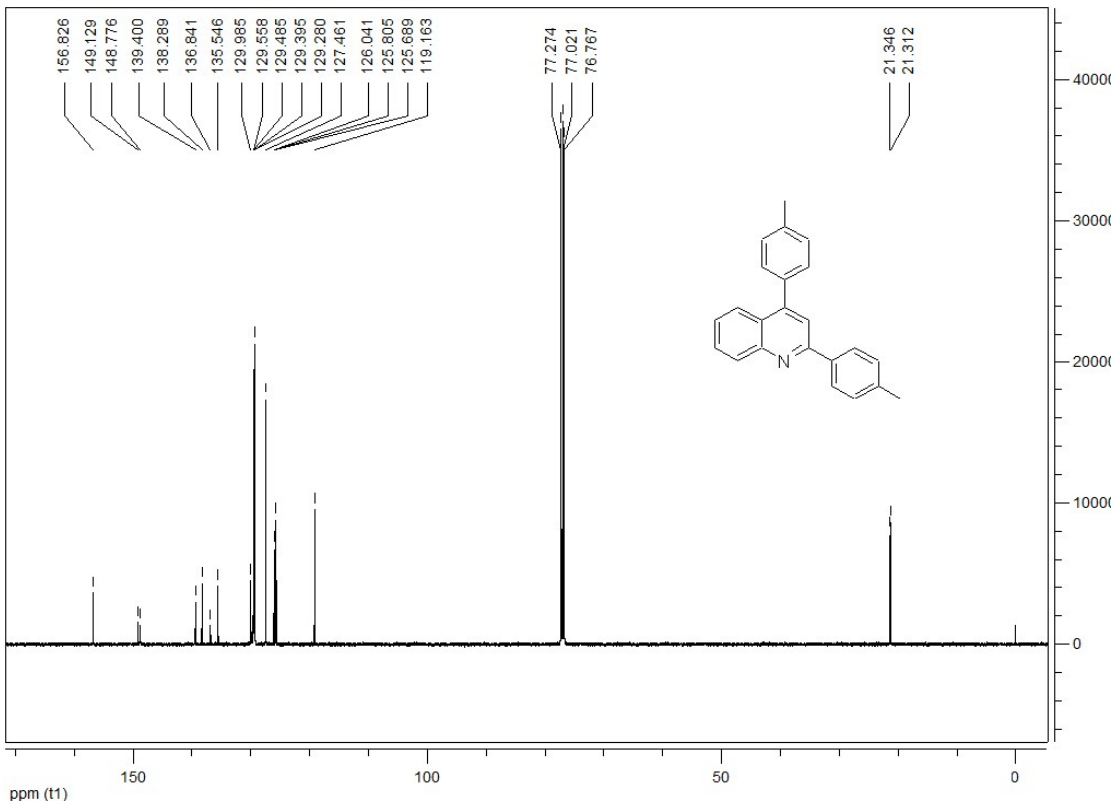
^{1}H NMR and ^{13}C NMR of compound **4t**



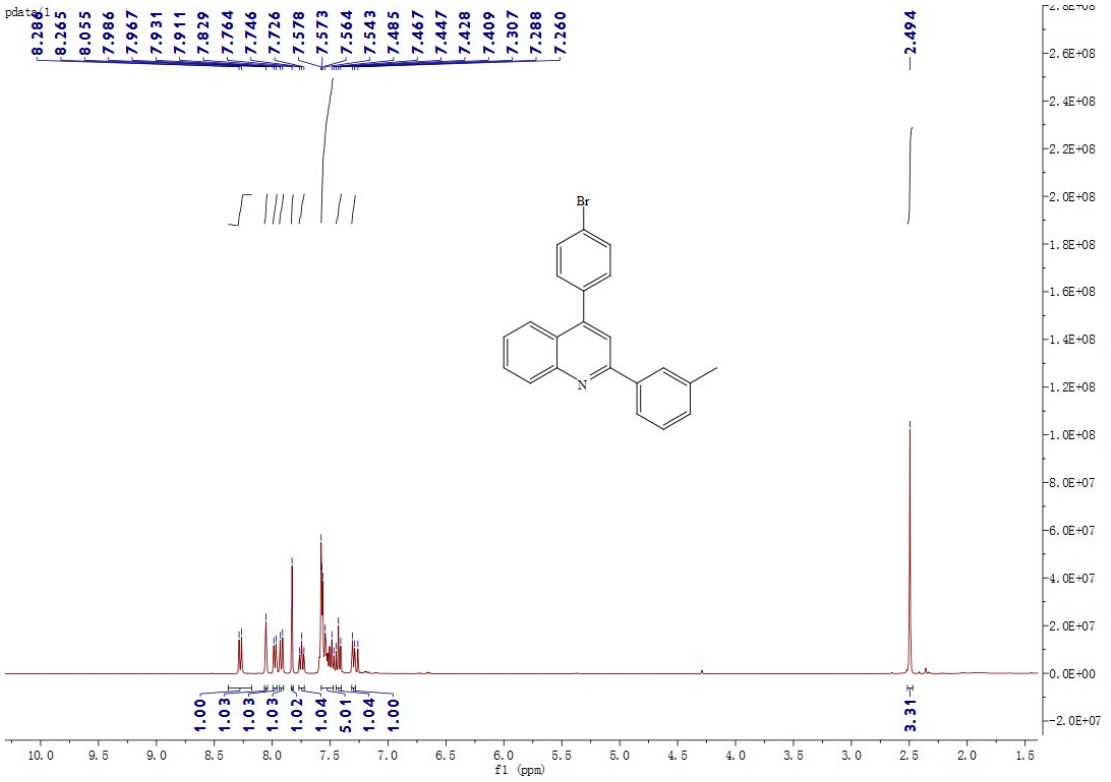


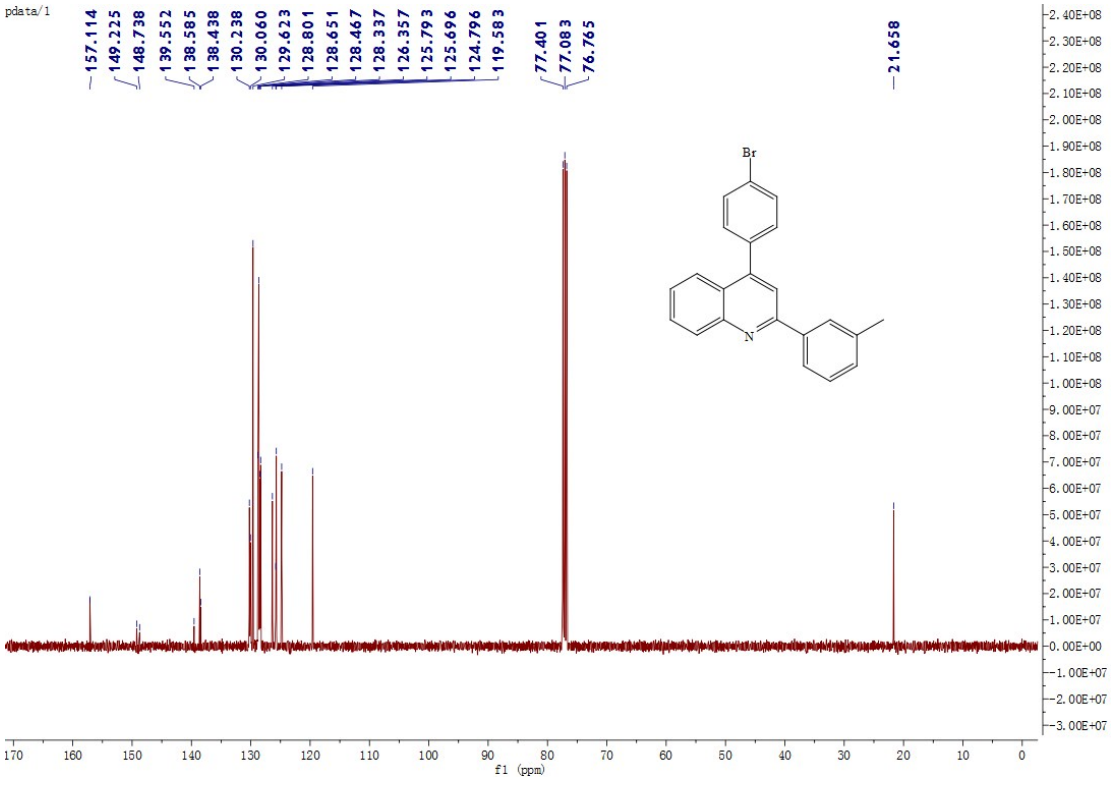
^{1}H NMR and ^{13}C NMR of compound **4u**



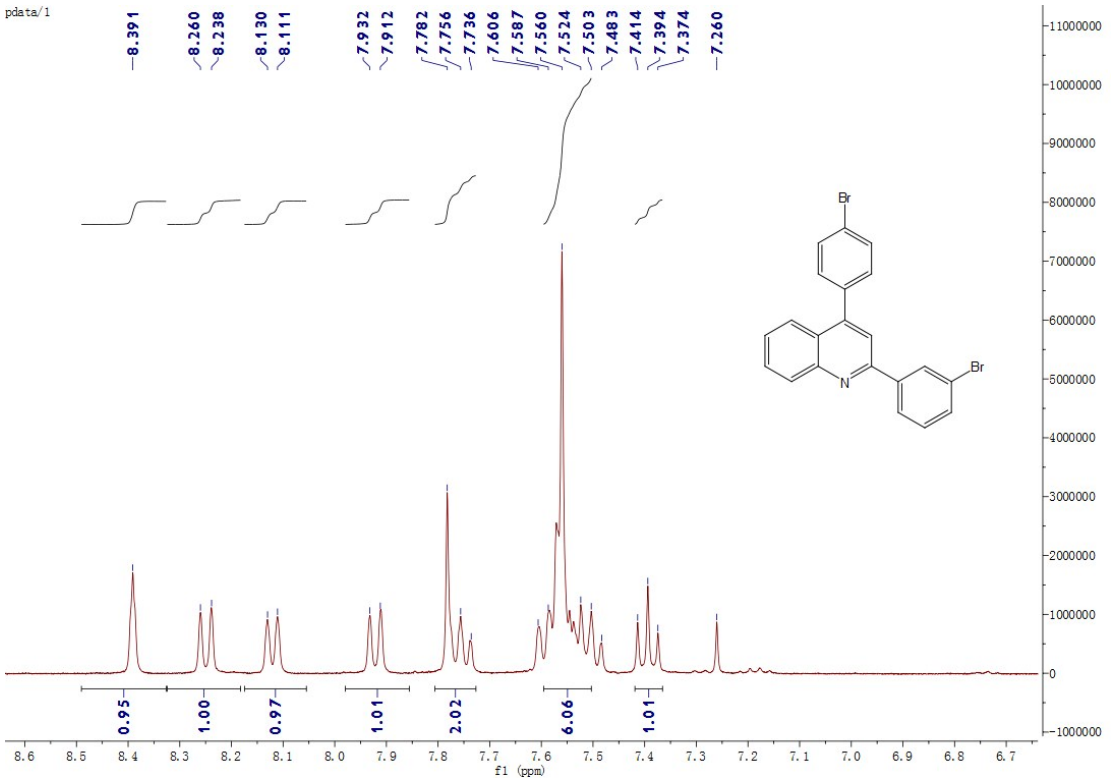


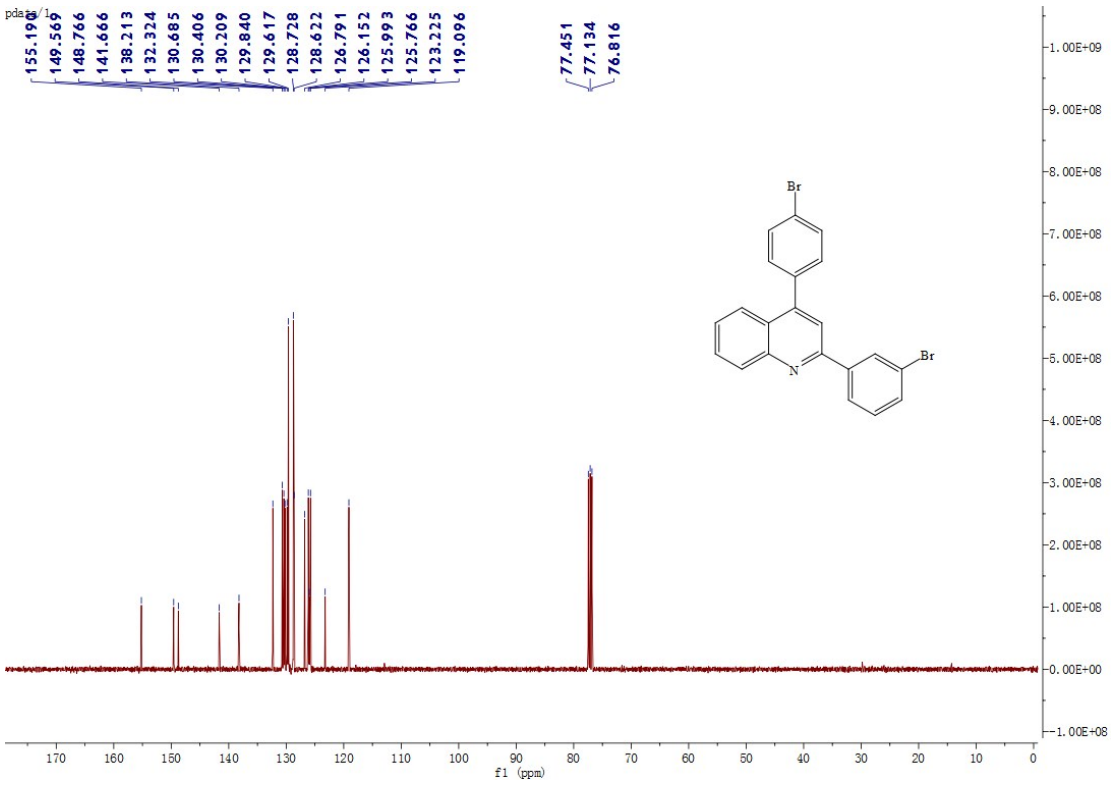
^{1}H NMR and ^{13}C NMR of compound **4v**



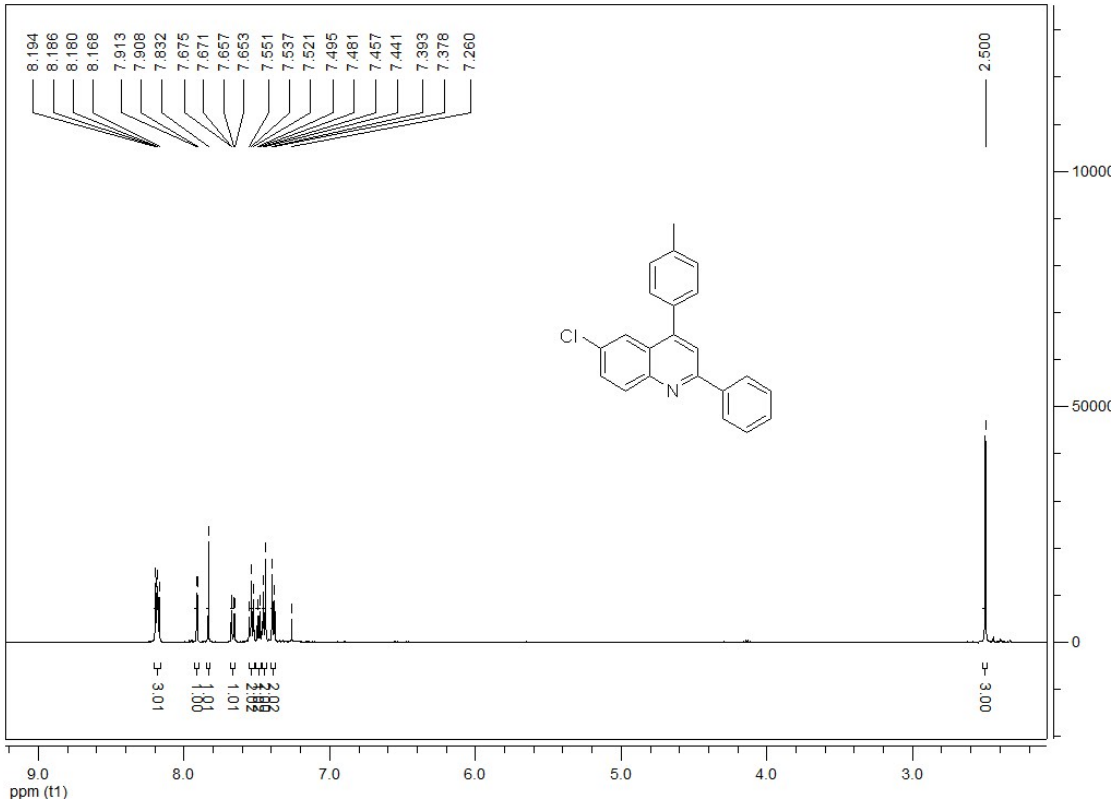


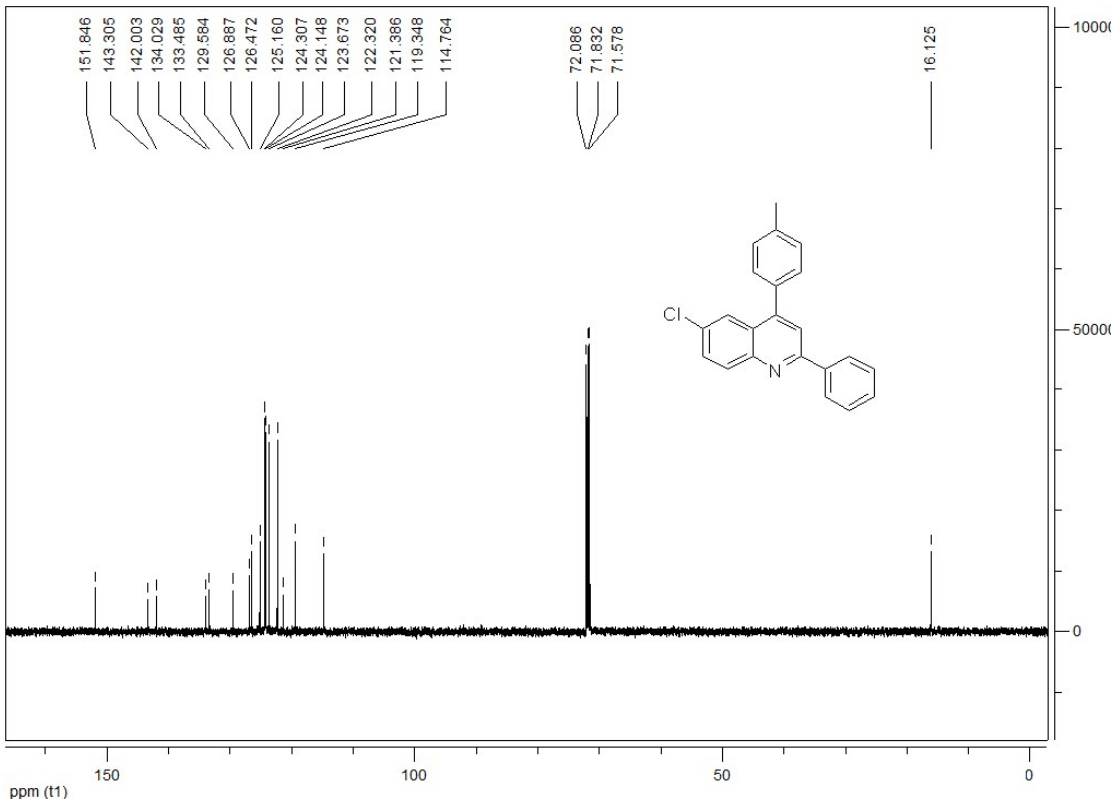
^{1}H NMR and ^{13}C NMR of compound **4w**





^{1}H NMR and ^{13}C NMR of compound **4x**





^{1}H NMR and ^{13}C NMR of compound **4y**