Metal-free three-component assemblies of anilines, α-keto acids and alkyl lactates for quinoline synthesis and their anti-inflammatory activity

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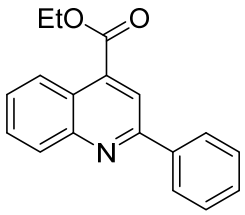
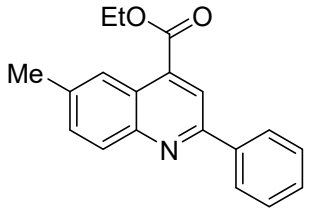
General experimental information

All experiments are performed under air atmosphere, and the reactions are monitored by TLC (GF254 silica gel). α-oxocarboxylic acids **2** (expect **2a**) are synthesized following literature procedures.[1] All other chemicals and reagents are obtained from commercial sources and used directly without further treatment. Solvents have been treated following standard processes prior to used. ^{1}H and ^{13}C NMR were recorded in 400 MHz apparatus. The frequencies for ^{1}H NMR and ^{13}C NMR test are 400 MHz and 100 MHz, respectively. The chemical shifts of most of compounds were reported in ppm with TMS as internal standard. Melting points were tested in X-4A instrument without correcting temperature and the HRMS were obtained under ESI model.

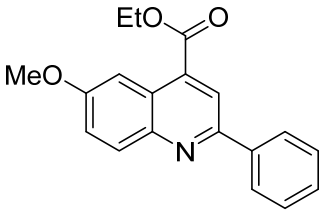
Characterization data of all products



Ethyl 2-phenylquinoline-4-carboxylate (**4a**).[2] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 37 mg (67 %); Yellow liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.73 (d, *J* = 8.4 Hz, 1H), 8.38 (s, 1H), 8.27 – 8.11 (m, 3H), 7.76 (t, *J* = 7.0 Hz, 1H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.57 – 7.51 (m, 2H), 7.48 (d, *J* = 7.2 Hz, 1H), 4.54 (q, *J* = 7.2 Hz, 2H), 1.49 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 156.7, 149.2, 138.8, 136.2, 130.3, 129.9, 129.7, 128.9, 127.7, 127.5, 125.4, 124.0, 120.2, 61.9, 14.4.

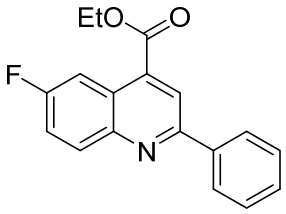


Ethyl 6-methyl-2-phenylquinoline-4-carboxylate (**4b**).[2] Eluent: V_{PE}/V_{EA} = 80:1; Yield: 29 mg (50 %); Yellow solid, m.p. 76-78 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (s, 1H), 8.33 (s, 1H), 8.18 (d, *J* = 8.0 Hz, 2H), 8.11 (d, *J* = 8.4 Hz, 1H), 7.59 (d, *J* = 8.4 Hz, 1H), 7.53 (d, *J* = 7.4 Hz, 2H), 7.47 (d, *J* = 6.0 Hz, 1H), 4.53 (d, *J* = 7.2 Hz, 2H), 2.57 (s, 3H), 1.49 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 155.8, 147.8, 138.9, 137.9, 135.4, 132.2, 129.9, 129.5, 128.9, 127.4, 124.2, 124.1, 120.1, 61.8, 22.1, 14.4.

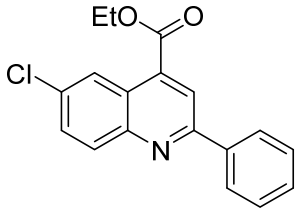


Ethyl 6-methoxy-2-phenylquinoline-4-carboxylate (**4c**).[3] Eluent: V_{PE}/V_{EA} = 50: 1; Yield: 18 mg (30 %); Yellow solid, m.p. 67-69 °C; ^{1}H NMR (400 MHz, C DCl_3) δ 8.42 (s, 1H), 8.22 (s, 1H), 8.17 (d, *J* = 8.0 Hz, 2H), 8.12 (d, *J* = 9.

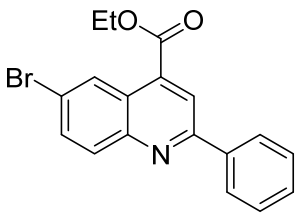
2 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 2H), 7.47 (d, *J* = 8.4 Hz, 1H), 7.43 (d, *J* = 10.4 Hz, 1H), 4.53 (d, *J* = 7.2 Hz, 2H), 3.98 (s, 3H), 1.51 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 159.0, 154.1, 145.6, 138.9, 133.9, 131.7, 129.3, 128.9, 127.2, 125.5, 122.8, 120.7, 103.3, 61.7, 55.6, 14.4.



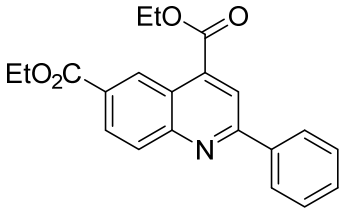
Ethyl 6-fluoro-2-phenylquinoline-4-carboxylate (**4d**).[2] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 20 mg (34 %); Yellow solid, m.p. 65-68 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (dd, *J* = 10.8, 2.8 Hz, 1H), 8.35 (s, 1H), 8.12 – 8.06 (m, 3H), 7.47 – 7.38 (m, 4H), 4.44 (d, *J* = 7.2 Hz, 2H), 1.41 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.0, 162.6 –160.2(d, J_{C-F} = 247.1 Hz), 156.1, 146.5, 138.5, 135.1–135.0(d, J_{C-F} = 6.0 Hz), 132.7–132.6(d,J_{C-F} = 9.3 Hz), 129.8, 129.0, 127.4, 125.0 – 124.9(d,J_{C-F} = 11.0 Hz), 121.1, 120.3 – 120.0 (d,J_{C-F} = 25.9 Hz), 109.7 – 109.4(d,J_{C-F} = 24.9 Hz), 62.0, 14.3.



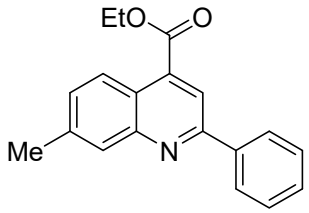
Ethyl 6-chloro-2-phenylquinoline-4-carboxylate (**4e**).[3] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 29 mg (47 %); Yellow solid, m.p. 78-80 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.83 (s, 1H), 8.44 (s, 1H), 8.23 – 8.12 (m, 3H), 7.70 (d, *J* = 9.0 Hz, 1H), 7.58 – 7.48 (m, 3H), 4.55 (d, *J* = 7.2 Hz, 2H), 1.51 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.9, 156.9, 147.6, 138.4, 135.0, 133.9, 131.7, 130.9, 130.0, 129.0, 127.5, 124.6, 121.1, 62.1, 14.3.



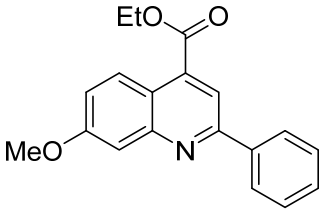
Ethyl 6-bromo-2-phenylquinoline-4-carboxylate(4f).[3] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 25 mg (35 %); Yellow solid, m.p. 100-102 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.00 (s, 1H), 8.42 (s, 1H), 8.19 (d, *J* = 8.0 Hz, 2H), 8.08 (d, *J* = 8.8 Hz, 1H), 7.83 (d, *J* = 9.2 Hz, 1H), 7.58 – 7.47 (m, 3H), 4.55 (d, *J* = 7.2 Hz, 2H), 1.51 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 157.0, 147.7, 138.3, 134.9, 133.5, 131.7, 130.1, 129.0, 127.9, 127.5, 125.1, 122.3, 121.1, 62.2, 14.3.



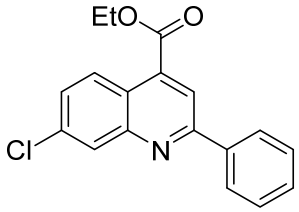
Diethyl 2-phenylquinoline-4,6-dicarboxylate (**4g**). Eluent: V_{PE}/V_{EA} = 25:1; Yield: 38 mg (54 %); Yellow solid, m.p. 100-102 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.48 (d, *J* = 1.6 Hz, 1H), 8.45 (s, 1H), 8.36 (dd, *J* = 8.8, 1.8 Hz, 1H), 8.25 (t, *J* = 10.0, 8.0 Hz, 3H), 7.61 – 7.52 (m, 3H), 4.59 (q, *J* = 7.2 Hz, 2H), 4.47 (q, *J* = 7.2 Hz, 2H), 1.54 (t, *J* = 7.2 Hz, 3H), 1.47 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.3, 166.0, 158.7, 150.9, 138.3, 137.4, 130.4, 130.3, 129.5, 129.3, 129.0, 128.6, 127.7, 123.2, 120.9, 77.3, 77.0, 76.7, 62.2, 61.4, 14.4, 14.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{20}NO_4^+$ 350.1387; Found 350.1391.



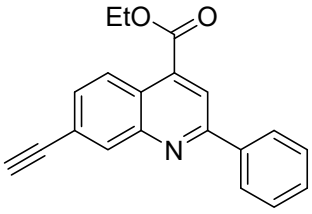
Ethyl 7-methyl-2-phenylquinoline-4-carboxylate (**4h**).[3] Eluent: V_{PE}/V_{EA} = 50:1; Yield: 25 mg (43 %); Brown solid, m.p. 98-101 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.62 (d, *J* = 8.8 Hz, 1H), 8.31 (s, 1H), 8.18 (d, *J* = 8.0 Hz, 2H), 8.01 (s, 1H), 7.53 (d, *J* = 7.2 Hz, 2H), 7.51 – 7.40 (m, 2H), 4.52 (d, *J* = 7.2 Hz, 2H), 2.57 (s, 3H), 1.49 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 156.6, 149.5, 140.2, 139.0, 135.8, 130.0, 129.6, 129.2, 128.9, 127.5, 125.1, 122.1, 119.4, 61.8, 21.7, 14.4.



Ethyl 7-methoxy-2-phenylquinoline-4-carboxylate (**4i**).[3] Eluent: V_{PE}/V_{EA} = 50:1; Yield: 20 mg (33 %); Yellow solid, m.p. 83-85 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 (d, *J* = 9.2 Hz, 1H), 8.15 (s, 1H), 8.09 (d, *J* = 7.2 Hz, 2H), 7.50 – 7.43 (m, 3H), 7.40 (d, *J* = 7.2 Hz, 1H), 7.19 (dd, *J* = 9.2, 2.6 Hz, 1H), 4.44 (d, *J* = 7.2 Hz, 2H), 3.90 (s, 3H), 1.41 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 160.9, 157.1, 151.1, 138.9, 135.9, 129.6, 128.9, 127.5, 126.5, 120.9, 119.3, 118.0, 108.0, 61.9, 55.6, 14.4.

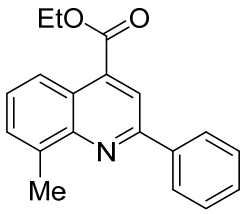


Ethyl 7-chloro-2-phenylquinoline-4-carboxylate (**4j**).[3] Eluent: V_{PE}/V_{EA} = 50:1; Yield: 39 mg (63 %); White solid; m.p. 89-91 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (d, *J* = 9.2 Hz, 1H), 8.28 (s, 1H), 8.15 – 8.04 (m, 3H), 7.50 – 7.35 (m, 4H), 4.45 (d, *J* = 7.2 Hz, 2H), 1.41 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.0, 157.8, 149.7, 138.3, 135.9, 135.9, 130.1, 129.1, 129.0, 128.6, 127.5, 126.9, 122.5, 120.3, 62.1, 14.3.

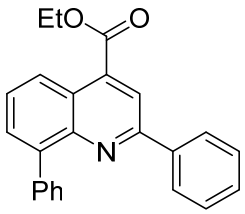


Ethyl 7-ethynyl-2-phenylquinoline-4-carboxylate (**4k**).[3] Eluent: V_{PE}/V_{EA} = 50:1; Yield: 17 mg (28 %); Yellow solid, m.p. 83-85 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 (d, *J* = 8.8 Hz, 1H), 8.39 (s, 1H), 8.37 (s, 1H), 8.19 (d, *J* = 7.0 Hz, 2H), 7.65 (dd, *J* = 8.8, 1.6 Hz, 1H), 7.55 (t, *J* = 7.2 Hz, 2H), 7.50 (d, *J* = 7.0 Hz, 1H), 4.54 (q, *J* = 7.2

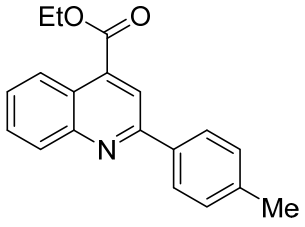
Hz, 2H), 3.26 (s, 1H), 1.50 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.1, 157.5, 148.8, 138.5, 135.9, 134.2, 130.4, 130.0, 128.9, 127.5, 125.7, 124.1, 123.7, 120.7, 83.0, 79.5, 77.3, 77.0, 76.7, 62.0, 14.3.



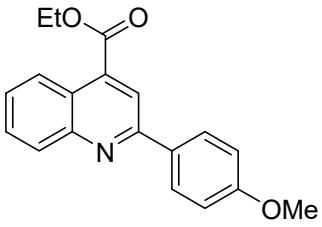
Ethyl 8-methyl-2-phenylquinoline-4-carboxylate (**4l**).[4] Eluent: V_{PE}/V_{EA} = 70:1; Yield: 15 mg (26 %); Yellow liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (d, J = 8.4 Hz, 1H), 8.37 (s, 1H), 8.27 (d, J = 7.6 Hz, 2H), 7.59 (d, J = 6.8 Hz, 1H), 7.56 – 7.50 (m, 2H), 7.46 (d, J = 7.2 Hz, 2H), 4.53 (d, J = 7.2 Hz, 2H), 2.90 (s, 3H), 1.49 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.8, 154.8, 148.1, 139.0, 138.1, 136.5, 130.0, 129.6, 128.9, 127.5, 127.4, 124.0, 123.2, 119.3, 61.9, 18.5, 14.4.



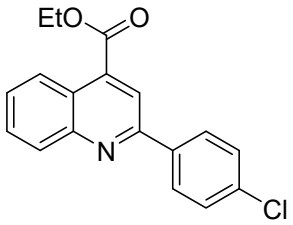
Ethyl 2,8-diphenylquinoline-4-carboxylate (**4m**). Eluent: V_{PE}/V_{EA} = 50:1; Yield: 36 mg (54 %); Yellow solid; m.p. 96-98 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.62 (d, J = 8.6 Hz, 1H), 8.34 (s, 1H), 8.07 (d, J = 7.0 Hz, 2H), 7.75 – 7.67 (m, 3H), 7.61 – 7.55 (m, 1H), 7.43 (t, J = 7.6 Hz, 2H), 7.40 – 7.30 (m, 4H), 4.47 (q, J = 7.0 Hz, 2H), 1.42 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.7, 154.2, 145.5, 140.3, 138.6, 137.6, 135.5, 130.1, 129.6, 128.6, 127.8, 126.6, 126.4, 126.3, 126.1, 123.8, 123.3, 118.0, 60.9, 13.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{24}H_{20}NO_2^+$ 354.1489; Found 354.1495.



Ethyl 2-(*p*-tolyl)quinoline-4-carboxylate (**4n**).[3] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 24 mg (41 %); Yellow liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.72 (d, *J* = 8.4 Hz, 1H), 8.36 (s, 1H), 8.22 (d, *J* = 8.4 Hz, 1H), 8.11 (d, *J* = 8.0 Hz, 2H), 7.75 (d, *J* = 7.6 Hz, 1H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.34 (d, *J* = 8.0 Hz, 2H), 4.54 (d, *J* = 7.2 Hz, 2H), 2.43 (s, 3H), 1.49 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 156.7, 149.2, 139.9, 136.1, 136.0, 130.2, 129.8, 129.7, 127.5, 127.4, 125.4, 123.9, 120.1, 61.9, 21.4, 14.4.

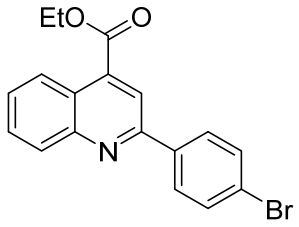


Ethyl 2-(4-methoxyphenyl)quinoline-4-carboxylate (**4o**).[3] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 25 mg (41 %); Yellow solid; m.p. 77-79 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.61 (d, *J* = 8.6 Hz, 1H), 8.24 (s, 1H), 8.14 – 8.04 (m, 3H), 7.65 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.8 Hz, 1H), 6.96 (d, *J* = 8.4 Hz, 2H), 4.45 (q, *J* = 7.2 Hz, 2H), 3.79 (s, 3H), 1.41 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 161.2, 156.3, 149.2, 136.0, 131.4, 130.1, 129.8, 128.9, 127.3, 125.4, 123.7, 119.8, 114.3, 61.9, 55.4, 14.4.

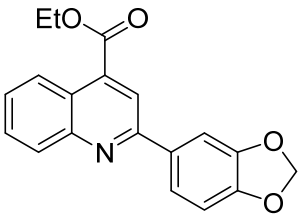


Ethyl 2-(4-chlorophenyl)quinoline-4-carboxylate (**4p**). Eluent: V_{PE}/V_{EA} = 100:1; Yield: 26mg (42 %); Yellow liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.72 (d, *J* = 8.4 Hz, 1H), 8.32 (s, 1H), 8.20 (d, *J* = 8.4 Hz, 1H), 8.14 (d, *J* = 8.4 Hz, 2H), 7.76 (d, *J* = 7.6 Hz, 1H), 7.62 (d, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 8.4 Hz, 2H), 4.54 (d, *J* = 7.2 Hz, 2H), 1.50 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.3, 155.3, 149.1, 137.1, 136.3, 136.0, 130.2, 130.1, 129.1, 128.7, 127.9, 125.5, 124.1, 119.7, 62.1, 14.4;

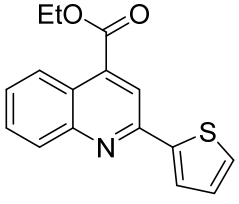
HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}ClNO_2^+$ 312.0786; Found 312.0789.



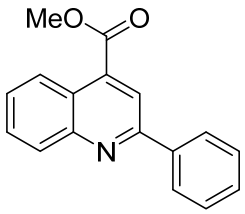
Ethyl 2-(4-bromophenyl)quinoline-4-carboxylate (**4q**).[5] Eluent: V_{PE}/V_{EA} = 100:1; Yield: 26 mg (36 %); White solid; m.p. 90-92 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.73 (d, *J* = 8.4 Hz, 1H), 8.34 (s, 1H), 8.22 (d, *J* = 8.4 Hz, 1H), 8.09 (d, *J* = 8.4 Hz, 2H), 7.77 (t, *J* = 7.0 Hz, 1H), 7.67 (d, *J* = 8.6 Hz, 2H), 7.63 (d, *J* = 7.2 Hz, 1H), 4.55 (q, *J* = 7.2 Hz, 2H), 1.51 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.3, 155.4, 149.1, 137.6, 136.4, 132.1, 130.2, 130.1, 129.0, 128.0, 125.5, 124.4, 124.1, 119.7, 62.0, 14.4.



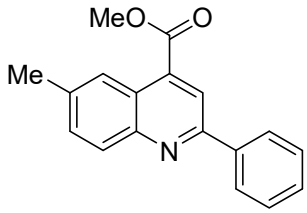
Ethyl 2-(benzo[*d*][1,3]dioxol-5-yl)quinoline-4-carboxylate (**4r**). Eluent: V_{PE}/V_{EA} = 70:1; Yield: 21 mg (33 %); Yellow solid, m.p. 103-105 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, *J* = 8.4 Hz, 1H), 8.30 (s, 1H), 8.18 (d, *J* = 8.4 Hz, 1H), 7.79 – 7.68 (m, 3H), 7.59 (t, *J* = 7.8 Hz, 1H), 6.96 (d, *J* = 8.2 Hz, 1H), 6.05 (s, 2H), 4.54 (q, *J* = 7.2 Hz, 2H), 1.50 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 156.0, 149.2, 149.1, 148.5, 136.1, 133.3, 130.1, 129.9, 127.5, 125.4, 123.8, 121.8, 119.8, 108.5, 107.8, 101.5, 61.9, 14.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{19}H_{16}NO_4^+$ 322.1074; Found 322.1085.



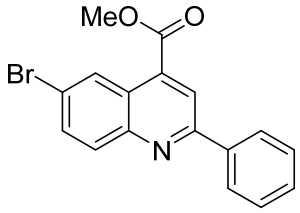
Ethyl 2-(thiophen-2-yl)quinoline-4-carboxylate (**4s**). Eluent: V_{PE}/V_{EA} = 70:1; Yield: 22mg (40 %); Yellow liquid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.67 (d, *J* = 8.4 Hz, 1H), 8.27 (s, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 7.79 (d, *J* = 3.4 Hz, 1H), 7.72 (t, *J* = 7.6 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 5.0 Hz, 1H), 7.19 – 7.13 (m, 1H), 4.54 (q, *J* = 7.2 Hz, 2H), 1.50 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 151.8, 149.0, 144.6, 136.1, 130.0, 129.8, 129.1, 128.2, 127.5, 126.4, 125.5, 124.0, 119.0, 62.0, 14.3; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}NO_2S^+$ 284.0740; Found 284.0749.



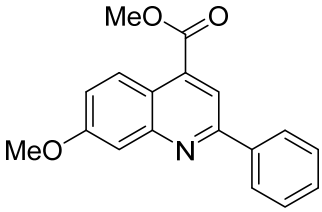
Methyl 2-phenylquinoline-4-carboxylate (**4t**).[6] Eluent: V_{PE}/V_{EA} = 80:1; Yield: 24 mg (46 %); Yellow solid, m.p. 56-58 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.73 (d, *J* = 8.8 Hz, 1H), 8.38 (s, 1H), 8.24 – 8.17 (m, 3H), 7.75 (d, *J* = 7.6 Hz, 1H), 7.60 (d, *J* = 7.8 Hz, 1H), 7.53 (d, *J* = 7.2 Hz, 2H), 7.48 (d, *J* = 7.2 Hz, 1H), 4.04 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.8, 156.7, 149.2, 138.7, 135.6, 130.3, 129.9, 129.8, 128.9, 127.8, 127.5, 125.4, 124.0, 120.3, 52.7.



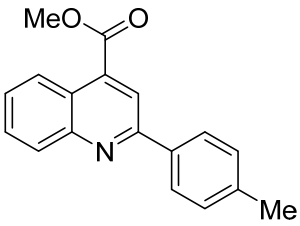
Methyl 6-methyl-2-phenylquinoline-4-carboxylate (**4u**).[3] Eluent: V_{PE}/V_{EA} = 80:1; Yield: 16 mg (29 %); Yellow solid, m.p. 92-94 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (s, 1H), 8.33 (s, 1H), 8.17 (d, *J* = 7.2 Hz, 2H), 8.10 (d, *J* = 8.4 Hz, 1H), 7.57 (dd, *J* = 8.8, 1.6 Hz, 1H), 7.52 (d, *J* = 7.2 Hz, 2H), 7.45 (d, *J* = 7.2 Hz, 1H), 4.04 (s, 3H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.9, 155.7, 147.9, 138.8, 138.0, 134.8, 132.2, 129.9, 129.5, 128.9, 127.4, 124.2, 124.0, 120.2, 52.7, 22.1.



Methyl 6-bromo-2-phenylquinoline-4-carboxylate (**4v**). Eluent: V_{PE}/V_{EA} = 80:1; Yield: 15 mg (22 %); Yellow solid, m.p. 102-104 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.99 (s, 1H), 8.43 (s, 1H), 8.19 (d, *J* = 8.0 Hz, 2H), 8.07 (d, *J* = 9.2 Hz, 1H), 7.83 (d, *J* = 9.2 Hz, 1H), 7.58 – 7.47 (m, 3H), 4.07 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.2, 157.0, 147.8, 138.2, 134.4, 133.5, 131.8, 130.1, 129.0, 127.9, 127.4, 125.0, 122.4, 121.1, 52.9; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}BrNO_2^+$ 342.0124; Found 342.0136.



Methyl 7-methoxy-2-phenylquinoline-4-carboxylate (**4w**). Eluent: V_{PE}/V_{EA} = 80:1; Yield: 16 mg (27 %); Yellow solid, m.p. 123-126 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 (d, *J* = 9.6 Hz, 1H), 8.25 (s, 1H), 8.18 (d, *J* = 7.2 Hz, 2H), 7.64 – 7.46 (m, 4H), 7.31 – 7.25 (m, 1H), 4.05 (s, 3H), 3.99 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.9, 161.0, 157.1, 151.0, 138.7, 135.6, 129.7, 128.9, 127.5, 126.5, 121.1, 119.3, 118.1, 107.9, 55.6, 52.7; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{13}NO_3^+$ 294.1125; Found 294.1140.



Methyl 2-(*p*-tolyl)quinoline-4-carboxylate (**4x**).[7] Eluent: V_{PE}/V_{EA} = 80:1; Yield: 16 mg (29 %); Yellow solid, m.p. 106-108 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 (d, *J* = 8.4 Hz, 1H), 8.30 (s, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 8.03 (d, *J* = 8.2 Hz, 2H), 7.68 (t,

J = 7.0 Hz, 1H), 7.53 (t, *J* = 8.0 Hz, 1H), 7.26 (d, *J* = 8.0 Hz, 2H), 3.99 (s, 3H), 2.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 155.6, 148.2, 138.9, 134.9, 134.6, 129.2, 128.8, 128.6, 126.6, 126.3, 124.4, 122.9, 119.1, 51.6, 20.3.

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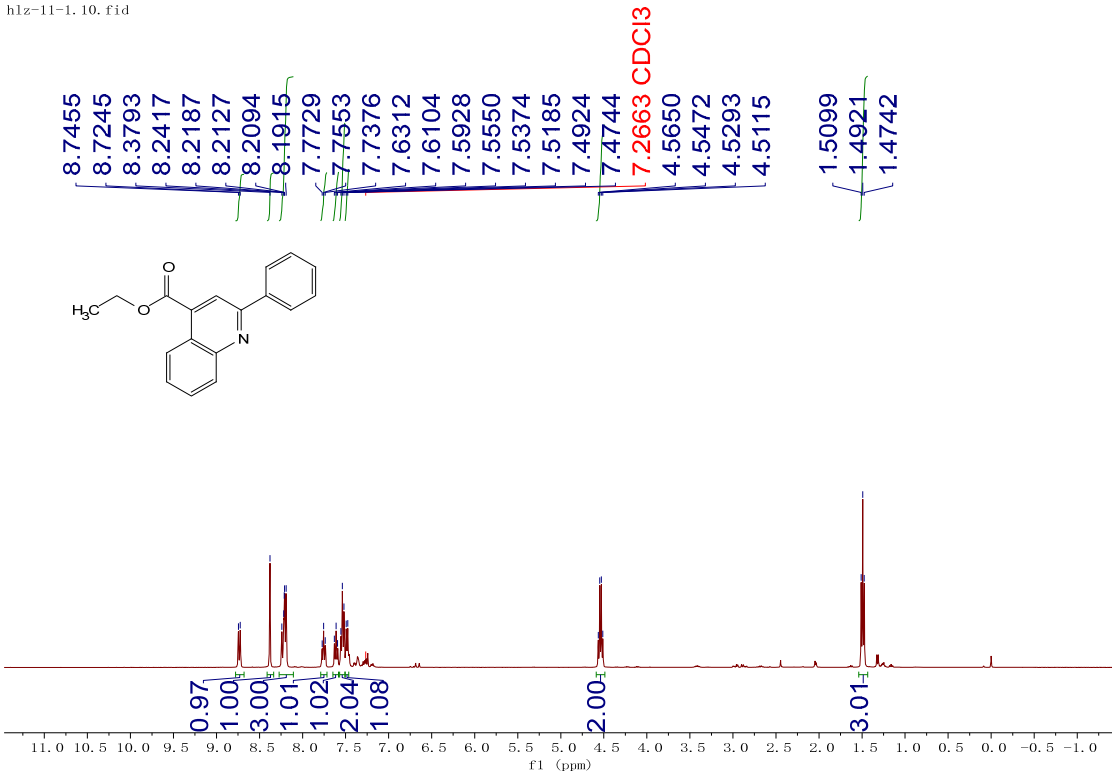
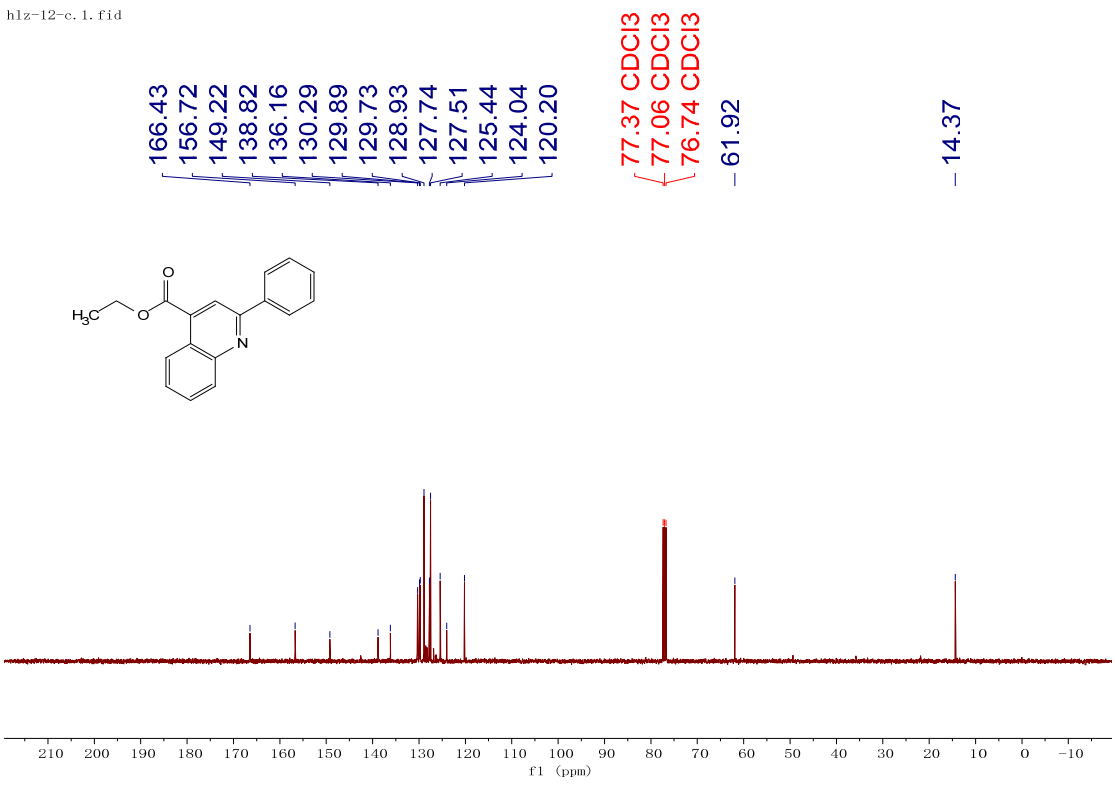
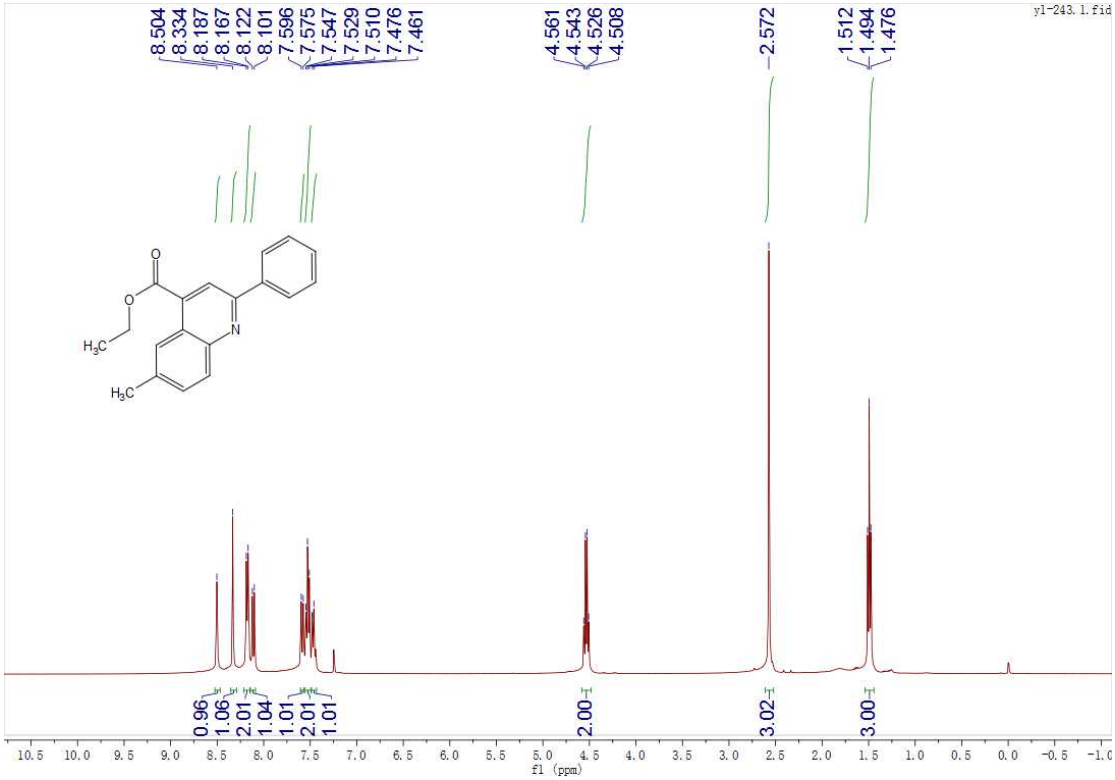
^{1}H and ^{13}C NMR spectra of all products



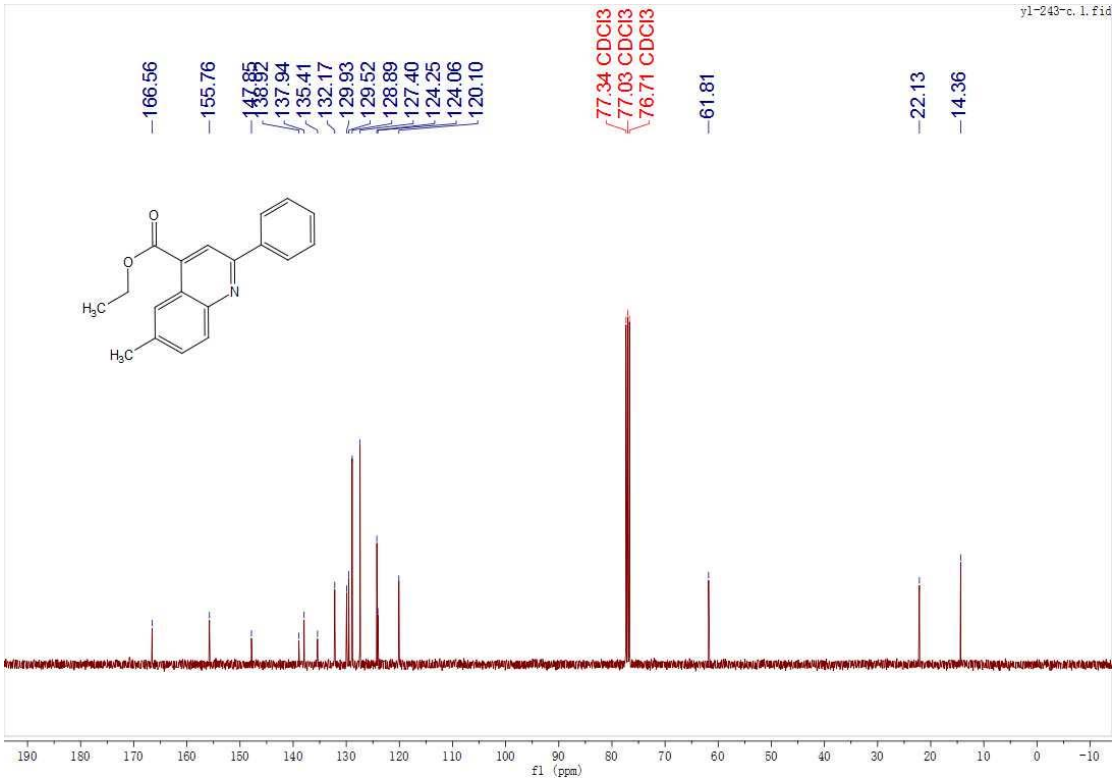
^{1}H NMR spectrum of 4a



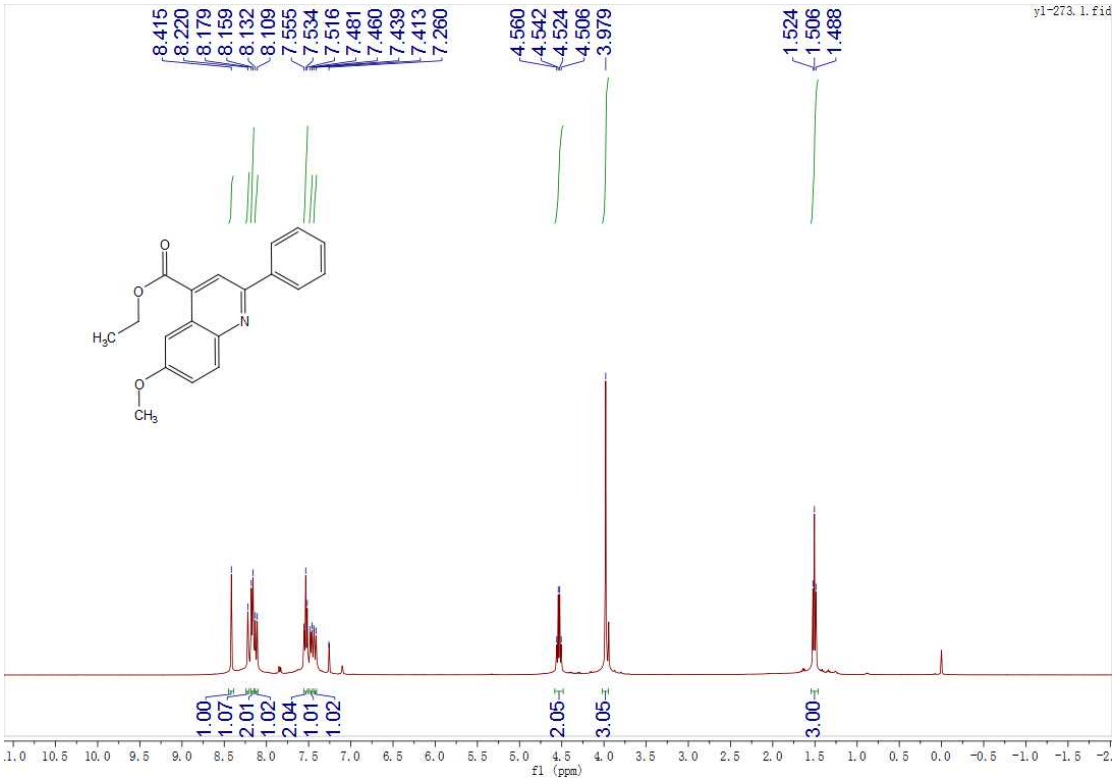
^{13}C NMR spectrum of 4a



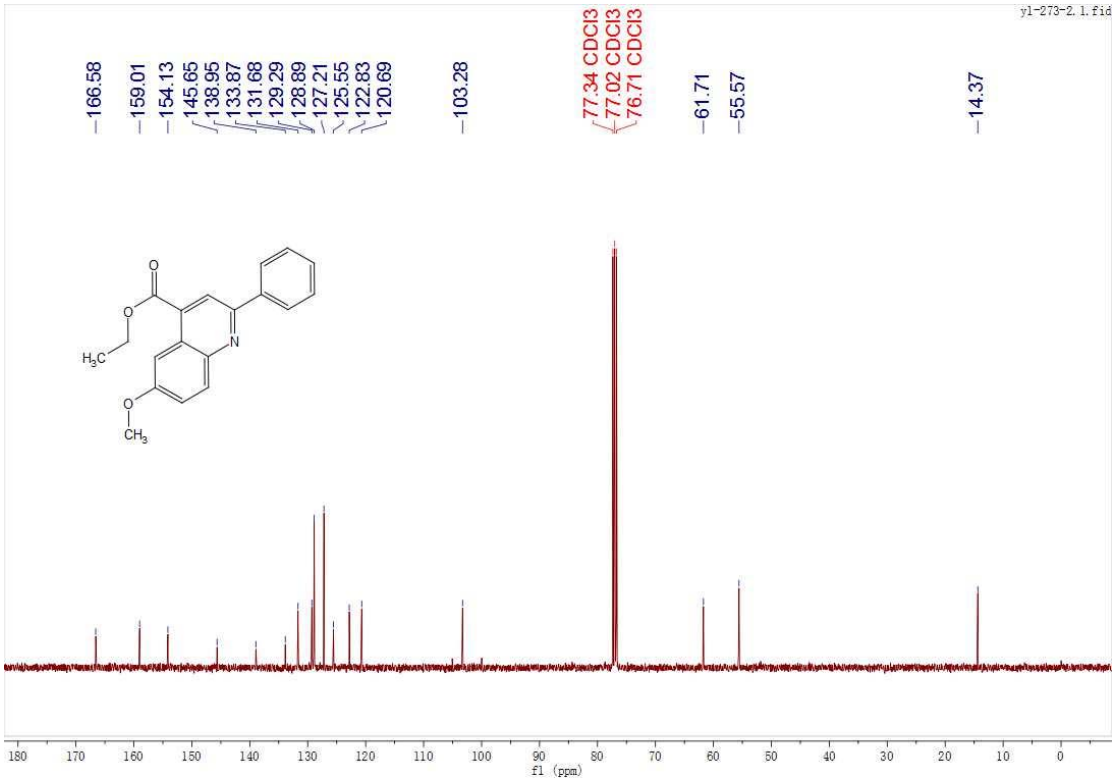
^{1}H NMR spectrum of 4b



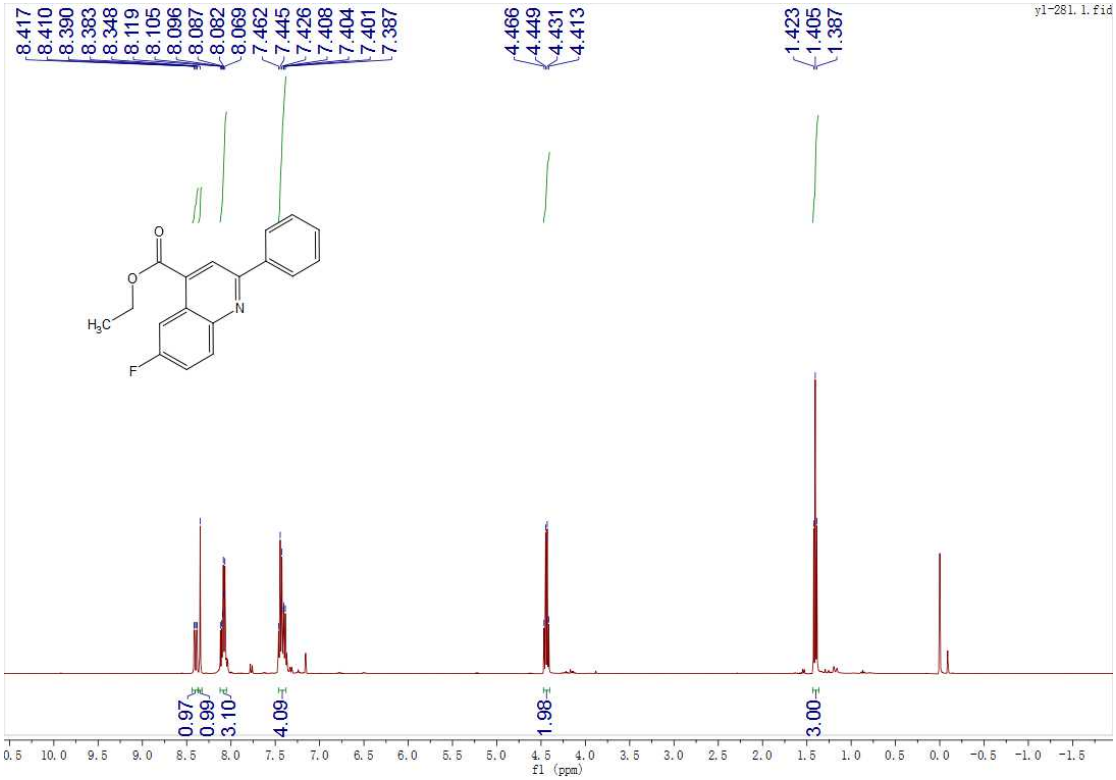
^{13}C NMR spectrum of 4b



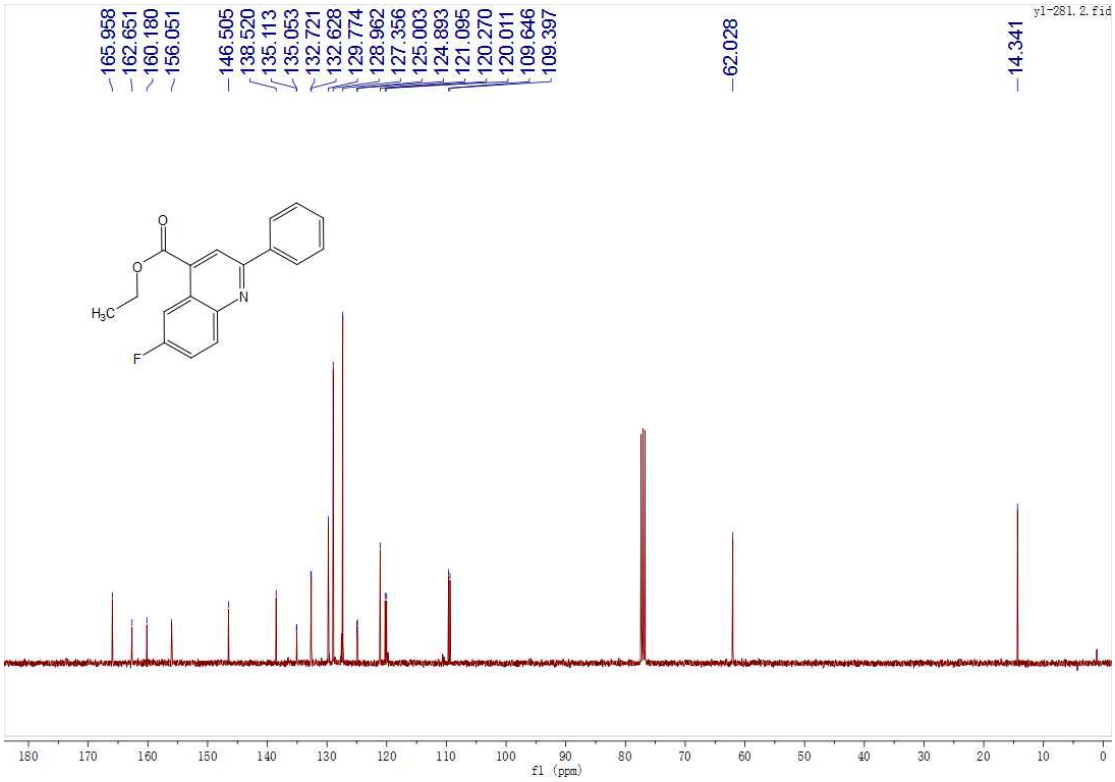
^{1}H NMR spectrum of 4c



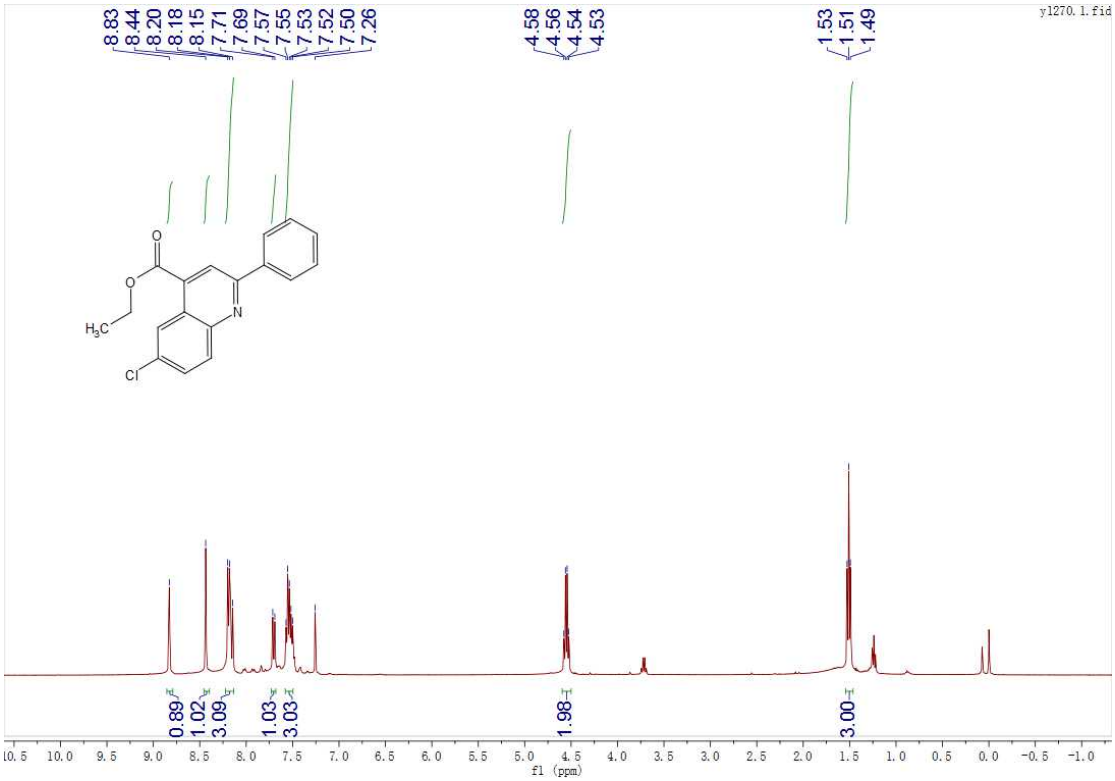
^{13}C NMR spectrum of 4c



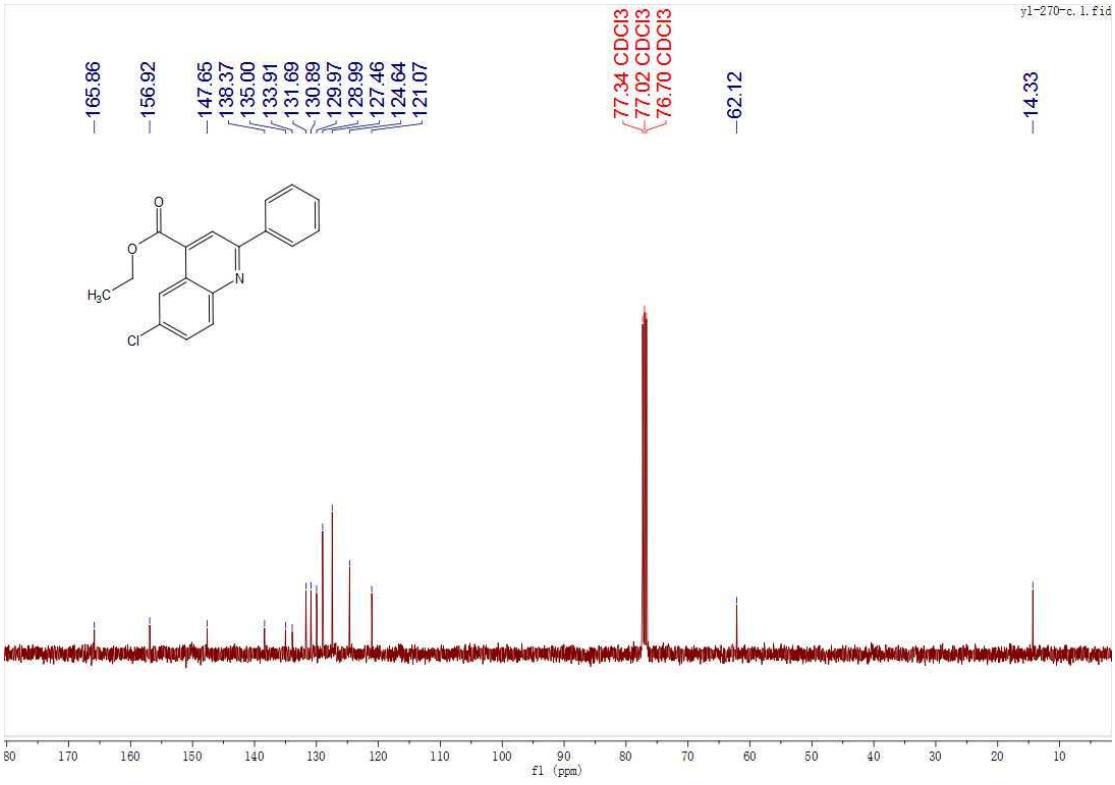
^{1}H NMR spectrum of 4d



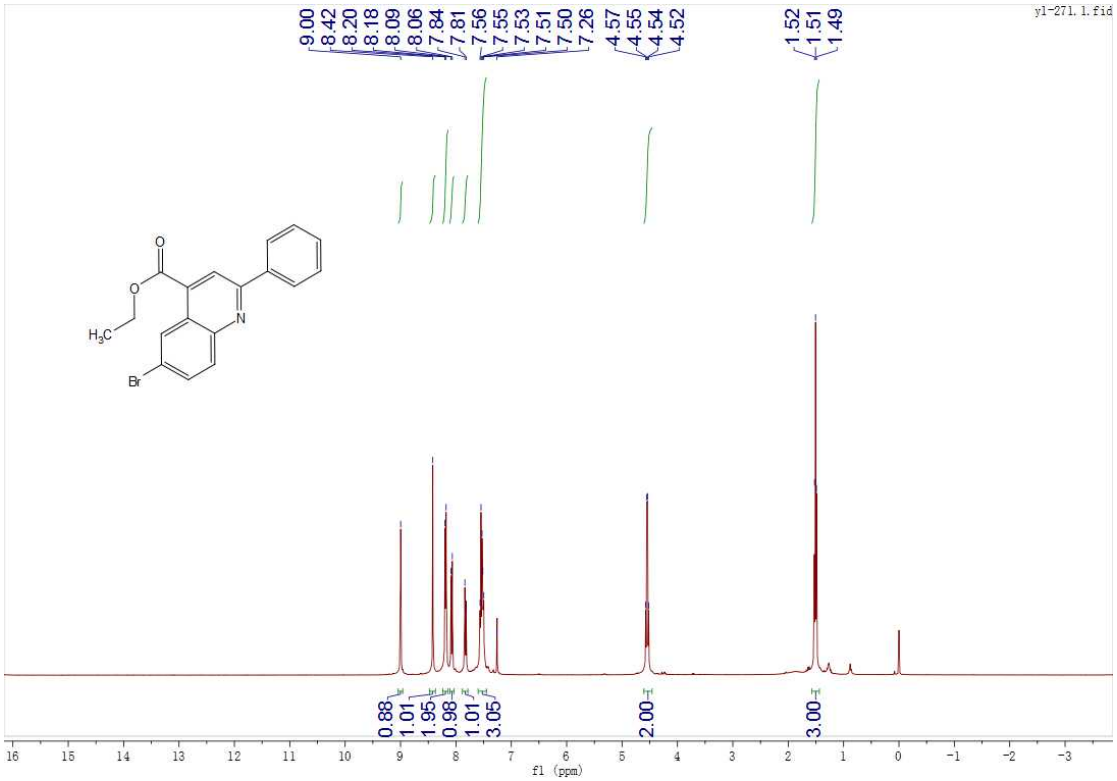
^{13}C NMR spectrum of 4d



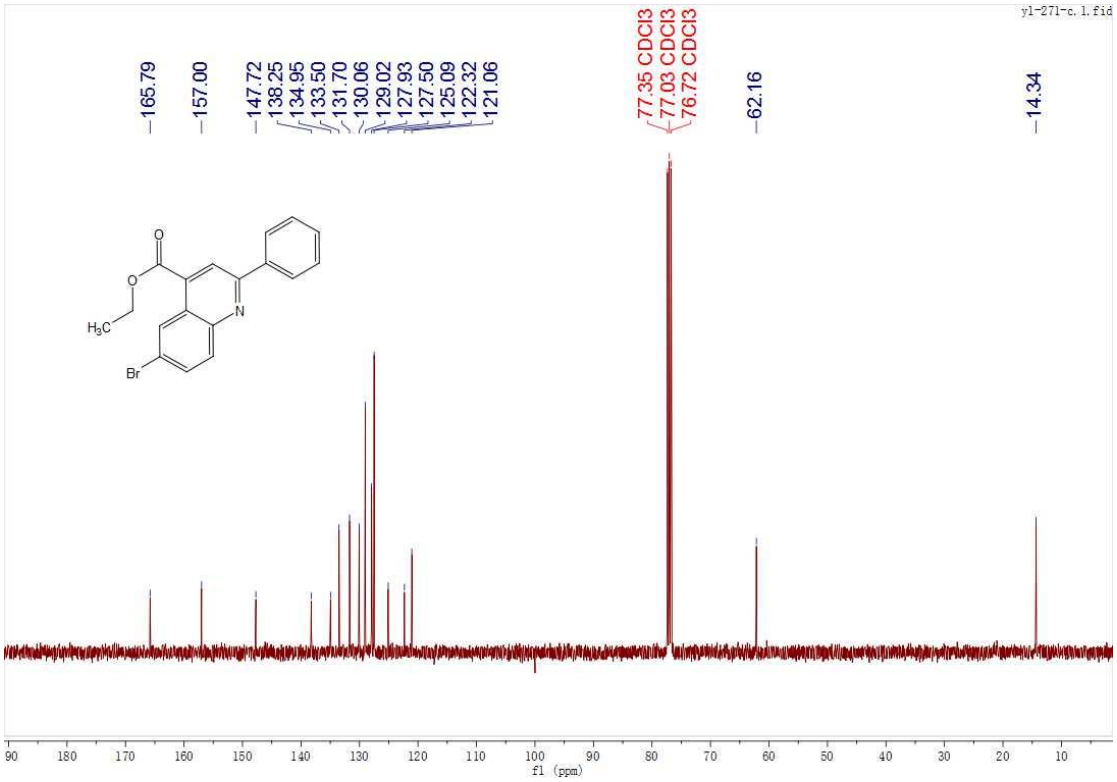
^{1}H NMR spectrum of 4e



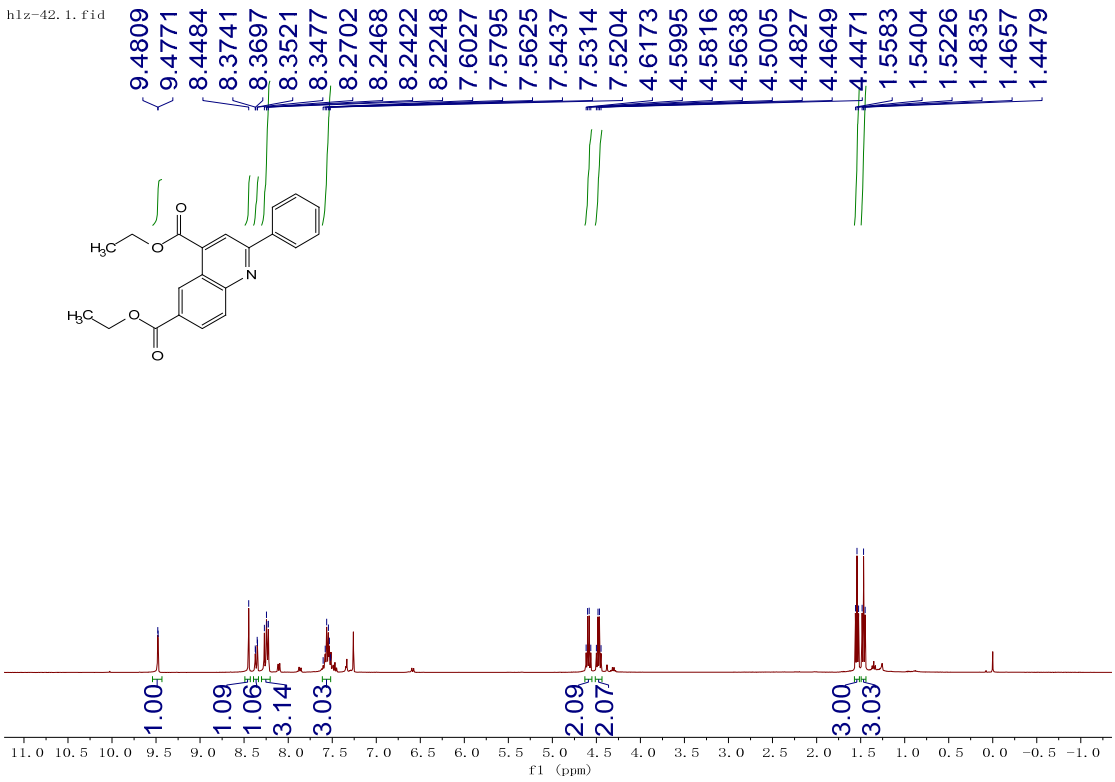
^{13}C NMR spectrum of 4e



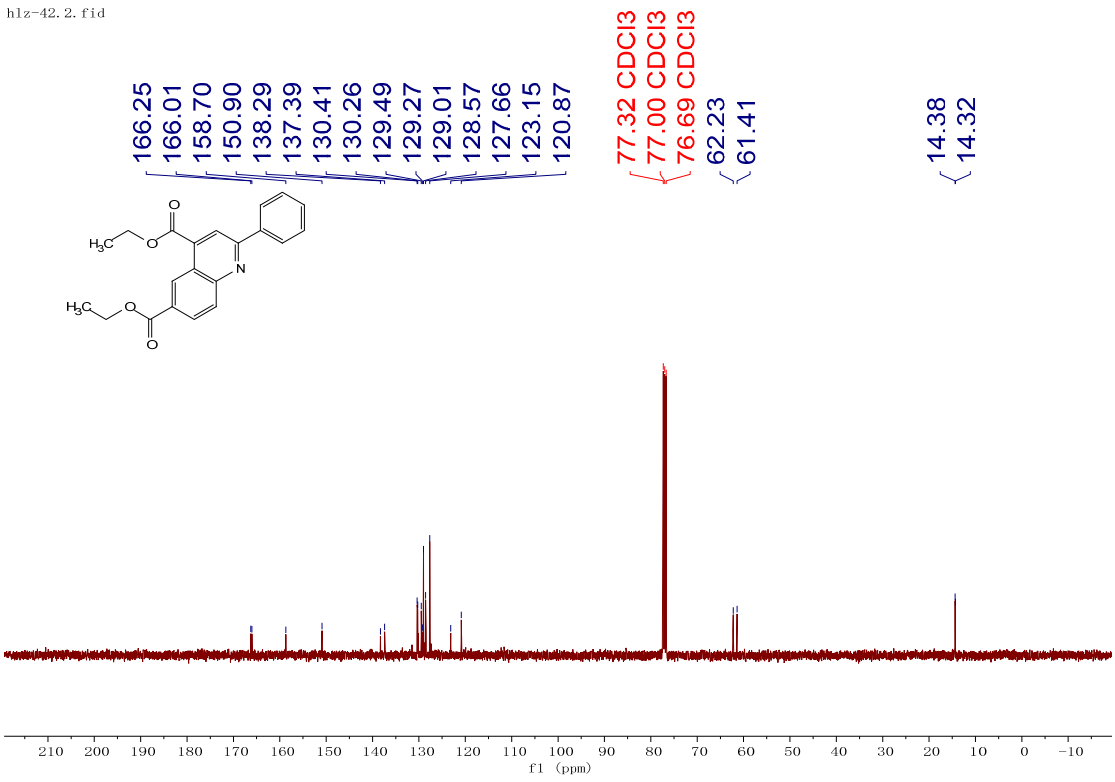
^{1}H NMR spectrum of 4f



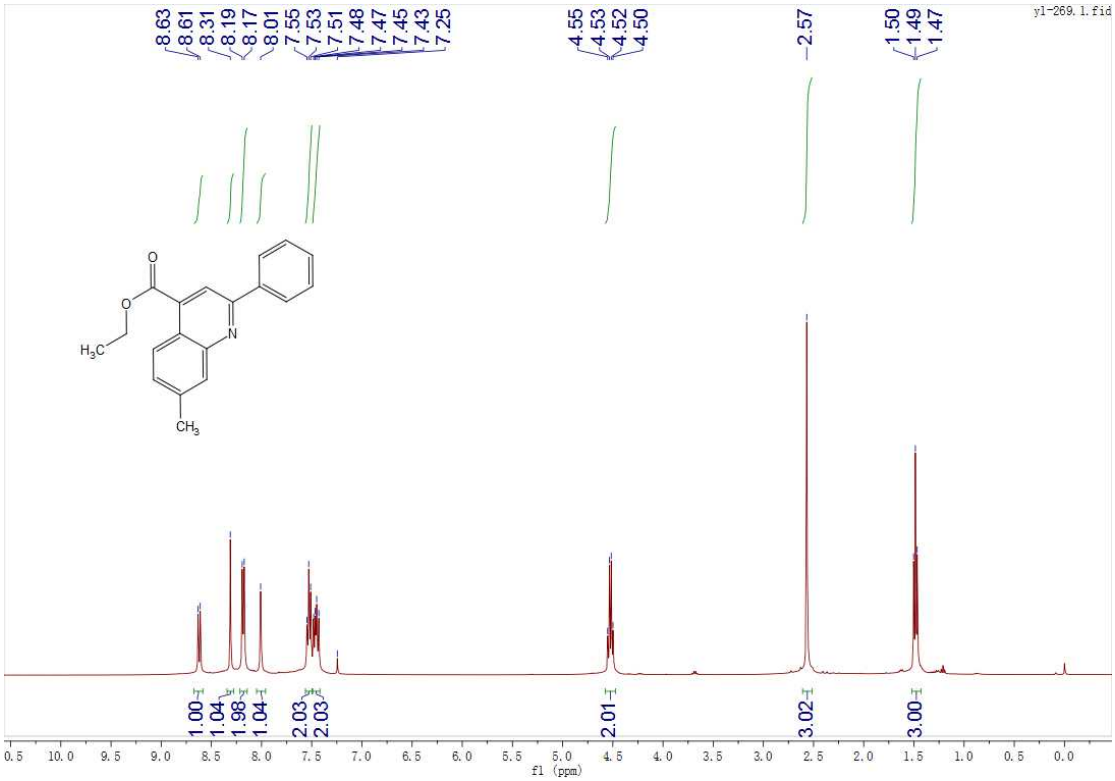
^{13}C NMR spectrum of 4f



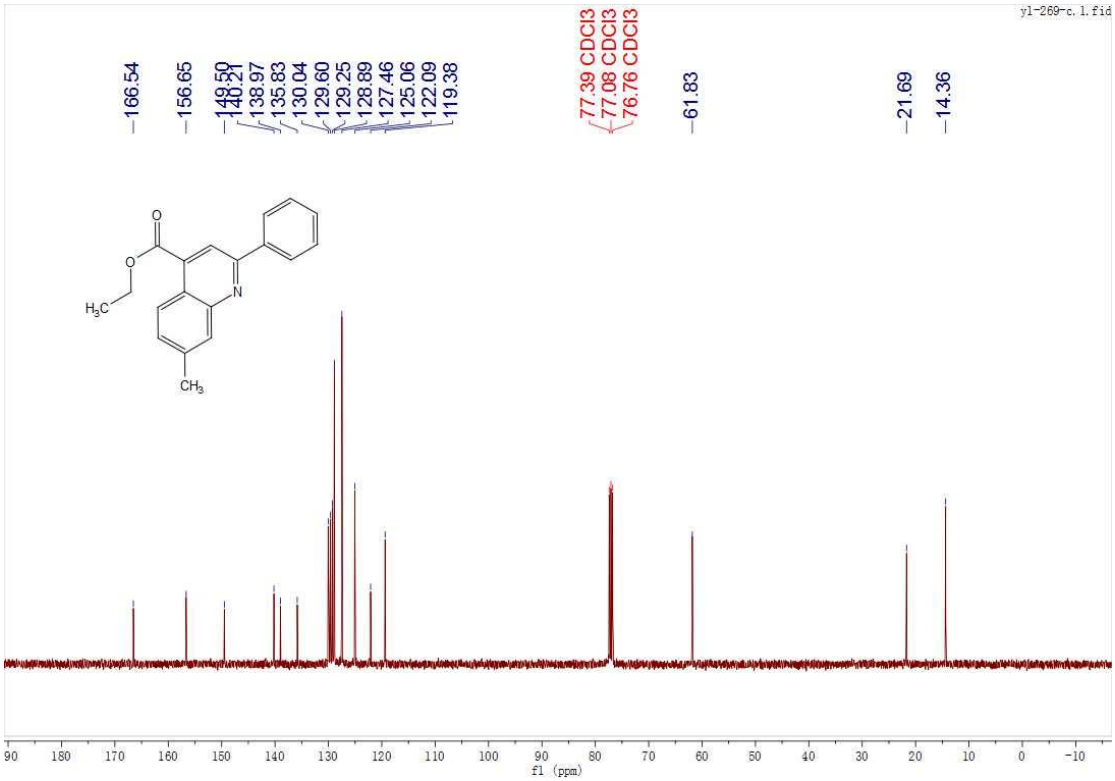
^{1}H NMR spectrum of 4g



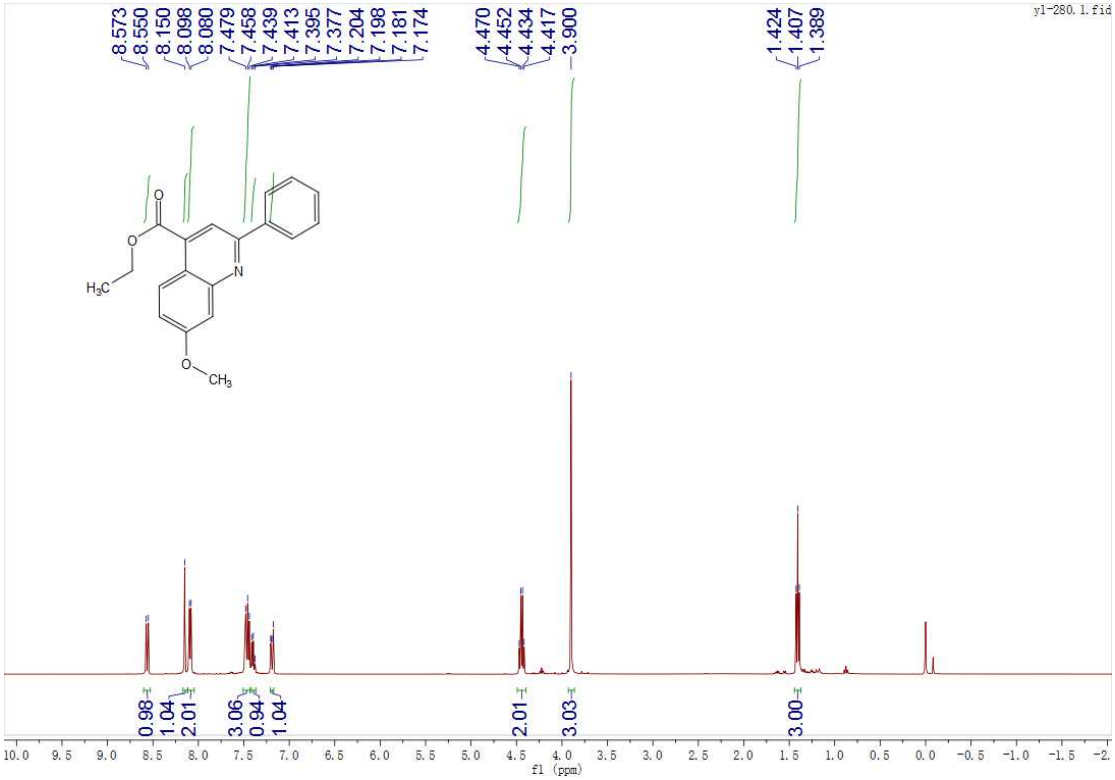
^{13}C NMR spectrum of 4g



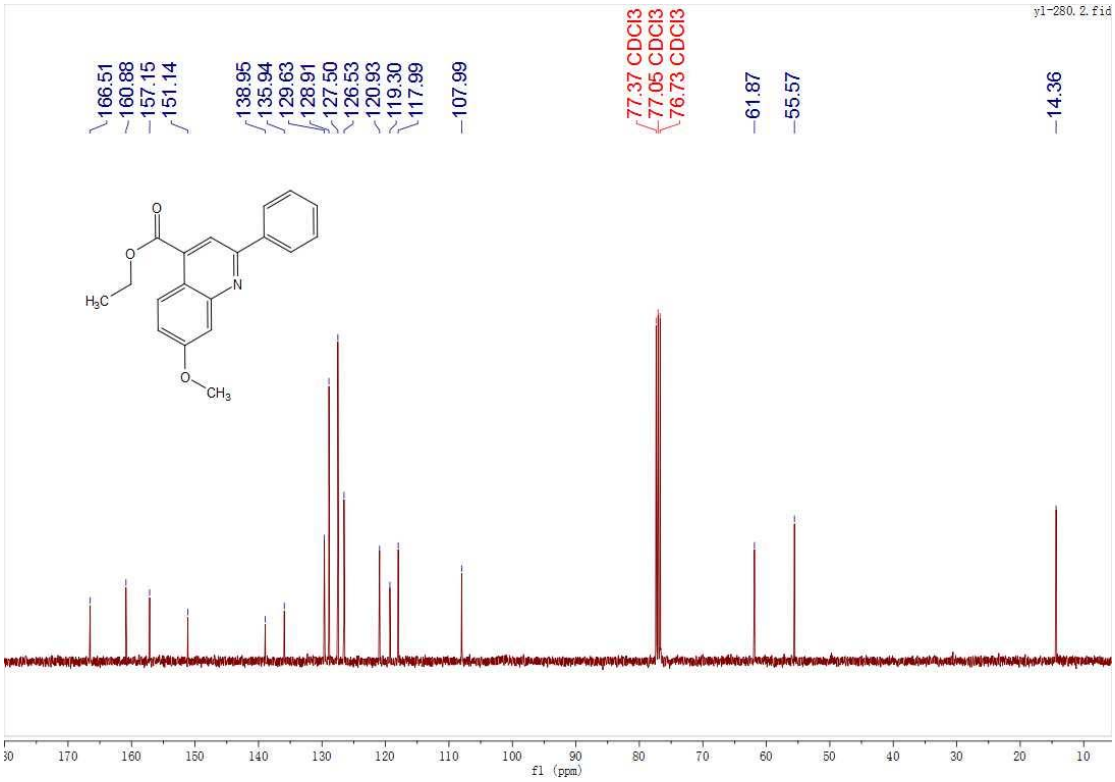
^{1}H NMR spectrum of 4h



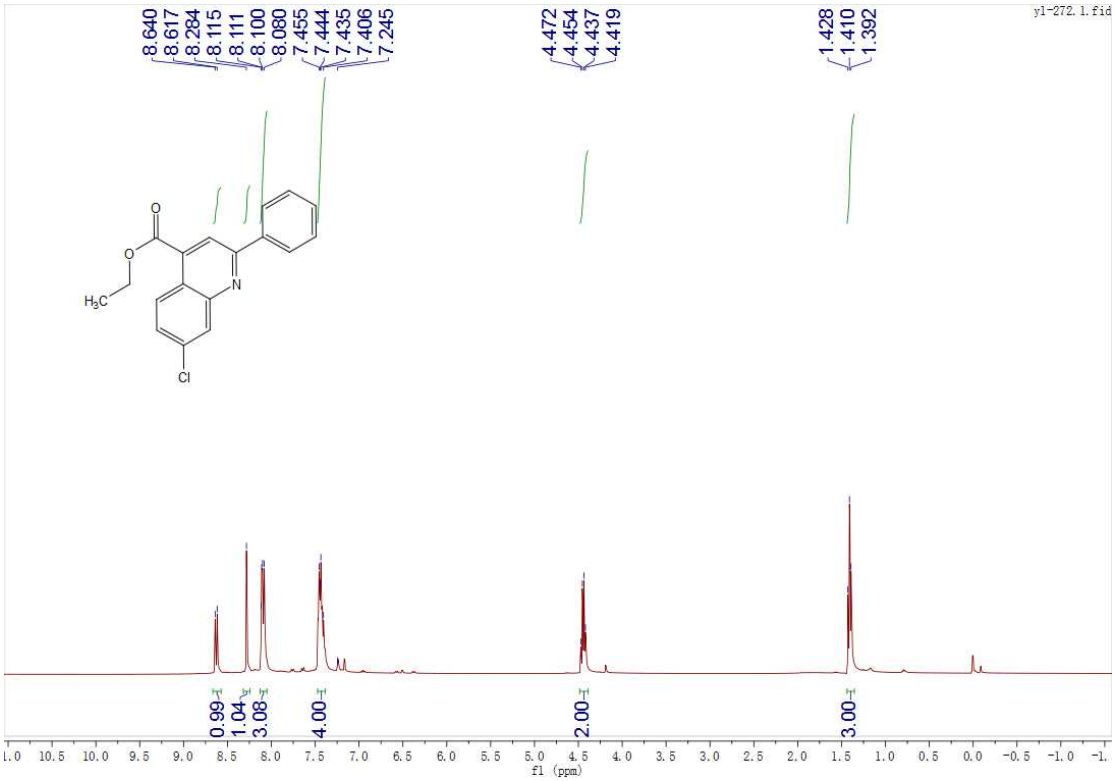
^{13}C NMR spectrum of 4h



^{1}H NMR spectrum of 4i



^{13}C NMR spectrum of 4i



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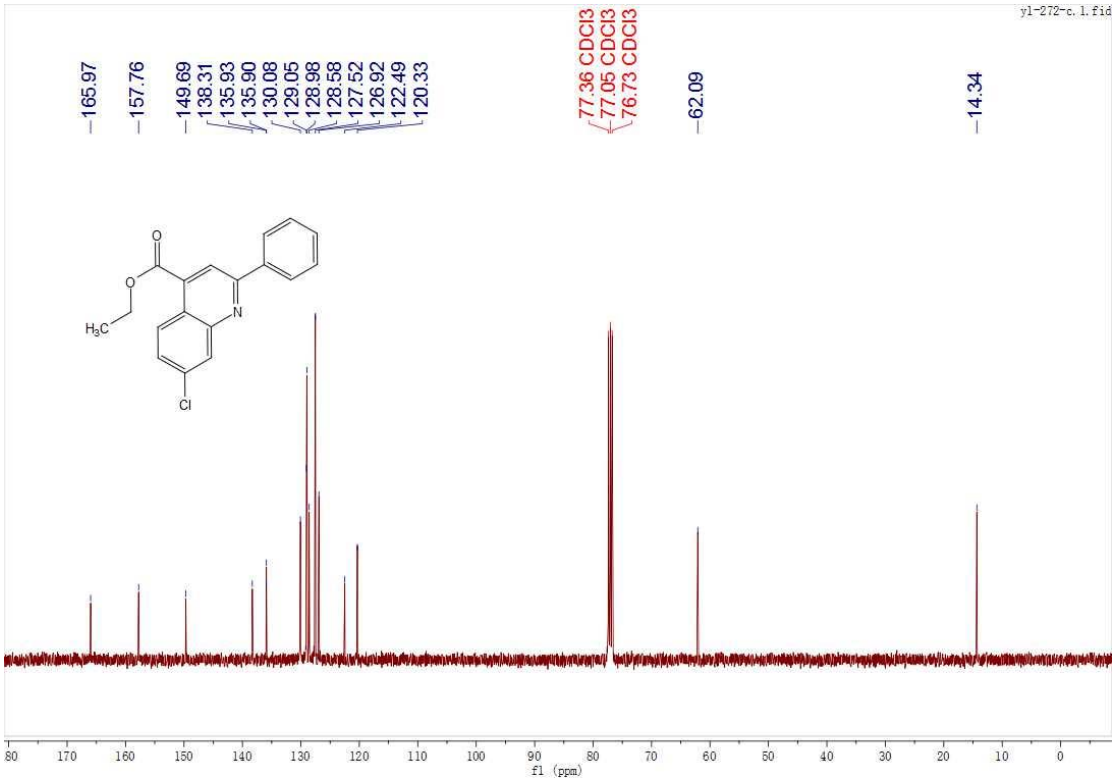
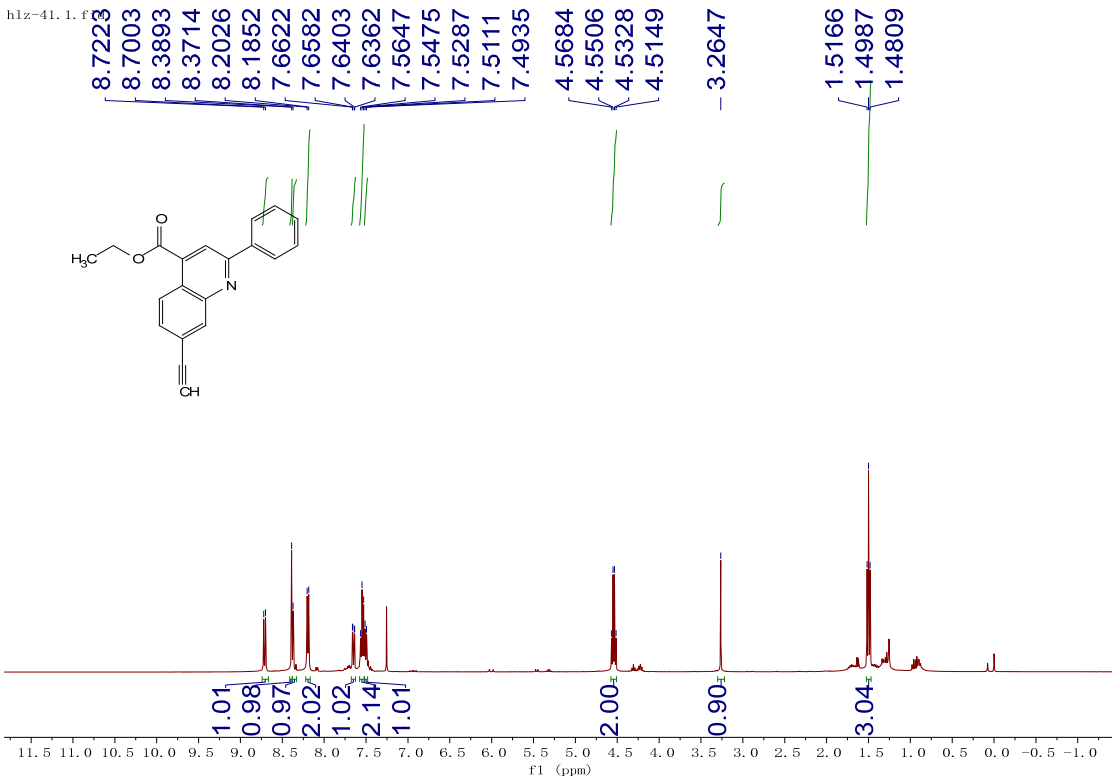


^{13}C NMR spectrum of 4j



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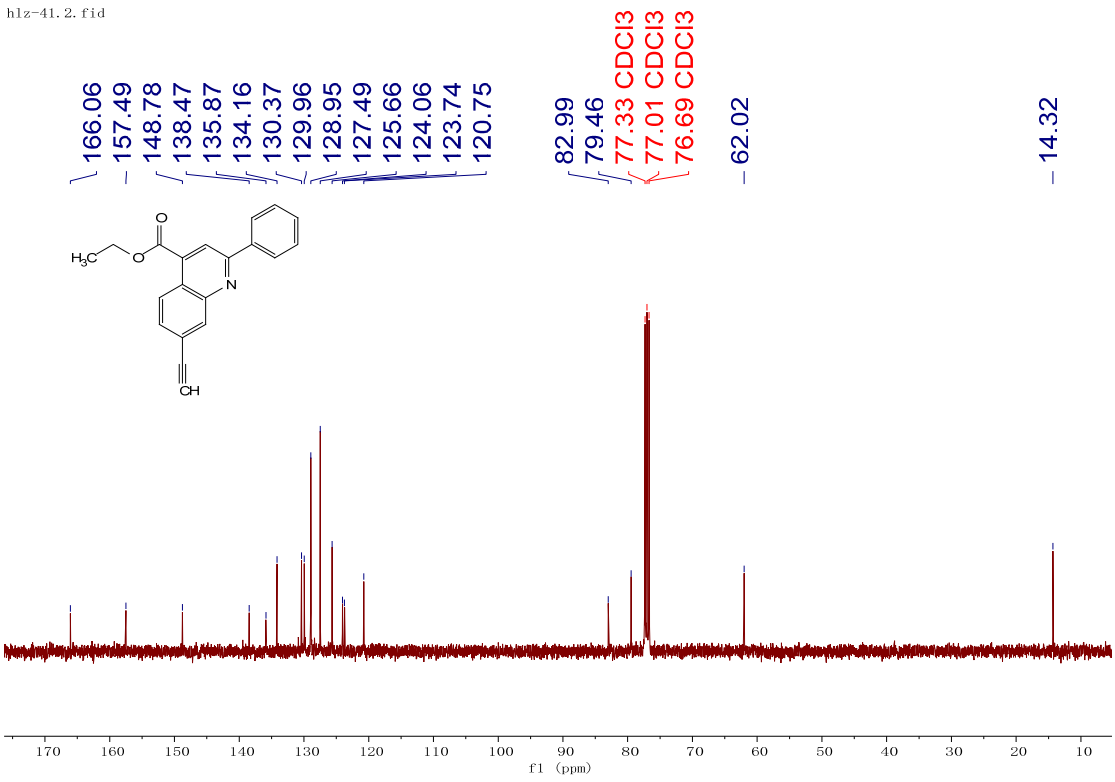
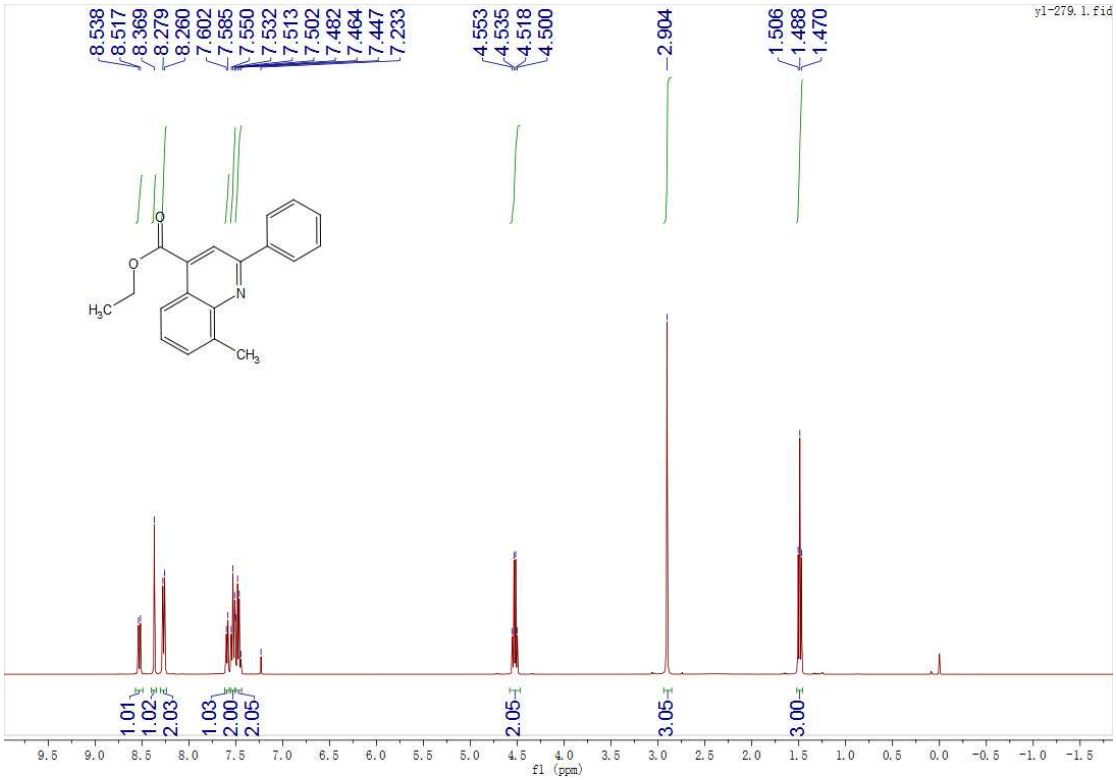
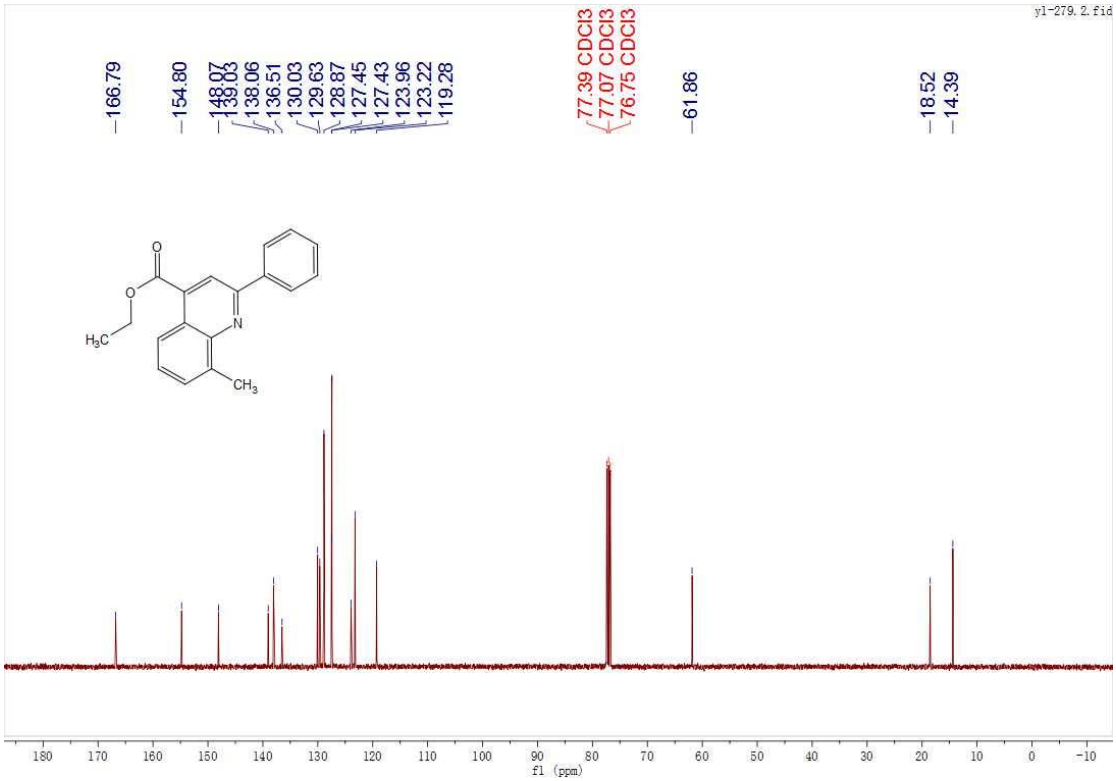


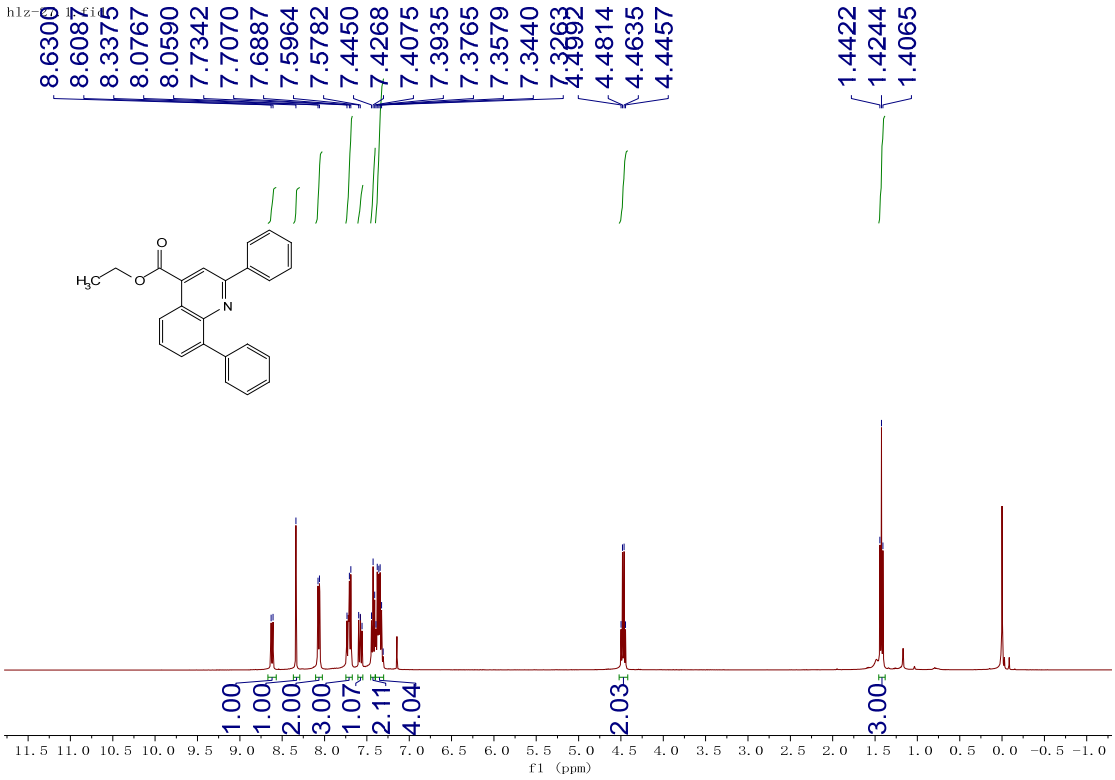
^{13}C NMR spectrum of 4k



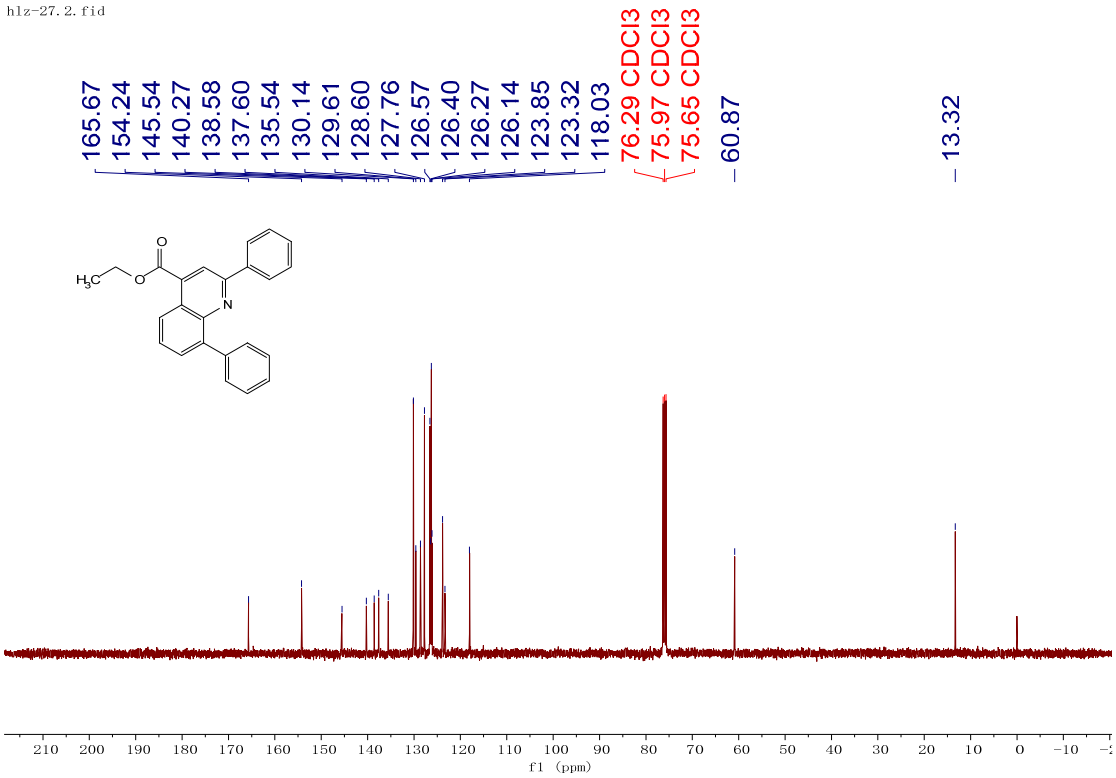
^{1}H NMR spectrum of 4l



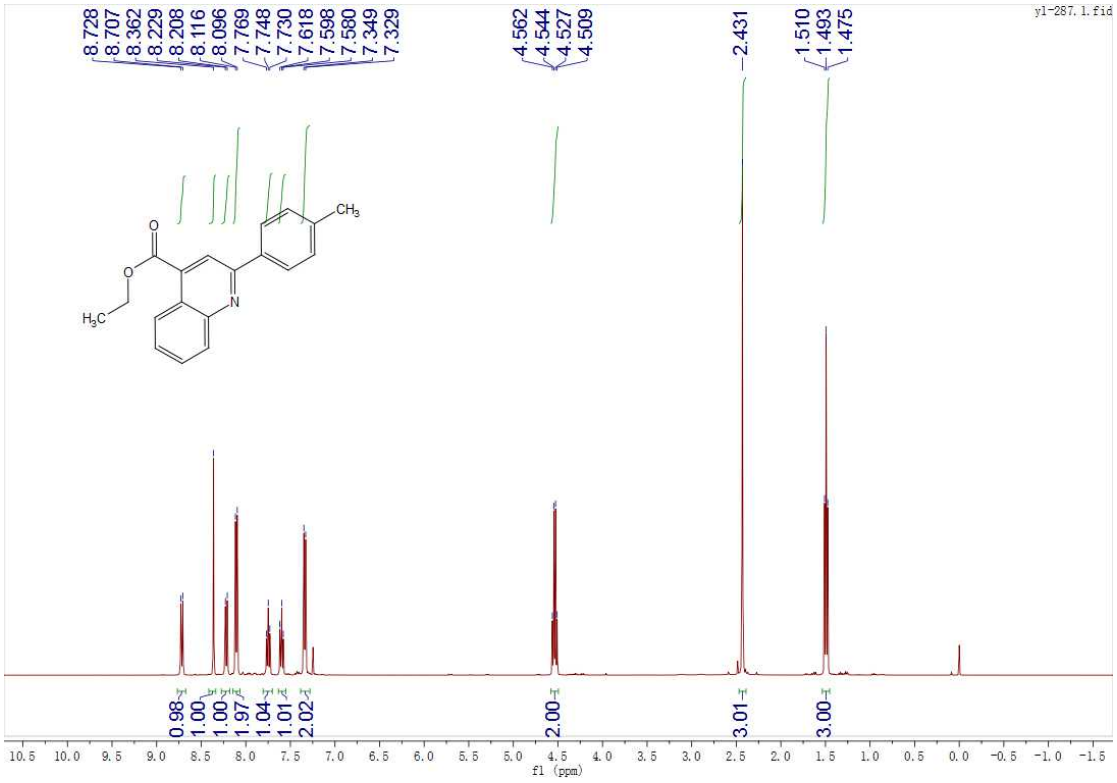
^{13}C NMR spectrum of 4l



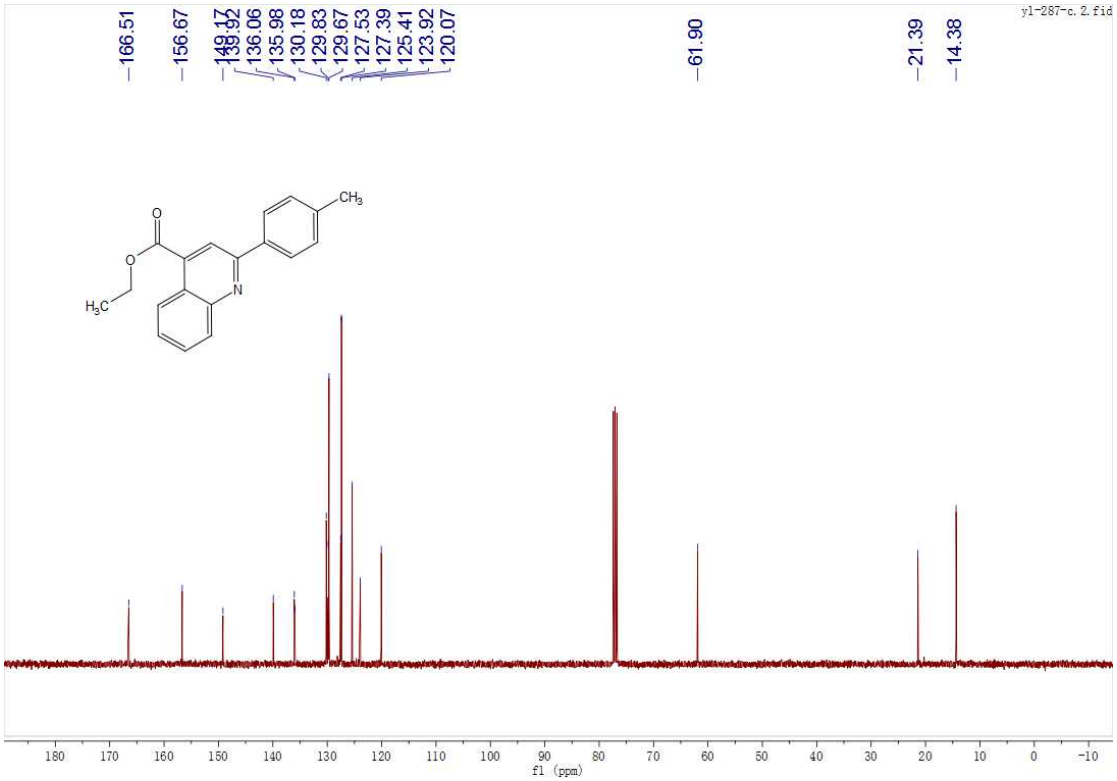
^{1}H NMR spectrum of 4m



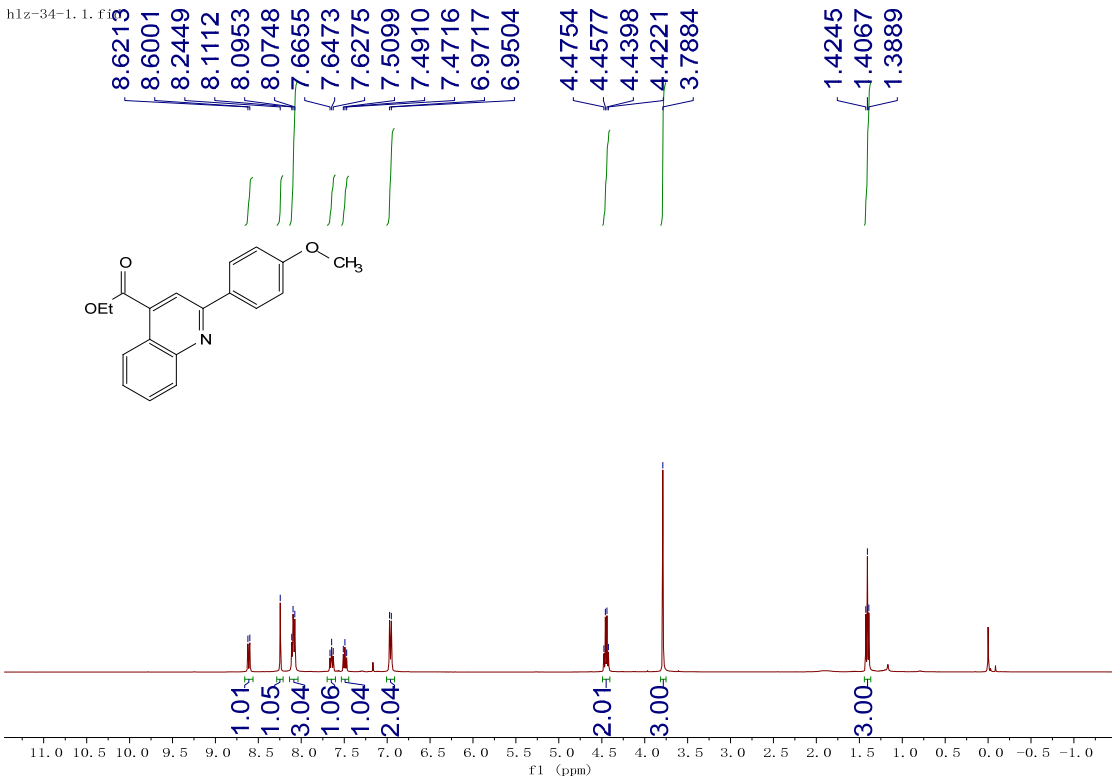
^{13}C NMR spectrum of 4m



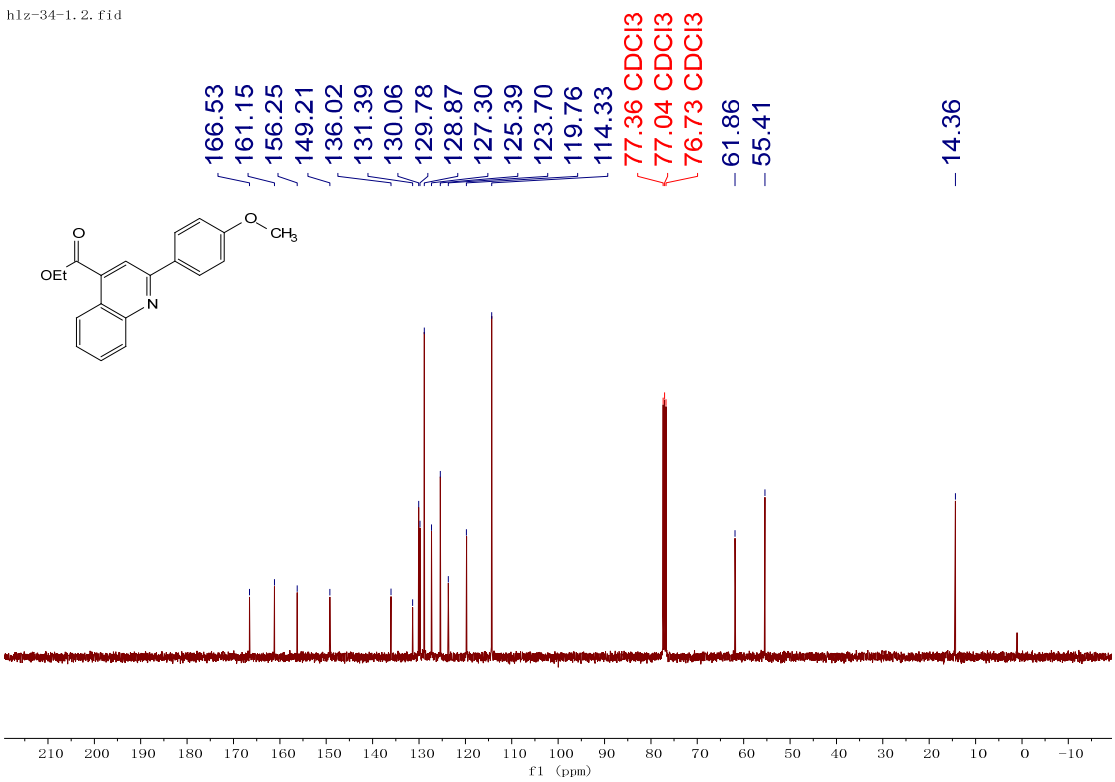
^{1}H NMR spectrum of 4n



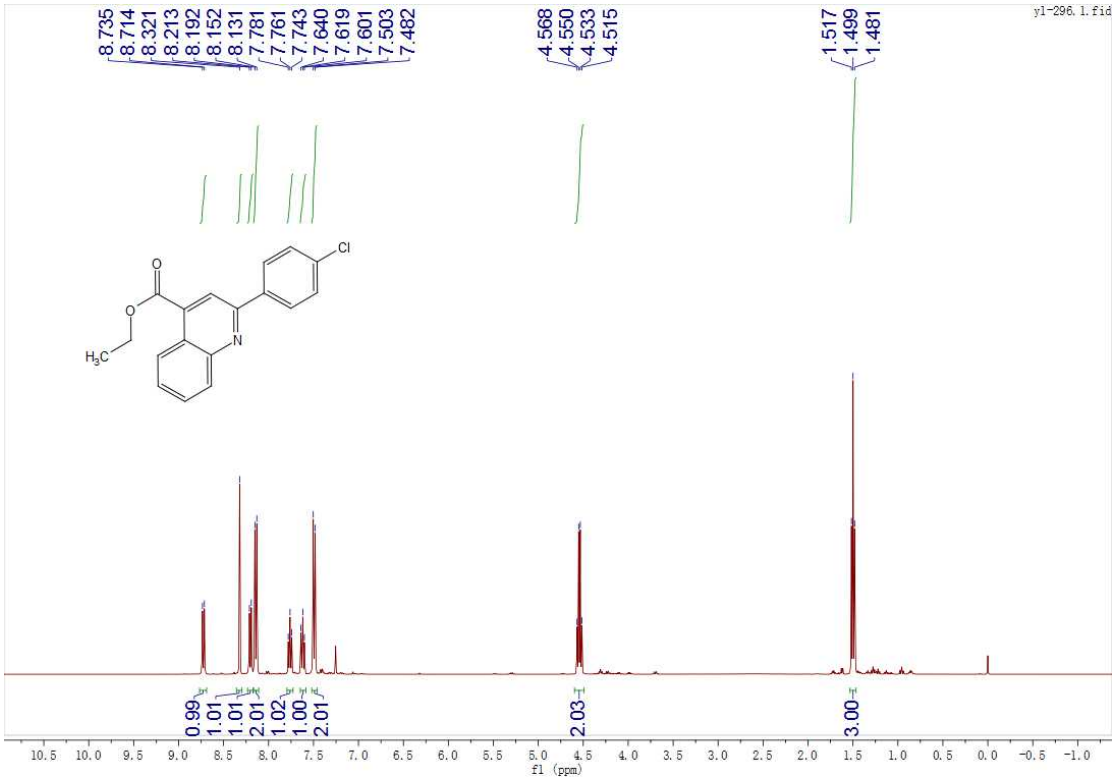
^{13}C NMR spectrum of 4n



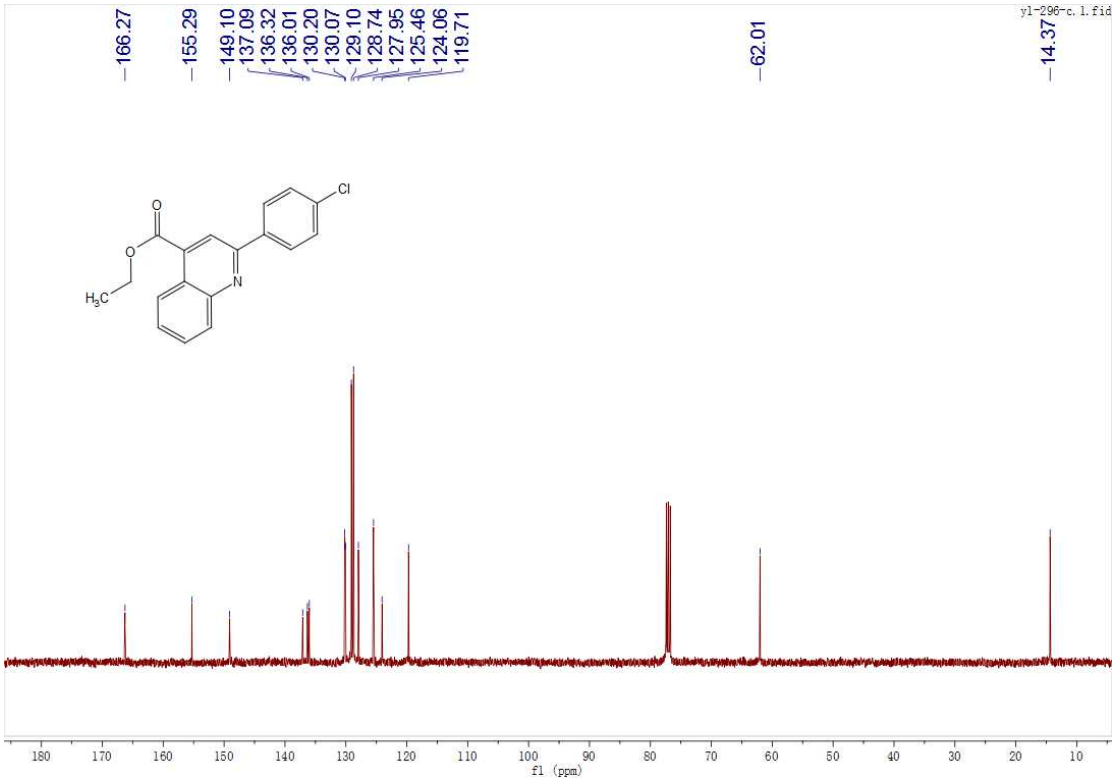
^{1}H NMR spectrum of 4o



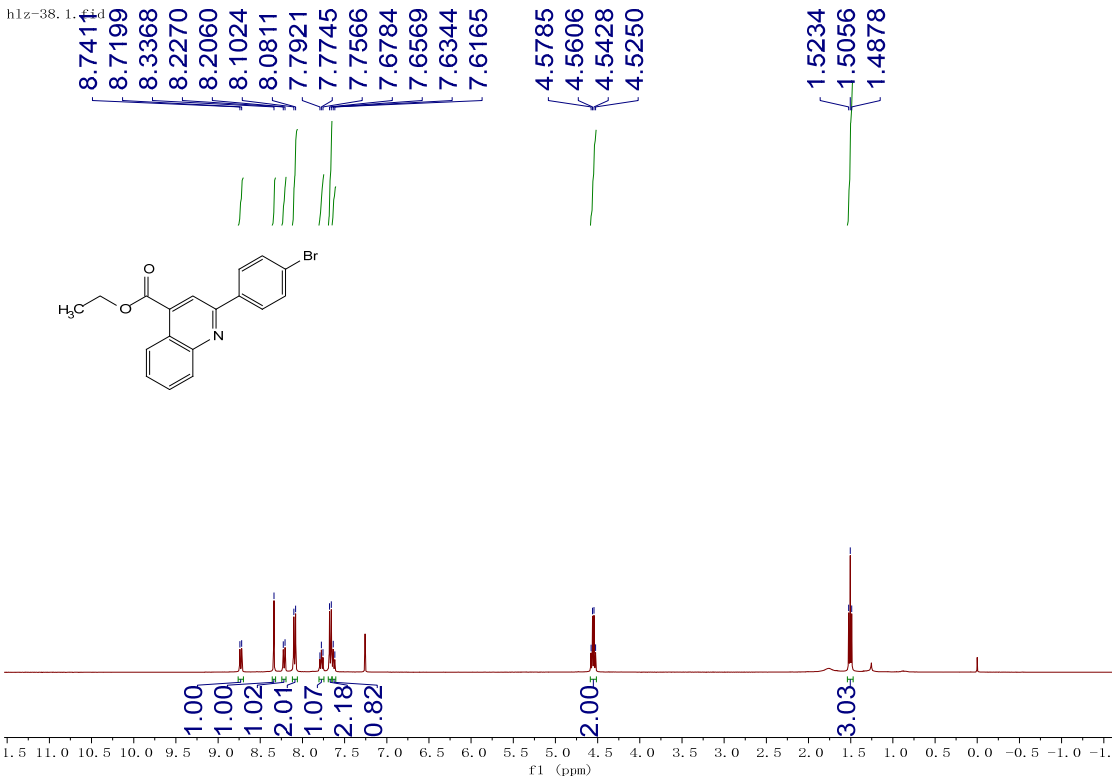
^{13}C NMR spectrum of 4o



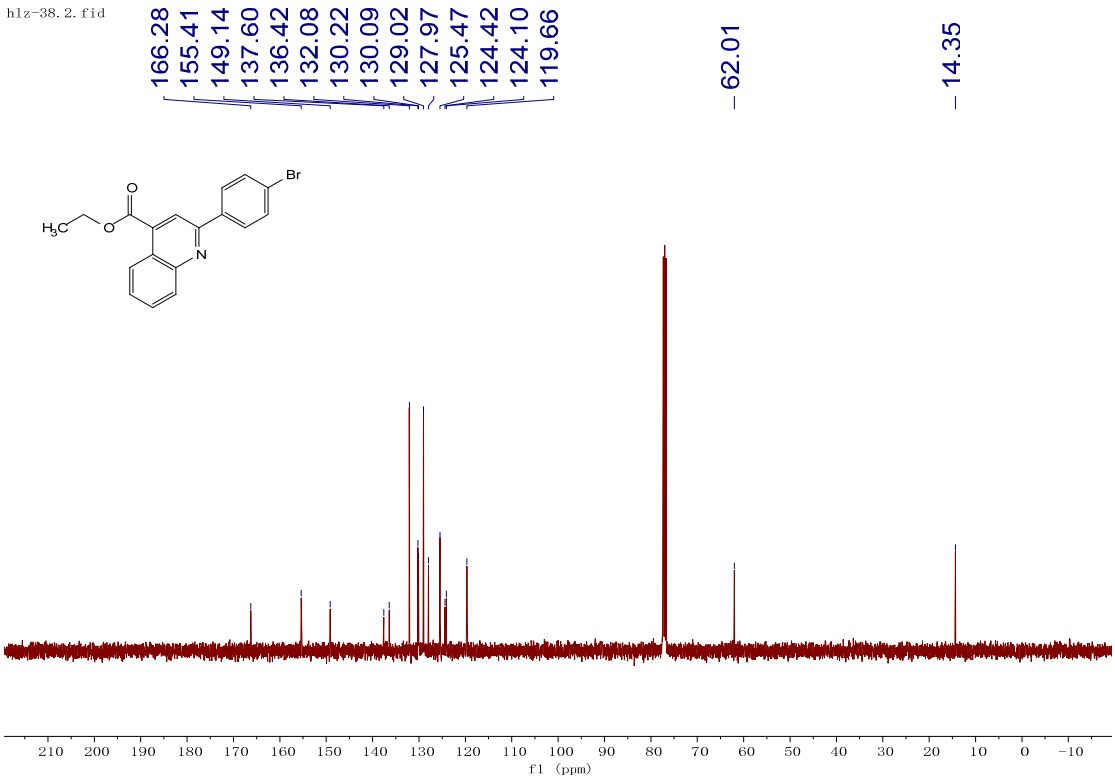
^{1}H NMR spectrum of 4p



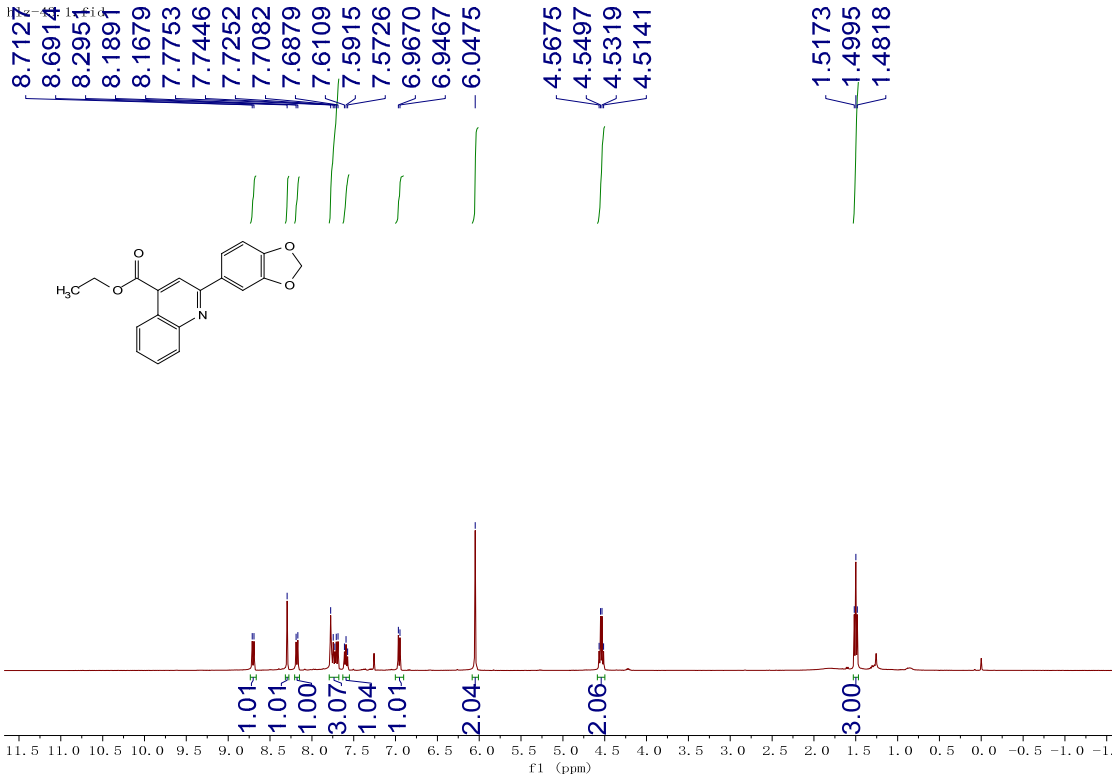
^{13}C NMR spectrum of 4p



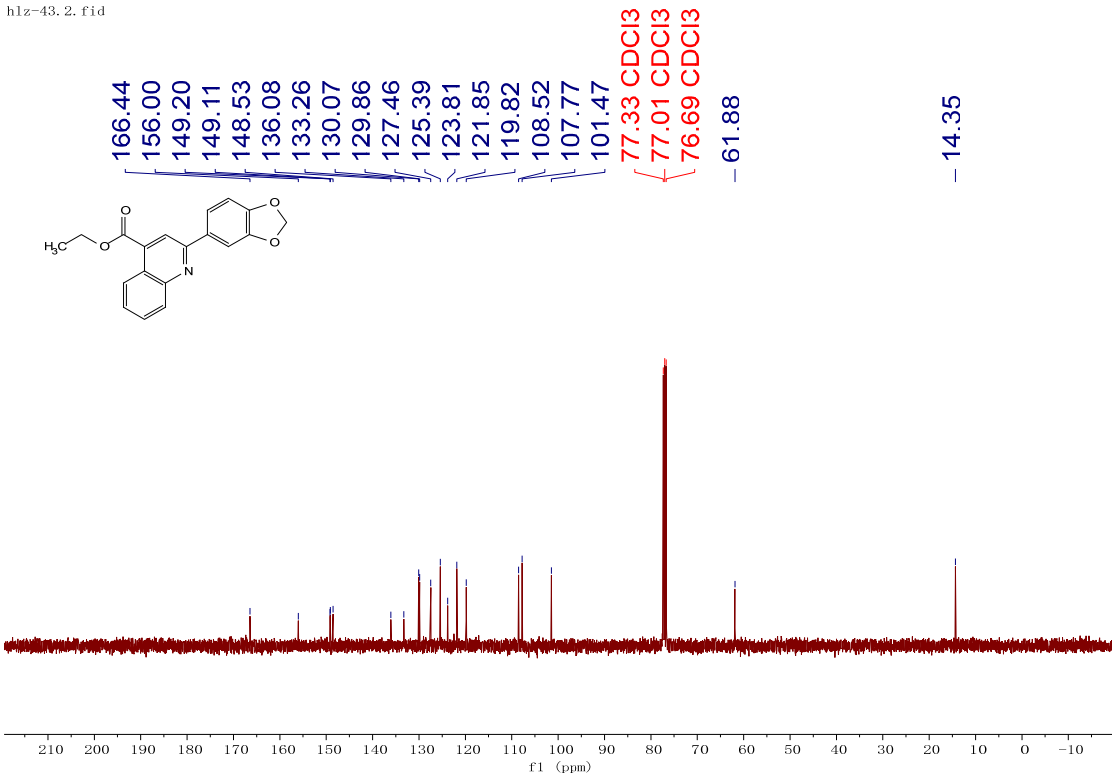
^{1}H NMR spectrum of 4q



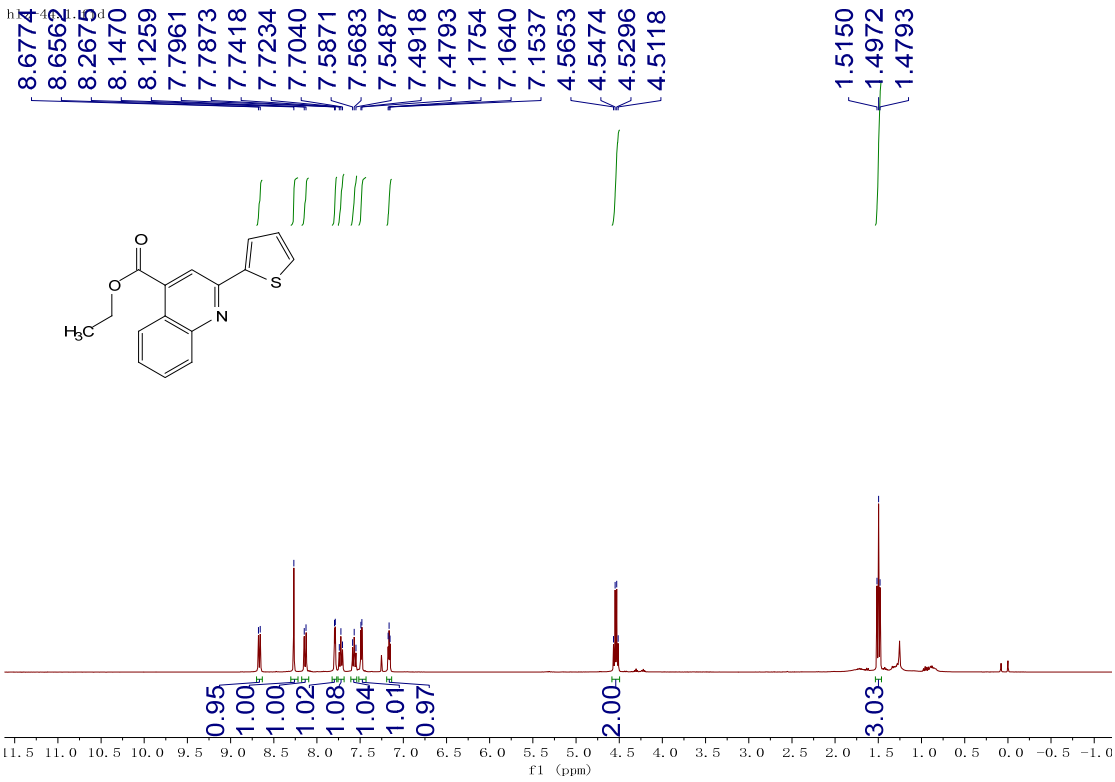
^{13}C NMR spectrum of 4q



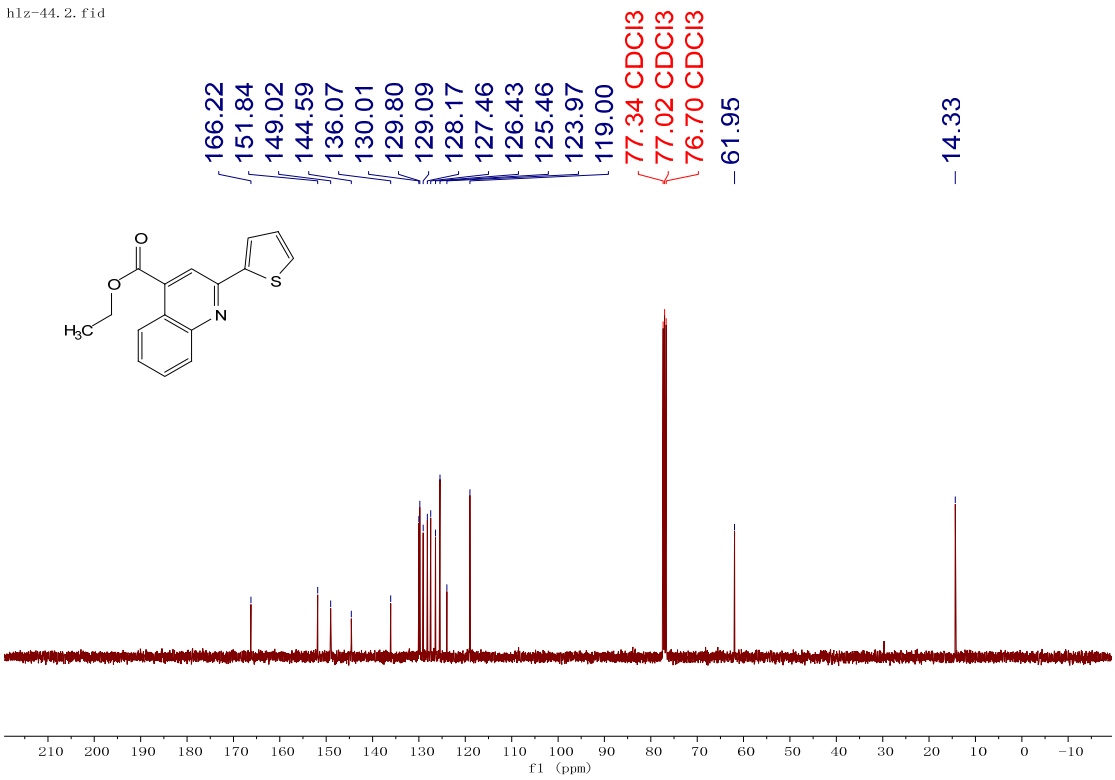
^{1}H NMR spectrum of 4r



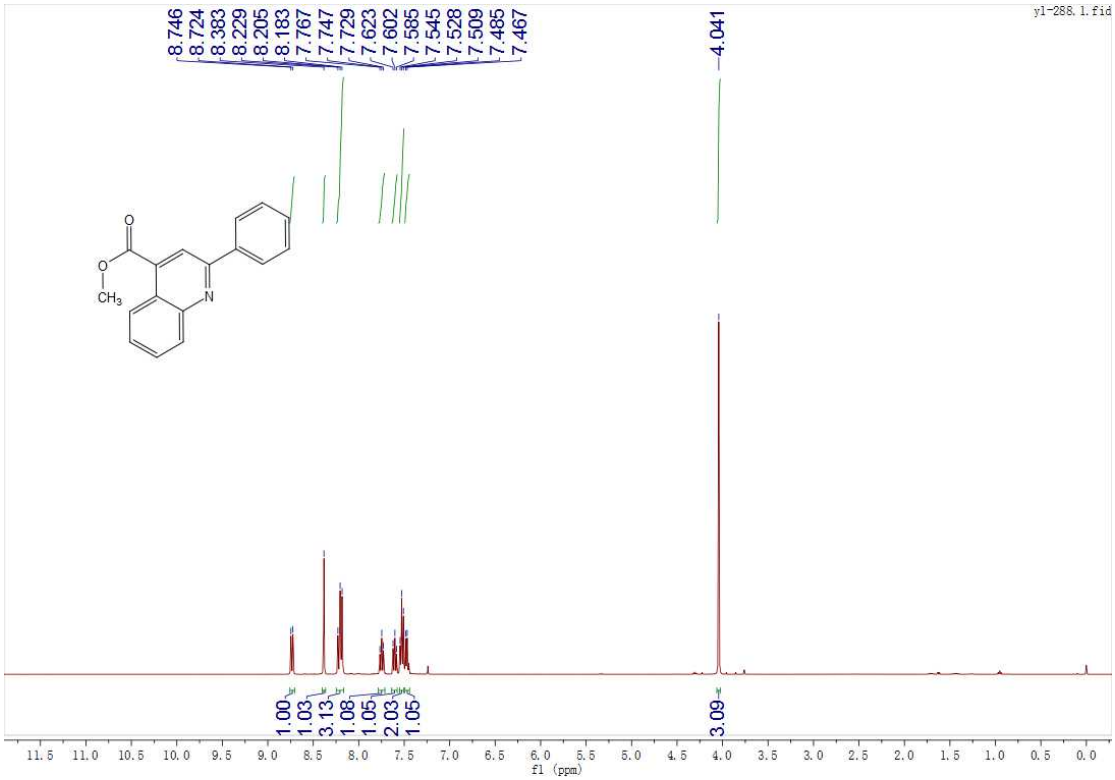
^{13}C NMR spectrum of 4r



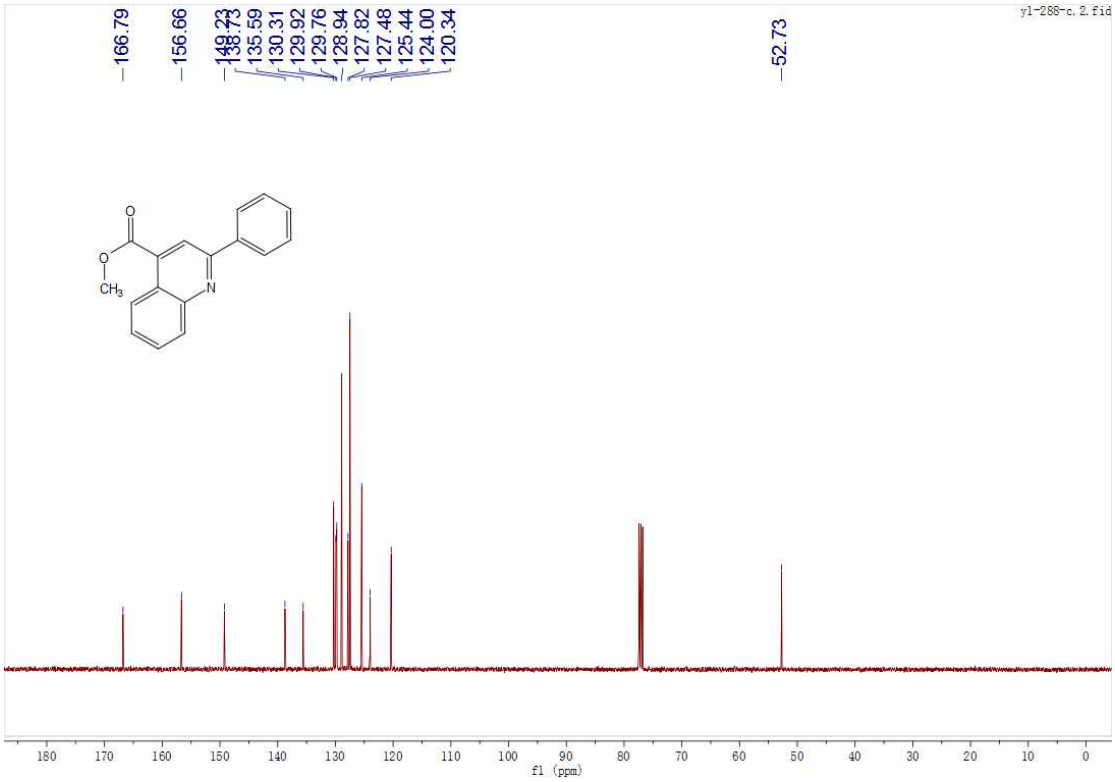
^{1}H NMR spectrum of 4s



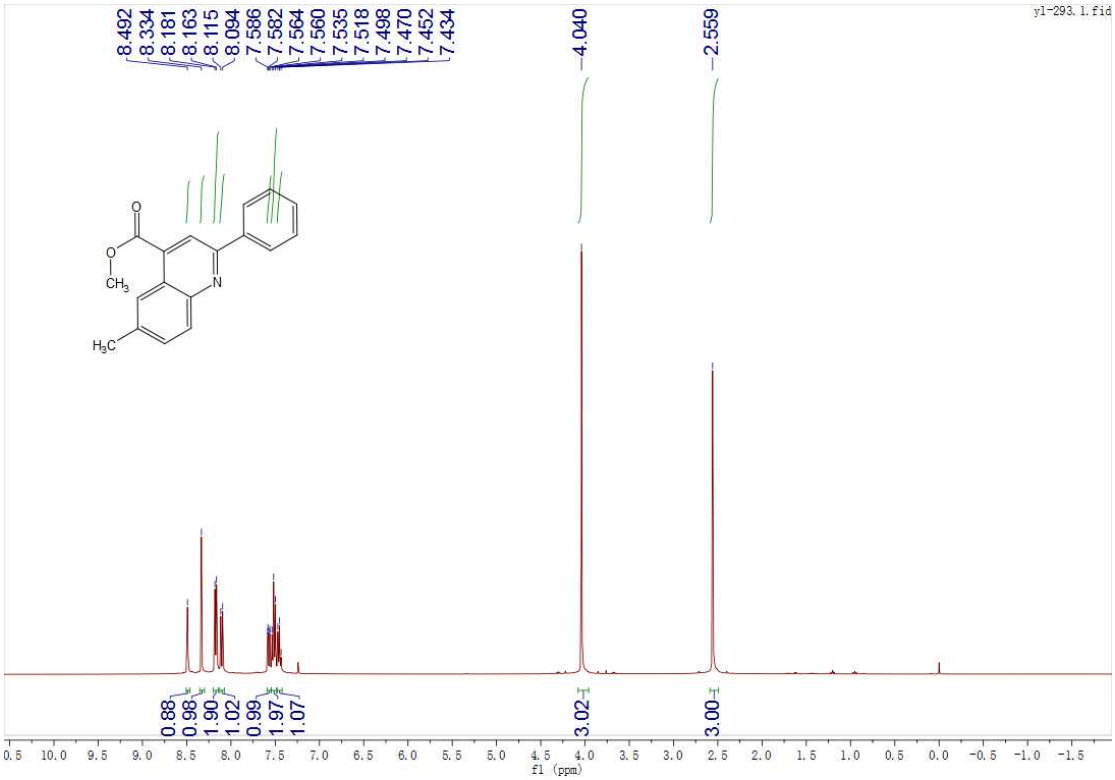
^{13}C NMR spectrum of 4s



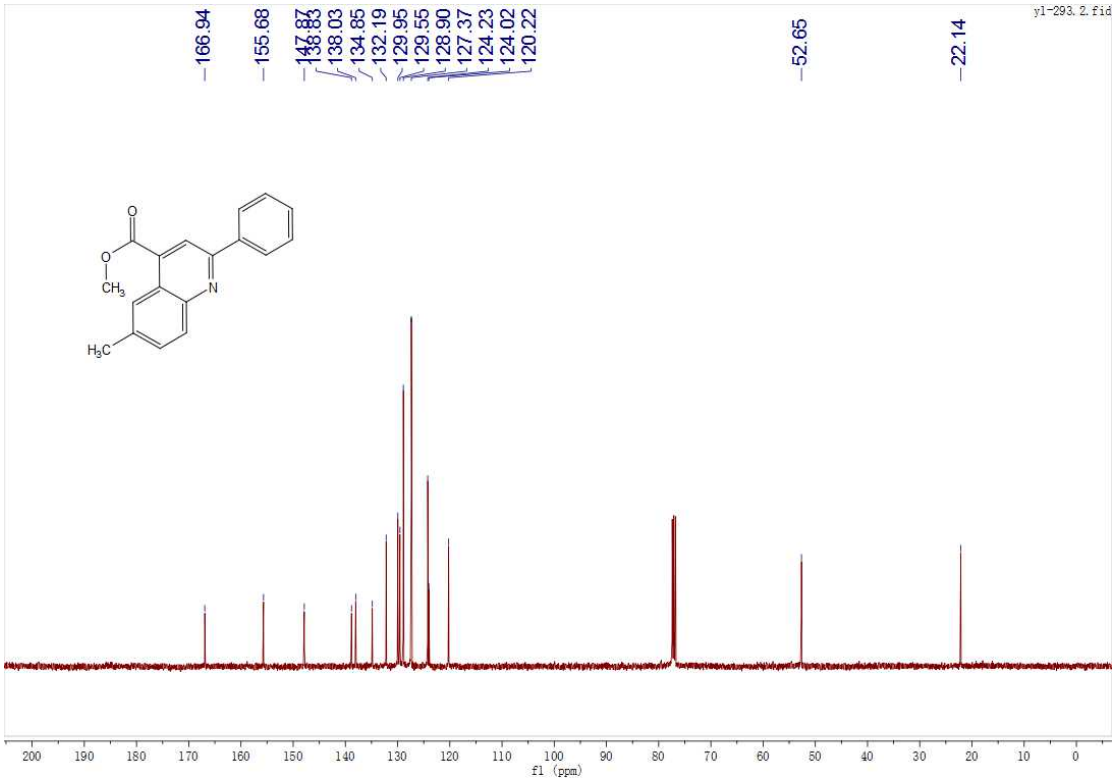
^{1}H NMR spectrum of 4t



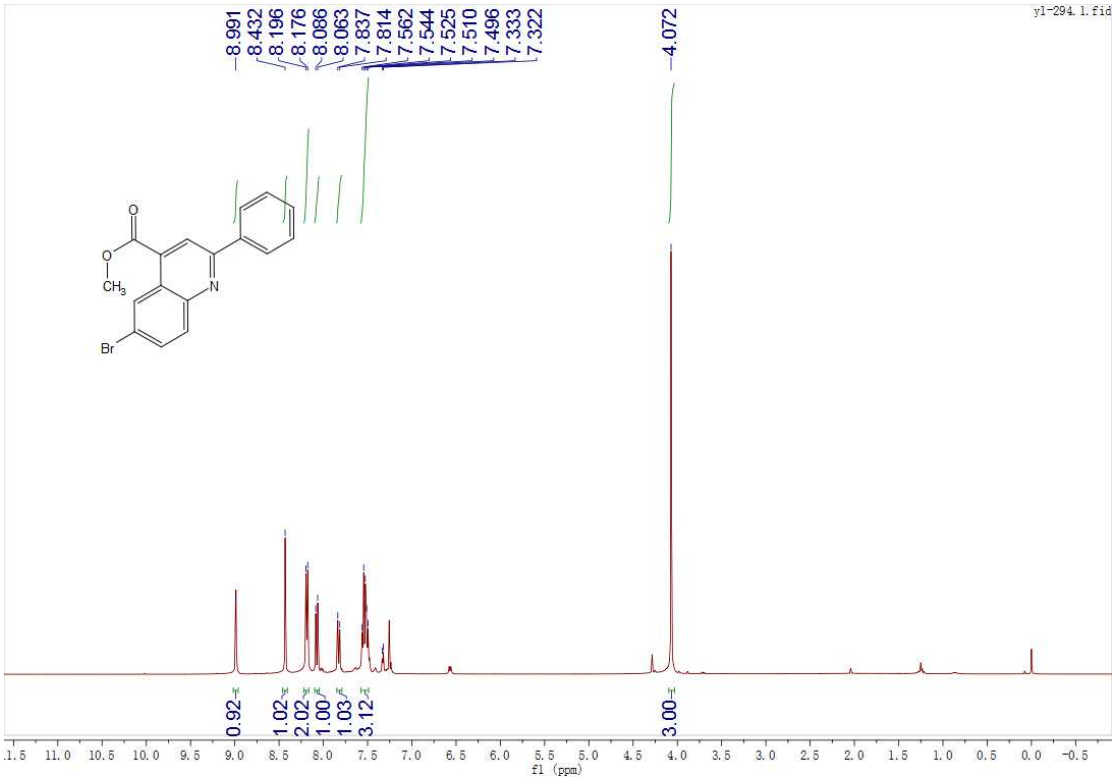
^{13}C NMR spectrum of 4t



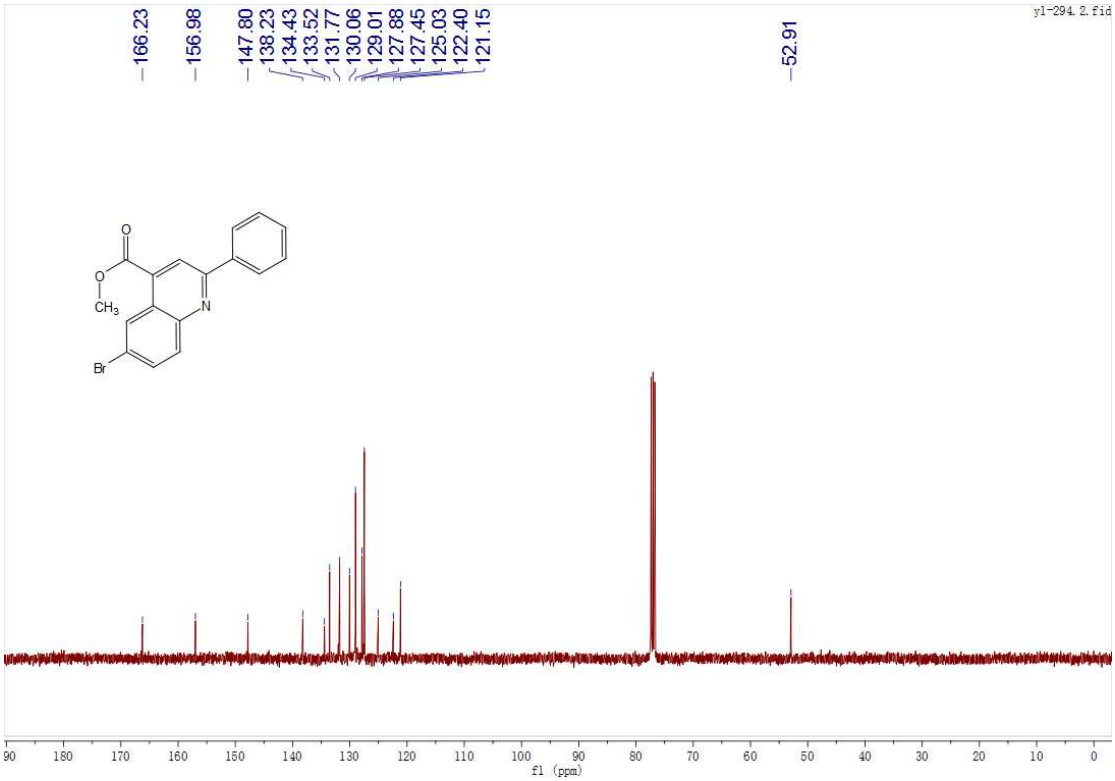
^{1}H NMR spectrum of 4u



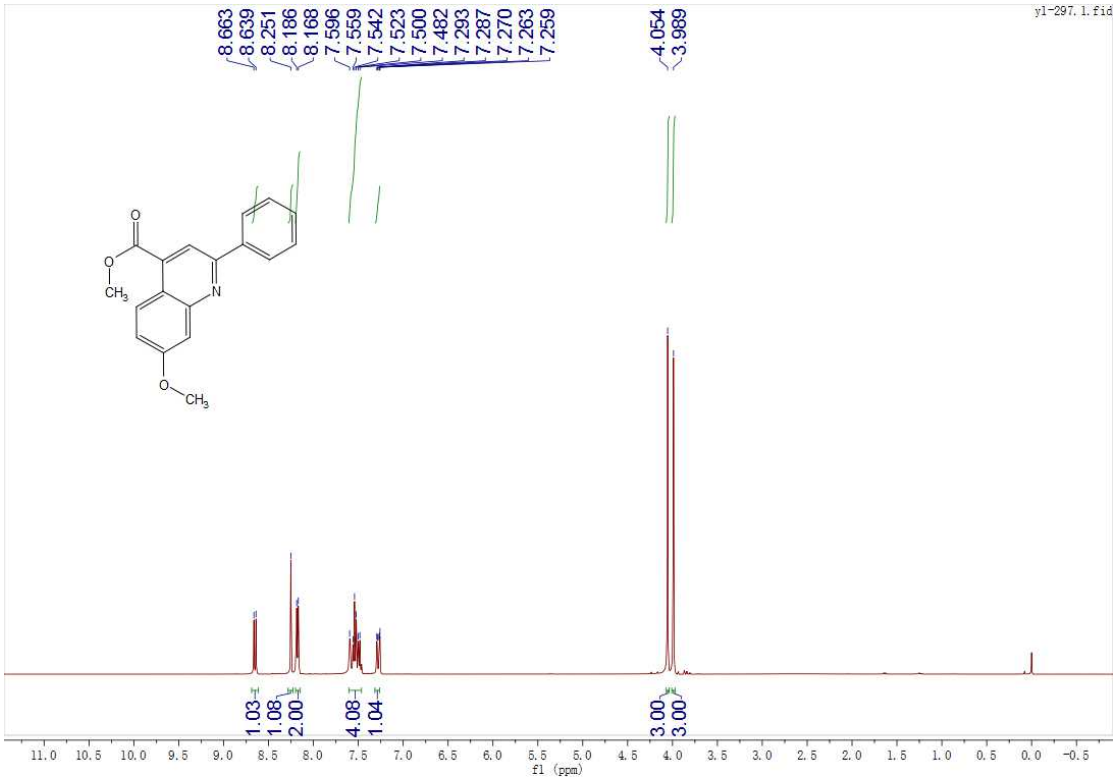
^{13}C NMR spectrum of 4u



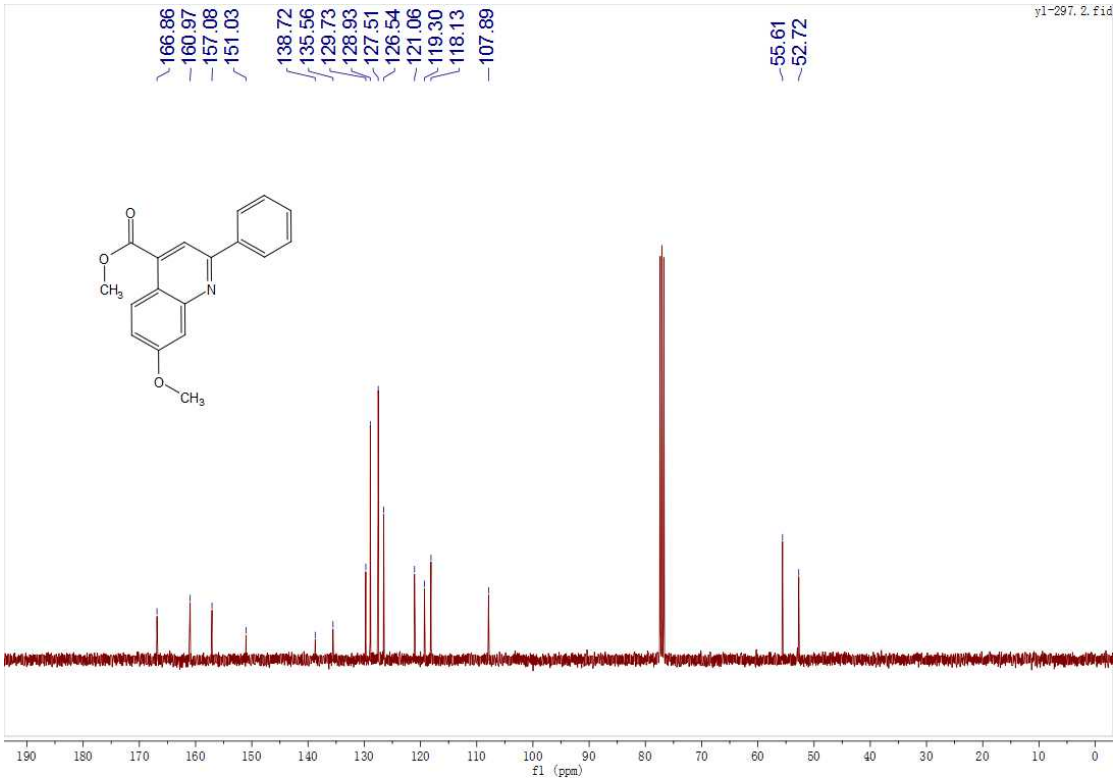
^{1}H NMR spectrum of 4v



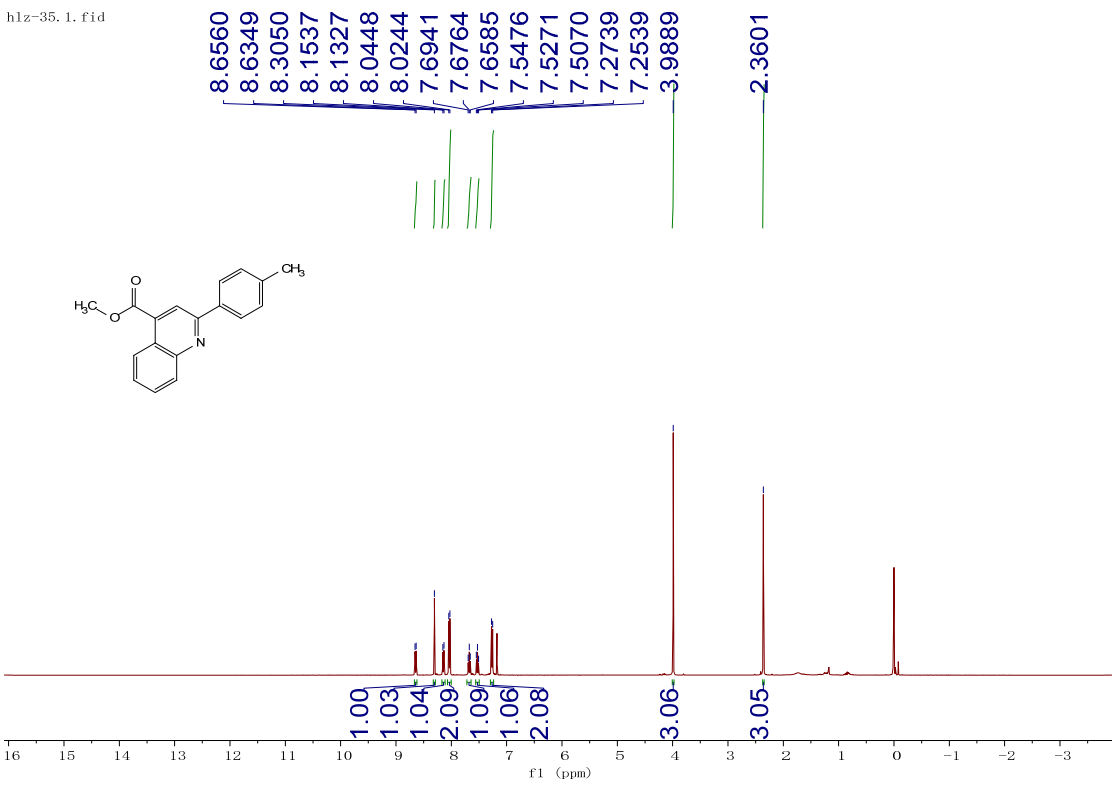
^{13}C NMR spectrum of 4v



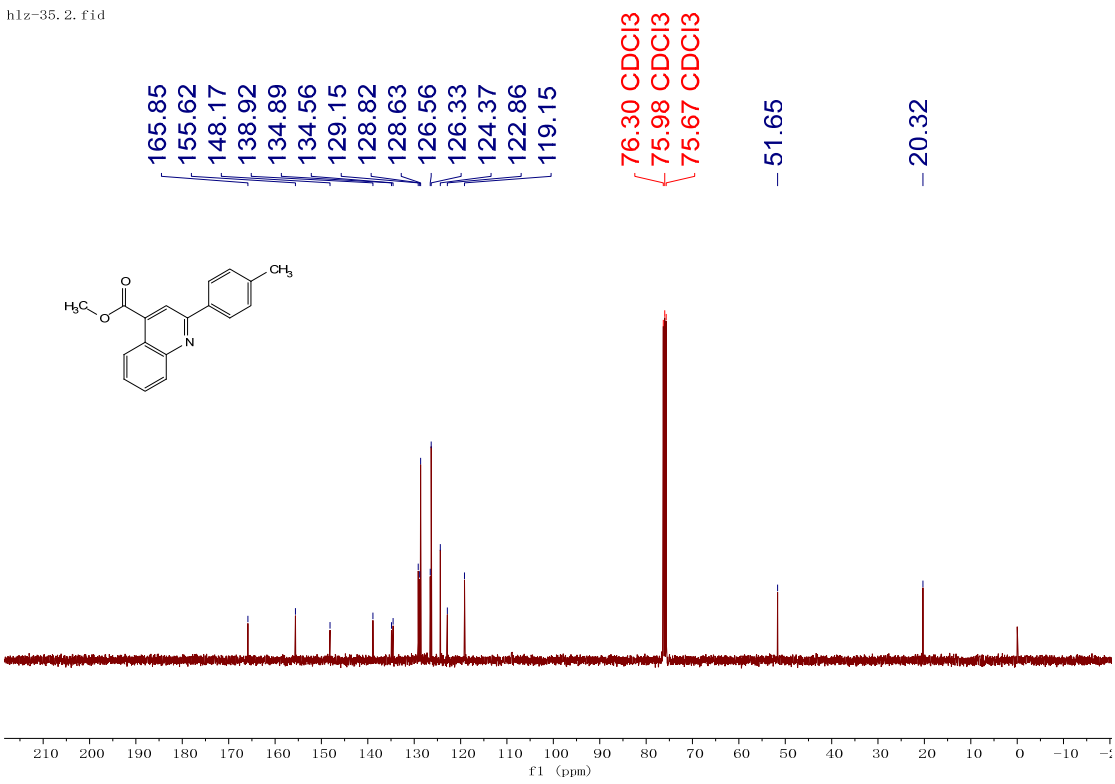
^{1}H NMR spectrum of 4w



^{13}C NMR spectrum of 4w



^{1}H NMR spectrum of 4x



^{13}C NMR spectrum of 4x

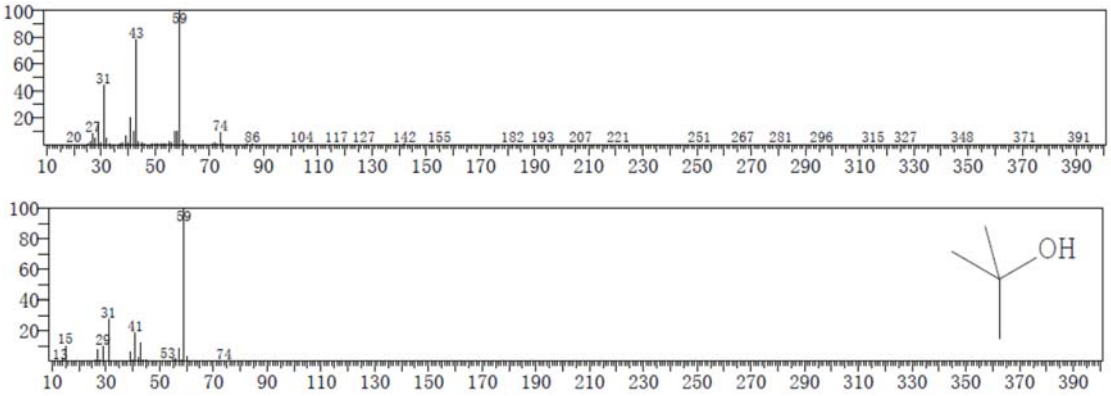


Figure S1 The GC-MS spectra of the *t*-BuOH in the reaction mixture and standard *t*-BuOH

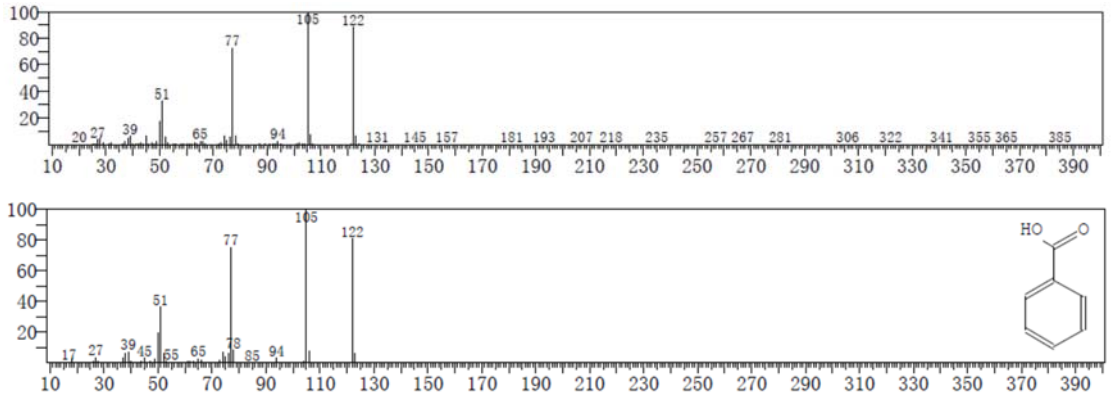


Figure S2 The GC-MS spectra of the $PhCO_2H$ in the reaction mixture and standard $PhCO_2H$