Supporting Information

Water-DMSO-promoted one-pot synthesis of two new series of dihydropyrrolo[2,3-*h*]quinolines

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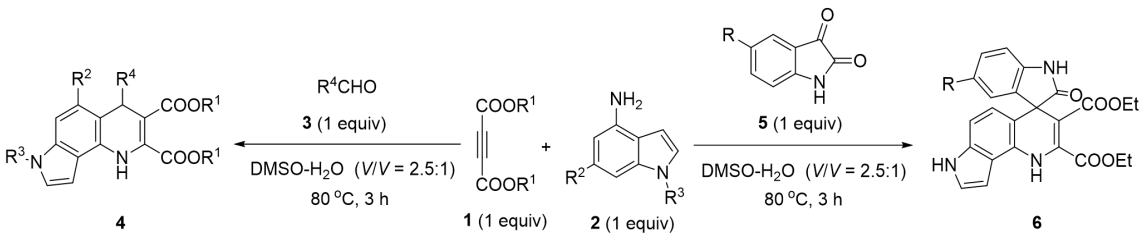
Experimental section

General information

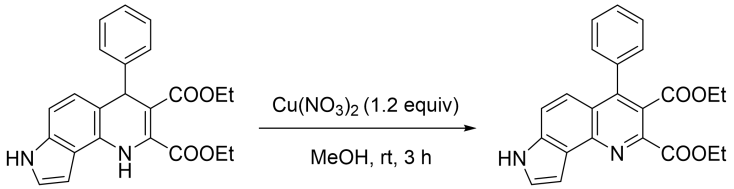
All melting points were measured using a X-5 micro melting point apparatus and were uncorrected. ^{1}H NMR (400 MHz) and ^{13}C NMR (101 MHz) spectra were recorded on a Bruker Avance 400 MHz NMR spectrometer with DMSO-d_6 or $CDCl_3$ as the solvent. ^{1}H NMR chemical shifts were referenced to DMSO-d_6 at 2.50 ppm or referenced to TMS at 0.00 ppm. ^{13}C NMR chemical shifts were referenced to DMSO-d_6 at 39.50 ppm. IR spectra were obtained as potassium bromide pellets or as liquid films on potassium bromide pellets with a Bruker Vector 22 spectrometer. High resolution mass spectra (HRMS) were recorded on an Agilent 6210 ESI/TOF mass spectrometer. Single-crystal X-ray diffraction data were measured by Bruker D8 Venture. The reactions were monitored by thin-layer chromatography (TLC) using 100–400 mesh silica gel plates (GF254) and were visualized using UV lamp (254 and 365 nm). All the starting materials were purchased from commercial suppliers and used without further purification.

General procedure for the synthesis of 4 and 6



The reactions were run with the following steps: (a) but-2-ynedioates **1** (0.5 mmol) and 4-aminoindoles **2** (0.5 mmol) were added into a 25 mL tube with 1.25 mL anhydrous DMSO (analytical reagent) and kept stirring at room temperature for suitable time (monitoring the reaction by thin layer chromatography, 10−30 min in this work). It was worth mentioning that the hydroamination reaction of **1** and **2** affords *Z*- and *E*-isomers. The hydroamination reaction of amines and but-2-ynedioates was studied in detail in our previous work,[1] including the influences of time, temperature, solvent and amine structures on the hydroamination, the influence of solvent on the regioselectivity of the hydroamination reaction, and the inter-conversion of the hydroamination regioselective products (*Z*- and *E*-isomers). (b) aldehydes **3** or isatins **5** (0.5 mmol) and H_2O (0.5 mL) were added into the above mixture sequentially and kept stirring at 80 °C (oil bath temperature) for 3 h. After the reactions were finished, the mixtures were cooled to room temperature, extracted with EtOAc three times. The organic phase was dried with anhydrous Na_2SO_4, filtered and evaporated under vacuum. The crude product was purified by column chromatography on silica gel (petroleum ether/DCM/EtOAc = 3:3:1 – 1:1:1 as eluent to yield products **4** and petroleum ether/EtOAc = 3:1–1:2 as eluent to yield products **6**).

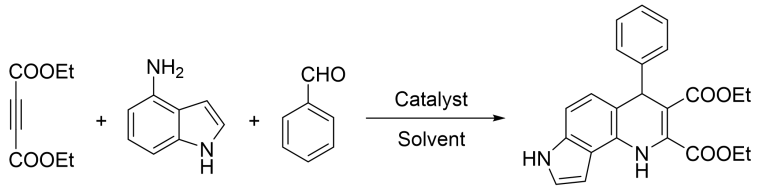
General procedure for the oxidation of dihydropyrrolo[2,3-*h*]quinoline ring of 4 into pyrrolo[2,3-*h*]quinoline ring



4a (1 equiv) **10a**

The reaction was run with the following steps: **4a** (0.5 mmol), $Cu(NO_3)_2$ (0.6 mmol) and MeOH (2 mL) were added into a 25 mL tube and kept stirring at room temperature for 3 h. After completion of the reaction, the product mixture was purified by column chromatography on silica gel (eluent: petroleum ether/EtOAc = 1:1) to afford the desired products **10a** in 94% yields.

Table S1 Optimization of reaction conditions for the 3CR synthesis of 4a[a]

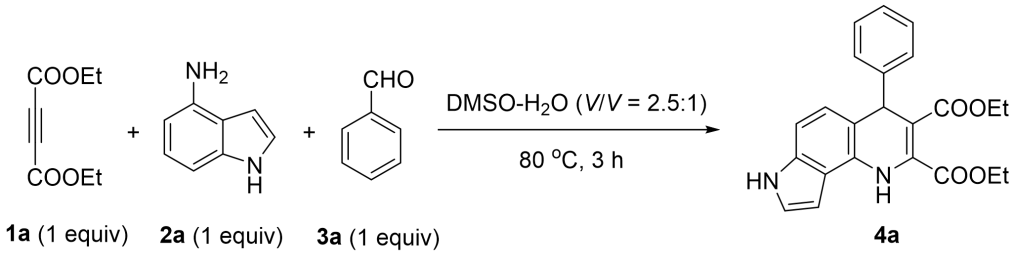


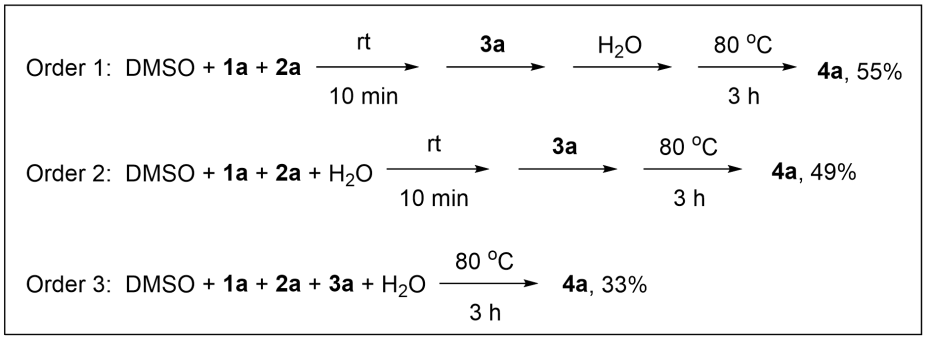
1a **2a** **3a** **4a**

Entry	Solvent[b]	Catalyst	*T* (°C)	*t* (h)	Yield[c] (%)
1	DMSO-H_2O (1:1)[d]		80	3	35
2	DMSO-H_2O (2:1)[d]		80	3	43
3	DMSO-H_2O (2.1:1)[d]		80	3	47
4	DMSO-H_2O (2.3:1)[d]		80	3	52
5	**DMSO-H_2O (2.5:1)**		**80**	**3**	**55**
6	DMSO-H_2O (3:1)		80	3	51
7	DMSO-H_2O (3.5:1)		80	3	47
8	DMSO-H_2O (4:1)		80	3	37
9	DMSO-H_2O (6:1)		80	3	37
10	DMSO-H_2O (9:1)		80	3	34
11	DMSO-H_2O (2.5:1)	AcOH	80	3	34
12	DMSO-H_2O (2.5:1)	TfOH	80	3	11
13	DMSO-H_2O (2.5:1)	$AlCl_3$	80	3	19
14	DMSO-H_2O (2.5:1)	$FeCl_3$	80	3	13

15	DMSO-H_2O (2.5:1)	$Cu(OAc)_2$	80	3	0
16	DMSO-H_2O (2.5:1)	$N(Et)_3$	80	3	0
17[e]	DMSO-H_2O (2.5:1)		80	3	47
18[f]	DMSO-H_2O (2.5:1)		80	3	53
19[g]	DMSO-H_2O (2.5:1)		80	3	49
20	DMSO-H_2O (2.5:1)		70	3	31
21	DMSO-H_2O (2.5:1)		90	3	48
22	DMSO-H_2O (2.5:1)		80	2	49
23	DMSO-H_2O (2.5:1)		80	4	54
24[h]	DMSO-H_2O (2.5:1)		80	3	54

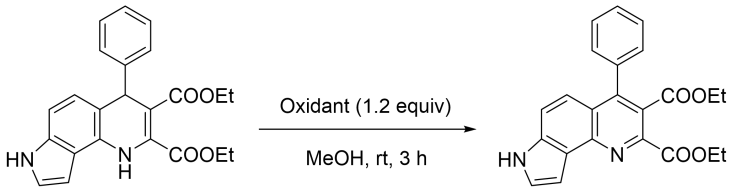
[a] Unless otherwise noted, reaction was carried out with **1a** (0.5 mmol), **2a** (0.5 mmol) and **3a** (0.5 mmol) without or with catalyst (0.05 mmol) in 1.75 mL solvent. [b] The data in parentheses is the ratio of volume. [c] Isolated yield. [d] The reactants were completely soluble in DMSO-H_2O mixtures except the DMSO-H_2O mixtures marked with superscript d. [e–g] Stoichiometry ratio of **1a**/**2a**/**3a** is 1/1/1.2, 1.2/1.2/1 and 1/1.2/1.2, respectively. [h] The reaction was under N_2 atmosphere.





Scheme S1 Screen of the addition order of reactants for the 3CR synthesis of 4a.

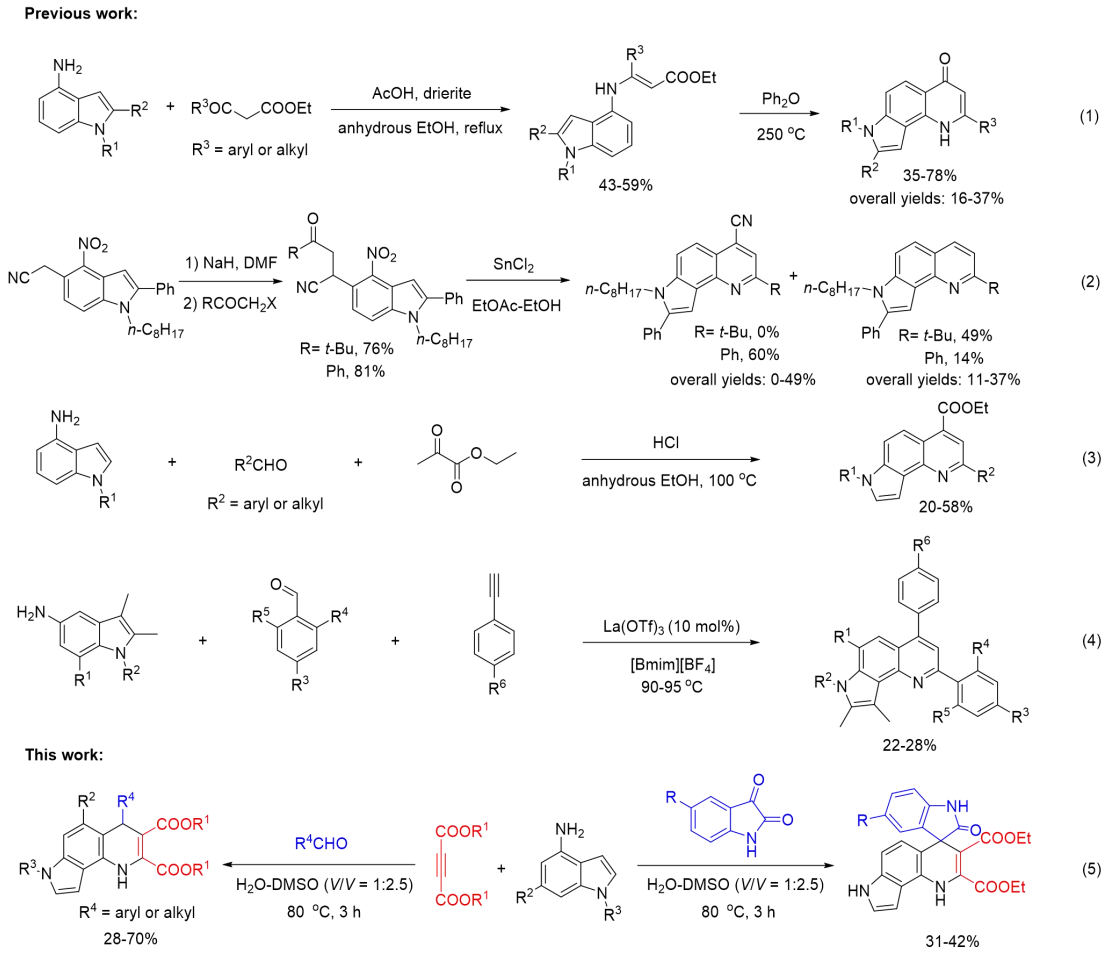
Table S2 Optimization of reaction conditions for the synthesis of 10a[a]



4a (1 equiv) **10a**

Entry	Oxidant	Yield[b] (%)
1	I_2	83
2	H_2O_2	17
3	$K_2S_2O_8$	62
4	TBHP	50
5	DTBP	21
6	**$Cu(NO_3)_2$**	**94**
7	$CuCl_2$	88
8	$Cu(OAc)_2$	55
9	$Cu(OTf)_2$	92
10	$FeCl_3$	90

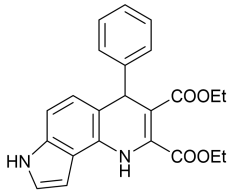
[a] Reaction was carried out with 0.5 mmol scale in 2 mL MeOH by using 1.2 equiv oxidant at room temperature for 3 h. [b] Isolated yield. TBHP = *tert*-butyl hydroperoxide. DTBP = di-*tert*-butyl peroxide.



Scheme S2 Reported methods for the synthesis of pyrrolo[2,3-*h*]quinolines[2] and the method in this work.

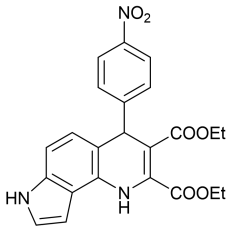
Characterization data of 4

Diethyl 4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4a)



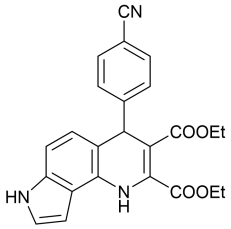
The title compound was obtained as yellow solid (107.9 mg, 55% yield); mp: 213–214 ºC; IR (KBr) ν_{max} = 3685, 3318, 3179, 2919, 2848, 1720, 1578, 1242, 1102, 755, 484 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.09 (s, 1H), 9.73 (s, 1H), 7.24 (m, 5H), 7.08 (m, 1H), 6.98 (d, J = 8.3 Hz, 1H), 6.85–6.74 (m, 2H), 5.12 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 3.97 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.62, 164.87, 148.89, 141.81, 135.40, 128.11, 127.09, 126.99, 125.79, 124.52, 122.46, 116.45, 112.85, 107.44, 98.61, 97.41, 61.44, 59.27, 41.87, 14.01, 13.70 ppm; HRMS (ESI) calculated for $C_{23}H_{22}N_2O_4$ $[M+Na]^+$: 413.1472; found: 413.1475.

Diethyl 4-(4-nitrophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4b)



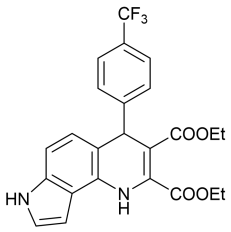
The title compound was obtained as yellow solid (126.5 mg, 58% yield); mp: 128–129 ºC; IR (KBr) ν_{max} = 3671, 3322, 2921, 2844, 1687, 1511, 1337, 1237, 1102, 752, 509 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.15 (s, 1H), 9.90 (s, 1H), 8.13 (d, J = 8.7 Hz, 2H), 7.47 (d, J = 8.7 Hz, 2H), 7.29 (t, J = 2.7 Hz, 1H), 7.00 (d, J = 8.3 Hz, 1H), 6.80 (m, 2H), 5.33 (s, 1H), 4.31 (q, J = 7.1 Hz, 2H), 3.97 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.28, 164.55, 155.97, 145.71, 142.36, 135.65, 128.19, 127.02, 124.85, 123.65, 122.39, 116.58, 111.47, 107.84, 98.69, 96.24, 61.59, 59.48, 41.92, 13.99, 13.69 ppm; HRMS (ESI) calculated for $C_{23}H_{21}N_3O_6$ $[M+Na]^+$: 458.1323; found: 458.1328.

Diethyl 4-(4-cyanophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4c)



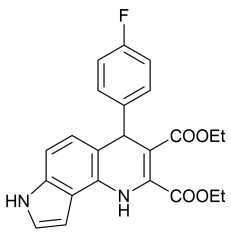
The title compound was obtained as yellow solid (145.6 mg, 70% yield); mp: 202–203 ºC; IR (KBr) ν_{max} = 3686, 3318, 3137, 2919, 2846, 2230, 1710, 1575, 1242, 1103, 873, 753, 498 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.15 (s, 1H), 9.88 (s, 1H), 7.77–7.66 (m, 2H), 7.49–7.36 (m, 2H), 7.33–7.26 (m, 1H), 7.01 (d, J = 8.3 Hz, 1H), 6.81 (m, 2H), 5.26 (s, 1H), 4.31 (q, J = 7.1 Hz, 2H), 4.05–3.92 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.33, 164.62, 154.00, 142.36, 135.62, 132.33, 127.99, 127.04, 124.82, 122.37, 118.91, 116.56, 111.68, 108.68, 107.81, 98.68, 96.33, 61.59, 59.46, 42.08, 14.00, 13.70 ppm; HRMS (ESI) calculated for $C_{24}H_{21}N_3O_4$ $[M+Na]^+$: 438.1424; found: 438.1426.

Diethyl 4-(4-(trifluoromethyl)phenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarbox ylate (4d)



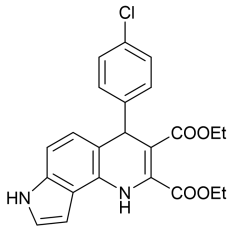
The title compound was obtained as yellow solid (149.0 mg, 65% yield); mp: 185–186 ºC; IR (KBr) ν_{max} = 3655, 3397, 2922, 1644, 1512, 1401, 1322, 1245, 1105, 755, 488 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.13 (s, 1H), 9.85 (s, 1H), 7.60 (d, J = 8.2 Hz, 2H), 7.43 (d, J = 8.1 Hz, 2H), 7.29 (t, J = 2.7 Hz, 1H), 7.00 (d, J = 8.3 Hz, 1H), 6.80 (m, 2H), 5.26 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 4.07–3.89 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.39, 164.66, 153.22, 142.20, 135.56, 127.75, 127.04, 126.39, 125.68, 125.24, 125.21, 125.17, 125.13, 124.74, 122.98, 122.38, 116.53, 111.96, 107.74, 98.66, 96.62, 61.55, 59.41, 41.84, 13.98, 13.69 ppm; HRMS (ESI) calculated for $C_{24}H_{21}F_3N_2O_4$ $[M+Na]^+$: 481.1346; found: 481.1347.

Diethyl 4-(4-fluorophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4e)



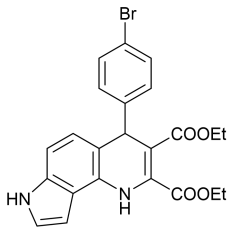
The title compound was obtained as yellow solid (136.8 mg, 67% yield); mp: 106–107 ºC; IR (KBr) ν_{max} = 3687, 3311, 3138, 2922, 1716, 1566, 1234 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.10 (s, 1H), 9.76 (s, 1H), 7.24 (m, 3H), 7.10–6.93 (m, 3H), 6.85–6.73 (m, 2H), 5.15 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 4.07–3.89 (m, 2H), 1.31 (t, J = 7.1 Hz, 3H), 1.10 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.54, 164.78, 145.19, 145.16, 141.81, 135.42, 128.72, 128.64, 127.04, 124.58, 122.41, 116.45, 114.88, 114.67, 112.67, 107.57, 98.62, 97.29, 61.48, 59.32, 41.08, 14.02, 13.70 ppm; HRMS (ESI) calculated for $C_{23}H_{21}FN_2O_4$ $[M+Na]^+$: 431.1378; found: 431.1375.

Diethyl 4-(4-chlorophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4f)



The title compound was obtained as yellow solid (121.9 mg, 57% yield); mp: 111–112 ºC; IR (KBr) ν_{max} = 3407, 2919, 2848, 1642, 1485, 1398, 1241, 1098, 754 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.11 (s, 1H), 9.79 (s, 1H), 7.25 (m, 5H), 6.99 (d, J = 8.3 Hz, 1H), 6.79 (m, 2H), 5.15 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 4.05–3.92 (m, 2H), 1.31 (t, J = 7.1 Hz, 3H), 1.10 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.48, 164.73, 147.82, 141.93, 135.48, 130.39, 128.82, 128.10, 127.05, 124.64, 122.39, 116.48, 112.34, 107.62, 98.64, 96.98, 61.50, 59.36, 41.29, 14.02, 13.69 ppm; HRMS (ESI) calculated for $C_{23}H_{21}ClN_2O_4$ $[M+Na]^+$: 447.1082; found: 447.1083.

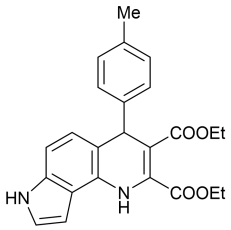
Diethyl 4-(4-bromophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4g)



The title compound was obtained as yellow solid (148.3 mg, 63% yield); mp: 114–115 ºC; IR (KBr) ν_{max} = 3677, 3333, 3191, 2918, 1649, 1488, 1396, 1241, 1091, 753, 503 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.11 (s, 1H), 9.78 (s, 1H), 7.41 (d, J = 8.3 Hz, 2H), 7.28 (t, J = 2.4 Hz, 1H), 7.15 (d, J = 8.3 Hz, 2H), 6.99 (d, J = 8.3 Hz, 1H), 6.78 (m, 2H), 5.13 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 3.98 (m, 2H), 1.31 (t, J = 7.1 Hz, 3H), 1.10 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.47, 164.71, 148.23, 141.92, 135.48, 131.01, 129.23, 127.03, 124.64, 122.38,

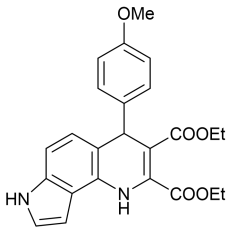
118.88, 116.47, 112.26, 107.62, 98.63, 96.91, 61.50, 59.36, 41.36, 14.02, 13.69 ppm; HRMS (ESI) calculated for $C_{23}H_{21}BrN_2O_4$ $[M+Na]^+$: 491.0577; found: 491.0582.

Diethyl 4-(*p*-tolyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4h)



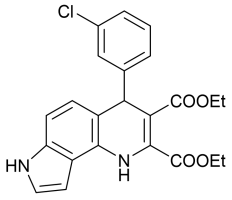
The title compound was obtained as yellow solid (101.1 mg, 50% yield); mp: 212–213 ºC; IR (KBr) ν_{max} = 3398, 2918, 2849, 1642, 1385, 1251, 1040, 755 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.07 (s, 1H), 9.68 (s, 1H), 7.26 (t, J = 2.7 Hz, 1H), 7.08 (d, J = 8.0 Hz, 2H), 6.98 (m, 3H), 6.81–6.71 (m, 2H), 5.07 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 3.97 (q, J = 7.1 Hz, 2H), 2.18 (s, 3H), 1.31 (t, J = 7.1 Hz, 3H), 1.10 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.65, 164.89, 146.05, 141.60, 135.35, 134.72, 128.64, 127.08, 126.90, 124.46, 122.46, 116.42, 113.01, 107.37, 98.59, 97.57, 61.41, 59.25, 41.43, 20.50, 14.03, 13.70 ppm; HRMS (ESI) calculated for $C_{24}H_{24}N_2O_4$ $[M+Na]^+$: 427.1628; found: 427.1633.

Diethyl 4-(4-methoxyphenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4i)



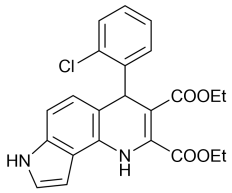
The title compound was obtained as yellow solid (90.1 mg, 43% yield); mp: 212–213 ºC; IR (KBr) ν_{max} = 3689, 3312, 3124, 2918, 1717, 1574, 1265, 755 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.07 (s, 1H), 9.68 (s, 1H), 7.26 (m, 1H), 7.10 (d, J = 8.4 Hz, 2H), 6.97 (d, J = 8.3 Hz, 1H), 6.77 (m, 4H), 5.06 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 3.98 (m, 2H), 3.65 (s, 3H), 1.31 (t, J = 7.1 Hz, 3H), 1.11 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.69, 164.91, 157.38, 141.48, 141.33, 135.33, 127.94, 127.08, 124.44, 122.47, 116.40, 113.47, 113.16, 107.38, 98.59, 97.73, 61.40, 59.25, 54.90, 40.95, 14.05, 13.71 ppm; HRMS (ESI) calculated for $C_{24}H_{24}N_2O_5$ $[M+Na]^+$: 443.1577; found: 443.1582.

Diethyl 4-(3-chlorophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4j)



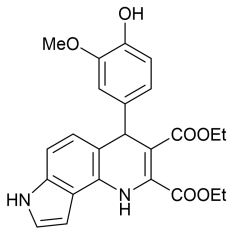
The title compound was obtained as yellow solid (132.0 mg, 62% yield); mp: 150–151 ºC; IR (KBr) ν_{max} = 3682, 3316, 2919, 1710, 1575, 1257, 1038, 755, 483 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.13 (s, 1H), 9.82 (s, 1H), 7.34–7.11 (m, 5H), 7.01 (d, J = 8.3 Hz, 1H), 6.90–6.73 (m, 2H), 5.16 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 3.99 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.10 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.41, 164.69, 151.19, 142.10, 135.52, 132.72, 130.13, 127.00, 126.75, 125.80, 125.74, 124.72, 122.38, 116.47, 112.17, 107.72, 98.62, 96.73, 61.55, 59.40, 41.57, 13.99, 13.69 ppm; HRMS (ESI) calculated for $C_{23}H_{21}ClN_2O_4$ $[M+Na]^+$: 447.1082; found: 447.1086.

Diethyl 4-(2-chlorophenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4k)



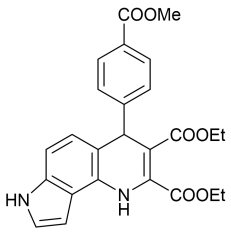
The title compound was obtained as yellow solid (108.5 mg, 51% yield); mp: 204–205 ºC; IR (KBr) ν_{max} = 3437, 2919, 1643, 1390, 1254, 1043, 754, 488 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.11 (s, 1H), 9.77 (s, 1H), 7.35 (d, J = 7.9 Hz, 1H), 7.33–7.25 (m, 2H), 7.21 (t, J = 7.5 Hz, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.96 (d, J = 8.4 Hz, 1H), 6.85 (d, J = 8.4 Hz, 1H), 6.78 (m, 1H), 5.75 (s, 1H), 4.31 (q, J = 7.1 Hz, 2H), 3.91 (q, J = 7.1 Hz, 2H), 1.33 (t, J = 7.1 Hz, 3H), 1.03 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.40, 164.70, 147.10, 142.68, 135.49, 130.12, 129.72, 128.82, 127.76, 127.41, 126.57, 124.68, 121.46, 116.60, 112.67, 107.64, 98.69, 96.97, 61.50, 59.24, 37.92, 13.86, 13.70 ppm; HRMS (ESI) calculated for $C_{23}H_{21}ClN_2O_4$ $[M+Na]^+$: 447.1082; found: 447.1086.

Diethyl 4-(4-hydroxy-3-methoxyphenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarb oxylate (4l)



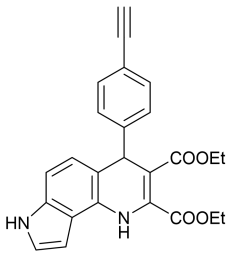
The title compound was obtained as orange red solid (78.6 mg, 36% yield); mp: 221–222 ºC;IR (KBr) ν_{max} = 3411, 3336, 2922, 1651, 1505, 1385, 1244, 1100, 1031, 754, 499 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.06 (s, 1H), 9.67 (s, 1H), 8.64 (s, 1H), 7.29–7.22 (m, 1H), 6.98 (d, J = 8.3 Hz, 1H), 6.89–6.81 (m, 2H), 6.79–6.73 (m, 1H), 6.59 (d, J = 8.1 Hz, 1H), 6.53 (m, 1H), 5.00 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 3.99 (m, 2H), 3.69 (s, 3H), 1.31 (t, J = 7.1 Hz, 3H), 1.12 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.78, 164.97, 146.97, 144.60, 141.48, 140.28, 135.30, 127.00, 124.39, 122.47, 119.37, 116.39, 115.27, 113.37, 111.37, 107.30, 98.59, 97.72, 61.39, 59.22, 55.47, 41.19, 14.09, 13.70 ppm; HRMS (ESI) calculated for $C_{24}H_{24}N_2O_6$ $[M+Na]^+$: 459.1527; found: 459.1531.

Diethyl 4-(4-(methoxycarbonyl)phenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4m)



The title compound was obtained as yellow solid (115.1 mg, 51% yield); mp: 204–205 ºC; IR (KBr) ν_{max} = 3681, 3322, 2921, 1707, 1606, 1501, 1431, 1371, 1275, 1103, 1024, 883, 756, 490 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.12 (s, 1H), 9.81 (s, 1H), 7.83 (d, J = 8.2 Hz, 2H), 7.36 (d, J = 8.2 Hz, 2H), 7.28 (t, J = 2.6 Hz, 1H), 6.99 (d, J = 8.3 Hz, 1H), 6.85–6.73 (m, 2H), 5.23 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 3.96 (m, 2H), 3.79 (s, 3H), 1.31 (t, J = 7.1 Hz, 3H), 1.08 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 166.07, 165.42, 164.69, 154.00, 142.12, 135.54, 129.25, 127.39, 127.27, 127.04, 124.70, 122.42, 116.52, 111.99, 107.65, 98.66, 96.69, 61.52, 59.36, 51.92, 42.02, 13.99, 13.69 ppm; HRMS (ESI) calculated for $C_{25}H_{24}N_2O_6$ $[M+Na]^+$: 471.1527; found: 471.1534.

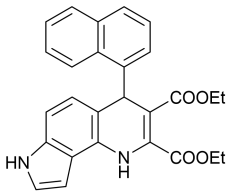
Diethyl 4-(4-ethynylphenyl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4n)



The title compound was obtained as light green solid (120.2 mg, 58% yield); mp: 196–197 ºC; IR (KBr) ν_{max} = 3683, 3312, 2916, 1707, 1582, 753, 492 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.11 (s, 1H), 9.78 (s, 1H), 7.34 (d, J = 8.2 Hz, 2H), 7.28 (t, J = 2.7 Hz, 1H), 7.21 (d, J = 8.2 Hz,

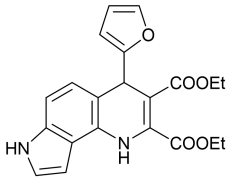
2H), 6.99 (d, J = 8.4 Hz, 1H), 6.79 (m, 2H), 5.15 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 4.05 (s, 1H), 4.03–3.90 (m, 2H), 1.31 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.48, 164.74, 149.65, 141.99, 135.49, 131.63, 127.31, 127.06, 124.64, 122.41, 119.19, 116.48, 112.25, 107.60, 98.63, 96.88, 83.48, 80.14, 61.50, 59.35, 41.78, 14.01, 13.69 ppm; HRMS (ESI) calculated for $C_{25}H_{22}N_2O_4$ $[M+Na]^+$: 437.1472; found: 437.1473.

Diethyl 4-(naphthalen-1-yl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4o)



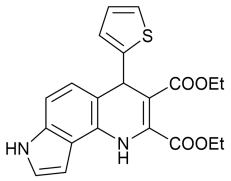
The title compound was obtained as dark yellow solid (72.7 mg, 33% yield); mp: 214–215 ºC; IR (KBr) ν_{max} = 3679, 3322, 2920, 2848, 1709, 1382, 1254, 1034, 756 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.04 (s, 1H), 9.76 (s, 1H), 8.69 (d, J = 8.6 Hz, 1H), 7.88 (d, J = 7.9 Hz, 1H), 7.68 (d, J = 7.6 Hz, 1H), 7.60 (t, J = 7.4 Hz, 1H), 7.50 (t, J = 7.4 Hz, 1H), 7.40 (m, 2H), 7.25 (m, 1H), 6.83 (m, 2H), 6.68 (d, J = 8.3 Hz, 1H), 6.09 (s, 1H), 4.32 (q, J = 7.1 Hz, 2H), 3.84–3.70 (m, 2H), 1.33 (t, J = 7.1 Hz, 3H), 0.80 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.73, 164.89, 147.00, 141.92, 135.30, 133.19, 129.99, 128.29, 126.48, 126.16, 125.93, 125.83, 125.32, 124.53, 124.04, 121.79, 116.59, 113.82, 107.18, 98.70, 98.46, 61.45, 59.08, 40.17, 13.72, 13.68 ppm; HRMS (ESI) calculated for $C_{27}H_{24}N_2O_4$ $[M+Na]^+$: 463.1628; found: 463.1632.

Diethyl 4-(furan-2-yl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4p)



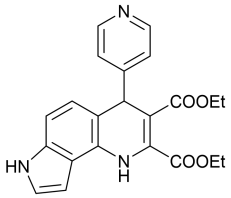
The title compound was obtained as yellow solid (93.4 mg, 49% yield); mp: 219–220 ºC; IR (KBr) ν_{max} = 3677, 3326, 2919, 1680, 1497, 1254, 1091, 875, 753, 488 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.13 (s, 1H), 9.80 (s, 1H), 7.39 (d, J = 0.8 Hz, 1H), 7.28 (t, J = 2.6 Hz, 1H), 7.05 (d, J = 8.3 Hz, 1H), 6.91 (d, J = 8.3 Hz, 1H), 6.76 (m, 1H), 6.25 (m, 1H), 5.90 (d, J = 3.1 Hz, 1H), 5.23 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 4.05 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.14 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.46, 164.66, 159.17, 142.49, 141.33, 135.66, 127.51, 124.62, 122.28, 116.51, 110.19, 109.90, 107.34, 103.90, 98.55, 94.01, 61.50, 59.34, 35.67, 14.11, 13.70 ppm; HRMS (ESI) calculated for $C_{21}H_{20}N_2O_5$ $[M+Na]^+$: 403.1264; found: 403.1266.

Diethyl 4-(thiophen-2-yl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4q)



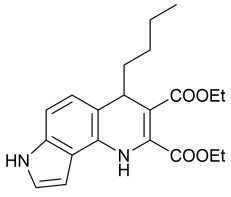
The title compound was obtained as light green solid (115.3 mg, 58% yield); mp: 236–237 ºC; IR (KBr) ν_{max} = 3681, 3326, 2920, 2848, 1708, 1262, 754, 487 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.14 (s, 1H), 9.88 (s, 1H), 7.29 (t, J = 2.7 Hz, 1H), 7.20 (m, 1H), 7.06 (d, J = 8.3 Hz, 1H), 6.92 (d, J = 8.4 Hz, 1H), 6.82 (m, 1H), 6.78 (m, 1H), 6.68 (d, J = 3.4 Hz, 1H), 5.42 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 4.06 (m, 2H), 1.31 (t, J = 7.1 Hz, 3H), 1.16 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.42, 164.64, 152.98, 141.66, 135.60, 127.26, 126.39, 124.63, 123.95, 122.48, 122.33, 116.40, 112.22, 107.60, 98.67, 96.95, 61.49, 59.44, 36.87, 14.12, 13.70 ppm; HRMS (ESI) calculated for $C_{21}H_{20}N_2O_4S$ $[M+Na]^+$: 419.1036; found: 419.1037.

Diethyl 4-(pyridin-4-yl)-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4r)



The title compound was obtained as yellow solid (86.5 mg, 44% yield); mp: 201–202 ºC; IR (KBr) ν_{max} = 3689, 3311, 3125, 2922, 1719, 1572, 1248, 754, 494 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.14 (s, 1H), 9.88 (s, 1H), 8.41 (m, 2H), 7.29 (t, J = 2.7 Hz, 1H), 7.20 (m, 2H), 7.01 (d, J = 8.3 Hz, 1H), 6.84 (d, J = 8.4 Hz, 1H), 6.78 (m, 1H), 5.17 (s, 1H), 4.31 (m, 2H), 3.98 (m, 2H), 1.32 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.30, 164.61, 156.42, 149.57, 142.56, 135.65, 127.10, 124.82, 122.26, 122.21, 116.53, 111.34, 107.78, 98.65, 95.82, 61.59, 59.46, 41.39, 14.00, 13.70 ppm; HRMS (ESI) calculated for $C_{22}H_{21}N_3O_4$ $[M+Na]^+$: 414.1424; found: 414.1429.

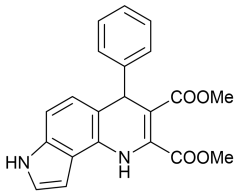
Diethyl 4-butyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4s)



The title compound was obtained as yellow solid (51.9 mg, 28% yield); mp: 129–130 ºC; IR (KBr) ν_{max} = 3677, 3312, 2917, 1710, 1258, 1041, 748, 623, 532, 457 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.05 (s, 1H), 9.49 (s, 1H), 7.29–7.20 (m, 1H), 7.09–6.98 (m, 1H), 6.80 (d, J = 8.3 Hz, 1H), 6.76–6.68 (m, 1H), 4.26 (m, 2H), 4.08 (m, 2H), 3.91 (t, J = 5.4 Hz, 1H), 1.43 (m, 2H),

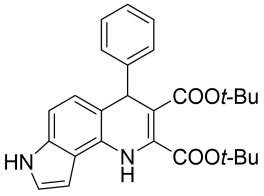
1.30 (t, J = 7.1 Hz, 3H), 1.26–1.11 (m, 6H), 1.03 (m, 1H), 0.76 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.80, 165.03, 142.40, 135.42, 128.31, 124.24, 121.95, 116.27, 112.37, 106.82, 98.38, 97.05, 61.29, 59.20, 38.47, 35.54, 26.70, 22.23, 14.20, 14.00, 13.70 ppm; HRMS (ESI) calculated for $C_{21}H_{26}N_2O_4$ $[M+Na]^+$: 393.1785; found: 393.1791.

Dimethyl 4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4t)



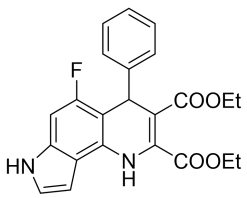
The title compound was obtained as orange red solid (94.8 mg, 52% yield); mp: 226–227 ºC; IR (KBr) ν_{max} = 3674, 3332, 2921, 2849, 1697, 1389, 1039, 756, 608 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.10 (s, 1H), 9.82 (s, 1H), 7.30–7.26 (m, 1H), 7.25–7.17 (m, 4H), 7.11–7.05 (m, 1H), 7.00 (d, J = 8.3 Hz, 1H), 6.84 (d, J = 8.4 Hz, 1H), 6.76 (m, 1H), 5.13 (s, 1H), 3.85 (s, 3H), 3.53 (s, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 166.13, 165.37, 148.71, 141.97, 135.41, 128.21, 126.96, 126.81, 125.86, 124.62, 122.41, 116.49, 112.98, 107.55, 98.52, 97.18, 52.59, 51.02, 41.71 ppm; HRMS (ESI) calculated for $C_{21}H_{18}N_2O_4$ $[M+Na]^+$: 385.1159; found: 385.1159.

Di-*tert*-butyl 4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4u)



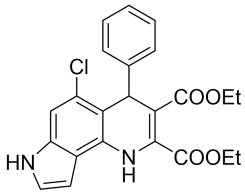
The title compound was obtained as light yellow solid (100.5 mg, 45% yield); mp: 189–190 ºC; IR (KBr) ν_{max} = 3427, 3370, 2974, 2925, 1711, 1629, 1580, 1244, 1164, 1105, 847, 702 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.04 (s, 1H), 9.36 (s, 1H), 7.27–7.18 (m, 5H), 7.09 (m, 1H), 6.94 (d, J = 8.3 Hz, 1H), 6.87 (m, 1H), 6.75 (d, J = 8.4 Hz, 1H), 5.06 (s, 1H), 1.53 (s, 9H), 1.26 (s, 9H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.48, 163.81, 149.34, 141.50, 135.39, 127.95, 127.33, 127.18, 125.70, 124.17, 122.64, 116.42, 112.82, 106.97, 99.81, 99.06, 81.80, 78.60, 42.76, 27.74, 27.71 ppm; HRMS (ESI) calculated for $C_{27}H_{30}N_2O_4$ $[M+H]^+$: 447.2278; found: 447.2268.

Diethyl 5-fluoro-4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4v)



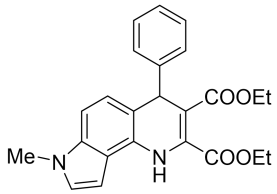
The title compound was obtained as yellow brown solid (87.5 mg, 43% yield); mp: 238–239 ºC; IR (KBr) ν_{max} = 3417, 3292, 2983, 2911, 1721, 1681, 1622, 1500, 1437, 1319, 1230, 1114, 756, 710 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.16 (s, 1H), 9.96 (s, 1H), 7.28–7.25 (m, 1H), 7.25–7.17 (m, 4H), 7.12 (m, 1H), 6.84–6.75 (m, 2H), 5.25 (s, 1H), 4.29 (q, J = 7.1 Hz, 2H), 4.06–3.95 (m, 2H), 1.30 (t, J = 7.1 Hz, 3H), 1.13 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.30, 164.54, 157.41, 155.08, 147.27, 141.46, 134.56, 134.42, 128.44, 128.35, 128.12, 127.21, 126.16, 124.70, 124.67, 112.82, 102.46, 102.23, 98.78, 98.26, 92.90, 92.64, 61.60, 59.58, 36.15, 36.12, 14.00, 13.68 ppm; HRMS (ESI) calculated for $C_{23}H_{21}FN_2O_4$ $[M+H]^+$: 409.1558; found: 409.1546.

Diethyl 5-chloro-4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4w)



The title compound was obtained as light yellow solid (102.0 mg, 48% yield); mp: 282–283 ºC; IR (KBr) ν_{max} = 3335, 3288, 2982, 2905, 1726, 1621, 1528, 1481, 1312, 1230, 1119, 756, 698 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.24 (s, 1H), 9.95 (s, 1H), 7.37–7.32 (m, 1H), 7.23–7.07 (m, 6H), 6.86 (m, 1H), 5.35 (s, 1H), 4.27 (q, J = 7.1 Hz, 2H), 4.11–3.99 (m, 2H), 1.29 (t, J = 7.1 Hz, 3H), 1.17 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.26, 164.46, 146.64, 140.97, 135.28, 129.53, 127.99, 127.73, 126.11, 126.02, 125.49, 115.64, 110.04, 107.54, 99.01, 98.94, 61.59, 59.66, 54.87, 14.05, 13.66 ppm; HRMS (ESI) calculated for $C_{23}H_{21}ClN_2O_4$ $[M+H]^+$: 425.1263; found: 425.1251.

Diethyl 7-methyl-4-phenyl-4,7-dihydro-1*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (4x)

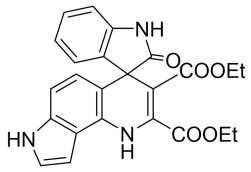


The title compound was obtained as yellow solid (89.0 mg, 44% yield); mp: 149–150 ºC; IR (KBr) ν_{max} = 3348, 2979, 2916, 1710, 1625, 1491, 1368, 1246, 1100, 1021, 771, 706 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 9.74 (s, 1H), 7.22 (m, 5H), 7.08 (m, 1H), 7.00 (d, J = 8.4 Hz, 1H), 6.87 (d, J = 8.4 Hz, 1H), 6.76 (d, J = 3.0 Hz, 1H), 5.14 (s, 1H), 4.30 (q, J = 7.1 Hz, 2H), 3.97 (m, 2H), 3.70 (s, 3H), 1.31 (t, J = 7.1 Hz, 3H), 1.09 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 165.60, 164.83, 148.82, 141.72, 135.93, 128.78, 128.12, 127.24, 126.99, 125.83, 122.61, 116.64,

113.16, 105.72, 97.83, 97.60, 61.48, 59.32, 41.82, 32.55, 14.01, 13.70 ppm; HRMS (ESI) calculated for $C_{24}H_{24}N_2O_4$ $[M+H]^+$: 405.1809; found: 405.1798.

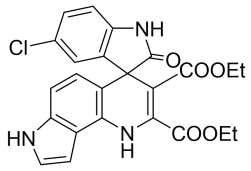
Characterization data of 6

Diethyl 2-oxo-1',7'-dihydrospiro[indoline-3,4'-pyrrolo[2,3-*h*]quinoline]-2',3'-dicarboxylate (6a)



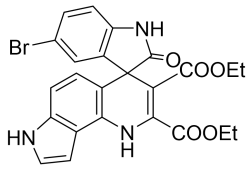
The title compound was obtained as yellow solid (82.5 mg, 38% yield); mp: 275–276 ºC; IR (KBr) ν_{max} = 3677, 3312, 1702, 1586, 1267, 899, 752 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.14 (s, 1H), 10.28 (s, 1H), 9.87 (s, 1H), 7.29 (m, 1H), 7.12 (t, J = 7.4 Hz, 1H), 6.99–6.73 (m, 5H), 6.28 (d, J = 8.5 Hz, 1H), 4.31 (q, J = 7.1 Hz, 2H), 3.82–3.70 (m, 2H), 1.33 (t, J = 7.1 Hz, 3H), 0.86 (t, J = 7.0 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 181.29, 164.78, 164.43, 143.17, 141.08, 141.02, 135.47, 127.45, 126.55, 124.86, 123.58, 121.69, 119.57, 116.48, 110.87, 108.93, 107.85, 98.86, 95.16, 61.60, 59.27, 52.17, 13.71, 13.29 ppm; HRMS (ESI) calculated for $C_{24}H_{21}N_3O_5$ $[M+Na]^+$: 454.1373; found: 454.1378.

Diethyl 5-chloro-2-oxo-1',7'-dihydrospiro[indoline-3,4'-pyrrolo[2,3-*h*]quinoline]-2',3'-dicarboxylate (6b)



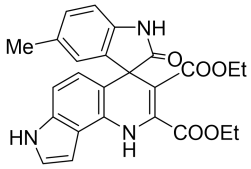
The title compound was obtained as yellow solid (97.8 mg, 42% yield); mp: 187–188 ºC; IR (KBr) ν_{max} = 3687, 3312, 2997, 1712, 1561, 1268, 907, 752 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6) δ = 11.20 (s, 1H), 10.46 (s, 1H), 9.99 (s, 1H), 7.32 (s, 1H), 7.19 (d, J = 8.2 Hz, 1H), 6.95–6.80 (m, 4H), 6.27 (d, J = 8.6 Hz, 1H), 4.32 (q, J = 7.0 Hz, 2H), 3.87–3.72 (m, 2H), 1.34 (t, J = 7.0 Hz, 3H), 0.90 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 180.94, 164.61, 164.23, 143.49, 142.75, 140.12, 135.59, 127.45, 126.47, 125.46, 125.07, 123.43, 119.26, 116.57, 110.53, 110.12, 108.18, 98.92, 94.37, 61.71, 59.47, 52.48, 13.70, 13.32 ppm; HRMS (ESI) calculated for $C_{24}H_{20}ClN_3O_5$ $[M+Na]^+$: 488.0984; found: 488.0987.

Diethyl 5-bromo-2-oxo-1',7'-dihydrospiro[indoline-3,4'-pyrrolo[2,3-*h*]quinoline]-2',3'-dicarboxylate (6c)



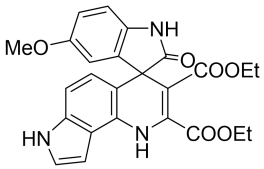
The title compound was obtained as brown solid (100.5 mg, 39% yield); mp: 200–201 ºC; IR (KBr) ν_{max} = 3678, 3314, 1698, 1585, 1452, 1258, 1103, 751 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.21 (s, 1H), 10.48 (s, 1H), 10.00 (s, 1H), 7.32 (d, J = 4.7 Hz, 2H), 6.93 (d, J = 4.2 Hz, 2H), 6.83 (m, 2H), 6.28 (d, J = 8.5 Hz, 1H), 4.32 (q, J = 6.9 Hz, 2H), 3.81 (m, 2H), 1.34 (t, J = 7.0 Hz, 3H), 0.90 (t, J = 6.9 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 180.81, 164.60, 164.23, 143.51, 143.15, 140.52, 135.59, 130.33, 126.46, 126.11, 125.10, 119.26, 116.57, 113.15, 111.13, 110.13, 108.22, 98.93, 94.36, 61.73, 59.50, 52.44, 13.71, 13.33 ppm; HRMS (ESI) calculated for $C_{24}H_{20}BrN_3O_5$ [M+Na]$^+$: 532.0479; found: 532.0484.

Diethyl 5-methyl-2-oxo-1',7'-dihydrospiro[indoline-3,4'-pyrrolo[2,3-*h*]quinoline]-2',3'-dicar boxylate (6d)



The title compound was obtained as brown solid (69.2 mg, 31% yield); mp: 209–210 ºC; IR (KBr) ν_{max} = 3685, 3318, 1695, 1588, 1472, 1258, 1099, 745 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.15 (s, 1H), 10.19 (s, 1H), 9.86 (s, 1H), 7.29 (s, 1H), 6.90 (m, 2H), 6.81 (s, 1H), 6.77–6.63 (m, 2H), 6.27 (d, J = 8.5 Hz, 1H), 4.31 (m, 2H), 3.84–3.67 (m, 2H), 2.14 (s, 3H), 1.34 (t, J = 7.0 Hz, 3H), 0.88 (t, J = 6.9 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 181.28, 164.79, 164.45, 143.11, 141.17, 138.60, 135.43, 130.33, 127.69, 126.49, 124.82, 124.16, 119.63, 116.44, 111.01, 108.68, 107.82, 98.83, 95.20, 61.58, 59.27, 52.20, 20.57, 13.70, 13.28 ppm; HRMS (ESI) calculated for $C_{25}H_{23}N_3O_5$ [M+Na]$^+$: 468.1530; found: 468.1532.

Diethyl 5-methoxy-2-oxo-1',7'-dihydrospiro[indoline-3,4'-pyrrolo[2,3-*h*]quinoline]-2',3'-dica rboxylate (6e)

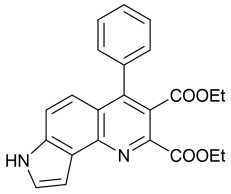


The title compound was obtained as brown solid (73.8 mg, 32% yield); mp: 196–197 ºC; IR (KBr) ν_{max} = 3686, 3308, 2928, 1701, 1583, 1471, 1270, 751 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.15 (s, 1H), 10.12 (s, 1H), 9.86 (s, 1H), 7.29 (s, 1H), 6.90 (d, J = 8.5 Hz, 1H), 6.83–6.66 (m,

3H), 6.42 (s, 1H), 6.28 (d, J = 8.5 Hz, 1H), 4.38–4.26 (m, 2H), 3.82–3.71 (m, 2H), 3.59 (s, 3H), 1.33 (t, J = 7.0 Hz, 3H), 0.88 (t, J = 7.0 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 181.12, 164.76, 164.41, 154.93, 143.13, 142.23, 135.49, 134.57, 126.49, 124.85, 119.60, 116.48, 111.76, 110.85, 110.63, 109.25, 107.86, 98.87, 95.15, 61.60, 59.29, 55.29, 52.65, 13.69, 13.30 ppm; HRMS (ESI) calculated for $C_{25}H_{23}N_3O_6$ [M+Na]$^+$: 484.1479; found: 484.1481.

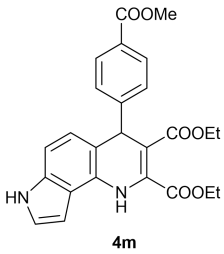
Characterization data of 10a

Diethyl 4-phenyl-7*H*-pyrrolo[2,3-*h*]quinoline-2,3-dicarboxylate (10a)

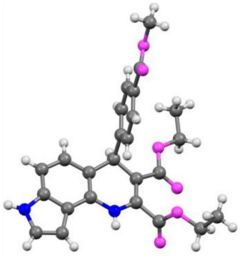


The title compound was obtained as green oil (182.6 mg, 94% yield); IR (KBr) ν_{max} = 3329, 2980, 2399, 1723, 1542, 1408, 1354, 1245, 1164, 1093, 1019, 751 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6) δ = 11.95 (s, 1H), 7.81 (d, J = 9.0 Hz, 1H), 7.65–7.46 (m, 4H), 7.35 (m, 2H), 7.27–7.10 (m, 2H), 4.40 (q, J = 7.1 Hz, 2H), 4.04–3.88 (m, 2H), 1.35 (t, J = 7.1 Hz, 3H), 0.89 (t, J = 7.1 Hz, 3H) ppm; ^{13}C NMR (101 MHz, DMSO-d_6) δ = 166.71, 165.57, 147.35, 144.69, 142.65, 135.73, 135.56, 129.11, 128.41, 128.18, 125.44, 123.58, 123.52, 121.77, 118.75, 117.27, 102.33, 61.71, 60.88, 13.93, 13.35 ppm; HRMS (ESI) calculated for $C_{23}H_{20}N_2O_4$ [M+Na]$^+$: 411.1315; found: 411.1317.

Crystallographic information of 4m (CCDC: 1918956)

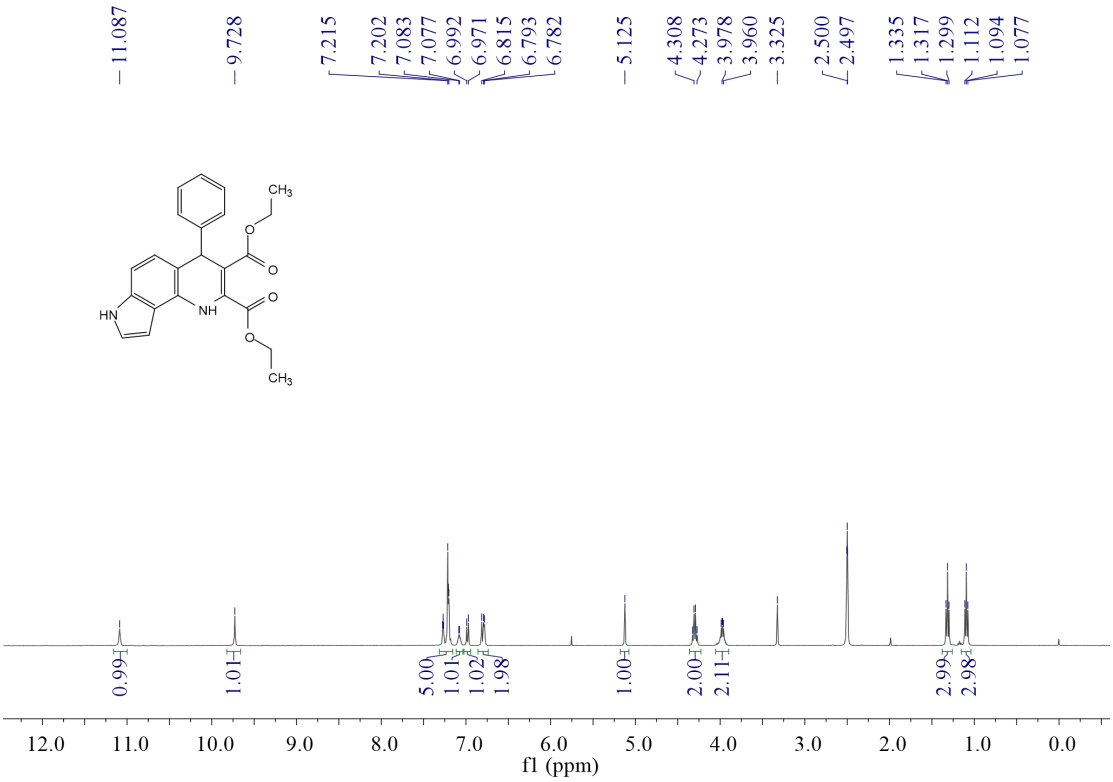


4m

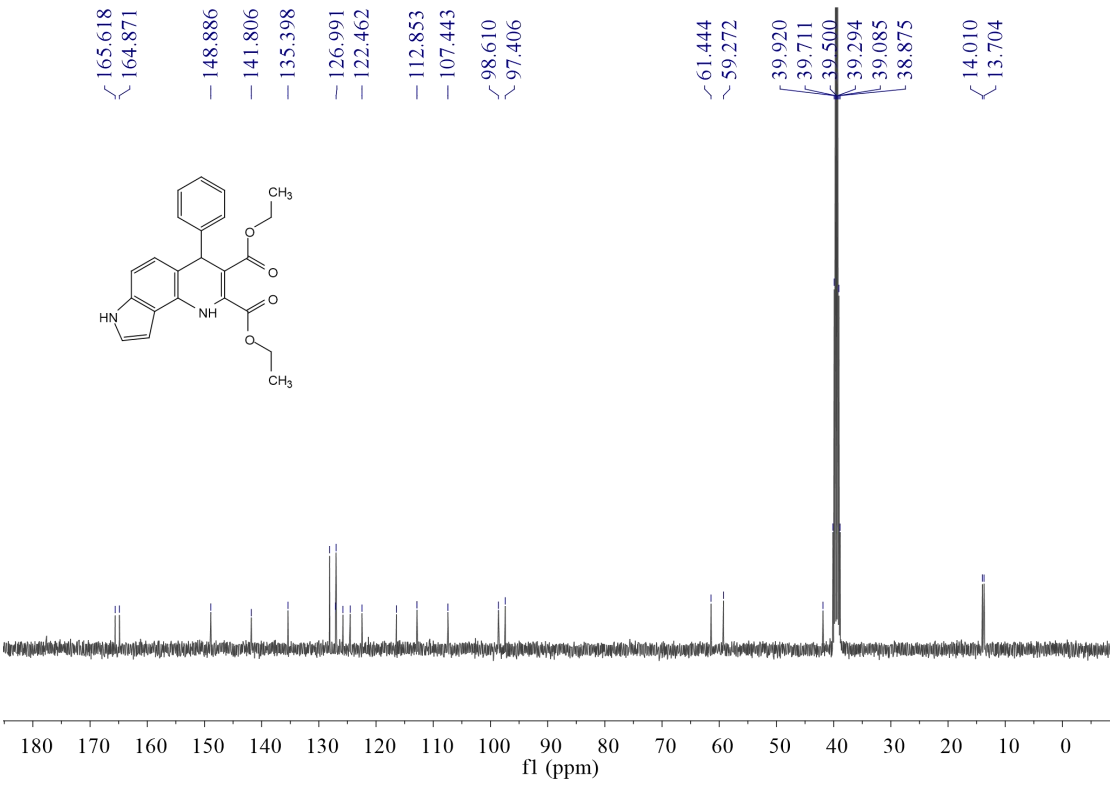


T^{u} [K]	296
crystal system	Monoclinic
space group	$P12/n1$
a [Å]	15.0700 (17)
b [Å]	11.1664 (12)
c [Å]	15.3653 (17)
α [Å]	90
β [deg]	97.227 (2)
γ [deg]	90
V [Å^3]	2565.1 (5)
Z	4
D_{calcu} [mg/m^3]	1.161
R	0.0549
wR_2	0.1748

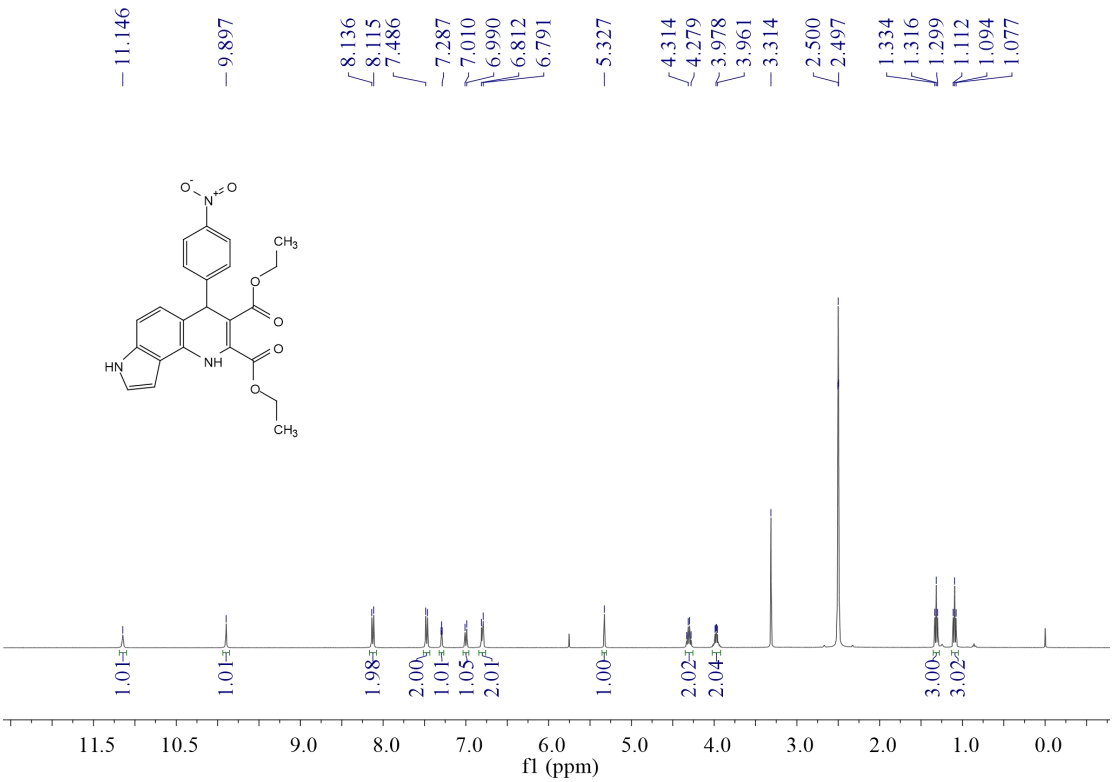
^{1}H and ^{13}C NMR spectra of products



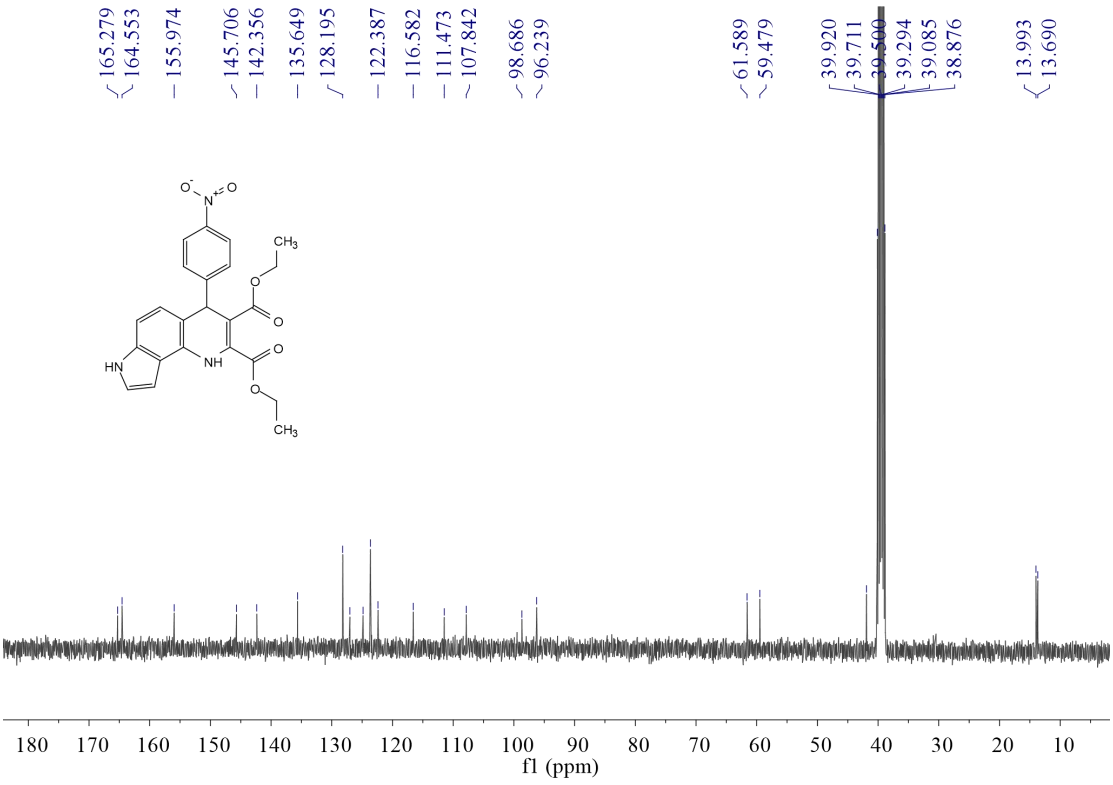
^{1}H NMR spectra of compound **4a**



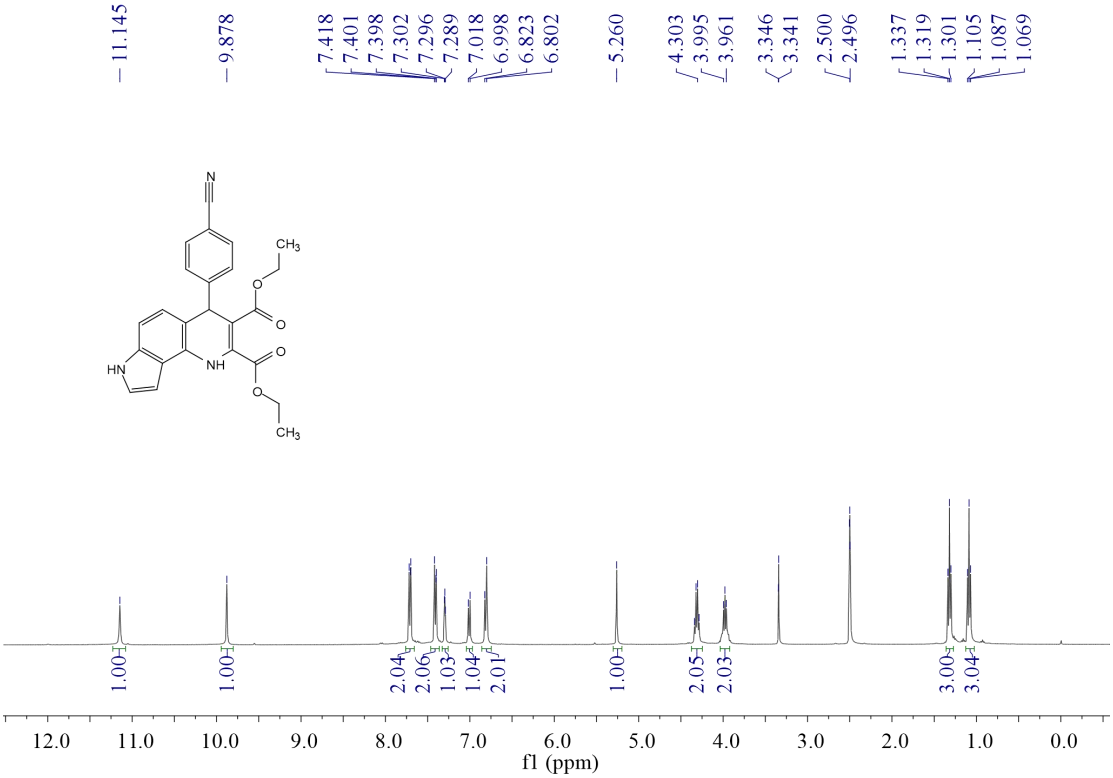
^{13}C NMR spectra of compound **4a**



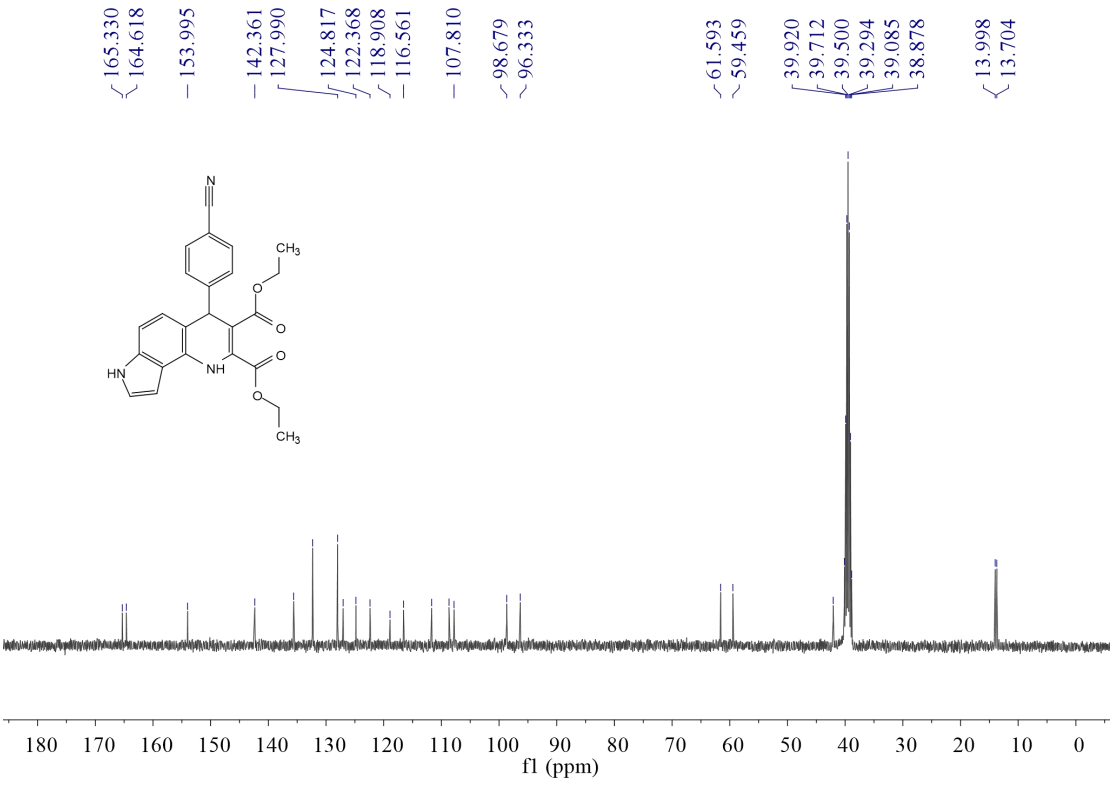
^{1}H NMR spectra of compound **4b**



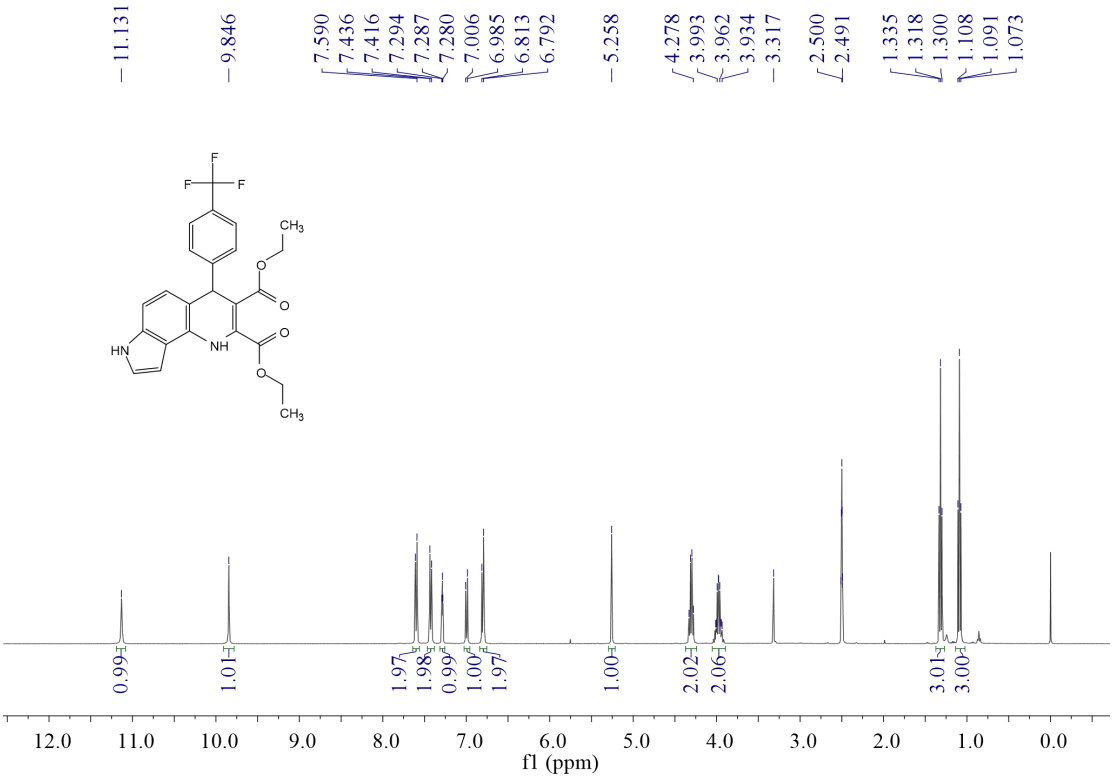
^{13}C NMR spectra of compound **4b**



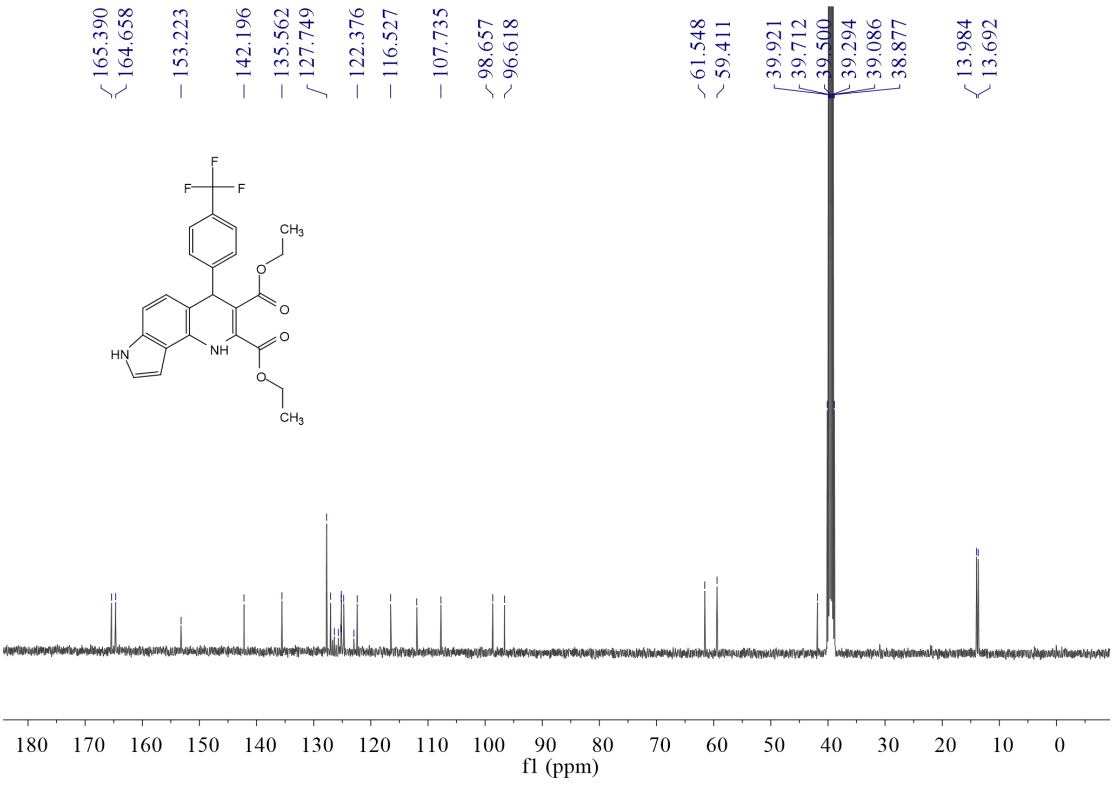
^{1}H NMR spectra of compound **4c**



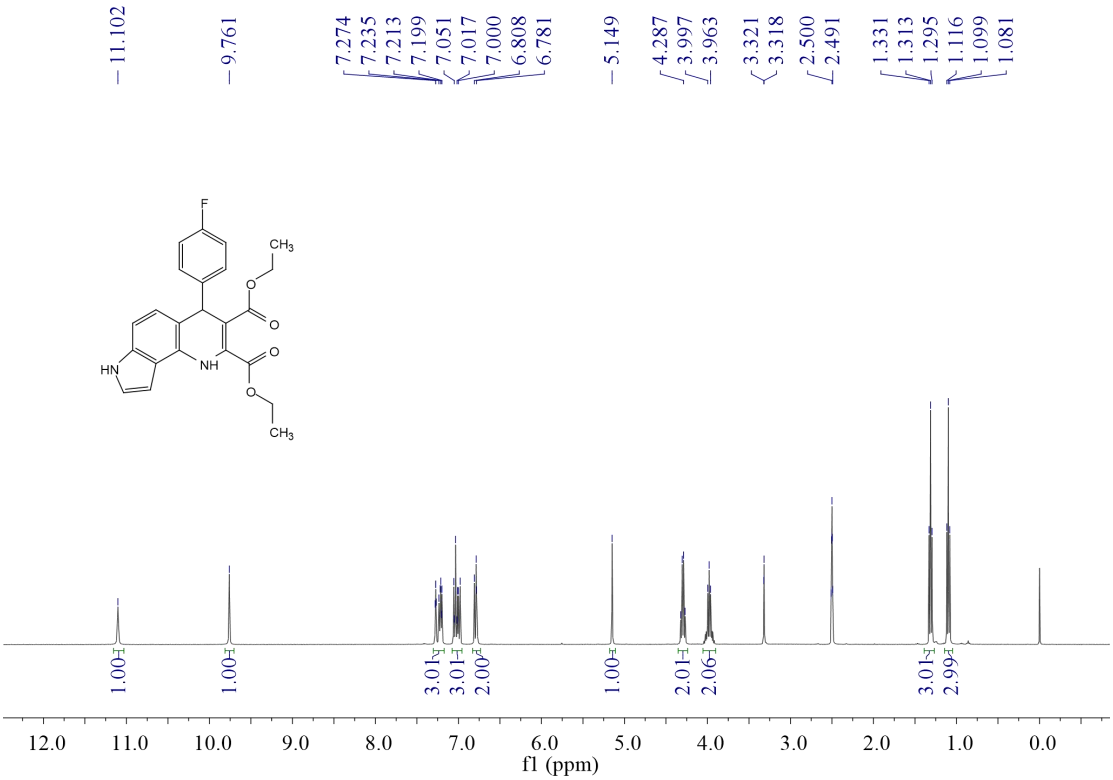
^{13}C NMR spectra of compound **4c**



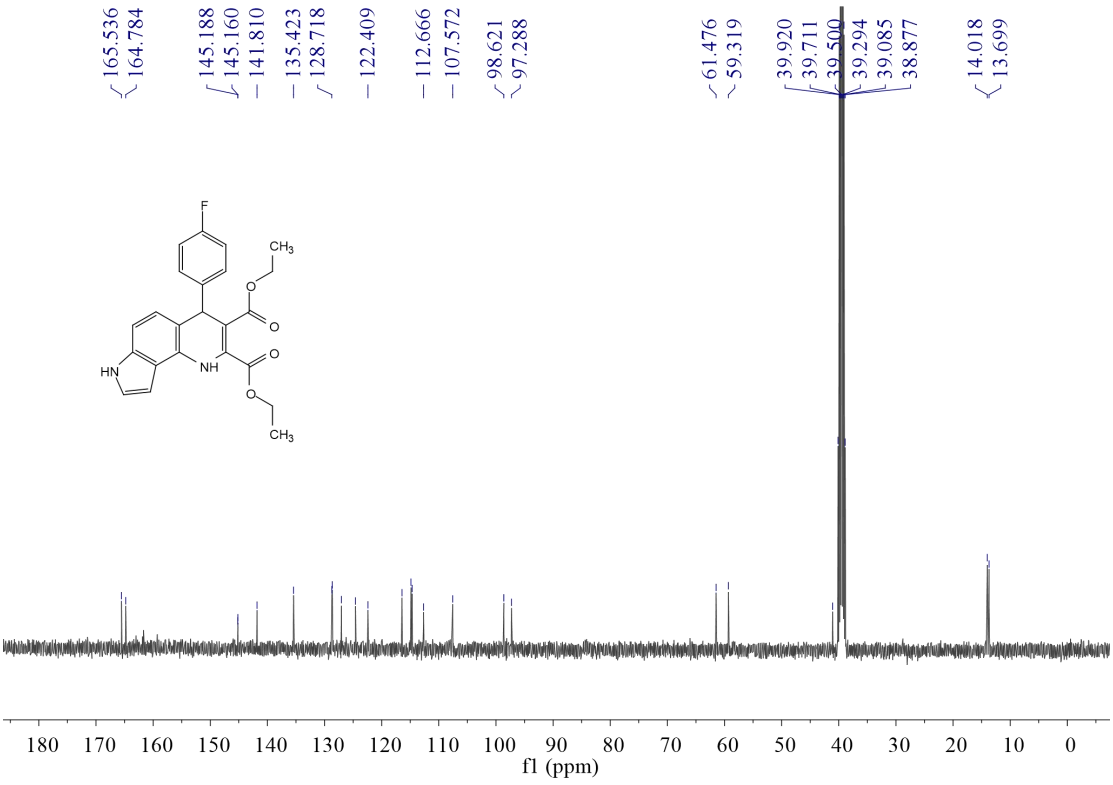
^{1}H NMR spectra of compound **4d**



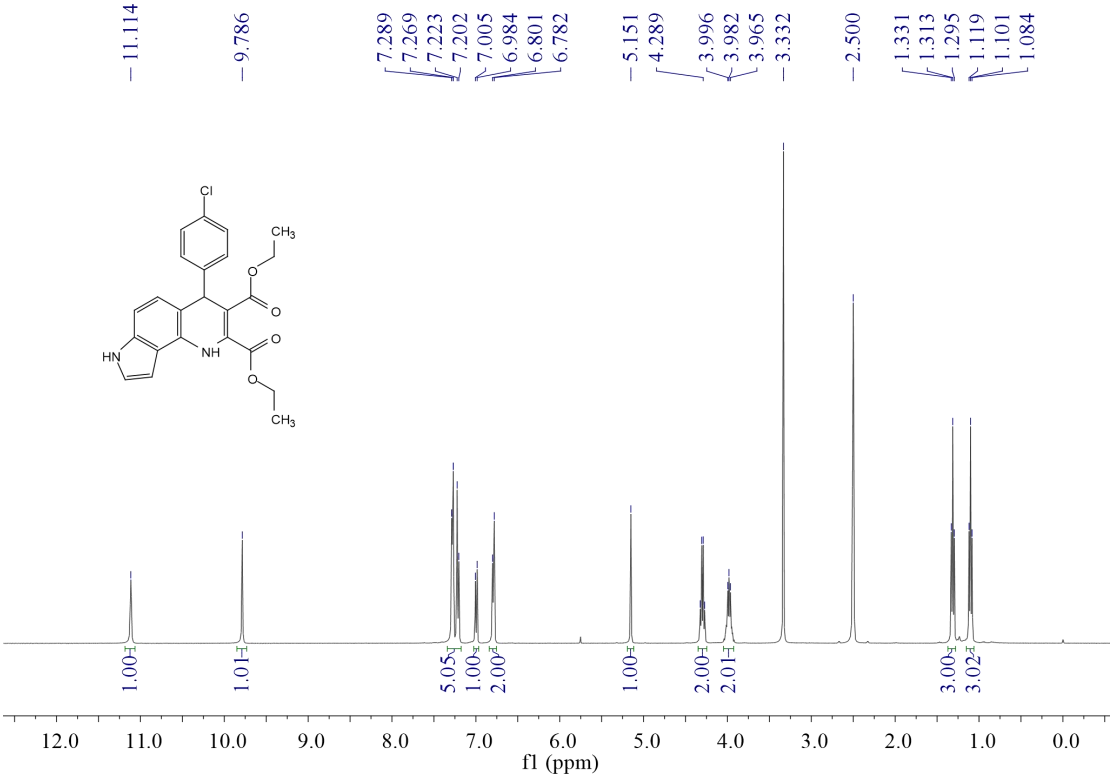
^{13}C NMR spectra of compound **4d**



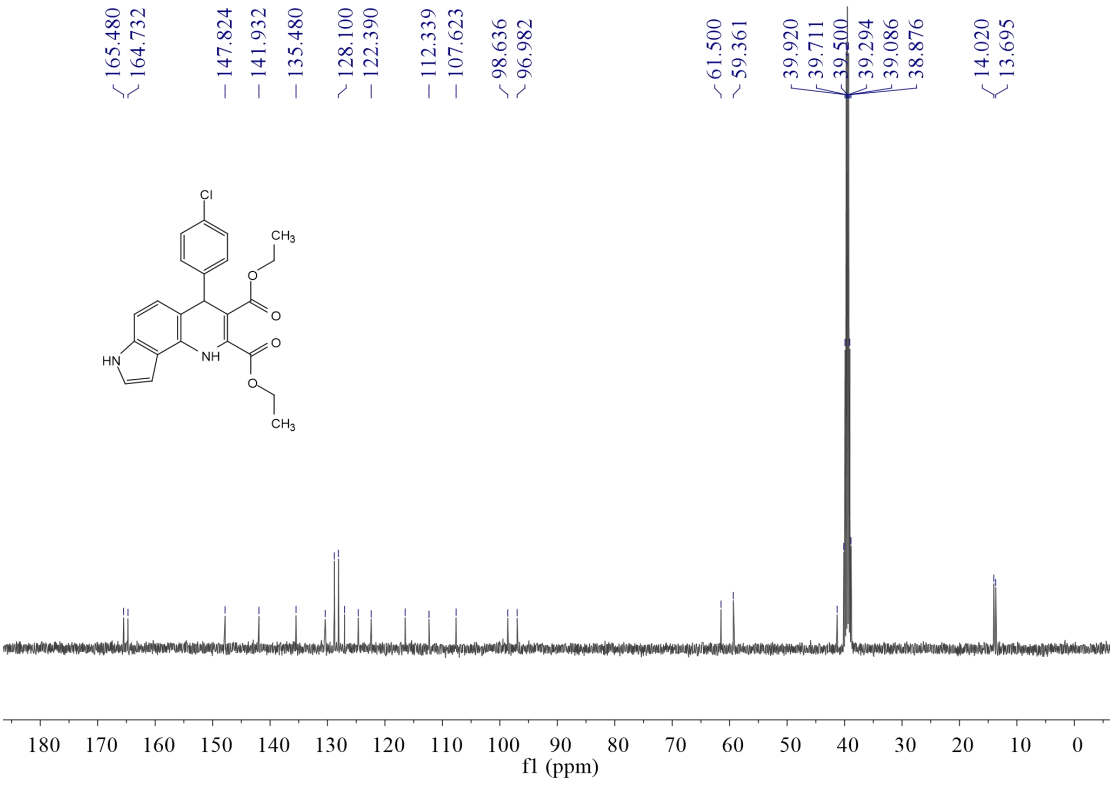
^{1}H NMR spectra of compound **4e**



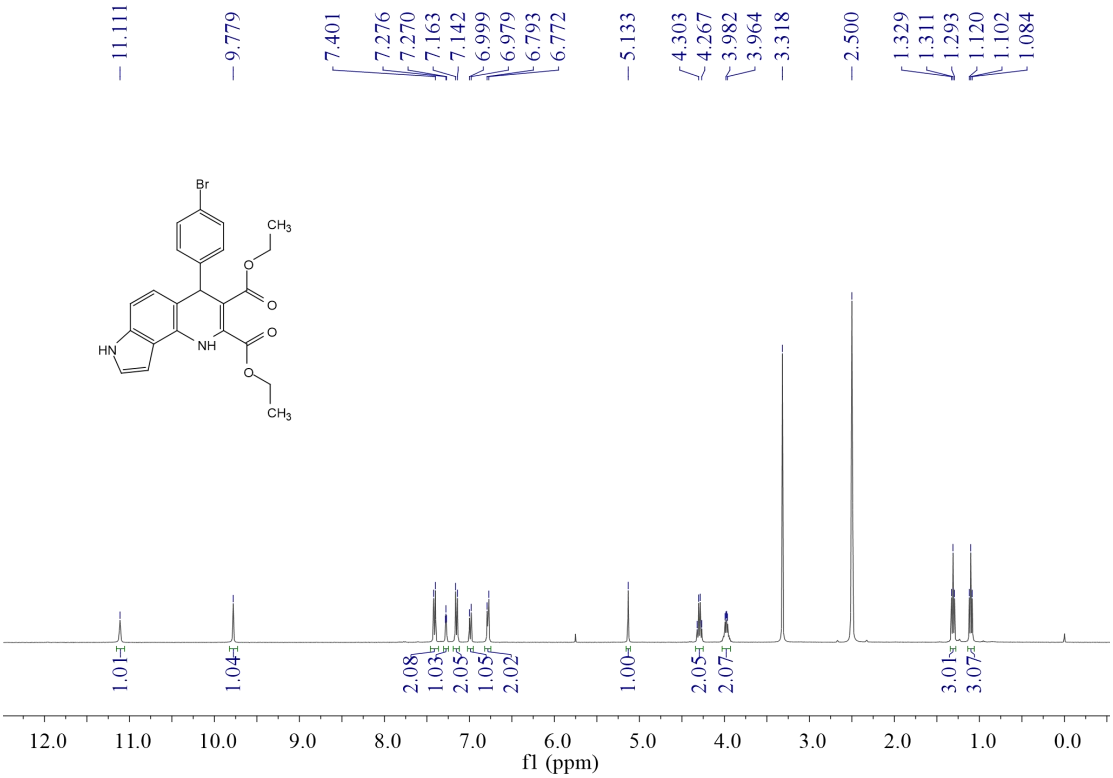
^{13}C NMR spectra of compound **4e**



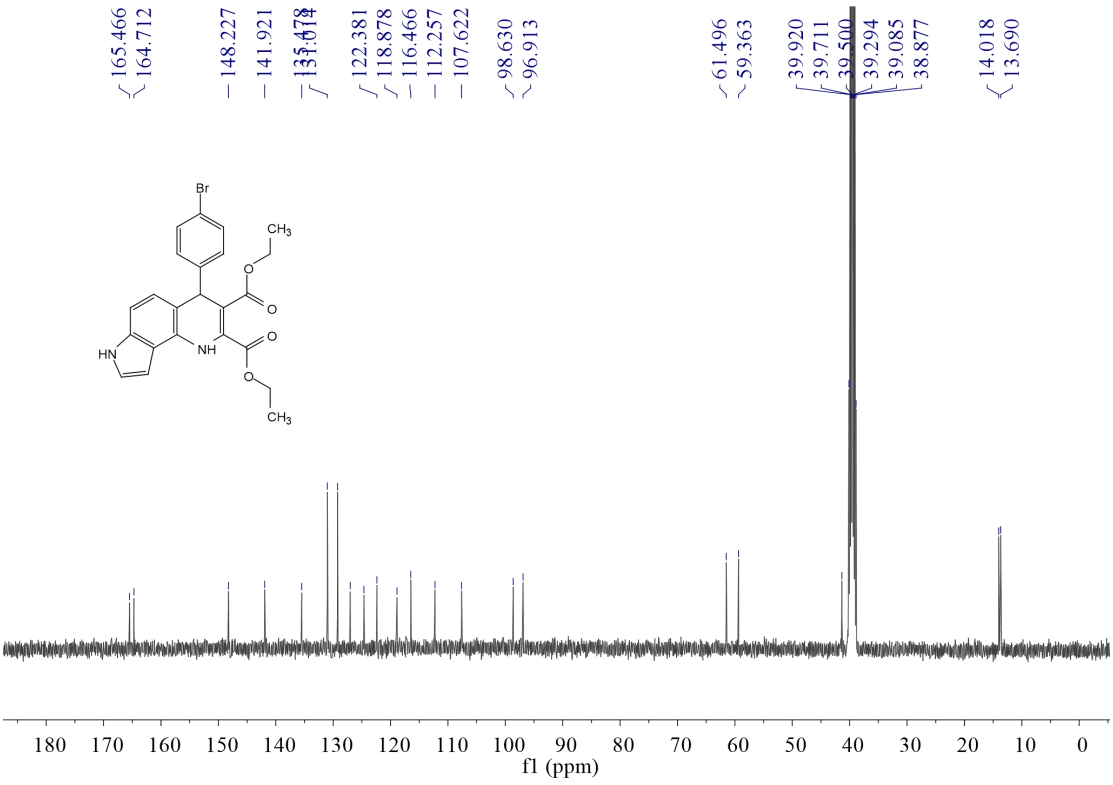
^{1}H NMR spectra of compound **4f**



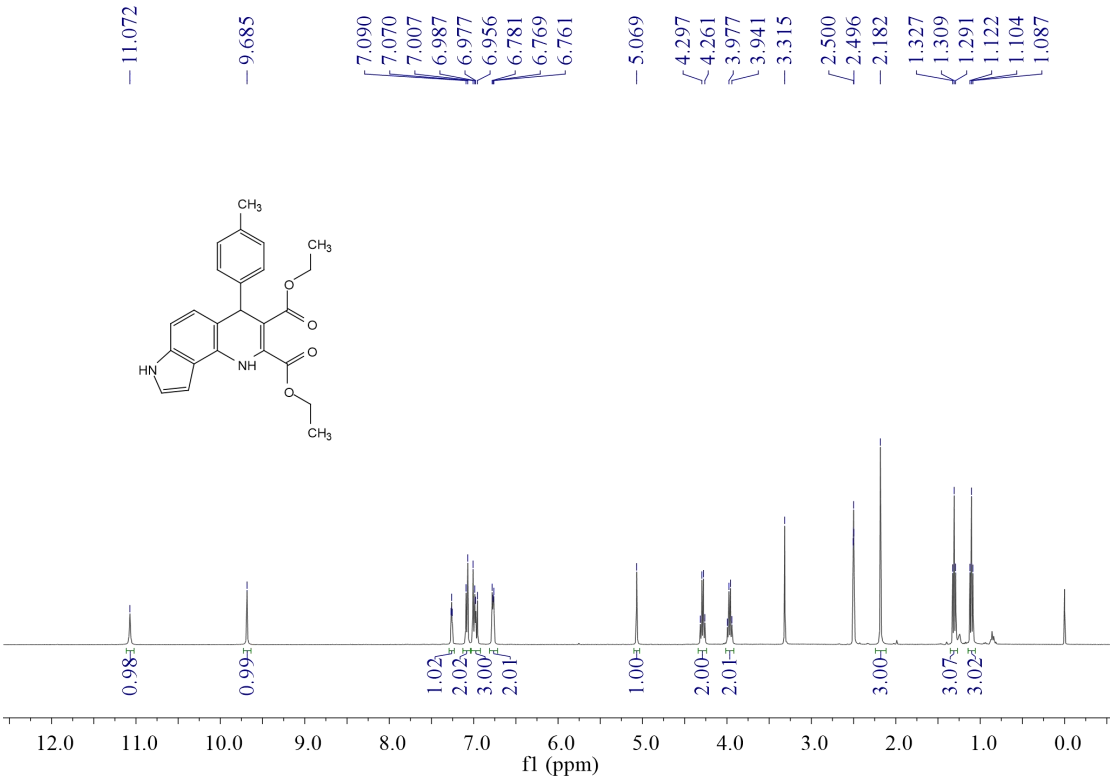
^{13}C NMR spectra of compound **4f**



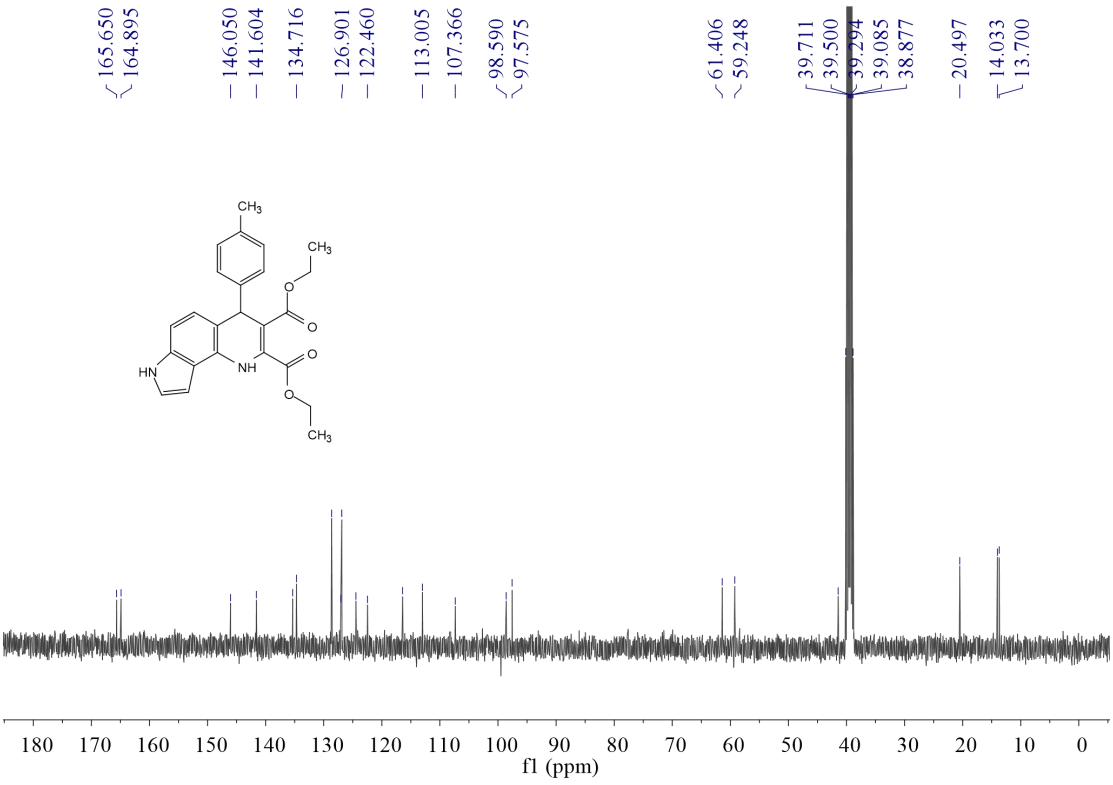
^{1}H NMR spectra of compound **4g**



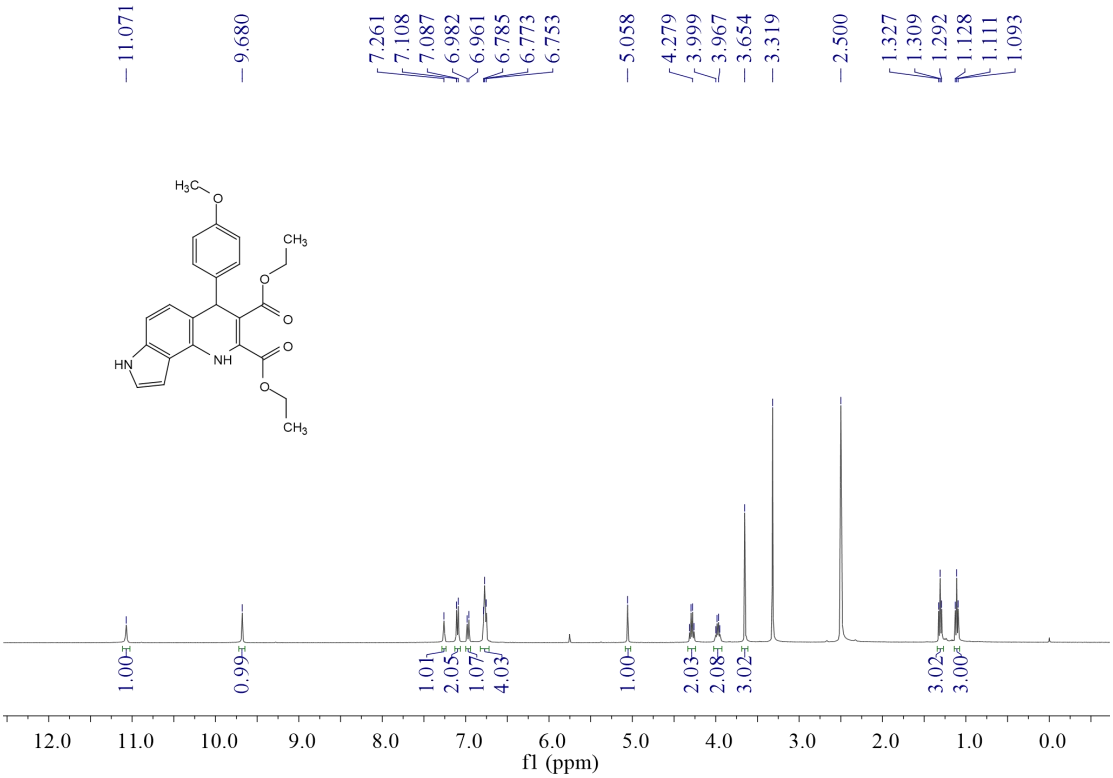
^{13}C NMR spectra of compound **4g**



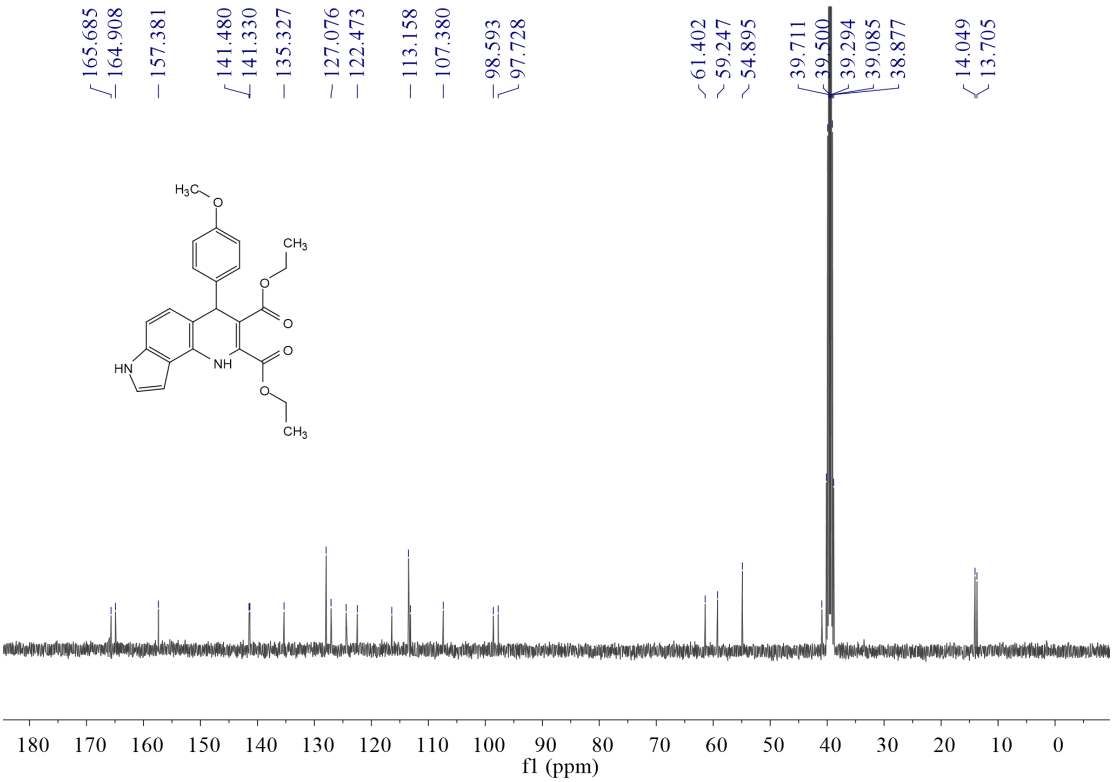
^{1}H NMR spectra of compound **4h**



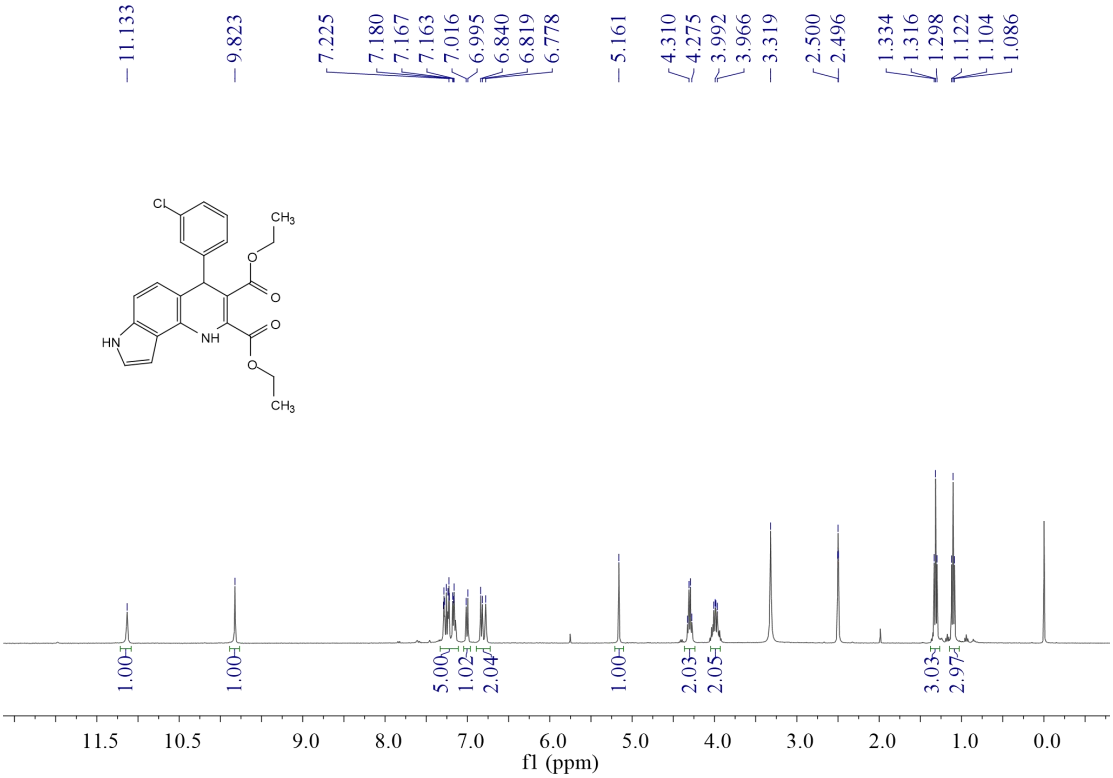
^{13}C NMR spectra of compound **4h**



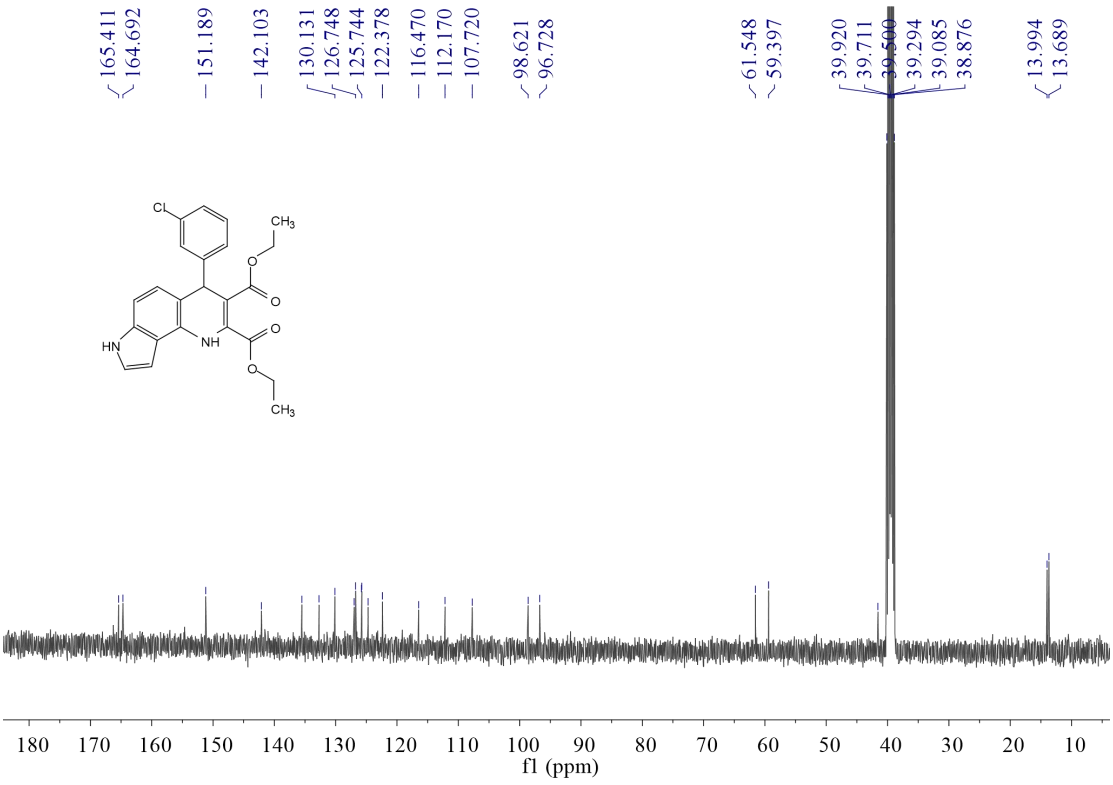
^{1}H NMR spectra of compound **4i**



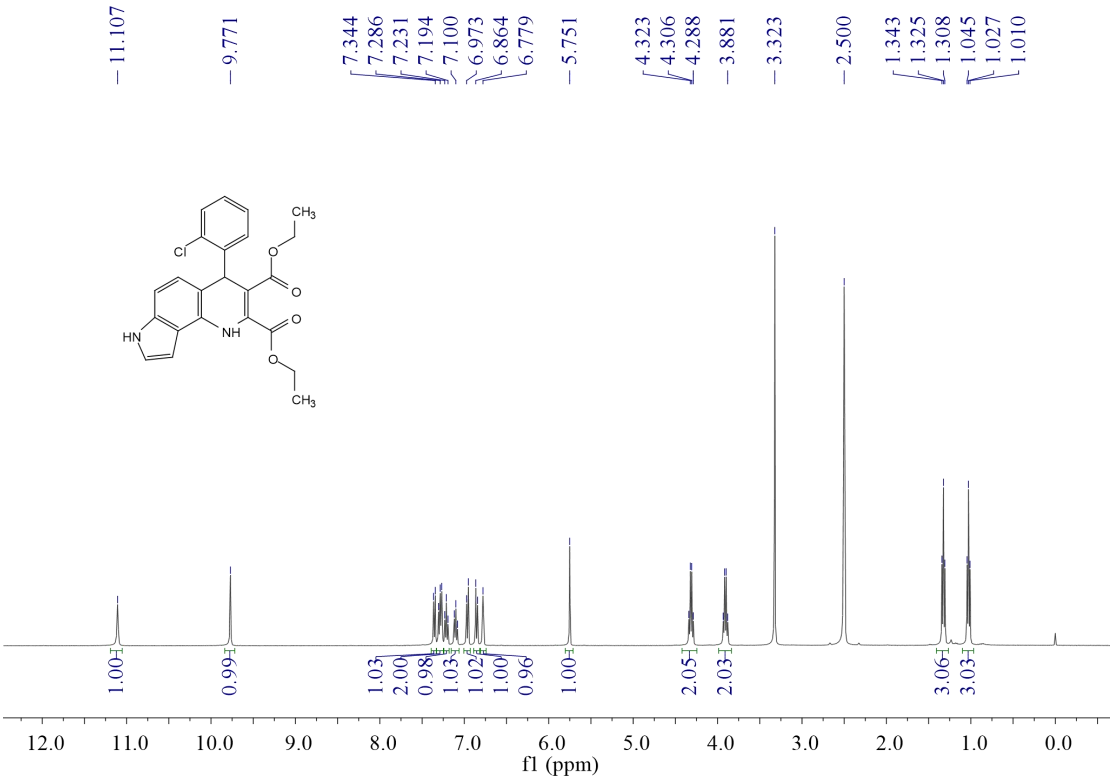
^{13}C NMR spectra of compound **4i**



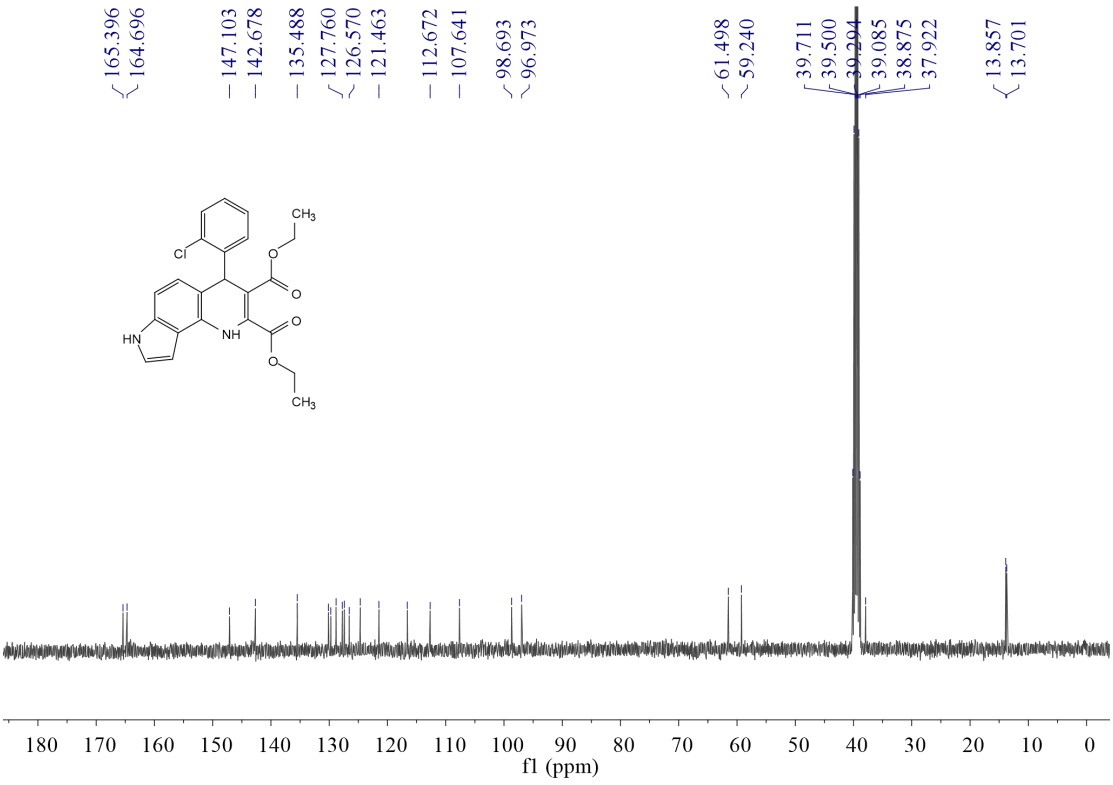
^{1}H NMR spectra of compound **4j**



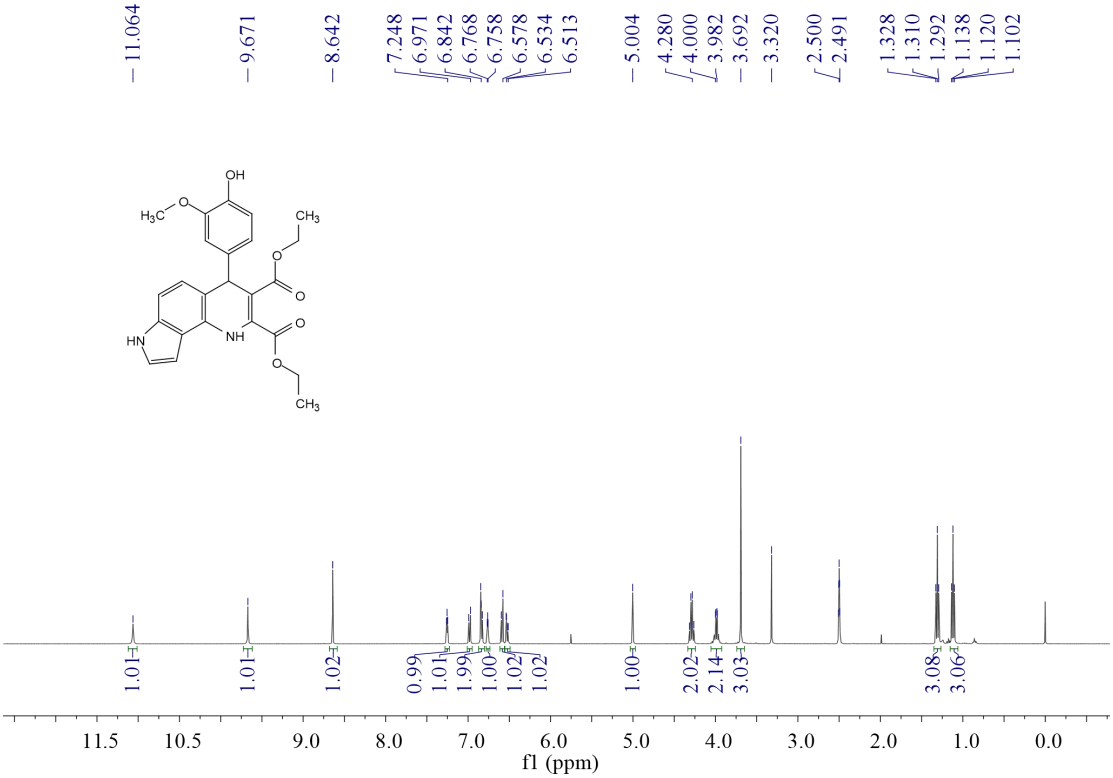
^{13}C NMR spectra of compound **4j**



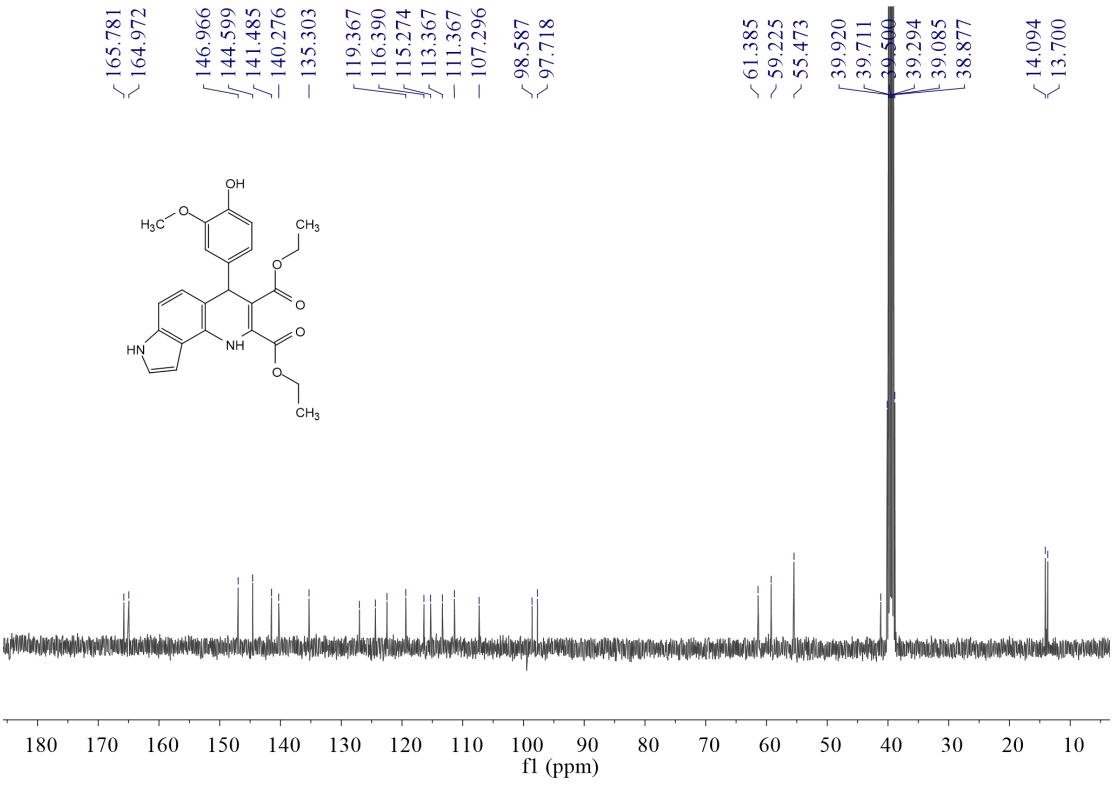
^{1}H NMR spectra of compound **4k**



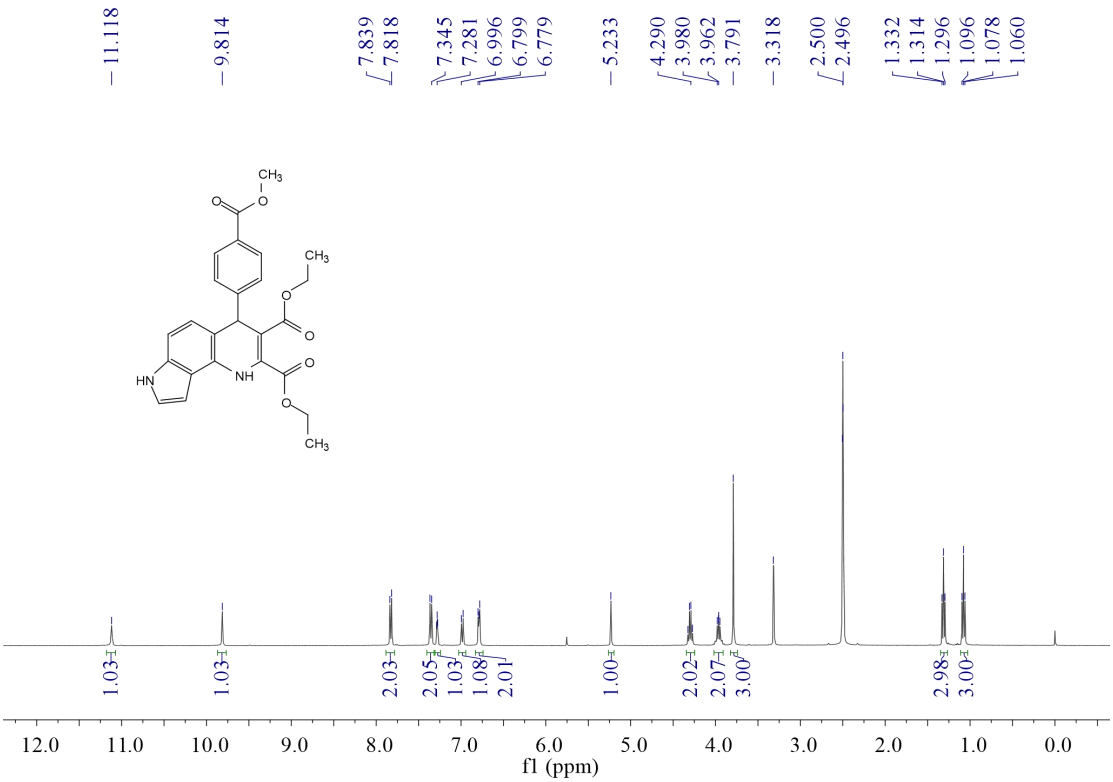
^{13}C NMR spectra of compound **4k**



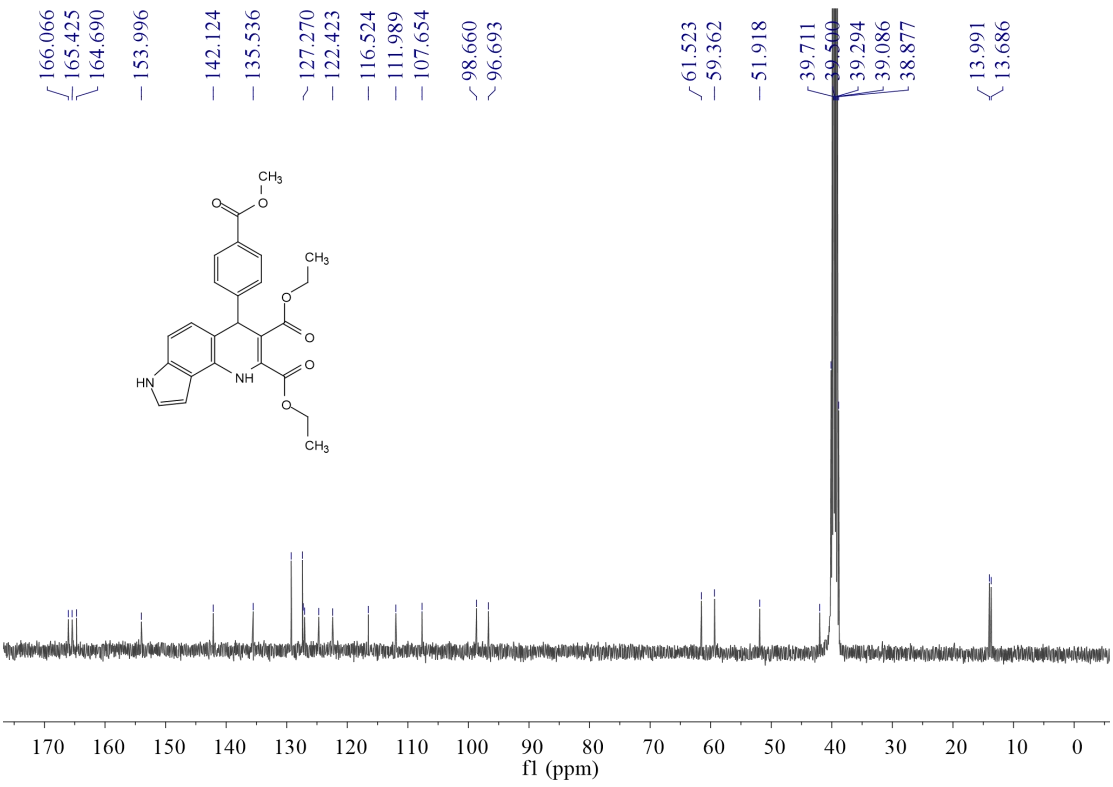
^{1}H NMR spectra of compound **4l**



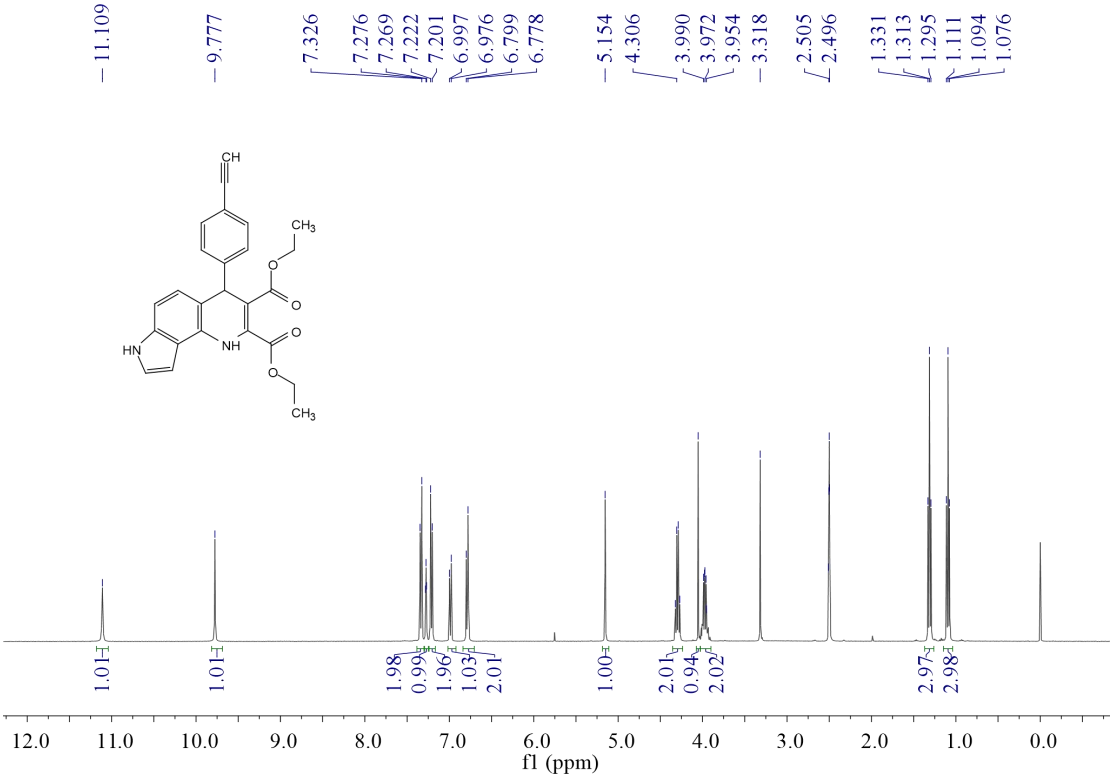
^{13}C NMR spectra of compound **4l**



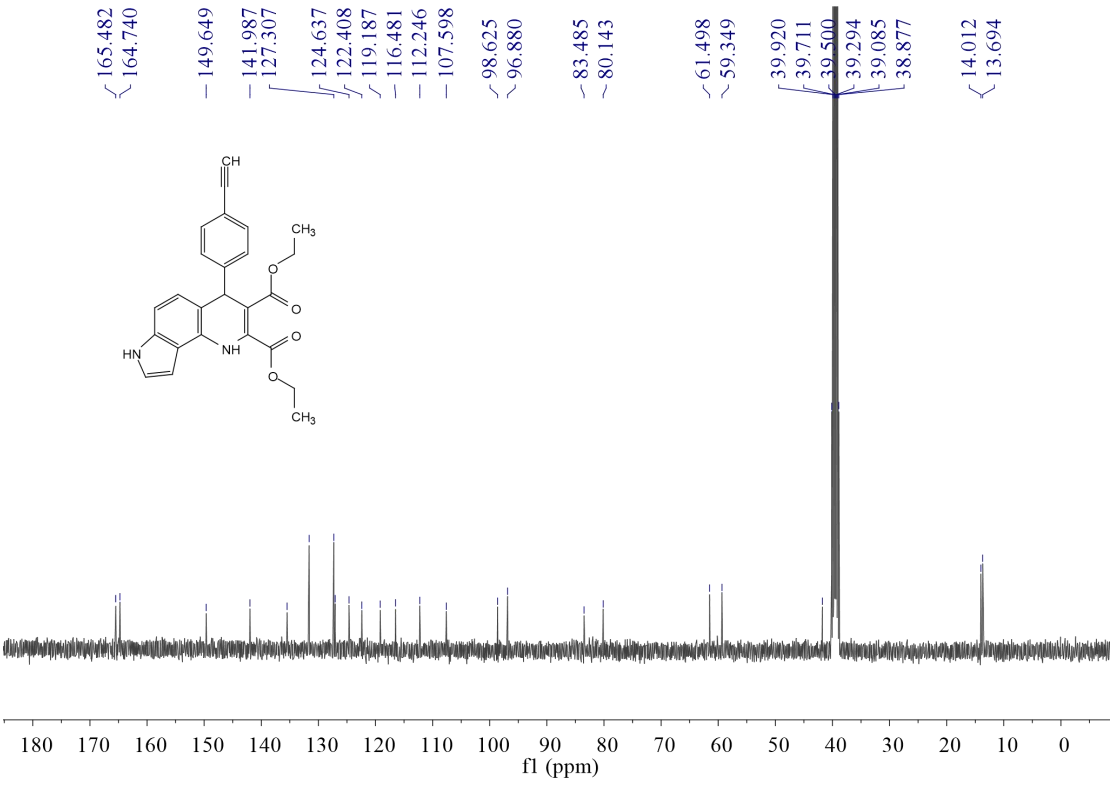
^{1}H NMR spectra of compound **4m**



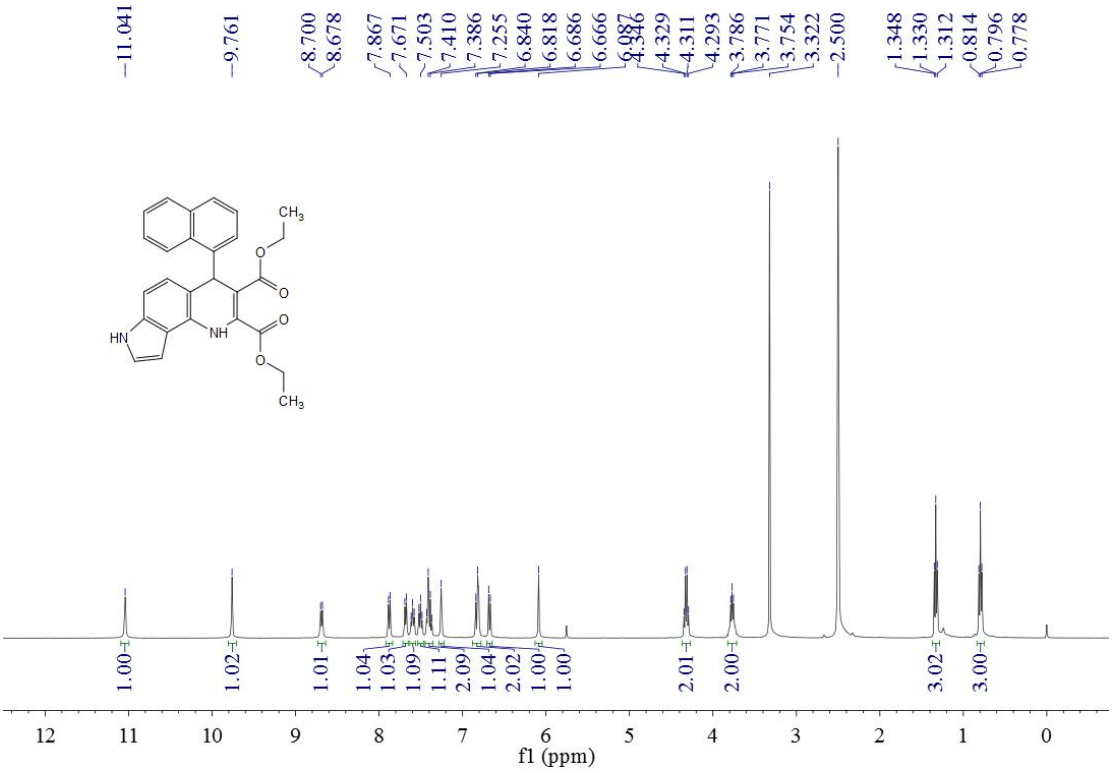
^{13}C NMR spectra of compound **4m**



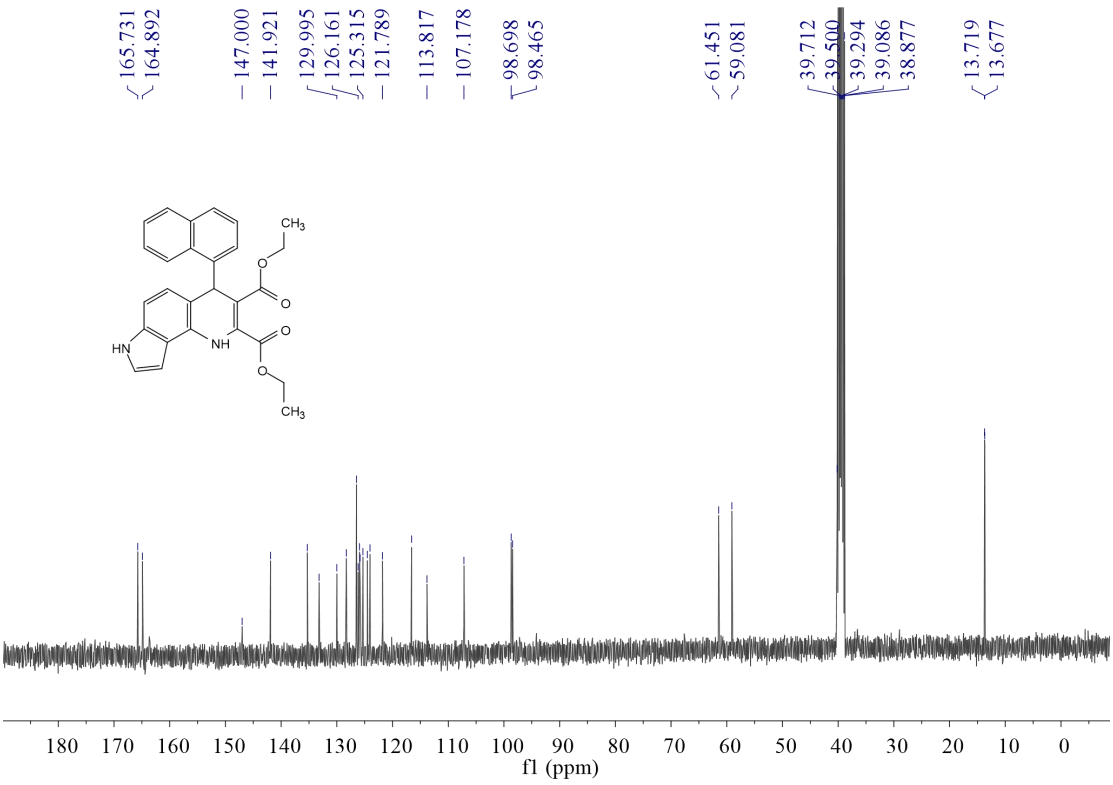
^{1}H NMR spectra of compound **4n**



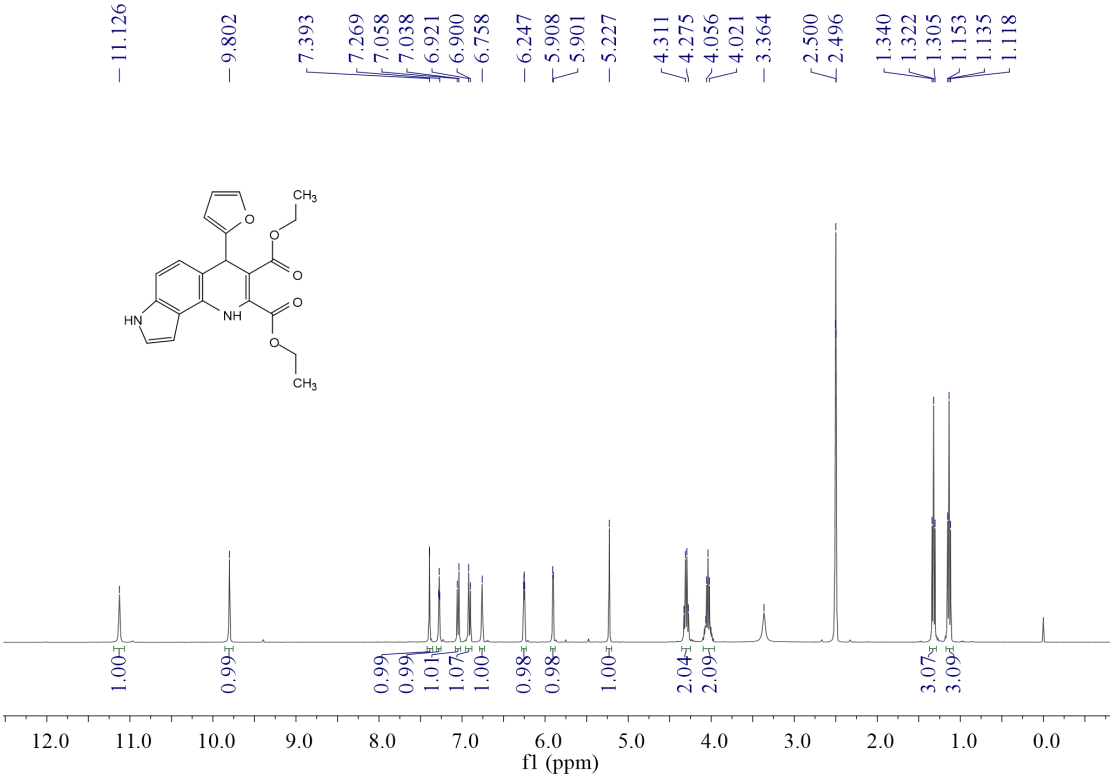
^{13}C NMR spectra of compound **4n**



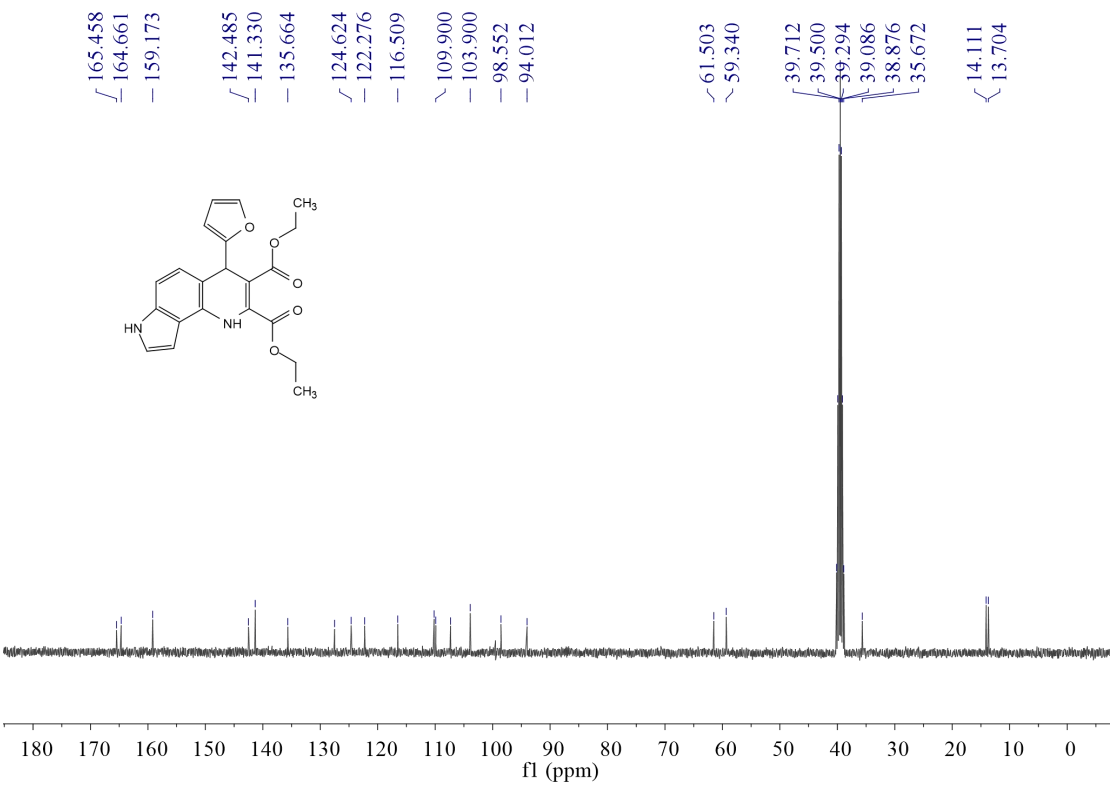
^{1}H NMR spectra of compound **4o**



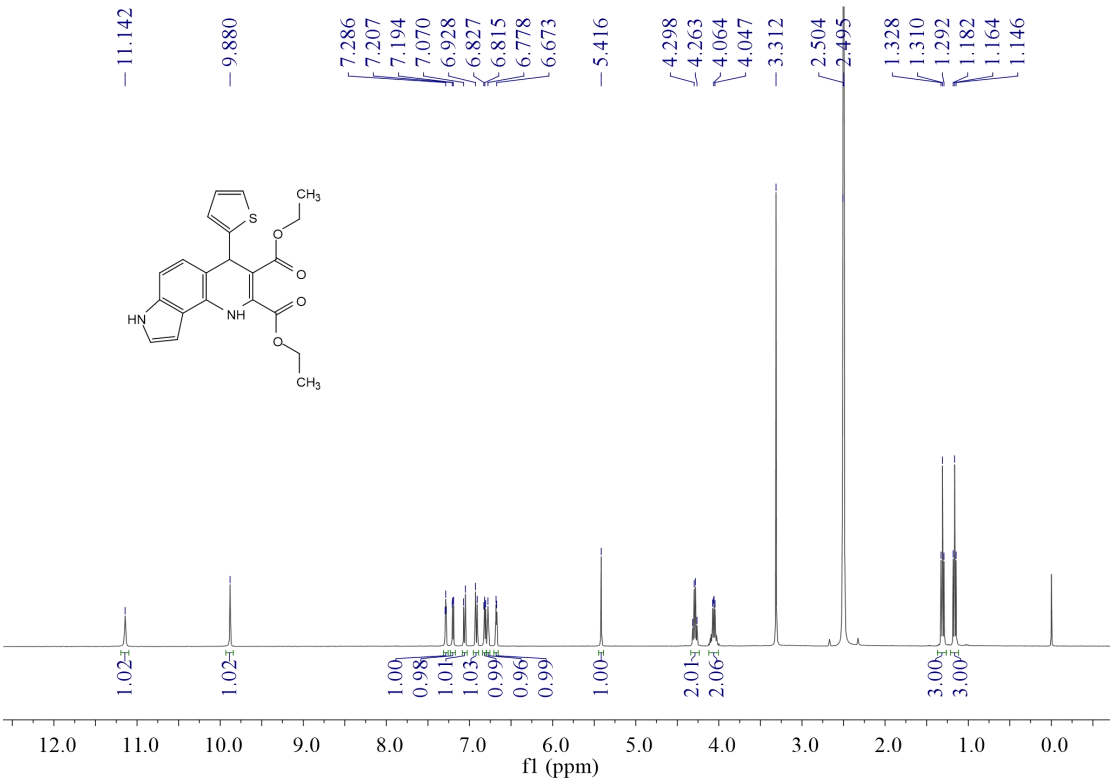
^{13}C NMR spectra of compound **4o**



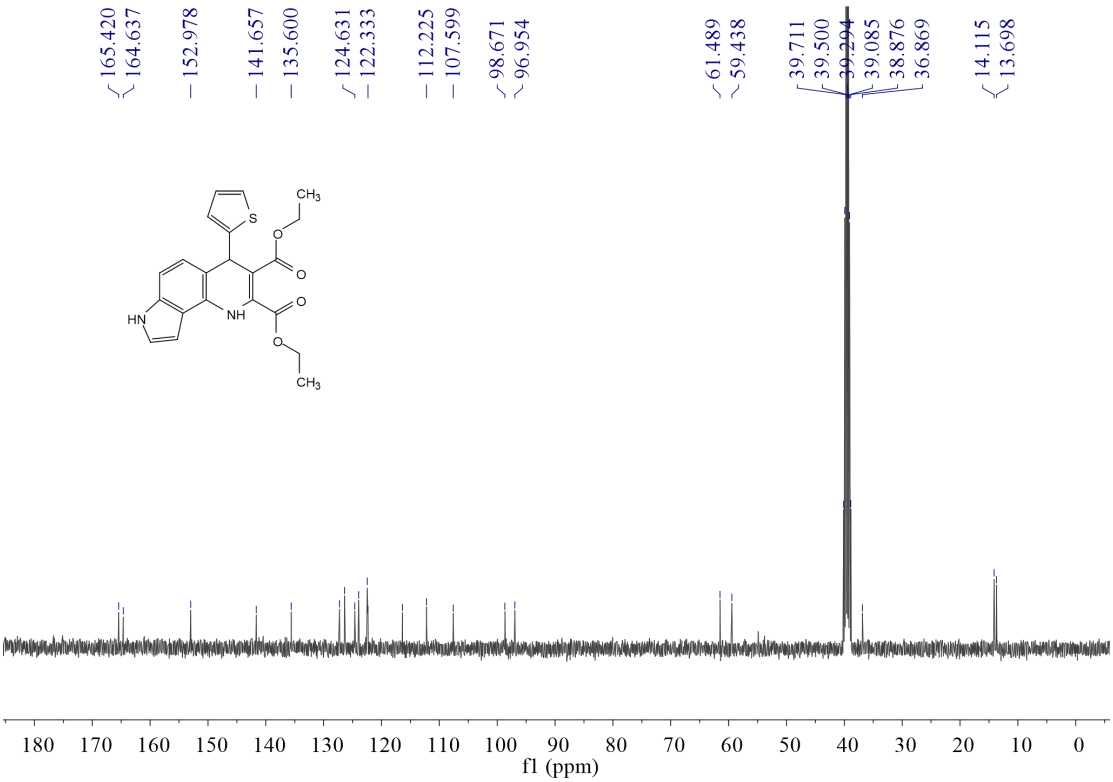
^{1}H NMR spectra of compound **4p**



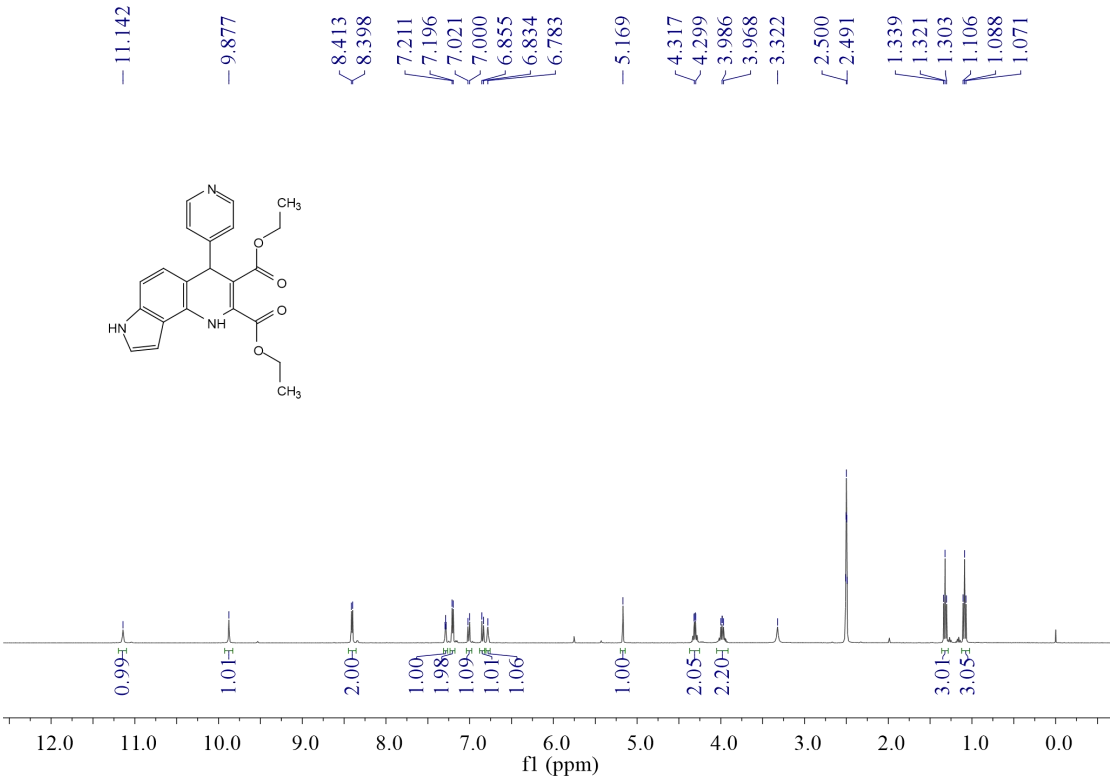
^{13}C NMR spectra of compound **4p**



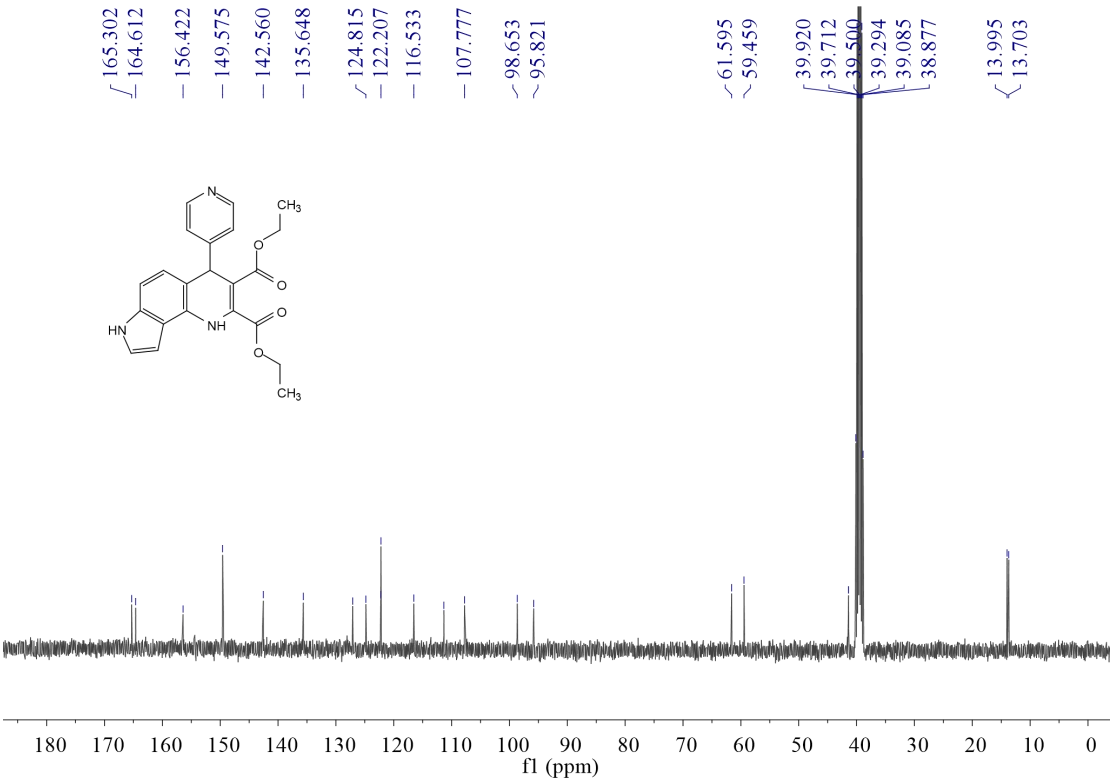
^{1}H NMR spectra of compound **4q**



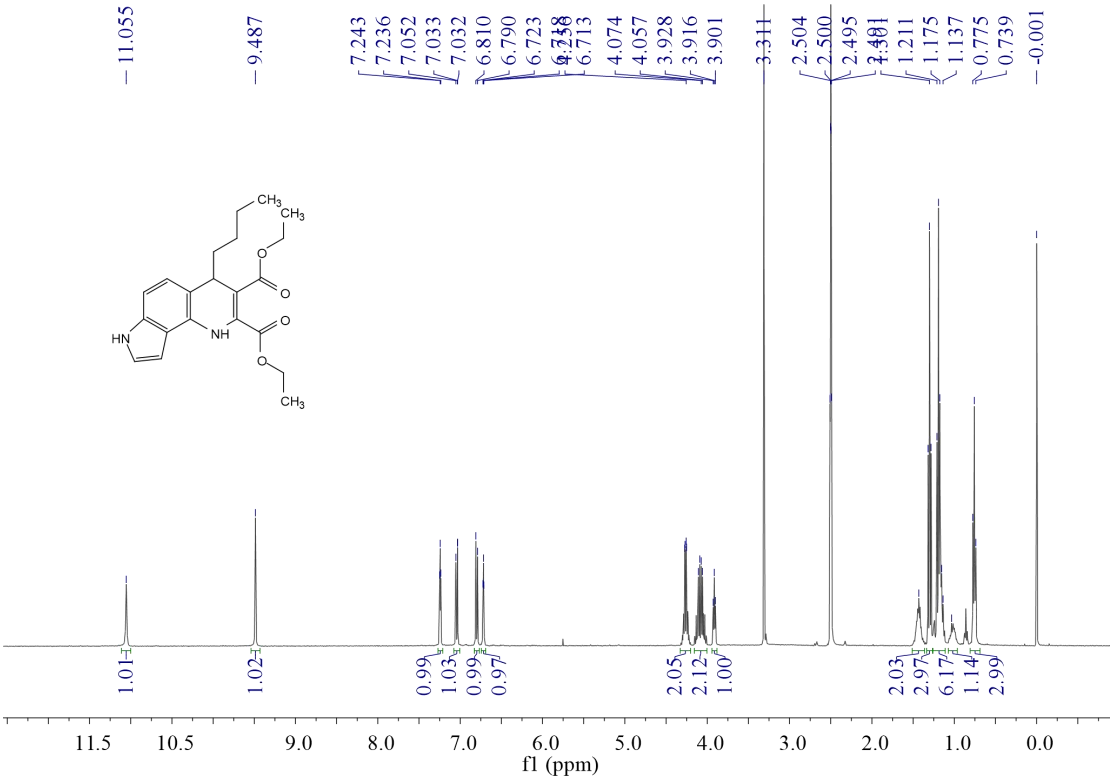
^{13}C NMR spectra of compound **4q**



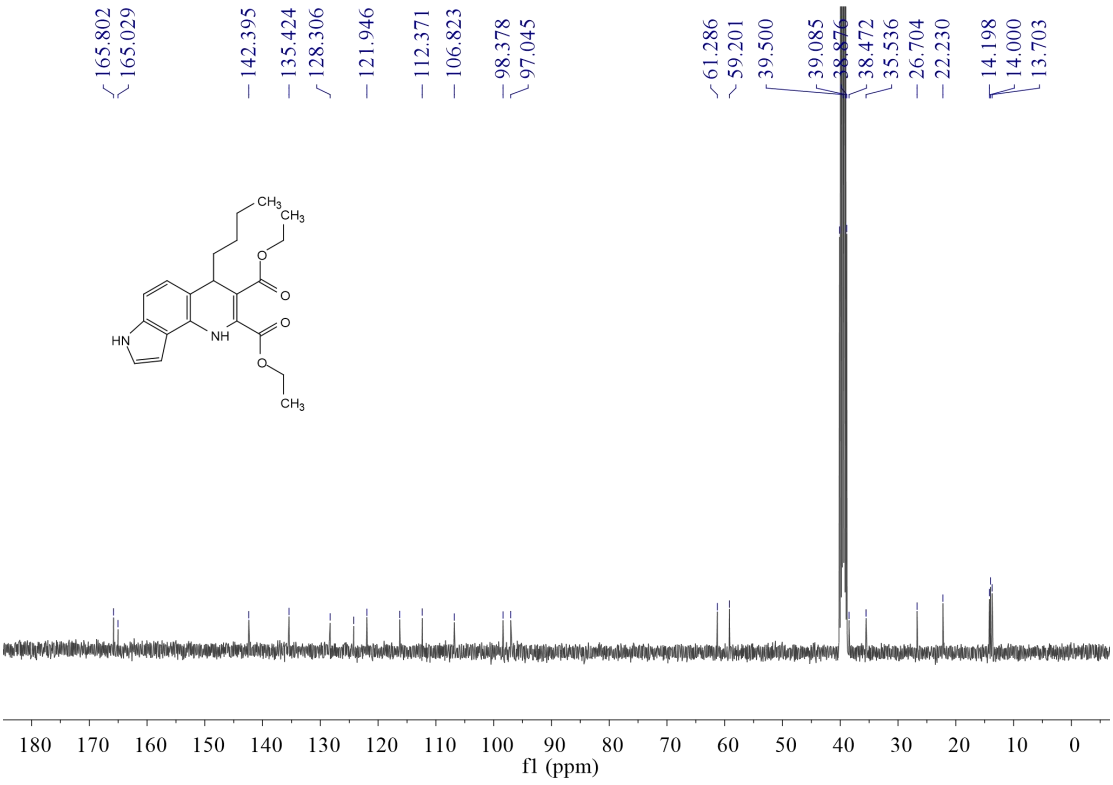
^{1}H NMR spectra of compound **4r**



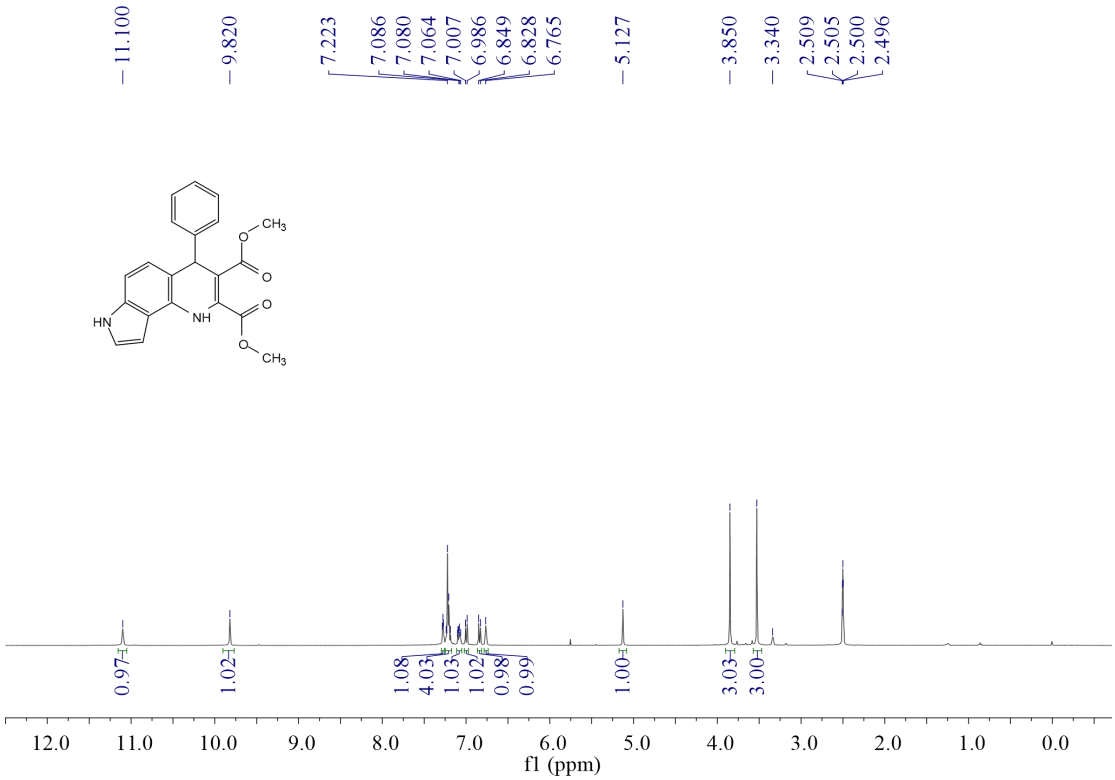
^{13}C NMR spectra of compound **4r**



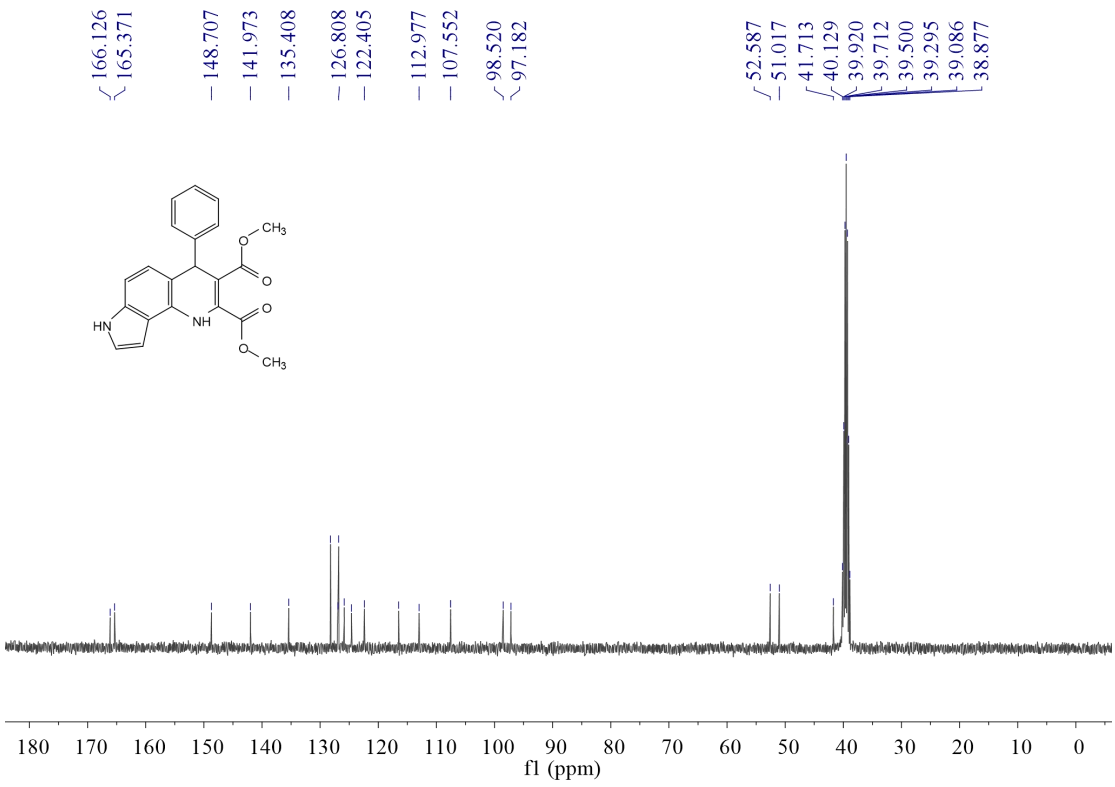
^{1}H NMR spectra of compound **4s**



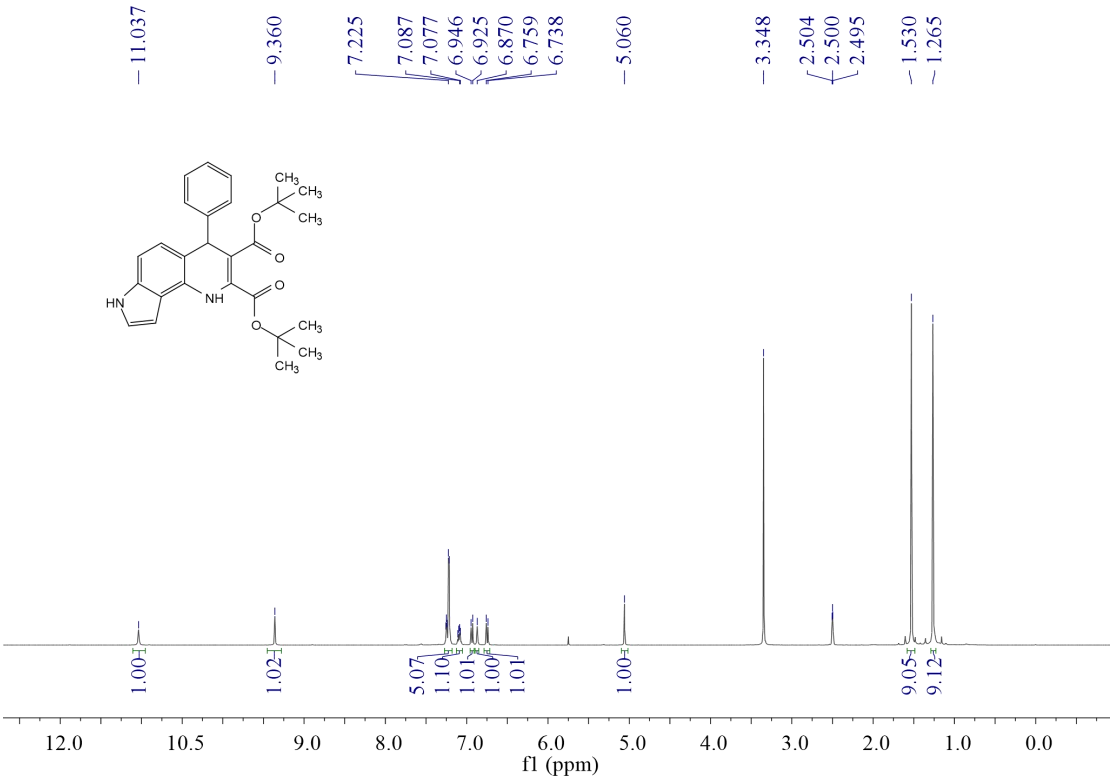
^{13}C NMR spectra of compound **4s**



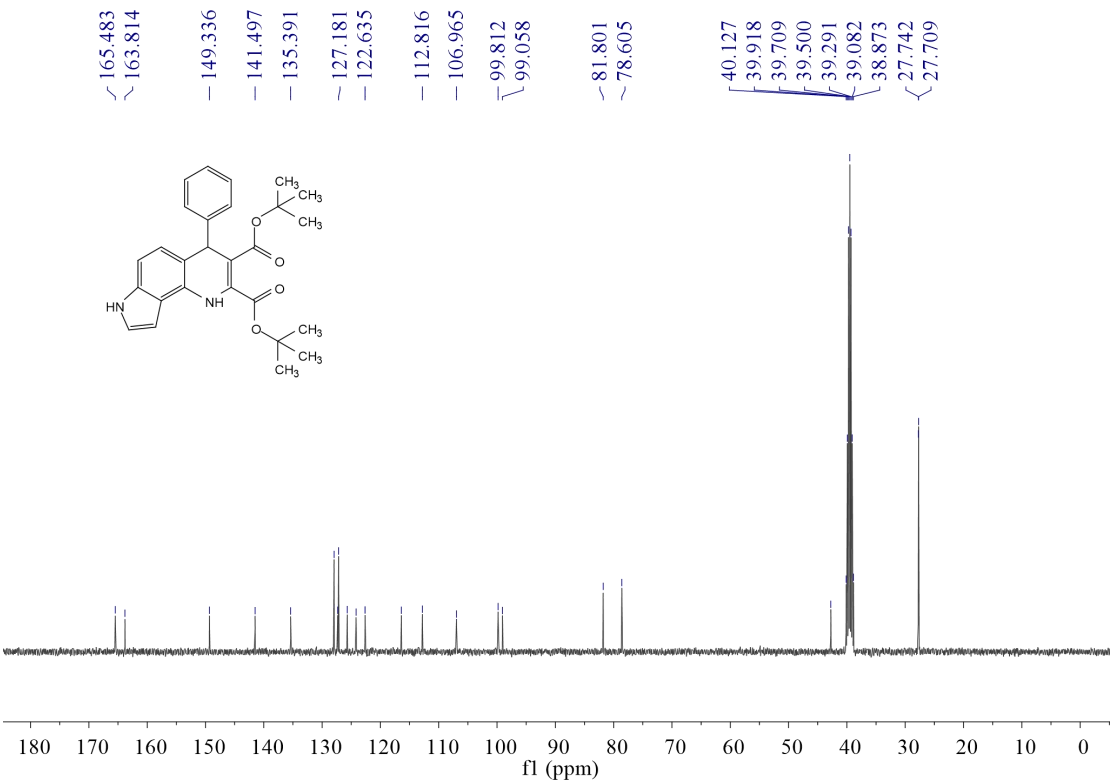
^{1}H NMR spectra of compound **4t**



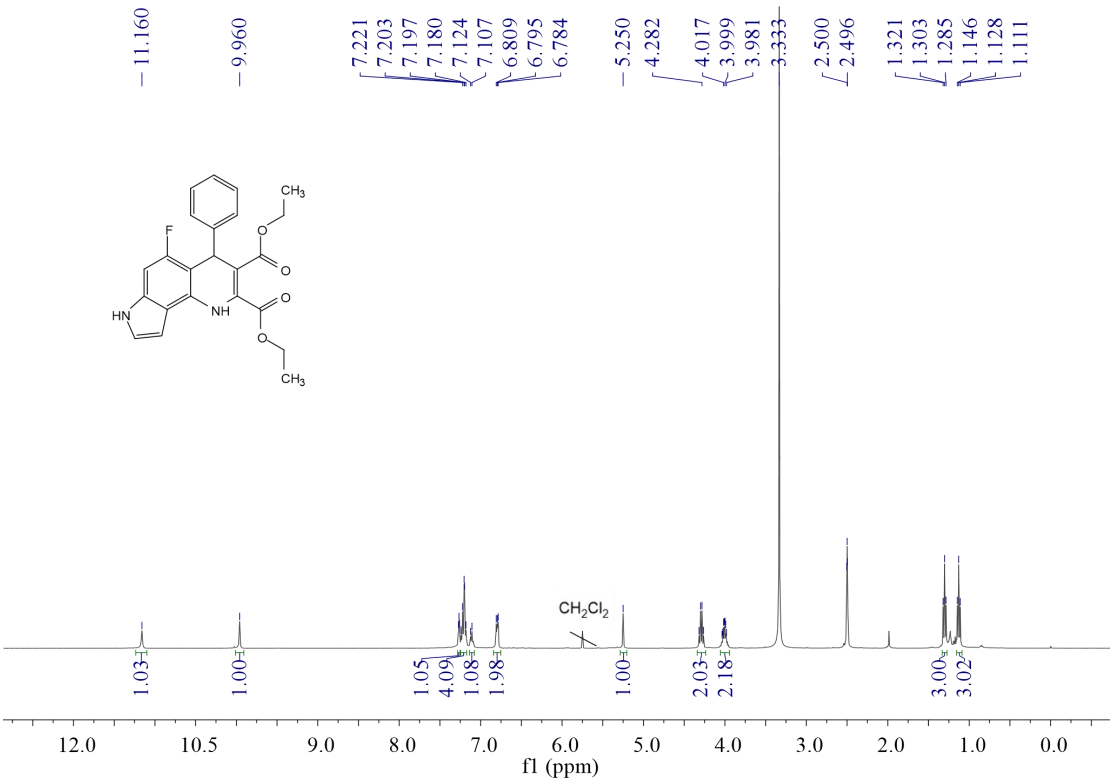
^{13}C NMR spectra of compound **4t**



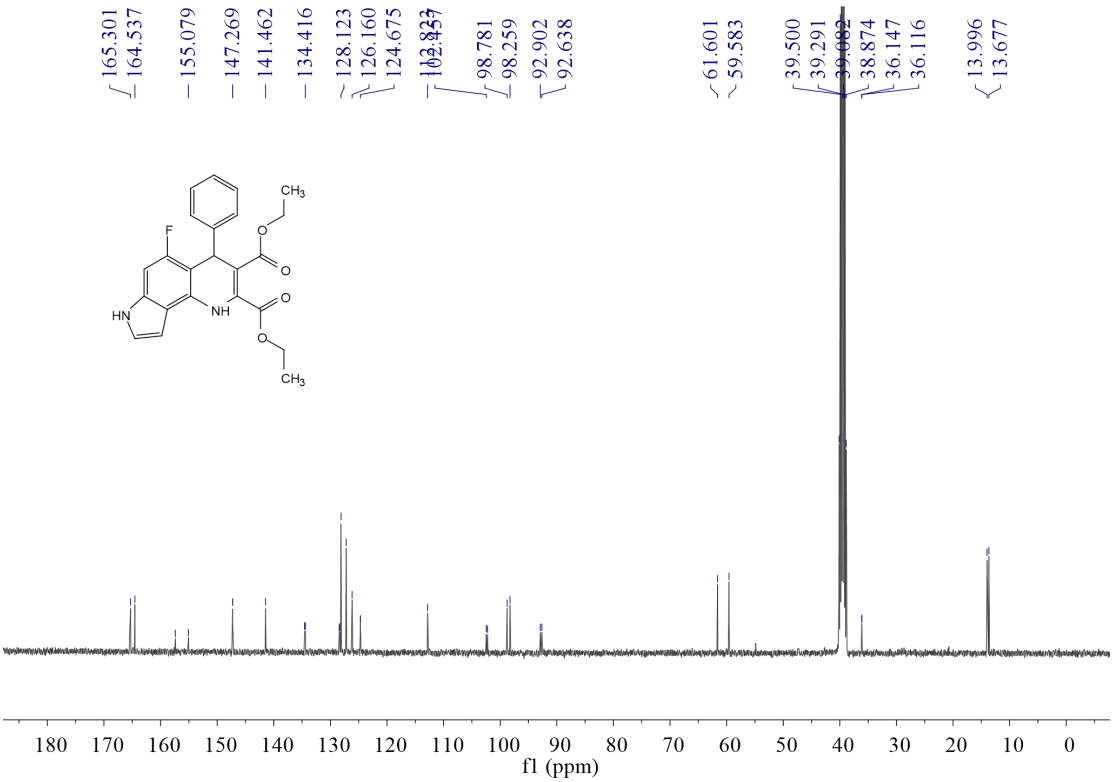
^{1}H NMR spectra of compound **4u**



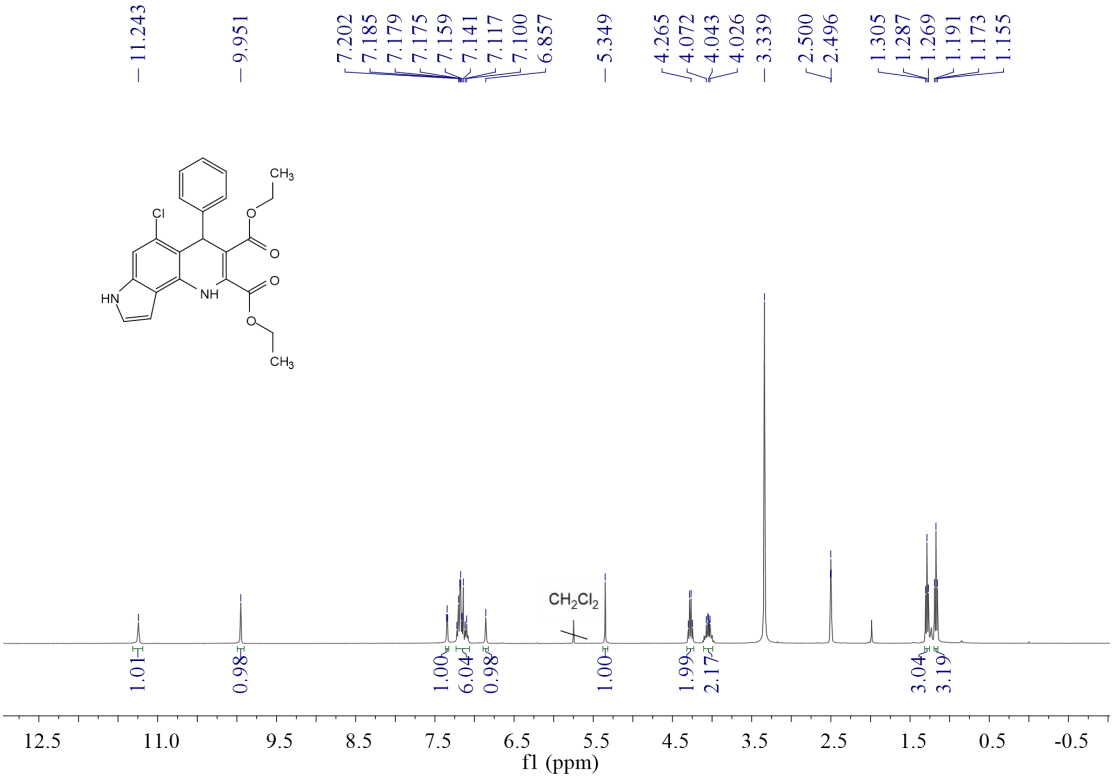
^{13}C NMR spectra of compound **4u**



^{1}H NMR spectra of compound **4v**



^{13}C NMR spectra of compound **4v**



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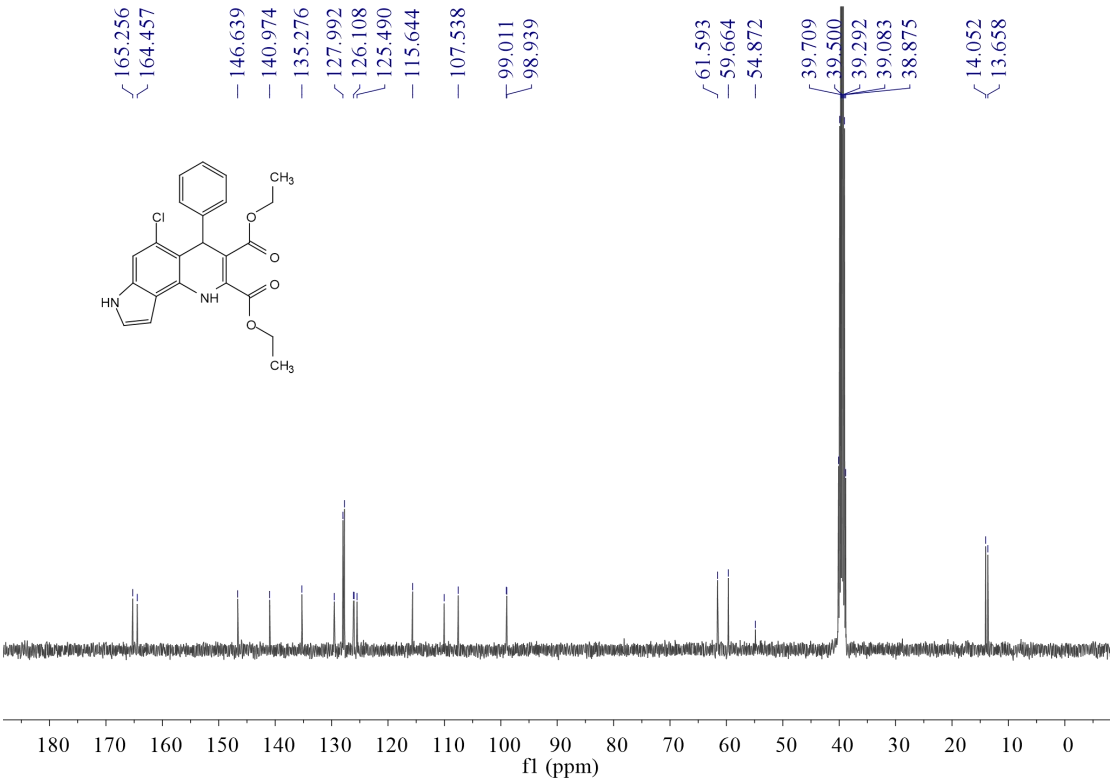
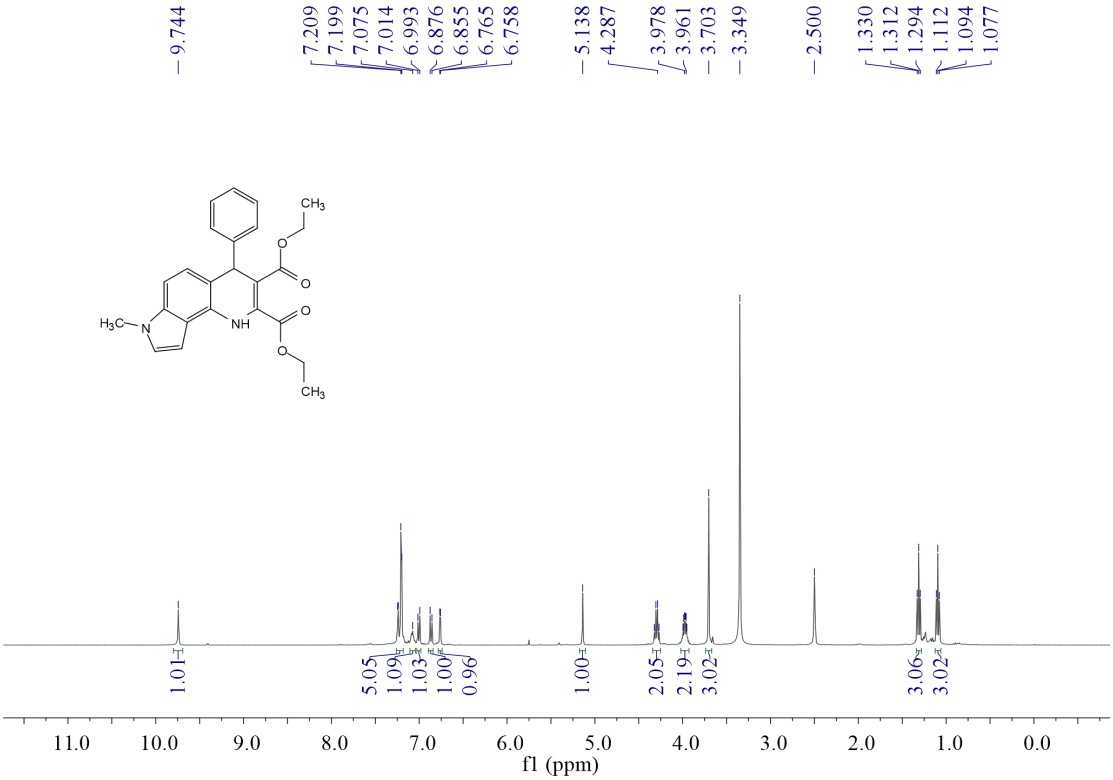
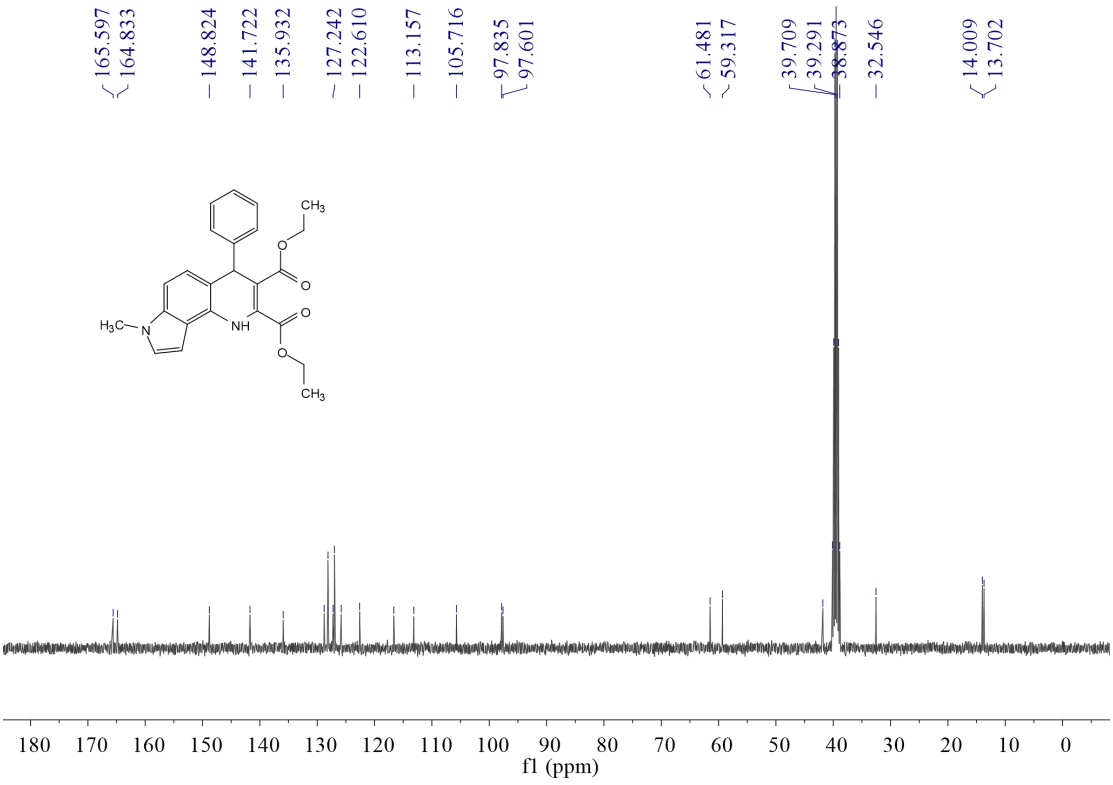


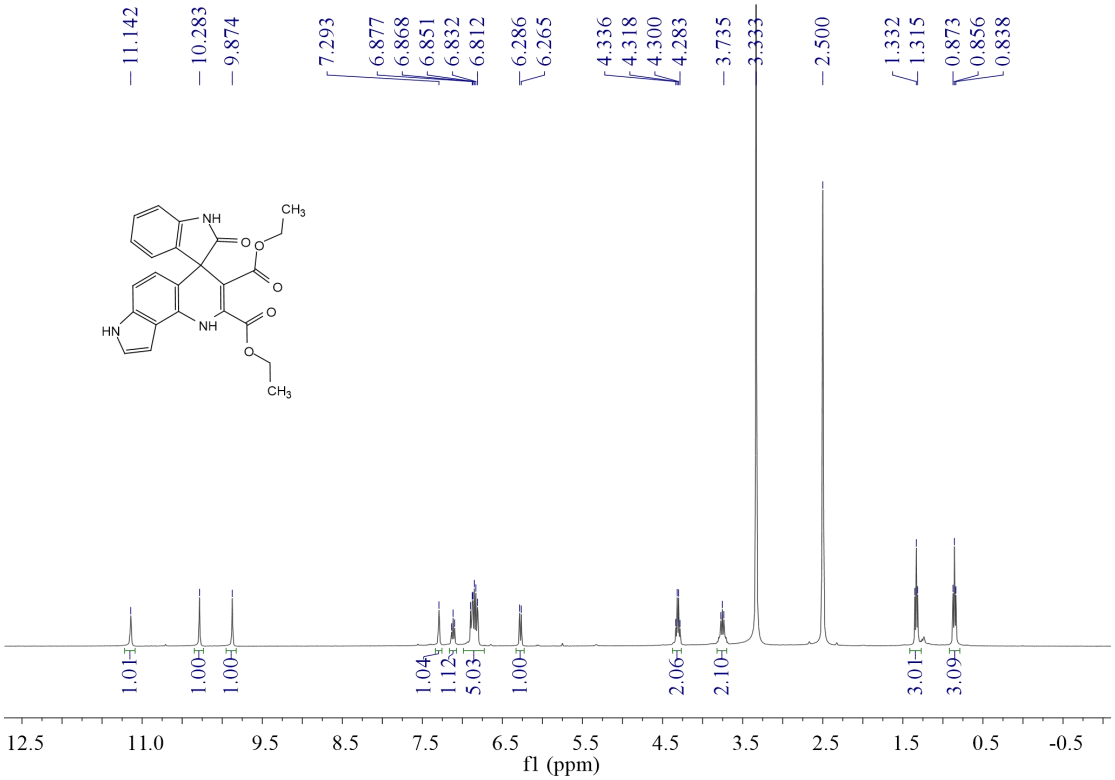
^{13}C NMR spectra of compound **4w**



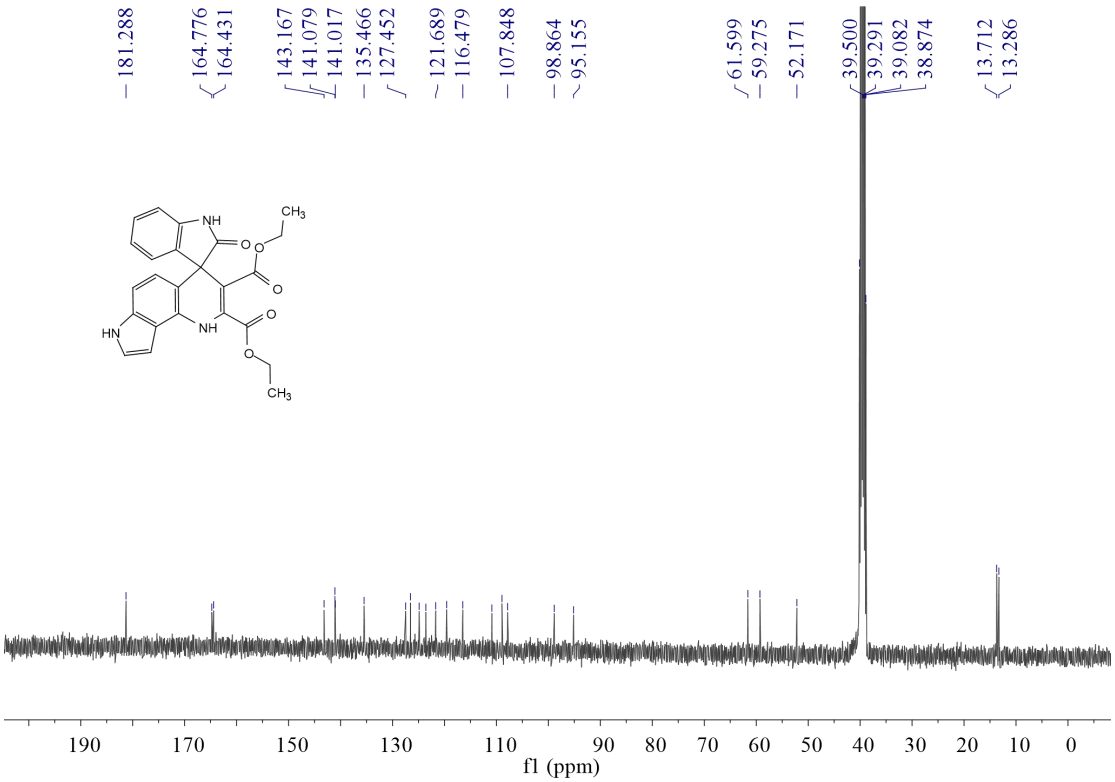
^{1}H NMR spectra of compound **4x**



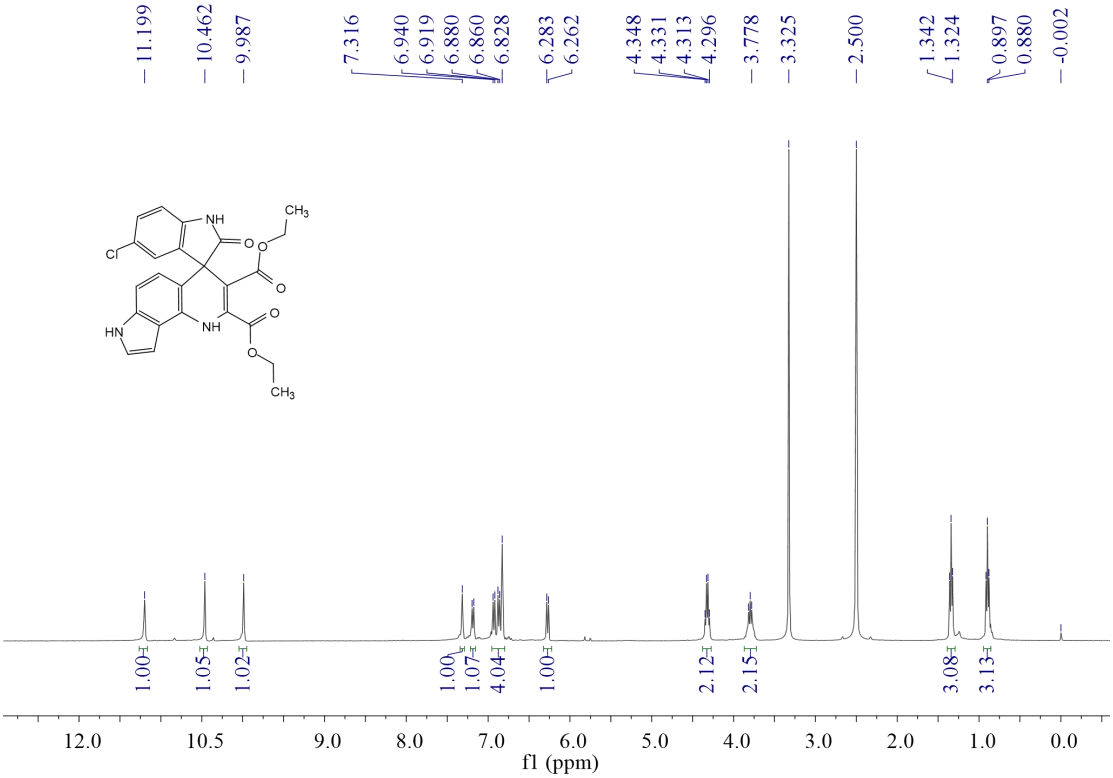
^{13}C NMR spectra of compound **4x**



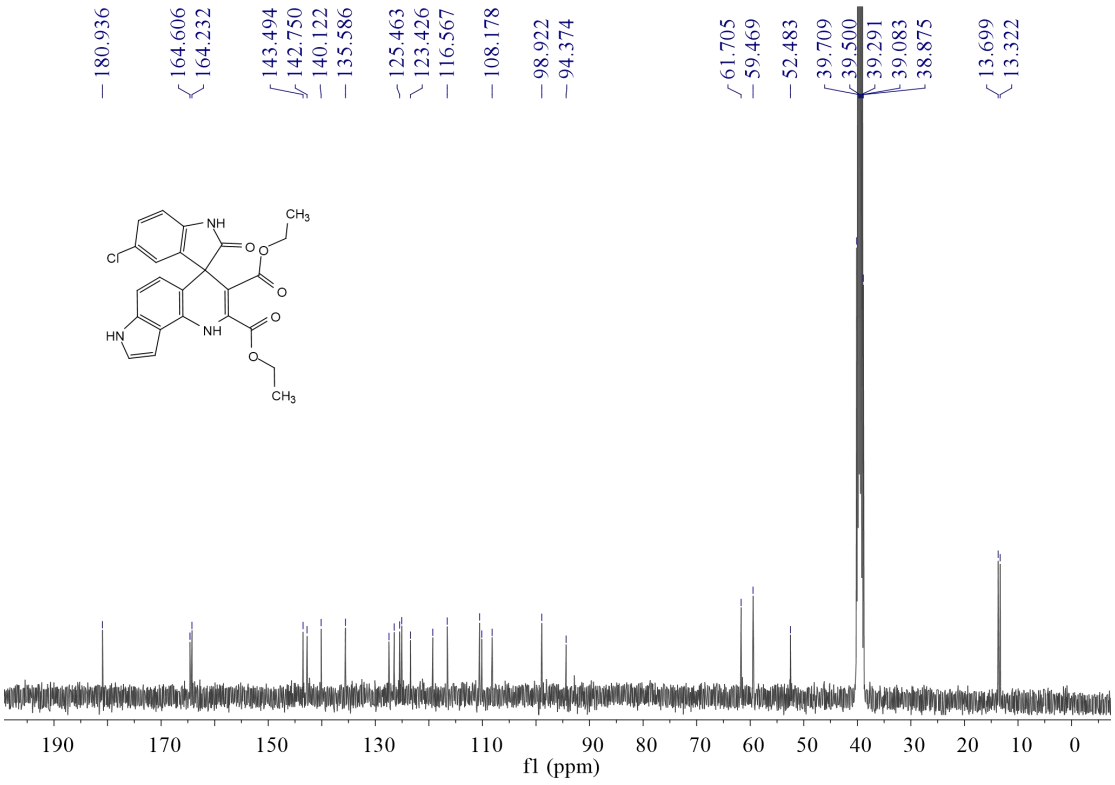
^{1}H NMR spectra of compound **6a**



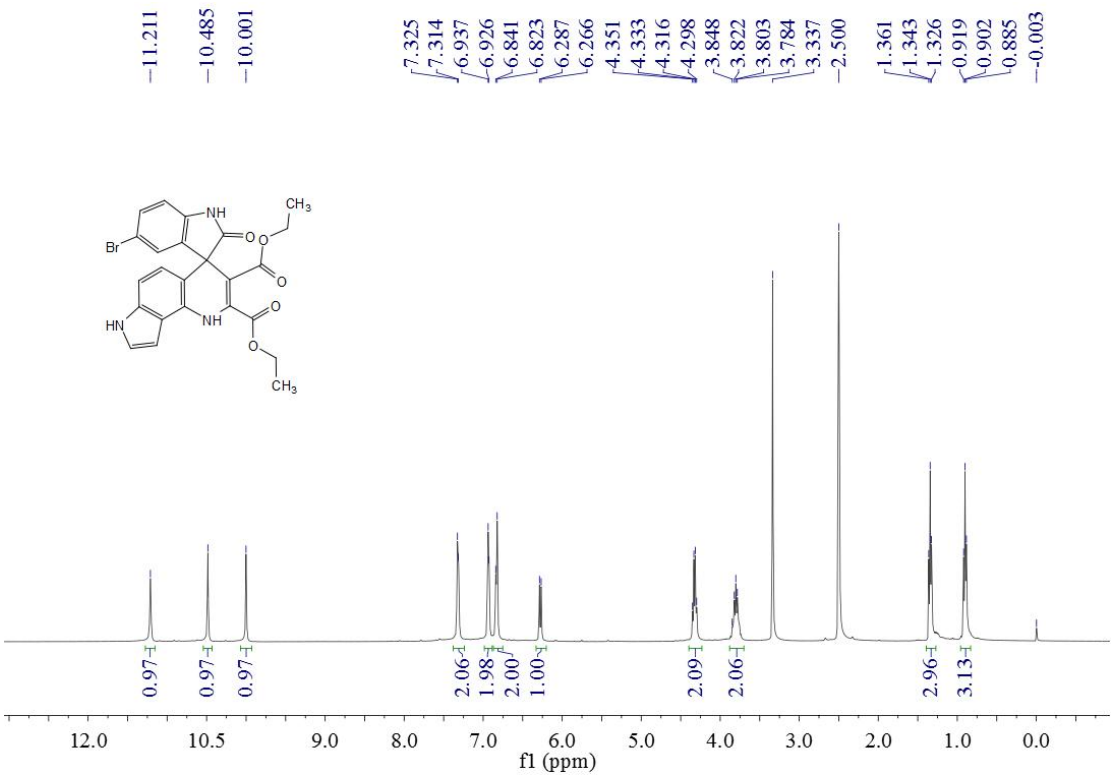
^{13}C NMR spectra of compound **6a**



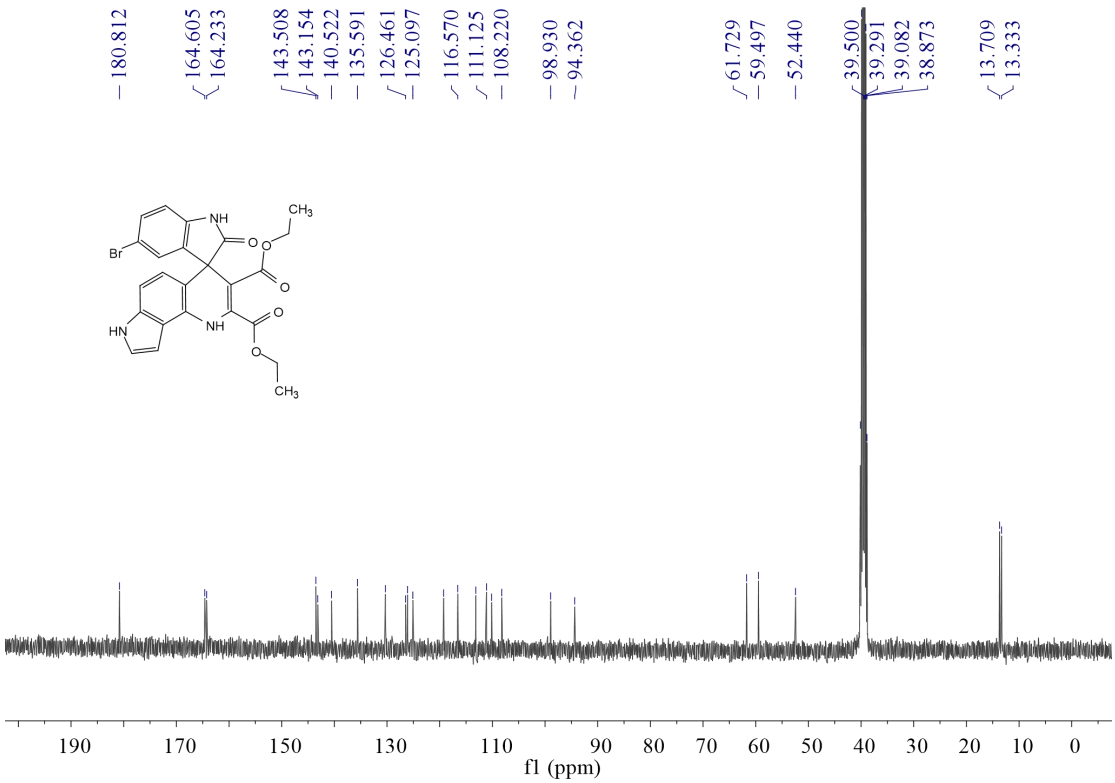
^{1}H NMR spectra of compound **6b**



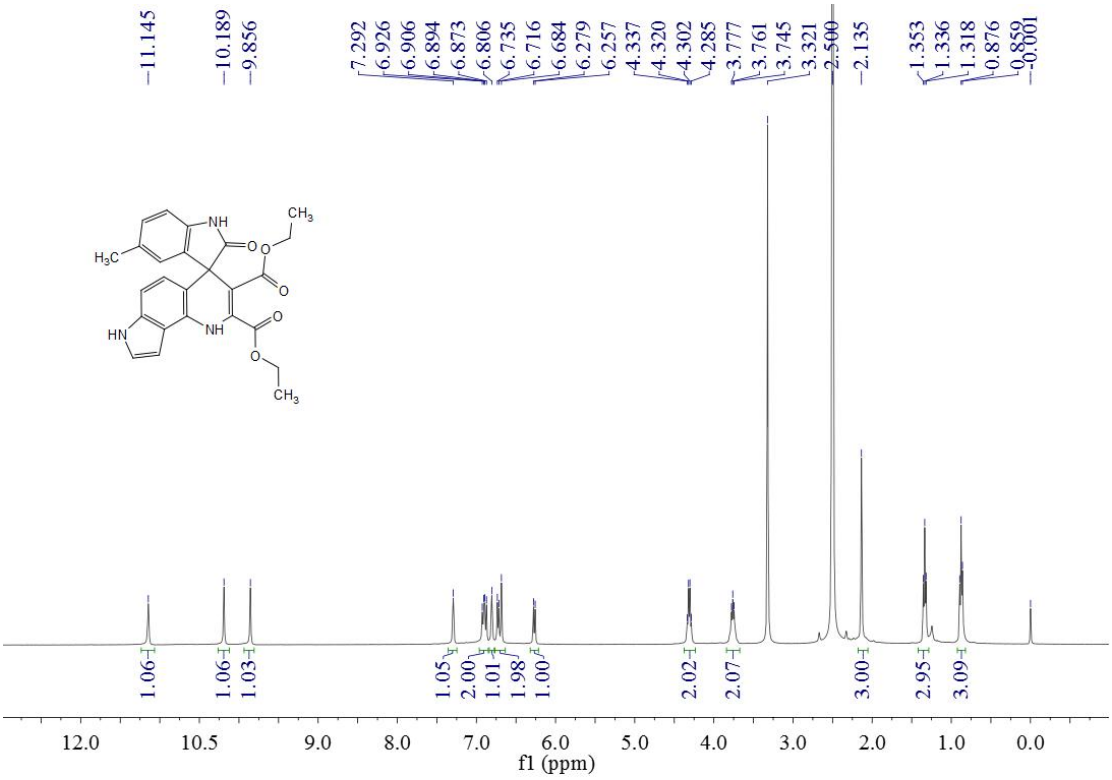
^{13}C NMR spectra of compound **6b**



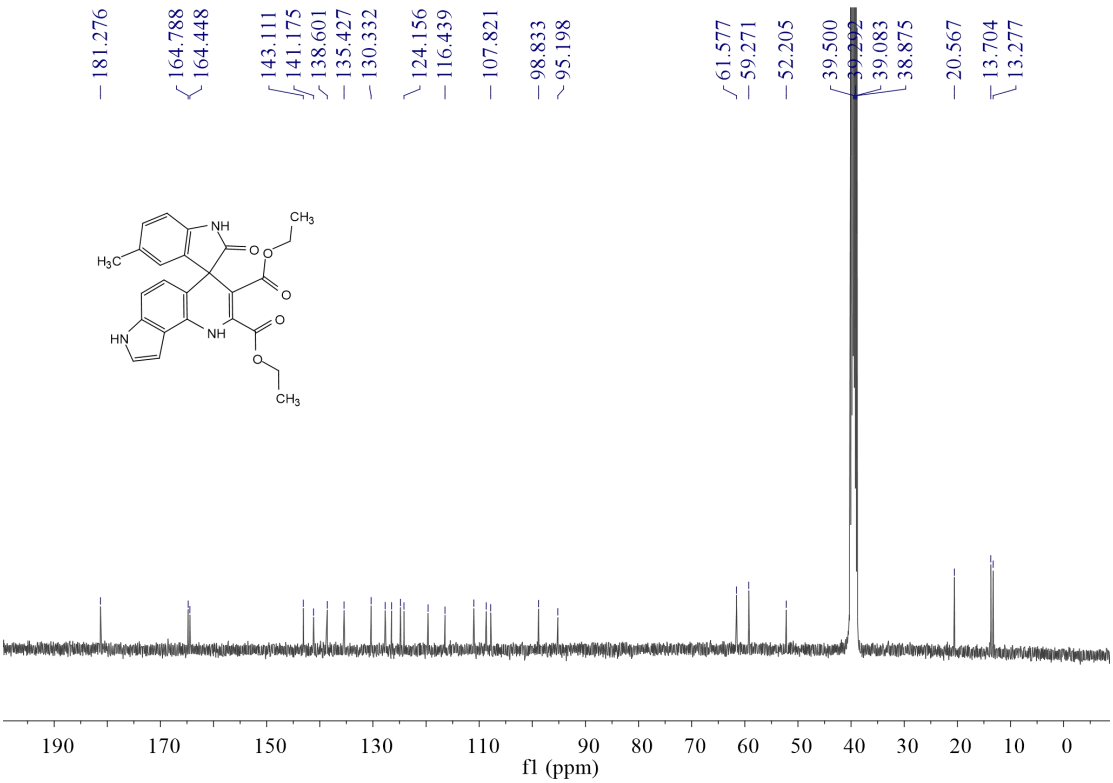
^{1}H NMR spectra of compound **6c**



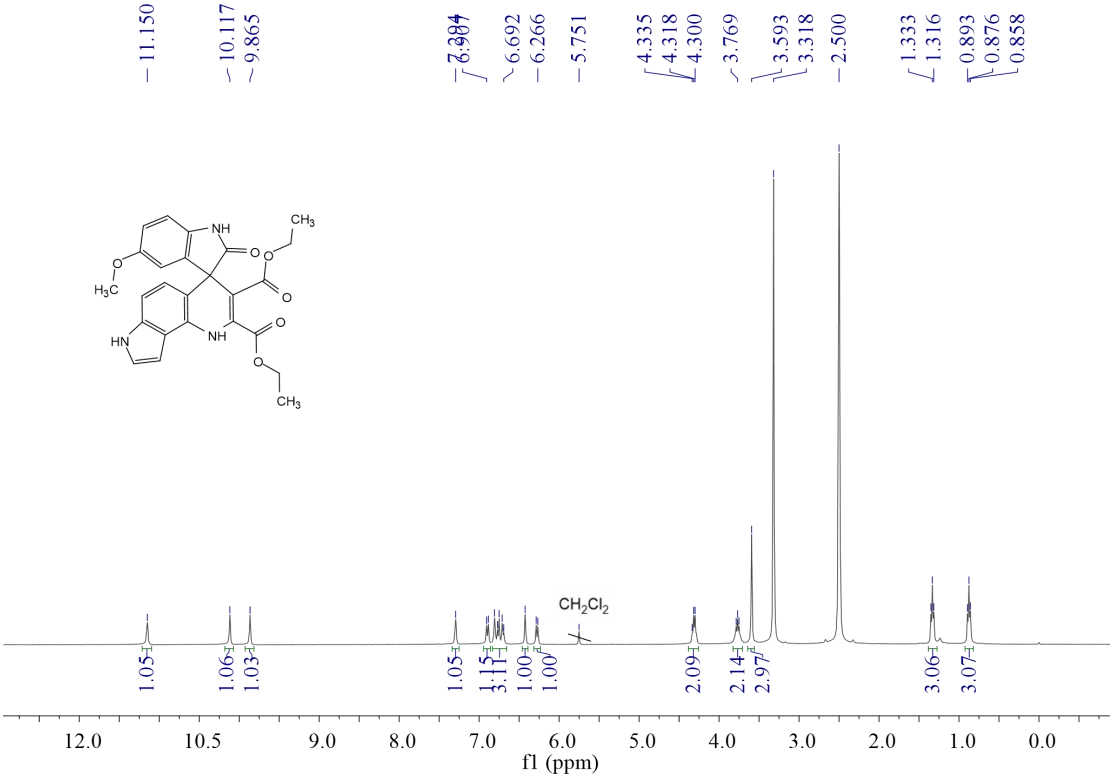
^{13}C NMR spectra of compound **6c**



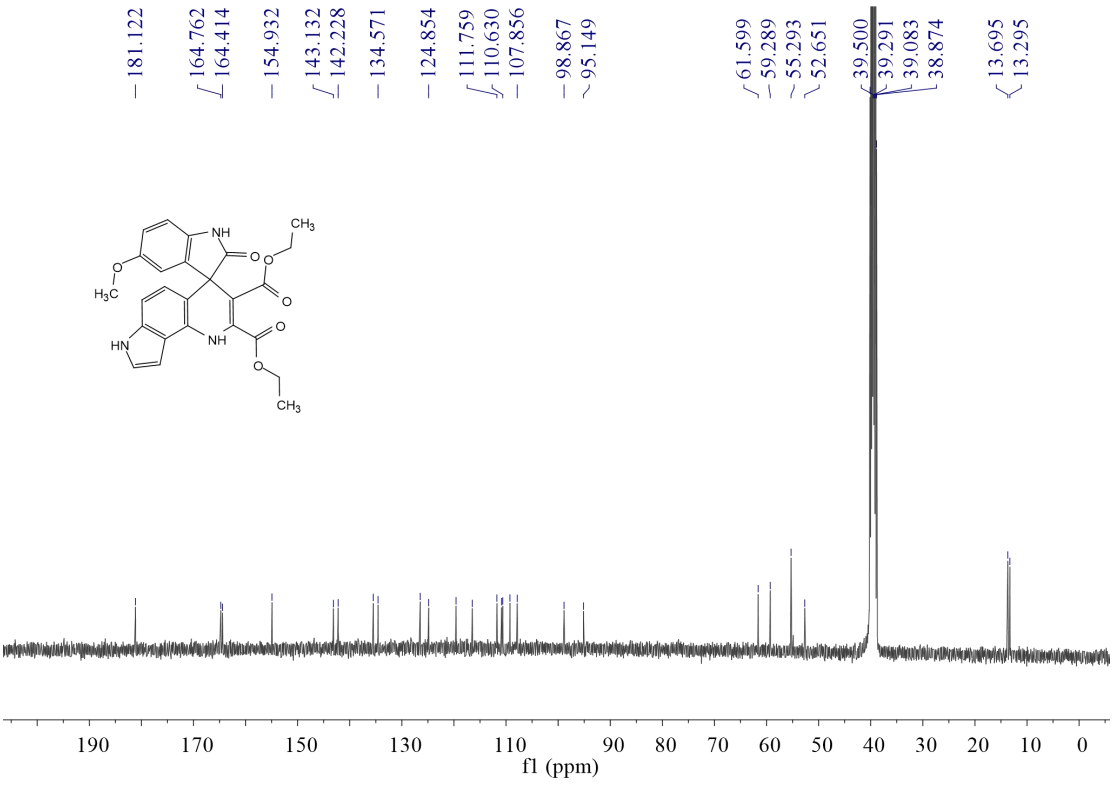
^{1}H NMR spectra of compound **6d**



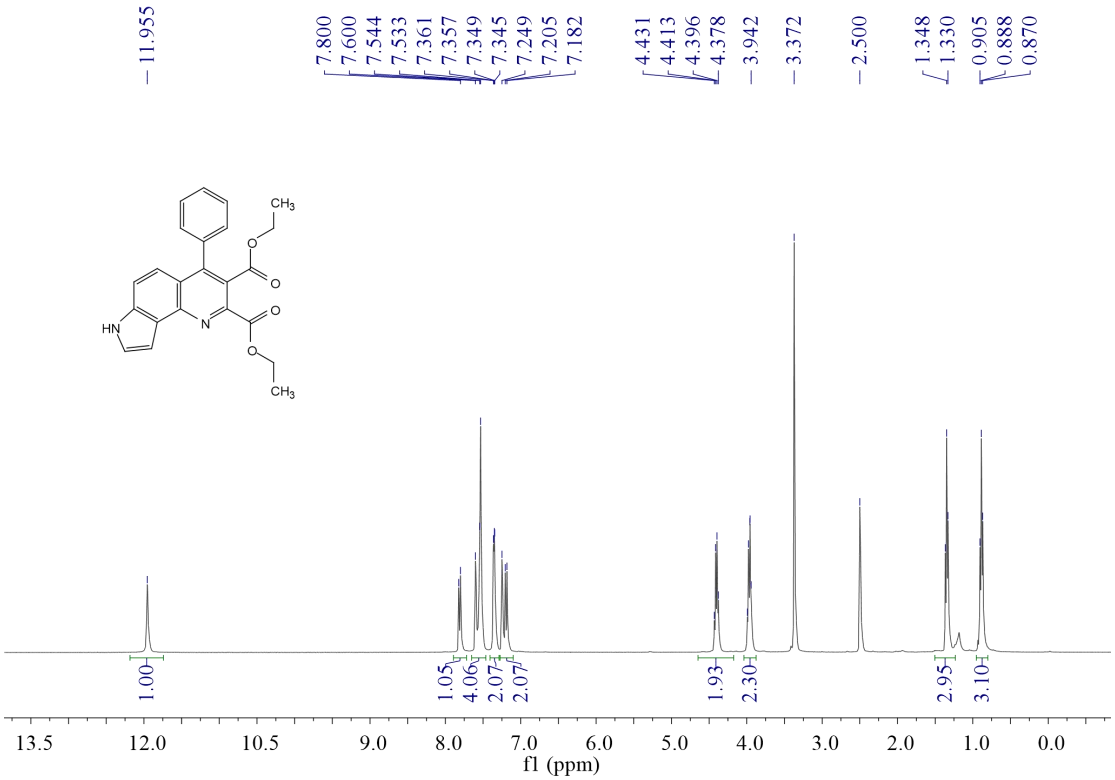
^{13}C NMR spectra of compound **6d**



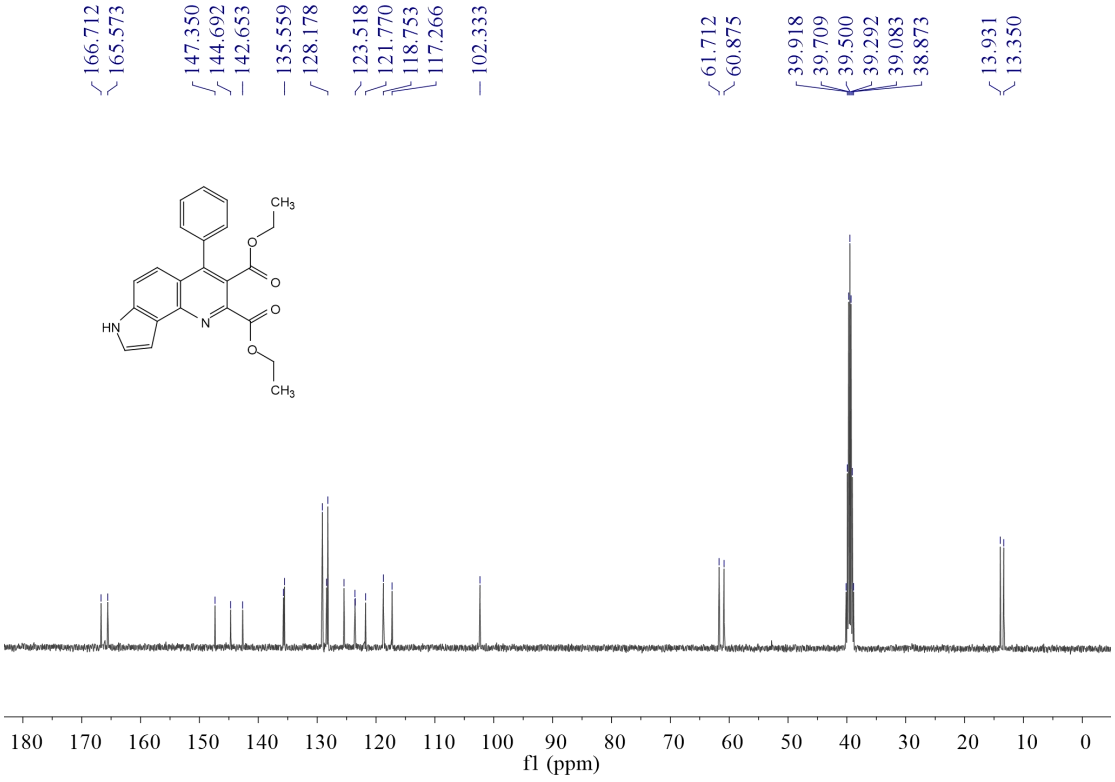
^{1}H NMR spectra of compound **6e**



^{13}C NMR spectra of compound **6e**

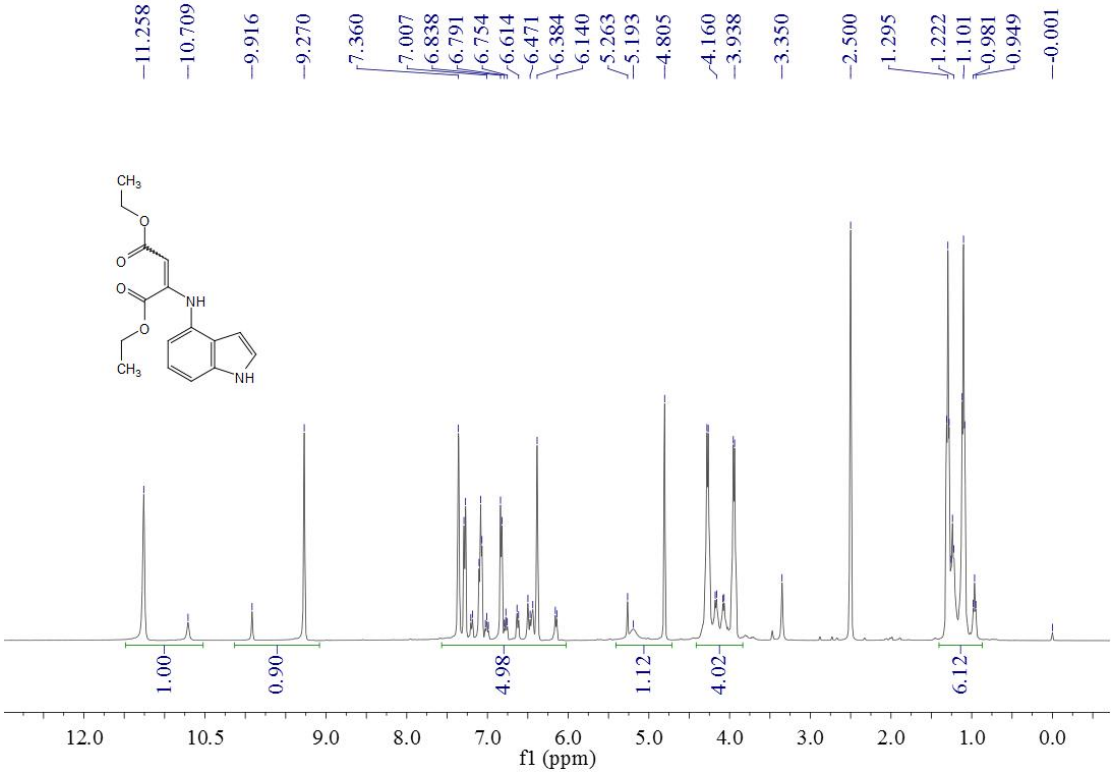


^{1}H NMR spectra of compound **10a**

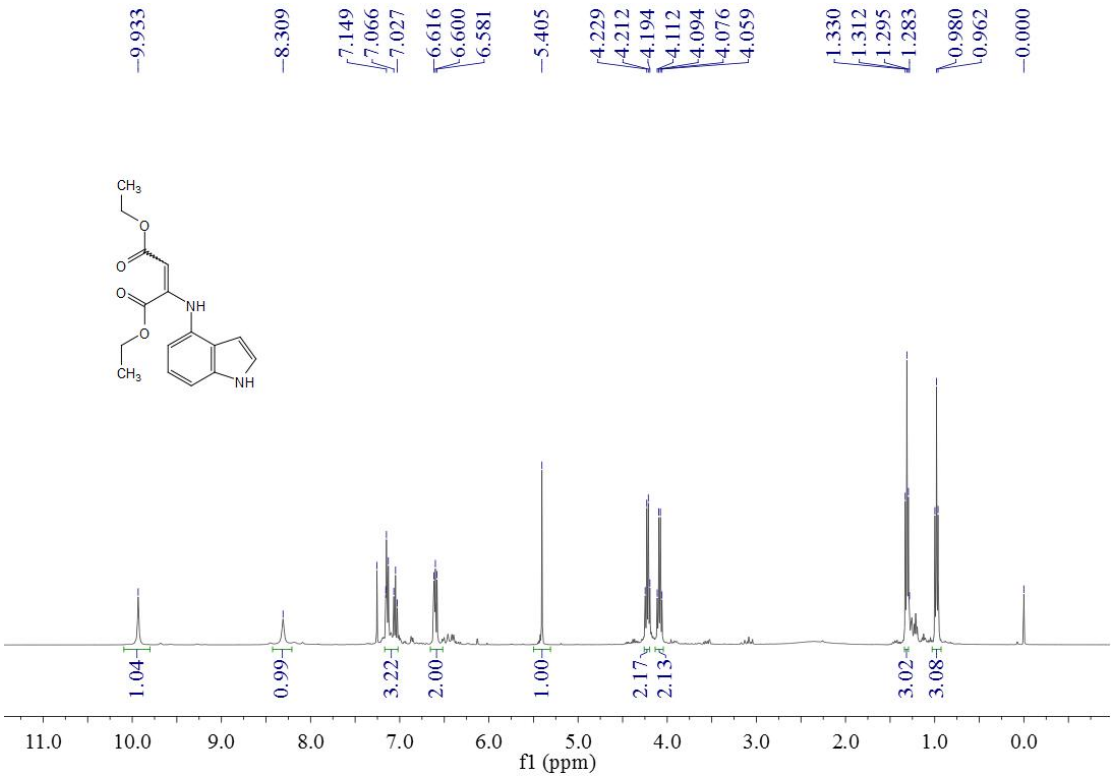


^{13}C NMR spectra of compound **10a**

^{1}H NMR spectra of 7a in DMSO-d_6 and $CDCl_3$



^{1}H NMR spectra of **7a** in DMSO-d_6



^{1}H NMR spectra of **7a** in $CDCl_3$

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1. Zhu, Q.; Jiang, H.; Li, J.; Zhang, M.; Wang, X.; Qi, C., Practical synthesis and mechanistic study of polysubstituted tetrahydropyrimidines with use of domino multicomponent reactions. *Tetrahedron,* **2009**, 65 (23), 4604-4613.

2. (*a*) Ferlin, M. G.; Chiarelotto, G.; Gasparotto, V.; Via, L. D.; Pezzi, V.; Barzon, L.; Palu, G.; Castagliuolo, I., Synthesis and in vitro and in vivo antitumor activity of 2-phenylpyrroloquinolin-4-ones. *J. Med. Chem.,* **2005**, 48 (9), 3417-3427; (*b*) Ferlin, M. G.; Conconi, M. T.; Urbani, L.; Oselladore, B.; Guidolin, D.; Di Liddo, R.; Parnigotto, P. P., Synthesis, in vitro and in vivo preliminary evaluation of anti-angiogenic properties of some pyrroloazaflavones. *Bioorg. Med. Chem.,* **2011**, 19 (1), 448-457; (*c*) Wojciechowski, K.; Bujok, R.; Trawczyński, A.; Wróbel, Z., New Simple Synthesis of Quinoline-4-carbonitriles. *Synlett,* **2012**, 23 (18), 2682-2686; (*d*) Ferlin, M. G.; Carta, D.; Bortolozzi, R.; Ghodsi, R.; Chimento, A.; Pezzi, V.; Moro, S.; Hanke, N.; Hartmann, R. W.; Basso, G.; Viola, G., Design, synthesis, and structure-activity relationships of azolylmethylpyrroloquinolines as nonsteroidal aromatase inhibitors. *J. Med. Chem.,* **2013**, 56 (19), 7536-7551; (*e*) Carta, D.; Dal Prà, M.; Ferlin, M. G., Amidic Coupling in the Synthesis of Pyrroloquinoline 4‐ and 9‐Carboxamides as Potential STAT3 Inhibitors. *ChemistrySelect,* **2018**, 3 (30), 8656-8661; (*f*) Nagarajan, R.; Ramesh, S., One-Pot Synthesis of Pyrrolo[3,2-*f*]- and Pyrrolo[2,3-*h*]quinoline Derivatives: Observation of an Unexpected Mechanistic Pathway. *Synlett,* **2012**, 23 (05), 717-722.