Supporting Information

Synthesis of Spiroindolenine-cyclopentenedione Skeletons and Their Chemical Behaviors: First Example of Lactone-type spiroindolenine structure

Meltem Tan Uygun[1,2 *] and Nurettin Menges[1,2 *]

[1]Pharmaceutical Chemistry Section, Van Yuzuncu Yil University, 65080, Van, Turkey

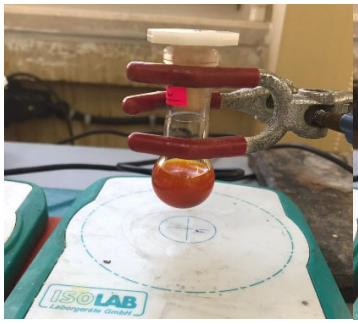
[2]SAFF Chemical Reagent RδD Laboratory, YYU-TEKNOKENT, 65080, Van, Turkey

Email: meltemtan@yyu.edu.tr; nurettinmenges@yyu.edu.tr

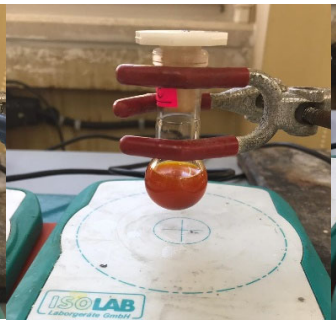
Table of Contents

1. General information

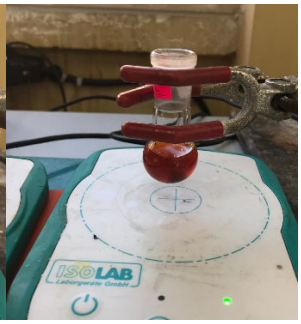
All solvents were dried and distilled using standard procedures. Unless otherwise noted, reagents were obtained from commercial sources and used without further purification. ^{1}H NMR and ^{13}C NMR were recorded in deuterated chloroform and dimethyl sulfoxide ($CDCl_3$ and d_6-DMSO). Coupling constants are recorded in hertz, and chemical shifts are recorded as δ values in ppm. The following abbreviations are used to describe multiplicities: s = singlet, d = doublet, dd = double doublet, t = triplet, m = multiplet. High-resolution mass spectra were carried out on a mass spectrometer with a TOF analyzer (ESI). Infrared spectra were recorded on a FT-IR spectrometer. Melting points were determined by using a local hot-stage melting point apparatus and are uncorrected.



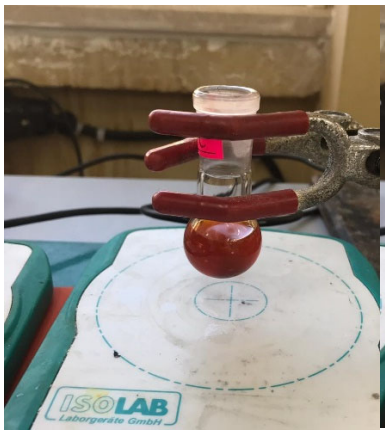
1



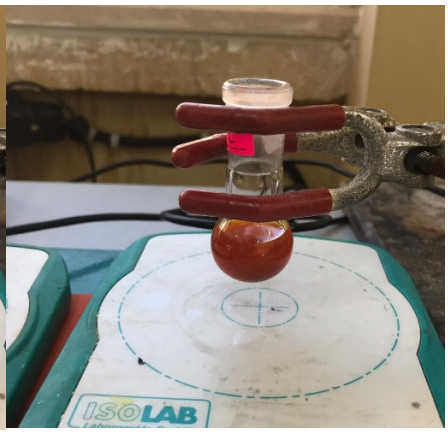
2



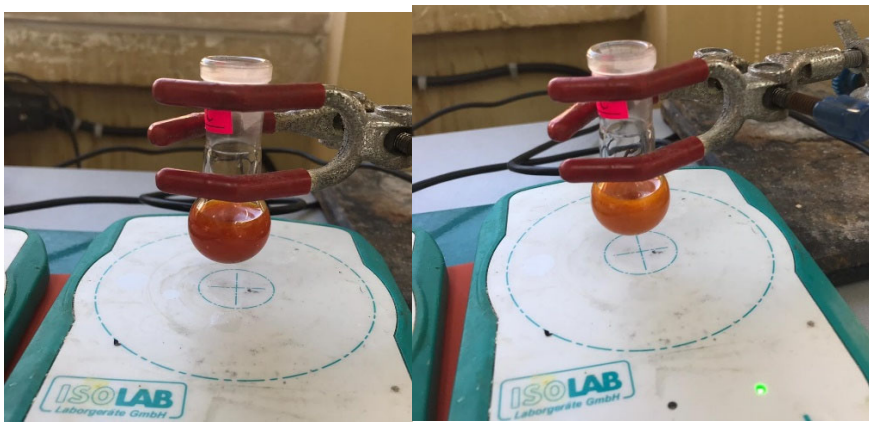
3



4

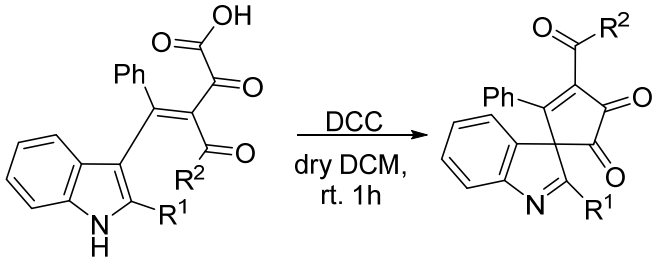


5



6 7

Figure S1. Visual representation of the cyclization reaction.

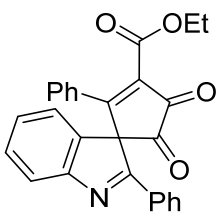


3a-e **4a-e**

Scheme S1. General procedure for synthesis of **4a-e**

In a 50 mL single neck flask, the corresponding indole-3-butenoic acid derivative (1 mmol) was dissolved in anhydrous DCM (10 mL). Then DCC (1.3 mmol) was added to the mixture and the resulting solution was stirred at room temperature for 1h. After completion of the reaction, the crude reaction mixture was refrigerated for 1 h and filtered to remove DCU and then concentrated under reduced pressure. This crude residue was dissolved in dry ether (10 mL), and it was crystallized during refrigeration.

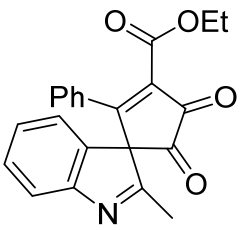
Ethyl 4,5-dioxo-2,2'-diphenylspiro[cyclopentane-1,3'-indol]-2-ene-3-carboxylate (**4a**)



Orange crystal (165-167 ºC), Yield 88% (708 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 (dt, *J*=0.8 and 7.8 Hz, 1H, Ar-H), 7.76-7.73 (m, 2H, Ar-H), 7.54 (td, *J*=1.5 and 7.3, 1H, Ar-H), 7.40 (tt, *J*= 1.5 and 7.3, 1H, Ar-H), 7.37-7.24 (m, 5H, Ar-H), 7.19-7.14 (m, 2H, Ar-H), 6.99-6.96 (m, 2H, Ar-H), 4.39 (dq, *J*=2.2 and 7.2 Hz, 2H, OCH_2), 1.27 (t, *J*=7.2 Hz, 3H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 190.8, 182.4, 173.5, 171.5, 163.4, 156.0, 138.1, 137.9, 133.3, 132.0,

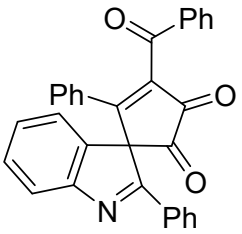
131.9, 131.2, 130.9, 129.3, 129.3, 128.0, 127.9, 127.5, 122.6, 121.7, 71.6, 62.6, 14.1. **HRMS** calculated for $[C_{27}H_{19}NO_4+H]^+$ 422.1387, Found 422.1393.

Ethyl 2'-methyl-4,5-dioxo-2-phenylspiro[cyclopentane-1,3'-indol]-2-ene-3-carboxylate (**4b**)



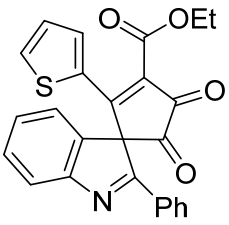
Green-yellow solid (152-155 ºC), Yield 86% (761 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.70 (d, *J*=7.8 Hz, 1H, Ar-H), 7.49 (td, *J*=1.3 and 7.6 Hz, 1H, Ar-H), 7.44 (tt, *J*=1.2 and 7.5 Hz, 1H, Ar-H), 7.30-7.22 (m, 3H, Ar-H), 7.18 (ddd, *J*=0.6, 1.3 and 7.5 Hz, 1H, Ar-H), 7.02-7.00 (m, 2H, Ar-H), 4.39 (q, *J*=7.1 Hz, 2H, OCH_2), 2.18 (s, 3H, CH_3), 1.29 (t, *J*=7.1, 3H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 192.1, 182.1, 175.7, 169.8, 163.4, 156.6, 139.8, 137.5, 133.5, 131.1, 130.6, 129.5, 127.9, 127.1, 122.3, 121.7, 73.5, 62.7, 17.8, 14.1. **HRMS** calculated for $[C_{22}H_{17}NO_4+H]^+$ 360.1230, Found 360.1235.

3-benzoyl-2,2'-diphenylspiro[cyclopentane-1,3'-indol]-2-ene-4,5-dione (**4c**)



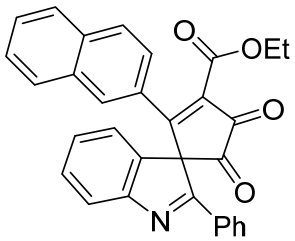
Brick coloured solid (156-158 ºC), Yield 82% (552 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92-7.89 (m, 3H, Ar-H), 7.85-7.82 (m, 2H, Ar-H), 7,63-7.57 (m, 2H, Ar-H), 7.47-7.34 (m, 7H, Ar-H), 7.22 (t, *J*=1.2 and 7.5 Hz, 1H, Ar-H), 7.06-7.02 (m, 2H, Ar-H), 6.96-6.93 (m, 2H, Ar-H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 192.1, 191.1, 183.9, 173.9, 169.8, 156.0, 144.4, 138.4, 135.3, 134.9, 133.4, 132.1, 132.0, 131.2, 130.9, 129.5, 129.5, 129.4, 129.3, 128.6, 128.0, 127.6, 122.8, 121.6, 71.9. **HRMS** calculated for $[C_{31}H_{20}NO_3+H]^+$ = 454.1443, Found $[M+H]^+$ = 454.1439.

Ethyl 4,5-dioxo-2'-phenyl-2-(thiophen-2-yl)spiro[cyclopentane-1,3'-indol]-2-ene-3 carboxylate (**4d**)

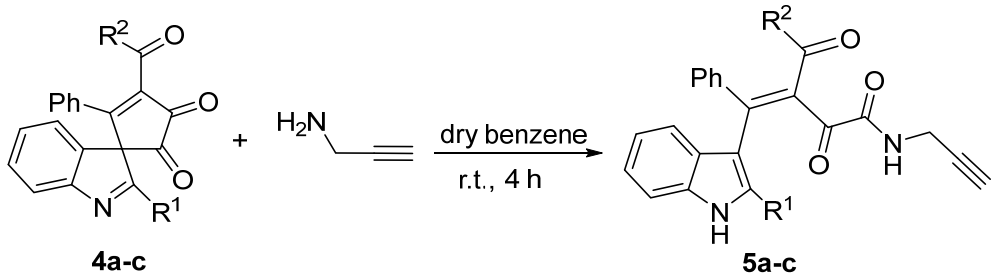


Brick coloured solid (157-159 ºC), Yield 80%; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.87 (dt, *J*=0.7, 7.8 Hz, 1H, Ar-H), 7.83-7.80 (m, 2H, Ar-H), 7.64 (dd, *J*=1.1, 5.0 Hz, 1H, Thp-H), 7.53 (ddd, *J*=2.0, 6.8, 7.8 Hz, 1H, Ar-H), 7.45-7.41 (m, 1H, Ar-H), 7.40-7.35 (m, 2H, Ar-H), 7.28-7.23 (m, 2H, Ar-H), 7.20 (dd, *J*=1.1, 4.1 Hz, 1H, Thp-H), 6.94 (dd, *J*=4.1, 5.0 Hz, 1H, Thp-H), 4.55 (q, J=7.12 Hz, 2H, -OCH_2), 1.46 (t, J=7.1 Hz, 3H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 190.3, 181.8, 173.9, 163.7, 159.9, 155.6, 138.1, 137.2, 135.1, 134.3, 132.9, 131.9, 131.8, 130.7, 129.4, 129.3, 127.7, 127.3, 122.5, 121.5, 71.3, 62.9, 14.1. **HRMS** Calculated for $[C_{25}H_{17}NO_4S+Na]^+$ 450.0771, Found 450.0776.

Ethyl 2-(naphthalen-2-yl)-4,5-dioxo-2'-phenylspiro[cyclopentane-1,3'-indol]-2-ene-3 carboxylate (**4e**)



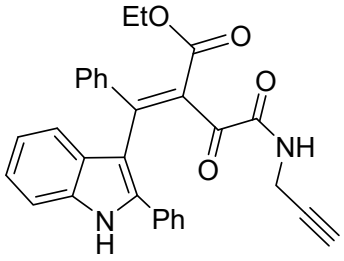
Dark yellow solid (142-144 ºC), Yield 92%; **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (dt, *J*=0.9, 7.9 Hz, 1H, Ar-H), 7.80-7.77 (m, 2H, Ar-H), 7.70 (dd, *J*=0.6, 8.1 Hz, 1H, Ar-H), 7.63 (d, *J*=8.8 Hz, 1H, Ar-H), 7.59-7.55 (m, 2H, Ar-H), 7.54-7.49 (m, 2H, Ar-H), 7.45-7.42 (m, 1H, Ar-H), 7.39-7.34 (m, 2H, Ar-H), 7.34-7.30 (m, 3H, Ar-H), 7.04 (dd, *J*=2.0, 8.7 Hz, 1H, Ar-H), 4.47-4.39 (m, 2H, -OCH_2), 1.28 (t, *J*=7.1 Hz, 3H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 190.6, 182.2, 173.6, 170.8, 163.6, 155.8, 138.0, 137.9, 135.1, 132.4, 131.9, 131.7, 130.8, 129.8, 129.4, 129.2, 129.1, 129.0, 128.4, 127.7, 127.6, 127.4, 127.2, 123.7, 122.5, 121.6, 71.6, 62.6, 14.1. **HRMS** Calculated for $[C_{31}H_{21}NO_4+Na]^+$ 494.1363, Found 494.1370.



Scheme S3. General procedure for synthesis of **5a-c**

In a 50 mL single neck flask, the corresponding spiroindolenine (**4a-c**) (1 mmol) was dissolved in anhydrous benzene (10 mL). Then proparyl amine (1 mmol) was added to the mixture and the resulting solution was stirred at room temperature for 4h. After completion of the reaction, the crude reaction filtered and compounds **5a-c** obtained without any purification.

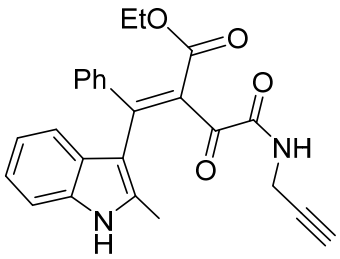
Ethyl 3,4-dioxo-2-(phenyl(2-phenyl-1*H*-indol-3-yl)methylene)-4-(prop-2-yn-1-ylamino)butanoate (**5a**)



Claret red (112-114 ºC), Yield 71% (160 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 9.17 (bs, 0.6H, NH-indole), 9.03 (bs, 0.4H, NH-indole), 7.58-7.56 (m, 1H, Ar-H), 7.49-7.47 (m, 1H, Ar-H), 7.42-7.39 (m, 1H, Ar-H), 7.34 (tt, *J*=1.3 Hz and 7.5 Hz, 1H, Ar-H), 7.30-7.15 (m, 7H, Ar-H), 7.13-7.08 (m, 1H, Ar-H), 6.99-6.92 (m,

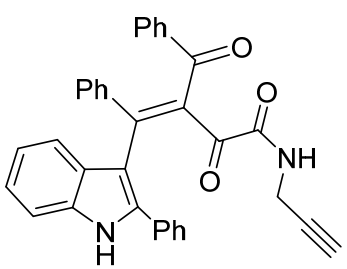
2H, Ar-H), 6.88 (t, *J*=5.6 Hz, 0.4H, NH-amide), 6.29 (t, *J*=5.6 Hz, 0.6H, NH-amide), 4.09-4.00 (m, 1.2H, OCH_2), 3.91 (ddd, *J*=2.6, 5.6 and 17.5 Hz, 0.8H, CH_2-propargyl), 3.82-3.61 (m, 0.8H, OCH_2), 3.51 (ddd, *J*= 2.6, 5.6 and 17.5 Hz, 1.2H, CH_2-propagryl), 2.21 (t, *J*=2.6 Hz, 0.4H, CH), 2.19 (t, *J*=2.6 Hz, 0.6H, CH), 1.00 (t, *J*=7.1 Hz, 1.8H, CH_3), 0.81 (t, *J*=7.1 Hz, 1.2H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 190.2, 188.3, 167.2, 166.0, 160.8, 160.5, 156.9, 155.4, 141.7, 140.4, 140.0, 139.3, 136.4, 136.2, 131.5, 130.8, 130.7, 130.3, 129.9, 129.0, 128.8, 128.7, 128.6, 128.4, 128.3, 128.3, 128.3, 128.2, 123.3, 122.8, 121.4, 121.0, 120.3, 120.0, 113.1, 113.1, 111.7, 111.6, 78.5, 78.3, 72.3, 72.1, 61.2, 61.0, 29.1, 28.8, 13.7, 13.6. **HRMS** calculated for $[C_{30}H_{24}N_2O_4+H]^+$ 477.1809, Found 477.1812.

Ethyl 2-((2-methyl-1*H*-indol-3-yl)(phenyl)methylene)-3,4-dioxo-4-(prop-2-yn-1-ylamino)butanoate (**5b**)



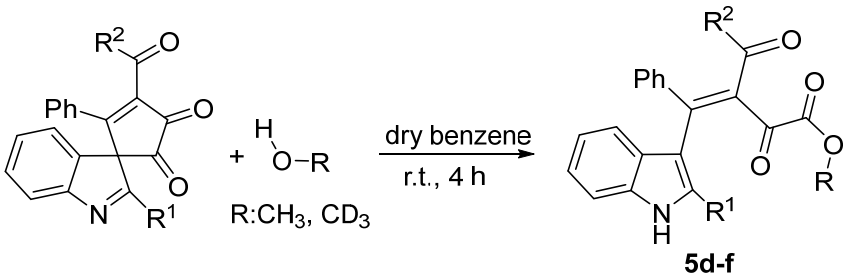
Yellow solid (182-184 ºC), Yield 75% (86.6 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 11.68 (bs, 0.4H, NH-indole), 11.65 (bs, 0.6H, NH-indole), 8.98 (t, *J*=5.8 Hz, 0.4H, NH-amide), 8.75 (t, *J*=5.8 Hz, 0.6H, NH-amide), 7.48-7.25 (m, 5.4 H, Ar-H), 7.12 (d, *J*=7.2 Hz, 0.6H, Ar-H), 7.04-6.98 (m, 1H, Ar-H), 6.84 (t, *J*=7.3 Hz, 0.4H, Ar-H), 6.78 (t, *J*=7.4 Hz, 0.6H, Ar-H), 6.64 (d, *J*=8.0 Hz, 0.4H, Ar-H), 6.55 (d, *J*=8.0 Hz, 0.6H, Ar-H), 3.94 (q, *J*=7.1 Hz, 2H, OCH_2), 3.82-3.80 (m, 0.8H, CH_2-propargyl), 3.46-3.38 (m, 1.2H, CH_2-propargyl), 3.11 (t, J=2.4 Hz, 0.4H, CH), 2.96 (t, J=2.4 Hz, 0.6H, CH), 2.11 (s, 2H, CH_3-indole), 2.07 (s, 1H, CH_3-indole), 0.95 (t, *J*=7.1Hz, 1H, CH_3), 0.90 (t, *J*=7.1Hz, 2H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 189.3, 167.0, 165.9, 162.7, 162.6, 155.7, 141.5, 140.7, 140.2, 136.5, 136.0, 134.9, 130.4, 130.4, 130.3, 129.9, 128.9, 128.7, 128.0, 127.7, 127.1, 122.1, 120.4, 119.9, 119.0, 113.4, 113.2, 111.5, 80.6, 80.5, 73.5, 73.2, 60.7, 28.5, 28.2, 14.0, 13.9, 13.1, 13.0. **HRMS** calculated for $[C_{25}H_{22}N_2O_4+H]^+$ 415.1652, Found 415.1654.

3-benzoyl-2-oxo-4-phenyl-4-(2-phenyl-1*H*-indol-3-yl)-*N*-(prop-2-yn-1-yl)but-3-enamide (**5c**)



Orange solid (204-207 ºC), Yield 78% (80.6 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 11.97 (bs, 0.45H, NH-indole), 11.54 (bs, 0.55H, NH-indole), 9.08 (t, *J*=5.9 Hz, 0.55H, NH-amide), 8.59 (t, *J*=5.8 Hz, 0.45H, NH-amide), 7.81-7.79 (m, 0.55H, Ar-H), 7.56-7.29 (m, 9.55H, Ar-H), 7.26-6.96 (m, 6.45H, Ar-H), 6.92-6.80 (m, 2H, Ar-H), 6.62 (d, *J*=7.9Hz, 0.45H, Ar-H), 3.77-3.74 (m, 1H,

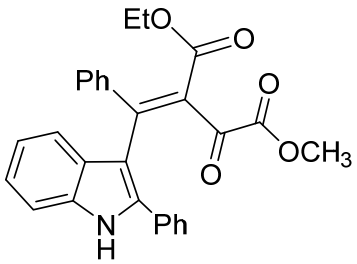
CH_2-propargyl), 3.59-3.41 (m, 1H, CH_2-propargyl), 3.10 (t, *J*=2.4 Hz, 0.55H, CH), 3.03 (t, *J*=2.4 Hz, 0.45H, CH). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 195.7, 194.8, 191.3, 189.9, 160.8, 160.7, 141.6, 141.3, 139.5, 139.0, 137.5, 136.9, 136.2, 136.1, 136.1, 135.9, 132.7, 131.2, 131.0, 130.7, 130.7, 130.5, 130.2, 129.7, 129.2, 129.1, 129.1, 129.0, 129.0, 128.9, 128.9, 128.4, 128.3, 128.3, 128.2, 128.1, 127.2, 123.6, 123.2, 121.8, 121.2, 120.6, 120.3, 114.2, 113.9, 111.6, 111.0, 78.5, 78.3, 72.5, 72.2, 29.3, 29.1. **HRMS** calculated for [$C_{34}H_{24}N_2O_3$+H] 509.1860, Found 509.1867.



Scheme S4. General procedure for synthesis of **5d-f**

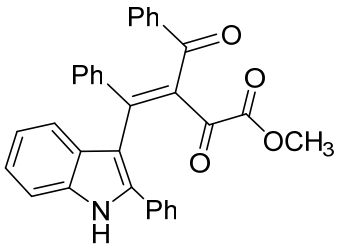
In a 50 mL single neck flask, the corresponding spiroindolenine (1 mmol) was dissolved in anhydrous benzene (10 mL). Then methanol or deuterated methanol (1 mmol) was added to the mixture and the resulting solution was stirred at room temperature for 4h. After completion of the reaction, the crude reaction filtered and compounds **5d-f** obtained without any purification.

1-Ethyl 4-methyl-3-oxo-2-(phenyl(2-phenyl-1*H*-indol-3-yl)methylene)succinate (**5d**)



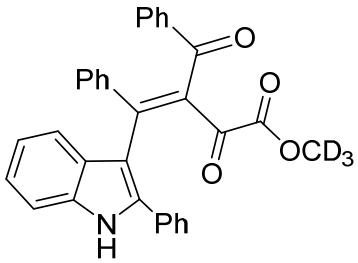
Orange solid (195-198 °C), Yield 91% (195.8 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 12.19 (bs, 1H, NH), 7.55-7.50 (m, 3H, Ar-H), 7.47-7.44 (m,4H, Ar-H), 7.42-7.35 (m, 4H, Ar-H), 7.19-7.15 (m, 1H, Ar-H), 6.95-6.91 (m, 1H, Ar-H), 6.67-6.65 (m, 1H, Ar-H), 4.06-3.91 (m, 2H, CH_2), 2.77 (s, 3H, OCH_3), 0.98 (t, *J*=7.1 Hz, 3H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 183.6, 166.0, 162.5, 155.0, 144.6, 138.3, 136.8, 130.9, 129.9, 129.7, 129.4, 128.7, 128.6, 128.5, 128.4, 127.9, 123.2, 121.0, 119.6, 112.0, 110.6, 60.7, 51.5, 13.5. **HRMS** calculated for [$C_{23}H_{21}NO_5$+H] 454.1649, Found 454.1652.

Methyl 3-benzoyl-2-oxo-4-phenyl-4-(2-phenyl-1*H*-indol-3-yl)but-3-enoate (**5e**)

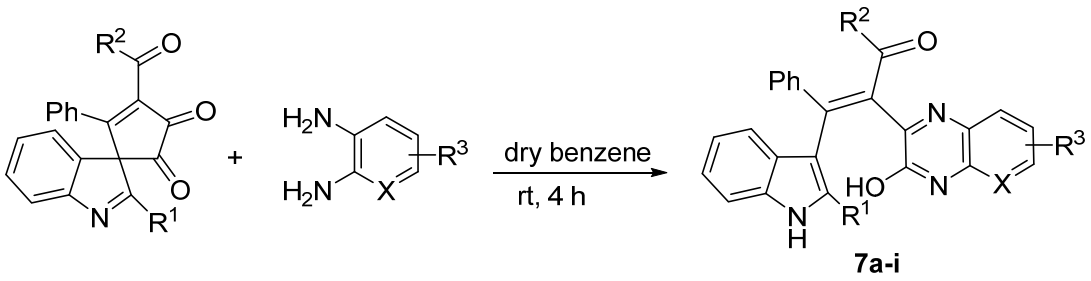


Yellow solid (268-270 ºC), Yield 89% (143.5 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 12.20 (s, 1H, NH), 7.84 (d, *J* = 7.3 Hz, 1H, Ar-H), 7.64-7.57 (m, 3H, Ar-H), 7.50-7.29 (m, 12H, Ar-H), 7.22 – 7.18 (m, 1H, Ar-H), 6.99 – 6.95 (m, 1H, Ar-H), 6.75 (d, *J* = 7.6 Hz, 1H, Ar-H), 2.87 (s, 3H, OCH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 194.2, 185.3, 162.7, 155.1, 144.7, 138.0, 136.9, 136.7, 136.2, 133.3, 130.7, 130.6, 130.0, 129.8, 128.9, 128.8 128.7, 128.6, 128.5, 128.0, 123.2, 121.0, 119.6, 112.0, 111.6, 51.8. **HRMS** calculated for $[C_{32}H_{23}NO_4+H]^+$ 486.1700, Found 486.1708.

Methyl-d_3 3-benzoyl-2-oxo-4-phenyl-4-(2-phenyl-1*H*-indol-3-yl)but-3-enoate (**5f**)

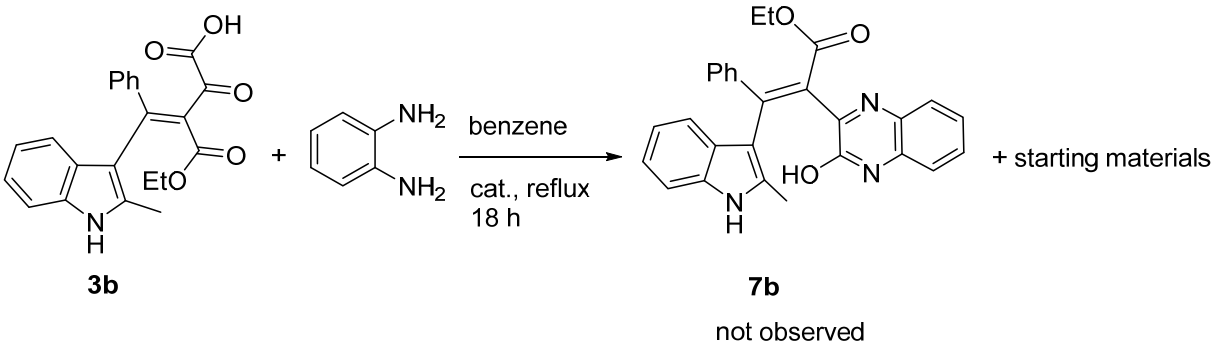


Yellow solid (260-263 ºC), Yield 92% (148.9 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 12.20 (s, 0.8H, NH, %20 ND), 7.84 (d, *J* = 6.8 Hz, 1H, Ar-H), 7.64-7.56 (m, 3H, Ar-H), 7.48-7.42 (m, 6H, Ar-H), 7.38 – 7.29 (m, 6H, Ar-H), 7.22 – 7.18 (m, 1H, Ar-H), 6.98 – 6.95 (m, 1H, Ar-H), 6.76 (d, *J* = 8.1 Hz, 1H, Ar-H). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 194.2, 185.3, 162.7, 155.1, 144.6, 137.9, 136.8, 136.2, 133.4, 130.7, 129.9, 129.8, 128.9, 128.7, 128.7, 128.6, 128.6, 128.5, 128.0, 127.3, 123.2, 120.9, 119.7, 111.9, 111.5. **HRMS** calculated for $[C_{32}H_{20}D_3NO_4+H]^+$ 489.1888, Found 489.1891.



Scheme S5. General procedure for synthesis of **7a-k**

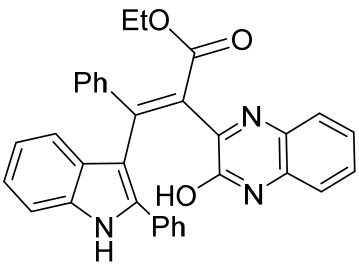
In a 50 mL single neck flask, the corresponding spiroindolenine (1 mmol) was dissolved in anhydrous benzene (10 mL). Then 1,2-diamine derivative (1 mmol) was added to the mixture and the resulting solution was stirred at room temperature for 4h. After completion of the reaction, the crude reaction filtered and compounds **7a-k** obtained without any purification.



Scheme S6. The reaction attempt of indole-3-butyric acid and 1,2-diamino benzene (cat: AcOH or TFA)

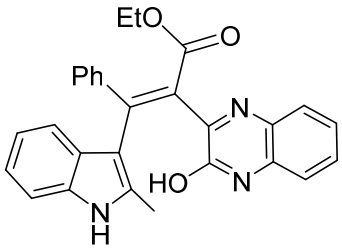
In a 50 mL single neck flask, compound 3b (1 mmol) was dissolved in benzene (10 mL). Then 1,2-diaminobenzene (1 mmol) was added to the solution and the resulting solution was stirred at room temperature for 18h. After 18h, TLC analysis was utilized, and the reaction media was analyzed with ^{1}H-NMR. Same rection was also run using catalytic amount of organic acid such as AcOH and TFA, but the result was the same.

Ethyl 2-(3-hydroxyquinoxalin-2-yl)-3-phenyl-3-(2-phenyl-1*H*-indol-3-yl)acrylate (**7a**)



Yellow solid (202-205 ºC), Yield 82% (99.2 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 12.10 (bs, 1H, OH), 11.48 (s, 1H, NH-indole), 7.50-7.47 (m, 2H, Ar-H), 7.40-7.36 (m, 1H, Ar-H), 7.28-7.16 (m, 10H, Ar-H), 7.11-7.06 (m, 3H, Ar-H), 7.01-6.97 (m, 1H, Ar-H), 6.84-6.80 (m, 1H, Ar-H), 3.94 (q, J=7Hz, 2H, OCH_2), 0.90 (t, 3H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 167.4, 157.6, 153.6, 147.8, 141.2, 138.2, 135.9, 131.7, 131.7, 131.6, 130.0, 129.02, 128.6, 128.4, 128.3, 128.2, 128.0, 127.8, 127.6, 127.6, 122.9, 121.6, 119.5, 118.9, 114.9, 113.0, 111.4, 60.0, 13.6. **HRMS** calculated for $C_{33}H_{25}N_3O_3$+H]$^+$ 512.1969, Found 512.1973.

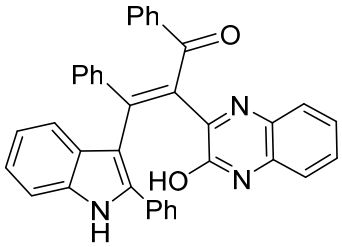
Ethyl 2-(3-hydroxyquinoxalin-2-yl)-3-(2-methyl-1*H*-indol-3-yl)-3-phenylacrylate (**7b**)



Orange solid (160-162 ºC), Yield 85% (212.5 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 11.94 (bs, 1H, OH), 8.31 (bs, 0.5H, NH-indole), 8.11 (bs, 0.5H, NH-indole), 7.59 (d, *J*=8.3 Hz, .05H, Ar-H), 7.52 (d, *J*=7.7 Hz, .05H, Ar-H), 7.42-7.30 (m, 3H, Ar-H), 7.25-7.18 (m, 2.5 H, Ar-H), 7.14-7.04 (m, 3.5H, Ar-H), 6.99-6.94 (m, 1.5H, Ar-H), 6.89 (t, *J*=7.3 Hz, 0.5H, Ar-H), 6.78-6.71 (m, 1H, Ar-H), 4.12-3.96 (m, 2H, OCH_2), 2.15

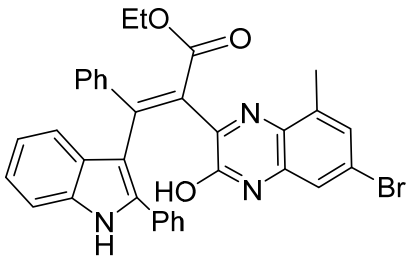
(s, 1.5 H, -CH_3), 1.99 (s, 1.5 H, -CH_3), 0.97 (t, *J*=7.1 Hz, 1.5 H, -CH_3), 0.88 (t, *J*=7.1 Hz, 1.5 H, -CH_3). **^{13}C NMR (100 MHz, d$_6$-DMSO)** δ 167.6, 167.0, 159.2, 158.4, 154.5, 154.1, 149.6, 148.7, 141.8, 141.4, 136.9, 136.4, 135.5, 135.4, 131.8, 131.8, 131.7, 131.6, 130.1, 130.0, 129.7, 129.1, 128.6, 128.4, 128.4, 128.3, 128.0, 127.9, 127.8, 127.6, 126.9, 126.3, 123.2, 123.1, 120.7, 120.5, 119.2, 119.0, 118.7, 118.6, 115.2, 115.0, 113.1, 112.8, 110.8, 110.6, 59.9, 59.8, 13.7, 13.5, 12.5, 12.4. **HRMS** calculated for [$C_{28}H_{23}N_3O_3$+H]$^+$ 450.1812, Found 450.1816.

2-(3-hydroxyquinoxalin-2-yl)-1,3-diphenyl-3-(2-phenyl-1*H*-indol-3-yl)prop-2-en-1-one (**7c**)



Orange solid (280-283 °C), Yield 80% (144 mg); **^{1}H NMR (400 MHz, d$_6$-DMSO)** δ 12.34 (bs, 0.5H, OH-indole), 12.09 (bs, 0.5H, OH-quinoxaline), 11.54 (bs, 0.5H, NH-indole), 11.35 (bs, 0.5H, NH-quinoxaline), 7.86-7.84 (m, 1H, Ar-H), 7.73-7.71 (m, 1H, Ar-H), 7.54-7.45 (m, 2H, Ar-H), 7.39-6.95 (m, 16.5H, Ar-H), 6.90-6.85 (m, 1.5H, Ar-H), 6.82-6.75 (m, 1H, Ar-H). **^{13}C NMR (100 MHz, d$_6$-DMSO)** δ 196.3, 195.2, 160.5, 159.4, 154.3, 153.5, 148.1, 146.9, 140.7, 140.0, 138.6, 138.4, 138.2, 136.2, 136.1, 135.5, 135.1, 132.2, 131.9, 131.8, 131.7, 131.6, 131.1, 130.3, 130.2, 130.1, 129.7, 129.0, 128.8, 128.6, 128.6, 128.5, 128.4, 128.3, 128.1, 128.0, 127.9, 127.8, 127.7, 127.6, 127.2, 126.7, 123.3, 122.9, 122.0, 121.7, 119.7, 119.7, 119.6, 119.0, 115.3, 114.9, 113.5, 113.2, 111.5, 111.1. **HRMS** calculated for [$C_{37}H_{25}N_3O_2$+H] 544.2020, Found 544.2000.

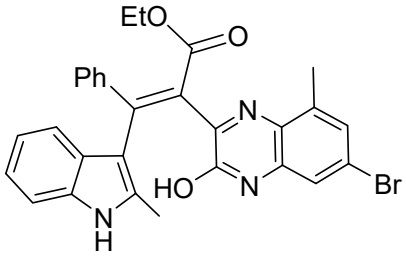
Ethyl 2-(6-bromo-3-hydroxy-8-methylquinoxalin-2-yl)-3-phenyl-3-(2-phenyl-1*H*-indol-3-yl)acrylate (**7d**)



Orange solid (213-216 °C), tautomer ratio: OH (1:1), NH (1:1), Yield 72% (154.8 mg); **^{1}H NMR (400 MHz, d$_6$-DMSO)** δ 11.89 (bs, 0.5H, OH-indole), 11.76 (bs, 0.5H, OH-quinoxaline), 11.63 (bs, 0.5H, NH-indole), 11.53 (bs, 0.5H, NH-quinoxaline), 7.80-7.78 (m, 1H, Ar-H), 7.54 (bs, 1H- Ar-H), 7.44-7.42 (m, 2H, Ar-H), 7.36-7.30 (m, 1H, Ar-H), 7.30-7.17 (m, 5H, Ar-H), 7.13-7.05 (m, 3.5H, Ar-H), 7.02-6.98 (m, 1.5H, Ar-H), 6.93-6.89 (m, 0.5H, Ar-H), 6.84-6.80 (m, 0.5H, Ar-H), 3.94 (qd, *J*=1.1, 7.0 Hz, 1H, OCH_2), 3.66-3.47 (m, 1H, OCH_2), 2.39 (s, 1.5H, CH_3-quinoxaline), 2.29 (s, 1.5H, CH_3-quinoxaline), 0.91 (t, *J*= 7.1 Hz, 1.5H, CH_3), 0.61 (t, *J*= 7.1 Hz, 1.5H, CH_3). **^{13}C NMR (100 MHz, d$_6$-DMSO)** δ 167.3, 166.3, 159.8, 158.5, 154.6, 153.8, 149.5, 148.4, 141.0, 140.8, 138.4, 137.7, 136.3, 136.1, 133.5, 133.2, 132.8, 132.6, 131.6, 131.5, 129.7, 129.6, 129.1, 128.6, 128.6, 128.4, 128.3, 128.3, 128.1, 128.0, 127.9, 127.9, 127.8, 127.7, 126.7, 126.3, 121.9, 121.7, 119.7, 119.7, 119.1, 119.1, 114.4, 113.8, 113.0, 112.8, 111.6, 111.5,

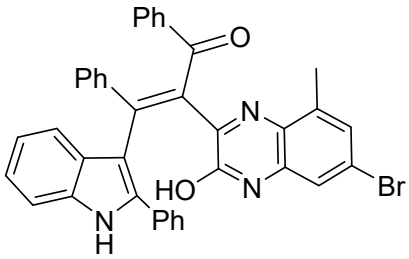
60.1, 59.7, 16.5, 16.4, 13.6, 13.4. **HRMS** calculated for $[C_{34}H_{26}BrN_3O_3+H]^+$= 604.1231, Found 604.1234

Ethyl 2-(6-bromo-3-hydroxy-8-methylquinoxalin-2-yl)-3-(2-methyl-1*H*-indol-3-yl)-3-phenylacrylate (**7e**)



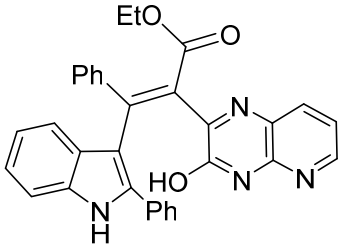
Mustard coloured solid (254-258 °C), Yield 77% (174 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 11.91 (bs, 0.45H, OH-indole), 11.82 (bs, 0.55H, OH-quinoxaline), 11.45 (bs, 0.55H, NH-indole), 11.18 (bs, 0.45H, NH-quinoxaline), 7.51-7.35 (m, 3.55H, Ar-H), 7.30 (d, *J*=8.0Hz, 0.55H, Ar-H), 7.23-7.14 (m, 3H, Ar-H), 7.04-6.98 (m, 1.55H, Ar-H), 6.90-6.87 (m, 0.55H, Ar-H), 6.82 (t, *J*=7.4 Hz, 0.55H, Ar-H), 6.74-6.68 (m, 1.45H, Ar-H), 3.95-3.88 (m, 2H, OCH_2), 2.40 (s, 1.65H, CH_3-quinoxaline), 2.33 (s, 1.35H, CH_3-quinoxaline), 2.15 (s, 1.65H, CH_3-indole), 1.90 (s, 1.35H, CH_3-indole), 0.90-0.85 (m,3H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 167.5, 166.8, 160.1, 159.3, 154.9, 154.3, 150.2, 149.4, 141.6, 141.3, 137.2, 136.6, 135.5, 133.3, 133.3, 132.8, 132.7, 129.7, 129.7, 129.6, 129.1, 128.8, 128.5, 128.1, 128.1, 128.0, 127.8, 127.5, 126.7, 126.5, 126.4, 125.6, 120.7, 120.6, 119.3, 119.2, 118.7, 118.6, 114.3, 114.1, 113.1, 112.9, 110.8, 110.7, 60.0, 59.9, 16.5, 16.4, 13.7, 13.6, 12.6. **HRMS** calculated for $[C_{29}H_{24}BrN_3O_3+H]^+$ 542.1074, Found 542.1078.

2-(6-bromo-3-hydroxy-8-methylquinoxalin-2-yl)-1,3-diphenyl-3-(2-phenyl-1*H*-indol-3-yl)prop-2-en-1-one (**7f**)



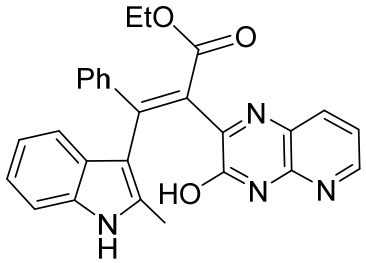
Yellow solid (235-238 °C), Yield 75% (105.4 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 11.59 (bs, 1H, OH), 11.58 (bs, 1H, NH), 7.84-7.83 (m, 2H, Ar-H), 7.47-7.45 (m, 2H, Ar-H), 7.42 (bs, 1H, Ar-H), 7.40-7.36 (m, 1H, Ar-H), 7.34-7.29 (m, 3H, Ar-H), 7.17-7.15 (m, 3H, Ar-H), 7.12-7.02 (m, 8H, Ar-H), 6.85 (t, *J*=7.5Hz, 1H, Ar-H), 2.28 (s, 3H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 195.9, 160.0, 153.5, 147.4, 140.6, 138.8, 138.2, 136.2, 134.4, 133.1, 133.0, 132.7, 132.0, 131.6, 129.9, 129.5, 128.9, 128.7, 128.4, 128.4, 128.1, 128.0, 127.9, 127.7, 126.3, 121.8, 119.8, 119.2, 113.7, 113.3, 111.6, 16.4. **HRMS** calculated for $[C_{38}H_{26}BrN_3O_2+H]^+$ 636.1281, Found 636.1293.

Ethyl 2-(3-hydroxypyrido[2,3-b]pyrazin-2-yl)-3-phenyl-3-(2-phenyl-1*H*-indol-3-yl)acrylate (**7g**)



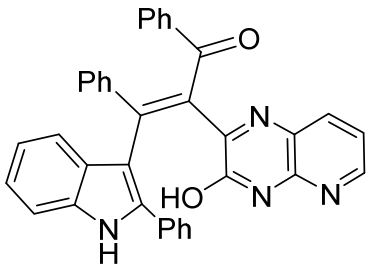
Orange solid (198-200 ºC), Yield 70% (150.6 mg); **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.57 (bs, 0.33H, NH-indole), 8.49 (dd, *J*=1.7 and 4.8 Hz, 0.33H, Py-H), 8.40 (bs, 0.66H, NH-indole), 8.38 (dd, *J*=1.7 and 4.8 Hz, 0.66H, Py-H), 7.95 (dd, *J*=1.7 and 8.0 Hz, 0.33H, Py-H), 7.72-7.70 (m, 0.66H, Ar-H), 7.61 (dd, *J*=1.7 and 8.0 Hz, 0.66H, Py-H), 7.47-7.44 (m, 1.33H, Ar-H), 7.39-7.37 (m, 0.33H, Ar-H), 7.35-7.26 (m, 4H, Ar-H), 7.21-7.16 (m, 2.31H, Ar-H), 7.12-6.97 (m, 5.61H, Ar-H), 6.89-6.85 (m, 0.66H, Ar-H), 4.07-4.00 (m, 1.33H, OCH_2), 3.86-3.68 (m, 0.66H, OCH_2), 0.96 (t, *J*=7.1Hz, 2H, CH_3), 0.71 (t, *J*=7.1Hz, 1H, CH_3). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 168.5, 167.4, 160.4, 158.8, 155.5, 151.1, 149.4, 143.6, 143.3, 141.3, 141.0, 138.1, 137.5, 137.2, 136.2, 136.0, 131.9, 131.8, 130.4, 129.6, 129.4, 129.1, 129.1, 129.0, 128.7, 128.7, 128.6, 128.3, 128.3, 128.2, 128.1, 127.9, 127.8, 122.8, 122.7, 120.9, 120.8, 120.4, 119.9, 119.5, 119.4, 114.9, 113.9, 111.0, 61.00, 60.8, 13.8, 13.7. **HRMS** calculated for $[C_{32}H_{24}N_4O_3+H]^+$ 513.1921, Found 513.1928.

Ethyl 2-(3-hydroxypyrido[2,3-b]pyrazin-2-yl)-3-(2-methyl-1*H*-indol-3-yl)-3-phenylacrylate (**7h**)



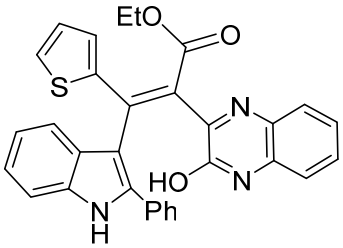
Yellow solid (294-295 ºC), Yield 74% (114.4 mg); **^{1}H NMR (400 MHz, d_6-DMSO)** δ 12.93 (bs, 0.45H, OH-indole), 12.82 (bs, 0.55H, OH-quinoxaline), 11.47 (bs, 0.55H, NH-indole), 11.21 (bs, 0.45H, NH-quinoxaline), 8.46 (dd, *J*=1.7 and 4.7 Hz, 0.55H, Py-H), 8.41 (dd, *J*=1.7 and 4.7 Hz, 0.45H, Py-H), 7.91 (dd, *J*=1.7 and 8.0 Hz, 0.55H, Py-H), 7.87 (dd, *J*=1.7 and 8.0 Hz, 0.45H, Py-H), 7.42-7.35 (m, 1.35H, Ar-H), 7.31-7.25 (m, 1H, Ar-H), 7.24-7.21 (m, 1.35H, Ar-H), 7.19-7.13 (m, 1.90H, Ar-H), 7.04-6.98 (m, 1.65H, Ar-H), 6.89-6.80 (m, 1H, Ar-H), 6.74-6.67 (m, 1.55H, Ar-H), 3.95-3.87 (m, 2H, OCH_2), 2.16 (s, 1.65H, CH_3-indole), 1.88 (s, 1.35H, CH_3-indole), 0.86 (t, *J*=7.1Hz, 1.35H, CH_3), 0.85 (t, *J*=7.1Hz, 1.65H, CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 167.5, 166.7, 160.4, 159.6, 155.9, 155.3, 150.5, 150.1, 150.0, 149.6, 143.5, 143.3, 141.6, 141.2, 137.3, 136.9, 136.3, 136.2, 135.5, 135.4, 129.8, 129.1, 128.8, 128.6, 128.1, 128.1, 127.8, 127.4, 126.9, 126.8, 126.2, 125.4, 120.8, 120.7, 119.9, 119.8, 119.3, 119.2, 118.7, 118.6, 113.0, 112.8, 110.8, 110.8, 60.1, 60.0, 13.7, 13.5, 12.6. **HRMS** calculated for $[C_{27}H_{22}N_4O_3+H]^+$ 451.1765, Found 451.1769.

2-(3-hydroxypyrido[2,3-b]pyrazin-2-yl)-1,3-diphenyl-3-(2-phenyl-1*H*-indol-3-yl)prop-2-en-1-one (**7i**)



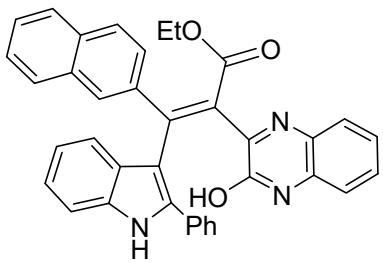
Orange solid (233-236 ºC), Yield 72% (77.9 mg); **^{1}H NMR (400 MHz, d$_6$-DMSO)** δ 12.54 (bs, 1H, OH), 11.60 (bs, 1H, NH), 8.36 (dd, *J*=1.7 and 4.7 Hz, 1H, Py-H), 7.85-7.82 (m, 2H, Ar-H), 7.54 (dd, *J*=1.6 and 8.0Hz, 1H, Py-H), 7.44-7.42 (m, 2H, Ar-H), 7.41-7.35 (m, 2H, Ar-H), 7.34-7.30 (m, 3H, Ar-H), 7.16-7.13 (m, 5H, Ar-H), 7.09-7.00 (m, 5H, Ar-H), 6.86-6.82 (m, 1H, Ar-H). **^{13}C NMR (100 MHz, d$_6$-DMSO)** δ 196.6, 195.4, 164.2, 163.0, 154.1, 153.2, 149.3, 147.8, 145.5, 145.1, 143.0, 142.8, 140.8, 140.7, 140.5, 139.2, 138.4, 138.3, 136.4, 136.3, 135.1, 134.5, 132.2, 131.7, 131.2, 130.7, 130.3, 130.0, 129.3, 129.1, 128.7, 128.6, 128.6, 128.5, 128.2, 127.9, 127.8, 127.6, 127.5, 127.0, 125.4, 125.1, 124.5, 124.0, 122.3, 122.0, 120.1, 120.0, 119.9, 119.2, 113.4, 111.9, 111.4, 109.8. **HRMS** calculated for $[C_{36}H_{24}N_4O_2+Na]^+$ 567.1792, Found 567.1794.

Ethyl 2-(3-hydroxyquinoxalin-2-yl)-3-(2-phenyl-1*H*-indol-3-yl)-3-(thiophen-2-yl)acrylate (**7j**)



Yellow solid (207-209 ºC), Yield 94%; **^{1}H NMR (400 MHz, d$_6$-DMSO)** δ 12.44 (s, 1H, -NH), 11.78 (s, 1H, -OH), 7.80-7.78 (m, 2H, Ar-H), 7.75 (d, *J*=8.0 Hz, 1H, Ar-H), 7.57-7.53 (m, 1H, Ar-H), 7.46 (d, *J*=8.1 Hz, 1H, Ar-H), 7.41 (dd, *J*=1.1, 4.9 Hz, 1H, Ar-H), 7.36-7.28 (m, 5H, Ar-H), 7.25-7.21 (m, 1H, Ar-H), 7.16-7.12 (m, 1H, Ar-H), 7.01-6.97 (m, 1H, Ar-H), 6.76-6.71 (m, 2H, Ar-H), 3.65-3.55 (m, 2H, -OCH_2), 0.55 (t, *J*=7.1 Hz, 3H, -CH_3). **^{13}C NMR (100 MHz, d$_6$-DMSO)** δ 166.8, 158.9, 154.4, 143.8, 141.0, 137.4, 136.4, 132.6, 132.5, 132.1, 131.3, 131.0, 130.4, 129.3, 129.2, 128.8, 128.8, 128.0, 127.5, 126.9, 123.8, 122.4, 120.1, 119.4, 115.8, 113.3, 111.9, 60.1, 13.7. **HRMS** Calculated for $[C_{31}H_{24}N3O_3S+H]^+$ 518.1538, Found 518.1522.

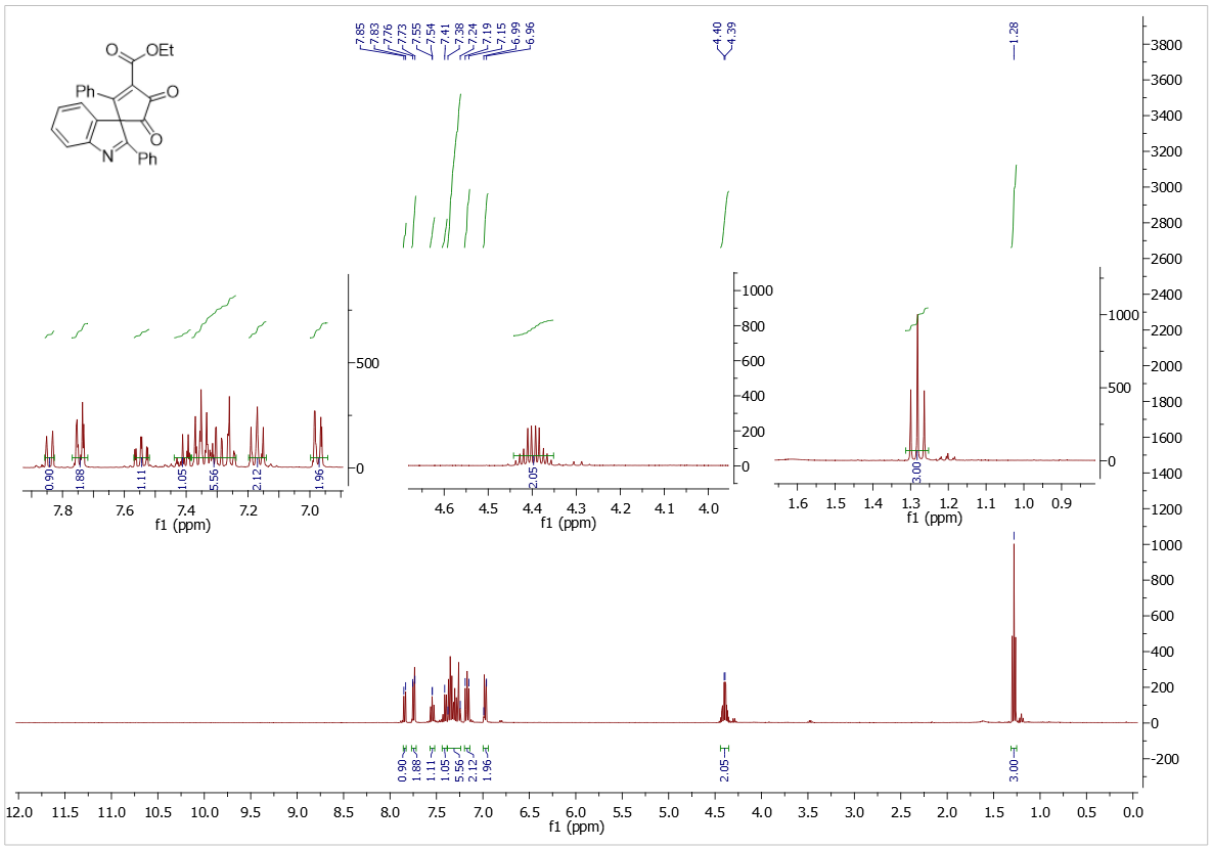
Ethyl 2-(3-hydroxyquinoxalin-2-yl)-3-(naphthalen-2-yl)-3-(2-phenyl-1*H*-indol-3-yl)acrylate (**7k**)



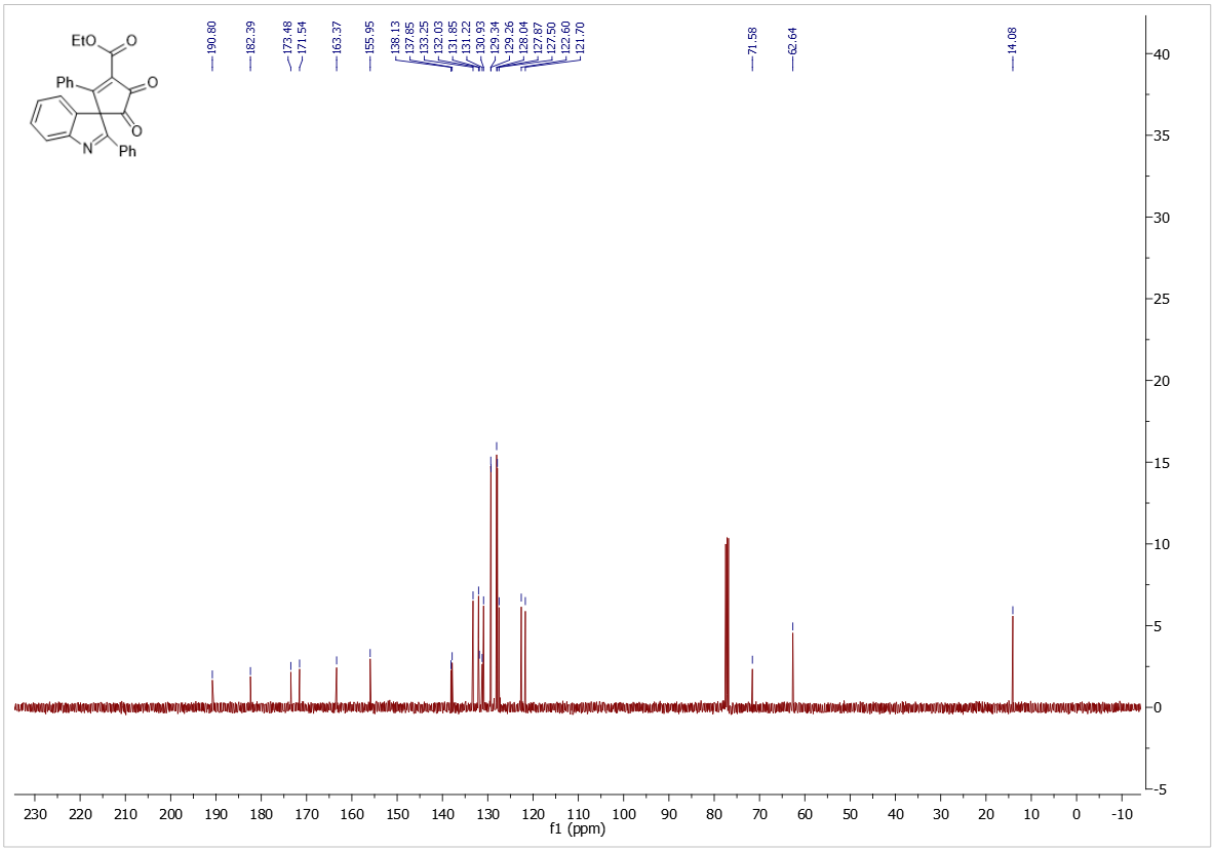
Mustard yellow solid (230-232 ºC), Yield 96%; **^{1}H NMR (400 MHz, d$_6$-DMSO)** δ 12.38 (bs, 0.4H, OH-indole), 12.17 (bs, 0.6H, OH-quinoxaline), 11.81 (bs, 0.4H, NH-indole), 11.57 (bs, 0.6H, NH-quinoxaline), 7.84-7.81 (m, 1.8H, Ar-H), 7.75-7.69 (m, 1.6H, Ar-H), 7.65-7.57 (m, 1.4H, Ar-H), 7.52-7.45 (m, 3.2H, Ar-H), 7.43-7.36 (m, 1.5H, Ar-H), 7.34-7.28 (m, 2.2H, Ar-H), 7.24-7.05 (m, 6.2H, Ar-

H), 7.01-6.97 (m, 0.8H, Ar-H), 6.92-6.88 (m, 0.6H, Ar-H), 6.82-6.78 (m, 0.7H, Ar-H), 3.95-3.89 (m, 1H, -OCH_2), 3.68-3.53 (m, 1H, -OCH_2), 0.80 (t, *J*=7.1 Hz, 1.8H, -CH_3), 0.61 (t, *J*=7.1 Hz, 1.2H, -CH_3). **^{13}C NMR (100 MHz, d_6-DMSO)** δ 167.8, 167.0, 159.2, 158.1, 154.6, 154.1, 149.1, 148.3, 139.2, 139.0, 138.8, 138.0, 136.7, 136.4, 133.2, 133.0, 132.8, 132.7, 132.3, 132.2, 132.2, 132.1, 132.0, 131.9, 130.7, 130.5, 129.9, 129.5, 129.2, 129.0, 128.7, 128.7, 128.6, 128.5, 128.5, 128.4, 128.3, 128.1, 127.9, 127.8, 127.7, 127.6, 127.5, 127.4, 127.0, 126.9, 126.6, 123.7, 123.4, 122.3, 122.1, 120.1, 120.0, 119.5, 119.3, 115.7, 115.4, 113.7, 113.4, 112.0, 111.9, 60.4, 60.1, 14.0, 13.8. **HRMS** Calculated for $[C_{37}H_{28}N_3O_3+H]^+$ 562.2131, Found 562.2111.

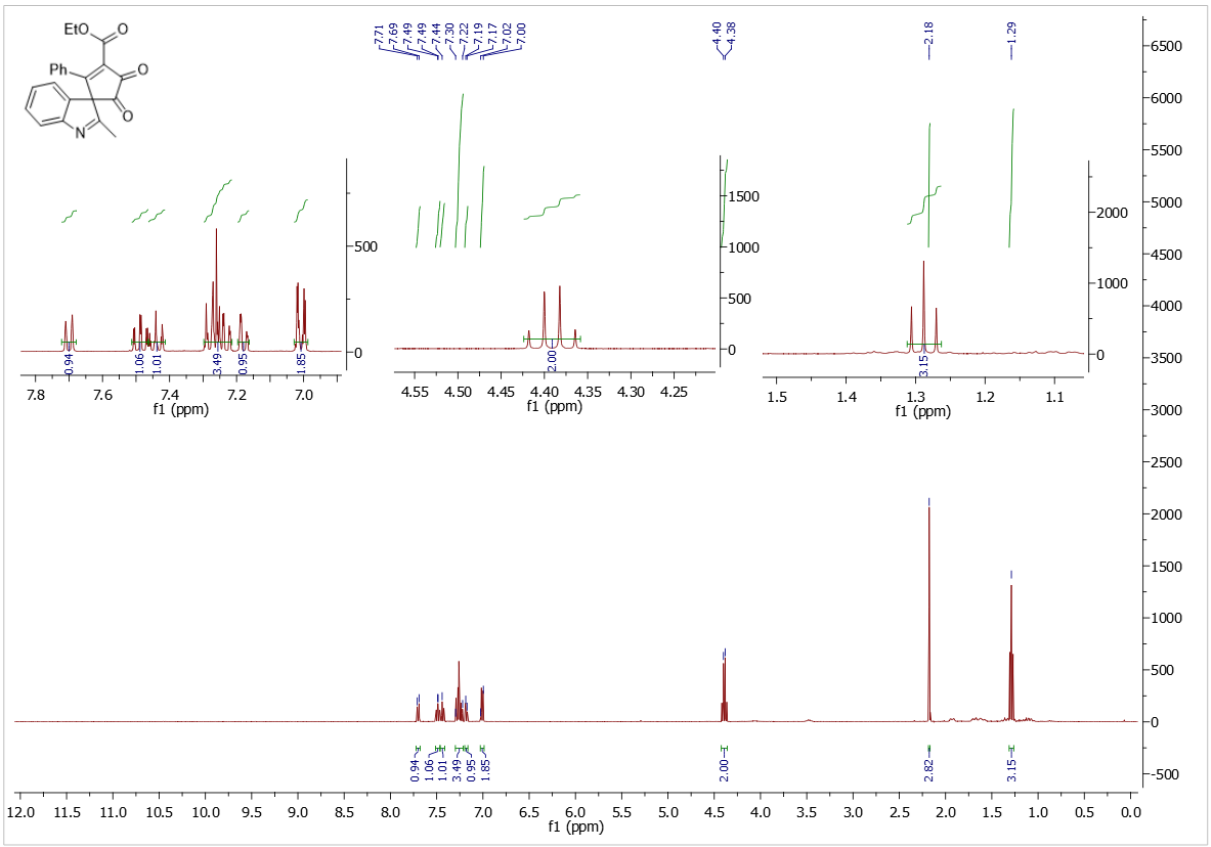
Copies of ^{1}H NMR and ^{13}C NMR spectra



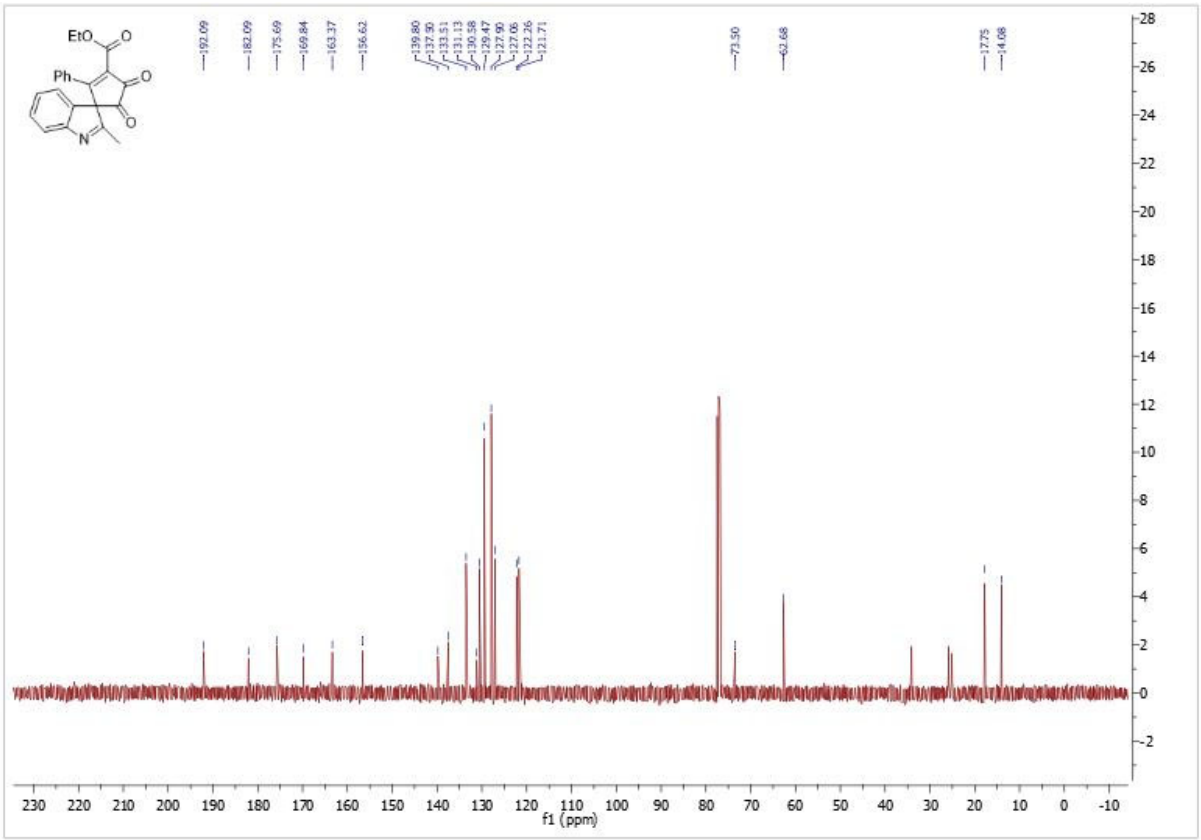
^{1}H-NMR spectrum of compound **4a**



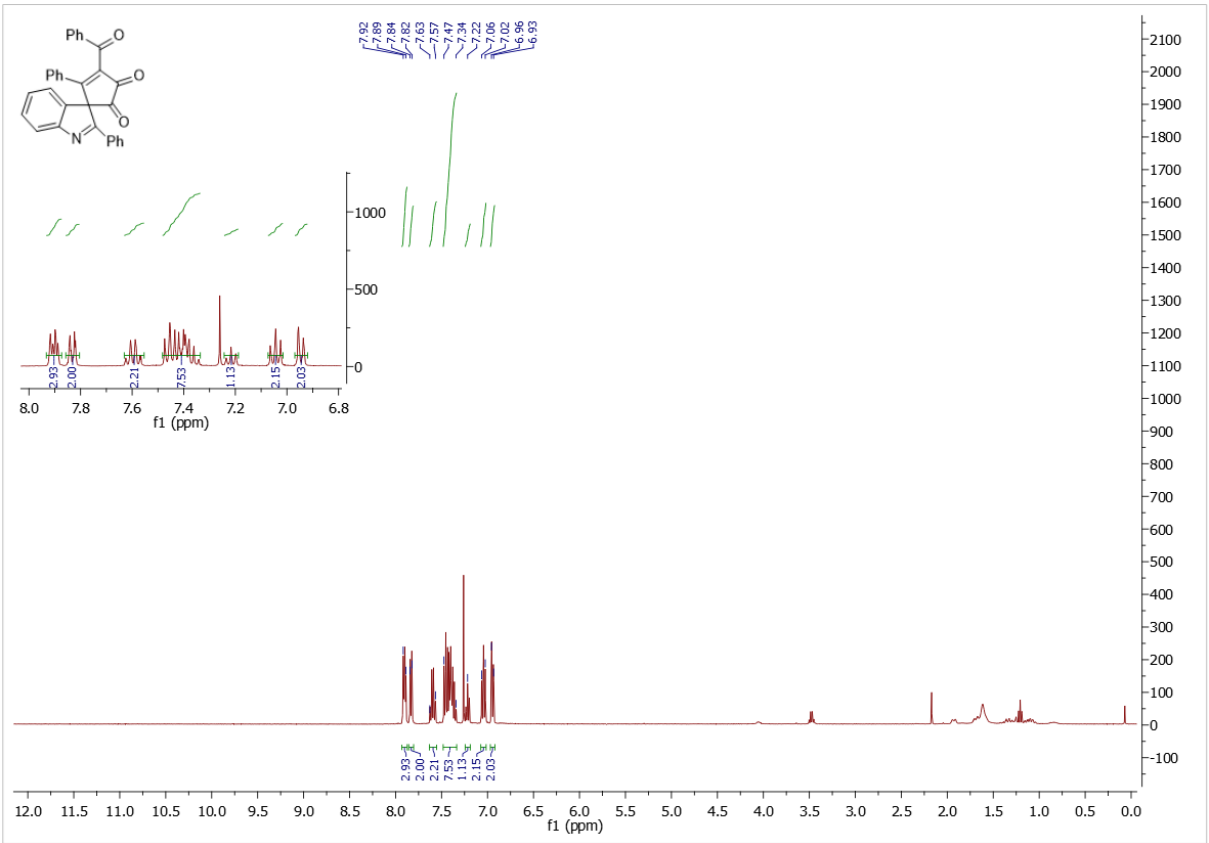
^{13}C-NMR spectrum of compound **4a**



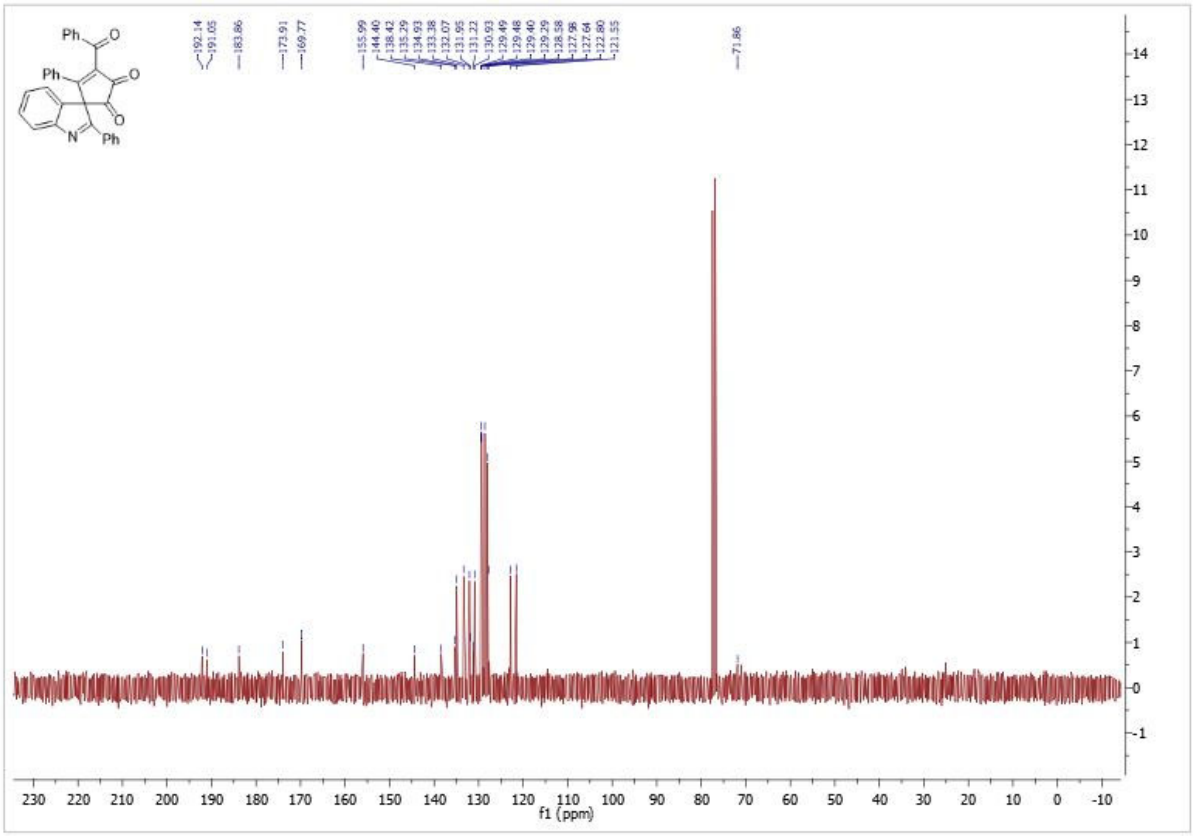
[1]H-NMR spectrum of compound **4b**



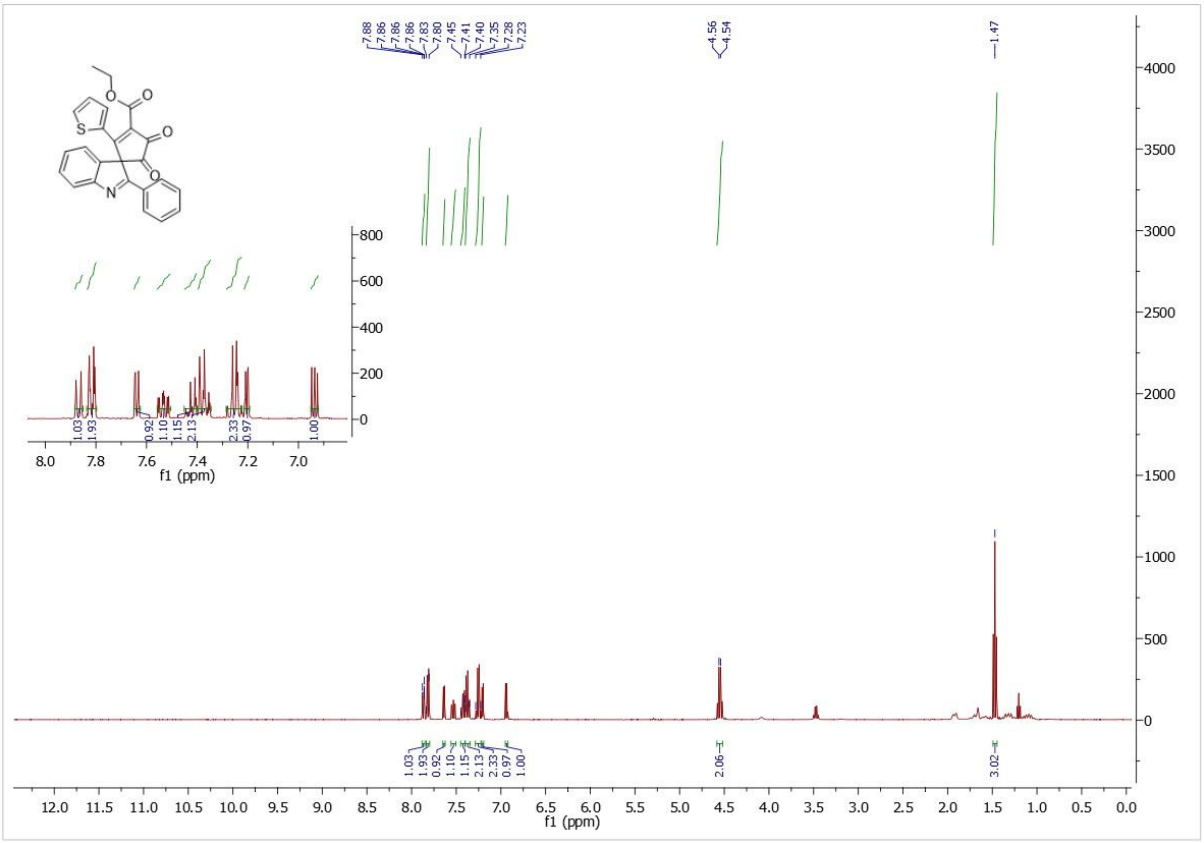
[13]C-NMR spectrum of compound **4b**



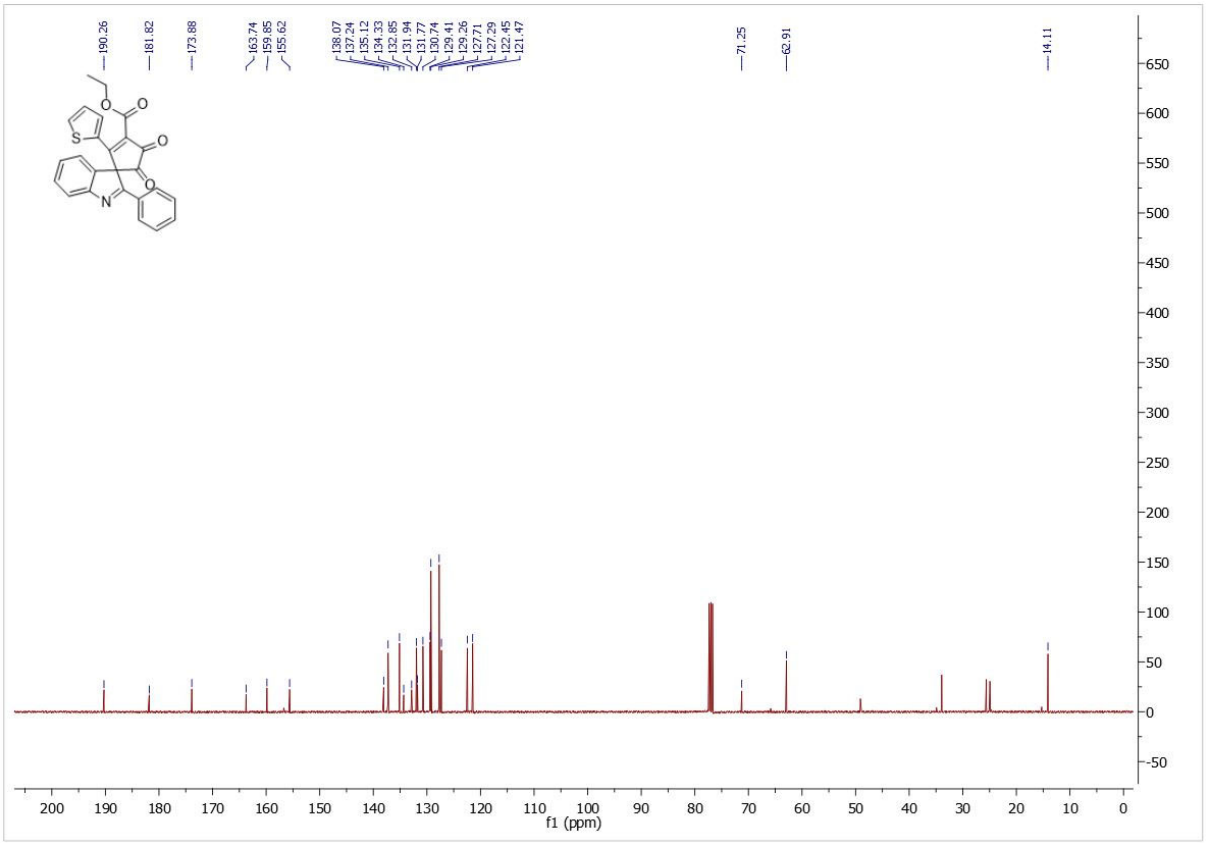
^{1}H-NMR spectrum of compound **4c**



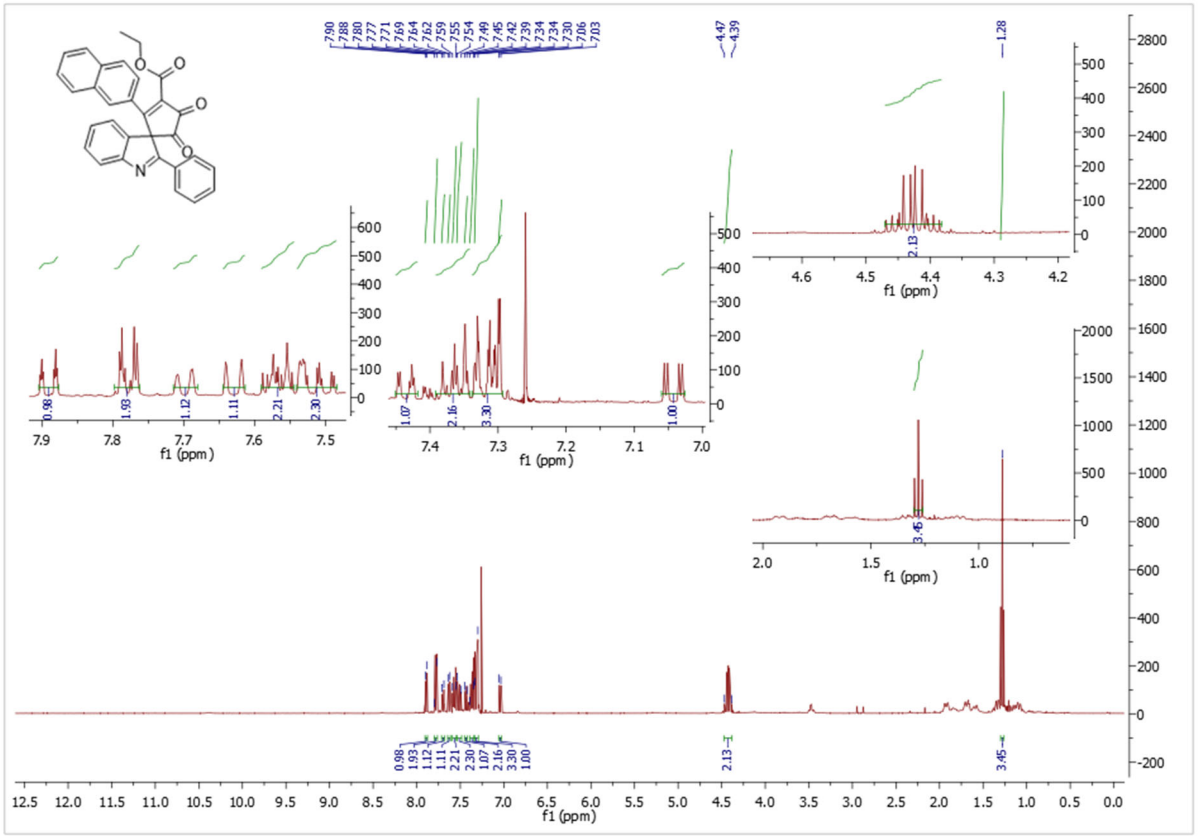
^{13}C-NMR spectrum of compound **4c**



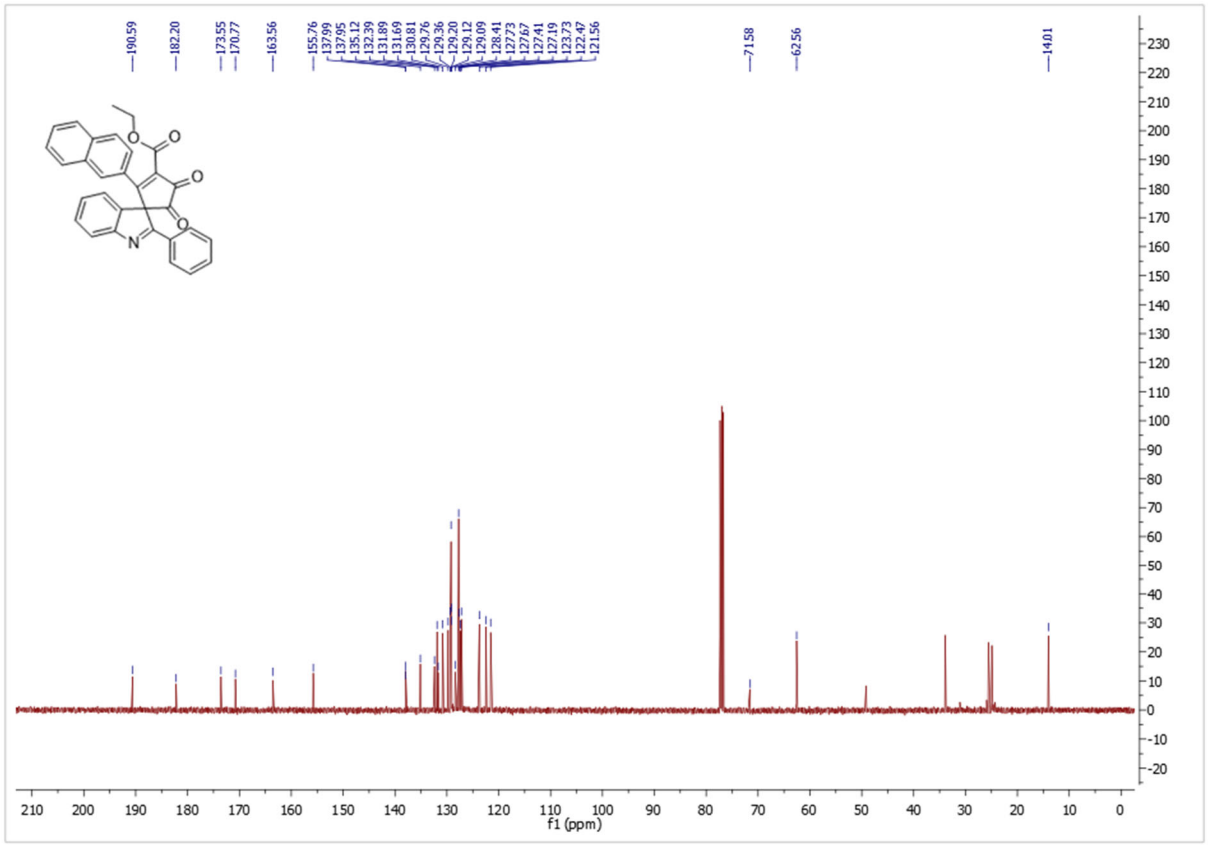
^{1}H-NMR spectrum of compound **4d**



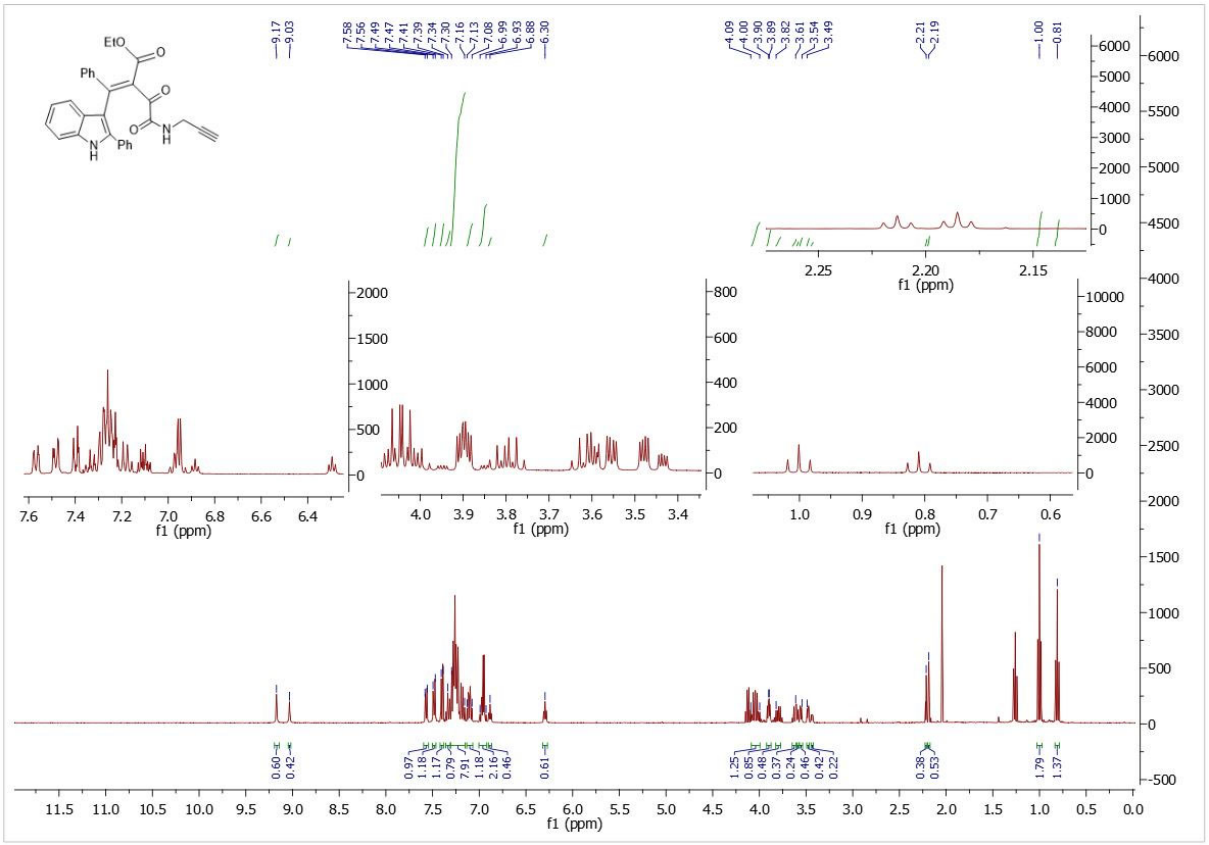
^{13}C-NMR spectrum of compound **4d**



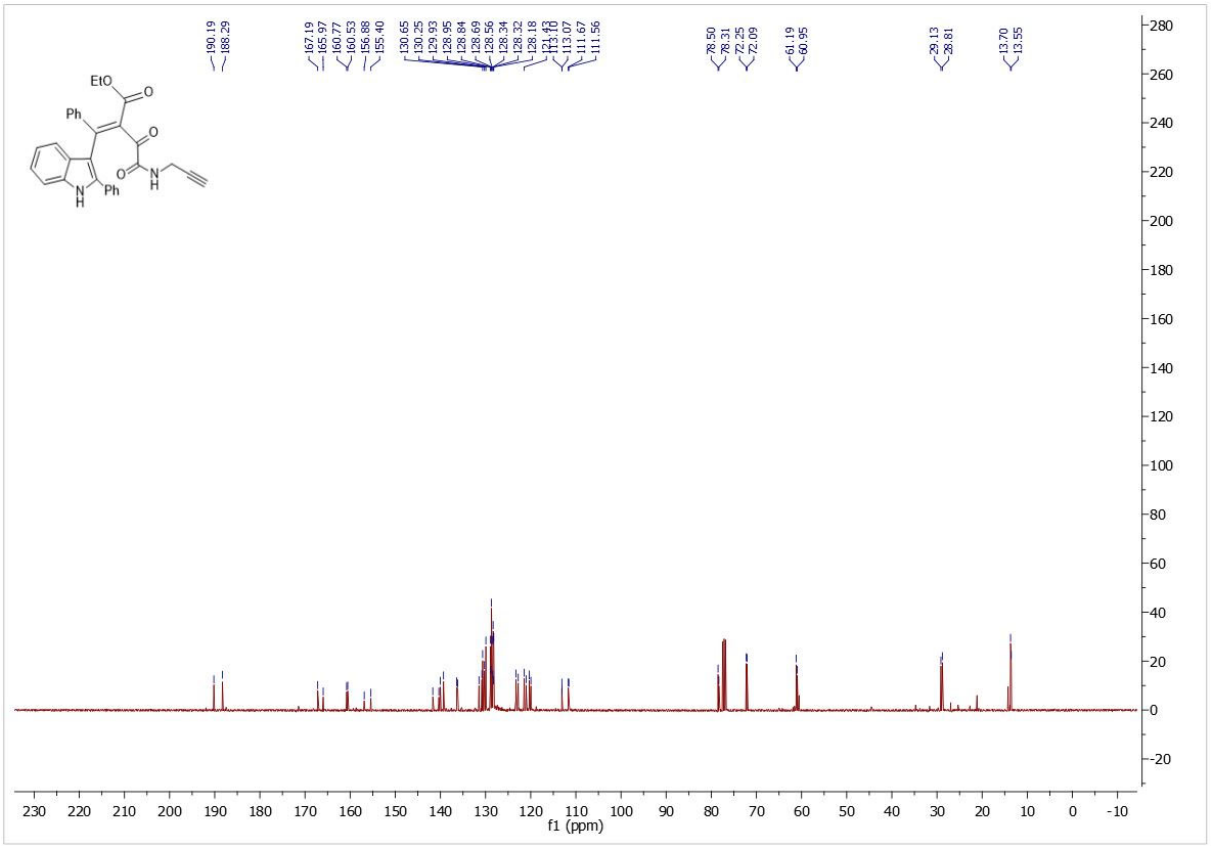
^{1}H-NMR spectrum of compound **4e**



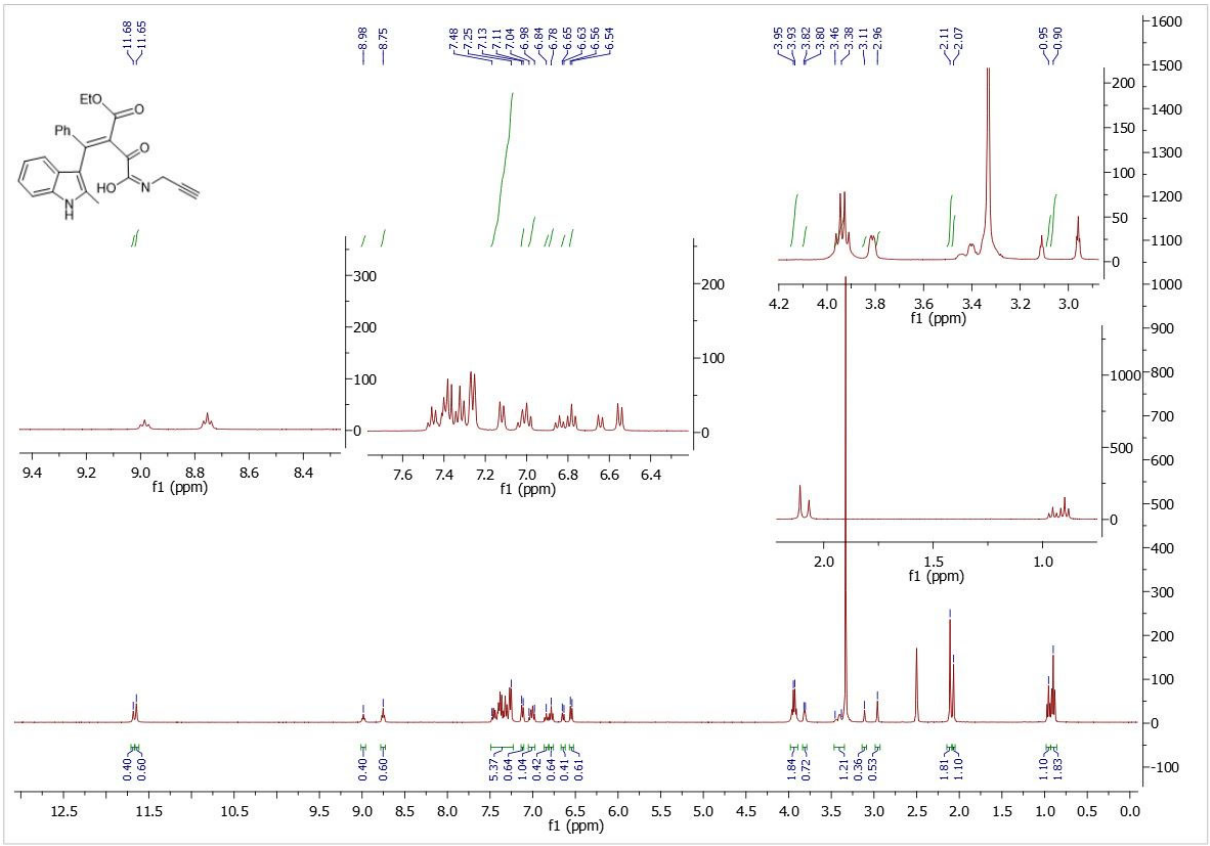
^{13}C-NMR spectrum of compound **4e**



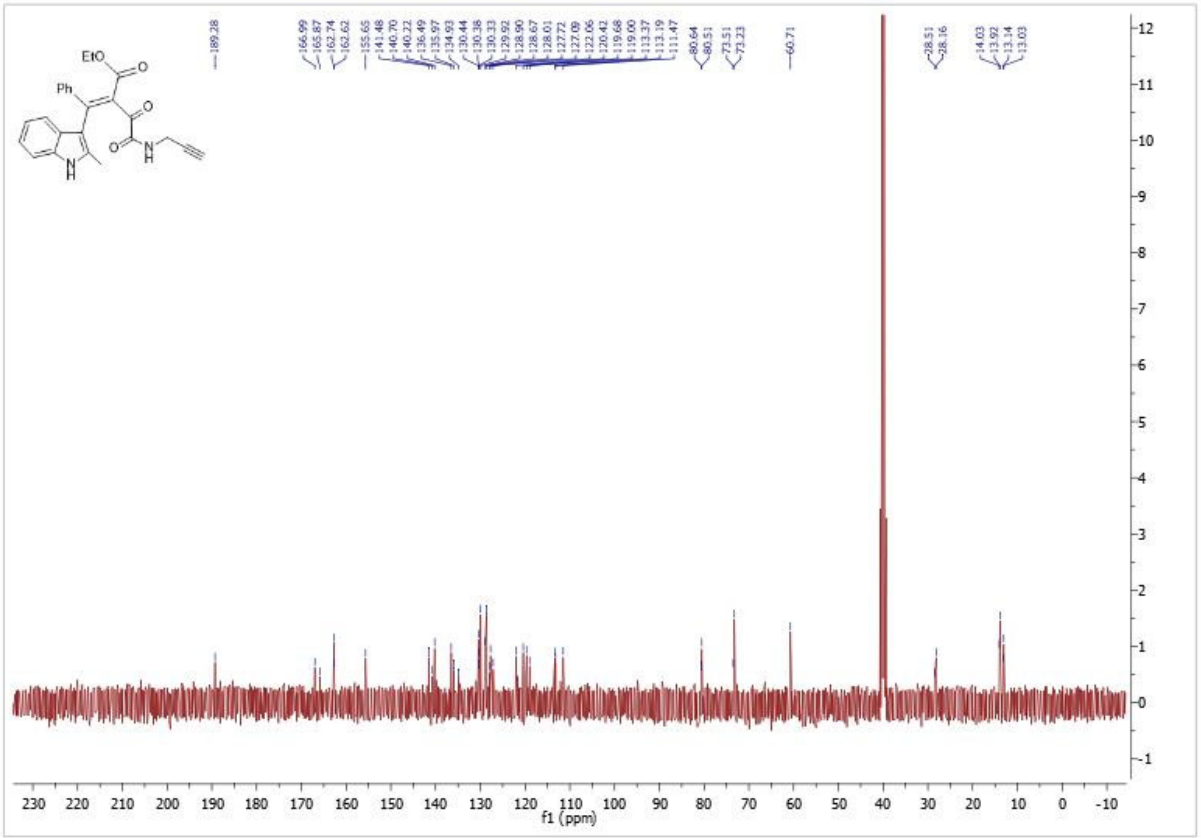
^{1}H-NMR spectrum of compound **5a**



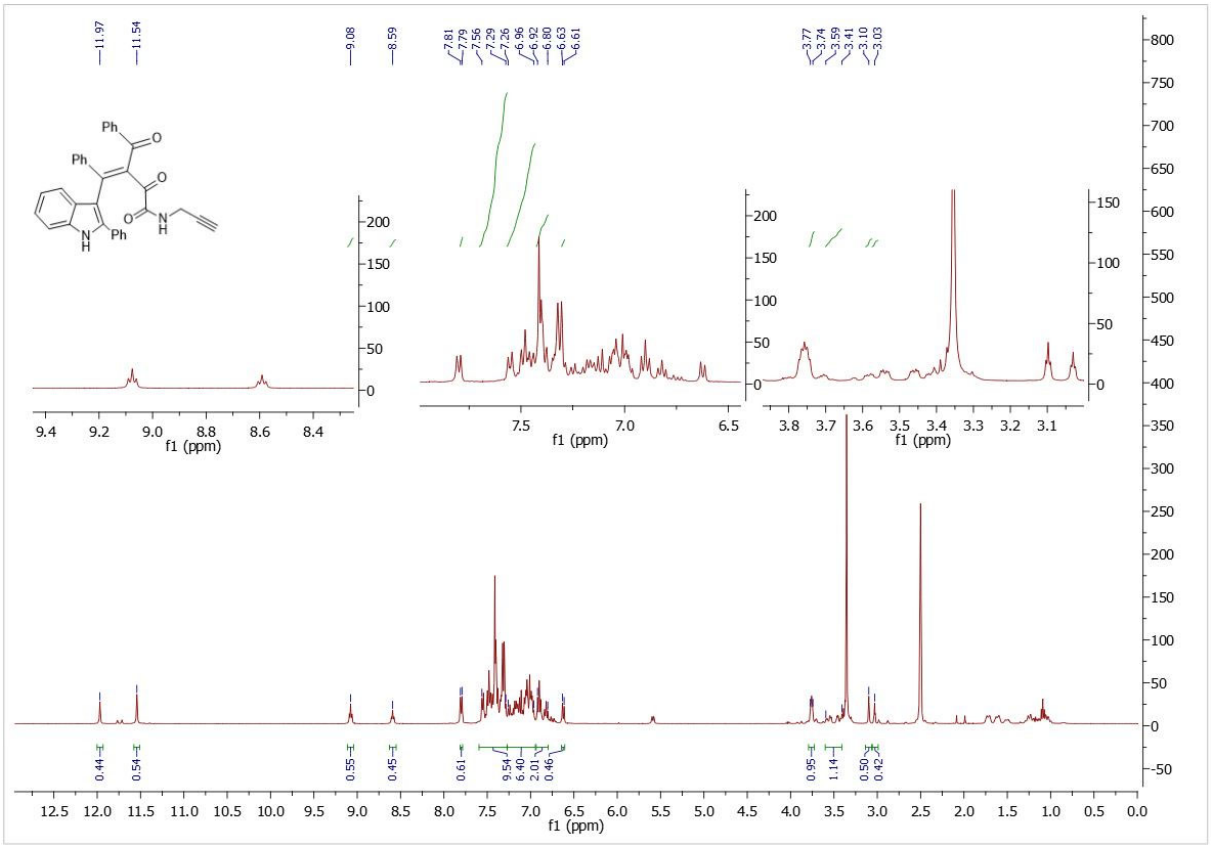
^{13}C-NMR spectrum of compound **5a**



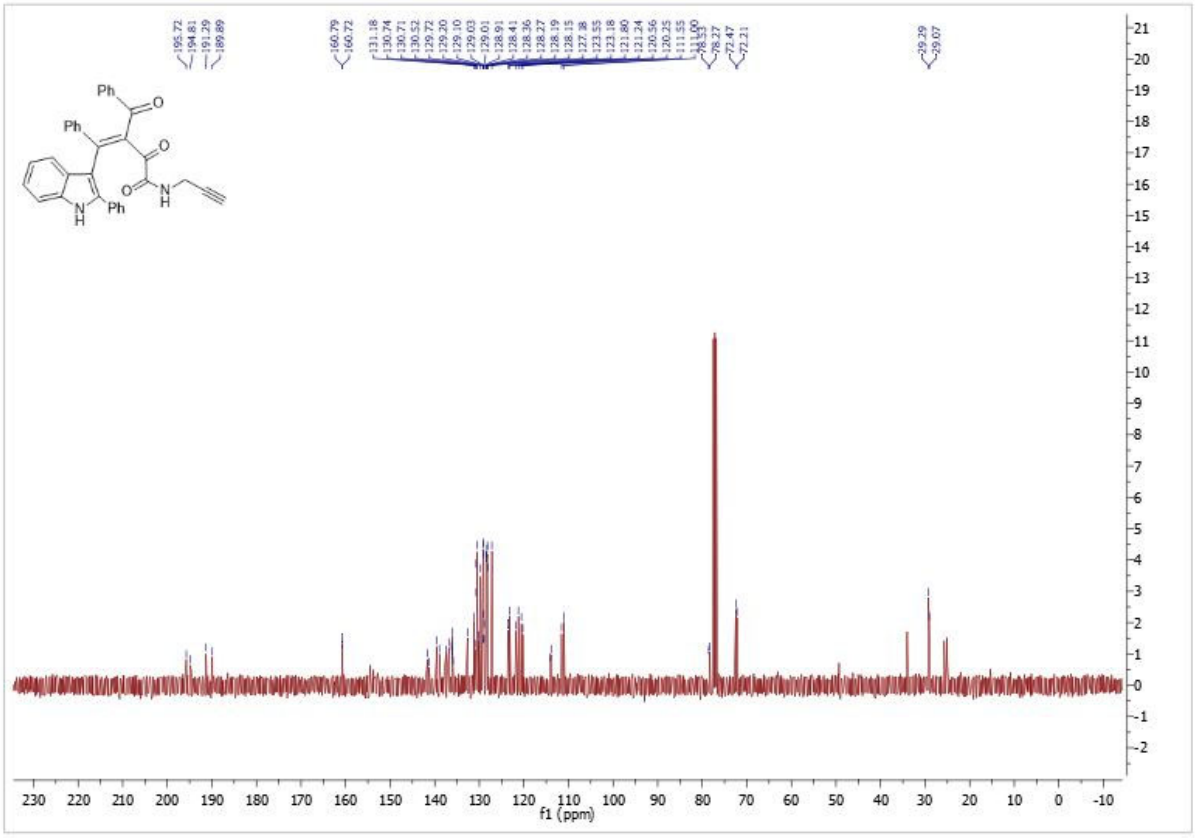
^{1}H-NMR spectrum of compound **5b**



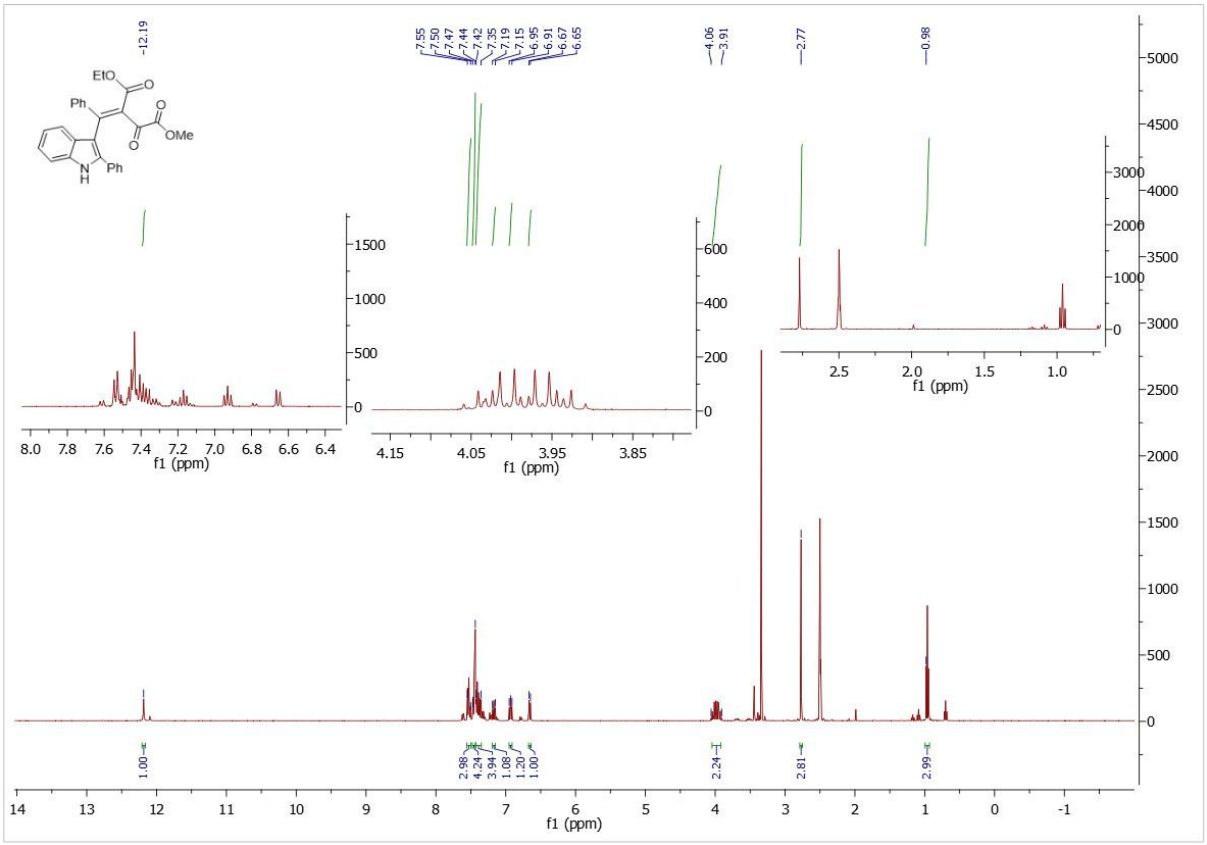
^{13}C-NMR spectrum of compound **5b**



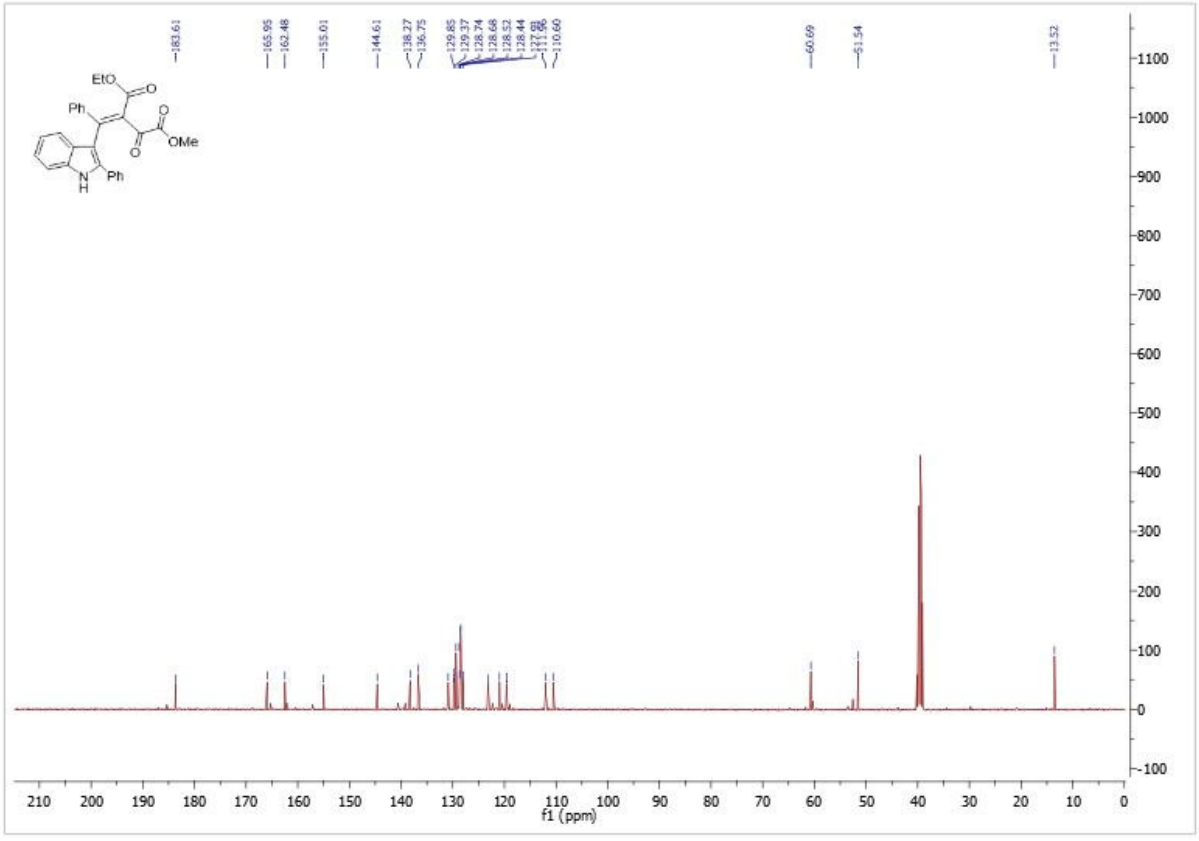
^{1}H-NMR spectrum of compound **5c**



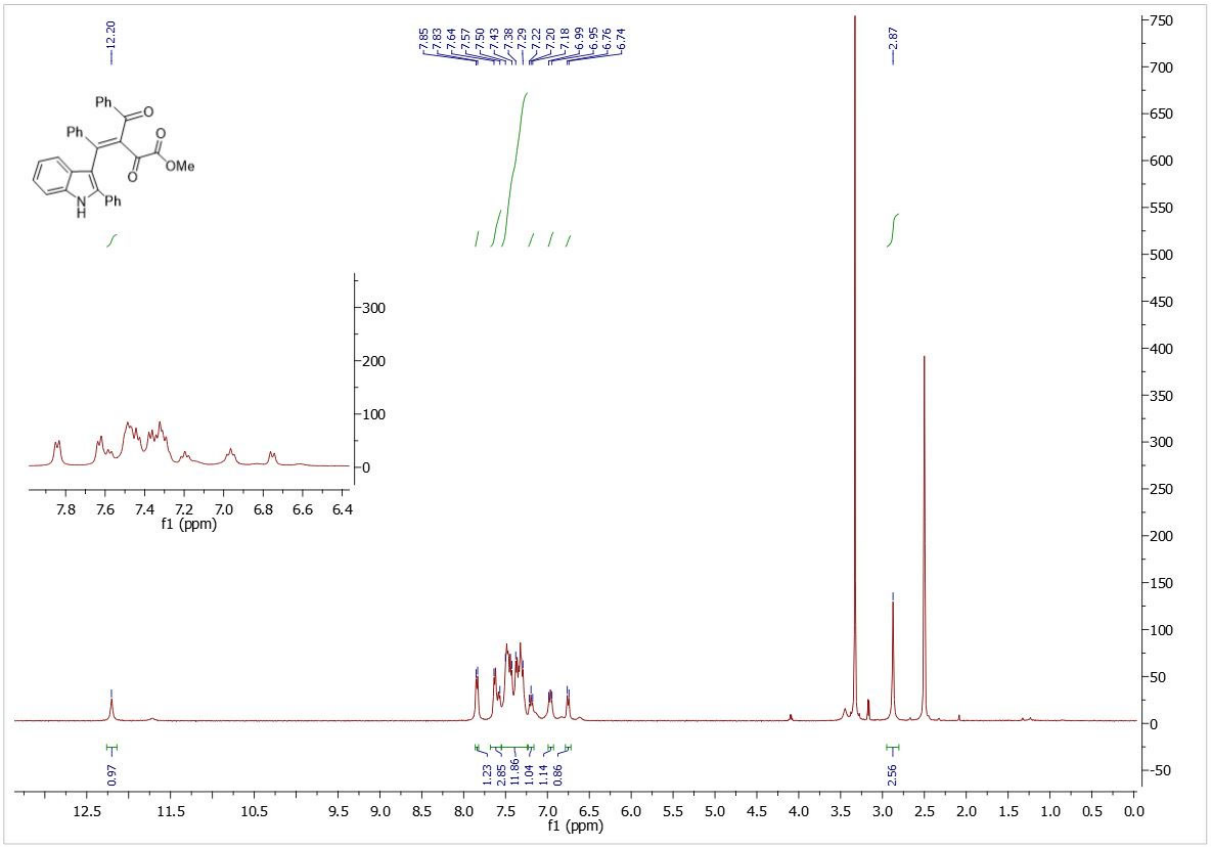
^{13}C-NMR spectrum of compound **5c**



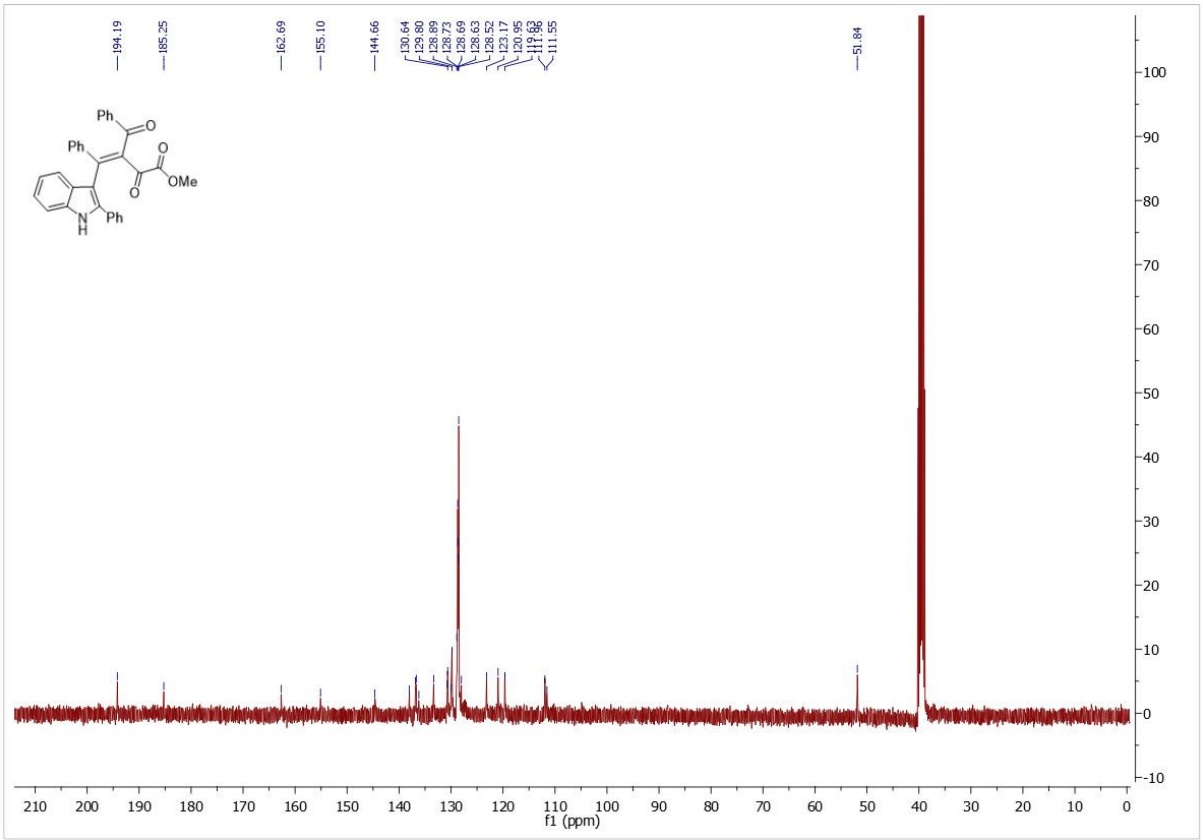
^{1}H-NMR spectrum of compound **5d**



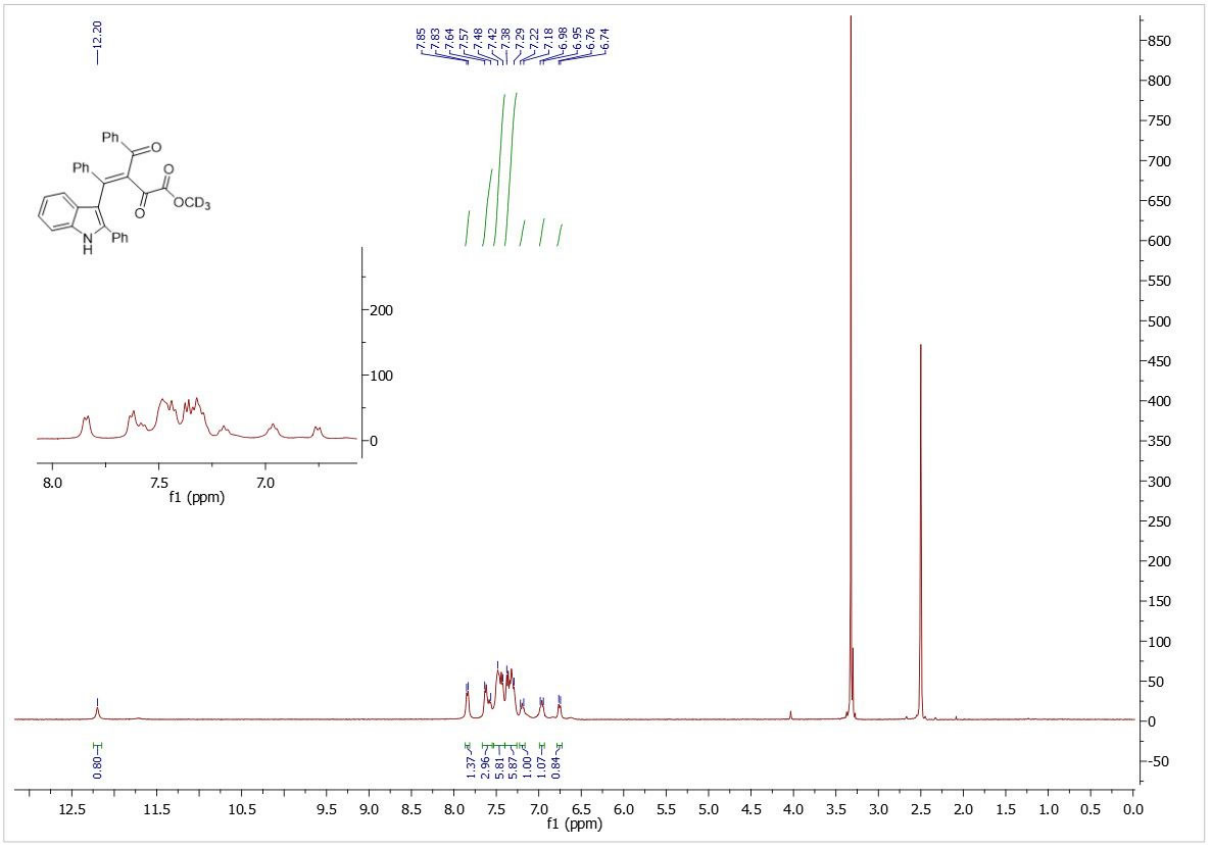
^{13}C-NMR spectrum of compound **5d**



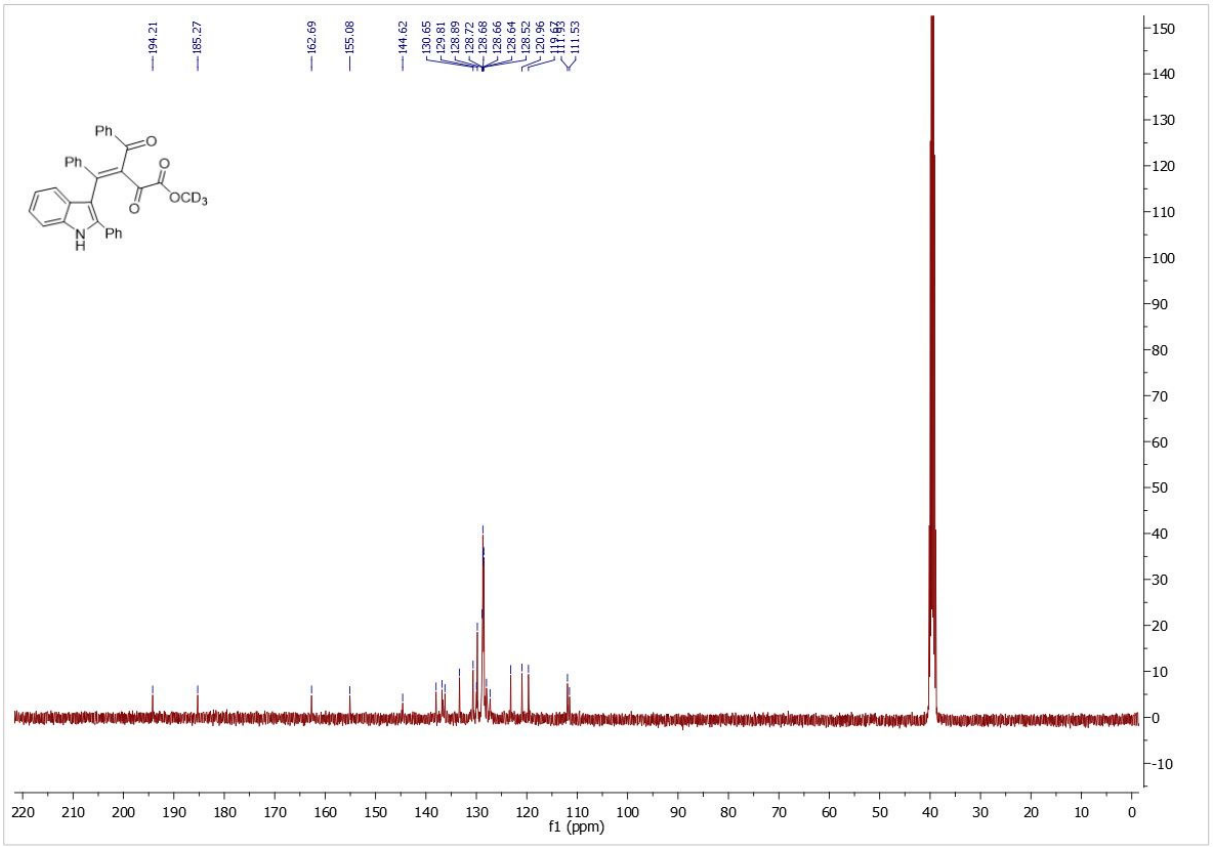
^{1}H-NMR spectrum of compound **5e**



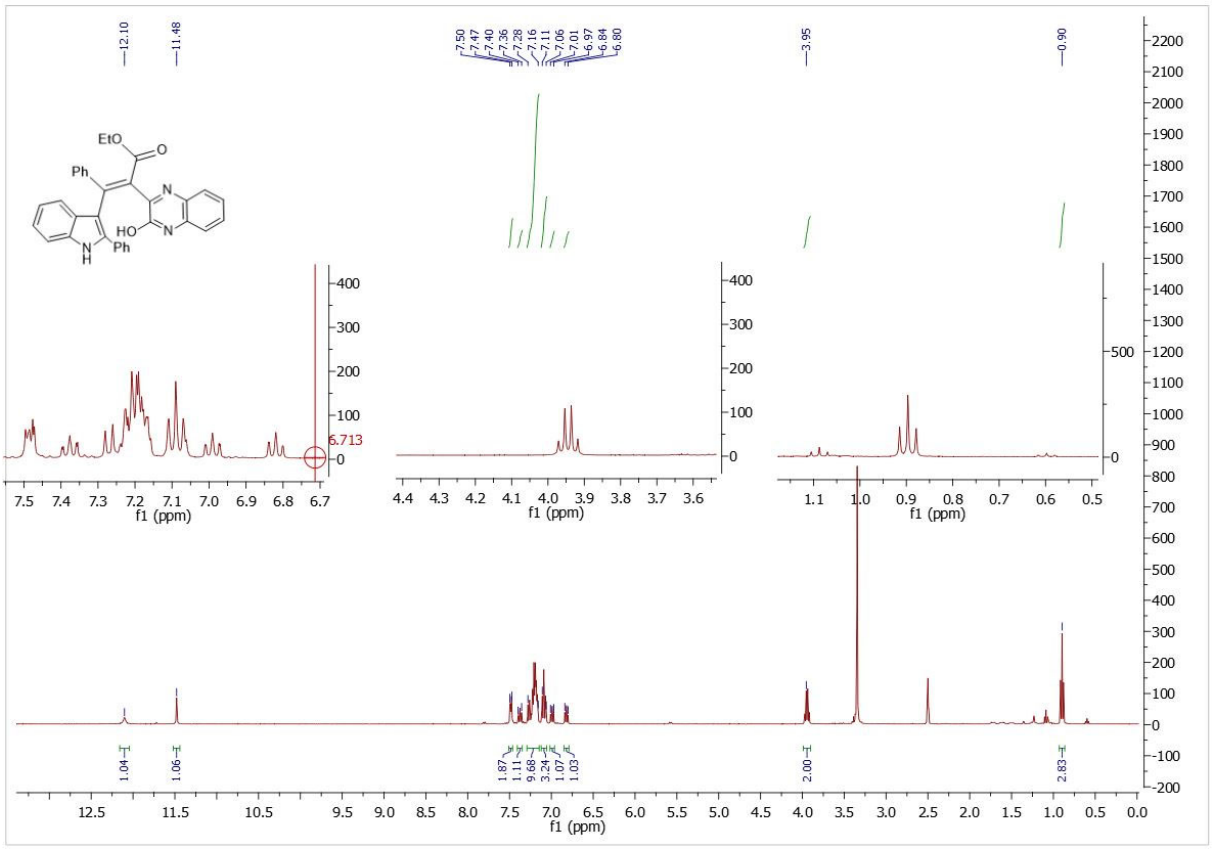
^{13}C-NMR spectrum of compound **5e**



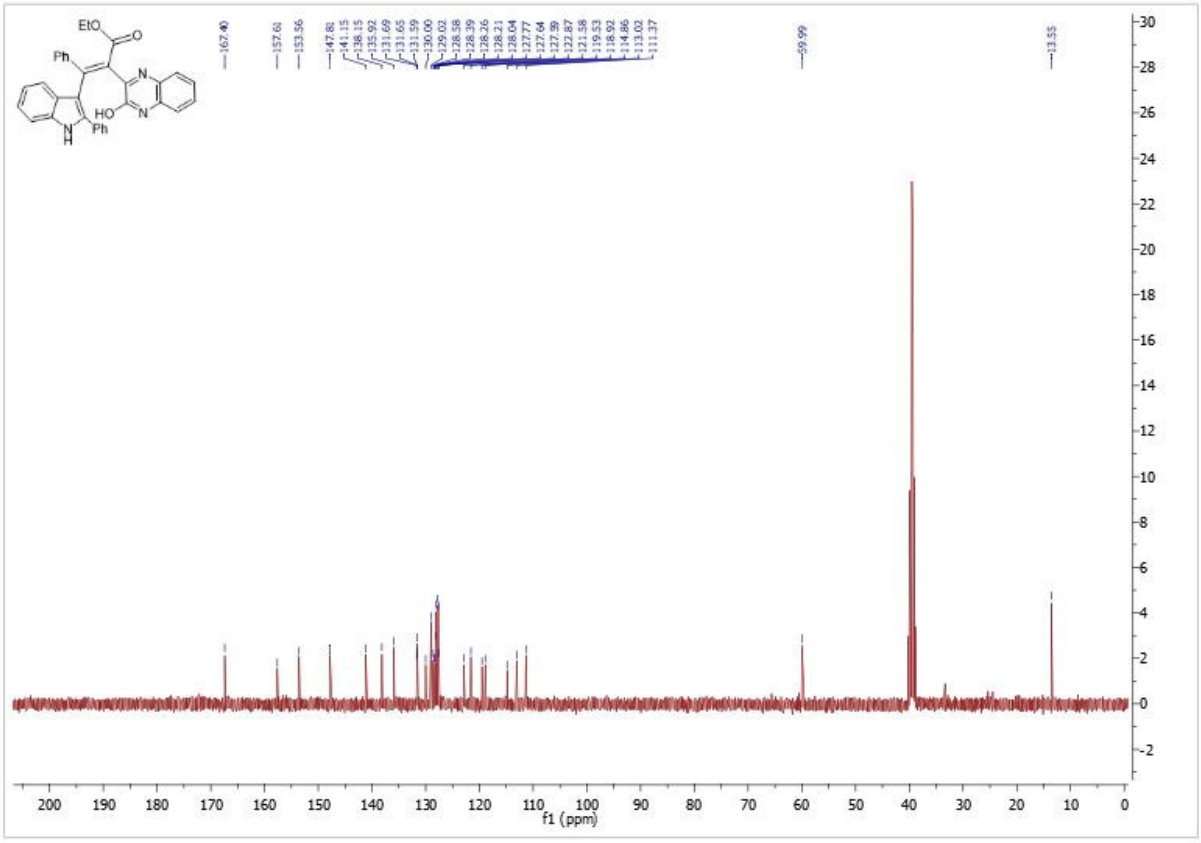
^{1}H-NMR spectrum of compound **5f**



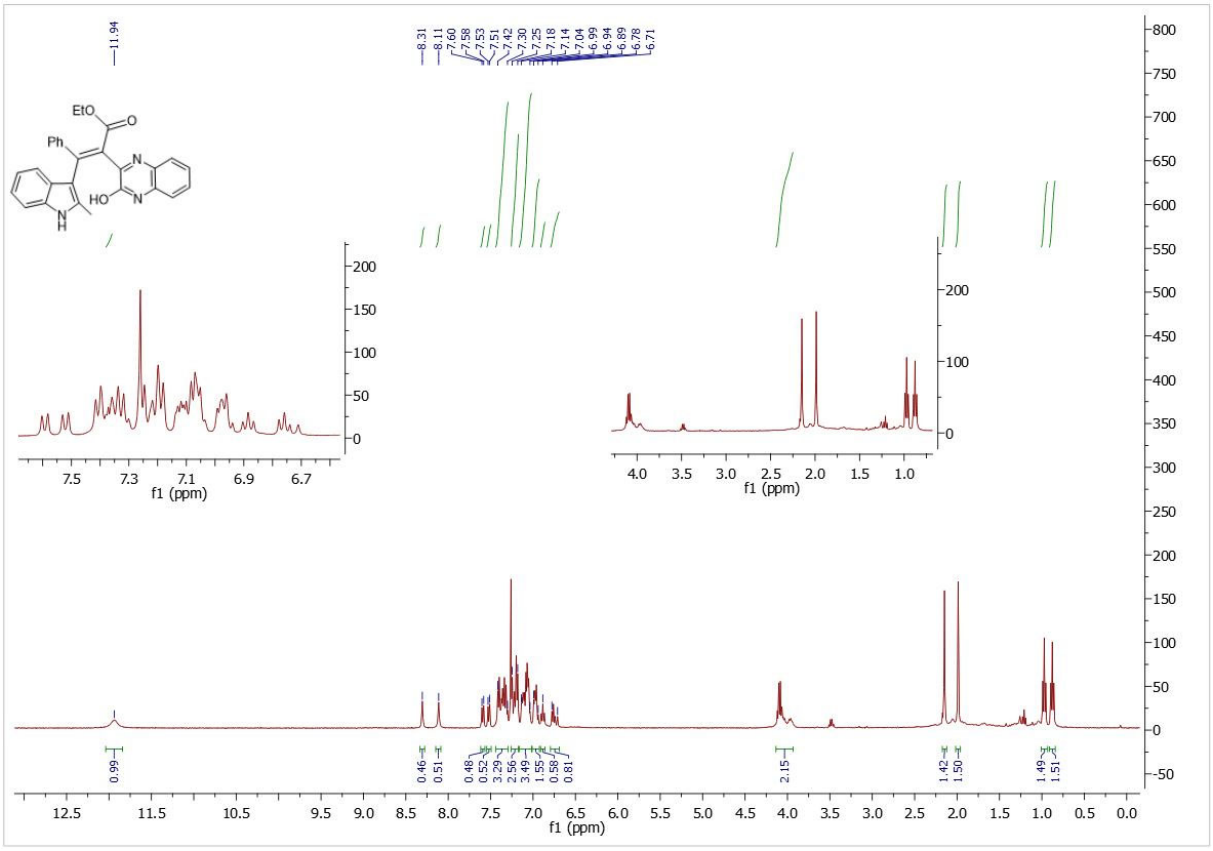
^{13}C-NMR spectrum of compound **5f**



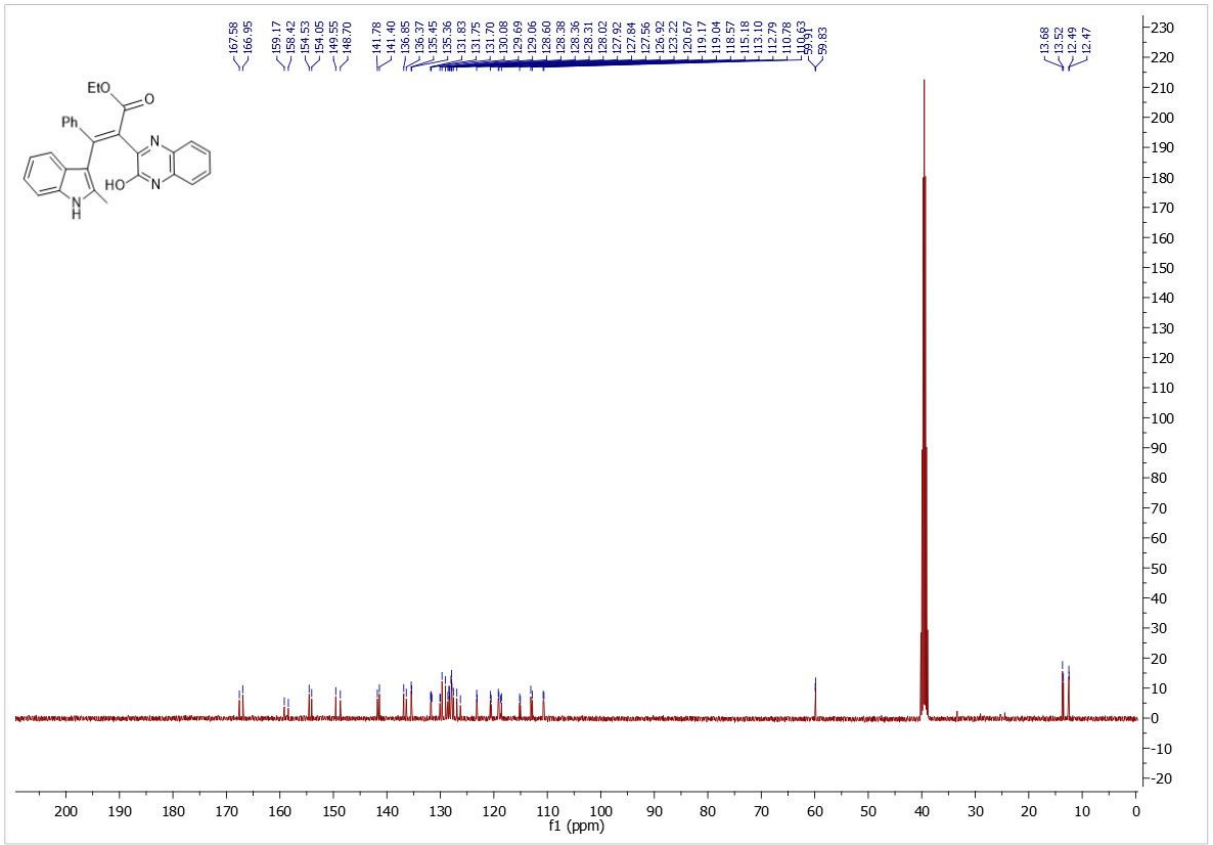
[1]H-NMR spectrum of compound **7a**



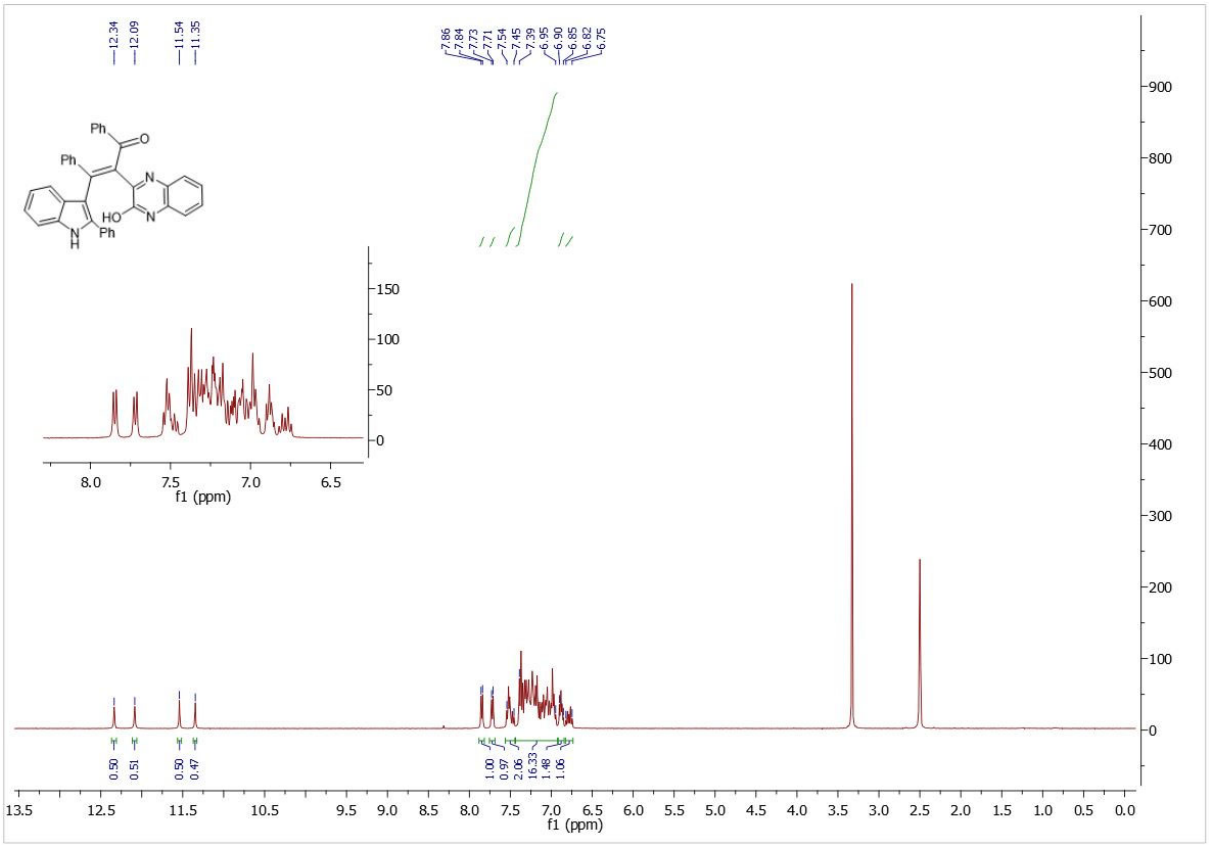
[13]C-NMR spectrum of compound **7a**



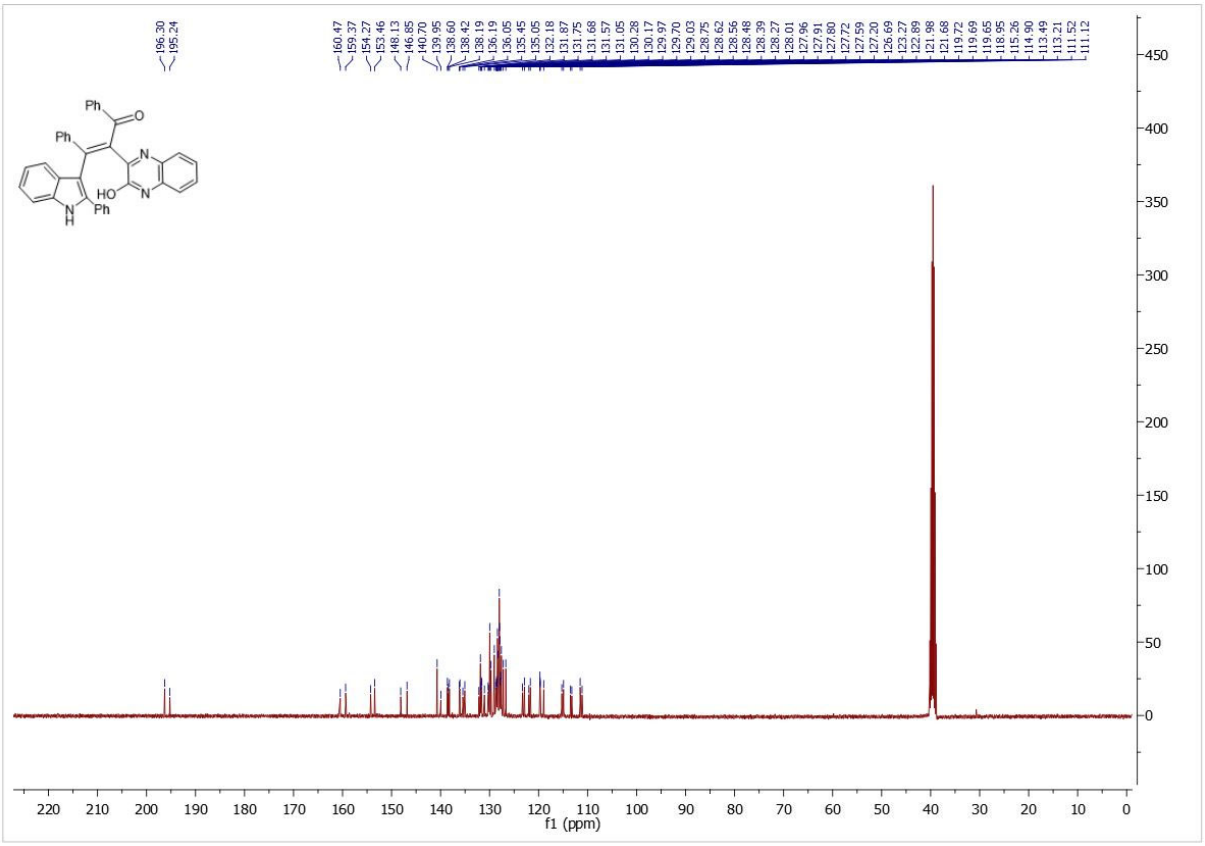
[1]H-NMR spectrum of compound **7b**



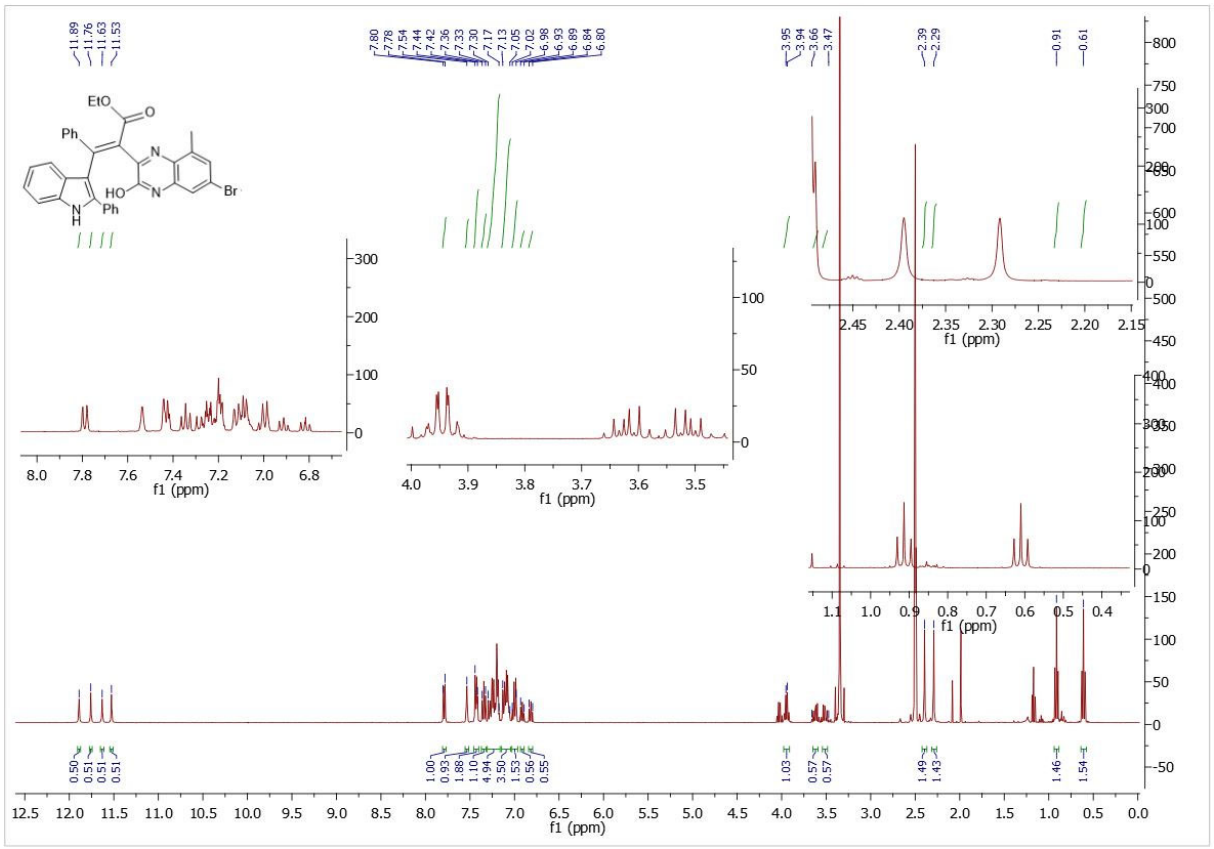
[13]C-NMR spectrum of compound **7b**



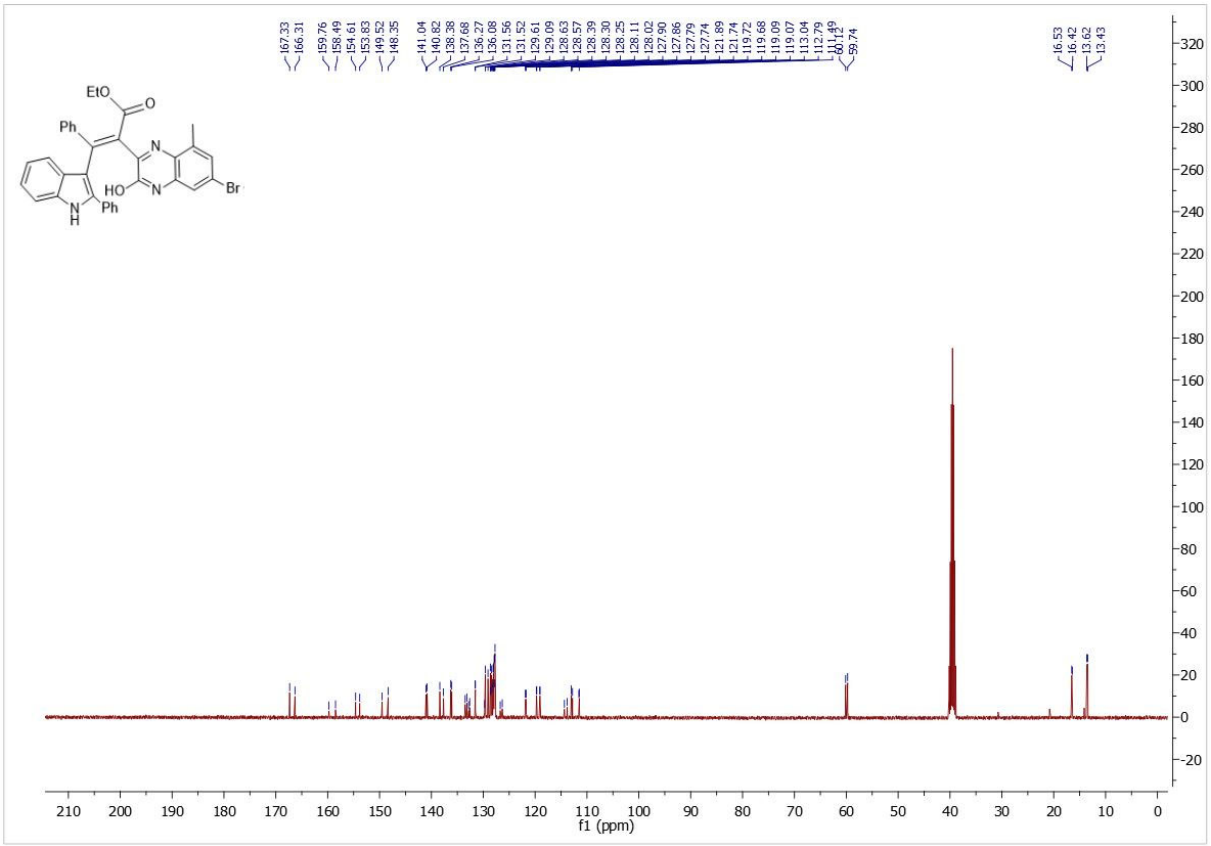
^{1}H-NMR spectrum of compound **7c**



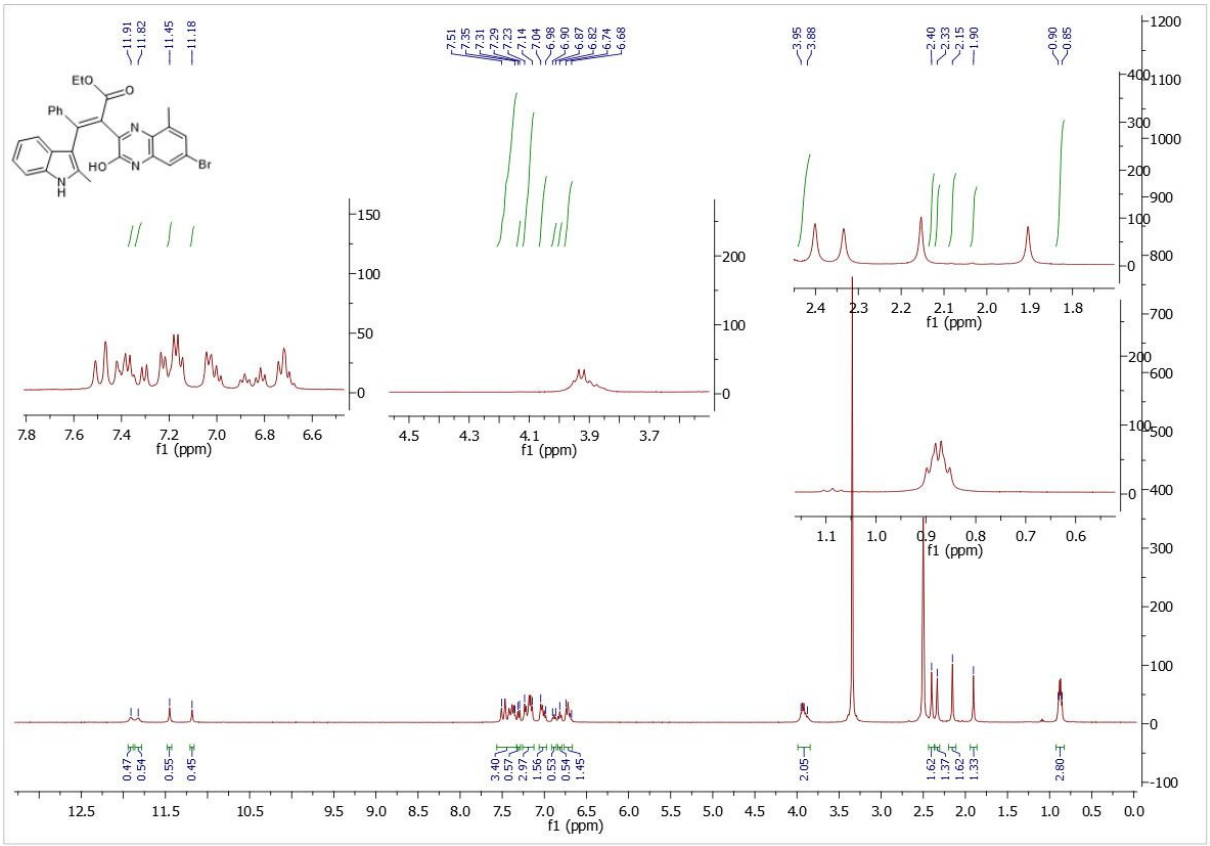
^{13}C-NMR spectrum of compound **7c**



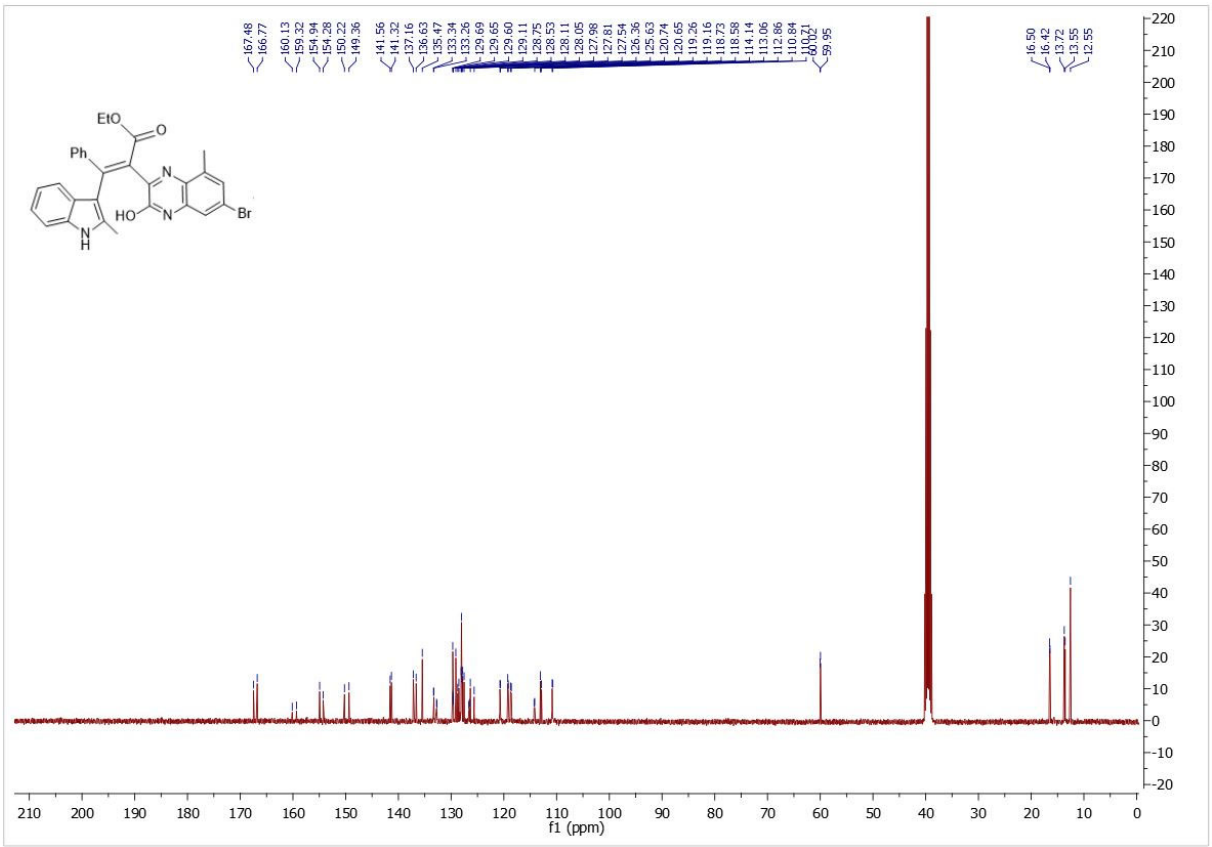
^{1}H-NMR spectrum of compound **7d**



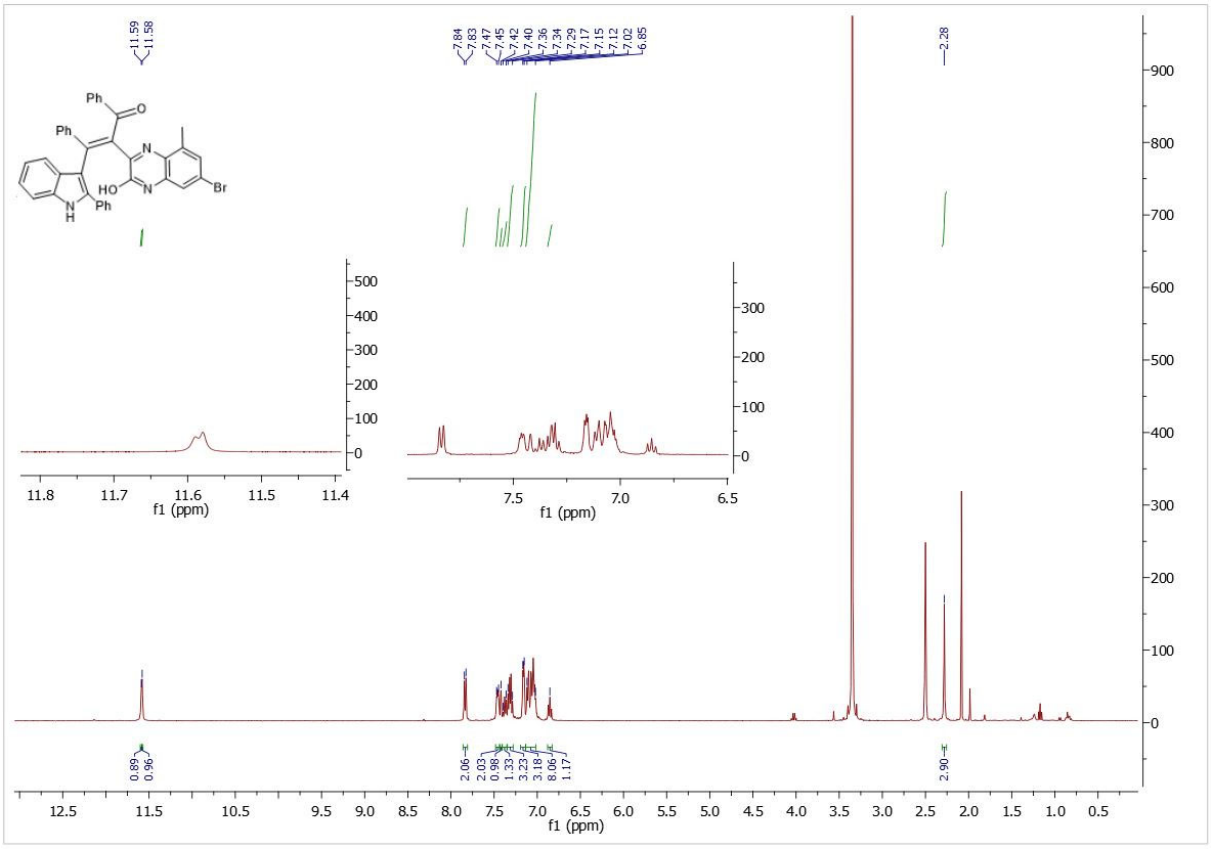
^{13}C-NMR spectrum of compound **7d**



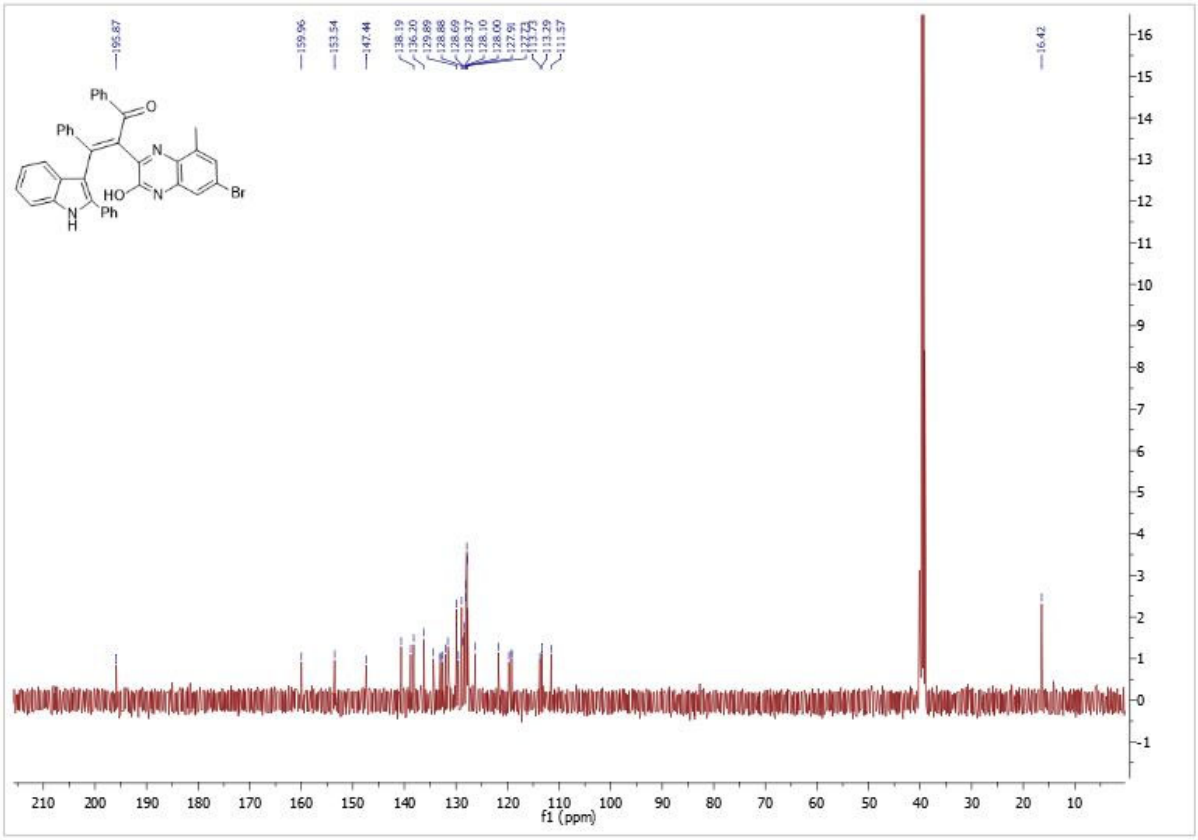
^{1}H-NMR spectrum of compound **7e**



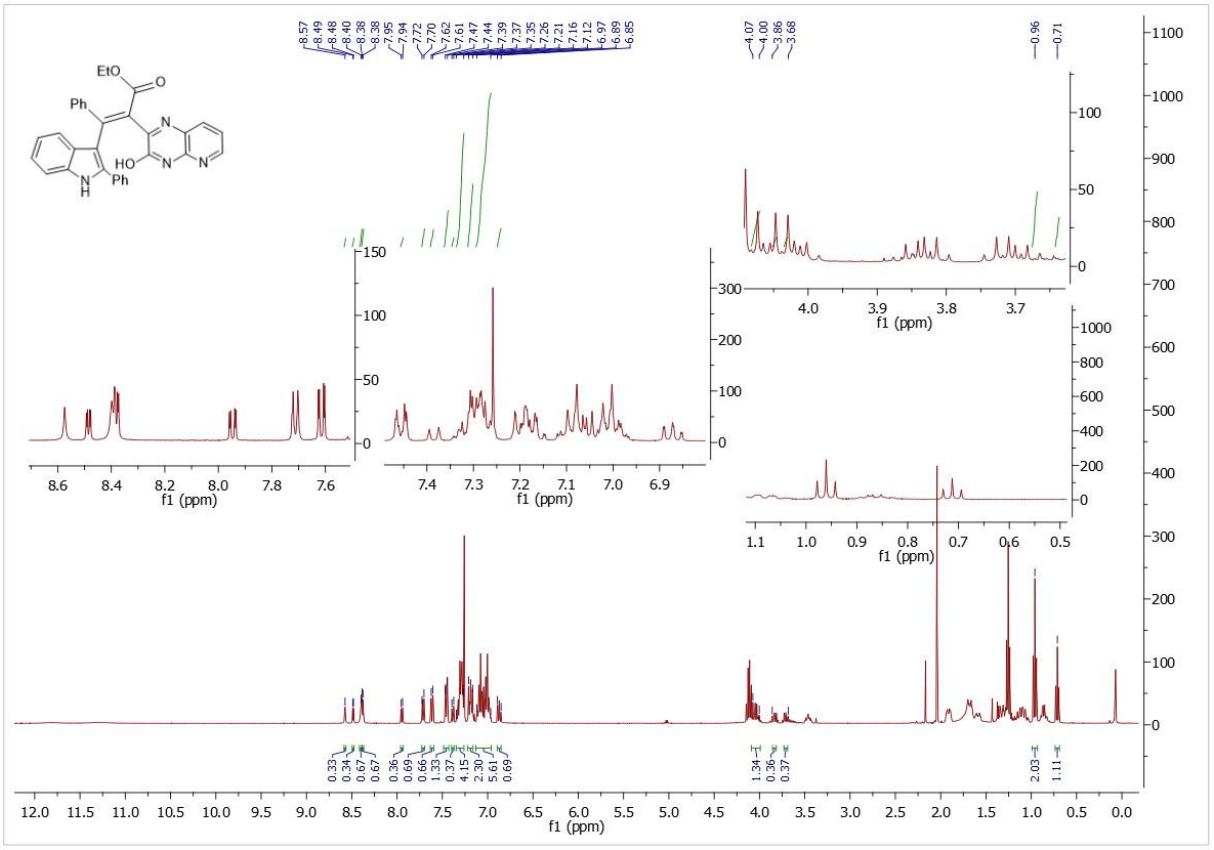
^{13}C-NMR spectrum of compound **7e**



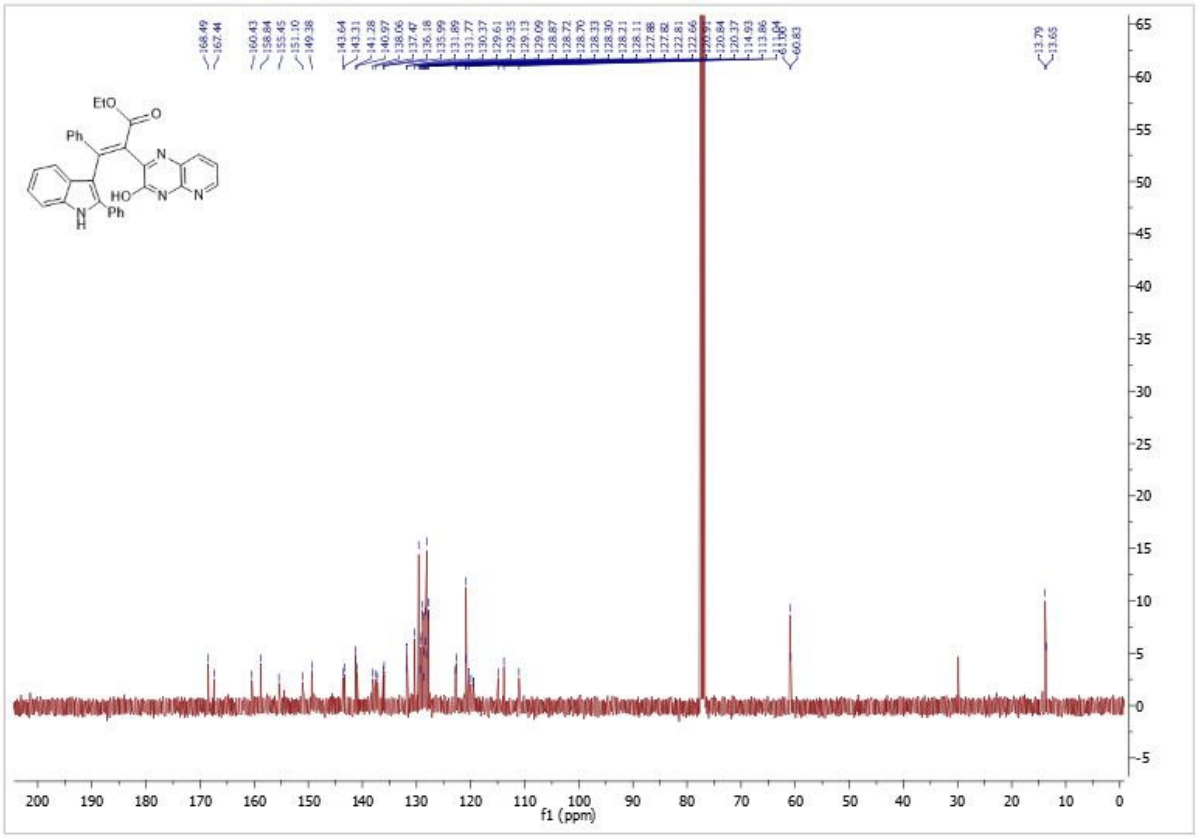
^{1}H-NMR spectrum of compound **7f**



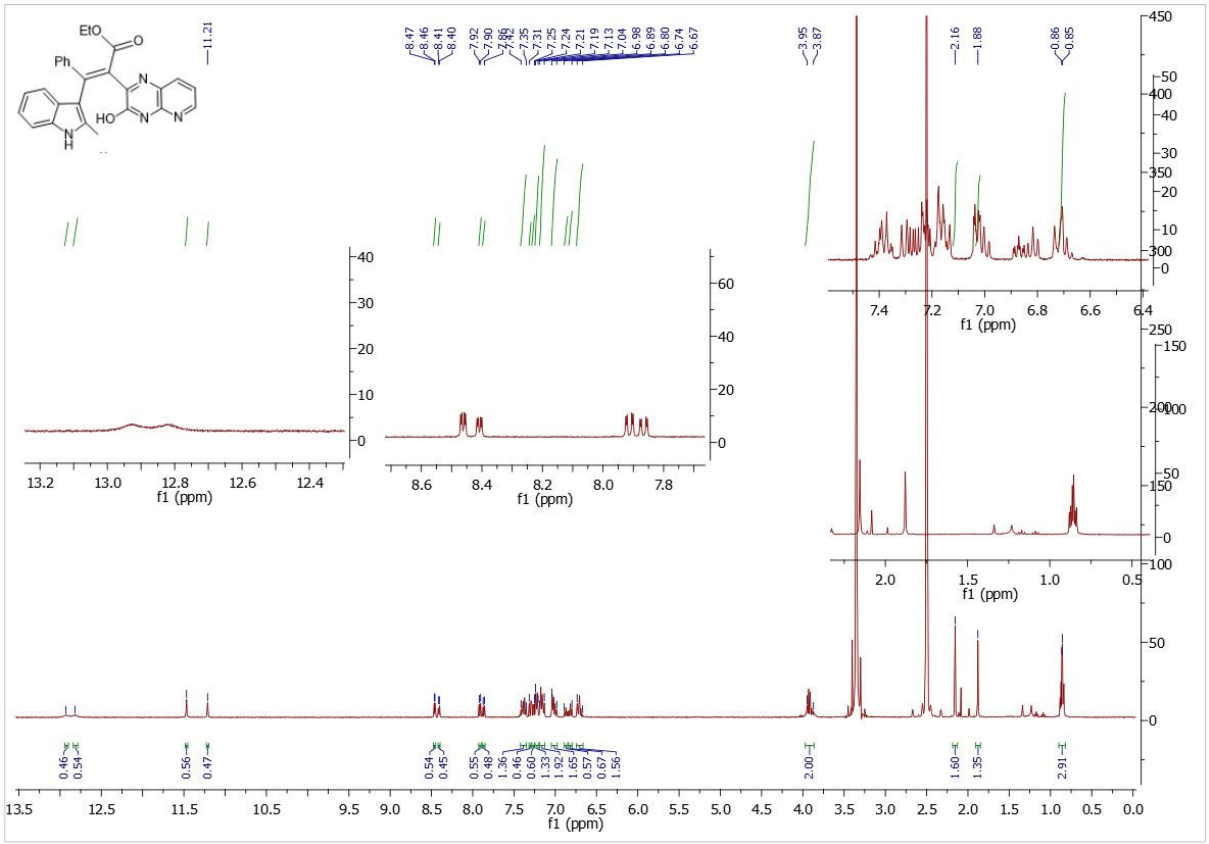
^{13}C-NMR spectrum of compound **7f**



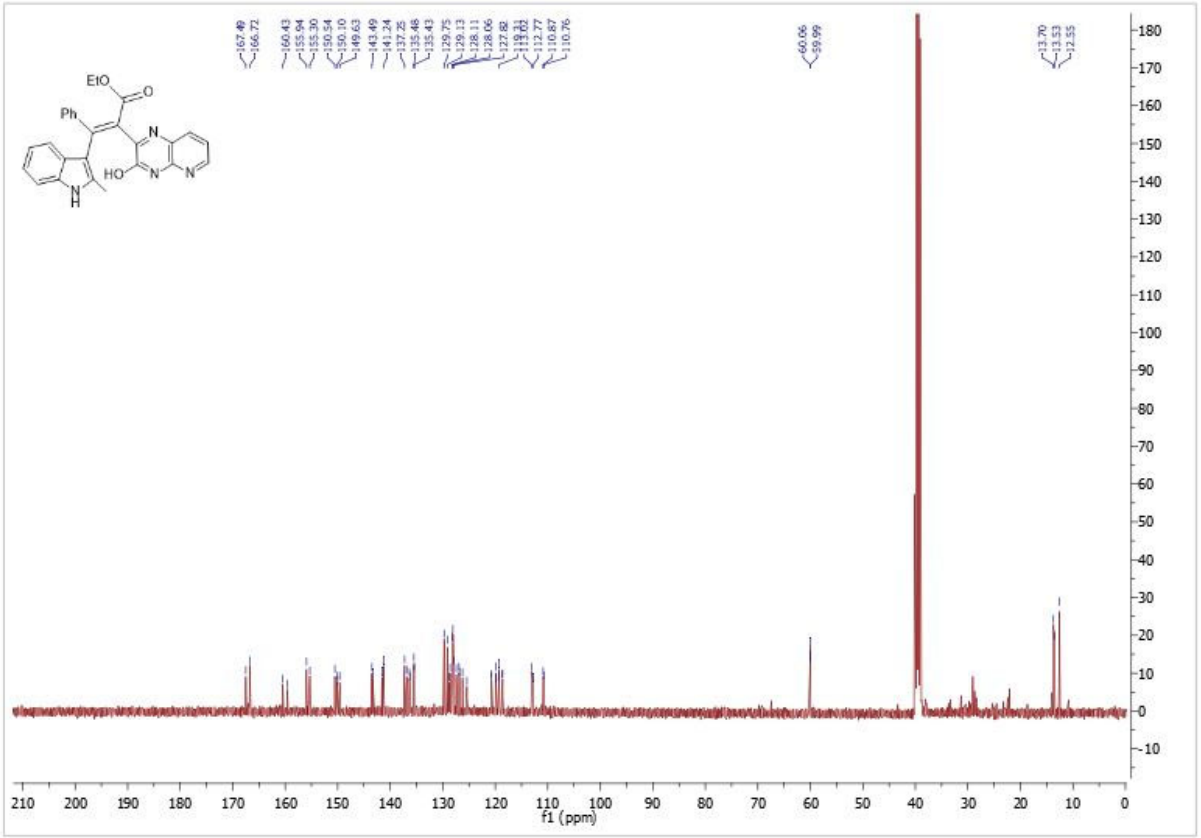
^{1}H-NMR spectrum of compound **7g**



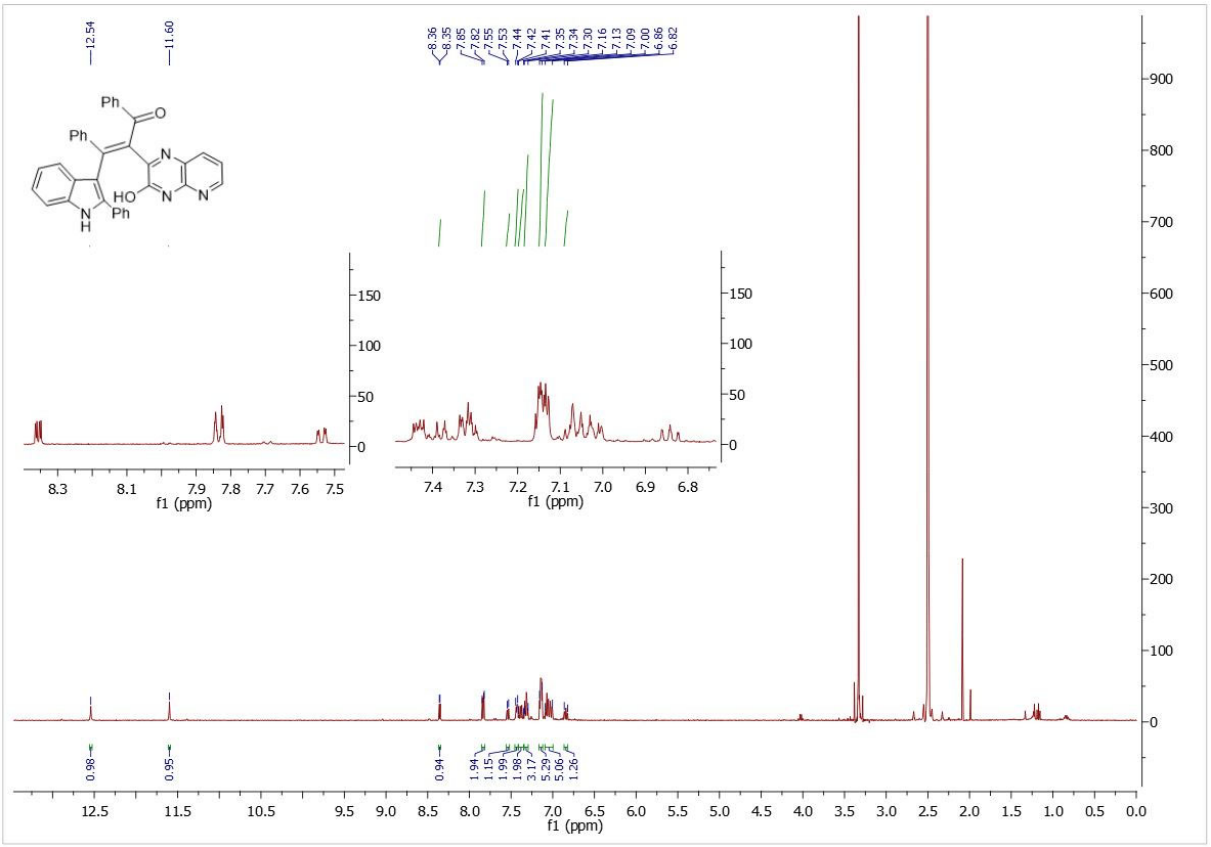
^{13}C-NMR spectrum of compound **7g**



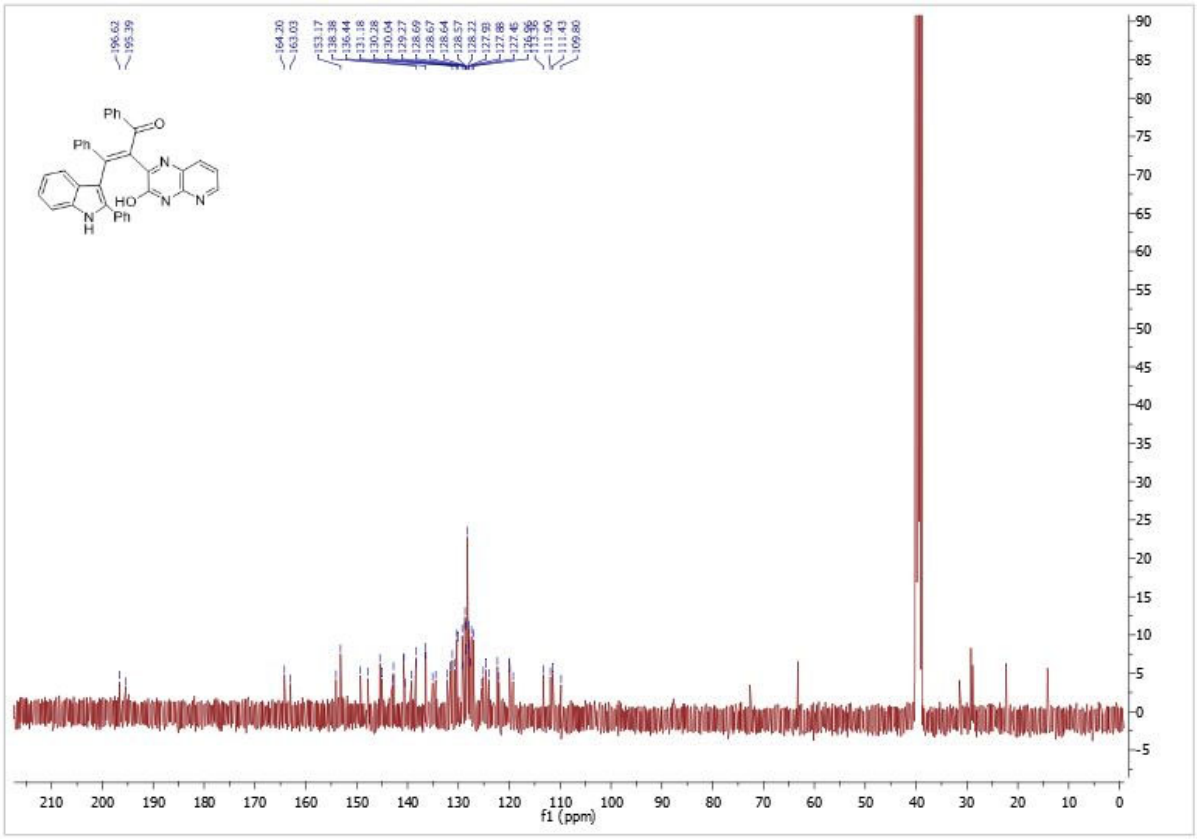
^{1}H-NMR spectrum of compound **7h**



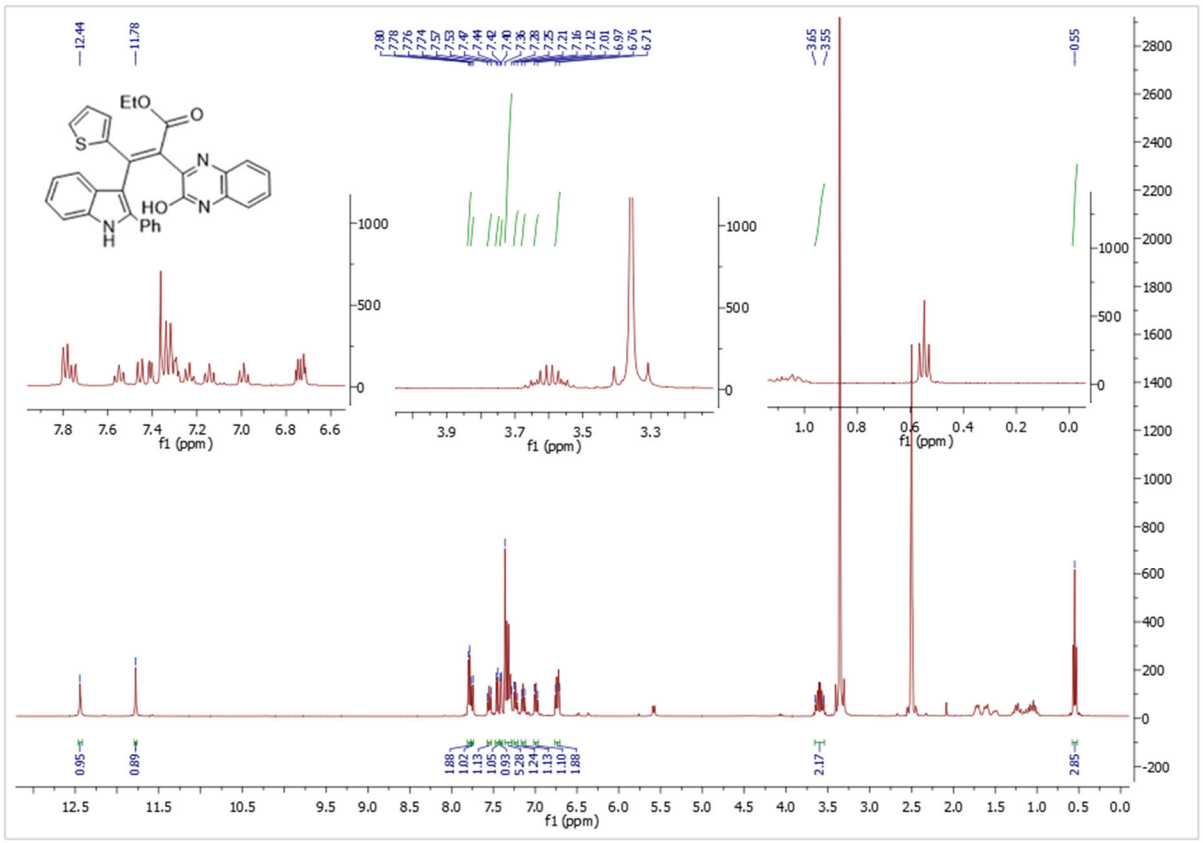
^{13}C-NMR spectrum of compound **7h**



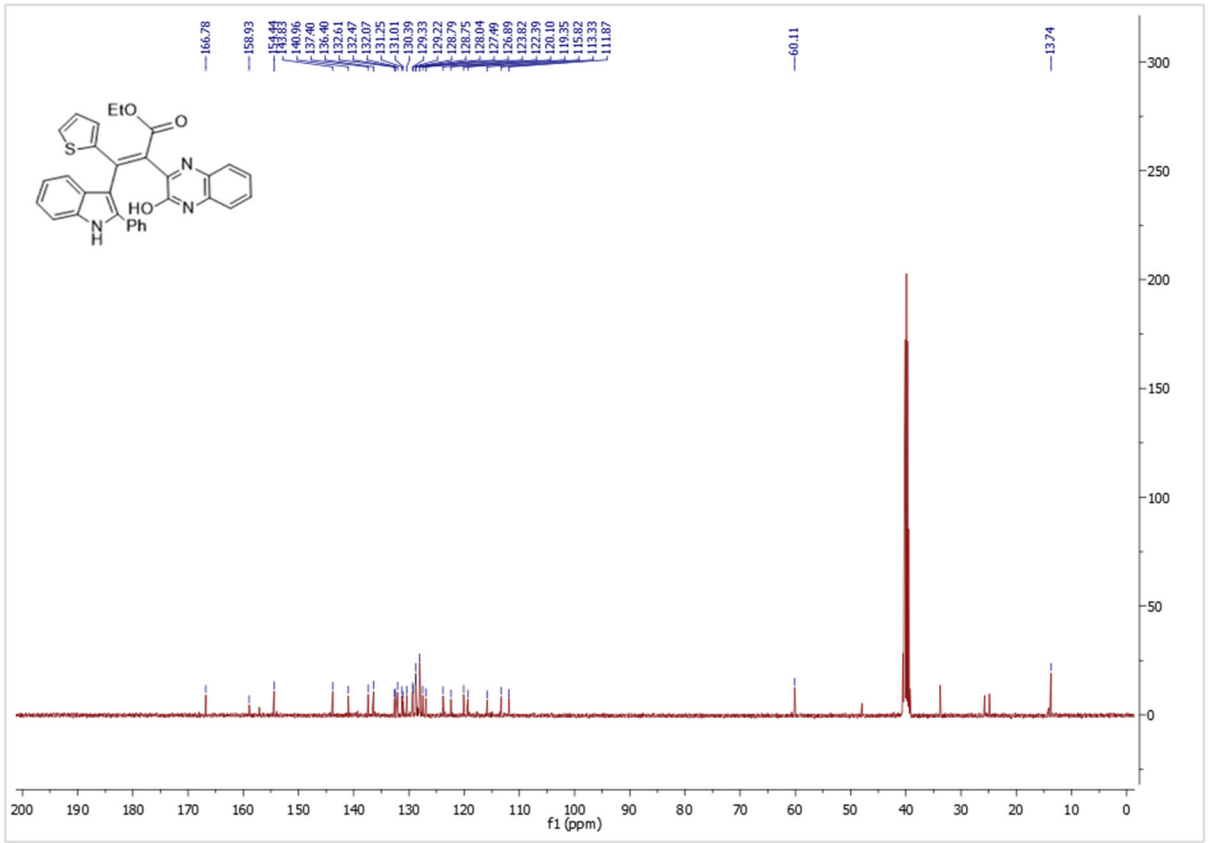
^{1}H-NMR spectrum of compound **7i**



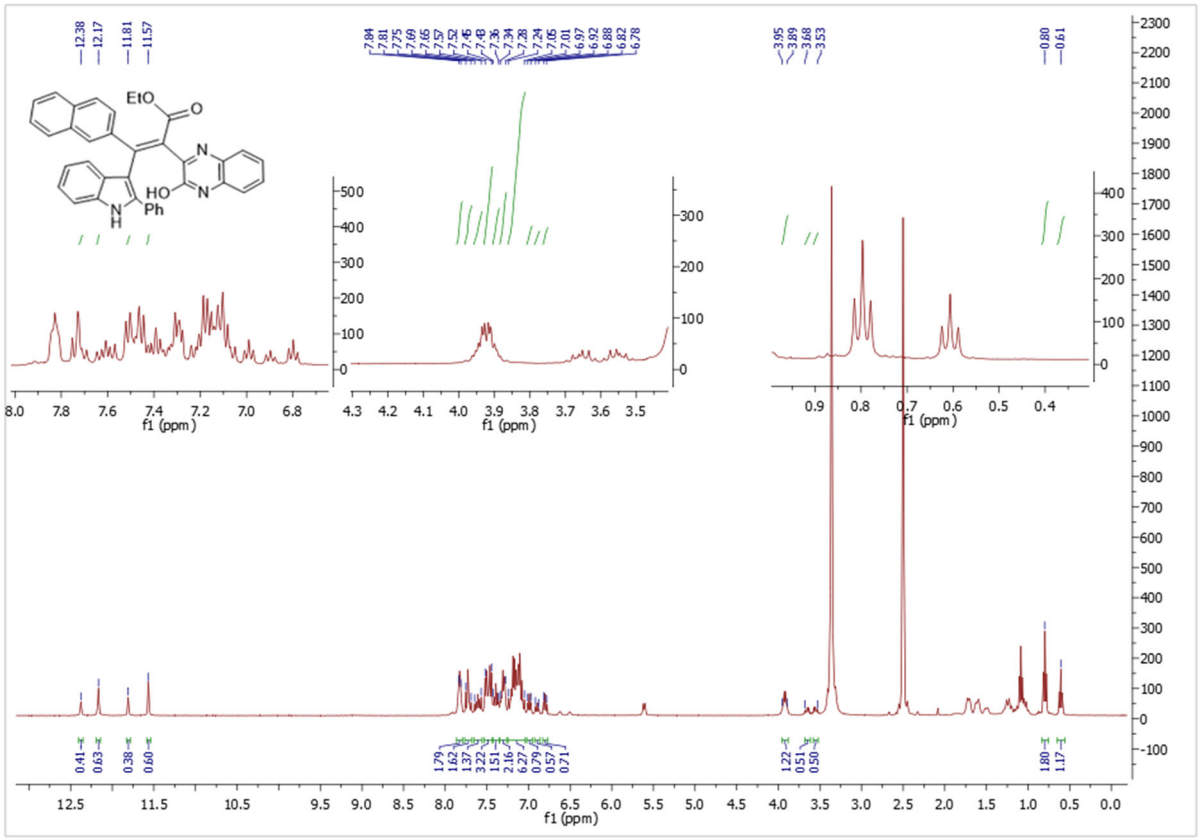
^{13}C-NMR spectrum of compound **7i**



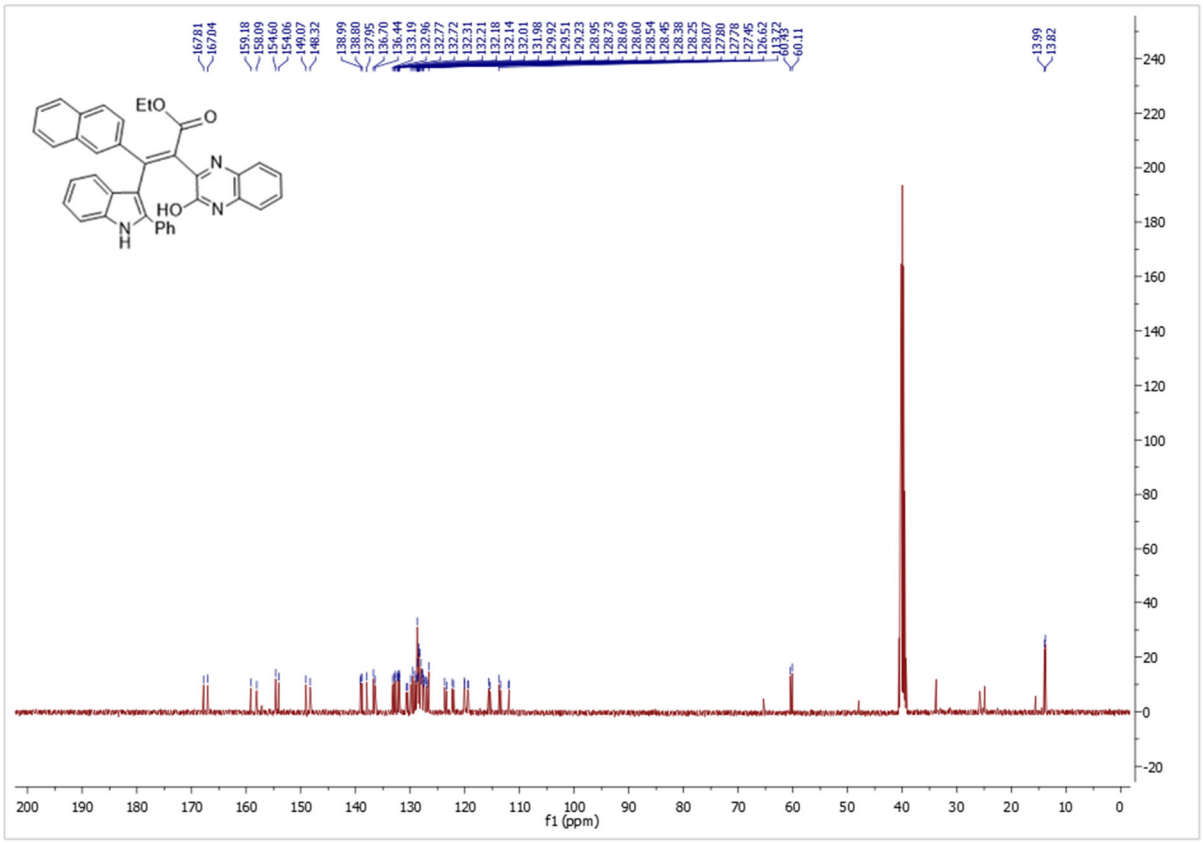
[1]H-NMR spectrum of compound **7j**



[13]C-NMR spectrum of compound **7j**

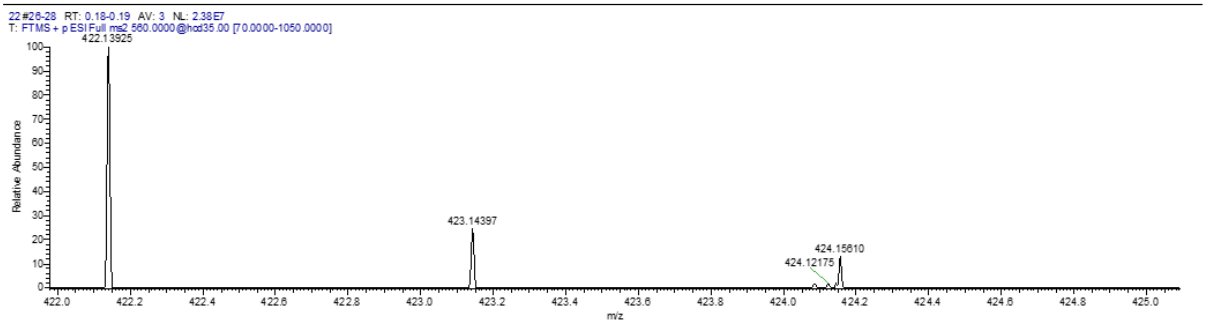


^{1}H-NMR spectrum of compound **7k**

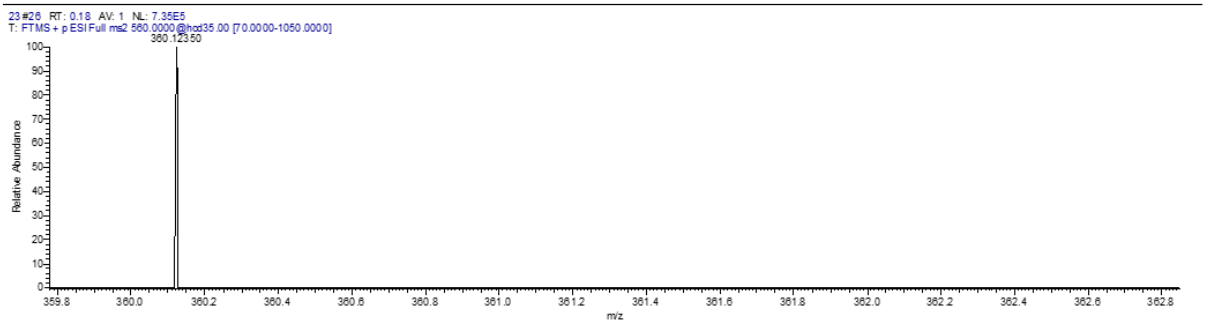


^{13}C-NMR spectrum of compound **7k**

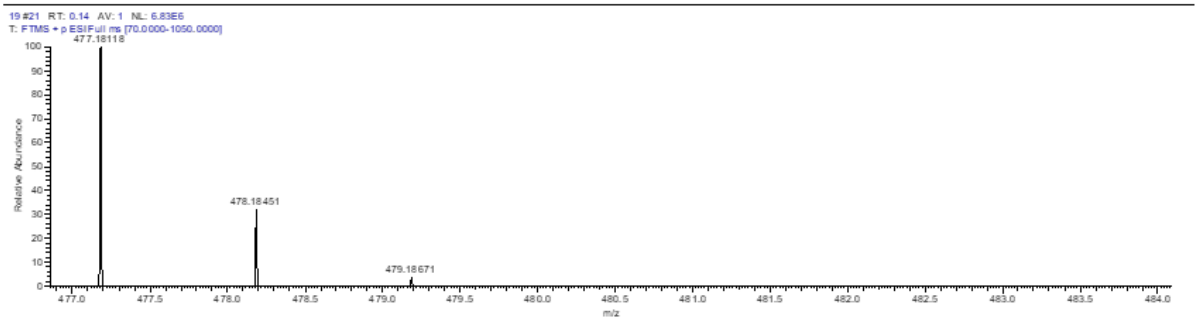
7. Copies of LC/MS spectra



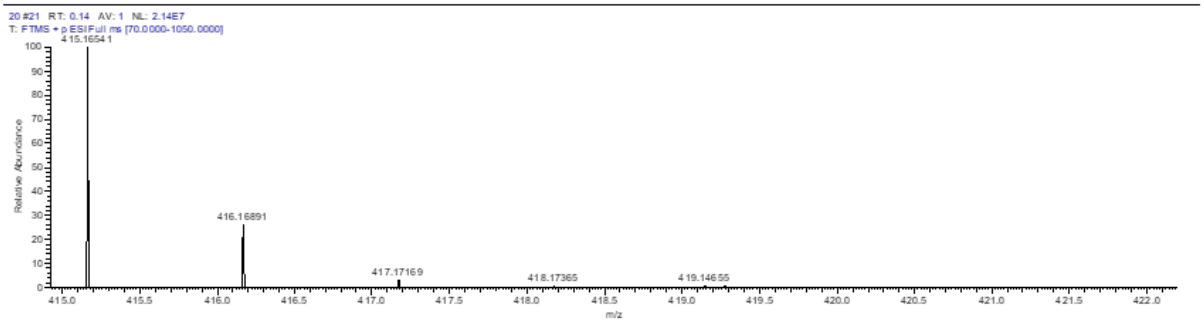
LC/MS Spectrum of compound **4a**



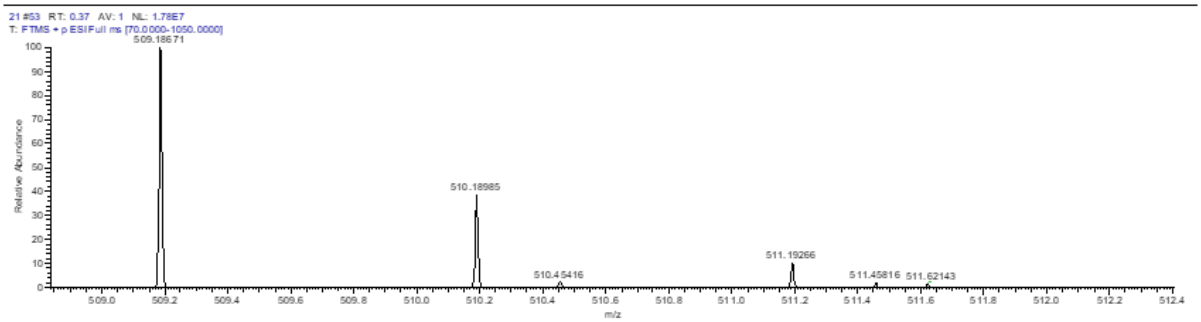
LC/MS Spectrum of compound **4b**



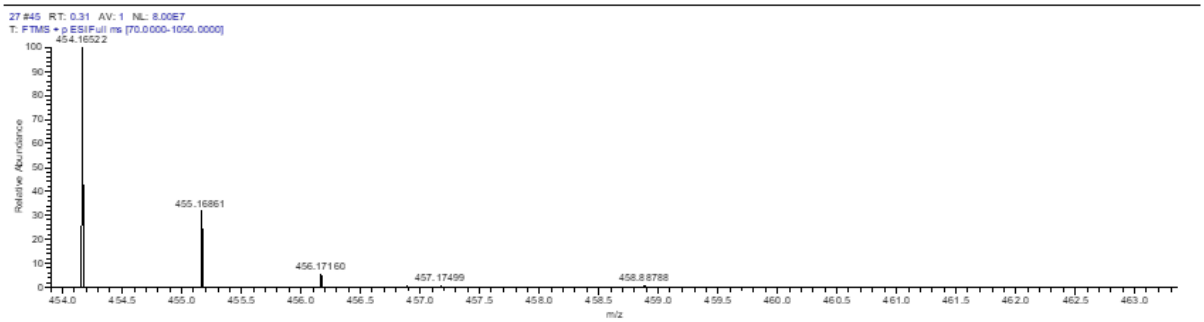
LC/MS Spectrum of compound **5a**



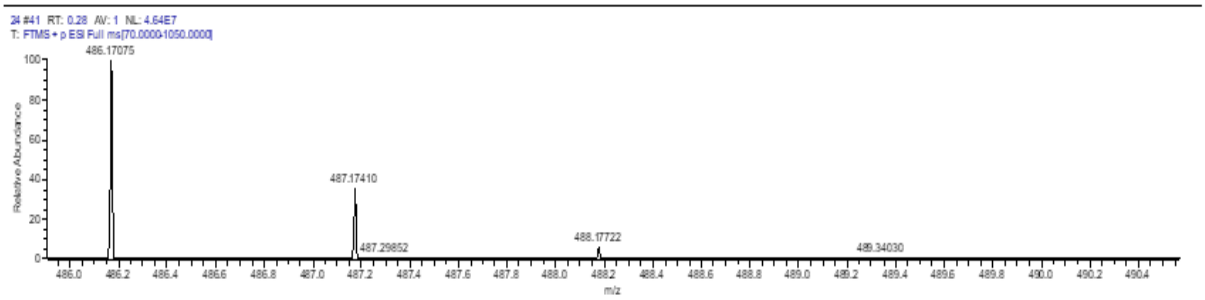
LC/MS Spectrum of compound **5b**



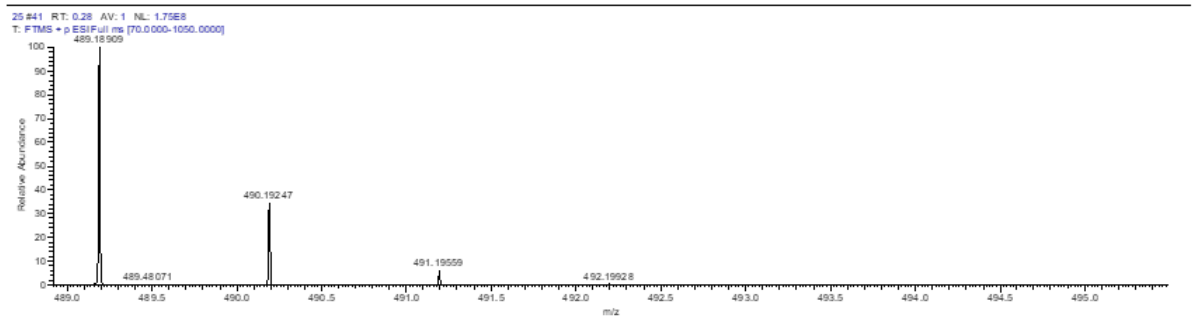
LC/MS Spectrum of compound **5c**



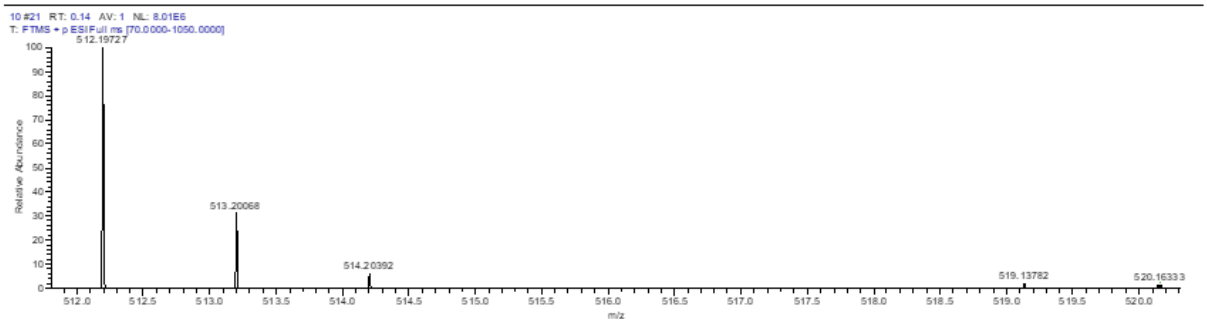
LC/MS Spectrum of compound **5d**



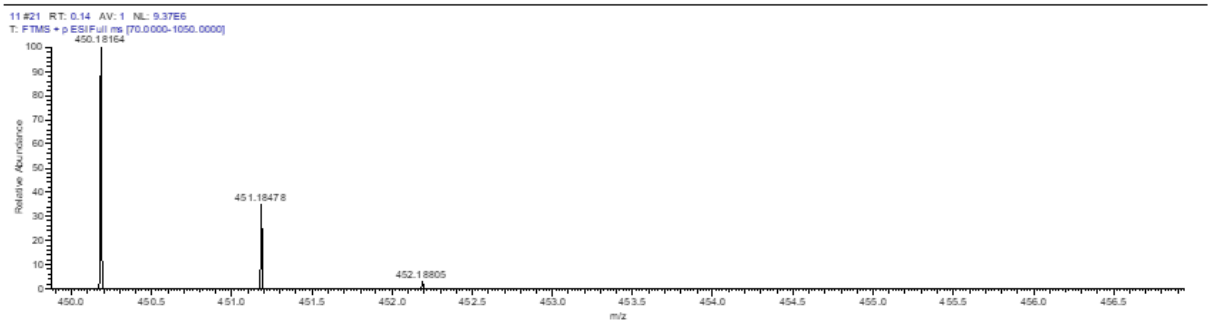
LC/MS Spectrum of compound **5e**



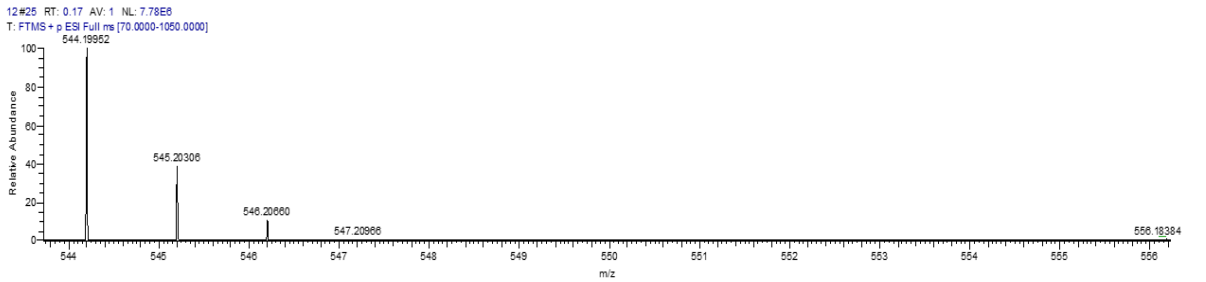
LC/MS Spectrum of compound **5f**



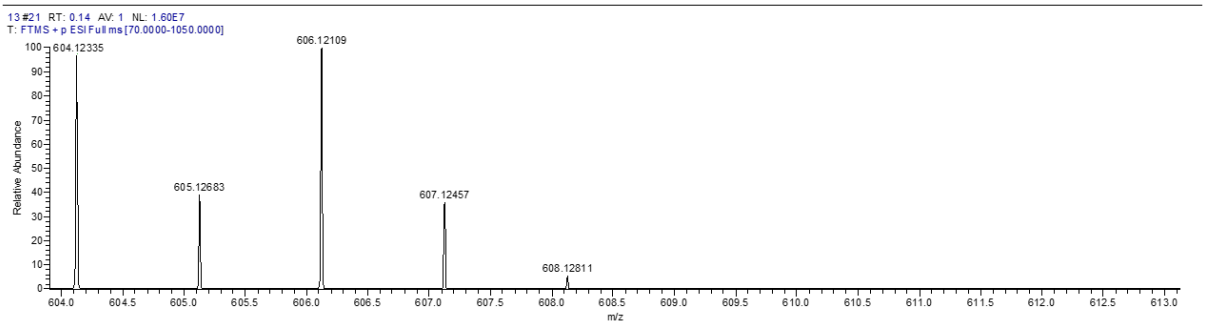
LC/MS Spectrum of compound **7a**



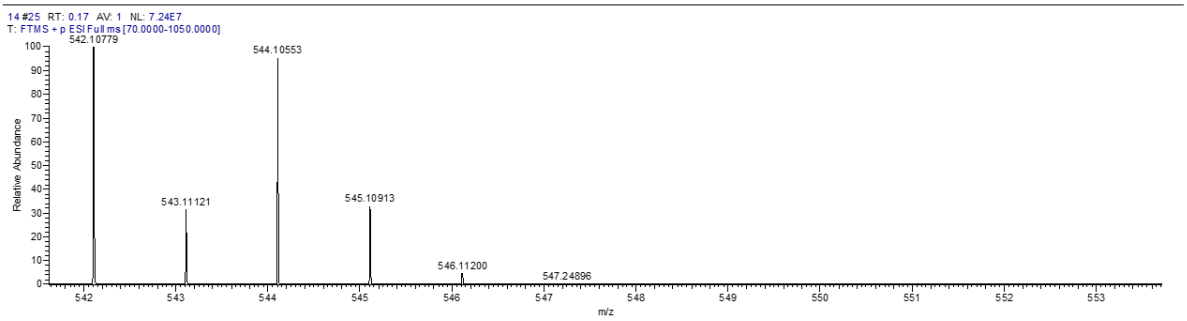
LC/MS Spectrum of compound **7b**



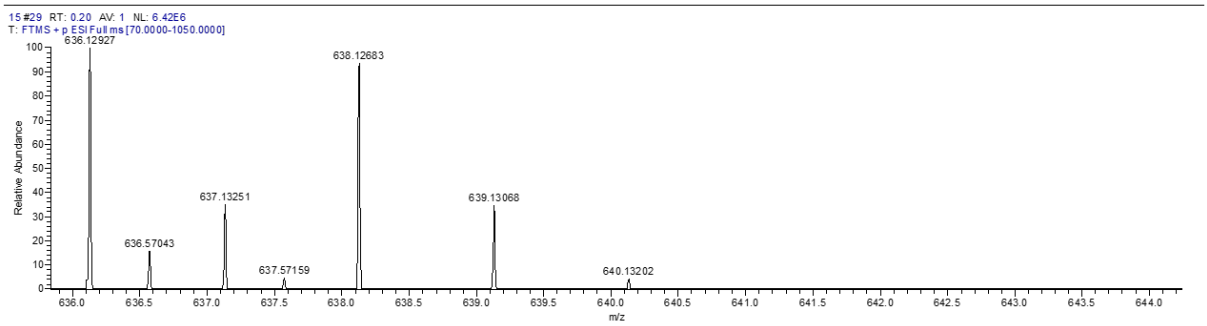
LC/MS Spectrum of compound **7c**



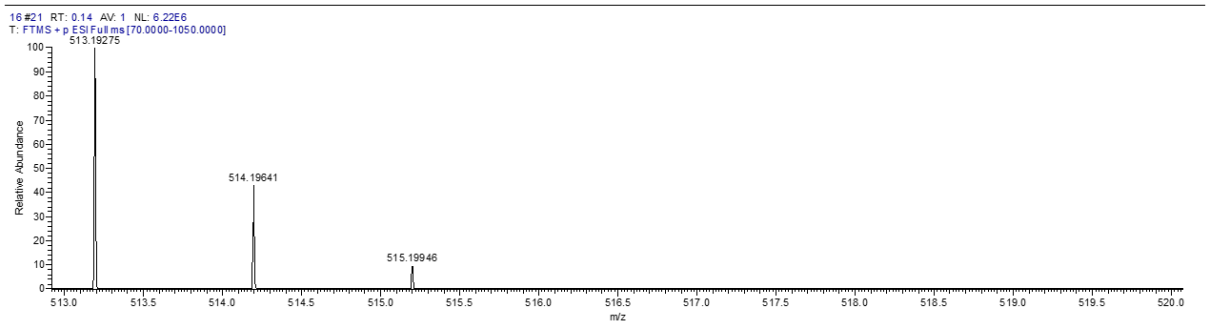
LC/MS Spectrum of compound **7d**



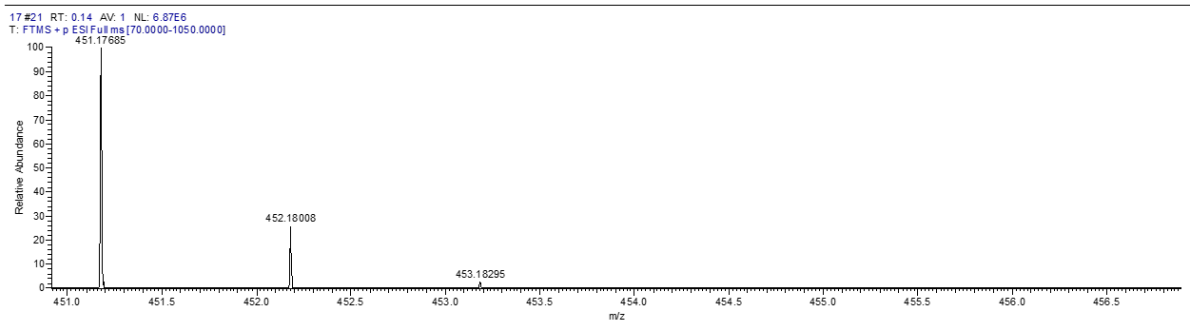
LC/MS Spectrum of compound **7e**



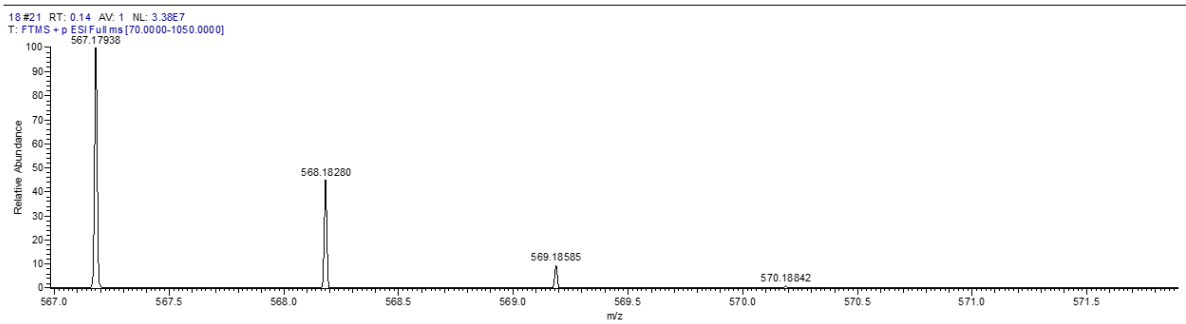
LC/MS Spectrum of compound **7f**



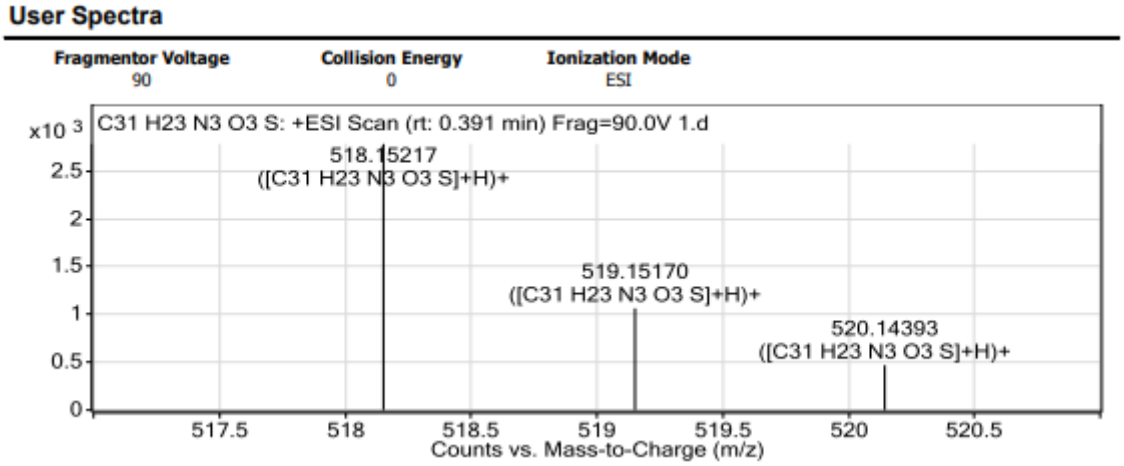
LC/MS Spectrum of compound **7g**



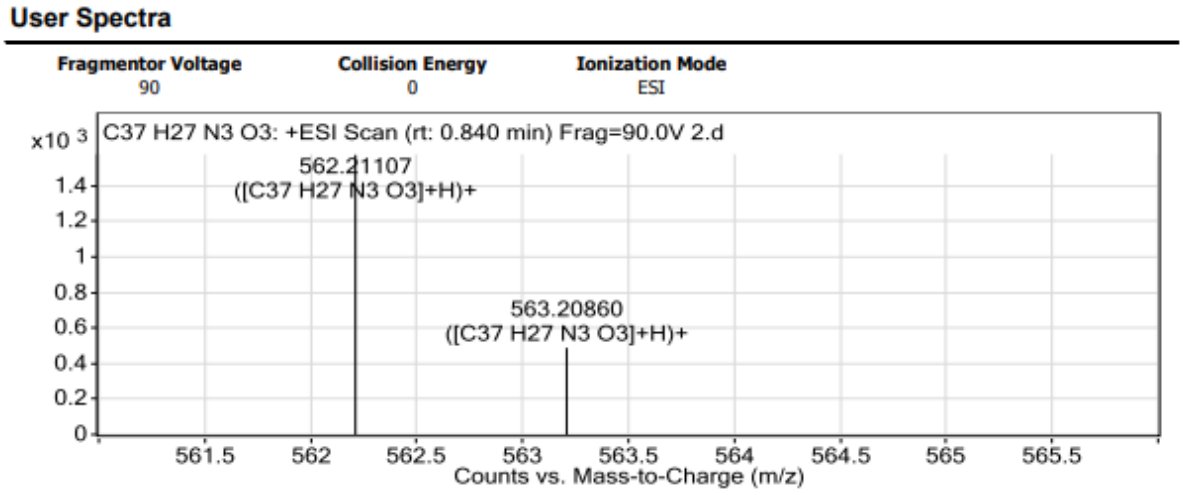
LC/MS Spectrum of compound **7h**



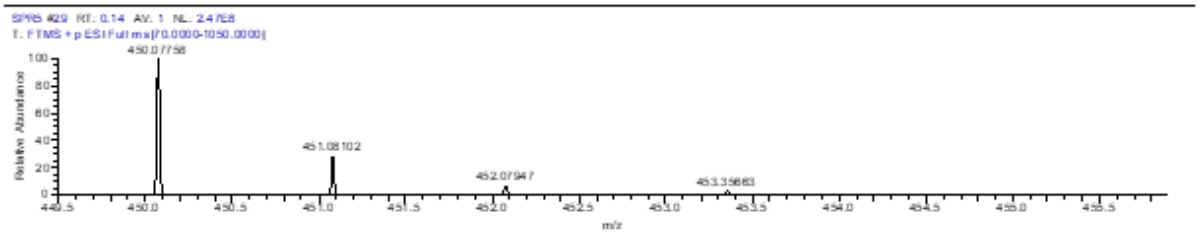
LC/MS Spectrum of compound **7i**



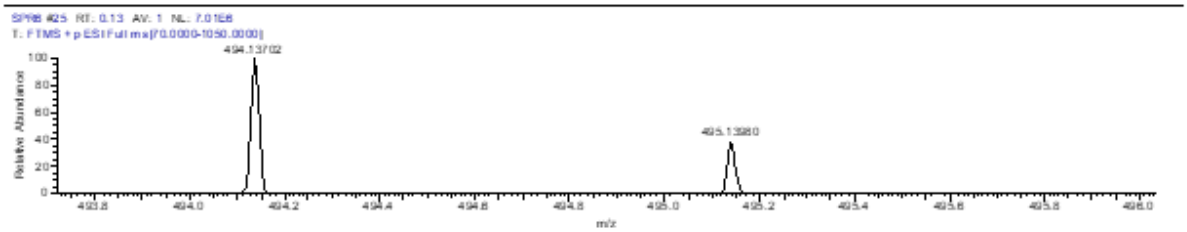
LC/MS Spectrum of compound **7j**



LC/MS Spectrum of compound **7k**



LC/MS Spectrum of compound **4d**



LC/MS Spectrum of compound **4e**