

## Efficient Synthesis of Spiro Diheterocycles via Multi-Component Dicyclization Reaction

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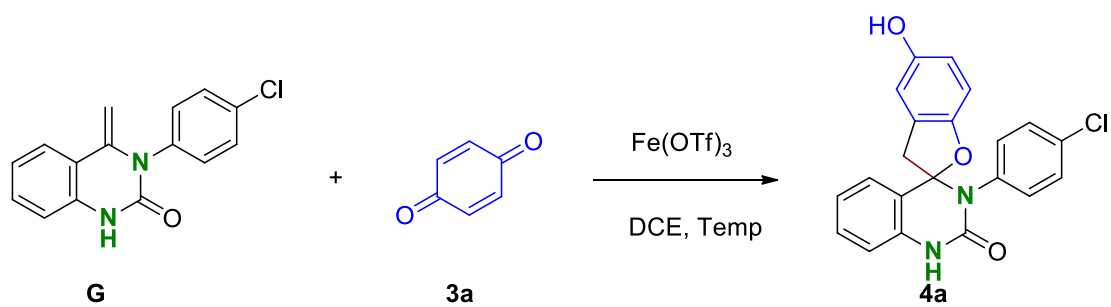
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**Table S1** Optimization of the reaction conditions<sup>a</sup>



Entry	Temperature (°C)	Catalyst amount (mol%)	Yield (%) <sup>b</sup>
1	rt	10	36
2	40	10	18
3	60	10	11
4	80	10	trace
5	rt	20	63
6	rt	30	45
7	rt	40	21

<sup>a</sup>Reaction conditions: **G** (0.5 mmol), **3** (0.5 mmol) and catalyst in DCE (3 mL) at the indicated temperature for 6 hours until the reaction completed (monitored by TLC). <sup>b</sup>Isolated yield.

## 1. General information

Quinone monoimines were prepared according to the previously reported literature<sup>13</sup>. Their analytical data were identical with the reported data. Other starting materials, reagents and solvents were purchased from commercial sources and used as received. <sup>1</sup>H and <sup>13</sup>C NMR spectra were recorded at 400 and 101 MHz, respectively. High-resolution mass spectra (HRMS) were performed with a Q-TOF-Premier mass spectrometer. HPLC analyses were carried out on an Agilent 1260 Infinity II instrument. All reactions were monitored by thin-layer chromatography (TLC) using silica gel plates (silica gel 60 F254).

## 2. General Procedure for Synthesis of quinoline-spiroquinazolinones (4a as an example)

A reaction tube was charged with 1-(2-aminophenyl)-ethanone **1** (0.5 mmol, 68 mg), Isocyanate **2** (0.5 mmol, 77 mg), ZnCl<sub>2</sub> (0.1 mmol, 20 mg) and DCE (3 mL). The tube was then sealed and heated at 80 °C for 6-10 h. The reaction was monitored by TLC (petroleum ether: ethyl acetate= 2 : 1). After reaction cooling, Quinone **3** (0.6 mmol, 65 mg) was added into the mixture. The reaction mixture was stirred in the tube at room temperature for 6-10 h and monitored by TLC (petroleum ether: ethyl acetate= 2 : 1). Then the solvent evaporated, and the residue was purified by flash silica gel chromatography (petroleum ether: ethyl acetate= 2 : 1) and recrystallized with dichloromethane giving the desired compound.

## 3. Characterization data for the products

**3'-(4-Chlorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4a)**. Petroleum ether/ethyl acetate=2:1; White powder (152 mg, 80%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.44 (s, 1H), 8.84 (s, 1H), 7.44–7.32 (m, 3H), 7.31–7.24 (m, 2H), 7.21 (d, *J* = 8.0 Hz, 1H), 6.99 (d, *J* = 8.0 Hz, 2H), 6.46 (q, *J* = 2.0 Hz, 3H), 3.76 (d, *J* = 18.0 Hz, 1H), 3.39 (s, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.4, 150.8, 149.4, 137.1, 134.8, 132.4, 130.2, 128.7, 125.8, 124.9, 122.0, 121.2, 114.4, 114.1, 111.0, 108.7, 99.2, 40.6. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>16</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 379.0844; found: 379.0845.

**5-Hydroxy-3'-(4-methoxyphenyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4b)**. Petroleum ether/ethyl acetate=2:1; Yellow powder (127 mg, 68%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.34 (s, 1H), 8.81 (s, 1H), 7.33 (td, *J* = 7.6, 1.2 Hz, 1H), 7.23–7.11 (m, 3H), 7.03–6.91 (m, 2H), 6.92–6.74 (m, 2H), 6.46 (d, *J* = 6.0 Hz, 3H), 3.71 (s, 3H), 3.67 (d, *J* = 10.8 Hz, 1H), 3.41 (d, *J* = 18.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 158.4, 151.3, 149.5, 134.9, 130.7, 130.1, 126.1, 124.8, 121.9, 121.4, 114.3, 114.0, 113.9, 111.1, 108.7, 99.5, 55.2, 40.3. HRMS(ESI): calcd. for C<sub>22</sub>H<sub>19</sub>N<sub>2</sub>O<sub>4</sub><sup>+</sup> [M+H]<sup>+</sup> 375.1339; found: 375.1334.

**5-Hydroxy-3'-(4-isopropylphenyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4c)**. Petroleum ether/ethyl acetate=2:1; White powder (131 mg, 68%) <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.36 (s, 1H), 8.80 (s, 1H), 7.33 (ddd, *J* = 8.4, 7.2, 1.2 Hz, 1H), 7.23–7.11 (m, 5H), 7.02–6.90 (m, 2H), 6.50–6.41 (m, 3H), 3.69 (d, *J* = 17.6 Hz, 1H), 3.37 (s, 1H), 2.86 (d, *J* = 6.9 Hz, 1H), 1.17 (d, *J* = 6.8, 3.2 Hz, 6H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.3, 151.2, 149.3, 147.7, 135.9, 134.8, 130.0, 126.6, 126.1, 124.4, 121.8, 121.4, 114.2, 113.9, 111.0, 108.7, 99.4, 32.9, 23.8, 23.6. HRMS(ESI): calcd. for C<sub>24</sub>H<sub>23</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 387.1703; found: 387.1700.

**5-Hydroxy-3'-(4-(trifluoromethoxy)phenyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4d).** Petroleum ether/ethyl acetate=2:1; White powder (164 mg, 77%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.55–10.44 (m, 1H), 8.90–8.82 (m, 1H), 7.35 (ddd, *J* = 24.8, 15.2, 7.6 Hz, 5H), 7.22 (d, *J* = 8.0 Hz, 1H), 6.99 (q, *J* = 7.6 Hz, 2H), 6.47 (s, 3H), 3.76 (d, *J* = 18.0 Hz, 1H), 3.36 (d, *J* = 14.4 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.5, 150.9, 149.4, 147.5, 137.2, 134.8, 132.5, 130.2, 125.8, 125.0, 122.1, 121.2, 118.8, 114.4, 114.1, 110.9, 108.7, 99.2, 40.7. HRMS(ESI): calcd. for C<sub>22</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sub>4</sub><sup>+</sup> [M+H]<sup>+</sup> 429.1057; found: 429.1051.

**3'-(2-Fluorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4e).** Petroleum ether/ethyl acetate=2:1; White powder (110 mg, 61%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.44 (s, 1H), 8.78 (s, 1H), 7.42–7.25 (m, 4H), 7.21 (d, *J* = 8.0 Hz, 1H), 7.06 (td, *J* = 7.6, 1.6 Hz, 1H), 7.02–6.95 (m, 2H), 6.54–6.31 (m, 3H), 3.81 (d, *J* = 17.6 Hz, 1H), 3.20 (d, *J* = 18.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 158.7 (d, *J* = 246 Hz), 151.4, 149.8, 149.3, 134.6, 132.1, 130.4, 130.1 (d, *J* = 8.0 Hz), 125.7, 125.5, 125.1, 124.9, 124.7 (d, *J* = 3.5 Hz), 122.3, 122.0, 121.1, 116.0, 115.8 (d, *J* = 21.2 Hz), 114.3 (d, *J* = 31.4 Hz), 111.1, 108.8, 108.2, 99.2, 40.9. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>16</sub>FN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 363.1139; found: 363.1135.

**3'-(3,4-Dichlorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4f).** Petroleum ether/ethyl acetate=2:1; White powder (134 mg, 65%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.49 (s, 1H), 8.85 (s, 1H), 7.56 (d, *J* = 8.8 Hz, 2H), 7.35 (td, *J* = 7.6, 1.2 Hz, 1H), 7.30–7.20 (m, 2H), 7.04–6.94 (m, 2H), 6.56–6.42 (m, 3H), 3.78 (d, *J* = 18.0 Hz, 1H), 3.40 (d, *J* = 18.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.5, 150.5, 149.4, 138.0, 134.7, 132.7, 131.0, 130.8, 130.6, 130.4, 130.2, 125.6, 125.1, 122.1, 121.1, 114.5, 114.1, 111.0, 108.6, 99.1, 41.0. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>15</sub>Cl<sub>2</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 413.0454; found: 413.0458.

**3'-(2,4-Difluorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4g).** Petroleum ether/ethyl acetate=2:1; White powder (97 mg, 51%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.44 (d, *J* = 51.2 Hz, 1H), 8.78 (d, *J* = 41.2 Hz, 1H), 7.58–7.27 (m, 3H), 7.26–7.15 (m, 1H), 7.13–6.89 (m, 3H), 6.55–6.44 (m, 2H), 6.42–6.29 (m, 1H), 3.76 (d, 18.0 Hz, 1H), 3.22 (d, 18.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 161.5 (d, *J* = 269 Hz), 161.4 (d, *J* = 267 Hz), 151.5, 151.4, 149.7, 149.2, 134.5, 133.1 (d, *J* = 10.4 Hz), 130.3, 125.5, 125.1, 122.3, 121.9, 120.8, 114.5, 114.2, 111.8 (dd, *J* = 20.3, 3.1 Hz), 111.0, 110.6 (d, *J* = 12.8 Hz), 108.6, 104.3 (t, *J* = 24.5 Hz), 99.2, 41.1. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>15</sub>F<sub>2</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 381.1045; found: 381.1049.

**3'-(3,5-Dimethylphenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4h).** Petroleum ether/ethyl acetate=2:1; White powder (124mg, 67%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.33 (s, 1H), 8.77 (s, 1H), 7.38–7.29 (m, 1H), 7.19 (d, *J* = 8.0 Hz, 1H), 7.00–6.94 (m, 2H), 6.87 (d, *J* = 25.6 Hz, 3H), 6.52–6.39 (m, 3H), 3.71 (d, *J* = 17.6 Hz, 1H), 3.38 (s, 1H), 2.16 (s, 6H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 152.2, 151.6, 150.4, 138.3, 135.3, 131.0, 130.1, 128.7, 126.9, 125.5, 123.1, 121.9, 115.1, 114.9, 111.8, 109.3, 100.0, 40.8, 21.4. HRMS(ESI): calcd. for C<sub>23</sub>H<sub>21</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 373.1547; found: 373.1544.

**5-Hydroxy-3'-(3-(trifluoromethyl)phenyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4i).** Petroleum ether/ethyl acetate=2:1; White powder (164 mg, 77%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.50 (s, 1H), 8.80 (s, 1H), 7.70–7.50 (m, 4H), 7.36 (t, *J* = 7.6 Hz, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.52–6.42 (m, 2H), 6.39 (s, 1H), 3.81 (d, *J* = 18.0 Hz, 1H), 3.32 (s, 1H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.4, 150.7, 149.5, 138.7, 134.9, 130.2, 129.8, 129.7, 129.5, 129.2, 127.4, 125.5, 125.3, 125.1, 124.6, 124.5, 122.3, 122.1, 121.1, 114.4, 114.1, 110.8, 108.5, 99.1, 41.2. HRMS(ESI): calcd. for C<sub>22</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 413.1108; found: 413.1103.

**3'-(3-Fluorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4j).** Petroleum ether/ethyl acetate=2:1; White powder (105 mg, 58%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.48 (s, 1H), 8.86 (s, 1H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.22 (d, *J* = 8.0 Hz, 1H), 7.14 (m, 3H), 6.98 (t, *J* = 8.4 Hz, 2H), 6.52–6.43 (m, 3H), 3.76 (d, *J* = 18.0 Hz, 1H), 3.36 (s, 1H). <sup>13</sup>C NMR (101 MHz, MeOD) δ 161.5 (d, *J* = 237 Hz), 154.0, 153.3, 152.3, 141.2 (d *J* = 10.1 Hz), 136.2, 131.9, 131.6 (d, *J* = 11.3 Hz), 128.5 (d *J* = 3.3 Hz), 127.5, 126.9, 124.4, 123.6, 119.8 (d, *J* = 22.5 Hz), 116.8 (d *J* = 21.2 Hz), 116.3, 115.8, 112.4, 110.4, 101.3, 43.5. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>16</sub>FN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 363.1139; found: 363.1135.

**5-Hydroxy-3'-(*m*-tolyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4k).** Petroleum ether/ethyl acetate=2:1; White powder (102 mg, 70%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) 10.44 (s, 1H), 8.87 (s, 1H), 7.33 (t, *J* = 7.8 Hz, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.11–7.05 (m, 3H), 7.06–6.99 (m, 1H), 6.95 (t, *J* = 7.6 Hz, 1H), 6.49 (s, 3H), 3.72 (d, *J* = 17.6 Hz, 1H), 3.38 (d, *J* = 17.9 Hz, 1H), 2.20 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.2, 151.0, 149.5, 138.1, 137.9, 134.9, 131.1, 130.0, 128.3, 126.0, 121.8, 121.3, 114.2, 114.0, 111.0, 108.5, 99.2, 20.7. HRMS(ESI): calcd. for C<sub>22</sub>H<sub>19</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 359.1390; found: 359.1388.

**3'-(4-Chlorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4l).** Petroleum ether/ethyl acetate=2:1; White powder (152 mg, 80%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.47 (s, 1H), 8.84 (s, 1H), 7.41–7.29 (m, 4H), 7.28–7.18 (m, 2H), 7.03–6.94 (m, 2H), 6.52–6.43 (m, 3H), 3.77 (d, *J* = 18.0 Hz, 1H), 3.39 (d, *J* = 7.6 Hz, 1H). <sup>13</sup>C NMR (101 MHz, DMSO) δ 151.4, 150.7, 149.4, 139.5, 134.8, 132.7, 130.7, 130.2, 127.9, 125.7, 125.1, 122.1, 121.2, 114.4, 114.1, 111.0, 108.6, 99.2, 40.8. HRMS(ESI): calcd. for C<sub>21</sub>H<sub>16</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 379.0844; found: 379.0843.

**3'-Benzyl-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (4m).** Petroleum ether/ethyl acetate=2:1; White powder (120 mg, 67%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.24 (s, 1H), 8.78 (s, 1H), 8.46 (s, 1H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.18 (t, *J* = 7.2 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 2H), 6.89 (d, *J* = 8.0 Hz, 1H), 6.77 (d, *J* = 8.4 Hz, 1H), 6.74 (d, *J* = 8.0 Hz, 1H), 6.69 (dd, *J* = 8.4, 2.8 Hz, 1H), 6.64 (t, *J* = 7.8 Hz, 1H), 6.54 (d, *J* = 7.6 Hz, 1H), 6.36 (d, *J* = 2.8 Hz, 1H), 5.07 (d, *J* = 15.2 Hz, 1H), 4.90 (d, *J* = 14.8 Hz, 1H), 3.38 (s, 2H). <sup>13</sup>C NMR (125 MHz, DMSO-*d*<sub>6</sub>) δ 150.9, 150.4, 148.4, 136.7, 134.1, 130.6, 129.3, 129.0, 127.4,

126.5, 126.3, 125.0, 124.1, 123.0, 121.0, 117.9, 117.0, 116.9, 116.0, 115.3, 114.1, 54.9, 42.9. HRMS(ESI): calcd. for  $C_{22}H_{19}N_2O_3^+$   $[M+H]^+$  359.1390; found: 359.1394.

**5-Hydroxy-3'-(naphthalen-1-yl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one**

(4n). Petroleum ether/ethyl acetate=2:1; White powder (146 mg, 74%).  $^1H$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.55 (d,  $J$  = 4.0 Hz, 1H), 8.86–8.64 (m, 1H), 8.08–7.96 (m, 1H), 7.91 (d,  $J$  = 8.4 Hz, 1H), 7.74–7.65 (m, 1H), 7.56 (m, 2H), 7.48 (d,  $J$  = 7.2 Hz, 1H), 7.43–7.35 (m, 2H), 7.22 (d,  $J$  = 8.0 Hz, 1H), 7.08 (d,  $J$  = 8.0 Hz, 1H), 7.01 (t,  $J$  = 7.6 Hz, 1H), 6.53 (d,  $J$  = 8.4 Hz, 1H), 6.49–6.41 (m, 1H), 6.35 (d,  $J$  = 2.8 Hz, 1H), 3.72 (d,  $J$  = 17.6 Hz, 1H), 2.96 (d,  $J$  = 17.6 Hz, 1H).  $^{13}C$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  151.3, 151.0, 149.2, 135.0, 134.8, 133.6, 131.6, 130.2, 128.4, 128.3, 128.2, 127.3, 126.3, 126.2, 125.8, 124.7, 122.6, 122.1, 121.3, 114.4, 114.3, 111.0, 108.8, 99.7. HRMS(ESI): calcd. for  $C_{25}H_{19}N_2O_3^+$   $[M+H]^+$  395.1390; found: 395.1389.

**6'-Chloro-3'-(4-chlorophenyl)-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one**

(4o). Petroleum ether/ethyl acetate=2:1; White powder (158 mg, 77%).  $^1H$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.61 (s, 1H), 8.90 (s, 1H), 7.43 (dd,  $J$  = 8.7, 2.3 Hz, 1H), 7.40–7.32 (m, 2H), 7.27 (s, 2H), 7.21 (d,  $J$  = 2.4 Hz, 1H), 7.02 (d,  $J$  = 8.7 Hz, 1H), 6.53–6.43 (m, 3H), 3.81 (d,  $J$  = 18.1 Hz, 1H), 3.33 (s, 1H).  $^{13}C$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  151.6, 150.6, 149.2, 136.8, 133.9, 132.5, 130.2, 128.8, 125.60, 125.60, 124.5, 122.8, 116.0, 114.5, 111.1, 108.8, 98.6, 40.4. HRMS(ESI): calcd. for  $C_{21}H_{15}Cl_2N_2O_3^+$   $[M+H]^+$  413.0454; found: 413.0419.

**6'-Chloro-5-hydroxy-3'-(p-tolyl)-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one**

(4p). Petroleum ether/ethyl acetate=2:1; Yellow powder (94 mg, 48%).  $^1H$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.52 (s, 1H), 8.86 (s, 1H), 7.42 (dd,  $J$  = 8.4, 2.4 Hz, 1H), 7.17 (d,  $J$  = 2.4 Hz, 1H), 7.10 (s, 3H), 7.01 (d,  $J$  = 8.8 Hz, 1H), 6.52–6.43 (m, 3H), 3.76 (d,  $J$  = 18.0 Hz, 1H), 3.37 (s, 1H), 2.26 (s, 3H).  $^{13}C$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  151.4, 150.9, 149.1, 137.2, 135.3, 134.0, 130.1, 125.8, 125.3, 124.2, 122.9, 115.9, 114.4, 111.1, 108.8, 98.7, 20.6. HRMS(ESI): calcd. for  $C_{22}H_{18}ClN_2O_3^+$   $[M+H]^+$  393.1000; found: 393.1004.

**3'-Cyclohexyl-5-hydroxy-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one**

(4q). Petroleum ether/ethyl acetate=2:1; Transparent liquid (123mg, 70%).  $^1H$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  9.77 (s, 1H), 8.96 (s, 1H), 7.23 (t,  $J$  = 7.6 Hz, 1H), 7.05 (d,  $J$  = 8.0 Hz, 1H), 6.88 (t,  $J$  = 7.6 Hz, 1H), 6.82 (d,  $J$  = 8.0 Hz, 1H), 6.71 (s, 1H), 6.56 (s, 2H), 3.63 (q,  $J$  = 18.4 Hz, 2H), 2.88 (m, 1H), 2.44–2.31 (m, 1H), 1.78–1.52 (m, 5H), 1.52–1.40 (m, 1H), 1.01 (q,  $J$  = 10.5 Hz, 2H), 0.82 (m, 1H).  $^{13}C$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  151.5, 150.7, 149.2, 134.1, 129.8, 125.9, 125.5, 121.5, 121.3, 114.6, 113.1, 111.1, 108.1, 100.1, 56.6, 45.1, 30.3, 30.1, 26.5, 26.3, 25.0. HRMS(ESI): calcd. for  $C_{21}H_{23}N_2O_3^+$   $[M+H]^+$  351.1703; found: 351.1706.

**5-Hydroxy-3'-isopropyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one**

(4r). Petroleum ether/ethyl acetate=2:1; Transparent liquid (71mg, 46%).  $^1H$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  9.76 (s, 1H), 8.96 (s, 1H), 7.30–7.20 (m, 1H), 7.04 (dd,  $J$  = 8.0, 1.6 Hz, 1H), 6.94–6.86 (m, 1H), 6.82 (dd,  $J$  = 8.0, 1.2 Hz, 1H), 6.70 (s, 1H), 6.57–6.54 (m, 2H), 3.65 (d,  $J$  = 3.6 Hz, 2H), 3.38 (q,  $J$  = 6.8 Hz, 1H), 1.45 (d,  $J$  = 6.8 Hz, 3H), 1.37 (d,  $J$  = 6.8 Hz, 3H).  $^{13}C$

NMR (100 MHz, DMSO-*d*<sub>6</sub>) δ 151.6, 150.6, 149.0, 134.0, 129.8, 125.8, 125.4, 121.5, 121.4, 115.6, 114.6, 113.1, 111.3, 108.2, 100.0, 47.7, 44.9, 21.0, 20.7. HRMS(ESI): calcd. for C<sub>18</sub>H<sub>19</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 311.1390; found: 311.1393.

**3'-(4-Chlorophenyl)-5-hydroxy-6-methyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one** and

**3'-(4-chlorophenyl)-5-hydroxy-7-methyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (5a).** Petroleum ether/ethyl acetate=2:1; White powder (132 mg, 67%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.41 (s, 1H), 8.70 (s, 1H), 7.42–7.32 (m, 3H), 7.29–7.15 (m, 3H), 6.99 (t, *J* = 8.0 Hz, 2H), 6.49–6.21 (m, 2H), 3.72 (t, *J* = 17.6 Hz, 1H), 3.46–3.37 (m, 1H), 2.00 (d, *J* = 8.8 Hz, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 151.1, 150.6, 148.1, 136.9, 134.8, 132.3, 130.0, 128.5, 125.3, 124.6, 123.4, 122.0, 121.4, 118.1, 115.7, 114.0, 108.0, 98.5, 41.8, 16.3, 15.2. HRMS(ESI): calcd. for C<sub>22</sub>H<sub>18</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 393.1000; found: 393.1006.

**3'-(4-Chlorophenyl)-5-hydroxy-4,7-dimethyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (5b).** Petroleum ether/ethyl acetate=2:1; White powder (110 mg, 54%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.40 (s, 1H), 8.55 (s, 1H), 7.43–7.17 (m, 6H), 6.99 (d, *J* = 7.6 Hz, 2H), 6.32 (s, 1H), 3.71 (d, *J* = 17.6 Hz, 1H), 3.48–3.25 (m, 2H), 1.95 (s, 3H), 1.81 (s, 3H). <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>) δ 150.7, 148.9, 147.7, 137.0, 134.8, 132.4, 130.1, 128.6, 125.4, 124.2, 122.1, 121.5, 116.8, 115.3, 114.6, 114.1, 98.6, 41.1, 15.0, 12.4. HRMS(ESI): calcd. for C<sub>23</sub>H<sub>20</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 407.1157; found: 407.1152.

**3'-(4-Chlorophenyl)-5-hydroxy-4,6-dimethyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (5c).** Petroleum ether/ethyl acetate=2:1; White powder (110 mg, 54%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.44 (s, 1H), 7.64 (s, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* = 7.2 Hz, 1H), 7.29 (s, 2H), 7.17 (d, *J* = 8.0 Hz, 1H), 7.01–6.91 (m, 2H), 6.27 (s, 1H), 3.68 (d, *J* = 17.6 Hz, 1H), 3.29 (d, *J* = 17.6 Hz, 1H), 2.05 (s, 3H), 1.92 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 150.9, 149.1, 146.7, 137.2, 134.6, 132.3, 130.1, 128.8, 124.8, 124.6, 122.2, 122.0, 121.5, 121.0, 114.0, 107.3, 99.1, 17.1, 13.3. HRMS(ESI): calcd. for C<sub>23</sub>H<sub>20</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 407.1157; found: 407.1153.

**3'-(4-Chlorophenyl)-5-hydroxy-4,6,7-trimethyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (5d).** Petroleum ether/ethyl acetate=2:1; White powder (65 mg, 24%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.40 (s, 1H), 7.52 (s, 1H), 7.40–7.31 (m, 3H), 7.31–7.25 (m, 2H), 7.21–7.16 (m, 1H), 6.98 (dd, *J* = 8.0, 6.5 Hz, 2H), 3.69 (d, *J* = 17.4 Hz, 1H), 3.38 (s, 1H), 2.00 (d, *J* = 2.0 Hz, 3H), 1.94 (s, 3H), 1.89 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 150.8, 148.2, 146.4, 137.1, 134.6, 132.2, 130.0, 128.6, 125.1, 123.5, 122.1, 121.7, 120.6, 117.9, 115.8, 114.0, 113.9, 98.2, 41.0, 13.3, 12.5, 12.2. HRMS(ESI): calcd. for C<sub>24</sub>H<sub>22</sub>ClN<sub>2</sub>O<sub>3</sub><sup>+</sup> [M+H]<sup>+</sup> 421.1313; found: 421.1308.

**3'-(4-chlorophenyl)-5-hydroxy-7-isopropyl-4-methyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one and**

**3'-(4-chlorophenyl)-5-hydroxy-4-isopropyl-7-methyl-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-2'(3'H)-one (5e).** Petroleum ether/ethyl acetate=2:1; White powder (65 mg, 30%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.39 (s, 1H), 8.57 (s, 1H), 7.68–7.24 (m, 5H), 7.19 (d, *J* = 8.0

Hz, 1H), 6.97 (t,  $J = 8.0$  Hz, 2H), 6.38 (s, 1H), 3.86–3.61 (d,  $J = 16.0$  Hz, 1H), 3.56–3.38 (m, 1H), 2.96–2.73 (m, 1H), 1.82 (d,  $J = 8.0$  Hz, 3H), 1.08 (d,  $J = 6.8$  Hz, 3H), 1.06–0.90 (m, 3H).  $^{13}\text{C}$  NMR (101 MHz, DMSO)  $\delta$  150.8, 149.2, 146.4, 137.0, 134.6, 132.5, 132.3, 130.0, 128.6, 125.8, 125.0, 124.5, 122.0, 121.7, 116.8, 114.0, 111.0, 98.6, 40.8, 27.5, 22.4, 12.3. RMS(ESI): calcd. for  $\text{C}_{25}\text{H}_{24}\text{ClN}_2\text{O}_3^+$   $[\text{M}+\text{H}]^+$  435.1470; found: 435.1467.

**5-Hydroxy-3'-(*m*-tolyl)-1'H,3H-spiro[naphtho[1,2-*b*]furan-2,4'-quinazolin]-2'(3'H)-one**

(5f). Petroleum ether/ethyl acetate=2:1; White powder (150 mg, 74%).  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.53 (s, 1H), 9.62 (s, 1H), 8.02 (d,  $J = 8.4$  Hz, 1H), 7.72 (d,  $J = 8.0$  Hz, 1H), 7.39 (dq,  $J = 12.0, 6.8$  Hz, 4H), 7.27 (t,  $J = 8.0$  Hz, 3H), 7.09–6.92 (m, 2H), 6.57 (s, 1H), 3.96 (d,  $J = 17.6$  Hz, 1H), 3.59 (d,  $J = 18.0$  Hz, 1H).  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  150.5, 147.3, 144.1, 139.4, 134.8, 132.5, 130.7, 130.3, 130.1, 127.9, 126.0, 125.5, 124.4, 124.2, 122.7, 122.2, 121.2, 120.6, 119.5, 117.8, 114.1, 103.9, 99.5, 42.5. HRMS(ESI): calcd. for  $\text{C}_{25}\text{H}_{18}\text{ClN}_2\text{O}_3^+$   $[\text{M}+\text{H}]^+$  429.1000; found: 429.0994.

**4-Methyl-N-(2'-oxo-3'-(4-(trifluoromethoxy)phenyl)-2',3'-dihydro-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-5-yl)benzenesulfonamide (5g)**. Petroleum ether/ethyl acetate=2:1; White powder (215 mg, 74%).  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.53 (s, 1H), 9.71 (s, 1H), 7.45 (d,  $J = 8.4$  Hz, 3H), 7.38–7.34 (m, 2H), 7.29 (d,  $J = 8.0$  Hz, 4H), 7.15 (d,  $J = 8.0$  Hz, 1H), 6.98 (t,  $J = 7.2$  Hz, 2H), 6.76–6.64 (m, 2H), 6.54 (d,  $J = 8.4$  Hz, 1H), 3.80 (d,  $J = 18.4$  Hz, 1H), 3.32 (s, 1H), 2.35 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  153.9, 150.6, 147.5, 142.9, 136.9, 136.5, 134.9, 130.5, 130.4, 129.4, 126.7, 125.8, 125.1, 122.6, 122.1, 121.2, 120.6, 118.5, 114.2, 108.7, 100.0, 40.3, 20.9. HRMS(ESI): calcd. for  $\text{C}_{29}\text{H}_{23}\text{F}_3\text{N}_3\text{O}_5\text{S}^+$   $[\text{M}+\text{H}]^+$  582.1305; found: 582.1302.

**N-(3'-(3-Fluorophenyl)-2'-oxo-2',3'-dihydro-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (5h)**. Petroleum ether/ethyl acetate=2:1; White powder (198 mg, 71%).  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.48 (s, 1H), 9.67 (s, 1H), 7.44 (d,  $J = 8.4$  Hz, 2H), 7.32 (dd,  $J = 19.2, 8.0$  Hz, 4H), 7.15 (t,  $J = 8.4$  Hz, 3H), 6.99 (t,  $J = 7.6$  Hz, 3H), 6.70 (d,  $J = 6.0$  Hz, 2H), 6.55 (d,  $J = 9.2$  Hz, 1H), 3.80 (d,  $J = 18.4$  Hz, 1H), 3.35 (s, 1H), 2.36 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  161.7 (d,  $J = 243$  Hz), 154.1, 150.5, 142.9, 139.3 (d,  $J = 10.1$  Hz), 136.5, 134.9, 134.0, 130.4, 130.0 (d,  $J = 9.5$  Hz), 129.5 (d,  $J = 5.0$  Hz), 126.7, 125.8, 125.2, 122.8, 122.1, 120.6, 118.7, 114.9 (d,  $J = 21.2$  Hz), 114.8, 114.2, 100.0, 40.4, 21.0. HRMS(ESI): calcd. for  $\text{C}_{28}\text{H}_{23}\text{FN}_3\text{O}_4\text{S}^+$   $[\text{M}+\text{H}]^+$  516.1388; found: 516.1384.

**N-(3'-(4-Chlorophenyl)-2'-oxo-2',3'-dihydro-1'H,3H-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (5i)**. Petroleum ether/ethyl acetate=2:1; White powder (239 mg, 90%).  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  10.48 (s, 1H), 9.68 (s, 1H), 7.44 (d,  $J = 8.0$  Hz, 2H), 7.33 (dd,  $J = 16.0, 8.0$  Hz, 5H), 7.15 (d,  $J = 8.0$  Hz, 1H), 6.99 (d,  $J = 8.0$  Hz, 2H), 6.70 (dd,  $J = 6.0, 2.8$  Hz, 2H), 6.57–6.51 (m, 1H), 3.79 (d,  $J = 18.0$  Hz, 1H), 3.37 (s, 1H), 2.36 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  153.9, 150.5, 142.9, 136.7, 136.5, 134.9, 132.5, 130.4, 130.3, 129.3, 128.7, 126.6, 125.8, 125.1, 122.8, 122.1, 120.6, 118.7, 114.1, 108.6, 99.9, 40.2, 21.0. HRMS(ESI): calcd. for  $\text{C}_{28}\text{H}_{23}\text{ClN}_3\text{O}_4\text{S}^+$   $[\text{M}+\text{H}]^+$  532.1092; found: 532.1097.



*N*-(3'-(3-Chlorophenyl)-2'-oxo-2',3'-dihydro-1*H*,3*H*-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (**5j**). Petroleum ether/ethyl acetate=2:1; White powder (213 mg, 80%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.48 (s, 1H), 9.67 (s, 1H), 7.44 (d, *J* = 8.4 Hz, 2H), 7.33 (dd, *J* = 20.4, 7.6 Hz, 6H), 7.16 (d, *J* = 8.0 Hz, 2H), 6.99 (dd, *J* = 7.6, 5.6 Hz, 2H), 6.75–6.66 (m, 2H), 6.56 (d, *J* = 8.4 Hz, 1H), 3.80 (d, *J* = 18.4 Hz, 1H), 3.33 (s, 1H), 2.36 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 154.0, 150.5, 142.9, 139.1, 136.5, 134.9, 132.7, 130.4, 130.1, 129.4, 128.0, 126.6, 125.7, 125.3, 122.9, 122.2, 120.6, 118.7, 114.2, 108.5, 99.9, 99.6, 40.5, 21.0. HRMS(ESI): calcd. for C<sub>28</sub>H<sub>23</sub>ClN<sub>3</sub>O<sub>4</sub>S<sup>+</sup> [M+H]<sup>+</sup> 532.1092; found: 532.1091.

*N*-(3'-(2-Chlorophenyl)-2'-oxo-2',3'-dihydro-1*H*,3*H*-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (**5k**). Petroleum ether/ethyl acetate=2:1; White powder (245 mg, 92%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.56 (s, 1H), 9.69 (s, 1H), 7.58 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.45 (d, *J* = 8.0 Hz, 2H), 7.41–7.34 (m, 2H), 7.32 (t, *J* = 6.8 Hz, 2H), 7.25 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.19–7.09 (m, 2H), 7.04–6.95 (m, 2H), 6.73 (dd, *J* = 11.6, 3.2 Hz, 2H), 6.58 (d, *J* = 8.4 Hz, 1H), 3.88 (d, *J* = 18.0 Hz, 1H), 3.05 (d, *J* = 18.0 Hz, 1H), 2.37 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) δ 153.8, 149.6, 142.9, 136.5, 135.3, 134.9, 133.8, 132.0, 130.5, 130.4, 129.8, 129.5, 129.4, 127.9, 126.7, 125.7, 125.0, 122.7, 122.2, 120.4, 118.6, 114.3, 108.6, 100.0, 39.0, 21.0. HRMS(ESI): calcd. for C<sub>28</sub>H<sub>23</sub>ClN<sub>3</sub>O<sub>4</sub>S<sup>+</sup> [M+H]<sup>+</sup> 532.1092; found: 532.1094.

*N*-(3'-(3,4-Dichlorophenyl)-2'-oxo-2',3'-dihydro-1*H*,3*H*-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (**5l**). Petroleum ether/ethyl acetate=2:1; White powder (206.5 mg, 73%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.54 (s, 1H), 9.68 (s, 1H), 7.54 (s, 2H), 7.47–7.42 (m, 2H), 7.40–7.34 (m, 1H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.23 (s, 1H), 7.18–7.14 (m, 1H), 7.00 (ddd, *J* = 8.0, 6.0, 1.2 Hz, 2H), 6.77–6.68 (m, 2H), 6.58 (d, *J* = 8.4 Hz, 1H), 3.81 (d, *J* = 18.4 Hz, 1H), 3.40 (s, 1H), 2.36 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO) δ 153.9, 150.3, 146.7, 142.9, 137.8, 136.5, 134.7, 130.9, 130.7, 130.5, 130.4, 129.4, 128.1, 126.6, 125.7, 122.9, 122.2, 120.5, 118.8, 114.2, 108.5, 101.7, 101.1, 99.8, 21.0. HRMS(ESI): calcd. for C<sub>28</sub>H<sub>22</sub>Cl<sub>2</sub>N<sub>3</sub>O<sub>4</sub>S<sup>+</sup> [M+H]<sup>+</sup> 566.0703; found: 566.0700.

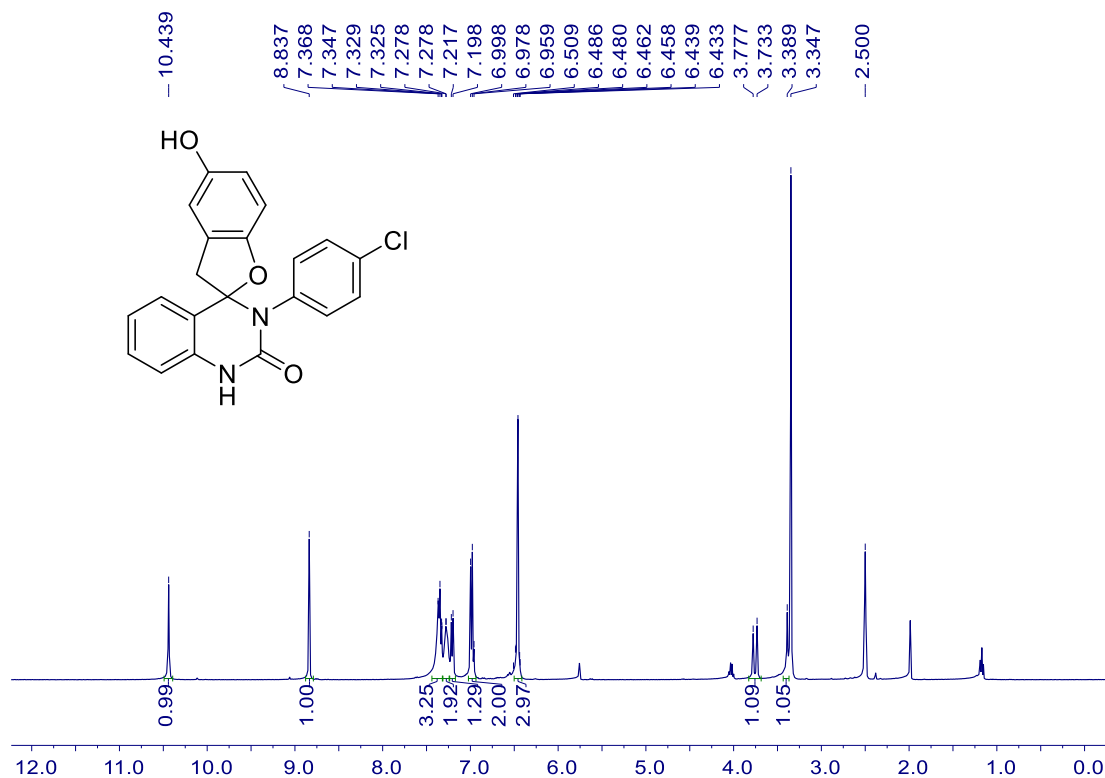
*N*-(3'-(2,4-Difluorophenyl)-2'-oxo-2',3'-dihydro-1*H*,3*H*-spiro[benzofuran-2,4'-quinazolin]-5-yl)-4-methylbenzenesulfonamide (**5m**). Petroleum ether/ethyl acetate=2:1; White powder (136 mg, 51%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.51 (s, 1H), 9.69 (s, 1H), 7.51–7.42 (m, 2H), 7.40–7.35 (m, 1H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.25–7.19 (m, 1H), 7.19–7.10 (m, 1H), 7.05–6.95 (m, 2H), 6.94–6.85 (m, 1H), 6.74 (d, *J* = 7.6 Hz, 2H), 6.61–6.54 (m, 1H), 3.79 (dd, *J* = 59.6, 18.0 Hz, 1H), 3.15 (d, *J* = 18.4 Hz, 1H), 2.36 (s, 3H). <sup>13</sup>C NMR (101 MHz, DMSO) δ 162.4 (d, *J* = 241 Hz), 161.8 (d, *J* = 251 Hz), 153.8, 149.5, 142.9, 136.5, 135.2, 134.6, 130.6 (d, *J* = 8.4 Hz), 129.3, 126.6, 126.5, 125.5, 125.4, 122.7, 122.3, 122.1 (d, *J* = 24.2 Hz), 120.2, 118.5, 114.3, 114.0 (d, *J* = 20.3 Hz), 111.7 (d, *J* = 21.7 Hz), 108.6, 99.9, 40.7, 20.9. HRMS(ESI): calcd. for C<sub>28</sub>H<sub>22</sub>F<sub>2</sub>N<sub>3</sub>O<sub>4</sub>S<sup>+</sup> [M+H]<sup>+</sup> 534.1294; found: 534.1290.

4-Methyl-*N*-(2'-oxo-3'-phenethyl-2',3'-dihydro-1*H*,3*H*-spiro[benzofuran-2,4'-quinazolin]-5-yl)benzenesulfonamide (**5n**). Petroleum ether/ethyl acetate=2:1; White powder (213 mg, 81%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 10.16 (s, 1H), 9.88 (s, 1H), 7.57 (d, *J* = 8.0 Hz, 2H),

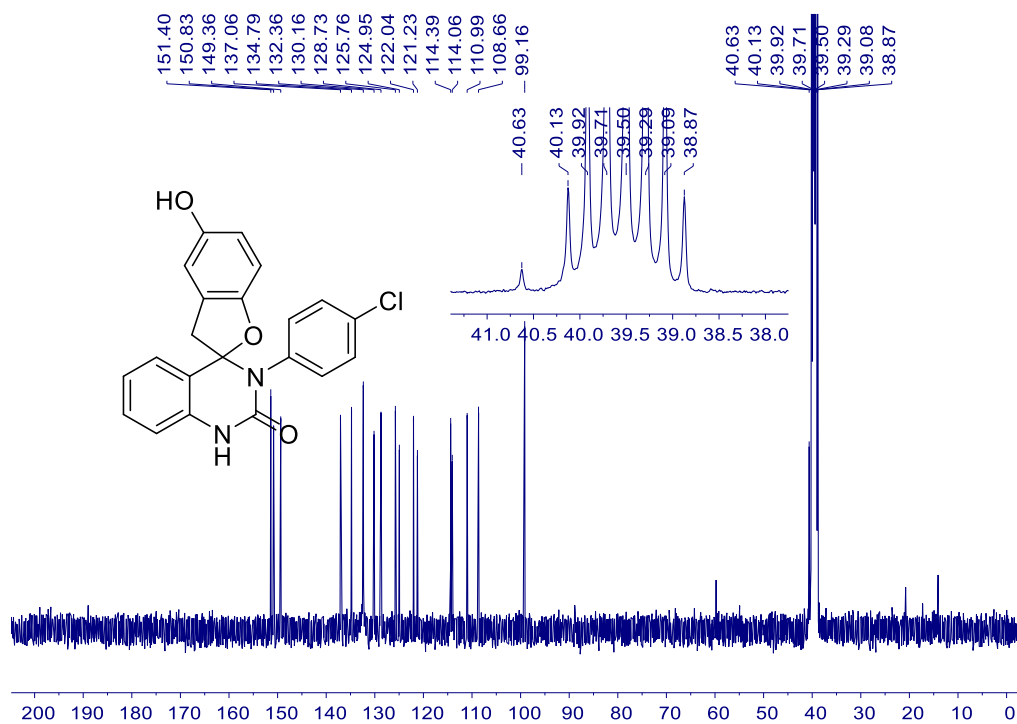
7.33–7.24 (m, 3H), 7.19 (m, 3H), 7.12–7.06 (m, 1H), 6.99 (d,  $J = 2.4$  Hz, 1H), 6.90 (ddt,  $J = 16.8, 8.4, 5.2$  Hz, 5H), 6.68 (d,  $J = 8.4$  Hz, 1H), 3.81–3.51 (m, 2H), 3.51–3.40 (m, 1H), 3.24–3.08 (m, 1H), 2.95 (td,  $J = 11.8, 11.4, 5.5$  Hz, 1H), 2.74 (m, 1H), 2.32 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  154.5, 149.8, 142.9, 139.2, 136.7, 134.6, 130.8, 130.1, 129.5, 128.40, 128.40, 126.7, 126.2, 126.1, 125.9, 122.7, 121.8, 120.4, 118.8, 113.6, 108.4, 100.1, 44.7, 43.1, 35.6, 21.0. HRMS(ESI): calcd. for  $\text{C}_{30}\text{H}_{28}\text{N}_3\text{O}_4\text{S}^+$   $[\text{M}+\text{H}]^+$  526.1795; found: 526.1790.

#### 4. Copies of NMR Spectra

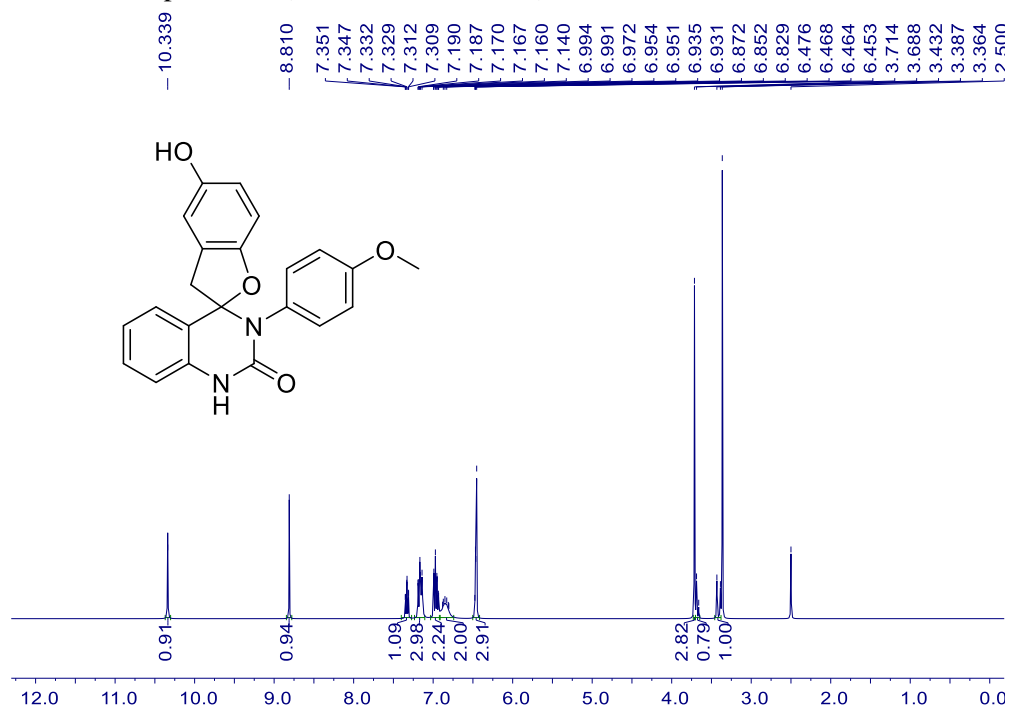
$^1\text{H}$  NMR of Compound **4a** (400 MHz,  $\text{DMSO-}d_6$ )



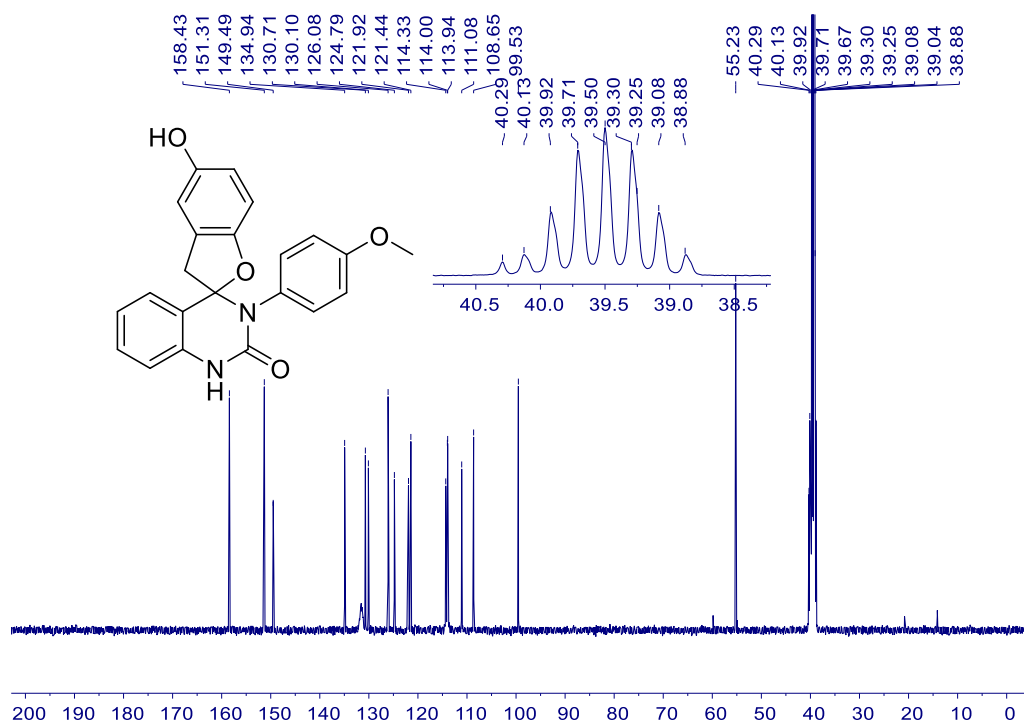
$^{13}\text{C}$  NMR of Compound **4a** (101 MHz,  $\text{DMSO-}d_6$ )



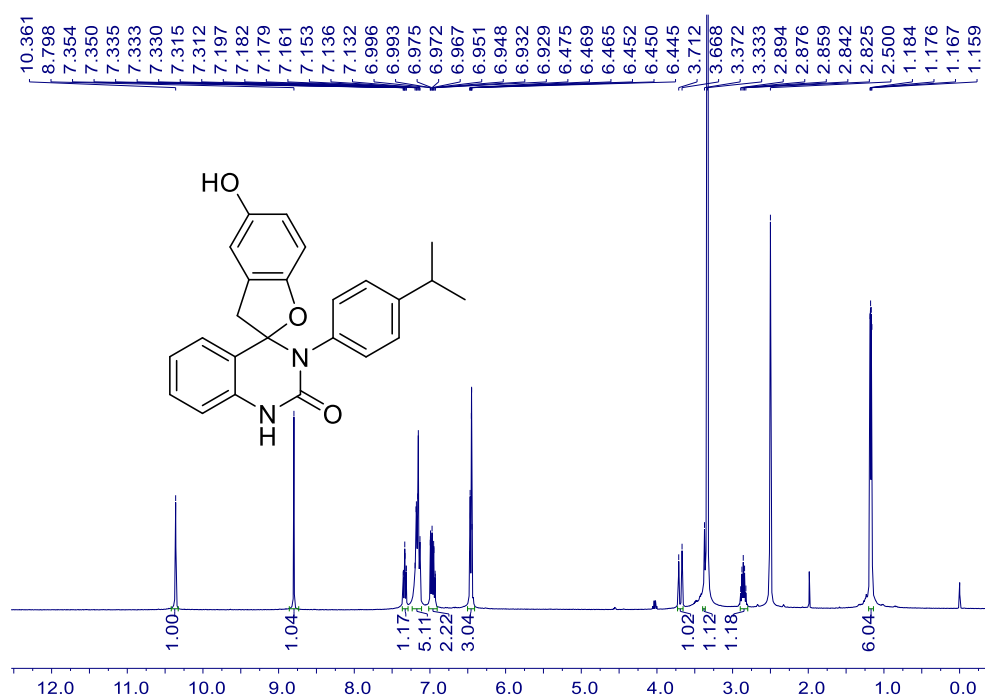
<sup>1</sup>H NMR of Compound **4b** (400 MHz, DMSO-*d*<sub>6</sub>)



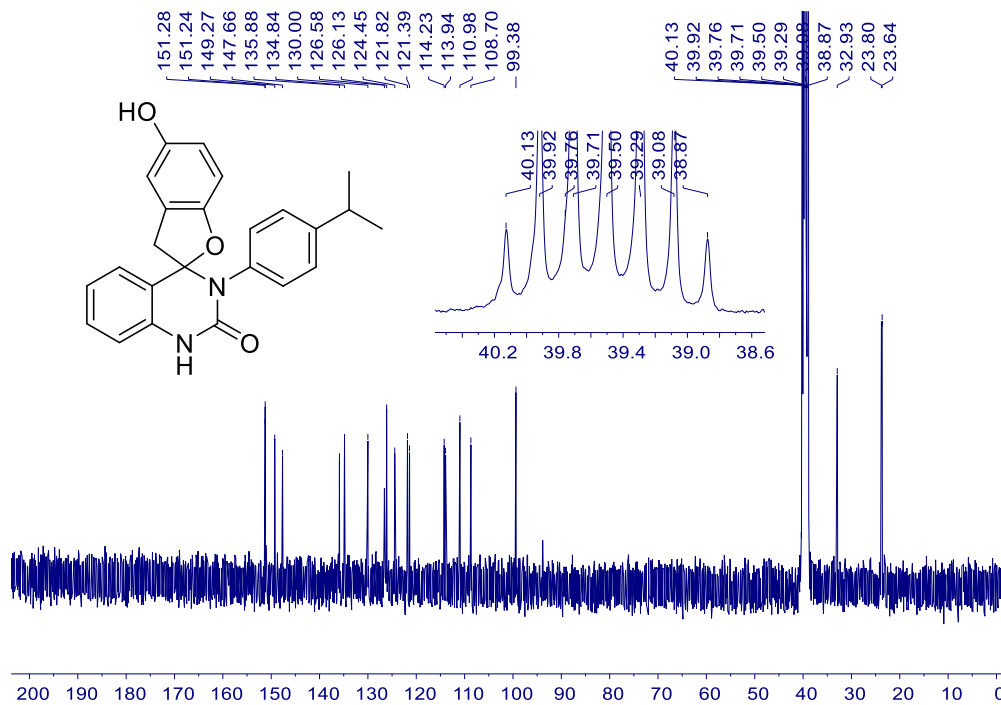
<sup>13</sup>C NMR of Compound **4b** (101 MHz, DMSO-*d*<sub>6</sub>)



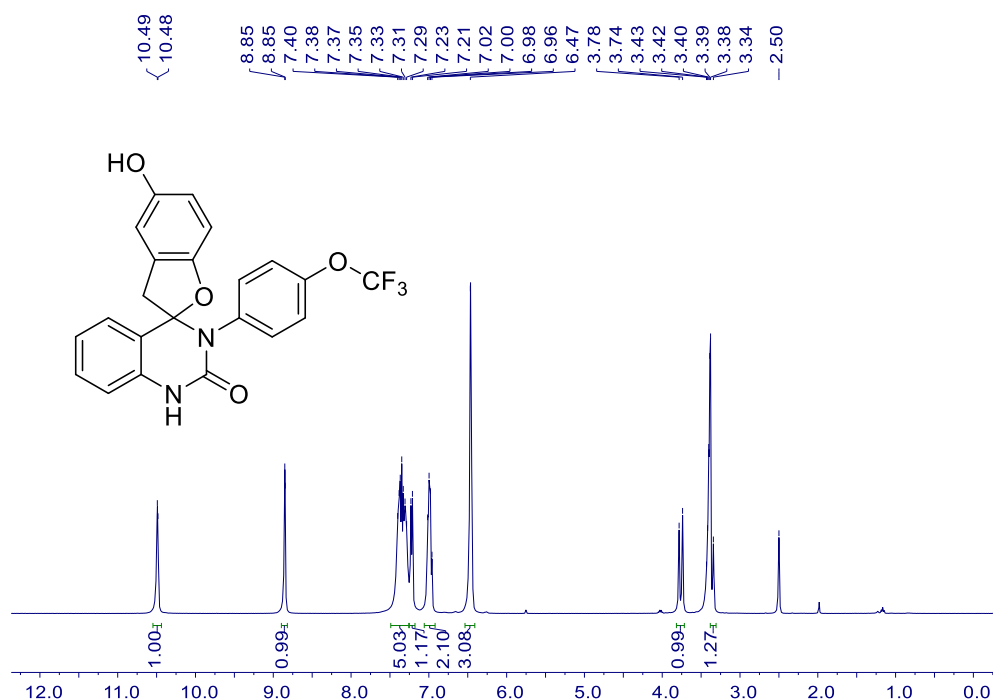
**<sup>1</sup>H NMR of Compound 4c (400 MHz, DMSO-*d*<sub>6</sub>)**



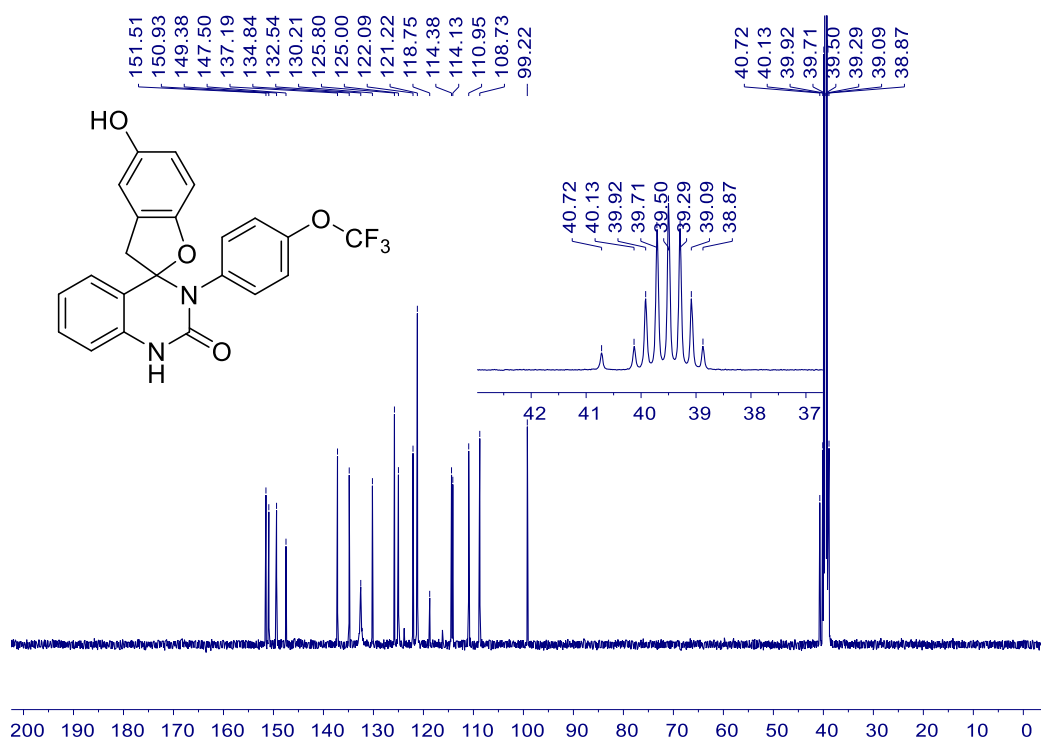
**<sup>13</sup>C NMR of Compound 4c (101 MHz, DMSO-*d*<sub>6</sub>)**



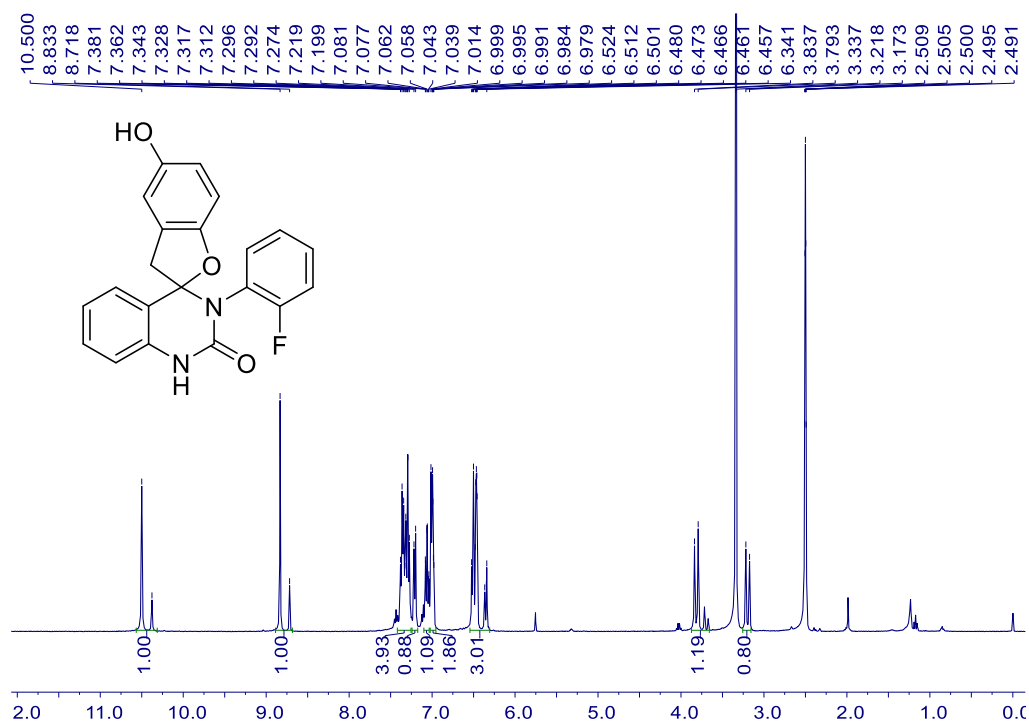
<sup>1</sup>H NMR of Compound **4d** (400 MHz, DMSO-*d*<sub>6</sub>)



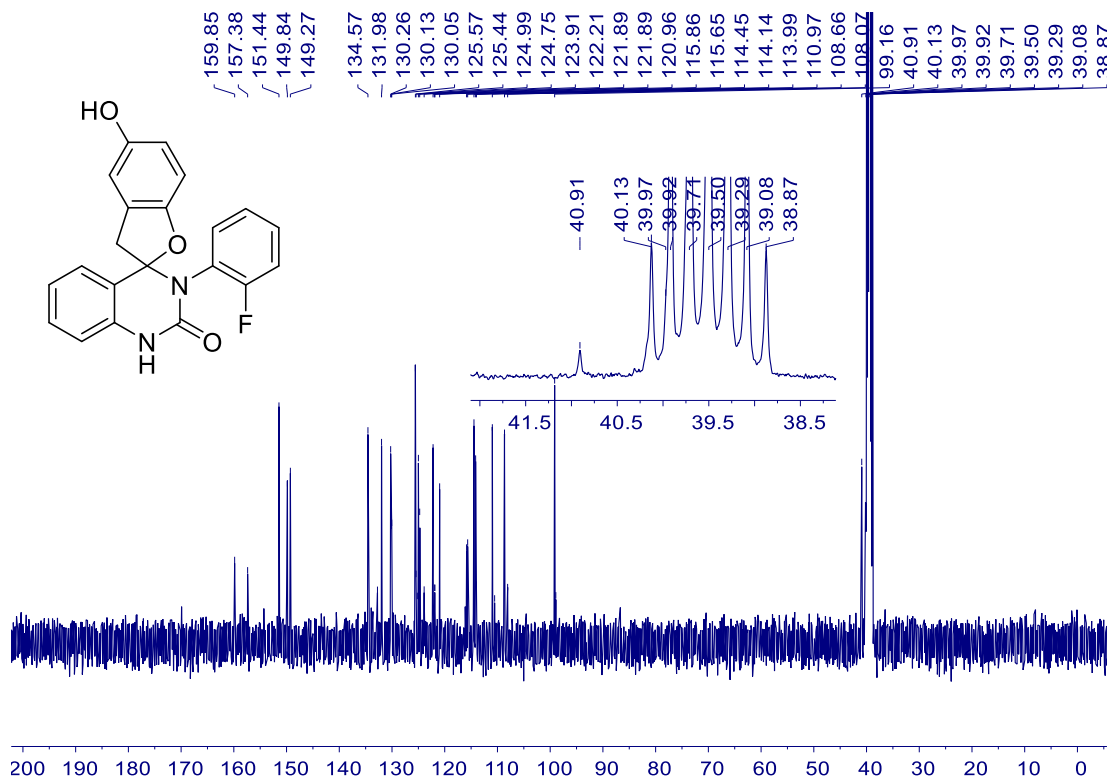
<sup>13</sup>C NMR of Compound **4d** (101 MHz, DMSO-*d*<sub>6</sub>)



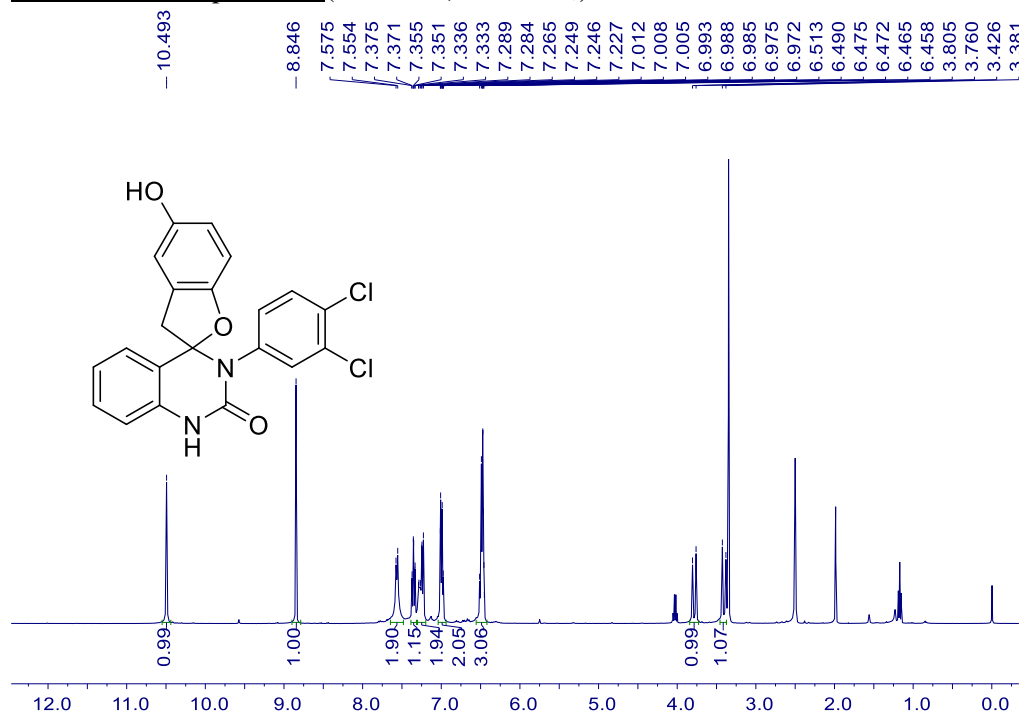
<sup>1</sup>H NMR of Compound **4e** (400 MHz, DMSO-*d*<sub>6</sub>)



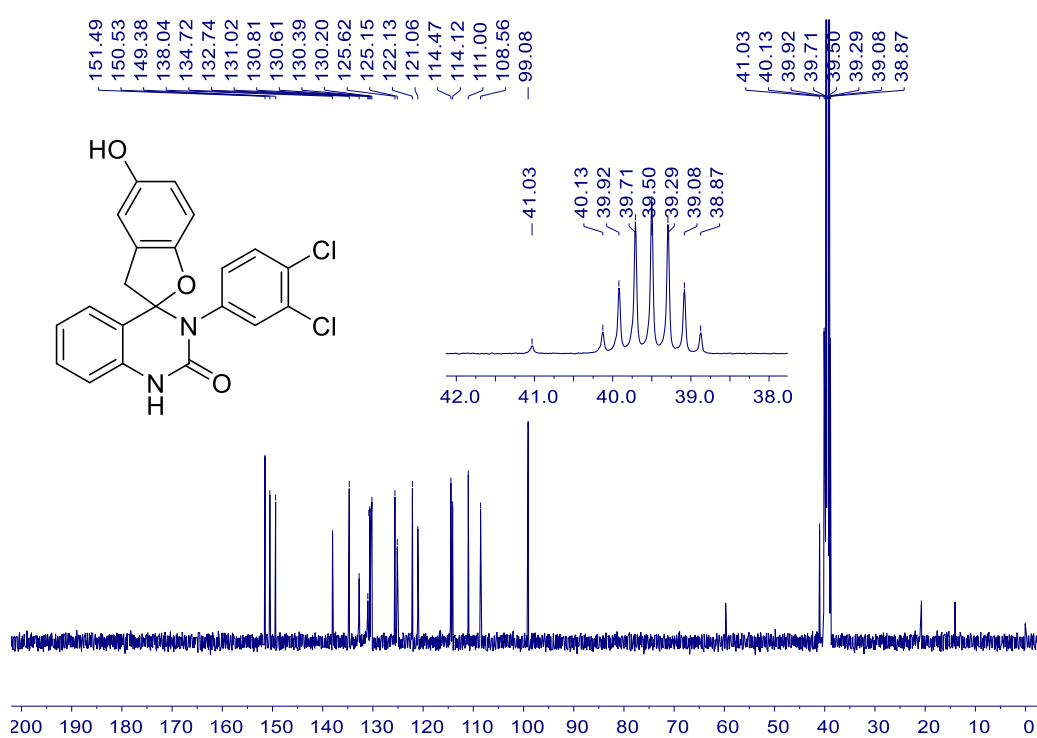
<sup>13</sup>C NMR of Compound **4e** (101 MHz, DMSO-*d*<sub>6</sub>)



<sup>1</sup>H NMR of Compound **4f** (400 MHz, DMSO-*d*<sub>6</sub>)

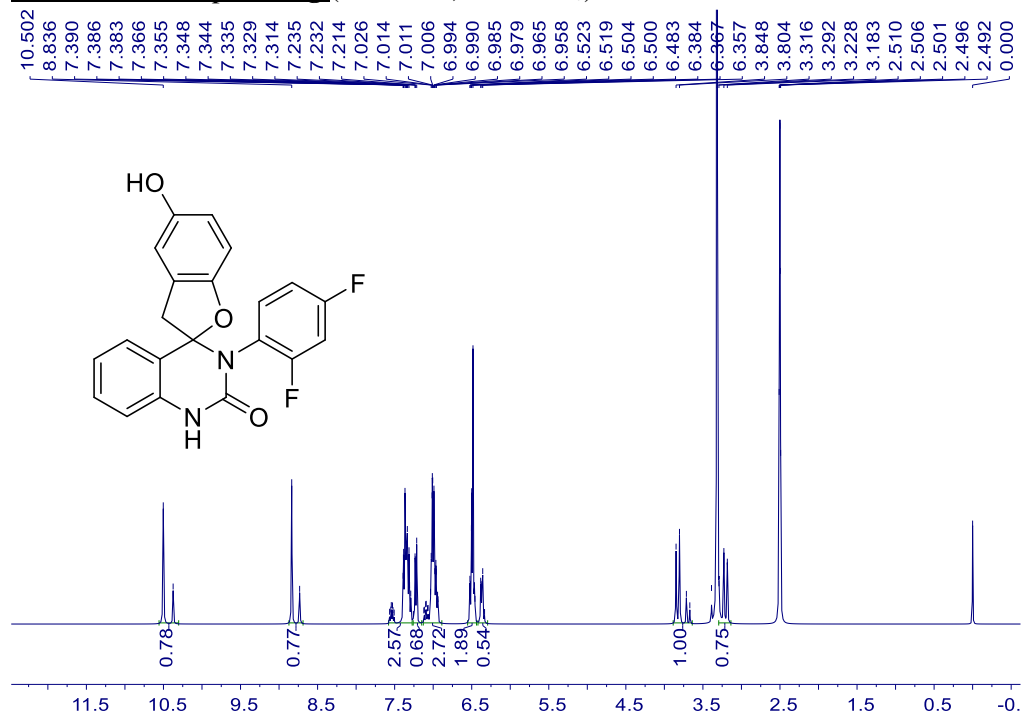


<sup>13</sup>C NMR of Compound **4f** (101 MHz, DMSO-*d*<sub>6</sub>)

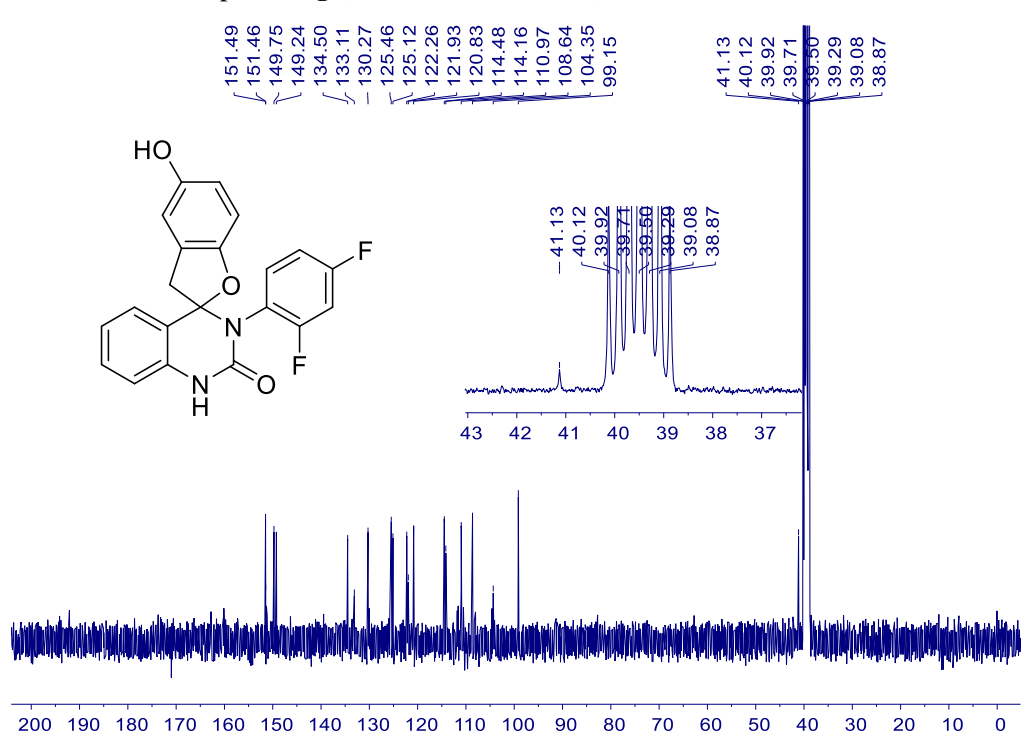




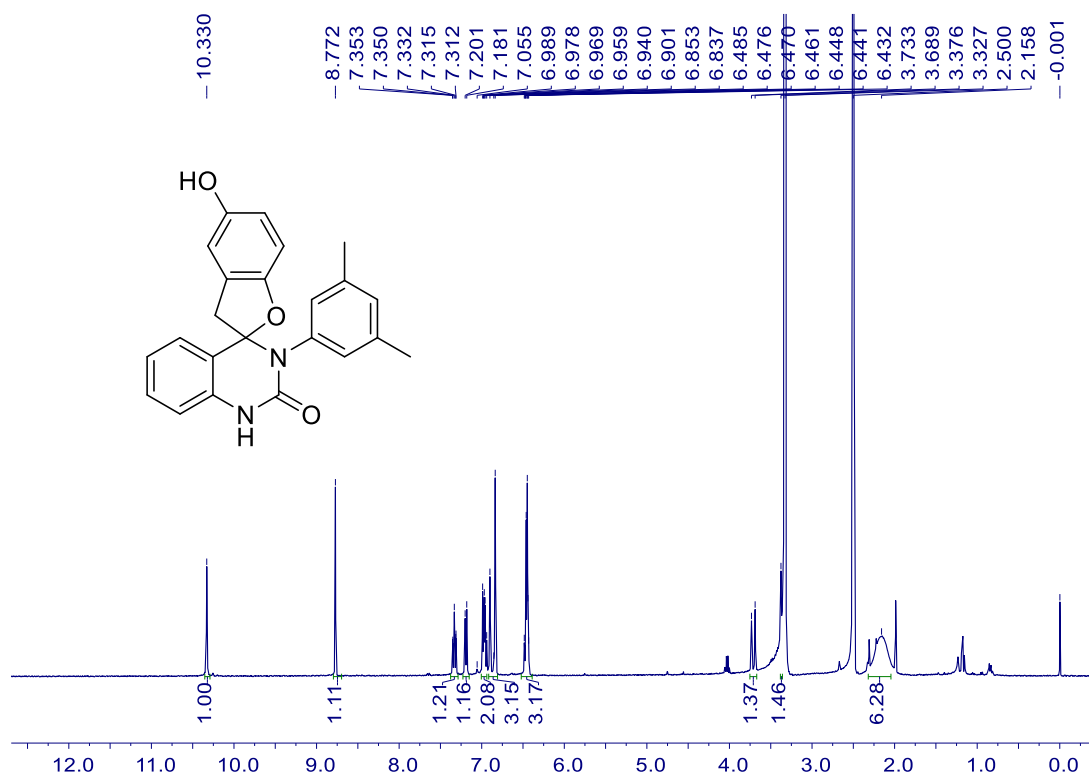
**<sup>1</sup>H NMR of Compound 4g (400 MHz, DMSO-*d*<sub>6</sub>)**



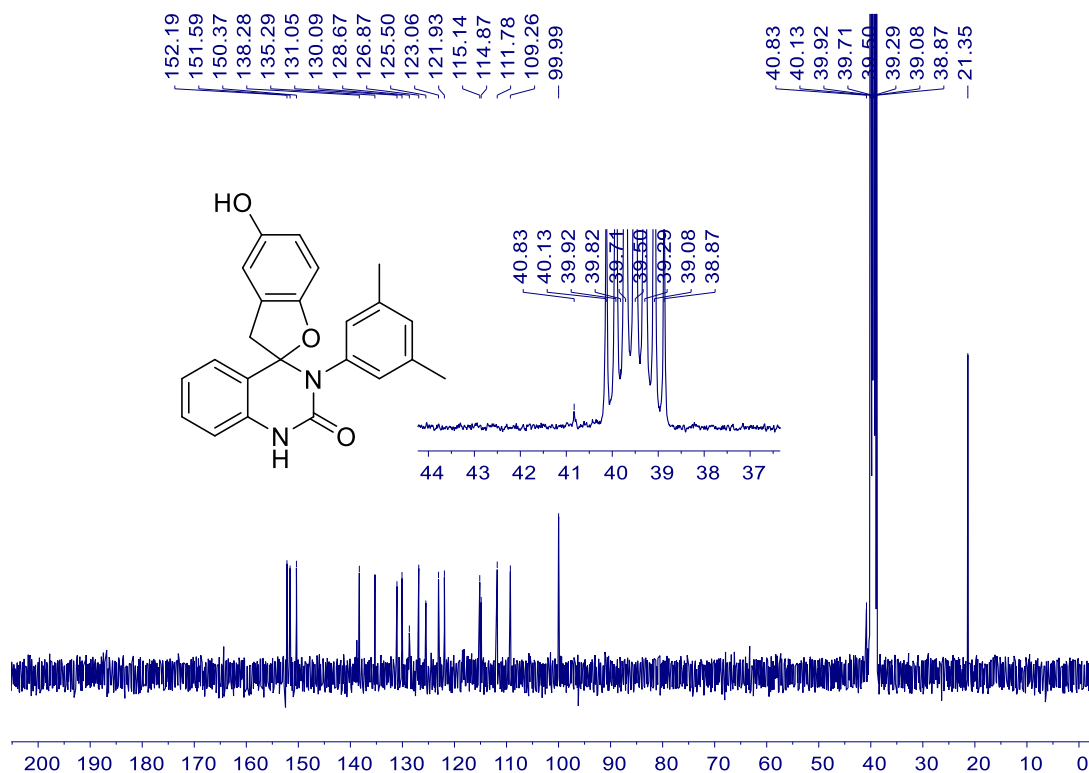
**<sup>13</sup>C NMR of Compound 4g (101 MHz, DMSO-*d*<sub>6</sub>)**



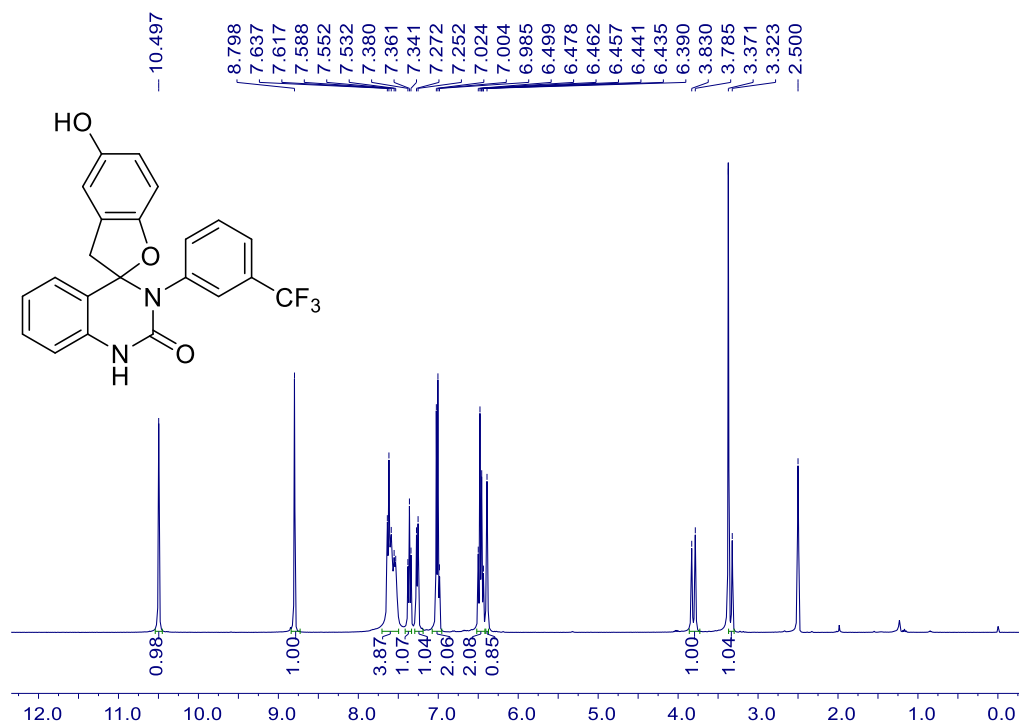
<sup>1</sup>H NMR of Compound **4h** (400 MHz, DMSO-*d*<sub>6</sub>)



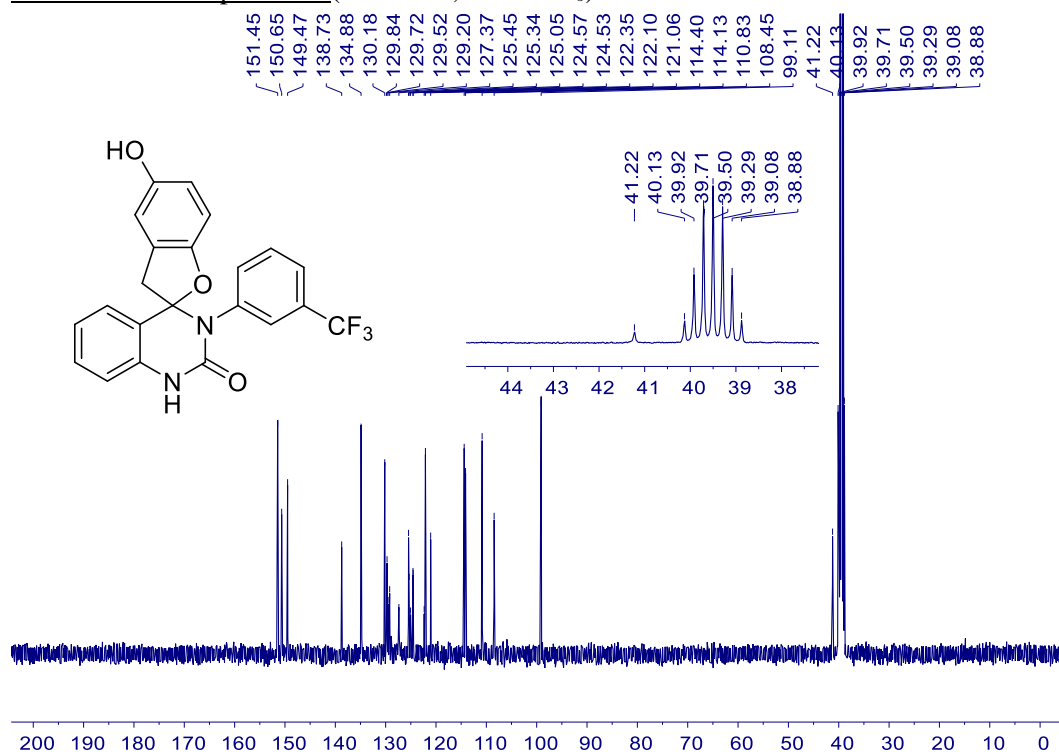
<sup>13</sup>C NMR of Compound **4h** (101 MHz, DMSO-*d*<sub>6</sub>)



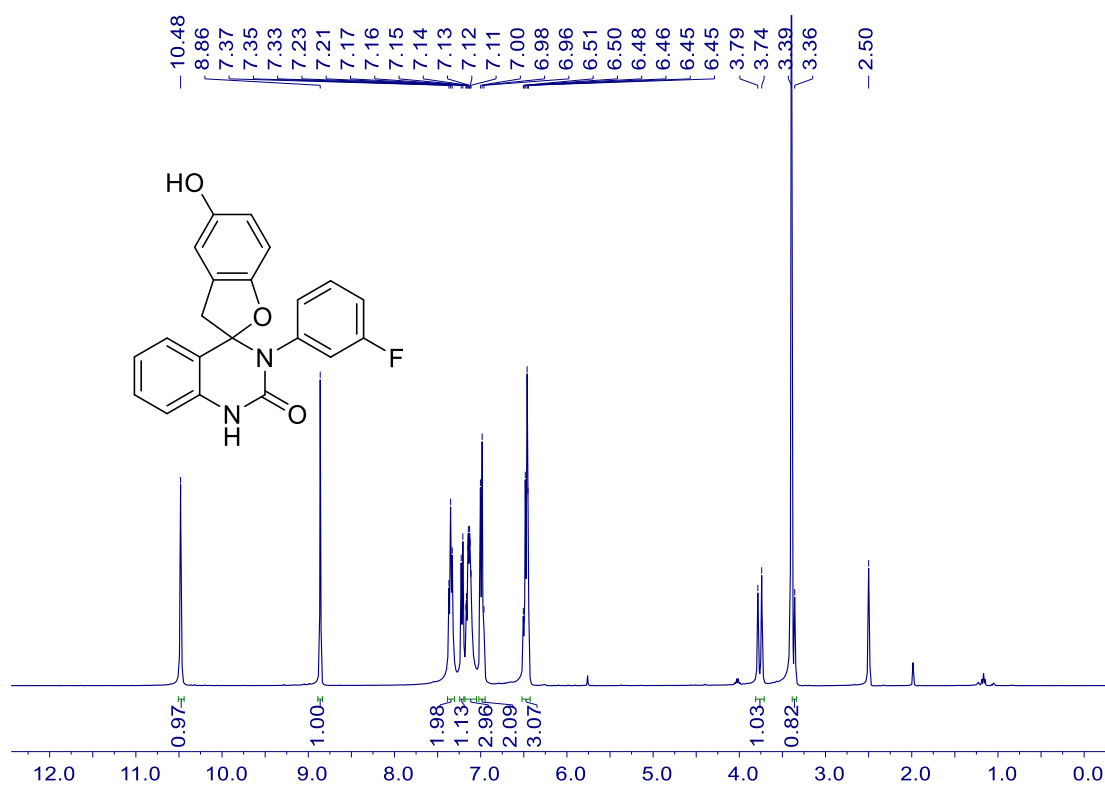
**<sup>1</sup>H NMR of Compound 4i (400 MHz, DMSO-*d*<sub>6</sub>)**



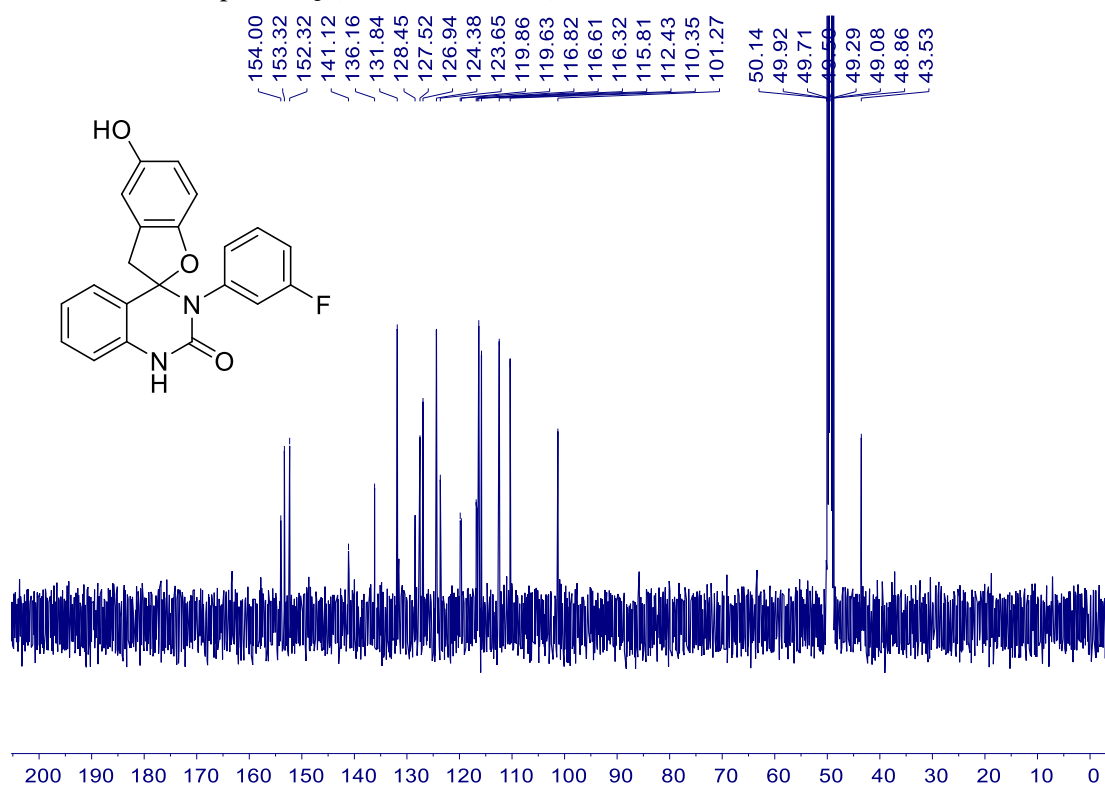
**<sup>13</sup>C NMR of Compound 4i (101 MHz, DMSO-*d*<sub>6</sub>)**



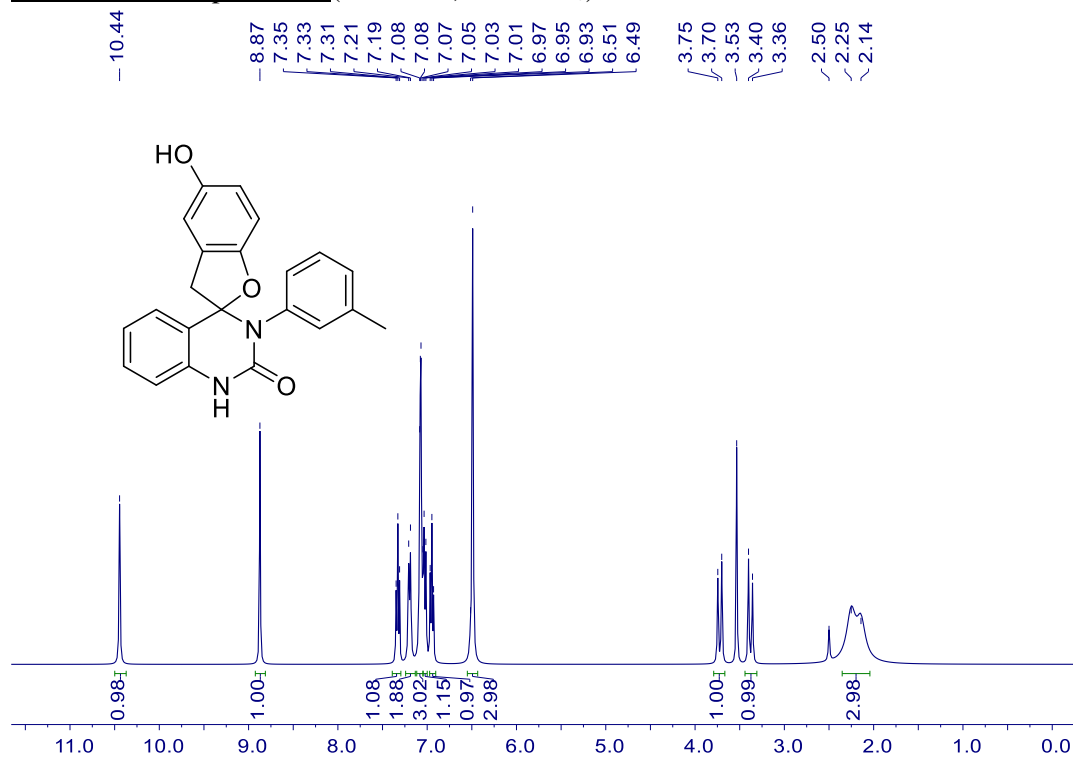
<sup>1</sup>H NMR of Compound **4j** (400 MHz, DMSO-*d*<sub>6</sub>)



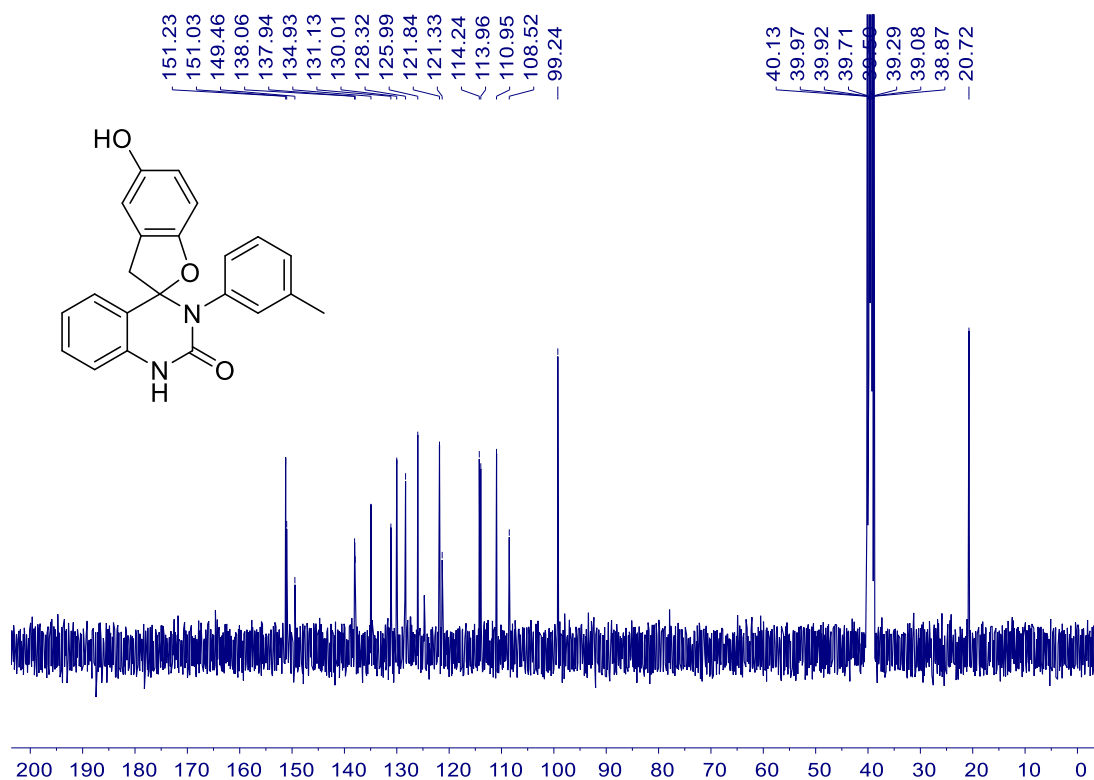
<sup>13</sup>C NMR of Compound **4j** (101 MHz, MeOD)



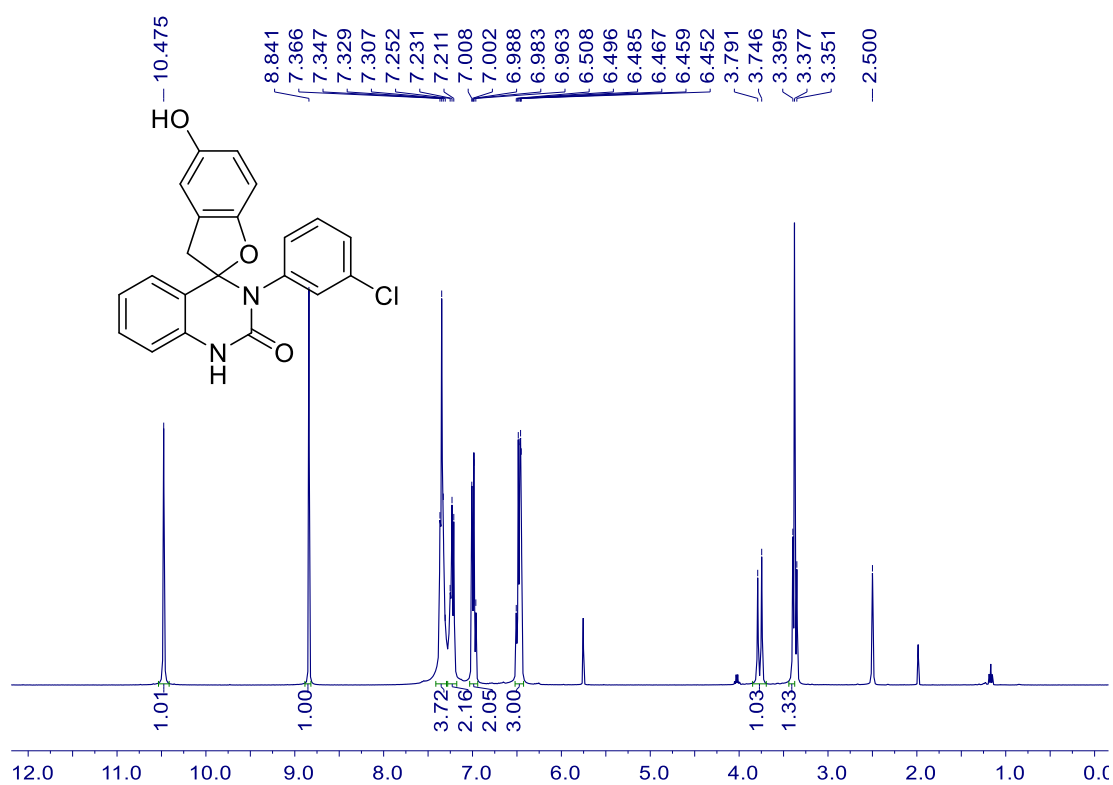
<sup>1</sup>H NMR of Compound **4k** (400 MHz, DMSO-*d*<sub>6</sub>)



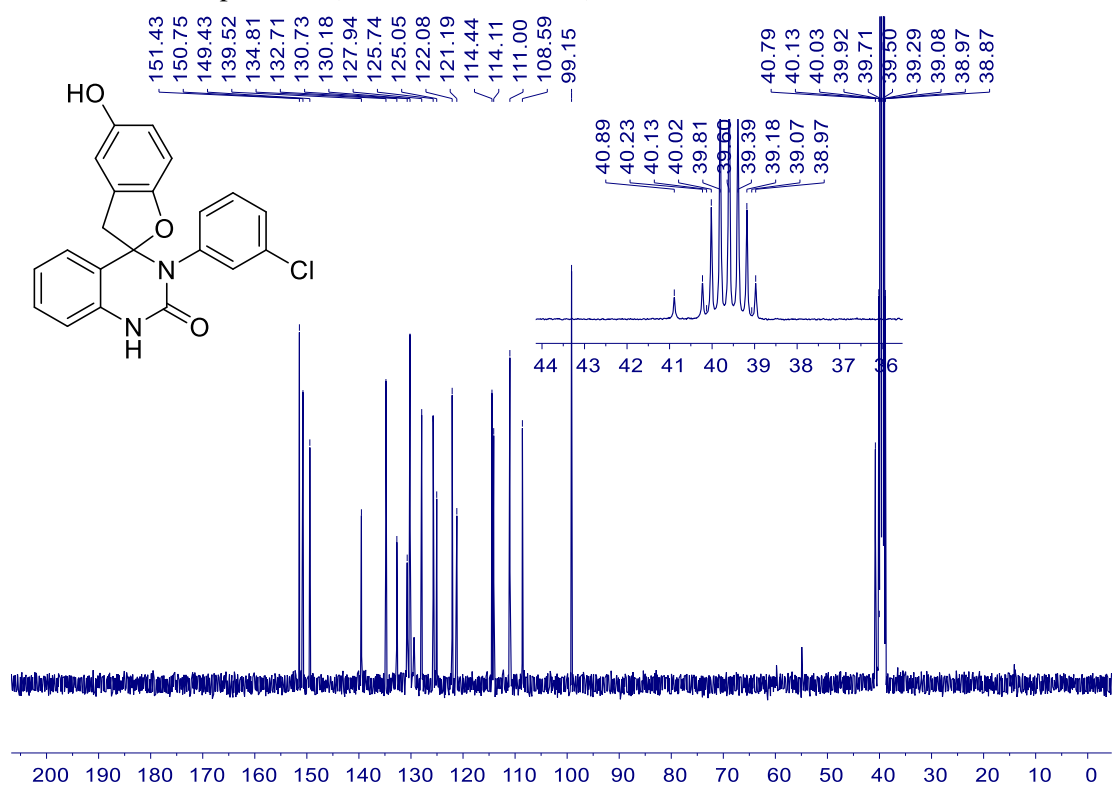
<sup>13</sup>C NMR of Compound **4k** (101 MHz, DMSO-*d*<sub>6</sub>)



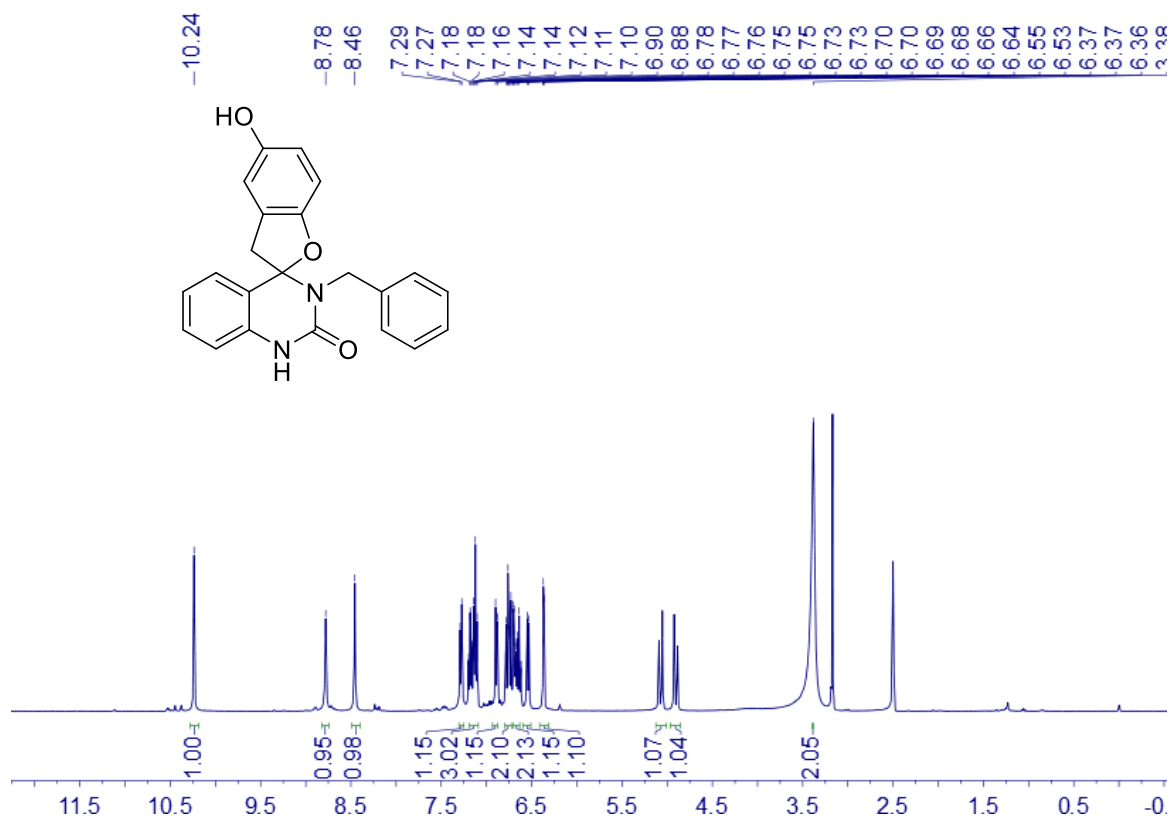
<sup>1</sup>H NMR of Compound **4I** (400 MHz, DMSO-*d*<sub>6</sub>)



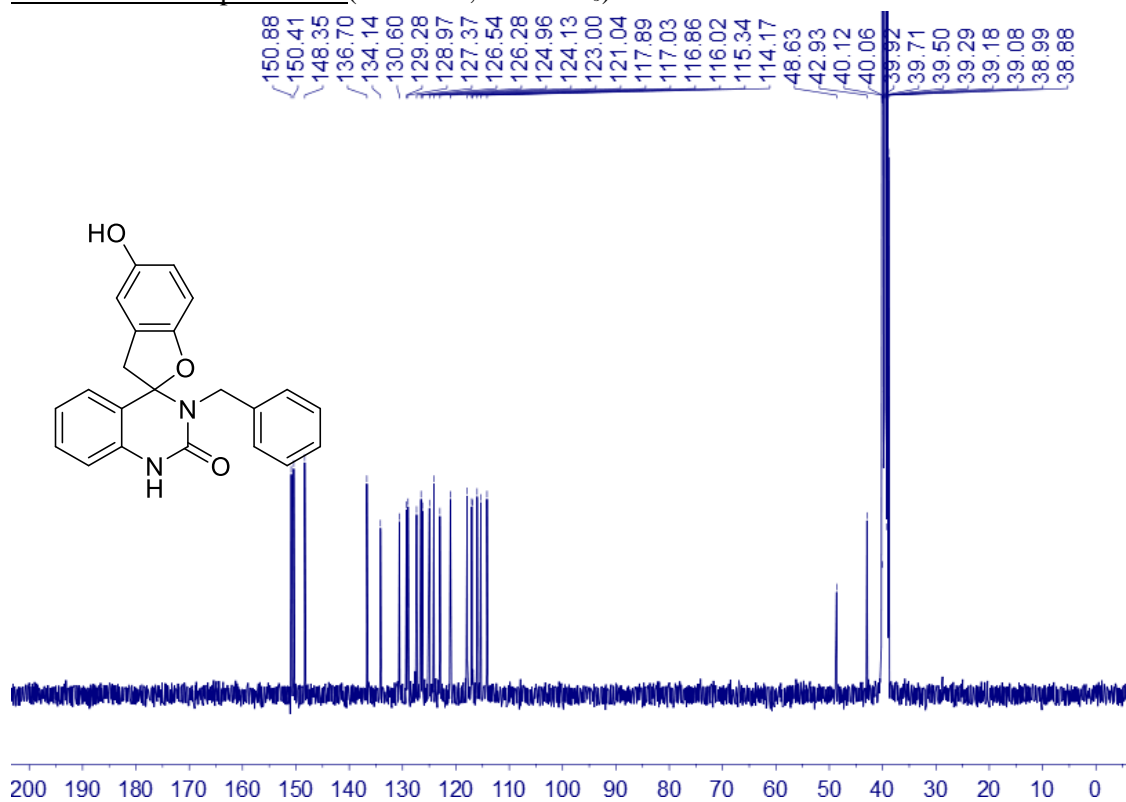
<sup>13</sup>C NMR of Compound **4I** (101 MHz, DMSO-*d*<sub>6</sub>)



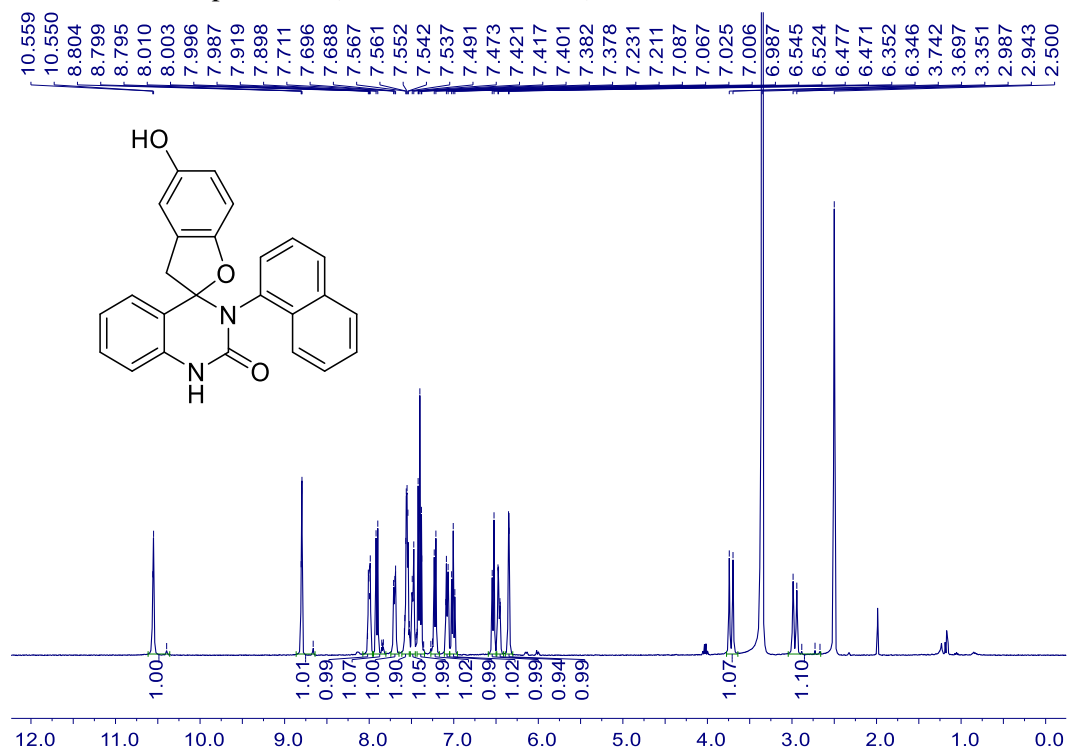
<sup>1</sup>H NMR of Compound **4m** (400 MHz, DMSO-*d*<sub>6</sub>)



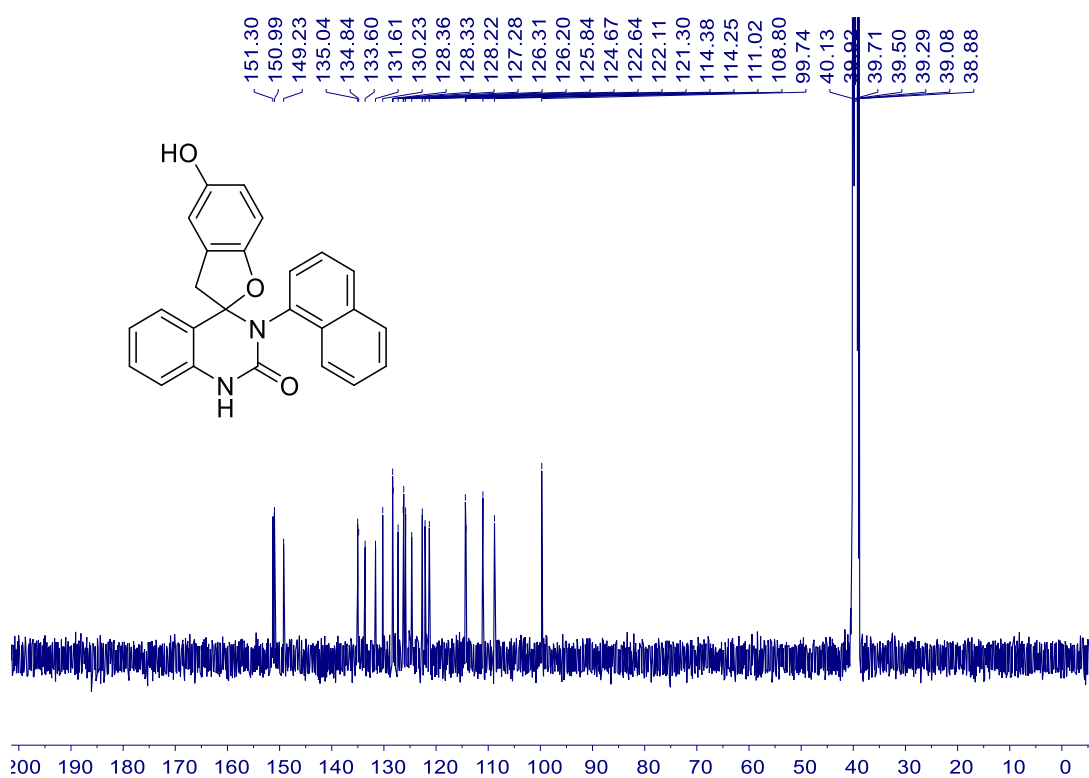
<sup>13</sup>C NMR of Compound **4m** (126 MHz, DMSO-*d*<sub>6</sub>)



**<sup>1</sup>H NMR of Compound 4n (400 MHz, DMSO-*d*<sub>6</sub>)**

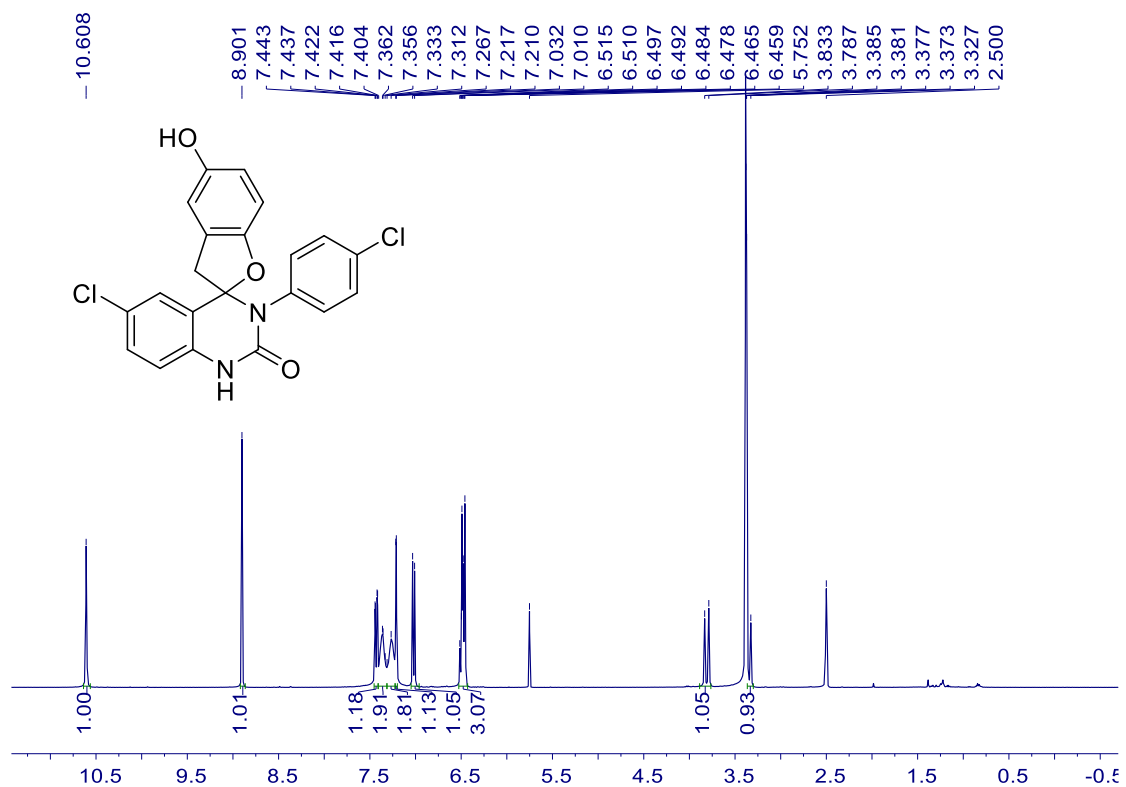


**<sup>13</sup>C NMR of Compound 4n (101 MHz, DMSO-*d*<sub>6</sub>)**

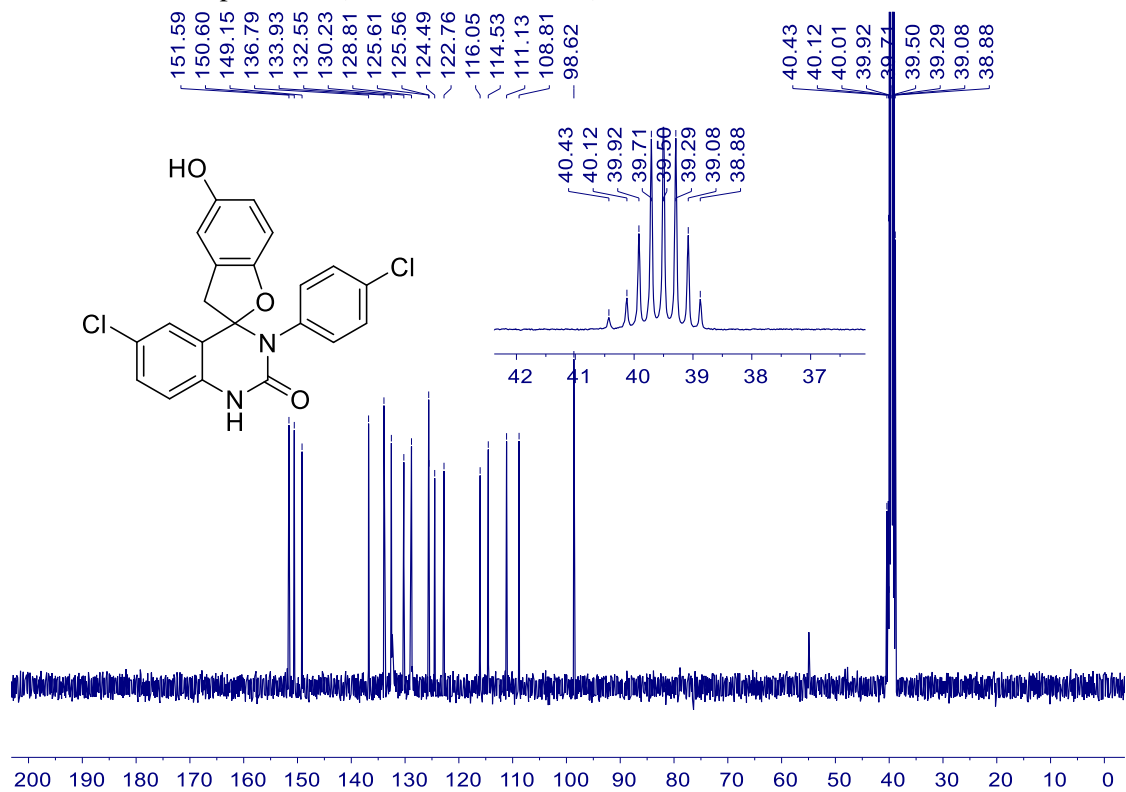




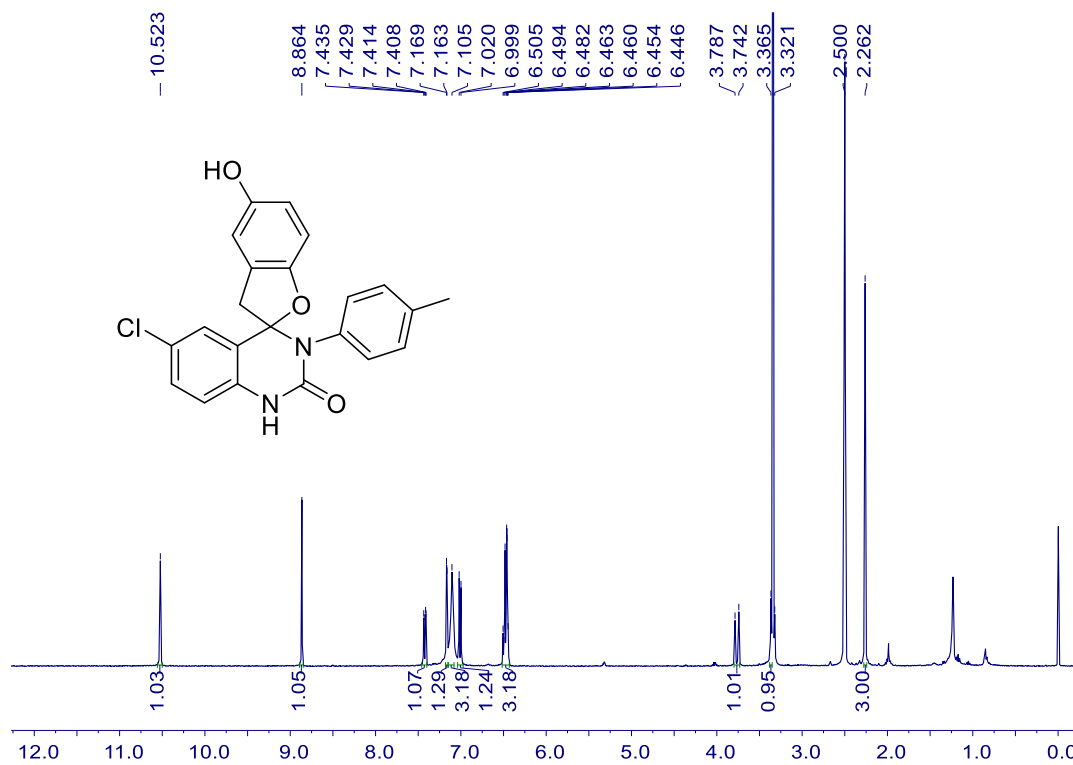
<sup>1</sup>H NMR of Compound **4o** (400 MHz, DMSO-*d*<sub>6</sub>)



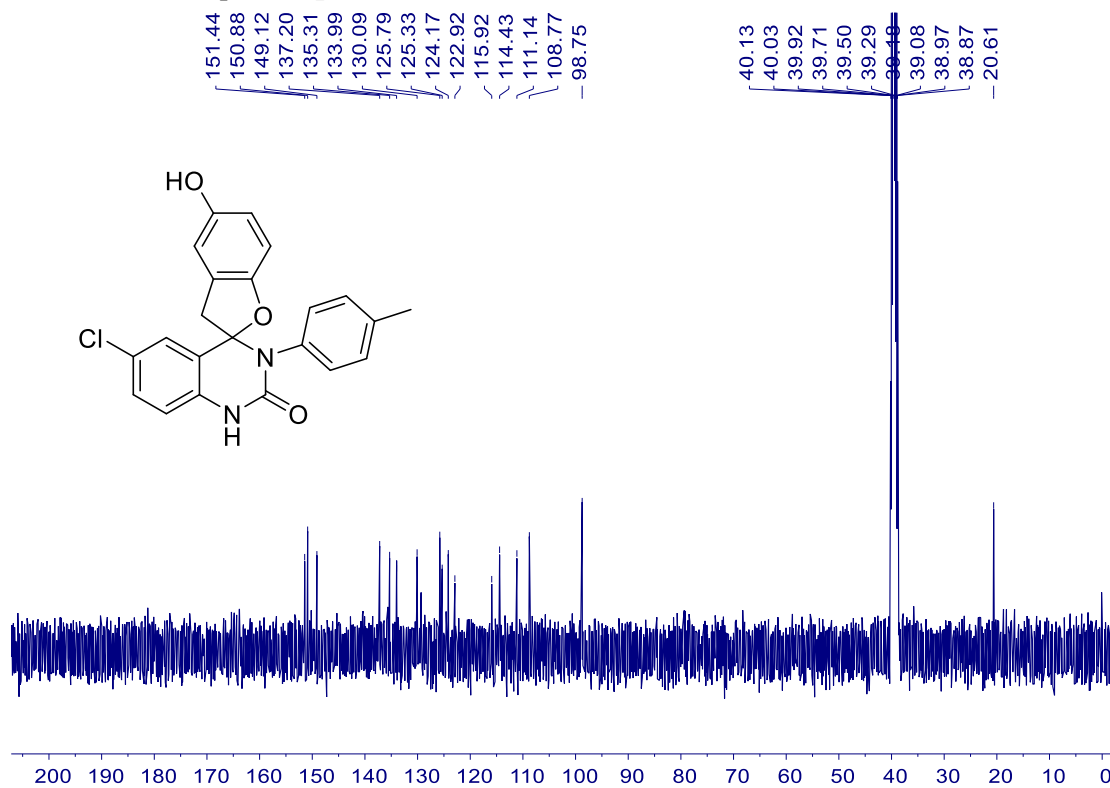
<sup>13</sup>C NMR of Compound **4o** (101 MHz, DMSO-*d*<sub>6</sub>)



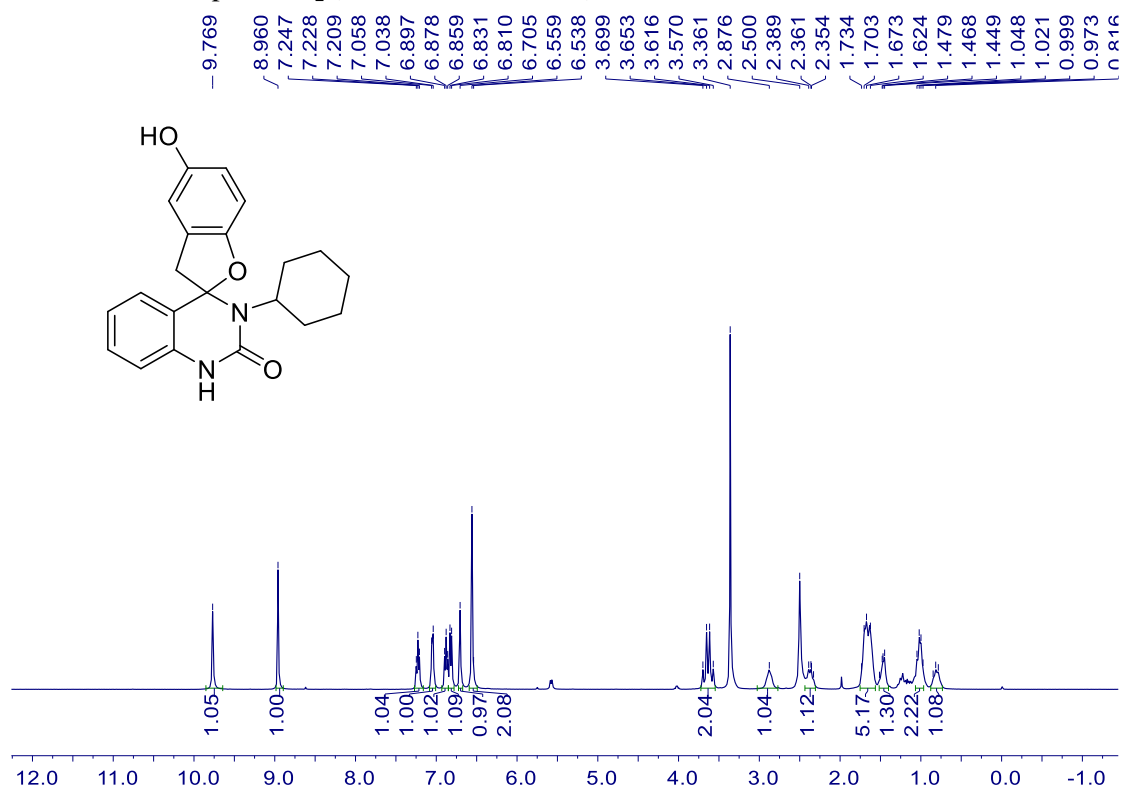
**<sup>1</sup>H NMR of Compound 4p (400 MHz, DMSO-*d*<sub>6</sub>)**



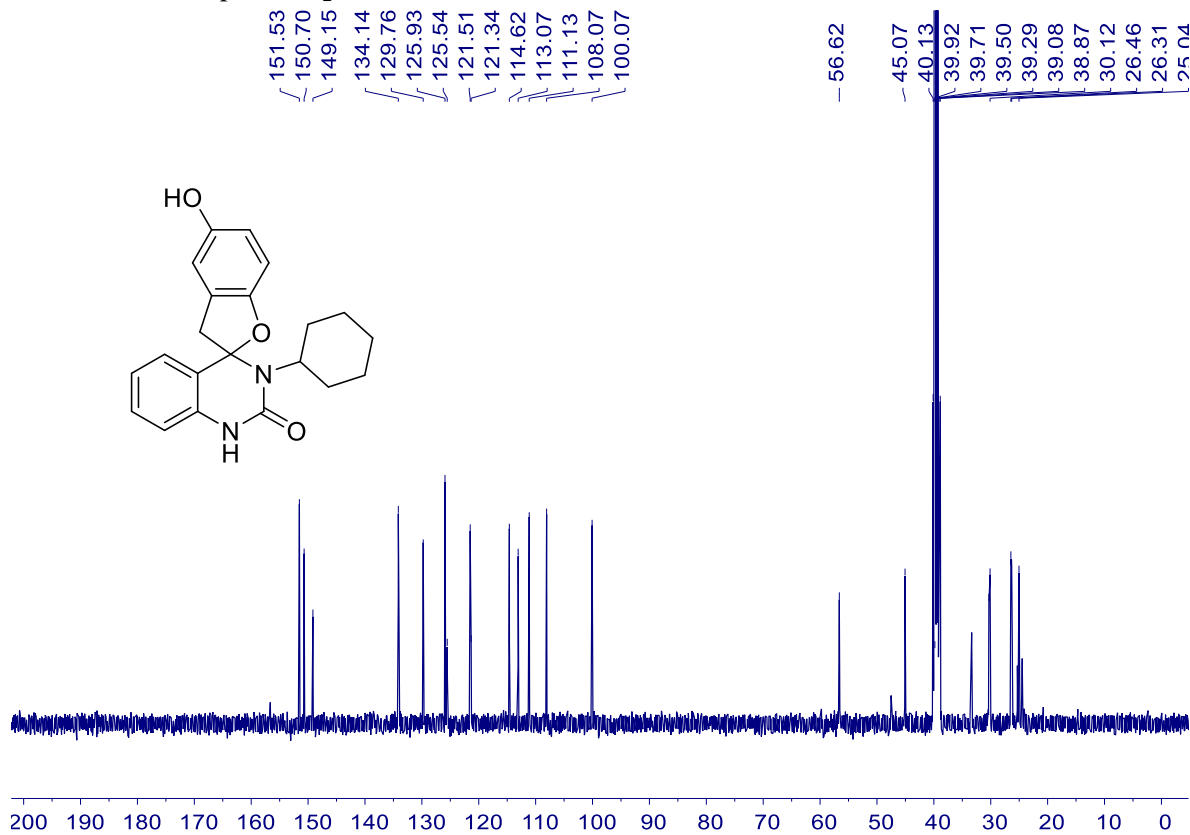
**<sup>13</sup>C NMR of Compound 4p (101 MHz, DMSO-*d*<sub>6</sub>)**



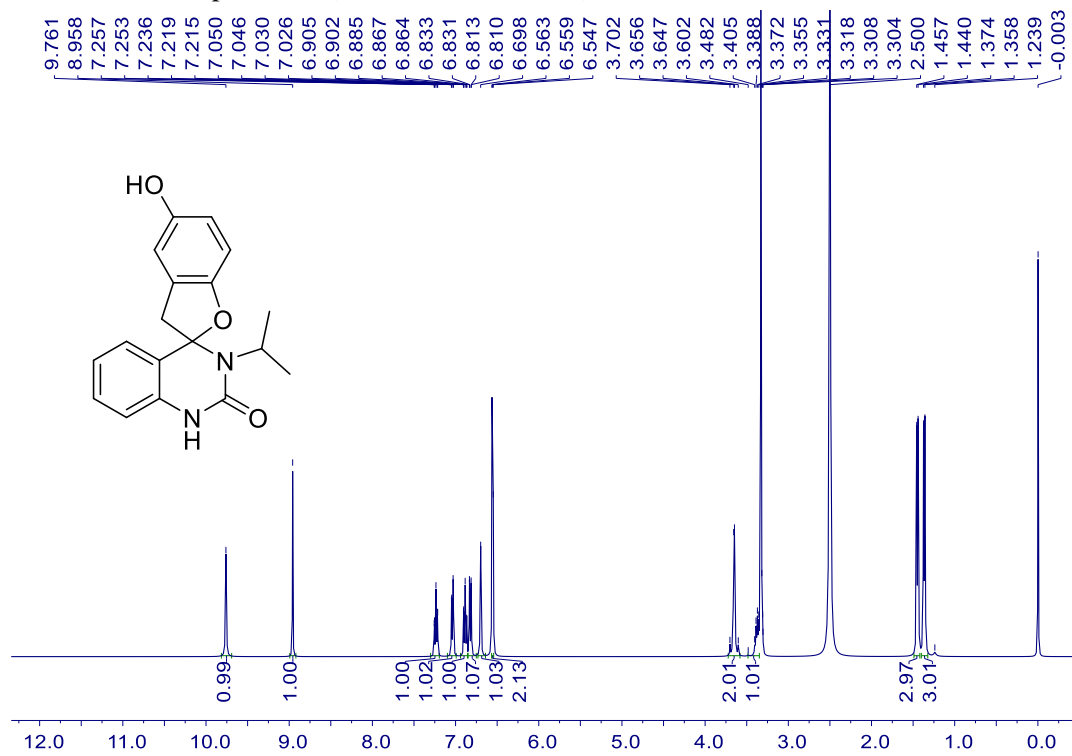
<sup>1</sup>H NMR of Compound **4q** (400 MHz, DMSO-*d*<sub>6</sub>)



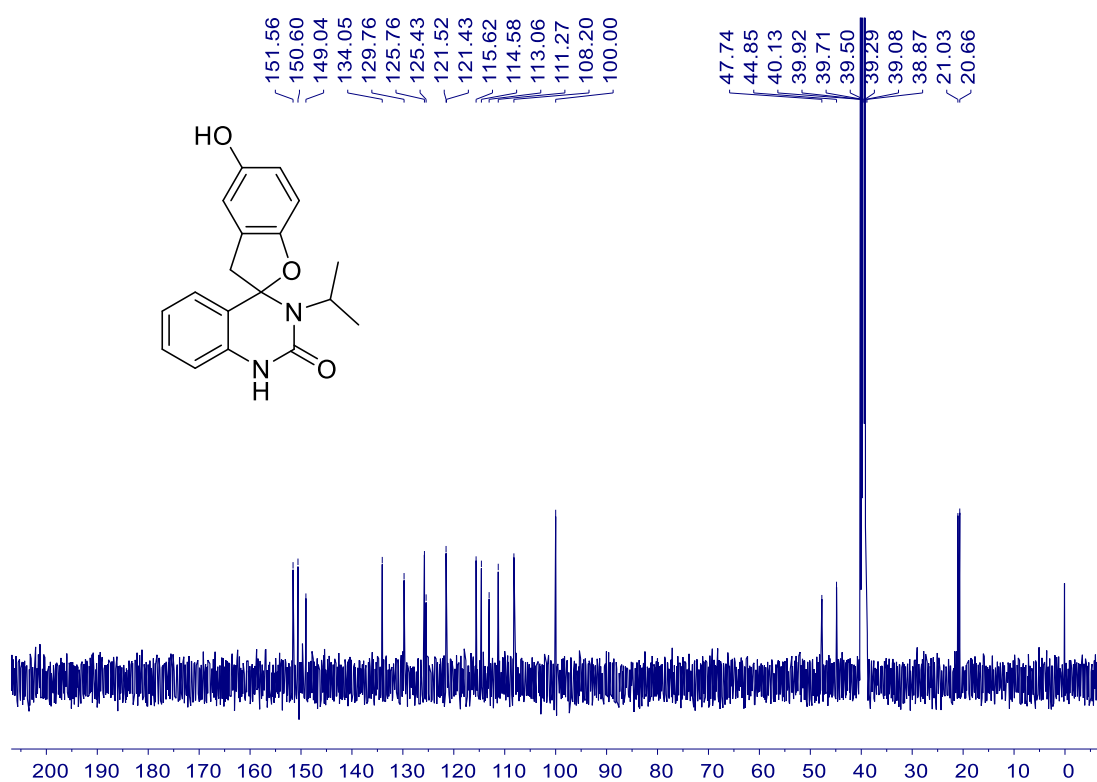
<sup>13</sup>C NMR of Compound **4q** (101 MHz, DMSO-*d*<sub>6</sub>)



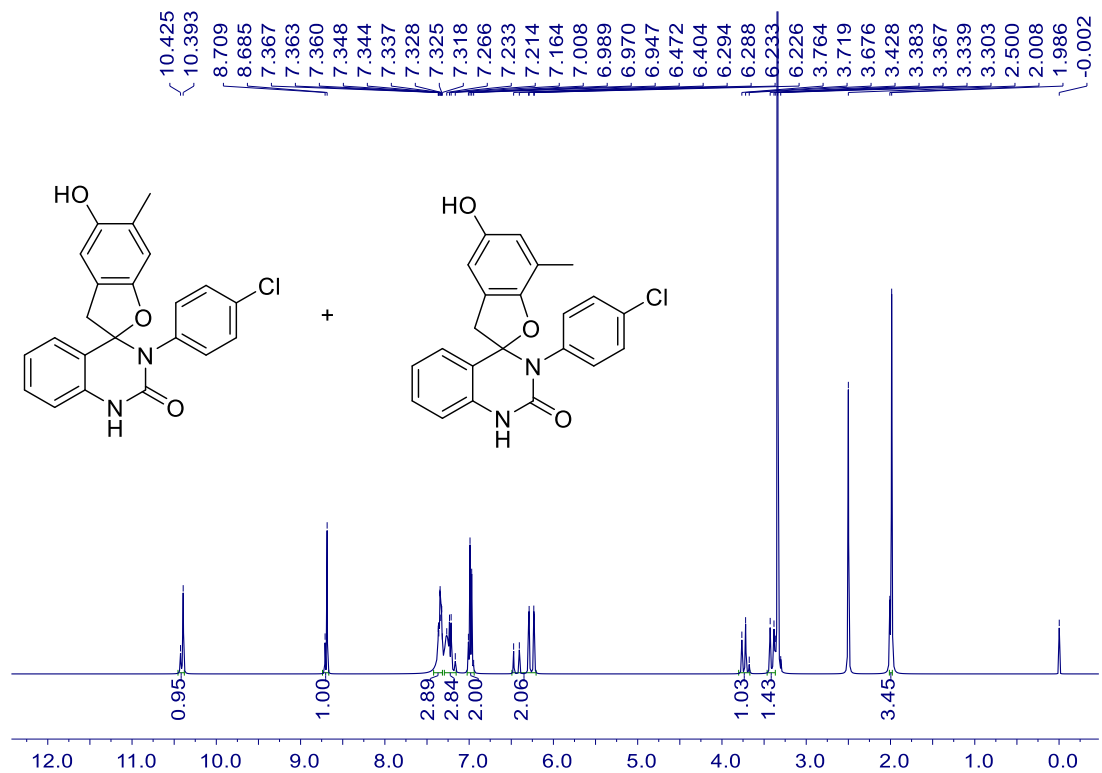
<sup>1</sup>H NMR of Compound **4r** (400 MHz, DMSO-d<sub>6</sub>)



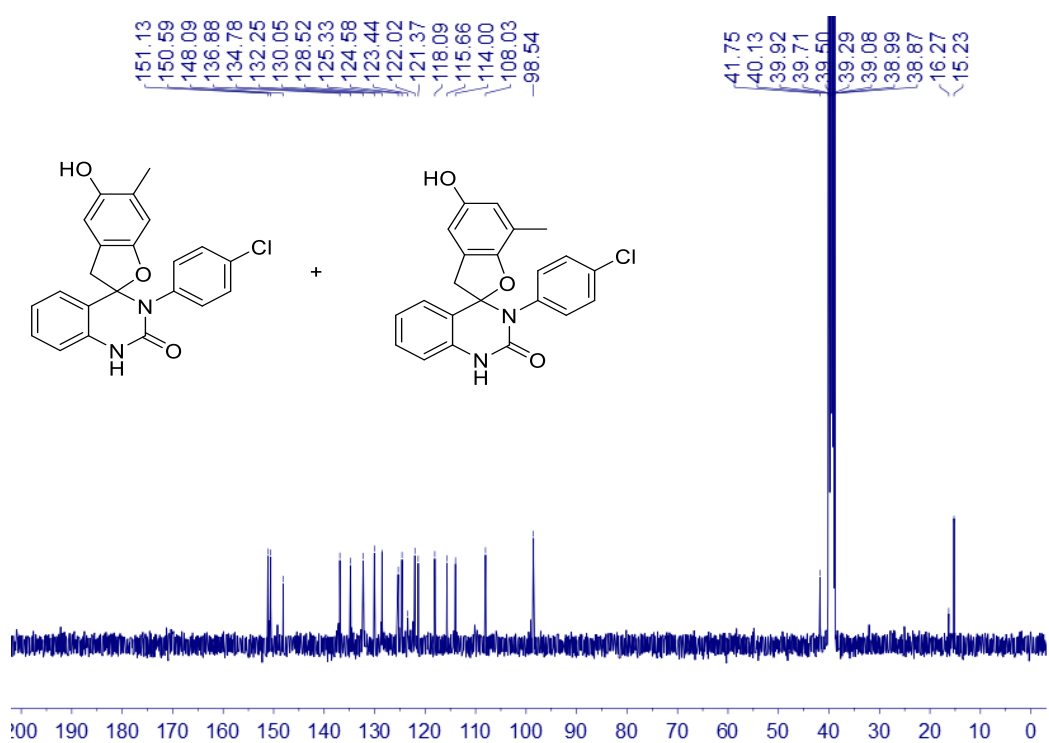
<sup>13</sup>C NMR of Compound **4r** (101 MHz, DMSO-d<sub>6</sub>)



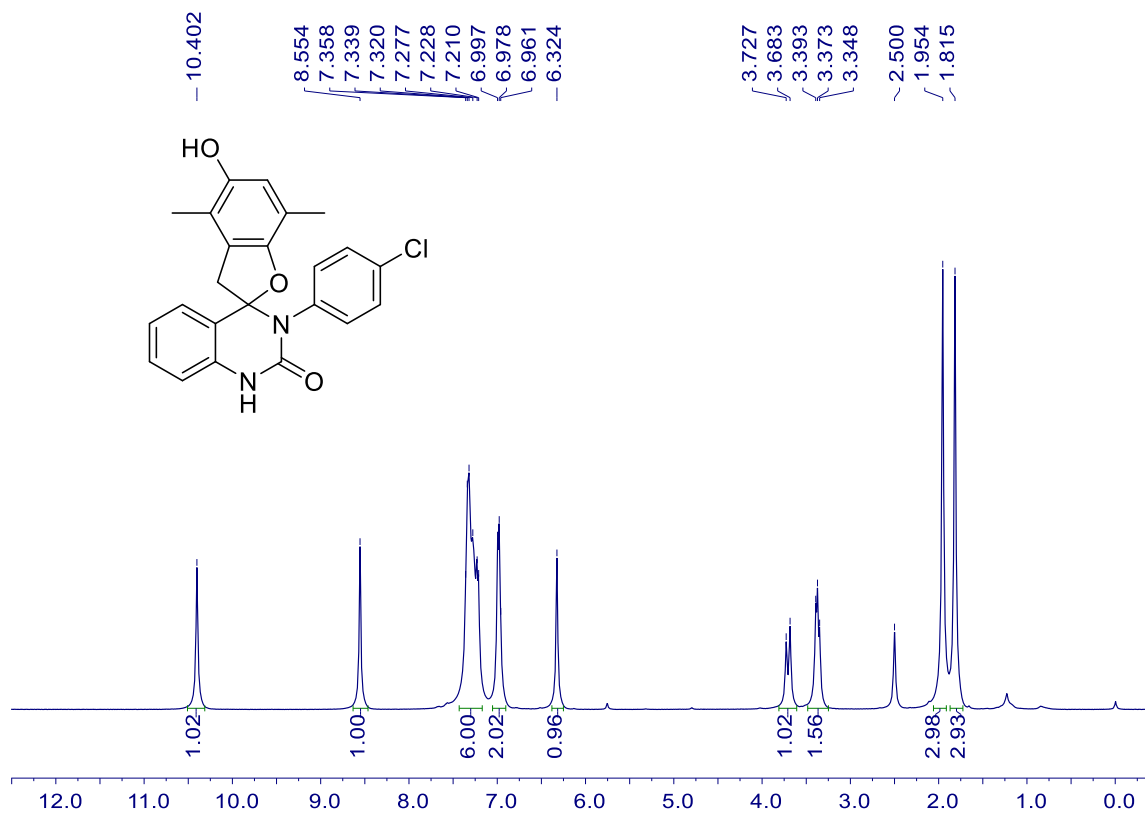
**<sup>1</sup>H NMR of Compound 5a (400 MHz, DMSO-*d*<sub>6</sub>)**



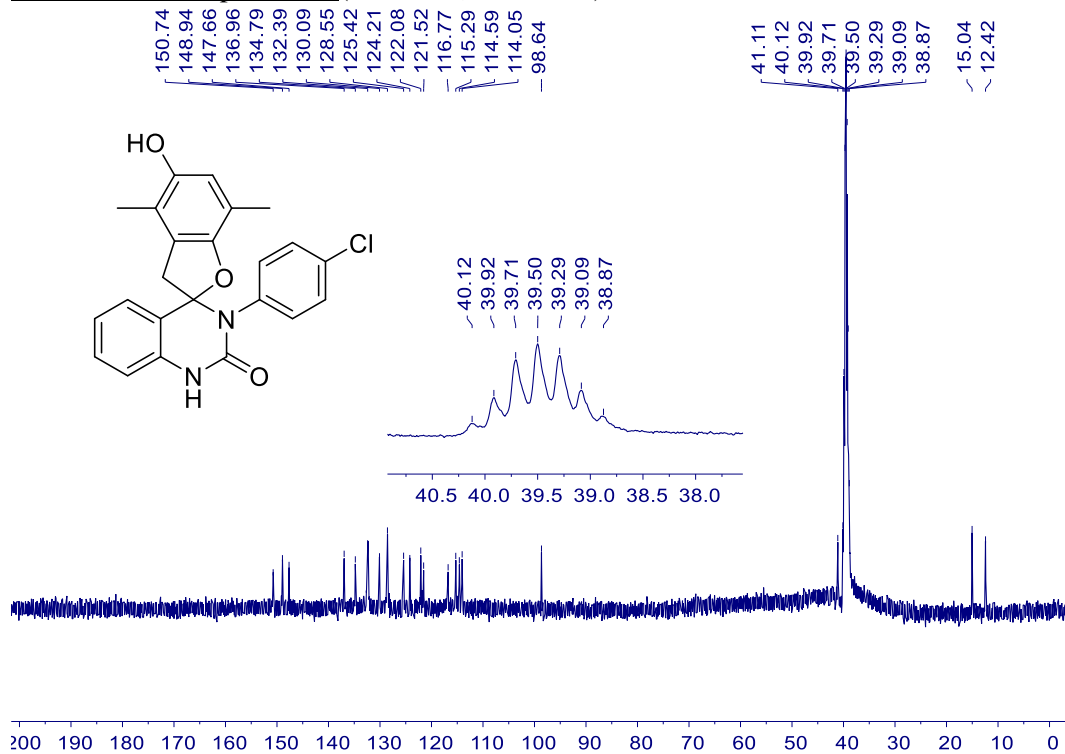
**<sup>13</sup>C NMR of Compound 5a (101 MHz, DMSO-*d*<sub>6</sub>)**



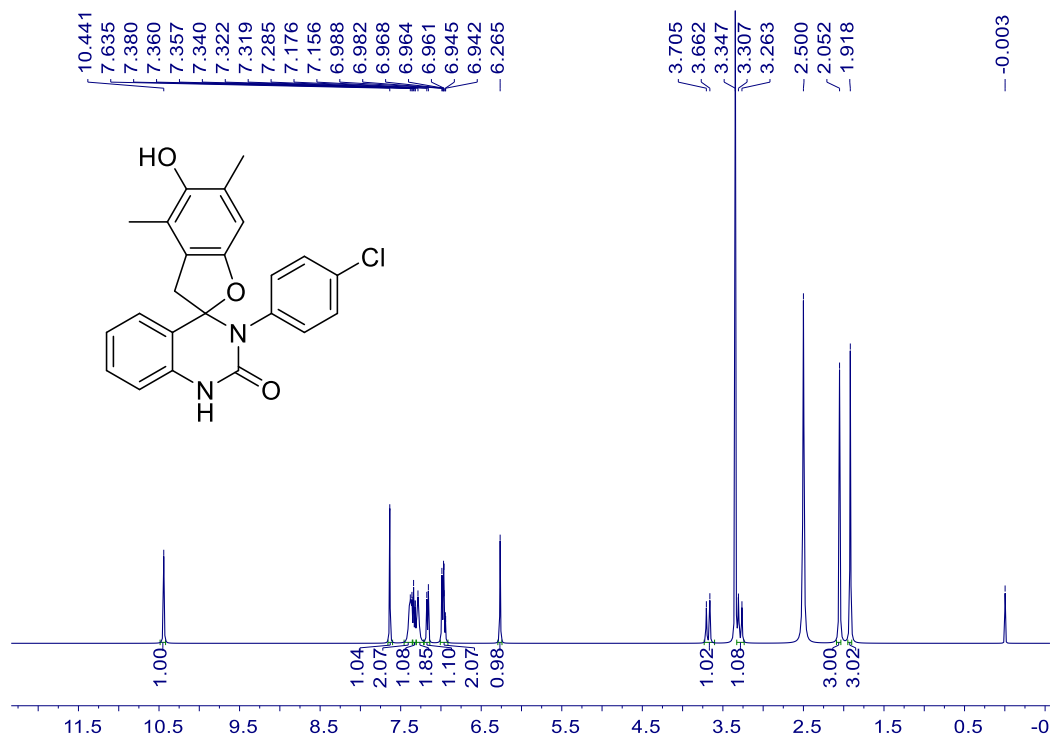
**<sup>1</sup>H NMR of Compound 5b (400 MHz, DMSO-*d*<sub>6</sub>)**



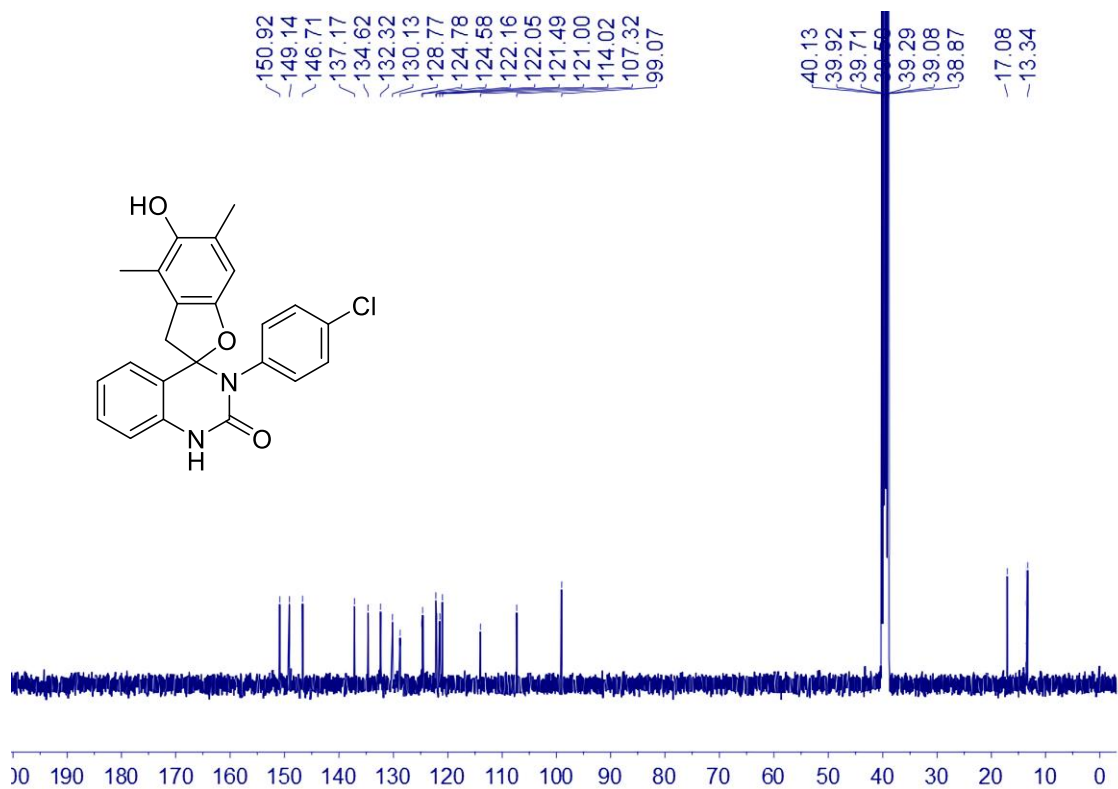
**<sup>13</sup>C NMR of Compound 5b (101 MHz, DMSO-*d*<sub>6</sub>)**



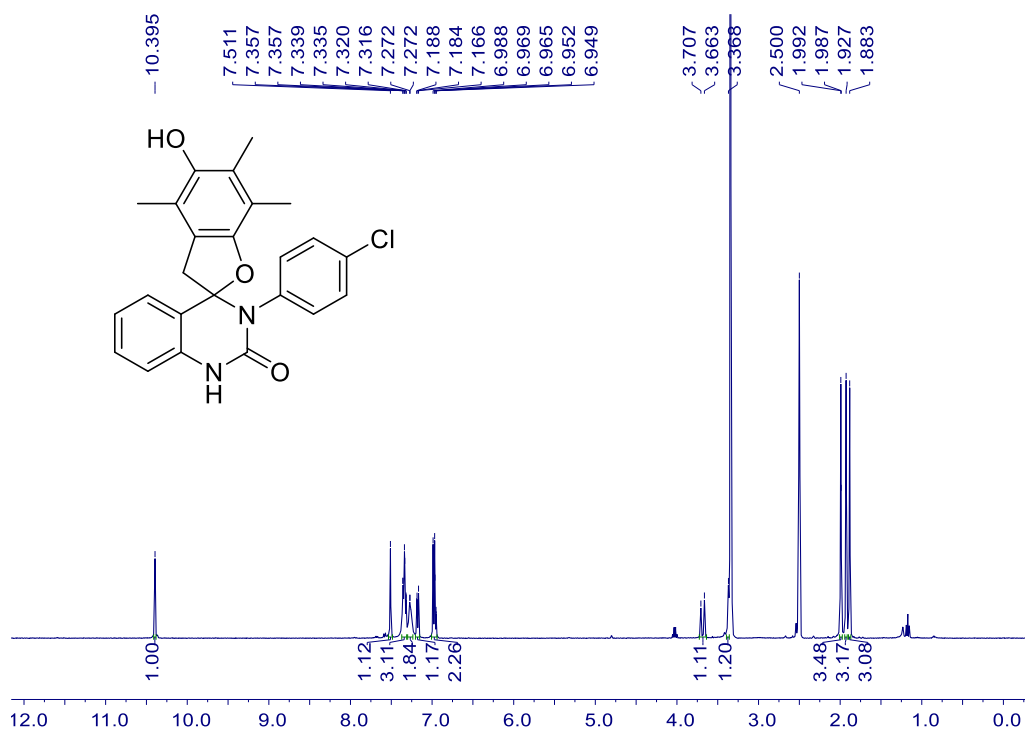
**<sup>1</sup>H NMR of Compound 5c (400 MHz, DMSO-*d*<sub>6</sub>)**



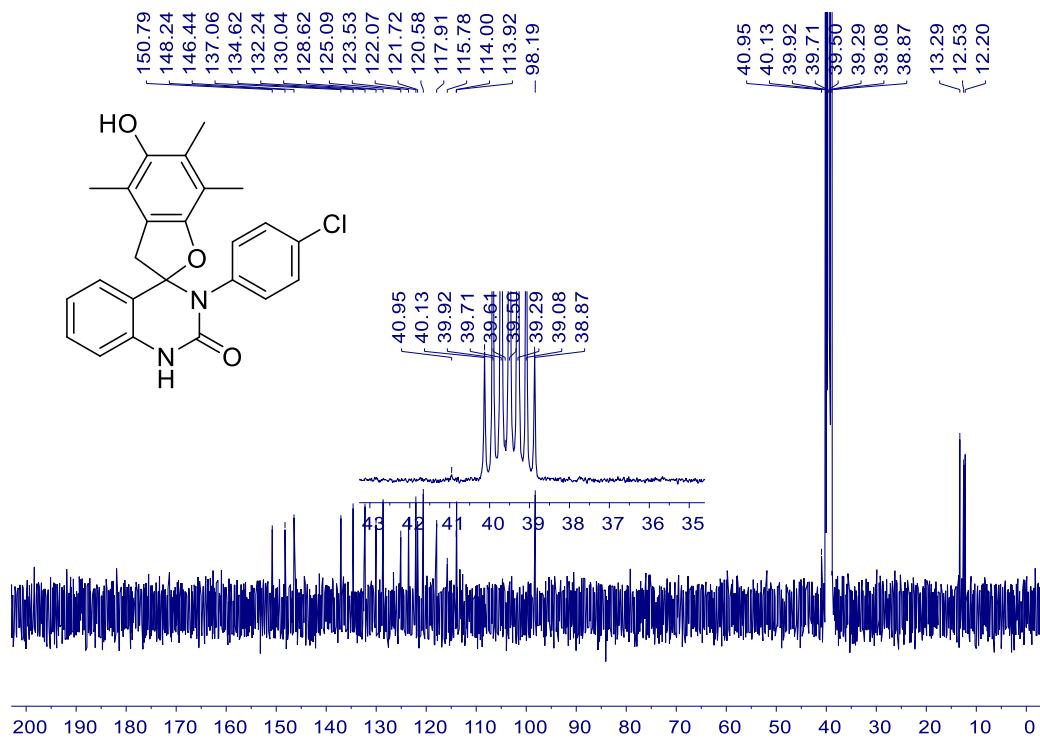
**<sup>13</sup>C NMR of Compound 5c (101 MHz, DMSO-*d*<sub>6</sub>)**



<sup>1</sup>H NMR of Compound **5d** (400 MHz, DMSO-*d*<sub>6</sub>)

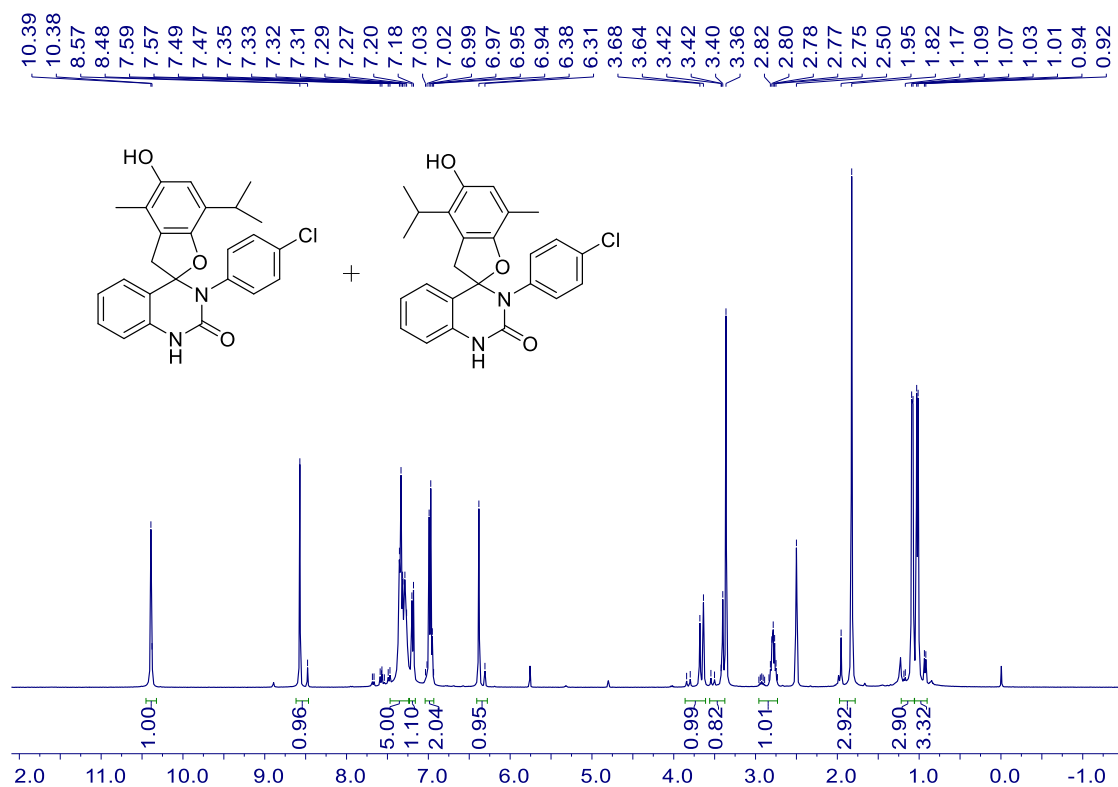


<sup>13</sup>C NMR of Compound **5d** (101 MHz, DMSO-*d*<sub>6</sub>)

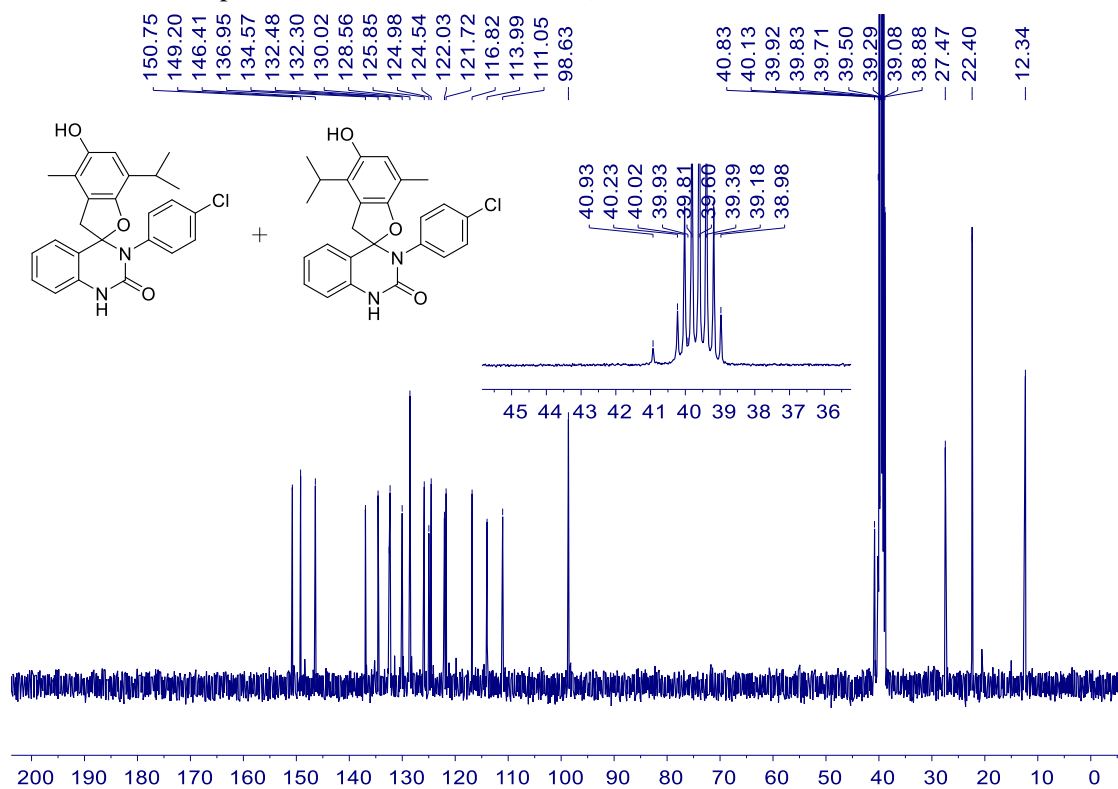




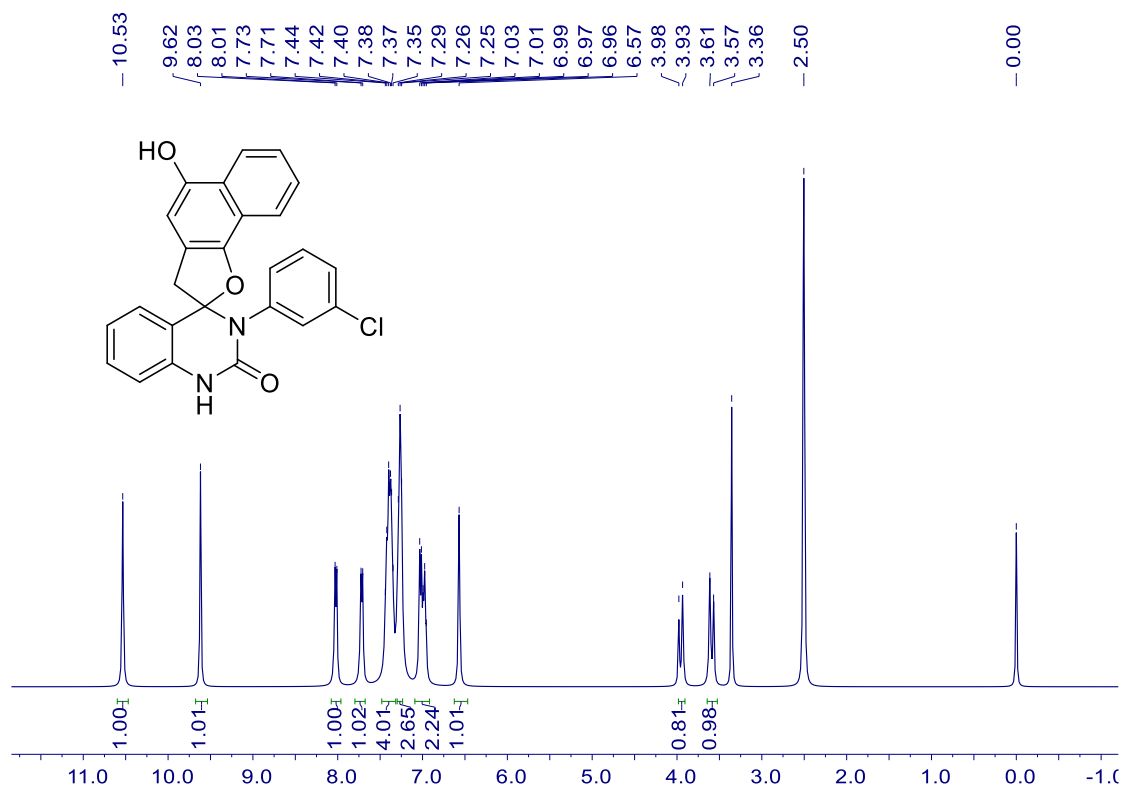
**<sup>1</sup>H NMR of Compound 5e (400 MHz, DMSO-d<sub>6</sub>)**



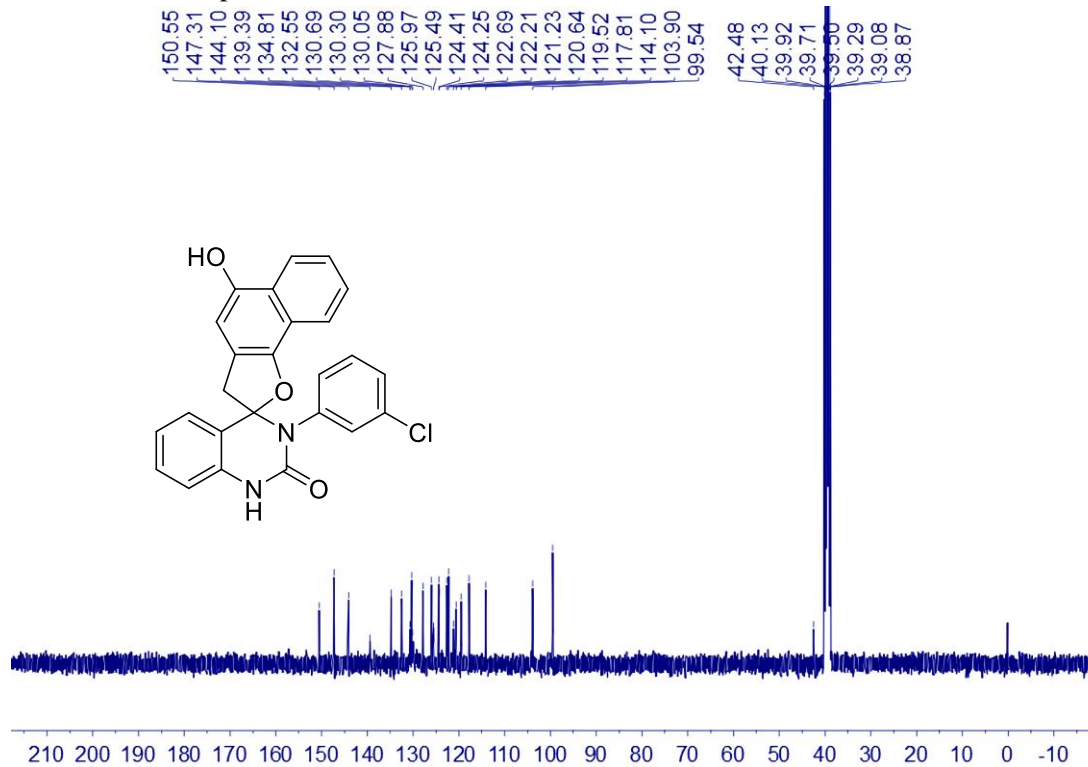
**<sup>13</sup>C NMR of Compound 5e (101 MHz, DMSO-d<sub>6</sub>)**



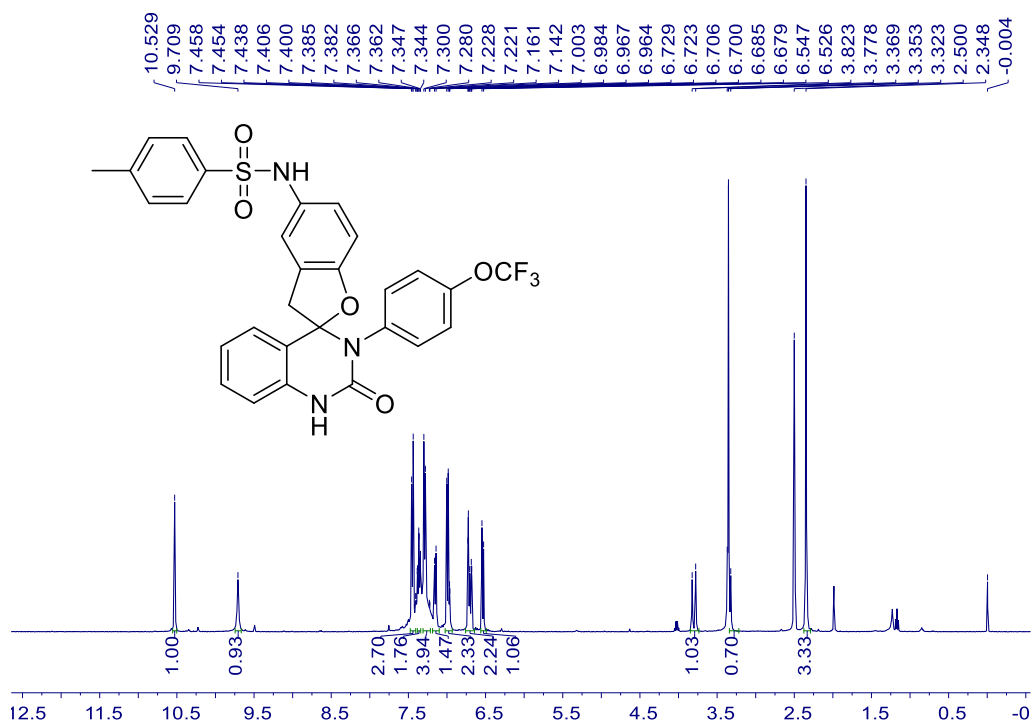
<sup>1</sup>H NMR of Compound **5f** (400 MHz, DMSO-*d*<sub>6</sub>)



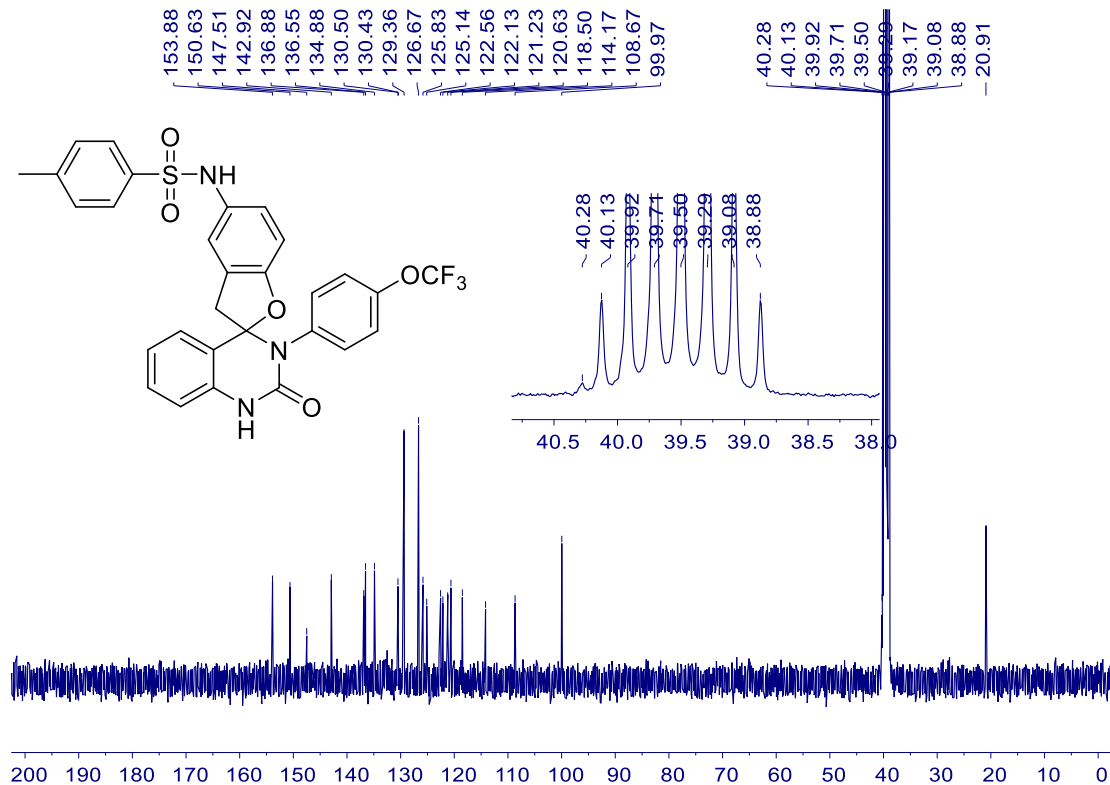
<sup>13</sup>C NMR of Compound **5f** (101 MHz, DMSO-*d*<sub>6</sub>)



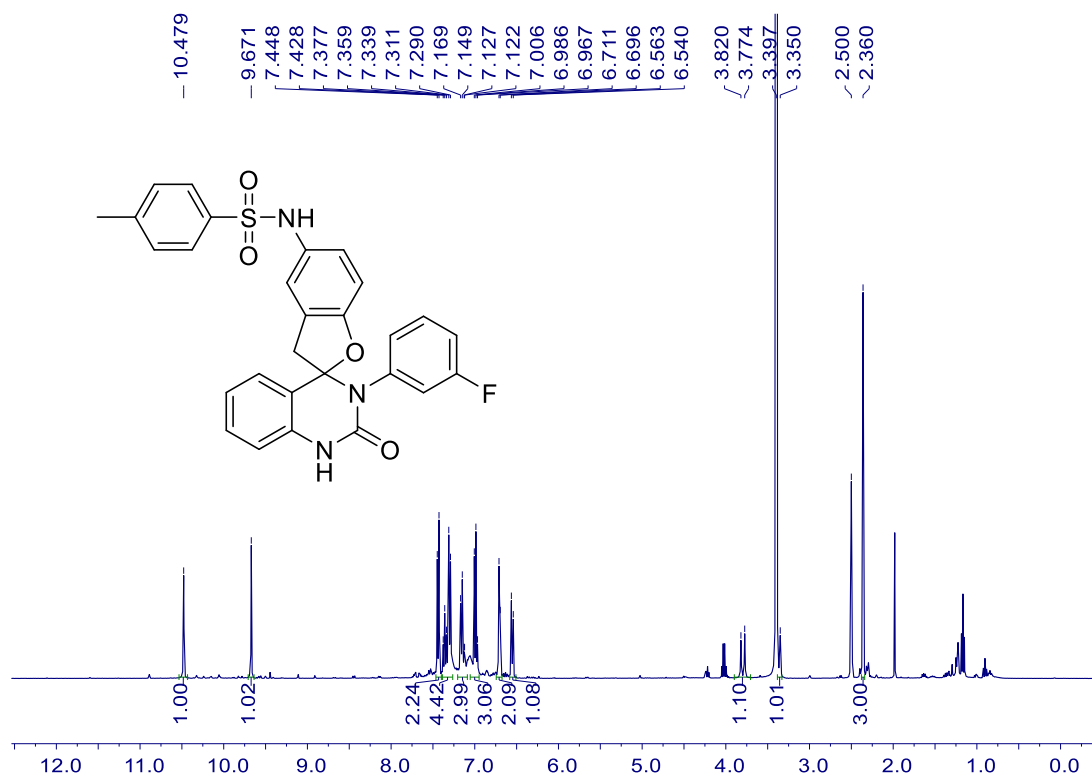
**<sup>1</sup>H NMR of Compound 5g (400 MHz, DMSO-*d*<sub>6</sub>)**



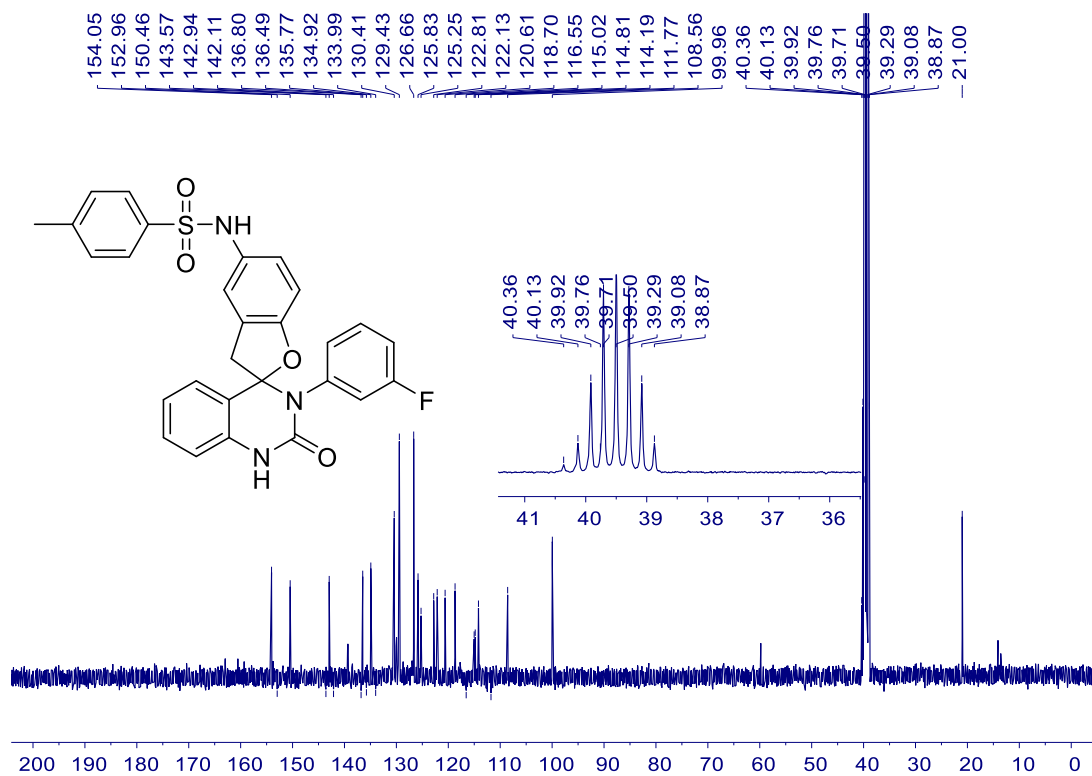
**<sup>13</sup>C NMR of Compound 5g (101 MHz, DMSO-*d*<sub>6</sub>)**



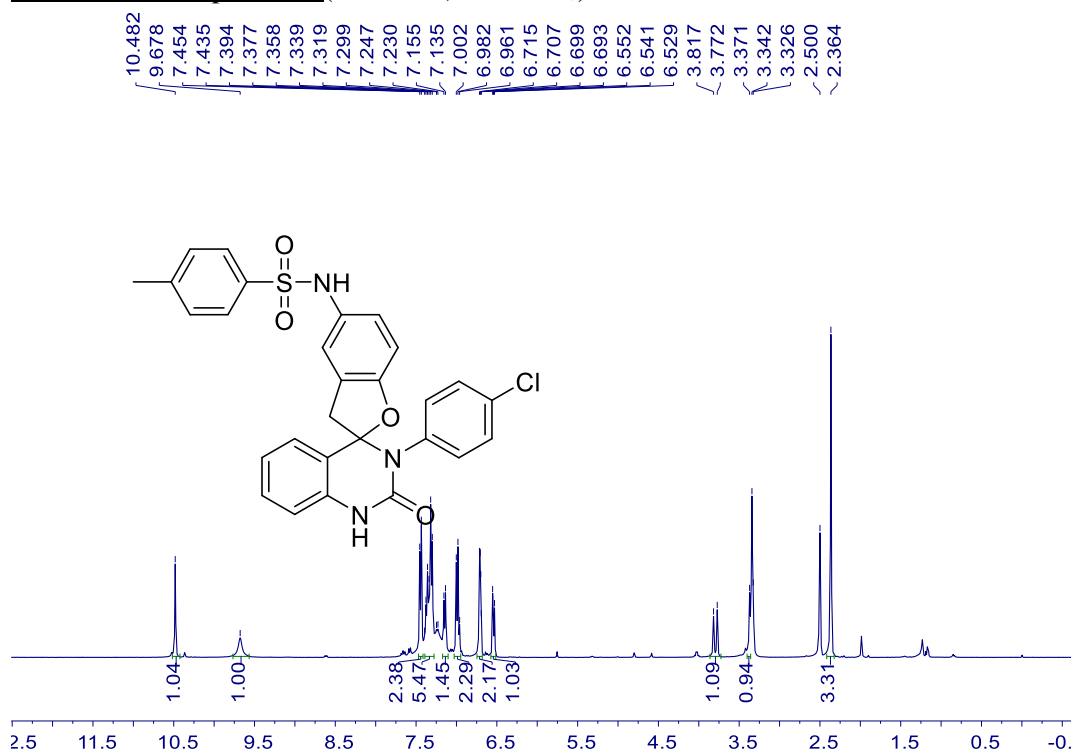
<sup>1</sup>H NMR of Compound **5h** (400 MHz, DMSO-*d*<sub>6</sub>)



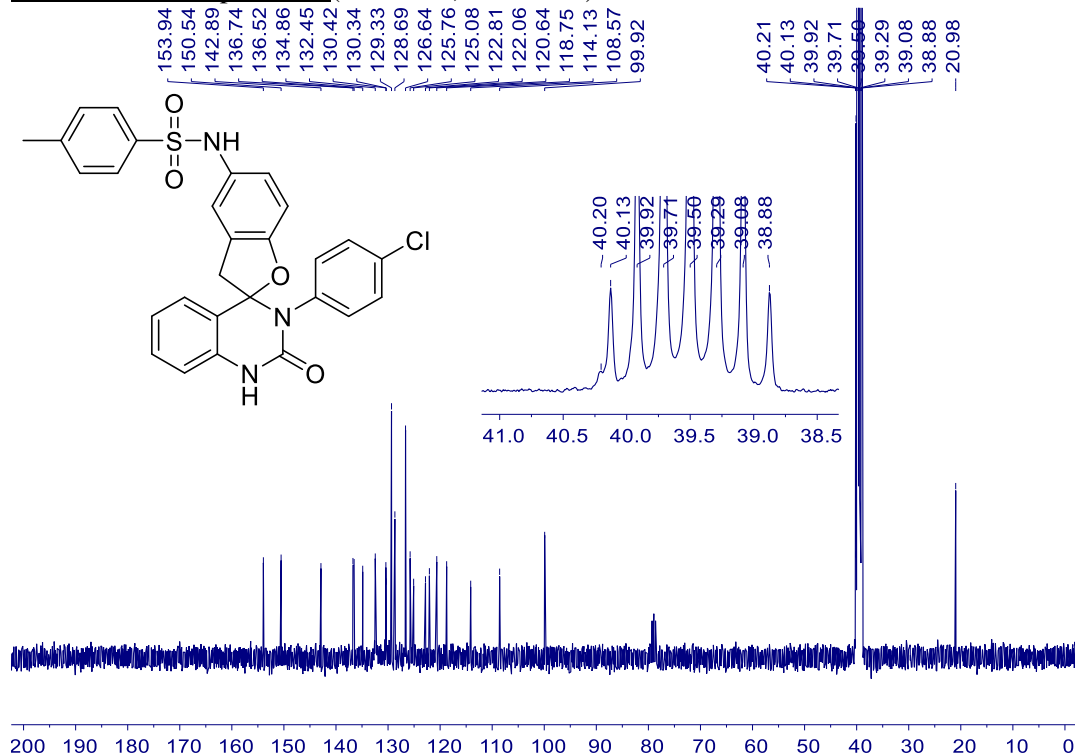
<sup>13</sup>C NMR of Compound **5h** (101 MHz, DMSO-*d*<sub>6</sub>)



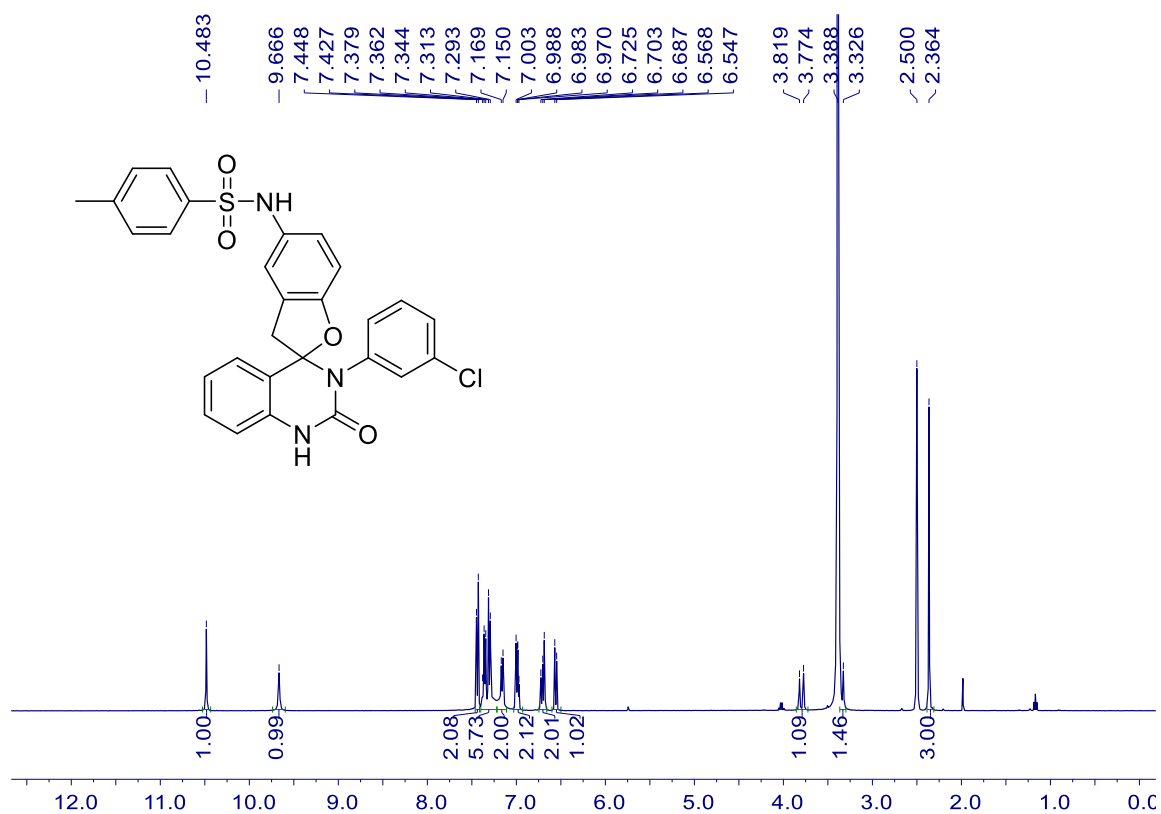
**<sup>1</sup>H NMR of Compound 5i (400 MHz, DMSO-*d*<sub>6</sub>)**



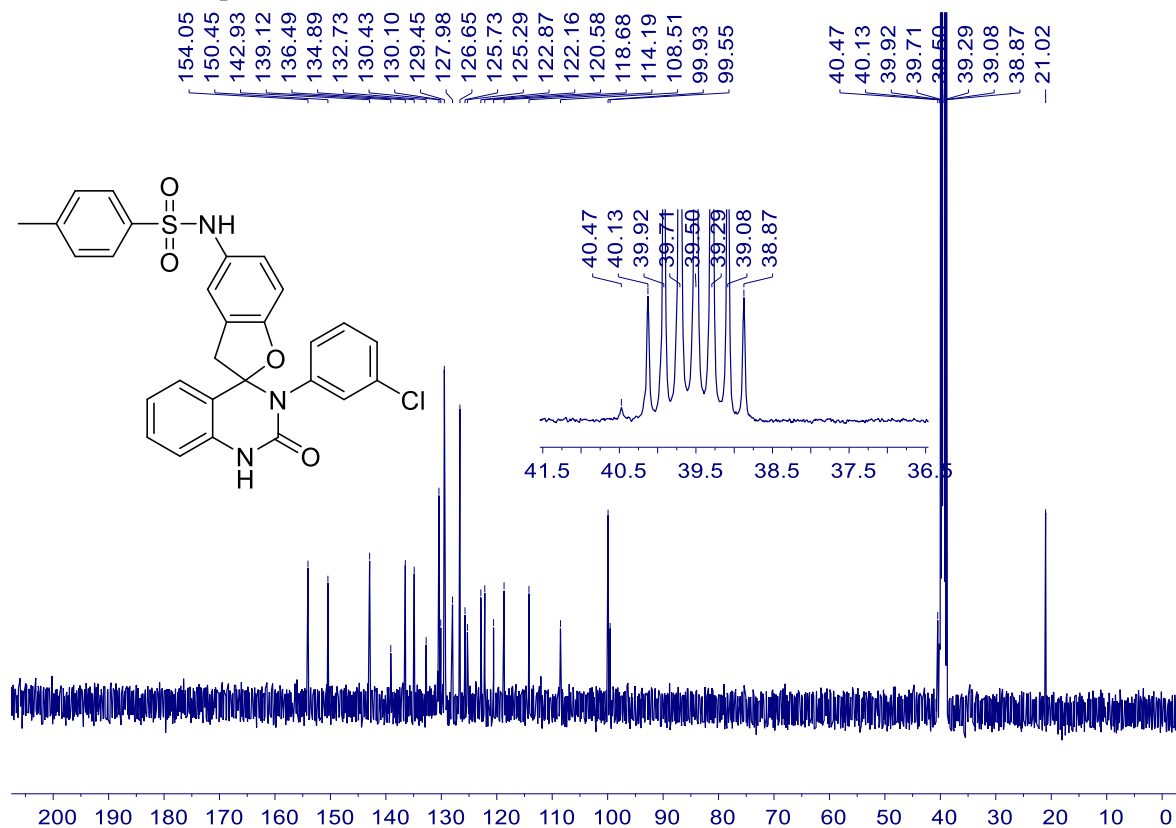
**<sup>13</sup>C NMR of Compound 5i (101 MHz, DMSO-*d*<sub>6</sub>)**



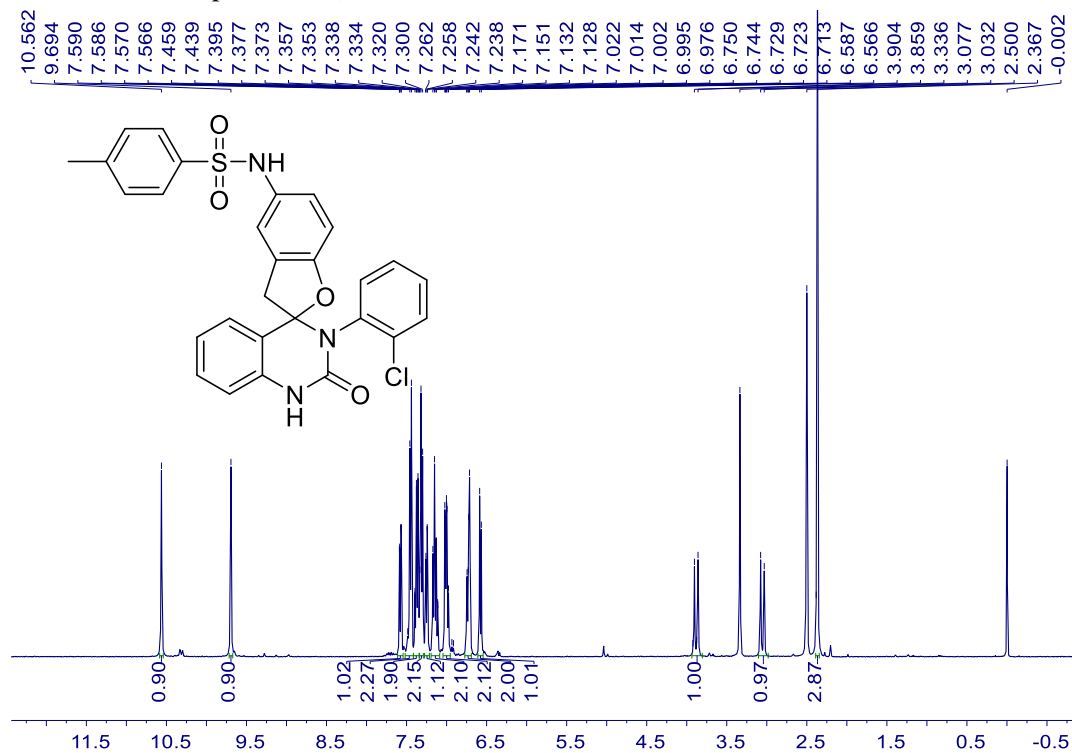
<sup>1</sup>H NMR of Compound **5j** (400 MHz, DMSO-*d*<sub>6</sub>)



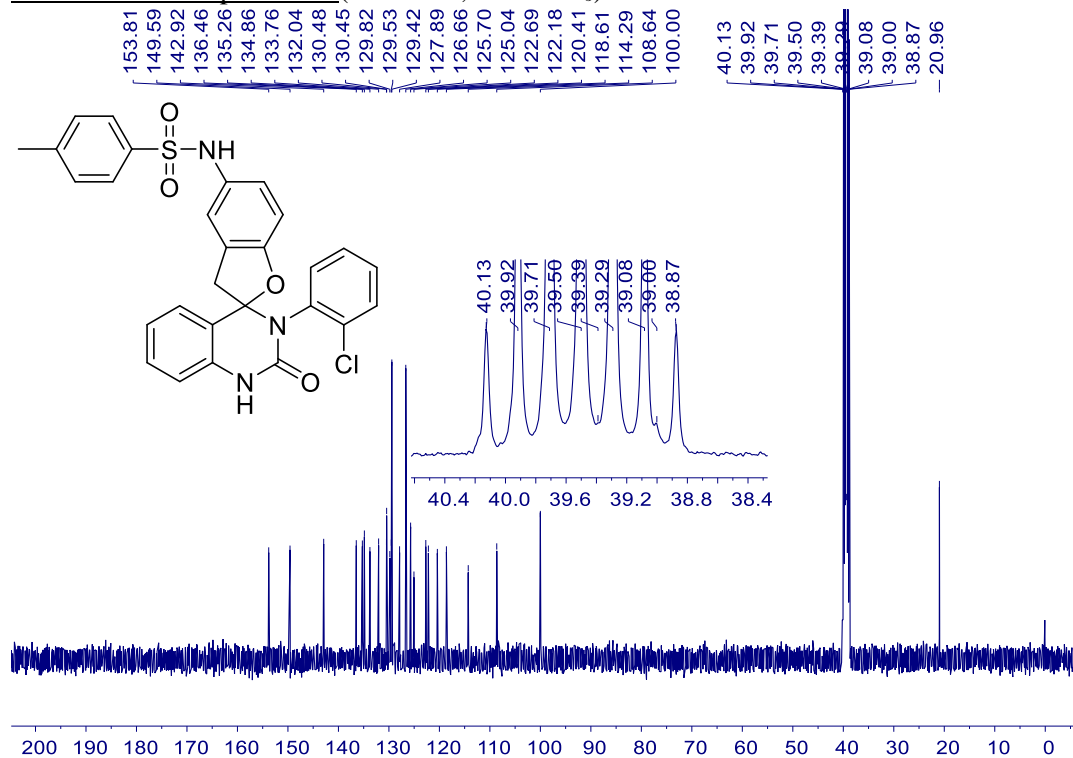
<sup>13</sup>C NMR of Compound **5j** (101 MHz, DMSO-*d*<sub>6</sub>)



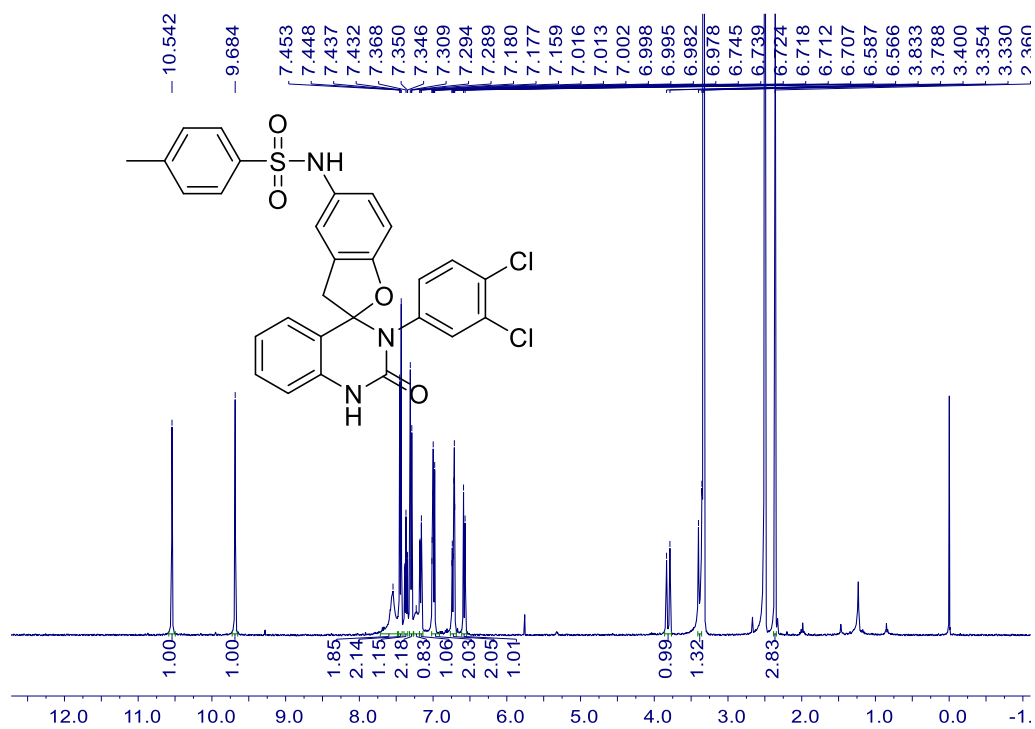
<sup>1</sup>H NMR of Compound **5k** (400 MHz, DMSO-*d*<sub>6</sub>)



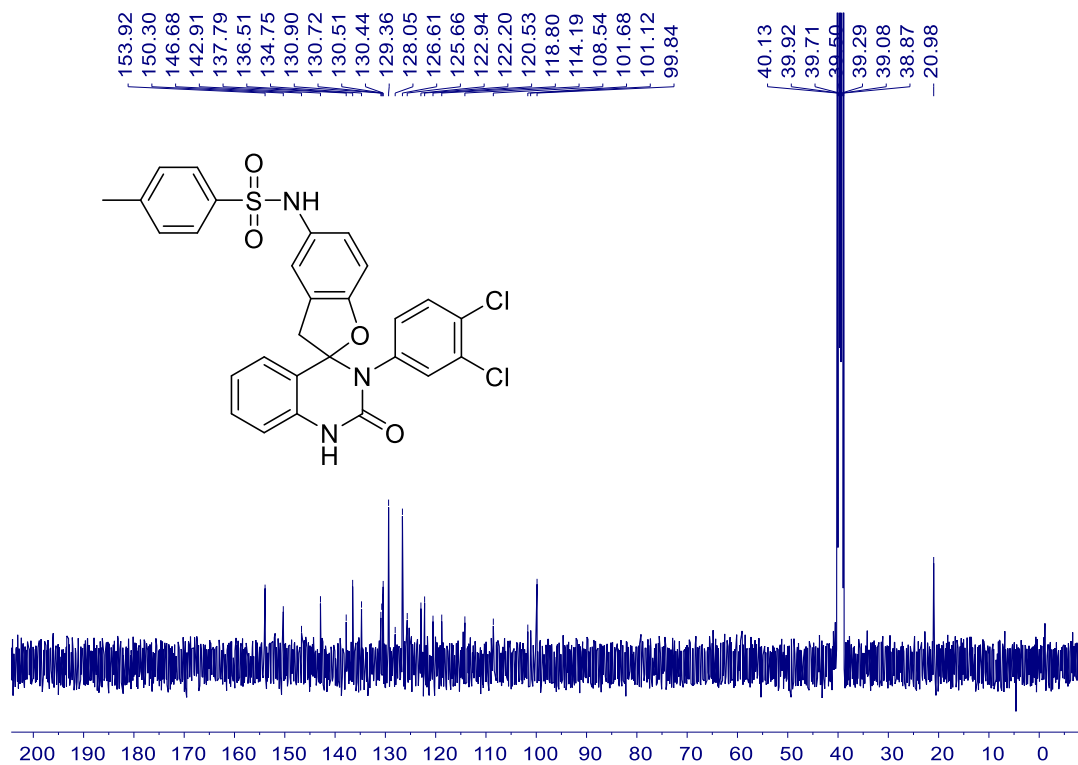
<sup>13</sup>C NMR of Compound **5k** (101 MHz, DMSO-*d*<sub>6</sub>)



<sup>1</sup>H NMR of Compound **51** (400 MHz, DMSO-*d*<sub>6</sub>)

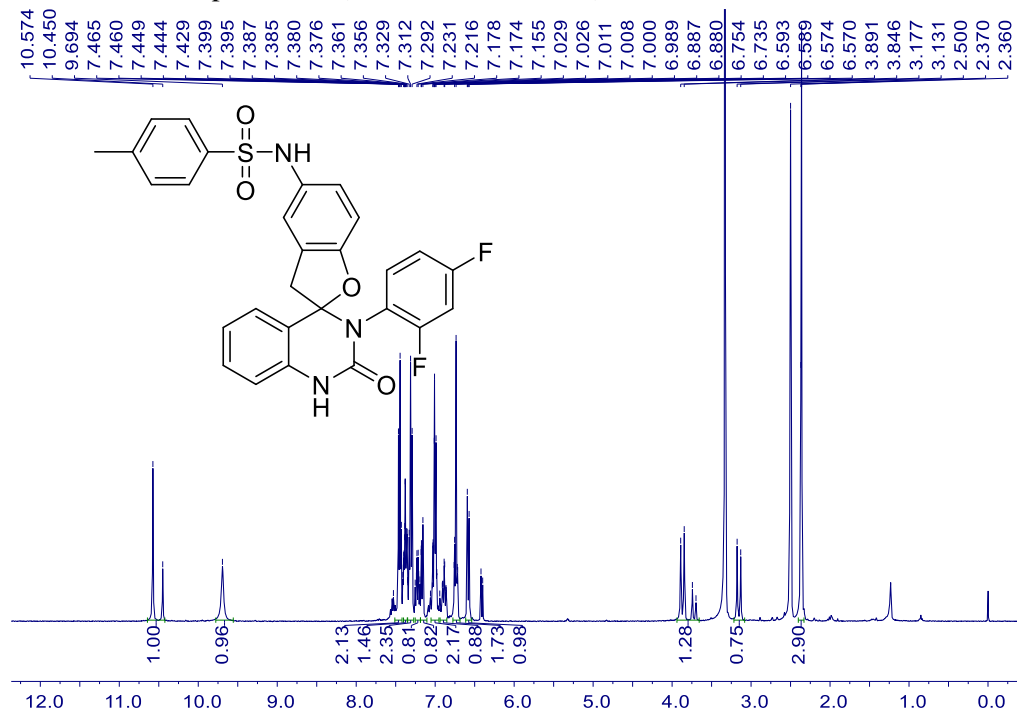


<sup>13</sup>C NMR of Compound **51** (101 MHz, DMSO-*d*<sub>6</sub>)

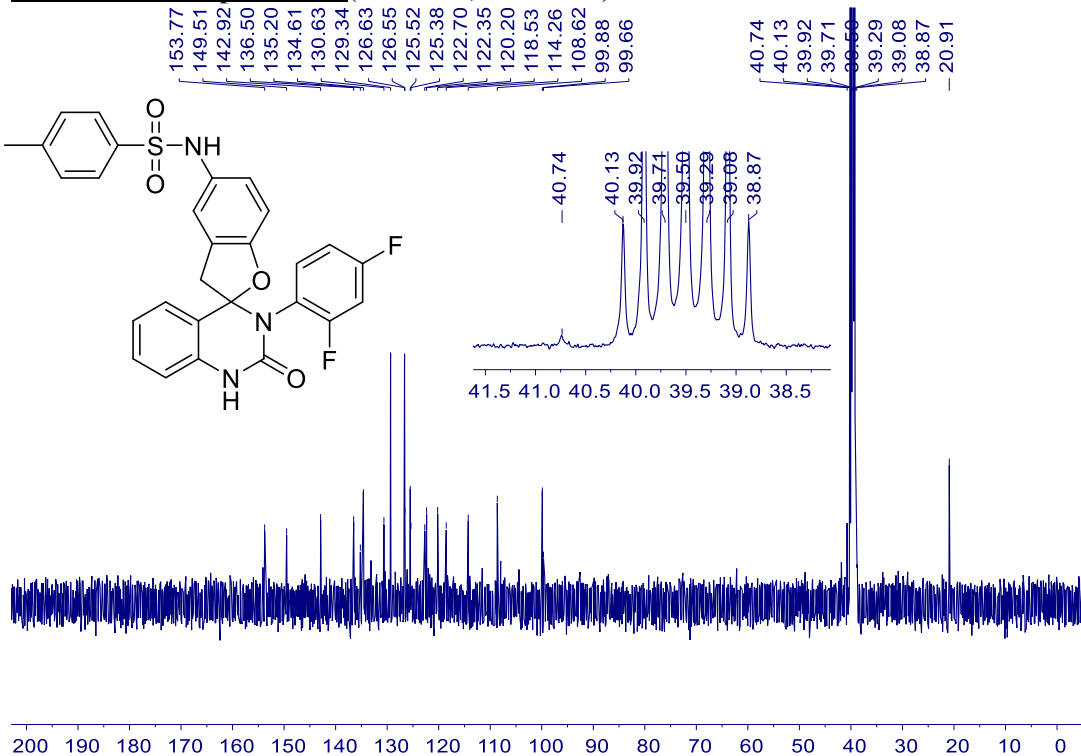




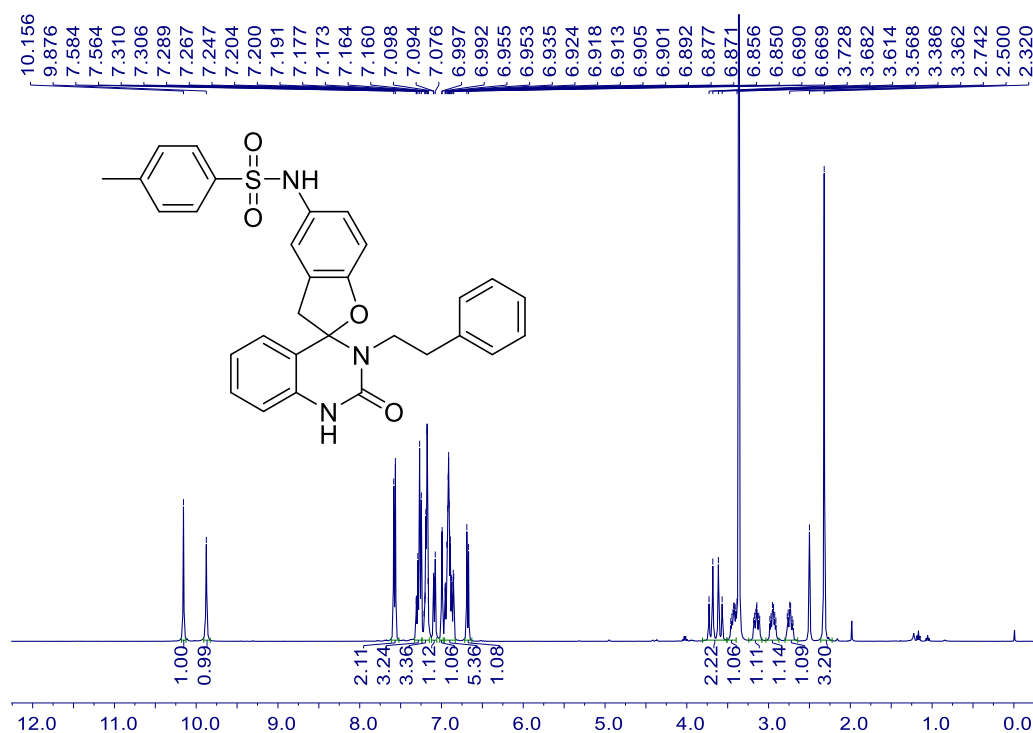
<sup>1</sup>H NMR of Compound **5m** (400 MHz, DMSO-*d*<sub>6</sub>)



<sup>13</sup>C NMR of Compound **5m** (101 MHz, DMSO-*d*<sub>6</sub>)



**<sup>1</sup>H NMR of Compound 5n (400 MHz, DMSO-*d*<sub>6</sub>)**



**<sup>13</sup>C NMR of Compound 5n (101 MHz, DMSO-*d*<sub>6</sub>)**

