

Synthesis of Functionalized 3-aryl-3H-benzofuranones derivatives from aryl acetate  
via [3 + 2] Annulation of 1,4-dihydroxy-2-naphthoic acid ester

Huan Wang<sup>a</sup>, Yuxiang Zhou<sup>a</sup>, Ying Xie<sup>\*a</sup>, Yi Liu<sup>a</sup>, Yulong Li<sup>a</sup>, Hao Zhang<sup>b</sup>, Jilang Long<sup>c</sup>

<sup>a</sup> School of Chemistry and Environmental Engineering, Sichuan University of Science & Engineering, Zigong, 643000, China

<sup>b</sup> College of chemistry and chemical engineering, china west normal university, Nanchong, Sichuan, 637002, China

<sup>c</sup> College of vanadium and titanium, Panzhihua university, Panzhihua, Sichuan, 617000(China)

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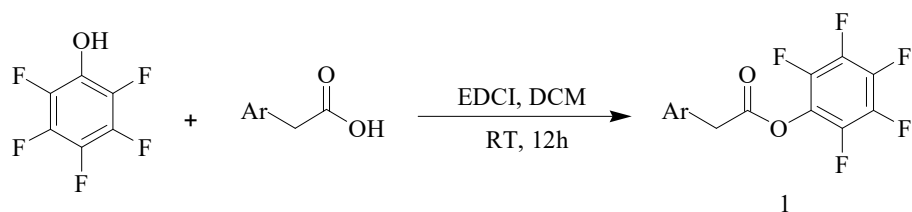
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## **Part I. Experimental section**

### **1.1. General information**

Unless stated otherwise, all reagents were purchased from Adamas, TCI or Strem. All reactions were carried out in air with magnetic stirring. Purifications of reaction products were carried out by flash chromatography using Qingdao Haiyang Chemical Co. Ltd silica gel (200-300 mm). <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra were recorded with tetramethylsilane (TMS) as internal standard at ambient temperature unless otherwise indicated on a Bruker Avance DPX 600 fourier Transform spectrometer operating at 400 MHz for <sup>1</sup>H NMR and 101 MHz for <sup>13</sup>C NMR. Chemical shifts are reported in parts per million (ppm) and coupling constants are reported as Hertz (Hz). Splitting patterns are designated as singlet (s), broad singlet (bs), doublet (d), triplet (t). Splitting patterns that could not be interpreted or easily visualized are designated as multiple (m). High resolution mass spectra (HRMS) were recorded on an IF-TOF spectrometer (Micromass).

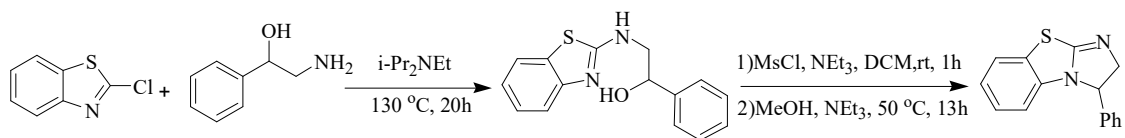
## 1.2 General experimental procedure for synthesis of substrates 1



Phenyl-acetic acid pentafluorophenyl esters were prepared following a published procedure reported by Smith<sup>[1]</sup> and Waser<sup>[2]</sup>

Aryl acetic acid (5 mmol) and EDC·HCl (6.5mmol) were dissolved in anhydrous DCM. then pentafluoro phenol (7.5mmol) was added and the mixture was further stirred for 12 h at rt. Then, water was added, the phases were separated, and the aqueous phase was washed with DCM trice. The combined organic layers were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and concentrated on the rotary evaporator. Purification by column chromatography on silica.

## 1.3 General experimental procedure for synthesis of catalyst.



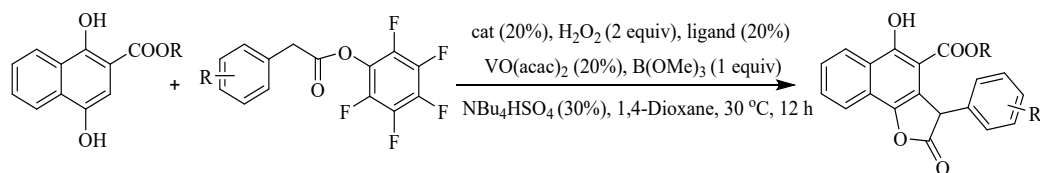
Catalyst was prepared following a published procedure reported by Shiina<sup>[3]</sup> and Okamoto<sup>[4]</sup>

A 10 mL autoclave was charged with 2-chlorobenzothiazole (1 eq), 2-hydroxyl-2-(phenyl)-1-Ethylamine (1 eq), and diisopropylethylamine (1.5 eq). The vessel was sealed and then the whole mixture was stirred for 20 h at 130°C. After cooling to room temperature, the reaction mixture was diluted with methanol and dichloromethane, The mixture was concentrated in vacuo to afford the crude intermediate, which was used for the next reaction without purification.

To a solution of the crude intermediate in dichloromethane (40 mL) at 0 °C were added triethylamine (3eq) and methanesulfonyl chloride (1.5 eq). After stirring for 1 h at room temperature, methanol (5 eq) and triethylamine (14 eq) were successively added at room temperature and the reaction mixture was stirred for 13 h at 50 °C. After cooling to room temperature, it was quenched with aqueous sodium hydroxide (1.0 M) and the organic layer was diluted with dichloromethane and separated. The combined organic layer was dried over sodium sulfate. After filtration of the mixture and evaporation of the solvent, the crude product was purified by column chromatography on silica (ethyl acetate/ petroleum ether = 1/9 to 1/1) to afford product.

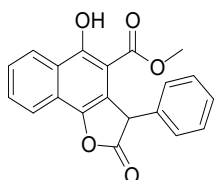
## 1.4 General experimental procedure for synthesis of 3-Aryl-3H-benzofuranones derivatives.

### 1.4.1 The synthesis of 3-Aryl-3H-benzofuranones derivatives from aryl acetate and 1,4-dihydroxy-2-naphthoic acid ester



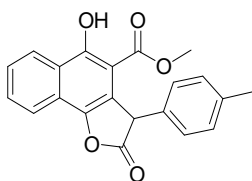
A 10 mL of reaction tube was charged with ligand (20mmol%, 3.7 mg), VO(acac)<sub>2</sub> (20mmol%, 5.3 mg) and 1, 4-dioxane (1 ml) stirred for 10 minutes, then 1,4-dihydroxy-2-naphthoic acid ester (0.15 mmol), cat (20mmol%, 5.0 mg), *n*-Bu<sub>4</sub>HSO<sub>4</sub> (30mmol%, 10.2 mg), H<sub>2</sub>O<sub>2</sub> (2 equiv, 22.6 mg), B(OMe)<sub>3</sub> (1 equiv, 10.4 mg), Aryl-acetic acid pentafluorophenyl esters (0.1 mmol), 1, 4-dioxane(1 ml) were added to the mixture. After stirring for 12 h at 30 °C, the solvent is removed by distillation under reduced pressure. The residue was purified by flash chromatography on silical gel using 5% (v/v) ethyl acetate in petroleum ether as eluent to afford the desired products .

### 5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan 3a:



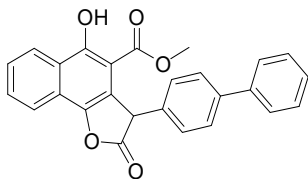
White solid 23.7mg, 71%, mp 210.8-211.8°C <sup>1</sup>H NMR (600 MHz, Chloroform-*d*) δ 12.09 – 11.90 (s, 1H), 8.52 – 8.47 (dt, *J* = 8.4, 0.9 Hz, 1H), 8.06 – 8.00 (dt, *J* = 8.2, 0.9 Hz, 1H), 7.80 – 7.74 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.69 – 7.62 (ddd, *J* = 8.3, 6.9, 1.2 Hz, 1H), 7.33 – 7.27 (m, 3H), 7.13 – 7.07 (m, 2H), 5.25 – 5.11 (s, 1H), 3.63 – 3.52 (s, 3H); <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 51.72, 53.09, 101.90, 117.86, 121.23, 123.51, 124.73, 125.25, 127.15, 127.37, 127.88, 129.01, 130.66, 136.43, 142.90, 159.04, 170.12, 175.51. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>16</sub>O<sub>5</sub> 335.0914, found: 335.0919

### 5-Hydroxy-2-oxo-3-p-tolyl-2,3-dihydro-naphtho[1,2-b]furan 3b:



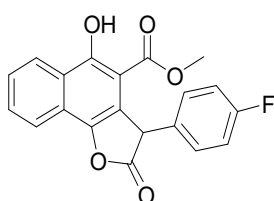
White solid 30.6mg, 88%,mp 208.3-218.5°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.06 – 11.88 (s, 1H), 8.55 – 8.37 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.95 (d, *J* = 8.2 Hz, 1H), 7.81 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.70 – 7.59 (t, *J* = 7.7 Hz, 1H), 7.15 – 7.06 (d, *J* = 7.7 Hz, 2H), 7.02 – 6.92 (d, *J* = 7.7 Hz, 2H), 5.23 – 5.02 (s, 1H), 3.70 – 3.49 (s, 3H), 2.40 – 2.18 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdcl<sub>3</sub>) δ 21.08, 51.74, 52.70, 101.89, 118.14, 121.17, 123.46, 124.64, 125.14, 127.04, 127.20, 129.67, 130.56, 133.40, 137.56, 142.79, 158.91, 170.13, 175.73. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>17</sub>O<sub>5</sub> 349.1071, found: 349.1069

### 3-Biphenyl-4-yl-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3c:



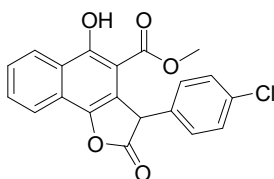
White solid 29.1 mg, 71%, mp 216.8-217.9°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.15 – 11.83 (s, 1H), 8.68 – 8.32 (d, *J* = 8.4 Hz, 1H), 8.10 – 7.99 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.73 (t, *J* = 7.6 Hz, 1H), 7.71 – 7.62 (d, *J* = 7.8 Hz, 1H), 7.61 – 7.49 (m, 4H), 7.48 – 7.38 (t, *J* = 7.5 Hz, 2H), 7.38 – 7.30 (d, *J* = 7.3 Hz, 1H), 7.22 – 7.13 (d, *J* = 7.9 Hz, 2H), 5.37 – 5.12 (s, 1H), 3.73 – 3.46 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.84, 52.82, 101.91, 117.86, 121.27, 123.55, 124.76, 125.30, 127.03, 127.19, 127.50, 127.70, 127.80, 128.82, 130.70, 135.44, 140.35, 140.81, 142.93, 159.10, 170.14, 175.54. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>26</sub>H<sub>18</sub>O<sub>5</sub> 411.1227, found: 411.1229

### 3-(4-Fluoro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3d:



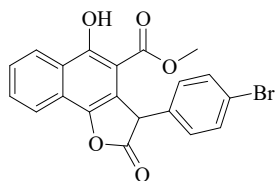
White solid 26.4 mg, 75%, mp 203.1-204.4°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.06 – 11.83 (s, 1H), 8.59 – 8.37 (d, *J* = 8.5 Hz, 1H), 8.07 – 7.93 (d, *J* = 8.3 Hz, 1H), 7.82 – 7.72 (t, *J* = 7.6 Hz, 1H), 7.71 – 7.59 (d, *J* = 7.8 Hz, 1H), 7.13 – 7.04 (dd, *J* = 8.6, 5.2 Hz, 2H), 7.05 – 6.93 (d, *J* = 8.5 Hz, 2H), 5.20 – 5.05 (s, 1H), 3.70 – 3.51 (s, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 175.30, 170.00, 162.30 (d, *J* = 246.7 Hz, *J*<sub>CF</sub>), 161.08, 159.12, 142.82, 132.29 (d, *J* = 3.7 Hz, *J*<sub>CF</sub>), 130.76, 128.97 (d, *J* = 8.3 Hz, *J*<sub>CF</sub>), 127.28, 125.27, 124.72, 123.46, 121.21, 117.51, 116.09, 115.88, 101.69, 52.22, 51.84. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>14</sub>FO<sub>5</sub> 353.0820, found: 353.0828

### 3-(4-Chloro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3e:



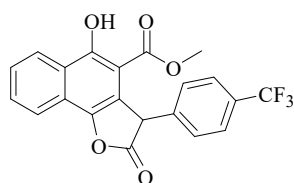
White solid 26.9 mg, 73%, mp 194.0-195.8°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.12 – 11.86 (s, 1H), 8.59 – 8.37 (d, *J* = 8.4 Hz, 1H), 8.13 – 7.89 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.72 (t, *J* = 7.6 Hz, 1H), 7.71 – 7.61 (t, *J* = 7.7 Hz, 1H), 7.34 – 7.22 (t, *J* = 8.4 Hz, 2H), 7.10 – 7.00 (d, *J* = 8.1 Hz, 2H), 5.22 – 5.02 (s, 1H), 3.68 – 3.50 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdcl<sub>3</sub>) δ 51.85, 52.36, 101.61, 117.17, 121.20, 123.43, 124.72, 125.28, 127.30, 128.67, 129.18, 130.76, 133.78, 134.98, 142.87, 159.13, 169.88, 174.96. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>14</sub>ClO<sub>5</sub> 369.0525, found: 369.0529

### 3-(4-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3f:



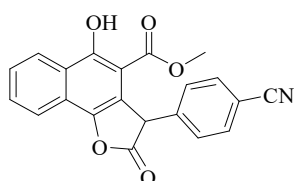
White solid 32.2 mg, 78%, mp 200.5-201.8°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.12 – 11.81 (s, 1H), 8.61 – 8.30 (d, *J* = 8.4 Hz, 1H), 8.20 – 7.84 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.61 (t, *J* = 7.7 Hz, 1H), 7.49 – 7.37 (d, *J* = 8.0 Hz, 2H), 7.06 – 6.89 (d, *J* = 8.0 Hz, 2H), 5.26 – 5.02 (s, 1H), 3.70 – 3.43 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.89, 52.49, 101.64, 117.11, 121.24, 121.94, 123.48, 124.77, 125.35, 127.34, 129.02, 130.80, 132.16, 135.53, 142.94, 159.19, 169.93, 174.92. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>14</sub>BrO<sub>5</sub> 413.0019, found: 413.0024

**5-Hydroxy-2-oxo-3-(4-trifluoromethyl-phenyl)-2,3-dihydro-naphtho[1,2-b]furan 3g:**



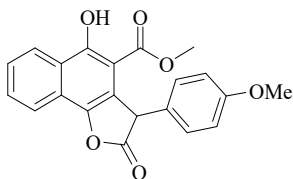
White solid 27.7 mg, 69%, mp 216.3-217.7°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.15 – 11.84 (s, 1H), 8.59 – 8.41 (d, *J* = 8.4 Hz, 1H), 8.13 – 7.93 (d, *J* = 8.2 Hz, 1H), 7.84 – 7.74 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.64 (t, *J* = 7.7 Hz, 1H), 7.63 – 7.53 (d, *J* = 8.0 Hz, 2H), 7.30 – 7.17 (d, *J* = 7.7 Hz, 2H), 5.34 – 5.12 (s, 1H), 3.70 – 3.43 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdcl<sub>3</sub>) δ 174.61, 169.84, 159.31, 143.04, 140.46, 130.90, 127.82, 127.47, 126.01 (q, *J* = 3.8 Hz, *J*<sub>CF</sub>), 126.03, 125.99, 125.96, 125.43, 124.81, 123.50, 121.27, 116.75, 101.55, 52.79, 51.84. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>14</sub>F<sub>3</sub>O<sub>5</sub> 403.0788, found: 403.0794.

**3-(4-Cyano-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3h:**



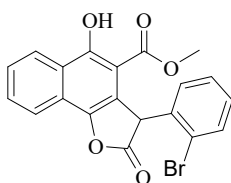
White solid 24.1 mg, 67%, mp 214.9-215.4°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.05 – 11.86 (s, 1H), 8.61 – 8.32 (d, *J* = 8.4 Hz, 1H), 8.11 – 7.89 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.73 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.56 (dd, *J* = 14.1, 7.9 Hz, 3H), 7.30 – 7.19 (d, *J* = 7.8 Hz, 2H), 5.34 – 5.08 (s, 1H), 3.68 – 3.40 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.89, 52.92, 101.38, 112.01, 116.16, 118.28, 121.24, 123.45, 124.82, 125.48, 127.60, 128.22, 130.99, 132.81, 141.73, 143.07, 159.39, 169.69, 174.13. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>14</sub>NO<sub>5</sub> 360.0867, found: 360.0872

**5-Hydroxy-3-(4-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3i:**



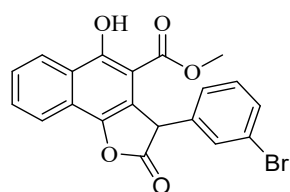
White solid 30.9 mg, 85%, mp 206.3-207.7°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.08 – 11.86 (s, 1H), 8.57 – 8.37 (d,  $J$  = 8.4 Hz, 1H), 8.11 – 7.93 (d,  $J$  = 8.2 Hz, 1H), 7.81 – 7.71 (m, 1H), 7.70 – 7.59 (s, 1H), 7.05 – 6.97 (dd,  $J$  = 6.8, 4.8 Hz, 2H), 6.88 – 6.77 (m, 2H), 5.26 – 4.99 (s, 1H), 3.84 – 3.69 (s, 3H), 3.69 – 3.51 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.85, 52.25, 55.28, 101.89, 114.39, 118.21, 121.19, 123.46, 124.66, 125.14, 127.07, 128.42, 128.49, 130.61, 142.71, 158.93, 159.17, 170.15, 175.86. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{21}\text{H}_{17}\text{O}_6$  365.1020, found: 365.1026

### 3-(2-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3j:



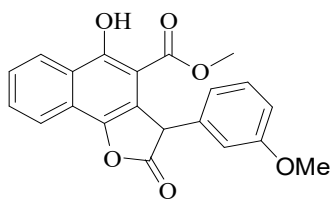
White solid 24.7 mg, 60%, mp 140.2-141.6°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.07 – 11.87 (s, 1H), 8.59 – 8.40 (d,  $J$  = 8.4 Hz, 1H), 8.09 – 7.96 (d,  $J$  = 8.2 Hz, 1H), 7.84 – 7.74 (t,  $J$  = 7.6 Hz, 1H), 7.75 – 7.61 (dd,  $J$  = 16.6, 7.7 Hz, 2H), 7.33 – 7.22 (m, 1H), 7.20 – 7.05 (m, 2H), 5.97 – 5.88 (s, 1H), 3.71 – 3.52 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.89, 52.16, 101.46, 117.73, 121.21, 123.41, 124.75, 125.29, 127.29, 127.62, 128.14, 129.14, 129.41, 130.78, 131.55, 132.87, 133.36, 136.63, 143.08, 159.24, 169.91, 174.03. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{20}\text{H}_{14}\text{BrO}_5$  413.0019, found: 413.0023

### 3-(3-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3k:



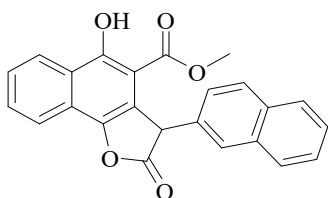
White solid 27.2 mg, 66%, mp 181.8-182.9°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.06 – 11.92 (s, 1H), 8.56 – 8.40 (d,  $J$  = 8.4 Hz, 1H), 8.10 – 7.91 (d,  $J$  = 8.2 Hz, 1H), 7.85 – 7.71 (t,  $J$  = 7.6 Hz, 1H), 7.72 – 7.60 (d,  $J$  = 7.8 Hz, 1H), 7.49 – 7.36 (d,  $J$  = 8.0 Hz, 1H), 7.31 – 7.23 (d,  $J$  = 5.9 Hz, 1H), 7.24 – 7.15 (t,  $J$  = 7.8 Hz, 1H), 7.08 – 6.98 (d,  $J$  = 7.7 Hz, 1H), 5.23 – 4.96 (s, 1H), 3.73 – 3.43 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.93, 52.66, 101.64, 117.03, 121.26, 123.05, 123.49, 124.79, 125.38, 126.13, 127.38, 130.58, 130.88, 131.12, 138.63, 142.93, 159.26, 169.93, 174.88. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{20}\text{H}_{14}\text{BrO}_5$  413.0019, found: 413.0025

### 5-Hydroxy-3-(3-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3l:



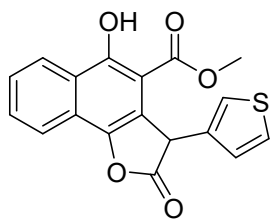
White solid 21.8 mg, 60%, mp 179.1-180.3°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.05 – 11.88 (s, 1H), 8.61 – 8.35 (d,  $J$  = 8.4 Hz, 1H), 8.09 – 7.89 (d,  $J$  = 8.2 Hz, 1H), 7.81 – 7.70 (t,  $J$  = 7.9 Hz, 1H), 7.70 – 7.59 (t,  $J$  = 7.7 Hz, 1H), 7.27 – 7.16 (m, 1H), 6.87 – 6.74 (dd,  $J$  = 8.3, 2.6 Hz, 1H), 6.73 – 6.65 (d,  $J$  = 7.6 Hz, 1H), 6.64 – 6.58 (t,  $J$  = 2.1 Hz, 1H), 5.26 – 4.96 (s, 1H), 3.78 – 3.70 (s, 3H), 3.65 – 3.57 (s, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  51.77, 52.98, 55.27, 101.84, 112.80, 113.50, 117.75, 119.84, 121.20, 123.43, 124.65, 125.20, 127.13, 129.96, 130.63, 137.83, 142.84, 158.95, 160.01, 170.07, 175.33. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{21}\text{H}_{17}\text{O}_6$  365.1020, found: 365.1024

### 5-Hydroxy-3-naphthalen-2-yl-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3m:



White solid 26.1 mg, 68%, mp 205.3-206.6°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.11 – 11.88 (s, 1H), 8.59 – 8.43 (d,  $J$  = 8.4 Hz, 1H), 8.14 – 7.99 (d,  $J$  = 8.2 Hz, 1H), 7.85 – 7.76 (m, 3H), 7.76 – 7.63 (m, 2H), 7.55 – 7.51 (s, 1H), 7.50 – 7.41 (dd,  $J$  = 6.3, 3.3 Hz, 2H), 7.30 – 7.21 (m, 1H), 5.42 – 5.20 (s, 1H), 3.62 – 3.38 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.86, 53.17, 101.93, 117.96, 121.29, 123.53, 124.74, 125.35, 126.24, 126.49, 127.21, 127.73, 128.94, 130.71, 132.84, 133.45, 133.92, 142.93, 159.06, 170.07, 175.46. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{24}\text{H}_{17}\text{O}_5$  385.1071, found: 385.1075

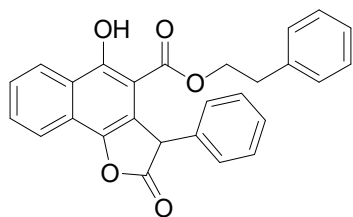
### 5-hydroxy-2-oxo-3-(thiophen-3-yl)-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylate 3n:



White solid 20.4 mg, 60%, mp 168.8-169.9°C  $^1\text{H}$  NMR (600 MHz, DMSO- $d_6$ )  $\delta$  11.81 – 11.64 (s, 1H), 8.53 – 8.30 (d,  $J$  = 8.4 Hz, 1H), 8.06 – 7.96 (d,  $J$  = 8.2 Hz, 1H), 7.93 – 7.83 (d,  $J$  = 1.3 Hz, 1H), 7.80 – 7.70 (m, 1H), 7.54 – 7.49 (dd,  $J$  = 5.0, 3.0 Hz, 1H), 7.36 – 7.31 (dd,  $J$  = 3.0, 1.4 Hz, 1H), 6.94 – 6.88 (dd,  $J$  = 5.0, 1.4 Hz, 1H), 5.73 – 5.54 (s, 1H), 3.76 – 3.52 (s, 3H).  $^{13}\text{C}$  NMR (151 MHz, DMSO)  $\delta$  48.31, 52.54, 103.05, 119.82, 121.33, 123.13, 123.56, 124.67, 124.77, 127.26, 127.32, 127.79, 131.36, 136.35, 142.26, 157.25, 169.68, 175.18. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{18}\text{H}_{13}\text{O}_5\text{S}$  341.0478, found: 341.0474

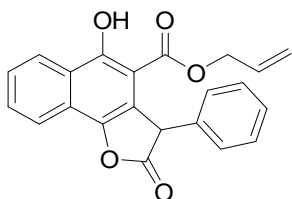


**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid phenethyl ester 3o:**



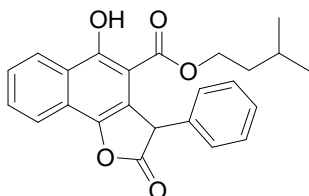
White solid 27.6 mg, 65%, mp 200.8-201.9°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.29 – 12.00 (s, 1H), 8.63 – 8.38 (d,  $J$  = 8.4 Hz, 1H), 8.12 – 7.91 (d,  $J$  = 8.2 Hz, 1H), 7.82 – 7.71 (t,  $J$  = 7.6 Hz, 1H), 7.71 – 7.59 (t,  $J$  = 7.7 Hz, 1H), 7.39 – 7.21 (tt,  $J$  = 13.2, 7.0 Hz, 6H), 7.17 – 7.08 (d,  $J$  = 7.3 Hz, 2H), 7.08 – 6.98 (m, 2H), 5.09 – 4.97 (s, 1H), 4.49 – 4.31 (td,  $J$  = 9.7, 9.3, 5.9 Hz, 1H), 4.13 – 3.92 (dt,  $J$  = 11.0, 7.8 Hz, 1H), 2.71 – 2.54 (m, 1H), 2.55 – 2.36 (m, 1H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  34.48, 52.76, 65.66, 102.09, 117.28, 121.23, 123.55, 124.74, 125.31, 126.97, 127.17, 127.37, 127.91, 128.75, 129.01, 129.48, 130.68, 136.45, 136.91, 142.94, 159.30, 169.74, 175.42. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{27}\text{H}_{21}\text{O}_5$  425.1384, found: 425.1388

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid allyl ester 3p:**



White solid 7.2 mg, 20%, mp 146.2-147.7°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.12 – 11.94 (s, 1H), 8.59 – 8.38 (d,  $J$  = 8.4 Hz, 1H), 8.07 – 7.89 (d,  $J$  = 8.3 Hz, 1H), 7.80 – 7.70 (t,  $J$  = 7.6 Hz, 1H), 7.70 – 7.58 (t,  $J$  = 7.7 Hz, 1H), 7.34 – 7.20 (d,  $J$  = 6.6 Hz, 3H), 7.17 – 6.98 (m, 2H), 5.53 – 5.37 (tt,  $J$  = 12.4, 5.1 Hz, 1H), 5.22 – 5.01 (m, 3H), 4.68 – 4.52 (dd,  $J$  = 12.7, 6.1 Hz, 1H), 4.47 – 4.33 (dd,  $J$  = 12.6, 6.3 Hz, 1H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  52.87, 66.20, 101.96, 117.51, 119.91, 121.20, 123.47, 124.69, 125.22, 127.14, 127.50, 127.88, 128.99, 130.66, 130.85, 136.35, 142.87, 159.19, 169.54, 175.43. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{22}\text{H}_{17}\text{O}_5$  361.1071, found: 361.1077

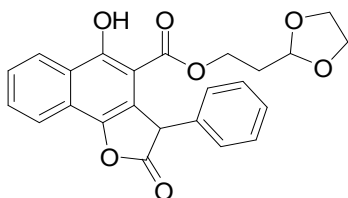
**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 3-methyl-butyl ester 3q:**



White solid 24.6 mg, 63%, mp 160.0-161.8°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.29 – 12.19 (s, 1H), 8.55 – 8.45 (d,  $J$  = 8.4 Hz, 1H), 8.06 – 7.96 (d,  $J$  = 8.2 Hz, 1H), 7.81 – 7.70 (t,  $J$  = 7.6 Hz, 1H), 7.69 – 7.60 (t,  $J$  = 7.7 Hz, 1H), 7.34 – 7.26 (d,  $J$  = 6.9 Hz, 3H), 7.17 – 7.07 (m, 2H), 5.27 – 5.12 (s, 1H), 4.05 – 3.90 (dd,  $J$  = 13.5, 4.8 Hz, 2H), 1.91 – 1.50 (m, 1H), 1.49 – 1.37 (d,  $J$  = 5.4 Hz, 2H), 0.93 – 0.75 (dd,  $J$  = 15.1, 6.6 Hz, 6H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  22.25, 22.44, 24.82, 36.70, 52.75, 64.32,

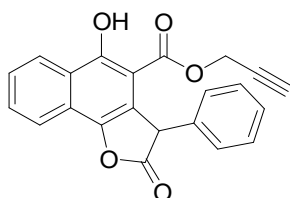
102.26, 117.15, 121.19, 123.45, 124.70, 125.32, 127.12, 127.34, 127.88, 129.00, 130.58, 136.35, 142.87, 159.19, 170.07, 175.51. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{24}H_{23}O_5$  391.1540, found: 391.1546

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 2-[1,3]dioxolan-2-yl-ethyl ester 3r:**



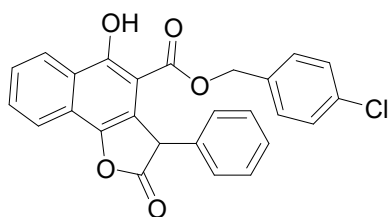
White solid 26.5 mg, 63%, mp 198.8-199.6°C  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.18 – 12.04 (s, 1H), 8.57 – 8.41 (d,  $J = 8.5$  Hz, 1H), 8.07 – 7.93 (d,  $J = 8.2$  Hz, 1H), 7.83 – 7.69 (t,  $J = 7.6$  Hz, 1H), 7.70 – 7.56 (d,  $J = 7.8$  Hz, 1H), 7.37 – 7.22 (m, 3H), 7.21 – 7.04 (m, 2H), 5.35 – 5.24 (s, 1H), 4.75 – 4.64 (t,  $J = 4.5$  Hz, 1H), 4.37 – 4.20 (m, 1H), 4.15 – 4.02 (dt,  $J = 11.7, 6.4$  Hz, 1H), 4.02 – 3.89 (m, 2H), 3.89 – 3.75 (d,  $J = 3.9$  Hz, 2H), 1.81 – 1.54 (dq,  $J = 9.7, 3.8, 2.6$  Hz, 2H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  32.31, 52.60, 61.22, 64.92, 65.00, 101.81, 102.12, 117.32, 121.18, 123.48, 124.72, 125.29, 127.11, 127.37, 127.88, 129.02, 130.62, 136.42, 142.87, 159.12, 169.73, 175.58. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{24}H_{21}O_7$  421.1282, found: 421.1287

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid prop-2-ynyl ester 3s:**



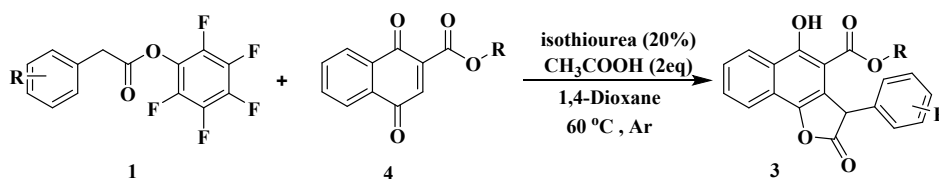
White solid 7.9 mg, 22%, mp 161.7-162.9°C  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  11.83 – 11.69 (s, 1H), 8.56 – 8.43 (d,  $J = 8.4$  Hz, 1H), 8.10 – 7.95 (d,  $J = 8.2$  Hz, 1H), 7.85 – 7.71 (t,  $J = 7.6$  Hz, 1H), 7.74 – 7.59 (d,  $J = 7.8$  Hz, 1H), 7.37 – 7.21 (m, 3H), 7.22 – 7.02 (m, 2H), 5.30 – 5.16 (s, 1H), 4.87 – 4.71 (dd,  $J = 15.5, 2.5$  Hz, 1H), 4.47 – 4.30 (dd,  $J = 15.5, 2.5$  Hz, 1H), 2.52 – 2.36 (t,  $J = 2.6$  Hz, 1H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  52.52, 52.99, 75.87, 76.39, 101.39, 117.75, 121.29, 123.67, 124.79, 125.17, 127.27, 127.65, 127.93, 129.06, 130.91, 136.17, 142.97, 159.38, 168.93, 175.41. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{22}H_{14}O_5$  359.0914, found: 359.0919

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 4-chlorobenzyl ester 3t:**



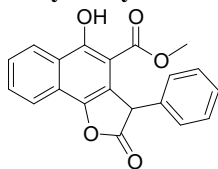
White solid 29.3 mg, 66%, mp 158.7-159.8°C <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.15 – 11.99 (s, 1H), 8.56 – 8.43 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.94 (d, *J* = 8.2 Hz, 1H), 7.86 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.60 (d, *J* = 7.8 Hz, 1H), 7.31 – 7.15 (m, 5H), 6.98 – 6.91 (d, *J* = 7.3 Hz, 2H), 6.91 – 6.83 (d, *J* = 8.0 Hz, 2H), 5.17 – 5.04 (t, *J* = 6.0 Hz, 2H), 4.93 – 4.83 (d, *J* = 12.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 52.81, 66.64, 101.79, 117.11, 121.26, 123.61, 124.78, 125.31, 127.25, 127.29, 127.83, 128.83, 129.07, 130.14, 130.80, 132.89, 134.66, 136.20, 142.99, 159.49, 169.71, 175.37. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>26</sub>H<sub>17</sub>ClO<sub>5</sub> 445.0838, found: 445.0841

#### 1.4.2 The synthesis of 3-Aryl-3H-benzofuranones derivatives from aryl acetate and 1,4-Naphthoquinone



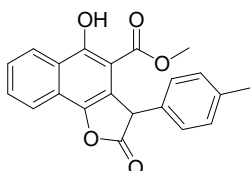
A 15 mL of reaction tube was charged with isothiurea(20%), Aryl acetic acid derivatives(0.12 mmol), 1,4-Naphthoquinone(0.1 mmol), CH<sub>3</sub>COOH(1 equiv) and 1, 4-dioxane(2 ml) under Ar at 60°C for 6h. The corresponding reaction mixture was cooled to room temperature, water (5 mL) was added, separated the organic layer which was brined the saturated aqueous NaCl. Finally the organic layer was separated and dried over the Na<sub>2</sub>SO<sub>4</sub> and concentrated. The residue was purified by flash chromatography on silical gel using 4% (v/v) ethyl acetate in petroleum ether as eluent to afford the desired products.

#### 5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan 3a:



White solid 30.4 mg, 91%, mp 210.8-211.8 <sup>1</sup>H NMR (600 MHz, Chloroform-*d*) δ 12.09 – 11.90 (s, 1H), 8.52 – 8.47 (dt, *J* = 8.4, 0.9 Hz, 1H), 8.06 – 8.00 (dt, *J* = 8.2, 0.9 Hz, 1H), 7.80 – 7.74 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.69 – 7.62 (ddd, *J* = 8.3, 6.9, 1.2 Hz, 1H), 7.33 – 7.27 (m, 3H), 7.13 – 7.07 (m, 2H), 5.25 – 5.11 (s, 1H), 3.63 – 3.52 (s, 3H); <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 51.72, 53.09, 101.90, 117.86, 121.23, 123.51, 124.73, 125.25, 127.15, 127.37, 127.88, 129.01, 130.66, 136.43, 142.90, 159.04, 170.12, 175.51. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>16</sub>O<sub>5</sub> 335.0914, found: 335.0919

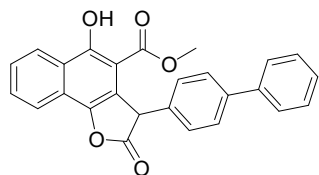
#### 5-Hydroxy-2-oxo-3-p-tolyl-2,3-dihydro-naphtho[1,2-b]furan 3b:



White solid 21.9 mg, 63%,mp 208.3-218.5 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.06 – 11.88 (s, 1H), 8.55 – 8.37 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.95 (d, *J* = 8.2 Hz, 1H), 7.81 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.70 – 7.59 (t, *J* = 7.7 Hz, 1H), 7.15 – 7.06 (d, *J* = 7.7 Hz, 2H), 7.02 – 6.92 (d, *J* = 7.7 Hz, 2H), 5.23 – 5.02 (s, 1H), 3.70 – 3.49 (s, 3H), 2.40 – 2.18 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdcl<sub>3</sub>) δ 21.08, 51.74, 52.70, 101.89,

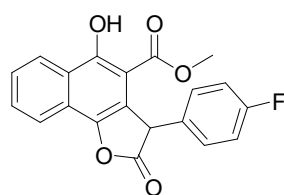
118.14, 121.17, 123.46, 124.64, 125.14, 127.04, 127.20, 129.67, 130.56, 133.40, 137.56, 142.79, 158.91, 170.13, 175.73. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{21}H_{17}O_5$  349.1071, found: 349.1069

### 3-Biphenyl-4-yl-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3c:



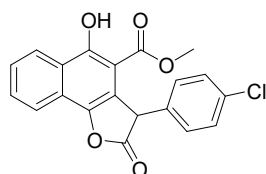
White solid 27.1 mg, 66%, mp 216.8-217.9  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.15 – 11.83 (s, 1H), 8.68 – 8.32 (d,  $J = 8.4$  Hz, 1H), 8.10 – 7.99 (d,  $J = 8.2$  Hz, 1H), 7.83 – 7.73 (t,  $J = 7.6$  Hz, 1H), 7.71 – 7.62 (d,  $J = 7.8$  Hz, 1H), 7.61 – 7.49 (m, 4H), 7.48 – 7.38 (t,  $J = 7.5$  Hz, 2H), 7.38 – 7.30 (d,  $J = 7.3$  Hz, 1H), 7.22 – 7.13 (d,  $J = 7.9$  Hz, 2H), 5.37 – 5.12 (s, 1H), 3.73 – 3.46 (s, 3H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  51.84, 52.82, 101.91, 117.86, 121.27, 123.55, 124.76, 125.30, 127.03, 127.19, 127.50, 127.70, 127.80, 128.82, 130.70, 135.44, 140.35, 140.81, 142.93, 159.10, 170.14, 175.54. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{26}H_{18}O_5$  411.1227, found: 411.1229

### 3-(4-Fluoro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3d:



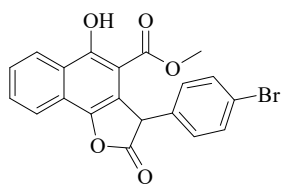
White solid 29.6 mg, 84% , mp 203.1-204.4  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.06 – 11.83 (s, 1H), 8.59 – 8.37 (d,  $J = 8.5$  Hz, 1H), 8.07 – 7.93 (d,  $J = 8.3$  Hz, 1H), 7.82 – 7.72 (t,  $J = 7.6$  Hz, 1H), 7.71 – 7.59 (d,  $J = 7.8$  Hz, 1H), 7.13 – 7.04 (dd,  $J = 8.6, 5.2$  Hz, 2H), 7.05 – 6.93 (d,  $J = 8.5$  Hz, 2H), 5.20 – 5.05 (s, 1H), 3.70 – 3.51 (s, 3H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  175.30, 170.00, 162.30 (d,  $J = 246.7$  Hz,  $J_{CF}$ ), 161.08, 159.12, 142.82, 132.29 (d,  $J = 3.7$  Hz,  $J_{CF}$ ), 130.76, 128.97 (d,  $J = 8.3$  Hz,  $J_{CF}$ ), 127.28, 125.27, 124.72, 123.46, 121.21, 117.51, 116.09, 115.88, 101.69, 52.22, 51.84. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{20}H_{14}FO_5$  353.0820, found: 353.0828

### 3-(4-Chloro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3e:



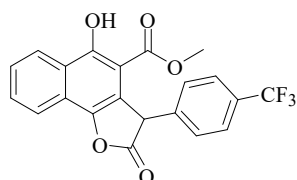
White solid 26.9 mg, 73%, mp 194.0-195.8  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.12 – 11.86 (s, 1H), 8.59 – 8.37 (d,  $J = 8.4$  Hz, 1H), 8.13 – 7.89 (d,  $J = 8.2$  Hz, 1H), 7.83 – 7.72 (t,  $J = 7.6$  Hz, 1H), 7.71 – 7.61 (t,  $J = 7.7$  Hz, 1H), 7.34 – 7.22 (t,  $J = 8.4$  Hz, 2H), 7.10 – 7.00 (d,  $J = 8.1$  Hz, 2H), 5.22 – 5.02 (s, 1H), 3.68 – 3.50 (s, 3H).  $^{13}C$  NMR (100 MHz,  $cdCl_3$ )  $\delta$  51.85, 52.36, 101.61, 117.17, 121.20, 123.43, 124.72, 125.28, 127.30, 128.67, 129.18, 130.76, 133.78, 134.98, 142.87, 159.13, 169.88, 174.96. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{20}H_{14}ClO_5$  369.0525, found: 369.0529

**3-(4-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3f:**



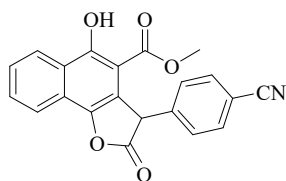
White solid 38.7 mg, 94%, mp 200.5-201.8 °C. <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.12 – 11.81 (s, 1H), 8.61 – 8.30 (d, *J* = 8.4 Hz, 1H), 8.20 – 7.84 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.61 (t, *J* = 7.7 Hz, 1H), 7.49 – 7.37 (d, *J* = 8.0 Hz, 2H), 7.06 – 6.89 (d, *J* = 8.0 Hz, 2H), 5.26 – 5.02 (s, 1H), 3.70 – 3.43 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.89, 52.49, 101.64, 117.11, 121.24, 121.94, 123.48, 124.77, 125.35, 127.34, 129.02, 130.80, 132.16, 135.53, 142.94, 159.19, 169.93, 174.92. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>14</sub>BrO<sub>5</sub> 413.0019, found: 413.0024

**5-Hydroxy-2-oxo-3-(4-trifluoromethyl-phenyl)-2,3-dihydro-naphtho[1,2-b]furan 3g:**



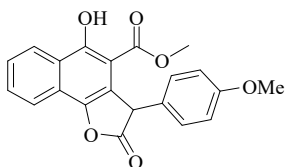
White solid 35.8 mg, 89%, mp 216.3-217.7 °C. <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.15 – 11.84 (s, 1H), 8.59 – 8.41 (d, *J* = 8.4 Hz, 1H), 8.13 – 7.93 (d, *J* = 8.2 Hz, 1H), 7.84 – 7.74 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.64 (t, *J* = 7.7 Hz, 1H), 7.63 – 7.53 (d, *J* = 8.0 Hz, 2H), 7.30 – 7.17 (d, *J* = 7.7 Hz, 2H), 5.34 – 5.12 (s, 1H), 3.70 – 3.43 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdCl<sub>3</sub>) δ 174.61, 169.84, 159.31, 143.04, 140.46, 130.90, 127.82, 127.47, 126.01 (q, *J* = 3.8 Hz, *J*<sub>CF</sub>), 126.03, 125.99, 125.96, 125.43, 124.81, 123.50, 121.27, 116.75, 101.55, 52.79, 51.84. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>14</sub>F<sub>3</sub>O<sub>5</sub> 403.0788, found: 403.0794.

**3-(4-Cyano-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3h:**



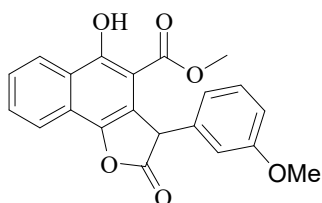
White solid 34.8 mg, 97%, mp 214.9-215.4 °C. <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.05 – 11.86 (s, 1H), 8.61 – 8.32 (d, *J* = 8.4 Hz, 1H), 8.11 – 7.89 (d, *J* = 8.2 Hz, 1H), 7.83 – 7.73 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.56 (dd, *J* = 14.1, 7.9 Hz, 3H), 7.30 – 7.19 (d, *J* = 7.8 Hz, 2H), 5.34 – 5.08 (s, 1H), 3.68 – 3.40 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.89, 52.92, 101.38, 112.01, 116.16, 118.28, 121.24, 123.45, 124.82, 125.48, 127.60, 128.22, 130.99, 132.81, 141.73, 143.07, 159.39, 169.69, 174.13. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>14</sub>NO<sub>5</sub> 360.0867, found: 360.0872

**5-Hydroxy-3-(4-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3i:**



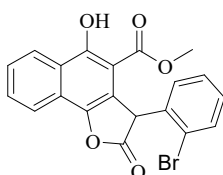
White solid 29.1 mg, 80%, mp 206.3-207.7 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.08 – 11.86 (s, 1H), 8.57 – 8.37 (d, *J* = 8.4 Hz, 1H), 8.11 – 7.93 (d, *J* = 8.2 Hz, 1H), 7.81 – 7.71 (m, 1H), 7.70 – 7.59 (s, 1H), 7.05 – 6.97 (dd, *J* = 6.8, 4.8 Hz, 2H), 6.88 – 6.77 (m, 2H), 5.26 – 4.99 (s, 1H), 3.84 – 3.69 (s, 3H), 3.69 – 3.51 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.85, 52.25, 55.28, 101.89, 114.39, 118.21, 121.19, 123.46, 124.66, 125.14, 127.07, 128.42, 128.49, 130.61, 142.71, 158.93, 159.17, 170.15, 175.86. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>17</sub>O<sub>6</sub> 365.1020, found: 365.1026

**5-Hydroxy-3-(3-methoxyphenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3j:**



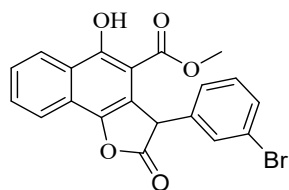
White solid 21.8 mg, 60%, mp 179.1-180.3 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.05 – 11.88 (s, 1H), 8.61 – 8.35 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.89 (d, *J* = 8.2 Hz, 1H), 7.81 – 7.70 (t, *J* = 7.9 Hz, 1H), 7.70 – 7.59 (t, *J* = 7.7 Hz, 1H), 7.27 – 7.16 (m, 1H), 6.87 – 6.74 (dd, *J* = 8.3, 2.6 Hz, 1H), 6.73 – 6.65 (d, *J* = 7.6 Hz, 1H), 6.64 – 6.58 (t, *J* = 2.1 Hz, 1H), 5.26 – 4.96 (s, 1H), 3.78 – 3.70 (s, 3H), 3.65 – 3.57 (s, 3H). <sup>13</sup>C NMR (100 MHz, cdcl<sub>3</sub>) δ 51.77, 52.98, 55.27, 101.84, 112.80, 113.50, 117.75, 119.84, 121.20, 123.43, 124.65, 125.20, 127.13, 129.96, 130.63, 137.83, 142.84, 158.95, 160.01, 170.07, 175.33. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>21</sub>H<sub>17</sub>O<sub>6</sub> 365.1020, found: 365.1024

**3-(2-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3k:**



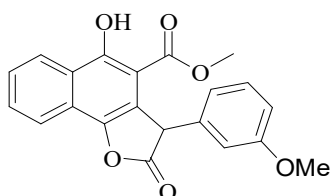
White solid 24.7 mg, 60%, mp 140.2-141.6 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.07 – 11.87 (s, 1H), 8.59 – 8.40 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.96 (d, *J* = 8.2 Hz, 1H), 7.84 – 7.74 (t, *J* = 7.6 Hz, 1H), 7.75 – 7.61 (dd, *J* = 16.6, 7.7 Hz, 2H), 7.33 – 7.22 (m, 1H), 7.20 – 7.05 (m, 2H), 5.97 – 5.88 (s, 1H), 3.71 – 3.52 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 51.89, 52.16, 101.46, 117.73, 121.21, 123.41, 124.75, 125.29, 127.29, 127.62, 128.14, 129.14, 129.41, 130.78, 131.55, 132.87, 133.36, 136.63, 143.08, 159.24, 169.91, 174.03. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>20</sub>H<sub>14</sub> Br O<sub>5</sub> 413.0019, found: 413.0023

**3-(3-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3k:**



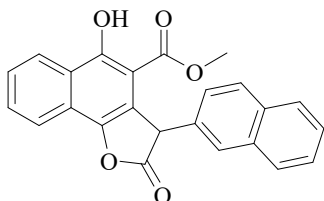
White solid 35.1 mg, 85%, mp 181.8-182.9°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.06 – 11.92 (s, 1H), 8.56 – 8.40 (d,  $J$  = 8.4 Hz, 1H), 8.10 – 7.91 (d,  $J$  = 8.2 Hz, 1H), 7.85 – 7.71 (t,  $J$  = 7.6 Hz, 1H), 7.72 – 7.60 (d,  $J$  = 7.8 Hz, 1H), 7.49 – 7.36 (d,  $J$  = 8.0 Hz, 1H), 7.31 – 7.23 (d,  $J$  = 5.9 Hz, 1H), 7.24 – 7.15 (t,  $J$  = 7.8 Hz, 1H), 7.08 – 6.98 (d,  $J$  = 7.7 Hz, 1H), 5.23 – 4.96 (s, 1H), 3.73 – 3.43 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.93, 52.66, 101.64, 117.03, 121.26, 123.05, 123.49, 124.79, 125.38, 126.13, 127.38, 130.58, 130.88, 131.12, 138.63, 142.93, 159.26, 169.93, 174.88. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{20}\text{H}_{14}\text{BrO}_5$  413.0019, found: 413.0025

### 5-Hydroxy-3-(3-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3l:



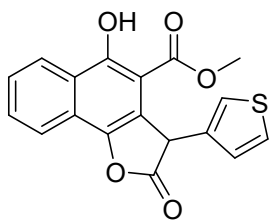
White solid 28.4 mg, 78%, mp 179.1-180.3°C  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.05 – 11.88 (s, 1H), 8.61 – 8.35 (d,  $J$  = 8.4 Hz, 1H), 8.09 – 7.89 (d,  $J$  = 8.2 Hz, 1H), 7.81 – 7.70 (t,  $J$  = 7.9 Hz, 1H), 7.70 – 7.59 (t,  $J$  = 7.7 Hz, 1H), 7.27 – 7.16 (m, 1H), 6.87 – 6.74 (dd,  $J$  = 8.3, 2.6 Hz, 1H), 6.73 – 6.65 (d,  $J$  = 7.6 Hz, 1H), 6.64 – 6.58 (t,  $J$  = 2.1 Hz, 1H), 5.26 – 4.96 (s, 1H), 3.78 – 3.70 (s, 3H), 3.65 – 3.57 (s, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{cdCl}_3$ )  $\delta$  51.77, 52.98, 55.27, 101.84, 112.80, 113.50, 117.75, 119.84, 121.20, 123.43, 124.65, 125.20, 127.13, 129.96, 130.63, 137.83, 142.84, 158.95, 160.01, 170.07, 175.33. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{21}\text{H}_{17}\text{O}_6$  365.1020, found: 365.1024

### 5-Hydroxy-3-naphthalen-2-yl-2-oxo-2,3-dihydro-naphtho[1,2-b]furan 3m:



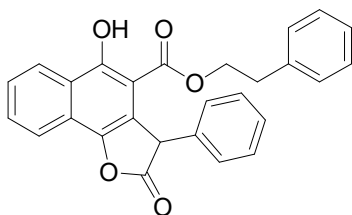
White solid 33.8 mg, 88%, mp 205.3-206.6  $^1\text{H}$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.11 – 11.88 (s, 1H), 8.59 – 8.43 (d,  $J$  = 8.4 Hz, 1H), 8.14 – 7.99 (d,  $J$  = 8.2 Hz, 1H), 7.85 – 7.76 (m, 3H), 7.76 – 7.63 (m, 2H), 7.55 – 7.51 (s, 1H), 7.50 – 7.41 (dd,  $J$  = 6.3, 3.3 Hz, 2H), 7.30 – 7.21 (m, 1H), 5.42 – 5.20 (s, 1H), 3.62 – 3.38 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  51.86, 53.17, 101.93, 117.96, 121.29, 123.53, 124.74, 125.35, 126.24, 126.49, 127.21, 127.73, 128.94, 130.71, 132.84, 133.45, 133.92, 142.93, 159.06, 170.07, 175.46. HR-MS (ESI) calcd for  $[\text{M} + \text{H}]^+$ :  $\text{C}_{24}\text{H}_{17}\text{O}_5$  385.1071, found: 385.1075

### 5-hydroxy-2-oxo-3-(thiophen-3-yl)-2,3-dihydronaphtho[1,2-b]furan-4-carboxylate 3n:



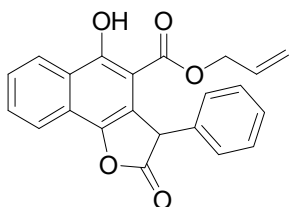
White solid 27.9 mg, 82%, mp 168.8-169.9°C <sup>1</sup>H NMR (600 MHz, DMSO-d<sub>6</sub>) δ 11.81 – 11.64 (s, 1H), 8.53 – 8.30 (d, *J* = 8.4 Hz, 1H), 8.06 – 7.96 (d, *J* = 8.2 Hz, 1H), 7.93 – 7.83 (d, *J* = 1.3 Hz, 1H), 7.80 – 7.70 (m, 1H), 7.54 – 7.49 (dd, *J* = 5.0, 3.0 Hz, 1H), 7.36 – 7.31 (dd, *J* = 3.0, 1.4 Hz, 1H), 6.94 – 6.88 (dd, *J* = 5.0, 1.4 Hz, 1H), 5.73 – 5.54 (s, 1H), 3.76 – 3.52 (s, 3H). <sup>13</sup>C NMR (151 MHz, DMSO) δ 48.31, 52.54, 103.05, 119.82, 121.33, 123.13, 123.56, 124.67, 124.77, 127.26, 127.32, 127.79, 131.36, 136.35, 142.26, 157.25, 169.68, 175.18. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>18</sub>H<sub>13</sub>O<sub>5</sub>S 341.0478, found: 341.0474

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid phenethyl ester 3o:**



White solid 28.4 mg, 67%, mp 200.8-201.9 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.29 – 12.00 (s, 1H), 8.63 – 8.38 (d, *J* = 8.4 Hz, 1H), 8.12 – 7.91 (d, *J* = 8.2 Hz, 1H), 7.82 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.71 – 7.59 (t, *J* = 7.7 Hz, 1H), 7.39 – 7.21 (tt, *J* = 13.2, 7.0 Hz, 6H), 7.17 – 7.08 (d, *J* = 7.3 Hz, 2H), 7.08 – 6.98 (m, 2H), 5.09 – 4.97 (s, 1H), 4.49 – 4.31 (td, *J* = 9.7, 9.3, 5.9 Hz, 1H), 4.13 – 3.92 (dt, *J* = 11.0, 7.8 Hz, 1H), 2.71 – 2.54 (m, 1H), 2.55 – 2.36 (m, 1H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 34.48, 52.76, 65.66, 102.09, 117.28, 121.23, 123.55, 124.74, 125.31, 126.97, 127.17, 127.37, 127.91, 128.75, 129.01, 129.48, 130.68, 136.45, 136.91, 142.94, 159.30, 169.74, 175.42. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>27</sub>H<sub>21</sub>O<sub>5</sub> 425.1384, found: 425.1388

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid allyl ester 3p:**

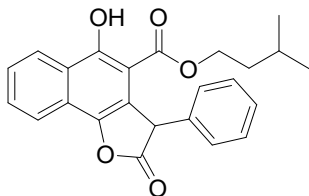


White solid 29.9 mg, 83%, mp 146.2-147.7 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.12 – 11.94 (s, 1H), 8.59 – 8.38 (d, *J* = 8.4 Hz, 1H), 8.07 – 7.89 (d, *J* = 8.3 Hz, 1H), 7.80 – 7.70 (t, *J* = 7.6 Hz, 1H), 7.70 – 7.58 (t, *J* = 7.7 Hz, 1H), 7.34 – 7.20 (d, *J* = 6.6 Hz, 3H), 7.17 – 6.98 (m, 2H), 5.53 – 5.37 (tt, *J* = 12.4, 5.1 Hz, 1H), 5.22 – 5.01 (m, 3H), 4.68 – 4.52 (dd, *J* = 12.7, 6.1 Hz, 1H), 4.47 – 4.33 (dd, *J* = 12.6, 6.3 Hz, 1H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 52.87, 66.20, 101.96, 117.51, 119.91, 121.20, 123.47,



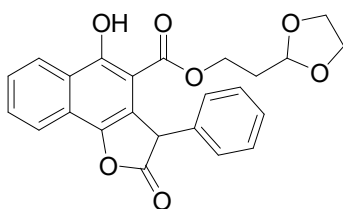
124.69, 125.22, 127.14, 127.50, 127.88, 128.99, 130.66, 130.85, 136.35, 142.87, 159.19, 169.54, 175.43. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{22}H_{17}O_5$  361.1071, found: 361.1077

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 3-methyl-butyl ester 3q:**



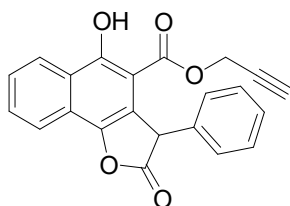
White solid 34.3 mg, 88 %, mp 160.0-161.8°C  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.29 – 12.19 (s, 1H), 8.55 – 8.45 (d,  $J = 8.4$  Hz, 1H), 8.06 – 7.96 (d,  $J = 8.2$  Hz, 1H), 7.81 – 7.70 (t,  $J = 7.6$  Hz, 1H), 7.69 – 7.60 (t,  $J = 7.7$  Hz, 1H), 7.34 – 7.26 (d,  $J = 6.9$  Hz, 3H), 7.17 – 7.07 (m, 2H), 5.27 – 5.12 (s, 1H), 4.05 – 3.90 (dd,  $J = 13.5, 4.8$  Hz, 2H), 1.91 – 1.50 (m, 1H), 1.49 – 1.37 (d,  $J = 5.4$  Hz, 2H), 0.93 – 0.75 (dd,  $J = 15.1, 6.6$  Hz, 6H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  22.25, 22.44, 24.82, 36.70, 52.75, 64.32, 102.26, 117.15, 121.19, 123.45, 124.70, 125.32, 127.12, 127.34, 127.88, 129.00, 130.58, 136.35, 142.87, 159.19, 170.07, 175.51. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{24}H_{23}O_5$  391.1540, found: 391.1546

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 2-[1,3]dioxolan-2-yl-ethyl ester 3r:**



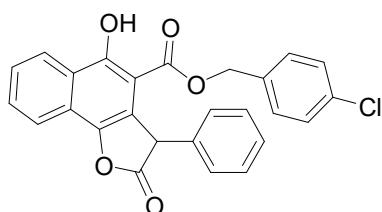
White solid 37 mg, 88%, mp 198.8-199.6  $^1H$  NMR (400 MHz, Chloroform-*d*)  $\delta$  12.18 – 12.04 (s, 1H), 8.57 – 8.41 (d,  $J = 8.5$  Hz, 1H), 8.07 – 7.93 (d,  $J = 8.2$  Hz, 1H), 7.83 – 7.69 (t,  $J = 7.6$  Hz, 1H), 7.70 – 7.56 (d,  $J = 7.8$  Hz, 1H), 7.37 – 7.22 (m, 3H), 7.21 – 7.04 (m, 2H), 5.35 – 5.24 (s, 1H), 4.75 – 4.64 (t,  $J = 4.5$  Hz, 1H), 4.37 – 4.20 (m, 1H), 4.15 – 4.02 (dt,  $J = 11.7, 6.4$  Hz, 1H), 4.02 – 3.89 (m, 2H), 3.89 – 3.75 (d,  $J = 3.9$  Hz, 2H), 1.81 – 1.54 (dq,  $J = 9.7, 3.8, 2.6$  Hz, 2H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  32.31, 52.60, 61.22, 64.92, 65.00, 101.81, 102.12, 117.32, 121.18, 123.48, 124.72, 125.29, 127.11, 127.37, 127.88, 129.02, 130.62, 136.42, 142.87, 159.12, 169.73, 175.58. HR-MS (ESI) calcd for  $[M + H]^+$ :  $C_{24}H_{21}O_7$  421.1282, found: 421.1287

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid prop-2-ynyl ester 3s:**



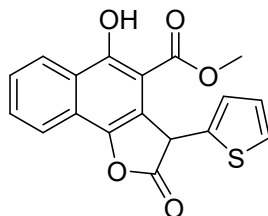
White solid 15.8 mg, 44%, mp 161.7-162.9 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 11.83 – 11.69 (s, 1H), 8.56 – 8.43 (d, *J* = 8.4 Hz, 1H), 8.10 – 7.95 (d, *J* = 8.2 Hz, 1H), 7.85 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.74 – 7.59 (d, *J* = 7.8 Hz, 1H), 7.37 – 7.21 (m, 3H), 7.22 – 7.02 (m, 2H), 5.30 – 5.16 (s, 1H), 4.87 – 4.71 (dd, *J* = 15.5, 2.5 Hz, 1H), 4.47 – 4.30 (dd, *J* = 15.5, 2.5 Hz, 1H), 2.52 – 2.36 (t, *J* = 2.6 Hz, 1H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 52.52, 52.99, 75.87, 76.39, 101.39, 117.75, 121.29, 123.67, 124.79, 125.17, 127.27, 127.65, 127.93, 129.06, 130.91, 136.17, 142.97, 159.38, 168.93, 175.41. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>22</sub>H<sub>14</sub>O<sub>5</sub> 359.0914, found: 359.0919

**5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 4-chlorobenzyl ester 3t:**



White solid 42.6 mg, 96%, mp 158.7-159.8 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 12.15 – 11.99 (s, 1H), 8.56 – 8.43 (d, *J* = 8.4 Hz, 1H), 8.09 – 7.94 (d, *J* = 8.2 Hz, 1H), 7.86 – 7.71 (t, *J* = 7.6 Hz, 1H), 7.72 – 7.60 (d, *J* = 7.8 Hz, 1H), 7.31 – 7.15 (m, 5H), 6.98 – 6.91 (d, *J* = 7.3 Hz, 2H), 6.91 – 6.83 (d, *J* = 8.0 Hz, 2H), 5.17 – 5.04 (t, *J* = 6.0 Hz, 2H), 4.93 – 4.83 (d, *J* = 12.0 Hz, 1H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 52.81, 66.64, 101.79, 117.11, 121.26, 123.61, 124.78, 125.31, 127.25, 127.29, 127.83, 128.83, 129.07, 130.14, 130.80, 132.89, 134.66, 136.20, 142.99, 159.49, 169.71, 175.37. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>26</sub>H<sub>17</sub>ClO<sub>5</sub> 445.0838, found: 445.0841

**methyl 5-hydroxy-2-oxo-3-(thiophen-2-yl)-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylate 3u**



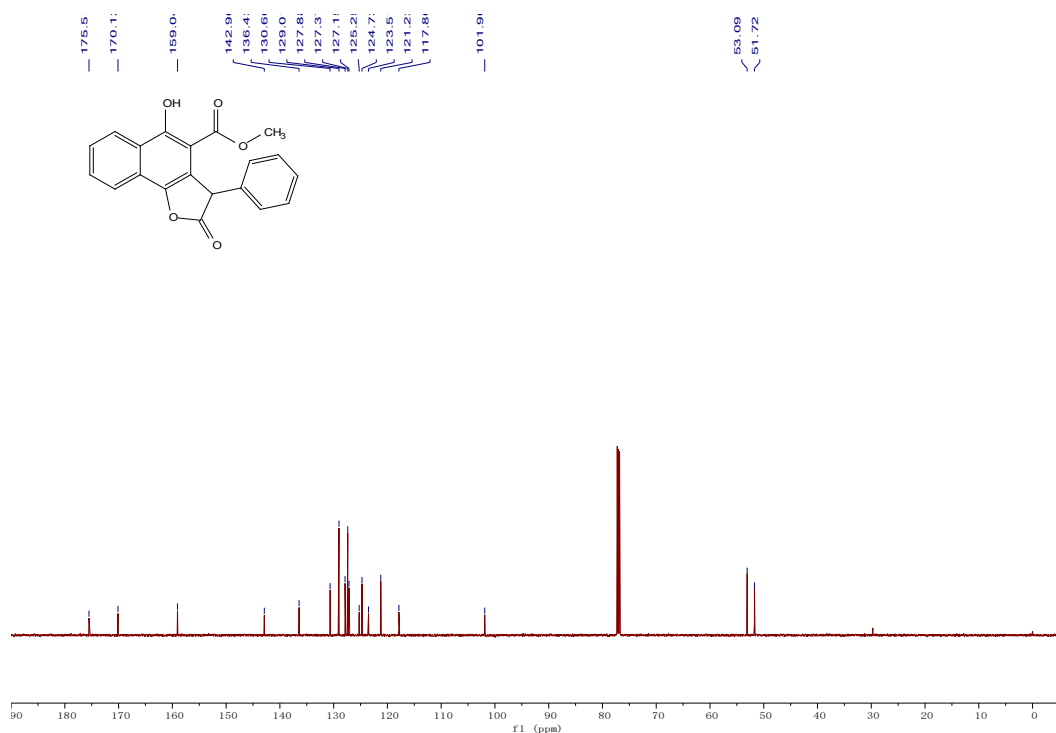
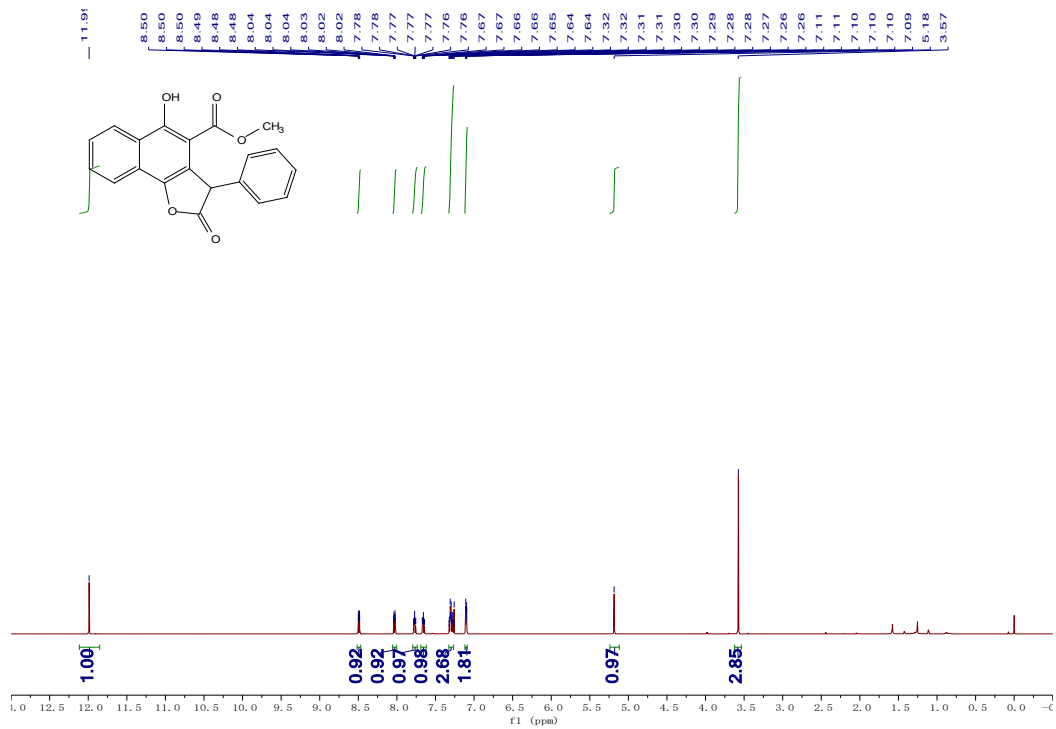
White solid 29.9 mg, 88 %, mp 150.1-151.3 <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 11.98 (s, 1H), 8.49 (d, *J* = 8.4 Hz, 1H), 8.02 (d, *J* = 8.2 Hz, 1H), 7.77 (t, *J* = 7.6 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.20 (d, *J* = 5.1 Hz, 1H), 6.94 (dd, *J* = 5.2, 3.5 Hz, 1H), 6.82 (d, *J* = 3.6 Hz, 1H), 5.44 (s, 1H), 3.69 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 174.16, 170.08, 159.03, 142.73, 138.05, 130.71, 127.34, 127.15, 125.42, 125.05, 124.74, 123.47, 121.31, 117.62, 101.74, 51.99, 48.05. HR-MS (ESI) calcd for [M + H]<sup>+</sup>: C<sub>18</sub>H<sub>13</sub>O<sub>5</sub>S 341.0478, found: 341.0483.

## References

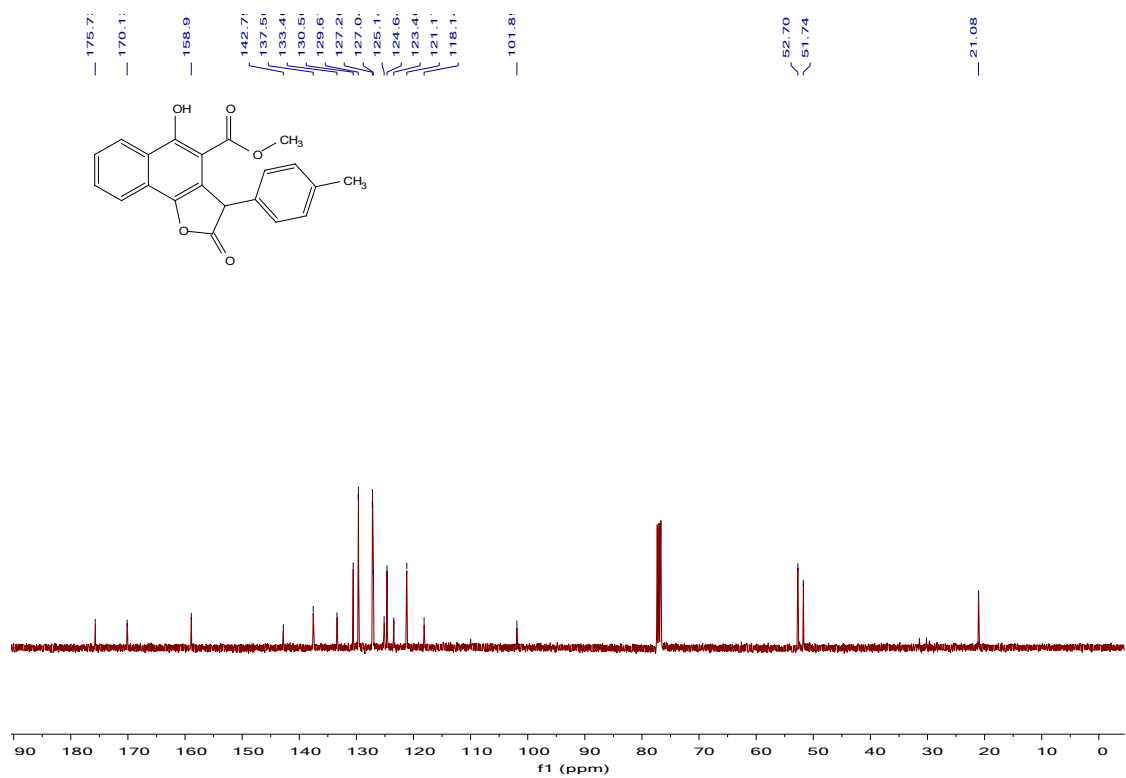
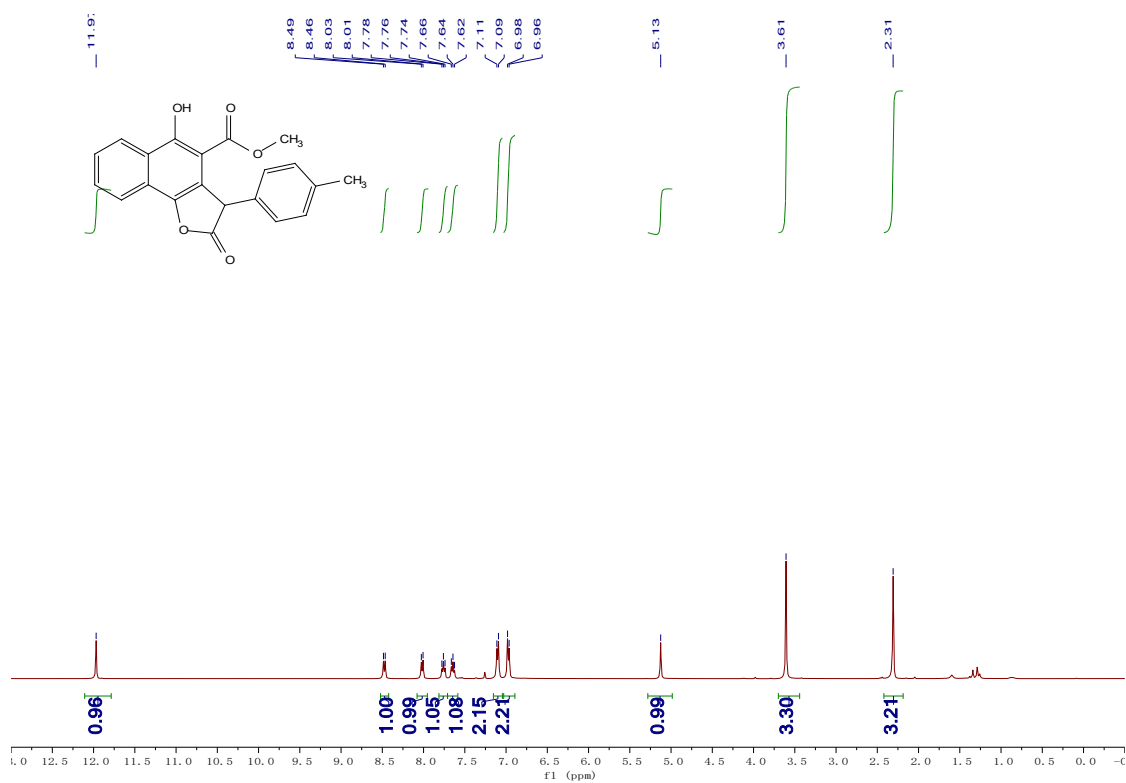
- [1] F. Zhao, C. Shu, C. M. Young, C. Carpenter-Warren, A. M. Z. Slawin, A. D. Smith, *Angewandte Chemie International Edition* **2021**, *60*, 11892-11900;
- [2] L. Stockhammer, D. Weinzierl, T. Bögl, M. Waser, *Organic Letters* **2021**, *23*, 6143-6147.
- [3] I. Shiina, K. Nakata, K. Ono, Y.-s. Onda, M. Itagaki, *Journal of the American Chemical Society* **2010**, *132*, 11629-11641;
- [4] B. Viswambharan, T. Okimura, S. Suzuki, S. Okamoto, *The Journal of Organic Chemistry* **2011**, *76*, 6678-6685.

Part II. <sup>1</sup>H NMR and <sup>13</sup>C NMR spectrum for products

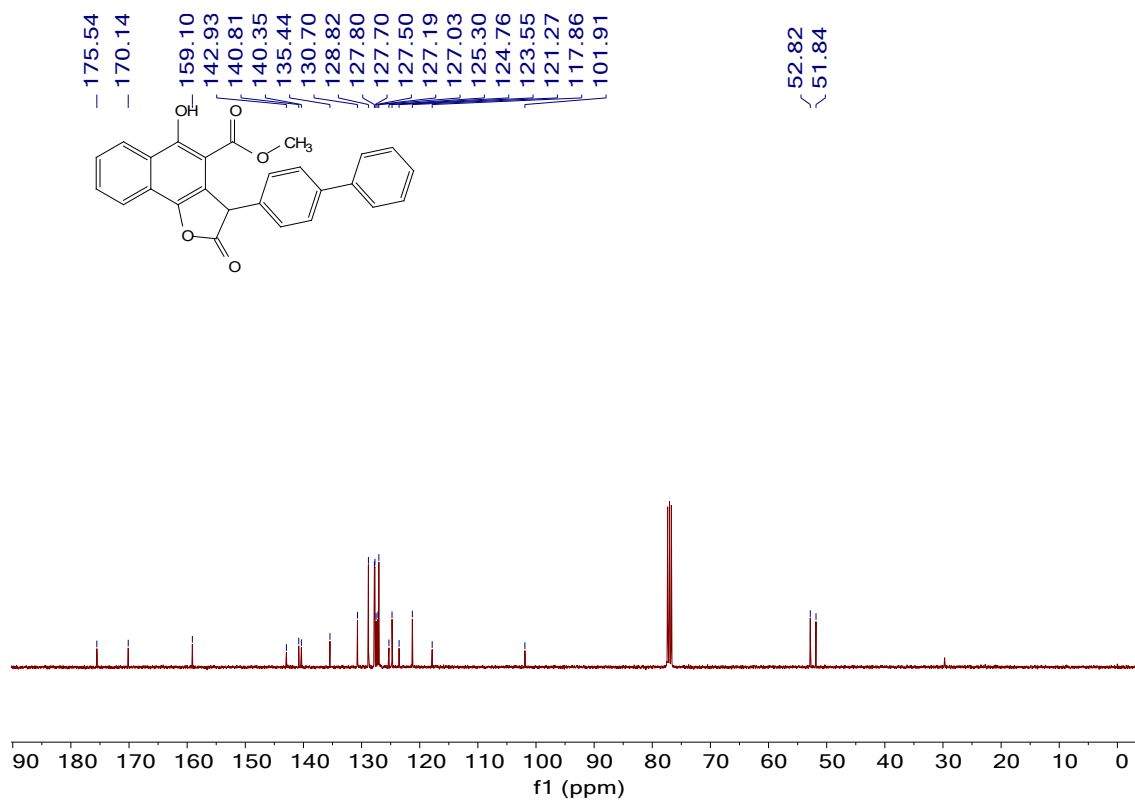
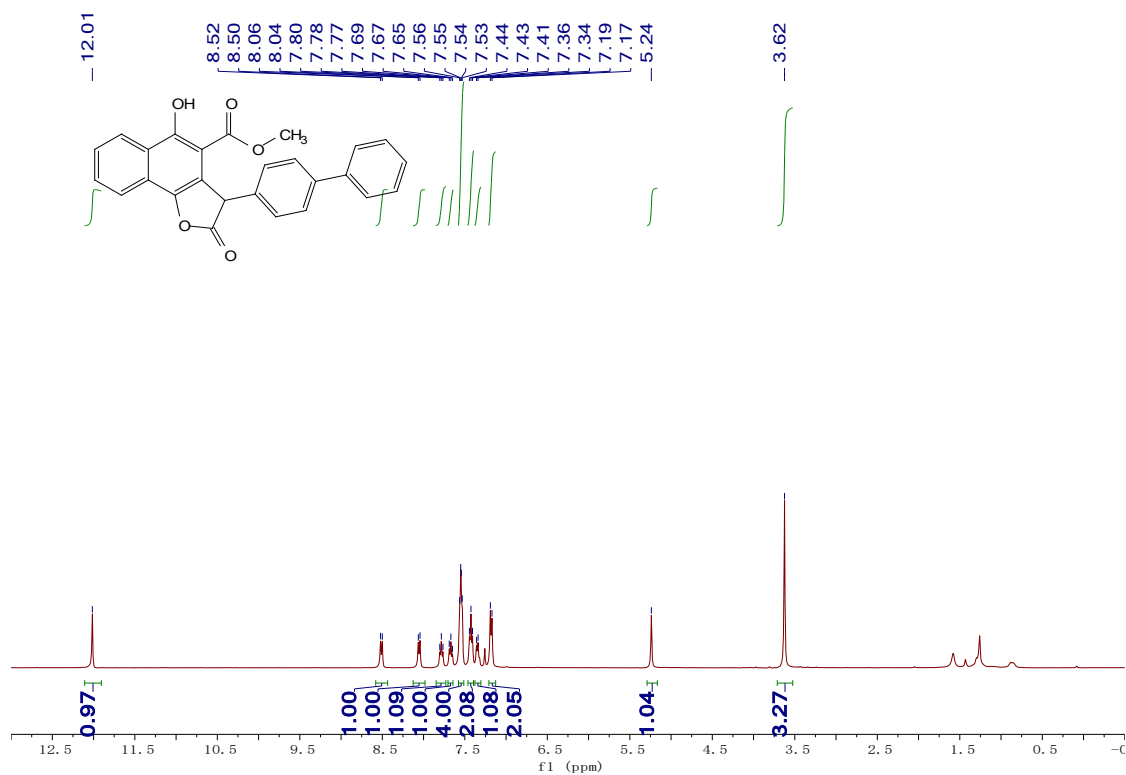
5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan (**3a**) (Using Chloroform-*d* as solvent)



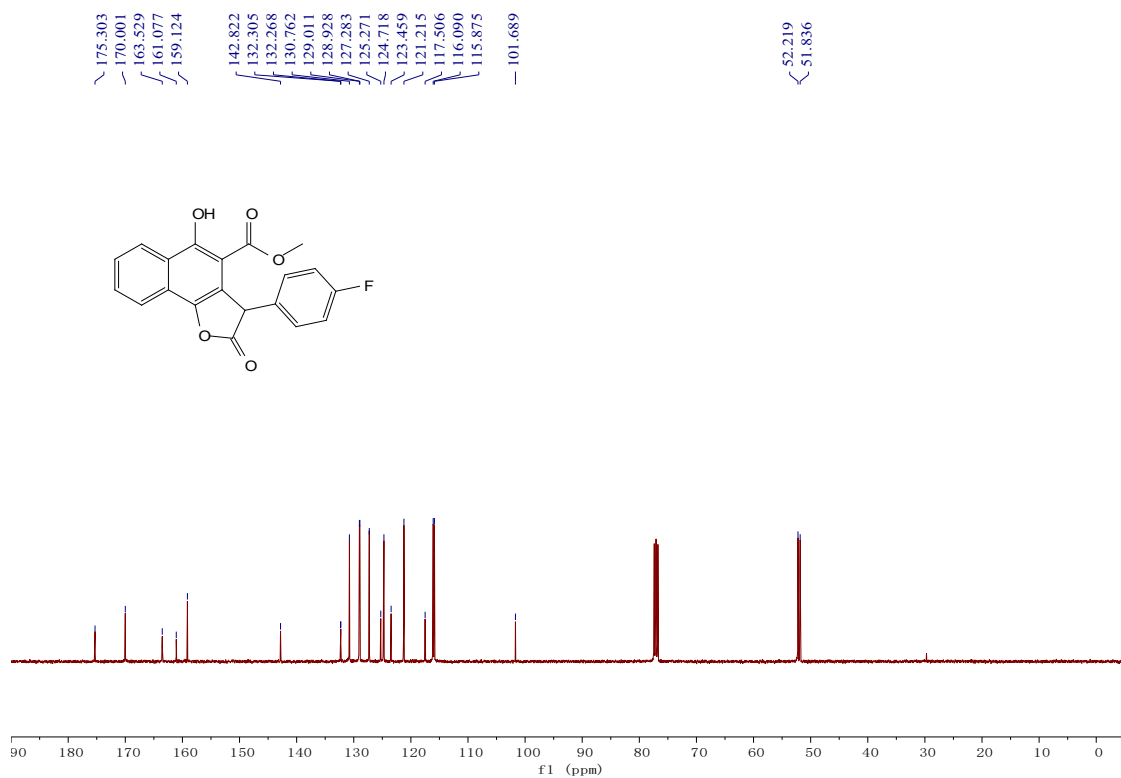
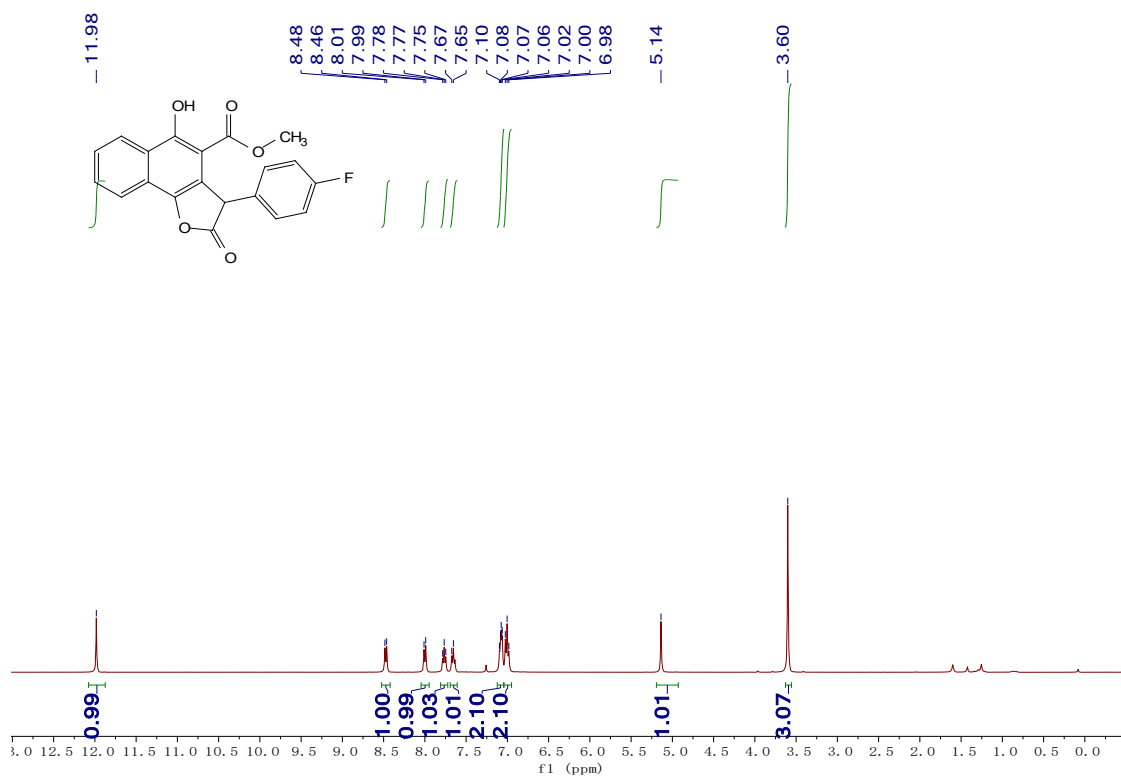
5-Hydroxy-2-oxo-3-p-tolyl-2,3-dihydro-naphtho[1,2-b]furan (**3b**) (Using Chloroform-*d* as solvent)



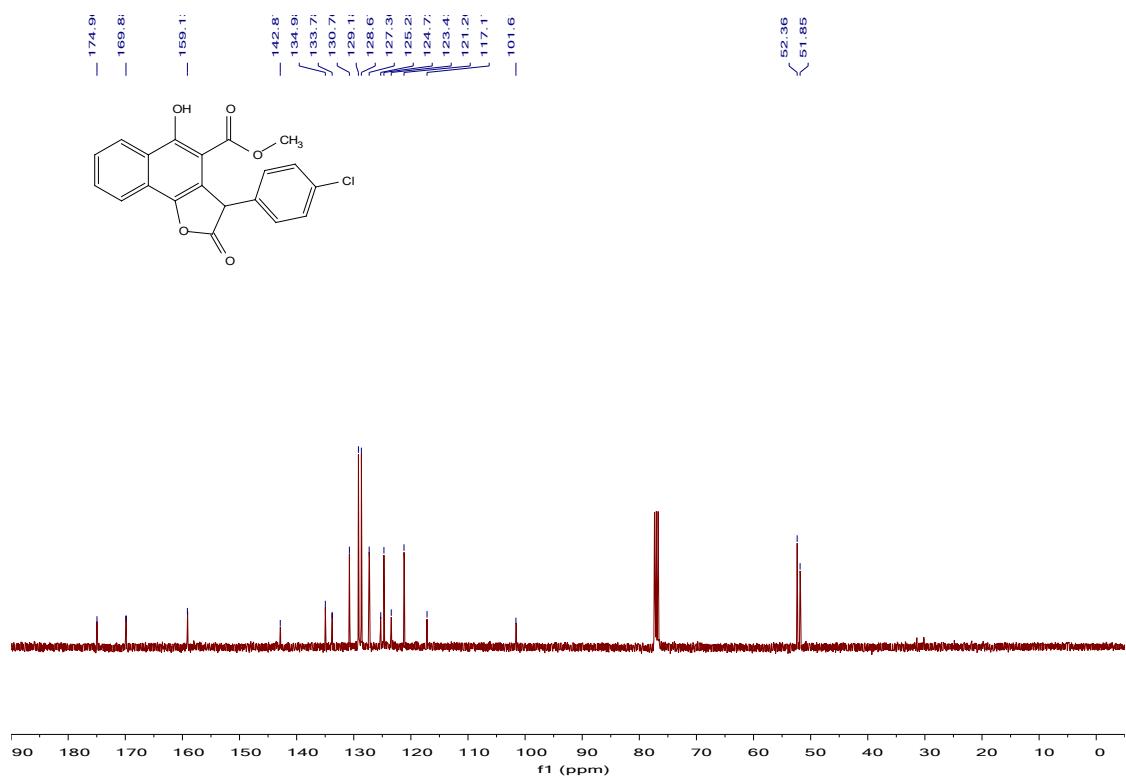
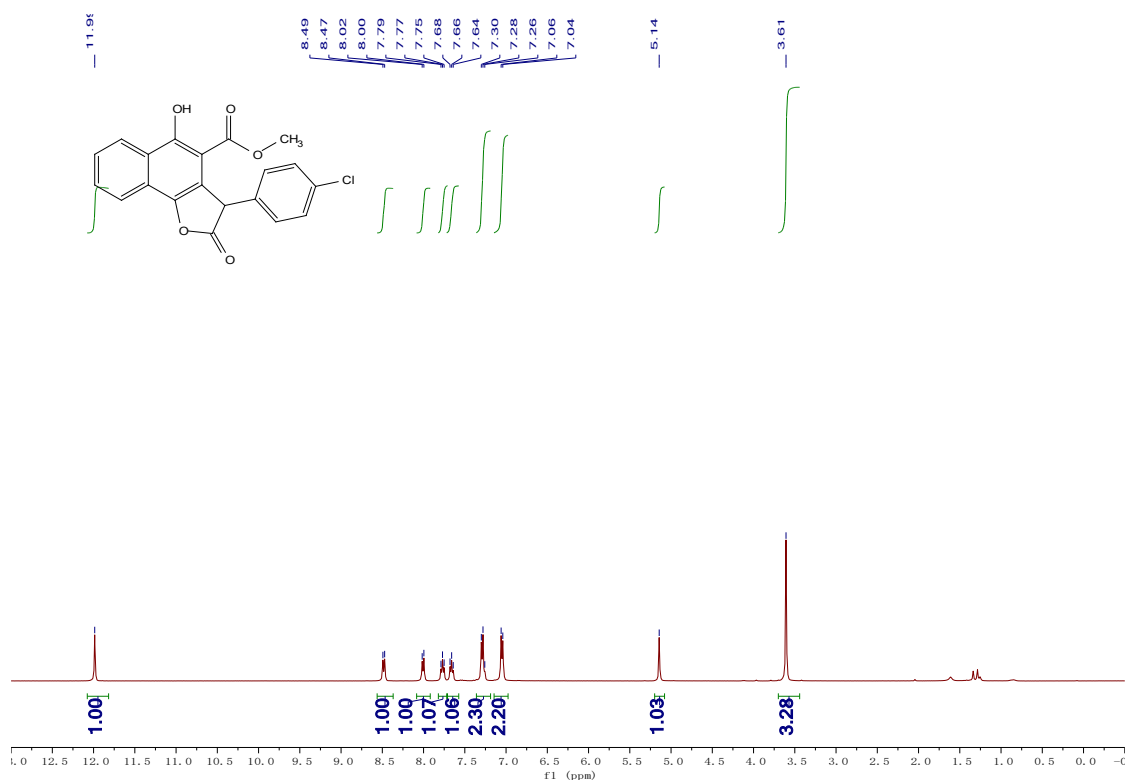
3-Biphenyl-4-yl-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3c**) (Using Chloroform-*d* as solvent)



3-(4-Fluoro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3d**) (Using Chloroform-*d* as solvent)

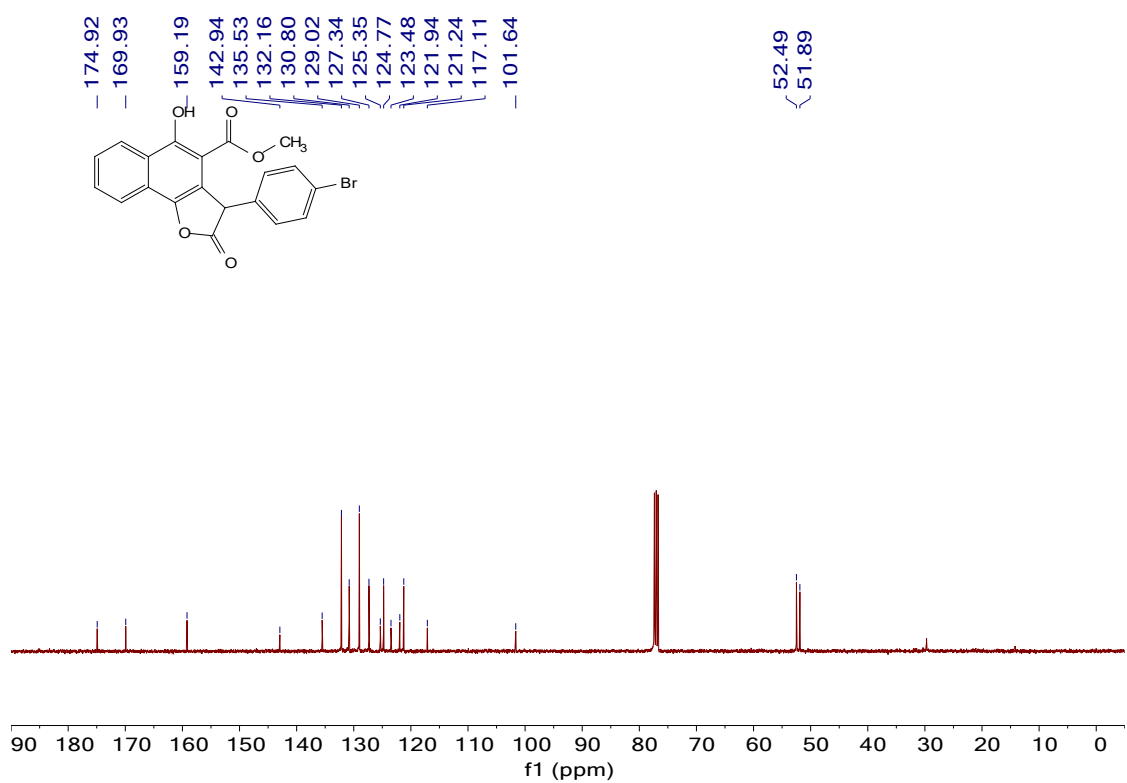
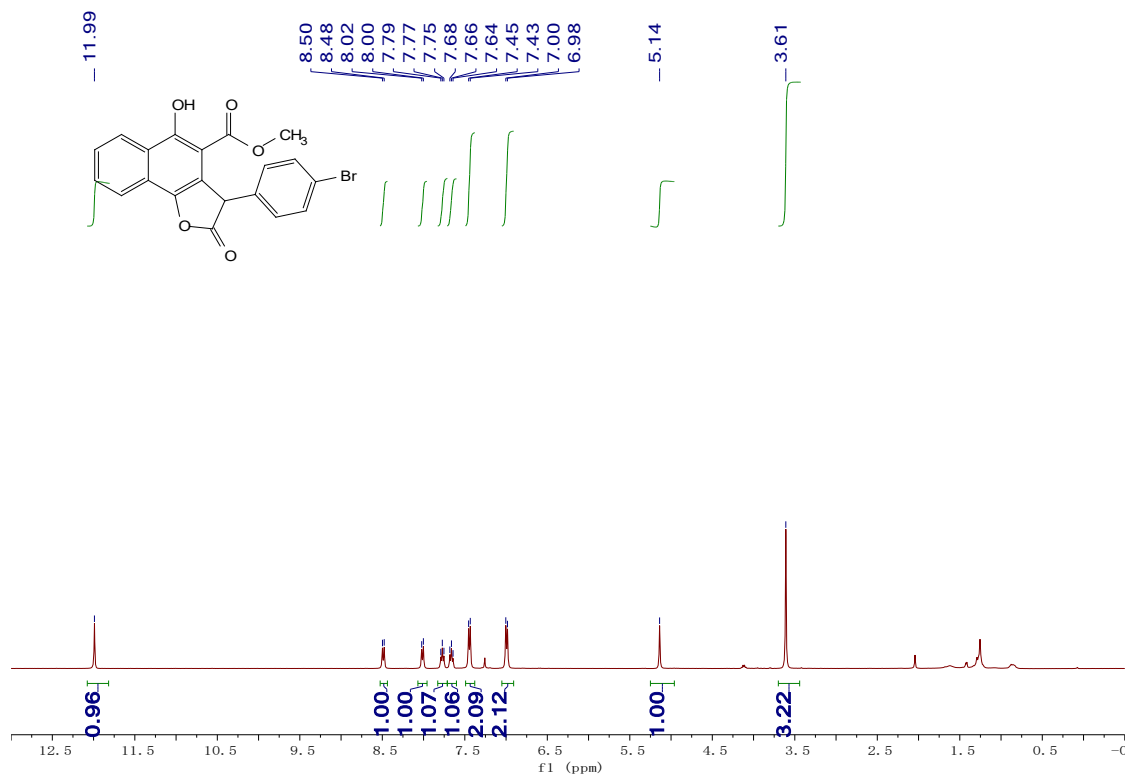


3-(4-Chloro-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (3e) (Using Chloroform-*d* as solvent)

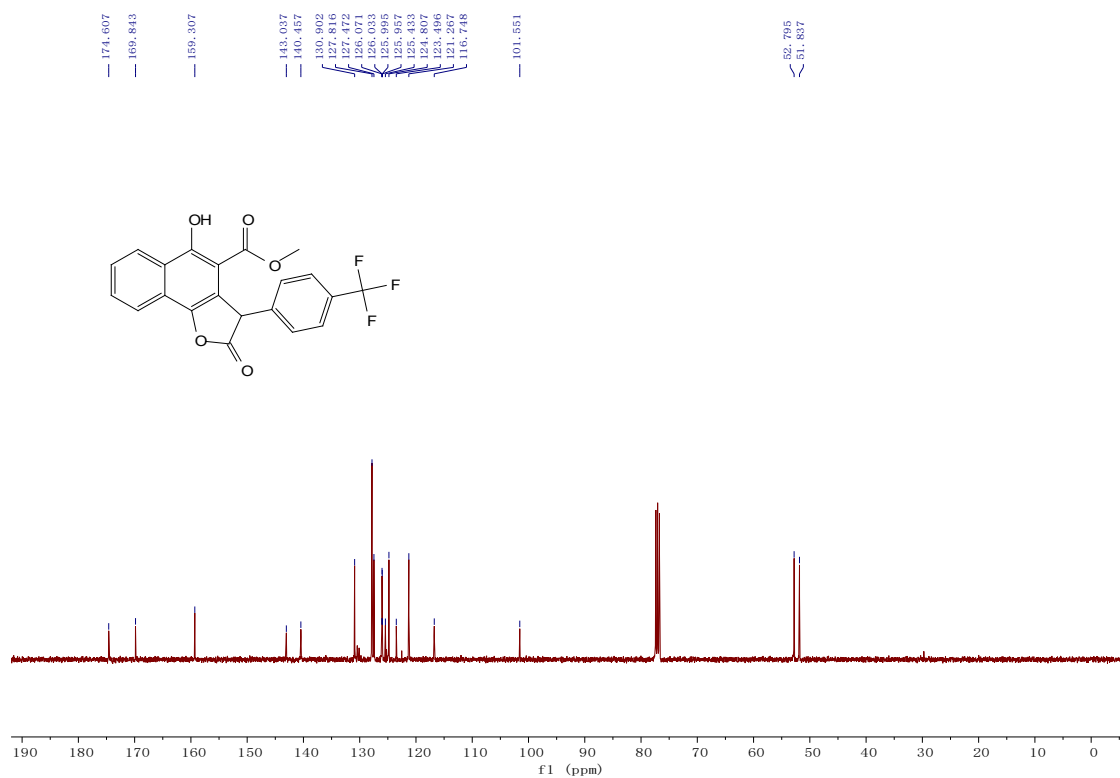
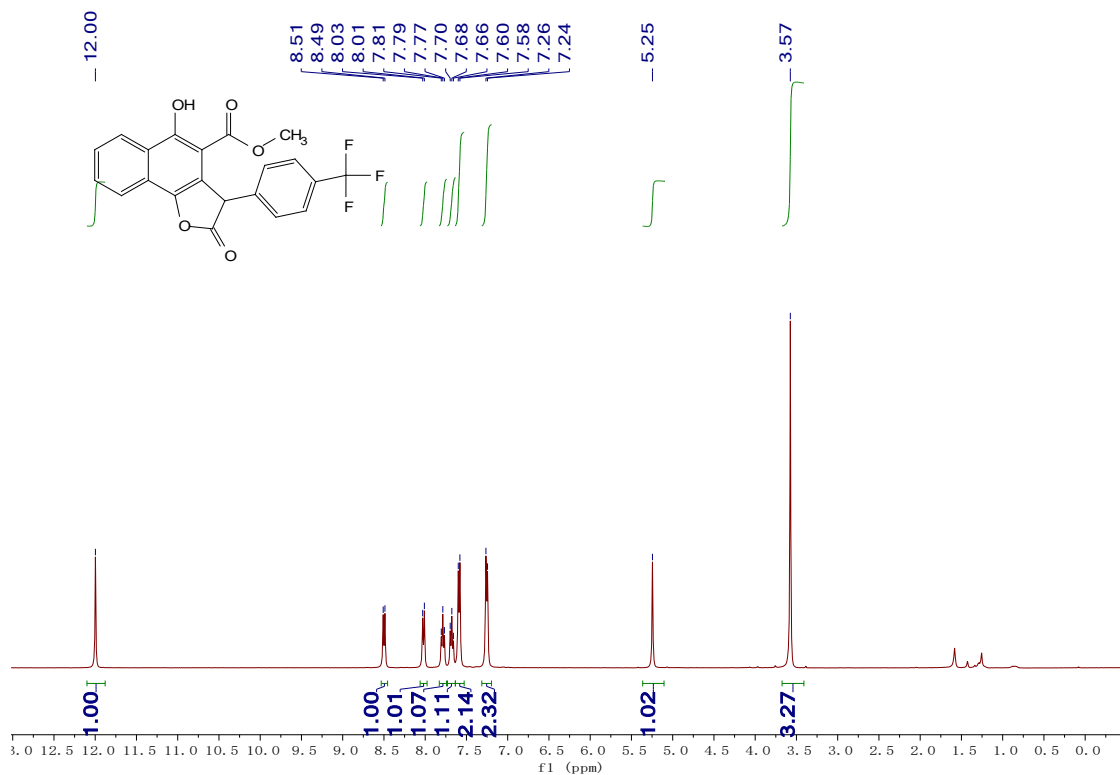




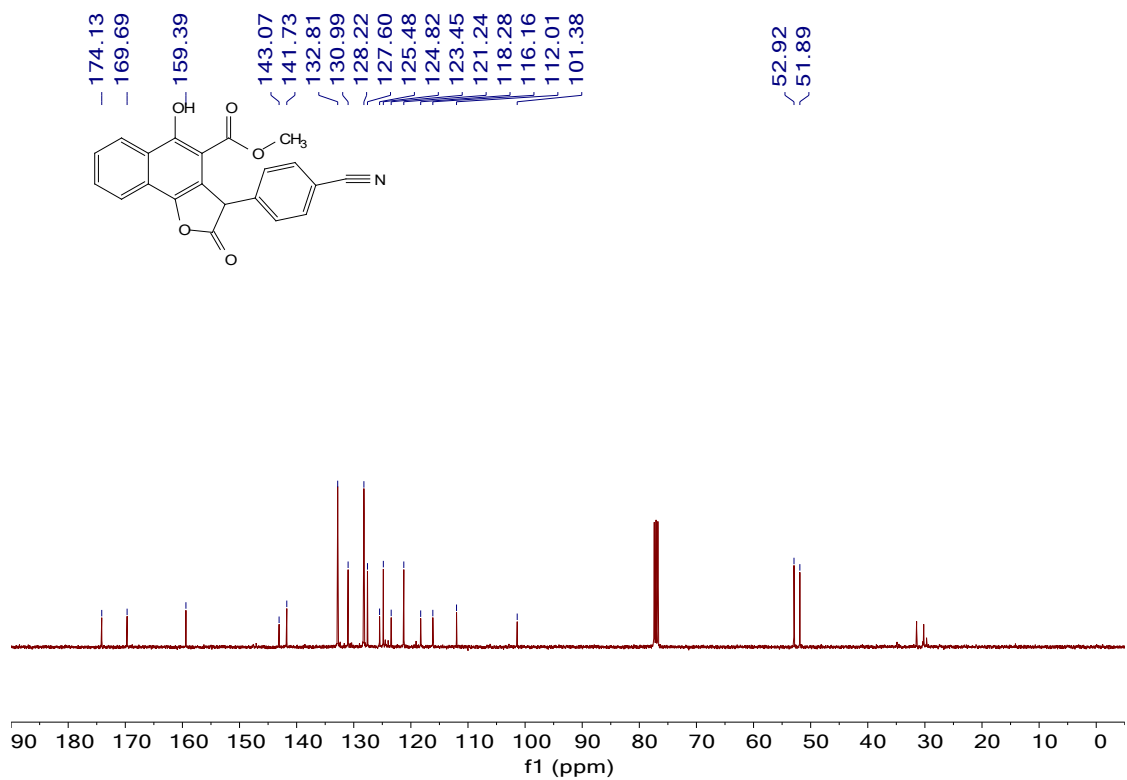
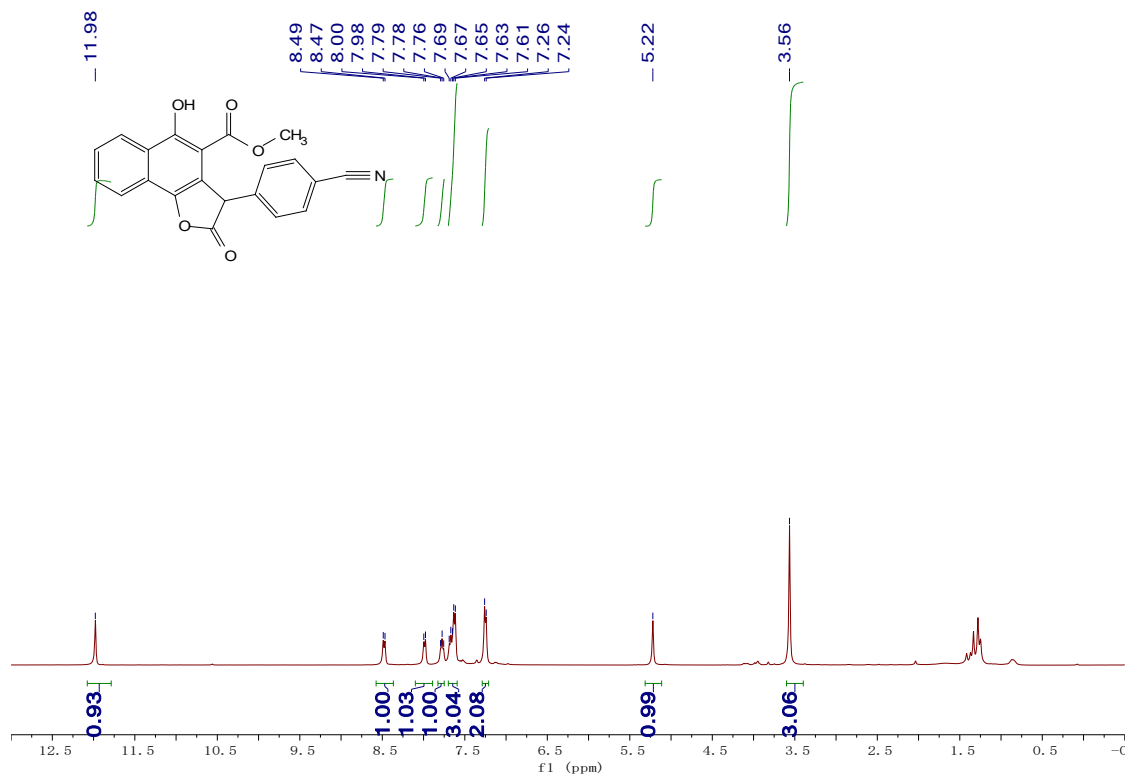
3-(4-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3f**) (Using Chloroform-*d* as solvent)



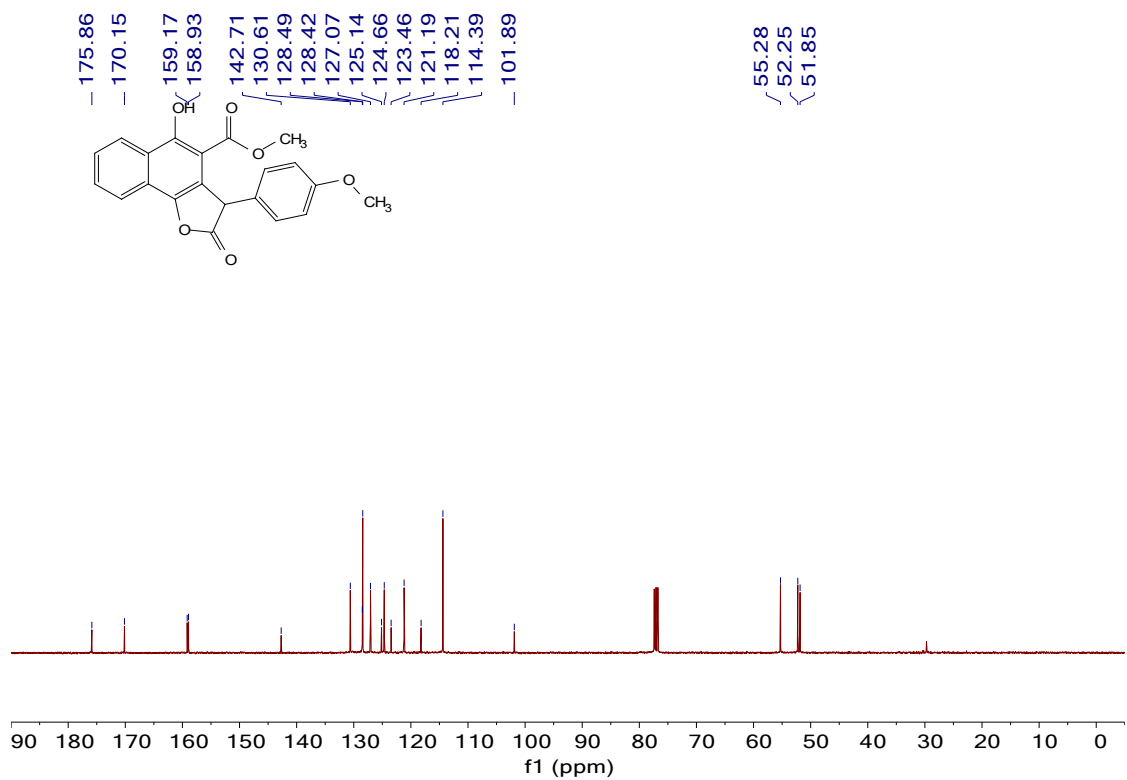
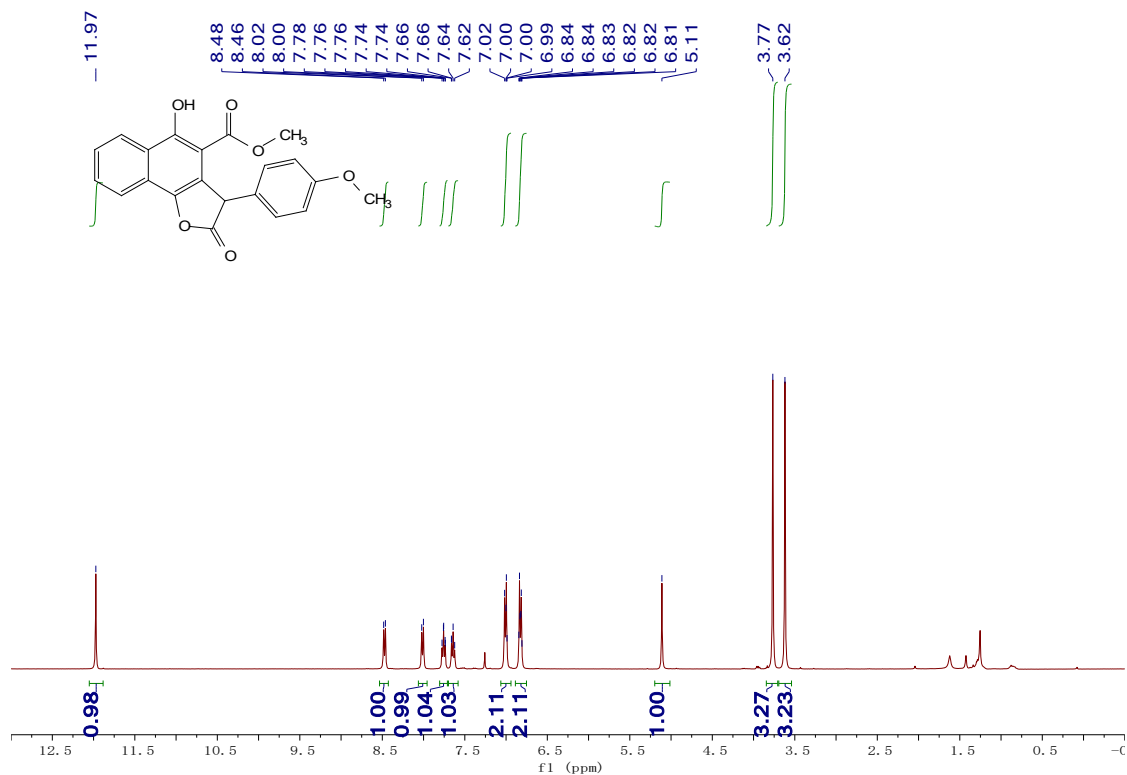
5-Hydroxy-2-oxo-3-(4-trifluoromethyl-phenyl)-2,3-dihydro-naphtho[1,2-b]furan (3g) (Using Chloroform-*d* as solvent)



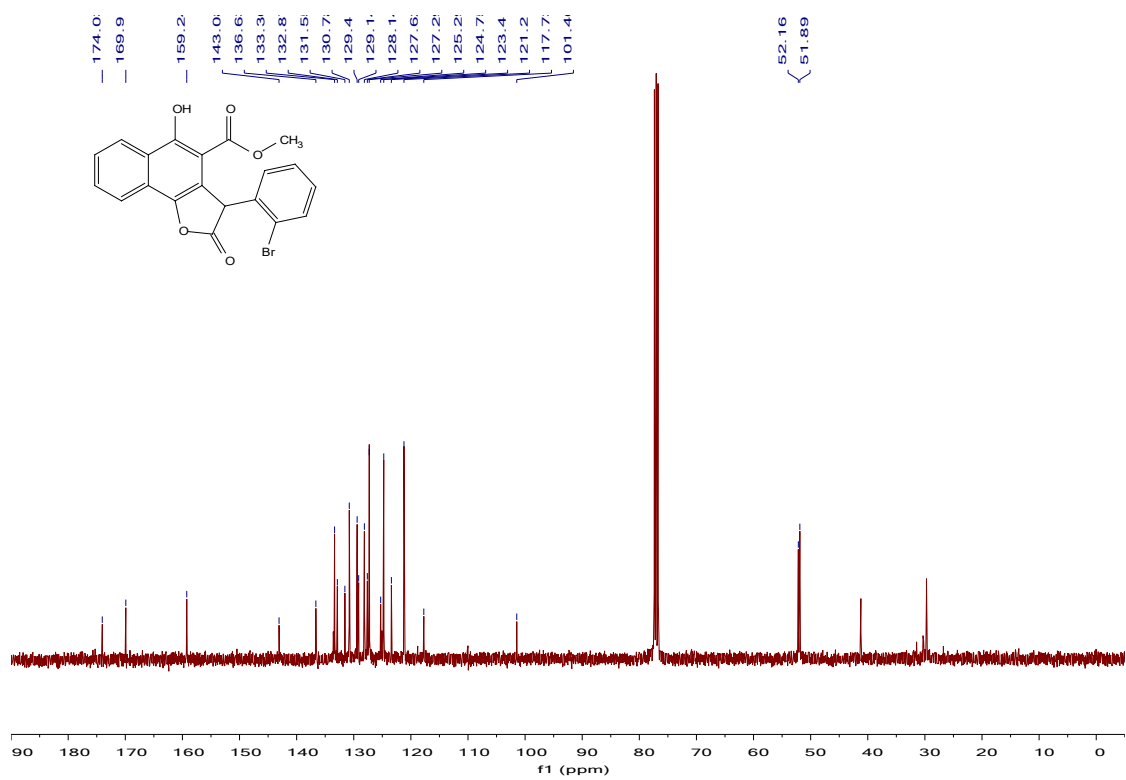
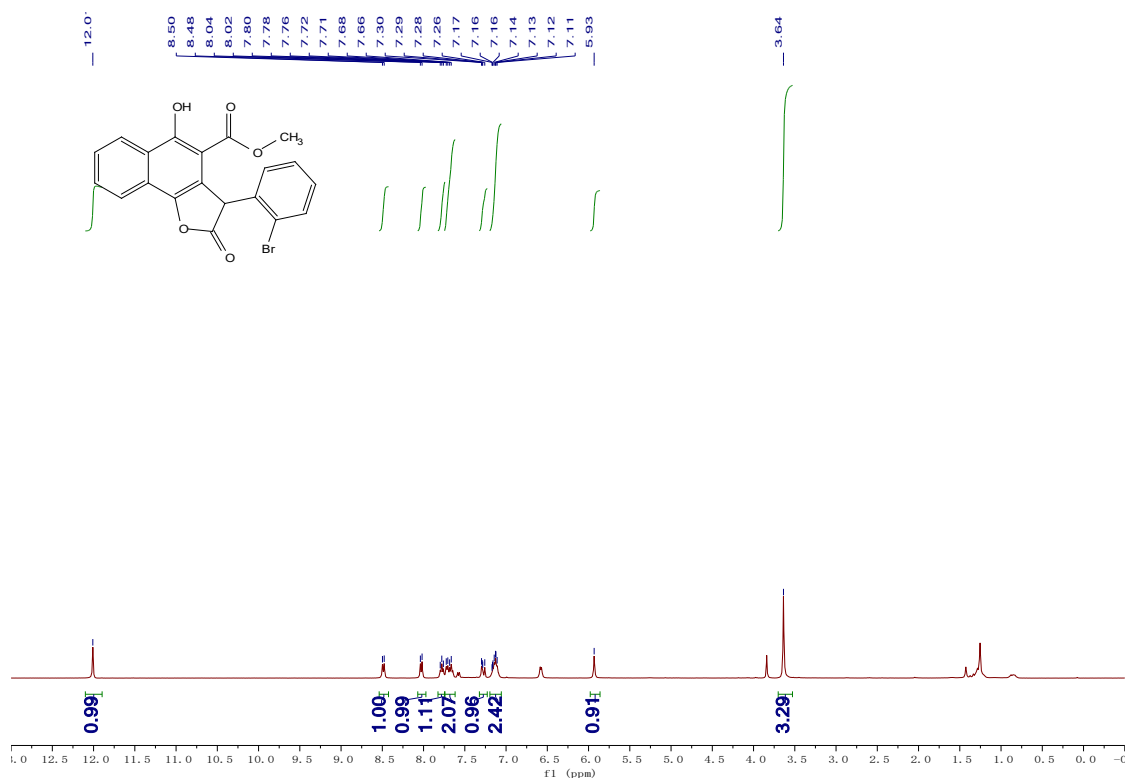
3-(4-Cyano-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3h**) (Using Chloroform-*d* as solvent)



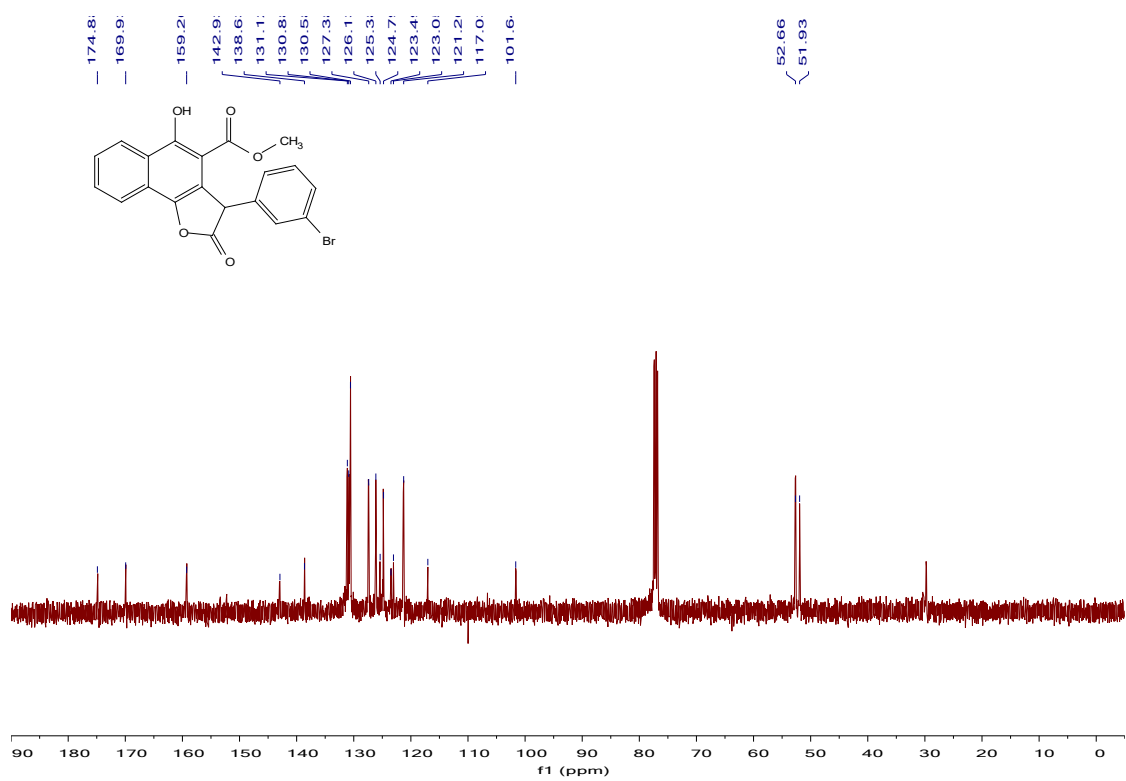
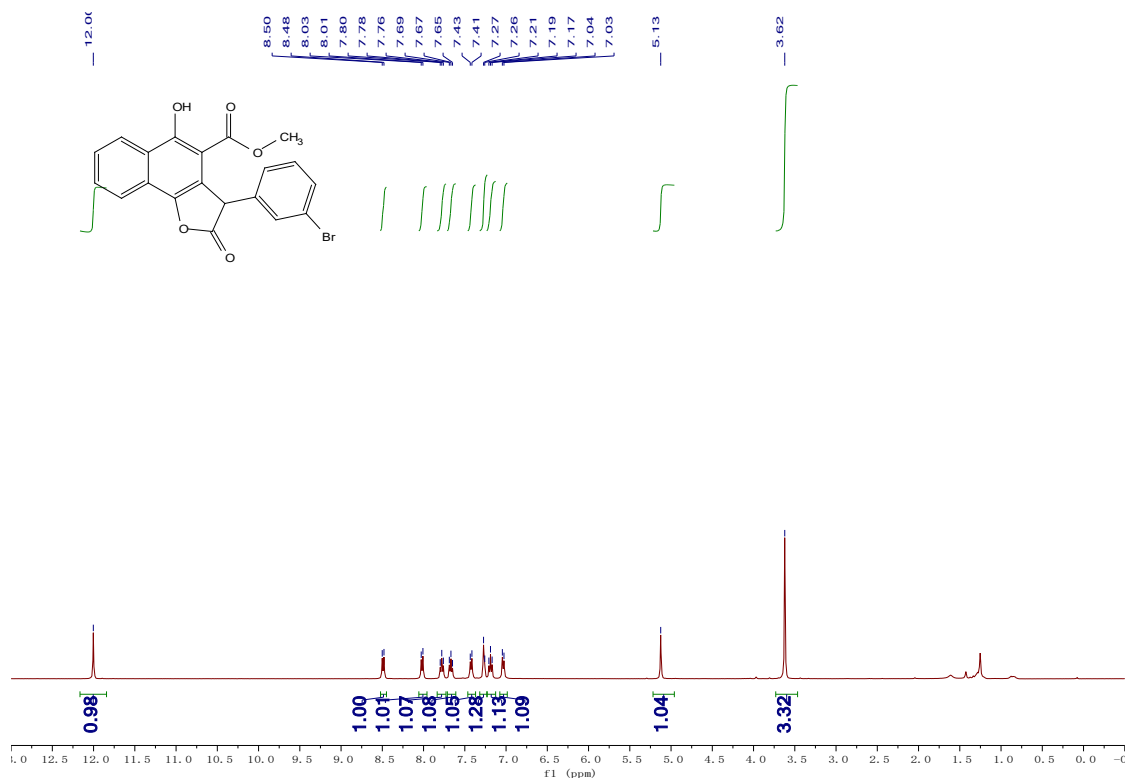
5-Hydroxy-3-(4-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (3i) (Using Chloroform-*d* as solvent)



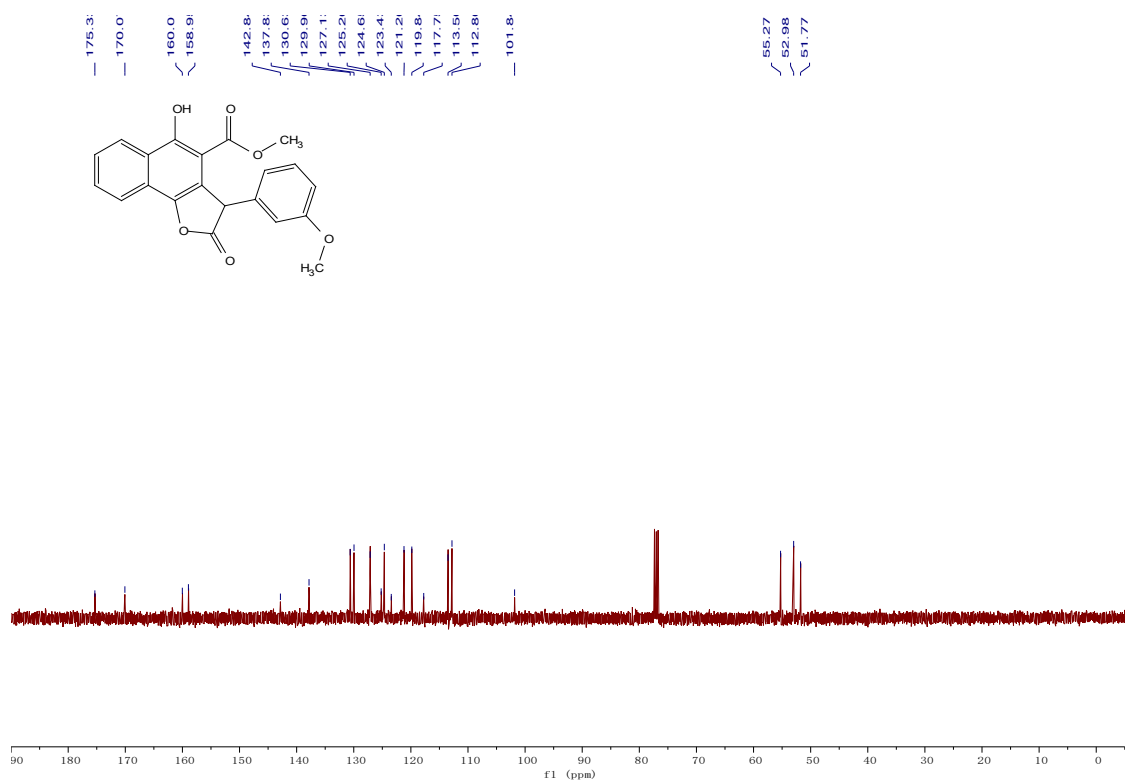
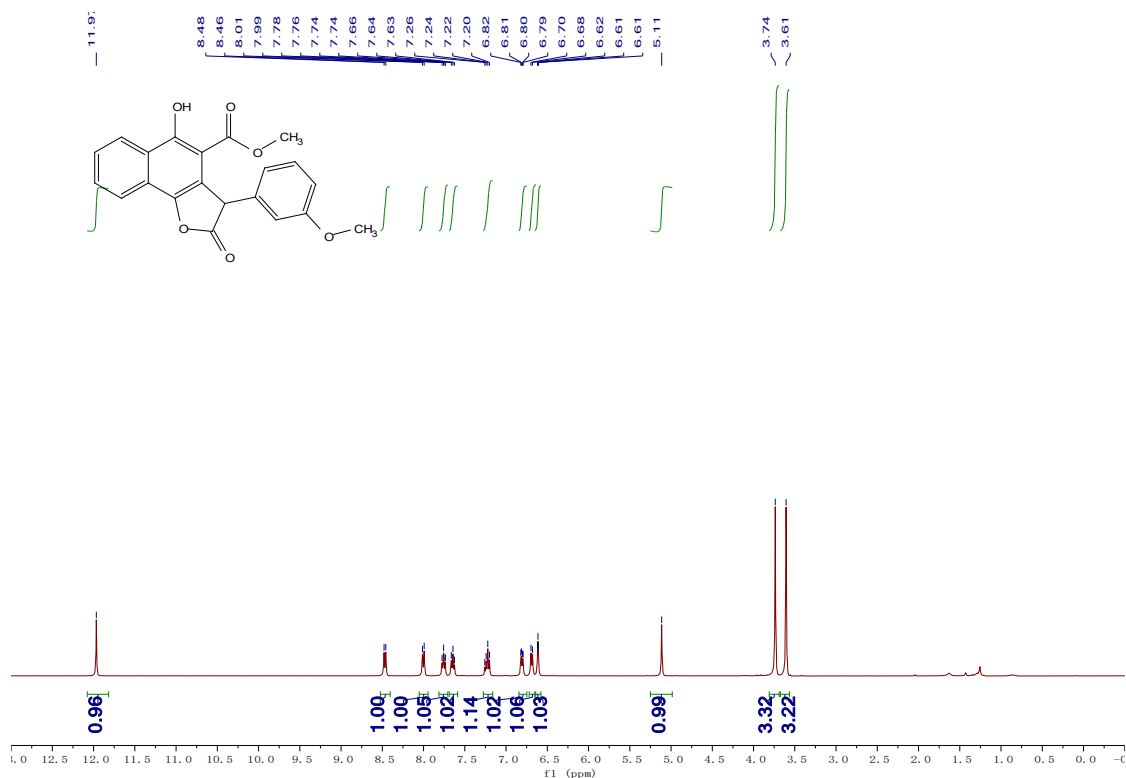
3-(2-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3j**) (Using Chloroform-*d* as solvent)



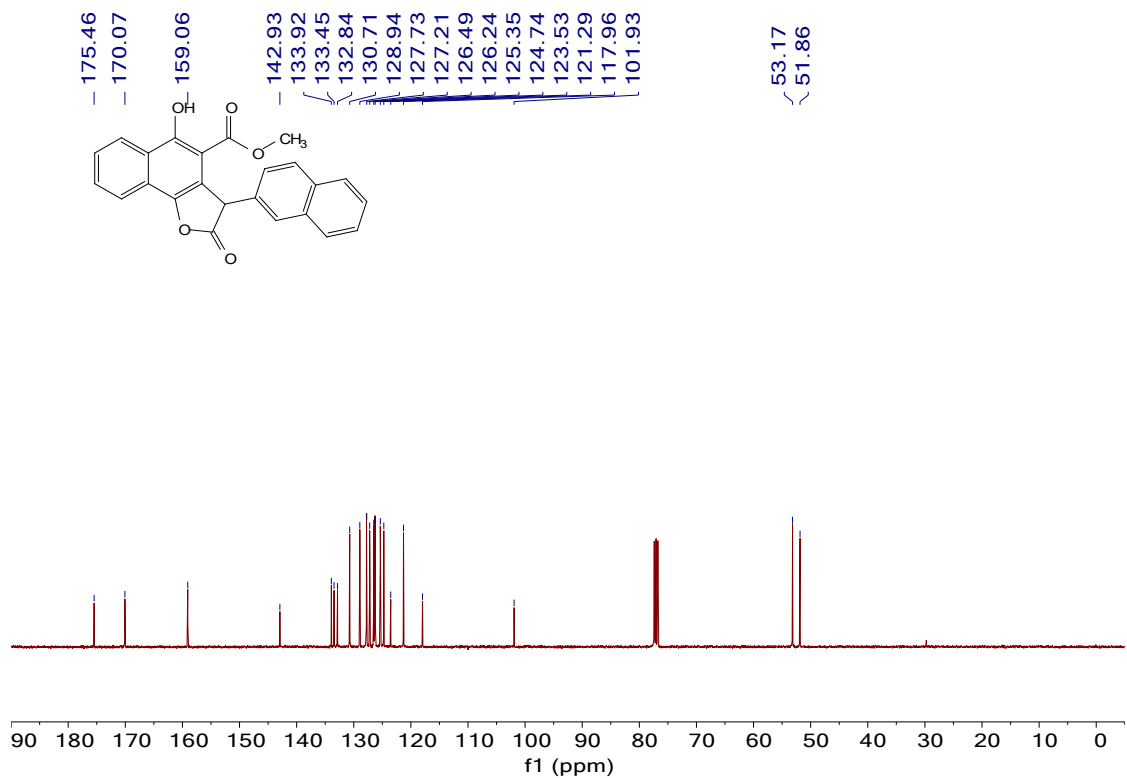
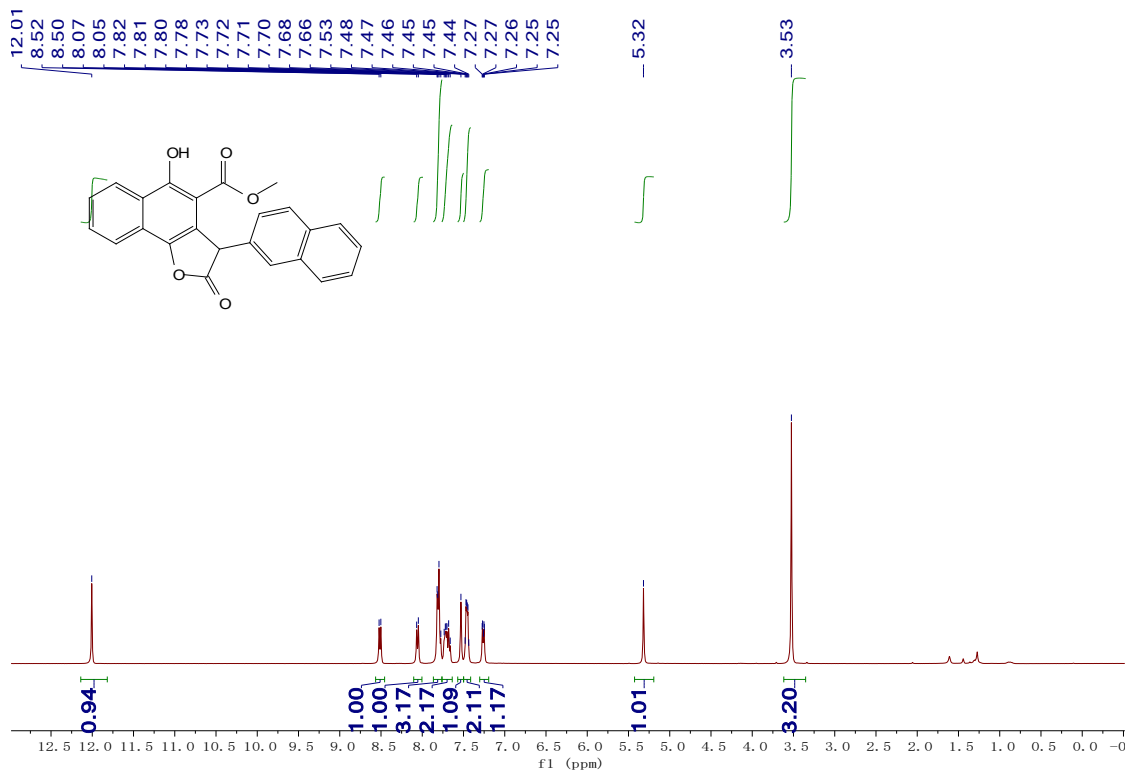
3-(3-Bromo-phenyl)-5-hydroxy-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3k**) (Using Chloroform-*d* as solvent)



5-Hydroxy-3-(3-methoxy-phenyl)-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (31) (Using Chloroform-*d* as solvent)

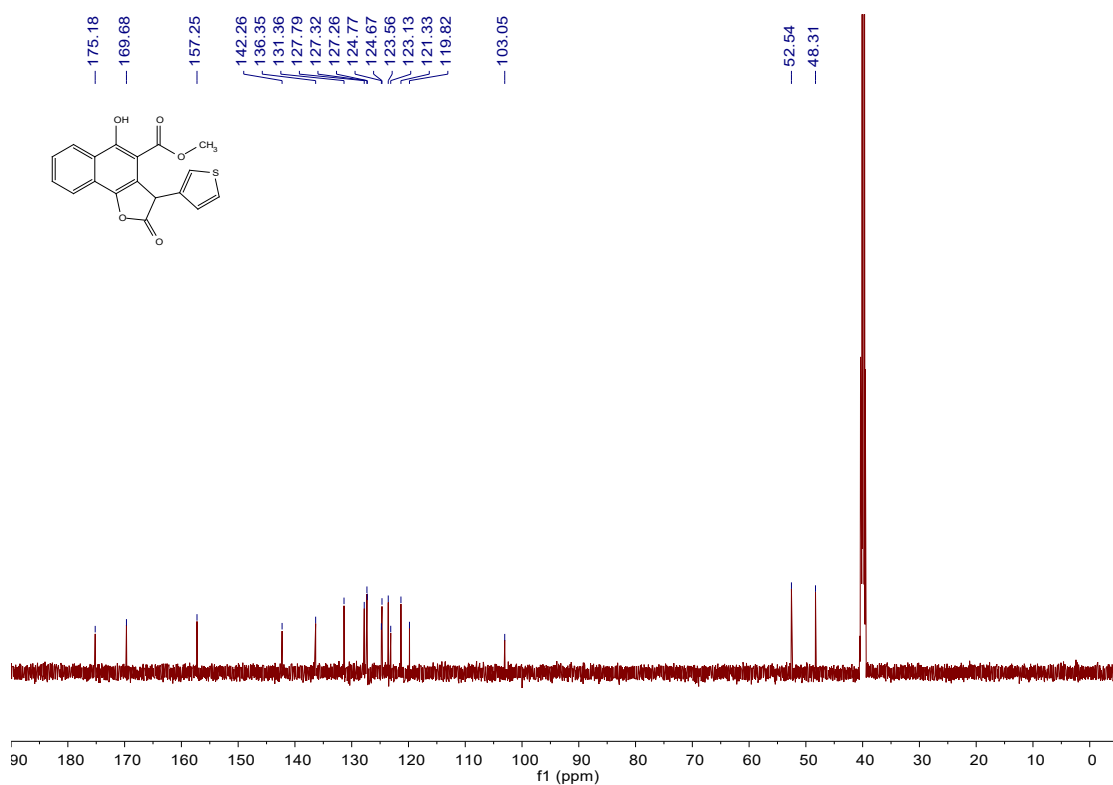
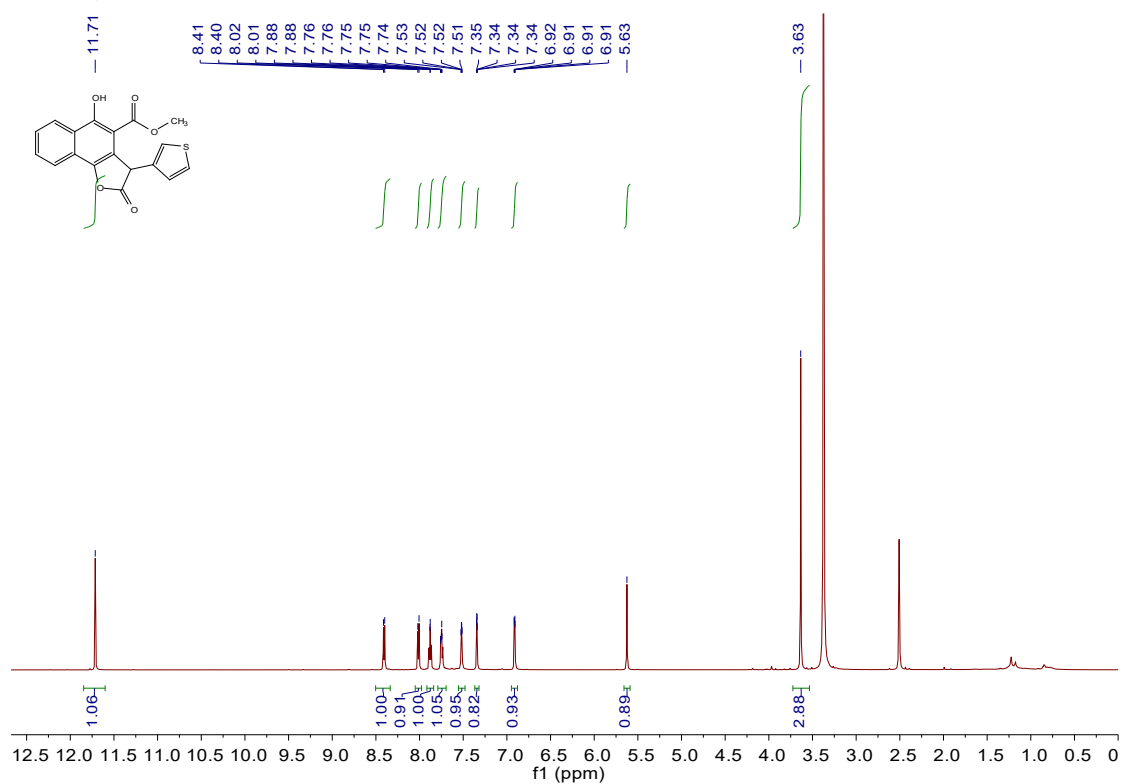


5-Hydroxy-3-naphthalen-2-yl-2-oxo-2,3-dihydro-naphtho[1,2-b]furan (**3m**) (Using Chloroform-*d* as solvent)



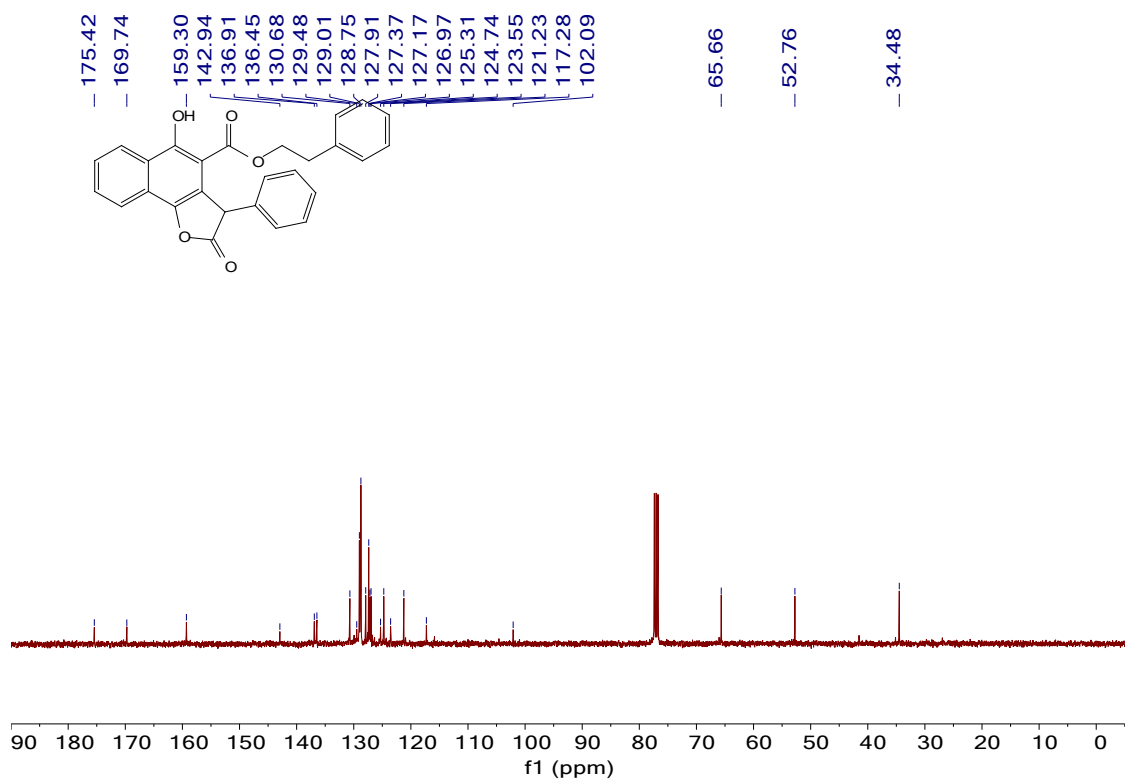
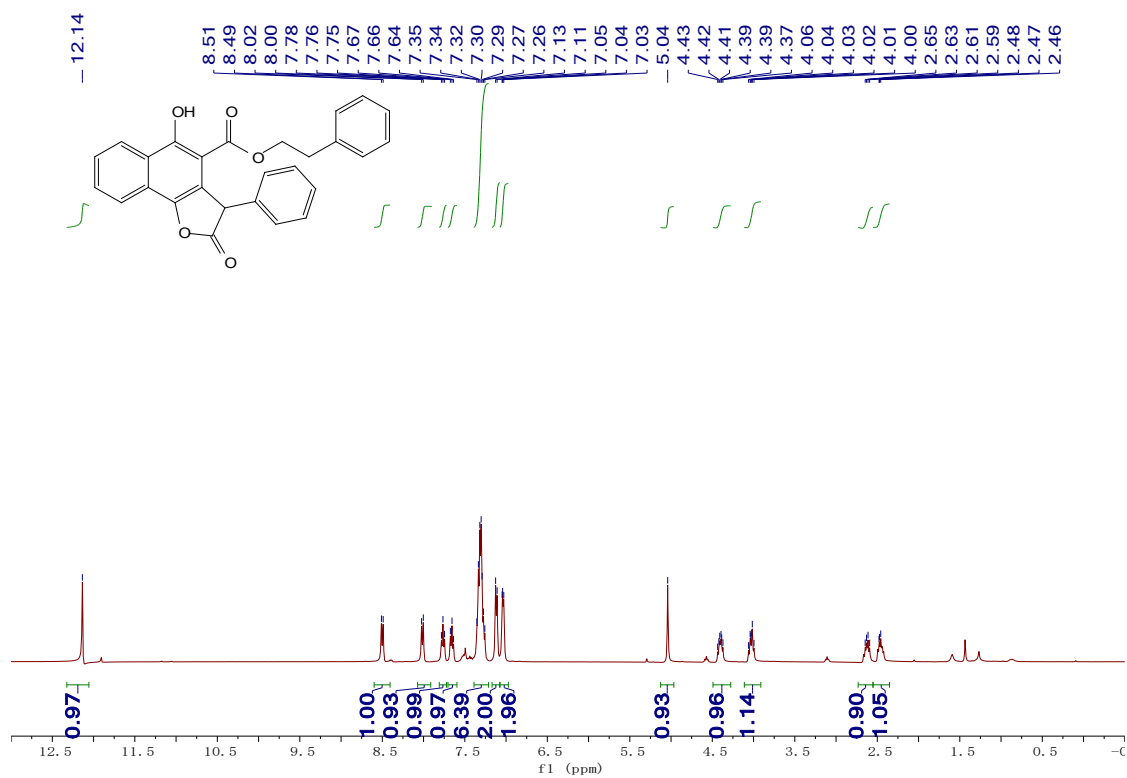


5-hydroxy-2-oxo-3-(thiophen-3-yl)-2,3-dihydrophtho[1,2-b]furan-4-carboxylate (**3n**) (Using Dimethylsulfoxide-*d* as solvent)

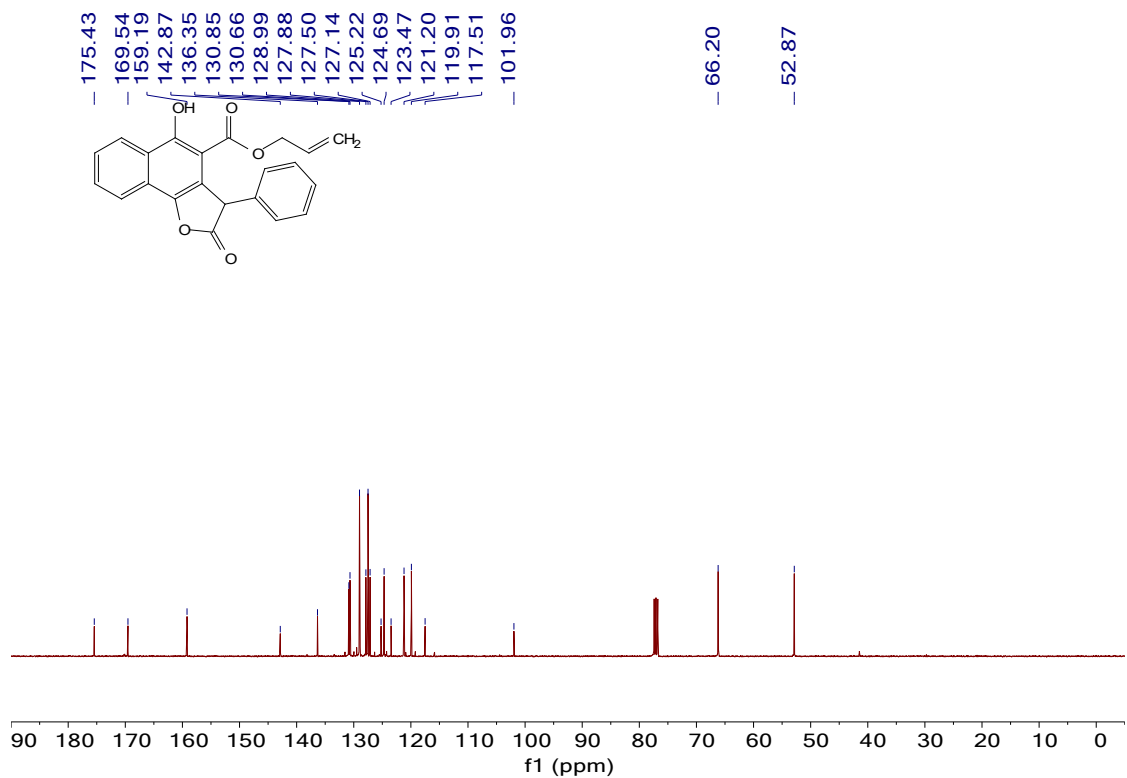
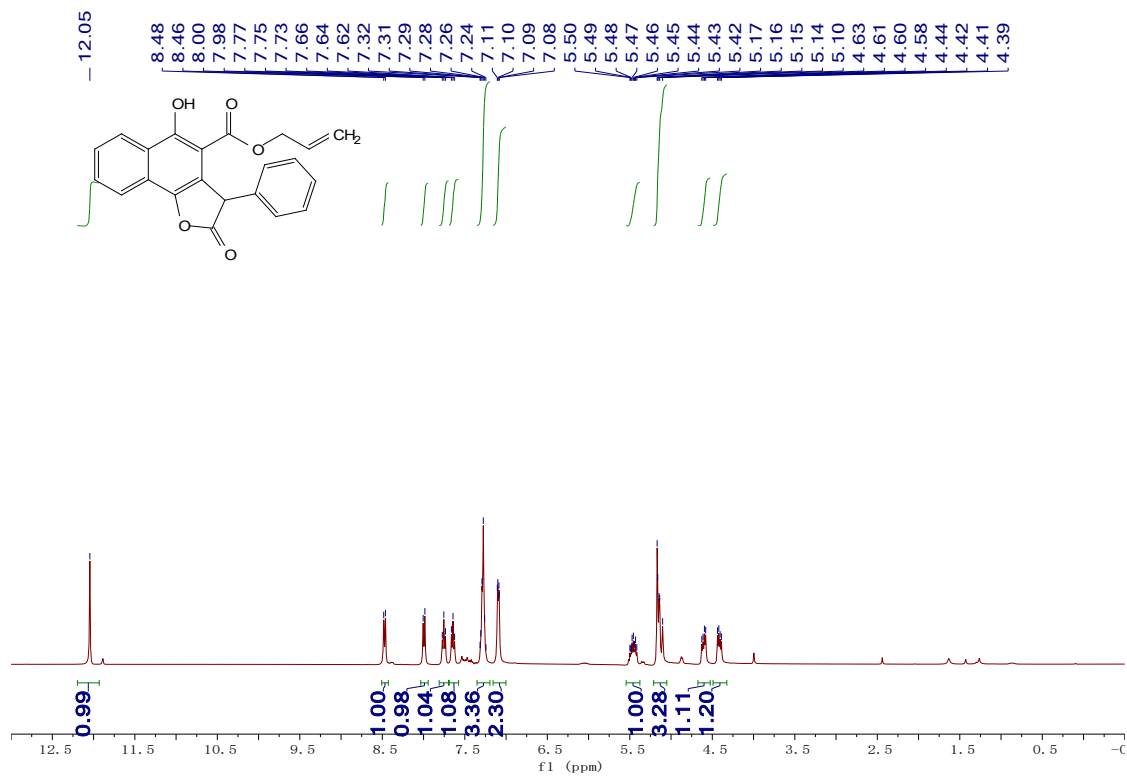


5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid phenethyl ester

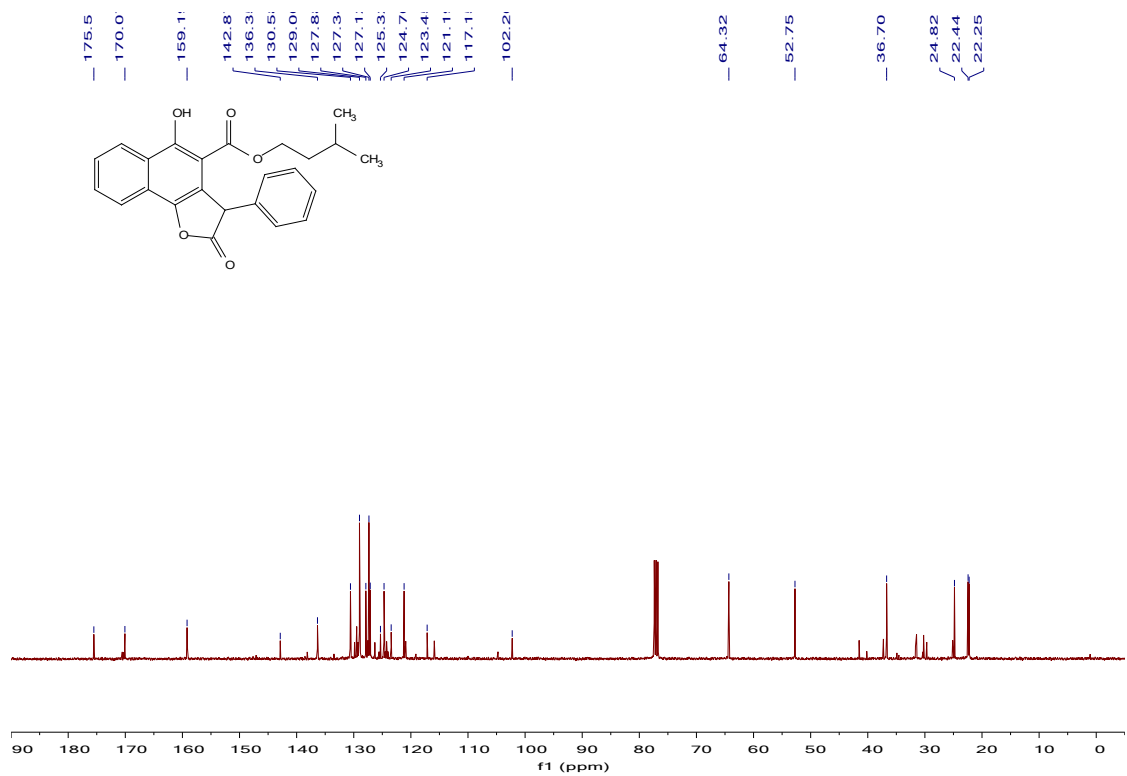
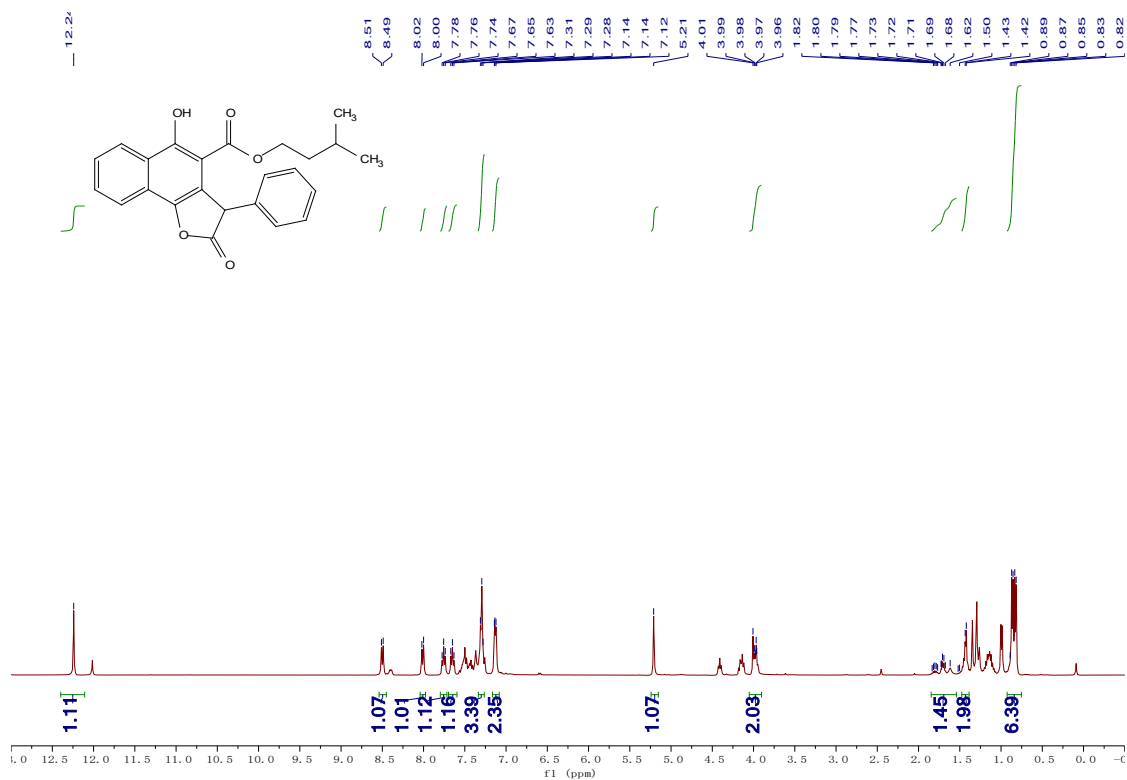
(30) (Using Chloroform-*d* as solvent)



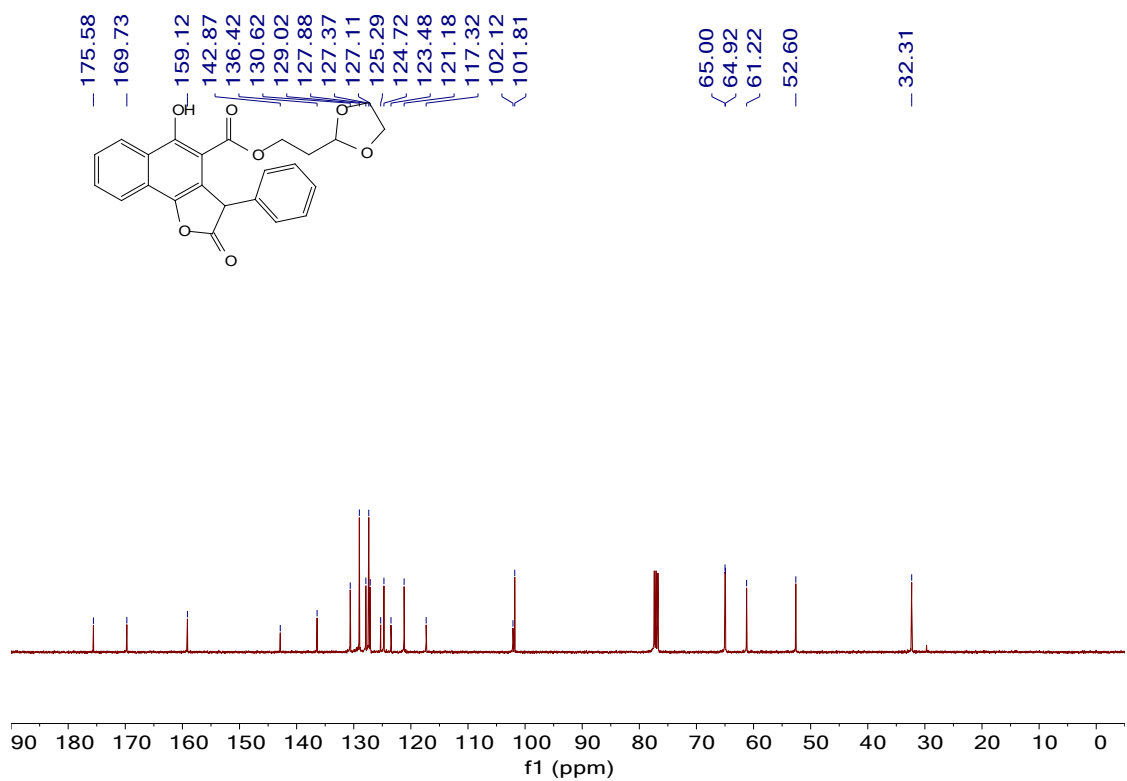
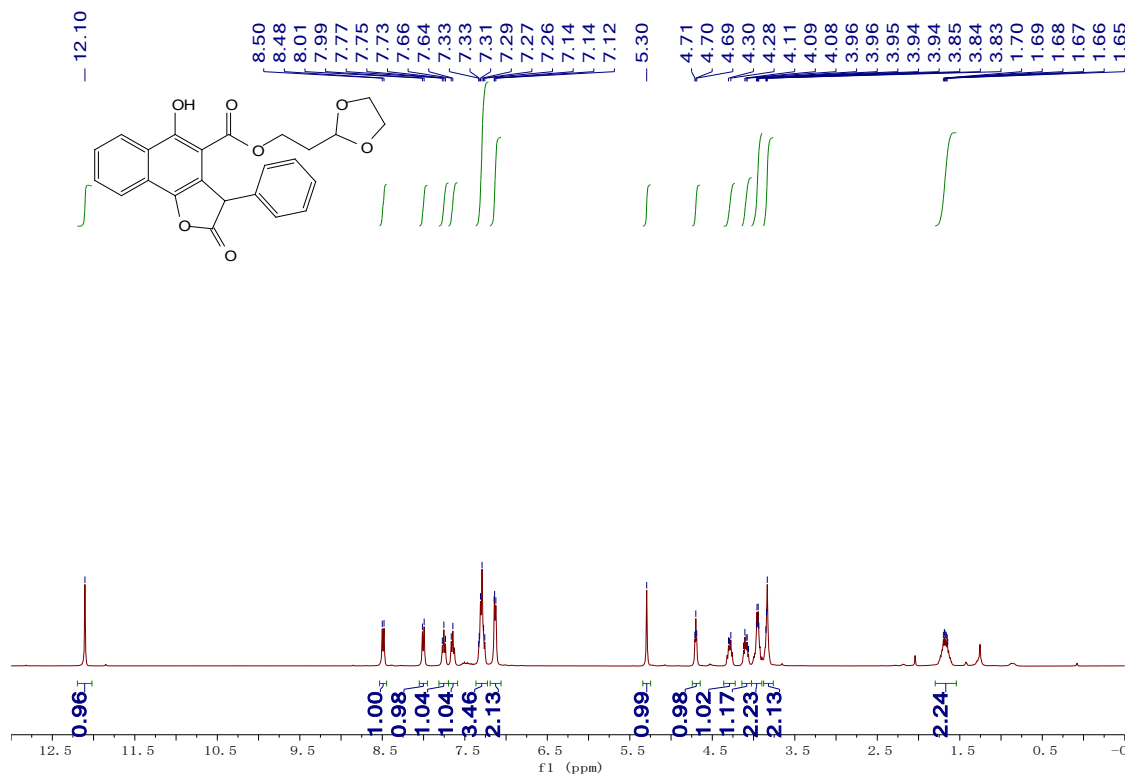
5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid allyl ester (**3p**)  
 (Using Chloroform-*d* as solvent)



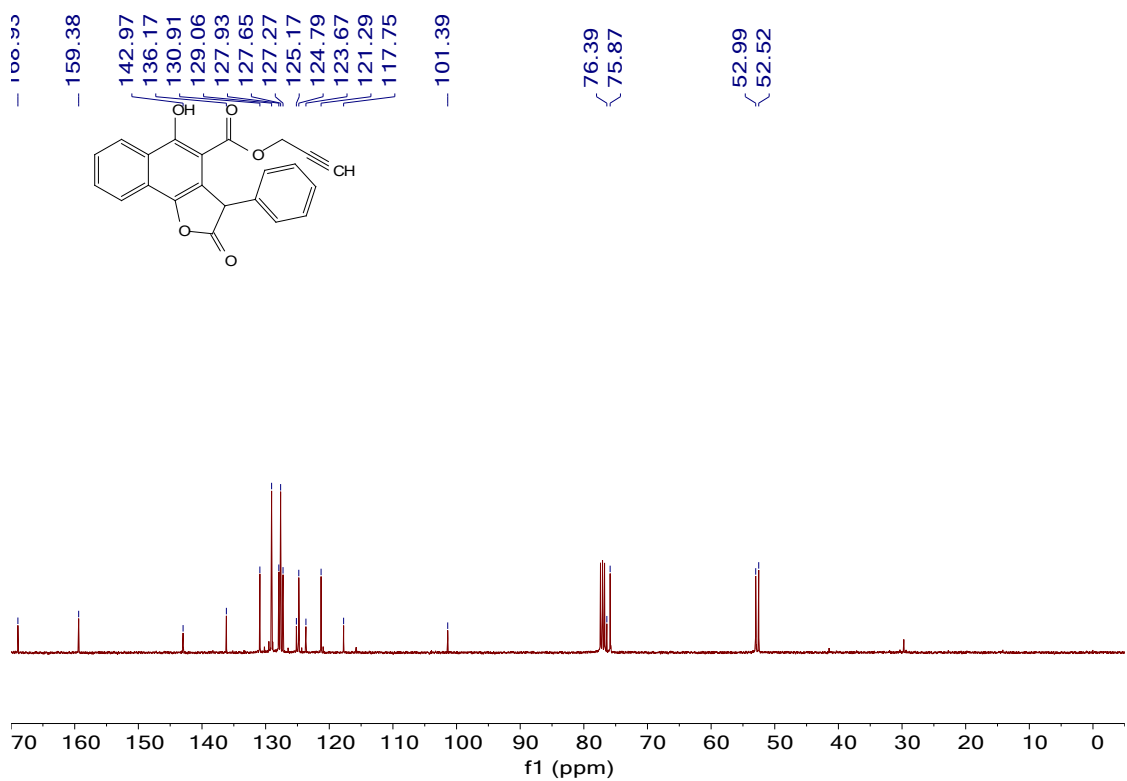
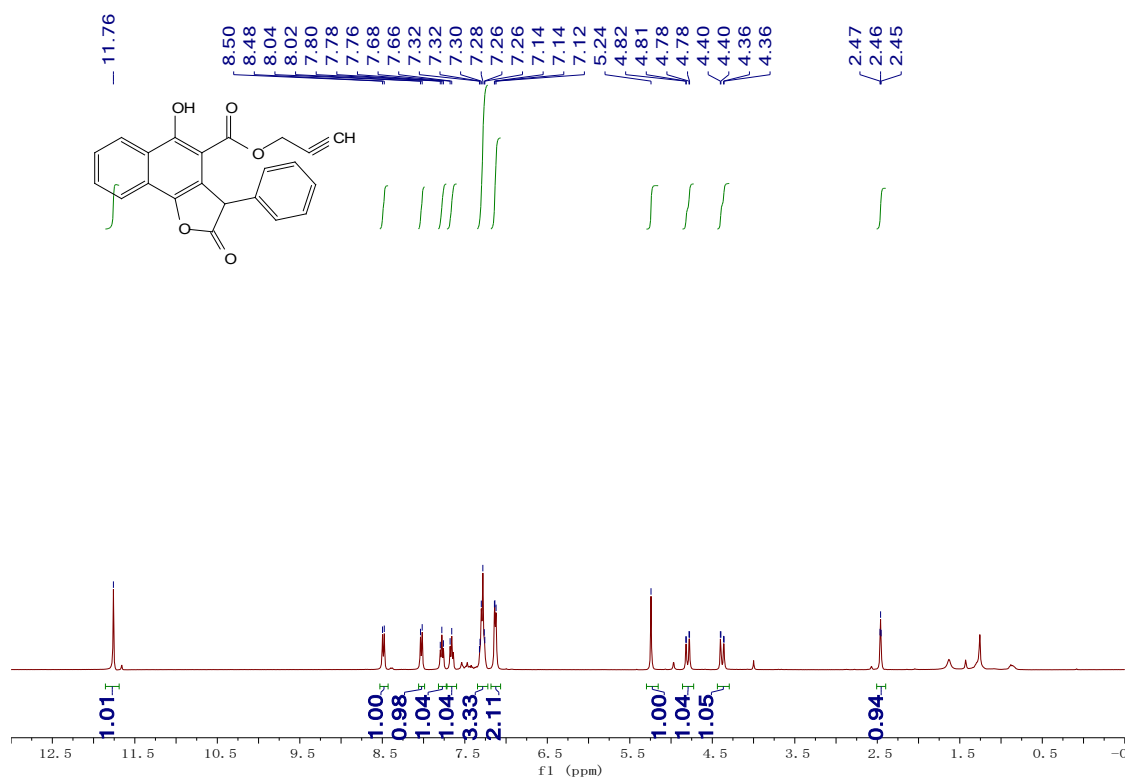
5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 3-methyl-butyl ester (**3q**) (Using Chloroform-*d* as solvent)



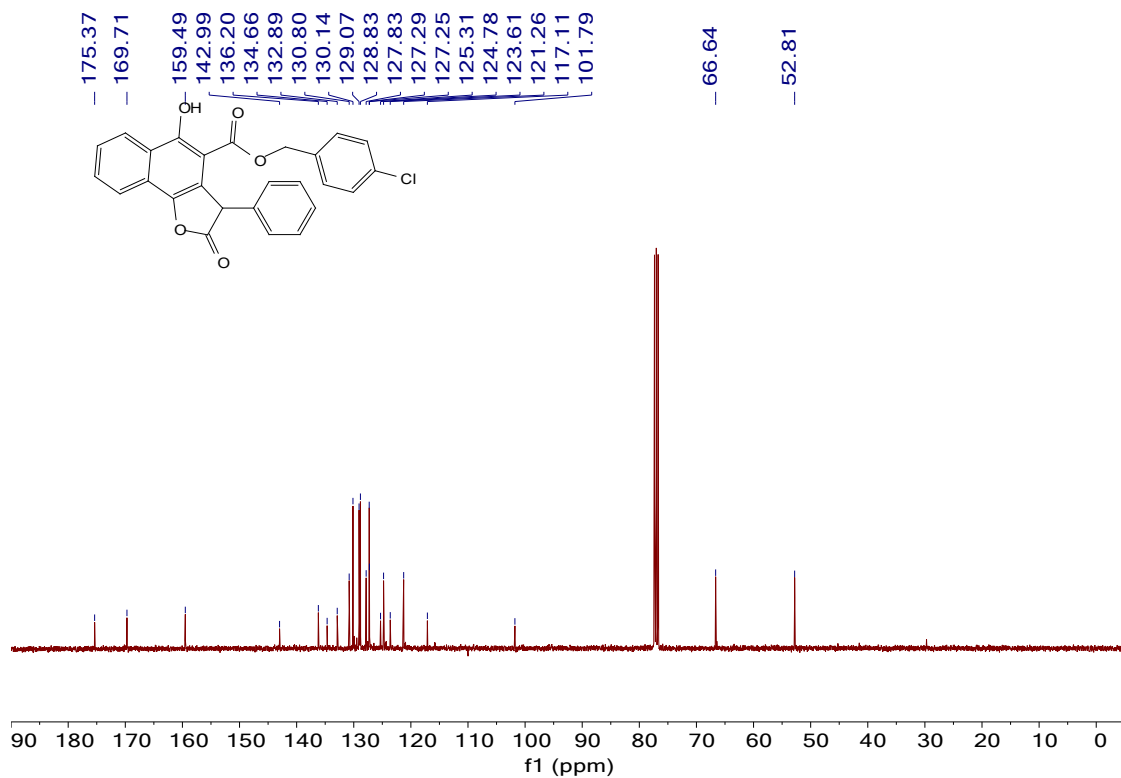
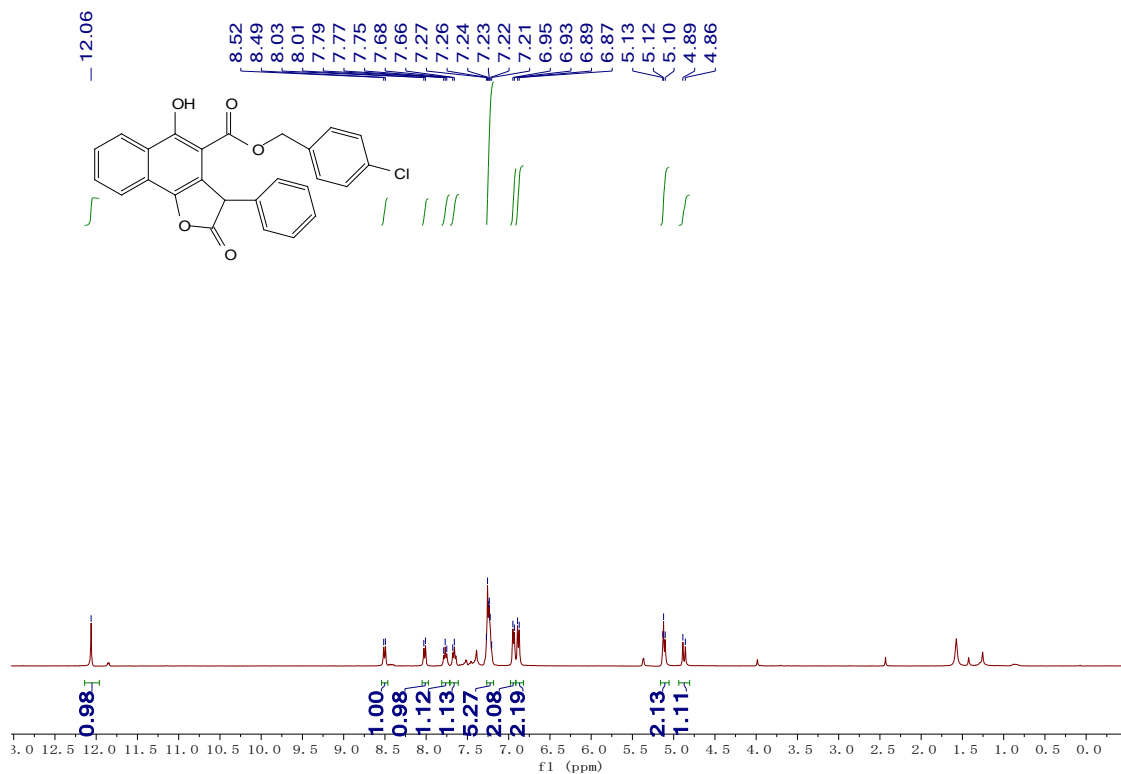
5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 2-[1,3]dioxolan-2-yl-ethyl ester (**3r**) (Using Chloroform-*d* as solvent)



5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid prop-2-ynyl ester  
**(3s)** (Using Chloroform-*d* as solvent)



5-Hydroxy-2-oxo-3-phenyl-2,3-dihydro-naphtho[1,2-b]furan-4-carboxylic acid 4-chloro-benzyl ester (**3t**) (Using Chloroform-*d* as solvent)



5-hydroxy-2-oxo-2-(thiophen-3-yl)-2,3-dihydronaphtho[1,2-b]furan-4-carboxylate (3u) (Using Chloroform-d as solvent)

