

**Supporting Information  
for  
Multicomponent synthesis of spiropyrrolidine analogues derived  
from vinylindole/indazole by a 1,3-dipolar cycloaddition reaction**

Manjunatha Narayananarao<sup>1</sup>, Lokesh Koodlur<sup>2</sup>, Vijayakumar G. Revanasiddappa<sup>3</sup>, Subramanya Gopal<sup>2</sup>, Susmita Kamila<sup>\*1</sup>

Address: <sup>1</sup>East Point College of Engineering and Technology, Visvesvaraya Technological University, Aavalahalli, Bangalore-560 049, India, <sup>2</sup>Department of Studies and Research in Chemistry, Vijayanagara Sri Krishnadevaraya University, Bellary-583105, India and <sup>3</sup>Department of Chemistry, University College of Science, Tumkur University, BH Road, Tumakuru-572103 India

Email: Susmita Kamila - sushkam@yahoo.co.in

\*Corresponding author

**Experimental and characterization data of all new compounds**

## **General Information**

All reagents and solvents were pure and analytical grade purchased from commercial sources and were used without further purification, if not stated otherwise. Melting points were measured using Buchi B-540 apparatus and were uncorrected.  $^1\text{H}$ -NMR and  $^{13}\text{C}$  NMR spectra were recorded on Bruker DPX 400 MHz FT-NMR spectrometer. Chemical shifts were expressed in  $\delta$  (ppm) units relative to tetramethylsilane (TMS) signal as internal reference. Mass spectra were recorded on ESQUIRE 3000 Mass Spectrometer. Column chromatography was performed on silica gel (60–120 mesh) using ethyl acetate and hexane as eluent. All reactions were carried out in an over-dried Schlenk tube equipped with a magnetic stir bar under N<sub>2</sub> atmosphere.

## *Analytical data for compounds 2a–k*

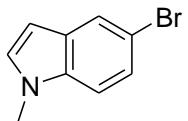
### **5-Bromo N-alkyl indole and indazole derivatives 2; General Procedure [1-4]**

NaH (6.1 mmol, 1.2 equiv) was slowly added to a solution of 5-bromoindole/indazole (5.1 mmol, 1 equiv) in DMF (10 mL) at 0 °C. The mixture was stirred at 0 °C for 10 min then the alkyl halide (6.1 mmol, 1.2 equiv) was added at the same temperature. The reaction mixture was continued to stir at rt for 2 h. When the reaction was complete [TLC (EtOAc/hexane 1:5)], the mixture was extracted with EtOAc (2 × 20 mL) and washed with water (2 × 20 mL). The organic layer was separated, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub> and the solvent removed under reduced pressure. The residue obtained was purified by flash column chromatography [silica gel (230–400 mesh; Merck), EtOAc/hexane 1:5].

### **5-Bromo-N-acetylindole or indazole derivatives 2c, 2g; General Procedure [5-6]**

Triethylamine (3.8 mmol, 1.5 equiv), acetic anhydride (9.6 mmol, 3.8 equiv) and DMAP (0.5 mmol, 0.2 equiv) were added at rt to a solution of 5-bromo-1*H*-indole (2.5 mmol, 1 equiv) in 1,2 dichloroethane (10 mL). The solution was heated to 60 °C for 8 h. When the reaction was complete [TLC (EtOAc/hexane 2:5)], the mixture was extracted with EtOAc (2 × 20 mL) and washed with water (2 × 20 mL). The organic layer was separated, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>, filtered and the solvent removed under reduced pressure. The residue was purified by flash column chromatography [silica gel (230–400 mesh; Merck), EtOAc/hexane 2:5].

**5-Bromo-1-methyl-1*H*-indole (2a) [1]**



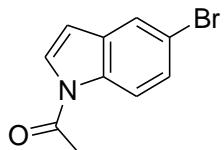
Colorless viscous liquid; yield 0.150g (0.71 mmol, 81%).  $^1\text{H}$  NMR (300 MHz, DMSO-d6):  $\delta$  = 7.73 (1 H, d,  $^3J$  = 1.80 Hz, CH), 7.37-7.43 (2 H, m, 2 CH), 7.23-7.27 (1 H, m, CH), 6.41 (1 H, d,  $^3J$  = 3.00 Hz, 1H), 3.78 (3 H, s, Me). LCMS:  $m/z$  (%) = 210.0 [M+1]. Anal. Calcd for  $\text{C}_9\text{H}_8\text{BrN}$  (208.98): C, 51.46; H, 3.84; Br, 38.04; N, 6.67. Found: C, 51.52; H, 3.89; Br, 38.15; N, 6.70.

**5-Bromo-1-isobutyl-1*H*-indole (2b) [2]**



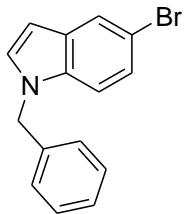
Colorless viscous liquid; yield 0.18g (0.71 mmol, 80%).  $^1\text{H}$  NMR(400 MHz, DMSO-d6 ):  $\delta$  = 7.72 (d,  $^3J$  = 2.40 Hz, 1 H), 7.40-7.49 (m, 2 H), 7.22 (dd,  $^3J$  = 14.40, Hz, 1 H), 7.42 (d,  $^3J$  = 4.00 Hz, 1 H), 3.98 (d,  $^3J$  = 9.60 Hz, 2 H), 2.05-2.14 (m, 1 H), 0.82 (dd,  $^3J$  = 8.80, Hz, 6 H). LCMS:  $m/z$  (%) = 252.2 [M+1]. Anal. Calcd for  $\text{C}_{12}\text{H}_{14}\text{BrN}$  (251.03): C, 57.16; H, 5.60; Br, 31.69; N, 5.55. Found: C, 57.25; H, 5.63; Br, 31.70, N, 5.59.

**1-(5-Bromo-1*H*-indol-1-yl)ethanone (2c) [5]**



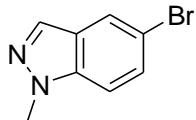
Off white solid; yield 0.22g (0.92 mmol, 66%).  $^1\text{H}$  NMR(400 MHz, DMSO-d6 ):  $\delta$  = 8.27 (1 H, d,  $^3J$  = 8.80 Hz, CH), 7.92 (1 H, d,  $^3J$  = 3.60 Hz, CH), 7.84 (1 H, d,  $^3J$  = 1.60 Hz, CH), 7.46 (1 H, m,  $^3J$  = 10.80 Hz, CH), 6.73 (1 H, d,  $^3J$  = 4.40 Hz, CH), 2.65 (3 H, s, Me). LCMS:  $m/z$  (%) = 240.1 [M+1]. Anal. Calcd for  $\text{C}_{10}\text{H}_8\text{BrNO}$  (236.98): C, 50.45; H, 3.39; Br, 33.56; N, 5.88; O, 6.72. Found: C, 50.61; H, 3.44; Br, 33.68; N, 5.97, O, 6.93.

**1-Benzyl-5-bromo-1*H*-indole (2d) [3]**



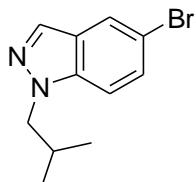
Light Pink solid; yield 0.80g (2.79 mmol, 87%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.79 (1 H, d,  $^3J$  = 1.51 Hz, CH), 7.21-7.37 (4 H, m, 4 CH), 7.09-7.17 (4 H, m, 4 CH), 6.51 (1 H, dd,  $^3J$  = 0.76, 3.02 Hz, CH), 5.32 (2 H, s,  $\text{CH}_2$ ). LCMS:  $m/z$  (%) = 288.0 [M+1]. Anal. Calcd for  $\text{C}_{15}\text{H}_{12}\text{BrN}$  (285.02): C, 62.96; H, 4.23; Br, 27.92; N, 4.89. Found: C, 63.10; H, 4.29; Br, 27.94; N, 4.95.

**5-Bromo-1-methyl-1*H*-indazole (2e)**



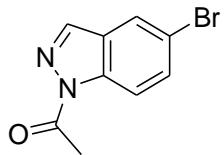
Off white solid; yield 0.15g (0.71 mmol, 77%)  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.95 (1 H, d,  $^3J$  = 1.00 Hz, CH), 7.66-7.68 (1 H, m, CH), 7.56 (1 H, dd,  $^3J$  = 1.50, 8.76 Hz, CH), 7.36 (1 H, d,  $^3J$  = 8.76 Hz, CH), 4.01 (3 H, s, Me). LCMS:  $m/z$  (%) = 212.2 [M+1]. Anal. Calcd for  $\text{C}_8\text{H}_7\text{BrN}_2$  (209.98): C, 45.53; H, 3.34; Br, 37.86; N, 13.27. Found: C, 45.75; H, 3.53; Br, 37.89; N, 13.31.

**5-Bromo-1-isobutyl-1*H*-indazole (2f)**



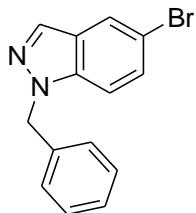
Off white solid; yield 0.11g (0.43 mmol, 70%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 8.55 (1 H, d,  $^3J$  = 1.75 Hz, CH), 7.67 (1 H, s, CH), 7.11 (1 H, dd,  $^3J$  = 3.22, 4.82 Hz, CH), 6.92 (1 H, dd,  $^3J$  = 11.76, 17.66 Hz, CH), 3.83-3.91 (2 H, s,  $\text{CH}_2$ ), 2.08-2.32 (1 H, m, CH), 0.94 (6 H, dd,  $^3J$  = 3.26, 6.66 Hz, 2 Me). LCMS:  $m/z$  = 253.14 [M+1]. Anal. Calcd for  $\text{C}_{11}\text{H}_{13}\text{BrN}_2$  (252.03): C, 52.19; H, 5.18; Br, 31.57; N, 11.07. Found: C, 52.23; H, 5.35; Br, 31.82; N, 11.30.

**1-(5-Bromo-1*H*-indazol-1-yl)ethanone (2g) [6]**



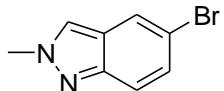
Off white solid; yield 0.18g (0.75 mmol, 58%).  $^1\text{H}$  NMR (400 MHz, DMSO-d<sub>6</sub>):  $\delta$  = 8.42 (1 H, d,  $^3J$  = 8.80 Hz, CH), 7.65 (1 H, d,  $^3J$  = 1.60 Hz, CH), 7.45 (1 H, m,  $^3J$  = 10.80 Hz, CH), 6.75 (1 H, d,  $^3J$  = 4.40 Hz, CH), 2.65 (3 H, s, Me). LCMS:  $m/z$  (%) = 241.0 [M+1]. Anal. Calcd for C<sub>10</sub>H<sub>8</sub>BrNO (237.97): C, 45.22; H, 2.95; Br, 33.42; N, 11.72; O, 6.69. Found: C, 45.52; H, 3.03; Br, 33.51; N, 11.99, O, 6.70.

**1-Benzyl-5-bromo-1*H*-indazole (2h) [4]**



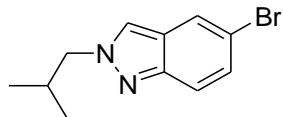
Colorless viscous liquid; yield 1.2g (4.17 mmol, 92%).  $^1\text{H}$  NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  = 8.00 (1 H, d,  $J$  = 0.76 Hz, CH), 7.80-7.93 (1 H, m, CH), 7.37-7.47 (1 H, m, CH), 7.26-7.34 (3 H, m, 3 CH), 7.13-7.23 (3 H, m, 3 CH), 5.60 (2 H, s, CH<sub>2</sub>). LCMS:  $m/z$  (%) = 288.2 [M+1]. Anal. Calcd for C<sub>14</sub>H<sub>11</sub>BrN<sub>2</sub> (286.01): C, 58.56; H, 3.86; Br, 27.83; N, 9.76. Found: C, 58.70; H, 3.88; Br, 27.87; N, 9.77.

**5-Bromo-2-methyl-2*H*-indazole (2i)**



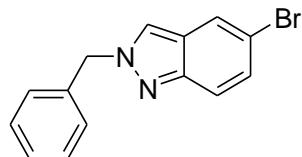
Off white solid; yield 0.10g (0.47 mmol, 69%)  $^1\text{H}$  NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  = 7.95 (1 H, d,  $^3J$  = 1.00 Hz, CH), 7.66-7.68 (1 H, m, CH), 7.56 (1 H, dd,  $^3J$  = 1.50, 8.76 Hz, CH), 7.33 (1 H, d,  $^3J$  = 8.76 Hz, CH), 4.05 (3 H, s, Me). LCMS:  $m/z$  (%) = 212.2 [M+1]. Anal. Calcd for C<sub>8</sub>H<sub>7</sub>BrN<sub>2</sub> (211.06): C, 45.53; H, 3.34; Br, 37.86; N, 13.27. Found: C, 45.62; H, 3.45; Br, 37.80; N, 13.33.

### **5-Bromo-2-isobutyl-2*H*-indazole (2j)**



Colorless viscous liquid; yield 0.180g (0.71 mmol, 89%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 8.54 (1 H, d,  $^3J$  = 1.75 Hz, CH), 7.60 (1 H, s, CH), 7.12 (1 H, dd,  $^3J$  = 3.22, 4.82 Hz, CH), 6.92 (1 H, dd,  $^3J$  = 11.76, 17.66 Hz, CH), 3.84-3.93 (2 H, s,  $\text{CH}_2$ ), 2.10-2.34 (1 H, m, CH), 0.92 (6 H, dd,  $^3J$  = 3.26, 6.66 Hz, 2 Me). LCMS:  $m/z$  254.2 [M+1]. Anal. Calcd for  $\text{C}_{11}\text{H}_{13}\text{BrN}_2$  (252.03): C, 52.19; H, 5.18; Br, 31.57; N, 11.07. Found: C, 52.31; H, 5.30; Br, 31.63; N, 11.09.

### **2-Benzyl-5-bromo-2*H*-indazole (2k) [4]**



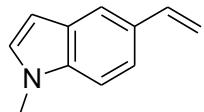
Off white solid; yield 0.75g (2.6 mmol, 88%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.85 (1 H, s, CH), 7.80 (1 H, d,  $^3J$  = 1.13 Hz, CH), 7.63 (1 H, d,  $^3J$  = 9.07 Hz, CH), 7.23-7.40 (6 H, m, 6 CH), 5.60 (2 H, s,  $\text{CH}_2$ ). LCMS:  $m/z$  (%) = 289.02 [M+1]. Anal. Calcd for  $\text{C}_{14}\text{H}_{11}\text{BrN}_2$  (286.01): C, 58.56; H, 3.86; Br, 27.83; N, 9.76. Found: C, 58.81; H, 3.97; Br, 27.87; N, 9.83.

### *Analytical data for compounds 3a–k*

#### **General procedure for the synthesis of N-alkylated vinylindole/indazole derivatives (3)[7-9]**

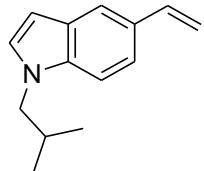
To a solution of *N*-alkyl bromoindole/indazoles (**2**, 2.4 mmol, 1 equiv) in DMF (5 mL) under a nitrogen atmosphere was added  $\text{CS}_2\text{CO}_3$  (7.2 mmol, 3 equiv), potassium vinyltrifluoroborate (4.8 mmol, 2 equiv) and  $\text{PdCl}_2(\text{dppf})\text{CH}_2\text{Cl}_2$  adduct (0.24 mmol, 0.1 equiv). The reaction mass was heated to 90 °C for 18 h. When the reaction was completed [TLC (EtOAc/hexane 2:5)], the mixture was extracted with EtOAc (2 × 20 mL) and washed with water (2 × 20 mL). The organic layer was dried over anhydrous  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure. The residue was purified by flash column chromatography [silica gel (230–400 mesh; Merck), EtOAc/hexane 2:5].

**1-Methyl-5-vinyl-1*H*-indole (3a) [7]**



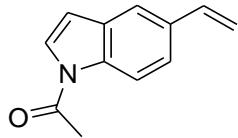
Off white solid; yield 0.21g (1.33 mmol, 75%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.63 (1 H, s, CH), 7.33-7.40 (1 H, m, CH), 7.28 (1 H, s, CH), 7.03 (1 H, d,  $^3J$  = 3.12 Hz, CH), 6.84 (1 H, dd,  $^3J$  = 10.95, 17.56 Hz, CH), 6.46 (1 H, d,  $^3J$  = 2.93 Hz, CH), 5.69 (1 H, d,  $^3J$  = 17.56 Hz, CH), 5.13 (1 H,  $^3J$  = 10.76 Hz, CH), 3.79 (3 H, s, Me). LCMS:  $m/z$  (%) = 158.08 [M+1]. Anal. Calcd for  $\text{C}_{11}\text{H}_{11}\text{N}$  (157.09): C, 84.04; H, 7.05; N, 8.91. Found: C, 84.54; H, 7.35; N, 8.99.

**1-Isobutyl-5-vinyl-1*H*-indole (3b)**



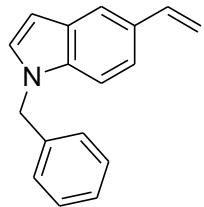
Off white solid; yield 0.19g (0.95 mmol, 73%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.74 (1 H, d,  $^3J$  = 1.70 Hz, CH), 7.62 (1 H, s, CH), 7.30-7.36 (1 H, m, CH), 7.22-7.29 (1 H, m, CH), 7.05 (1 H, dd,  $^3J$  = 3.12, 4.72 Hz, CH), 6.83 (1 H, dd,  $^3J$  = 10.86, 17.56 Hz, CH), 6.44 (1 H, dd,  $^3J$  = 3.12, 13.12 Hz, CH), 5.68 (1 H, dd,  $^3J$  = 0.85, 17.56 Hz, CH), 5.12 (1 H, dd,  $^3J$  = 0.90, 10.91 Hz, CH), 3.83-3.91 (2 H, s,  $\text{CH}_2$ ), 2.11-2.25 (1 H, m, CH), 0.91 (6 H, dd,  $^3J$  = 3.26, 6.66 Hz, 2 Me). LCMS:  $m/z$  (%) = 200.14 [M+1]. Anal. Calcd for  $\text{C}_{14}\text{H}_{17}\text{N}$  (199.14): C, 85.37; H, 9.60; N, 7.03. Found: C, 85.52; H, 9.75; N, 7.33

**1-(5-Vinyl-1*H*-indol-1-yl)ethanone (3c) [8]**



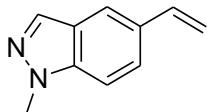
Off white solid; yield 0.21g (1.13 mmol, 78%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 8.37 (1 H, d,  $^3J$  = 8.69 Hz, CH), 7.58 (1 H, s, CH), 7.38-7.49 (2 H, m, 2 CH), 6.81 (1 H, dd,  $^3J$  = 10.91, 17.61 Hz, CH), 6.63 (1 H, d,  $^3J$  = 3.78 Hz, CH), 5.77 (1 H, d,  $^3J$  = 17.56 Hz, CH), 5.24 (1 H, d,  $^3J$  = 10.86 Hz, CH), 2.64 (3 H, s, Me), 1.54 (3 H, s, Me). LCMS:  $m/z$  (%) = 186.2 [M+1]. Anal. Calcd for  $\text{C}_{12}\text{H}_{11}\text{NO}$  (185.08): C, 77.81; H, 5.99; N, 7.56; O, 8.64. Found: C, 77.82; H, 6.10; N, 7.56; O, 8.73.

**1-Benzyl-5-vinyl-1*H*-indole (3d) [9]**



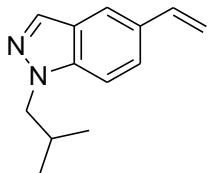
Off white solid; yield 0.52g (2.23 mmol, 81%).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.65 (1 H, d,  $^3J$  = 1.75 Hz, CH), 7.24-7.33 (3 H, m, 3 CH), 7.19-7.23 (2 H, m, 2 CH), 7.07-7.14 (3 H, m, CH), 6.83 (1 H, dd,  $^3J$  = 11.13, 17.39 Hz, CH), 6.53 (1 H, dd,  $^3J$  = 0.88, 3.13 Hz, CH), 5.68 (1 H, dd,  $^3J$  = 1.00, 17.51 Hz, CH), 5.58 (2 H, s,  $\text{CH}_2$ ), 5.08-5.16 (1 H, m, CH). LCMS:  $m/z$  (%) = 234.2 [M+1]. Anal. Calcd for  $\text{C}_{17}\text{H}_{15}\text{N}$  (233.12): C, 87.52; H, 6.48; N, 6.00. Found: C, 87.59; H, 6.50; N, 6.23.

**1-Methyl-5-vinyl-1*H*-indazole (3e)**



Off white solid; yield 0.18g (1.13 mmol, 78%)  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.95 (1 H, d,  $^3J$  = 1.00 Hz, CH), 7.66-7.68 (1 H, m, CH), 7.55 (1 H, dd,  $^3J$  = 1.50, 8.76 Hz, CH), 7.34 (1 H, d,  $^3J$  = 8.76 Hz, CH), 6.82 (1 H, dd,  $^3J$  = 10.76, 17.51 Hz, CH), 5.73 (1 H, dd,  $^3J$  = 0.88, 17.64 Hz, CH), 5.21 (1 H, dd,  $^3J$  = 0.75, 10.76 Hz, CH), 4.06 (3 H, s, Me). LCMS:  $m/z$  (%) = 159.2 [M+1]. Anal. Calcd for  $\text{C}_{10}\text{H}_{10}\text{N}_2$  (158.08): C, 75.92; H, 6.37; N, 17.71. Found: C, 75.88; H, 6.83; N, 17.58.

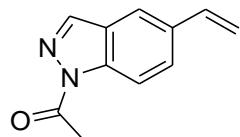
**1-Isobutyl-5-vinyl-1*H*-indazole (3f)**



Off white solid; yield 0.18g (0.89 mmol, 65%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  = 8.54 (1 H, d,  $^3J$  = 1.75 Hz, CH), 7.62 (1 H, s, CH), 7.10 (1 H, dd,  $^3J$  = 3.22, 4.82 Hz, CH), 6.92 (1 H, dd,  $^3J$  = 11.76, 17.66 Hz, CH), 6.52 (1 H, dd,  $^3J$  = 3.12, 13.12 Hz, CH), 5.76 (1 H, dd,  $^3J$  = 0.85, 17.56 Hz, CH), 5.20 (1 H, dd,  $^3J$  = 0.90, 10.91 Hz, CH), 3.83-3.91 (2 H, s,  $\text{CH}_2$ ), 2.09-2.33 (1 H, m,

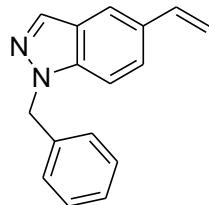
CH), 0.92 (6 H, dd,  $^3J$  = 3.26, 6.66 Hz, 2 Me). LCMS:  $m/z$  (%) = 201.2 [M+1]. Anal. Calcd for C<sub>13</sub>H<sub>16</sub>N<sub>2</sub>(200.13): C, 77.96; H, 8.05; N, 13.99. Found: C, 78.00; H, 8.25; N, 14.09.

### 1-(5-Vinyl-1*H*-indazol-1-yl)ethanone (3g)



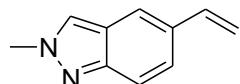
Pale yellow solid; yield 0.20g (1.07 mmol, 80%).  $^1\text{H}$  NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  = 8.42 (1 H, d,  $^3J$  = 8.69 Hz, CH), 7.42-7.51 (2 H, m, CH), 6.81 (1 H, dd,  $^3J$  = 10.91, 17.61 Hz, CH), 6.70 (1 H, d,  $^3J$  = 3.78 Hz, CH), 5.87 (1 H, d,  $^3J$  = 17.56 Hz, CH), 5.32 (1 H, d,  $^3J$  = 10.86 Hz, CH), 2.68 (3 H, s, Me), 1.62 (3 H, s, Me). LCMS:  $m/z$  (%) = 187.2 [M+1]. Anal. Calcd for C<sub>11</sub>H<sub>10</sub>N<sub>2</sub>O (186.08): C, 70.95; H, 5.41; N, 15.04; O, 8.59. Found: C, 71.02; H, 5.62; N, 15.53; O, 8.71.

### 1-Benzyl-5-vinyl-1*H*-indazole (3h)



Pale yellow solid; yield 0.46g (1.96 mmol, 82%).  $^1\text{H}$  NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  = 8.01 (1 H, d,  $^3J$  = 0.75 Hz, CH), 7.65-7.71 (1 H, m, CH), 7.49 (1 H, dd,  $^3J$  = 1.50, 8.76 Hz, CH), 7.26-7.32 (4 H, m, CH), 7.16-7.20 (1 H, m, CH) 6.81 (1 H, dd,  $^3J$  = 11.6, 17.51 Hz, CH), 5.70 (1 H, dd,  $^3J$  = 0.75, 17.51 Hz, CH), 5.58 (2 H, s, CH<sub>2</sub>), 5.20 (1 H, dd,  $^3J$  = 0.75, 11.01 Hz, CH). LCMS:  $m/z$  (%) = 235.2 [M+1]. Anal. Calcd for C<sub>16</sub>H<sub>14</sub>N<sub>2</sub> (234.12): C, 82.02; H, 6.02; N, 11.96. Found: C, 82.32; H, 6.47; N, 12.06.

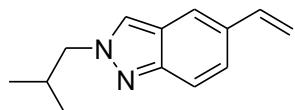
### 2-Methyl-5-vinyl-2*H*-indazole (3i)



Off white solid; yield 0.13g (0.82 mmol, 73%).  $^1\text{H}$  NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  = 7.86 (1 H, s, CH), 7.64 (1 H, d,  $^3J$  = 9.07 Hz, CH), 7.45-7.56 (2 H, m, 2 CH), 6.79 (1 H, dd,  $^3J$  = 10.95, 17.37 Hz, CH), 5.71 (1 H, d,  $^3J$  = 17.37 Hz, CH), 5.20 (1 H, d,  $^3J$  = 10.95 Hz, CH), 4.20 (3 H, s, Me).

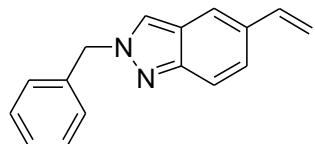
LCMS:  $m/z$  (%) = 159.2 [M+1]. Anal. Calcd for C<sub>10</sub>H<sub>10</sub>N<sub>2</sub> (158.08): C, 75.92; H, 6.37; N, 17.71. Found: C, 76.00; H, 6.50; N, 17.92.

### **2-Isobutyl-5-vinyl-2H-indazole (3j)**



Pale yellow solid; yield 0.13g (0.64 mmol, 75%). <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ = 8.54 (1 H, d, <sup>3</sup>J = 1.75 Hz, CH), 7.60 (1 H, s, CH), 7.12 (1 H, dd, <sup>3</sup>J = 3.22, 4.82 Hz, CH), 6.92 (1 H, dd, <sup>3</sup>J = 11.76, 17.66 Hz, CH), 6.53 (1 H, dd, <sup>3</sup>J = 3.12, 13.12 Hz, CH), 5.76 (1 H, dd, <sup>3</sup>J = 0.85, 17.56 Hz, CH), 5.20 (1 H, dd, <sup>3</sup>J = 0.90, 10.91 Hz, CH), 3.84-3.93 (2 H, s, CH<sub>2</sub>), 2.10-2.34 (1 H, m, CH), 0.92 (6 H, dd, <sup>3</sup>J = 3.26, 6.66 Hz, 2 Me). LCMS:  $m/z$  = 201.2 [M+1]. Anal. Calcd for C<sub>13</sub>H<sub>16</sub>N<sub>2</sub> (200.13): C, 77.96; H, 8.05; N, 13.99. Found: C, 78.20; H, 8.27; N, 13.98.

### **2-Benzyl-5-vinyl-2H-indazole (3k)**



Pale yellow solid; yield 0.320g (1.36 mmol, 72%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ = 7.95 (1 H, d, <sup>3</sup>J = 0.75 Hz, CH), 7.68-7.73 (1 H, m, CH), 7.53 (2 H, dd, <sup>3</sup>J = 1.50, 8.76 Hz, 2 CH), 7.34-7.40 (5 H, m, CH), 6.84 (1 H, dd, <sup>3</sup>J = 11.6, 17.51 Hz, CH), 5.73 (1 H, dd, <sup>3</sup>J = 0.75, 17.51 Hz, CH), 5.67 (2 H, s, CH<sub>2</sub>), 5.21 (1 H, dd, <sup>3</sup>J = 0.75, 11.01 Hz, CH). LCMS:  $m/z$  = 235.2 [M+1]. Anal. Calcd for C<sub>16</sub>H<sub>14</sub>N<sub>2</sub> (234.12): C, 82.02; H, 6.02; N, 11.96. Found: C, 82.12; H, 6.20; N, 12.22.

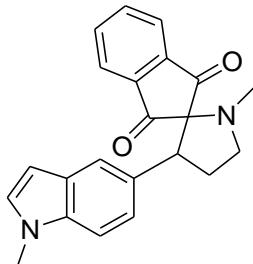
### *Analytical data for compounds 7a–k and 8a–k*

#### **General procedure for the preparation of spiropyrrolidine derivatives compounds (7 and 8).**

To the solution of **3** (1 mmol, 1 equiv) in dry methanol (5 mL) in a single-necked round-bottomed flask, ninhydrin (1.2 mmol, 1.2 equiv) and L-proline/sarcosine (1.2 mmol, 1.2 equiv) were added. The reaction mixture was heated to 60 °C for 30 min and reaction progress was monitored by TLC (EtOAc/hexanes 1:1). After completion of the reaction, the organic solvent was evaporated to dryness. Water (10 mL) was added to the residue and extracted twice with

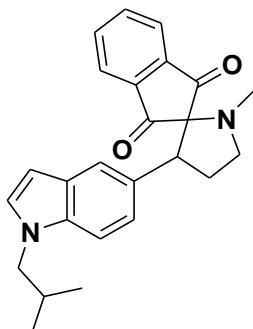
ethyl acetate ( $2 \times 10$  mL) and solvent was removed under vacuum. The crude product obtained was purified by flash chromatography on silica gel (EtOAc/hexane 1:1) to get corresponding spiropyrrolidine derivatives **7** and **8**.

**1'-Methyl-3'-(1-methyl-1*H*-indol-5-yl)spiro[indene-2,2'-pyrrolidine]-1,3-dione (7a)**



Yellow solid; yield 0.07g (0.20 mmol, 90%).  $^1\text{H}$  NMR(400 MHz, CDCl<sub>3</sub>):  $\delta$  = 7.83 (1 H, d,  $^3J$  = 10.00 Hz, CH), 7.51-7.64 (3 H, m, 3 CH), 7.28 (1 H, d,  $^3J$  = 14.40 Hz, CH), 6.86-6.97 (3 H, m, 3 CH), 6.27 (1 H, d,  $^3J$  = 4.00 Hz, CH), 3.99 (1 H, q,  $^3J$  = 26.00 Hz, CH), 3.63 (3 H, s, 3 CH), 3.55 (1 H, q,  $^3J$  = 19.60 Hz, CH), 3.38-3.46 (1 H, m, CH), 2.81-2.87 (1 H, m, CH), 2.40-2.46 (1 H, m, CH), 2.36 (3 H, s, Me).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 20.40, 32.22, 38.00, 42.11, 52.42, 102.71, 104.26, 111.21, 117.60, 119.33, 128.59, 128.92, 128.72, 128.77, 133.15, 133.21, 141.29, 141.33, 197.45, 197.74. LCMS:  $m/z$  (%) = 345.1 [M+1]. Anal. Calcd for C<sub>22</sub>H<sub>20</sub>N<sub>2</sub>O<sub>2</sub> (344.15): C, 76.72; H, 5.85; N, 8.13; O, 9.29. Found: C, 76.80; H, 5.89; N, 8.30; O, 9.41.

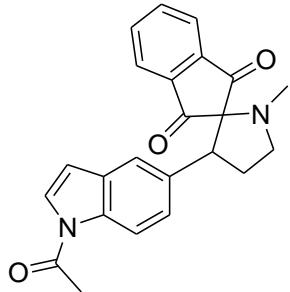
**3'-(1-Isobutyl-1*H*-indol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7b)**



Yellow solid; yield 0.058g (0.15 mmol, 93%).  $^1\text{H-NMR}$ (400 MHz, MeOD):  $\delta$  = 7.82 (1 H, q,  $^3J$  = 7.60 Hz, CH), 7.68-7.72 (1 H, m, CH), 7.61 (1 H, t,  $^3J$  = 16.00 Hz, CH), 7.45-7.47 (1 H, m, CH), 7.20 (1 H, d,  $^3J$  = 1.60 Hz, CH), 6.99-7.05 (2 H, m, 2 CH), 6.73-6.76 (1 H, m, CH), 6.24 (1 H, q,  $^3J$  = 3.60 Hz, CH), 3.90 (1 H, q,  $^3J$  = 11.20 Hz, CH), 3.80 (2 H, d,  $^3J$  = 7.60 Hz, CH<sub>2</sub>), 3.49-3.51 (2 H, m, CH<sub>2</sub>), 2.82-2.90 (1 H, m, CH), 2.41-2.47 (1 H, m, CH), 2.33 (3 H, s, Me), 2.02-2.08 (1

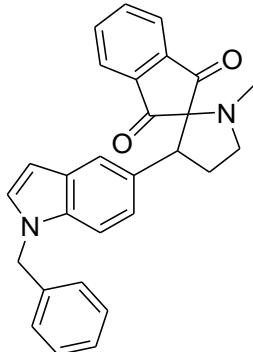
H, m, CH), 0.77-0.80 (6 H, m, 2 Me),  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 20.36, 30.66, 30.88, 36.92, 54.52, 54.98, 57.47, 81.90, 101.51, 110.36, 121.11, 122.58, 123.05, 123.39, 127.18, 129.77, 130.02, 136.85, 137.21, 137.29, 142.73, 143.19, 203.74, 204.49. LCMS:  $m/z$  (%) = 387.2 [M+1]. Anal. Calcd for  $\text{C}_{25}\text{H}_{26}\text{N}_2\text{O}_2$  (386.2): C, 77.69; H, 6.78; N, 7.25; O, 8.28. Found: C, 77.76; H, 6.80; N, 7.32; O, 8.40.

### **3'-(1-Acetyl-1*H*-indol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7c)**



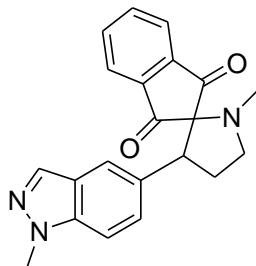
Pale yellow solid; yield 0.076g (0.20 mmol, 87%).  $^1\text{H}$  NMR (400 MHz, MeOD)  $\delta$  = 7.98-8.03 (1 H, m, CH), 7.85-7.88 (1 H, m, CH), 7.73-7.79 (1 H, m, CH), 7.68 (1 H, dt,  $^3J$  = 1.26, 7.40 Hz CH), 7.50-7.58 (2 H, m, 2 CH), 7.26 (1 H, d,  $^3J$ =2.01 Hz, CH), 6.93 (1 H, dd,  $^3J$  = 2.01, 8.53 Hz, CH), 6.49-6.53 (1 H, m, CH), 3.92 (1 H, dd,  $^3J$ =8.28, 11.29 Hz, CH), 3.45-53 (1 H, m, CH), 3.36-3.45 (1 H, m, CH), 2.78-2.90 (1 H, m, CH), 2.56(3 H, s, Me), 2.44 (1 H, dtd,  $^3J$  = 4.02, 8.16, 12.30 Hz, CH), 2.32 (3 H, s, Me),  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 23.648, 23.828, 30.653, 30.852, 36.839, 54.995, 55.136, 56.652, 82.342, 109.600, 109.820, 117.264, 121.426, 123.173, 123.575, 126.113, 127.778, 132.363, 133.452, 137.244, 137.652, 142.423, 142.673, LCMS:  $m/z$  (%) = 374 [M+1]. Anal. Calcd for  $\text{C}_{23}\text{H}_{20}\text{N}_2\text{O}_3$  (372.15): C, 74.18; H, 5.41; N, 7.52; O, 12.89. Found: C, 74.26; H, 5.49; N, 7.55; O, 12.85.

**3'-(1-Benzyl-1*H*-indol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7d)**



Pale yellow solid; yield 0.093g (0.22 mmol, 91%).  $^1\text{H}$  NMR(300 MHz, DMSO):  $\delta$  = 7.66-7.86 (3 H, m, 3 CH), 7.50 (1 H, d,  $^3J$  = 7.55 Hz, CH), 7.32 (1 H, d,  $^3J$  = 3.02 Hz, CH), 7.14-7.28 (4 H, m, 4 CH), 7.08 (1 H, d,  $^3J$  = 8.69 Hz, CH), 6.97 (2 H, d,  $^3J$  = 6.04 Hz, CH), 6.64 (1 H, d,  $^3J$  = 8.69 Hz, CH), 6.30 (1 H, d,  $^3J$  = 3.02 Hz, CH), 5.25 (2 H, s,  $\text{CH}_2$ ), 3.80 (1 H, dd,  $^3J$  = 8.31, 11.33 Hz, CH), 3.35-3.41 (1 H, m, CH), 3.19-3.28 (1 H, m, CH), 2.62-2.76 (1 H, m, CH), 2.25-2.36 (1 H, m, CH), 2.14-2.21 (3 H, m,  $\text{CH}_3$ ).  $^{13}\text{C}$  NMR (300 MHz):  $\delta$  = 30.0, 36.7, 49.9, 54.0, 56.0, 76.5, 77.2, 77.4, 80.6, 101.6, 109.2, 120.5, 122.0, 122.2, 122.4, 126.5, 127.0, 127.5, 128.3, 128.4, 128.6, 135.0, 135.5, 135.5, 137.4, 141.3, 141.7, 203.1, 203.8. LCMS:  $m/z$  (%) = 421.2 [M+1]. Anal. Calcd for  $\text{C}_{28}\text{H}_{24}\text{N}_2\text{O}_2$  (420.18): C, 79.98; H, 5.75; N, 6.66; O, 7.61. Found: C, 80.12; H, 5.95; N, 6.76; O, 7.65.

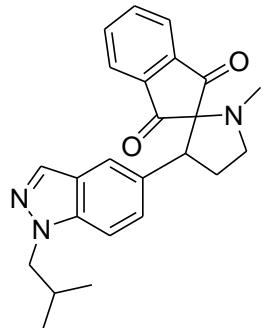
**1'-Methyl-3'-(1-methyl-1*H*-indazol-5-yl)spiro[indene-2,2'-pyrrolidine]-1,3-dione (7e)**



Pale yellow solid; yield 0.068g (0.19 mmol, 85%).  $^1\text{H}$  NMR (400 MHz, MeOD)  $\delta$  = 7.85-7.89 (1 H, m, CH), 7.82 (1 H, d,  $^3J$  = 1.00 Hz, CH), 7.73-7.79 (1 H, m, CH), 7.65-7.71 (1 H, m, CH), 7.52 (1 H, td,  $^3J$  = 1.00, 7.53 Hz, CH), 7.44 (1 H, d,  $^3J$  = 1.00 Hz, CH), 7.19-7.24 (1 H, m, CH), 7.06 (1 H, dd,  $^3J$  = 1.51, 9.04 Hz, CH), 3.92-3.98 (1 H, m, CH), 3.91 (3 H, s, Me), 3.46-3.53 (1 H, m, CH), 3.37-3.45 (1 H, m, CH), 2.84 (1 H, dddd,  $^3J$  = 7.03, 9.91, 11.23, 12.49 Hz, CH), 2.45 (1 H, dtd,  $^3J$  = 3.76, 8.09, 12.17 Hz, CH), 2.32 (3 H, s, Me),  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 30.384, 36.819,

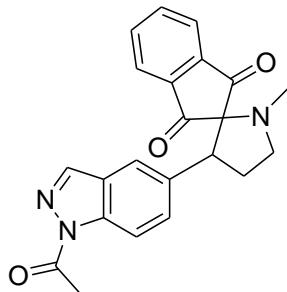
40.137, 54.955, 56.840, 81.180, 117.097, 120.691, 122.952, 123.156, 123.571, 126.214, 128.289, 130.404, 137.234, 137.644, 142.623, 143.035, 149.241, 203.465, 204.125. LCMS:  $m/z$  (%) = 347 [M+1]. Anal. Calcd for  $C_{21}H_{19}N_3O_2$  (345.15): C, 73.03; H, 5.54; N, 12.17; O, 9.26. Found: C, 73.20; H, 5.63; N, 12.15; O, 9.27.

**3'-(1-Isobutyl-1*H*-indazol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7f)**



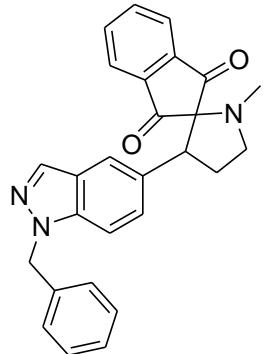
Pale yellow solid; yield 0.070g (0.18 mmol, 82%).  $^1H$  NMR (300 MHz, MeOD)  $\delta$  = 7.82-7.87 (2 H, m, 2 CH), 7.73 (1 H, dt,  $^3J$  = 1.00, 7.53 Hz, CH), 7.64 (1 H, dt,  $^3J$  = 1.00, 7.53 Hz, CH), 7.42-7.49 (2 H, m, 2 CH), 7.21 (1 H, d,  $^3J$  = 9.04 Hz, CH), 7.03 (1 H, dd,  $^3J$  = 1.51, 9.04 Hz, CH), 4.06 (2 H, d,  $^3J$  = 7.53 Hz, CH<sub>2</sub>), 3.94 (1 H, dd,  $^3J$  = 8.28, 11.29 Hz, CH), 3.47-3.54 (1 H, m, CH), 3.39 (1 H, m, CH), 2.79-2.91 (1 H, m, CH), 2.45 (1 H, dtd,  $^3J$  = 3.76, 8.03, 12.30 Hz, CH), 2.33 (3 H, s, Me), 2.15 (1 H, td,  $^3J$  = 6.96, 13.68 Hz, CH), 0.78 (6 H, dd,  $^3J$  = 6.78, 8.28 Hz, 2 Me).  $^{13}C$  NMR (400 MHz):  $\delta$  = 20.46, 20.66, 20.68, 26.52, 31.82, 38.01, 52.40, 60.11, 104.21, 113.62, 120.23, 124.58, 125.65, 128.70, 130.45, 133.01, 133.12, 133.16, 137.00, 141.20, 141.25, 197.63, 197.65. LCMS:  $m/z$  (%) = 389 [M+1]. Anal. Calcd for  $C_{24}H_{25}N_3O_2$  (387.19): C, 74.39; H, 6.50; N, 10.84; O, 8.26. Found: C, 74.43; H, 6.59; N, 10.87; O, 8.30.

**3'-(1-Acetyl-1*H*-indazol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7g)**



Pale yellow solid; yield 0.069g (0.18 mmol, 78%).  $^1\text{H}$  NMR(300 MHz, MeOD ):  $\delta$  = 8.11 (1 H, d,  $^3J$  = 0.90 Hz, CH), 8.02 (1 H, d,  $^3J$  = 8.70 Hz, CH), 7.89 (1 H, t,  $^3J$  = 7.20 Hz, CH), 7.68-7.82 (2 H, m, 2 CH), 7.54 (2 H, t,  $^3J$  = 7.20 Hz, 2 CH), 7.22 (1 H, dd,  $^3J$  = 10.50, Hz, CH), 3.98 (1 H, q,  $^3J$  = 19.50 Hz, CH), 3.43-3.53 (2 H, m, CH<sub>2</sub>), 2.82-2.85 (1 H, m, CH), 2.67 (3 H, s, Me), 2.46-2.51 (1 H, m, CH), 2.33 (3 H, s, Me),  $^{13}\text{C}$  NMR (300 MHz):  $\delta$  = 22.74, 30.68, 36.79, 55.00, 56.15, 81.00, 115.79, 121.75, 123.21, 123.69, 127.82, 130.99, 134.27, 137.45, 137.81, 139.37, 140.93, 142.55, 142.91, 172.38, 203.29, 203.98, LCMS:  $m/z$  (%) = 374.2 [M+1]. Anal. Calcd for C<sub>22</sub>H<sub>19</sub>N<sub>3</sub>O<sub>3</sub> (373.14): C, 70.76; H, 5.13; N, 11.25; O, 12.85. Found: C, 70.78; H, 5.22; N, 11.28; O, 12.88.

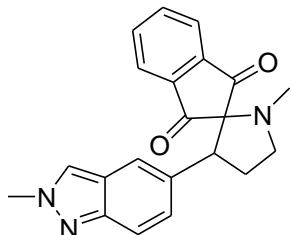
**3'-(1-Benzyl-1*H*-indazol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7h)**



Off white solid; yield 0.073g (0.17 mmol, 79%).  $^1\text{H}$  NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  = 7.79-7.85 (2 H, m, 2 CH), 7.61 (1 H, dt,  $^3J$  = 1.25, 7.38 Hz, CH), 7.52 (1 H, dt,  $^3J$  = 1.00, 7.38 Hz, CH), 7.39 - 7.47 (2 H, m, 2 CH), 7.20 - 7.25 (3 H, m, 3 CH), 6.97-7.05 (4 H, m, 4 CH), 5.43 (2 H, s, CH<sub>2</sub>), 3.96 (1 H, dd,  $^3J$  = 8.13, 11.13 Hz, CH), 3.52-3.60 (1 H, m, CH), 3.43 (1 H, dt,  $^3J$  = 3.63, 9.32 Hz, CH), 2.73-2.86 (1 H, m, CH), 2.39-2.45 (1 H, m, CH), 2.36 (3 H, br. S., CH<sub>3</sub>).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 21.0, 31.5, 35.4, 37.8, 52.1, 61.9, 103.8, 114.0, 122.0, 124.6, 126.2, 129.1, 129.3, 130.0, 130.4, 131.7, 133.0, 133.2, 134.5, 134.7, 137.3, 137.9, 142.6, 142.9, 197.6, 197.8. LCMS:

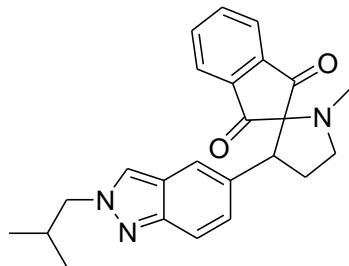
*m/z* (%) = 422.2 [M+1]. Anal. Calcd for C<sub>27</sub>H<sub>23</sub>N<sub>3</sub>O<sub>2</sub> (421.18): C, 76.94; H, 5.50; N, 9.97; O, 7.59. Found: C, 77.00; H, 5.53; N, 10.09; O, 7.65.

**1'-Methyl-3'-(2-methyl-2*H*-indazol-5-yl)spiro[indene-2,2'-pyrrolidine]-1,3-dione (7i)**



Pale yellow solid; yield 0.048g (0.13 mmol, 70%). <sup>1</sup>H NMR (400 MHz, MeOD) δ = 8.01 (1 H, s, CH), 7.89 - 7.85 (1 H, m, CH), 7.79-7.73 (1 H, m, CH), 7.72 - 7.64 (1 H, m, CH), 7.54 - 7.49 (1 H, m, CH), 7.38 (1 H, d, <sup>3</sup>J=1.0 Hz, CH), 7.22 (1 H, d, <sup>3</sup>J=9.0 Hz, CH), 6.91 (1 H, dd, <sup>3</sup>J=9.0, 1.5 Hz, CH), 4.10 (3 H, s, Me), 3.90 (1 H, dd, <sup>3</sup>J= 11.0, 8.0 Hz, CH), 3.54- 3.46 (1 H, m, CH), 3.45- 3.37 (1 H, m, CH), 2.90 - 2.76 (1 H, m, CH), 2.42 (1 H, dt, <sup>3</sup>J=12.1, 8.1, 3.8 Hz, CH), 2.32 (3 H, s, Me), <sup>13</sup>C NMR (400 MHz): δ = 30.755, 35.417, 36.838, 54.978, 56.509, 81.127, 110.041, 121.465, 123.157, 123.585, 124.913, 128.433, 129.870, 133.540, 137.276, 137.674, 140.586, 142.624, 143.004, 203.504, 204.183. LCMS: *m/z* (%) = 346 [M+1]. Anal. Calcd for C<sub>21</sub>H<sub>19</sub>N<sub>3</sub>O<sub>2</sub> (345.15): C, 73.03; H, 5.54; N, 12.17; O, 9.26. Found: C, 73.28; H, 5.61; N, 12.20; O, 9.27.

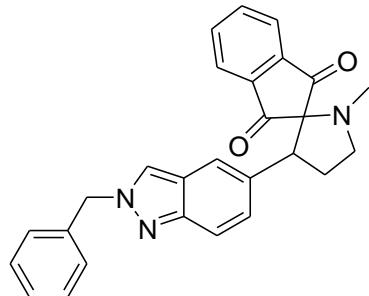
**3'-(2-Isobutyl-2*H*-indazol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7j)**



Pale yellow solid; yield 0.050g (0.12 mmol, 65%). <sup>1</sup>H NMR (400 MHz, MeOD) δ = 8.03 (1 H, d, <sup>3</sup>J = 0.76 Hz, CH), 7.87 (1 H, td, <sup>3</sup>J = 0.94, 7.55 Hz, CH), 7.75 (1 H, dt, <sup>3</sup>J = 1.32, 7.46 Hz, CH), 7.66 (1 H, dt, <sup>3</sup>J = 1.13, 7.37 Hz, CH), 7.51 (1 H, td, <sup>3</sup>J = 0.94, 7.55 Hz, CH), 7.36-7.41 (1 H, m, CH), 7.23 (1 H, d, <sup>3</sup>J = 9.07 Hz, CH), 6.91 (1 H, dd, <sup>3</sup>J = 1.89, 9.07 Hz, CH), 4.14 (2 H, d, <sup>3</sup>J = 7.18 Hz, CH<sub>2</sub>), 3.84-3.95 (1 H, m, CH), 3.36-3.54 (2 H, m, CH<sub>2</sub>), 2.75-2.91 (1 H, m, CH), 2.35-2.49 (1 H, m, CH), 2.32 (3 H, s, Me), 2.18-2.29 (1 H, m, CH), 0.87 (6 H, dd, <sup>3</sup>J = 2.46, 6.61 Hz, 2 Me). <sup>13</sup>C NMR (400 MHz): δ = 20.46, 20.72, 20.78, 27.12, 31.82, 38.18, 52.47, 58.50, 104.21,

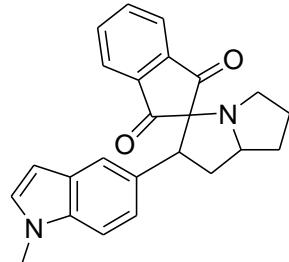
113.63, 120.21, 122.93, 124.50, 125.62, 128.72, 130.42, 133.12, 133.15, 141.20, 141.25, 145.00, 197.63, 197.65. LCMS:  $m/z$  (%) = 389 [M+1]. Anal. Calcd for C<sub>24</sub>H<sub>25</sub>N<sub>3</sub>O<sub>2</sub>, (387.19): C, 74.39; H, 6.50; N, 10.84; O, 8.26. Found: C, 74.40; H, 6.57; N, 10.91; O, 8.30.

**3'-(2-Benzyl-2*H*-indazol-5-yl)-1'-methylspiro[indene-2,2'-pyrrolidine]-1,3-dione (7k)**



Off white solid; yield 0.048g (0.11 mmol, 60%). <sup>1</sup>H NMR(400 MHz, CDCl<sub>3</sub>) δ = 7.79-7.85 (2 H, m, 2 CH), 7.61 (1 H, dt, <sup>3</sup>J = 1.25, 7.38 Hz, CH), 7.52 (1 H, dt, <sup>3</sup>J = 1.00, 7.38 Hz, CH), 7.39-7.47 (2 H, m, 2 CH), 7.20-7.25 (3 H, m, 3 CH), 6.97-7.05 (4 H, m, 4 CH), 5.43 (2 H, s, CH<sub>2</sub>), 3.96 (1 H, dd, <sup>3</sup>J = 8.13, 11.13 Hz, CH), 3.52-3.60 (1 H, m, CH), 3.43 (1 H, dt, <sup>3</sup>J = 3.63, 9.32 Hz CH), 2.73-2.86 (1 H, m, CH), 2.39-2.45 (1 H, m, CH), 2.36 (3 H, br. S., Me). <sup>13</sup>C NMR (400 MHz): δ = 22.1, 31.3, 39.2, 54.1, 61.3, 105.3, 112.5, 122.2, 124.8, 126.3, 129.2, 129.4, 130.0, 130.5, 131.7, 133.1, 133.2, 134.6, 134.4, 137.2, 137.1, 142.7, 143.0, 197.7, 197.9. LCMS:  $m/z$  (%) = 422.2 [M+1]. Anal. Calcd for C<sub>27</sub>H<sub>23</sub>N<sub>3</sub>O<sub>2</sub> (421.18): C, 76.94; H, 5.50; N, 9.97; O, 7.59. Found: C, 77.97; H, 5.53; N, 10.05; O, 7.66.

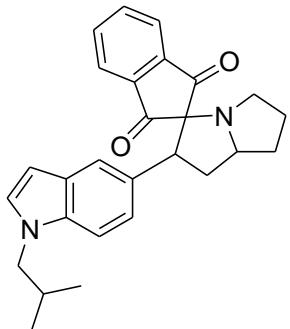
**2'-(1-Methyl-1*H*-indol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8a)**



Pale yellow solid; yield 0.062g (0.16 mmol, 86%). <sup>1</sup>H NMR(400 MHz, MeOD) δ = 7.82-7.84 (1 H, m, CH), 7.64-7.75 (3 H, m, 3 CH), 7.26 (1 H, s, CH), 7.01-7.26 (2 H, m, 2 CH), 6.92 (1 H, d, <sup>3</sup>J = 63.20 Hz, CH), 6.23 (1 H, q, <sup>3</sup>J = 3.60 Hz, CH), 4.01-0.00 (1 H, m, CH), 3.63 (3 H, d, <sup>3</sup>J =

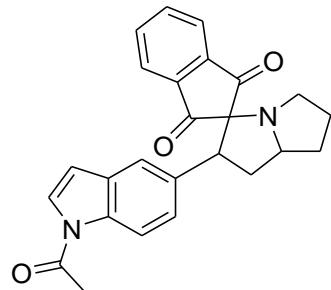
6.00 Hz, 3 CH), 3.48 (1 H, s, CH), 3.06-3.08 (2 H, m, CH<sub>2</sub>), 2.80 (2 H, d, <sup>3</sup>J = 5.20 Hz, CH<sub>2</sub>), 2.23-2.23 (1 H, m, CH), 2.10-2.18 (3 H, m, 3 CH), 1.71-1.81 (3 H, m, 3 CH). <sup>13</sup>C NMR (400 MHz): δ = 23.4, 29.0, 30.8, 31.9, 42.1, 50.3, 61.7, 99.8, 102.7, 110.9, 117.6, 119.3, 128.0, 128.9, 128.7, 128.7, 131.0, 133.1, 133.1, 133.8, 141.2, 141.2, 197.7, 197.7. LCMS: *m/z* (%) = 373 [M+1]. Anal. Calcd for C<sub>24</sub>H<sub>22</sub>N<sub>2</sub>O<sub>2</sub> (372.18): C, 77.39; H, 6.49; N, 7.52; O, 8.59. Found: C, 77.44; H, 6.55; N, 7.56; O, 8.64.

**2'-(1-Isobutyl-1*H*-indol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8b)**



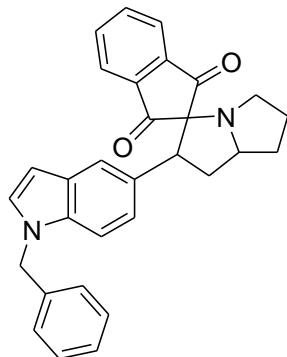
Pale yellow solid; yield 0.070g (0.16 mmol, 80%). <sup>1</sup>H NMR(400 MHz, MeOD) δ = 7.79-7.85 (1 H, m, CH), 7.59-7.74 (3 H, m, 3 CH), 7.25 (1 H, d, <sup>3</sup>J=1.51 Hz, CH), 6.99-7.06 (2 H, m, 2 CH), 6.81 (1 H, dd, <sup>3</sup>J = 1.88, 8.66 Hz, CH), 6.23 (1 H, dd, <sup>3</sup>J = 0.75, 3.26 Hz, CH), 4.16-4.27 (1 H, m, CH), 3.99 (1 H, dd, <sup>3</sup>J = 7.78, 11.54 Hz, CH), 3.79 (2 H, d, <sup>3</sup>J=7.28 Hz, CH<sub>2</sub>), 3.38-3.49 (1 H, m, CH), 3.05 (1 H, dt, <sup>3</sup>J = 8.53, 12.17 Hz, 1H), 2.79 (1 H, dt, <sup>3</sup>J=3.26, 6.90 Hz, CH), 1.96-2.30 (4 H, m, 4 CH), 1.62-1.87 (2 H, m, CH<sub>2</sub>), 0.78 (6 H, dd, <sup>3</sup>J=2.38, 6.65 Hz, 2 CH<sub>3</sub>) <sup>13</sup>C NMR (400 MHz): δ = 21.0, 21.0, 24.4, 29.0, 29.2, 30.0, 31.9, 50.3, 62.2, 66.1, 100.3, 103.8, 110.9, 116.5, 120.3, 128.3, 128.6, 128.6, 128.9, 131.0, 133.1, 133.1, 134.0, 141.9, 141.9, 197.6, 197.6. LCMS: *m/z* (%) = 413.2 [M+1]. Anal. Calcd for C<sub>27</sub>H<sub>28</sub>N<sub>2</sub>O<sub>2</sub> (414.23): C, 78.23; H, 7.29; N, 6.76; O, 7.72. Found: C, 78.31; H, 7.36; N, 6.87; O, 7.73.

**2'-(1-Acetyl-1*H*-indol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8c)**



Off white solid; yield 0.081g (0.20 mmol, 83%).  $^1\text{H}$  NMR (400 MHz, MeOD)  $\delta$  = 8.05 (1 H, d,  $^3J$  = 8.53 Hz, CH), 7.87-7.90 (1 H, m, CH), 7.72-7.81 (2 H, m, 2 CH), 7.67-7.71 (1 H, m, CH), 7.57 (1 H, d,  $^3J$  = 4.02 Hz, CH), 7.33 (1 H, d,  $^3J$  = 1.51 Hz, CH), 7.02 (1 H, dd,  $^3J$  = 1.76, 8.78 Hz, CH), 6.51-6.55 (1 H, m, CH), 4.22 (1 H, dq,  $^3J$  = 3.01, 8.03 Hz, CH), 4.01 (1 H, dd,  $^3J$  = 7.78, 11.29 Hz, CH), 3.35-3.41 (1 H, m, CH), 3.06 (1 H, ddd,  $^3J$  = 8.53, 11.04, 12.55 Hz, CH), 2.72-2.80 (1 H, m, CH), 2.56 (2 H, s,  $\text{CH}_2$ ), 2.16-2.29 (2 H, m,  $\text{CH}_2$ ), 2.07-2.15 (1 H, m, CH), 1.65-1.86 (2 H, m,  $\text{CH}_2$ ).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 23.4, 24.2, 29.2, 30.5, 31.9, 50.3, 61.7, 99.2, 102.4, 110.9, 117.6, 119.3, 125.5, 127.9, 128.7, 128.7, 131.0, 133.1, 133.1, 133.2, 141.2, 167.8, 197.6. LCMS:  $m/z$  (%) = 401.2 [M+1]. Anal. Calcd for  $\text{C}_{25}\text{H}_{22}\text{N}_2\text{O}_3$  (400.18): C, 74.98; H, 6.04; N, 7.00; O, 11.99. Found: C, 75.00; H, 6.10; N, 7.03; O, 12.05.

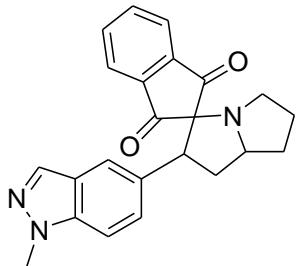
**2'-(1-Benzyl-1*H*-indol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8d)**



Yellow solid; yield 0.091g (0.20 mmol, 85%).  $^1\text{H}$  NMR (300 MHz, DMSO-d6)  $\delta$  = 7.77-7.93 (3 H, m, 3 CH), 7.65-7.74 (1 H, m, CH), 7.35 (1 H, d,  $^3J$  = 3.02 Hz, CH), 7.12-7.29 (6 H, m, 6 CH), 7.07 (2 H, d,  $^3J$  = 6.42 Hz, 2 CH), 6.79 (1 H, d,  $^3J$  = 8.31 Hz, CH), 6.32 (1 H, d,  $^3J$  = 3.02 Hz, CH), 5.26 (2 H, s,  $\text{CH}_2$ ), 3.98 (1 H, br. S., CH), 3.80-3.91 (1 H, m, CH), 2.97-3.08 (1 H, m, CH),

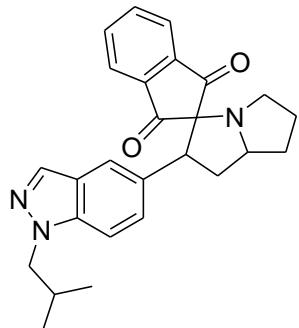
2.84 (1 H, dd,  $^3J = 11.90, 19.07$  Hz, CH), 1.89-2.16 (3 H, m, 3 CH), 1.44-1.74 (3 H, m, 3 CH).  $^{13}\text{C}$  NMR (300 MHz):  $\delta = 27.6, 33.5, 37.1, 49.5, 49.9, 52.4, 65.5, 76.5, 77.0, 77.2, 77.4, 78.3, 101.6, 109.3, 120.7, 122.4, 122.7, 123.2, 126.7, 127.5, 127.6, 128.2, 128.5, 128.6, 135.0, 135.5, 135.5, 137.4, 141.4, 141.6, 200.9$ . LCMS:  $m/z$  (%) = 447.2 [M+1]. Anal. Calcd for  $\text{C}_{25}\text{H}_{22}\text{N}_2\text{O}_3$  (446.54): C, 80.69; H, 5.87; N, 6.27; O, 7.17. Found: C, 80.75; H, 5.89; N, 6.32; O, 7.19.

**2'-(1-Methyl-1*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8e)**



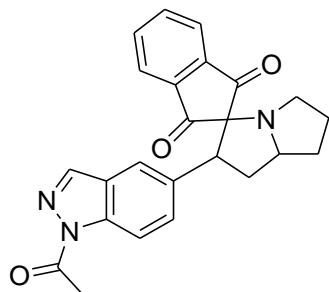
Pale yellow solid; yield 0.077g (0.20 mmol, 86%).  $^1\text{H}$  NMR (400 MHz, MeOD ):  $\delta = 8.02$  (1 H, s, CH), 7.88 (1 H, d,  $^3J = 9.60$  Hz, CH), 7.72-7.80 (2 H, m, 2 CH), 7.67-7.70 (1 H, m, CH), 7.44 (1 H, s, CH), 7.27 (1 H, d,  $^3J = 8.80$  Hz, CH), 6.99 (1 H, d,  $^3J = 2.00$  Hz, CH), 4.12 (1 H, d,  $^3J = 7.20$  Hz, CH), 4.09 (3 H, s, Me), 4.00 (1 H, t,  $^3J = 19.20$  Hz, CH), 3.40 (1 H, d,  $^3J = 6.00$  Hz, CH), 3.52 (1 H, q,  $^3J = 374.40$  Hz, CH), 2.62-2.79 (2 H, m, CH<sub>2</sub>), 2.10-2.31 (3 H, m, Me), 1.65-1.89 (2 H, m, CH<sub>2</sub>). (300 MHz):  $\delta = 29.8, 34.3, 39.1, 49.9, 50.5, 53.6, 67.2, 76.5, 77.2, 77.2, 77.6, 78.7, 101.8, 110.3, 121.8, 122.5, 122.9, 123.4, 126.9, 128.1, 128.2, 128.7, 128.9, 129.2, 135.0, 135.9, 136.1, 137.8, 141.5, 141.9, 200.9$ . LCMS:  $m/z$  (%) = 372.2 [M+1]. Anal. Calcd for  $\text{C}_{23}\text{H}_{21}\text{N}_3\text{O}_2$  (371.16): C, 74.37; H, 5.70; N, 11.31; O, 8.61. Found: 74.40; H, 5.77; N, 11.44; O, 8.67.

**2'-(1-Isobutyl-1*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8f)**



Brown Solid; yield 0.055g (0.13 mmol, 68%).  $^1\text{H}$  NMR(400 MHz, MeOD ):  $\delta$  = 8.04 (1 H, s, CH), 7.69-8.04 (4 H, m, 4 CH), 7.45 (1 H, s, CH), 7.30 (1H, d,  $^3J$  = 0.03 Hz, CH), 7.15 (1 H, d,  $^3J$  = 12.00 Hz, CH), 7.02 (1 H, d,  $^3J$  = 2.00 Hz, 1H), 4.15 (1 H, d,  $^3J$  = 28.00 Hz, CH), 3.80 (2 H, t,  $^3J$  = 14.00 Hz, CH<sub>2</sub>), 3.31-3.32 (1 H, m, CH), 2.62-2.77 (1 H, m, CH), 2.02-2.12 (3 H, m, 3 CH), 1.72-1.89 (2 H, m, 2 CH), 0.87-0.93 (2 H, m, 2 CH), 0.77-0.81 (6 H, m, 2 Me).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 21.0, 21.1, 23.5, 25.5, 29.0, 29.6, 32.0, 51.1, 59.3, 61.2, 99.1, 113.4, 120.2, 125.2, 125.8, 129.0, 129.2, 132.5, 133.2, 133.6, 133.8, 137.3, 141.6, 141.7, 198.2, 198.4. LCMS: *m/z* (%) = 372.2 [M+1]. Anal. Calcd for C<sub>26</sub>H<sub>27</sub>N<sub>3</sub>O<sub>2</sub> (414.2): C, 75.52; H, 6.58; N, 10.16; O, 7.74. Found: 75.60; H, 6.63; N, 10.17; O, 7.82.

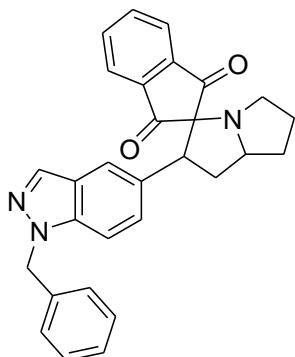
**2'-(1-Acetyl-1*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8g)**



Off white solid; yield 0.090g (0.22 mmol, 70%).  $^1\text{H}$  NMR(400 MHz, MeOD ):  $\delta$  = 8.06-8.12 (2 H, m, CH), 7.89-7.92 (1 H, m, CH), 7.62-7.82 (3 H, m, 3 CH), 7.62 (1 H, s, CH), 7.30 (1 H, d,  $^3J$  = 2.00 Hz, CH), 4.12 (1 H, t,  $^3J$  = 26.00 Hz, CH), 3.01-3.12 (1 H, m, CH), 2.79 (1 H, t,  $^3J$  = 10.00 Hz, CH), 2.65 (3 H, s, Me), 2.24-2.26 (2 H, m, CH<sub>2</sub>), 2.00-2.03 (1 H, m, CH), 1.26-1.31 (2 H, m, CH<sub>2</sub>).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 23.5, 23.9, 29.2, 29.6, 32.3, 50.5, 61.9, 99.5, 113.5, 121.1,

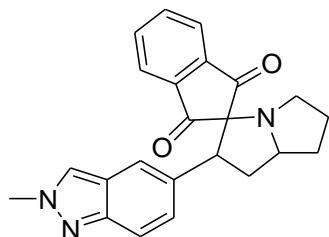
124.5, 126.0, 128.0, 128.8, 129.0, 132.4, 133.5, 133.7, 139.1, 143.4, 143.6, 169.0, 197.7, 197.9. LCMS:  $m/z$  (%) = 400.2 [M+1]. Anal. Calcd for  $C_{24}H_{21}N_3O_3$  (399.16): C, 73.00; H, 6.50; N, 11.03; O, 12.52. Found: C, 73.16; H, 6.54; N, 11.12; O, 12.55.

**2'-(1-Benzyl-1*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8h)**



Brown semi solid; yield 0.065g (0.14 mmol, 82%). <sup>1</sup>H-NMR(400 MHz, CDCl<sub>3</sub>):  $\delta$  = 7.91-7.96 (1 H, m, CH), 7.71-7.82 (4 H, m, 4 CH), 7.42-7.47 (2 H, m, 2 CH), 7.32-7.38 (3 H, m, 3 CH), 7.22-7.26 (2 H, m, 2 CH), 7.02 (1 H, dd, <sup>3</sup>J = 2.01, 9.04 Hz, CH), 5.50 (2 H, s, CH<sub>2</sub>), 3.87-3.95 (1 H, m, CH), 3.15-3.24 (1 H, m, CH), 3.01 (1 H, ddd, <sup>3</sup>J = 8.28, 10.42, 12.42 Hz, CH), 2.78-2.86 (1 H, m, CH), 2.05-2.26 (3 H, m, 3 CH), 1.79-1.94 (3 H, m, 3 CH), 1.57-1.72 (1 H, m, CH). <sup>13</sup>C NMR (400 MHz):  $\delta$  = 23.4, 29.0, 29.6, 32.3, 50.3, 61.7, 61.9, 99.3, 114.7, 120.2, 124.3, 126.3, 126.6, 128.6, 128.7, 128.7, 128.9, 131.5, 133.1, 133.5, 133.8, 136.3, 136.5, 141.6, 141.8, 197.2, 197.5. LCMS:  $m/z$  (%) = 448.2 [M+1]. Anal. Calcd for  $C_{29}H_{25}N_3O_2$  (447.19): C, 78.02; H, 6.53; N, 10.00; O, 7.65. Found: C, 78.09; H, 6.63; N, 10.09; O, 7.68.

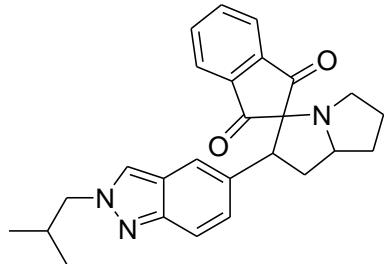
**2'-(2-Methyl-2*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8i)**



Pale yellow solid; yield 0.072g (0.19 mmol, 68%). <sup>1</sup>H NMR(400 MHz, MeOD)  $\delta$  = 8.02 (1 H, s, CH), 7.86-7.90 (1 H, m, CH), 7.73-7.79 (2 H, m, 2 CH), 7.67-7.70 (1 H, m, CH), 7.43-7.46 (1 H,

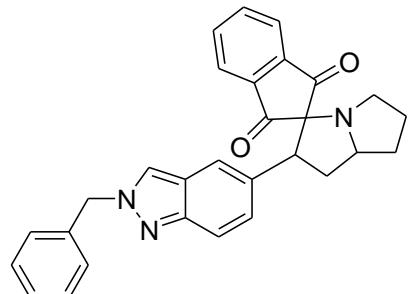
m, CH), 7.27 (1 H, d,  $^3J = 9.03$  Hz, CH), 7.01 (1 H, dd,  $^3J = 2.01, 9.04$  Hz, CH), 5.50 (1 H, s, CH), 4.13 (1 H, s, CH), 4.11 (3 H, s, Me), 4.00 (1 H, dd,  $^3J = 7.78, 11.29$  Hz, CH), 3.40 (1 H, dt,  $^3J = 6.02, 10.04$  Hz, CH), 3.04 (1 H, ddd,  $^3J = 8.53, 11.42, 12.67$  Hz, CH), 2.79 (1 H, ddd,  $^3J = 2.76, 6.90, 9.91$  Hz, CH), 2.58-2.76 (1 H, m, CH), 2.23-2.38 (1 H, m, CH), 2.19 (1 H, ddd,  $^3J = 3.01, 7.91, 12.67$  Hz, CH), 2.08-2.15 (1 H, m, CH), 1.62-1.86 (2 H, m, 2 CH).  $^{13}\text{C}$  NMR (125 MHz):  $\delta = 27.4, 29.0, 33.4, 36.2, 40.1, 49.6, 52.0, 58.5, 65.6, 116.9, 119.1, 122.8, 123.2, 123.6, 127.0, 136.0, 141.5, 148.2, 148.2, 200.0, 200.0, 200.2, 203.9$ . LCMS:  $m/z$  (%) = 373 [M+1]. Anal. Calcd for  $\text{C}_{23}\text{H}_{21}\text{N}_3\text{O}_2$  (371.16): C, 75.17; H, 6.00; N, 11.62; O, 8.92. Found: C, 75.22; H, 6.17; N, 11.71; O, 8.99.

**2'-(2-Isobutyl-2*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (8j)**



Brown semi solid; yield 0.058g (0.14 mmol, 68%).  $^1\text{H}$  NMR(400 MHz, MeOD):  $\delta = 7.55$ -7.76 (5 H, m, 5 CH), 7.39 (1 H, d,  $^3J = 0.80$  Hz, CH), 7.15 (1 H, d,  $^3J = 12.00$  Hz, CH), 7.03 (1 H, d,  $^3J = 2.00$  Hz, CH), 4.16 (1 H, d,  $^3J = 28.00$  Hz, CH), 3.95 (2 H, t,  $^3J = 14.00$  Hz,  $\text{CH}_2$ ), 2.86-2.99 (1 H, m, CH), 2.60-2.75 (1 H, m, CH), 2.03-2.10 (3 H, m, 3 CH), 1.55-1.80 (2 H, m,  $\text{CH}_2$ ), 0.75-0.82 (2 H, m,  $\text{CH}_2$ ), 0.61-0.70 (m, 6H).  $^{13}\text{C}$  NMR (400 MHz):  $\delta = 21.0, 21.1, 23.7, 25.8, 29.0, 29.8, 32.1, 51.2, 59.4, 61.3, 99.1, 113.5, 120.3, 125.2, 125.8, 129.0, 129.1, 132.5, 133.2, 133.7, 133.9, 137.5, 141.7, 141.9, 198.3, 198.4$ . LCMS  $m/z$  (%) = 414.2 [M+1]. Anal. Calcd for  $\text{C}_{26}\text{H}_{27}\text{N}_3\text{O}_2$  (413.2): C, 75.52; H, 6.58; N, 10.16; O, 7.74. Found: C, 75.66; H, 6.71; N, 10.25; O, 7.91.

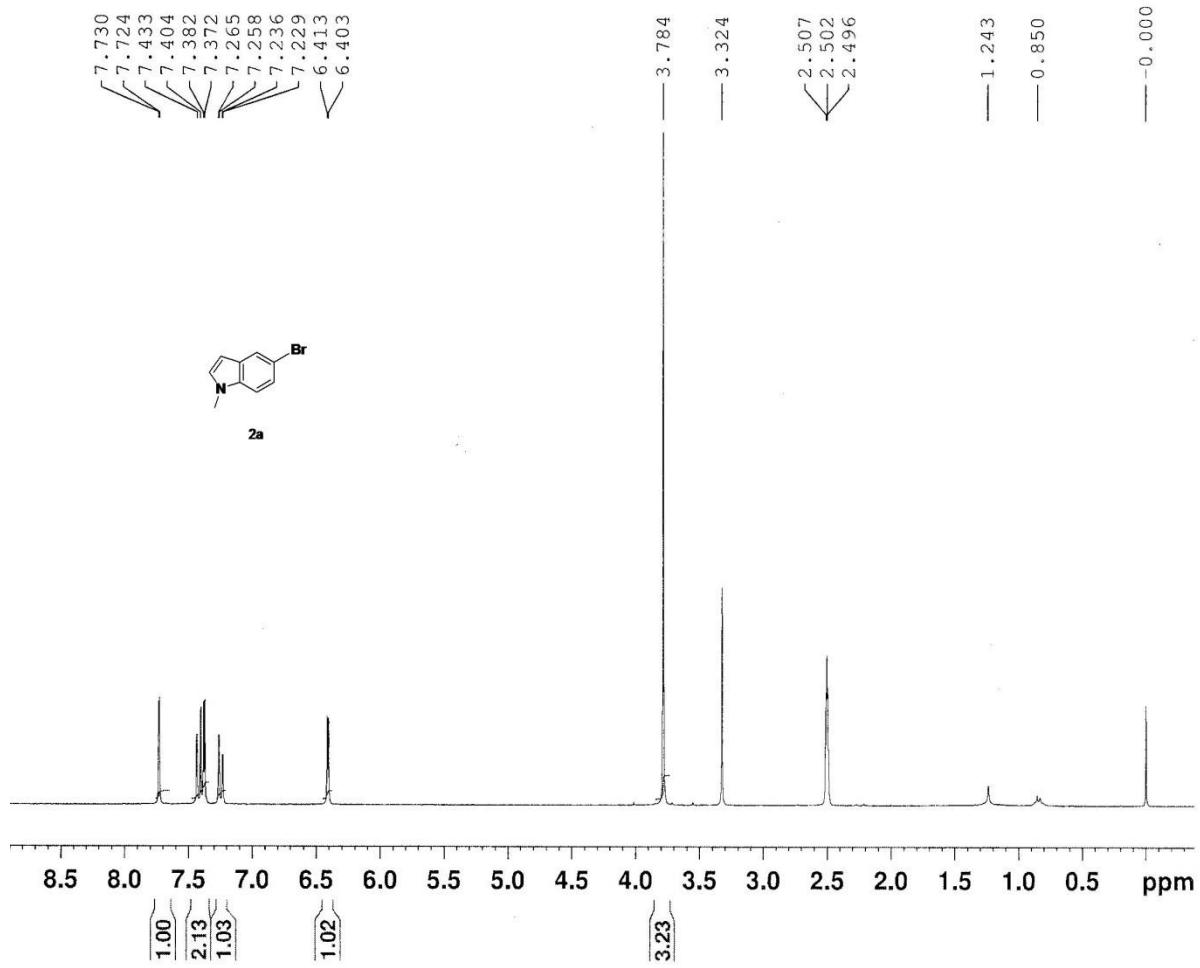
**2'-(2-Benzyl-2*H*-indazol-5-yl)-1',2',5',6',7',7a'-hexahydrospiro[indene-2,3'-pyrrolizine]-1,3-dione (**8k**)**

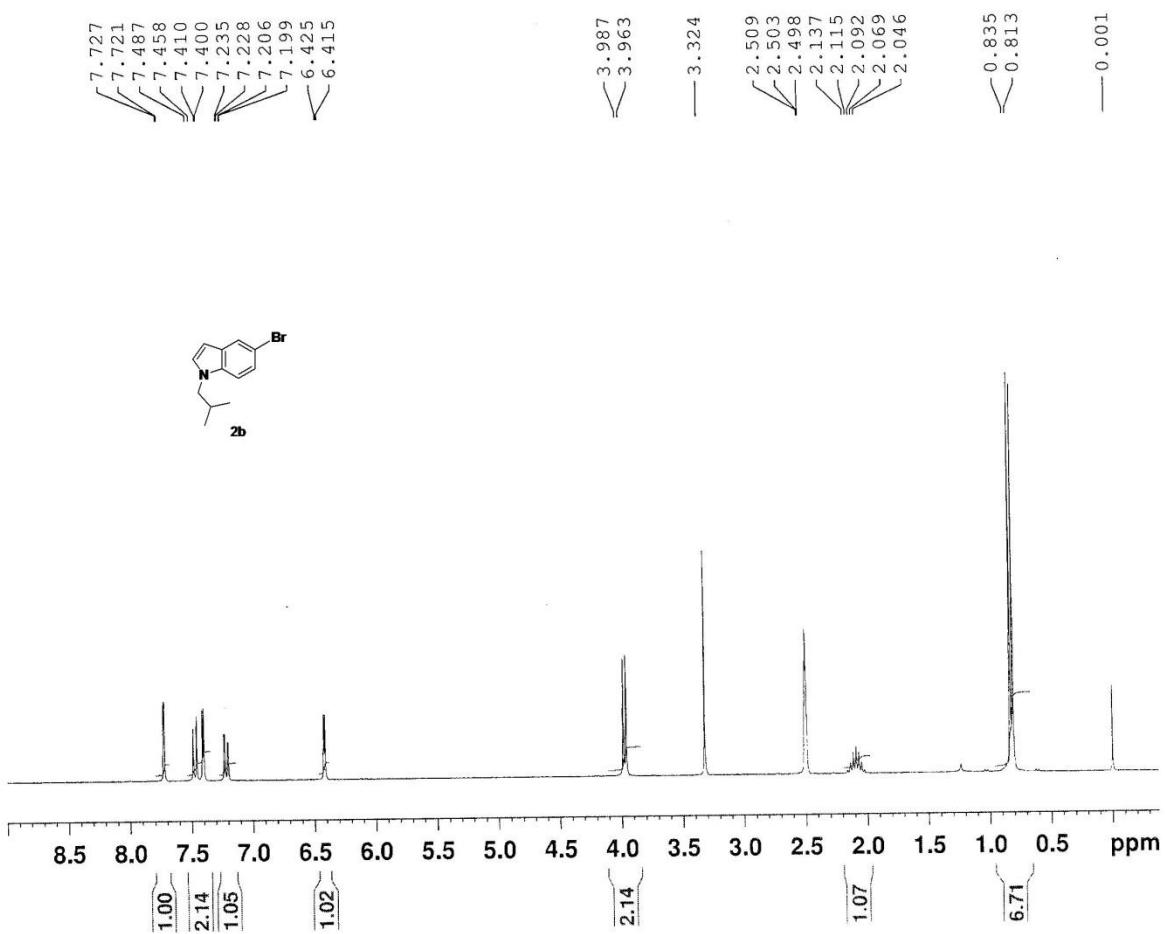


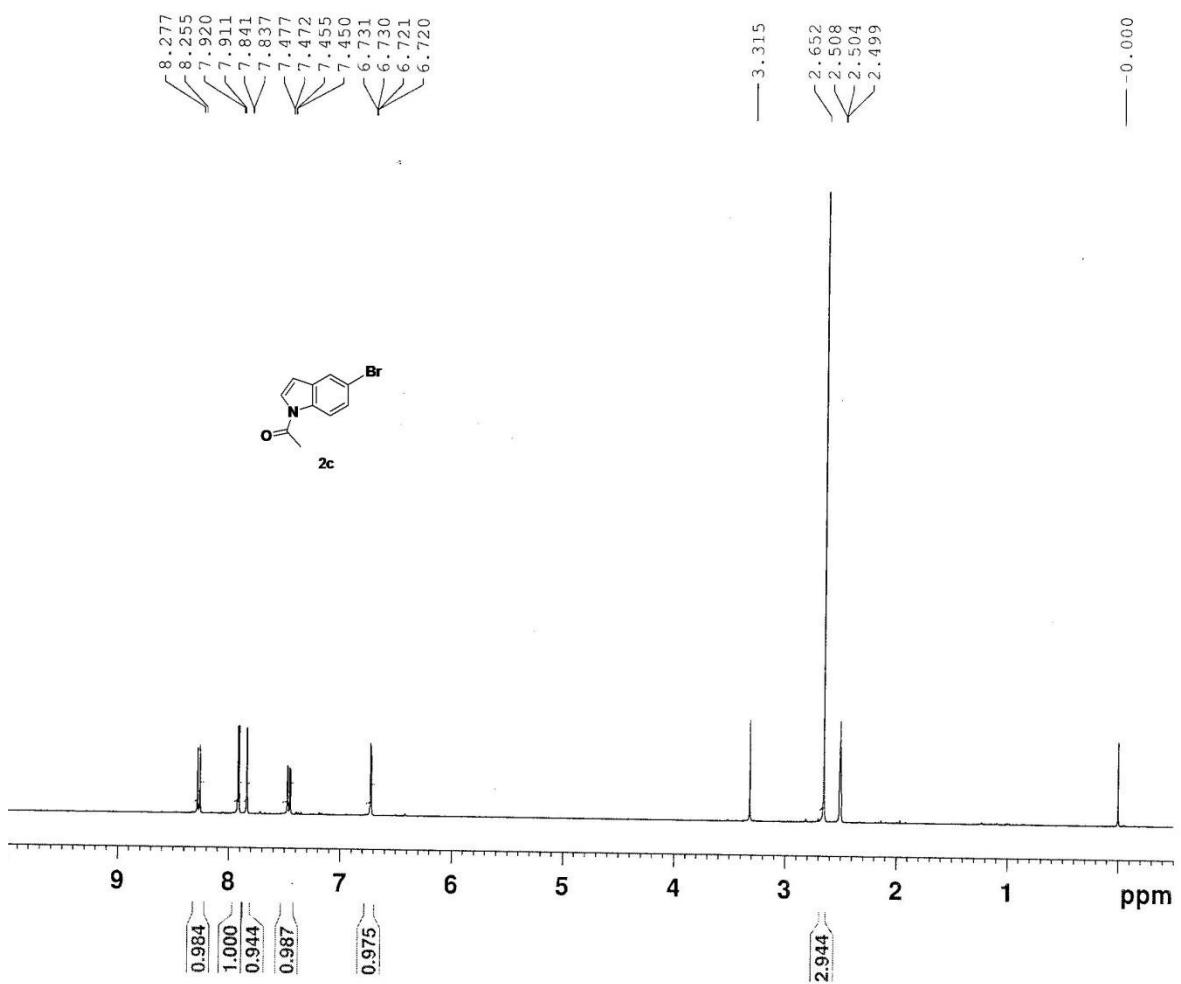
Pale yellow solid; yield 0.047g (0.10 mmol, 68%).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  = 7.83-7.88 (1 H, m, CH), 7.63-7.74 (4 H, m, 4 CH), 7.40-7.45 (2 H, m, 2 CH), 7.28-7.34 (3 H, m, 3 CH), 7.20-7.24 (2 H, m, 2 CH), 7.02 (1 H, dd,  $^3J$  = 2.01, 9.04 Hz, CH), 5.49 (2 H, s,  $\text{CH}_2$ ), 3.85-3.93 (1 H, m, CH), 3.12-3.21 (1 H, m, CH), 2.99 (1 H, ddd,  $^3J$  = 8.28, 10.42, 12.42 Hz, CH), 2.77-2.85 (1 H, m, CH), 2.02-2.23 (3 H, m, 3 CH), 1.77-1.91 (3 H, m, 3 CH), 1.57-1.71 (1 H, m, CH).  $^{13}\text{C}$  NMR (400 MHz):  $\delta$  = 23.5, 29.4, 29.6, 32.5, 50.5, 61.8, 62.2, 99.4, 114.9, 120.4, 124.5, 126.4, 126.8, 128.7, 128.8, 128.9, 130.0, 131.7, 133.4, 133.5, 133.8, 136.4, 136.7, 141.8, 141.9, 197.3, 197.5. LCMS  $m/z$  (%) = 448.2 [M+1]. Anal. Calcd for  $\text{C}_{29}\text{H}_{25}\text{N}_3\text{O}$  (447.19): C, 77.83; H, 5.63; N, 9.39; O, 7.15. Found: C, 77.83; H, 5.67; N, 9.48; O, 7.23.

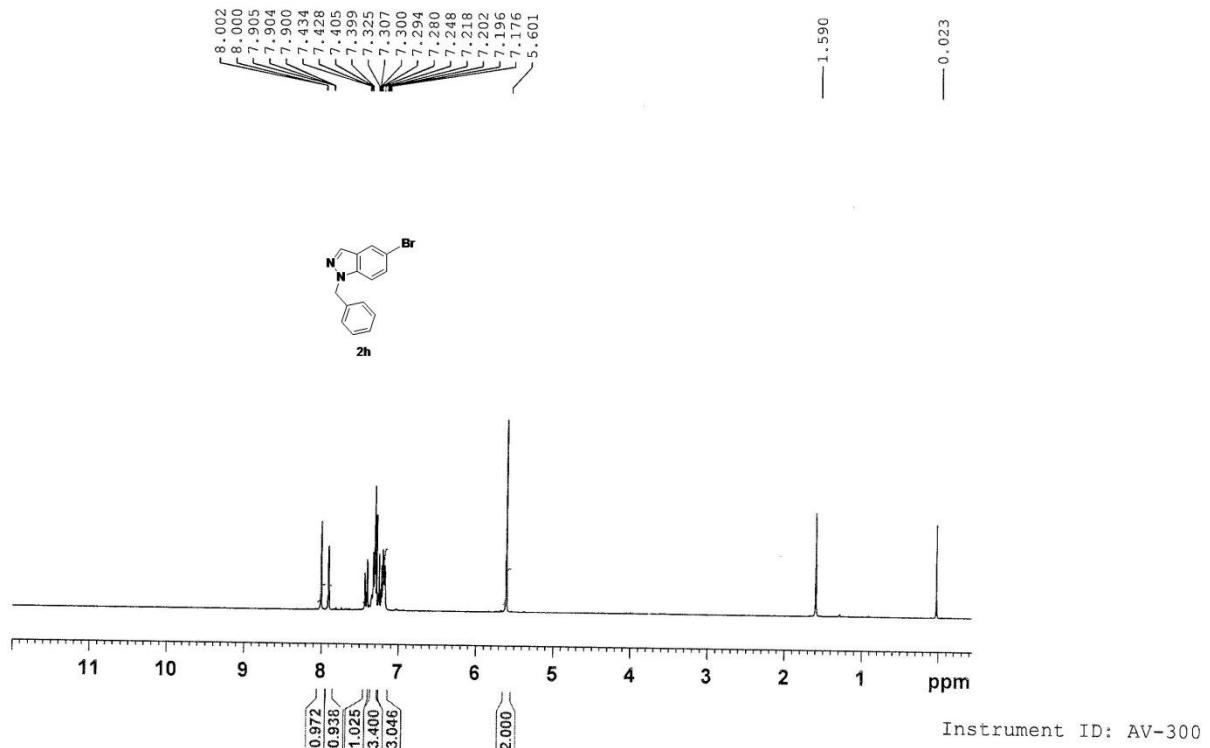
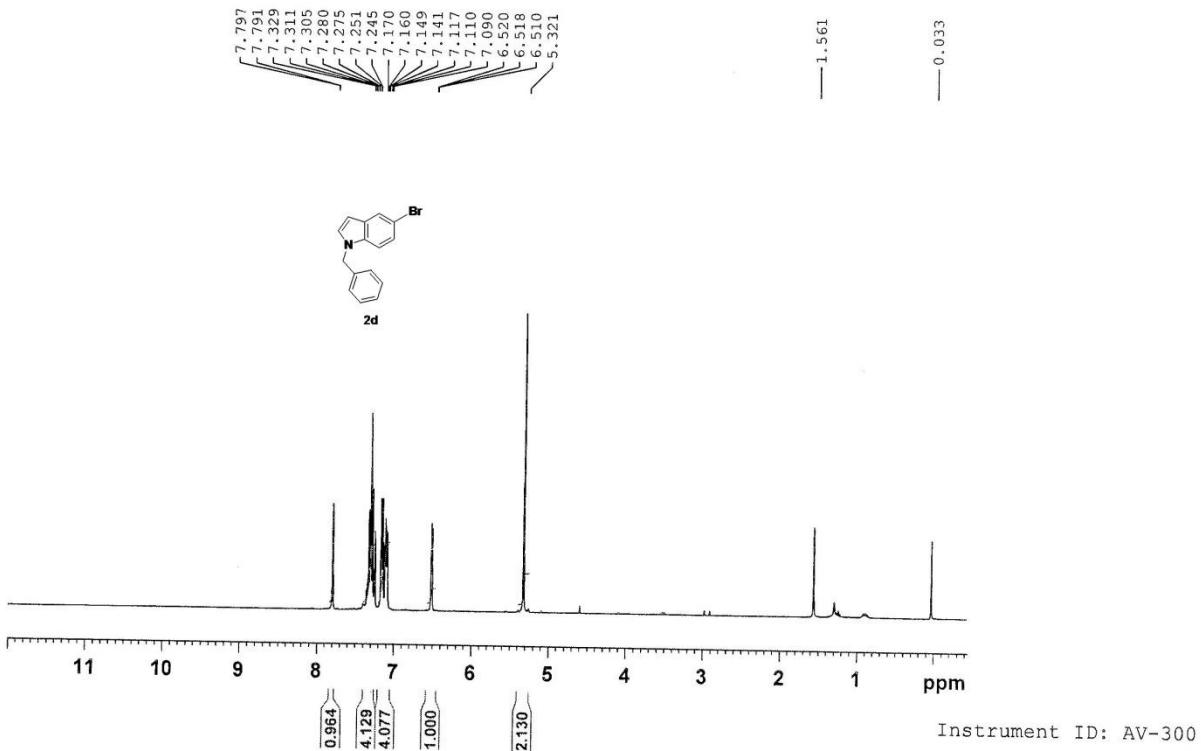
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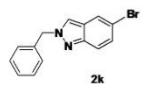
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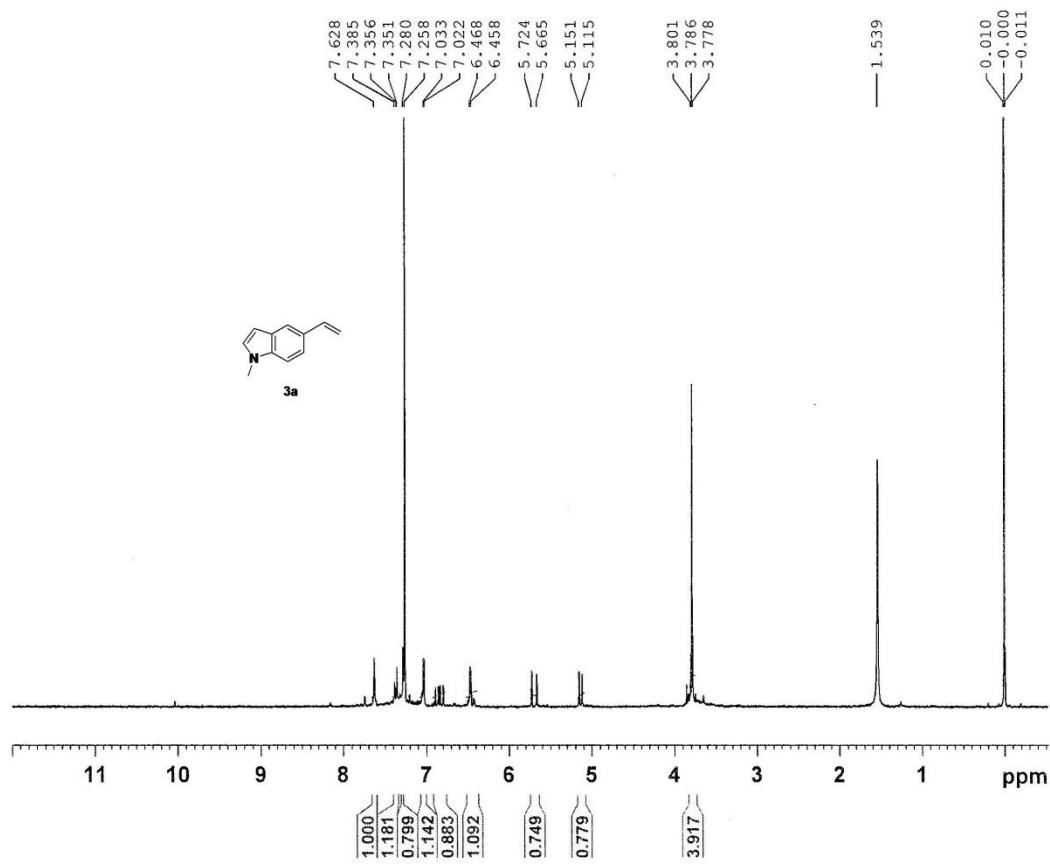




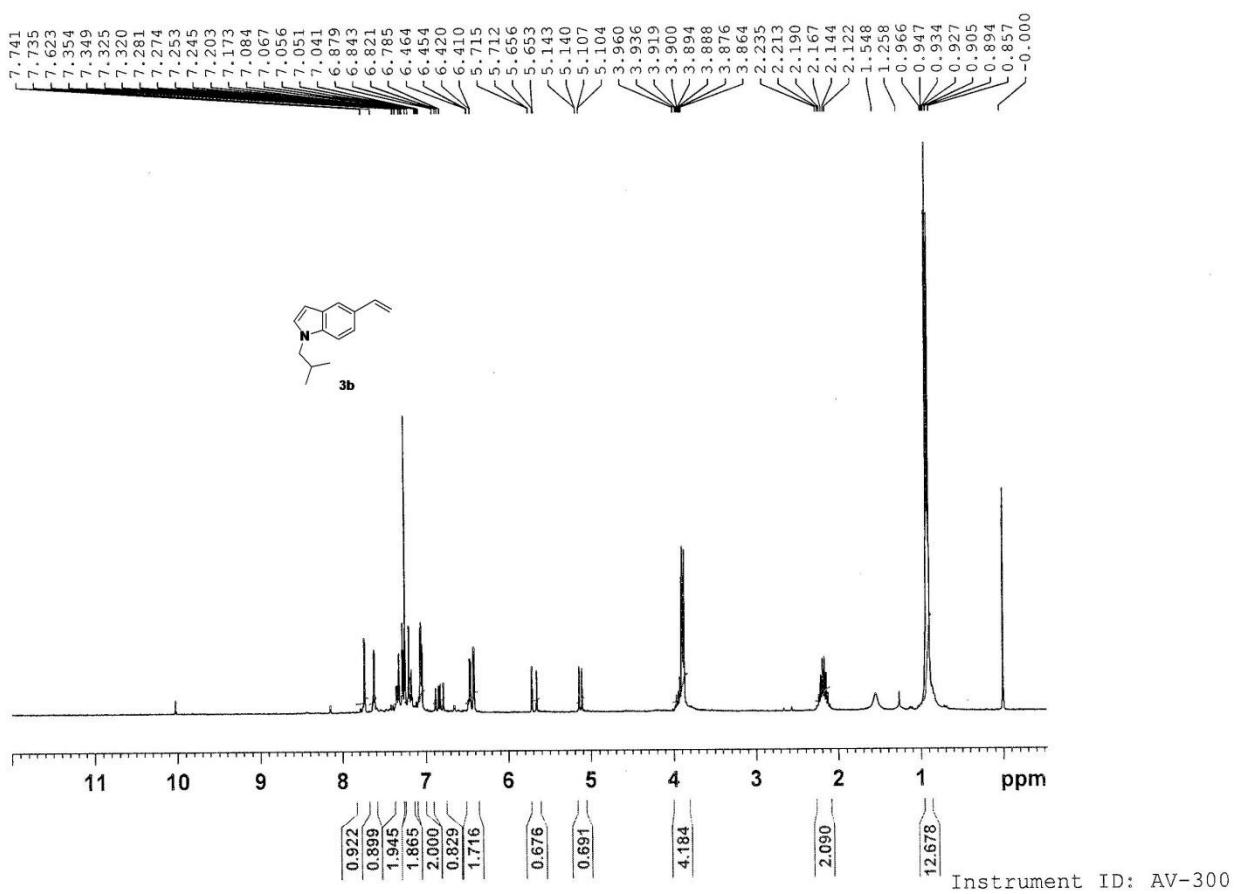


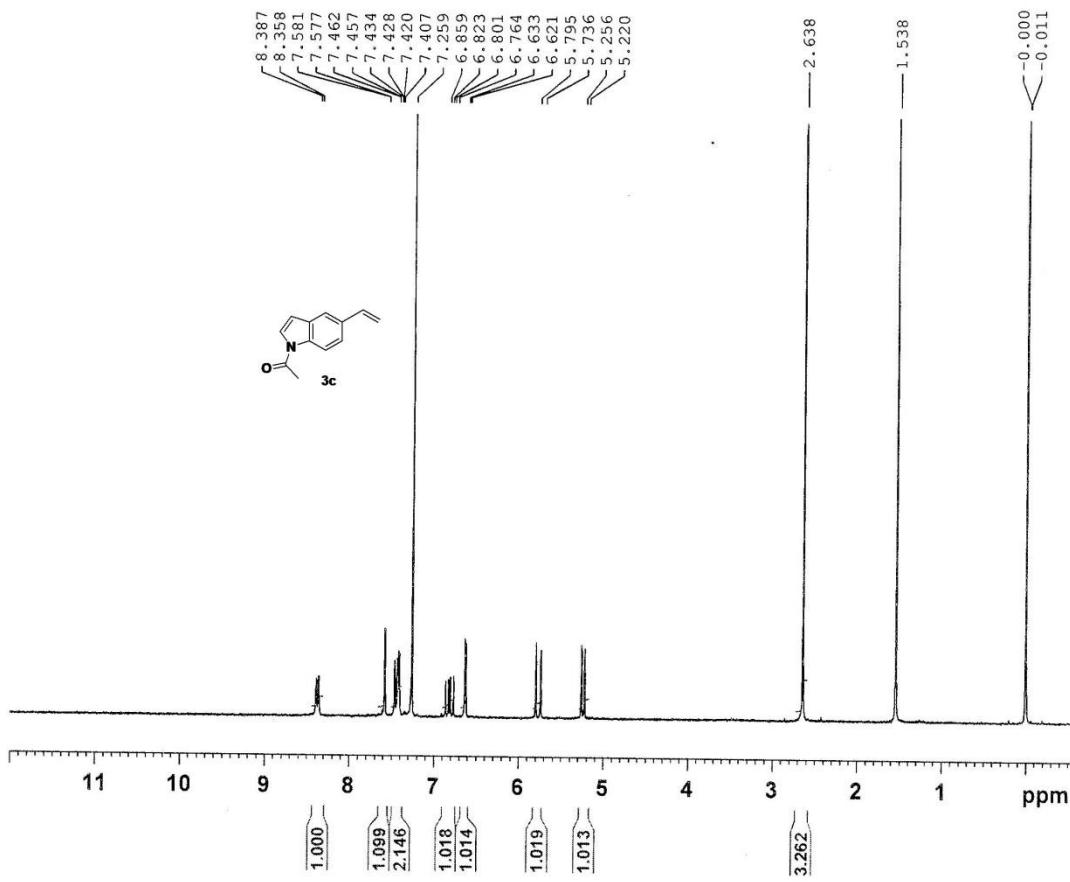


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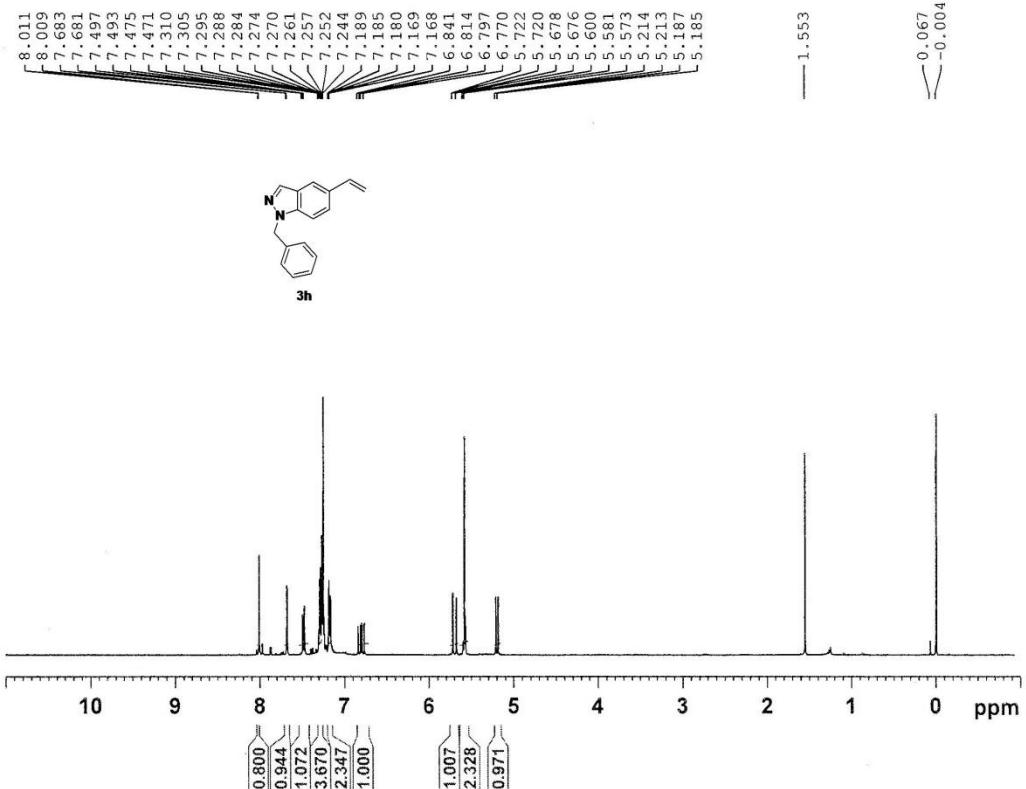


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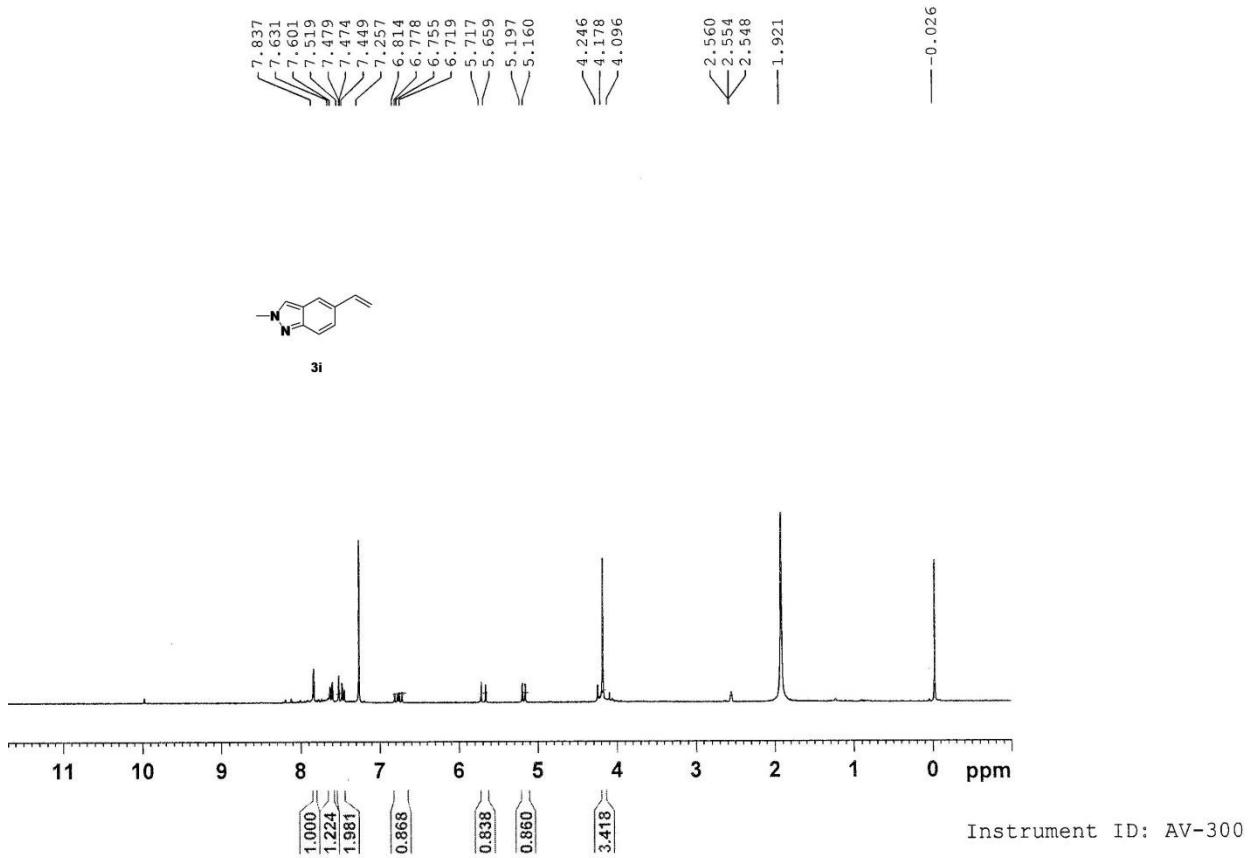


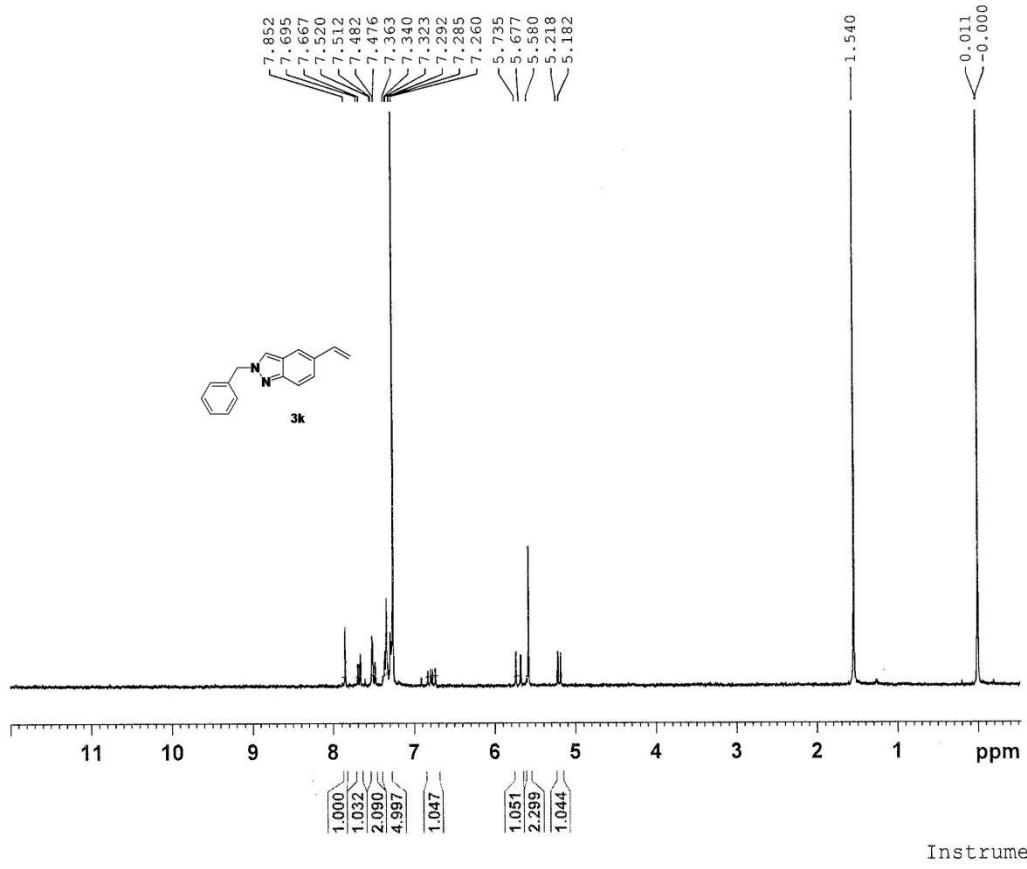


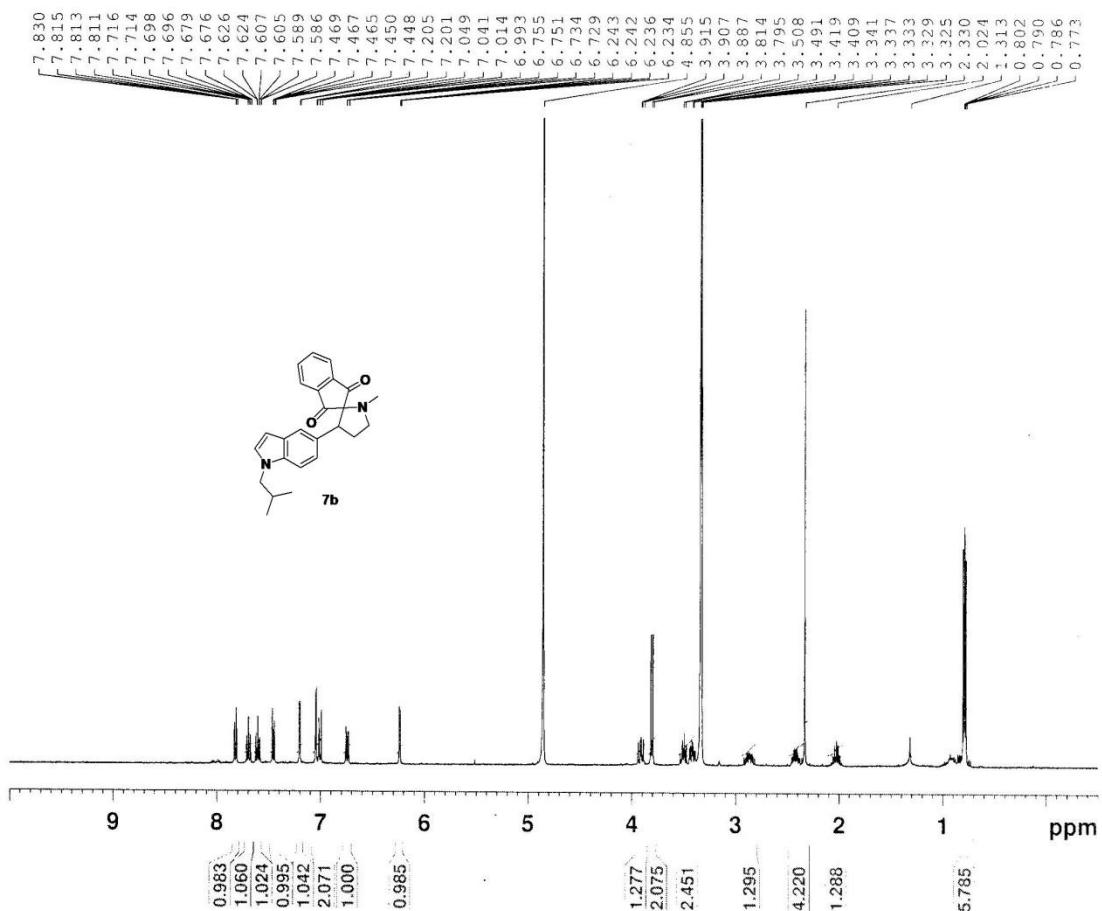
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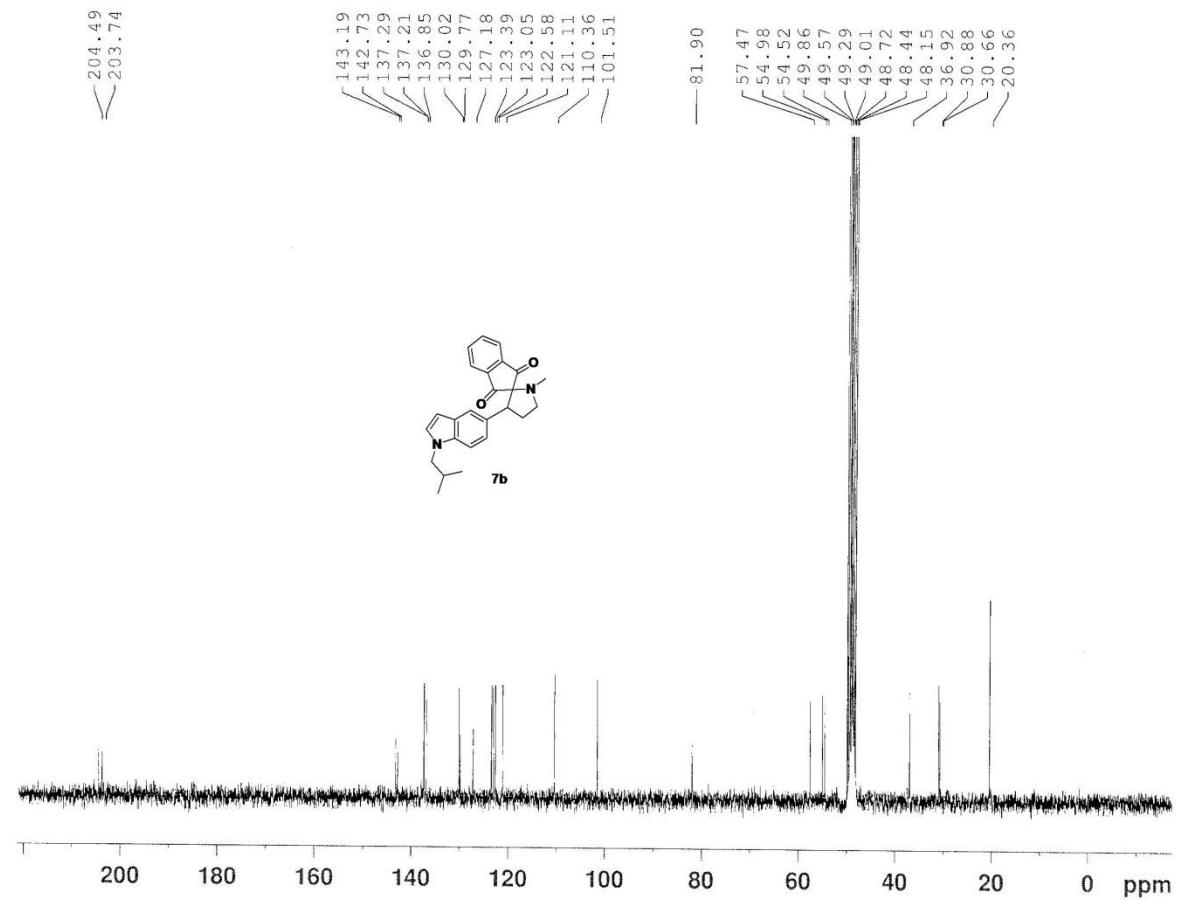


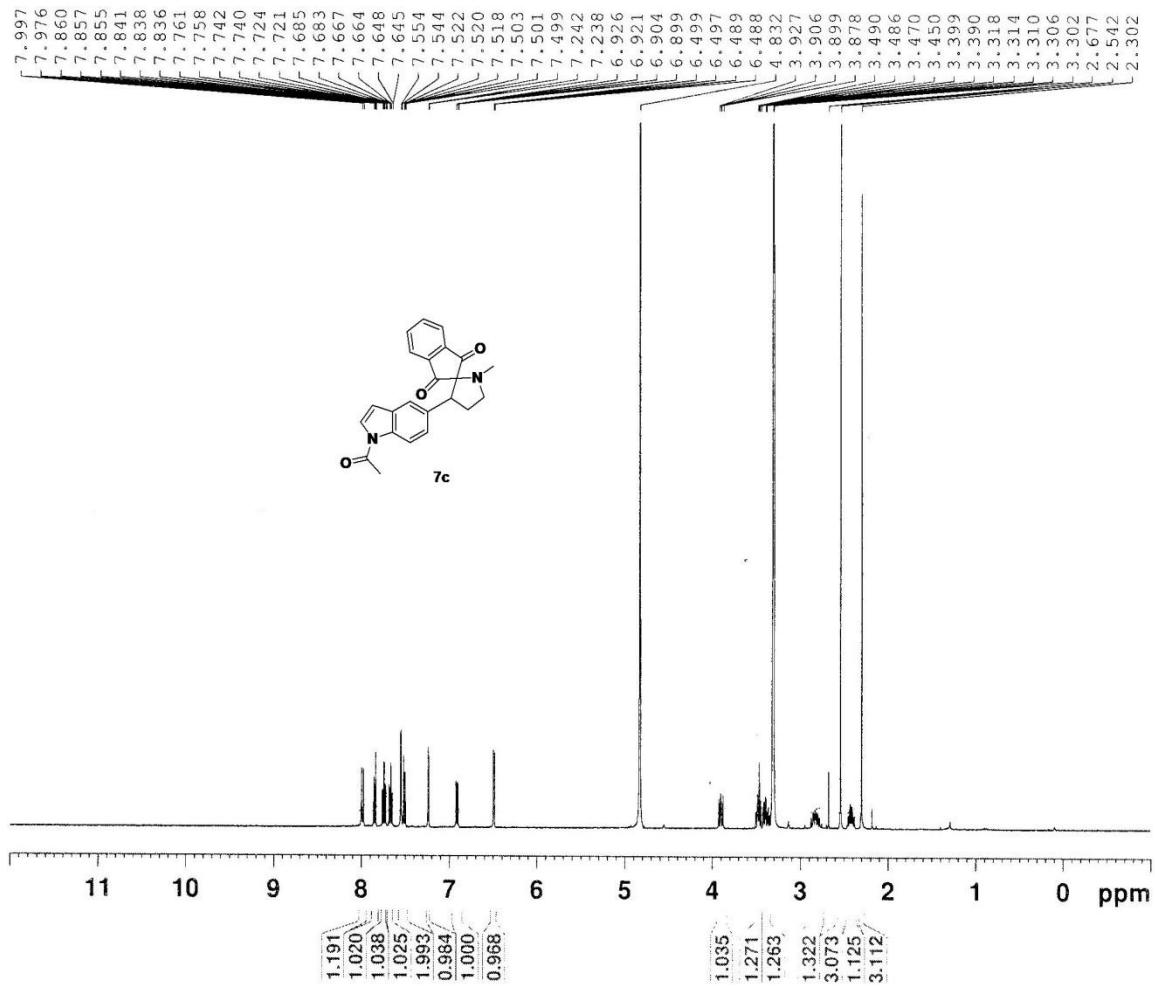
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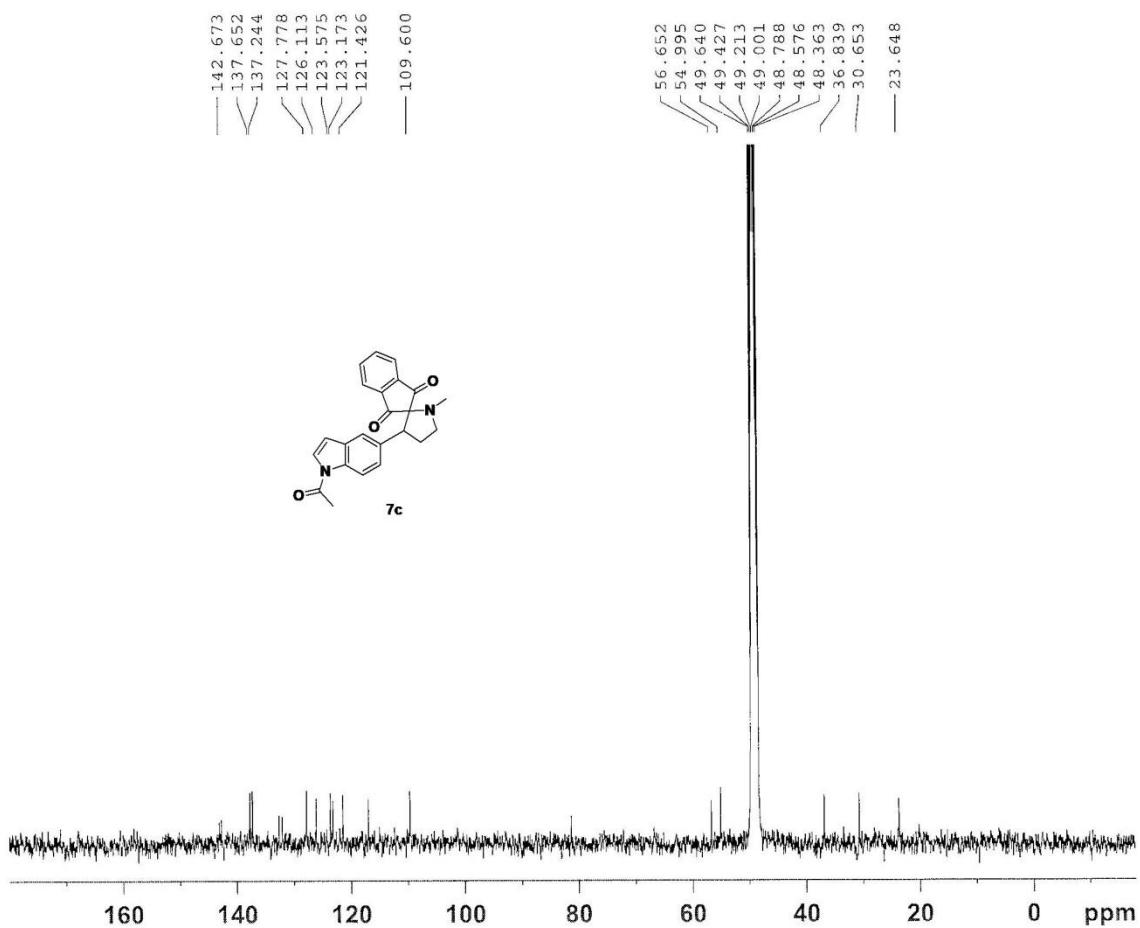


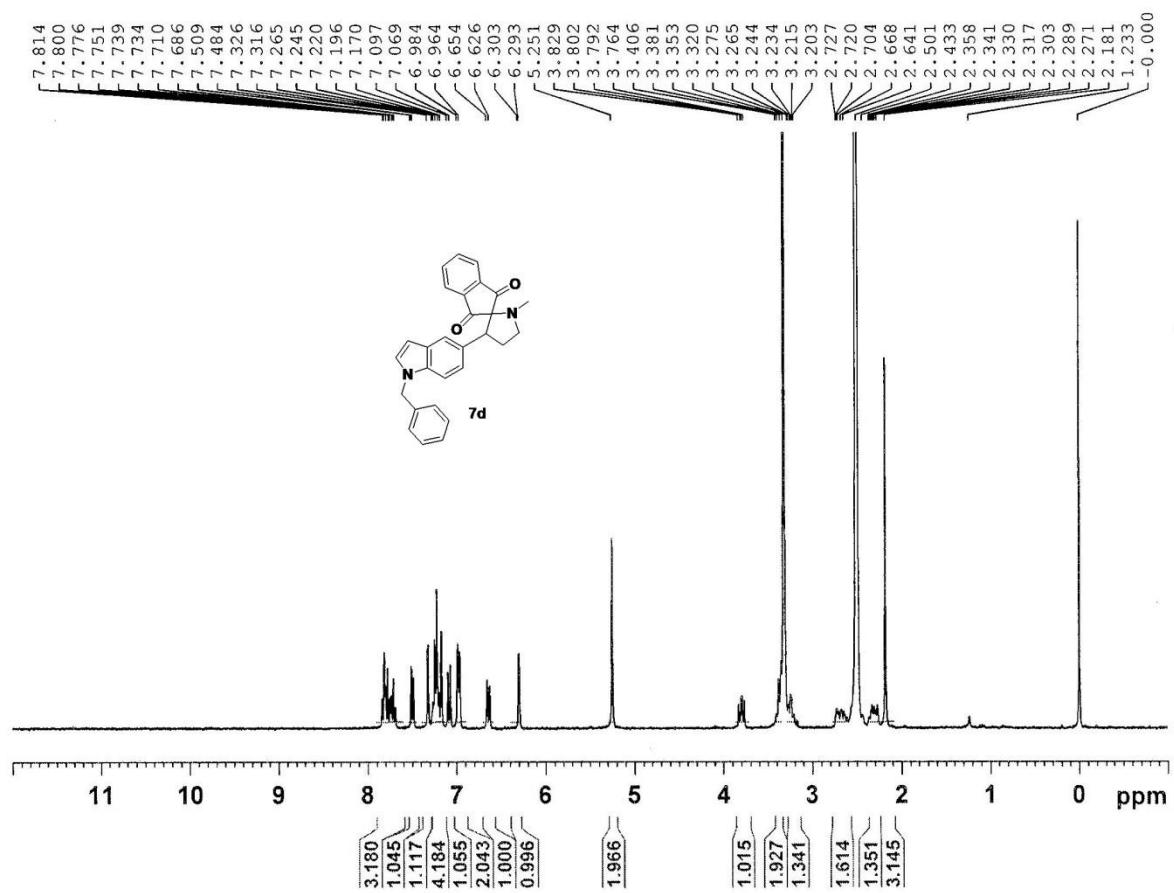


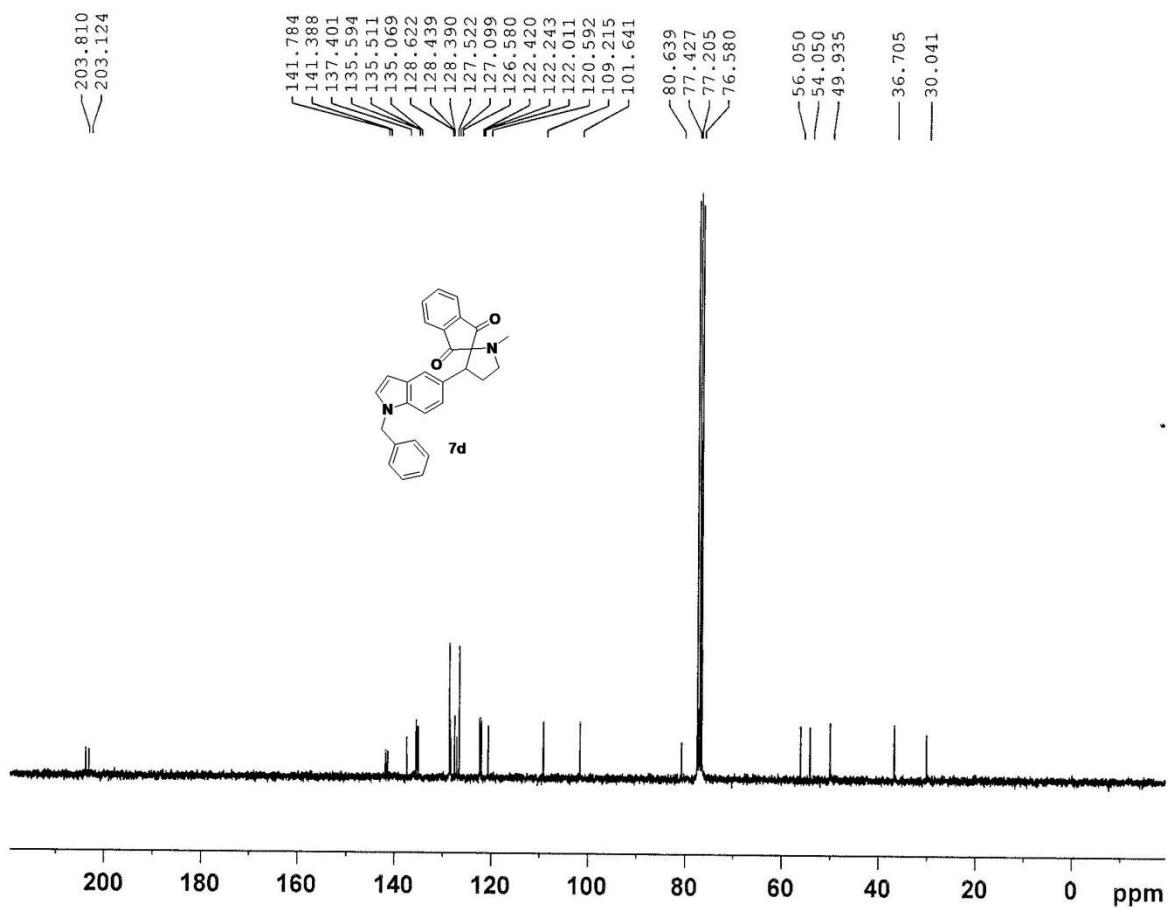


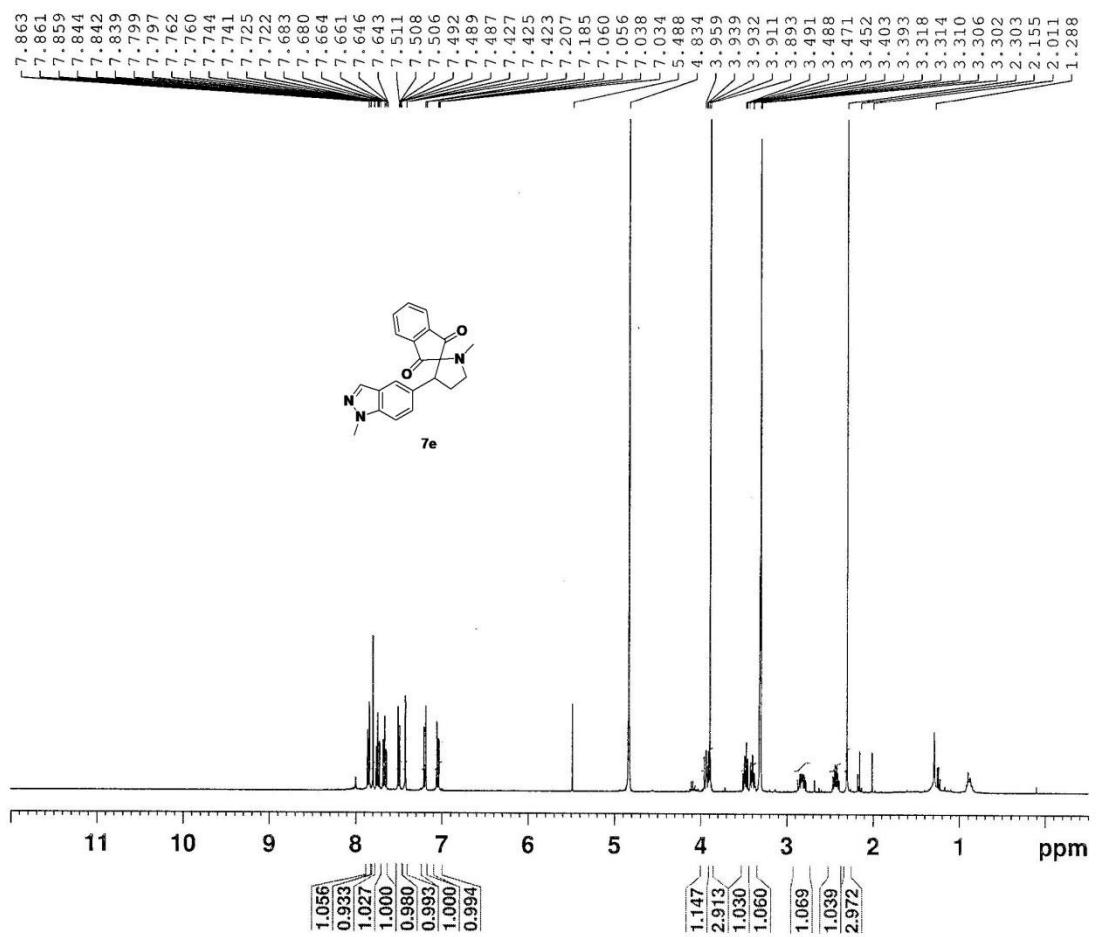


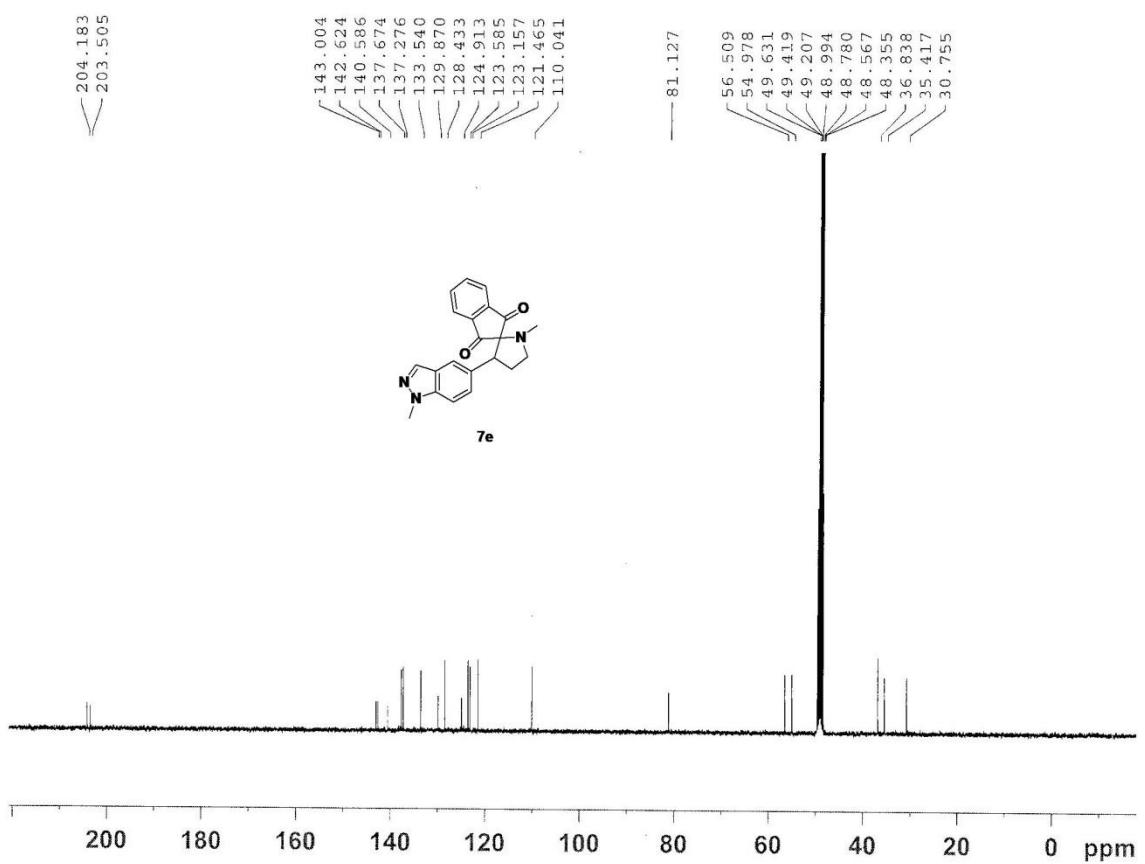


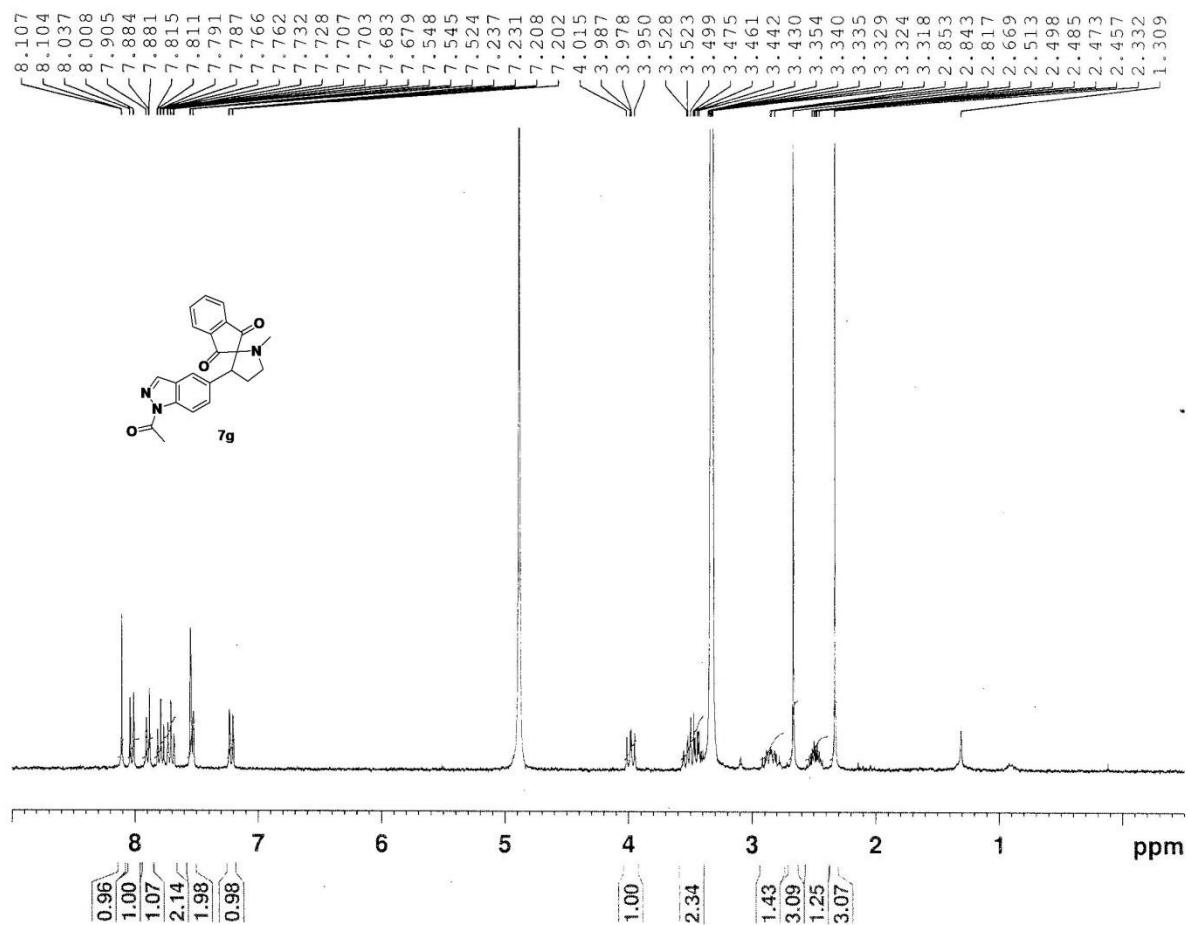


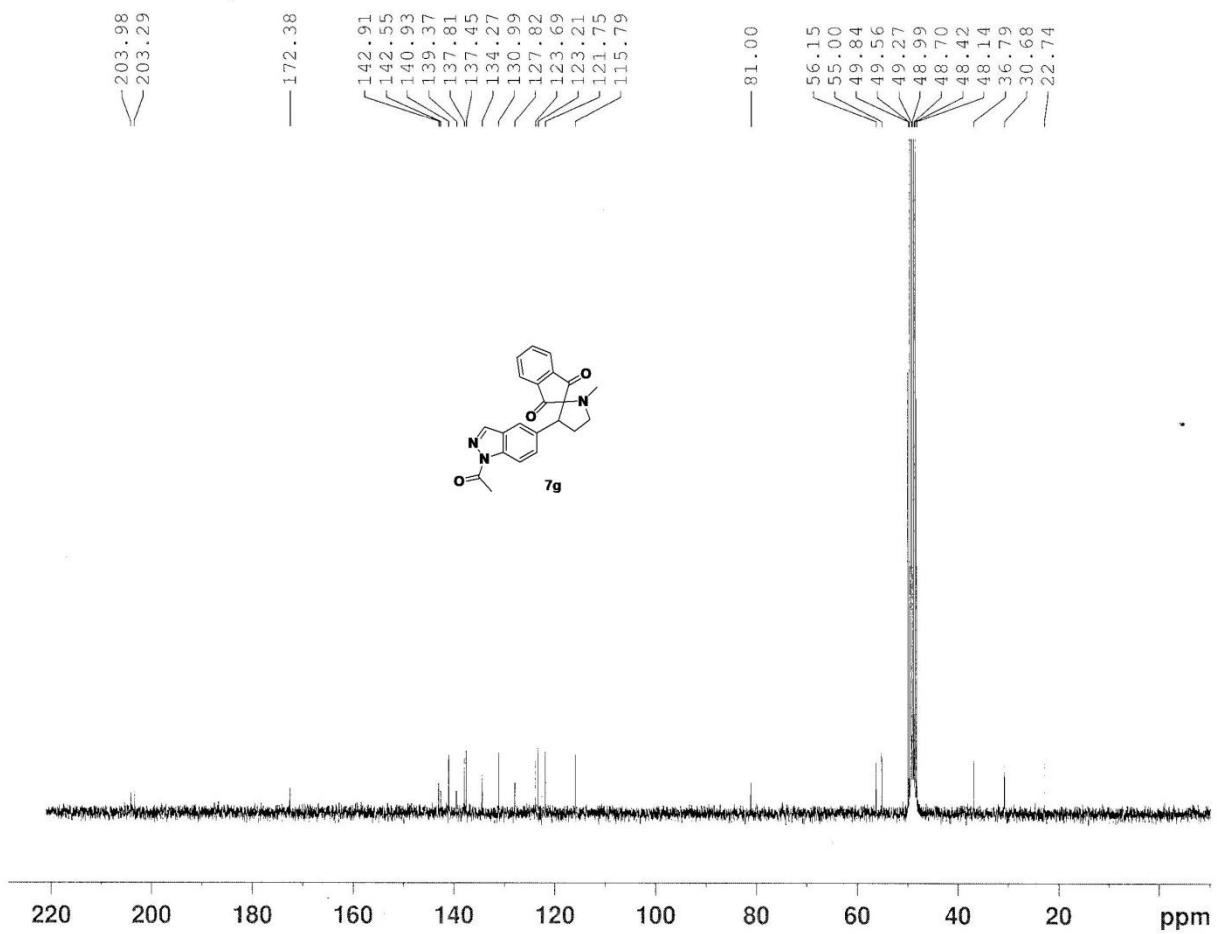


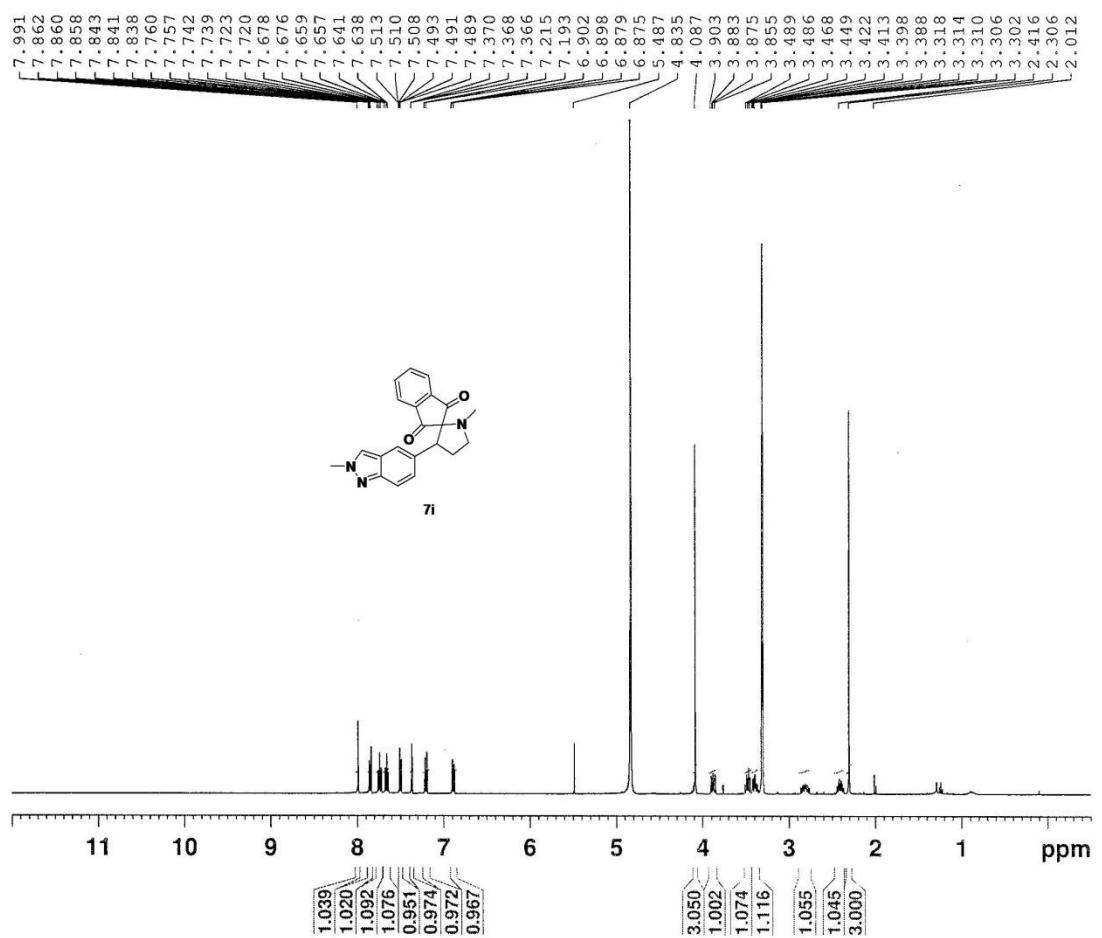


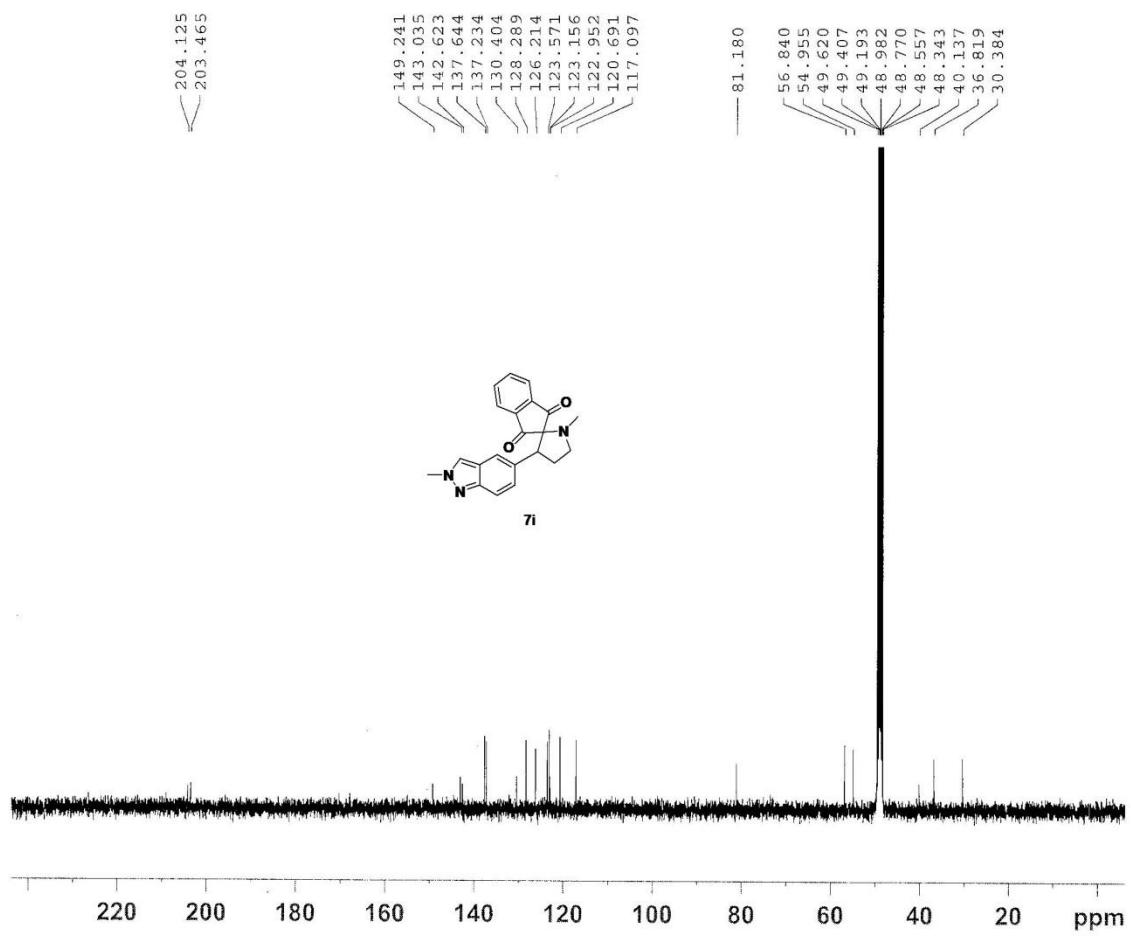


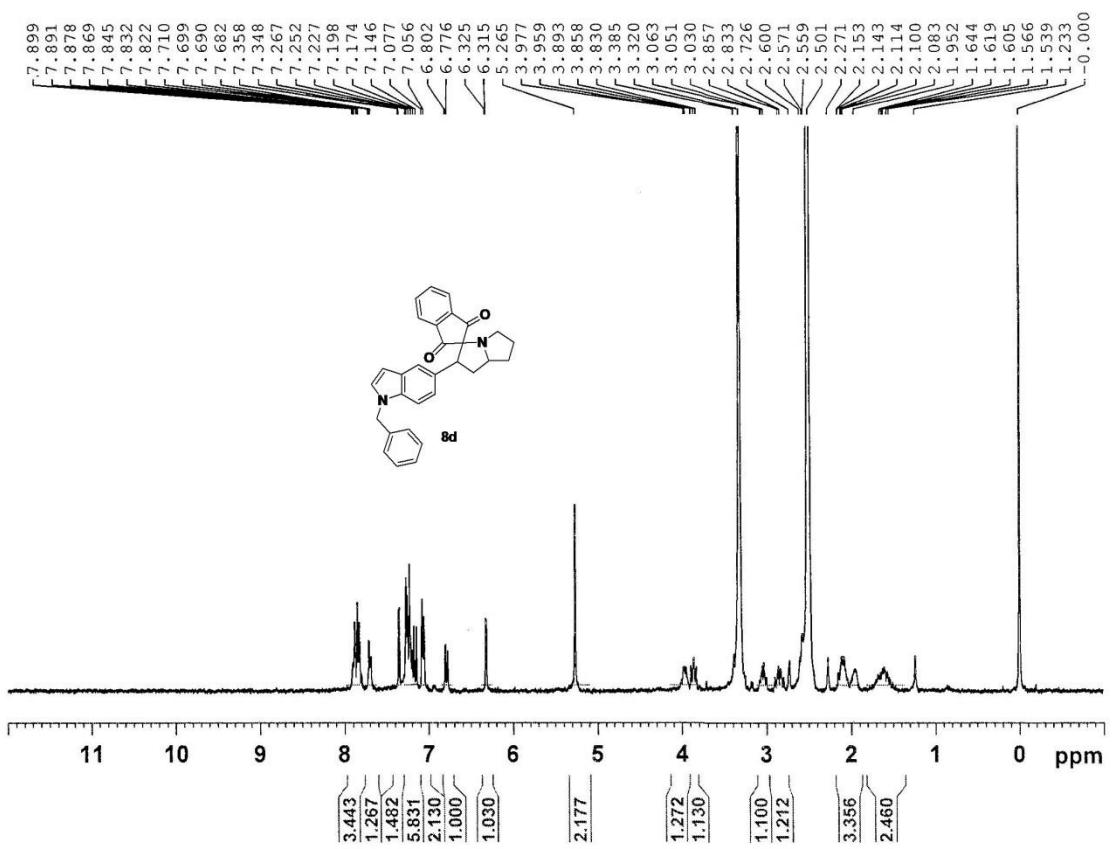


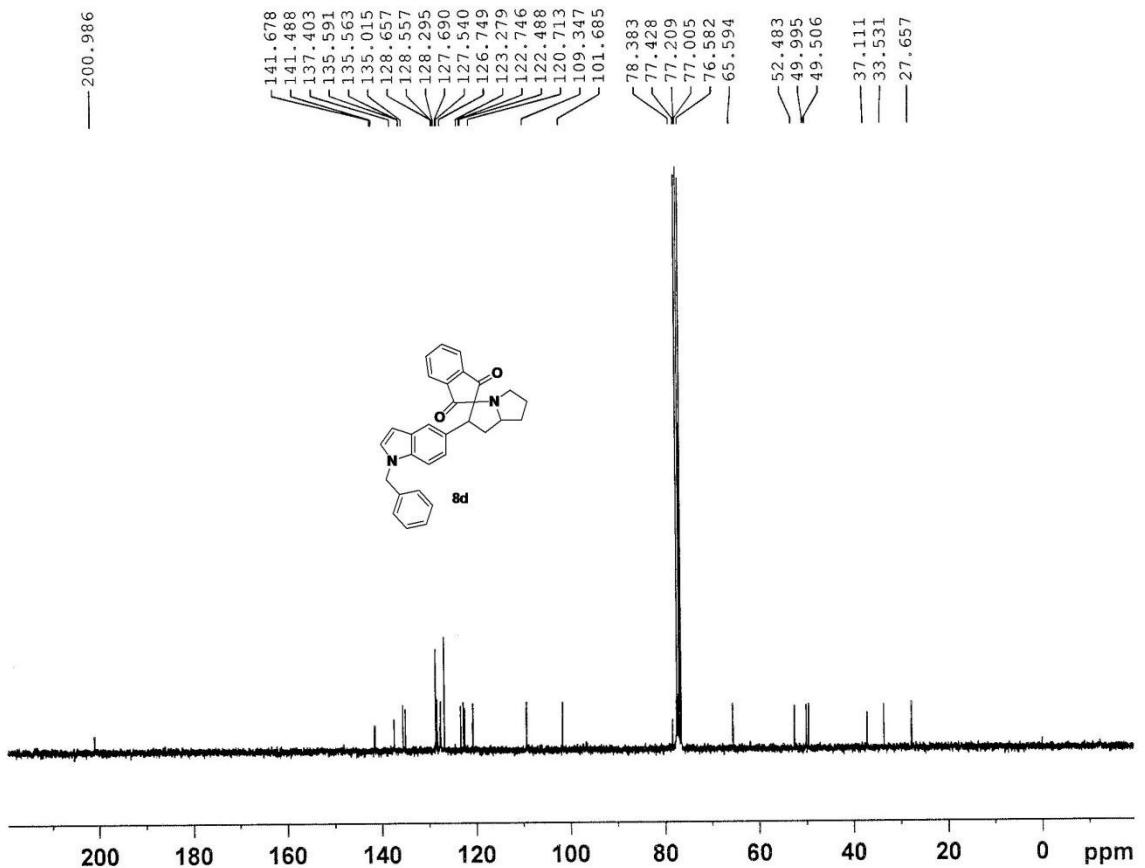


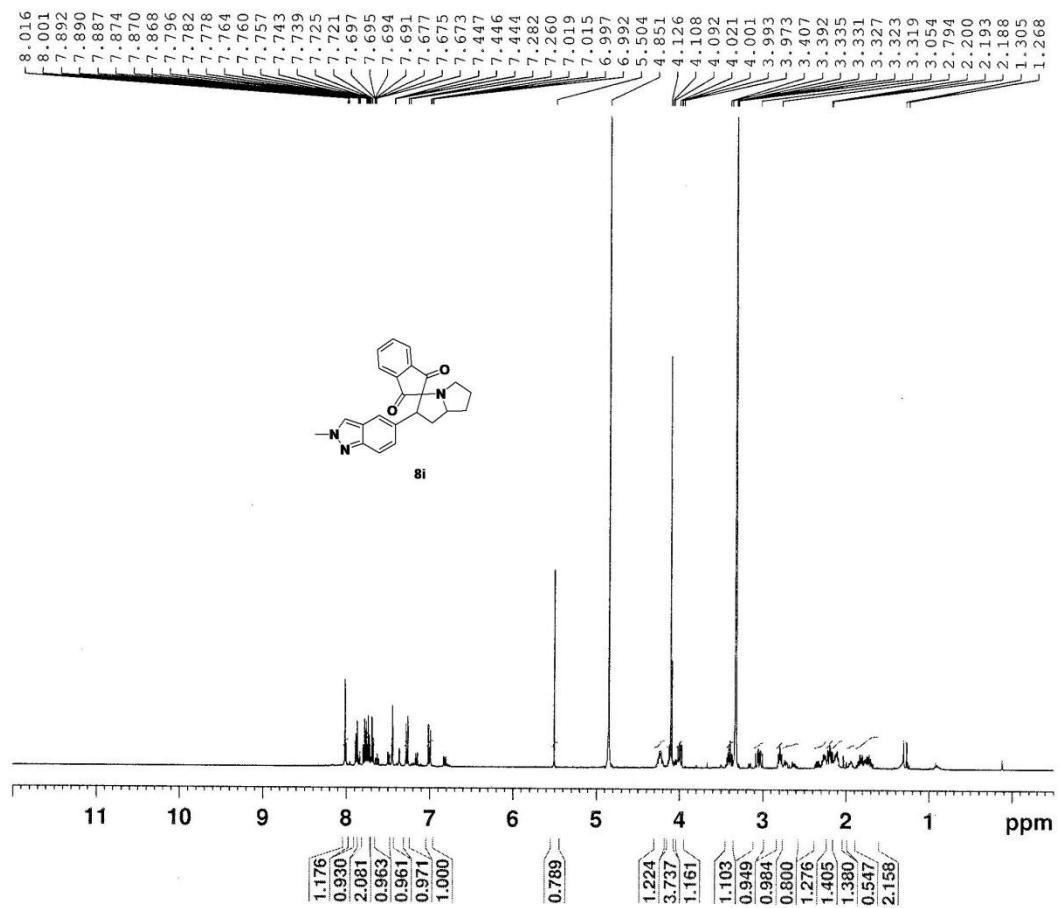


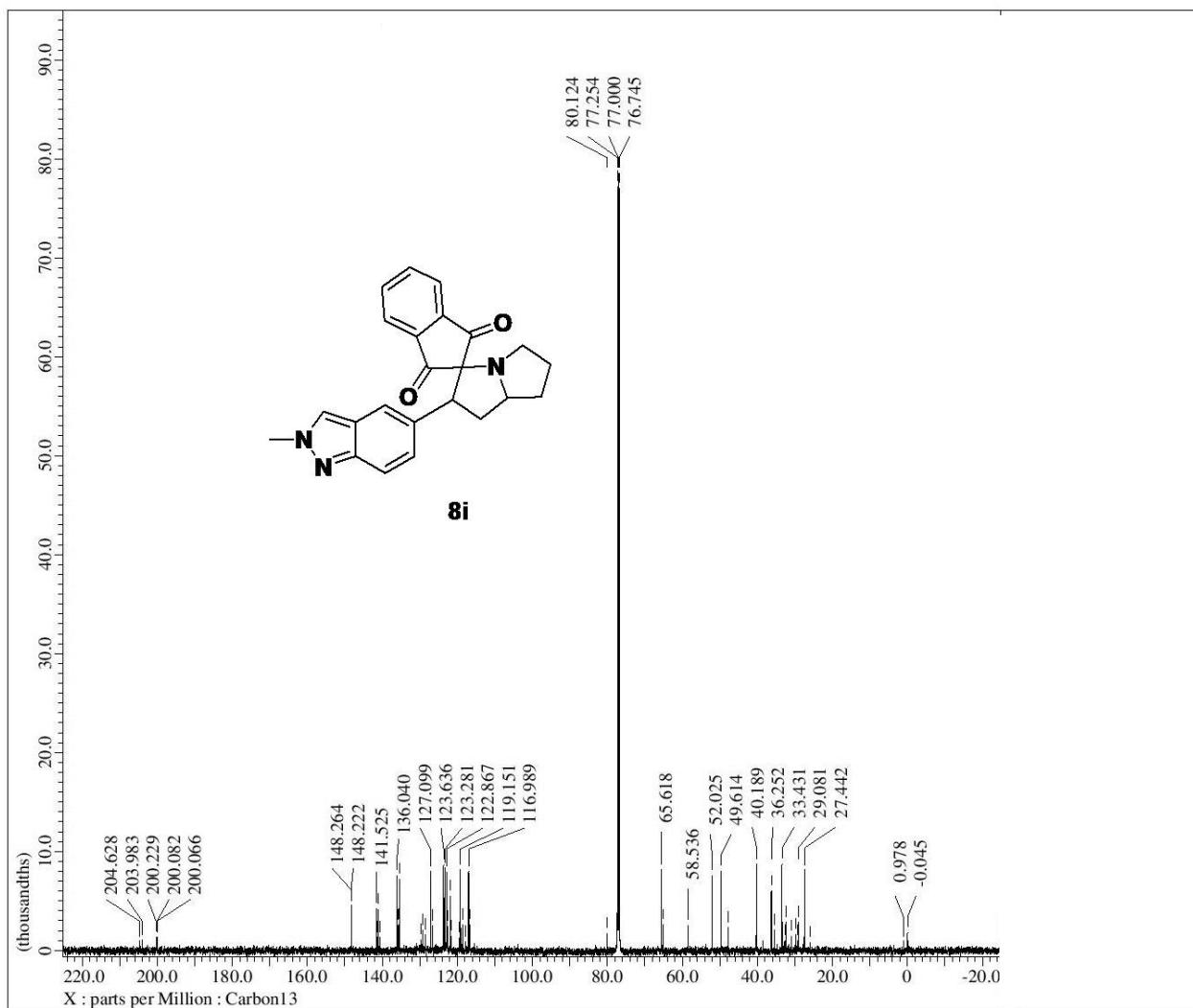












### **X-ray Crystal structure determination of 7a and 7f**

The X-ray diffraction data sets were collected on a Bruker SMART APEX II diffractometer using Mo K $\alpha$  radiation. The crystal-to-detector distance was fixed at 40 mm for the crystal. The scan width per frame was  $\Delta\omega = 0.5^\circ$ . The cell refinement and data reduction were carried out using the SAINTPLUS and numerical absorption correction using the analytical method was performed by face indexing. The sorting, scaling and merging were carried out by SORTAV. The crystal structures were solved by direct methods using SHELXS97 and refined in the spherical-atom approximation (based on  $F^2$ ) by using SHELXL97 included in the WinGX package suite. The ORTEP diagrams were generated using POV-Ray. Supporting information for this paper contains crystallographic data and structure refinement of the title compounds.

### Crystal Data for 7a

**Table S1:** Crystal data and structure refinement for **7a**

CCDC number	CCDC 1520097
Empirical formula	C <sub>22</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>
Formula weight	344.40
Temperature	293 K
Wavelength	0.71073 Å
Crystal system, space group	Triclinic, P-1
a(Å), b(Å), c(Å)	7.5967 (16), 8.4114 (16), 14.507 (3)
α (°) β (°) γ(°)	98.389 (12), 94.880 (14), 95.230 (13)
Volume, Z	V= 909.0 (3), 2
Calculated density	1.258 g/m <sup>3</sup>
Absorption coefficient	0.075 mm <sup>-1</sup>
F(000)	365.0
Crystal size (mm <sup>3</sup> )	0.16 x 0.21 x 0.24
Theta range for data collection	1.4 to 25°
Limiting indices	-9 ≤ h 17 ≥ 1 ≥ 17-, 9 ≥ k ≥ 9-, 9 ≥
Reflection collected/unique	2192/3069 [R <sub>int</sub> =0.0448]
Completeness to theta	0.997
Refinement method	Full-matrix least-square on F <sup>2</sup>
Data/restraints/parameters	3155/0/237
Goodness-of-fit on F <sup>2</sup>	1.070
Final R indices [I>2σ(I)]	R1 = 0.0786, wR2 = 0.2166
R indices (all data)	R1 = 0.1008, wR2 = 0.2318
Largest diff. peak and hole	0.63 and -0.24 eÅ <sup>-3</sup>

**Table S2:** Bond lengths for **7a**

<b>Bond</b>	<b>Length/Å</b>	<b>Bond</b>	<b>Length/Å</b>
O1-C4	1.207(4)	C9-C10	1.409(4)
C1-C2	1.377(6)	C9-C13	1.422(5)
C1-C21	1.376(7)	C10-N11	1.377(4)
C2-C3	1.394(5)	C10-C16	1.386(4)
C3-C4	1.489(4)	N11-C12	1.448(4)
C3-C17	1.364(4)	N11-C14	1.371(4)
C4-C5	1.515(5)	C13-C14	1.363(5)
C5-C6	1.562(4)	C15-C16	1.370(5)
C5-C18	1.528(5)	C17-C18	1.507(5)
C5-N22	1.462(4)	C17-C20	1.380(4)
C6-C7	1.533(4)	C18-O19	1.210(4)
C6-C24	1.471(5)	C20-C21	1.376(6)
C7-C8	1.390(5)	N22-C23	1.435(5)
C7-C15	1.377(5)	N22-C25	1.456(4)
C8-C9	1.414(4)	C23-C24	1.523(5)

**Table S3:** Bond angles for **7a**

<b>Bond</b>	<b>Angle/<math>^{\circ}</math> Bond</b>	<b>Angle/<math>^{\circ}</math></b>
C21-C1-C2	121.0(4) N11-C10-C9	108.5(3)
C1-C2-C3	117.8(4) N11-C10-C16	130.3(3)
C2-C3-C4	128.4(3) C16-C10-C9	121.3(3)
C17-C3-C2	121.1(3) C10-N11-C12	126.0(3)
C17-C3-C4	110.5(3) C14-N11-C10	108.3(3)
O1-C4-C3	125.3(3) C14-N11-C12	125.8(3)
O1-C4-C5	125.9(3) C14-C13-C9	108.0(3)
C3-C4-C5	108.8(2) C13-C14-N11	109.5(3)
C4-C5-C6	111.2(3) C16-C15-C7	123.2(3)
C4-C5-C18	102.3(2) C15-C16-C10	118.3(3)
C18-C5-C6	113.3(2) C3-C17-C18	108.7(3)
N22-C5-C4	114.4(2) C3-C17-C20	120.8(3)
N22-C5-C6	100.4(2) C20-C17-C18	130.5(3)
N22-C5-C18	115.8(3) C17-C18-C5	108.8(2)
C7-C6-C5	116.8(3) O19-C18-C5	125.9(3)
C24-C6-C5	101.6(3) O19-C18-C17	125.2(3)
C24-C6-C7	120.5(3) C21-C20-C17	118.6(4)
C8-C7-C6	123.3(3) C1-C21-C20	120.8(4)
C15-C7-C6	117.9(3) C23-N22-C5	109.0(3)
C15-C7-C8	118.8(3) C23-N22-C25	116.4(3)
C7-C8-C9	120.3(3) C25-N22-C5	116.6(3)
C8-C9-C13	136.0(3) N22-C23-C24	105.5(3)
C10-C9-C8	118.2(3) C6-C24-C23	105.5(3)
C10-C9-C13	105.8(3)	

### Crystal Data for **7f**

**Table S4:** Crystal data and structure refinement for **7f**

CCDC number	CCDC 1435212
Empirical formula	C <sub>24</sub> H <sub>25</sub> N <sub>3</sub> O <sub>2</sub>
Formula weight	387.47
Temperature/K	296.15
Crystal system	monoclinic
Space group	P2 <sub>1</sub> /n
a/Å	8.7531(18)
b/Å	17.051(3)
c/Å	14.480(3)
β/°	105.00(2)
Volume/Å <sup>3</sup>	2087.5(7)
Z	4
ρ <sub>calc</sub> g/cm <sup>3</sup>	1.233
μ/mm <sup>-1</sup>	0.080
F(000)	824.0
Radiation	MoKα ( $\lambda = 0.71073$ )
2Θ range for data collection/°	4.78 to 54.96
Index ranges	-7 ≤ h ≤ 11, -18 ≤ k ≤ 22, -18 ≤ l ≤ 15
Reflections collected	9013
Independent reflections	4669 [R <sub>int</sub> = 0.0870, R <sub>sigma</sub> = 0.1591]
Data/restraints/parameters	4669/0/265
Goodness-of-fit on F <sup>2</sup>	0.975
Final R indexes [I>=2σ (I)]	R <sub>1</sub> = 0.1460, wR <sub>2</sub> = 0.3445
Final R indexes [all data]	R <sub>1</sub> = 0.3115, wR <sub>2</sub> = 0.4691
Largest diff. peak/hole / e Å <sup>-3</sup>	0.31/-0.67

**Table S5:** Bond lengths for **7f**

Bond	Length/Å	Bond	Length/Å
O2-C8	1.204(7)	C15- C14	1.378(8)
C7-O1	1.251(7)	C15- C16	1.375(10)
C7-C5	1.447(10)	C17- C16	1.402(11)
C7-C9	1.534(9)	N2- C20	1.291(10)
C5-C4	1.375(9)	C14- C19	1.427(10)
C5-C6	1.361(10)	C14- C13	1.508(10)
N3-C9	1.447(9)	C16- C20	1.422(10)
N3-C11	1.452(10)	C4- C3	1.379(10)
N3-C10	1.465(9)	C22- C21	1.537(11)
C8-C9	1.543(11)	C22- C23	1.513(10)
C8-C4	1.507(10)	C22- C24	1.531(11)
C18-C17	1.406(9)	C13- C12	1.521(11)
C18-C19	1.354(10)	C12- C11	1.536(10)
N1-C17	1.385(9)	C3- C2	1.414(11)
N1-N2	1.368(8)	C2- C1	1.376(12)
N1-C21	1.453(9)	C6- C1	1.388(12)
C9-C13	1.577(9)		

**Table S6:** Bond angles for **7f**

<b>Bond</b>	<b>Angle/<sup>°</sup></b>	<b>Bond</b>	<b>Angle/<sup>°</sup></b>
O1-C7-C5	128.9(6)	C20- N2- N1	104.2(6)
O1-C7-C9	120.6(7)	C15- C14- C19	119.4(8)
C5-C7-C9	110.4(6)	C15- C14- C13	123.0(8)
C4-C5-C7	108.4(7)	C19- C14- C13	117.5(6)
C6-C5-C7	126.5(7)	C15- C16- C17	117.4(6)
C6-C5-C4	125.1(7)	C15- C16- C20	141.0(8)
C9-N3-C11	108.7(6)	C17- C16- C20	101.5(7)
C9-N3-C10	116.5(6)	C5- C4- C8	111.2(7)
C11-N3-C10	115.7(7)	C5- C4- C3	120.1(8)
O2-C8-C9	126.4(8)	C3- C4- C8	128.7(7)
O2-C8-C4	127.3(8)	C18- C19- C14	123.0(7)
C4-C8-C9	106.3(5)	C23- C22- C21	110.3(6)
C19-C18-C17	114.7(8)	C23- C22- C24	113.6(7)
C17-N1-C21	129.7(7)	C24- C22- C21	107.7(6)
N2-N1-C17	111.2(6)	C14- C13- C9	114.6(6)
N2-N1-C21	119.1(6)	C14- C13- C12	116.5(6)
C7-C9-C8	101.4(6)	C12- C13- C9	101.4(7)
C7-C9-C13	111.9(5)	C13- C12- C11	103.1(6)
N3-C9-C7	120.4(6)	N2- C20- C16	115.6(8)
N3-C9-C8	112.6(5)	C4- C3- C2	117.0(8)
N3-C9-C13	102.3(6)	N1- C21- C22	115.1(7)
C8-C9-C13	108.1(6)	C1- C2- C3	119.8(9)
C16-C15-C14	120.5(8)	C5- C6- C1	114.3(8)
N1-C17-C18	127.8(8)	N3- C11- C12	107.6(7)
N1-C17-C16	107.3(6)	C2- C1- C6	123.6(9)
C16-C17-C18	124.9(7)		