Supporting Information

for

Application of 7-azaisatins in enantioselective Morita–Baylis–Hillman reaction

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Full experimental details and analytical data

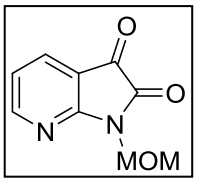
1. General methods

NMR data were obtained for ^{1}H at 400 MHz and for ^{13}C at 100 MHz or 150 MHz. Chemical shifts were given in parts per million (δ) from tetramethylsilane with the residual solvent resonance as the internal standard in $CDCl_3$ solution. In all cases, the enantiomeric ratio was determined by HPLC analysis on a chiral column, using a Daicel Chiralpak IC Column (250 x 4.6 mm), Chiralpak ID Column (250 x 4.6 mm), Chiralpak IE Column (250 x 4.6 mm), Chiralpak AD Column (250 x 4.6 mm) or Chiralpak AS Column (250 x 4.6 mm). UV detection was monitored at 254 nm. Optical rotation data were examined in $CHCl_3$ solution at 20 °C. Column chromatography was performed on silica gel (200–300 mesh) eluting with ethyl acetate and petroleum ether. TLC was performed on glass-backed silica plates. UV light and I_2 were used to visualize the products. All commercially available chemicals were used without purification unless otherwise noted. THF, ethyl acetate, petroleum ether, methylene chloride (CH_2Cl_2), and toluene were distilled before use. Cinchona alkaloids catalysts β-ICD and α-IC were prepared according to the literature procedures [1,2].

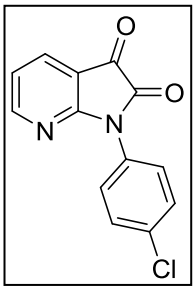
2. Preparation of N-protected 7-azaisatins 1a–d

The preparation of the known compound **1a**: A dried round-bottomed flask equipped with a magnetic stirring bar was charged with 7-azaindole (2 g, 16.95 mmol) and DMF (10 mL) under a nitrogen atmosphere. The mixture was cooled to 0 °C, NaH (1.2 equiv) was added and stirring continued for 1 h. Then, methyl iodide (1.1 equiv) was added and the mixture was stirred for another 1 h. Afterwards the reaction was quenched with ice cold water (100 mL) and extracted with ethyl acetate (3 x 100 mL). The combined organic layers were dried over Na_2SO_4 and the solvent was removed under reduced pressure to give *N*-methyl-7-azaindoles in a quantitative yield [3].

PCC (5.37 g, 25 mmol) was ground with silica gel (5.37 g, 70–230 mesh) and transferred to a 250 mL round-bottomed flask containing DCE (40 mL). To the orange suspension was added a solution of *N*-methyl-7-azaindole (1.32 g, 10 mmol) in DCE (5 mL) while stirring at room temperature. Then, $AlCl_3$ (15 wt %, 1.3 mol % with respect to *N*-methyl-7-azaindole) was added and the mixture was stirred at 80 °C. The progress of the reaction was monitored by TLC. After completion, the solvent was removed under reduced pressure and the black solid was treated with 50 mL of *n*-hexane/ethyl acetate (4:1) and filtered under suction through a sintered funnel layered with silica gel (5 cm, 70–230 mesh). The filtrate was evaporated to furnish **1a** as a yellow solid (1.29 g, 80%). In addition, **1c** was prepared according to the literature procedure [4]. A similar procedure was utilized for the preparation of **1b** and **1d**.

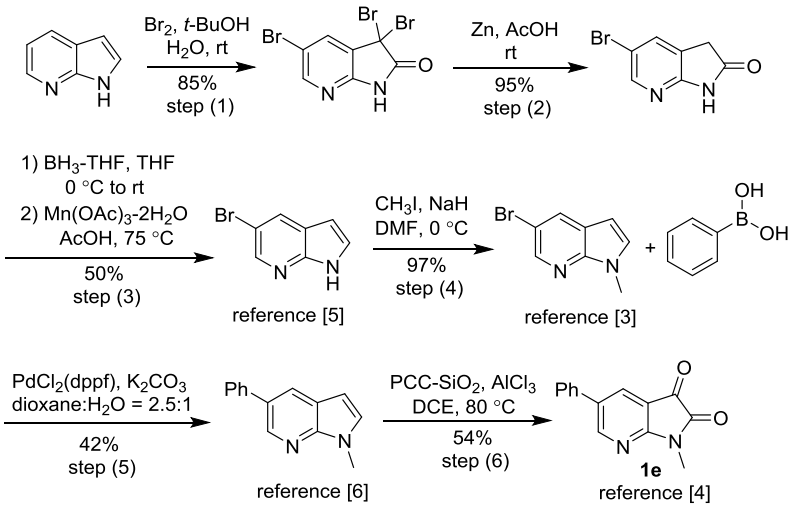


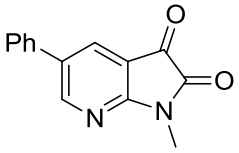
1b: Yellow solid, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 (d, *J* = 4.4 Hz, 1H), 7.91 (d, *J* = 7.2 Hz, 1H), 7.17 (dd, *J* = 7.2 Hz, *J* = 5.2 Hz, 1H), 5.29 (s, 2H), 3.48 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 181.3, 163.2, 158.4, 156.3, 133.4, 120.2, 111.8, 70.0, 57.7 ppm.



1d: Yellow solid, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.47 (d, *J* = 4.8 Hz, 1H), 7.97 (d, *J* = 7.6 Hz, 1H), 7.52 (s, 4H), 7.20 (dd, *J* = 7.2 Hz, *J* = 5.6 Hz, 1H), ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 180.9, 163.4, 157.0, 155.9, 134.3, 133.6, 130.0, 129.6, 127.2, 120.6, 112.1 ppm.

3. Preparation of *N*-protected 7-azaisatin 1e





1e: Yellow solid, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.67 (d, *J* = 2.0 Hz, 1H), 8.02 (d, *J* = 2.0 Hz, 1H), 7.51-7.44 (m, 5H), 3.39 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 182.0, 162.9, 158.5, 154.0, 136.1, 133.5, 131.2, 129.3, 128.5, 126.6, 111.9, 25.2 ppm.

4. Preparation of N-protected 7-azaisatins 1f and 1g

To a solution of **1a** (0.10 g, 0.6 mmol) in DMF (5 mL) was added NCS or NBS (0.16 g, 0.9 mmol) at room temperature. The solution was stirred for 4 h and then at 50 °C for 41 h. The progress of the reaction was monitored by TLC. After the disappearance of **1a**, the mixture was poured into water (30 mL), followed by extraction with CH_2Cl_2 (10 mL x 3). The combined organic layers were washed three times with distilled water and dried (Na_2SO_4). After removal of the solvent, the residue was purified by flash chromatography on silica gel with dichloromethane as an eluent to give the pure product **1f** and **1g** [7].

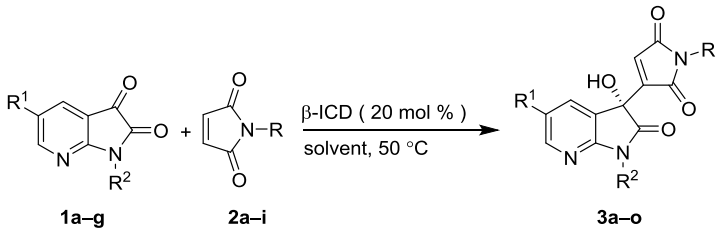
5. Preparation of N-protected 7-azaisatin 1h

Compound **1h** was synthesized by literature procedure [8].

6. Preparation of N-substituted maleimides 2a–i

Maleimides **2a–i** were synthesized by known literature procedures [9-13].

7. General procedure for MBH reaction

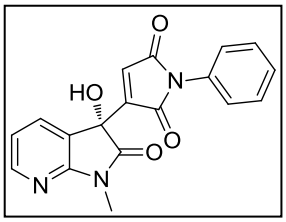


1a–g **2a–i** **3a–o**

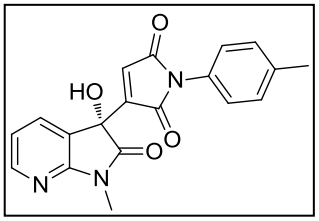
A solution of N-protected 7-azaisatin **1** (0.1 mmol), N-substituted maleimide **2** (0.6 mmol) and catalyst β-ICD (20 mol %) in dry solvent (1.0 mL) was stirred at 50 °C. Purification by flash chromatography on silica gel (EtOAc/petroleum ether) gave the corresponding MBH product **3a–o**.

Typical procedure for the synthesis of 3p and 3q: A solution of *N*-methyl-7-azaisatin (**1**, 0.1 mmol), acrylate (0.6 mmol) and catalyst β-ICD (20 mol %) in dry DCM (1.0 mL) was stirred at 30 °C. Purification by flash chromatography on silica gel (EtOAc/petroleum ether) gave the corresponding MBH product **3p** and **3q**.

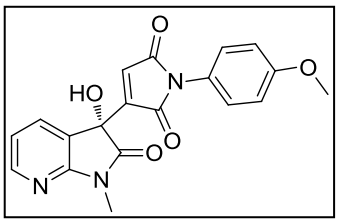
Typical procedure for the synthesis of 3r: Acrolein (0.15 mmol) was added dropwise to a solution of 7-azaisatin (0.1 mmol) and β-ICD (10 mol %) in dry DCM (1.0 mL) at −20 °C. The progress of the reaction was monitored by TLC. After completion, the MBH reaction product **3r** was purified by flash chromatography on silica gel with petroleum ether/EtOAc as the eluent.



3a: 98% yield, 33.0 mg, light yellow solid, $[\alpha]_D^{20}$ = –80.4 (*c* = 4.4 in $CHCl_3$), 94% ee, determined by HPLC analysis [Daicel Chiralpak AD, (*n*-hexane/*i*-PrOH = 80/20, 1 mL/min, UV 254nm, t_{major} = 9.91 min, t_{minor} = 12.26 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, *J* = 4.8 Hz, 1H), 7.66 (d, *J* = 6.8 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.2 Hz, 1H), 7.27-7.25 (m, 2H), 7.03 (dd, *J* = 6.8 Hz, *J* = 5.2 Hz, 1H), 6.94 (s, 1H), 4.24 (brs, 1H), 3.35 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$) δ 174.1, 167.8, 167.5, 157.1, 149.7, 146.1, 132.6, 130.7, 129.4, 129.1, 128.1, 125.8, 122.2, 119.2, 74.0, 25.9 ppm; ESI HRMS: calcd. for $C_{18}H_{13}N_3O_4$+Na^+ 358.0798, found 358.0796.

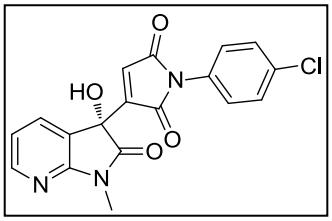


3b: 87% yield, 30.0 mg, light yellow solid, $[\alpha]_D^{20}$ = –69.6 (*c* = 6.5 in $CHCl_3$), 90% ee, determined by HPLC analysis [Daicel Chiralpak AD, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 5.40 min, t_{minor} = 6.62 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, *J* = 5.2 Hz, 1H), 7.65 (d, *J* = 7.2 Hz, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.12(d, *J* = 8.4 Hz, 2H), 7.04-7.01 (m, 1H), 6.93 (s, 1H), 4.50 (brs, 1H), 3.34 (s, 3H), 2.34 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.1, 167.9, 167.6, 157.2, 149.7, 146.0, 138.2, 132.6, 129.7, 129.3, 128.0, 125.7, 122.2, 119.2, 74.0, 25.9, 21.1 ppm; ESI HRMS: calcd. for $C_{19}H_{15}N_3O_4$+Na^+ 372.0955, found 372.0952.

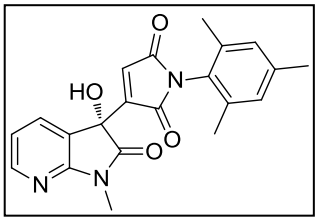


3c: 88% yield, 32.0 mg, yellow solid, $[\alpha]_D^{20}$ = –86.2 (*c* = 10 in $CHCl_3$), 92% ee, determined by HPLC analysis [Daicel Chiralpak AD, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 6.80 min, t_{minor} = 8.34 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 5.2 Hz, 1H), 7.64 (d, *J* = 7.2 Hz, 1H), 7.14 (d, *J* = 8.8 Hz, 2H), 7.04-7.01 (m, 1H), 6.93-6.90 (m, 3H), 4.60-4.54 (brs, 1H), 3.79 (s, 3H), 3.33 (s, 3H)

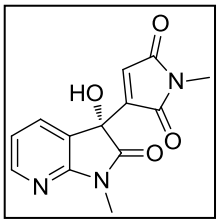
ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.2, 168.1, 167.7, 159.1, 157.1, 149.6, 146.0, 132.6, 129.3, 127.3, 123.2, 122.3, 119.2, 114.4, 74.0, 55.4, 25.9 ppm; ESI HRMS: calcd. for $C_{19}H_{15}N_3O_5$+Na^+ 388.0904, found 388.0909.



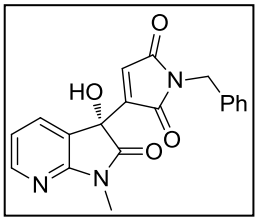
3d: 87% yield, 32.1 mg, white solid, $[\alpha]_D^{20}$ = –94.3 (*c* = 5.5 in $CHCl_3$), 92% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{minor} = 5.97 min, t_{major} = 8.88 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, *J* = 5.2 Hz, 1H), 7.65 (d, *J* = 7.2 Hz, 1H), 7.26-7.23 (m, 2H), 7.12-7.08 (m, 2H), 7.04 (dd, *J* = 7.2 Hz, *J* = 1.6 Hz, 1H), 6.95 (s, 1H), 4.29 (brs, 1H), 3.35 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.0, 167.6, 167.4, 157.1, 149.8, 146.2, 132.6, 129.4, 127.7, 127.6, 122.0, 119.2, 116.2, 116.0, 74.0, 25.9 ppm; ESI HRMS: calcd. for $C_{18}H_{12}ClN_3O_4$+Na^+ 392.0409, found 392.0403.



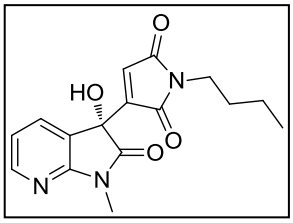
3e: 90% yield, 34.0 mg, white solid, $[\alpha]_D^{20}$ = –71.9 (*c* = 4.4 in $CHCl_3$), 79% ee, determined by HPLC analysis [Daicel Chiralpak IE, (*n*-hexane/*i*-PrOH = 80/20, 1 mL/min, UV 254 nm, t_{major} = 8.80 min, t_{minor} = 9.92 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29-8.28 (m, 1H), 7.67 (d, *J* = 7.2 Hz, 1H), 7.03 (dd, *J* = 7.2 Hz, *J* = 1.6 Hz, 1H), 6.92-6.90 (m, 3H), 4.55 (brs, 1H), 3.33 (s, 3H), 2.27 (s, 3H), 2.01 (s, 3H), 1.94 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.0, 168.0, 167.8, 157.2, 149.7, 146.0, 139.5, 136.4, 136.2, 132.4, 129.3, 129.2, 129.0, 125.9, 122.3, 119.2, 74.0, 25.8, 21.0, 17.8, 17.7 ppm; ESI HRMS: calcd. for $C_{21}H_{19}N_3O_4$+Na^+ 400.1268, found 400.1275.



3f: 84% yield, 23.0 mg, white solid, $[\alpha]_D^{20}$ = –114.4 (*c* = 4.0 in $CHCl_3$), 89% ee, determined by HPLC analysis [Daicel Chiralpak ID, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 6.17 min, t_{minor} = 7.48 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 5.2 Hz, 1H), 7.58 (d, *J* = 7.2 Hz, 1H), 7.03-7.00 (m, 1H), 6.80 (s, 1H), 4.89-4.86 (brs, 1H), 3.33 (s, 3H), 2.92 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.3, 169.1, 168.7, 157.1, 149.6, 146.3, 132.5, 129.2, 122.3, 119.1, 73.9, 25.8, 23.8 ppm; ESI HRMS: calcd. for $C_{13}H_{11}N_3O_4$+Na^+ 296.0642, found 296.0656.

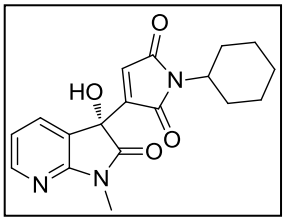


3g: 86% yield, 30.0 mg, white solid, $[\alpha]_D^{20}$ = –79.7 (*c* = 5.0 in $CHCl_3$), 89% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{minor} = 6.54 min, t_{major} = 15.29 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 5.2 Hz, 1H), 7.59 (d, *J* = 7.2 Hz, 1H), 7.26 (m, 5H), 7.02-6.99 (m, 1H), 6.73 (s, 1H), 4.58 (s, 2H), 4.34 (brs, 1H), 3.33 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.0, 168.6, 168.4, 157.1, 149.7, 145.8, 135.6, 132.7, 129.2, 128.7, 128.5, 128.0, 122.0, 119.2, 73.9, 41.7, 25.8 ppm; ESI HRMS: calcd. for $C_{19}H_{15}N_3O_4$+Na^+ 372.0955, found 372.0958.

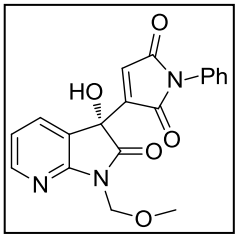


3h: 86% yield, 26.7 mg, white solid, $[\alpha]_D^{20}$ = –62.8 (*c* = 8.0 in $CHCl_3$), 66% ee, determined by HPLC analysis [Daicel Chiralpak IC, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{minor} = 4.97 min, t_{major} = 6.11 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, *J* = 4.4 Hz, 1H), 7.60 (d, *J* = 7.2 Hz, 1H), 7.02 (dd, *J* = 7.6 Hz, *J* = 1.6 Hz, 1H), 6.73 (s, 1H), 4.52 (brs, 1H), 3.41 (t, *J* = 3.2 Hz, 2H), 3.34 (s, 3H), 1.51-1.46 (m, 2H), 1.27-1.20 (m, 2H), 0.90-0.86 (m, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.2,

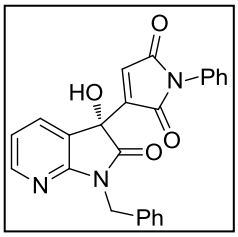
169.1, 168.8, 157.1, 149.6, 145.7, 132.6, 129.1, 122.2, 119.1, 73.9, 38.0, 30.4, 25.8, 19.9, 13.5 ppm; ESI HRMS: calcd. for $C_{16}H_{17}N_3O_4$+Na^+ 338.1111, found 338.1107.



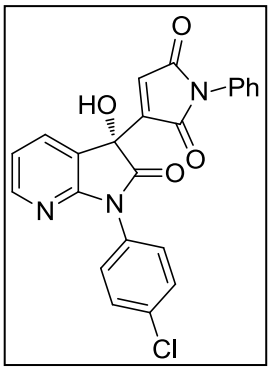
3i: 84% yield, 28.6 mg, white solid, $[\alpha]_D^{20}$ = –80.1 (*c* = 9.5 in $CHCl_3$), 61% ee, determined by HPLC analysis [Daicel Chiralpak ID, (*n*-hexane/*i*-PrOH = 80/20, 1 mL/min, UV 254 nm, t_{major} = 7.10 min, t_{minor} = 8.07 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 5.2 Hz, 1H), 7.61 (d, *J* = 7.2 Hz, 1H), 7.02 (dd, *J* = 7.2 Hz, *J* = 1.6 Hz, 1H), 6.66 (s, 1H), 4.45-4.36 (brs, 1H), 3.82-3.77 (m, 1H), 3.34 (s, 3H), 2.01-1.88 (m, 2H), 1.80-1.77 (m, 2H), 1.62-1.60 (m, 3H), 1.30-1.14 (m, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.1, 169.1, 168.9, 157.1, 149.6, 145.3, 132.6, 129.0, 122.4, 119.1, 73.9, 51.2, 29.8, 25.8, 24.9 ppm; ESI HRMS: calcd. for $C_{18}H_{19}N_3O_4$+Na^+ 364.1268, found 364.1275.



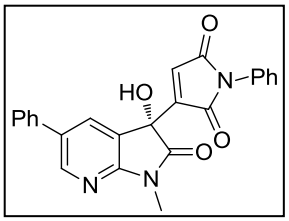
3j: 92% yield, 33.6 mg, light yellow solid, $[\alpha]_D^{20}$ = –86.3 (*c* = 4.0 in $CHCl_3$), 91% ee, determined by HPLC analysis [Daicel Chiralpak AD, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 6.45 min, t_{minor} = 7.32 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 4.8 Hz, 1H), 7.68 (d, *J* = 7.2 Hz, 1H), 7.44-7.40 (m, 2H), 7.35-7.32 (m, 1H), 7.27-7.25 (m, 2H), 7.08 (dd, *J* = 5.2 Hz, *J* = 1.6 Hz, 1H), 7.00 (s, 1H), 5.27 (s, 2H), 4.48 (brs, 1H), 3.47 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.5, 167.8, 167.5, 156.3, 150.1, 146.0, 133.1, 130.6, 129.6, 129.1, 128.1, 125.8, 121.6, 119.7, 73.9, 70.7, 57.5 ppm; ESI HRMS: calcd. for $C_{19}H_{15}N_3O_5$+Na^+ 388.0904, found 388.0898.



3k: 93% yield, 38.0 mg, light yellow solid, $[\alpha]_D^{20}$ = –99.5 (*c* = 5.6 in $CHCl_3$), 87% ee, determined by HPLC analysis [Daicel Chiralpak ID, (*n*-hexane/*i*-PrOH = 70/30, 1 mL/min, UV 254 nm, t_{major} = 9.66 min, t_{minor} = 10.71 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.26 (d, *J* = 4.8 Hz, 1H), 7.65 (d, *J* = 7.2 Hz, 1H), 7.46 (d, *J* = 7.2 Hz, 2H), 7.42-7.39 (m, 2H), 7.34-7.28 (m, 3H), 7.26-7.24 (m, 3H), 7.01-6.98 (m, 1H), 6.88 (s, 1H), 5.02 (s, 2H) , 4.57-4.56 (brs, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.7, 167.8, 167.5, 156.7, 149.8, 145.7, 135.5, 132.9, 130.7, 129.4, 129.1, 128.6, 128.3, 128.1, 127.8, 125.8, 122.9, 119.3, 74.0, 43.3 ppm; ESI HRMS: calcd. for $C_{24}H_{17}N_3O_4$+K^+ 450.0851, found 450.0862.

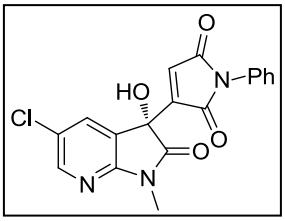


3l: 37% yield, 16.0 mg, light yellow solid, $[\alpha]_D^{20}$ = –58.1 (*c* = 5.0 in $CHCl_3$), 71% ee, determined by HPLC analysis [Daicel Chiralpak AD, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 9.10 min, t_{minor} = 15.10 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, *J* = 4.8Hz, 1H), 7.71 (d, *J* = 7.6 Hz, 1H), 7.55-7.49 (m, 4H), 7.45-7.41 (m, 2H), 7.36-7.33 (m, 1H), 7.27-7.26 (m, 2H), 7.13-7.10 (m, 1H), 7.05 (s, 1H), 4.10 (brs, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 167.7, 167.5, 156.9, 145.0, 146.6, 134.5, 133.2, 130.8, 130.6, 129.6, 129.4, 129.1, 128.2, 127.9, 125.8, 121.5, 120.0, 74.0 ppm; ESI HRMS: calcd. for $C_{23}H_{14}ClN_3O_4$+Na^+ 454.0565, found 454.0571.

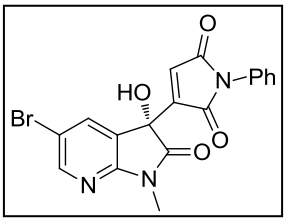


3m: 87.8% yield, 36.0 mg, yellowish solid, $[\alpha]_D^{20}$ = +53.9 (*c* = 7.5 in $CHCl_3$), 92% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{minor} = 6.00 min, t_{major} = 8.88 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 2.0

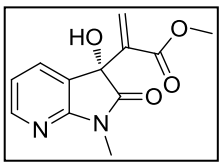
Hz, 1H), 7.86 (d, *J* = 2.0 Hz, 1H), 7.52 (d, *J* = 7.6 Hz, 2H), 7.47-7.42 (m, 3H), 7.41-7.37 (m, 3H), 7.32 (t, *J* = 7.2 Hz, 1H), 7.27-7.25 (m, 2H), 7.00 (s, 1H), 4.42 (brs, 1H), 3.39 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.1, 167.6, 167.5, 156.2, 148.0, 146.1, 137.0, 133.1, 131.6, 130.6, 129.4, 129.2, 129.1, 128.1, 128.1, 126.8, 125.8, 122.2, 74.1, 26.0 ppm; ESI HRMS: calcd. for $C_{24}H_{17}N_3O_4$+Na^+ 434.1111, found 434.1108.



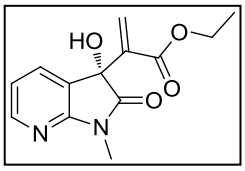
3n: 81% yield, 30.0 mg, white solid, $[\alpha]_D^{20}$ = –18.9 (*c* = 10.0 in $CHCl_3$), 85% ee, determined by HPLC analysis [Daicel Chiralpak IE, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 6.61 min, t_{minor} = 7.91 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.24 (d, *J* = 2.4 Hz, 1H), 7.63 (d, *J* = 1.6. Hz, 1H), 7.44-7.40 (m, 2H), 7.36-7.32 (m, 1H), 7.27-7.25 (m, 2H), 7.00 (s, 1H), 4.74 (brs, 1H), 3.32 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.9, 167.6, 167.4, 155.4, 148.2, 145.6, 133.0, 130.5, 129.7, 129.1, 128.2, 127.1, 125.8, 123.1, 73.9, 26.0 ppm; ESI HRMS: calcd. for $C_{18}H_{12}ClN_3O_4$+Na^+ 392.0409, found 392.0412.



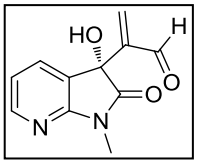
3o: 82% yield, 34.0 mg, yellow solid, $[\alpha]_D^{20}$ = +4.86 (*c* = 7.0 in $CHCl_3$), 88% ee, determined by HPLC analysis [Daicel Chiralpak ID, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, t_{major} = 5.36 min, t_{minor} = 6.45 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (d, *J* = 2.0 Hz, 1H), 7.74 (d, *J* = 2.4 Hz, 1H), 7.43-7.40 (m, 2H), 7.35-7.32 (m, 1H), 7.27-7.25 (m, 2H), 7.00 (s, 1H), 4.70 (brs, 1H), 3.31 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$) δ 173.8, 167.6, 167.4, 155.7, 150.4, 145.6, 135.4, 130.6, 129.8, 129.1, 128.1, 125.8, 123.6, 114.6, 73.9, 26.0 ppm; ESI HRMS: calcd. for $C_{18}H_{12}BrN_3O_4$+Na^+ 435.9903, found 435.9910.



3p: 93% yield, 23.0 mg, white solid, $[\alpha]_D^{20}$ = –76.8 (*c* = 7.5 in $CHCl_3$), 92% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, tminor = 4.65 min, tmajor = 6.67 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 5.2 Hz, 1H), 7.42 (dd, *J* = 7.2 Hz, J = 6.0 Hz, 1H), 6.94 (dd, *J* = 7.2 Hz, *J* = 2.0 Hz, 1H), 6.60 (s, 1H), 6.47 (s, 1H), 4.38 (brs , 1H), 3.63 (s, 3H), 3.31(s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.2, 164.8, 157.8, 148.6, 138.4, 131.2, 128.4, 124.3, 118.5, 75.7, 52.2, 25.5 ppm; ESI HRMS: calcd. for $C_{12}H_{12}N_2O_4$+Na^+ 271.0689, found 271.0697.



3q: 98% yield, 26.0 mg, white solid, $[\alpha]_D^{20}$ = –95.4 (*c* = 5.0 in $CHCl_3$), 91% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, tminor = 4.49 min, tmajor = 6.13 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (d, *J* = 5.2 Hz, 1H), 7.41 (d, *J* = 7.2 Hz, 1H), 6.93 (dd, *J* = 6.8 Hz, *J* = 1.2 Hz, 1H), 6.61 (s, 1H), 6.44 (s, 1H), 4.46-4.40 (brs , 1H), 4.06-4.02 (m, 2H), 3.29 (s, 3H), 1.14-1.10 (m, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.3, 164.3, 157.8, 148.5, 138.6, 131.2, 128.5, 124.5, 118.5, 75.6, 61.1, 25.5, 13.8 ppm; ESI HRMS: calcd. for $C_{13}H_{14}N_2O_4$+Na^+ 285.0846, found 285.0852.



3r: 96% yield, 20.9 mg, white solid, $[\alpha]_D^{20}$ = –171.4 (*c* = 7.0 in $CHCl_3$), 94% ee, determined by HPLC analysis [Daicel Chiralpak AS, (*n*-hexane/*i*-PrOH = 60/40, 1 mL/min, UV 254 nm, tminor = 5.62 min, tmajor = 7.13 min]; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.48 (m, 1H), 8.21 (d, *J* = 4.4 Hz, 1H), 7.39 (d, *J* = 6.8 Hz, 1H), 7.00 (s, 1H), 6.95-6.92 (m, 1H), 6.44 (s, 1H), 4.19-4.14 (brs, 1H), 3.32 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.7, 175.6, 157.6, 148.8,

148.0, 136.5, 131.3, 123.6, 118.6, 75.0, 25.6 ppm; ESI HRMS: calcd. for $C_{11}H_{10}N_2O_3$+Na^+ 241.0584, found 241.0584.

8. References

1. Nakamoto, Y.; Urabe, F.; Takahashi, K.; Ishihara, J.; Hatakeyama, S. *Chem. – Eur. J.* **2013**, *19*, 12653–12656. doi: 10.1002/chem.201302665

2. Waldmann, H.; Khedkar, V.; Dückert, H.; Schürmann, M.; Oppel, I. M.; Kumar, K. *Angew. Chem. Int. Ed.* **2008**, *47*, 6869–6872. doi: 10.1002/anie.200802413

3. Kannaboina, P.; Anilkumar, K.; Aravinda, S.; Vishwakarma, R. A.; Das, P. *Org. Lett.* **2013**, *15*, 5718–5721. doi: 10.1021/ol4027478

4. Sriram, R.; Kumar, C. N. S. S. P.; Raghunandan, N.; Ramesh, V.; Sarangapani, M.; Rao. V. J. *Synth. Commun.* **2012**, *42*, 3419–3428. doi: 10.1080/00397911.2011.584008

5. Wu, P.-W.; Hsieh, W.-T.; Cheng, Y.-M.; Wei, C.-Y.; Chou, P.-T. *J. Am. Chem. Soc.* **2006**, *128*, 14426–14427. doi: 10.1021/ja064310e

6. Hammond, M.; Washburn, D.-J. et al *Bioorg. Med. Chem. Lett.* **2009**, *19*, 4441–4445. doi: 10.1016/j.bmcl.2009.05.051

7. Tatsugi, J.; Tong, Z. W.; Tsuchiya, Y.; Takayoshi, I. *Arkivoc* **2009**, *2*, 132–137. doi: 10.3998/ark.5550190.0010.214

8. Yan, W.-J.; Wang, D.; Feng, J.-C.; Li, P.; Zhao, D.-P.; Wang, R. *Org. Lett.* **2012**, *14*, 2512–2515. doi: 10.1021/ol3007953

9. Gaidamaviciute. G.; Tauraite, D.; Gagilas, J.; Lagunavicius, A. *Biochimica et Biophysica Act.* **2010**, *1804*, 1385–1393. doi: 10.1016/j.bbapap.2010.01.024

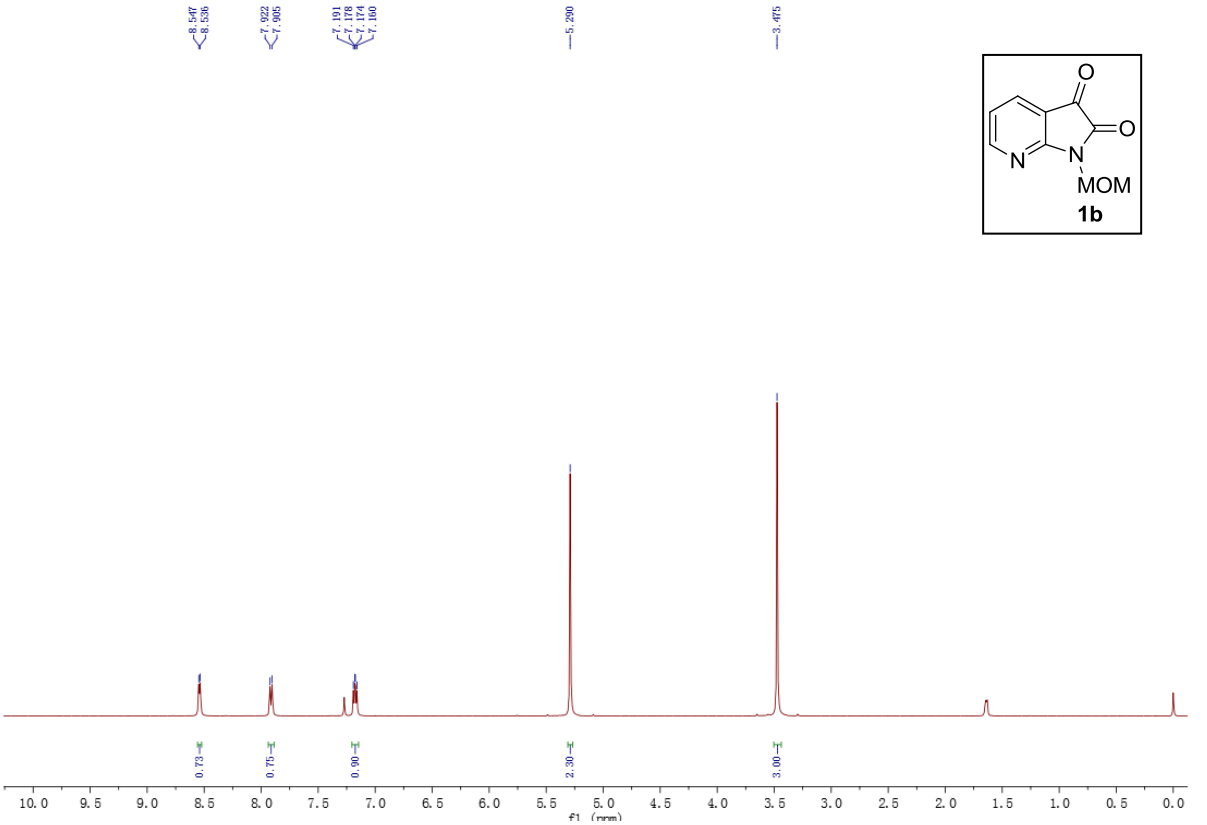
10. Akalay, D.; Dürner, G.; Bats, J. W.; Göbel, M. W. *Beilstein J. Org. Chem.* **2008**, *4*, No. 28. doi:10.3762/bjoc.4.28

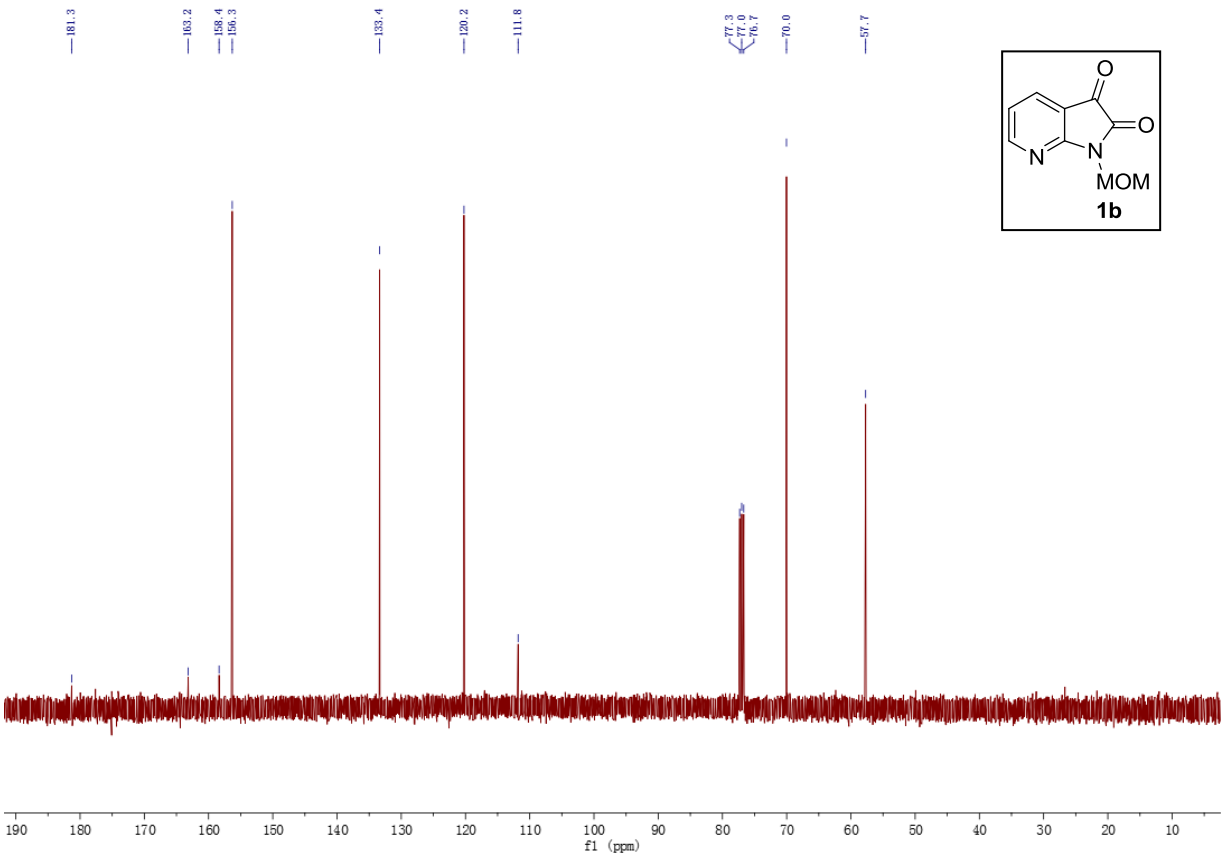
11. Samgina, T. Y.; Gorshkov, V. A.; Vorontsov, E. A.; Bagrov, V. V.; Nifant’ev, I. E.; Lebedev, A. T. *Anal. Chem.* **2010**, *65*, 1320–1327. doi: 10.1134/S1061934810130034

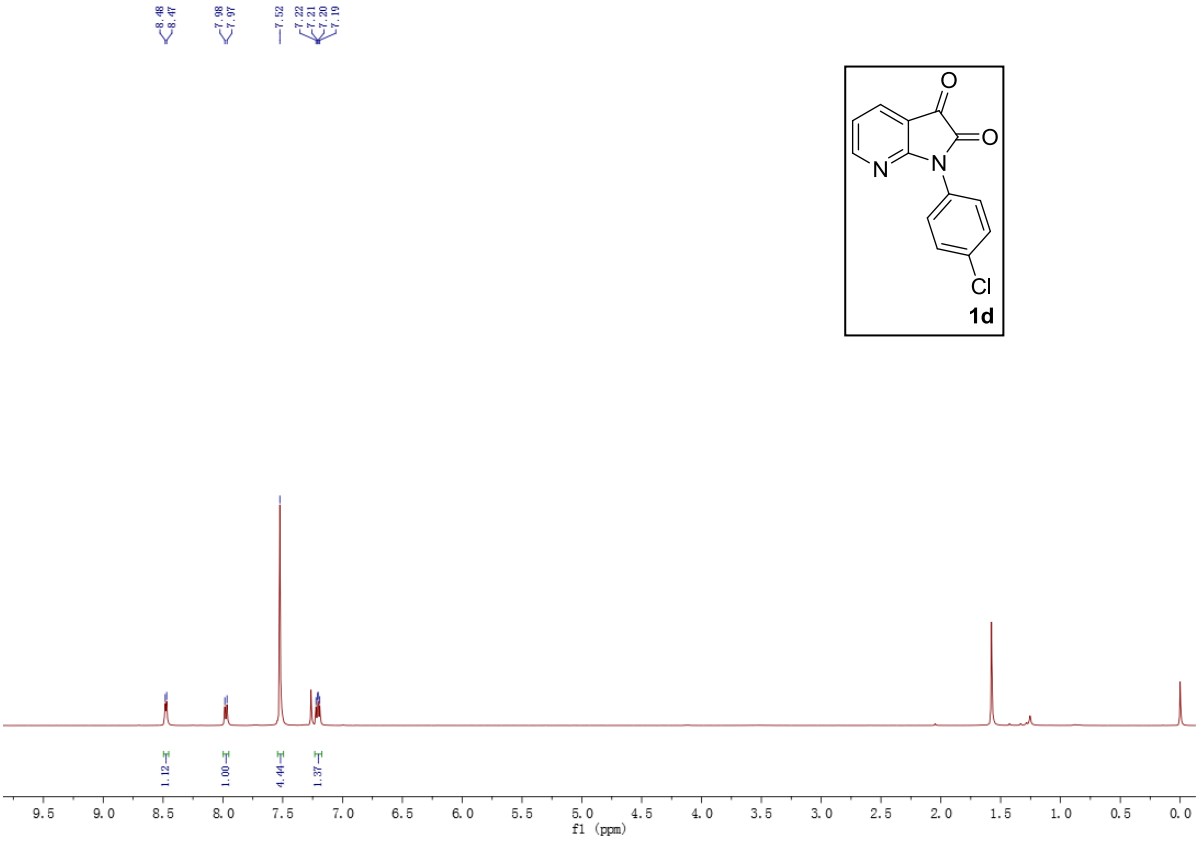
12. Hota, S. K.; Chatterjee, A.; Bhattacharya, P. K.; Chattopadhyay. P. *Green Chem.* **2009**, *11*, 169–176. doi: 10.1039/b812290c

13. Rajalakshmi, R.; Chezhian, S.; Arulmani, R. *Elixir Appl. Chem.* **2014**, *72*, 25375–25378.

9 NMR spectra and HPLC chromatograms



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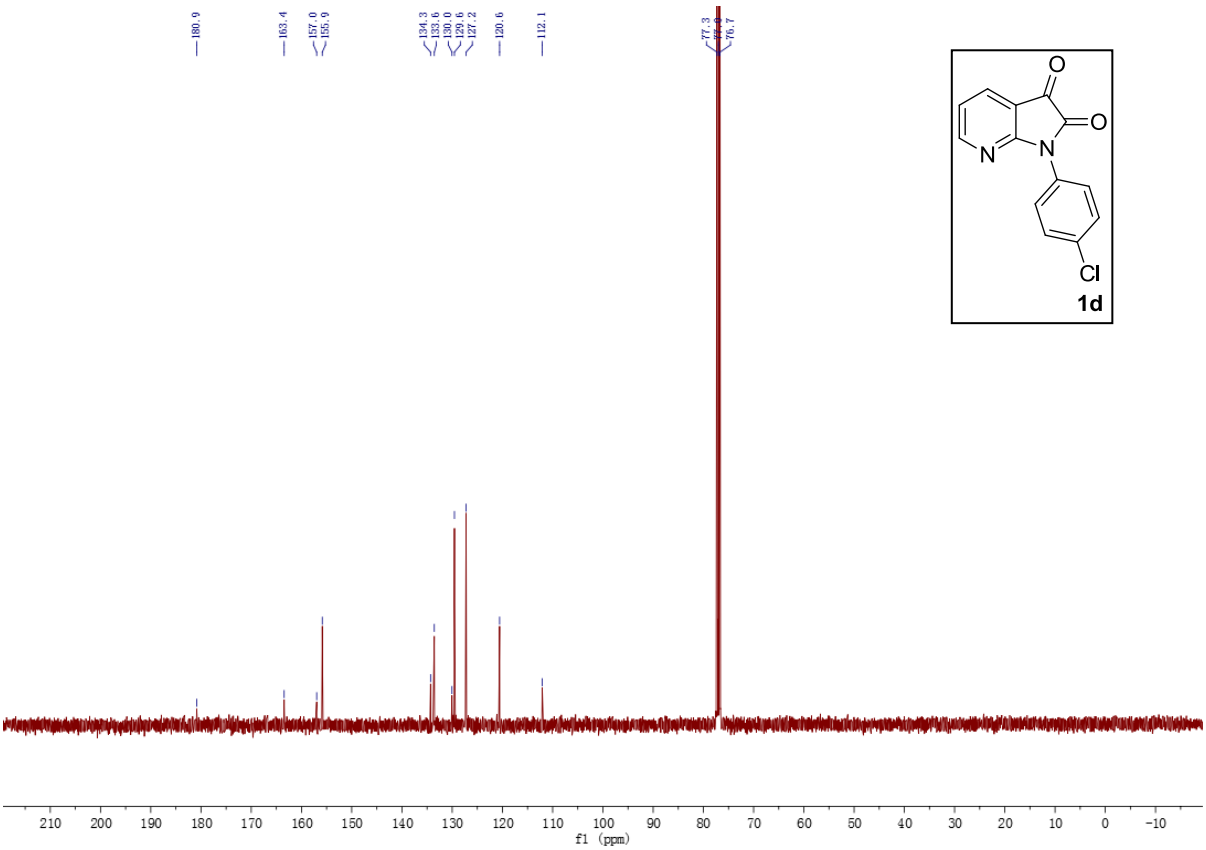
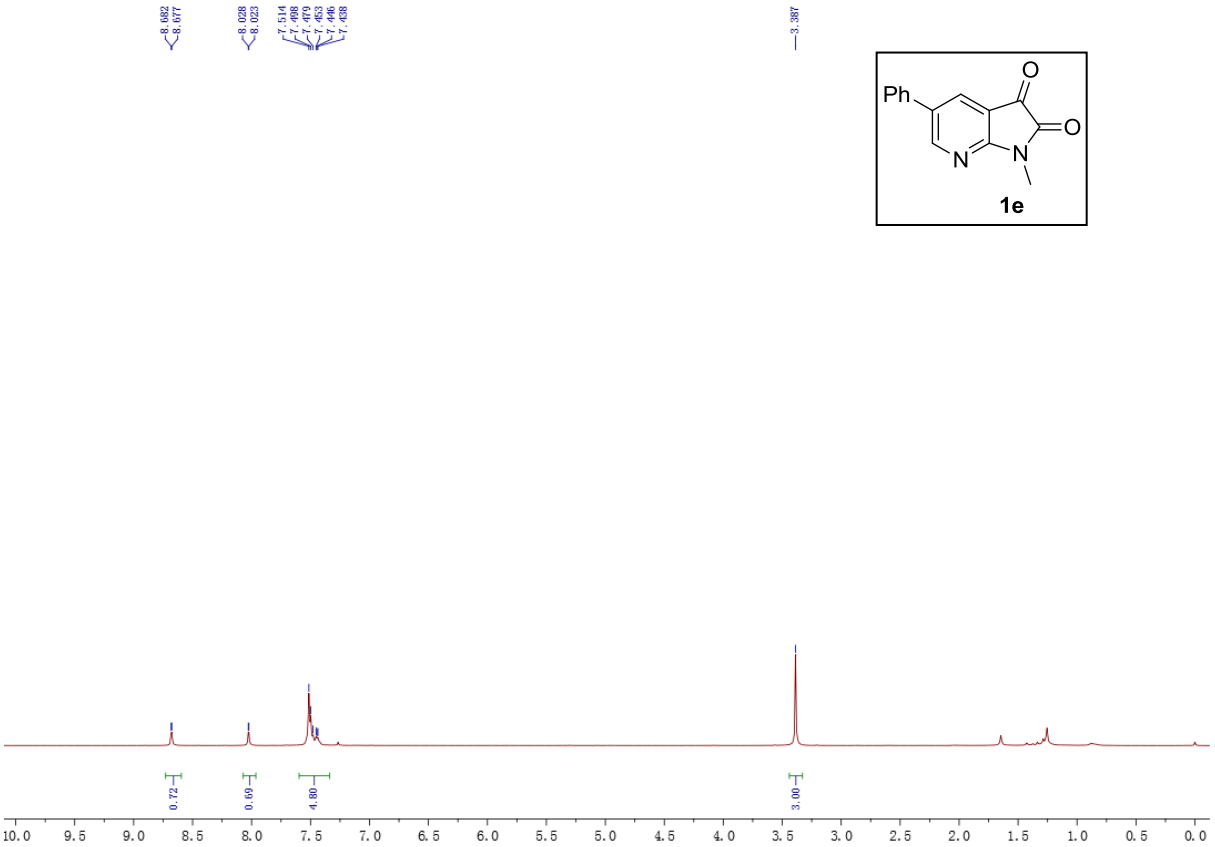
8.47
7.98
7.97
7.52
7.22
7.21
7.20
7.19
O
O
N
N
Cl
1d
1.12
1.00
4.44
1.37
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


180.9
163.4
157.0
155.9
134.3
133.6
130.0
129.6
127.2
120.6
112.1
77.3
77.0
76.7
O
O
N
N
Cl
1d
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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8.023
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7.465
7.446
7.438
3.387
Ph
O
O
N
N
1e
0.72
0.69
4.80
3.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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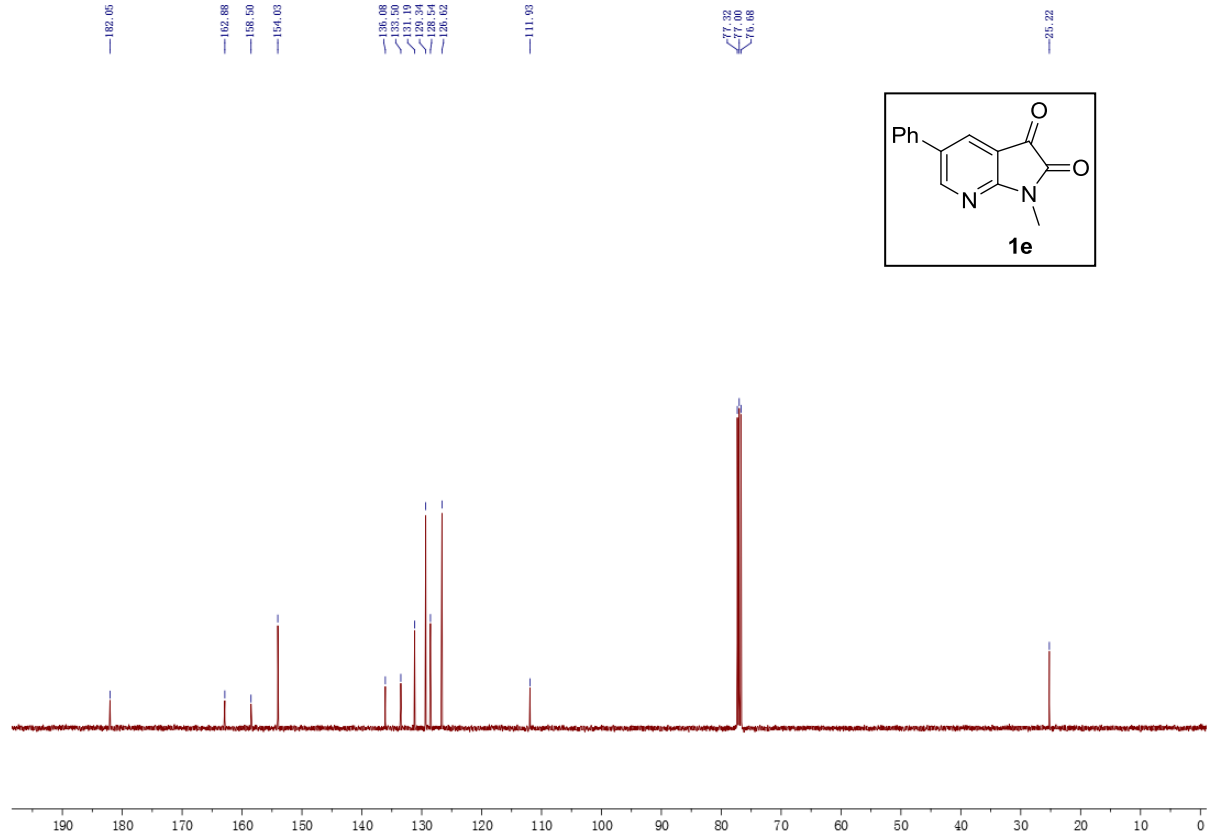
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76.68
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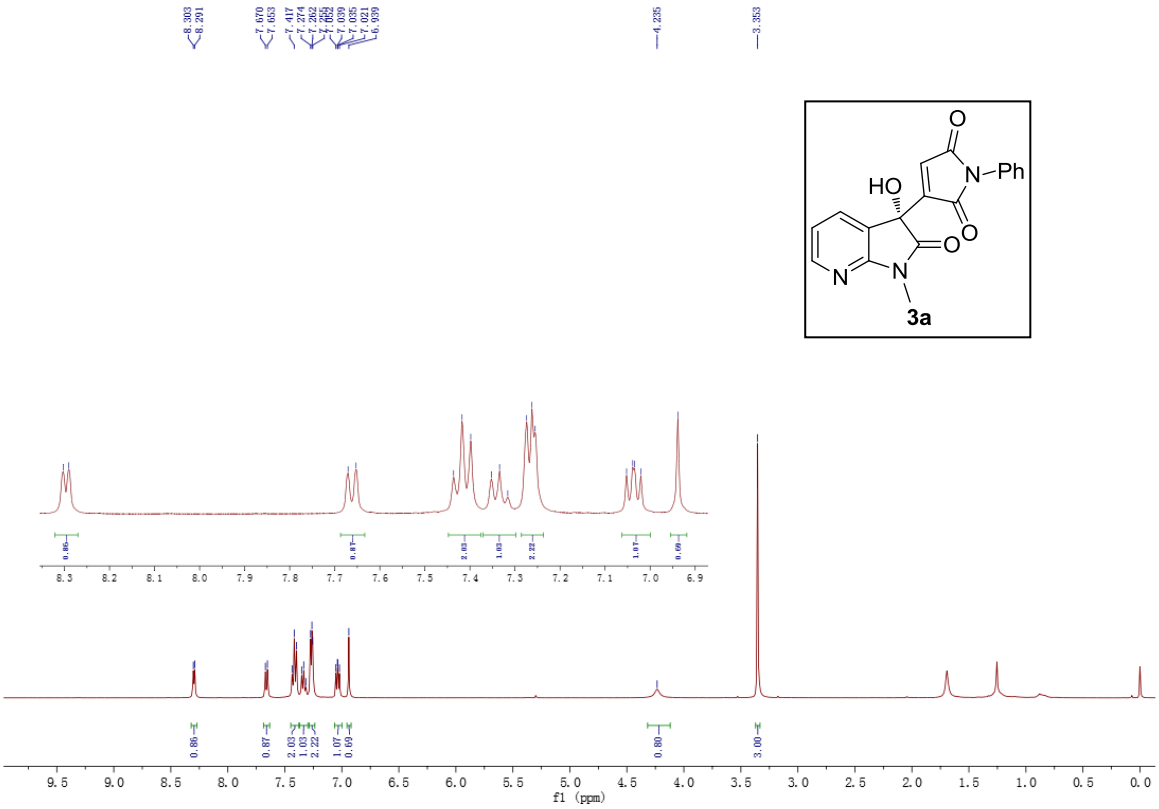
80
70
60
50
40
30
20
10
0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7.039
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7.021
6.999
4.235
3.353
HO
N–Ph
O
O
O
N
N
3a
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0.87
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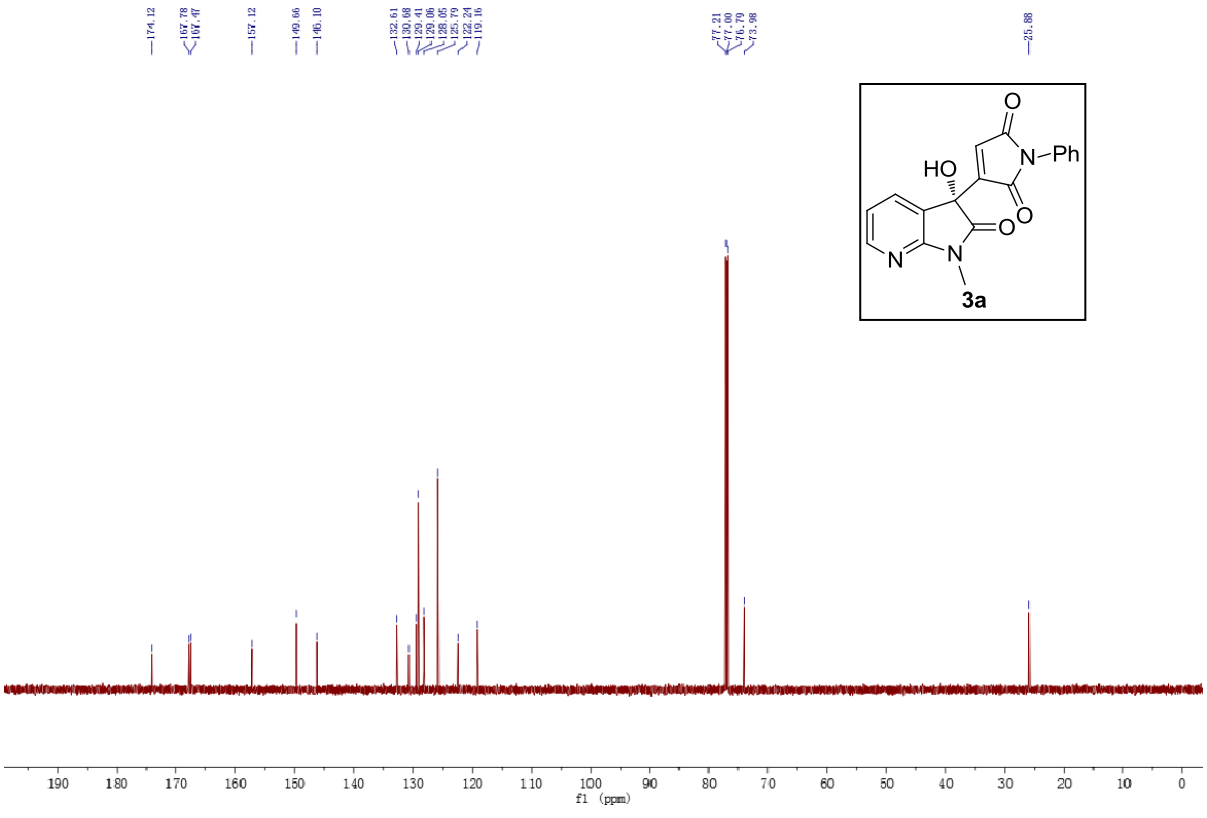
2.22
1.07
0.69
0.80
3.00
f1 (ppm)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119.16
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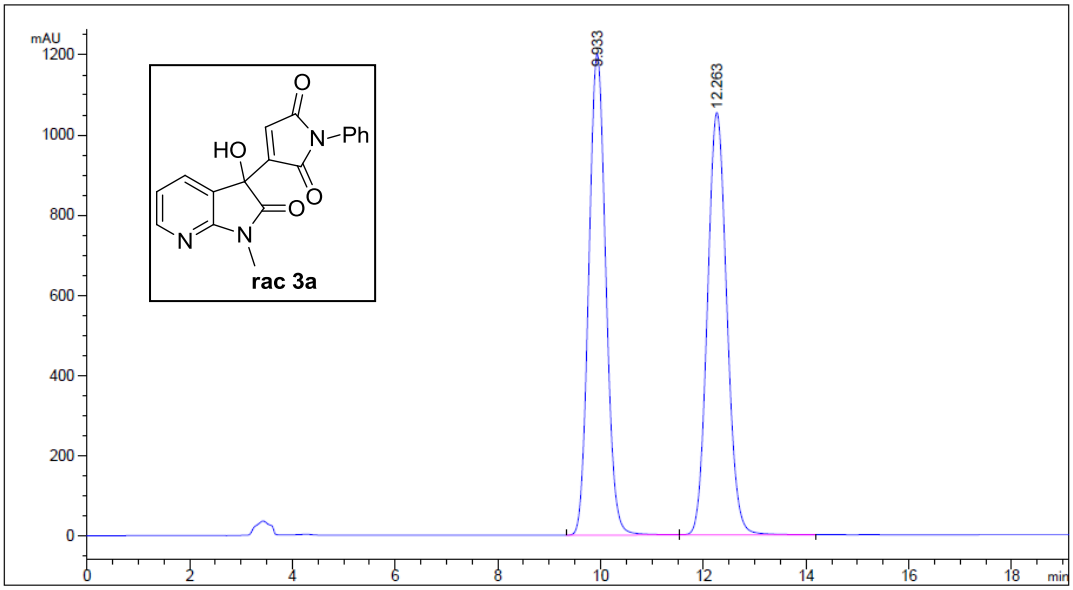
O
O
O
N
N
3a
f1 (ppm)



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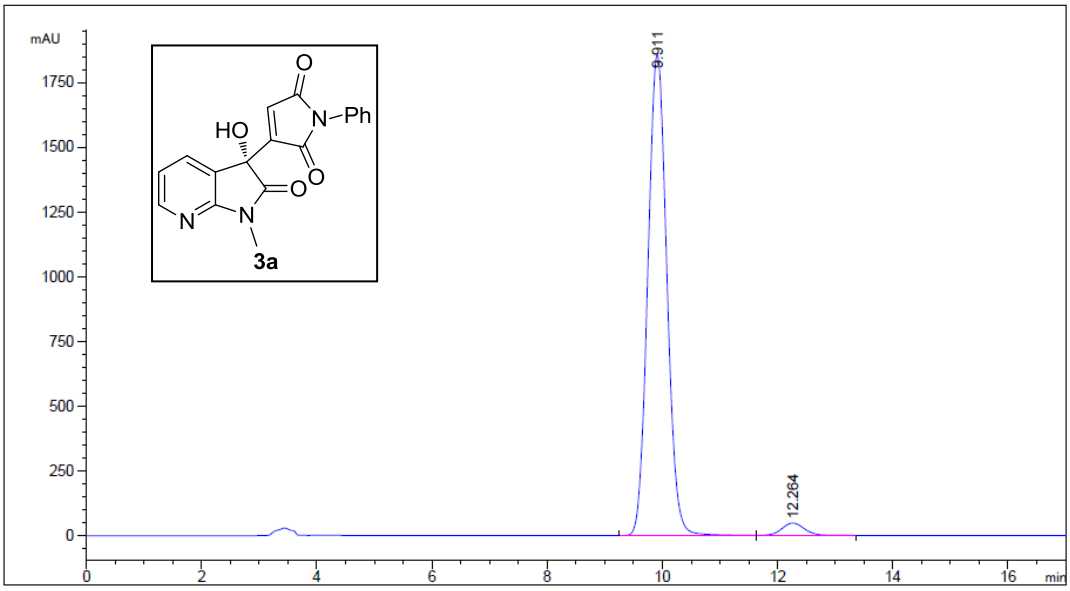

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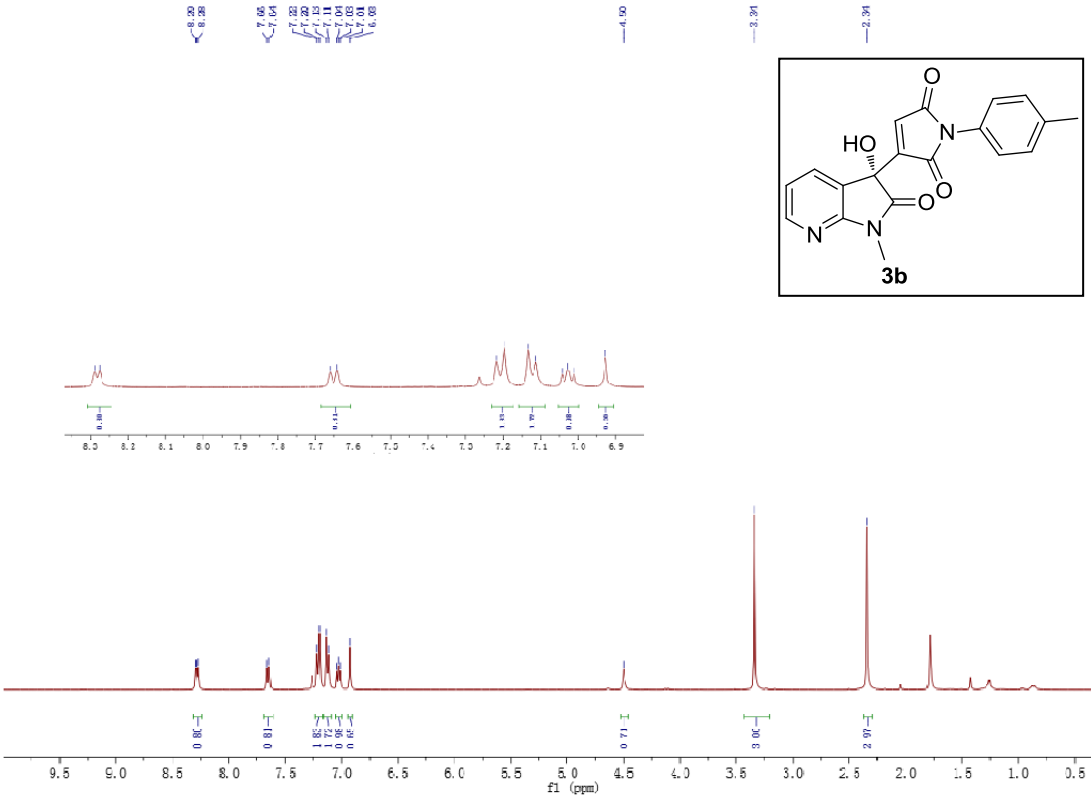
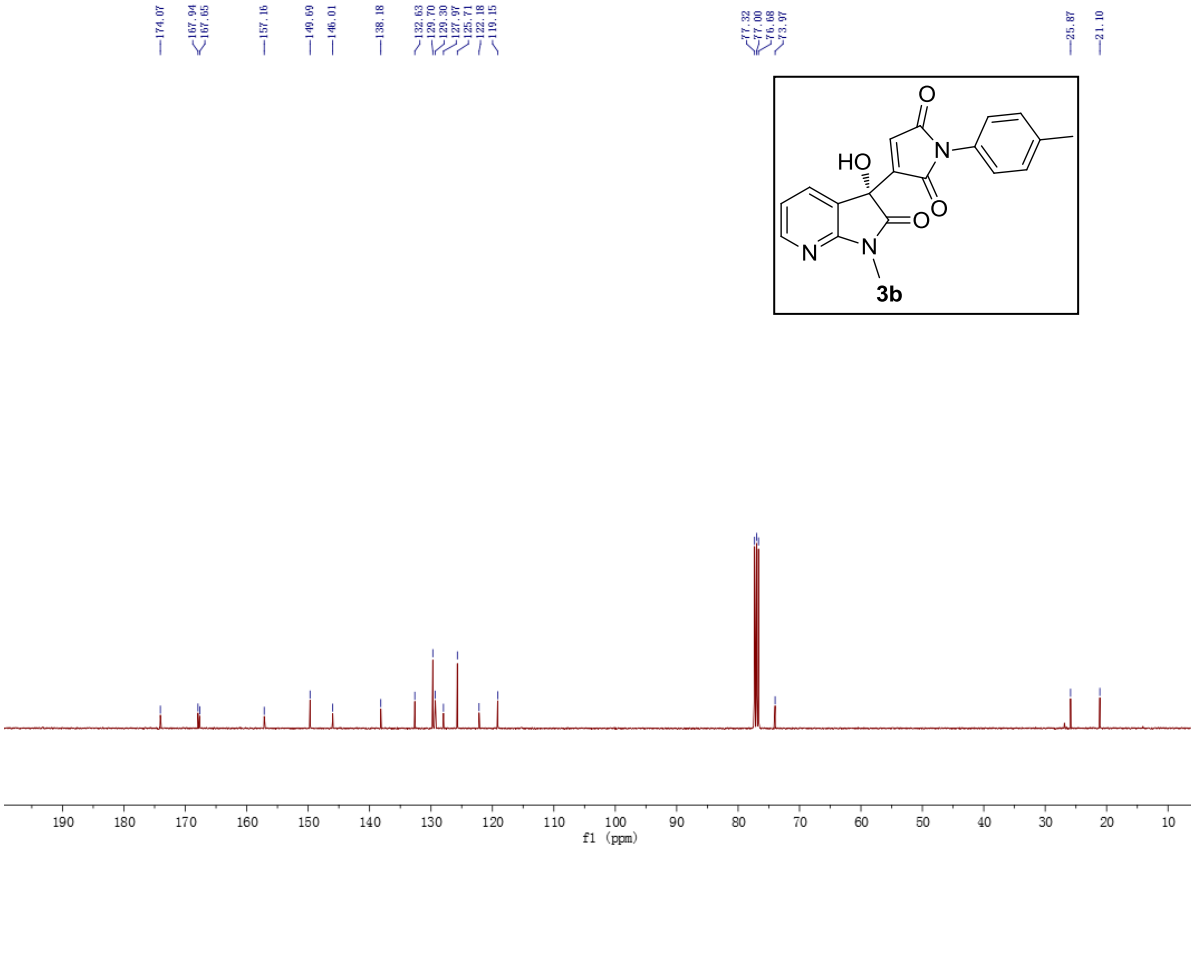
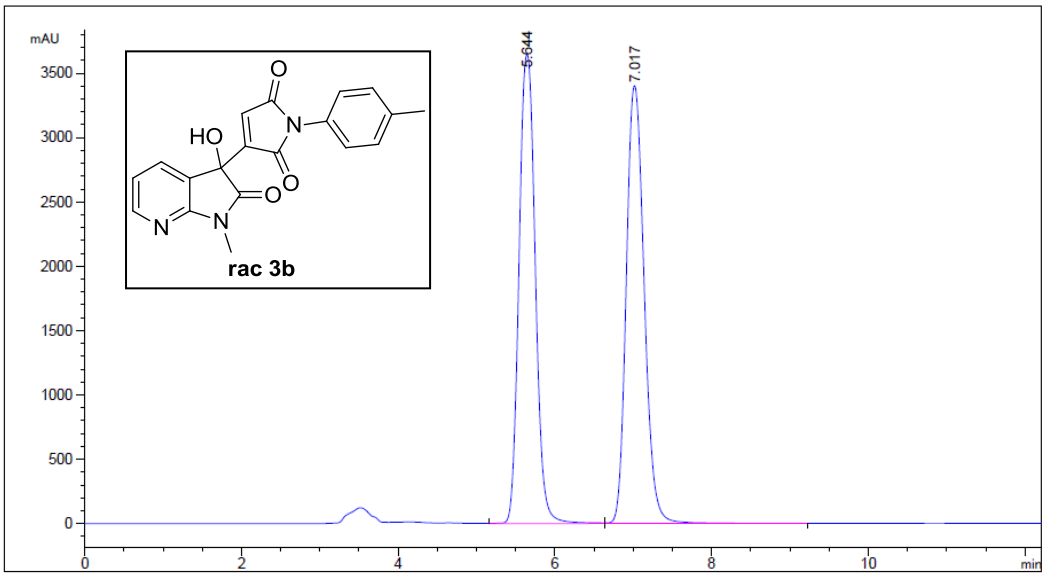

HO
O
N
3b

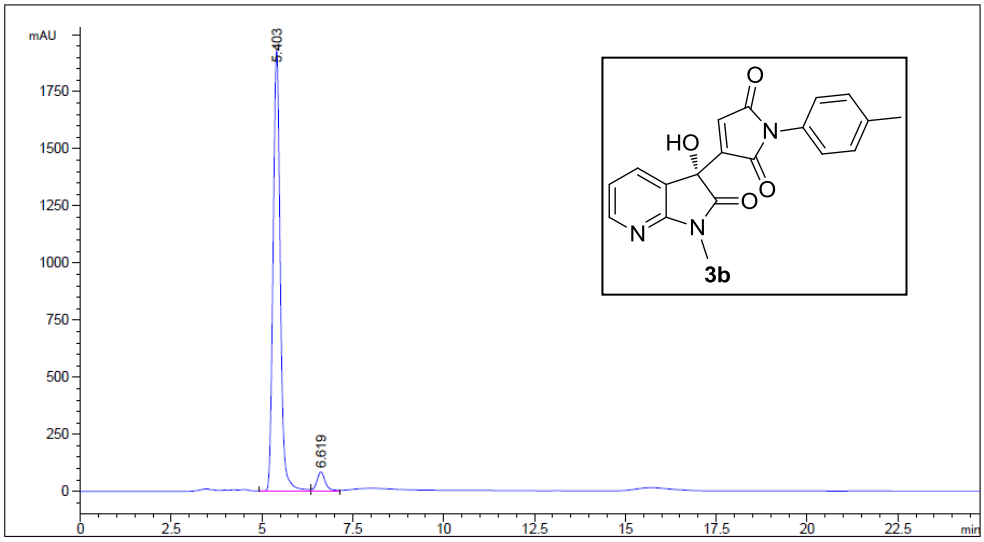

f1 (ppm)

HO
O
N
3b

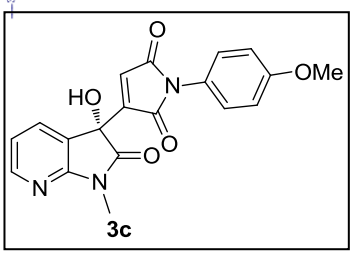
f1 (ppm)



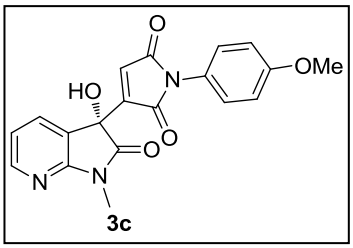
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	5.644	VV	0.2267	5.26513e4	3646.11646	49.3181
2	7.017	VB	0.2497	5.41073e4	3400.50415	50.6819



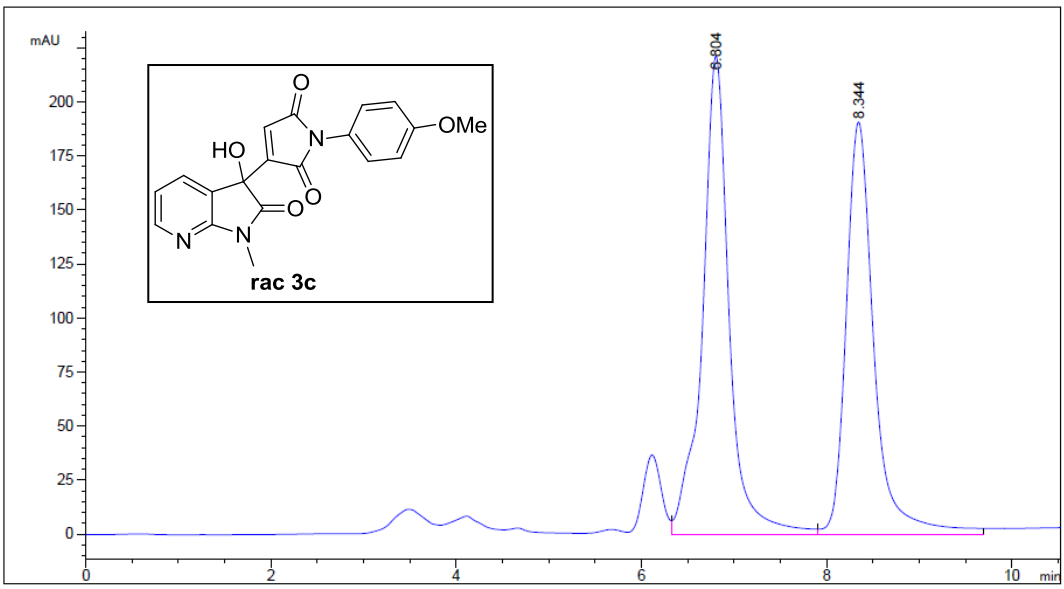
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	5.403	VV	0.2128	2.64968e4	1927.74768	95.0458
2	6.619	VV	0.2509	1381.13953	83.61592	4.9542


HO
O
N
OMe
O
O
N
N
3c

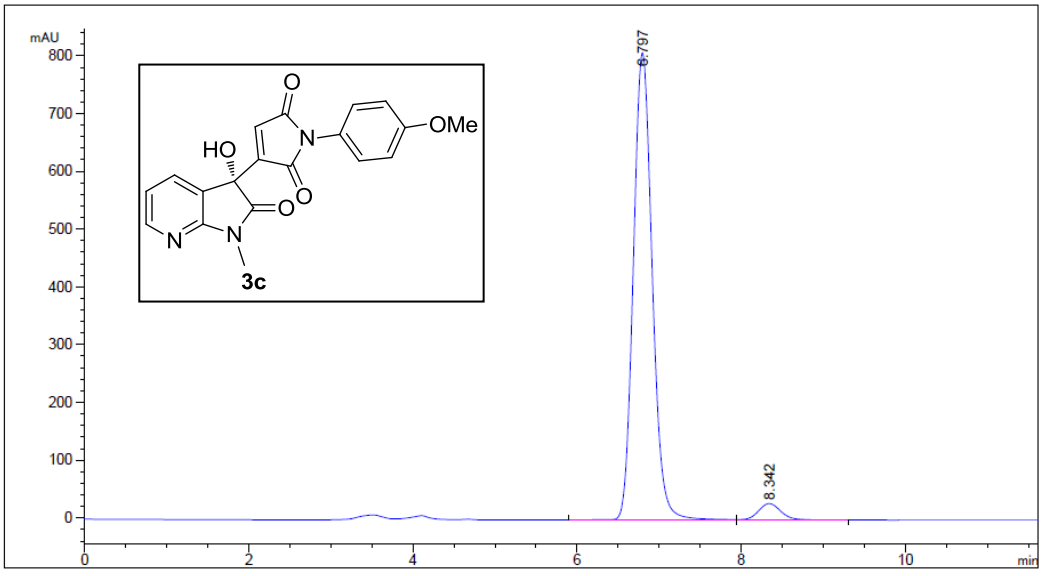
8.28
8.27
7.66
7.64
7.16
7.14
7.04
7.02
7.01
6.93
6.92
6.90
4.60
4.54
3.79
3.33
f1 (ppm)


HO
O
N
OMe
O
O
N
N
3c

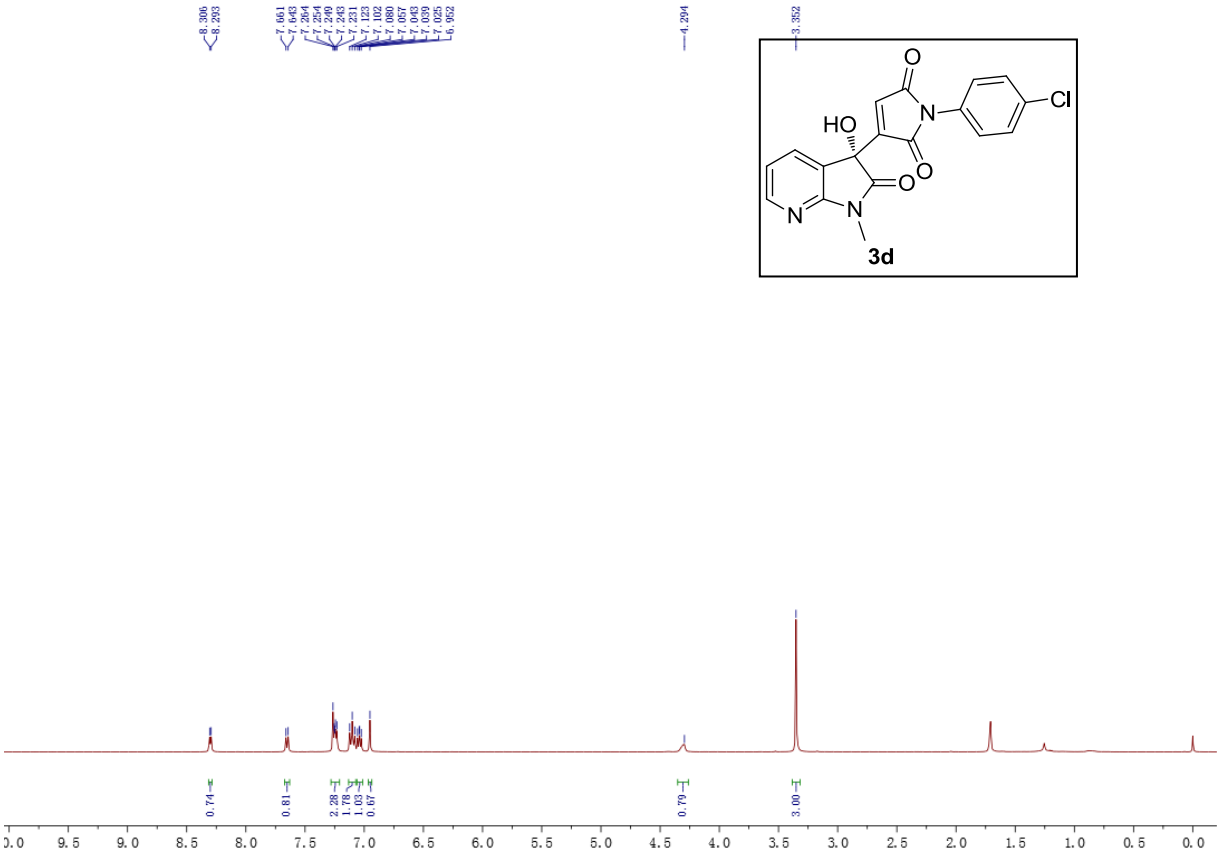
174.17
168.11
167.74
159.14
157.10
149.62
146.00
132.62
129.31
127.33
123.23
122.28
119.16
114.36
77.32
77.00
76.68
73.97
55.44
25.86
f1 (ppm)

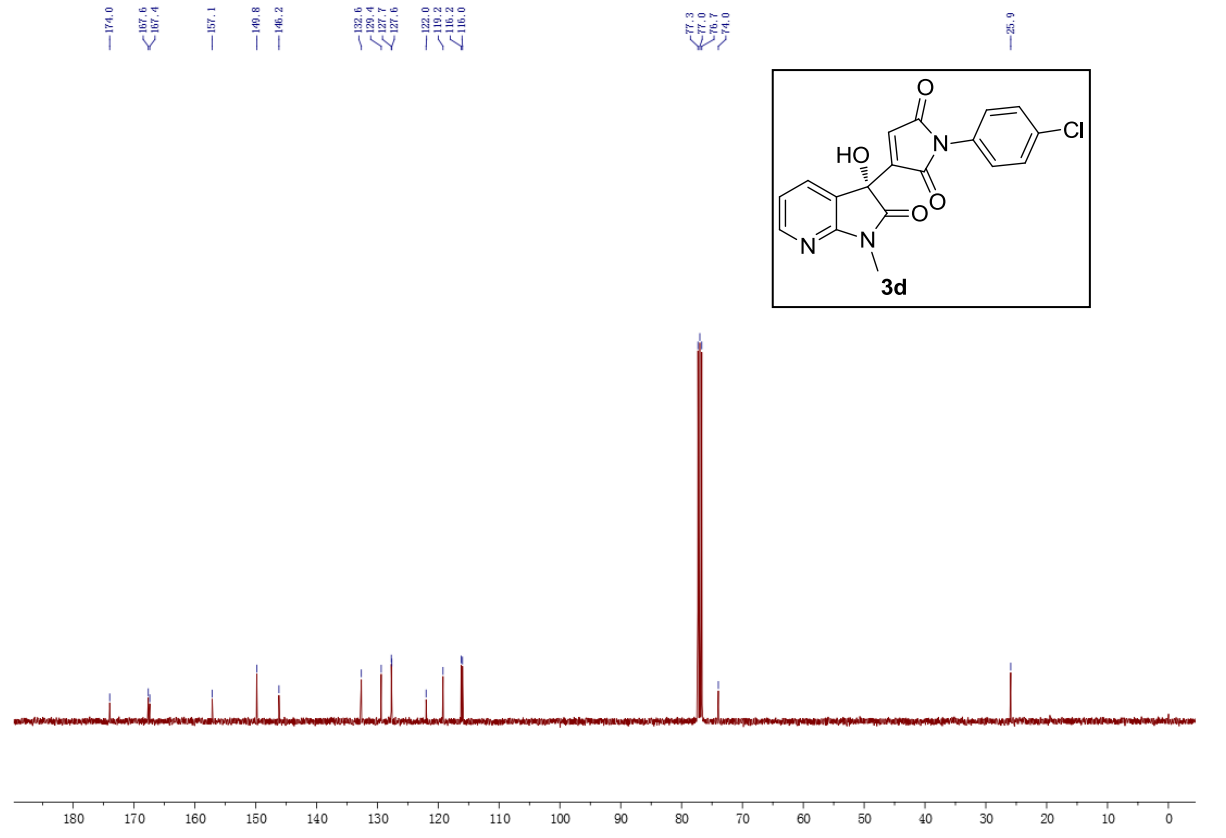


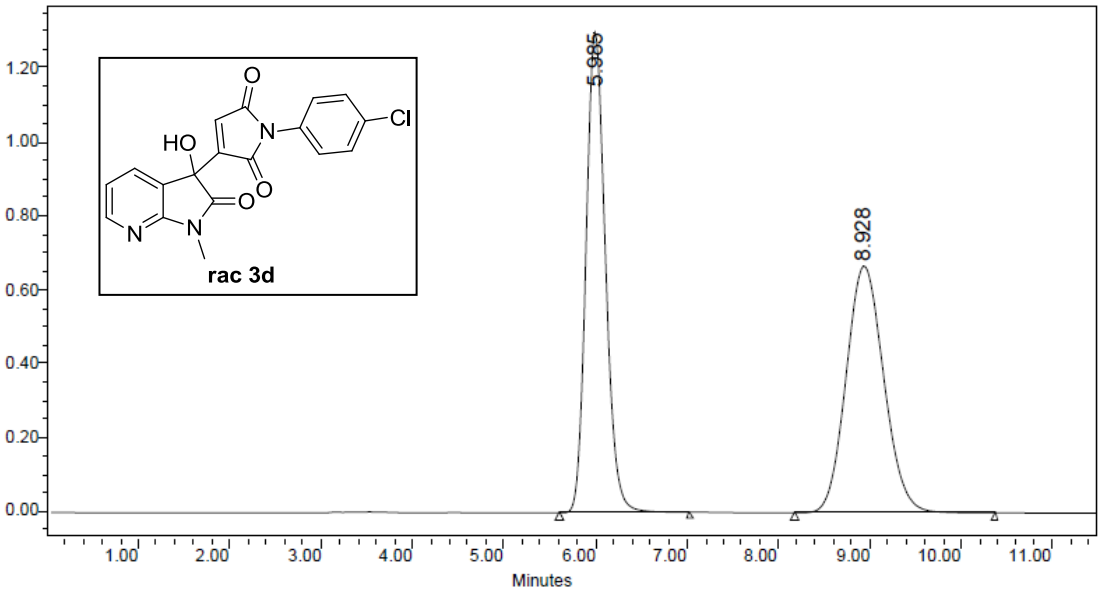
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.804	VV	0.2999	4470.23682	221.12601	52.6916
2	8.344	VB	0.3154	4013.54565	190.71477	47.3084



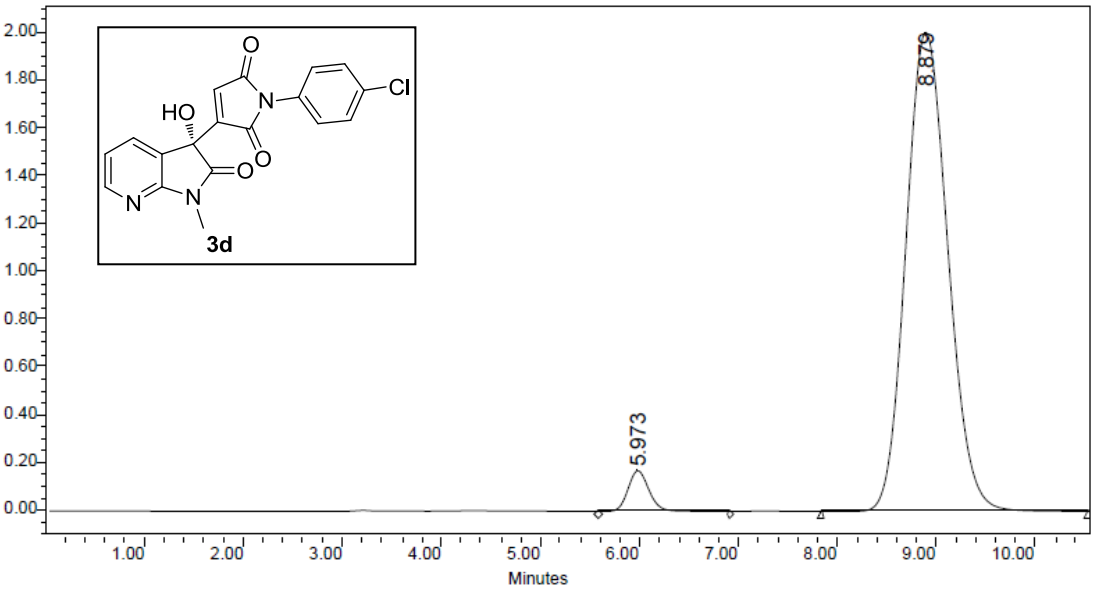
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.797	VV	0.2504	1.28962e4	807.57745	95.8827
2	8.342	VB	0.2957	553.77148	28.60598	4.1173


8.306
8.293
7.661
7.645
7.264
7.254
7.249
7.243
7.231
7.123
7.102
7.080
7.057
7.043
7.039
7.025
6.952
4.294
3.352
HO
O
N
Cl
O
O
N
N
3d
0.74
0.81
2.28
1.78
1.03
0.67
0.79
3.00
0.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

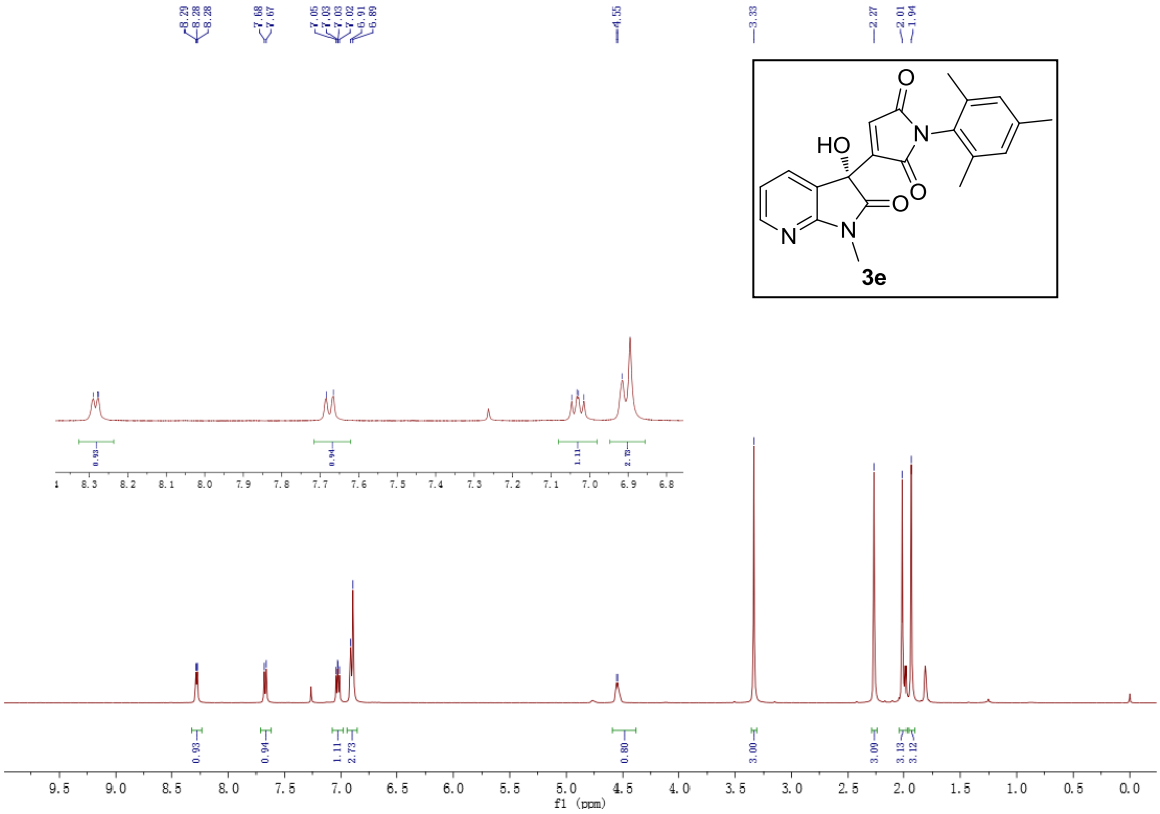

174.0
167.6
167.4
157.1
149.8
146.2
132.6
129.4
127.7
127.6
122.0
119.2
116.2
116.0
77.3
77.0
76.7
74.0
25.9
HO
O
N
Cl
O
O
N
N
3d
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

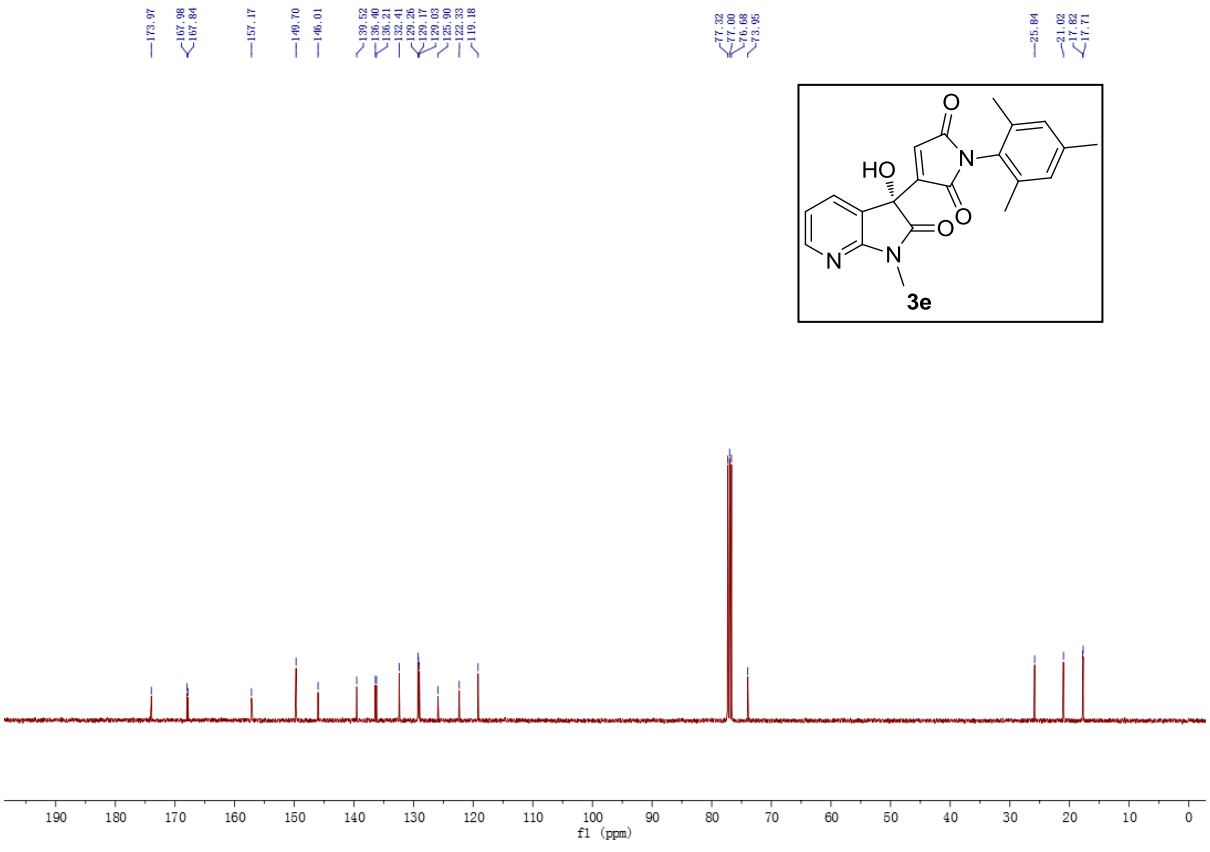


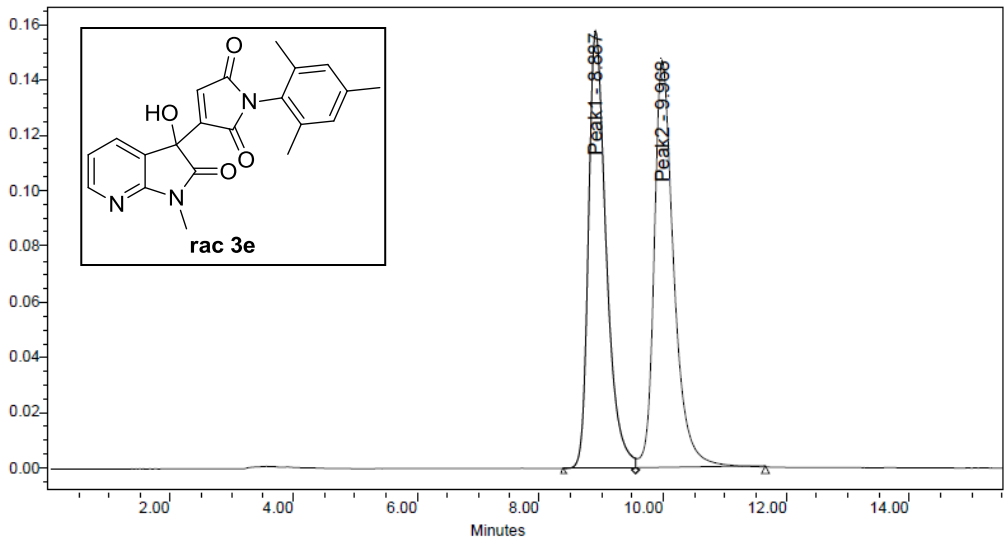
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	5.985	19128519	49.91	1299253	66.06
2	8.928	19197621	50.09	667649	33.94



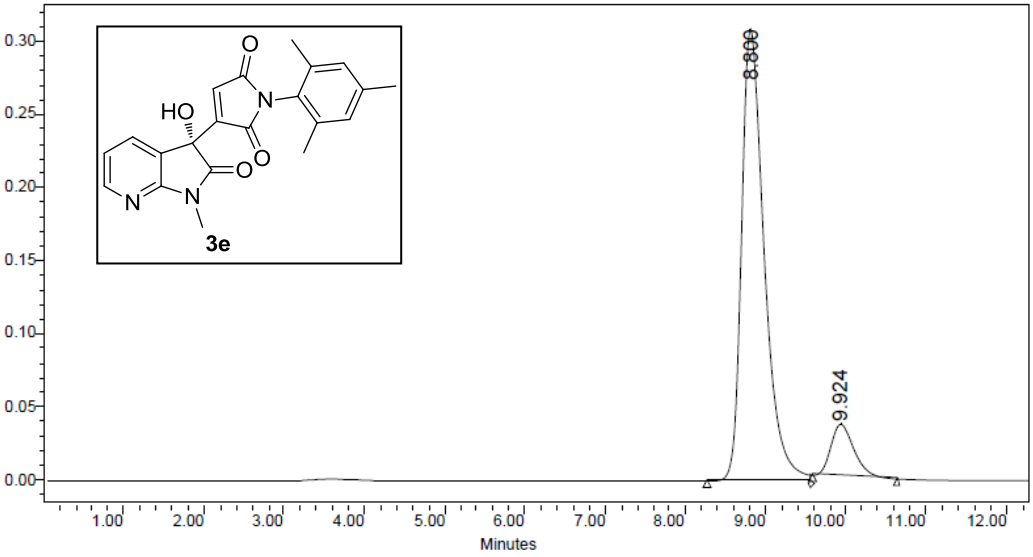
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	5.973	2497291	4.06	170177	7.83
2	8.879	58975772	95.94	2002944	92.17


8.29
8.28
8.28
7.68
7.67
7.05
7.03
7.03
7.02
6.91
6.89
4.55
3.33
2.27
2.01
1.94
HO
O
N
O
O
N
N
3e
0.93
0.94
1.11
2.73
0.80
3.00
3.09
3.13
3.12
f1 (ppm)

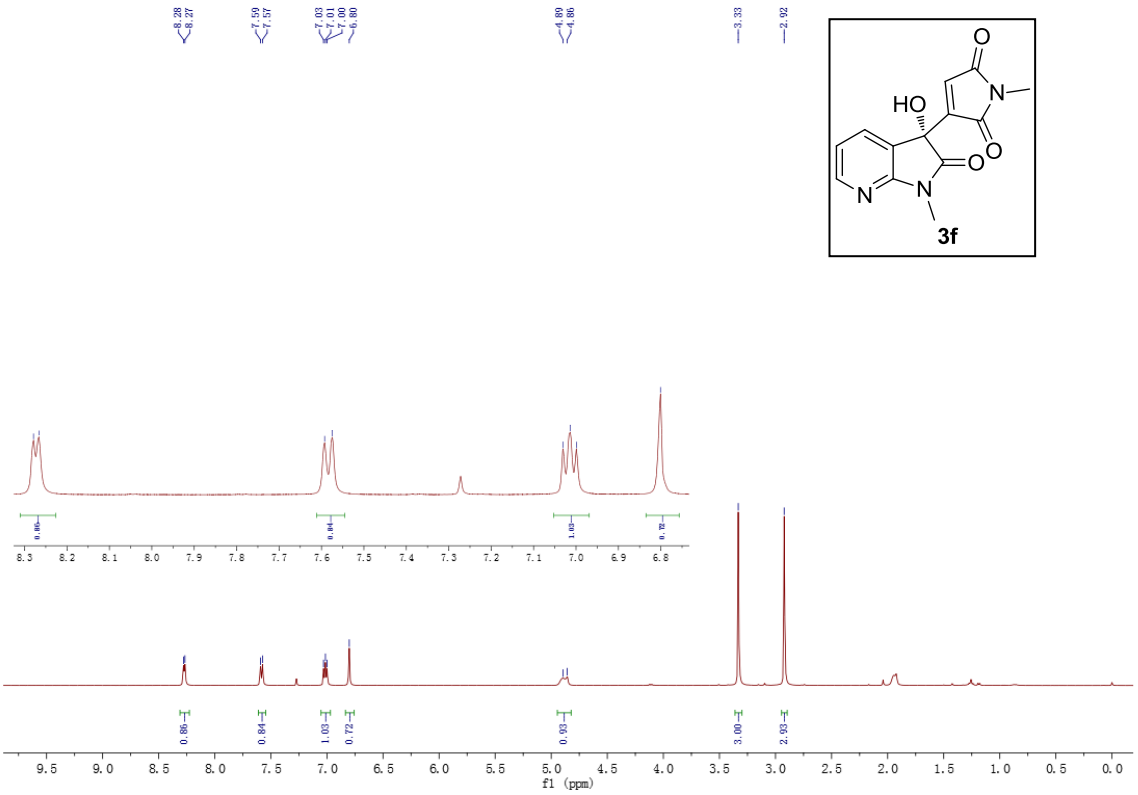

173.97
167.98
167.84
157.17
149.70
146.01
139.52
136.60
136.21
132.41
129.26
129.17
129.03
125.90
123.33
119.18
77.32
77.00
76.68
73.95
25.84
21.02
17.82
17.71
HO
O
N
O
O
N
N
3e
f1 (ppm)

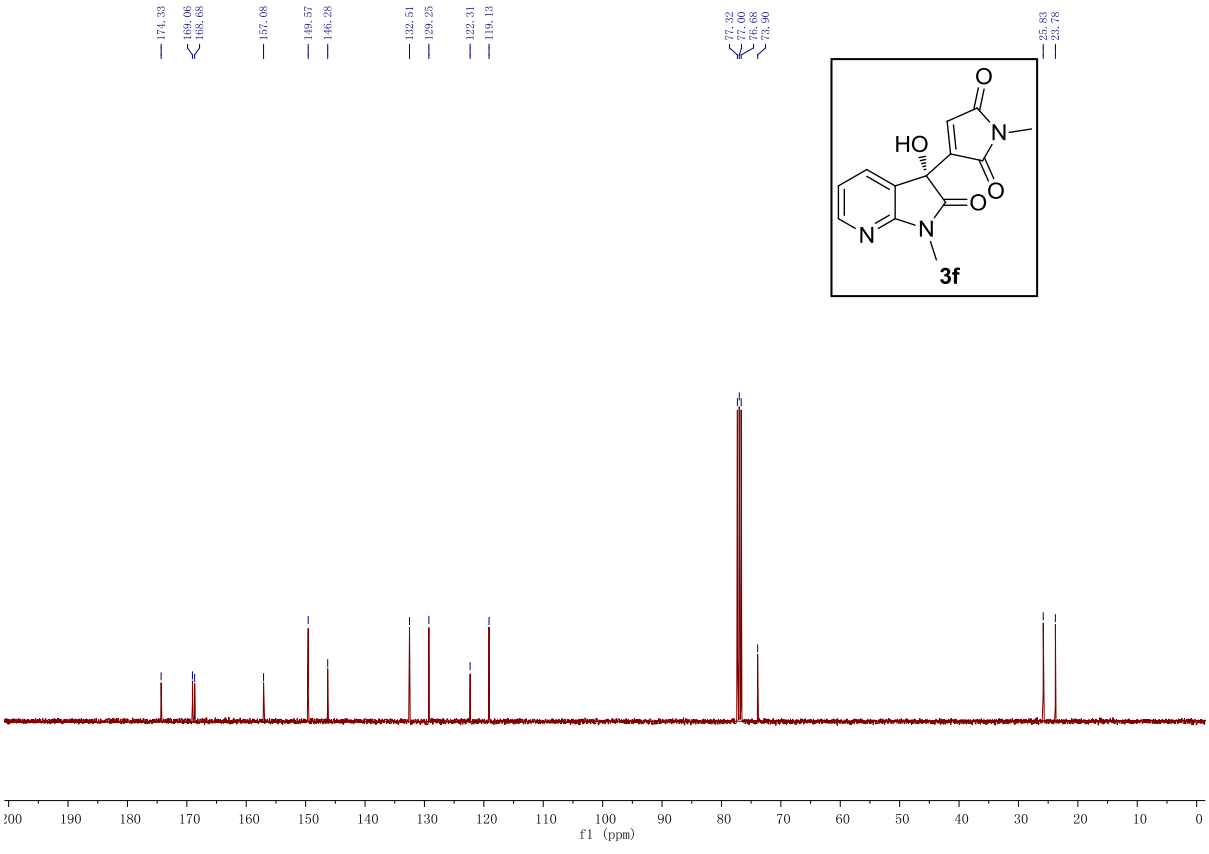


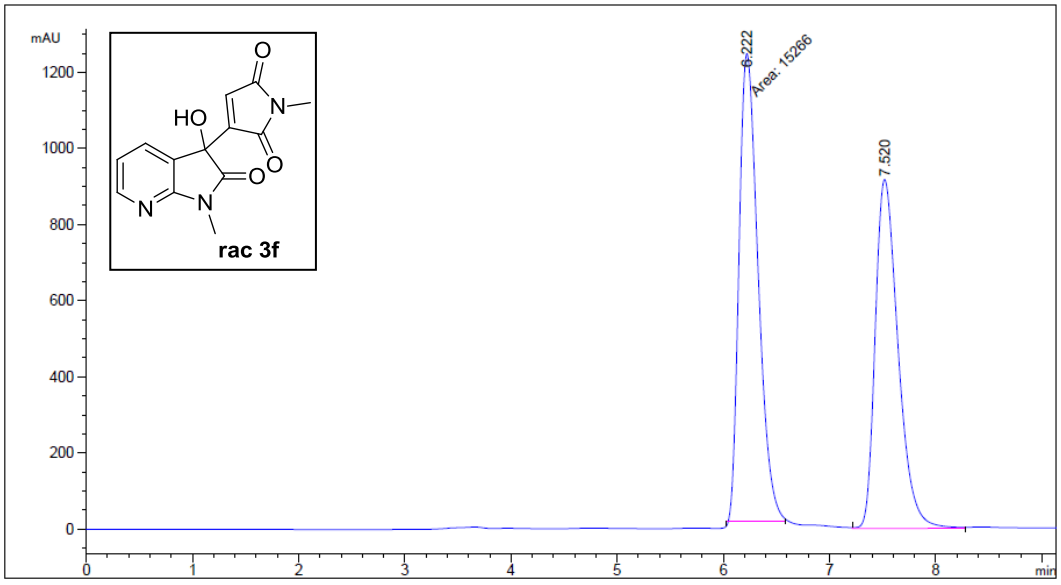
	Peak Name	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	Peak1	8.887	3160968	49.24	157631	51.76
2	Peak2	9.968	3258195	50.76	146938	48.24



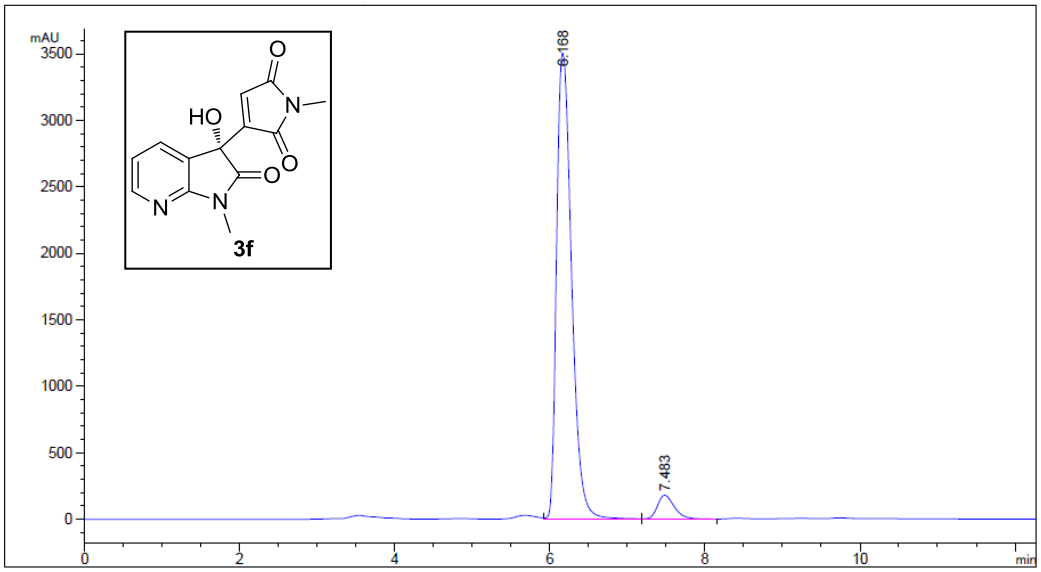
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	8.800	6060208	89.34	309007	89.65
2	9.924	722961	10.66	35679	10.35


8.28
8.27
7.59
7.57
7.03
7.01
7.00
6.80
4.89
4.86
3.33
2.92
HO
O
N
O
O
N
N
3f
0.86
0.84
1.03
0.72
0.93
3.00
2.93
f1 (ppm)

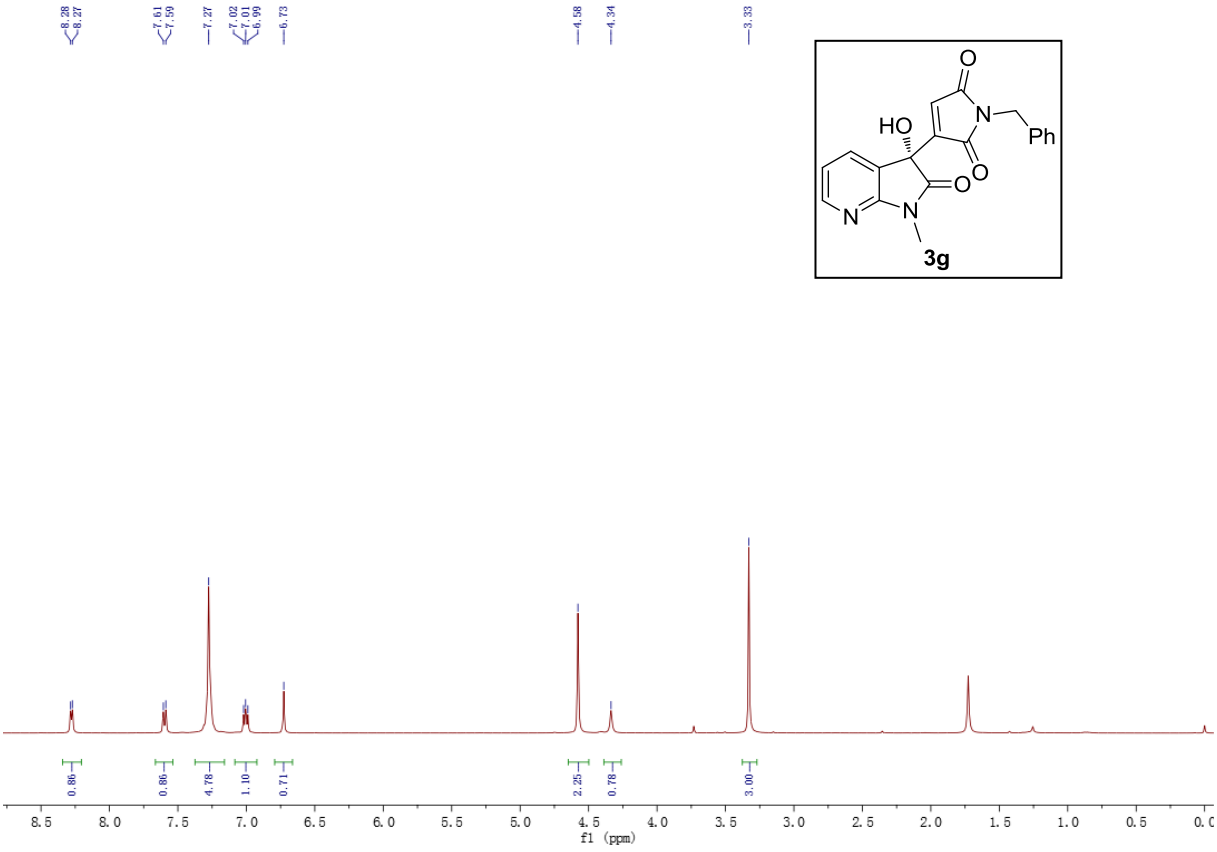

174.33
169.06
168.68
157.08
149.57
146.28
132.51
129.25
122.31
119.13
77.32
77.00
76.68
73.90
25.83
23.78
HO
O
N
O
O
N
N
3f
f1 (ppm)

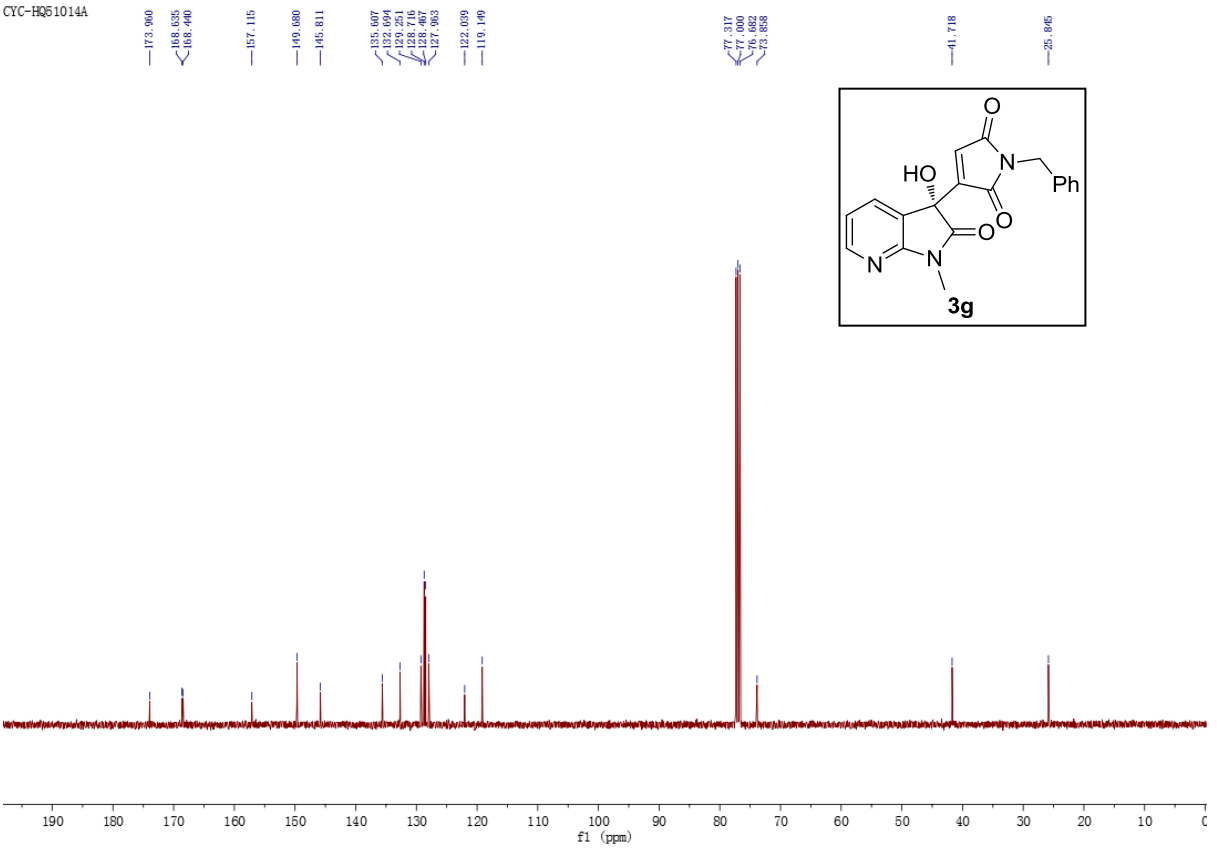


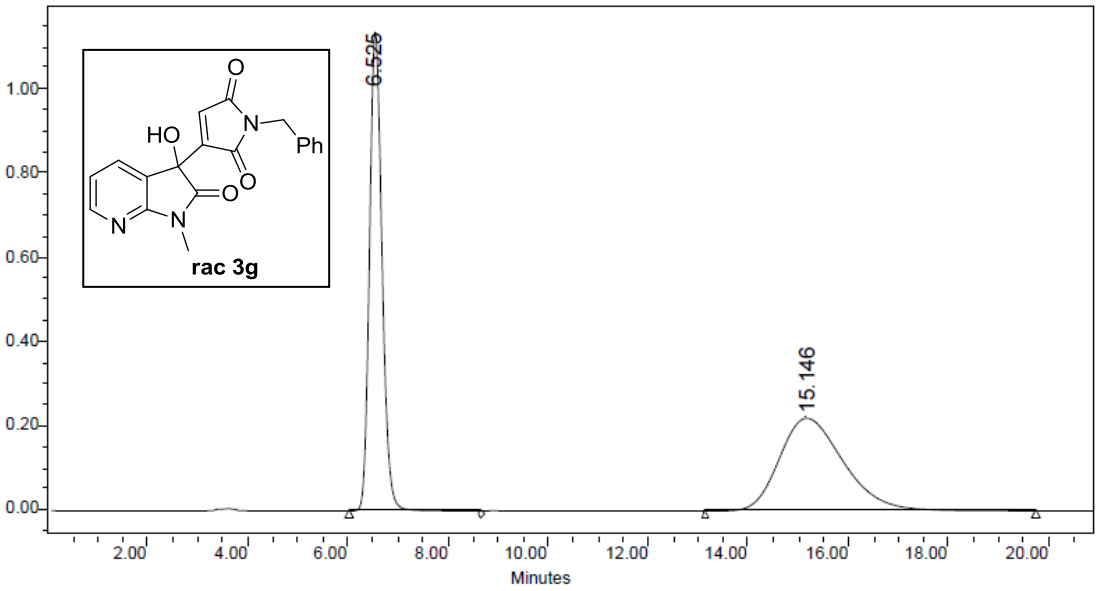
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.222	MM	0.2066	1.52660e4	1231.45105	52.6886
2	7.520	VV	0.2271	1.37080e4	915.30383	47.3114



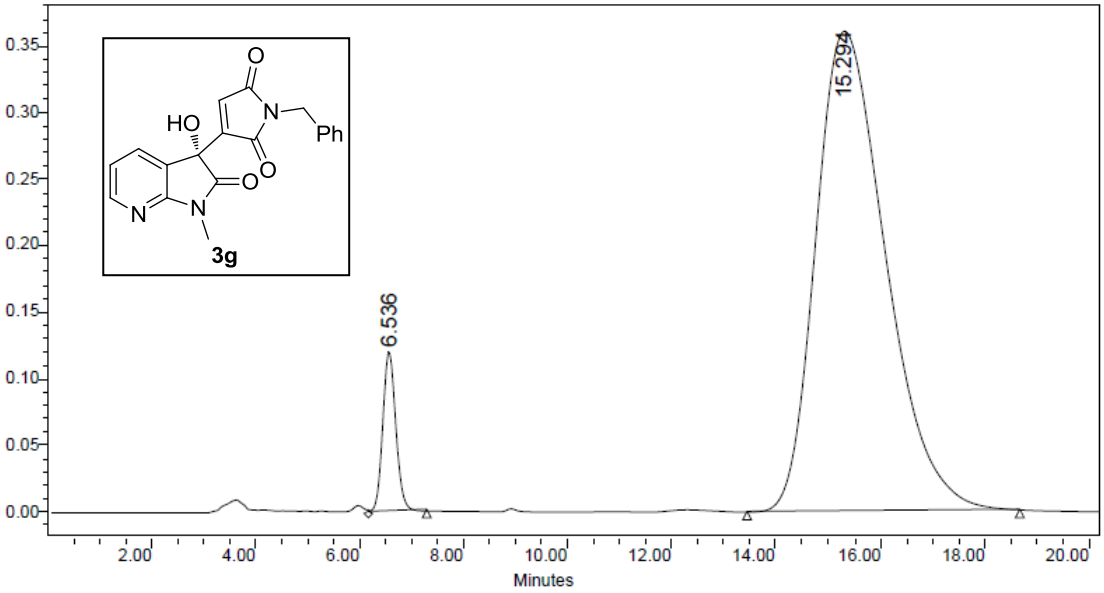
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.168	VV	0.2150	4.71425e4	3508.30396	94.3077
2	7.483	VV	0.2356	2845.48120	181.20529	5.6923


8.28
8.27
7.61
7.59
7.27
7.02
7.01
6.99
6.73
4.58
4.34
3.33
HO
O
N
Ph
O
O
N
N
3g
0.86
0.86
4.78
1.10
0.71
2.25
0.78
3.00
f1 (ppm)

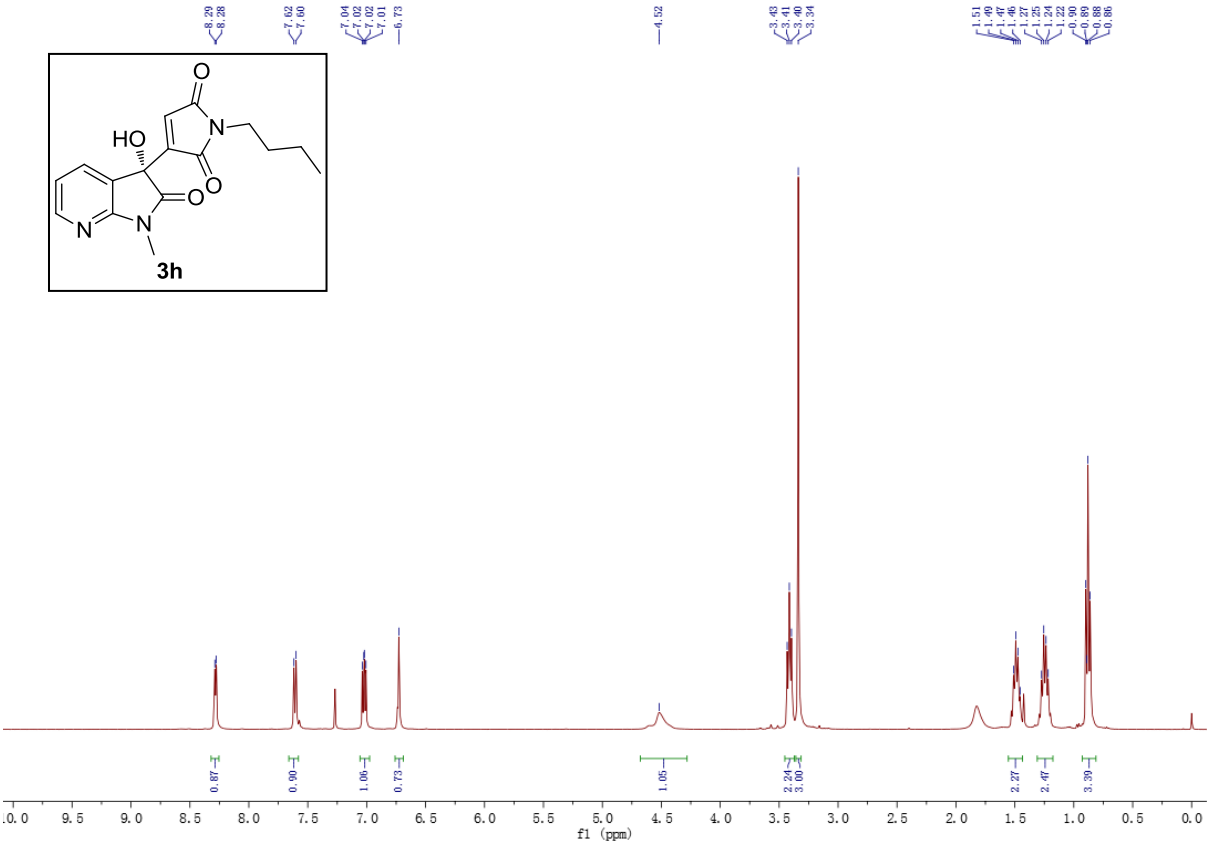

CYC-HQ51014A
173.960
168.635
168.440
157.115
149.680
145.811
135.607
132.694
129.251
128.716
128.467
127.963
122.039
119.149
77.317
77.000
76.682
73.858
41.718
25.845
HO
O
N
Ph
O
O
N
N
3g
f1 (ppm)

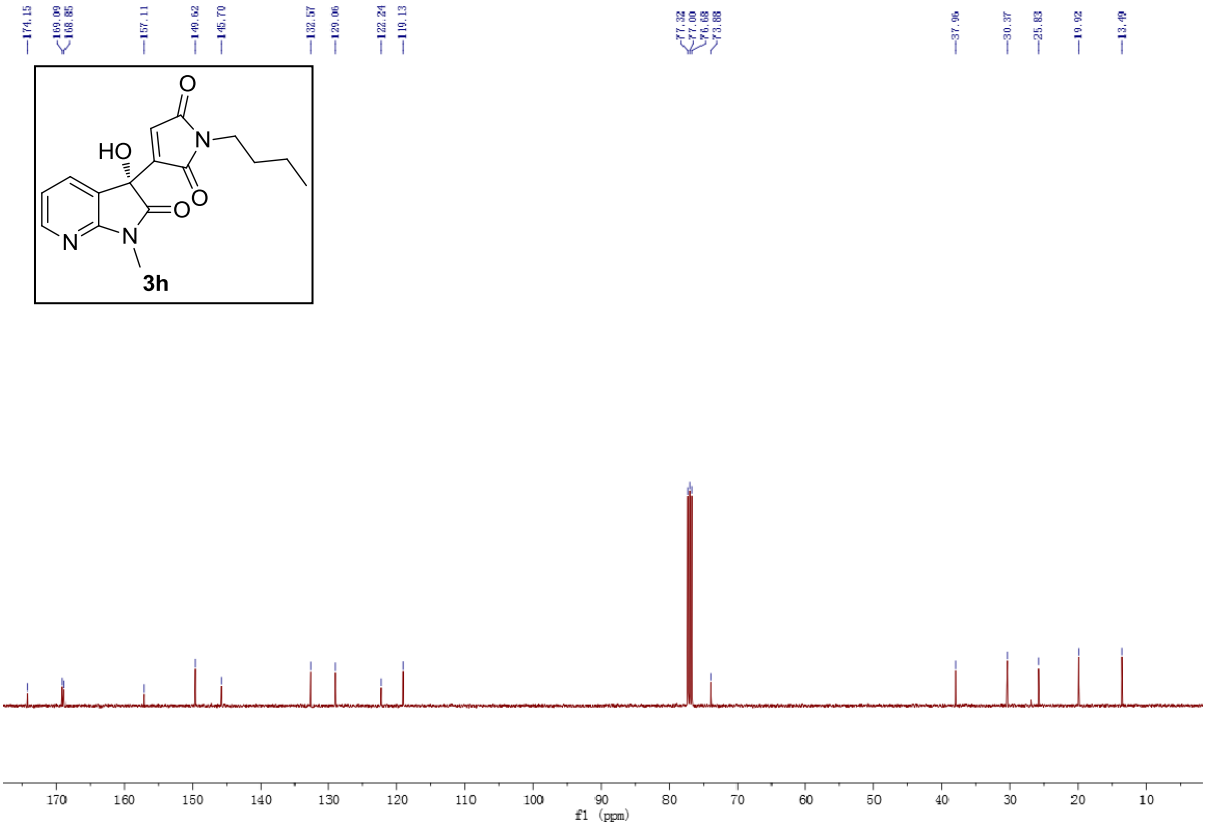


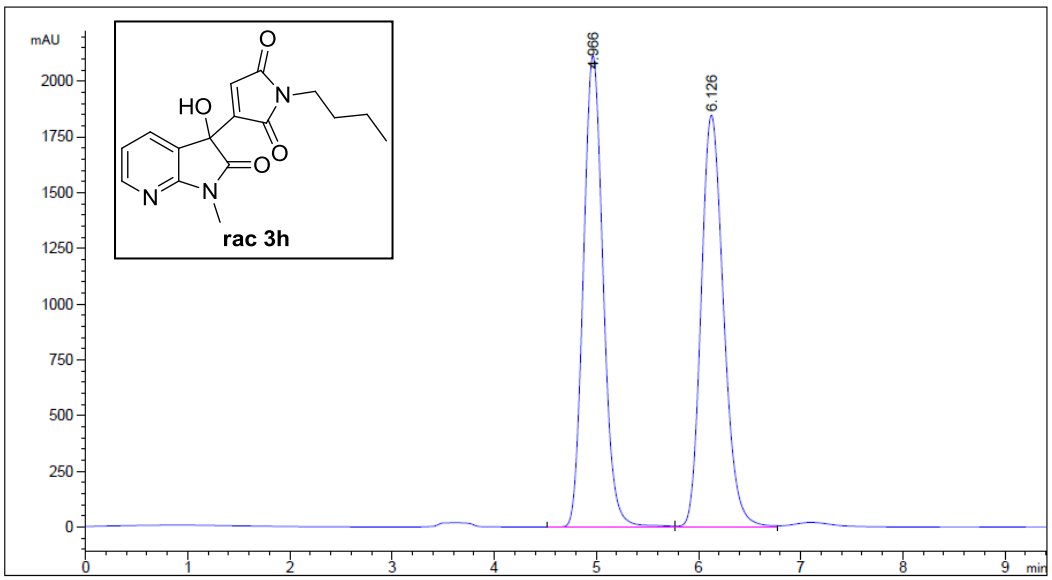
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	6.525	19754004	50.10	1138906	83.79
2	15.146	19676964	49.90	220265	16.21



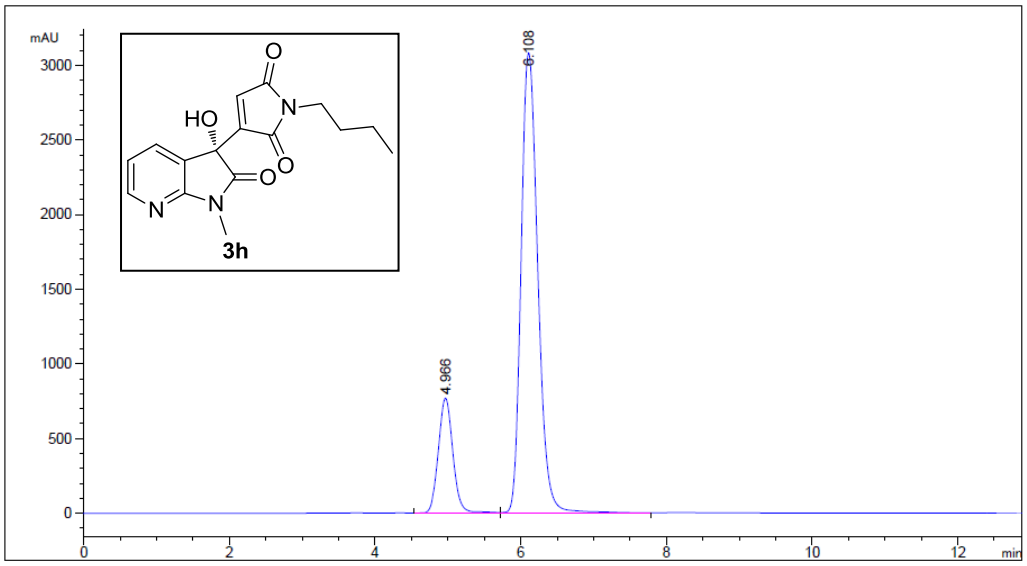
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	6.536	2097836	5.86	119643	24.90
2	15.294	33686572	94.14	360829	75.10


HO
O
N
O
O
N
N
3h
8.29
8.28
7.62
7.60
7.04
7.02
7.02
7.01
6.73
4.52
3.43
3.41
3.40
3.34
1.51
1.49
1.47
1.46
1.27
1.25
1.24
1.22
0.90
0.89
0.88
0.86
0.87
0.90
1.06
0.73
1.05
2.24
3.00
2.27
2.47
3.39
f1 (ppm)

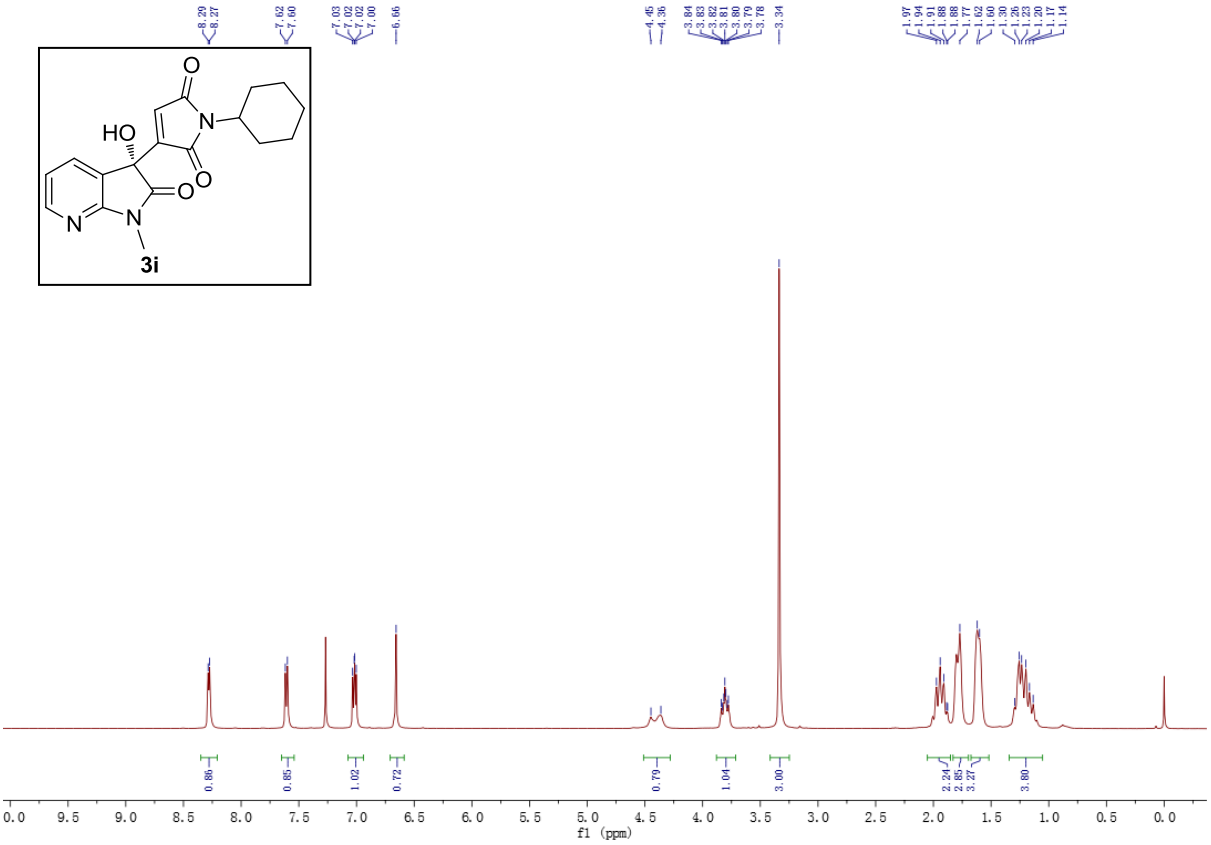

HO
O
N
O
O
N
N
3h
174.15
169.99
168.85
157.11
149.62
145.70
132.57
129.06
122.24
119.13
77.32
77.00
76.68
73.88
37.96
30.37
25.83
19.92
13.49
f1 (ppm)

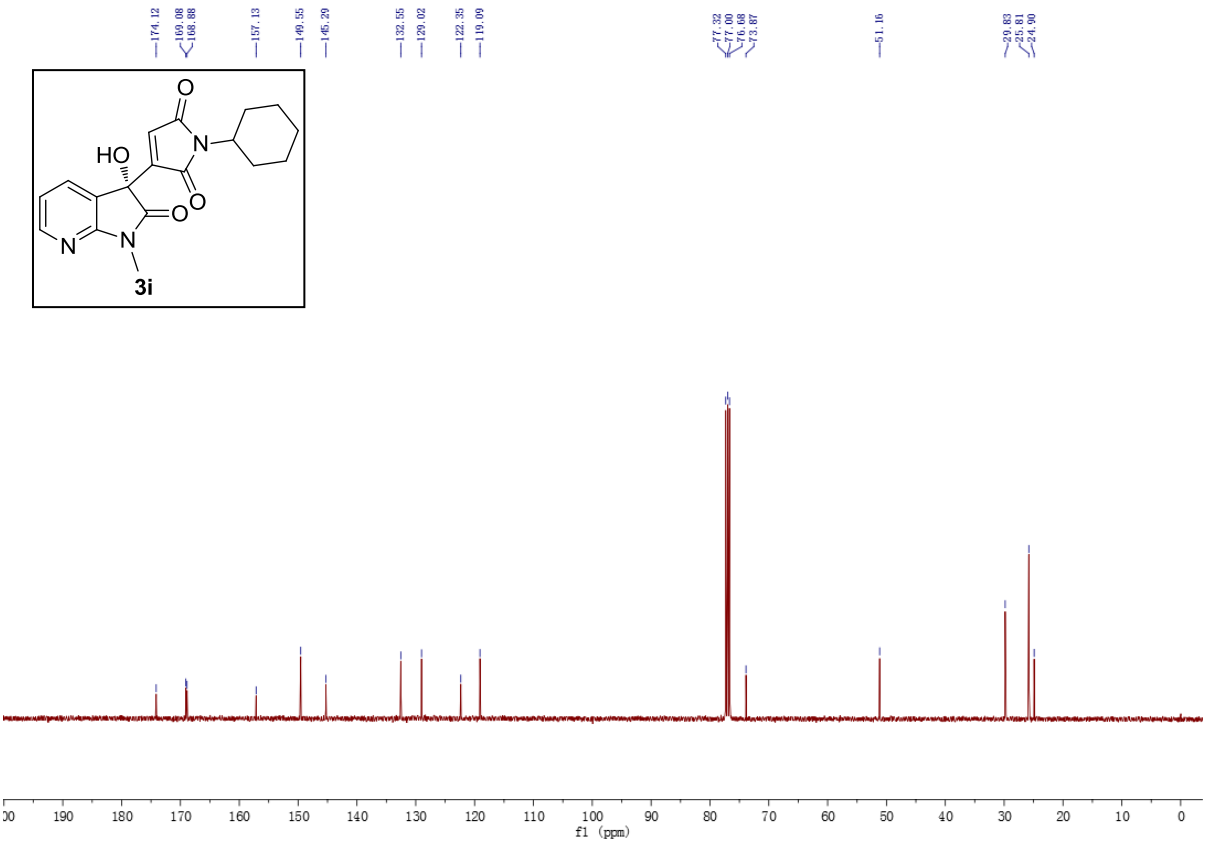


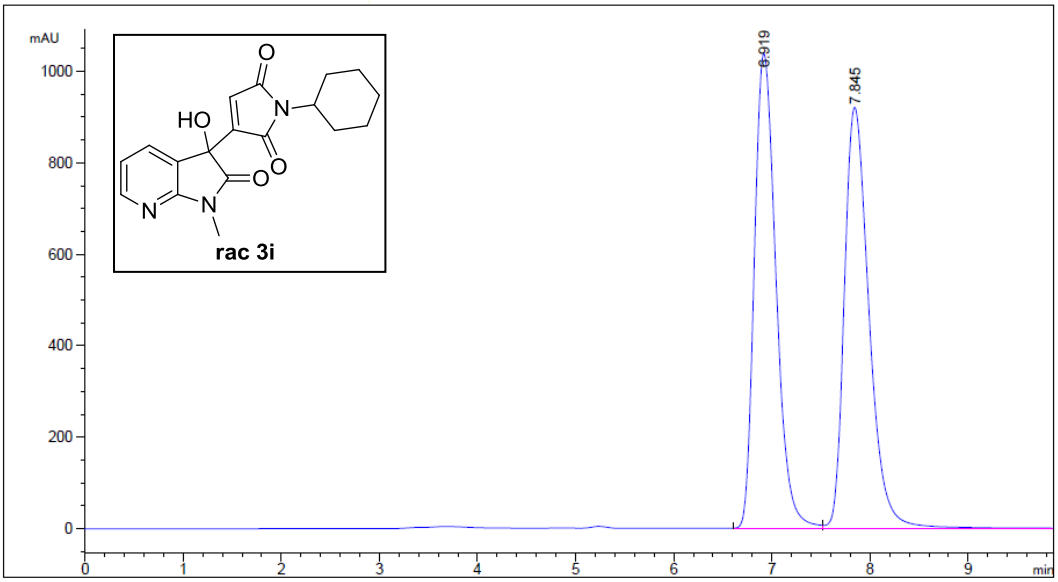
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	4.966	VV	0.2090	2.83408e4	2112.02271	50.0482
2	6.126	VV	0.2370	2.82862e4	1845.99268	49.9518



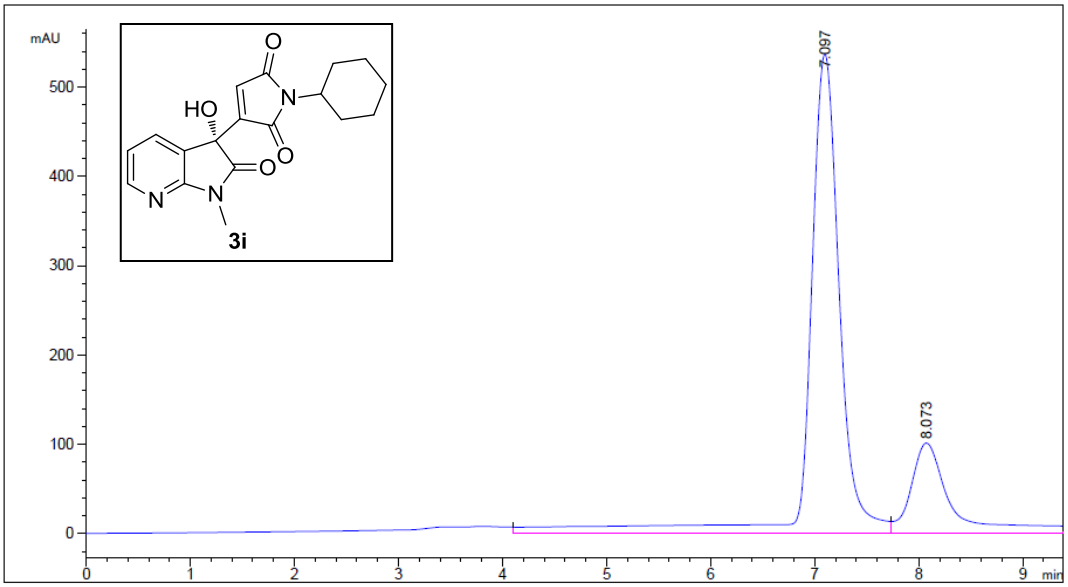
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	4.966	VV	0.2167	1.08344e4	769.50647	18.0121
2	6.108	VV	0.2450	4.93160e4	3080.80444	81.9879


HO
O
N
O
O
N
N
3i
8.29
8.27
7.62
7.60
7.03
7.02
7.01
7.00
6.66
4.45
4.36
3.84
3.83
3.82
3.81
3.80
3.79
3.78
3.34
1.97
1.94
1.91
1.88
1.88
1.77
1.62
1.60
1.30
1.26
1.23
1.20
1.17
1.14
0.86
0.85
1.02
0.72
0.79
1.04
3.00
2.24
2.85
3.27
3.80
f1 (ppm)

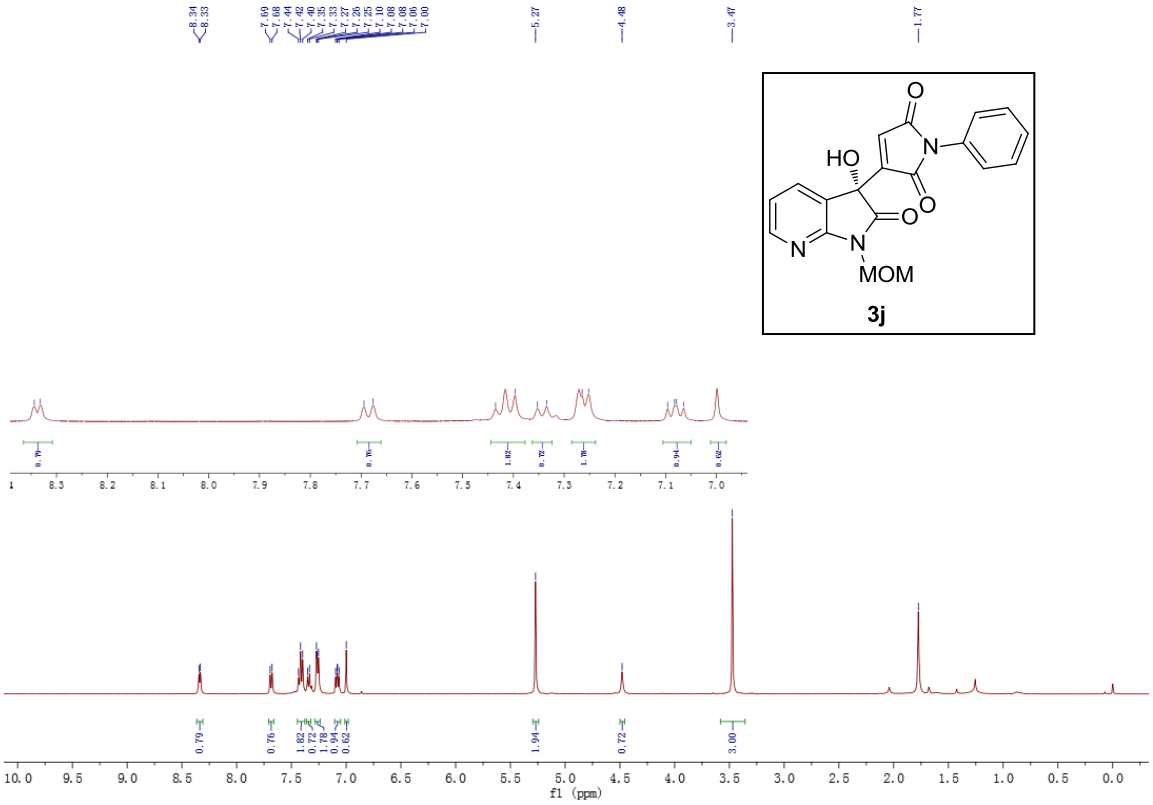

HO
O
N
O
O
N
N
3i
174.12
169.08
168.88
157.13
149.55
145.29
132.55
129.02
122.35
119.09
77.32
77.00
76.68
73.87
51.16
29.83
25.61
24.90
f1 (ppm)

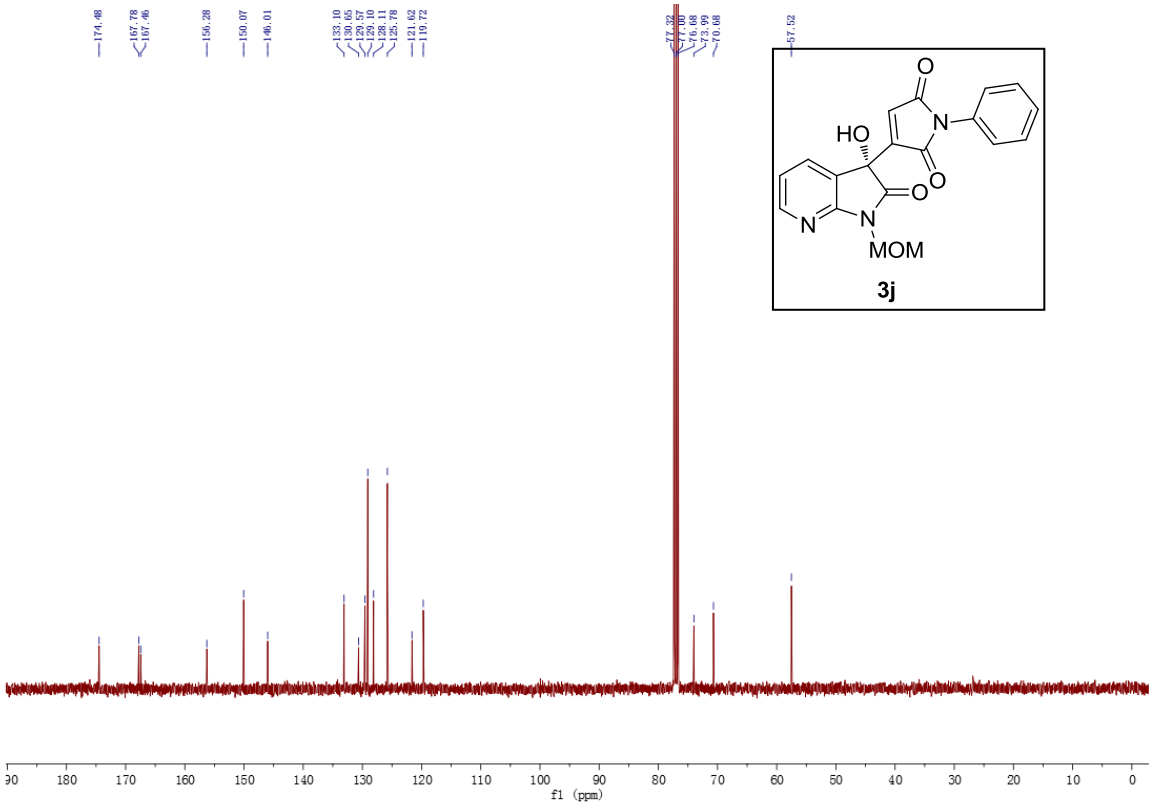


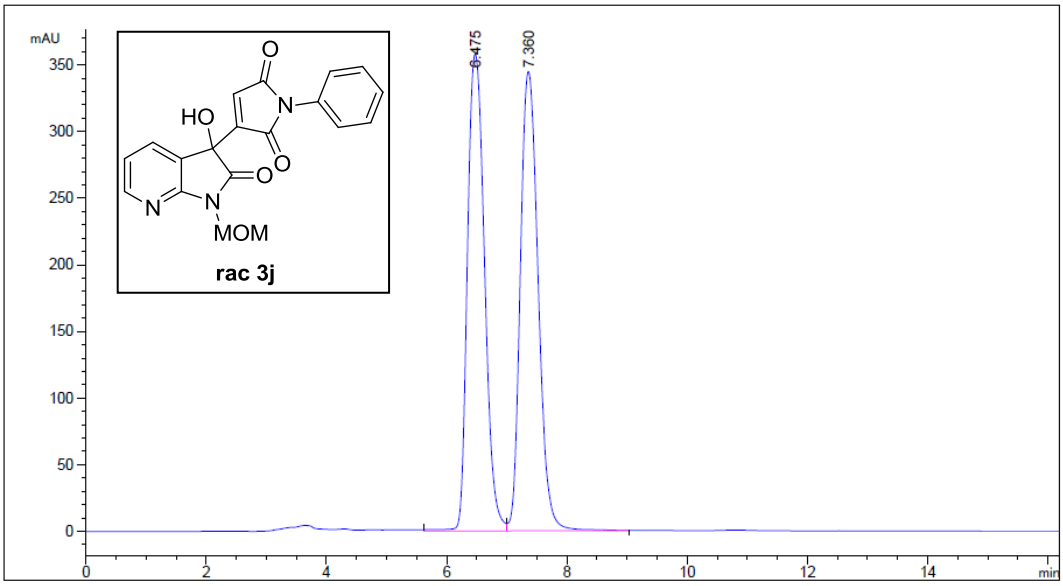
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.919	BV	0.2430	1.59147e4	1037.87170	49.5678
2	7.845	VBA	0.2693	1.61922e4	920.42444	50.4322



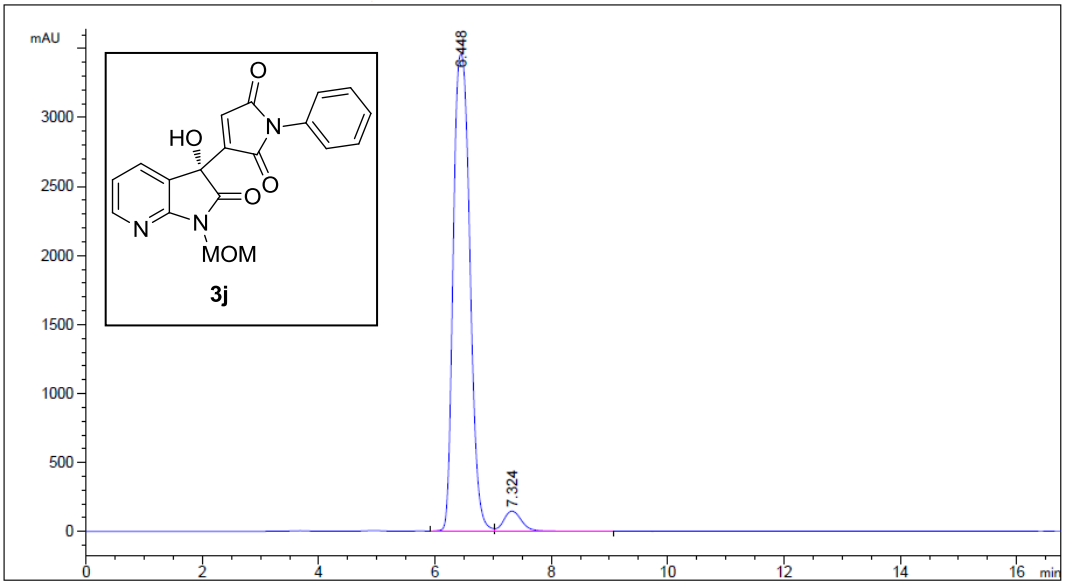
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	7.097	VV	0.3082	1.09523e4	536.19336	80.1268
2	8.073	VBA	0.3895	2716.41528	101.00495	19.8732


HO
O
N
O
O
N
N
MOM
3j
f1 (ppm)

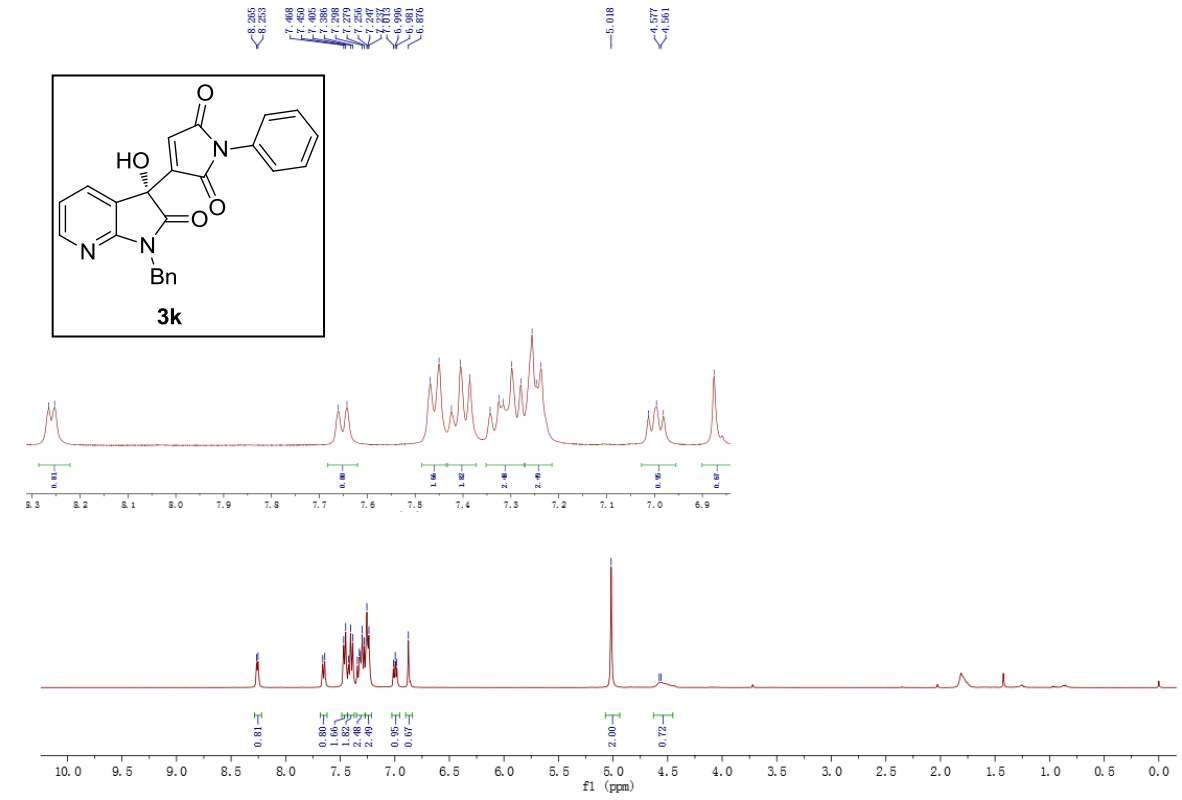

HO
O
N
O
O
N
N
MOM
3j
f1 (ppm)

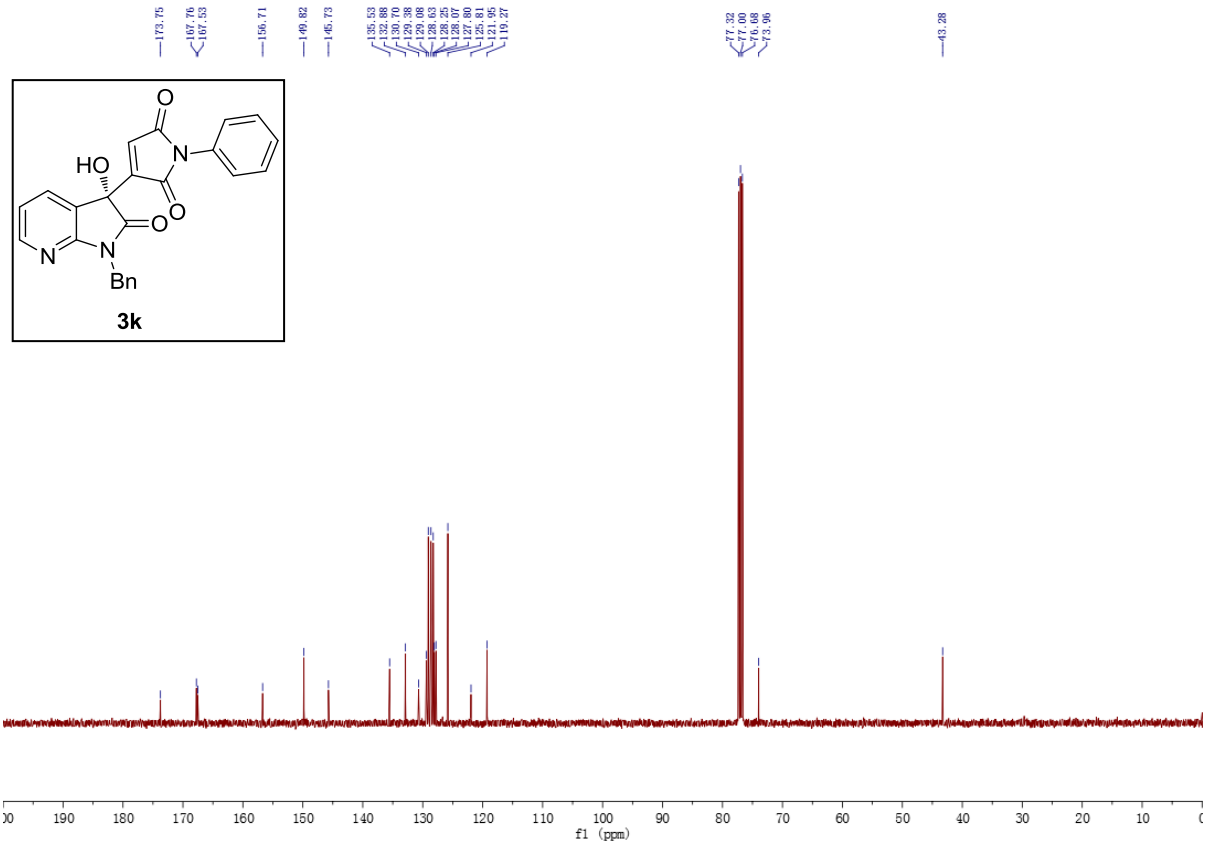


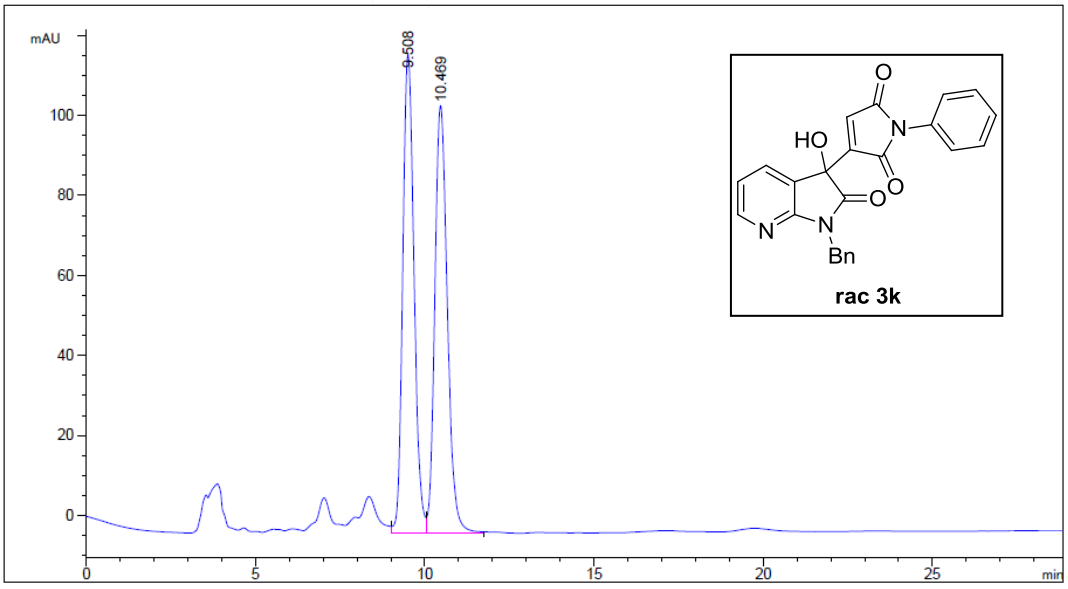
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.475	BV	0.3180	7070.14600	357.59406	49.9557
2	7.360	VB	0.3273	7082.67432	344.38330	50.0443



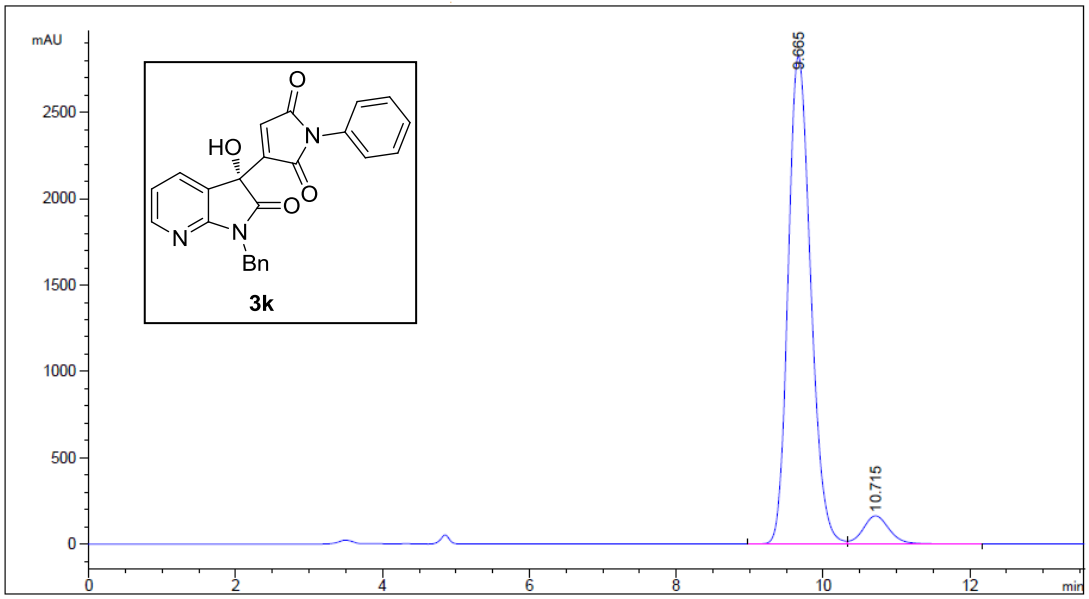
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.448	VV	0.3188	6.86286e4	3460.13452	95.4869
2	7.324	VB	0.3463	3243.63623	146.11922	4.5131


8.265
8.253
7.468
7.460
7.456
7.386
7.298
7.279
7.256
7.247
7.237
7.215
6.896
6.881
6.876
5.018
4.577
4.561
HO
O
N
O
O
N
N
Bn
3k
0.81
0.80
1.66
1.82
2.49
0.95
0.67
2.00
0.72
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

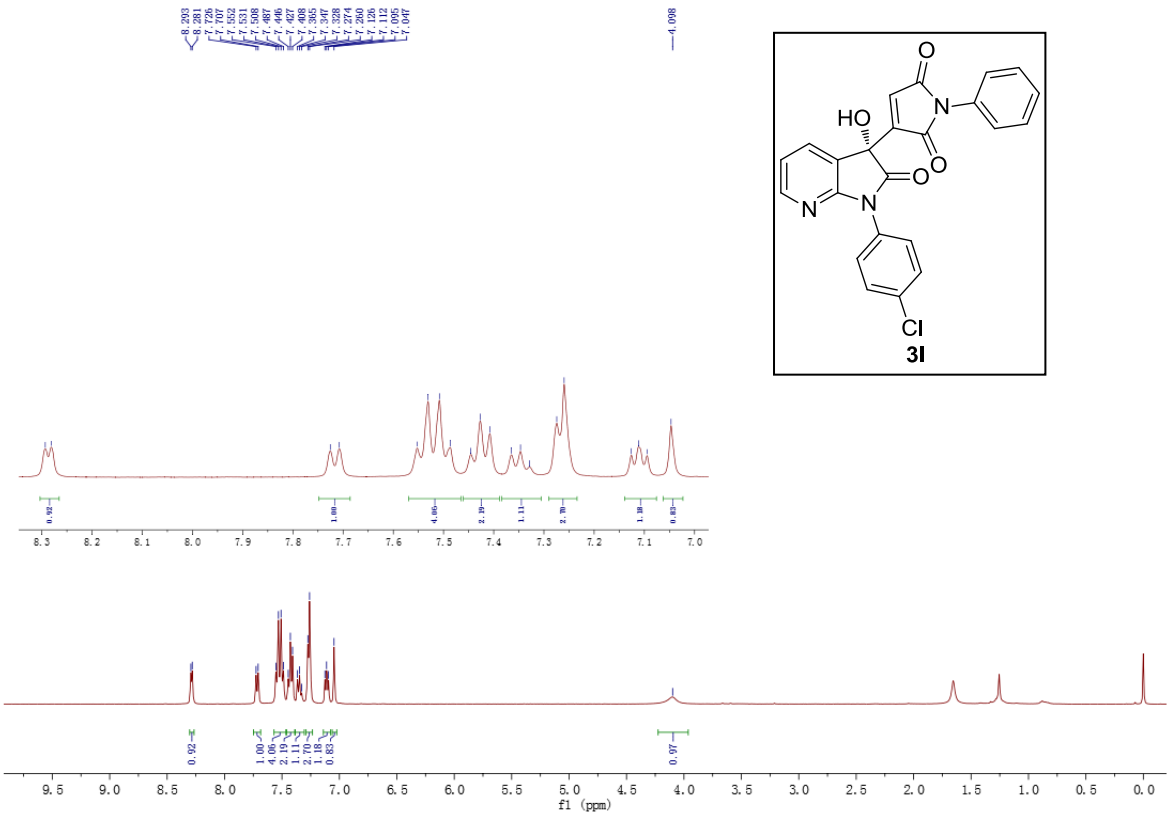

173.75
167.76
167.53
156.71
149.82
145.73
135.53
132.88
130.70
129.38
129.08
128.63
128.25
128.07
127.80
125.81
121.95
119.27
77.32
77.00
76.68
75.96
43.28
HO
O
N
O
O
N
N
Bn
3k
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

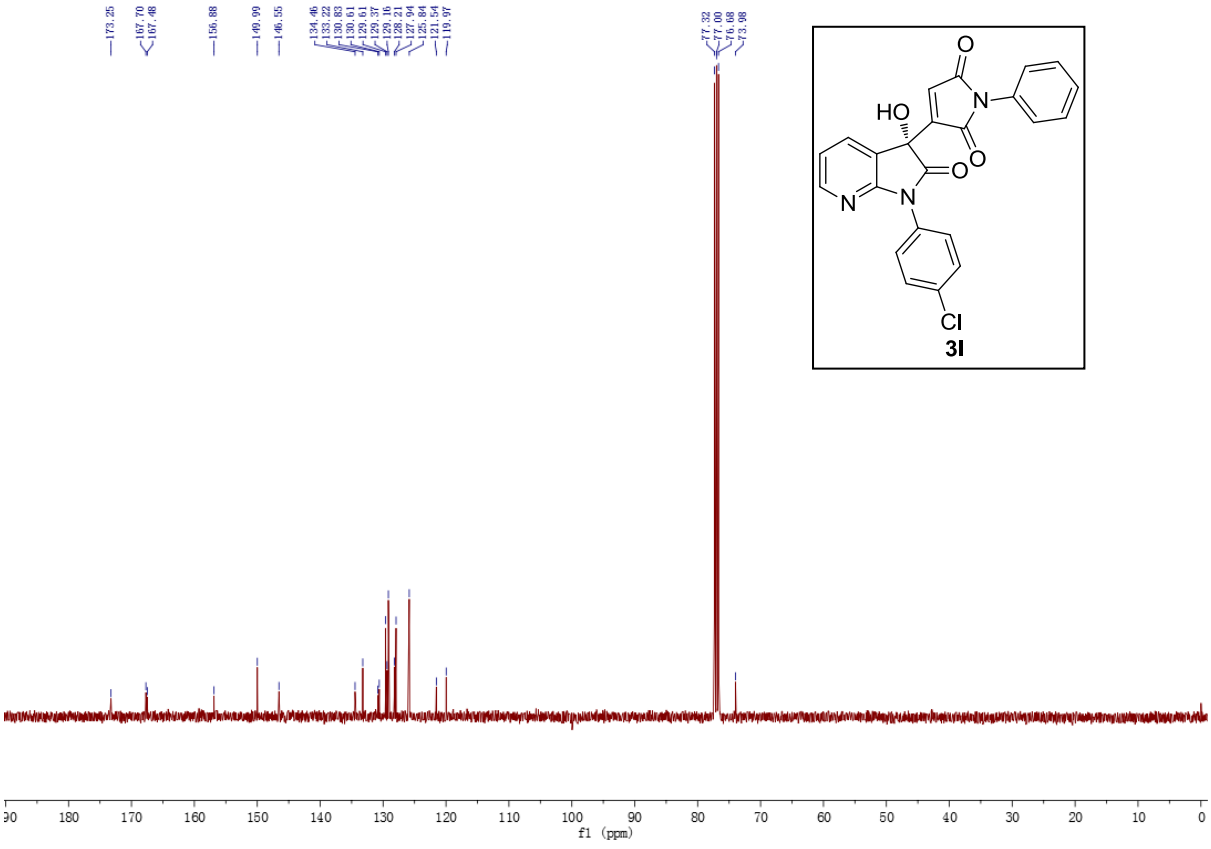


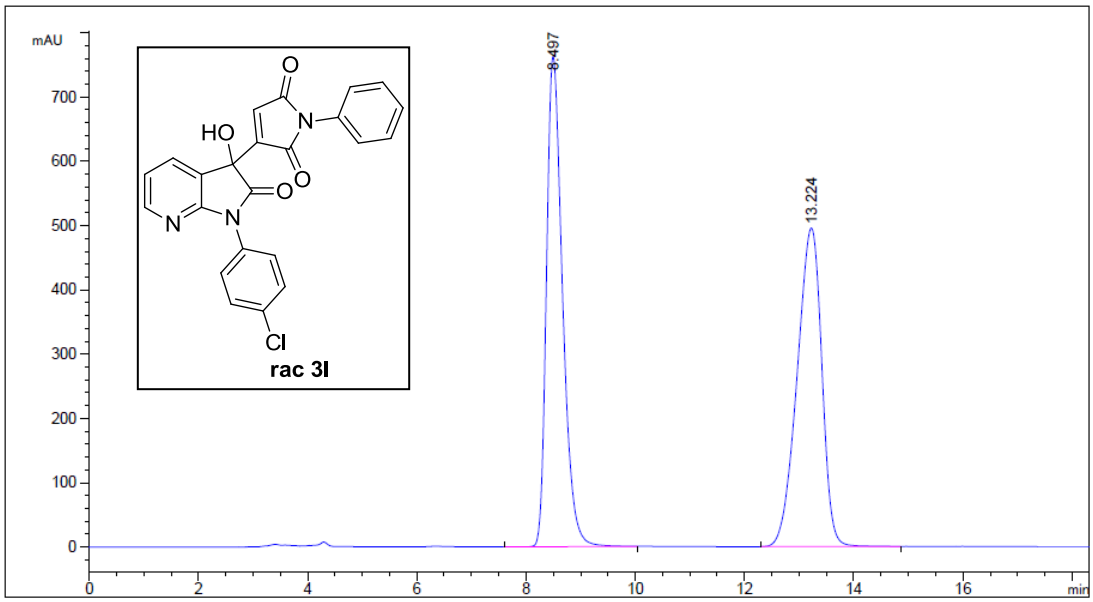
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	9.508	VV	0.3626	2759.91113	119.53596	50.1232
2	10.469	VB	0.3993	2746.34204	106.69016	49.8768



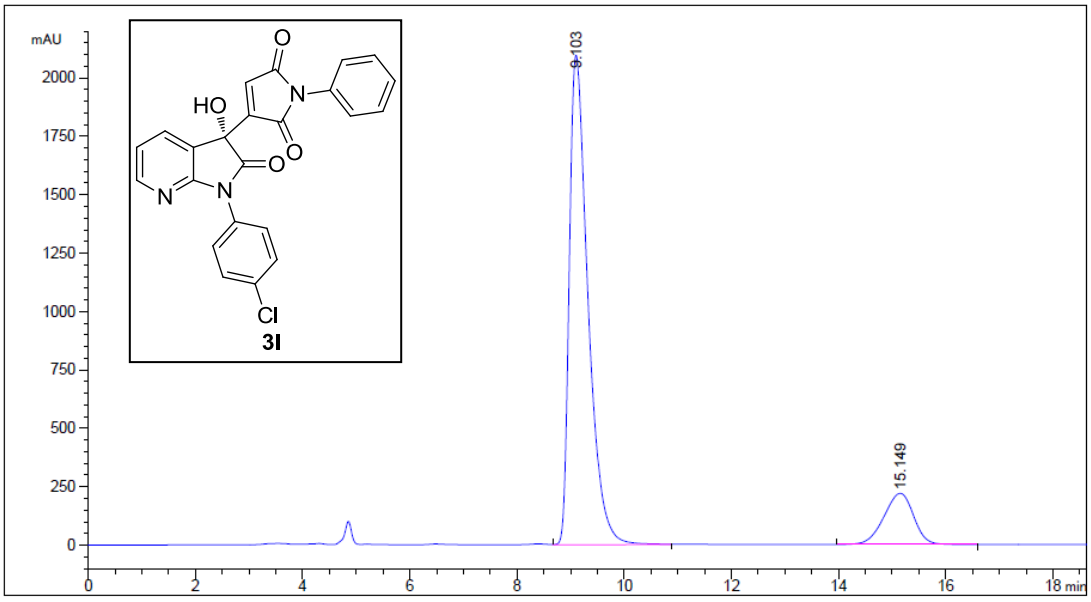
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	9.665	VV	0.3299	6.01519e4	2825.41870	93.7241
2	10.715	VB	0.3824	4027.87354	162.50554	6.2759


HO
O
N
O
O
N
N
Cl
3l
f1 (ppm)

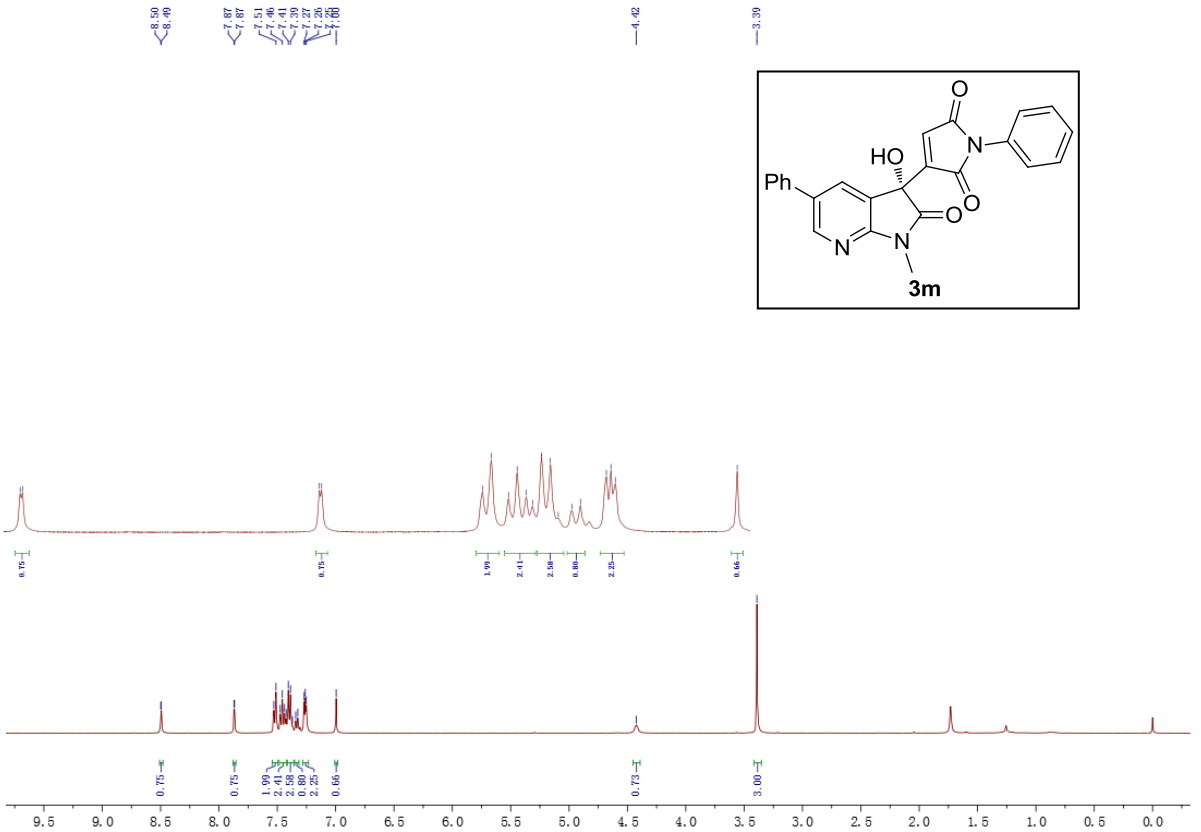

HO
O
N
O
O
N
N
Cl
3l
f1 (ppm)

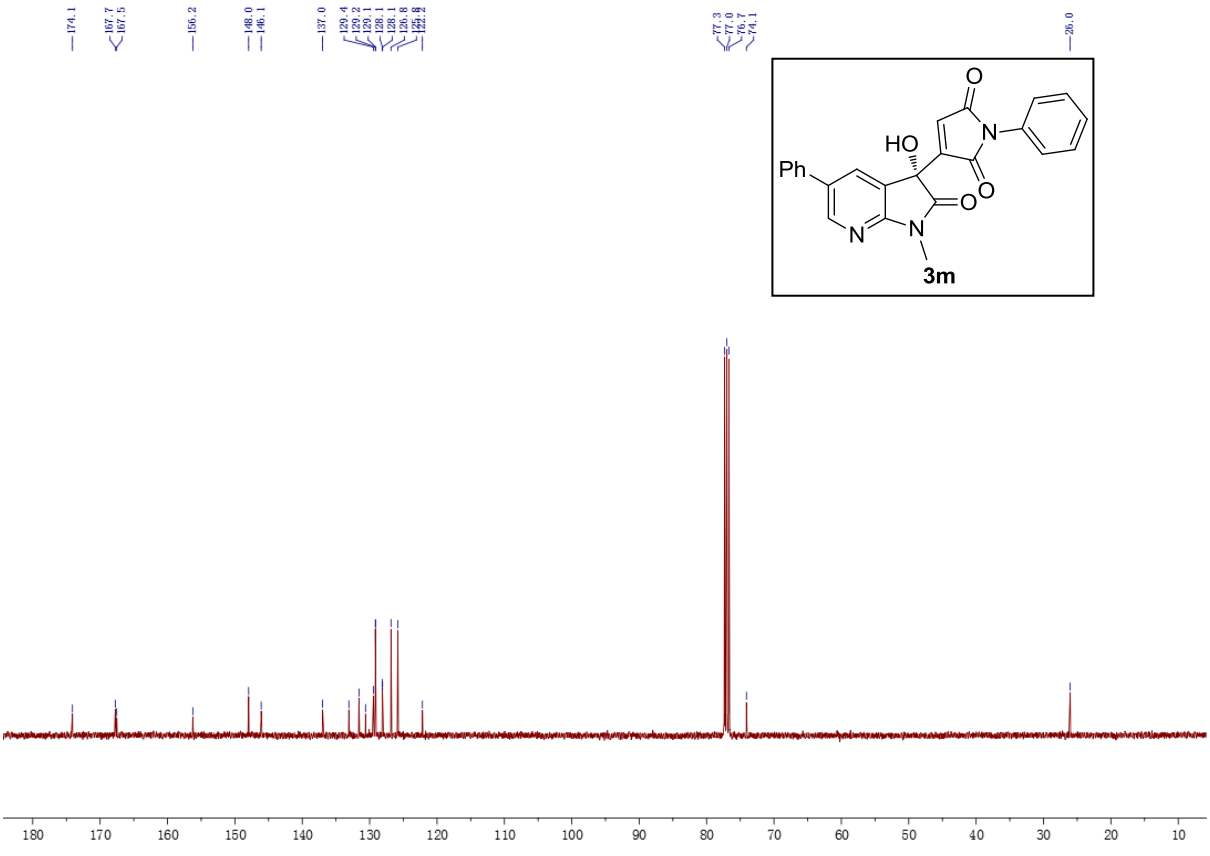


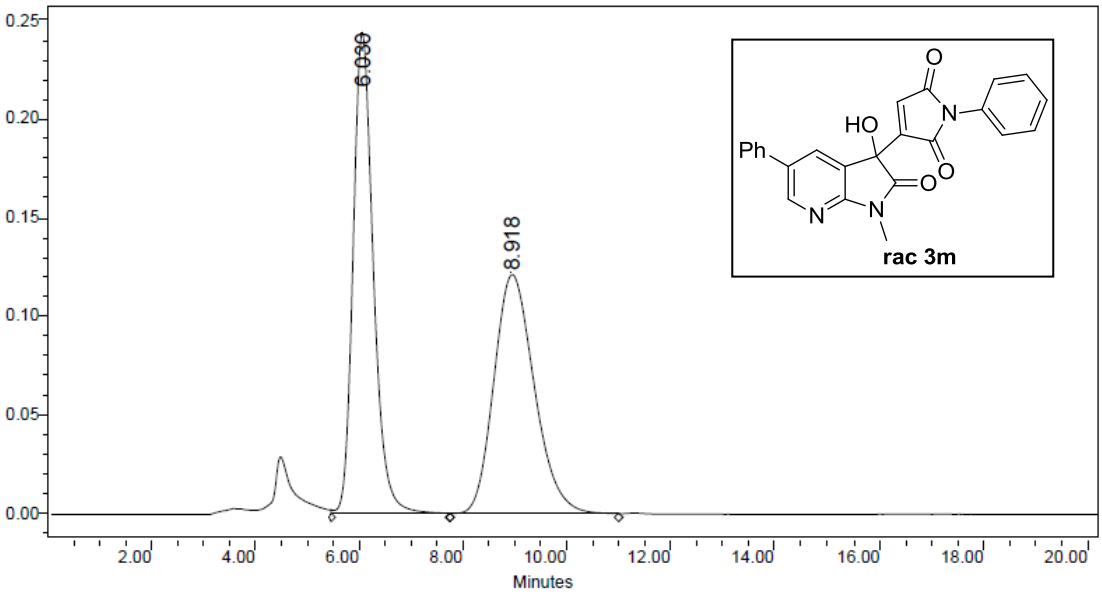
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	8.497	BB	0.3072	1.55036e4	762.28271	49.9124
2	13.224	BB	0.4888	1.55580e4	495.27643	50.0876



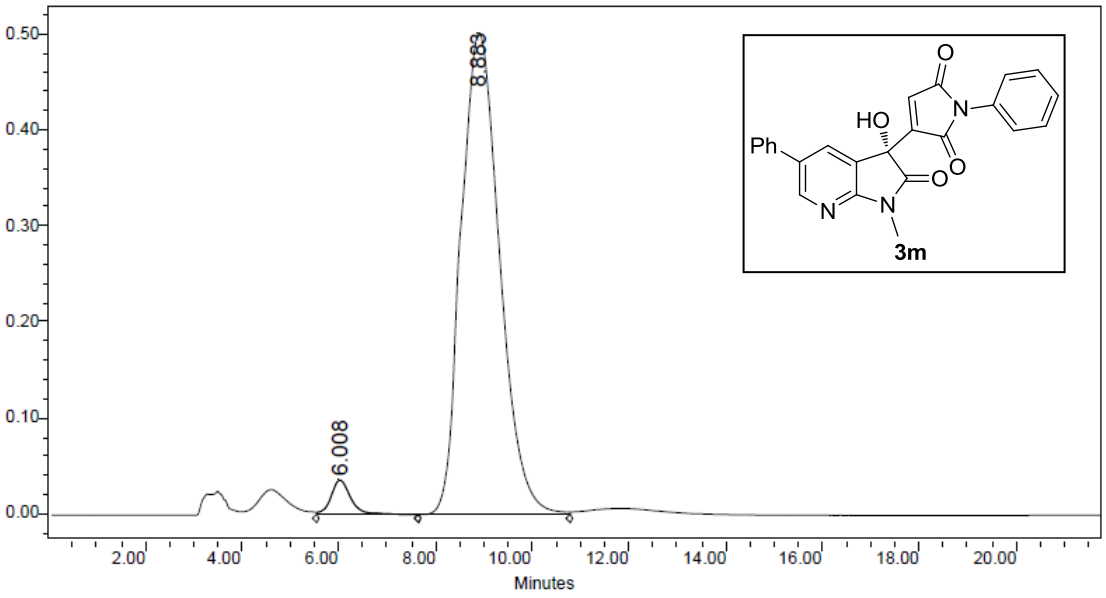
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	9.103	VV	0.3634	5.05777e4	2093.53223	85.6904
2	15.149	BB	0.6009	8446.07617	219.22653	14.3096


8.50
8.49
7.87
7.87
7.51
7.46
7.41
7.39
7.27
7.26
7.00
4.42
3.39
O
N
HO
Ph
O
O
N
N
3m
0.75
0.75
1.99
2.41
2.58
0.80
2.25
0.66
0.73
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

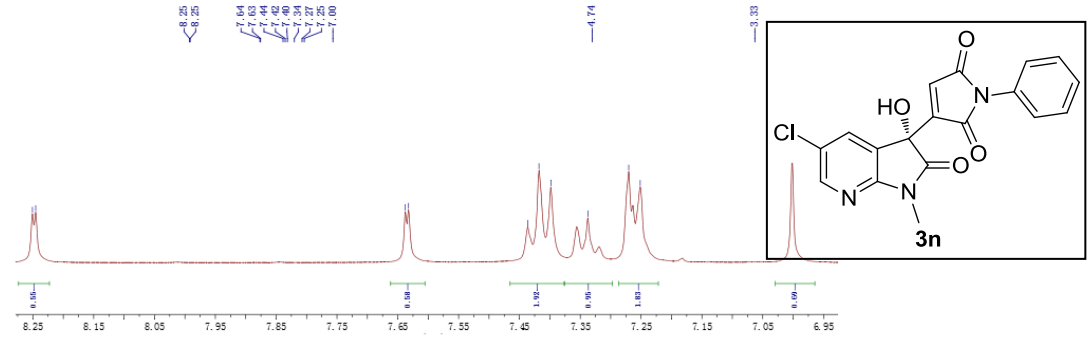

174.1
167.7
167.5
156.2
148.0
146.1
137.0
129.4
129.2
129.1
128.1
128.1
126.8
122.2
77.3
77.0
76.7
74.1
26.0
O
N
HO
Ph
O
O
N
N
3m
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

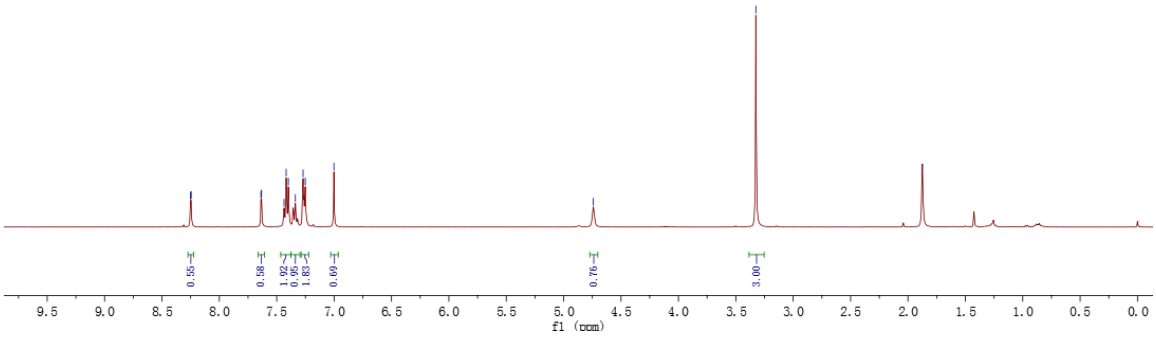


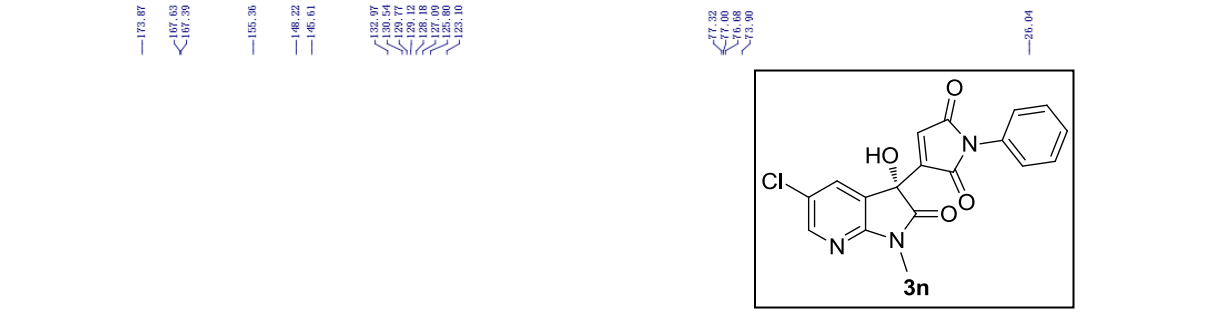
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	6.030	6658183	50.17	244390	66.78
2	8.918	6613900	49.83	121564	33.22

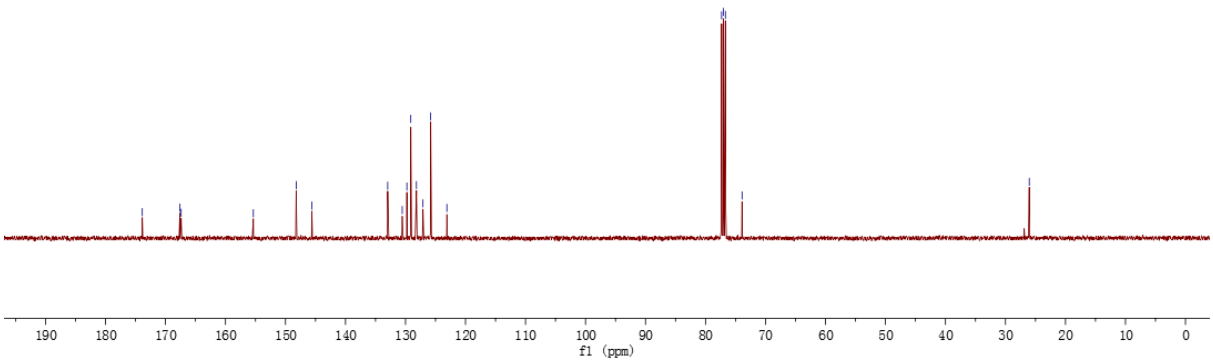


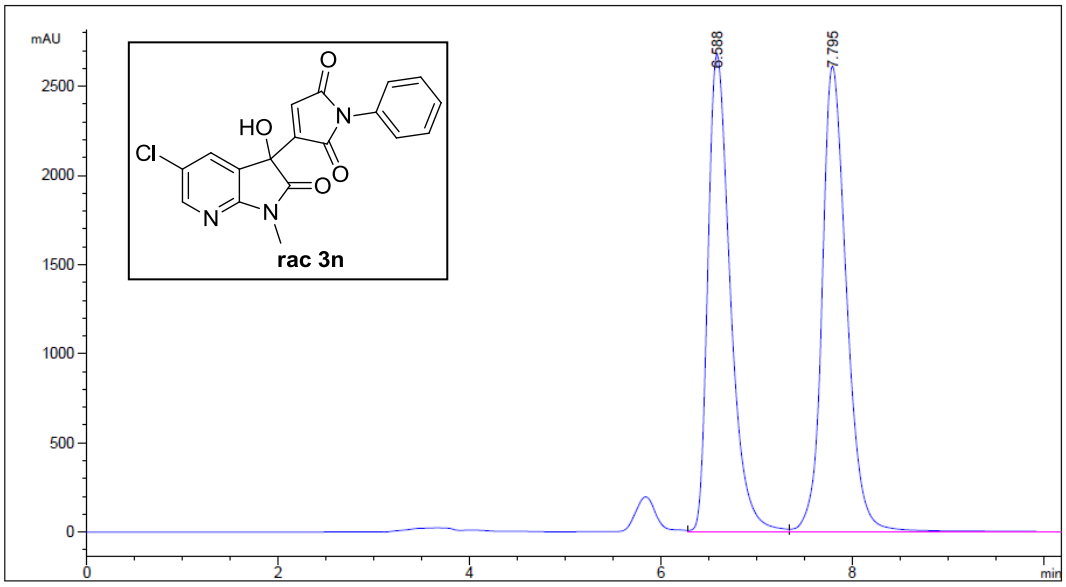
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	6.008	1123134	3.86	36691	6.80
2	8.883	27946419	96.14	502897	93.20


8.25
8.25
7.64
7.63
7.44
7.42
7.40
7.34
7.27
7.25
7.00
4.74
3.33
HO
Cl
O
N
O
O
N
N
3n

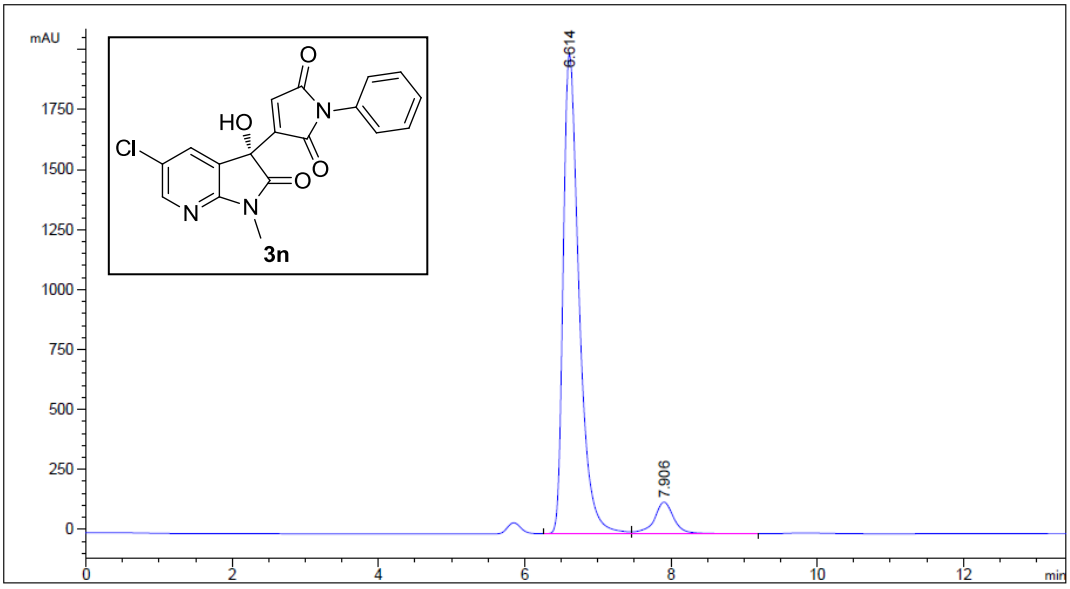

0.55
0.58
1.92
0.95
1.83
0.69
0.76
3.00
f1 (ppm)


173.87
167.63
167.39
155.36
148.22
145.61
132.97
130.54
129.77
129.12
128.18
127.09
125.80
123.10
77.32
77.00
76.68
73.90
26.04
HO
Cl
O
N
O
O
N
N
3n

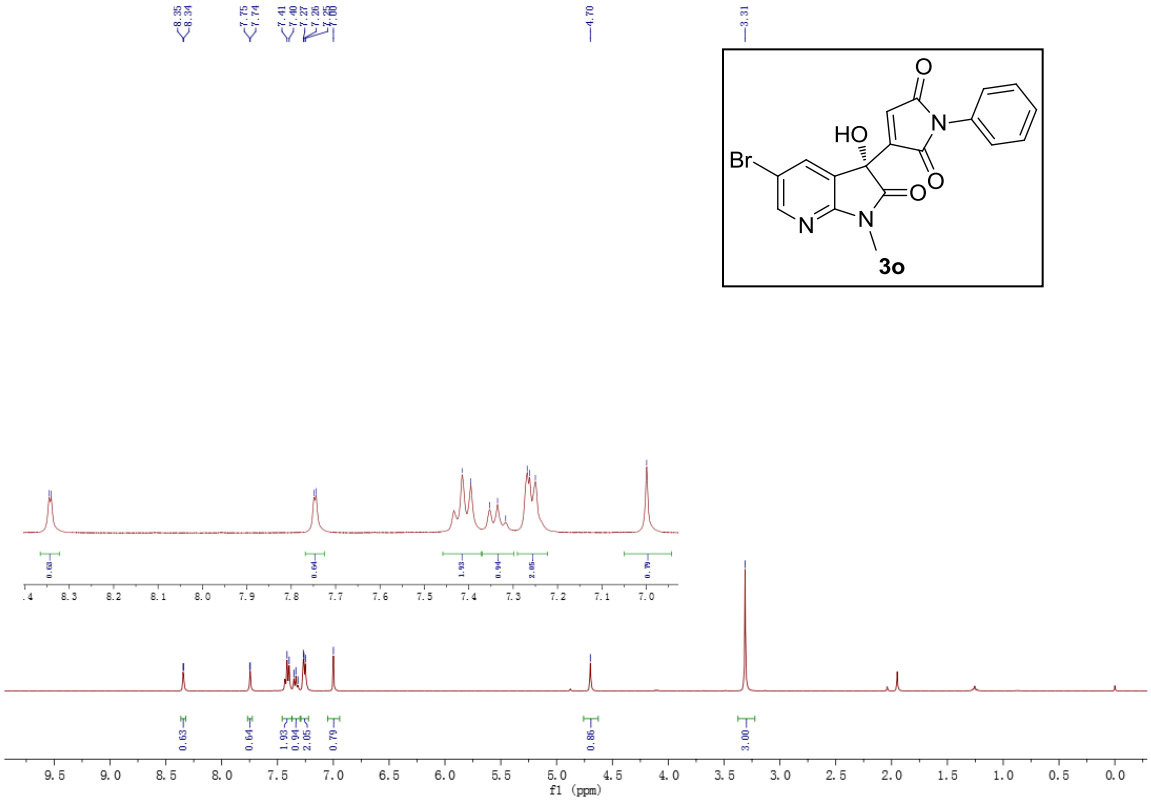

f1 (ppm)

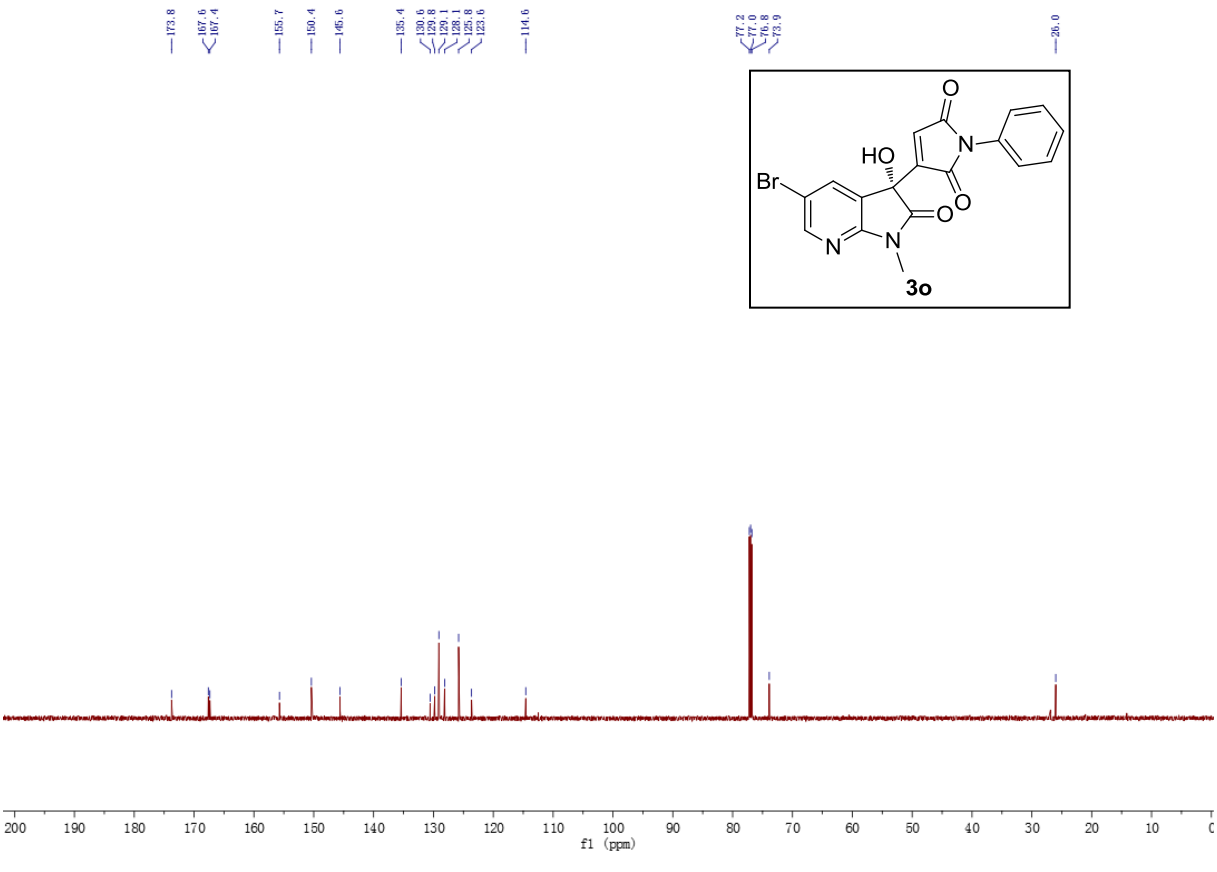


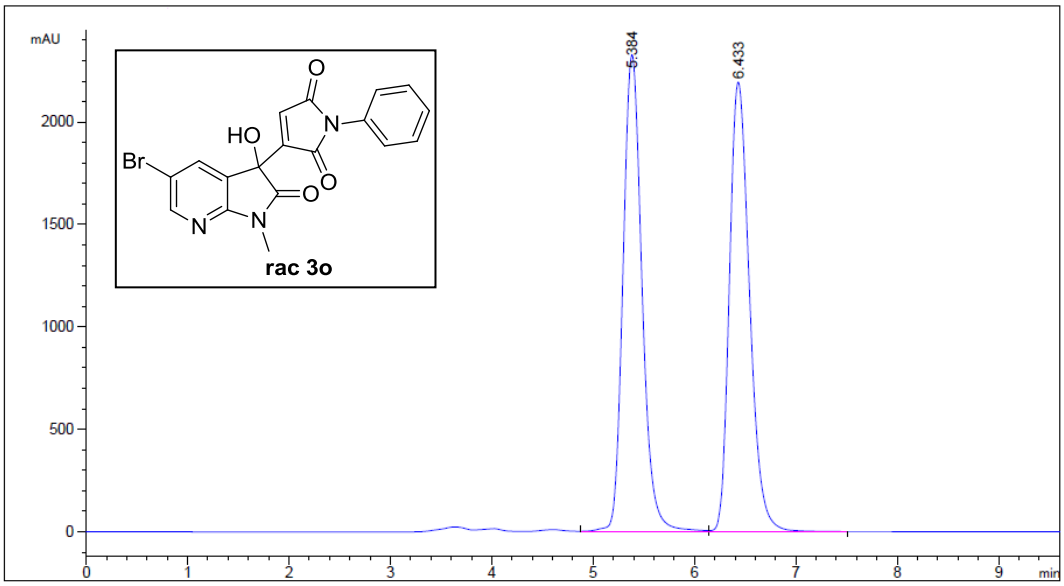
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.588	VV	0.2542	4.35827e4	2674.33325	48.2507
2	7.795	VBA	0.2730	4.67428e4	2609.88525	51.7493



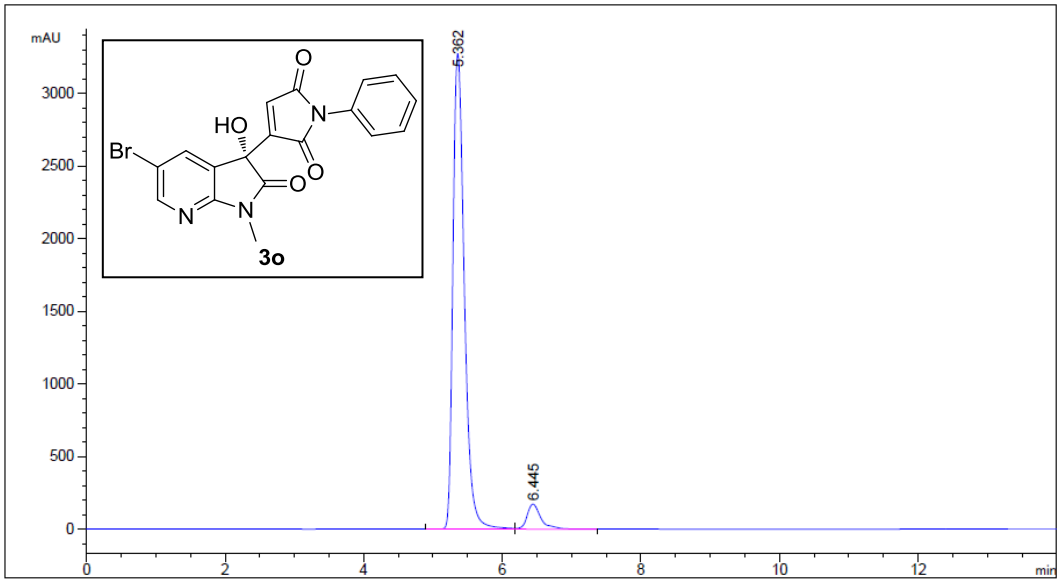
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	6.614	VV	0.2343	3.01889e4	2000.41687	92.3205
2	7.906	VV	0.2861	2511.18506	131.96326	7.6795


8.35
8.34
7.75
7.74
7.41
7.40
7.27
7.26
7.05
7.00
4.70
3.31
HO
Br
O
N
O
O
N
N
3o
0.63
0.64
1.93
0.94
2.05
0.79
0.88
3.00
f1 (ppm)

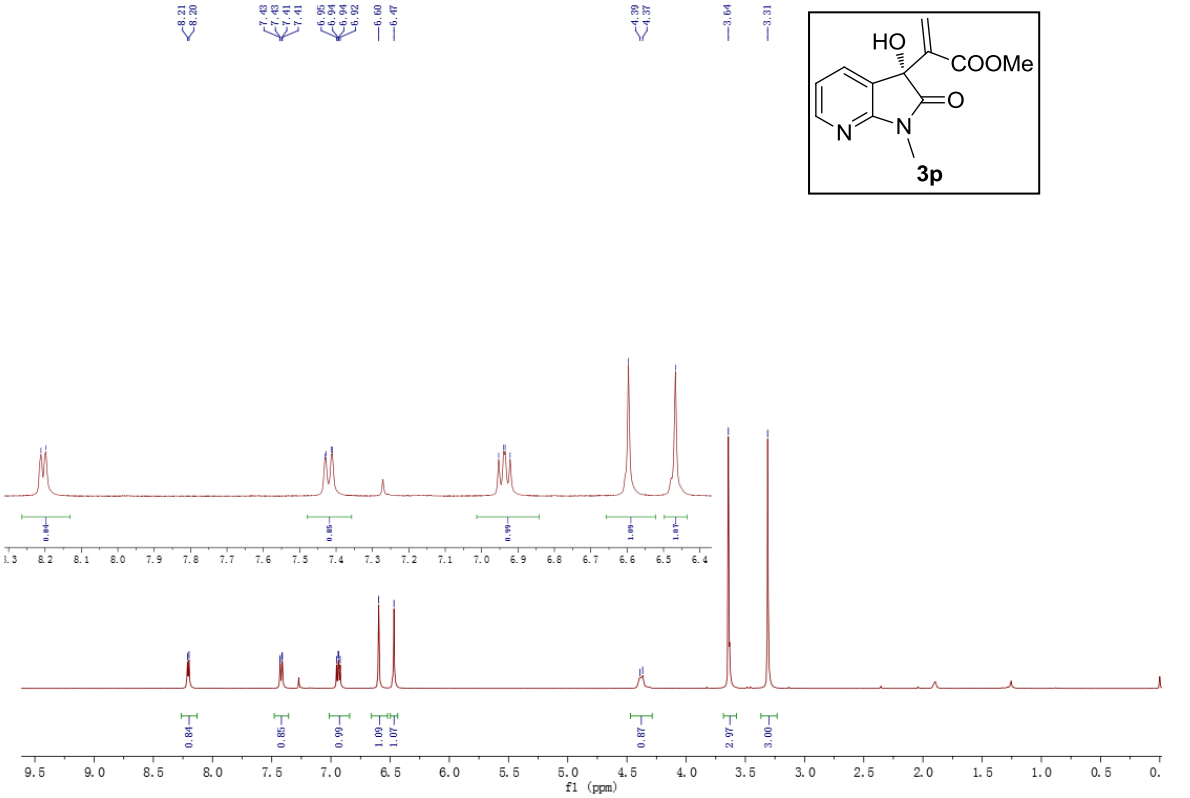

173.8
167.6
167.4
155.7
150.4
145.6
135.4
130.6
129.8
129.1
128.1
125.8
123.6
114.6
77.2
77.0
76.8
73.9
26.0
HO
Br
O
N
O
O
N
N
3o
f1 (ppm)

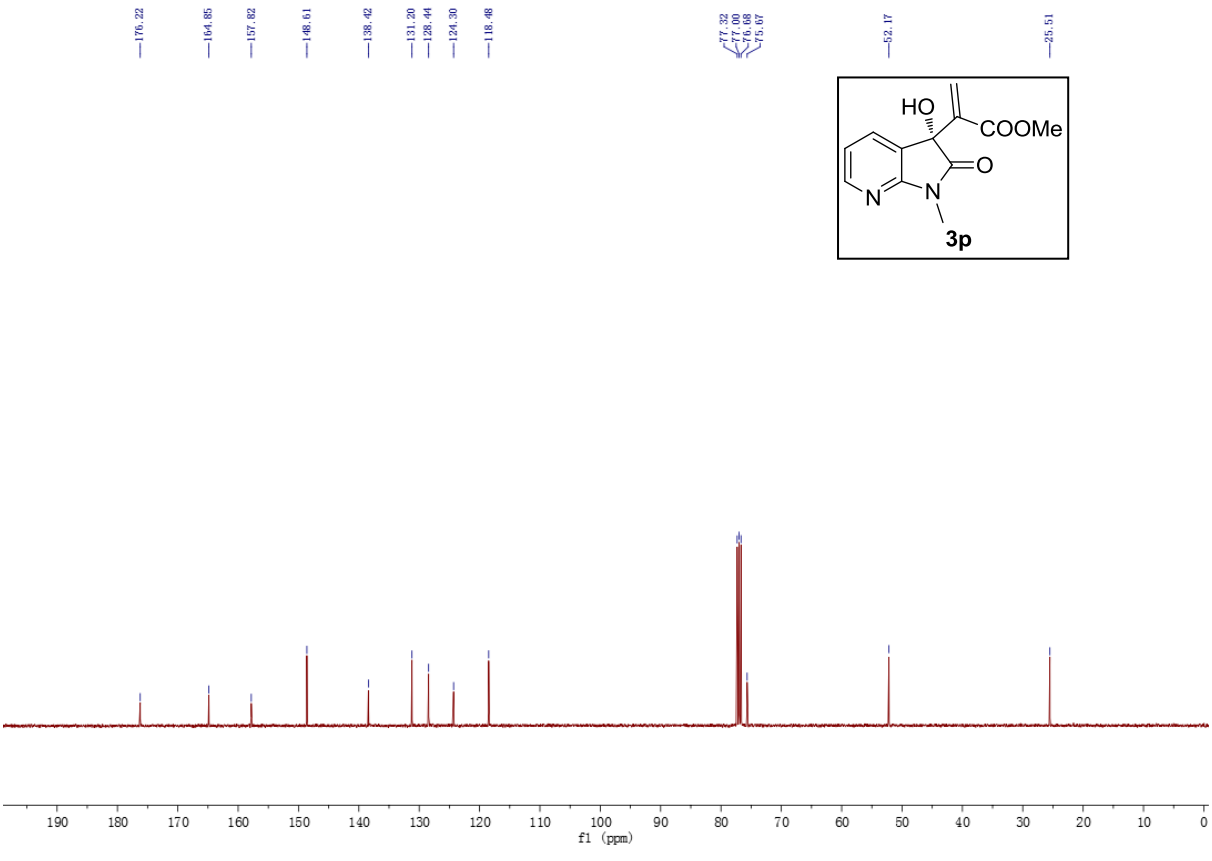


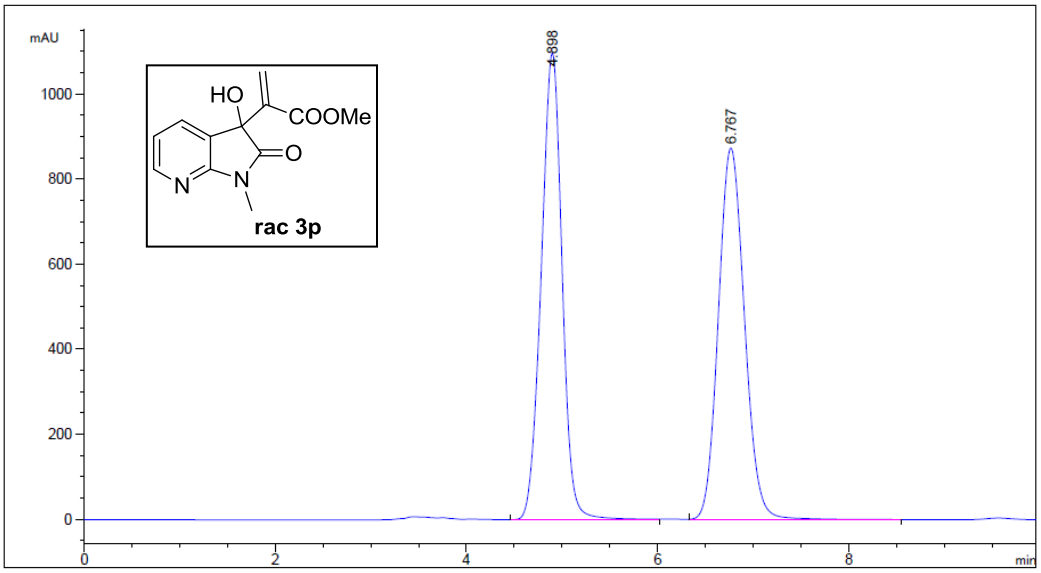
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	5.384	VV	0.2051	3.04184e4	2324.98242	50.0584
2	6.433	VV	0.2139	3.03474e4	2192.14185	49.9416



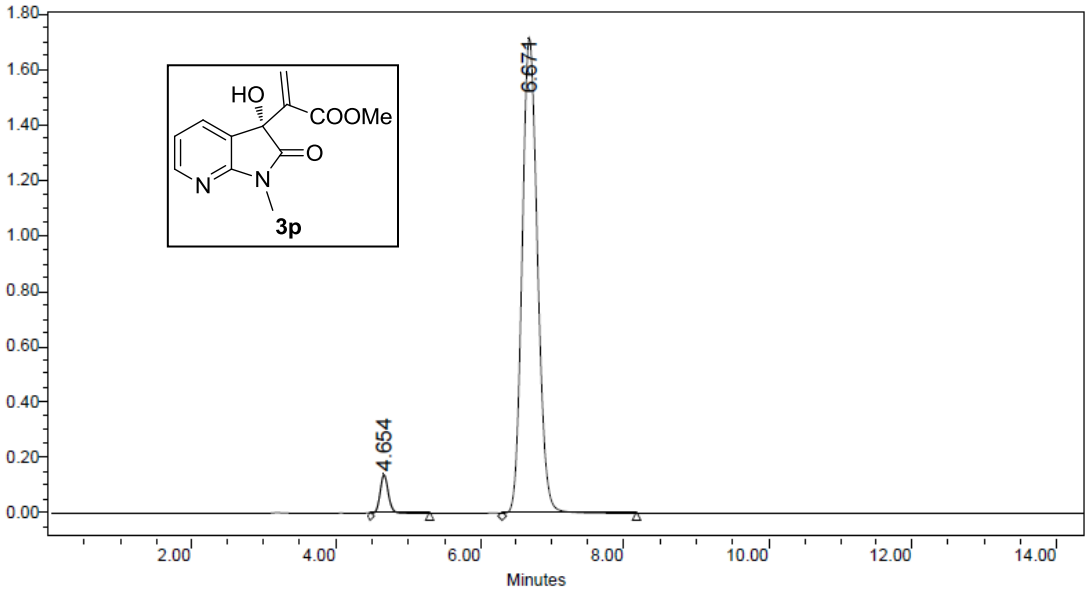
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	5.362	VV	0.1804	3.73162e4	3253.93433	93.9258
2	6.445	VB	0.2106	2413.22998	171.63893	6.0742


8.21
8.20
7.43
7.42
7.41
7.41
6.95
6.94
6.94
6.92
6.60
6.47
4.39
4.37
3.64
3.31
HO
COOMe
O
N
N
3p
0.84
0.85
0.99
1.09
1.07
0.87
2.97
3.00
f1 (ppm)

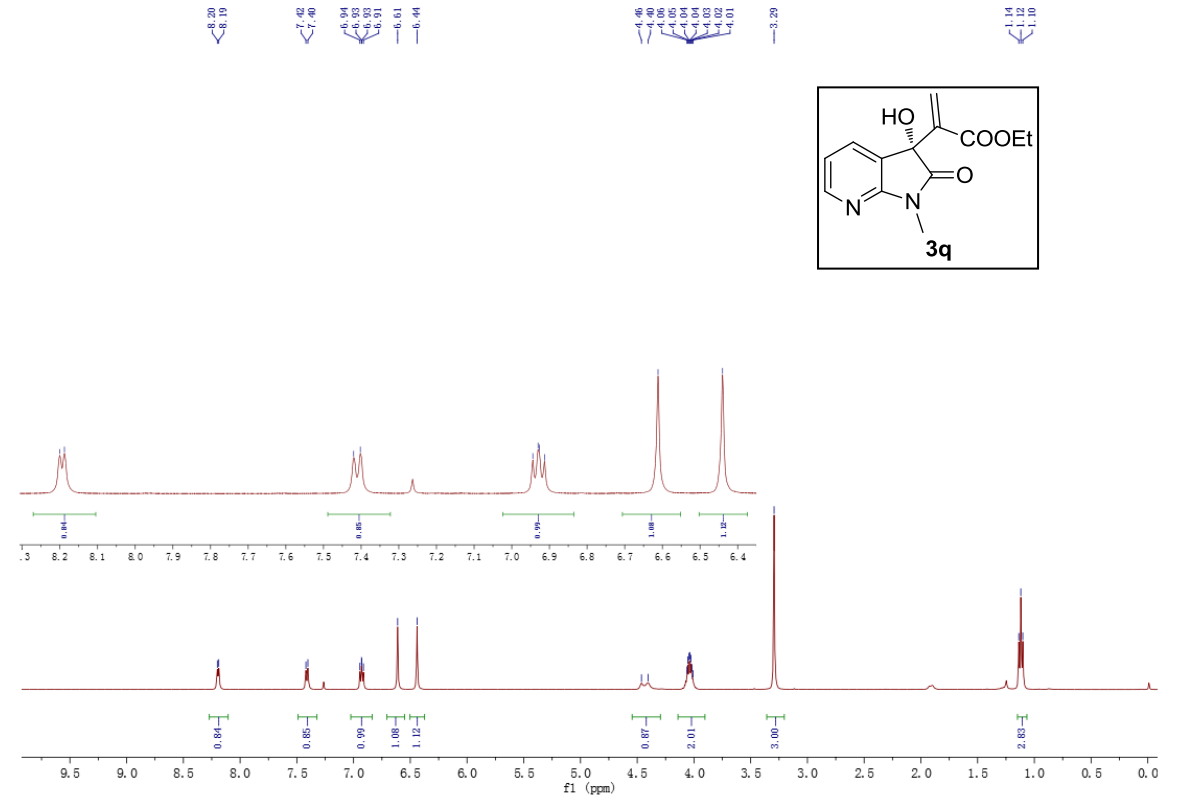

176.22
164.85
157.82
148.61
138.42
131.20
128.44
124.30
118.48
77.32
77.00
76.68
75.67
52.17
25.51
HO
COOMe
O
N
N
3p
f1 (ppm)

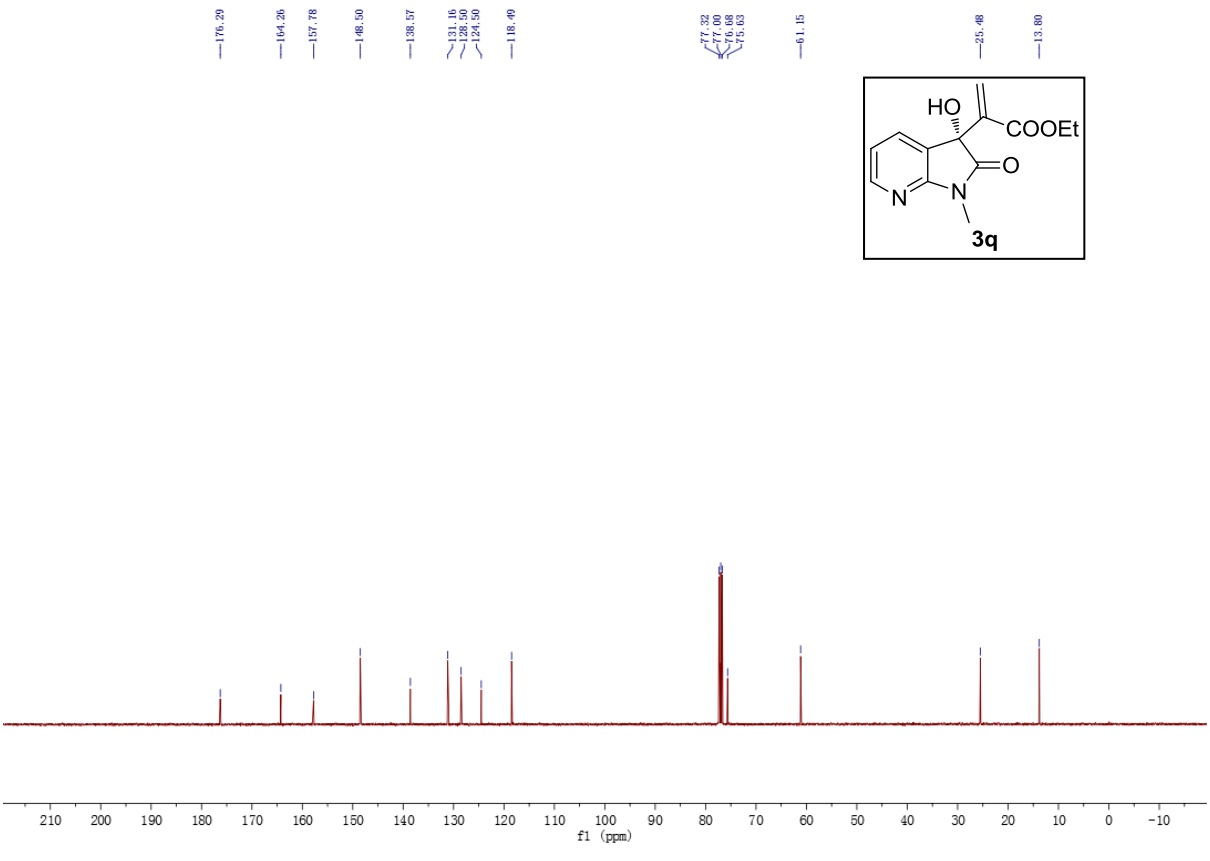


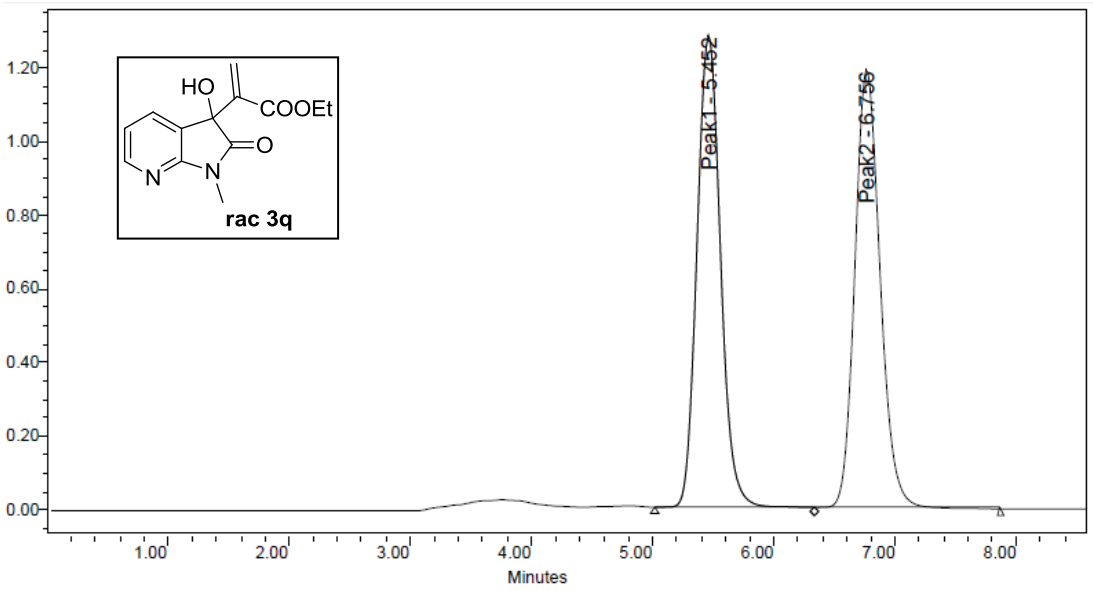
Peak #	RetTime [min]	Type	Width [min]	Area mAU *s	Height [mAU]	Area %
1	4.898	VB	0.2354	1.66453e4	1096.21497	49.9500
2	6.767	BB	0.2984	1.66786e4	873.77759	50.0500



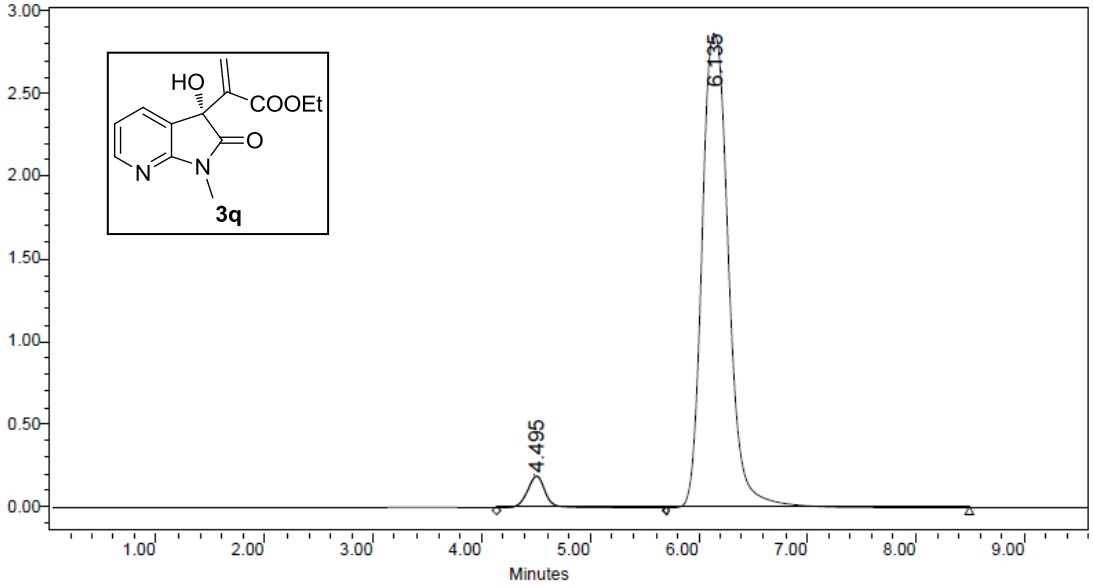
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	4.654	1114311	4.19	139172	7.49
2	6.671	25475615	95.81	1719491	92.51


HO
COOEt
O
N
N
3q
f1 (ppm)

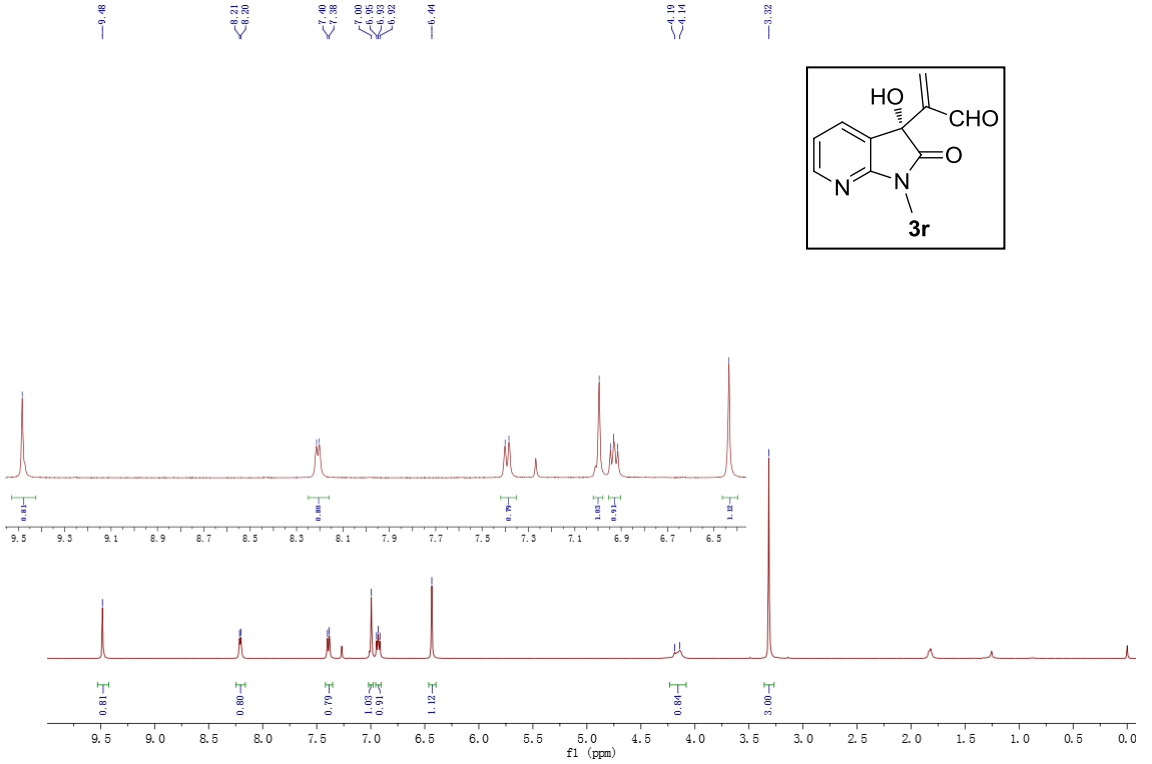

HO
COOEt
O
N
N
3q
f1 (ppm)

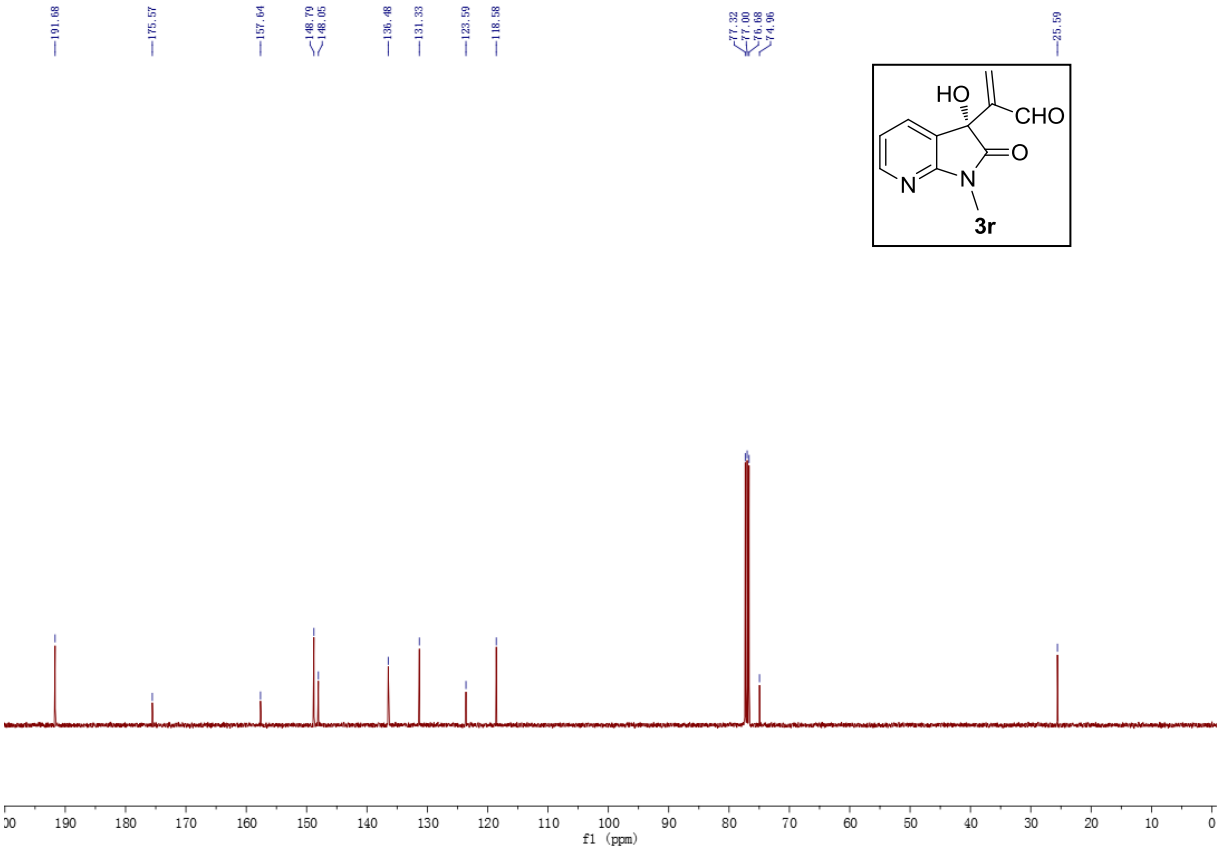


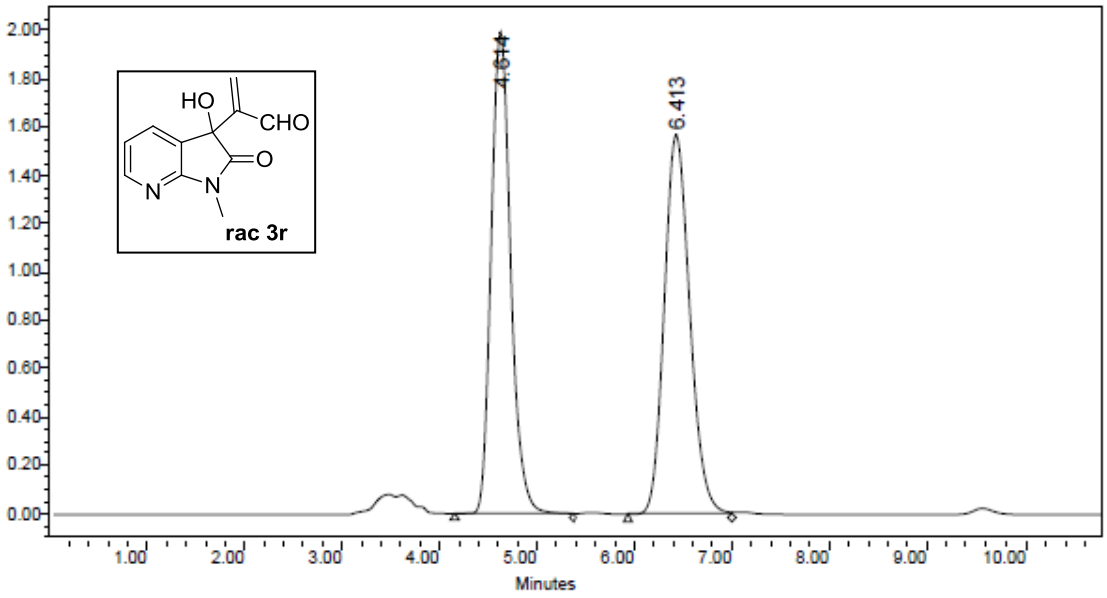
	Peak Name	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	Peak1	5.452	17295118	49.99	1281684	51.81
2	Peak2	6.756	17301318	50.01	1191986	48.19



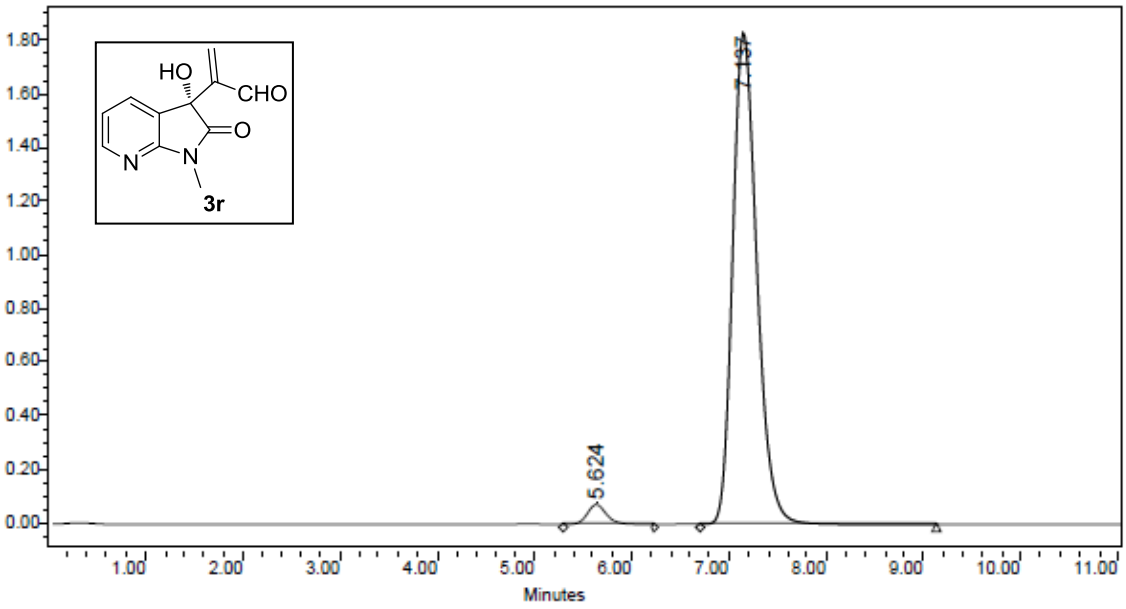
	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	4.495	2235840	4.40	191649	6.26
2	6.135	48609769	95.60	2871950	93.74


9.48
8.21
8.20
7.40
7.38
7.00
6.95
6.93
6.92
6.44
4.19
4.14
3.32
HO
CHO
O
N
N
3r
0.81
0.80
0.79
1.03
0.91
1.12
0.84
3.00
f1 (ppm)


191.68
175.57
157.64
148.79
148.05
136.48
131.33
123.59
118.58
77.32
77.00
76.68
74.96
25.59
HO
CHO
O
N
N
3r
f1 (ppm)



	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	4.614	27750191	49.22	1996050	55.94
2	6.413	28631347	50.78	1572143	44.06



	RT (min)	Area (*sec)	% Area	Height ( )	% Height
1	5.624	1026751	3.15	74290	3.89
2	7.137	31595220	96.85	1833210	96.11