Supporting Information

I_2-DMSO Mediated N-H/α-C(sp^3)-H Difunctionalization of Tetrahydroisoquinoline: Formal [2+2+1] Annulation for the Construction of Pyrrolo [2,1-*a*]isoquinoline Derivatives

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1. General

All of the substrates and reagents were commercially available and used without further purification. TLC analysis was performed using pre-coated glass plates. Flash column chromatography was performed on silica gel (200–300 mesh). ^{1}H NMR spectra were determined at 25 °C on a Varian Mercury 600 MHz spectrometer. Chemical shifts were provided in ppm relative to the internal standard of tetramethylsilane (TMS). ^{13}C spectra were recorded in $CDCl_3$ or DMSO-d_6 on 150 MHz NMR spectrometers and resonances (δ) in ppm. The data is being reported as s = singlet, d = doublet, t = triplet, m = multiplet or unresolved coupling constant(s) in Hz, integration. HRMS were obtained on Thermo Scientific Q Exactive equipped with an electron spray ionization source. Melting points were determined by using an electrothermal capillary melting point apparatus and not corrected. The X-ray crystal-structures were obtained on a Bruker APEX DUO CCD system.

2. Experimental procedures

General procedure for the synthesis of 3 and 4 (1 mmol scale of 3a as an example)

A sealed tube equipped with a magnetic stirring bar was charged with acetophenone (**1a**) (120.0 mg, 1.0 mmol), iodine (254.0 mg, 1.0 mmol) at room temperature, and DMSO (3 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then 1,2,3,4-tetrahydroisoquinoline (**2a**) (133.0 mg, 1.0 mmol) was added at 130 °C (heating block) to react for 4 h. After the reaction completed, the mixture was quenched with saturation $Na_2S_2O_3$ solution (100 mL), extracted with EtOAc (3 × 100 mL). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2:1) to yield the desired product **3a** (243.0 mg, yield 64%) as yellow solid (Rf = 0.3).

3. The crystallographic data

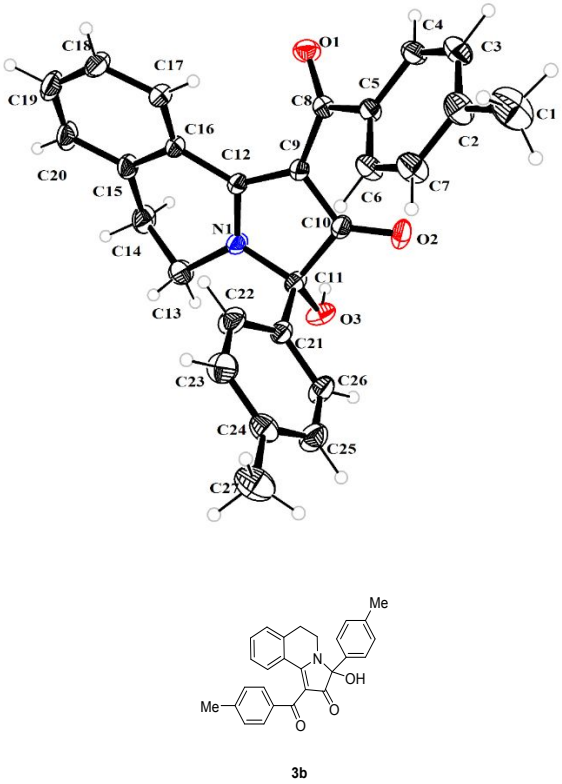


Figure S1. X-ray crystal structure of **3b** ORTEP (30%) drawing

Crystal Data for Compound **3b**: CCDC 2094616 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic.

Sample preparation: In a 10 mL glass bottle, 15 mg of pure **3b** was completely dissolved in the mixed solvent of 3 mL $CHCl_3$, and then 2 mL of n-hexane was added slowly. After a week of solvent evaporation, some yellow transparent crystals were obtained. The crystals were mounted on a glass fiber for diffraction experiments. Intensity data were collected on a Bruker SMART APEX CCD diffractometer with Mo Kα radiation (0.71073 Å) at room temperature.

Bond precision: C-C = 0.0021 A Wavelength=0.71073

Cell: a=10.3782(18) b=10.9639(19) c=11.464(2)
alpha=117.539(2) beta=106.494(2) gamma=94.119(3)
Temperature: 296 K

	Calculated	Reported
Volume	1076.9(3)	1077.0(3)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C27 H23 N O3	C27 H23 N O3
Sum formula	C27 H23 N O3	C27 H23 N O3
Mr	409.46	409.46
Dx,g cm-3	1.263	1.263
Z	2	2
Mu (mm-1)	0.082	0.082
F000	432.0	432.0
F000'	432.19	
h,k,lmax	15,16,17	15,15,17
Nref	7512	6717
Tmin,Tmax	0.981,0.984	0.661,0.746
Tmin'	0.976	

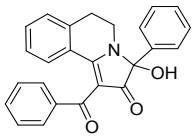
Correction method= # Reported T Limits: Tmin=0.661 Tmax=0.746
AbsCorr = MULTI-SCAN

Data completeness= 0.894 Theta(max)= 32.044

R(reflections)= 0.0509(5089) wR2(reflections)= 0.1654(6717)

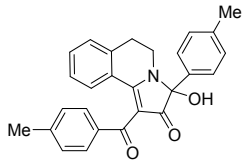
S = 1.027 Npar= 283

4. Spectroscopic data



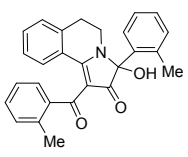
3a

1-benzoyl-3-hydroxy-3-phenyl-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3a**)
Prepared according to the **1a** (1.0 equiv, 0.5 mmol, 60.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3a** (133.4 mg , yield 70%) as yellow solid (Rf = 0.3); mp 200-202 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.72 (d, J = 6.0 Hz, 3H), 7.67 (s, 1H), 7.60-7.57 (m, 1H), 7.53-7.50 (m, 1H), 7.46 (s, 3H), 7.43-7.36 (m, 5H), 7.32 (d, J = 7.2 Hz, 1H), 3.52–3.48 (m, 1H), 3.17-3.10 (m, 2H), 3.09-3.04 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.3, 189.8, 170.6, 139.2, 138.0, 136.2, 133.6, 132.2, 130.9, 129.4, 128.8, 128.7, 127.9, 126.7, 125.5, 124.1, 103.1, 90.8, 37.1, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{20}NO_3^+$ 382.14377; Found 382.14337.



3b

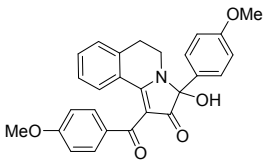
3-hydroxy-1-(4-methylbenzoyl)-3-(*p*-tolyl)-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3b**)
Prepared according to the **1b** (1.0 equiv, 0.5 mmol, 67.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3b** (139.2 mg yield 68%) as yellow solid (Rf = 0.3); mp 219-220 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.69 (d, J = 8.4 Hz, 1H), 7.64 (d, J = 7.8 Hz, 2H), 7.58 (d, J = 7.2 Hz, 1H), 7.56 (s, 1H), 7.45 (d, J = 7.8 Hz, 1H), 7.34 (d, J = 7.8 Hz, 2H), 7.30 (d, J = 7.8 Hz, 1H), 7.24-7.19 (m, 4H), 3.50–3.44 (m, 1H), 3.16–3.12 (m, 1H), 3.12–3.07 (m, 1H), 3.07-3.02 (m, 1H), 2.34 (s, 3H), 2.30 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.4, 189.6, 170.1, 142.4, 137.9, 136.6, 133.4, 130.8, 129.6, 129.3, 128.6, 128.5, 126.6, 125.4, 124.2, 103.3, 90.7, 37.0, 27.8, 21.2, 20.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{24}NO_3^+$ 410.17507; Found 410.17484.



3c

3-hydroxy-1-(2-methylbenzoyl)-3-(*o*-tolyl)-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3c**)

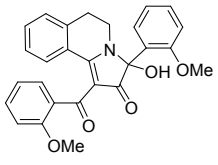
Prepared according to the **1c** (1.0 equiv, 0.5 mmol, 67.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3c** (118.8 mg, yield 58%) as yellow solid (Rf = 0.3); mp 215-217 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.03 (d, J = 7.8 Hz, 1H), 7.75 (s, 1H), 7.64 (s, 1H), 7.60 (t, J = 7.2 Hz, 1H), 7.44 (d, J = 7.2 Hz, 1H), 7.37 (t, J = 7.8 Hz, 2H), 7.31-7.23 (m, 3H), 7.19 (d, J = 7.2 Hz, 1H), 7.17-7.08 (m, 2H), 3.50–3.43 (m, 1H), 3.12-3.01 (m, 2H), 2.99-2.92 (m, 1H), 2.33 (s, 3H), 2.17 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.4, 190.7, 170.7, 141.4, 137.8, 135.6, 135.3, 134.1, 133.8, 131.7, 131.6, 131.3, 130.3, 129.3, 128.8, 128.31, 128.29, 126.5, 125.8, 125.0, 124.4, 37.2, 27.7, 19.6, 15.3; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{24}NO_3^+$ 410.17507; Found 410.17520.



3d

3-hydroxy-1-(4-methoxybenzoyl)-3-(4-methoxyphenyl)-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one **(3d)**

Prepared according to the **1d** (1.0 equiv, 0.5 mmol, 75.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3d** (112.6 mg, yield 51%) as yellow solid (Rf = 0.28); mp 222-224 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.73 (d, J = 8.4 Hz, 2H), 7.64 (d, J = 8.4 Hz, 1H), 7.57 (t, J = 7.2 Hz, 1H), 7.50 (s, 1H), 7.46 (d, J = 7.2 Hz, 1H), 7.36 (d, J = 8.4 Hz, 2H), 7.31 (t, J = 7.2 Hz, 1H), 6.96 (t, J = 8.4 Hz, 4H), 3.81 (s, 3H), 3.75 (s, 3H), 3.49-3.45 (m, 1H), 3.16-3.13 (m, 1H), 3.12–3.08 (m, 1H), 3.08-3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.5, 188.7, 169.8, 162.6, 159.4, 137.9, 133.3, 131.7, 130.6, 128.6, 128.3, 126.8, 126.6, 124.2, 114.0, 113.2, 103.3, 90.5, 55.4, 55.1, 37.0, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{24}NO_5^+$ 442.16490; Found 442.16537.

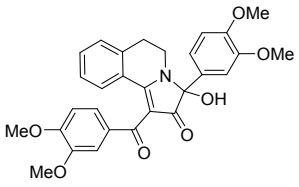


3e

3-hydroxy-1-(2-methoxybenzoyl)-3-(2-methoxyphenyl)-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3e**)

Prepared according to the **1e** (1.0 equiv, 0.5 mmol, 75.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl

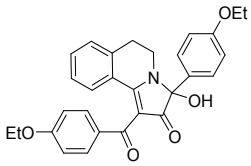
acetate (1:1 v/v) as eluent afforded **3e** (99.3 mg, yield 45%) as yellow solid (Rf = 0.3); mp 202-203 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.11 (s, 1H), 7.77 (s, 1H), 7.55–7.51 (m, 1H), 7.45 (s, 1H), 7.40–7.29 (m, 4H), 7.28-7.23 (m, 1H), 7.01 (t, J = 7.2 Hz, 1H), 6.95 (t, *J* = 7.2 Hz, 2H), 6.91-6.84 (m, 1H), 3.67 (s, 3H), 3.56 (s, 3H), 3.43-3.38 (m, 1H), 3.03–2.96 (m, 1H), 2.92-2.86 (m, 1H), 2.74-2.65 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.4, 187.2, 170.0, 157.1, 156.1, 137.6, 133.1, 132.3, 131.3, 130.4, 130.2, 129.0, 128.8, 128.0, 126.2, 125.0, 124.4, 120.1, 119.6, 111.4, 111.2, 105.7, 87.7, 79.2, 55.6, 55.5, 37.2, 27.9; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{24}NO_5^+$ 442.16490; Found 442.16479.



3f

1-(3,4-dimethoxybenzoyl)-3-(3,4-dimethoxyphenyl)-3-hydroxy-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3f**)

Prepared according to the **1f** (1.0 equiv, 0.5 mmol, 90.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:2 v/v) as eluent afforded **3f** (120.4 mg, yield 48%) as yellow solid (Rf = 0.35); mp 216-218 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.63 (d, *J* = 7.2 Hz, 1H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.53 (s, 1H), 7.46 (d, *J* = 7.2 Hz, 1H), 7.40 (d, *J* = 7.8 Hz, 1H), 7.31 (s, 2H), 7.06 (s, 1H), 6.97 (d, *J* = 8.4 Hz, 2H), 6.92 (d, *J* = 7.8 Hz, 1H), 3.81 (s, 3H), 3.75 (s, 6H), 3.70 (s, 3H), 3.50–3.45 (m, 1H), 3.21–3.15 (m, 1H), 3.14-3.09 (m, 1H), 3.09–3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.6, 189.0, 169.4, 152.5, 149.0, 148.8, 148.1, 137.9, 133.3, 131.6, 130.6, 130.5, 128.8, 128.7, 126.7, 124.3, 124.2, 117.5, 111.8, 110.5, 109.3, 103.3, 90.4, 55.7, 55.6, 55.5, 55.3, 37.0, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{28}NO_7^+$ 502.18603; Found 502.18646.

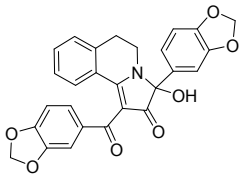


3g

1-(4-ethoxybenzoyl)-3-(4-ethoxyphenyl)-3-hydroxy-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3g**)

Prepared according to the **1g** (1.0 equiv, 0.5 mmol, 82.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3g** (117.4 mg, yield 50%) as yellow solid (Rf = 0.3); mp 208-210 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.72 (d, *J* = 9.0 Hz, 2H), 7.64 (d, *J* = 7.8 Hz, 1H), 7.56

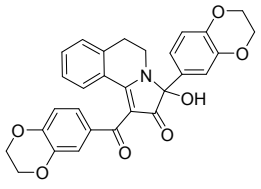
(t, J = 7.2 Hz, 1H), 7.50 (s, 1H), 7.45 (d, J = 7.8 Hz, 1H), 7.35 (d, J = 8.4 Hz, 2H), 7.31 (t, J = 7.8 Hz, 1H), 6.94 (t, J = 9.0 Hz, 4H), 4.11-4.06 (m, 2H), 4.04-3.99 (m, 2H), 3.49-3.44 (m, 1H), 3.17–3.12 (m, 1H), 3.12-3.08 (m, 1H), 3.07–3.03 (m, 1H), 1.36-1.32 (m, 3H), 1.32-1.28 (m, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.6, 188.7, 169.8, 162.0, 158.7, 137.9, 133.3, 131.8, 131.6, 130.7, 128.6, 128.2, 128.1, 126.8, 126.6, 124.2, 114.5, 113.6, 103.3, 90.5, 63.4, 63.1, 37.0, 27.8, 14.7, 14.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{28}NO_5^+$ 470.19620; Found 470.19675.



3h

3-(benzo[*d*][1,3]dioxol-5-yl)-1-(benzo[*d*][1,3]dioxole-5-carbonyl)-3-hydroxy-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3h**)

Prepared according to the **1h** (1.0 equiv, 0.5 mmol, 82.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3h** (129.1 mg, yield 55%) as yellow solid (Rf = 0.35); mp 205-207 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.63 (d, J = 7.8 Hz, 1H), 7.57 (t, J = 7.2 Hz, 2H), 7.46 (d, J = 7.8 Hz, 1H), 7.38 (d, J = 8.4 Hz, 1H), 7.32 (t, J = 7.2 Hz, 1H), 7.24 (s, 1H), 6.98–6.94 (m, 2H), 6.94-6.89 (m, 2H), 6.10 (d, J = 4.8 Hz, 2H), 6.03 (s, 2H), 3.49–3.44 (m, 1H), 3.21–3.16 (m, 1H), 3.15–3.10 (m, 1H), 3.07–3.02 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.2, 188.4, 169.9, 150.8, 147.6, 147.5, 147.1, 137.9, 133.6, 133.4, 130.7, 130.2, 128.7, 126.7, 125.7, 124.1, 119.0, 109.6, 109.0, 108.3, 107.6, 106.1, 103.1, 101.8, 101.3, 90.3, 37.0, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{20}NO_7^+$ 470.12343; Found 470.12387.

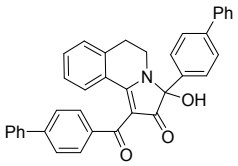


3i

3-(2,3-dihydrobenzo[*b*][1,4]dioxin-6-yl)-1-(2,3-dihydrobenzo[*b*][1,4]dioxine-6-carbonyl)-3-hydroxy-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**3i**)

Prepared according to the **1i** (1.0 equiv, 0.5 mmol, 89.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3i** (136.8 mg, yield 55%) as yellow oil yellow solid (Rf = 0.33); ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.62 (d, J = 7.8 Hz, 1H), 7.56 (t, J = 7.2 Hz, 1H), 7.52 (s, 1H), 7.45 (d, J = 7.2 Hz, 1H), 7.30 (t, J = 7.8 Hz, 3H), 7.27 (s, 1H), 6.95 (s, 1H), 6.88 (t, J = 7.8 Hz, 2H), 6.83 (d, J = 8.4 Hz, 1H), 6.83 (d, J = 8.4 Hz, 1H), 4.29 (s, 2H), 4.24 (s, 6H), 3.49-3.44 (m, 1H),

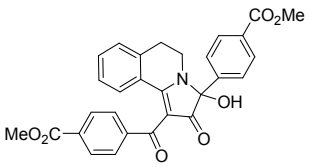
3.17–3.12 (m, 1H), 3.10-3.02 (m, 2H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.3, 188.7, 169.8, 147.3, 143.6, 143.4, 142.6, 137.8, 133.3, 132.5, 130.6, 129.3, 128.7, 126.7, 124.1, 123.3, 118.7, 118.0, 117.3, 116.5, 114.6, 103.2, 90.2, 64.5, 64.1, 63.9, 37.0, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{24}NO_7^+$ 498.15473; Found 498.15485.



3j

1-([1,1'-biphenyl]-4-carbonyl)-3-([1,1'-biphenyl]-4-yl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3j**)

Prepared according to the **1j** (1.0 equiv, 0.5 mmol, 98.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3j** (160.1 mg, yield 60%) as yellow solid (Rf = 0.3); mp 161-163 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.87 (d, J = 7.2 Hz, 2H), 7.84–7.75 (m, 3H), 7.73 (d, J = 5.4 Hz, 5H), 7.67 (d, J = 6.6 Hz, 2H), 7.59 (t, J = 7.8 Hz, 3H), 7.48 (d, J = 6.6 Hz, 5H), 7.43–7.33 (m, 3H), 3.60–3.52 (m, 1H), 3.27-3.20 (m, 1H), 3.19-3.06 (m, 2H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.3, 189.4, 170.6, 143.7, 140.4, 139.6, 139.3, 138.0, 138.0, 135.3, 133.6, 130.9, 130.2, 129.0, 129.0, 128.7, 128.1, 127.7, 127.1, 126.9, 126.7, 126.2, 124.1, 103.3, 90.8, 37.2, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{37}H_{28}NO_3^+$ 534.20637; Found 534.20660.

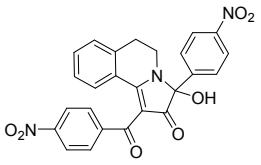


3k

methyl4-(3-hydroxy-1-(4-(methoxycarbonyl)benzoyl)-2-oxo-2,3,5,6-tetrahydropyrrolo[2,1-*a*]isoquinolin-3-yl)benzoate (**3k**)

Prepared according to the **1k** (1.0 equiv, 0.5 mmol, 89.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3k** (129.4 mg, yield 52%) as yellow solid (Rf = 0.35); mp 223-225 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.01 (d, J = 7.8 Hz, 2H), 7.97 (d, J = 7.8 Hz, 2H), 7.91 (s, 1H), 7.85 (d, J = 7.8 Hz, 1H), 7.78 (d, J = 7.8 Hz, 2H), 7.62 (d, J = 7.8 Hz, 3H), 7.49 (d, J = 7.2 Hz, 1H), 7.35 (t, J = 7.2 Hz, 1H), 3.87 (s, 3H), 3.86 (s, 3H), 3.57-3.48 (m, 1H), 3.25–3.18 (m, 1H), 3.18–3.13 (m, 1H), 3.11-3.02 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.7, 188.7, 171.3, 165.8, 143.4, 141.1, 138.1, 133.9, 132.0, 131.2, 129.9, 129.7, 129.3, 128.7, 128.6, 126.7, 126.1, 123.9,

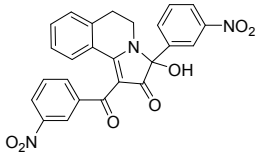
103.4, 102.9, 90.6, 52.4, 52.2, 37.3, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{24}NO_7^+$ 498.15473; Found 498.15491.



3l

3-hydroxy-1-(4-nitrobenzoyl)-3-(4-nitrophenyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3l**)

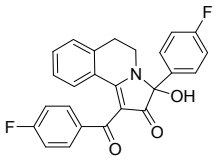
Prepared according to the **1l** (1.0 equiv, 0.5 mmol, 82.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3l** (134.4 mg, yield 57%) as yellow solid (Rf = 0.28); mp 205-207 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.26 (t, J = 9.0 Hz, 4H), 8.11 (s, 1H), 7.95 (d, J = 7.8 Hz, 1H), 7.86 (d, J = 8.4 Hz, 2H), 7.76 (d, J = 9.0 Hz, 2H), 7.65 (t, J = 7.2 Hz, 1H), 7.51 (d, J = 7.8 Hz, 1H), 7.39 (t, J = 7.2 Hz, 1H), 3.58–3.53 (m, 1H), 3.27-3.22 (m, 1H), 3.21–3.16 (m, 1H), 3.11-3.05 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.3, 187.6, 171.8, 149.0, 147.8, 145.0, 142.9, 138.2, 134.3, 131.5, 131.4, 130.2, 128.6, 127.3, 126.7, 124.0, 123.1, 102.7, 90.4, 37.4, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}N_3O_7^+$ 472.11393; Found 472.11411.



3m

3-hydroxy-1-(3-nitrobenzoyl)-3-(3-nitrophenyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3m**)

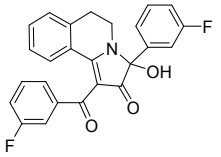
Prepared according to the **1m** (1.0 equiv, 0.5 mmol, 82.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **3m** (127.3 mg, yield 54%) as yellow solid (Rf = 0.28); mp 191-193 °C;^{1}H NMR (600 MHz, DMSO-d_6) δ 8.43 (s, 1H), 8.37 (d, J = 8.4 Hz, 1H), 8.31 (s, 1H), 8.27 (d, J = 8.4 Hz, 1H), 8.19 (s, 1H), 8.08 (d, J = 7.2 Hz, 1H), 7.95 (d, J = 8.4 Hz, 1H), 7.87 (d, J = 7.8 Hz, 1H), 7.72 (t, J = 7.8 Hz, 2H), 7.65 (t, J = 7.2 Hz, 1H), 7.51 (d, J = 7.2 Hz, 1H), 7.39 (t, J = 7.2 Hz, 1H), 3.59–3.54 (m, 1H), 3.31-3.26 (m, 1H), 3.22-3.17 (m, 1H), 3.12-3.06 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.4, 186.9, 172.1, 148.2, 147.4, 140.7, 138.3, 138.2, 135.5, 134.3, 131.9, 131.4, 130.7, 129.6, 128.6, 126.7, 126.3, 123.9, 123.8, 120.8, 102.6, 90.1, 37.4, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}N_3O_7^+$ 472.11393; Found 472.11404.



3n

1-(4-fluorobenzoyl)-3-(4-fluorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3n**)

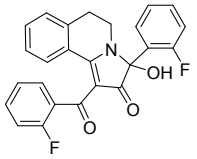
Prepared according to the **1n** (1.0 equiv, 0.5 mmol, 69.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3n** (129.4 mg, yield 62%) as yellow solid (Rf = 0.3); mp 219-220 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.81-7.76 (m, 2H), 7.74 (s, 1H), 7.73 (s, 1H), 7.60 (t, J = 7.2 Hz, 1H), 7.52–7.45 (m, 3H), 7.34 (t, J = 7.2 Hz, 1H), 7.28-7.21 (m, 4H), 3.53–3.47 (m, 1H), 3.21–3.16 (m, 1H), 3.16–3.11 (m, 1H), 3.09-3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.0, 188.2, 170.8, 165.3, 163.7, 163.0, 161.4, 138.0, 135.8, 133.7, 132.4, 132.1, 131.0, 128.6, 127.8, 126.7, 124.0, 115.7, 115.5, 114.9, 114.8, 102.8, 90.3, 37.1, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}F_2NO_3^+$ 418.12493; Found 418.12491.



3o

1-(3-fluorobenzoyl)-3-(3-fluorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3o**)

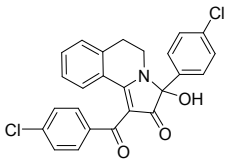
Prepared according to the **1o** (1.0 equiv, 0.5 mmol, 69.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3o** (123.1 mg, yield 59%) as yellow solid (Rf = 0.3); mp 192-194 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.89 (s, 1H), 7.83 (d, J = 7.2 Hz, 1H), 7.64–7.55 (m, 2H), 7.54–7.42 (m, 4H), 7.42–7.31 (m, 3H), 7.28 (d, J = 7.2 Hz, 1H), 7.25-7.19 (m, 1H), 3.60–3.49 (m, 1H), 3.28-3.20 (m, 1H), 3.20–3.12 (m, 1H), 3.12-3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.7, 188.3, 171.2, 163.3, 162.6, 161.6, 161.0, 141.7, 139.1, 138.1, 133.8, 131.1, 130.9, 130.0, 128.6, 126.7, 125.3, 124.0, 121.4, 118.8, 115.7, 115.6, 113.0, 112.8, 102.9, 90.2, 37.2, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}F_2NO_3^+$ 418.12493; Found 418.12460.



3p

1-(2-fluorobenzoyl)-3-(2-fluorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3p**)

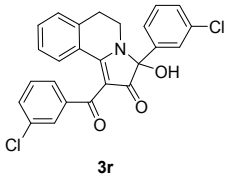
Prepared according to the **1p** (1.0 equiv, 0.5 mmol, 69.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3p** (114.8 mg, yield 55%) as yellow solid (Rf = 0.3); mp 236-238 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.09 (d, J = 7.8 Hz, 1H), 7.95 (s, 1H), 7.85 (t, J = 7.2 Hz, 1H), 7.61 (t, J = 7.2 Hz, 1H), 7.52-7.41 (m, 4H), 7.38 (t, J = 7.8 Hz, 1H), 7.31 (t, J = 7.2 Hz, 1H), 7.24-7.12 (m, 3H), 3.53-3.50 (m, 1H), 3.09–3.02 (m, 1H), 3.01–2.95 (m, 1H), 2.95–2.88 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.7, 184.3, 170.4, 160.8, 159.8, 159.2, 158.1, 138.0, 134.0, 132.3, 132.2, 131.4, 131.3, 130.1, 130.0, 129.9, 129.8, 128.4, 126.6, 124.6, 124.3, 123.9, 123.4, 123.3, 115.8, 115.7, 115.6, 115.5, 104.8, 87.4, 37.3, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}F_2NO_3^+$ 418.12493; Found 418.12454.



3q

1-(4-chlorobenzoyl)-3-(4-chlorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3q**)

Prepared according to the **1q** (1.0 equiv, 0.5 mmol, 77.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3q** (153.1 mg, yield 68%) as yellow solid (Rf = 0.3); mp 200-202 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.80 (s, 1H), 7.77 (d, J = 7.8 Hz, 1H), 7.70 (d, J = 8.4 Hz, 2H), 7.61 (t, J = 7.2 Hz, 1H), 7.49 (d, J = 7.8 Hz, 3H), 7.47 (s, 4H), 7.35 (t, J = 7.8 Hz, 1H), 3.53-3.47 (m, 1H), 3.22–3.17 (m, 1H), 3.17-3.12 (m, 1H), 3.08-3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.8, 188.3, 171.0, 138.04, 137.96, 136.8, 135.1, 133.8, 133.4, 131.2, 131.1, 128.8, 128.6, 128.0, 127.6, 126.7, 123.9, 102.8, 90.3, 37.1, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}Cl_2NO_3^+$ 450.06583; Found 450.06598.

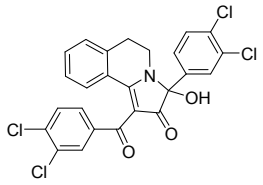


3r

1-(3-chlorobenzoyl)-3-(3-chlorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3r**)

Prepared according to the **1r** (1.0 equiv, 0.5 mmol, 77.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C

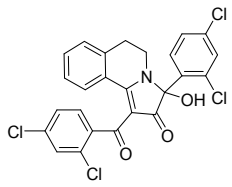
(heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3r** (146.3 mg, yield 65%) as yellow solid (Rf = 0.3); mp 192-194 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.92 (s, 1H), 7.85 (d, J = 7.8 Hz, 1H), 7.72 (s, 1H), 7.66 (d, J = 7.8 Hz, 1H), 7.62-7.58 (m, 2H), 7.56 (s, 1H), 7.49–7.42 (m, 4H), 7.39–7.33 (m, 2H), 3.57–3.50 (m, 1H), 3.26-3.20 (m, 1H), 3.18-3.12 (m, 1H), 3.11–3.04 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 193.7, 188.1, 171.3, 141.3, 138.6, 138.1, 133.9, 133.6, 132.7, 131.7, 131.1, 130.8, 129.8, 129.0, 128.8, 128.6, 127.8, 126.7, 125.8, 124.0, 123.9, 102.8, 90.2, 37.3, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}Cl_2NO_3^+$ 450.06583; Found 450.06598.



3s

1-(3,4-dichlorobenzoyl)-3-(3,4-dichlorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3s**)

Prepared according to the **1s** (1.0 equiv, 0.5 mmol, 95.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3s** (161.0 mg, yield 62%) as yellow solid (Rf = 0.3); mp 138-140 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.02 (s, 1H), 7.89 (d, J = 7.2 Hz, 2H), 7.75–7.68 (m, 2H), 7.69–7.60 (m, 3H), 7.49 (d, J = 7.2 Hz, 1H), 7.41 (d, J = 8.4 Hz, 1H), 7.37 (t, J = 7.2 Hz, 1H), 3.58–3.49 (m, 1H), 3.31-3.24 (m, 1H), 3.22-3.14 (m, 1H), 3.11–3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.4, 186.9, 171.6, 139.6, 138.2, 137.1, 134.5, 134.1, 131.64, 131.62, 131.3, 131.10, 131.06, 130.7, 130.2, 129.2, 128.6, 128.0, 126.6, 125.8, 123.8, 102.6, 89.8, 37.3, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{16}Cl_4NO_3^+$ 517.98788; Found 517.98798.

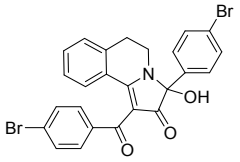


3t

1-(2,4-dichlorobenzoyl)-3-(2,4-dichlorophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3t**)

Prepared according to the **1t** (1.0 equiv, 0.5 mmol, 95.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3t** (168.7 mg, yield 65%) as yellow solid (Rf = 0.3); mp 253-254 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.30 (d, J = 8.4 Hz, 1H), 8.17 (s, 1H), 8.01 (d, J = 9.0

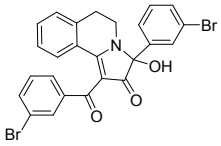
Hz, 1H), 7.65 (t, J = 7.2 Hz, 1H), 7.63-7.58 (m, 3H), 7.58-7.53 (m, 1H), 7.49-7.40 (m, 3H), 7.35 (d, J = 8.4 Hz, 1H), 3.51-3.45 (m, 1H), 3.13–3.06 (m, 1H), 3.04-2.97 (m, 1H), 2.96-2.89 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.2, 185.1, 171.8, 140.6, 138.0, 134.8, 134.4, 133.7, 132.3, 131.62, 131.60, 131.2, 129.9, 129.8, 128.6, 128.2, 127.4, 126.9, 126.6, 124.3, 105.0, 87.8, 37.4, 27.7；HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{16}Cl_4NO_3^+$ 517.98788; Found 517.98724.



3u

1-(4-bromobenzoyl)-3-(4-bromophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3u**)

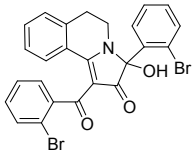
Prepared according to the **1u** (1.0 equiv, 0.5 mmol, 99.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3u** (175.2 mg, yield 65%) as yellow solid (Rf = 0.3); mp 210-212 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.80 (s, 1H), 7.77 (d, J = 7.8 Hz, 1H), 7.64–7.61 (m, 4H), 7.61-7.59 (m, 2H), 7.48 (d, J = 7.8 Hz, 1H), 7.40 (d, J = 8.4 Hz, 2H), 7.35 (t, J = 7.2 Hz, 1H), 3.52–3.47 (m, 1H), 3.21–3.17 (m, 1H), 3.15–3.11 (m, 1H), 3.08–3.03 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.8, 188.4, 171.1, 138.3, 138.0, 135.5, 133.8, 131.7, 131.3, 131.1, 130.9, 128.6, 127.9, 126.7, 125.9, 123.9, 122.0, 102.7, 90.4, 37.1, 27.6; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}Br_2NO_3^+$ 537.96480; Found 537.96533.



3v

1-(3-bromobenzoyl)-3-(3-bromophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3v**)

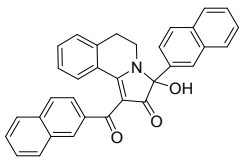
Prepared according to the **1v** (1.0 equiv, 0.5 mmol, 99.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3v** (167.2 mg, yield 62%) as yellow solid (Rf = 0.3); mp 212-214 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.92 (s, 1H), 7.85-7.80 (d, J = 8.4 Hz, 2H), 7.72 (d, J = 8.4 Hz, 1H), 7.69-7.66 (m, 2H), 7.64–7.58 (m, 2H), 7.48 (d, J = 7.8 Hz, 1H), 7.39 (t, J = 7.2 Hz, 3H), 7.35 (t, J = 7.8 Hz, 1H), 3.55-3.49 (m, 1H), 3.26-3.20 (m, 1H), 3.18–3.13 (m, 1H), 3.10–3.04 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.7, 188.0, 171.3, 141.5, 138.7, 138.1, 134.6, 133.9, 131.8, 131.7, 131.14, 131.05, 130.1, 128.7, 128.6, 128.2, 126.7, 124.3, 123.9, 122.1, 121.2, 102.7, 90.1, 37.3, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}Br_2NO_3^+$ 537.96480; Found 537.96497.



3w

1-(2-bromobenzoyl)-3-(2-bromophenyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3w**)

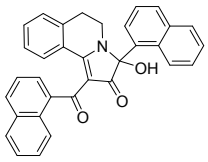
Prepared according to the **1w** (1.0 equiv, 0.5 mmol, 95.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3w** (153.7 mg, yield 57%) as yellow solid (Rf = 0.3); mp 226-228 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.30 (d, J = 7.8 Hz, 1H), 8.01 (t, J = 7.8 Hz, 2H), 7.63 (t, J = 7.2 Hz, 1H), 7.58 (t, J = 8.4 Hz, 2H), 7.49 (t, J = 7.2 Hz, 1H), 7.44 (d, J = 6.0 Hz, 2H), 7.39–7.30 (m, 3H), 7.29-7.24 (m, 1H), 3.49–3.42 (m, 1H), 3.14–3.06 (m, 1H), 3.04-2.98 (m, 1H), 2.93-2.86 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.2, 187.0, 172.2, 143.6, 137.8, 134.7, 134.1, 133.8, 132.2, 131.6, 131.0, 130.0, 128.6, 128.1, 127.6, 127.0, 126.5, 124.6, 119.8, 118.9, 105.3, 88.6, 37.5, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{18}Br_2NO_3^+$ 537.96480; Found 537.96454.



3x

1-(2-naphthoyl)-3-hydroxy-3-(naphthalen-2-yl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3x**)

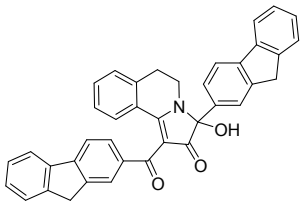
Prepared according to the **1x** (1.0 equiv, 0.5 mmol, 85.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3x** (139.6 mg, yield 58%) as yellow solid (Rf = 0.3); mp 224-226 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.39 (s, 1H), 8.17 (s, 1H), 8.07–8.04 (m, 1H), 7.98 (d, J = 8.4 Hz, 1H), 7.96–7.92 (m, 3H), 7.92 (s, 1H), 7.89-7.83 (m, 3H), 7.64-7.56 (m, 3H), 7.55 (d, J = 7.8 Hz, 3H), 7.48 (d, J = 7.8 Hz, 1H), 7.34 (t, J = 7.2 Hz, 1H), 3.61–3.55 (m, 1H), 3.28–3.23 (m, 1H), 3.22-3.17 (m, 1H), 3.13-3.07 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.4, 190.0, 170.6, 138.1, 136.7, 134.8, 133.8, 133.6, 132.9, 132.8, 132.0, 130.9, 130.7, 129.2, 128.7, 128.5, 128.3, 128.0, 127.6, 127.4, 126.7, 126.6, 126.50, 126.46, 125.6, 125.2, 124.2, 123.0, 103.6, 90.8, 37.3, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{33}H_{24}NO_3^+$ 482.17507; Found 482.17542.



3y

1-(1-naphthoyl)-3-hydroxy-3-(naphthalen-1-yl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3y**)

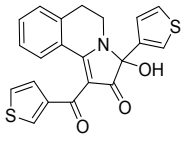
Prepared according to the **1y** (1.0 equiv, 0.5 mmol, 85 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3y** (132.4 mg, yield 55%) as yellow solid (Rf = 0.3); mp 230-232 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.37 (s, 1H), 8.26 (s, 1H), 8.04–7.83 (m, 6H), 7.77 (s, 1H), 7.62–7.52 (m, 3H), 7.51-7.44 (m, 7.2 Hz, 4H), 7.43–7.28 (m, 3H), 3.52 (s, 1H), 3.05 (s, 1H), 2.86 (s, 2H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 190.3, 170.8, 138.8, 138.0, 134.0, 133.2, 131.3, 131.2, 130.3, 130.0, 128.4, 128.2, 127.1, 126.7, 126.6, 125.83, 125.75, 124.8, 124.5, 103.4, 86.0, 37.4, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{33}H_{24}NO_3^+$ 482.17507; Found 482.17545.



3z

3-(9*H*-fluoren-2-yl)-1-(9*H*-fluorene-2-carbonyl)-3-hydroxy-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3z**)

Prepared according to the **1z** (1.0 equiv, 0.5 mmol, 104.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3z** (161.3 mg, yield 58%) as yellow solid (Rf = 0.3); mp 235-237 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.00 (s, 1H), 7.97–7.88 (m, 4H), 7.85-7.75 (m, 2H), 7.72 (d, J = 4.0 Hz, 2H), 7.63-7.55 (m, 3H), 7.49 (t, J = 7.6 Hz, 2H), 7.43–7.30 (m, 5H), 3.95 (d, J = 5.2 Hz, 4H), 3.60-3.49 (m, 1H), 3.30–3.04 (m, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 194.5, 189.9, 170.2, 144.9, 144.3, 143.5, 143.4, 142.4, 141.5, 140.5, 140.3, 138.0, 137.8, 135.0, 133.5, 130.8, 129.1, 128.7, 127.7, 127.1, 127.0, 126.8, 126.7, 126.0, 125.3, 125.2, 124.2, 122.4, 120.9, 120.2, 120.1, 119.3, 103.6, 90.9, 37.2, 36.5, 36.4, 27.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{39}H_{28}NO_3^+$ 558.20637; Found 558.20667.

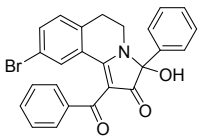


3aa

3-hydroxy-3-(thiophen-3-yl)-1-(thiophene-3-carbonyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**3aa**)

Prepared according to the **1aa** (1.0 equiv, 0.5 mmol, 63.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2a** (1.0 equiv, 0.5 mmol, 67.5 mg) was added at 130 °C (heating block)

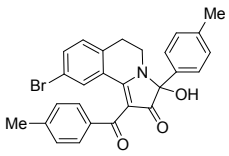
to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **3aa** (98.3 mg, yield 50%) as yellow solid (Rf = 0.3); mp 266-268 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.09 (d, J = 2.0 Hz, 1H), 7.64 (d, J = 7.6 Hz, 2H), 7.59–7.52 (m, 3H), 7.52-7.48 (m, 1H), 7.45 (d, J = 7.6 Hz, 1H), 7.38 (d, J = 5.2 Hz, 1H), 7.30 (t, J = 7.6 Hz, 1H), 7.06 (d, J = 5.2 Hz, 1H), 3.54–3.46 (m, 1H), 3.24–3.10 (m, 2H), 3.10–2.98 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 193.6, 183.4, 168.9, 143.4, 138.1, 138.0, 133.9, 133.3, 130.7, 128.6, 127.8, 127.3, 126.6, 126.0, 125.3, 124.2, 123.9, 104.1, 89.4, 37.1, 27.7; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{21}H_{16}NO_3S_2^+$ 394.05661; Found 394.05658.



4a

1-benzoyl-9-bromo-3-hydroxy-3-phenyl-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**4a**)

Prepared according to the **1a** (1.0 equiv, 0.5 mmol, 60.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2b** (1.0 equiv, 0.5 mmol, 106.0 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **4a** (154.2 mg, yield 67%) as yellow solid (Rf = 0.3); mp 216-218 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.94 (s, 1H), 7.80 (d, J = 7.8 Hz, 1H), 7.73 (s, 1H), 7.68 (d, J = 6.0 Hz, 2H), 7.54-7.51 (m, 1H), 7.49-7.44 (m, 3H), 7.43–7.36 (m, 5H), 3.53-3.49 (m, 1H), 3.16–3.08 (m, 2H), 3.05-3.00 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 194.6, 189.8, 169.5, 139.3, 137.4, 136.0, 135.9, 133.1, 132.2, 130.8, 129.3, 128.8, 128.0, 126.2, 125.6, 119.2, 103.3, 90.8, 37.0, 27.4; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{19}BrNO_3^+$ 460.05428; Found 460.05466.

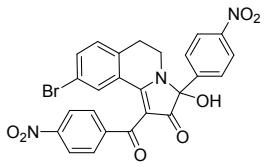


4b

9-bromo-3-hydroxy-1-(4-methylbenzoyl)-3-(*p*-tolyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**4b**)

Prepared according to the **1b** (1.0 equiv, 0.5 mmol, 67.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2b** (1.0 equiv, 0.5 mmol, 106.0 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (2:1 v/v) as eluent afforded **4b** (149.0 mg, yield 61%) as yellow solid (Rf = 0.3); mp 212-214 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.90 (s, 1H), 7.80 (d, J=7.8 Hz, 1H), 7.63 (s, 1H), 7.60 (d, J = 6.0 Hz, 2H), 7.45 (d, J= 7.2 Hz, 1H), 7.34 (d, J= 6.6 Hz, 2H), 7.22 (d, J = 7.2 Hz, 4H), 3.51–3.46 (m, 1H), 3.14-3.06 (m, 2H), 3.04–2.99 (m, 1H), 2.35 (s, 3H), 2.30 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.7, 189.5, 169.0, 142.5, 138.1, 137.3, 136.7, 133.0, 129.5, 128.6, 126.2,

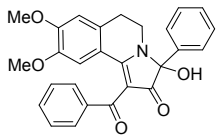
125.5, 119.1, 103.5, 36.9, 27.4, 21.2, 20.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{23}BrNO_3^+$ 488.08558; Found 488.08551.



4c

9-bromo-3-hydroxy-1-(4-nitrobenzoyl)-3-(4-nitrophenyl)-5,6-dihydropyrrolo [2,1-*a*]isoquinolin-2(3*H*)-one (**4c**)

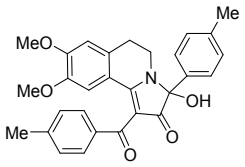
Prepared according to the **1l** (1.0 equiv, 0.5 mmol, 82.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2b** (1.0 equiv, 0.5 mmol, 106.0 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:1 v/v) as eluent afforded **4c** (132.1 mg, yield 48%) as yellow solid (Rf = 0.28); mp 226-228 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.25 (s, 4H), 8.19 (s, 2H), 7.86 (d, J = 8.4 Hz, 1H), 7.82 (d, J = 7.2 Hz, 2H), 7.77 (d, J = 7.2 Hz, 2H), 7.49 (d, J = 7.2 Hz, 1H), 3.60–3.55 (m, 1H), 3.25–3.20 (m, 1H), 3.17-3.12 (m, 1H), 3.07-3.02 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.6, 187.6, 170.7, 149.0, 147.9, 145.1, 142.5, 137.6, 136.7, 133.7, 130.7, 130.3, 127.3, 125.9, 124.1, 123.1, 119.2, 103.0, 90.5, 37.2, 27.3; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{25}H_{17}BrN_3O_7^+$ 550.02444; Found 550.02472.



4d

1-benzoyl-3-hydroxy-8,9-dimethoxy-3-phenyl-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**4d**)

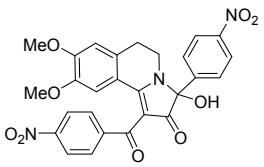
Prepared according to the **1a** (1.0 equiv, 0.5 mmol, 60.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2c** (1.0 equiv, 0.5 mmol, 96.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:2 v/v) as eluent afforded **4d** (116.9 mg, yield 53%) as yellow solid (Rf = 0.34); mp 236-238 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.69 (s, 2H), 7.58 (s, 1H), 7.44 (s, 5H), 7.36 (d, J = 15.0 Hz, 4H), 7.08 (s, 1H), 3.86 (s, 3H), 3.53 (s, 3H), 3.16–2.96 (m, 4H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.4, 189.8, 169.8, 153.2, 146.5, 139.8, 136.5, 132.9, 131.9, 129.3, 129.2, 128.7, 127.9, 125.6, 116.1, 114.1, 111.4, 102.6, 90.5, 55.9, 55.5, 37.4, 27.4; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{24}NO_5^+$ 442.16490; Found 442.16452.



4e

3-hydroxy-8,9-dimethoxy-1-(4-methylbenzoyl)-3-(*p*-tolyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**4e**)

Prepared according to the **1b** (1.0 equiv, 0.5 mmol, 67.0 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2c** (1.0 equiv, 0.5 mmol, 96.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:2 v/v) as eluent afforded **4e** (117.2 mg, yield 50%) as yellow solid (Rf = 0.32); mp 221-223 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.61 (d, J = 7.2 Hz, 2H), 7.48 (s, 1H), 7.32 (d, J = 8.4 Hz, 3H), 7.22 (d, J = 6.0 Hz, 2H), 7.18 (d, J = 6.0 Hz, 2H), 7.07 (s, 1H), 3.86 (s, 3H), 3.52 (s, 3H), 3.44 (s, 1H), 3.13-3.07 (m, 1H), 3.04–2.96 (m, 2H), 2.31 (d, J = 14.4 Hz, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.5, 189.7, 169.5, 153.1, 146.5, 142.1, 137.8, 137.2, 133.7, 132.8, 129.5, 129.4, 128.6, 125.6, 116.2, 113.9, 111.4, 102.7, 90.4, 55.9, 55.4, 37.3, 27.4, 21.2, 20.8; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{28}NO_5^+$ 470.19620; Found 470.19601.

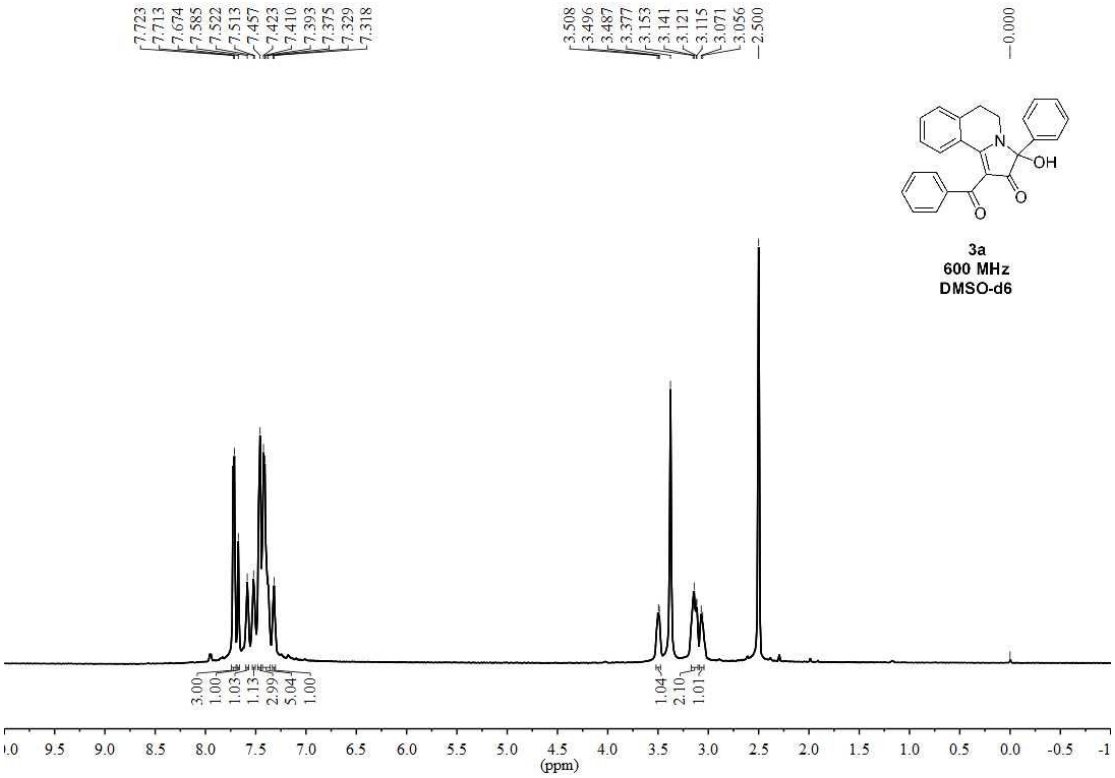


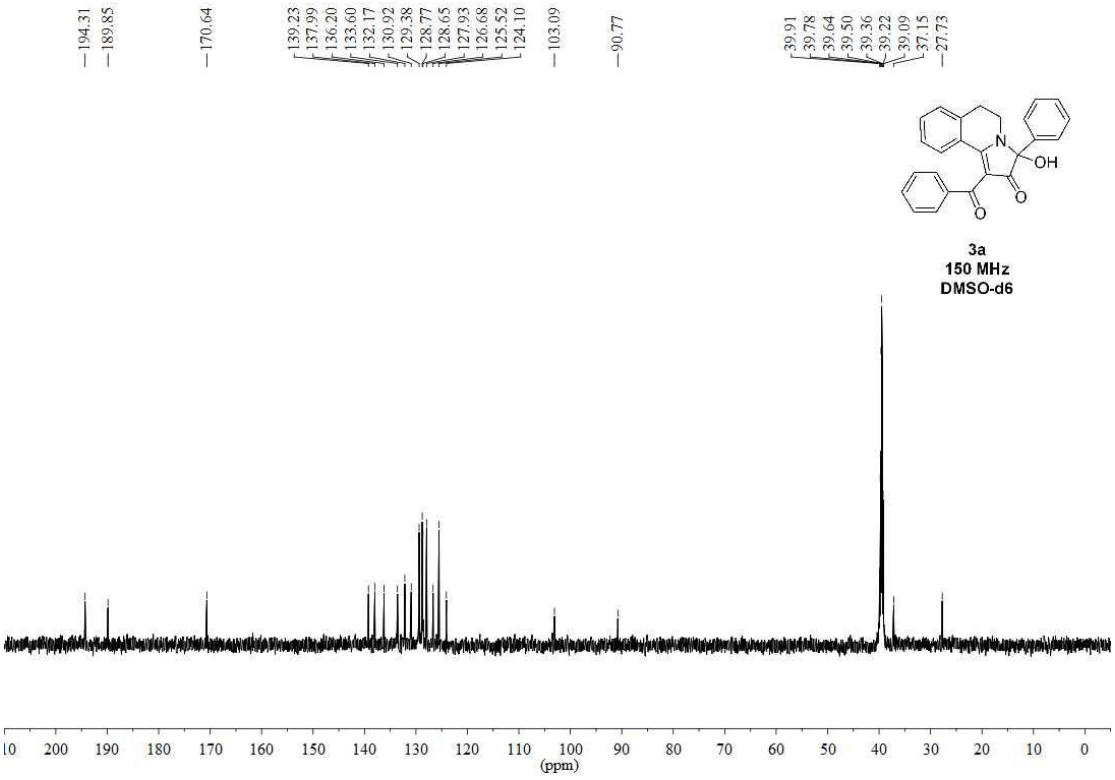
4f

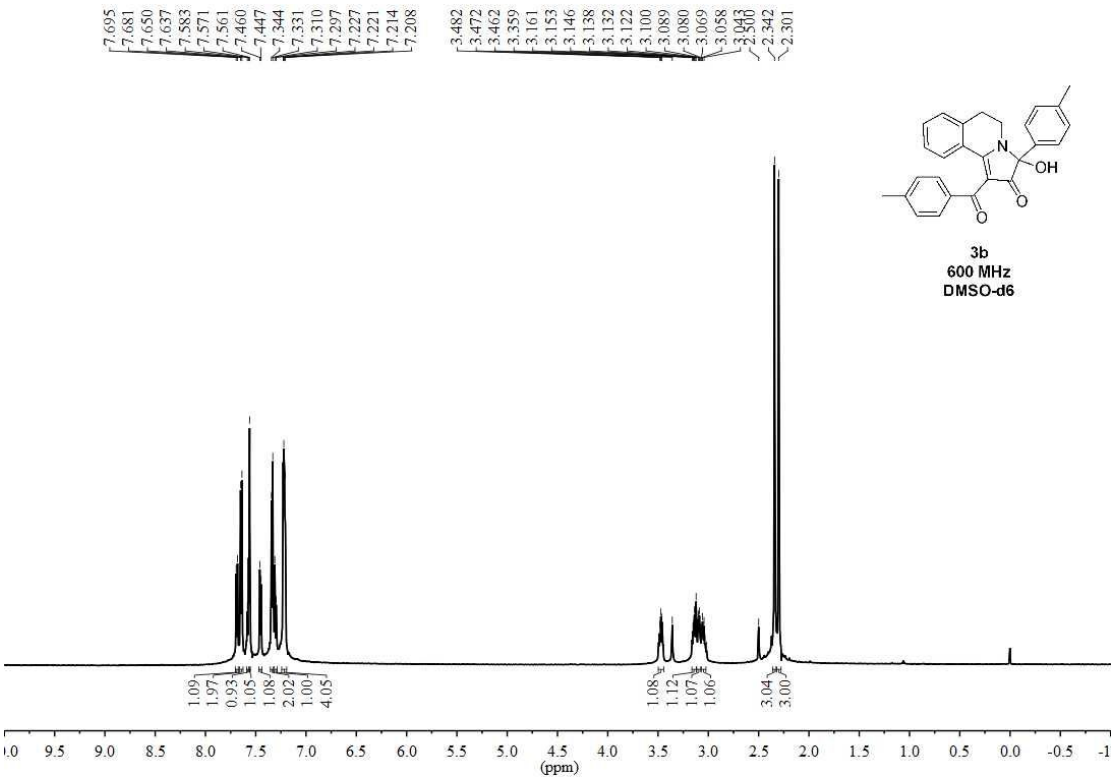
3-hydroxy-8,9-dimethoxy-1-(4-nitrobenzoyl)-3-(4-nitrophenyl)-5,6-dihydropyrrolo[2,1-*a*]isoquinolin-2(3*H*)-one (**4f**)

Prepared according to the **1l** (1.0 equiv, 0.5 mmol, 82.5 mg), I_2 (1.0 equiv, 0.5 mmol, 127.0 mg) at room temperature, and DMSO (2 mL) was added. The resulting mixture was stirred at 130 °C (heating block) for 1 h. Then **2c** (1.0 equiv, 0.5 mmol, 96.5 mg) was added at 130 °C (heating block) to react for 4 h. Purification by column chromatography on silica gel using petroleum ether/ethyl acetate (1:2 v/v) as eluent afforded **4f** (119.7 mg, yield 45%) as yellow solid (Rf = 0.27); mp 220-222 °C; ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.26 (d, J = 8.4 Hz, 2H), 8.22 (d, J = 8.4 Hz, 2H), 8.01 (s, 1H), 7.82 (d, J = 8.4 Hz, 2H), 7.73 (d, J = 9.0 Hz, 3H), 7.13 (s, 1H), 3.90 (s, 3H), 3.65 (s, 3H), 3.54–3.50 (m, 1H), 3.24–3.18 (m, 1H), 3.13-3.08 (m, 1H), 3.05-3.00 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ 193.4, 187.7, 170.9, 153.9, 148.8, 147.7, 146.6, 145.8, 143.3, 133.5, 130.1, 130.0, 127.3, 127.2, 123.0, 115.8, 114.6, 102.3, 90.1, 56.0, 55.7, 37.6, 27.3; HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{27}H_{22}N_3O_9^+$ 532.13506; Found 532.13544.

5. Copies of ^{1}H NMR, ^{13}C NMR spectra



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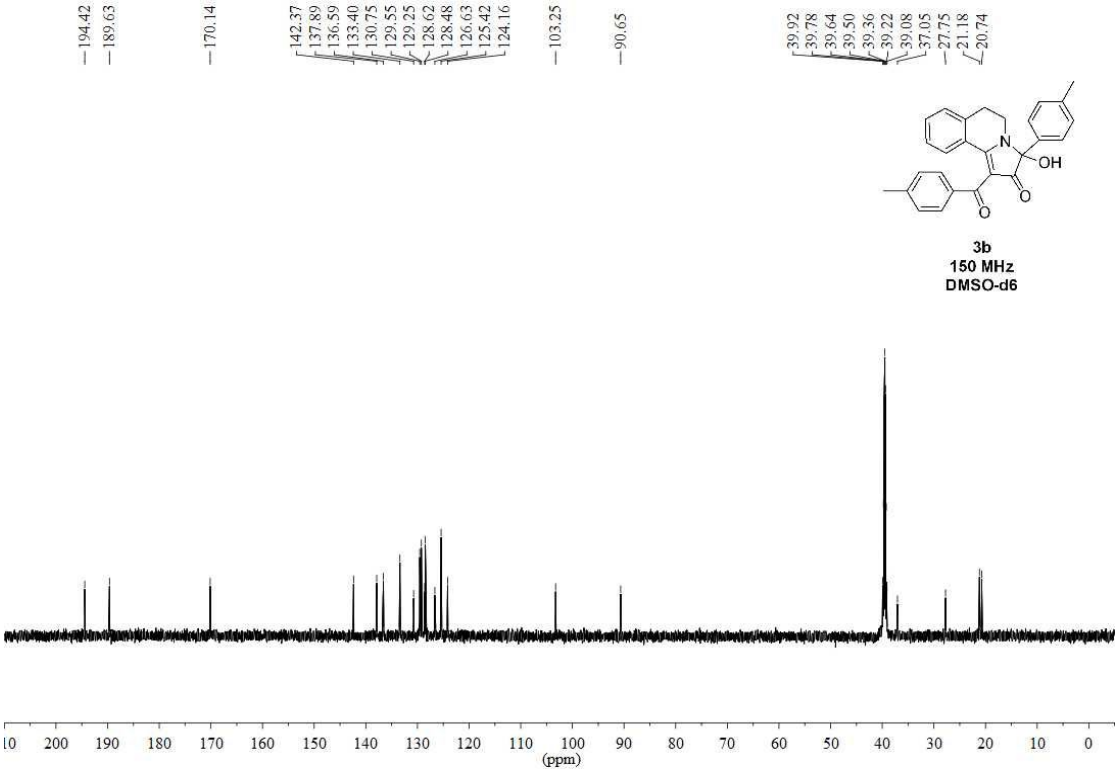
7.297
7.227
7.221
7.214
7.208
3.482
3.472
3.462
3.359
3.161
3.153
3.146
3.138
3.132
3.122
3.100
3.089
3.080
3.069
3.058
3.043
2.500
2.342
2.301
OH
O
O
3b
600 MHz
DMSO-d6
1.09
1.97
0.93
1.05
1.08
2.02
1.00
4.05
1.08
1.12
1.07
1.06
3.04
3.00
(ppm)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136.59
133.40
130.75
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129.25
128.62
128.48
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125.42
124.16
103.25
90.65
39.92
39.78
39.64
39.50
39.36
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37.05
27.75
21.18
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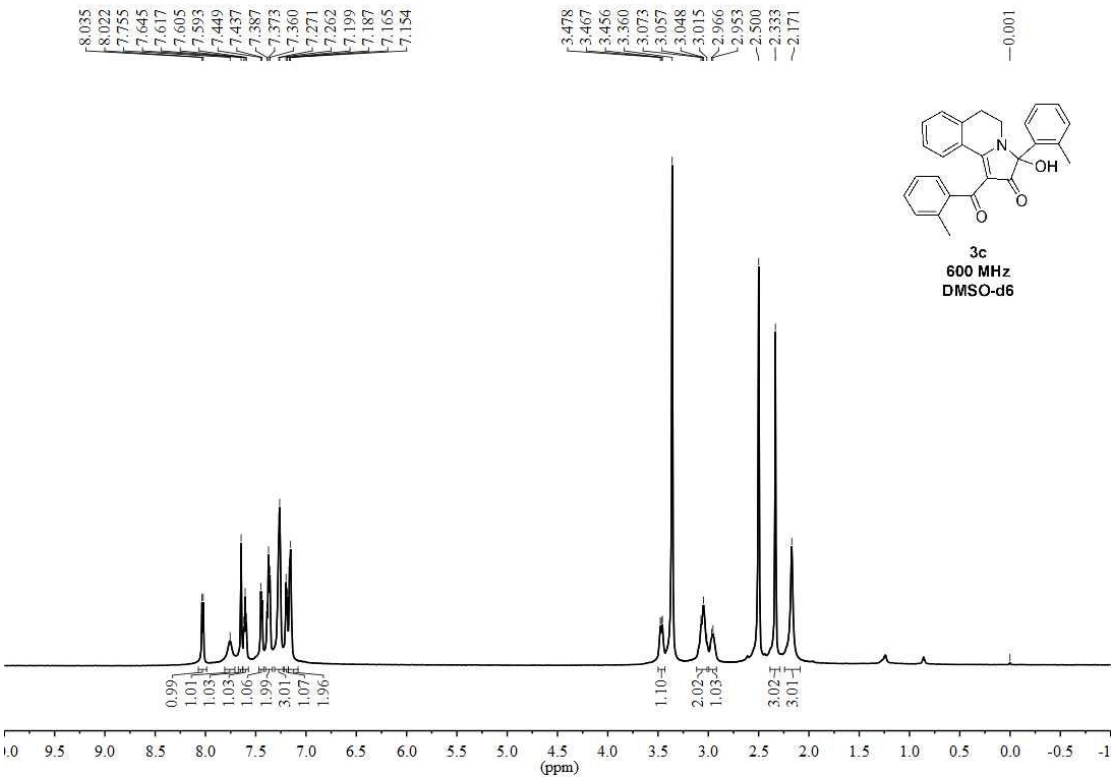
O
O
3b
150 MHz
DMSO-d6
(ppm)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7.262
7.199
7.187
7.165
7.154
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3.467
3.456
3.360
3.073
3.057
3.048
3.015
2.966
2.953
2.500
2.333
2.171
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OH
O
O
3c
600 MHz
DMSO-d6
0.99
1.01
1.03
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2.02
1.03
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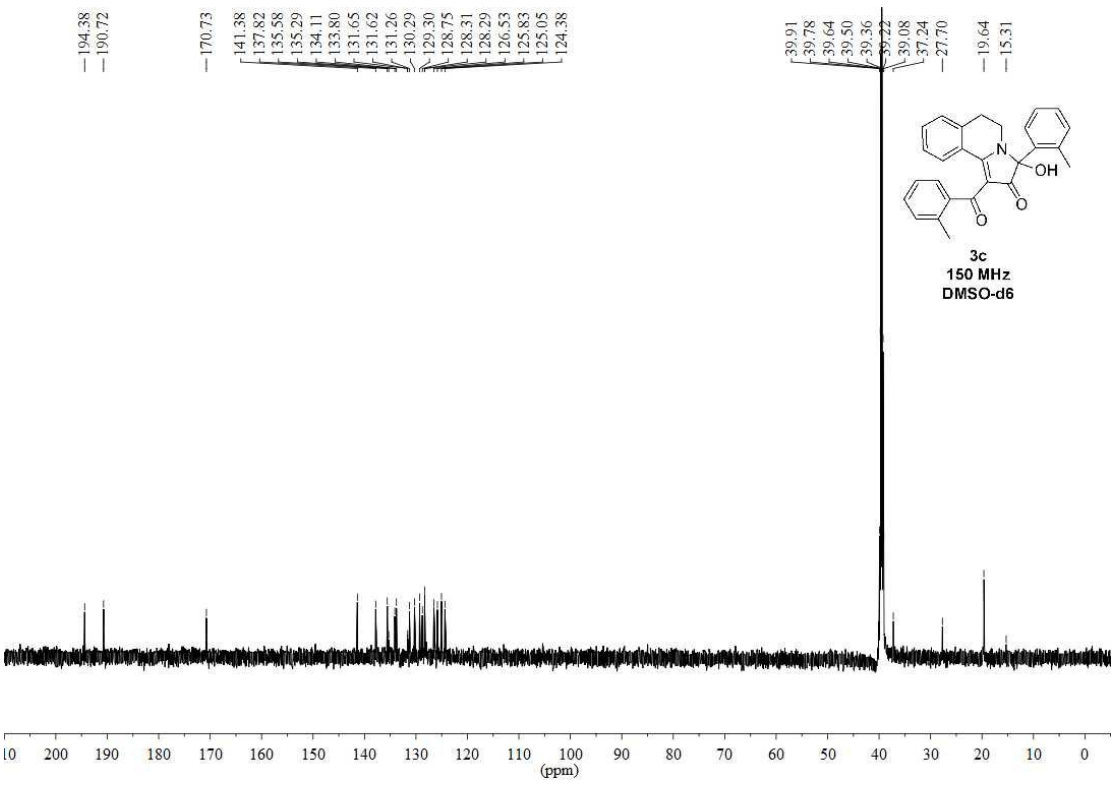
3.01
(ppm)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135.58
135.29
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131.65
131.62
131.26
130.29
129.30
128.75
128.31
128.29
126.53
125.83
125.05
124.38
39.91
39.78
39.64
39.50
39.36
39.22
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37.24
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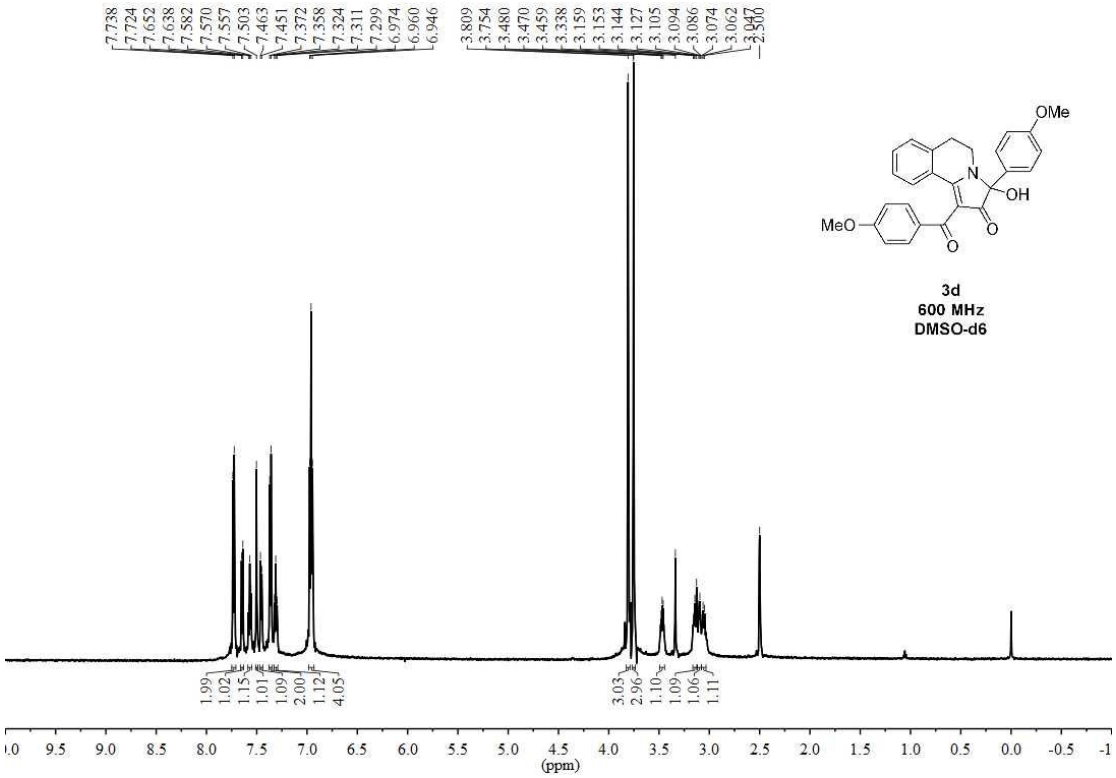
3c
150 MHz
DMSO-d6
(ppm)



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600 MHz
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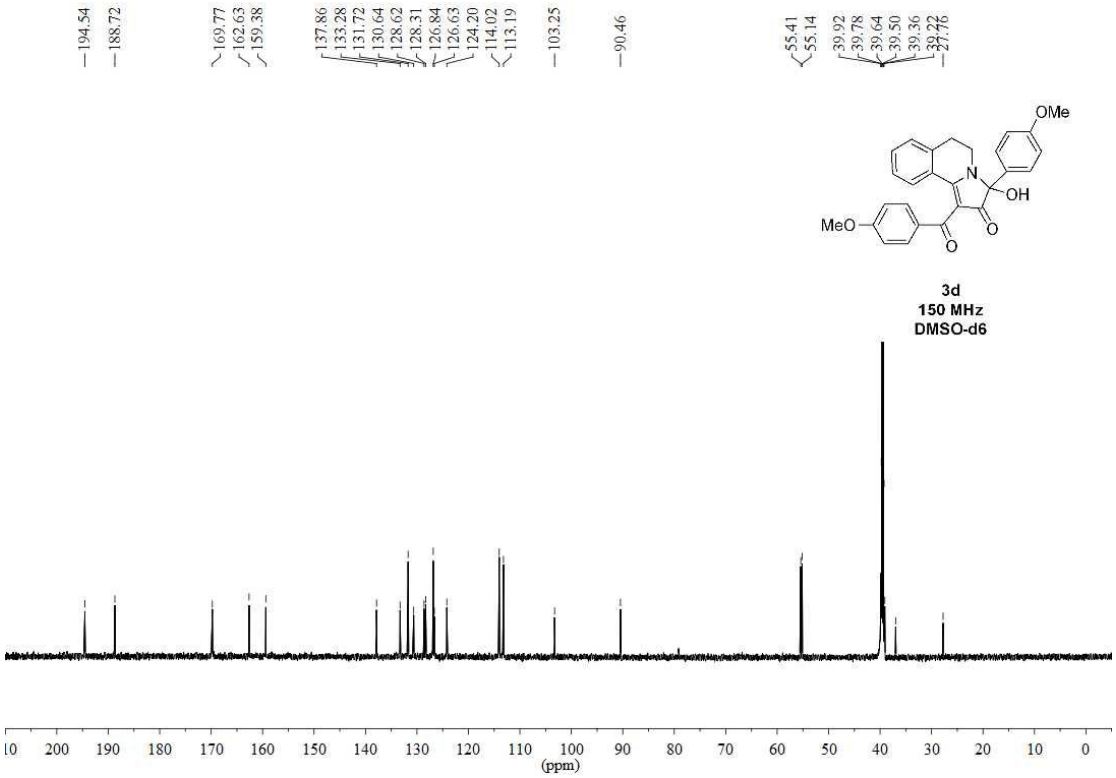
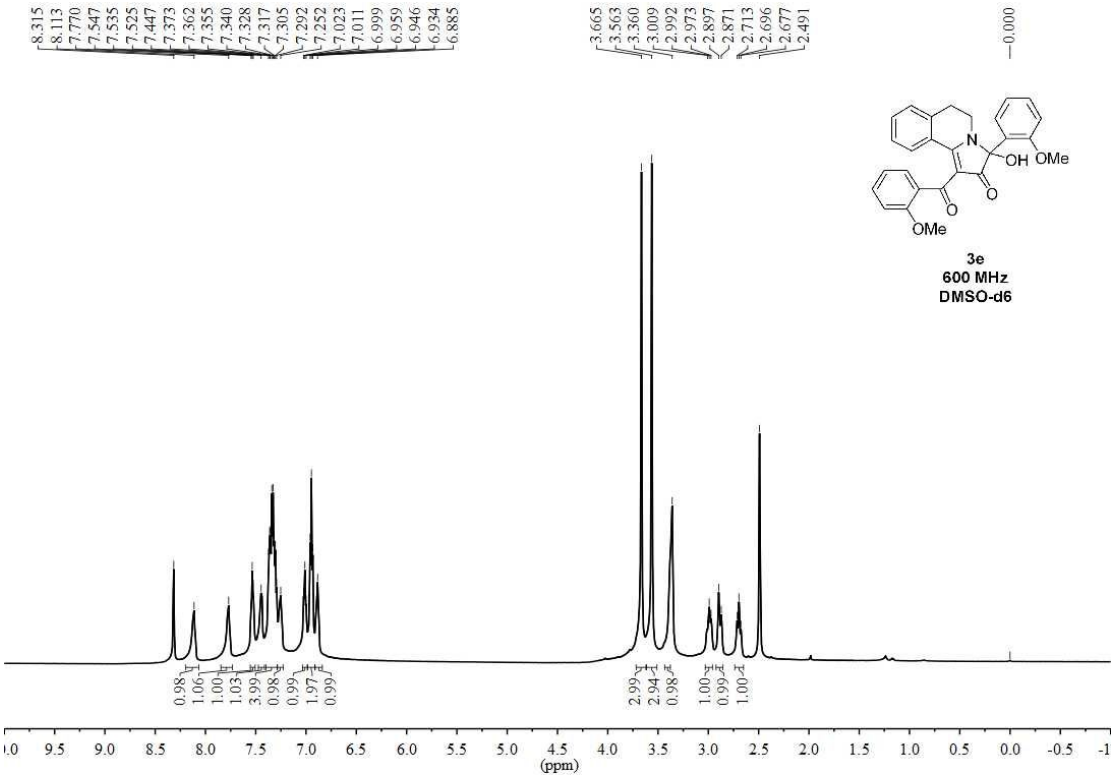


3d
150 MHz
DMSO-d6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7.355
7.340
7.328
7.317
7.305
7.292
7.252
7.023
7.011
6.999
6.959
6.946
6.934
6.885
3.665
3.563
3.360
3.009
2.992
2.973
2.897
2.871
2.713
2.696
2.677
2.491
0.000
OH
OMe
O
O
OMe
3e
600 MHz
DMSO-d6
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1.06
1.00
1.03
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0.99
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0.98
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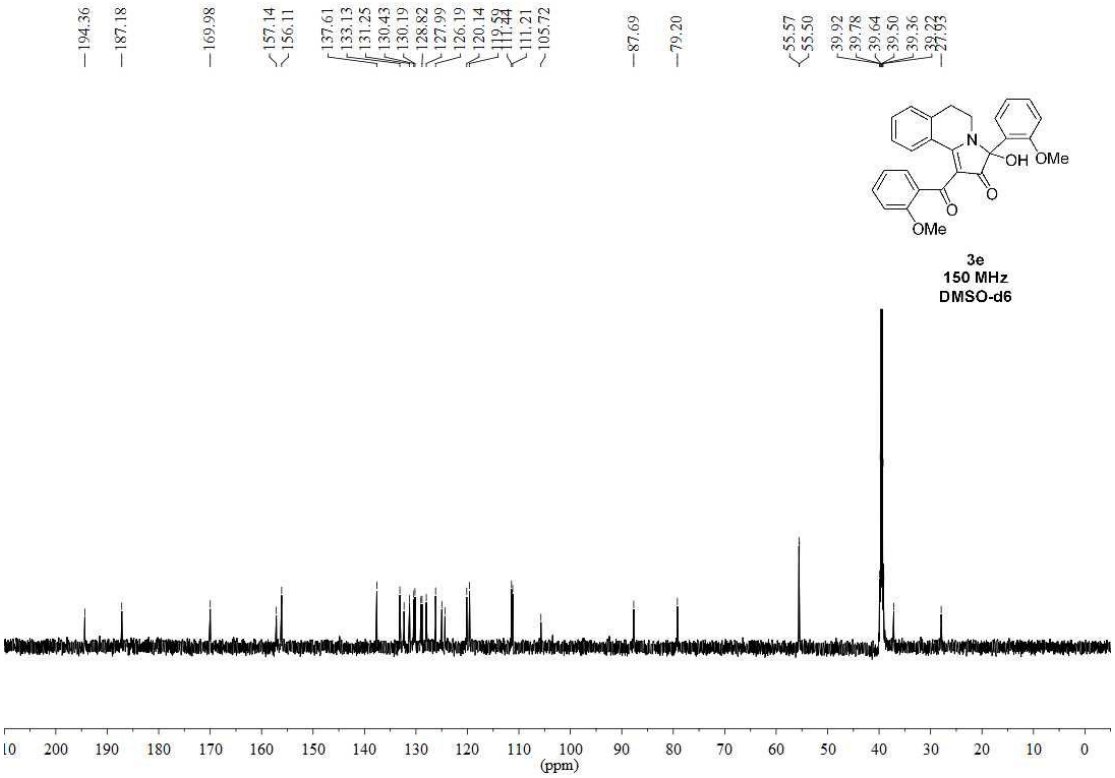
0.99
1.00
(ppm)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127.99
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120.14
111.44
111.21
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55.57
55.50
39.92
39.78
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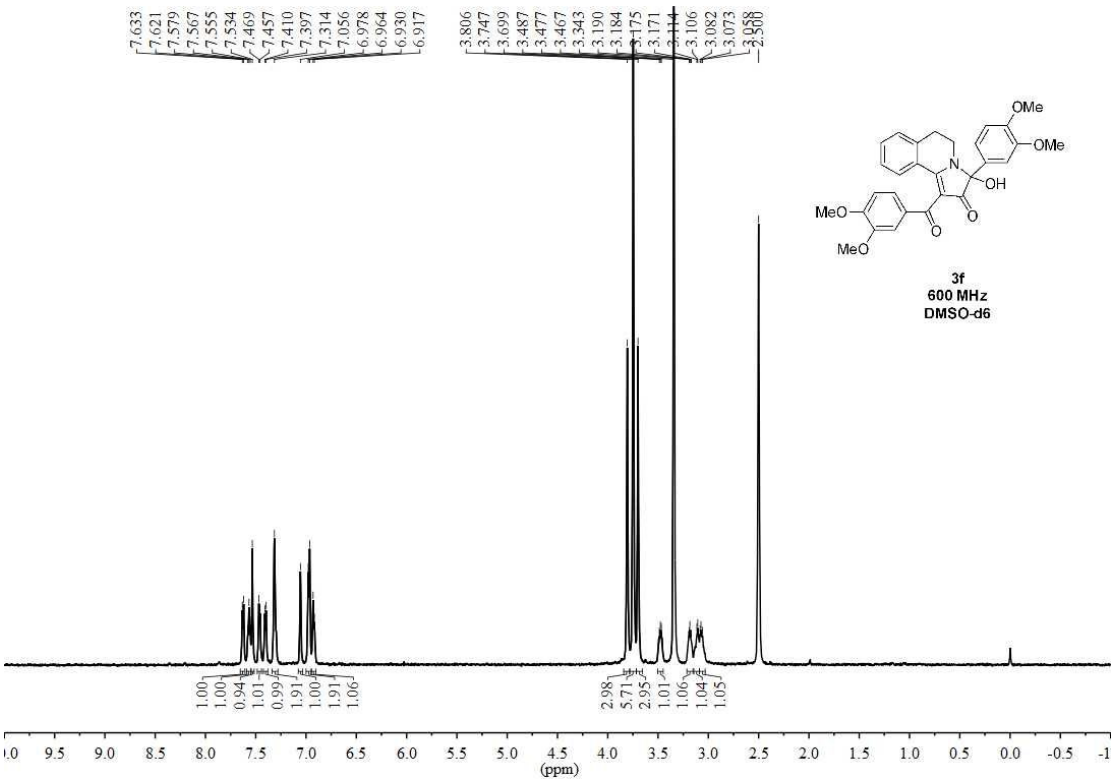
39.36
27.93
OH
OMe
O
O
OMe
3e
150 MHz
DMSO-d6
(ppm)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7.397
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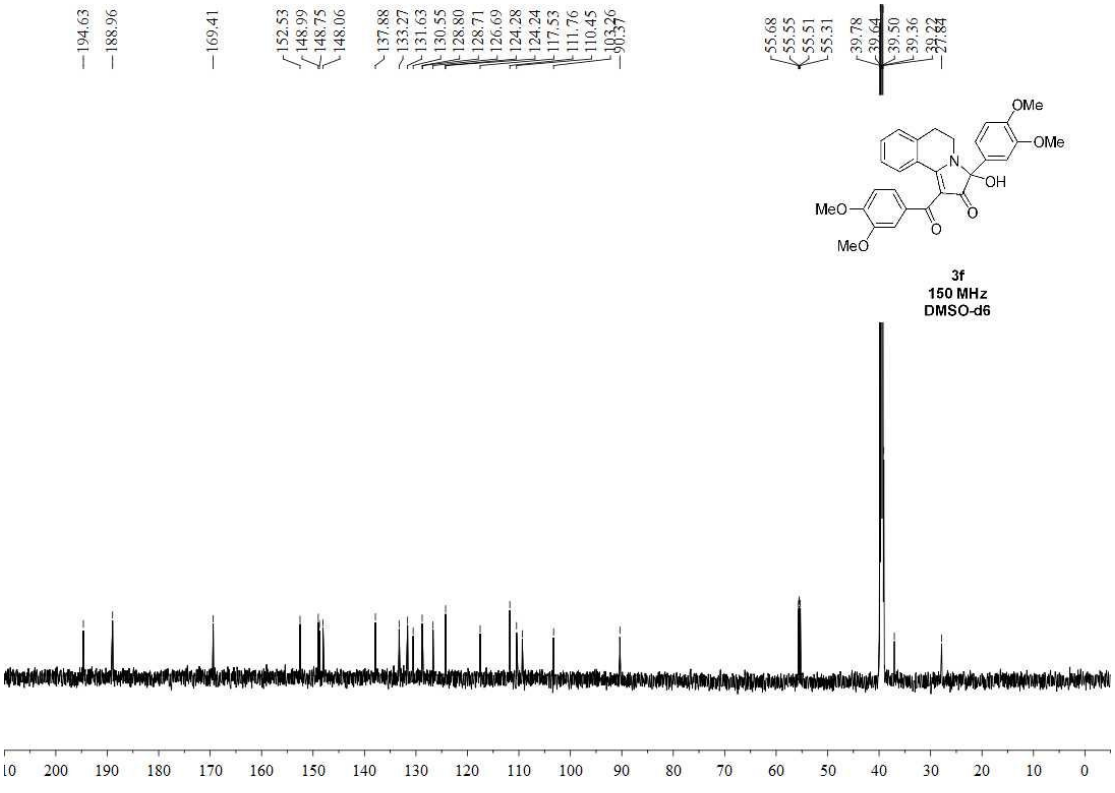
7.056
6.978
6.964
6.930
6.917
3.806
3.747
3.699
3.487
3.477
3.467
3.343
3.190
3.184
3.175
3.171
3.114
3.106
3.082
3.073
2.500
1.00
1.00
0.94
1.01
0.99
1.91
1.00
1.91
1.06
2.98
5.71
2.95
1.01
1.06
1.04
1.05
(ppm)
OMe
OMe
OH
MeO
MeO
3f
600 MHz
DMSO-d6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128.71
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124.28
124.24
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103.26
90.37
55.68
55.55
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55.31
39.78
39.64
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39.36
39.22
27.84
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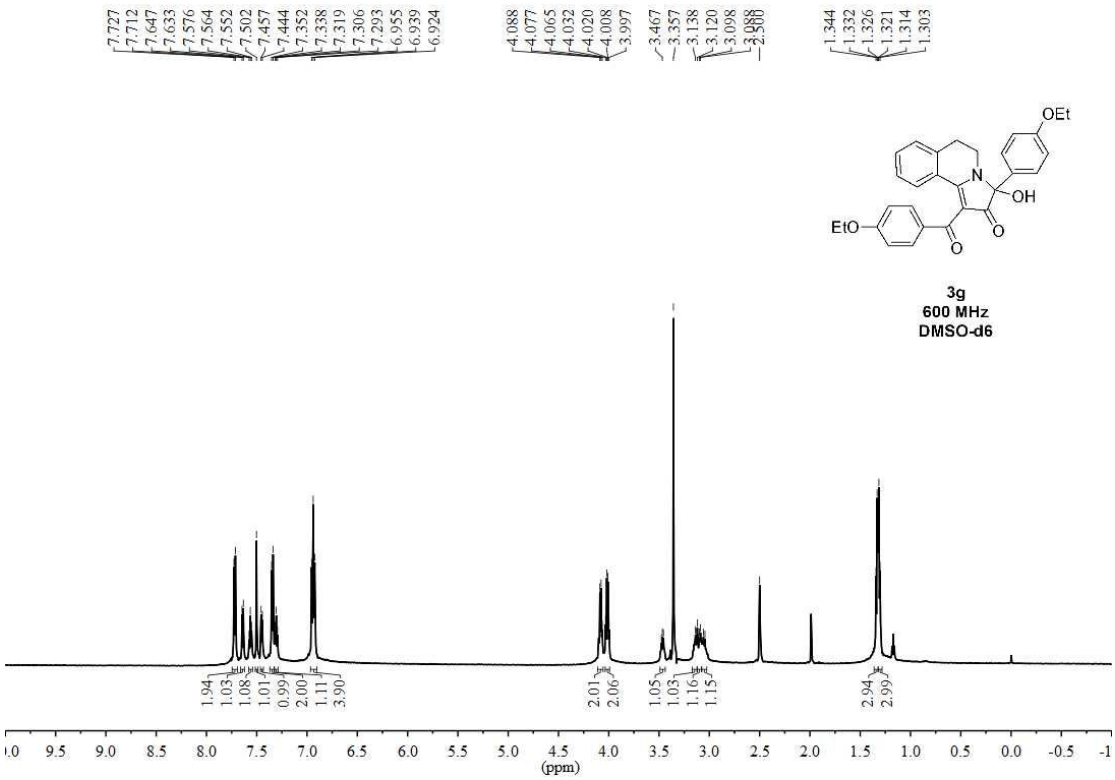
OMe
OH
MeO
MeO
3f
150 MHz
DMSO-d6



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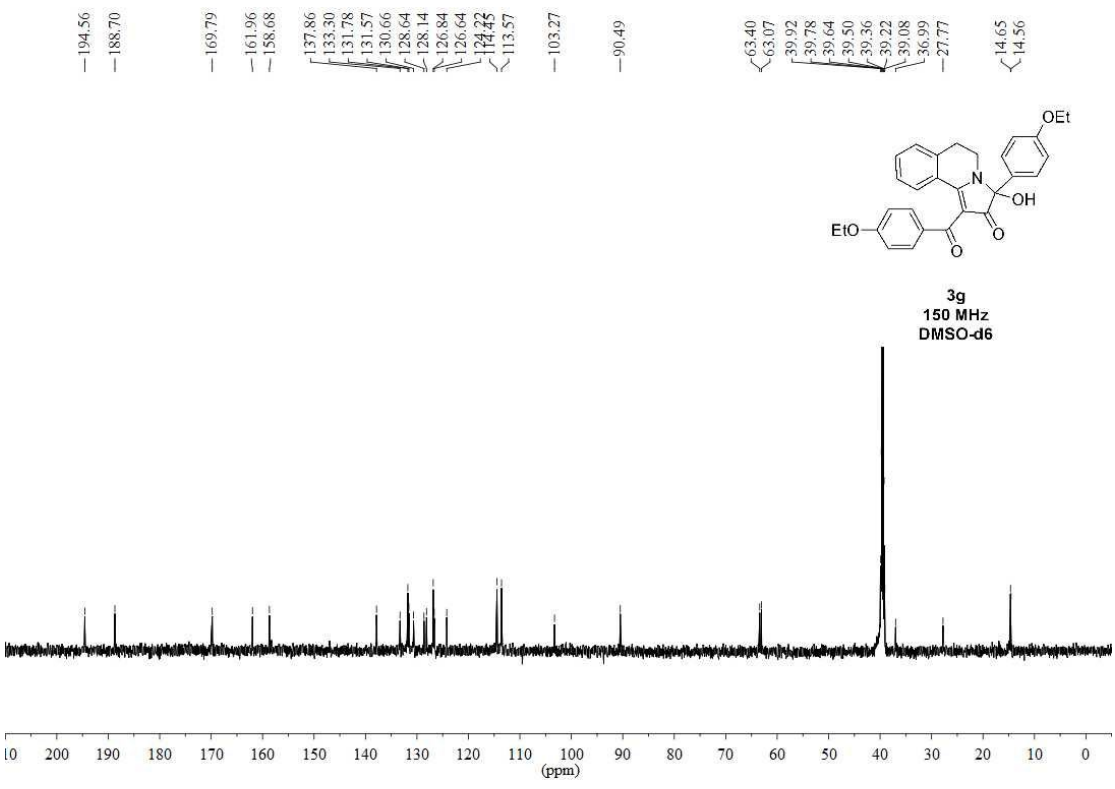

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150 MHz
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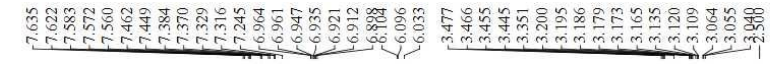

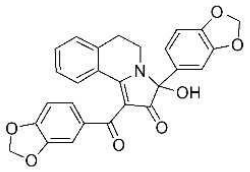

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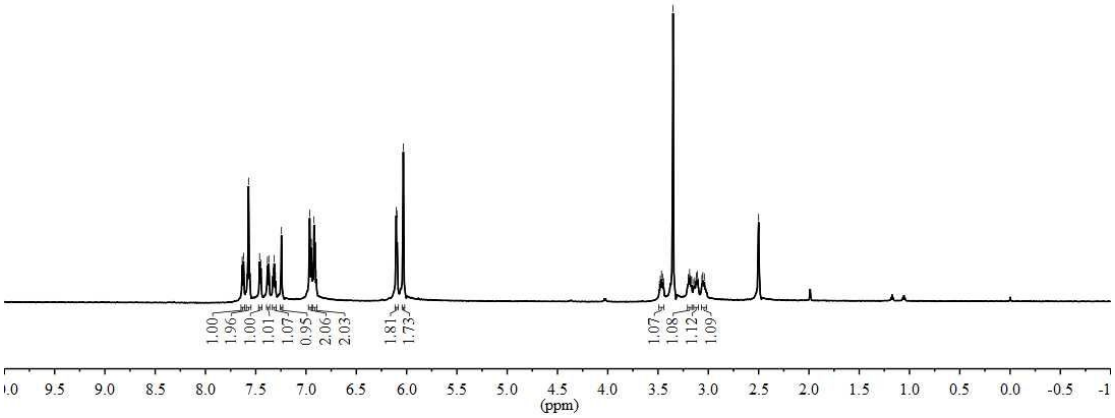
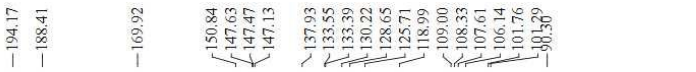
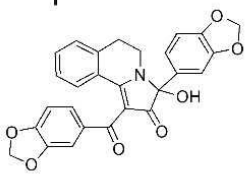
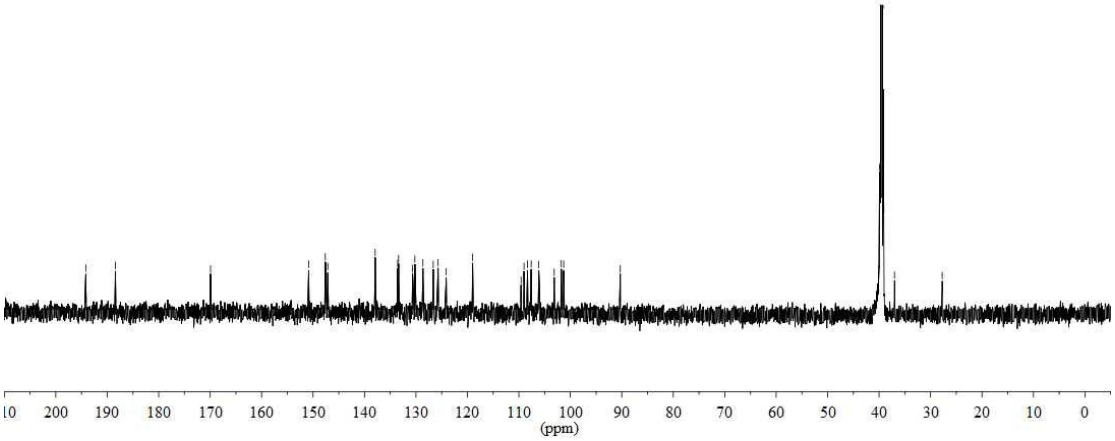
600 MHz
DMSO-d6

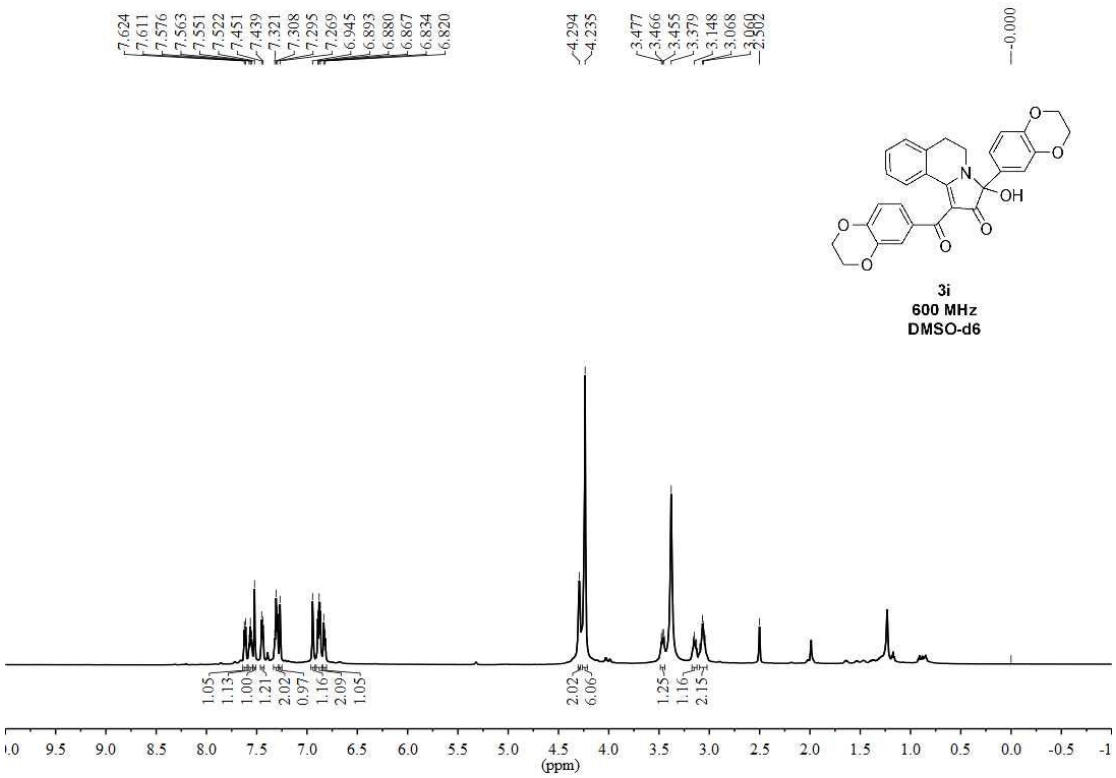






3h
150 MHz
DMSO-d6

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6.867
6.834
6.820
4.294
4.235
3.477
3.466
3.455
3.379
3.148
3.068
2.502
0.000
OH
O
N
3i
600 MHz
DMSO-d6
1.05
1.13
1.00
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1.16
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1.05
2.02
6.06
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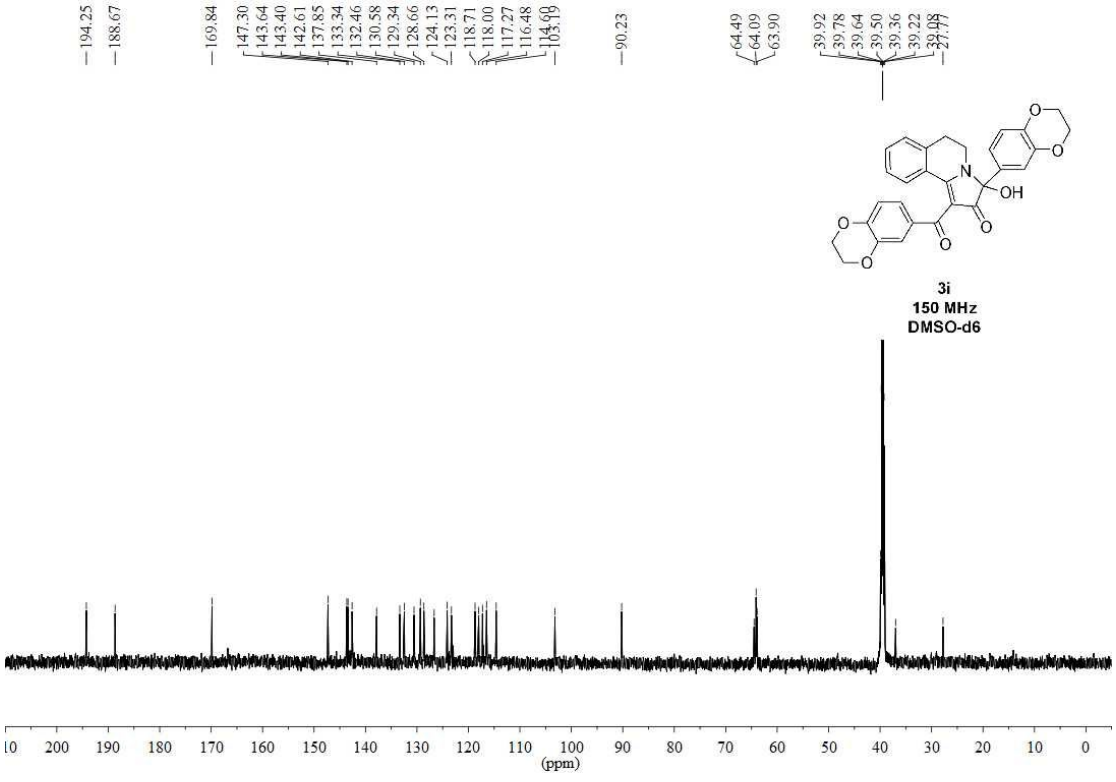
1.16
2.15
(ppm)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124.13
123.31
118.71
118.00
117.27
116.48
114.60
103.19
90.23
64.49
64.09
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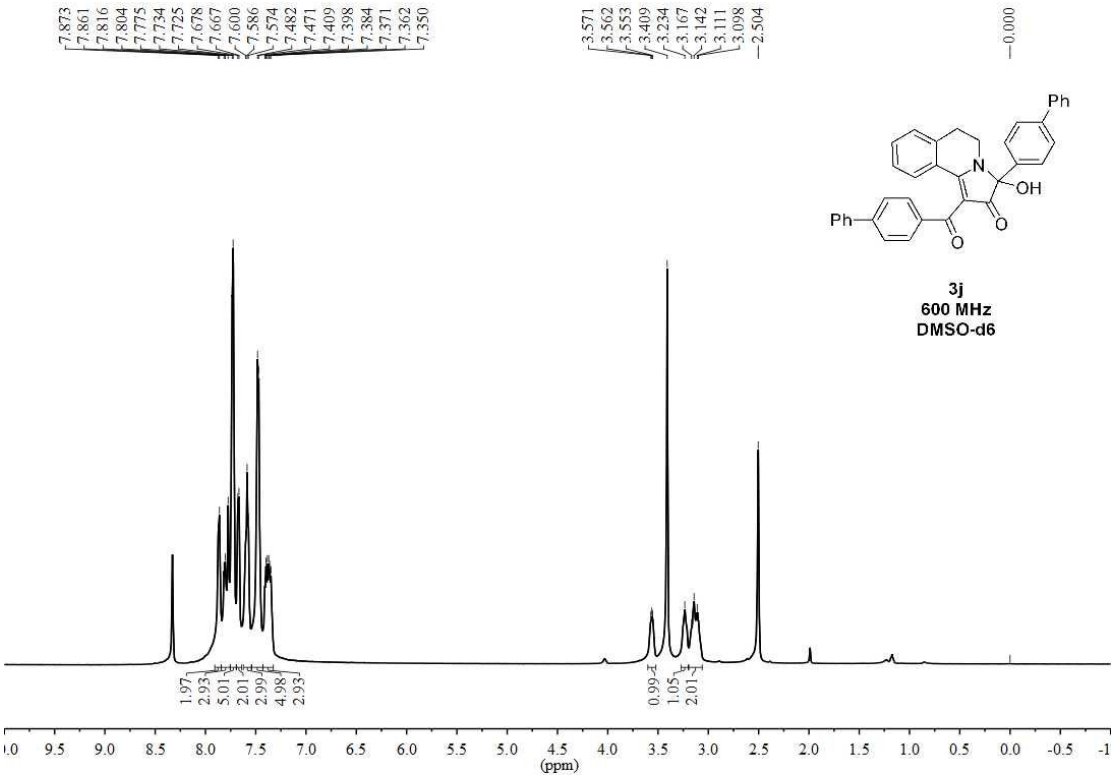
O
N
3i
150 MHz
DMSO-d6
(ppm)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7.362
7.350
3.571
3.562
3.553
3.409
3.234
3.167
3.142
3.111
3.098
2.504
0.000
Ph
N
OH
O
Ph
O
3j
600 MHz
DMSO-d6
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2.93
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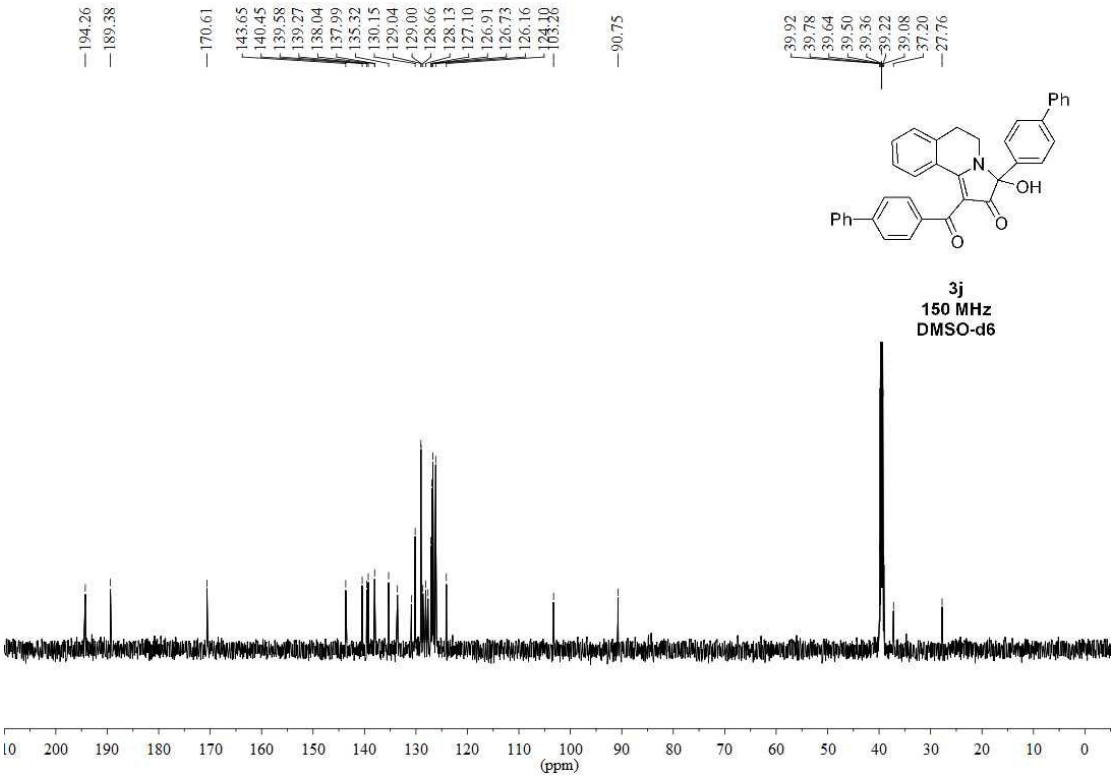
1.05
2.01
(ppm)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39.64
39.50
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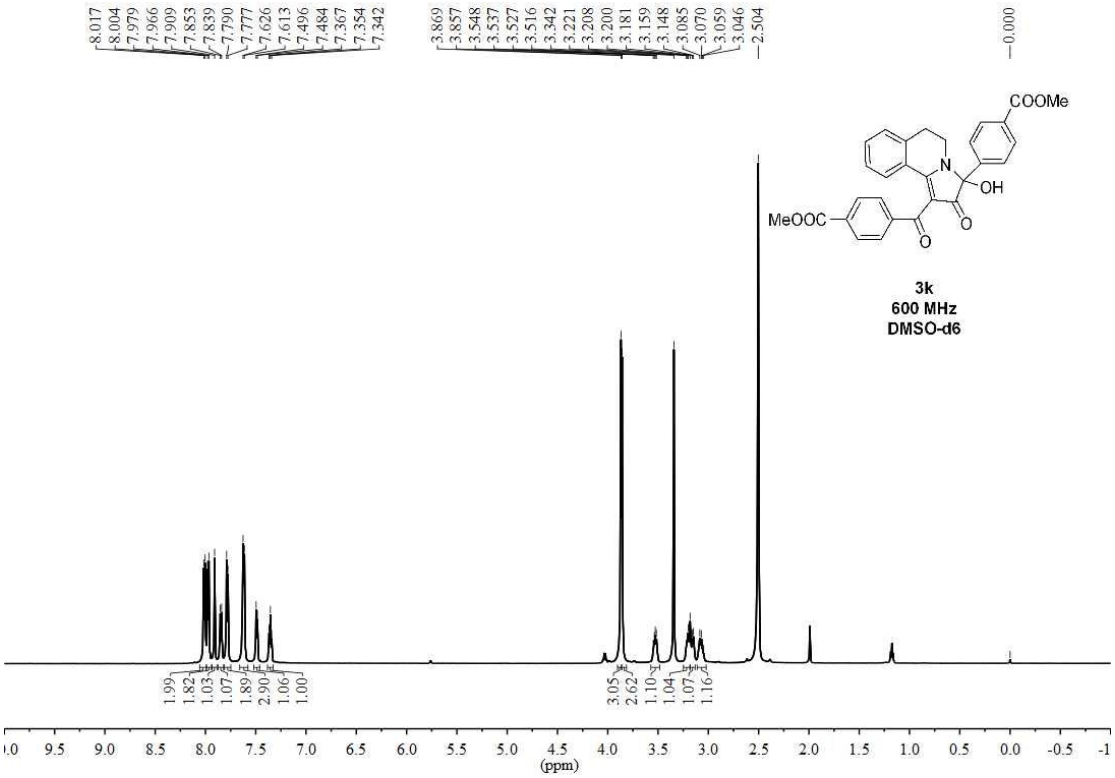
Ph
O
3j
150 MHz
DMSO-d6
(ppm)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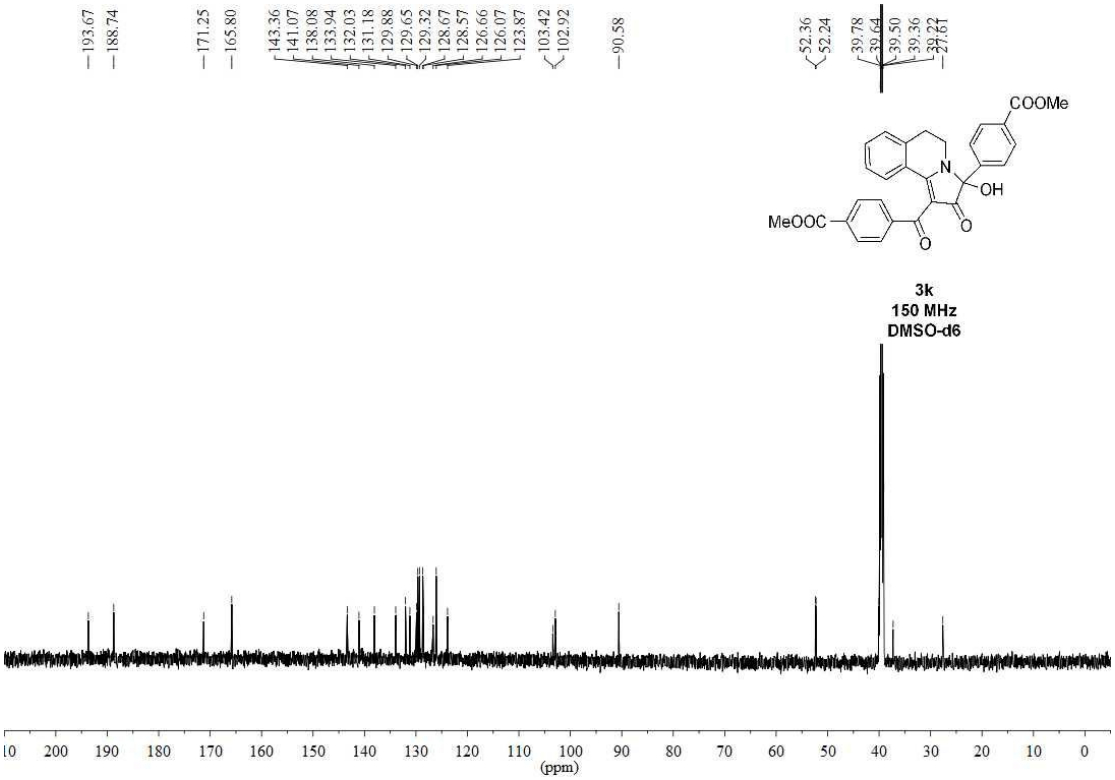
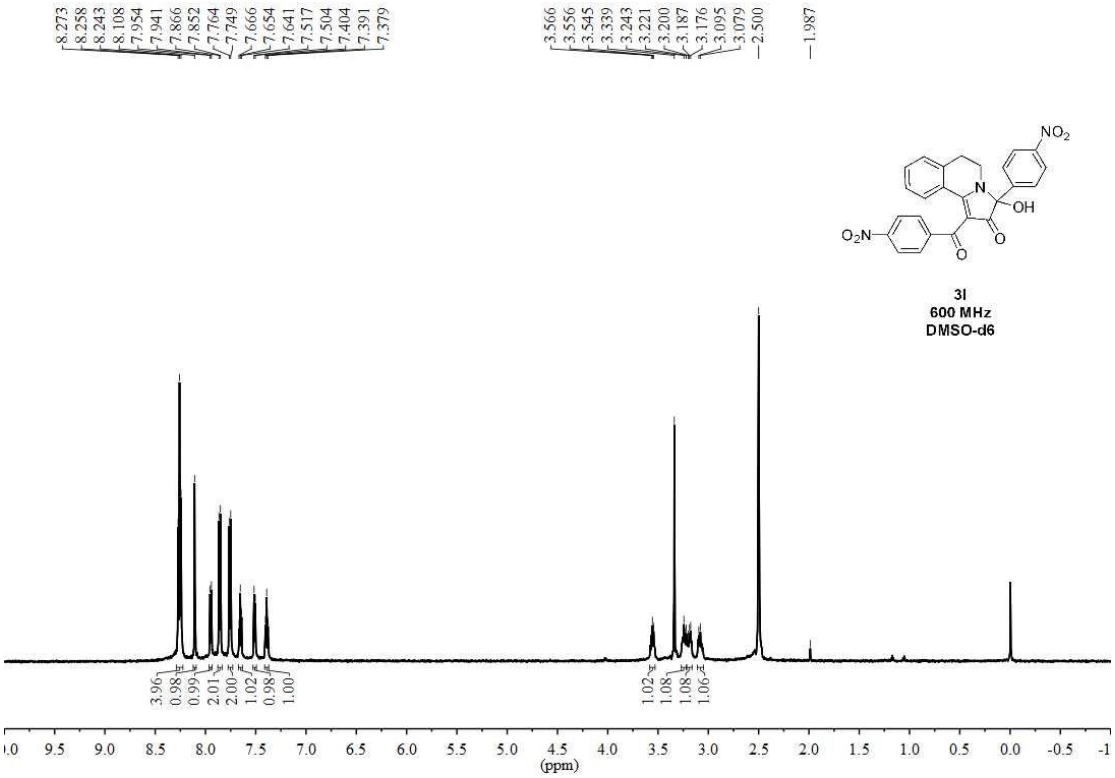
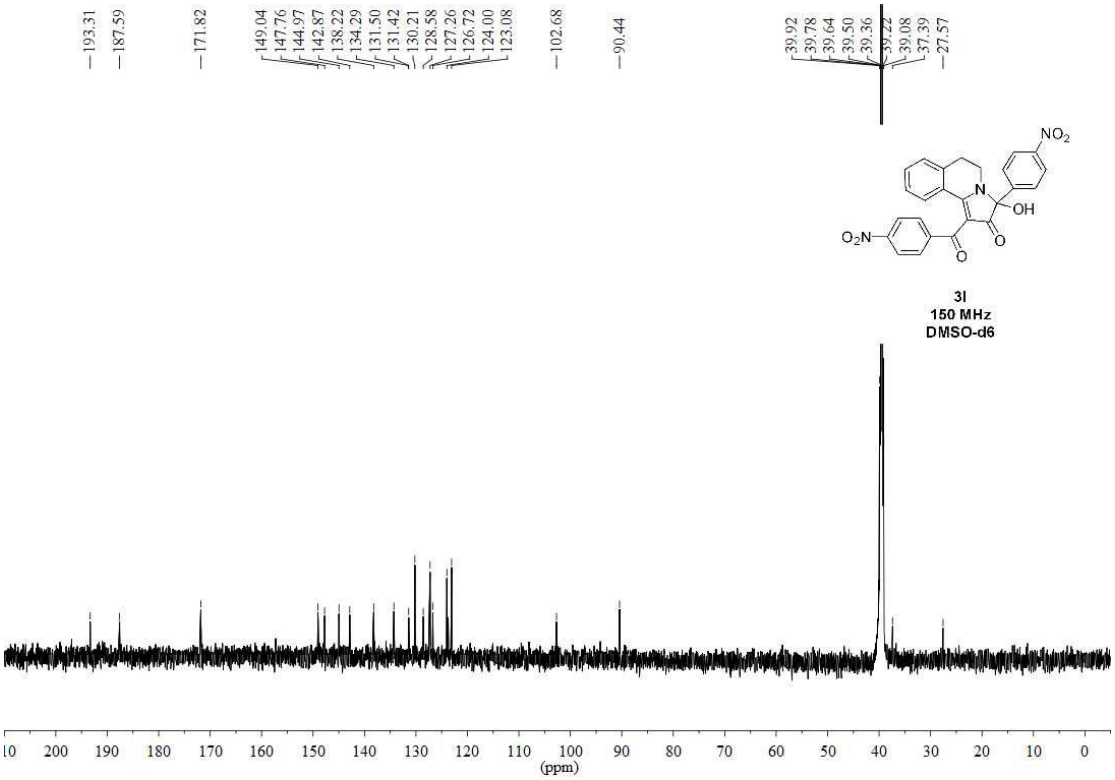
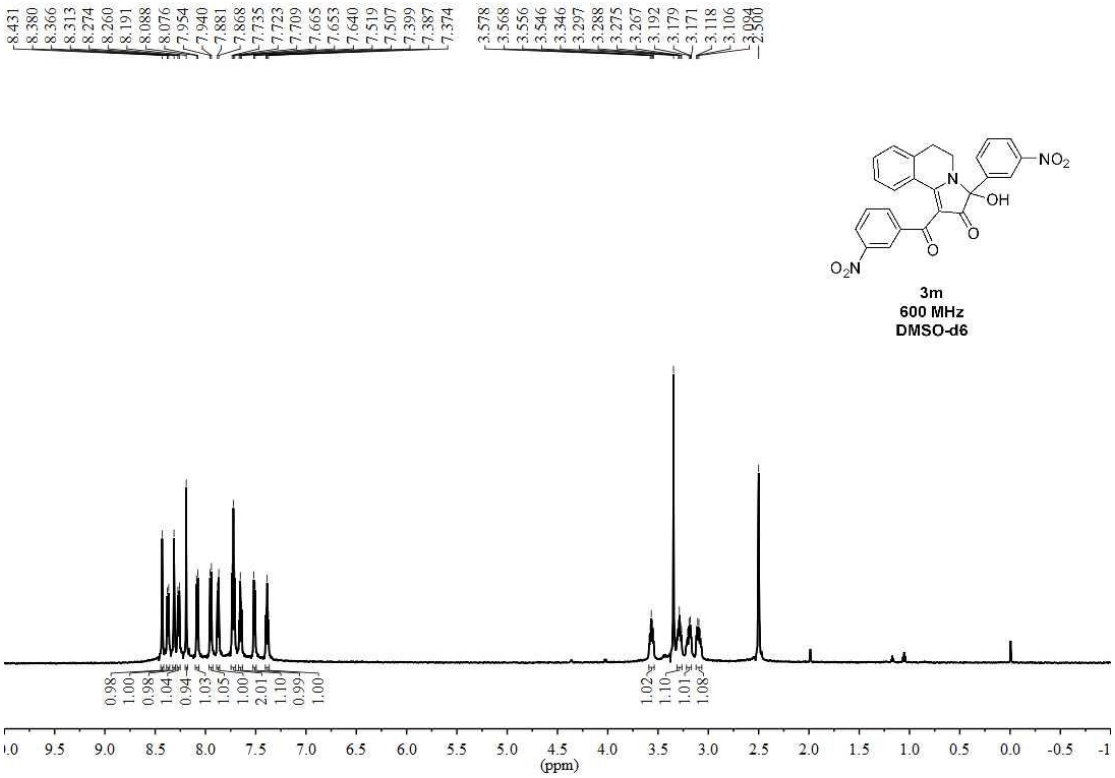
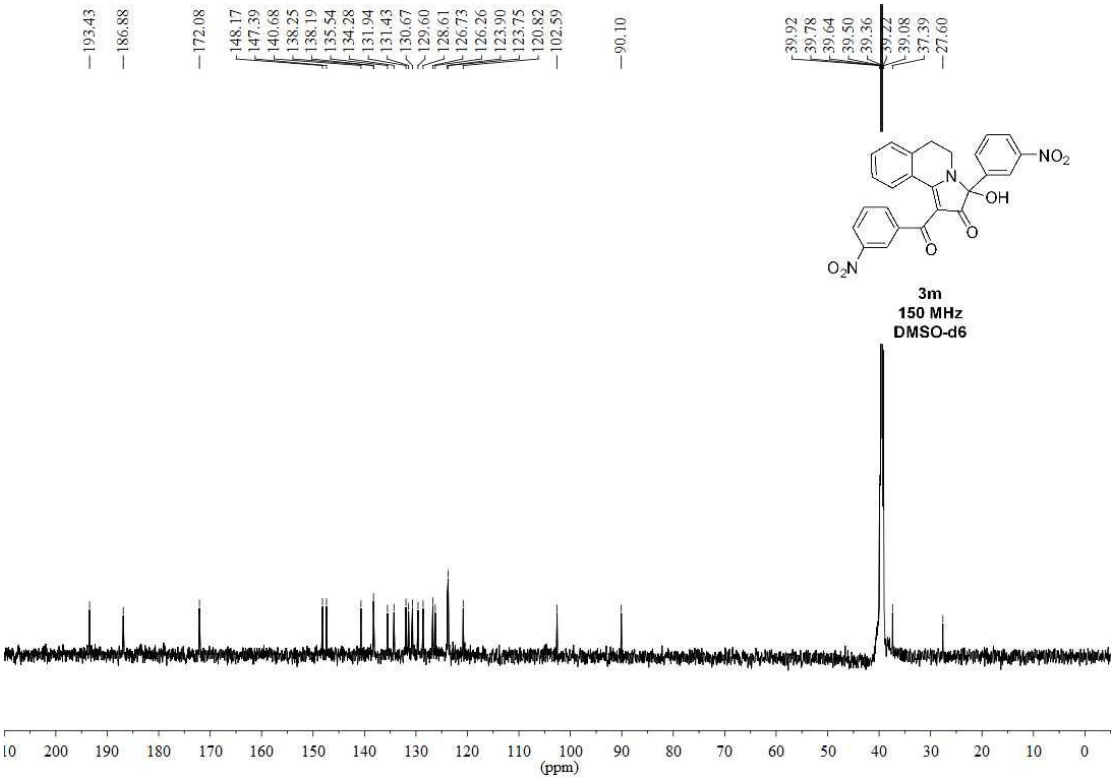
2.504
0.000
COOMe
N
OH
MeOOC
O
O
3k
600 MHz
DMSO-d6
1.99
1.82
1.03
1.07
1.89
2.90
1.06
1.00
3.05
2.62
1.10
1.04
1.07
1.16
(ppm)

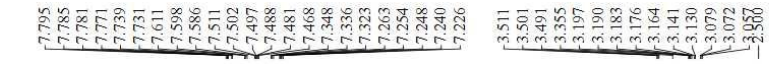

193.67
188.74
171.25
165.80
143.36
141.07
138.08
133.94
132.03
131.18
129.88
129.65
129.32
128.67
128.57
126.66
126.07
123.87
103.42
102.92
90.58
52.36
52.24
39.78
39.64
39.50
39.36
39.22
27.61
COOMe
N
OH
MeOOC
O
O
3k
150 MHz
DMSO-d6
(ppm)

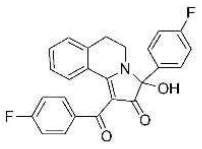

8.273
8.258
8.243
8.108
7.954
7.941
7.866
7.852
7.764
7.749
7.666
7.654
7.641
7.517
7.504
7.404
7.391
7.379
3.566
3.556
3.545
3.339
3.243
3.221
3.200
3.187
3.176
3.095
3.079
2.500
1.987
NO2
N
OH
O2N
O
O
3l
600 MHz
DMSO-d6
3.96
0.98
0.99
2.01
2.00
1.02
0.98
1.00
1.02
1.08
1.08
1.06
(ppm)


193.31
187.59
171.82
149.04
147.76
144.97
142.87
138.22
134.29
131.50
131.42
130.21
128.58
127.26
126.72
124.00
123.08
102.68
90.44
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.39
27.57
NO2
N
OH
O2N
O
O
3l
150 MHz
DMSO-d6
(ppm)

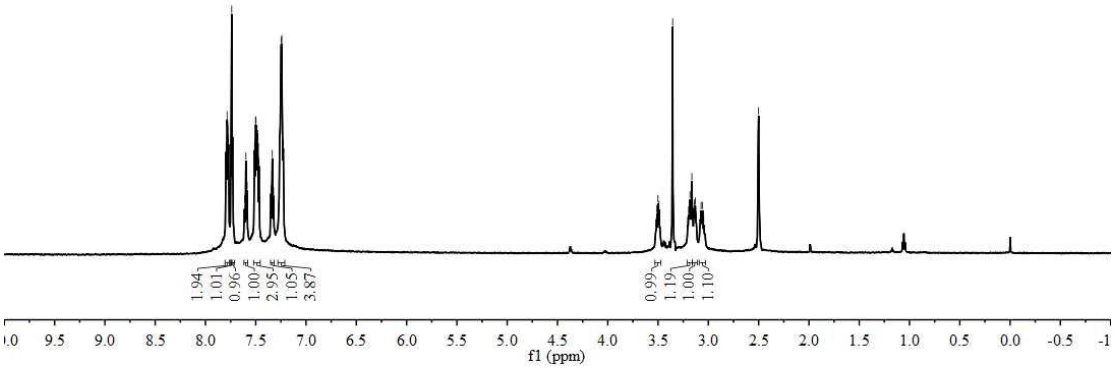

8.431
8.380
8.366
8.313
8.274
8.260
8.191
8.088
8.076
7.954
7.940
7.881
7.868
7.735
7.723
7.709
7.665
7.653
7.640
7.519
7.507
7.399
7.387
7.374
3.578
3.568
3.556
3.546
3.346
3.297
3.288
3.275
3.267
3.192
3.179
3.171
3.118
3.106
3.004
2.500
NO2
N
OH
O
O
O2N
3m
600 MHz
DMSO-d6
0.98
1.00
0.98
1.04
0.94
1.03
1.05
1.00
2.01
1.10
0.99
1.00
1.02
1.10
1.01
1.08
(ppm)

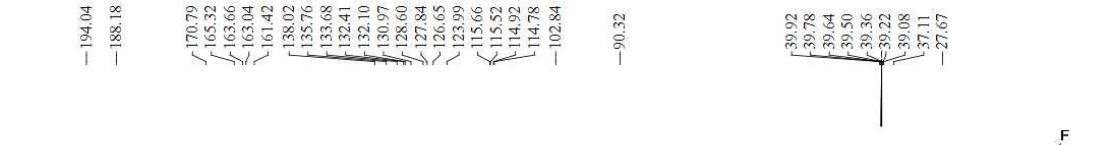

193.43
186.88
172.08
148.17
147.39
140.68
138.25
138.19
135.54
134.28
131.94
131.43
130.67
129.60
128.61
126.73
126.26
123.90
123.75
120.82
102.59
90.10
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.39
27.60
NO2
N
OH
O
O
O2N
3m
150 MHz
DMSO-d6
(ppm)

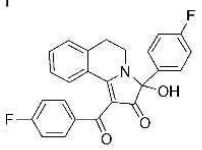




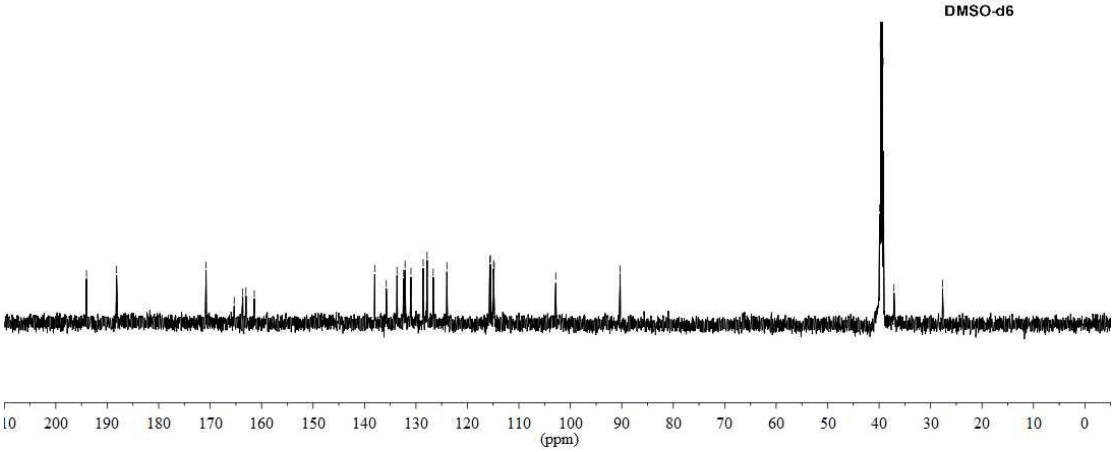
3n
600 MHz
DMSO-d6

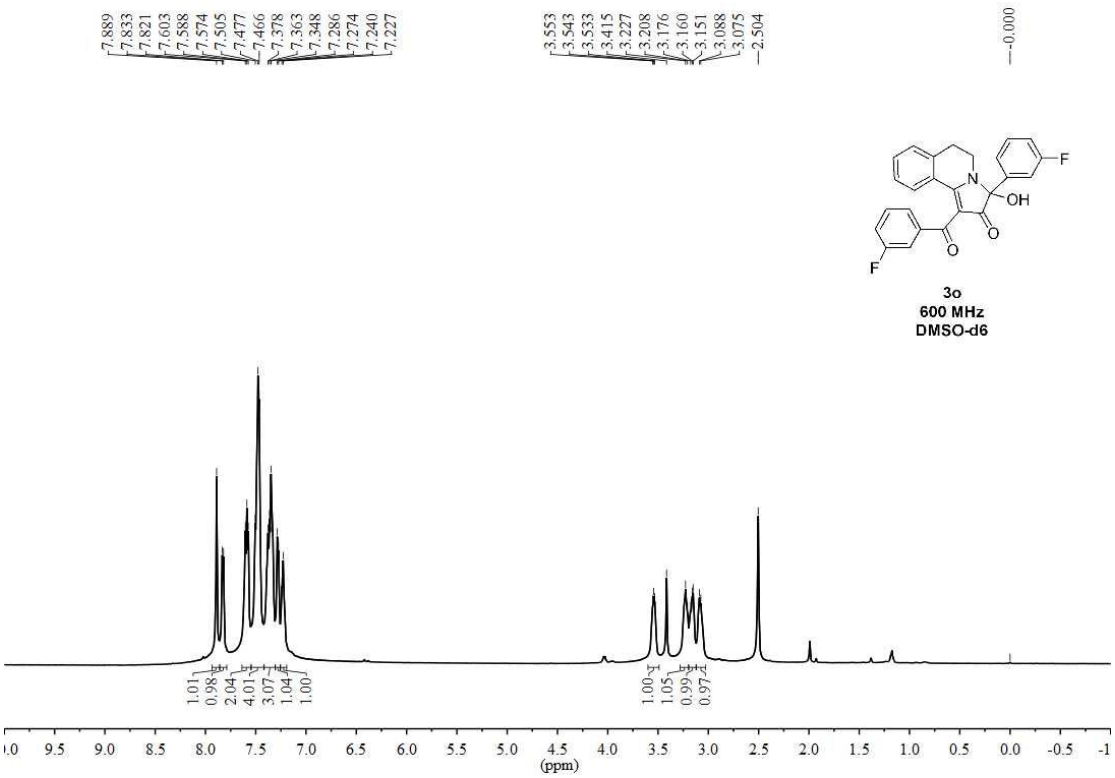


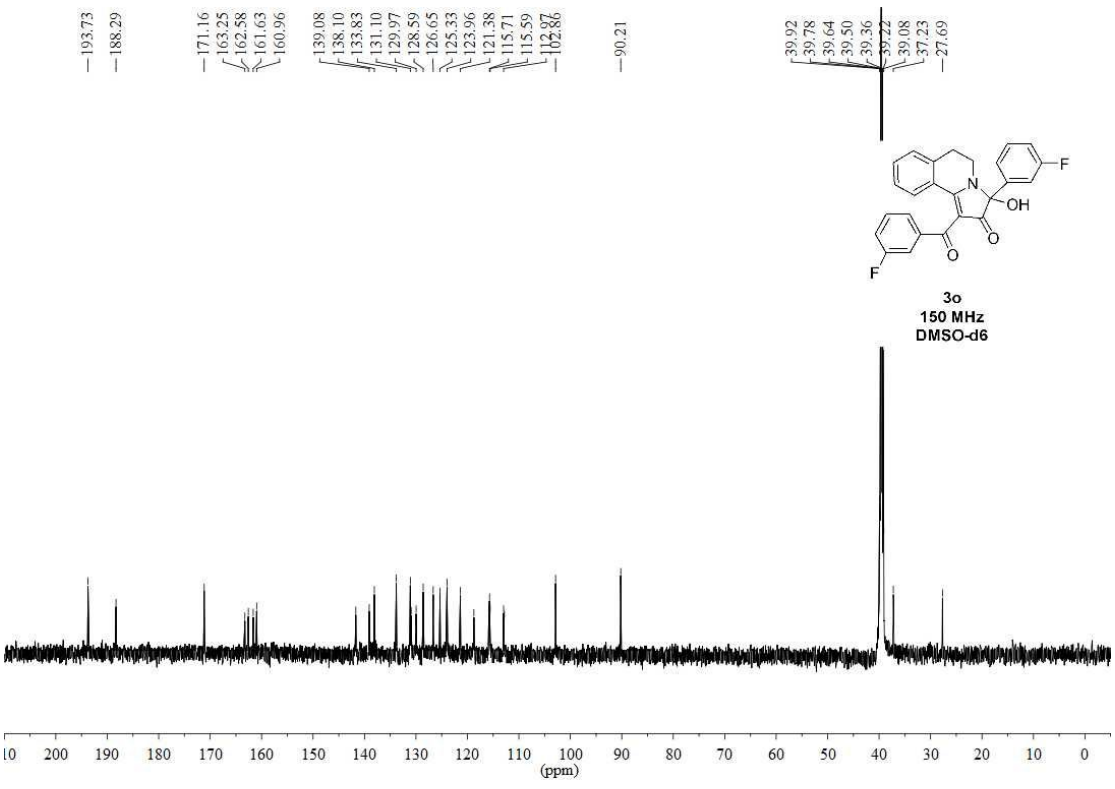


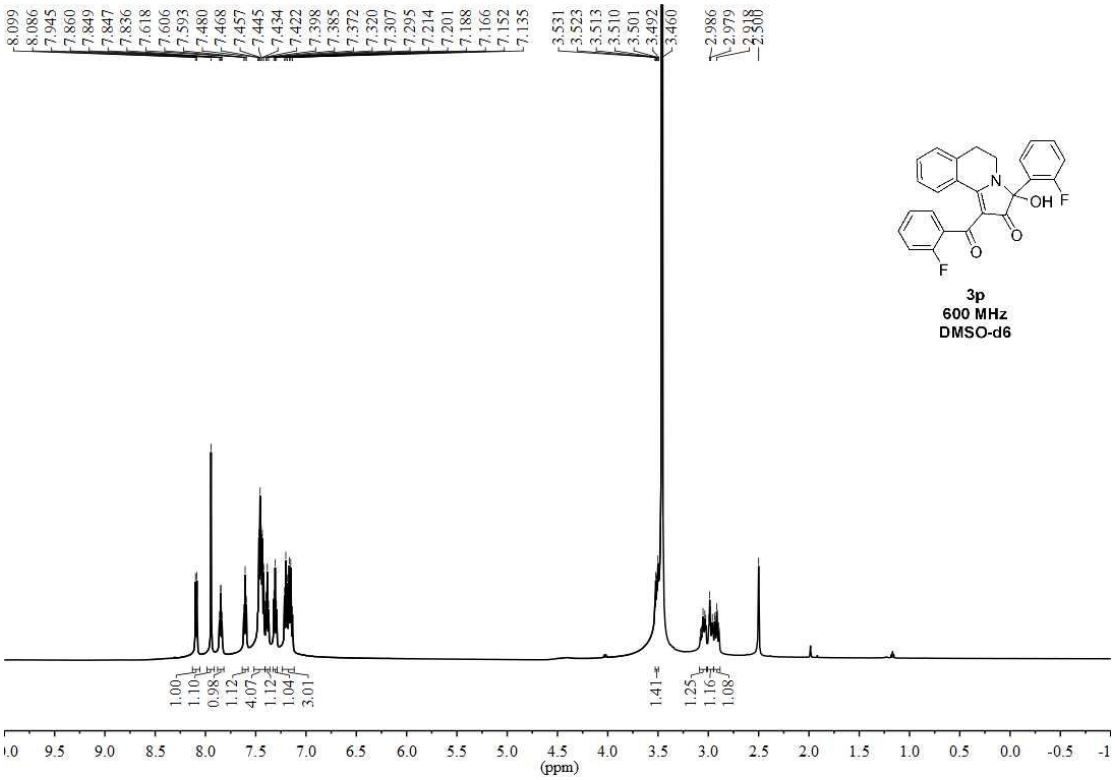


3n
150 MHz
DMSO-d6

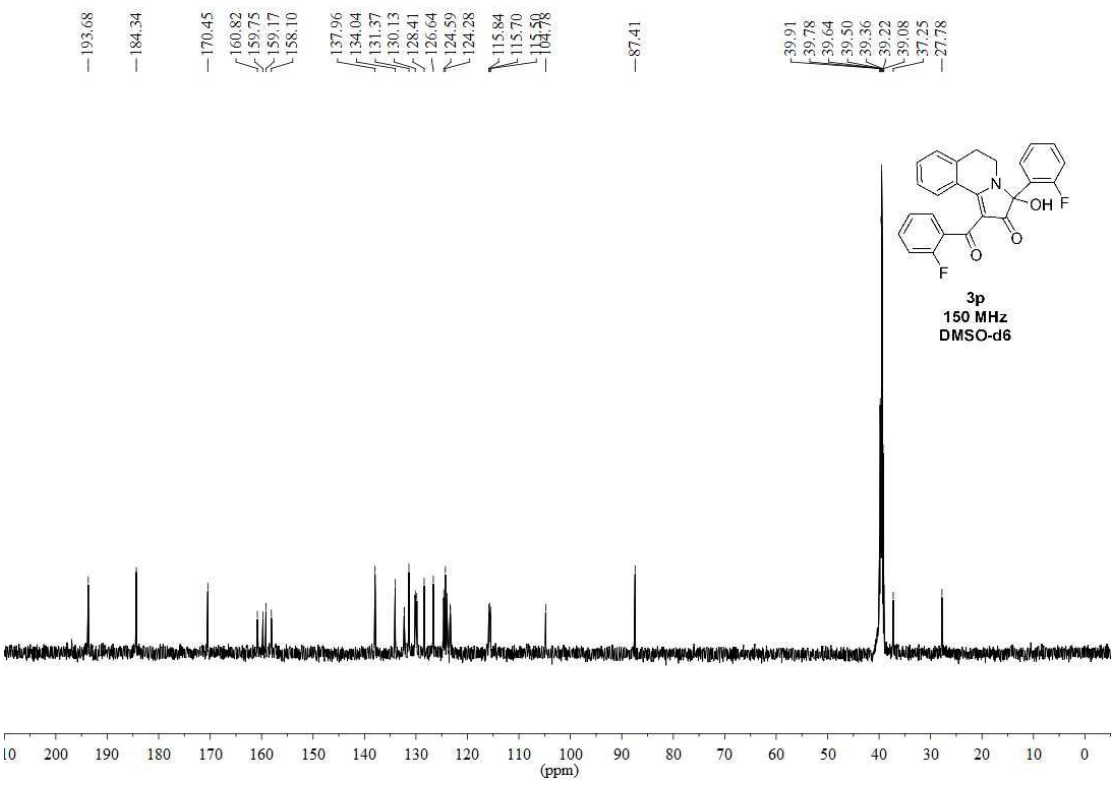



7.889
7.833
7.821
7.603
7.588
7.574
7.505
7.477
7.466
7.378
7.363
7.348
7.286
7.274
7.240
7.227
3.553
3.543
3.533
3.415
3.227
3.208
3.176
3.160
3.151
3.088
3.075
2.504
0.000
F
N
OH
O
O
F
3o
600 MHz
DMSO-d6
1.01
0.98
2.04
4.01
3.07
1.04
1.00
1.00
1.05
0.99
0.97
(ppm)

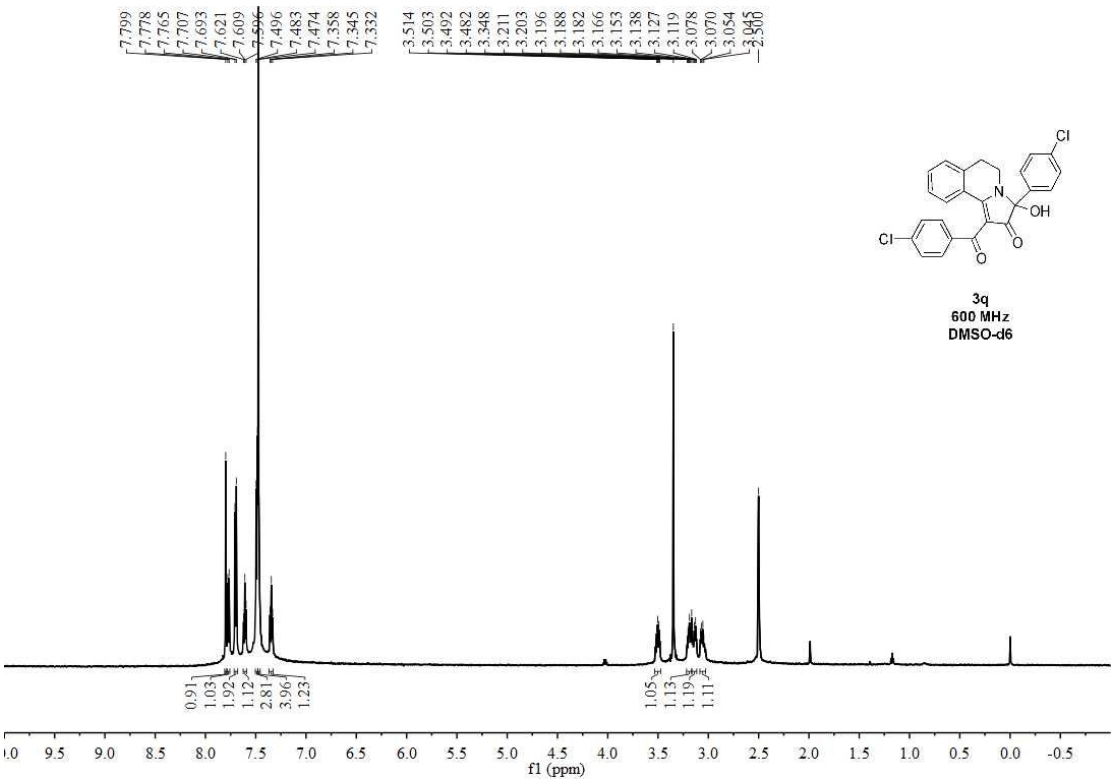

193.73
188.29
171.16
163.25
162.58
161.63
160.96
139.08
138.10
133.83
131.10
129.97
128.59
126.65
125.33
123.96
121.38
115.71
115.59
112.97
112.86
90.21
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.23
27.69
F
N
OH
O
O
F
3o
150 MHz
DMSO-d6
(ppm)

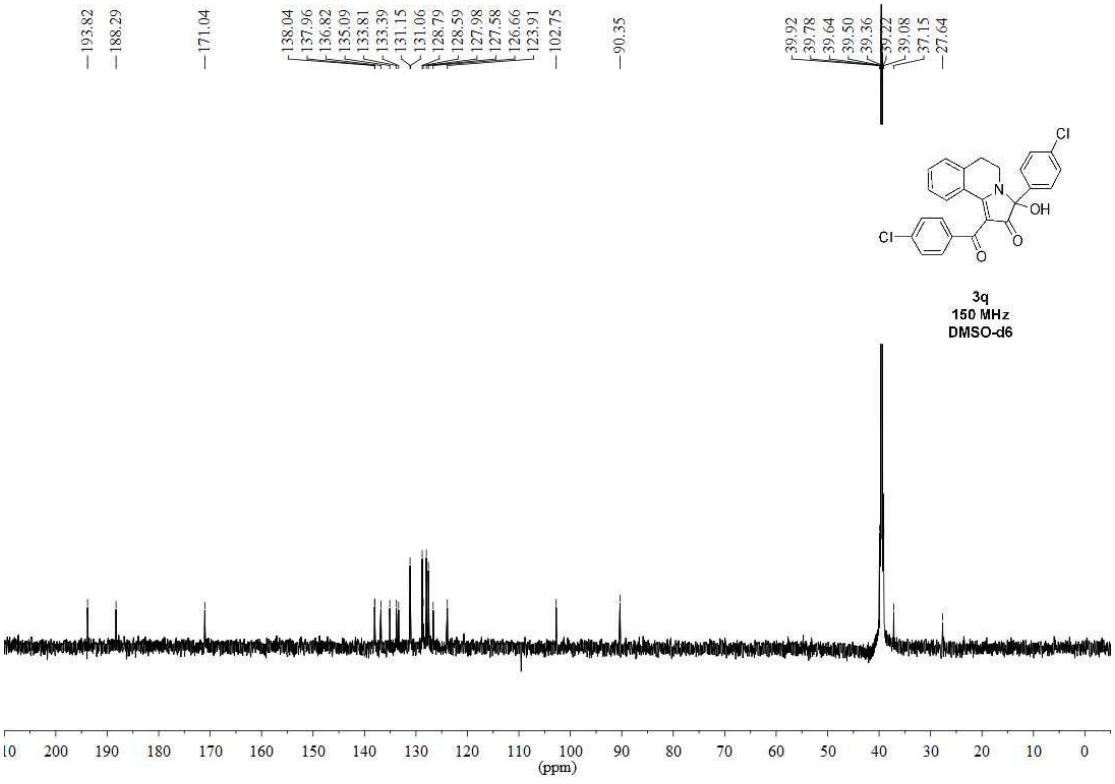


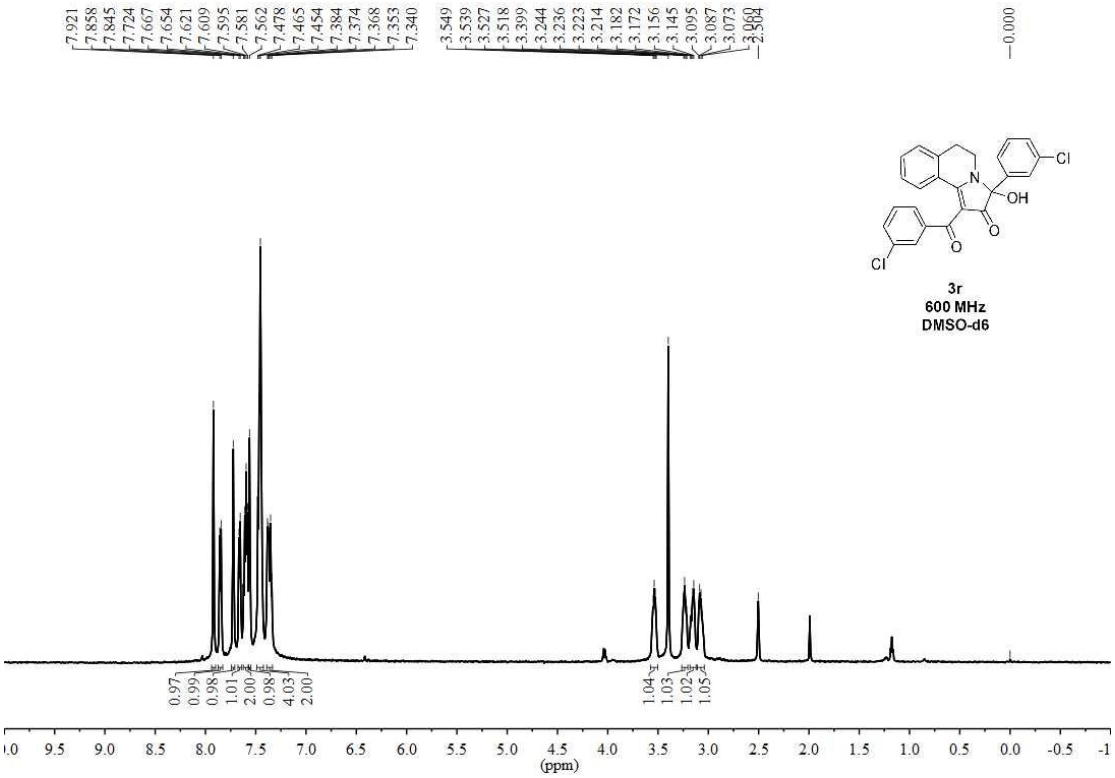
3p
600 MHz
DMSO-d6

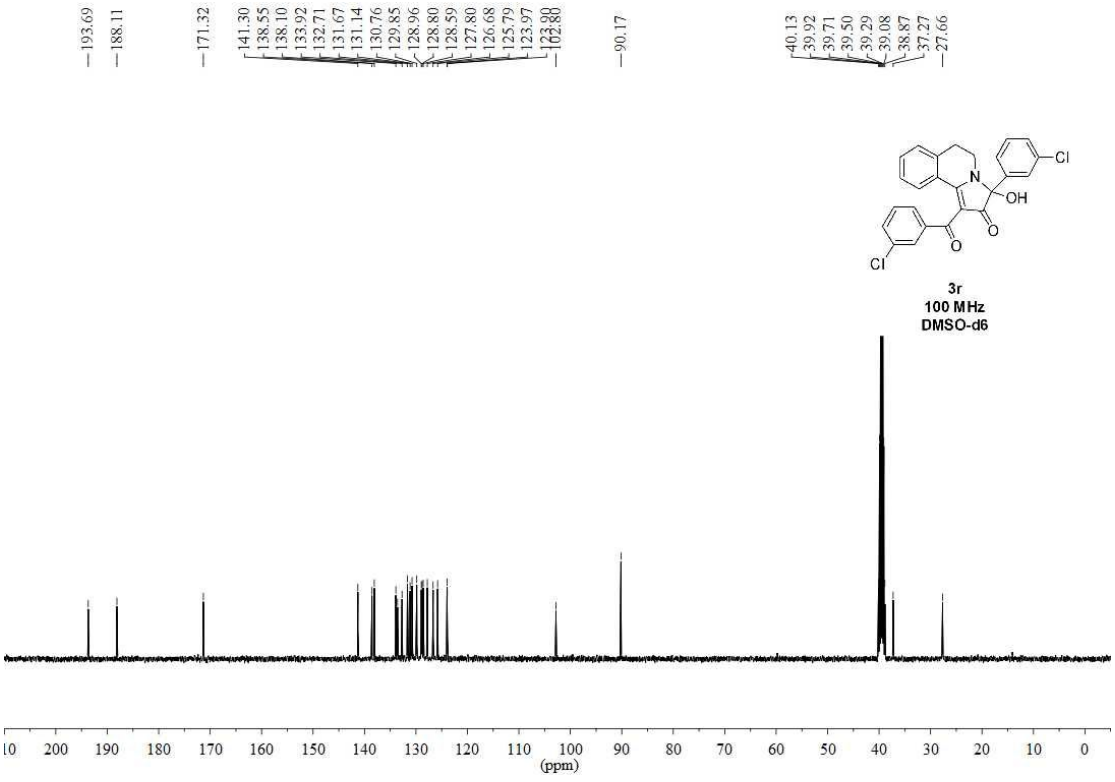


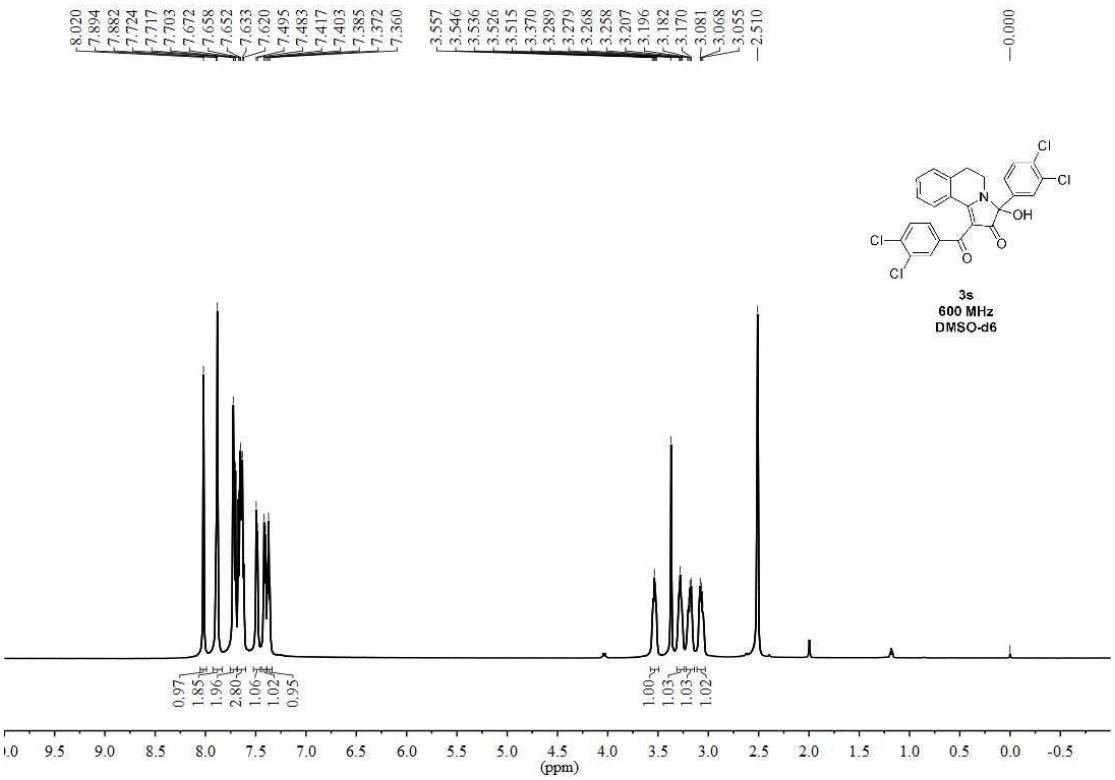
3p
150 MHz
DMSO-d6

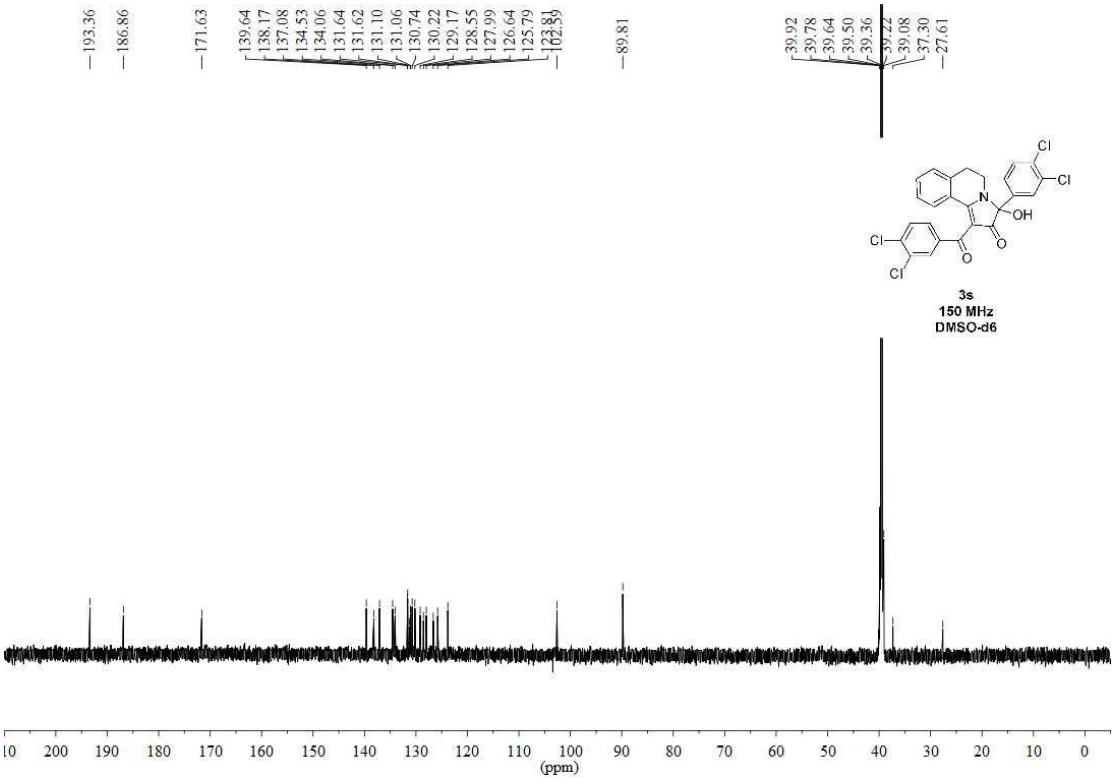

7.799
7.778
7.765
7.707
7.693
7.621
7.609
7.596
7.496
7.483
7.474
7.358
7.345
7.332
3.514
3.503
3.492
3.482
3.348
3.211
3.203
3.196
3.188
3.182
3.166
3.153
3.138
3.127
3.119
3.078
3.070
3.054
2.500
0.91
1.03
1.92
1.12
2.81
3.96
1.23
1.05
1.13
1.19
1.11
f1 (ppm)
Cl
N
OH
O
Cl
O
3q
600 MHz
DMSO-d6

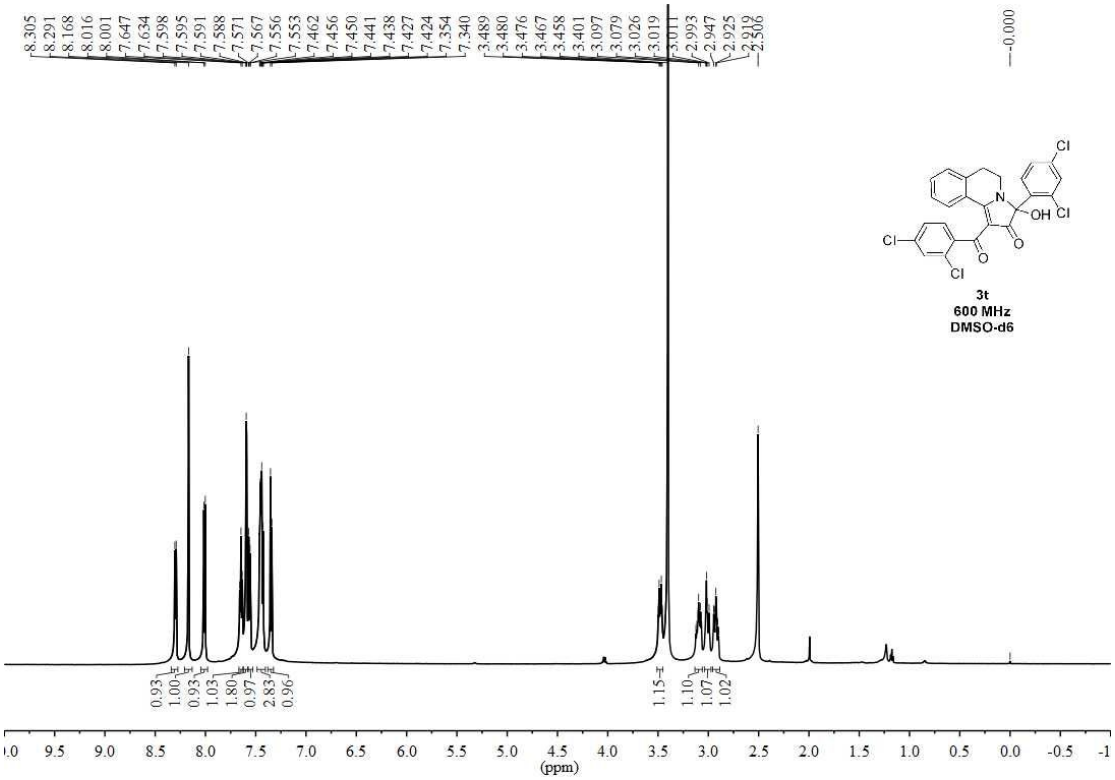

193.82
188.29
171.04
138.04
137.96
136.82
135.09
133.81
133.39
131.15
131.06
128.79
128.59
127.98
127.58
126.66
123.91
102.75
90.35
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.15
27.64
(ppm)
Cl
N
OH
O
Cl
O
3q
150 MHz
DMSO-d6

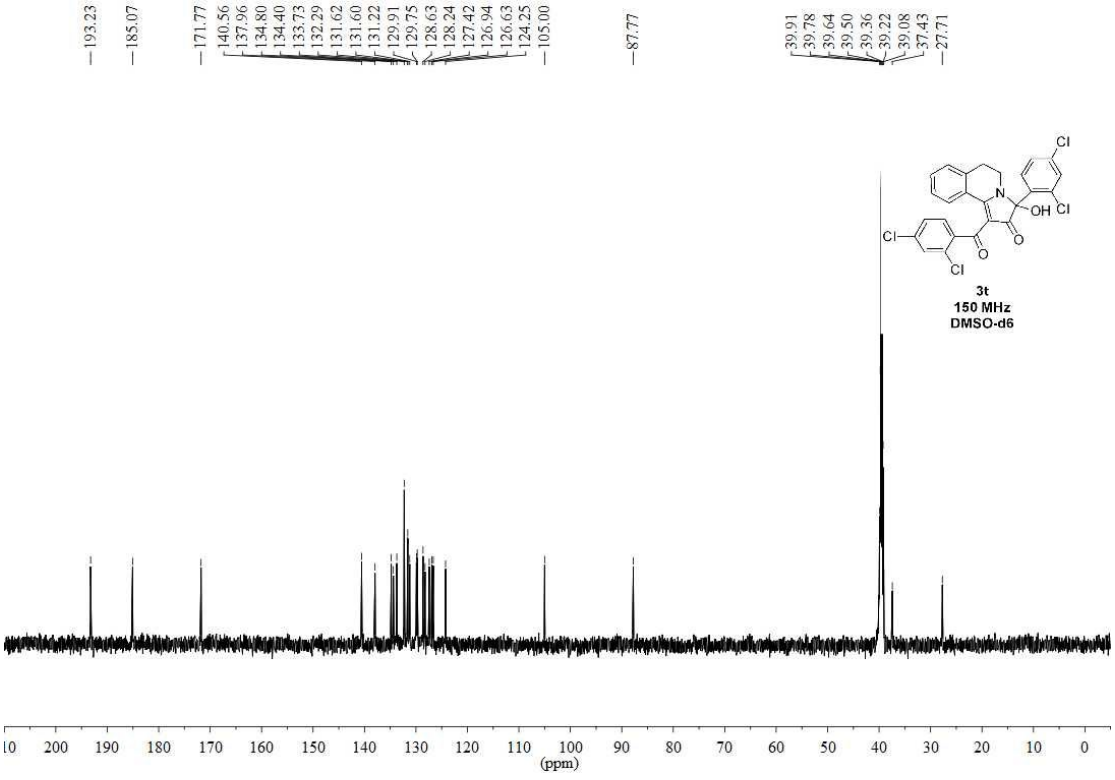

7.921
7.858
7.845
7.724
7.667
7.654
7.621
7.609
7.595
7.581
7.562
7.478
7.465
7.454
7.384
7.374
7.368
7.353
7.340
3.549
3.539
3.527
3.518
3.399
3.244
3.236
3.223
3.214
3.182
3.172
3.156
3.145
3.095
3.087
3.073
2.504
0.000
Cl
N
OH
O
O
Cl
3r
600 MHz
DMSO-d6
0.97
0.99
0.98
1.01
2.00
0.98
4.03
2.00
1.04
1.03
1.02
1.05
(ppm)

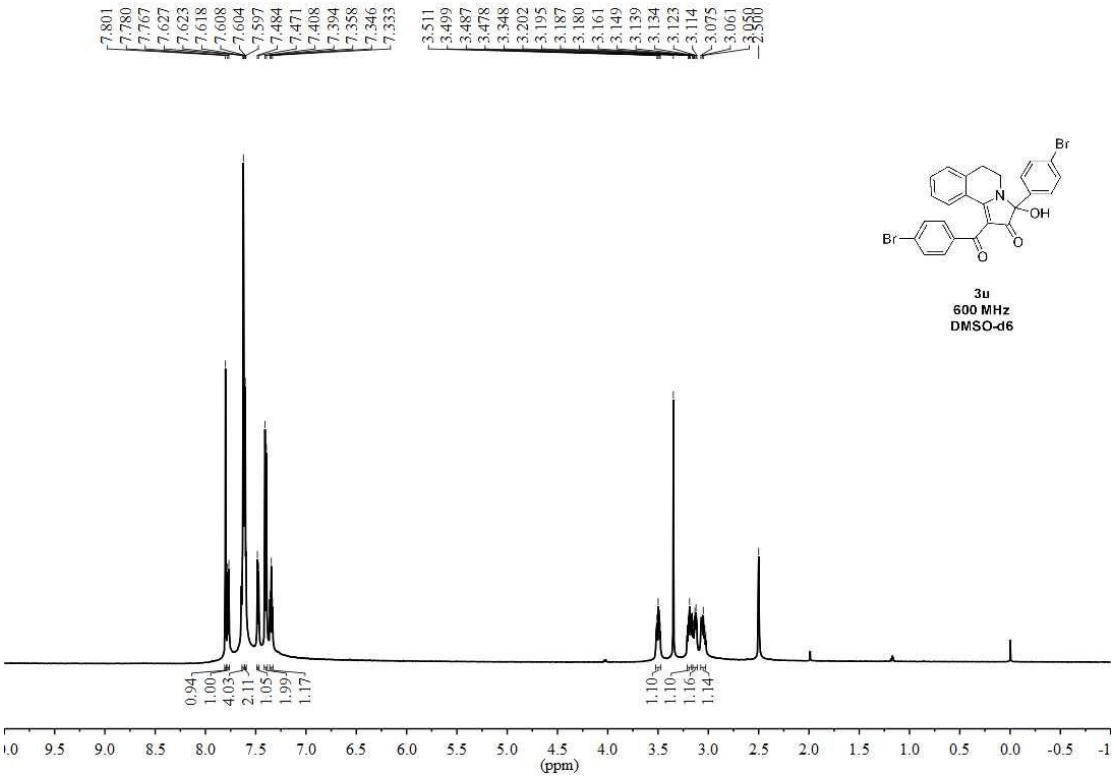

193.69
188.11
171.32
141.30
138.55
138.10
133.92
132.71
131.67
131.14
130.76
129.85
128.96
128.80
128.59
127.80
126.68
125.79
123.97
123.90
122.80
90.17
40.13
39.92
39.71
39.50
39.29
39.08
38.87
37.27
27.66
Cl
N
OH
O
O
Cl
3r
100 MHz
DMSO-d6
(ppm)

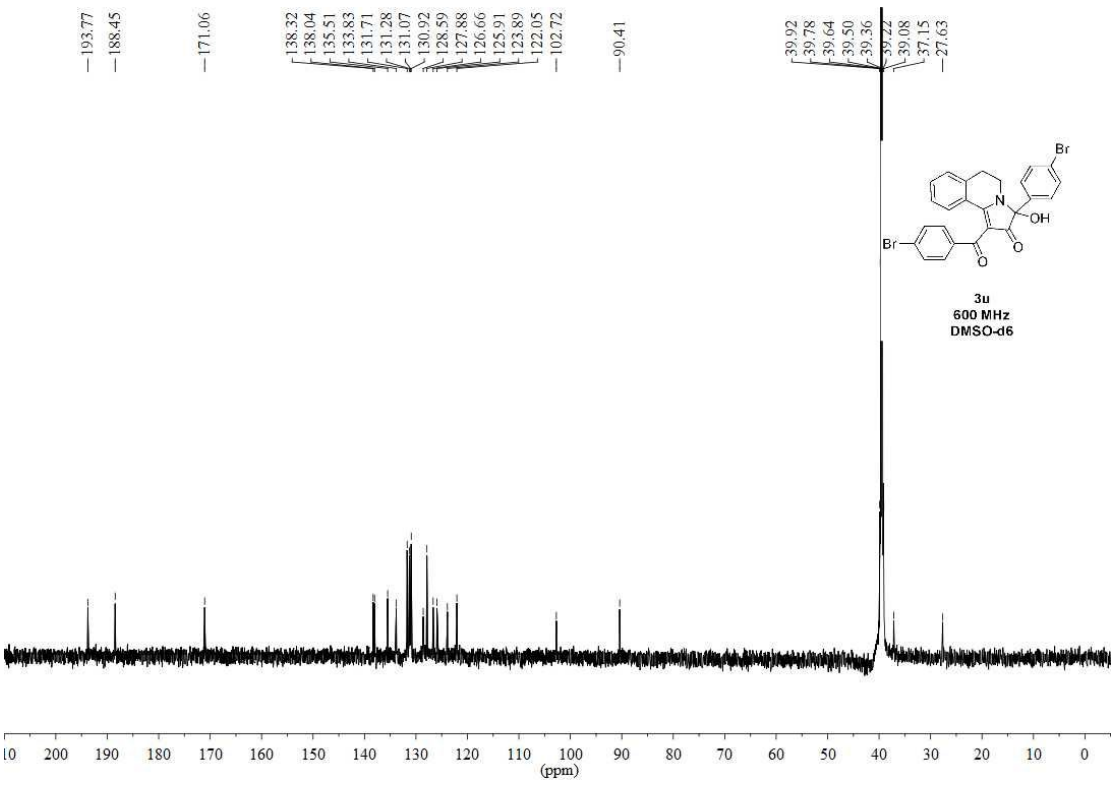

8.020
7.894
7.882
7.724
7.717
7.703
7.672
7.658
7.652
7.633
7.620
7.495
7.483
7.417
7.403
7.385
7.372
7.360
3.557
3.546
3.536
3.526
3.515
3.370
3.289
3.279
3.268
3.258
3.207
3.196
3.182
3.170
3.081
3.068
3.055
2.510
0.000
Cl
Cl
N
OH
O
Cl
Cl
O
3s
600 MHz
DMSO-d6
0.97
1.85
1.96
2.80
1.06
1.02
0.95
1.00
1.03
1.03
1.02
(ppm)

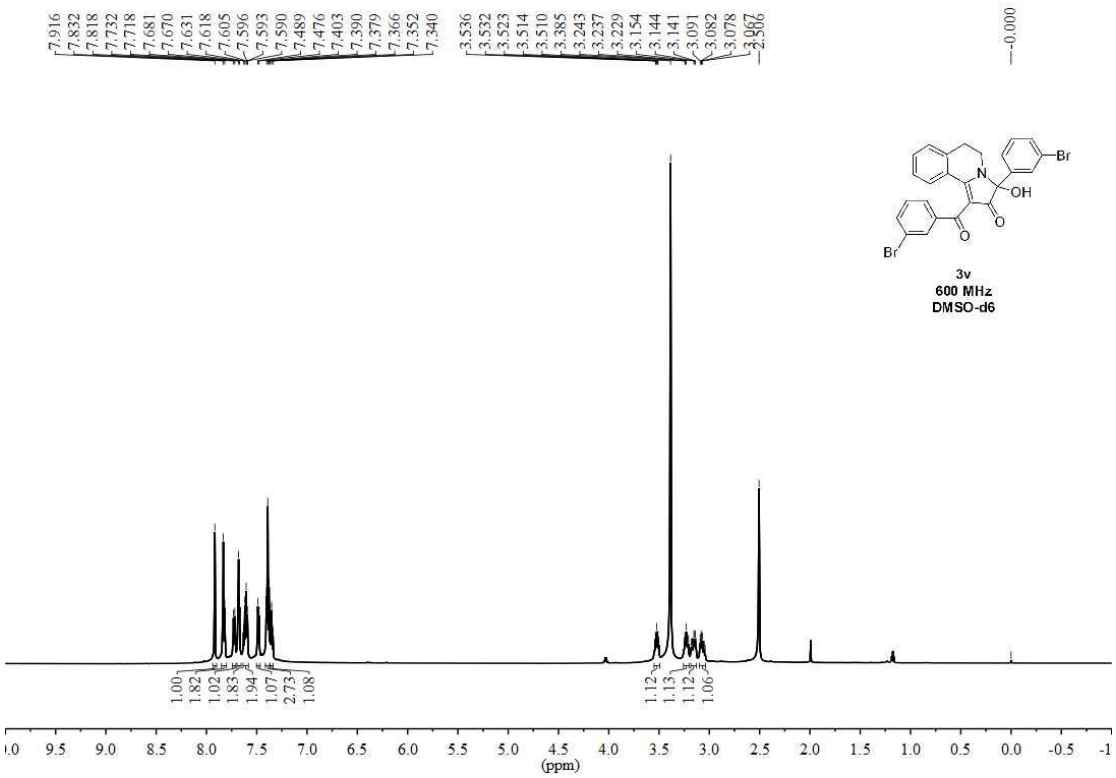

193.36
186.86
171.63
139.64
138.17
137.08
134.53
134.06
131.64
131.62
131.10
131.06
130.74
130.22
129.17
128.55
127.99
126.64
125.79
123.81
102.39
89.81
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.30
27.61
Cl
Cl
N
OH
O
Cl
Cl
O
3s
150 MHz
DMSO-d6
(ppm)

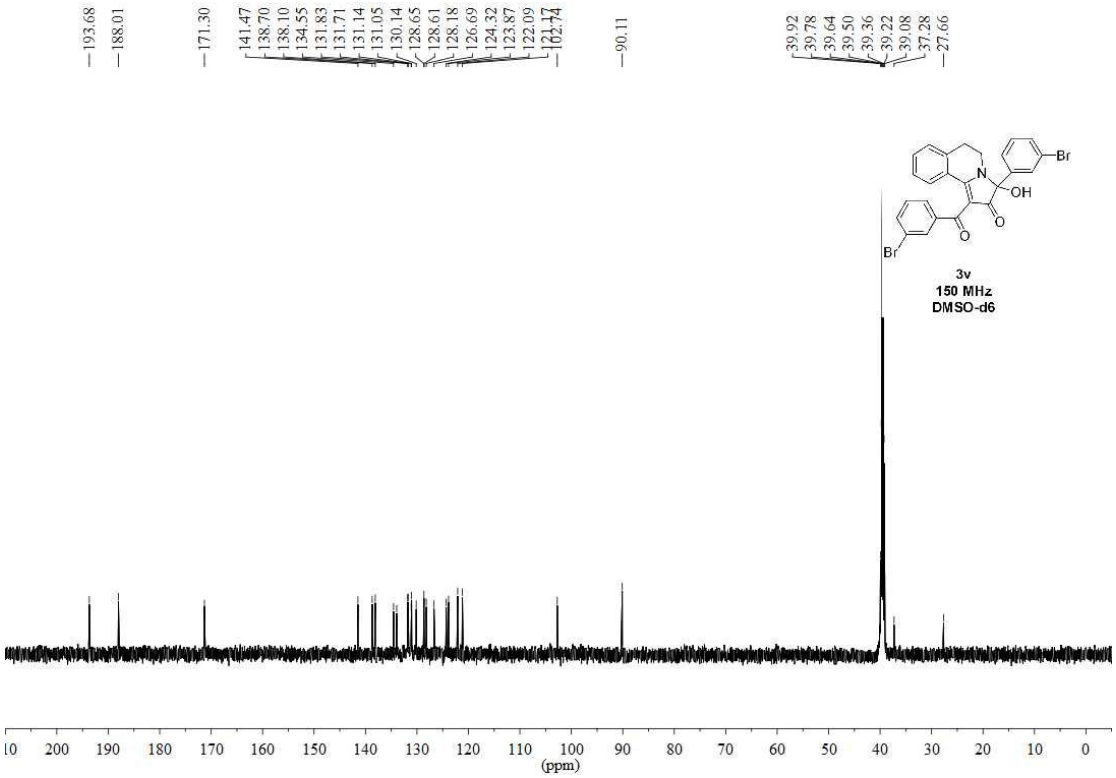

8.305
8.291
8.168
8.016
8.001
7.647
7.634
7.598
7.595
7.591
7.588
7.571
7.567
7.556
7.553
7.462
7.456
7.450
7.441
7.438
7.427
7.424
7.354
7.340
3.489
3.480
3.476
3.467
3.458
3.401
3.097
3.079
3.026
3.019
3.011
2.993
2.947
2.925
2.519
2.506
0.000
0.93
1.00
0.93
1.03
1.80
0.97
2.83
0.96
1.15
1.10
1.07
1.02
(ppm)
3t
600 MHz
DMSO-d6

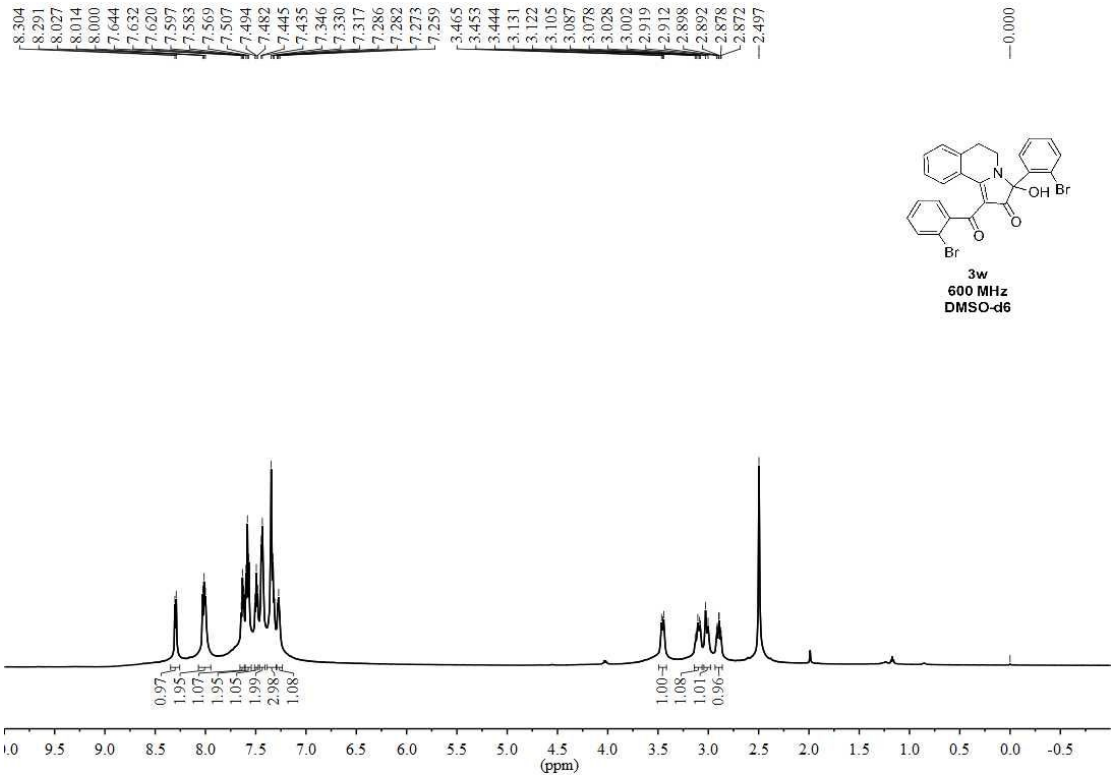

193.23
185.07
171.77
140.56
137.96
134.80
134.40
133.73
132.29
131.62
131.60
131.22
129.91
129.75
128.63
128.24
127.42
126.94
126.63
124.25
105.00
87.77
39.91
39.78
39.64
39.50
39.36
39.22
39.08
37.43
27.71
(ppm)
3t
150 MHz
DMSO-d6

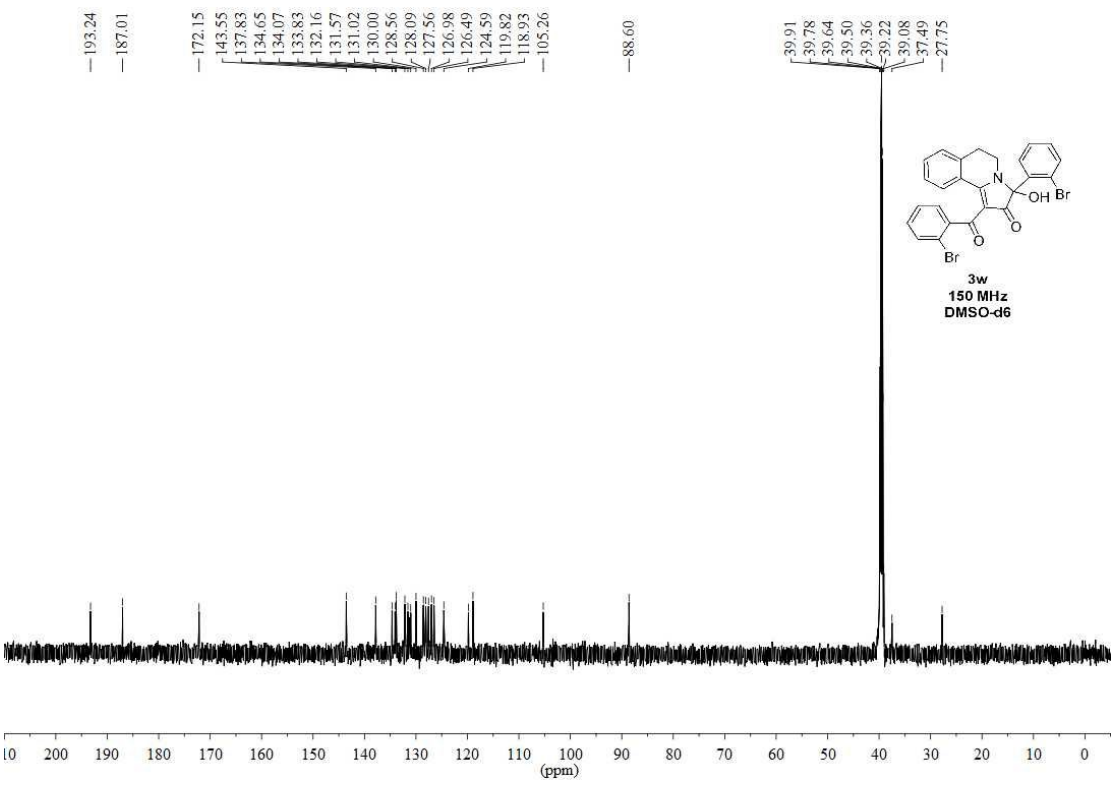

7.801
7.780
7.767
7.627
7.623
7.618
7.608
7.604
7.597
7.484
7.471
7.408
7.394
7.358
7.346
7.333
3.511
3.499
3.487
3.478
3.348
3.202
3.195
3.187
3.180
3.161
3.149
3.139
3.134
3.123
3.114
3.075
3.061
2.500
0.94
1.00
4.03
2.11
1.05
1.99
1.17
1.10
1.10
1.16
1.14
(ppm)
Br
OH
O
N
3u
600 MHz
DMSO-d6

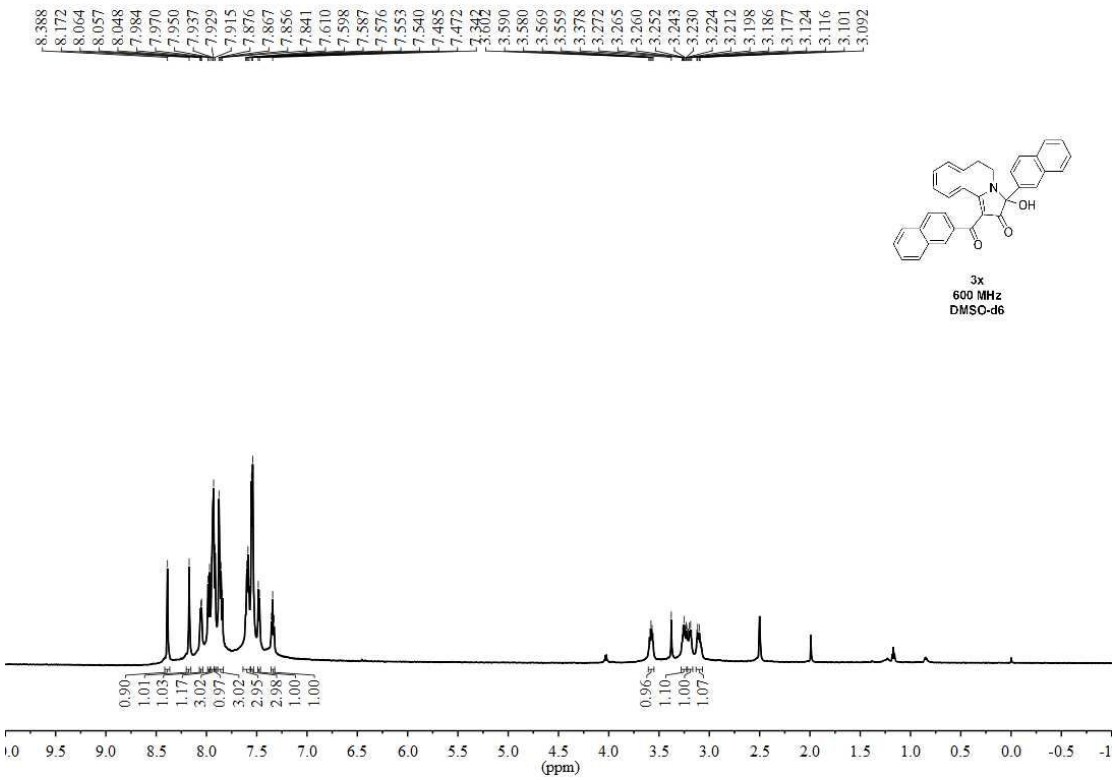

193.77
188.45
171.06
138.32
138.04
135.51
133.83
131.71
131.28
131.07
130.92
128.59
127.88
126.66
125.91
123.89
122.05
102.72
90.41
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.15
27.63
(ppm)
Br
OH
O
N
3u
600 MHz
DMSO-d6

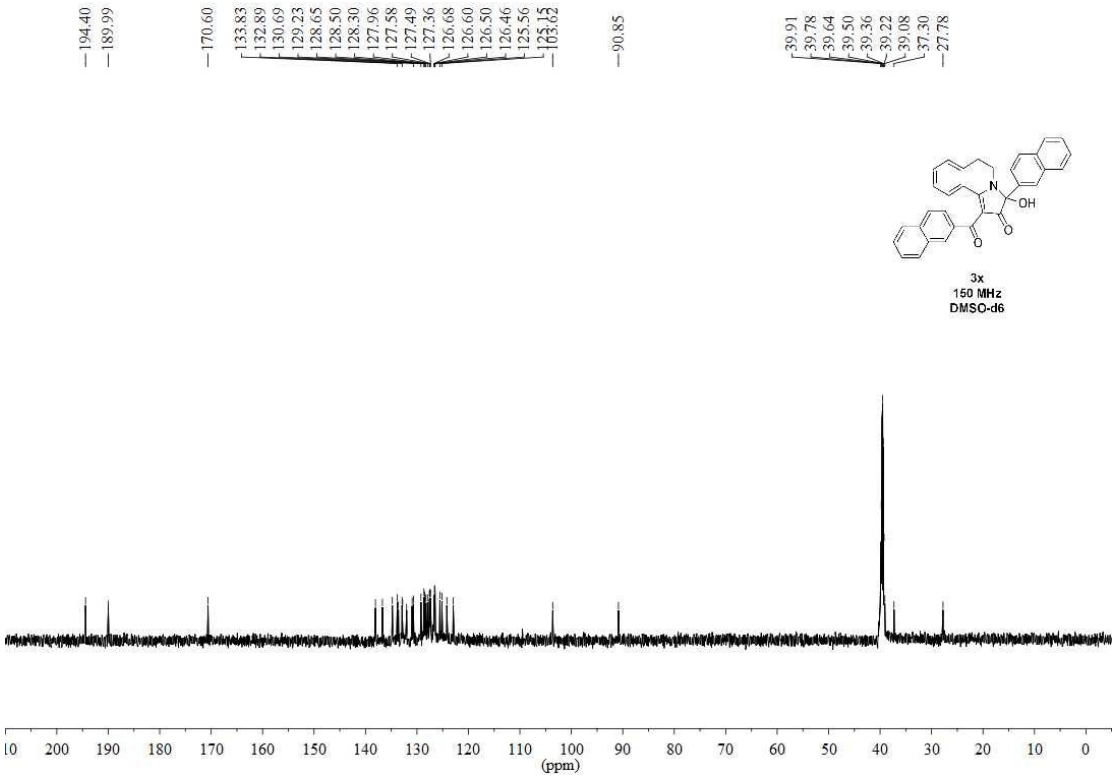

7.916
7.832
7.818
7.732
7.718
7.681
7.670
7.631
7.618
7.605
7.596
7.593
7.590
7.489
7.476
7.403
7.390
7.379
7.366
7.352
7.340
3.536
3.532
3.523
3.514
3.510
3.385
3.243
3.237
3.229
3.154
3.144
3.141
3.091
3.082
3.078
2.506
0.000
Br
N
OH
O
O
Br
3v
600 MHz
DMSO-d6
1.00
1.82
1.02
1.83
1.94
1.07
2.73
1.08
1.12
1.13
1.12
1.06
(ppm)

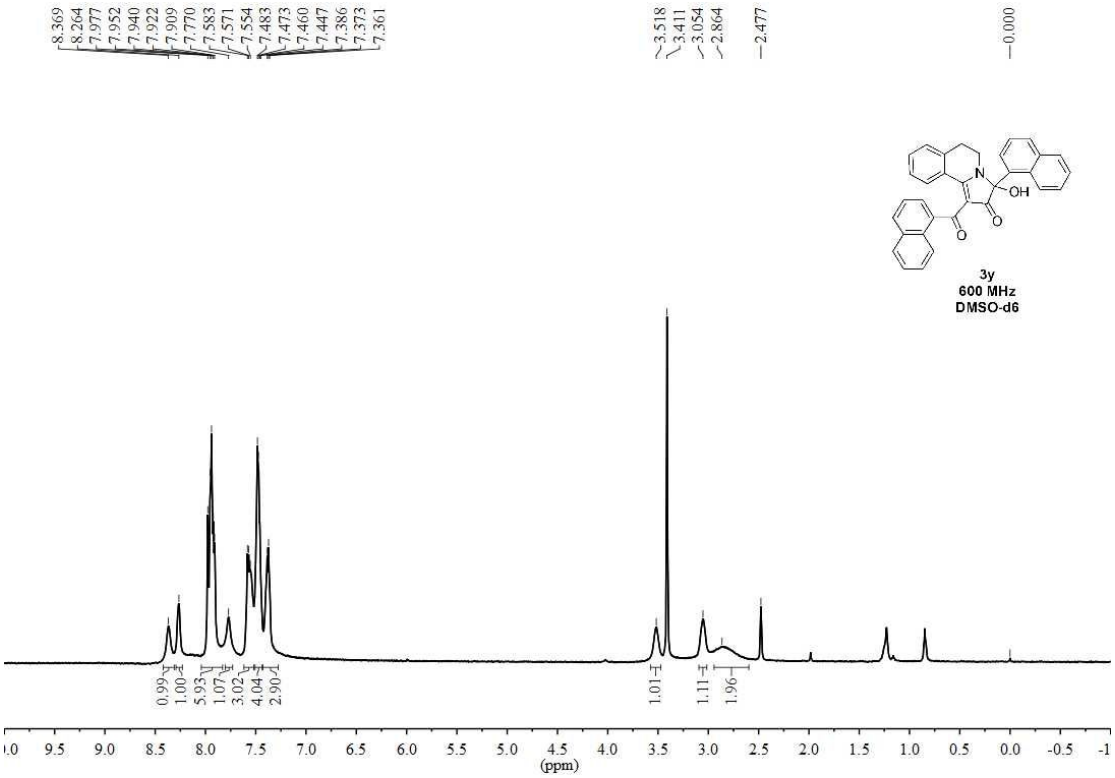

193.68
188.01
171.30
141.47
138.70
138.10
134.55
131.83
131.71
131.14
131.05
130.14
128.65
128.61
128.18
126.69
124.32
123.87
122.09
121.17
102.74
90.11
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.28
27.66
Br
N
OH
O
O
Br
3v
150 MHz
DMSO-d6
(ppm)

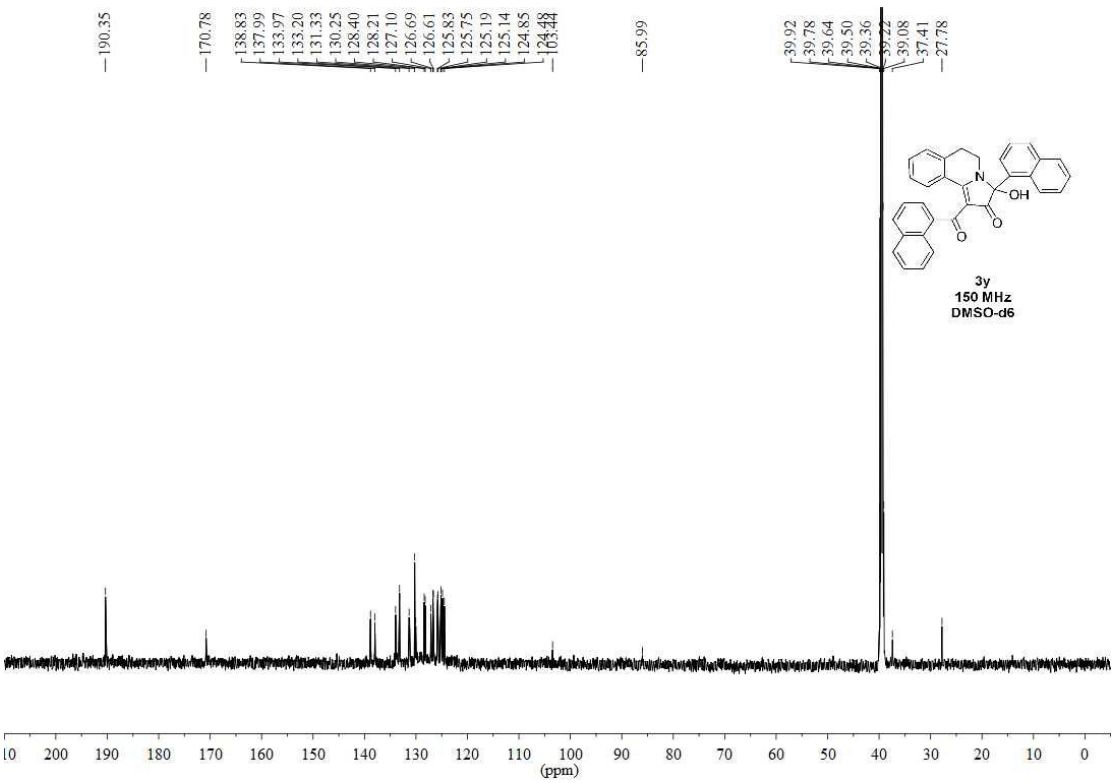

8.304
8.291
8.027
8.014
8.000
7.644
7.632
7.620
7.597
7.583
7.569
7.507
7.494
7.482
7.445
7.435
7.346
7.330
7.317
7.286
7.282
7.273
7.259
3.465
3.453
3.444
3.131
3.122
3.105
3.087
3.078
3.028
3.002
2.919
2.912
2.898
2.892
2.878
2.872
2.497
0.000
0.97
1.95
1.07
1.95
1.05
1.99
2.98
1.08
1.00
1.08
1.01
0.96
(ppm)
3w
600 MHz
DMSO-d6

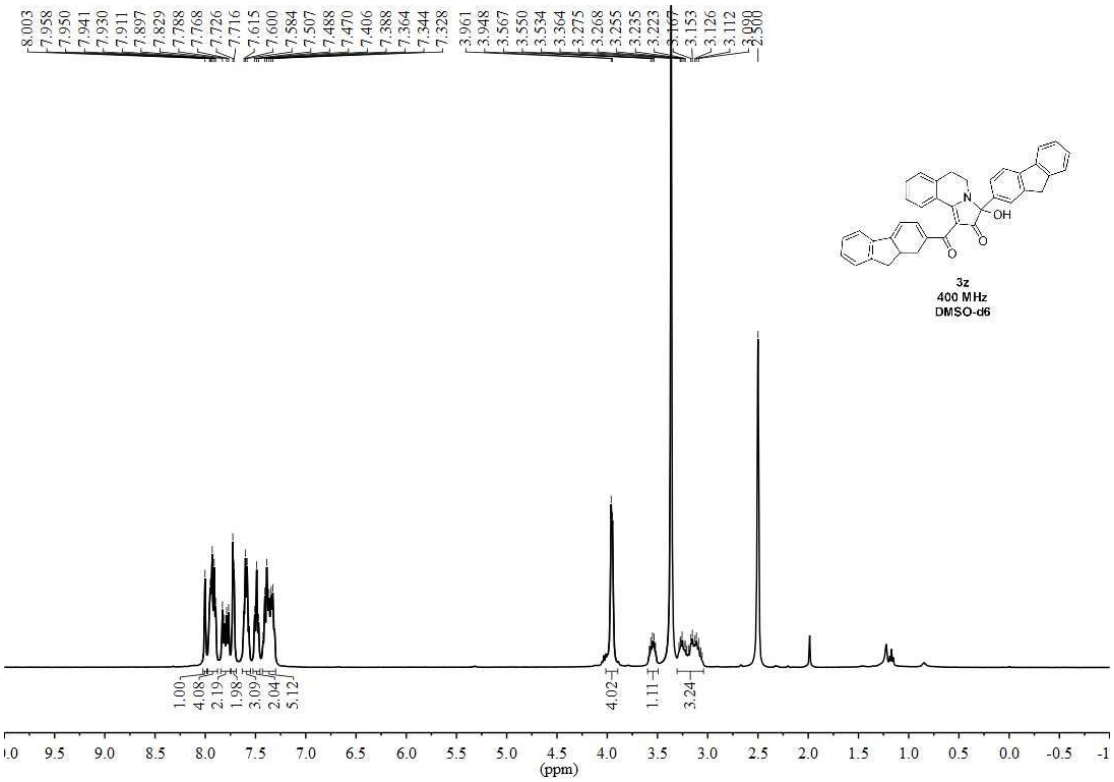

193.24
187.01
172.15
143.55
137.83
134.65
134.07
133.83
132.16
131.57
131.02
130.00
128.56
128.09
127.56
126.98
126.49
124.59
119.82
118.93
105.26
88.60
39.91
39.78
39.64
39.50
39.36
39.22
39.08
37.49
27.75
(ppm)
3w
150 MHz
DMSO-d6

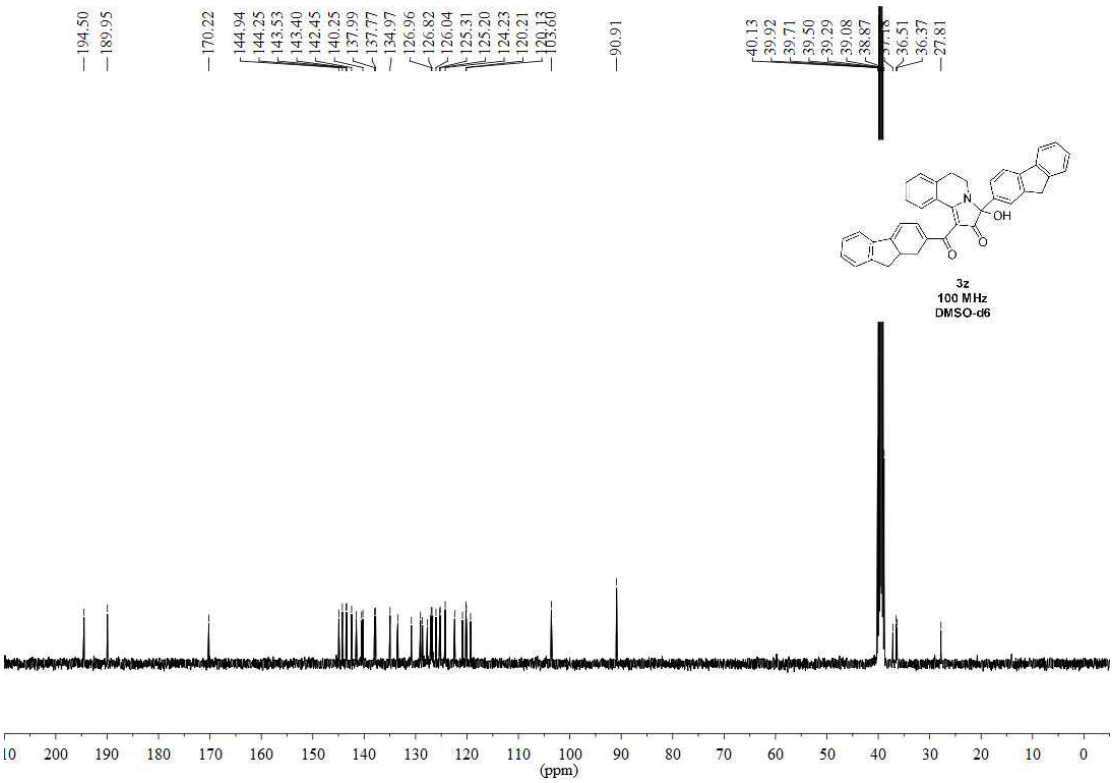

8.388
8.172
8.064
8.057
8.048
7.984
7.970
7.950
7.937
7.929
7.915
7.876
7.867
7.856
7.841
7.610
7.598
7.587
7.576
7.553
7.540
7.485
7.472
7.342
3.602
3.590
3.580
3.569
3.559
3.378
3.272
3.265
3.260
3.252
3.243
3.230
3.224
3.212
3.198
3.186
3.177
3.124
3.116
3.101
3.092
N
OH
O
O
3x
600 MHz
DMSO-d6
0.90
1.01
1.03
1.17
3.02
0.97
3.02
2.95
2.98
1.00
1.00
0.96
1.10
1.00
1.07
(ppm)

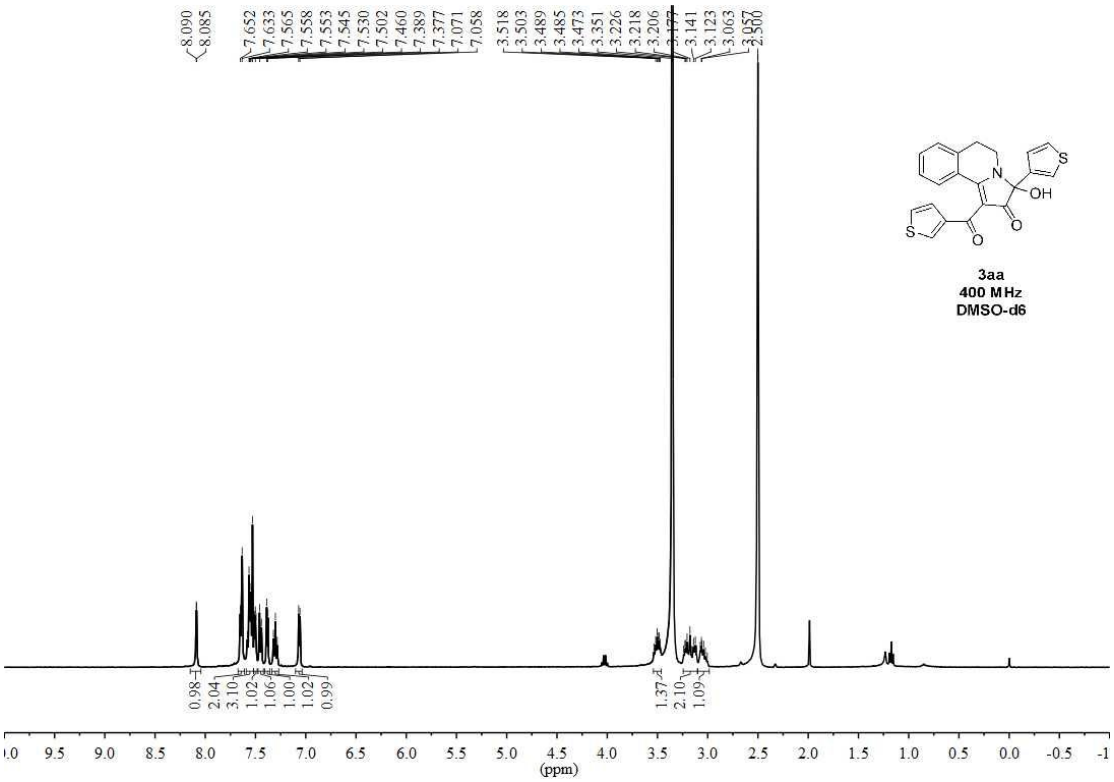

194.40
189.99
170.60
133.83
132.89
130.69
129.23
128.65
128.50
128.30
127.96
127.58
127.49
127.36
126.68
126.60
126.50
126.46
125.56
125.15
103.62
90.85
39.91
39.78
39.64
39.50
39.36
39.22
39.08
37.30
27.78
N
OH
O
O
3x
150 MHz
DMSO-d6
(ppm)

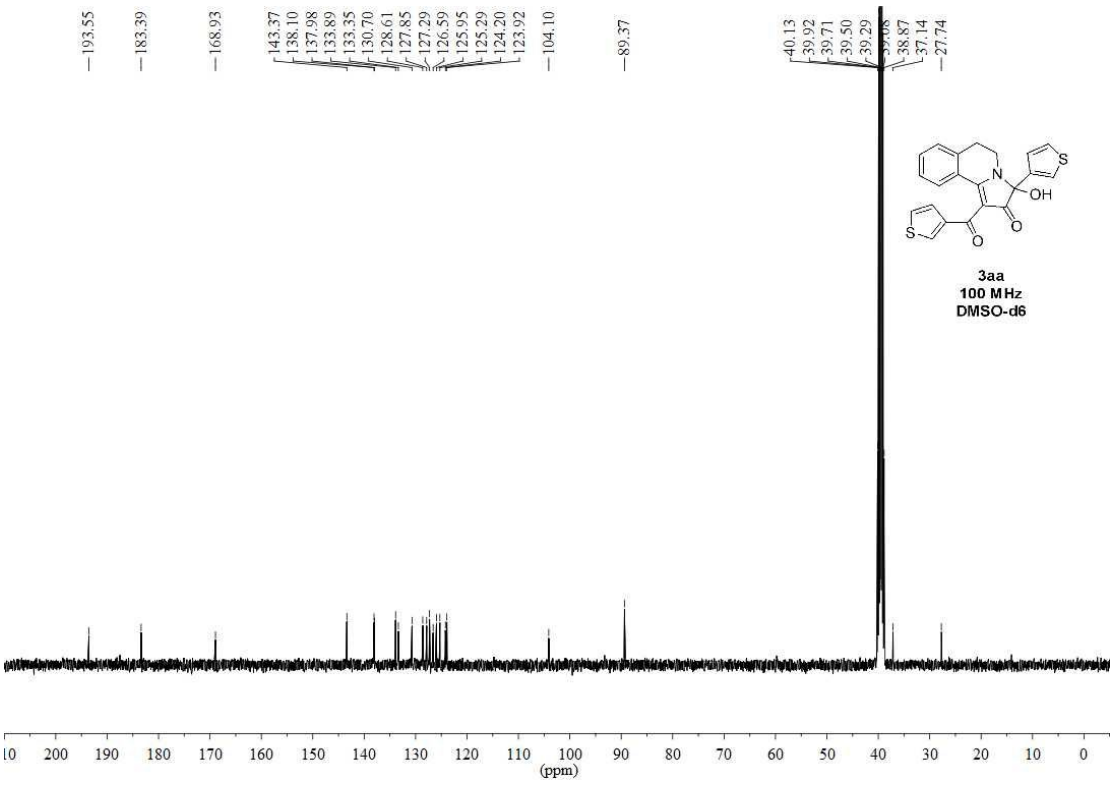

8.369
8.264
7.977
7.952
7.940
7.922
7.909
7.770
7.583
7.571
7.554
7.483
7.473
7.460
7.447
7.386
7.373
7.361
3.518
3.411
3.054
2.864
2.477
0.000
OH
O
O
3y
600 MHz
DMSO-d6
0.99
1.00
5.93
1.07
3.02
4.04
2.90
1.01
1.11
1.96
(ppm)

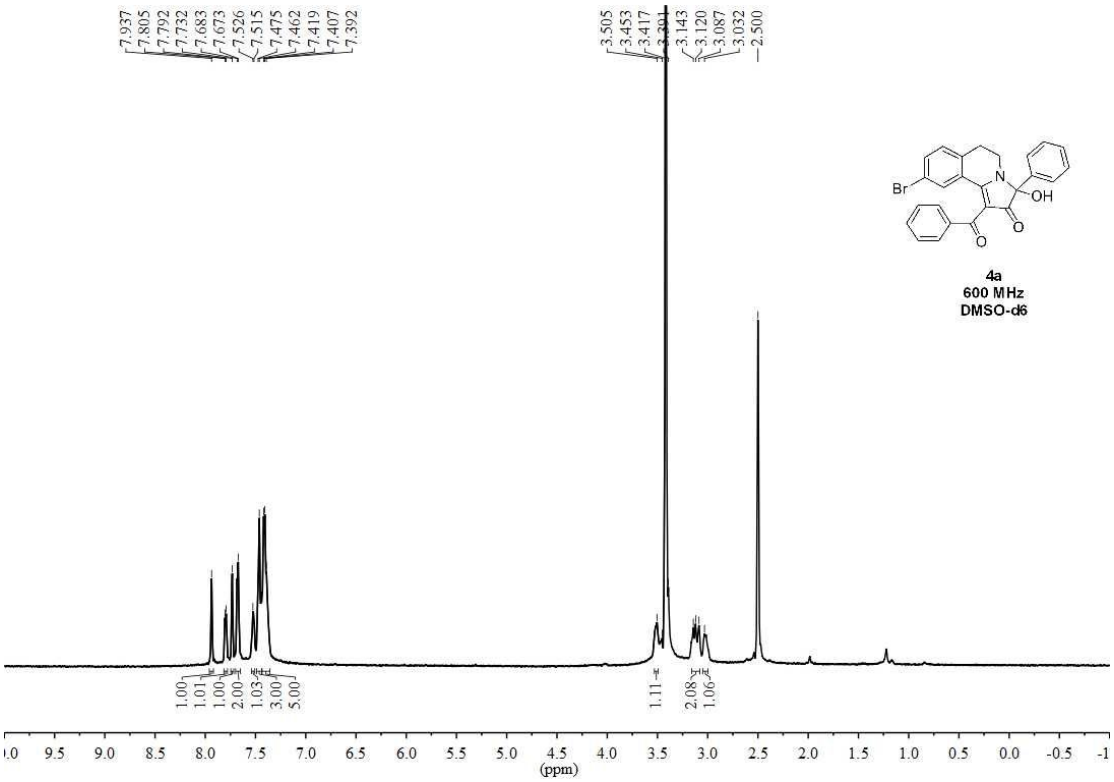

190.35
170.78
138.83
137.99
133.97
133.20
131.33
130.25
128.40
128.21
127.10
126.69
126.61
125.83
125.75
125.19
125.14
124.85
124.48
123.44
85.99
39.92
39.78
39.64
39.50
39.36
39.22
39.08
37.41
27.78
OH
O
O
3y
150 MHz
DMSO-d6
(ppm)


8.003
7.958
7.950
7.941
7.930
7.911
7.897
7.829
7.788
7.768
7.726
7.716
7.615
7.600
7.584
7.507
7.488
7.470
7.406
7.388
7.364
7.344
7.328
3.961
3.948
3.567
3.550
3.534
3.364
3.275
3.268
3.255
3.235
3.223
3.167
3.153
3.126
3.112
2.500
1.00
4.08
2.19
1.98
3.09
2.04
5.12
4.02
1.11
3.24
(ppm)
3z
400 MHz
DMSO-d6

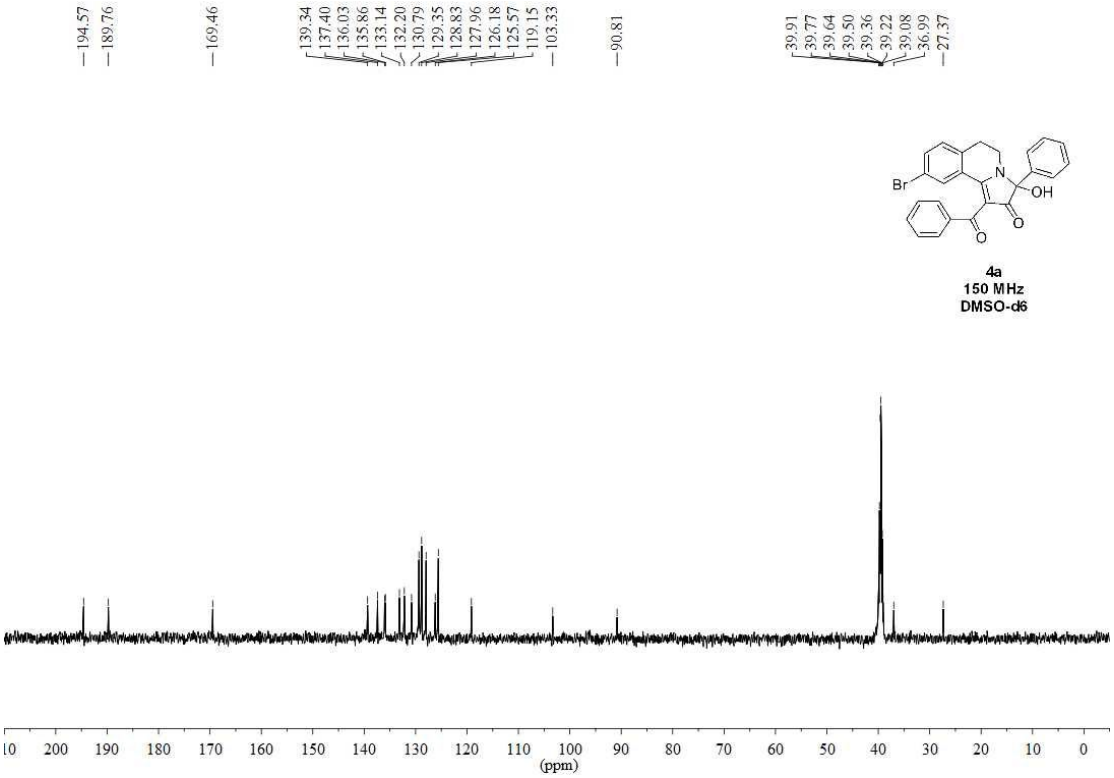

194.50
189.95
170.22
144.94
144.25
143.53
143.40
142.45
140.25
137.99
137.77
134.97
126.96
126.82
126.04
125.31
125.20
124.23
120.21
120.13
120.00
90.91
40.13
39.92
39.71
39.50
39.29
39.08
38.87
36.51
36.37
27.81
(ppm)
3z
100 MHz
DMSO-d6


8.090
8.085
7.652
7.633
7.565
7.558
7.553
7.545
7.530
7.502
7.460
7.389
7.377
7.071
7.058
3.518
3.503
3.489
3.485
3.473
3.351
3.226
3.218
3.206
3.141
3.123
3.063
2.500
0.98
2.04
3.10
1.02
1.06
1.00
1.02
0.99
1.37
2.10
1.09
(ppm)
3aa
400 MHz
DMSO-d6

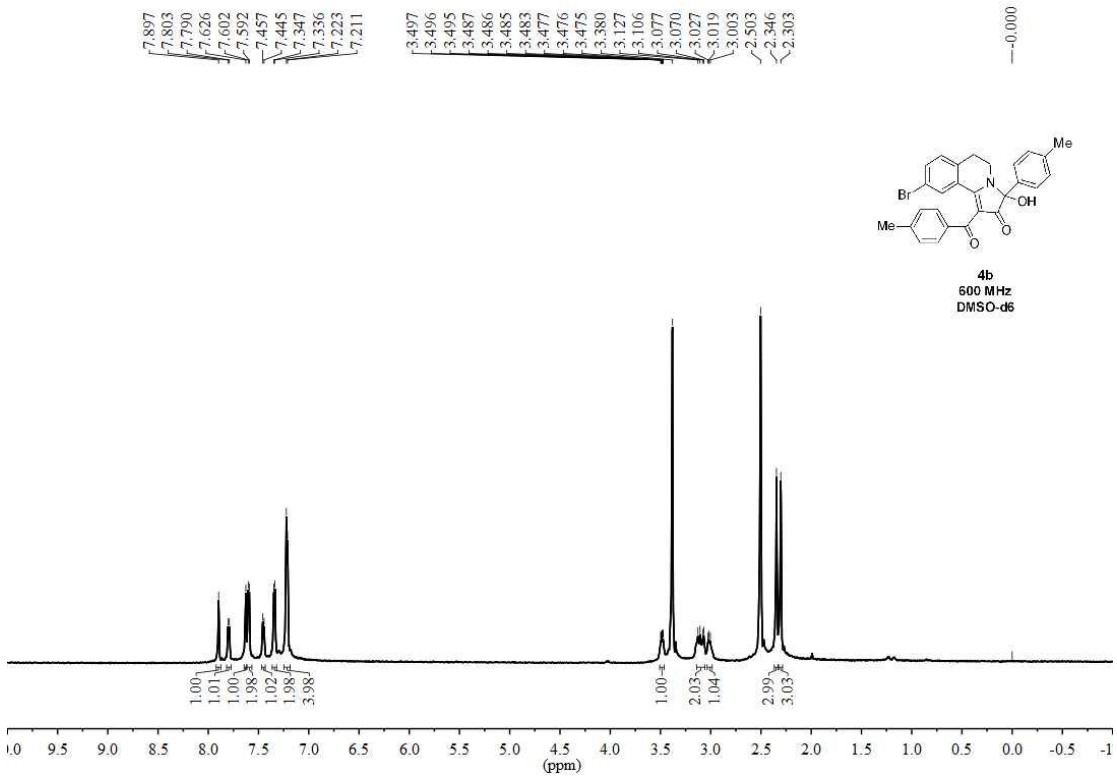

193.55
183.39
168.93
143.37
138.10
137.98
133.89
133.35
130.70
128.61
127.85
127.29
126.59
125.95
125.29
124.20
123.92
104.10
89.37
40.13
39.92
39.71
39.50
39.29
38.87
37.14
27.74
(ppm)
3aa
100 MHz
DMSO-d6

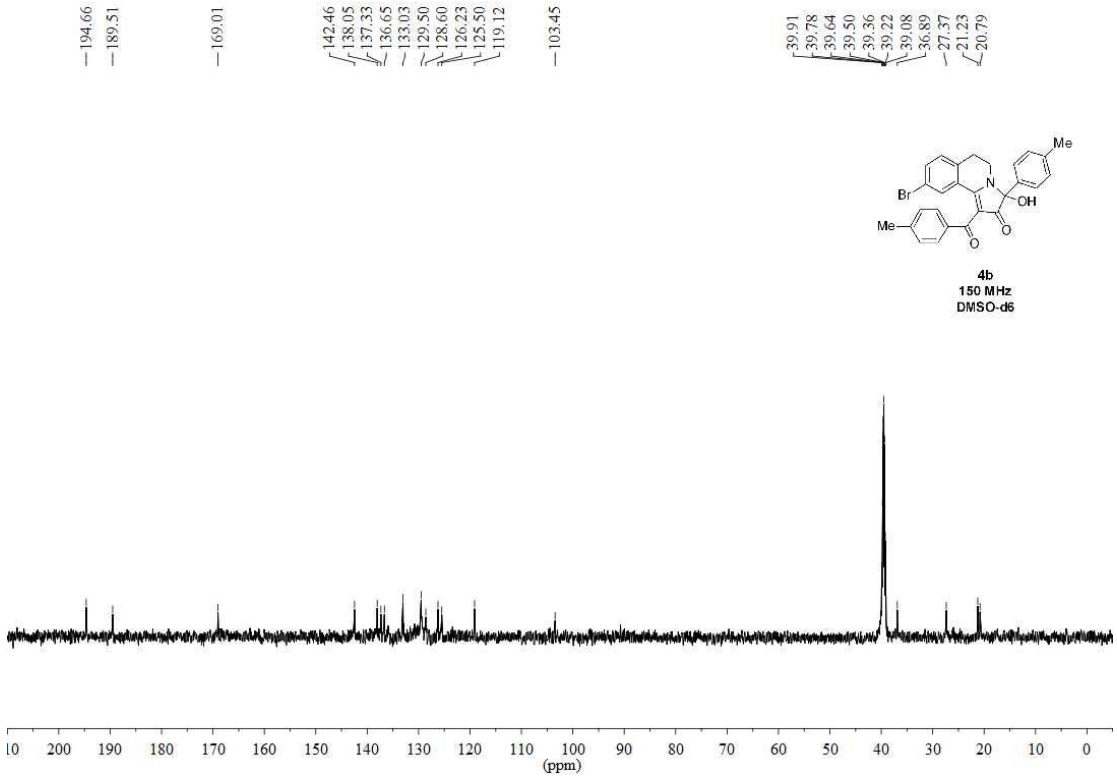


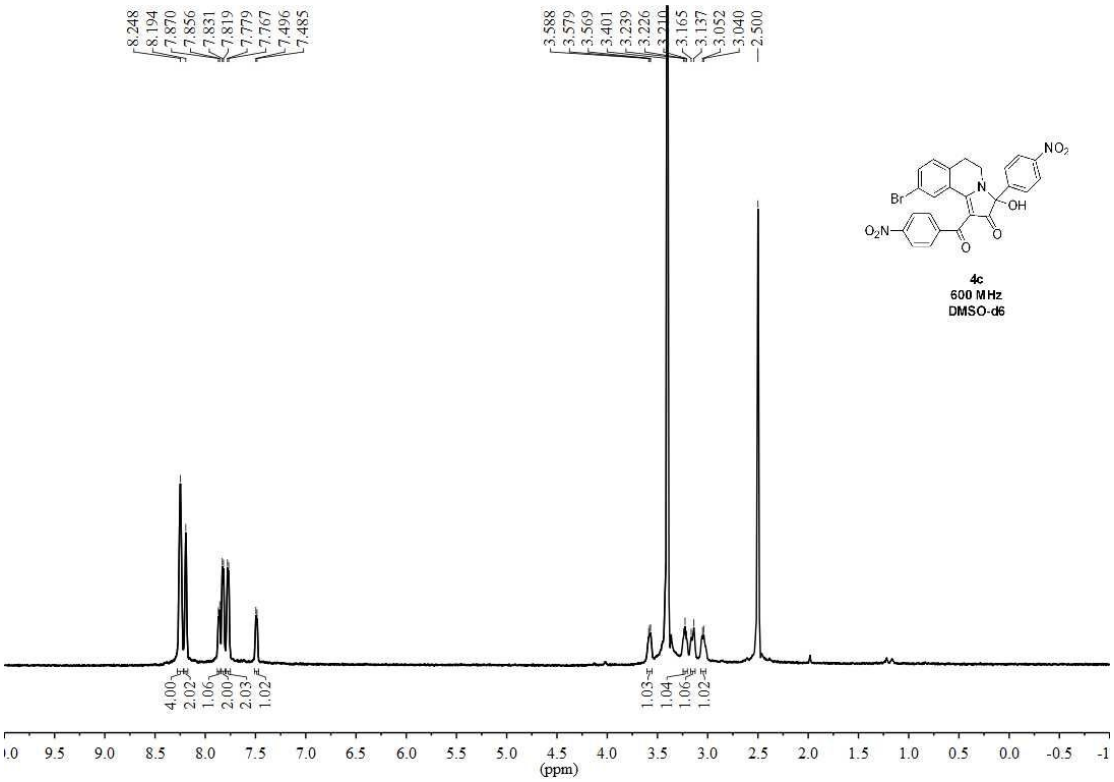
4a
600 MHz
DMSO-d6



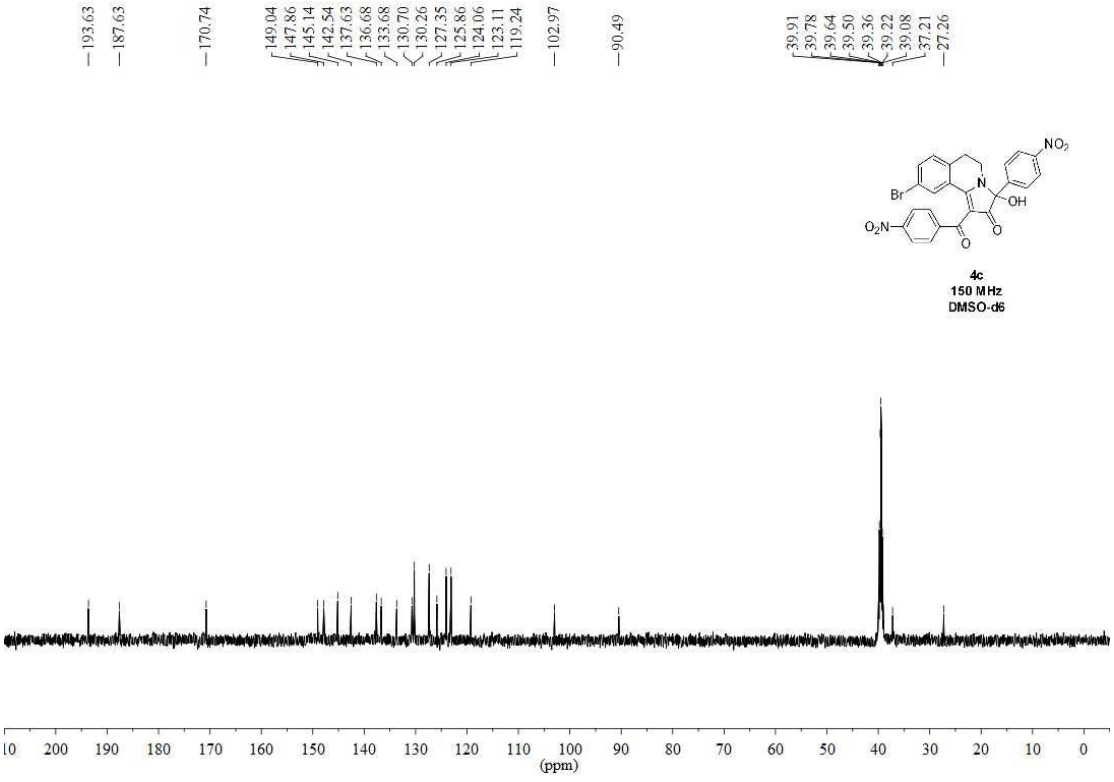
4a
150 MHz
DMSO-d6


7.897
7.803
7.790
7.626
7.602
7.592
7.457
7.445
7.347
7.336
7.223
7.211
3.497
3.496
3.495
3.487
3.486
3.485
3.483
3.477
3.476
3.475
3.380
3.127
3.106
3.077
3.070
3.027
3.019
3.003
2.503
2.346
2.303
-0.000
Me
Br
N
OH
Me
O
O
4b
600 MHz
DMSO-d6
1.00
1.01
1.00
1.98
1.02
1.98
3.98
1.00
2.03
1.04
2.99
3.03
(ppm)

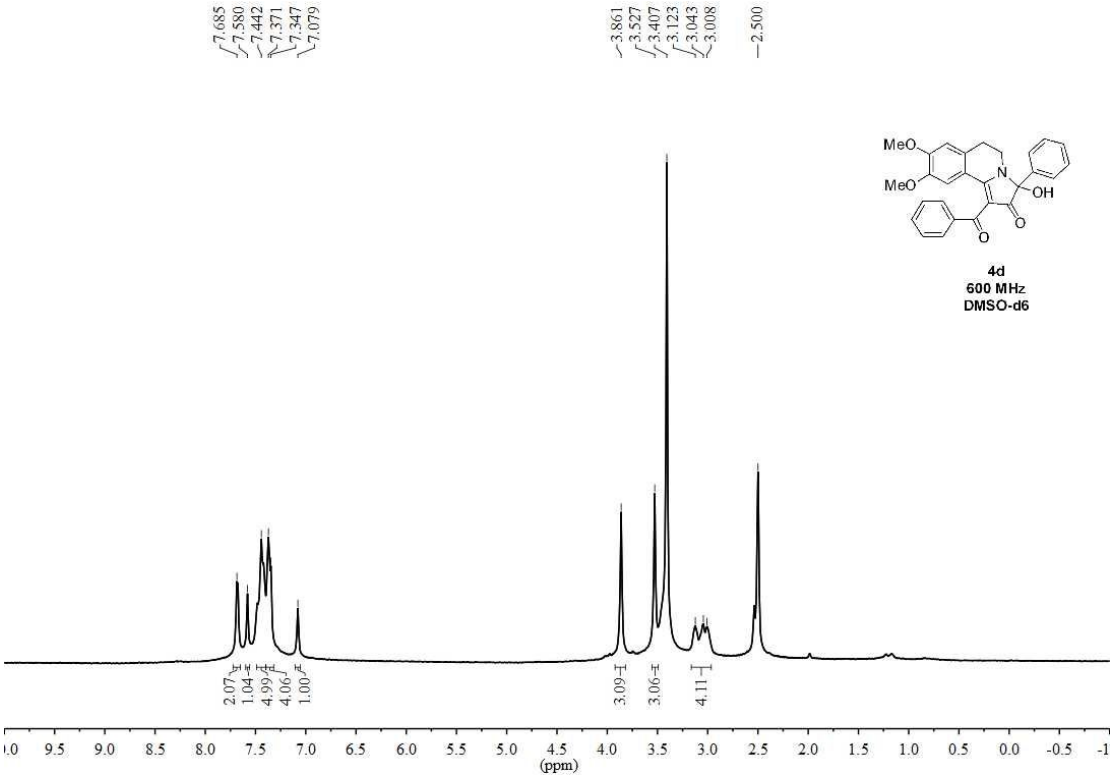

194.66
189.51
169.01
142.46
138.05
137.33
136.65
133.03
129.50
128.60
126.23
125.50
119.12
103.45
39.91
39.78
39.64
39.50
39.36
39.22
39.08
36.89
27.37
21.23
20.79
Me
Br
N
OH
Me
O
O
4b
150 MHz
DMSO-d6
(ppm)



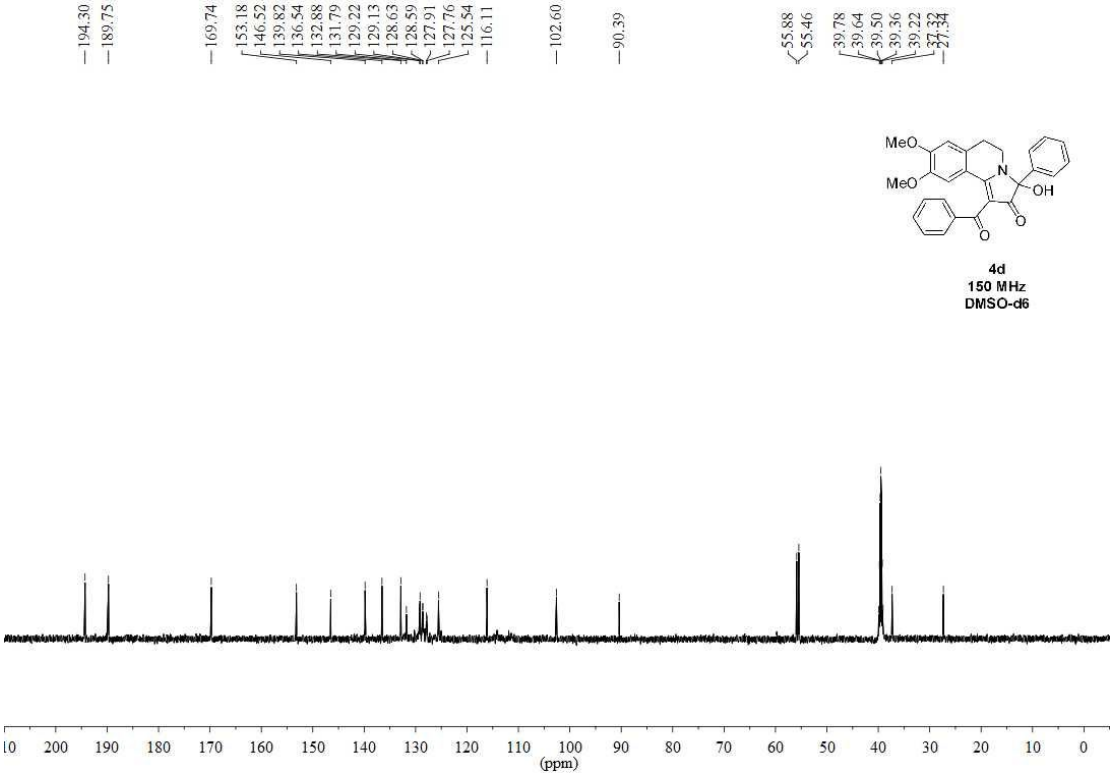
4c
600 MHz
DMSO-d6



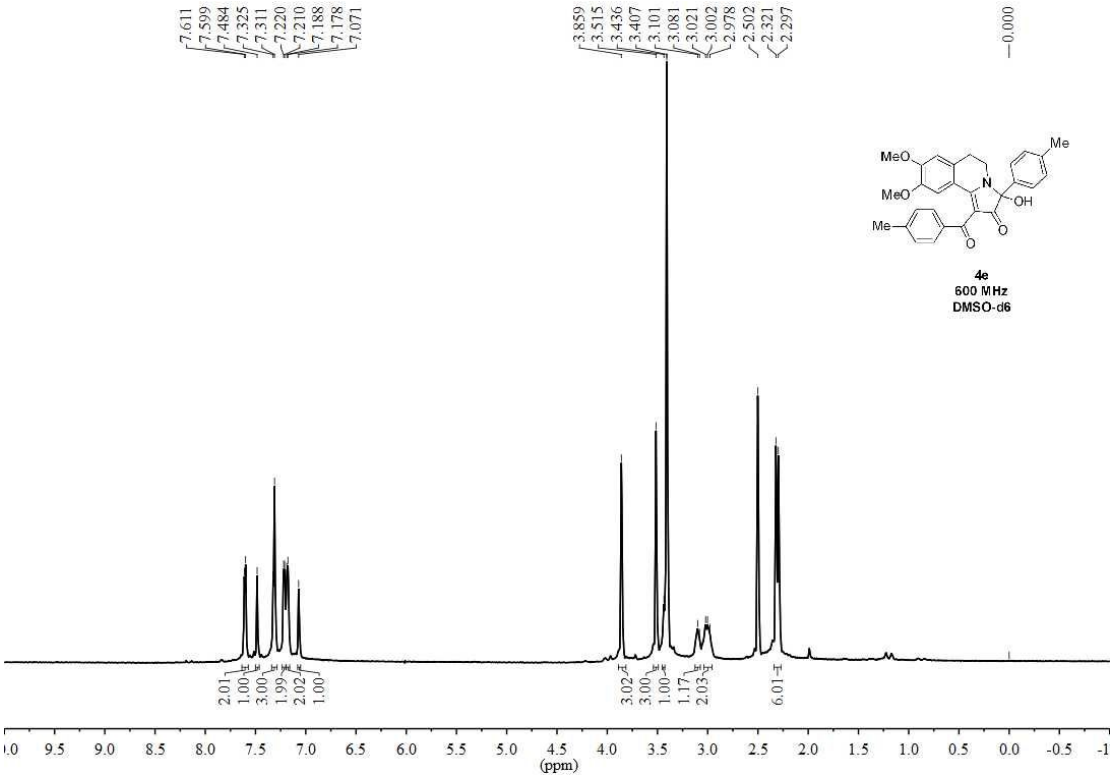
4c
150 MHz
DMSO-d6

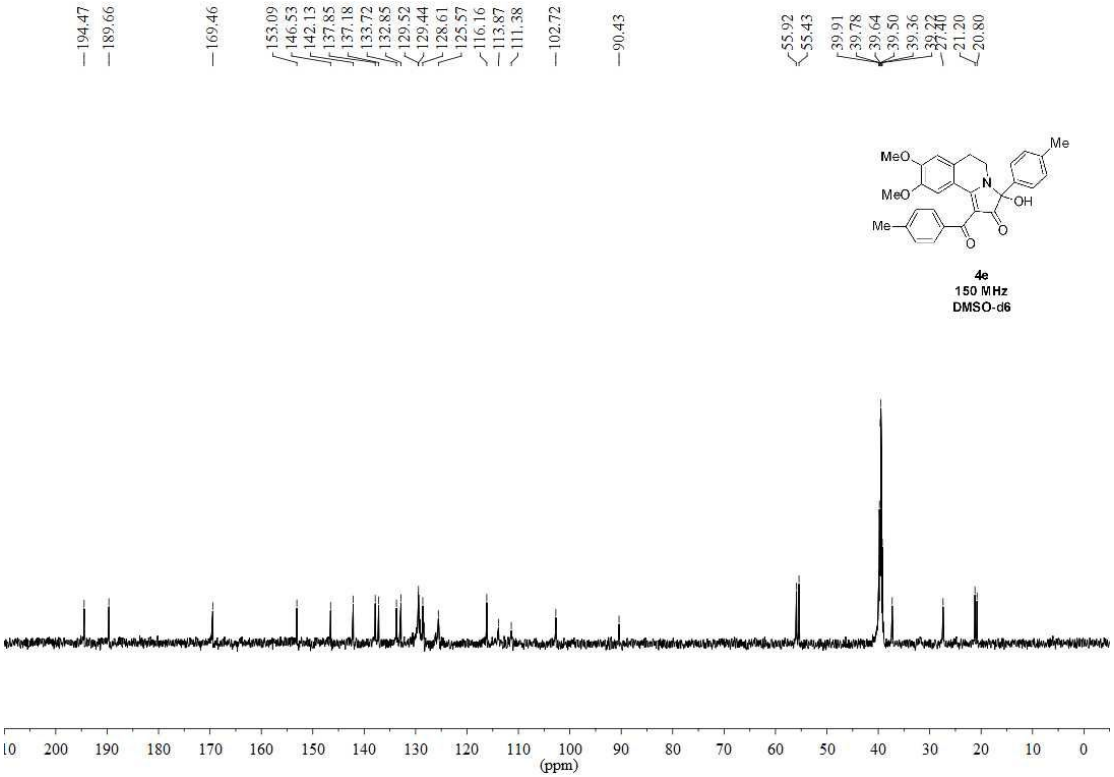


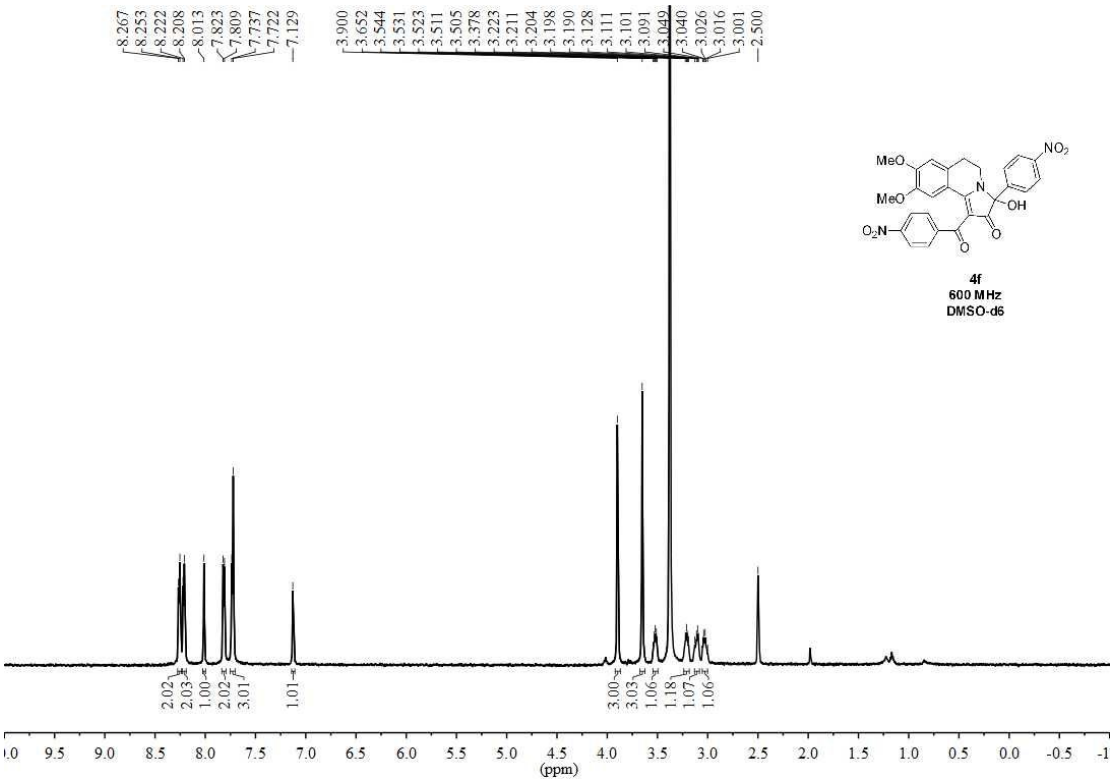
4d
600 MHz
DMSO-d6

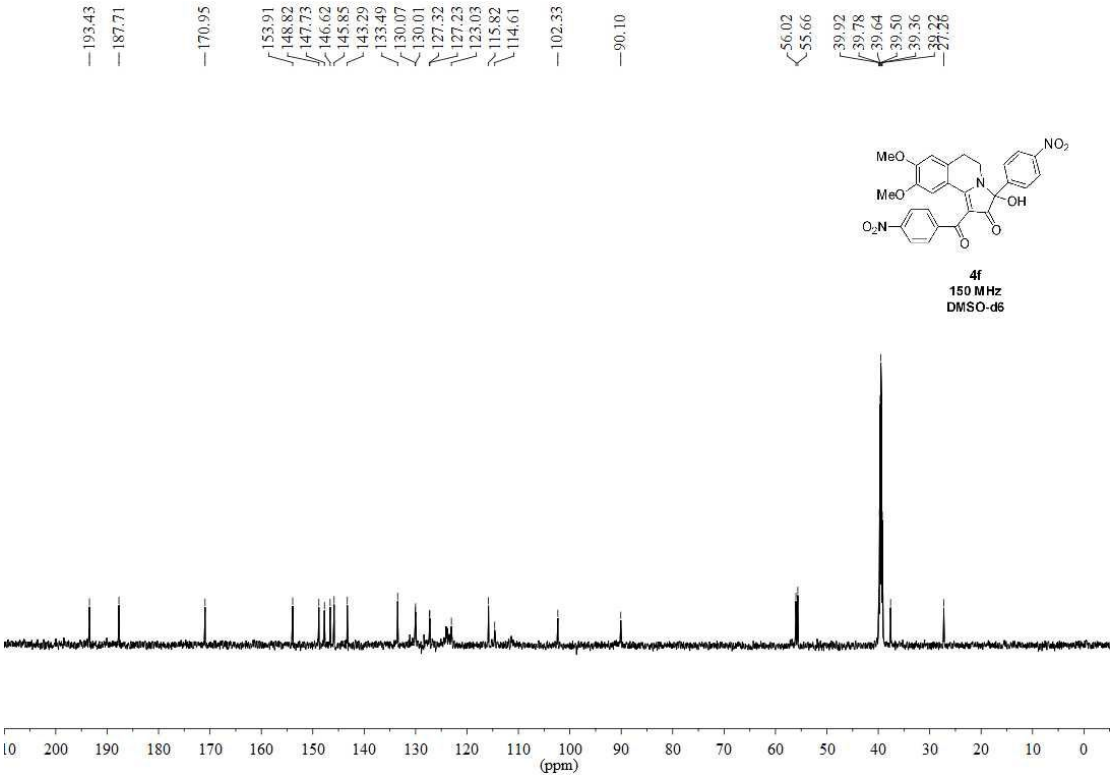


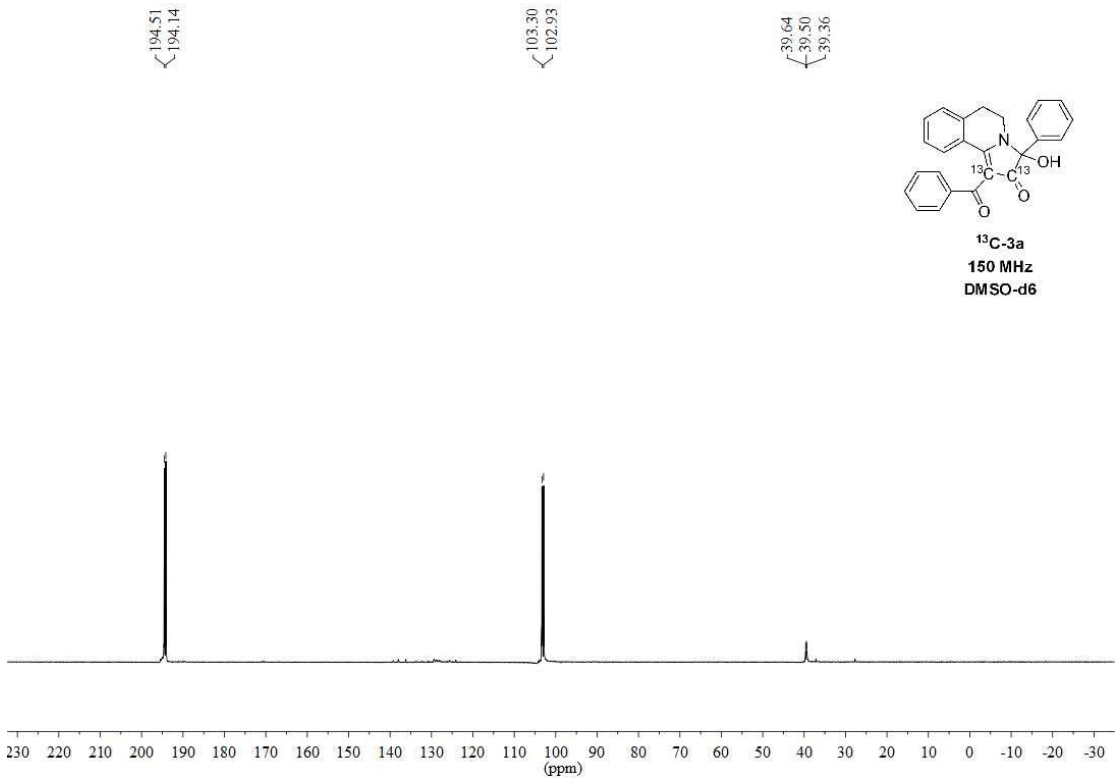
4d
150 MHz
DMSO-d6


7.611
7.599
7.484
7.325
7.311
7.220
7.210
7.188
7.178
7.071
3.859
3.515
3.436
3.407
3.101
3.081
3.021
3.002
2.978
2.502
2.321
2.297
0.000
MeO
MeO
Me
N
OH
O
Me
4e
600 MHz
DMSO-d6
2.01
1.00
3.00
1.99
2.02
1.00
3.02
3.00
1.00
1.17
2.03
6.01
(ppm)


194.47
189.66
169.46
153.09
146.53
142.13
137.85
137.18
133.72
132.85
129.52
129.44
128.61
125.57
116.16
113.87
111.38
102.72
90.43
55.92
55.43
39.91
39.78
39.64
39.50
39.36
39.22
27.40
21.20
20.80
MeO
MeO
Me
N
OH
O
Me
4e
150 MHz
DMSO-d6
(ppm)


8.267
8.253
8.222
8.208
8.013
7.823
7.809
7.737
7.722
7.129
3.900
3.652
3.544
3.531
3.523
3.511
3.505
3.378
3.223
3.211
3.204
3.198
3.190
3.128
3.111
3.101
3.091
3.049
3.040
3.026
3.016
3.001
2.500
MeO
MeO
NO2
OH
O2N
O
O
4f
600 MHz
DMSO-d6
2.02
2.03
1.00
2.02
3.01
1.01
3.00
3.03
1.06
1.18
1.07
1.06
(ppm)


193.43
187.71
170.95
153.91
148.82
147.73
146.62
145.85
143.29
133.49
130.07
130.01
127.32
127.23
123.03
115.82
114.61
102.33
90.10
56.02
55.66
39.92
39.78
39.64
39.50
39.36
39.22
27.26
MeO
MeO
NO2
OH
O2N
O
O
4f
150 MHz
DMSO-d6
(ppm)


194.51
194.14
103.30
102.93
39.64
39.50
39.36
OH
O
O
^{13}C-3a
150 MHz
DMSO-d6
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30
(ppm)