Electronic Supplementary Material (ESI) for ChemComm.

Asymmetric construction of six vicinal stereogenic centers on hexahydroxanthones via organocatalytic one-pot reactions

Min Zhang, [a,b] Xue-Wen He, [a,b] Ya Xiong, [a] Xiong Zuo, [a] Wei Zhou [a] and Xiong-Li Liu*[a]

[a] National & Local Joint Engineering Research Center for the Exploition of Homology Resources of Southwest Medicine and Food, Guizhou University, Guiyang, Guizhou 550025, P. R. China.

[b] These two authors contributed equally to this work

E-mail: xlliu1@gzu.edu.cn

Table of Contents

1. General experimental information

Reactions were monitored by thin layer chromatography using UV light to visualize the course of reaction. Purification of reaction products was carried out by flash chromatography on silica gel. The ee values were determined by chiral HPLC analysis. The d.r. values were determined by ^{1}H-NMR analysis. ^{1}H and ^{13}CNMR spectra were obtained using a Bruker DPX-400 spectrometer.

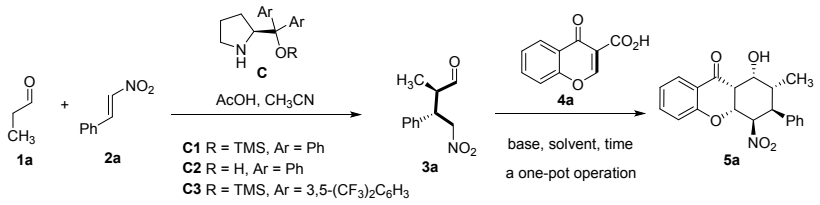
^{1}H NMR chemical shifts are reported in ppm (δ) relative to tetramethylsilane (TMS) with the solvent resonance employed as the internal standard. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet), coupling constants (Hz) and integration. ^{13}C NMR chemical shifts are reported in ppm (δ) from tetramethylsilane (TMS) with the solvent resonance as the internal standard. Optical rotations were measured with a polarimer with the solvent indicated. Melting points were measured on an electrothermal digital melting point apparatus.

2. Optimization of reaction conditions

In our initial study, we investigated the three-component one-pot reaction using the substrates propanal **1a**, nitroolefin **2a** and carboxylic acid group-activated chromone **4a**. The first Michael reaction of **1a** and **2a** proceeded in the presence of Hayashi-Jørgensen secondary amine catalyst **C1** (10 mol%) in CH_3CN at room temperature for 8 h. After the removal of solvent, the chromone **4a** and a triethylamine in dichloromethane were added sequentially. To our delight, the tandem reaction proceeded smoothly to afford the desired product **5a** bearing six vicinal stereogenic centers with moderate diastereoselectivity (3:1 dr) and excellent enantioselectivity (97% ee), albeit in 42% yield. Catalyst diarylprolinol **C2** exhibited almost no catalytic activity (entry 2). Catalyst **C3** only afforded the desired product **6a** in 27% yield (entry 3). The screening of other bases in the second Michael step showed that the 1.0 eq of DBU provides the best yield as well as good stereoselectivity (entries 4-7). The further increase in the amount of DBU did not show any improvement in the product yield (entry 8). Further optimization of the reaction conditions by screening different solvents and temperature (entries 9-14) showed that with 10 mol% of catalyst

C1 and 1.0 eq of DBU in $CHCl_3$ at 40 °C provides good yield of 61% and excellent stereoselectivity (5:1 dr, >99% ee, entry 13).

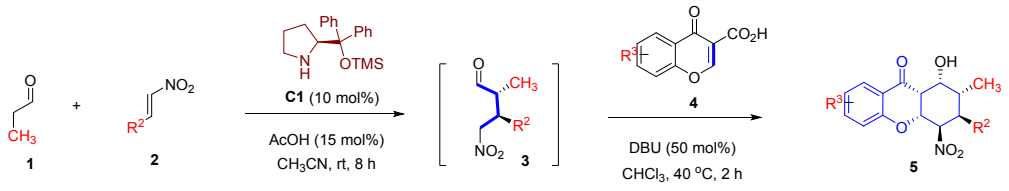
Table S1: optimization of reaction conditions for synthesis of compound 5a[a]



Entry	Cat.	Solvent	Base	Time [h]	Yield [%]	Dr[b]	Ee [%][c]
1	**C1**	CH_2Cl_2	TEA	3	42	3:1	97
2	**C2**	CH_2Cl_2	TEA	6	<5	-	-
3	**C3**	CH_2Cl_2	TEA	4	27	3:1	93
4	**C1**	CH_2Cl_2	K_2CO_3	4	31	2:1	96
5	**C1**	CH_2Cl_2	DMAP	4	<10	-	-
6	**C1**	CH_2Cl_2	DBU	4	47	3:1	98
7[d]	**C1**	CH_2Cl_2	DBU	4	55	3:1	96
8[e]	**C1**	CH_2Cl_2	DBU	4	50	3:1	96
9[d]	**C1**	$CHCl_3$	DBU	2	56	3:1	99
10[d]	**C1**	CH_3OH	DBU	2	23	3:1	93
11[d]	**C1**	CH_3CN	DBU	4	31	2:1	97
12[d]	**C1**	THF	DBU	4	20	2:1	97
13[d,f]	**C1**	$CHCl_3$	DBU	2	61	5:1	>99
14[d,f]	**C1**	$CHCl_3$	DBU	5	52	6:1	98

[a] Reactions were performed with **1a** (0.5 mmol), **2a** (0.3 mmol), **C** (10 mol%) and AcOH (0.03 mmol) in the CH_3CN (3 mL) at room temperature for 8 h. After the removal of solvent, **4a** (0.2 mmol) and base (0.1 mmol) in the indicated solvent (2 mL) were added.
[b] The diastereomeric ratios values were determined by ^1H NMR.
[c] The enantiomeric ratios were determined by chiral HPLC.
[d] 1.0 eq of DBU was added.
[e] 1.5 eq of DBU was added.
[f] After the addition of **4a** and DBU, the reaction was performed at 40 °C.

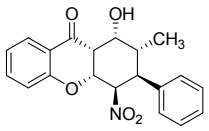
3. Typical experimental procedures for asymmetric synthesis of compounds 5



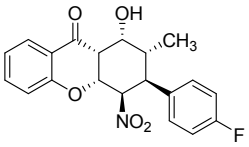
Compound **1** (0.5 mmol), **2** (0.3 mmol), **C1** (10 mol%) and AcOH (0.03 mmol) in the CH_3CN (3 mL) at room temperature for 8 h. After the removal of solvent, **4** (0.2 mmol) and DBU (0.2 mmol) in the $CHCl_3$ (2 mL) were added and stirred at 40 °C for 2 h. After the removal of solvent,

purification by flash column chromatography (hexane/ethyl acetate = 8:1~5:1) was carried out to give product **5** as a white solid.

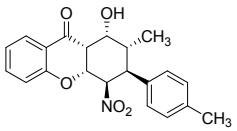
4. Characterization data and HPLC conditions of compounds 5



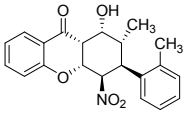
5a: White solid, m.p. 122.0-122.7 °C; yield 61%, 43.0 mg, >99% ee, 5:1 dr, $[\alpha]_D^{20}$ = -2.5 (*c* 2.9, MeOH); The ee was determined by HPLC analysis using a Chiralpak IA column (90/10 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 28.44 min; τ_{minor} = 52.88 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.90 (d, *J* = 6.4 Hz, 3H), 2.66-2.75 (m, 2H), 3.19-3.29 (m, 2H), 3.64-3.69 (m, 1H), 4.95-4.96 (m, 1H), 5.00-5.02 (m, 1H), 6.98-7.00 (m, 1H), 7.05-7.09 (m, 1H), 7.14-7.16 (m, 2H), 7.25-7.31 (m, 3H), 7.49-7.54 (m, 1H), 7.89-7.91 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 15.1, 34.6, 46.1, 49.7, 70.0, 74.5, 87.4, 116.7, 116.9, 118.7, 121.3, 122.0, 126.0, 126.9, 127.0, 127.1, 127.3, 128.0, 128.1, 135.2, 135.3, 135.7, 135.9, 158.8, 191.5; HRMS (ESI-TOF) m/z: Calcd. for $C_{20}H_{19}NNaO_5$ $[M+Na]^+$: 376.11554; Found: 376.11557.



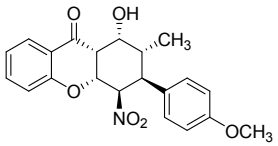
5b: White solid, m.p. 139.8-140.4 °C; yield 46%, 34.1 mg, >99% ee, 5:1 dr, $[\alpha]_D^{20}$ = +10.0 (*c* 2.1, MeOH); The ee was determined by HPLC analysis using a Chiralpak IA column (85/15 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 21.24 min; τ_{minor} = 33.33 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.89 (d, *J* = 6.4 Hz, 3H), 2.62-2.76 (m, 2H), 3.19-3.26 (m, 2H), 3.63-3.68 (m, 1H), 4.96-4.99 (m, 2H), 6.97-7.02 (m, 3H), 7.06-7.15 (m, 3H), 7.50-7.54 (m, 1H), 7.89-7.92 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 15.1, 34.7, 45.3, 49.7, 69.8, 74.5, 87.4, 115.2 (d, J_{CF} = 21.0 Hz), 116.8, 118.8, 122.1, 127.0, 128.8, 128.9, 130.9, 131.0, 136.0, 158.8, 161.7 (d, J_{CF} = 245.2 Hz), 191.5; HRMS (ESI-TOF) m/z: Calcd. for $C_{20}H_{18}FNNaO_5$ $[M+Na]^+$: 394.10612; Found: 394.10607.



5c: White solid, m.p. 151.4-152.2 °C; yield 49%, 36.0 mg, 94% ee, 10:1 dr, $[\alpha]_D^{20}$ = +18.1 (*c* 1.8, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (70/30 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 31.90 min; τ_{minor} = 10.78 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.90 (d, *J* = 6.4 Hz, 3H), 2.27 (s, 3H), 2.63-2.70 (m, 2H), 3.15-3.20 (m, 1H), 3.25-3.28 (m, 1H), 3.63-3.68 (m, 1H), 4.94-5.00 (m, 2H), 6.98-7.11 (m, 6H), 7.49-7.54 (m, 1H), 7.90-7.92 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 16.2, 21.1, 35.6, 46.7, 50.8, 71.0, 75.6, 88.6, 117.8, 119.8, 123.0, 128.0, 128.1, 129.9, 133.1, 137.0, 137.9, 159.9, 192.6; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{21}NNaO_5$ $[M+Na]^+$: 390.13119; Found: 390.13125.

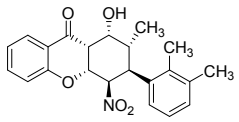


5d: White solid, m.p. 146.5-147.2 °C; yield 63%, 46.2 mg, 97% ee, 9:1 dr, $[\alpha]_D^{20}$ = +7.5 (*c* 1.6, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (80/20 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 38.72 min; τ_{minor} = 15.68 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.97 (d, *J* = 6.0 Hz, 3H), 2.36 (s, 3H), 2.72-2.80 (m, 2H), 3.22-3.26 (m, 1H), 3.32-3.36 (m, 1H), 3.70-3.75 (m, 1H), 5.01-5.02 (m, 1H), 5.06-5.08 (m, 1H), 6.99-7.07 (m, 3H), 7.12-7.14 (m, 2H), 7.23-7.26 (m, 1H), 7.56-7.61 (m, 1H), 7.96-7.97 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 16.2, 21.5, 35.6, 47.1, 50.8, 71.0, 75.6, 88.5, 117.8, 119.8, 123.0, 125.1, 127.9, 128.9, 129.0, 129.1, 136.1, 137.0, 138.8, 159.9, 192.6; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{21}NNaO_5$ $[M+Na]^+$: 390.13119; Found: 390.13121.

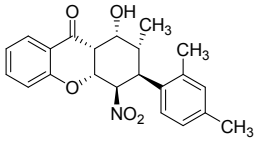


5e: White solid, m.p. 134.7-135.2 °C; yield 58%, 44.4 mg, 96% ee, 4:1 dr, $[\alpha]_D^{20}$ = +17.4 (*c* 1.9, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (70/30 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 41.17 min; τ_{minor} = 12.09 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.89 (d, *J* = 6.4 Hz, 3H), 2.60-2.73 (m, 2H), 3.14-3.18 (m, 1H), 3.23-3.27

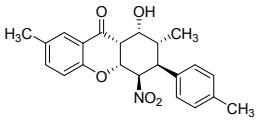
(m, 1H), 3.62-3.69 (m, 1H), 3.73 (s, 3H), 4.94-4.95 (m, 1H), 4.97-4.99 (m, 1H), 6.81 (d, J = 8.8 Hz, 2H), 6.98 (d, J = 8.0 Hz, 1H), 7.05-7.09 (m, 3H), 7.49-7.53 (m, 1H), 7.89-7.91 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.1, 34.8, 45.3, 49.7, 54.2, 70.0, 74.5, 87.6, 113.5, 116.8, 118.8, 122.0, 126.9, 127.1, 128.3, 135.9, 158.3, 158.9, 191.6; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{21}NNaO_6$ [M+Na]$^+$: 406.12611; Found: 406.12613.



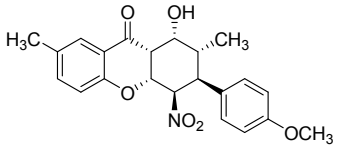
5f: White solid, m.p. 152.6-153.2 ^{o}C; yield 61%, 46.4 mg, 96% ee, 4:1 dr, $[\alpha]_D^{20}$ = +8.5 (c 1.1, MeOH); The ee was determined by HPLC analysis using a Chiralpak IF column (90/10 hexane/i-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 40.23 min; τ_{minor} = 46.37 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.89 (d, J = 6.4 Hz, 3H), 2.26 (s, 3H), 2.28 (s, 3H), 2.65-2.72 (m, 1H), 3.31-3.34 (m, 1H), 3.59-3.65 (m, 1H), 3.68-3.72 (m, 1H), 4.92-4.94 (m, 1H), 4.97-4.98 (m, 1H), 6.85 (d, J = 7.2 Hz, 1H), 7.00-7.04 (m, 3H), 7.09-7.11 (m, 1H), 7.50-7.55 (m, 1H), 7.91-7.93 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 13.7, 15.1, 20.3, 34.8, 41.0, 49.9, 70.3, 74.5, 85.8, 116.9, 118.9, 122.1, 123.6, 125.1, 126.9, 128.6, 132.6, 133.5, 135.9, 136.5, 158.9, 191.7; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{23}NNaO_5$ [M+Na]$^+$: 404.14684; Found: 404.14683.



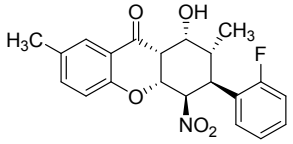
5g: White solid, m.p. 149.1-149.8 ^{o}C; yield 60%, 45.7 mg, 97% ee, 6:1 dr, $[\alpha]_D^{20}$ = +152.9 (c 4.2, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (80/20 hexane/i-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 38.55 min; τ_{minor} = 16.49 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.87 (d, J = 6.4 Hz, 3H), 2.22 (s, 3H), 2.32 (s, 3H), 2.62-2.69 (m, 1H), 2.76 (s, 1H), 3.29-3.33 (m, 1H), 3.45-3.50 (m, 1H), 3.65-3.70 (m, 1H), 4.91-4.96 (m, 2H), 6.85 (d, J = 8.0 Hz, 1H), 6.91 (d, J = 6.8 Hz, 1H), 6.97-6.99 (m, 2H), 7.05-7.09 (m, 1H), 7.48-7.52 (m, 1H), 7.89-7.91 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.0, 18.3, 20.0, 34.7, 40.6, 49.8, 70.2, 74.5, 85.7, 116.8, 118.8, 122.0, 125.7, 126.6, 126.9, 129.8, 130.8, 134.7, 135.9, 136.3, 158.8, 191.7; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{23}NNaO_5$ [M+Na]$^+$: 404.14684; Found: 404.14684.



5h: White solid, m.p. 124.7-125.3 °C; yield 53%, 40.4 mg, 98% ee, 5:1 dr, $[\alpha]_D^{20}$ = -36.5 (*c* 2.3, MeOH); The ee was determined by HPLC analysis using a Chiralpak IF column (80/20 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 15.47 min; τ_{minor} = 20.15 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.96 (d, *J* = 6.4 Hz, 3H), 2.34 (s, 6H), 2.71-2.76 (m, 1H), 2.84 (s, 1H), 3.22-3.26 (m, 1H), 3.28-3.32 (m, 1H), 3.68-3.73 (m, 1H), 4.97-4.98 (m, 1H), 5.03-5.05 (m, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 7.09 (d, *J* = 8.4 Hz, 2H), 7.16 (d, *J* = 8.1 Hz, 2H), 7.37-7.40 (m, 1H), 7.75 (s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 16.2, 20.5, 21.1, 35.6, 46.8, 50.8, 71.1, 75.5, 117.6, 119.4, 127.5, 128.1, 129.8, 132.6, 133.2, 137.8, 138.0, 158.0, 192.9; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{23}NNaO_5$ $[M+Na]^+$: 404.14684; Found: 404.14689.

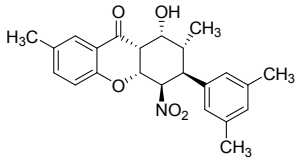


5i: White solid, m.p. 167.4-167.9 °C; yield 52%, 41.3 mg, >99% ee, 8:1 dr, $[\alpha]_D^{20}$ = +1.8 (*c* 1.7, MeOH); The ee was determined by HPLC analysis using a Chiralpak IF column (93/7 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 63.70 min; τ_{minor} = 93.51 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.96 (d, *J* = 6.4 Hz, 3H), 2.34 (s, 3H), 2.68-2.74 (m, 1H), 2.78 (s, 1H), 3.20-3.25 (m, 1H), 3.27-3.31 (m, 1H), 3.67-3.73 (m, 1H), 3.81 (s, 3H), 4.97-4.98 (m, 1H), 5.03-5.05 (m, 1H), 6.88 (d, *J* = 8.8 Hz, 2H), 6.95 (d, *J* = 8.4 Hz, 1H), 7.13 (d, *J* = 8.4 Hz, 2H), 7.38-7.40 (m, 1H), 7.75 (s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 14.1, 18.5, 33.8, 44.3, 48.7, 53.2, 69.1, 73.5, 86.7, 112.5, 115.5, 117.4, 125.4, 126.1, 127.3, 130.7, 136.0, 156.0, 157.2, 190.9; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{23}NNaO_6$ $[M+Na]^+$: 420.14176; Found: 420.14179.

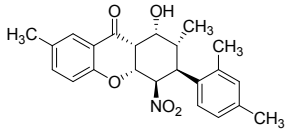


5j: White solid, m.p. 142.4-143.2 °C; yield 60%, 46.2 mg, 93% ee, 6:1 dr, $[\alpha]_D^{20}$ = -9.5 (*c* 2.1, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (93/7 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 107.07 min; τ_{minor} = 41.26 min); ^{1}H NMR

($CDCl_3$, 400 MHz) δ: 0.93 (d, J = 6.4 Hz, 3H), 2.27 (s, 3H), 2.63-2.72 (m, 1H), 2.77-2.80 (m, 1H), 3.18-3.22 (m, 1H), 3.65-3.70 (m, 2H), 4.93-4.94 (m, 1H), 5.04-5.05 (m, 1H), 6.91 (d, J = 8.4 Hz, 1H), 7.03-7.11 (m, 3H), 7.21-7.28 (m, 1H), 7.31-7.33 (m, 1H), 7.67 (s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.0, 19.5, 33.9, 49.7, 69.9, 74.4, 85.6, 114.7 (d, J_{CF} = 22.1 Hz), 116.7, 116.8, 118.4, 122.0 (d, J_{CF} = 14.5 Hz), 123.8, 125.6, 126.4, 128.6 (d, J_{CF} = 3.6 Hz), 131.7, 137.0, 157.0, 160.5 (d, J_{CF} = 244.3 Hz), 191.8; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{20}FNNaO_5$ $[M+Na]^+$: 408.12177; Found: 408.12177.

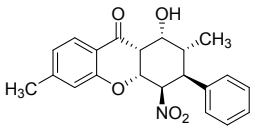


5k: White solid, m.p. 156.5-157.4 °C; yield 48%, 37.9 mg, 97% ee, 10:1 dr, $[\alpha]_D^{20}$ = +9.0 (*c* 1.7, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (90/10 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 57.50 min; τ_{minor} = 35.05 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.90 (d, *J* = 6.4 Hz, 3H), 2.24 (s, 6H), 2.28 (s, 3H), 2.62-2.69 (m, 2H), 3.09-3.14 (m, 1H), 3.21-3.24 (m, 1H), 3.59-3.65 (m, 1H), 4.89-4.90 (m, 1H), 4.97-4.98 (m, 1H), 6.74 (s, 2H), 6.87 (s, 2H), 7.31-7.33 (m, 1H), 7.69 (s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.2, 19.5, 20.3, 34.5, 45.9, 49.7, 70.1, 74.5, 87.6, 116.5, 118.4, 125.0, 126.4, 128.8, 131.6, 135.0, 137.0, 137.5, 157.0, 191.9; HRMS (ESI-TOF) m/z: Calcd. for $C_{23}H_{25}NNaO_5$ $[M+Na]^+$: 418.16249; Found: 418.16251.

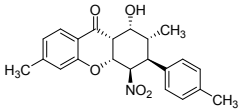


5l: White solid, m.p. 146.5-147.3 °C; yield 52%, 41.1 mg, 97% ee, 10:1 dr, $[\alpha]_D^{20}$ = +6.3 (*c* 1.1, MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (80/20 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 47.64 min; τ_{minor} = 18.47 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.87 (d, *J* = 6.4 Hz, 3H), 2.23 (s, 3H), 2.32 (s, 3H), 2.34 (s, 3H), 2.62-2.74 (m, 2H), 3.25-3.29 (m, 1H), 3.44-3.48 (m, 1H), 3.63-3.68 (m, 1H), 4.90-4.94 (m, 2H), 6.81 (s, 1H), 6.85-6.94 (m, 3H), 6.99 (s, 1H), 7.79 (d, *J* = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.0, 18.3, 20.0, 21.0, 34.6, 40.5, 49.7, 70.3, 74.4, 85.8, 116.5, 116.8, 123.4, 125.7, 126.6, 126.8, 129.9,

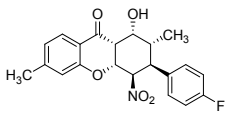
130.8, 134.7, 136.3, 147.8, 158.9, 191.4; HRMS (ESI-TOF) m/z: Calcd. for $C_{23}H_{25}NNaO_5$ $[M+Na]^+$: 418.16249; Found: 418.16255.



5m: White solid, m.p. 144.3-144.9 °C; yield 51%, 37.4 mg, 99% ee, 12:1 dr, $[\alpha]_D^{20}$ = -0.3 (*c* 3.3, MeOH); The ee was determined by HPLC analysis using a Chiralpak IE column (90/10 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 22.71 min; τ_{minor} = 28.63 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.97 (d, *J* = 6.4 Hz, 3H), 2.41 (s, 3H), 2.72-2.80 (m, 1H), 2.87 (s, 1H), 3.24-3.33 (m, 2H), 3.69-3.73 (m, 1H), 4.99-5.00 (m, 1H), 5.05-5.07 (m, 1H), 6.87 (s, 1H), 6.95 (d, *J* = 8.0 Hz, 1H), 7.21-7.23 (m, 2H), 7.32-7.37 (m, 3H), 7.85 (d, *J* = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 15.2, 21.1, 34.5, 46.1, 49.6, 70.1, 74.5, 87.5, 116.5, 116.7, 123.4, 126.8, 127.1, 127.3, 128.1, 135.2, 147.9, 158.9, 191.3; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{21}NNaO_5$ $[M+Na]^+$: 390.13119; Found: 390.13125.

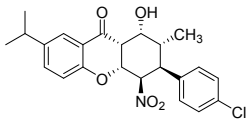


5n: White solid, m.p. 113.2-113.8 °C; yield 60%, 45.7 mg, 95% ee, 6:1 dr, $[\alpha]_D^{20}$ = -1.3 (*c* 1.4, MeOH); The ee was determined by HPLC analysis using a Chiralpak IF column (80/20 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 20.20 min; τ_{minor} = 42.13 min); ^{1}H NMR ($CDCl_3$, 400 MHz) *δ*: 0.89 (d, *J* = 6.4 Hz, 3H), 2.27 (s, 3H), 2.34 (s, 3H), 2.62-2.71 (m, 2H), 3.13-3.17 (m, 1H), 3.20-3.23 (m, 1H), 3.60-3.65 (m, 1H), 4.91-4.92 (m, 1H), 4.93-4.98 (m, 1H), 6.79 (s, 1H), 6.88-6.90 (m, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 7.10 (d, *J* = 8.0 Hz, 2H), 7.78 (d, *J* = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ*: 15.2, 20.1, 21.1, 34.5, 45.7, 49.6, 70.1, 74.5, 87.6, 116.5, 116.7, 123.4, 126.8, 126.9, 127.1, 128.3, 128.8, 132.1, 136.8, 147.8, 158.9, 191.4; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{23}NNaO_5$ $[M+Na]^+$: 404.14684; Found: 404.14687.



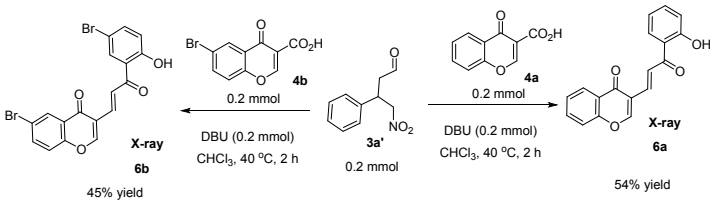
5o: White solid, m.p. 156.0-156.8 °C; yield 54%, 41.6 mg, 98% ee, 4:1 dr, $[\alpha]_D^{20}$ = +43.5 (*c* 3.0,

MeOH); The ee was determined by HPLC analysis using a Chiralpak IC column (75/25 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 45.98 min; τ_{minor} = 83.40 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.88 (d, J = 6.4 Hz, 3H), 2.34 (s, 3H), 2.59-2.65 (m, 1H), 2.78 (d, J = 3.2 Hz, 1H), 3.16-3.21 (m, 2H), 2.59-3.65 (m, 1H), 4.92-4.97 (m, 2H), 6.79 (s, 1H), 6.88-6.90 (m, 1H), 6.96-7.01 (m, 2H), 7.10-7.14 (m, 2H), 7.78 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 15.1, 21.1, 34.7, 45.3, 49.5, 70.0, 74.4, 87.5, 115.1 (d, J_{CF} = 21.0 Hz), 116.5, 116.7, 123.5, 126.8, 128.8 (d, J_{CF} = 7.2 Hz), 131.0, 147.9, 158.8, 161.4 (d, J_{CF} = 245.4 Hz), 191.2; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{20}FNNaO_5$ $[M+Na]^+$: 408.12177; Found: 408.12174.

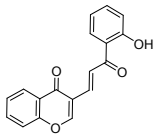


5p: White solid, yield 56%, 48.0 mg, 96% ee, 7:1 dr; The ee was determined by HPLC analysis using a Chiralpak IA column (97/3 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 92.64 min; τ_{minor} = 40.90 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.80 (d, J = 6.4 Hz, 3H), 1.15 (s, 3H), 1.17 (s, 3H), 1.74-1.81 (m, 1H), 2.54 (br s, 1H), 2.68-2.71 (m, 1H), 2.80-2.87 (m, 1H), 3.47-3.53 (m, 1H), 3.66-3.71 (m, 1H), 4.88-4.92 (m, 1H), 5.14-5.15 (m, 1H), 6.88 (d, J = 8.4 Hz, 1H), 7.17-7.19 (m, 2H), 7.25 (d, J = 8.4 Hz, 2H), 7.36-7.39 (m, 1H), 7.71 (d, J = 2.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 14.3, 22.8, 22.9, 32.4, 42.0, 44.1, 52.5, 69.0, 87.8, 117.1, 118.1, 123.6, 128.1, 132.6, 135.0, 135.8, 142.8, 156.9, 190.9; HRMS (ESI-TOF) m/z: Calcd. for $C_{23}H_{24}ClNNaO_5$ $[M+Na]^+$: 452.1235; Found: 452.1238.

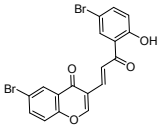
5. Experimental procedures for synthesis of compounds 6



Compound **3a'** (0.2 mmol), **4** (0.2 mmol) and DBU (0.2 mmol) in the $CHCl_3$ (2 mL) were added and stirred at 40 °C for 2 h. After the removal of solvent, purification by flash column chromatography (hexane/ethyl acetate = 10:1~8:1) was carried out to give product **6** as a light yellow solid.

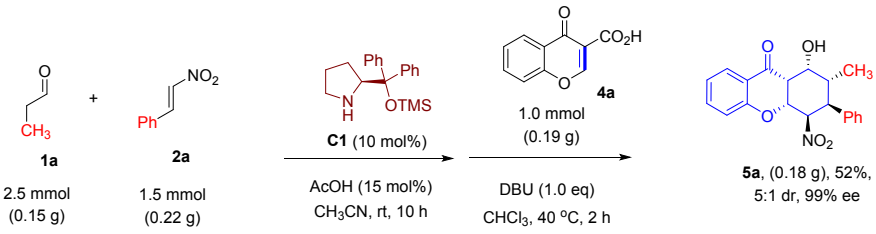


6a: Light yellow solid, yield 54%, 15.8 mg,; ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 6.84-6.88 (m, 1H), 6.91-6.93 (m, 1H), 7.38-7.45 (m, 4H), 7.61-7.66 (m, 1H), 7.93-7.96 (m, 1H), 8.13 (s, 1H), 8.21-8.23 (m, 1H), 8.72 (d, J = 13.2 Hz, 1H), 12.74 (br s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 116.2, 116.4, 117.0, 117.3, 118.0, 122.3, 122.4, 124.1, 124.3, 128.3, 132.2, 134.2, 134.5, 153.4, 157.5, 161.6, 174.3, 192.5; HRMS (ESI-TOF) m/z: Calcd. for $C_{18}H_{12}NaO_4$ $[M+Na]^+$: 315.0628; Found: 315.0632.



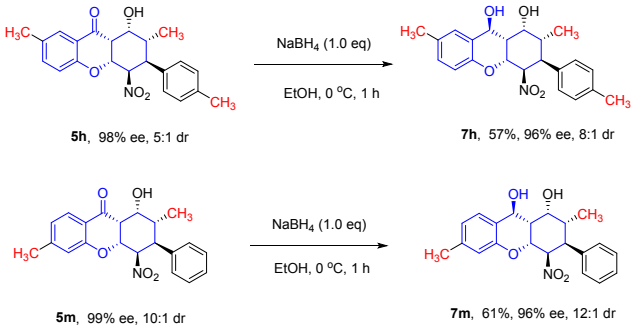
6b: Light yellow solid, yield 45%, 20.1 mg,; ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 6.85 (d, J = 8.8 Hz, 1H), 7.36 (d, J = 9.2 Hz, 1H), 7.47 (d, J = 15.2 Hz, 1H), 7.50-7.52 (m, 1H), 7.74-7.77 (m, 1H), 8.03 (d, J = 2.4 Hz, 1H), 8.17 (s, 1H), 8.38 (d, J = 2.4 Hz, 1H), 8.62 (d, J = 15.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 109.7, 118.4, 118.8, 119.1, 119.4, 120.1, 123.2, 128.0, 131.3, 135.6, 136.3, 138.2, 153.2, 158.6, 161.5, 173.9, 192.5; HRMS (ESI-TOF) m/z: Calcd. for $C_{18}H_{10}Br_2NaO_4$ $[M+Na]^+$: 470.8838; Found: 470.8843.

6. Large-scale synthesis of product 5a

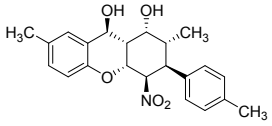


Compound **1a** (2.5 mmol), **2a** (1.5 mmol), **C1** (10 mol%) and AcOH (0.15 mmol) in the CH_3CN (12 mL) at room temperature for 10 h. After the removal of solvent, **4a** (1.0 mmol) and DBU (1.0 mmol) in the $CHCl_3$ (7 mL) were added and stirred at 40 °C for 2 h. After the removal of solvent, purification by flash column chromatography (hexane/ethyl acetate = 8:1~5:1) was carried out to give product **5a** as a white solid (0.18 g, 52% yield, 5:1 dr, 99% ee).

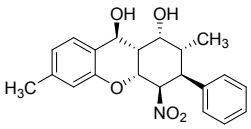
7. Product elaboration



Compound **5** (0.2 mmol) and $NaBH_4$ (0.1 mmol) in the EtOH (3 mL) were added and stirred at 0 °C for 1 h. After the removal of solvent, purification by flash column chromatography (hexane/ethyl acetate = 10:1~8:1) was carried out to give product **7** as a white solid.



7h: White solid; yield 57%, 43.7 mg, 96% ee, 8:1 dr; The ee was determined by HPLC analysis using a Chiralpak IB column (98/2 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 34.96 min; τ_{minor} = 23.10 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.80 (d, J = 6.4 Hz, 3H), 2.25 (s, 3H), 2.26 (s, 3H), 2.68-2.75 (m, 1H), 2.92-2.96 (m, 1H), 3.02-3.06 (m, 1H), 3.27 (br s, 1H), 3.67-3.72 (m, 1H), 4.48 (br s, 1H), 4.62-4.63 (m, 1H), 4.89-4.91 (m, 1H), 5.14 (d, J = 4.4 Hz, 1H), 6.66 (d, J = 8.4 Hz, 1H), 6.95 (d, J = 8.0 Hz, 1H), 7.02 (d, J = 8.0 Hz, 2H), 7.07 (d, J = 8.0 Hz, 2H), 7.35 (s, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 14.6, 19.7, 20.1, 35.4, 37.7, 44.9, 67.8, 72.2, 73.0, 88.6, 114.3, 122.8, 126.2, 127.2, 127.8, 128.6, 128.7, 129.9, 130.3, 132.4, 136.6, 148.4; HRMS (ESI-TOF) m/z: Calcd. for $C_{22}H_{25}NNaO_5$ $[M+Na]^+$: 406.1625; Found: 406.1621.



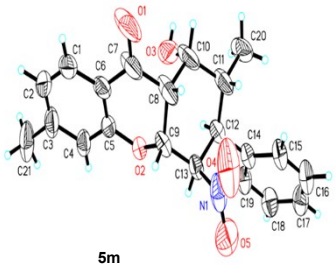
7m: White solid; yield 61%, 45.0 mg, 96% ee, 12:1 dr; The ee was determined by HPLC analysis using a Chiralpak IE column (95/5 hexane/*i*-PrOH; flow rate: 1.0 mL/min; λ = 254 nm; τ_{major} = 22.58 min; τ_{minor} = 45.25 min); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 0.80 (d, J = 6.4 Hz, 3H), 2.26 (s, 3H), 2.69-2.79 (m, 1H), 2.90-2.93 (m, 1H), 3.05-3.09 (m, 1H), 3.63 (br s, 1H), 3.68-3.73 (m, 1H), 4.62 (br s, 1H), 4.63 (s, 1H), 4.91-4.93 (m, 1H), 5.15 (d, J = 4.4 Hz, 1H), 6.61 (s, 1H),

6.79 (d, J = 7.6 Hz, 1H), 7.13 (d, J = 7.2 Hz, 2H), 7.21-7.29 (m, 3H), 7.40 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ: 14.6, 20.1, 35.2, 37.7, 45.3, 67.7, 72.0, 73.0, 88.5, 115.0, 120.1, 121.9, 125.8, 126.9, 127.4, 127.8, 128.0, 129.9, 135.5, 138.2, 150.5; HRMS (ESI-TOF) m/z: Calcd. for $C_{21}H_{23}NNaO_5$ $[M+Na]^+$: 392.1468; Found: 392.1468.

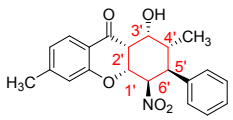
8. General experimental procedures for in vitro cytotoxicity assay

Two human cancer cell lines, K562 and A549 were purchased from Chinese Academy of Sciences. All the cells were cultured in RPMI-1640 medium (GIBICO, USA), supplemented with 10% fetal bovine serum (Hyclone, USA) and Penicillin-Streptomycin (respectively 100 U/mL) in 5% CO_2 at 37°C. The cytotoxicity assay was performed according to the MTT (3-(4,5-dimethylthiazol-2-yl)-2, 5-diphenyl tetrazolium bromide) method in 96-well microplates. Briefly, 5000 cells were seeded into each well of 96-well cell culture plates and allowed to grow for 24 h before drug addition. The K562 tumor cell line was exposed to test compounds **5c**, **5h**, **5i**, **5k**, **5l** and **5q** at the concentrations of 10, 20, 40, 80, and 100 μmol·L^{-1} in triplicates for 48 h, comparable to cisplatin (Aladdin, China). Then the MTT reagent was added to reaction with the cancer cells for 4 hours. At least, measure the OD value at 490 wavelengths. IC_{50} of all the compounds were calculated by IBM SPSS Statistics (version 19).

9. X-Ray crystal data for compound 5m, 6a and 6b



5m

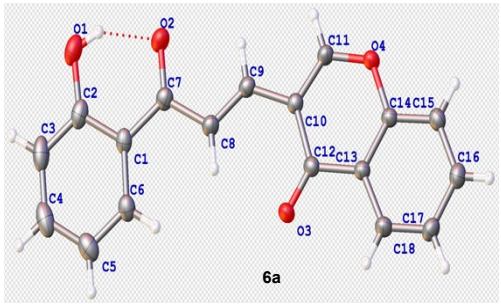


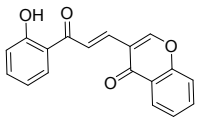
5m

Table S1 Crystal data and structure refinement for 5m

Identification code	**5m**
Empirical formula	$C_{21}H_{21}NO_5$
Formula weight	367.39
Temperature/K	293(2)
Crystal system	monoclinic
Space group	I2
a/Å, b/Å, c/Å	21.9574(10), 5.9872(3), 14.5153(8)
α/°, β/°, γ/°	90, 92.023(5), 90.
Volume/Å^3	1907.05(16)
Z	4
ρ_{calc}g/cm^3	1.280
μ/mm^{-1}	0.754
F(000)	776.0
Radiation	Cu Kα (λ = 1.54184)
Crystal size/mm^3	0.14 × 0.12 × 0.11
2Θ range for data collection/°	7.186 to 146.89
Index ranges	-26 ≤ h ≤ 25, -7 ≤ k ≤ 6, -18 ≤ l ≤ 17
Reflections collected	6212
Independent reflections	3225 [R_{int} = 0.0181, R_{sigma} = 0.0225]
Data/restraints/parameters	3225/1/248
Goodness-of-fit on F^2	1.083
Final R indexes [I>=2σ (I)]	R_1 = 0.0636, wR_2 = 0.1766
Final R indexes [all data]	R_1 = 0.0713, wR_2 = 0.1874
Largest diff. peak/hole / e Å^{-3}	0.20/-0.24
Flack/Hooft parameter	0.02(15)/0.08(13)

Crystal Data for $C_{21}H_{21}NO_5$ (*M* =367.39 g/mol): monoclinic, space group I2 (no. 5), *a* = 21.9574(10) Å, *b* = 5.9872(3) Å, *c* = 14.5153(8) Å, *β* = 92.023(5)°, *V* = 1907.05(16) Å^3, *Z* = 4, *T* = 293(2) K, μ(Cu Kα) = 0.754 mm^{-1}, *Dcalc* = 1.280 g/cm^3, 6212 reflections measured (7.186° ≤ 2Θ ≤ 146.89°), 3225 unique (R_{int} = 0.0181, R_{sigma} = 0.0225) which were used in all calculations. The final R_1 was 0.0636 (I > 2σ(I)) and wR_2 was 0.1874 (all data).



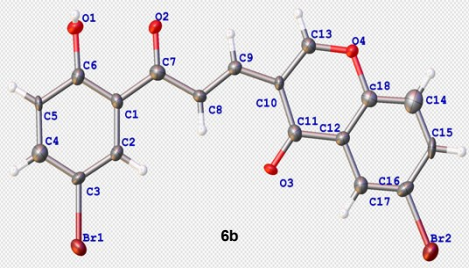


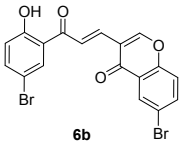
6a

Table S2 Crystal data and structure refinement for 6a

Identification code	**6a**
Empirical formula	$C_{18}H_{12}O_4$
Formula weight	292.28
Temperature/K	149.99(10)
Crystal system	orthorhombic
Space group	$Pna2_1$
a/Å, b/Å, c/Å	23.3436(14), 4.9735(3), 11.5943(5)
α/°, β/°, γ/°,	90, 90, 90.
Volume/Å^3	1346.09(13)
Z	4
ρ_{calc}g/cm^3	1.442
μ/mm^{-1}	0.845
F(000)	608.0
Radiation	Cu Kα (λ = 1.54184)
Crystal size/mm^3	0.13 × 0.12 × 0.1
2Θ range for data collection/°	7.574 to 147.238
Index ranges	$-20 \le h \le 28$, $-5 \le k \le 4$, $-12 \le l \le 14$
Reflections collected	2876
Independent reflections	1857 [R_{int} = 0.0170, R_{sigma} = 0.0288]
Data/restraints/parameters	1857/1/201
Goodness-of-fit on F^2	1.074
Final R indexes [I>=2σ (I)]	R_1 = 0.0348, wR_2 = 0.0876
Final R indexes [all data]	R_1 = 0.0364, wR_2 = 0.0900
Largest diff. peak/hole / e Å^{-3}	0.13/-0.20
Flack parameter	0.1(3)

Crystal Data for $C_{18}H_{12}O_4$ (M =292.28 g/mol): orthorhombic, space group $Pna2_1$ (no. 33), a = 23.3436(14) Å, b = 4.9735(3) Å, c = 11.5943(5) Å, V = 1346.09(13) Å^3, Z = 4, T = 149.99(10) K, μ(Cu Kα) = 0.845 mm^{-1}, $Dcalc$ = 1.442 g/cm^3, 2876 reflections measured (7.574° ≤ 2Θ ≤ 147.238°), 1857 unique (R_{int} = 0.0170, R_{sigma} = 0.0288) which were used in all calculations. The final R_1 was 0.0348 (I > 2σ(I)) and wR_2 was 0.0900 (all data).





6b

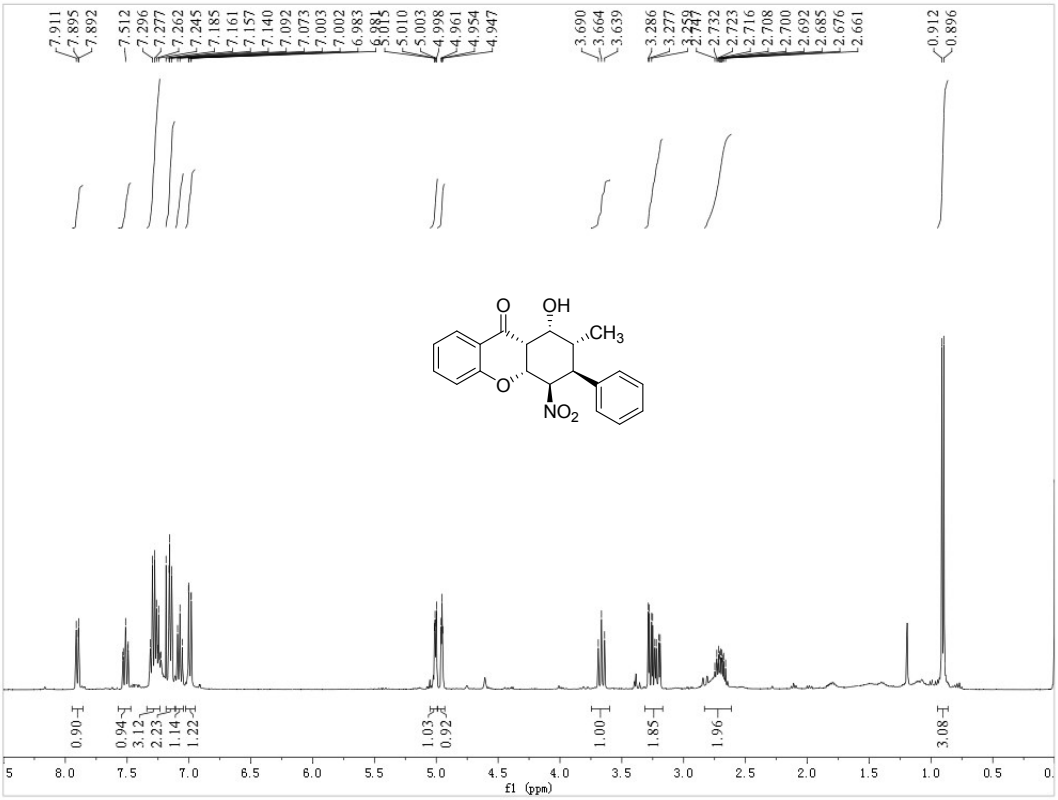
Table S3 Crystal data and structure refinement for 6b

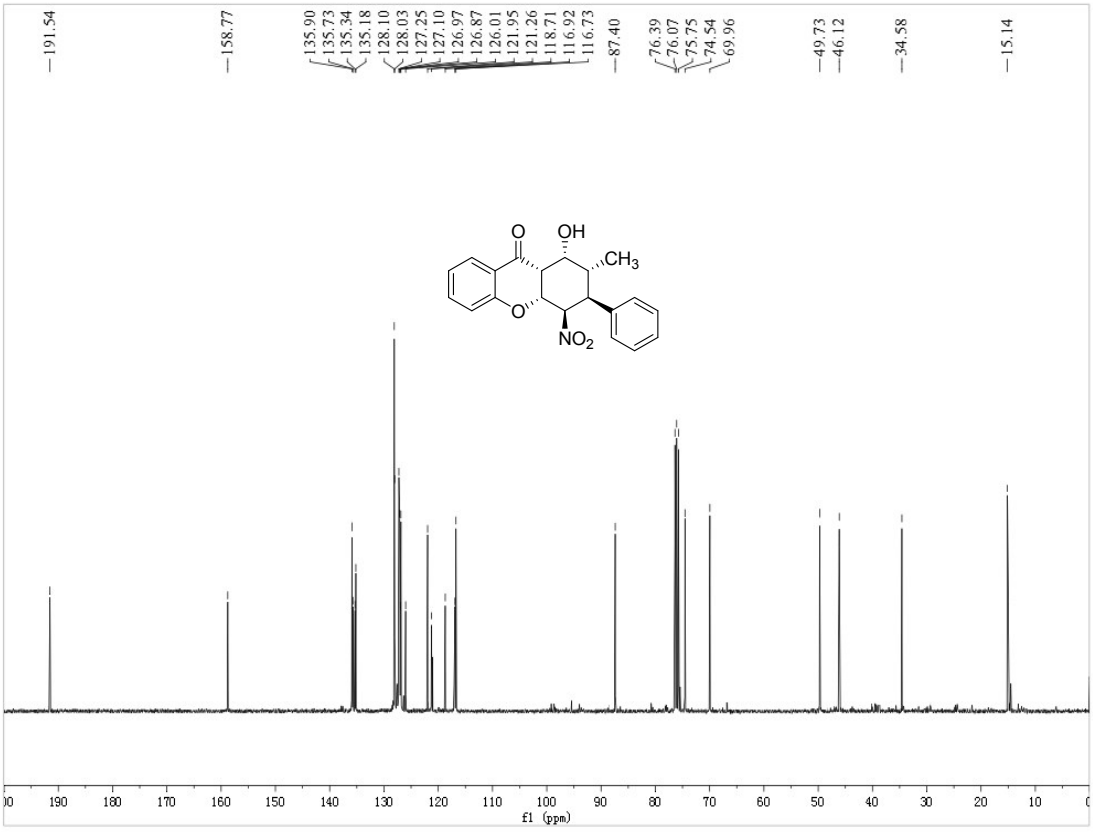
Identification code	**6b**
Empirical formula	$C_{18}H_{10}Br_2O_4$
Formula weight	450.08
Temperature/K	149.99(10)
Crystal system	orthorhombic
Space group	Pnma
a/Å, b/Å, c/Å	12.5529(7), 6.6080(5), 19.3655(12)
α/°, β/°, γ/°,	90, 90, 90.
Volume/Å^3	1606.36(18)
Z	4
ρ_{calc}g/cm^3	1.861
μ/mm^{-1}	6.584
F(000)	880.0
Radiation	Cu Kα (λ = 1.54184)
Crystal size/mm^3	0.14 × 0.11 × 0.09
2Θ range for data collection/°	78.394 to 147.074
Index ranges	-14 ≤ h ≤ 15, -4 ≤ k ≤ 7, -22 ≤ l ≤ 23
Reflections collected	3861
Independent reflections	1716 [R_{int} = 0.0488, R_{sigma} = 0.0442]
Data/restraints/parameters	1716/0/145
Goodness-of-fit on F^2	1.097
Final R indexes [I>=2σ (I)]	R_1 = 0.0995, wR_2 = 0.2587
Final R indexes [all data]	R_1 = 0.1041, wR_2 = 0.2644
Largest diff. peak/hole / e Å^{-3}	1.33/-1.17

Crystal Data for $C_{18}H_{10}Br_2O_4$ (M =450.08 g/mol): orthorhombic, space group Pnma (no. 62), a = 12.5529(7) Å, b = 6.6080(5) Å, c = 19.3655(12) Å, V = 1606.36(18) Å^3, Z = 4, T = 149.99(10) K, μ(Cu Kα) = 6.584 mm^{-1}, *Dcalc* = 1.861 g/cm^3, 3861 reflections measured (8.394° ≤ 2Θ ≤ 147.074°), 1716 unique (R_{int} = 0.0488, R_{sigma} = 0.0442) which were used in all calculations. The final R_1 was 0.0995 (I > 2σ(I)) and wR_2 was 0.2644 (all data).

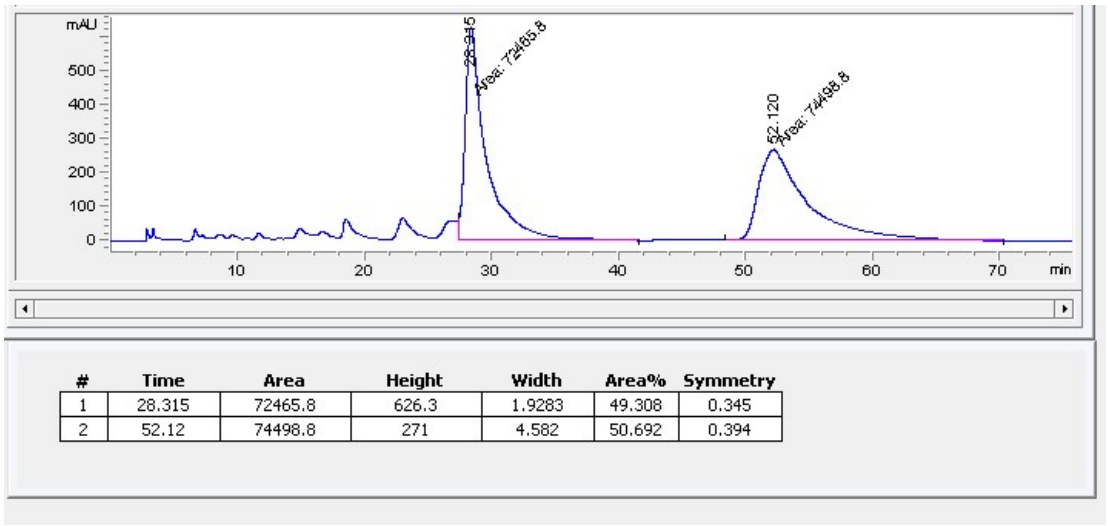
10. The copies of ^{1}H NMR, ^{13}C NMR and HPLC spectra for compounds 5-7

^{1}H and ^{13}C NMR of **5a**

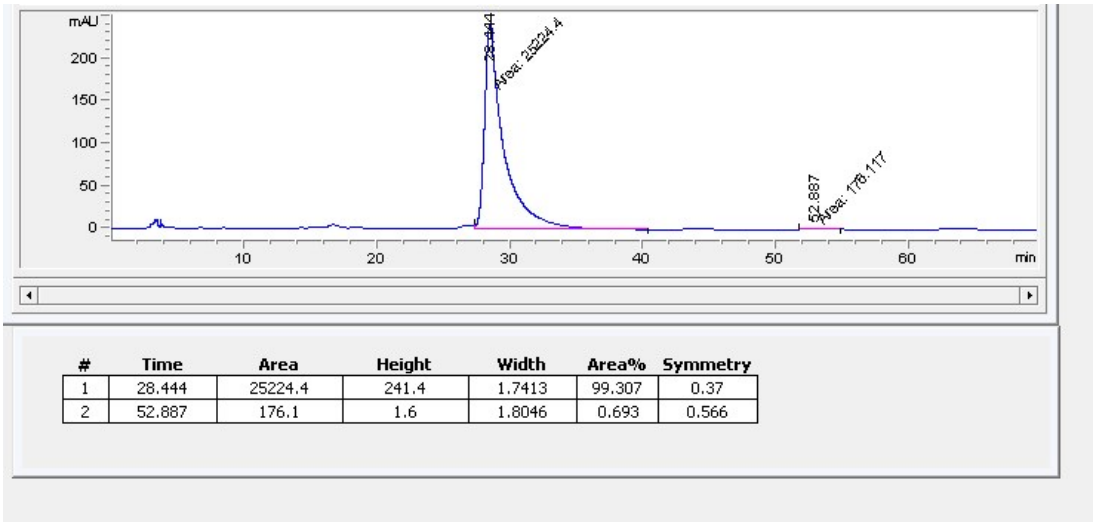




HPLC of **5a**

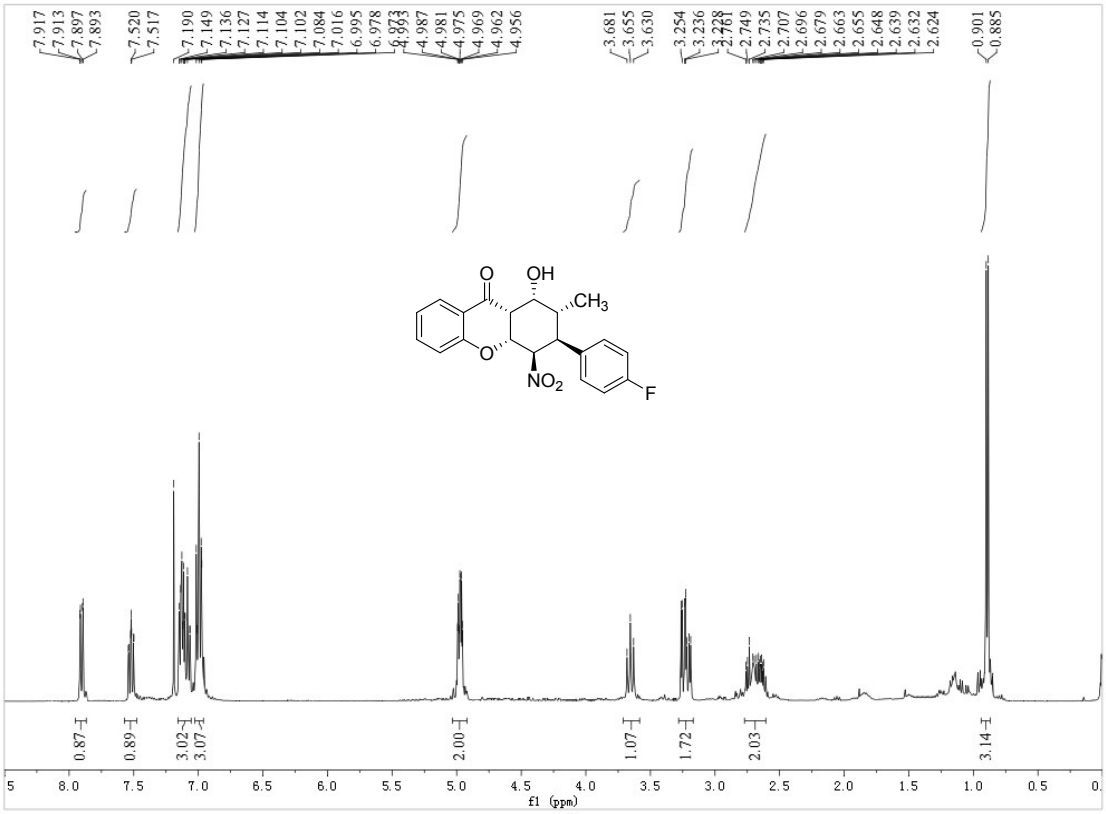


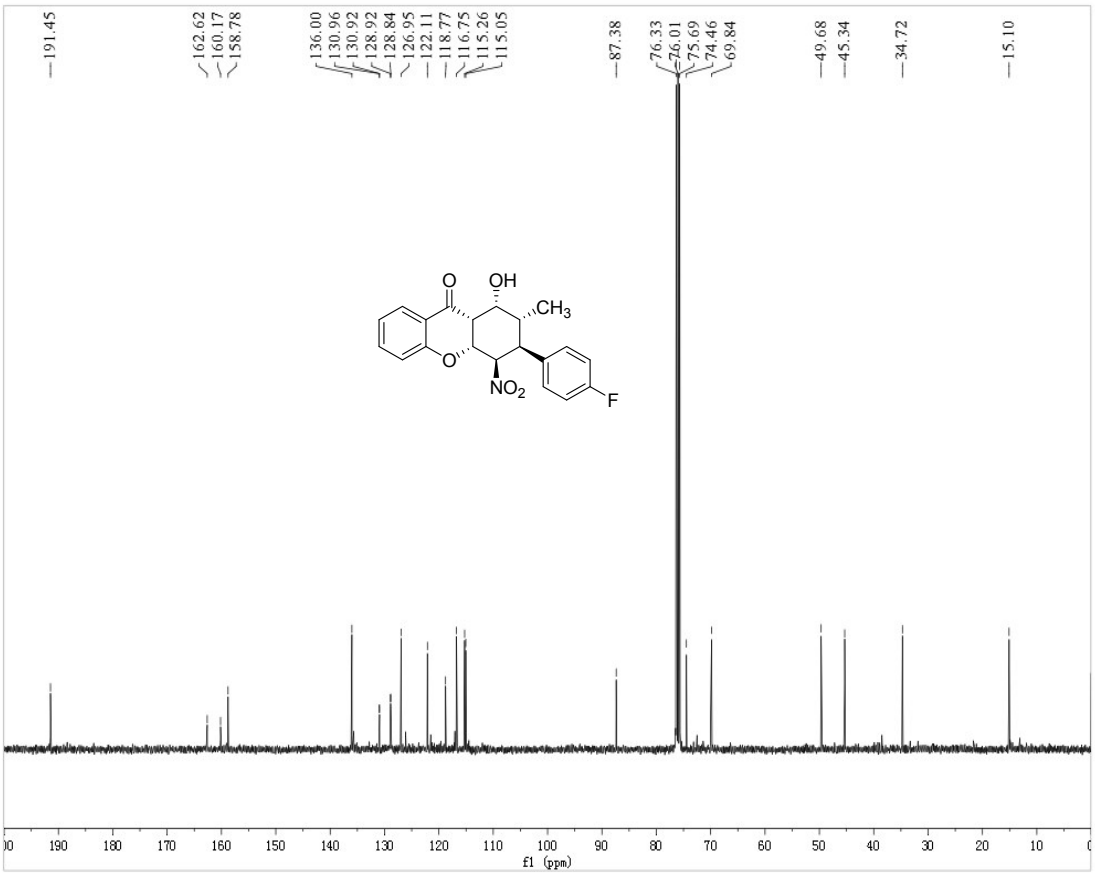
#	Time	Area	Height	Width	Area%	Symmetry
1	28.315	72465.8	626.3	1.9283	49.308	0.345
2	52.12	74498.8	271	4.582	50.692	0.394



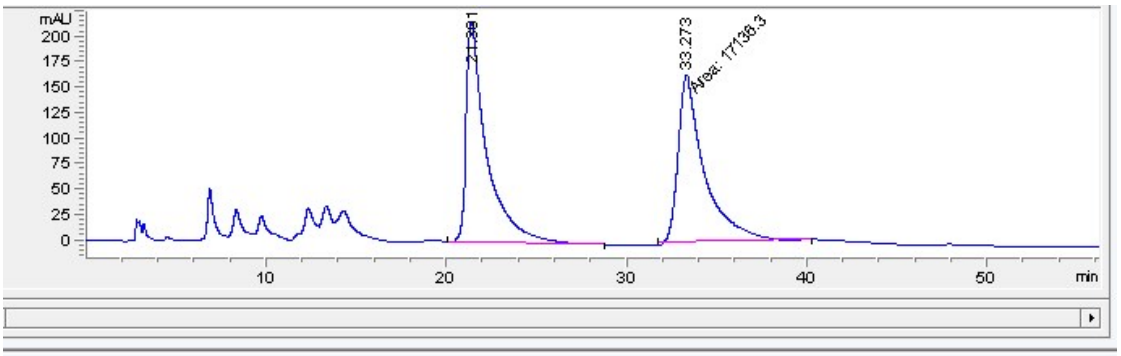
#	Time	Area	Height	Width	Area%	Symmetry
1	28.444	25224.4	241.4	1.7413	99.307	0.37
2	52.887	176.1	1.6	1.8046	0.693	0.566

^{1}H and ^{13}C NMR of **5b**

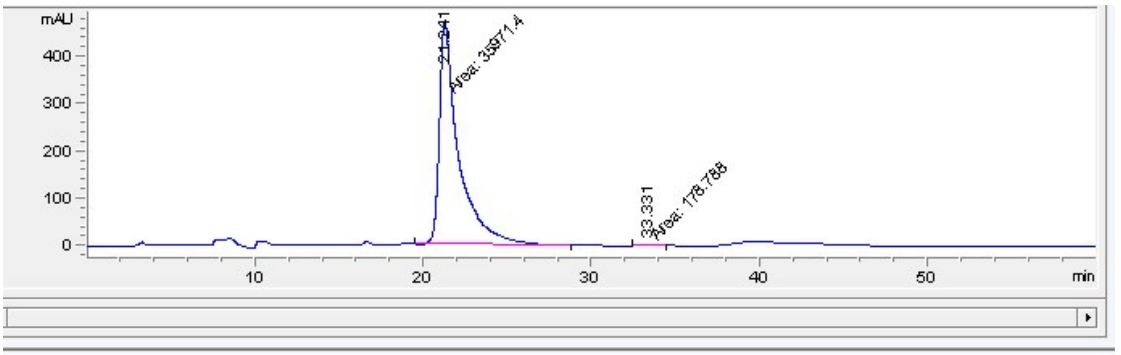




HPLC of **5b**

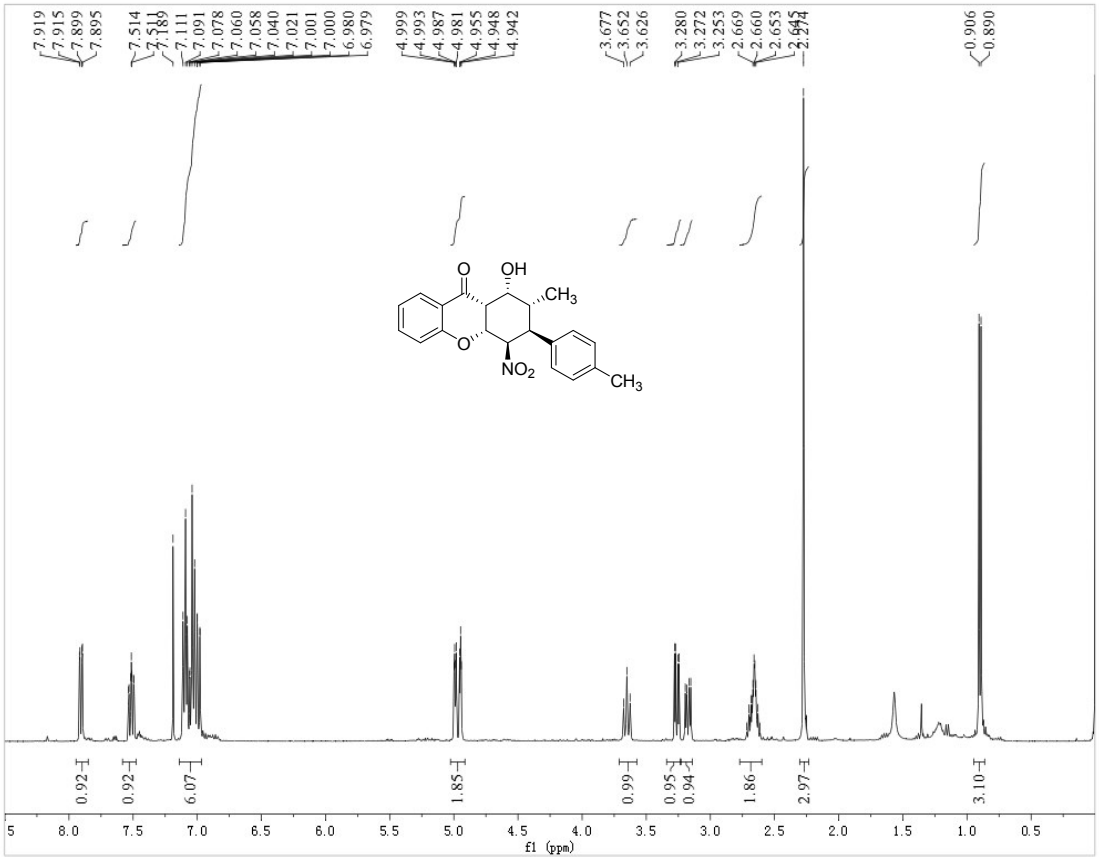


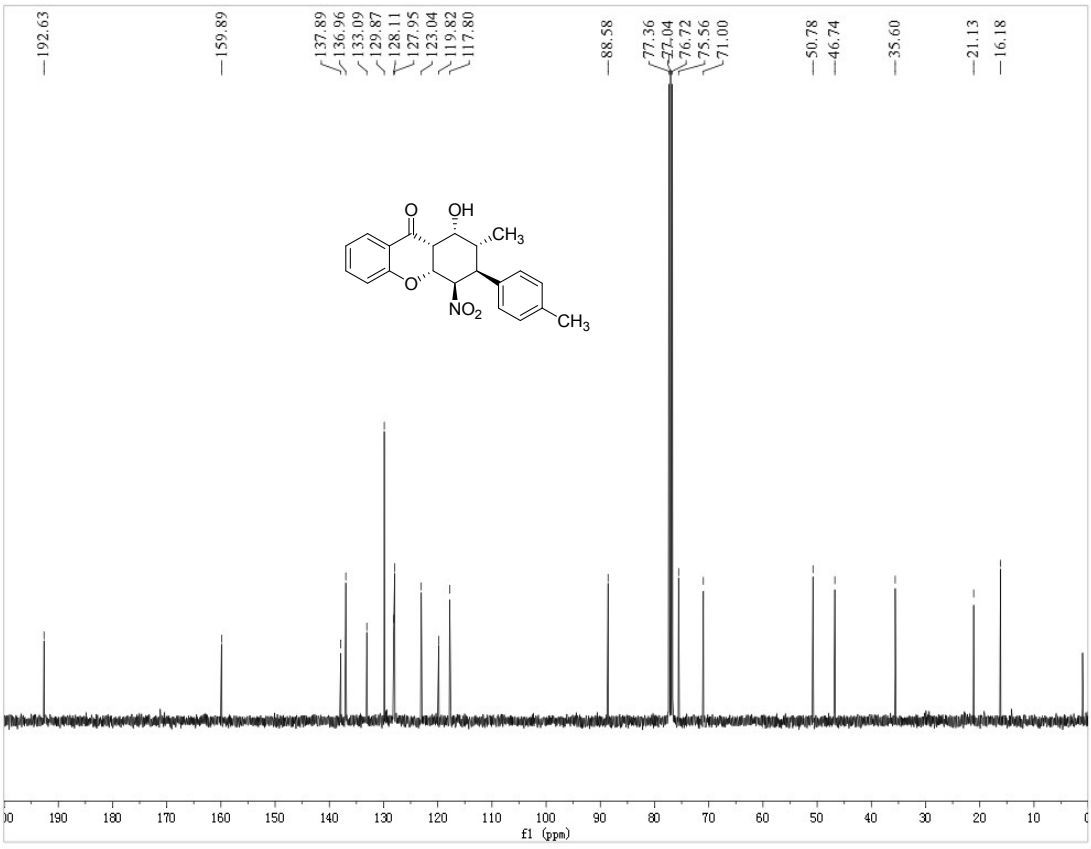
#	Time	Area	Height	Width	Area%	Symmetry
1	21.391	17087.1	216.9	1.0861	49.928	0.344
2	33.273	17136.3	164.5	1.7357	50.072	0.437



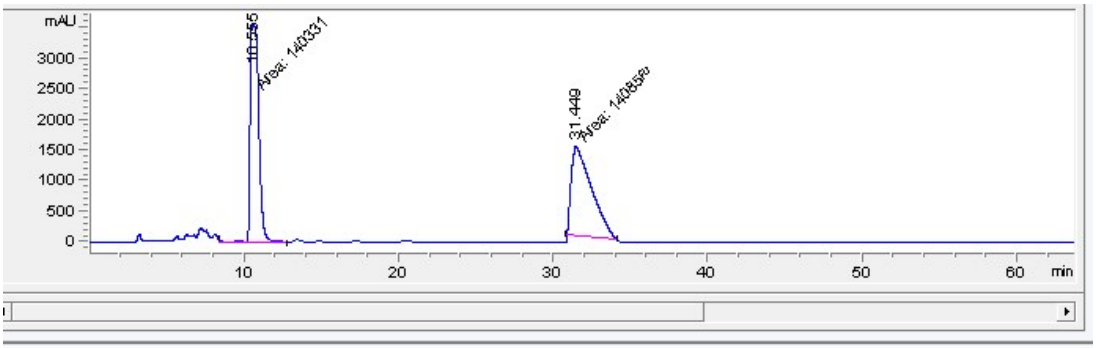
#	Time	Area	Height	Width	Area%	Symmetry
1	21.241	35971.4	468.5	1.2797	99.505	0.364
2	33.331	178.8	2.9	1.0161	0.495	1.287

^{1}H and ^{13}C NMR of **5c**

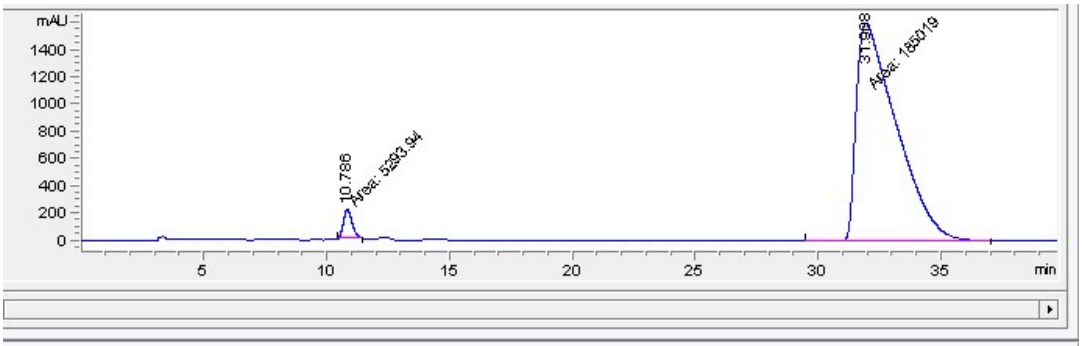




HPLC of **5c**

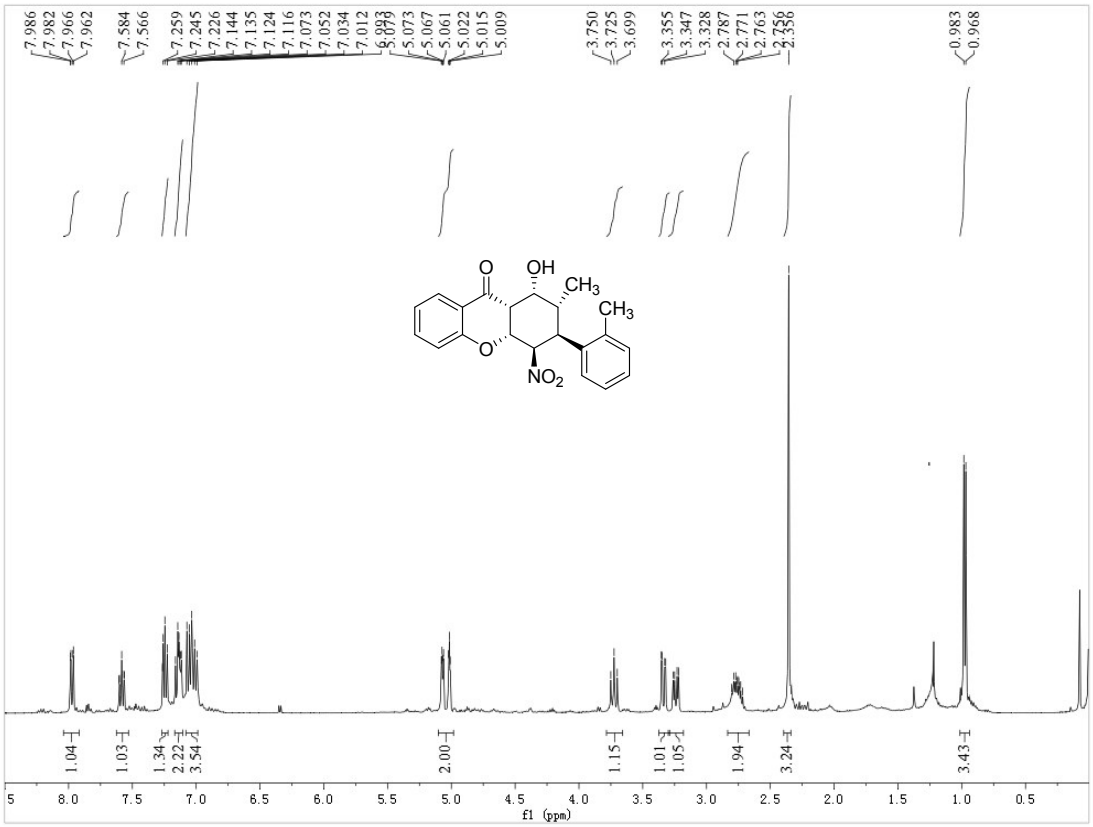


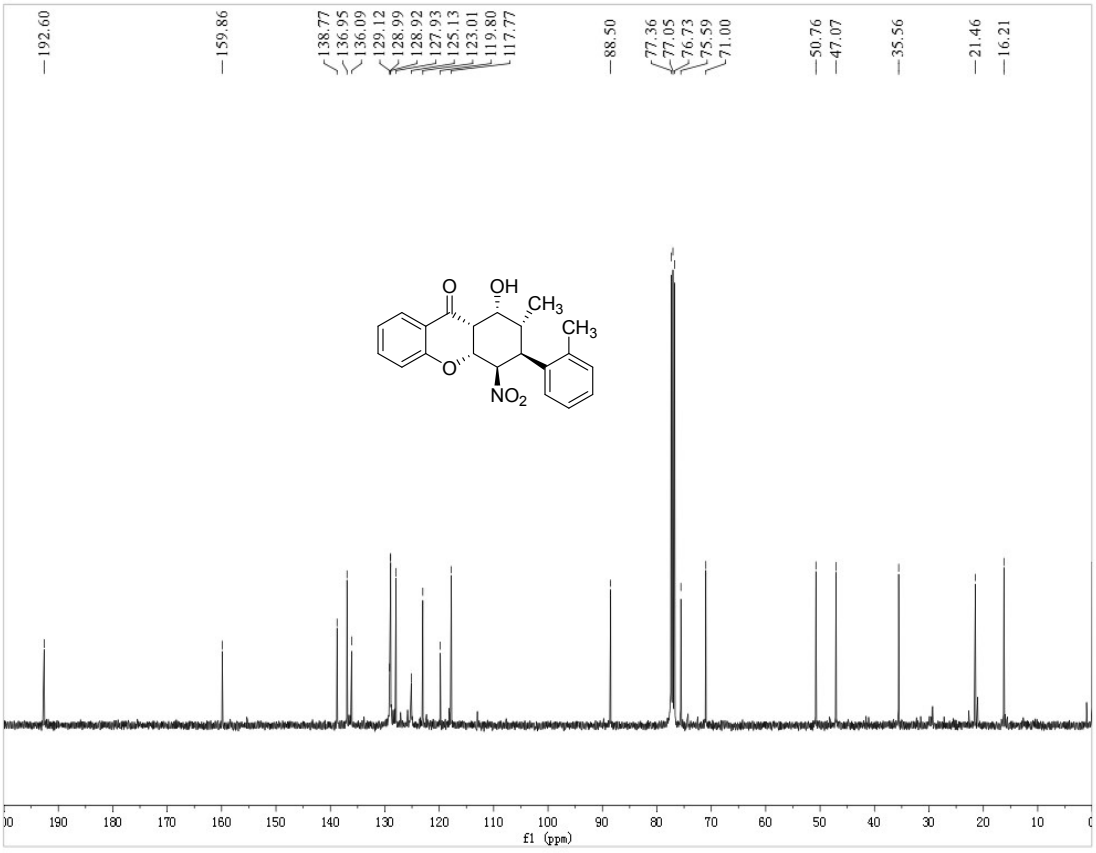
#	Time	Area	Height	Width	Area%	Symmetry
1	10.555	140331	3584.6	0.6525	49.907	0.527
2	31.449	140856.3	1474.7	1.5919	50.093	0.345



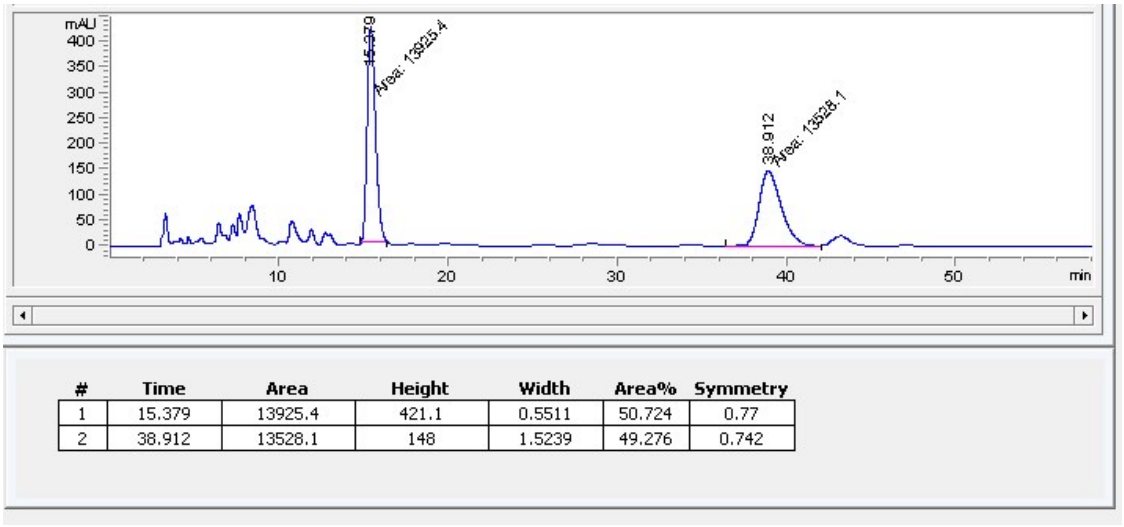
#	Time	Area	Height	Width	Area%	Symmetry
1	10.786	5293.9	211.6	0.417	2.782	0.77
2	31.908	185019.3	1606.6	1.9194	97.218	0.308

^{1}H and ^{13}C NMR of **5d**

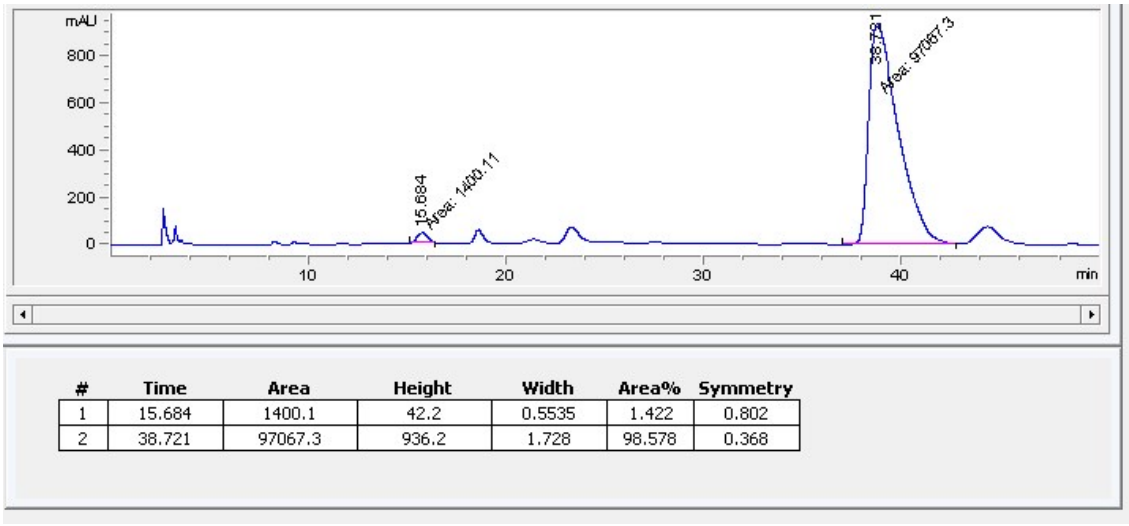




HPLC of **5d**

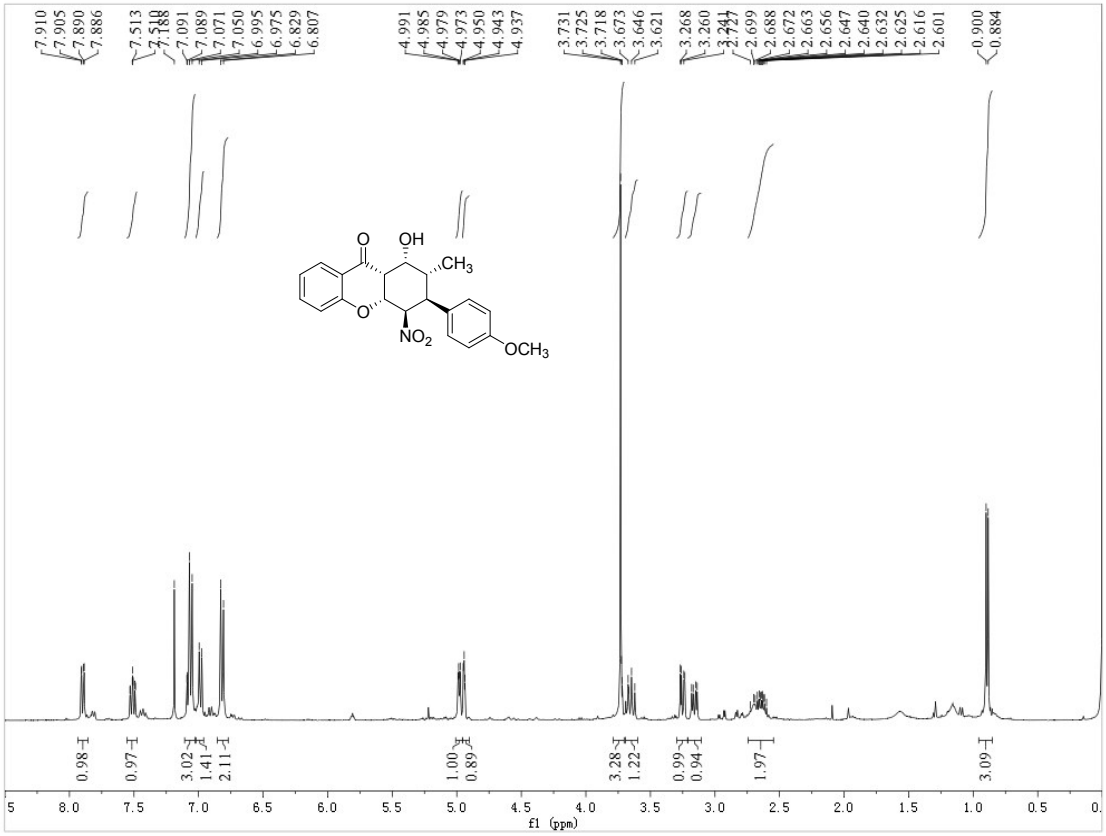


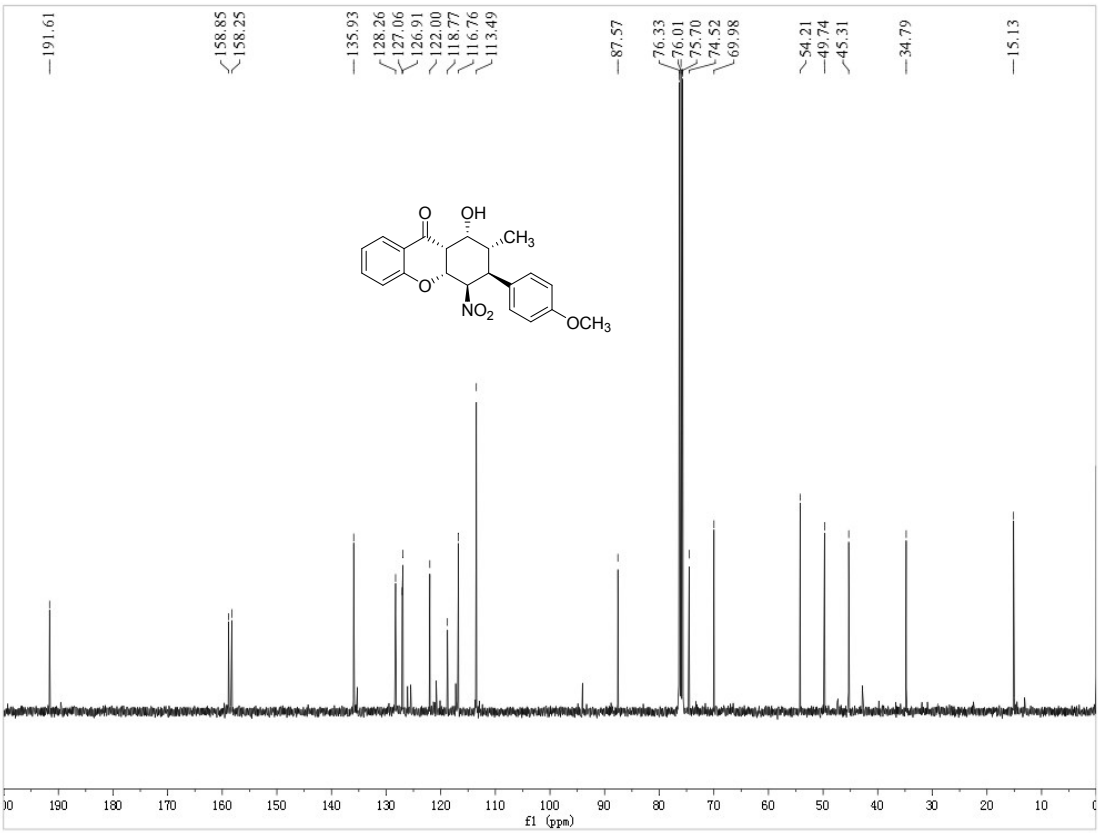
#	Time	Area	Height	Width	Area%	Symmetry
1	15.379	13925.4	421.1	0.5511	50.724	0.77
2	38.912	13528.1	148	1.5239	49.276	0.742



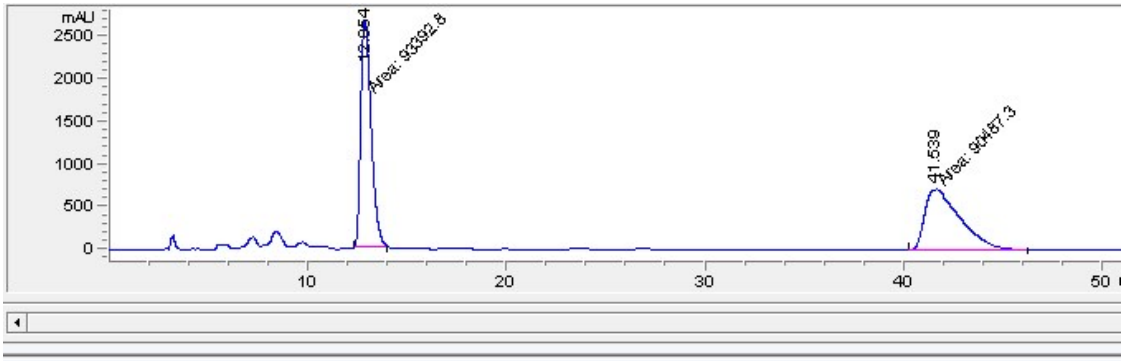
#	Time	Area	Height	Width	Area%	Symmetry
1	15.684	1400.1	42.2	0.5535	1.422	0.802
2	38.721	97067.3	936.2	1.728	98.578	0.368

^{1}H and ^{13}C NMR of **5e**

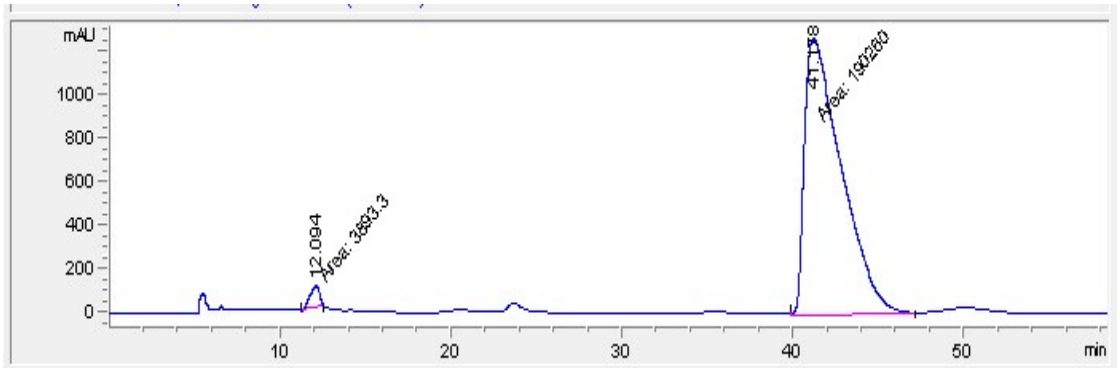




HPLC of **5e**

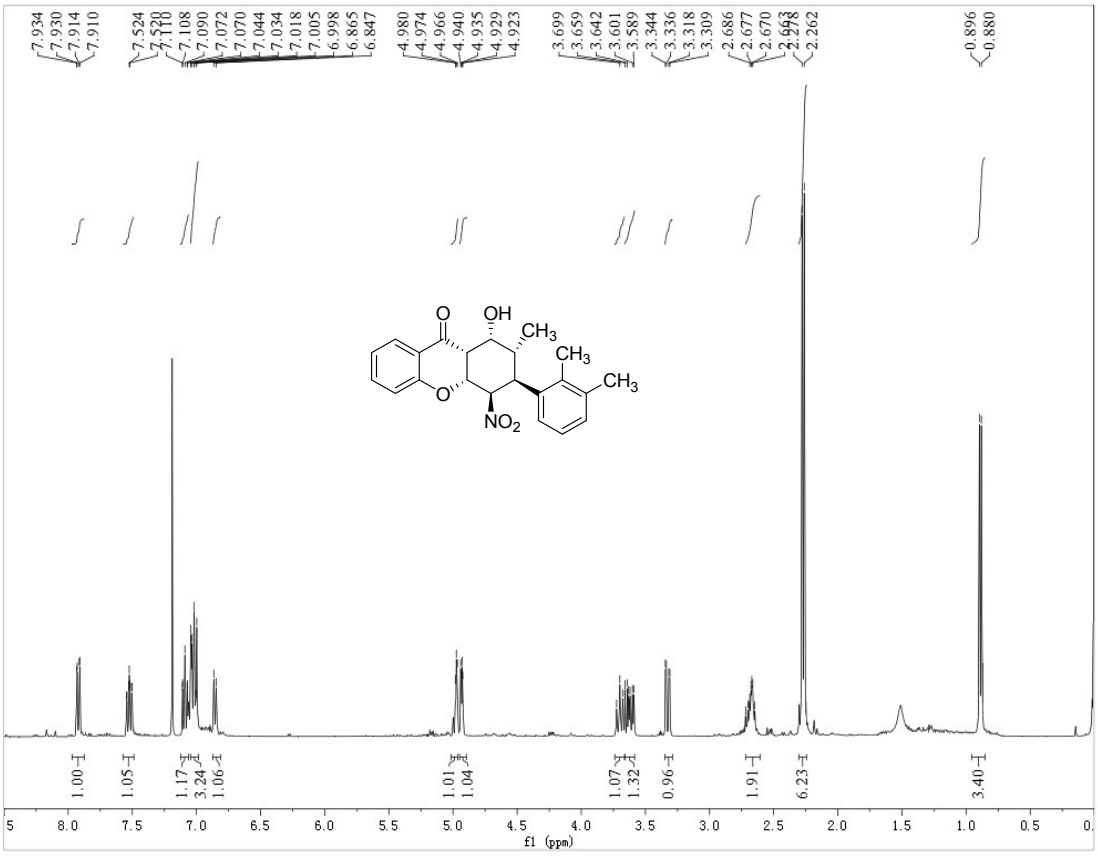


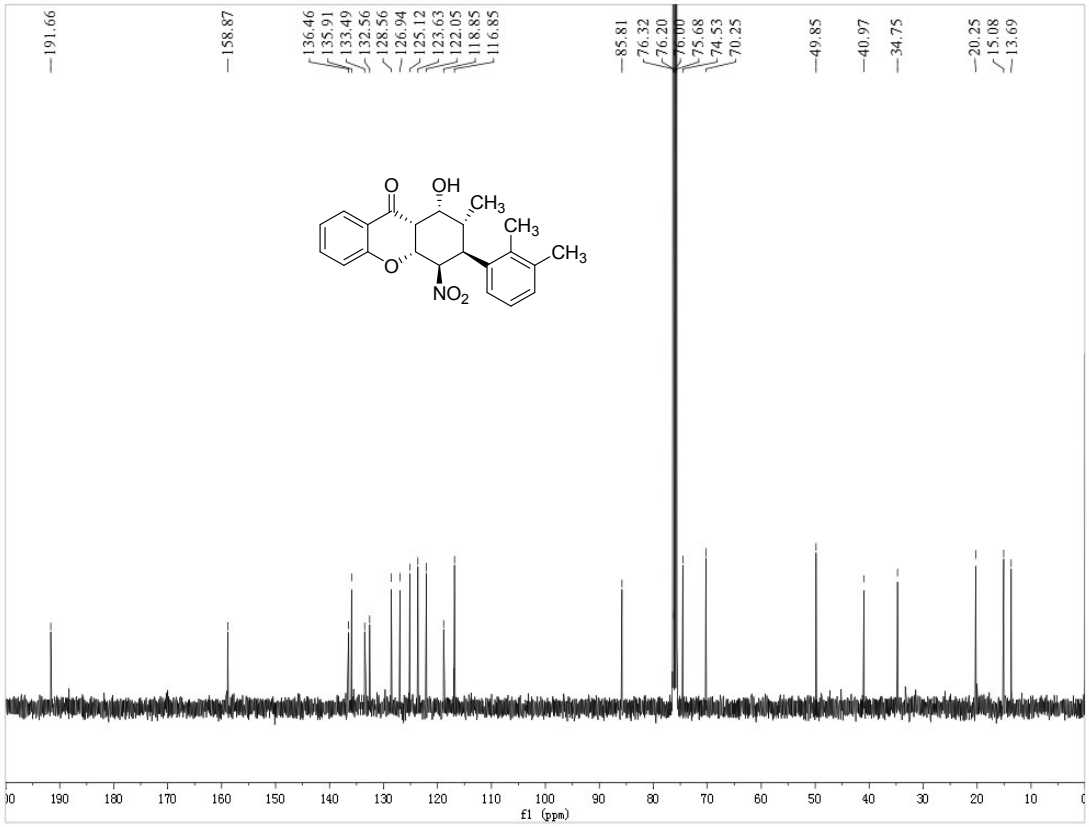
#	Time	Area	Height	Width	Area%	Symmetry
1	12.854	93392.8	2667.5	0.5835	50.790	0.634
2	41.539	90487.3	715.4	2.108	49.210	0.392



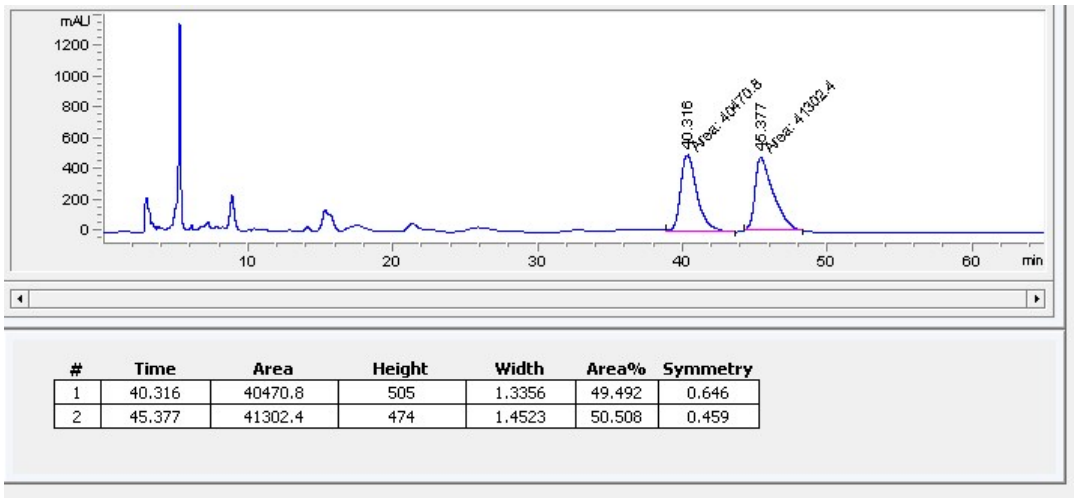
#	Time	Area	Height	Width	Area%	Symmetry
1	12.094	3893.3	103	0.6298	2.005	1.613
2	41.178	190260.4	1268.3	2.5003	97.995	0.319

^{1}H and ^{13}C NMR of **5f**

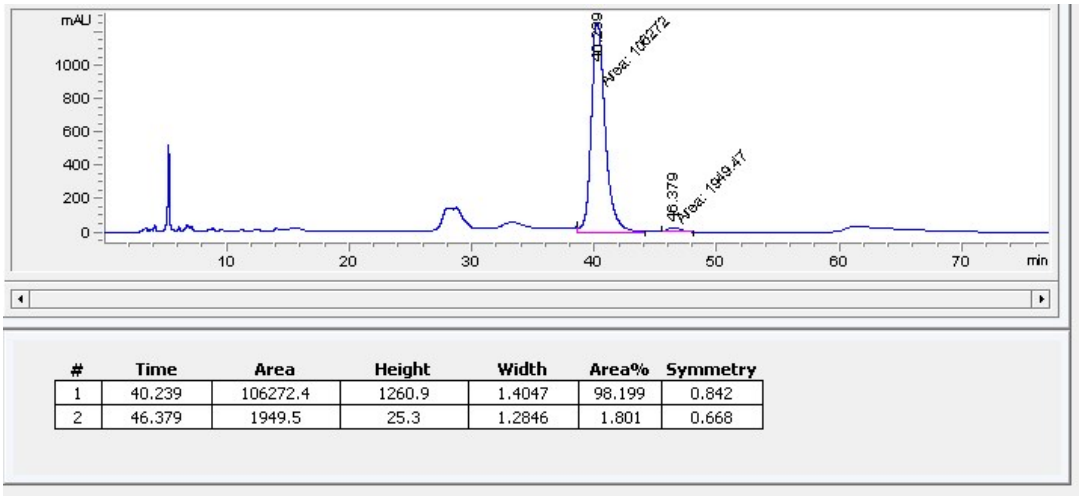




HPLC of **5f**

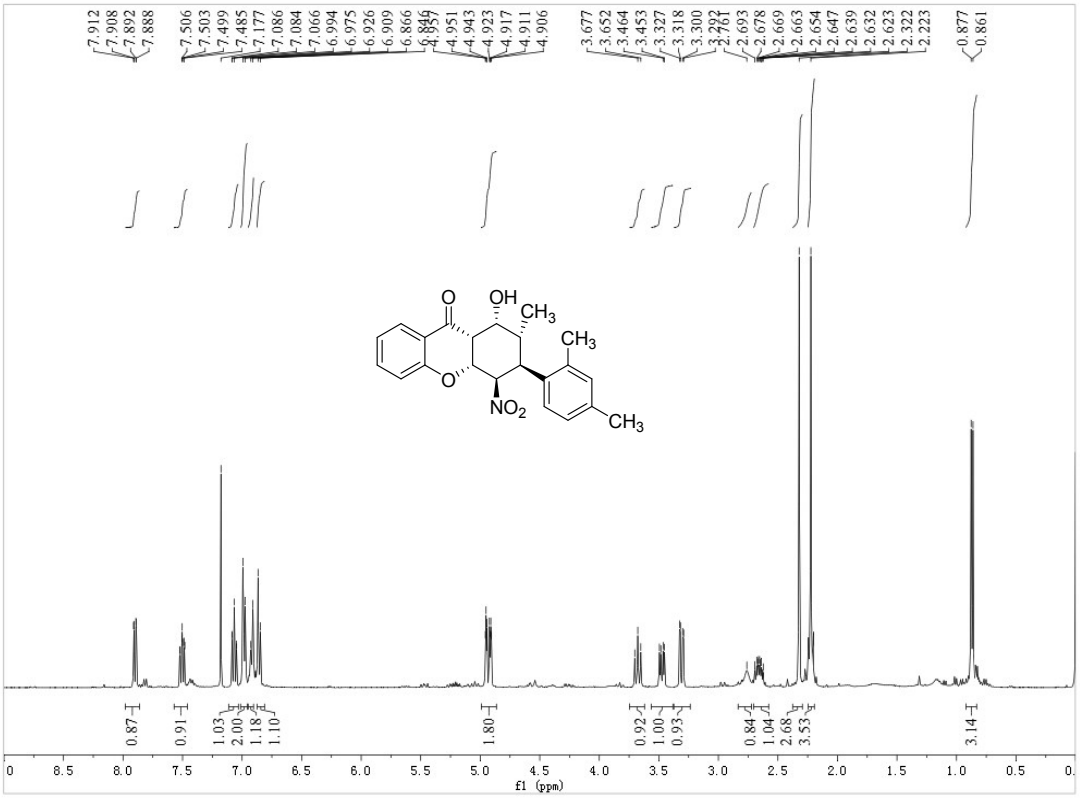


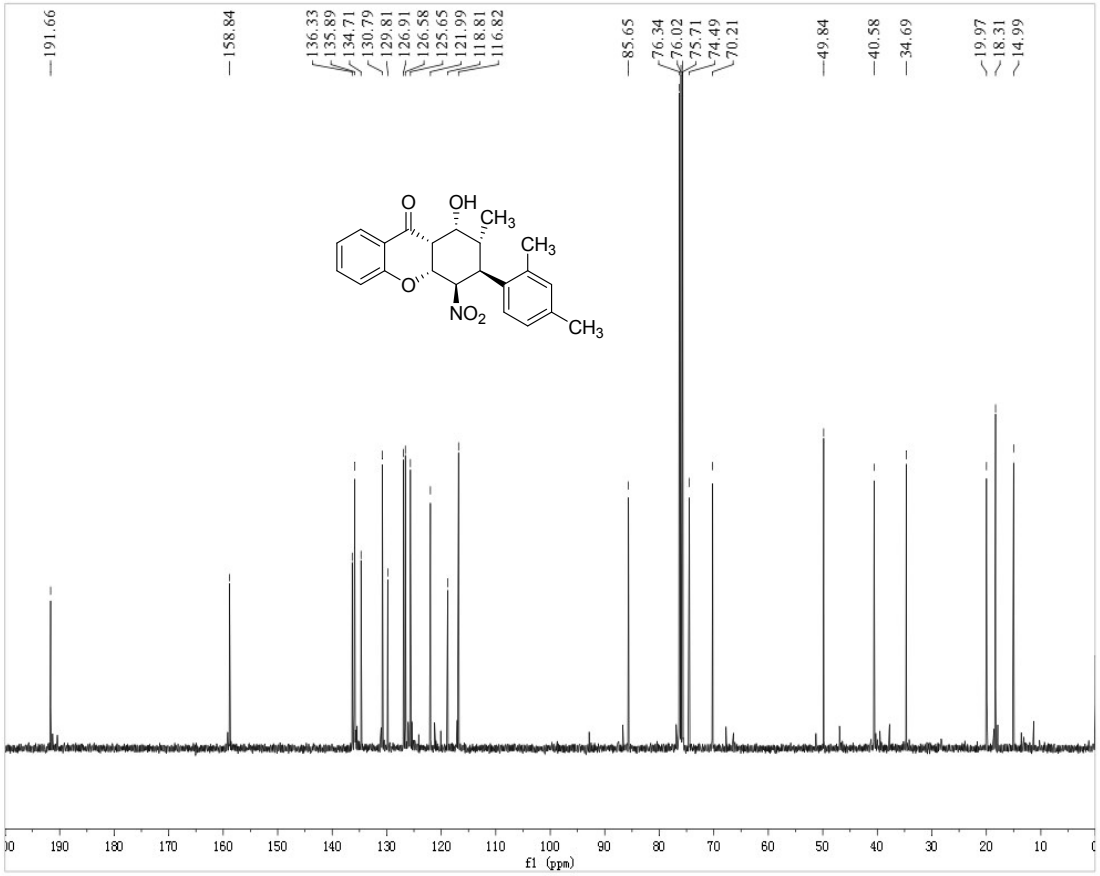
#	Time	Area	Height	Width	Area%	Symmetry
1	40.316	40470.8	505	1.3356	49.492	0.646
2	45.377	41302.4	474	1.4523	50.508	0.459



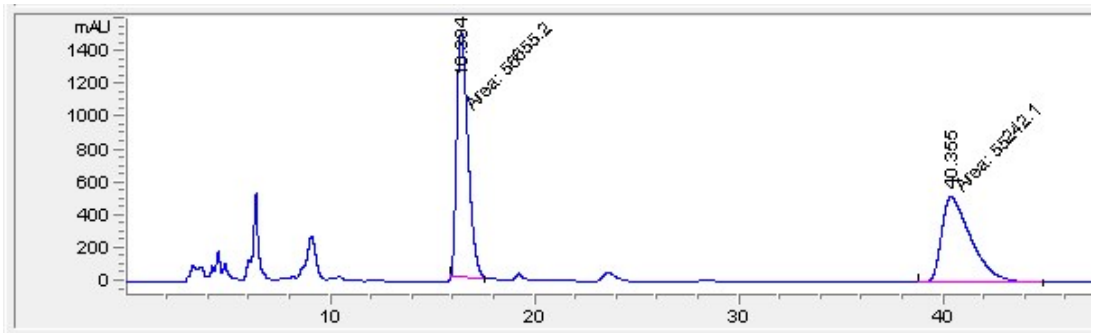
#	Time	Area	Height	Width	Area%	Symmetry
1	40.239	106272.4	1260.9	1.4047	98.199	0.842
2	46.379	1949.5	25.3	1.2846	1.801	0.668

^{1}H and ^{13}C NMR of **5g**

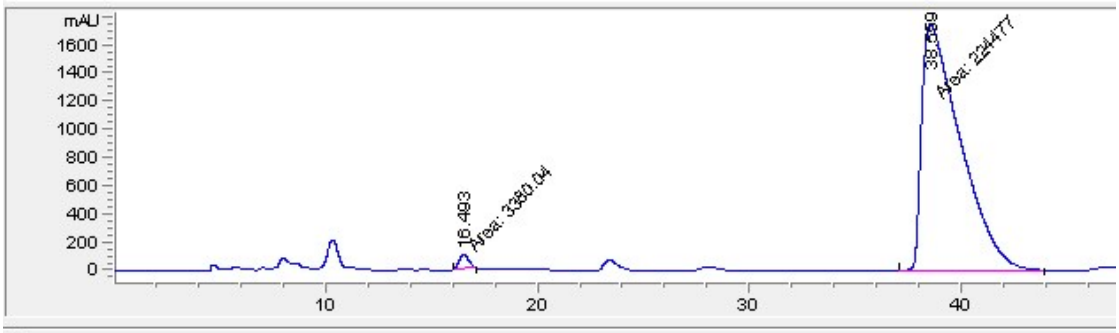




HPLC of **5g**

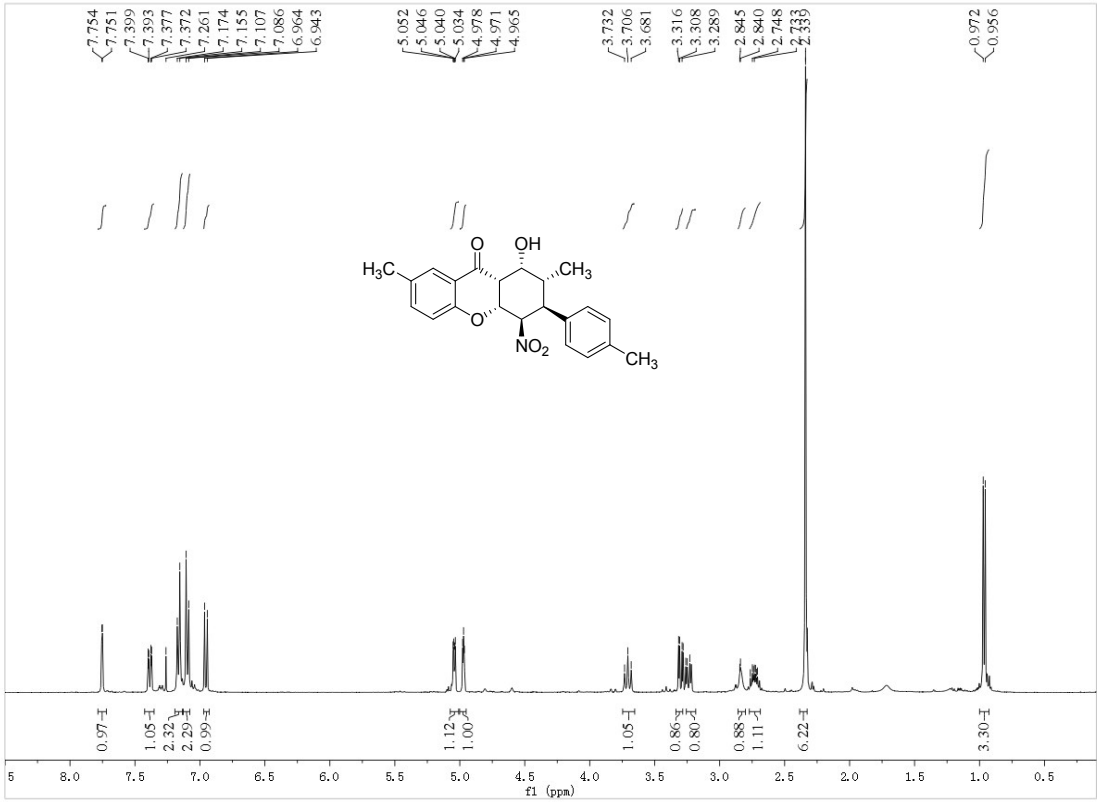


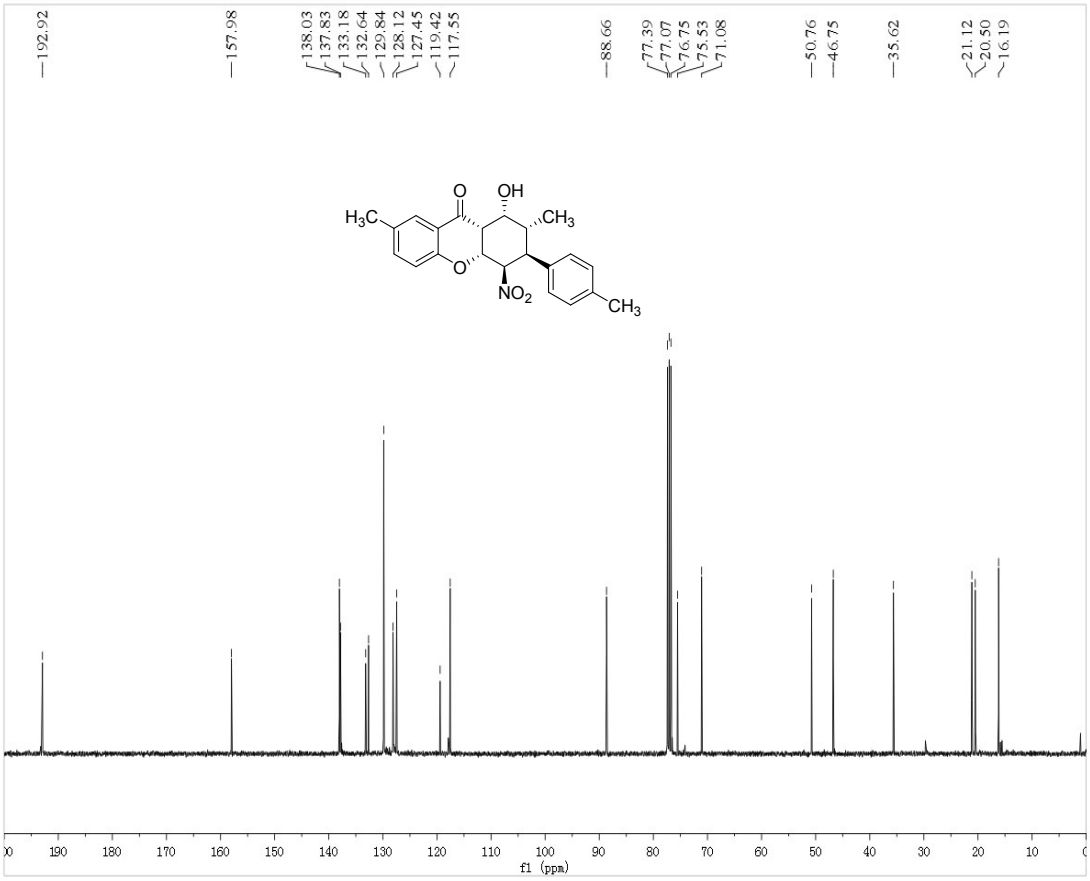
#	Time	Area	Height	Width	Area%	Symmetry
1	16.384	56655.2	1509.3	0.6256	50.631	0.622
2	40.355	55242.1	526.9	1.7474	49.369	0.472



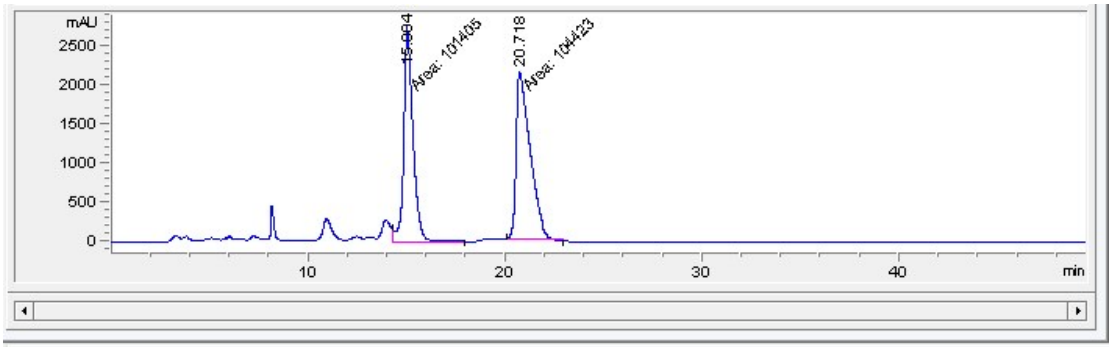
#	Time	Area	Height	Width	Area%	Symmetry
1	16.493	3380	100.4	0.5614	1.483	0.854
2	38.559	224477.4	1755.8	2.1309	98.517	0.284

^{1}H and ^{13}C NMR of **5h**

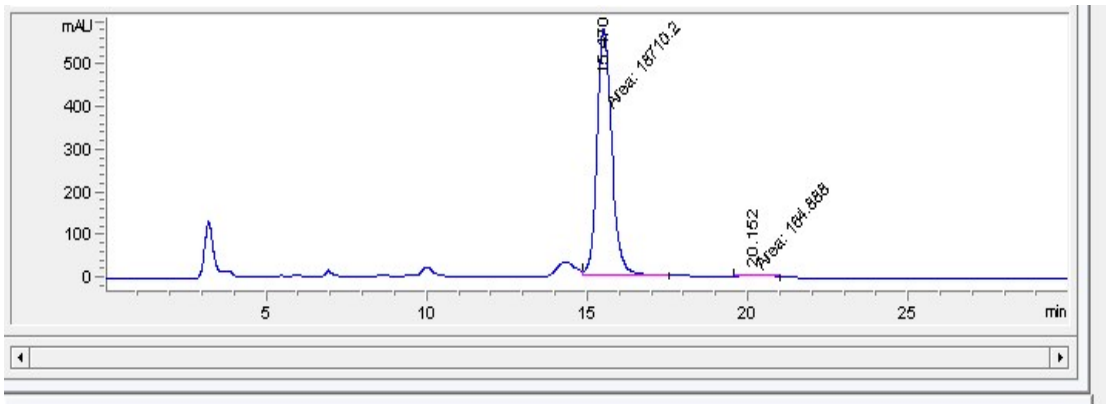




HPLC of **5h**

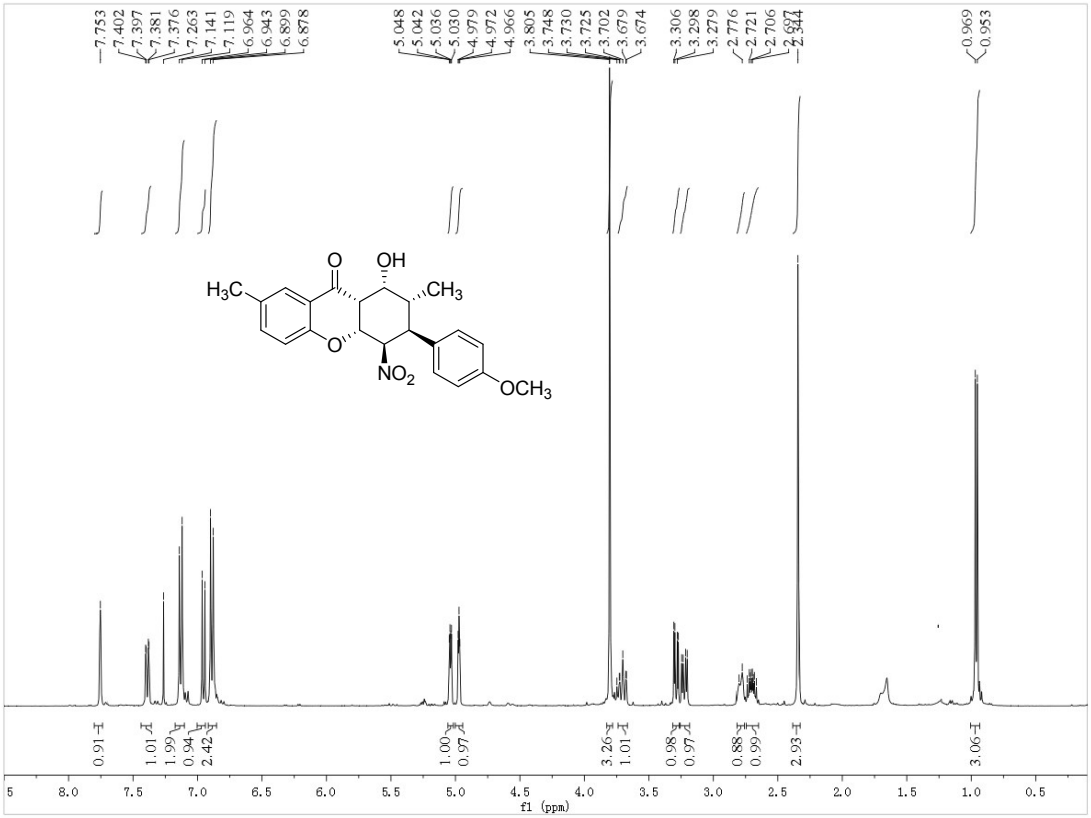


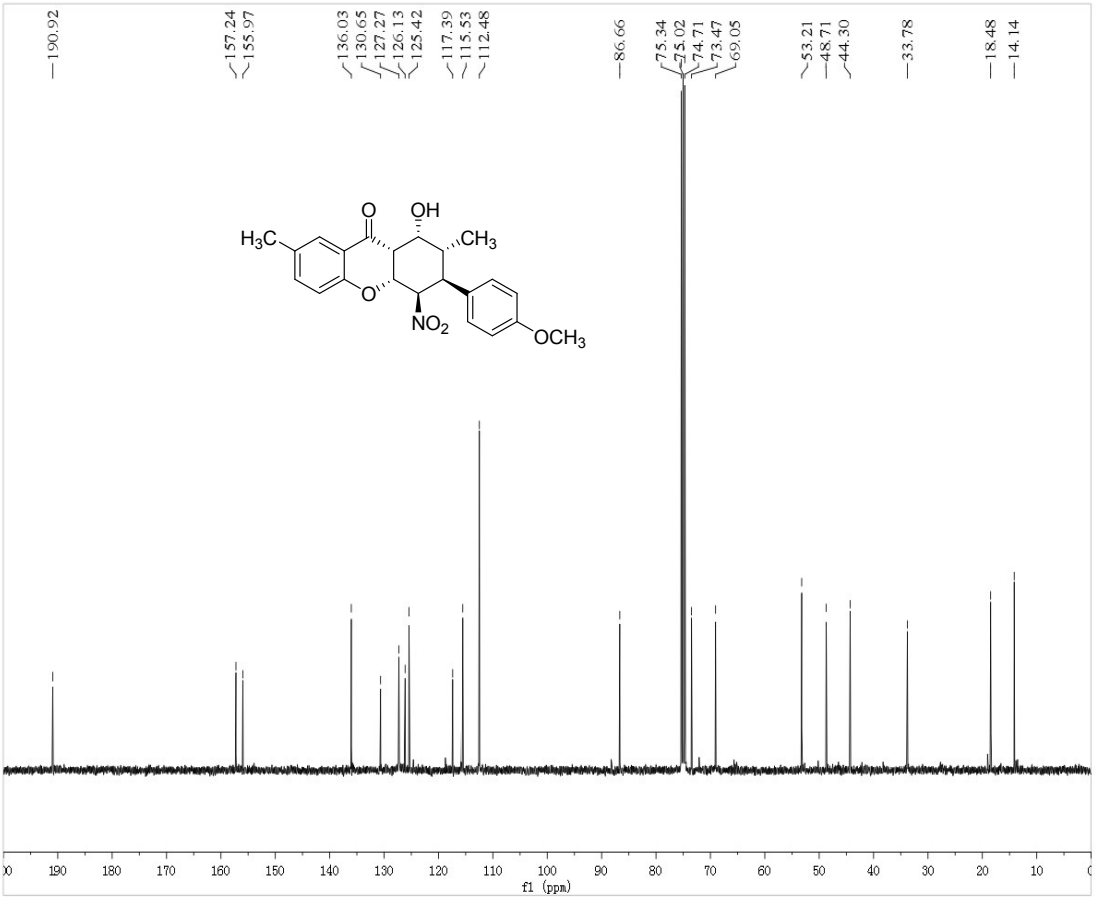
#	Time	Area	Height	Width	Area%	Symmetry
1	15.004	101405.1	2789	0.606	49.267	0.601
2	20.718	104422.5	2153.8	0.8081	50.733	0.328



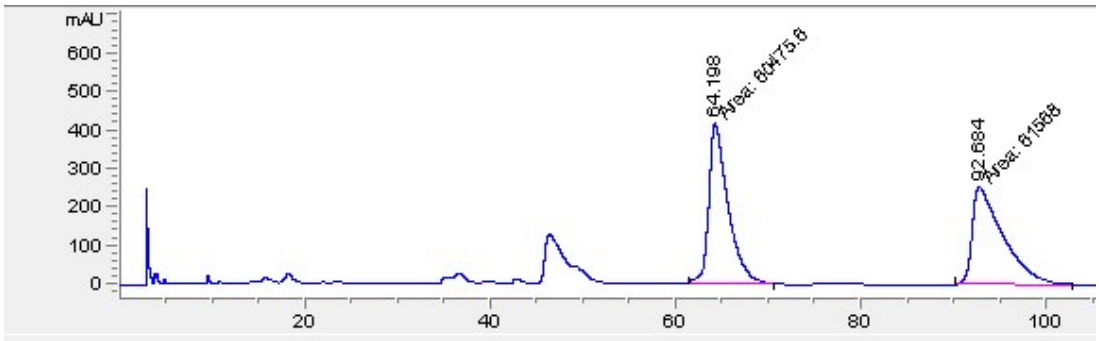
#	Time	Area	Height	Width	Area%	Symmetry
1	15.47	18710.2	579.1	0.5385	99.126	0.712
2	20.152	164.9	3.4	0.7984	0.874	0.686

^{1}H and ^{13}C NMR of **5i**

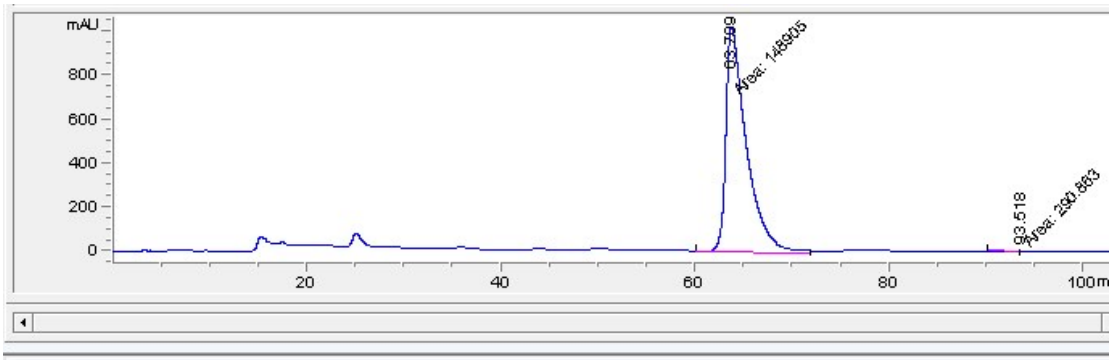




HPLC of **5i**

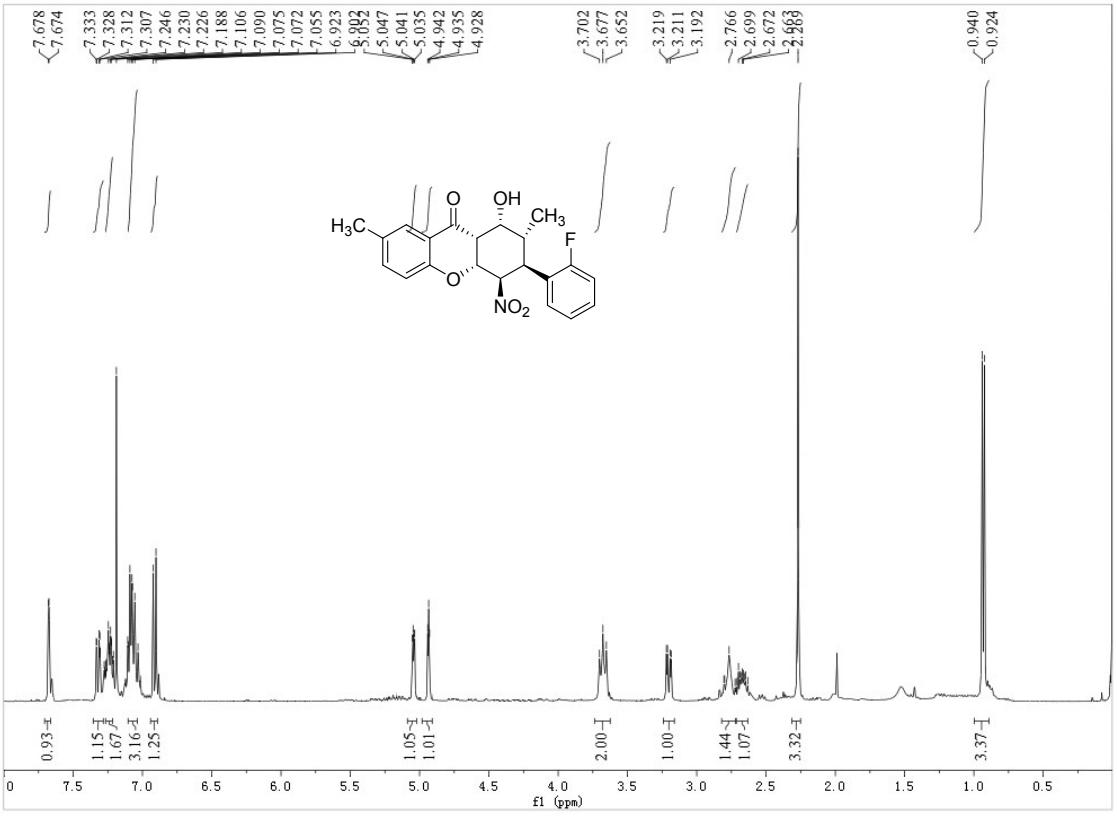


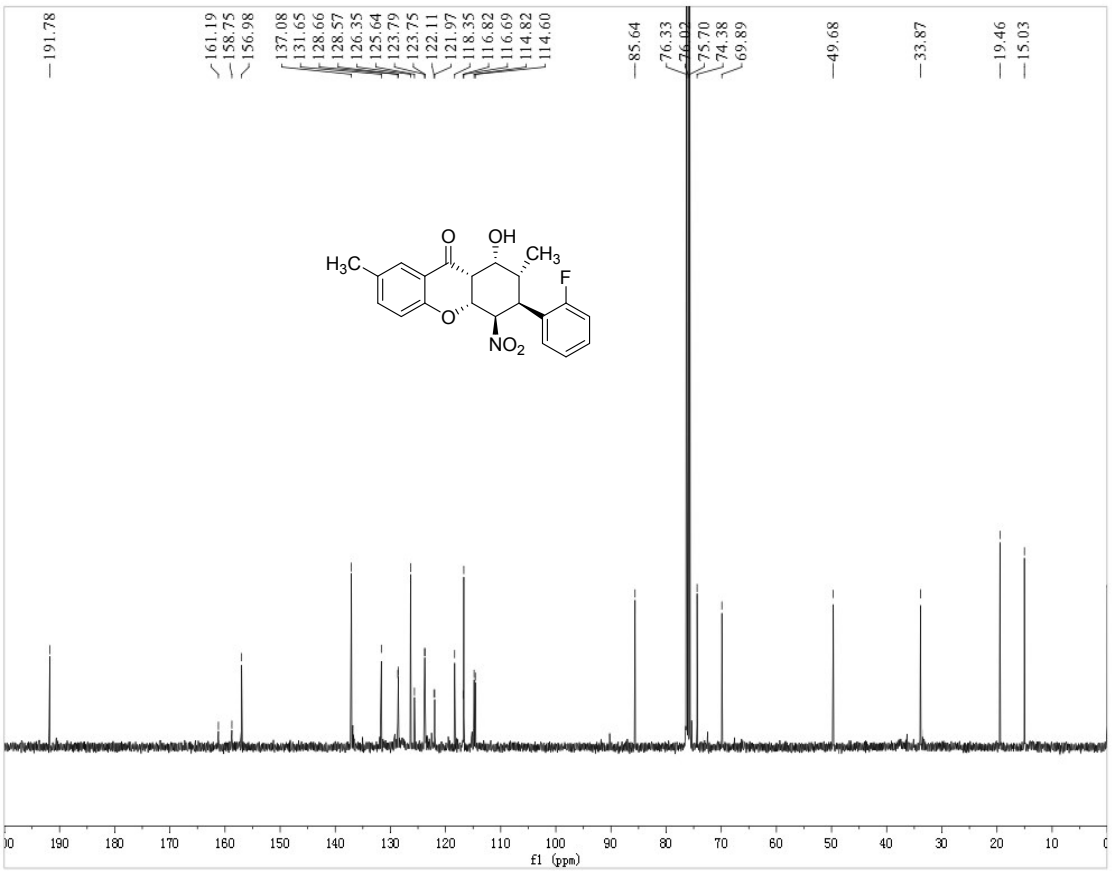
#	Time	Area	Height	Width	Area%	Symmetry
1	64.198	60475.6	416.5	2.4199	49.552	0.441
2	92.684	61568	255	4.0235	50.448	0.292



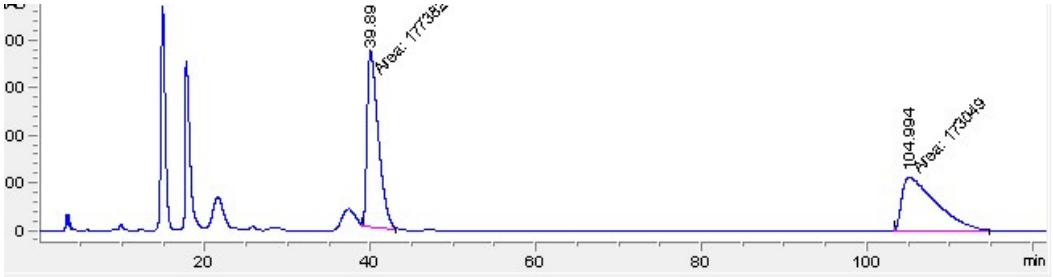
#	Time	Area	Height	Width	Area%	Symmetry
1	63.709	148904.5	1021.5	2.4296	99.805	0.368
2	93.518	290.9	2.3	2.1139	0.195	5.91

^{1}H and ^{13}C NMR of **5j**

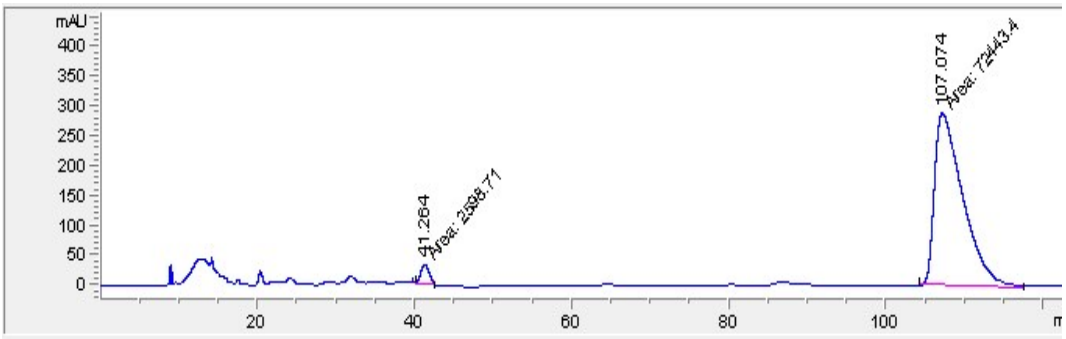




HPLC of **5j**

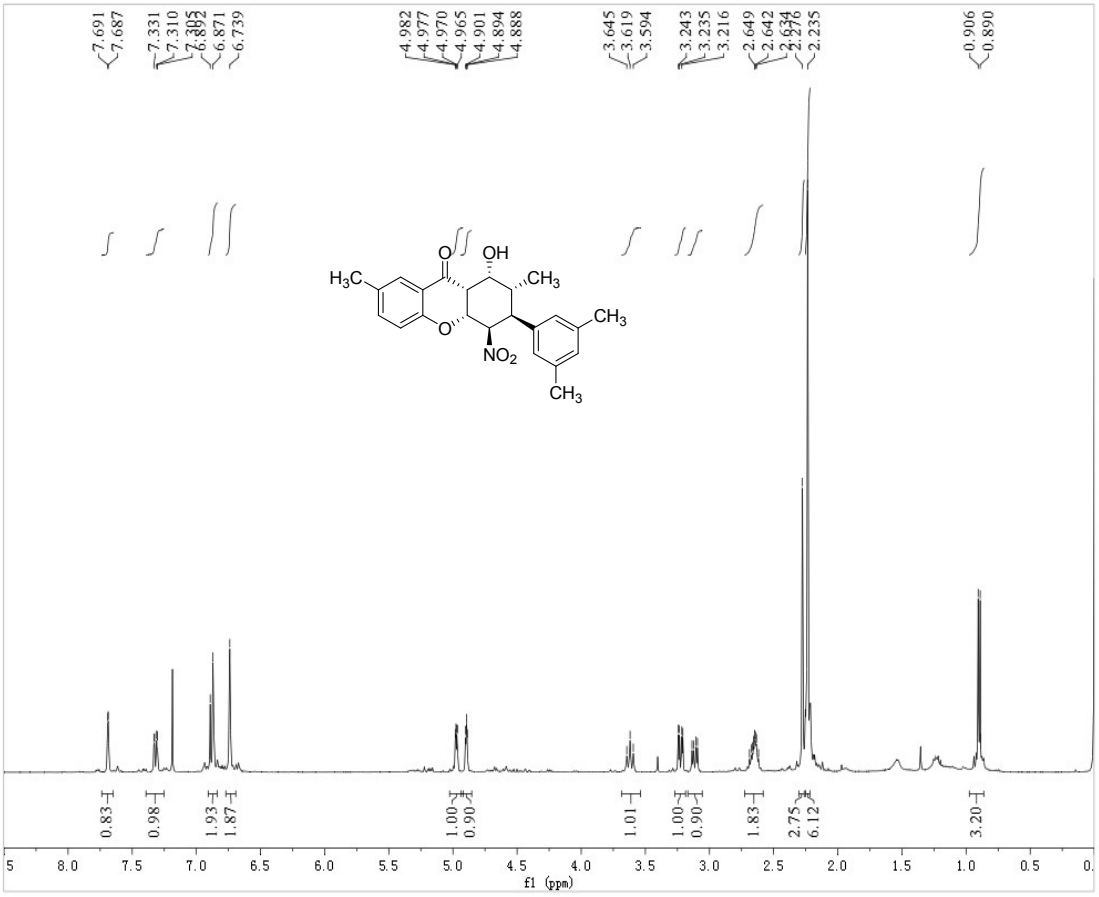


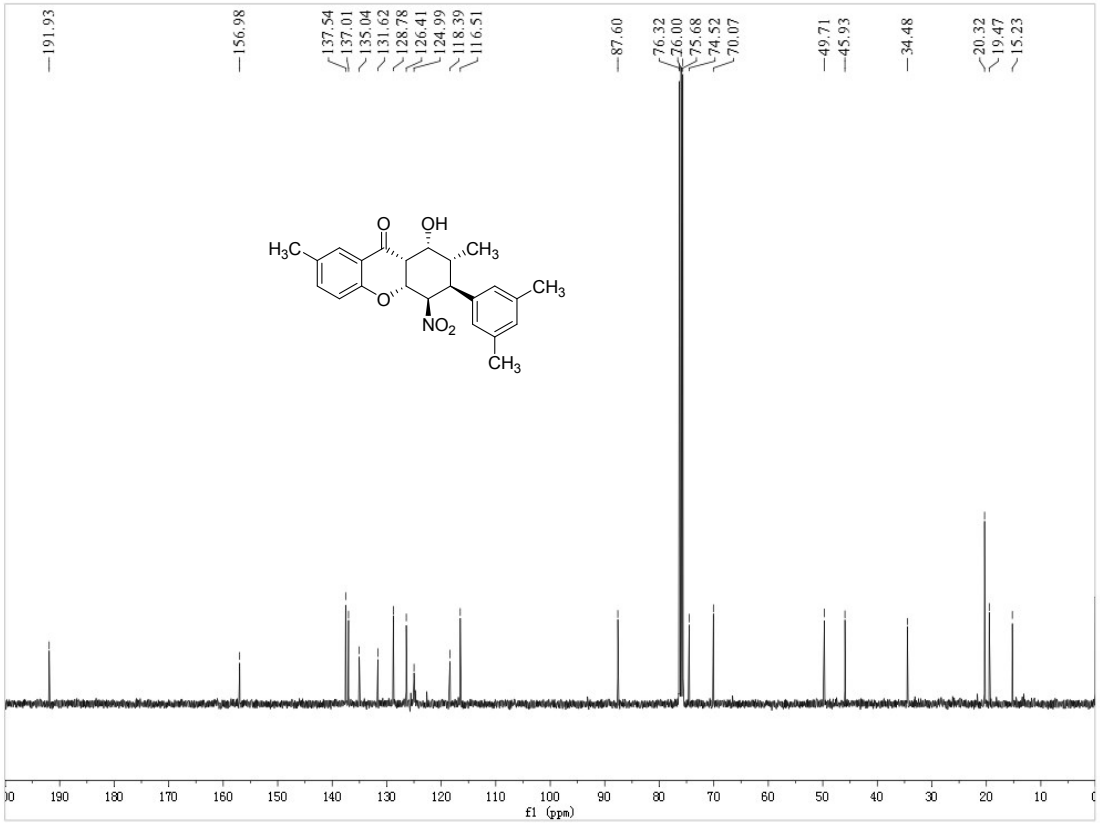
#	Time	Area	Height	Width	Area%	Symmetry
1	39.89	177382.1	1869.1	1.5817	50.618	0.413
2	104.994	173049.5	580.5	4.9686	49.382	0.247



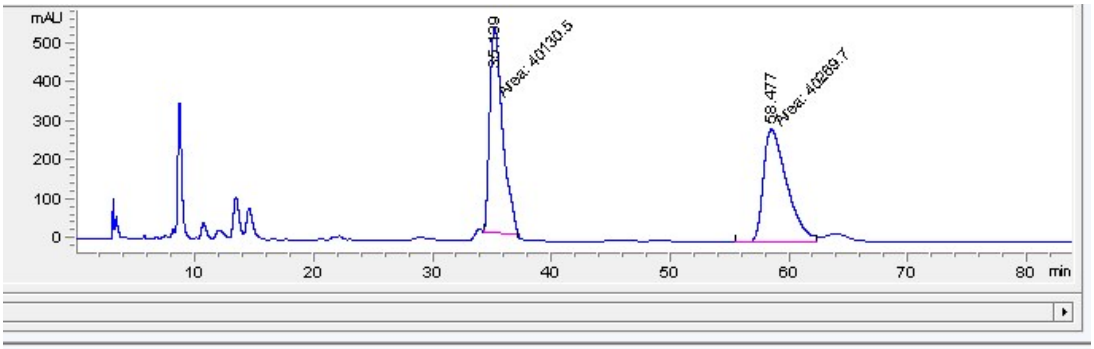
#	Time	Area	Height	Width	Area%	Symmetry
1	41.264	2598.7	35.2	1.2321	3.463	0.883
2	107.074	72443.4	289.1	4.1768	96.537	0.34

^{1}H and ^{13}C NMR of **5k**

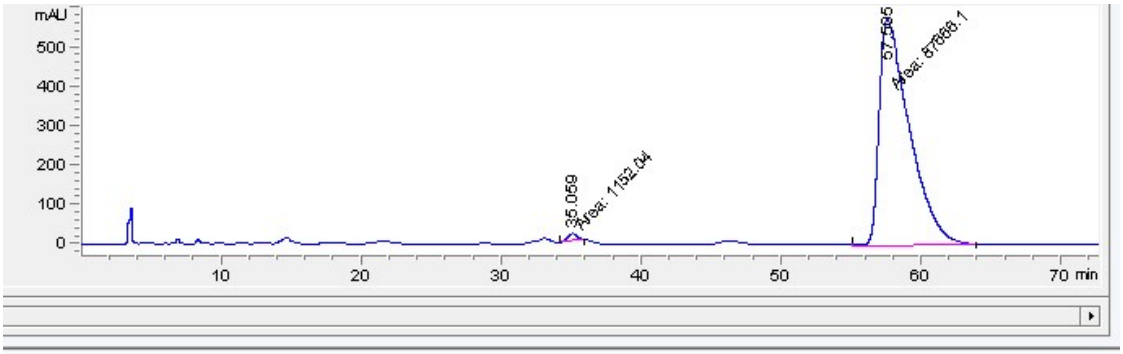




HPLC of **5k**

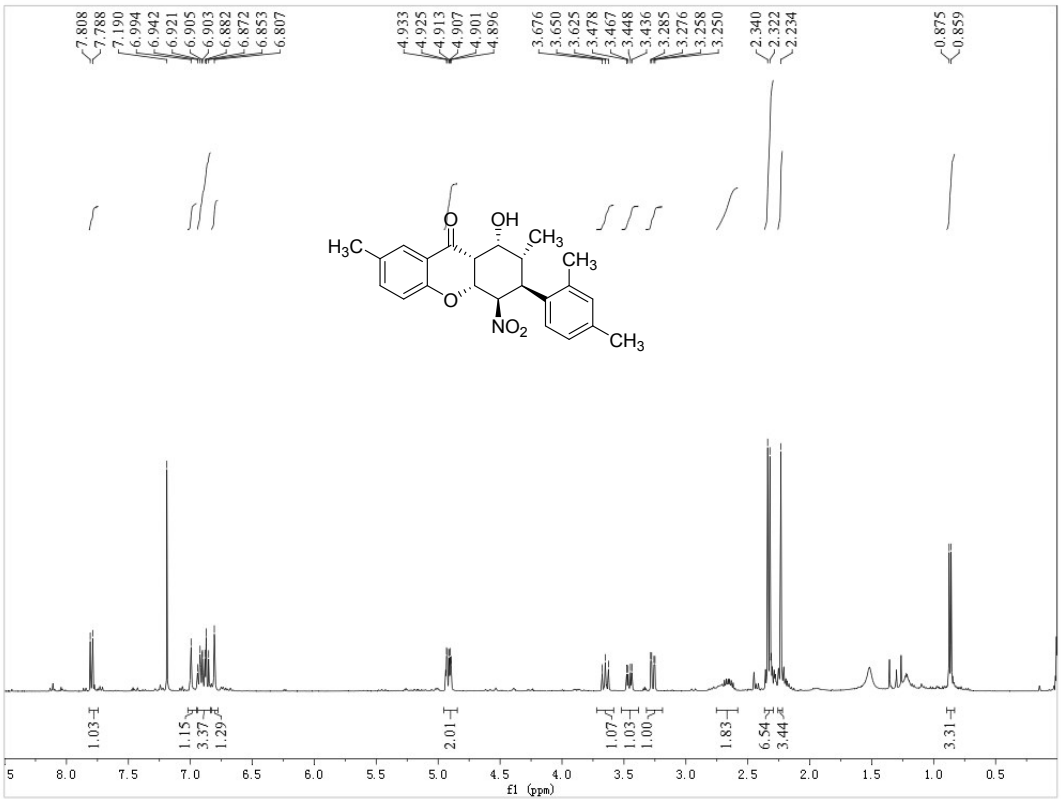


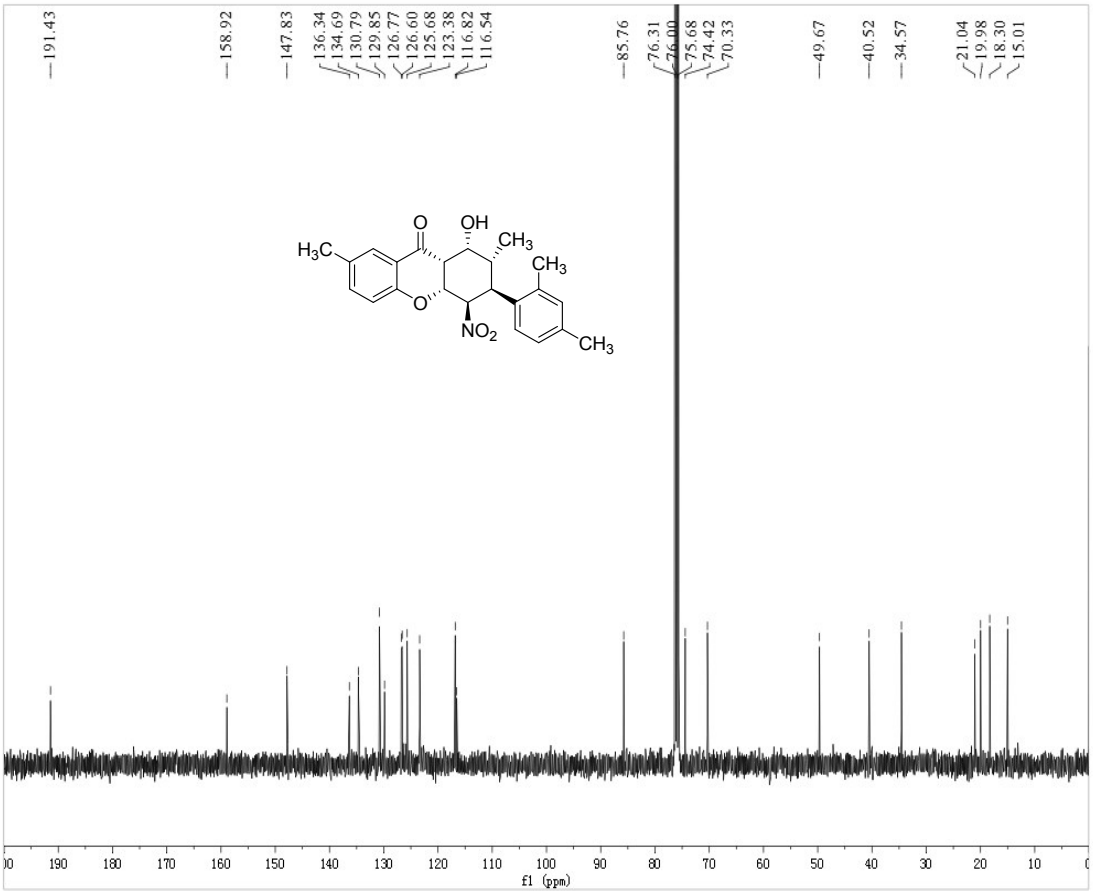
#	Time	Area	Height	Width	Area%	Symmetry
1	35.139	40130.5	530.4	1.2609	49.913	0.571
2	58.477	40269.7	290.6	2.3092	50.087	0.502



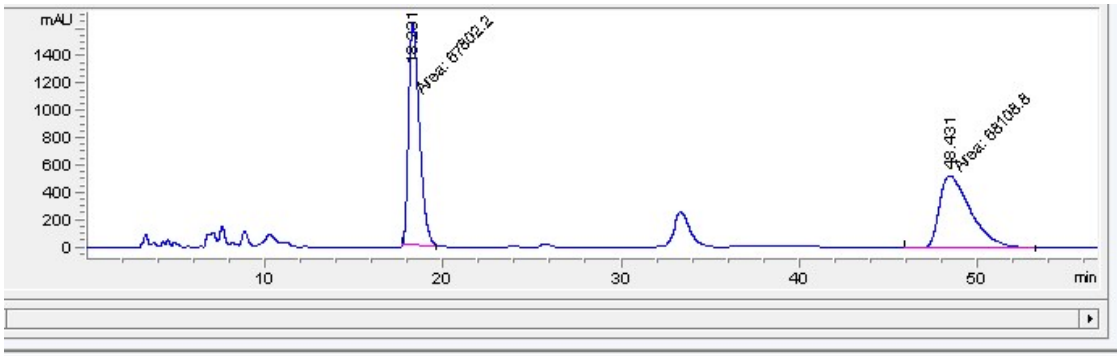
#	Time	Area	Height	Width	Area%	Symmetry
1	35.059	1152	20.1	0.9545	1.297	1.044
2	57.505	87666.1	578.5	2.5255	98.703	0.341

^{1}H and ^{13}C NMR of **5l**

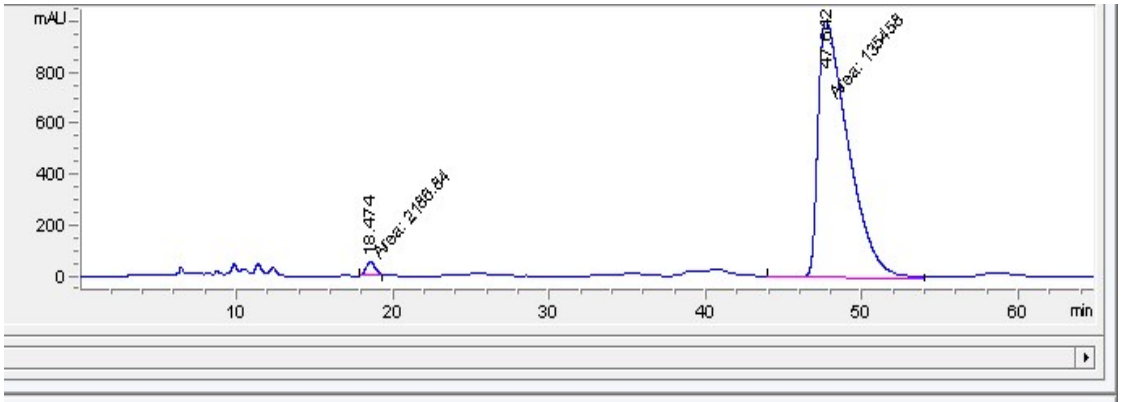




HPLC of **5l**

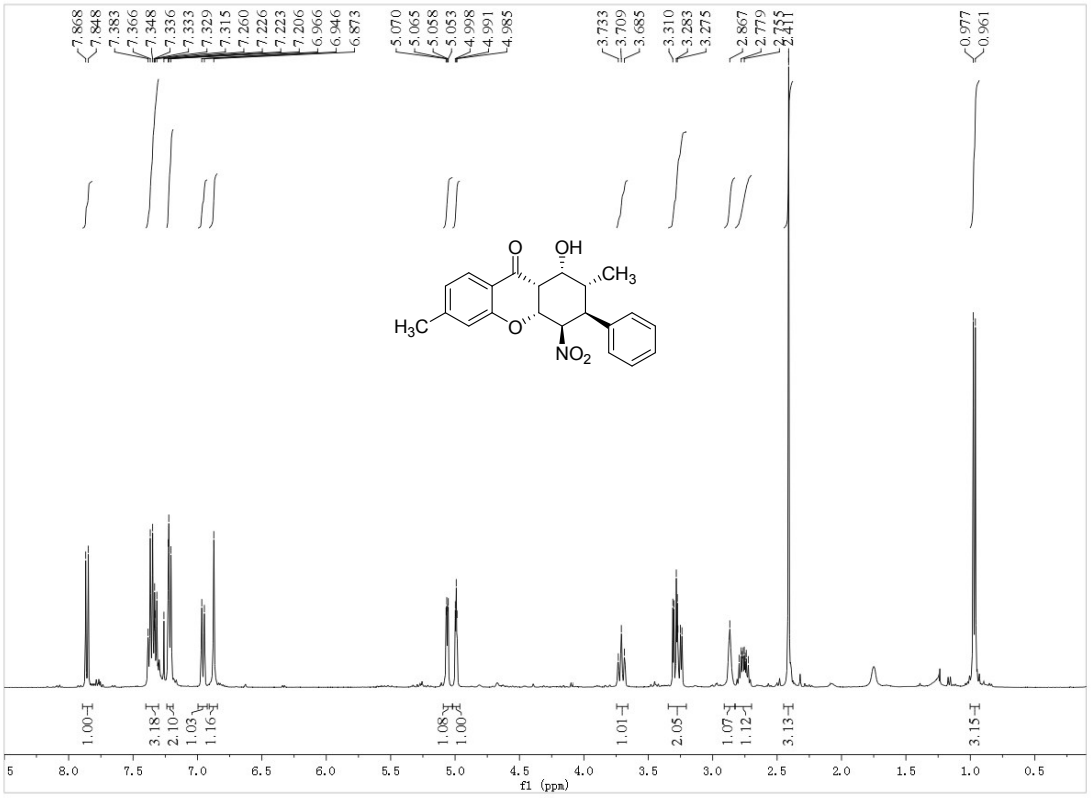


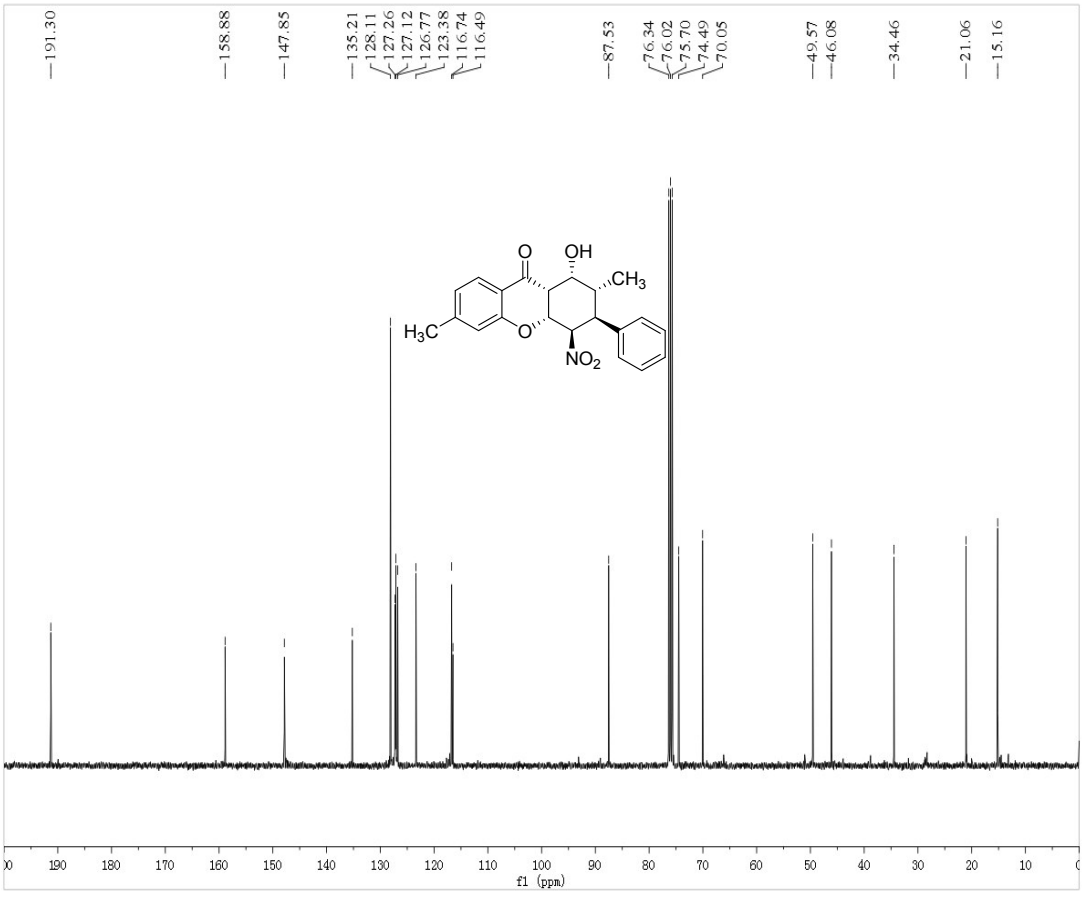
#	Time	Area	Height	Width	Area%	Symmetry
1	18.231	67802.2	1629.6	0.6934	49.887	0.605
2	48.431	68108.8	538.3	2.1089	50.113	0.504



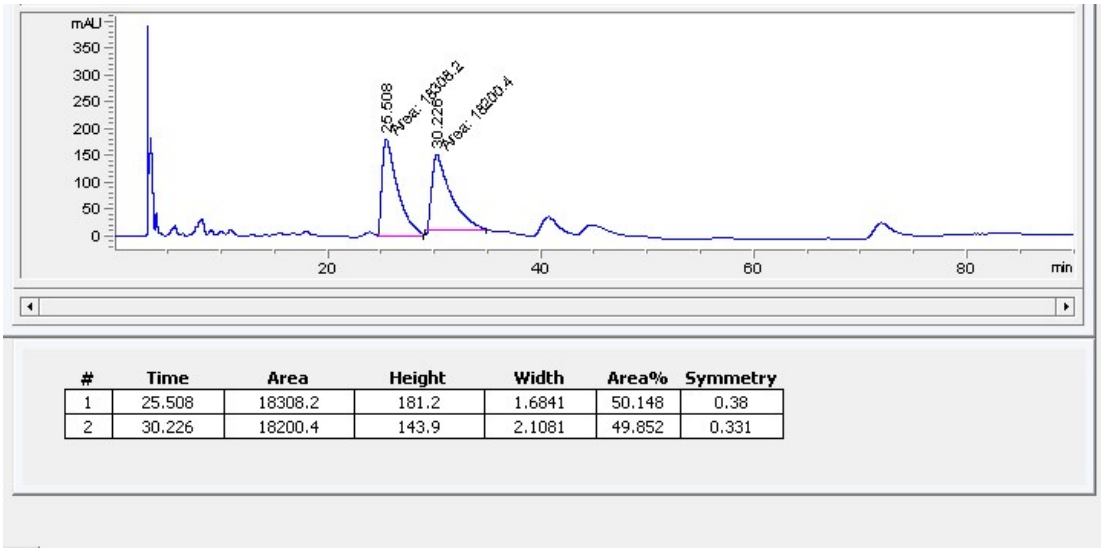
#	Time	Area	Height	Width	Area%	Symmetry
1	18.474	2186.8	52.5	0.6936	1.589	0.761
2	47.642	135457.6	1007.2	2.2415	98.411	0.339

^{1}H and ^{13}C NMR of **5m**

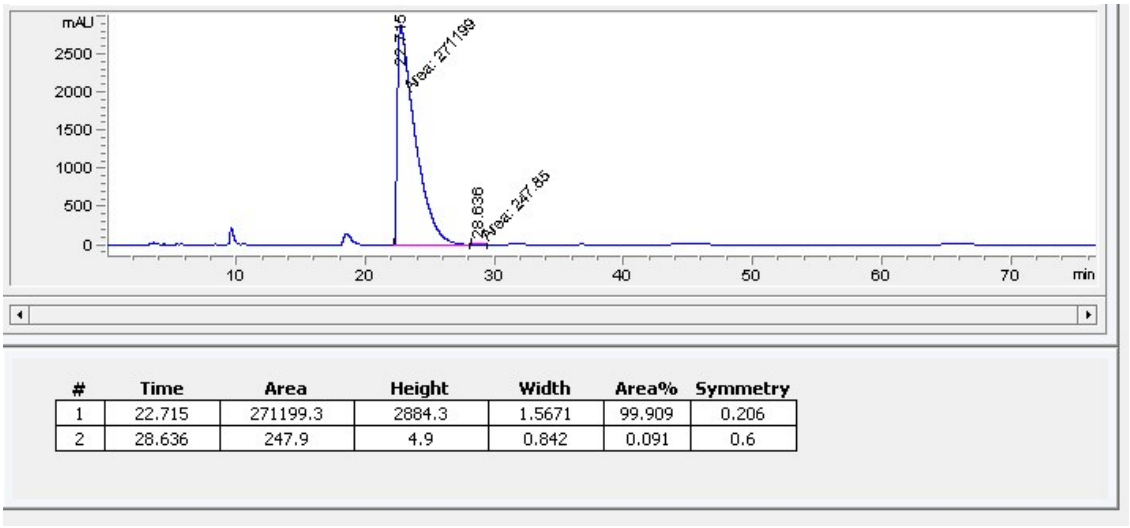




HPLC of **5m**

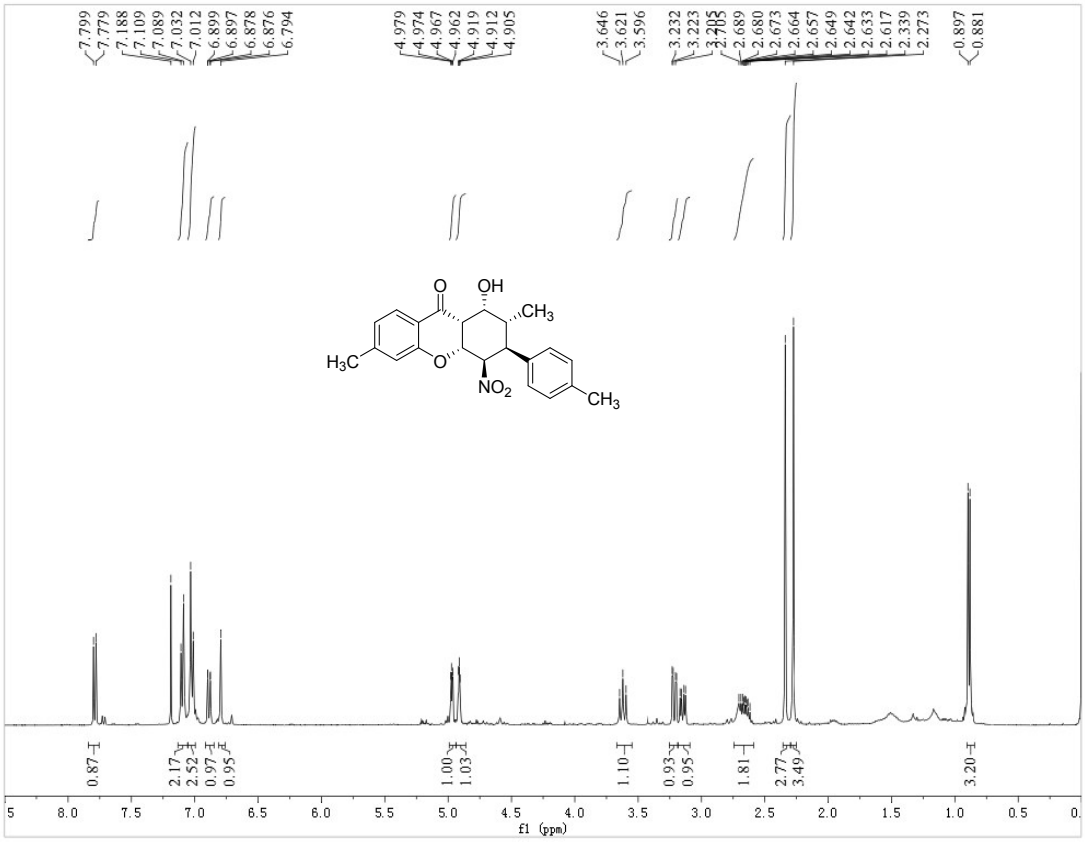


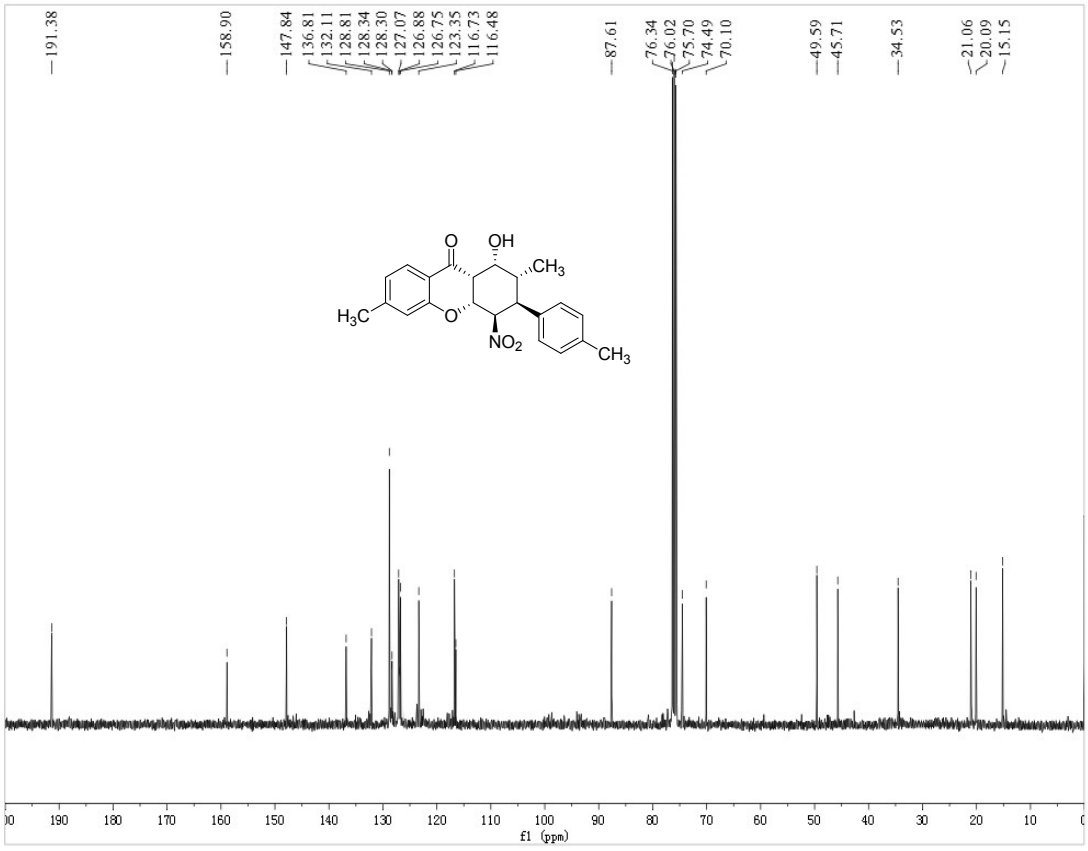
#	Time	Area	Height	Width	Area%	Symmetry
1	25.508	18308.2	181.2	1.6841	50.148	0.38
2	30.226	18200.4	143.9	2.1081	49.852	0.331



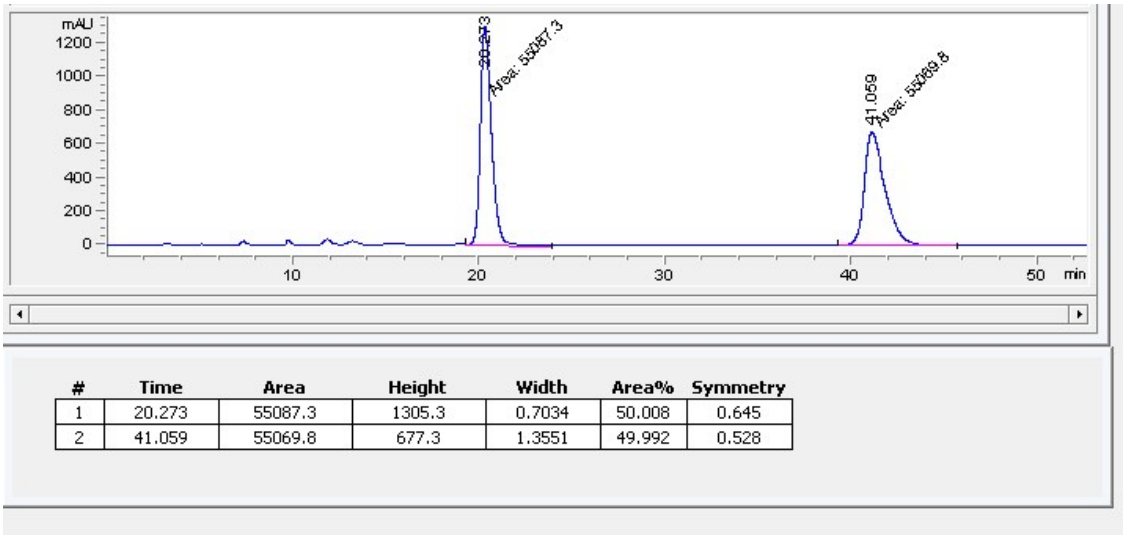
#	Time	Area	Height	Width	Area%	Symmetry
1	22.715	271199.3	2884.3	1.5671	99.909	0.206
2	28.636	247.9	4.9	0.842	0.091	0.6

^{1}H and ^{13}C NMR of **5n**

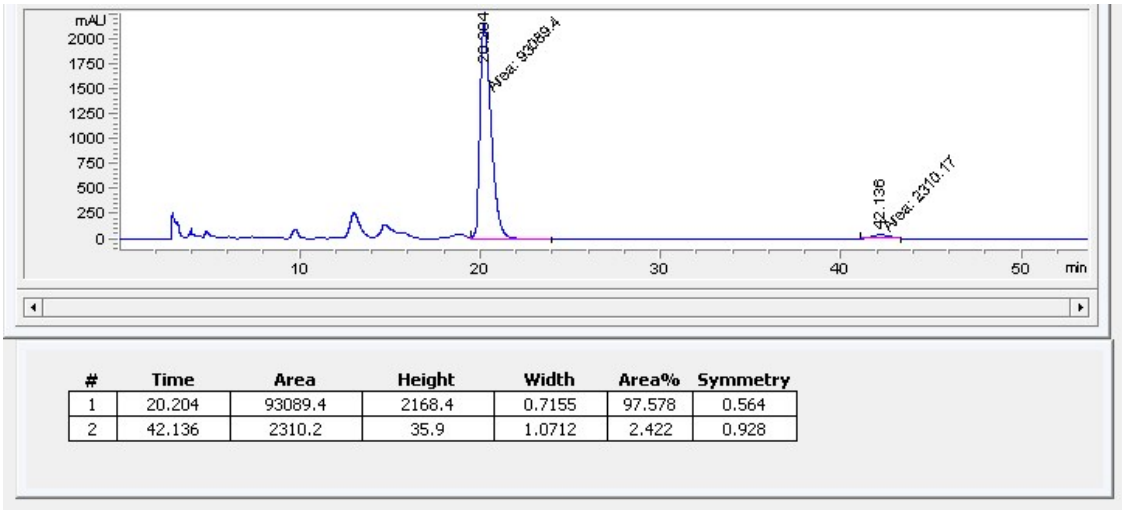




HPLC of **5n**

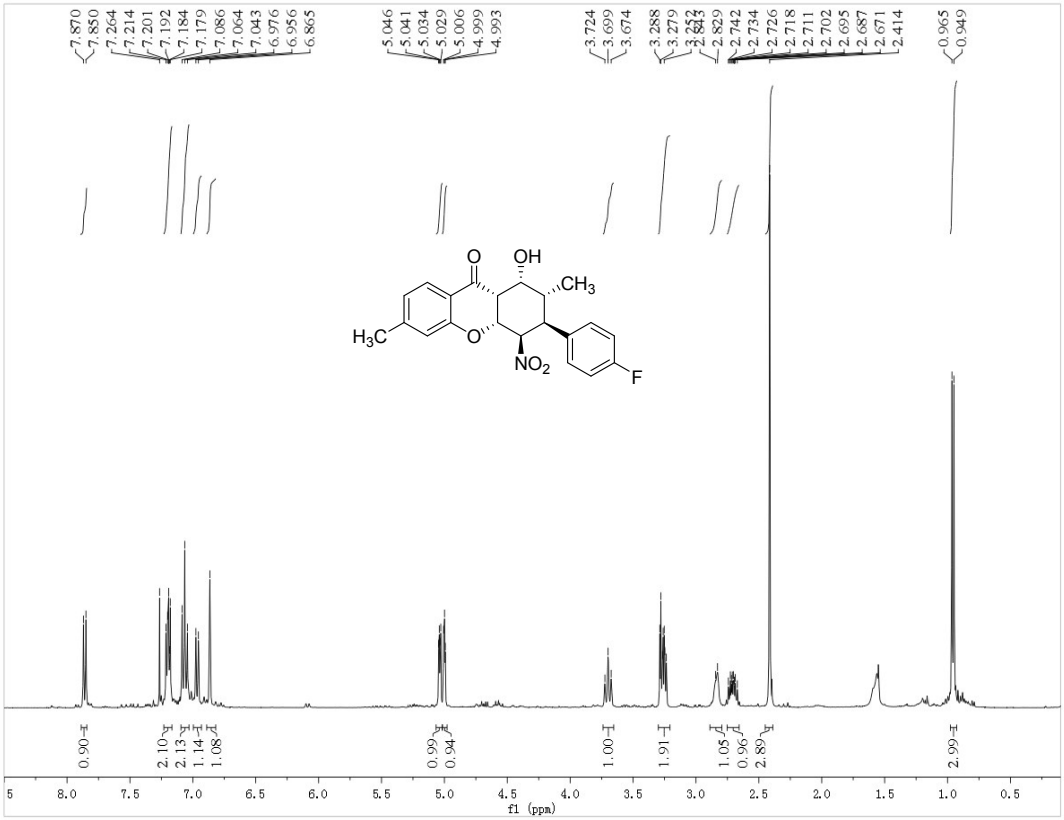


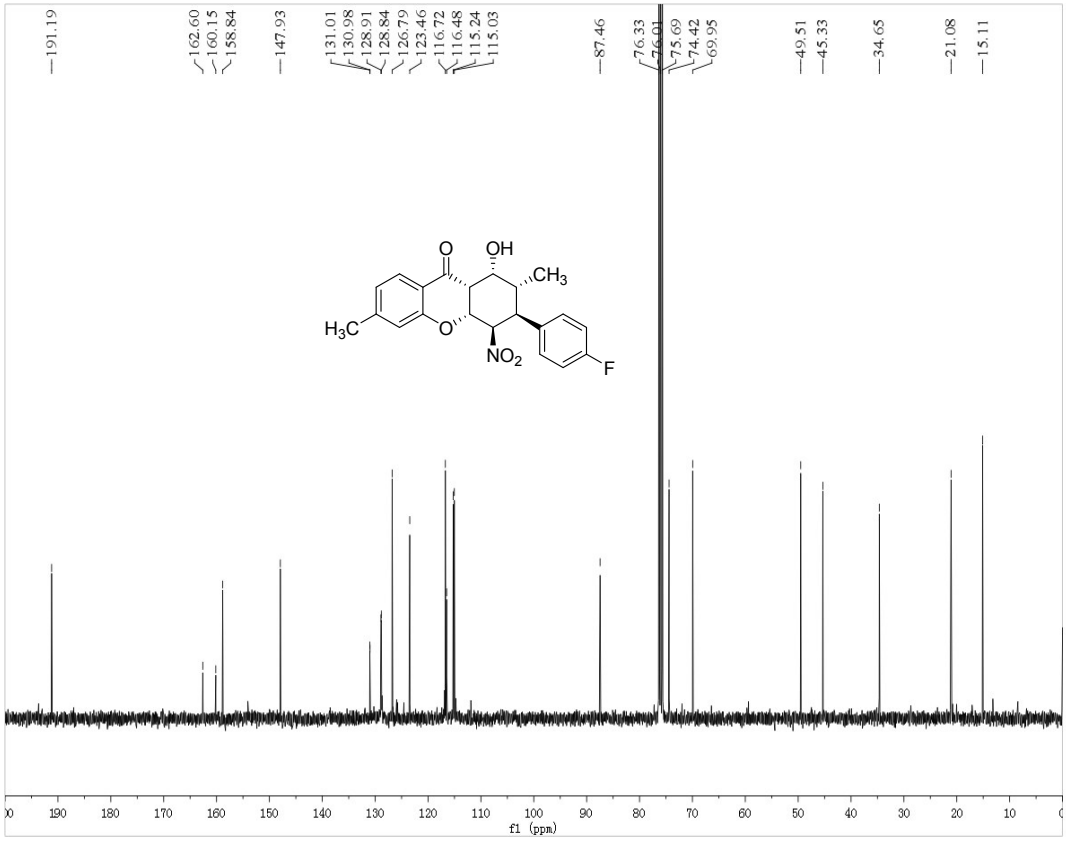
#	Time	Area	Height	Width	Area%	Symmetry
1	20.273	55087.3	1305.3	0.7034	50.008	0.645
2	41.059	55069.8	677.3	1.3551	49.992	0.528



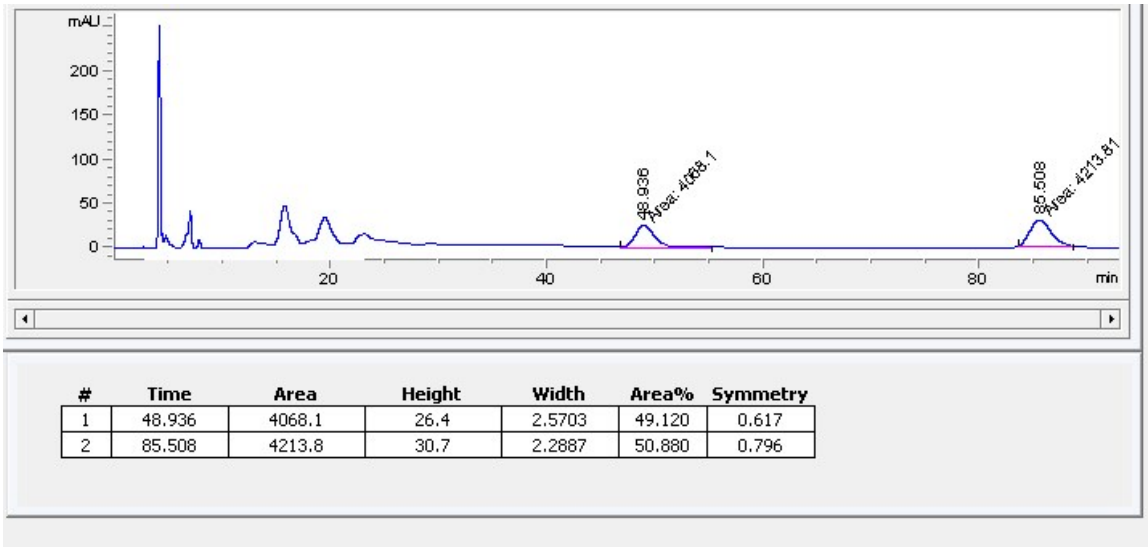
#	Time	Area	Height	Width	Area%	Symmetry
1	20.204	93089.4	2168.4	0.7155	97.578	0.564
2	42.136	2310.2	35.9	1.0712	2.422	0.928

^{1}H and ^{13}C NMR of **5o**

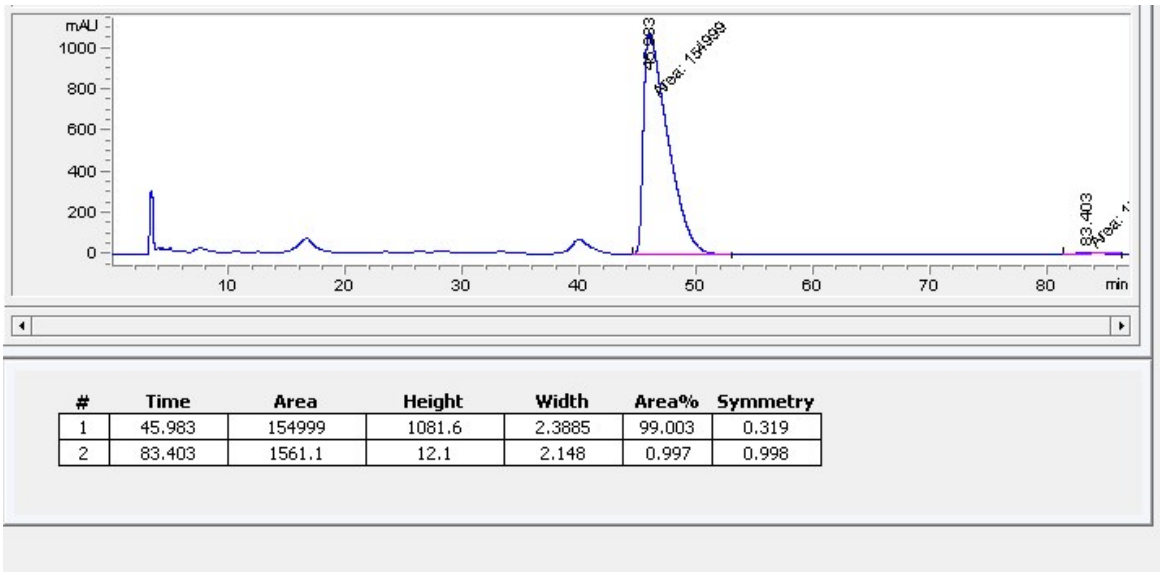




HPLC of **5o**

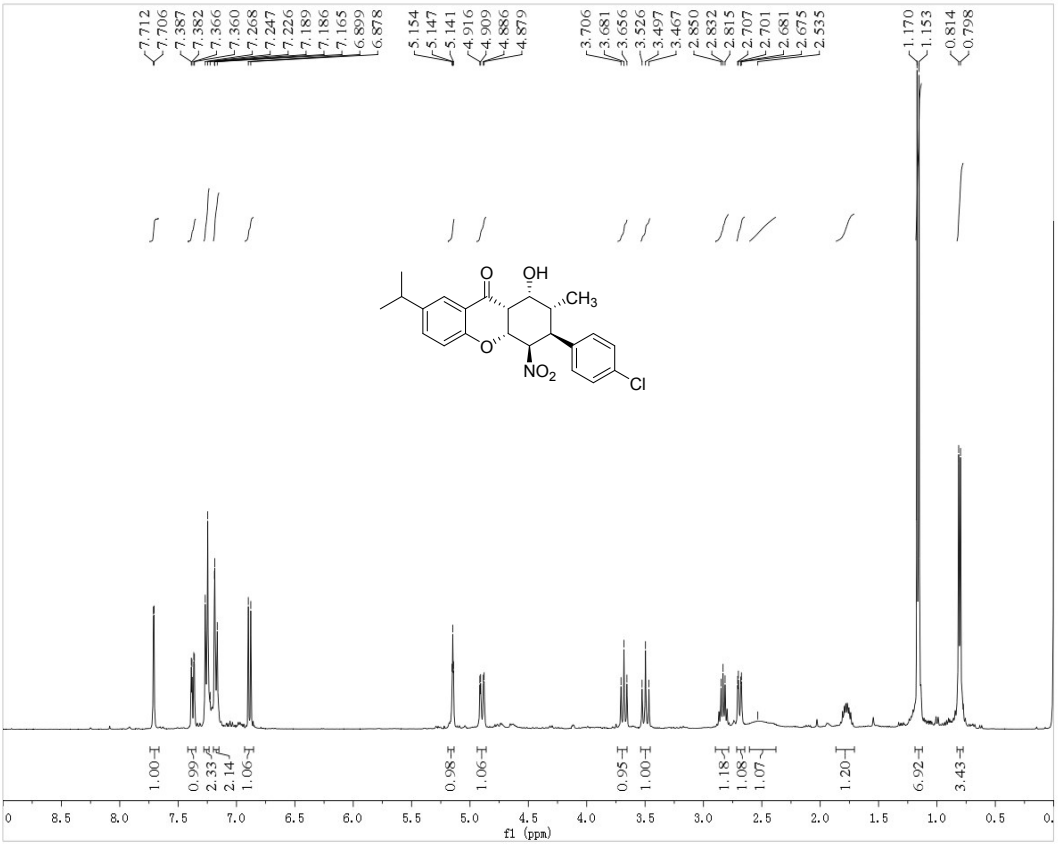


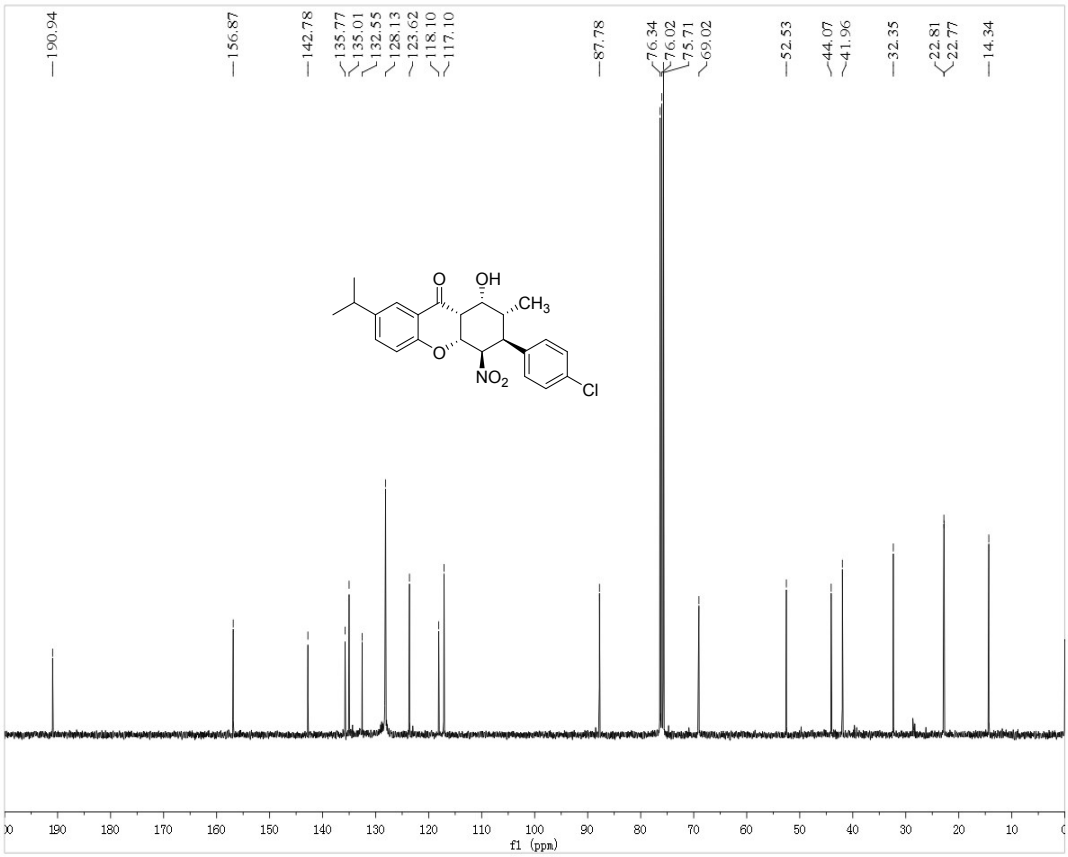
#	Time	Area	Height	Width	Area%	Symmetry
1	48.936	4068.1	26.4	2.5703	49.120	0.617
2	85.508	4213.8	30.7	2.2887	50.880	0.796



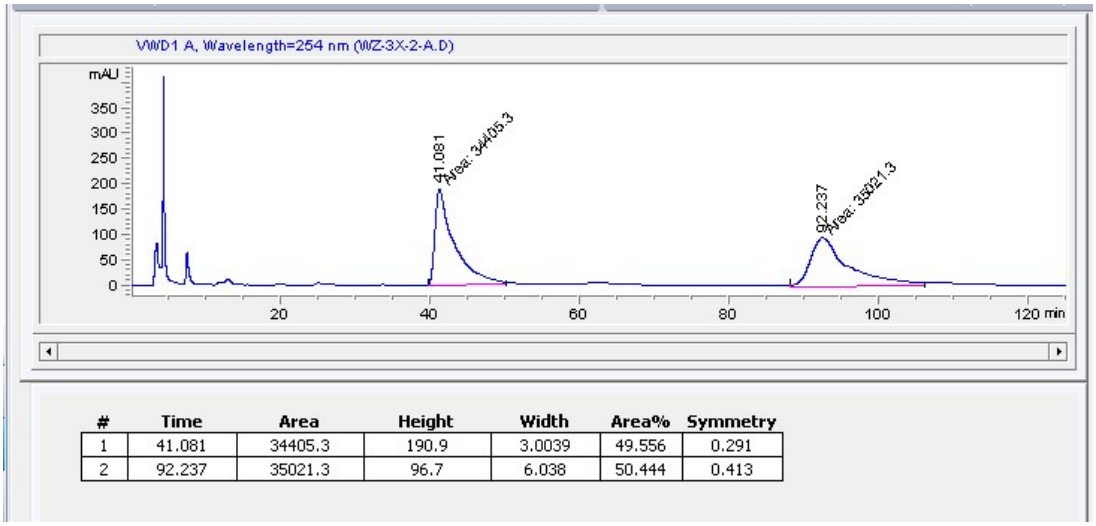
#	Time	Area	Height	Width	Area%	Symmetry
1	45.983	154999	1081.6	2.3885	99.003	0.319
2	83.403	1561.1	12.1	2.148	0.997	0.998

^{1}H and ^{13}C NMR of **5p**

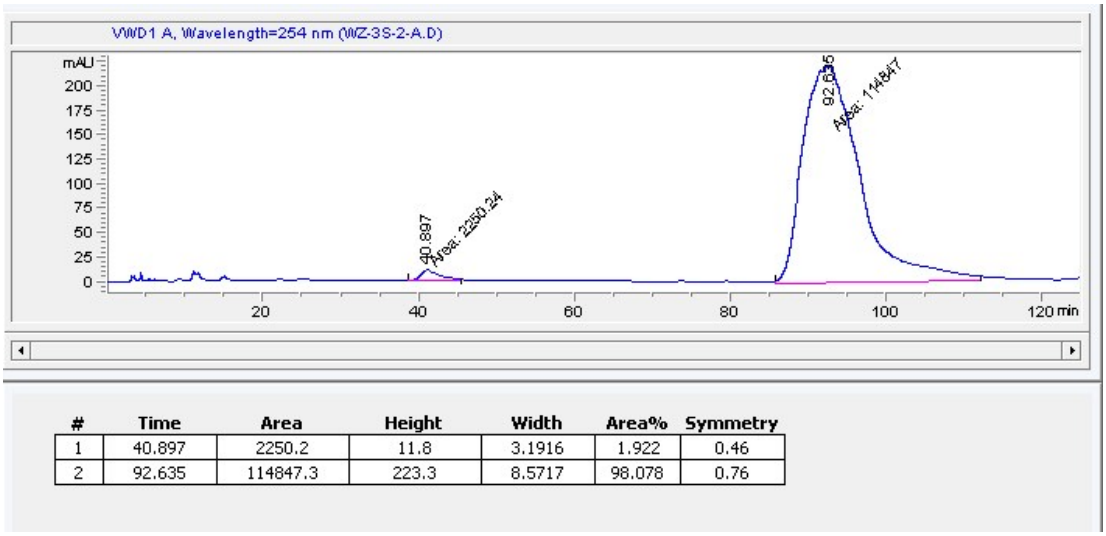




HPLC of **5p**

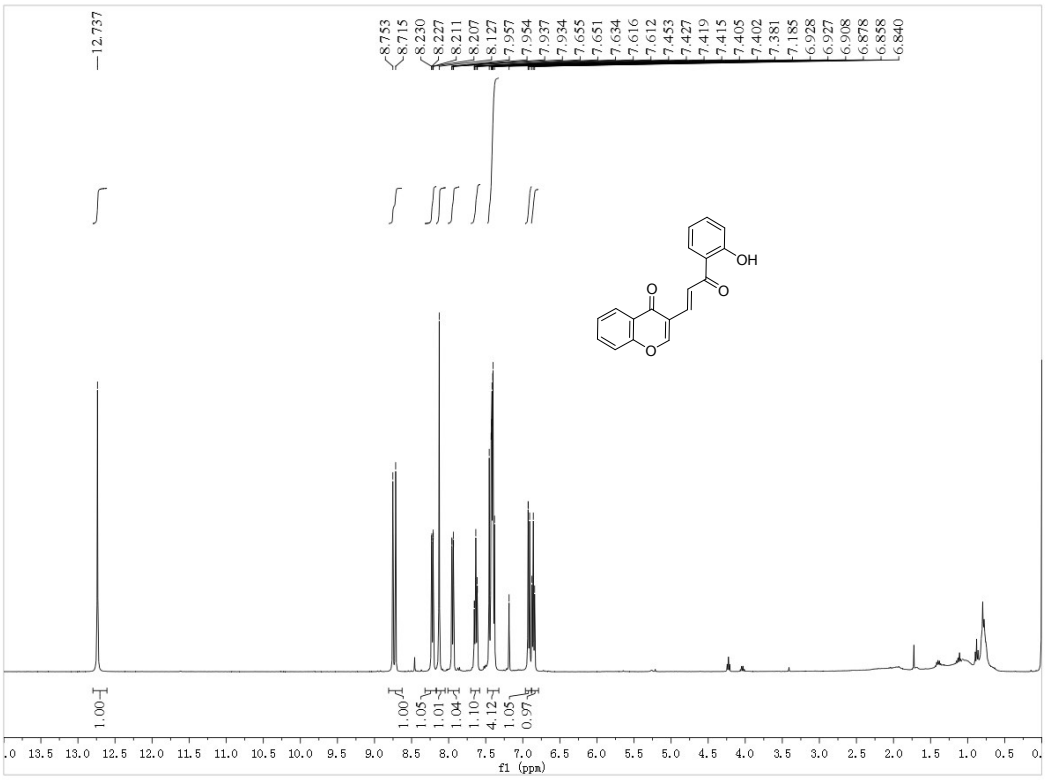


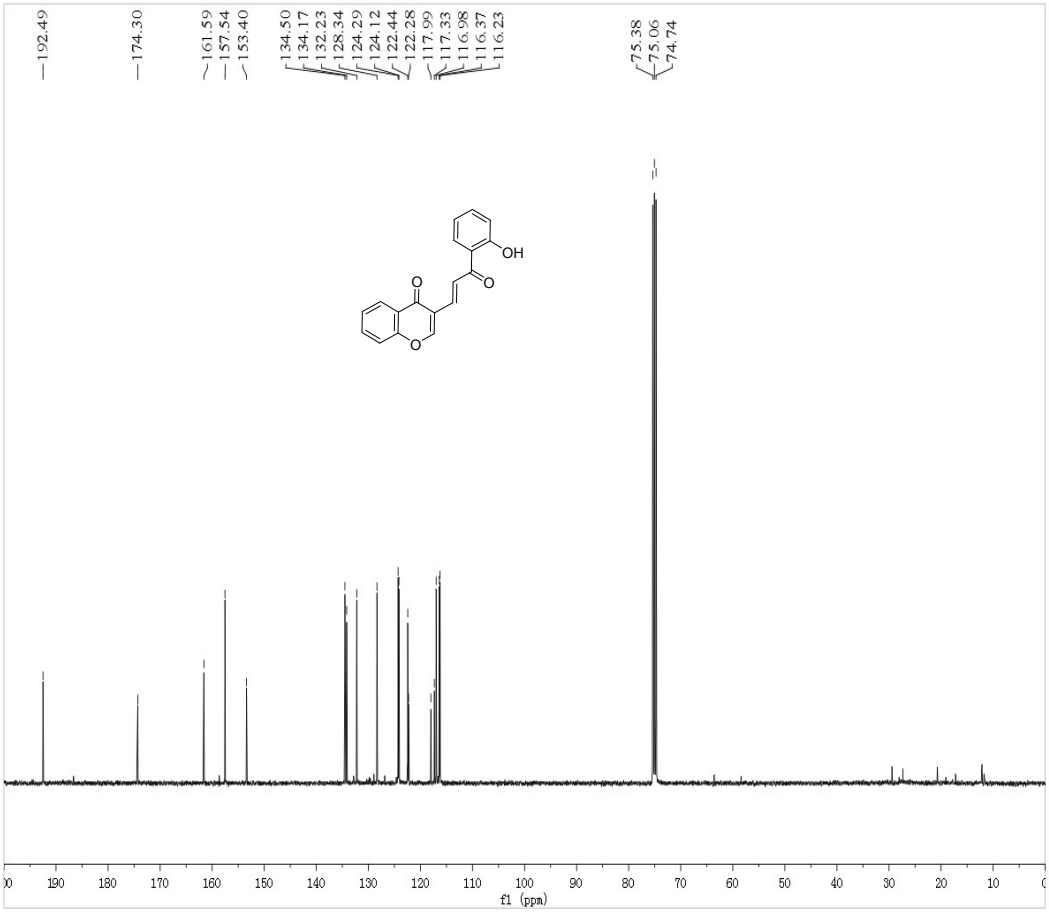
#	Time	Area	Height	Width	Area%	Symmetry
1	41.081	34405.3	190.9	3.0039	49.556	0.291
2	92.237	35021.3	96.7	6.038	50.444	0.413



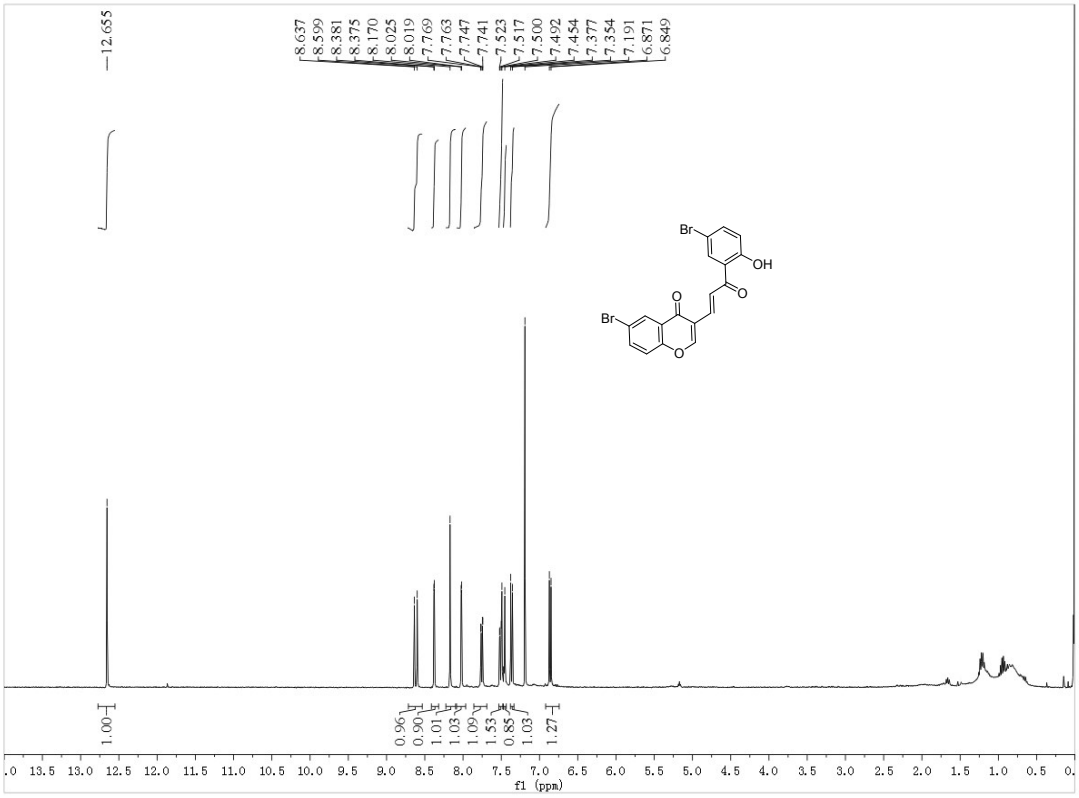
#	Time	Area	Height	Width	Area%	Symmetry
1	40.897	2250.2	11.8	3.1916	1.922	0.46
2	92.635	114847.3	223.3	8.5717	98.078	0.76

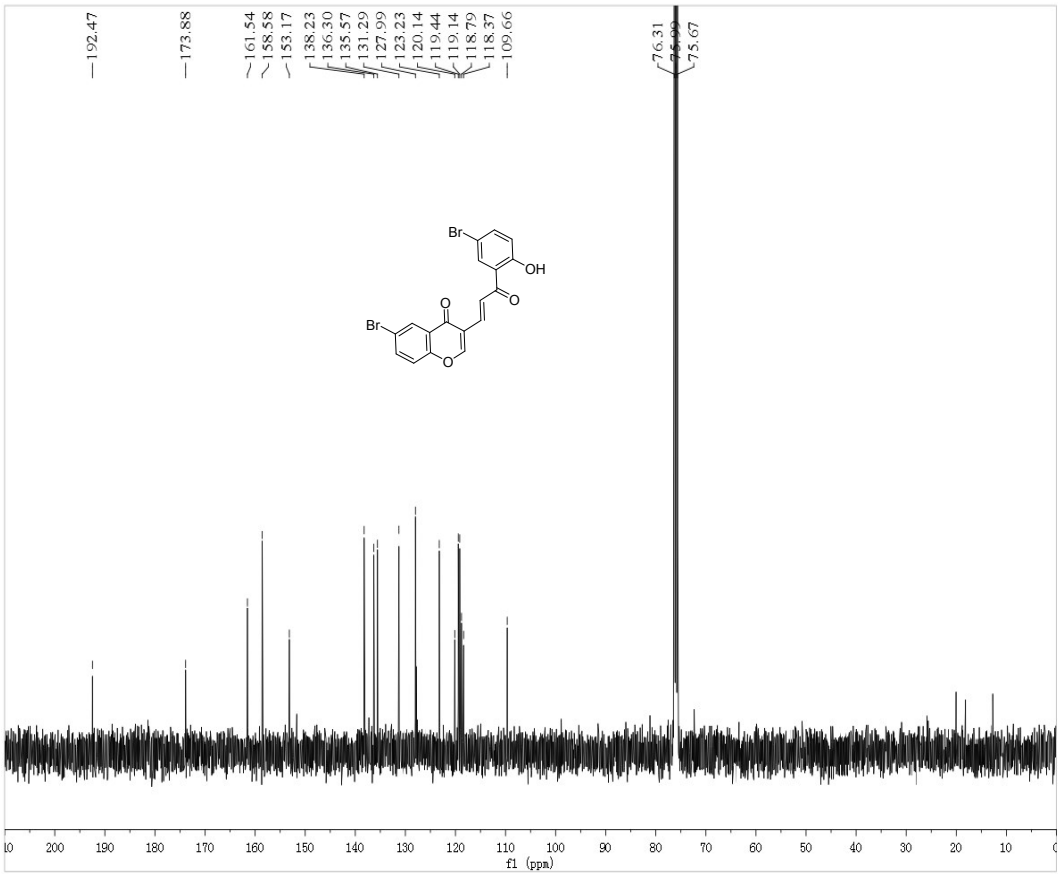
^{1}H and ^{13}C NMR of **6a**



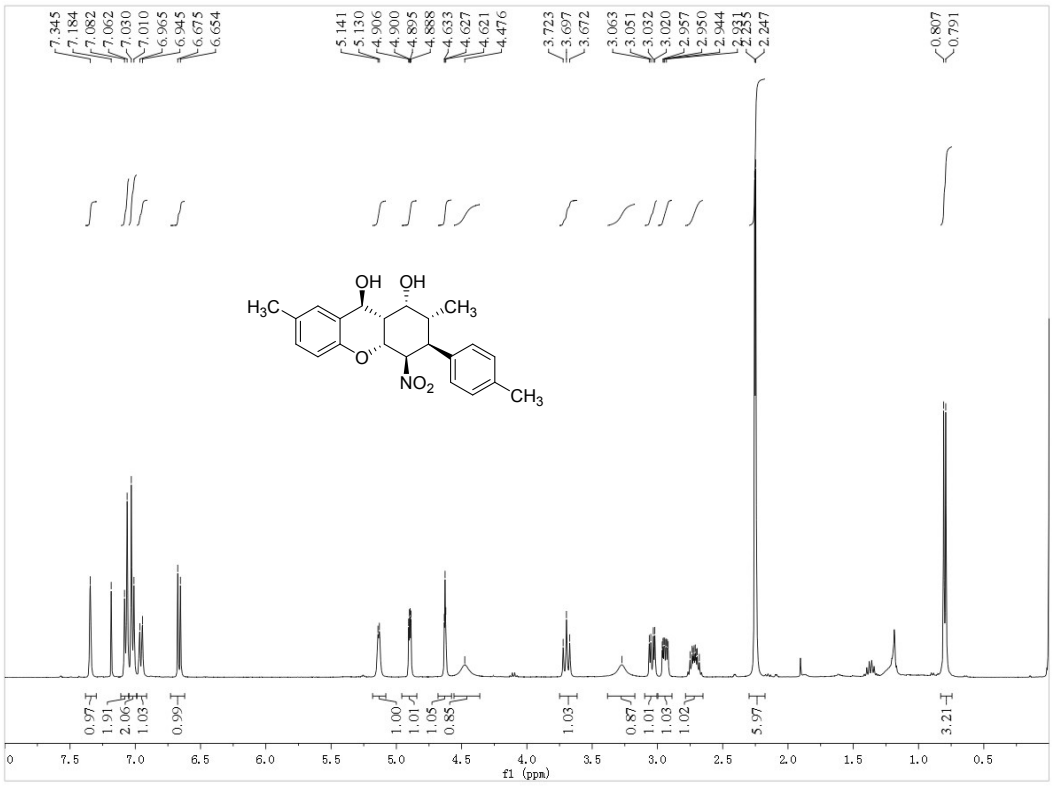


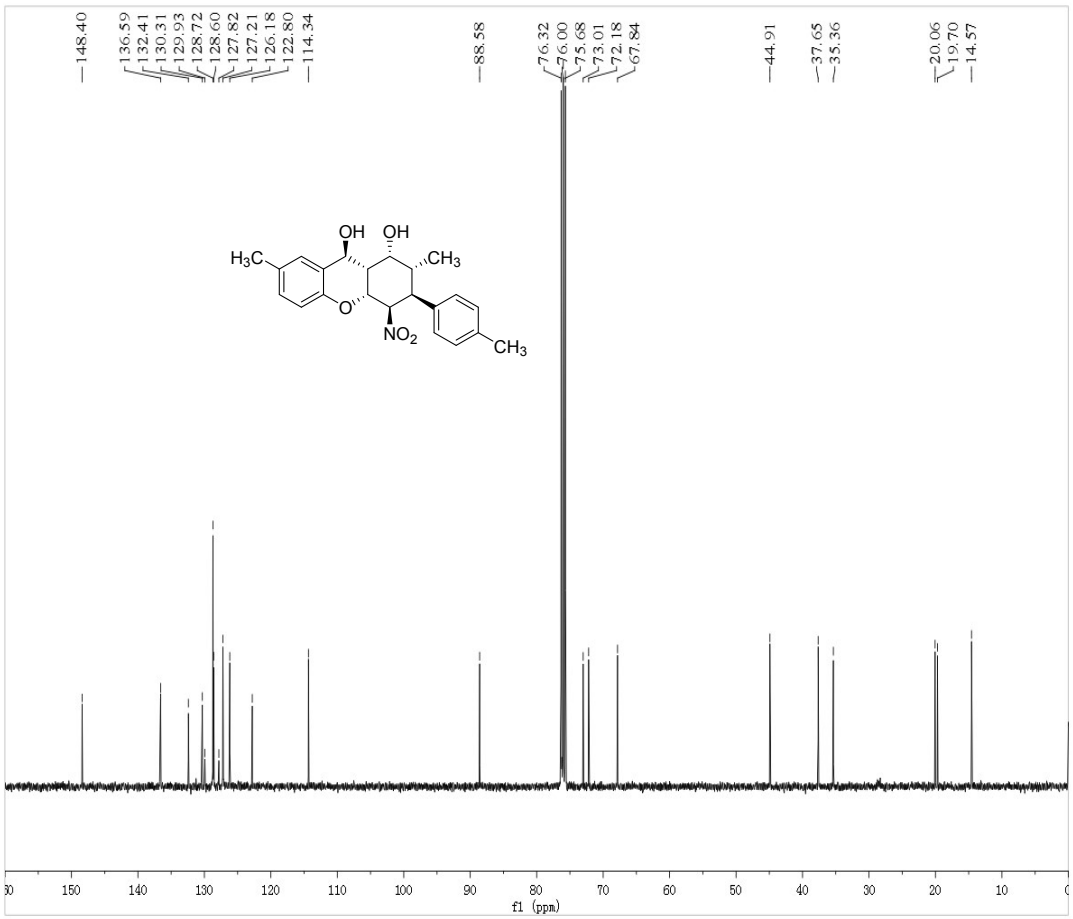
^{1}H and ^{13}C NMR of **6b**



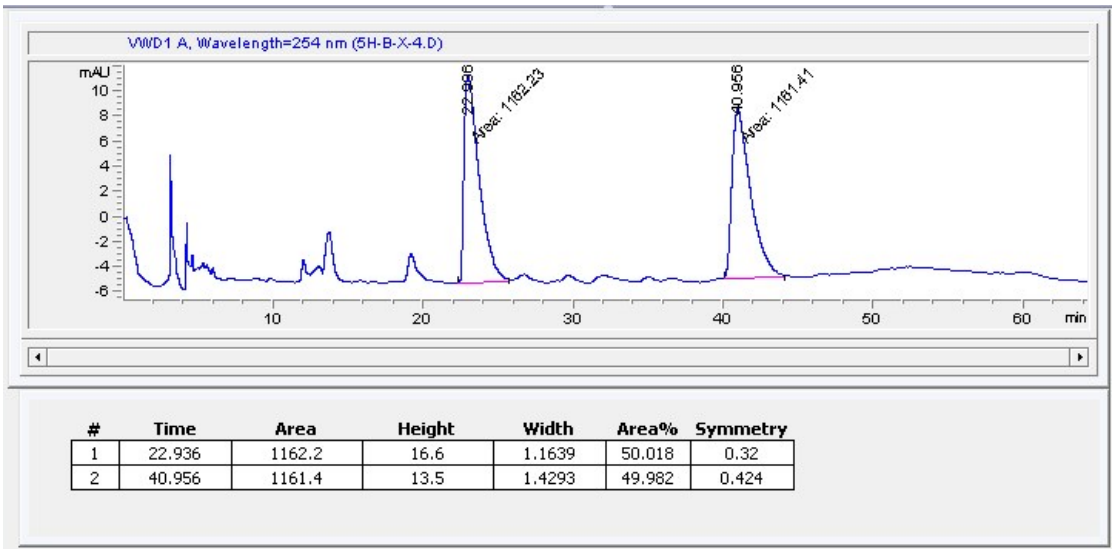


^{1}H and ^{13}C NMR of **7h**

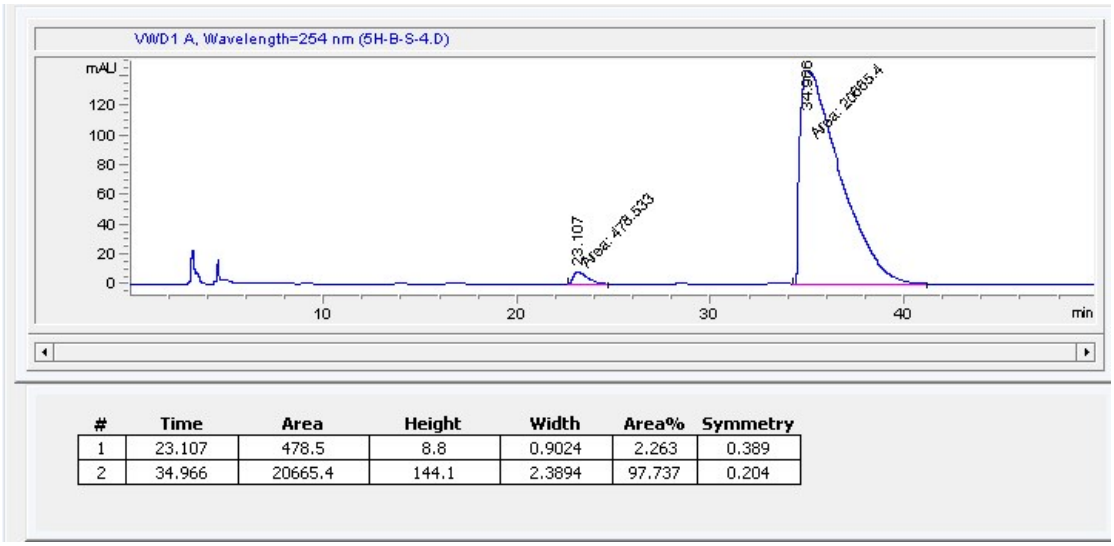




HPLC of **7h**

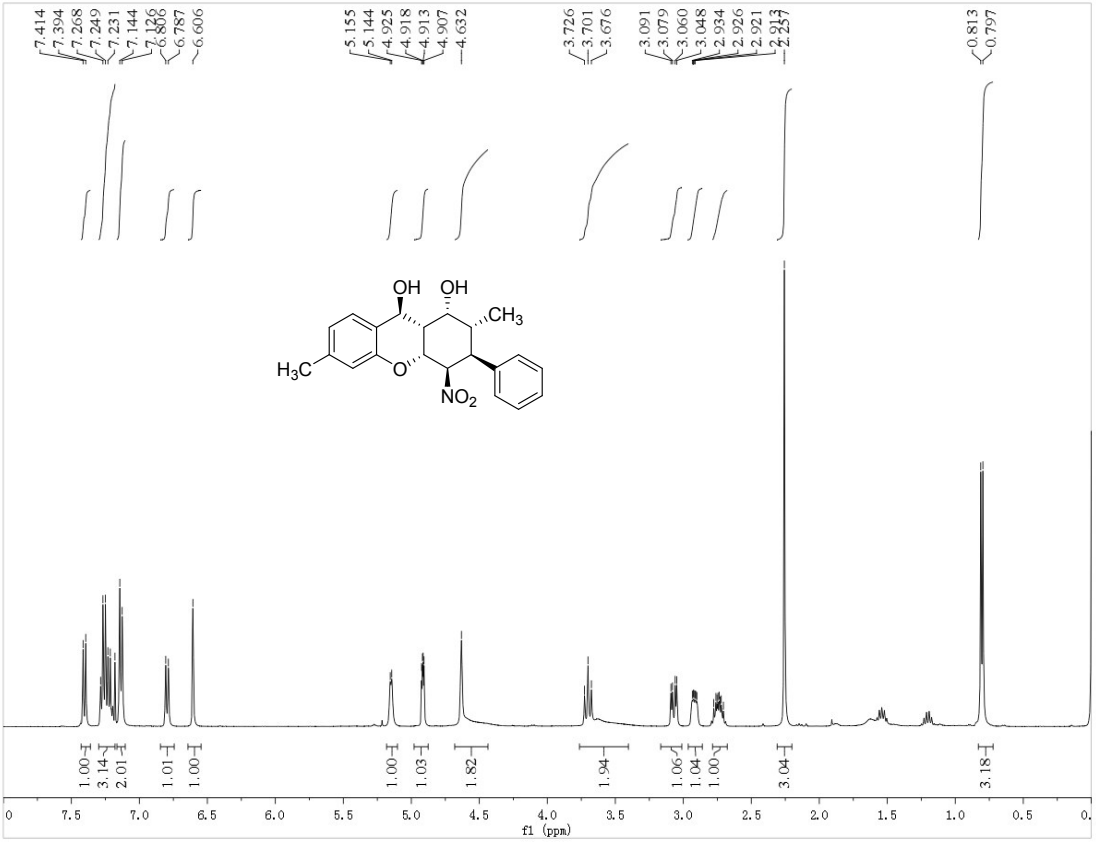


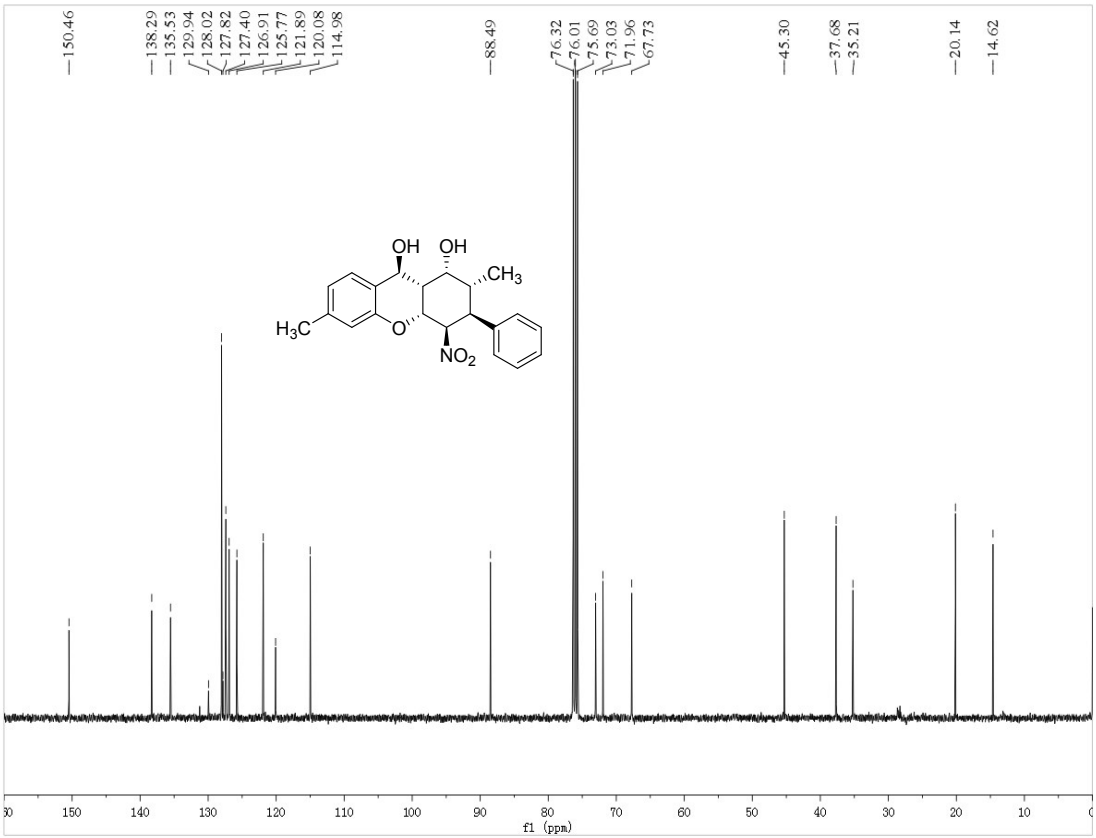
#	Time	Area	Height	Width	Area%	Symmetry
1	22.936	1162.2	16.6	1.1639	50.018	0.32
2	40.956	1161.4	13.5	1.4293	49.982	0.424



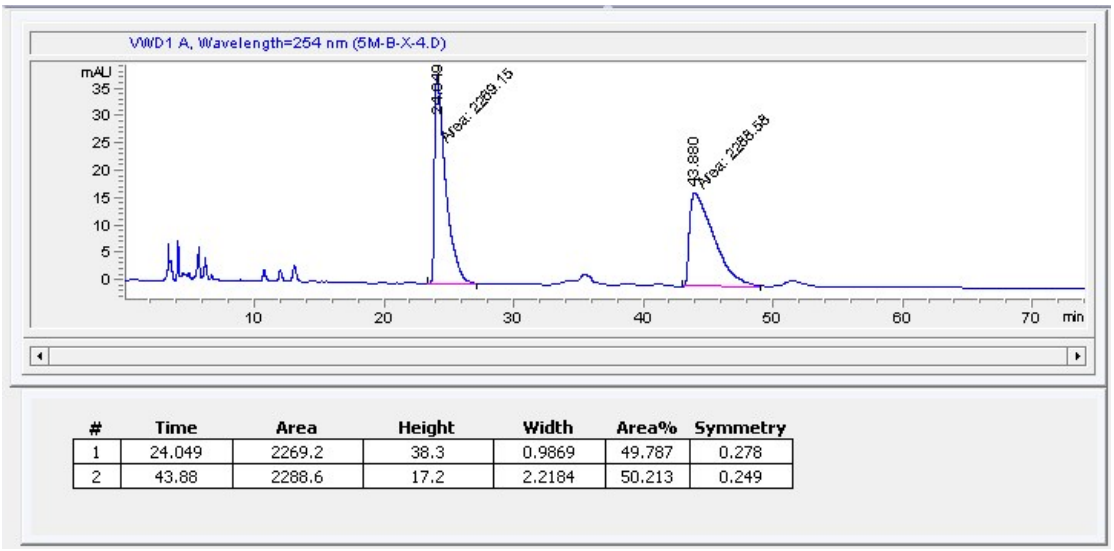
#	Time	Area	Height	Width	Area%	Symmetry
1	23.107	478.5	8.8	0.9024	2.263	0.389
2	34.966	20665.4	144.1	2.3894	97.737	0.204

^{1}H and ^{13}C NMR of **7m**

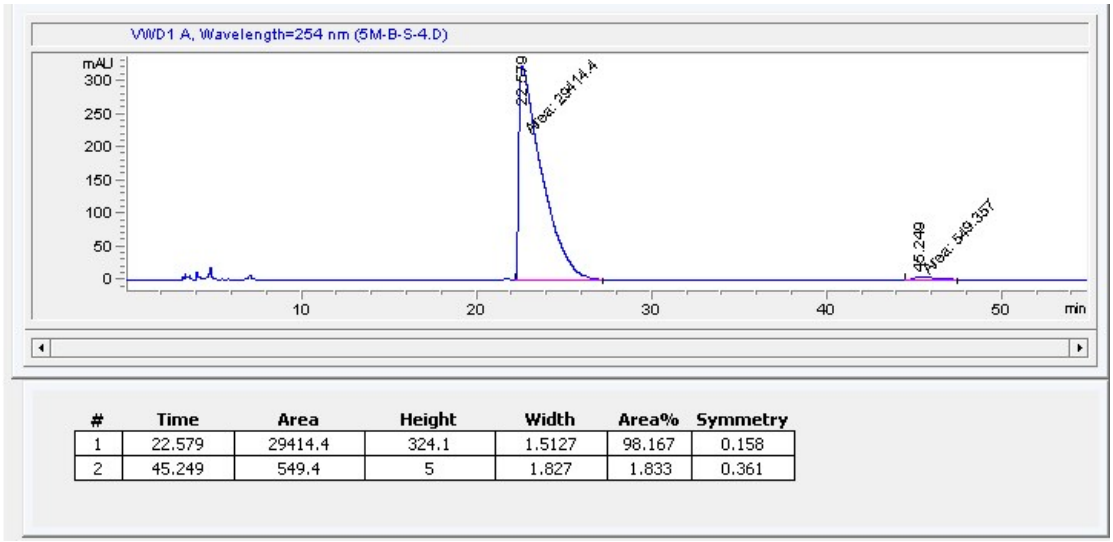




HPLC of **7m**



#	Time	Area	Height	Width	Area%	Symmetry
1	24.049	2269.2	38.3	0.9869	49.787	0.278
2	43.88	2288.6	17.2	2.2184	50.213	0.249



#	Time	Area	Height	Width	Area%	Symmetry
1	22.579	29414.4	324.1	1.5127	98.167	0.158
2	45.249	549.4	5	1.827	1.833	0.361