Kinetic Resolution of 2,3-Epoxy 3-Aryl Ketones via Catalytic Asymmetric Ring-Opening with Pyrazole Derivatives†

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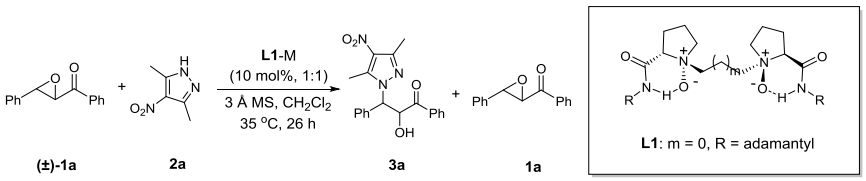
1. General information

^{1}H NMR spectra were recorded on commercial instruments (400 MHz). Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$, δ = 7.26). Spectra were reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), integration and assignment. ^{13}C NMR spectra were collected on commercial instruments (100 MHz) with complete proton decoupling. Chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, δ = 77.0). Enantiomeric excesses (*ee*) were determined by HPLC analysis using the corresponding commercial chiralpak column as stated in the experimental procedures at 23 °C. Optical rotations were reported as follows: $[\alpha]_D^{28}$ (*c*: g/100 mL, in solvent). HRMS was recorded on a commercial apparatus (ESI Source). All catalytic reactions were run in dried glassware. THF, toluene and diethyl ether (Et_2O) were distilled from sodium benzophenone ketyl. CH_2Cl_2 was distilled over CaH_2. The *N*,*N*'-dioxides (**L1**-**L6**) were prepared according to the previous reports.[1] Starting material epoxides were prepared according to reported procedure.[2]

2. Optimization of the reaction conditions

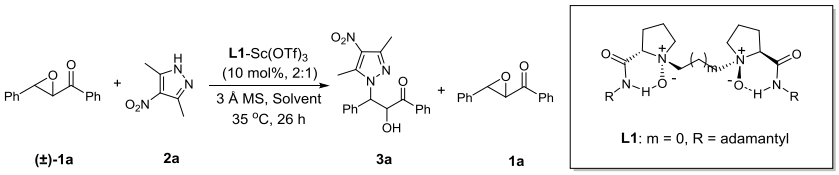
Table 1. Screening of the metals



Entry[a]	Metal	Yield [%][b]		*ee* [%][c]		d.r.[d]
		3a	1a	3a	1a	
1	$Sc(OTf)_3$	55	40	53	77	> 19:1
2	$La(OTf)_3$	81	12	race	25	> 19:1
3	$Fe(OTf)_3$	16	75	37	4	> 19:1
4	$Y(OTf)_3$	52	40	race	43	> 19:1
5	$Gd(OTf)_3$	62	30	8	53	> 19:1
6	$Ni(OTf)_2$	N.R.				
7	$Zn(OTf)_2$	N.R.				
8	$Mg(OTf)_2$	N.R.				

[a] Unless otherwise noted, the reactions were performed with **L1**-metal (10 mol%, 1:1), 3 Å MS 30 mg in CH_2Cl_2 (0.5 mL) at 35 °C for 30 min, (±)-**1a** (0.10 mmol, 1.0 equiv) and **2a** (0.10 mmol, 1.0 equiv) were added in one-portion. The mixture was reacted at 35 °C for 26 h. [b] Isolated yield. [c] Determined by HPLC analysis (Chiralcel IC and IE). [d] Determined by ^{1}H NMR analysis of the product **3a**.

Table 2. Screening of the solvents

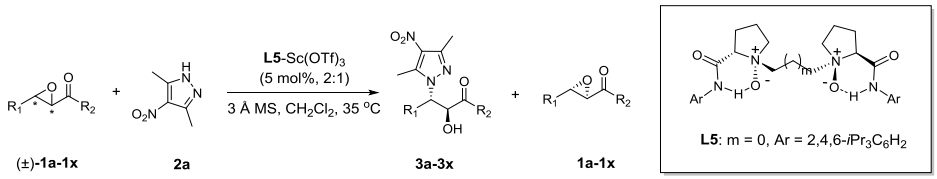


Entry[a]	Solvent	Yield [%][b]		*ee* [%][c]		d.r.[d]
		3a	1a	3a	1a	
1	THF	N.R.				> 19:1
2	Et_2O	7	90	85	race	> 19:1
3	CH_2Cl_2	19	70	95	26	> 19:1
4	$CHCl_3$	13	77	95	10	> 19:1
5	$CHCl_2CH_2Cl$	13	80	84	15	> 19:1
6	$CHCl_3CH_3$	11	75	82	21	> 19:1

[a] Unless otherwise noted, the reactions were performed with **L1**-metal (10 mol%, 1:1), 3 Å MS 30 mg in CH_2Cl_2 (0.5 mL) at 35 °C for 30 min, (±)-**1a** (0.10 mmol, 1.0 equiv) and **2a** (0.10 mmol, 1.0 equiv) were added in one-portion. The mixture was reacted at 35 °C for 26 h. [b] Isolated yield. [c] Determined by HPLC analysis (Chiralcel IC and IE). [d] Determined by ^{1}H NMR analysis of the product **3a**.

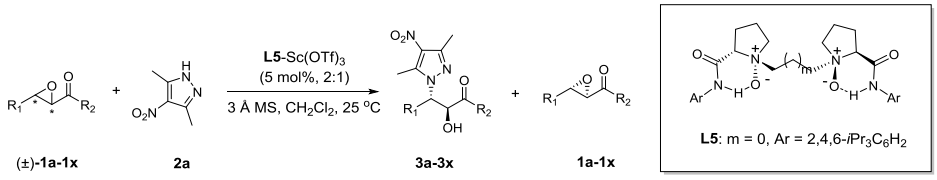
3. General procedure for the Ring-Opening reaction of different epoxides (1a-1x)

General procedure A for the reaction of epoxides (±)-**1**:



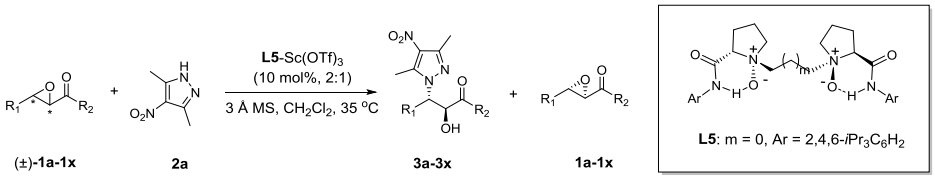
In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 35 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** were added to the reaction mixture at 35 °C. The reaction was stirred at 35 °C for 12-72 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

General procedure B for the reaction of epoxides (±)-**1**:



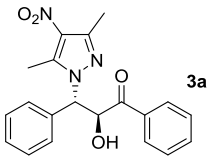
In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 25 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** were added to the reaction mixture at 25 °C. The reaction was stirred at 25 °C for 12-24 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

General procedure C for the reaction of epoxides (±)-**1**:



In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.02 mmol, 13.2 mg), $Sc(OTf)_3$ (0.01 mmol, 4.9 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 35 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** were added to the reaction mixture at 35 °C. The reaction was stirred at 35 °C for 12-72 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

4. The analytical and spectral characterization data of the products (3a-3x)

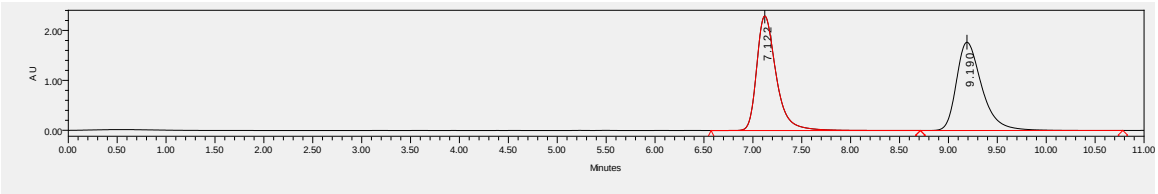


(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1,3-diphenylpropan-1-one (**3a**)
General procedure A; White solid; 47% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{24}$ = -54 (c 0.28, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.97 min, t (major) = 9.03 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.6 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.37 – 7.28 (m, 5H), 5.92 (t, *J* = 5.6 Hz, 1H), 5.64 (d, *J* = 5.6 Hz, 1H), 3.82 (d, *J* = 5.6 Hz, 1H), 2.46 (d, *J* = 7.2 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.94, 146.10, 140.78, 134.89, 134.88, 133.83, 128.98, 128.95, 128.83, 128.44, 128.25, 74.57, 64.46, 14.23, 11.35.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{19}N_3NaO_4$, m/z: 388.1268, observed: 388.1269.



Retention Time	Area	% Area
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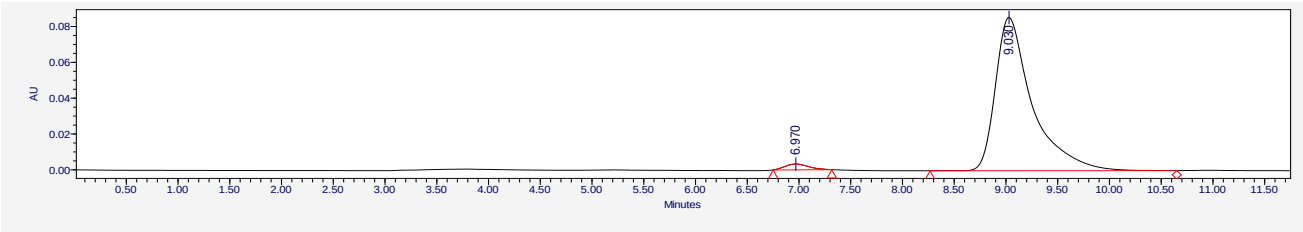
9.190	31924377	50.20



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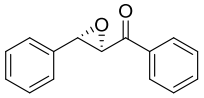
9.030	2114907	97.62



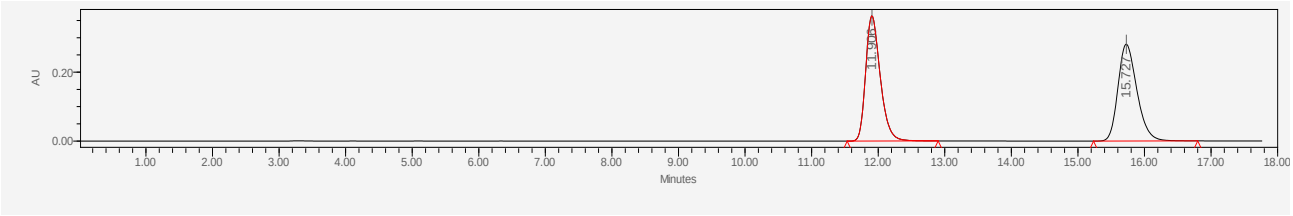
1a

(2*R*,3*S*)-phenyl(3-phenyloxiran-2-yl)methanone (**1a**)

General procedure A; White solid; 49% yield, 94% *ee*, > 99:1 d.r.; $[\alpha]_D^{24}$ = -225 (c 0.15, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 12.31 min, t (minor) = 16.32 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 – 7.96 (m, 2H), 7.62 (m, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.45 – 7.31 (m, 5H), 4.30 (d, *J* = 2.0 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{12}NaO_2$, m/z: 247.0730, observed: 247.0732.



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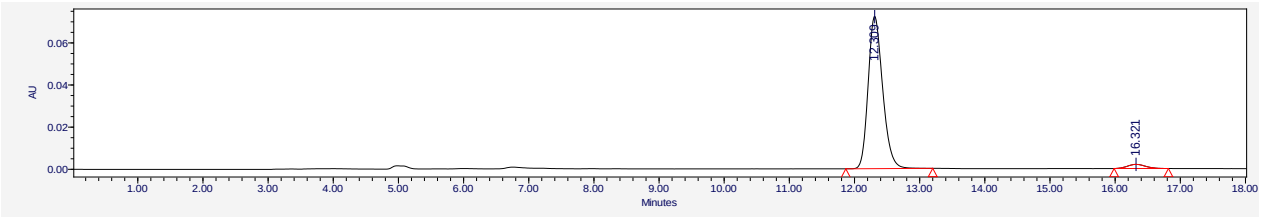
15.727	5544341	50.06



Retention Time	Area	% Area
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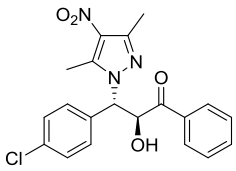
16.321	34345	2.96



3b

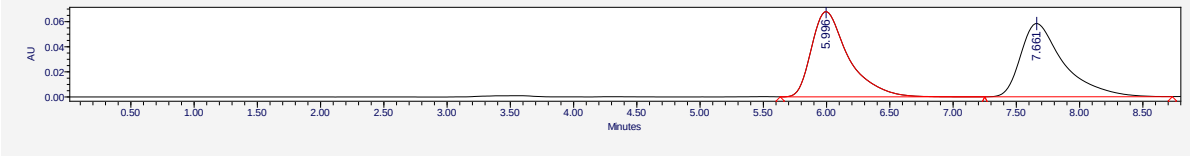
(2*S*,3*S*)-3-(4-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3b**)

General procedure C; White solid; 50% yield, 94% *ee*, > 19:1 d.r.; $[\alpha]_D^{30}$ = -39 (c 0.21, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.48 min, t (major) = 8.05 min];

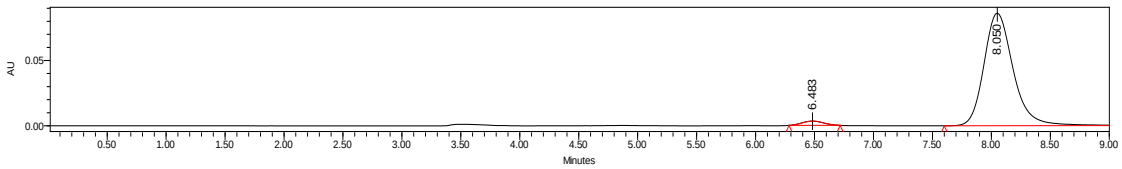
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.79 (m, 2H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.34 – 7.22 (m, 3H), 5.88 (t, *J* = 6.0 Hz, 1H), 5.61 (d, *J* = 6.0 Hz, 1H), 4.08 (d, *J* = 6.8 Hz, 1H), 3.93 (d, *J* = 6.4 Hz, 1H), 2.51 (d, *J* = 2.4 Hz, 1H), 2.46 (d, *J* = 3.6 Hz, 5H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.83, 146.35, 140.74, 135.00, 134.64, 134.04, 133.37, 129.74, 128.99, 128.51, 74.55, 63.70, 14.24, 11.35.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{35}ClN_3NaO_4$, m/z: 422.0879, observed: 422.0885; $C_{20}H_{18}{}^{37}ClN_3NaO_4$, m/z: 424.0849, observed: 422.0868.



Retention Time	Area	% Area
5.996	1384563	50.06
7.661	1380992	49.94



Retention Time	Area	% Area
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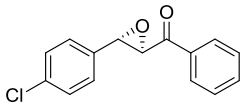
8.050	1485456	97.28



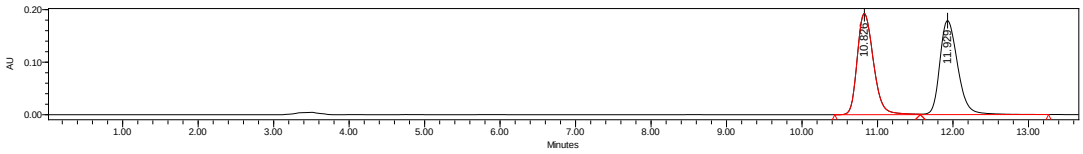
1b

(2*R*,3*S*)-(3-(4-chlorophenyl)oxiran-2-yl)(phenyl)methanone (**1b**)

General procedure C; White solid; 49% yield, 95% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -204 (c 0.16, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 10.73 min, t (minor) = 11.79 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 7.6 Hz, 2H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.39 (d, *J* = 8.4 Hz, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 4.25 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.6 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{35}ClNaO_2$, m/z: 281.0340, observed: 281.0348; $[M+Na]^+$ $C_{15}H_{11}{}^{37}ClNaO_2$, m/z: 283.0311, observed: 283.0335.



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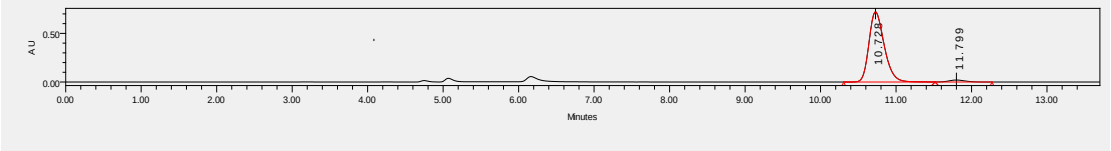
11.929	2937552	50.58



Retention Time	Area	% Area
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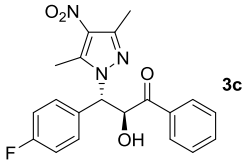
11.799	247009	2.38



3c

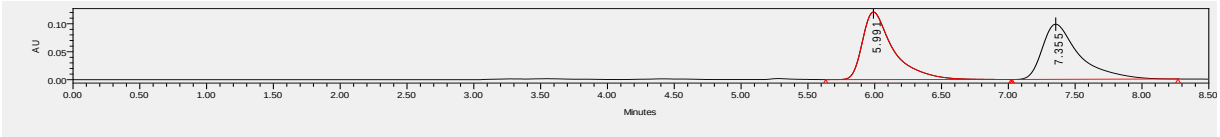
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-3-(4-fluorophenyl)-2-hydroxy-1-phenylpropan-1-one (**3c**)

General procedure A; White solid; 48% yield, 96% *ee*, > 19:1 d.r.; $[\alpha]_D^{30}$ = -66 (c 0.20, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.57 min, t (major) = 8.06 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.77 (m, 2H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 8.0 Hz, 2H), 7.35 – 7.27 (m, 2H), 7.03 (m, 2H), 5.87 (t, *J* = 6.0 Hz, 1H), 5.62 (d, *J* = 5.6 Hz, 1H), 3.92 (d, *J* = 6.4 Hz, 1H), 2.46 (d, *J* = 6.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.94, 164.12, 161.65, 146.29, 140.69, 134.70, 133.99, 131.43, 130.71, 130.68, 130.24, 130.16, 128.97, 128.48, 115.91, 115.69, 74.65, 63.68, 14.24, 11.33.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{18}FN_3NaO_4$, m/z: 406.1174, observed: 406.1176; $[M+Na]^+$ $C_{20}H_{18}{}^{19}FN_3NaO_4$, m/z: 407.1208, observed: 407.1188.



Retention Time	Area	% Area
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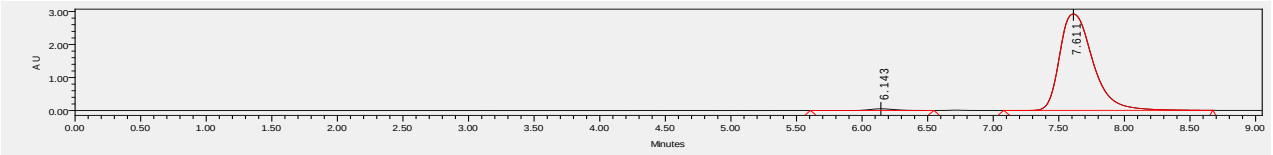
7.355	1897781	49.37



Retention Time	Area	% Area
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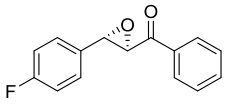
7.611	51365534	98.71



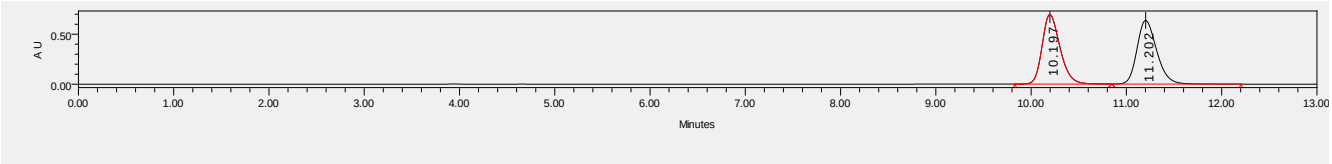
1c

(2*R*,3*S*)-(3-(4-fluorophenyl)oxiran-2-yl)(phenyl)methanone（**1c**）

General procedure A; White solid; 51% yield, 91% *ee*, > 99:1 d.r.; $[\alpha]_D^{30}$ = -167 (c 0.21，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 10.49 min, t (minor) = 11.52 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 7.6 Hz, 2H), 7.63 (t, *J* = 7.2 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.35 (m, 2H), 7.10 (t, *J* = 8.4 Hz, 2H), 4.26 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.6 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{18}FNaO_2$, m/z: 265.0635, observed: 265.0640.



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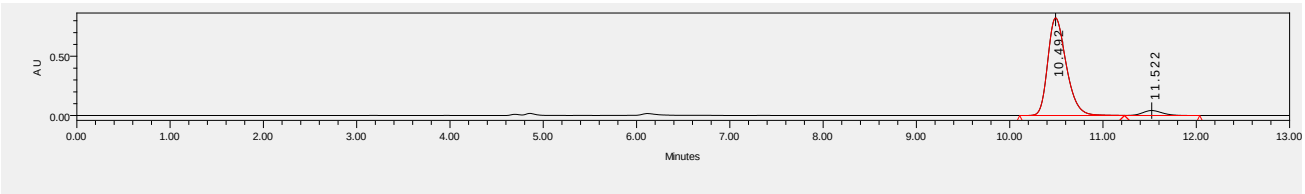
11.202	9164885	50.08



\Retention Time	Area	% Area
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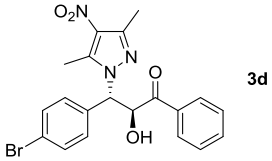
11.522	488776	4.13



3d

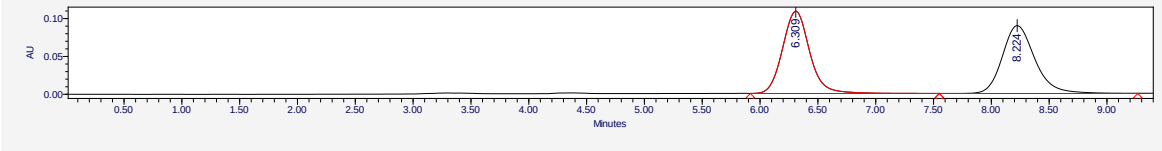
(2*S*,3*S*)-3-(4-bromophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3d**)

General procedure C; colorless oil; 48% yield, 93% *ee*, d.r. = 17:1; $[\alpha]_D^{31}$ = -28 (c 0.16，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.80 min, t (major) = 8.89 min];

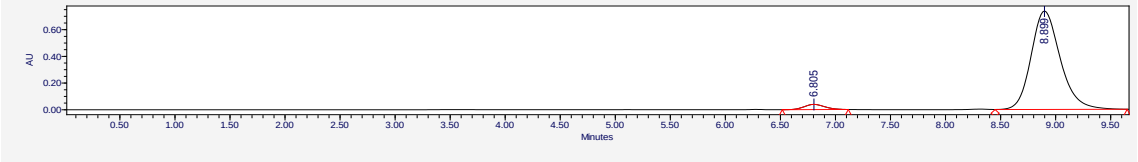
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.6 Hz, 2H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.50 – 7.38 (m, 4H), 7.21 (d, *J* = 8.4 Hz, 2H), 5.87 (d, *J* = 5.6 Hz, 1H), 5.60 (d, *J* = 5.6 Hz, 1H), 4.12 – 3.61 (m, 1H), 2.46 (d, *J* = 4.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.81, 146.34, 140.72, 134.65, 134.02, 133.91, 131.94, 130.03, 128.98, 128.50, 123.21, 74.50, 63.78, 14.21, 11.33.

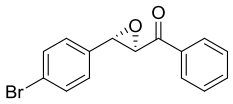
HRMS (ESI) calcd for $[M+H]^+$ $C_{20}H_{18}{}^{79}BrN_3O_4$, m/z: 444.0554, observed: 444.0553; $[M+H]^+$ $C_{20}H_{18}{}^{81}BrN_3O_4$, m/z: 446.0533, observed: 444.0542.



Retention Time	Area	% Area
6.309	1765827	50.06
8.224	1761612	49.94



Retention Time	Area	% Area
6.805	511650	3.63
8.899	13600580	96.37



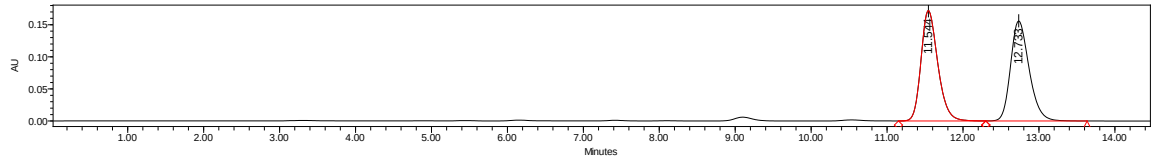
1d

(2*R*,3*S*)-(3-(4-bromophenyl)oxiran-2-yl)(phenyl)methanone (**1d**)

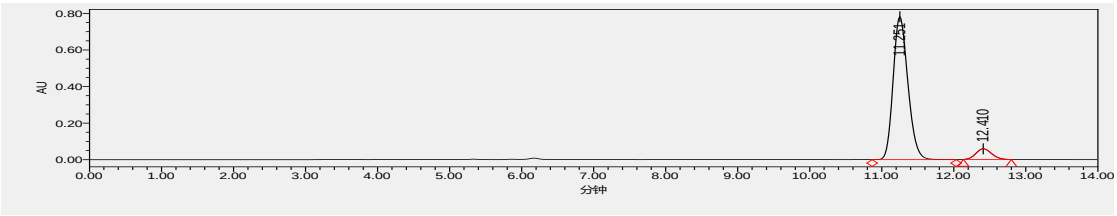
General procedure C; White solid; 52% yield, 85% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -154 (c 0.29，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 11.25 min, t (minor) = 12.41 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 – 7.94 (m, 2H), 7.67 – 7.60 (m, 1H), 7.57 – 7.45 (m, 4H), 7.26 – 7.21 (m, 2H), 4.24 (d, *J* = 1.6 Hz, 1H), 4.05 (d, *J* = 1.6 Hz, 1H).

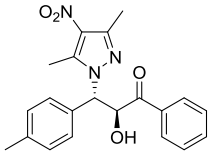
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{79}BrNaO_2$, m/z: 324.9835, observed: 324.9836; $[M+Na]^+$ $C_{15}H_{11}{}^{81}BrNaO_2$, m/z: 326.9815, observed: 326.9820.



Retention Time	Area	% Area
11.544	2639531	50.01
12.733	2638257	49.99



Retention Time	Area	% Area
11.251	11155295	92.67
12.410	882343	7.33



3e

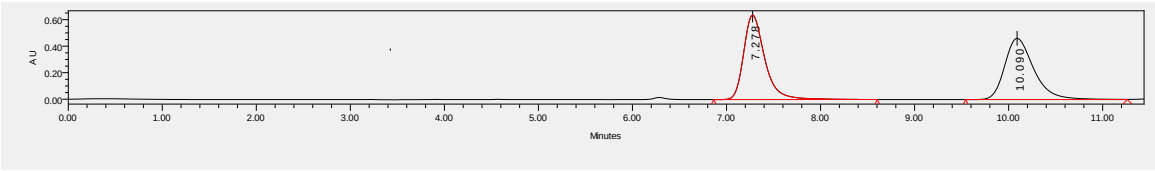
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenyl-3-(p-tolyl)propan-1-one (**3e**)

General procedure B; White solid; 50% yield, 91% *ee*, > 19:1 d.r.; $[\alpha]_D^{31}$ = -58 (c 0.17, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 7.02 min, t (major) = 9.62 min];

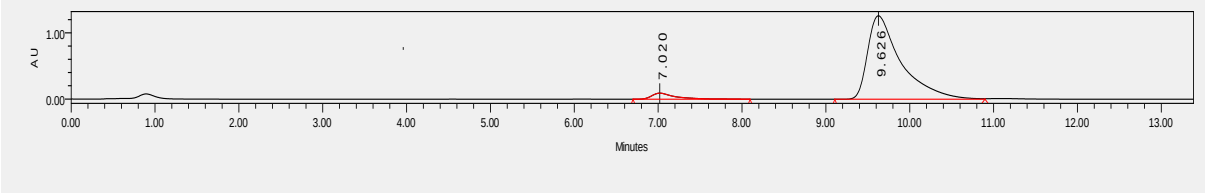
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.17 (m, 4H), 5.91 (t, *J* = 6.0 Hz, 1H), 5.59 (d, *J* = 6.0 Hz, 1H), 3.76 (d, *J* = 6.0 Hz, 1H), 2.45 (d, *J* = 7.2 Hz, 6H), 2.32 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 199.02, 146.06, 140.68, 138.92, 134.84, 133.85, 131.82, 131.37, 129.53, 128.96, 128.45, 128.16, 74.39, 64.26, 21.17, 14.26, 11.36.

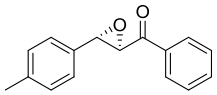
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{21}N_3NaO_4$, m/z: 402.1424, observed: 402.1424.



Retention Time	Area	% Area
7.278	9952884	50.01
10.090	9949981	49.99



Retention Time	Area	% Area
7.020	1554652	4.27
9.626	34852371	95.73



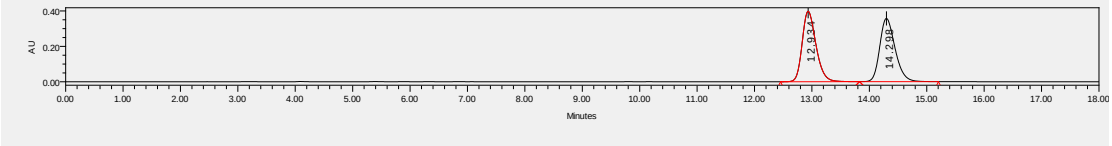
1e

(2*R*,3*S*)-phenyl(3-(p-tolyl)oxiran-2-yl)methanone (**1e**)

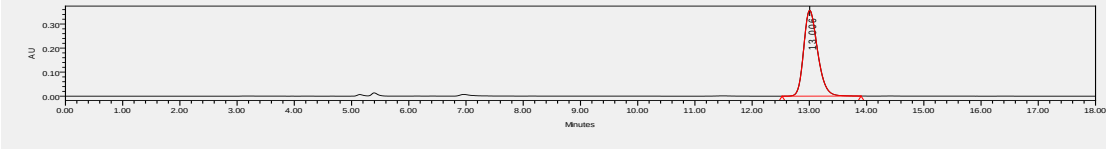
General procedure B; White solid; 43% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -206 (c 0.16，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 13.06 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 7.2 Hz, 2H), 7.62 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.27 (d, *J* = 7.6 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 4.29 (d, *J* = 1.6 Hz, 1H), 4.04 (d, *J* = 1.6 Hz, 1H), 2.38 (s, 3H).

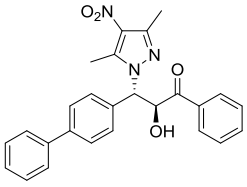
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{14}NaO_2$, m/z: 261.0886, observed: 261.0893.



Retention Time	Area	% Area
12.934	6653296	50.08
14.298	6630912	49.92



Retention Time	Area	% Area
13.006	6022414	100.00



3f

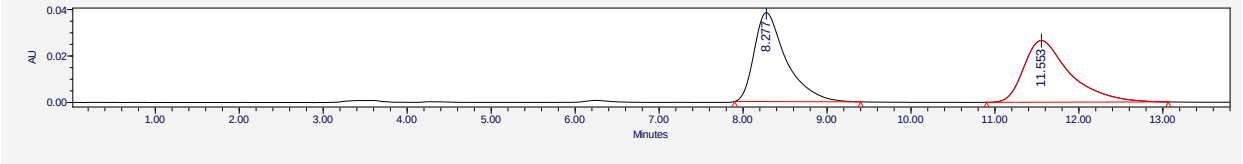
(2*S*,3*S*)-3-([1,1'-biphenyl]-4-yl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3f**)

General procedure A; White solid; 49% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{17}$ = 6 (c 0.19，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 8.91 min, t (major) = 12.51 min];

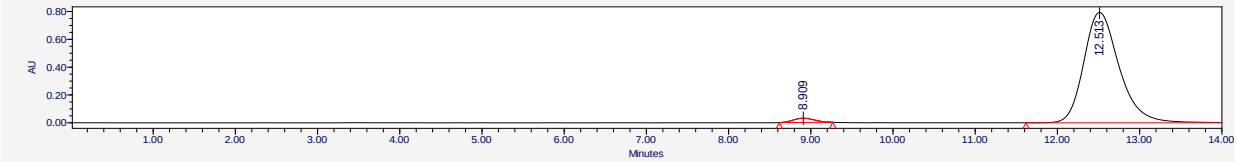
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.6 Hz, 2H), 7.54 (m, 5H), 7.45 – 7.31 (m, 7H), 5.93 (d, *J* = 6.0 Hz, 1H), 5.68 (d, *J* = 6.0 Hz, 1H), 3.91 (d, *J* = 6.0 Hz, 1H), 2.47 (d, *J* = 18.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.97, 146.18, 141.86, 140.81, 140.24, 134.88, 133.87, 131.44, 129.00, 128.87, 128.72, 128.46, 127.69, 127.51, 127.11, 74.51, 64.17, 14.25, 11.38.

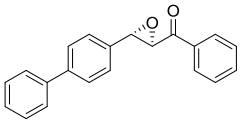
HRMS (ESI) calcd for $[M+Na]^+$ $C_{26}H_{23}N_3NaO_4$, m/z: 464.1581, observed: 464.1585.



Retention Time	Area	% Area
8.277	1013796	50.10
11.553	1009787	49.90



Retention Time	Area	% Area
8.909	550999	2.26
12.513	23883011	97.74



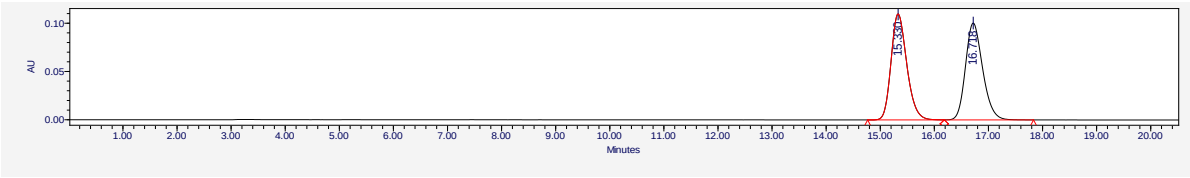
1f

(2*R*,3*S*)-(3-([1,1'-biphenyl]-4-yl)oxiran-2-yl)(phenyl)methanone (**1f**)

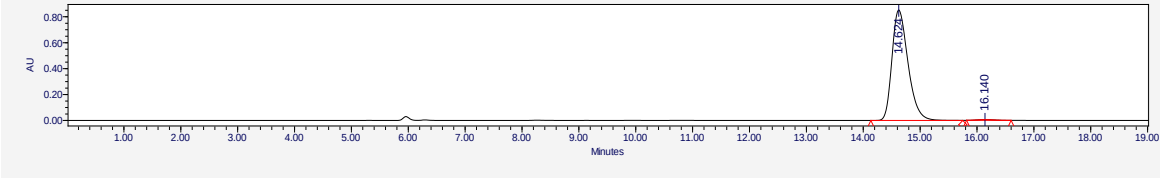
General procedure A; White solid; 48% yield, 98% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -248 (c 0.21, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 14.62 min, t (minor) = 16.14 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 7.4 Hz, 2H), 7.62 (m, 5H), 7.54 – 7.43 (m, 6H), 7.38 (t, *J* = 7.2 Hz, 1H), 4.35 (d, *J* = 1.6 Hz, 1H), 4.13 (d, *J* = 1.2 Hz, 1H).

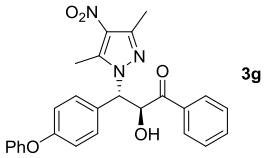
HRMS (ESI) calcd for $[M+H]^+$ $C_{21}H_{16}O_2$, m/z: 301.1223, observed: 301.1233.



Retention Time	Area	% Area
15.330	2212822	50.02
16.718	2211067	49.98



Retention Time	Area	% Area
14.624	16693482	99.29
16.140	119198	0.71



3g

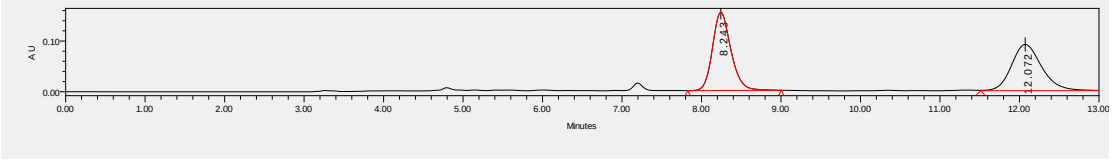
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(4-phenoxyphenyl)-1-phenylpropan-1-one (**3g**)

General procedure B; colorless oil; 50% yield, 91% *ee*, d.r. = 16:1; $[\alpha]_D^{31}$ = -33 (c 0.22, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 8.30 min, t (major) = 12.75 min];

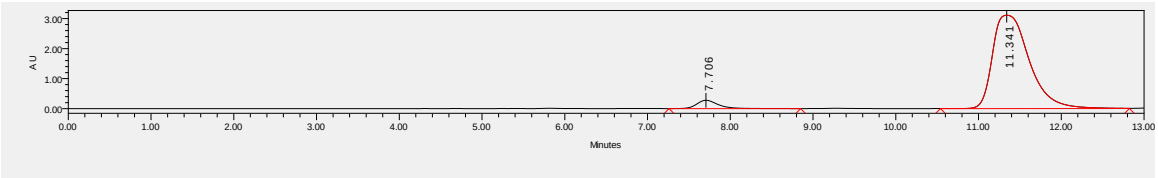
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (t, *J* = 11.2 Hz, 2H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.6 Hz, 2H), 7.31 – 7.27 (m, 2H), 7.13 (t, *J* = 7.6 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 2H), 6.93 (t, *J* = 10 Hz, 2H), 5.88 (d, *J* = 4.8 Hz, 1H), 5.61 (d, *J* = 6.0 Hz, 1H), 3.89 (d, *J* = 5.2 Hz, 1H), 2.50 (m, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 199.03, 158.08, 156.33, 146.16, 140.67, 134.86, 133.87, 129.87, 129.82, 129.18, 129.00, 128.44, 123.91, 119.49, 118.45, 74.70, 63.90, 14.22, 11.36.

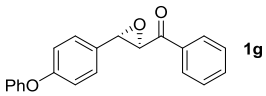
HRMS (ESI) calcd for $[M+K]^+$ $C_{26}H_{23}KN_3O_5$, m/z: 496.1269, observed: 496.1276.



Retention Time	Area	% Area
8.243	2485991	50.79
12.072	2408978	49.21



Retention Time	Area	% Area
7.706	4446021	4.47
11.341	94957345	95.53



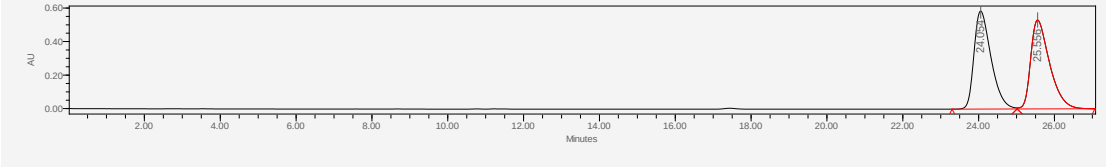
1g

(2*R*,3*S*)-(3-(4-phenoxyphenyl)oxiran-2-yl)(phenyl)methanone (**1g**)

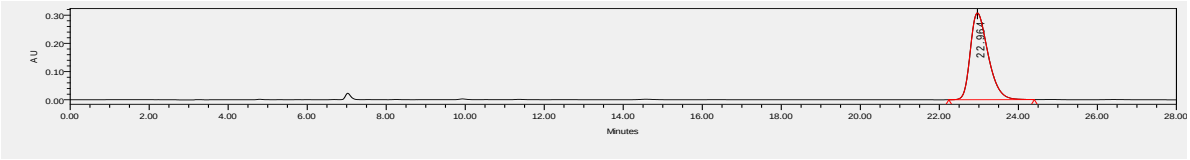
General procedure B; White solid; 46% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -213 (c 0.19, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 22.96 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.62 (d, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.35 (m, 4H), 7.14 (t, *J* = 7.2 Hz, 1H), 7.03 (m, 4H), 4.30 (d, *J* = 1.6 Hz, 1H), 4.06 (d, *J* = 1.2 Hz, 1H).

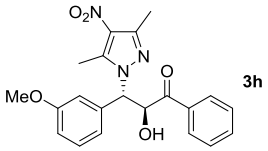
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{16}NaO_3$, m/z: 339.0992, observed: 339.0990.



Retention Time	Area	% Area
24.054	18266081	49.95
25.556	18302963	50.05



Retention Time	Area	% Area
22.964	9616968	100.00



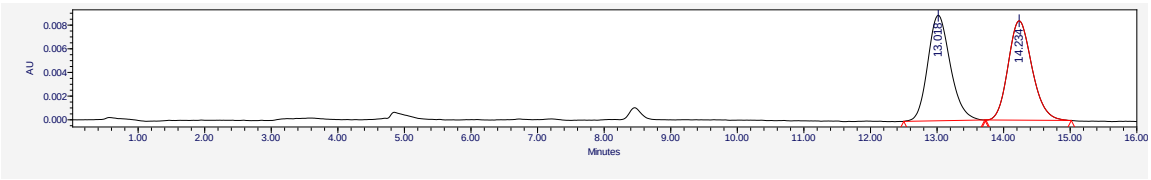
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(3-methoxyphenyl)-1-phenylpropan-1-one (**3h**)

General procedure C; colorless oil; 48% yield, 91% *ee*, > 19:1 d.r.; $[\alpha]_D^{31}$ = -54 (c 0.10, CH_2Cl_2) Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 10.79 min, t (major) = 12.14 min];

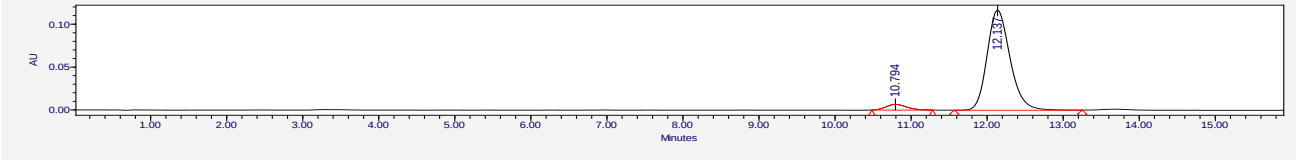
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.2 Hz, 2H), 7.55 (d, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.27 (s, 1H), 7.24 (s, 1H), 6.92 – 6.77 (m, 3H), 5.90 (t, *J* = 6.0 Hz, 1H), 5.61 (d, *J* = 6.0 Hz, 1H), 3.76 (s, 3H), 2.46 (d, *J* = 14.8 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.80, 159.82, 146.06, 140.86, 136.38, 134.94, 133.80, 129.89, 128.99, 128.44, 120.47, 114.30, 113.93, 74.55, 64.34, 55.28, 14.23, 11.35.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{21}N_3NaO_5$, m/z: 418.1373, observed: 418.1381.

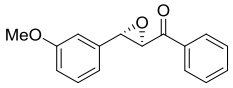


Retention Time	Area	% Area
13.018	209689	50.15
14.234	208413	49.85



Retention Time	Area	% Area
10.794	124868	4.86

12.137	2442466	95.14



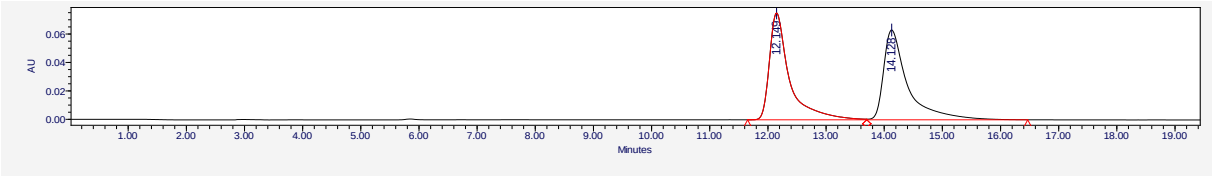
1h

(2*R*,3*S*)-(3-(3-methoxyphenyl)oxiran-2-yl)(phenyl)methanone (**1h**)

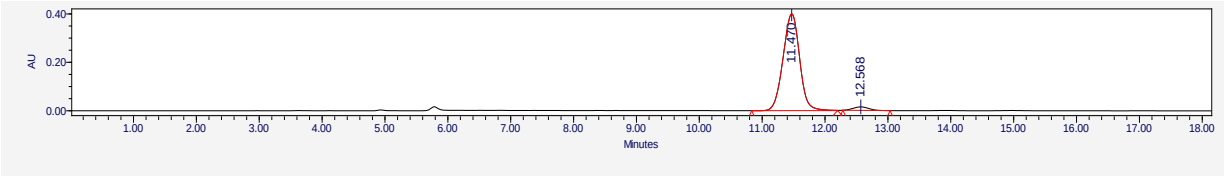
General procedure C; White solid; 48% yield, 93% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -225 (c 0.19, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IA, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 11.47 min, t (minor) = 12.57 min] ;

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (m, 2H), 7.62 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.32 (t, *J* = 7.6 Hz, 1H), 7.03 – 6.85 (m, 3H), 4.28 (d, *J* = 1.6 Hz, 1H), 4.06 (d, *J* = 1.6 Hz, 1H), 3.83 (s, 3H).

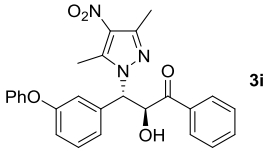
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{14}NaO_3$, m/z: 277.0835, observed: 277.0840.



Retention Time	Area	% Area
12.149	1801348	49.90
14.128	1808915	50.10



Retention Time	Area	% Area
11.470	7312077	96.68
12.568	250723	3.32



3i

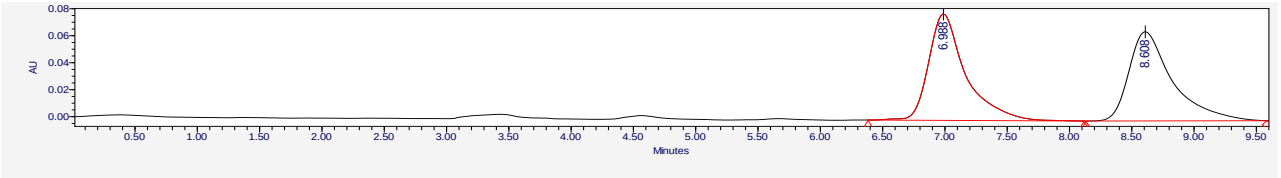
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(3-phenoxyphenyl)-1-phenylpropan-1-one (**3i**)

General procedure C; colorless oil; 42% yield, 93% *ee*, d.r. = 10:1; $[\alpha]_D^{30}$ = -71 (c 0.11, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 7.37 min, t (major) = 9.18 min];

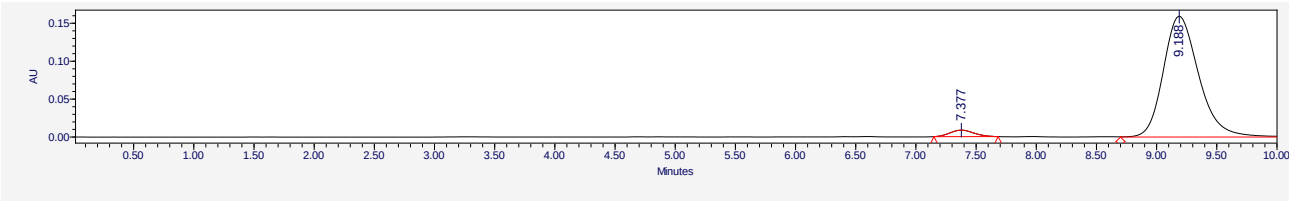
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.2 Hz, 2H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.32 (m, 3H), 7.13 (t, *J* = 7.2 Hz, 1H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.94 (m, 4H), 5.87 (s, 1H), 5.60 (d, *J* = 5.6 Hz, 1H), 3.90 (s, 1H), 2.45 (d, *J* = 20.2 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.81, 157.75, 156.43, 146.16, 140.84, 136.79, 134.85, 133.87, 130.10, 129.85, 129.03, 128.44, 123.78, 122.75, 119.21, 118.70, 118.35, 74.72, 64.17, 14.19, 11.35.

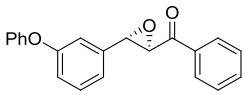
HRMS (ESI) calcd for $[M+Na]^+$ $C_{26}H_{23}N_3NaO_5$, m/z: 480.1530, observed: 480.1536.



Retention Time	Area	% Area
6.988	1629393	50.43
8.608	1601548	49.57



Retention Time	Area	% Area
7.377	118591	3.50
9.188	3272449	96.50



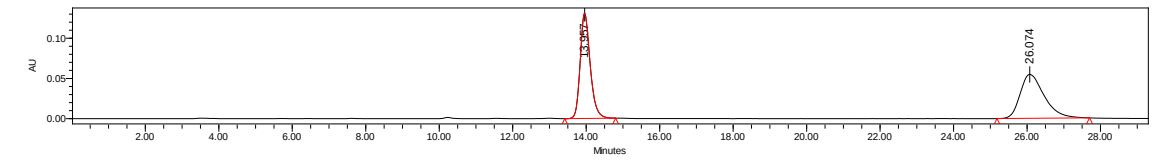
1i

(2*R*,3*S*)-(3-(3-phenoxyphenyl)oxiran-2-yl)(phenyl)methanone (**3i**)

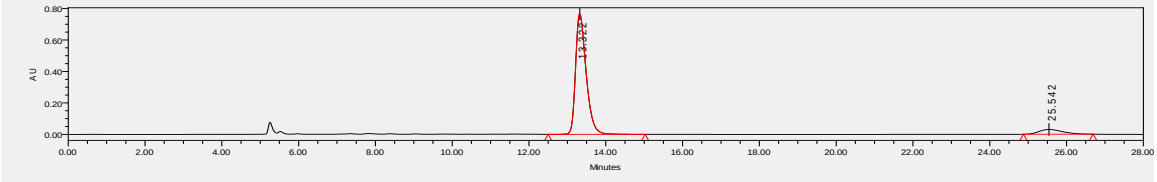
General procedure C; White solid; 52% yield, 83% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -130 (c 0.30, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 13.32 min, t (major) = 25.54 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.6 Hz, 2H), 7.61 (d, *J* = 7.2 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.36 (m, 3H), 7.12 (m, 2H), 7.02 (m, 4H), 4.25 (d, *J* = 1.6 Hz, 1H), 4.05 (d, *J* = 1.6 Hz, 1H).

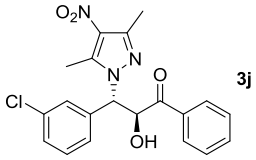
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{16}NaO_3$, m/z: 339.0992, observed: 339.0996.



Retention Time	Area	% Area
13.957	2465878	49.83
26.074	2482718	50.17



Retention Time	Area	% Area
13.322	14599620	91.76
25.542	1311397	8.24



3j

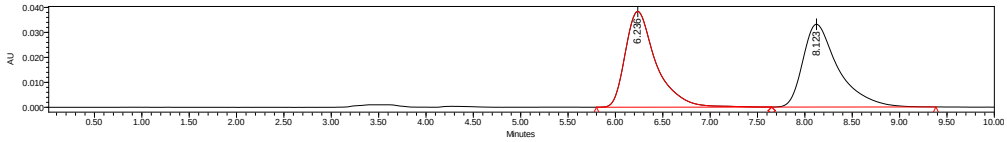
(2*S*,3*S*)-3-(3-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3j**)

General procedure C; colorless oil; 32% yield, 97% *ee*, > 19:1 d.r.; $[\alpha]_D^{31}$ = -44 (c 0.10, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 6.35 min, t (major) = 8.19 min];

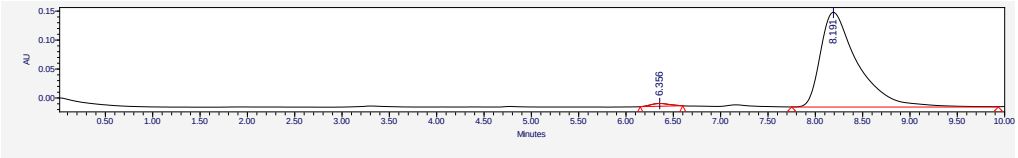
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.82 (m, 2H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.37 – 7.27 (m, 3H), 7.22 (d, *J* = 7.2 Hz, 1H), 5.88 (t, *J* = 6.0 Hz, 1H), 5.60 (d, *J* = 6.0 Hz, 1H), 3.85 (d, *J* = 6.4 Hz, 1H), 2.47 (d, *J* = 11.2 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.76, 146.40, 140.79, 136.91, 134.76, 134.67, 134.03, 130.00, 129.17, 128.99, 128.49, 126.59, 74.45, 63.76, 14.23, 11.34.

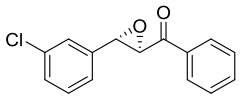
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{35}ClN_3NaO_4$, m/z: 422.0879, observed: 422.0883; $C_{20}H_{18}{}^{37}ClN_3NaO_4$, m/z: 424.0849, observed: 424.0868



Retention Time	Area	% Area
6.236	866195	50.13
8.123	861676	49.87



Retention Time	Area	% Area
6.356	66749	1.46
8.191	4492145	98.54



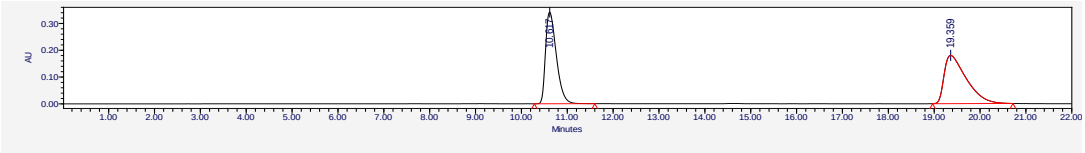
1j

(2*R*,3*S*)-(3-(3-chlorophenyl)oxiran-2-yl)(phenyl)methanone (**1j**)

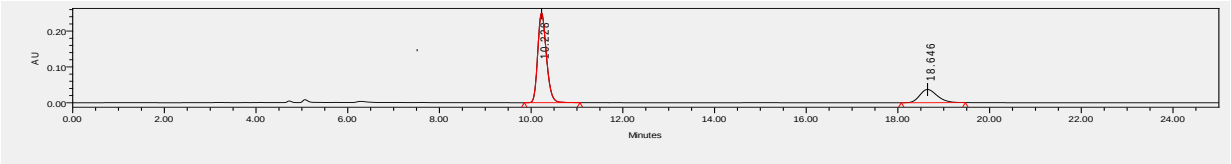
General procedure C; White solid; 63% yield, 54% *ee*, > 99:1 d.r.; $[\alpha]_D^{28}$ = -100 (c 0.29, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 10.22 min, t (minor) = 18.65 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.6 Hz, 2H), 7.63 (t, *J* = 7.2 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.39 – 7.30 (m, 3H), 7.29 – 7.23 (m, 1H), 4.26 (d, *J* = 1.6 Hz, 1H), 4.06 (d, *J* = 1.2 Hz, 1H).

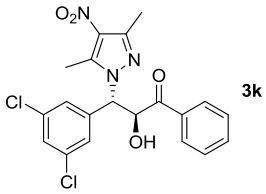
HRMS (ESI) calcd for $[M+K]^+$ $C_{15}H_{11}{}^{35}ClKO_2$, m/z: 297.0080, observed: 297.0087; $[M+K]^+$ $C_{15}H_{11}{}^{37}ClKO_2$, m/z: 299.0050, observed: 299.0053.



Retention Time	Area	% Area
10.617	5580943	48.05
19.359	6033762	51.95



Retention Time	Area	% Area
10.228	3295080	77.07
18.646	980253	22.93



3k

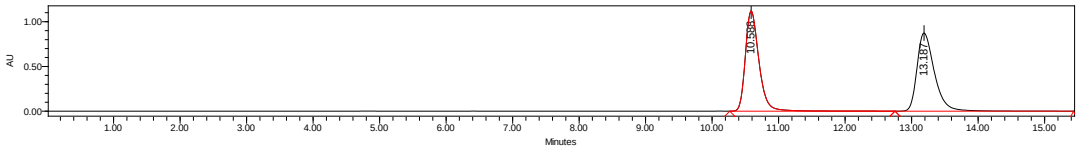
(2*S*,3*S*)-3-(3,5-dichlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenyl propan-1-one (**3k**)

General procedure C; colorless oil; 28% yield, 98% *ee*, > 19:1 d.r.; $[\alpha]_D^{31}$ = -17 (c 0.11, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 9.14 min, t (major) = 12.94 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.2 Hz, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.50 – 7.37 (m, 4H), 7.21 (m, 1H), 5.85 (t, *J* = 6.0 Hz, 1H), 5.58 (d, *J* = 6.0 Hz, 1H), 3.92 (d, *J* = 6.4 Hz, 1H), 2.47 (d, *J* = 10.1 Hz, 6H).

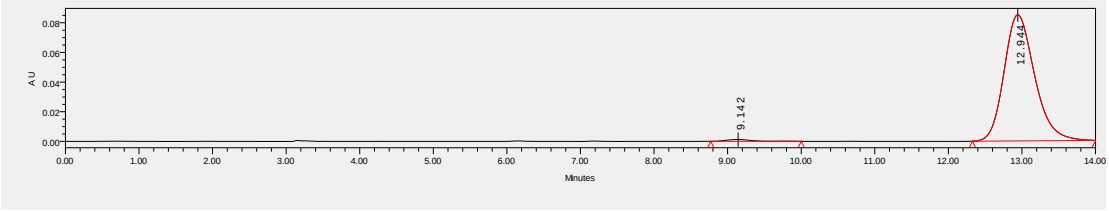
^{13}C NMR (100 MHz, $CDCl_3$) δ 198.69, 146.60, 140.75, 135.06, 134.49, 134.19, 133.34, 133.01, 130.65, 130.43, 129.00, 128.52, 127.80, 74.40, 63.14, 14.22, 11.33.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{17}{}^{35}Cl_2N_3NaO_4$, m/z: 456.0489, observed: 456.0488; $[M+Na]^+$ $C_{20}H_{17}{}^{37}Cl_2N_3NaO_4$, m/z: 458.0459, observed: 456.046.

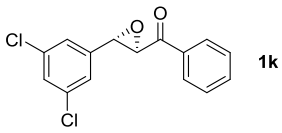


Retention Time	Area	% Area
10.588	15894585	50.09

13.187	15834355	49.91



Retention Time	Area	% Area
9.142	20387	0.83
12.944	2448445	99.17



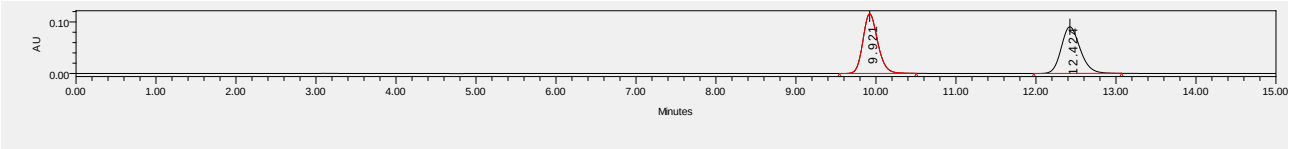
1k

(2*R*,3*S*)-(3-(3,5-dichlorophenyl)oxiran-2-yl)(phenyl)methanone (**1k**)

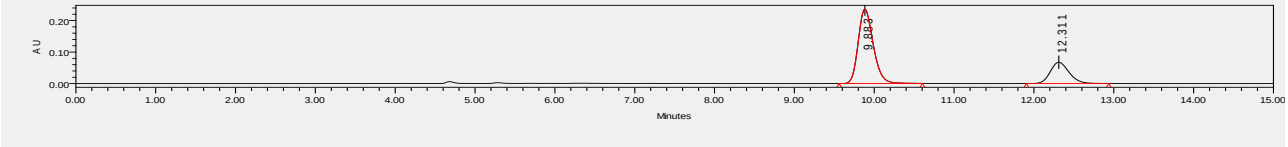
General procedure C; White solid; 66% yield, 49% *ee*, > 99:1 d.r.; $[\alpha]_D^{23}$ = -99 (c 0.35, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 9.89 min, t (minor) = 12.31 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.6 Hz, 2H), 7.64 (t, *J* = 7.2 Hz, 1H), 7.55 – 7.44 (m, 4H), 7.22 (m, 1H), 4.24 (d, *J* = 1.6 Hz, 1H), 4.06 (s, 1H).

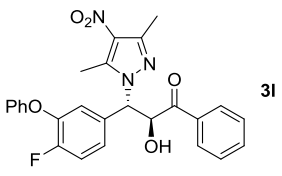
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{10}{}^{35}Cl_2NaO_2$, m/z: 314.9951, observed: 314.9961; $[M+Na]^+$ $C_{15}H_{10}{}^{37}Cl_2NaO_2$, m/z: 316.9921, observed: 314.9935;



Retention Time	Area	% Area
9.921	1487109	50.09
12.424	1482037	49.91



Retention Time	Area	% Area
9.883	3085170	74.87
12.311	1035790	25.13



3l

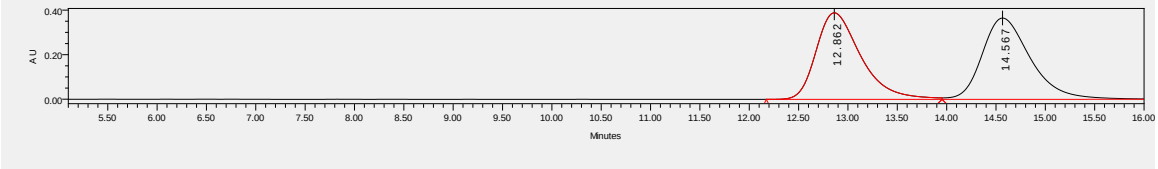
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-3-(4-fluoro-3-phenoxyphenyl)-2-hydroxy-1-phenylpropan-1-one (**3l**)

General procedure C; colorless oil; 43% yield, 92% *ee*, > 19:1 d.r.; $[\alpha]_D^{33}$ = -43 (c 0.33, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 12.96 min, t (major) = 14.54 min];

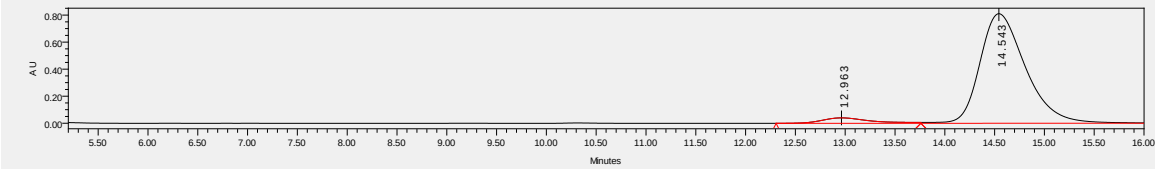
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.2 Hz, 2H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.32 (t, *J* = 8.0 Hz, 2H), 7.17 – 7.09 (m, 2H), 7.08 – 7.00 (m, 2H), 6.89 (d, *J* = 7.6 Hz, 2H), 5.80 (t, *J* = 5.6 Hz, 1H), 5.55 (d, *J* = 5.6 Hz, 1H), 3.97 (d, *J* = 6.0 Hz, 1H), 2.43 (d, *J* = 18.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.84, 156.73, 155.45, 152.95, 146.33, 144.04, 143.93, 140.74, 134.67, 134.03, 131.65, 131.61, 131.44, 129.80, 129.01, 128.47, 124.50, 124.43, 123.57, 121.56, 117.50, 117.43, 117.24, 74.81, 63.59, 14.16, 11.33.

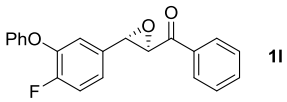
HRMS (ESI) calcd for $[M+Na]^+$ $C_{26}H_{22}{}^{18}FN_3NaO_5$, m/z: 498.1436, observed: 498.1442; $[M+Na]^+$ $C_{26}H_{22}{}^{19}FN_3NaO_5$, m/z: 499.1470, observed: 499.1475.



Retention Time	Area	% Area
12.862	12230774	49.57
14.567	12442833	50.43



Retention Time	Area	% Area
12.963	1031087	3.84
14.543	25792195	96.16



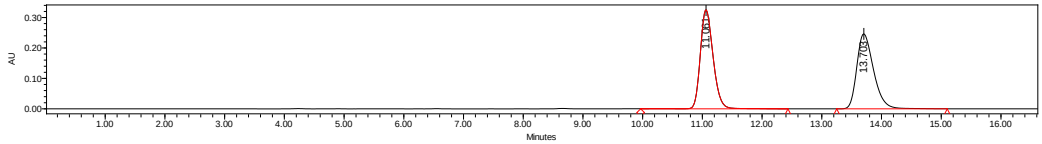
1l

(2*R*,3*S*)-(3-(4-fluoro-3-phenoxyphenyl)oxiran-2-yl)(phenyl)methanone (**1l**)

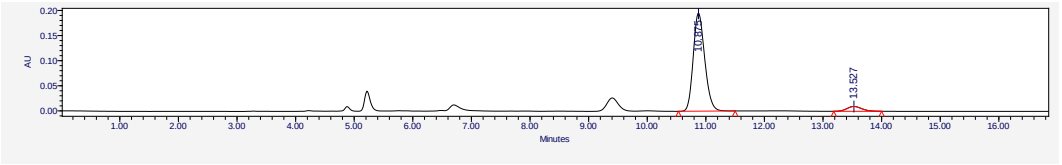
General procedure C; White solid; 47% yield, 88% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -122 (c 0.32, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 10.88 min, t (minor) = 13.53 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 7.6 Hz, 2H), 7.63 (t, *J* = 7.2 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.35 (t, *J* = 8.0 Hz, 2H), 7.22 (m, 1H), 7.17 – 7.08 (m, 2H), 7.06 – 6.95 (m, 3H), 4.19 (d, *J* = 1.6 Hz, 1H), 4.01 (s, 1H).

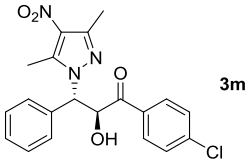
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{15}{}^{18}FNaO_3$, m/z: 357.0897, observed: 357.0902; $[M+Na]^+$ $C_{21}H_{15}{}^{19}FNaO_3$, m/z: 358.0931, observed: 357.0938;



Retention Time	Area	% Area
11.061	4827979	50.19
13.703	4790596	49.81



Retention Time	Area	% Area
10.875	2660315	94.02
13.527	169117	5.98



3m

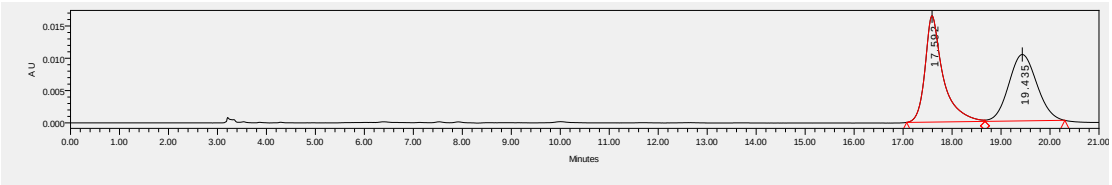
(2*S*,3*S*)-1-(4-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3m**)

General procedure C; White solid; 50% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{33}$ = -119 (c 0.21, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 16.73 min, t (major) = 18.11 min];

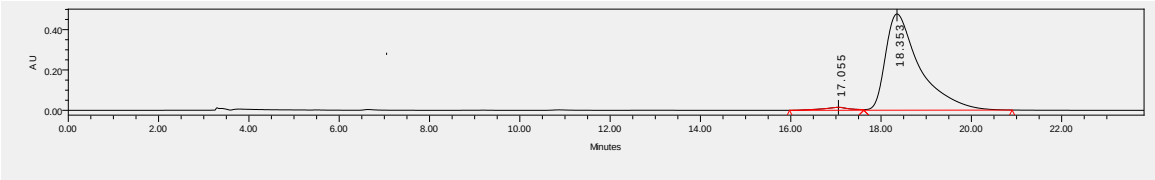
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.4 Hz, 2H), 7.48 – 7.27 (m, 6H), 7.25 (s, 1H), 5.80 (t, *J* = 5.6 Hz, 1H), 5.71 (d, *J* = 5.6 Hz, 1H), 4.00 (d, *J* = 5.6 Hz, 1H), 2.49 (d, *J* = 8.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 197.52, 146.05, 140.94, 140.21, 134.78, 133.46, 130.63, 129.02, 128.90, 128.69, 128.13, 75.47, 64.23, 14.25, 11.36.

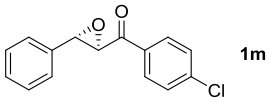
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{35}ClN_3NaO_4$, m/z: 422.0879, observed: 422.0884; $[M+Na]^+$ $C_{20}H_{18}{}^{37}ClN_3NaO_4$, m/z: 424.0849, observed: 424.0869.



Retention Time	Area	% Area
17.592	419618	50.58
19.435	410035	49.42



Retention Time	Area	% Area
17.055	601801	2.35
18.353	25011278	97.65



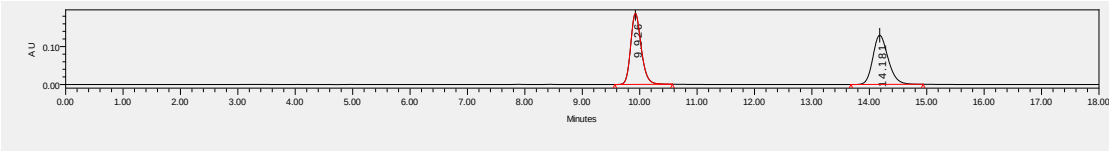
1m

(2*R*,3*S*)- (4-chlorophenyl)(3-phenyloxiran-2-yl)methanone (**1m**)

General procedure C; White solid; 49% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -214 (c 0.16, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 95/5, 1.0 mL/min, λ = 254 nm, t (major) = 9.93 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.4 Hz, 2H), 7.45 (t, *J* = 7.2 Hz, 2H), 7.38 (m, 5H), 4.23 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.2 Hz, 1H);

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{35}ClNaO_2$, m/z: 281.0340, observed: 281.0346; $[M+Na]^+$ $C_{15}H_{11}{}^{37}ClNaO_2$, m/z: 283.0311, observed: 281.0329.



Retention Time	Area	% Area
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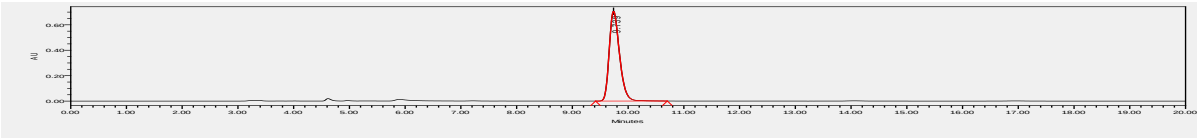
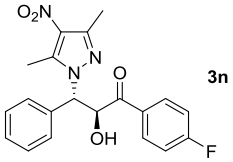
14.181	2393114	50.00



Retention Time	Area	% Area
9.739	9094943	100.00



3n

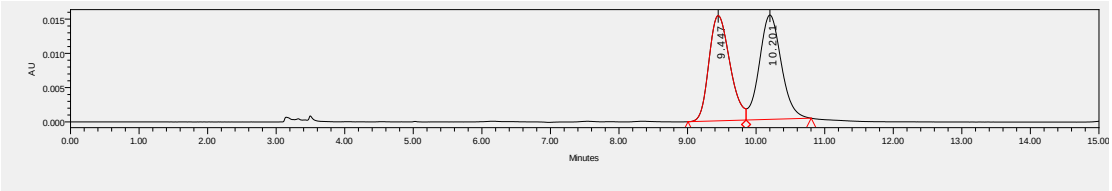
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-1-(4-fluorophenyl)-2-hydroxy-3-phenylpropan-1-one (**3n**)

General procedure C; White solid; 51% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{30}$ = -61 (c 0.10, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 9.16 min, t (major) = 9.87 min];

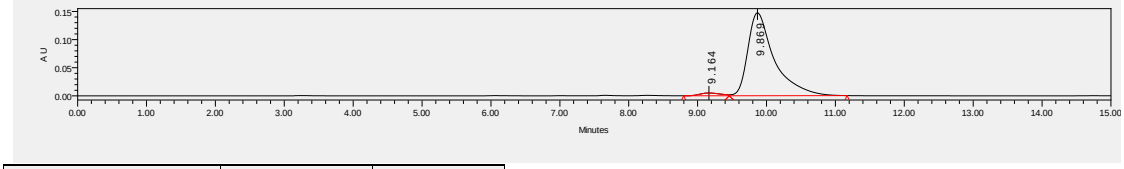
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (m, 2H), 7.46 – 7.20 (m, 5H), 7.06 (t, *J* = 8.4 Hz, 2H), 5.82 (t, *J* = 5.6 Hz, 1H), 5.70 (d, *J* = 5.6 Hz, 1H), 3.96 (d, *J* = 5.6 Hz, 1H), 2.48 (d, *J* = 10.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 197.08, 167.29, 164.74, 146.04, 140.90, 134.85, 132.07, 131.97, 131.50, 128.99, 128.88, 128.17, 115.68, 115.46, 75.27, 64.28, 14.22, 11.33.

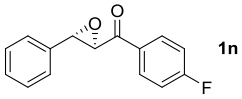
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{18}FN_3NaO_4$, m/z: 406.1174, observed: 406.1176; $[M+Na]^+$ $C_{20}H_{18}{}^{19}FN_3NaO_4$, m/z: 407.1208, observed: 407.1216.



Retention Time	Area	% Area
9.447	326445	49.09
10.201	338608	50.91



Retention Time	Area	% Area
9.164	98148	2.45
9.869	3913950	97.55



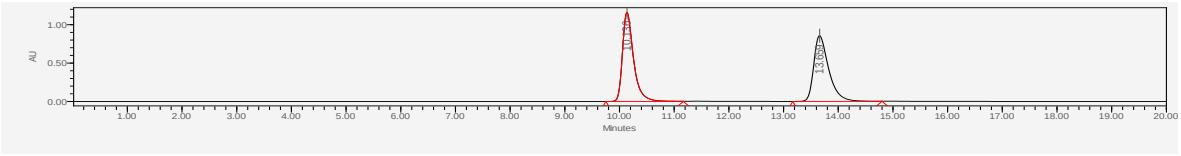
1n

(2*R*,3*S*)- (4-fluorophenyl)(3-phenyloxiran-2-yl)methanone (**1n**)

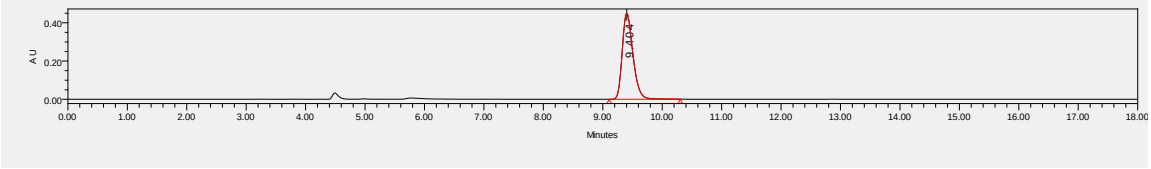
General procedure C; White solid; 49% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{30}$ = -187 (c 0.23，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 9.40 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 7.98 (m, 2H), 7.48 – 7.29 (m, 5H), 7.17 (t, *J* = 8.4 Hz, 2H), 4.24 (d, *J* = 1.6 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H)；

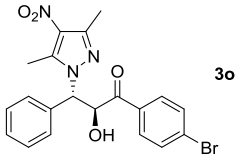
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{18}FNaO_2$, m/z: 265.0635, observed: 265.0639; $[M+Na]^+$ $C_{15}H_{11}{}^{19}FNaO_2$, m/z: 266.0669, observed: 265.0678.



Retention Time	Area	% Area
10.136	16305463	50.06
13.659	16269563	49.94



Retention Time	Area	% Area
9.404	5634983	100.00



3o

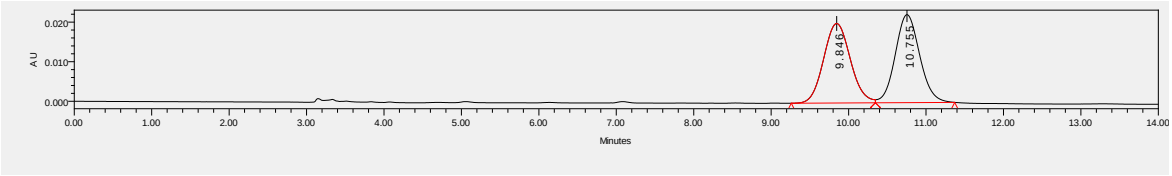
(2*S*,3*S*)-1-(4-bromophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3o**)

General procedure C; White solid; 51% yield, 96% *ee*, > 19:1 d.r.; $[\alpha]_D^{30}$ = -83 (c 0.05，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 9.96 min, t (major) = 10.84 min];

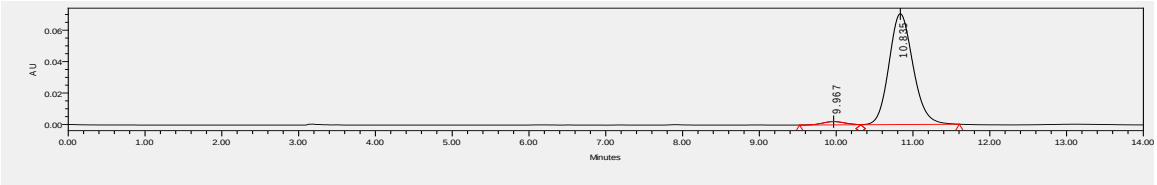
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.4 Hz, 2H), 7.53 (d, *J* = 8.4 Hz, 2H), 7.39 – 7.28 (m, 3H), 7.26 (t, *J* = 2.8 Hz, 2H), 5.99 – 5.55 (m, 2H), 4.01 (d, *J* = 5.6 Hz, 1H), 2.49 (d, *J* = 7.2 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 197.74, 146.05, 140.94, 134.76, 133.89, 131.68, 130.68, 129.03, 128.98, 128.91, 128.12, 75.50, 64.22, 14.25, 11.36.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{79}BrN_3NaO_4$, m/z: 466.0373, observed: 466.0382; $[M+Na]^+$ $C_{20}H_{18}{}^{81}BrN_3NaO_4$, m/z: 468.0353, observed: 466.0375.



Retention Time	Area	% Area
9.846	481747	49.73
10.755	487032	50.27



Retention Time	Area	% Area
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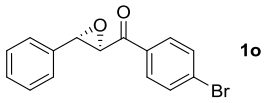
10.835	1533332	98.11



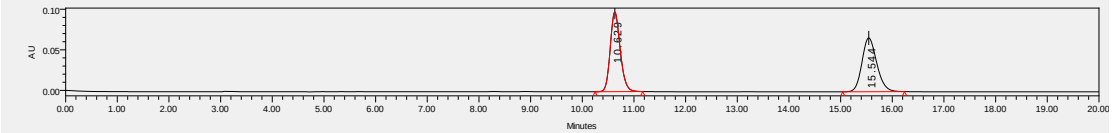
1o

(2*R*,3*S*)-(4-bromophenyl)(3-phenyloxiran-2-yl)methanone (**1o**)

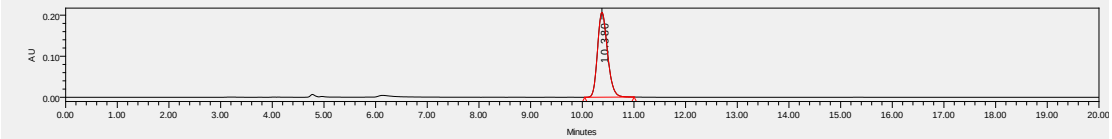
General procedure C; White solid; 47% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -126 (c 0.29，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 10.38 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.64 (d, *J* = 8.4 Hz, 2H), 7.38 (m, 5H), 4.22 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.2 Hz, 1H)；

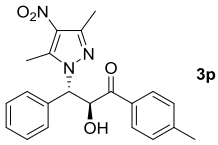
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{79}BrNaO_2$, m/z: 324.9835, observed: 324.9838; $[M+Na]^+$ $C_{15}H_{11}{}^{81}BrNaO_2$, m/z: 326.9815, observed: 324.9824.



Retention Time	Area	% Area
10.629	1317442	50.01
15.544	1316953	49.99



Retention Time	Area	% Area
10.380	2779639	100.00



3p

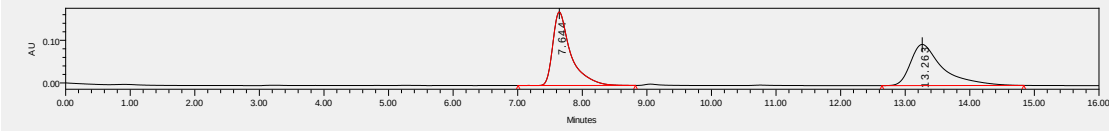
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(p-tolyl)propan-1-one (**3p**)

General procedure C; colorless oil; 48% yield, 82% *ee*, > 19:1 d.r.; $[\alpha]_D^{30}$ = -63 (c 0.11, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 8.04 min, t (major) = 14.31 min];

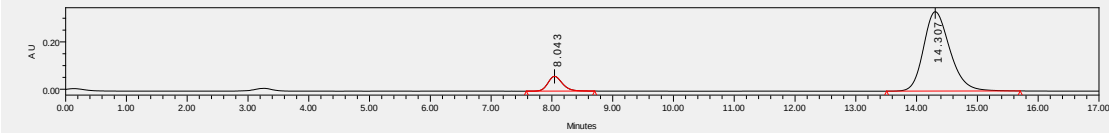
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.4 Hz, 2H), 7.40 – 7.27 (m, 5H), 7.21 (d, *J* = 8.0 Hz, 2H), 5.91 (t, *J* = 6.0 Hz, 1H), 5.60 (d, *J* = 6.0 Hz, 1H), 3.75 (d, *J* = 6.4 Hz, 1H), 2.43 (d, *J* = 24.4 Hz, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.46, 146.13, 145.13, 140.74, 134.89, 132.14, 129.19, 129.11, 128.92, 128.79, 128.31, 74.25, 64.57, 21.76, 14.27, 11.36.

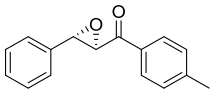
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{21}N_3NaO_4$, m/z: 402.1424, observed: 402.1428.



Retention Time	Area	% Area
7.644	3329482	50.07
13.263	3319873	49.93



Retention Time	Area	% Area
8.043	1005501	9.00
14.307	10171377	91.00



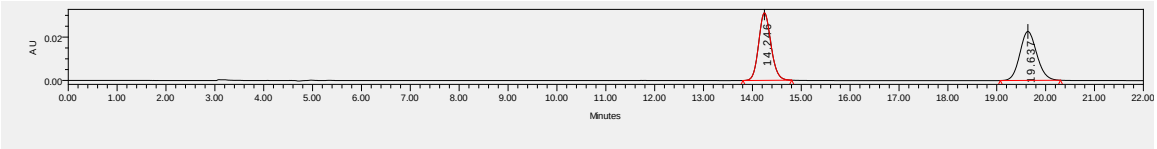
1p

(2*R*,3*S*)-(3-phenyloxiran-2-yl)(p-tolyl)methanone (**1p**)

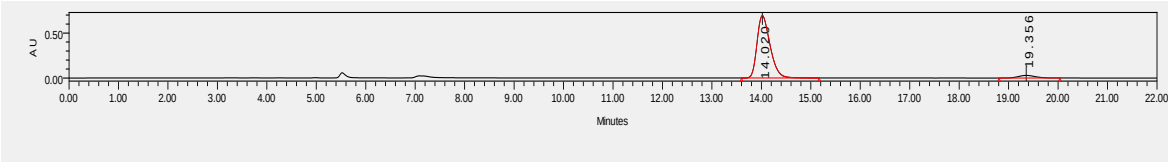
General procedure C; White solid; 42% yield, 90% *ee*, > 99:1 d.r.; $[\alpha]_D^{31}$ = -153 (c 0.24, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 14.25 min, t (minor) = 19.64 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.0 Hz, 2H), 7.47 – 7.33 (m, 5H), 7.32 – 7.23 (m, 2H), 4.28 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.2 Hz, 1H), 2.42 (s, 3H);

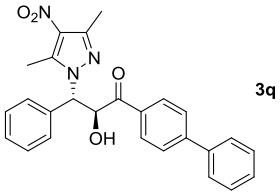
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{14}NaO_2$, m/z: 261.0886, observed: 261.0887.



Retention Time	Area	% Area
14.246	544206	50.09
19.637	542206	49.91



Retention Time	Area	% Area
14.020	12675657	95.12
19.356	650792	4.88



3q

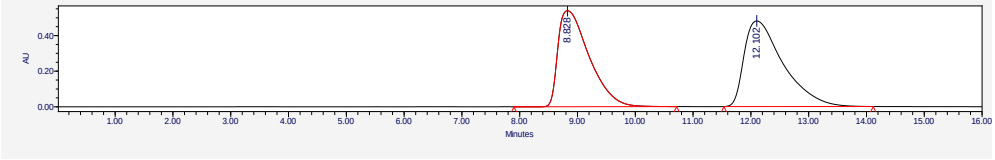
(2*S*,3*S*)-1-([1,1'-biphenyl]-4-yl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3q**)

General procedure A; White solid; 46% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{29}$ = -131 (c 0.12, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 9.02 min, t (major) = 11.99 min];

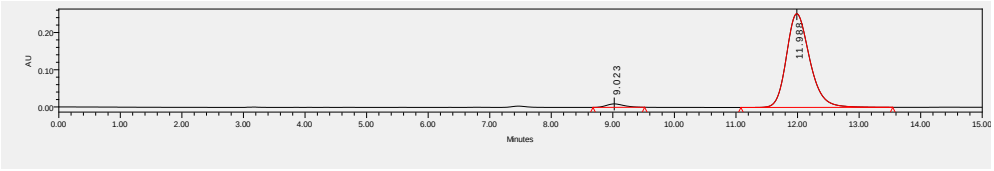
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.61 (m, 4H), 7.52 – 7.28 (m, 8H), 5.94 (t, *J* = 6.0 Hz, 1H), 5.68 (d, *J* = 5.6 Hz, 1H), 3.88 (d, *J* = 6.0 Hz, 1H), 2.48 (d, *J* = 10.0 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.42, 146.61, 146.12, 140.85, 139.61, 134.88, 133.52, 129.64, 129.03, 128.96, 128.85, 128.48, 128.27, 127.31, 127.08, 74.79, 64.50, 14.30, 11.40.

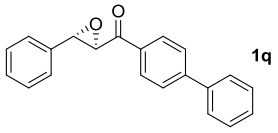
HRMS (ESI) calcd for $[M+Na]^+$ $C_{26}H_{23}N_3NaO_4$, m/z: 464.1581, observed: 464.1590.



Retention Time	Area	% Area
8.828	20177562	47.21
12.102	22562437	52.79



Retention Time	Area	% Area
9.023	180506	2.66
11.988	6605163	97.34

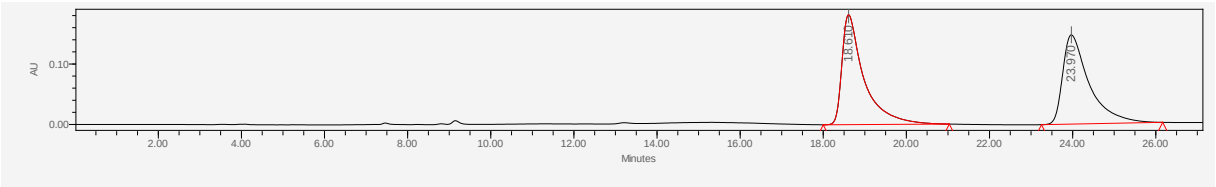


(2*R*,3*S*)-[1,1'-biphenyl]-4-yl(3-phenyloxiran-2-yl)methanone (**1q**)

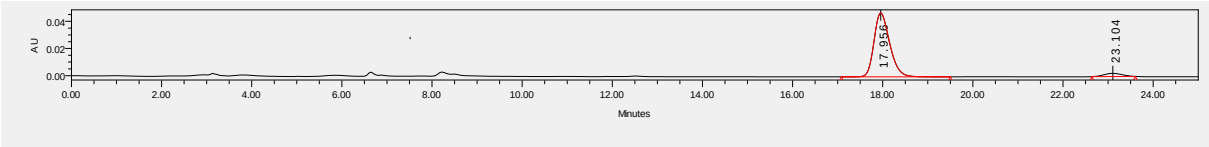
General procedure A; White solid; 50% yield, 89% *ee*, > 99:1 d.r.; $[\alpha]_D^{29}$ = -151 (c 0.23, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 17.96 min, t (minor) = 23.10 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 8.4 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 7.2 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.45 – 7.36 (m, 6H), 4.33 (d, *J* = 1.6 Hz, 1H), 4.11 (d, *J* = 1.2 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{16}NaO_2$, m/z: 323.1043, observed: 323.1047.

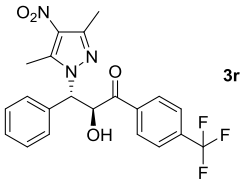


Retention Time	Area	% Area
18.610	6645429	50.52
23.970	6509203	49.48



Retention Time	Area	% Area
17.956	1133399	94.53

23.104	65572	5.47



3r

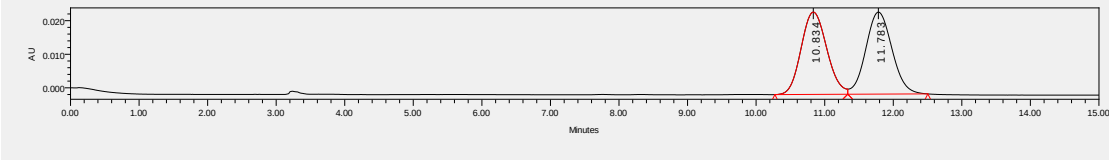
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(4-(trifluoromethyl) phenyl)propan-1-one (**3r**)

General procedure B; colorless oil; 50% yield, 97% *ee*, > 19:1 d.r.; $[\alpha]_D^{32}$ = -93 (c 0.20, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 95/5, 1.0 mL/min, λ = 254 nm, t (minor) = 10.94 min, t (major) = 12.02 min];

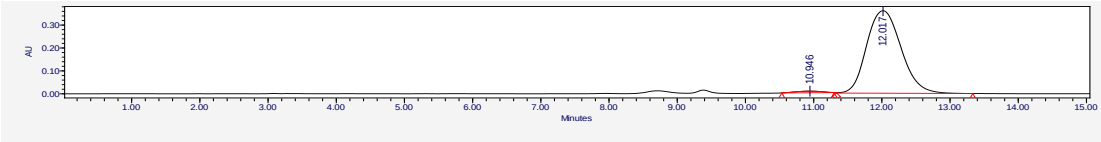
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.35 – 7.28 (m, 3H), 7.24 (m, 2H), 5.77 (d, *J* = 5.2 Hz, 2H), 4.16 (s, 1H), 2.50 (d, *J* = 10.4 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 198.09, 146.01, 141.02, 138.26, 134.67, 134.35, 131.57, 129.47, 129.07, 128.95, 128.02, 125.24, 125.20, 124.81, 122.10, 76.20, 64.19, 14.20, 11.34.

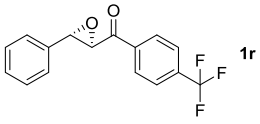
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{18}{}^{18}F_3N_3NaO_4$, m/z: 456.1142, observed: 456.1150; $[M+Na]^+$ $C_{21}H_{18}{}^{19}F_3N_3NaO_4$, m/z: 457.1176, observed: 456.1170.



Retention Time	Area	% Area
10.834	638608	49.56
11.783	649828	50.44



Retention Time	Area	% Area
10.946	191652	1.49
12.017	12643015	98.51



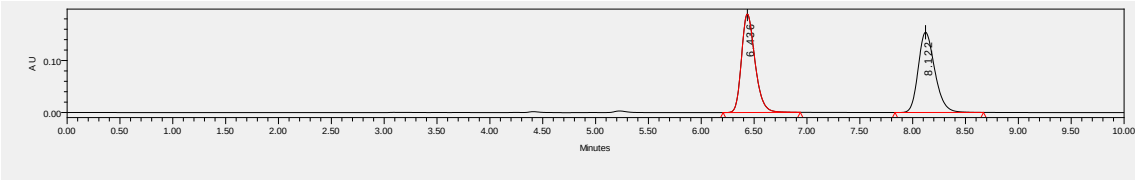
1r

(2*R*,3*S*)-(3-phenyloxiran-2-yl)(4-(trifluoromethyl)phenyl)methanone (**1r**)

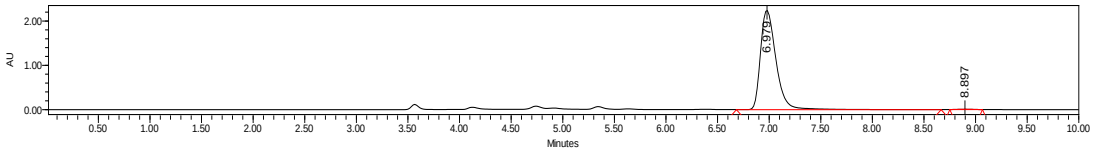
General procedure B; White solid; 49% yield, > 99% *ee*, > 99:1 d.r.; $[\alpha]_D^{18}$ = -128 (c 0.23, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.97 min, t (minor) = 8.88 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.4 Hz, 2H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.38 (m, 5H), 4.26 (d, *J* = 1.6 Hz, 1H), 4.09 (d, *J* = 1.2 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{11}{}^{18}F_3NaO_2$, m/z: 315.0603, observed: 315.0609; $[M+K]^+$ $C_{16}H_{11}{}^{19}F_3NaO_2$, m/z: 332.0377, observed: 332.0379.

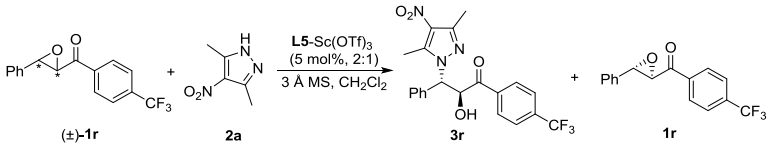


Retention Time	Area	% Area
6.436	1679737	49.97
8.122	1682041	50.03

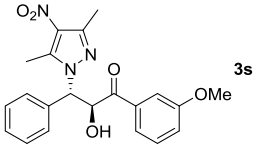


Retention Time	Area	% Area
6.979	23414261	99.74
8.897	61195	0.26

we did three parallel tests by using substrate **1r** to confirm the *s* value.



entry	Yield [%]		*ee* [%]		*s*
	1r	**3r**	**1r**	**3r**	
1	50	50	97.3	97.4	329
2	50	50	96.5	98.0	404
3	49	50	99.1	97.1	367



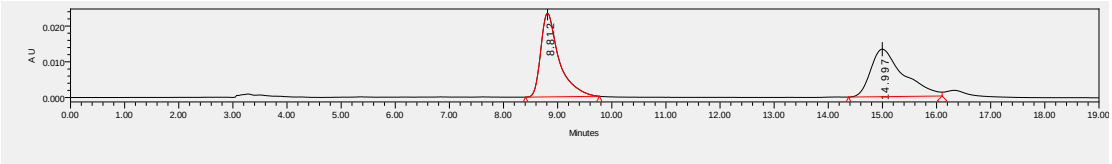
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-(3-methoxyphenyl)-3-phenylpropan-1-one (**3s**)

General procedure C; colorless oil; 49% yield, 91% *ee*, > 19:1 d.r.; $[\alpha]_D^{32}$ = -33 (c 0.07, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 9.36 min, t (major) = 16.28 min];

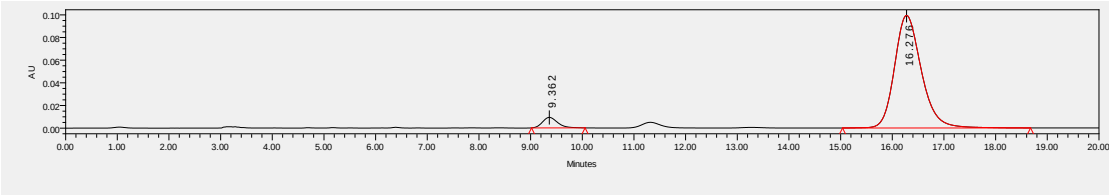
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.6 Hz, 1H), 7.38 – 7.27 (m, 7H), 7.10 (m, 1H), 5.89 (d, *J* = 4.8 Hz, 1H), 5.63 (d, *J* = 6.0 Hz, 1H), 3.81 (s, 4H), 2.47 (s, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 193.08, 159.38, 146.14, 146.12, 140.79, 136.11, 134.86, 129.49, 128.97, 128.83, 128.27, 121.47, 120.16, 113.45, 74.66, 64.51, 55.47, 14.25, 11.37.

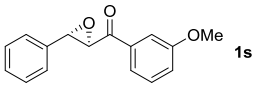
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{21}N_3NaO_5$, m/z: 418.1373, observed: 418.1378.



Retention Time	Area	% Area
8.812	549040	49.54
14.997	559244	50.46



Retention Time	Area	% Area
9.362	187574	4.99
16.276	3571343	95.01



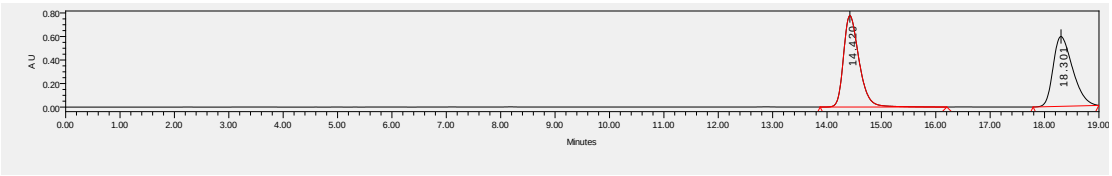
1s

(2*R*,3*S*)-(3-methoxyphenyl)(3-phenyloxiran-2-yl)methanone (**1s**)

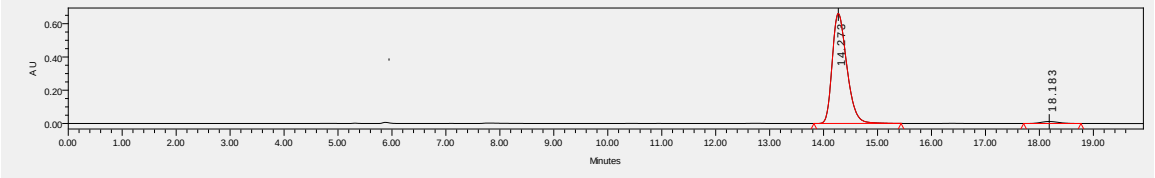
General procedure C; colorless oil; 47% yield, 95% *ee*, > 99:1 d.r.; $[\alpha]_D^{29}$ = -180 (c 0.11, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 14.27 min, t (minor) = 18.18min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (m, 1H), 7.52 (d, *J* = 1.6 Hz, 1H), 7.42 – 7.33 (m, 6H), 7.18 – 7.12 (m, 1H), 4.27 (d, *J* = 1.6 Hz, 1H), 4.06 (d, *J* = 1.6 Hz, 1H), 3.84 (d, *J* = 1.2 Hz, 3H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{14}NaO_3$, m/z: 277.0835, observed: 277.0844.

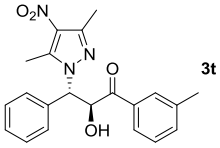


Retention Time	Area	% Area
14.420	15505719	51.25
18.301	14751523	48.75



Retention Time	Area	% Area
14.273	12411419	97.83

18.183	275528	2.17



3t

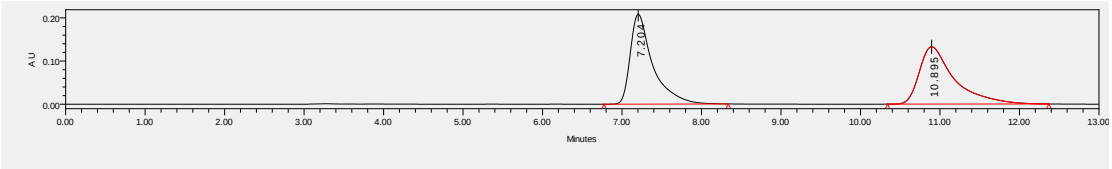
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(m-tolyl)propan-1-one (**3t**)

General procedure C; White solid; 46% yield, 90% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -41 (c 0.20, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 7.28 min, t (major) = 10.61 min];

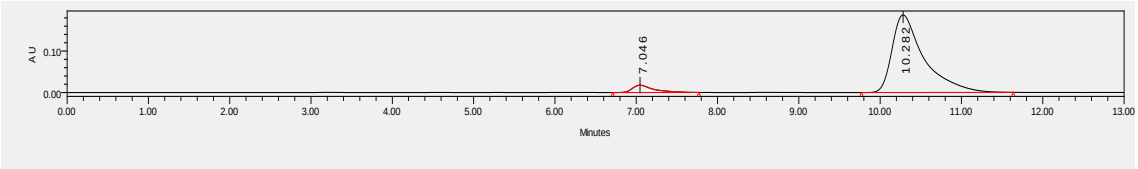
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 – 7.52 (m, 2H), 7.42 – 7.27 (m, 7H), 5.91 (t, *J* = 6.0 Hz, 1H), 5.61 (d, *J* = 6.0 Hz, 1H), 3.78 (d, *J* = 6.4 Hz, 1H), 2.77 – 2.18 (m, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 199.17, 146.11, 140.78, 138.40, 134.91, 134.82, 134.68, 129.39, 128.93, 128.80, 128.35, 128.29, 126.17, 74.40, 64.53, 21.30, 14.28, 11.36.

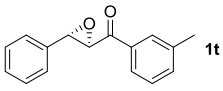
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{21}N_3NaO_4$, m/z: 402.1424, observed: 402.1424.



Retention Time	Area	% Area
7.204	4093715	50.23
10.895	4056049	49.77



Retention Time	Area	% Area
7.046	263480	4.91
10.282	5103290	95.09



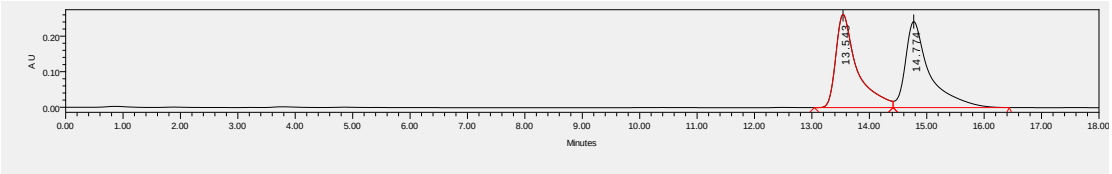
1t

(2*R*,3*S*)-(3-phenyloxiran-2-yl)(m-tolyl)methanone (**1t**)

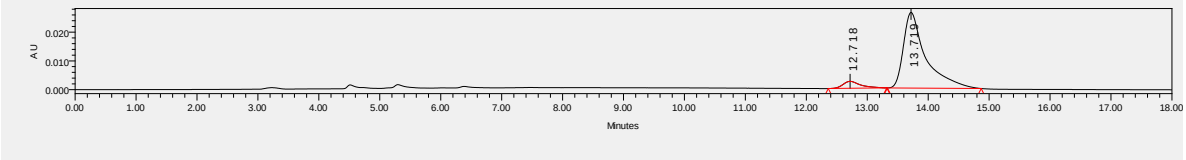
General procedure C; White solid; 47% yield, 89% *ee*, > 99:1 d.r.; $[\alpha]_D^{29}$ = -138 (c 0.25, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 12.72 min, t (major) = 13.72 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.68 (m, 2H), 7.48 – 7.31 (m, 7H), 4.29 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.2 Hz, 1H), 2.40 (s, 3H).

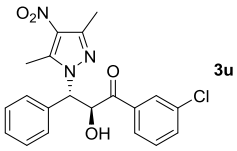
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{14}NaO_2$, m/z: 261.0886, observed: 261.0896.



Retention Time	Area	% Area
13.543	6770077	48.81
14.774	7100673	51.19



Retention Time	Area	% Area
12.718	37679	5.34
13.719	668186	94.66



3u

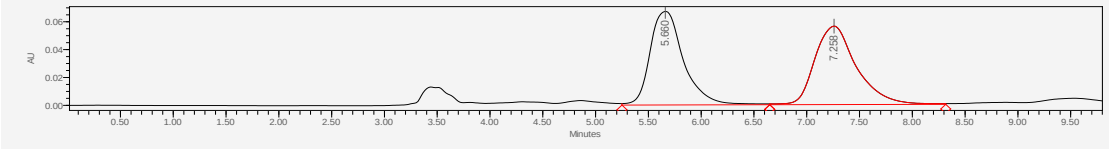
(2*S*,3*S*)-1-(3-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3u**)

General procedure C; colorless oil; 46% yield, 85% *ee*, > 19:1 d.r.; $[\alpha]_D^{27}$ = -47 (c 0.15, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.43 min, t (minor) = 8.57 min];

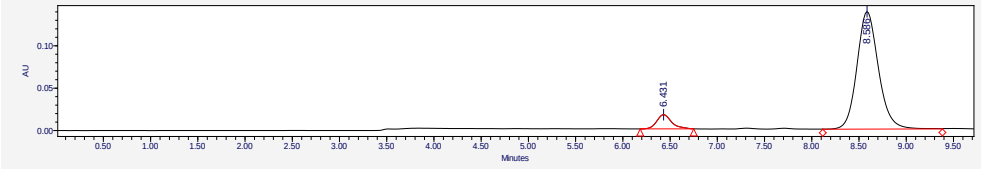
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 1.6 Hz, 1H), 7.73 (d, *J* = 7.6 Hz, 1H), 7.50 (m, 1H), 7.34 (m, 4H), 7.31 – 7.27 (m, 2H), 5.79 (t, *J* = 5.2 Hz, 1H), 5.69 (d, *J* = 5.6 Hz, 1H), 3.98 (d, *J* = 5.2 Hz, 1H), 2.50 (t, *J* = 4.8 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 197.65, 146.12, 140.91, 136.69, 134.73, 134.62, 133.50, 129.65, 129.29, 129.08, 128.92, 128.14, 127.17, 75.49, 64.23, 14.24, 11.34.

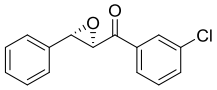
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{18}{}^{35}ClN_3NaO_4$, m/z: 422.0879, observed: 422.0885; $[M+Na]^+$ $C_{20}H_{18}{}^{37}ClN_3NaO_4$, m/z: 424.0849, observed: 424.0869.



Retention Time	Area	% Area
5.660	1483352	49.00
7.258	1543825	51.00



Retention Time	Area	% Area
6.431	181837	7.66
8.586	2190765	92.34



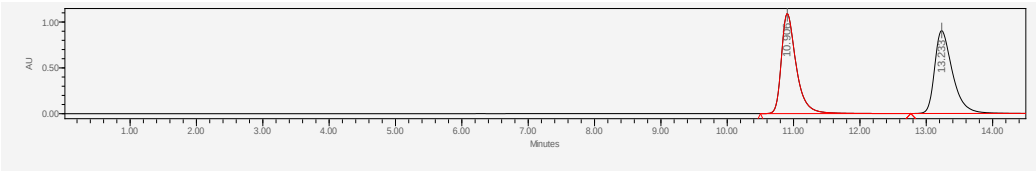
1u

(2*R*,3*S*)-(3-chlorophenyl)(3-phenyloxiran-2-yl)methanone (**1u**)

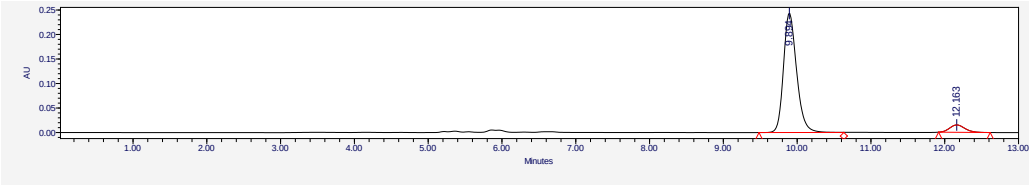
General procedure C; White solid; 49% yield, 87% *ee*, > 99:1 d.r.; $[\alpha]_D^{29}$ = -157 (c 0.14, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 9.89 min, t (minor) = 12.16 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (s, 1H), 7.89 (d, *J* = 7.6 Hz, 1H), 7.59 (d, *J* = 8.0 Hz, 1H), 7.47 – 7.32 (m, 6H), 4.24 (d, *J* = 1.6 Hz, 1H), 4.08 (s, 1H).

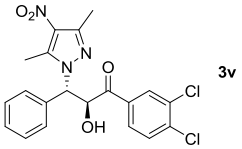
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{35}ClNaO_2$, m/z: 281.0340, observed: 281.0347; $[M+Na]^+$ $C_{15}H_{11}{}^{37}ClNaO_2$, m/z: 283.0311, observed: 283.0325.



Retention Time	Area	% Area
10.906	16940061	50.08
13.233	16885253	49.92



Retention Time	Area	% Area
9.894	3009377	93.30
12.163	216145	6.70



3v

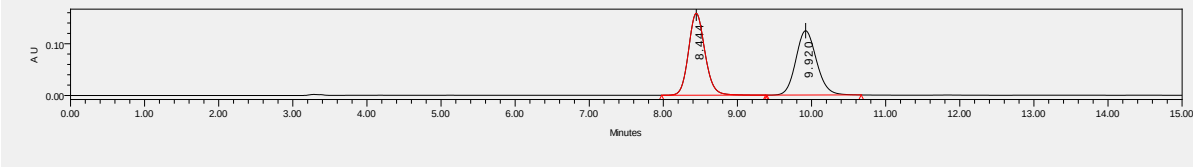
(2*S*,3*S*)-1-(3,4-dichlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl propan-1-one (**3v**)

General procedure B; White solid; 48% yield, 95% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -116 (c 0.30, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 8.05 min, t (major) = 9.61 min];

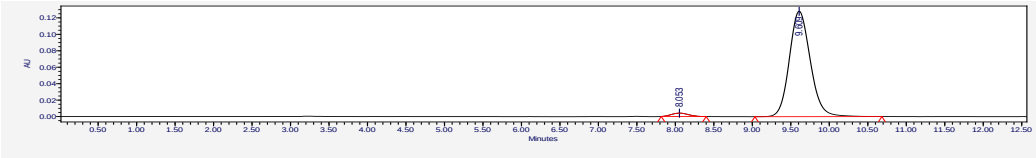
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 1.6 Hz, 1H), 7.68 (m, 1H), 7.45 (d, *J* = 8.4 Hz, 1H), 7.37 – 7.29 (m, 3H), 7.25 (m, 2H), 5.73 (s, 2H), 4.20 (s, 1H), 2.51 (d, *J* = 2.4 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 196.57, 146.08, 141.01, 138.16, 134.84, 134.62, 132.92, 131.37, 130.39, 129.14, 128.97, 128.32, 128.06, 76.16, 64.12, 14.23, 11.34.

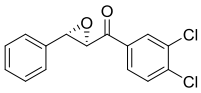
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{17}{}^{35}Cl_2N_3NaO_4$, m/z: 456.0489, observed: 456.0496; $[M+Na]^+$ $C_{20}H_{17}{}^{37}Cl_2N_3NaO_4$, m/z: 458.0459, observed: 458.0470.



Retention Time	Area	% Area
8.444	2437261	50.25
9.920	2412968	49.75



Retention Time	Area	% Area
8.053	63205	2.54
9.609	2426362	97.46



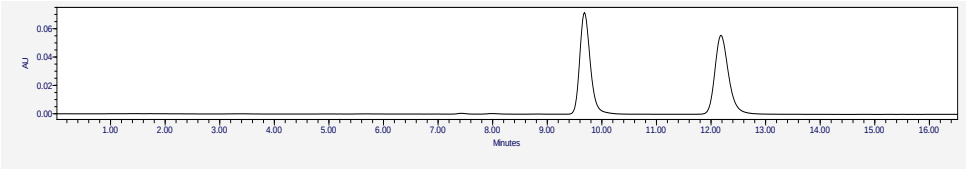
1v

(2*R*,3*S*)-(3,4-dichlorophenyl)(3-phenyloxiran-2-yl)methanone (**1v**)

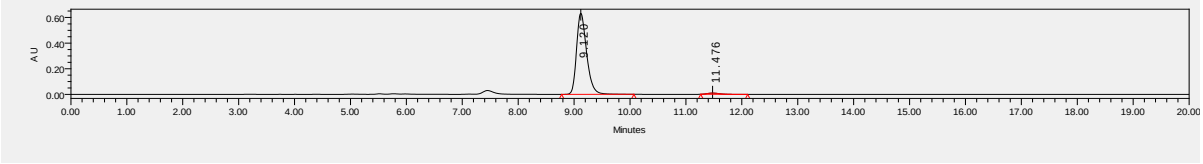
General procedure B; White solid; 49% yield, 96% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -137 (c 0.19, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 9.12 min, t (minor) = 11.48 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 2.0 Hz, 1H), 7.86 (m, 1H), 7.58 (d, *J* = 8.4 Hz, 1H), 7.48 – 7.31 (m, 5H), 4.19 (d, *J* = 1.6 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H);

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{10}{}^{35}Cl_2NaO_2$, m/z: 314.9951, observed: 314.9951; $[M+Na]^+$ $C_{15}H_{10}{}^{37}Cl_2NaO_2$, m/z: 316.9921, observed: 316.9932

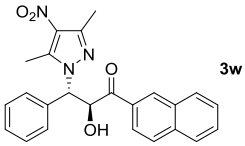


Retention Time	Area	% Area
9.681	961711	49.97
12.182	962741	50.03



Retention Time	Area	% Area
9.120	7903751	98.27

11.476	139299	1.73



3w

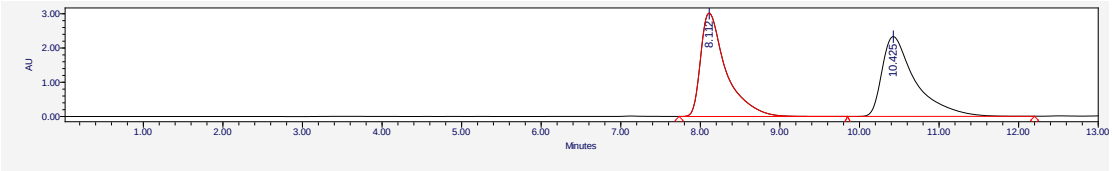
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-(naphthalen-2-yl)-3-phenylpropan-1-one (**3w**)

General procedure C; White solid; 48% yield, 83% *ee*, > 19:1 d.r.; $[\alpha]_D^{32}$ = -117 (c 0.25, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 8.61 min, t (major) = 11.25 min];

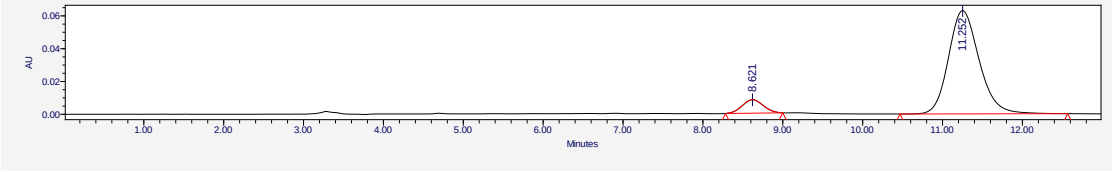
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (s, 1H), 8.06 – 7.77 (m, 4H), 7.58 (m, 2H), 7.34 (s, 5H), 6.05 (t, *J* = 6.0 Hz, 1H), 5.68 (d, *J* = 6.0 Hz, 1H), 3.90 (d, *J* = 6.0 Hz, 1H), 2.43 (d, *J* = 38.0 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 190.78, 146.12, 141.03, 140.64, 135.84, 135.35, 134.42, 128.82, 128.68, 128.20, 127.92, 77.65, 64.32.

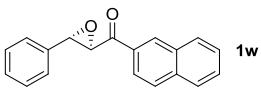
HRMS (ESI) calcd for $[M+Na]^+$ $C_{24}H_{21}N_3NaO_4$, m/z: 438.1424, observed: 438.1432.



Retention Time	Area	% Area
8.112	66885594	49.58
10.425	68008882	50.42



Retention Time	Area	% Area
8.621	148996	8.17
11.252	1675602	91.83

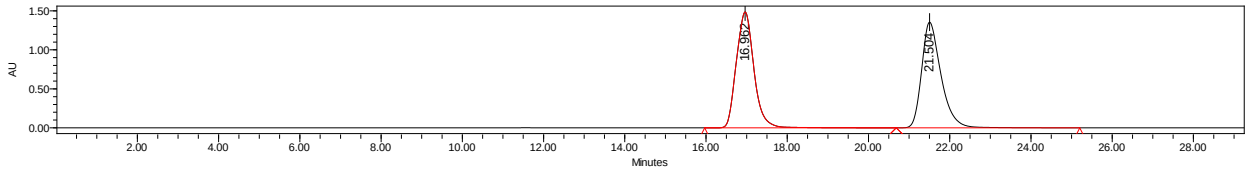

1w

(2*R*,3*S*)-naphthalen-2-yl(3-phenyloxiran-2-yl)methanone (**1w**)

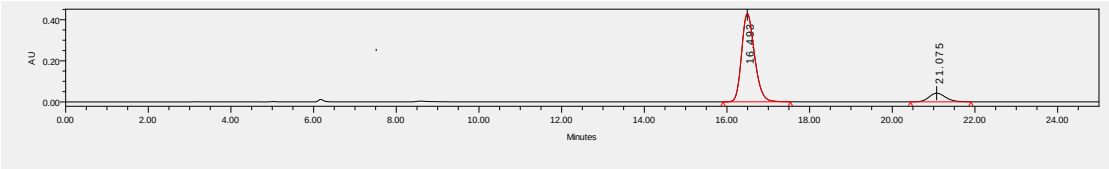
General procedureC; White solid; 47% yield, 79% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -110 (c 0.23, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 16.49 min, t (minor) = 21.01 min,];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 (s, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.96 – 7.80 (m, 3H), 7.57 (m, 2H), 7.41 (s, 5H), 4.42 (d, *J* = 1.6 Hz, 1H), 4.14 (d, *J* = 12 Hz, 1H).

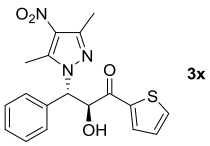
HRMS (ESI) calcd for $[M+Na]^+$ $C_{19}H_{14}NaO_2$, m/z: 297.0886, observed: 297.0886.



Retention Time	Area	% Area
16.962	44515793	49.87
21.504	44742642	50.13



Retention Time	Area	% Area
16.493	9347917	89.71
21.075	1072442	10.29



3x

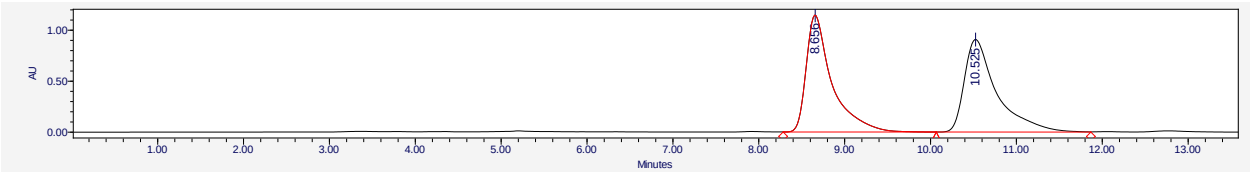
(2*S*,3*S*)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(thiophen-2-yl)propan-1-one (**3x**)

General procedure C; colorless oil; 35% yield, 82% *ee*, > 19:1 d.r.; $[\alpha]_D^{32}$ = -117 (c 0.25, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 10.18 min, t (major) = 12.43 min];

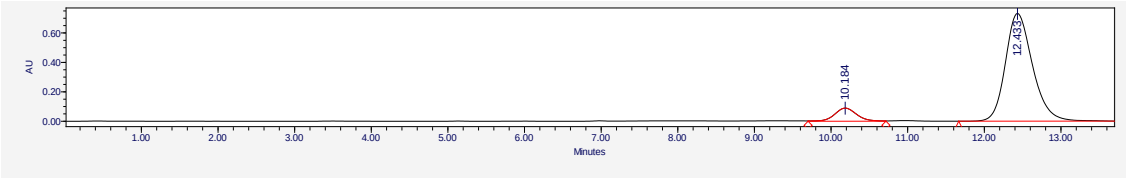
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 3.6 Hz, 1H), 7.65 (d, *J* = 4.8 Hz, 1H), 7.28 (d, *J* = 2.4 Hz, 3H), 7.23 (d, *J* = 3.2 Hz, 2H), 7.04 (t, *J* = 4.4 Hz, 1H), 5.80 (d, *J* = 4.0 Hz, 1H), 5.60 (t, *J* = 4.0 Hz, 1H), 4.63 (d, *J* = 4.4 Hz, 1H), 2.52 (d, *J* = 22.6 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.83, 146.14, 140.80, 135.80, 135.00, 132.13, 132.02, 131.44, 129.70, 129.08, 128.99, 128.85, 128.41, 128.31, 127.81, 126.98, 124.09, 74.67, 64.64, 14.23, 11.35.

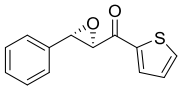
HRMS (ESI) calcd for $[M+Na]^+$ $C_{18}H_{17}N_3NaO_4S$, m/z: 394.0832, observed: 394.0833.



Retention Time	Area	% Area
8.656	23867507	50.05
10.525	23820314	49.95



Retention Time	Area	% Area
10.184	1784240	9.01
12.433	18022249	90.99



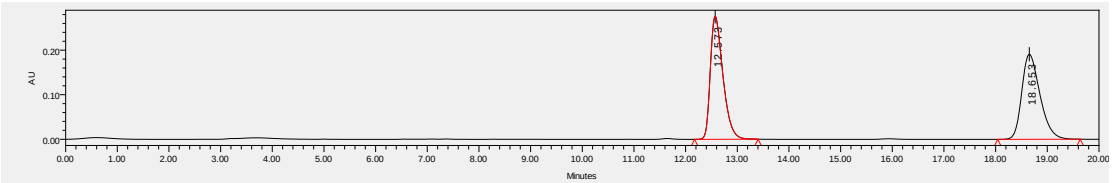
1x

(2*R*,3*S*)-(3-phenyloxiran-2-yl)(thiophen-2-yl)methanone (**1x**)

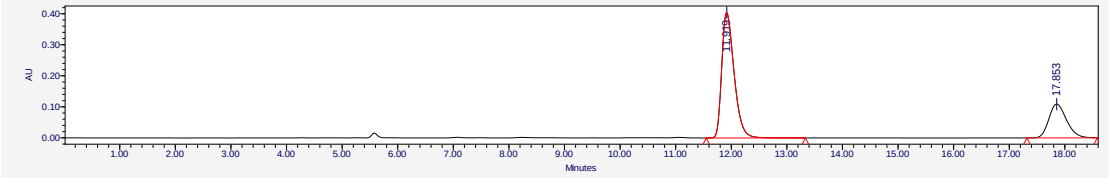
General procedure C; White solid; 65% yield, 44% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -110 (c 0.24, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 11.92 min, t (minor) = 17.85 min,];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 3.6 Hz, 1H), 7.74 (d, *J* = 4.8 Hz, 1H), 7.36 (m, 5H), 7.18 (t, *J* = 4.4 Hz, 1H), 4.17 (d, *J* = 1.6 Hz, 1H), 4.07 (d, *J* = 1.6 Hz, 1H);

HRMS (ESI) calcd for $[M+Na]^+$ $C_{13}H_{10}NaO_2S$, m/z: 253.0294, observed: 253.0296.



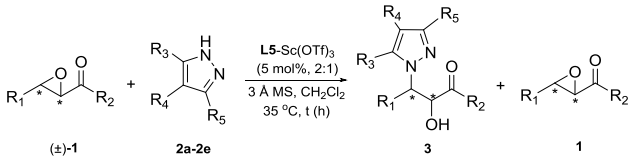
Retention Time	Area	% Area
12.573	4663239	50.01
18.653	4660842	49.99



Retention Time	Area	% Area
11.919	6218685	72.06
17.853	2411023	27.94

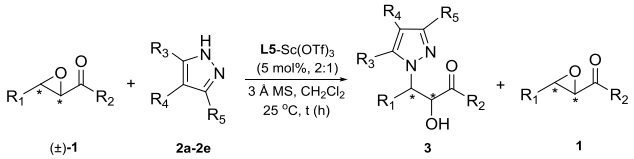
5. General procedure for the Ring-Opening reaction of different pyrazoles (2)

General procedure D for the reaction of pyrazoles **2**:



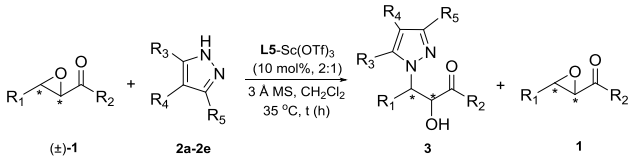
In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 35 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** (0.2 mmol) were added to the reaction mixture at 35 °C. The reaction was stirred at 35 °C for 22-26 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

General procedure E for the reaction of pyrazoles **2**:



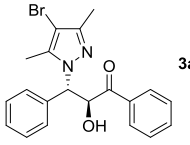
In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 25 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** (0.2 mmol) were added to the reaction mixture at 25 °C. The reaction was stirred at 25 °C for 25 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

General procedure F for the reaction of pyrazoles **2**:



In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.02 mmol, 13.2 mg), $Sc(OTf)_3$ (0.01 mmol, 4.9 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 35 °C for 30 min. Then, epoxide (±)-**1** (0.1 mmol) and pyrazole **2** (0.2 mmol) were added to the reaction mixture at 35 °C. The reaction was stirred at 35 °C for 22-26 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3** and **1**. The product was determined by HPLC and NMR analysis.

6. The analytical and spectral characterization data of the products (3)



3ab

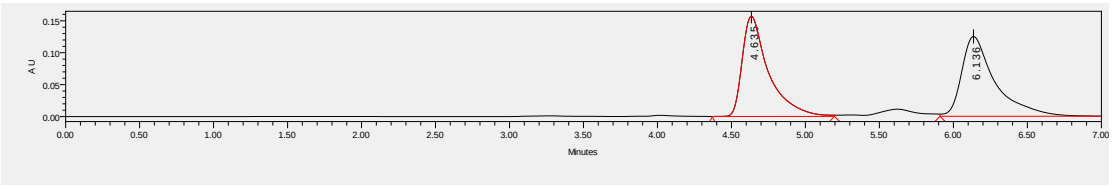
(2*S*,3*S*)-3-(4-bromo-3,5-dimethyl-1*H*-pyrazol-1-yl)-2-hydroxy-1,3-diphenylpropan-1-one (**3ab**)

General procedure E; White solid; 49% yield, 90% *ee*, > 19:1 d.r.; $[\alpha]_D^{32}$ = -49(c 0.16, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (minor) = 4.63 min, t (major) = 6.14 min];

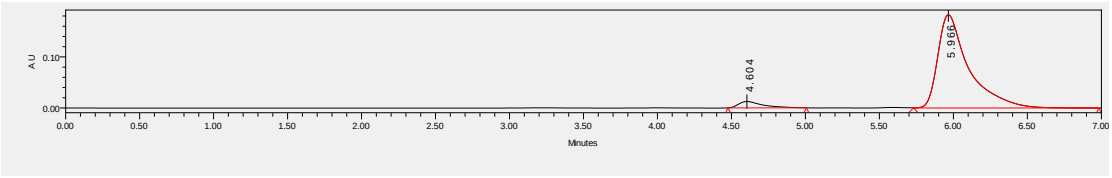
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 2H), 7.53 (t, *J* = 7.2 Hz, 1H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.31 – 7.26 (m, 3H), 7.20 (m, 2H), 5.86 (d, *J* = 4.0 Hz, 1H), 5.62 (d, *J* = 4.4 Hz, 1H), 4.61 (s, 1H), 2.18 (s, 3H), 2.04 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 199.67, 146.19, 137.81, 135.88, 135.27, 133.40, 129.05, 128.47, 128.33, 128.24, 128.23, 95.04, 76.23, 64.54, 12.41, 10.29.

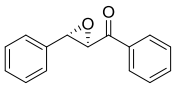
HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{19}{}^{79}BrN_2NaO_2$, m/z: 421.0523, observed: 421.0523; $[M+Na]^+$ $C_{20}H_{19}{}^{81}BrN_2NaO_2$, m/z: 423.0502, observed: 423.0511.



Retention Time	Area	% Area
4.635	1941989	49.65
6.136	1969559	50.35



Retention Time	Area	% Area
4.604	137530	4.95
5.966	2642595	95.05



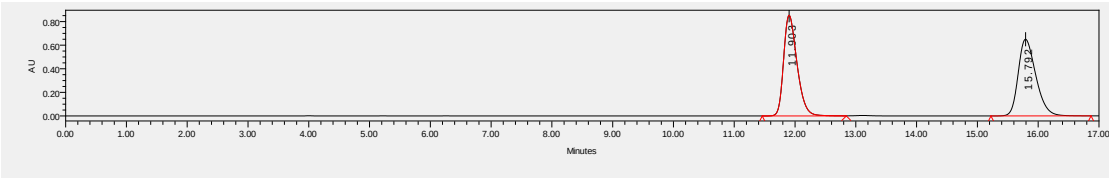
1ab

(2*R*,3*S*)-phenyl(3-phenyloxiran-2-yl)methanone (**1ab**)

General procedure E; White solid; 50% yield, 91% *ee*, > 99:1 d.r.; $[\alpha]_D^{32}$ = -183 (c 0.23, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 11.90 min, t (minor) = 15.79 min];

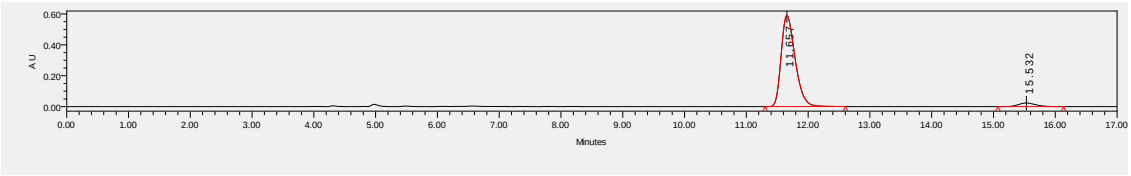
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (m, 2H), 7.68 – 7.58 (m, 1H), 7.49 (m, 2H), 7.45 – 7.33 (m, 5H), 4.30 (d, *J* = 2.0 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H).

HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{12}NaO_2$, m/z: 247.0730, observed: 247.0732.

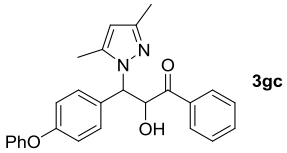


Retention Time	Area	% Area

11.903	13059530	50.00
15.792	13059754	50.00



Retention Time	Area	% Area
11.657	9259680	95.51
15.532	435470	4.49



3gc

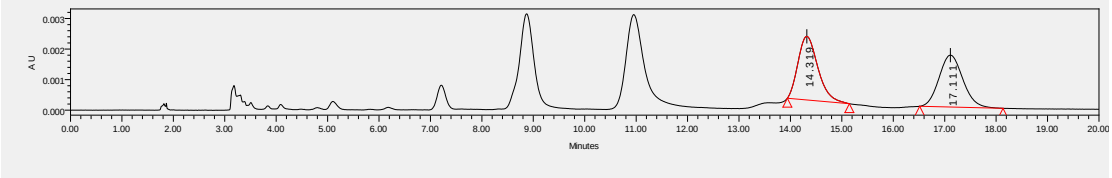
3-(3,5-dimethyl-1*H*-pyrazol-1-yl)-2-hydroxy-3-(4-phenoxyphenyl)-1-phenylpropan-1-one (**3gc**)

General procedure D; colorless oil; 40% yield, 88% *ee*, d.r. = 12:1; $[\alpha]_D^{27}$ = -62 (c 0.28, CH_2Cl_2) Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 14.20 min, t (major) = 16.66 min];

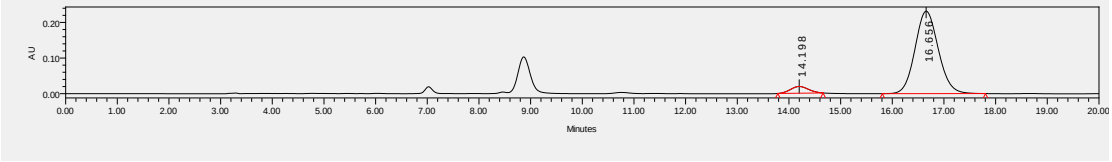
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.6 Hz, 2H), 7.52 (s, 1H), 7.43 – 7.23 (m, 5H), 7.15 (d, *J* = 8.4 Hz, 2H), 7.09 (d, *J* = 7.2 Hz, 1H), 6.95 (d, *J* = 8.0 Hz, 2H), 6.87 (d, *J* = 8.4 Hz, 2H), 5.81 – 5.73 (m, 2H), 5.63 (d, *J* = 3.6 Hz, 1H), 2.21 (s, 3H), 2.07 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 199.86, 157.10, 156.85, 147.52, 139.61, 135.70, 133.17, 131.12, 129.73, 129.71, 129.27, 128.17, 123.42, 119.10, 118.40, 105.48, 77.72, 62.68, 13.57, 11.01.

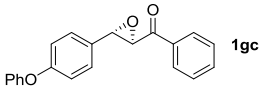
HRMS (ESI) calcd for $[M+Na]^+$ $C_{26}H_{24}N_2NaO_3$, m/z: 435.1679, observed: 435.1684.



Retention Time	Area	% Area
14.319	55899	50.59
17.111	54586	49.41



Retention Time	Area	% Area
14.198	456823	5.93
16.656	7244320	94.07

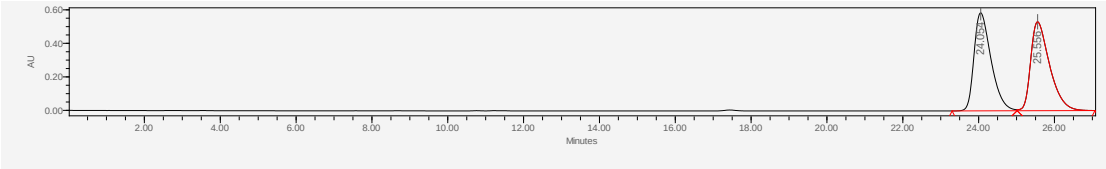


(3-(4-phenoxyphenyl)oxiran-2-yl)(phenyl)methanone (**1gc**)

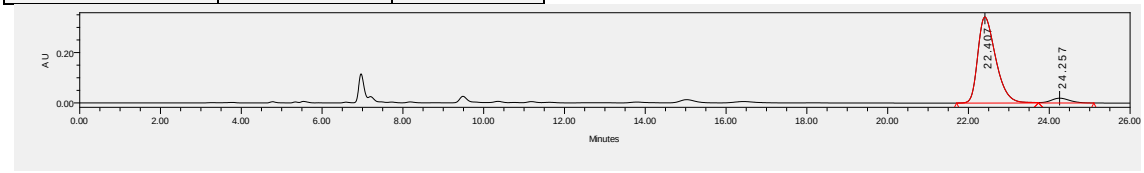
General procedure D; White solid; 49% yield, 90% *ee*, > 99:1 d.r.; $[\alpha]_D^{18}$ = -86 (c 0.24, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 24.05 min, t (minor) = 25.55 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.62 (d, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.35 (m, 4H), 7.14 (t, *J* = 7.2 Hz, 1H), 7.03 (m, 4H), 4.30 (d, *J* = 1.6 Hz, 1H), 4.06 (d, *J* = 1.2 Hz, 1H).

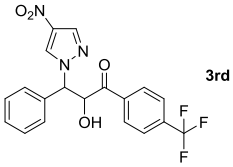
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{16}NaO_3$, m/z: 339.0992, observed: 339.0990.



Retention Time	Area	% Area
24.054	18266081	49.95
25.556	18302963	50.05



Retention Time	Area	% Area
22.407	10544776	95.32
24.257	517230	4.68



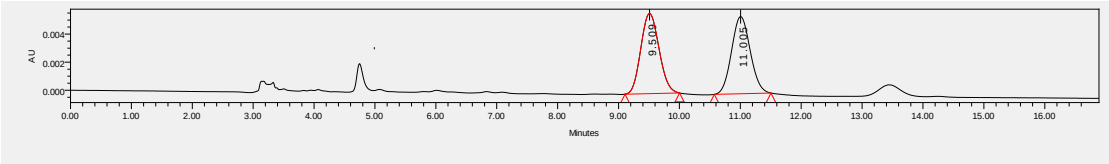
2-hydroxy-3-(4-nitro-1*H*-pyrazol-1-yl)-3-phenyl-1-(4-(trifluoromethyl)phenyl)propan-1-one (**3rd**)

General procedure F; White solid; 44% yield, 95% *ee*, > 19:1 d.r.; $[\alpha]_D^{27}$ = -33 (c 0.25, CH_2Cl_2) Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 9.52 min, t (major) = 11.19 min];

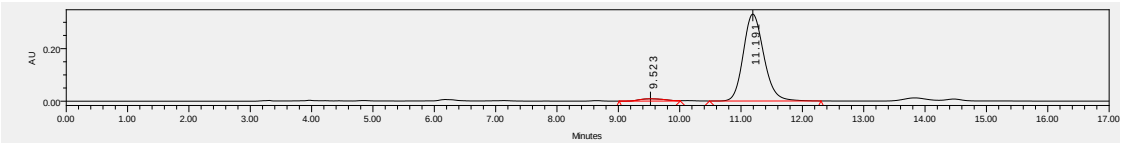
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (s, 1H), 8.13 (s, 1H), 7.99 (d, *J* = 8.0 Hz, 2H), 7.79 (d, *J* = 8.4 Hz, 2H), 7.35 (m, 3H), 7.15 (d, *J* = 7.6 Hz, 2H), 6.05 (d, *J* = 2.0 Hz, 1H), 5.79 (d, *J* = 3.2 Hz, 1H), 3.94 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 196.82, 136.61, 135.93, 131.83, 129.97, 129.31, 129.14, 129.07, 128.52, 126.26, 126.22, 124.60, 77.34, 77.02, 76.70, 75.15, 68.73, 31.93, 29.70, 29.37, 22.70, 14.12.

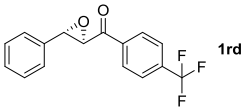
HRMS (ESI) calcd for $[M+Na]^+$ $C_{19}H_{14}{}^{18}F_3N_3NaO_4$, m/z: 428.0829, observed: 428.0833; $[M+Na]^+$ $C_{19}H_{14}{}^{19}F_3N_3NaO_4$, m/z: 429.0863, observed: 429.0872.



Retention Time	Area	% Area
9.509	118598	50.30
11.005	117198	49.70



Retention Time	Area	% Area
9.523	183148	2.34
11.191	7636978	97.66

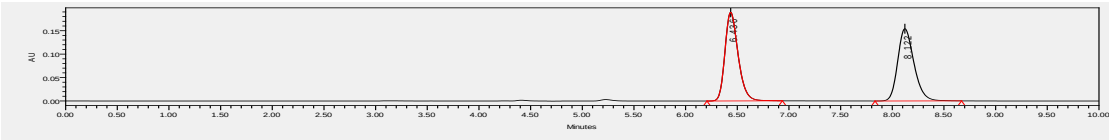


(3-phenyloxiran-2-yl)(4-(trifluoromethyl)phenyl)methanone (**1rd**)

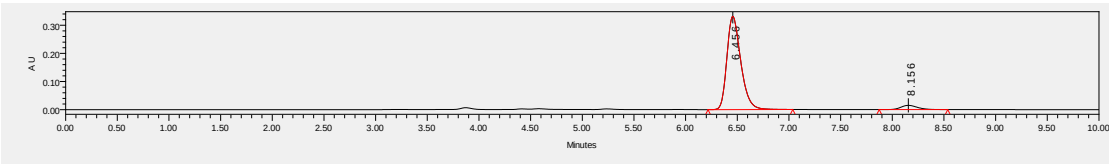
General procedure D; White solid; 50% yield, 90% *ee*, > 99:1 d.r.; $[\alpha]_D^{18}$ = -120 (c 0.15，CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.43 min, t (minor) = 8.12 min,];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.4 Hz, 2H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.38 (m, 5H), 4.26 (d, *J* = 1.6 Hz, 1H), 4.09 (d, *J* = 1.2 Hz, 1H).

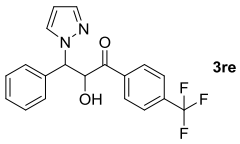
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{11}{}^{18}F_3NaO_2$, m/z: 315.0603, observed: 315.0609; $[M+K]^+$ $C_{16}H_{11}{}^{19}F_3NaO_2$, m/z: 332.0377, observed: 332.0379.



Retention Time	Area	% Area
6.436	1679737	49.97
8.122	1682041	50.03



Retention Time	Area	% Area
6.456	3087726	95.00
8.156	162664	5.00



3re

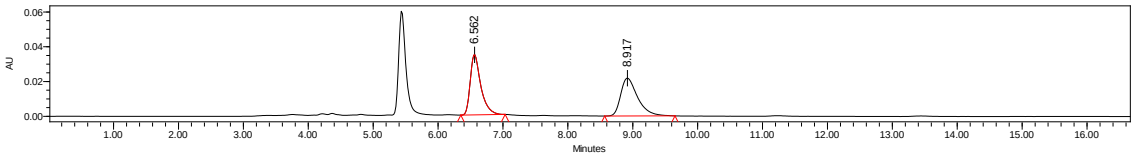
2-hydroxy-3-phenyl-3-(1*H*-pyrazol-1-yl)-1-(4-(trifluoromethyl)phenyl)propan-1-one (**3re**)

General procedure D; colorless oil; 40% yield, 57% *ee*, > 19:1 d.r.; $[\alpha]_D^{27}$ = -19 (c 0.21, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak Id, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.60 min, t (minor) = 9.04 min];

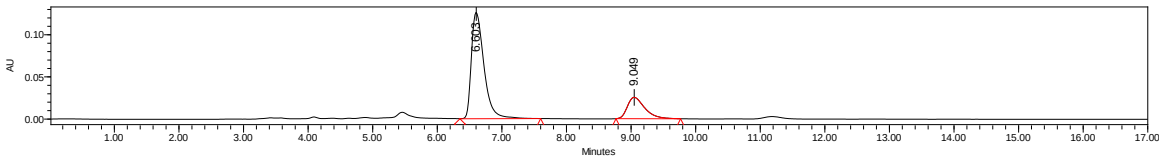
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.0 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 2H), 7.56 (m, 2H), 7.36 – 7.23 (m, 4H), 7.16 (m, 2H), 6.27 (t, *J* = 2.0 Hz, 1H), 5.94 (d, *J* = 3.6 Hz, 1H), 5.83 (d, *J* = 3.6 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 198.53, 139.51, 137.59, 134.86, 129.94, 129.28, 128.82, 128.56, 128.31, 125.67, 125.64, 106.08, 67.32.

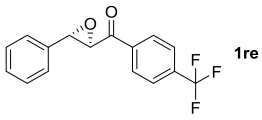
HRMS (ESI) calcd for $[M+Na]^+$ $C_{19}H_{15}{}^{18}F_3N_2NaO_2$, m/z: 383.0978, observed: 383.0984; $[M+Na]^+$ $C_{19}H_{15}{}^{19}F_3N_2NaO_2$, m/z: 384.1012, observed: 384.1034.



Retention Time	Area	% Area
6.562	394272	50.05
8.917	393517	49.95



Retention Time	Area	% Area
6.603	1709366	78.32
9.049	473270	21.68



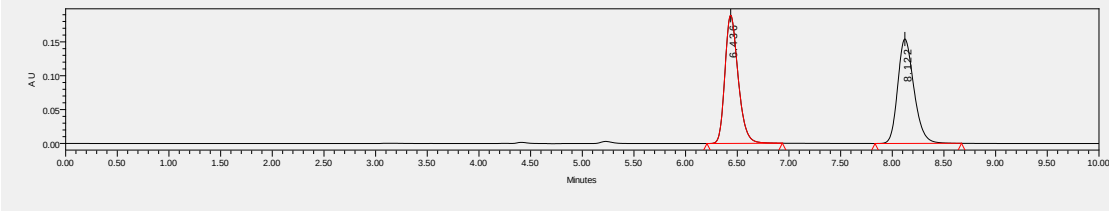
1re

(3-phenyloxiran-2-yl)(4-(trifluoromethyl)phenyl)methanone (**1re**)

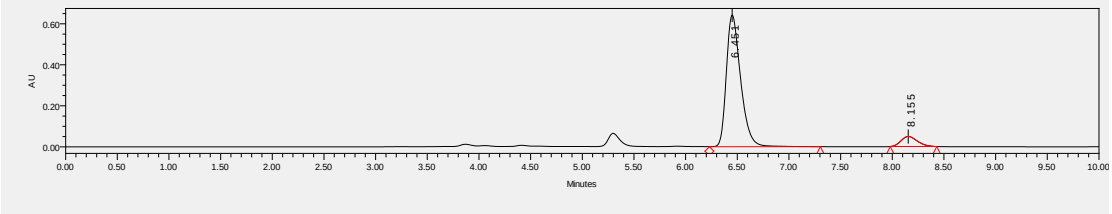
General procedure D; White solid; 50% yield, 84% *ee*, > 99:1 d.r.; $[\alpha]_D^{18}$ = -107 (c 0.16, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 6.43 min, t (minor) = 8.12 min,];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.4 Hz, 2H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.38 (m, 5H), 4.26 (d, *J* = 1.6 Hz, 1H), 4.09 (d, *J* = 1.2 Hz, 1H);

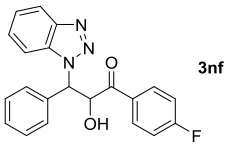
HRMS (ESI) calcd for $[M+Na]^+$ $C_{16}H_{11}{}^{18}F_3NaO_2$, m/z: 315.0603, observed: 315.0609; $[M+Na]^+$ $C_{16}H_{11}{}^{19}F_3NaO_2$, m/z: 316.0637, observed: 316.0638.



Retention Time	Area	% Area
6.436	1679737	49.97
8.122	1682041	50.03



Retention Time	Area	% Area
6.451	6172741	91.98
8.155	538005	8.02



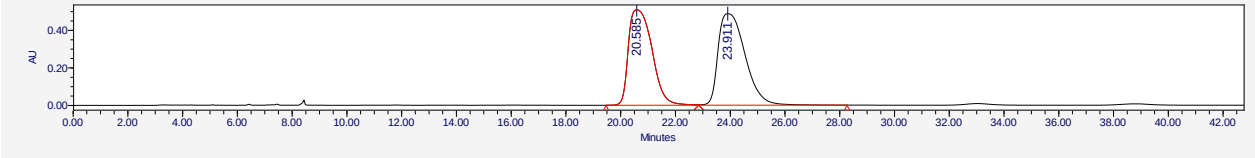
3nf

3-(1*H*-benzo[d][1,2,3]triazol-1-yl)-1-(4-fluorophenyl)-2-hydroxy-3-phenylpropan-1-one (**3nf**)
General procedure D; colorless oil; 22% yield, 35% *ee*, > 19:1 d.r., *s* factor of 3.$[\alpha]_D^{26}$ = -7 (c 0.15，CH_2Cl_2);Determined by HPLC analysis [Daicel chiralpak Ic, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 20.58 min, t (major) = 23.91 min];

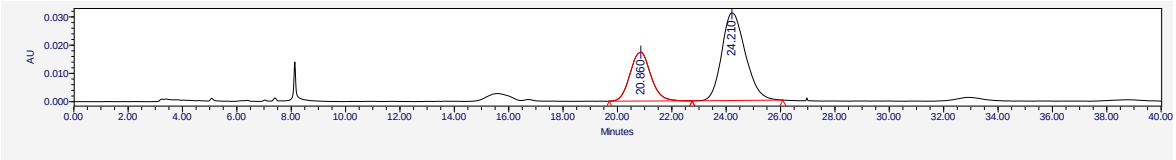
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.4 Hz, 1H), 7.94 – 7.87 (m, 2H), 7.38 – 7.27 (m, 8H), 7.06 (m, 2H), 6.29 – 6.18 (m, 2H), 3.82 (d, *J* = 6.4 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 196.97, 134.09, 131.76, 131.66, 129.14, 128.82, 128.43, 127.72, 124.28, 120.01, 116.07, 115.85, 110.20, 74.56, 65.33.

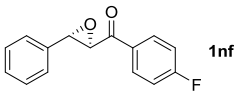
HRMS (ESI) calcd for $[M+Na]^+$ $C_{21}H_{16}{}^{18}FN_3NaO_2$, m/z: 384.1119, observed: 384.1122; $[M+Na]^+$ $C_{21}H_{16}{}^{19}FN_3NaO_2$, m/z: 385.1153, observed: 385.1214.



Retention Time	Area	% Area
20.585	30387160	47.66
23.911	33370033	52.34



Retention Time	Area	% Area
20.860	915917	32.83
24.210	1874209	67.17



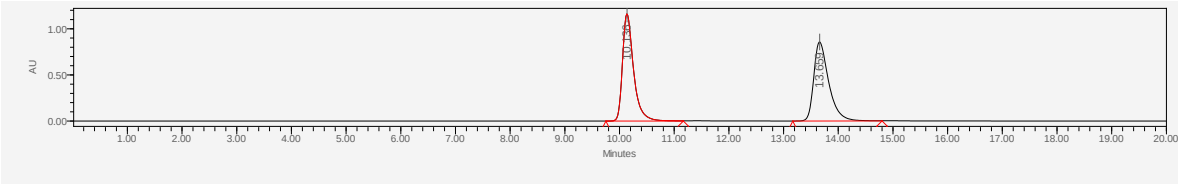
1nf

(4-fluorophenyl)(3-phenyloxiran-2-yl)methanone (**1nf**)

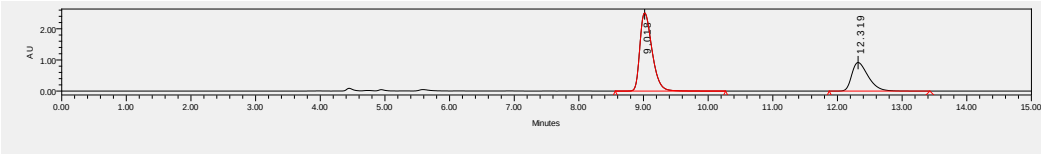
General procedure D; White solid; 50% yield, 34% *ee*, > 99:1 d.r.; $[\alpha]_D^{26}$ = -78 (c 0.24, CH_2Cl_2); Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 9.02 min, t (minor) = 12.32 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 – 8.00 (m, 2H), 7.38 (m, 5H), 7.17 (m, 2H), 4.24 (d, *J* = 1.6 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H).

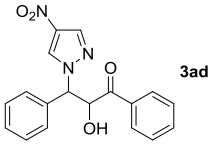
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{11}{}^{18}FNaO_2$, m/z: 265.0636, observed: 265.0641; $[M+Na]^+$ $C_{15}H_{11}{}^{19}FNaO_2$, m/z: 266.0669, observed: 266.0682.



Retention Time	Area	% Area
10.136	16305463	50.06
13.659	16269563	49.94



Retention Time	Area	% Area
9.018	32753780	66.95
12.319	16167391	33.05



3ad

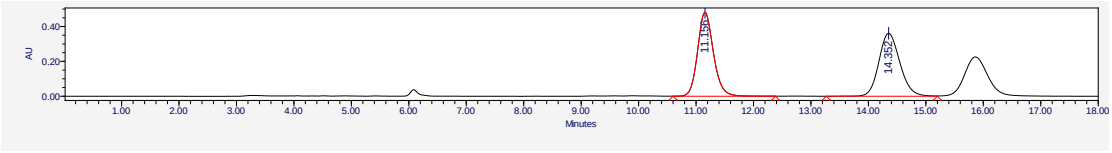
2-hydroxy-3-(4-nitro-1*H*-pyrazol-1-yl)-1,3-diphenylpropan-1-one (**3ad**)

General procedure D; colorless oil; 28% yield, 90% *ee*; $[\alpha]_D^{26}$ = -21 (c 0.26, CH_2Cl_2);Determined by HPLC analysis [Daicel chiralpak IC, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (minor) = 11.16 min, t (major) = 14.35 min];

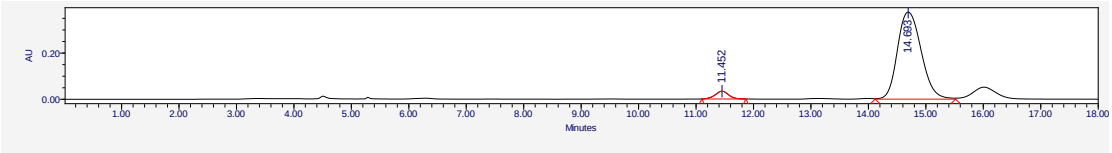
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (s, 1H), 8.13 (s, 1H), 7.94 – 7.87 (m, 2H), 7.70 (t, *J* = 7.6 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.39 – 7.27 (m, 3H), 7.09 (d, *J* = 7.2 Hz, 2H), 6.06 (m, 1H), 5.82 (d, *J* = 3.2 Hz, 1H), 4.04 (d, *J* = 6.4 Hz, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 197.19, 135.92, 134.81, 133.41, 131.72, 129.78, 129.39, 129.28, 128.95, 128.64, 128.53, 74.58, 69.23.

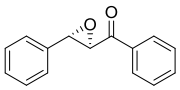
HRMS (ESI) calcd for $[M+Na]^+$ $C_{18}H_{15}N_3NaO_4$, m/z: 360.0955, observed: 360.0962.



Retention Time	Area	% Area
11.156	9246197	50.16
14.352	9186262	49.84



Retention Time	Area	% Area
11.452	538627	4.74
14.693	10814272	95.26



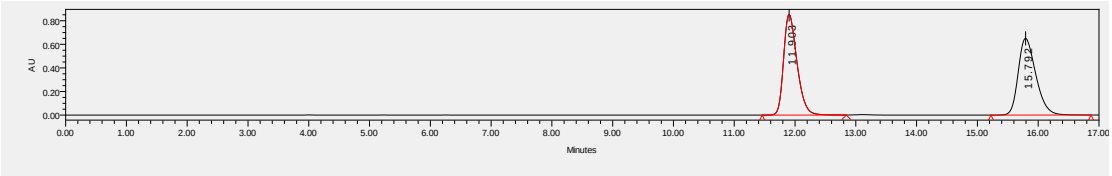
1ad

phenyl(3-phenyloxiran-2-yl)methanone (**1ad**)

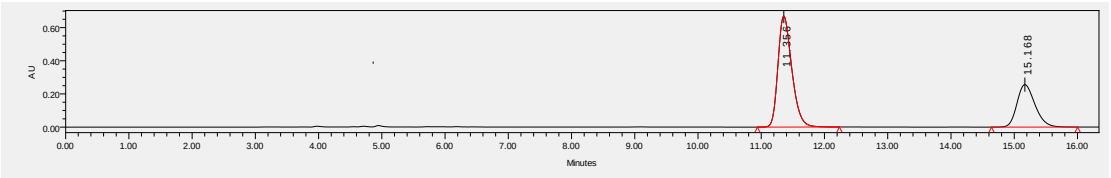
General procedure D; White solid; 65% yield, 33% *ee*, > 99:1 d.r.; $[\alpha]_D^{26}$ = -65 (c 0.32，CH_2Cl_2);Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 80/20, 1.0 mL/min, λ = 254 nm, t (major) = 11.36 min, t (minor) = 15.17 min];

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 – 7.95 (m, 2H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.39 (t, *J* = 4.8 Hz, 5H), 4.30 (d, *J* = 1.6 Hz, 1H), 4.08 (d, *J* = 1.6 Hz, 1H).

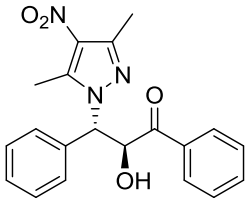
HRMS (ESI) calcd for $[M+Na]^+$ $C_{15}H_{12}NaO_2$, m/z: 247.0730, observed: 247.0732.



Retention Time	Area	% Area
11.903	13059530	50.00
15.792	13059754	50.00

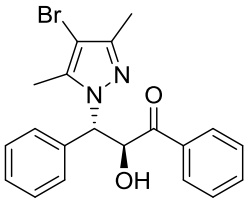


Retention Time	Area	% Area
11.356	10188503	66.77
15.168	5070589	33.23



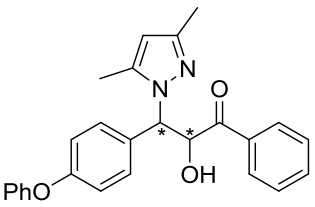
3aa

s: 49% yield, 94% *ee*
p: 47% yield, 95% *ee* *s* = 140
> 19:1 d.r.
26 h



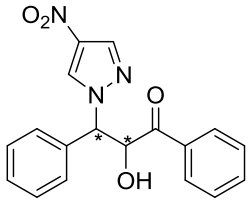
3ab[b]

s: 50% yield, 91% *ee*
p: 49% yield, 90% *ee* *s* = 60
> 19:1 d.r.
25 h



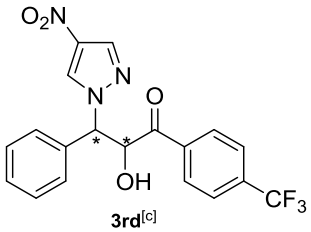
3gc

s: 49% yield, 90% *ee*
p: 40% yield, 88% *ee* *s* = 48
d.r. = 12:1
22 h



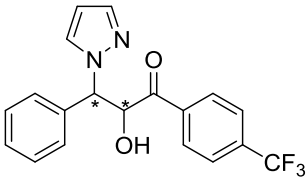
3ad[c]

s: 65% yield, 33% *ee*
p: 28% yield, 90% *ee*
s = 26
26 h



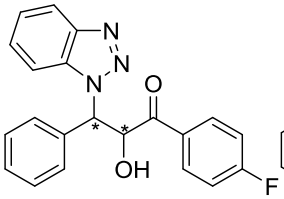
3rd[c]

s: 50% yield, 90% *ee*
p: 44% yield, 95% *ee* *s* = 120
> 19:1 d.r.
22 h



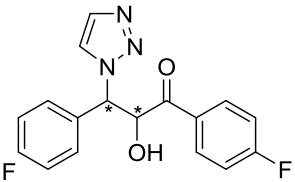
3re[c]

s: 50% yield, 84% *ee*
p: 40% yield, 57% *ee* *s* = 10
> 19:1 d.r.
22 h



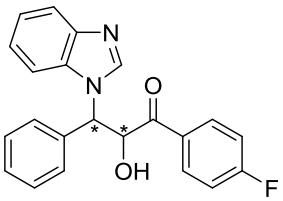
3nf[c]

s: 50% yield, 34% *ee*
p: 22% yield, 35% *ee* *s* = 3
> 19:1 d.r.
26 h



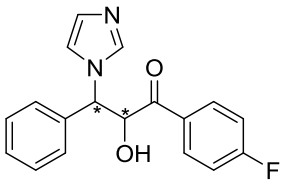
3ng[c]

n.d.
26 h



3nh[c]

n.d.
26 h



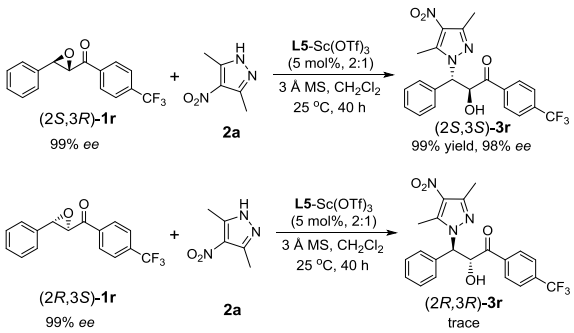
3ni[c]

n.d.
26 h

[a] Unless otherwise noted, the reactions were performed with **L5**–Sc(OTf)$_3$ (5 mol%), 30 mg 3 Å MS and **2** (0.2 mmol) with (±)-**1** (0.1 mmol) under nitrogen in CH_2Cl_2 (0.5 mL) at 35 °C; The diastereoselectivities were determined by ^{1}H NMR analysis of the product **3**; The enantioselectivities were determined by HPLC analysis; Isolated yield; $s = \ln[(1 - \text{Conv.})(1 - ee^1)]/\ln[(1 - \text{Conv.})(1 + ee^1)]$; Conv = $ee^1/(ee^1 + ee^3)$; **s** = starting material; **p** = product; n.d. = not detected. [b] At 25 °C. [c] 10 mol% catalyst loading.

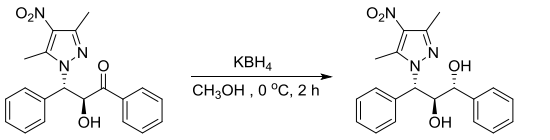
7.

a. Control experiments



In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 25 °C for 30 min, corresponding optical epoxides **1r** (0.1 mmol) and pyrazole **2a** (28.3 mg, 0.2 mmol) were added to the reaction mixture at 25 °C. Then the reaction was stirred at 25 °C for 40 h. The mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3r** as a white solid. The product was determined by HPLC and NMR analysis.

b. Experimental procedure for the reduction of 3a.



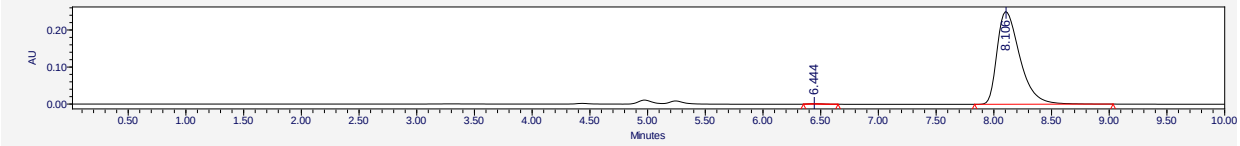
To a solution of the adduct **3a** (73.0 mg, 0.2 mmol) in CH_3OH (1.0 mL) was added KBH_4 (29.0 mg) at 0 ℃. The mixture was allowed to stir for 2 h. Then saturated NH_4Cl aqueous solution (2.0 mL) was added to the mixture. The mixture was extracted with CH_2Cl_2, drying over Na_2SO_4. After evaporation of the solvent, the adduct **4a** was purified on silica gel chromatography (EtOAc : Pet = 1 : 5). The results were 99% yield, > 95:5 d.r. and 96% *ee*.

8. The analytical and spectral characterization data of the products

a. Control experiments

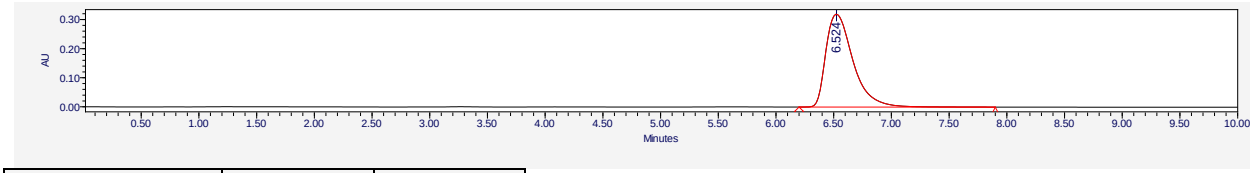
Before reaction

(2R,3S) – **1r**



Retention Time	Area	% Area
6.444	9035	0.26
8.106	3438999	99.74

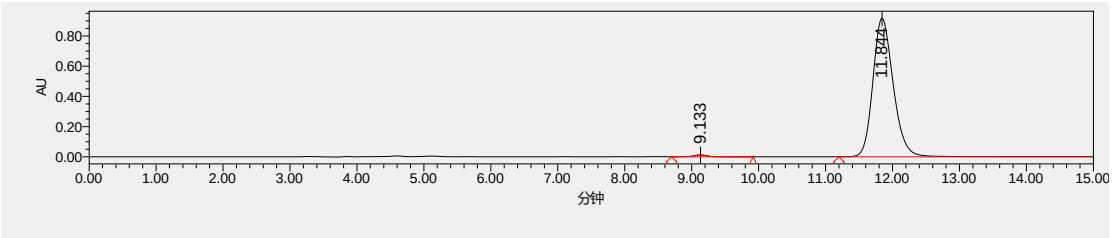
(2S,3R) – **1r**



Retention Time	Area	% Area
6.524	5219999	100.00

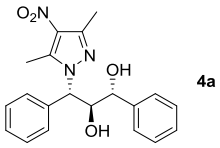
After reaction

(2S,3S) – **3r**



Retention Time	Area	% Area
9.133	176887	0.90
11.844	19440593	99.10

b. Experimental procedure for the reduction of 3a.



4a

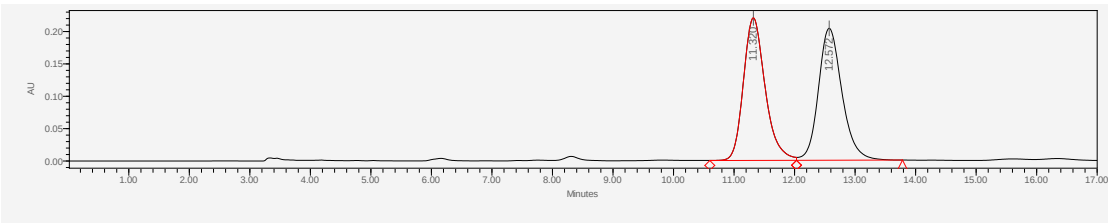
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-1,3-diphenylpropane-1,2-diol (**4a**)

White solid; 99% yield, 96% *ee*, > 19:1 d.r.; Determined by HPLC analysis [Daicel chiralpak IE, n-hexane/i-PrOH = 90/10, 1.0 mL/min, λ = 254 nm, t (major) = 11.27 min, t (minor) = 12.56 min];

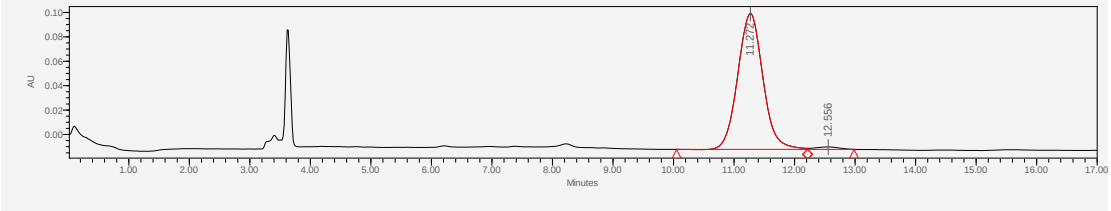
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (m, 10H), 5.63 (d, *J* = 2.4 Hz, 1H), 4.78 – 4.61 (m, 2H), 4.30 (d, *J* = 8.4 Hz, 1H), 2.46 (d, *J* = 38.6 Hz, 6H), 2.36 (s, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 145.80, 141.10, 141.03, 134.78, 128.67, 128.57, 128.48, 128.47, 128.43, 127.11, 76.16, 73.47, 62.78, 14.32, 11.41.

HRMS (ESI) calcd for $[M+Na]^+$ $C_{20}H_{21}N_3NaO_4$, m/z: 390.1424, observed: 390.1434.

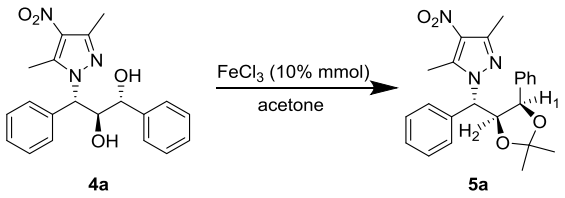


Retention Time	Area	% Area
11.320	5493283	49.97
12.572	5500366	50.03



Retention Time	Area	% Area
11.272	3218916	98.34
12.556	54404	1.66

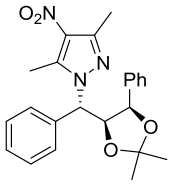
c. Determination of the absolute configuration of 4a



4a **5a**

In a test tube with a magnetic stirring bar, **4a** (0.2 mmol, 73.4 mg), $FeCl_3$ (0.02 mmol, 3.2 mg), in acetone (1 mL) were stirred at 15 °C for 8 h, then, the mixture was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **5a** (16.4 mg, 20% yield) as a colorless oil. The product was determined by NMR analysis.

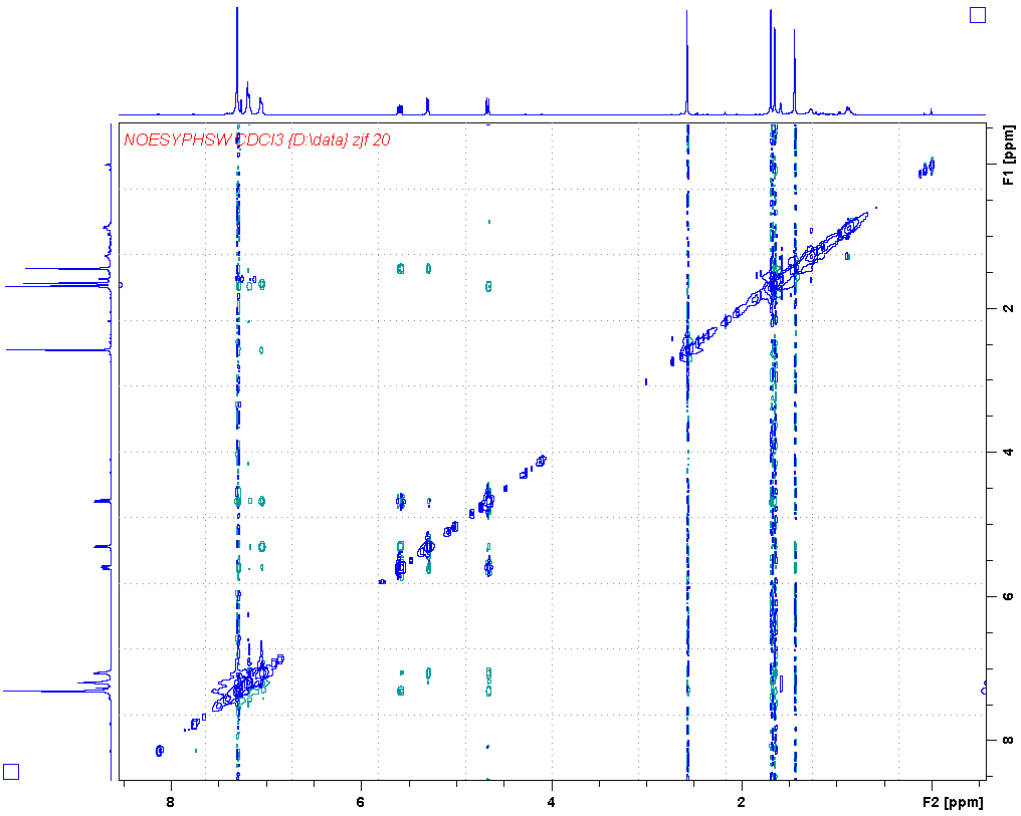
To determine the absolute configuration of **4a**, we convert **4a** to **5a**. We could easily found the signal between H_1 and H_2 from the NOESY spectra, so the absolute configuration of **5a** was determined to be (1*R*,2*S*,3*S*). Based on these information, we deduce the absolute configuration of **4a** is (1*R*,2*S*,3*S*).



5a

1-((S)-((4S,5R)-2,2-dimethyl-5-phenyl-1,3-dioxolan-4-yl)(phenyl)methyl)-3,5-dimethyl-4-nitro-1H-pyrazole (**5a**)

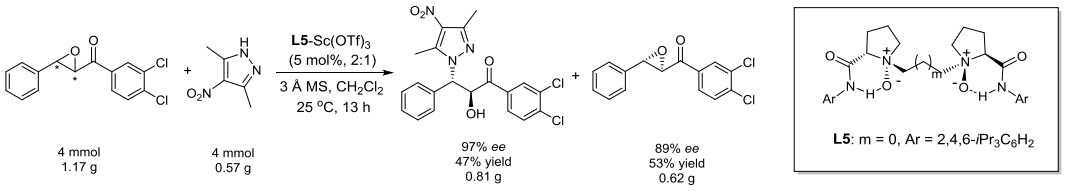
Colorless oil; 20% yield.



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (s, 5H, Ar-H), 7.18 (d, *J* = 5.6 Hz, 3H, Ar-H), 7.05 (d, *J* = 5.6 Hz, 2H, Ar-H), 5.59 (dd, *J* = 9.8, 6.7 Hz, 1H, Chiral center: N-CH), 5.29 (d, *J* = 6.4 Hz, 1H, Chiral center: O-CH), 4.66 (d, *J* = 9.6 Hz, 1H, Chiral center: O-CH), 2.57 (s, 3H, C-H), 1.69 (s, 3H, C-H), 1.65 (s, 3H, C-H), 1.44 (s, 3H, C-H).

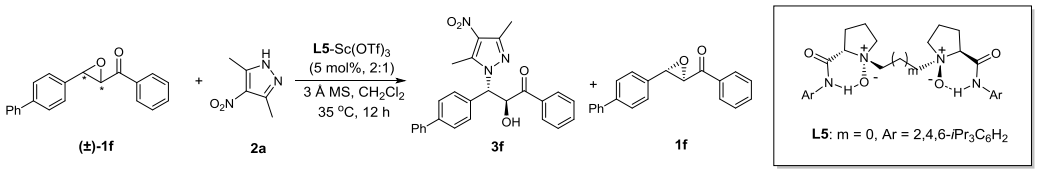
^{13}C NMR (100 MHz, $CDCl_3$) δ 145.72, 140.67, 137.26, 137.03, 128.71, 128.52, 128.24, 127.91, 127.55, 126.62, 109.02, 79.47, 78.69, 62.07, 26.91, 24.27, 14.25, 10.15.

9. Gram scale experiment

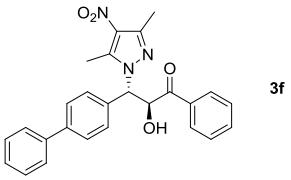


In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.4 mmol, 268 mg), $Sc(OTf)_3$ (0.20 mmol, 100 mg), and the 3 Å MS (1.20 g) in CH_2Cl_2 (20 mL) were stirred at 25 °C for 2 h, epoxide (±)-**1v** (1.17 g, 4 mmol) and pyrazole **2a** (0.57 g, 4 mmol) were added to the reaction mixture at 25 °C. Then the reaction was stirred at 25 °C for 13 h. After 50% consumption of the starting materials, the mixture was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3v** (0.81 g, 47% yield) as a white solid, and **1v** (0.62 g, 53% yield) as a white solid. The product was determined by HPLC and NMR analysis.

10. Determination of the absolute configuration of 3f by the x-ray crystal structure.

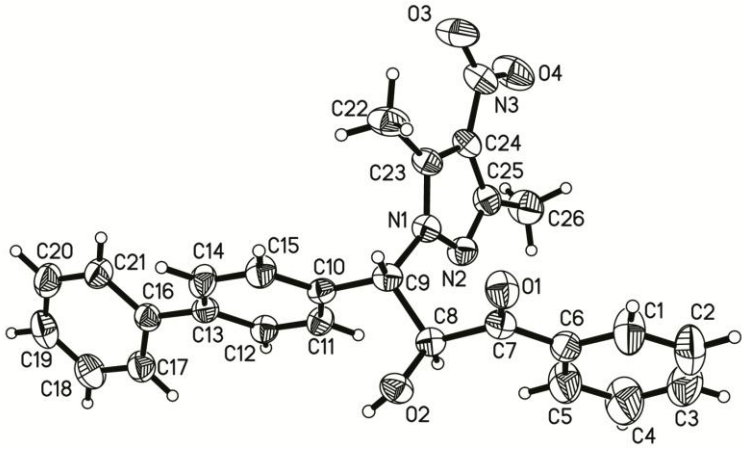


In a test tube with a magnetic stirring bar, *N*,*N*'-dioxide **L5** (0.01 mmol, 6.6 mg), $Sc(OTf)_3$ (0.005 mmol, 2.5 mg), and the 3 Å MS (30 mg) in CH_2Cl_2 (0.5 mL) were stirred at 35 °C for 30 min, epoxides (±)-**1f** (30 mg, 0.1 mmol) and pyrazole **2a** (28.3 mg, 0.2 mmol) were added to the reaction mixture at 35 °C. Then the reaction was stirred at 35 °C for 12 h. After 50% consumption of the starting materials, the mixture was directly purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 5 : 1) to afford **3f** (0.05 mmol, 50% yield) as a white solid, and **1f** (0.05 mmol, 50% yield) as a white solid. The product was determined by HPLC and NMR analysis.



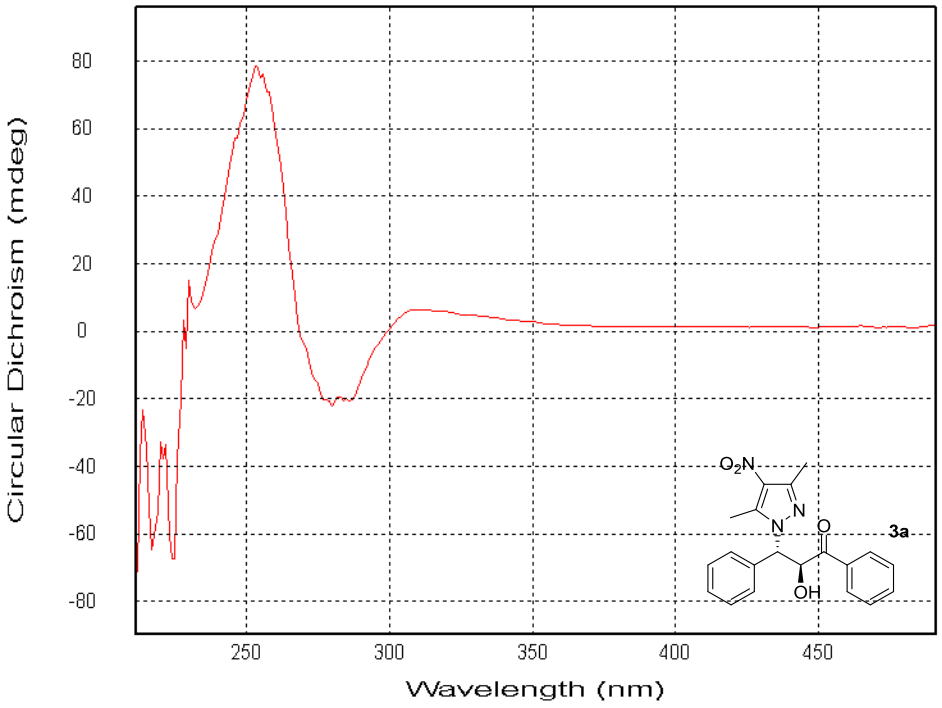
3-([1,1'-biphenyl]-4-yl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3f**)

X-ray crystal structure of product 3f:

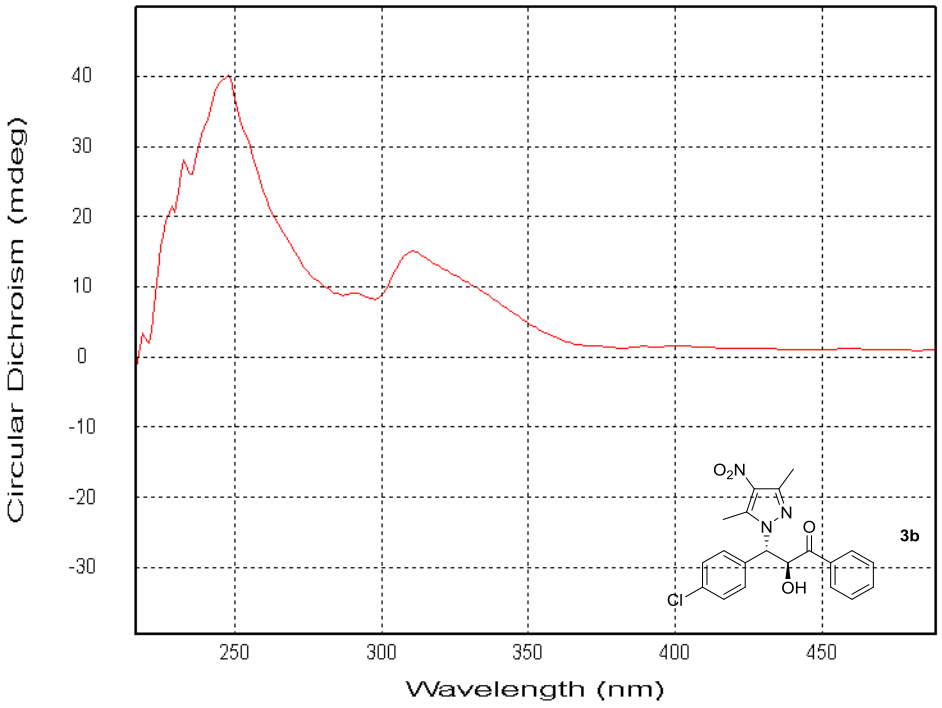


11. CD information of the products

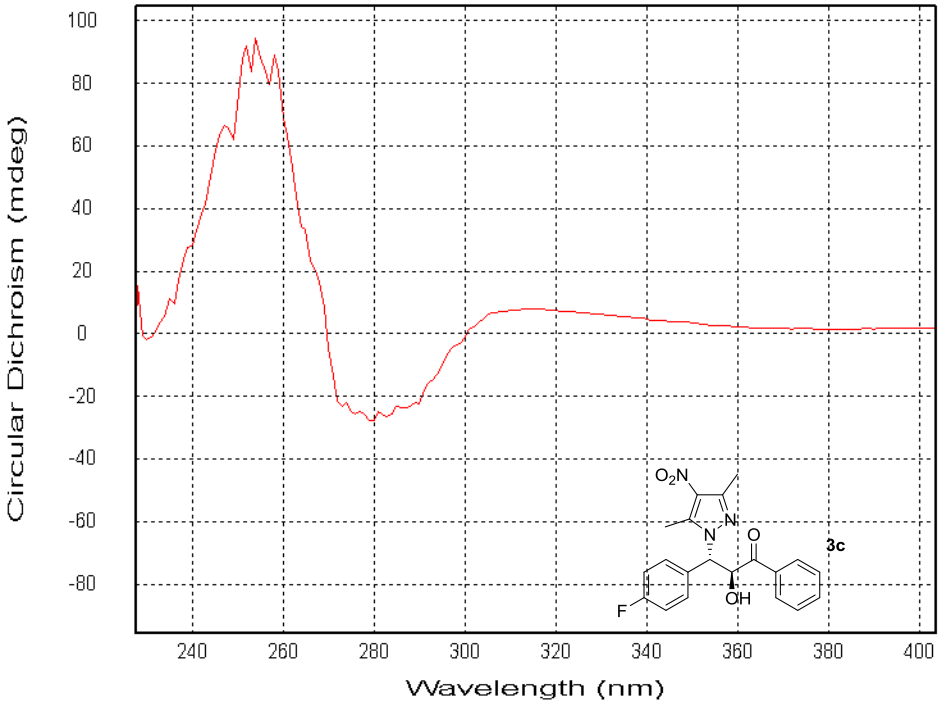
(**2S,3S**) - 3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1,3-diphenylpropan-1-one (**3a**)



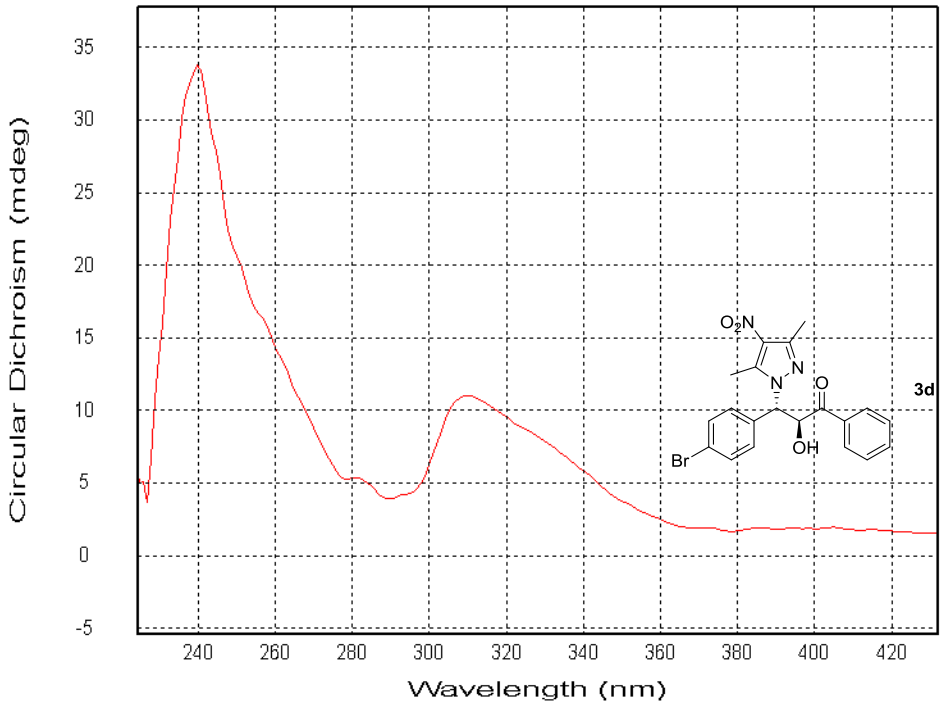
3-(4-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3b**)



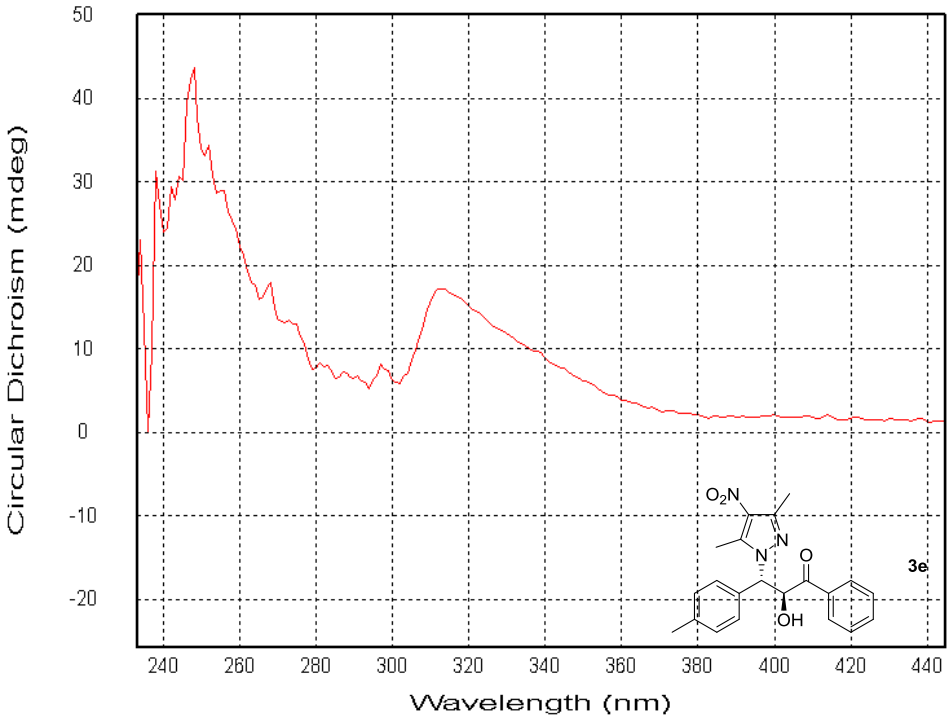
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-3-(4-fluorophenyl)-2-hydroxy-1-phenylpropan-1-one (**3c**)



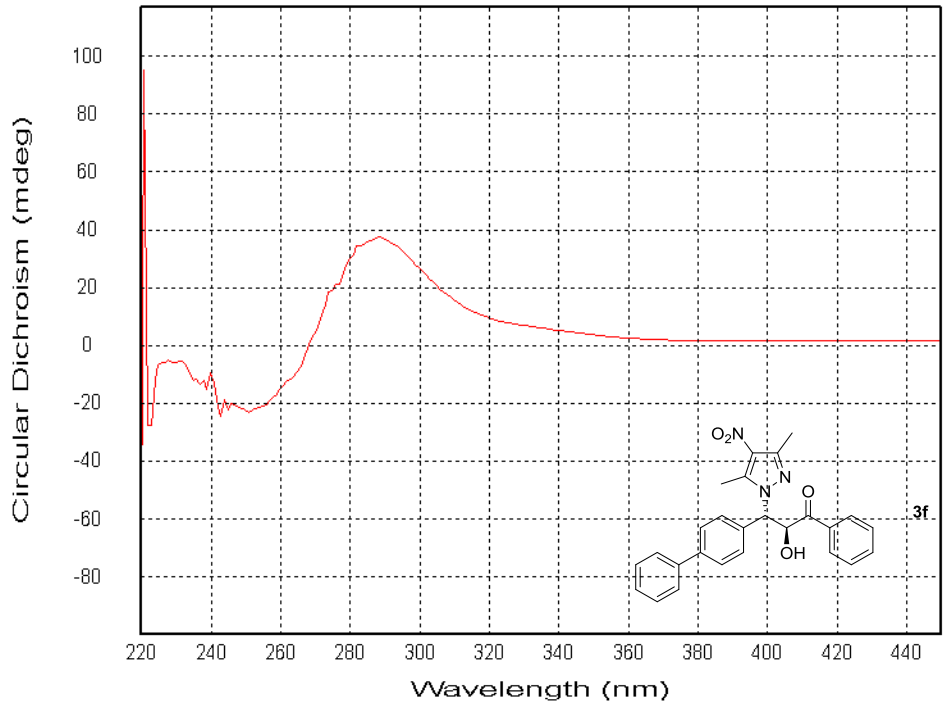
3-(4-bromophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3d**)



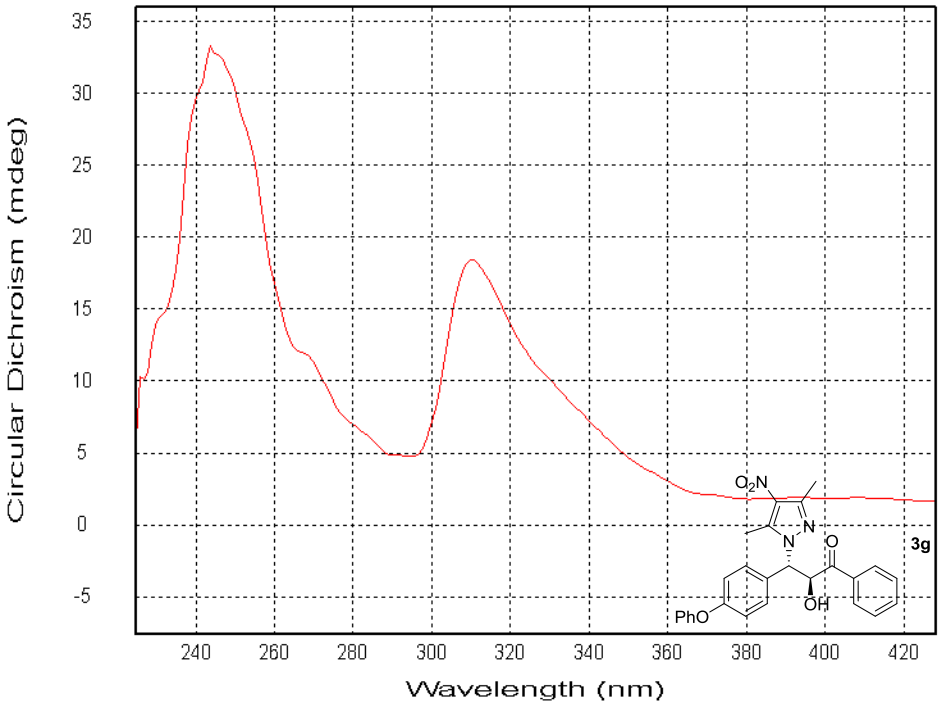
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenyl-3-(p-tolyl)propan-1-one (**3e**)



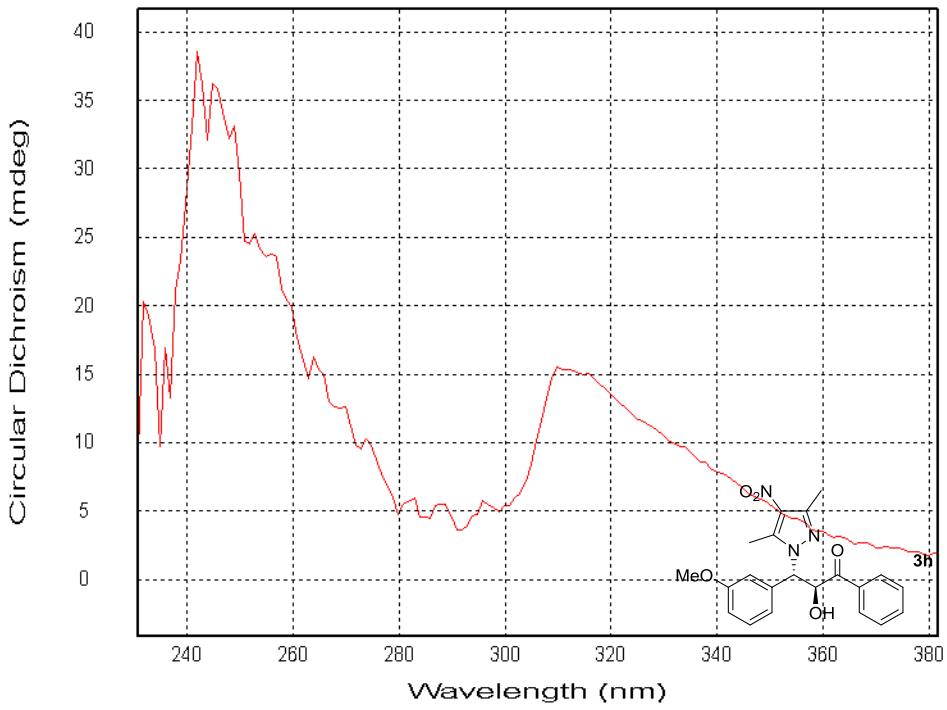
3-([1,1'-biphenyl]-4-yl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3f**)



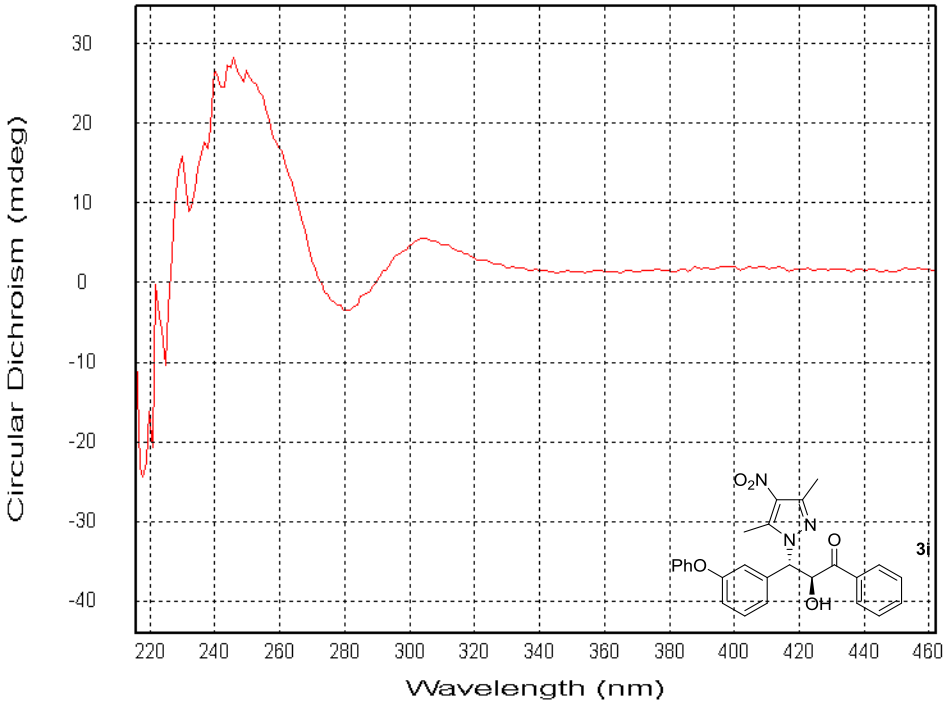
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(4-phenoxyphenyl)-1-phenylpropan-1-one (**3g**)



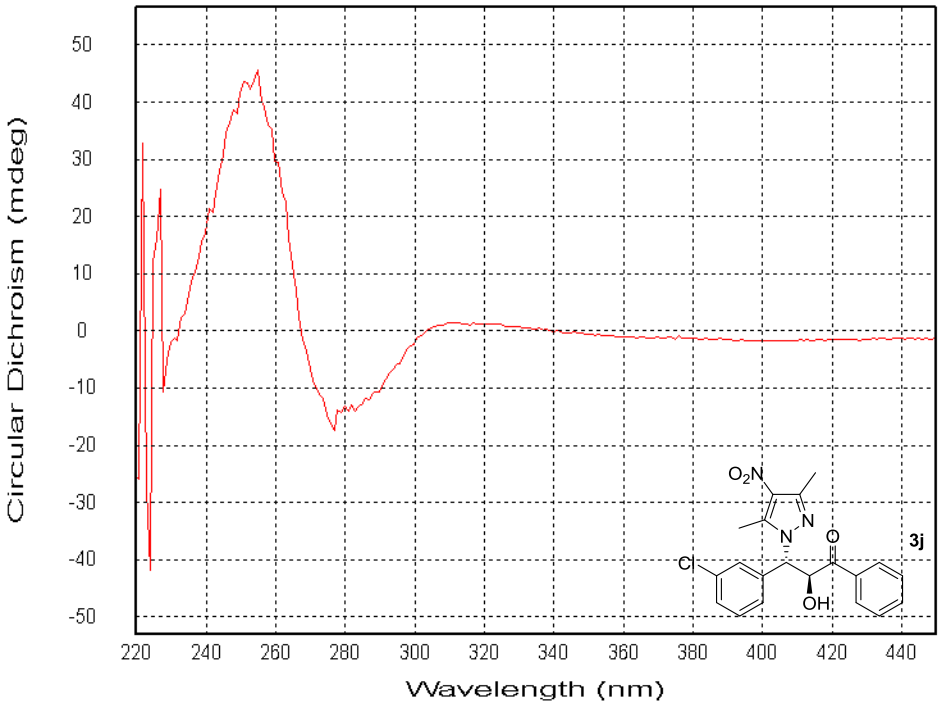
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(3-methoxyphenyl)-1-phenylpropan-1-one (**3h**)



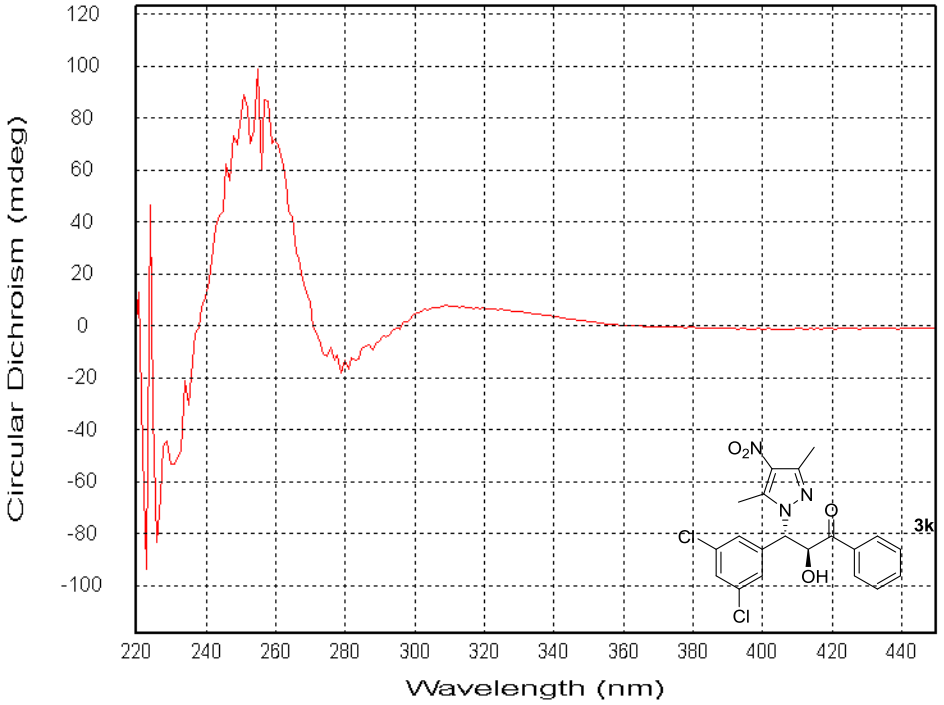
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-(3-phenoxyphenyl)-1-phenylpropan-1-one (**3i**)



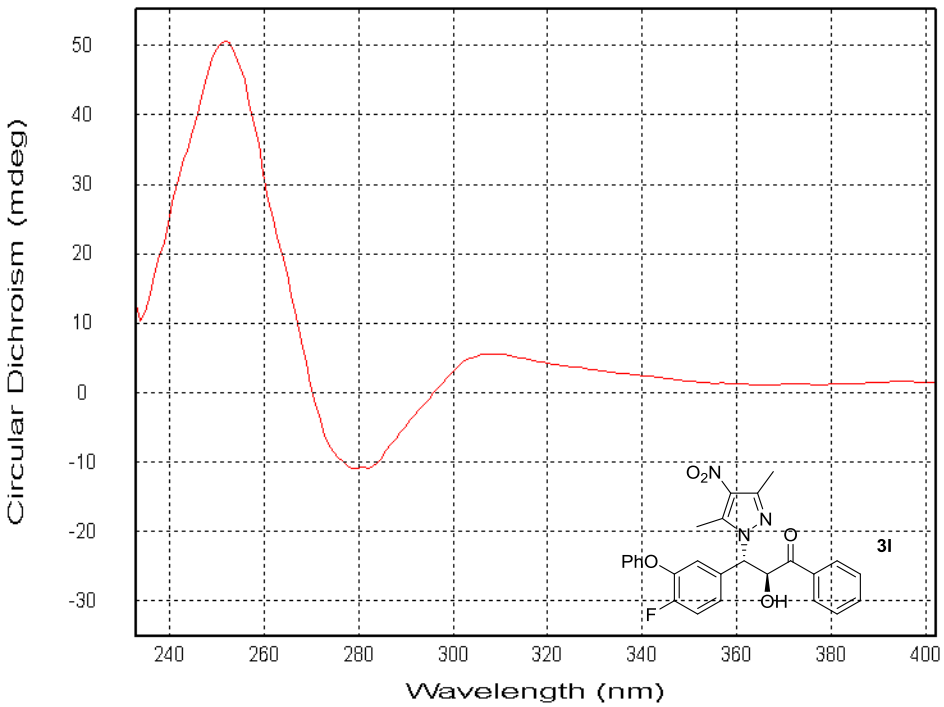
3-(3-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3j**)



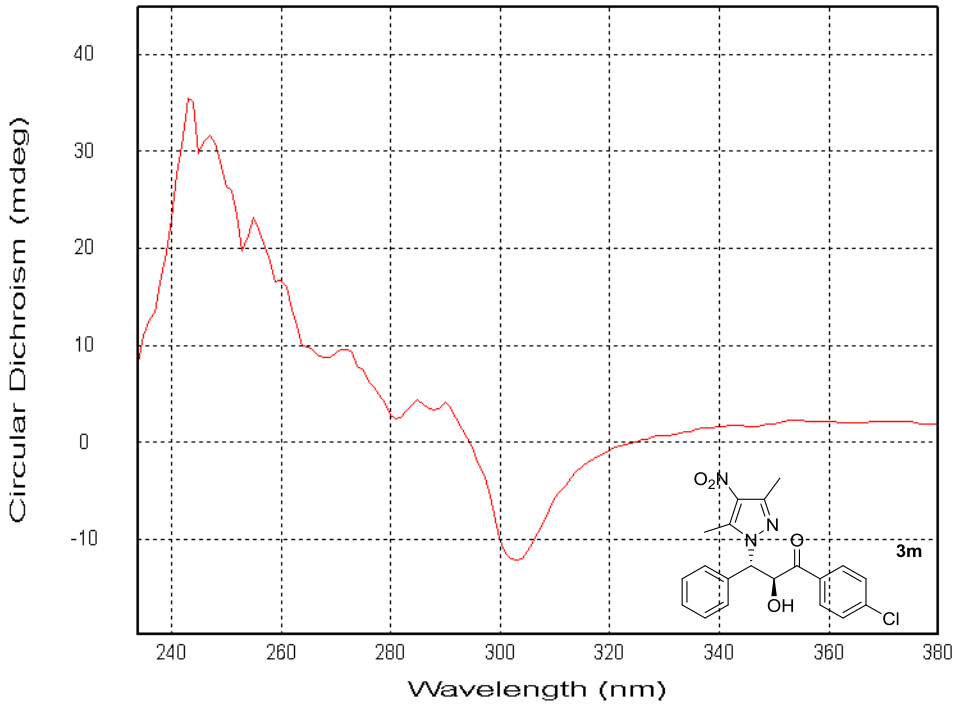
3-(3,5-dichlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-phenylpropan-1-one (**3k**)



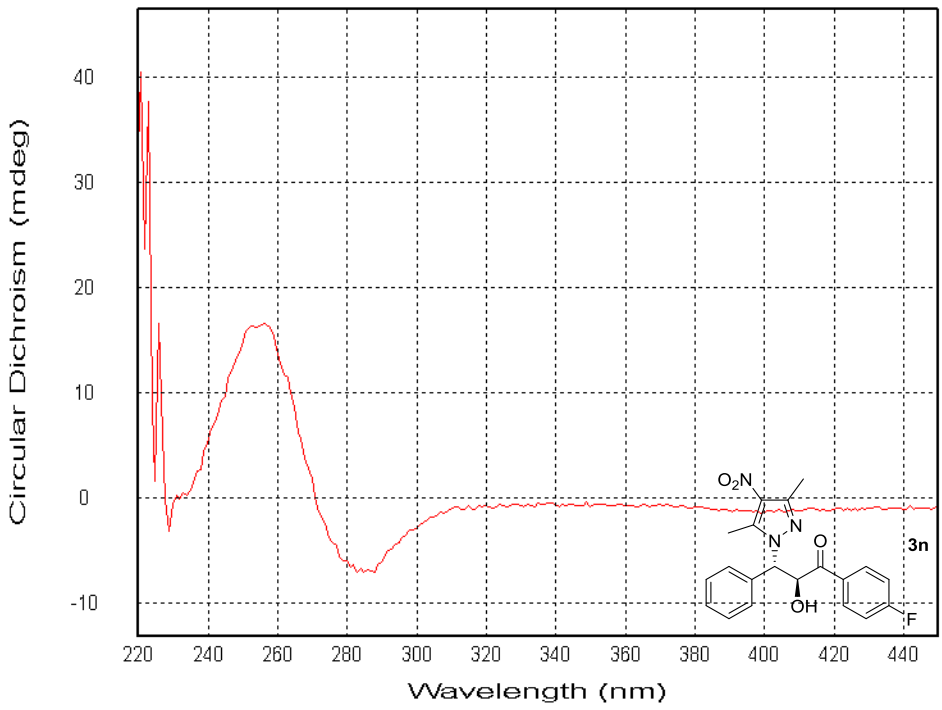
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-3-(4-fluoro-3-phenoxyphenyl)-2-hydroxy-1-phenyl propan-1-one (**3l**)



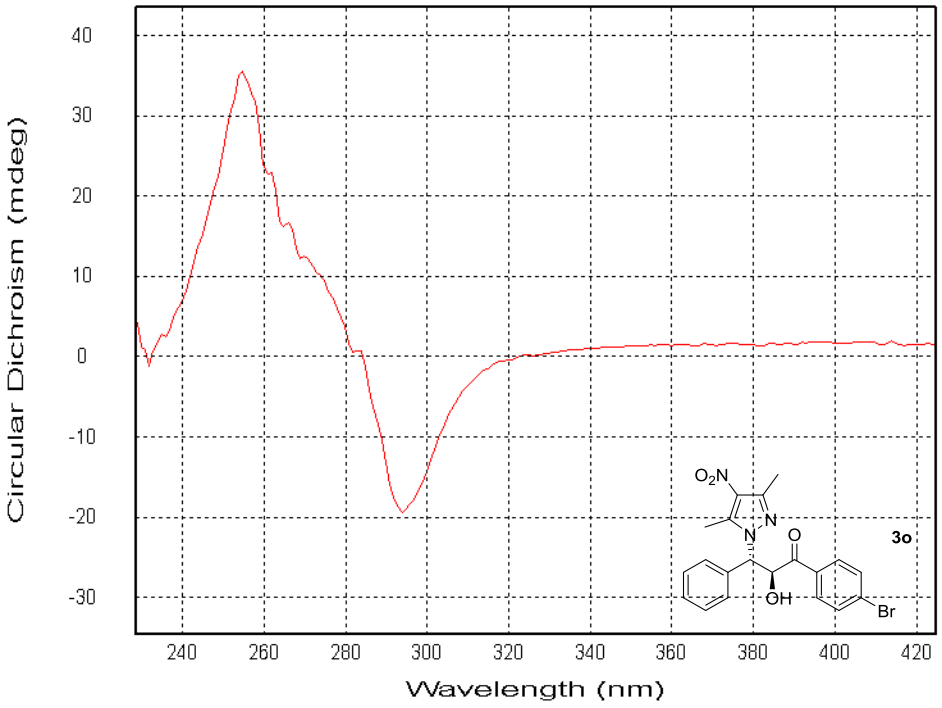
1-(4-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3m**)



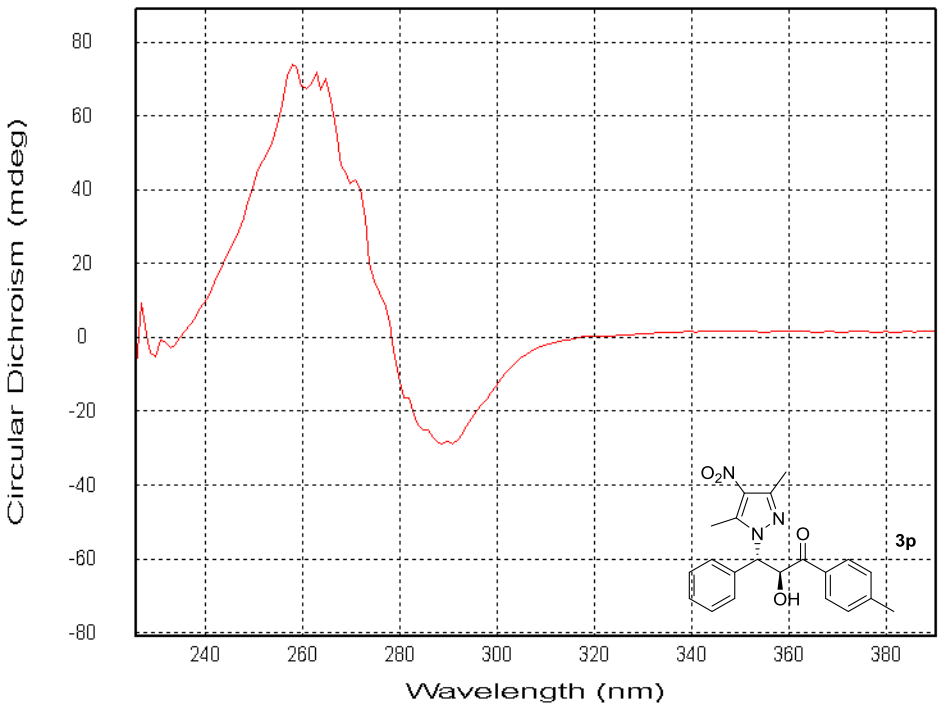
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-1-(4-fluorophenyl)-2-hydroxy-3-phenylpropan-1-one (**3n**)



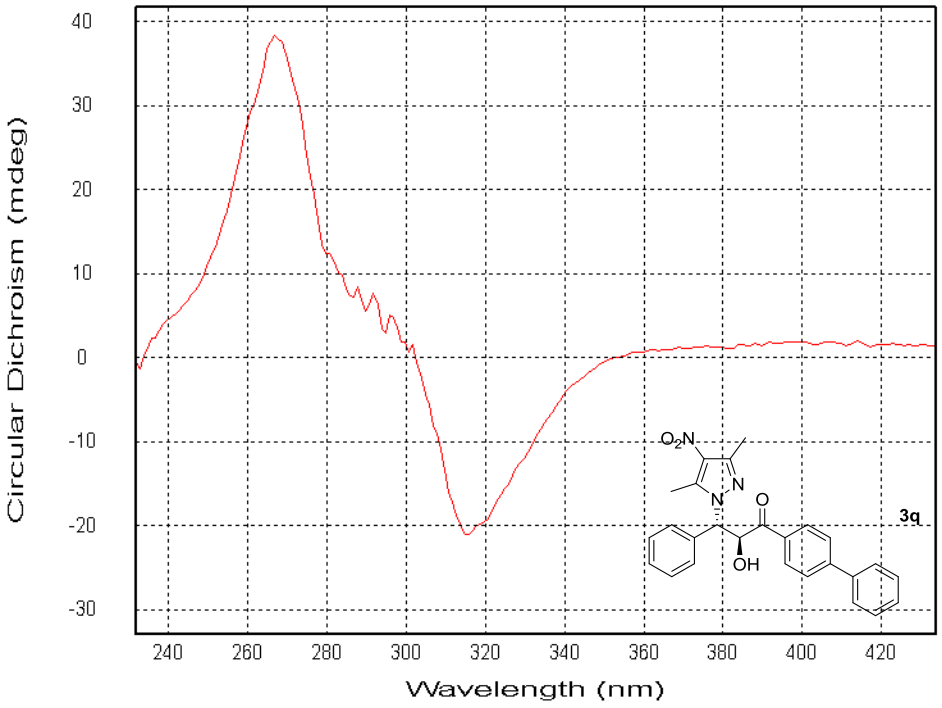
1-(4-bromophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3o**)



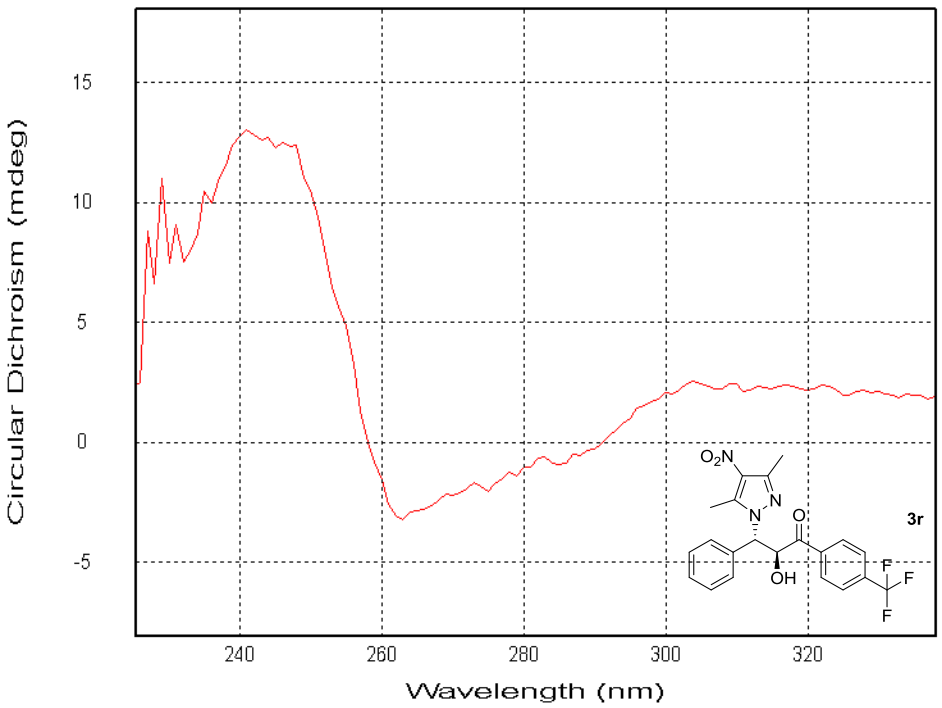
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(p-tolyl)propan-1-one (**3p**)



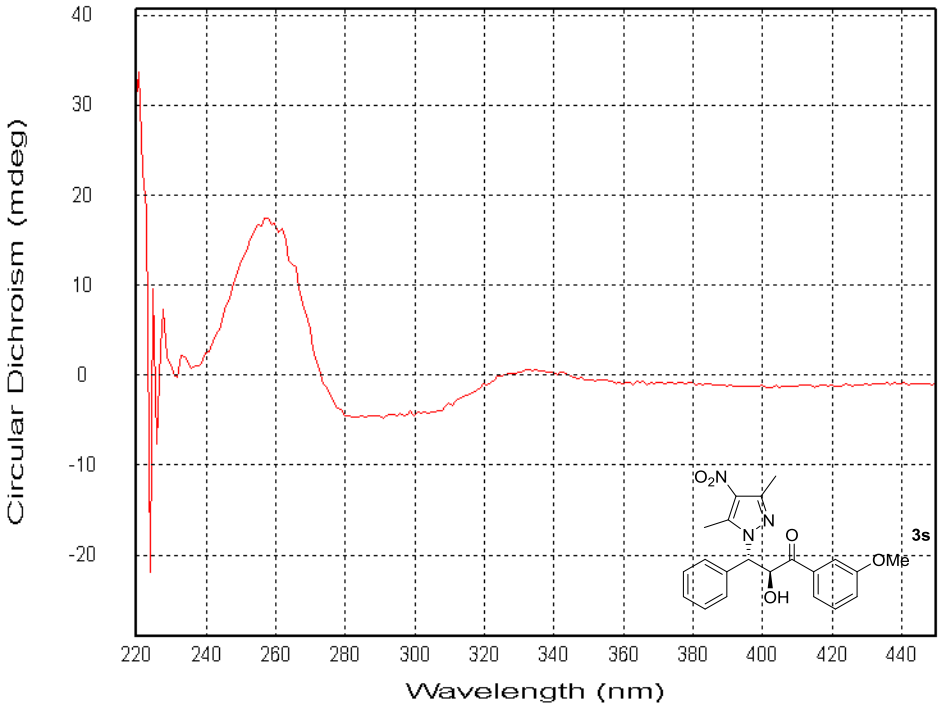
1-([1,1'-biphenyl]-4-yl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3q**)



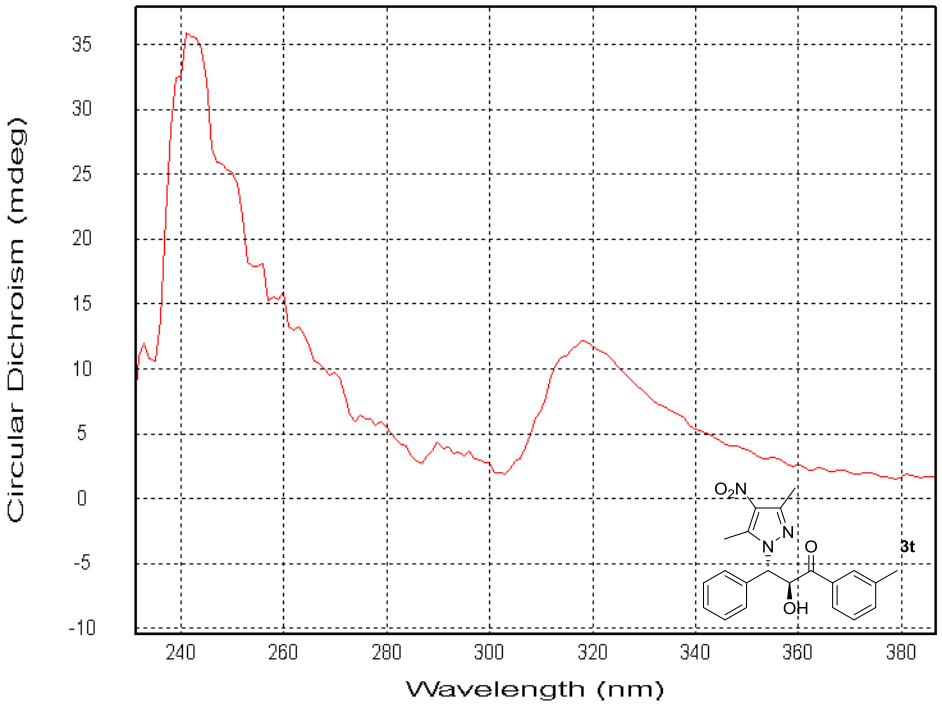
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(4-(trifluoromethyl)phenyl)propan-1-one (**3r**)



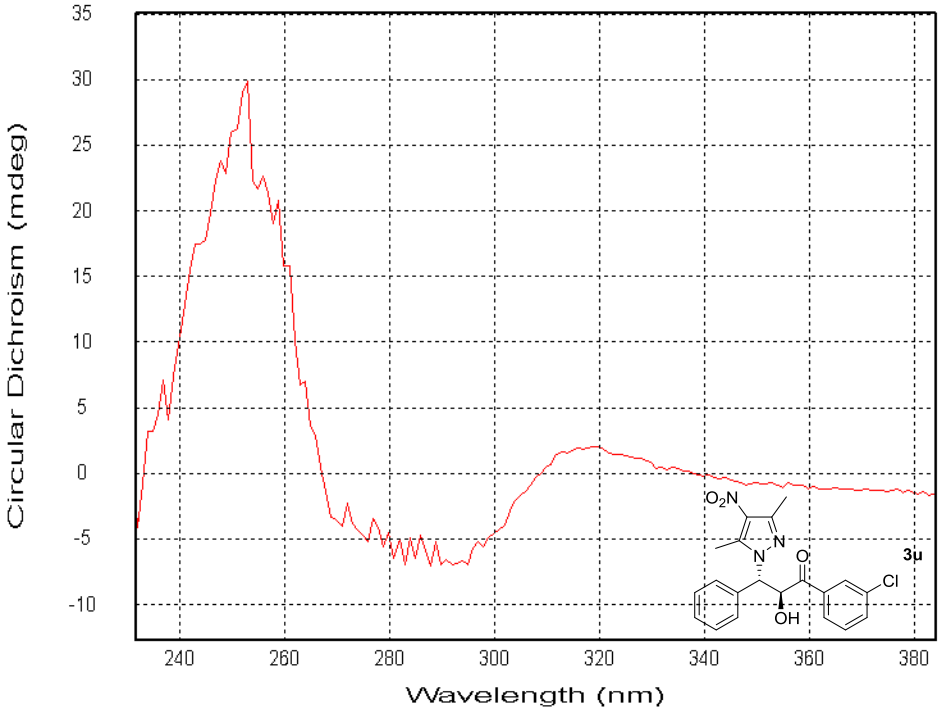
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-(3-methoxyphenyl)-3-phenylpropan-1-one (**3s**)



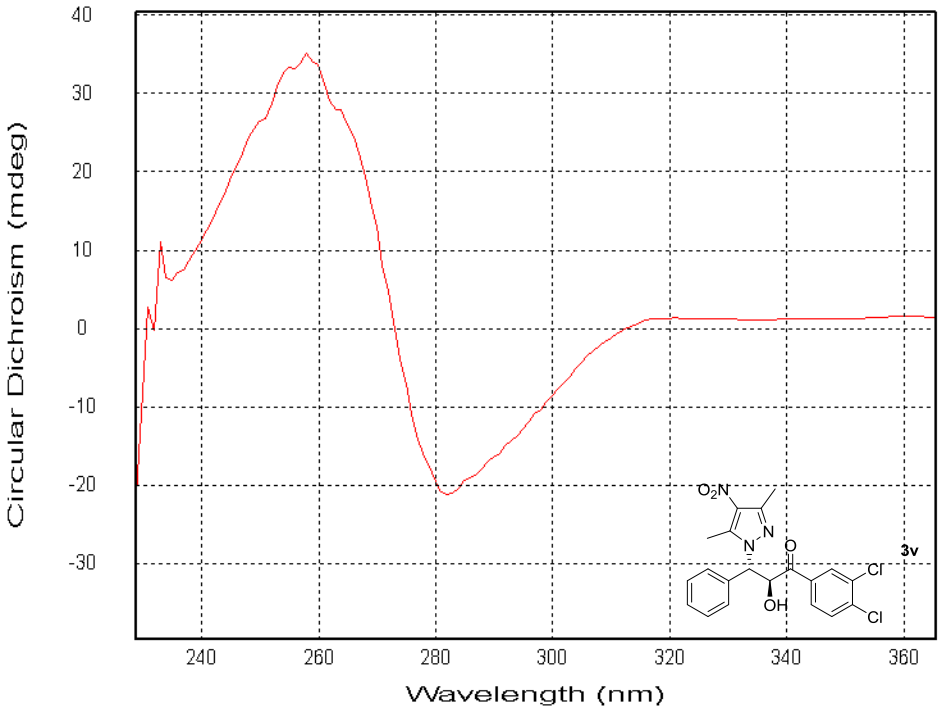
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(m-tolyl)propan-1-one (**3t**)



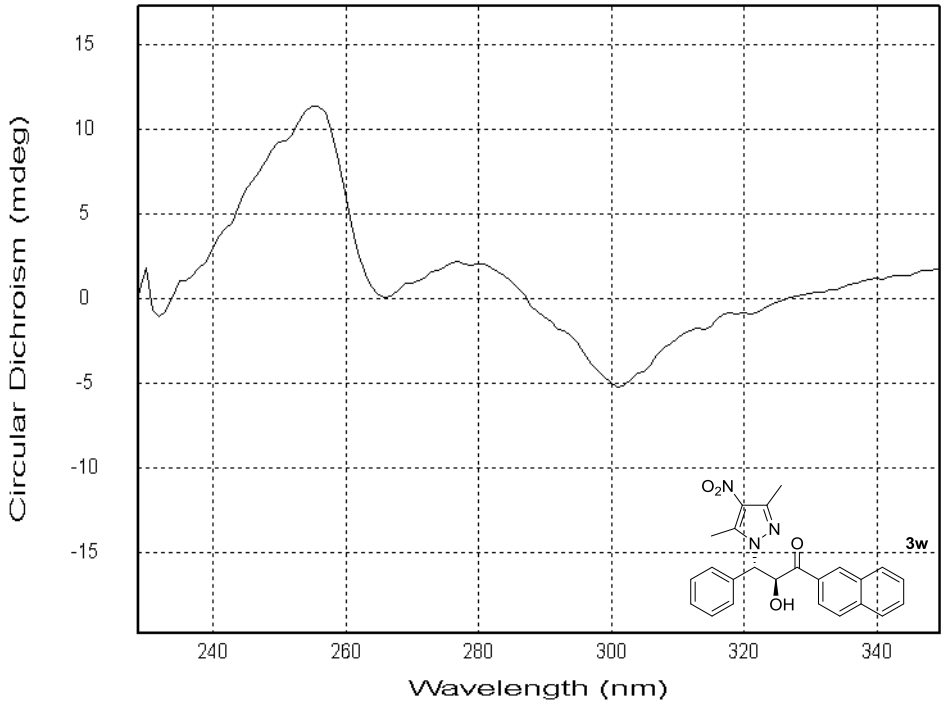
1-(3-chlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3u**)



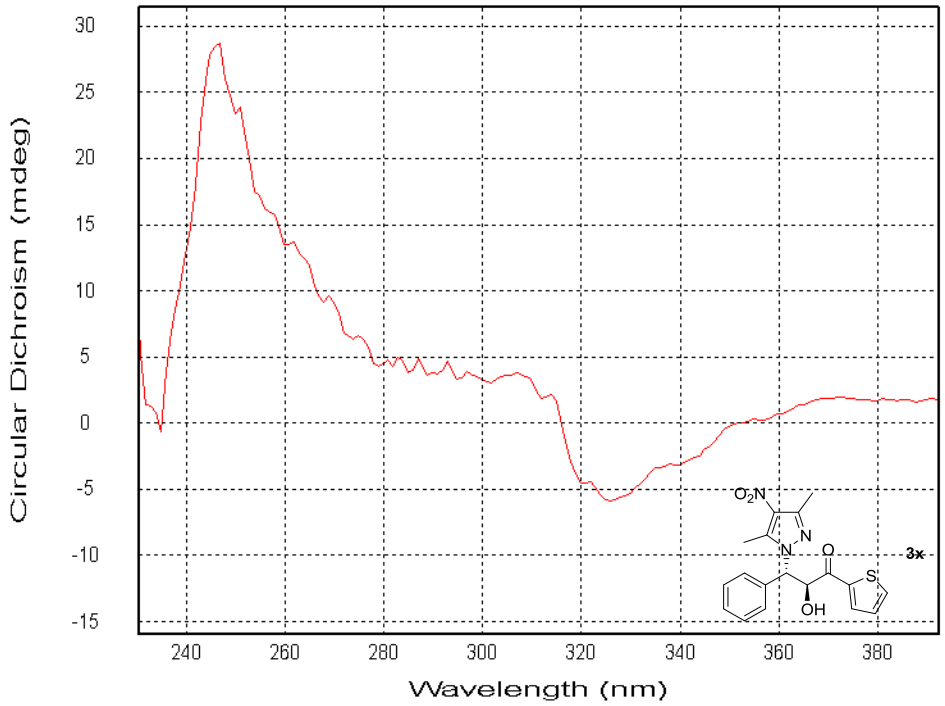
1-(3,4-dichlorophenyl)-3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenylpropan-1-one (**3v**)



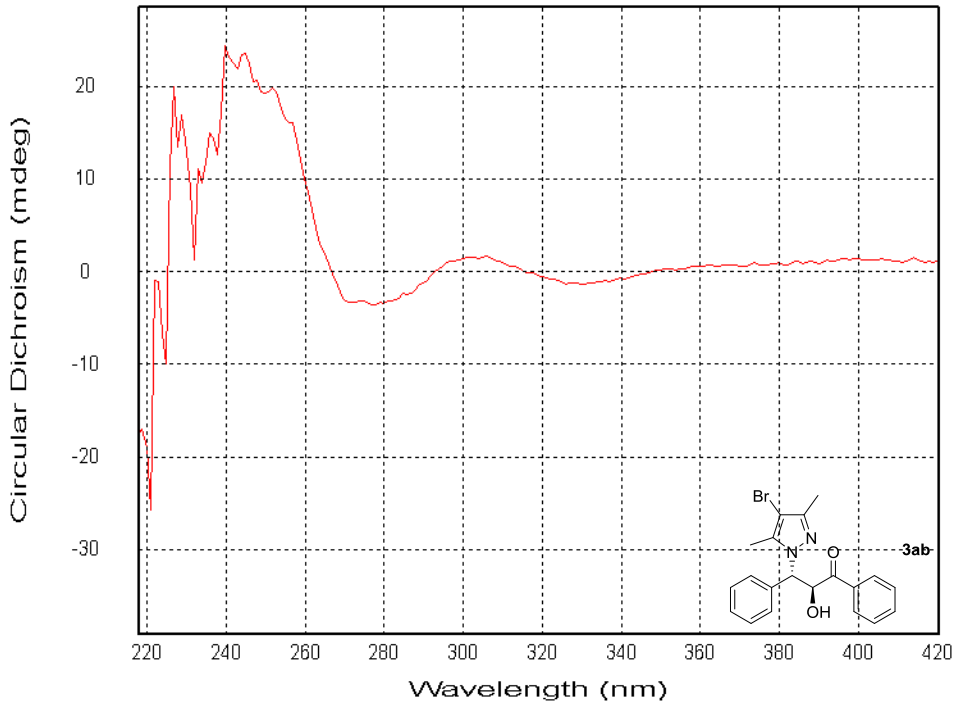
3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-1-(naphthalen-2-yl)-3-phenylpropan-1-one (**3w**)



3-(3,5-dimethyl-4-nitro-1*H*-pyrazol-1-yl)-2-hydroxy-3-phenyl-1-(thiophen-2-yl)propan-1-one (**3x**)



3-(4-bromo-3,5-dimethyl-1*H*-pyrazol-1-yl)-2-hydroxy-1,3-diphenylpropan-1-one (**3ab**)

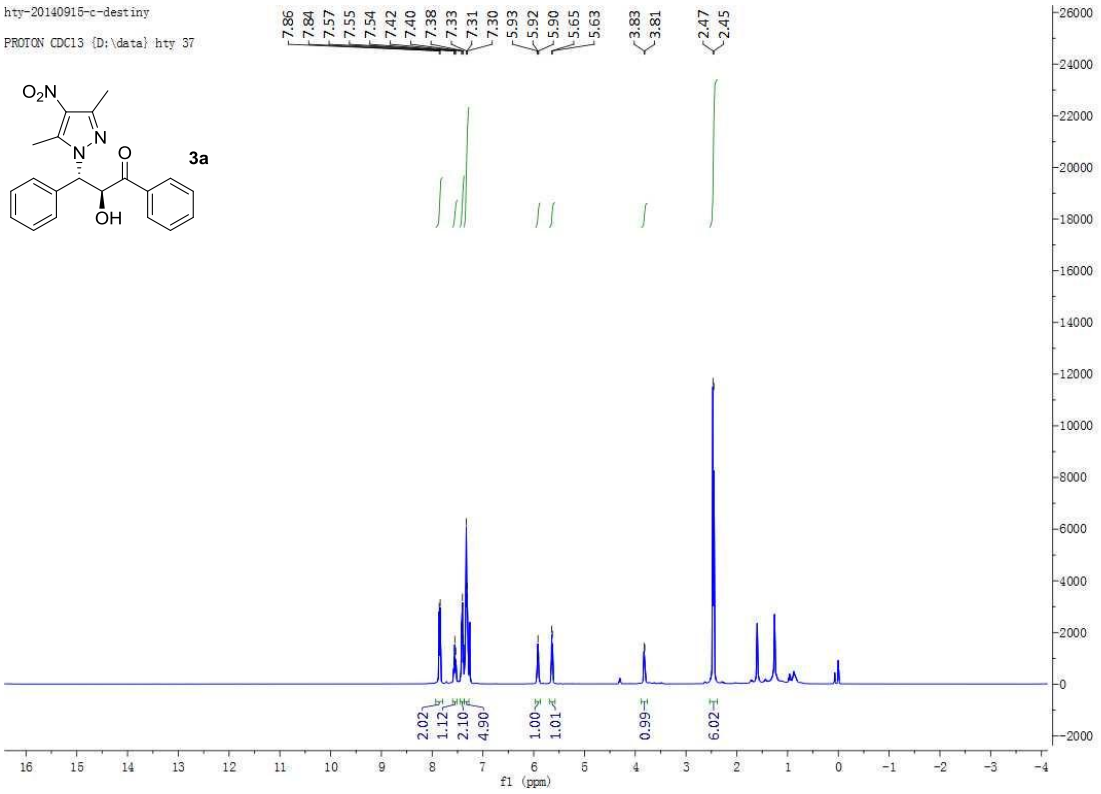


12.References

[1] Y. H. Wen, X. Huang, J. L. Huang, Y. Xiong, B. Qin, X. M. Feng, *Synlett*. **2005**, 2445.

[2] Y. Y. Chu, X. H. Liu, W. Li, X. L. Hu, L. L. Lin, X. M. Feng, *Chem. Sci*. **2012**, *3*, 1996.

13.NMR spectra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5.92
5.90
5.65
5.63
3.83
3.81
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2.10
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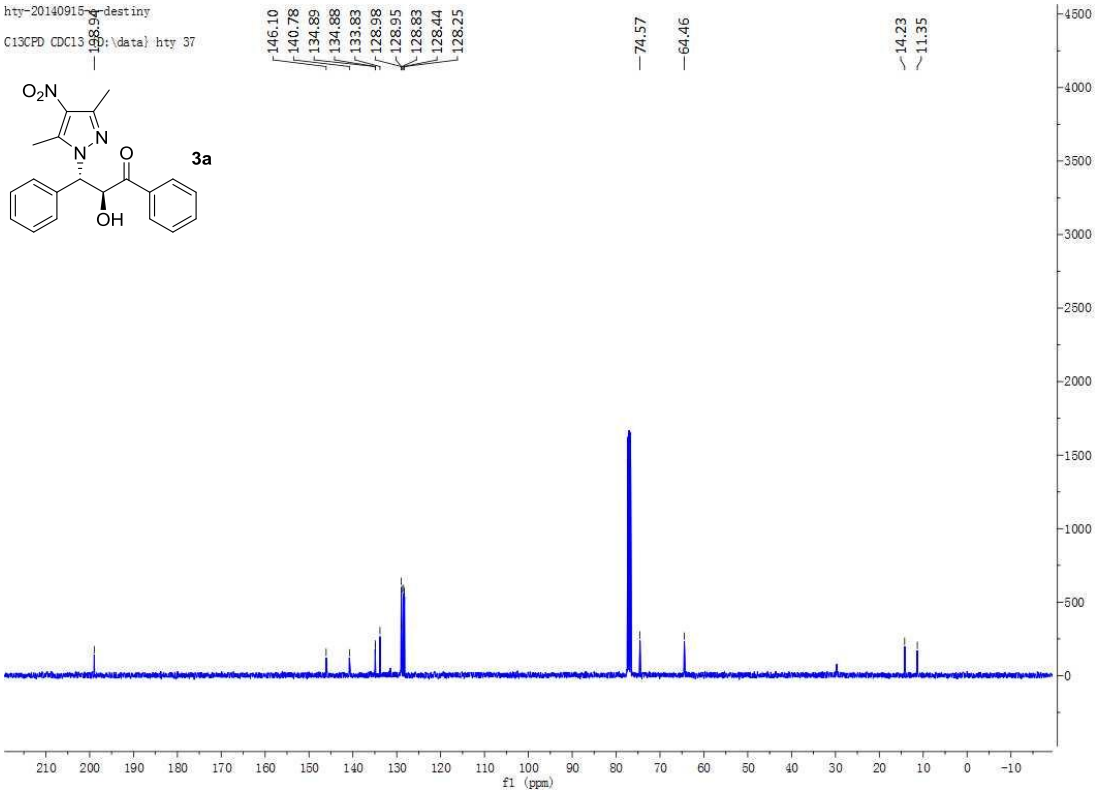
1.00
1.01
0.99
6.02
f1 (ppm)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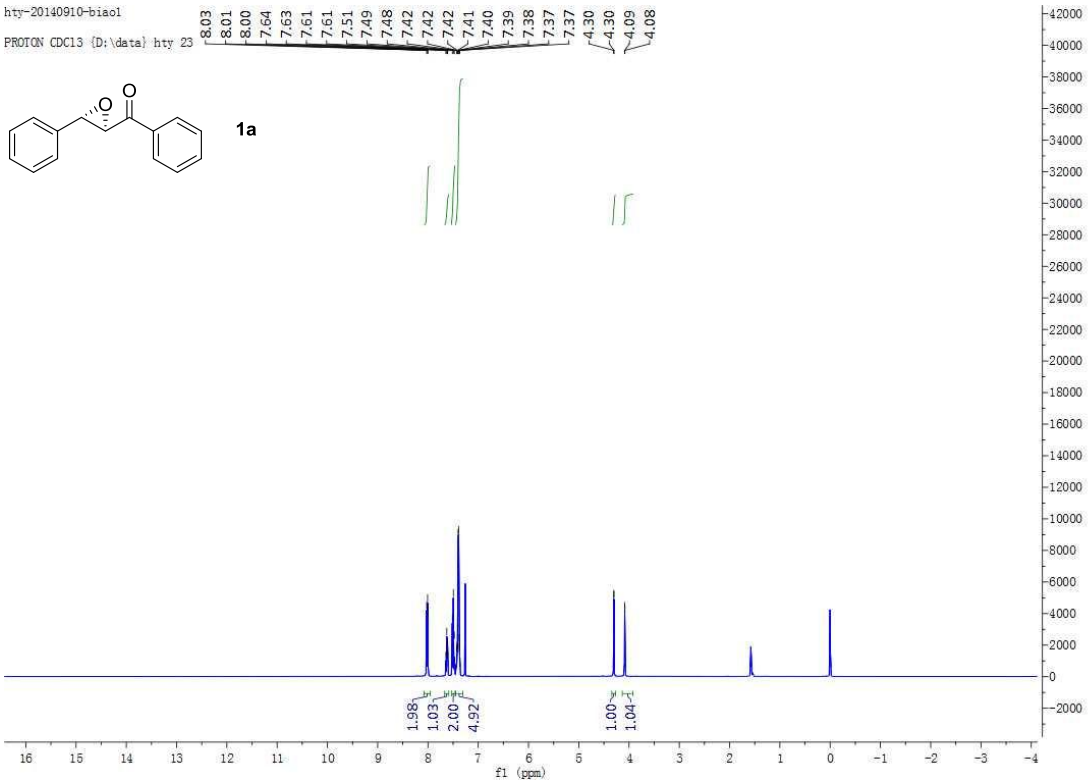
3a
f1 (ppm)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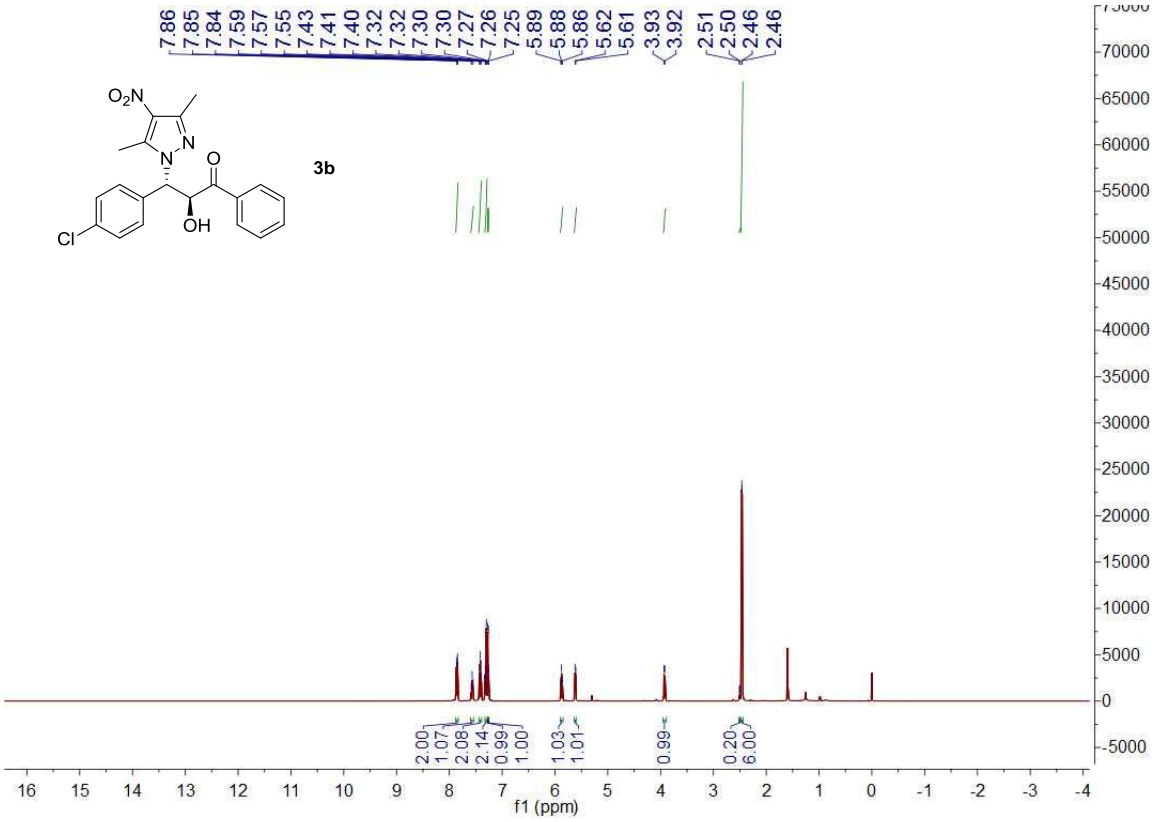
f1 (ppm)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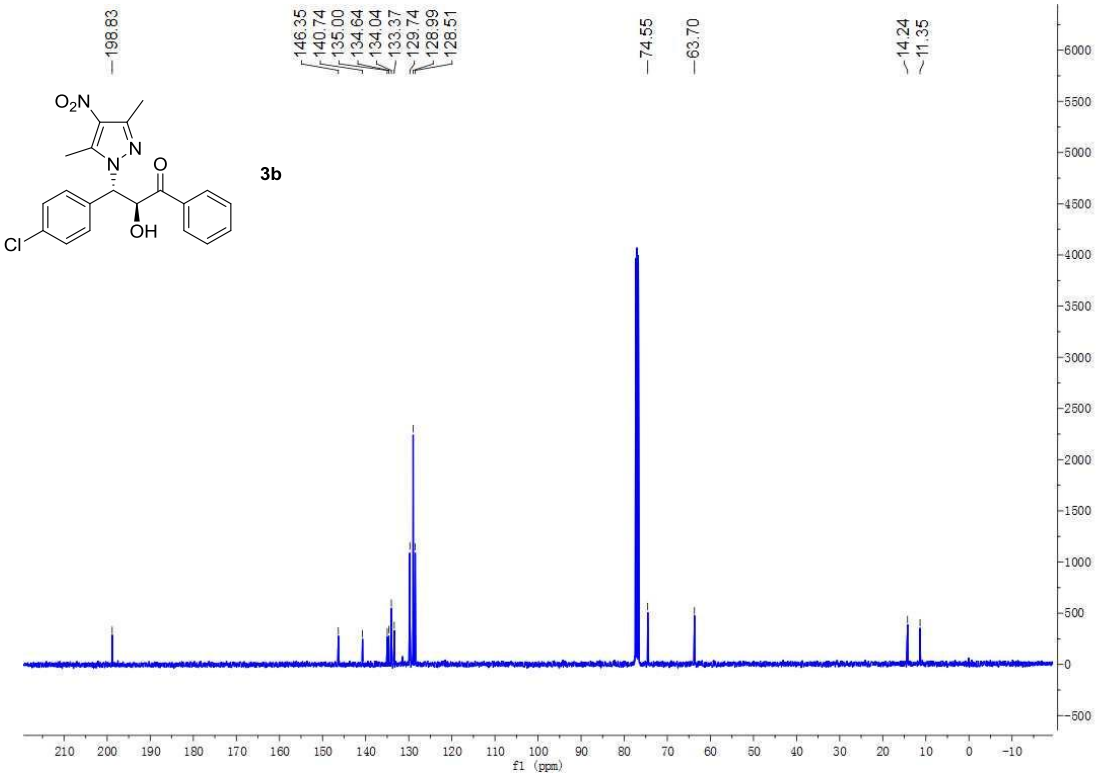
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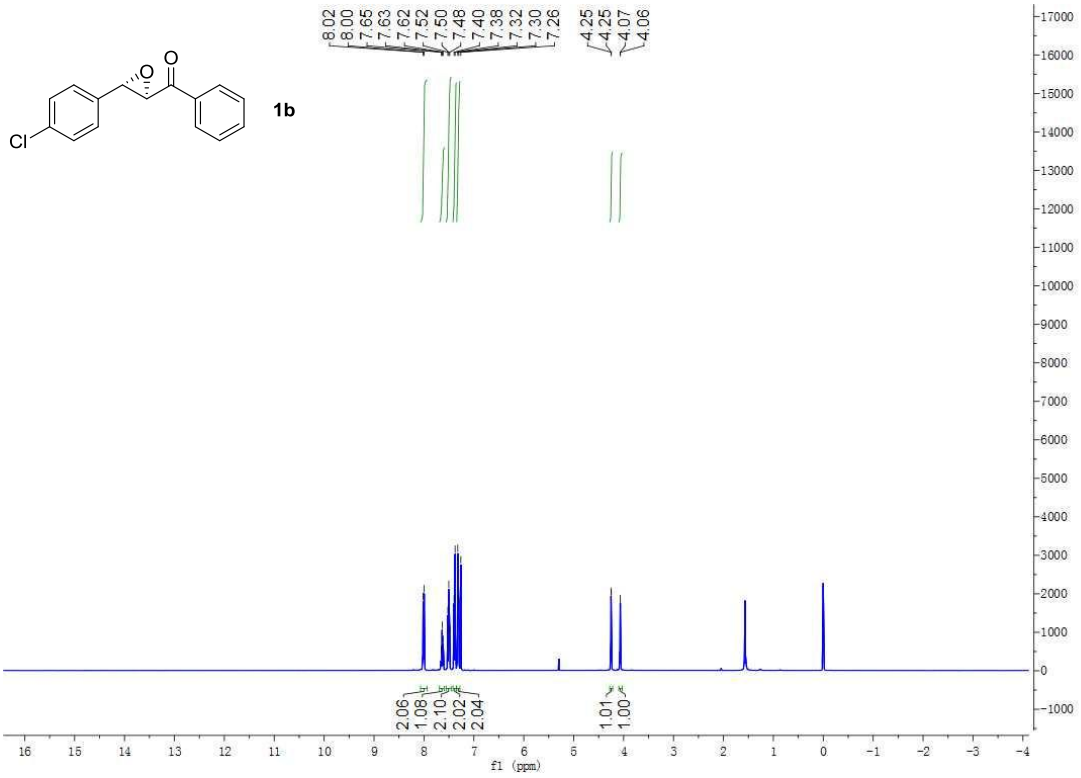
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7.32
7.30
7.26
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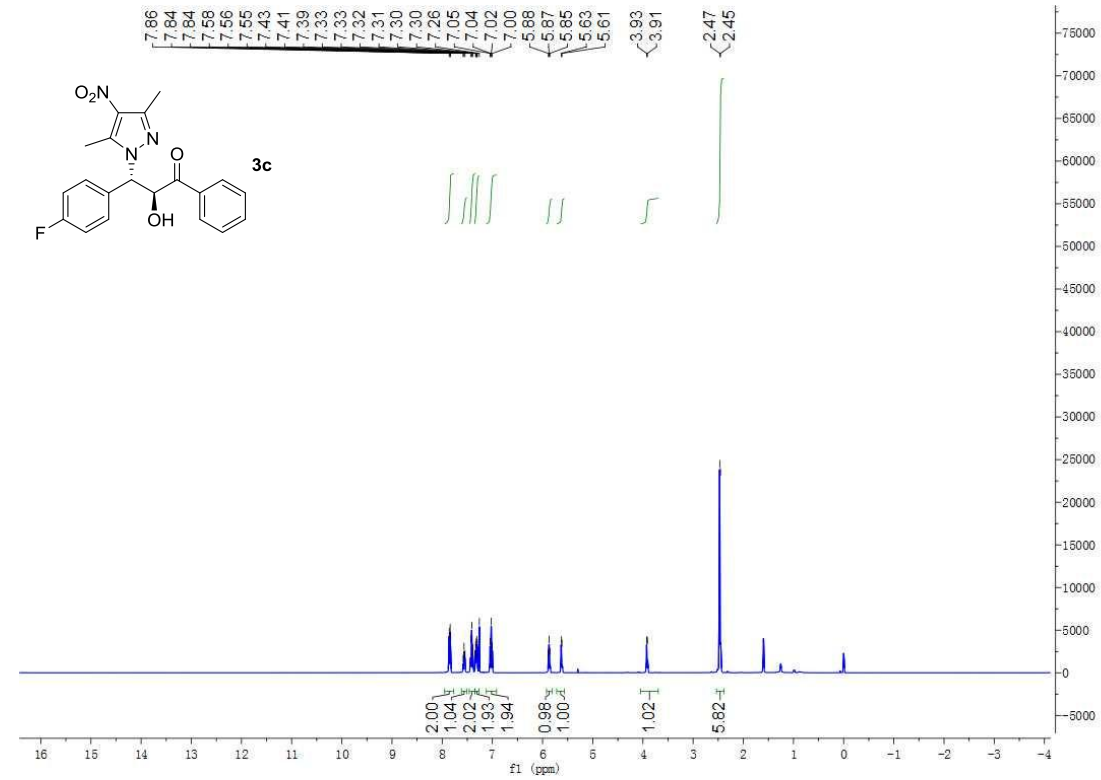
f1 (ppm)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N
O
OH
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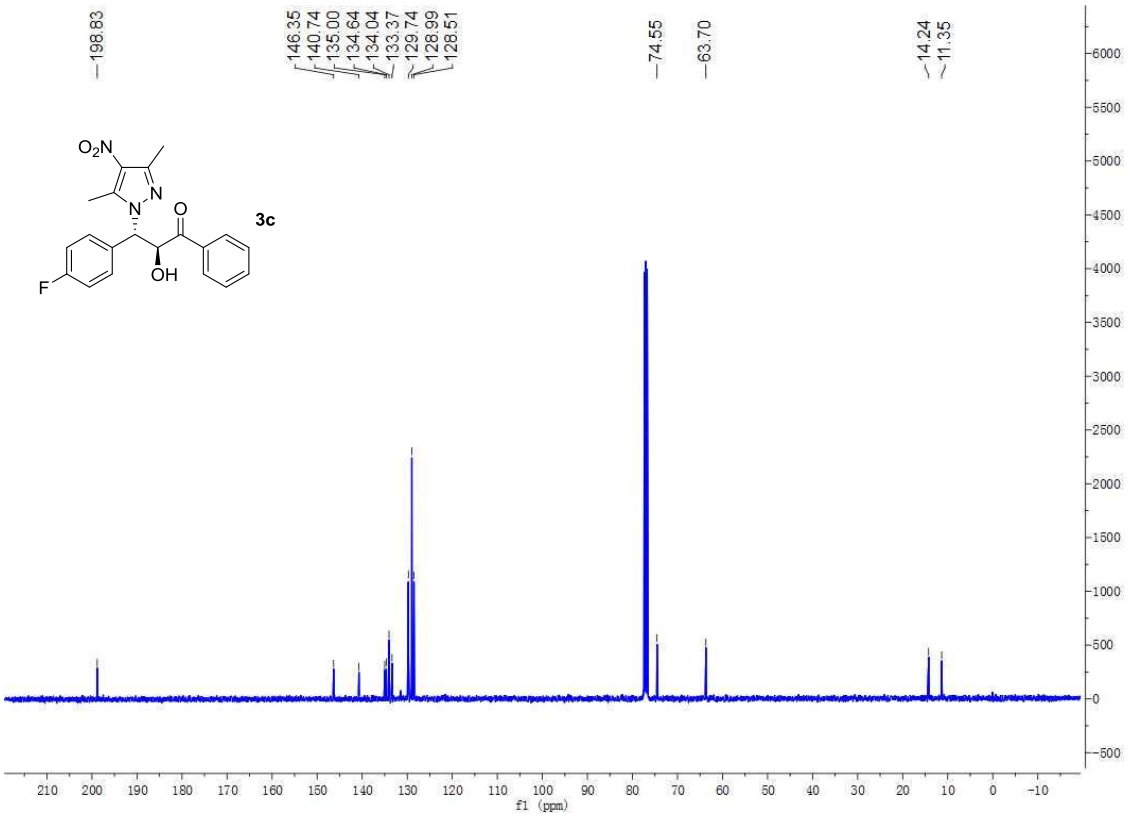
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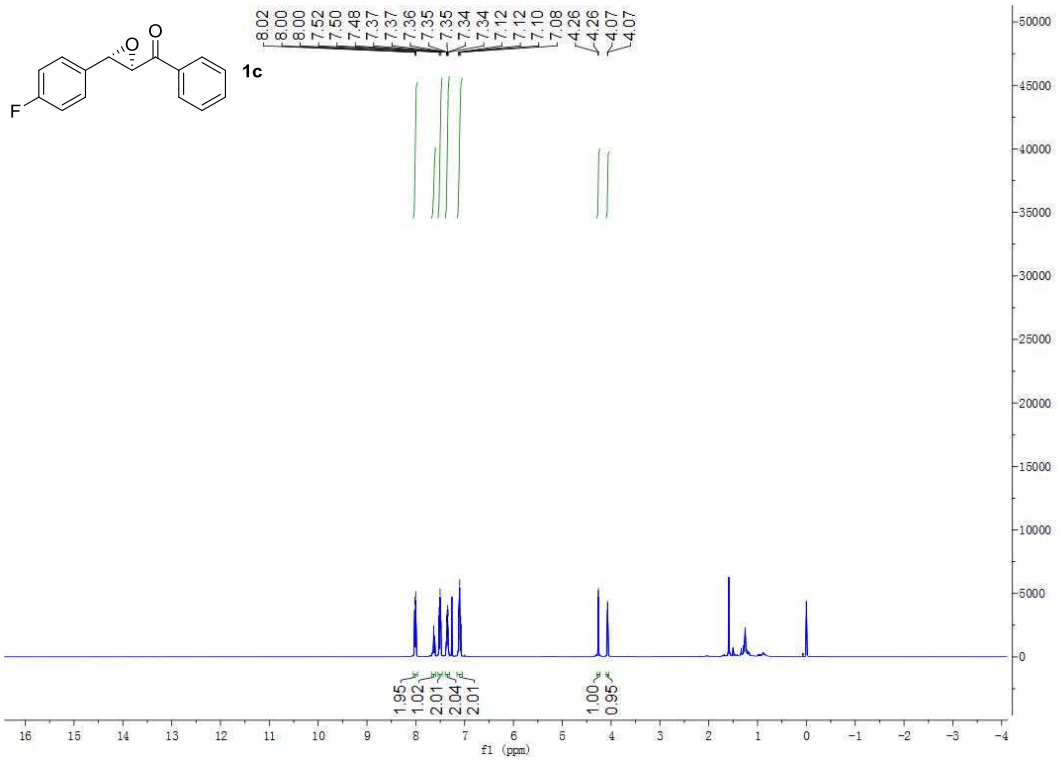
N
N
O
OH
F
3c
f1 (ppm)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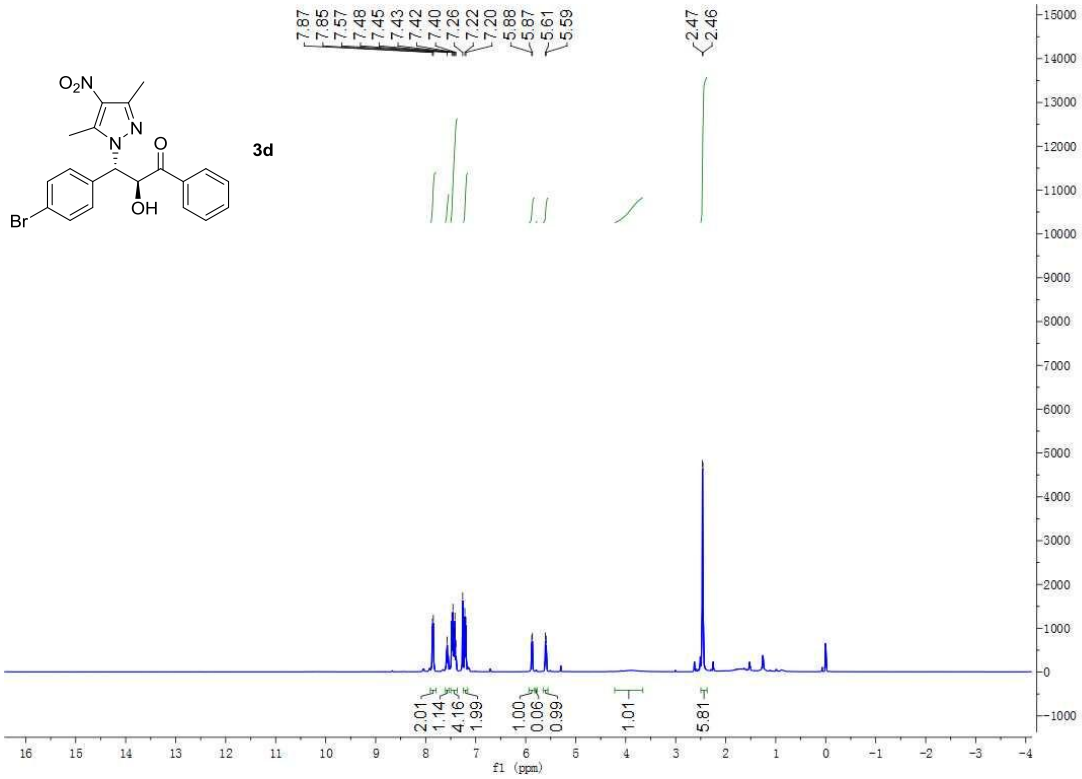
f1 (ppm)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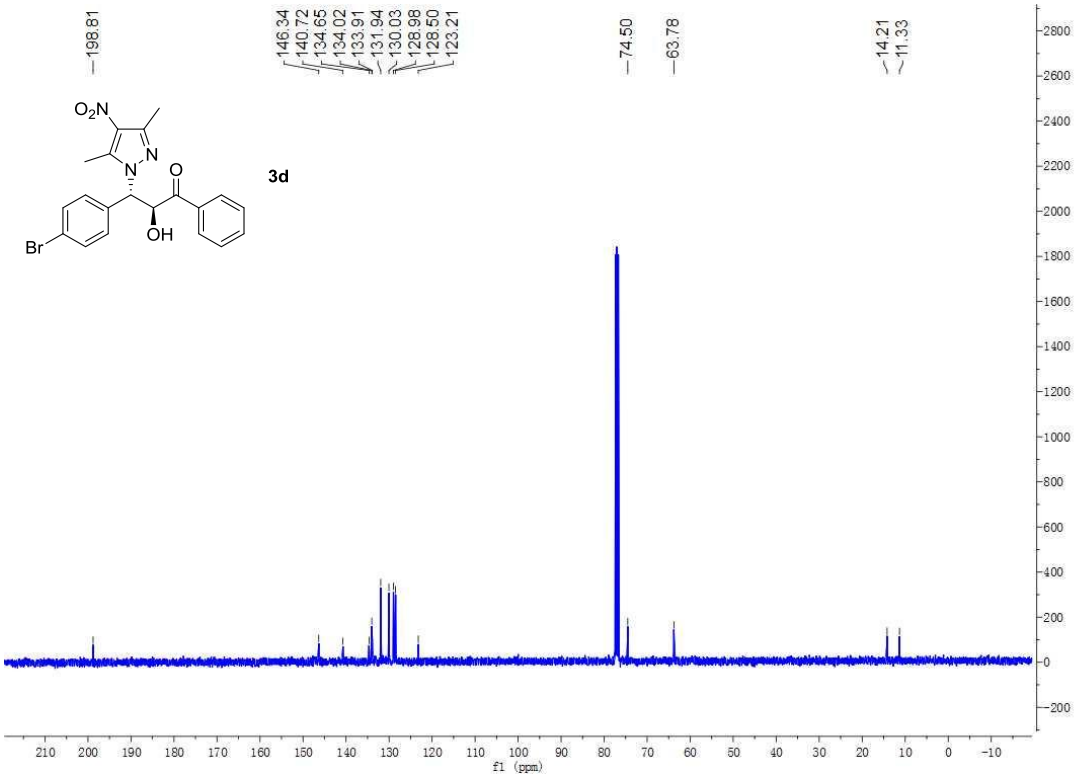
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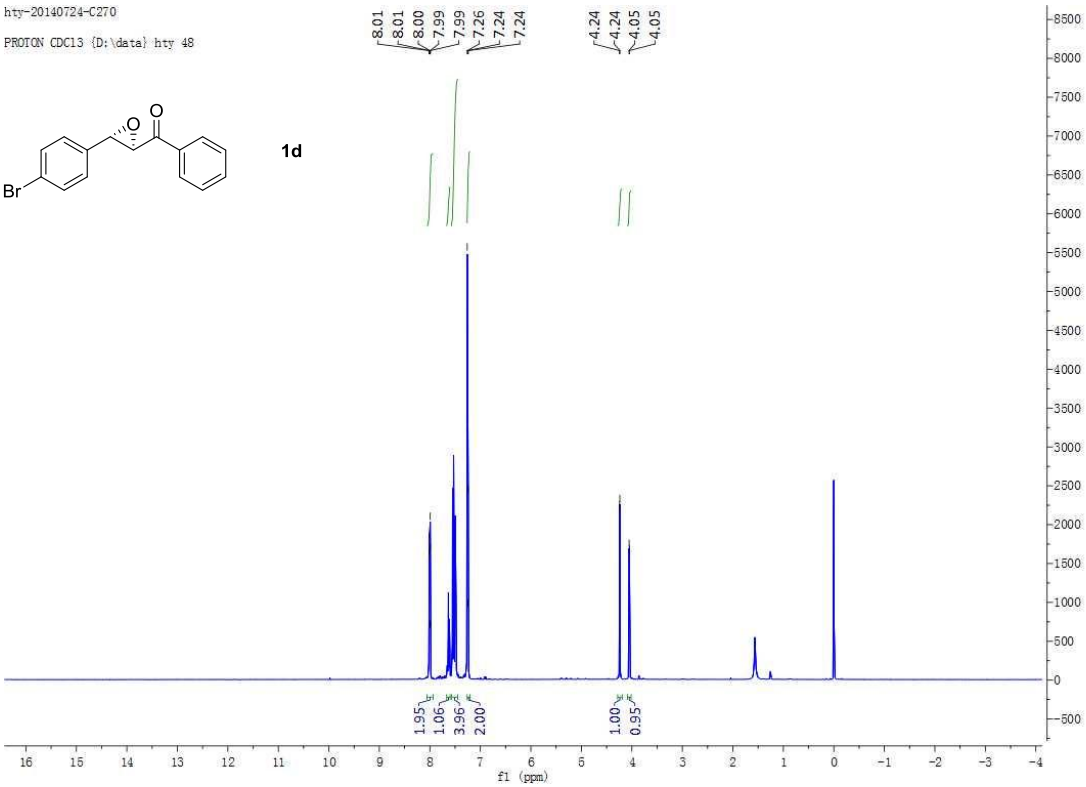
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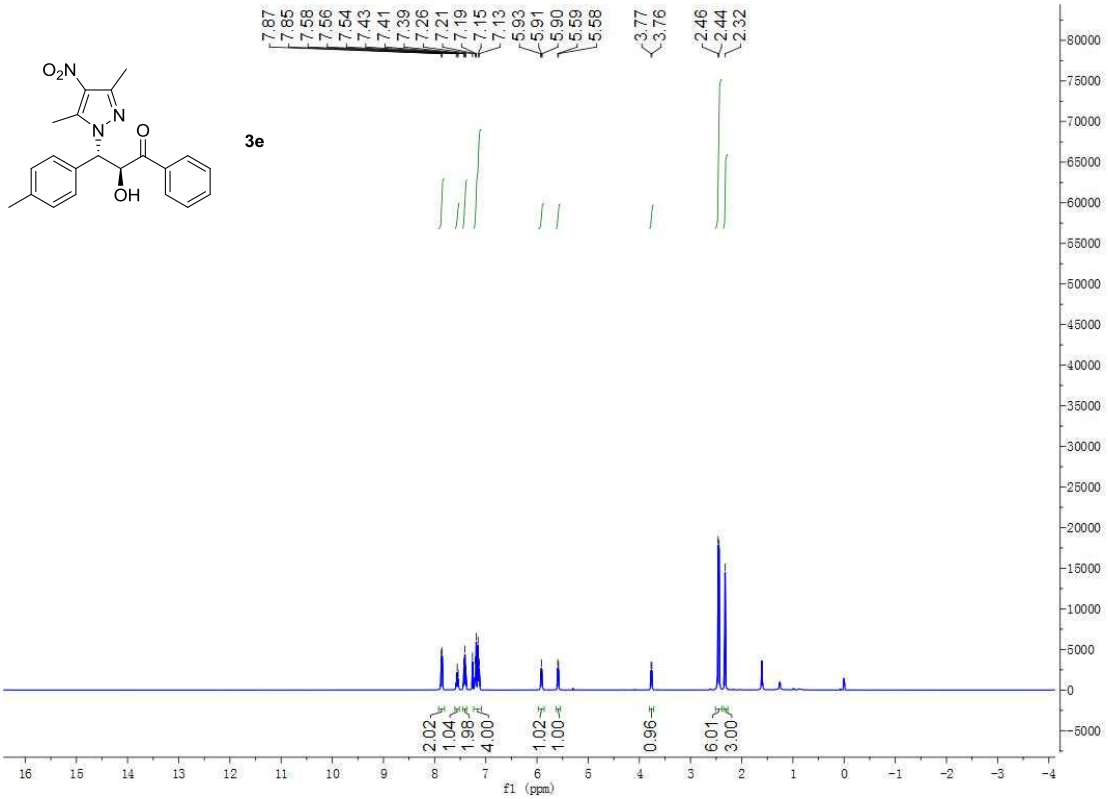
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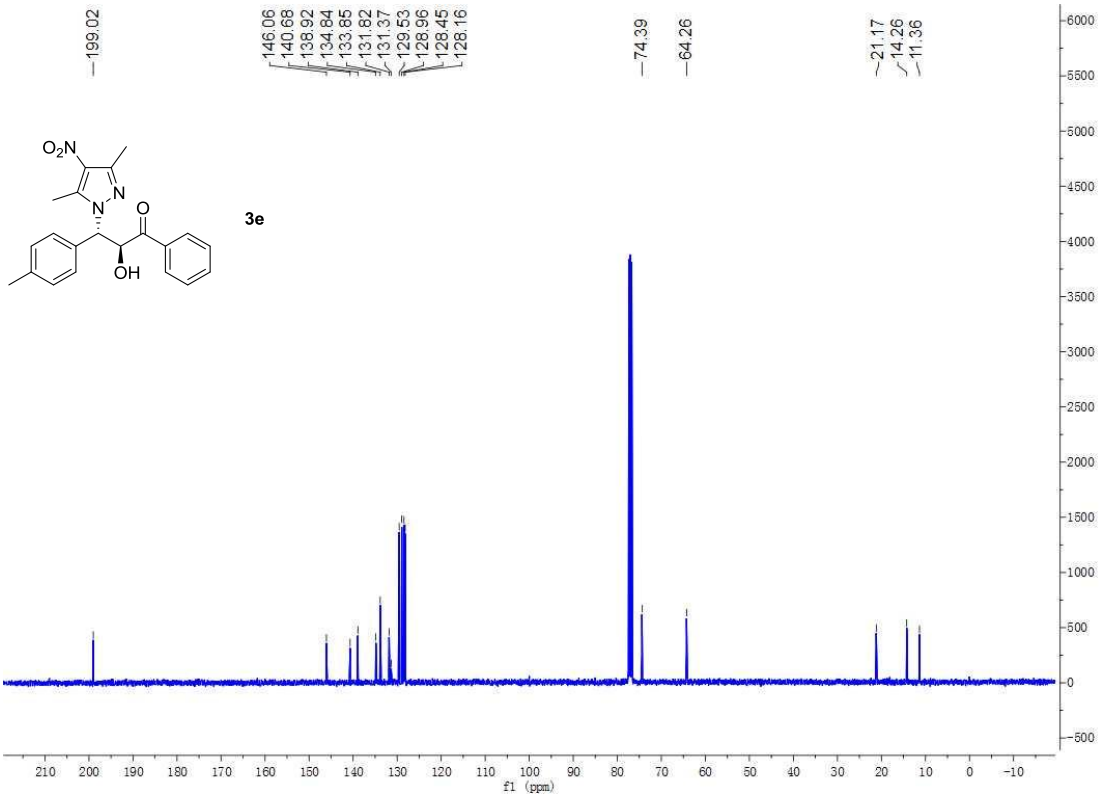
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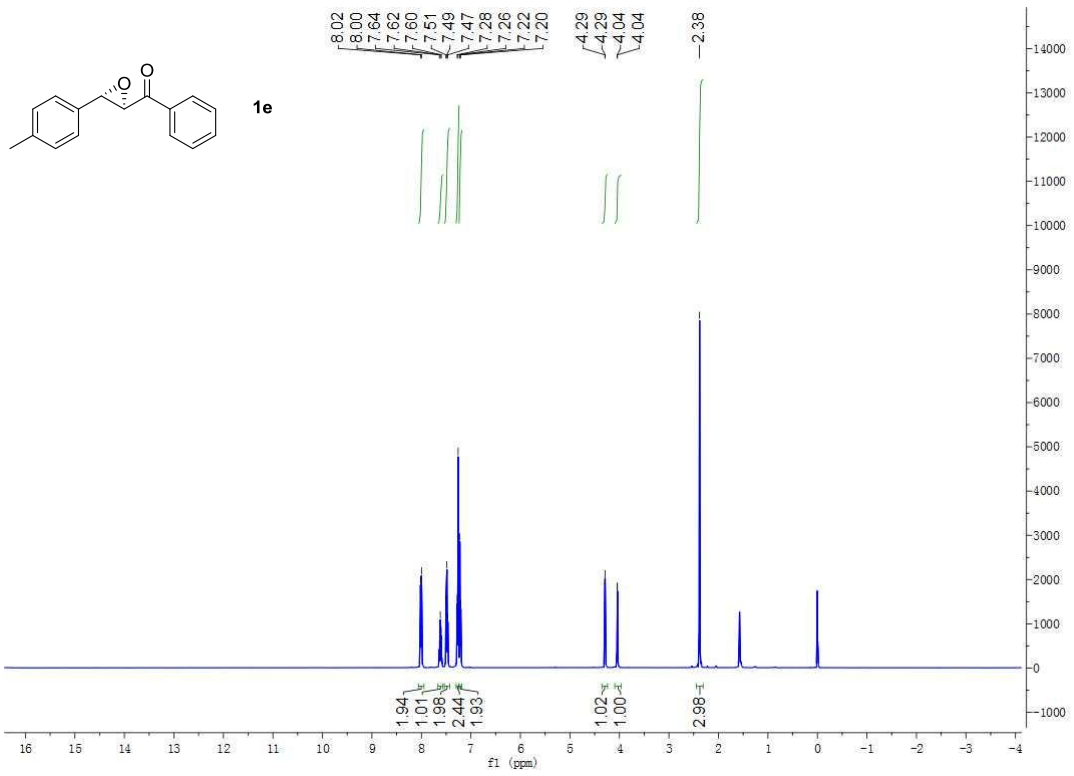
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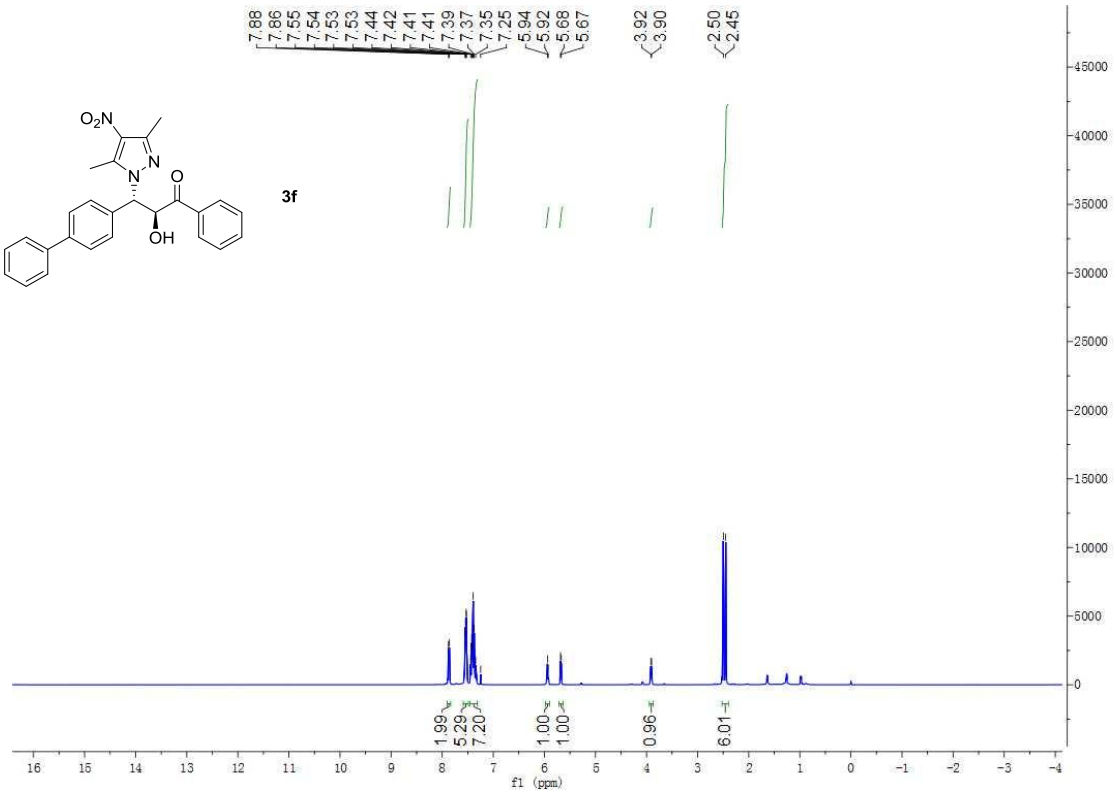
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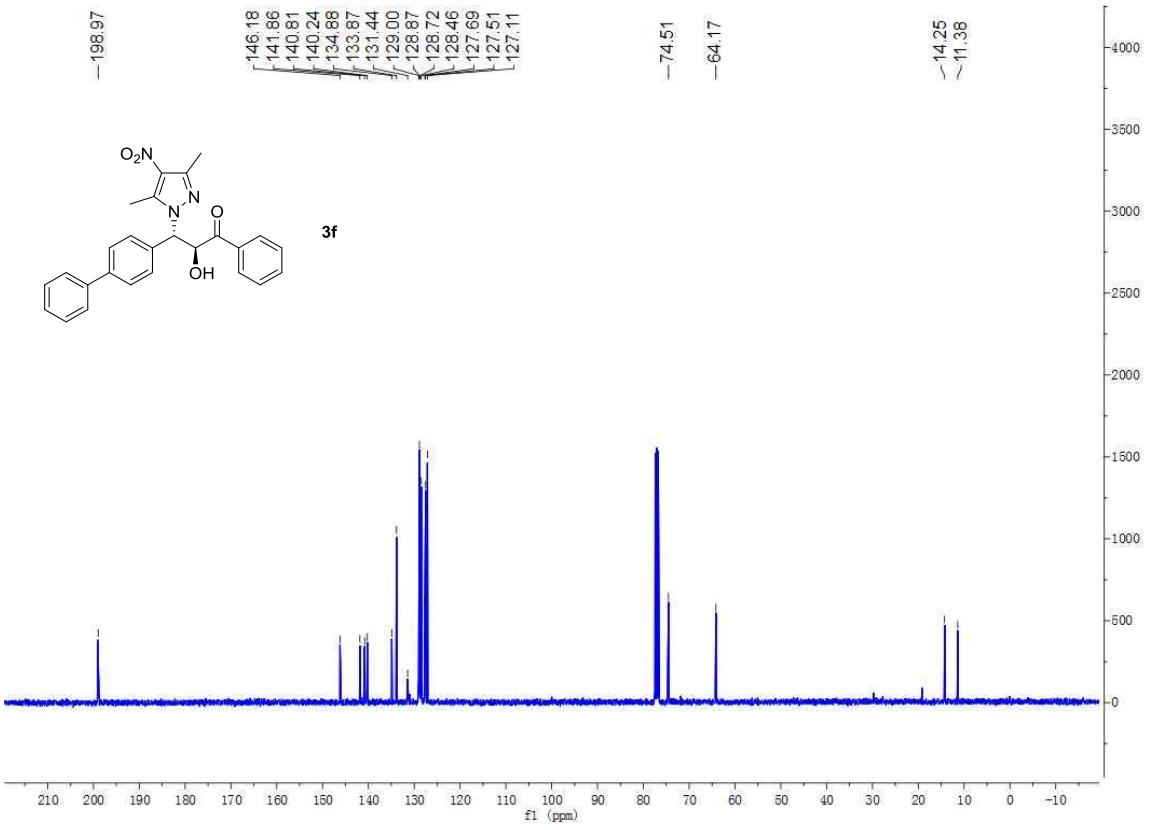
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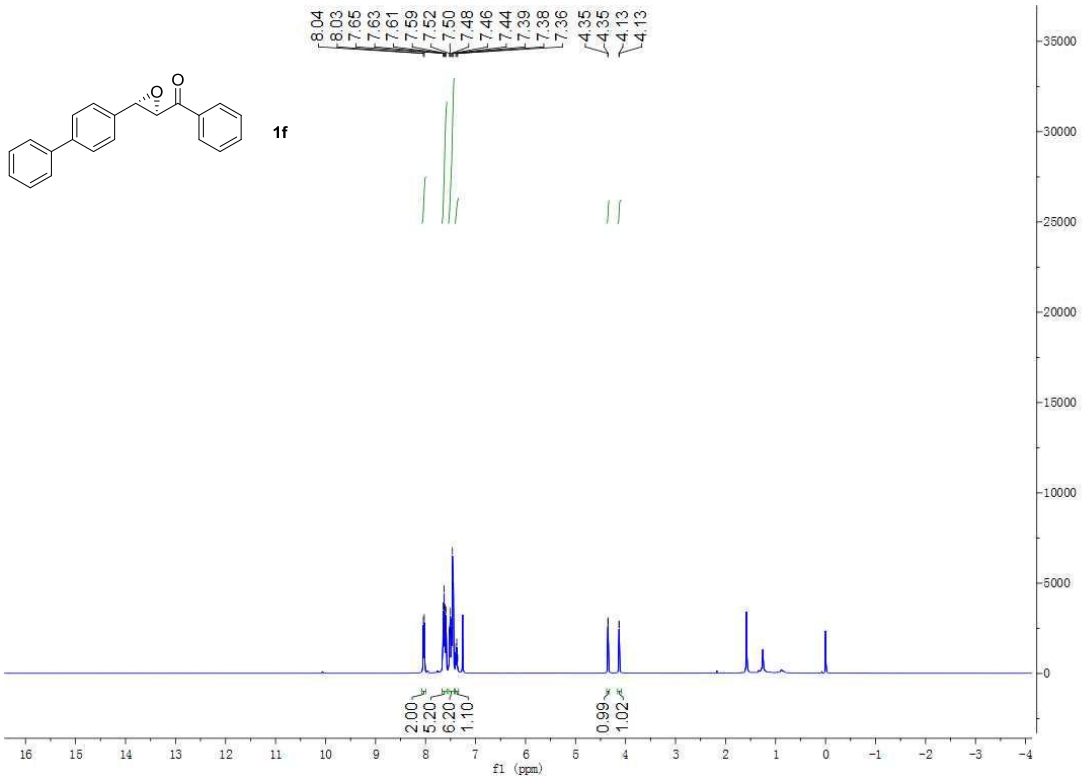
3f
f1 (ppm)


1f
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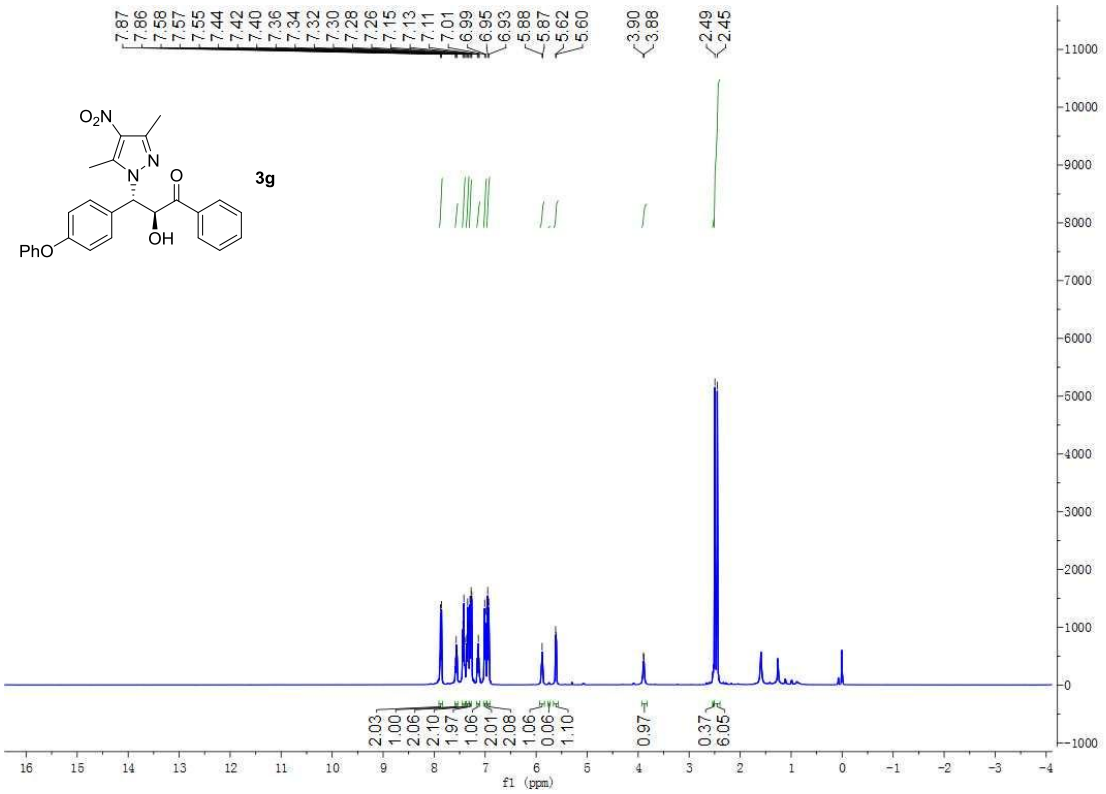
8.03
7.65
7.63
7.61
7.59
7.52
7.50
7.48
7.46
7.44
7.39
7.38
7.36
4.35
4.35
4.13
4.13
2.00
5.20
6.20
1.10
0.99
1.02
f1 (ppm)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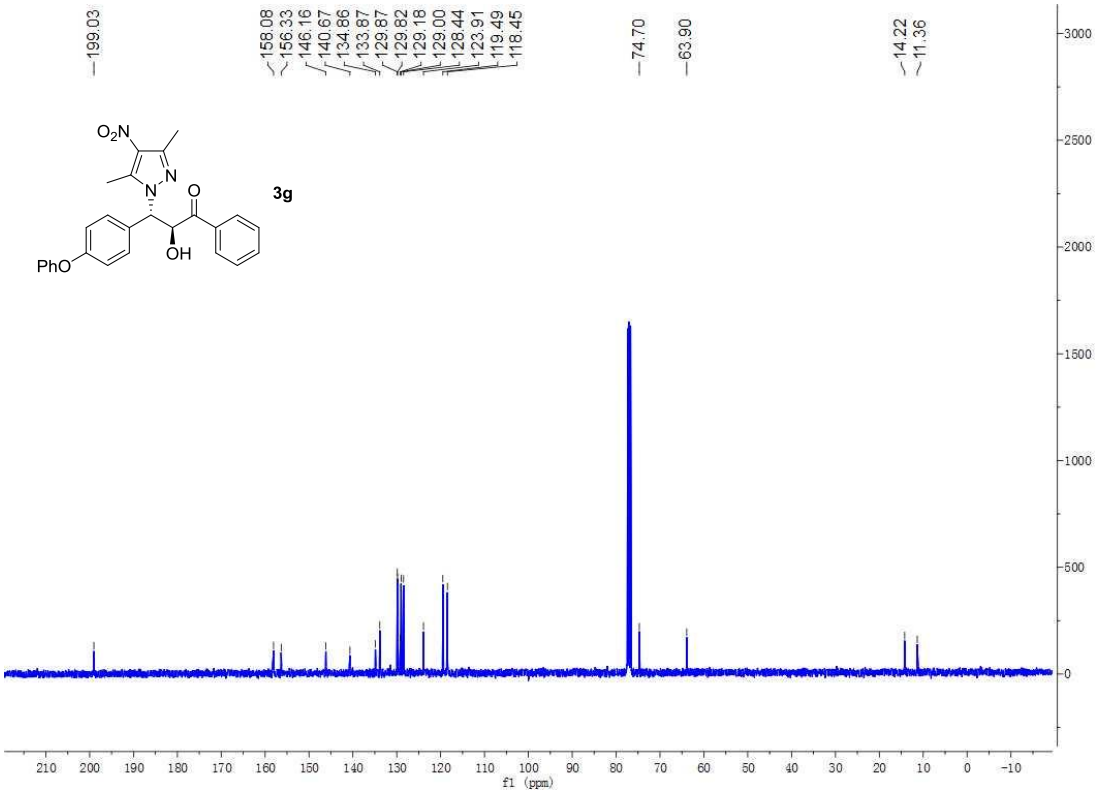
7.44
7.42
7.40
7.36
7.34
7.32
7.30
7.28
7.26
7.15
7.13
7.11
7.01
6.99
6.95
6.93
5.88
5.87
5.62
5.60
3.90
3.88
2.49
2.45
O2N
N
N
O
OH
PhO
3g
2.03
1.00
2.06
2.10
1.97
1.06
2.01
2.08
1.06
0.06
1.10
0.97
0.37
6.05
f1 (ppm)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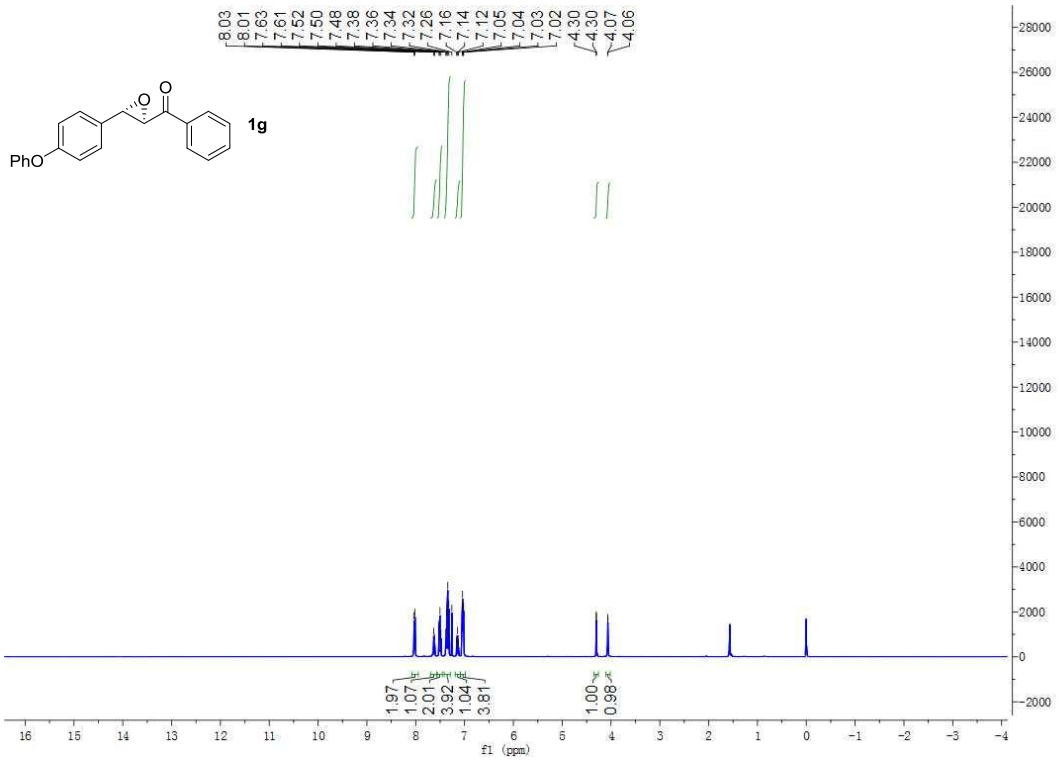
133.87
129.87
129.82
129.18
129.00
128.44
123.91
119.49
118.45
74.70
63.90
14.22
11.36
O2N
N
N
O
OH
PhO
3g
f1 (ppm)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7.61
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7.38
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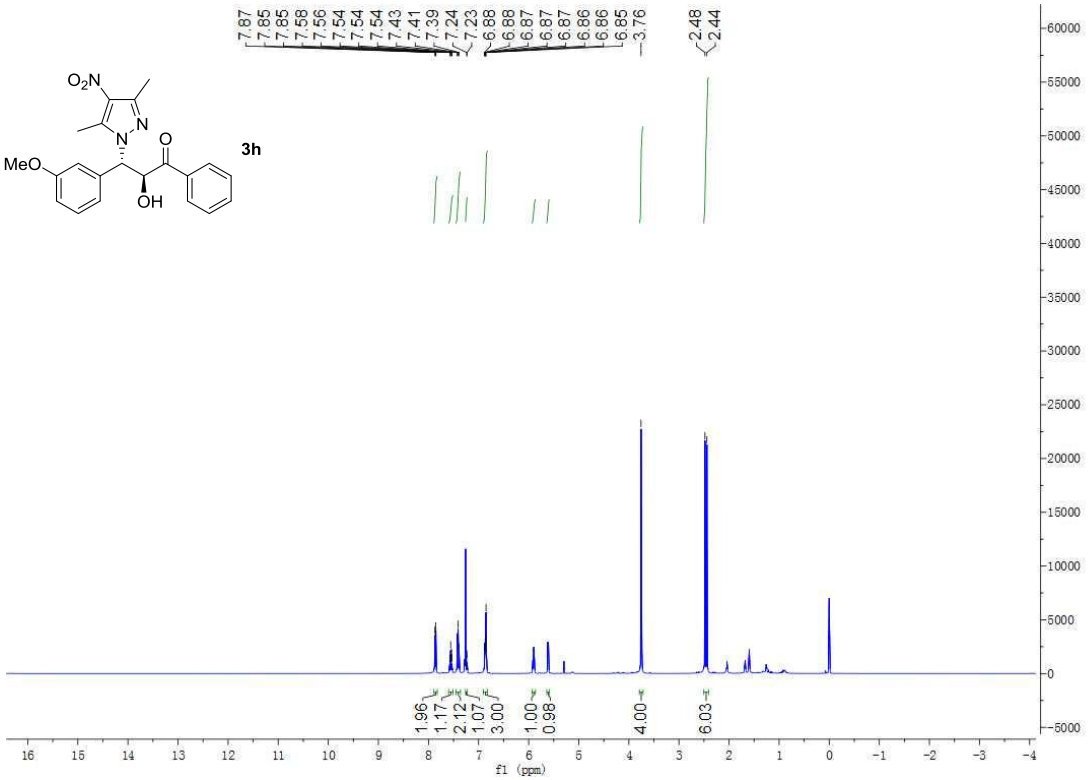
7.34
7.32
7.26
7.16
7.14
7.12
7.05
7.04
7.03
7.02
4.30
4.30
4.07
4.06
O
O
PhO
1g
1.97
1.07
2.01
3.92
1.04
3.81
1.00
0.98
f1 (ppm)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7.24
7.23
6.88
6.88
6.87
6.87
6.86
6.86
6.85
3.76
2.48
2.44
3h
1.96
1.17
2.12
1.07
3.00
1.00
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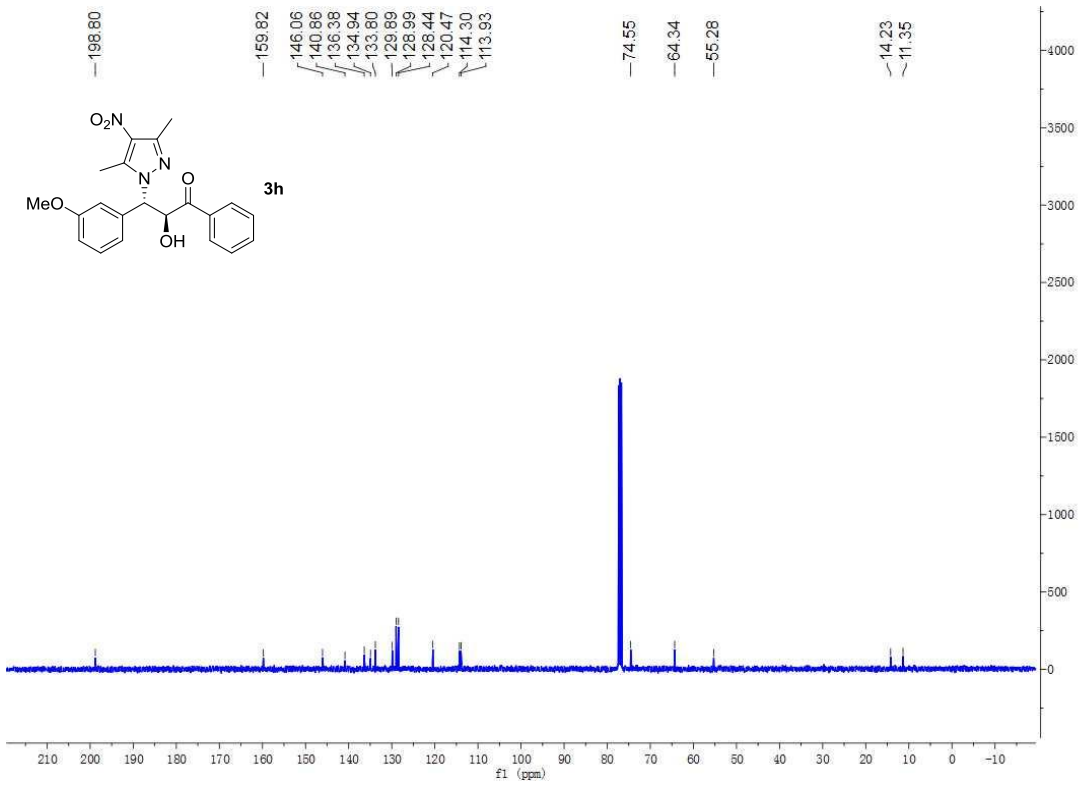
4.00
6.03
f1 (ppm)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136.38
134.94
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114.30
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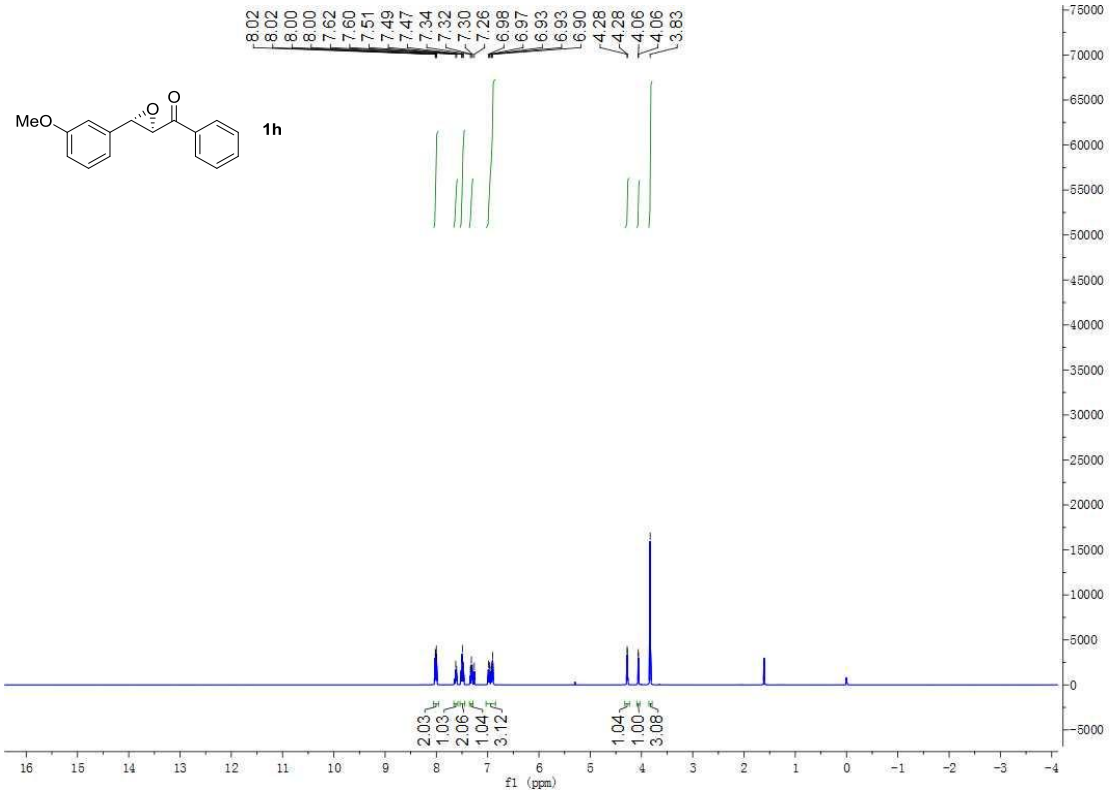
74.55
64.34
55.28
14.23
11.35
3h
f1 (ppm)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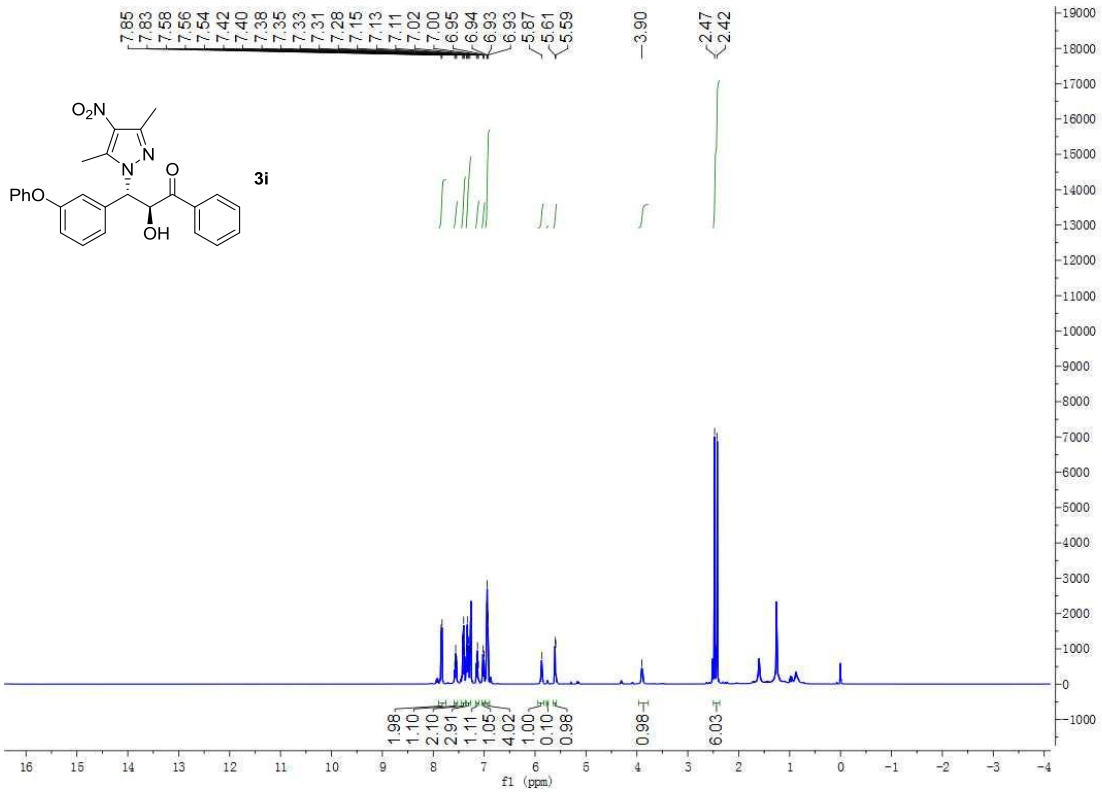
7.34
7.32
7.30
7.26
6.98
6.97
6.93
6.93
6.90
4.28
4.28
4.06
4.06
3.83
MeO
O
O
1h
2.03
1.03
2.06
1.04
3.12
1.04
1.00
3.08
f1 (ppm)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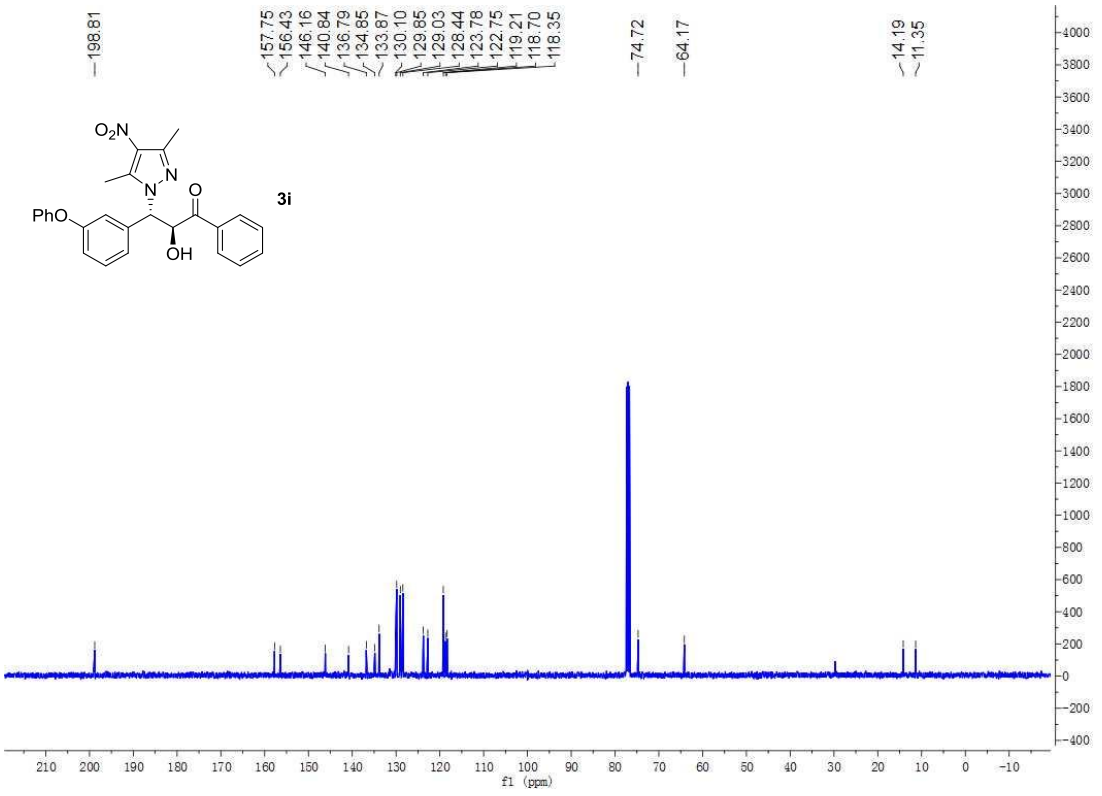
7.40
7.38
7.35
7.33
7.31
7.28
7.15
7.13
7.11
7.02
7.00
6.95
6.94
6.93
6.93
5.87
5.61
5.59
3.90
2.47
2.42
O2N
N
N
O
PhO
OH
3i
1.98
1.10
2.10
2.91
1.11
1.05
4.02
1.00
0.10
0.98
0.98
6.03
f1 (ppm)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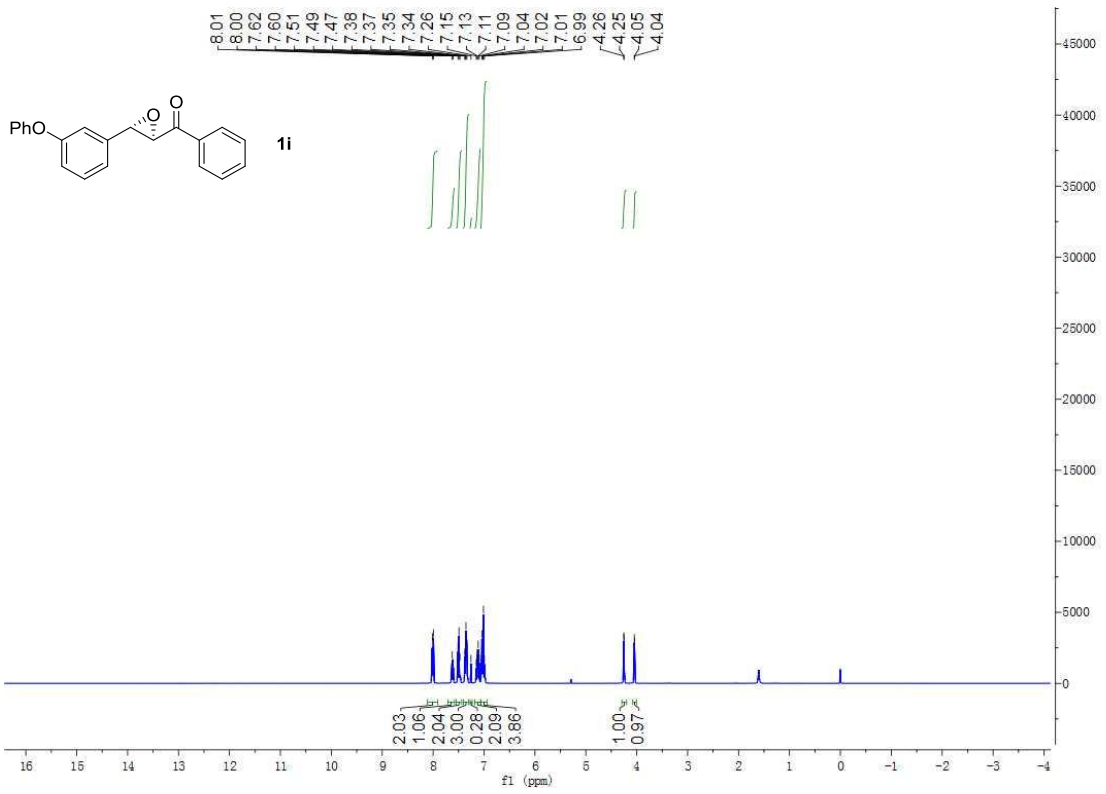
136.79
134.85
133.87
130.10
129.85
129.03
128.44
123.78
122.75
119.21
118.70
118.35
74.72
64.17
14.19
11.35
O2N
N
N
O
PhO
OH
3i
f1 (ppm)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8.00
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7.60
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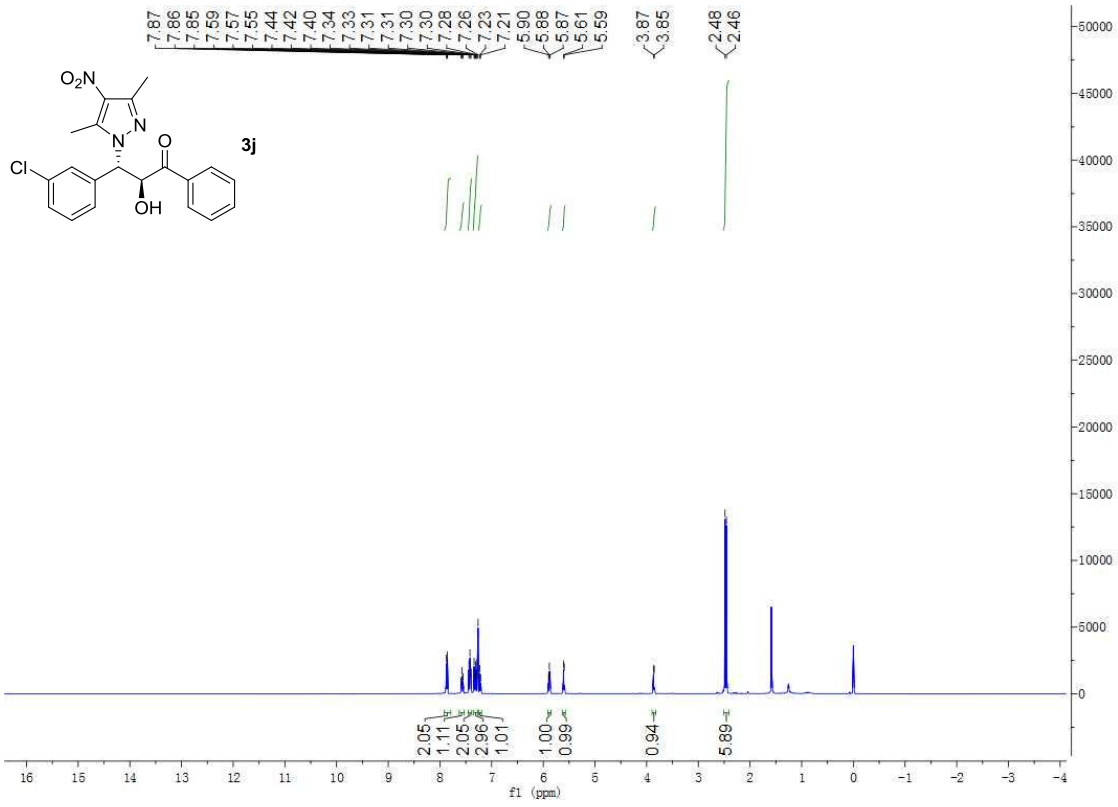
7.49
7.47
7.38
7.37
7.35
7.34
7.26
7.15
7.13
7.11
7.09
7.04
7.02
7.01
6.99
4.26
4.25
4.05
4.04
PhO
O
O
1i
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2.03
1.06
2.04
3.00
0.28
2.09
3.86
1.00
0.97
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
−3
−4
f1 (ppm)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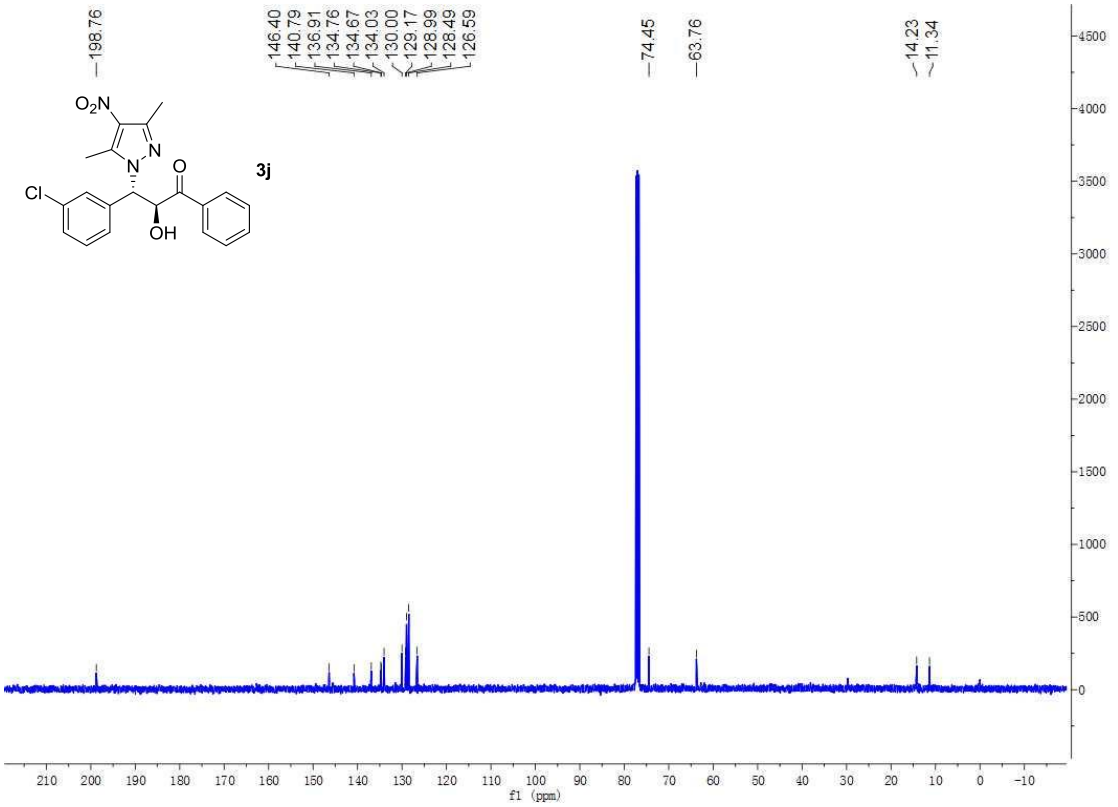
7.33
7.31
7.31
7.30
7.30
7.28
7.26
7.23
7.21
5.90
5.88
5.87
5.61
5.59
3.87
3.85
2.48
2.46
O2N
Cl
OH
O
3j
2.05
1.11
2.05
2.96
1.01
1.00
0.99
0.94
5.89
f1 (ppm)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130.00
129.17
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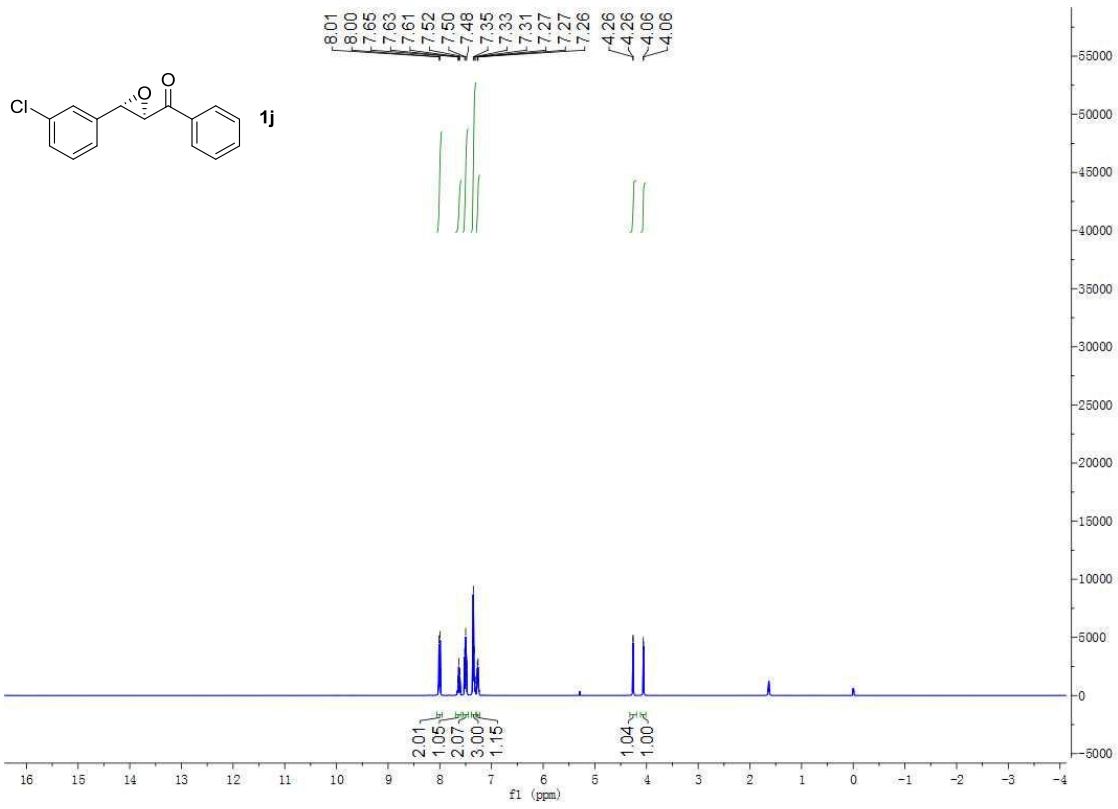
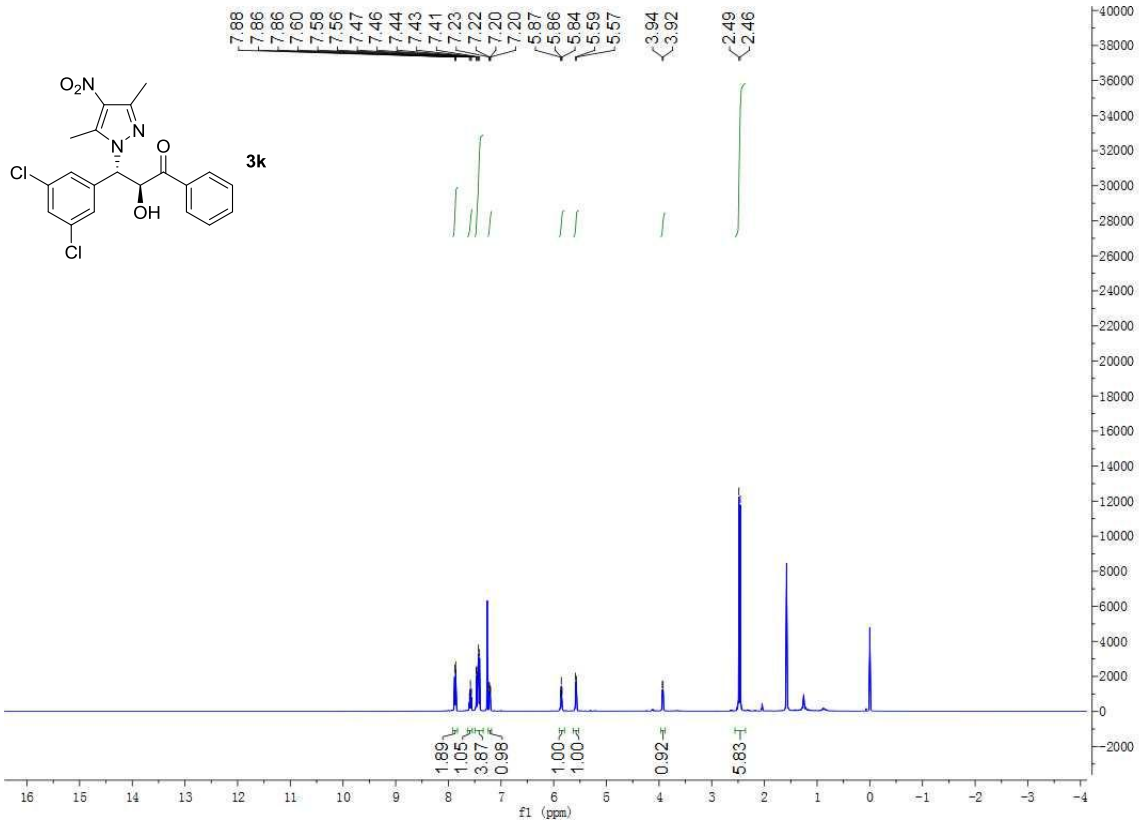
128.49
126.59
74.45
63.76
14.23
11.34
O2N
Cl
OH
O
3j
f1 (ppm)


Cl
O
O
1j
8.01
8.00
7.65
7.63
7.61
7.52
7.50
7.48
7.35
7.33
7.31
7.27
7.27
7.26
4.26
4.26
4.06
4.06
2.01
1.05
2.07
3.00
1.15
1.04
1.00
f1 (ppm)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7.86
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7.47
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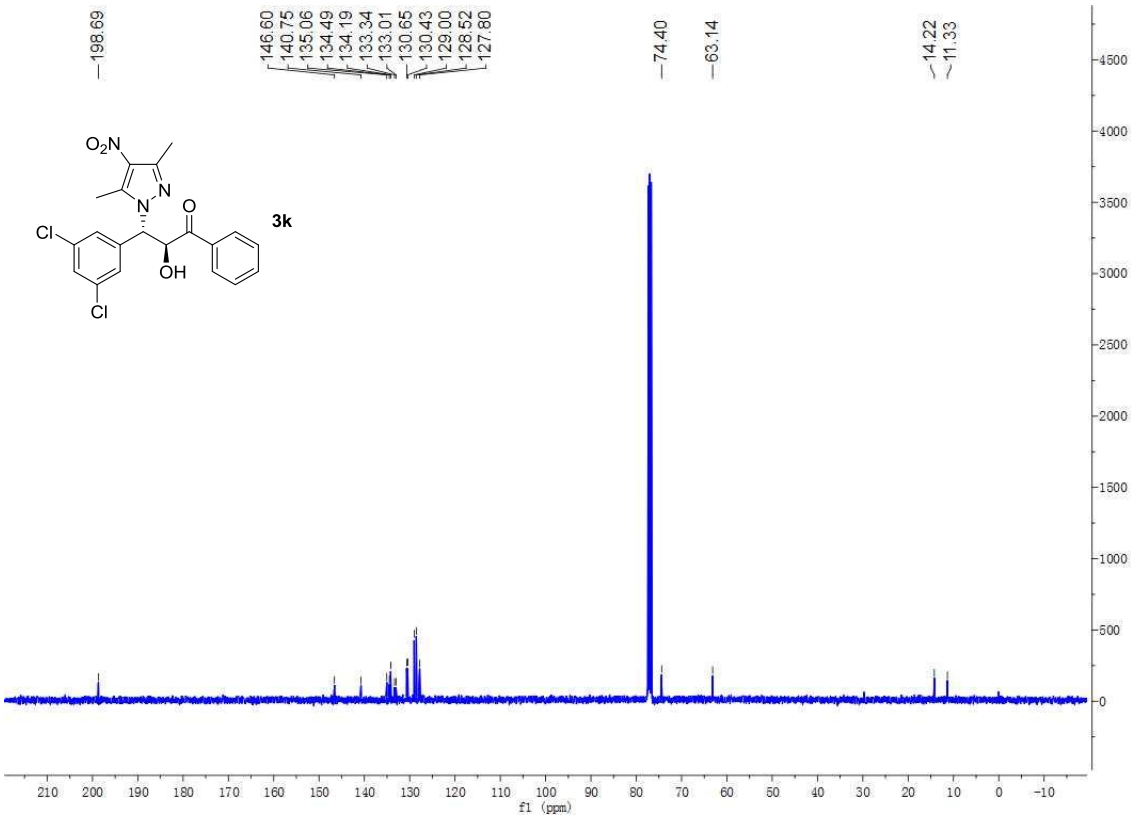
7.44
7.43
7.41
7.23
7.22
7.20
7.20
5.87
5.86
5.84
5.59
5.57
3.94
3.92
2.49
2.46
3k
1.89
1.05
3.87
0.98
1.00
1.00
0.92
5.83
f1 (ppm)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134.49
134.19
133.34
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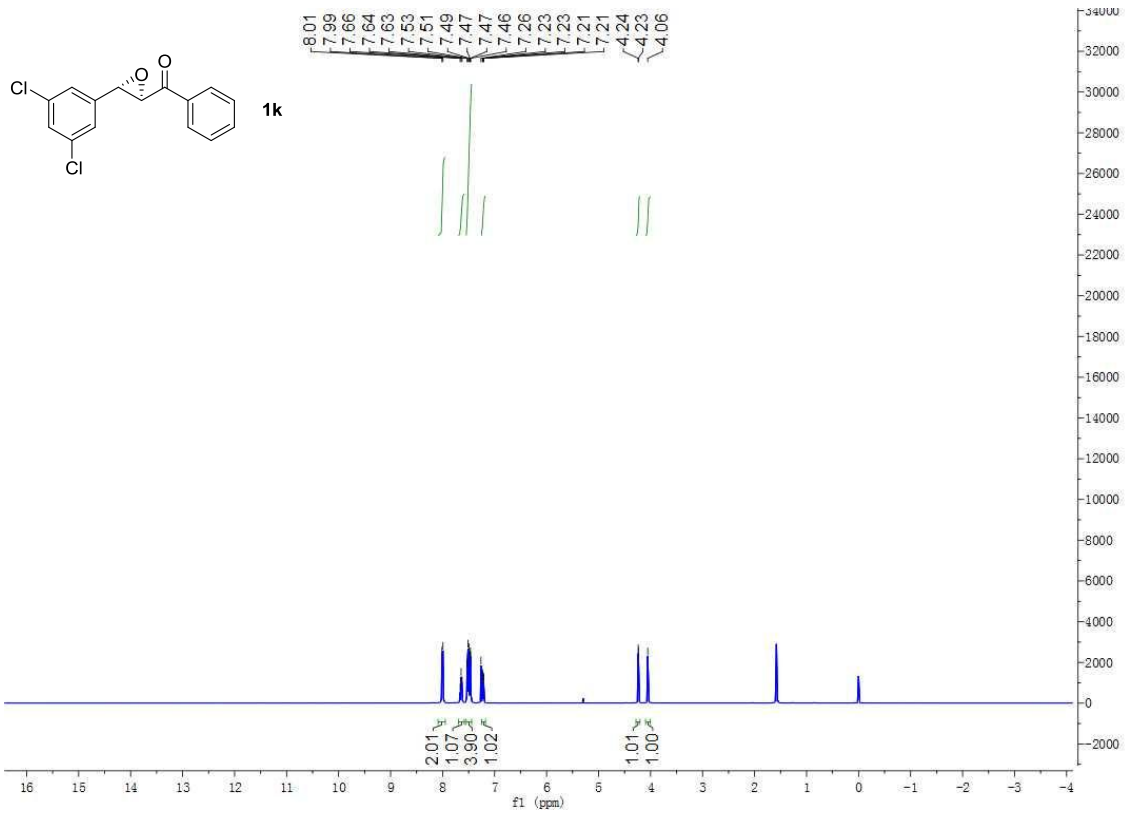
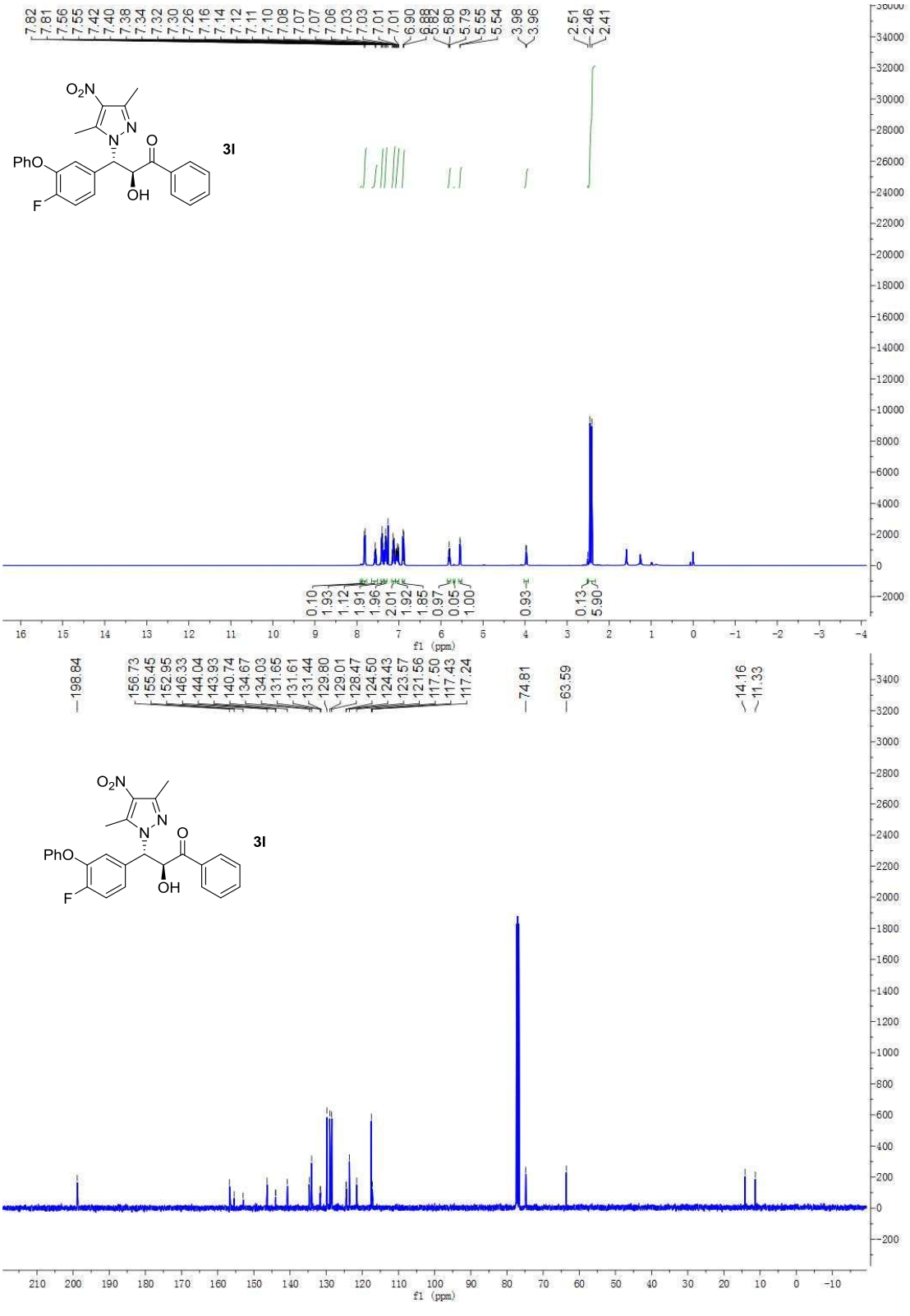
130.65
130.43
129.00
128.52
127.80
74.40
63.14
14.22
11.33
3k
f1 (ppm)


Cl
Cl
O
O
1k
8.01
7.99
7.66
7.64
7.63
7.53
7.51
7.49
7.47
7.47
7.46
7.26
7.23
7.23
7.21
7.21
4.24
4.23
4.06
2.01
1.07
3.90
1.02
1.01
1.00
f1 (ppm)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7.55
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7.40
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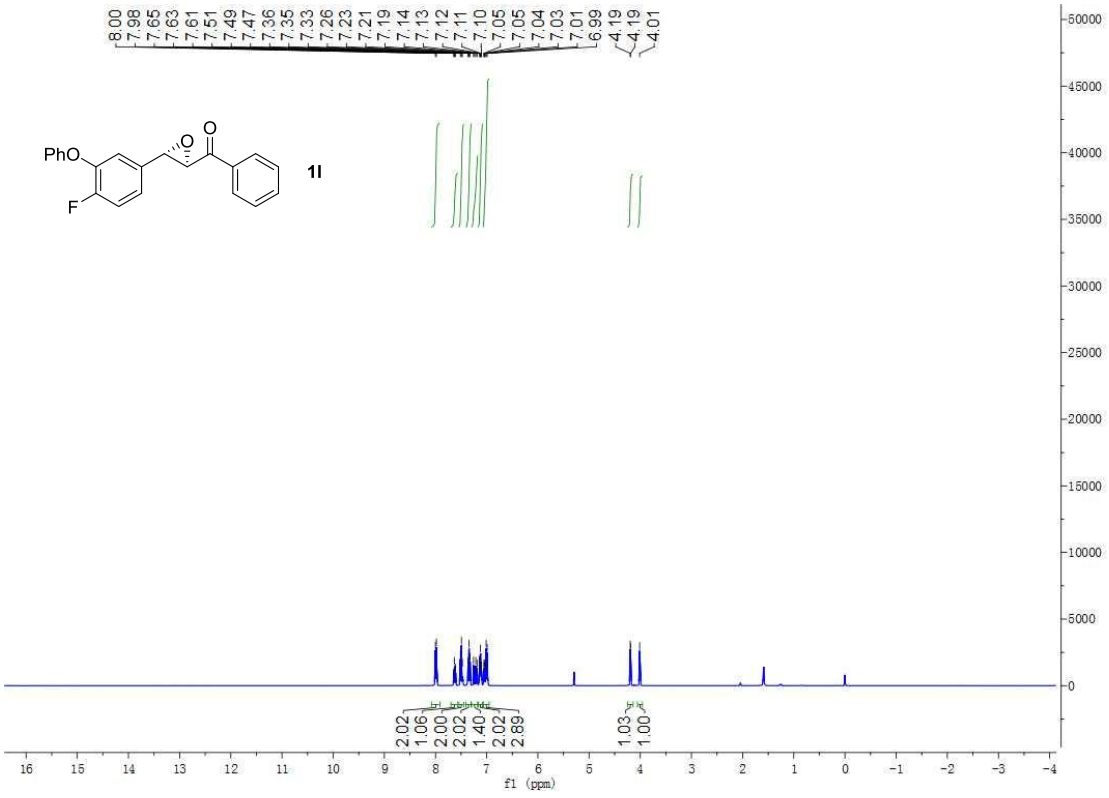
7.34
7.32
7.30
7.26
7.16
7.14
7.12
7.11
7.10
7.08
7.07
7.07
7.06
7.03
7.03
7.01
7.01
6.90
5.80
5.79
5.55
5.54
3.98
3.96
2.51
2.46
2.41
O2N
PhO
F
OH
O
3l
0.10
1.93
1.12
1.91
1.96
2.01
1.92
1.85
0.97
0.05
1.00
0.93
0.13
5.90
f1 (ppm)
198.84
156.73
155.45
152.95
146.33
144.04
143.93
140.74
134.67
134.03
131.65
131.61
131.44
129.80
129.01
128.47
124.50
124.43
123.57
121.56
117.50
117.43
117.24
74.81
63.59
14.16
11.33
f1 (ppm)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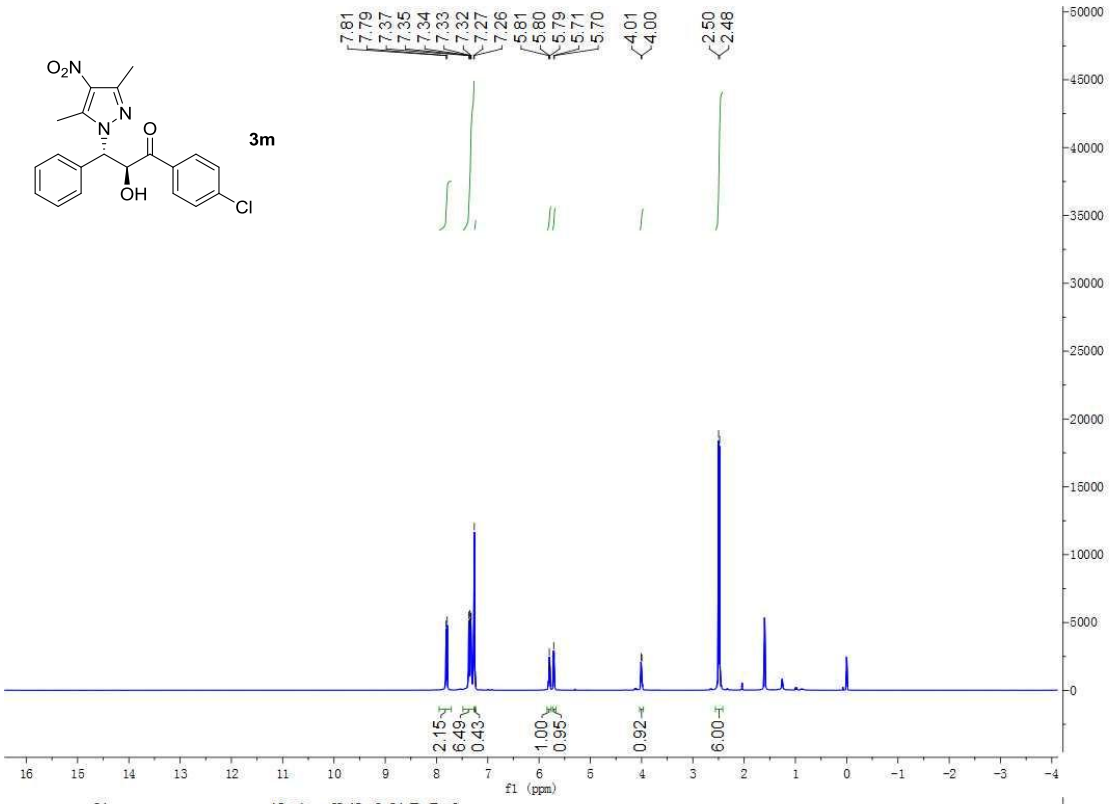
7.63
7.61
7.51
7.49
7.47
7.36
7.35
7.33
7.26
7.23
7.21
7.19
7.14
7.13
7.12
7.11
7.10
7.05
7.05
7.04
7.03
7.01
6.99
4.19
4.19
4.01
PhO
F
O
O
1l
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
2.02
1.06
2.00
2.02
1.40
2.02
2.89
1.03
1.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
−3
−4
f1 (ppm)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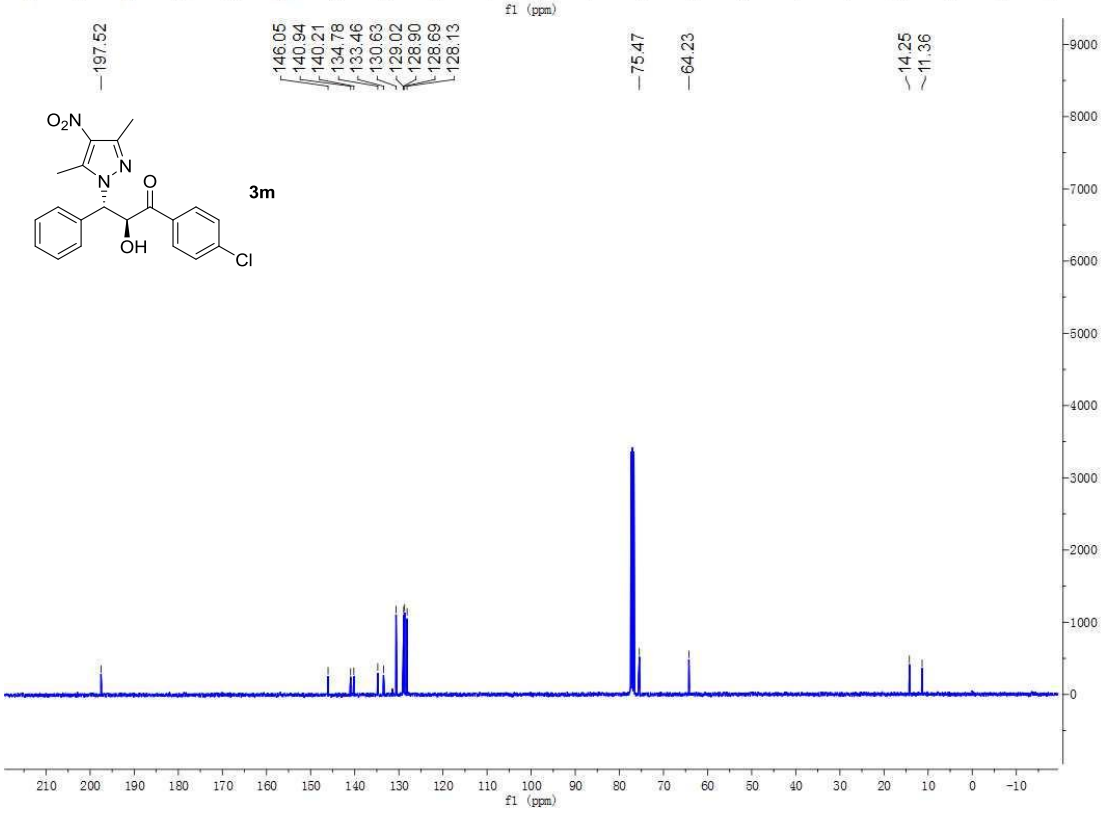
7.33
7.32
7.27
7.26
5.81
5.80
5.79
5.71
5.70
4.01
4.00
2.50
2.48
3m
2.15
6.49
0.43
1.00
0.95
0.92
6.00
f1 (ppm)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140.21
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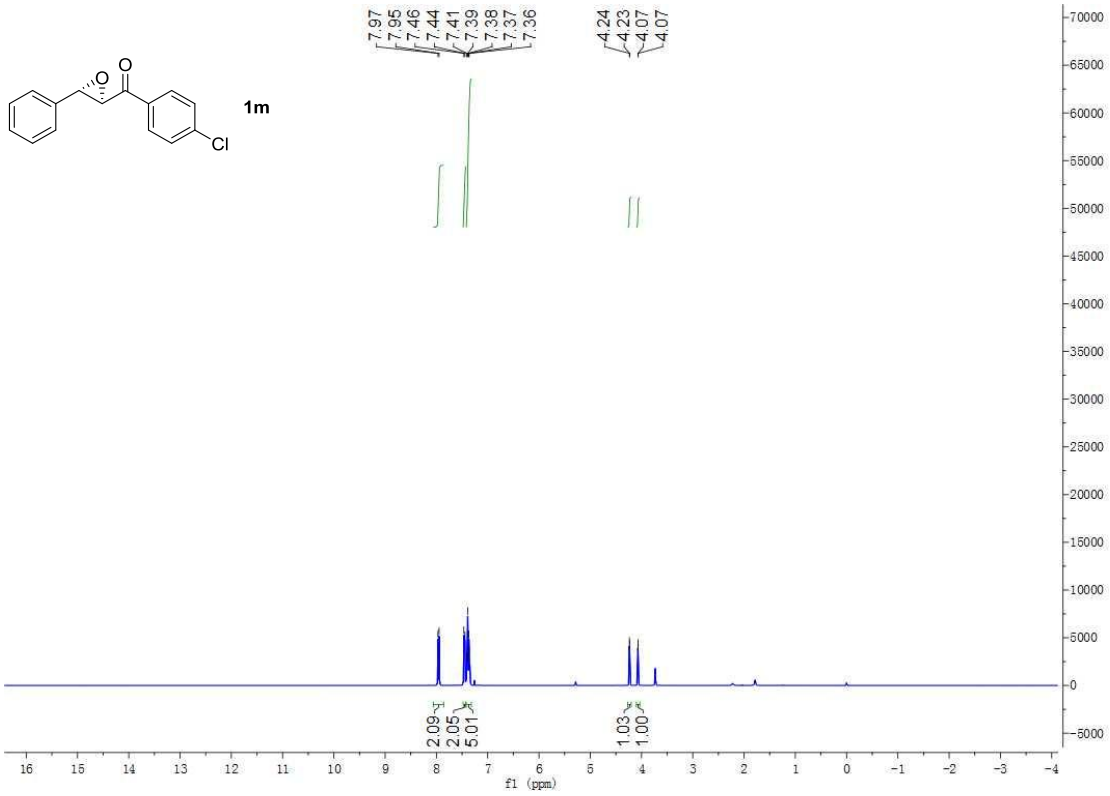
130.63
129.02
128.90
128.69
128.13
75.47
64.23
14.25
11.36
3m
f1 (ppm)


1m
Cl
7.97
7.95
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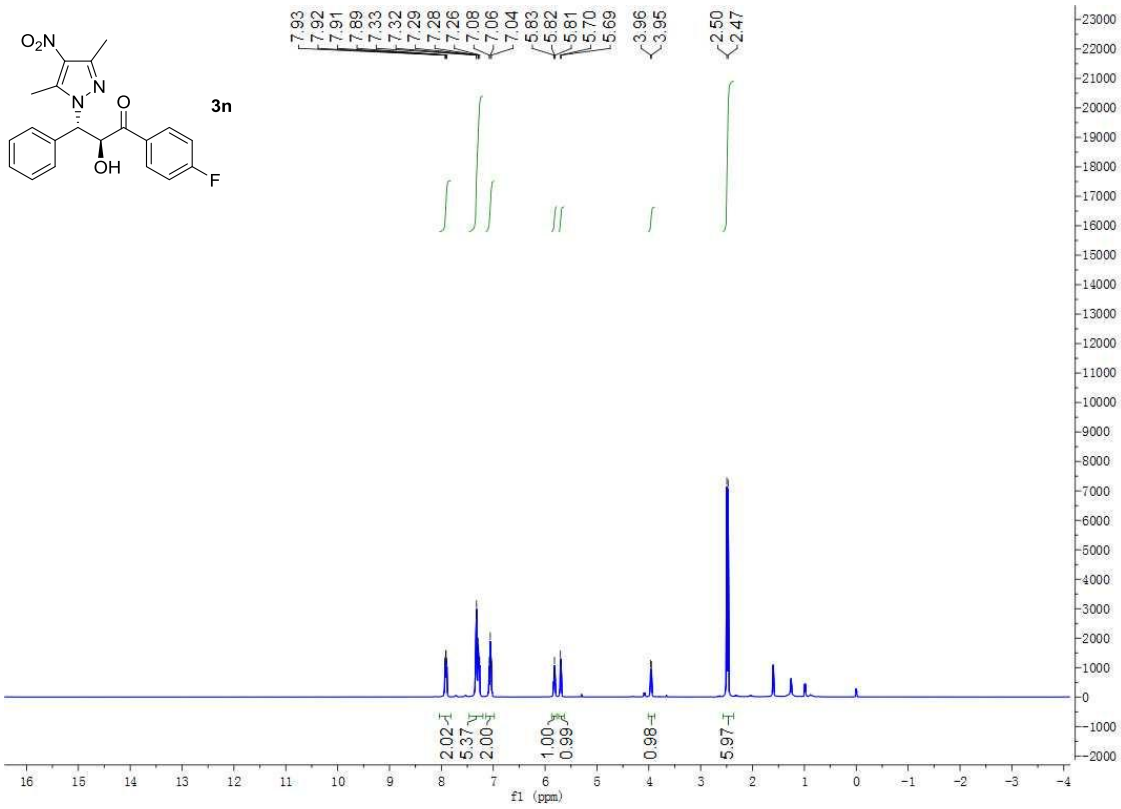
7.44
7.41
7.39
7.38
7.37
7.36
4.24
4.23
4.07
4.07
2.09
2.05
5.01
1.03
1.00
f1 (ppm)


3n
7.93
7.92
7.91
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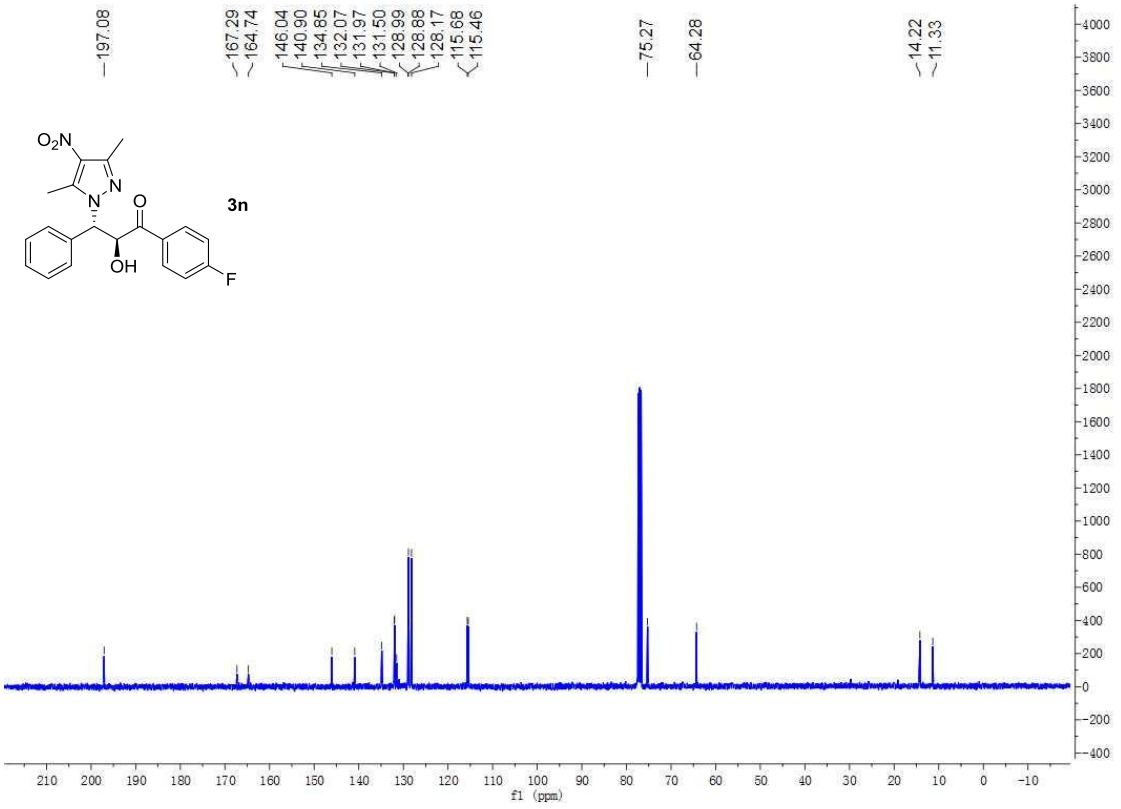
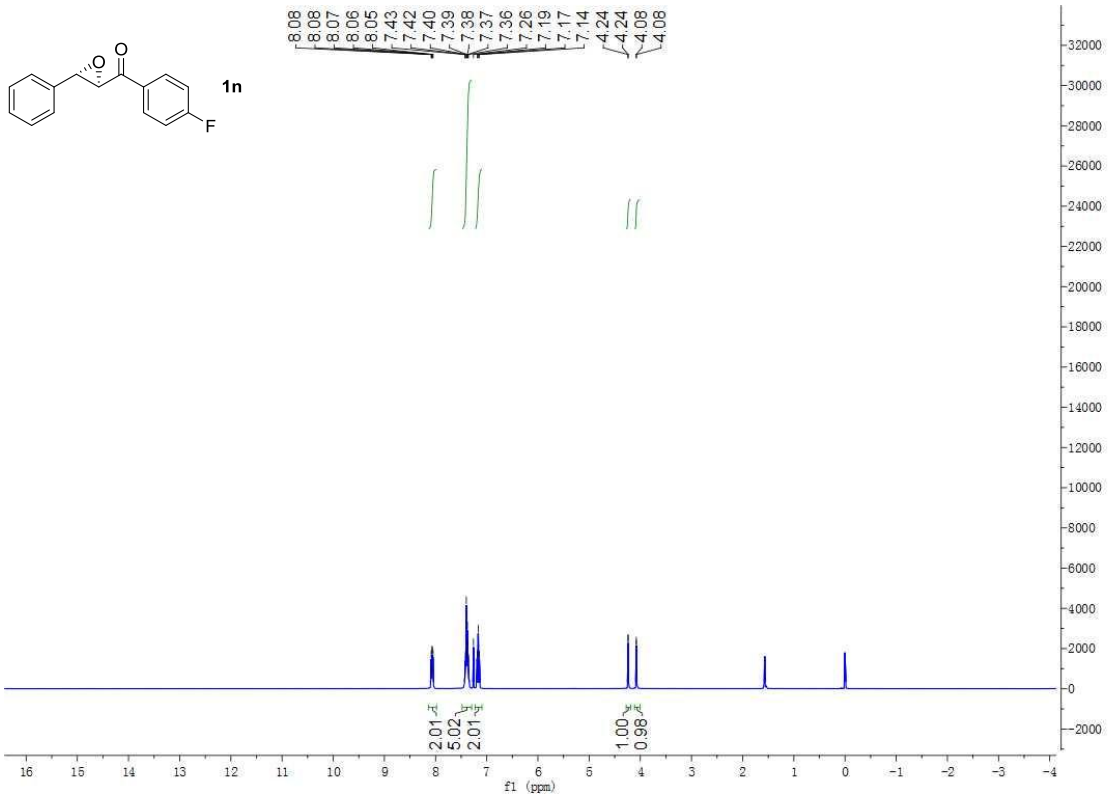
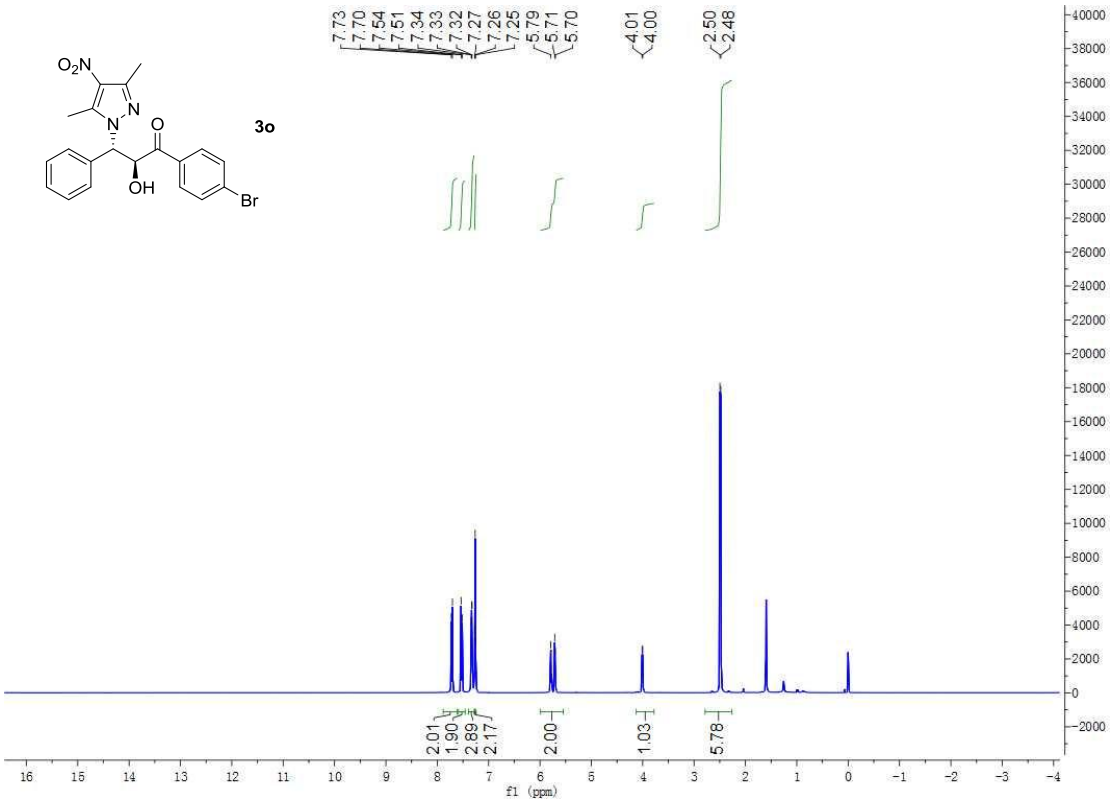
7.33
7.32
7.29
7.28
7.26
7.08
7.06
7.04
5.83
5.82
5.81
5.70
5.69
3.96
3.95
2.50
2.47
2.02
5.37
2.00
1.00
0.99
0.98
5.97
f1 (ppm)


3n
197.08
167.29
164.74
146.04
140.90
134.85
132.07
131.97
131.50
128.99
128.88
128.17
115.68
115.46
75.27
64.28
14.22
11.33
f1 (ppm)


1n
F
8.08
8.08
8.07
8.06
8.05
7.43
7.42
7.40
7.39
7.38
7.37
7.36
7.26
7.19
7.17
7.14
4.24
4.24
4.08
4.08
2.01
5.02
2.01
1.00
0.98
f1 (ppm)


3o
7.73
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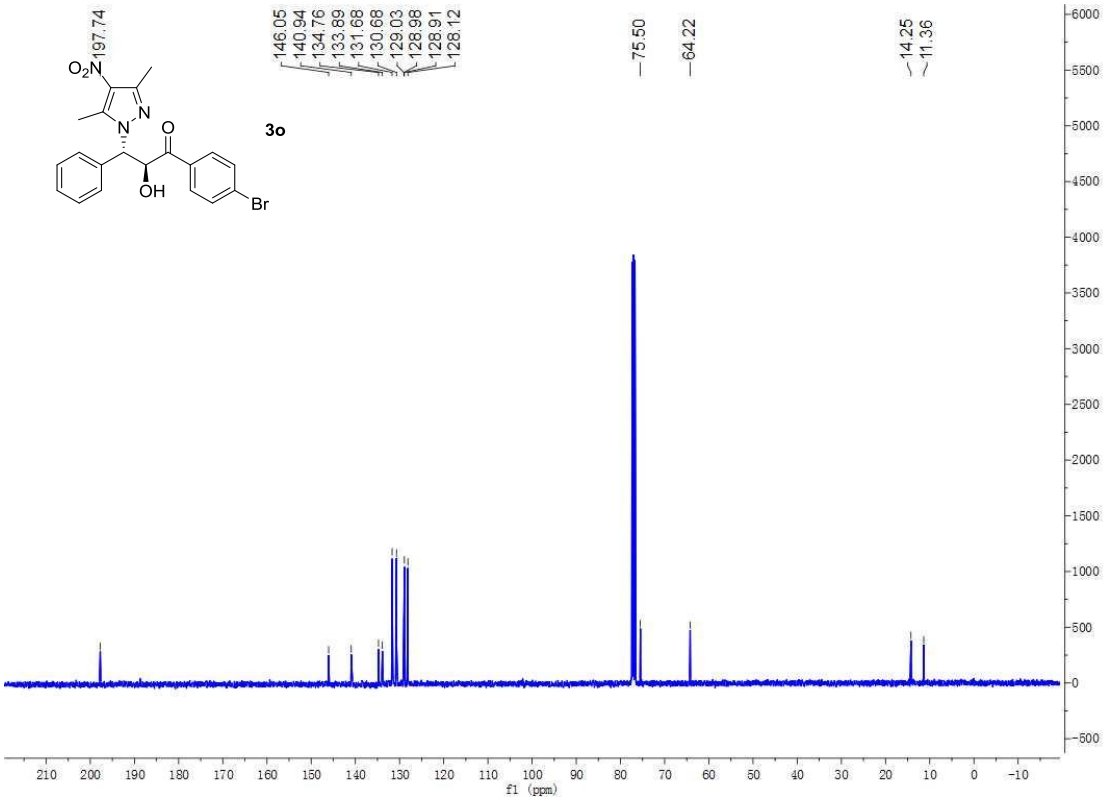
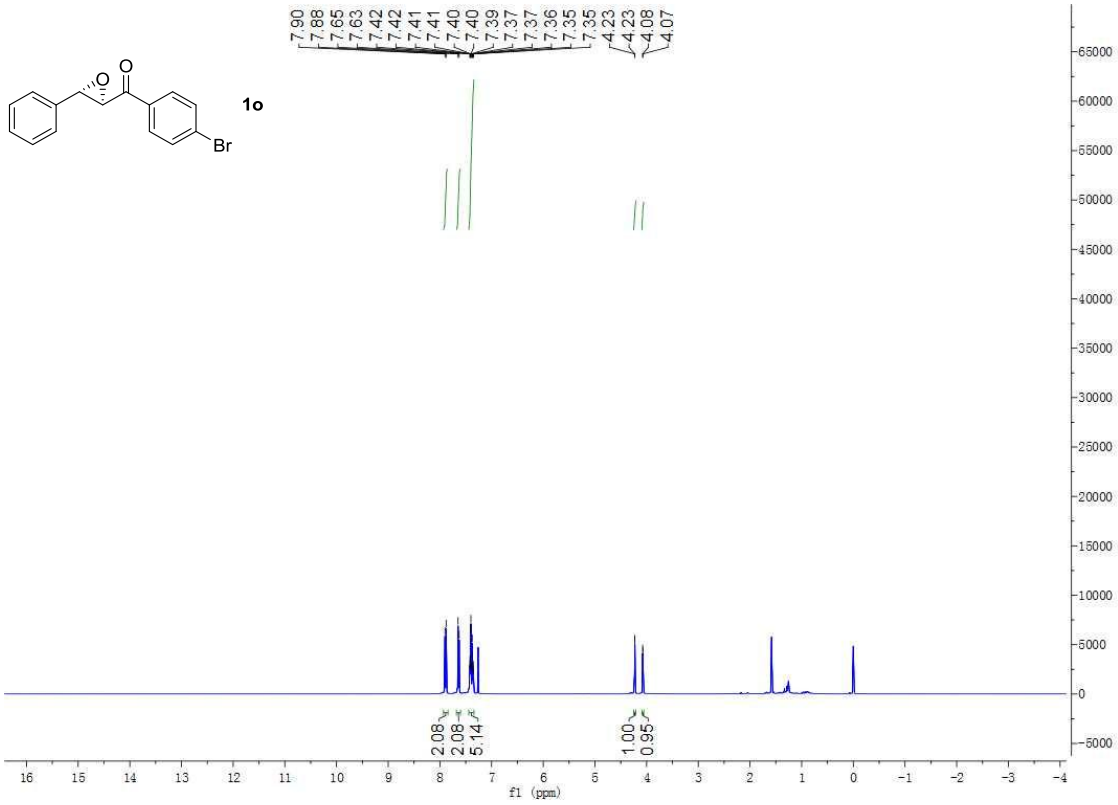
7.54
7.51
7.34
7.33
7.32
7.27
7.26
7.25
5.79
5.71
5.70
4.01
4.00
2.50
2.48
2.01
1.90
2.89
2.17
2.00
1.03
5.78
f1 (ppm)


3o
197.74
146.05
140.94
134.76
133.89
131.68
130.68
129.03
128.98
128.91
128.12
75.50
64.22
14.25
11.36
f1 (ppm)


1o
Br
O
O
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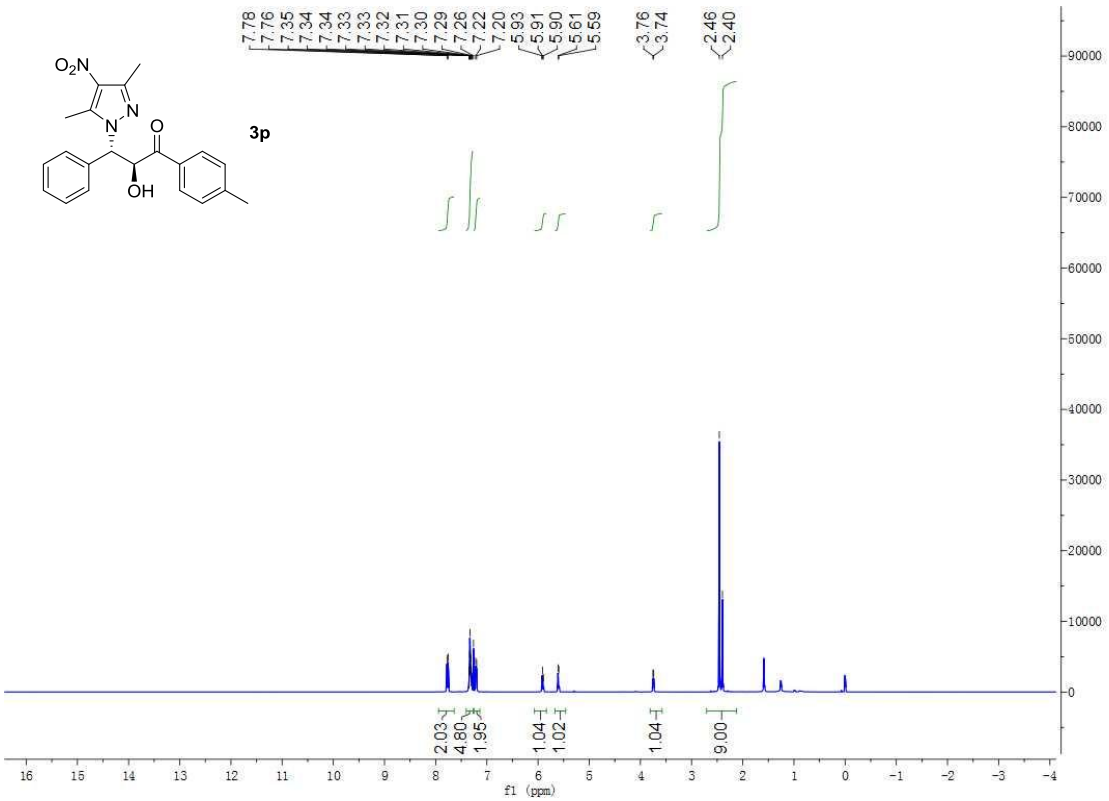
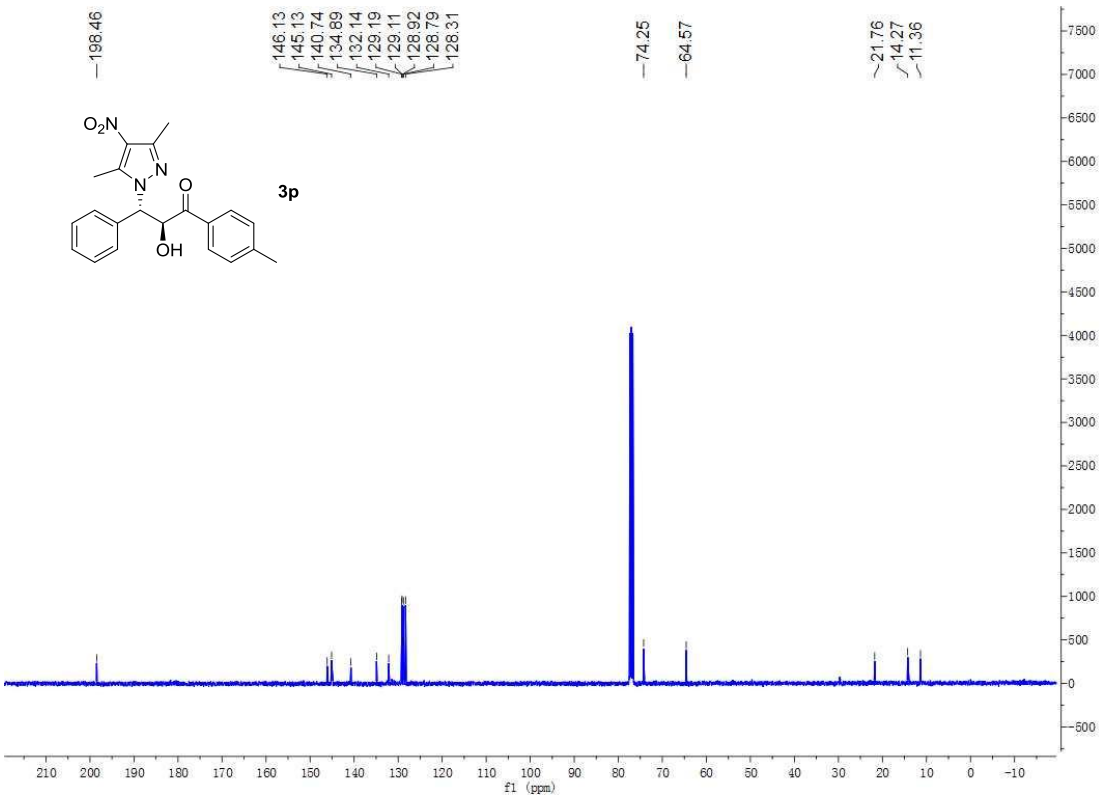
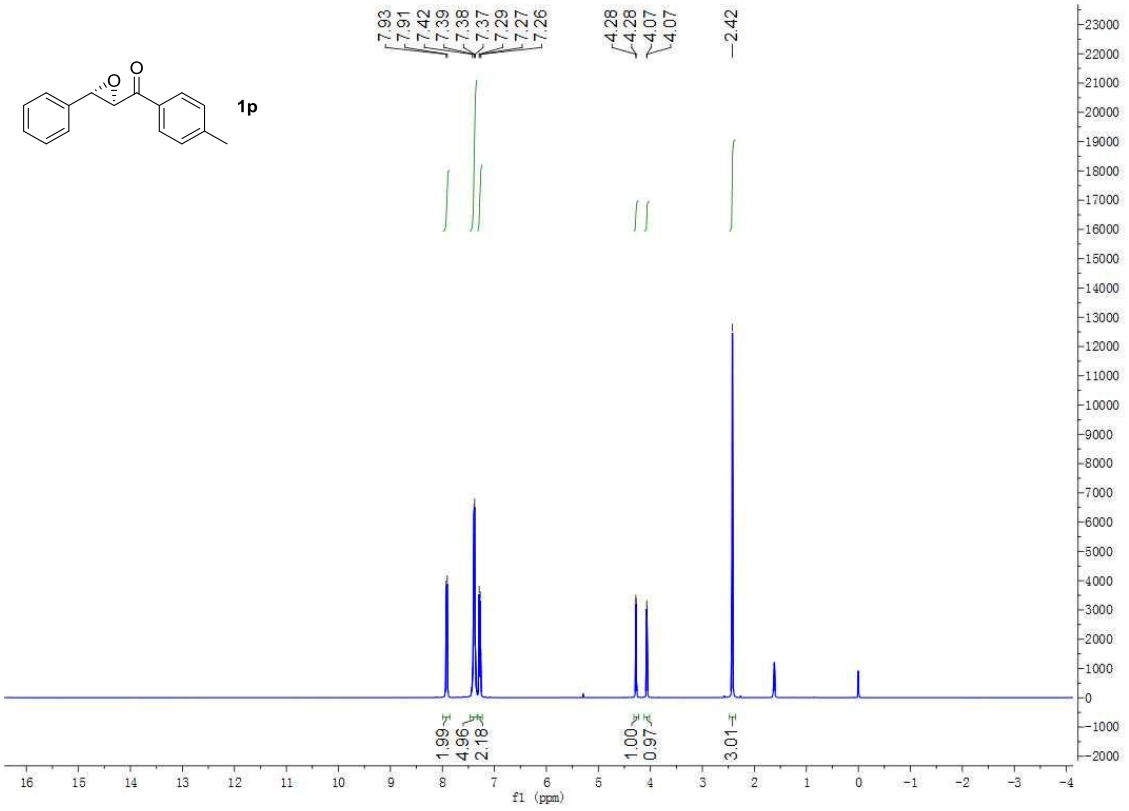
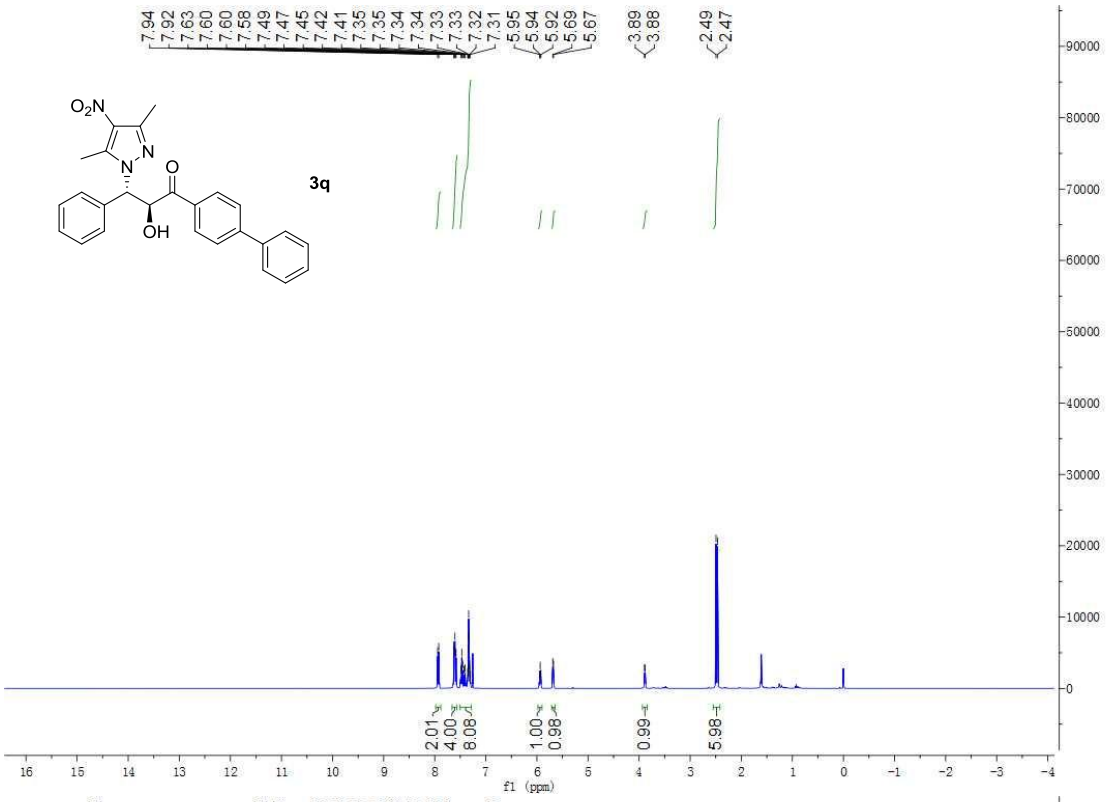
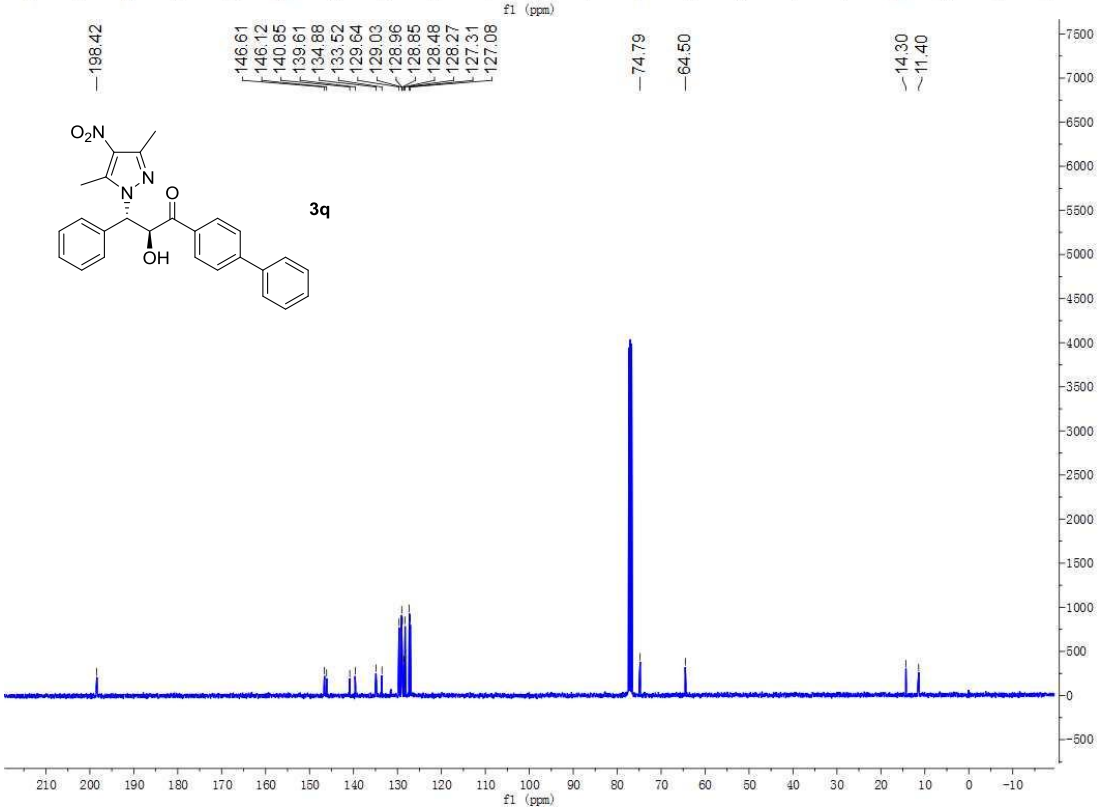
7.88
7.65
7.63
7.42
7.42
7.41
7.41
7.40
7.40
7.39
7.37
7.37
7.36
7.35
4.23
4.08
4.07
2.08
2.08
5.14
1.00
0.95
f1 (ppm)


7.78
7.76
7.35
7.34
7.34
7.33
7.33
7.32
7.31
7.30
7.29
7.26
7.22
7.20
5.93
5.91
5.90
5.61
5.59
3.76
3.74
2.46
2.40
O2N
N
N
O
OH
3p
2.03
4.80
1.95
1.04
1.02
1.04
9.00
f1 (ppm)


198.46
146.13
145.13
140.74
134.89
132.14
129.19
129.11
128.92
128.79
128.31
74.25
64.57
21.76
14.27
11.36
O2N
N
N
O
OH
3p
f1 (ppm)


1p
7.93
7.91
7.42
7.39
7.38
7.37
7.29
7.27
7.26
4.28
4.28
4.07
4.07
2.42
1.99
4.96
2.18
1.00
0.97
3.01
f1 (ppm)


7.94
7.92
7.63
7.60
7.60
7.58
7.49
7.47
7.45
7.42
7.41
7.35
7.35
7.34
7.34
7.33
7.33
7.32
7.31
5.95
5.94
5.92
5.69
5.67
3.89
3.88
2.49
2.47
O2N
N
N
O
OH
3q
2.01
4.00
8.08
1.00
0.98
0.99
5.98
f1 (ppm)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146.12
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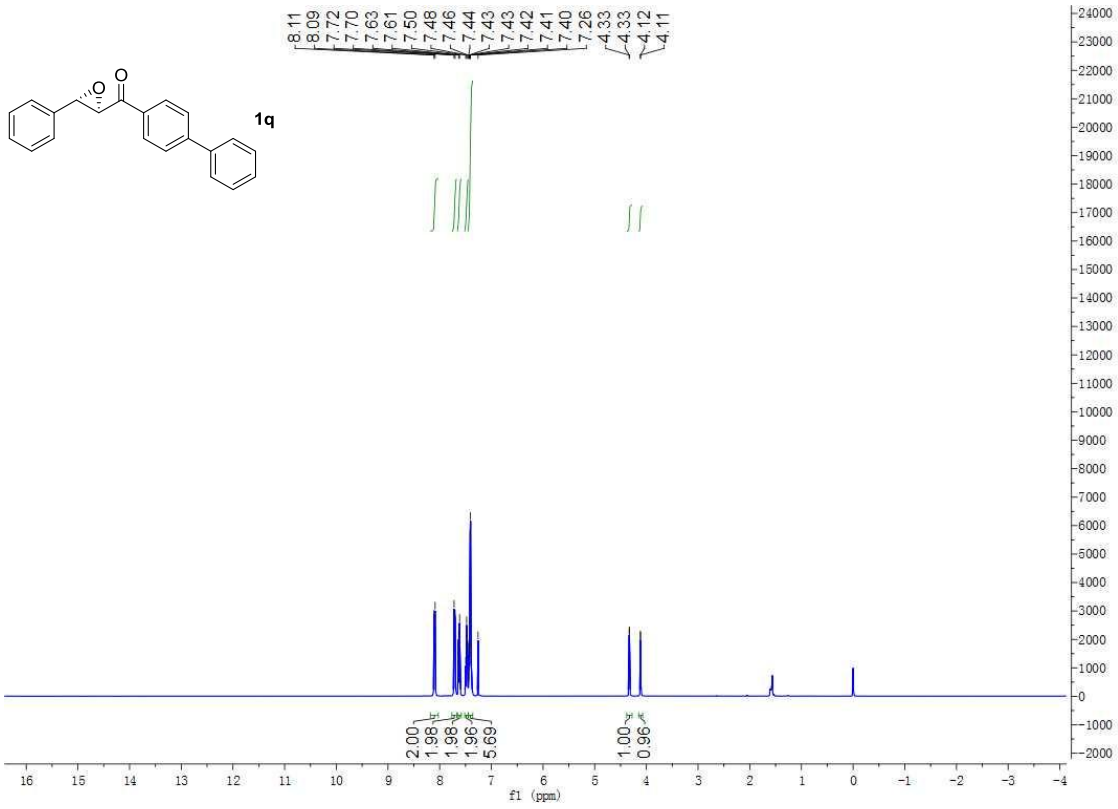
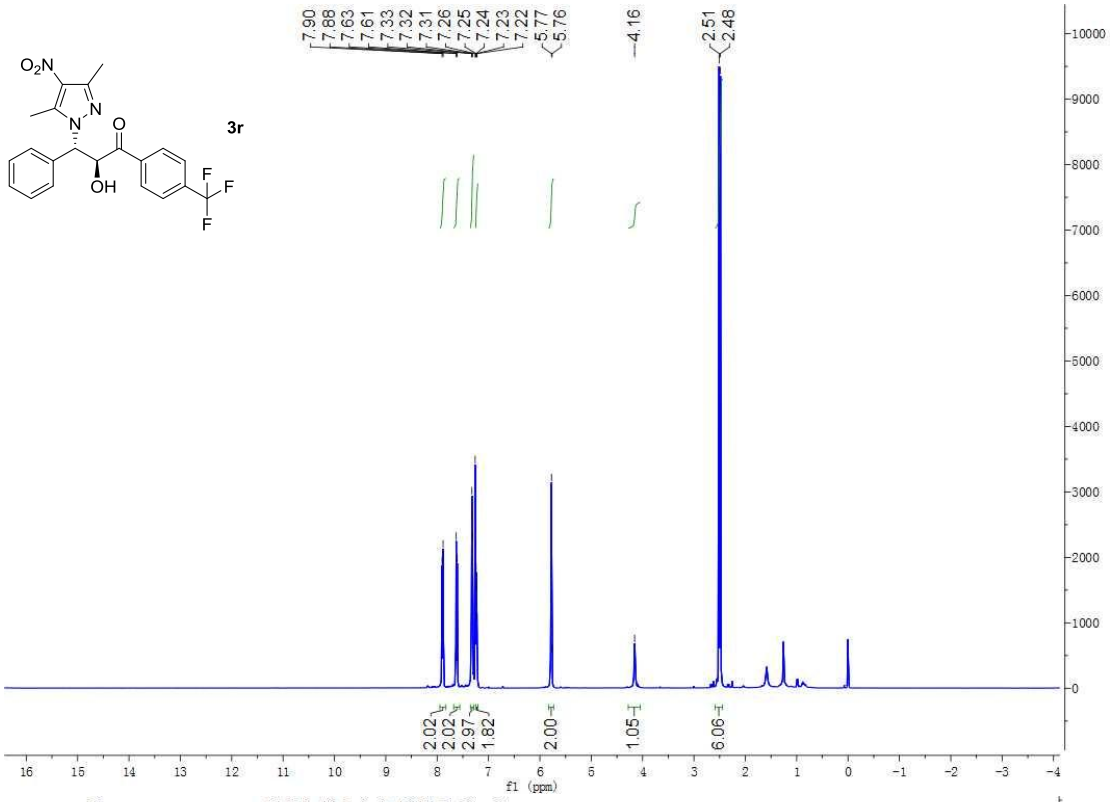
134.88
133.52
129.64
129.03
128.96
128.85
128.48
128.27
127.31
127.08
74.79
64.50
14.30
11.40
O2N
N
N
O
OH
3q
f1 (ppm)


1q
8.11
8.09
7.72
7.70
7.63
7.61
7.50
7.48
7.46
7.44
7.43
7.43
7.42
7.41
7.40
7.26
4.33
4.33
4.12
4.11
2.00
1.98
1.98
1.96
5.69
1.00
0.96
f1 (ppm)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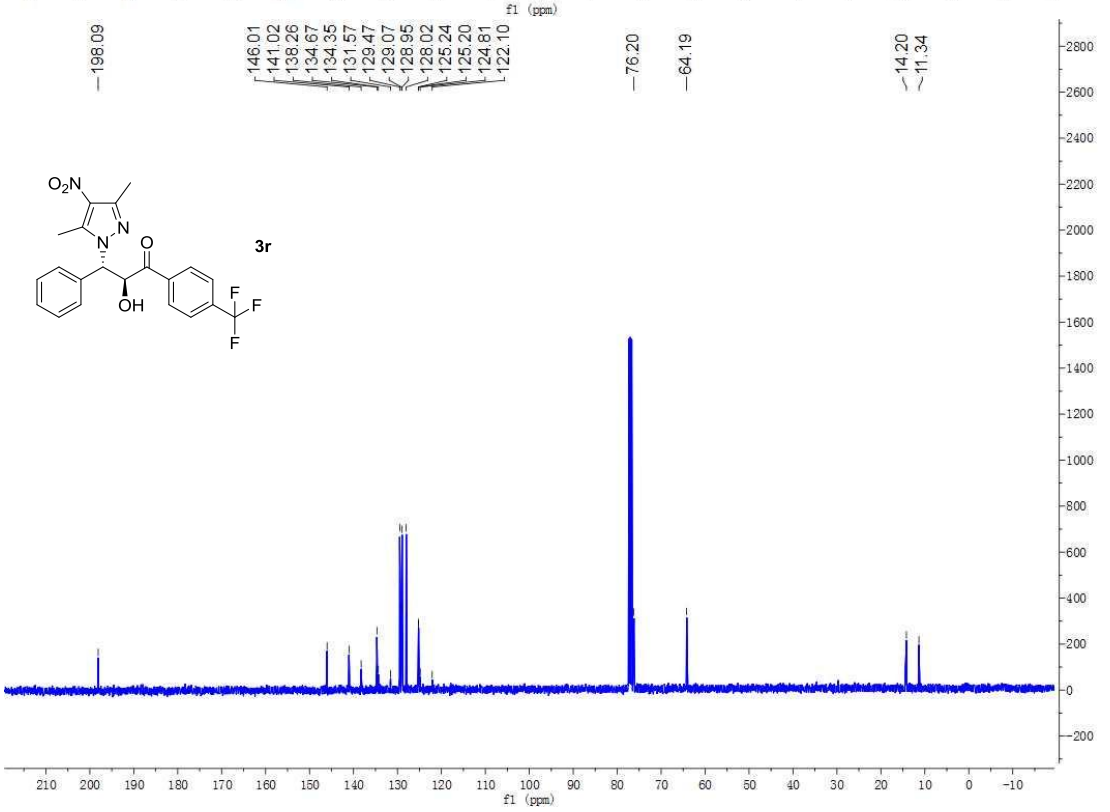
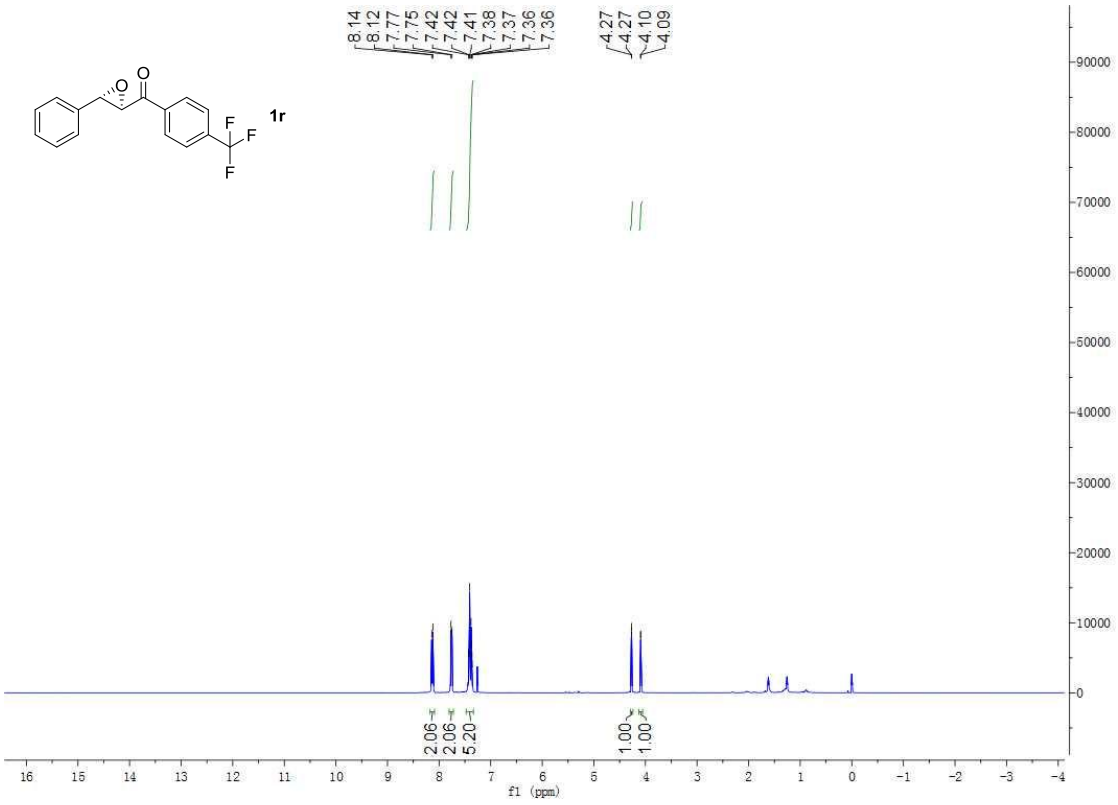
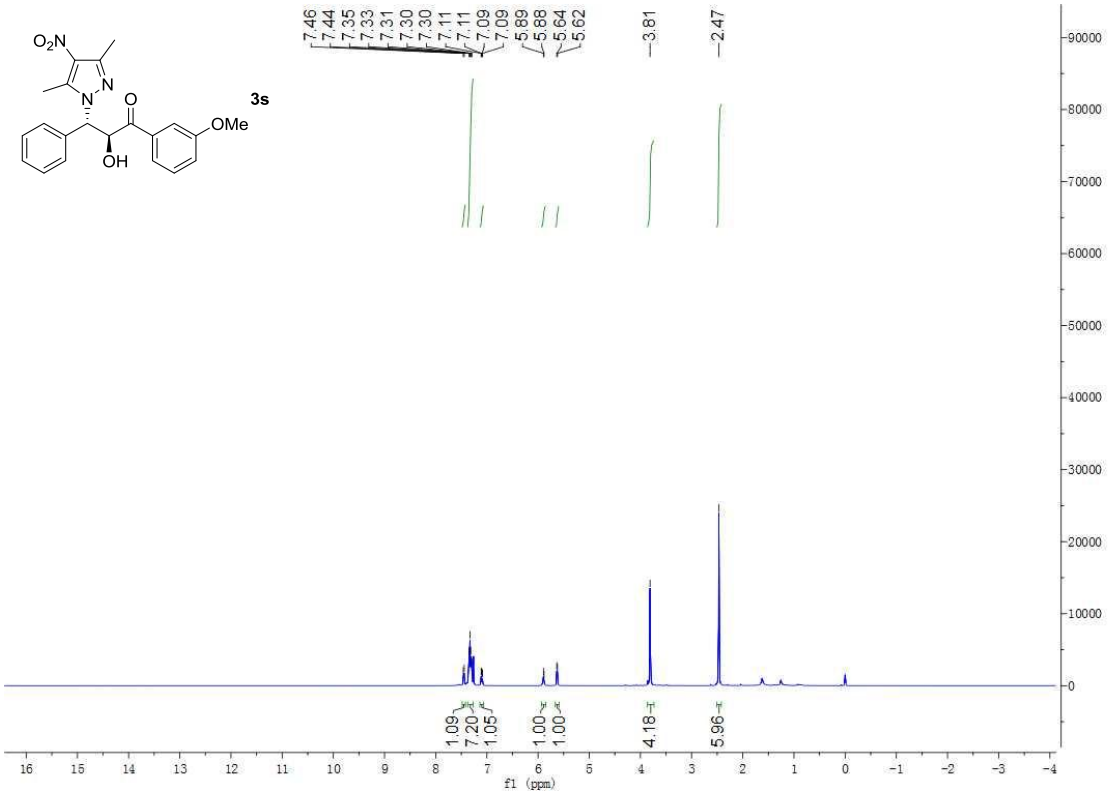
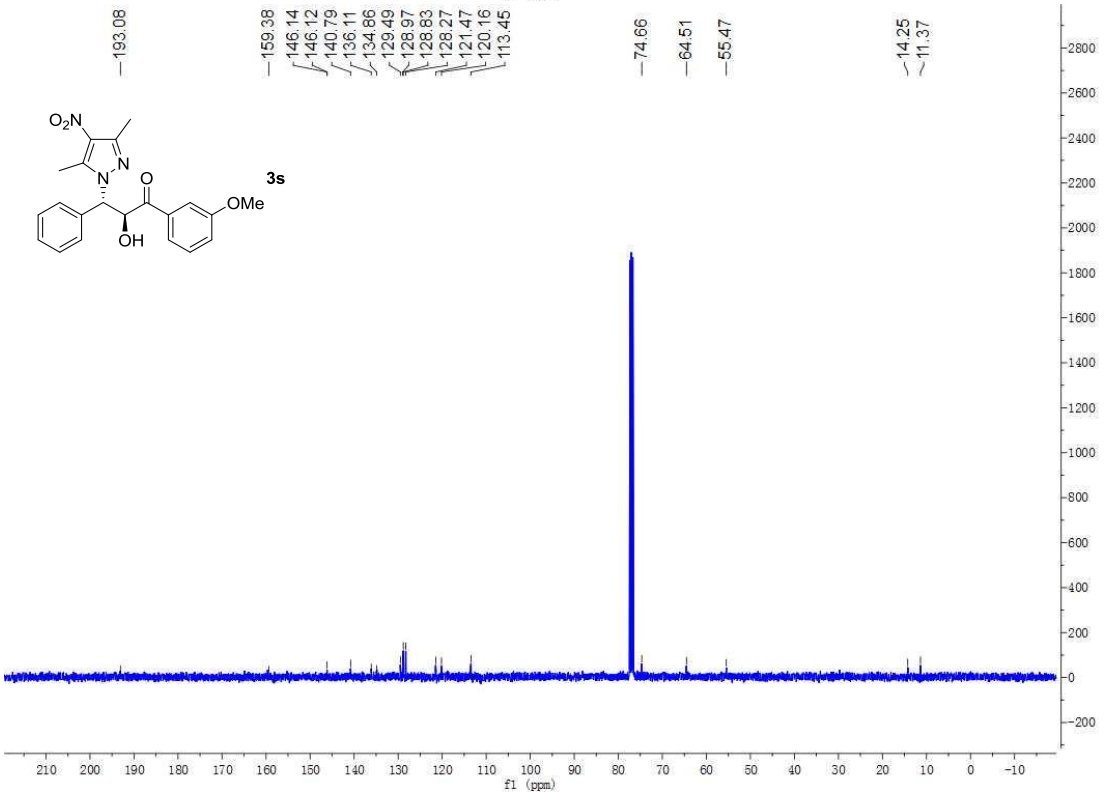
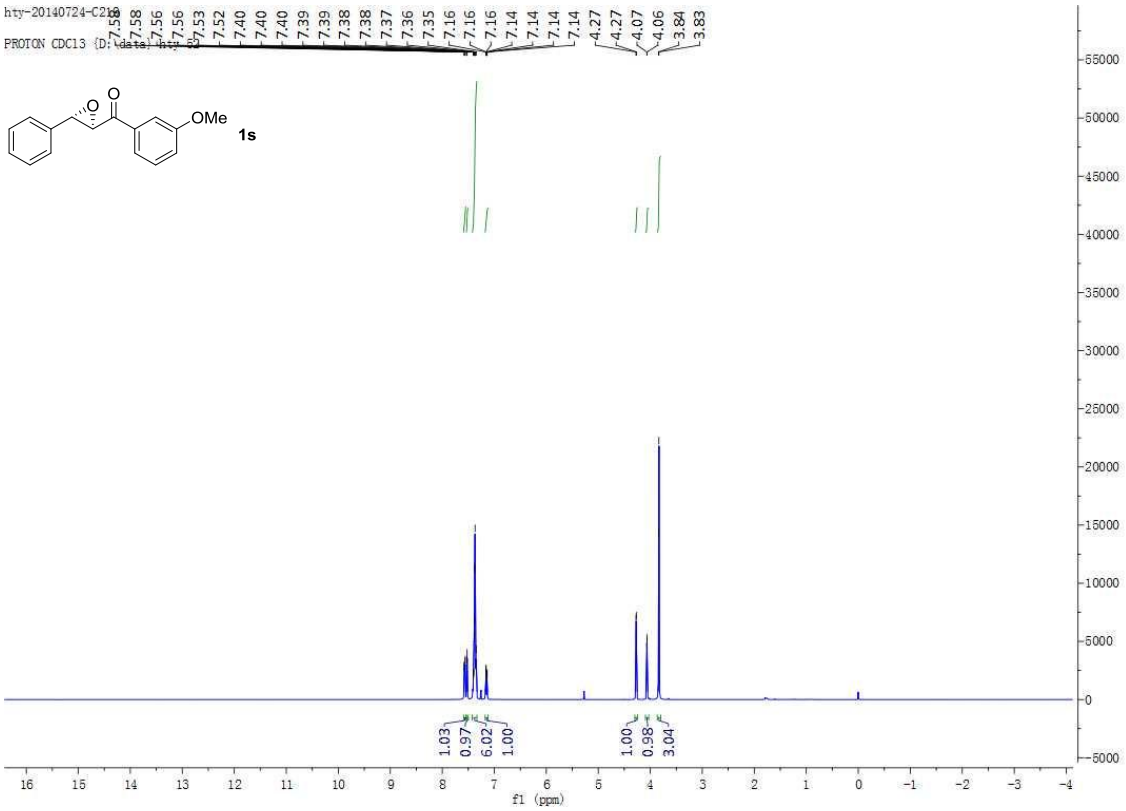
7.88
7.63
7.61
7.33
7.32
7.31
7.26
7.25
7.24
7.23
7.22
5.77
5.76
4.16
2.51
2.48
3r
2.02
2.02
2.97
1.82
2.00
1.05
6.06
f1 (ppm)

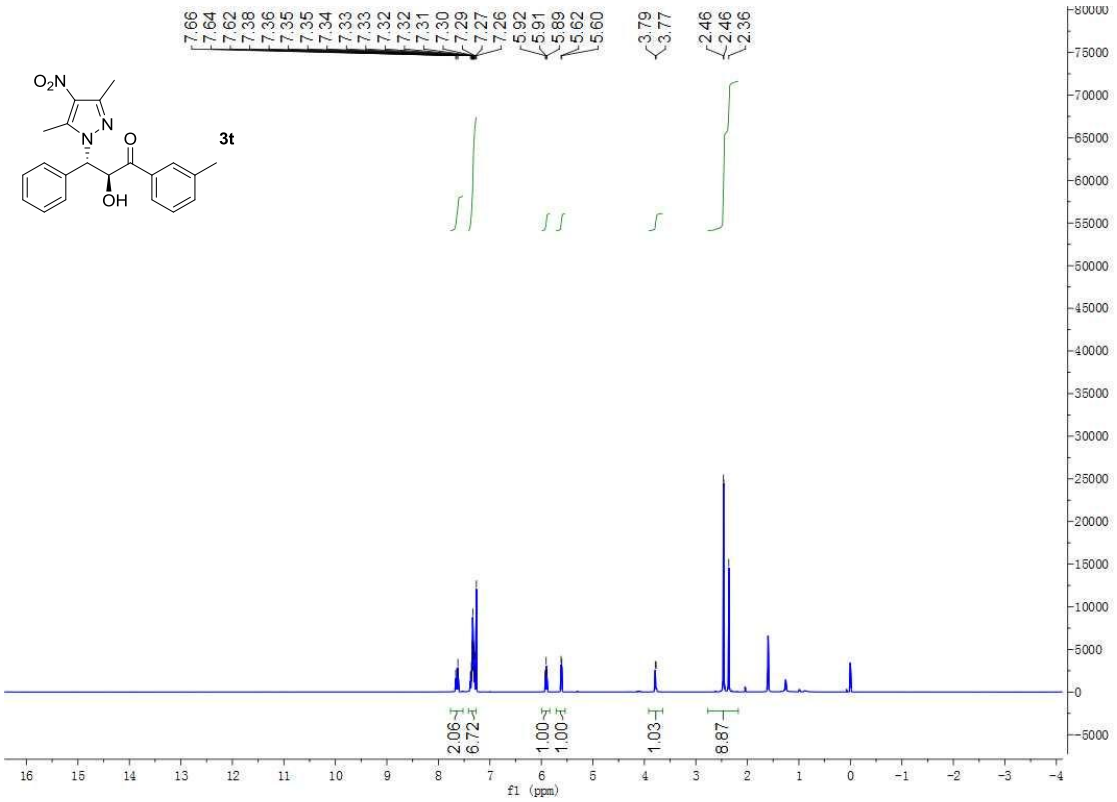

198.09
146.01
141.02
138.26
134.67
134.35
131.57
129.47
129.07
128.95
128.02
125.24
125.20
124.81
122.10
76.20
64.19
14.20
11.34
3r
f1 (ppm)


8.14
8.12
7.77
7.75
7.42
7.42
7.41
7.38
7.37
7.36
7.36
4.27
4.27
4.10
4.09
O
O
F
F
F
1r
2.06
2.06
5.20
1.00
1.00
f1 (ppm)


3s
7.46
7.44
7.35
7.33
7.31
7.30
7.30
7.11
7.11
7.09
7.09
5.89
5.88
5.64
5.62
3.81
2.47
1.09
7.20
1.05
1.00
1.00
4.18
5.96
f1 (ppm)


3s
193.08
159.38
146.14
146.12
140.79
136.11
134.86
129.49
128.97
128.83
128.27
121.47
120.16
113.45
74.66
64.51
55.47
14.25
11.37
f1 (ppm)


hty-20140724-C2h8
PROTON CDCl3
7.58
7.58
7.56
7.56
7.56
7.53
7.52
7.40
7.40
7.40
7.39
7.39
7.38
7.38
7.37
7.36
7.35
7.16
7.16
7.16
7.14
7.14
7.14
7.14
7.14
4.27
4.27
4.07
4.06
3.84
3.83
O
O
OMe
1s
1.03
0.97
6.02
1.00
1.00
0.98
3.04
f1 (ppm)


7.66
7.64
7.62
7.38
7.36
7.35
7.35
7.34
7.33
7.33
7.32
7.32
7.31
7.30
7.29
7.27
7.26
5.92
5.91
5.89
5.62
5.60
3.79
3.77
2.46
2.46
2.36
3t
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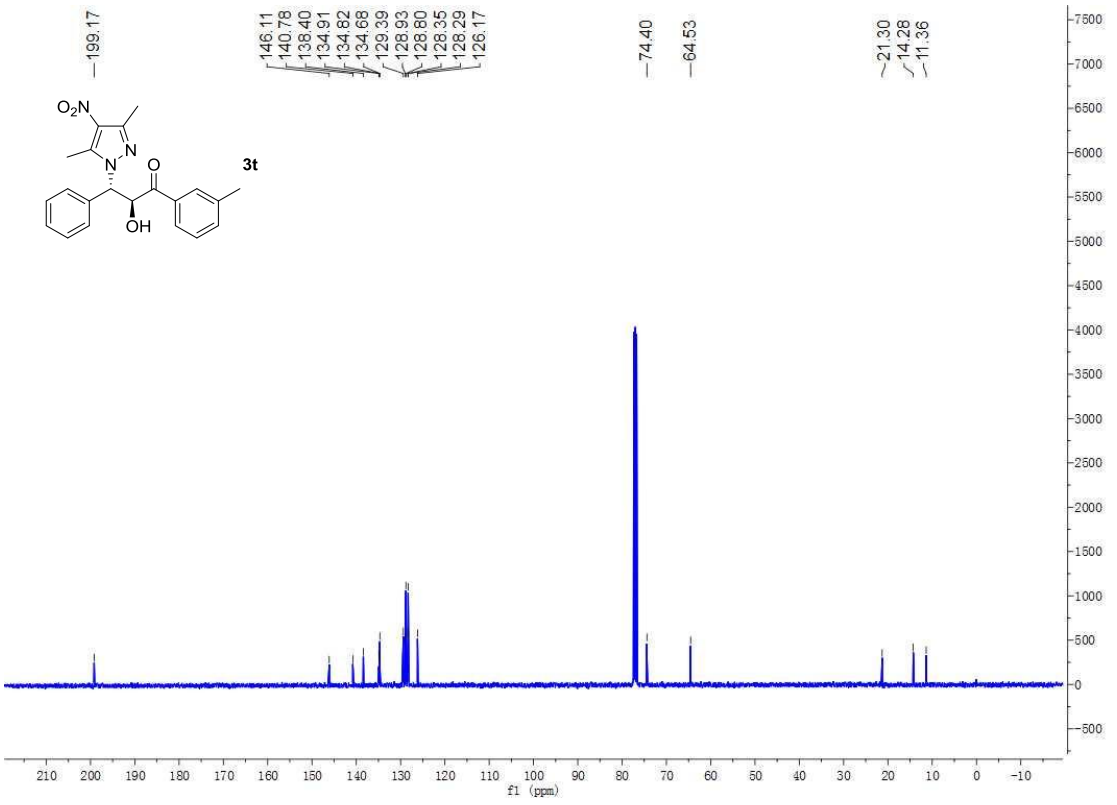
1.00
1.00
1.03
8.87
f1 (ppm)


199.17
146.11
140.78
138.40
134.91
134.82
134.68
129.39
128.93
128.80
128.35
128.29
126.17
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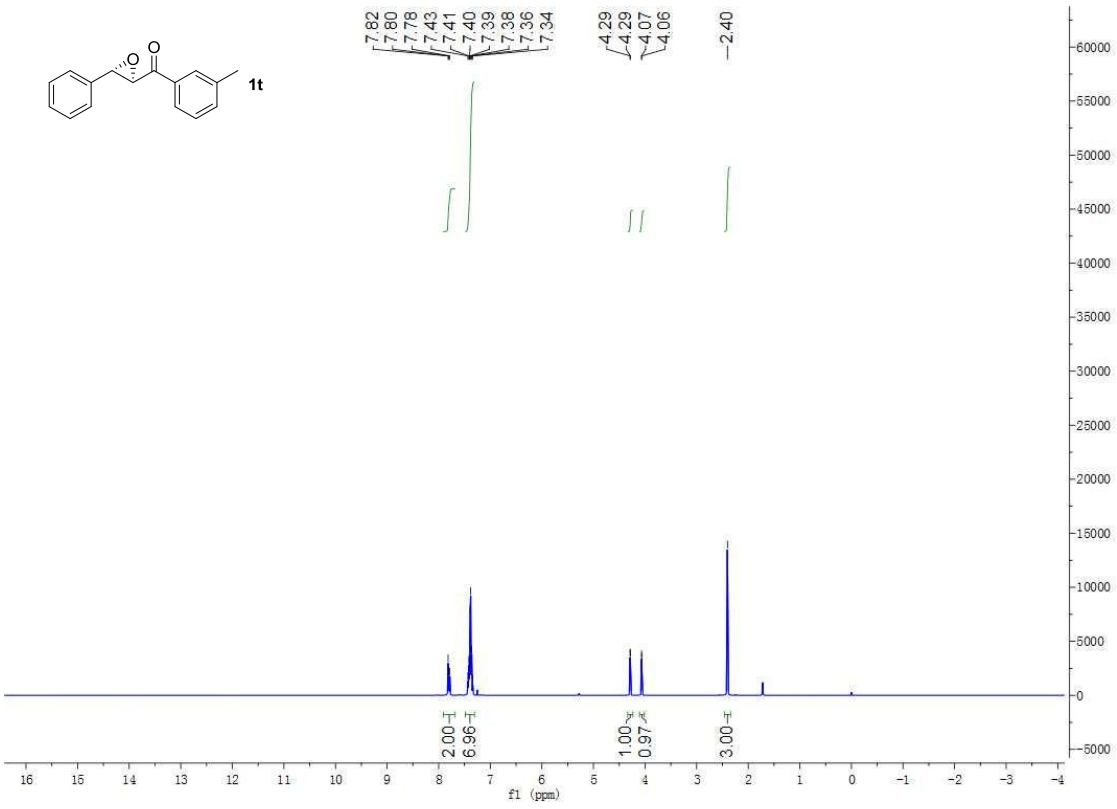
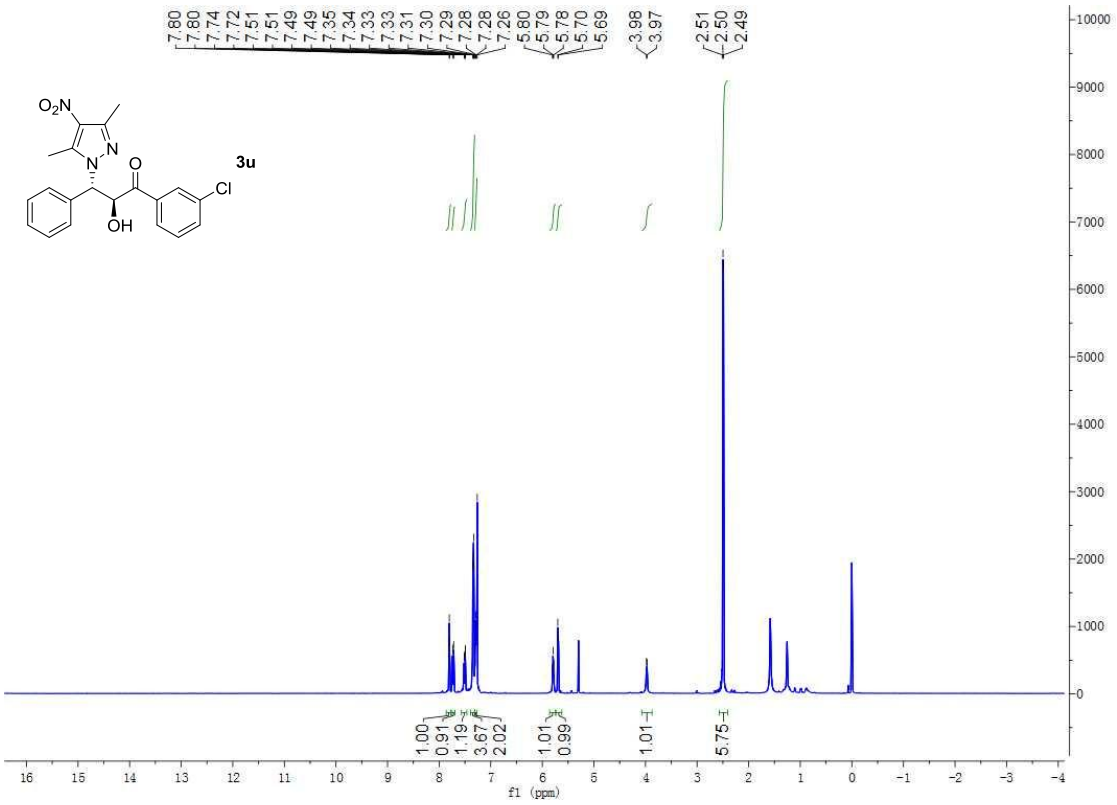
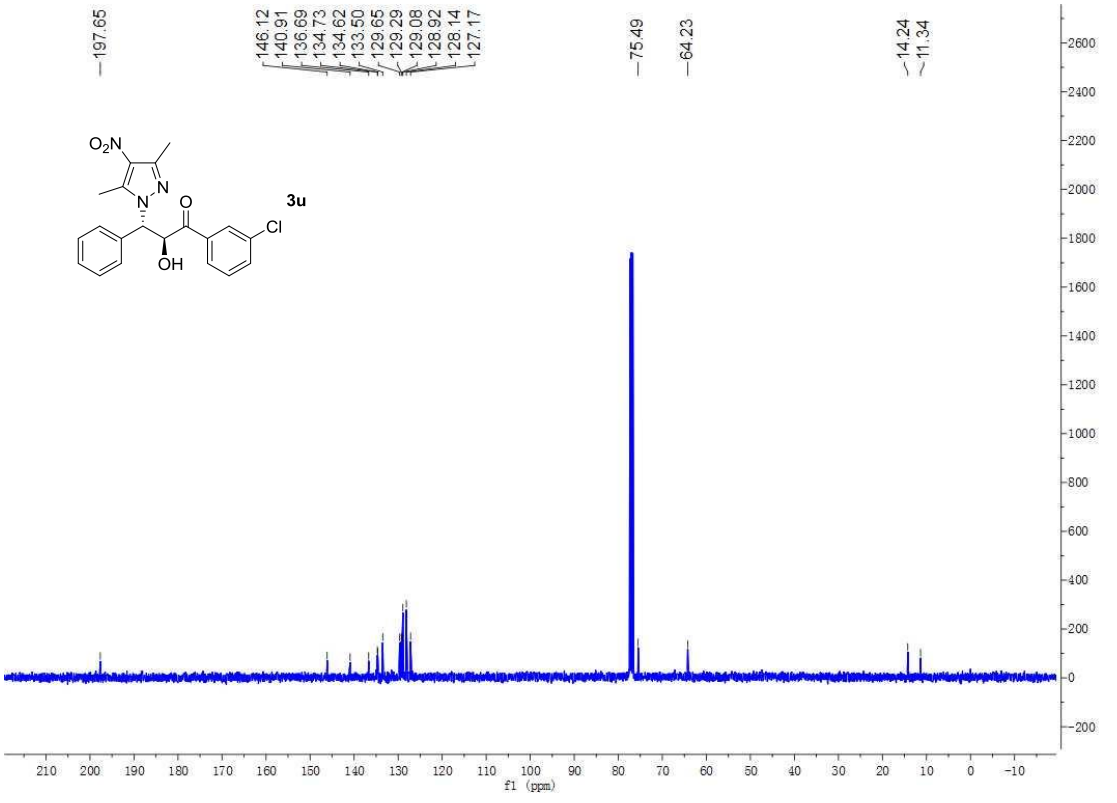
64.53
21.30
14.28
11.36
3t
f1 (ppm)


1t
7.82
7.80
7.78
7.43
7.41
7.40
7.39
7.38
7.36
7.34
4.29
4.29
4.07
4.06
2.40
2.00
6.96
1.00
0.97
3.00
f1 (ppm)


7.80
7.80
7.74
7.72
7.51
7.51
7.49
7.35
7.34
7.33
7.33
7.31
7.30
7.29
7.28
7.28
7.26
5.80
5.79
5.78
5.70
5.69
3.98
3.97
2.51
2.50
2.49
3u
1.00
0.91
1.19
3.67
2.02
1.01
0.99
1.01
5.75
f1 (ppm)


197.65
146.12
140.91
136.69
134.73
134.62
133.50
129.65
129.29
129.08
128.92
128.14
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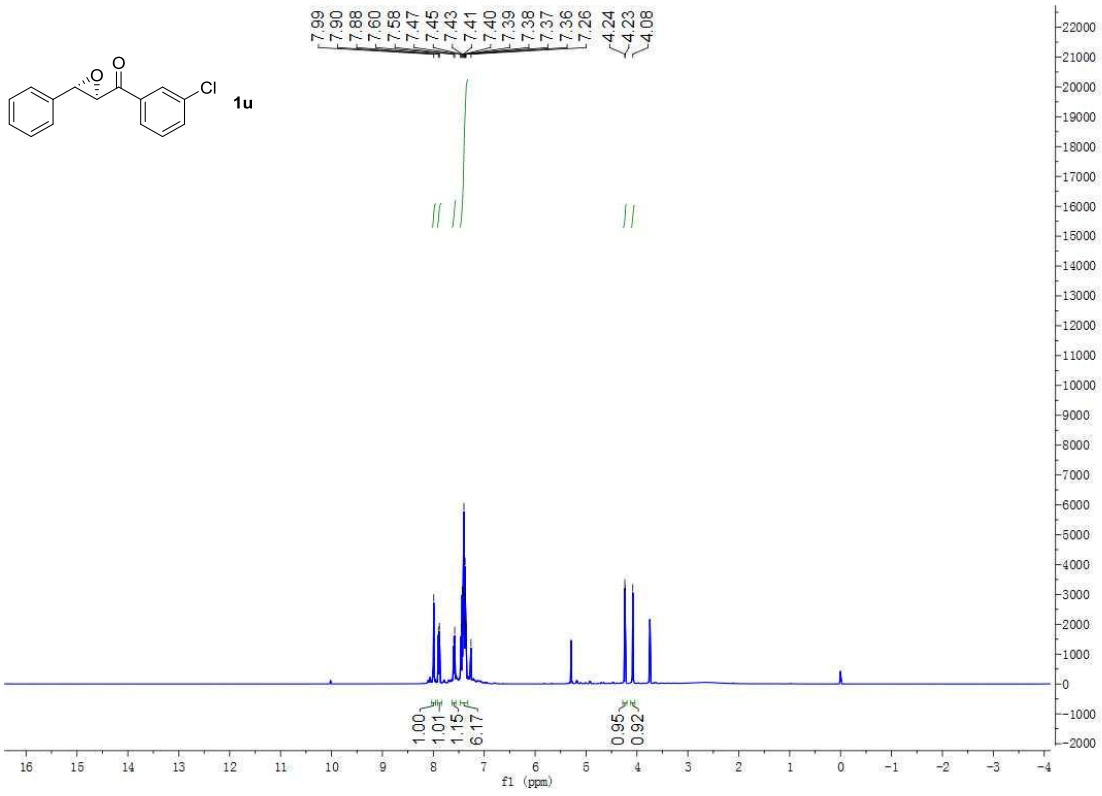
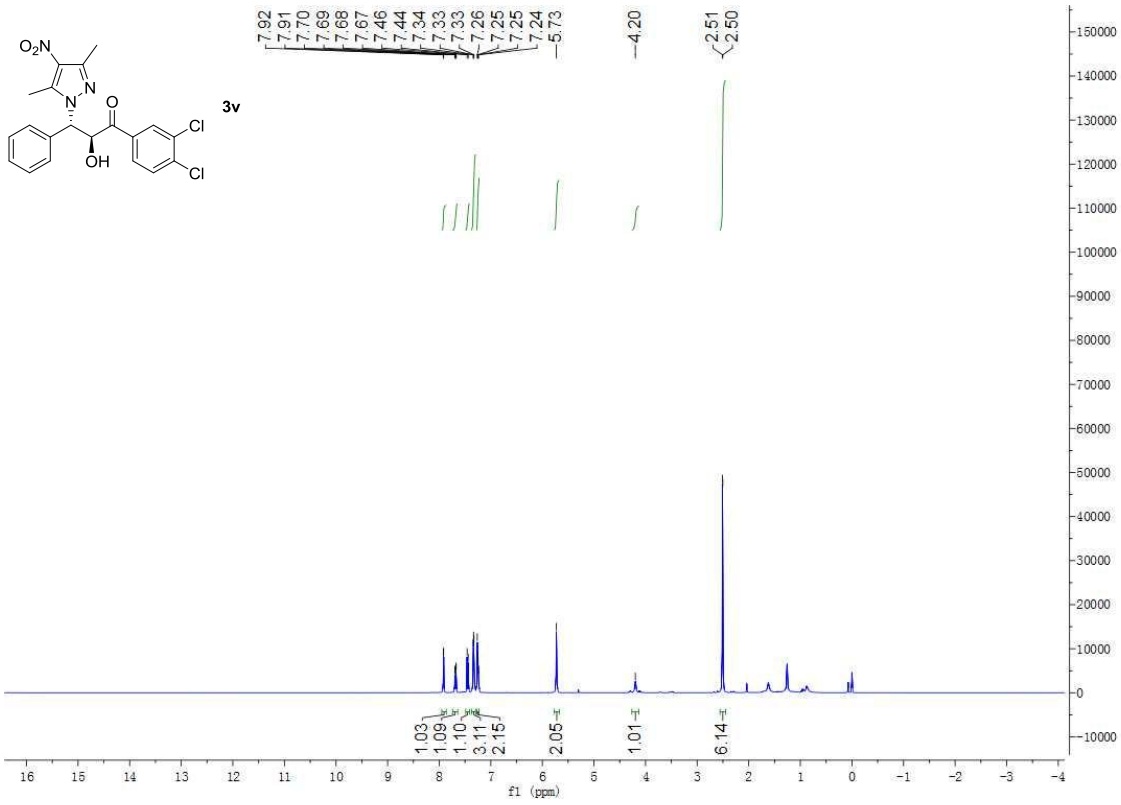
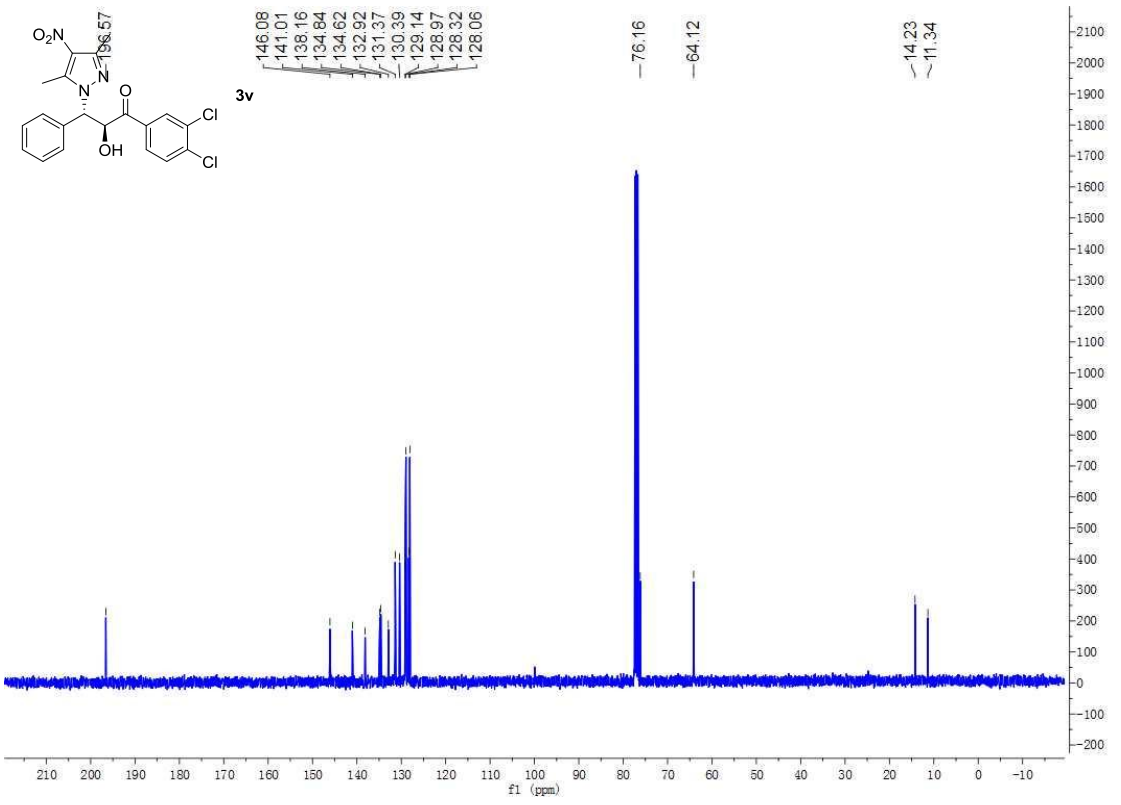
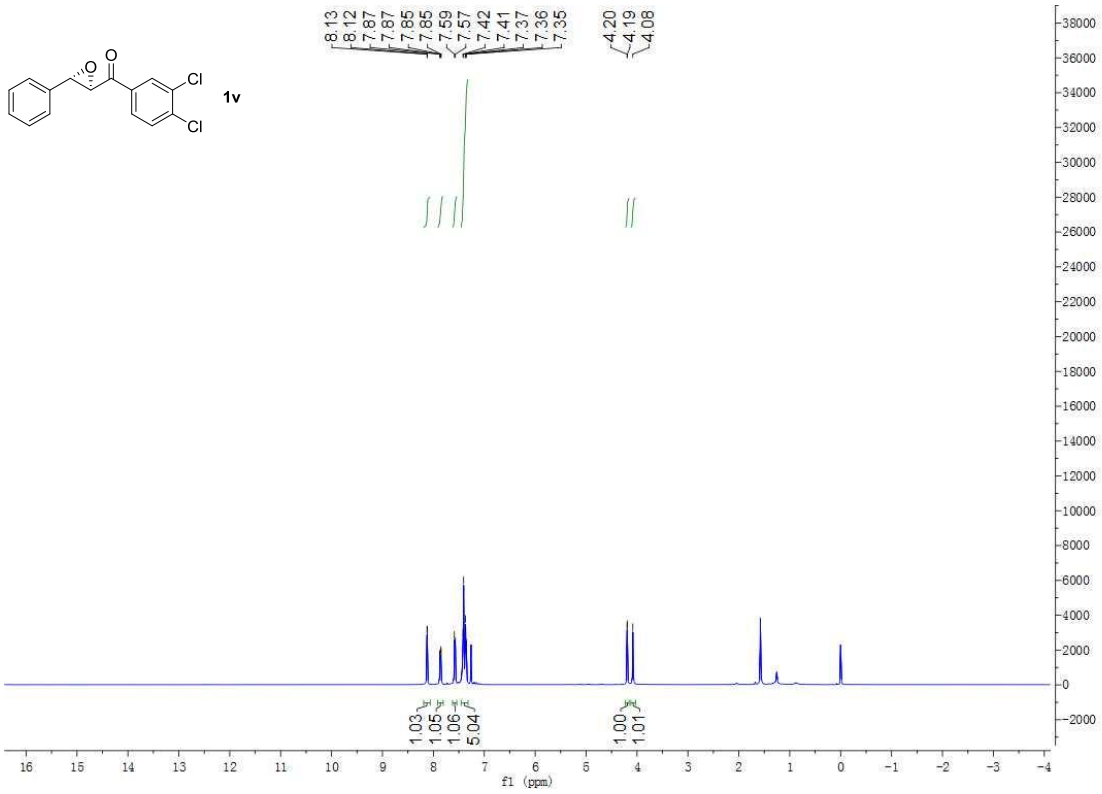
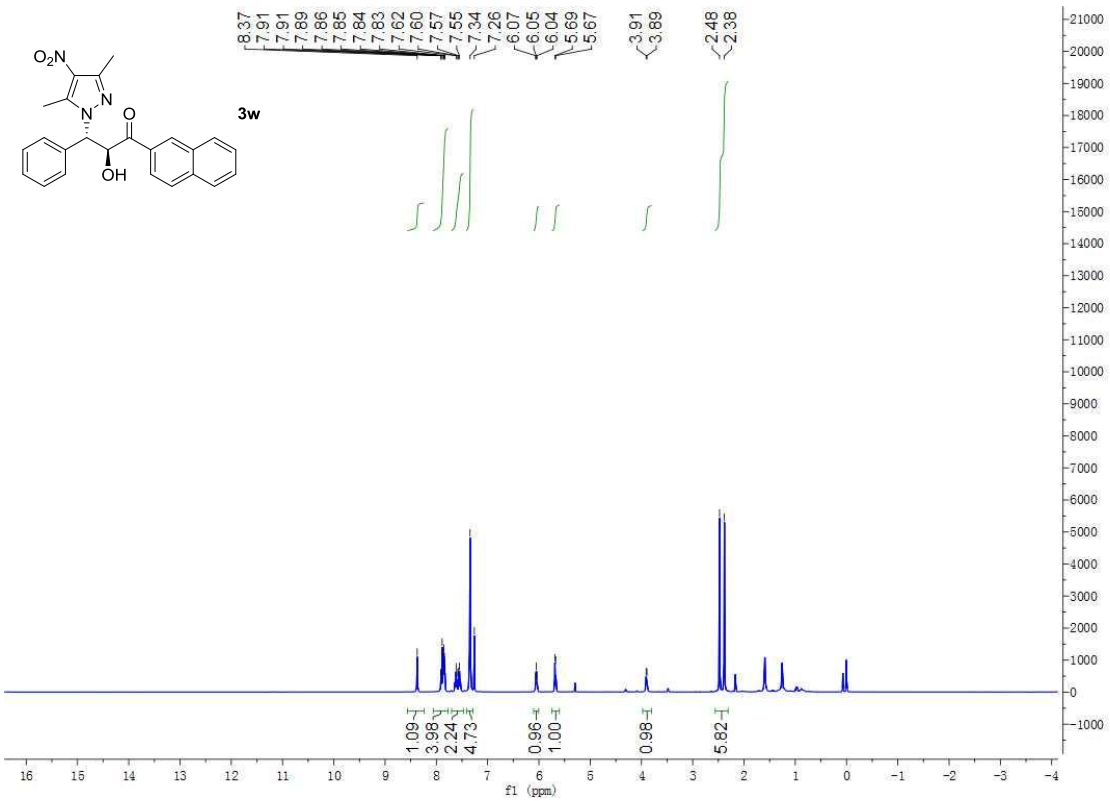
64.23
14.24
11.34
3u
f1 (ppm)

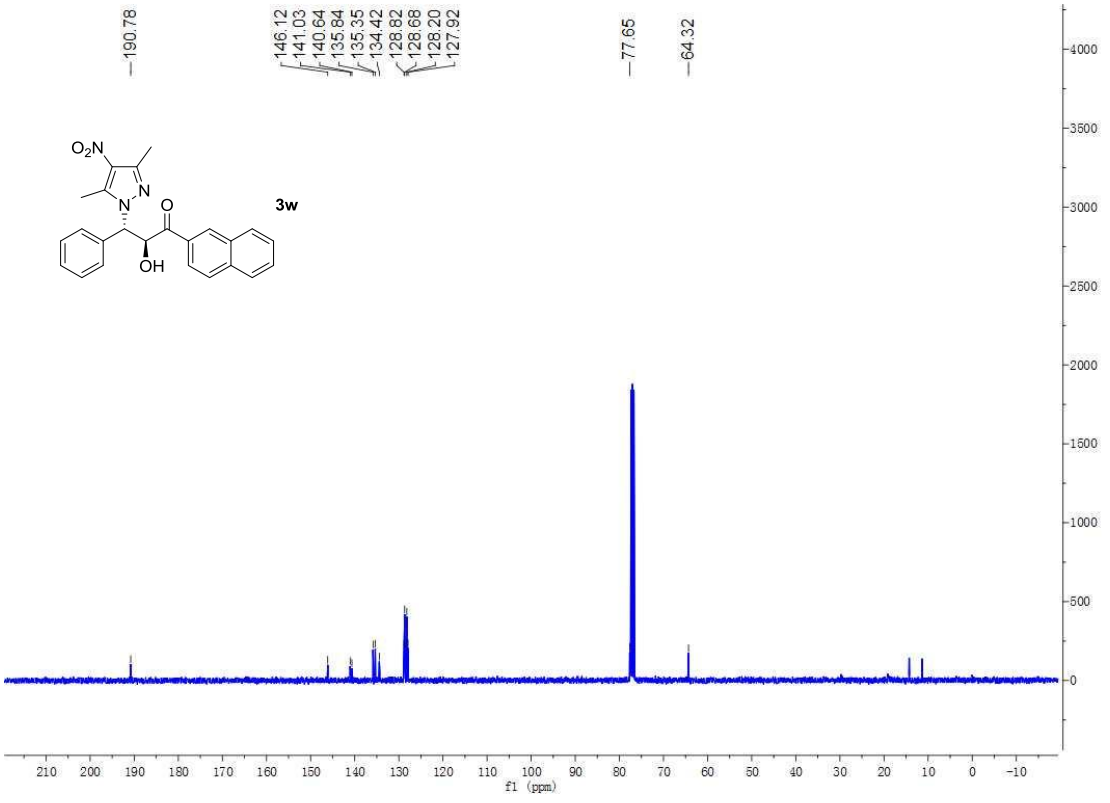

O
O
Cl
1u
7.99
7.90
7.88
7.60
7.58
7.47
7.45
7.43
7.41
7.40
7.39
7.38
7.37
7.36
7.26
4.24
4.23
4.08
1.00
1.01
1.15
6.17
0.95
0.92
f1 (ppm)

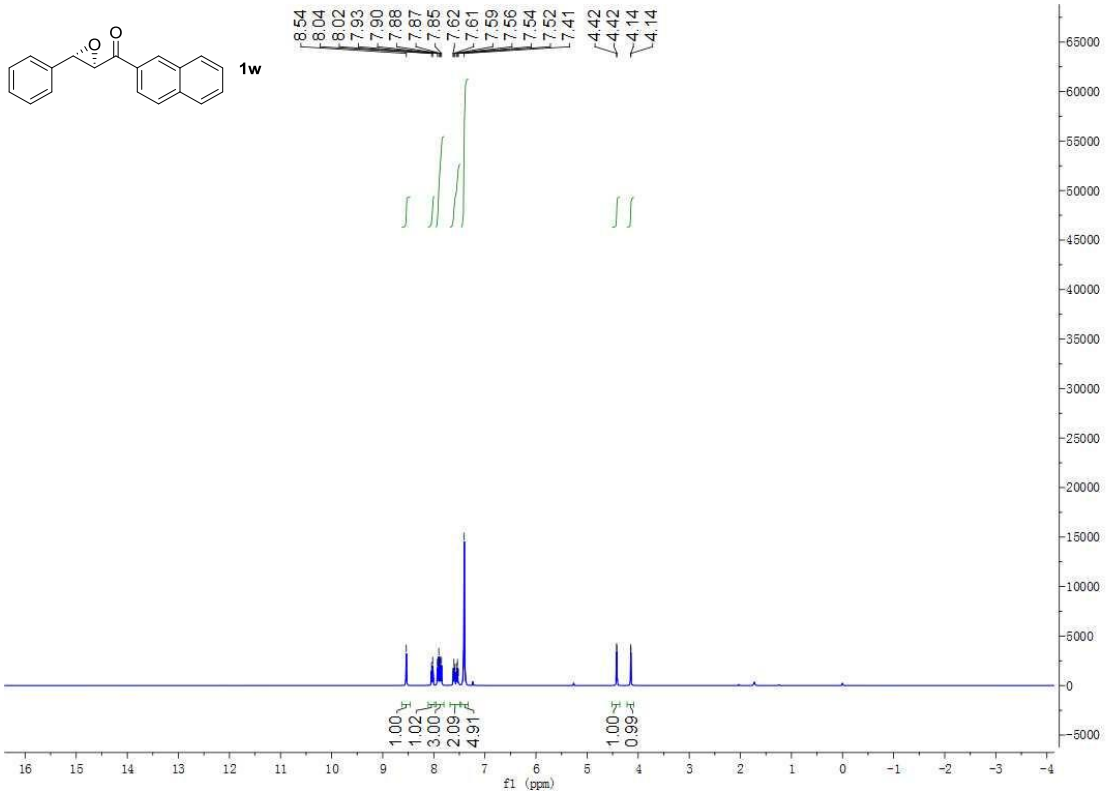

3v
7.92
7.91
7.70
7.69
7.68
7.67
7.46
7.44
7.34
7.33
7.33
7.26
7.25
7.25
7.24
5.73
4.20
2.51
2.50
1.03
1.09
1.10
3.11
2.15
2.05
1.01
6.14
f1 (ppm)

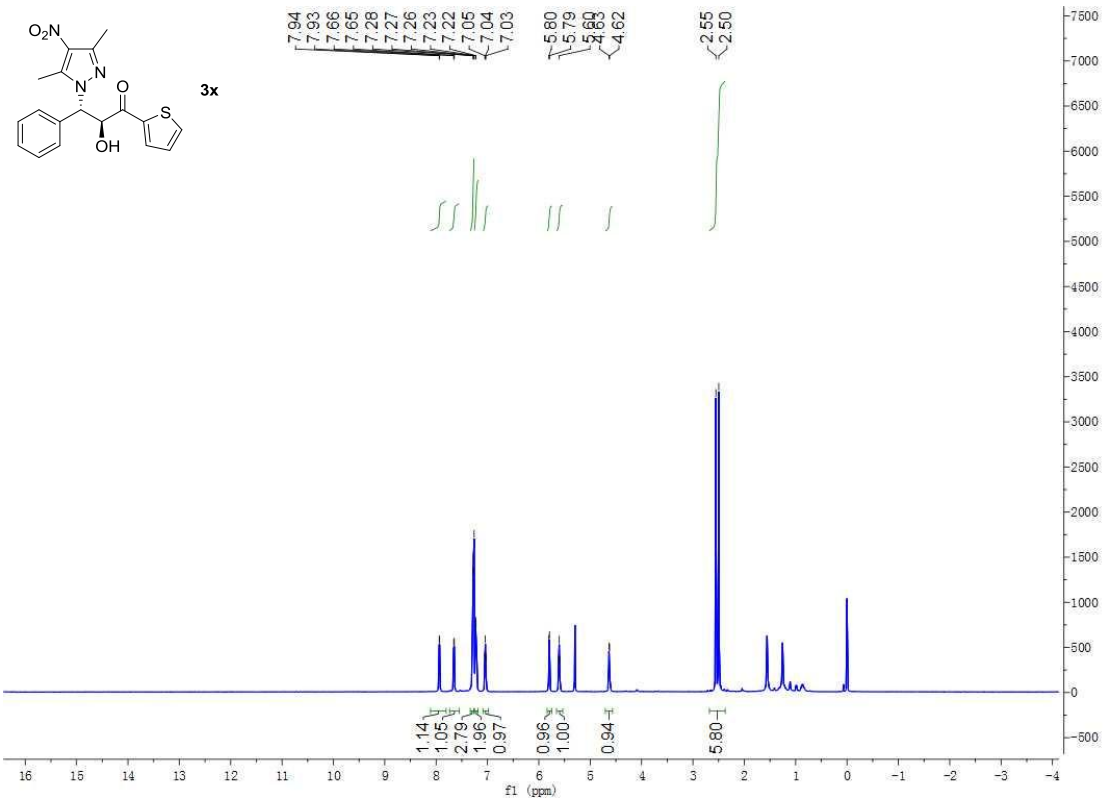

3v
196.57
146.08
141.01
138.16
134.84
134.62
132.92
131.37
130.39
129.14
128.97
128.32
128.06
76.16
64.12
14.23
11.34
f1 (ppm)

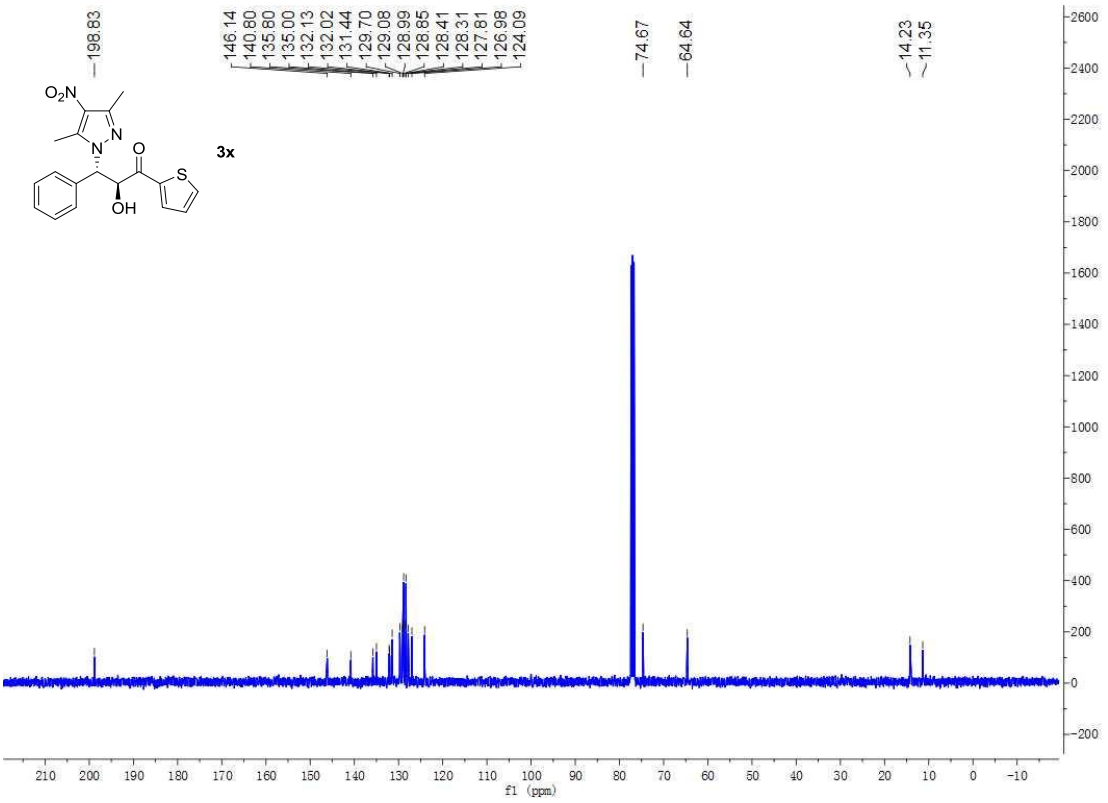

1v
Cl
Cl
O
O
8.13
8.12
7.87
7.87
7.85
7.85
7.59
7.57
7.42
7.41
7.37
7.36
7.35
4.20
4.19
4.08
1.03
1.05
1.06
5.04
1.00
1.01
f1 (ppm)

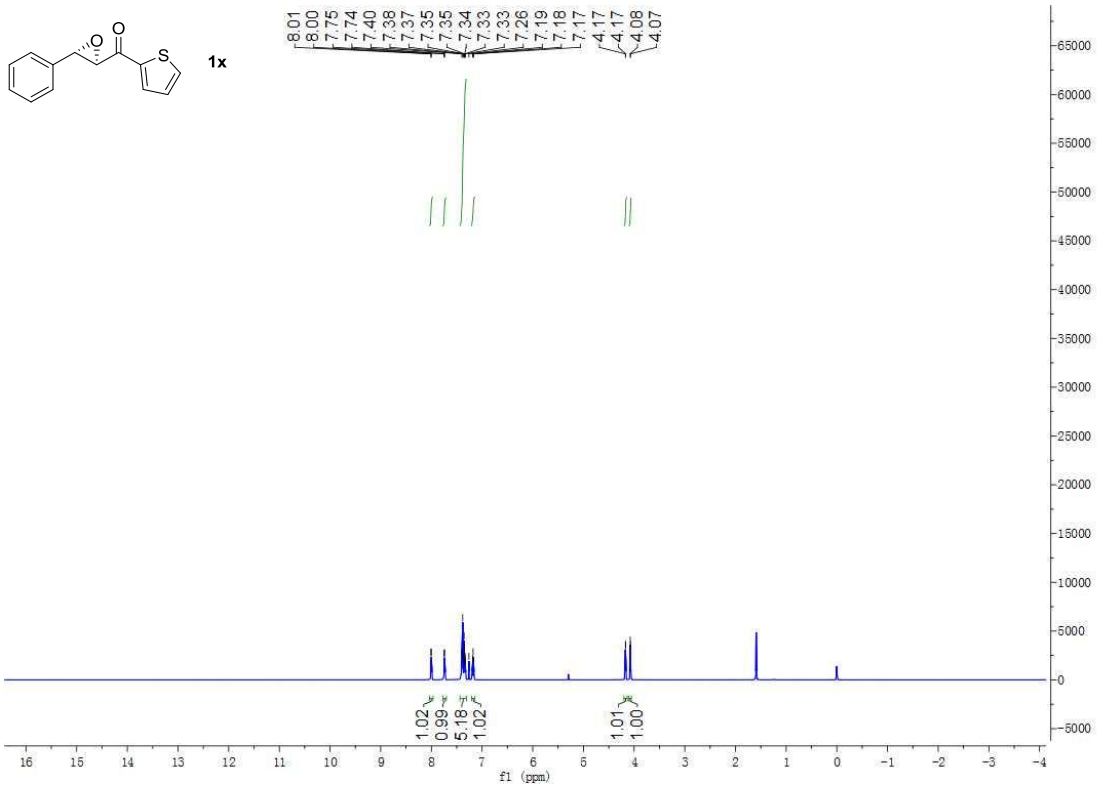

8.37
7.91
7.89
7.86
7.85
7.84
7.83
7.62
7.60
7.57
7.55
7.34
7.26
6.07
6.05
6.04
5.69
5.67
3.91
3.89
2.48
2.38
O2N
N
N
O
OH
3w
1.09
3.98
2.24
4.73
0.96
1.00
0.98
5.82
f1 (ppm)

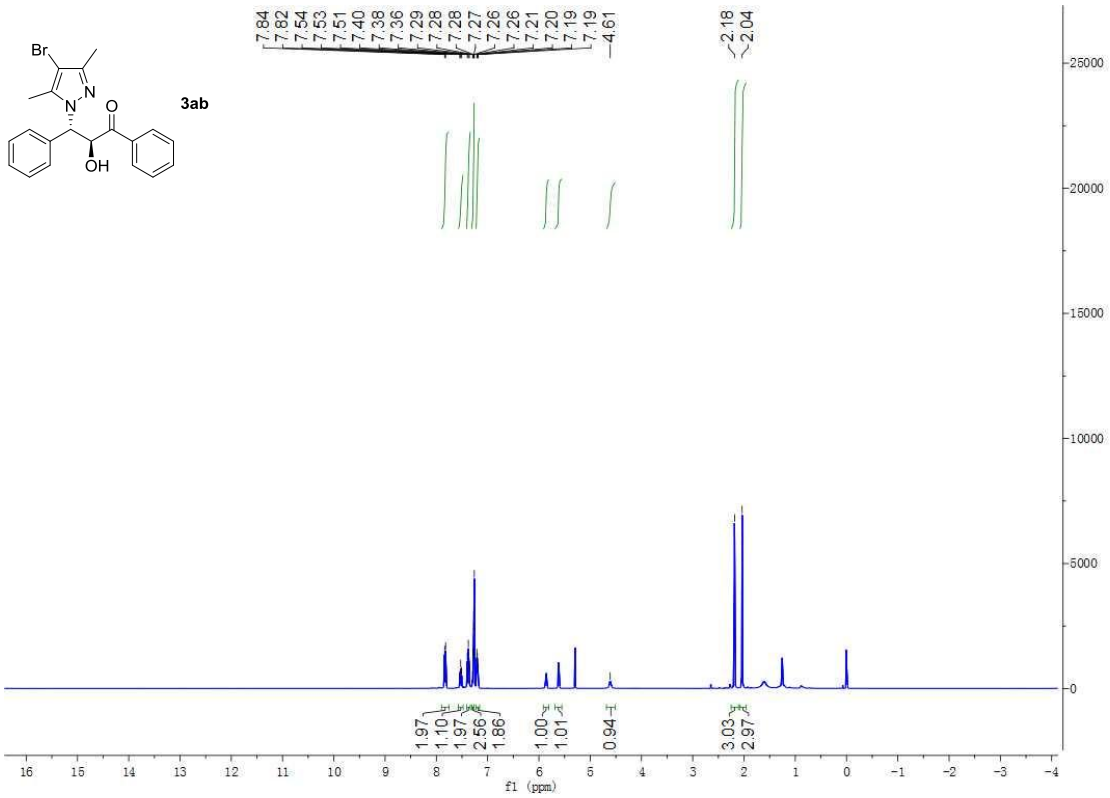

190.78
146.12
141.03
140.64
135.84
135.35
134.42
128.82
128.68
128.20
127.92
77.65
64.32
O2N
N
N
O
OH
3w
f1 (ppm)

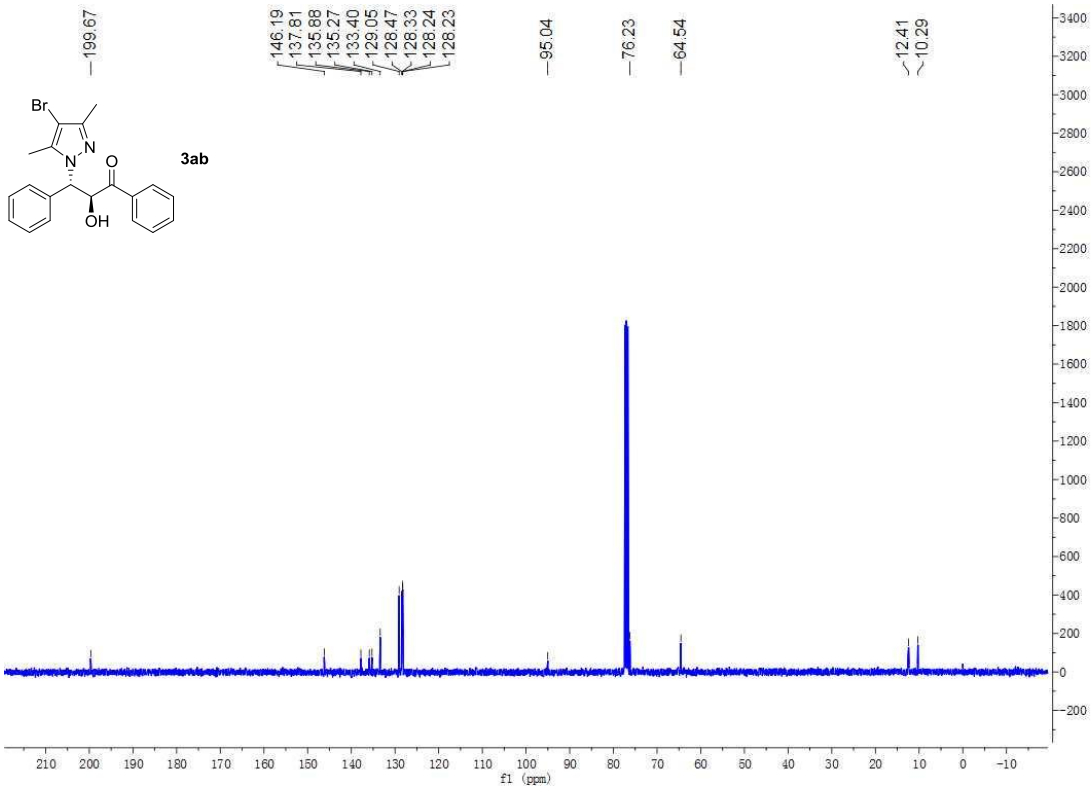

1w
8.54
8.04
8.02
7.93
7.90
7.88
7.87
7.85
7.62
7.61
7.59
7.56
7.54
7.52
7.41
4.42
4.42
4.14
4.14
1.00
1.02
3.00
2.09
4.91
1.00
0.99
f1 (ppm)

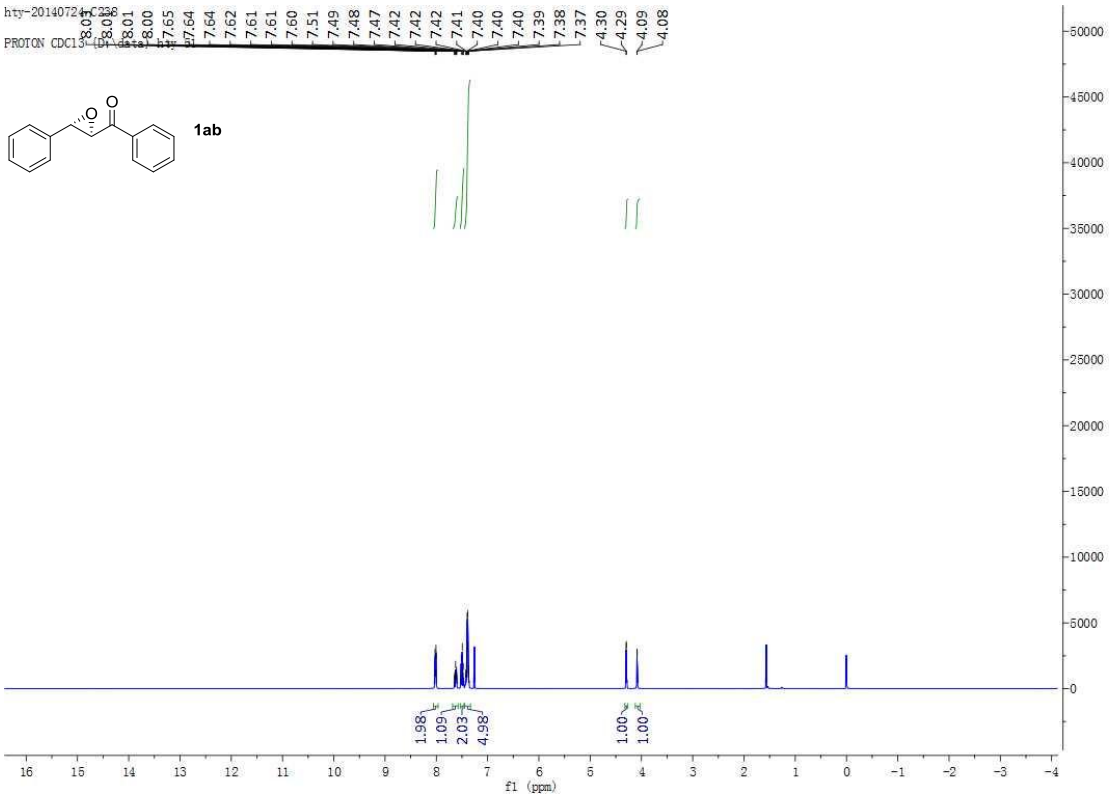

3x
7.94
7.93
7.66
7.65
7.28
7.27
7.26
7.23
7.22
7.05
7.04
7.03
5.80
5.79
5.60
4.63
4.62
2.55
2.50
1.14
1.05
2.79
1.96
0.97
0.96
1.00
0.94
5.80
f1 (ppm)

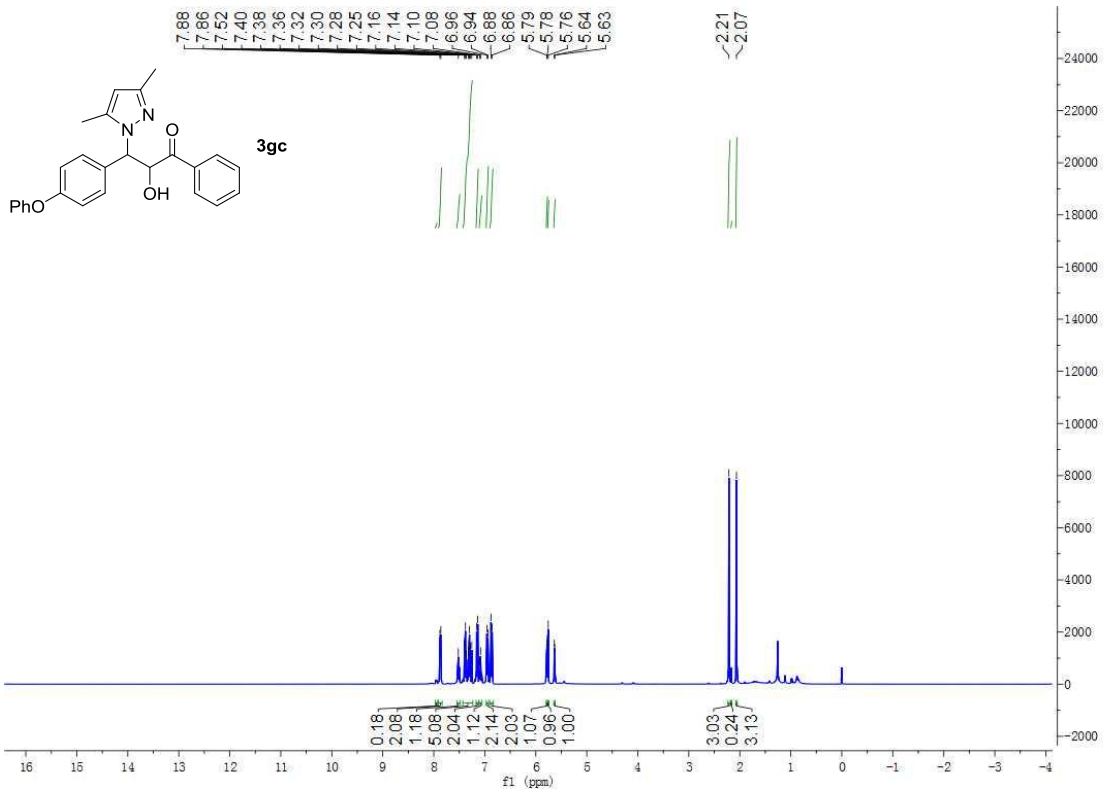

3x
198.83
146.14
140.80
135.80
135.00
132.13
132.02
131.44
129.70
129.08
128.99
128.85
128.41
128.31
127.81
126.98
124.09
74.67
64.64
14.23
11.35
f1 (ppm)


1x
8.01
8.00
7.75
7.74
7.40
7.38
7.37
7.35
7.35
7.34
7.33
7.33
7.26
7.19
7.18
7.17
4.17
4.17
4.08
4.07
1.02
0.99
5.18
1.02
1.01
1.00
f1 (ppm)


Br
N
N
O
OH
3ab
7.84
7.82
7.54
7.53
7.51
7.40
7.38
7.36
7.29
7.28
7.28
7.27
7.26
7.26
7.21
7.20
7.19
7.19
4.61
2.18
2.04
1.97
1.10
1.97
2.56
1.86
1.00
1.01
0.94
3.03
2.97
f1 (ppm)


Br
N
N
O
OH
3ab
199.67
146.19
137.81
135.88
135.27
133.40
129.05
128.47
128.33
128.24
128.23
95.04
76.23
64.54
12.41
10.29
f1 (ppm)


hty-20140724-C238
PROTON CDCl3 (DY-data) hty
8.03
8.02
8.01
8.00
7.65
7.64
7.64
7.62
7.61
7.61
7.60
7.51
7.49
7.48
7.47
7.42
7.42
7.42
7.41
7.40
7.40
7.40
7.39
7.38
7.37
4.30
4.29
4.09
4.08
1ab
1.98
1.09
2.03
4.98
1.00
1.00
f1 (ppm)


7.88
7.86
7.52
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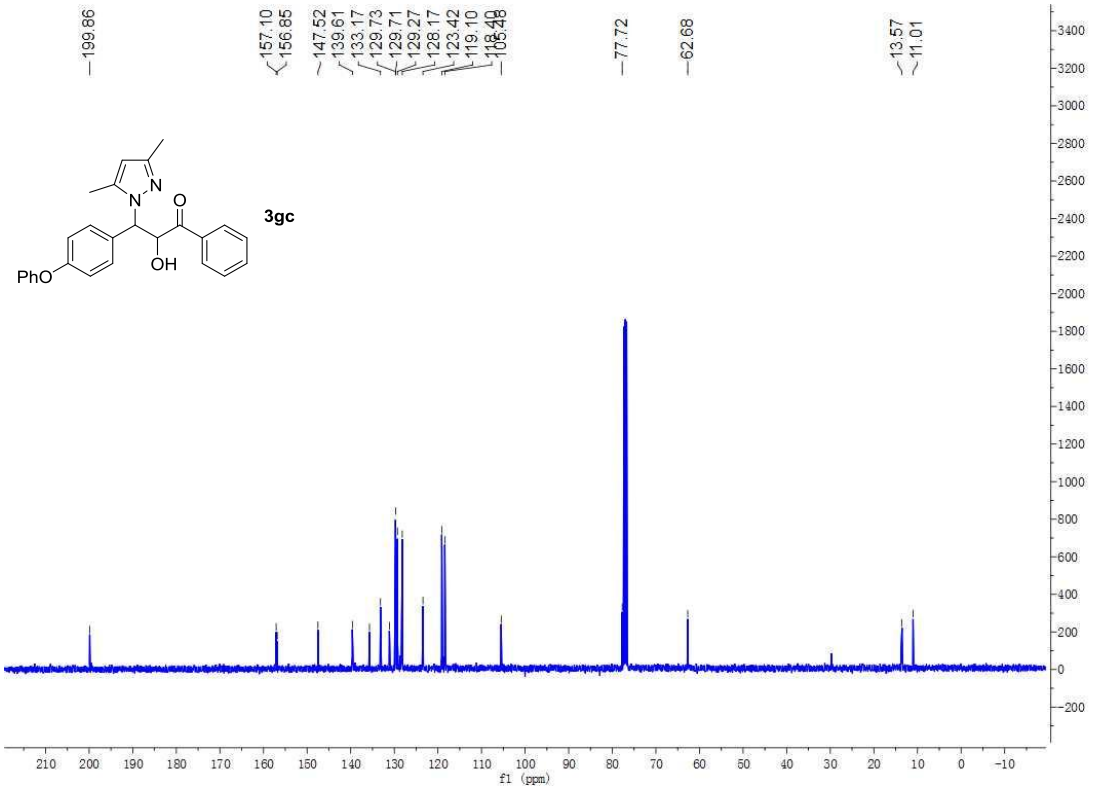
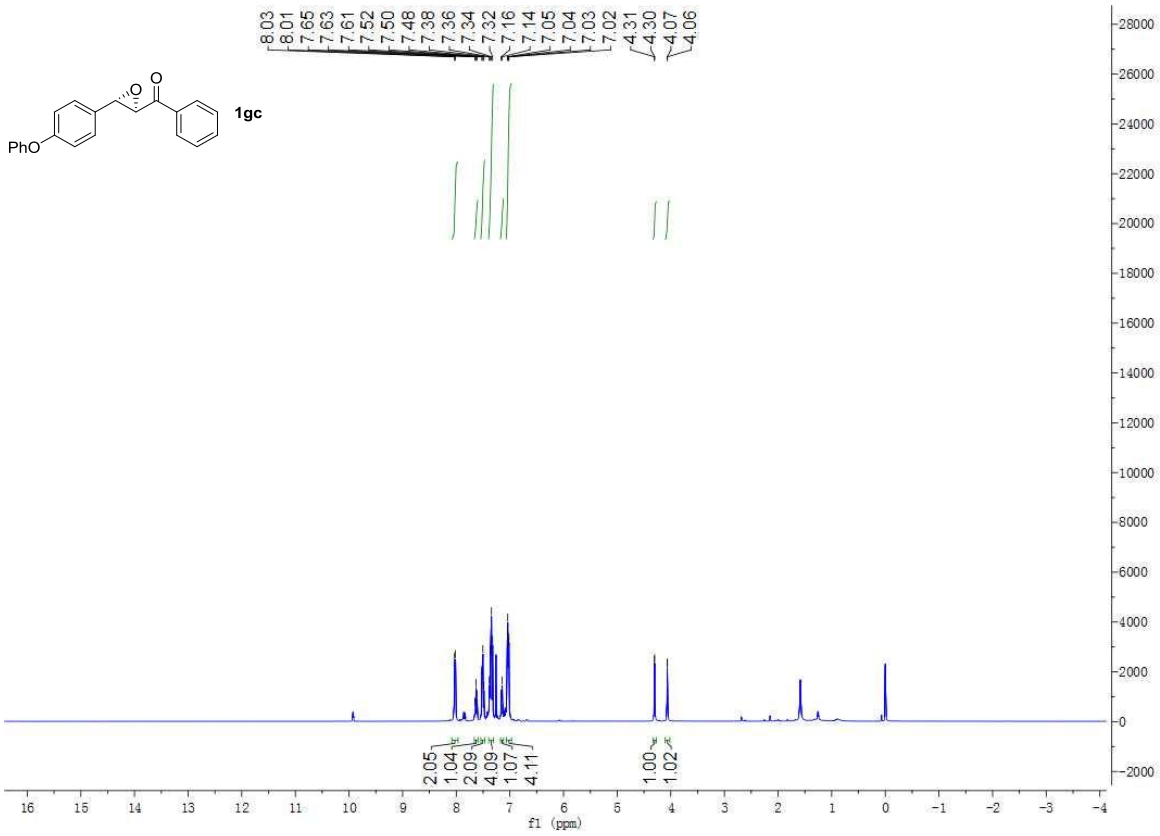
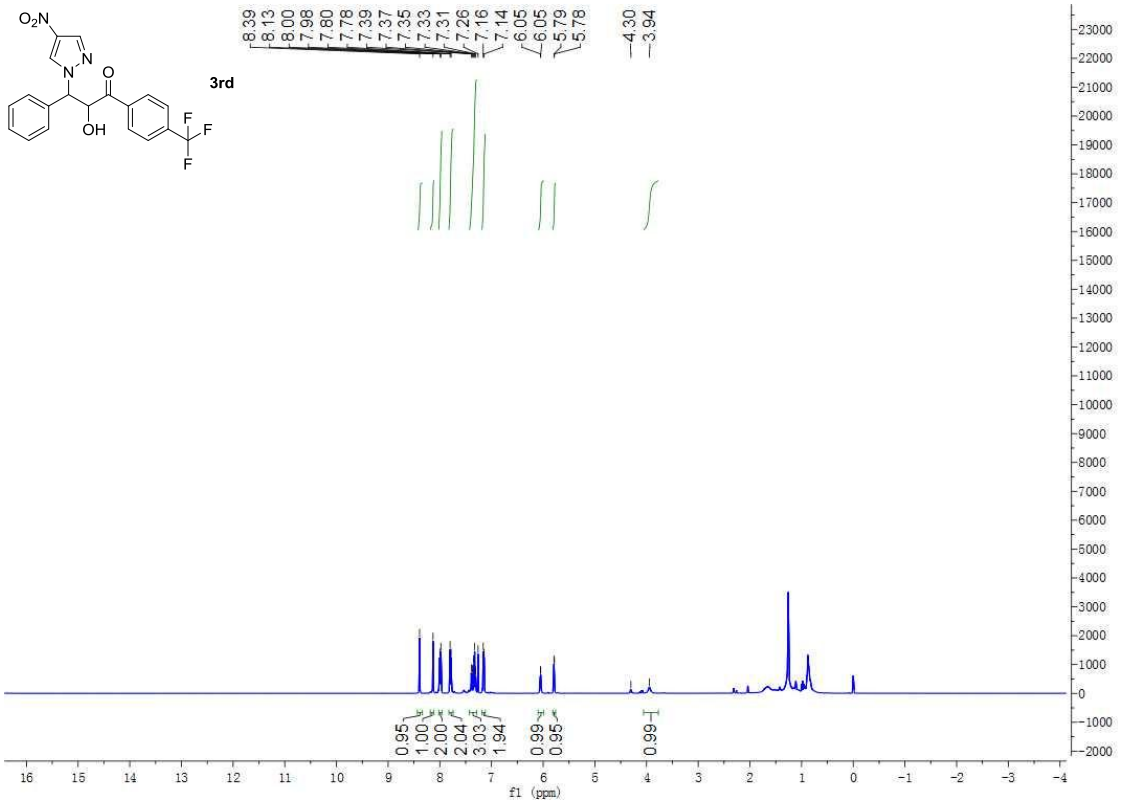
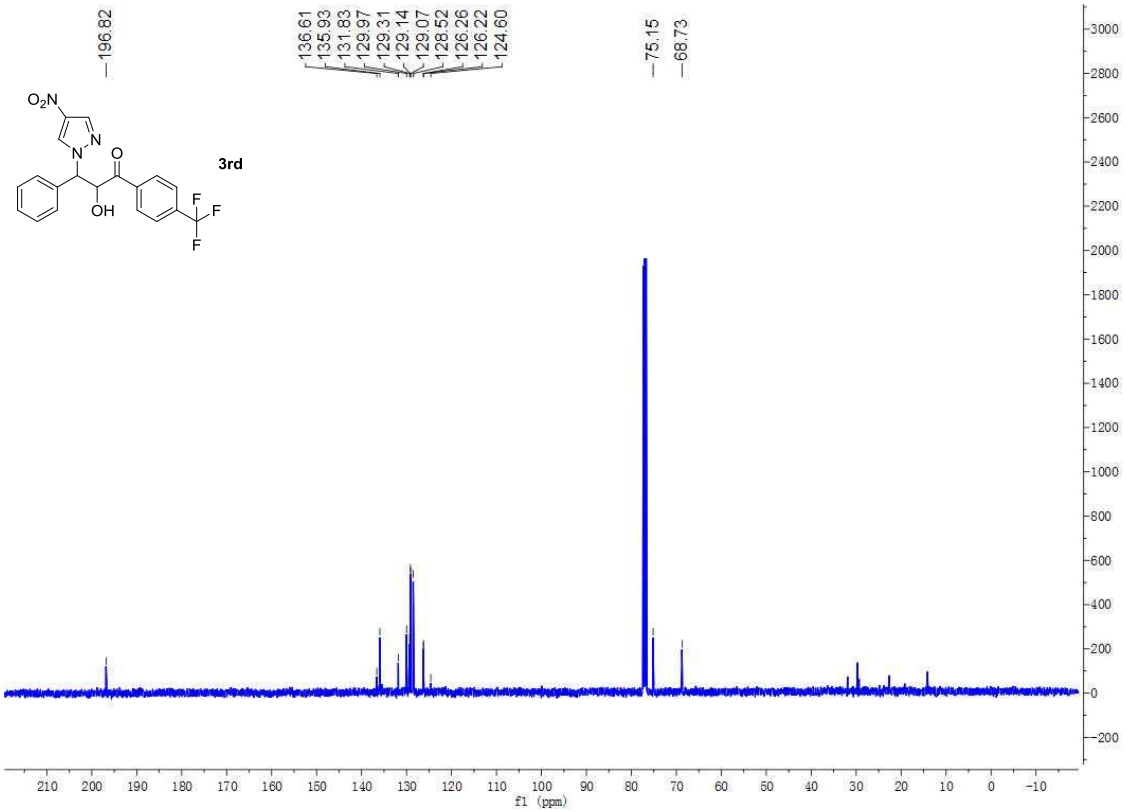
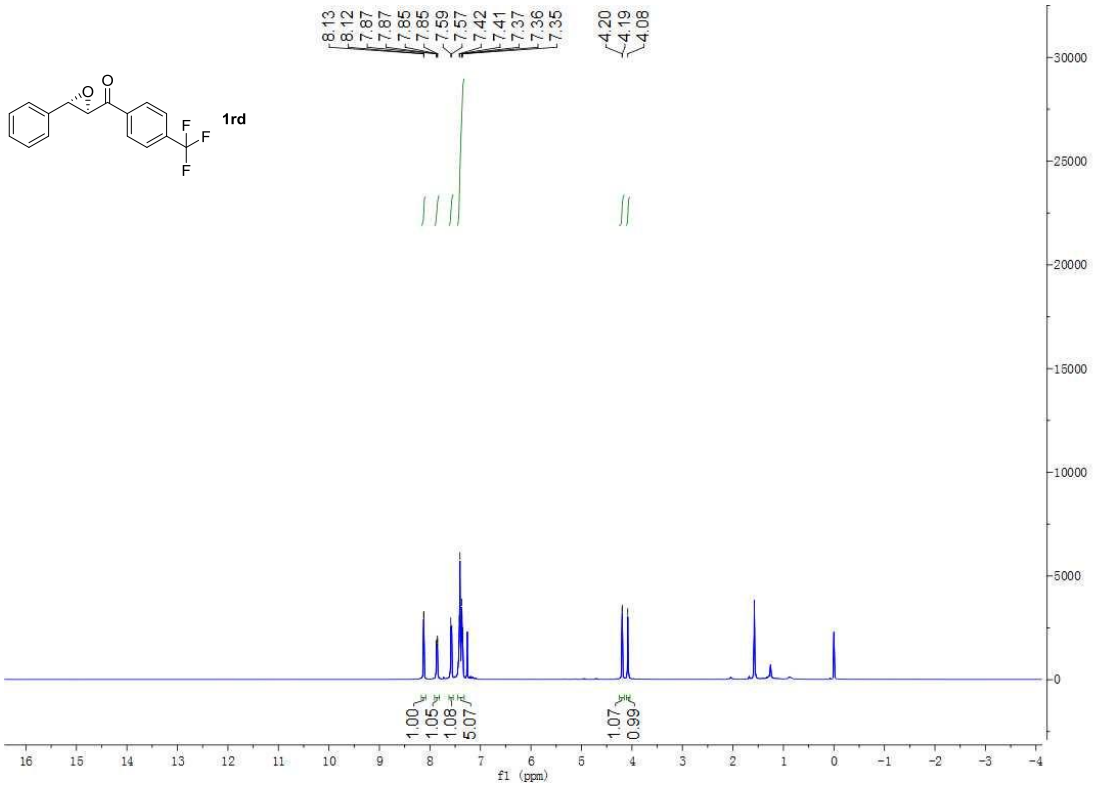
7.38
7.36
7.32
7.30
7.28
7.25
7.16
7.14
7.10
7.08
6.96
6.94
6.88
6.86
5.79
5.78
5.76
5.64
5.63
2.21
2.07
3gc
PhO
OH
O
N
0.18
2.08
1.18
5.08
2.04
1.12
2.14
2.03
1.07
0.96
1.00
3.03
0.24
3.13
f1 (ppm)

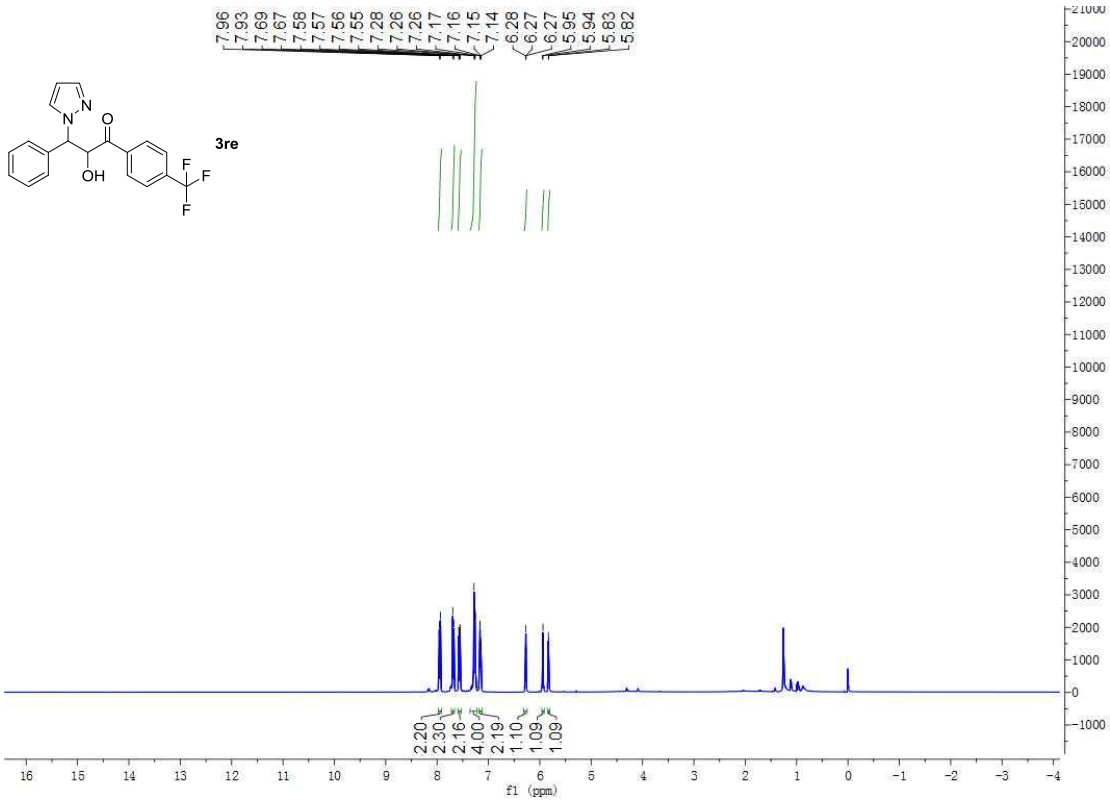

199.86
157.10
156.85
147.52
139.61
133.17
129.73
129.71
129.27
128.17
123.42
119.10
77.72
62.68
13.57
11.01
3gc
PhO
OH
O
N
f1 (ppm)

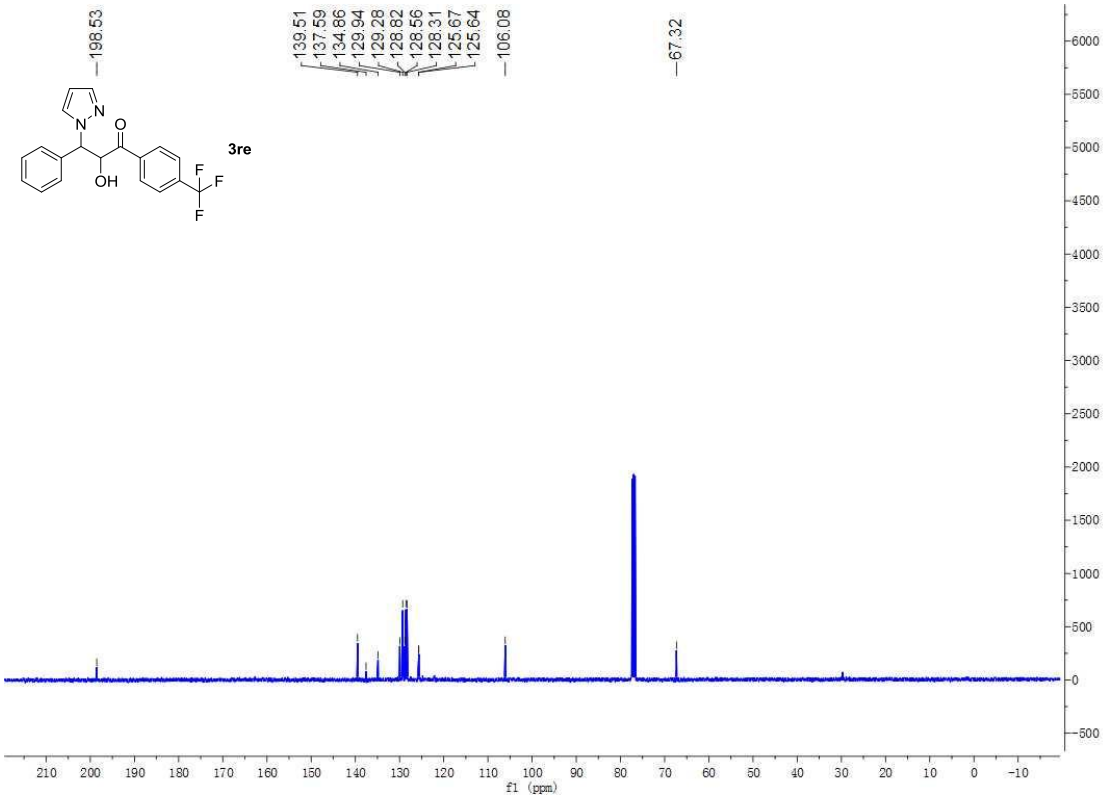

1gc
PhO
8.03
8.01
7.65
7.63
7.61
7.52
7.50
7.48
7.38
7.36
7.34
7.32
7.16
7.14
7.05
7.04
7.03
7.02
4.31
4.30
4.07
4.06
2.05
1.04
2.09
4.09
1.07
4.11
1.00
1.02
f1 (ppm)

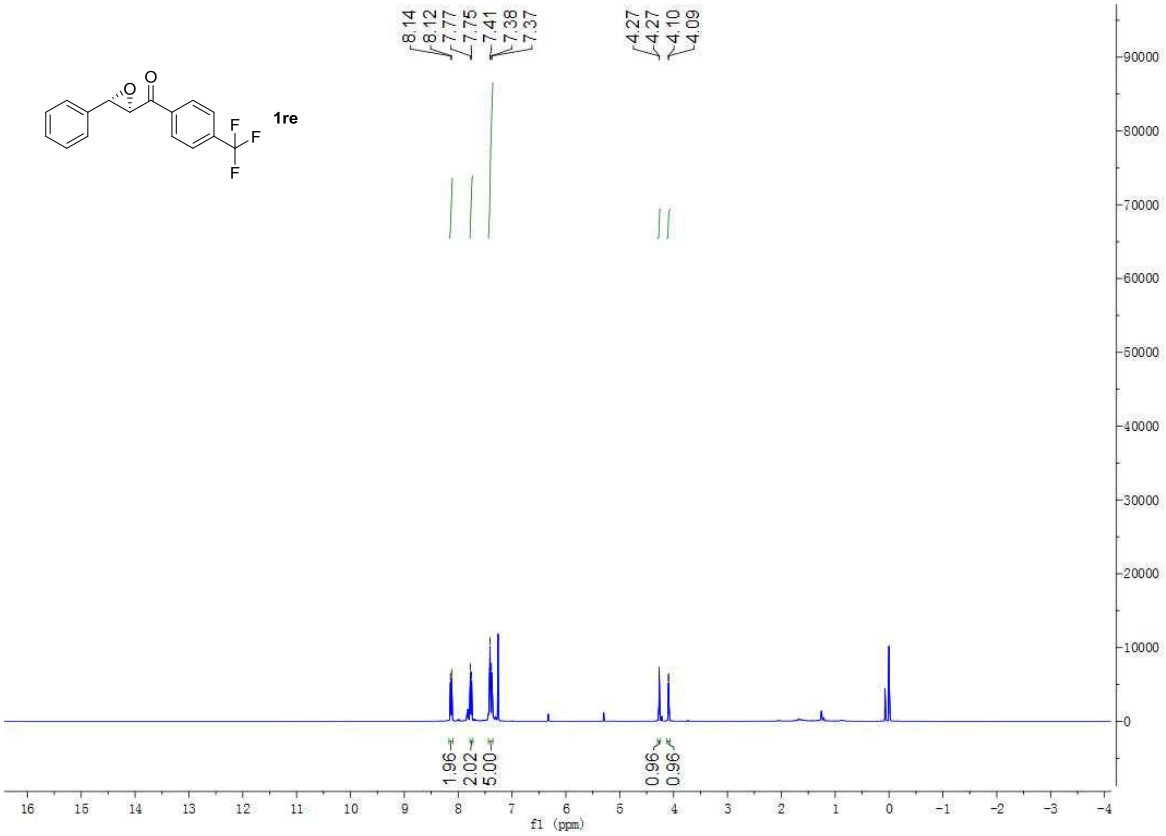

3rd
8.39
8.13
8.00
7.98
7.80
7.78
7.39
7.37
7.35
7.33
7.31
7.26
7.16
7.14
6.05
6.05
5.79
5.78
4.30
3.94
0.95
1.00
2.00
2.04
3.03
1.94
0.99
0.95
0.99
f1 (ppm)

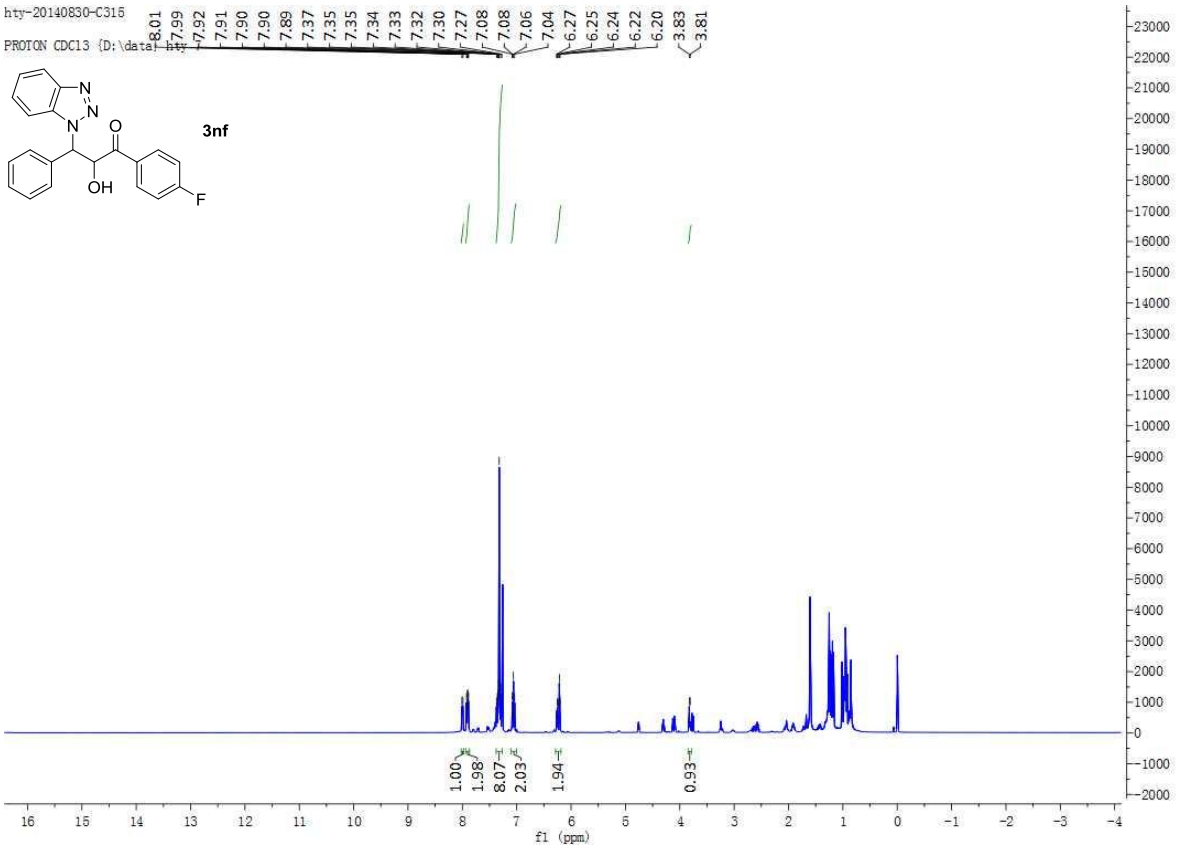

3rd
196.82
136.61
135.93
131.83
129.97
129.31
129.14
129.07
128.52
126.26
126.22
124.60
75.15
68.73
f1 (ppm)

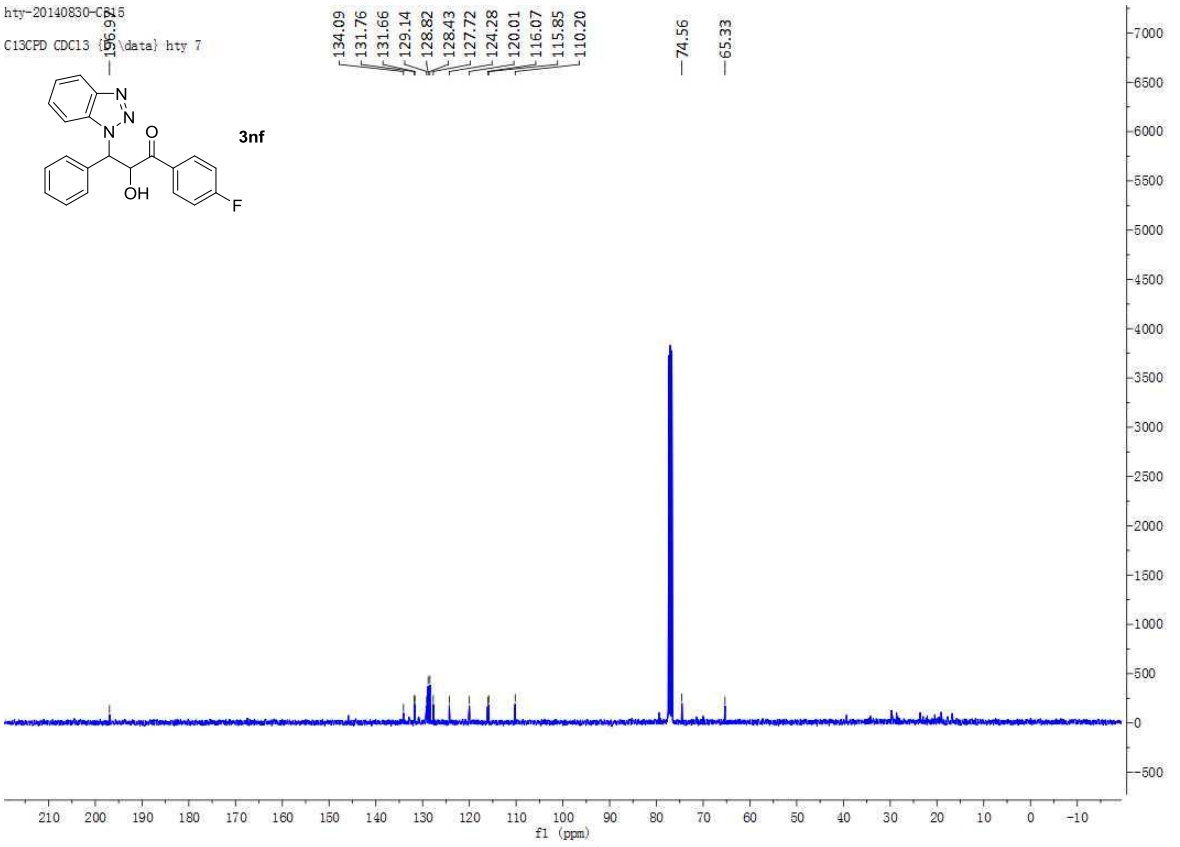

1rd
8.13
8.12
7.87
7.87
7.85
7.85
7.59
7.57
7.42
7.41
7.37
7.36
7.35
4.20
4.19
4.08
1.00
1.05
1.08
5.07
1.07
0.99
f1 (ppm)

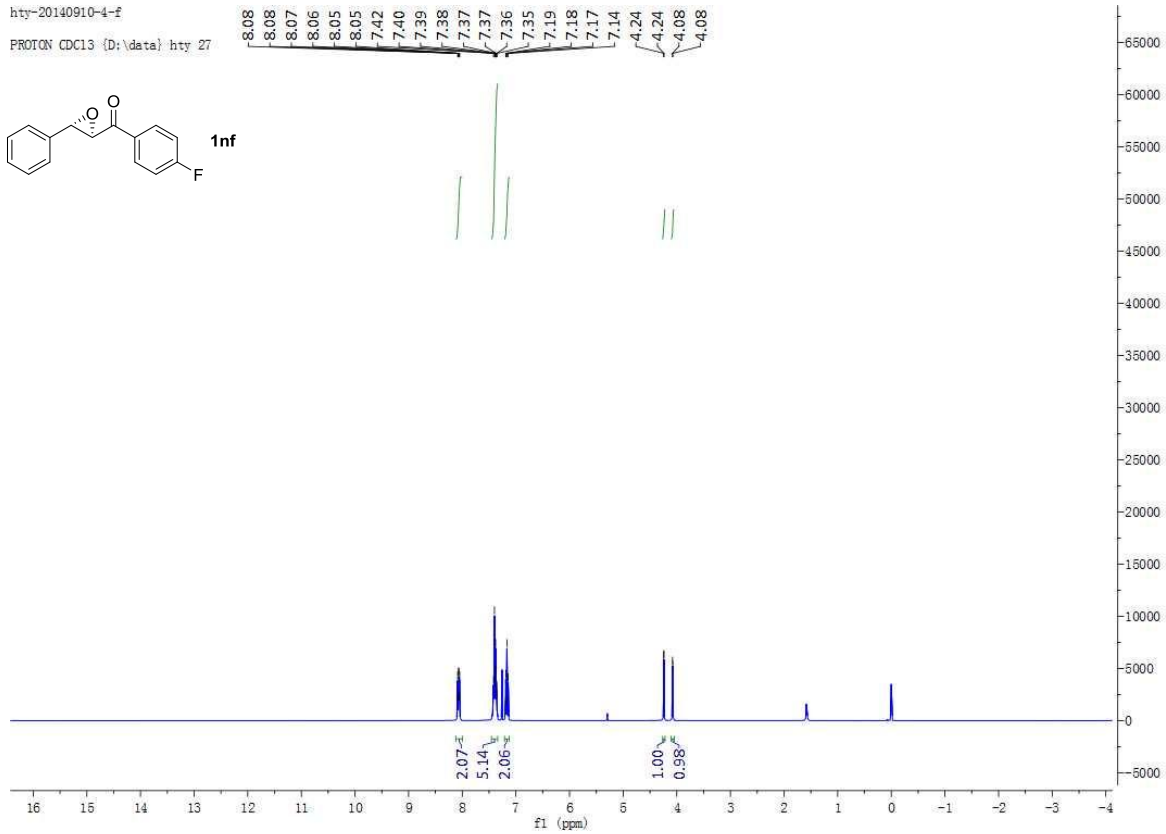

7.96
7.93
7.69
7.67
7.58
7.57
7.56
7.55
7.28
7.26
7.17
7.16
7.15
7.14
6.28
6.27
6.27
5.95
5.94
5.83
5.82
3re
OH
F
F
F
2.20
2.30
2.16
4.00
2.19
1.10
1.09
1.09
f1 (ppm)

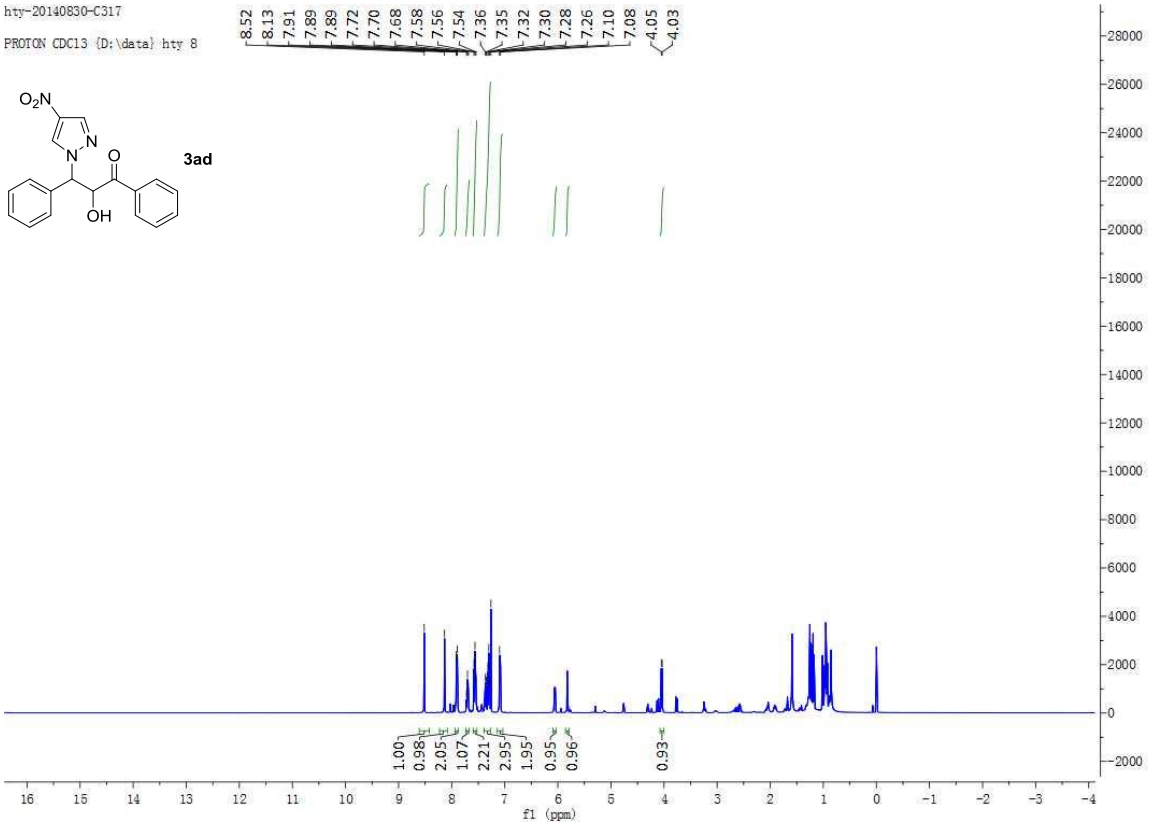

198.53
139.51
137.59
134.86
129.94
129.28
128.82
128.56
128.31
125.67
125.64
106.08
67.32
3re
OH
F
F
F
f1 (ppm)

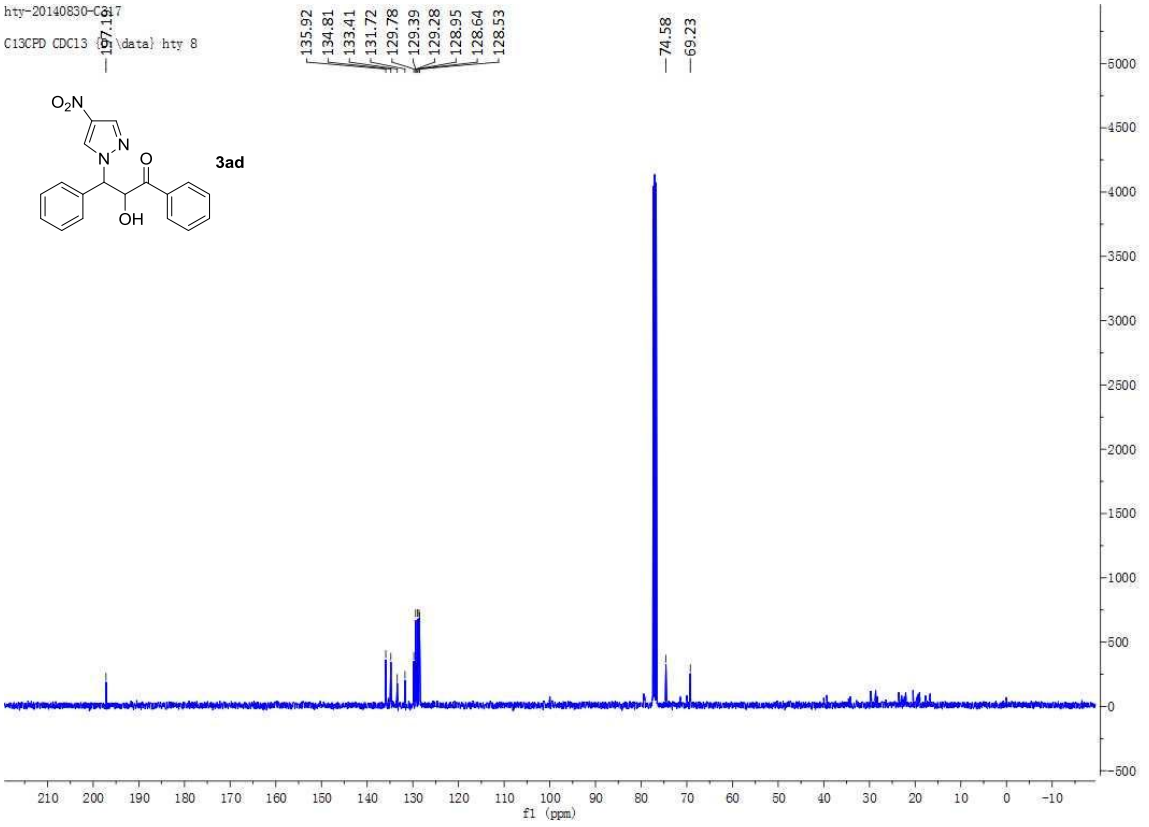

1re
8.14
8.12
7.77
7.75
7.41
7.38
7.37
4.27
4.27
4.10
4.09
1.96
2.02
5.00
0.96
0.96
f1 (ppm)

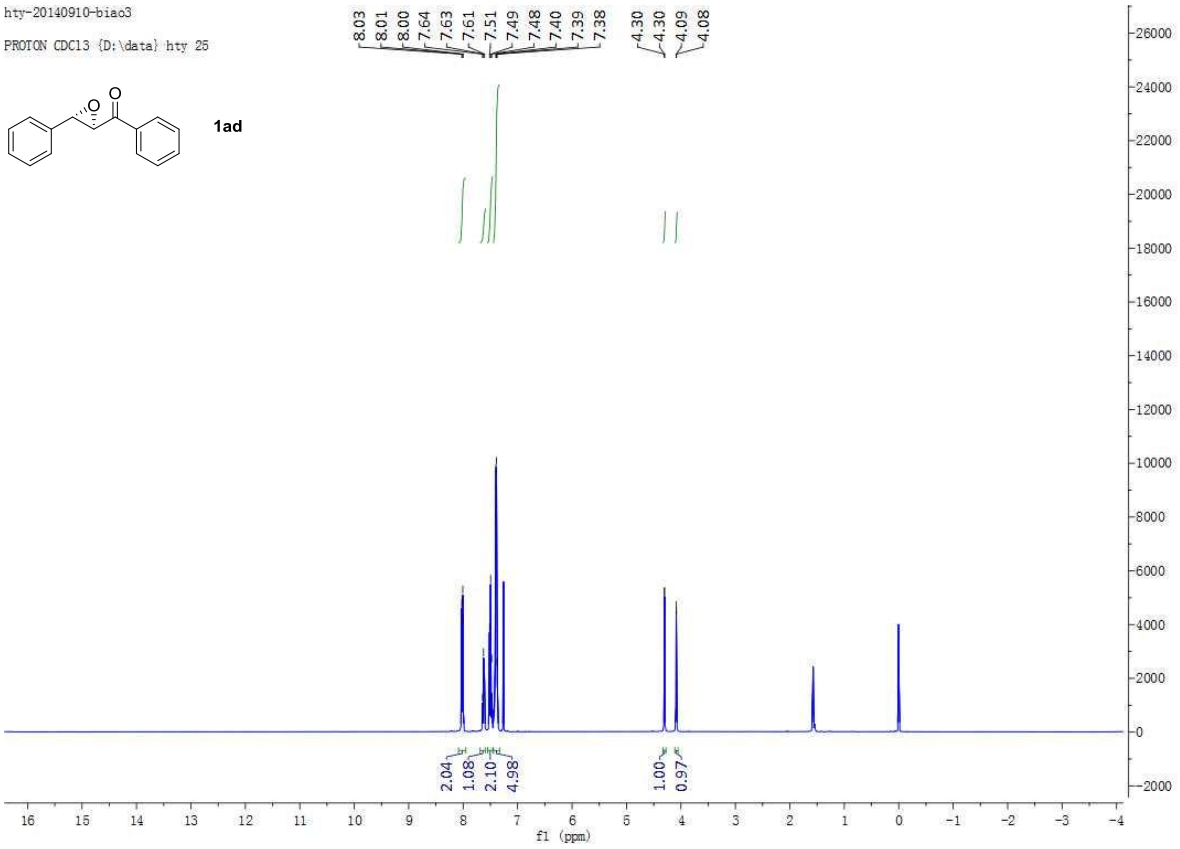

hty-20140830-C315
PROTON CDC13 {D:\data} hty 7
3nf
f1 (ppm)

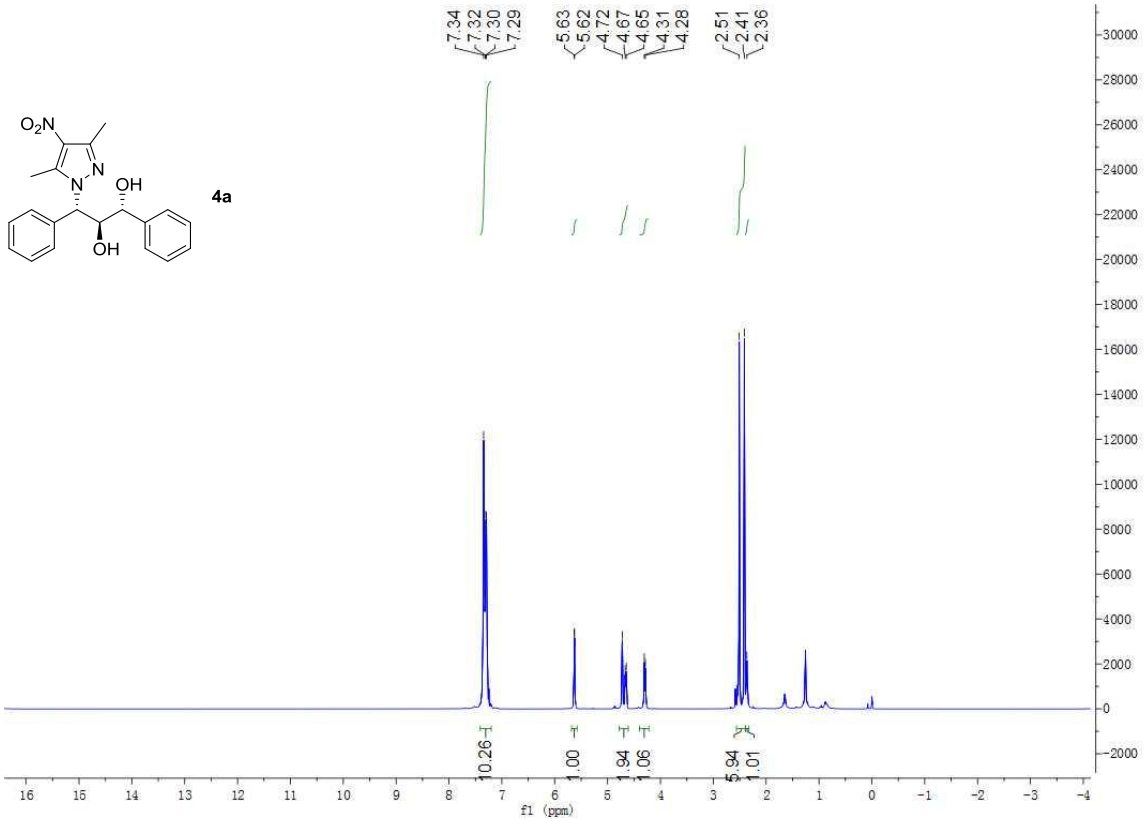

hty-20140830-C315
C13CPD CDC13 {D:\data} hty 7
3nf
f1 (ppm)

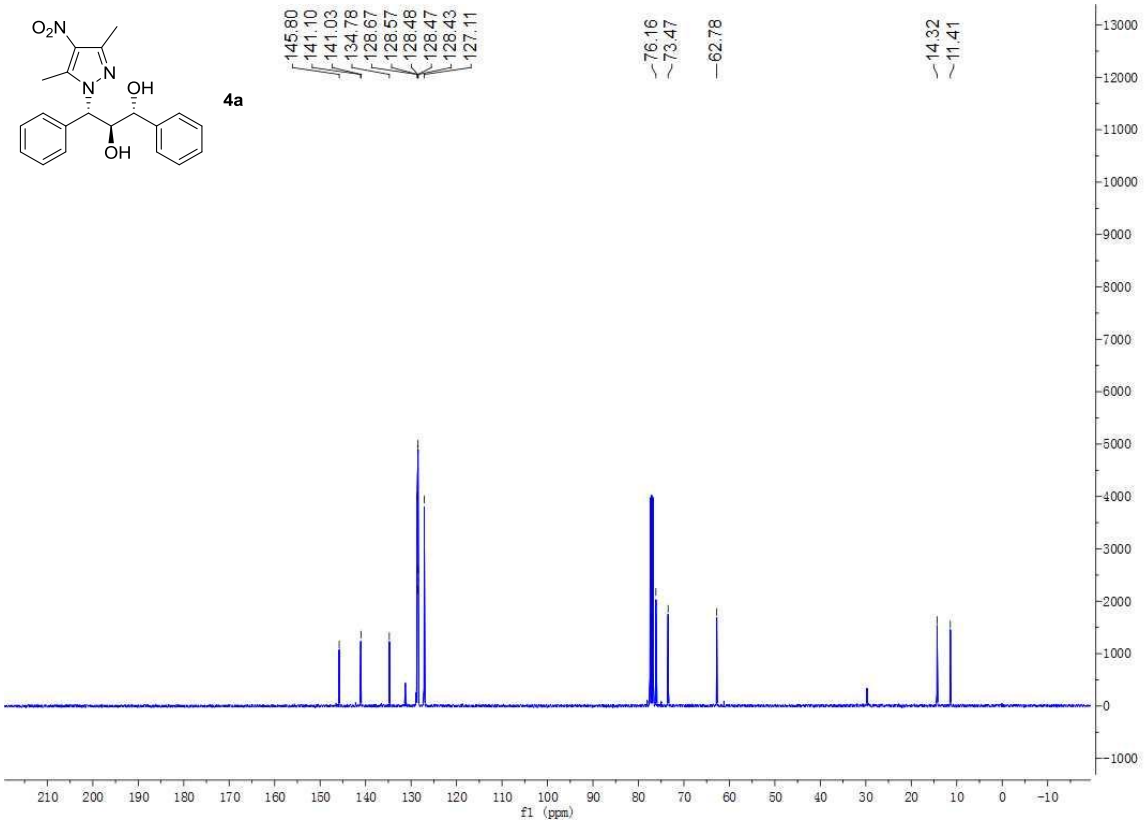

hty-20140910-4-f
PROTON CDC13 {D:\data} hty 27
1nf
F
O
8.08
8.08
8.07
8.06
8.05
8.05
7.42
7.40
7.39
7.38
7.37
7.37
7.36
7.35
7.19
7.18
7.17
7.14
4.24
4.24
4.08
4.08
2.07
5.14
2.06
1.00
0.98
f1 (ppm)

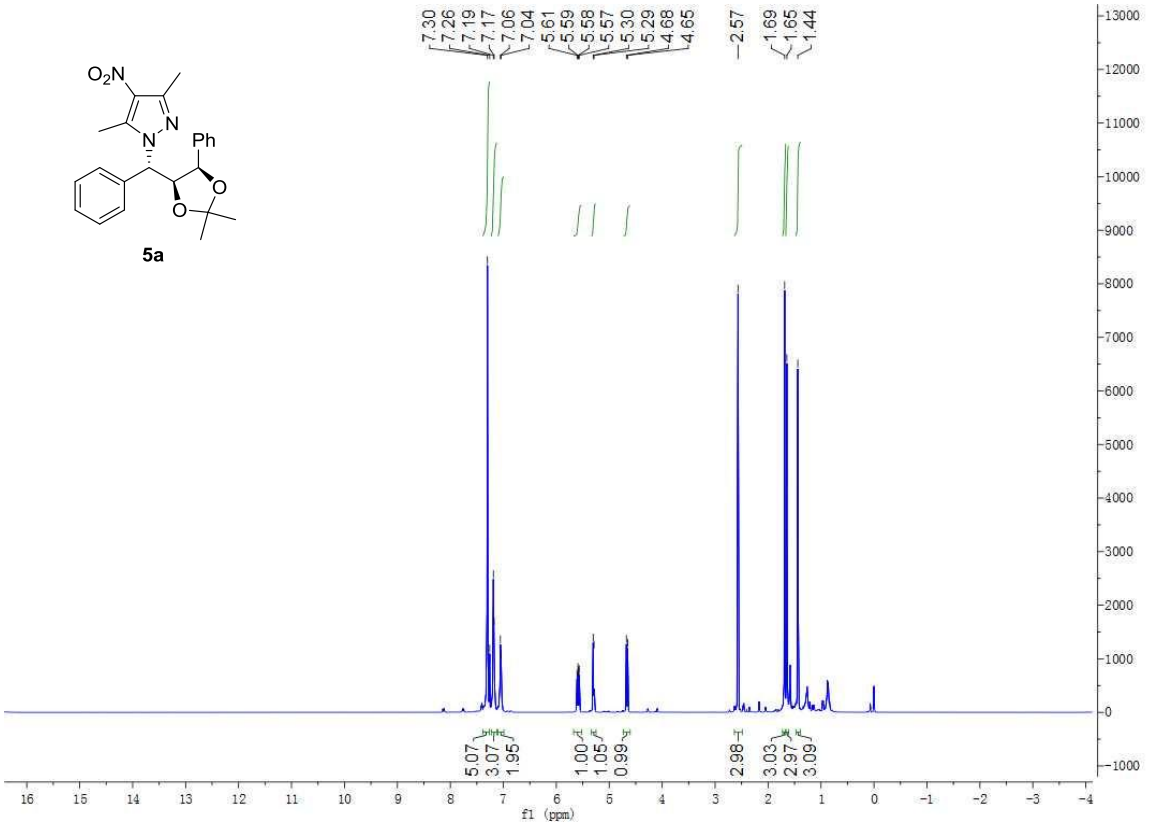

hty-20140830-C317
PROTON CDC13 {D:\data} hty 8
8.52
8.13
7.91
7.89
7.89
7.72
7.70
7.68
7.58
7.56
7.54
7.36
7.35
7.32
7.30
7.28
7.26
7.10
7.08
4.05
4.03
3ad
1.00
0.98
2.05
1.07
2.21
2.95
1.95
0.95
0.96
0.93
f1 (ppm)


hty-20140830-C317
C13CPD CDC13 {D:\data} hty 8
197.18
135.92
134.81
133.41
131.72
129.78
129.39
129.28
128.95
128.64
128.53
74.58
69.23
3ad
f1 (ppm)

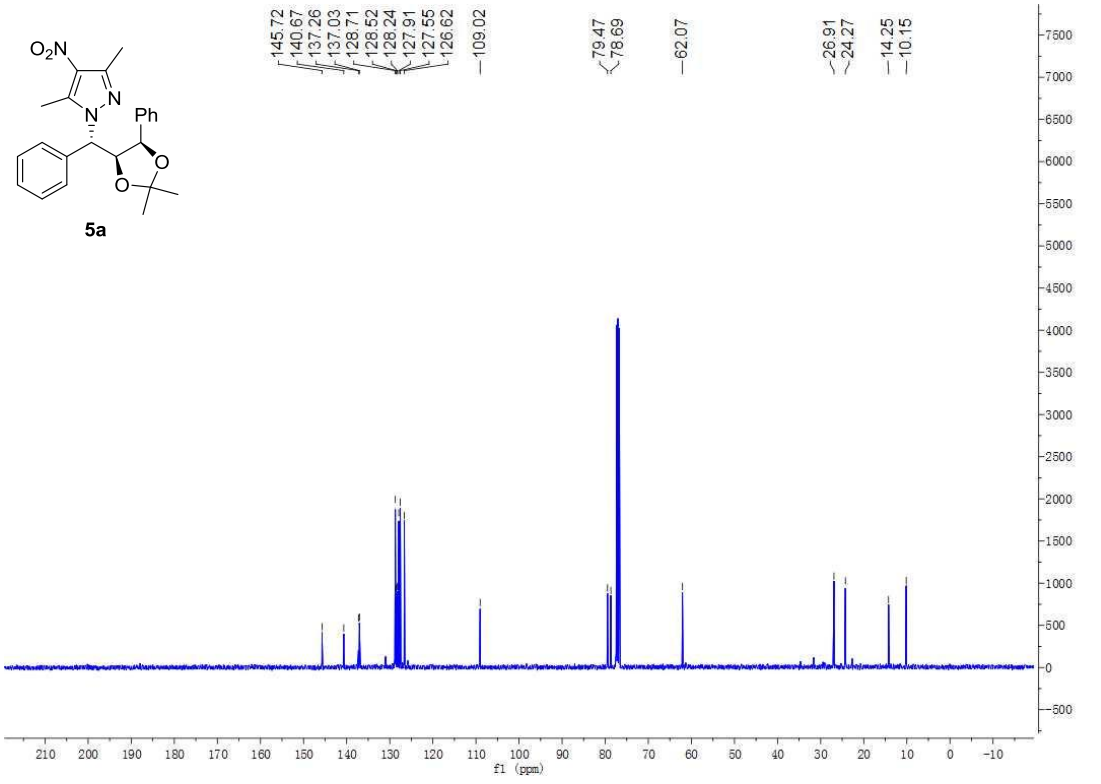

hty-20140910-biao3
PROTON CDCl3 {D:\data} hty 25
1ad
8.03
8.01
8.00
7.64
7.63
7.61
7.51
7.49
7.48
7.40
7.39
7.38
4.30
4.30
4.09
4.08
2.04
1.08
2.10
4.98
1.00
0.97
f1 (ppm)

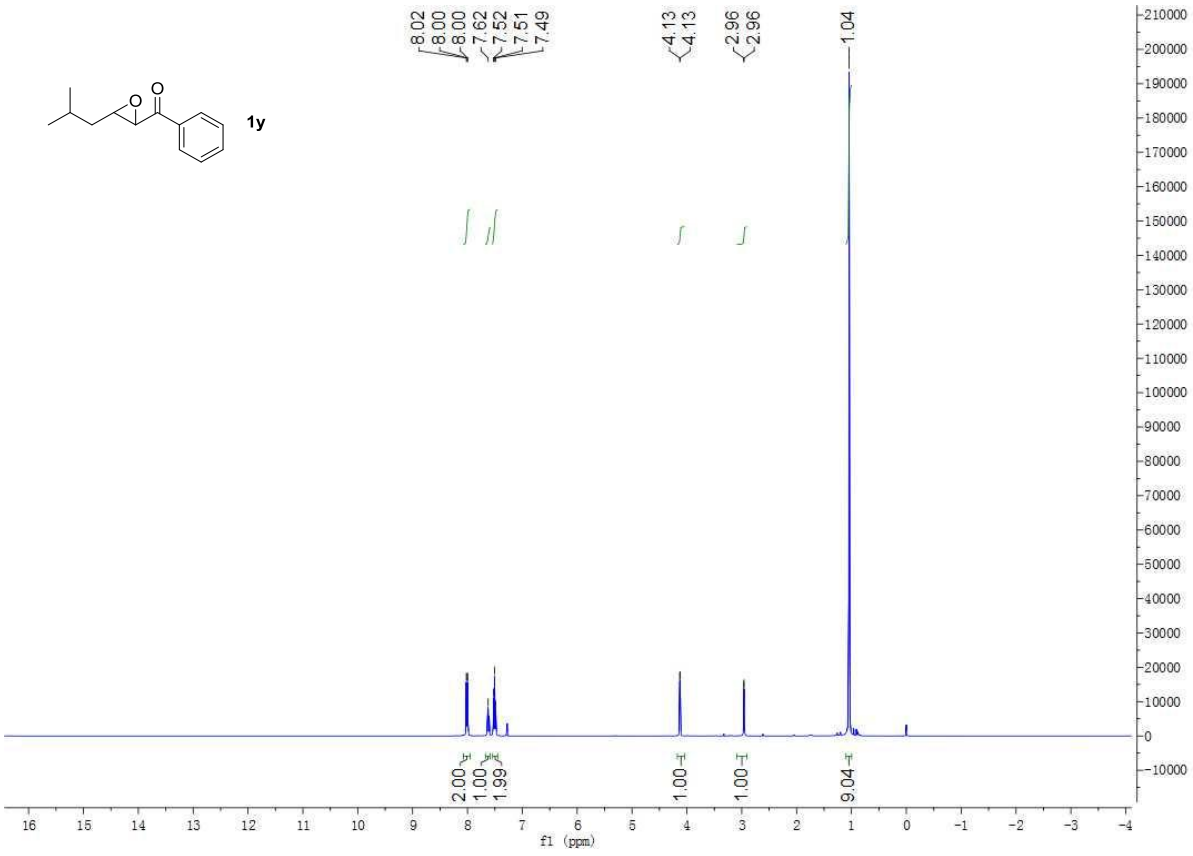

4a
7.34
7.32
7.30
7.29
5.63
5.62
4.72
4.67
4.65
4.31
4.28
2.51
2.41
2.36
10.26
1.00
1.94
1.06
5.94
1.01
f1 (ppm)

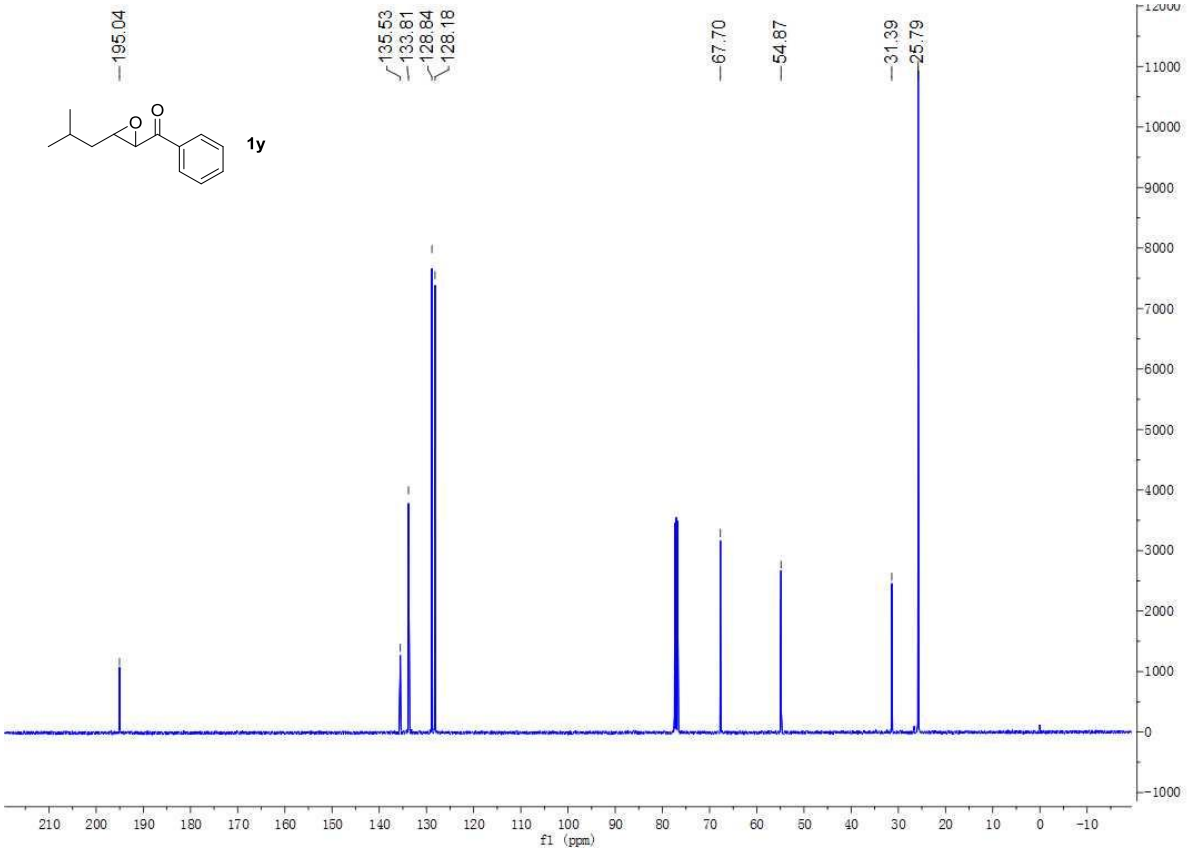

4a
145.80
141.10
141.03
134.78
128.67
128.57
128.48
128.47
128.43
127.11
76.16
73.47
62.78
14.32
11.41
f1 (ppm)


7.30
7.26
7.19
7.17
7.06
7.04
5.61
5.59
5.58
5.57
5.30
5.29
4.68
4.65
2.57
1.69
1.65
1.44
5.07
3.07
1.95
1.00
1.05
0.99
2.98
3.03
2.97
3.09
f1 (ppm)

5a


145.72
140.67
137.26
137.03
128.71
128.52
128.24
127.91
127.55
126.62
109.02
79.47
78.69
62.07
26.91
24.27
14.25
10.15
f1 (ppm)


1y
8.02
8.00
8.00
7.62
7.52
7.51
7.49
4.13
4.13
2.96
2.96
1.04
2.00
1.00
1.99
1.00
1.00
9.04
f1 (ppm)


1y
195.04
135.53
133.81
128.84
128.18
67.70
54.87
31.39
25.79
f1 (ppm)