Supplementary Information

A Chiral Ferrocene-Tethered Ruthenium Diamine Catalyst for Asymmetric Transfer Hydrogenation of Ketones

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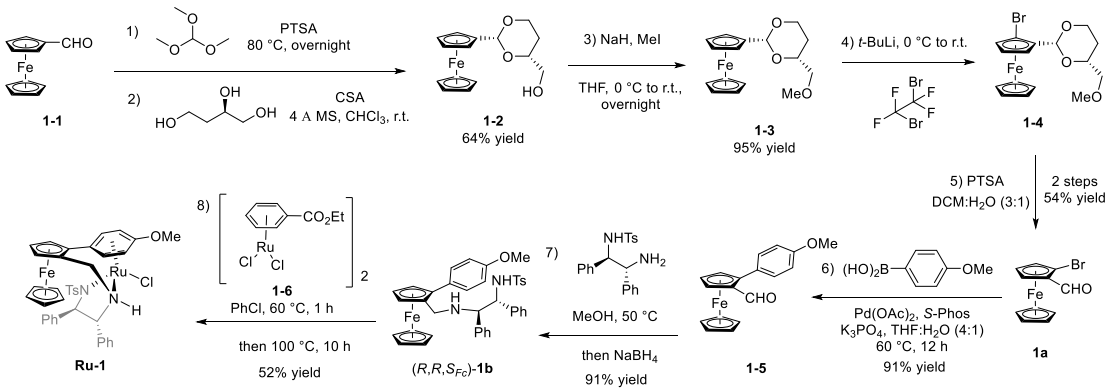
1. General information and materials:

^{1}H, ^{13}C and ^{19}F NMR data were recorded on Bruker DRX500 or DRX400 NMR Spectrometer with $CDCl_3$ or DMSO as solvent. ^{13}C NMR chemical shifts were obtained with ^{1}H decoupling. MS was measured on Agilent 1100 series LC/MSD, Thermo Fisher LTQ FT, Agilent 5973N and Waters Micromass G1540/GCT Premier spectrometers. High resolution mass spectra (HRMS) were recorded on a Bruker APEXIII 7.0 Tesla ESI-FT. Enantiomeric excesses were determined with Agilent Series HPLC using AD-3, OD-H, OD-3, OJ-H, OJ-3, IC, IC-3 chiral columns. Optical rotations were measured on a Rudolph-Autopol I instrument. All reagents were used as received from commercial sources, unless otherwise specified. All reactions and manipulations sensitive to moisture or air were performed in a nitrogen-filled glovebox or using standard Schlenk techniques, unless otherwise noted. Analytical thin-layer chromatography (TLC) was carried out with silica gel pre-coated glass plates (TLC-Silica gel GF254, coating thickness: 0.20-0.25 mm, particle size: 10-40 μm). The TLC was visualized with a UV lamp (254 or 365 nm). Column chromatography was performed with silica gel (200-300 mesh).

2. General procedure for synthesizing Ru catalyst:



Synthesis of 1-2[1]

Ferrocene formaldehyde (**1-1**) (2.14 g, 10 mmol, 1.0 equiv) was dissolved in dry trimethoxymethane (12 mL) and then PTSA (86 mg, 0.5 mmol, 5% equiv) was added. The resulting mixture was stirred at 80 °C overnight. K_2CO_3 (1.66 g, 12 mmol, 1.2 equiv) was added and the mixture was further stirred at room temperature (monitored by TLC). Upon completion of the reaction, the reaction

mixture was partitioned between ethyl acetate (30 mL) and water (20 mL). The organic layer was separated and the aqueous lay was extracted with EA (3 × 20 mL). The organic phases were combined, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure.

The above crude reside was dissolved in $CHCl_3$ (15 mL). Activated molecular sieves (4 Å) (6 g), (2*R*)-1,2,4-butanetriol[2] (0.89 mL, 10 mmol, 1.0 equiv), and (±)-CSA (116 mg, 0.5 mmol, 5% equiv) were added. After the reaction mixture being stirred at room temperature for 20 h, K_2CO_3 (1.66 g, 12 mmol, 1.2 equiv) was added and then the mixture was stirred for 20 minutes. After completion of the reaction, the mixture was partitioned between ethyl acetate (30 mL) and water (30 mL). The organic layer was separated and the aqueous lay was extracted with EA (3 × 20 mL). The organic phases were combined, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The residue was firstly purified by recrystallization (-20 °C for 2-3 days), and then by silica gel column chromatography to give compound **1-2** (1.92 g, yellow solid, 64% yield). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 5.34 (s, 1H), 4.38 (s, 2H), 4.23 (s, 5H), 4.20 (s, 2H), 3.97 - 3.85 (m, 2H), 3.63 (dd, *J* = 24.3, 9.4 Hz, 2H), 2.12 (s, 1H), 1.81 (qd, *J* = 12.3, 4.8 Hz, 1H), 1.38 (d, *J* = 12.9 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 100.3, 86.2, 69.5, 69.0, 68.7, 67.2, 67.0, 66.6, 65.8, 26.9; **HRMS (MALDI)** calculated for [M, $C_{15}H_{18}O_3Fe]^+$: 302.1510; found: 302.7454.

Synthesis of 1-3[2]: Alcohol **1-2** (1.81 g, 6 mmol, 1.0 equiv) was dissolved in dry THF (15 mL). NaH (360 mg, 60 wt%, 9 mmol, 1.5 equiv) was slowly added at 0 ℃ and the mixture was stirred for 1.5 hours. MeI (0.56 mL, 9 mmol, 1.5 equiv) was slowly added at 0 °C and the reaction mixture was allowed to warm to room temperature and stirred overnight. Upon complete conversion of substrate, the reaction was quenched with H_2O (20 mL). The mixture was extracted with EA (3 × 25 mL). The organic phases were combined, dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography (PE: EA = 15:1) to give compound **1-3** (1.8 g, auburn oil, 95% yield.). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 5.37 (s, 1H), 4.41 - 4.07 (m, 9H), 4.05 - 3.84 (m, 2H), 3.61 - 3.49 (m, 1H), 3.43 (s, 3H), 1.85 - 1.69 (m, 1H), 1.48 (d, *J* = 12.4 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 100.2, 86.1, 76.2, 75.7, 69.0, 68.0, 67.9, 66.8, 66.8, 66.7, 59.6, 28.1; **HRMS (MALDI)** calculated for [M, $C_{16}H_{20}O_3Fe]^+$: 316.1780; found: 316.7006.

Synthesis of 1-4[3]: An oven dried 100 mL three necked flask was charged with compound **1-3** (1.58 g, 5 mmol, 1.0 equiv). The system was evacuated under high vacuum and back-filled with N_2 for three times. Anhydrous THF (20 mL) was added and the mixture was cooled to 0 °C. *t*-BuLi (4.7 mL, 6 mmol, 1.2 equiv, 1.3 M in pentane) was added dropwise over 15 minutes and then the reaction was allowed to warm to room temperature and stirred for 2 h. The flask was put in an ice/water bath and 1,2-dibromotetrafluoroethane (0.9 mL, 7.5 mmol, 1.5 equiv) was added dropwise. After completion of the addition, the reaction mixture was allowed to warm to room temperature and stirred overnight. Afterwards, the reaction was quenched with H_2O (30 mL). The mixture was extracted with DCM (3 × 25 mL). The organic phases were combined, washed once with saturated NaCl solution (20 mL), dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure give crude compound **1-4** which was used in the next step without further purification (dark red oil).

Synthesis of 1a[3]: The crude compound **1-4** was dissolved in DCM (15 mL)/H_2O (5 mL) and PTSA (856 mg, 5 mmol, 1.0 equiv) was added. The mixture was stirred at room temperature until completion of the reaction. The reaction mixture was partitioned between DCM (15 mL) and water (10 mL). The organic layer was separated, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography (PE: EA = 20:1) to give compound **1a** (792 mg, dark red oil, 54% yield over two steps). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 10.16 (s, 1H), 4.82 (d, *J* = 15.6 Hz, 2H), 4.59 (s, 1H), 4.32 (s, 5H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 193.2, 80.3, 75.8, 75.2, 72.4, 71.4, 66.8; **HRMS (MALDI)** calculated for [M, $C_{11}H_9BrOFe]^+$: 292.9410; found: 292.5322.

Synthesis of 1-5: An oven dried 50 mL Schlenk flask equipped with a magnetic stir bar was charged with **1a** (1.18 g, 4 mmol, 1.0 equiv), 4-methoxyphenylboronic acid (912 mg, 6 mmol, 1.5 equiv), $Pd(OAc)_2$ (90 mg, 0.4 mmol, 10% equiv), SPhos (197 mg, 0.48 mmol, 12% equiv), and K_3PO_4 (2.55 g, 12 mmol, 3.0 equiv). The system was evacuated under high vacuum and back-filled with N_2 for three times. Degassed THF (12 mL) and H_2O (3 mL) were added and the mixture was stirred at 60 °C for 12 h. The reaction mixture was cooled to rt, filtered through a layer of Celite and the solid was washed with ethyl acetate (3 × 5 mL). The filtrate was concentrated under reduced pressure and

the crude residue was purified by silica gel column chromatography (PE: EA = 6:1) to give the compound **1-5** (1.17 g, dark red viscous oil, 91% yield). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 10.19 (s, 1H), 7.45 (d, *J* = 8.1 Hz, 2H), 6.91 (d, *J* = 8.2 Hz, 2H), 4.97 (d, *J* = 2.3 Hz, 1H), 4.78 (s, 1H), 4.68 (d, *J* = 2.9 Hz, 1H), 4.24 (s, 5H), 3.85 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 193.3, 159.0, 130.8, 127.9, 113.8, 92.8, 76.6, 74.6, 71.9, 71.1, 68.3, 55.5; **HRMS (MALDI)** calculated for [M, $C_{18}H_{16}O_2Fe]^+$: 320.1690; found: 320.7240.

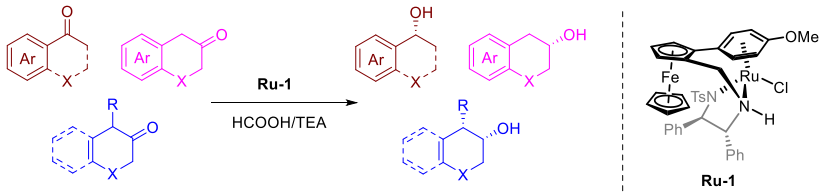
Synthesis of (*R*,*R*,*S*$_{Fc}$)-1b: Compound **1-5** (384 mg, 1.2 mmol, 1.0 equiv) and (1*R*, 2*R*)-N-(4-toluenesulfonyl)-1,2-diphenylethylenediamine (440 mg, 1.2 mmol, 1.0 equiv) were dissolved in MeOH (6 mL) and the reaction solution was stirred at 50 °C for 2 h. After the reaction mixture being cooled to room temperature, $NaBH_4$ (92 mg, 2.4 mmol, 2.0 equiv) was added and the mixture was stirred for additional 2 h. Upon completion of the reaction, the reaction was quenched with H_2O (20 mL). The mixture was extracted with DCM (3 × 20 mL). The organic phases were combined, washed once with saturated NaCl solution (20 mL), dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography (PE: EA = 4:1) to give compound (*R*,*R*,*S*$_{Fc}$)-**1b** (732 mg, yellow solid, 91% yield). **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.8 Hz, 2H), 7.25 (d, *J* = 6.6 Hz, 2H), 7.20 - 6.86 (m, 12H), 6.79 (d, *J* = 8.0 Hz, 2H), 4.44 (s, 1H), 4.28 (d, *J* = 31.5 Hz, 3H), 4.05 (s, 5H), 3.83 (s, 3H), 3.79 - 3.68 (m, 1H), 3.58 - 3.39 (m, 2H), 2.33 (s, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 158.2, 142.6, 138.1, 137.0, 130.0, 129.9, 129.1, 128.4, 128.0, 127.6, 127.5, 127.4, 127.3, 127.0, 113.5, 70.4, 69.9, 69.6, 67.4, 62.7, 55.3, 45.4, 21.5; **HRMS (MALDI)** calculated for [M, $C_{39}H_{38}N_2O_3SFe]^+$: 670.6490; found: 670.5936.

Synthesis of Ru-1[4]: An oven dried 50 mL Schlenk tube was charged with compound (*R*,*R*,*S*$_{Fc}$)-**1b** (537 mg, 0.8 mmol, 2.0 equiv) and dimeric Ru complex **1-6**[5] (258 mg, 0.4 mmol, 1.0 equiv). The system was evacuated under high vacuum and back-filled with N_2 for three times. Anhydrous PhCl (8 mL) was added under N_2 and the mixture was stirred at 60 °C for 1 h. Then the mixture was heated to 100 °C and stirred for additional 10 h. Upon completion of the reaction, the mixture was cooled to room temperature and filtered through a layer of Celite. The solid was washed with DCM (3 × 5 mL) and the filtrate was concentrated under reduced pressure. The crude Ru complex was

firstly purified by silica gel column chromatography (DCM: EA = 6:1, DCM: MeOH = 30:1) and then recrystallization in DCM/MTBE to give catalyst **Ru-1** (335 mg, brown solid, 52% yield). **^{1}H NMR** (500 MHz, DMSO-d_6) δ 7.20 - 7.00 (m, 8H), 6.77 (d, J = 7.5 Hz, 2H), 6.70 - 6.59 (m, 2H), 6.55 (d, J = 7.2 Hz, 1H), 6.48 (s, 1H), 5.69 (s, 1H), 5.49 (s, 1H), 5.36 (s, 1H), 4.51 (s, 1H), 4.33 - 4.20 (m, 7H), 4.16 - 3.99 (m, 4H), 3.80 (s, 3H), 2.18 (s, 3H); **^{13}C NMR** (126 MHz, DMSO-d_6) δ 145.5, 139.6, 138.0, 137.9, 137.4, 133.8, 132.7, 130.0, 129.7, 129.2, 129.0, 128.6, 128.4, 127.8, 126.7, 126.5, 126.1, 126.0, 90.1, 86.2, 83.9, 82.8, 82.7, 78.1, 70.8, 70.6, 70.5, 70.4, 68.2, 67.3, 66.3, 63.6, 57.0, 50.5, 21.2; **HRMS (MALDI)** calculated for [M-Cl, $C_{39}H_{37}FeN_2O_3RuS]^+$: 770.7110; found: 770.5443; [M, $C_{39}H_{37}ClFeN_2O_3RuS]^+$: 806.1610; found: 806.5259.

3. General procedures for Ru-catalyzed asymmetric transfer hydrogenation of ketones.

General procedure

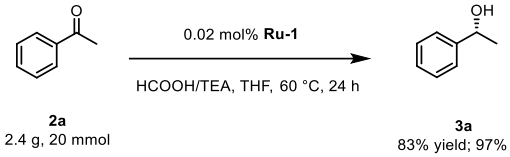


Ketone (0.2 mmol, 1.0 equiv) and catalyst **Ru-1** (2 mol%) was added into a dry Schlenk tube equipped with a magnetic stir bar. The system was evacuated under high vacuum and back-filled with N_2 for three times. Anhydrous THF (1 mL) was added, followed by the addition of a mixture of HCOOH/TEA (5:2) (0.15 mL). The mixture was stirred at 60 °C for indicated time. After the reaction was completed, the mixture was concentrated under vacuum and purified by silica gel column chromatography to give the corresponding alcohol product. The ee values were determined by chiral HPLC. The ee values of product **5l**, **7g** and **7h** were obtained by measuring the ees of their benzoylated derivatives by chiral HPLC.

Derivatization method[6] of 5l, 7g and 7h for HPLC analysis

The chiral alcohol product was dissolved in DCM (1 mL) and then DMAP (1.2 equiv), TEA (2.0 equiv), and BzCl (1.2 equiv) was added sequentially. The mixture was stirred at room temperature. Upon completion, the mixture was concentrated under vacuum and the crude product was purified by silica gel column chromatography to give pure benzoylated product for chiral HPLC analysis.

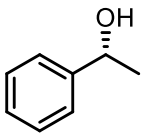
Procedure for gram scale reaction



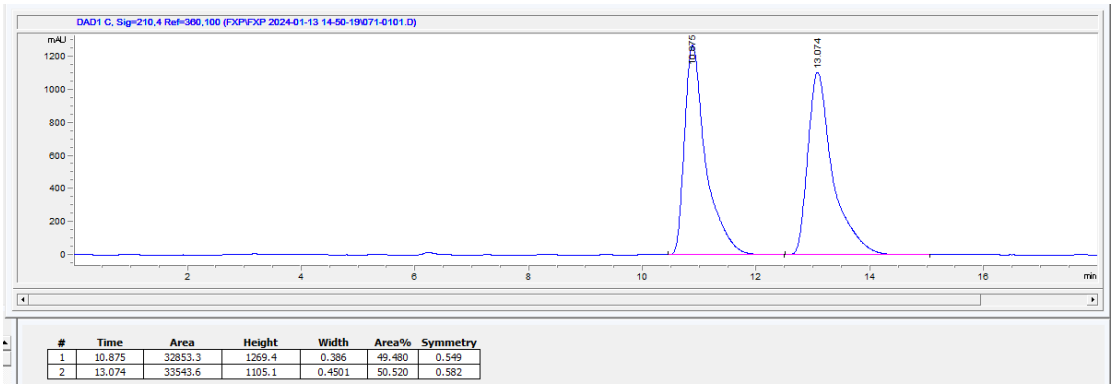
Ru-1 (4.0 mg, 0.025 mol%) was added to a 50 mL Schlenk tube under N_2. Then distilled acetophenone (2.4 g, 20 mmol, 1.0 equiv), 1 mL dry THF, and 4 mL degassed HCOOH/TEA (5:2) azeotrope were added. The mixture was stirred at 60 °C for 24 hours and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography to give alcohol **3a** in 83% yield and 97% ee.

4. Analytical data of alcohol products from Ru-catalyzed ATH

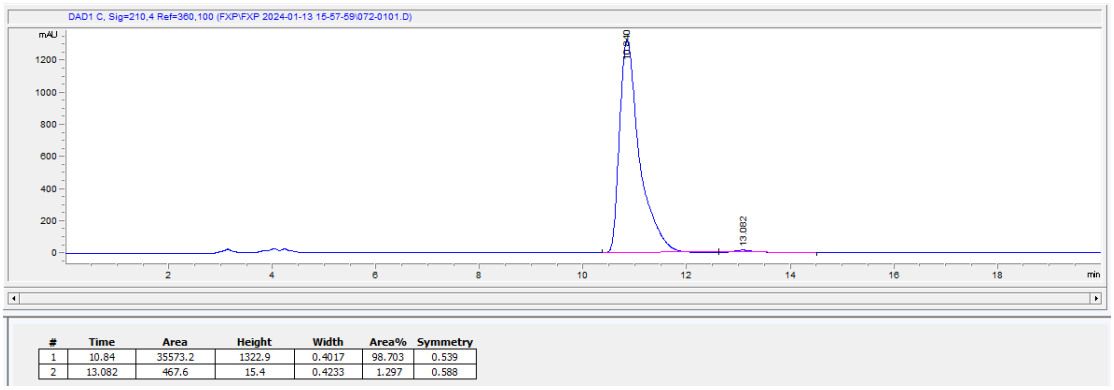
(*R*)-1-Phenylethanol (3a) [7]



Colorless oil, 95% yield, 98% ee; $[\alpha]_D^{25}$: 44.7 (c = 0.51, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.41 - 7.32 (m, 4H), 7.32 - 7.24 (m, 1H), 4.90 (q, *J* = 6.5 Hz, 1H), 1.50 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 145.9, 128.6, 127.6, 125.5, 70.6, 25.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 10.8 min (major), t_R = 13.1 min (minor).

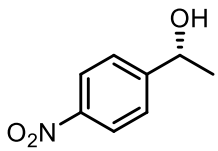


#	Time	Area	Height	Width	Area%	Symmetry
1	10.875	32853.3	1269.4	0.386	49.480	0.549
2	13.074	33543.6	1105.1	0.4501	50.520	0.582

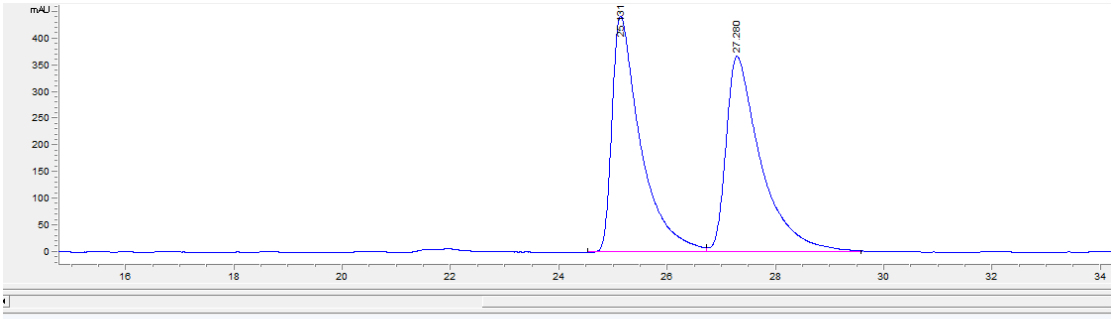


#	Time	Area	Height	Width	Area%	Symmetry
1	10.84	35573.2	1322.9	0.4017	98.703	0.539
2	13.082	467.6	15.4	0.4233	1.297	0.588

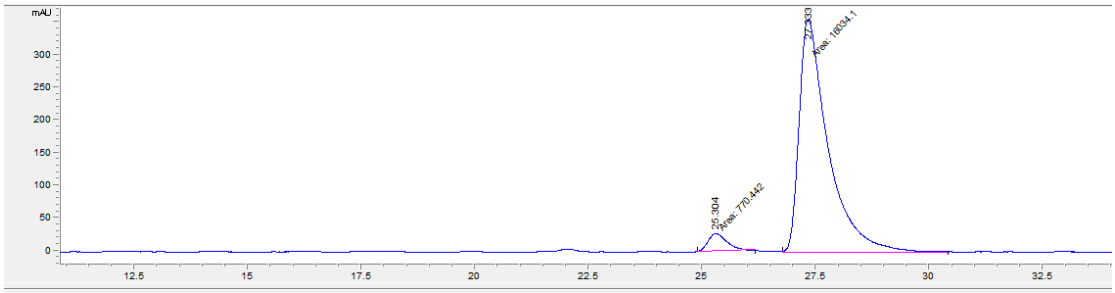
(*R*)-1-(4-Nitrophenyl) Ethanol (3b)[9]



Colorless oil, 95% yield, 90% ee; **$[\alpha]_D^{25}$**: 26.7 (c = 2.47, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.18 (d, *J* = 5.6 Hz, 2H), 7.53 (d, *J* = 5.6 Hz, 2H), 5.01 (q, *J* = 8.6, 7.3 Hz, 1H), 2.12 (s, 1H), 1.50 (d, *J* = 3.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 153.2, 147.2, 126.2, 123.9, 69.6, 25.6; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 90 : 10, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 25.3 min (minor), t_R = 27.3 min (major).

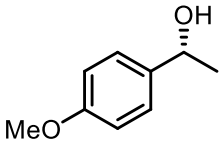


#	Time	Area	Height	Width	Area%	Symmetry
1	25.131	16252.6	442.5	0.5265	49.763	0.393
2	27.28	16407.4	366.8	0.6339	50.237	0.424

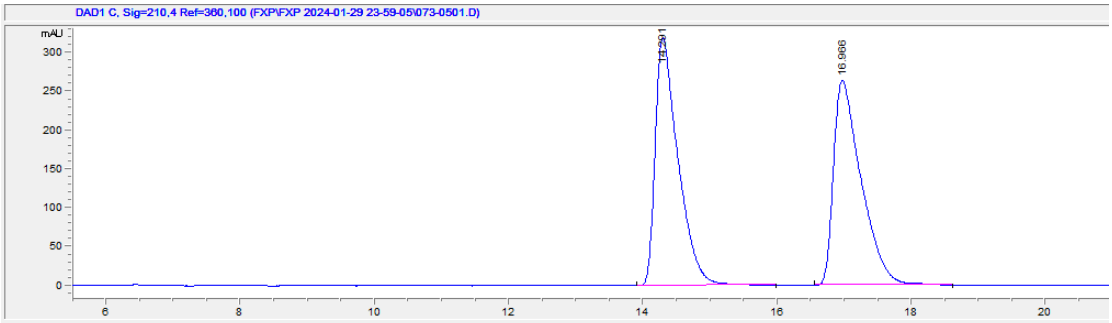


#	Time	Area	Height	Width	Area%	Symmetry
1	25.304	770.4	26.7	0.4802	4.585	0.684
2	27.333	16034.1	357.1	0.7484	95.415	0.427

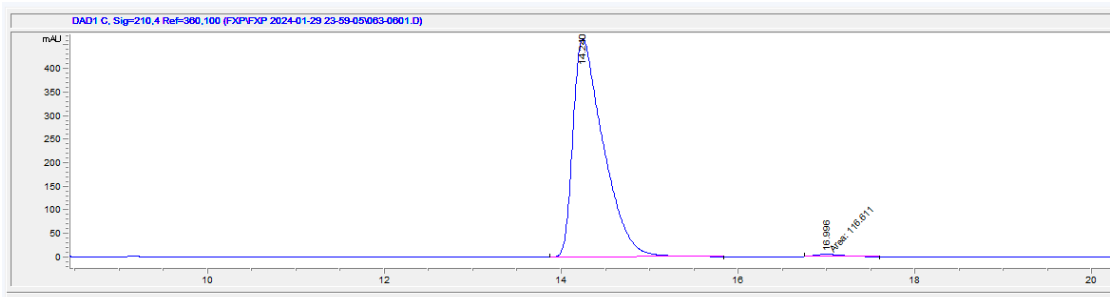
(*R*)-1-(4-Methoxyphenyl) Ethanol (3c)[7]



Colorless oil, 99% yield, 98% ee; **[α]$_D^{25}$**: 46.8 (c = 1.55, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.29 (d, *J* = 8.7 Hz, 2H), 6.88 (d, *J* = 8.7 Hz, 2H), 4.84 (q, *J* = 5.2, 4.4 Hz, 1H), 3.80 (s, 3H), 2.01 (s, 1H), 1.47 (d, *J* = 6.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 159.0, 138.1, 126.8, 113.9, 70.1, 55.4, 25.1; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 14.2 min (major), t_R = 17.0 min (minor).

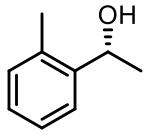


#	Time	Area	Height	Width	Area%	Symmetry
1	14.291	7579.6	319	0.3432	49.998	0.46
2	16.966	7580.3	264.2	0.4207	50.002	0.433

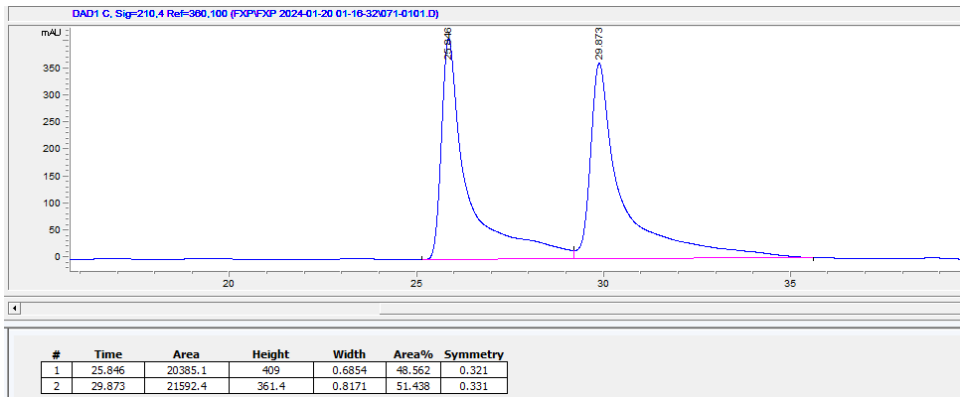


#	Time	Area	Height	Width	Area%	Symmetry
1	14.24	11056.5	462.9	0.3467	98.956	0.444
2	16.996	116.6	5.2	0.3731	1.044	0.651

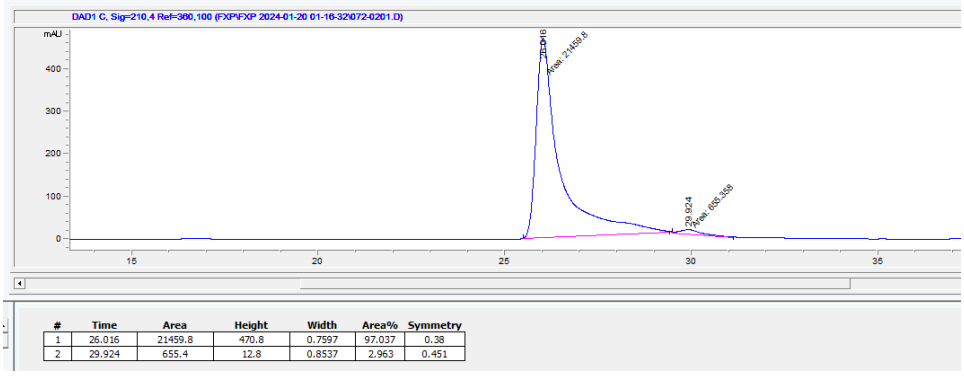
(*R*)-1-(2-Methylphenyl) Ethanol (3d)[7]



Colorless oil, 99% yield, 94% ee; **[α]$_D^{25}$**: 60.4 (c = 1.68, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.52 (d, *J* = 7.3 Hz, 1H), 7.24 (t, *J* = 8.0 Hz, 1H), 7.22 - 7.11 (m, 2H), 5.13 (q, *J* = 6.5 Hz, 1H), 2.35 (s, 3H), 1.47 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 143.9, 134.3, 130.5, 127.3, 126.5, 124.6, 66.9, 24.1, 19.1; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak AD-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.6 mL/min, T = 20 °C, λ = 210 nm), t_R = 26.0 min (major), t_R = 29.9 min (minor).

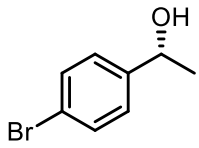


#	Time	Area	Height	Width	Area%	Symmetry
1	25.846	20385.1	409	0.6854	48.562	0.321
2	29.873	21592.4	361.4	0.8171	51.438	0.331

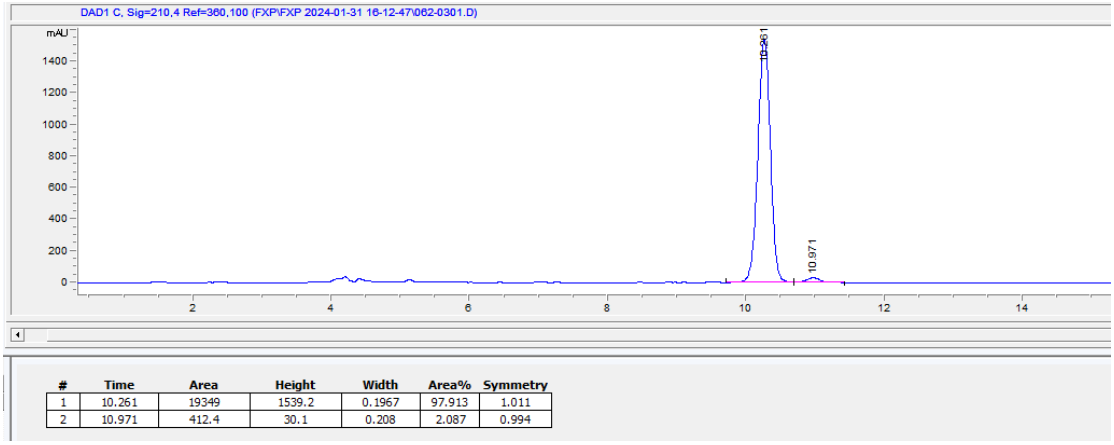


#	Time	Area	Height	Width	Area%	Symmetry
1	26.016	21459.8	470.8	0.7597	97.037	0.38
2	29.924	655.4	12.8	0.8537	2.963	0.451

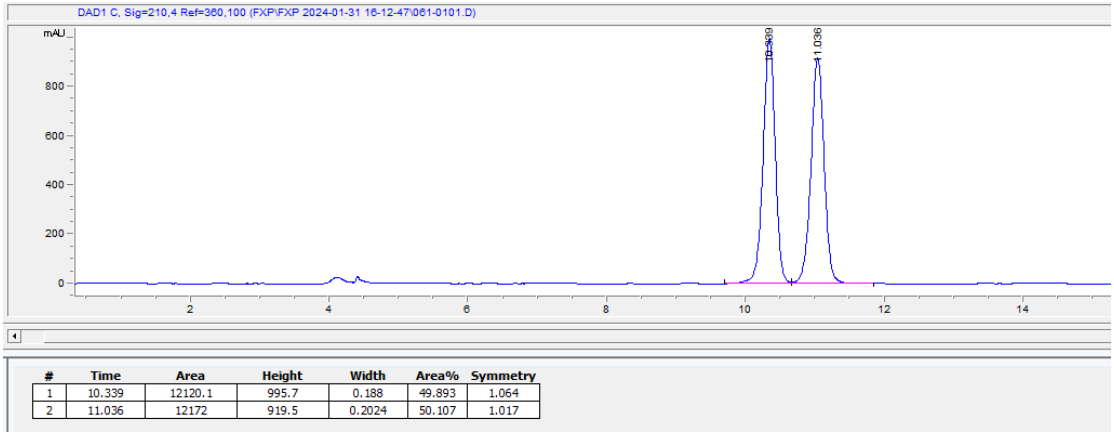
(*R*)-1-(4-Bromophenyl) Ethanol (3e)[8]



Colorless oil, 97% yield, 96% ee; **[α]$_D^{25}$**: 37.7 (c = 2.89, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.46 (d, *J* = 6.6 Hz, 2H), 7.24 (d, *J* = 7.3 Hz, 2H), 4.85 (q, *J* = 7.1, 6.7 Hz, 1H), 1.46 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 144.9, 131.7, 127.3, 121.3, 69.9, 25.4; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 10.3 min (major), t_R = 11.0 min (minor).

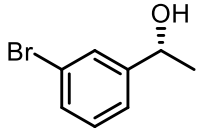


#	Time	Area	Height	Width	Area%	Symmetry
1	10.261	19349	1539.2	0.1967	97.913	1.011
2	10.971	412.4	30.1	0.208	2.087	0.994



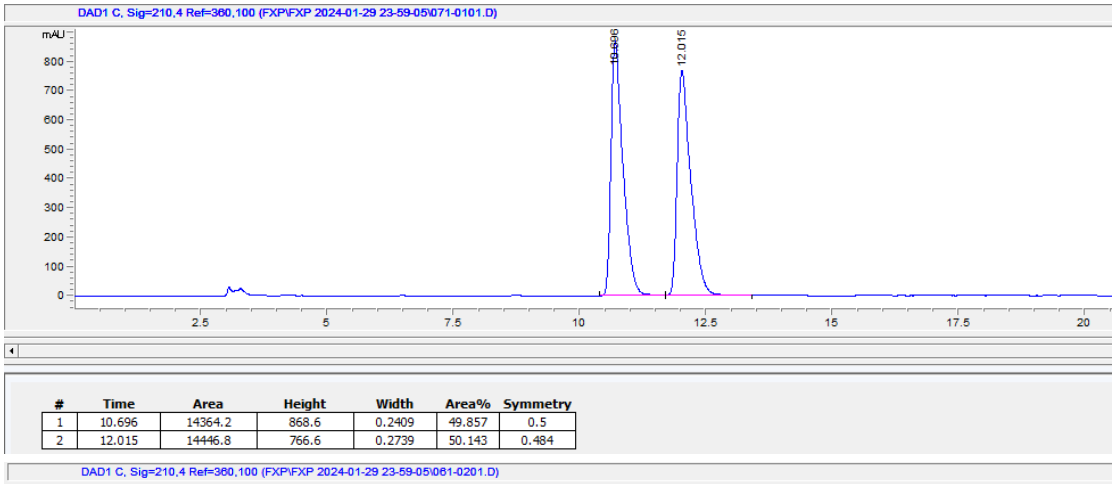
#	Time	Area	Height	Width	Area%	Symmetry
1	10.339	12120.1	995.7	0.188	49.893	1.064
2	11.036	12172	919.5	0.2024	50.107	1.017

(*R*)-1-(3-Bromophenyl) Ethanol (3f)[7]

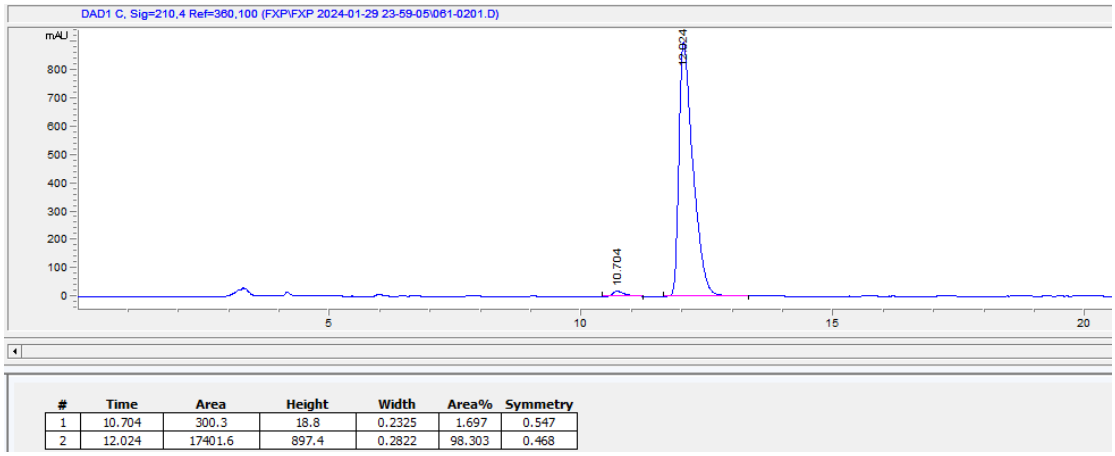


Colorless oil, 99% yield, 97% ee; **[α]$_D^{25}$**: 27.6 (c = 2.81, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.52 (s, 1H), 7.39 (d, *J* = 7.8 Hz, 1H), 7.27 (d, *J* = 7.5 Hz, 1H), 7.20 (t, *J* = 7.7 Hz, 1H), 4.83 (q, *J* = 6.3 Hz, 1H), 2.30 (s, 1H), 1.46 (d, *J* = 9.7 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 148.2, 130.5, 130.2, 128.7, 124.1, 122.7,

69.8, 25.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 10.7 min (minor), t_R = 12.0 min (major).

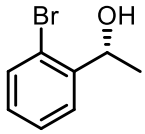


#	Time	Area	Height	Width	Area%	Symmetry
1	10.696	14364.2	868.6	0.2409	49.857	0.5
2	12.015	14446.8	766.6	0.2739	50.143	0.484

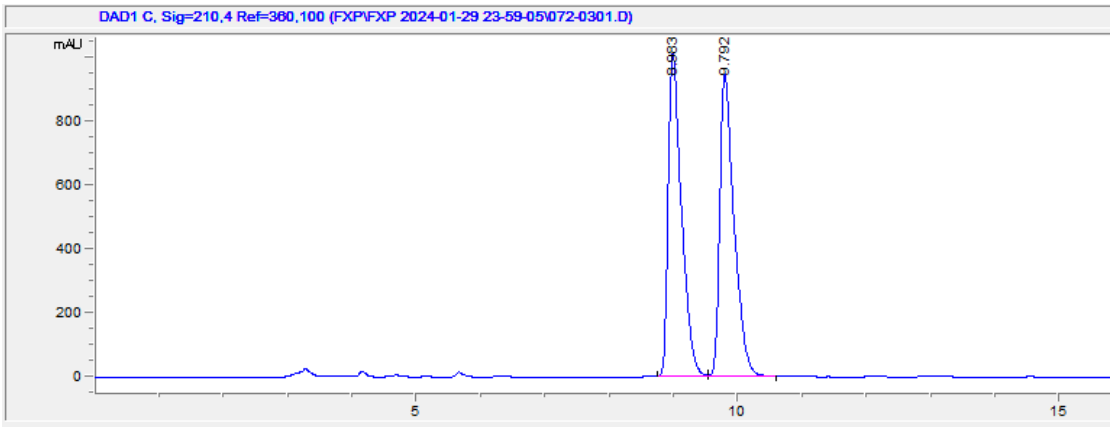


#	Time	Area	Height	Width	Area%	Symmetry
1	10.704	300.3	18.8	0.2325	1.697	0.547
2	12.024	17401.6	897.4	0.2822	98.303	0.468

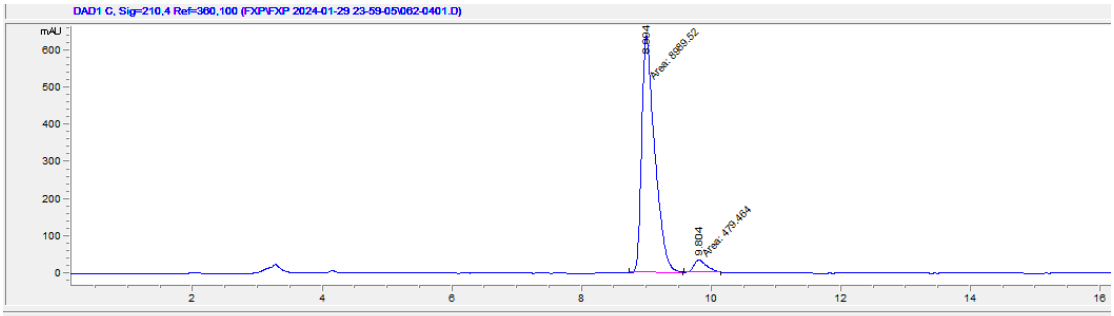
(*R*)-1-(2-Bromophenyl) Ethanol (3g)[10]



White solid, 93% yield, 90% ee; **[α]$_D^{25}$**: 43.2 (c = 2.90, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.8 Hz, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.34 (t, *J* = 7.6 Hz, 1H), 7.13 (t, *J* = 7.6 Hz, 1H), 5.24 (q, *J* = 6.3 Hz, 1H), 1.48 (d, *J* = 6.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 144.7, 132.8, 128.9, 128.0, 126.8, 121.8, 69.3, 23.7; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 9.0 min (major), t_R = 9.8 min (minor).

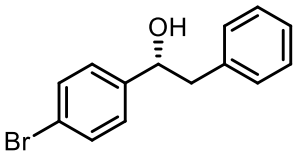


#	Time	Area	Height	Width	Area%	Symmetry
1	8.983	14547.8	1013.9	0.2094	49.800	0.496
2	9.792	14664.9	948.7	0.2243	50.200	0.509

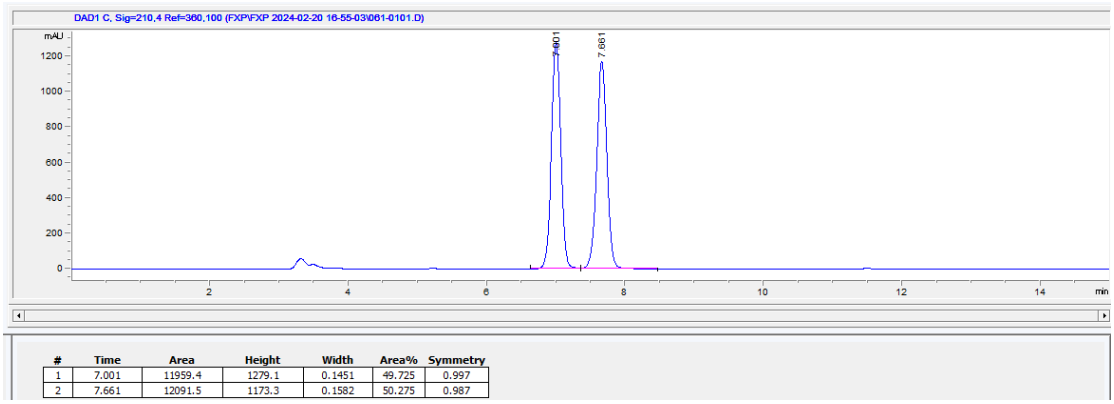


#	Time	Area	Height	Width	Area%	Symmetry
1	8.994	8989.5	636.3	0.2355	94.936	0.523
2	9.804	479.5	34.1	0.2341	5.064	0.614

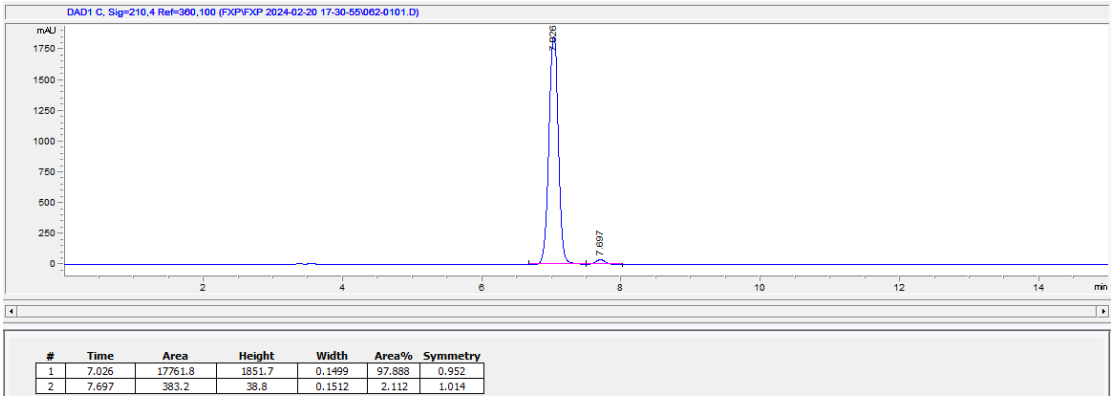
(*R*)-1-(4-Bromophenyl)-2-Phenylethanol (3h)[8]



Colorless oil, 92% yield, 96% ee; **$[\alpha]_D^{25}$**: -3.7 (c = 4.39, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.47 (d, *J* = 8.3 Hz, 2H), 7.31 (t, *J* = 7.3 Hz, 2H), 7.26 (d, *J* = 7.2 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 2H), 7.17 (d, *J* = 7.0 Hz, 2H), 4.86 (dd, *J* = 8.4, 5.1 Hz, 1H), 2.98 (qd, *J* = 13.6, 6.7 Hz, 2H), 2.04 (s, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 142.8, 137.6, 131.6, 129.6, 128.7, 127.8, 126.9, 121.4, 74.8, 46.2; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 °C, λ = 210 nm), t_R = 7.0 min (major), t_R = 7.7 min (minor).

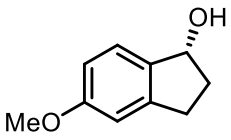


#	Time	Area	Height	Width	Area%	Symmetry
1	7.001	11959.4	1279.1	0.1451	49.725	0.997
2	7.661	12091.5	1173.3	0.1582	50.275	0.987

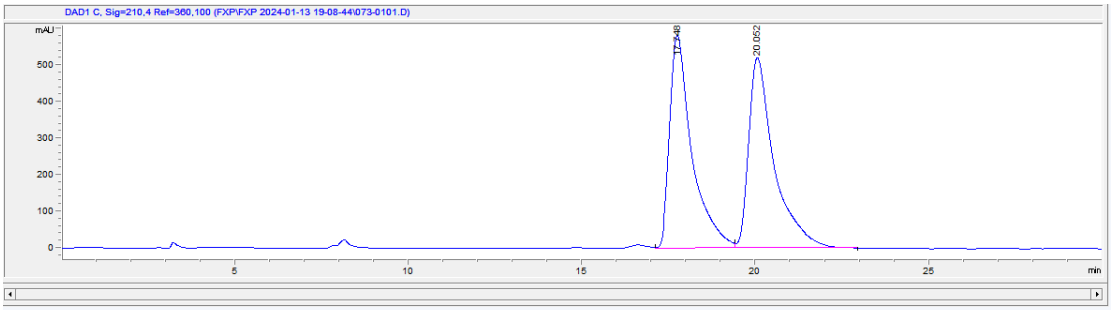


#	Time	Area	Height	Width	Area%	Symmetry
1	7.026	17761.8	1851.7	0.1499	97.888	0.952
2	7.697	383.2	38.8	0.1512	2.112	1.014

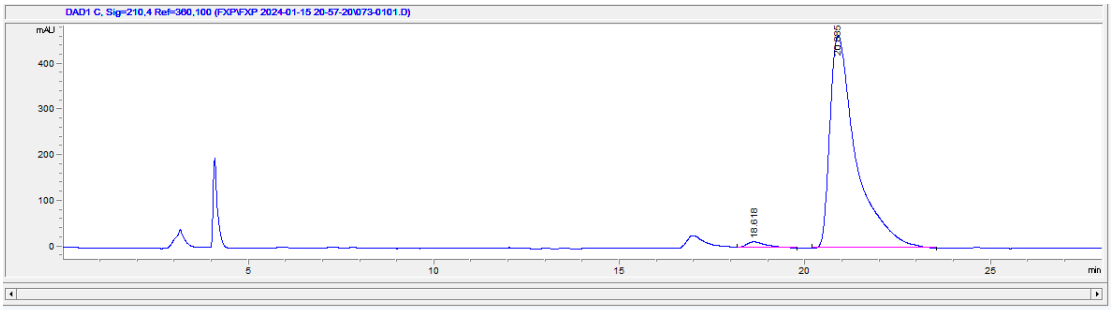
(*R*)-5-Methoxy-1-Indenol (3i)[7]



Colorless oil, 95% yield, 96% ee; **$[\alpha]_D^{25}$**: -20.6 (c = 1.69, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.31 (d, *J* = 8.9 Hz, 1H), 6.79 (dd, *J* = 5.8, 2.5 Hz, 2H), 5.19 (dd, *J* = 6.6, 4.5 Hz, 1H), 3.80 (s, 3H), 3.05 (ddd, *J* = 16.1, 8.5, 5.5 Hz, 1H), 2.79 (ddd, *J* = 15.5, 8.4, 5.9 Hz, 1H), 2.47 (dddd, *J* = 13.6, 8.5, 6.7, 5.4 Hz, 1H), 1.96 (dddd, *J* = 13.2, 8.5, 5.9, 4.6 Hz, 1H), 1.78 (s, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 158.9, 138.7, 131.3, 130.2, 113.4, 112.6, 67.7, 55.3, 32.5, 29.7, 18.7; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC column (hexane : isopropanol = 95 : 5, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 18.6 min (minor), t_R = 20.9 min (major).

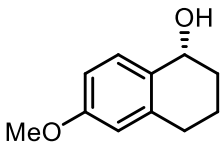


#	Time	Area	Height	Width	Area%	Symmetry
1	17.748	25990.4	582.2	0.6489	49.549	0.486
2	20.052	26464	521.8	0.7357	50.451	0.463

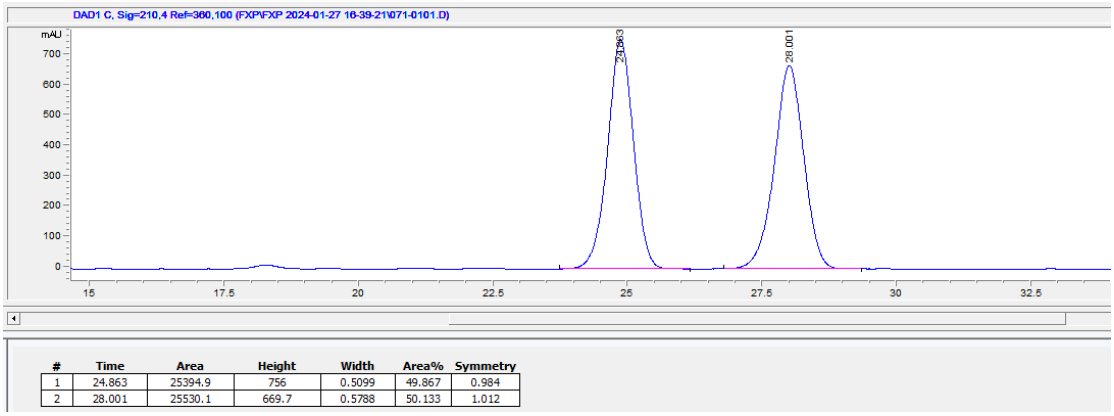


#	Time	Area	Height	Width	Area%	Symmetry
1	18.618	519.4	13.6	0.5126	2.227	0.578
2	20.885	22809.3	465.1	0.7161	97.773	0.413

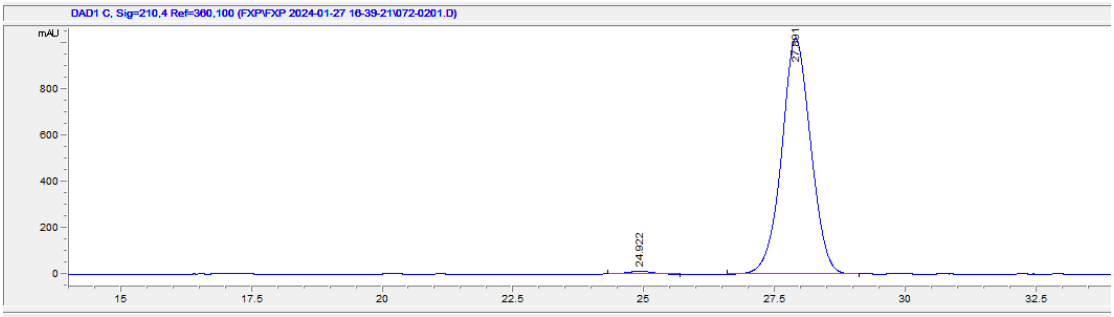
(*R*)-6-Methoxy-1,2,3,4-Tetrahydronaphthalen-1-ol (3j)[7]



Colorless oil, 95% yield, 98% ee; **$[\alpha]_D^{25}$**: -18.1 (c = 3.01, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.33 (d, *J* = 8.3 Hz, 1H), 6.77 (dd, *J* = 8.5, 2.5 Hz, 1H), 6.62 (d, *J* = 2.4 Hz, 1H), 4.74 (t, *J* = 3.2 Hz, 1H), 3.79 (s, 3H), 2.84 - 2.75 (m, 1H), 2.75 - 2.65 (m, 1H), 2.00 - 1.87 (m, 3H), 1.77 (qd, *J* = 10.7, 8.2, 3.2 Hz, 2H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 160.3, 145.4, 137.4, 125.2, 113.1, 109.9, 76.0, 55.5, 36.4, 30.1; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 96 : 4, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 24.9 min (minor), t_R = 27.9 min (major).

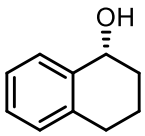


#	Time	Area	Height	Width	Area%	Symmetry
1	24.863	25394.9	756	0.5099	49.867	0.984
2	28.001	25530.1	669.7	0.5788	50.133	1.012

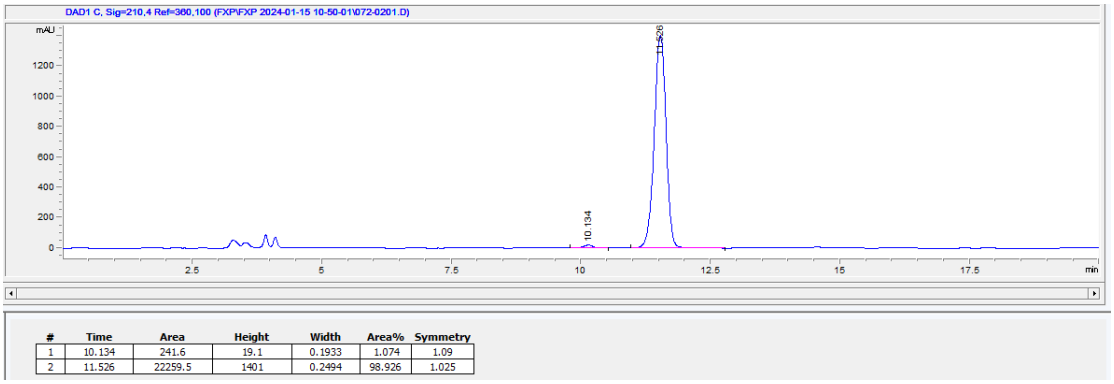


#	Time	Area	Height	Width	Area%	Symmetry
1	24.922	401.5	12.4	0.4489	1.009	0.965
2	27.891	39392.1	1018.5	0.5792	98.991	0.897

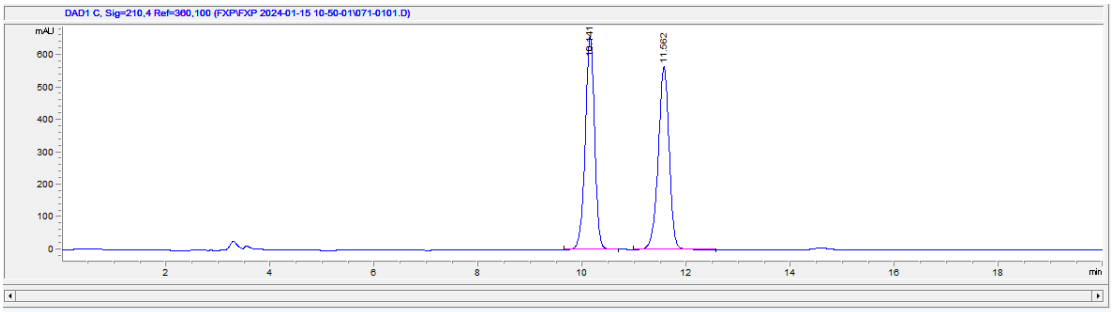
(*R*)- 1,2,3,4-Tetrahydro-1-Naphthol (3k)[7]



Colorless oil, 91% yield, 98% ee; **$[\alpha]_D^{25}$**: -30.7 (c = 2.15, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.43 (dt, *J* = 6.6, 2.0 Hz, 1H), 7.20 (dq, *J* = 7.7, 3.1, 2.6 Hz, 2H), 7.11 (dt, *J* = 6.0, 1.9 Hz, 1H), 4.78 (t, *J* = 4.0 Hz, 1H), 2.83 (dt, *J* = 17.0, 5.6 Hz, 1H), 2.73 (dt, *J* = 17.0, 6.8 Hz, 1H), 2.03 - 1.93 (m, 2H), 1.91 (ddd, *J* = 10.5, 7.8, 5.4 Hz, 1H), 1.82 - 1.73 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 138.9, 137.2, 129.1, 128.8, 127.7, 126.3, 68.2, 32.4, 29.4, 18.9; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC column (hexane : isopropanol = 96 : 4, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 10.1 min (minor), t_R = 11.5 min (major).

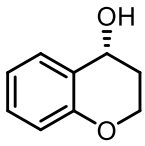


#	Time	Area	Height	Width	Area%	Symmetry
1	10.134	241.6	19.1	0.1933	1.074	1.09
2	11.526	22259.5	1401	0.2494	98.926	1.025

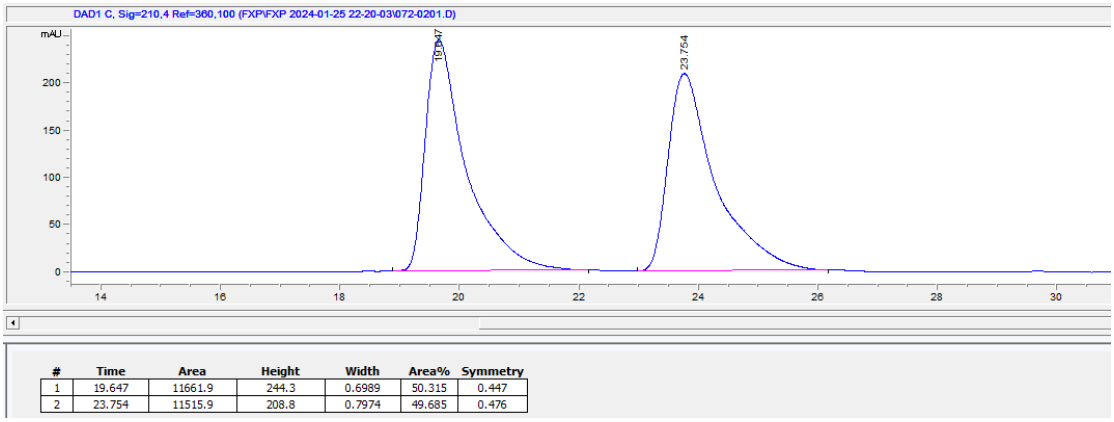


#	Time	Area	Height	Width	Area%	Symmetry
1	10.141	8164.3	656.1	0.1912	49.757	1.062
2	11.562	8243.9	564.1	0.2225	50.243	1.076

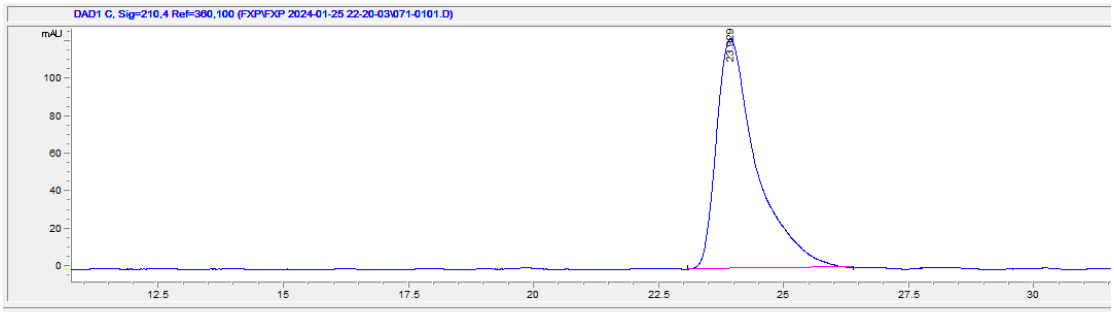
(*R*)-3,4-Dihydro-2H-1-Benzopyran-4-ol (3l)[7]



White solid, 99% yield, >99% ee; **$[\alpha]_D^{25}$**: 68.3 (c = 2.84, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.32 (d, *J* = 7.6 Hz, 1H), 7.21 (dd, *J* = 8.4, 7.2 Hz, 1H), 6.93 (t, *J* = 7.4 Hz, 1H), 6.85 (d, *J* = 8.2 Hz, 1H), 4.80 (t, *J* = 4.0 Hz, 1H), 4.27 (dd, *J* = 9.1, 3.1 Hz, 2H), 2.19 - 2.08 (m, 1H), 2.04 (dq, *J* = 14.4, 3.6 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 154.7, 129.8, 129.8, 124.4, 120.7, 117.2, 63.4, 62.0, 30.9; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 19.6 min (minor), t_R = 23.9 min (major).

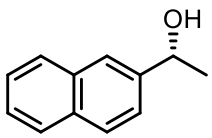


#	Time	Area	Height	Width	Area%	Symmetry
1	19.647	11661.9	244.3	0.6989	50.315	0.447
2	23.754	11515.9	208.8	0.7974	49.685	0.476

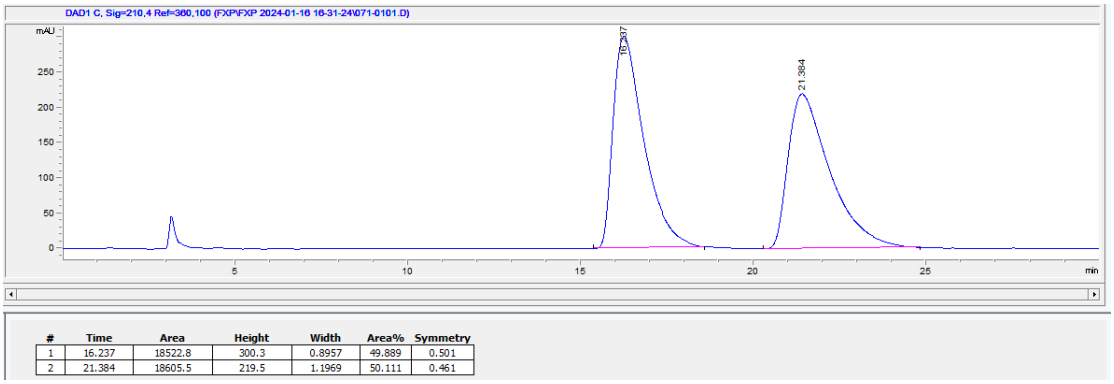


#	Time	Area	Height	Width	Area%	Symmetry
1	23.929	6823.4	122.7	0.8028	100.000	0.492

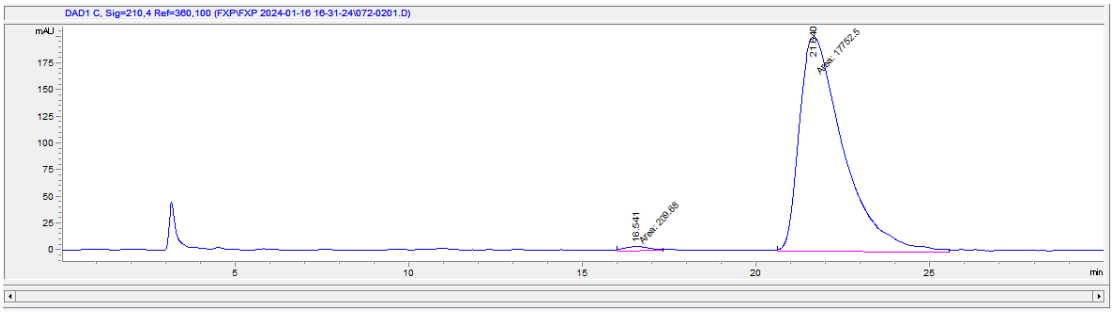
(*R*)-1-(2-Naphthyl) Ethanol (3m)[7]



White solid, 99% yield, 98% ee; **$[\alpha]_D^{25}$**: 46.6 (c = 3.13, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.87 - 7.78 (m, 4H), 7.54 - 7.43 (m, 3H), 5.06 (q, *J* = 6.4 Hz, 1H), 1.58 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 143.3, 133.4, 133.0, 128.4, 128.0, 127.8, 126.3, 125.9, 123.9, 123.9, 70.6, 25.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-H column (hexane : isopropanol = 90 : 10, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 16.5 min (minor), t_R = 21.6 min (major).

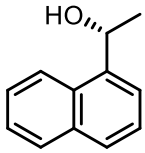


#	Time	Area	Height	Width	Area%	Symmetry
1	16.237	18522.8	300.3	0.8957	49.889	0.501
2	21.384	18605.5	219.5	1.1969	50.111	0.461

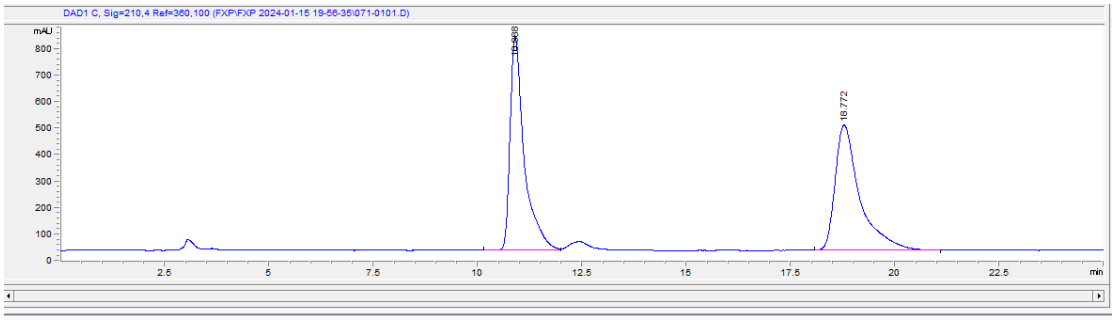


#	Time	Area	Height	Width	Area%	Symmetry
1	16.541	209.7	4.2	0.8325	1.167	1.012
2	21.64	17752.5	201.1	1.4715	98.833	0.479

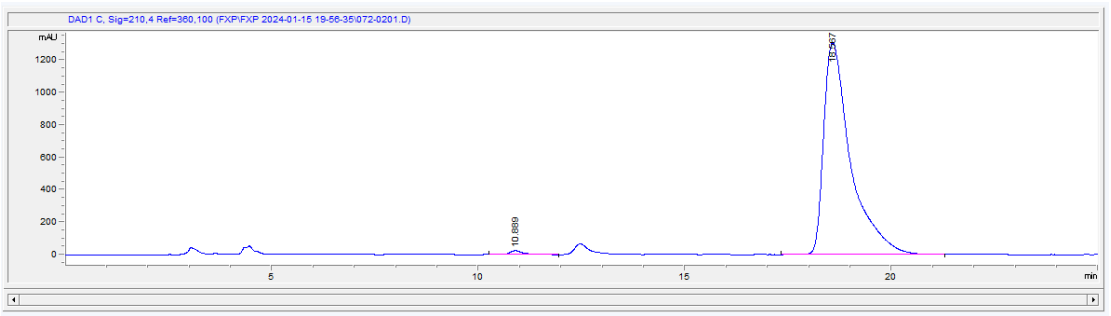
(*R*)-Naphthyl-1-Ethanol (3n)[7]



Colorless oil, 99% yield, 98% ee; **$[\alpha]_D^{25}$**: 53.8 (c = 3.30, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.11 (d, *J* = 8.1 Hz, 1H), 7.88 (d, *J* = 8.2 Hz, 1H), 7.79 (d, *J* = 8.2 Hz, 1H), 7.68 (d, *J* = 7.1 Hz, 1H), 7.51 (dq, *J* = 15.0, 7.6, 7.1 Hz, 3H), 5.66 (q, *J* = 6.6 Hz, 1H), 1.67 (d, *J* = 6.3 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 141.4, 133.9, 130.3, 129.0, 128.0, 126.1, 125.6, 125.6, 123.3, 122.1, 67.2, 24.5; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 90 : 10, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 10.9 min (minor), t_R = 18.6 min (major).

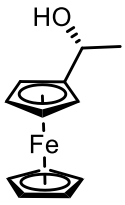


#	Time	Area	Height	Width	Area%	Symmetry
1	10.888	19104	805.8	0.3486	49.749	0.504
2	18.772	19297	471.9	0.6031	50.251	0.518

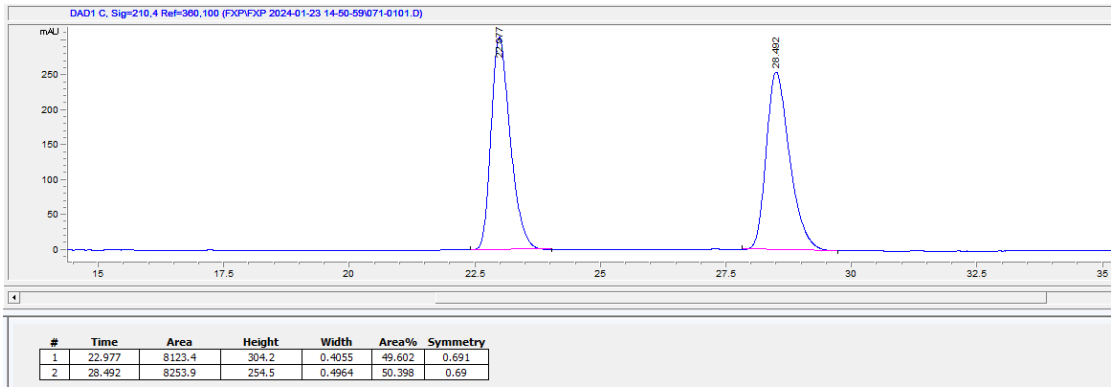


#	Time	Area	Height	Width	Area%	Symmetry
1	10.889	559.2	24.1	0.3392	0.934	0.605
2	18.567	59277.6	1306.8	0.6732	99.066	0.448

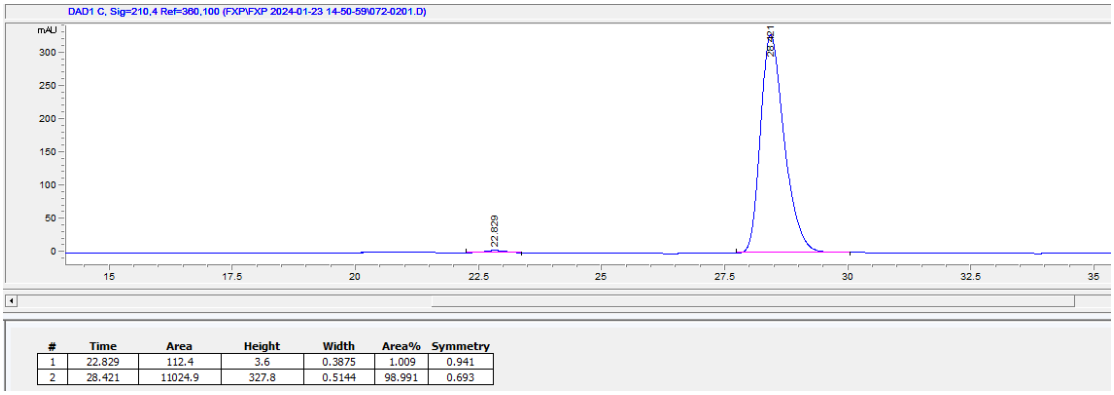
[(*R*)-1-Hydroxyethyl] Ferrocene (3o)[7]



Red solid, 99% yield, 98% ee; $[\alpha]_D^{25}$: -27.0 (c = 4.17, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 4.55 (d, *J* = 7.0 Hz, 1H), 4.27 - 4.04 (m, 9H), 1.86 (s, 1H), 1.44 (d, *J* = 6.3 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 94.9, 68.4, 68.1, 68.0, 66.3, 66.2, 65.7, 23.9; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC-3 column (hexane : isopropanol = 97 : 3, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 22.8 min (minor), t_R = 28.4 min (major).

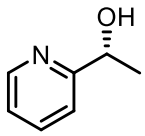


#	Time	Area	Height	Width	Area%	Symmetry
1	22.977	8123.4	304.2	0.4055	49.602	0.691
2	28.492	8253.9	254.5	0.4964	50.398	0.69

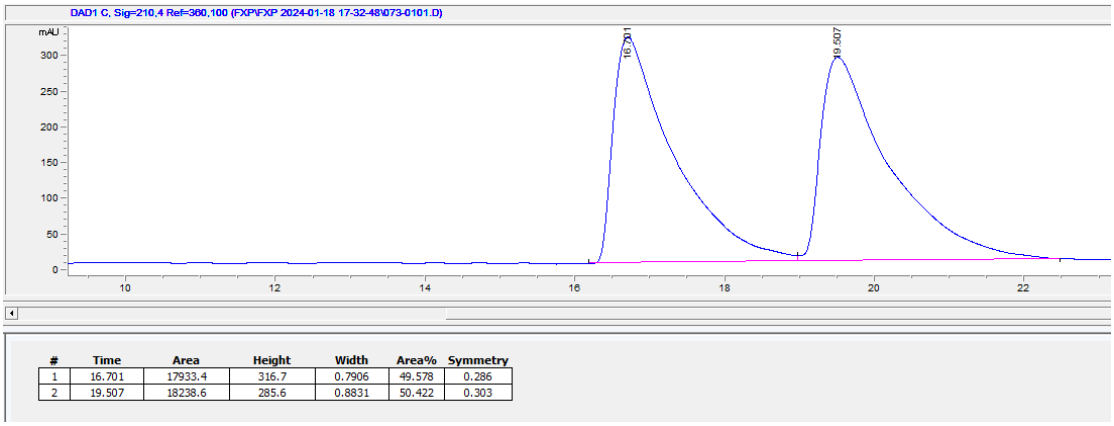


#	Time	Area	Height	Width	Area%	Symmetry
1	22.829	112.4	3.6	0.3875	1.009	0.941
2	28.421	11024.9	327.8	0.5144	98.991	0.693

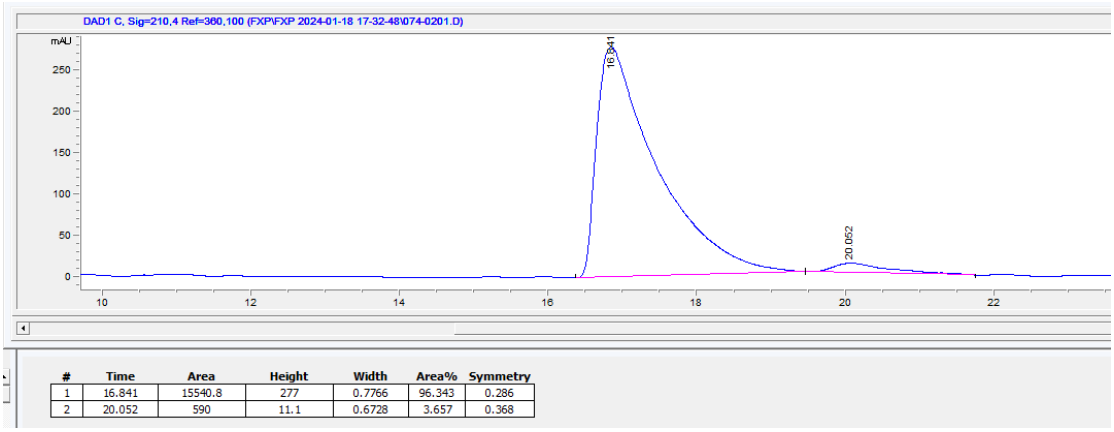
(*R*)-2-(1-Hydroxyethyl) Pyridine (3p)[11]



Colorless oil, 90% yield, 93% ee; **$[\alpha]_D^{25}$**: 16.2 (c = 1.29, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.53 (d, *J* = 4.7 Hz, 1H), 7.69 (d, *J* = 7.9 Hz, 1H), 7.30 (d, *J* = 7.9 Hz, 1H), 7.23 - 7.16 (m, 1H), 4.90 (q, *J* = 6.6 Hz, 1H), 3.52 (br, 1H), 1.50 (d, *J* = 6.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 163.0, 148.0, 137.2, 122.4, 120.1, 68.9, 24.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 97 : 3, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 16.8 min (major), t_R = 20.0 min (minor).

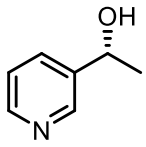


#	Time	Area	Height	Width	Area%	Symmetry
1	16.701	17933.4	316.7	0.7906	49.578	0.286
2	19.507	18238.6	285.6	0.8831	50.422	0.303

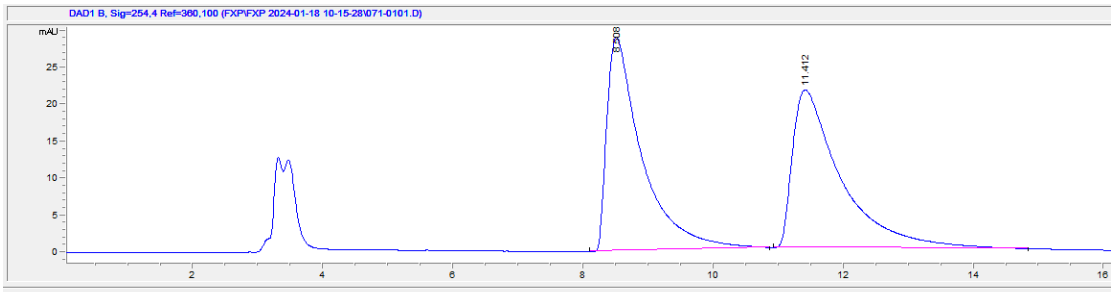


#	Time	Area	Height	Width	Area%	Symmetry
1	16.841	15540.8	277	0.7766	96.343	0.286
2	20.052	590	11.1	0.6728	3.657	0.368

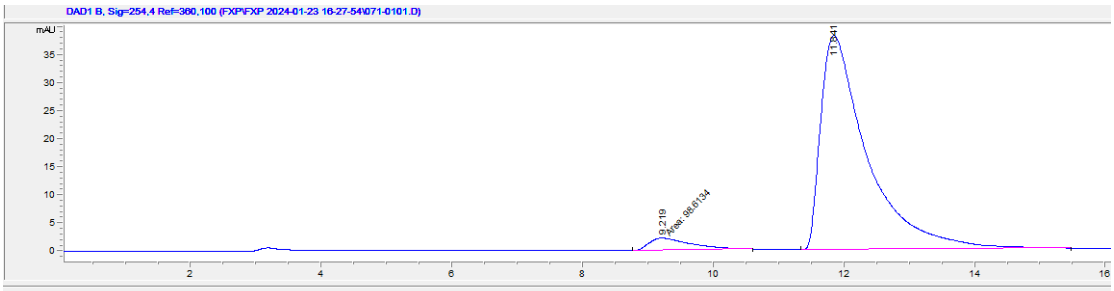
(*R*)-1-(3-Pyridyl) Ethanol (3q)[9]



Colorless oil, 92% yield, 90% ee; **$[\alpha]_D^{25}$**: 38.5 (c = 1.60, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.46 (d, *J* = 41.5 Hz, 2H), 7.74 (d, *J* = 7.8 Hz, 1H), 7.27 (d, *J* = 5.7 Hz, 1H), 4.92 (q, *J* = 6.6 Hz, 1H), 1.49 (d, *J* = 6.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 148.3, 147.1, 141.6, 133.7, 123.8, 67.9, 25.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-H column (hexane : isopropanol = 90 : 10, flow rate = 1 mL/min, T = 20 ℃, λ = 254 nm), t_R = 9.2 min (minor), t_R = 11.8 min (major).

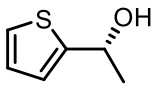


#	Time	Area	Height	Width	Area%	Symmetry
1	8.508	1084	28.9	0.5336	49.430	0.336
2	11.412	1109	21.3	0.7286	50.570	0.325

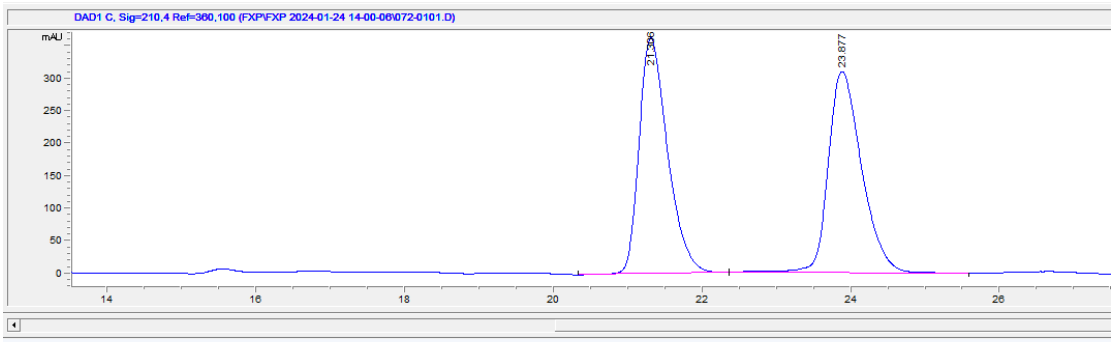


#	Time	Area	Height	Width	Area%	Symmetry
1	9.219	98.6	2.1	0.7656	4.956	0.446
2	11.841	1891	38.2	0.7122	95.044	0.36

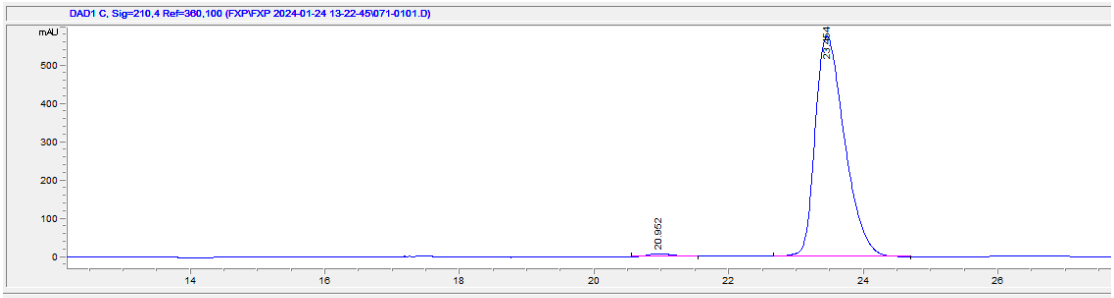
(*R*)-1-(2-Thienyl) Ethanol (3r)[7]



Colorless oil, 94% yield, 98% ee; **$[\alpha]_D^{25}$**: 24.7 (c = 1.63, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.27 - 7.21 (m, 1H), 7.01 - 6.93 (m, 2H), 5.14 (q, *J* = 6.5, 5.6 Hz, 1H), 2.02 (br, 1H), 1.61 (d, *J* = 6.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 150.0, 126.8, 124.6, 123.3, 66.4, 25.4; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 20.9 min (minor), t_R = 23.4 min (major).

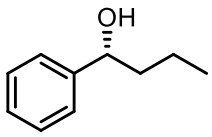


#	Time	Area	Height	Width	Area%	Symmetry
1	21.306	9659.3	362.7	0.4067	49.686	0.661
2	23.877	9781.2	309.9	0.4802	50.314	0.688

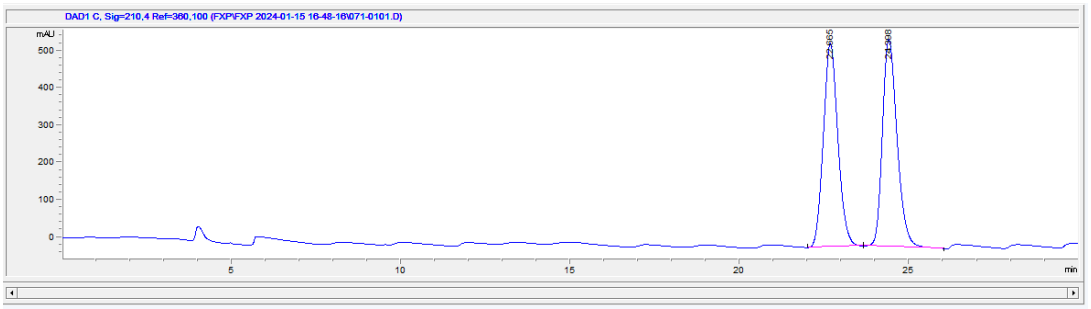


#	Time	Area	Height	Width	Area%	Symmetry
1	20.952	189.9	8	0.3307	1.076	0.74
2	23.454	17453.1	575	0.4681	98.924	0.627

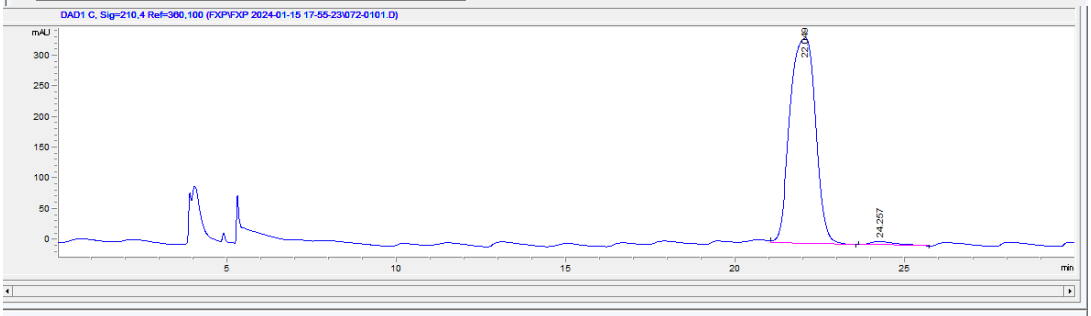
(*R*)-1-Phenyl-1-Butanol (3s)[7]



White solid, 98% yield, 96% ee; **[α]$_D^{25}$**: 41.5 (c = 1.99, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 4.7 Hz, 4H), 7.31 - 7.25 (m, 1H), 4.67 (t, *J* = 6.7 Hz, 1H), 1.98 (s, 1H), 1.84 - 1.73 (m, 1H), 1.74 - 1.62 (m, 1H), 1.48 - 1.38 (m, 1H), 1.37 - 1.27 (m, 1H), 0.94 (t, *J* = 7.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 145.0, 128.5, 127.6, 126.0, 74.5, 41.4, 19.2, 14.1; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC-3 column (hexane : isopropanol = 98 : 2, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 22.0 min (major), t_R = 24.3 min (minor).

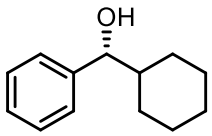


#	Time	Area	Height	Width	Area%	Symmetry
1	22.665	16075.1	546.6	0.4451	49.347	0.87
2	24.398	16500.3	555.1	0.4608	50.653	0.729

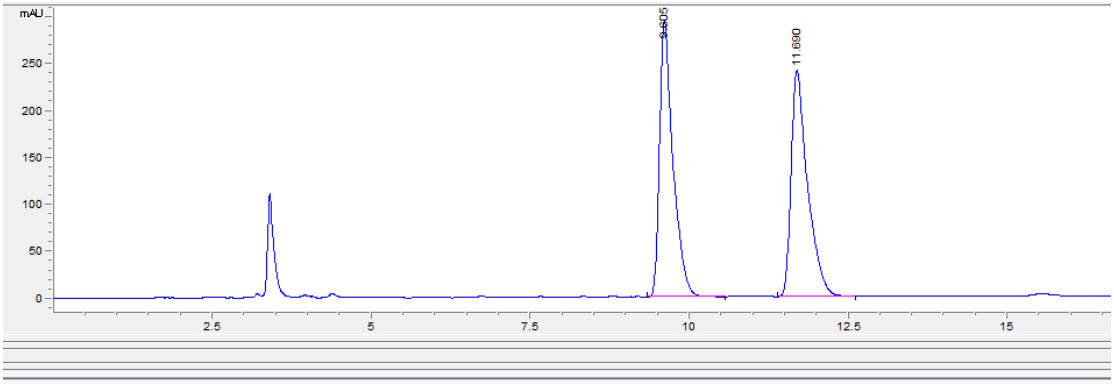


#	Time	Area	Height	Width	Area%	Symmetry
1	22.049	17534.6	335.2	0.8603	98.256	1.374
2	24.257	311.2	5.9	0.6316	1.744	0.565

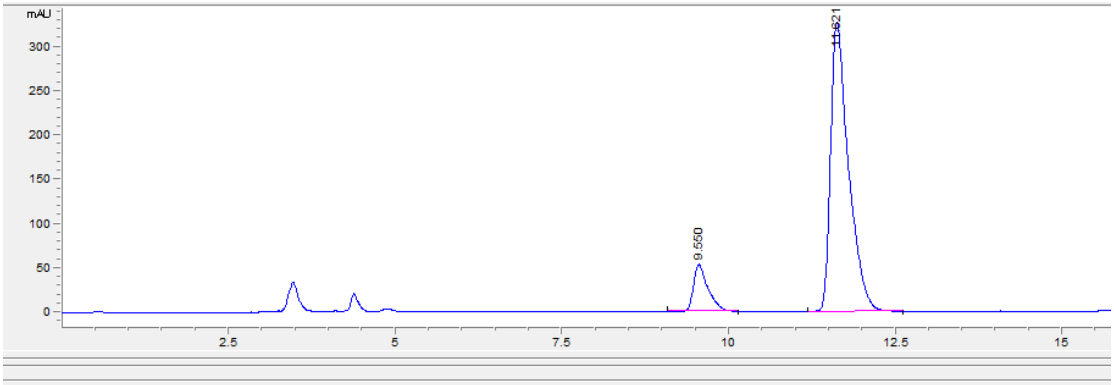
(*R*)-1-Phenyl-1-Cyclohexyl-Mathanol (3t)[7]



Colorless oil, 28% yield, 76% ee; **$[\alpha]_D^{25}$**: 29.6 (c = 0.32, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.41 - 7.23 (m, 5H), 4.37 (d, *J* = 7.2 Hz, 1H), 2.04 - 1.95 (m, 1H), 1.81 - 1.71 (m, 2H), 1.67 - 1.56 (m, 2H), 1.39 - 1.34 (m, 1H), 1.29 - 0.86 (m, 6H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 143.7, 128.3, 127.6, 126.8, 79.5, 45.1, 29.4, 29.0, 26.5, 26.2, 26.1; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 9.6 min (minor), t_R = 11.6 min (major).

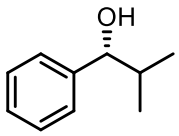


#	Time	Area	Height	Width	Area%	Symmetry
1	9.605	4321.4	293.8	0.2136	49.904	0.524
2	11.69	4338.1	240.9	0.2601	50.096	0.505

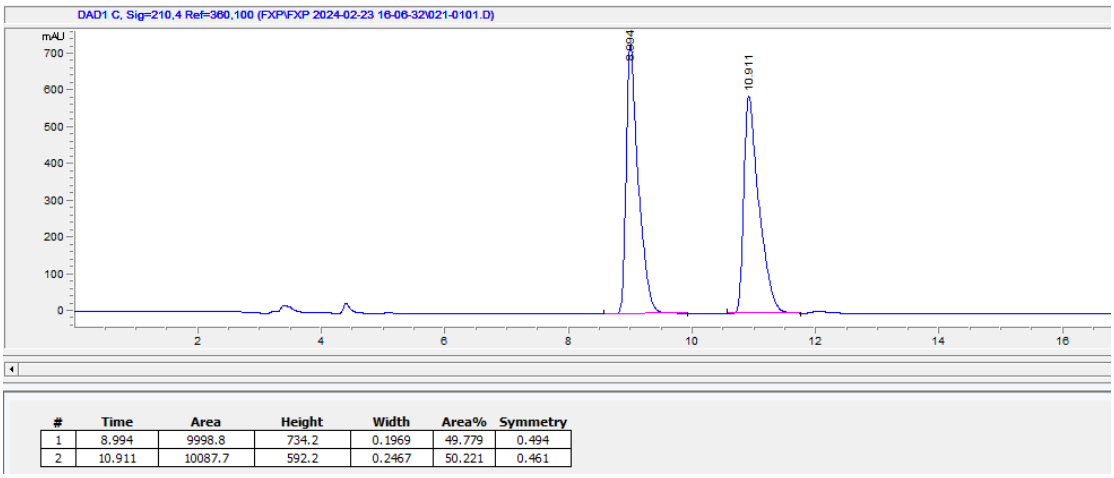


#	Time	Area	Height	Width	Area%	Symmetry
1	9.55	804.5	53.2	0.2204	11.618	0.562
2	11.621	6119.6	327.2	0.2722	88.382	0.511

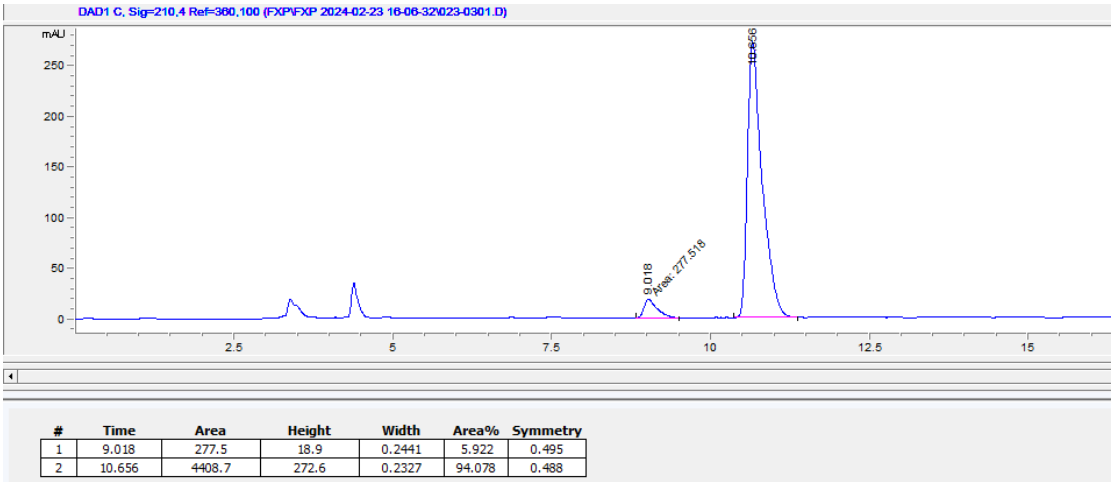
(*R*)-2-Methyl-1-Phenyl-1-Propanol (3u)[7]



Colorless oil, 39% yield, 88% ee; **[α]$_D^{25}$**: 15.2 (c = 0.45, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.38 - 7.24 (m, 5H), 4.33 (d, *J* = 7.6 Hz, 1H), 2.24 (s, 1H), 1.95 (dq, *J* = 13.6, 6.8 Hz, 1H), 1.01 (d, *J* = 6.7 Hz, 3H), 0.80 (d, *J* = 6.9 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 143.7, 128.2, 127.4, 126.7, 80.0, 35.3, 19.0, 18.4; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 9.0 min (minor), t_R = 10.7 min (major).

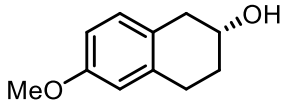


#	Time	Area	Height	Width	Area%	Symmetry
1	8.994	9998.8	734.2	0.1969	49.779	0.494
2	10.911	10087.7	592.2	0.2467	50.221	0.461



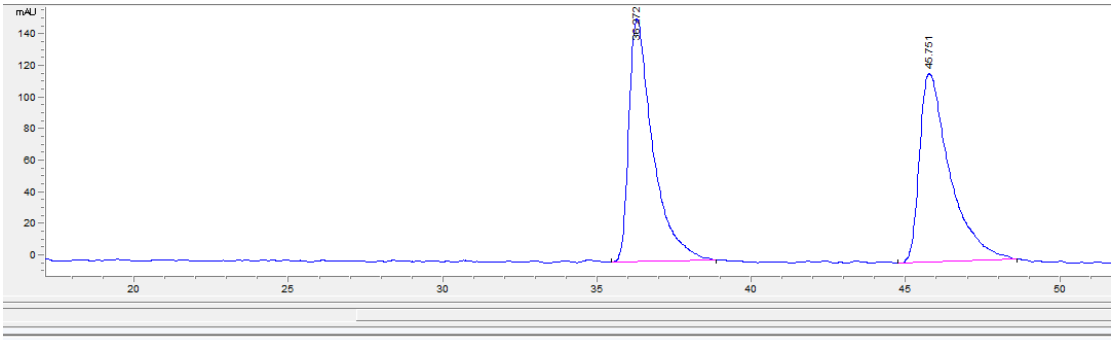
#	Time	Area	Height	Width	Area%	Symmetry
1	9.018	277.5	18.9	0.2441	5.922	0.495
2	10.656	4408.7	272.6	0.2327	94.078	0.488

(*R*)-1,2,3,4-Tetrahydro-6-Methoxy-2-Naphthalenol (5a)[12]

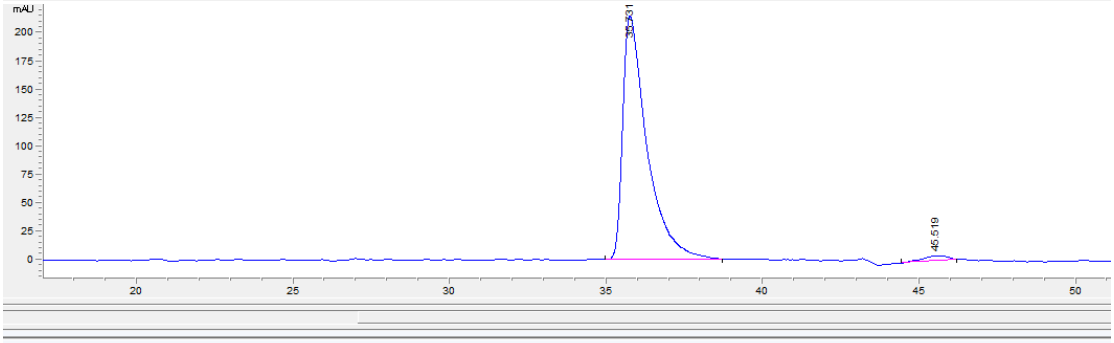


Colorless oil, 98% yield, 96% ee; **[α]$_D^{25}$**: 45.6 (c = 3.07, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.00 (dd, *J* = 8.5, 2.6 Hz, 1H), 6.71

(dd, *J* = 8.5, 2.7 Hz, 1H), 6.64 (d, *J* = 2.6 Hz, 1H), 4.16 - 4.12 (m, 1H), 3.78 (s, 3H), 3.06 - 2.99 (m, 1H), 2.97 - 2.89 (m, 1H), 2.82 (dt, *J* = 16.6, 7.5 Hz, 1H), 2.74 - 2.65 (m, 1H), 2.07 - 2.00 (m, 1H), 1.86 - 1.76 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 158.0, 136.9, 130.5, 126.4, 113.3, 112.4, 67.6, 55.4, 37.8, 31.5, 27.4; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 35.7 min (major), t_R = 45.5 min (minor).

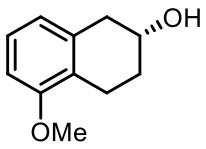


#	Time	Area	Height	Width	Area%	Symmetry
1	36.272	8342	153.8	0.7686	50.374	0.46
2	45.751	8218	119.7	0.9912	49.626	0.442



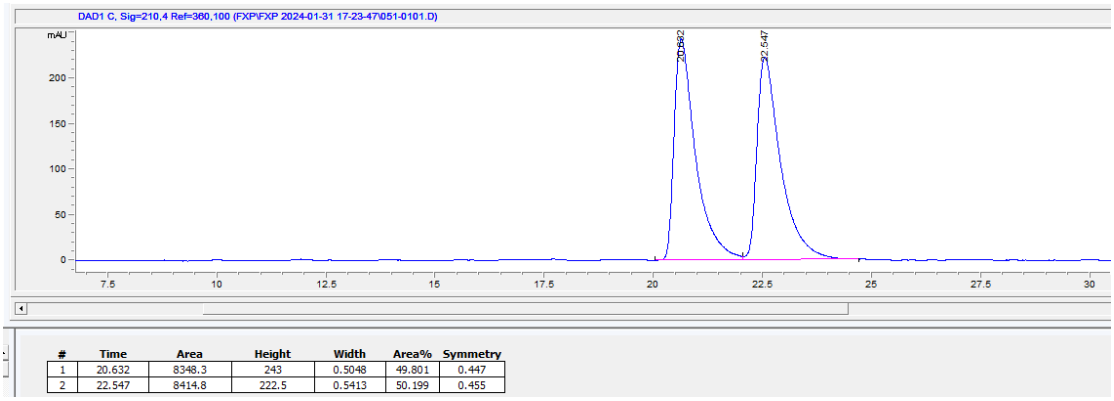
#	Time	Area	Height	Width	Area%	Symmetry
1	35.731	11582.4	214.8	0.757	97.919	0.39
2	45.519	246.2	4.6	0.6471	2.081	1.424

(*R*)-5-Methoxy-1,2,3,4-Tetrahydronahthalen-2-ol (5b)[12]

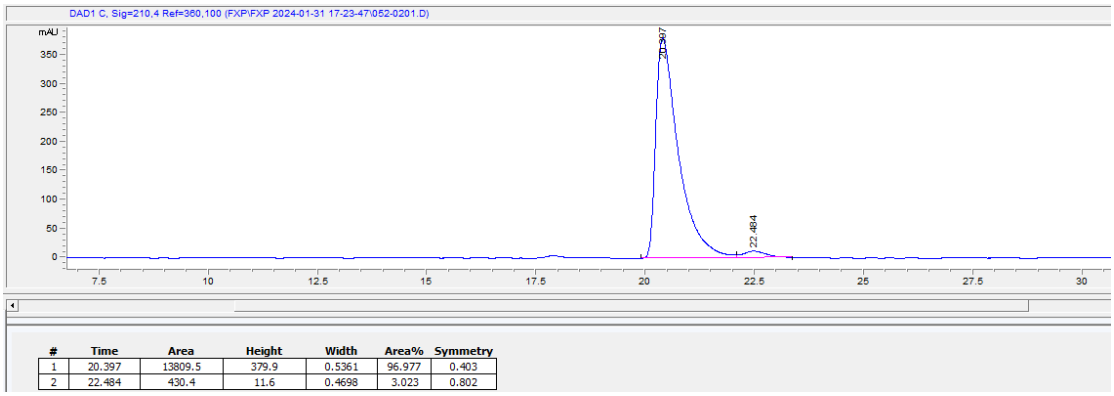


White solid, 99% yield, 94% ee; **[α]$_D^{25}$**: 54.1 (c = 2.94, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.14 - 7.08 (m, 1H), 6.69 (dd, *J* = 17.0, 7.9 Hz, 2H), 4.17- 4.08 (m, 1H), 3.82 (s, 3H), 3.06 (d, *J* = 12.7 Hz, 1H), 2.91 (dt, *J* = 17.9, 5.8 Hz, 1H), 2.76 (dd, *J* = 16.2, 8.1 Hz, 1H), 2.70 - 2.61 (m, 1H), 2.11 - 2.02 (m, 1H), 1.83 - 1.75 (m, 1H), 1.73 - 1.67 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.2, 135.7, 126.6, 124.6, 121.8, 107.3, 67.2, 55.4, 38.5, 31.2, 21.3; The enantiomeric excess was determined by chiral HPLC

analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 20.4 min (major), t_R = 22.5 min (minor).

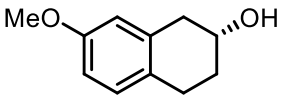


#	Time	Area	Height	Width	Area%	Symmetry
1	20.632	8348.3	243	0.5048	49.801	0.447
2	22.547	8414.8	222.5	0.5413	50.199	0.455

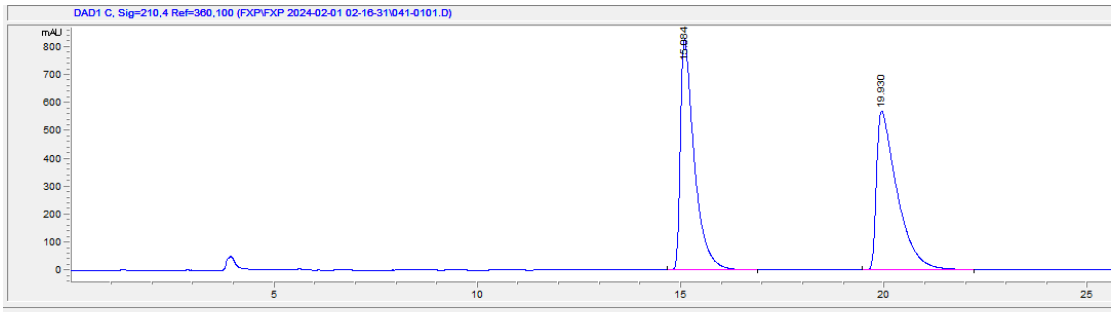


#	Time	Area	Height	Width	Area%	Symmetry
1	20.397	13809.5	379.9	0.5361	96.977	0.403
2	22.484	430.4	11.6	0.4698	3.023	0.802

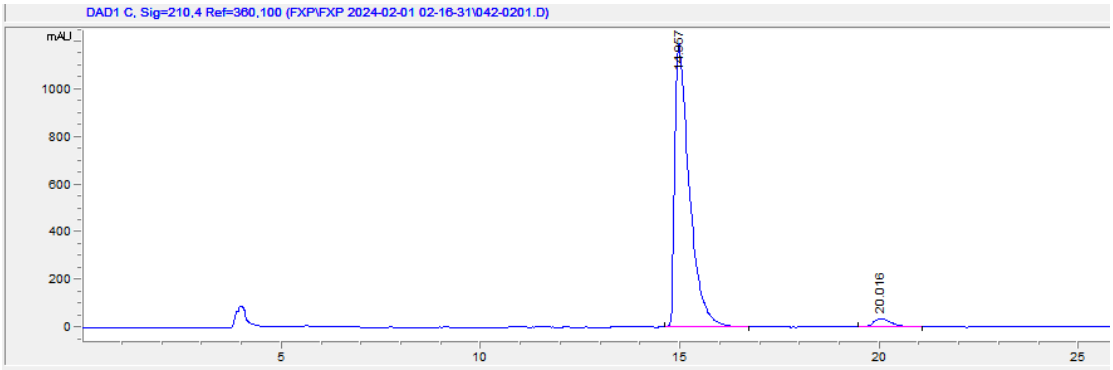
(*R*)-7-Methoxy-1,2,3,4-Tetrahydronahthalen-2-ol (5c)[12]



White solid, 90% yield, 93% ee; **$[\alpha]_D^{25}$**: 33.1 (c = 2.89, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.01 (dd, *J* = 8.4, 1.8 Hz, 1H), 6.70 (dd, *J* = 8.4, 2.2 Hz, 1H), 6.62 (d, *J* = 2.5 Hz, 1H), 4.19 - 4.10 (m, 1H), 3.78 (s, 3H), 3.06 (d, *J* = 12.3 Hz, 1H), 2.89 (dt, *J* = 16.9, 5.8 Hz, 1H), 2.77 (td, *J* = 15.7, 8.2 Hz, 2H), 2.09 - 1.99 (m, 1H), 1.84 - 1.75 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.8, 135.5, 129.6, 127.8, 114.0, 112.5, 67.3, 55.4, 38.7, 31.8, 26.2; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 90 : 10, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 15.0 min (major), t_R = 20.0 min (minor).

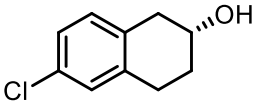


#	Time	Area	Height	Width	Area%	Symmetry
1	15.084	19588.6	827.8	0.3481	49.507	0.39
2	19.93	19978.8	567.4	0.5008	50.493	0.305

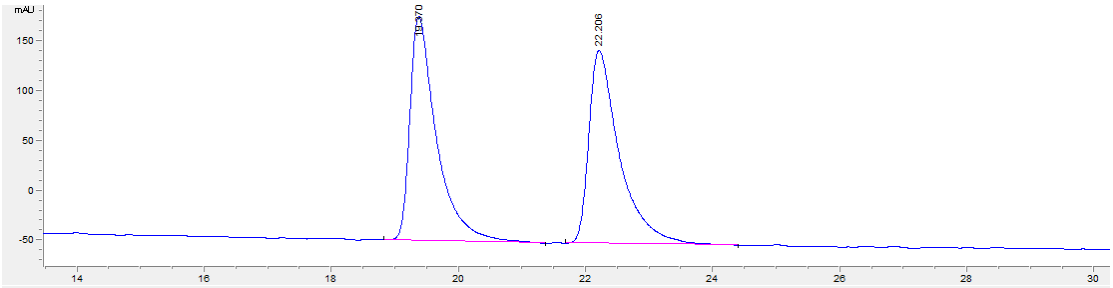


#	Time	Area	Height	Width	Area%	Symmetry
1	14.957	30043.1	1189.1	0.3608	96.480	0.344
2	20.016	1096.2	36	0.4496	3.520	0.657

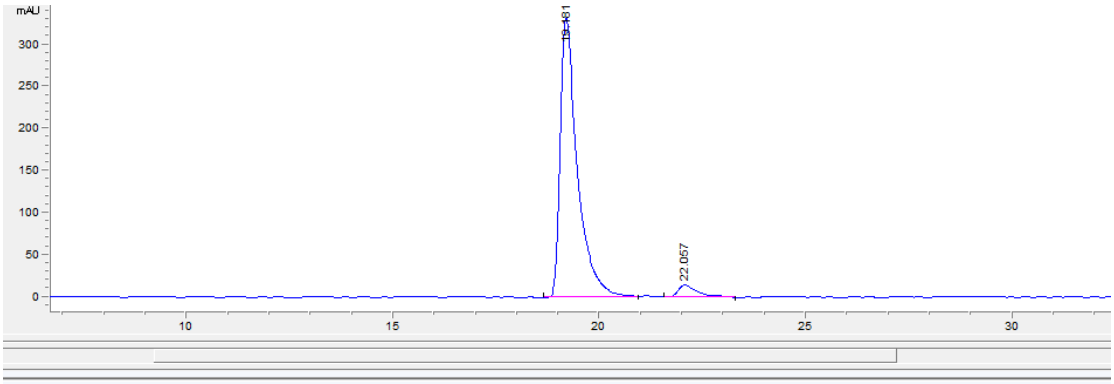
(*R*)-7-Chloro-1,2,3,4-Tetrahydronahthalen-2-ol (5d)[12]



Colorless oil, 97% yield, 90% ee; **$[\alpha]_D^{25}$**: 41.8 (c = 3.03, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.11 - 7.05 (m, 2H), 7.00 (d, *J* = 8.8 Hz, 1H), 4.20 - 4.11 (m, 1H), 3.03 (dd, *J* = 16.4, 5.0 Hz, 1H), 2.93 (dt, *J* = 17.2, 5.9 Hz, 1H), 2.85 - 2.74 (m, 1H), 2.71 (dd, *J* = 16.3, 7.6 Hz, 1H), 2.08 - 1.97 (m, 1H), 1.87 - 1.75 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 137.6, 132.7, 131.6, 130.9, 128.5, 126.1, 67.0, 37.8, 31.1, 26.8; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 19.2 min (major), t_R = 22.1 min (minor).

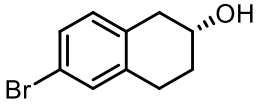


#	Time	Area	Height	Width	Area%	Symmetry
1	19.37	6561.4	224.5	0.4289	50.247	0.452
2	22.206	6496.8	193.6	0.4896	49.753	0.45

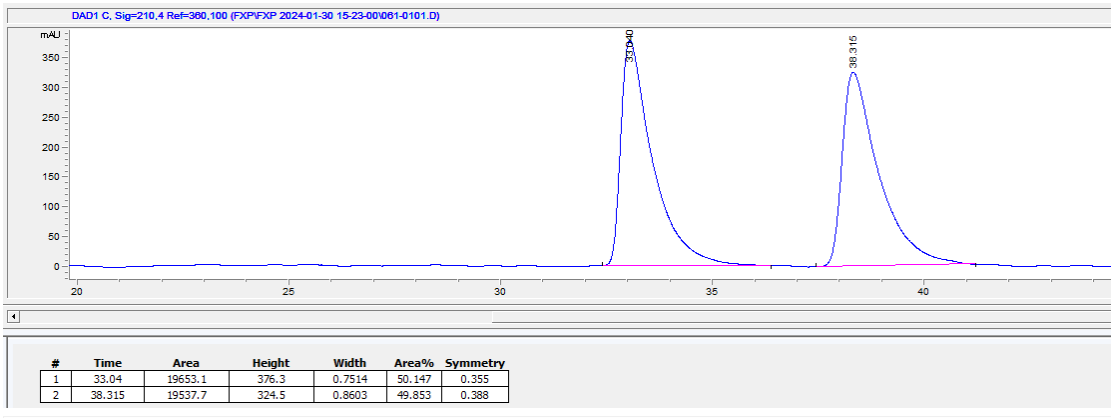


#	Time	Area	Height	Width	Area%	Symmetry
1	19.181	9545	331.6	0.4218	95.254	0.437
2	22.057	475.6	14.5	0.4592	4.746	0.471

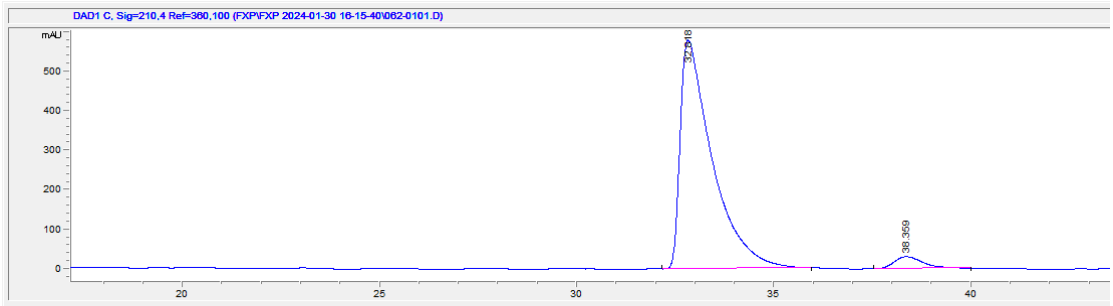
(*R*)-6-Bromo-1,2,3,4-Tetrahydronahthalen-2-ol (5e)[13]



Yellow oil, 94% yield, 91% ee; $[\alpha]_D^{25}$: 44.3 (c = 1.10, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.28 - 7.18 (m, 2H), 6.94 (d, *J* = 8.0 Hz, 1H), 4.19 - 4.09 (m, 1H), 3.01 (d, *J* = 16.3 Hz, 1H), 2.93 (dt, *J* = 17.2, 5.9 Hz, 1H), 2.79 (dt, *J* = 16.2, 7.3 Hz, 1H), 2.69 (dd, *J* = 16.4, 7.5 Hz, 1H), 2.06 - 1.97 (m, 1H), 1.87 - 1.78 (m, 2H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 138.1, 133.3, 131.4, 131.2, 129.0, 119.6, 66.9, 37.9, 31.1, 26.7; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 32.8 min (major), t_R = 38.4 min (minor).

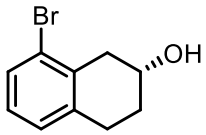


#	Time	Area	Height	Width	Area%	Symmetry
1	33.04	19653.1	376.3	0.7514	50.147	0.355
2	38.315	19537.7	324.5	0.8603	49.853	0.388

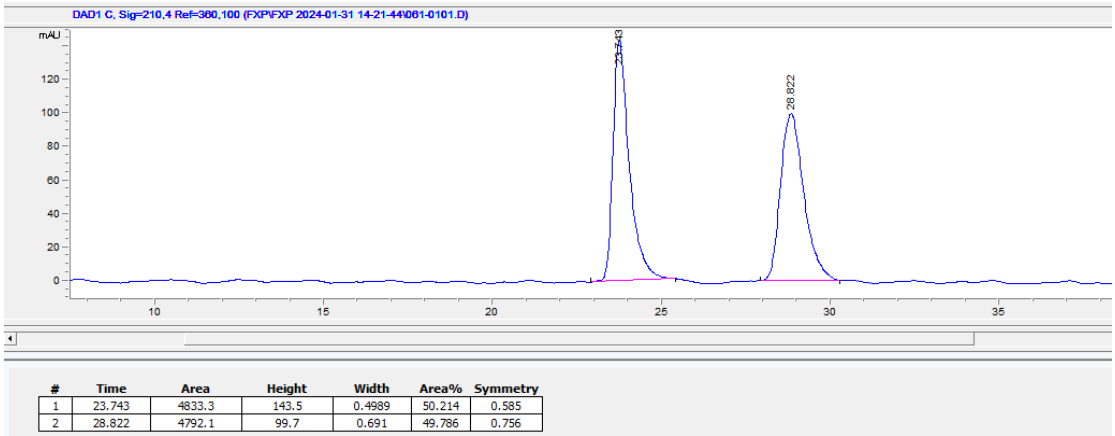


#	Time	Area	Height	Width	Area%	Symmetry
1	32.818	32601.3	578.8	0.7772	95.441	0.307
2	38.359	1557.3	30.2	0.6245	4.559	0.702

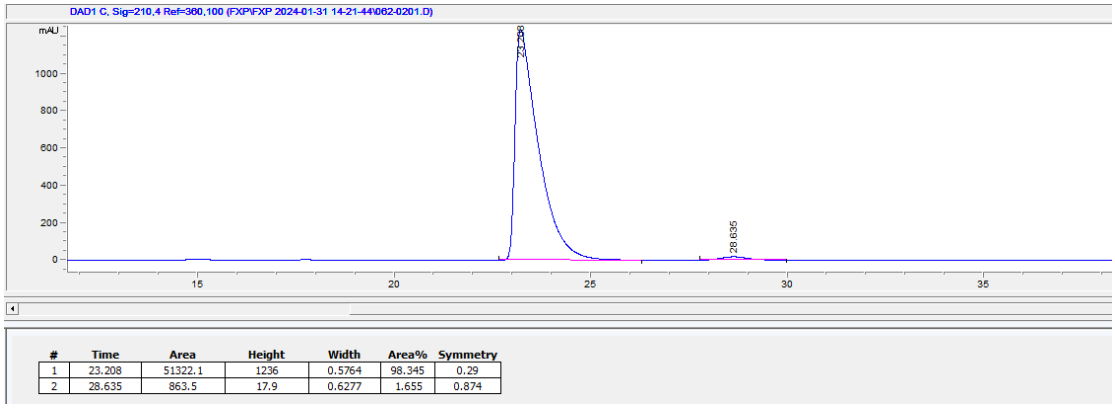
(*R*)-8-Bromo-1,2,3,4-Tetrahydronahthalen-2-ol (5f)[13]



Colorless oil, 95% yield, 97% ee; **$[\alpha]_D^{25}$**: 30.1 (c = 2.80, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.39 (d, *J* = 7.8 Hz, 1H), 7.06 (d, *J* = 7.5 Hz, 1H), 6.99 (t, *J* = 7.7 Hz, 1H), 4.24 - 4.16 (m, 1H), 3.14 (dd, *J* = 17.2, 5.1 Hz, 1H), 2.98 (dt, *J* = 17.0, 5.8 Hz, 1H), 2.88 - 2.78 (m, 1H), 2.70 (dd, *J* = 17.2, 7.1 Hz, 1H), 2.05 - 1.95 (m, 1H), 1.86 - 1.80 (m, 1H), 1.78 (s, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 138.5, 134.1, 130.2, 127.9, 127.2, 125.9, 67.2, 39.2, 30.8, 27.4; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 23.2 min (major), t_R = 28.6 min (minor).

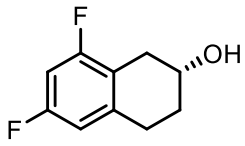


#	Time	Area	Height	Width	Area%	Symmetry
1	23.743	4833.3	143.5	0.4989	50.214	0.585
2	28.822	4792.1	99.7	0.691	49.786	0.756

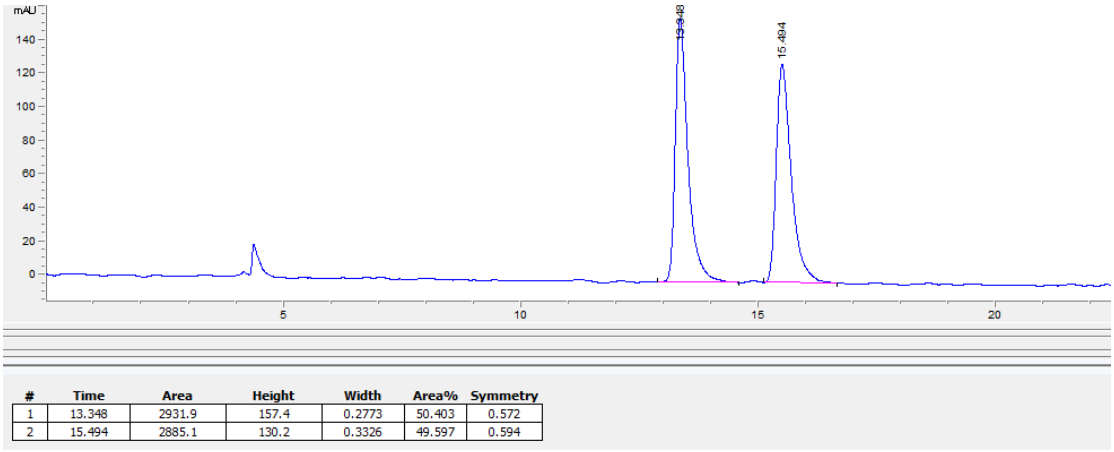


#	Time	Area	Height	Width	Area%	Symmetry
1	23.208	51322.1	1236	0.5764	98.345	0.29
2	28.635	863.5	17.9	0.6277	1.655	0.874

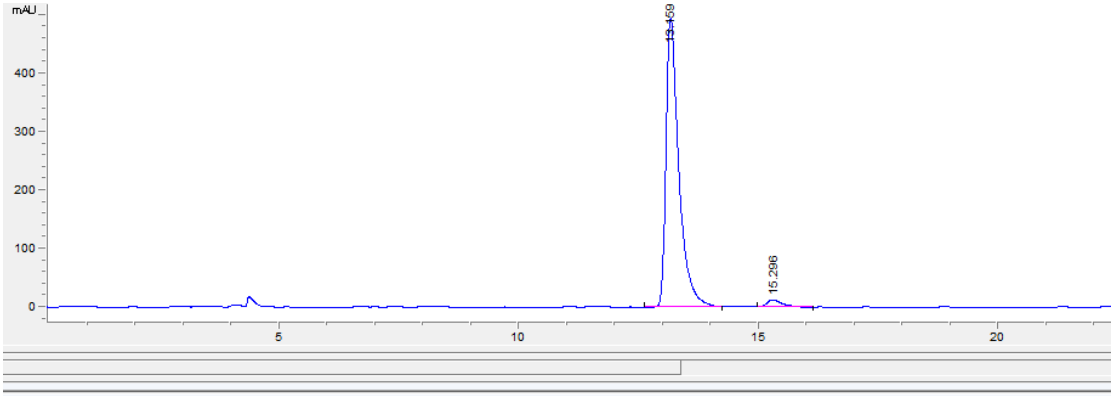
(*R*)-6,8-Difluoro-1,2,3,4-Tetrahydronahthalen-2-ol (5g)[14]



White solid, 99% yield, 94% ee; **[α]$_D^{25}$**: 34.8 (c = 3.31, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 6.62 (tt, *J* = 9.1, 2.6 Hz, 2H), 4.19 (qd, *J* = 5.2, 2.5 Hz, 1H), 3.04 - 2.90 (m, 2H), 2.79 (dt, *J* = 16.2, 7.2 Hz, 1H), 2.61 (dd, *J* = 16.9, 7.1 Hz, 1H), 2.07 - 1.95 (m, 1H), 1.88 - 1.79 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 161.9 (t, *J* = 11.8 Hz), 159.9, 139.3 (d, *J* = 6.3 Hz), 117.4 (d, *J* = 3.6 Hz), 110.5 (dd, *J* = 20.4, 3.5 Hz), 100.9 (t, *J* = 25.7 Hz), 66.0, 30.7 (d, *J* = 3.2 Hz), 30.5, 26.6; **^{19}F NMR** (376 MHz, Chloroform-*d*) δ -114.6, -114.8; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 13.2 min (major), t_R = 15.3 min (minor).

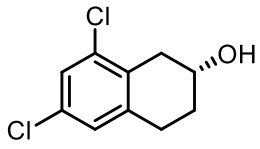


#	Time	Area	Height	Width	Area%	Symmetry
1	13.348	2931.9	157.4	0.2773	50.403	0.572
2	15.494	2885.1	130.2	0.3326	49.597	0.594

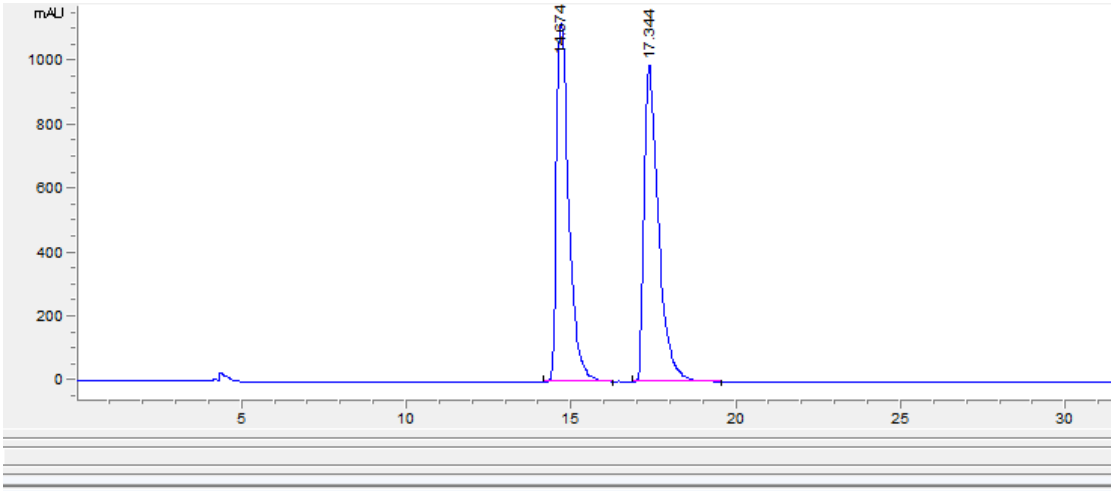


#	Time	Area	Height	Width	Area%	Symmetry
1	13.159	9224.4	495.2	0.2753	97.110	0.51
2	15.296	274.5	12.5	0.3204	2.890	0.587

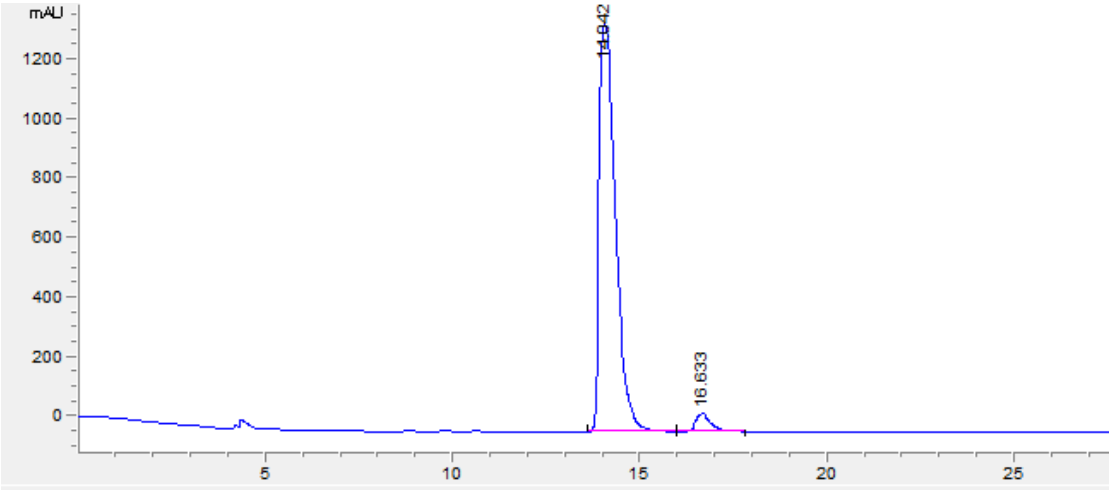
(*R*)-6,8-Dichloro-1,2,3,4-Tetrahydronahthalen-2-ol (5h)[15]



White solid, 96% yield, 92% ee; $[\alpha]_D^{25}$: 30.8 (c = 3.85, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.20 (d, *J* = 2.1 Hz, 1H), 7.01 (d, *J* = 2.0 Hz, 1H), 4.19 (qd, *J* = 8.2, 6.8, 2.9 Hz, 1H), 3.07 (dd, *J* = 17.4, 5.2 Hz, 1H), 2.94 (dt, *J* = 17.2, 6.1 Hz, 1H), 2.77 (ddd, *J* = 17.0, 8.4, 5.8 Hz, 1H), 2.65 (dd, *J* = 17.4, 6.9 Hz, 1H), 1.96 (qd, *J* = 6.1, 2.6 Hz, 1H), 1.86 - 1.73 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 139.5, 135.4, 131.8, 131.1, 127.1, 126.6, 66.5, 35.8, 30.4, 26.9; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 14.0 min (major), t_R = 16.6 min (minor).

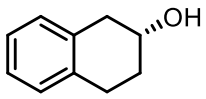


#	Time	Area	Height	Width	Area%	Symmetry
1	14.674	29162.2	1121.9	0.3973	49.443	0.528
2	17.344	29819	989.2	0.4537	50.557	0.476



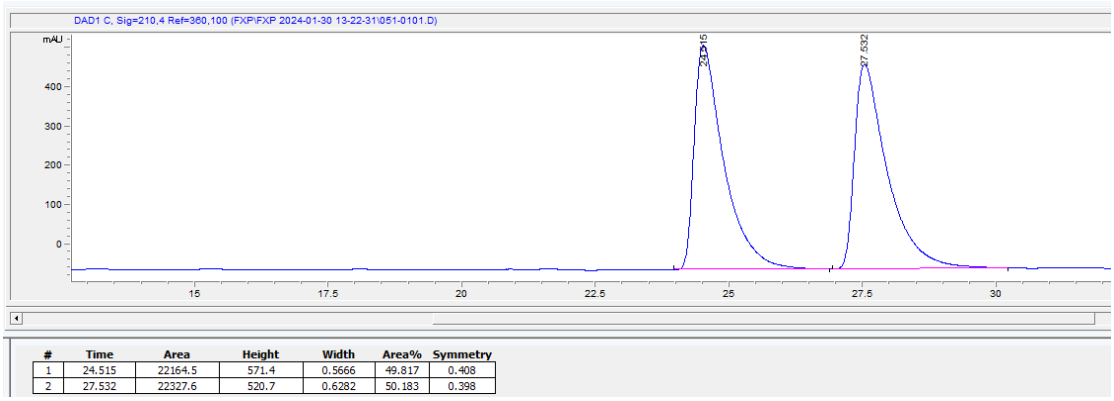
#	Time	Area	Height	Width	Area%	Symmetry
1	14.042	41500.6	1368.5	0.4778	96.195	0.453
2	16.633	1641.7	60	0.4134	3.805	0.634

(*R*)-1,2,3,4-Tetrahydronaphthalen-2-ol (5i)[12]

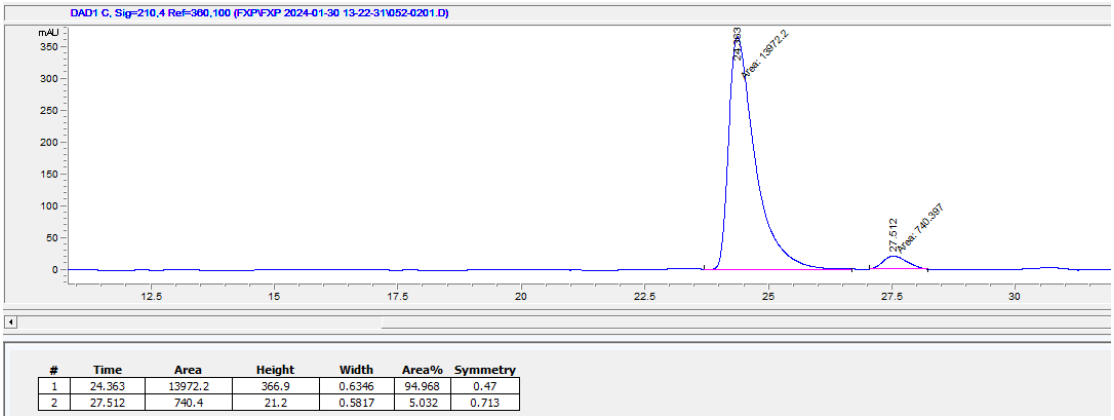


White solid, 97% yield, 90% ee; **[α]$_D^{25}$**: 54.3 (c = 2.54, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.17 - 7.06 (m, 4H), 4.17 (dd, *J* = 9.1, 5.1 Hz, 1H), 3.11 (d, *J* = 16.2 Hz, 1H), 2.97 (dt, *J* = 17.1, 5.7 Hz, 1H), 2.91 - 2.74 (m, 1H), 2.78 (dd, *J* = 16.2, 7.6 Hz, 1H), 2.08 (dd, *J* = 12.9, 6.0 Hz, 1H), 1.92 - 1.80 (m, 2H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 135.7, 134.3, 129.6, 128.7, 126.1, 126.0, 67.4, 38.5, 31.6, 27.1; The enantiomeric excess was

determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 24.4 min (major), t_R = 27.5 min (minor).

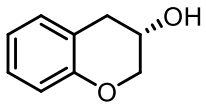


#	Time	Area	Height	Width	Area%	Symmetry
1	24.515	22164.5	571.4	0.5666	49.817	0.408
2	27.532	22327.6	520.7	0.6282	50.183	0.398

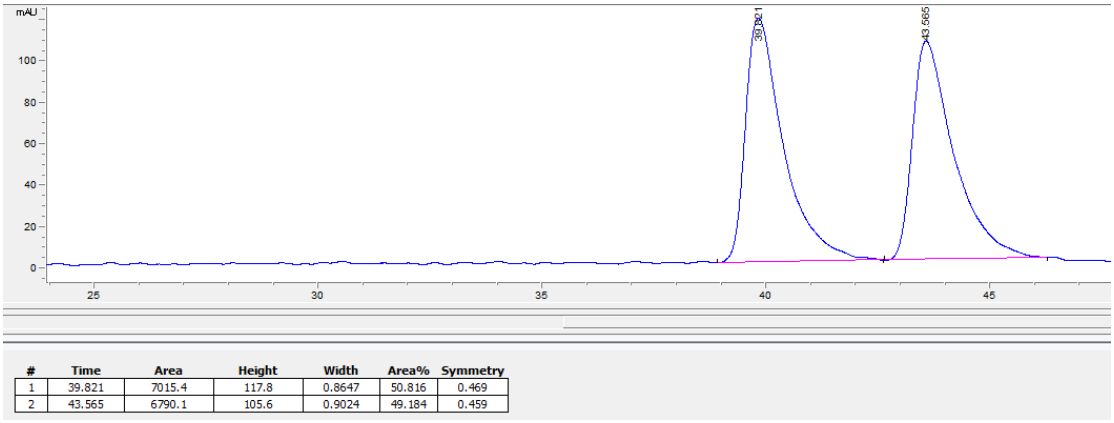


#	Time	Area	Height	Width	Area%	Symmetry
1	24.363	13972.2	366.9	0.6346	94.968	0.47
2	27.512	740.4	21.2	0.5817	5.032	0.713

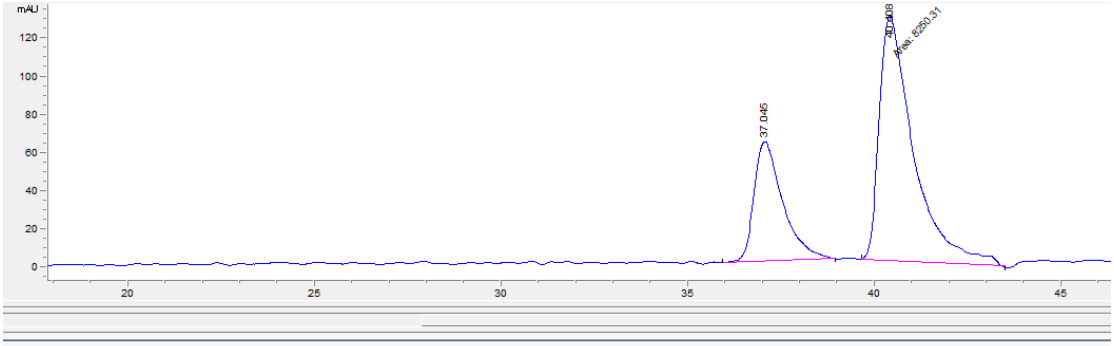
3,4-Dihydro-2H-1-Benzopyran-3-ol (5j)[16]



White solid, 93% yield, 40% ee; **$[\alpha]_D^{25}$**: 6.2 (c = 1.72, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.17 - 7.00 (m, 2H), 6.94 - 6.76 (m, 2H), 4.25 (d, *J* = 5.4 Hz, 1H), 4.16 - 3.97 (m, 2H), 3.10 (dd, *J* = 16.4, 4.4 Hz, 1H), 2.80 (dd, *J* = 16.5, 4.5 Hz, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 153.9, 130.6, 127.7, 121.2, 119.4, 116.7, 69.8, 63.4, 33.6; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 37.0 min (minor), t_R = 40.4 min (major).

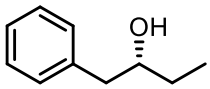


#	Time	Area	Height	Width	Area%	Symmetry
1	39.821	7015.4	117.8	0.8647	50.816	0.469
2	43.565	6790.1	105.6	0.9024	49.184	0.459

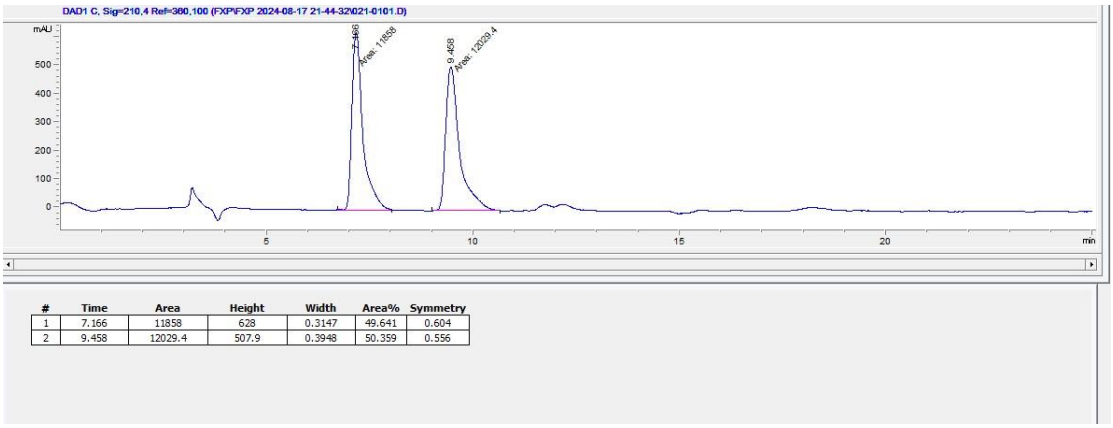


#	Time	Area	Height	Width	Area%	Symmetry
1	37.045	3384.7	62.7	0.7794	29.091	0.543
2	40.408	8250.3	129	1.0659	70.909	0.436

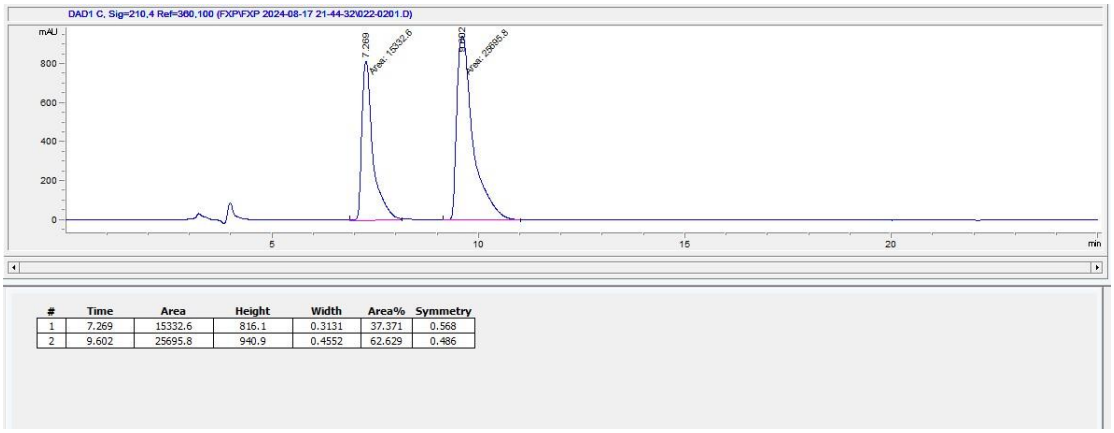
(*R*)-1-Phenyl-2-Butanol (5k)[17]



Colorless oil, 94% yield, 25% ee; **$[\alpha]_D^{25}$**: -9.7 (c = 1.80, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.38 - 7.19 (m, 5H), 3.77 (ddp, *J* = 11.8, 7.8, 4.2, 3.7 Hz, 1H), 2.91 - 2.78 (m, 1H), 2.74 - 2.58 (m, 1H), 1.65 - 1.50 (m, 2H), 1.01 (dt, *J* = 15.1, 7.4 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 138.8, 129.5, 128.6, 126.5, 74.2, 43.7, 29.7, 10.2; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 °C, λ = 210 nm), t_R = 7.3 min (minor), t_R = 9.6 min (major).

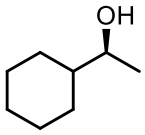


#	Time	Area	Height	Width	Area%	Symmetry
1	7.166	11858	628	0.3147	49.641	0.604
2	9.458	12029.4	507.9	0.3948	50.359	0.556

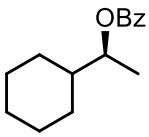


#	Time	Area	Height	Width	Area%	Symmetry
1	7.269	15332.6	816.1	0.3131	37.371	0.568
2	9.602	25695.8	940.9	0.4552	62.629	0.486

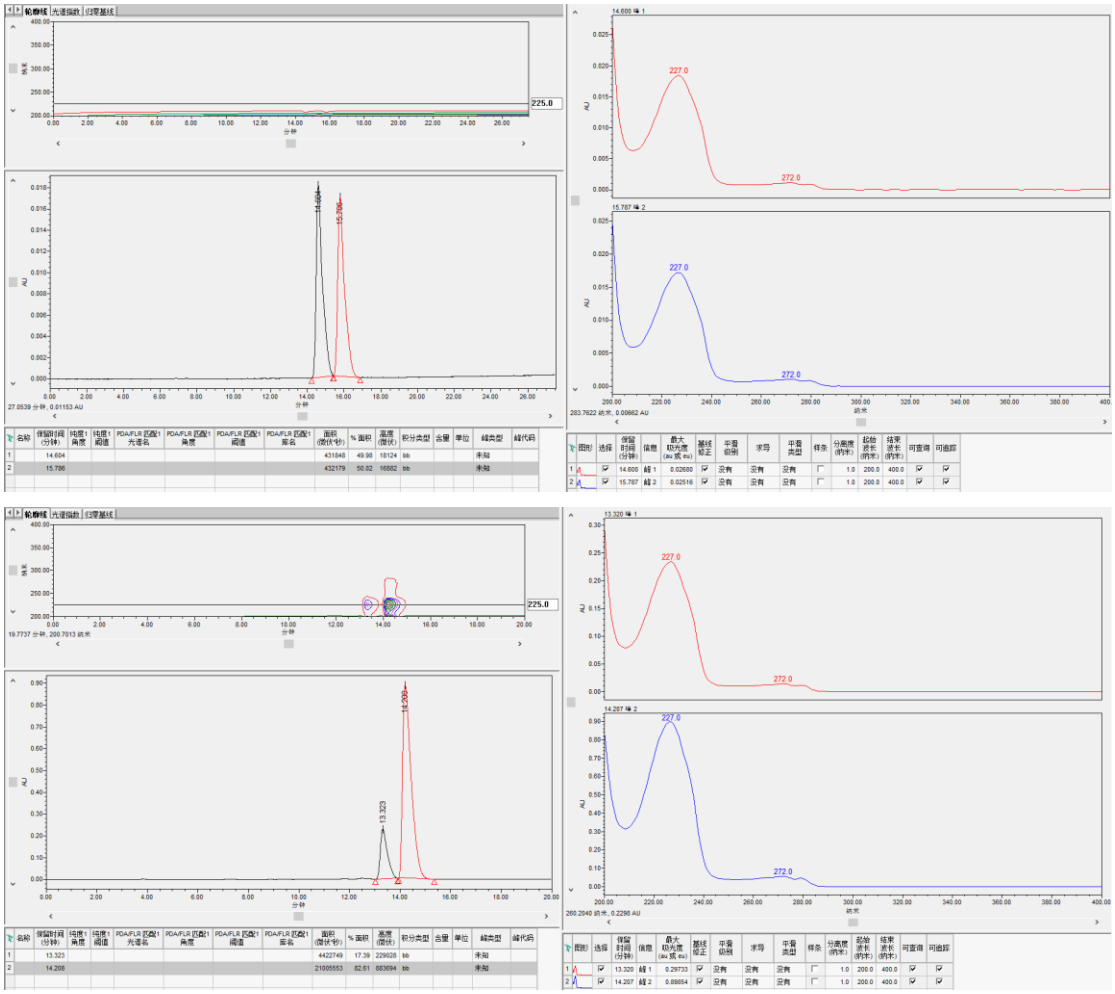
(*S*)-1-Cyclohexyl-Ethanol (5l)[9]



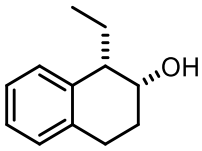
Colorless oil, 94% yield, 65% ee; **[α]$_D^{25}$**: 2.5 (c = 1.37, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 3.53 (p, *J* = 6.3 Hz, 1H), 1.83 (d, *J* = 13.1 Hz, 1H), 1.78 - 1.71 (m, 2H), 1.65 (d, *J* = 12.8 Hz, 2H), 1.31 - 1.11 (m, 4H), 1.14 (d, *J* = 6.3 Hz, 3H), 1.05 - 0.91 (m, 2H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 72.4, 45.2, 28.8, 28.5, 26.6, 26.4, 26.3, 20.5.



Colorless oil, 65% ee; **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.21 - 7.91 (m, 2H), 7.64 - 7.48 (m, 1H), 7.44 (dd, *J* = 8.4, 7.1 Hz, 2H), 4.99 (p, *J* = 6.3 Hz, 1H), 1.90 - 1.60 (m, 7H), 1.30 (d, *J* = 6.4 Hz, 3H), 1.28 - 1.04 (m, 4H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 166.4, 132.8, 131.1, 129.7, 128.4, 75.4, 43.0, 28.9, 28.6, 26.6, 26.2, 17.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 100 : 0, flow rate = 0.8 mL/min, T = 20 °C, λ = 225 nm), t_R = 13.3 min (minor), t_R = 14.2 min (major)

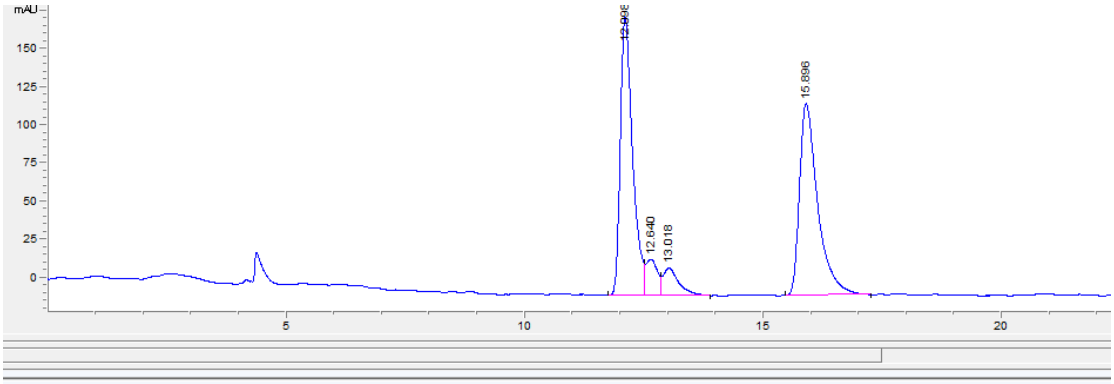


***cis*-1-Ethyl-1,2,3,4-tetrahydro-2-naphthalenol (7a)**

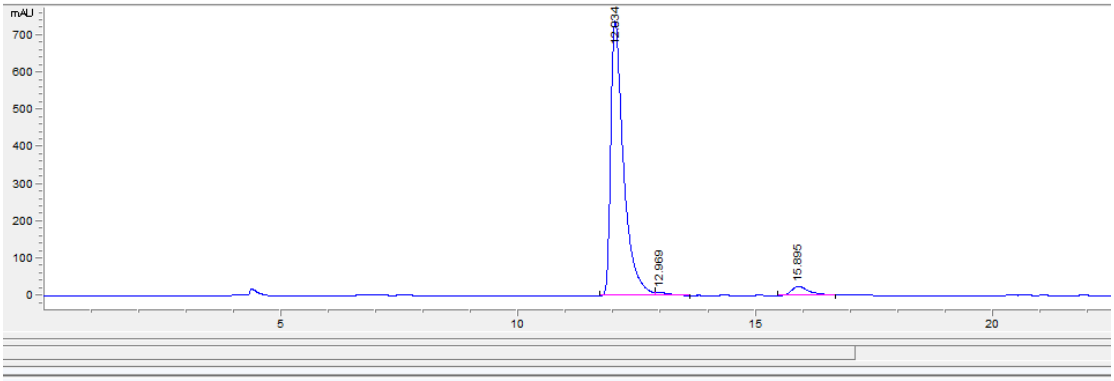


Colorless oil, 94% yield, 91% ee, >20:1 dr.; **[α]$_D^{25}$**: 42.2 (c = 2.45, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.23 - 7.07 (m, 4H), 4.23 (dt, *J* = 7.8, 3.9 Hz, 1H), 3.08 - 2.94 (m, 1H), 2.89 - 2.77 (m, 1H), 2.69 (dt, *J* = 10.4, 5.5 Hz, 1H), 2.08 - 1.88 (m, 2H), 1.90 - 1.80 (m, 1H), 1.77 - 1.62 (m, 1H), 1.08 (t, *J* = 7.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 138.9, 135.7, 128.9, 128.9, 126.2, 125.6, 68.6, 45.8, 28.1, 26.6, 22.6, 12.6; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 0.8 mL/min, T = 20 ℃, λ = 210 nm), t_R = 12.0 min (major, *cis*), t_R = 12.6 min (minor, *trans*), t_R = 13.0 min (minor, *trans*), t_R = 15.9 min (minor,

cis).

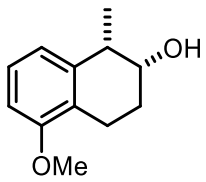


#	Time	Area	Height	Width	Area%	Symmetry
1	12.098	3282.6	182.4	0.2679	44.186	0.58
2	12.64	390.6	23.8	0.2398	5.258	0.617
3	13.018	413	18	0.327	5.560	0.498
4	15.896	3342.7	125.6	0.3985	44.996	0.531

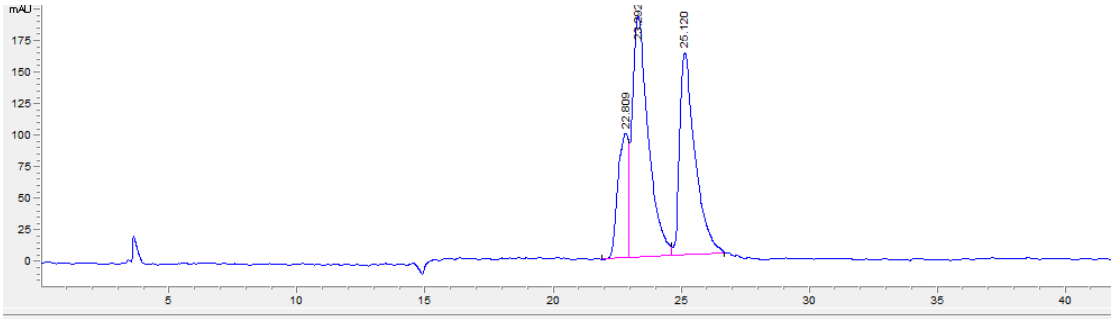


#	Time	Area	Height	Width	Area%	Symmetry
1	12.034	13916.2	739.8	0.2775	94.543	0.459
2	12.969	172.6	8.8	0.2558	1.172	0.305
3	15.895	630.6	24.3	0.3767	4.284	0.59

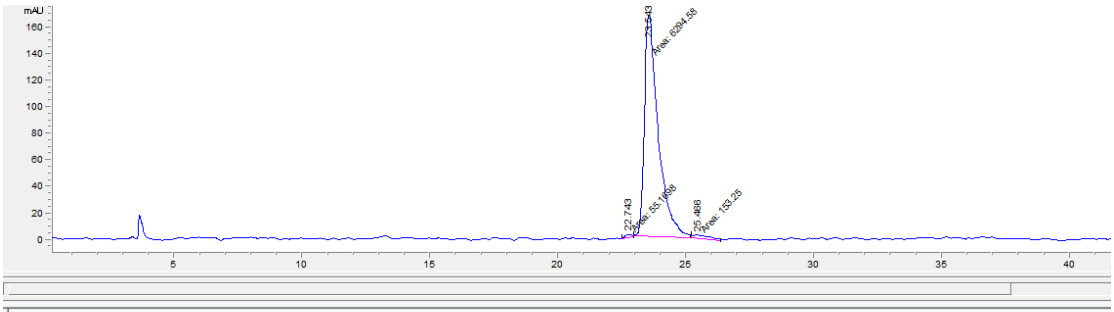
cis-1,2,3,4-Tetrahydro-5-methoxy-1-methyl-2-naphthalenol (7b)



White solid, 94% yield, 94% ee; >20:1 dr.; **$[\alpha]_D^{25}$**: 49.3 (c = 2.51, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.15 (t, *J* = 7.8 Hz, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.68 (d, *J* = 8.1 Hz, 1H), 4.10 (dt, *J* = 9.9, 4.1 Hz, 1H), 3.81 (s, 3H), 3.08 - 2.99 (m, 1H), 2.89 (dt, *J* = 18.1, 5.8 Hz, 1H), 2.66 (dt, *J* = 17.9, 7.9 Hz, 1H), 2.02 - 1.83 (m, 2H), 1.29 (d, *J* = 7.1 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.1, 141.8, 126.6, 124.1, 121.1, 107.3, 70.1, 55.4, 38.7, 26.7, 21.5, 16.7; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 97 : 3, flow rate = 1 mL/min, T = 20 °C, λ = 210 nm), t_R = 22.7 min (minor, *trans*), t_R = 23.5 min (major, *cis*), t_R = 25.5 min (minor, *cis*).

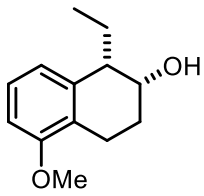


#	Time	Area	Height	Width	Area%	Symmetry
1	22.809	2874.2	99.2	0.3901	16.052	2.555
2	23.292	8333	191.3	0.6001	46.538	0.495
3	25.12	6698.8	160.4	0.5933	37.411	0.448

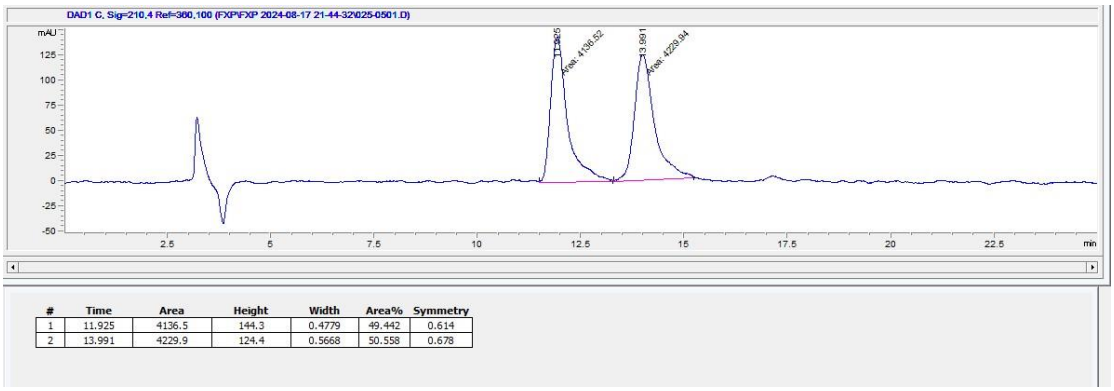


#	Time	Area	Height	Width	Area%	Symmetry
1	22.743	55.2	2.8	0.3301	0.848	0.861
2	23.543	6294.6	166.8	0.6291	96.795	0.467
3	25.466	153.2	3	0.8646	2.357	0.229

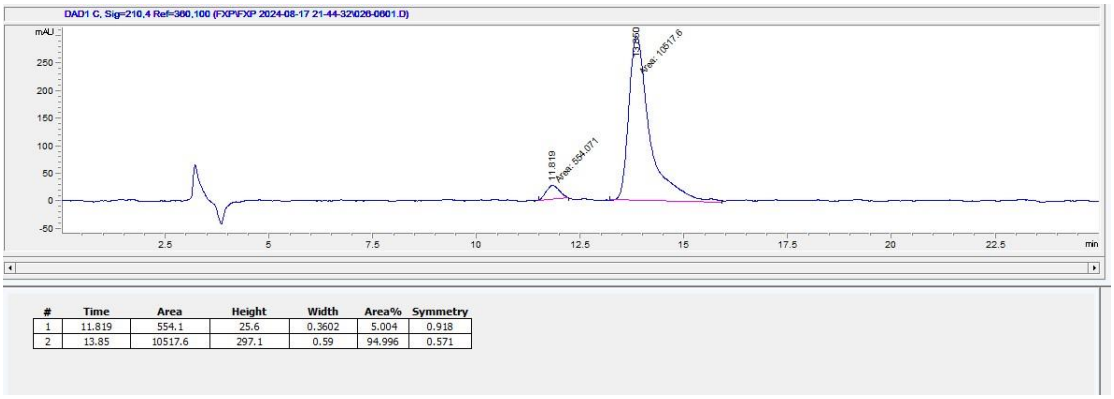
cis-1,2,3,4-Tetrahydro-5-methoxy-1-ethyl-2-naphthalenol (7c)



White solid, 96% yield, 90% ee; >20:1 dr.; $[\alpha]_D^{25}$: 39.4 (c = 3.01, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.17 - 7.09 (m, 1H), 6.81 (d, *J* = 7.8 Hz, 1H), 6.70 (d, *J* = 5.5 Hz, 1H), 4.23 - 4.15 (m, 1H), 3.82 (s, 3H), 2.91 - 2.79 (m, 1H), 2.77 - 2.65 (m, 2H), 2.07 - 1.94 (m, 1H), 1.93 - 1.78 (m, 2H), 1.67 - 1.57 (m, 1H), 1.06 (t, *J* = 7.3 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.3, 140.4, 126.1, 124.2, 121.3, 107.5, 68.6, 55.4, 45.9, 27.2, 22.9, 20.9, 12.8; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 °C, λ = 210 nm), t_R = 11.8 min (minor, *cis*), t_R = 13.9 min (major, *cis*).

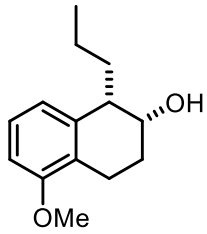


#	Time	Area	Height	Width	Area%	Symmetry
1	11.925	4136.5	144.3	0.4779	49.442	0.614
2	13.991	4229.9	124.4	0.5668	50.558	0.678

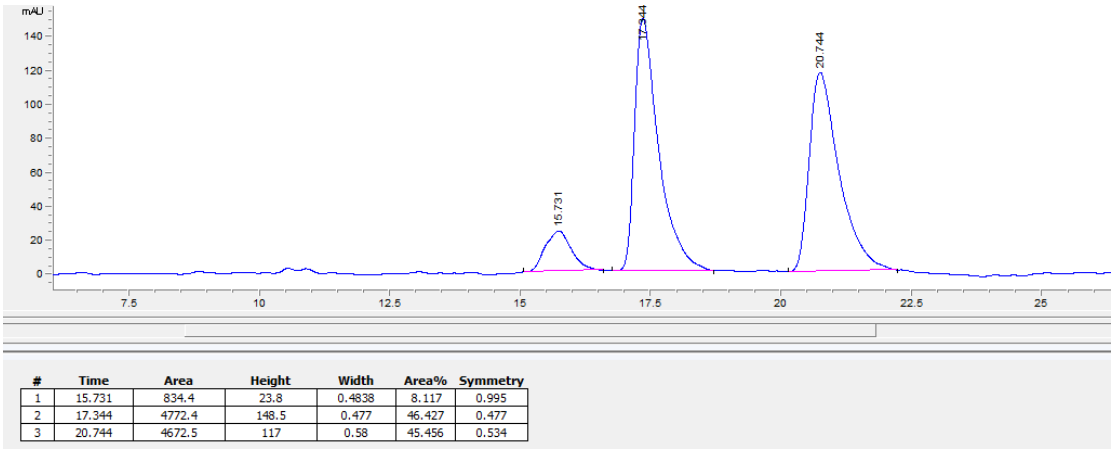


#	Time	Area	Height	Width	Area%	Symmetry
1	11.819	554.1	25.6	0.3602	5.004	0.918
2	13.85	10517.6	297.1	0.59	94.996	0.571

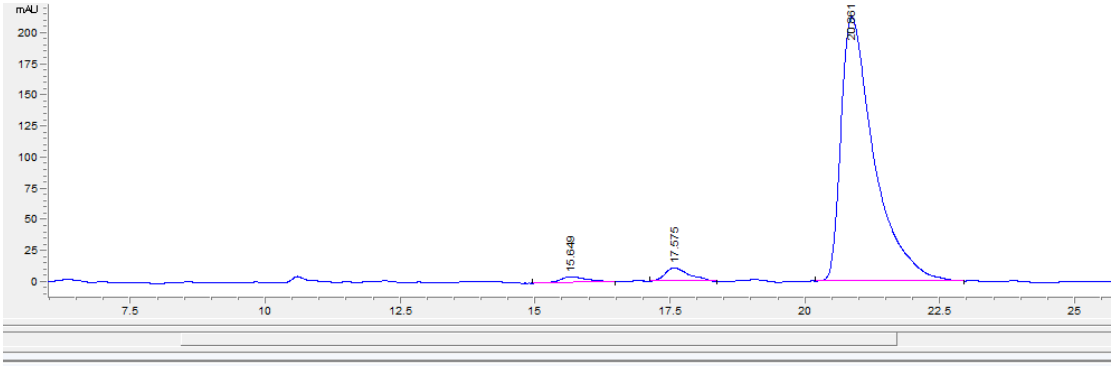
cis-1,2,3,4-Tetrahydro-5-methoxy-1-(_n_-propyl)-2-naphthalenol (7d)



White solid, 95% yield, 93% ee; >20:1 dr.; **$[\alpha]_D^{25}$**: 41.9 (c = 3.37, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.13 (t, *J* = 7.9 Hz, 1H), 6.80 (d, *J* = 7.7 Hz, 1H), 6.70 (d, *J* = 8.1 Hz, 1H), 4.16 (dt, *J* = 9.0, 4.0 Hz, 1H), 3.82 (s, 3H), 2.92 - 2.67 (m, 3H), 2.04 - 1.87 (m, 2H), 1.79 (dq, *J* = 11.1, 4.8, 3.6 Hz, 1H), 1.51 (hept, *J* = 8.2, 7.2 Hz, 3H), 0.96 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.2, 140.8, 126.1, 124.2, 121.3, 107.4, 68.9, 55.3, 44.1, 32.4, 27.0, 21.3, 21.1, 14.6; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 96 : 4, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 15.6 min (minor, *trans*), t_R = 17.6 min (minor, *cis*), t_R = 20.9 min (major, *cis*).

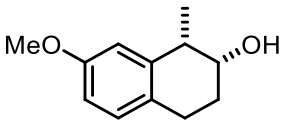


#	Time	Area	Height	Width	Area%	Symmetry
1	15.731	834.4	23.8	0.4838	8.117	0.995
2	17.344	4772.4	148.5	0.477	46.427	0.477
3	20.744	4672.5	117	0.58	45.456	0.534

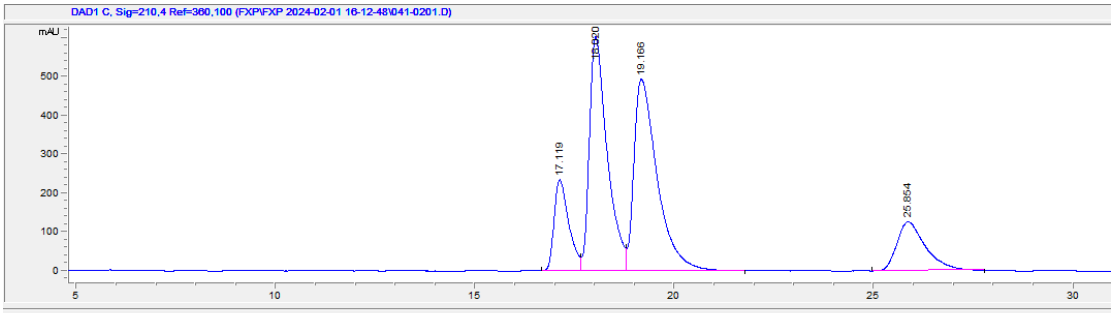


#	Time	Area	Height	Width	Area%	Symmetry
1	15.649	162.5	4.7	0.4167	1.706	0.669
2	17.575	336.1	10.8	0.4454	3.527	0.57
3	20.861	9030.8	212.1	0.6267	94.767	0.442

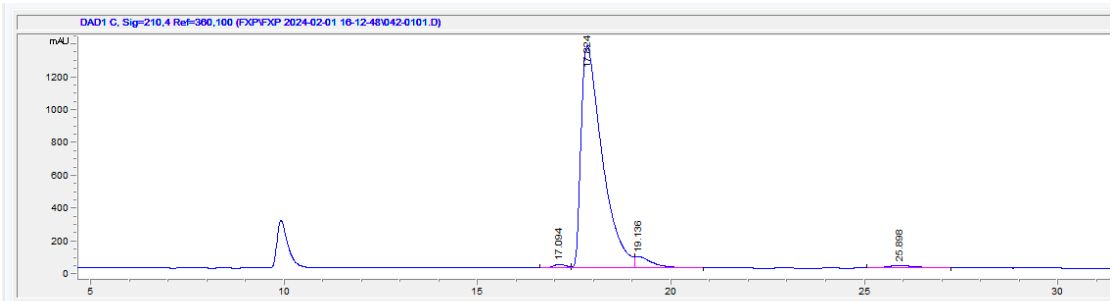
***cis*-1,2,3,4-Tetrahydro-7-methoxy-1-methyl-2-naphthalenol (7e)**



White solid, 99% yield, 92% ee; >20:1 dr.; $[\alpha]_D^{25}$: 36.9 (c = 2.62, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.01 (d, *J* = 8.2 Hz, 1H), 6.73 - 6.69 (m, 2H), 4.14 - 4.08 (m, 1H), 3.79 (s, 3H), 3.00 (p, *J* = 6.7 Hz, 1H), 2.90 (dt, *J* = 17.0, 6.0 Hz, 1H), 2.77 (dt, *J* = 16.3, 7.7 Hz, 1H), 2.02 - 1.93 (m, 1H), 1.92 - 1.84 (m, 1H), 1.30 (d, *J* = 7.2 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.9, 141.5, 129.6, 127.3, 113.7, 112.1, 70.3, 55.4, 38.8, 27.7, 26.3, 16.6; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OJ-3 column (hexane : isopropanol = 93 : 7, flow rate = 0.8 mL/min, T = 20 °C, λ = 210 nm), t_R = 17.1 min (minor, *trans*), t_R = 17.8 min (major, *cis*), t_R = 19.1 min (minor, *cis*), t_R = 25.9 min (minor, *trans*).

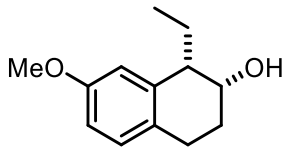


#	Time	Area	Height	Width	Area%	Symmetry
1	17.119	6032.3	234.7	0.3879	11.798	0.578
2	18.02	18755.6	603.2	0.4627	36.681	0.508
3	19.166	20014.1	493.6	0.621	39.143	0.434
4	25.854	6329.4	126.4	0.7023	12.379	0.593

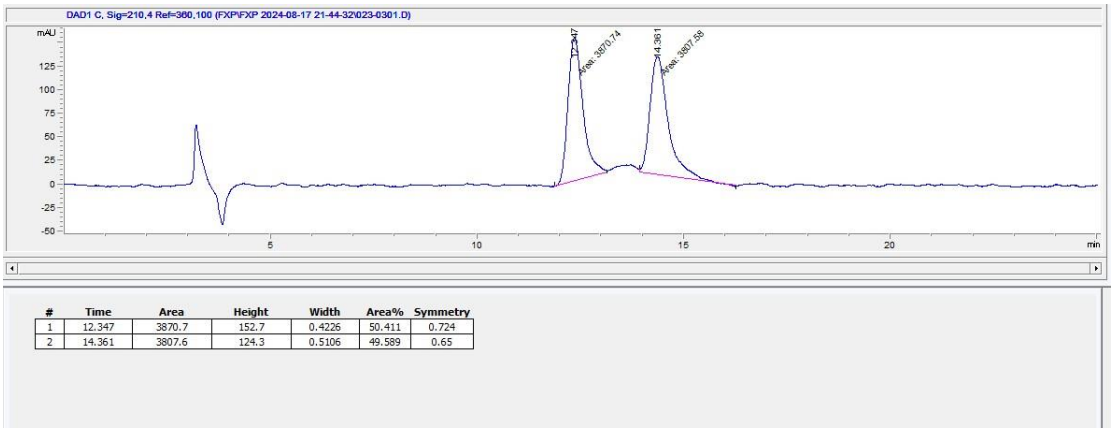


#	Time	Area	Height	Width	Area%	Symmetry
1	17.094	505.7	22.6	0.3348	0.920	0.784
2	17.824	51621	1350.6	0.5299	93.864	0.388
3	19.136	2105.5	68.3	0.4358	3.829	0.177
4	25.898	763.2	15.6	0.6184	1.388	0.691

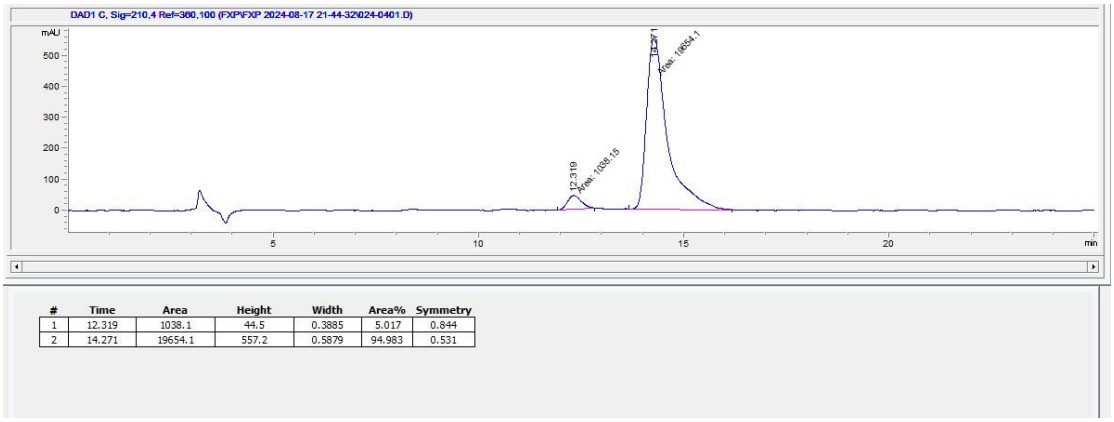
cis-1,2,3,4-Tetrahydro-7-methoxy-1-ethyl-2-naphthalenol (7f)



Colorless oil, 95% yield, 90% ee; **$[\alpha]_D^{25}$**: 23.4 (c = 0.63, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.02 (d, *J* = 8.2 Hz, 1H), 6.76 - 6.68 (m, 2H), 4.25 - 4.17 (m, 1H), 3.79 (s, 3H), 2.98 - 2.87 (m, 1H), 2.80 - 2.71 (m, 1H), 2.68 - 2.60 (m, 1H), 2.02 - 1.95 (m, 1H), 1.94 - 1.88 (m, 1H), 1.88 - 1.79 (m, 1H), 1.68 (dq, *J* = 13.8, 7.3 Hz, 1H), 1.08 (t, *J* = 7.5 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 157.6, 140.1, 129.6, 127.7, 114.1, 112.0, 68.5, 55.4, 45.9, 28.3, 25.6, 22.6, 12.7; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-H column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 °C, λ = 210 nm), t_R = 12.3 min (minor), t_R = 14.3 min (major).

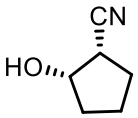


#	Time	Area	Height	Width	Area%	Symmetry
1	12.347	3870.7	152.7	0.4226	50.411	0.724
2	14.361	3807.6	124.3	0.5106	49.589	0.65

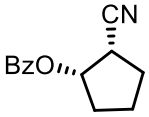


#	Time	Area	Height	Width	Area%	Symmetry
1	12.319	1038.1	44.5	0.3885	5.017	0.844
2	14.271	19654.1	557.2	0.5879	94.983	0.531

(1*S*, 2*S*)-2-Hydroxycyclopentane-1-Carbonitrile (7g)[18]

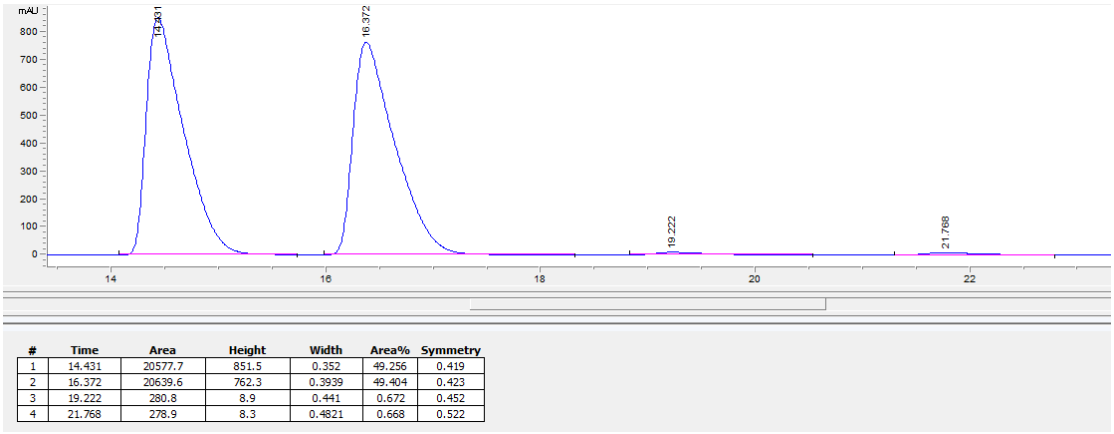


Light yellow oil, 95% yield, 60% ee, >20:1 dr.; **$[\alpha]_D^{25}$**: 3.0 (c = 2.21, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 4.46 - 4.38 (m, 1H), 2.74 (td, *J* = 8.8, 4.6 Hz, 1H), 2.20 (s, 1H), 2.14 - 2.01 (m, 2H), 2.04 - 1.56 (m, 4H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 120.5, 73.3, 36.7, 33.7, 28.0, 22.1; The absolute configuration of **7g** was assigned by comparing the optical rotation value with reported data.[16]

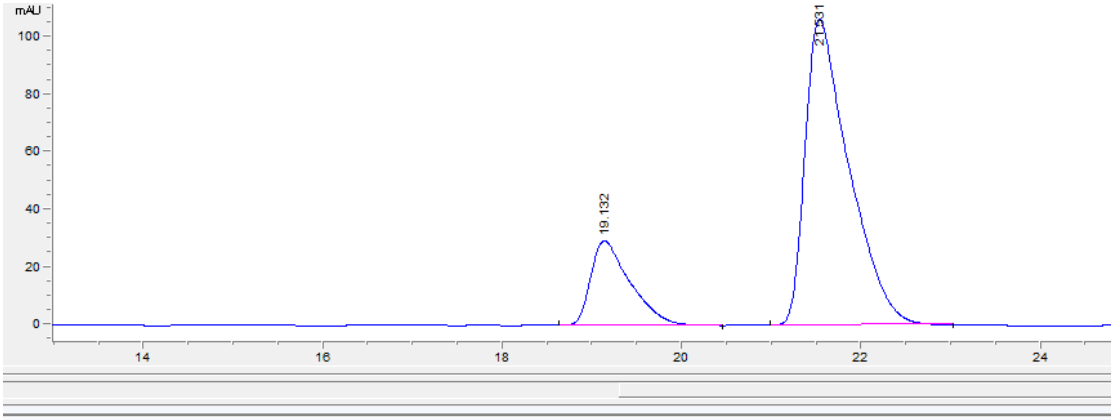


Light yellow oil, 60% ee, >20:1 dr.; **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.09 (d, *J* = 7.9 Hz, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 5.49 (td, *J* = 5.9, 3.4 Hz, 1H), 3.11 (td, *J* = 7.9, 5.6 Hz, 1H), 2.25 - 2.11 (m, 3H), 2.07 - 1.96 (m, 2H), 1.82 - 1.72 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 165.9, 133.5, 129.9, 129.7, 128.6, 119.1, 75.2, 34.3, 31.6, 29.3, 22.3. The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak OD-3 column (hexane : isopropanol = 97 : 3, flow rate = 0.8 mL/min, T = 20 ℃, λ = 230

nm), t_R = 14.4 min (minor, *trans*), t_R = 16.4 min (minor, *trans*), t_R = 19.1 min (minor, *cis*), t_R = 21.5 min (major, *cis*).

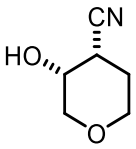


#	Time	Area	Height	Width	Area%	Symmetry
1	14.431	20577.7	851.5	0.352	49.256	0.419
2	16.372	20639.6	762.3	0.3939	49.404	0.423
3	19.222	280.8	8.9	0.441	0.672	0.452
4	21.768	278.9	8.3	0.4821	0.668	0.522

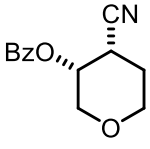


#	Time	Area	Height	Width	Area%	Symmetry
1	19.132	892.8	29.4	0.438	19.807	0.491
2	21.531	3614.6	106.4	0.4885	80.193	0.457

cis-1,5-Anhydro-3-cyano-2,3-dideoxy-_threo_-pentitol (7h)

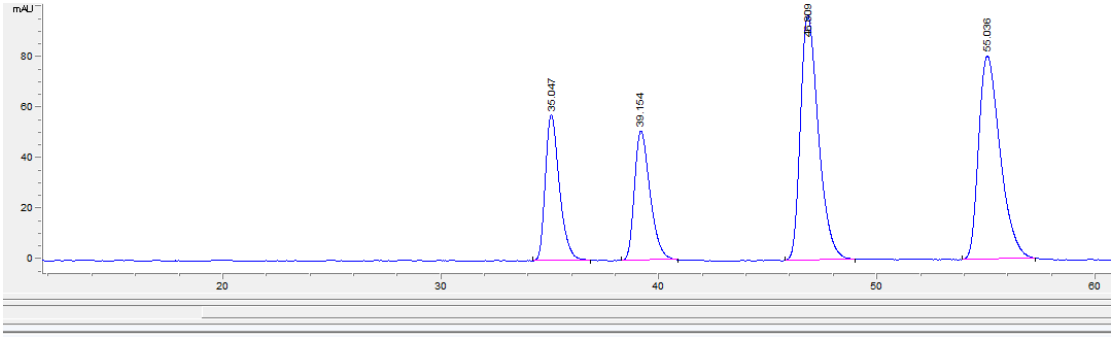


White solid, 93% yield, 99% ee, >20:1 dr.; **$[\alpha]_D^{25}$**: 11.3 (c = 2.36, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 3.99 - 3.79 (m, 2H), 3.78 - 3.55 (m, 3H), 3.11 - 3.01 (m, 1H), 2.31 (s, 1H), 2.21 - 2.09 (m, 1H), 1.99 - 1.81 (m, 1H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 119.5, 70.1, 65.1, 64.6, 33.2, 25.9.

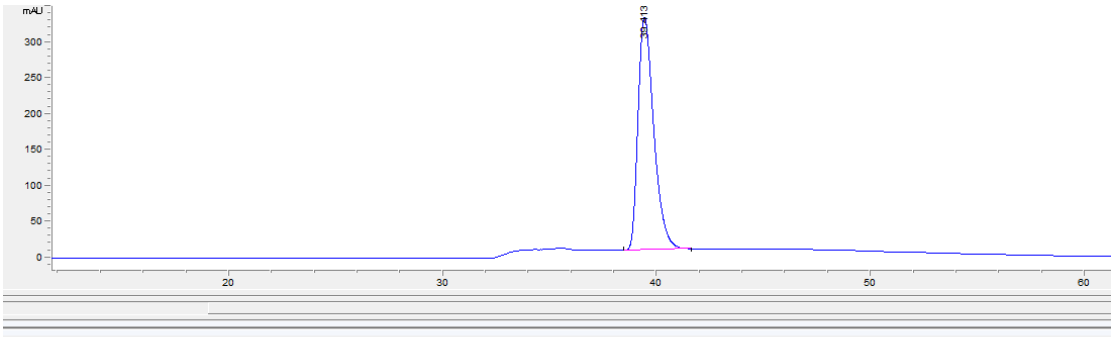


Light yellow oil, 99% ee, >20:1 dr.; **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 8.08 (d, *J* = 6.9 Hz, 2H), 7.63 - 7.56 (m, 1H), 7.46 (d, *J* = 7.7 Hz, 2H), 5.16 (dt, *J* = 7.9, 4.3 Hz, 1H), 3.94 - 3.76 (m, 4H), 3.42 (q, *J* = 4.9 Hz, 1H), 2.24 - 2.03 (m, 2H); **^{13}C**

NMR (126 MHz, Chloroform-*d*) δ 165.5, 133.8, 130.1, 128.7, 128.5, 118.3, 66.9, 66.3, 64.6, 31.1, 27.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC-3 column (hexane : isopropanol = 92 : 8, flow rate = 0.8 mL/min, T = 20 ℃, λ = 230 nm), t_R = 35.0 min (minor, *cis*), t_R = 39.4 min (major, *cis*), t_R = 46.8 min (minor, *trans*), t_R = 55.0 min (minor, *trans*).

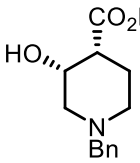


#	Time	Area	Height	Width	Area%	Symmetry
1	35.047	2558.3	57.7	0.6528	15.936	0.688
2	39.154	2525.5	51.2	0.7273	15.732	0.66
3	46.809	5512	96.7	0.8288	34.335	0.646
4	55.036	5457.7	80.5	0.9306	33.997	0.62



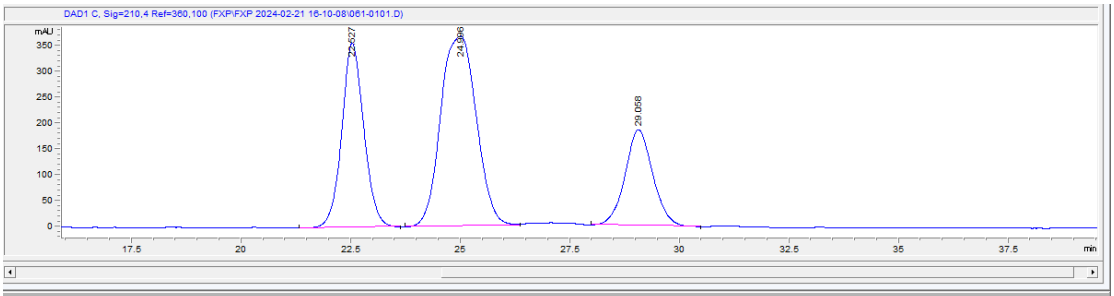
#	Time	Area	Height	Width	Area%	Symmetry
1	39.413	16413.6	323.6	0.7618	100.000	0.636

Ethyl (3*R*,4*R*)-3-hydroxy-1-(phenylmethyl)-4-piperidinecarboxylate (7i)[19]

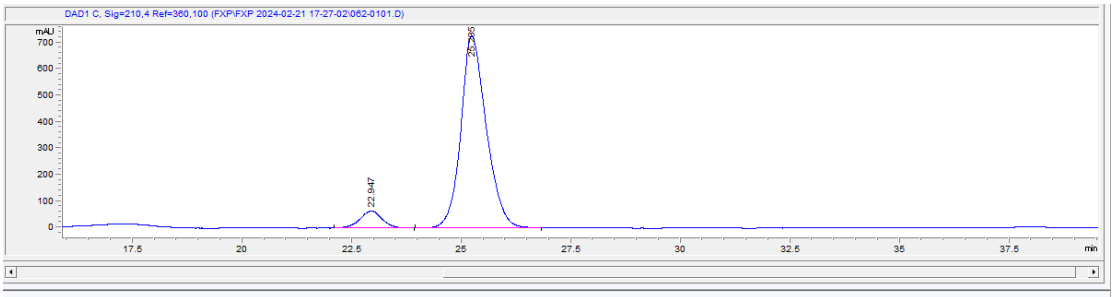


Colorless oil, 97% yield, 85% ee, >20:1 dr.; **[α]$_D^{25}$**: 32.0 (c = 4.83, $CHCl_3$); **^{1}H NMR** (500 MHz, Chloroform-*d*) δ 7.36 - 7.19 (m, 5H), 4.17 (td, *J* = 13.9, 13.4, 6.4 Hz, 3H), 3.57 - 3.46 (m, 2H), 3.08 (br, 1H), 2.90 (dt, *J* = 49.7, 11.0 Hz, 2H), 2.40 - 1.67 (m, 5H), 1.24 (dt, *J* = 14.0, 7.2 Hz, 3H); **^{13}C NMR** (126 MHz, Chloroform-*d*) δ 173.3, 137.8, 129.1, 128.4, 127.3, 66.6, 62.6, 60.7, 59.1, 52.2, 45.7, 22.4, 14.3; The enantiomeric excess was determined by chiral HPLC analysis on Chiralpak IC column (hexane : isopropanol = 95 : 5, flow rate = 1 mL/min, T = 20 ℃, λ = 210 nm), t_R = 22.9 min (minor, *cis*), t_R = 25.2 min (major, *cis* and *trans*), t_R = 29.1 min (minor, *trans*). The dr value was determined by ^{1}H NMR spectrum and the

absolute configuration of **7i** was assigned by comparing the optical rotation value with reported data.[17]



#	Time	Area	Height	Width	Area%	Symmetry
1	22.527	12504.3	356.9	0.5127	30.111	0.872
2	24.996	20857.8	367.4	0.7664	50.226	1.153
3	29.058	8165.6	185.5	0.6356	19.663	0.895



#	Time	Area	Height	Width	Area%	Symmetry
1	22.947	2264.2	64.5	0.4995	7.165	1.034
2	25.235	29336.9	725.5	0.6038	92.835	0.725

5. References

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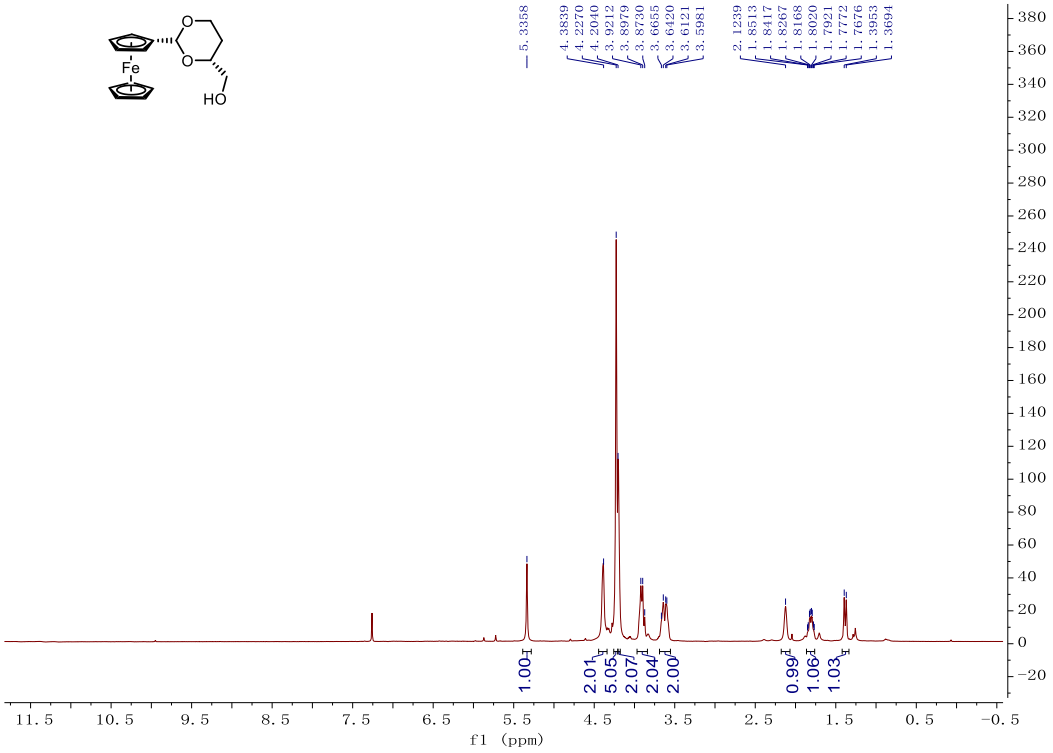
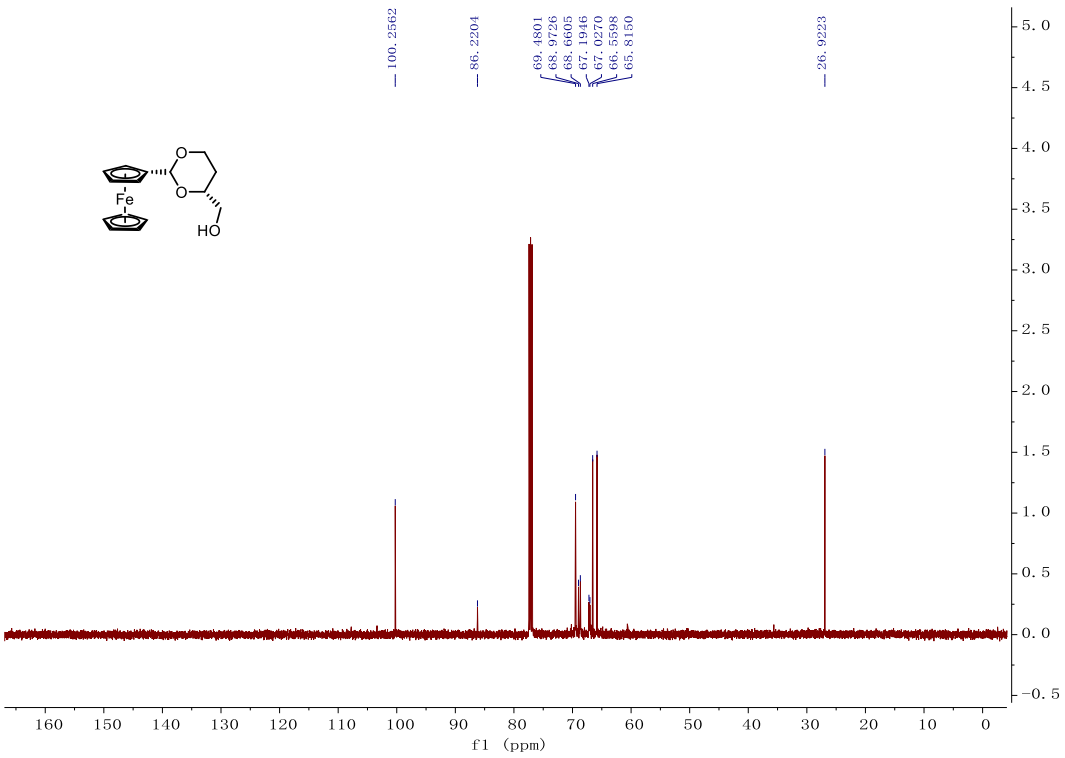
6. NMR Spectra

1-2-^{1}H NMR (500 MHz, Chloroform-*d*)



1-2-^{13}C NMR (126 MHz, Chloroform-*d*)



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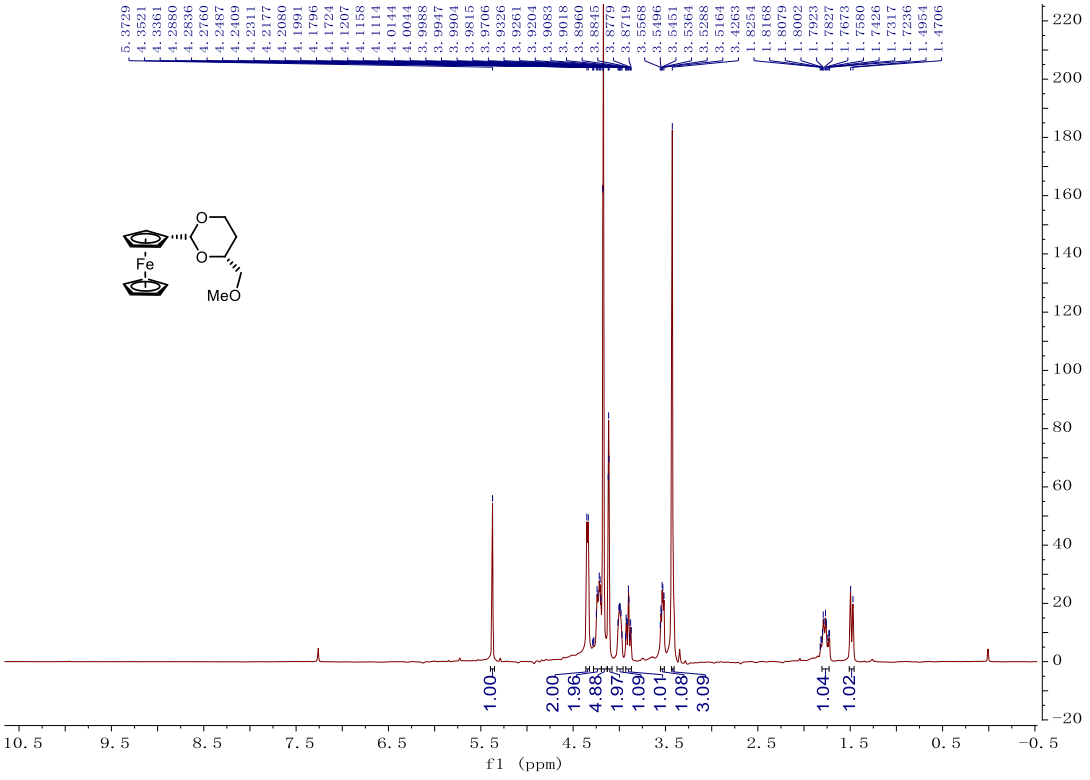
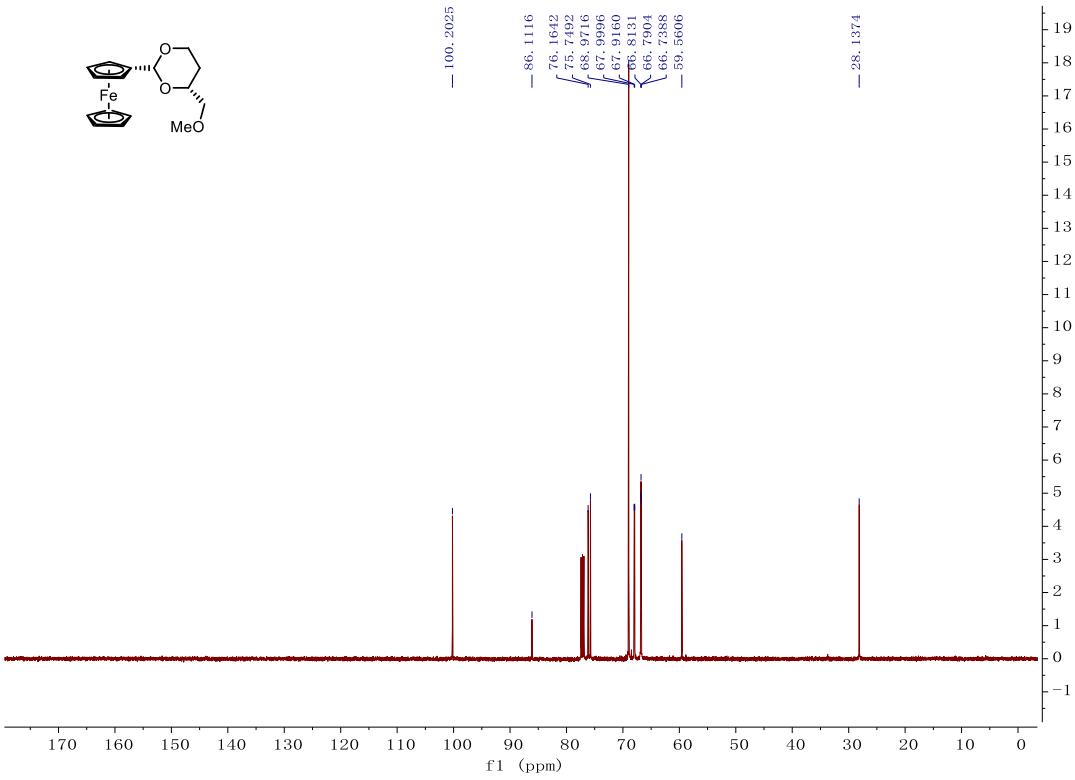
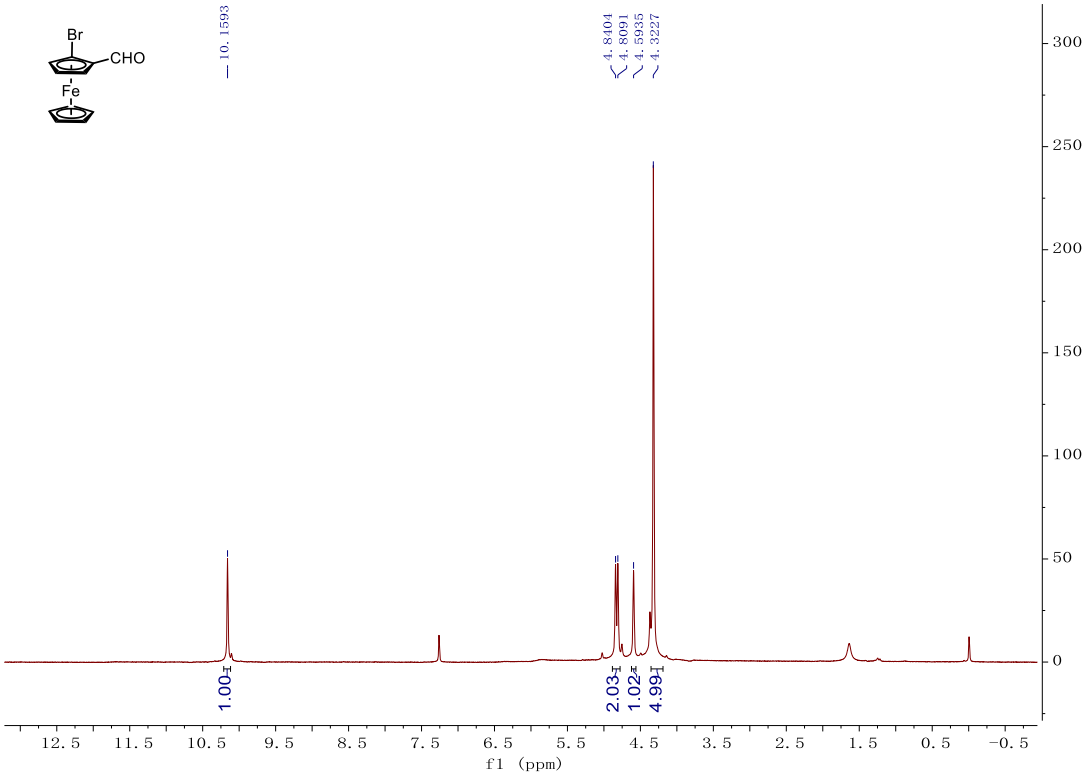


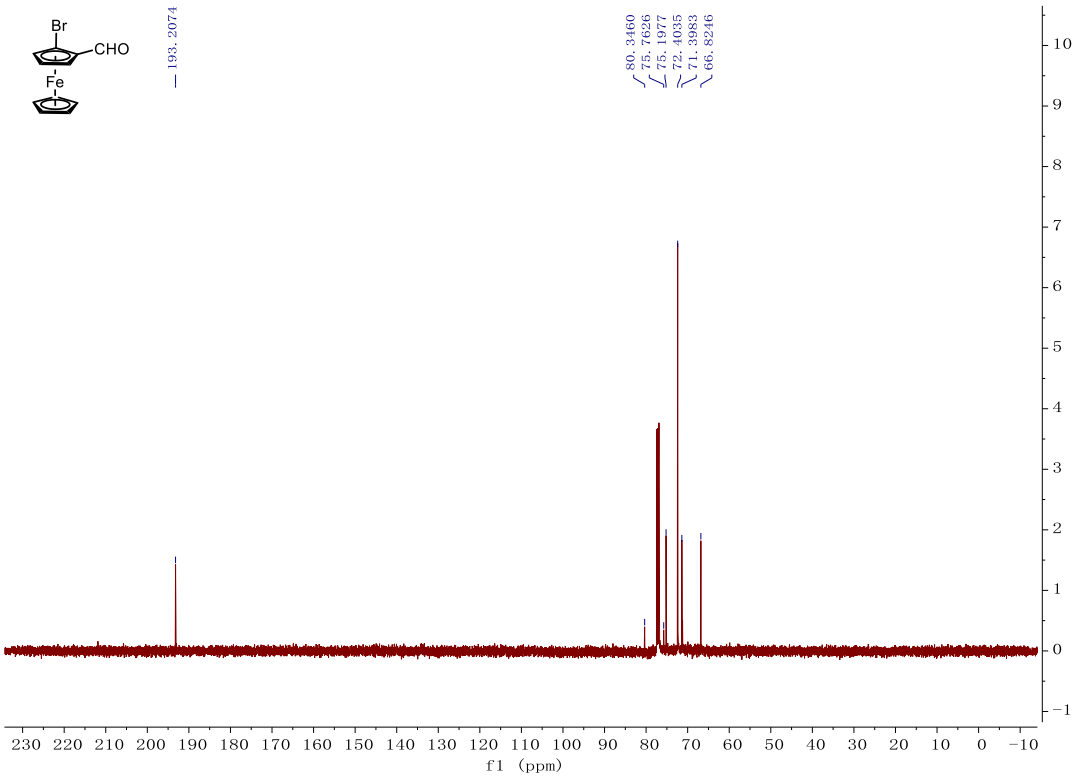
1-3-^{13}C NMR (126 MHz, Chloroform-*d*)



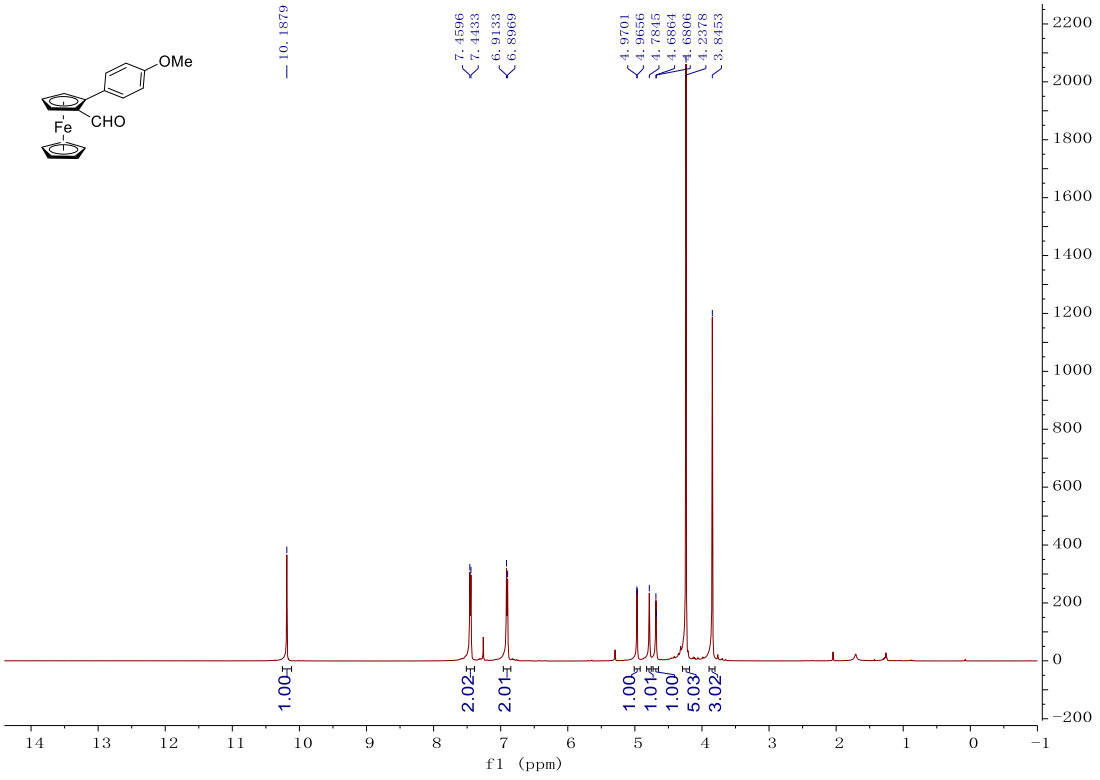
1a-^{1}H NMR (500 MHz, Chloroform-*d*)



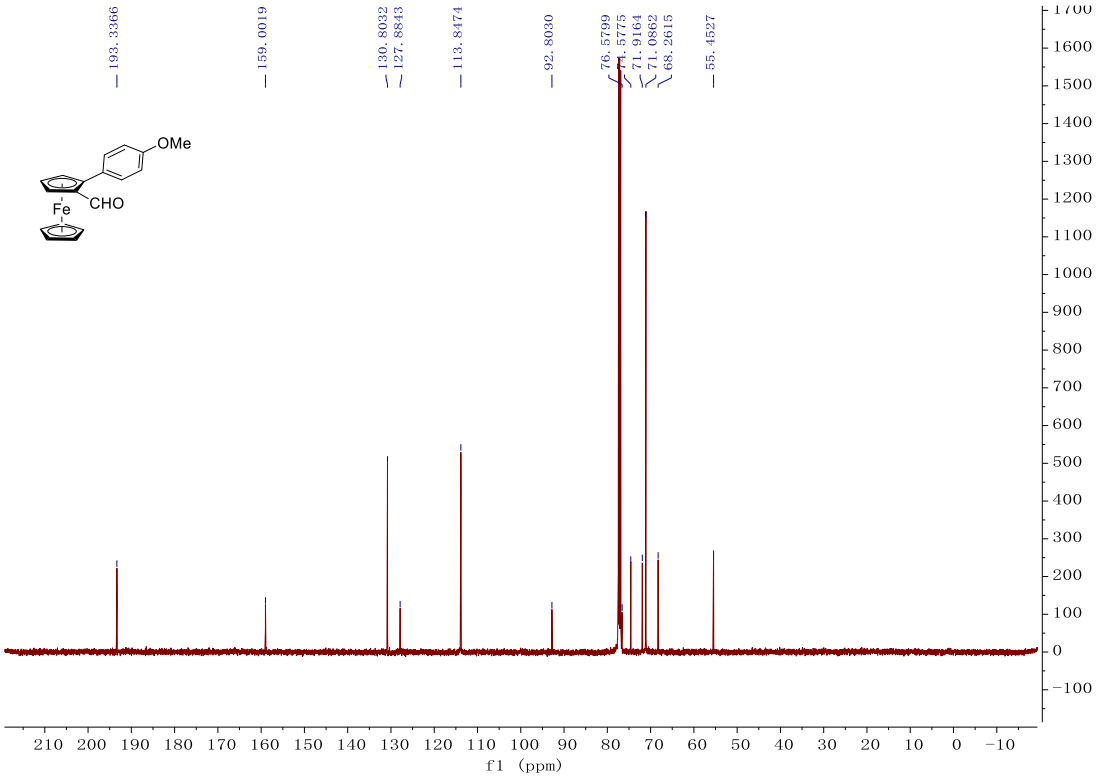
1a-^{13}C NMR (126 MHz, Chloroform-*d*)



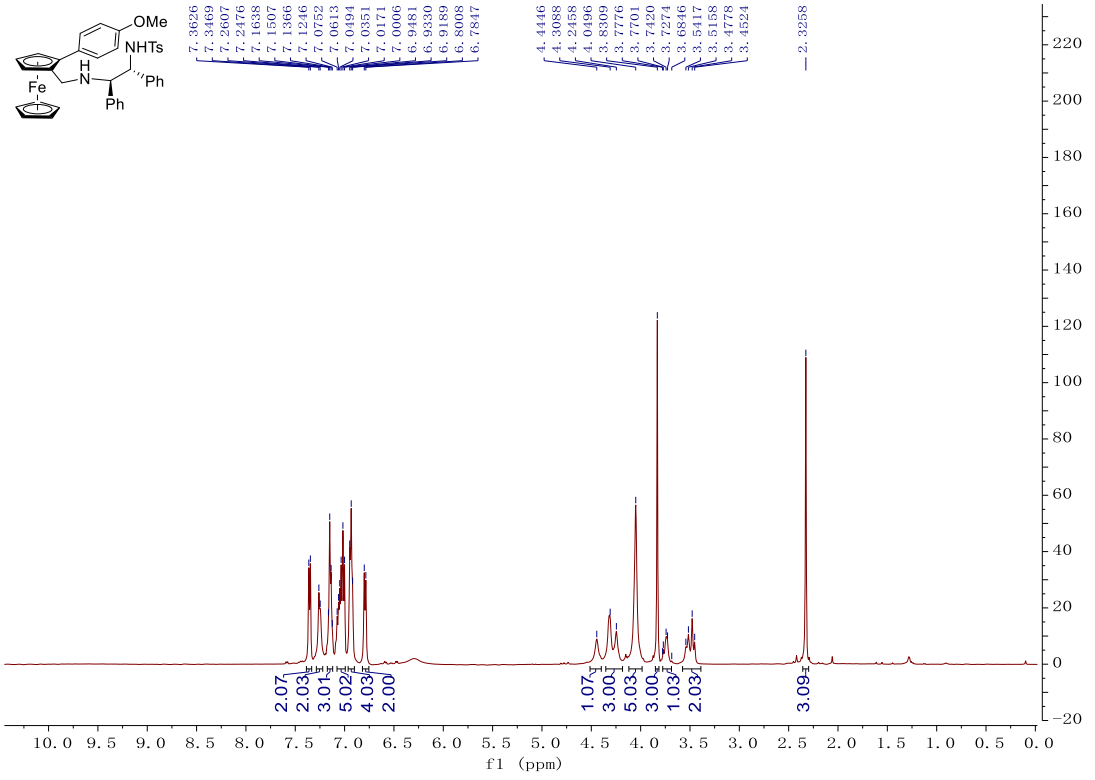
1-5-^{1}H NMR (500 MHz, Chloroform-*d*)



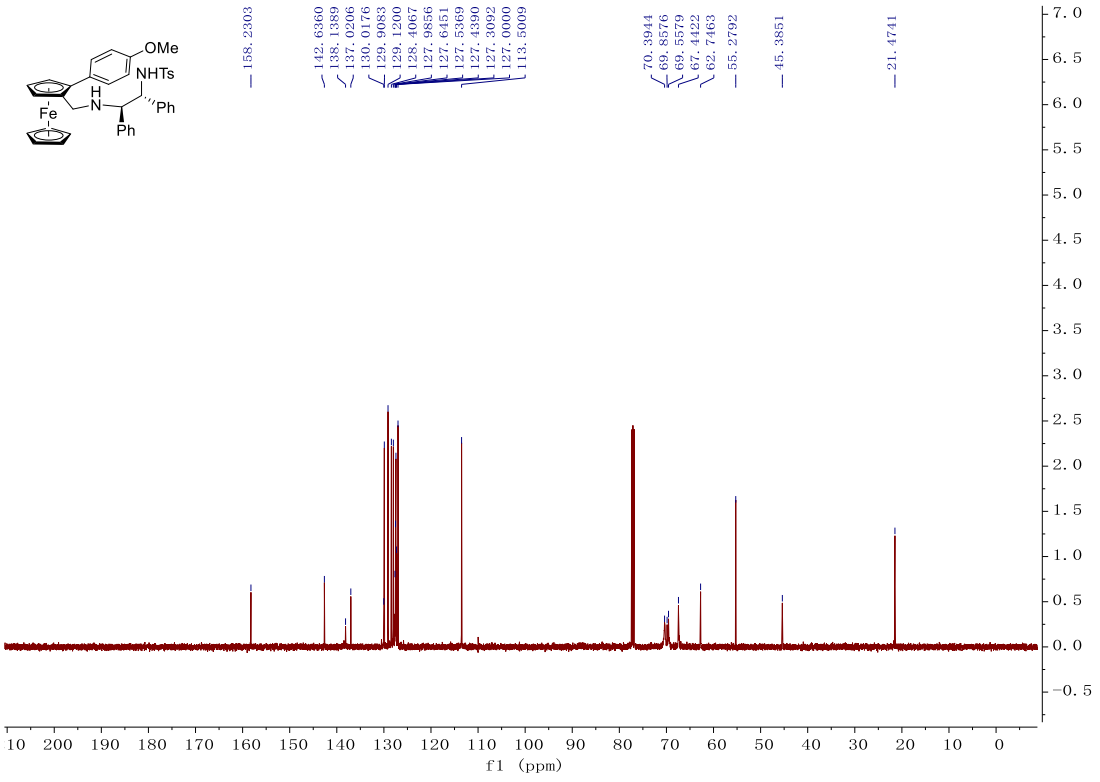
1-5-^{13}C NMR (126 MHz, Chloroform-*d*)



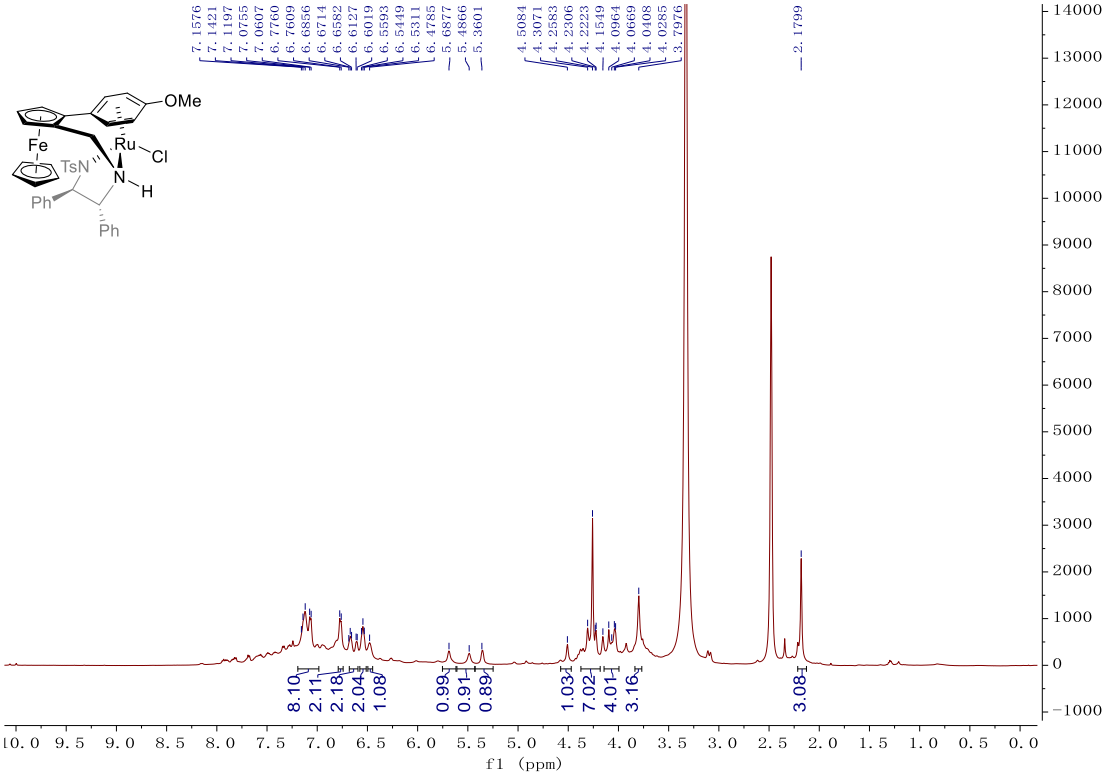
(R,R,S_{Fc})-**1b**-^{1}H NMR (500 MHz, Chloroform-*d*)



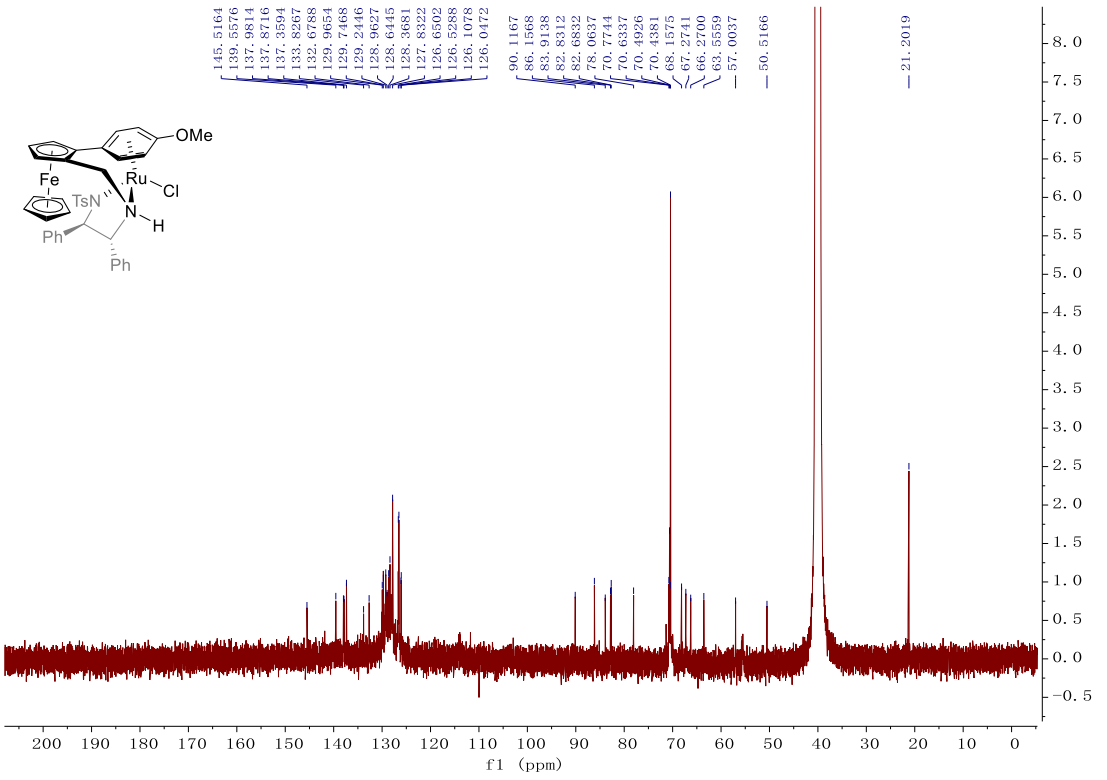
(R,R,S_{Fc})-**1b**-^{13}C NMR (126 MHz, Chloroform-*d*)



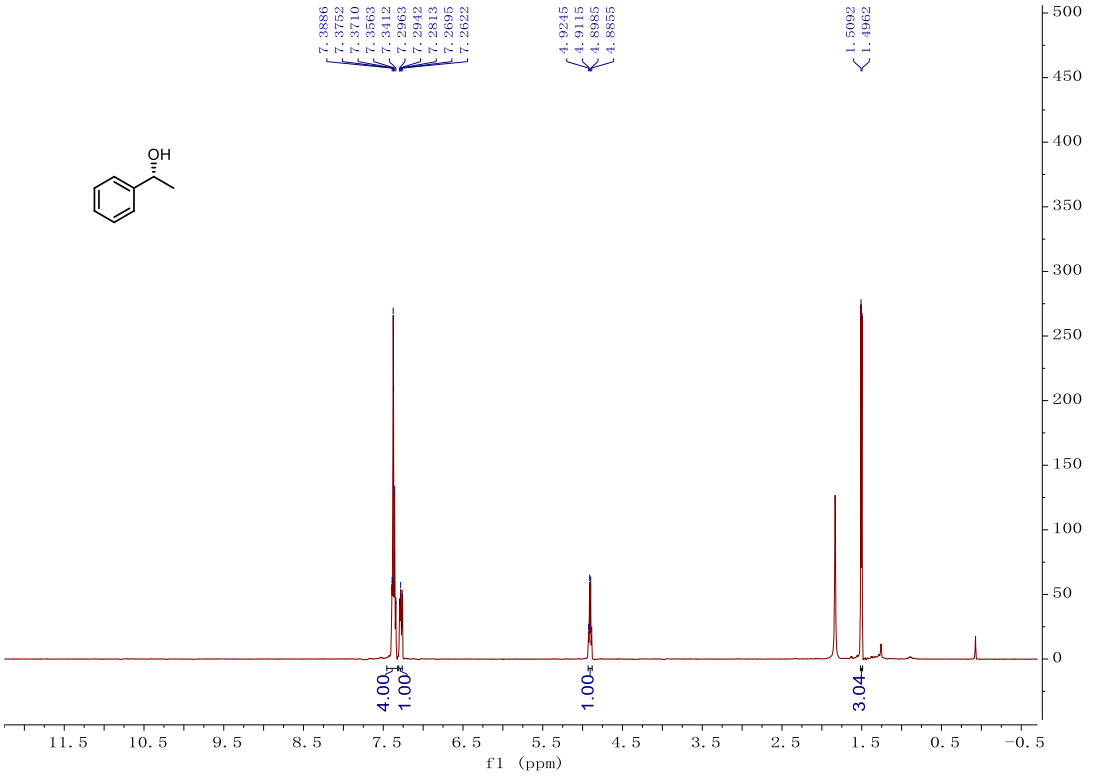
Ru-1-^{1}H NMR (500 MHz, DMSO-d_6)



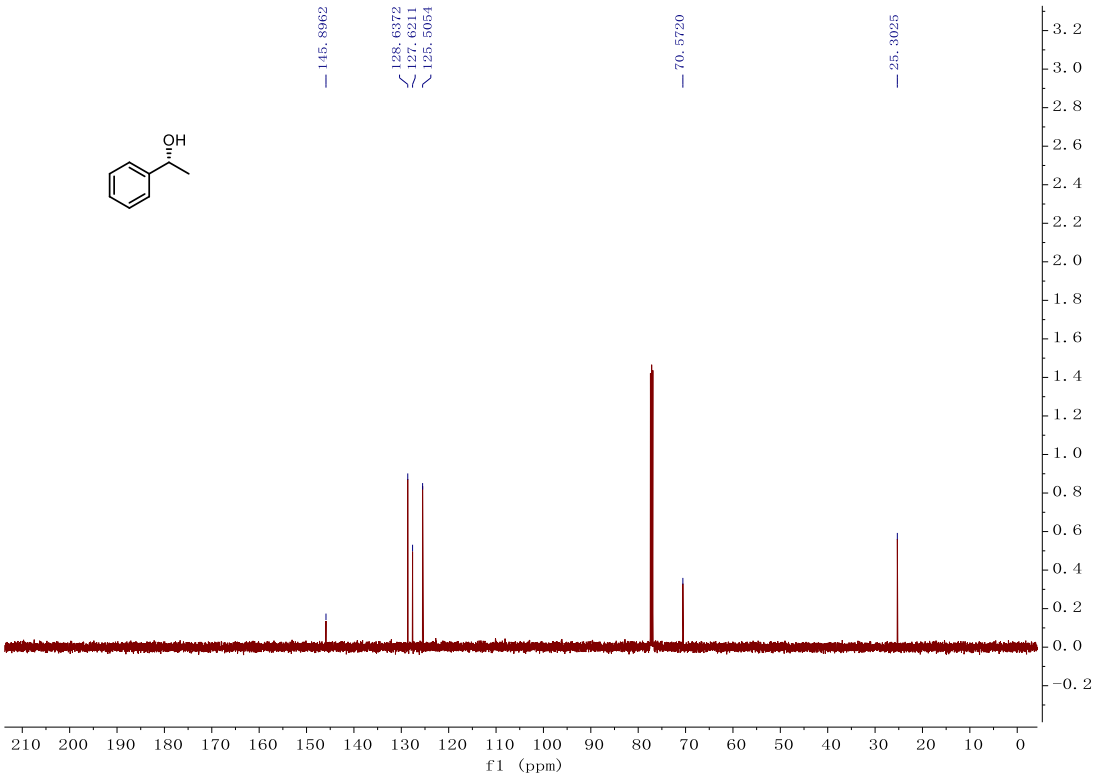
Ru-1-^{13}C NMR (126 MHz, DMSO-d_6)



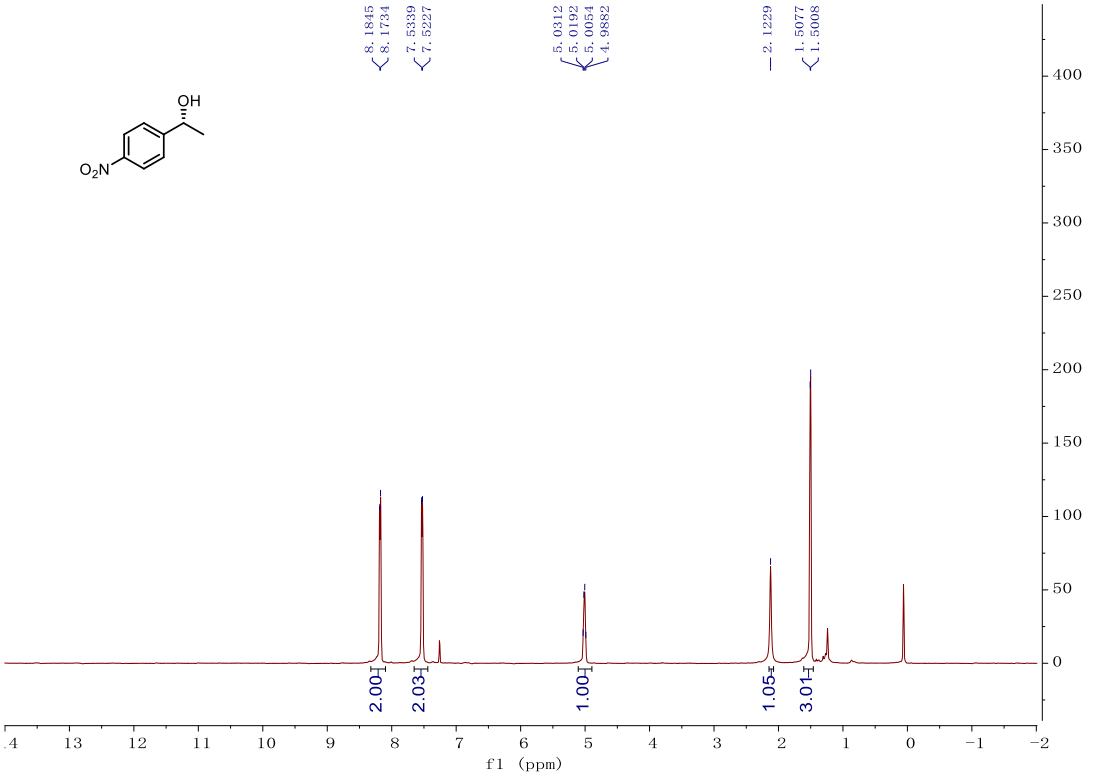
3a-^{1}H NMR (500 MHz, Chloroform-*d*)



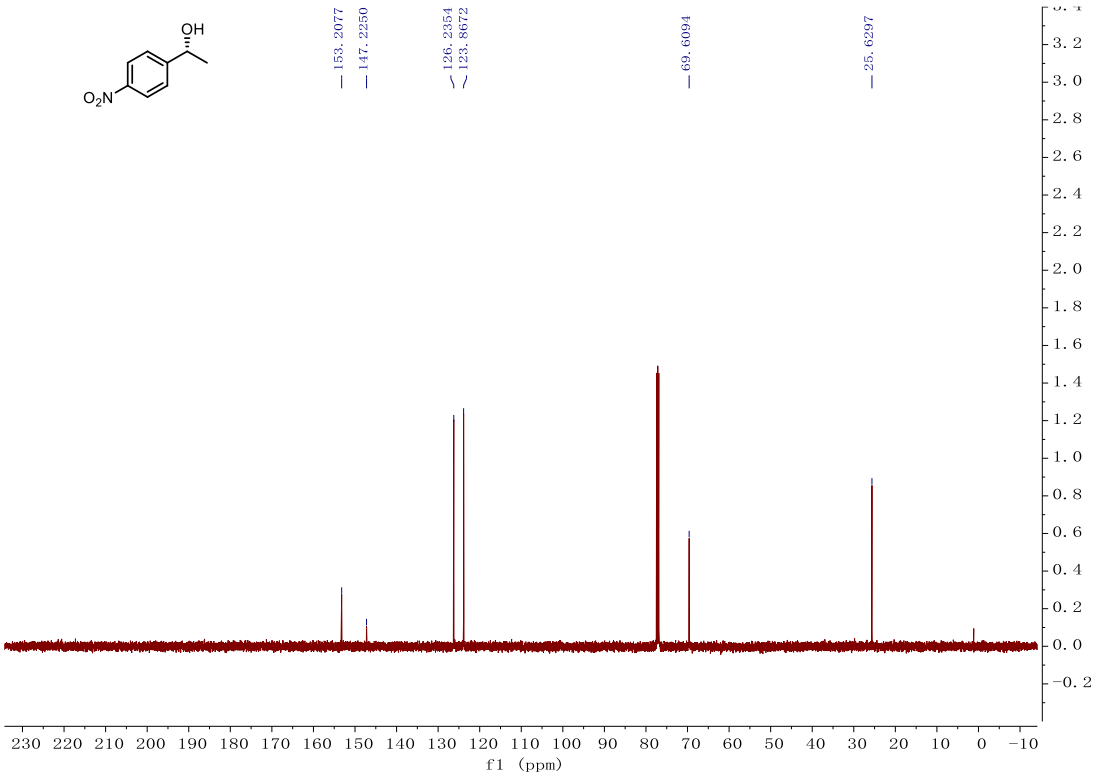
3a-^{13}C NMR (126 MHz, Chloroform-*d*)



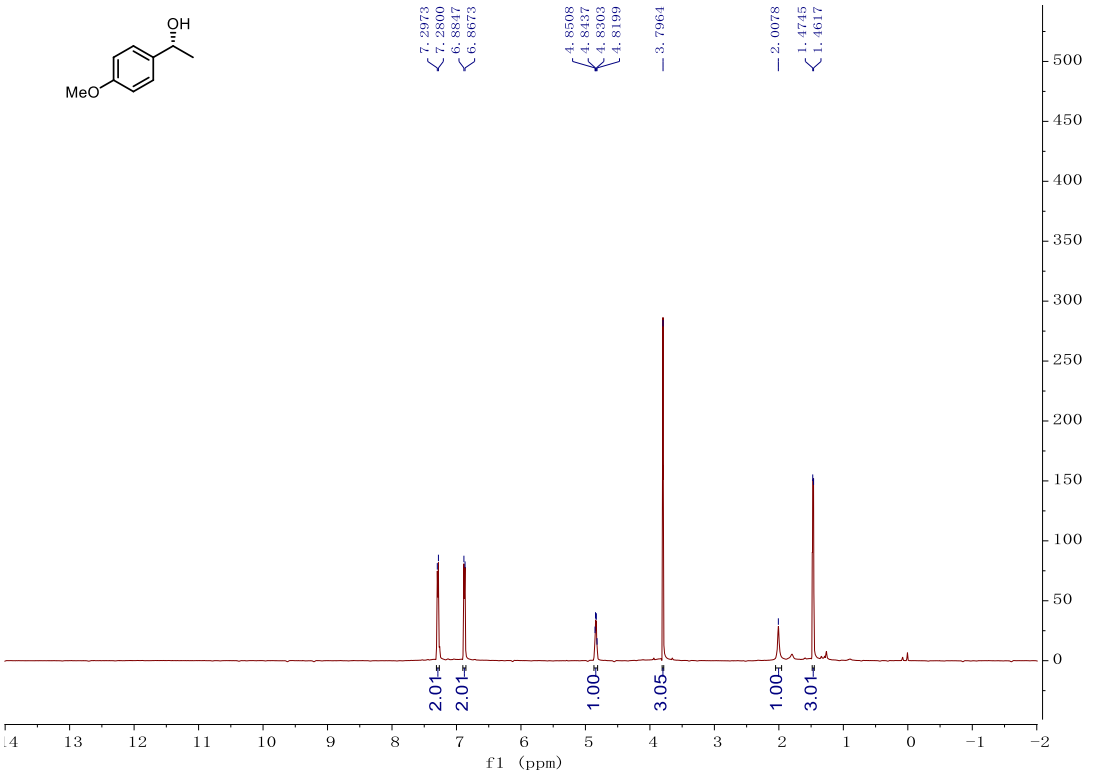
3b-^{1}H NMR (500 MHz, Chloroform-*d*)



3b-^{13}C NMR (126 MHz, Chloroform-*d*)



3c-^{1}H NMR (500 MHz, Chloroform-*d*)



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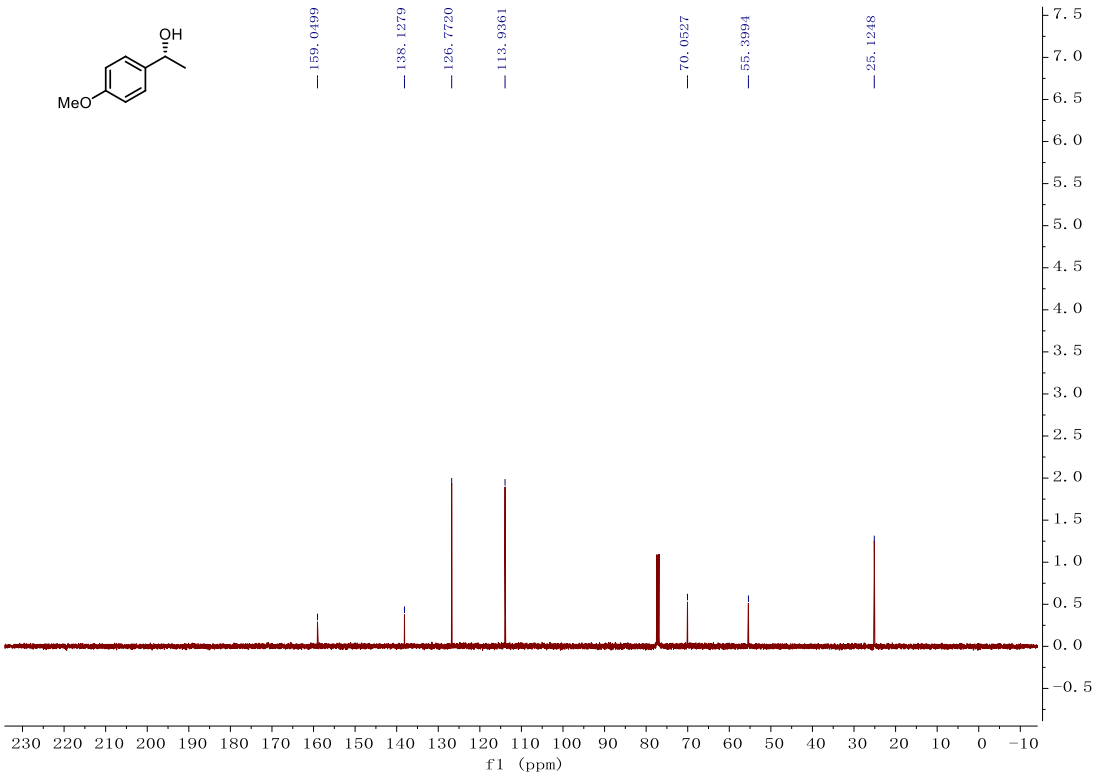
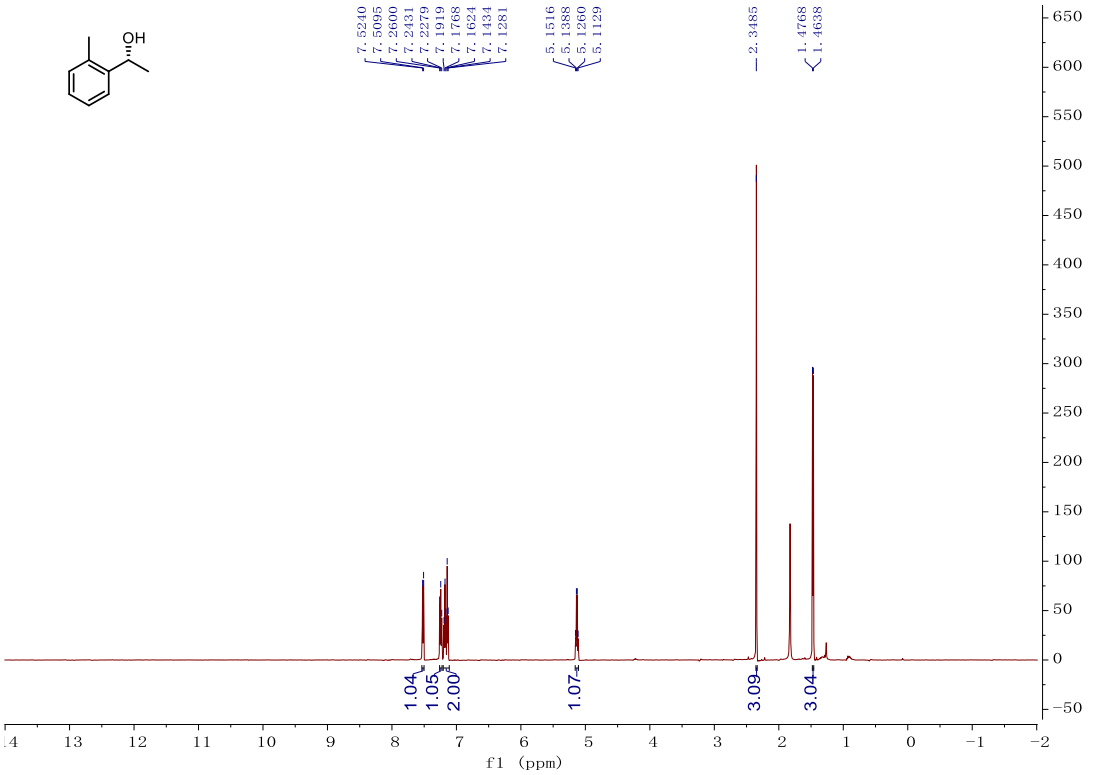


3d-^{1}H NMR (500 MHz, Chloroform-*d*)



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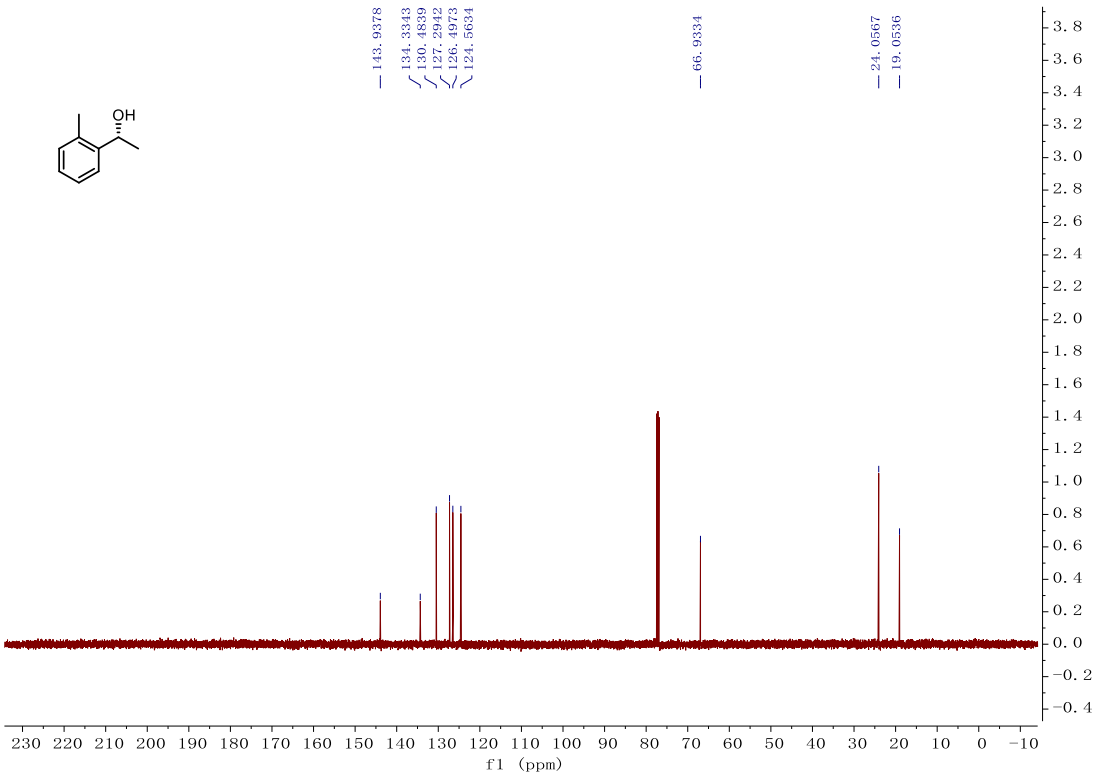

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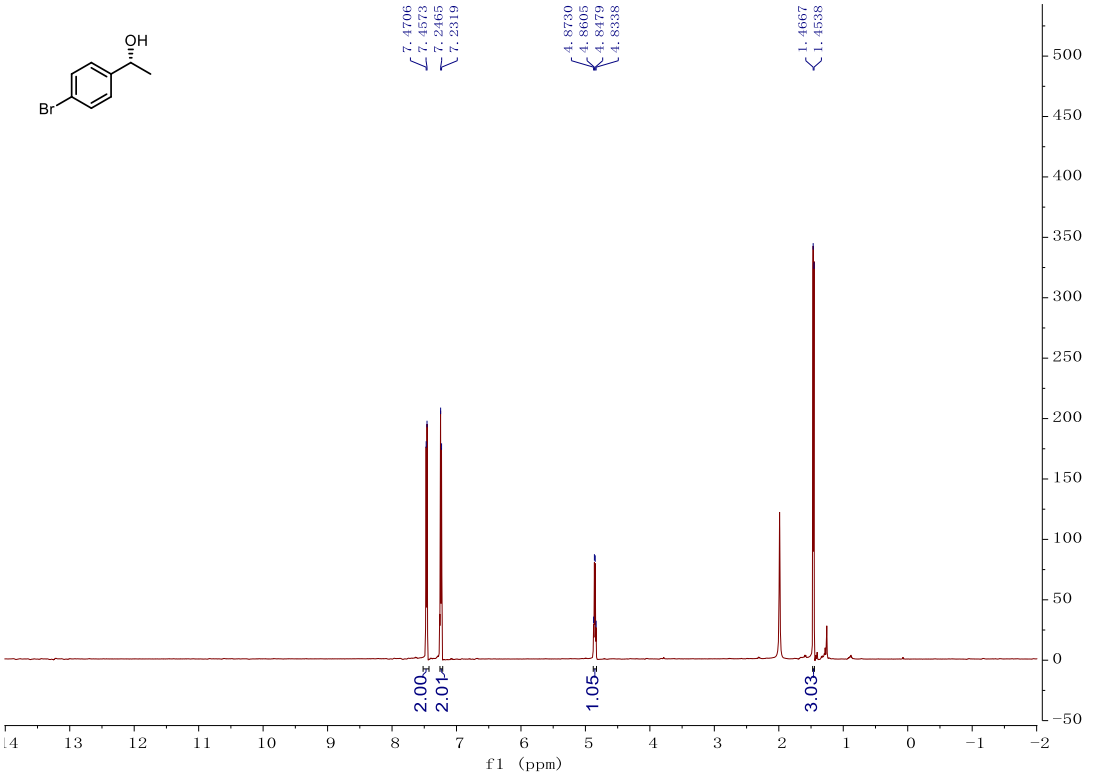
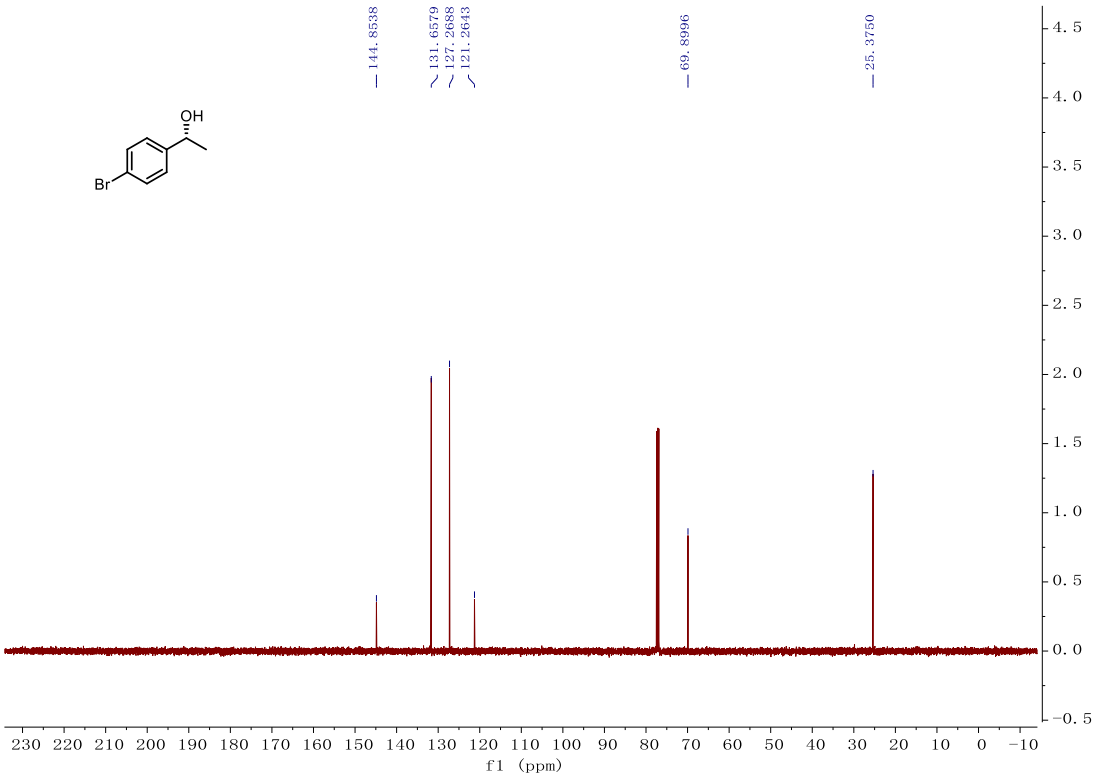
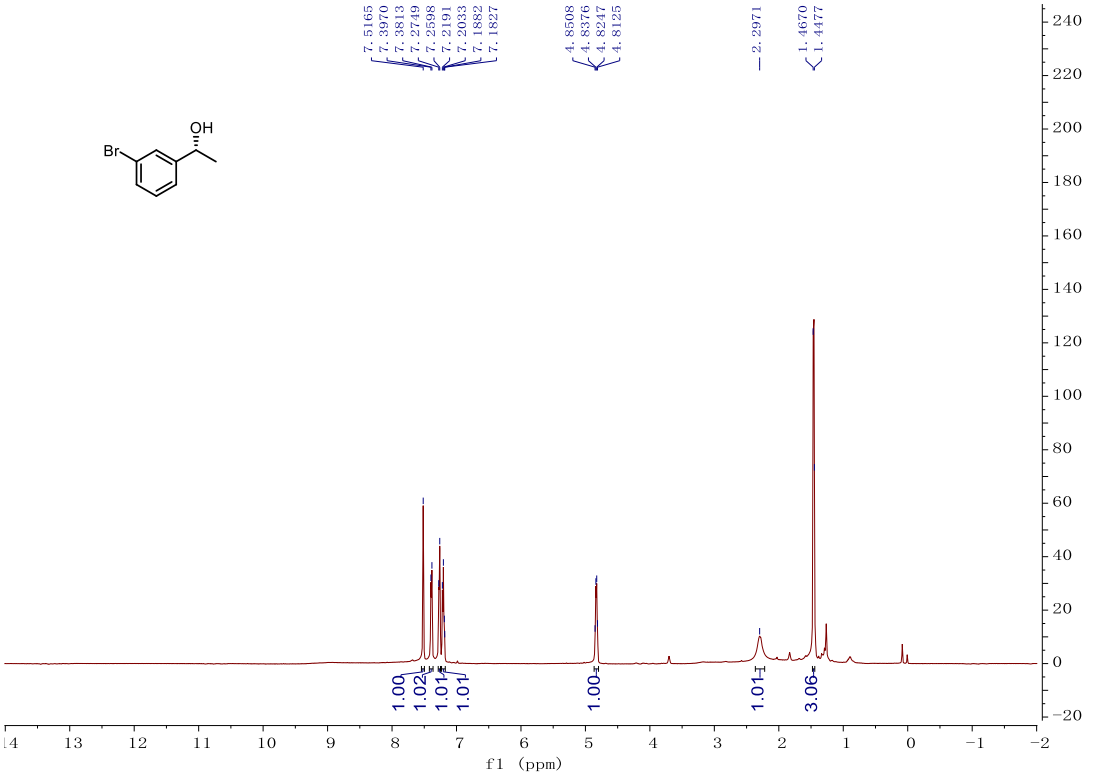


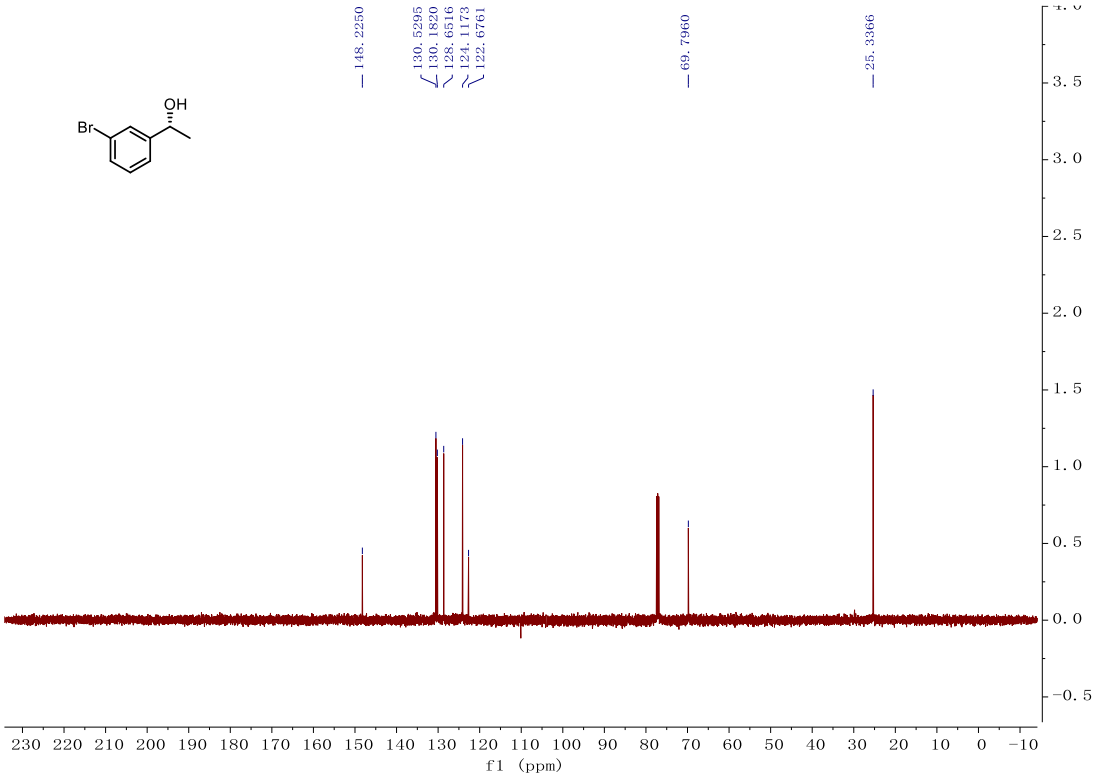
3e-^{13}C NMR (126 MHz, Chloroform-*d*)



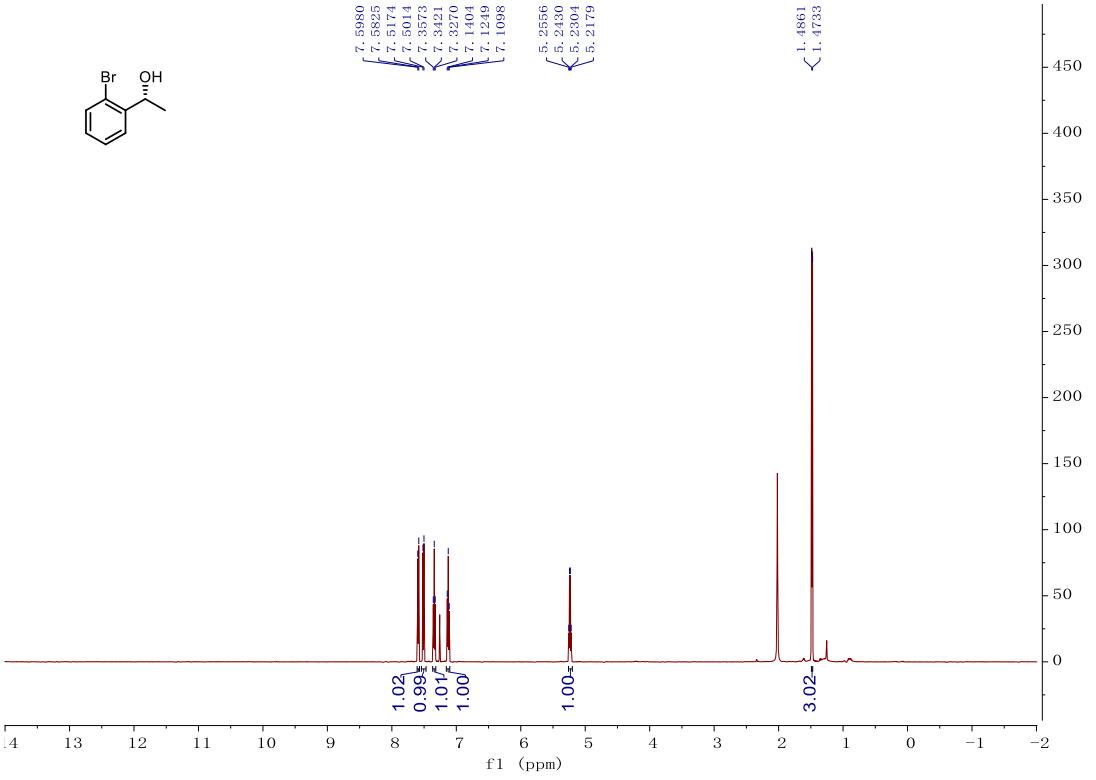
3f-^{1}H NMR (500 MHz, Chloroform-*d*)



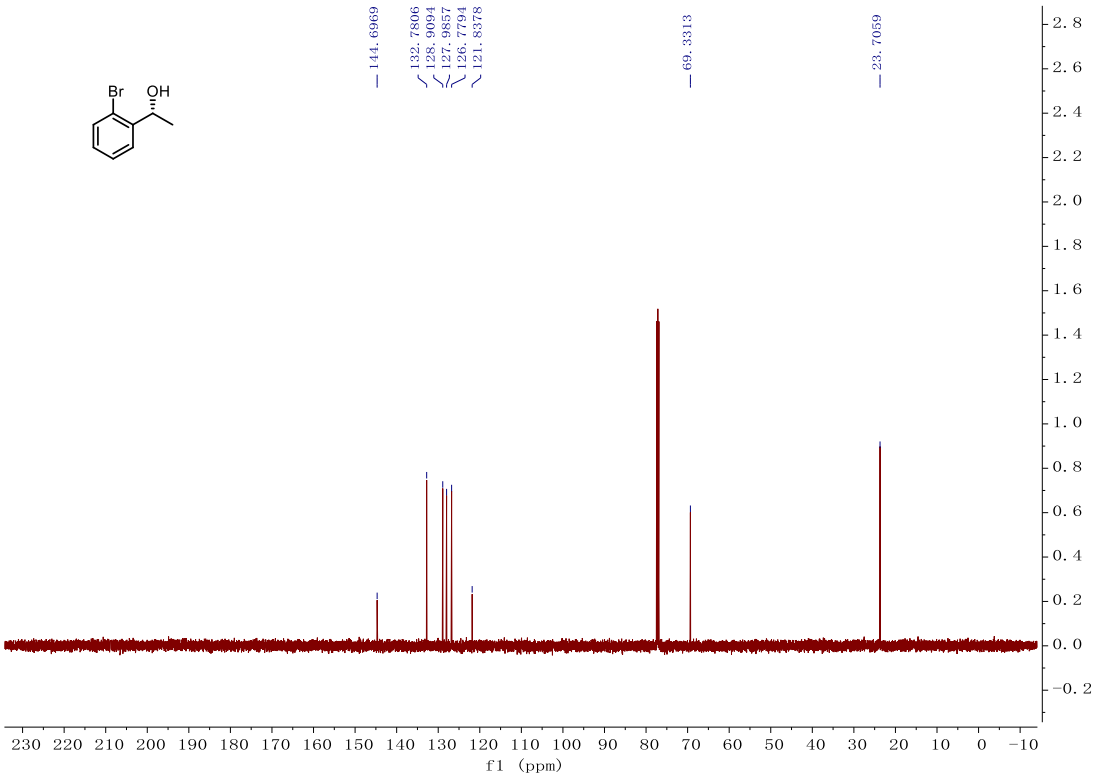
3f-^{13}C NMR (126 MHz, Chloroform-*d*)



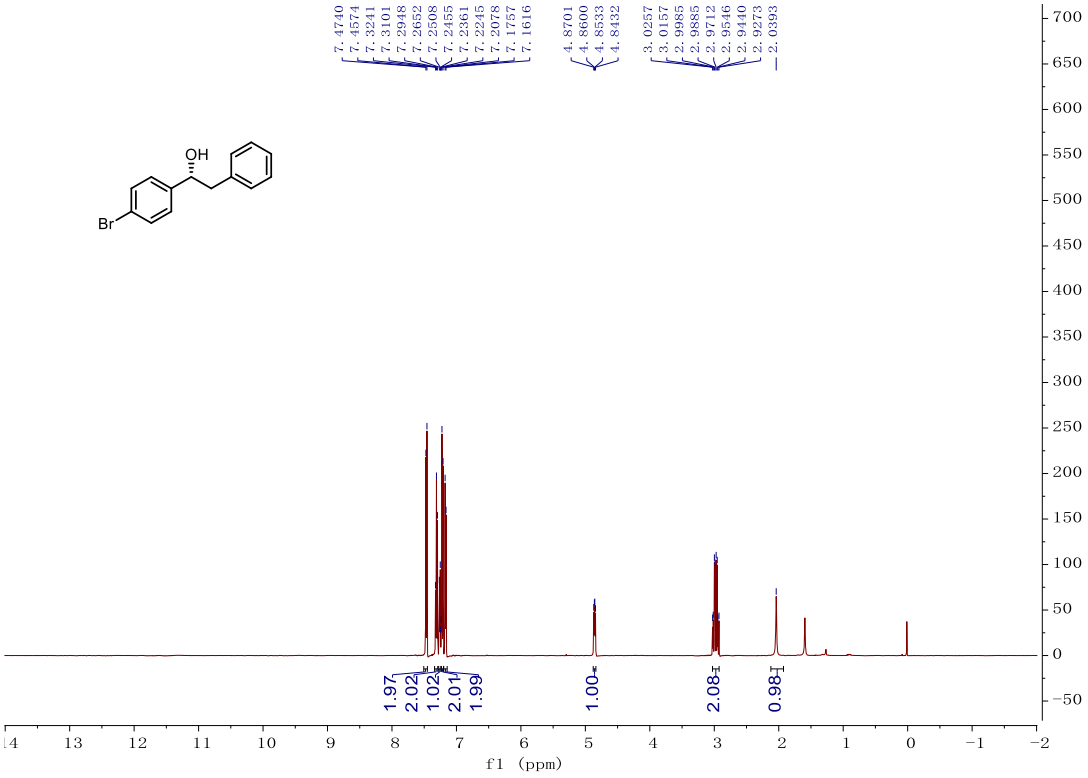
3g-^{1}H NMR (500 MHz, Chloroform-*d*)



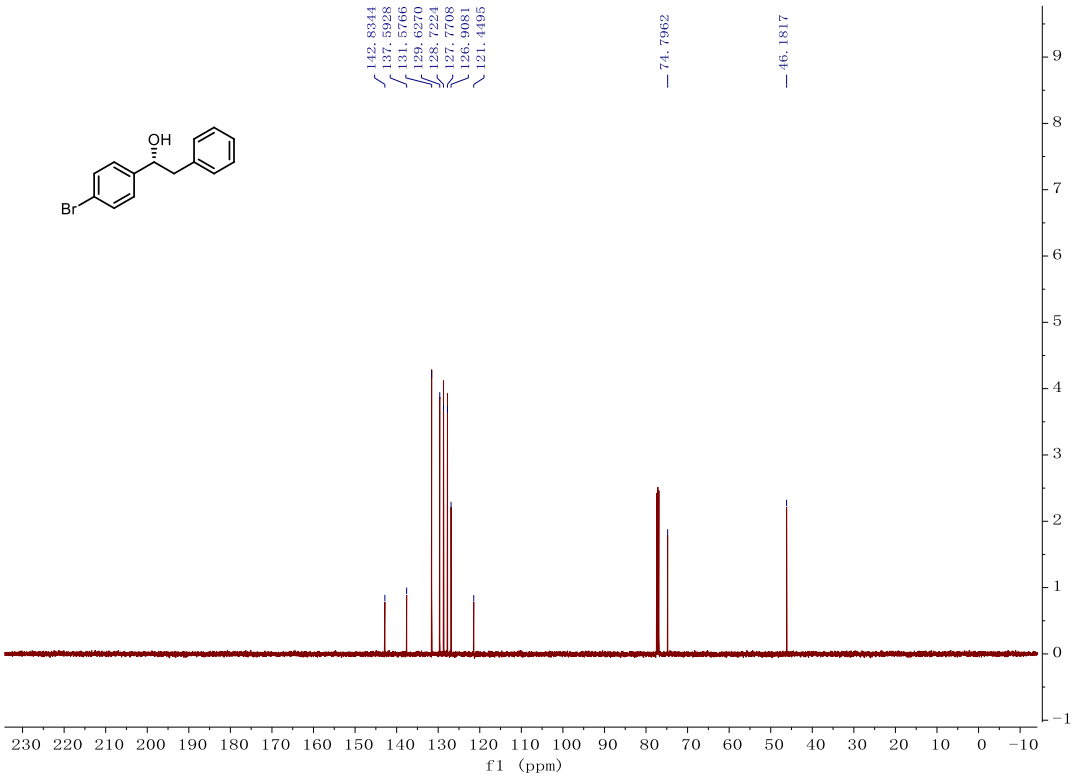
3g-^{13}C NMR (126 MHz, Chloroform-*d*)



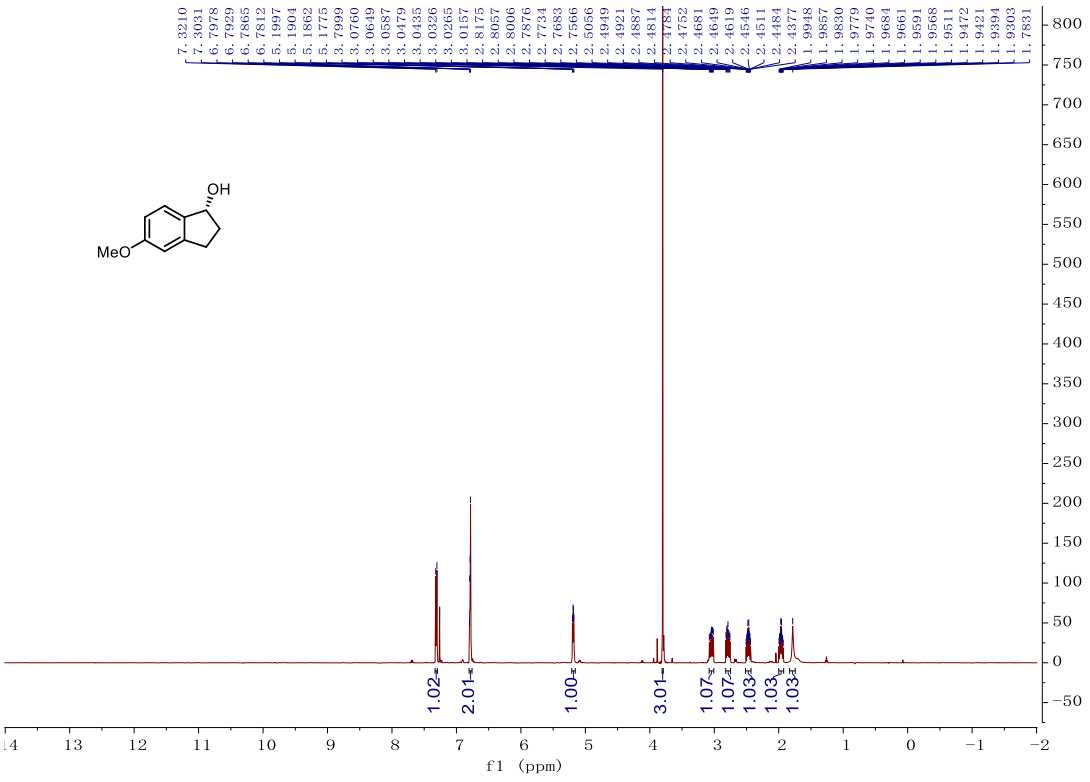
3h-^{1}H NMR (500 MHz, Chloroform-*d*)



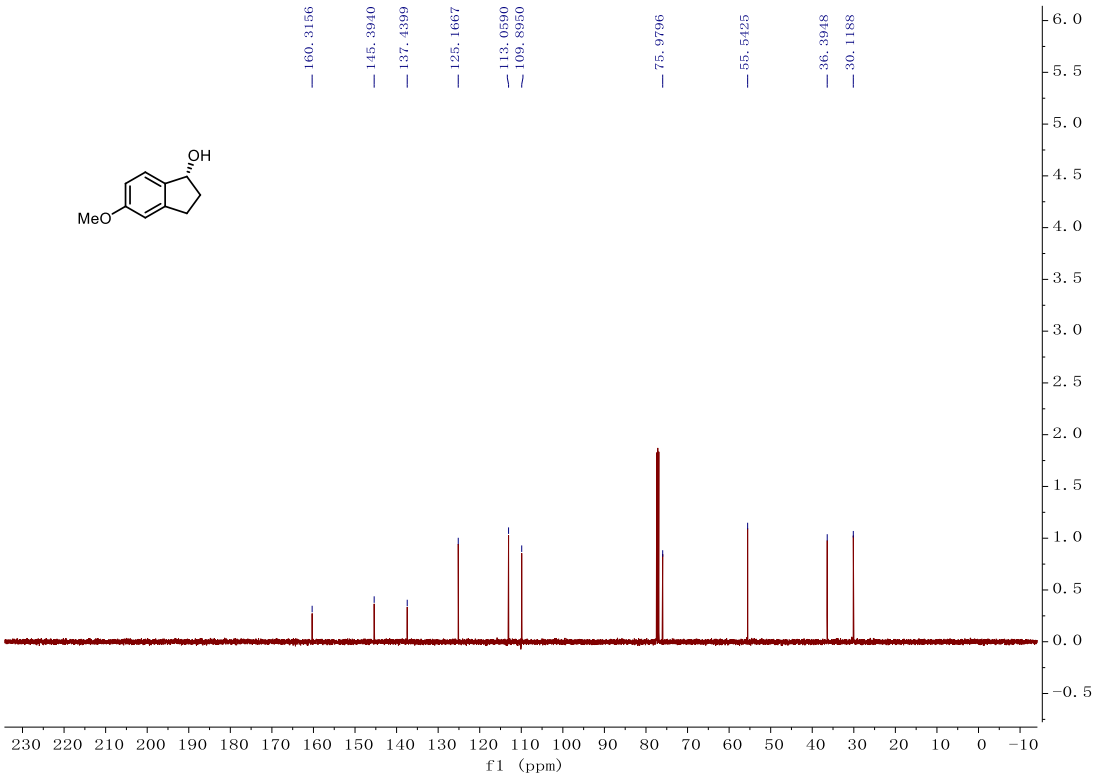
3h-^{13}C NMR (126 MHz, Chloroform-*d*)



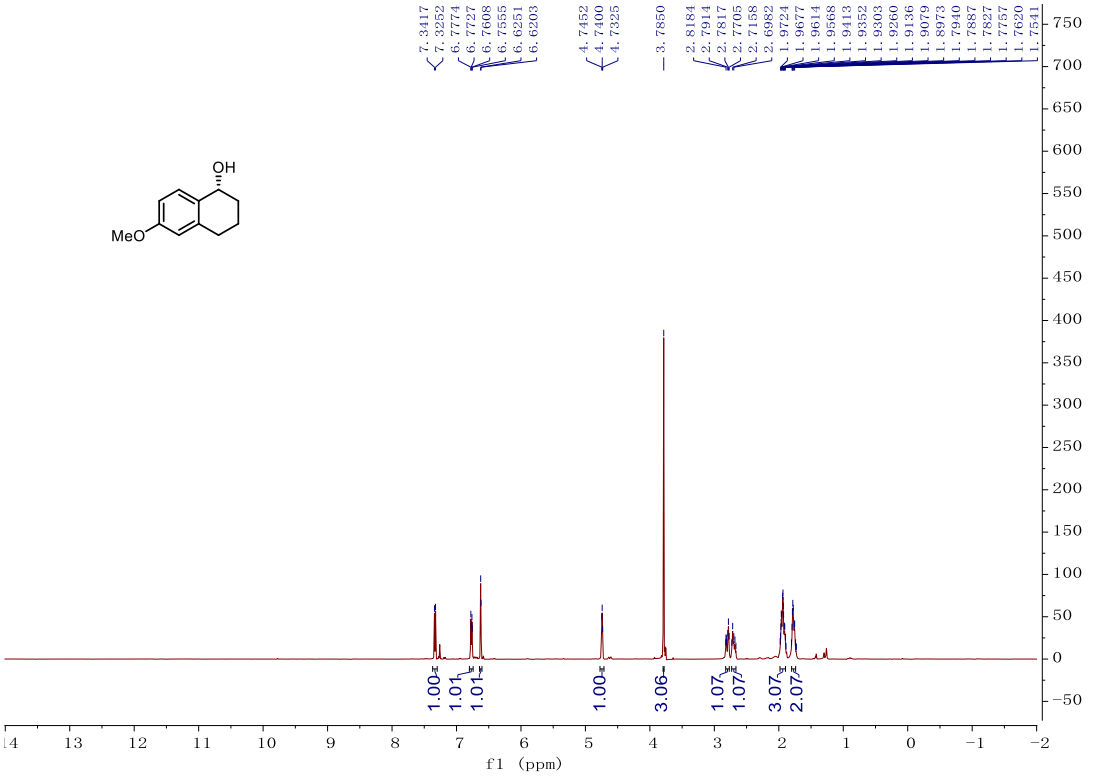
3i-^{1}H NMR (500 MHz, Chloroform-*d*)



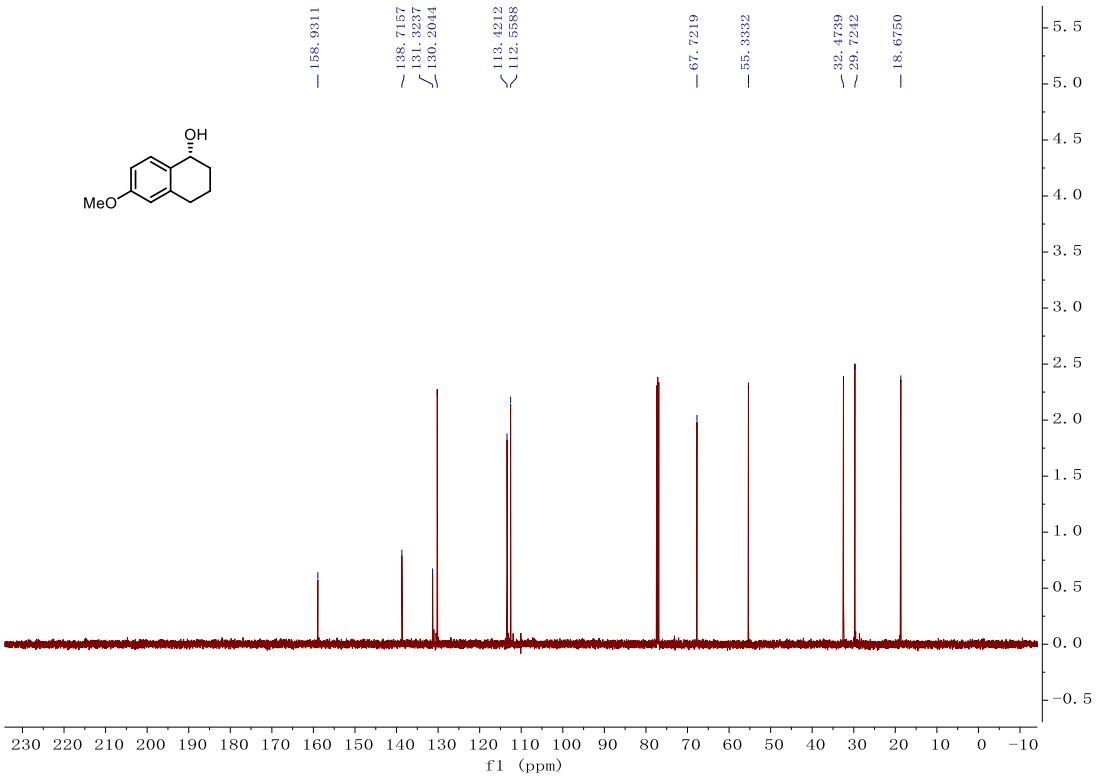
3i-^{13}C NMR (126 MHz, Chloroform-*d*)



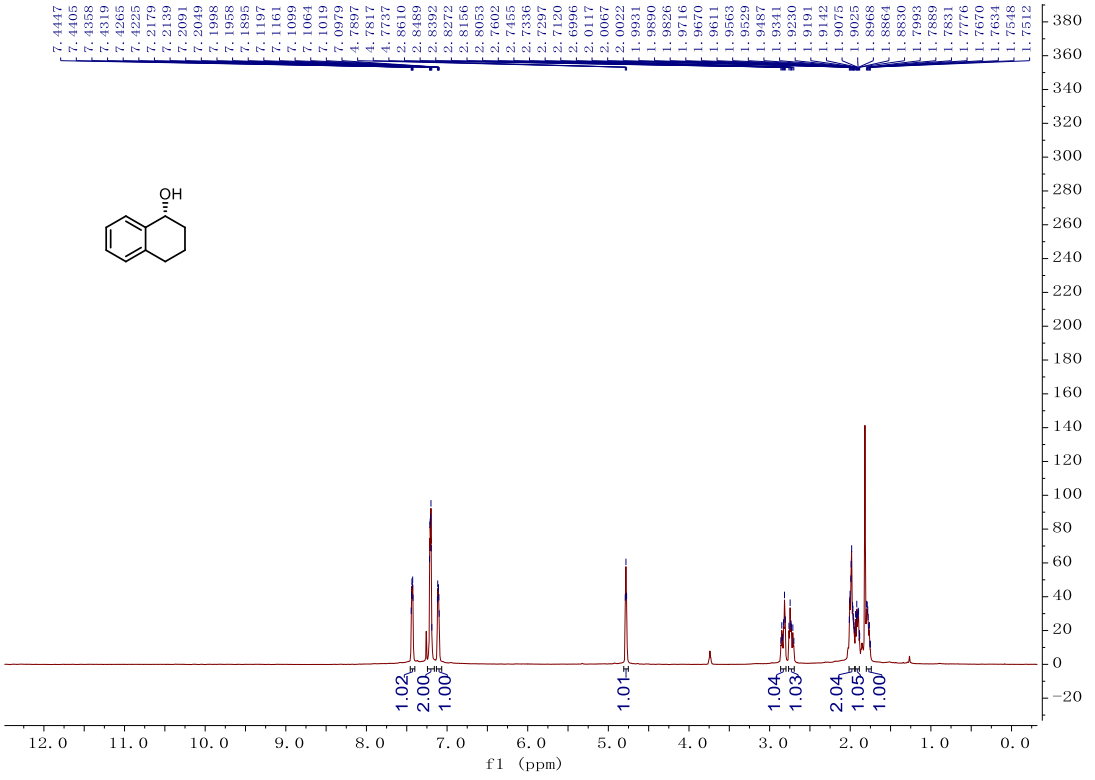
3j-^{1}H NMR (500 MHz, Chloroform-*d*)



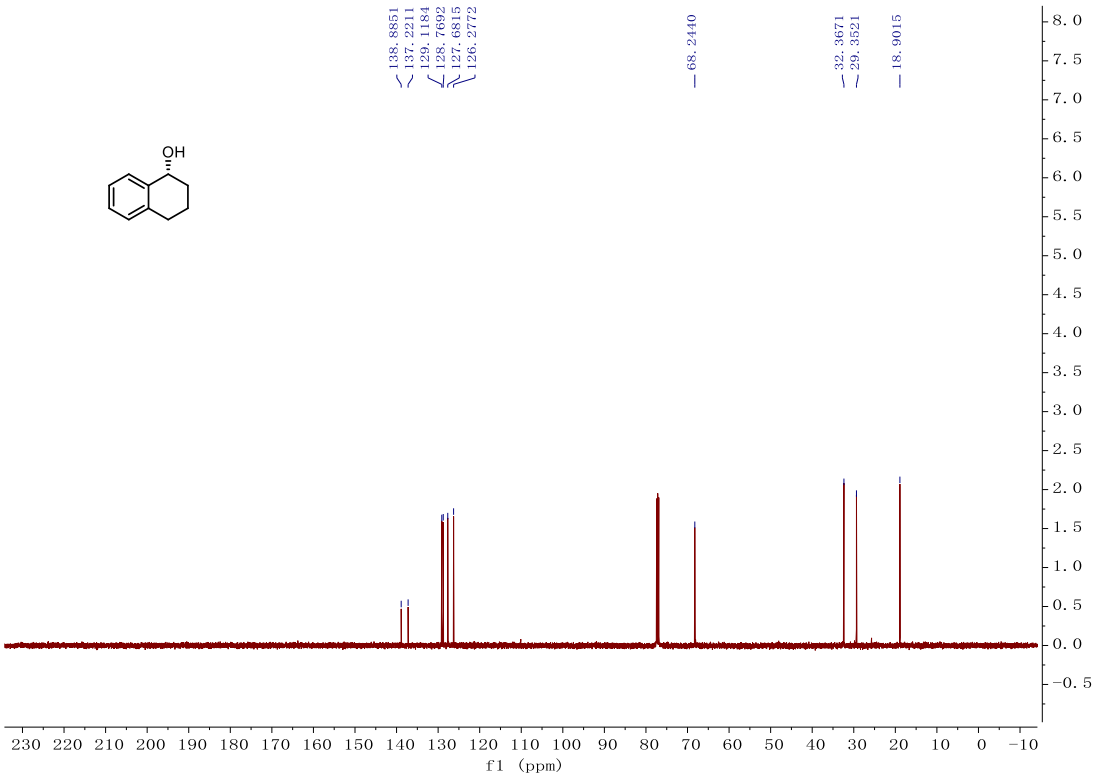
3j-^{13}C NMR (126 MHz, Chloroform-*d*)



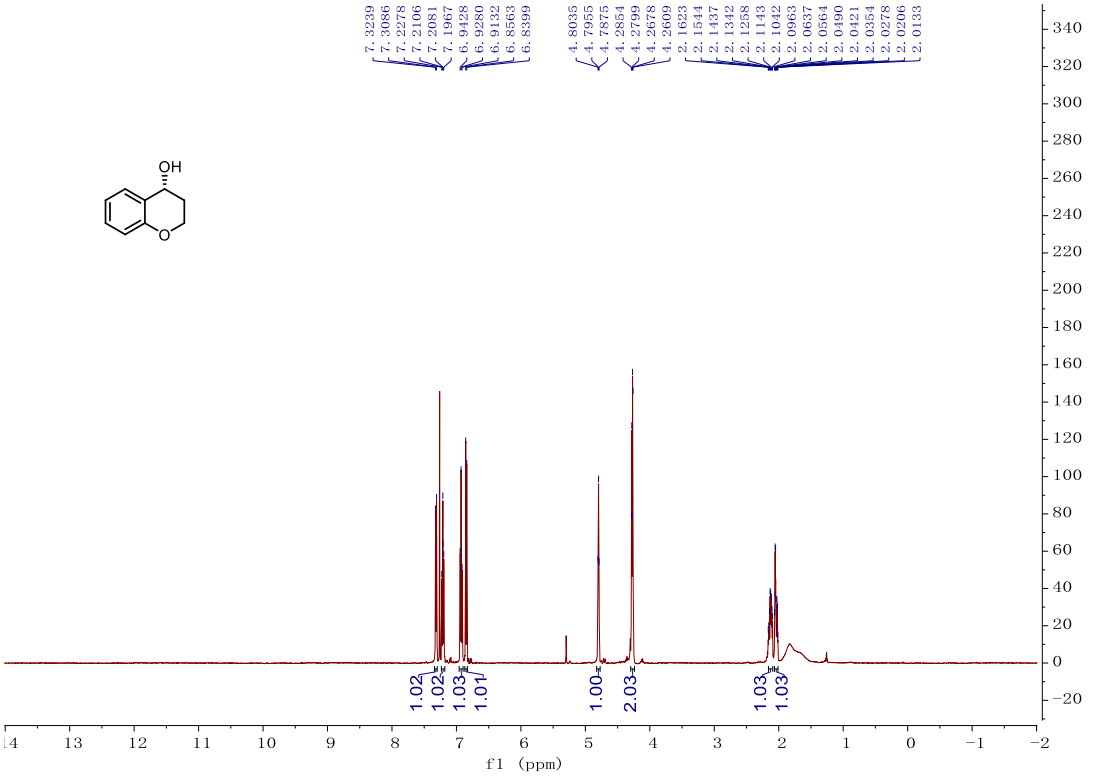
3k-^{1}H NMR (500 MHz, Chloroform-*d*)



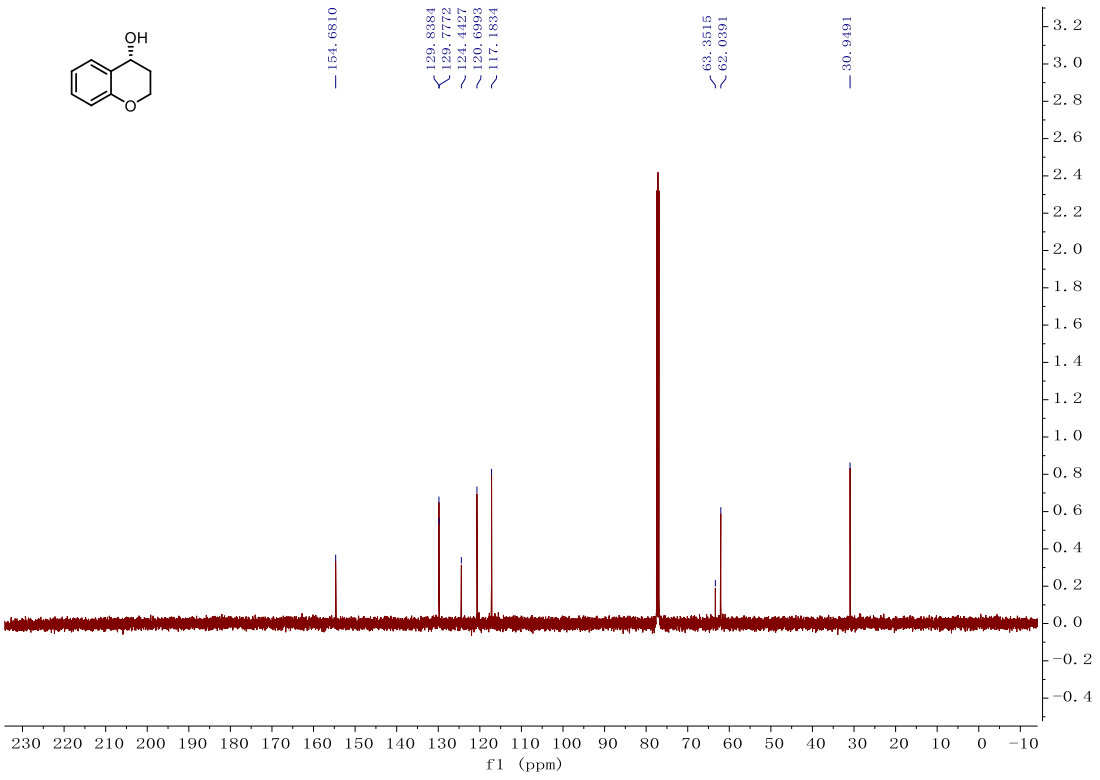
3k-^{13}C NMR (126 MHz, Chloroform-*d*)



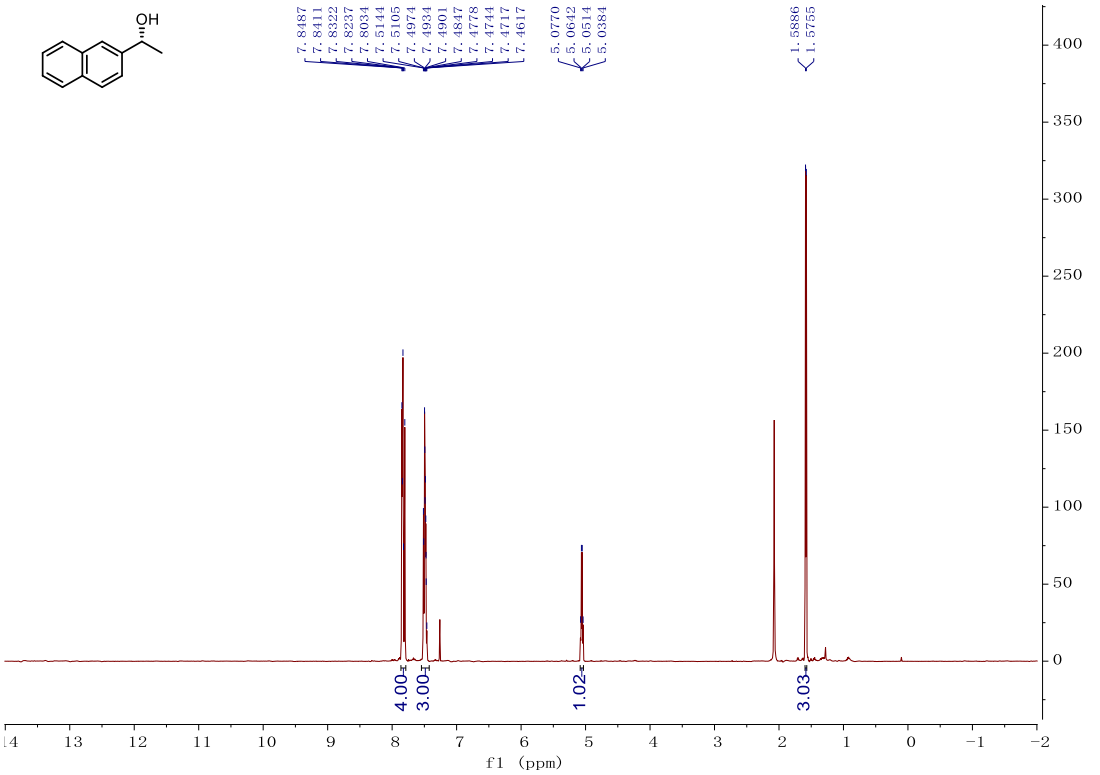
3l-^{1}H NMR (500 MHz, Chloroform-*d*)



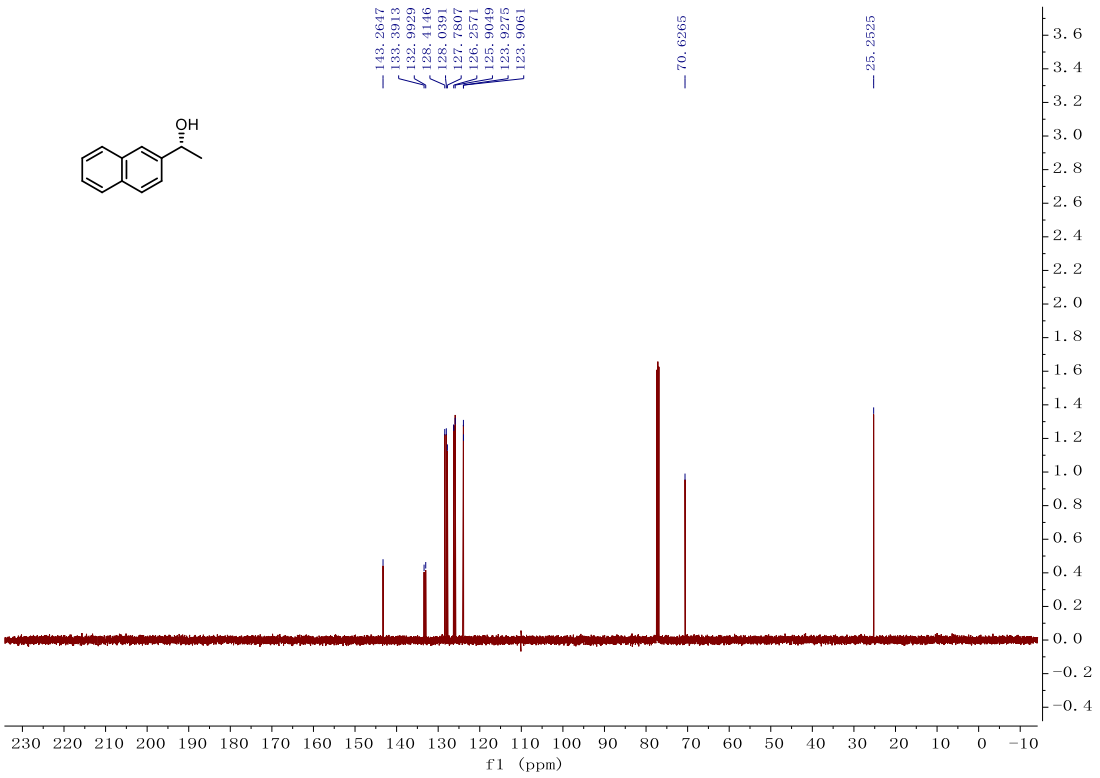
3l-^{13}C NMR (126 MHz, Chloroform-*d*)



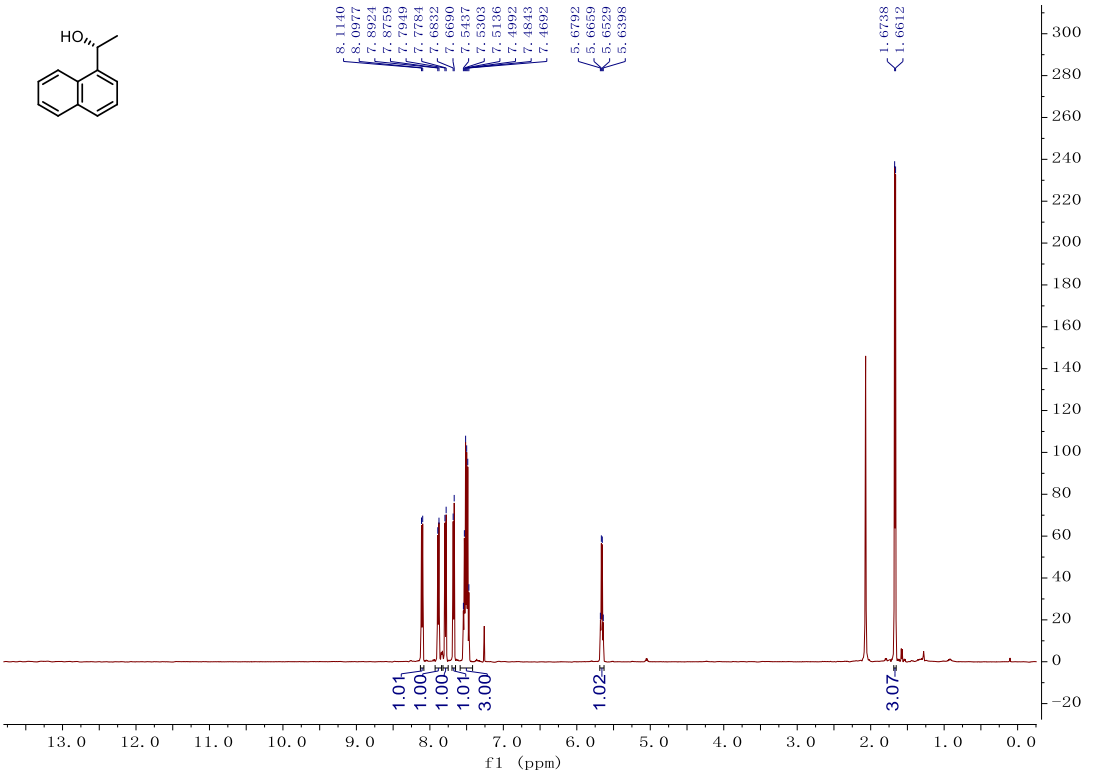
3m-^{1}H NMR (500 MHz, Chloroform-*d*)



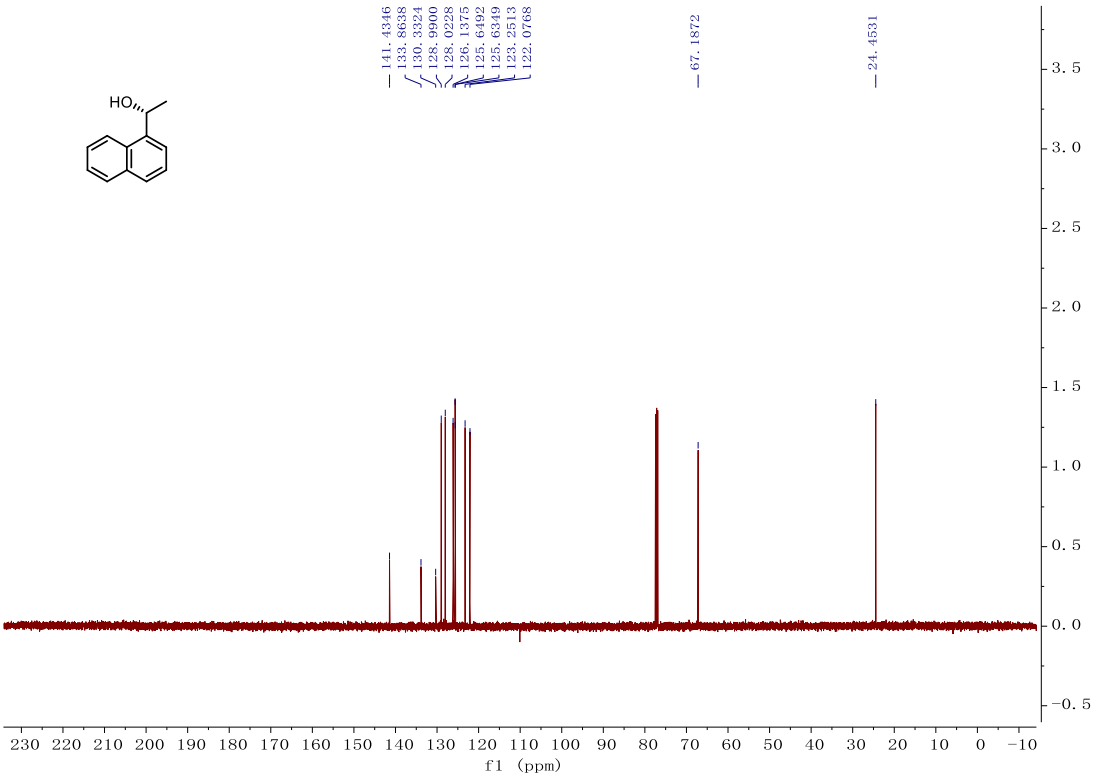
3m-^{13}C NMR (126 MHz, Chloroform-*d*)



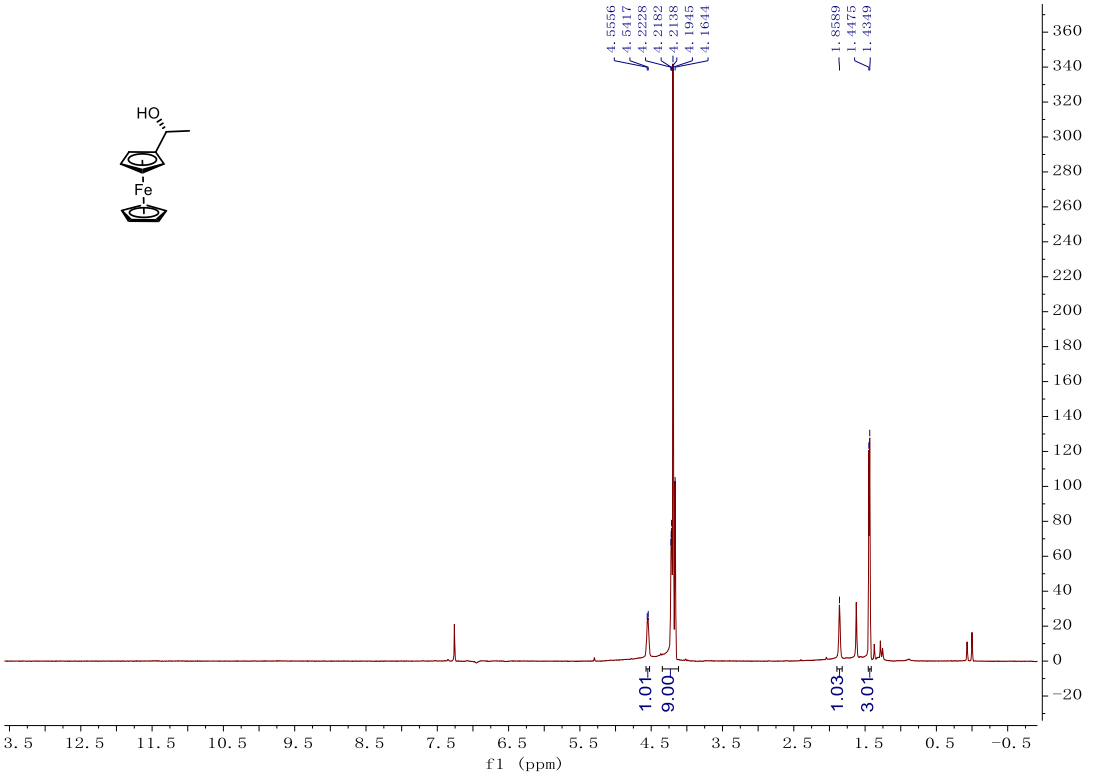
3n-^{1}H NMR (500 MHz, Chloroform-*d*)



3n-^{13}C NMR (126 MHz, Chloroform-*d*)



3o-^{1}H NMR (500 MHz, Chloroform-*d*)



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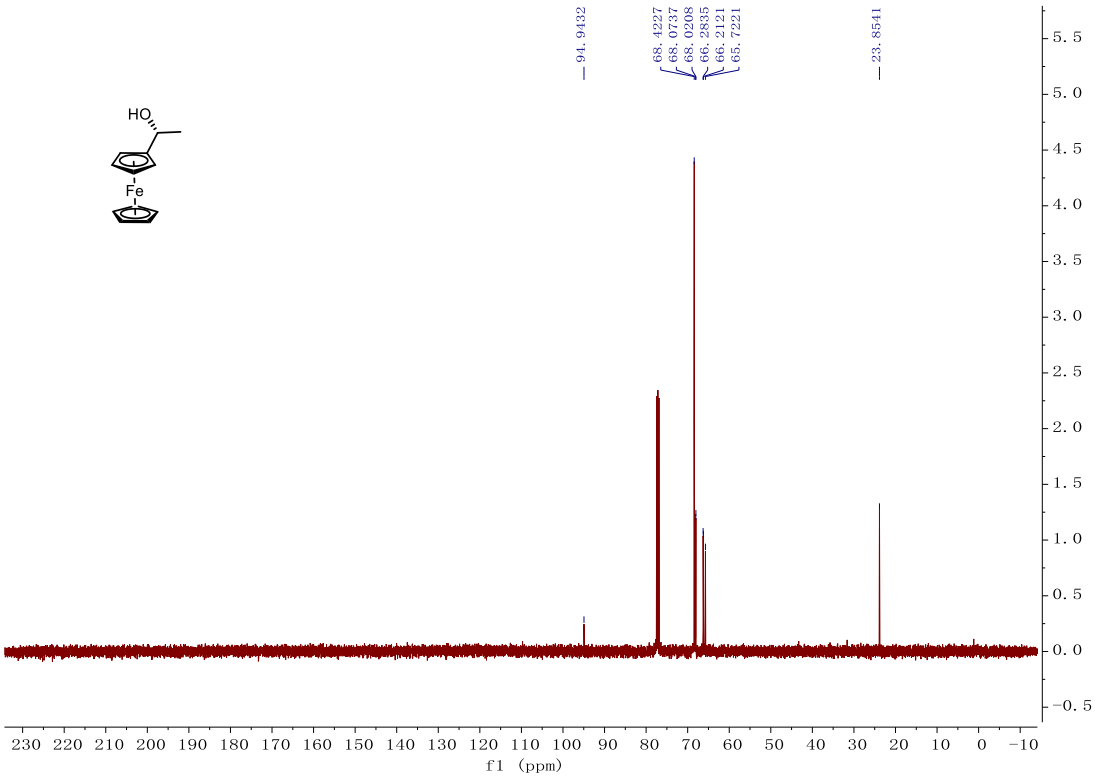
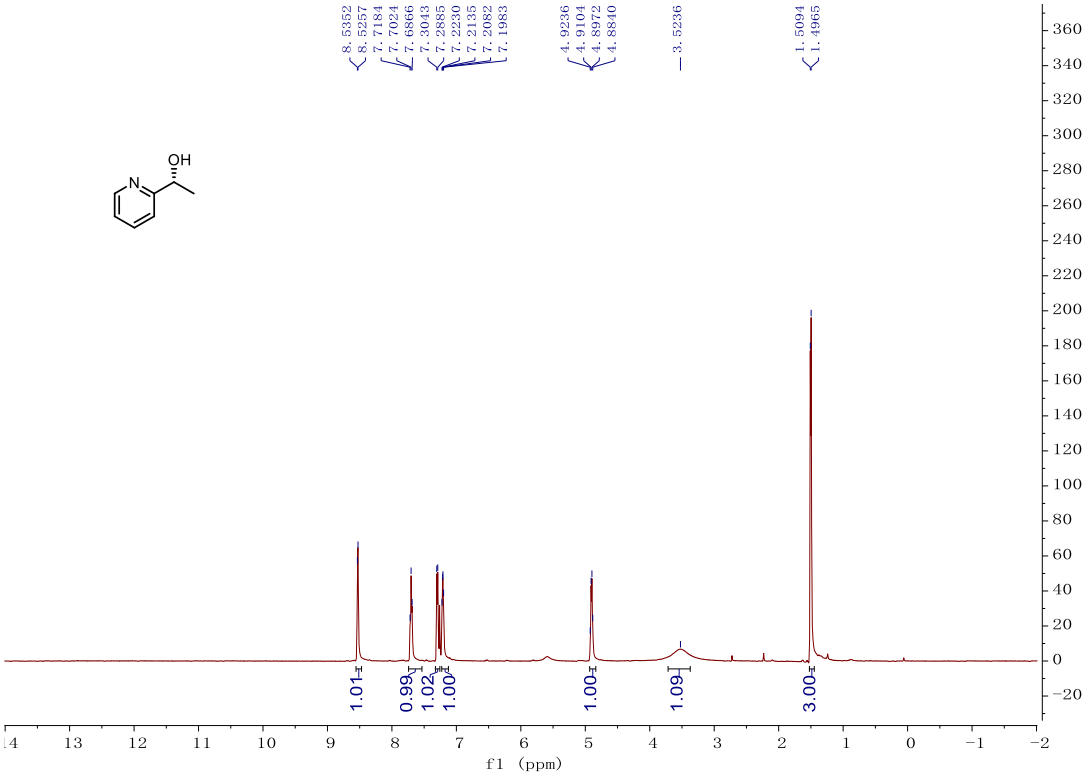
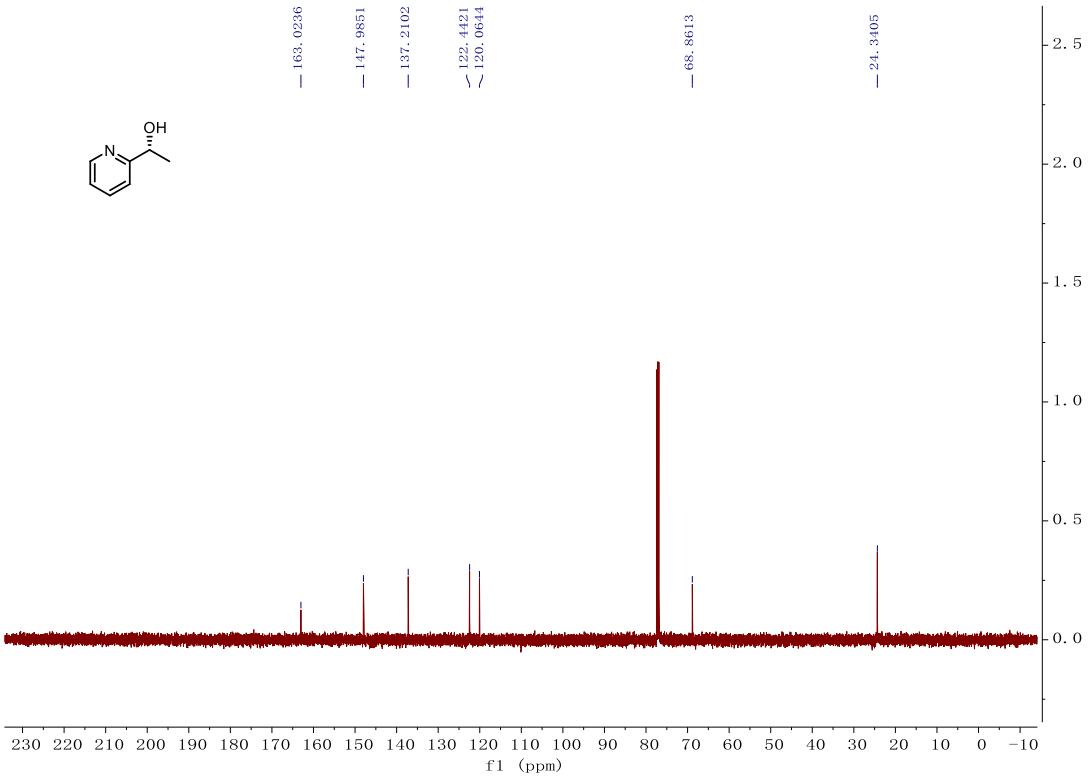


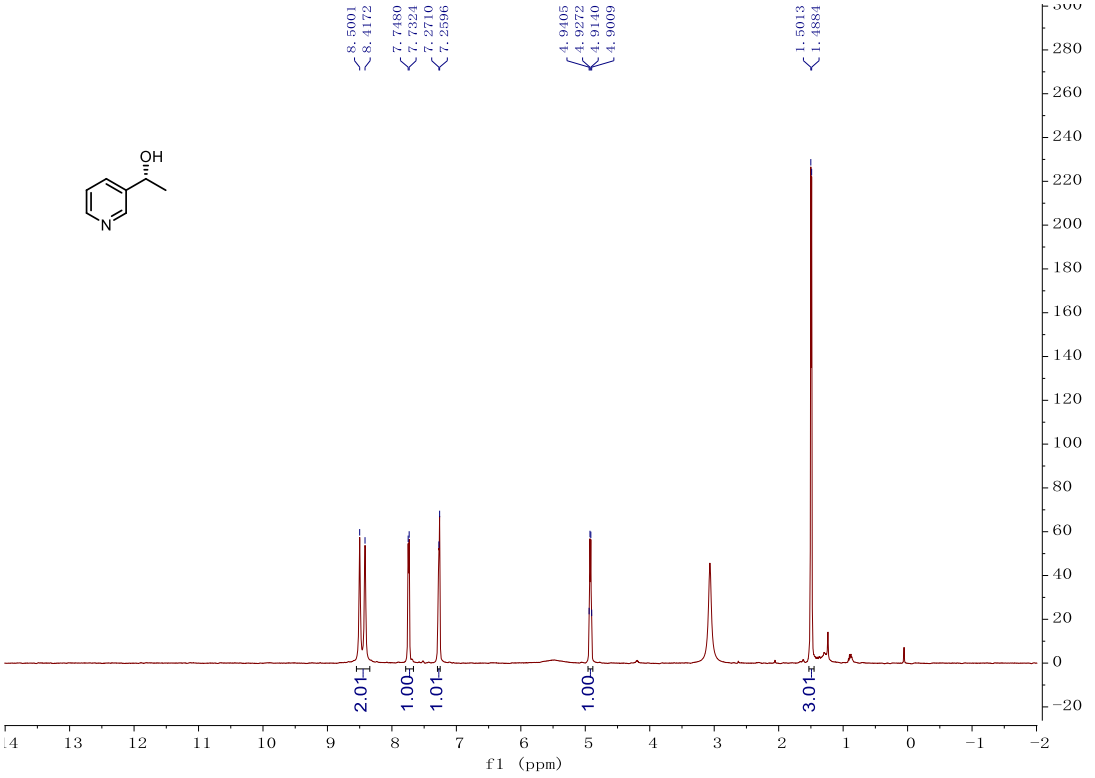
3p-^{1}H NMR (500 MHz, Chloroform-*d*)



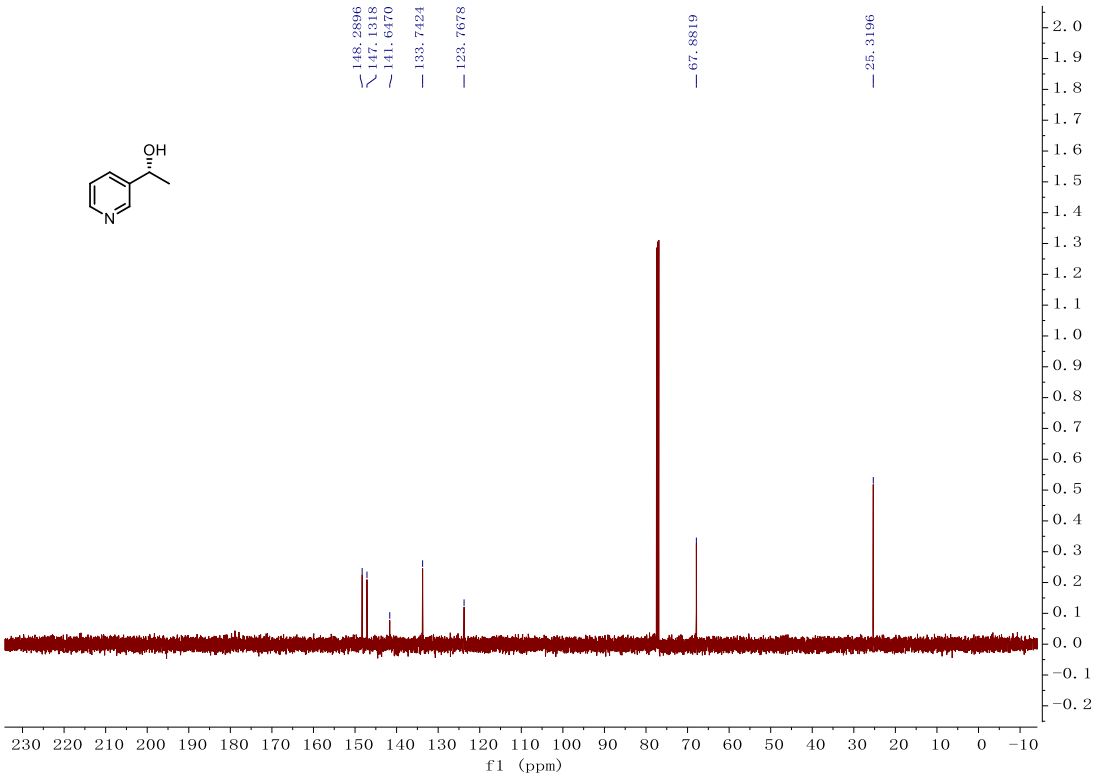
3p-^{13}C NMR (126 MHz, Chloroform-*d*)



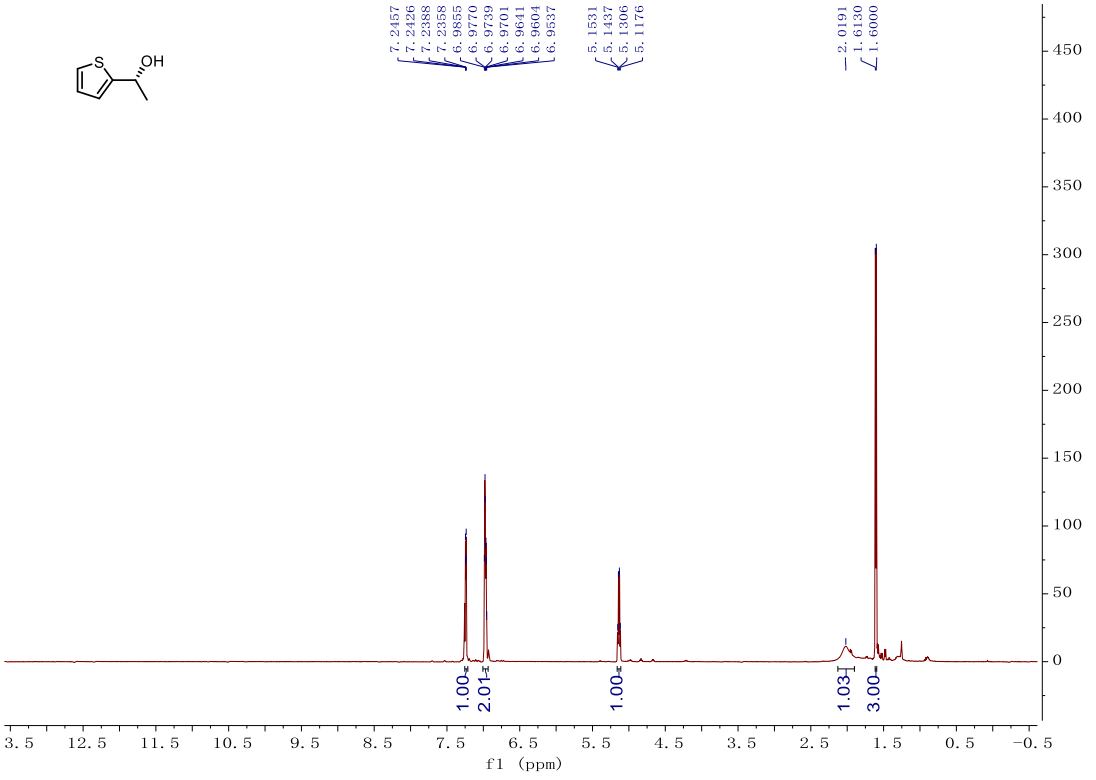
3q-^{1}H NMR (500 MHz, Chloroform-*d*)



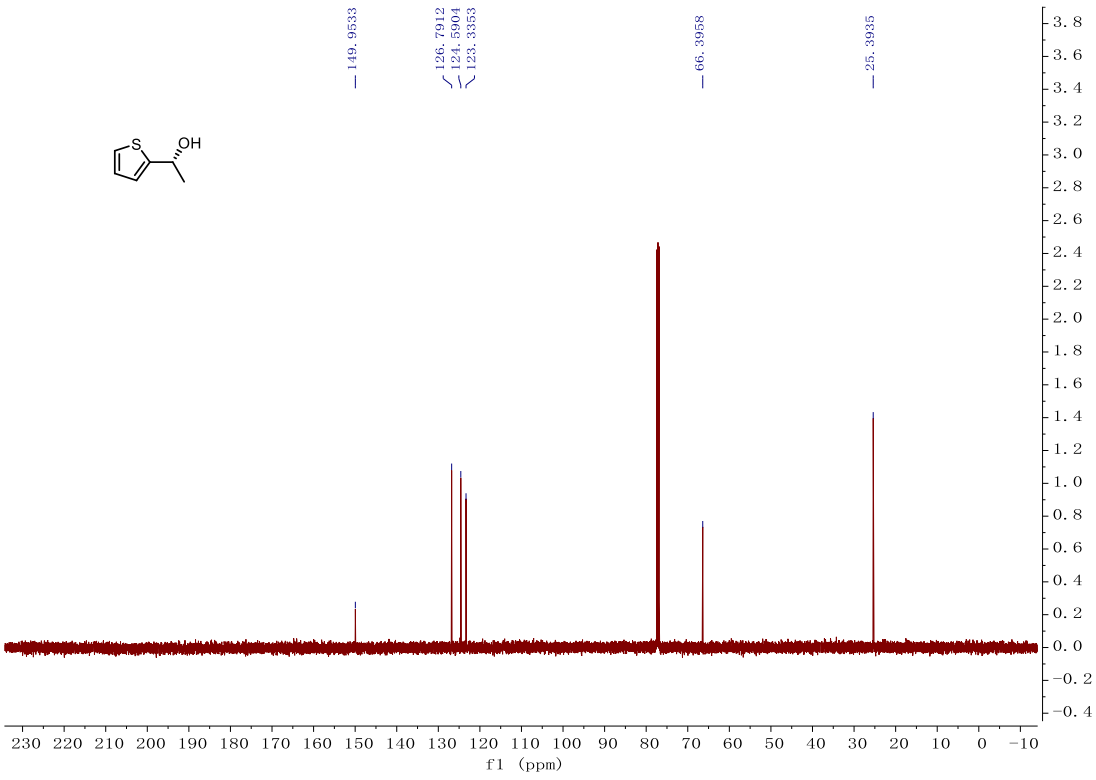
3q-^{13}C NMR (126 MHz, Chloroform-*d*)



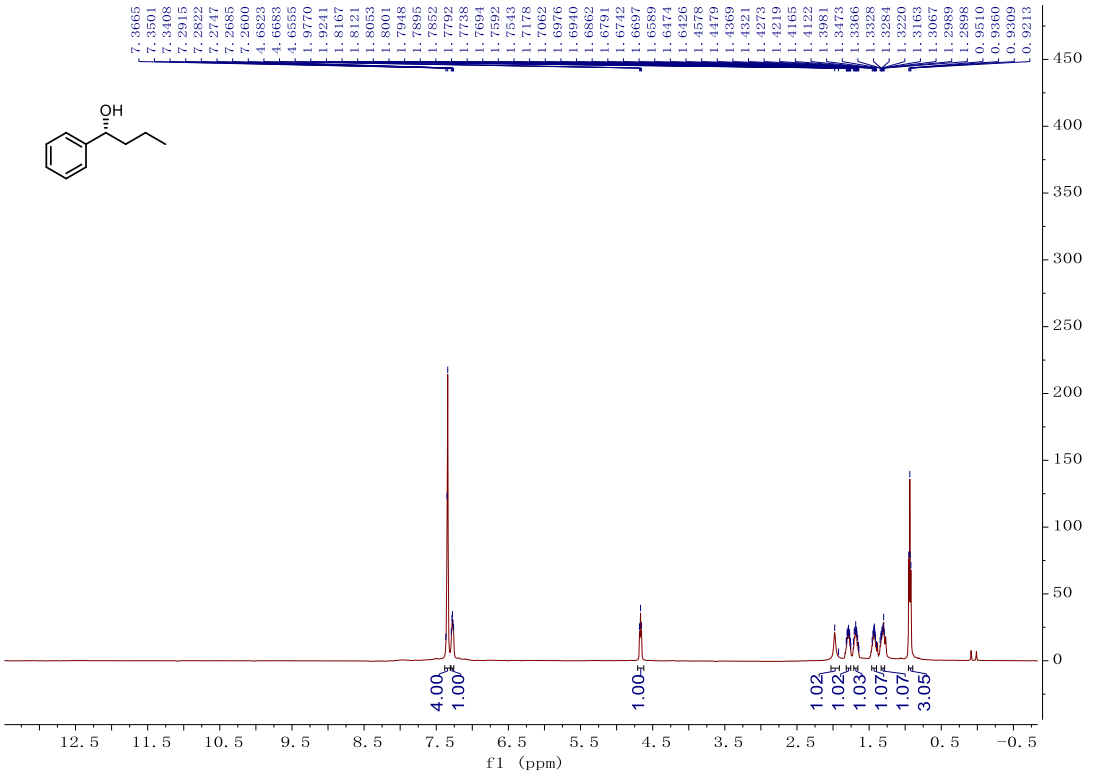
3r-^{1}H NMR (500 MHz, Chloroform-*d*)



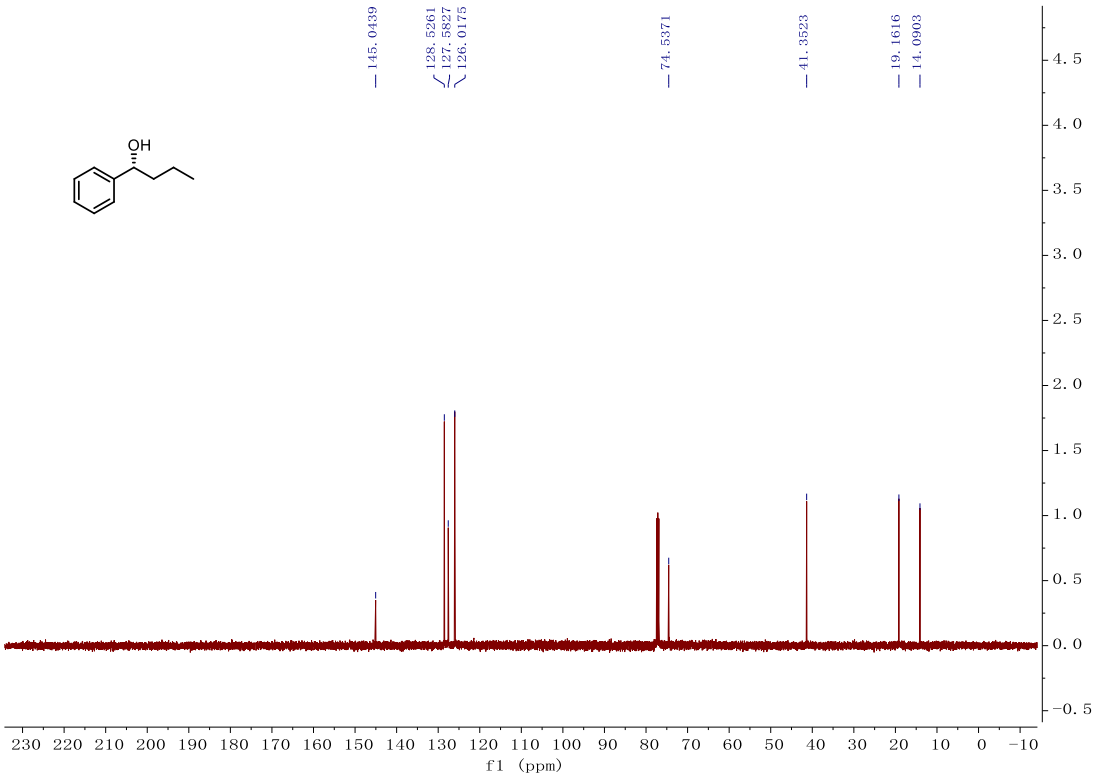
3r-^{13}C NMR (126 MHz, Chloroform-*d*)



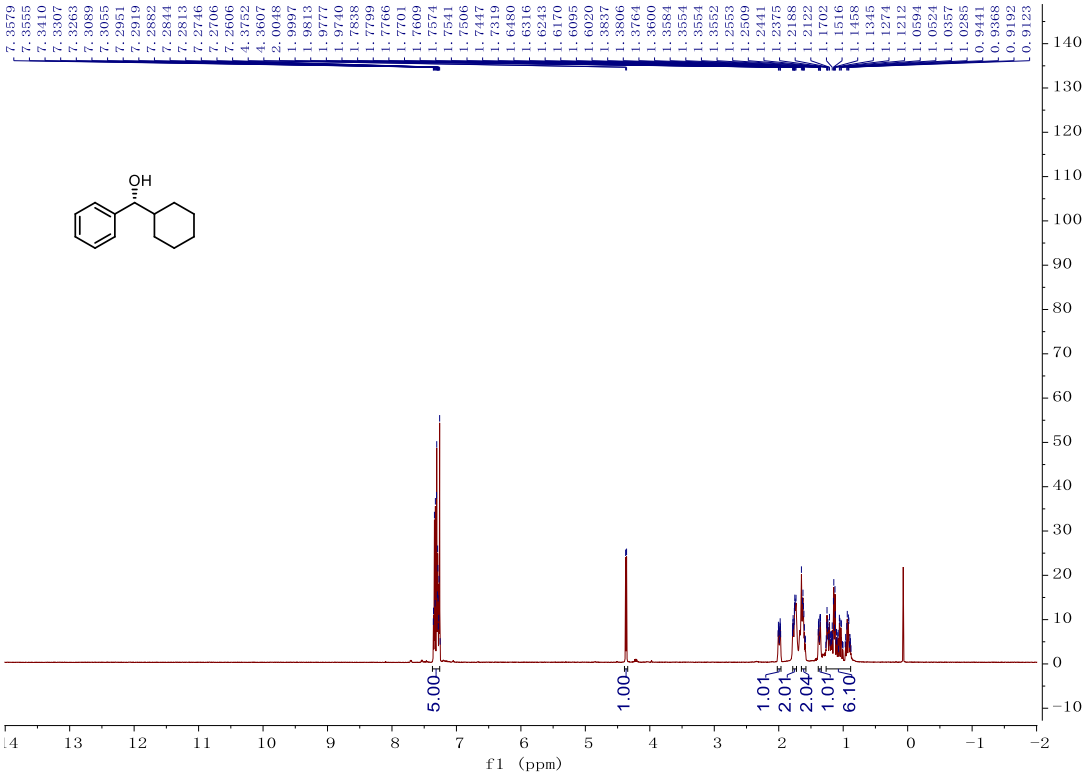
3s-^{1}H NMR (500 MHz, Chloroform-*d*)



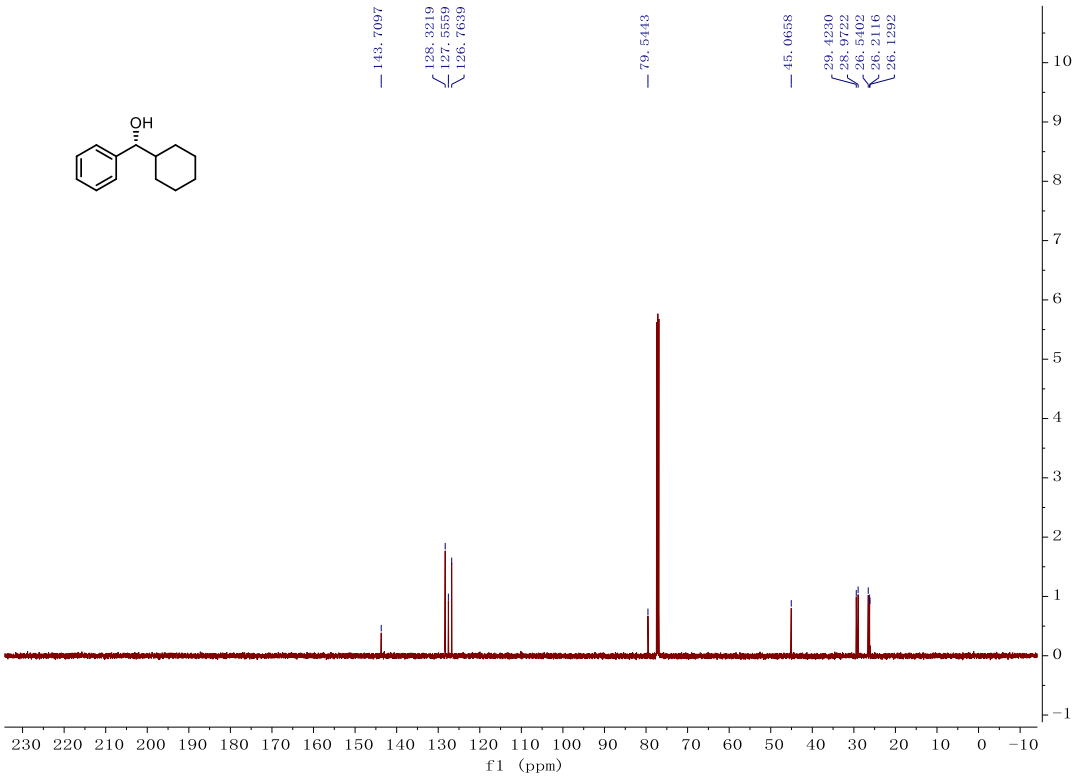
3s-^{13}C NMR (126 MHz, Chloroform-*d*)



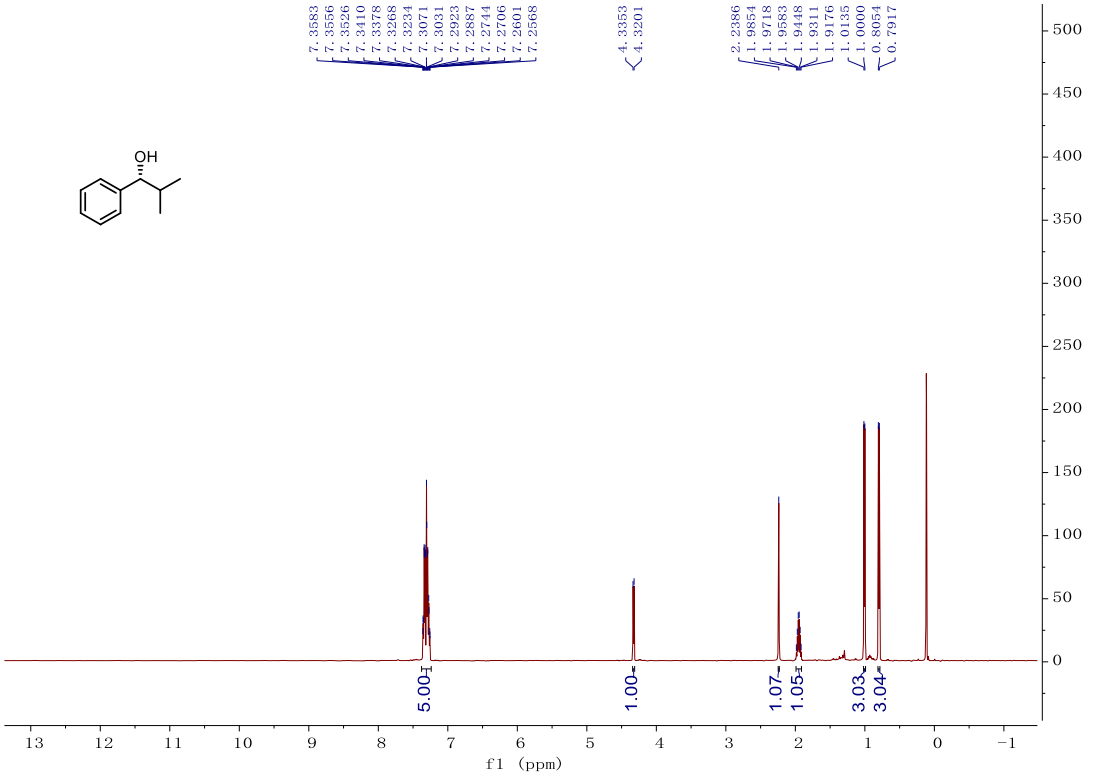
3t-^{1}H NMR (500 MHz, Chloroform-*d*)



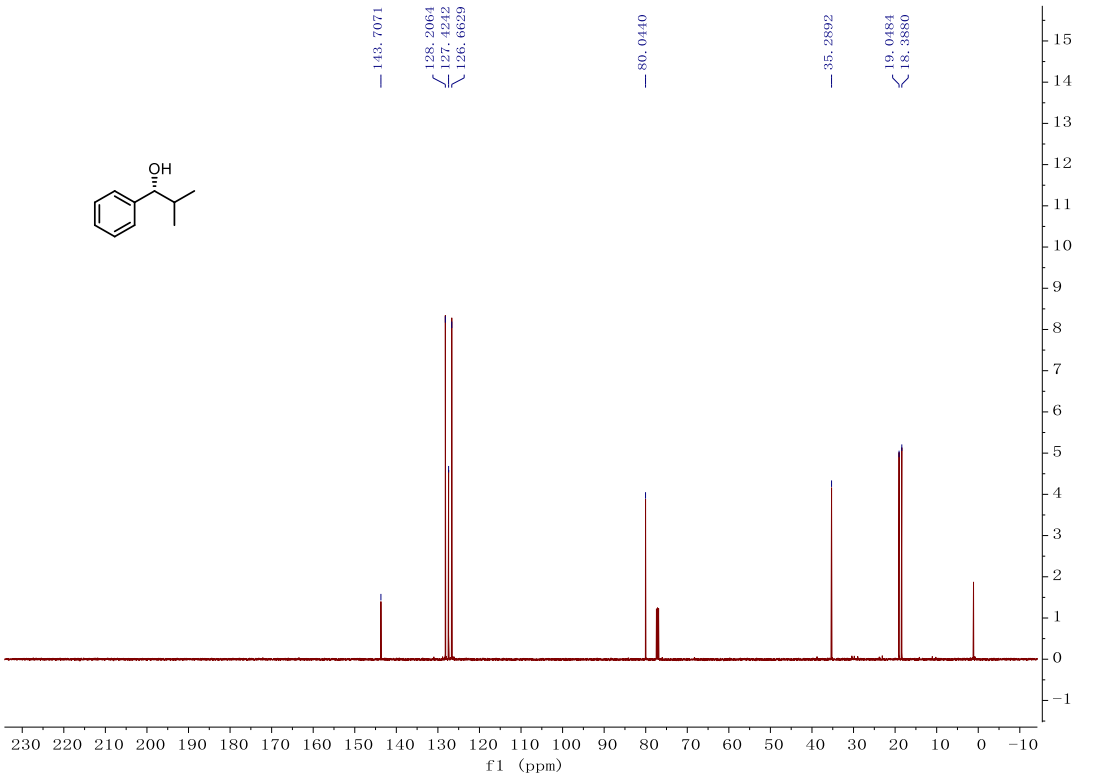
3t-^{13}C NMR (126 MHz, Chloroform-*d*)



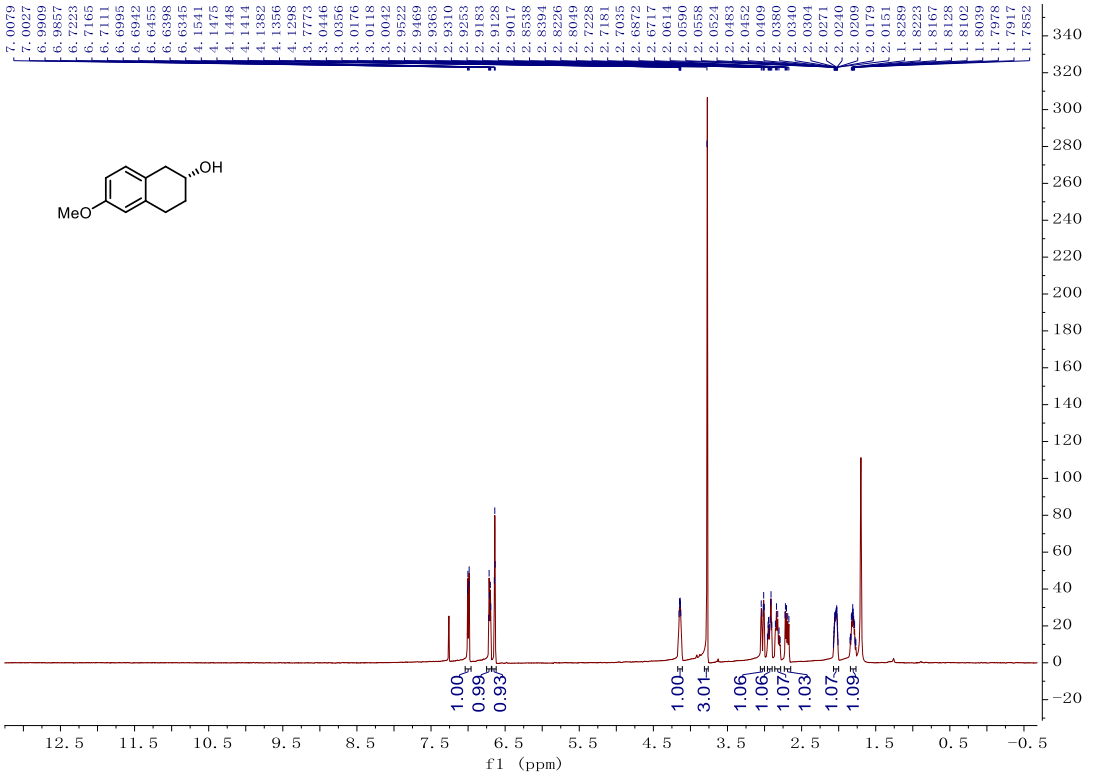
3u-^{1}H NMR (500 MHz, Chloroform-*d*)



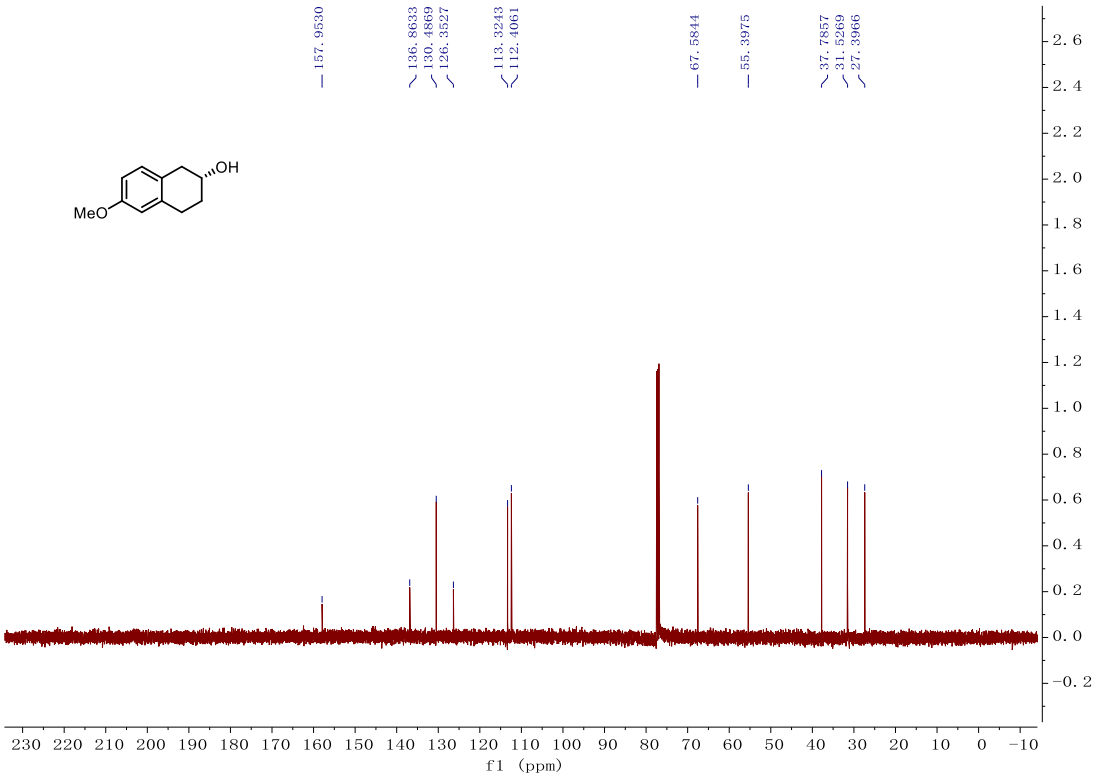
3u-^{13}C NMR (126 MHz, Chloroform-*d*)



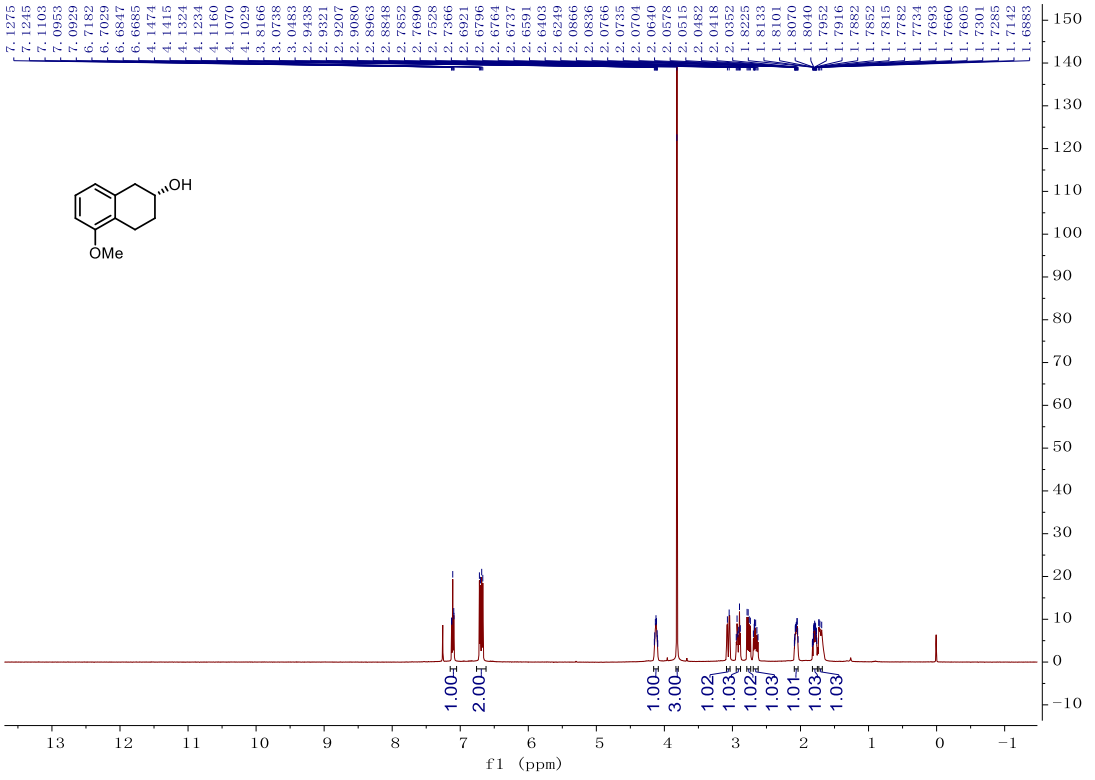
5a-^{1}H NMR (500 MHz, Chloroform-*d*)



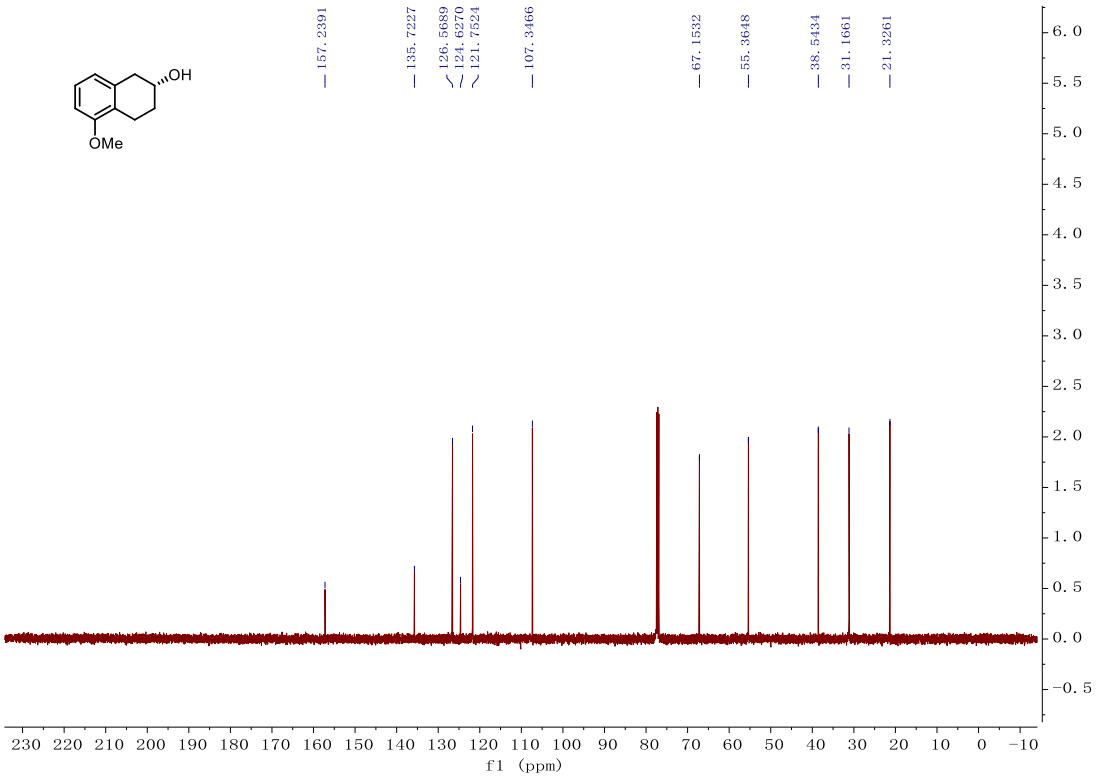
5a-^{13}C NMR (126 MHz, Chloroform-*d*)



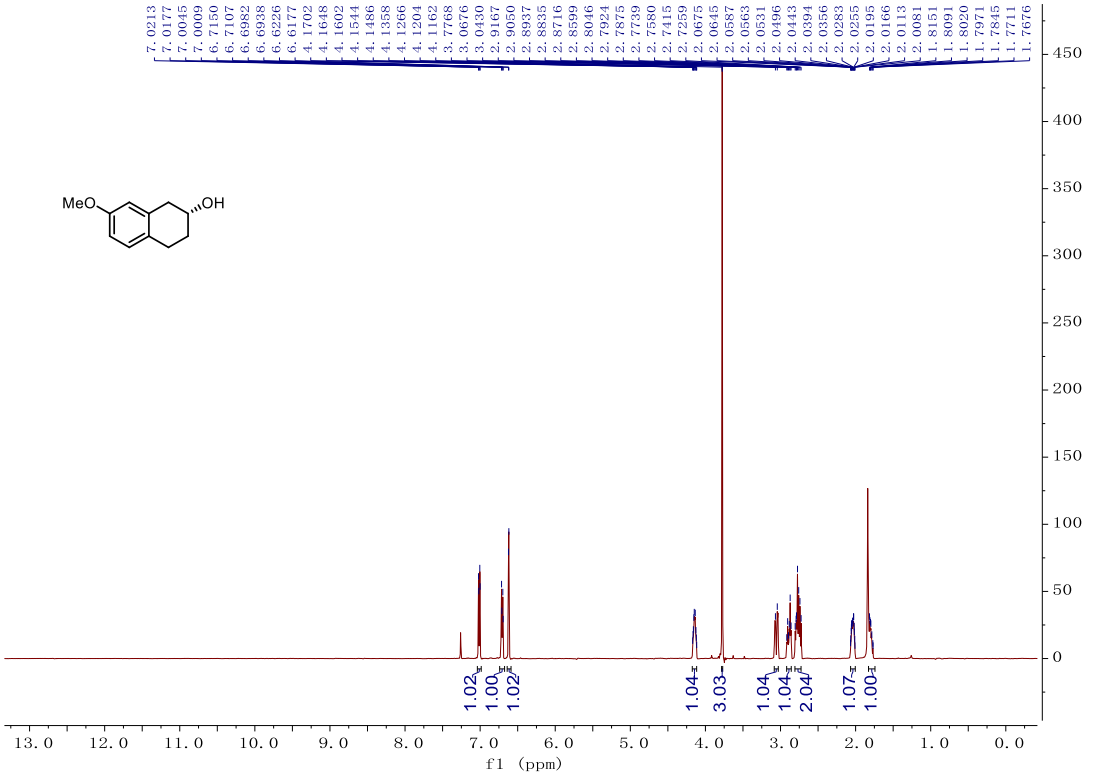
5b-^{1}H NMR (500 MHz, Chloroform-*d*)



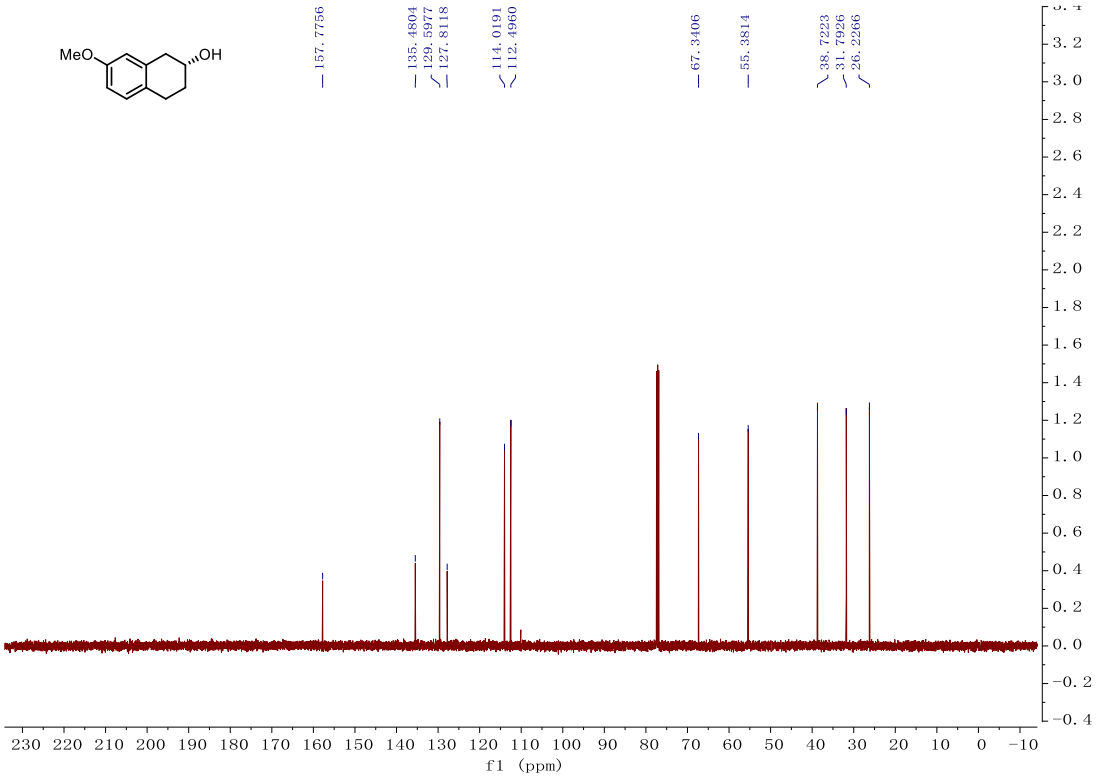
5b-^{13}C NMR (126 MHz, Chloroform-*d*)



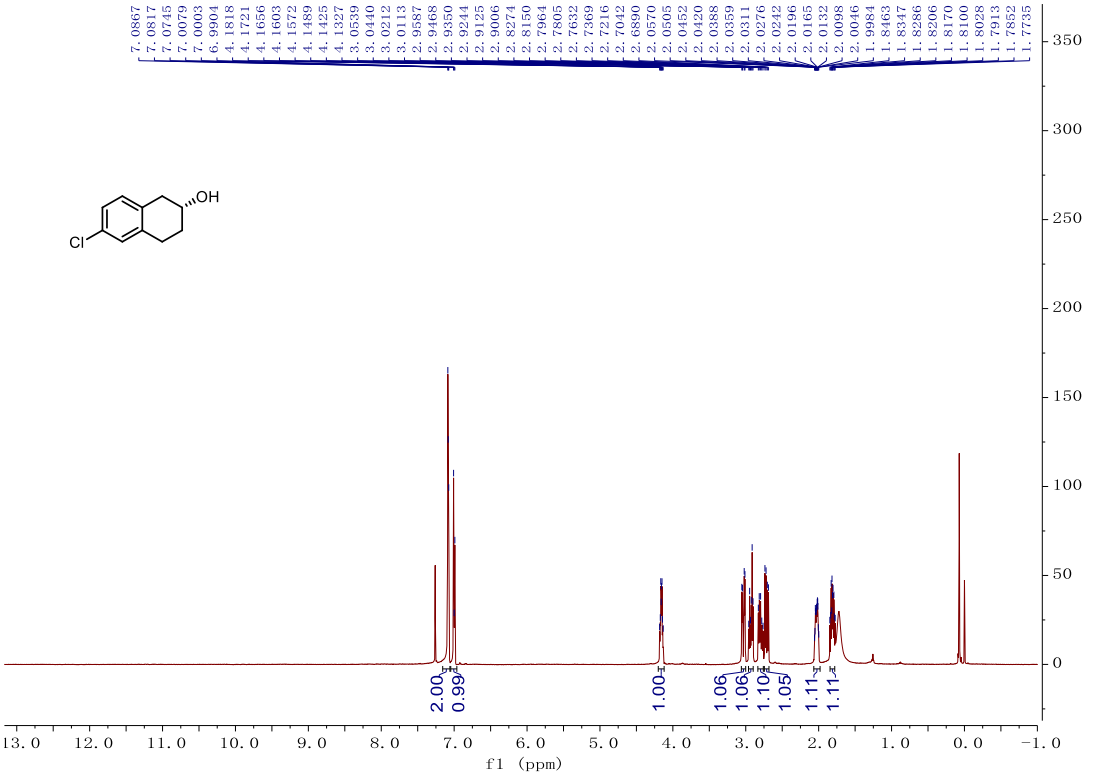
5c-^{1}H NMR (500 MHz, Chloroform-*d*)



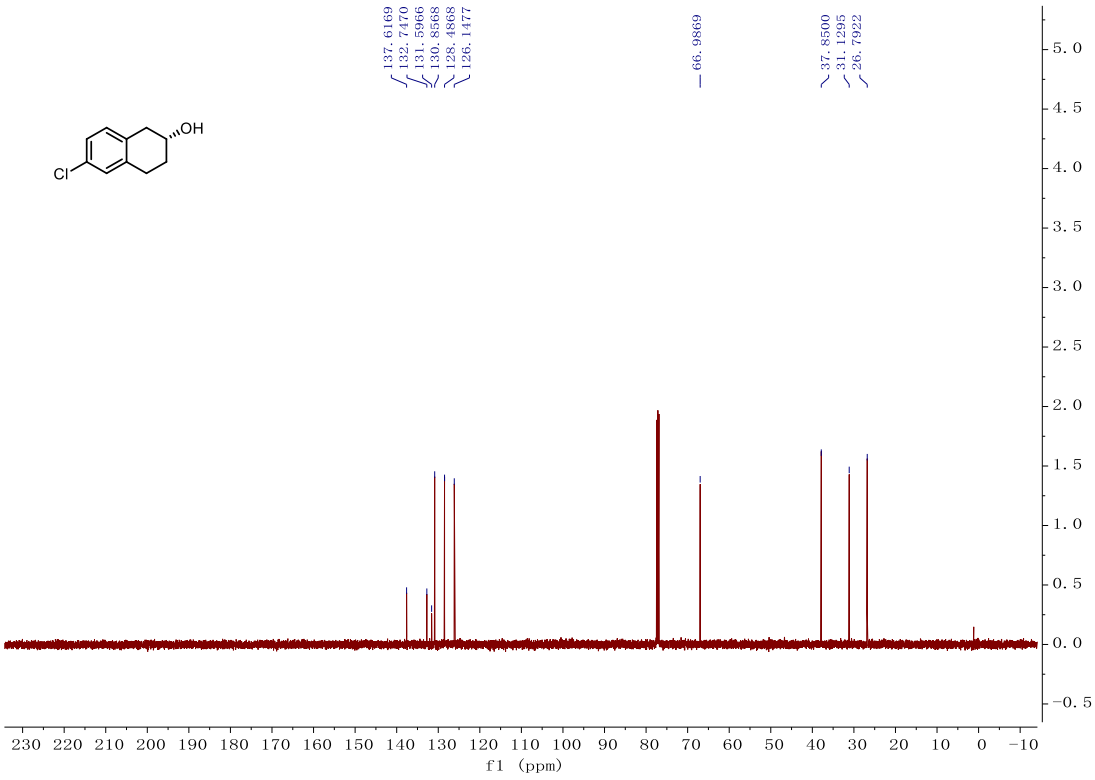
5c-^{13}C NMR (126 MHz, Chloroform-*d*)



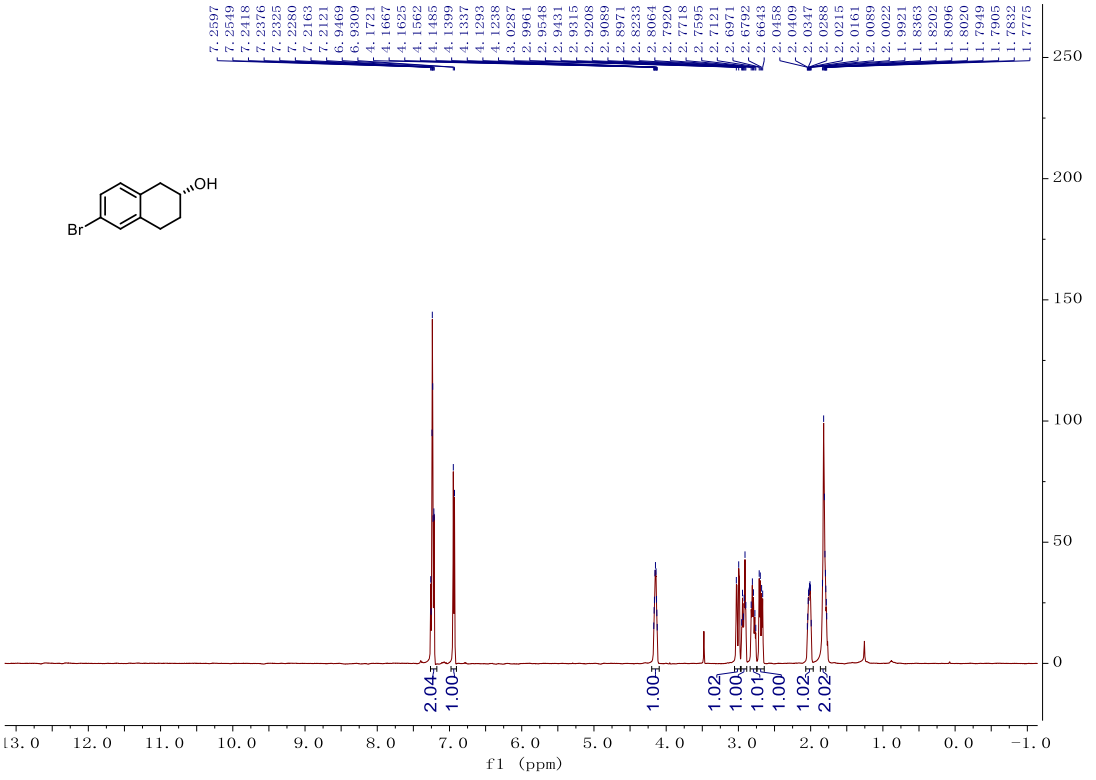
5d-^{1}H NMR (500 MHz, Chloroform-*d*)



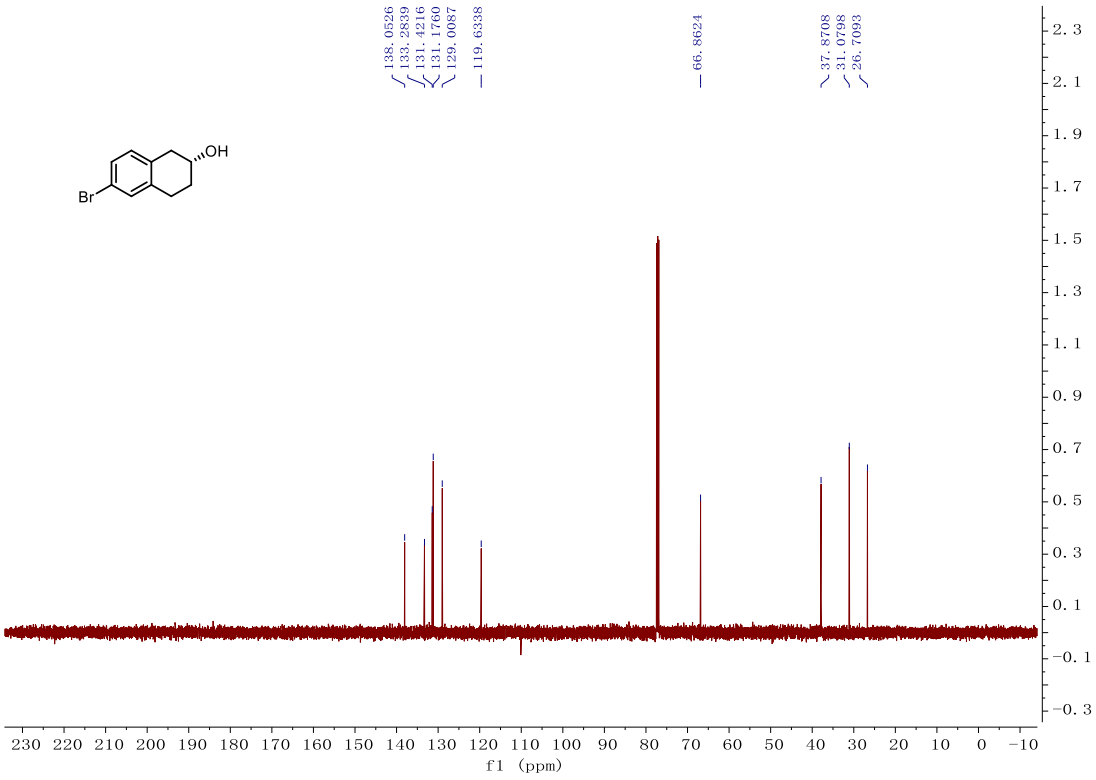
5d-^{13}C NMR (126 MHz, Chloroform-*d*)



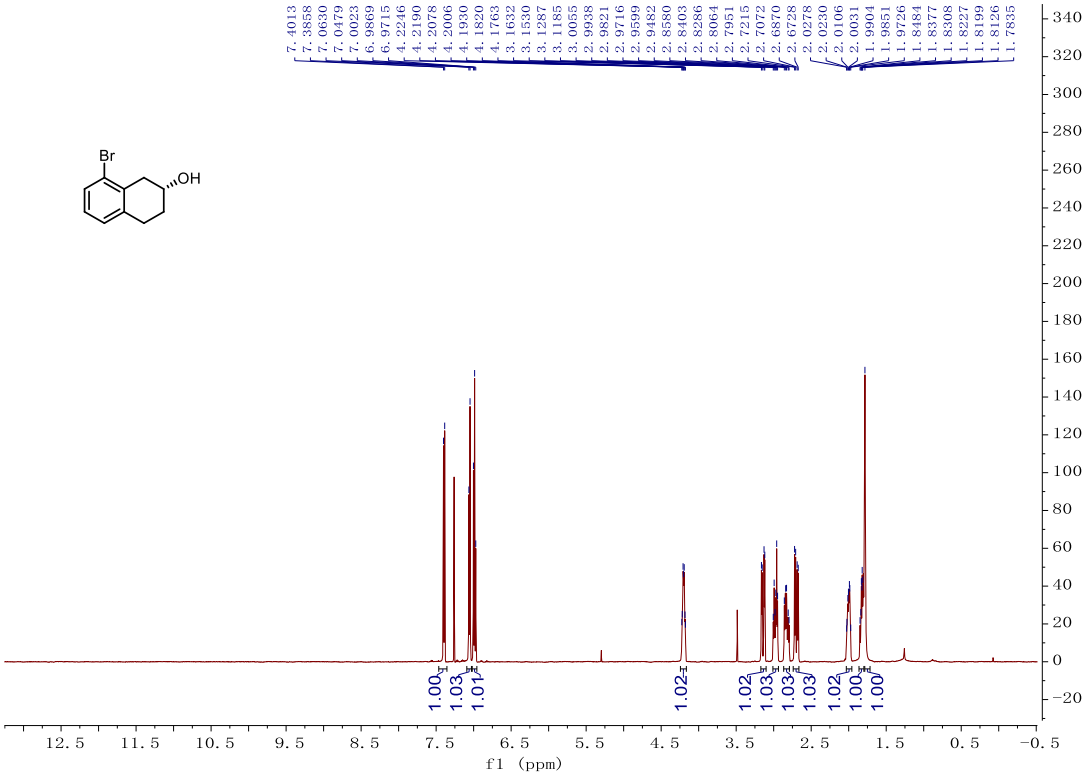
5e-^{1}H NMR (500 MHz, Chloroform-*d*)



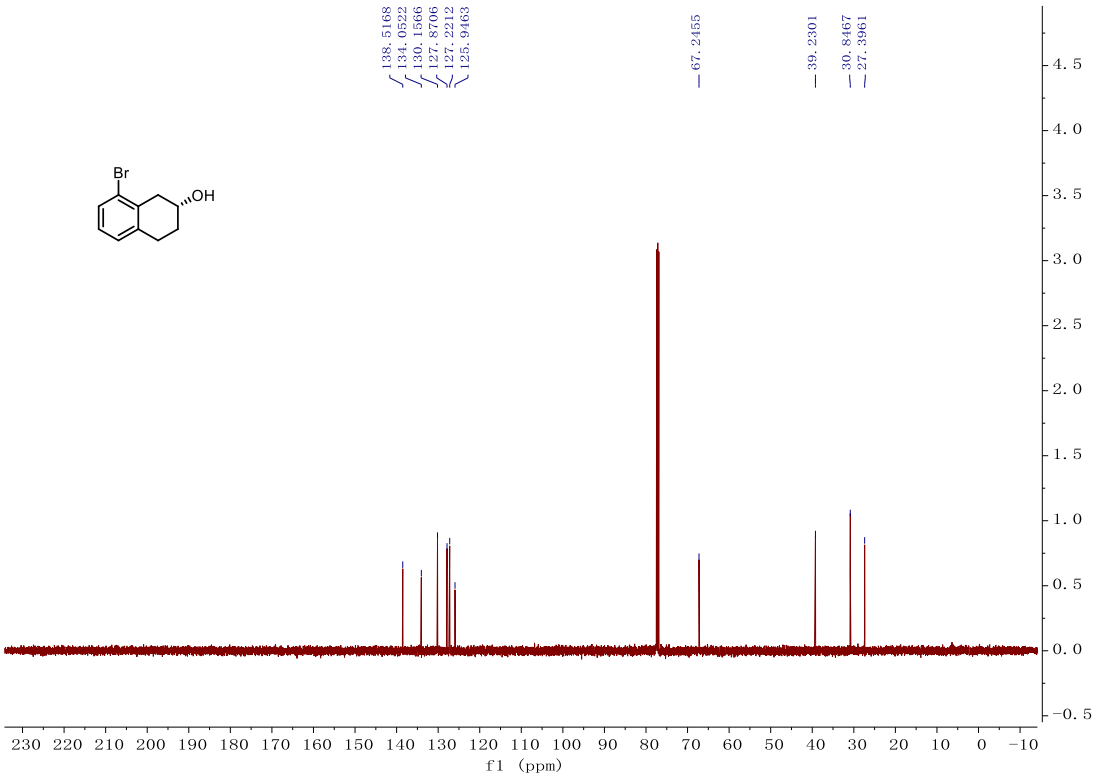
5e-^{13}C NMR (126 MHz, Chloroform-*d*)



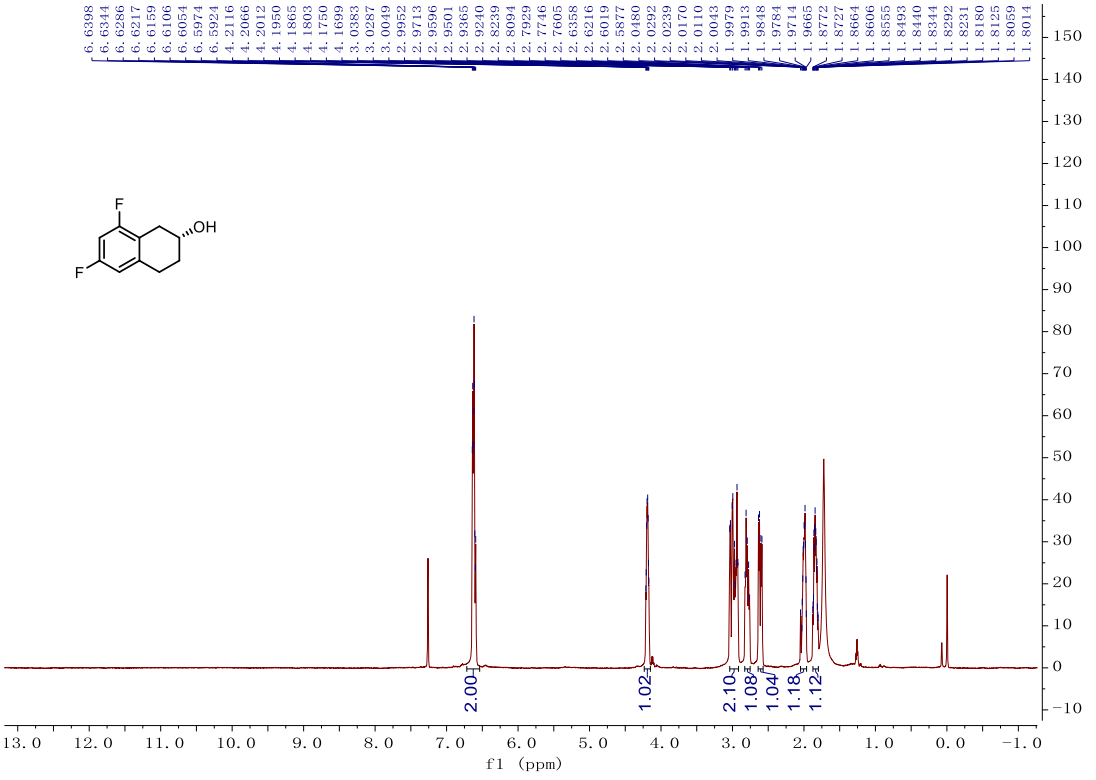
5f-^{1}H NMR (500 MHz, Chloroform-*d*)



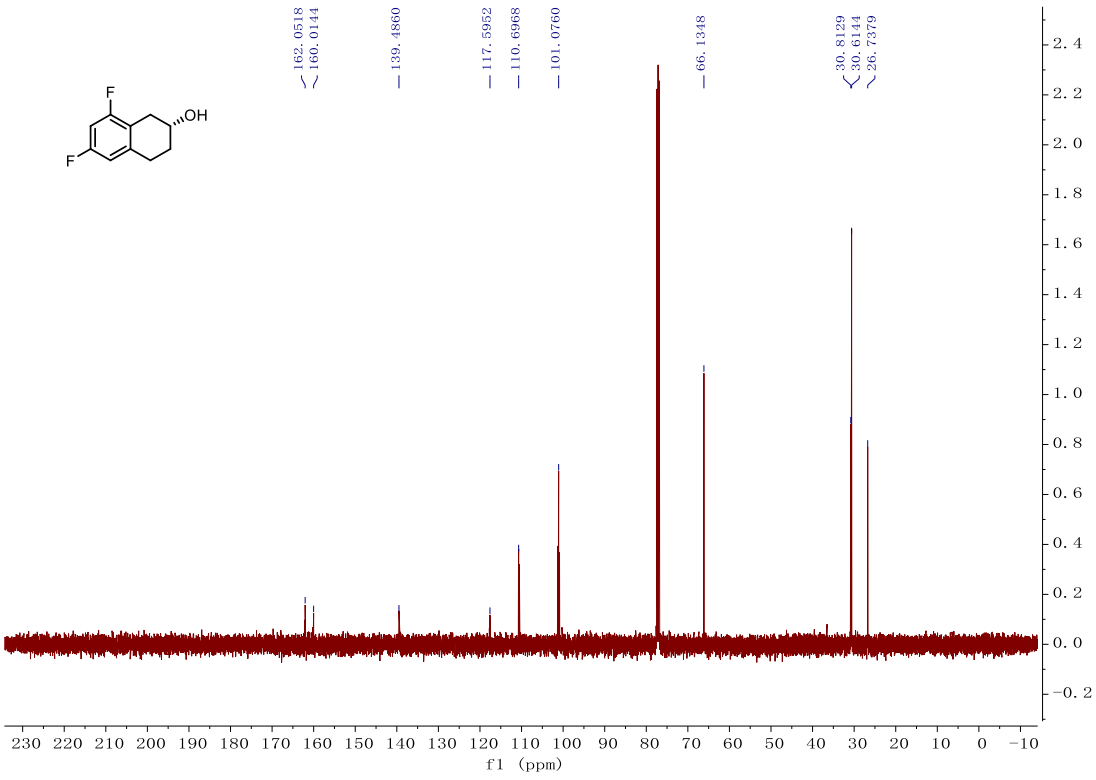
5f-^{13}C NMR (126 MHz, Chloroform-*d*)



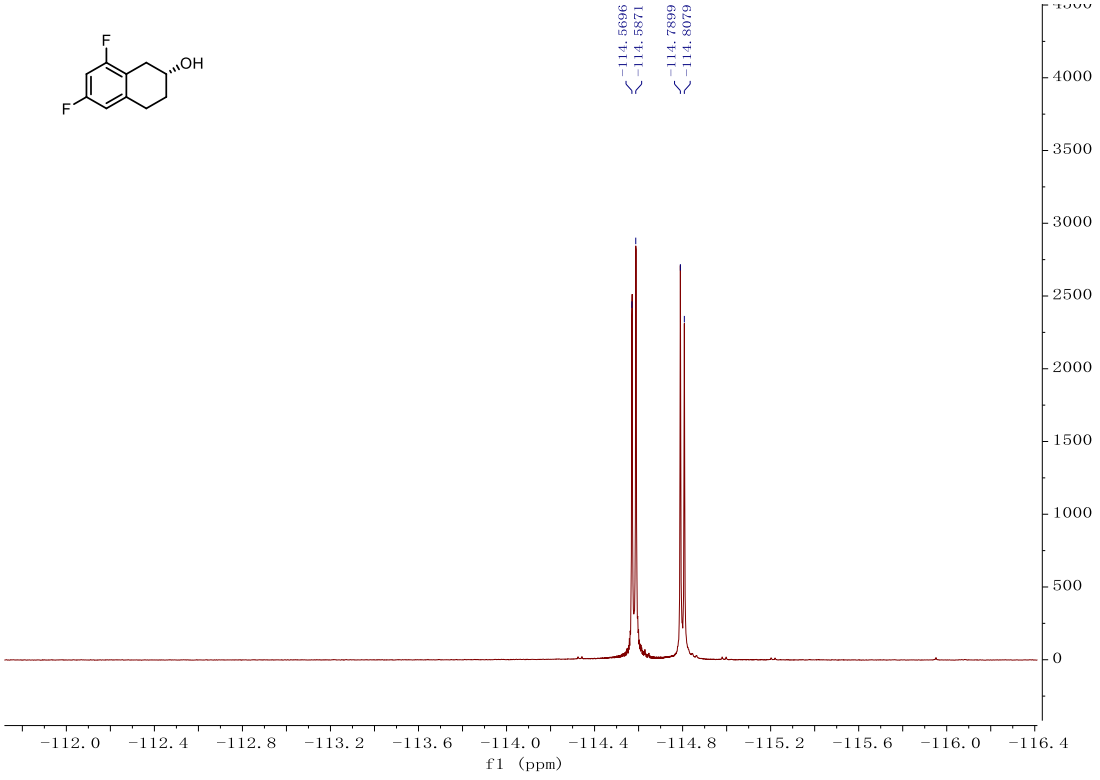
5g-^{1}H NMR (500 MHz, Chloroform-*d*)



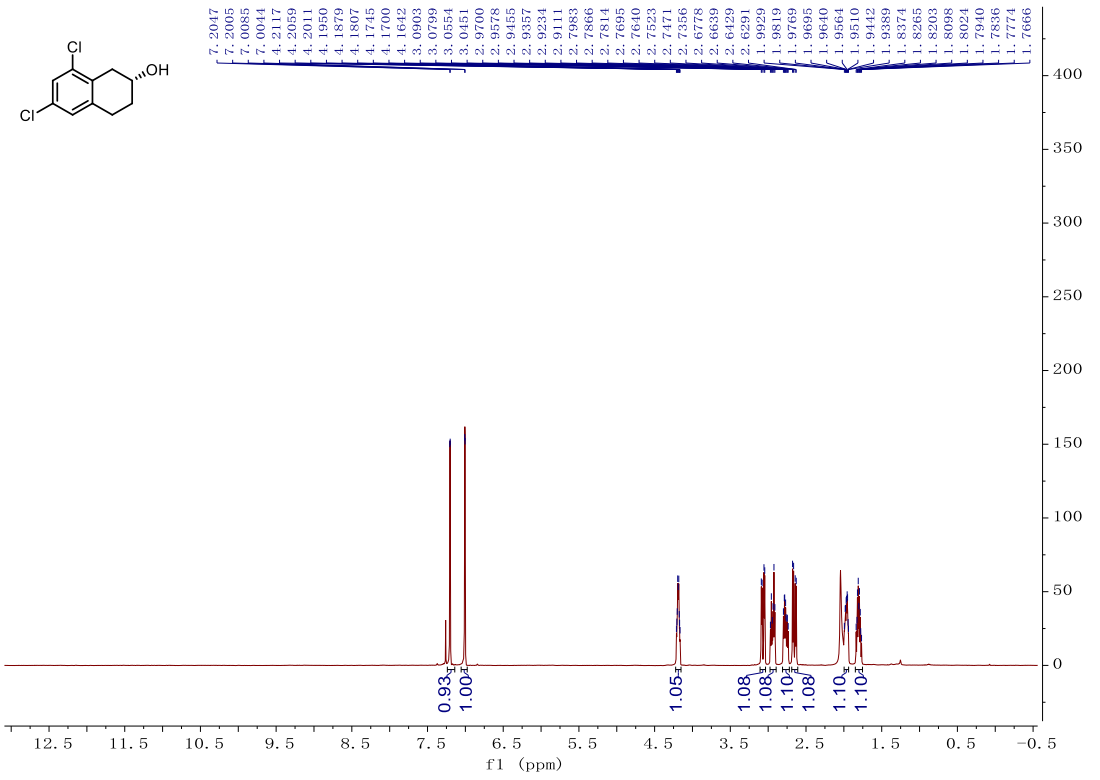
5g-^{13}C NMR (126 MHz, Chloroform-*d*)



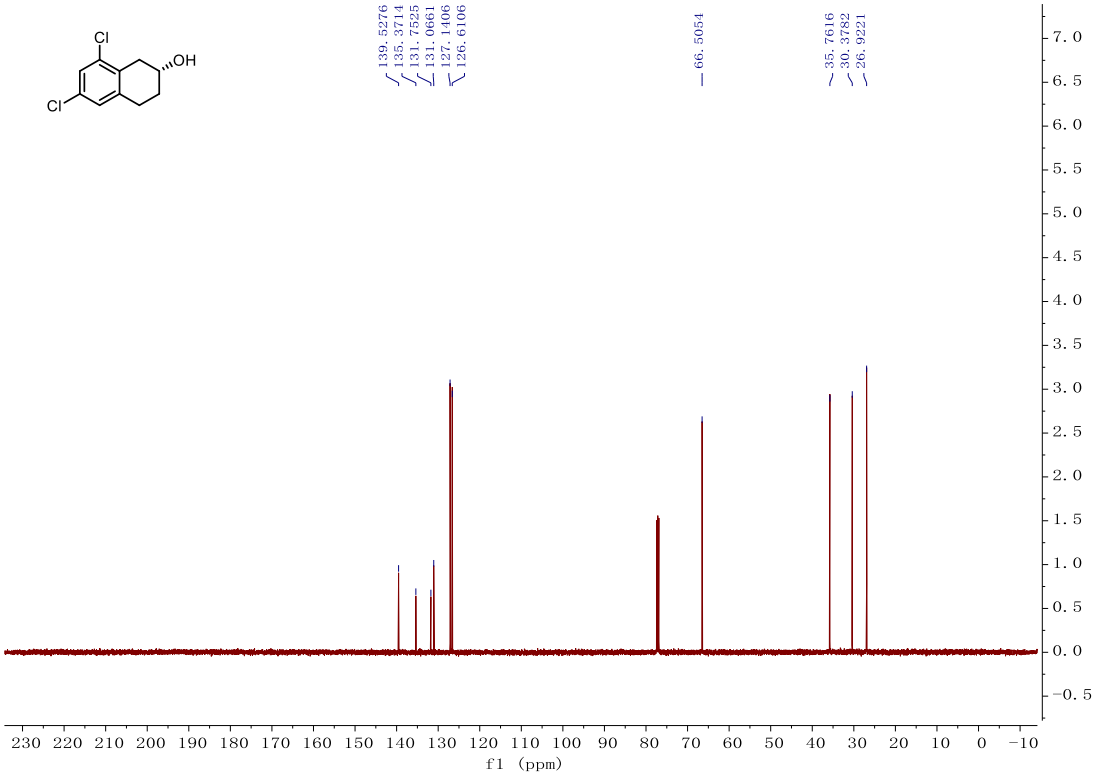
5g-^{19}F NMR (376 MHz, Chloroform-*d*)



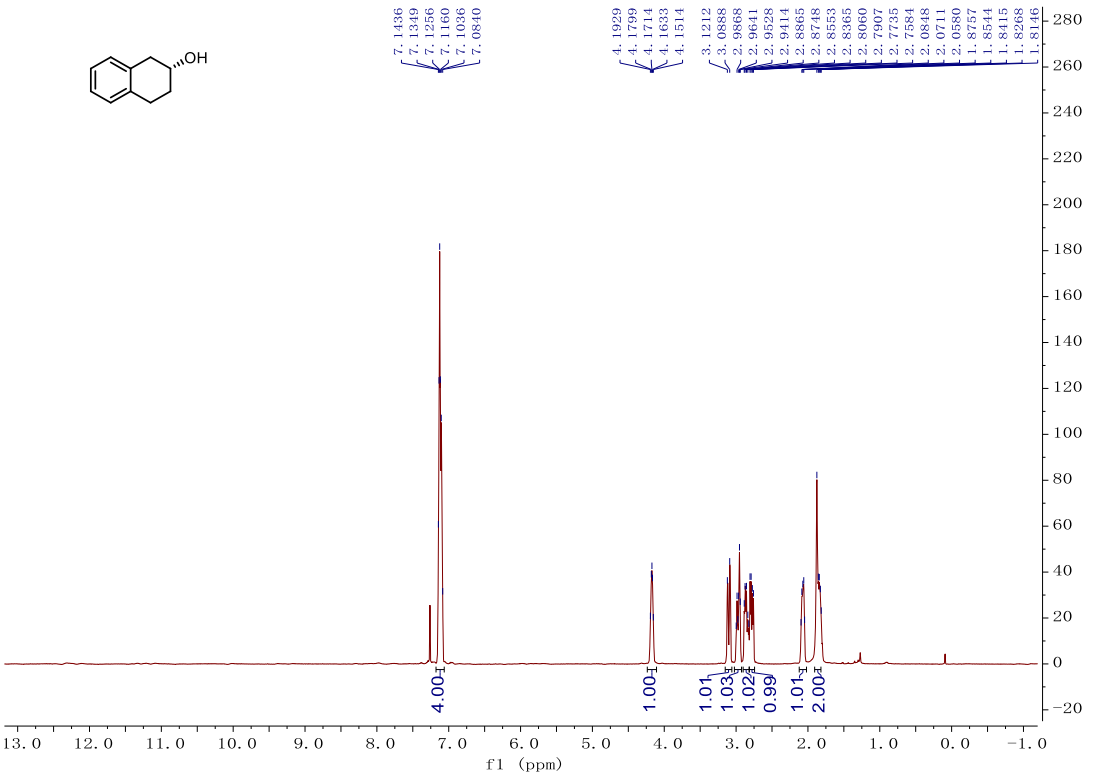
5h-^{1}H NMR (500 MHz, Chloroform-*d*)



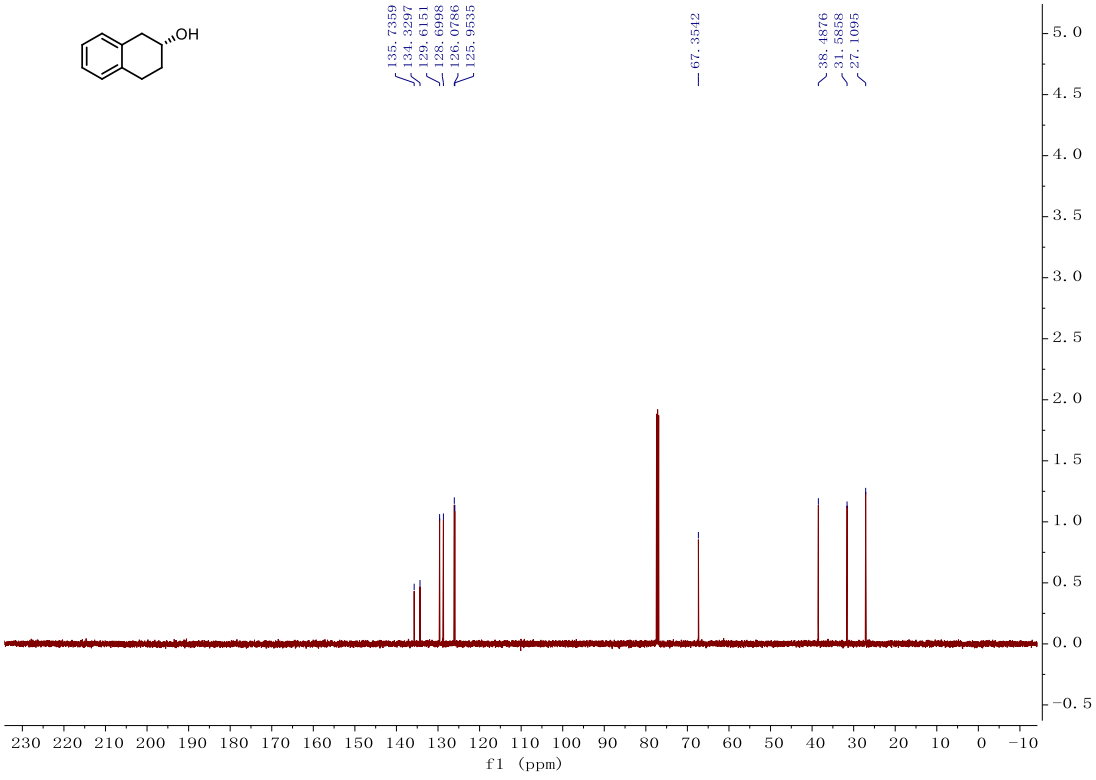
5h-^{13}C NMR (126 MHz, Chloroform-*d*)



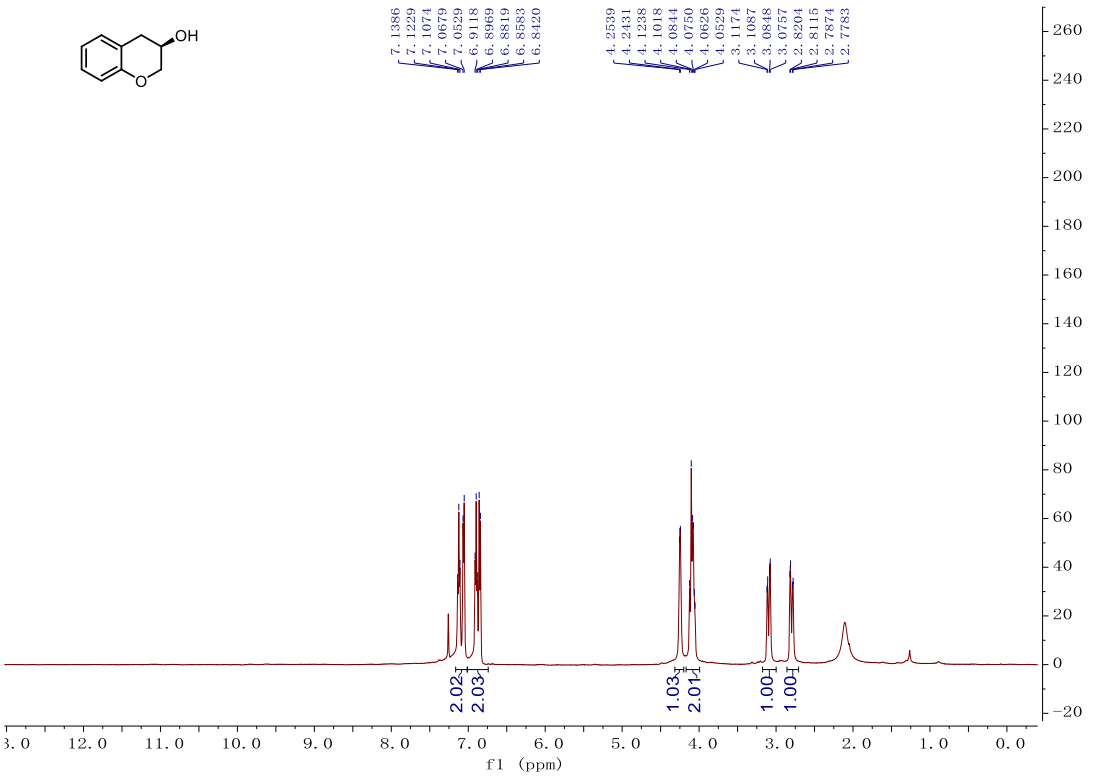
5i-^{1}H NMR (500 MHz, Chloroform-*d*)



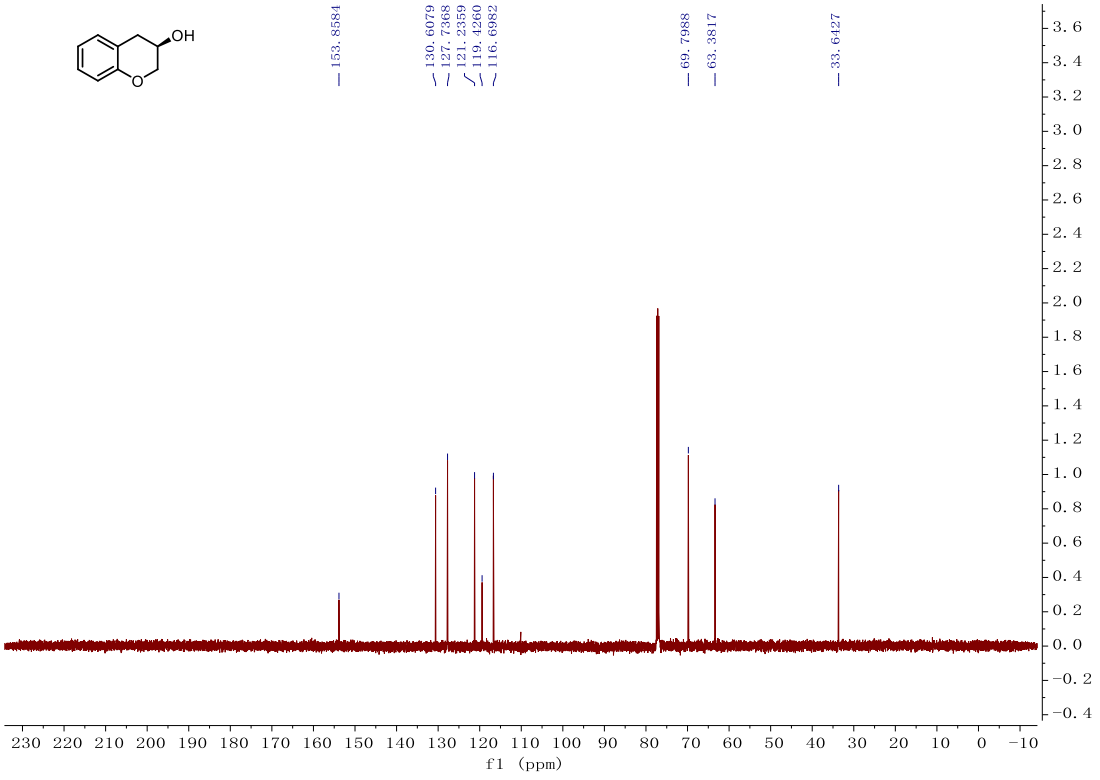
5i-^{13}C NMR (126 MHz, Chloroform-*d*)



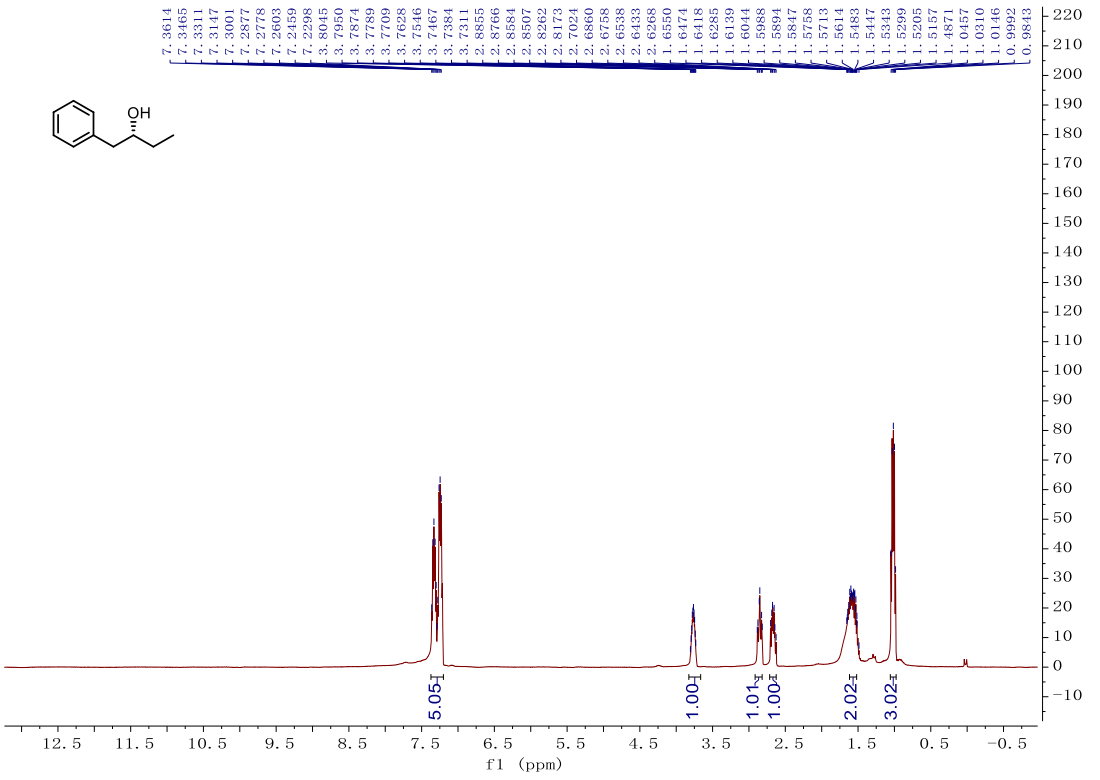
5j-^{1}H NMR (500 MHz, Chloroform-*d*)



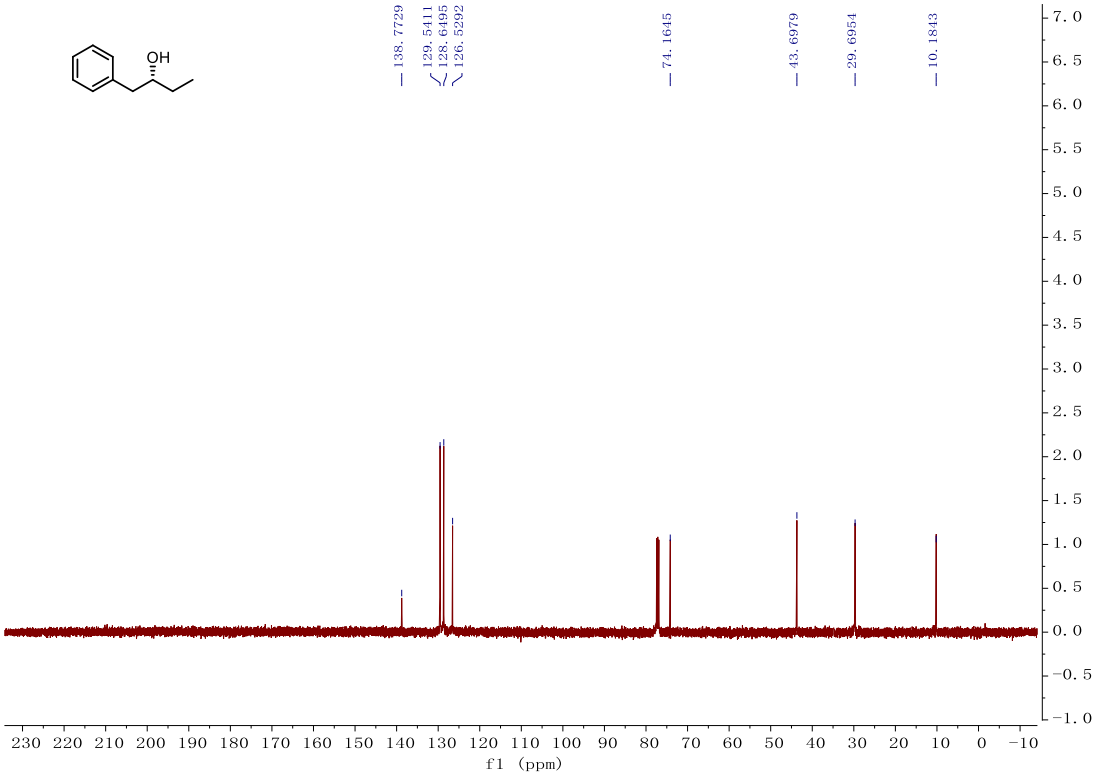
5j-^{13}C NMR (126 MHz, Chloroform-*d*)



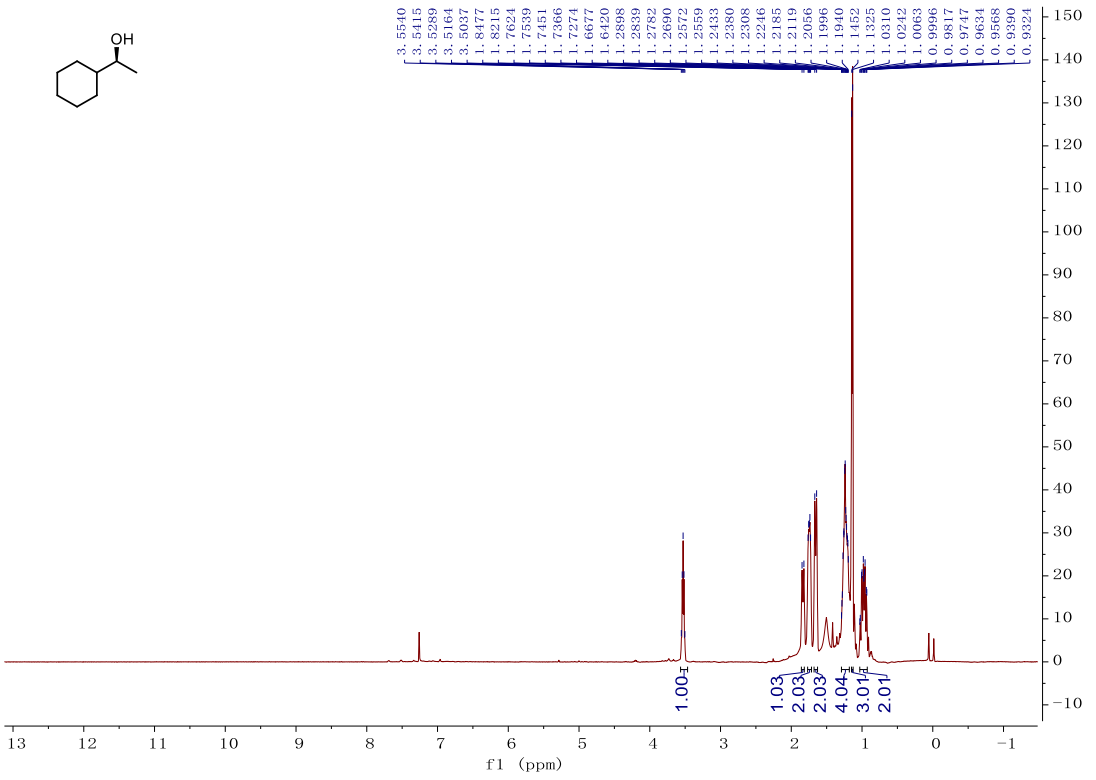
5k-^{1}H NMR (500 MHz, Chloroform-*d*)



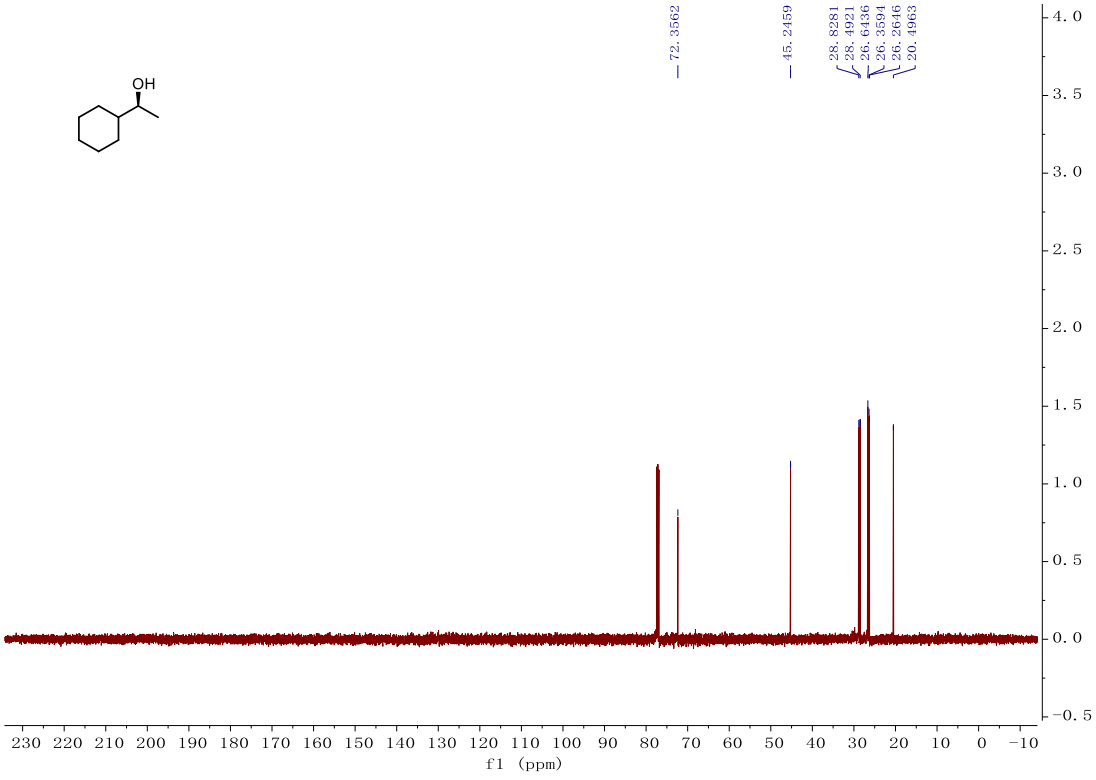
5k-^{13}C NMR (126 MHz, Chloroform-*d*)



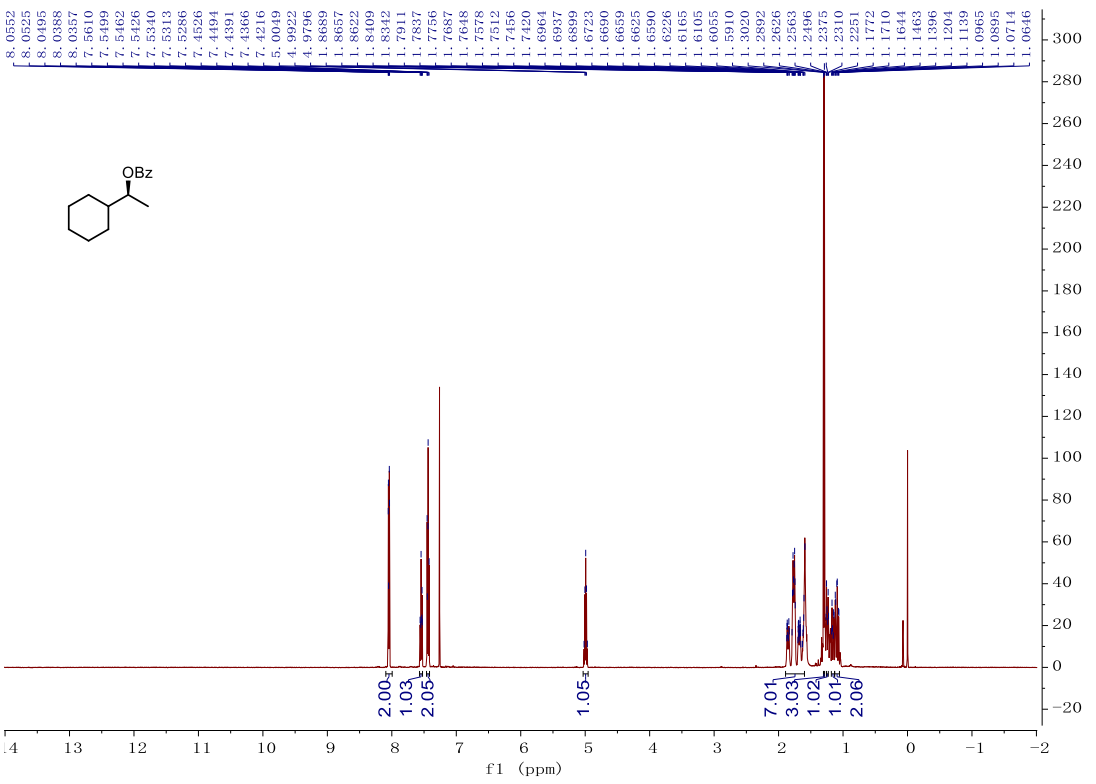
5l-^{1}H NMR (500 MHz, Chloroform-*d*)



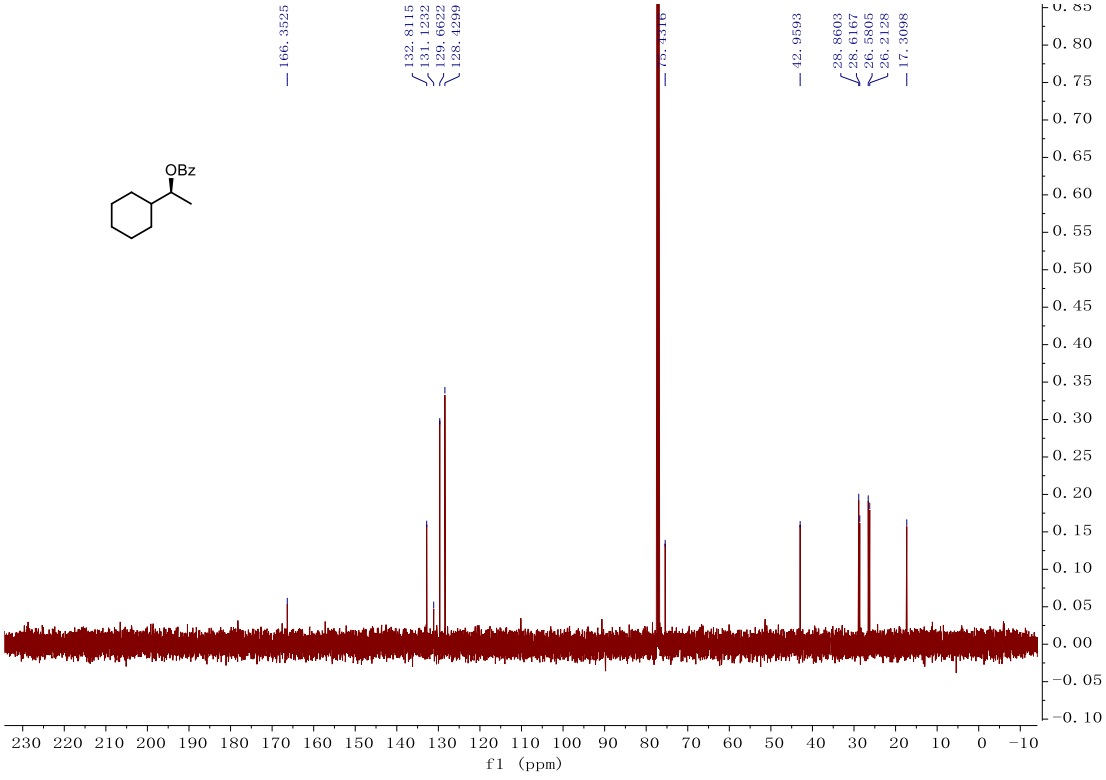
5l-^{13}C NMR (126 MHz, Chloroform-*d*)



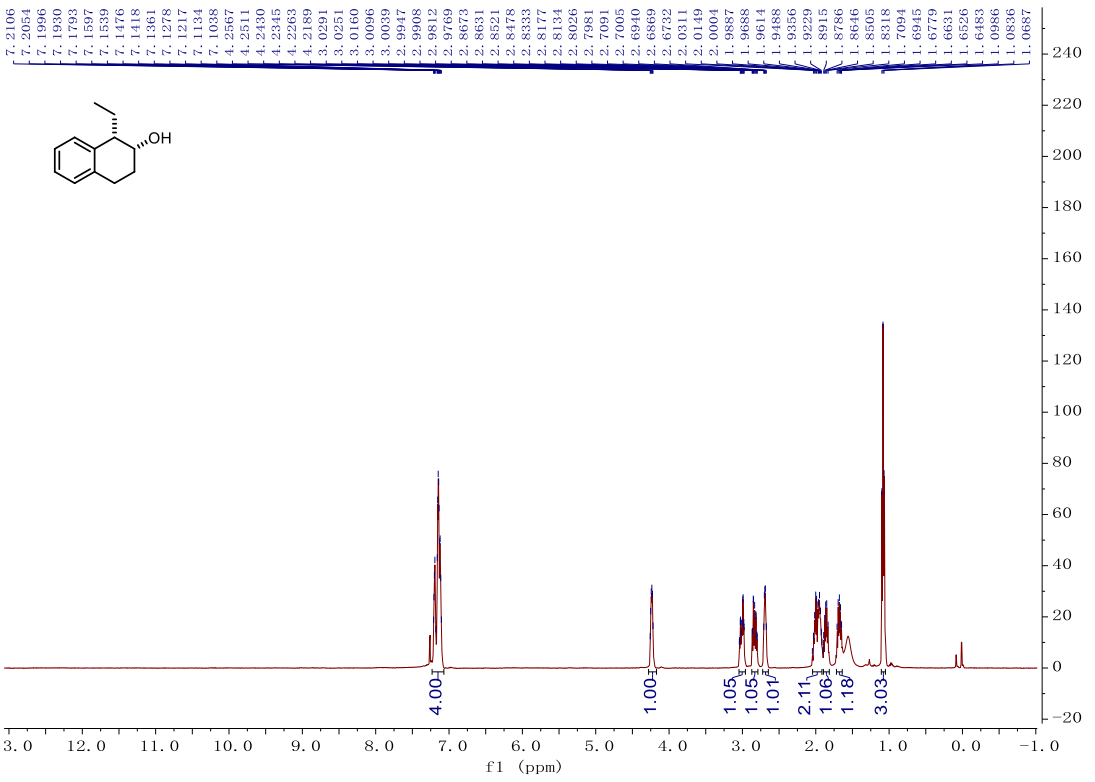
5l-Bz-^{1}H NMR (500 MHz, Chloroform-*d*)



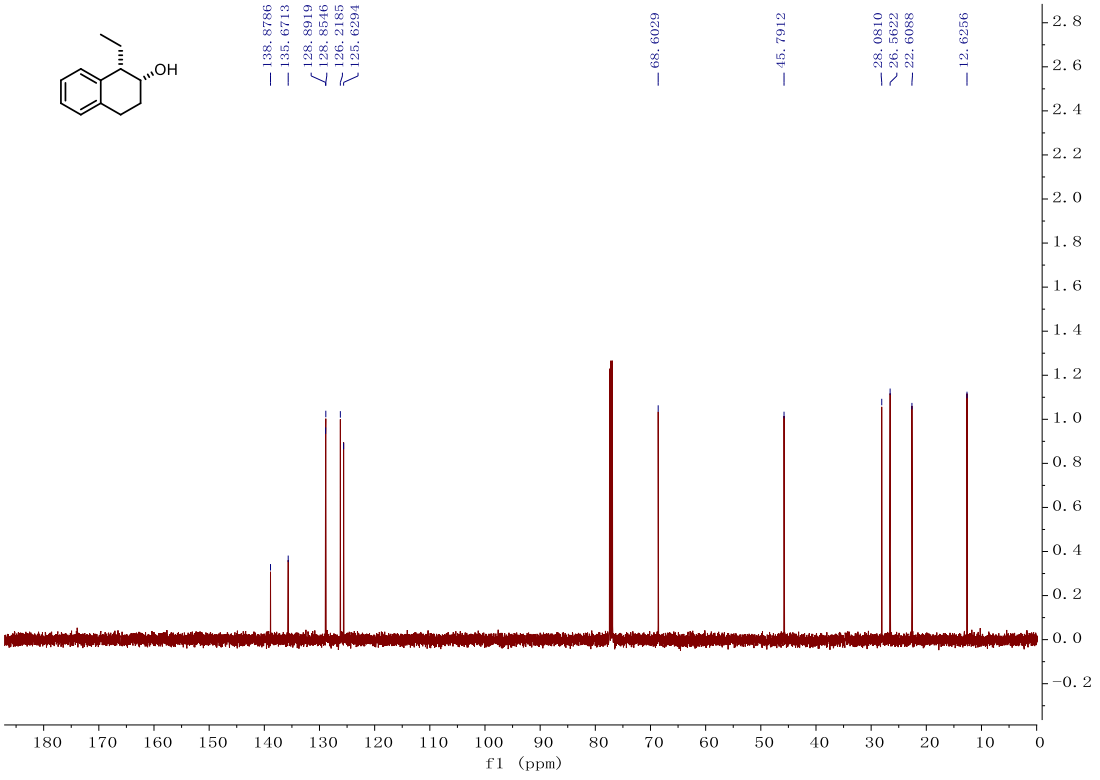
5l-Bz-^{13}C NMR (126 MHz, Chloroform-*d*)



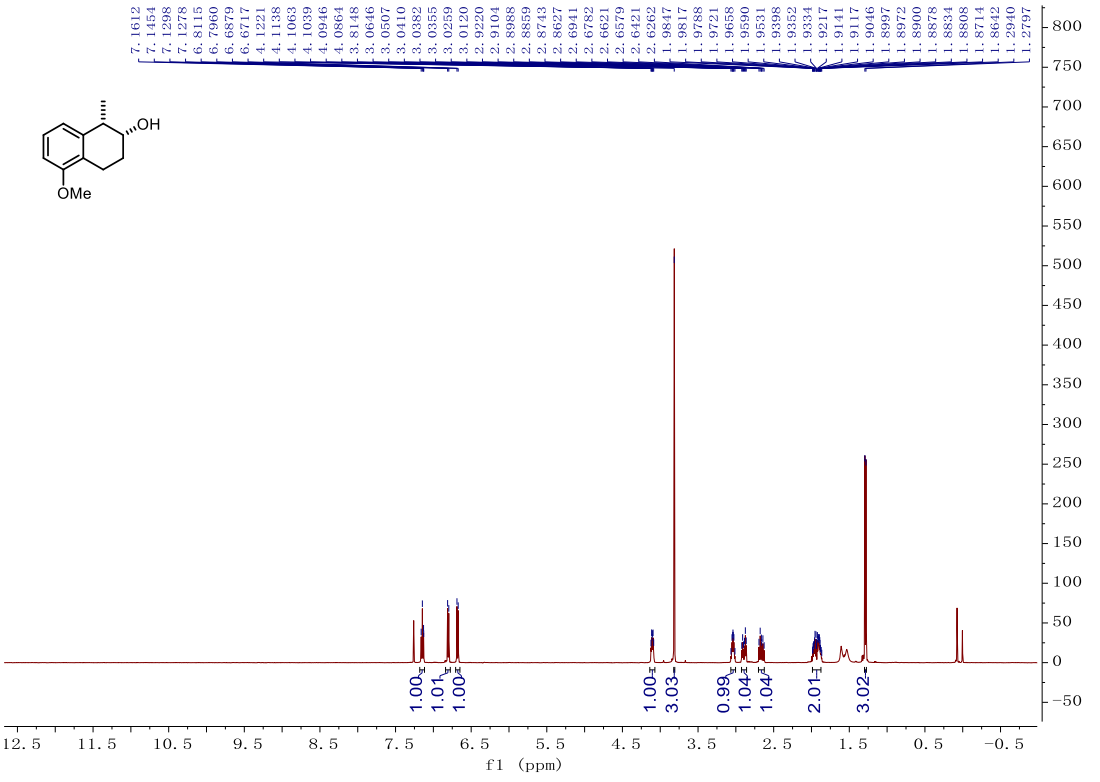
7a-^{1}H NMR (500 MHz, Chloroform-*d*)



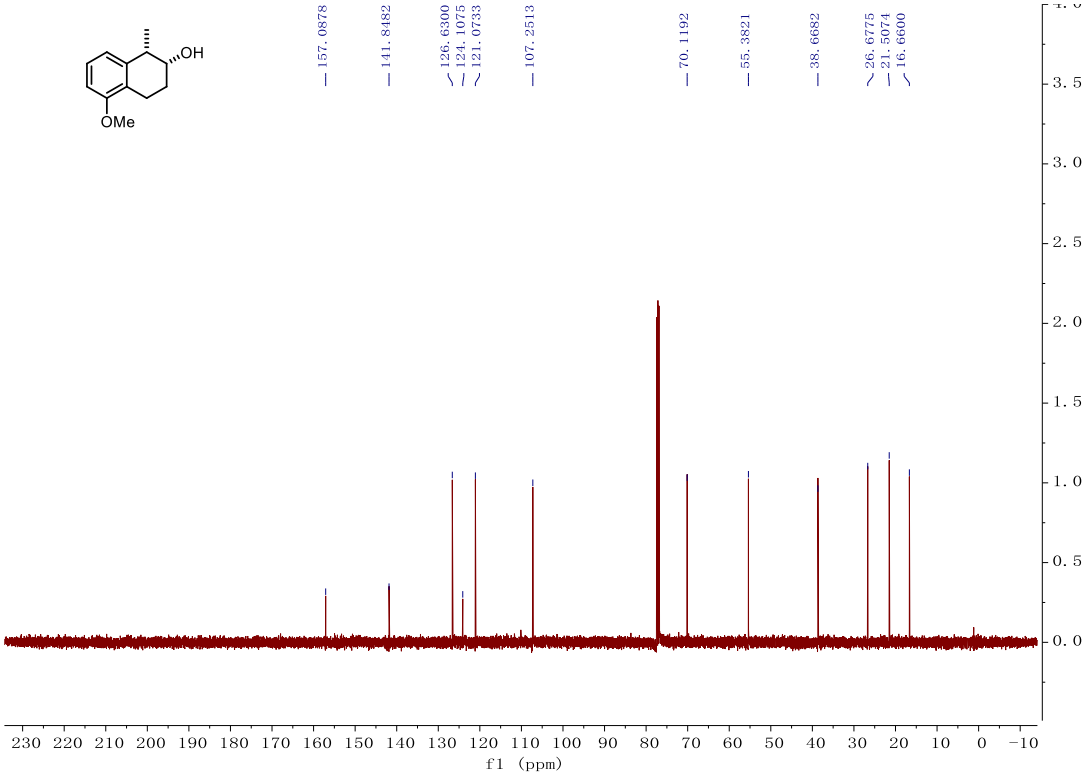
7a-^{13}C NMR (126 MHz, Chloroform-*d*)



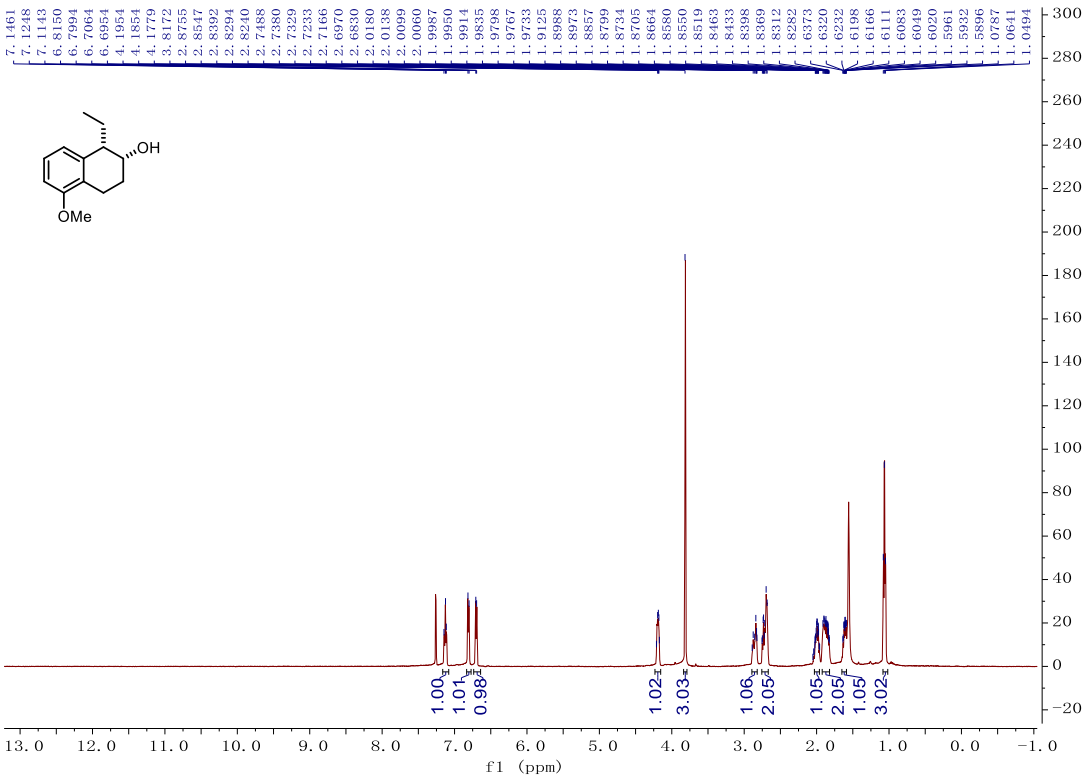
7b-^{1}H NMR (500 MHz, Chloroform-*d*)



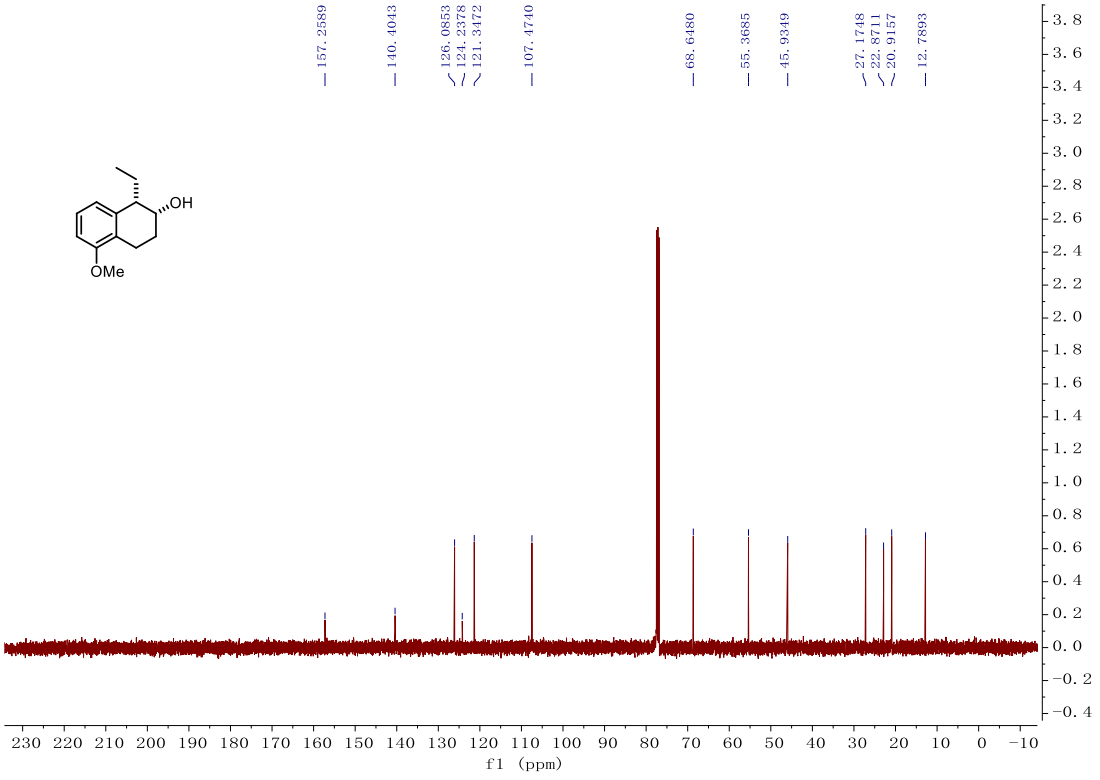
7b-^{13}C NMR (126 MHz, Chloroform-*d*)



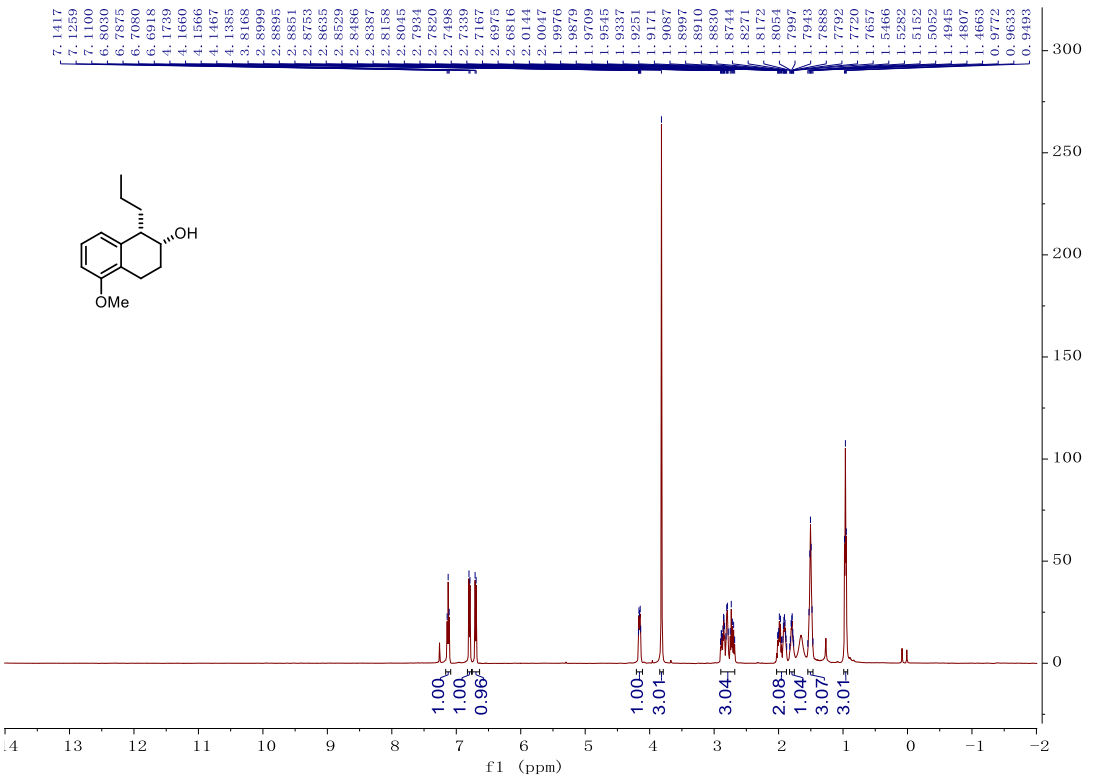
7c-^{1}H NMR (500 MHz, Chloroform-*d*)



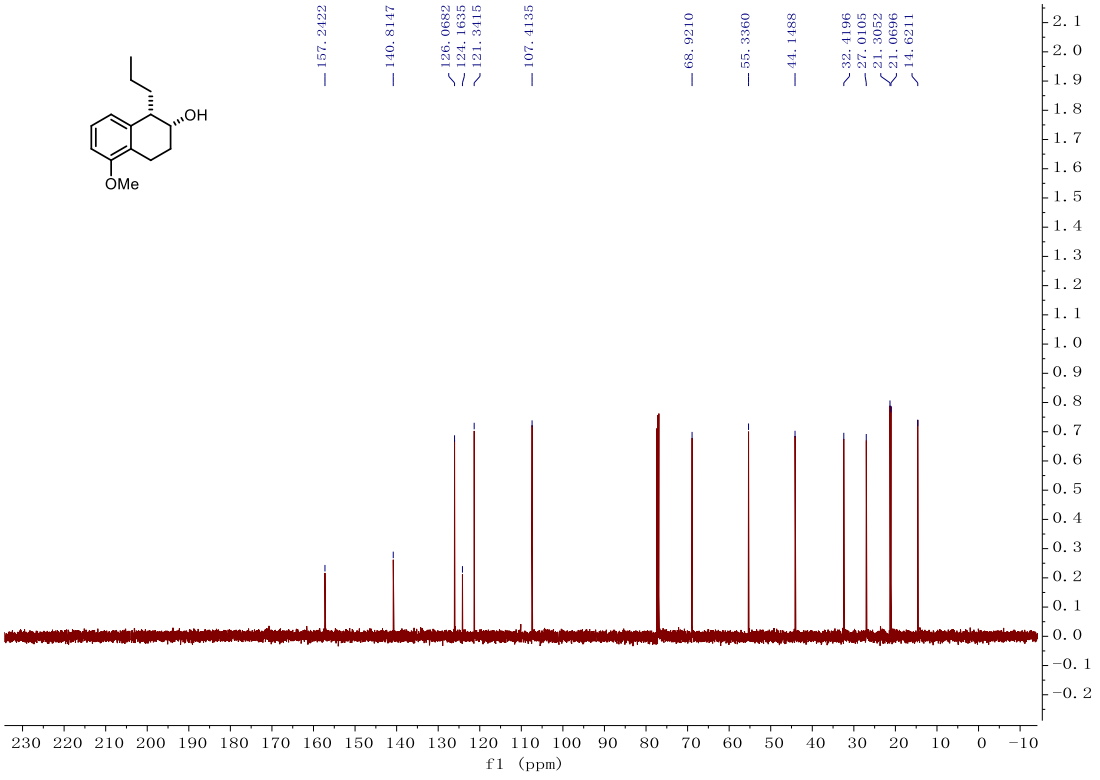
7c-^{13}C NMR (126 MHz, Chloroform-*d*)



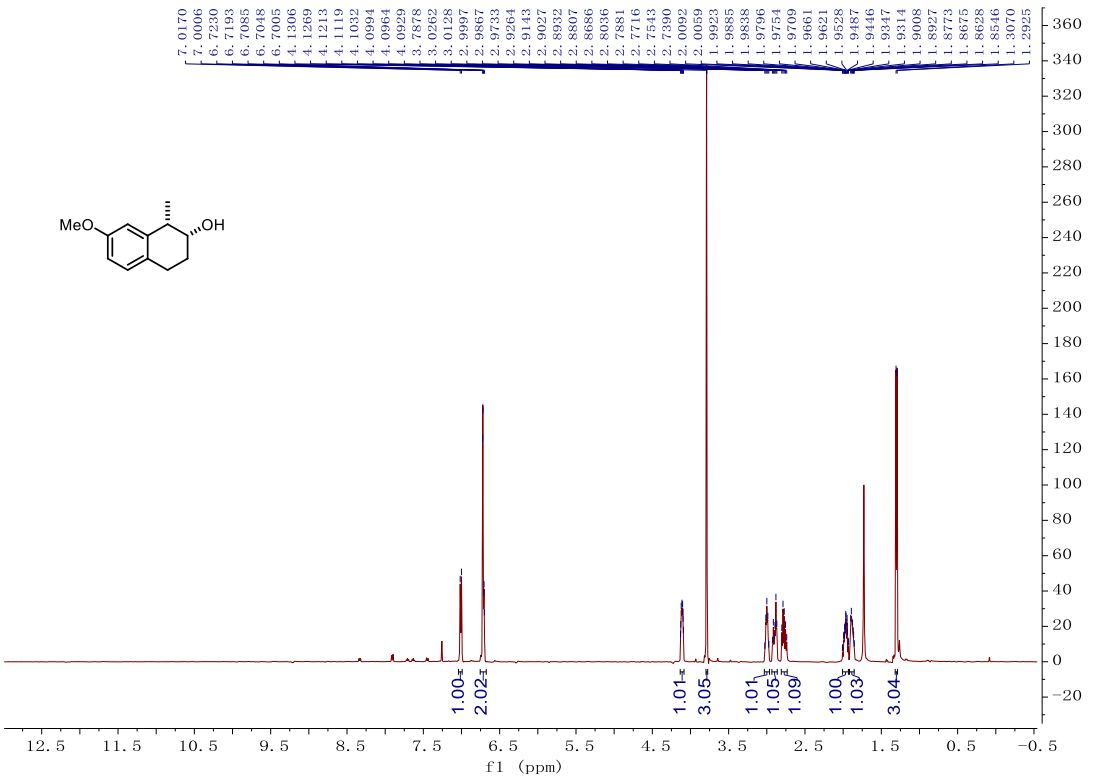
7d-^{1}H NMR (500 MHz, Chloroform-*d*)



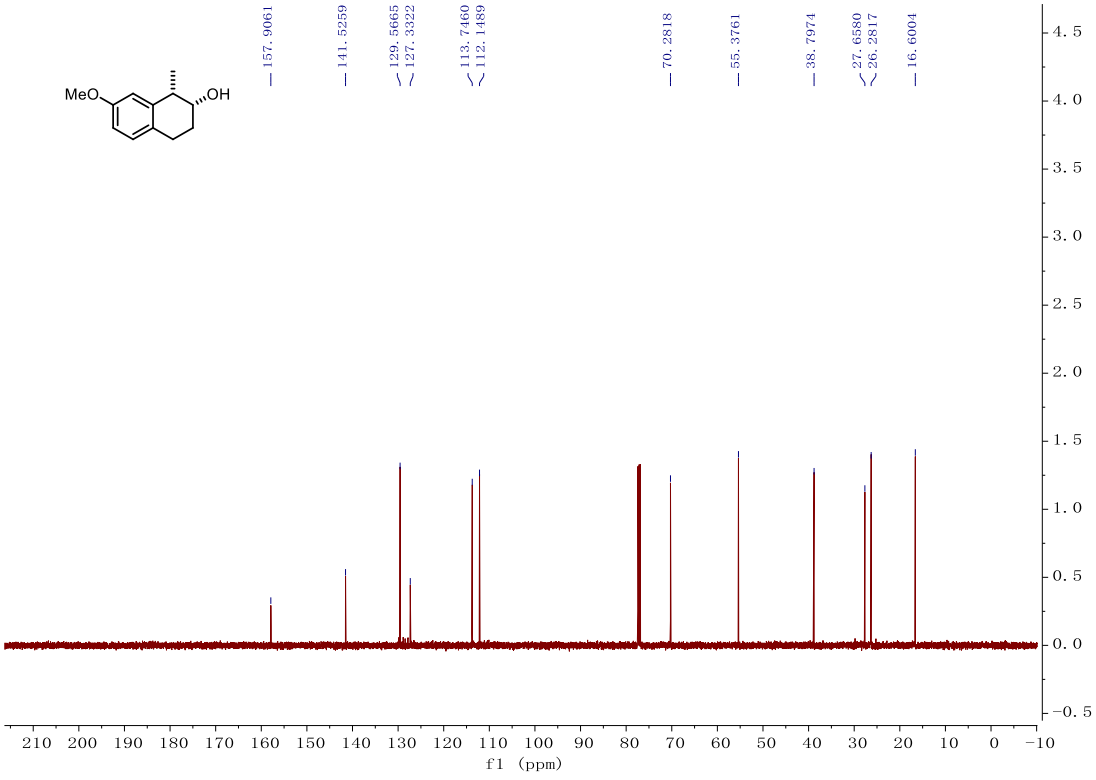
7d-^{13}C NMR (126 MHz, Chloroform-*d*)



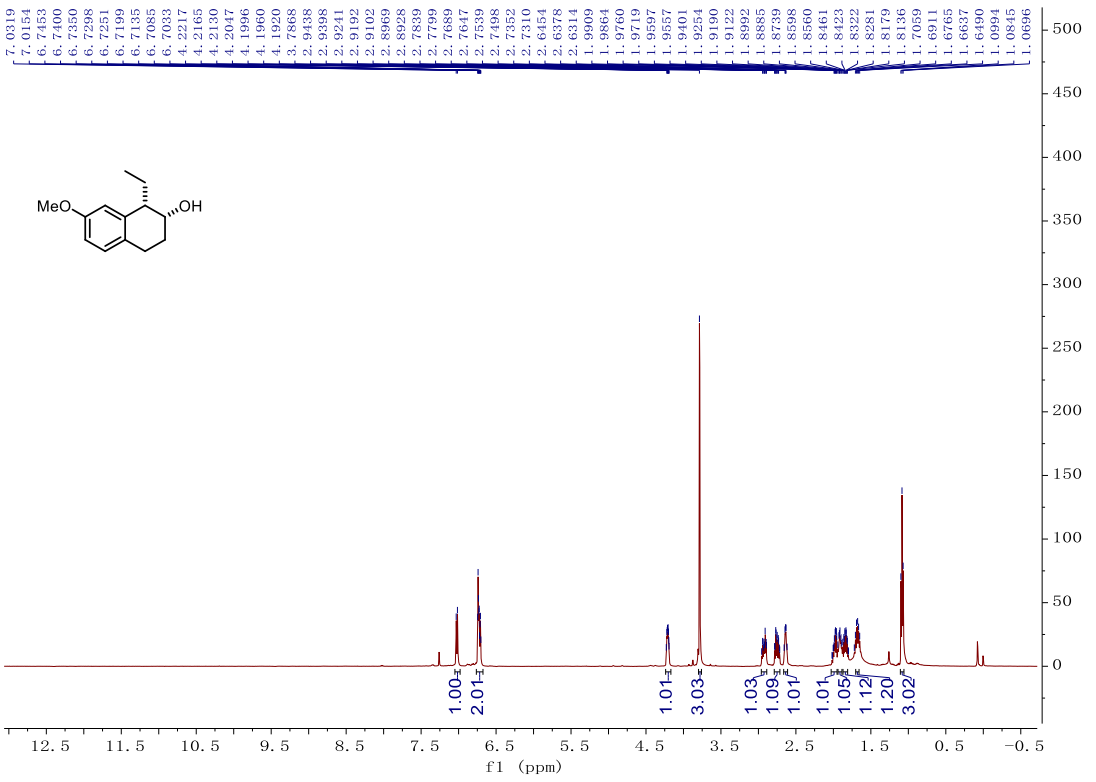
7e-^{1}H NMR (500 MHz, Chloroform-*d*)



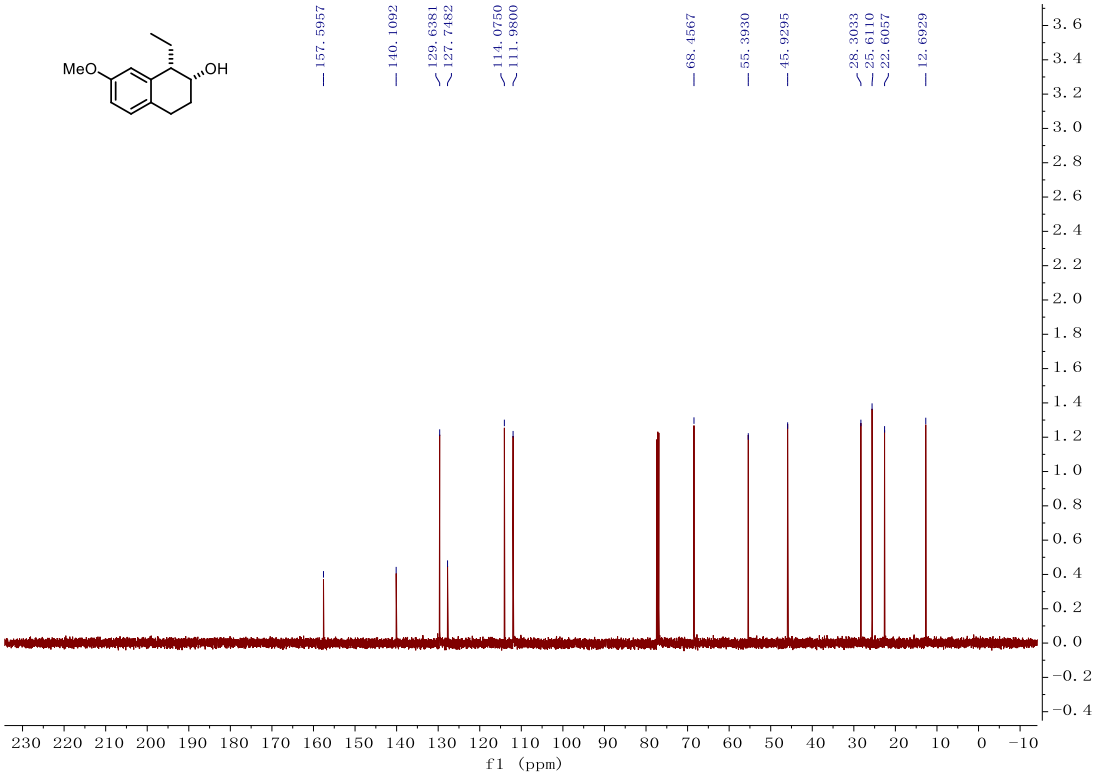
7e-^{13}C NMR (126 MHz, Chloroform-*d*)



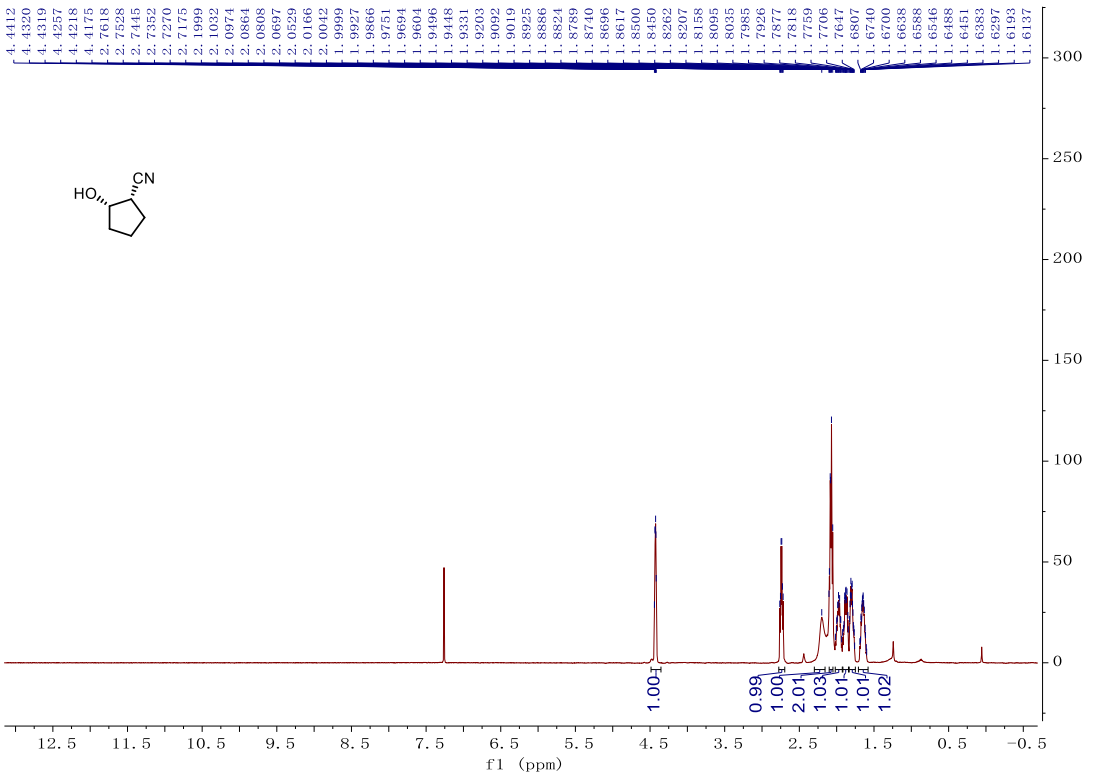
7f-^{1}H NMR (500 MHz, Chloroform-*d*)



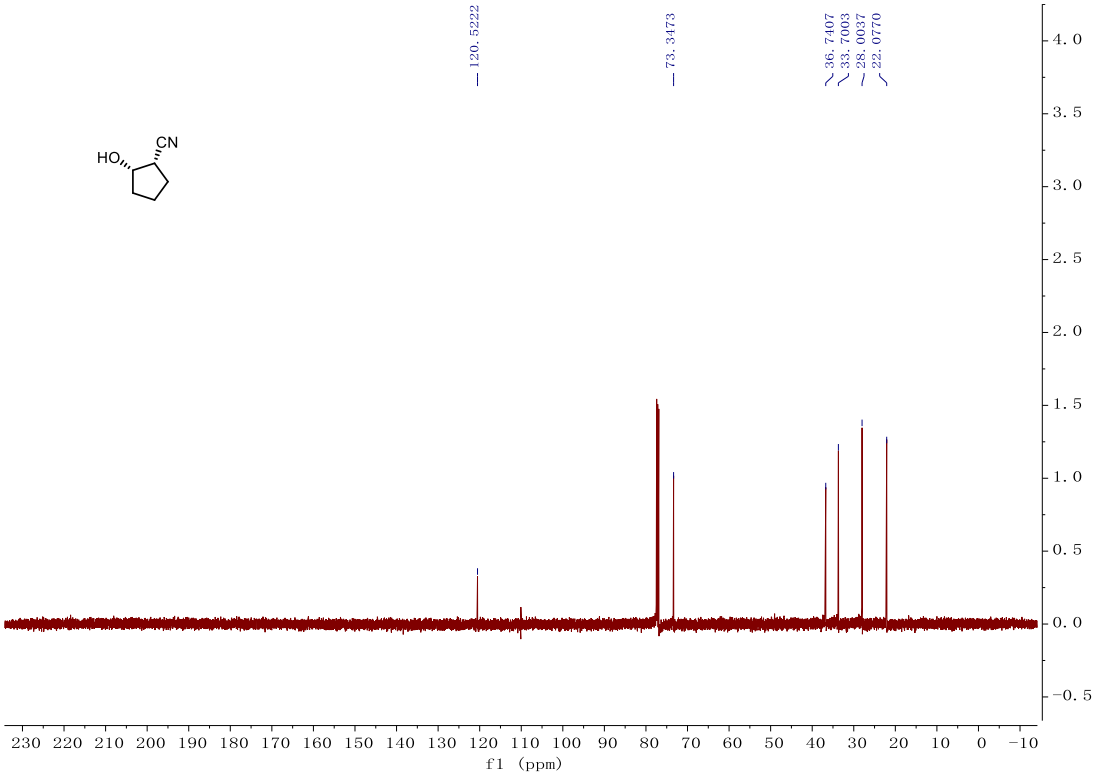
7f-^{13}C NMR (126 MHz, Chloroform-*d*)



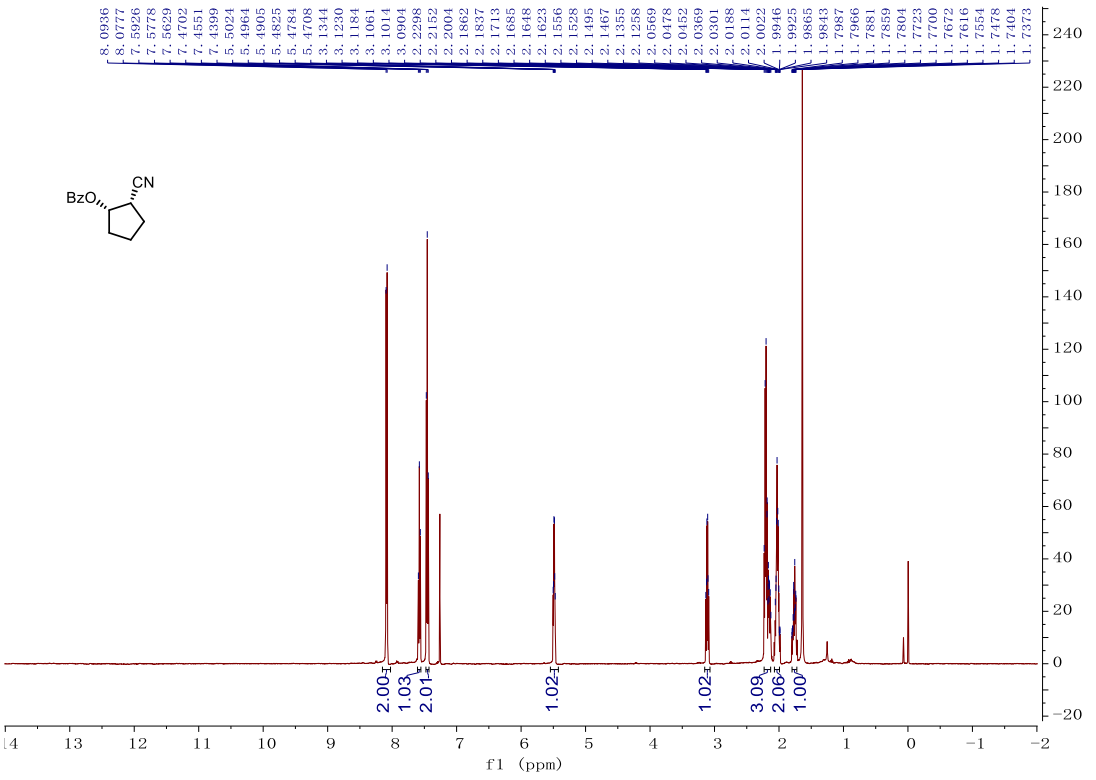
7g-^{1}H NMR (500 MHz, Chloroform-*d*)



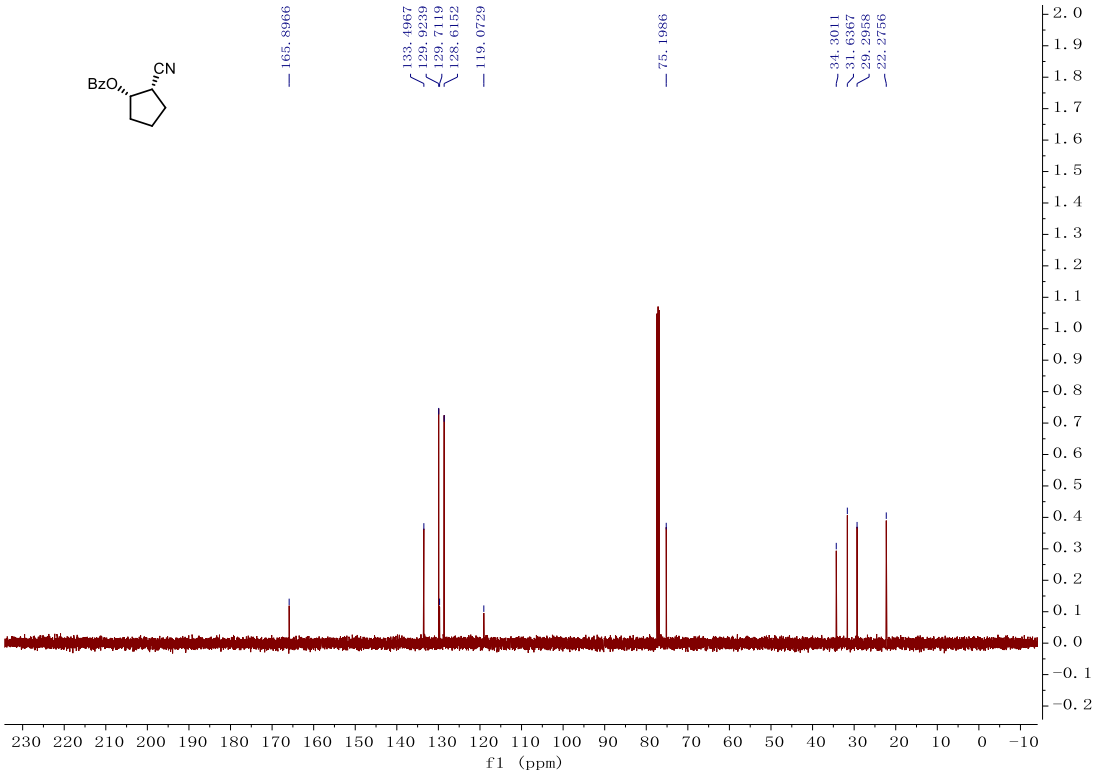
7g-^{13}C NMR (126 MHz, Chloroform-*d*)



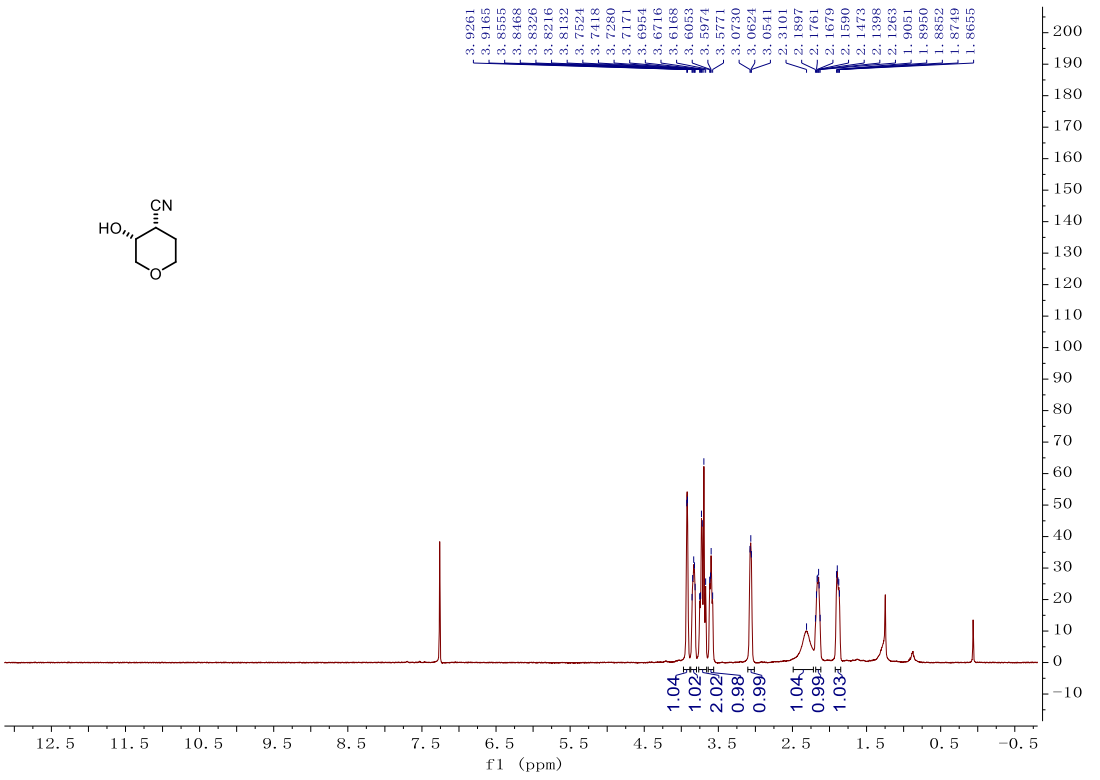
7g-Bz-^{1}H NMR (500 MHz, Chloroform-*d*)



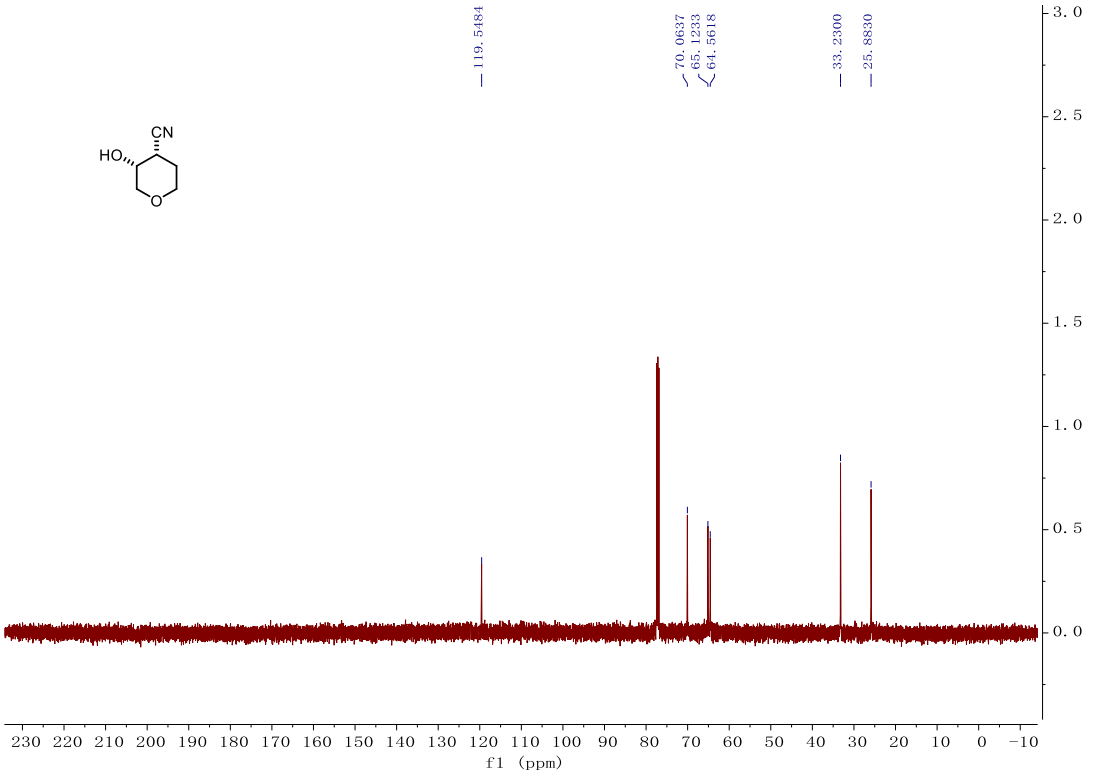
7g-Bz-^{13}C NMR (126 MHz, Chloroform-*d*)



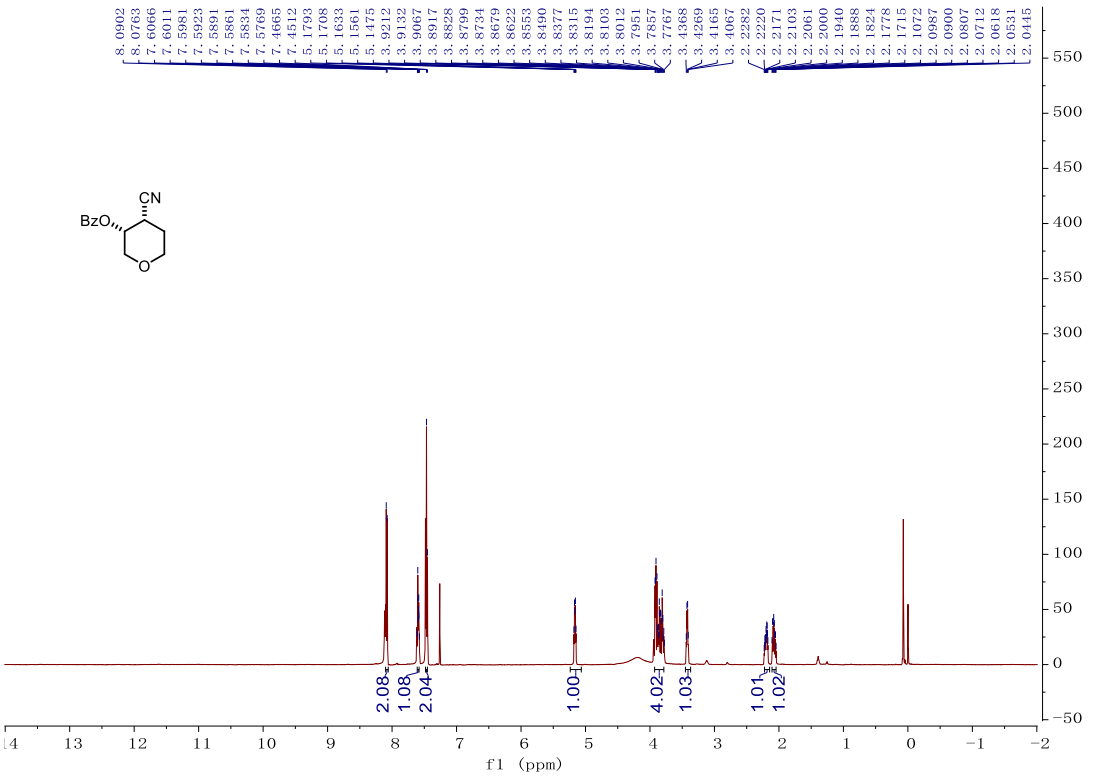
7h-^{1}H NMR (500 MHz, Chloroform-*d*)



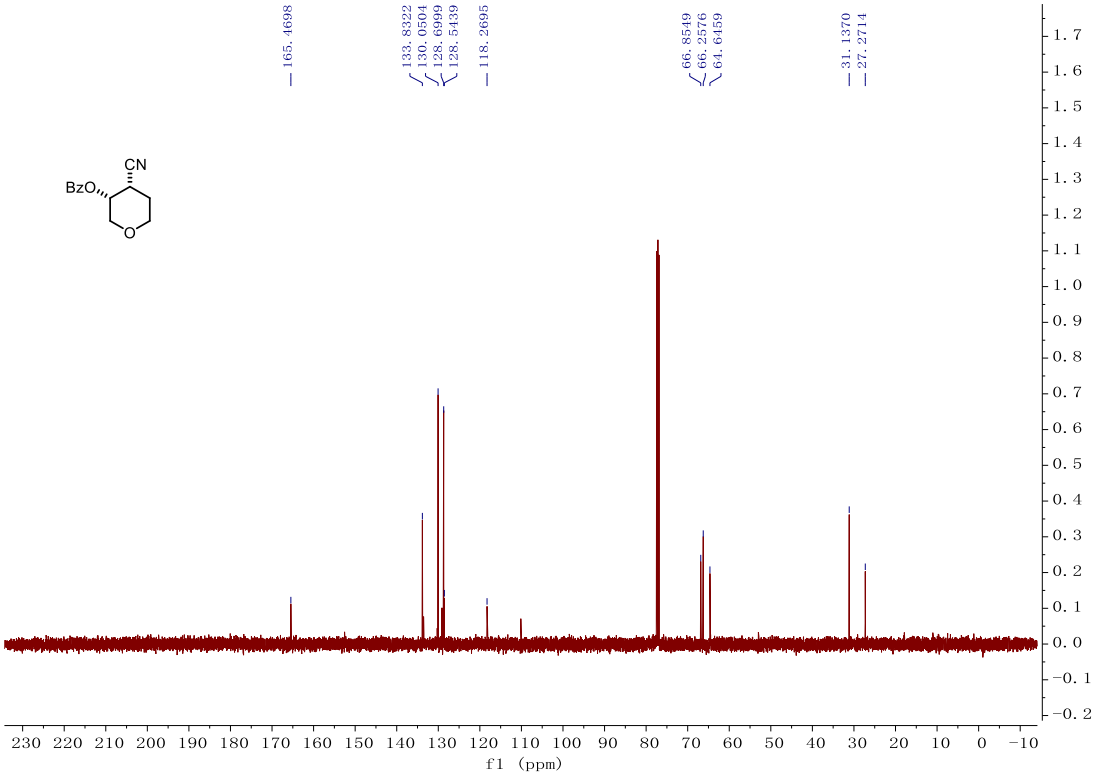
7h-^{13}C NMR (126 MHz, Chloroform-*d*)



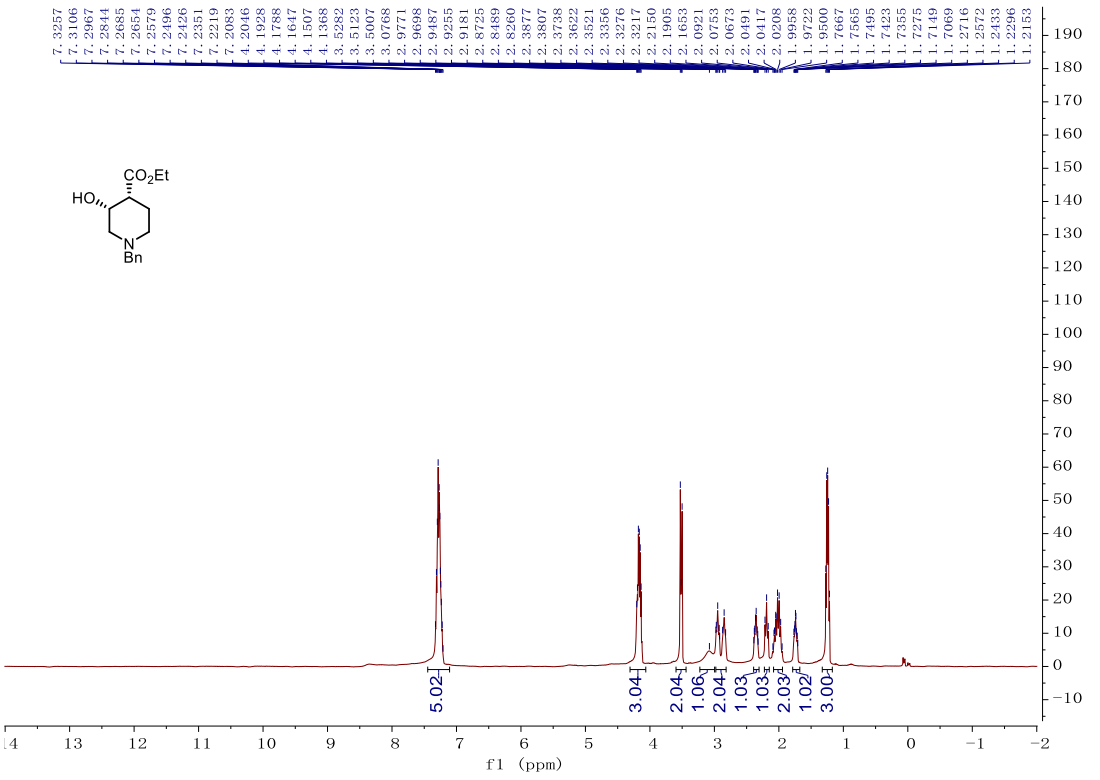
7h-Bz-^{1}H NMR (500 MHz, Chloroform-*d*)



7h-Bz-^{13}C NMR (126 MHz, Chloroform-*d*)



7i-^{1}H NMR (500 MHz, Chloroform-*d*)



7i-^{13}C NMR (126 MHz, Chloroform-*d*)