Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

SUPPORTING INFORMATION

For

Fragmentation of Structural Units of Lignin Promoted by Persulfate through Selective C-C Cleavage under Mild Conditions

Fei-Xian Luo[a], Tai-Gang Zhou[a], Xin Li[a], Yun-Lei Luo[b], Zhang-Jie Shi*[a]

[a]*Beijing National Laboratory forMolecular Sciences (BNLMS) and Key Laboratory of Bioorganic Chemistry and Molecular Engineering of Ministry of Education, College of Chemistry and Green Chemistry Center, Peking University, Beijing 100871, China, and State Key Laboratory of Organometallic Chemistry, Chinese Academy of Sciences, Shanghai 200032, China.*

[b]*School of Chemistry and Chemical engineering, Southwest University, Chongqing 400715, China.*

Table of Contents

I General Consideration

General Experimental Section

^{1}H NMR and ^{13}C NMR data were obtained on AVANCE III Bruker 400 M Hz or 500 M Hz nuclear resonance spectrometers unless otherwise noted. $CDCl_3$ or DMSO-d_6 was used as solvent and tetramethylsilane (TMS) was used as the internal standard. Chemical shifts were reported in units (ppm) by assigning TMS resonance in the ^{1}H NMR spectrum as 0.00 ppm. The data of ^{1}H NMR were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet and br = broad), coupling constant (*J* values) in Hz and integration. Chemical shifts for ^{13}C NMR spectra were recorded in ppm from TMS using the central peak of $CDCl_3$ (77.0 ppm) as the internal standard. Flash chromatography was performed using 200-300 mesh silica gel with the indicated eluent according to standard techniques. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Visualization of the developed chromatogram was performed by UV absorbance (254 nm) unless otherwise noted. High-resolution mass spectral (HRMS) data were recorded on Bruker APEX IV Fourier transform ion cyclotron resonance mass spectrometer using electrospray ionization (ESI) by the State-authorized Analytical Center in Peking University. The analytical data for the known compounds(**1a-1e**, **1h**, **4f-4h**) were found to match the literature data and the new compounds(**1f-1g**, **1i-1k**, **4a-4b**, **4d-4e**) were fully characterized by ^{1}H NMR, ^{13}C NMR, and FT-MS analysis.

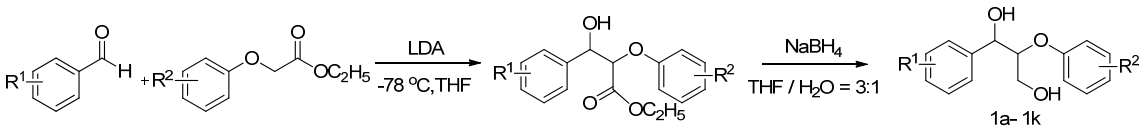
General preparation for chemicals

All the aromatic aldehydes were purchased from Alfa Aesar. 2-methoxyphenol and other phenols were purchased from J&K Chemicals. Ethyl 2-bromoacetate, methyl 2-(4-methoxyphenyl) acetate, ethyl 2-(benzyloxy) acetate, ethyl 2-(benzyloxy) acetate, and ethyl 2-((4-methoxybenzyl) oxy) acetate were purchased from Sinopharm Chemical Reagent Co. Ltd and used without further purification. $Na_2S_2O_8$ and other persulfate were purchased from XiLong Chemicals and used directly. Tetrahydrofuran (THF) was freshly distilled strictly before used, and all the other reagents were directly used from purchased without any further purification unless otherwise specified.

II General Procedure for Preparation of Lignin Model

General Procedure for Preparation of β-O-4 Lignin Model (1a-1k)

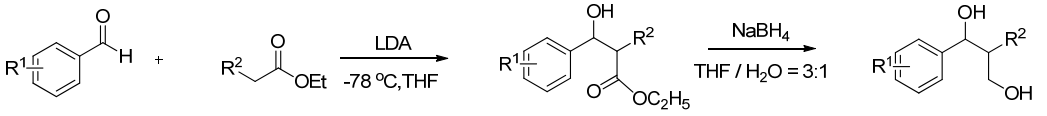
The lignin models (**1a-1k**) were prepared following the previous reported procedure[1] Spectral data are consistent with those reported in the literature:



To a solution of *i*Pr_2NH (1.05 mL, 11.0 mmol) in anhydrous THF (30 mL) at 0 °C was added *n*-BuLi (2.5 M in hexanes, 4.5 mL, 11.0 mmol) dropwise under nitrogen. After 20 min, the mixture was cooled to –78 °C, and a solution of methyl 2-(2-methoxyphenoxy)acetate (1.96 g, 10.0 mmol) in anhydrous THF (20 mL) was added dropwise followed by a solution of substituted benzaldehyde (10.0 mmol) in THF (10 mL) in 10 min. After 1 h, the reaction was quenched by addition of a saturated aqueous solution of NH_4Cl. The aqueous layer was extracted with EtOAc (30 mL x 3), and the combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The resulting compound was isolated as a diastereomer mixture by silicon column chromatography with hexane/EtOAc (3:1). Then, the resulting compound (3.5 mmol) was dissolved in the mixture of THF/H_2O (3:1) (25 mL), and sodium borohydride (7 mmol, 0.26 g) was added portionwise to maintain a gentle evolution of gas. Then, the mixture was stirred for 6 h at room temperature. The reaction mixture was quenched with saturated aqueous NH_4Cl (50 mL) and diluted with 30 mL water. The aqueous portion was extracted with ethyl acetate (3 × 30). The organic parts were combined, dried over $MgSO_4$, filtered and concentrated under vacuum. The residue was purified by column chromatography with hexane/ EtOAc (2:1).

General Procedure for Preparation of Lignin Model (4a, 4b, 4d)

The lignin models (**4a, 4b, 4d)** were prepared following the previous reported procedure with some modification[1, 2].

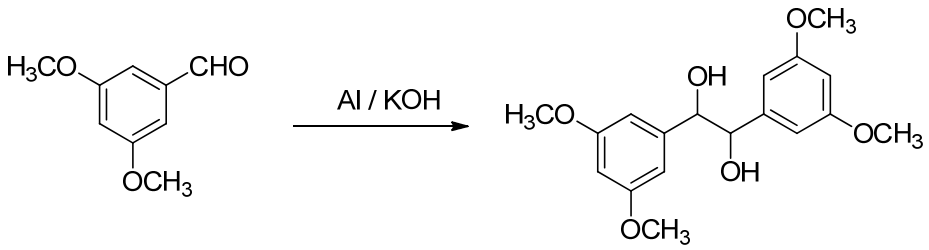


To a solution of *i*Pr_2NH (1.05 mL, 11.0 mmol) in anhydrous THF (30 mL) at 0 °C was added *n*-BuLi (2.5 M in hexanes, 4.5 mL, 11.0 mmol) dropwise under nitrogen. After 20 min, the mixture was cooled to –78 °C, and a solution of methyl 2-(substituted phenoxy)acetate (10.0 mmol) in anhydrous THF (20 mL) was added dropwise followed by a solution of 3,5-dimethoxy

benzaldehyde (1.66 g, 10.0 mmol) in THF (10 mL) in 10 min. After 1 hour, the reaction was quenched by addition of a saturated aqueous solution of NH_4Cl. The aqueous layer was extracted with EtOAc (30 mL x 3), and the combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The resulting compound was isolated as a diastereomer mixture by silicon column chromatography with hexanes/EtOAc (3:1).

The resulting compound (3.5 mmol) was dissolved in the mixture of THF/H_2O (3:1) (25 mL), and sodium borohydride (7 mmol, 0.26 g) was added portionwise to maintain a gentle evolution of gas. Then, the mixture was stirred for 6 h at room temperature. The reaction mixture was quenched with saturated aqueous NH_4Cl (50 mL) and diluted with 30 mL water. The aqueous portion was extracted with ethyl acetate (30 mL×3). The organic parts were combined, dried over $MgSO_4$, filtered and concentrated under vacuum. The residue was purified by column chromatography on silica gel with hexane: EtOAc (2:1).

General Procedure for Preparation of *β*-O-4 lignin Model (4c)

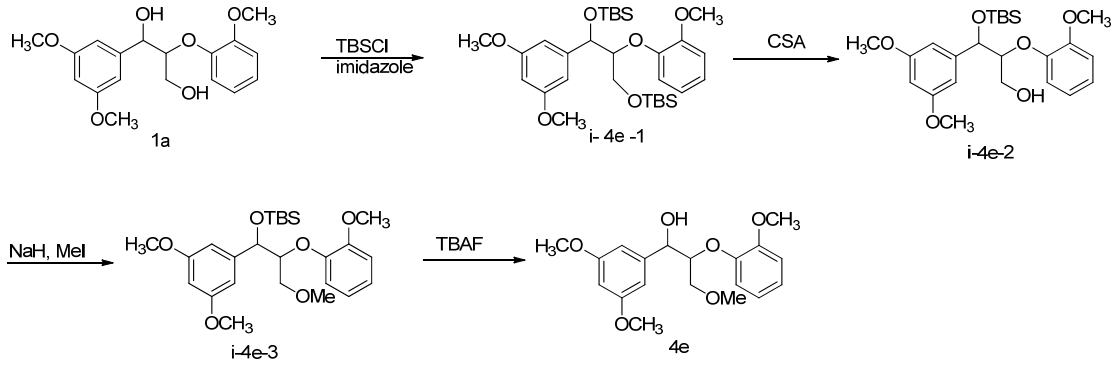


The lignin model (**4c**) can be prepared according to the literature[6].

3,5-dimethoxy benzaldehyde (5.0 mmol) was dissolved in methanol (10 mL) and aluminum powder (0.27 g, 10 mmol) was added, followed by KOH (2.53 g, 45 mmol). After 10 min where the vigorous reaction had subsided, the slurry was filtrated and 50 mL of H_2O was added. The resulted solution was extracted with ethyl acetate (50 mL×3), the organic layer was dried with anhydrous Na_2SO_4 and removed the solvent in vacuum to give a white crude solid of the mixed pinacols in quantitative yield.

General Procedure for Preparation of *β*-O-4 Lignin Model (4e)

The lignin model (**4e**) was prepared following the previous reported procedure with some modification[3].



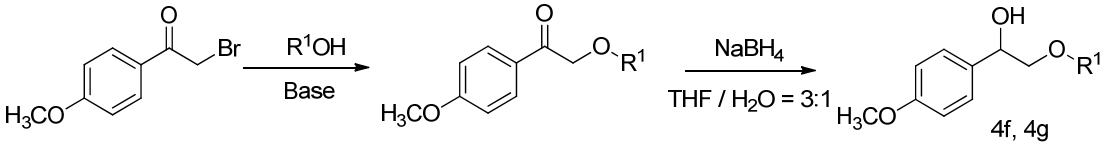
To a solution of **1a** (501.0 mg, 1.5 mmol) in DCM (3 mL) was added imidazole (340.0 mg, 5.0 mmol), and TBSCl (603.0 mg, 4.0 mmol), and the reaction mixture was stirred at room temperature for 5 hours then concentrated. The residue was purified by column chromatography with hexanes/EtOAc (5:1) to give **i-4e-1.**

To a solution of **i-4e-1** in DCM/MeOH (10 mL 1:1, v/v) at 0 °C was added Camphorsulfonic acid (CSA) (96 mg, 0.42 mmol). The reaction mixture was stirred at 0 °C for 2 h. then quenched with saturated aqueous solution of $NaHCO_3$ (20 mL). The aqueous layer was extracted with DCM (10 mL x 3), and the combined organic layers were dried over $MgSO_4$ and concentrated under reduced pressure, the residue was purified by column chromatography with hexanes/EtOAc (4:1) to give the mono-TBS ether **i-4e-2**.

To a solution of **i-4e-2** (694.4 mg, 1.55 mmol) in dry THF (5.0 mL) was added NaH (68 mg, 1.70 mmol) followed by MeI (106 μL, 1.70 mmol) in 5 min. The reaction mixture was stirred overnight and quenched by addition of a saturated aqueous solution of NH_4Cl. The mixture was extracted with EtOAc (10 mL × 3), and the combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The resulting oil was purified by flash column chromatography with hexanes/EtOAc (5:1) to give **i-4e-3**.

To a solution of **i-4e-3** (526.7 mg, 1.14 mmol) in THF (4.0 mL) was added a solution of TBAF in THF (1.0 M, 1.4 mL, 1.4 mmol). The reaction mixture was stirred for 30 min and concentrated. The primary alcohol **4e** was obtained after column chromatography with hexanes/EtOAc (3:1 to 1:1).

General Procedure for Preparation of *β*-O-4 Lignin Model (4f and 4g)



These substrates were synthesized in two-steps from the corresponding phenol and 2-bromoacetophenone according to literature procedure[5].

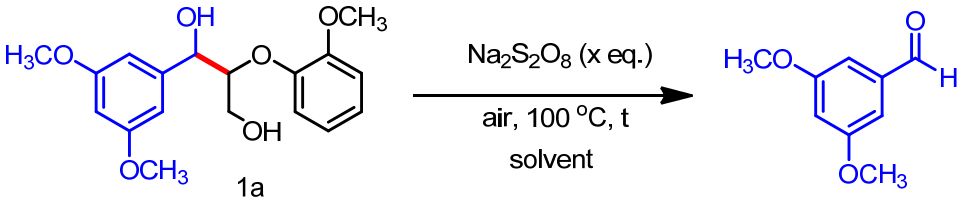
2-bromo-1-(4-methoxyphenyl) ethanone (5 mmol, 1.45 g) was added to a stirred solution of K_2CO_3 (7.5 mmol, 1.04 g) and guaiacol (6.25 mmol, 0.78 g) in acetone (50 mL). The mixture was stirred at reflux temperature for 5 h. it was filtered off and concentrated under vacuum. The residue was recrystallized in acetone to afford the intermediate. The resulting compound (3.5 mmol, 0.85 g) was dissolved in the mixture of THF/H_2O (5:1) (25 mL), and sodium borohydride (7 mmol, 0.26 g) was added portionwise to maintain a gentle evolution of gas. Then, the mixture was stirred for 6 h at room temperature. The reaction mixture was quenched with saturated aqueous NH_4Cl (50 mL) and diluted with 30 mL water. The aqueous portion was extracted with ethyl acetate (30 mL×3). The organic parts were combined, dried over $MgSO_4$, filtered and concentrated under vacuum. The residue was purified by column chromatography with hexane: ethyl acetate (2:1) to give the desired product.

Ⅲ Standard Procedure for Lignin model Fragmentation using $Na_2S_2O_8$

To a Schlenk tube equipped with a magnetic stir bar was added $Na_2S_2O_8$ (47.6 mg, 0.2 mmol) and 0.5 mL deionized water, then the solution of lignin model **1a** (1 mL, 0.1 M in MeCN) was injected into the mixture with additional MeCN (0.5 mL). The resulting mixture was refluxed at 100 ^oC for 12 h. After reaction, silica gel (200-300 mesh) was added to the reaction mixture and the solvent was removed under vacuum. The resulted residue was purified by column chromatography on silica gel (200-300 mesh) with petro ether/ethyl acetate(5:1) to give aldehyde product.

IV Optimization of Reaction Conditions

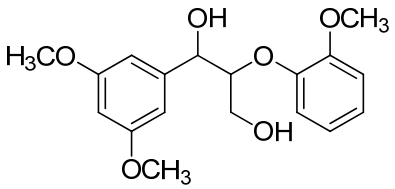
Table S1 the reaction condition screening [a]



Entry	$Na_2S_2O_8$ (x eq.)	Solvent	t (h)	Result
1	2	MeCN / H_2O (3:1)	12	61%
2	2	Acetone / H_2O (3:1)	12	31%
3	2	DMF / H_2O (3:1)	12	trace[b]
4	2	THF / H_2O (3:1)	12	trace[b]
5	2	EtOH / H_2O (3:1)	12	trace[b]
6	2	DCE / H_2O (3:1)	12	trace[b]
7	2	PhCl / H_2O(3:1)	12	trace[b]
8	2	MeCN / H_2O (3:1)	3	50%
9	2	MeCN / H_2O (3:1)	6	53%
10	2	MeCN / H_2O (3:1)	18	53%
11	2	MeCN / H_2O (2:1)	12	46%
12	2	MeCN / H_2O (1:2)	12	30%
13	2	MeCN / H_2O (1:3)	12	20%
14	2	MeCN / H_2O (6:1)	12	16%
15	1.5	MeCN / H_2O (3:1)	12	40%
16	3	MeCN / H_2O (3:1)	12	49%
17	3.5	MeCN / H_2O (3:1)	12	58%
18	4	MeCN / H_2O (3:1)	12	57%

[a] 0.05 mmol of lignin model **1a** and 0.1mmol of $Na_2S_2O_8$, 0.75 mL of organic solvent and 0.25 mL of H_2O, 100 °C , 12 h. NMR yield with using CH_2Br_2 as internal standard reagent.
[b] trace of desire product was found by TLC, substrate was recovered

V Characterization of Substrate

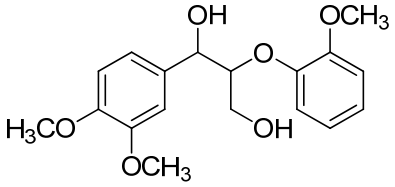


1-(3,5-dimethoxyphenyl)-2-(2-methoxyphenoxy)propane-1,3-diol(1a) colorless sticky semi-solid, mixture of *erythro* : *threo* (4.16 : 1), 51.2% of total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.10-6.87 (m, 4H), 6.60 (d, J = 4.0 Hz, 2H, minor diastereomer), 6.50 (J = 4.0 Hz, 2H, major diastereomer), 6.39 (t, J = 4.0 Hz, 1H, minor diastereomer), 6.36 (J = 4.0 Hz, 1H, major diastereomer), 4.96 (t, J = 4.0 Hz, 1H, both diastereomers), 4.19-4.16 (m, 1H, both diastereomers), 3.93-3.89 (m, 2H, both diastereomers), 3.86 (s, 3H, minor diastereomer), 3.84 (s, 3H, major diastereomer), 3.76 (s, 3H, minor diastereomer), 3.75 (s, 3H, major diastereomer), 3.67-3.63 (m, 1H, both diastereomers), 3.03 (t, J = 4.0 Hz, 1H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 160.9, 151.5, 146.8, 142.5, 124.1, 121.6, 120.7, 112.2, 101.1, 99.9, 86.9, 72.9, 60.8, 55.4. minor diastereomer: δ 160.9, 151.2, 147.7, 142.2, 124.1, 121.7, 120.8, 112.2, 105.0, 100.3, 88.9, 74.1, 61.1, 55.9.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{18}H_{22}NaO_6$: 357.13086; found: 357.13174.



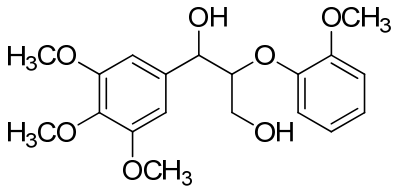
1-(3,4-dimethoxyphenyl)-2-(2-methoxyphenoxy)propane-1,3-diol(1b) colorless sticky semi-solid, mixture of *erythro* : *threo* (4:1), 52.3 % of total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.05-6.72(m, 7H), 4.88-4.87(m, 1H, both diastereomer) 4.12 (m, 2H, major diastereomer), 4.03-3.99(m, 2H, minor diastereomer), 3.87-3.72 (m, 11H), 3.67-3.56(m, 1H both diastereomers), 3.44-3.36(m, 1H, major diastereomer).3.28-3.26(m, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 151.2, 148.9, 148.3, 147.1, 133.1, 123.7, 121.5, 120.7, 118.7, 112.2, 111.0, 109.6, 86.6, 72.8, 60.9, 55.8, 55.8, 55.8. minor diastereomer: δ

151.0, 149.0, 148.7, 147.7, 123.8, 120.4, 119.5, 112.2, 111.0, 110.0, 88.6, 73.7, 61.0, 55.8, 55.8, 55.8.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{18}H_{22}NaO_6$: 357.13086; found: 357.13150.

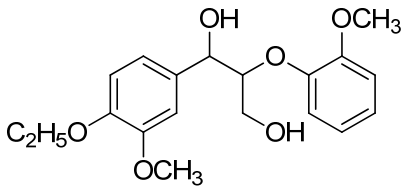


2-(2-methoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)propane-1,3-diol(1c) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.6:1), 40.0% total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.02-6.74 (m, 4H, both diastereomers), 6.61 (s, 2H, minor diastereomer), 6.57 (s, 2H, major diastereomer), 4.88 (t, *J* = 8.0 Hz, 1H, both diastereomers), 4.30 (brs, 1H, major diastereomer), 4.24 (brs, 1H, minor diastereomer), 4.12 (q, *J* = 8.0 Hz, 1H, major diastereomer), 4.04 (q, J =8.0 Hz, 1H, minor diasteromer), 3.91-3.85 (m, 1H, both diastereomers), 3.73, 3.72, 3.71 (all singlets for methoxy groups, 12H for both diastereomers), 3.69-3.61 (m, 1H, both diastereomers), 3.49 (brs, 1H, major diastereomer), 3.44 (brs, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 153.0, 151.2, 147.0, 137.2, 136.3, 123.5, 121.4, 119.7, 112.1, 103.4, 88.0, 86.1, 73.1, 61.0, 56.0, 55.7. minor diastereomer: δ 153.1, 150.8, 147.6, 137.5, 135.8, 123.7, 121.5, 120.0, 112.1, 104.0, 88.0, 86.1, 73.8, 61.0, 60.7, 55.7.

HRMS(ESI): m/z: $[M + NH_4]^+$ calculated for: $C_{19}H_{28}NO_7$: 382.18603; found: 382.18628.

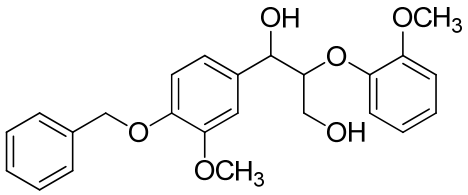


1-(4-ethoxy-3-methoxyphenyl)-2-(2-methoxyphenoxy)propane-1,3-diol (1d) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.42:1), 36.3% of total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13-6.81 (m, 7H, both diastereomers), 4.96 (m, 1H, both, diastereomer), 4.17-4.03 (m, 3H, both diastereomers), 3.94-3.82(m, 7H, both diastereomers), 3.75-3.47 (m, 2H, both diastereomers), 3.01(m, 1H, major diastereomer), 2.92(m, 1H, minor diastereomer). 1.43(t, *J* = 8.0 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 151.5, 149.3, 147.8, 147.0, 132.7, 124.1, 121.6, 120.8, 118.1, 112.5, 112.2, 109.6, 87.2, 72.8, 64.4, 60.9, 56.0, 55.9, 14.8. minor diastereomer: δ 151.2, 149.4, 148.2, 147.7, 132.2, 124.1, 121.7, 120.9, 119.6, 112.5, 112.2, 110.2, 89.3, 73.9, 64.4, 61.1, 56.0, 55.9, 14.8.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{19}H_{24}NaO_6$: 371.14651; found: 371.14716.

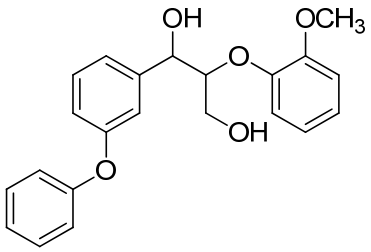


1-(4-(benzyloxy)-3-methoxyphenyl)-2-(2-methoxyphenoxy)propane-1,3-diol(1e) colorless sticky semi-solid, mixture of *erythro* : *threo* (3:1), 21.2% of total yield .

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40(s, 2H, minor diastereomer), 7.38 (s, 2H, major diastereomer), 7.31 (t, *J* = 8.0 Hz, 3H, major diastereomer), 7.25 (t, *J* = 8.0 Hz, 3H, minor diastereomer), 7.07-6.94 (m, 2H, both diastereomers), 6.87-6.79 (m, 5H, both diastereomers), 5.07 (s, 2H), 4.91 (s, 1H), 4.14-4.01 (m, 2H, both diastereomers), 3.89-3.81 (m, 1H, both diastereomers), 3.81-3.72 (m, 6H), 3.67-3.58 (m, 1H, both diastereomers), 3.31 (m, 1H, major diastereomer), 3.19 (t, *J* = 4.0 Hz, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 151.3, 149.7, 147.6, 147.1, 137.2, 133.7, 128.6, 127.9, 127.4, 123.8, 121.6, 120.3, 118.7, 114.0, 112.3, 110.2, 86.8, 72.8, 71.1, 61.0, 56.0, 55.8. minor diasteromer: δ 151.1, 149.8, 148.0, 147.8, 137.2, 133.1, 128.6, 127.9, 127.4, 123.9, 121.6, 120.6, 119.5, 114.0, 112.3, 110.7, 88.8, 73.8, 71.1, 61.1, 56.0, 55.8.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{24}H_{26}NaO_6$: 433.16216; found: 433.16275.



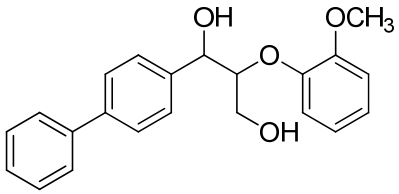
2-(2-methoxyphenoxy)-1-(3-phenoxyphenyl)propane-1,3-diol(1f) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.42 : 1), 35.4% of total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55-7.45 (m, 5 H, both diastereomers), 7.43-7.35 (m ,3H, both

diastereomers), 7.33-7.28 (m, 1H, both diastereomers), 7.09-6.81 (m, 4H, both diastereomers), 5.01 (brs, 1H,both diastereomers), 1.21-1.08 (m, 2H, both diastereomers), 3.95-3.90 (m, 1H, both diastereomers), 3.79 (s, 3H,minor diastereomer), 3.76 (s, 3H, major daistereomer), 3.69-3.43 (m,1H, both diastereomers), 3.32 (t, *J* = 4.0 Hz, 1H, major diastereomer), 3.23 (t, *J* = 4.0 Hz, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 151.5, 147.0, 140.8, 140.5, 139.5, 128.9, 127.7, 127.4, 127.2, 127.1, 127.1, 126.8, 124.1, 121.7, 120.7, 112.3, 86.9, 72.9, 60.8, 55.9. minor diastereomer 151.2, 147.7, 141.0, 140.8, 139.0, 128.9, 127.7, 127.4, 127.2, 127.2, 127.1, 126.8, 124.1, 121.7, 120.8, 112.3, 88.8, 73.8, 61.09, 55.9.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{22}H_{22}NaO_4$: 373.14103; found: 373.14005.

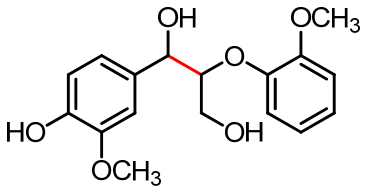


1-([1,1'-biphenyl]-4-yl)-2-(2-methoxyphenoxy)propane-1,3-diol(1g) colorless sticky semi-solid, mixture of *erythro* : *threo* (3:1), 31.1% total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.28 (m, 3H, both diasteromer), 7.19-7.04 (m, 4H, both diasteromer), 7.02-6.86(m, 6H, both diasteromer), 5.02(t, *J* = 4.0 Hz, 1H, both diastereomers), 4.19(q, *J* = 4.0 Hz, 1H, major diastereomer), 4.10 (q, *J* = 4.0 Hz, 1H, minor diastereomer), 4.06 (d, *J* = 4.0 Hz, 1H, both diastereomers), 3.93 (m, 1H,both diastereomers), 3.84 (s, 3H, minor diastereomer), 3.81(s, 3H, major diastereomer), 3.69 (m, 1H, major diastereomer), 3.56(m, 1H, minor diastereomer), 3.25(t, *J* = 4.0 Hz, 1H, major diastereomer), 3.18(t, *J* = 4.0 Hz, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 157.3, 151.4, 146.9, 142.6, 129.8, 124.0, 123.2, 121.6, 121.3, 120.5, 118.8, 118.2, 117.1, 112.3. 86.9, 72.9, 60.8, 55.9. minor diasteromer δ 157.3, 151.1, 147.6, 142.2, 129.7, 124.1, 123.3, 122.1, 121.7, 120.7, 118.8, 118.6, 117.8, 112.3. 88.5, 73.7, 61.2, 55.9.

HRMS(ESI): m/z: $[M + NH_4]^+$ calculated for: $C_{24}H_{28}NO_5$: 410.19620; found: 410.19657.



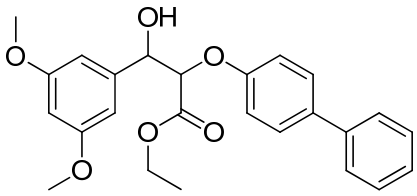
1-(4-hydroxy-3-methoxyphenyl)-2-(2-methoxyphenoxy)propane-1,3-diol(1h) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.62:1), 85% total yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.15–6.73(m, 7H), 5.96(s, 1H, minor diastereomer), 5.92(s, 1H, major diastereomer) 4.94(br 1H), 4.19–4.13(m, 1H, major diastereomer), 4.04–3.99(m, 1H, minor diastereomer), 3.96–3.73(m, 8H), 3.73–3.38 (m, 1H), 3.08(br, 1H, major diastereomer), 2.99(br, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 151.5, 147.0, 146.7, 145.6, 132.0, 124.1, 121.7, 120.7, 119.1, 114.4, 112.2, 108.9, 87.2, 72.8, 60.8, 56.0, 55.9.

minor diastereomer: δ151.2, 147.7, 146.8, 145.1, 131.6, 124.2, 121,7, 120.9, 120.3, 114.5, 112.2, 109.5, 89.3, 74.0, 61.1, 56.0, 55.9.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{17}H_{20}O_6Na$: 343.11521; found: 343.11572.



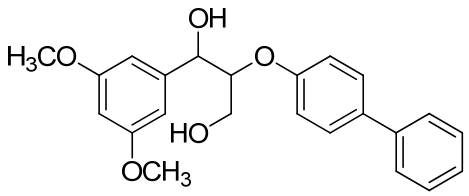
ethyl 2-([1,1'-biphenyl]-4-yloxy)-3-(3,5-dimethoxyphenyl)-3-hydroxypropanoate (i-1i) colorless sticky semi-solid, mixture of *erythro* : *threo* (1.25:1), 51.7% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.43(m, 4H), 7.40(t, *J* = 7.5 Hz, 2H), 7.29(t, *J* = 7.3 Hz, 1H), 6.93(dd, *J* = 8.6, 3.6 Hz, 2H), 6.64(d, *J* = 1.9 Hz, 2H, major diastereomer), 6.62(d, *J* = 1.9 Hz, 2H, minor diastereomer), 6.41(d, *J* = 2.2 Hz, 1H), 5.23-5.05(m, 1H, both diastereomers), 4.79(d, *J* = 5.5 Hz, 1H, major diastereomer), 4.75(d, *J* = 5.5 Hz, 1H, minor diastereomer), 4.17(m, 2H), 3.78(s, 6H), 3.07(d, J = 4.0 Hz, 1H, minor diastereomer,), 2.90(brs, 1H, major diastereomer), 1.21–1.09(m, 3H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 169.5, 160.8, 157.0, 141.6, 140.5, 135.3, 128.8, 128.3, 126.9, 126.8, 115.8, 104.7, 100.1, 80.8, 74.3, 61.6, 55.4, 14.1.

Minor diastereomer: δ 169.3, 160.9, 157.1, 141.0, 140.5, 135.4, 128.8, 128.3, 126.9, 126.8, 115.79, 104.7, 100.5, 81.7, 74.8, 61.7, 55.4, 14.0.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{25}H_{27}O_6$: 423.18022; found: 423.17993.

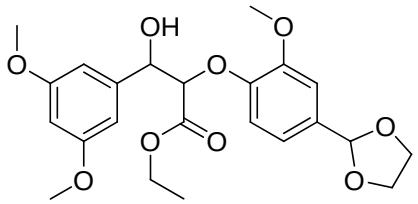


2-([1,1'-biphenyl]-4-yloxy)-1-(3,5-dimethoxyphenyl)propane-1,3-diol (1i) colorless sticky semi-solid, mixture of *erythro* : *threo* (5.86:1), 89.5% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.45(m, 4H, both diastereomers), 7.42(t, *J* = 7.6 Hz, 2H, both diastereomers), 7.32(t, *J* = 7.3 Hz, 1H, both diastereomers), 7.03(d, *J* = 12.0Hz, 2H, minor diastereomer),6.98(d, *J* = 8.0 Hz, 2H, major diastereomer), 6.64(d, *J* = 8.8, 2.2 Hz, 2H, minor diastereomer), 6.40(dt, *J* = 11.9, 2.2 Hz, 1H), 5.05(d, *J* = 3.0 Hz, 1H, both diastereomers), 4.45 (dd, *J* = 9.2, 4.5 Hz, 1H), 3.94(m, 2H, both diastereomers), 3.76(s, 6H), 3.47(d, *J* = 4.0Hz, 1H, major diastereomer), 3.26(s, 1H, minor diastereomer), 2.75(s, 1H, major diastereomer), 2.42(s, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 160.9, 157.2, 142.9, 140.6, 134.9, 128.3, 126.9, 126.8, 116.9, 104.4, 99.8, 81.9, 74.0, 61.4, 55.4. minor diastereomer: δ 161.3, 157.7, 142.3, 140.6, 135.0, 128.8, 128.4, 126.9, 126.8, 116.8, 104.9, 100.2, 82.8, 73.9, 61.3, 55.4.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{23}H_{25}O_5$: 381.16965; found: 381.16963.



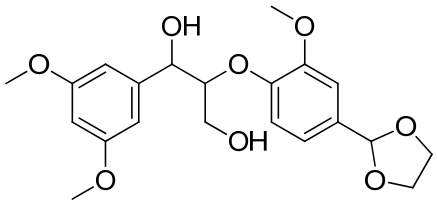
Ethyl 2-(4-(1,3-dioxolan-2-yl)-2-methoxyphenoxy)-3-(3,5-dimethoxyphenyl)-3-hydroxyl-propanoate (i-1j) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.5:1), 45.1% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13 (dd, *J* = 8.3, 1.5 Hz, 1H, both diastereomers), 7.05 (d, *J* = 1.7 Hz, 1H, major diastereomer), 7.01 (d, *J* = 1.6 Hz, 1H, minor diastereomer), 6.89 (d, *J* = 8.3 Hz, 1H), 6.63 (d, *J* = 2.1 Hz, 2H, major diastereomer), 6.58 (d, *J* = 2.1 Hz, 2H, minor diastereomer),

6.39 (s, 1H), 5.70 (d, *J* = 15.2 Hz, 1H), 5.15 (t, *J* = 4.3 Hz, 1H, major diastereomer), 5.06 (d, *J* = 6.4 Hz, 1H, minor diastereomer), 4.75 (d, *J* = 4.9 Hz, 1H, major diastereomer), 4.55 (d, *J* = 6.7 Hz, 1H, minor diastereomer), 4.15 (dd, *J* = 14.4, 7.2 Hz, 2H), 4.09 – 3.96 (m, 4H, both diastereomers), 3.86 (s, 3H), 3.78 (s, 6H), 3.74 (d, *J* = 1.8 Hz, 1H, minor diastereomer), 3.69 (d, *J* = 5.0 Hz, 1H, major diastereomer), 1.13 (t, *J* = 7.1 Hz, 3H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 169.0, 160.6, 151.3, 147.0, 141.4, 130.9, 122.2, 116.8, 111.9, 104.8, 103.3, 100.3, 83.6, 74.0, 65.2, 65.2, 61.3, 56.0, 55.3, 23.7, 14.0. minor diastereomer: δ 169.2, 160.8, 151.0, 147.2, 140.5, 130.8, 122.0, 116.0, 111.9, 104.9, 103.3, 100.7, 84.8, 75.0, 65.2, 65.2, 61.3, 56.0, 55.4, 13.9.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{23}H_{29}O_9$: 449.18061; found: 449.18072.

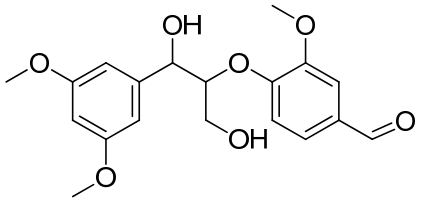


2-(4-(1,3-dioxolan-2-yl)-2-methoxyphenoxy)-1-(3,5-dimethoxyphenyl)propane-1,3-diol (1j), colorless sticky semi-solid, mixture of *erythro* : *threo* (2.5:1), 80.2% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.04 (m, 2H), 6.87 (d, *J* = 8.3 Hz, 1H), 6.59 (d, *J* = 2.0 Hz, 2H, minor diastereomer), 6.54 (d, *J* = 2.0 Hz, 2H, major diasrereomer), 6.37 (d, *J* = 1.9 Hz, 1H, minor diastereomer), 6.34(d, *J* = 1.9 Hz, 1H, major diastereomer), 5.65 (s, 1H), 4.93 (s, 1H), 4.13 – 3.85 (m, 7H, both diastereomers), 3.84, 3.82, 3.74 (all singlets for methoxy groups, 9H for both diastereomerss), 3.69 – 3.60 (m, 1H, both diastereomers), 3.49 (ddd, *J* = 12.2, 7.8, 4.1 Hz, 1H, both diasteromer), 3.05 (d, *J* = 6.5 Hz, 1H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 160.8, 152.1, 146.8, 142.6, 131.2, 122.3, 118.6, 111.8, 105.0, 104.1, 103.2, 99.8, 88.7, 86.7, 73.0, 65.2, 60.8, 56.0, 55.3. minor diastereomer: δ 160.8, 151.8, 147.5, 142.2, 131.2, 122.3, 118.6, 111.7, 105.0, 104.1, 103.2, 100.3, 88.8, 86.7, 73.9, 65.2, 61.0, 56.0, 55.3.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{21}H_{27}O_8$: 407.17004; found: 407.16947.



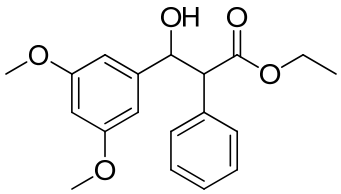
4-((1-(3,5-dimethoxyphenyl)-1,3-dihydroxypropan-2-yl)oxy)-3-methoxybenzaldehyde(1k)

colorless sticky semi-solid, mixture of *erythro* : *threo* (3:1), 96.5% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.79 (s, 1H, minor diastereomer), 9.78 (s, 1H, major diastereomer), 7.64 – 7.38 (m, 2H, both diastereomers), 7.00 (t, *J* = 7.3 Hz, 1H, both diastereomers), 6.59 (s, 2H, minor diastereomer), 6.57 (s, 2H, major diastereomer), 6.38 (s, 1H, minor diastereomer), 6.36 (s, 1H, major diastereomer), 4.99 (s, 1H, major diastereomer), 4.96 (s, 1H, minor diastereomer), 4.33 (q, *J* = 4.0 Hz,1H, major diastereomer), 4.26 (q, *J* = 4.0 Hz,1H, minor diastereomer), 3.96, 3.92 (s, 4H), 3.82 – 3.66 (m, 7H), 3.65 – 3.49 (m, 1H, both diastereomers), 2.87 (brs, 1H, major diastereomer), 2.72(brs, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 190.6, 160.9, 156.3,147.6, 142.3,130.4, 127.5, 118.6, 111.6, 104.9, 99.9, 85.8, 73.4, 61.0, 56.2, 55.4. minor diastereomer: δ 190.5, 161.0, 156.1, 148.4, 141.9,130.5, 127.6, 118.4, 111.5, 104.2, 100.3, 87.9, 74.0, 61.3, 56.2, 55.4.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{19}H_{22}NaO_7$: 385.12577; found: 385.12535.



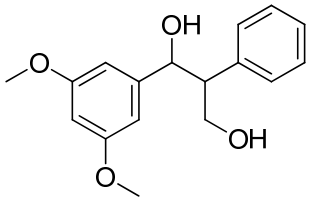
ethyl 3-(3,5-dimethoxyphenyl)-3-hydroxy-2-phenylpropanoate (i-4a) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.0:1), 32.9% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (dd, *J* = 7.1, 3.3 Hz, 2H), 7.18 (d, *J* = 6.0 Hz, 2H), 7.14 – 7.08 (m, 1H), 6.43 (d, *J* = 2.0 Hz, 1H, major diastereomer), 6.34 (s, 1H, minor diastereomer), 6.29 – 6.15 (m, 2H, both diastereomers), 5.21 (d, *J* = 7.2 Hz, 1H, minor diastereomer), 5.08 (d, *J* = 9.3 Hz, 1H, major diastereomer), 4.14 (m, 2H both diastereomers), 3.86 – 3.77 (m, 1H), 3.70 (s, 6H, minor diastereomer), 3.61 (s, 4H, major diastereomer), 3.39 (brs, 1H, major diastereomer), 2.88 (brs, 1H, minor diastereomer), 1.21 (t, *J* = 7.1 Hz, 3H, major diastereomer), 1.08 (t, *J* = 7.1 Hz, 3H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 173.4 160.4, 143.4, 135.4, 128.6, 128.5, 127.4, 127.5, 104.6, 100.3, 75.0, 61.2, 61.0, 59.9, 55.5 (d, J = 7.3 Hz), 14.05.

Minor diastereomer: δ 172.5, 160.6, 143.4, 134.8, 129.3, 128.5, 127.8, 104.6, 100.3, 75.0, 61.0, 59.5, 13.9.

HRMS(ESI): m/z: $[M + NH_4]^+$ calculated for: $C_{22}H_{32}NO_5$ 390.22750; found: 390.22818.

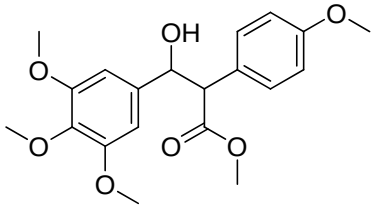


1-(3,5-dimethoxyphenyl)-2-phenylpropane-1,3-diol (4a), colorless sticky semi-solid, mixture of *erythro* : *threo* (1.29:1), 86.8% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.21 (m, 2H, both diastereomers), 7.19-7.12 (m, 2H, both diastereomers), 6.99 (d, J = 7.1 Hz, 1H, both diastereomers), 6.33 (s, 2H, major diastereomer), 6.23 (s, 1H, minor diastereomer), 4.91 (d, J = 6.5 Hz, 1H, major diastereomer), 4.86 (d, J = 8.0 Hz, 1H,minor diastereomer), 4.10 (dd, J = 10.7, 8.0 Hz, 1H, minor diastereomer), 3.89 (dd, J = 10.9, 4.1 Hz, 1H, major diastereomer), 3.76 (m, 2H, both diastereomers), 3.68 (s, 6H, major diasrereomer), 3.61 (s, 6H, minor diastereomer), 3.30 (s, 1H, minor diastereomer), 3.06 (m, 1H, both diastereomers), 2.68 (s, 1H, major diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diasrereomer: δ 160.6, 144.6, 138.6, 129.2, 128.5, 127.2, 104.5, 99.9, 77.4, 64.0, 55.3, 54.7. minor diastereomer: δ 160.4, 145.3, 139.3, 129.2, 128.4, 126.9, 104.5, 99.7, 79.4, 66.2, 55.2, 54.7.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{17}H_{20}NaO_4$: 311.12538; found: 311.12609.

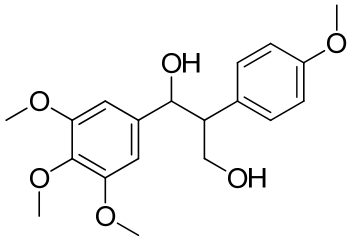


methyl 3-hydroxy-2-(4-methoxyphenyl)-3-(3,4,5-trimethoxyphenyl)propanoate(i-4b) white solid, 55.9% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, *J* = 8.6 Hz, 2H), 6.87 (d, *J* = 8.6 Hz, 2H), 6.49 (s, 2H), 5.14 (ddd, *J* = 12.9, 8.2, 2.7 Hz, 1H), 3.84 – 3.78 (m, 12H), 3.77 (s, 1H), 3.59 (s, 3H), 2.69 (d, *J* = 2.1 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.3, 159.4, 153.0, 136.5, 130.3, 126.4, 114.0, 103.6, 75.0, 60.8, 58.6, 56.1, 55.3, 52.1.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{20}H_{24}NaO_7$ 399.14142; found: 399.14262.

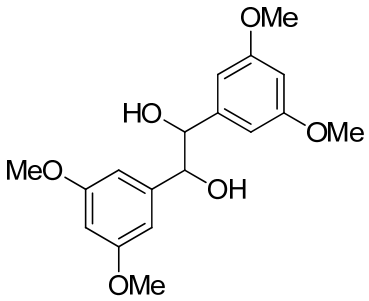


2-(4-methoxyphenyl)-1-(3,4,5-trimethoxyphenyl)propane-1,3-dio(4b), white solid, 81.4% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21-7.00 (m, 2H, both diastereomers), 6.88 (m, *J* = 8.9, 2.3 Hz, 2H, both diastereomers), 6.51-6.33 (m, 2H, both diastereomers), 5.35-5.24 (m, 2H, both diastereomers), 4.91 (s, 1H, both diastereomers), 3.84-3.70 (m, 14H, both diastereomers), 3.07 (s, 1H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.9, 153.0, 137.8, 137.2, 130.3, 130.2, 114.0, 103.6, 75.8, 64.1, 60.9, 56.0, 55.3, 54.6, 53.5.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{19}H_{24}NaO_6$, 371.14651; found: 371.14656.

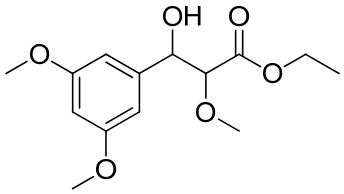


1,2-bis(3,5-dimethoxyphenyl)ethane-1,2-diol (4c) white solid, 95.1% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.48 (d, *J* = 2.0 Hz, 1H), 6.41 (d, *J* = 2.1 Hz, 1H), 6.36 (d, *J* = 2.0 Hz, 1H), 6.33 – 6.28 (m, 4H), 4.67 (s, 1H), 4.56 (d, *J* = 6.5 Hz, 2H), 3.76 (s, 1H), 3.69 (d, *J* = 15.7 Hz, 12H), 3.24 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.5 (d, *J* = 11.6 Hz), 142.4 (d, *J* = 17.3 Hz), 104.9 (d, *J* = 19.2 Hz), 104.6, 100.3, 100.1, 78.8, 78.0, 65.2, 55.3.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{18}H_{23}O_6$, 335.14891; found: 335.14967.

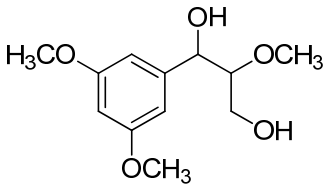


ethyl 3-(3,5-dimethoxyphenyl)-3-hydroxy-2-methoxypropanoate (i-4d) colorless sticky semi-solid, mixture of *erythro* : *threo* (3.57:1), 43.0% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.44 (dd, *J* = 5.1, 2.3 Hz, 2H, both diastereomers), 6.28 (dd, *J* = 5.1, 2.8 Hz, 1H, both diastereomers), 4.79 (d, *J* = 5.9 Hz, 1H, major diastereomer), 4.73 (d, *J* = 5.5 Hz, 1H, minor diastereomer), 4.12 – 3.98 (m, 2H, both diastereomers), 3.84 (d, *J* = 5.9 Hz, 1H, major diastereomer), 3.78 (d, *J* = 5.5 Hz, 1H, minor diastereomer), 3.69 – 3.62 (m, 6H, both diastereomers), 3.30 (s, 1H), 3.26 (s, 3H, minor diastereomer), 1.09 (dt, *J* = 21.2, 7.1 Hz, 3H, major diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 170.4, 160.5, 142.3, 104.6, 100.0, 84.6, 73.9, 60.9, 58.6, 55.2, 14.0. Minor diastereomer: 170.3, 160.6, 141.8, 104.5, 100.0, 85.2, 74.6, 61.0, 58.7, 55.2, 13.9.

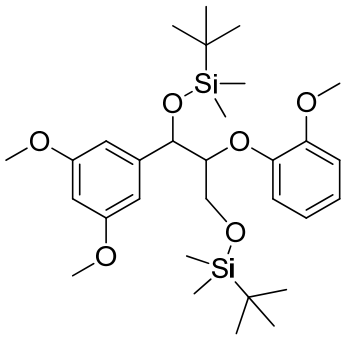
HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{14}H_{20}NaO_6$: 307.11521 ; found: 307.11591.



1-(3,5-dimethoxyphenyl)-2-methoxypropane-1,3-diol (4d) colorless sticky semi-solid, mixture of *erythro* : *threo* (2 : 1), 83.1% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.62-6.49 (m, 2H, both diastereomers), 6.37 (s, 1H, both diastereomers), 4.85 (s, 1H, major diastereomer), 4.69 (d, *J* = 5.4 Hz, 1H, minor diastereomer), 3.77 (s, 7H), 3.69 (d, *J* = 10.5 Hz, 1H, both diastereomers), 3.52-3.27 (m, 5H, both diastereomers), 3.01 (s, 1H, major diastereomer), 2.77 (s, 1H, minor diastereomer).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 160.8, 143.6, 104.2, 99.5, 84.54, 73.4, 60.8, 57.9, 55.3. minor diastereomer: δ 160.8, 143.2, 104.7, 99.8, 85.5, 73.7, 60.4, 58.9, 55.3.

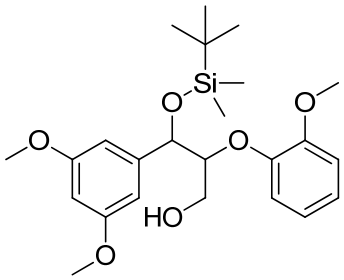


5-(3,5-dimethoxyphenyl)-6-(2-methoxyphenoxy)-2,2,3,3,9,9,10,10-octamethyl-4,8-dioxa-3,9-disilaundecane (i-4e-1) colorless sticky semi-solid, mixture of *erythro* : *threo* (2.6 : 1), 86.1% of yield..

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.02 (d, *J* = 7.6 Hz, 1H, minor diastereomer), 6.95(d, *J* = 7.6 Hz, 1H, major diastereomer), 7.00 – 6.93 (m, 1H, both diastereomers), 6.90 – 6.75 (m, 3H), 6.68 (d, *J* = 2.2 Hz, 2H, minor diastereomer), 6.61 (d, *J* = 2.2 Hz, 2H, major diastereomer), 6.36 (t, *J* = 2.2 Hz, 1H, minor diasrereomer), 6.31 (t, *J* = 2.2 Hz, 1H, major diastereomer), 4.96 (d, *J* = 4.9 Hz, 1H), 4.39 (dd, *J* = 10.3, 4.6 Hz, 1H, major diastereomer), 4.32 (d, *J* = 3.5 Hz, 1H, minor diastereomer), 3.92 (t, *J* = 4.7 Hz, 2H), 3.78 (m, 9H, both diastereomers), 0.91 – 0.79 (m, 18H, both diastereomers), 0.09 – -0.13 (m, 12H, both diastereomers).

^{13}C NMR (101 MHz, $CDCl_3$) major diastereomer: δ 160.3, 150.2, 148.8, 144.1, 121.2, 120.6, 116.6, 112.2, 105.1, 99.5, 85.1, 74.5, 62.4, 55.7, 55.3, 25.9, 25.8, 18.2, -4.9, -5.1, -5.4, -5.6. Minod diastereomer: δ 160.3, 150.3, 148.9, 144.0, 121.2, 120.8, 116.5, 112.5, 105.1, 99.6, 84.7, 74.0, 62.2, 55.8, 55.3, 25.9, 25.8, 18.2, -4.9, -5.1, -5.5, -5.6.

HRMS(ESI): m/z: $[M + NH_4]^+$ calculated for: $C_{30}H_5NO_6Si_2$: 580.34842; found: 580.34966.

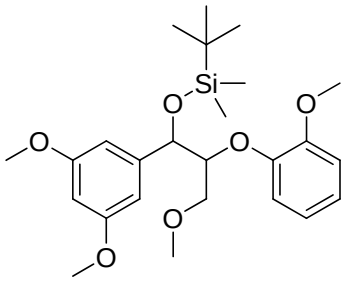


3-((tert-butyldimethylsilyl)oxy)-3-(3,5-dimethoxyphenyl)-2-(2-methoxyphenoxy)propan-1-ol(i-4e-2) colorless oil, 55.8% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.94 (dd, *J* = 11.2, 4.3 Hz, 1H), 6.85 (dd, *J* = 8.1, 1.2 Hz, 1H), 6.77 (td, *J* = 7.9, 1.4 Hz, 1H), 6.61 (d, *J* = 2.2 Hz, 2H), 6.56 (dd, *J* = 8.0, 1.3 Hz, 1H), 6.37 (t, *J* = 2.2 Hz, 1H), 4.93 (d, *J* = 6.4 Hz, 1H), 4.11 – 4.01 (m, 1H), 3.96 – 3.86 (m, 1H), 3.83 (d, *J* = 6.9 Hz, 3H), 3.82 – 3.74 (m, 7H), 3.16 (t, *J* = 6.5 Hz, 1H), 0.89 (d, *J* = 20.0 Hz, 9H), 0.11 (s, 3H), -0.08 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.6, 151.1, 147.8, 144.7, 123.3, 121.3, 119.8, 112.0, 105.0, 99.7, 87.7, 74.9, 61.3, 55.7, 55.3, 25.8, 18.2, -4.7, -5.1.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{24}H_{37}O_6Si$: 449.23539; found: 449.23589.



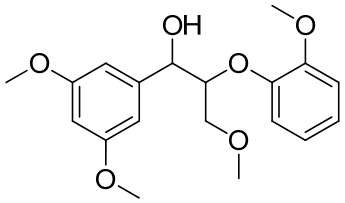
tert-butyl(1-(3,5-dimethoxyphenyl)-3-methoxy-2-(2-methoxyphenoxy)propoxy)dimethylsilan e(i-4e-3) colorless oil, mixture of *erythro* : *threo* (1.1 : 1), 74.6% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.88 – 6.67 (m, 4H, both diastereomers), 6.54 (d, *J* = 2.2 Hz, 2H, major diastereomer), 6.50 (d, *J* = 2.2 Hz, 1H, minor diastereomer), 6.29 (t, *J* = 2.2 Hz, 1H, major diastereomer), 6.25 (t, *J* = 2.2 Hz, 1H, minor diastereomer), 4.90 (d, *J* = 5.7 Hz, 1H, major diastereomer), 4.37 (d, *J* = 5.4 Hz, 1H, minor diastereomer), 4.32 (d, *J* = 4.1 Hz, 1H, minor diastereomer), 4.26 (d, *J* = 3.0 Hz, 1H, major diastereomer), 3.89–3.82 (m, 1H, major diastereomer), 3.80 – 3.73 (m, 1H, major diastereomer), 3.71–3.67 (m, 9H, both diastereomers), 3.65 (d, *J* = 2.2Hz 1H, minor diastereomer), 3.57 (dd, *J* = 10.4, 2.9 Hz, 1H, major diastereomer),

3.30 – 3.18 (m, 3H), 0.80 (d, *J* = 8.0 Hz, 9H), 0.00 (s, 1H), -0.05 (d, *J* = 4.2 Hz, 1H), -0.07 (s, 2H), -0.20 (s, 1H).

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{25}H_{39}O_6Si$ 463.25104,; found: 463.25086.

.

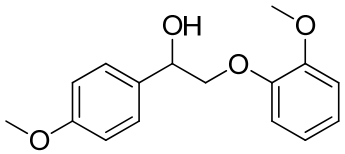


3-(1-hydroxy-3-methoxy-2-(2-methoxyphenoxy)propyl)-5-methoxyphenol (**4e**), colorless sticky semi-solid, mixture of *erythro* : *threo* (1 : 1),82.2% of yield .

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.15 – 7.10 (m, 1H), 7.08 – 7.01 (m, 1H), 7.00 – 6.89 (m, 2H), 6.88 – 6.83 (m, 1H), 6.79 (td, *J* = 7.8, 1.4 Hz, 1H), 6.63 (dd, *J* = 8.0, 1.4 Hz, 1H), 6.56 (dd, *J* = 5.3, 2.2 Hz, 2H), 6.38 (dt, *J* = 13.5, 2.2 Hz, 1H), 4.89 (t, *J* = 4.2 Hz, 1H), 4.45 (d, *J* = 6.7 Hz, 1H), 4.40 – 4.31 (m, 1H), 4.12 – 4.04 (m, 1H), 3.99 (d, *J* = 4.7 Hz, 1H), 3.93 (dd, *J* = 12.0, 6.6 Hz, 1H), 3.89 (s, 1H), 3.83 (s, 1H), 3.79 (s, 1H), 3.78 (d, *J* = 0.8 Hz, 6H), 3.67 (dd, *J* = 10.6, 6.6 Hz, 1H), 3.46 (dd, *J* = 10.6, 3.4 Hz, 1H), 3.35 (d, *J* = 7.7 Hz, 3H), 3.13 (t, *J* = 6.6 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.8 (d, *J* = 11.3 Hz), 152.3 – 151.8 (m), 151.5 (d, *J* = 34.5 Hz), 147.5, 147.1, 142.4, 141.5, 123.9, 123.6, 121.4 (d, *J* = 10.6 Hz), 120.9, 120.5, 112.2 (d, *J* = 12.3 Hz), 105.5, 104.2, 100.0, 99.5, 86.5, 85.1, 83.2, 73.1, 71.2, 61.4, 59.3, 57.5, 55.9 (d, *J* = 9.7 Hz), 55.4 (d, *J* = 3.1 Hz).

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{19}H_{25}O_6$: 349.16456,; found: 349.16521.

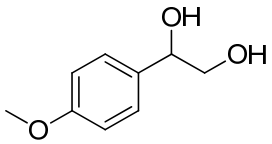


2-(2-methoxyphenoxy)-1-(4-methoxyphenyl)ethanol (4f) white solid, 77.7% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.6 Hz, 2H), 7.00–6.76 (m, 6H), 5.06 (d, *J* = 9.2 Hz, 1H), 4.12 (dd, *J* = 10.0, 2.8 Hz, 1H), 3.96 (t, *J* = 9.7 Hz, 1H), 3.85 (s, 3H), 3.79 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4, 149.9, 148.0, 131.8, 127.6, 122.3, 121.1, 115.5, 113.9, 112.0, 76.0, 71.9, 55.8, 55.3.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_{16}H_{18}NaO_4$: 297.10973; found: 297.11043.

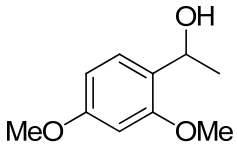


1-(4-methoxyphenyl)ethane-1,2-diol(4g) colorless solid, 86.3% of yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 8.6 Hz, 2H), 6.90 (d, *J* = 8.7 Hz, 2H), 4.82 – 4.73 (m, 1H), 3.81 (s, 3H), 3.76 – 3.57 (m, 2H), 2.45 (d, *J* = 3.2 Hz, 1H), 2.06 (dd, *J* = 7.3, 4.8 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.4, 132.6, 127.4, 114.0, 74.3, 68.1, 55.3.

HRMS(ESI): m/z: $[M + Na]^+$ calculated for: $C_9H_{12}NaO_3$:191.06787; found: 191.06807.



1-(2,4-dimethoxyphenyl)ethanol(4h) white solid, 97.3% of solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (d, *J* = 8.0 Hz, 1H), 6.50 – 6.36 (m, 2H), 5.03 (d, *J* = 6.1 Hz, 1H), 3.80 (d, *J* = 10.3 Hz, 6H), 2.71 (d, *J* = 8.4 Hz, 1H), 1.48 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.0, 157.6, 126.7, 126.2, 104.1, 98.6, 65.8, 55.3, 22.9.

HRMS(ESI): m/z: $[M + H]^+$ calculated for: $C_{10}H_{14}NaO_3$, 205.08352; found: 205.08294.

Ⅵ Reference

[1] J. Buendia, J. Mottweiler, C. Bolm, *Chem. Eur. J.* **2011**, *17*, 13877.

[2] (a) B. Sedai, C. Diaz-Urrutia, R. T. Baker, R. L. Wu, L. A. Silks, S. K. Hanson, *Acs Catalysis* **2013**, *3*, 3111; (b) E. Baciocchi, C. Fabbri, O. Lanzalunga, *J. Org. Chem*. **2003**, *68*, 9061.

[3] S. Son, F. D. Toste, *Angew. Chem.Int. Ed.* **2010**, *49*, 3791.

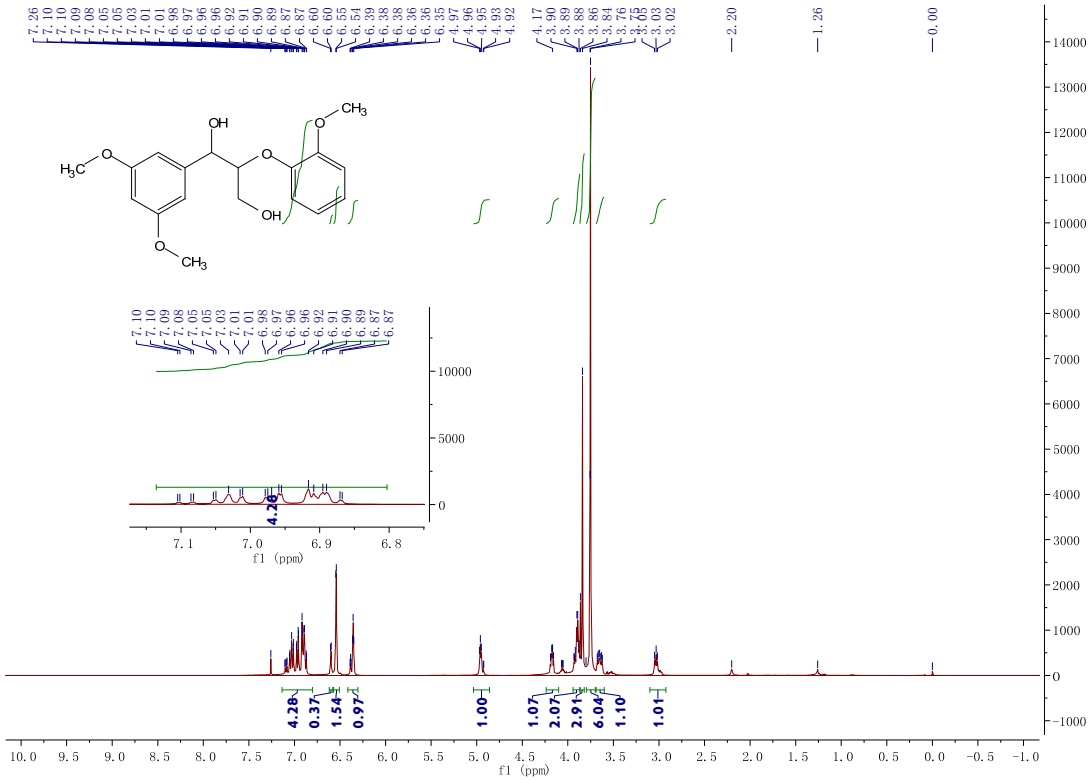
[4] V. Carine, S. Florence, L. Marie-Isabelle, A. Janick, R. Jacques, *Eur. J. Org. Chem.* **2009**, 3138.

[5] H. U. Shetty, W. L. Nelson, *J. Med. Chem.*, **1988**, *31*, 55.

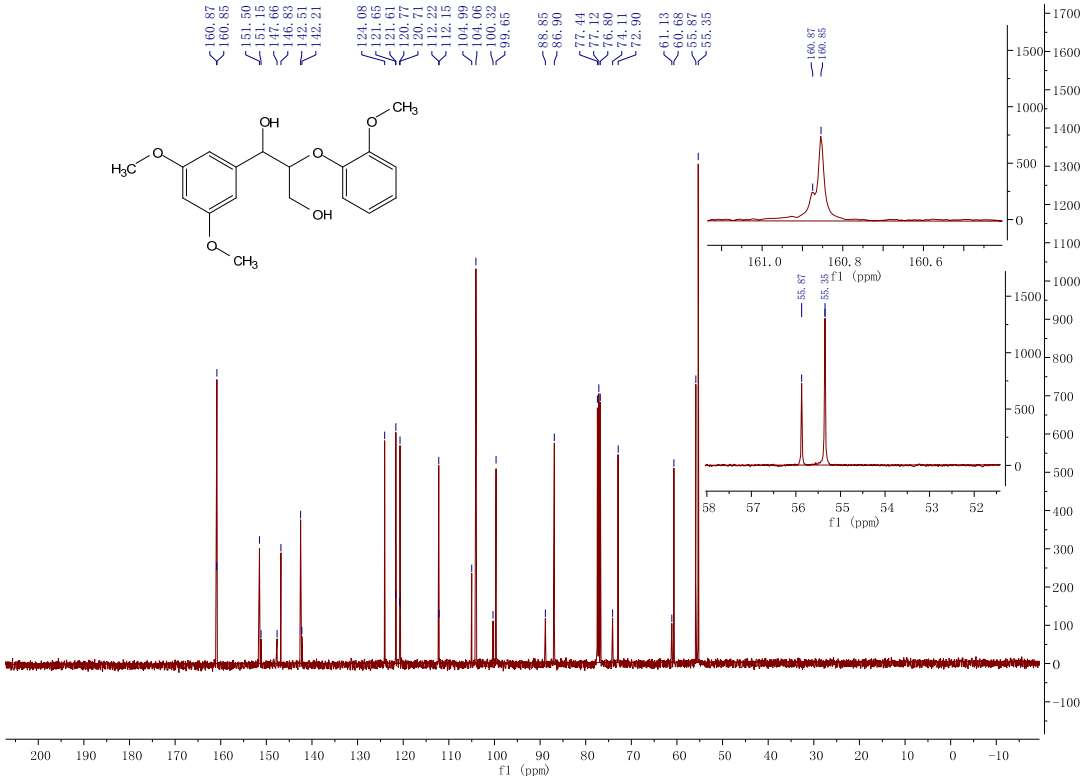
[6] H. D. Johan, F. Peter, M. Robert, *J. Org. Chem.*, **2008**, *73*, 3228..

Ⅶ NMR Spectra of product

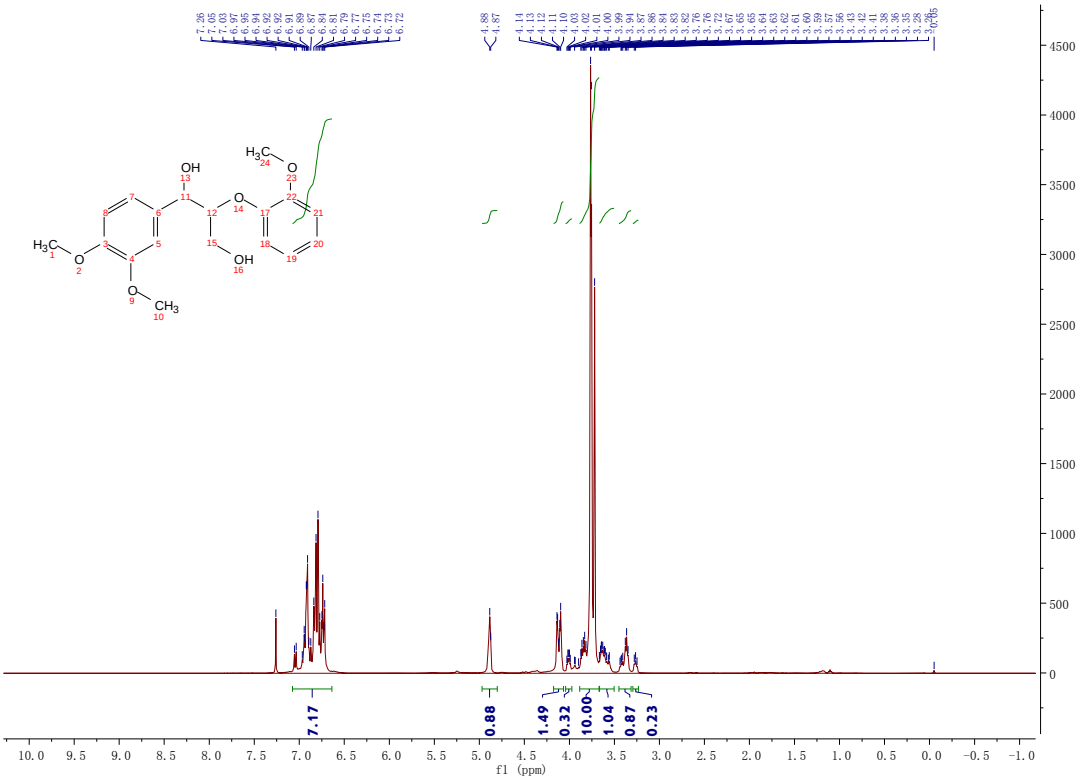
1a ^{1}H NMR



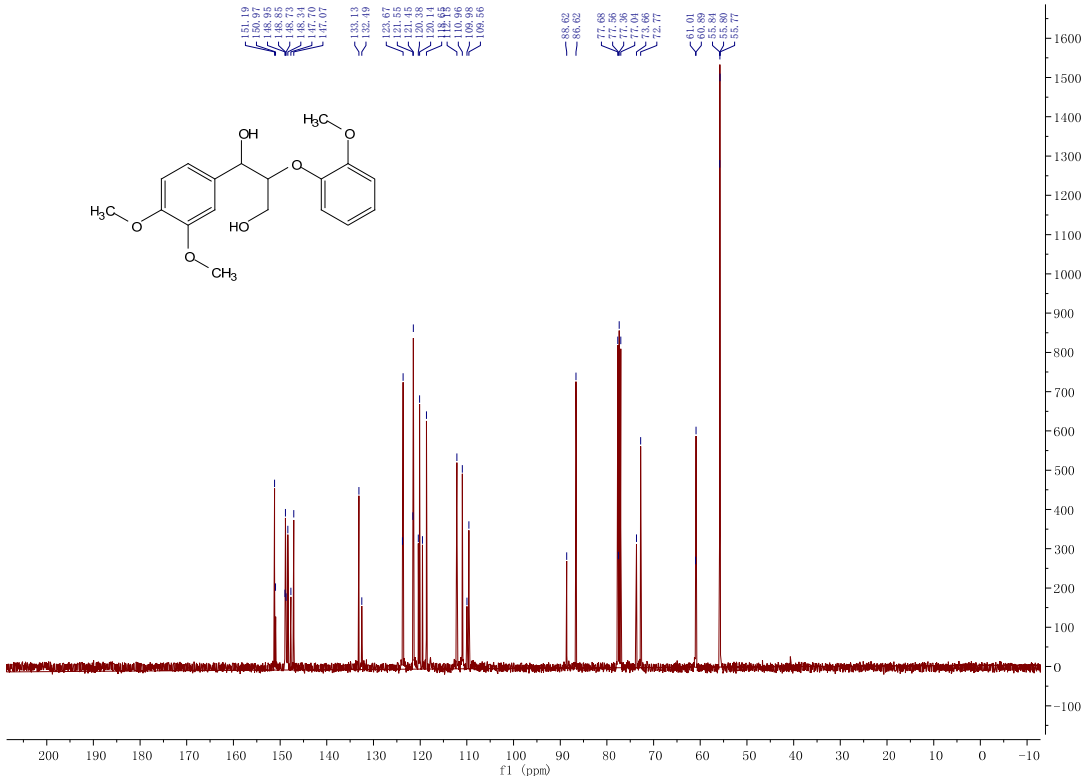
1a ^{13}C NMR



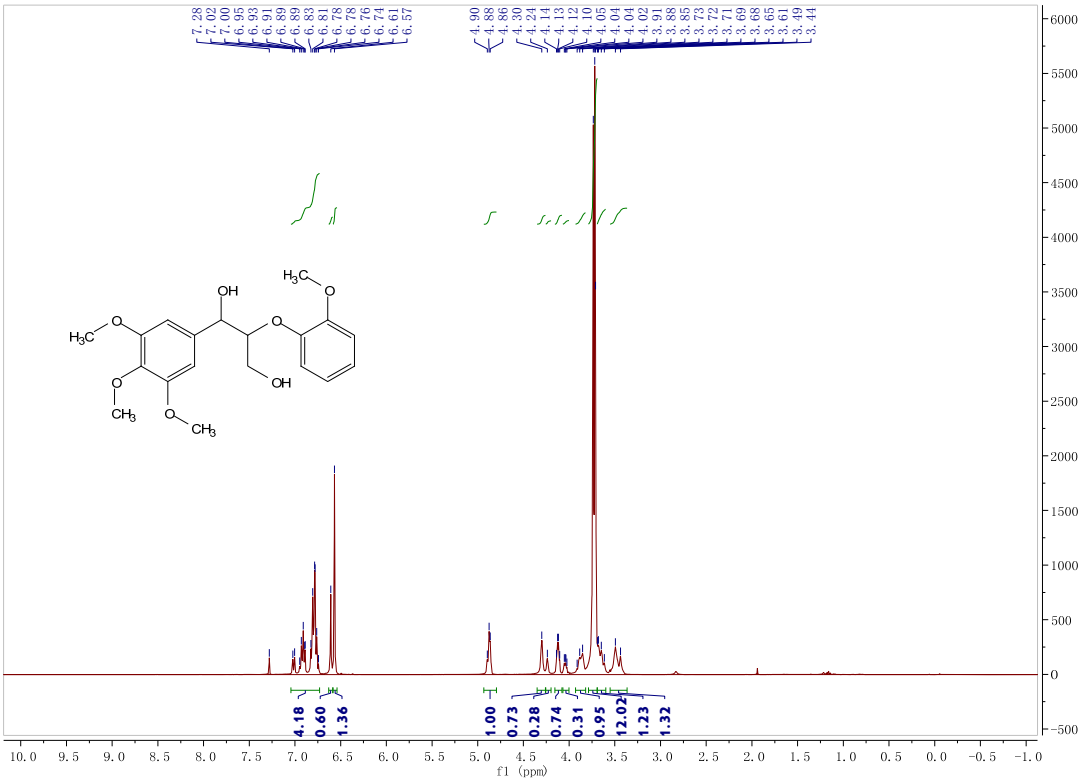
1b ^{1}H NMR



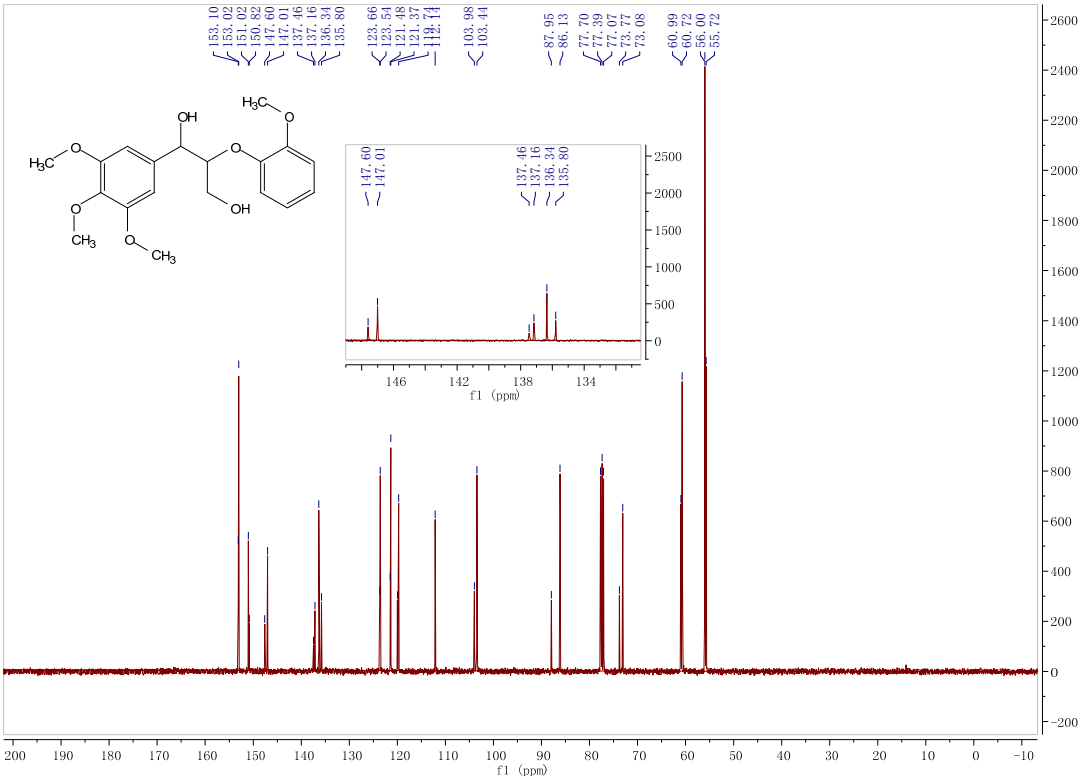
1b ^{13}C NMR



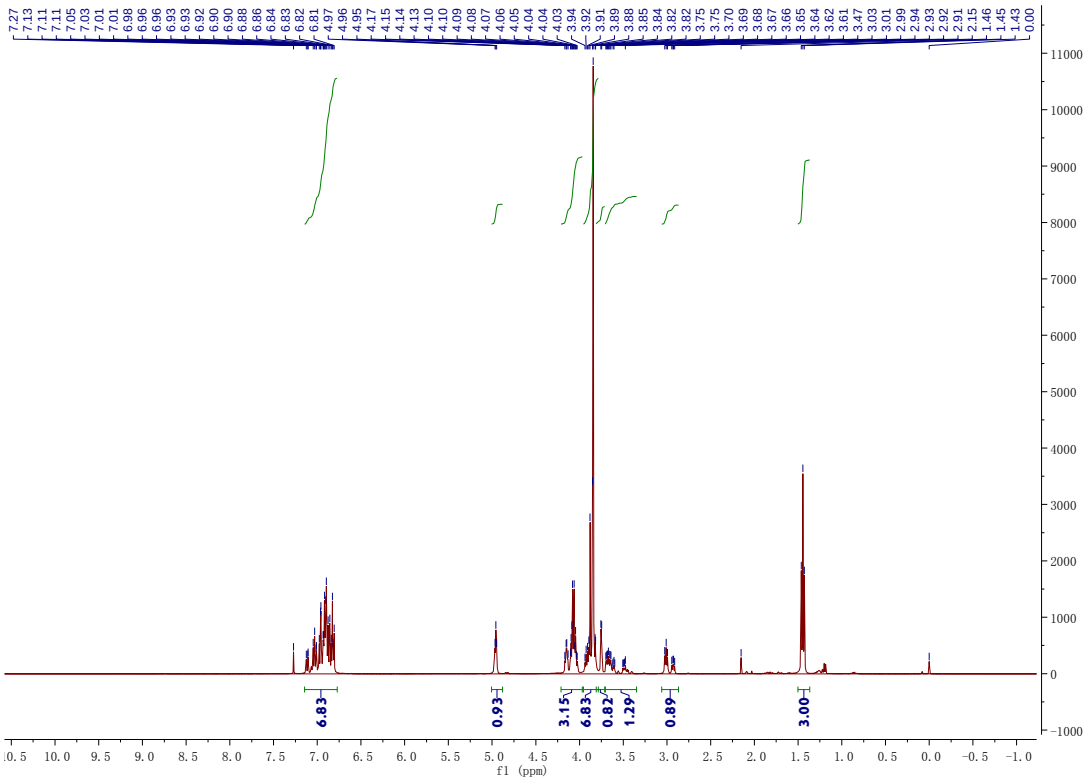
1c ^{1}HNMR



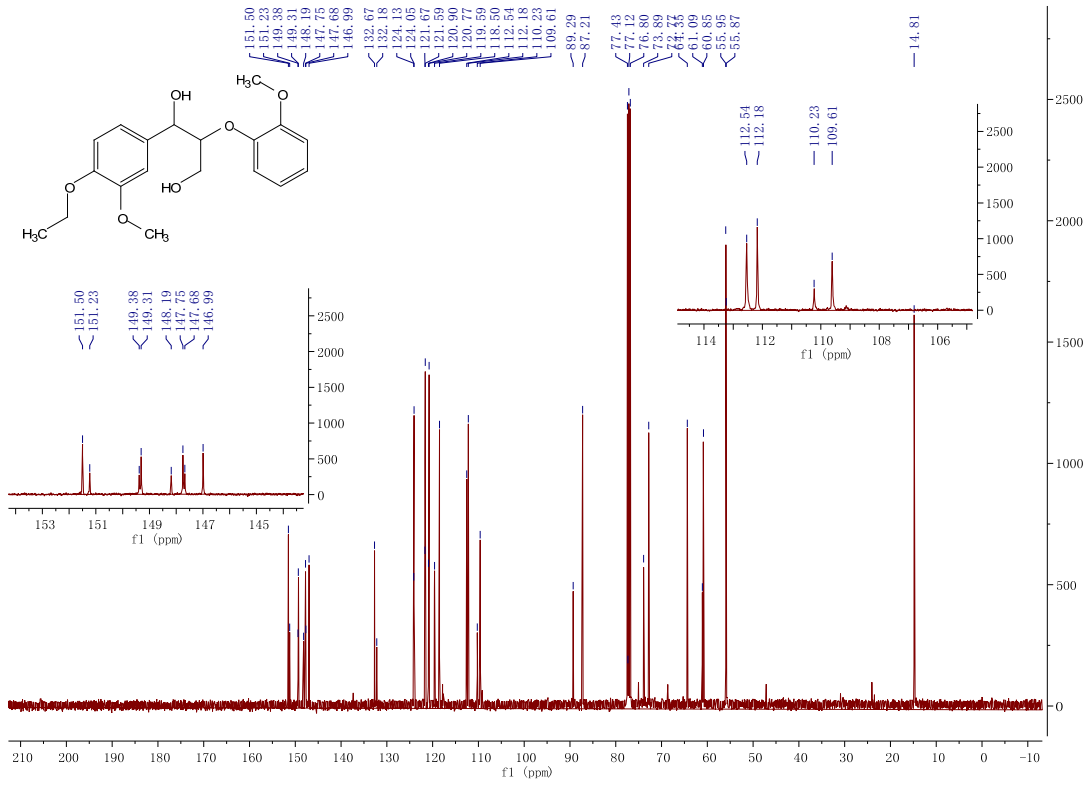
1c ^{13}C NMR



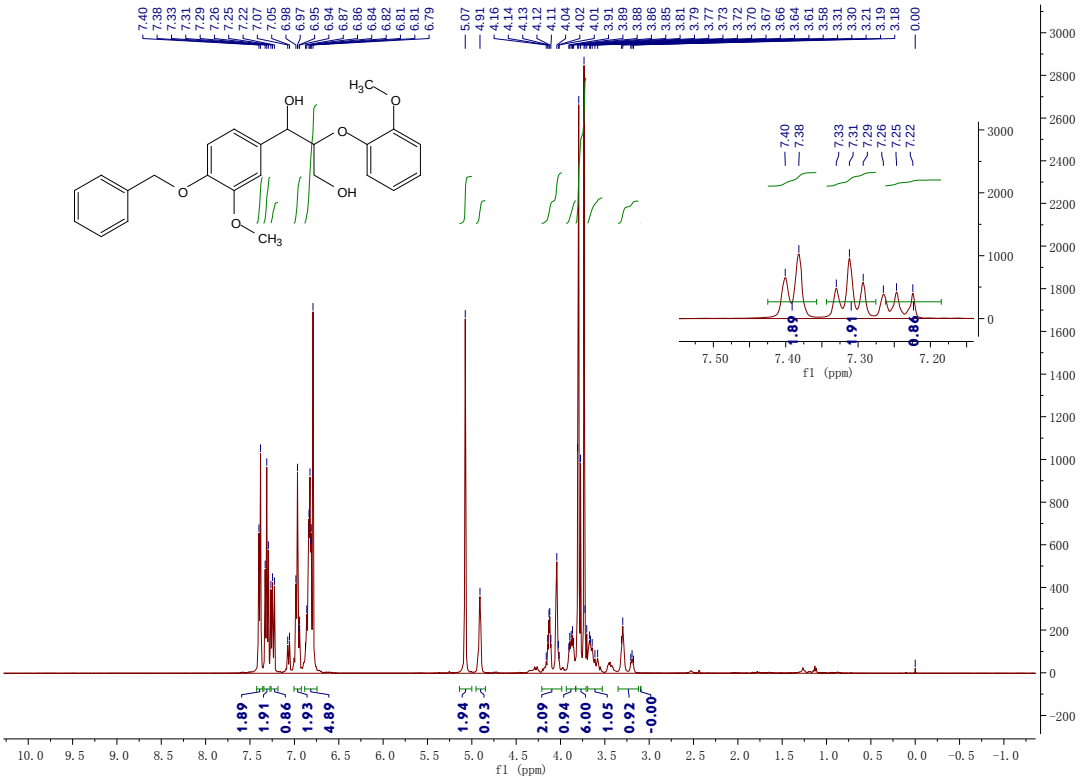
1d ^{1}H NMR



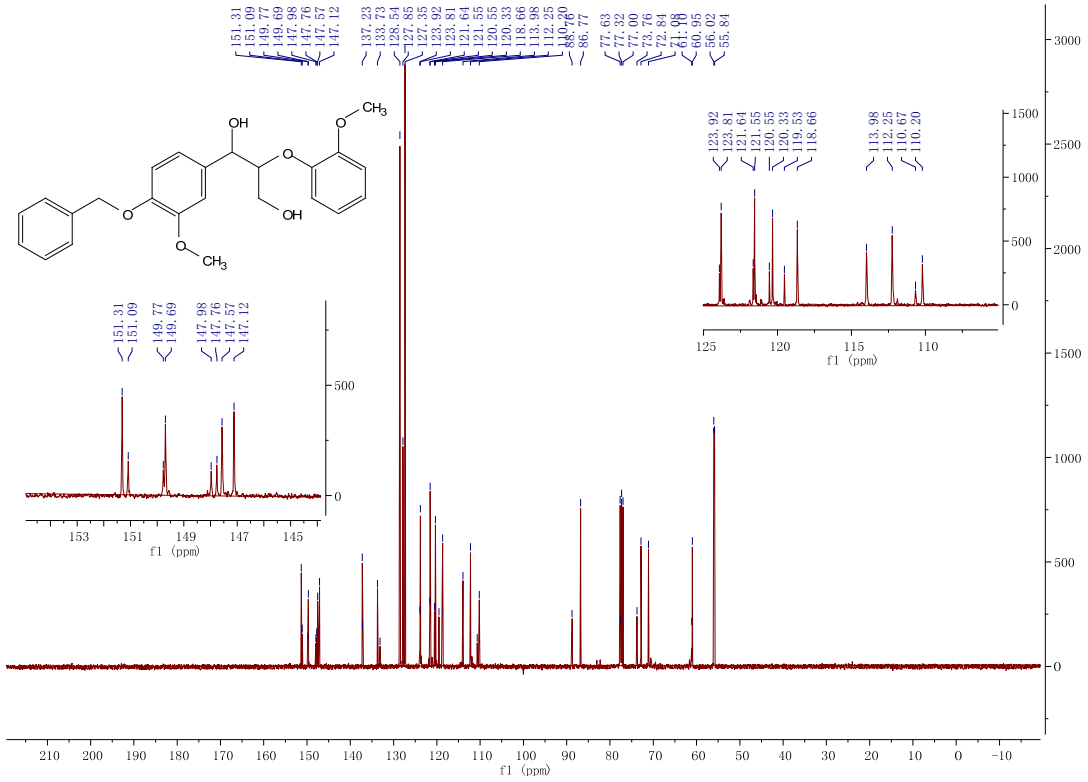
1d ^{13}C NMR



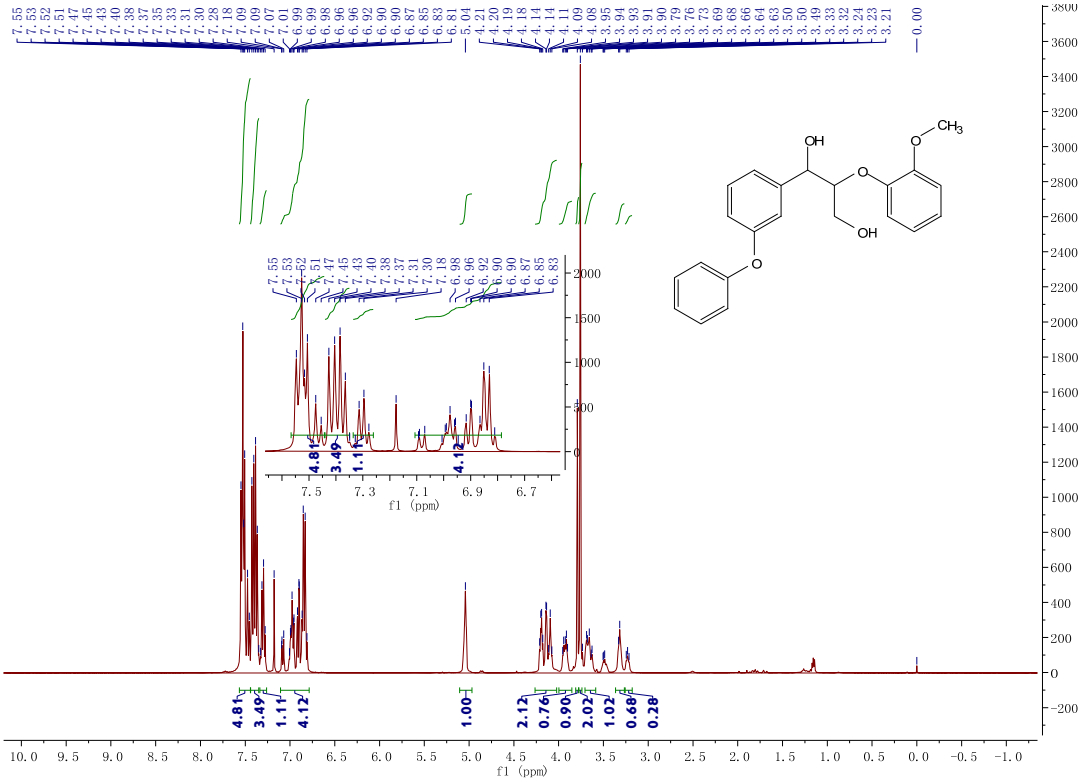
1e ^{1}H NMR



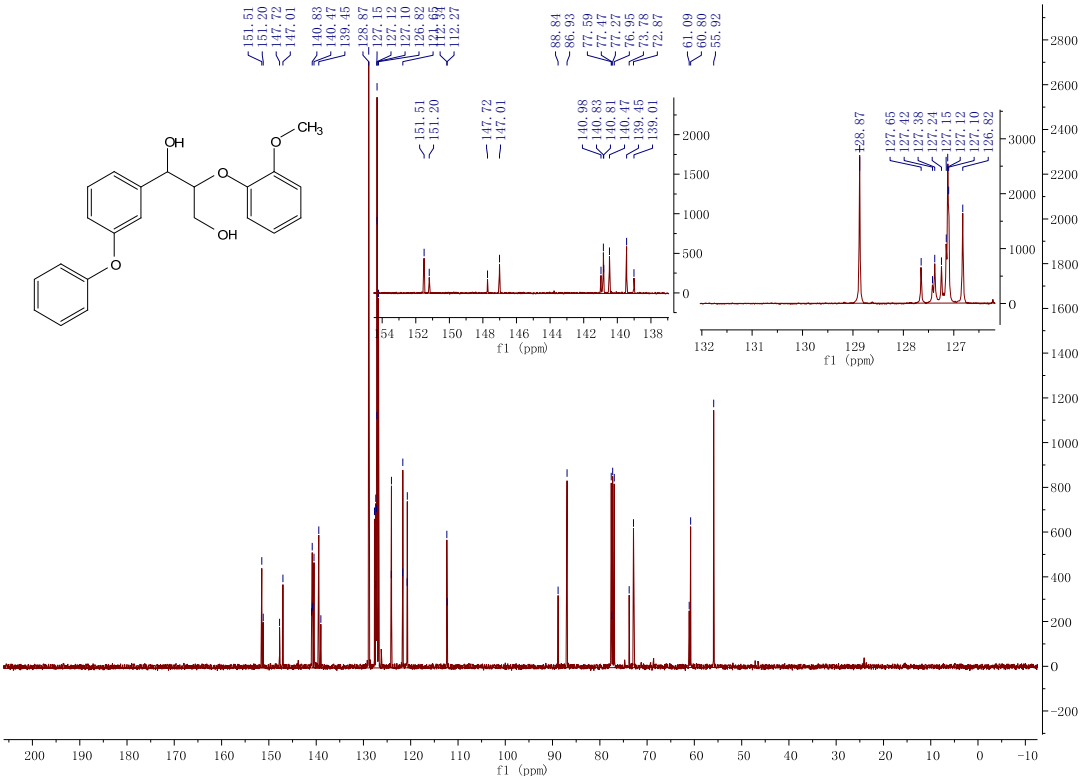
1e ^{13}C NMR



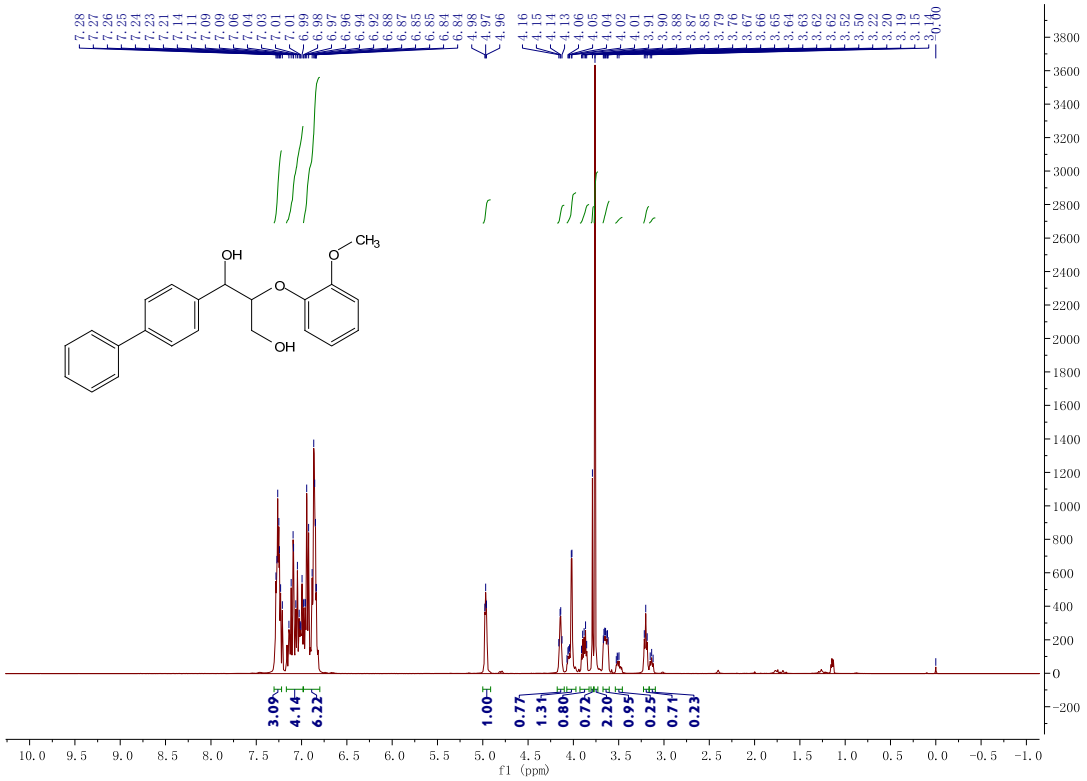
1f ^{1}H NMR



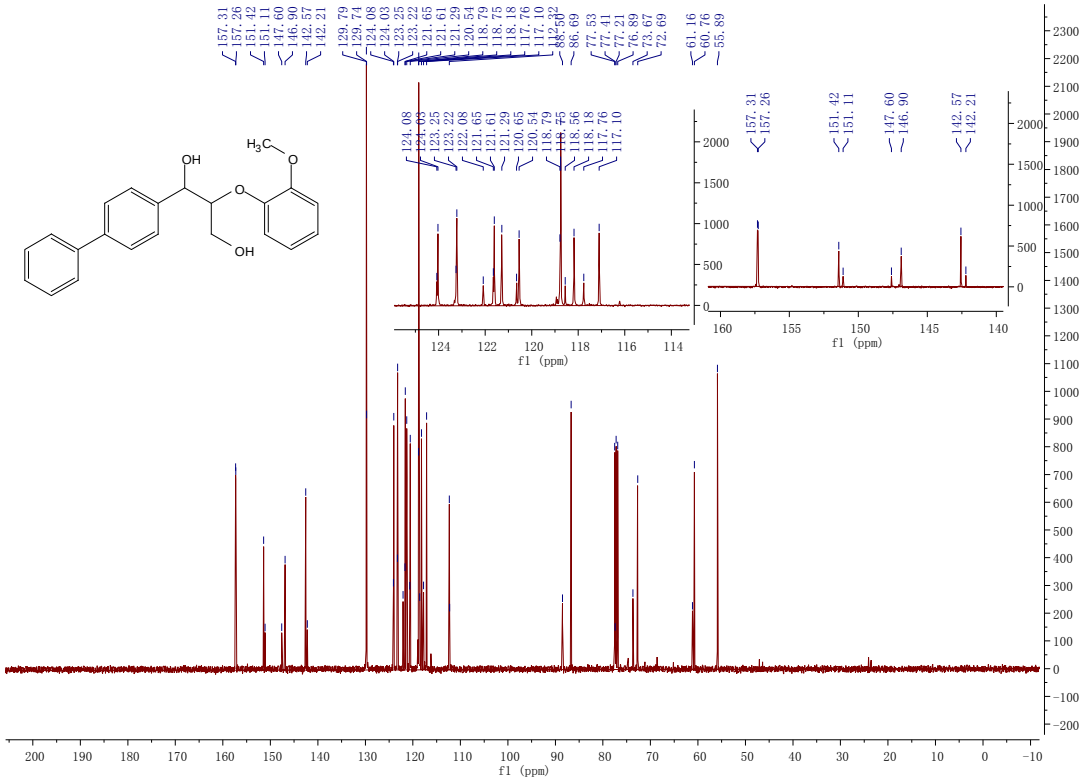
1f ^{13}C NMR



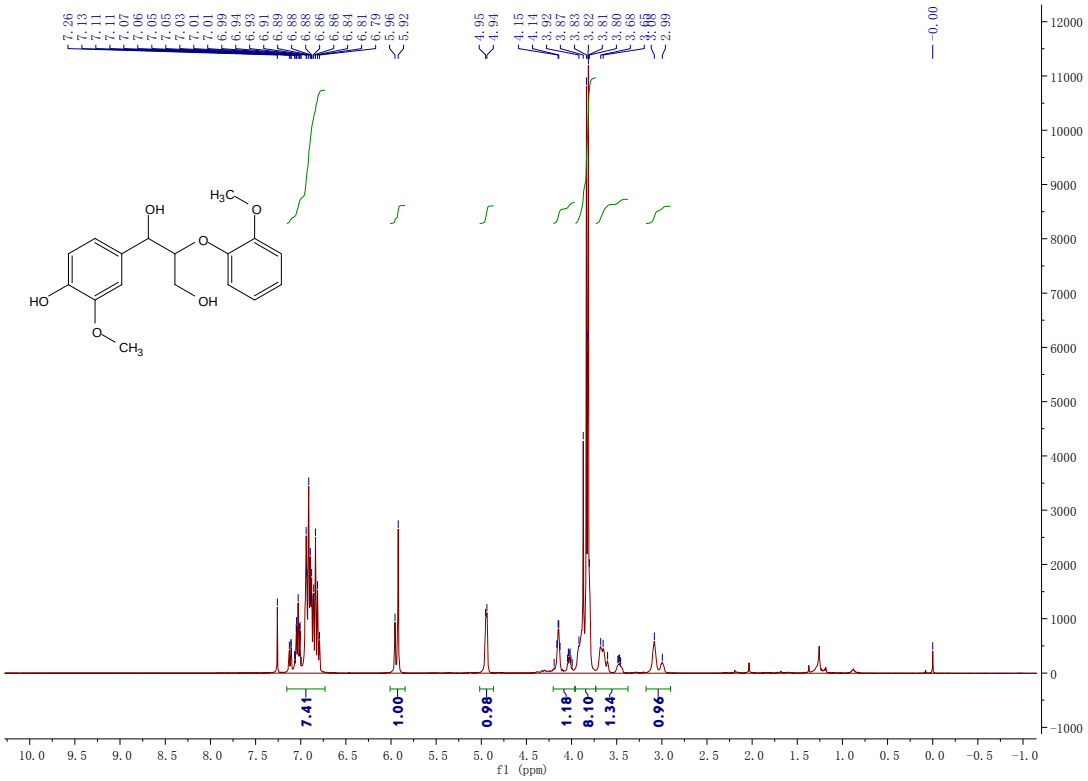
1g ^{1}H NMR



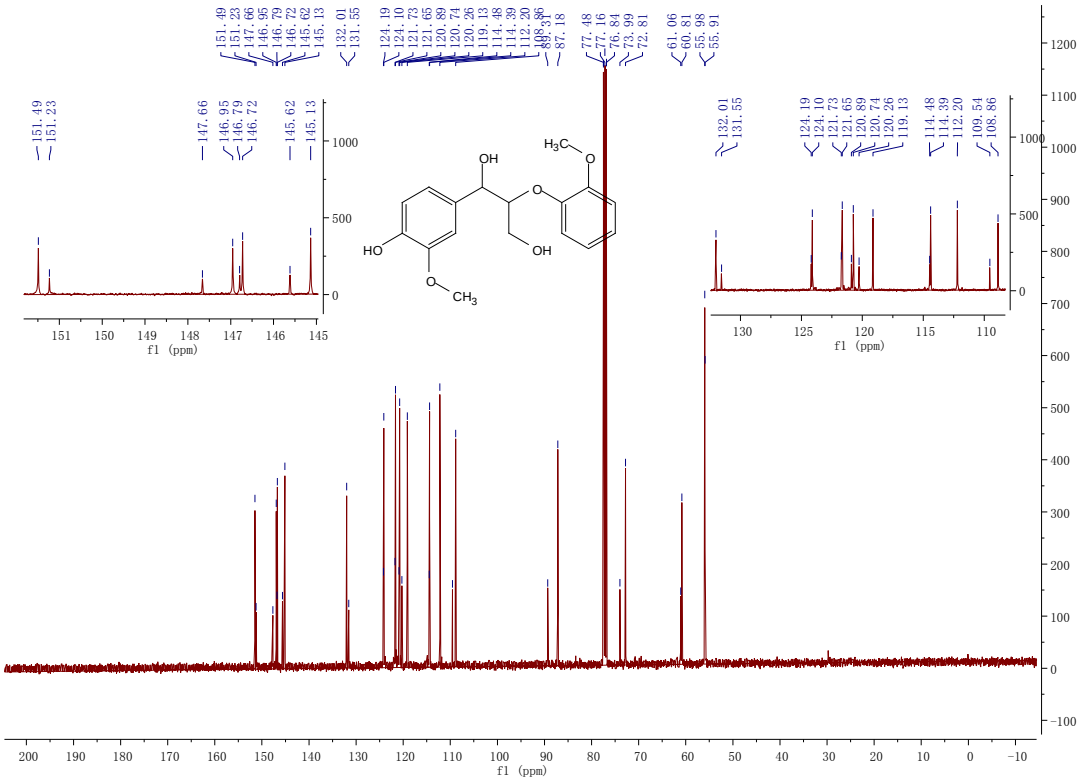
1g ^{13}C NMR



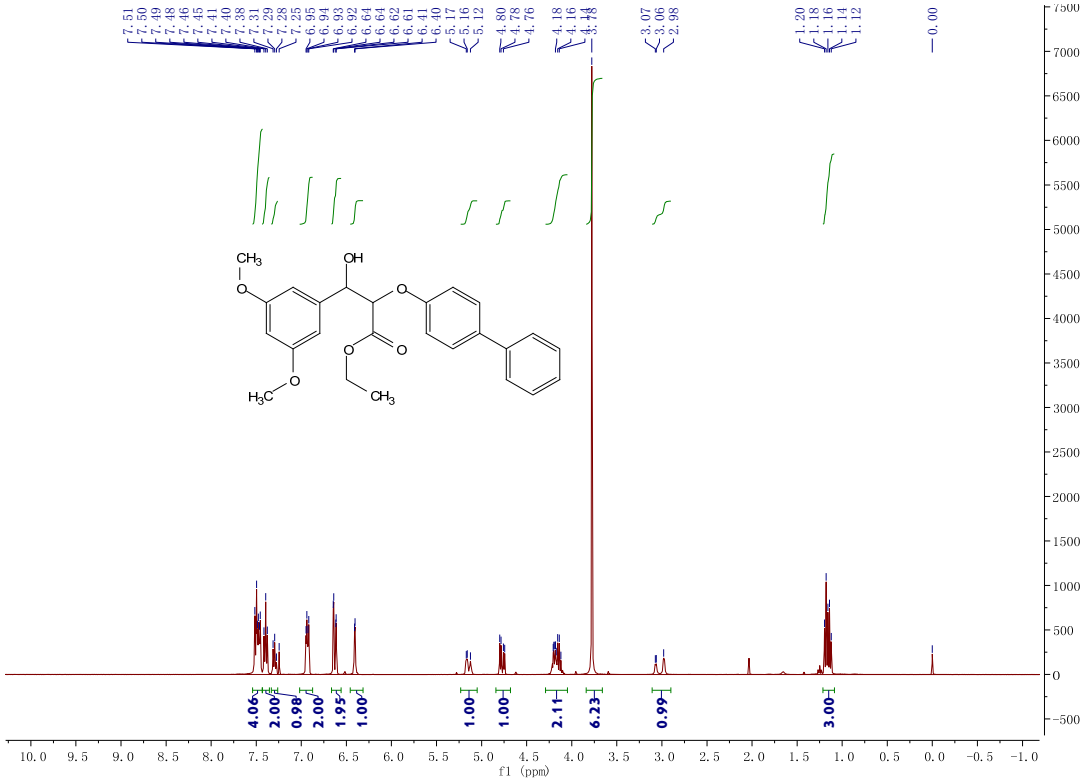
1h ^{1}H NMR



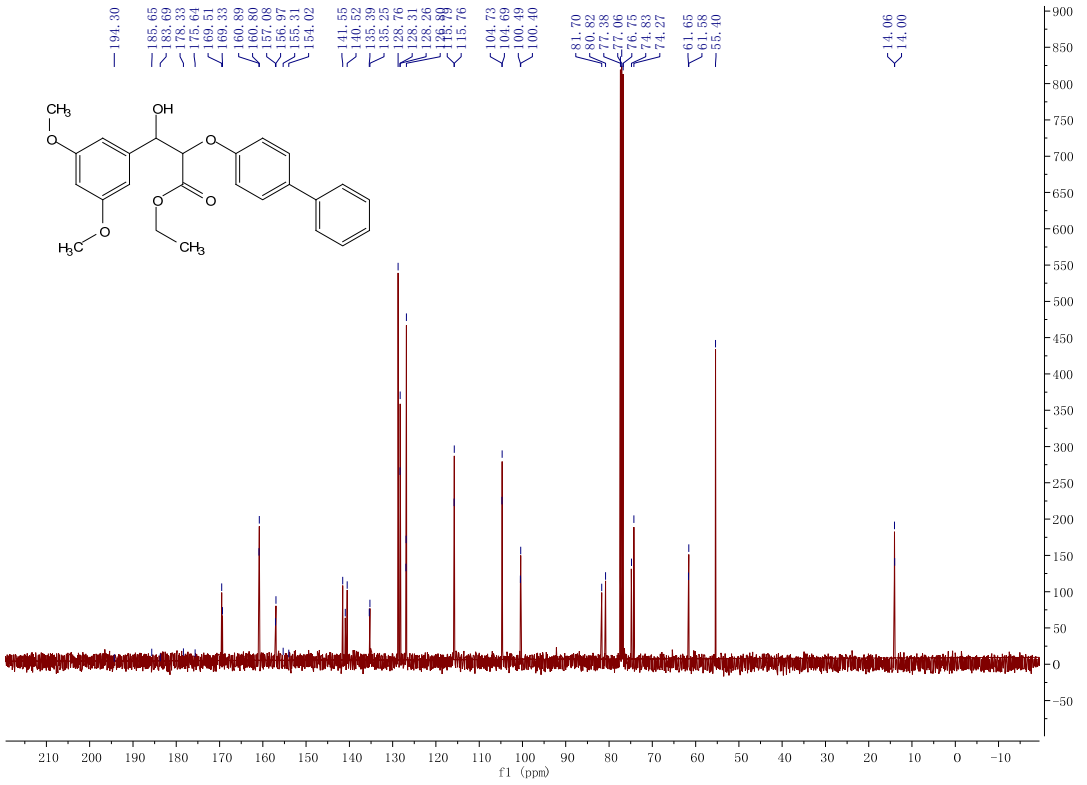
1h ^{13}C NMR



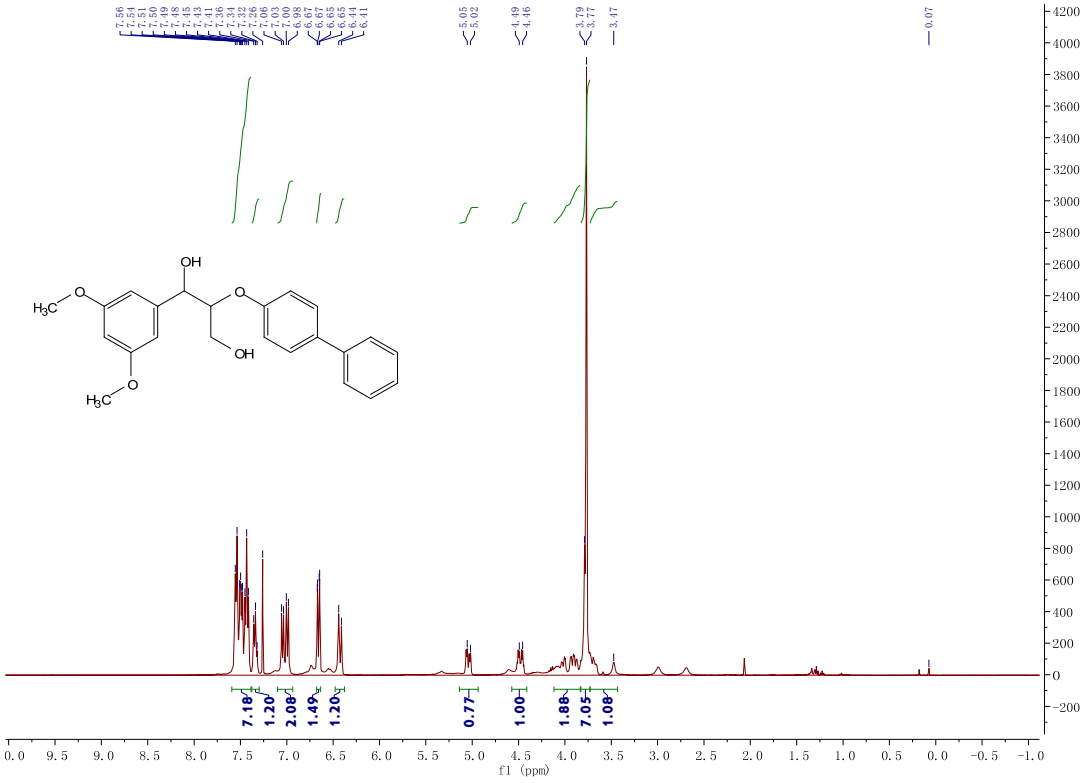
i-1i ^{1}H NMR



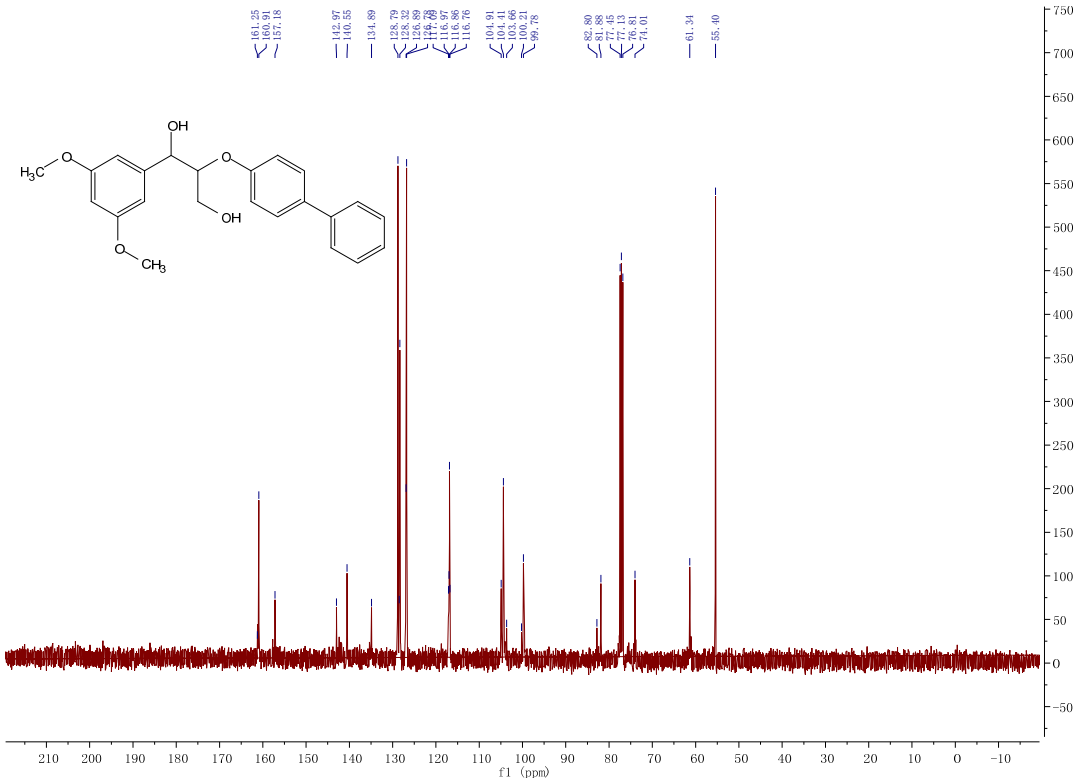
i-1i ^{13}C NMR



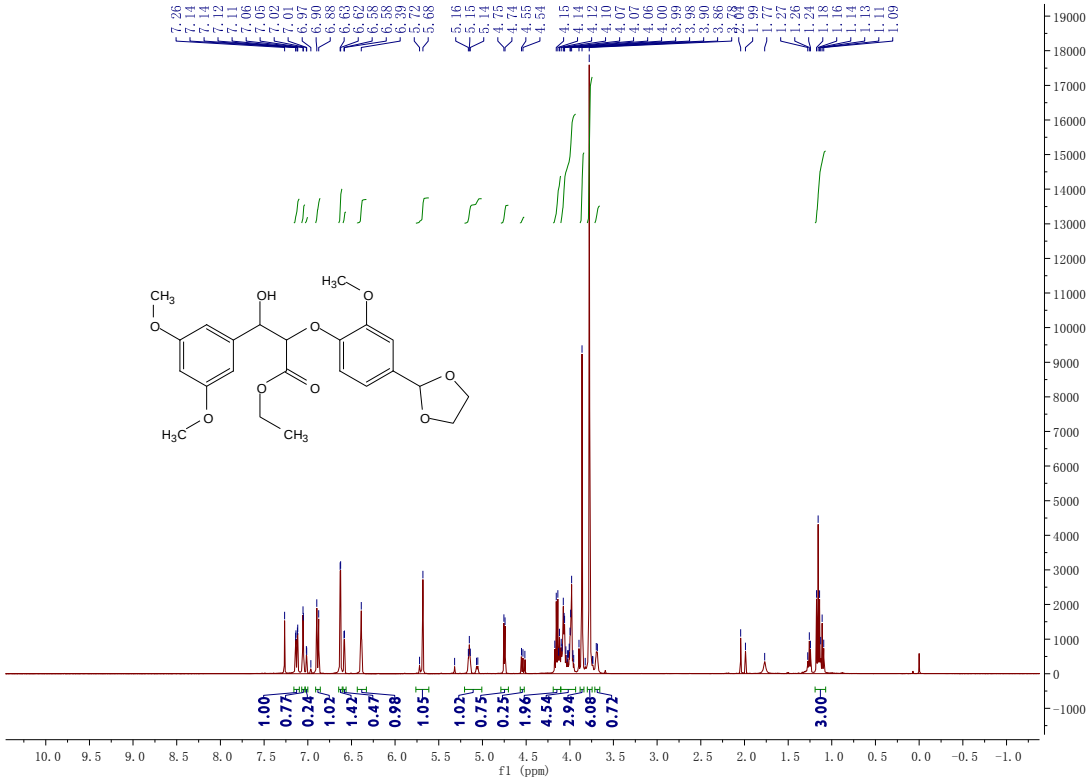
1i ^{1}H NMR



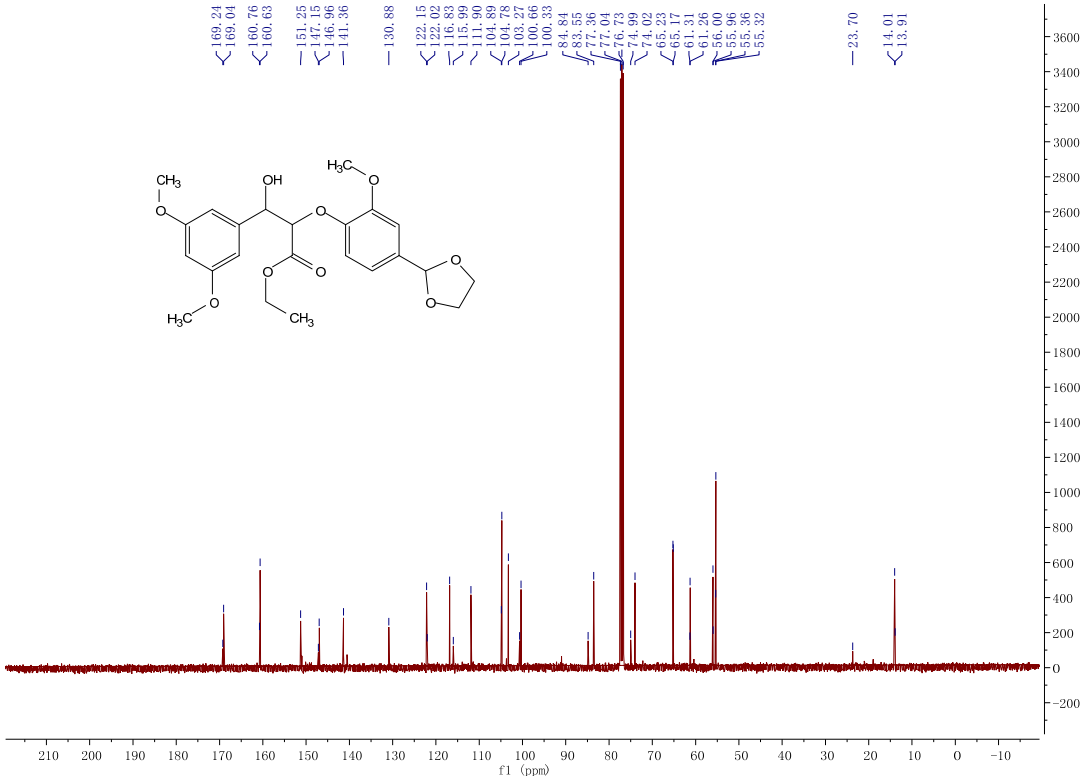
1i ^{13}C NMR



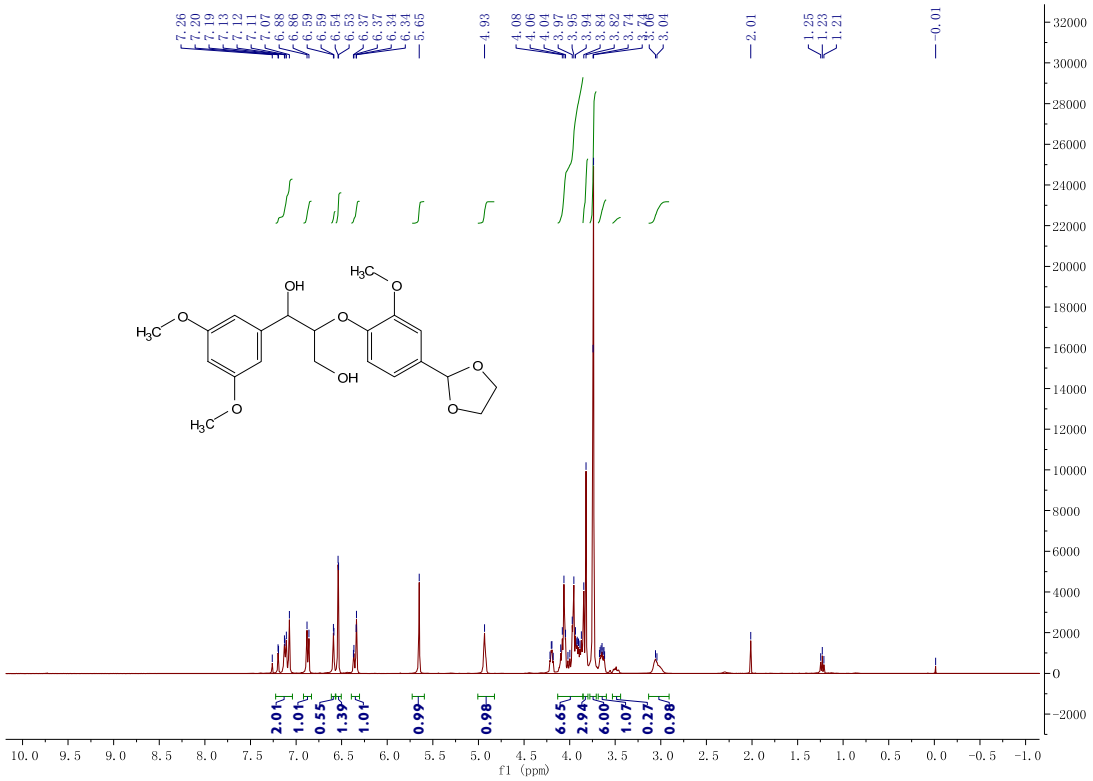
i-1j ^{1}H NMR



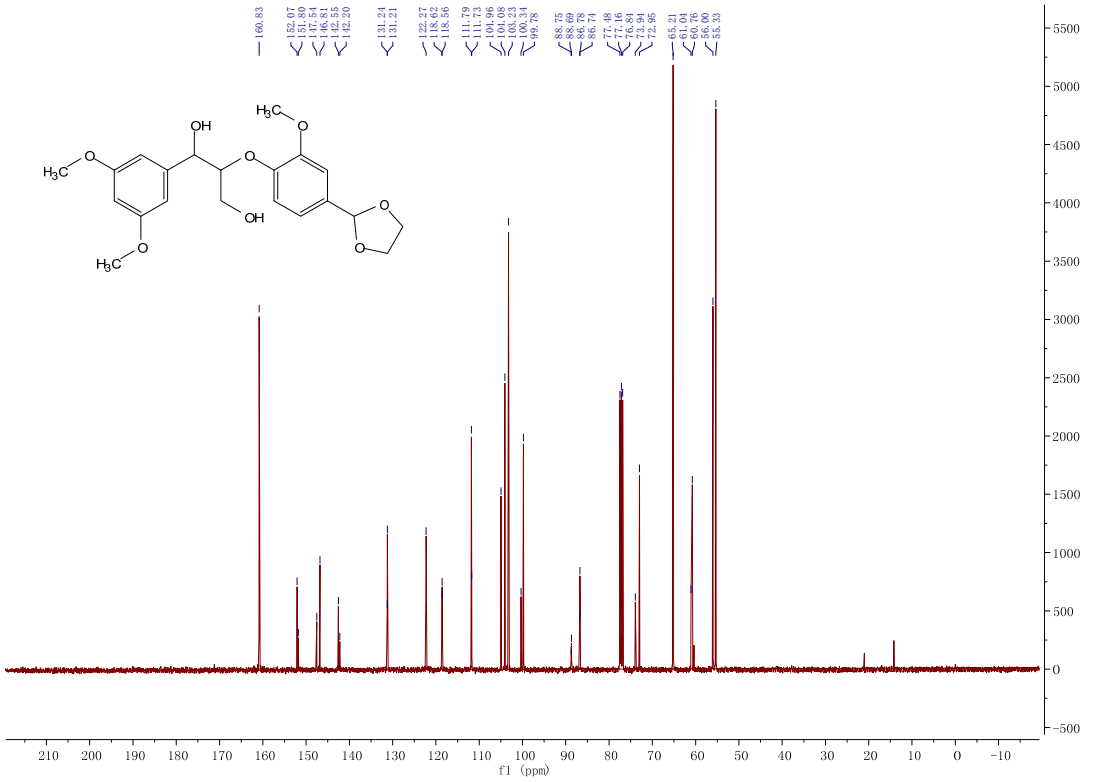
i-1j ^{13}C NMR



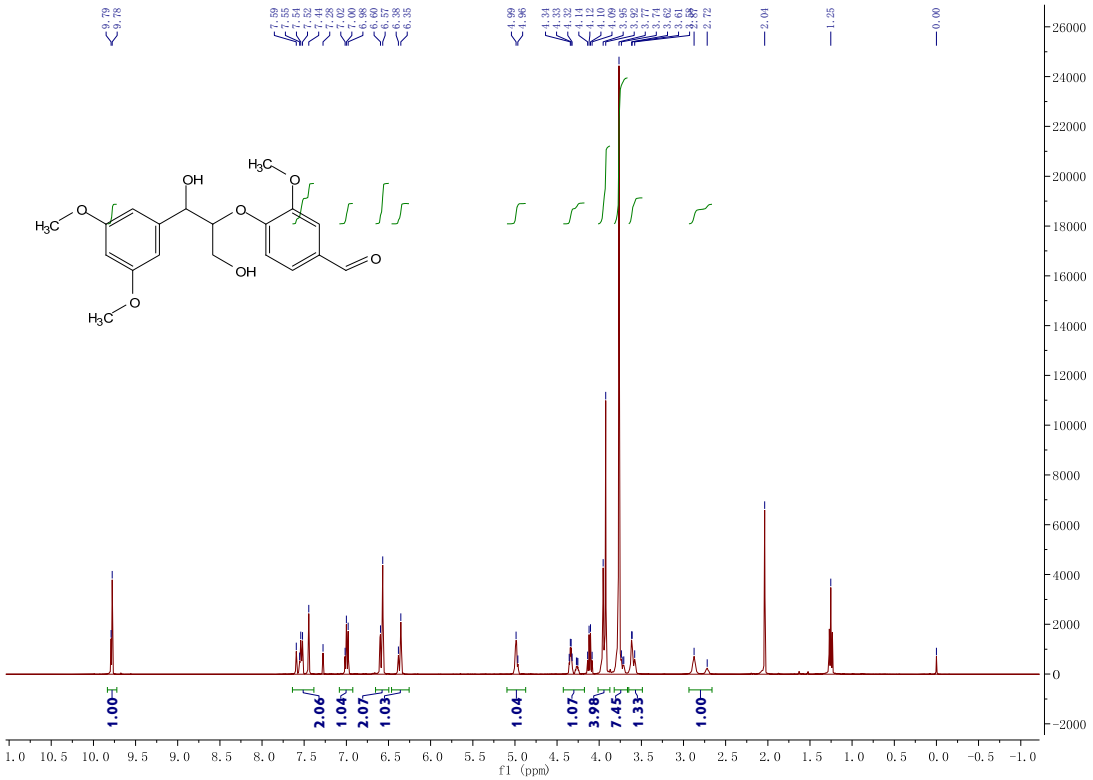
1j ^{1}H NMR



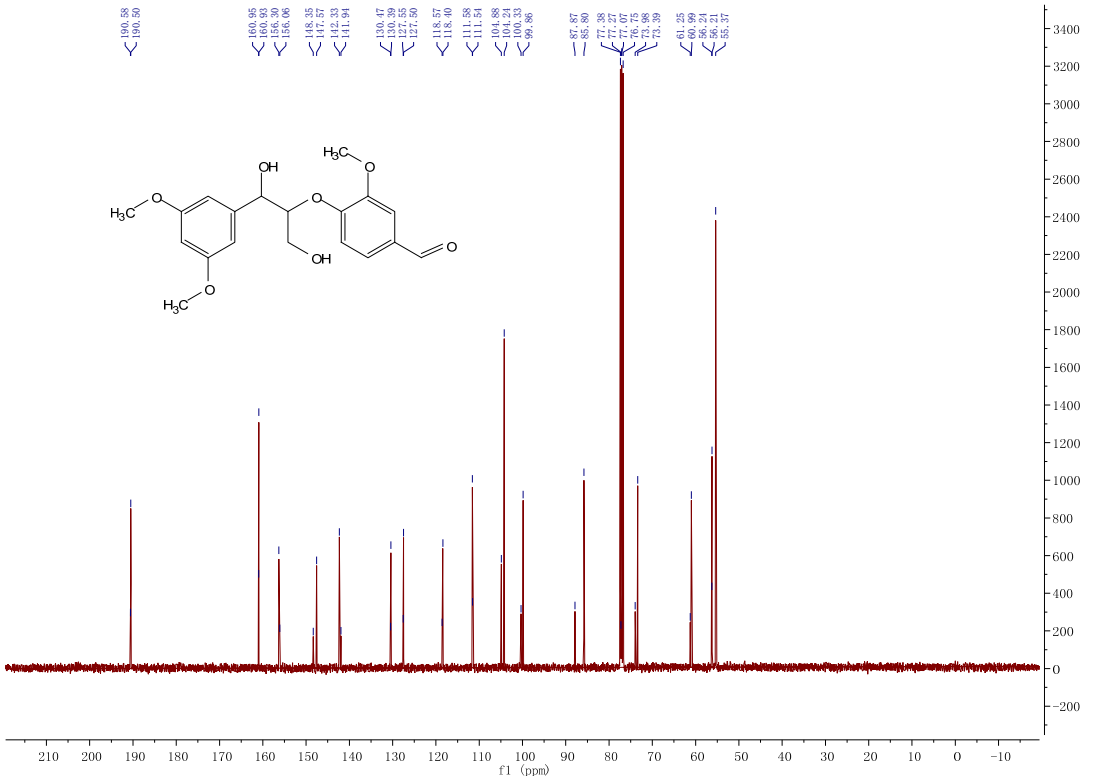
1j ^{13}C NMR



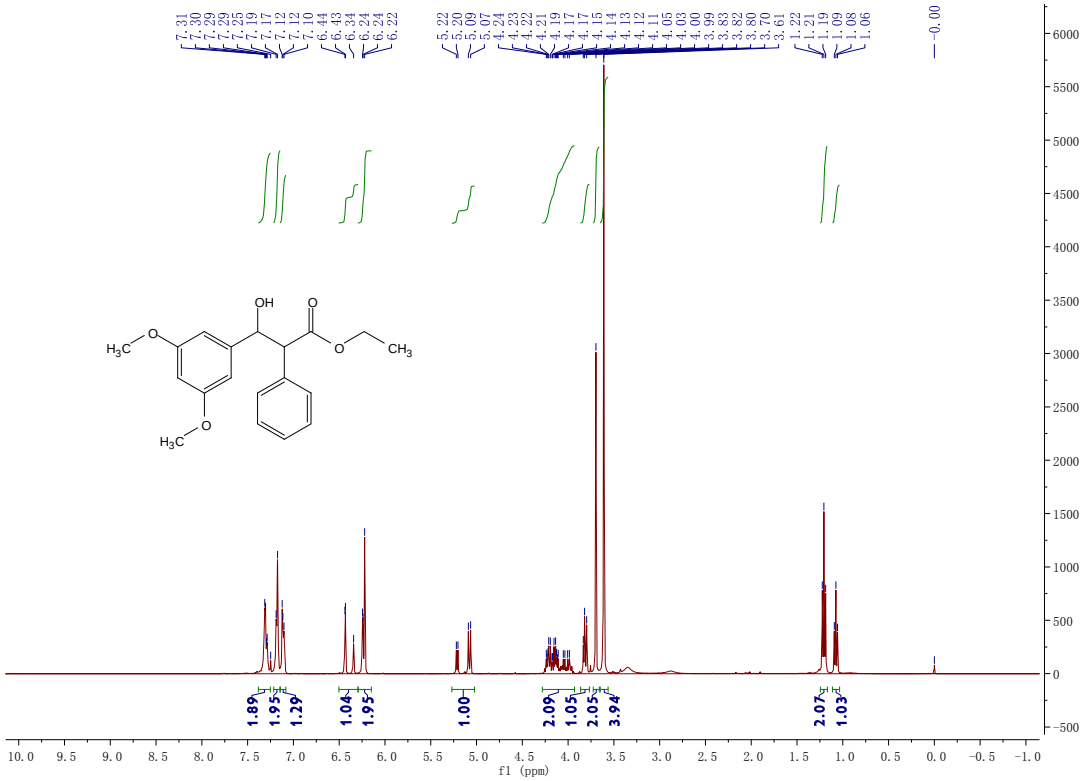
1k ^{1}H NMR



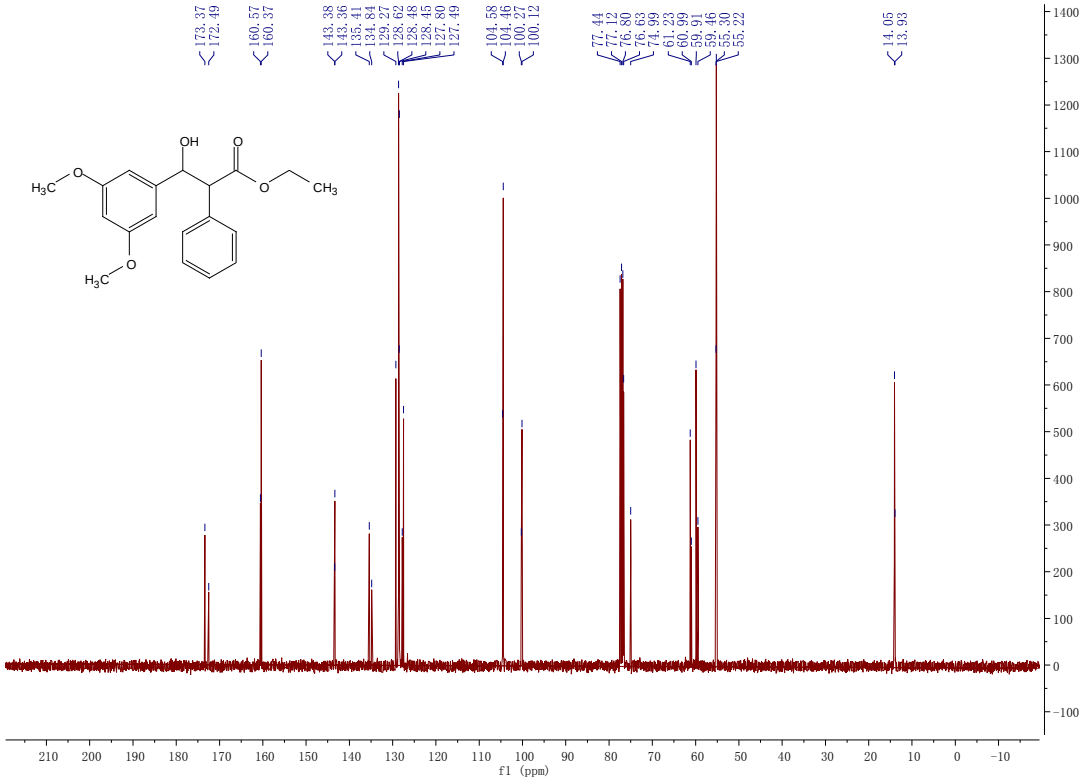
1k ^{13}C NMR



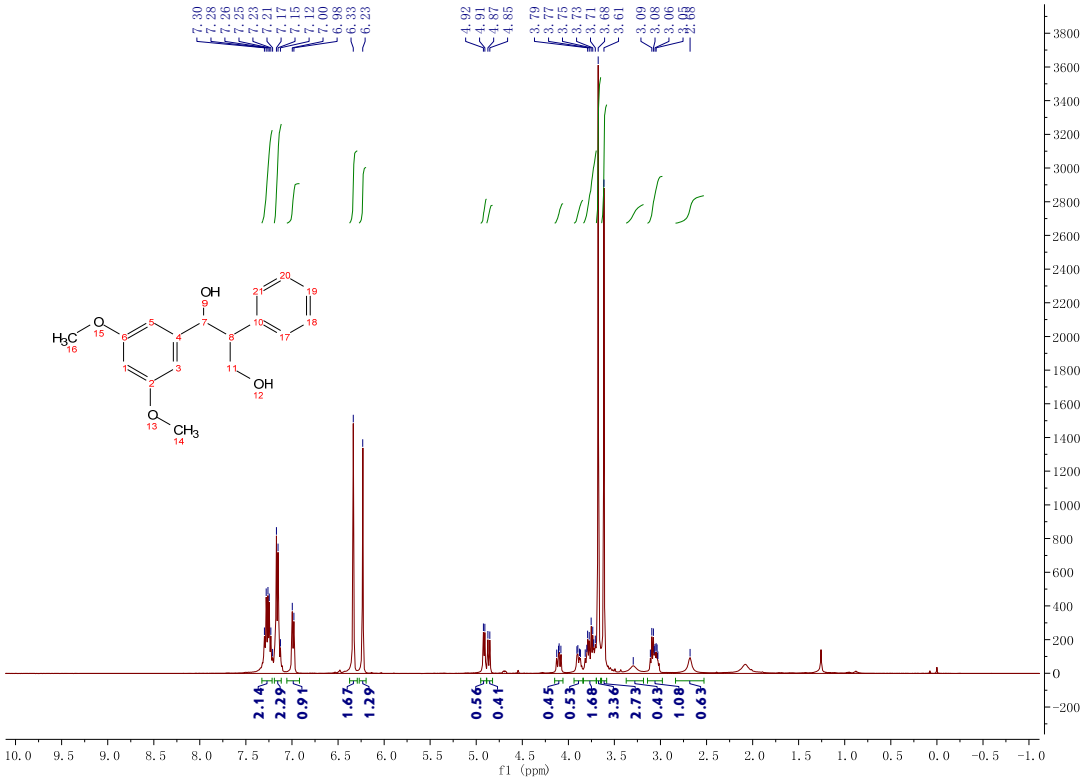
i-4a ^{1}H NMR



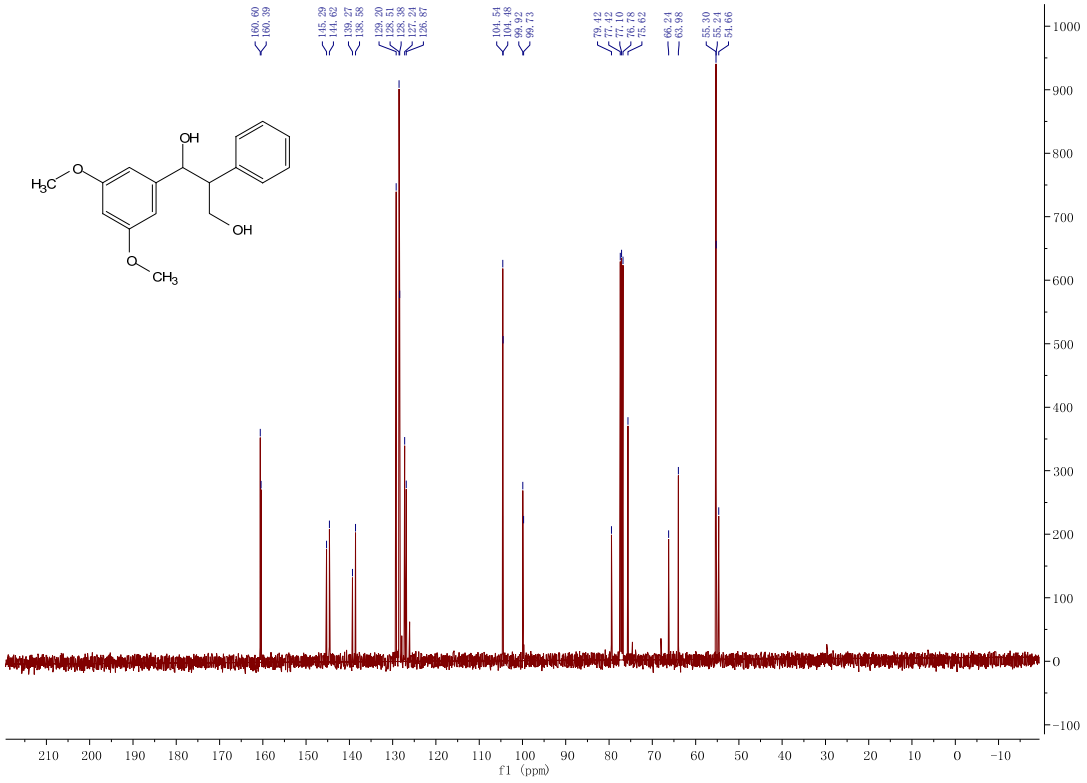
i-4a ^{13}CNMR



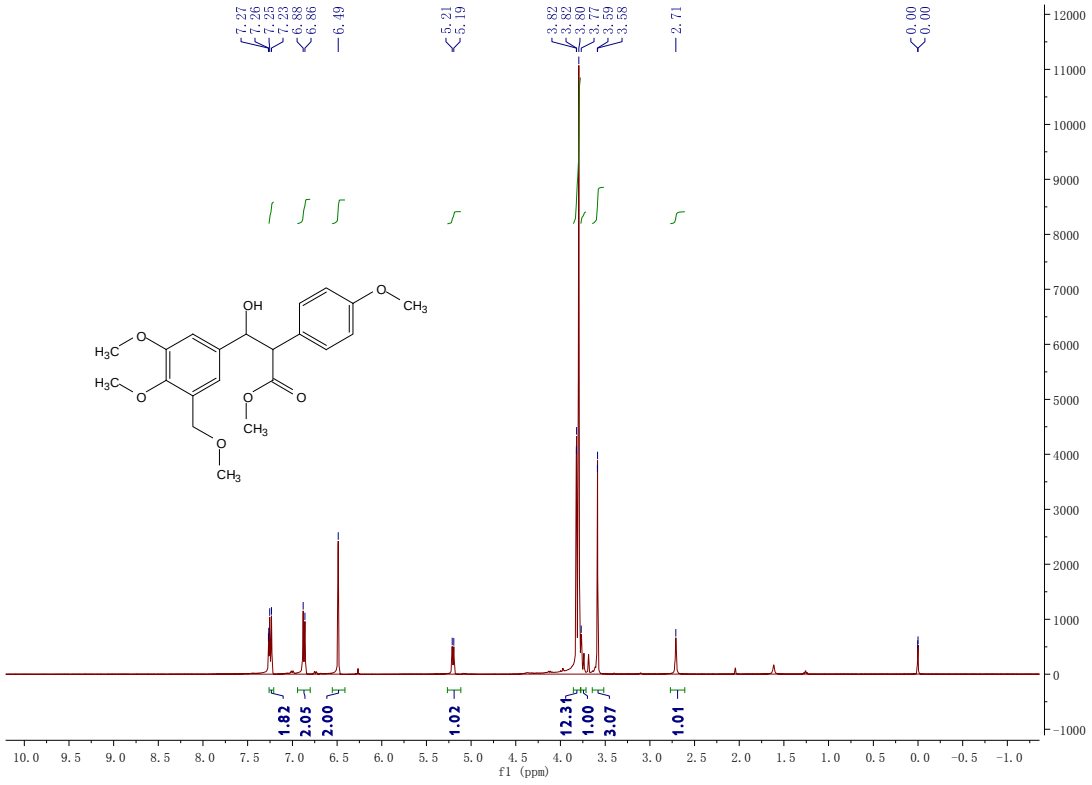
4a ^{1}H NMR



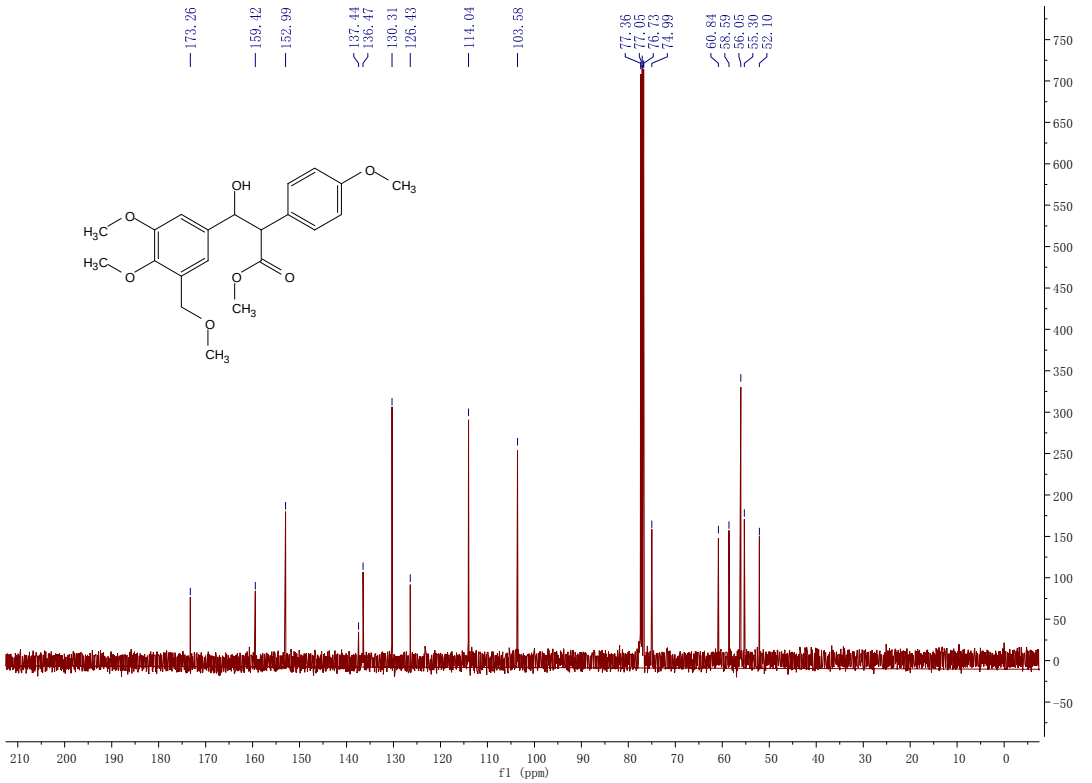
4a ^{13}C NMR



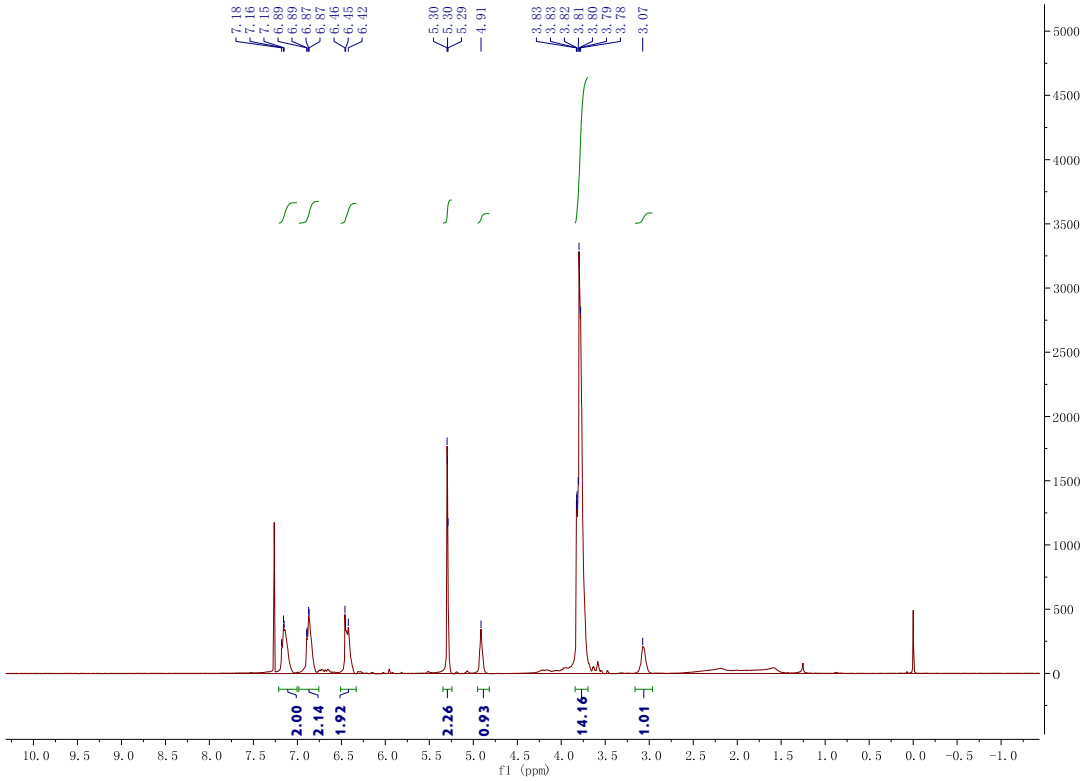
i-4b ^{1}H NMR



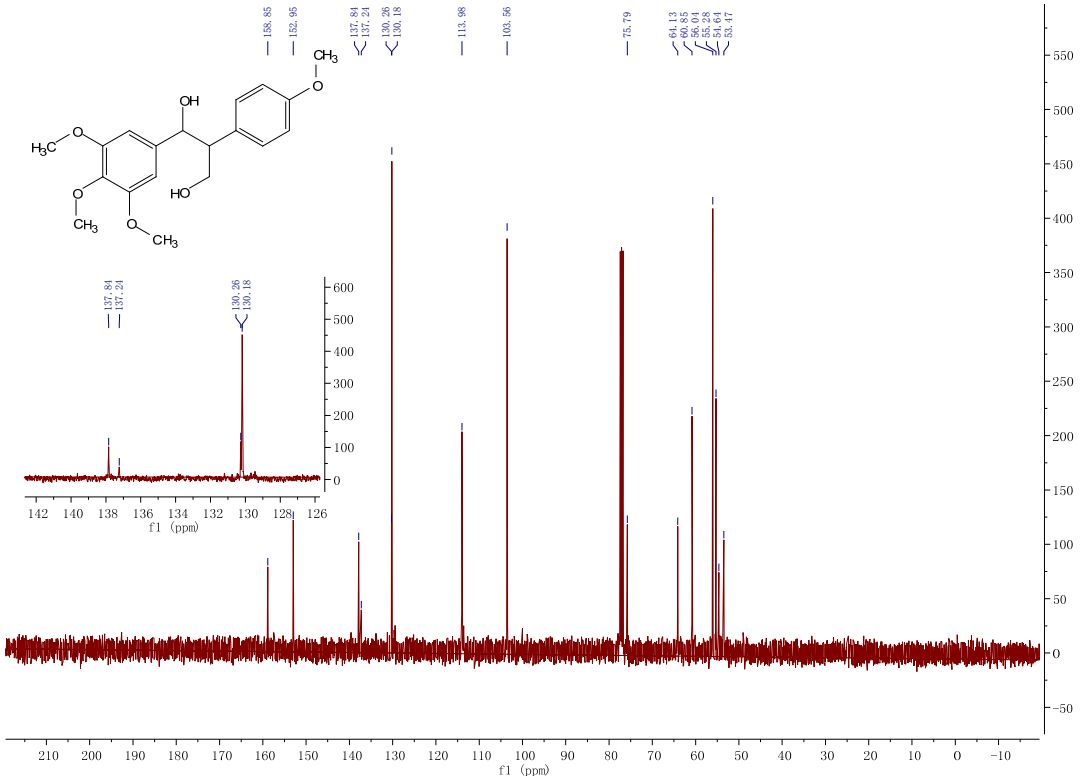
i-4b ^{13}C NMR



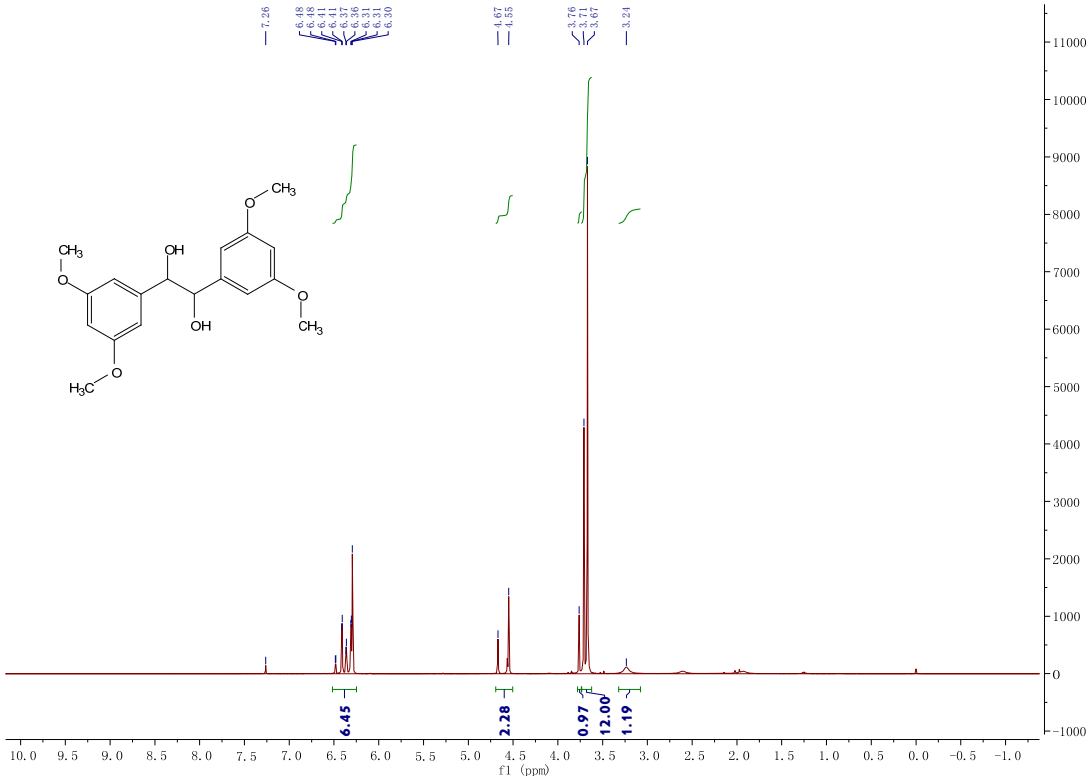
4b ^{1}H NMR



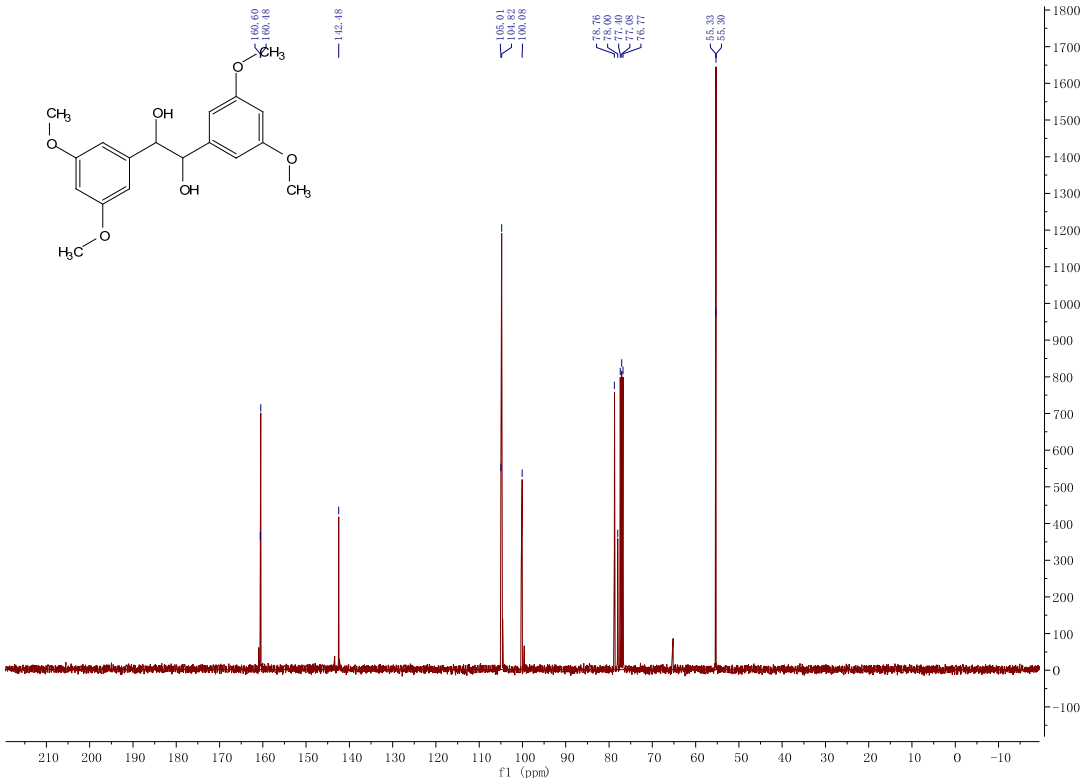
4b ^{13}C NMR



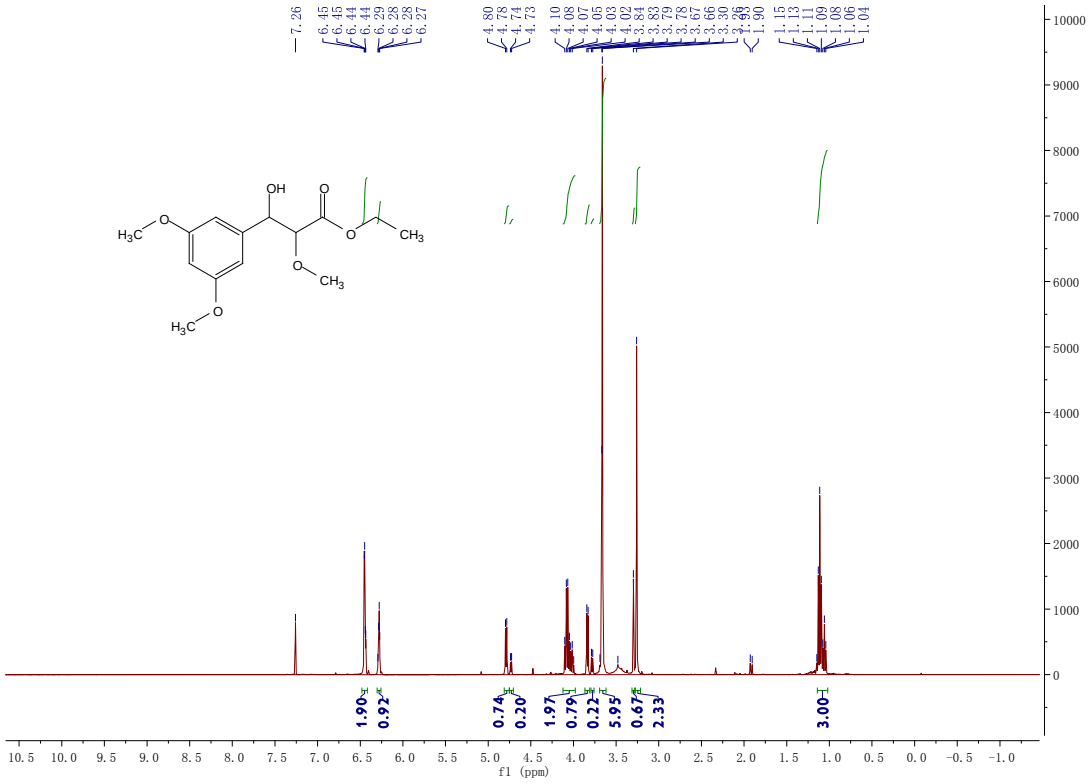
4c ^{1}H NMR



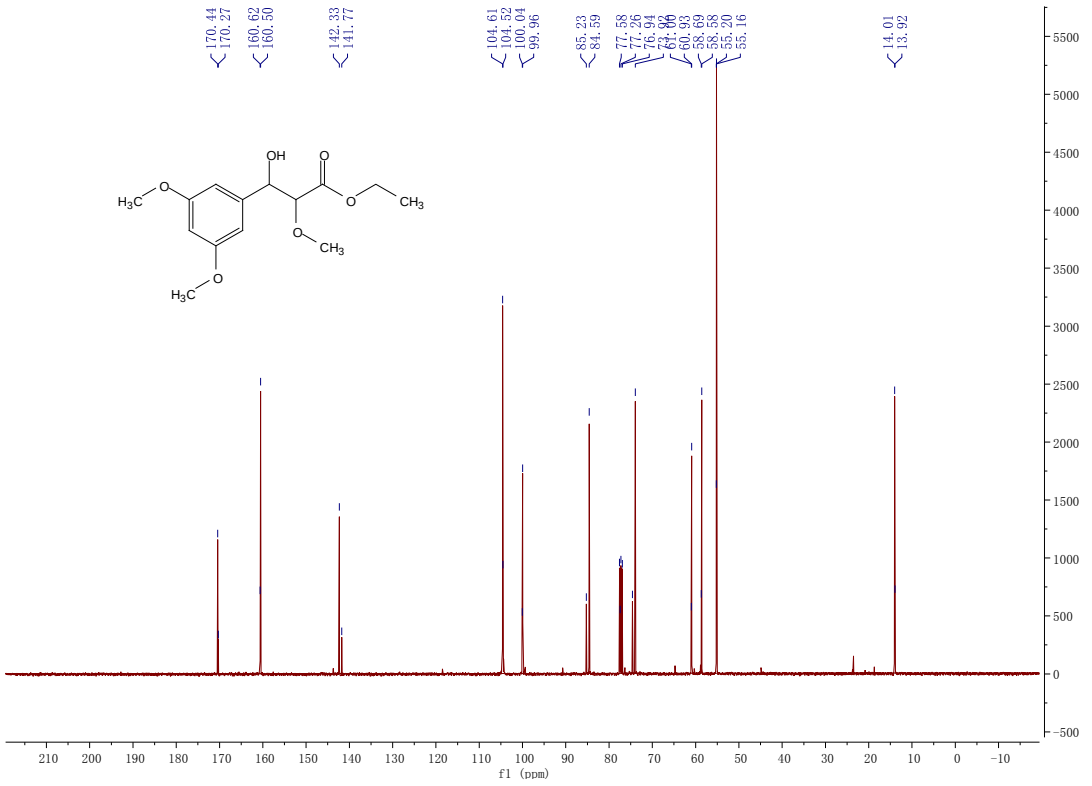
4c ^{13}C NMR



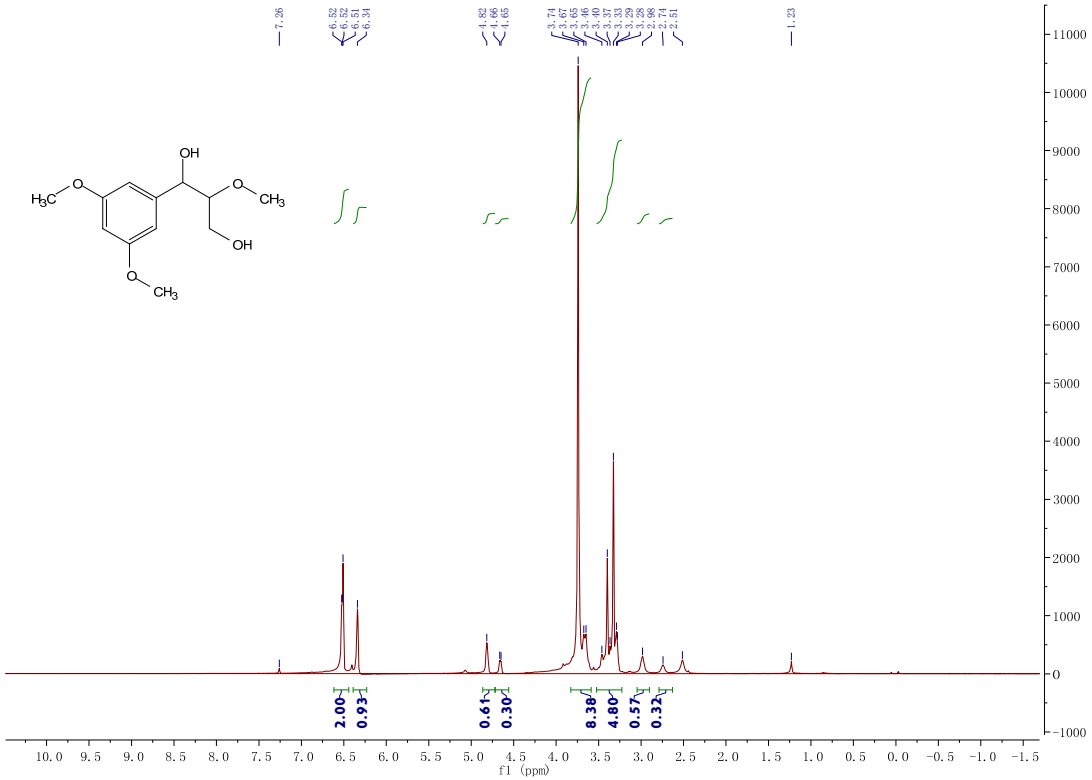
i-4d ^{1}H NMR



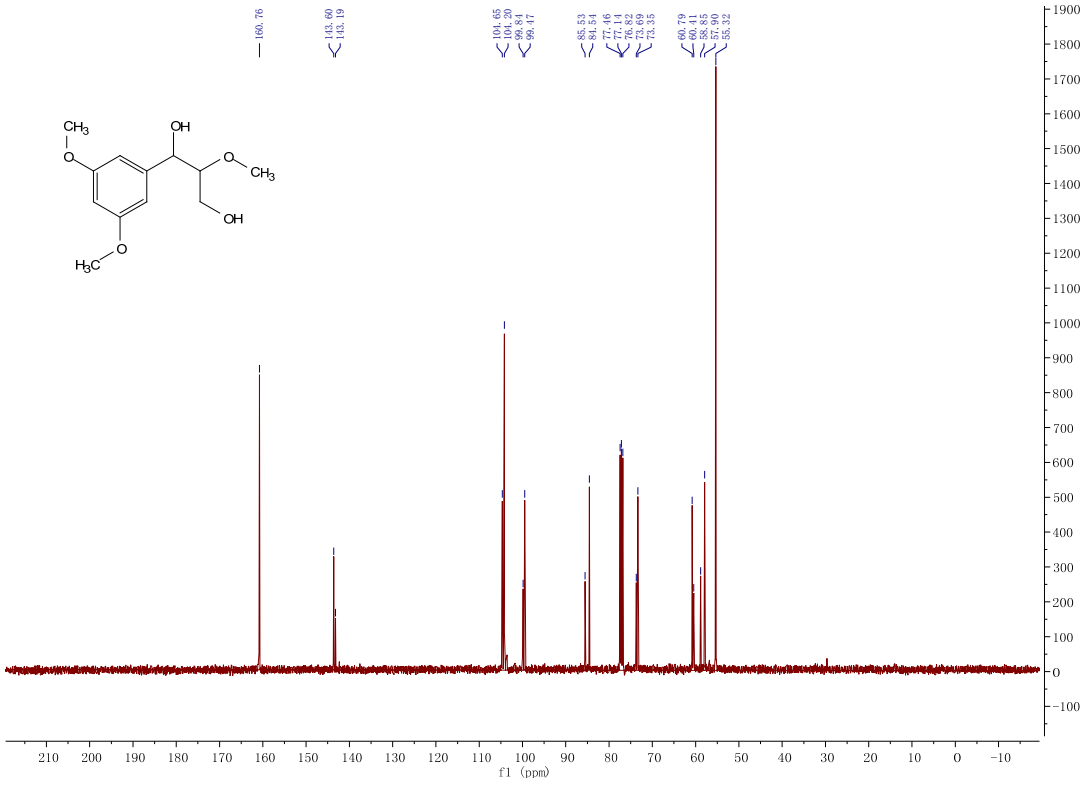
i-4d ^{13}C NMR



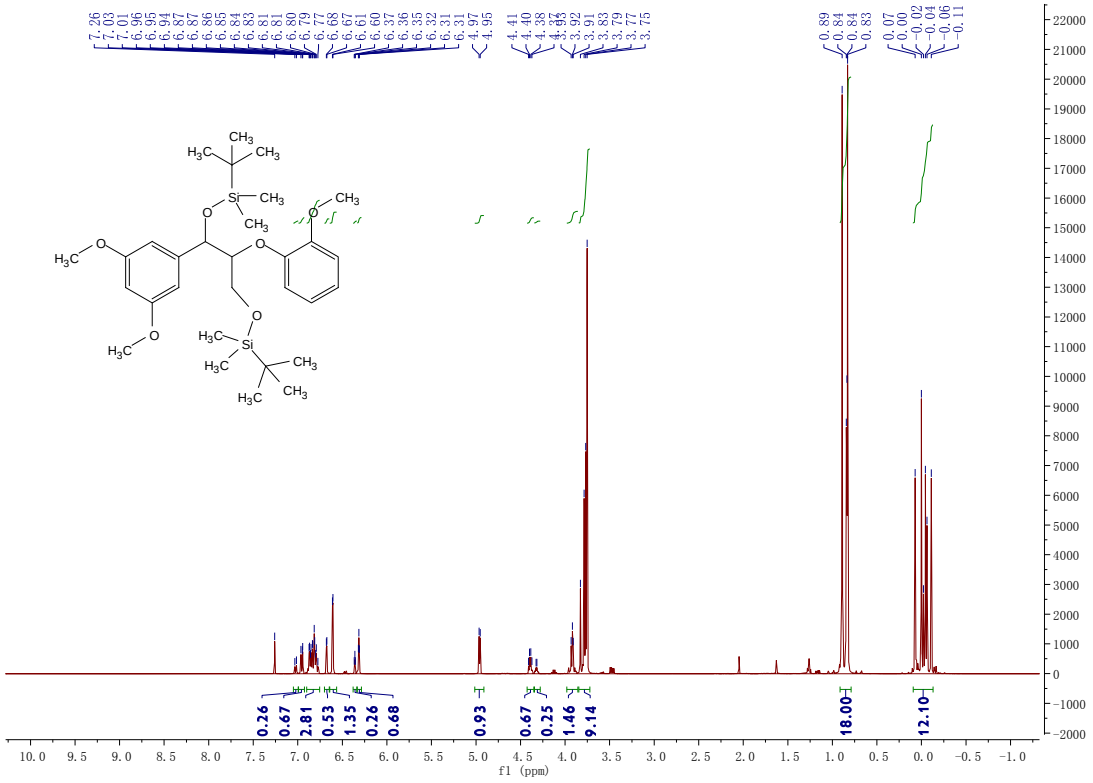
4d ^{1}H NMR



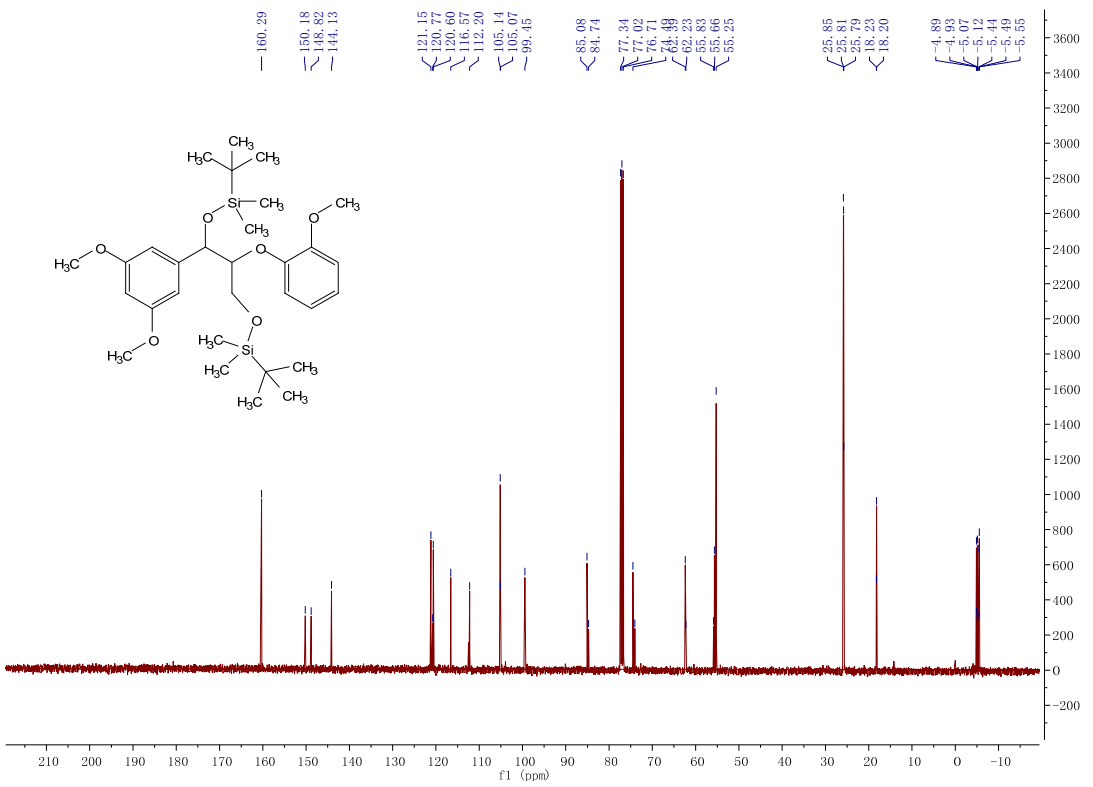
4d-^{13}C NMR



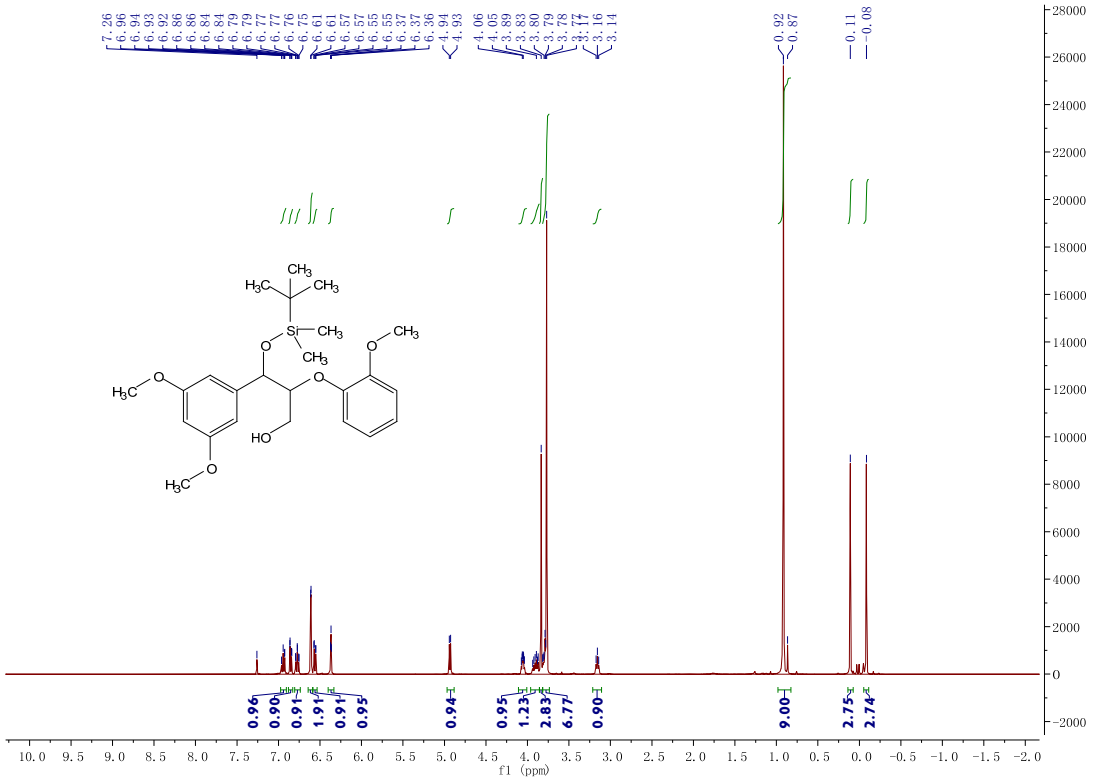
i-4e-1 ^{1}H NMR



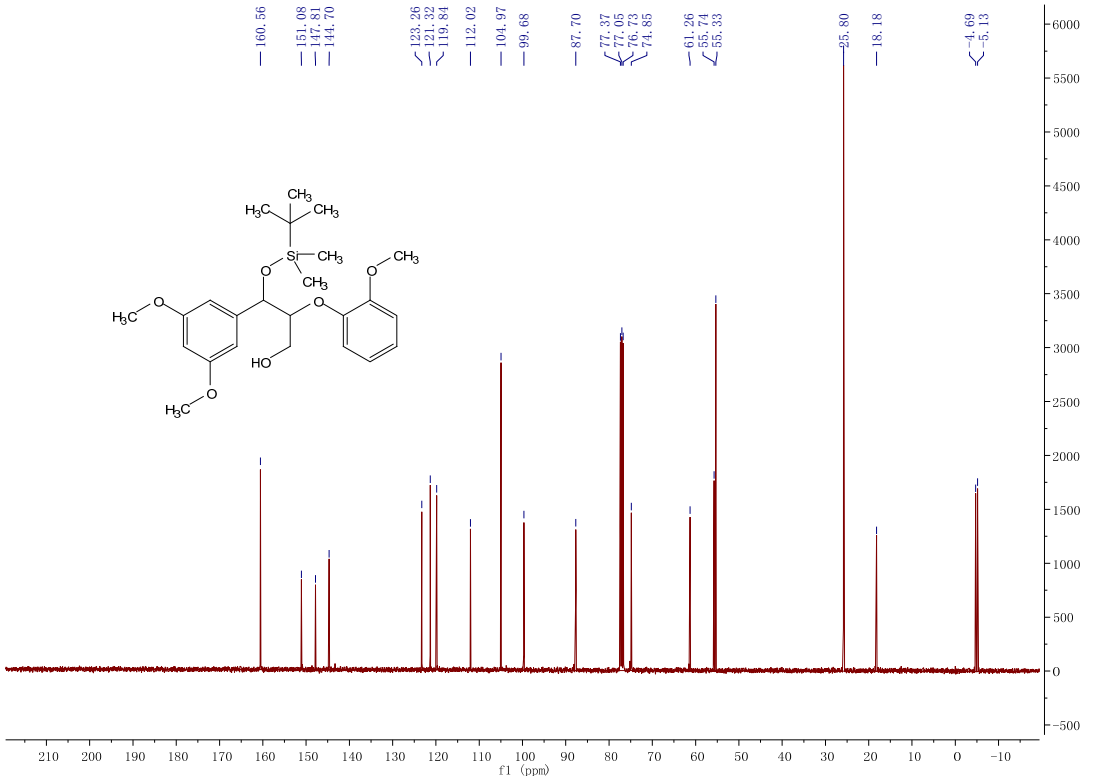
i-4e-1 ^{13}C NMR



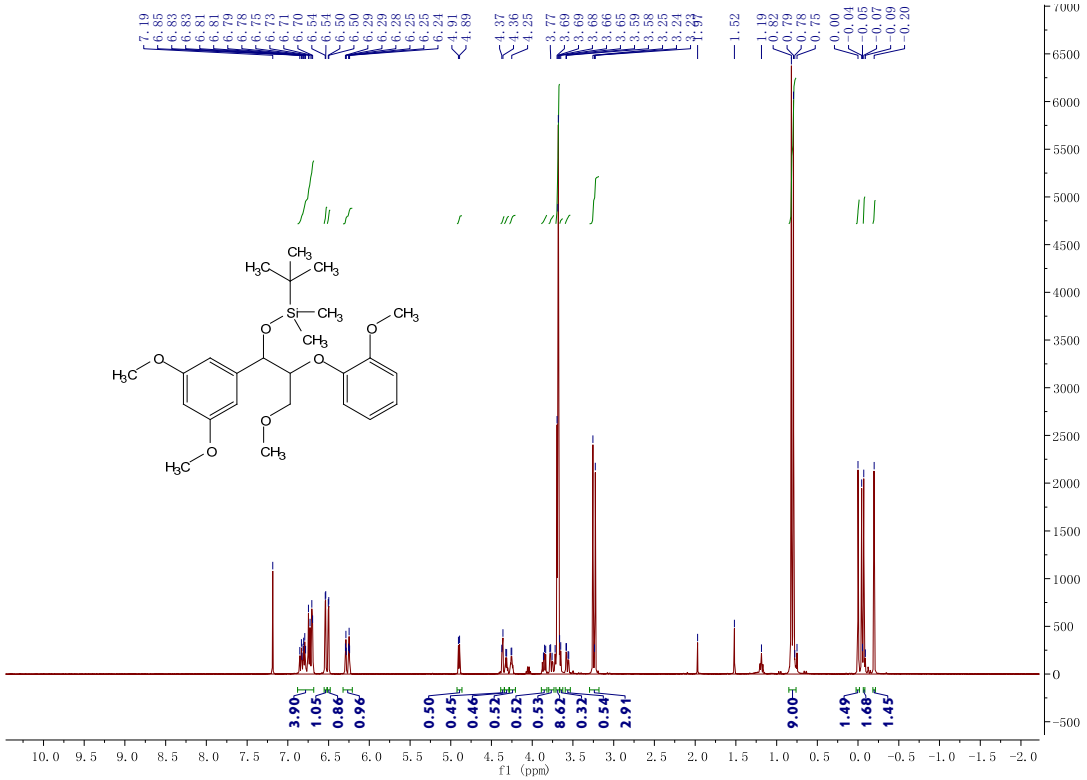
i-4e-2 ^{1}H NMR



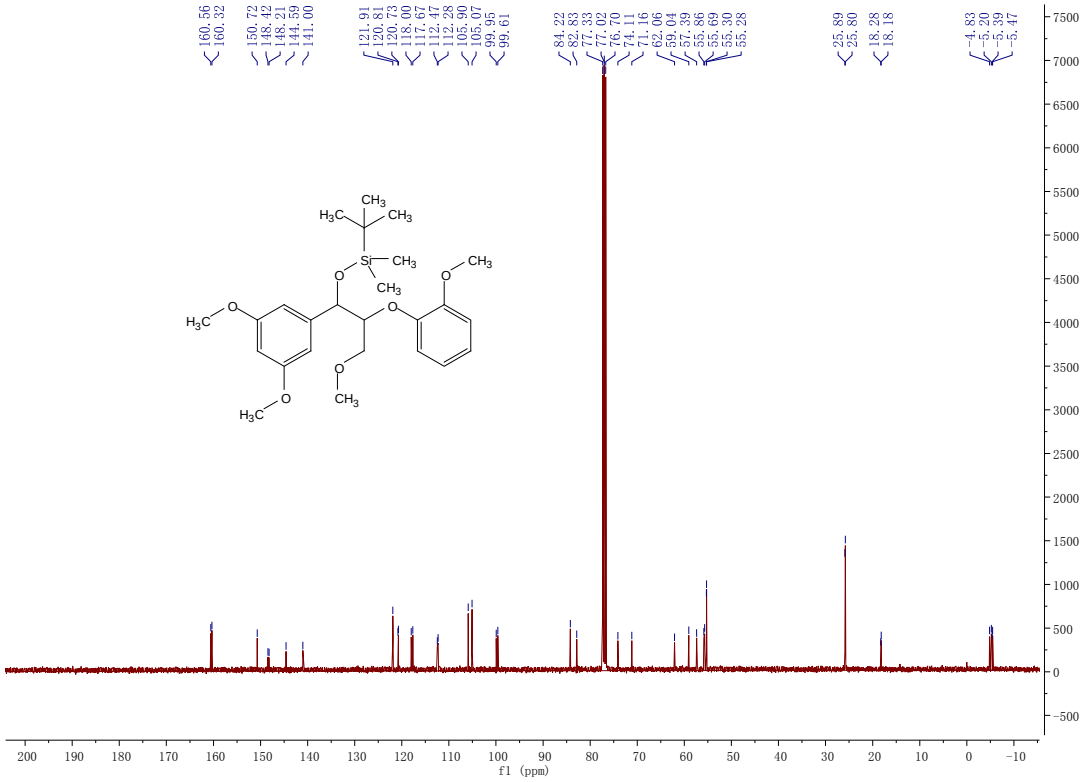
i-4e-2 ^{13}C NMR



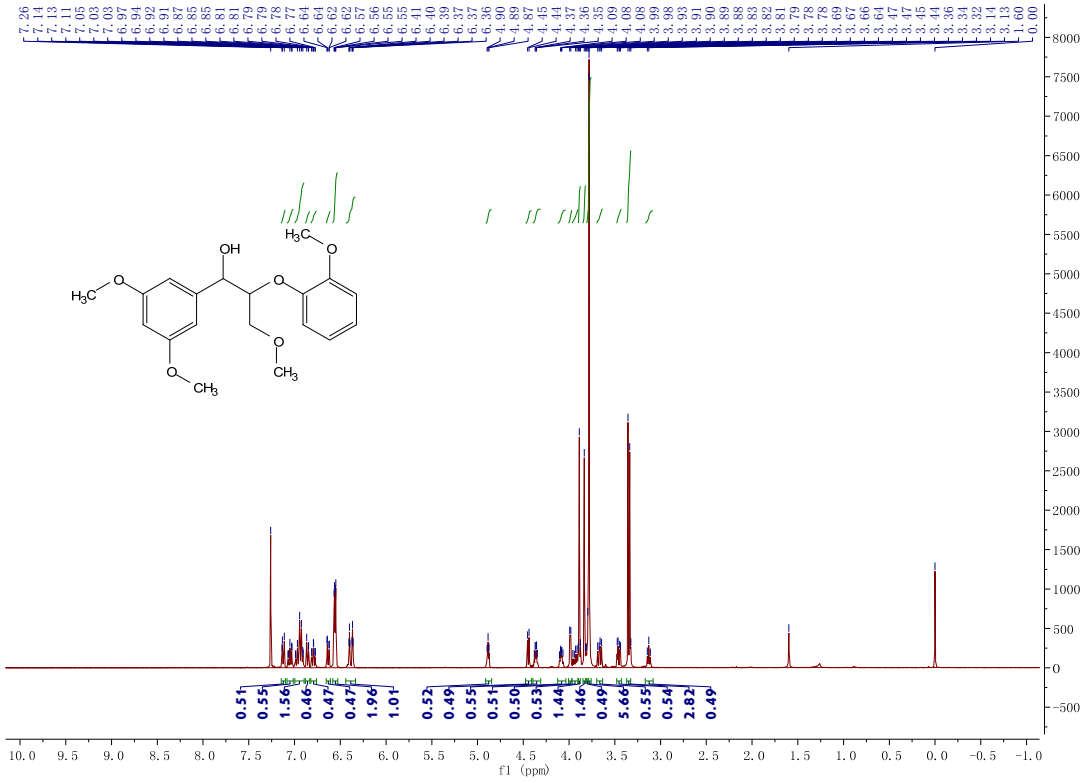
i-4e-3 ^{1}H NMR



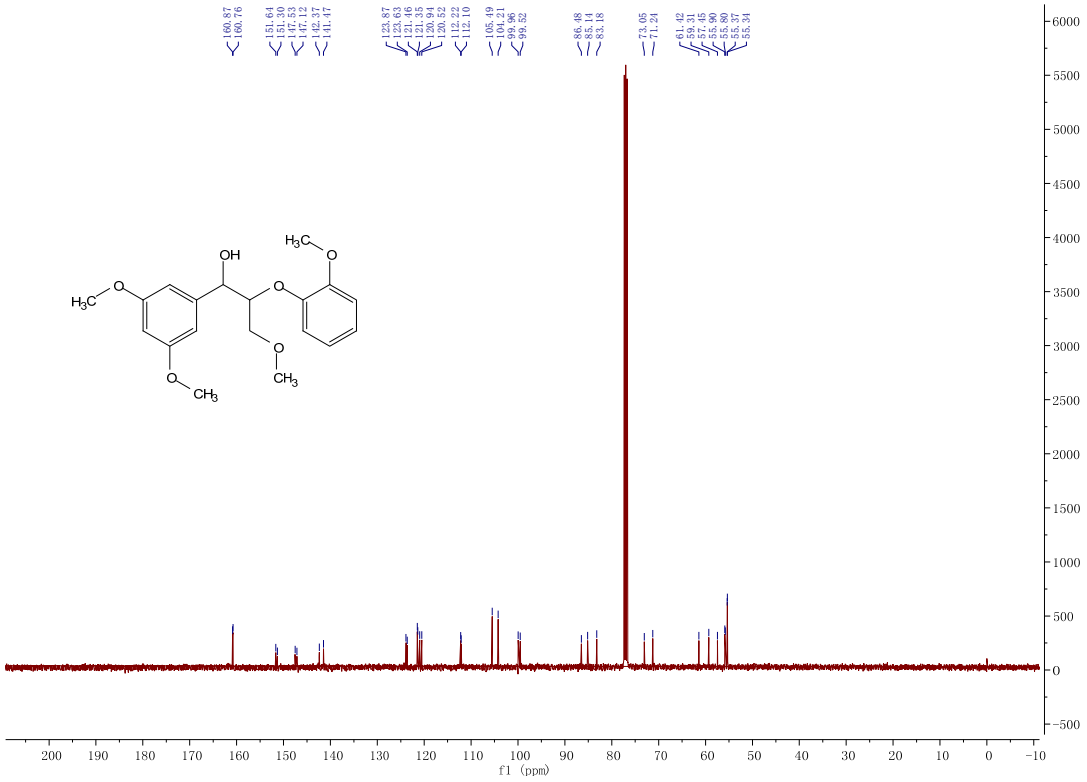
i-4e -3 ^{13}CNMR



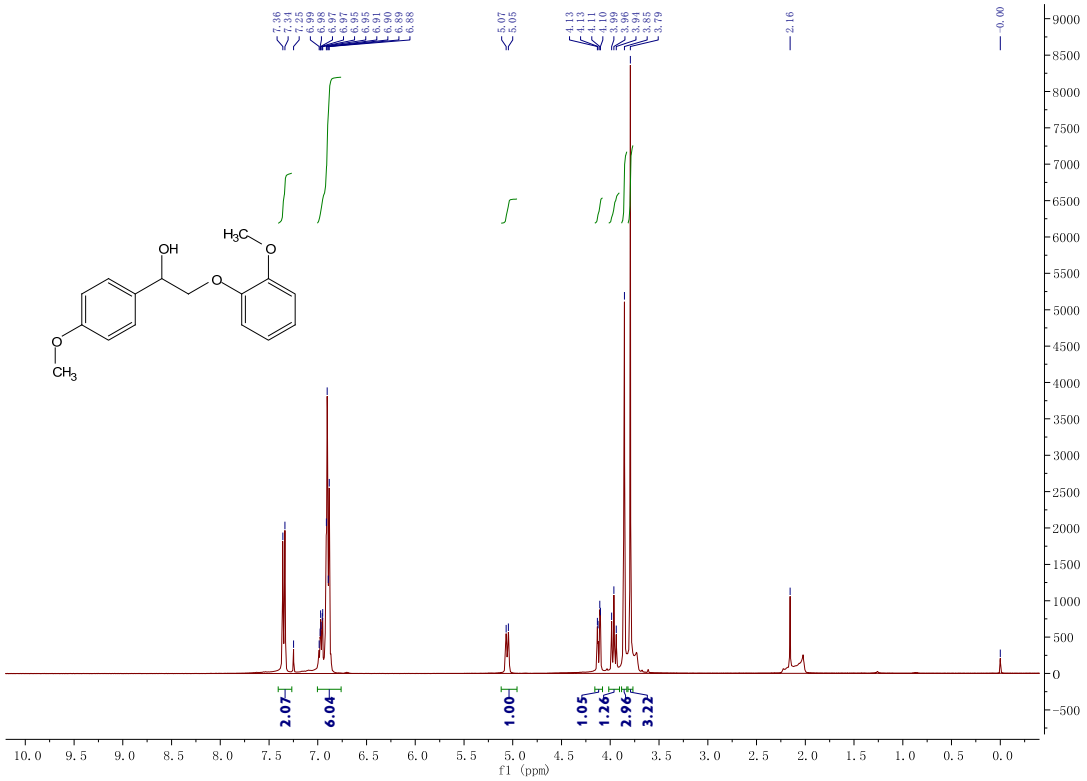
4e ^{1}H NMR



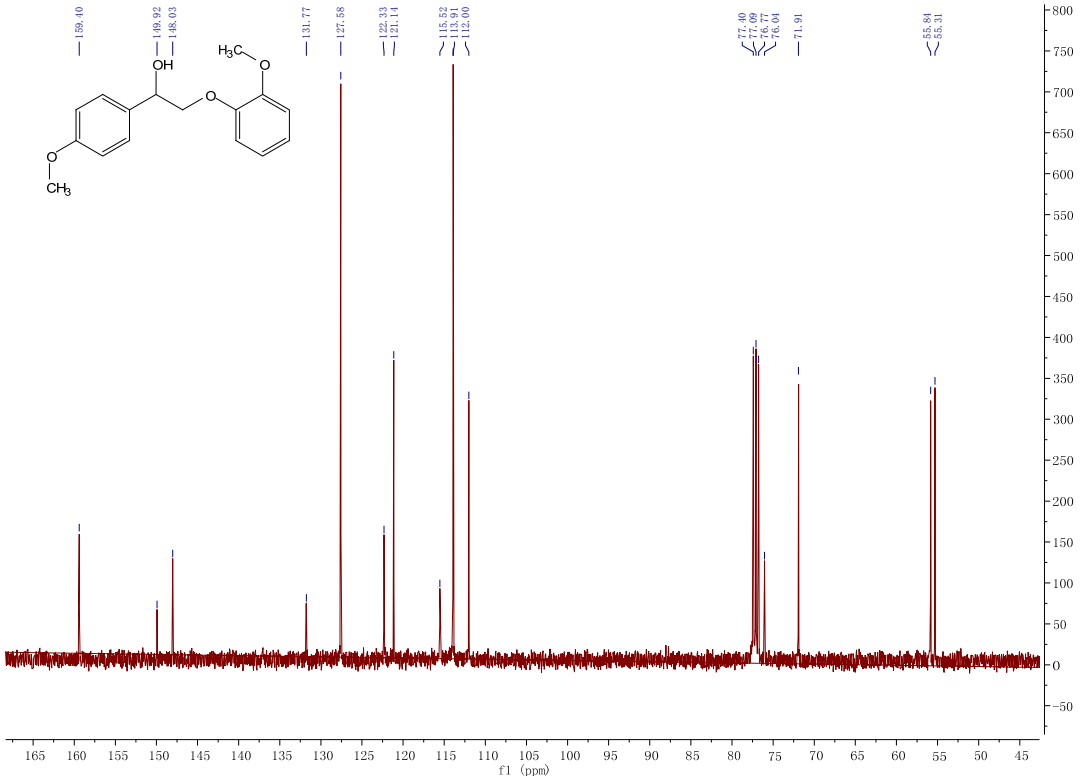
4e ^{13}C NMR



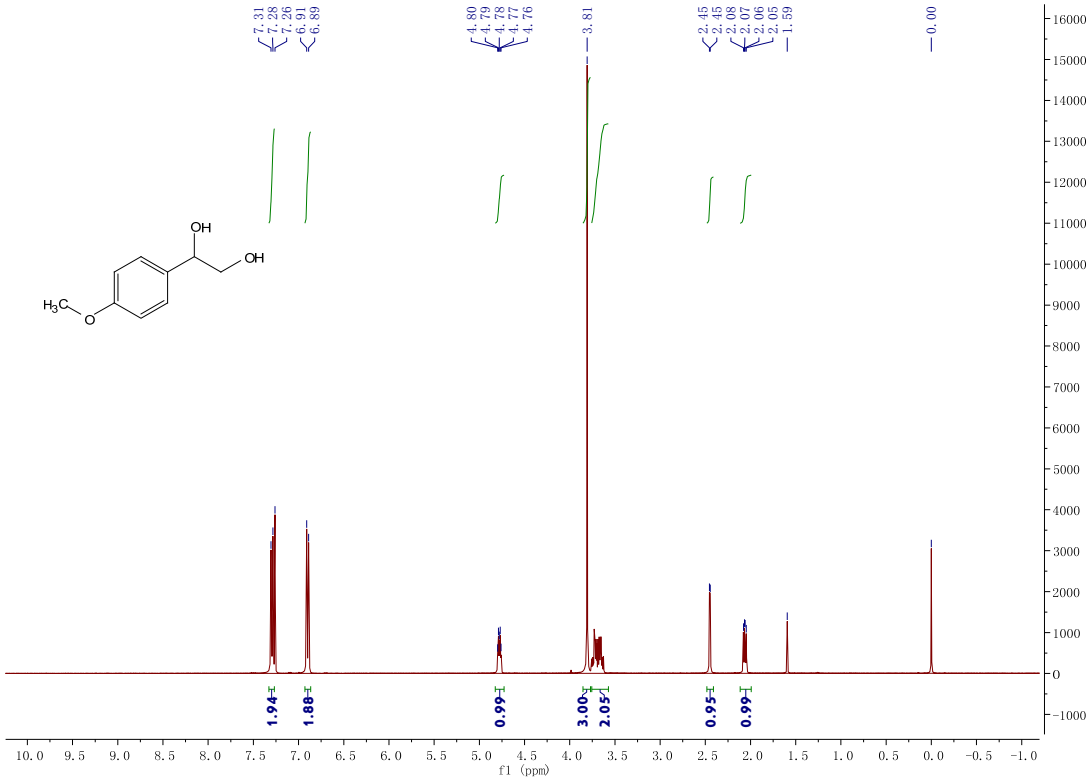
4f ^{1}H NMR



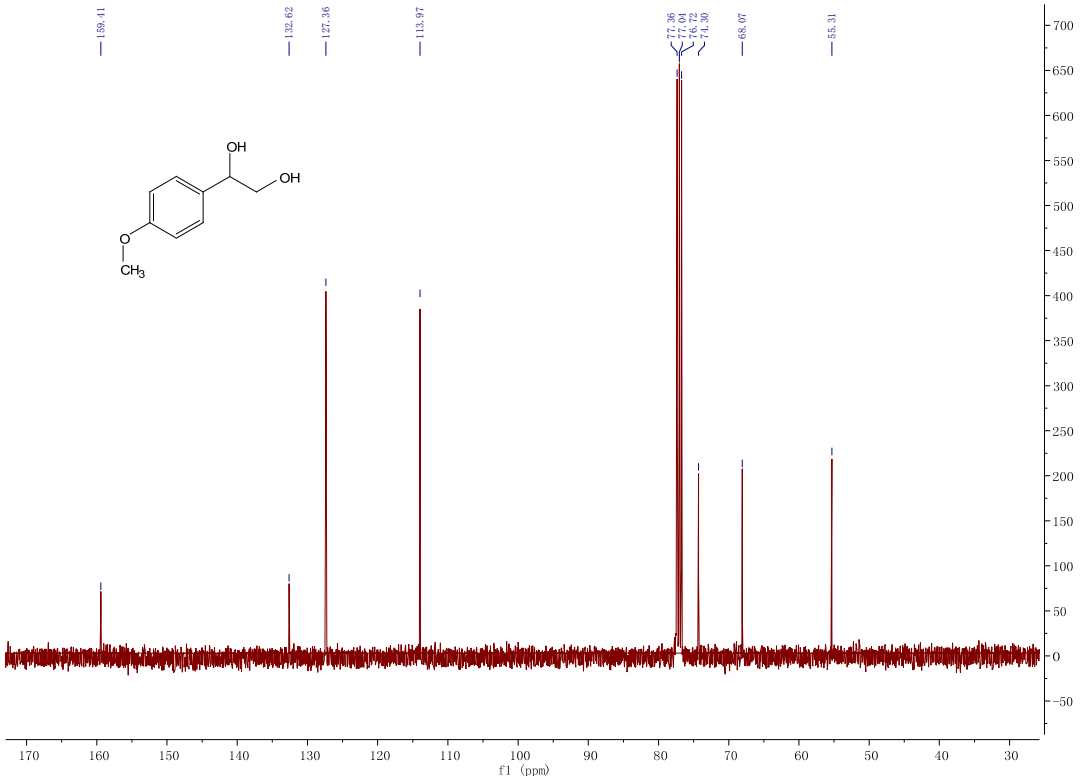
4f ^{13}C NMR



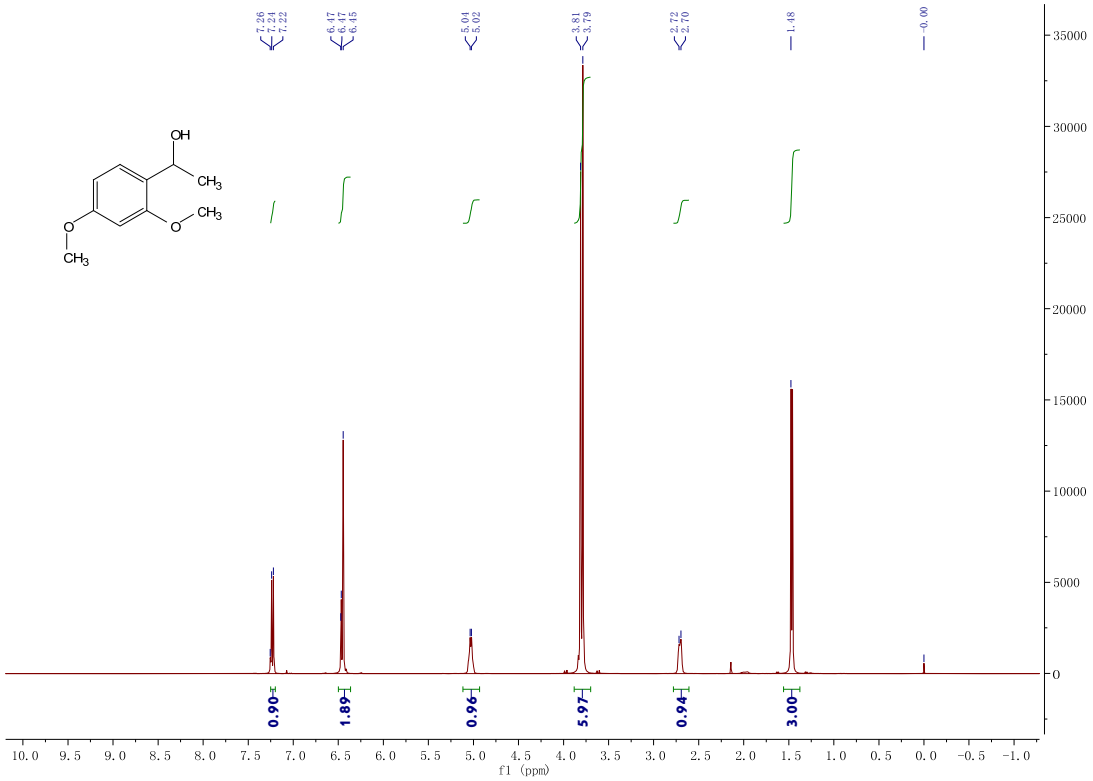
4g ^{1}HNMR



4g ^{13}C NMR



4h ^{1}H NMR



4h^{13}C NMR