

**Organocatalytic Enantioselective aza-Friedel-Crafts Reaction between Benzothiazolimines and 2-Naphthols for Effective Preparation of Chiral 2'-aminobenzothiazolomethyl Naphthols**

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**Table of contents**

<b>1.</b> General information	S2
<b>2.</b> General procedure for the Syntheses of reactants <b>1</b>	S2
<b>3.</b> General procedure for the synthesis of <b>3</b>	S2
<b>4.</b> Scale-up preparation and representative transformation of product of <b>3aa</b>	S3-4
<b>5.</b> X-ray diffraction parameters and data for <b>3aa</b>	S4-5
<b>6.</b> NMR data of products	S5-15
<b>7.</b> HPLC,NMR spectra of products	S16-72

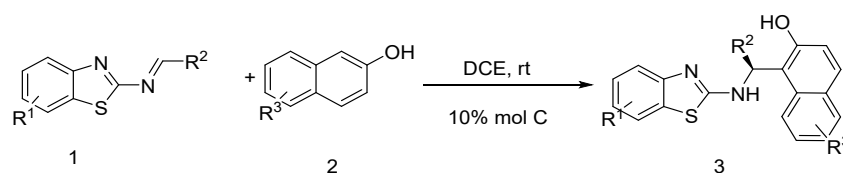
## 1. General Information

Commercial grade solvent was dried and purified by standard procedures as specified in Purification of Laboratory Chemicals.  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra were recorded on a Bruker Avance (600 and 300 MHz for  $^1\text{H}$  NMR, 150 and 75 MHz for  $^{13}\text{C}$  NMR) instrument. Data for  $^1\text{H}$  NMR are reported as chemical shift (ppm, tetramethylsilane as the internal standard), integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constant (Hz). Data for  $^{13}\text{C}$  NMR are reported as chemical shift. High resolution mass spectra were obtained with Thermo Scientific LTQ Orbitrap XL mass spectrometer. Enantiomeric excess was determined by HPLC on chiralpak AD-H, IC. Optical rotations were measured at 589 nm at 20 °C. Melting points were recorded on a Buchi Melting Point B-545. Flash column chromatography was carried out using silica gel eluting with ethyl acetate and petroleum ether. Reactions were monitored by TLC and visualized with ultraviolet light.

## 2. General Procedure for the Syntheses of Reactants 1

Benzothiazolamines<sup>13</sup> were prepared as reported procedures. Unless otherwise noted, materials were purchased from commercial suppliers and used without further purification.

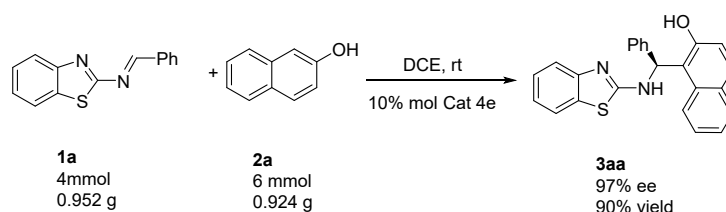
## 3. General procedure for the synthesis of 3



A mixture of 0.1 mmol **1** (23.8 mg), 0.15 mmol **2** (21.6 mg) and 10 mol (8h, Rf = 0.2, PE: EA = 6:1), the solvent was evaporated and the mixture was directly purified by flash column chromatography (petroleum ether/ethyl acetate 8/1 to 6/1) to afford product **3aa** (35.1 mg). Other reactants were operated by the same procedures.

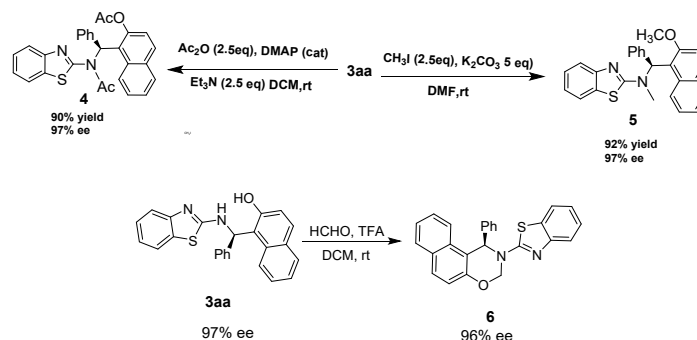
## 4. Scale-up preparation and representative transformation of product 3aa

### 4.1 Scale-up preparation.



A solution of Benzothiazolimine **1a** (0.952g, 4.0 mmol, 1 equiv.), 2-naphthols **2a** (0.864 g, 6 mmol, 1.5 equiv.), and cat **4e** (10% mol,) in DCE (40 mL, 0.1 M) was stirred at room temperature. After **1a** was consumed monitored by TLC, the solvent was evaporated and the mixture was directly purified by column chromatography on silica gel eluting with petroleum ether/ethyl acetate to afford product **3aa**.

#### 4.2 Diacetylation and methylation of product **3aa**<sup>[5b]</sup>[17][18]



A solution of **3aa** (38.3mg, 0.1 mmol.), Et<sub>3</sub>N (25.2 mg ,0.25 mmol,2.5 eq) and Ac<sub>2</sub>O(25.5 mg ,0.25mmol, 2.5 eq) in DCM (1mL, 0.1 M) was stirred at room temperature. After **3aa** was consumed by TLC, the solvent was evaporated and the mixture was directly purified by column chromatography on silica gel eluting with petroleum ether/ethyl acetate to afford product **4**.

A solution of **3aa** (38.3mg, 0.1mmol,), CH<sub>3</sub>I (35.5 mg, 0.25 mmol, 2.5 equiv.), and K<sub>2</sub>CO<sub>3</sub> (69 mg, 0.5mmol, 5 equiv) in DMF (1mL, 0.1 M) was stirred at 25 °C. After **3aa** was consumed by TLC. the solvent was evaporated and the mixture was directly purified by column chromatography on silica gel eluting with petroleum ether/ethyl acetate to afford product **5**.

A solution of **3aa** (38.3mg, 0.1 mmol.), (HCHO)<sub>n</sub> (25.2 mg ,0.25 mmol,2.5 eq) and TFA (25.5 mg ,0.25mmol, 2.5 eq) in DCM (1mL, 0.1 M) was stirred at room temperature. After **3aa** was consumed by TLC, the solvent was evaporated and the mixture was directly purified by column chromatography on silica gel eluting with petroleum ether/DCM to afford product **6**.

#### references:

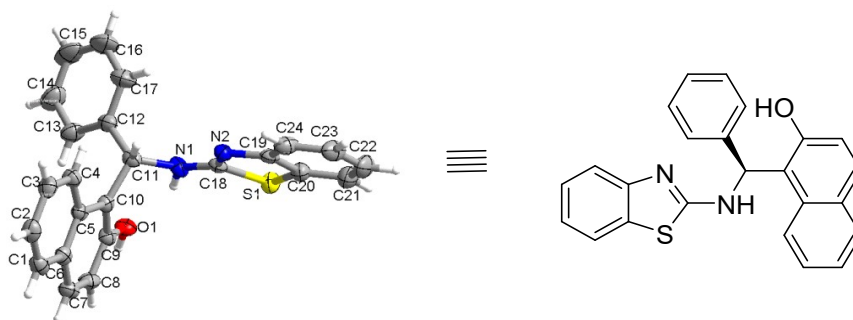
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## 5.X-ray diffraction parameters and data for 3aa

Single crystals of compound **3aa** was obtained by EA/PE at room temperature. The ellipsoid contour was set at 50% probability levels. Details for data collection and structure refinement are summarized in Table S1. CCDC 2055754, contain supplementary crystallographic data for this paper.

**Table S1:** Important crystal data of compound **3a**

Empirical formula	C <sub>24</sub> H <sub>18</sub> N <sub>2</sub> OS
Formula weight	382.46
Temperature/K	293(2)
Crystal system	monoclinic
Space group	P2 <sub>1</sub>
a/Å	6.8325(3)
b/Å	15.6420(8)
c/Å	8.9374(5)
α/°	90
β/°	92.861(5)
γ/°	90
Volume/Å <sup>3</sup>	953.99(8)
Z	2
ρ <sub>calc</sub> /cm <sup>3</sup>	1.331
μ/mm <sup>-1</sup>	1.633
F(000)	400.0
Crystal size/mm <sup>3</sup>	0.16 × 0.1 × 0.08
Radiation	CuKα (λ = 1.54184)
2θ range for data collection/°	9.91 to 134.14
Index ranges	-8 ≤ h ≤ 8, -18 ≤ k ≤ 18, 0 ≤ l ≤ 10
Reflections collected	3412
Independent reflections	3412 [R <sub>int</sub> = ?, R <sub>sigma</sub> = 0.0538]
Data/restraints/parameters	3412/2/226
Goodness-of-fit on F <sup>2</sup>	1.048
Final R indexes [I>=2σ (I)]	R <sub>1</sub> = 0.0566, wR <sub>2</sub> = 0.1347
Final R indexes [all data]	R <sub>1</sub> = 0.0676, wR <sub>2</sub> = 0.1433
Largest diff. peak/hole / e Å <sup>-3</sup>	0.26/-0.24
Flack parameter	0.00(2)

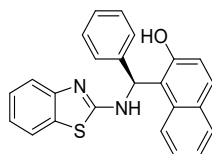


**Figure S1.** ORTEP plot of compound **3aa**  
Thermal ellipsoids are drawn at 50% probability level.

## 6. $^1\text{H}$ and $^{13}\text{C}$ NMR data for all compounds

### (S)-1-((benzo[d]thiazol-2-ylamino)(phenyl)methyl)naphthalen-2-ol (**3aa**)

white solid, mp: 202.7-204.6 °C, 92% yield (35.1 mg), 97% ee,  $[\alpha]_{\text{D}}^{20} = -197.3$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 8.523$  min,  $t_{\text{minor}} = 12.548$  min).



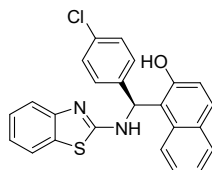
$^1\text{H}$  NMR (300 MHz, DMSO):  $^1\text{H}$  NMR (300 MHz, DMSO)  $\delta$  10.22 (s, 1H), 8.85 (d,  $J = 7.2$  Hz, 1H), 7.88 (s, 1H), 7.81 (dd,  $J = 8.2, 3.5$  Hz, 2H), 7.68 (d,  $J = 7.7$  Hz, 1H), 7.42–7.14 (m, 11H), 7.02 (t,  $J = 7.5$  Hz, 1H).

$^{13}\text{C}$  NMR (75 MHz, DMSO- $d_6$ ):  $\delta$  166.3, 153.2, 152.1, 142.5, 132.2, 130.8, 129.6, 128.7, 128.6, 128.1, 126.2, 126.1, 125.5, 123.9, 122.4, 121.0, 120.9, 118.7, 118.4, 118.1, 53.1.

HRMS (ESI)  $m/z$  calcd for  $\text{C}_{24}\text{H}_{19}\text{N}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  383.1212, found 383.1213.

### (S)-1-((benzo[d]thiazol-2-ylamino)(4-chlorophenyl)methyl)naphthalen-2-ol (**3ba**)

white solid, Mp: 147.8-149.2 °C 95% yield (39.5 mg), 98% ee,  $[\alpha]_{\text{D}}^{20} = -190$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 7.668$  min,  $t_{\text{minor}} = 9.433$  min).

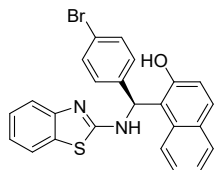


$^1\text{H}$  NMR (300 MHz, DMSO- $d_6$ ):  $^1\text{H}$  NMR (300 MHz, DMSO)  $\delta$  10.21 (s, 1H), 8.81 (s, 1H), 7.81 (dd,  $J$

= 8.2, 4.0 Hz, 3H), 7.67 (d,  $J = 7.6$  Hz, 1H), 7.47–7.12 (m, 10H), 7.02 (t,  $J = 7.4$  Hz, 1H).  
 $^{13}\text{C NMR}$  (75 MHz, DMSO)  $\delta$  166.2, 153.2, 152.1, 141.8, 132.0, 130.9, 130.7, 129.9, 128.7, 128.1, 127.9, 126.4, 125.5, 123.7, 122.6, 121.2, 121.0, 118.3, 118.2, 52.6.  
**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{24}\text{H}_{18}\text{ClN}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  417.0822, found 417.0823.

**(S)-1-((benzo[d]thiazol-2-ylamino)(4-bromophenyl)methyl)naphthalen-2-ol (3ca)**

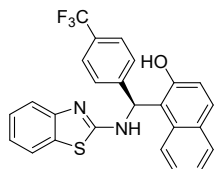
white solid, Mp: 141.6-143.4 °C, 95% yield (43.7 mg), 98% ee,  $[\alpha]_{\text{D}}^{20} = -156.3$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 8.023$  min,  $t_{\text{minor}} = 9.715$  min).



$^1\text{H NMR}$  (300 MHz, DMSO):  $^1\text{H NMR}$  (300 MHz, DMSO)  $\delta$  10.25 (s, 1H), 8.87 (d,  $J = 6.9$  Hz, 1H), 7.82 (d,  $J = 9.0$  Hz, 3H), 7.69 (d,  $J = 7.6$  Hz, 1H), 7.47 (d,  $J = 8.4$  Hz, 2H), 7.41 (d,  $J = 7.8$  Hz, 2H), 7.35–7.26 (m, 3H), 7.25–7.16 (m, 3H), 7.03 (t,  $J = 7.4$  Hz, 1H).  
 $^{13}\text{C NMR}$  (75 MHz, DMSO)  $\delta$  166.2, 153.2, 152.1, 142.2, 132.0, 131.0, 129.8, 128.6, 128.3, 126.4, 125.5, 123.7, 122.5, 121.1, 120.9, 119.2, 118.4, 118.2, 118.2, 52.6.  
**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{24}\text{H}_{18}\text{BrN}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  461.0317, found 461.03226.

**(S)-1-((benzo[d]thiazol-2-ylamino)(4-(trifluoromethyl)phenyl)methyl)naphthalen-2-ol (3da)**

white solid, Mp: 205.8-207.1 °C, 85 % yield(38.3 mg), 98% ee,  $[\alpha]_{\text{D}}^{20} = -132.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 92/8, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 12.015$  min,  $t_{\text{minor}} = 13.382$  min).

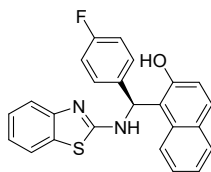


$^1\text{H NMR}$  (600 MHz, DMSO)  $\delta$  10.26 (s, 1H), 8.91 (d,  $J = 7.1$  Hz, 1H), 7.84 (d,  $J = 9.0$  Hz, 3H), 7.70 (d,  $J = 7.7$  Hz, 1H), 7.66 (d,  $J = 8.4$  Hz, 2H), 7.47 (d,  $J = 8.2$  Hz, 2H), 7.41 (d,  $J = 7.9$  Hz, 3H), 7.34–7.18 (m, 3H), 7.07–6.99 (m, 1H).  
 $^{13}\text{C NMR}$  (150MHz, DMSO)  $\delta$  166.6, 153.7, 152.5, 148.2, 132.5, 131.4, 130.9 (d,  $J = 142.4$  Hz), 130.4, 129.1, 127.4, 127.2 (d,  $J = 7.5$  Hz), 126.8, 125.9, 125.7, 125.5, 123.9, 121.6, 121.4, 118.8 (d,  $J = 9.6$  Hz), 118.5, 53.3.

**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{25}\text{H}_{18}\text{F}_3\text{N}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  451.1086, found 451.1088.

**(S)-1-((benzo[d]thiazol-2-ylamino)(4-fluorophenyl)methyl)naphthalen-2-ol (3ea)**

white solid, Mp: 127.4-129.3 °C, 92 % yield(36.8 mg), 95% ee,  $[\alpha]_{\text{D}}^{20} = -312.6$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 7.507$  min,  $t_{\text{minor}} = 9.907$  min).



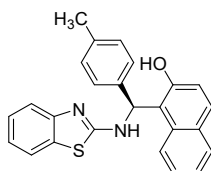
**<sup>1</sup>H NMR** (600 MHz, DMSO) δ 10.22 (s, 1H), 8.86 (d, *J* = 6.3 Hz, 1H), 7.88 (s, 1H), 7.81 (t, *J* = 8.3 Hz, 2H), 7.68 (d, *J* = 7.7 Hz, 1H), 7.39 (t, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 6.6 Hz, 1H), 7.28 (t, *J* = 11.6 Hz, 4H), 7.21 (t, *J* = 7.6 Hz, 1H), 7.10 (t, *J* = 8.6 Hz, 2H), 7.02 (t, *J* = 7.5 Hz, 1H).

**<sup>13</sup>C NMR** (150MHz, DMSO) δ 166.7, 161.23 (d, *J* = 242.0 Hz), 153.6, 152.5, 139.0, 132.5 131.3, 130.1, 129.0, 128.4 (d, *J* = 7.9 Hz), 126.8, 125.9, 122.9, 121.5, 121.3, 118.9, 118.6, 115.3 (d, *J* = 21.3 Hz), 53.0.

HRMS (ESI) *m/z* calcd for C<sub>24</sub>H<sub>18</sub>FN<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 401.1118, found 401.11212.

**(S)-1-((benzo[d]thiazol-2-ylamino)(p-tolyl)methyl)naphthalen-2-ol (3fa)**

White solid, mp: 186.7-188.9 °C, 94% yield ( 37.2 mg ) , 95% ee, [α]<sub>D</sub><sup>20</sup> = -290.6 (*c* = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ =254 nm, *t*<sub>major</sub> =8.140 min, *t*<sub>minor</sub> = 11.540 min).



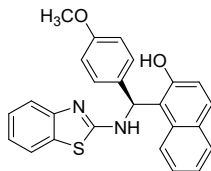
**<sup>1</sup>H NMR** (600 MHz, DMSO) δ 10.18 (s, 1H), 8.82 (d, *J* = 6.0 Hz, 1H), 8.03 – 7.82 (m, 1H), 7.79 (t, *J* = 9.1 Hz, 2H), 7.67 (d, *J* = 7.6 Hz, 1H), 7.27 (m, 8H), 7.09 – 6.98 (m, 3H), 2.22 (s, 3H).

**<sup>13</sup>C NMR** (150 MHz, DMSO) δ 166.8, 153.6, 152.6, 139.9, 135.6, 132.6, 131.2, 129.9, 129.1, 129.0, 126.5, 125.9, 122.8, 121.4, 121.3, 119.3, 118.9, 118.5, 53.4, 18.5.

HRMS (ESI) *m/z* calcd for C<sub>25</sub>H<sub>21</sub>N<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 397.1369, found 397.1370.

**(S)-1-((benzo[d]thiazol-2-ylamino)(4-methoxyphenyl)methyl)naphthalen-2-ol (3ga)**

white solid, Mp: 178.2-180.3 °C, 98 % yield(40.3 mg), 85% ee, [α]<sub>D</sub><sup>20</sup> = -346.3 (*c* = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ =254 nm, *t*<sub>major</sub> = 12.073 min, *t*<sub>minor</sub> = 23.790 min).



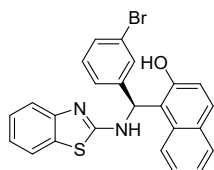
**<sup>1</sup>H NMR** (300 MHz, DMSO):δ 10.19 (s, 1H), 8.82 (d, *J* = 7.0 Hz, 1H), 7.90 (s, 1H), 7.82–7.75 (m, 2H), 7.67 (d, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 7.9 Hz, 2H), 7.32–7.13 (m, 6H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.84 (d, *J* = 8.7 Hz, 2H), 3.68 (s, 3H).

**<sup>13</sup>C NMR** (75 MHz, DMSO) δ 166.3, 157.7, 153.1, 152.2, 134.2 132.1, 130.7, 129.5, 128.7, 128.6, 127.3, 126.2, 125.5, 123.9, 122.4, 121.0, 120.9, 118.8, 118.4, 118.1, 113.5, 55.0, 52.8.

HRMS (ESI) *m/z* calcd for C<sub>25</sub>H<sub>21</sub>N<sub>2</sub>O<sub>2</sub>S<sup>+</sup> (M+H)<sup>+</sup> 413.1318, found 413.1318.

**(S)-1-((benzo[d]thiazol-2-ylamino)(3-bromophenyl)methyl)naphthalen-2-ol (3ha)**

white solid, Mp: 199.2-200.1 °C, 96 % yield ( 44.1 mg ) , 98% ee,  $[\alpha]_D^{20} = -191.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 7.607$  min,  $t_{\text{minor}} = 8.757$  min).



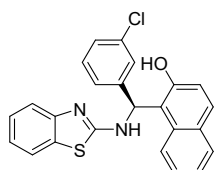
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.25 (s, 1H), 8.88 (d,  $J = 7.4$  Hz, 1H), 7.88 (d,  $J = 36.7$  Hz, 1H), 7.83 (t,  $J = 7.7$  Hz, 2H), 7.69 (d,  $J = 7.7$  Hz, 1H), 7.47–7.34 (m, 5H), 7.29 (dd,  $J = 8.0, 4.9$  Hz, 2H), 7.26–7.20 (m, 3H), 7.07–7.00 (m, 1H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  166.6, 153.7, 152.4, 146.1, 132.5, 131.3, 130.8, 130.3, 129.5, 129.1, 129.0, 127.0, 125.9, 125.7, 123.0, 122.0, 121.6, 121.4, 118.8, 118.7, 118.5, 53.1.

**HRMS** (ESI)  $m/z$  calcd for  $C_{24}H_{18}BrN_2OS^+$  ( $M+H$ )<sup>+</sup> 461.0317, found 461.0323.

**(S)-1-((benzo[d]thiazol-2-ylamino)(3-chlorophenyl)methyl)naphthalen-2-ol (3ia)**

white solid, Mp: 183.8-184.9 °C, 92 % yield(38.2 mg), 93% ee,  $[\alpha]_D^{20} = -170.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 6.300$  min,  $t_{\text{minor}} = 7.225$  min).



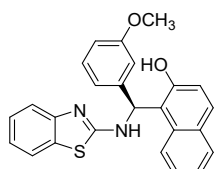
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.25 (s, 1H), 8.90 (t,  $J = 22.9$  Hz, 1H), 7.92 (t,  $J = 45.5$  Hz, 1H), 7.85–7.80 (m, 2H), 7.69 (d,  $J = 7.6$  Hz, 1H), 7.41 (d,  $J = 7.9$  Hz, 2H), 7.36 (d,  $J = 7.3$  Hz, 1H), 7.32 – 7.19 (m, 7H), 7.06–7.01 (m, 1H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  166.6, 153.7, 152.4, 145.9, 133.3, 132.5, 131.3, 130.5, 130.3, 129.1, 129.0, 127.0, 126.6, 126.2, 125.9, 125.3, 123.0, 121.6, 121.4, 118.8, 118.7, 118.5, 53.1,

**HRMS** (ESI)  $m/z$  calcd for  $C_{24}H_{18}ClN_2OS^+$  ( $M+H$ )<sup>+</sup> 417.0822, found 417.0822.

**(S)-1-((benzo[d]thiazol-2-ylamino)(3-methoxyphenyl)methyl)naphthalen-2-ol (3ja)**

white solid, Mp: 189.1-190.9 °C, 95% yield(39.1 mg) ,95% ee,  $[\alpha]_D^{20} = -160.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 9.632$  min,  $t_{\text{minor}} = 13.282$  min).



**<sup>1</sup>H NMR** (300 MHz, DMSO): $\delta$  10.22 (s, 1H), 8.86 (d,  $J = 7.6$  Hz, 1H), 7.91 (s, 1H), 7.81 (dd,  $J = 8.4, 4.0$  Hz, 2H), 7.69 (d,  $J = 7.8$  Hz, 1H), 7.47–7.09 (m, 7H), 7.02 (t,  $J = 7.5$  Hz, 1H), 6.91–6.82 (m, 2H), 6.76 (d,  $J = 6.5$  Hz, 1H), 3.65 (s, 3H).

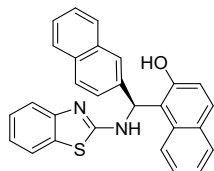


**<sup>13</sup>C NMR** (75 MHz, DMSO)  $\delta$  166.3, 159.2, 153.2, 152.1, 144.3, 132.2, 130.8, 129.6, 129.3, 128.6, 128.6, 126.3, 125.5, 123.9, 122.5, 121.0, 120.9, 118.7, 118.5, 118.1, 54.9, 53.0.

**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{21}N_2O_2S^+$  (M+H)<sup>+</sup> 413.1318, found 413.1319.

**(S)-1-((benzo[d]thiazol-2-ylamino)(naphthalen-2-yl)methyl)naphthalen-2-ol (3ka)**

white solid, Mp: 197.8-199.8 °C, 80% yield (34.5 mg), 97% ee,  $[\alpha]_D^{20} = -138.2$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm, 97% ee:  $t_{major} = 9.273$  min,  $t_{minor} = 12.590$  min).



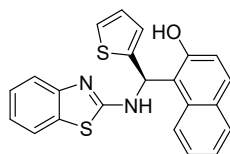
**<sup>1</sup>H NMR** (300 MHz, DMSO)  $\delta$  10.26 (s, 1H), 8.97 (d,  $J = 7.1$  Hz, 1H), 7.99 (s, 1H), 7.87 – 7.67 (m, 6H), 7.59–7.43 (m, 2H), 7.39 (m, 6H), 7.29–7.17 (m, 2H), 7.03 (t,  $J = 7.6$  Hz, 1H).

**<sup>13</sup>C NMR** (75 MHz, DMSO)  $\delta$  166.3, 153.5, 152.4, 147.3, 132.5, 131.2, 130.3, 129.0, 127.1, 126.8, 125.9, 125.0, 124.5, 122.9, 121.6, 121.4, 118.8, 118.7, 118.5, 50.8.

**HRMS** (ESI)  $m/z$  calcd for  $C_{28}H_{21}N_2OS^+$  (M+H)<sup>+</sup> 433.1369, found 433.1370.

**(R)-1-((benzo[d]thiazol-2-ylamino)(thiophen-2-yl)methyl)naphthalen-2-ol (3la)**

white solid, Mp: 197.8-199.8 °C, 92% yield (35.6 mg), 91% ee,  $[\alpha]_D^{20} = -165.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm, 97% ee:  $t_{major} = 10.607$  min,  $t_{minor} = 17.658$  min).



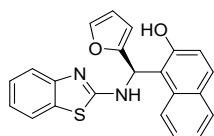
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.30 (s, 1H), 8.99 (s, 1H), 8.03 (s, 1H), 7.81 (t,  $J = 8.6$  Hz, 2H), 7.68 (d,  $J = 7.7$  Hz, 1H), 7.52 (d,  $J = 7.5$  Hz, 1H), 7.42 (d,  $J = 8.0$  Hz, 2H), 7.33 (d,  $J = 5.0$  Hz, 1H), 7.30 – 7.17 (m, 3H), 7.02 (t,  $J = 7.5$  Hz, 1H), 6.95–6.76 (m, 2H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  166.3, 153.5, 152.4, 147.3, 132.5, 131.2, 130.3, 129.0, 127.1, 126.8, 125.9, 125.0, 124.5, 122.9, 121.6, 121.4, 118.8, 118.7, 118.5, 50.8.

**HRMS** (ESI)  $m/z$  calcd for  $C_{22}H_{17}N_2OS_2^+$  (M+H)<sup>+</sup> 389.0776, found 389.0775.

**(R)-1-((benzo[d]thiazol-2-ylamino)(furan-2-yl)methyl)naphthalen-2-ol (3ma)**

white solid, Mp: 180.1-181.5 °C, 90% yield (33.4 mg), 95% ee,  $[\alpha]_D^{20} = +84.4$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm, 97% ee:  $t_{major} = 10.710$  min,  $t_{minor} = 13.930$  min).



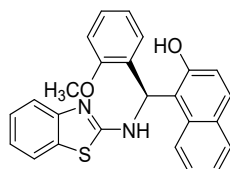
**<sup>1</sup>H NMR** (300 MHz, DMSO)  $\delta$  10.24 (s, 1H), 8.90 (d,  $J = 7.5$  Hz, 1H), 8.08 (d,  $J = 8.6$  Hz, 1H), 7.85 – 7.72 (m, 2H), 7.66 (d,  $J = 7.5$  Hz, 1H), 7.51 (s, 1H), 7.40 (d,  $J = 7.7$  Hz, 2H), 7.27 (dd,  $J = 12.3, 8.1$  Hz, 4H), 7.01 (t,  $J = 7.1$  Hz, 1H), 6.38 (s, 1H), 6.22 (s, 1H).

<sup>13</sup>C NMR (75 MHz, DMSO) δ 165.8, 154.5, 153.4, 151.9, 141.8, 132.4, 130.6, 129.8, 128.5, 126.2, 125.5, 123.3, 122.4, 121.0, 120.9, 118.4, 118.1, 116.1, 110.5, 106.4, 48.7.

HRMS (ESI) m/z calcd for C<sub>22</sub>H<sub>16</sub>N<sub>2</sub>O<sub>2</sub>S<sub>2</sub><sup>+</sup> (M+H)<sup>+</sup> 373.1005, found 373.1024.

### 1-((benzo[d]thiazol-2-ylamino)(2-methoxyphenyl)methyl)naphthalen-2-ol (3na)

white solid, Mp: 178.5-179.6 °C, 85% yield (37.9 mg), >99% ee, [α]<sub>D</sub><sup>20</sup> = -180.5 (c = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 8.723 min, *t*<sub>minor</sub> = 20.923 min).



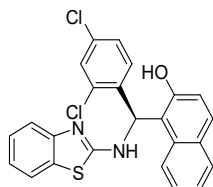
<sup>1</sup>H NMR (600 MHz, DMSO) δ 9.91 (s, 1H), 8.64 (d, *J* = 7.8 Hz, 1H), 8.22 (d, *J* = 8.6 Hz, 1H), 7.76 (d, *J* = 7.9 Hz, 1H), 7.71 (d, *J* = 8.8 Hz, 1H), 7.62 (d, *J* = 7.6 Hz, 1H), 7.51 (d, *J* = 6.1 Hz, 1H), 7.41 (t, *J* = 7.2 Hz, 1H), 7.34–7.13 (m, 6H), 6.99–6.85 (m, 3H), 3.58 (s, 3H).

<sup>13</sup>C NMR (75 MHz, DMSO) δ 166.4, 153.3, 152.1, 140.2, 132.8, 132.2, 131.8, 130.8, 129.7, 128.7, 128.6, 127.7, 127.6, 126.3, 126.1, 125.4, 125.0, 123.9, 121.0, 120.9, 118.6, 118.6, 118.5, 53.3.

HRMS (ESI) m/z calcd for C<sub>25</sub>H<sub>21</sub>N<sub>2</sub>O<sub>2</sub>S<sup>+</sup> (M+H)<sup>+</sup> 413.1318, found 413.1317.

### (S)-1-((benzo[d]thiazol-2-ylamino)(2,4-dichlorophenyl)methyl)naphthalen-2-ol (3oa)

white solid, Mp: 192.5-193.6 °C, 65% yield (29.3 mg), 90% ee, [α]<sub>D</sub><sup>20</sup> = -199.4 (c = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 7.607 min, *t*<sub>minor</sub> = 13.740 min).



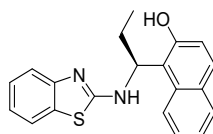
<sup>1</sup>H NMR (600 MHz, DMSO) δ 9.97 (s, 1H), 8.90 (d, *J* = 6.9 Hz, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.80 (dd, *J* = 18.5, 8.5 Hz, 2H), 7.67 (dd, *J* = 12.5, 8.2 Hz, 2H), 7.50 (d, *J* = 1.7 Hz, 1H), 7.46–7.32 (m, 3H), 7.27 (t, *J* = 7.4 Hz, 1H), 7.21–7.10 (m, 3H), 7.01 (t, *J* = 7.6 Hz, 1H).

<sup>13</sup>C NMR (151 MHz, DMSO) δ 165.6, 154.2, 152.6, 139.5, 133.4, 133.1, 132.2, 131.5, 131.2, 130.4, 129.1, 128.7, 127.0, 125.9, 122.8, 121.5, 121.4, 119.0, 118.8, 116.3, 52.8.

HRMS (ESI) m/z calcd for C<sub>24</sub>H<sub>17</sub>Cl<sub>2</sub>N<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 451.0433, found 451.0435.

### (S)-1-(1-(benzo[d]thiazol-2-ylamino)propyl)naphthalen-2-ol (3pa)

white solid, Mp: 109.7-110.4 °C, 50% yield (16.7 mg), 45% ee, [α]<sub>D</sub><sup>20</sup> = -199.4 (c = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 5.657 min, *t*<sub>minor</sub> = 8.082 min).



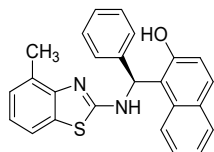
**<sup>1</sup>H NMR** (300 MHz, DMSO) δ 10.05 (s, 1H), 8.51 (d, *J* = 7.8 Hz, 1H), 8.16 (d, *J* = 8.6 Hz, 1H), 7.74 (dd, *J* = 16.5, 8.3 Hz, 2H), 7.61 (d, *J* = 7.7 Hz, 1H), 7.38 (dd, *J* = 14.3, 7.4 Hz, 2H), 7.22 (dt, *J* = 16.0, 7.4 Hz, 3H), 6.96 (t, *J* = 7.4 Hz, 1H), 6.45 (d, *J* = 7.5 Hz, 1H), 5.49 (s, 1H), 2.33–1.84 (m, 2H), 0.88 (t, *J* = 7.5 Hz, 3H).

**<sup>13</sup>C NMR** (75 MHz, DMSO) δ 166.2, 153.3, 152.1, 132.9, 132.7, 130.4, 129.1, 128.5, 128.4, 125.8, 125.4, 125.2, 123.7, 122.3, 120.8, 120.7, 118.4, 117.8, 117.2, 56.0, 20.6, 14.4, 14.0.

**HRMS** (ESI) *m/z* calcd for C<sub>24</sub>H<sub>17</sub>Cl<sub>2</sub>N<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 335.1212, found 335.1075.

**(S)-1-(((4-methylbenzo[d]thiazol-2-yl)amino)(phenyl)methyl)naphthalen-2-ol (3qa)**

white solid, Mp:198.3-199.9 °C, 92% yield(36.4 mg), 96% ee, [α]<sub>D</sub><sup>20</sup> = -360.2 (*c* = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 5.292 min, *t*<sub>minor</sub> = 4.693 min).



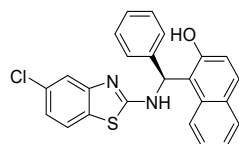
**<sup>1</sup>H NMR** (600 MHz, DMSO) δ 10.17 (s, 1H), 8.90 (d, *J* = 5.3 Hz, 1H), 8.17–7.92 (m, 1H), 7.78 (d, *J* = 8.9 Hz, 2H), 7.47 (d, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 1.2 Hz, 2H), 7.29 (dt, *J* = 19.5, 6.0 Hz, 6H), 7.18 (t, *J* = 7.2 Hz, 1H), 7.02 (d, *J* = 7.4 Hz, 1H), 6.90 (t, *J* = 7.6 Hz, 1H), 2.43 (s, 3H).

**<sup>13</sup>C NMR** (150 MHz, DMSO-d<sub>6</sub>) δ 166.0, 155.7, 153.8, 151.3, 142.6, 132.8, 130.5, 129.9, 129.7, 128.9, 128.5, 128.0, 127.6, 126.7, 126.6, 126.4, 123.1, 122.8, 121.3, 119.5, 119.0, 118.7, 53.7.

**HRMS** (ESI) *m/z* calcd for C<sub>25</sub>H<sub>21</sub>N<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 397.1369, found 397.1371.

**(S)-1-(((5-chlorobenzo[d]thiazol-2-yl)amino)(phenyl)methyl)naphthalen-2-ol (3ra)**

white solid, Mp:182.4-184.5 °C, 88% yield(36.5 mg), 97% ee, [α]<sub>D</sub><sup>20</sup> = -254.5 (*c* = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 8.832min, *t*<sub>minor</sub> = 10.665 min).



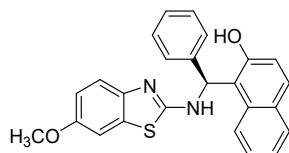
**<sup>1</sup>H NMR** (600 MHz, DMSO) δ 10.17 (s, 1H), 8.90 (d, *J* = 5.3 Hz, 1H), 8.17–7.92 (m, 1H), 7.78 (d, *J* = 8.9 Hz, 2H), 7.47 (d, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 1.2 Hz, 2H), 7.29 (m, 6.0 Hz, 6H), 7.18 (t, *J* = 7.2 Hz, 1H), 7.02 (d, *J* = 7.4 Hz, 1H), 6.90 (t, *J* = 7.6 Hz, 1H), 2.43 (s, 3H).

**<sup>13</sup>C NMR** (150 MHz, DMSO-d<sub>6</sub>) δ 166.0, 155.7, 153.8, 151.3, 142.6, 132.8, 130.5, 129.9, 129.7, 128.9, 128.5, 128.0, 127.6, 126.7, 126.6, 126.4, 123.1, 122.8, 121.3, 119.5, 119.0, 118.7, 53.7.

**HRMS** (ESI) *m/z* calcd for C<sub>24</sub>H<sub>18</sub>ClN<sub>2</sub>OS<sup>+</sup> (M+H)<sup>+</sup> 417.0821, found 417.0827.

**(S)-1-(((6-methoxybenzo[d]thiazol-2-yl)amino)(phenyl)methyl)naphthalen-2-ol (3sa)**

white solid, Mp: 172.3-174.6 °C, 90% yield(37.1 mg), 72% ee, [α]<sub>D</sub><sup>20</sup> = -340.5 (*c* = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm, *t*<sub>major</sub> = 15.365 min, *t*<sub>minor</sub> = 24.298 min).



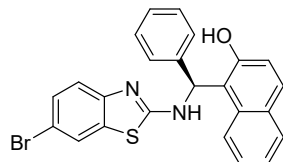
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.17 (s, 1H), 8.62 (d,  $J$  = 6.9 Hz, 1H), 7.85 (d,  $J$  = 25.3 Hz, 1H), 7.79 (t,  $J$  = 9.4 Hz, 2H), 7.29 (m, 10H), 7.16 (t,  $J$  = 6.6 Hz, 1H), 6.81 (dd,  $J$  = 8.7, 2.5 Hz, 1H), 3.72 (s, 3H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  165.2, 154.8, 153.6, 146.6, 143.1, 132.3, 129.9, 129.0, 128.5, 126.5, 126.5, 122.8, 119.4, 118.9, 113.3, 105.9, 56.0, 53.4.

**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{21}N_2O_2S^+$  (M+H)<sup>+</sup> 413.1318, found 413.1317.

**(S)-1-(((6-bromobenzo[d]thiazol-2-yl)amino)(phenyl)methyl)naphthalen-2-ol (3ta)**

white solid, Mp: 193.6-194.5°C, 90% yield(41.3 mg), 98% ee,  $[\alpha]_D^{20}$  = -274.5 ( $c$  = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda$  =254 nm,  $t_{major}$  = 11.990 min,  $t_{minor}$  = 21.9408 min).



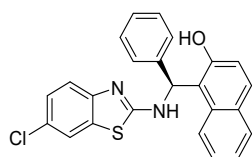
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.17 (s, 1H), 8.62 (d,  $J$  = 6.9 Hz, 1H), 7.85 (d,  $J$  = 25.3 Hz, 1H), 7.79 (t,  $J$  = 9.4 Hz, 2H), 7.29 (m, 10H), 7.16 (t,  $J$  = 6.6 Hz, 1H), 6.81 (dd,  $J$  = 8.7, 2.5 Hz, 1H), 3.72 (s, 3H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  165.2, 154.8, 153.6, 146.6, 143.1, 132.3, 129.9, 129.0, 128.5, 126.5, 126.5, 122.8, 119.4, 118.9, 113.3, 105.9, 56.0, 53.4.

**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{21}N_2O_2S^+$  (M+H)<sup>+</sup> 463.0317, found 463.0298.

**(S)-1-(((6-chlorobenzo[d]thiazol-2-yl)amino)(phenyl)methyl)naphthalen-2-ol (3ua)**

white solid, Mp: 202.5-204.3 °C, 90 % yield(37.4 mg), 96% ee,  $[\alpha]_D^{20}$  = -240.5 ( $c$  = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda$  =254 nm,  $t_{major}$  = 10.598 min,  $t_{minor}$  = 20.440 min).



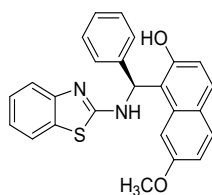
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.18 (s, 1H), 8.96 (d,  $J$  = 7.5 Hz, 1H), 7.89 (m, 1H), 7.81 (dd,  $J$  = 9.3, 5.4 Hz, 3H), 7.37 (d,  $J$  = 8.6 Hz, 3H), 7.31 – 7.24 (m, 6H), 7.22 (dd,  $J$  = 8.6, 2.2 Hz, 1H), 7.17 (dt,  $J$  = 8.4, 4.0 Hz, 1H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  167.3, 153.6, 151.5, 142.8, 133.0, 132.6, 130.1, 129.0, 128.6, 126.7, 126.5, 126.0, 125.1, 122.9, 121.0, 119.4, 118.9, 118.8, 53.6.

**HRMS** (ESI)  $m/z$  calcd for  $C_{24}H_{18}ClN_2OS^+$  (M+H)<sup>+</sup> 417.0822, found 417.0823.

**(S)-1-(((benzo[d]thiazol-2-yl)amino)(phenyl)methyl)-7-methoxynaphthalen-2-ol (3ab)**

white solid, Mp: 190.1-192.3 °C, 85% yield(35.1 mg), 95% ee,  $[\alpha]_D^{20}$  = -370.3 ( $c$  = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min,  $\lambda$  =254 nm,  $t_{major}$  = 17.933 min,  $t_{minor}$  = 22.342 min).



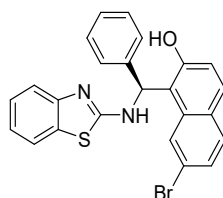
**<sup>1</sup>H NMR** (300 MHz, DMSO)  $\delta$  10.15 (s, 1H), 8.86 (d,  $J$  = 7.3 Hz, 1H), 7.70 (dd,  $J$  = 7.7, 4.0 Hz, 3H), 7.40 (d,  $J$  = 7.5 Hz, 2H), 7.36–7.25 (m, 4H), 7.24–7.09 (m, 4H), 7.03 (t,  $J$  = 7.5 Hz, 1H), 6.91 (d,  $J$  = 7.0 Hz, 1H), 3.65 (s, 3H).

**<sup>13</sup>C NMR** (75MHz, DMSO)  $\delta$  166.7, 154.1, 152.5, 143.2, 131.2, 130.4, 129.7, 129.5, 128.5, 126.4, 126.3, 125.9, 124.4, 121.4, 121.3, 118.6, 118.5, 116.1, 114.7, 108.5, 104.9, 55.5, 55.2, 53.3.

**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{21}N_2O_2S^+$  (M+H)<sup>+</sup> 413.1318, found 413.1317.

**(S)-1-((benzo[d]thiazol-2-ylamino)(phenyl)methyl)-7-bromonaphthalen-2-ol (3ac)**

white solid, Mp: 204.1-206.2 °C, 94% yield(43.2 mg),90% ee,  $[\alpha]_D^{20}$  = -335.5( $c$  = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min,  $\lambda$  =254 nm,  $t_{major}$  = 11.148 min,  $t_{minor}$  = 12.232 min).



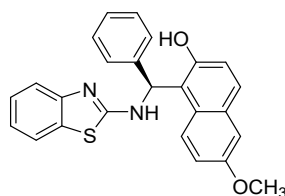
**<sup>1</sup>H NMR** (300 MHz, DMSO)  $\delta$  10.15 (s, 1H), 8.86 (d,  $J$  = 7.3 Hz, 1H), 7.70 (dd,  $J$  = 7.7, 4.0 Hz, 3H), 7.40 (d,  $J$  = 7.5 Hz, 2H), 7.36–7.25 (m, 4H), 7.24–7.09 (m, 4H), 7.03 (t,  $J$  = 7.5 Hz, 1H), 6.91 (d,  $J$  = 7.0 Hz, 1H), 3.65 (s, 3H).

**<sup>13</sup>C NMR** (75MHz, DMSO)  $\delta$  166.7, 154.1, 152.5, 143.2, 131.2, 130.4, 129.7, 129.5, 128.5, 126.4, 126.3, 125.9, 124.4, 121.4, 121.3, 118.6, 118.5, 116.1, 114.7, 108.5, 104.9, 55.5, 55.2, 53.3.

**HRMS** (ESI)  $m/z$  calcd for  $C_{24}H_{18}BrN_2OS^+$  (M+H)<sup>+</sup> 463.0317, found 463.0299.

**(S)-1-((benzo[d]thiazol-2-ylamino)(phenyl)methyl)-6-methoxynaphthalen-2-ol (3ad)**

white solid, Mp: 191.3-192.5°C, 90% yield (37.1mg), 98% ee,  $[\alpha]_D^{20}$  = -264.8( $c$  = 1.0, EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda$  =254 nm,  $t_{major}$  = 14.390 min,  $t_{minor}$  =13.190 min).



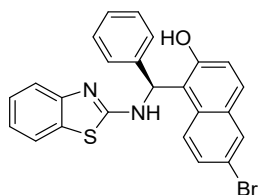
**<sup>1</sup>H NMR** (600 MHz, DMSO)  $\delta$  10.37 (s, 1H), 8.83 (d,  $J$  = 7.3 Hz, 1H), 8.09 (d,  $J$  = 2.1 Hz, 1H), 7.74 (m, 3H), 7.46 (d,  $J$  = 8.1 Hz, 1H), 7.37 (d,  $J$  = 7.9 Hz, 1H), 7.34 – 7.16 (m, 8H), 7.06 – 6.95 (m, 1H).

**<sup>13</sup>C NMR** (150 MHz, DMSO)  $\delta$  166.6, 154.1, 152.5, 142.6, 131.2, 130.6, 129.3, 128.6, 126.7, 126.5, 125.9, 121.5, 121.3, 120.0, 119.5, 118.6, 115.7, 53.3.

**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{21}N_2O_2S^+$  (M+H)<sup>+</sup> 413.1318, found 413.1311.

**(S)-1-((benzo[d]thiazol-2-ylamino)(phenyl)methyl)-6-bromonaphthalen-2-ol (3ae)**

white solid, Mp: 197.8-198.9 °C, 92 % yield (42.3 mg), 92% ee ,  $[\alpha]_D^{20} = -216.7$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 10.432$  min,  $t_{\text{minor}} = 8.365$  min).



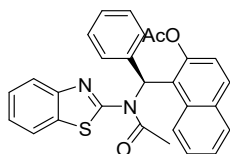
$^1\text{H NMR}$  (600 MHz, DMSO)  $\delta$  10.37 (s, 1H), 8.83 (d,  $J = 7.3$  Hz, 1H), 8.09 (d,  $J = 2.1$  Hz, 1H), 7.74 (m, 3H), 7.46 (d,  $J = 8.1$  Hz, 1H), 7.37 (d,  $J = 7.9$  Hz, 1H), 7.34–7.16 (m, 8H), 7.06–6.95 (m, 1H).

$^{13}\text{C NMR}$  (150 MHz, DMSO)  $\delta$  166.6, 154.1, 152.5, 142.6, 131.2, 130.6, 129.3, 128.6, 126.7, 126.5, 125.9, 121.5, 121.3, 120.0, 119.5, 118.6, 115.7, 53.3.

**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{24}\text{H}_{18}\text{BrN}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  463.0317, found 463.0323.

**(S)-1-((benzo[d]thiazol-2-ylamino)(phenyl)methyl)naphthalen-2-yl acetate (4)**

white solid, Mp: 180.1-181.5 °C, 90% yield (41.9 mg), 97% ee ,  $[\alpha]_D^{20} = -364.6$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 8.198$  min,  $t_{\text{minor}} = 8.965$  min).



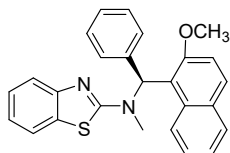
$^1\text{H NMR}$  (300 MHz, DMSO)  $\delta$  7.98 (d,  $J = 9.7$  Hz, 2H), 7.91 (d,  $J = 8.1$  Hz, 2H), 7.80 (d,  $J = 8.1$  Hz, 1H), 7.57 (d,  $J = 8.3$  Hz, 1H), 7.44 (t,  $J = 7.7$  Hz, 3H), 7.40–7.18 (m, 7H), 2.04 (s, 3H), 1.75 (s, 3H).

$^{13}\text{C NMR}$  (75 MHz, DMSO)  $\delta$  169.8, 168.3, 160.9, 148.8, 148.6, 139.8, 135.8, 132.5, 131.5, 130.9, 128.8, 128.4, 126.6, 126.3, 125.9, 125.8, 125.3, 123.7, 123.0, 122.6, 122.0, 55.7, 22.6, 20.1.

**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{28}\text{H}_{22}\text{BrN}_2\text{OS}^+$  ( $\text{M}+\text{H}$ ) $^+$  467.1423, found 467.1427.

**(S)-N-((2-methoxynaphthalen-1-yl)(phenyl)methyl)benzo[d]thiazol-2-amine (5)**

white solid, Mp: 145.6-147.1 °C, 92 % yield (37.7 mg), 97% ee ,  $[\alpha]_D^{20} = -212.5$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel IC column, hexane/*i*-PrOH = 97/3, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 5.330$  min,  $t_{\text{minor}} = 4.785$  min).



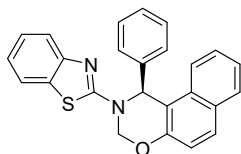
$^1\text{H NMR}$  (300 MHz, DMSO)  $\delta$  8.39–8.25 (m, 1H), 7.87 (d,  $J = 9.0$  Hz, 1H), 7.81–7.71 (m, 1H), 7.55 (d,  $J = 9.1$  Hz, 1H), 7.43 (t,  $J = 6.1$  Hz, 3H), 7.22 (m, 6H), 7.03 (d,  $J = 8.0$  Hz, 1H), 6.93 (s, 1H), 6.40 (s, 1H), 4.11 (s, 3H), 3.50 (s, 3H).

$^{13}\text{C NMR}$  (75 MHz, DMSO)  $\delta$  155.1, 154.8, 144.2, 140.5, 131.3, 129.6, 129.5, 128.1, 128.0, 126.8, 126.4, 126.1, 126.0, 125.2, 123.0, 122.1, 121.6, 120.8, 113.5, 109.1, 60.6, 57.1, 30.1.

**HRMS** (ESI)  $m/z$  calcd for  $\text{C}_{26}\text{H}_{22}\text{BrN}_2\text{OS}^+$  410.1453, found 410.1396

**(S)-2-(benzo[d]thiazol-2-yl)-1-phenyl-2,3-dihydro-1H-naphtho[1,2-e][1,3]oxazine (6)**

white solid, Mp: 98.5-99.6 °C, 65 % yield 25.6 mg), 96% ee ,  $[\alpha]_D^{20} = +284.4$  ( $c = 1.0$ , EA); The ee was determined by chiral HPLC (Chiralcel AD-H column, hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min,  $\lambda = 254$  nm,  $t_{\text{major}} = 6.773$ min,  $t_{\text{minor}} = 7.332$  min).



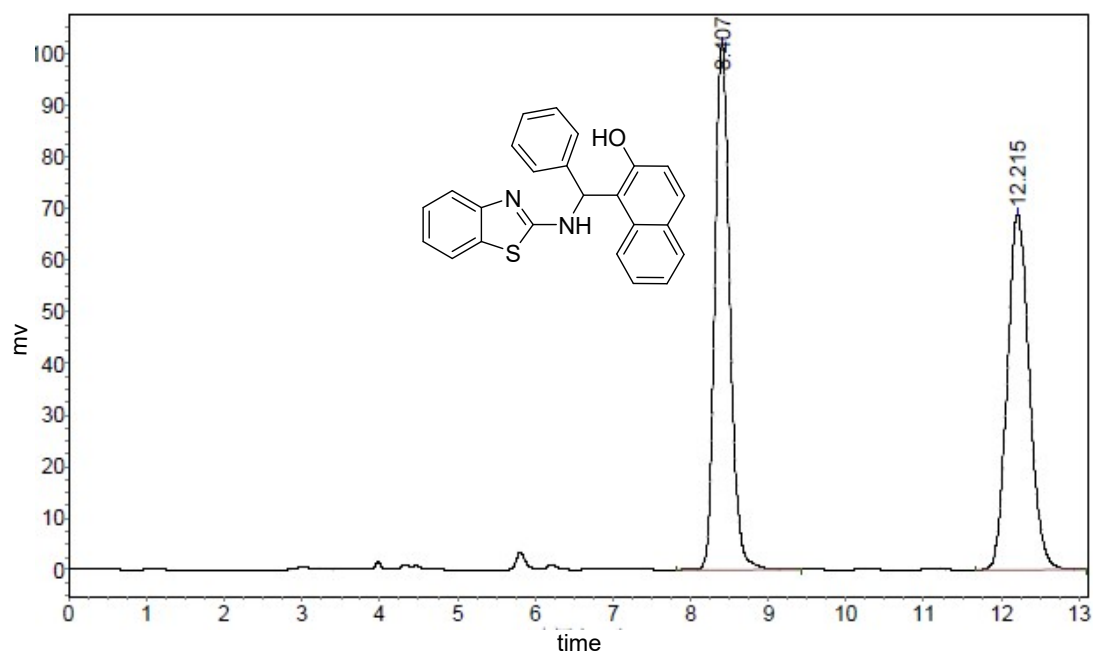
**<sup>1</sup>H NMR** (300 MHz, DMSO)  $\delta$  8.39–8.25 (m, 1H), 7.87 (d,  $J = 9.0$  Hz, 1H), 7.81–7.71 (m, 1H), 7.55 (d,  $J = 9.1$  Hz, 1H), 7.43 (t,  $J = 6.1$  Hz, 3H), 7.22 (m, 6H), 7.03 (d,  $J = 8.0$  Hz, 1H), 6.93 (s, 1H), 6.40 (s, 1H), 4.11 (s, 3H), 3.50 (s, 3H).

**<sup>13</sup>C NMR** (75 MHz, DMSO)  $\delta$  155.1, 154.8, 144.2, 140.5, 131.3, 129.6, 129.5, 128.1, 128.0, 126.8, 126.4, 126.1, 126.0, 125.2, 123.0, 122.1, 121.6, 120.8, 113.5, 109.1, 60.6, 57.1, 30.1.

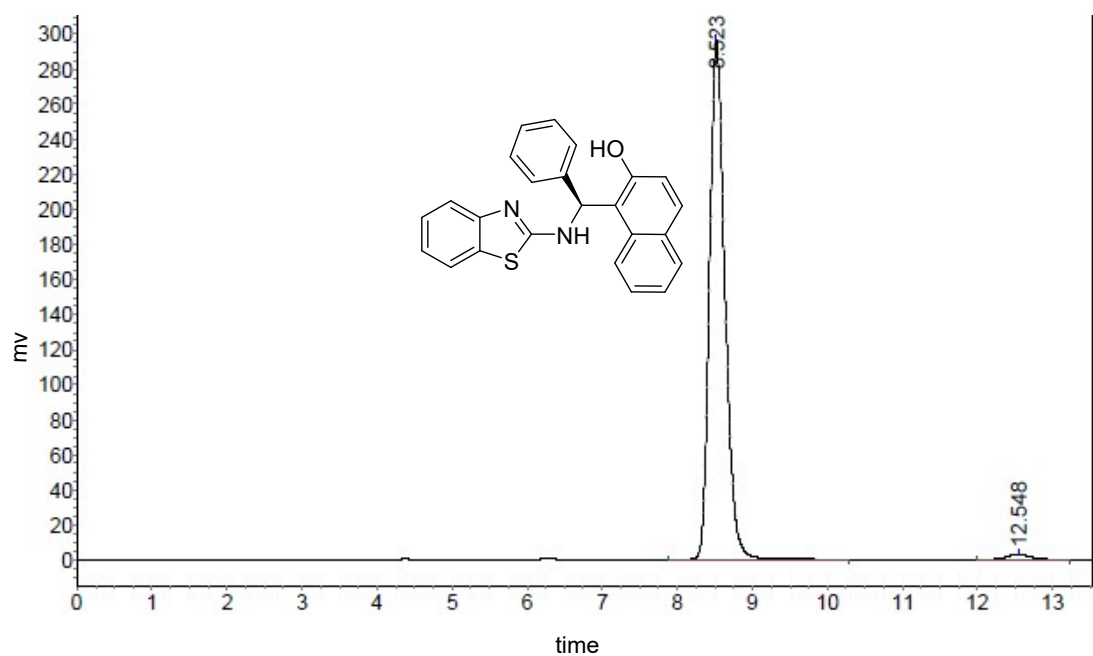
**HRMS** (ESI)  $m/z$  calcd for  $C_{25}H_{18}N_2OS^+$  ( $M+H$ )<sup>+</sup> 395.1212, found 395.1215

7 .HPLC,NMR spectra of products

**3aa**



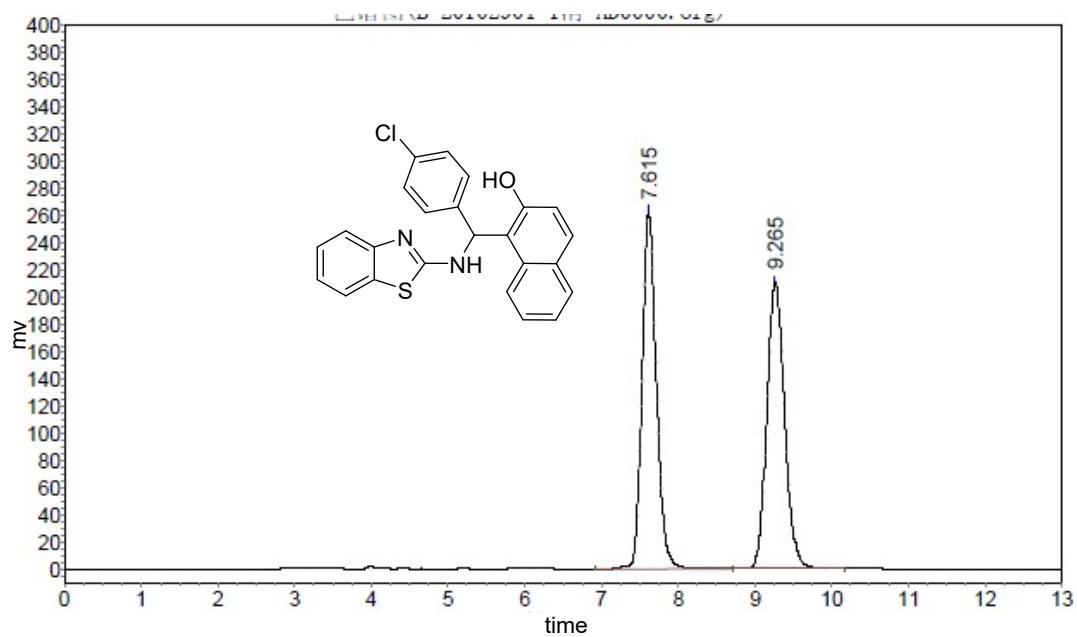
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.407	102369.242	1373413.000	50.0903
2	12.215	69116.086	1368461.625	49.9097



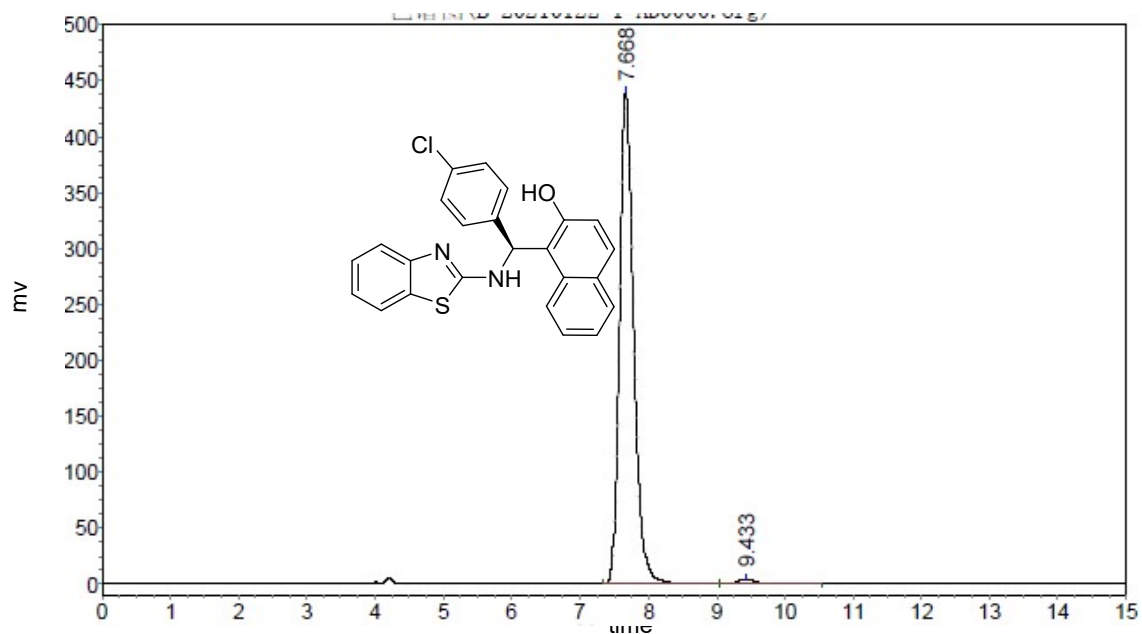
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.523	296055.219	4250956.000	98.3939
2	12.548	3272.000	69391.203	1.6061



3ba

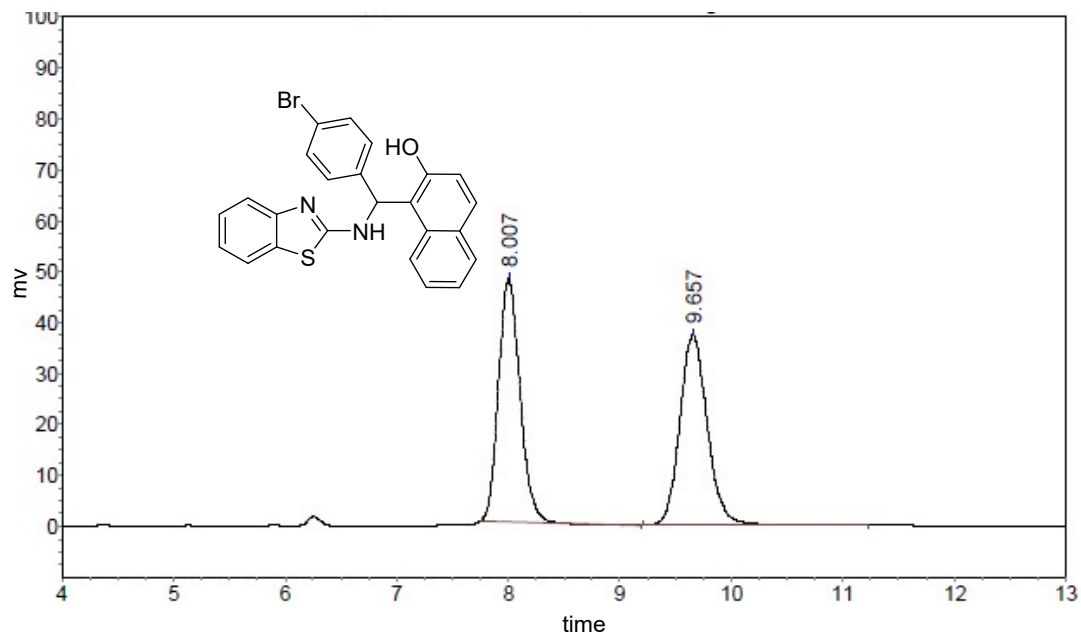


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.615	262926.219	3443677.500	50.1661
2	9.265	211300.453	3420868.750	49.8339

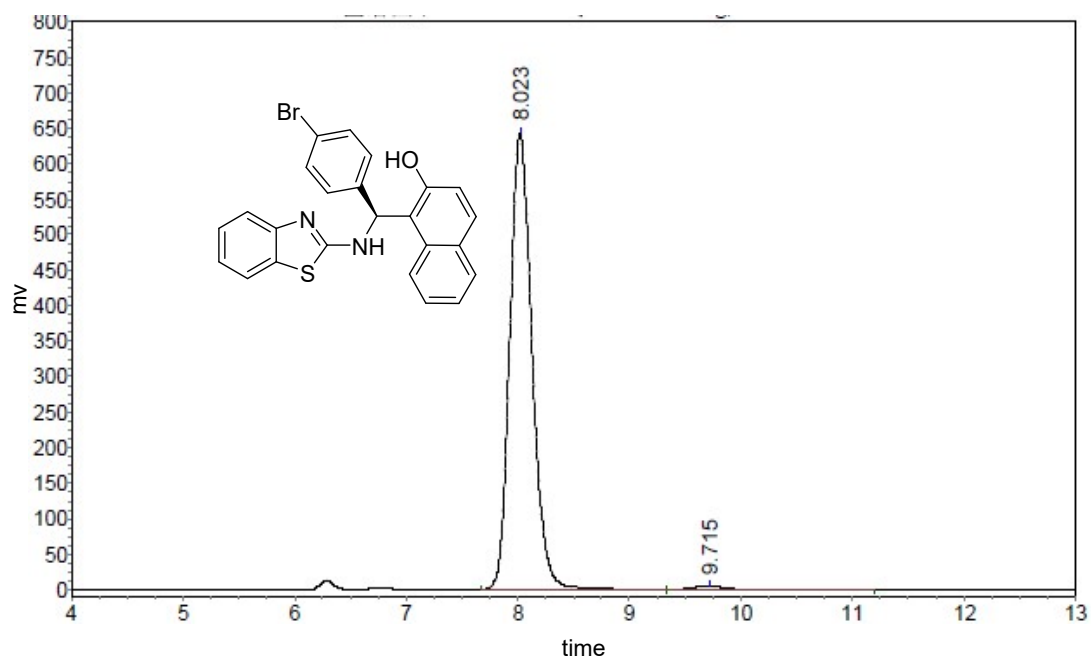


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.668	438940.656	6319465.000	98.9073
2	9.433	3776.414	69812.758	1.0927

3ca



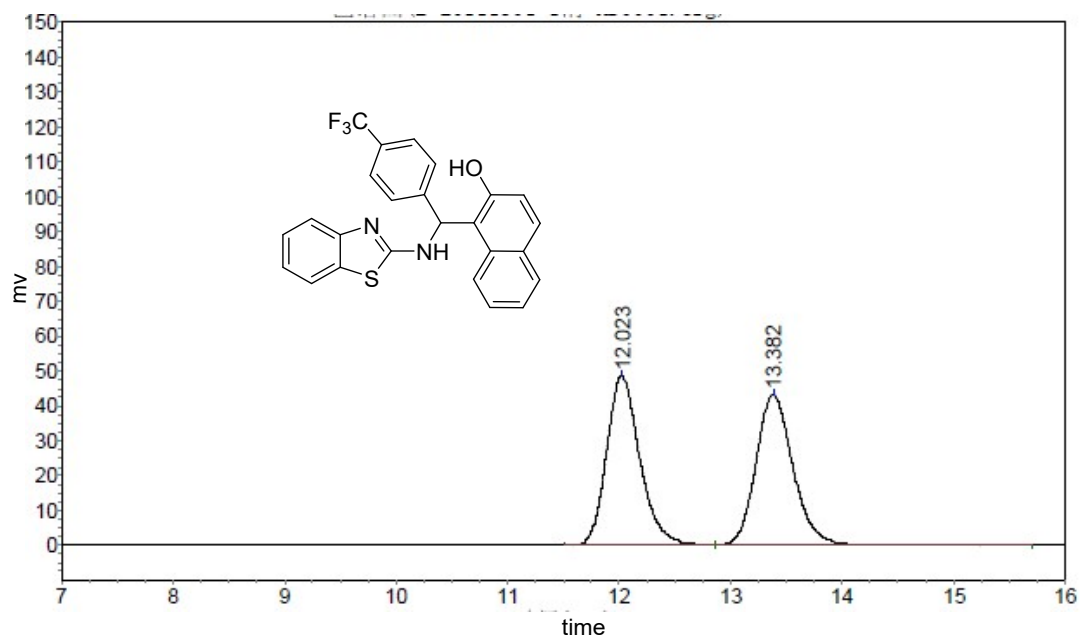
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.007	47803.188	637159.813	49.6793
2	9.657	37356.355	645384.875	50.3207



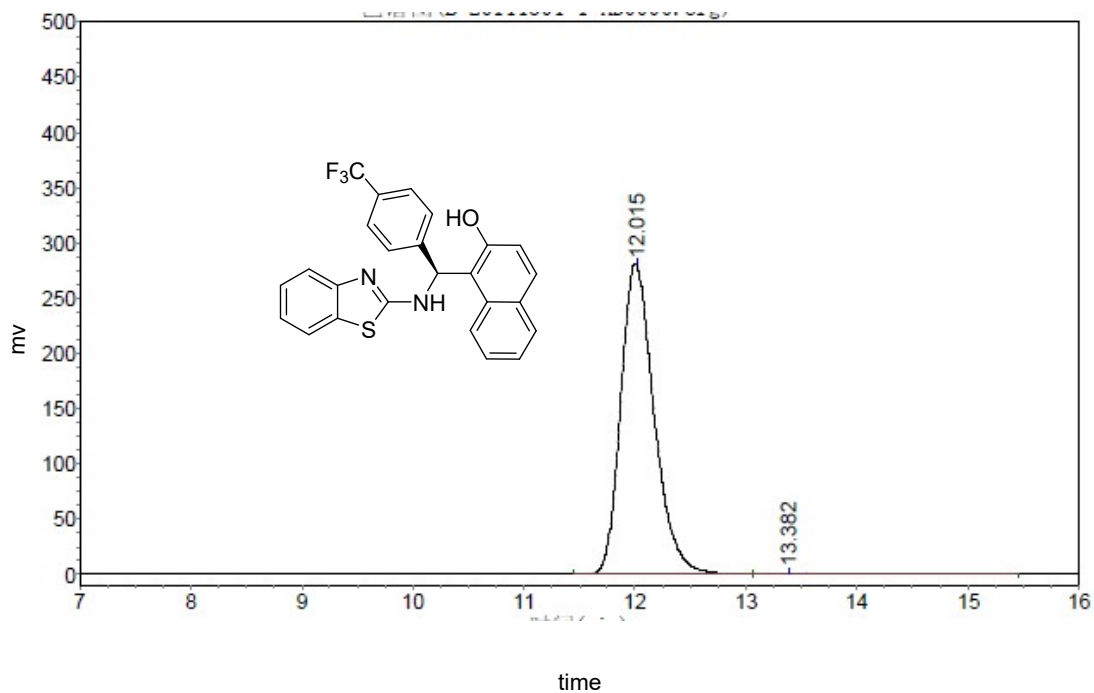
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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1	8.023	642294.875	8880231.000	99.1121
2	9.715	4185.954	79551.961	0.8879

3da

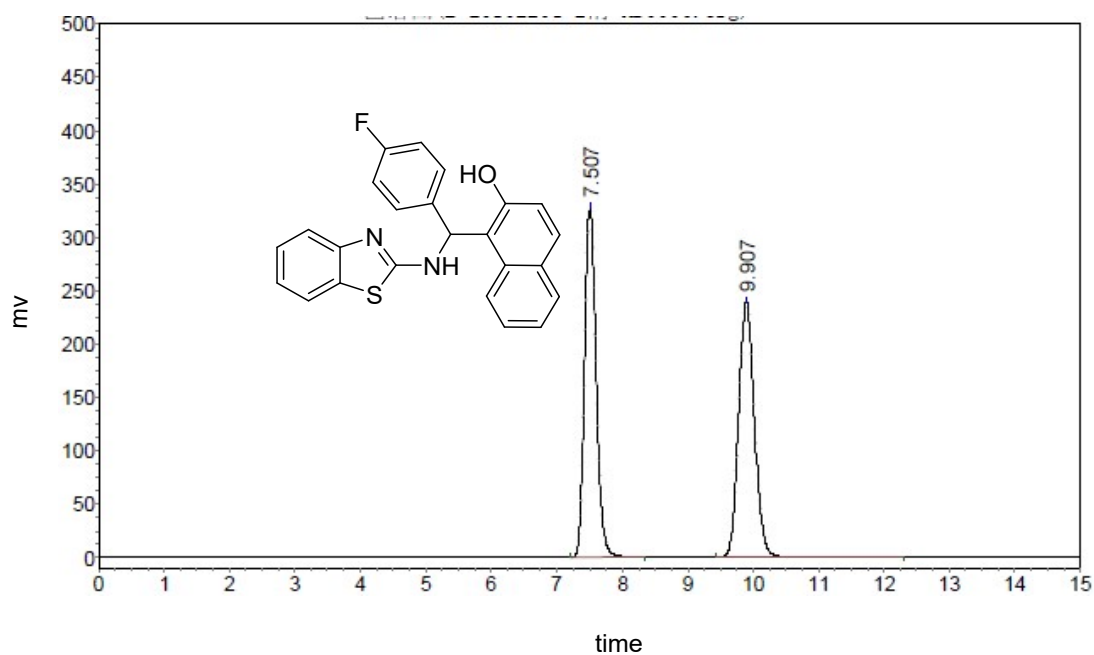


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	12.023	48367.000	1002415.125	50.1978
2	13.382	43077.063	994513.938	49.8022



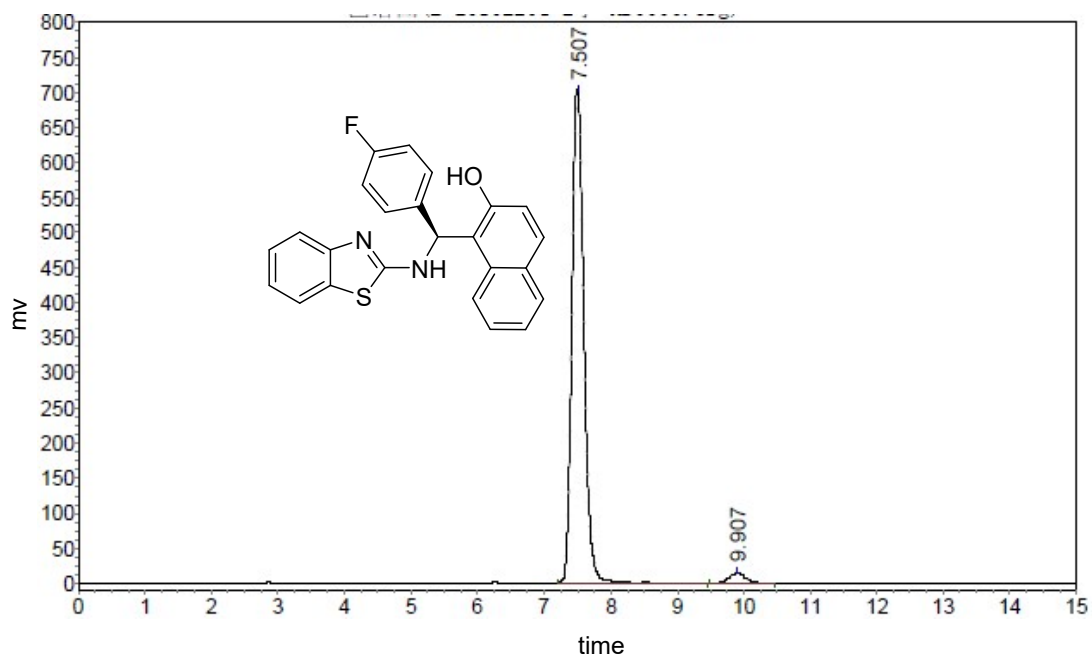
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	12.015	281270.188	5888700.500	99.2370
2	13.382	1444.781	45273.535	0.7630

3ea



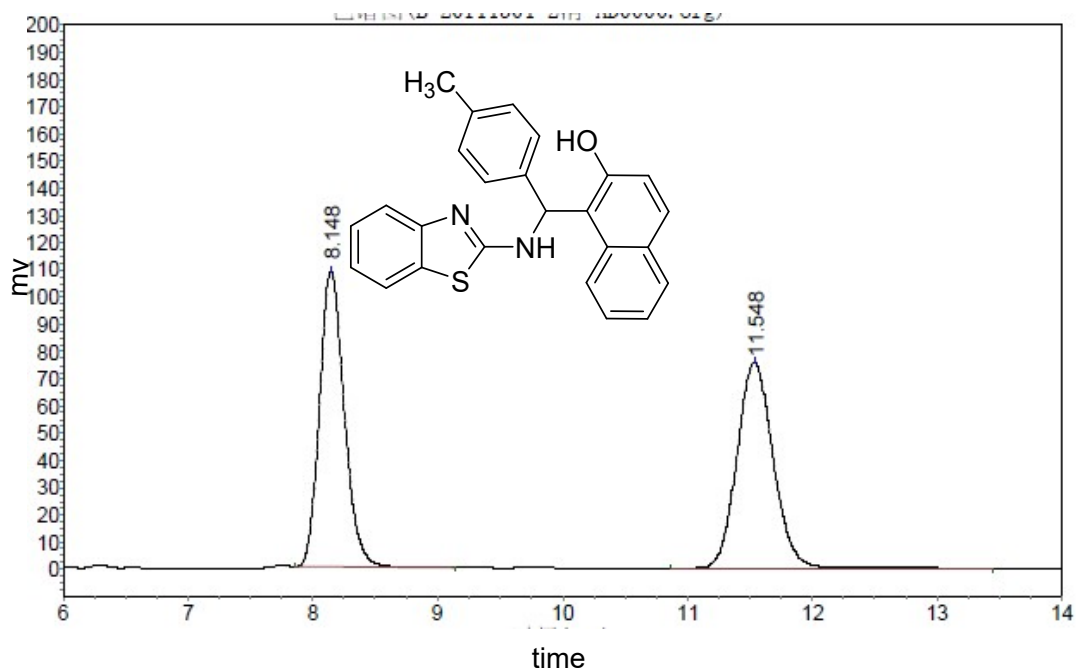
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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1	7.507	326965.844	4021054.250	49.9278
2	9.907	240057.219	4032676.000	50.0722

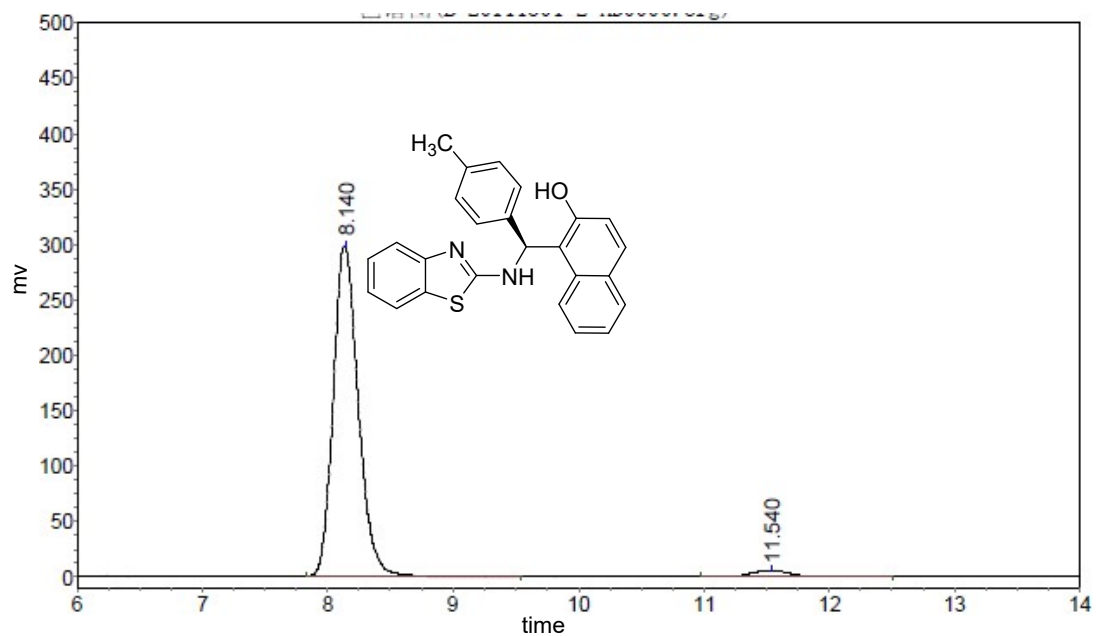


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.507	703042.063	701308.000	97.3544
2	9.907	14327.000	236456.297	2.6456

3fa

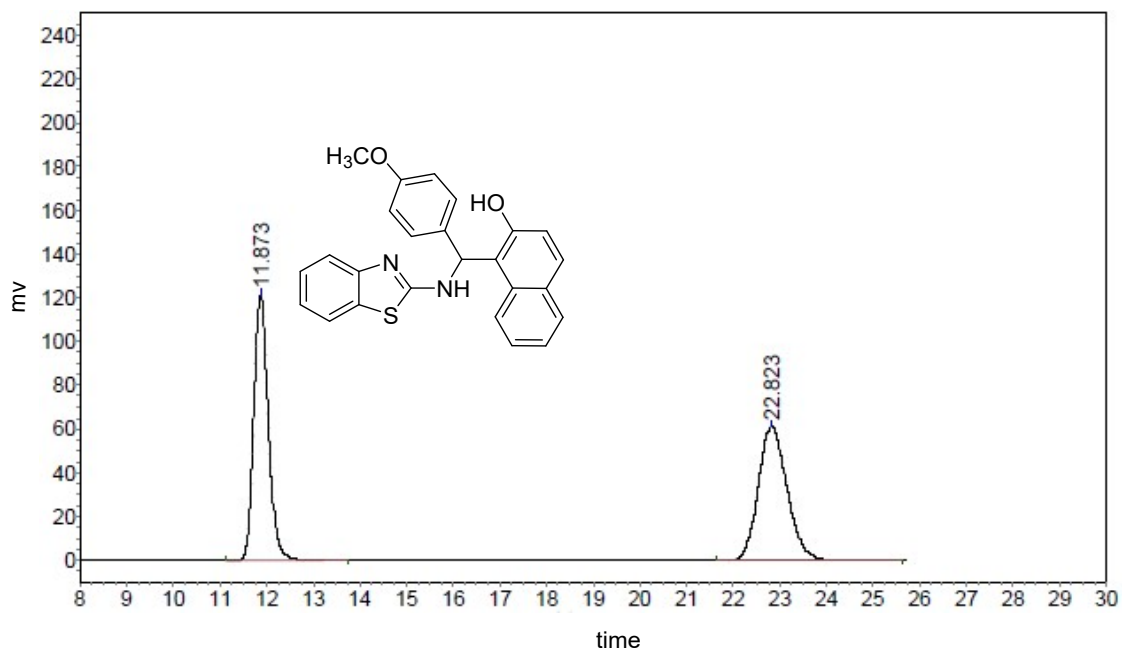


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.148	109042.781	1523715.875	49.9619
2	11.548	75587.508	1526038.875	50.0381

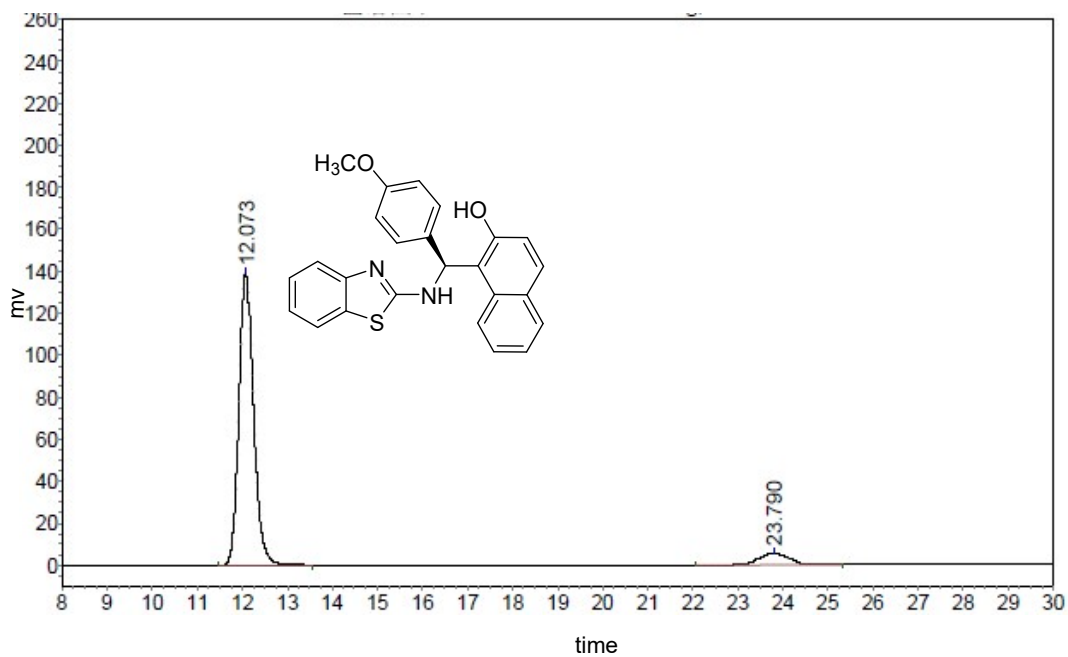


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.140	298191.000	4152295.750	97.2020
2	11.540	5878.370	119526.102	2.7980

**3ga**

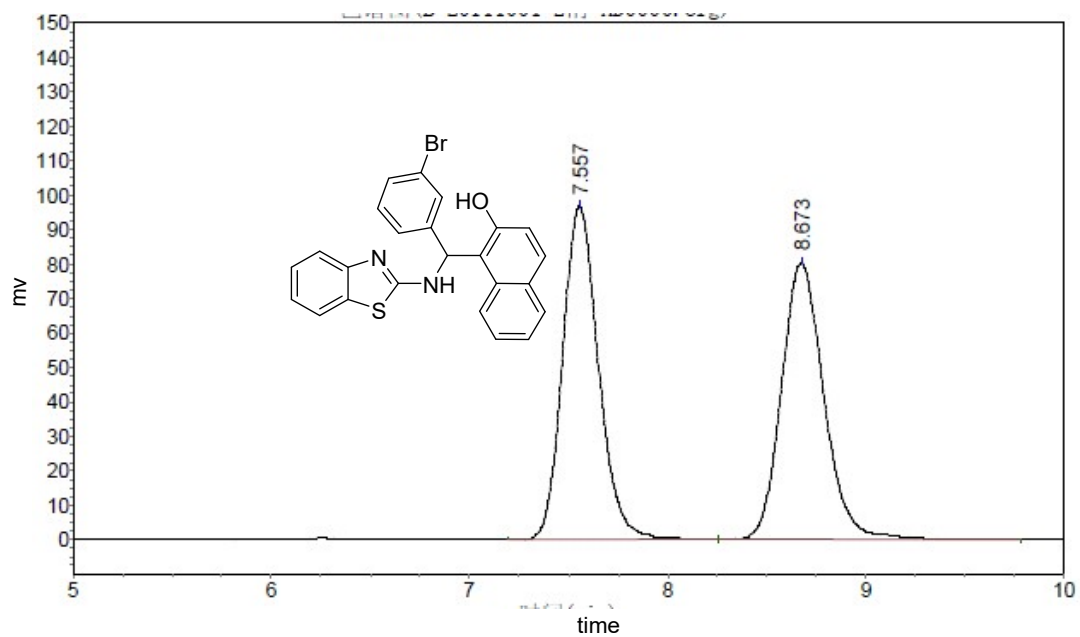


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	11.873	121126.328	2620573.750	50.0023
2	22.823	61030.250	2620334.500	49.9977

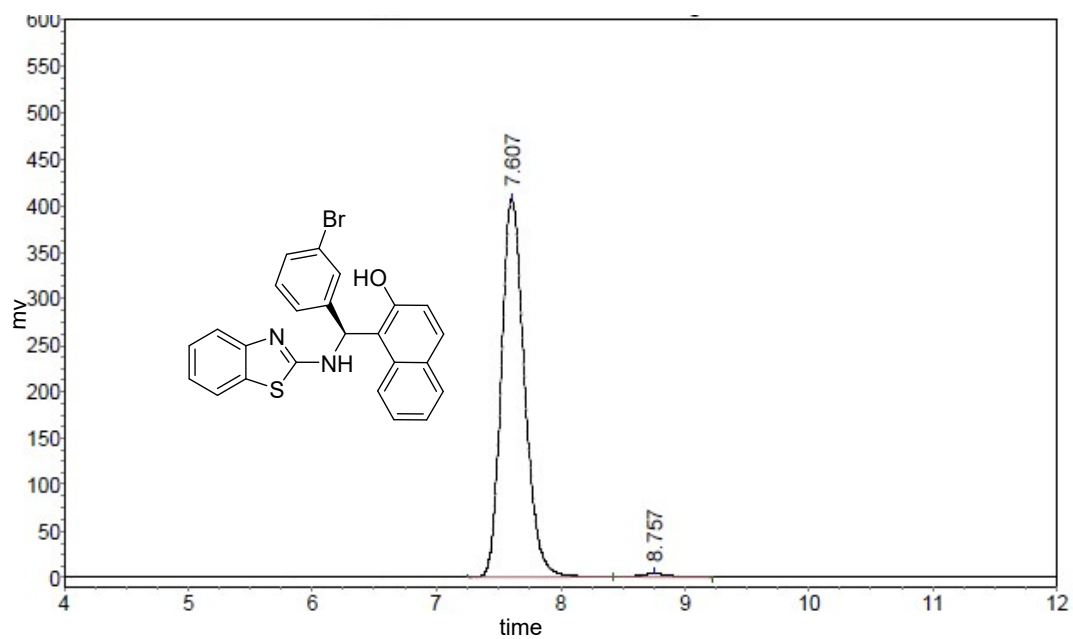


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	12.073	138869.109	3165810.250	92.6276
2	23.790	5450.775	251973.906	7.3724

3ha



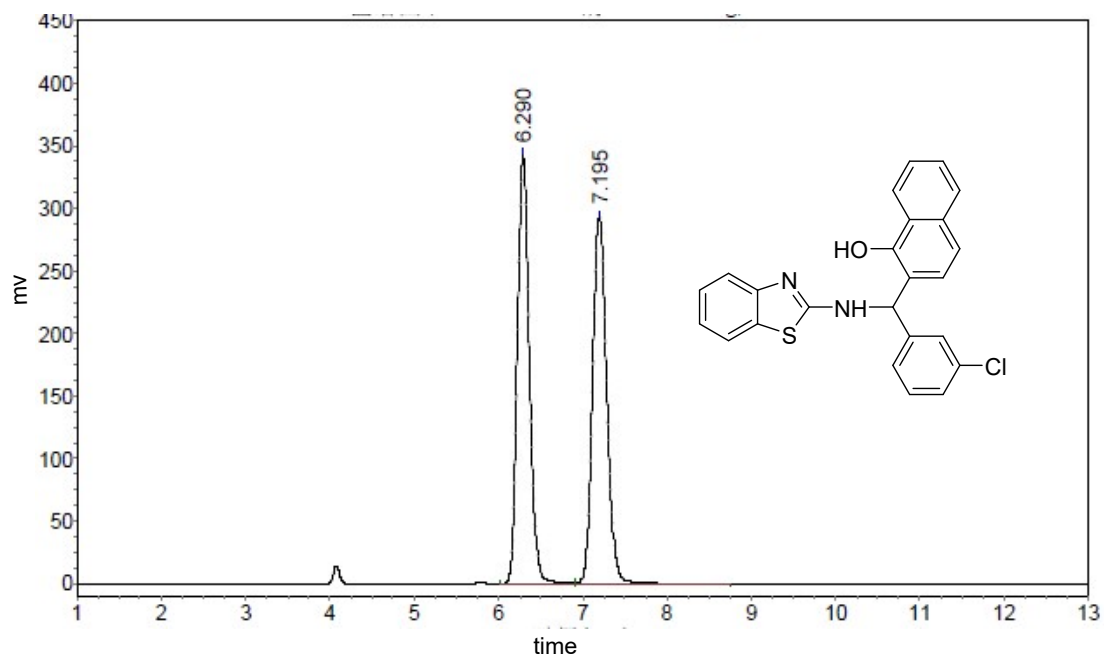
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.557	96532.813	1211480.750	50.5840
2	8.673	80006.063	1183509.250	49.4160



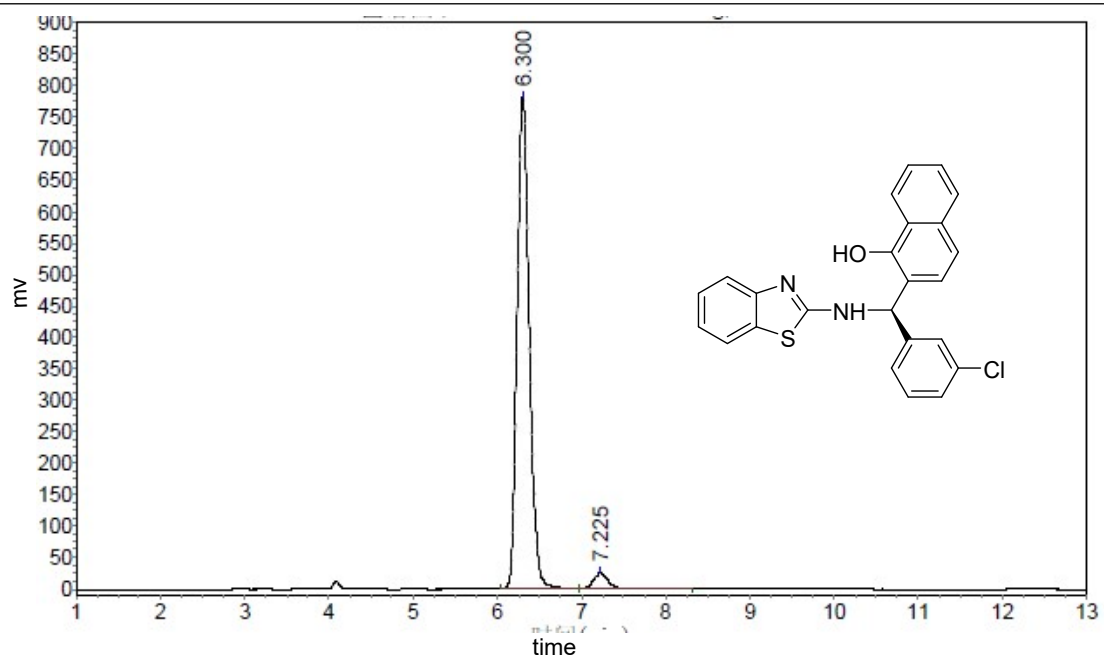
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.607	407577.031	5295992.000	98.9284
2	8.757	3904.750	57364.301	1.0716



3ia



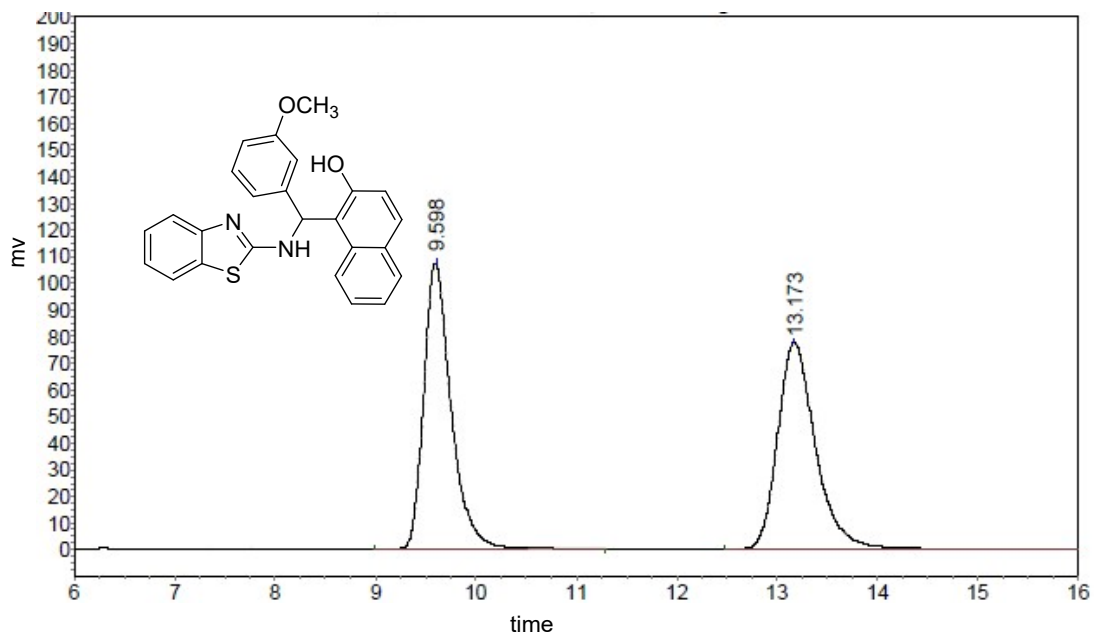
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	6.290	343128.375	3374870.500	49.8512
2	7.195	293935.844	3395023.250	50.1488



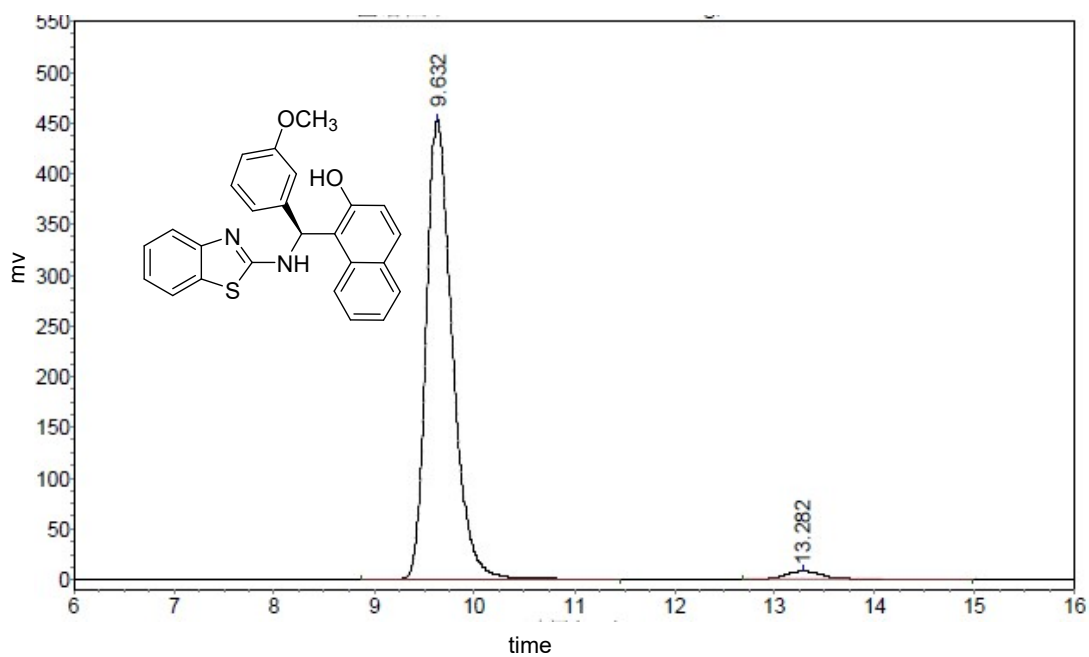
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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1	6.300	780771.688	7838786.500	96.2398
2	7.225	25234.920	306272.219	3.7602

3ja

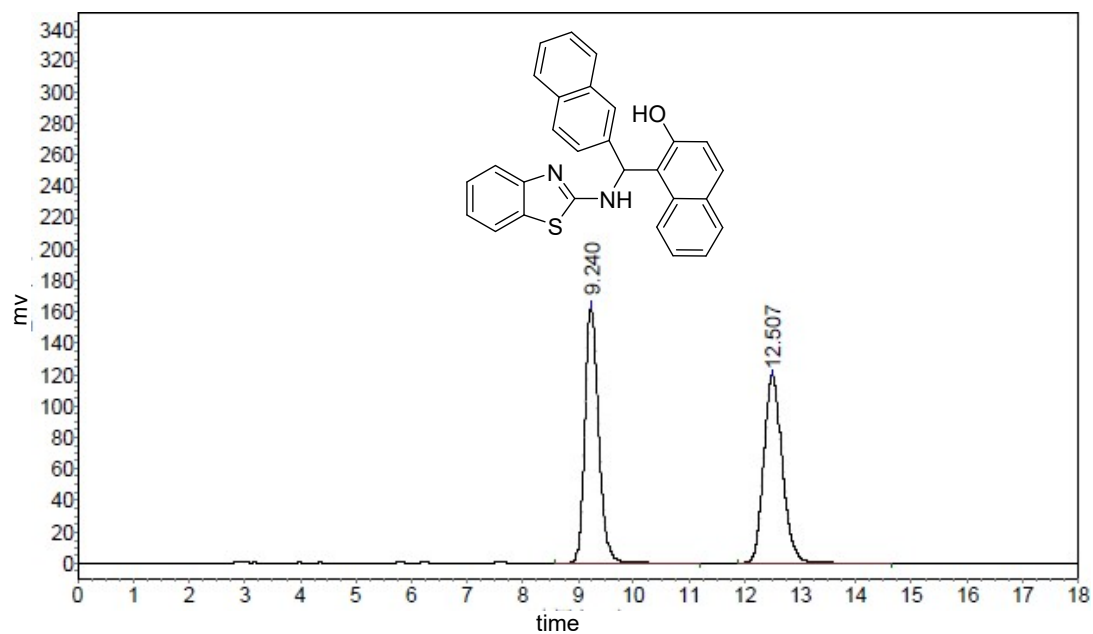


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	9.598	106978.102	2036837.750	49.9146
2	13.173	77374.039	2043810.375	50.0854

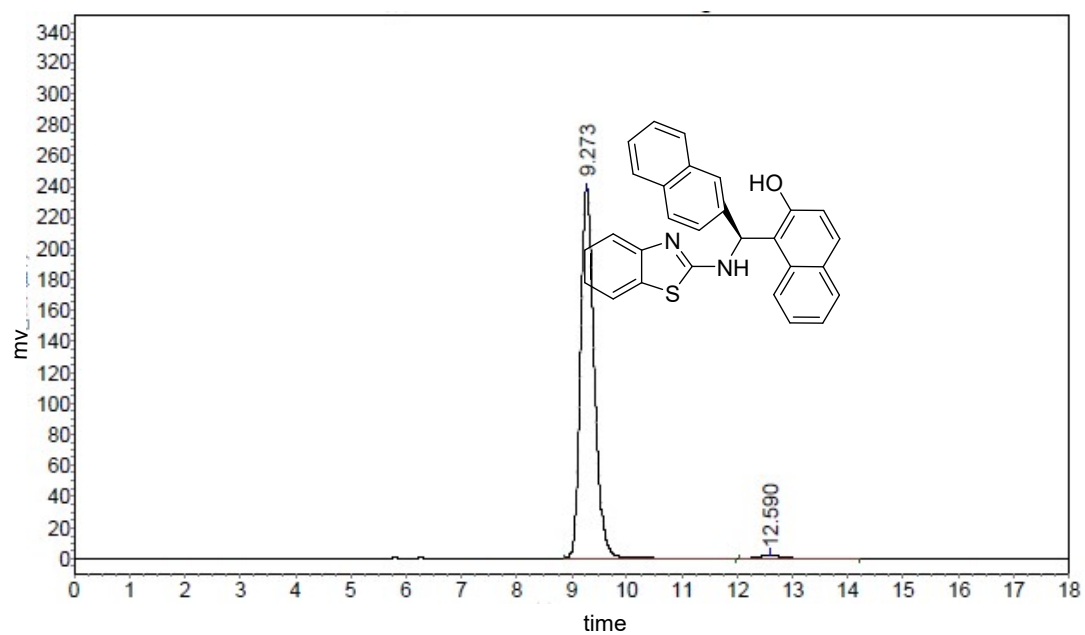


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	9.632	453973.563	8235654.500	97.4943
2	13.282	8288.007	211660.297	2.5057

3ka



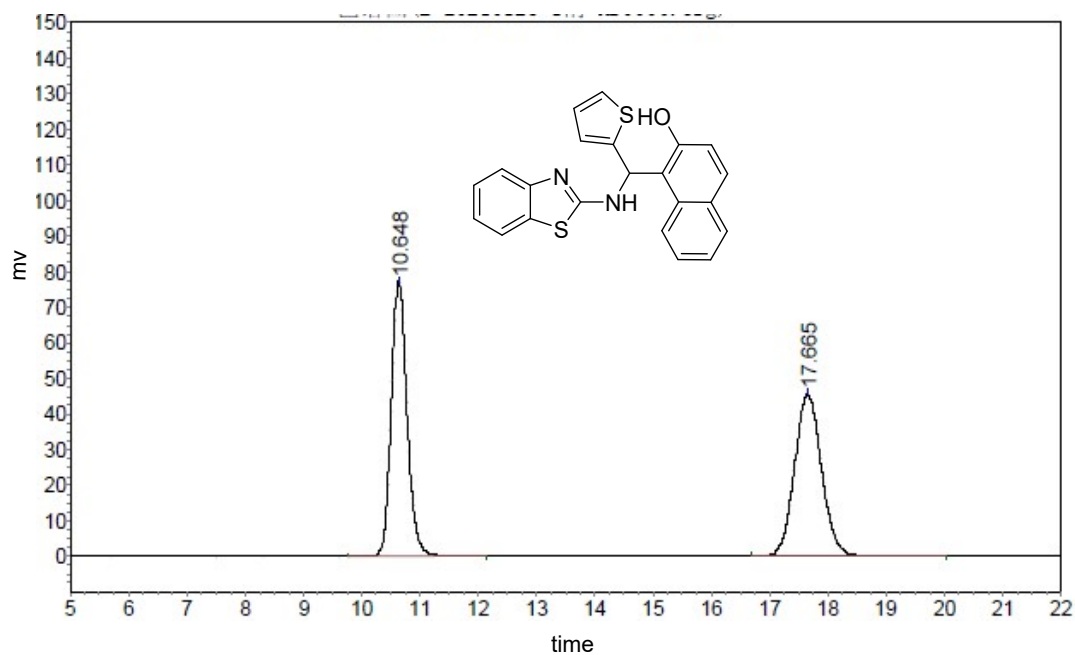
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	9.240	163233.813	2796312.000	50.1140
2	12.507	119537.086	2783587.750	49.8860



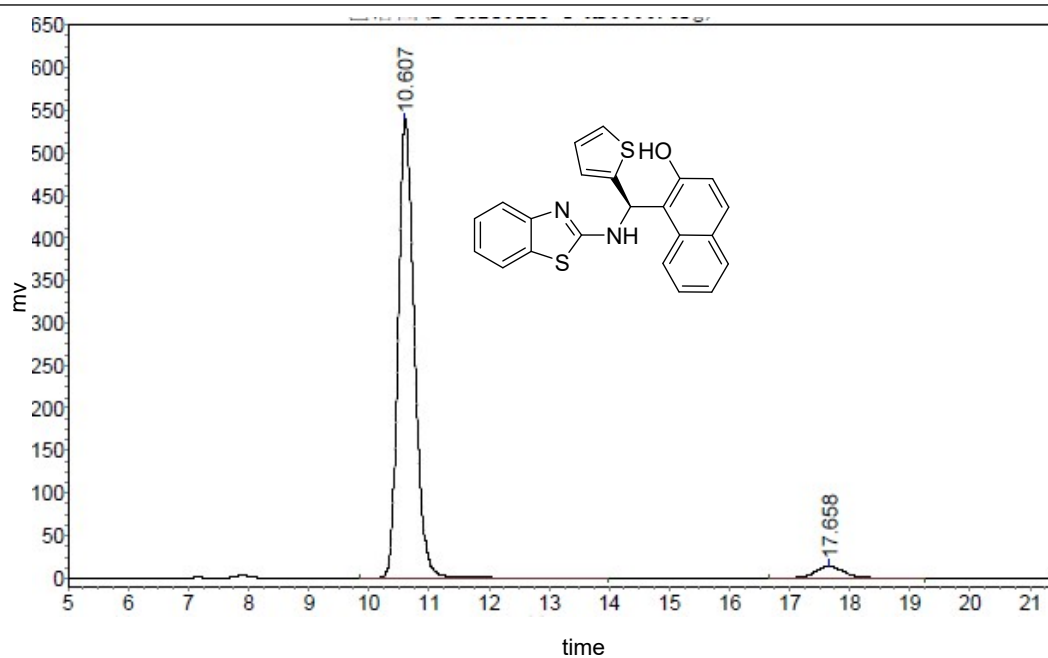
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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1	9.273	238114.203	4140383.250	98.6271
2	12.590	2395.122	57632.602	1.3729

**3la**

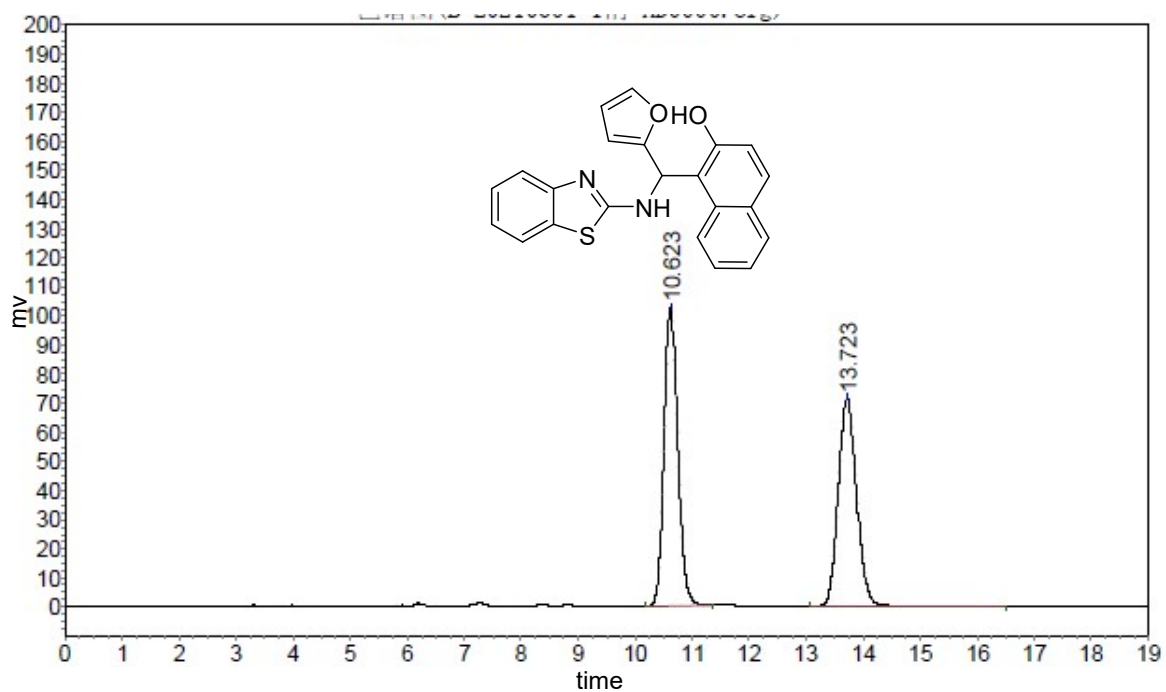


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.648	76907.164	1451676.750	49.9171
2	17.665	45294.012	1456496.000	50.0829

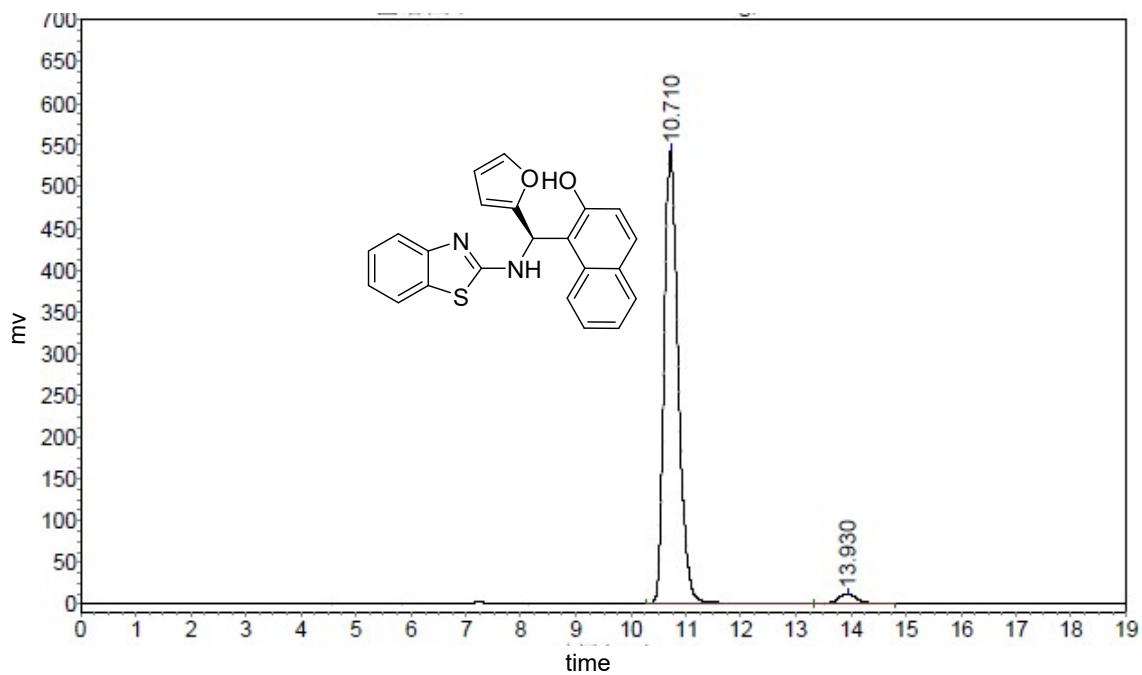


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.607	539487.313	10148960.000	95.6469
2	17.658	14434.413	461906.469	4.3531

3ma

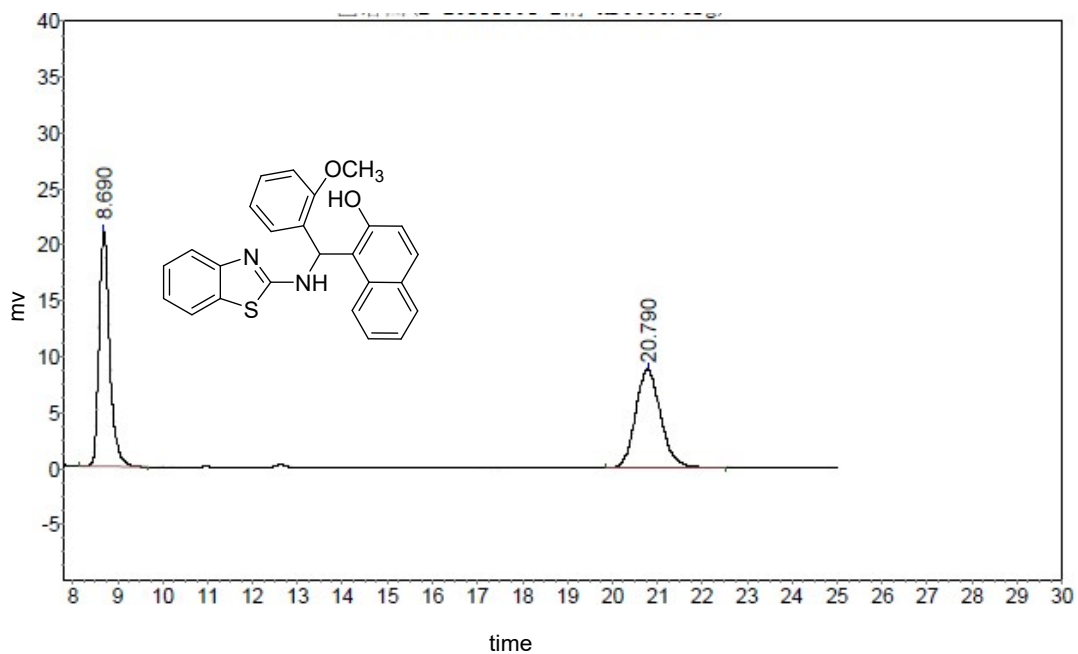


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.623	102390.078	1741645.375	51.9279
2	13.723	71460.461	1612321.500	48.0721

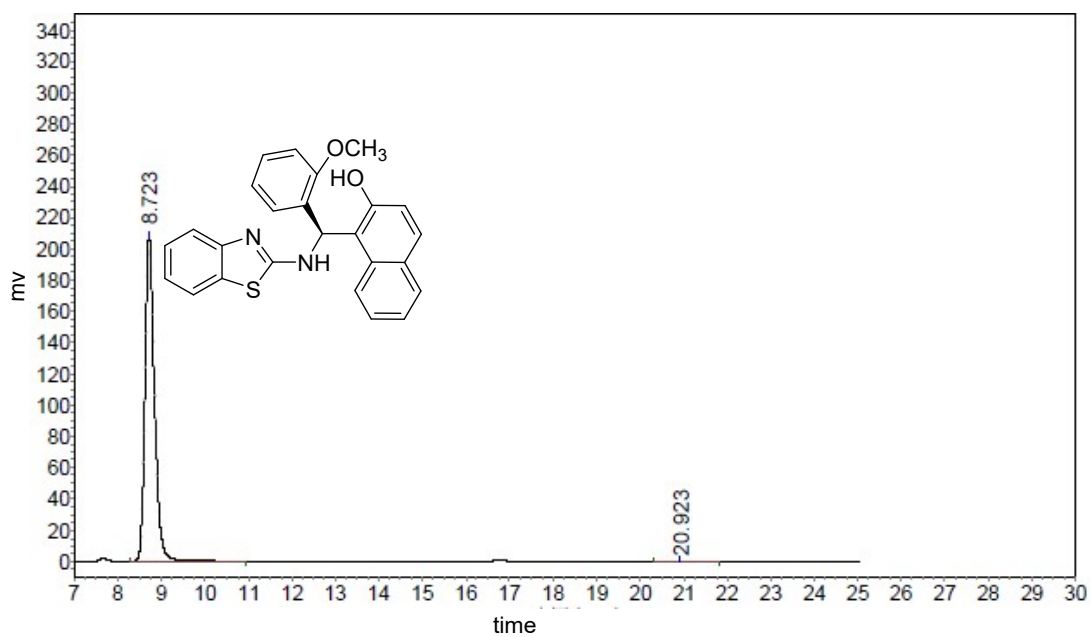


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.710	543389.375	9627044.000	97.3318
2	13.930	11547.053	263908.563	2.6682

3na

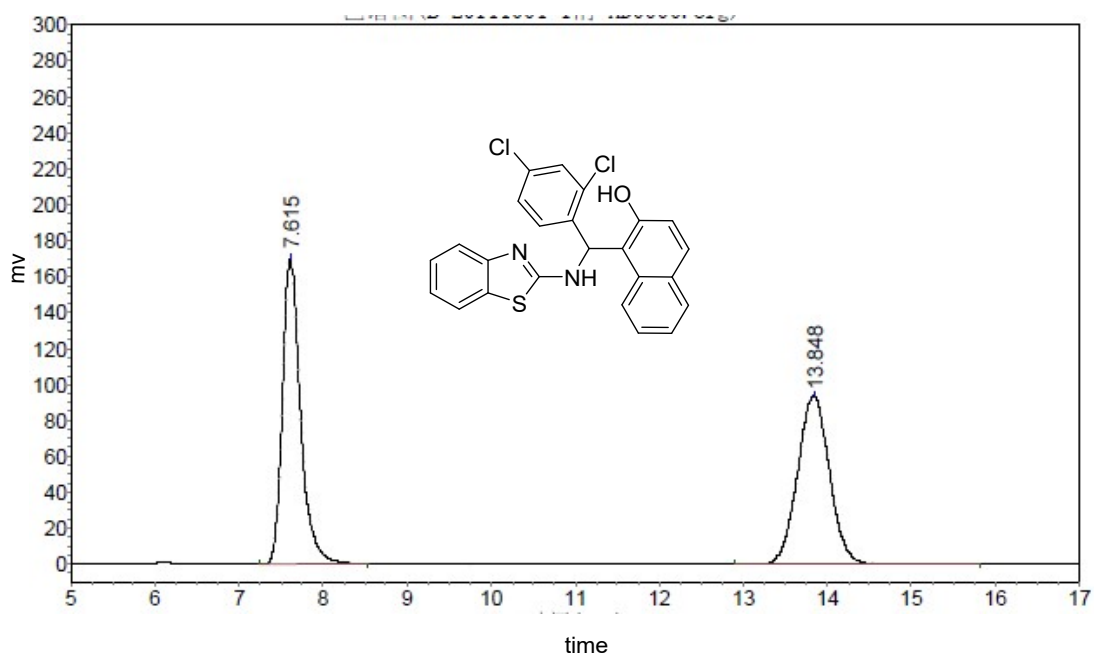


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.690	21036.607	342912.406	50.3763
2	20.790	8758.305	337788.813	49.6236



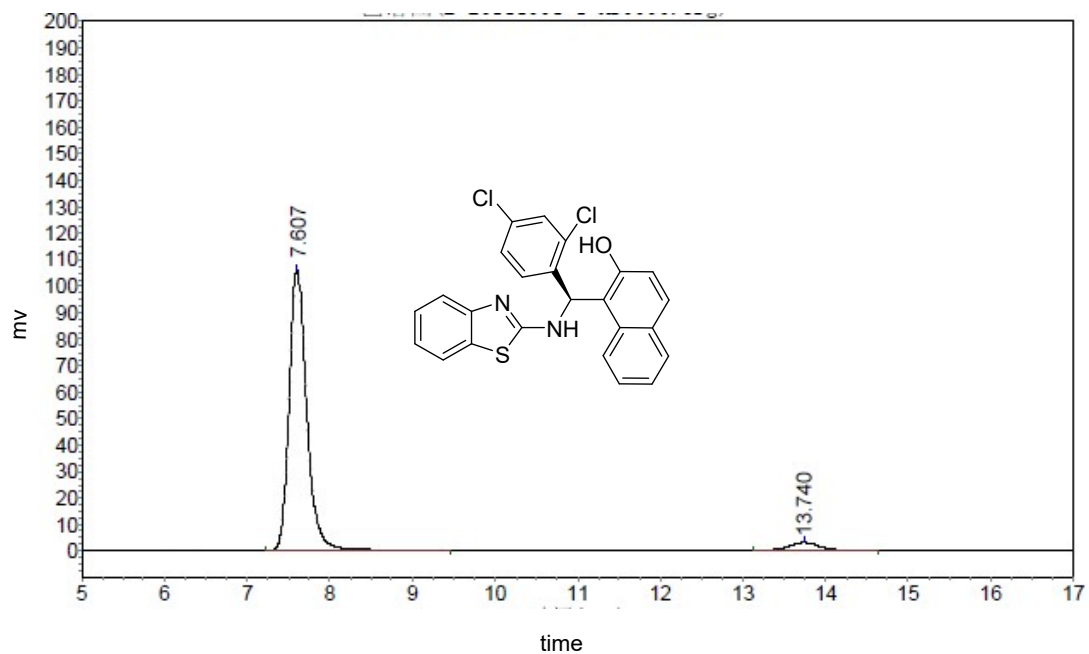
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.723	207264.047	3193744.000	99.8703
2	20.923	111.505	4148.000	0.1297

30a



Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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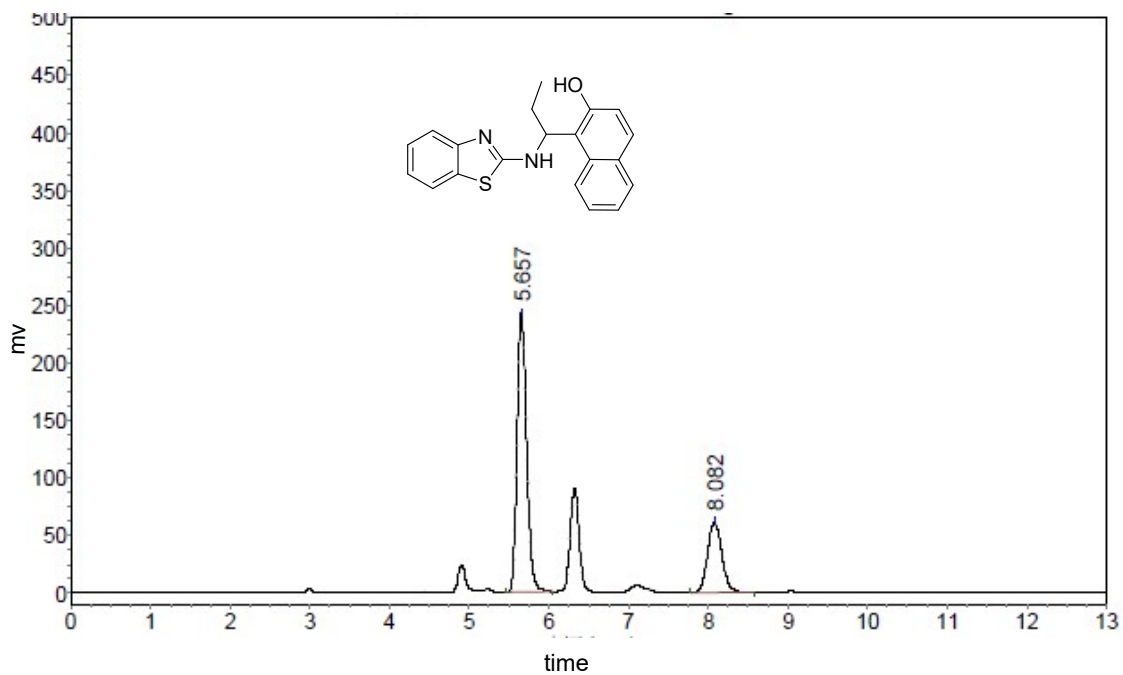
1	7.615	169371.922	2536585.250	50.6551
2	13.848	93501.430	2470975.000	49.3449



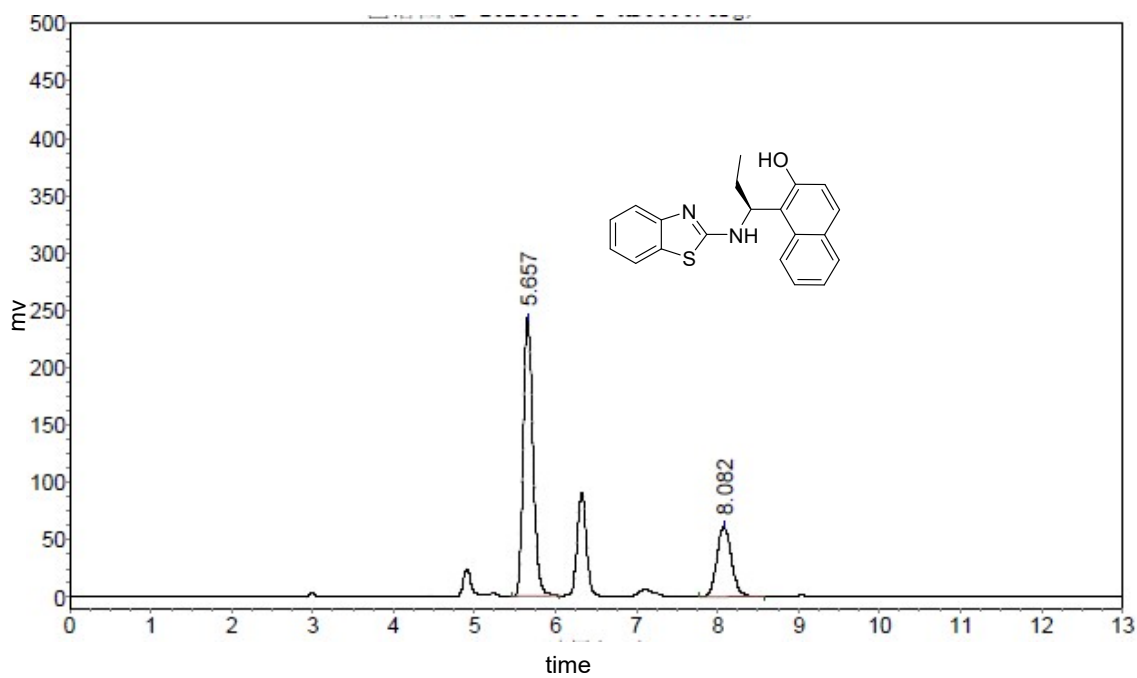
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	7.607	106127.859	1569139.375	95.2093
2	13.740	3050.131	78955.148	4.7907

3pa



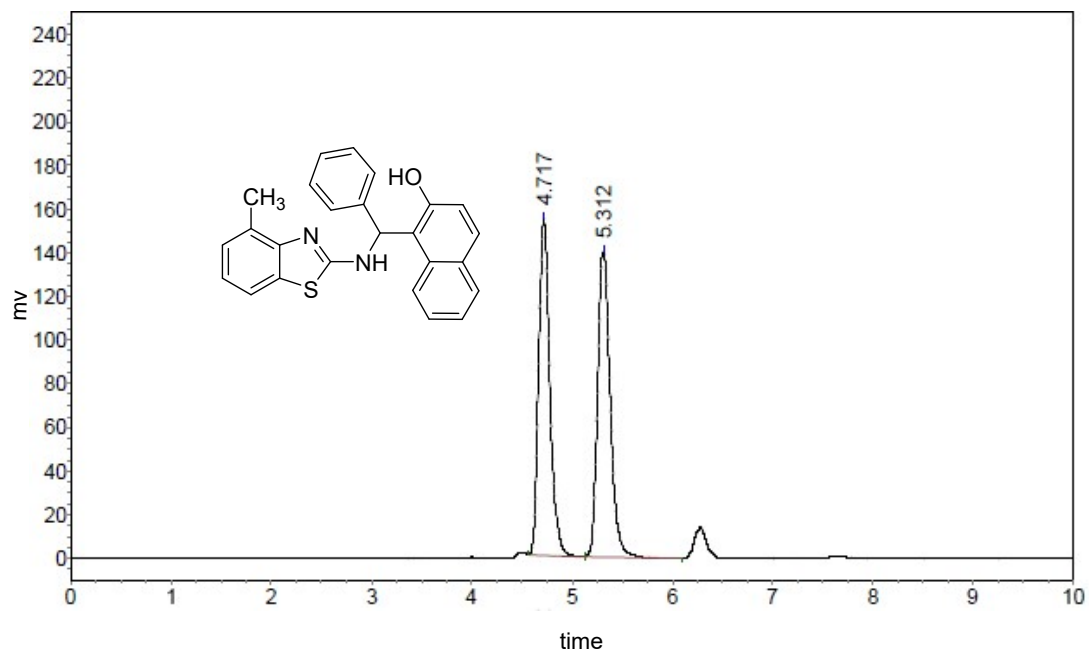


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	5.657	340418.063	2849213.000	49.4188
2	8.082	226742.844	2916235.750	50.5812

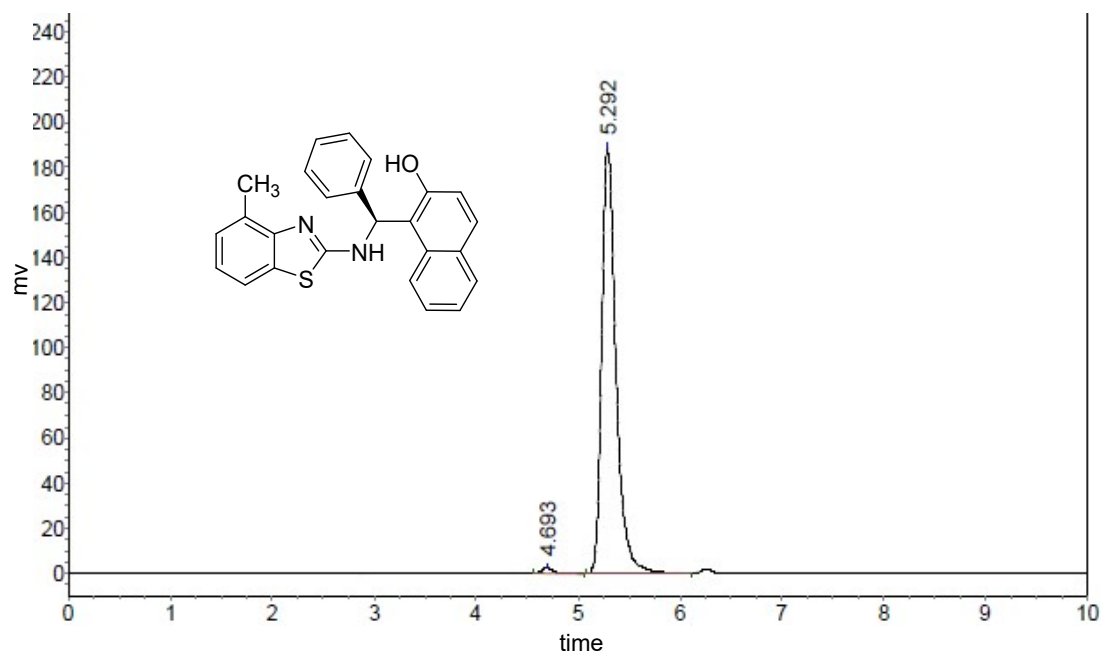


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	5.657	241767.000	2007547.250	72.1178
2	8.082	61316.758	776159.438	27.8822

3qa

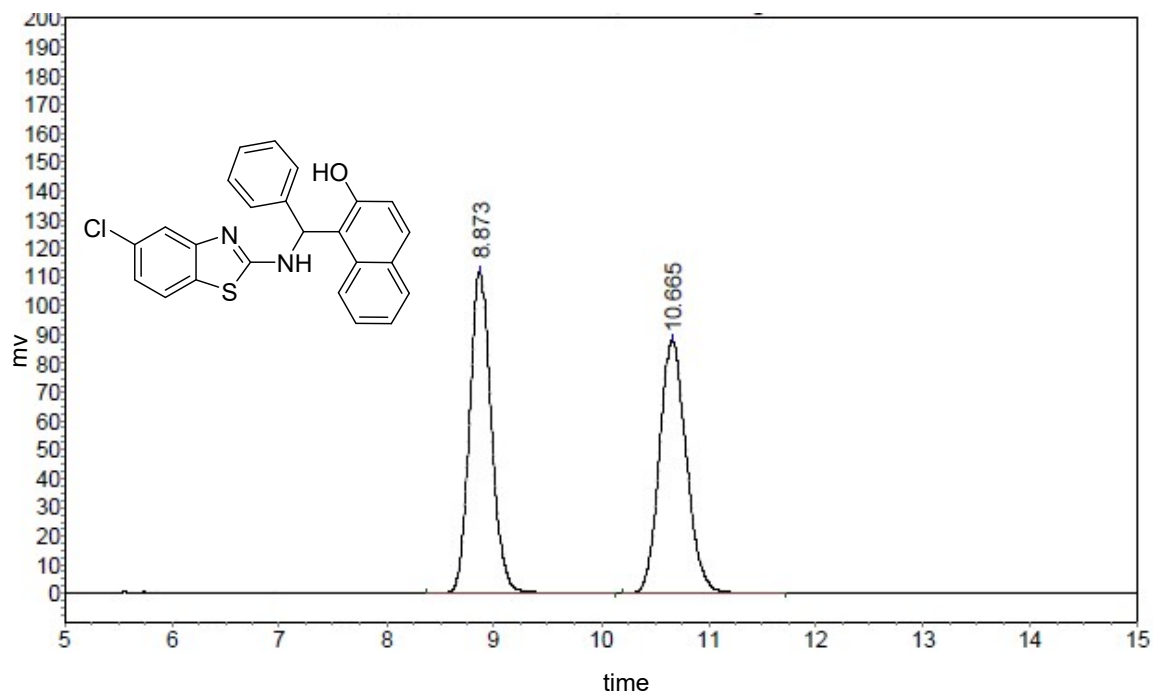


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	4.717	154520.938	1186992.125	49.5108
2	5.312	139928.094	1210446.500	50.4892

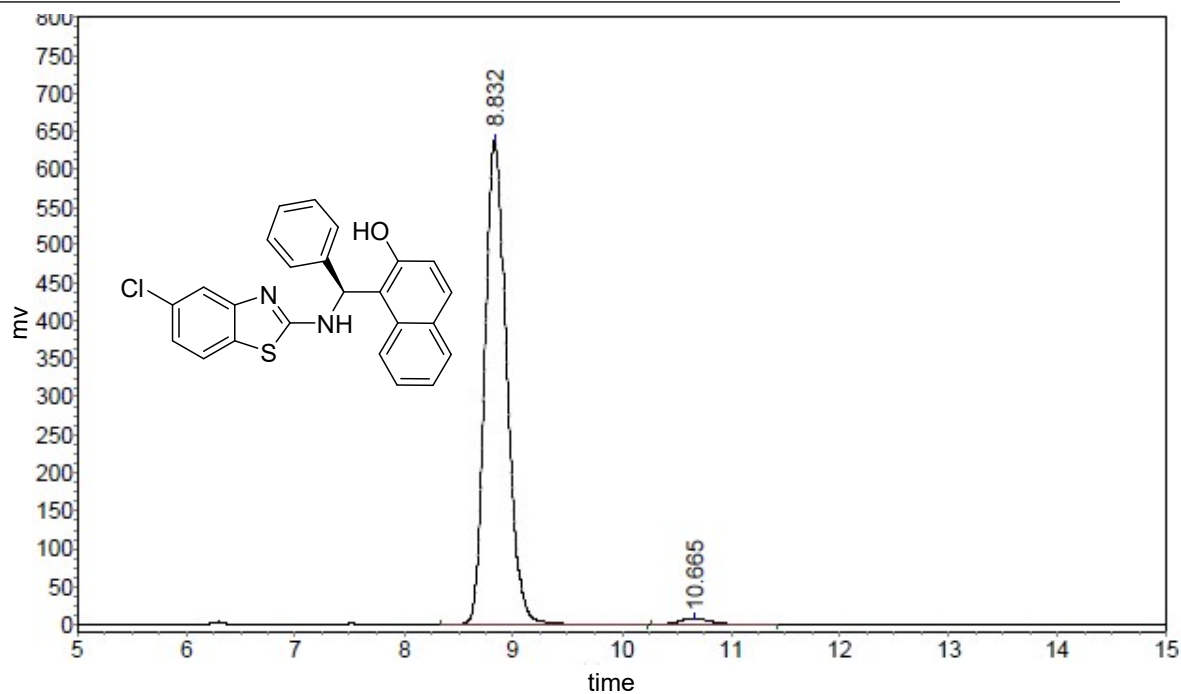


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	4.693	2125.622	18382.504	0.9944
2	5.292	188388.750	1830248.000	99.0056

3ra

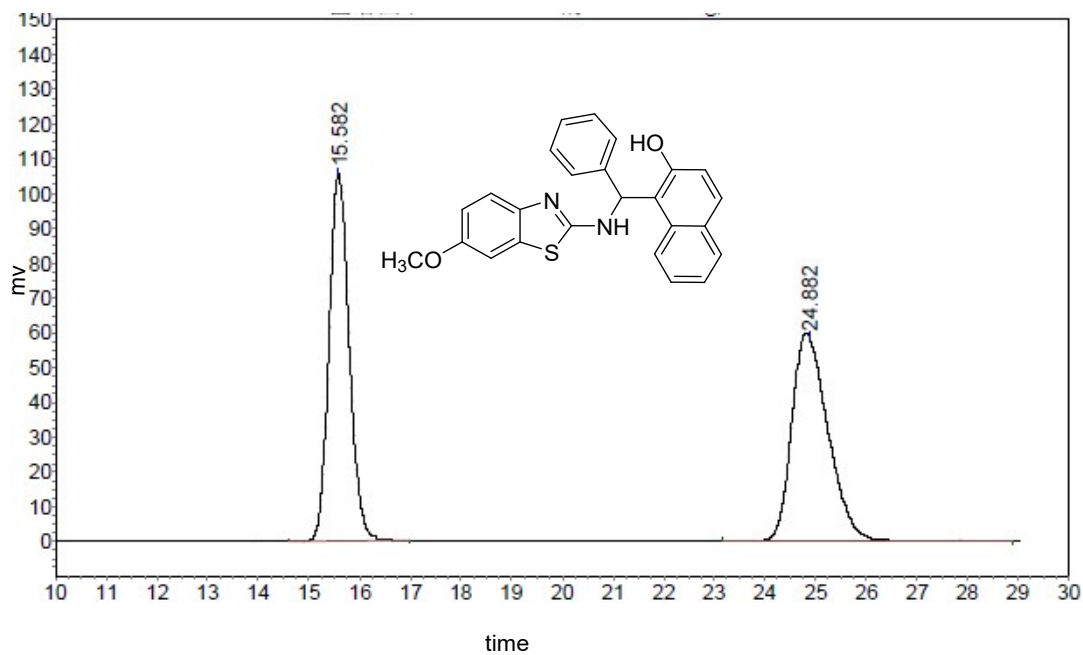


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.873	111873.570	1576312.375	50.6126
2	10.665	88131.977	1538150.875	49.3874

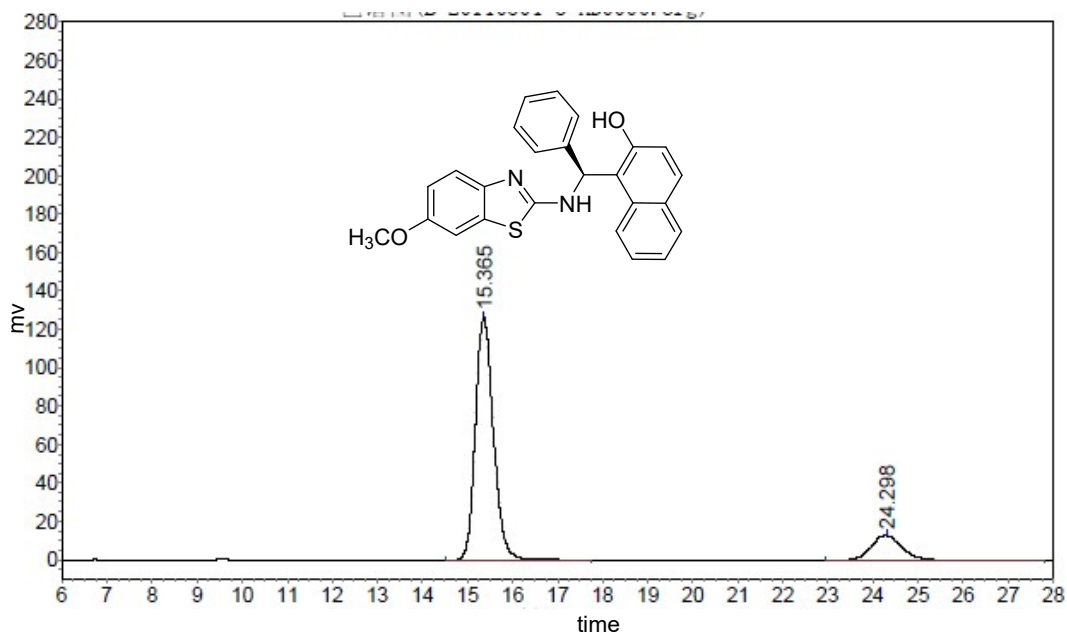


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.832	638030.563	8831569.000	98.4319
2	10.665	8163.655	140692.953	1.5681

3sa

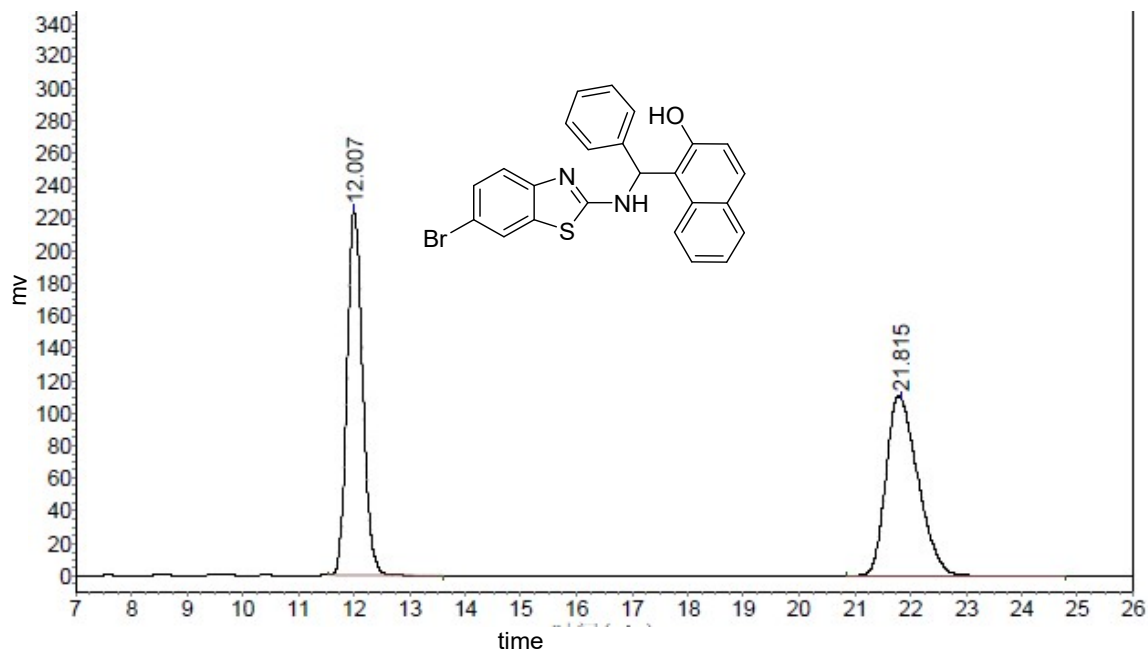


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	15.582	105389.063	2919095.750	49.7084
2	24.882	59336.141	2953338.750	50.2916

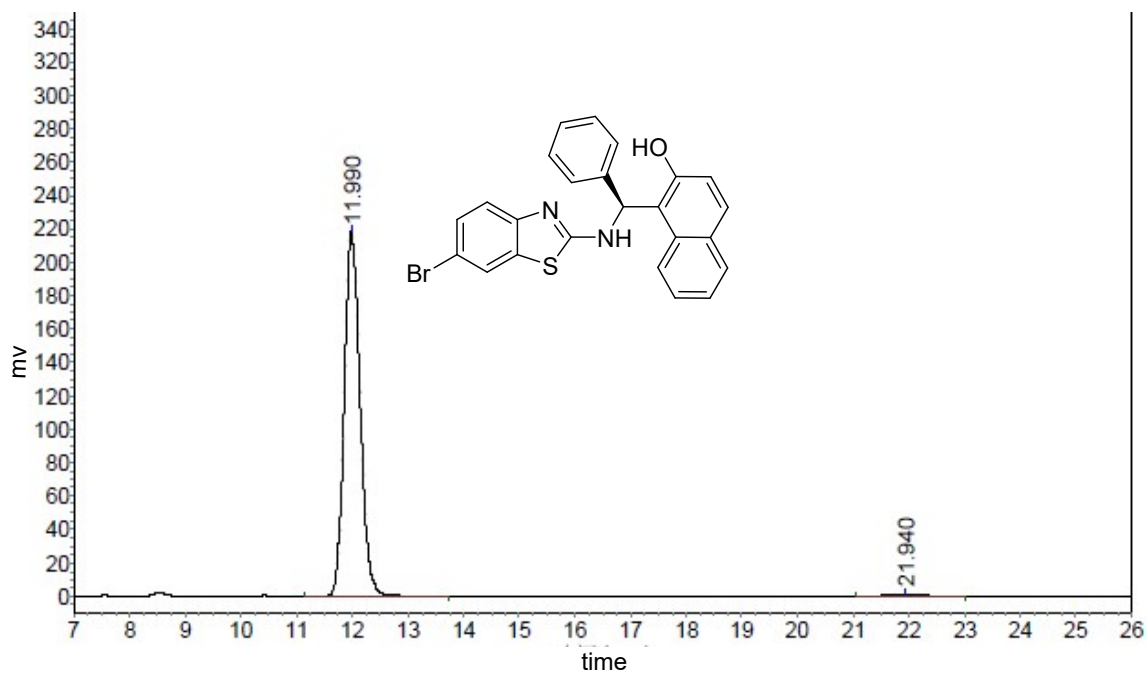


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	15.365	126085.805	3484544.000	85.9216

3ta

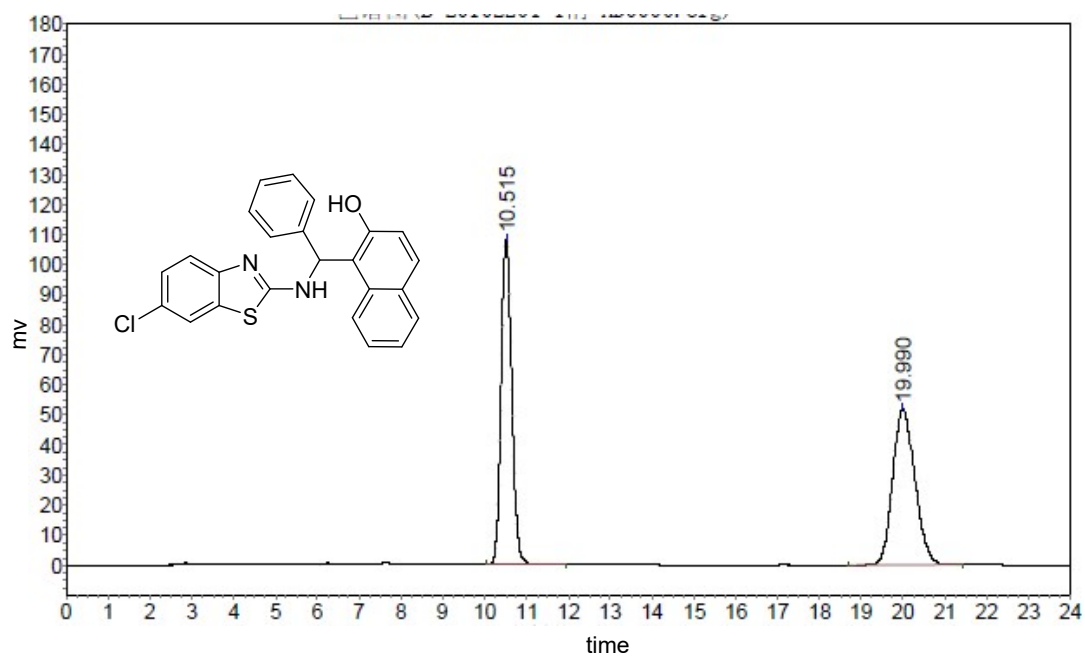


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	12.007	225066.734	4404016.500	50.0496
2	21.815	110261.000	4395291.000	49.9504

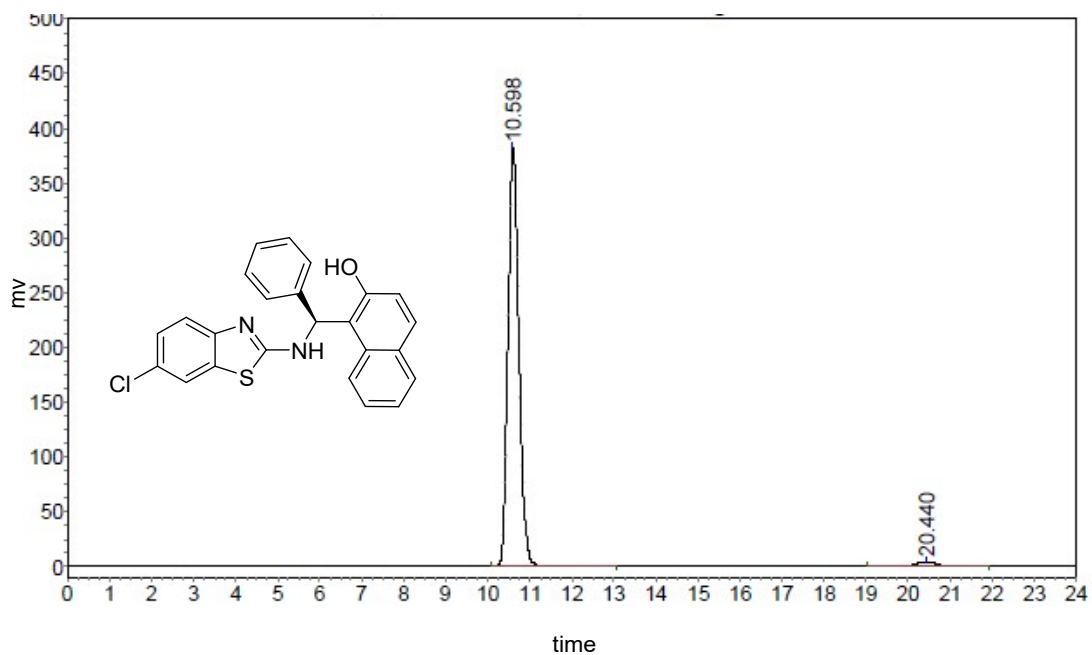


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	11.990	218125.828	4303426.000	98.9127
2	21.940	1270.353	47306.000	1.0873

3ua

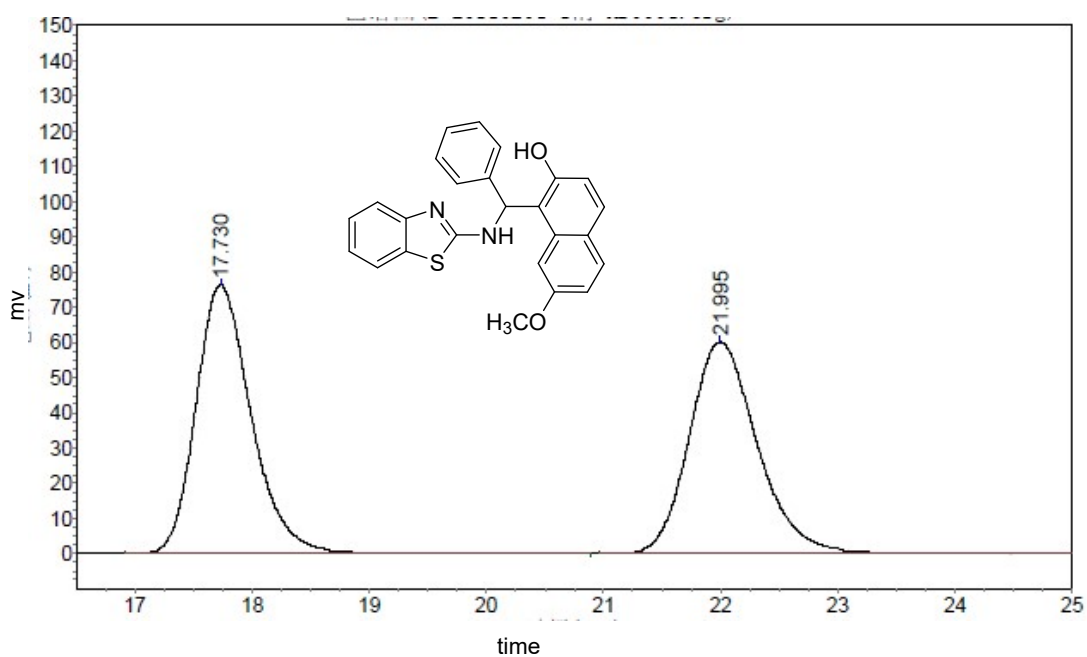


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.515	108218.914	1904935.750	49.7608
2	19.990	51843.641	1923248.000	50.2392



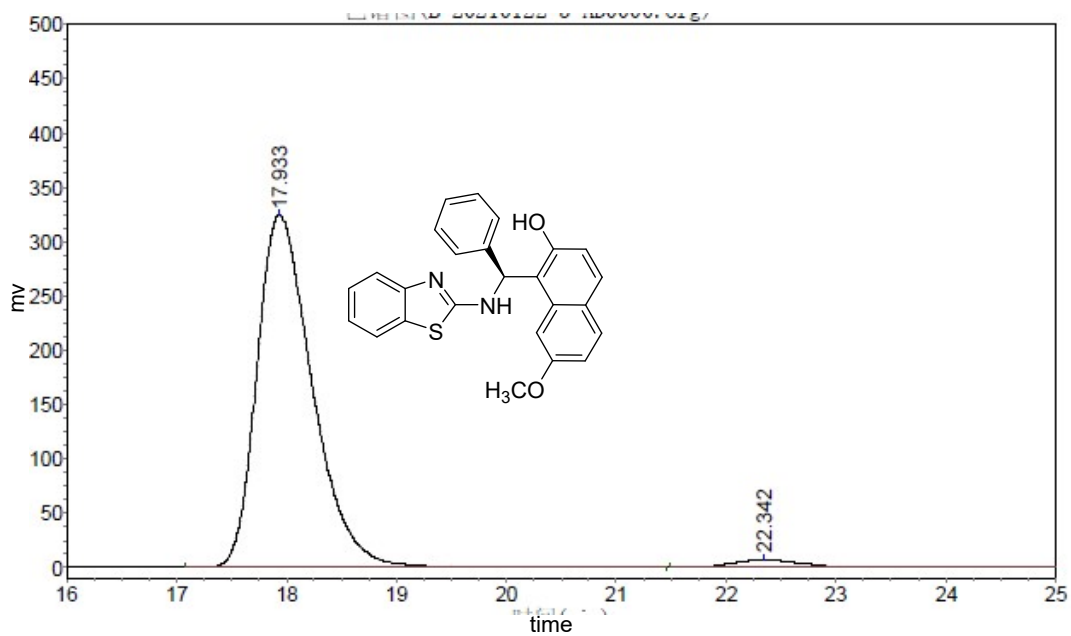
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	10.598	382101.719	6904129.500	97.9246
2	20.440	3926.406	146323.203	2.0754

**3ab**



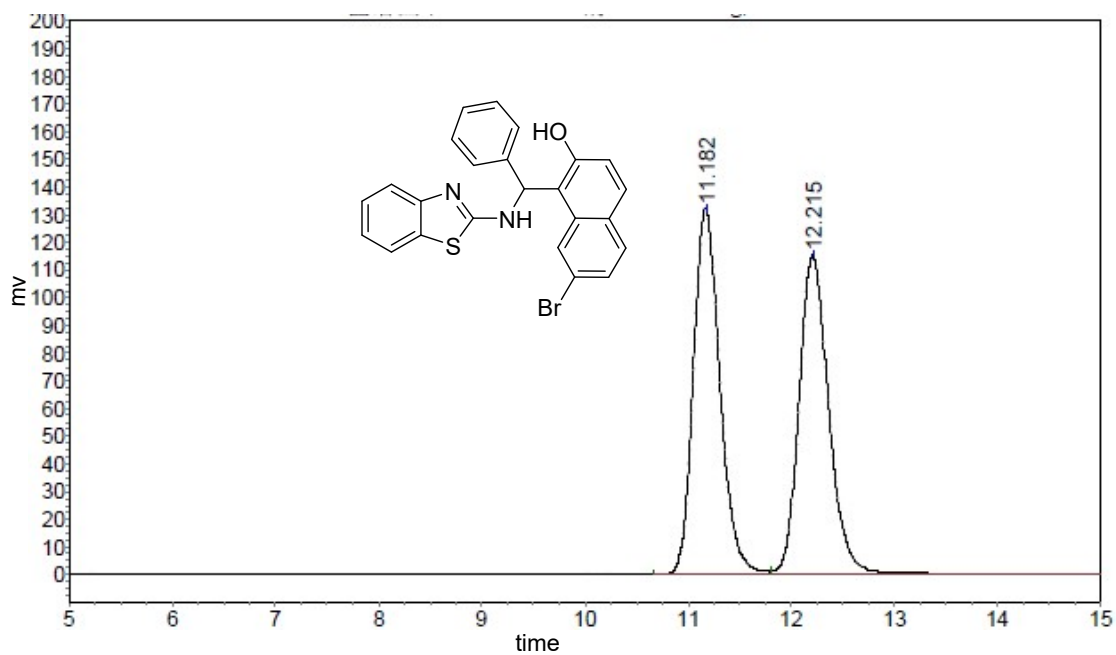
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
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1	17.730	76191.742	2492876.750	50.7228
2	21.995	60027.770	2421831.500	49.2772



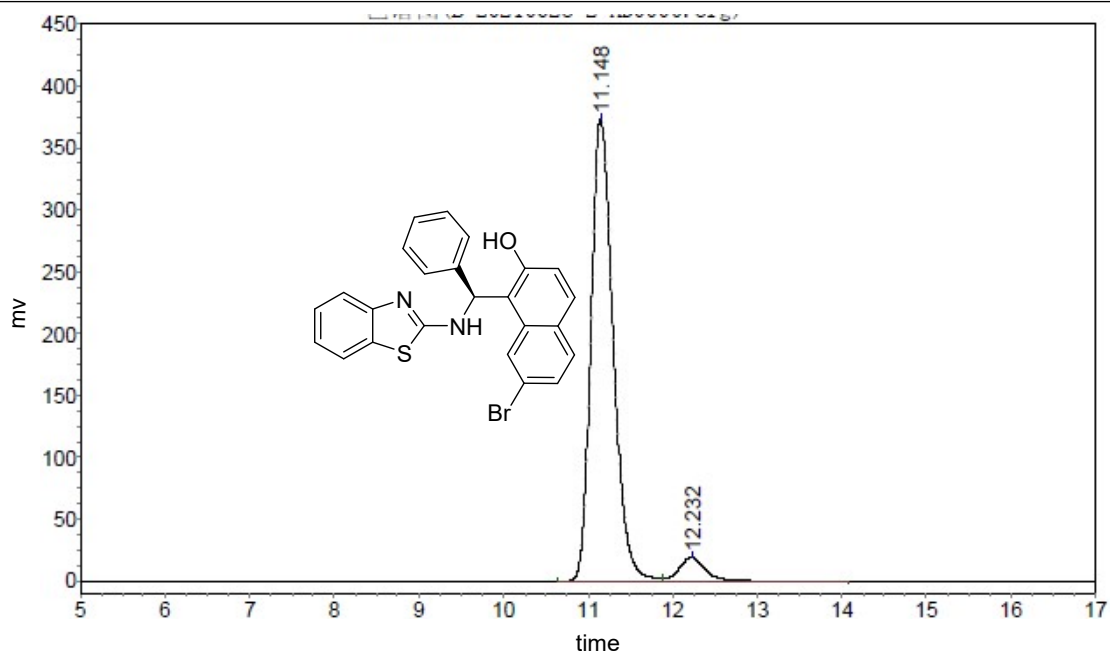
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	17.933	324475.469	11387319.000	97.3346
2	22.342	7223.419	311833.781	2.6654

### 3ac



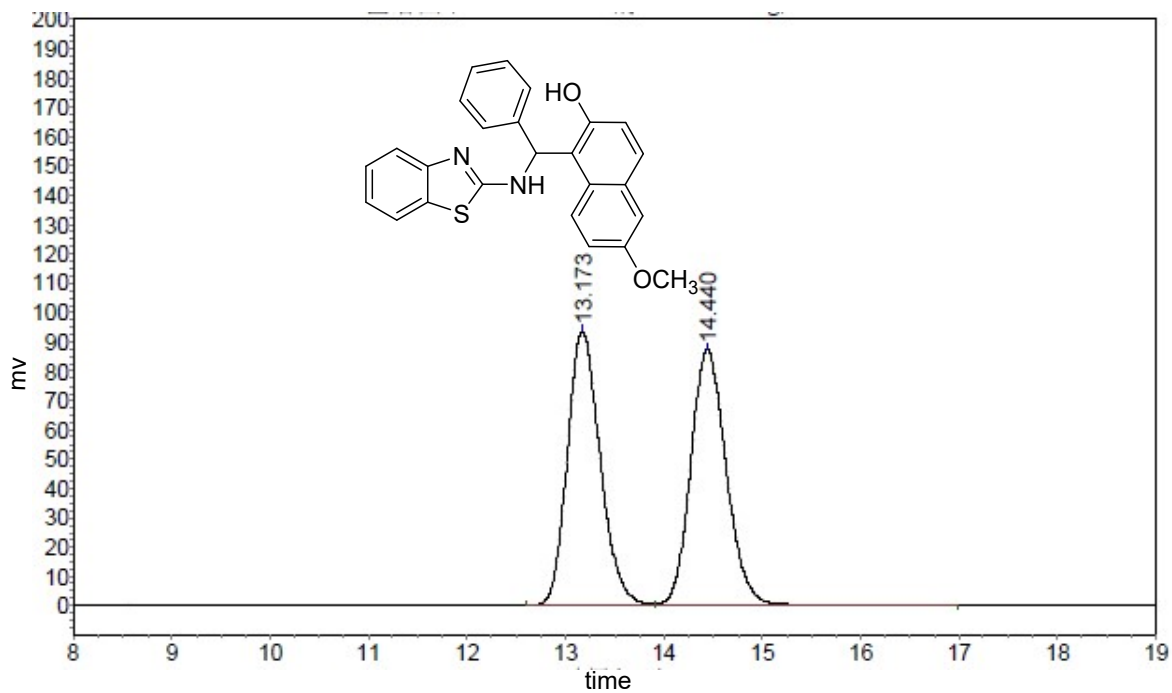


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	11.182	131963.406	2363182.500	50.4834
2	12.215	115029.234	2317921.500	49.5166

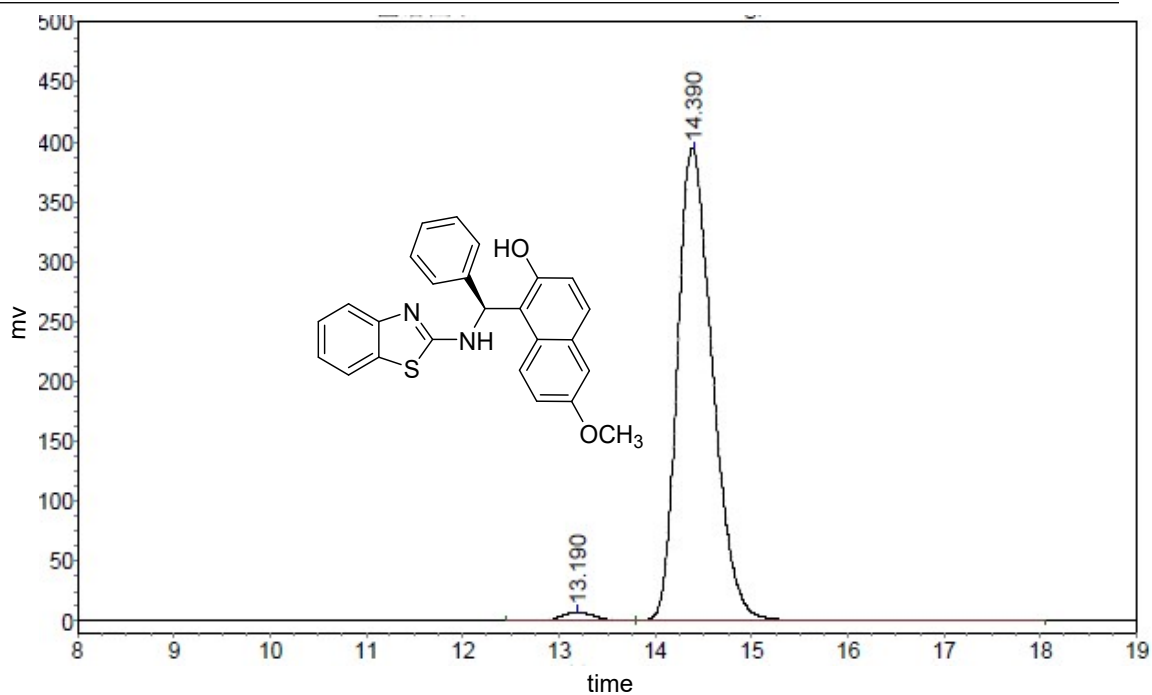


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	11.148	372138.438	6790832.000	94.2629
2	12.232	19061.492	413304.781	5.7370

**3ad**

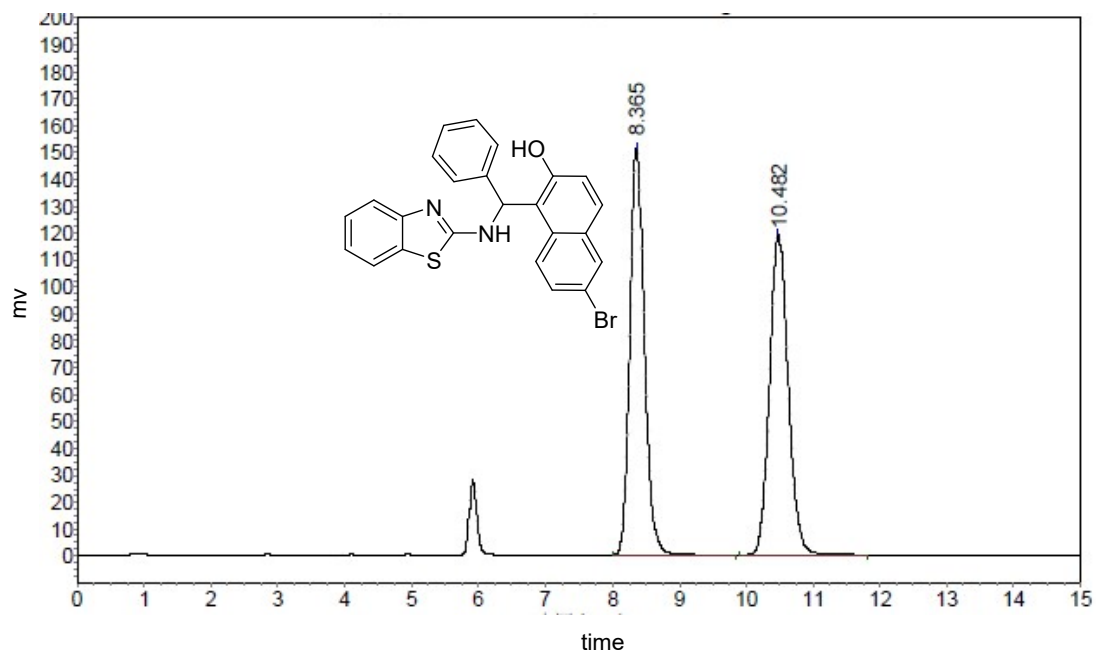


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	13.173	93075.500	2179968.750	49.7349
2	14.440	86897.664	2203204.000	50.2650

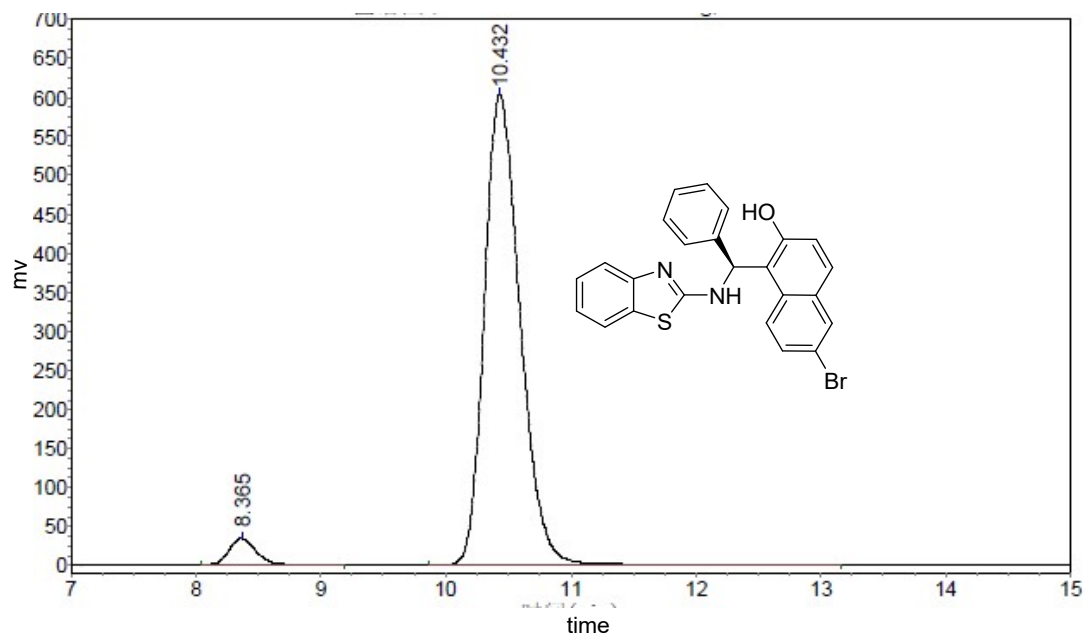


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	13.190	7578.833	172744.563	1.6980
2	14.390	394714.844	10000522.000	98.3020

3ae

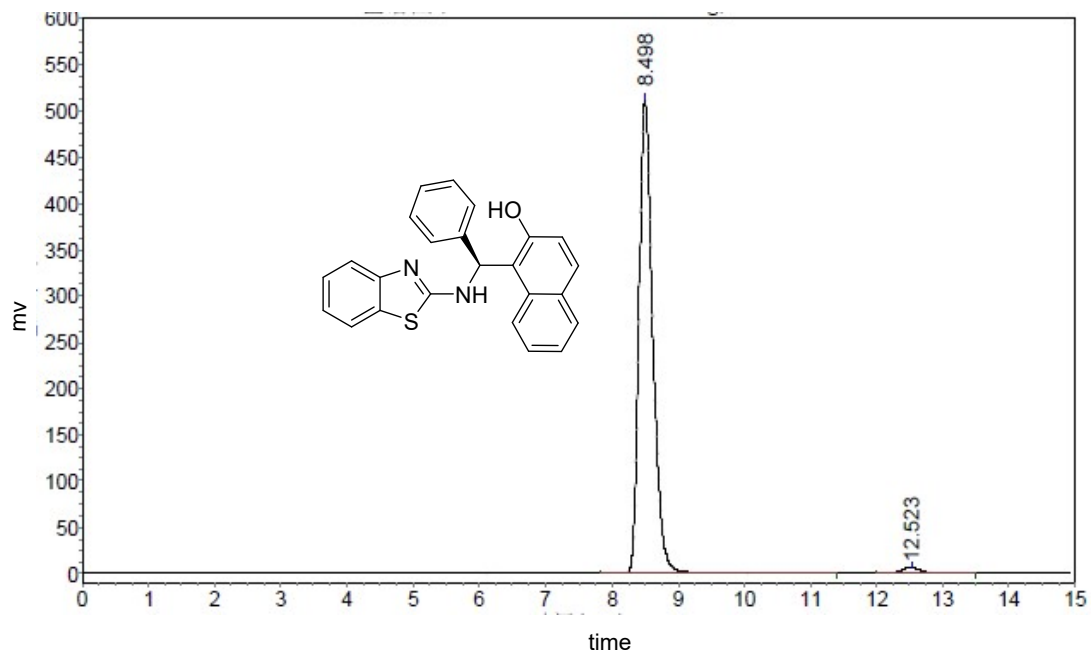


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.365	151563.734	2307079.750	49.8155
2	10.482	119015.297	2324170.250	50.1845



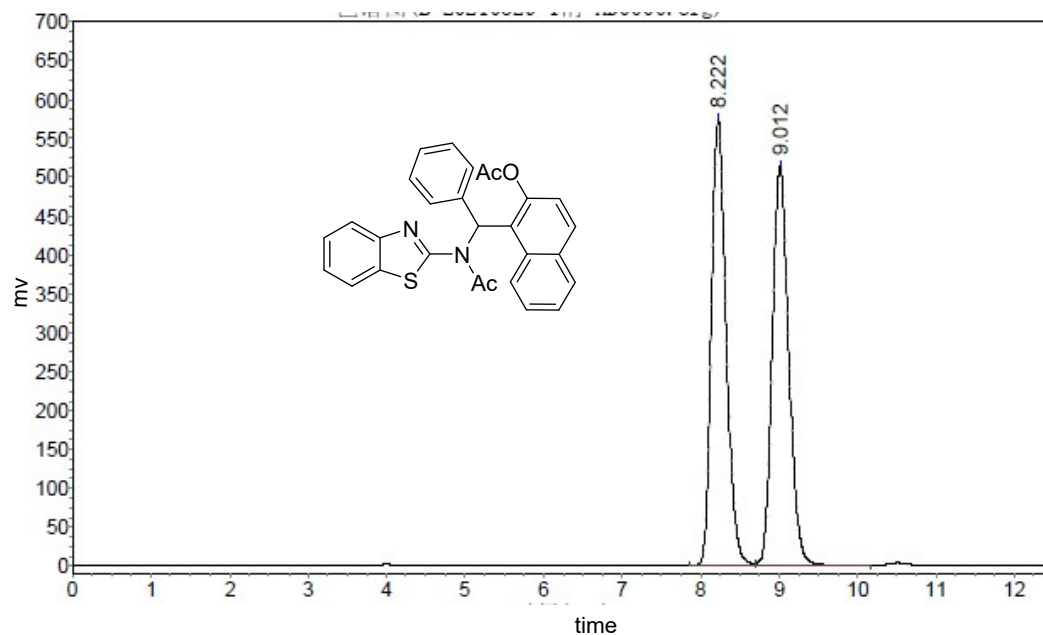
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.365	34343.176	521081.000	4.1488
2	10.432	604113.500	12038578.000	95.8512

4 .HPLC analysis of scale-up experiment and transformations of product **3aa**  
scale-up product **3aa**

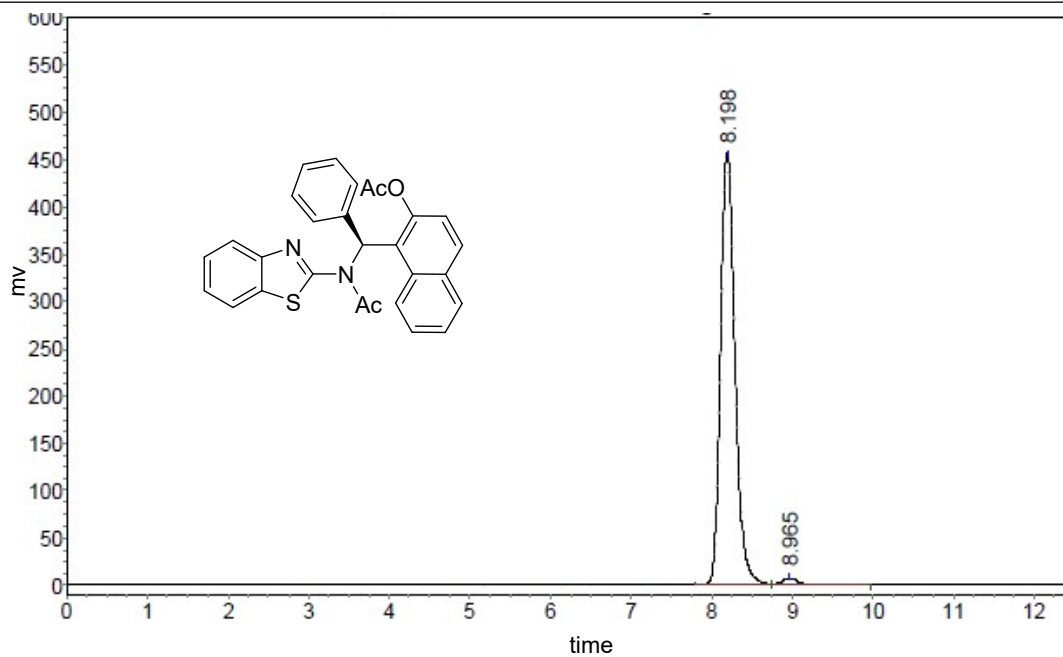


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.498	513132.813	7450997.000	98.2792
2	12.523	6168.544	130463.898	1.7208

4

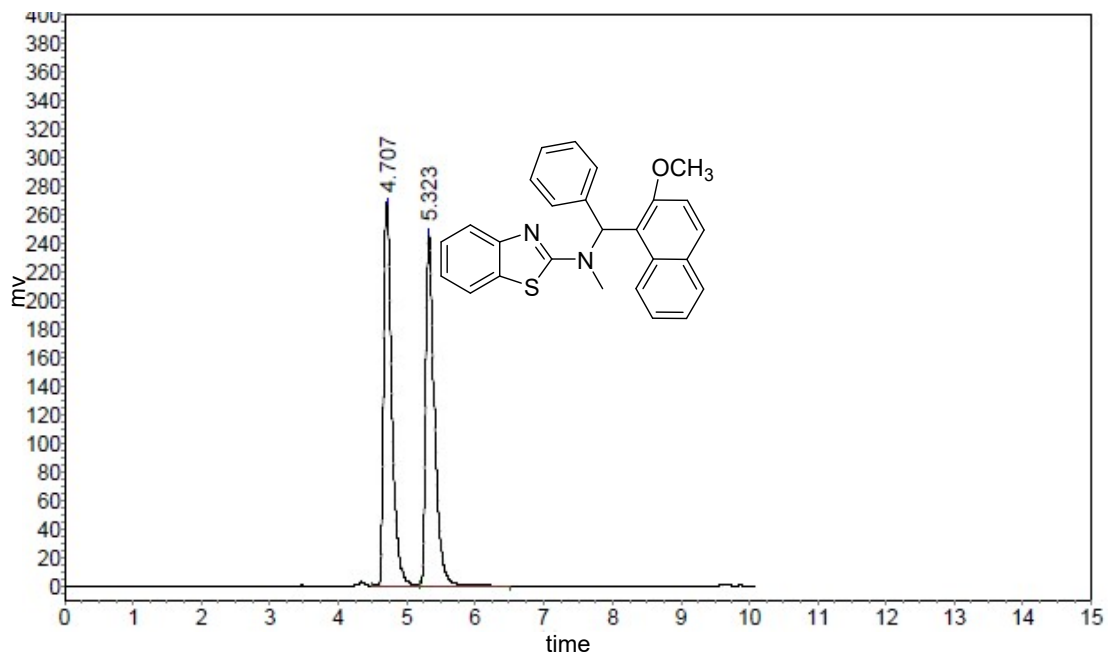


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.222	575201.063	7479676.500	49.8737
2	9.012	513908.563	7517544.500	50.1263

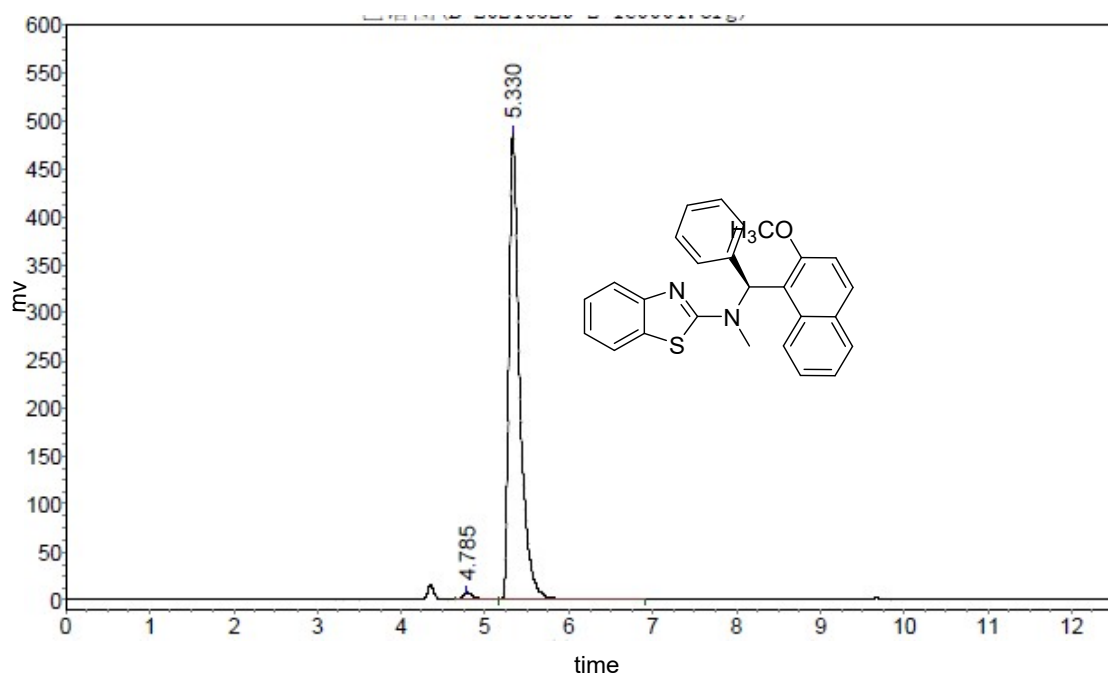


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	8.198	455040.594	5659906.500	98.2451
2	8.965	7046.539	101098.102	1.7549

5

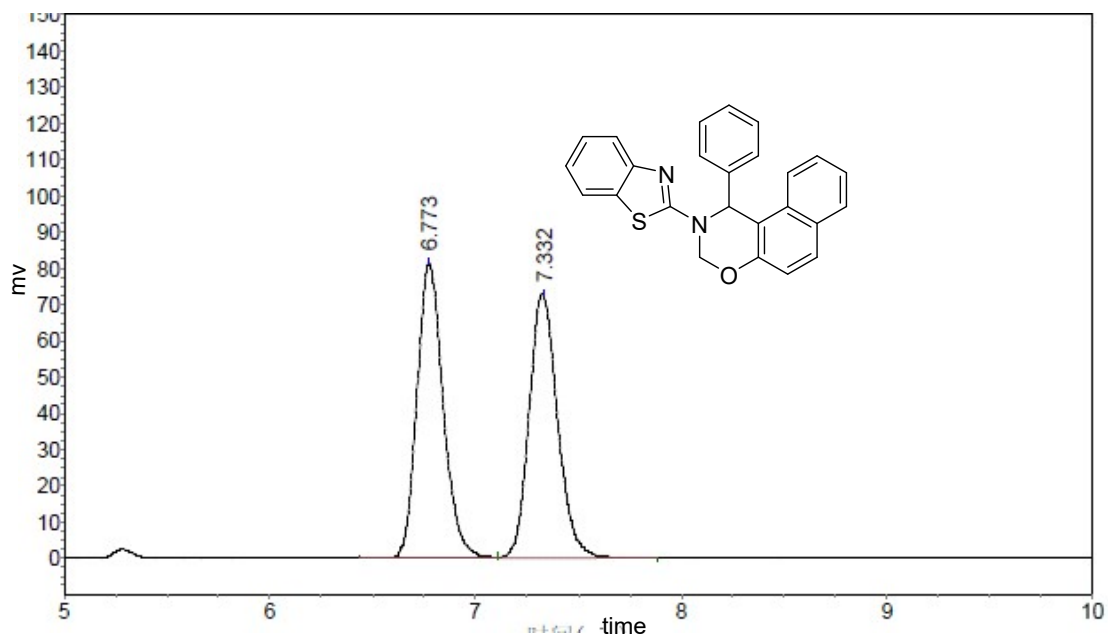


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	4.707	268195.750	2171926.250	49.7435
2	5.323	246482.188	2194323.250	50.2565

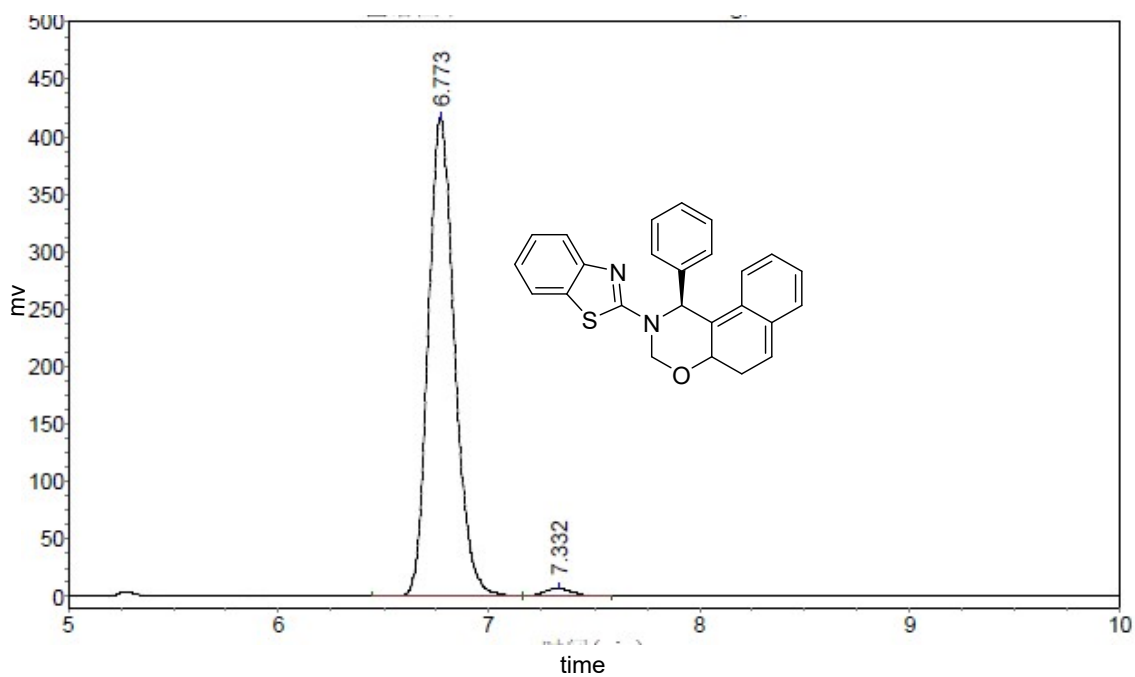


Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	4.785	7360.049	66226.086	1.4847
2	5.330	488855.438	12038578.000	98.5153

6



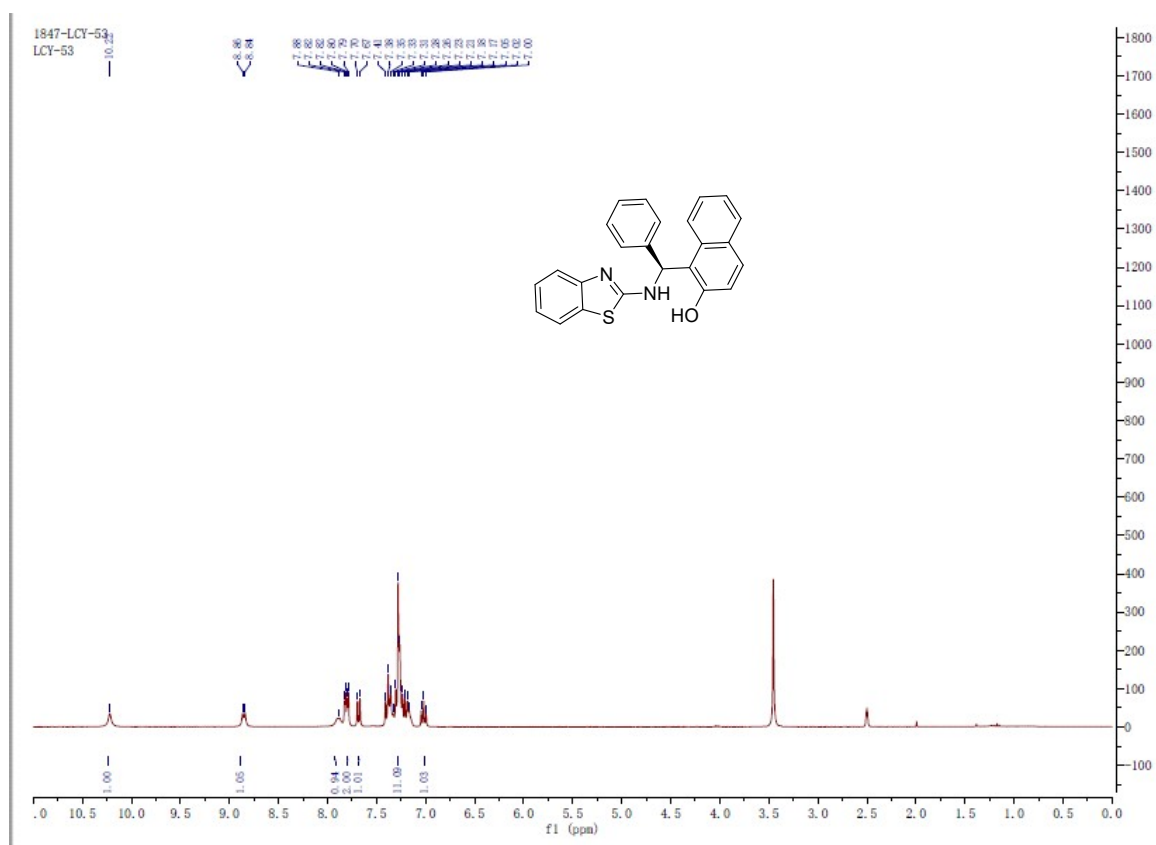
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	6.773	81186.094	721409.500	50.5644
2	7.332	72692.609	705306.063	49.4356



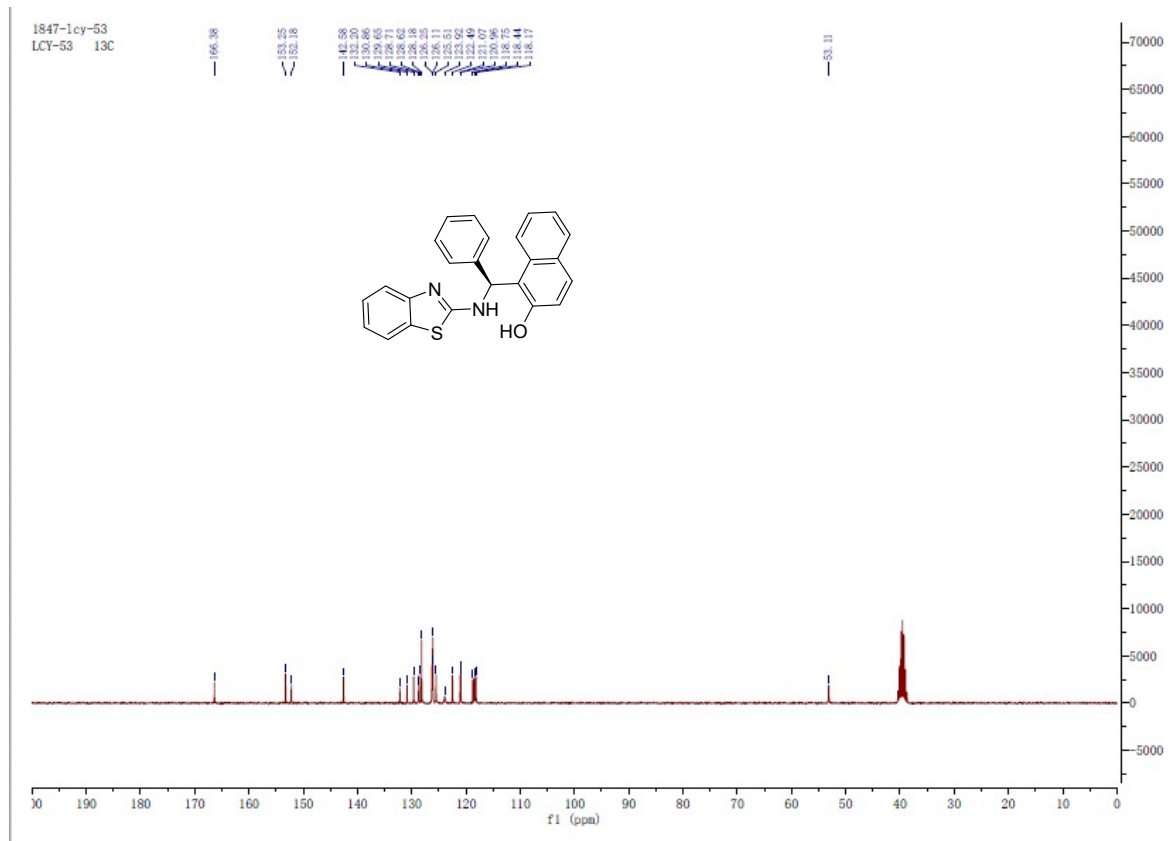
Peak#	Ret. Time (min)	Height (mV*sec)	Area (mv)	Area (%)
1	6.773	416487.031	3620665.000	98.2464
2	7.332	6923.368	64623.594	1.7536

## 5. NMR spectra of products **3**

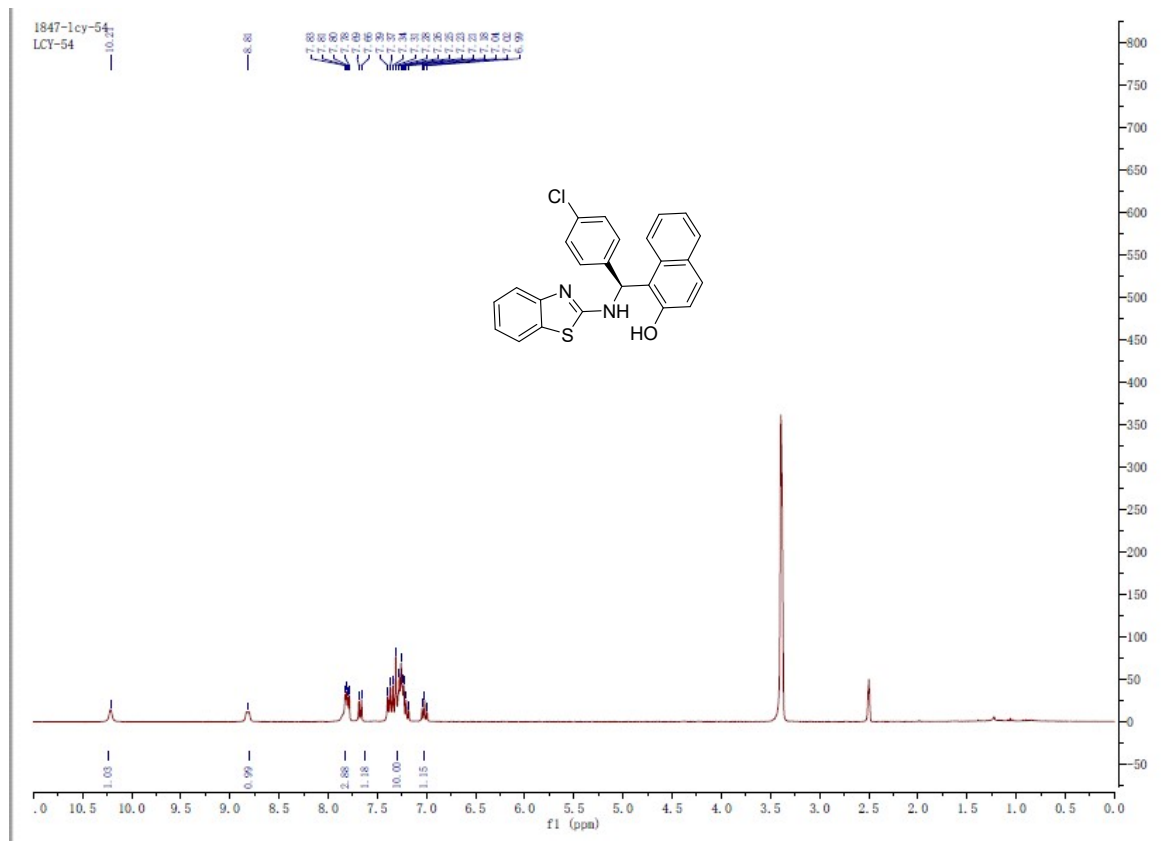
### **3aa**

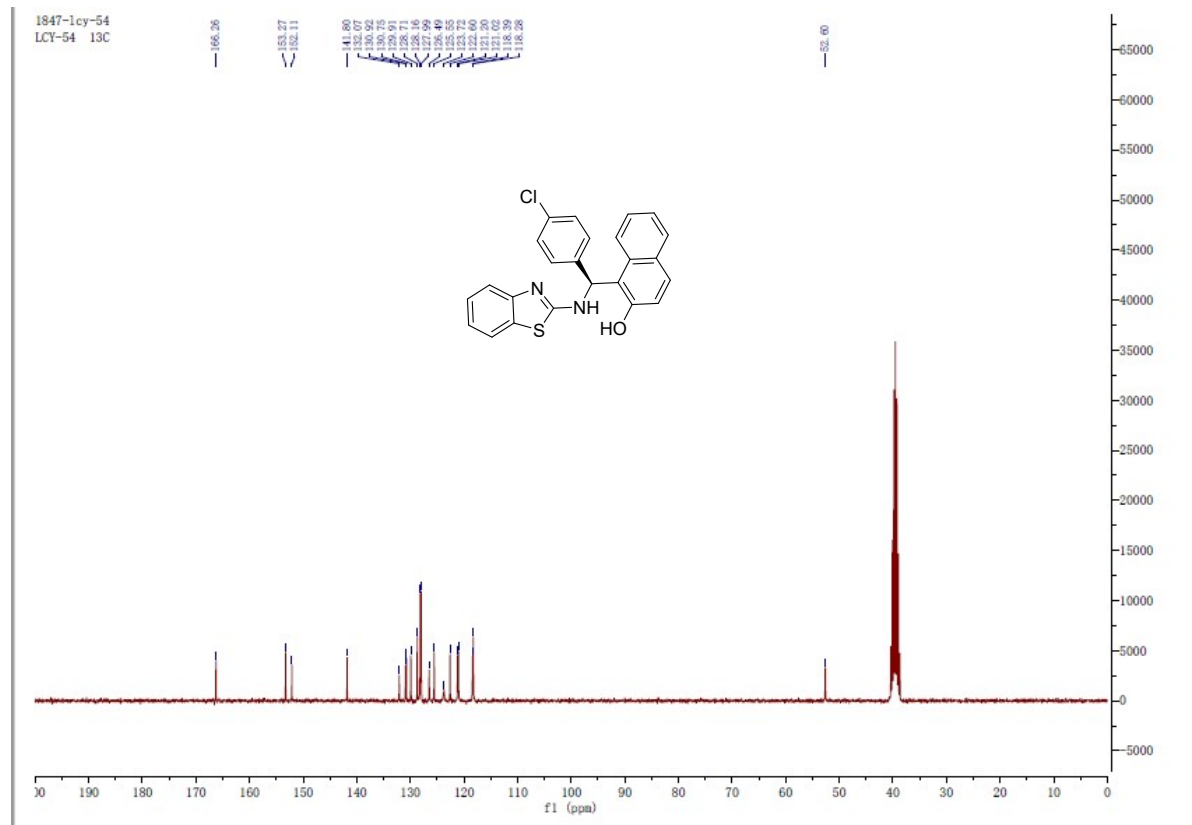




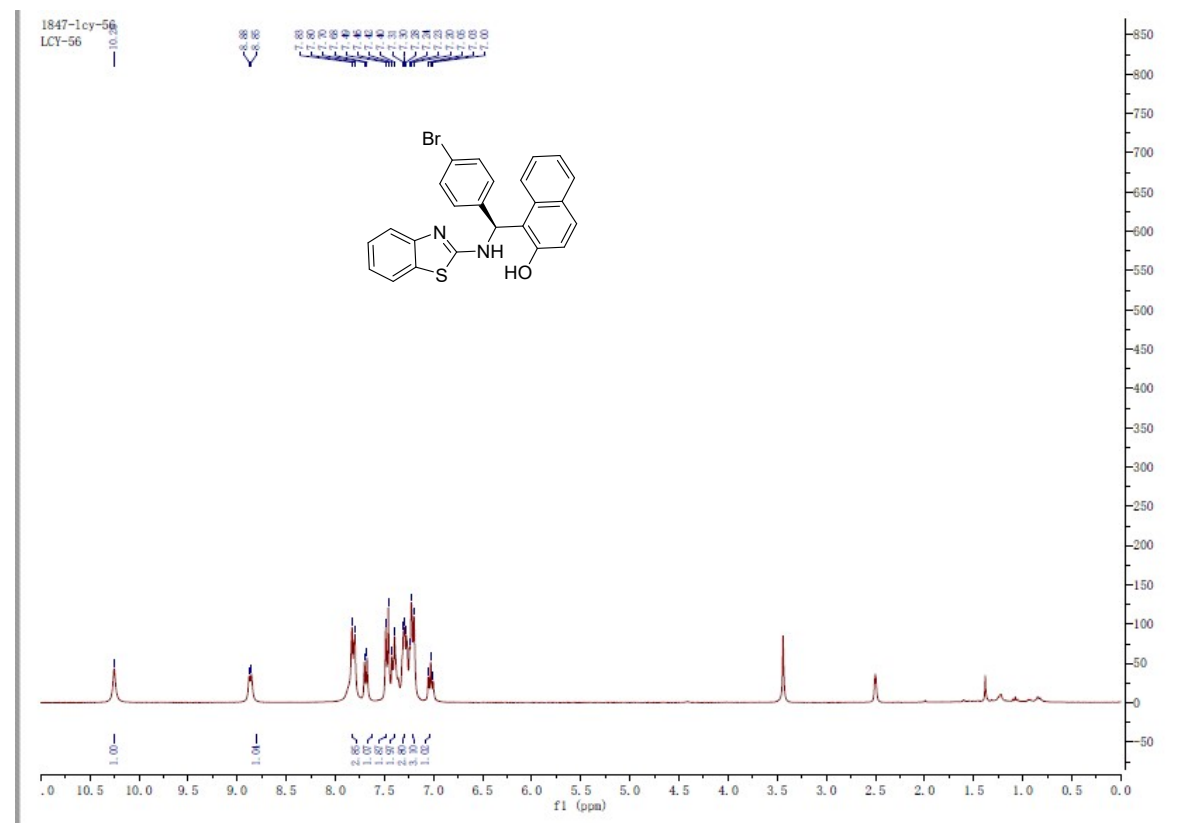


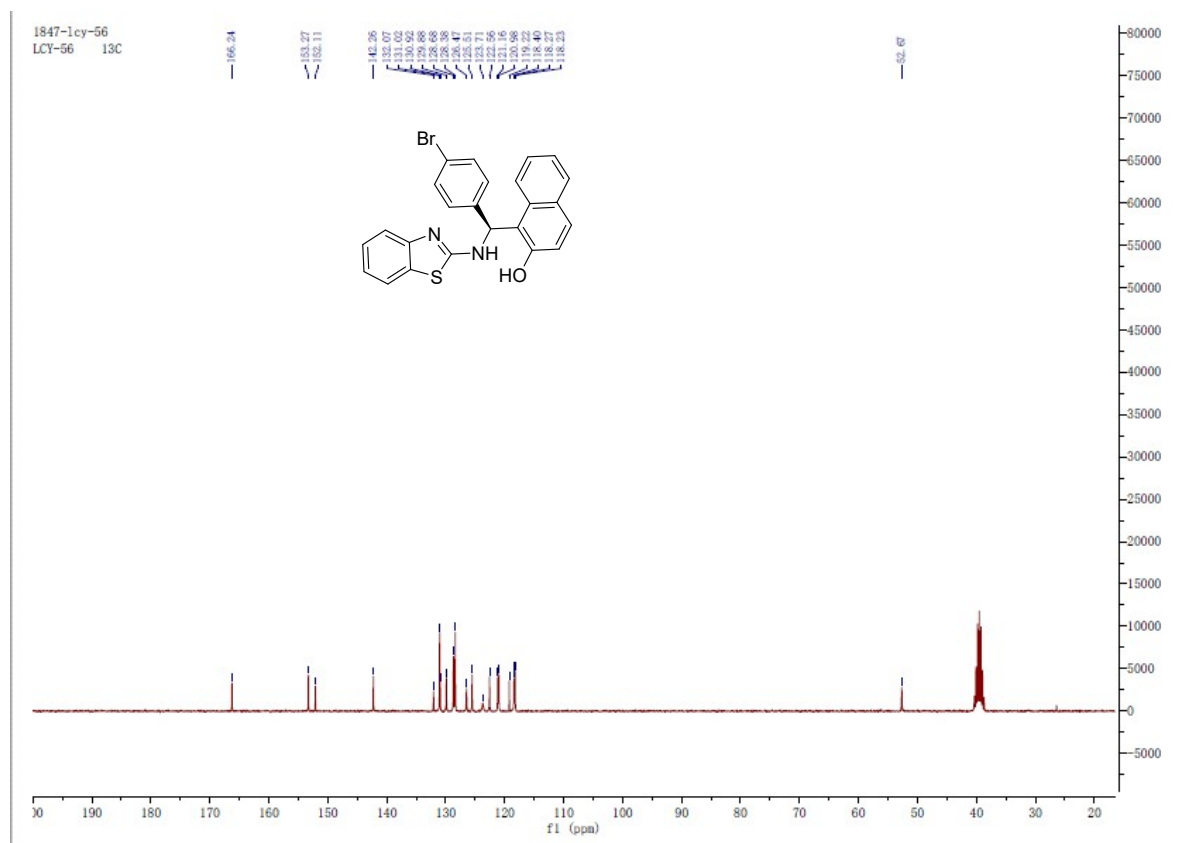
**3ba**



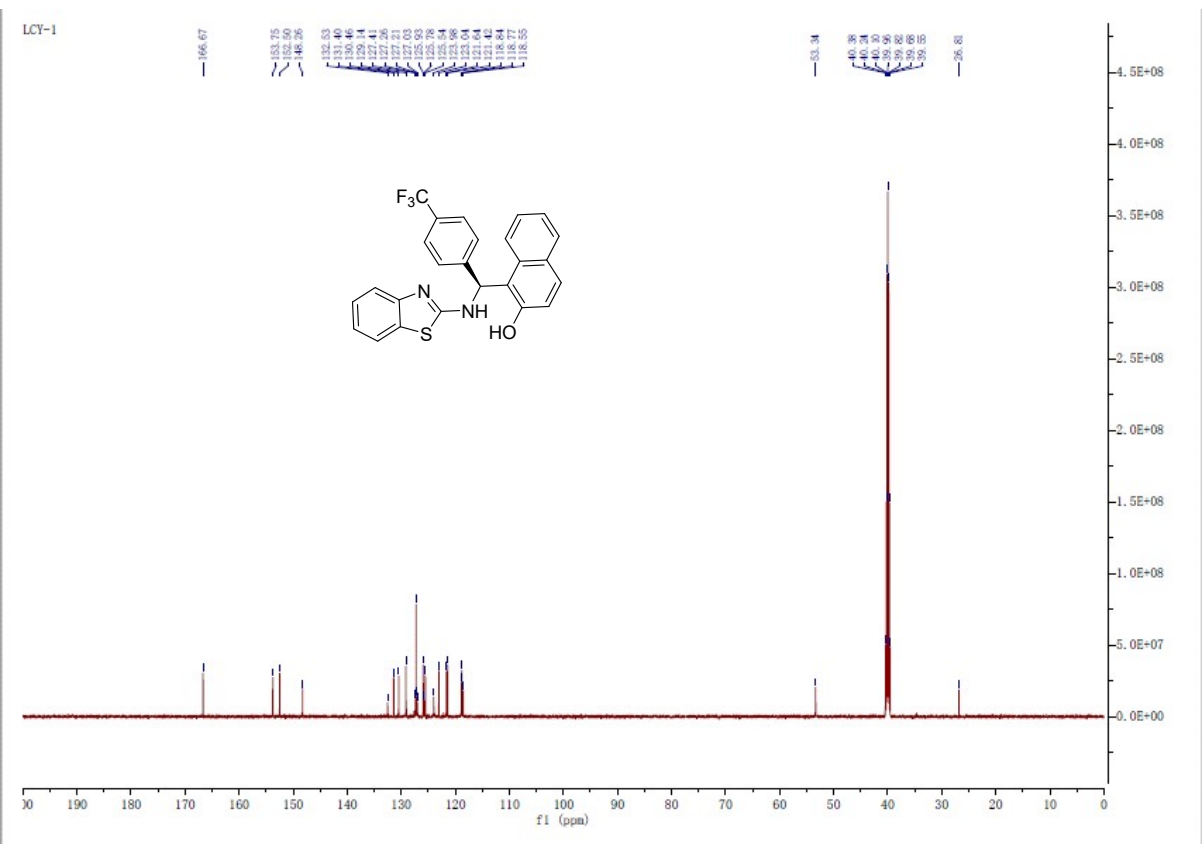
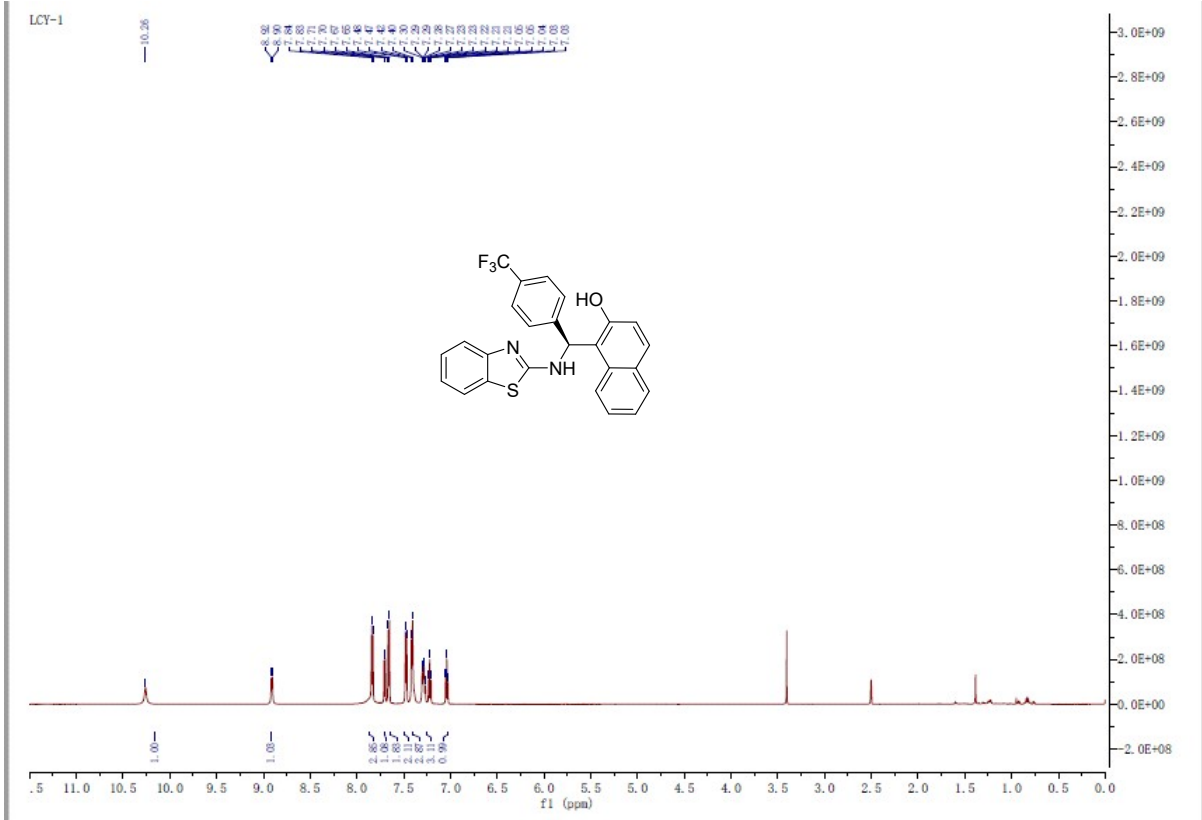


3ca

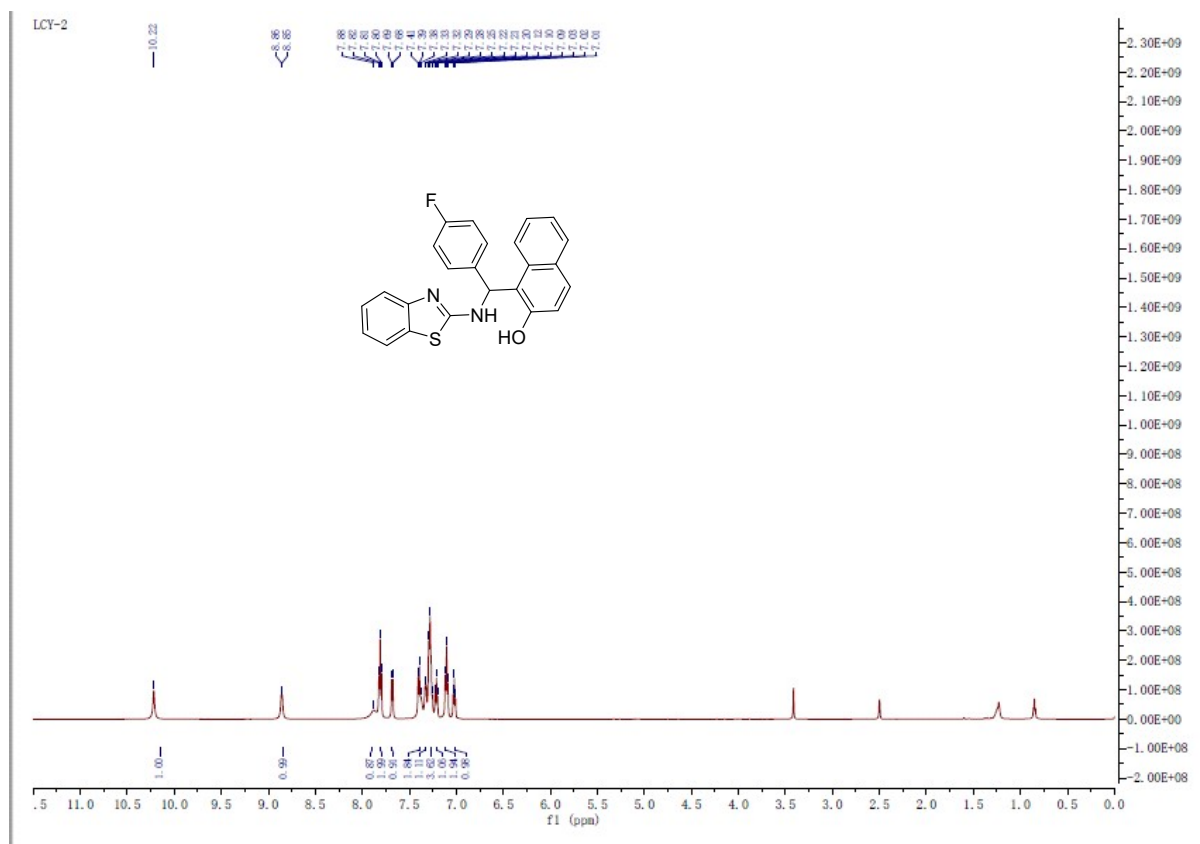


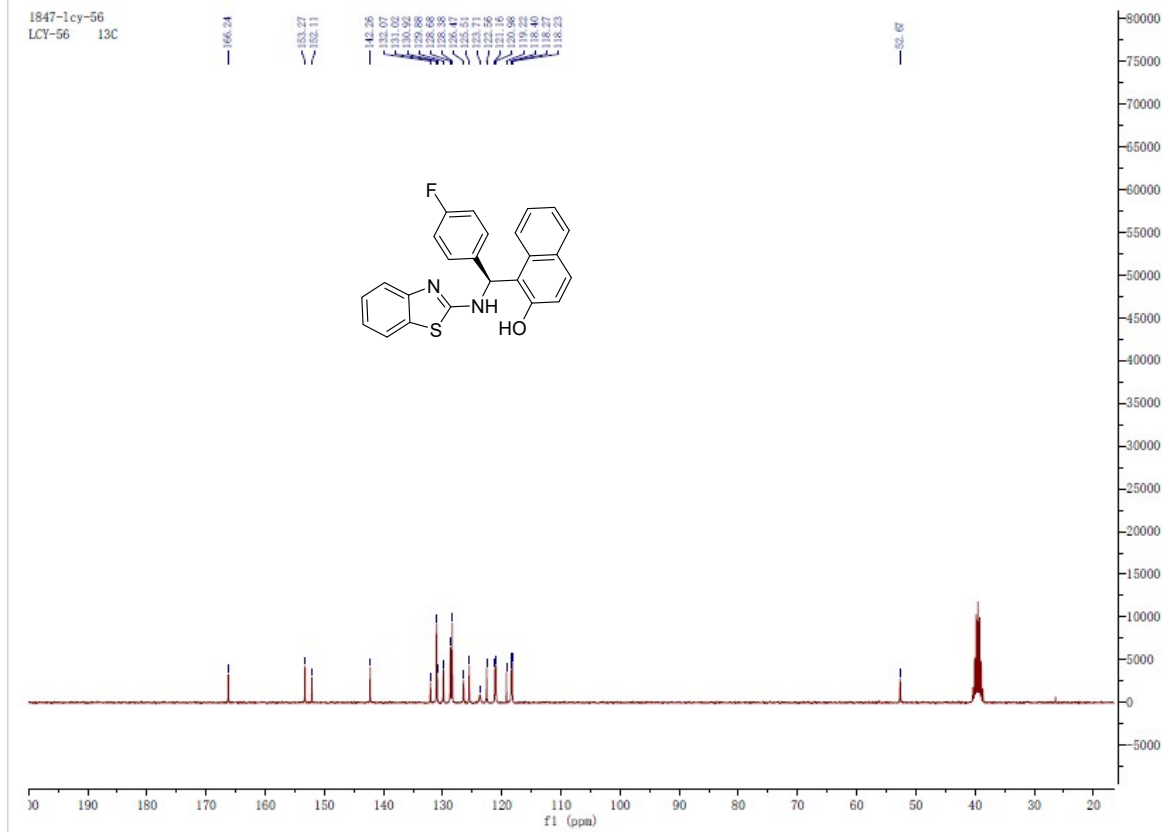


3da

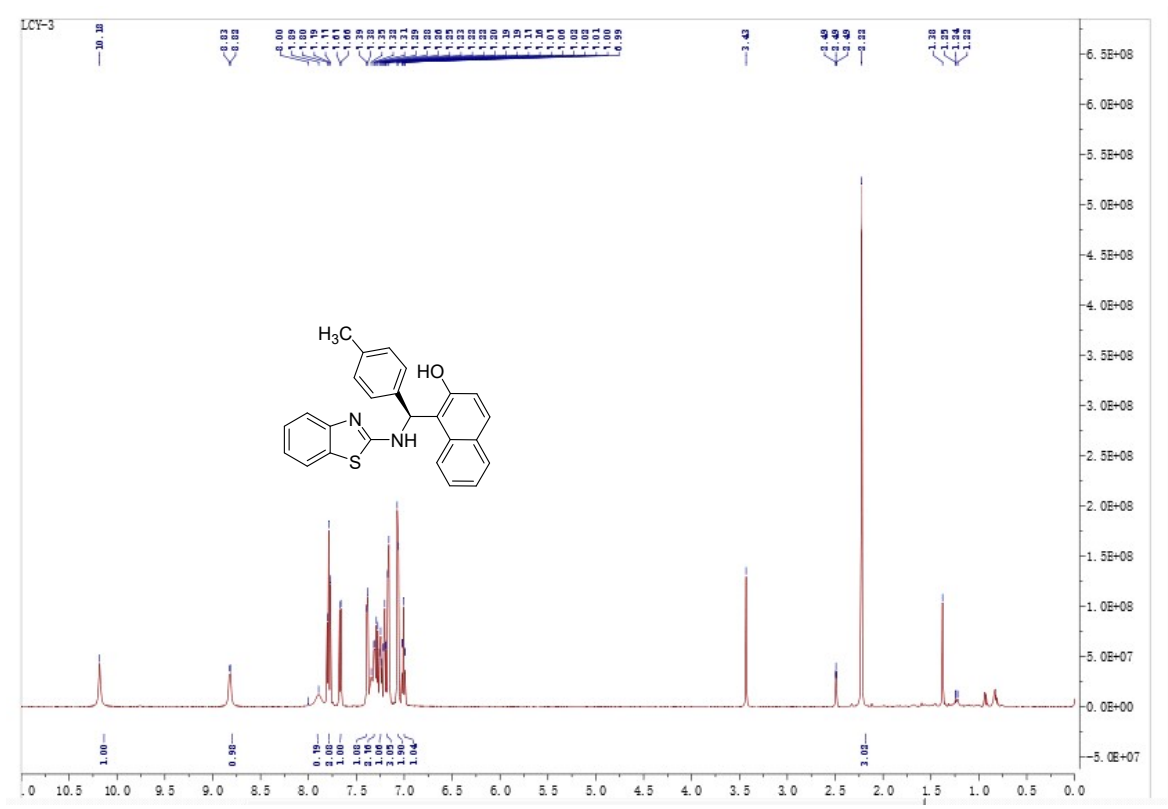


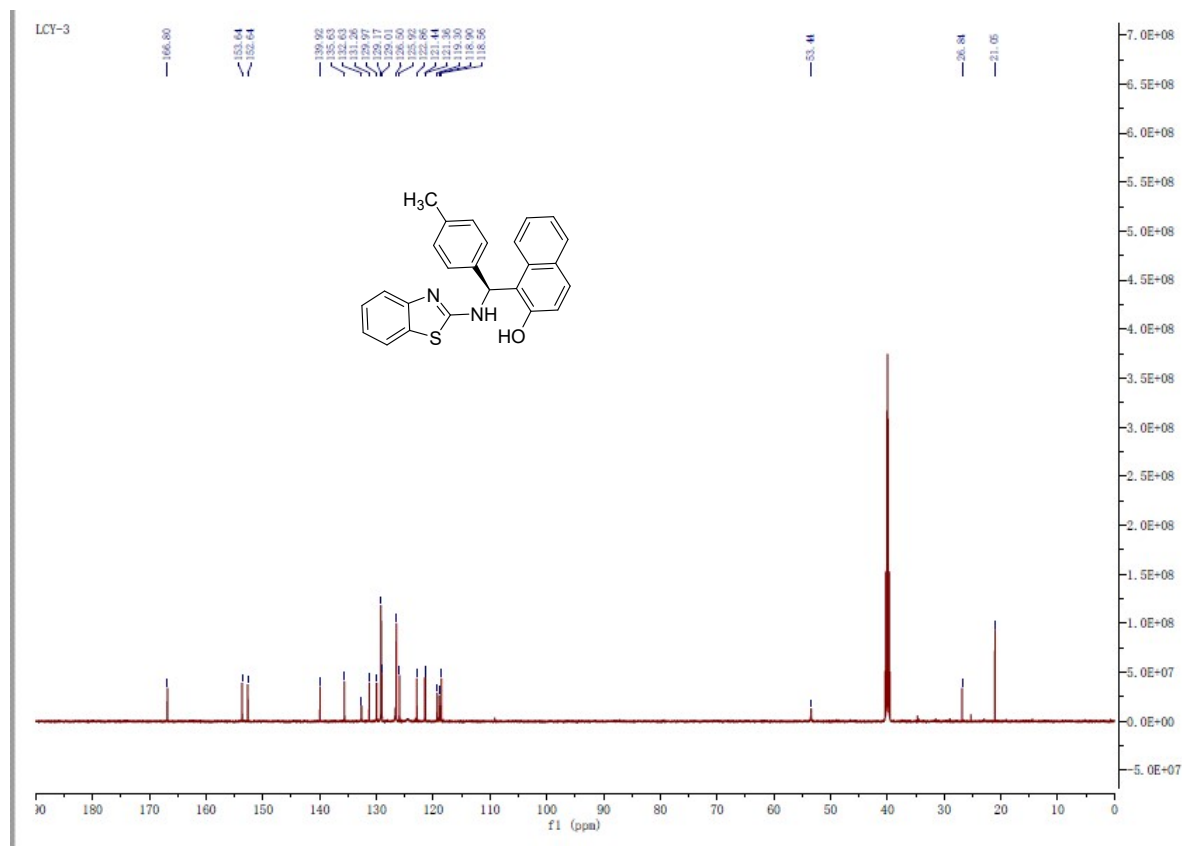
3ea



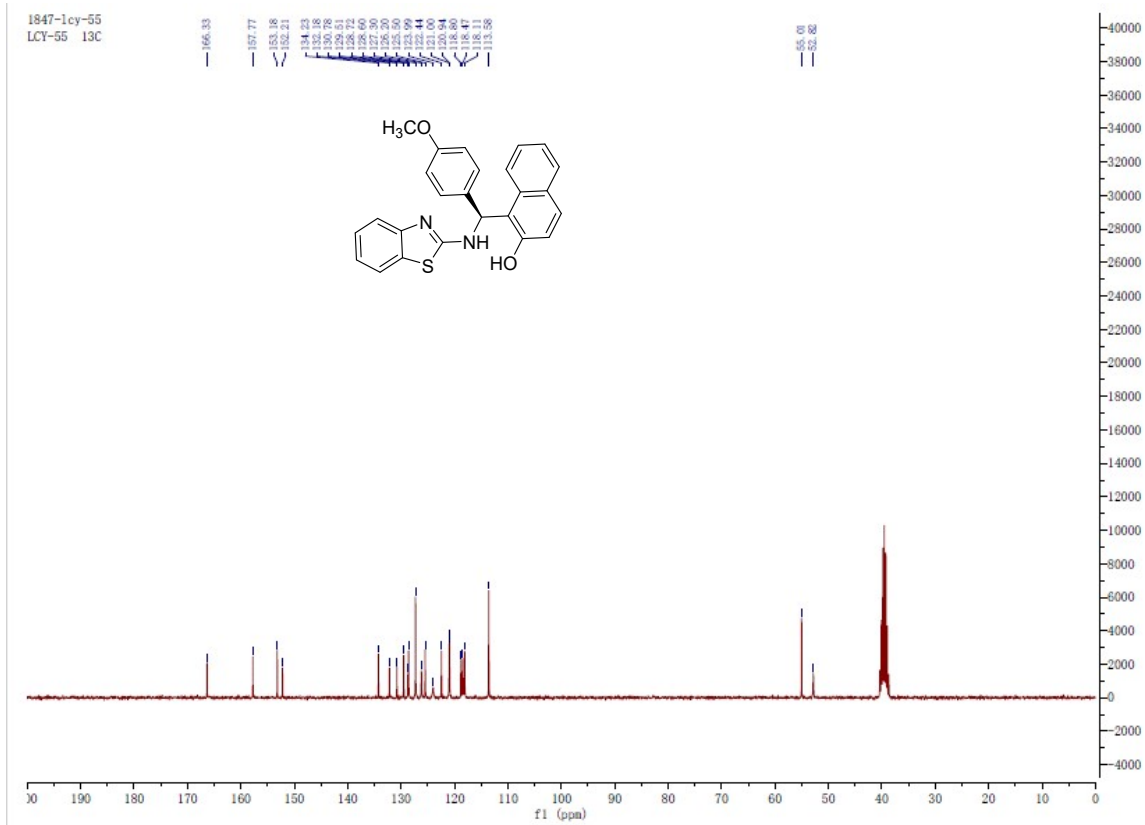
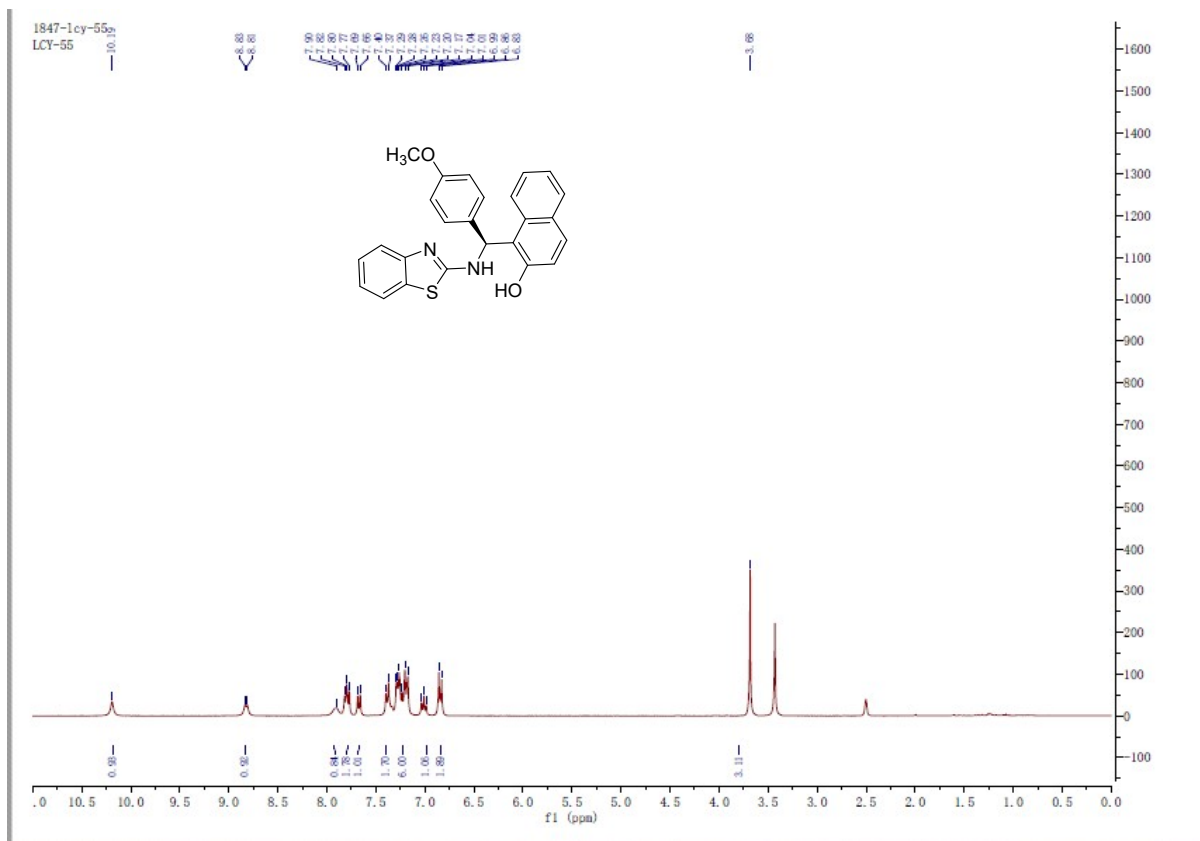


3fa



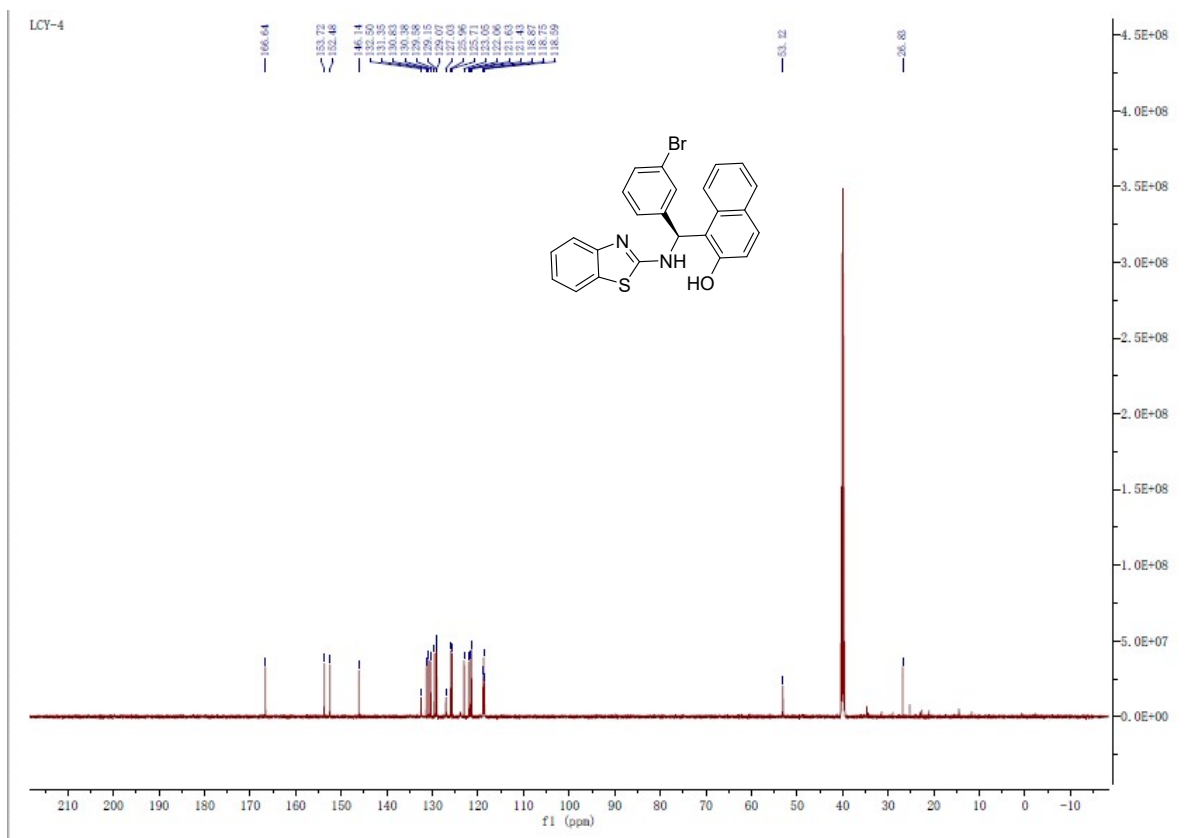
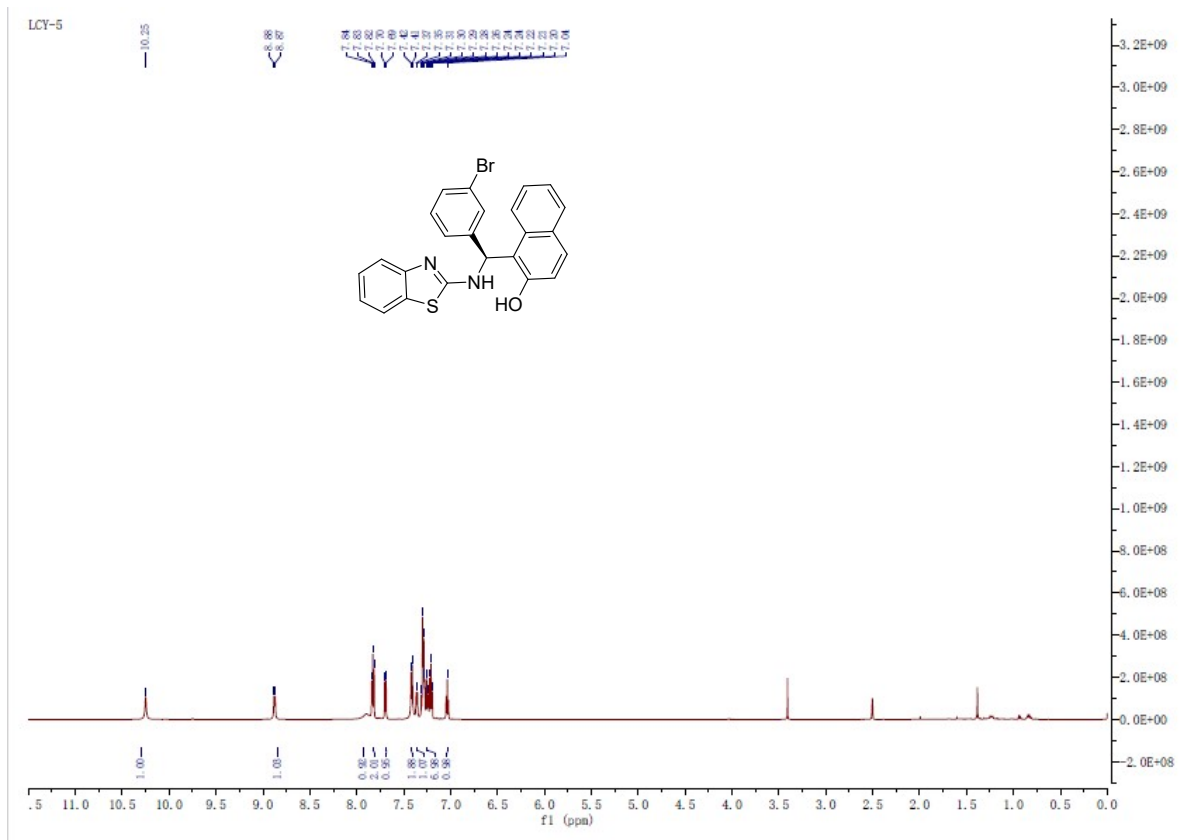


3ga

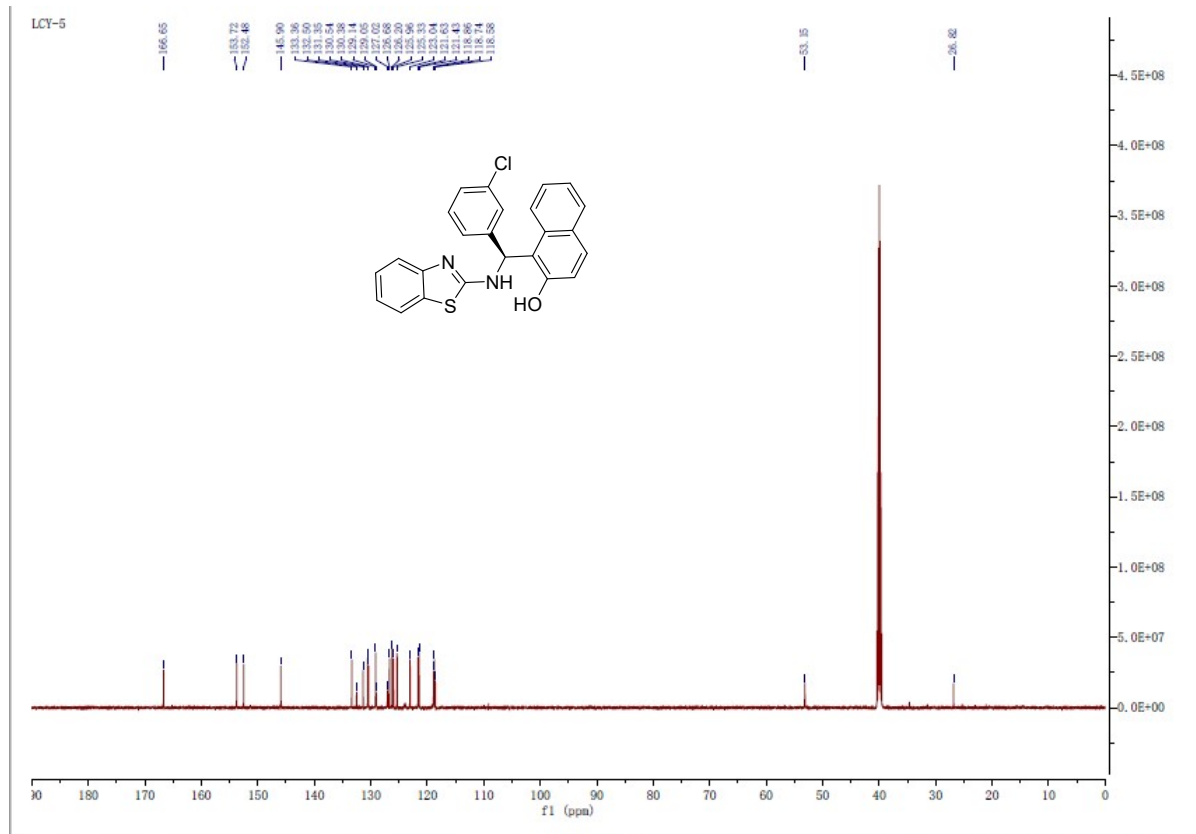




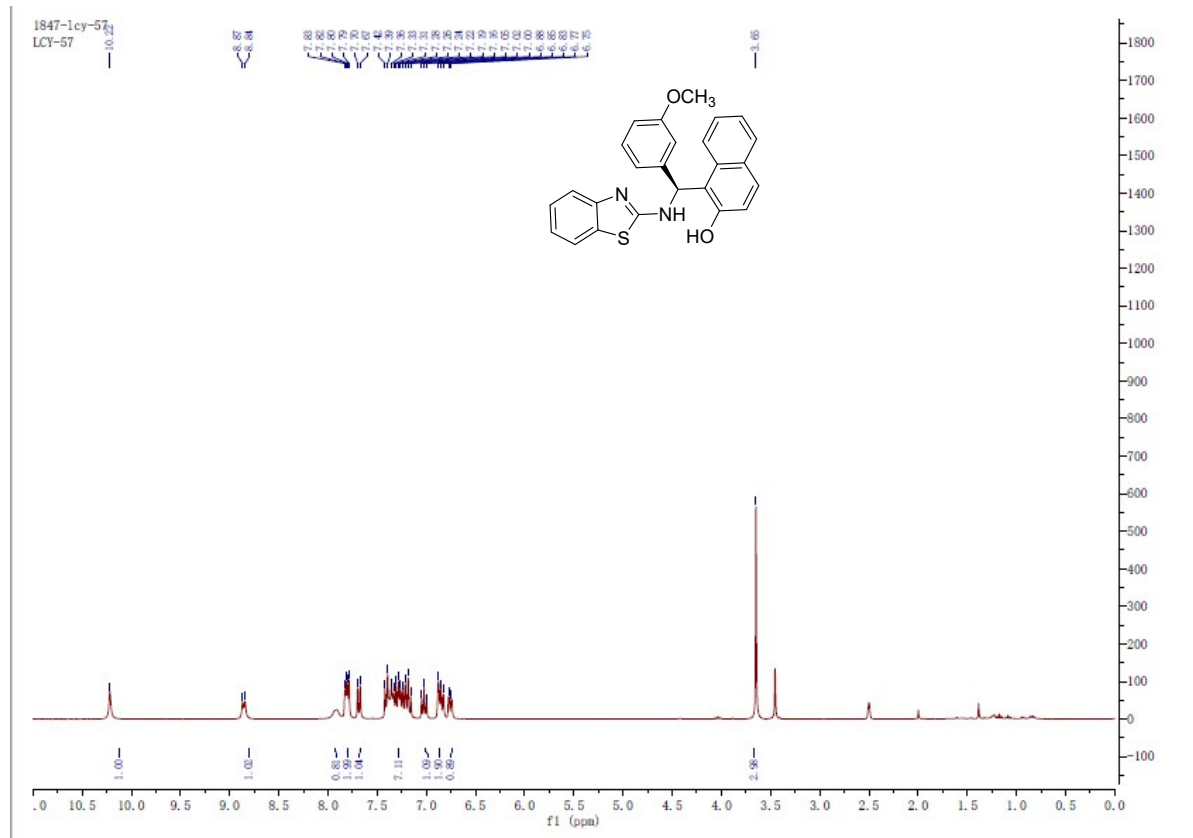
3ha

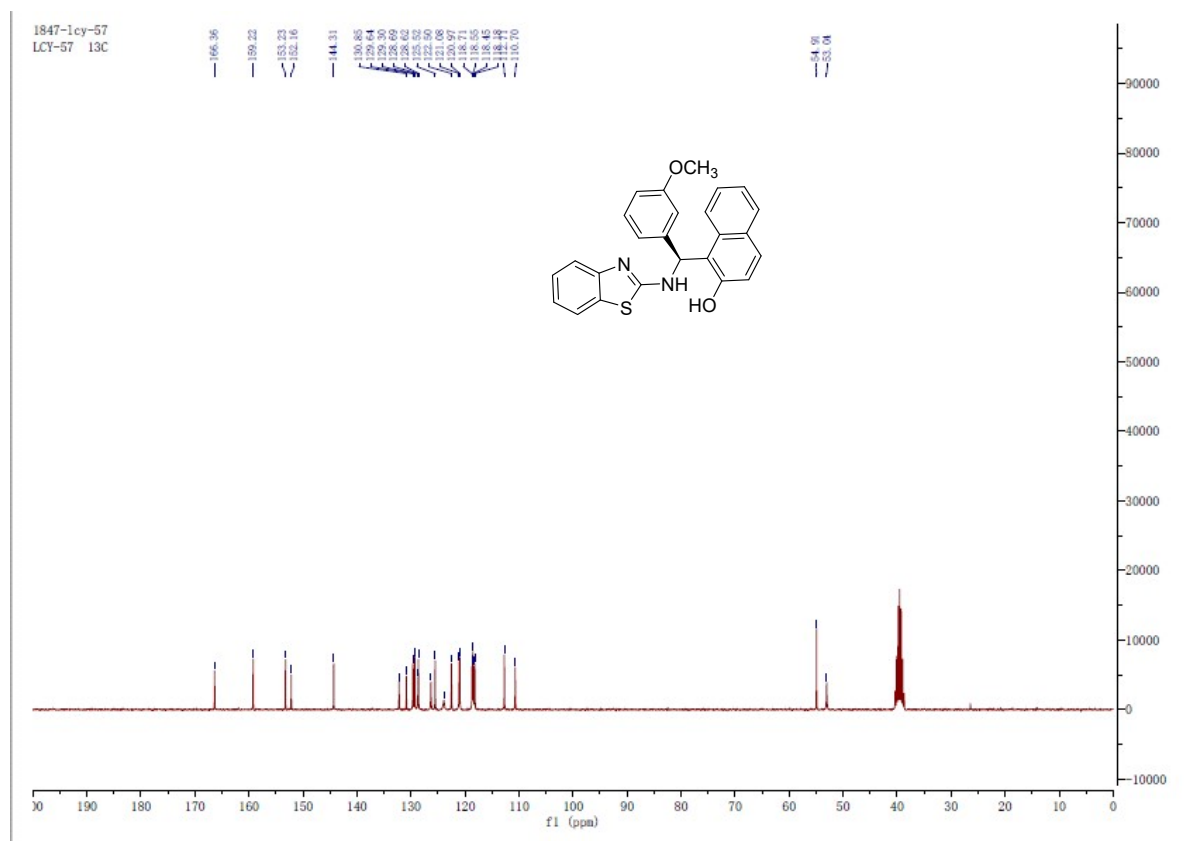




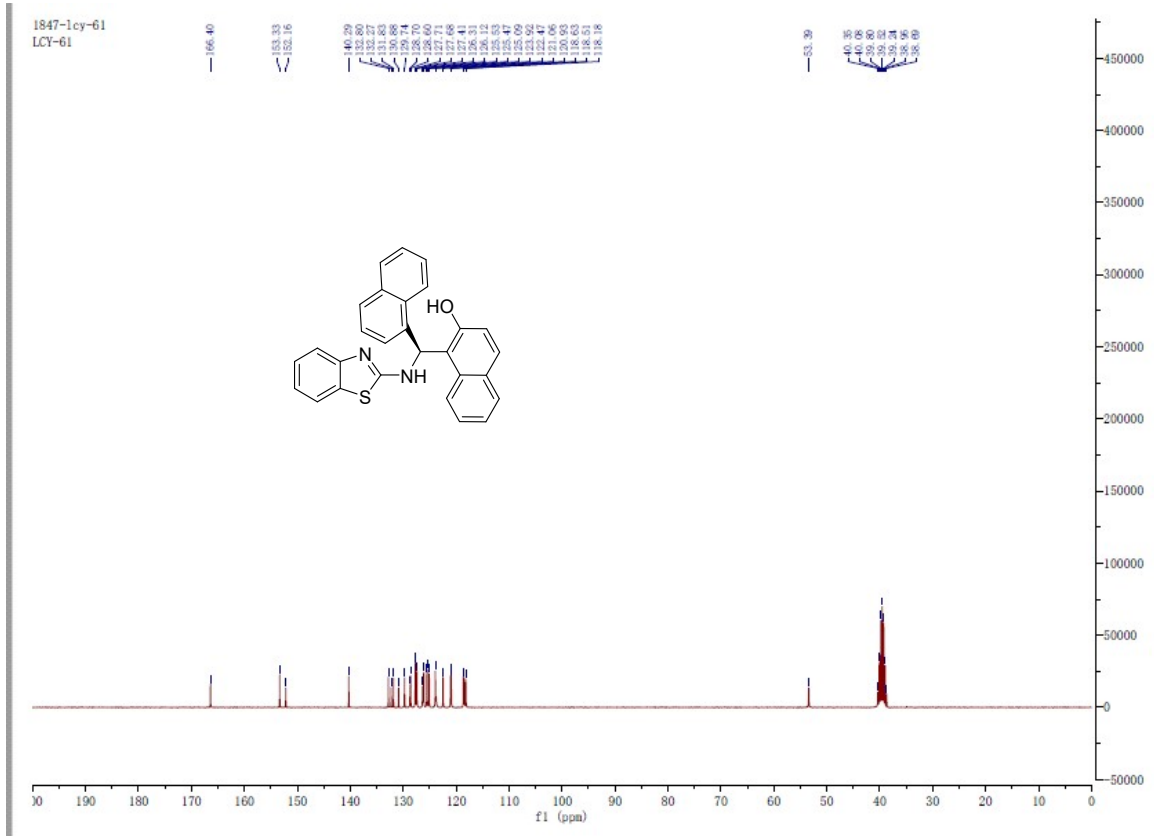
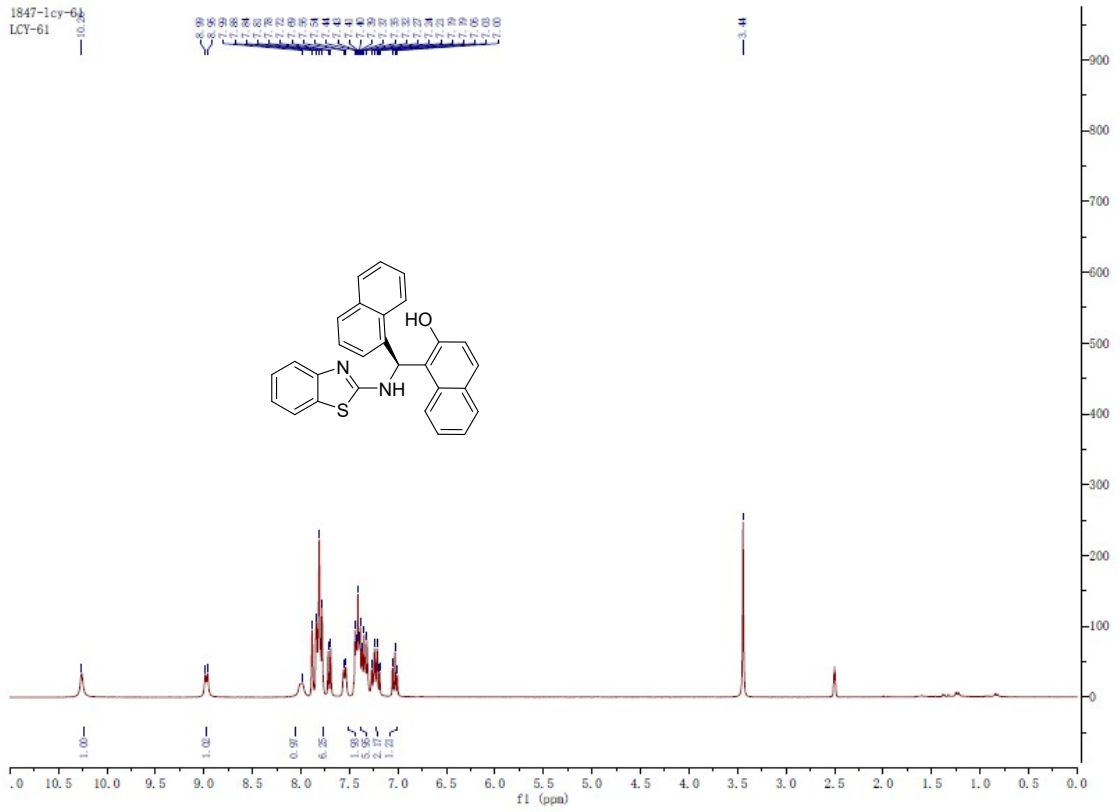


### 3ja



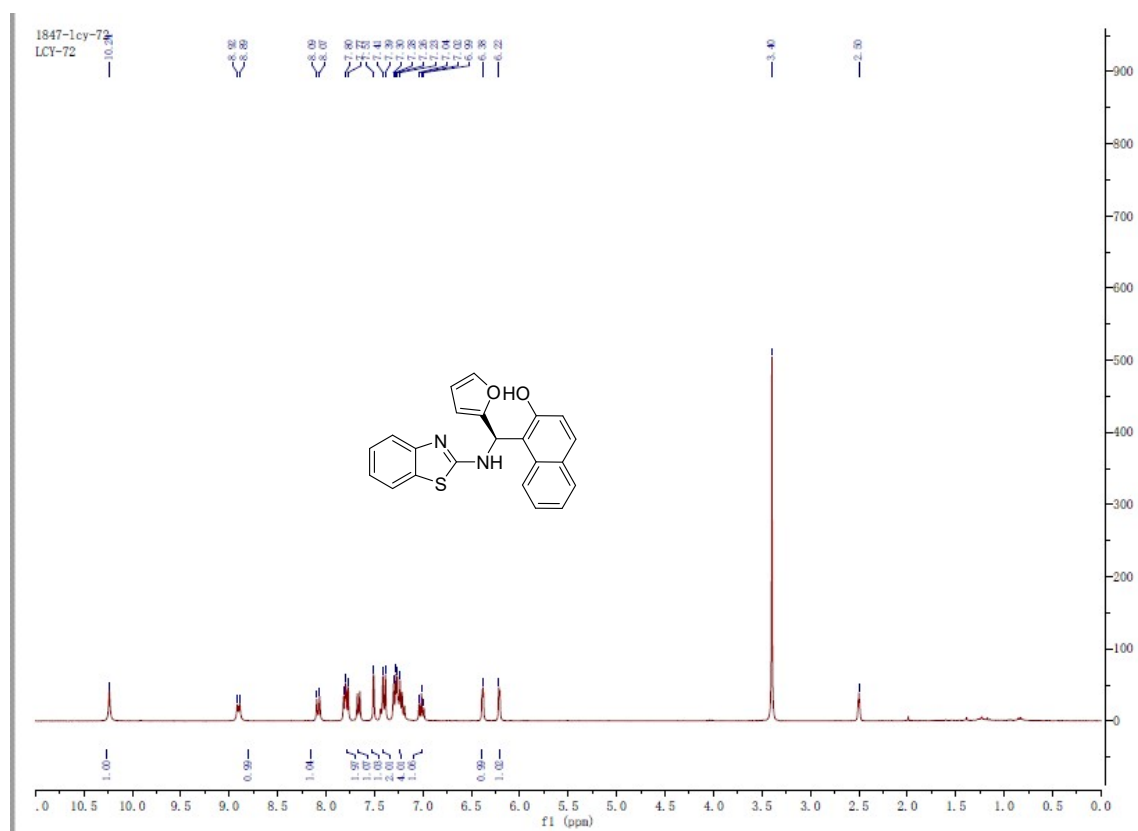


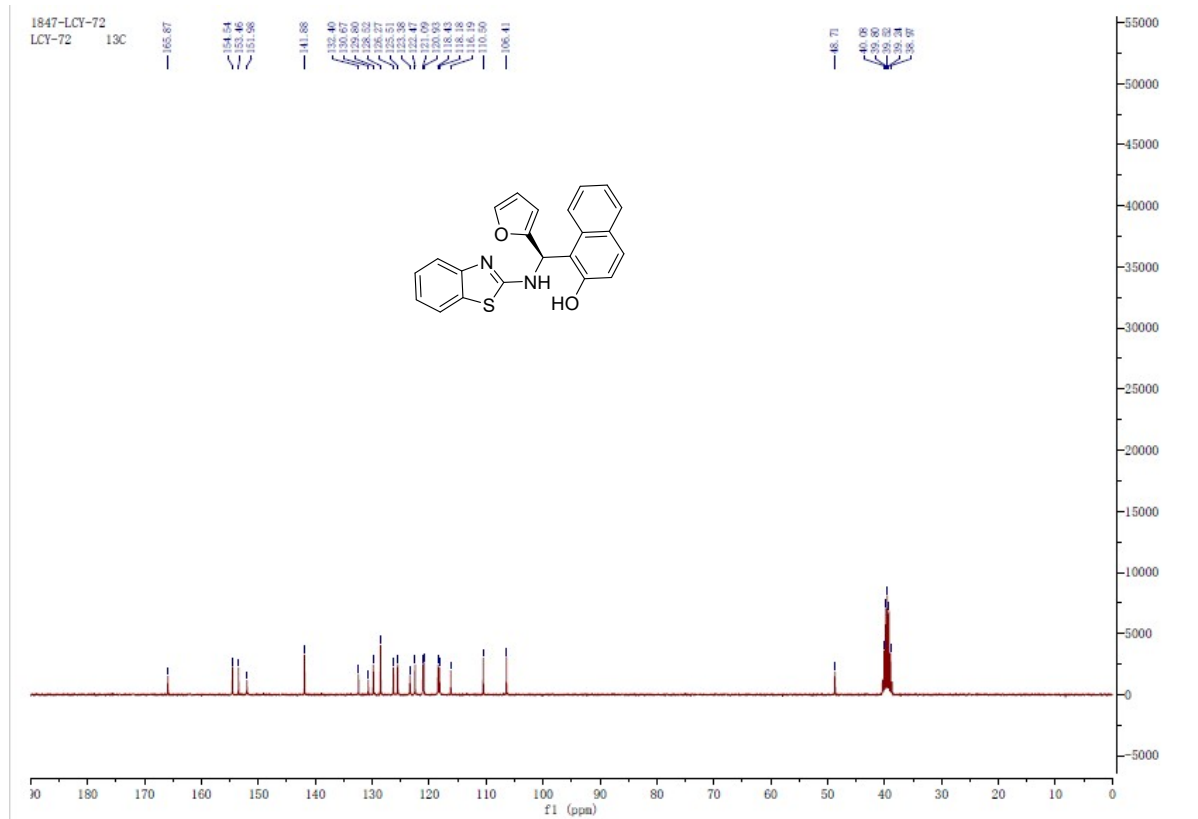
3ka



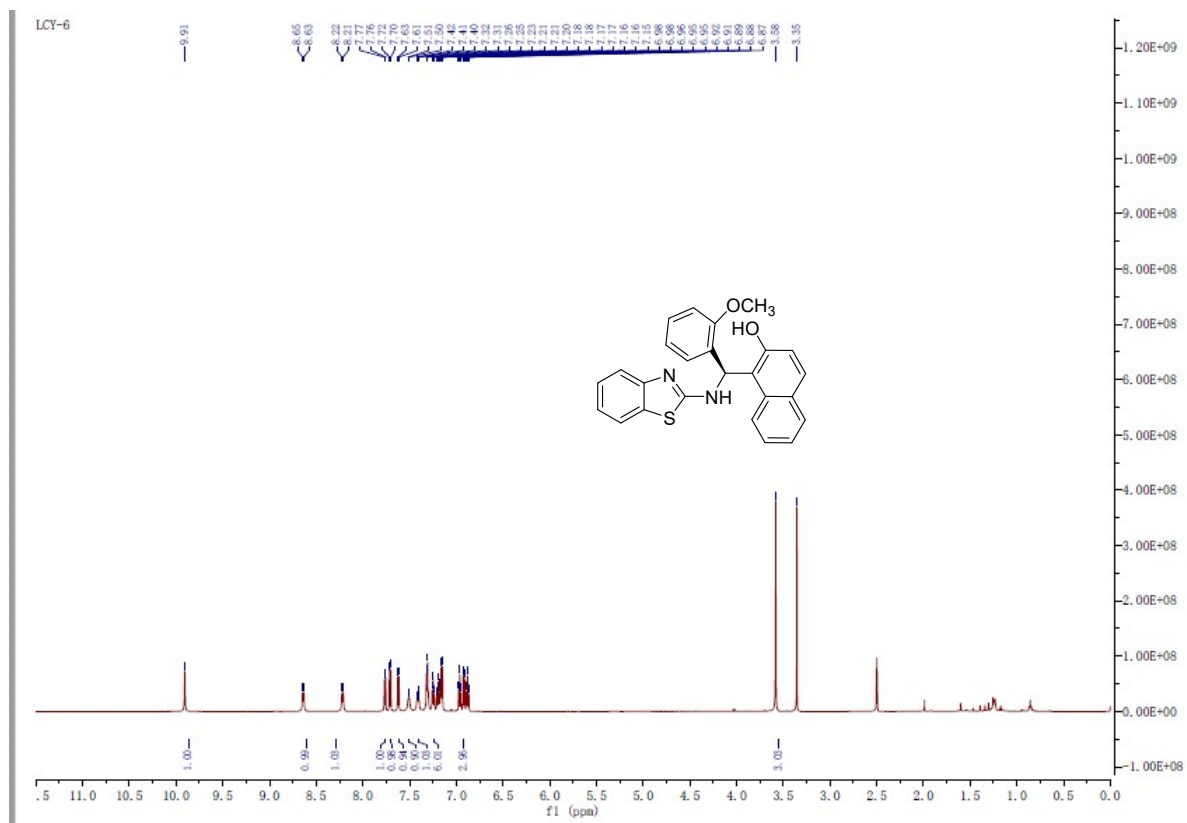


### 3ma

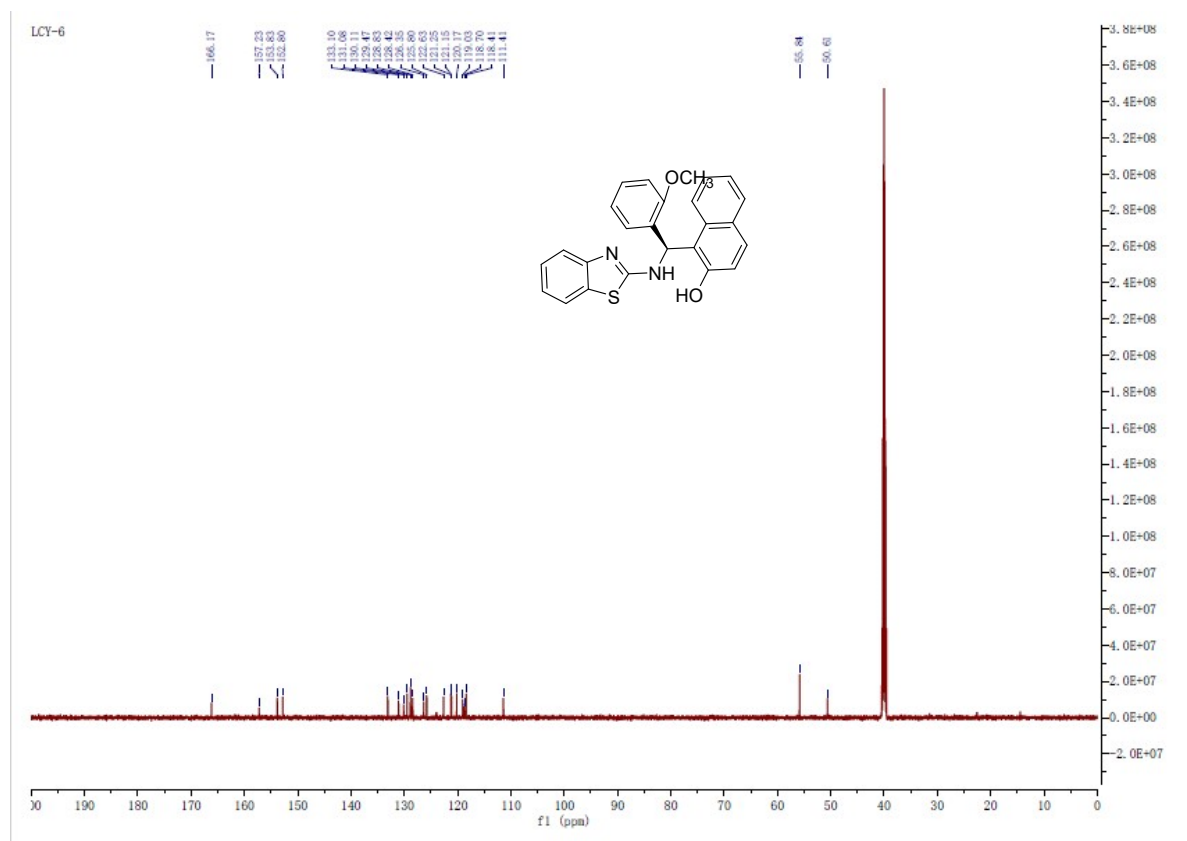




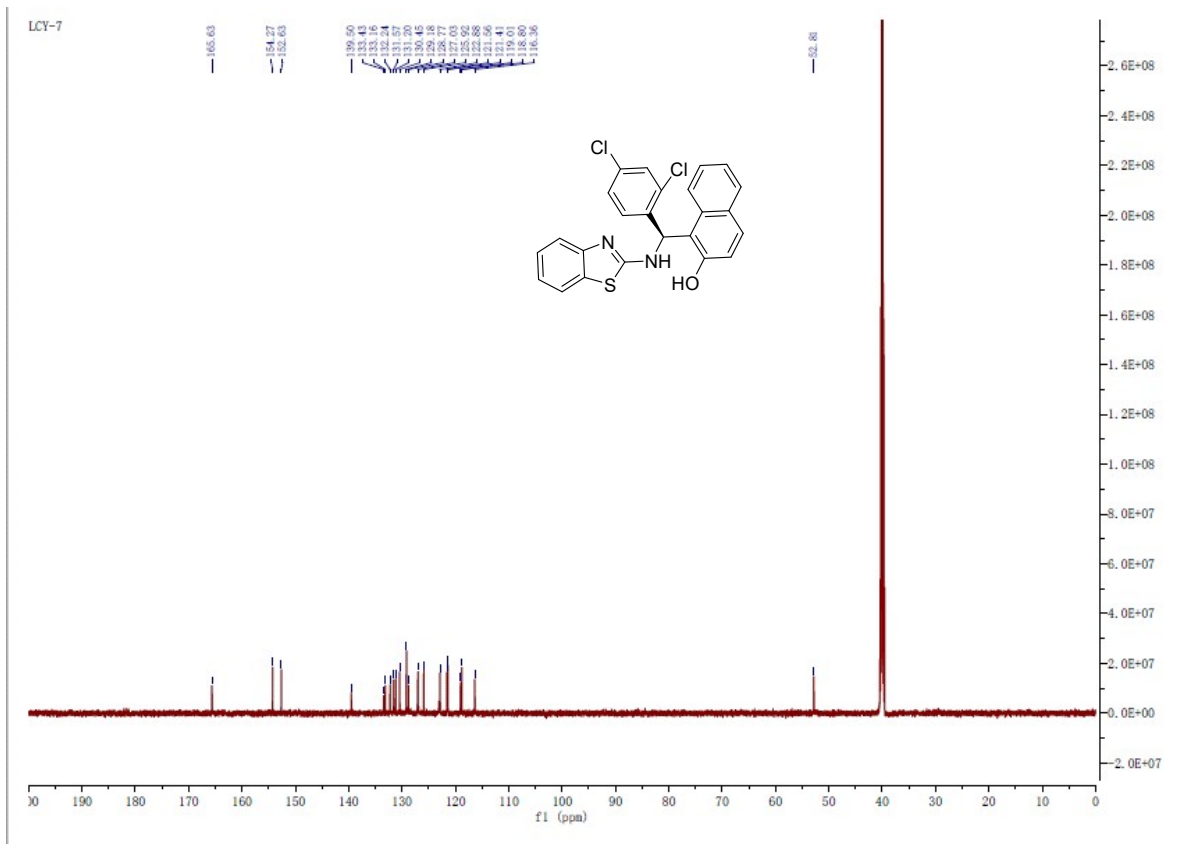
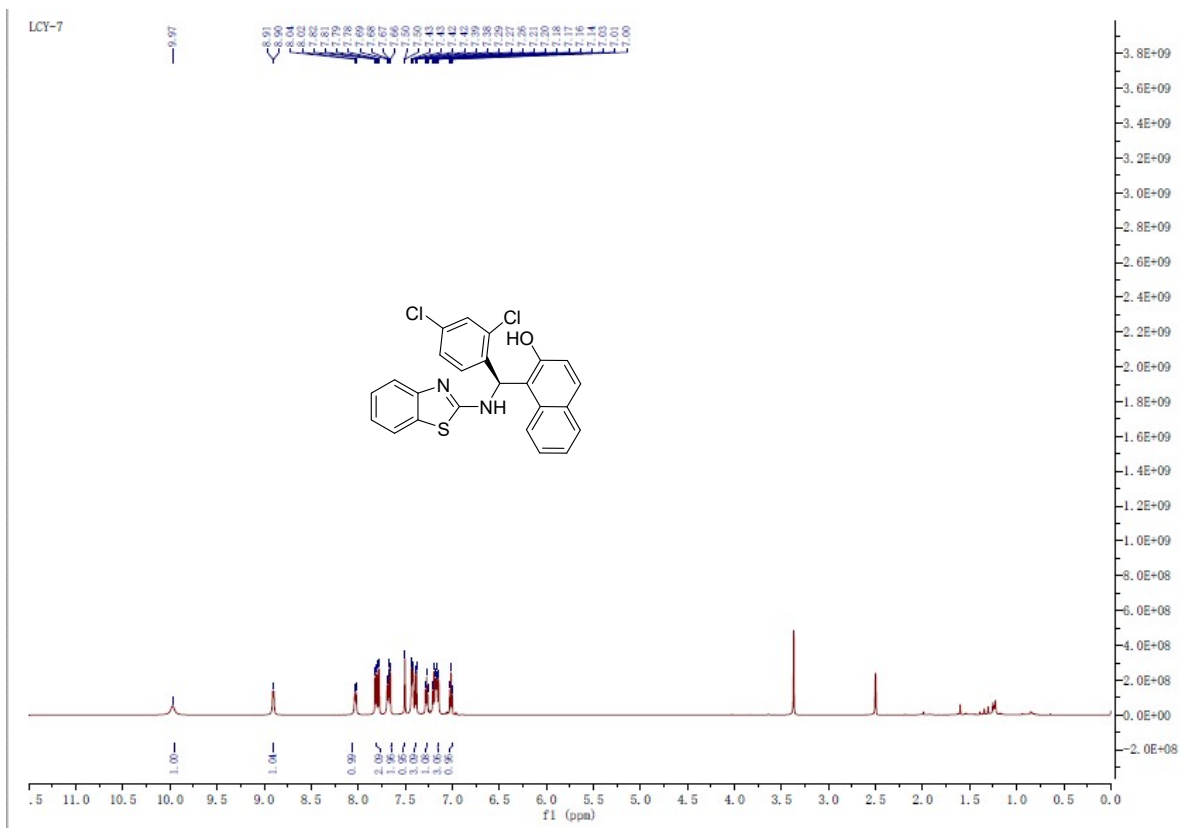
### 3na



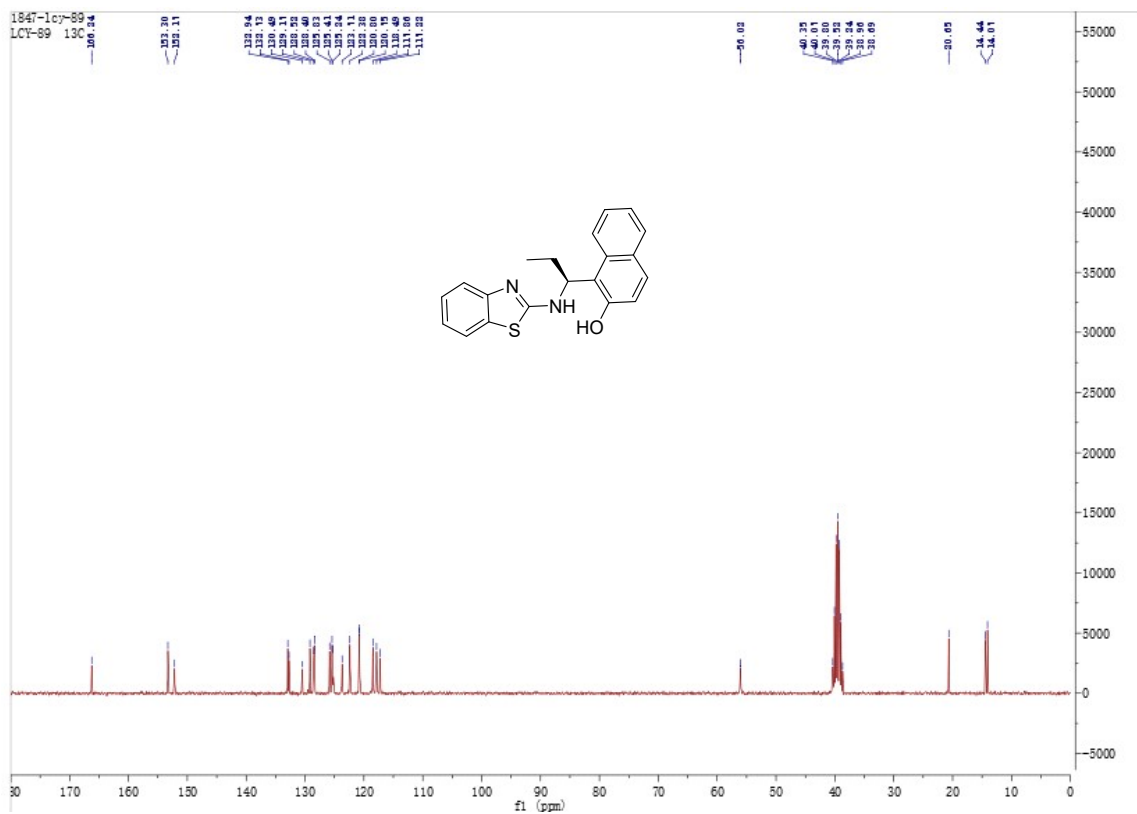
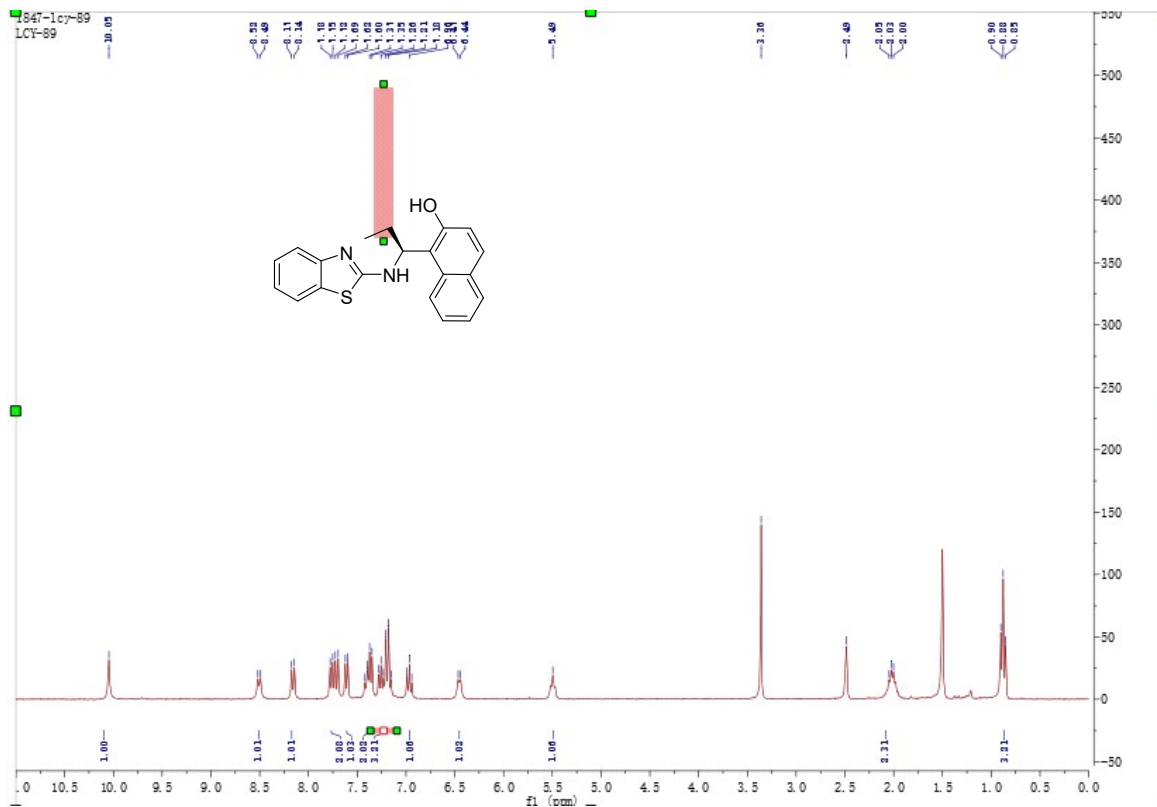




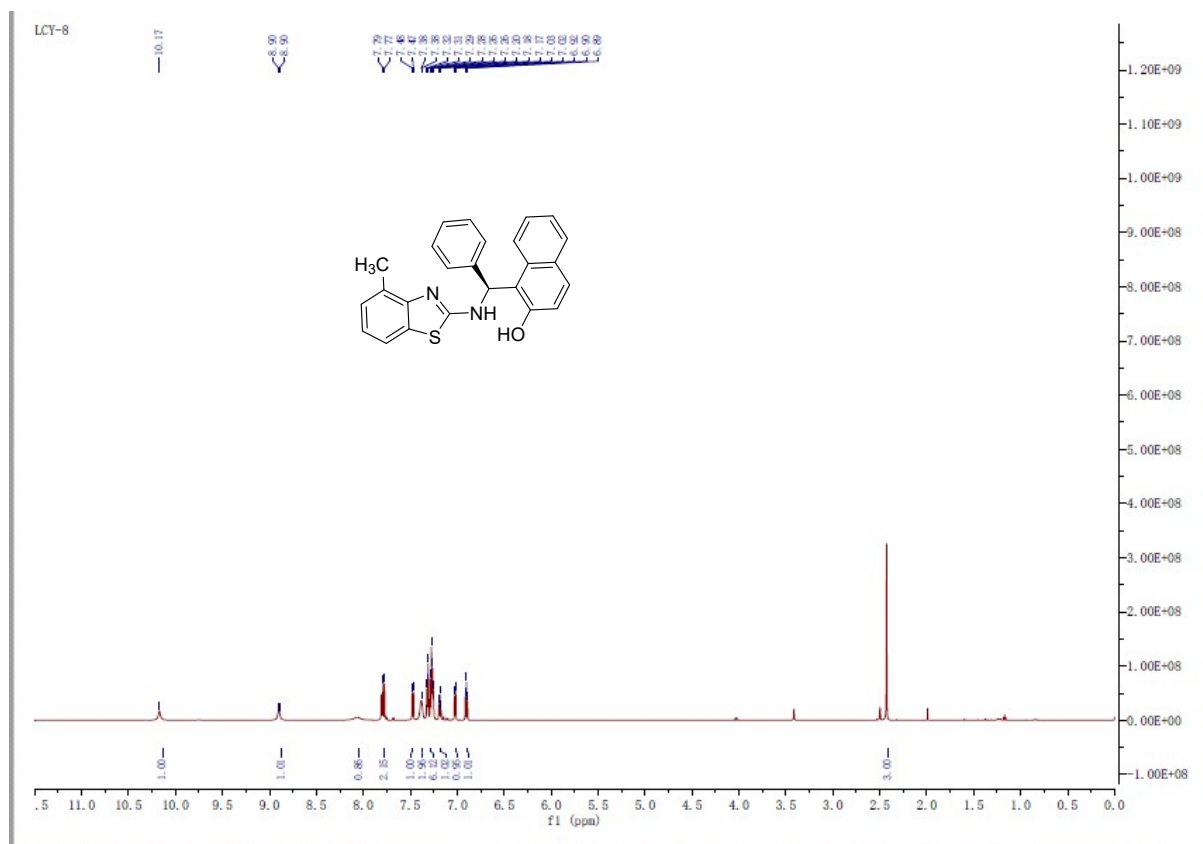
30a

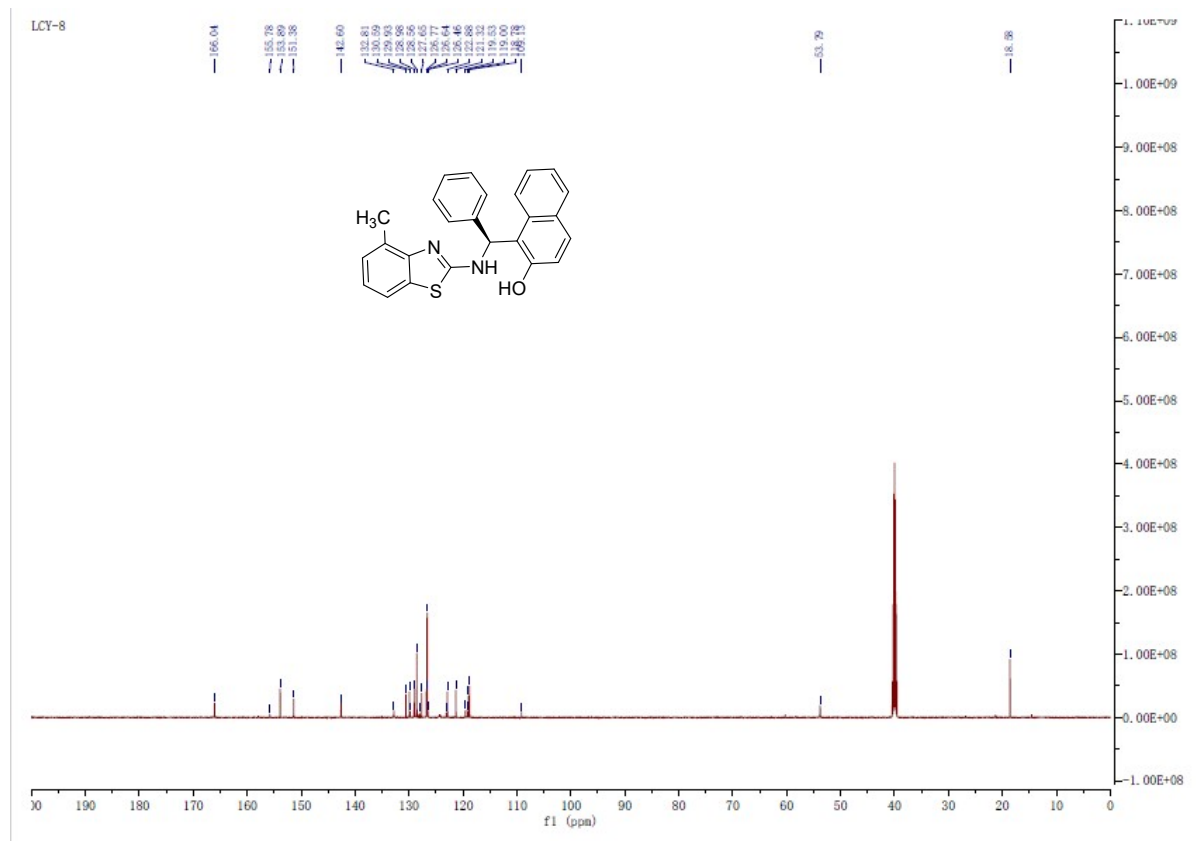


3pa

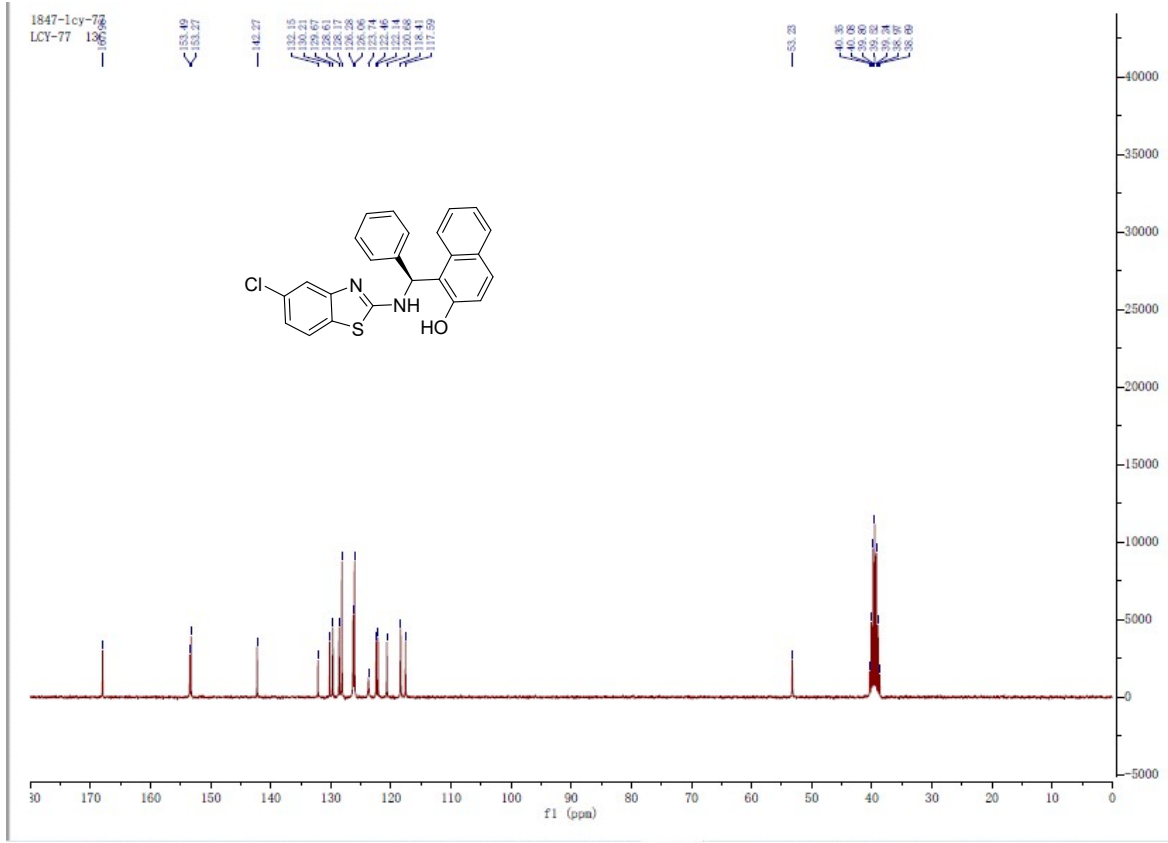
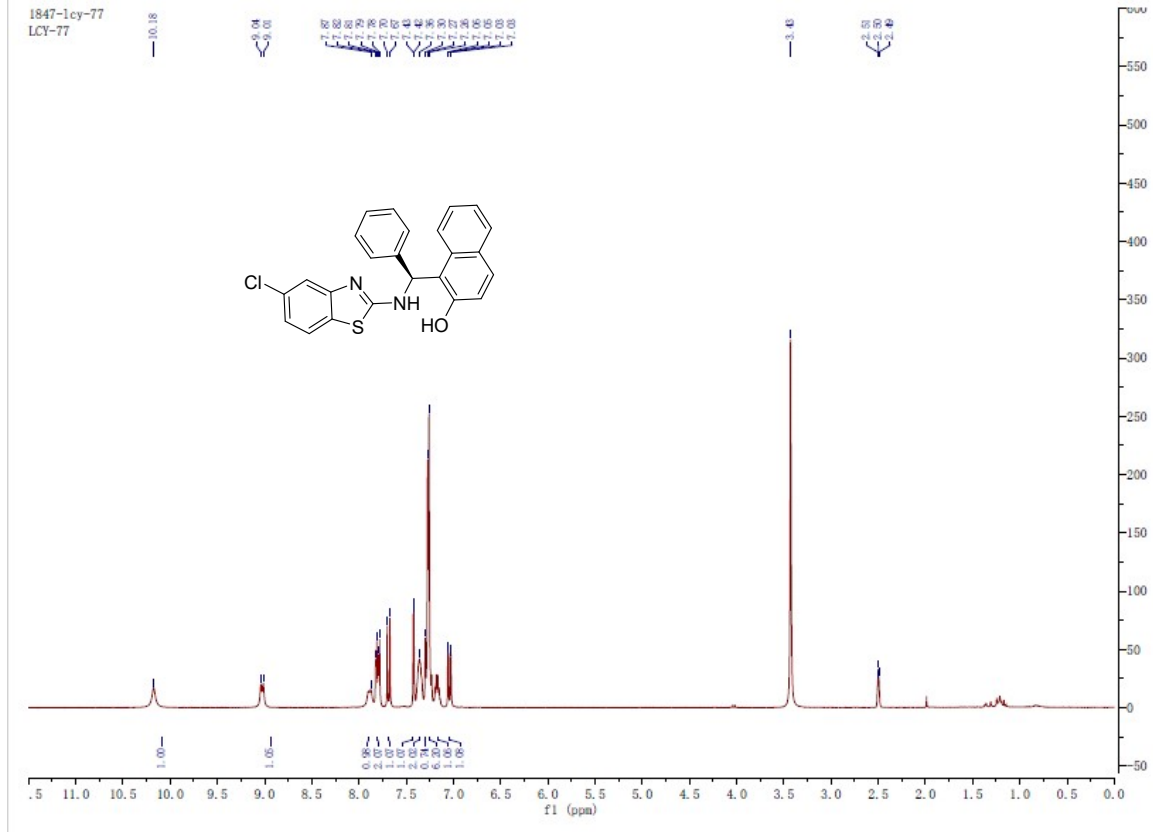


3qa

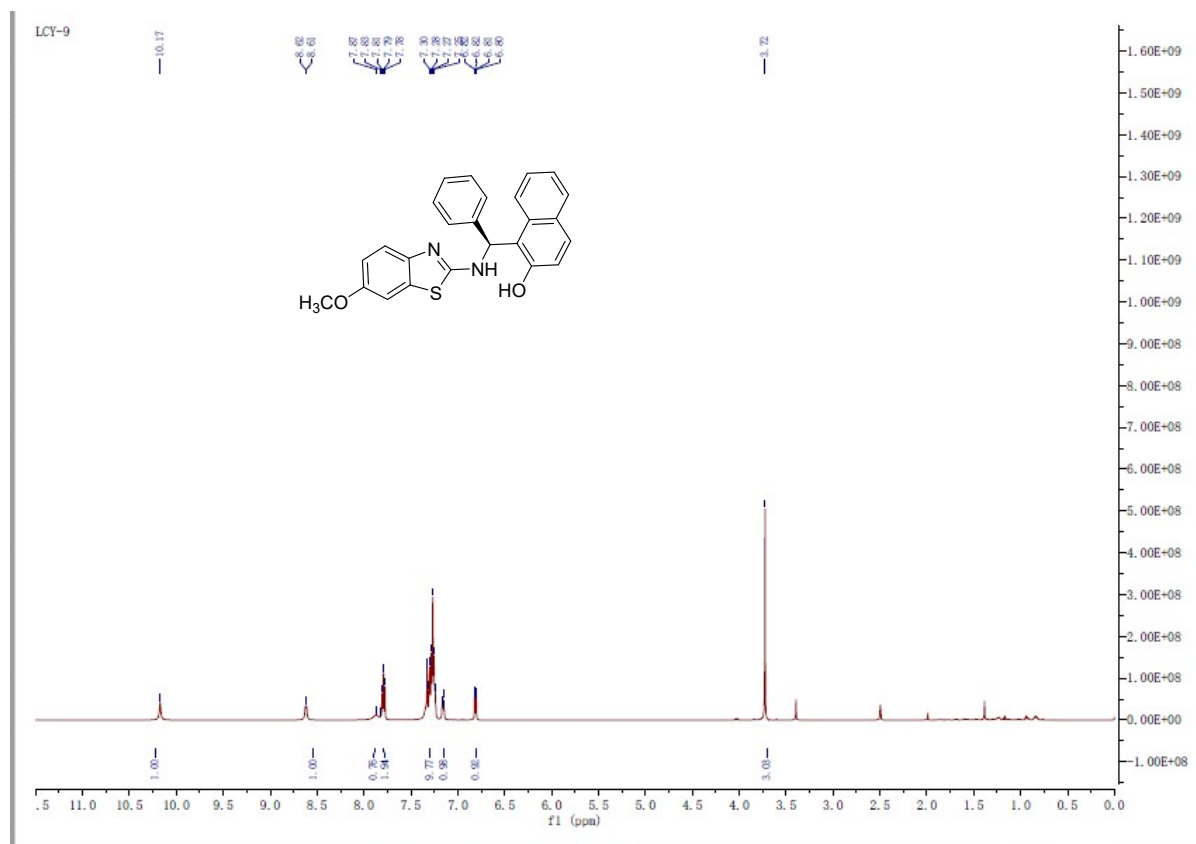


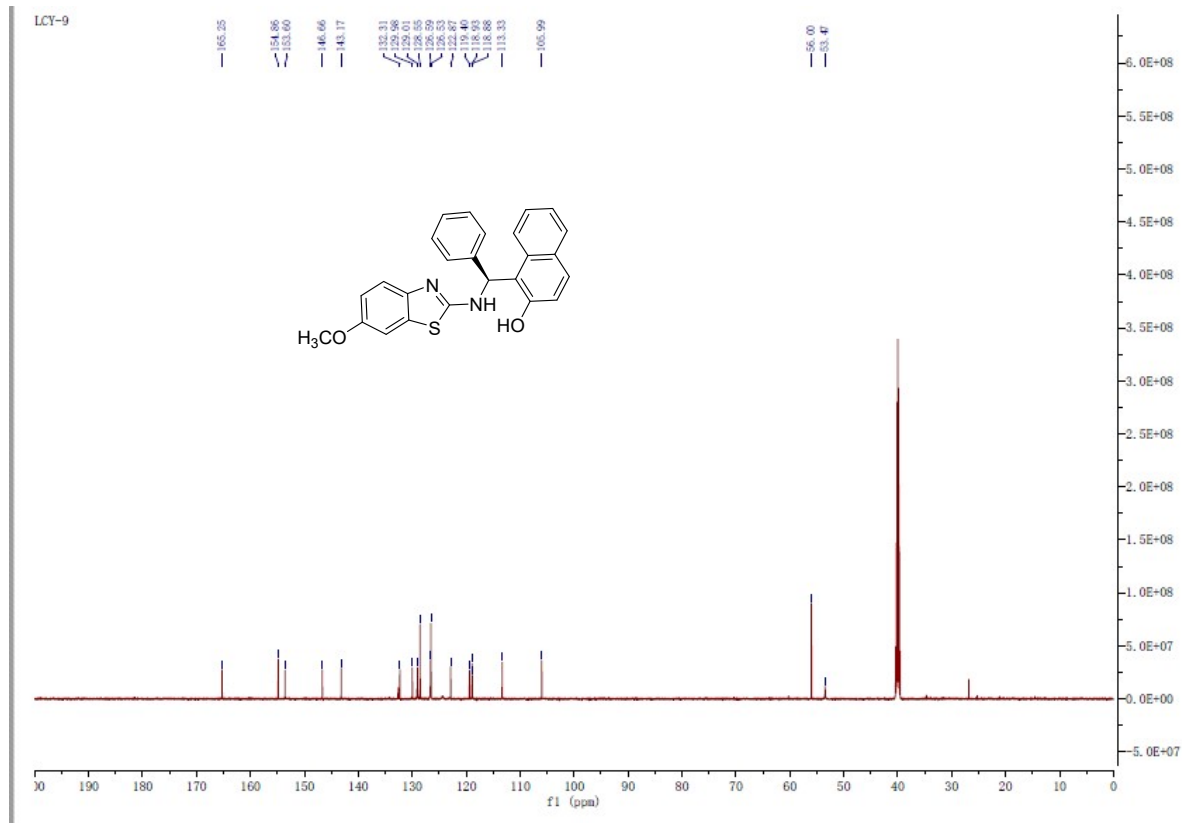


3ra

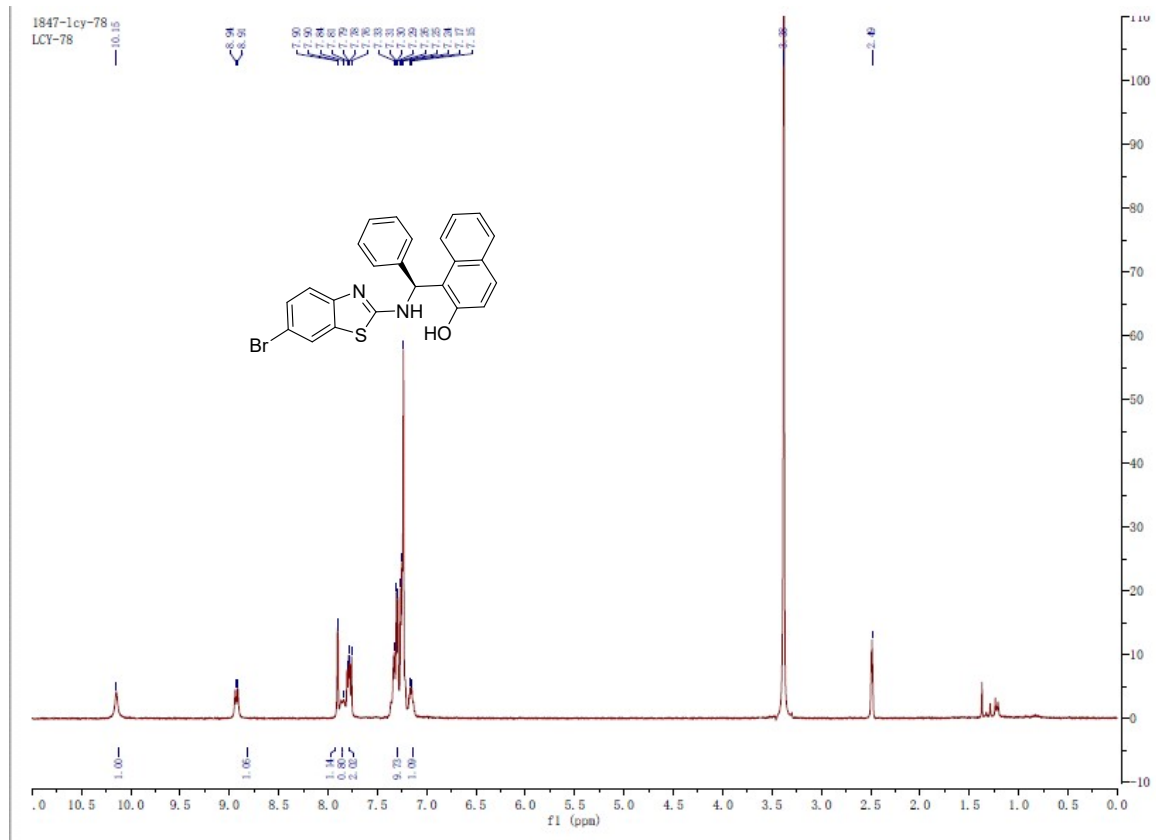


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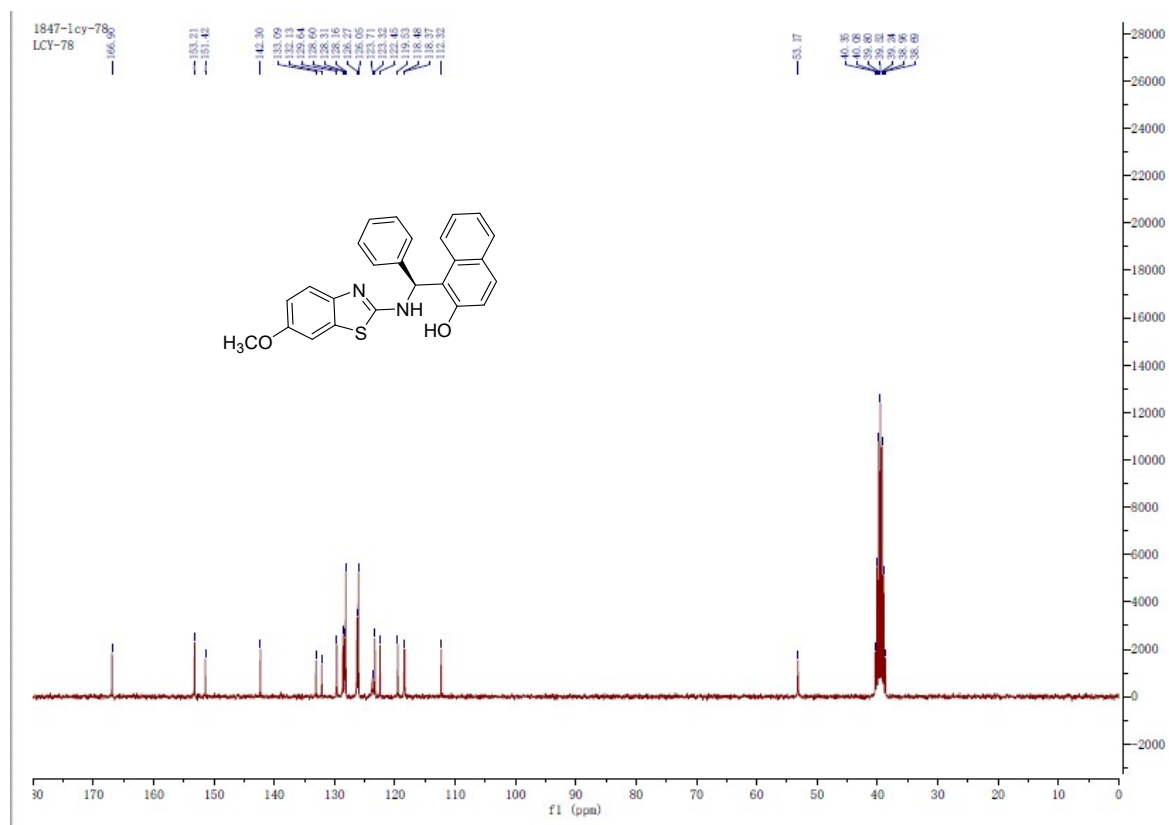




### 3ta







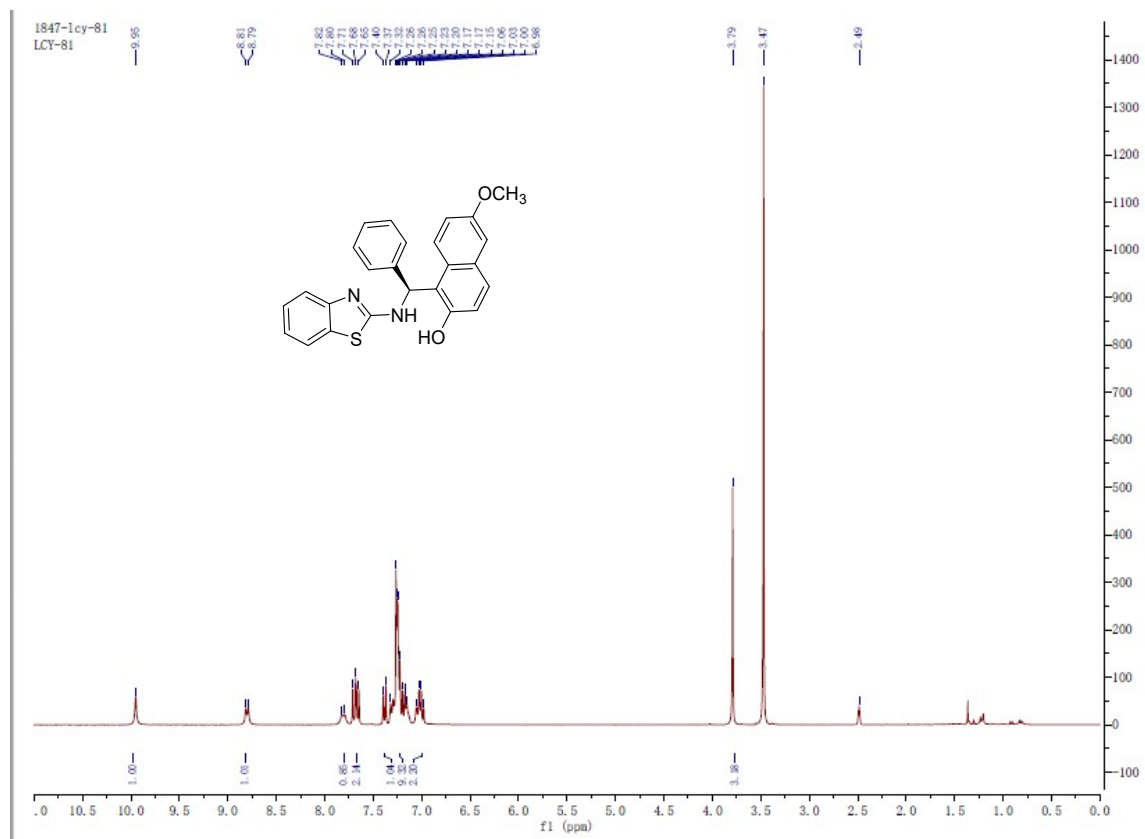
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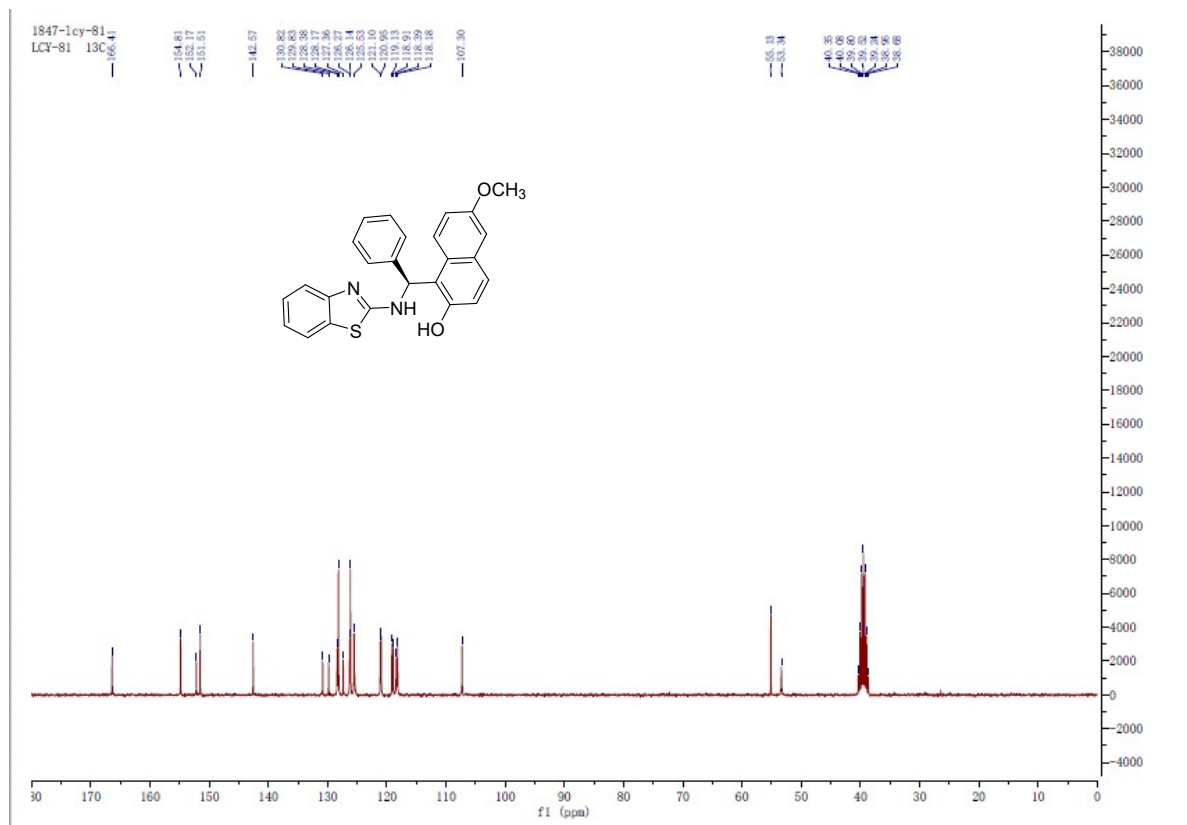




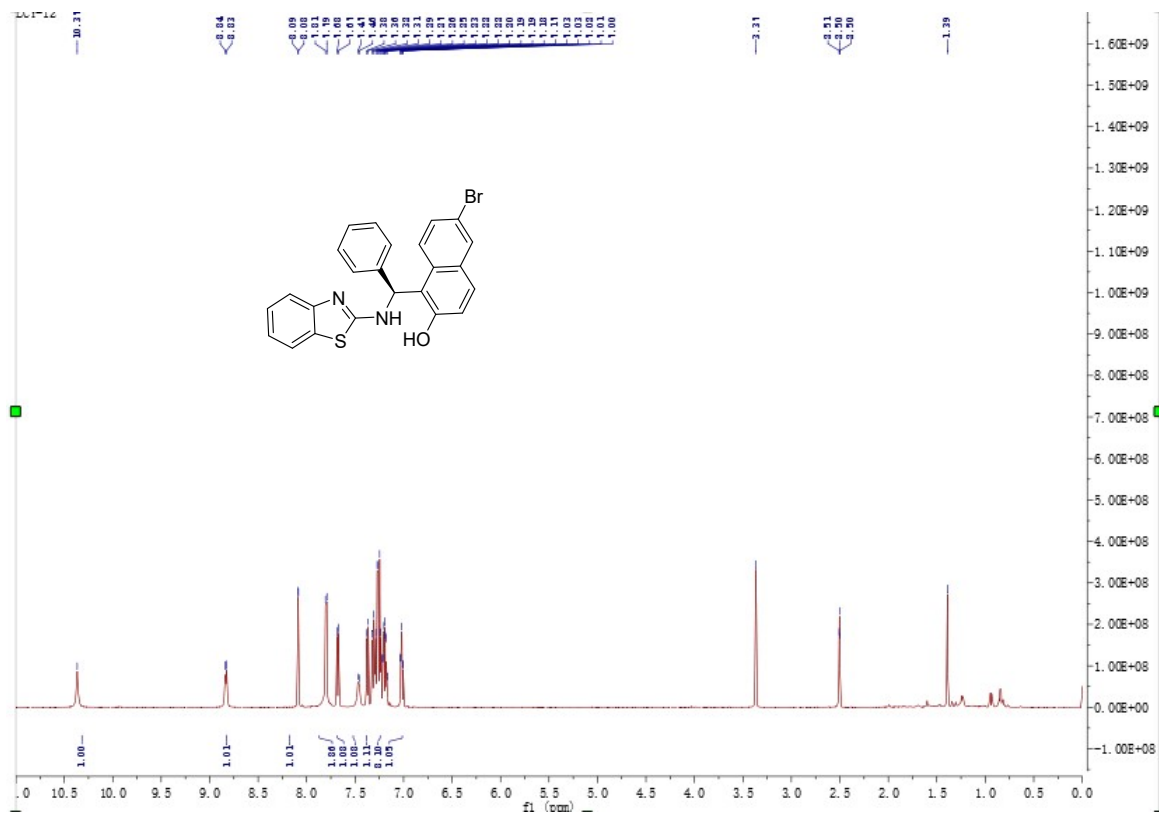


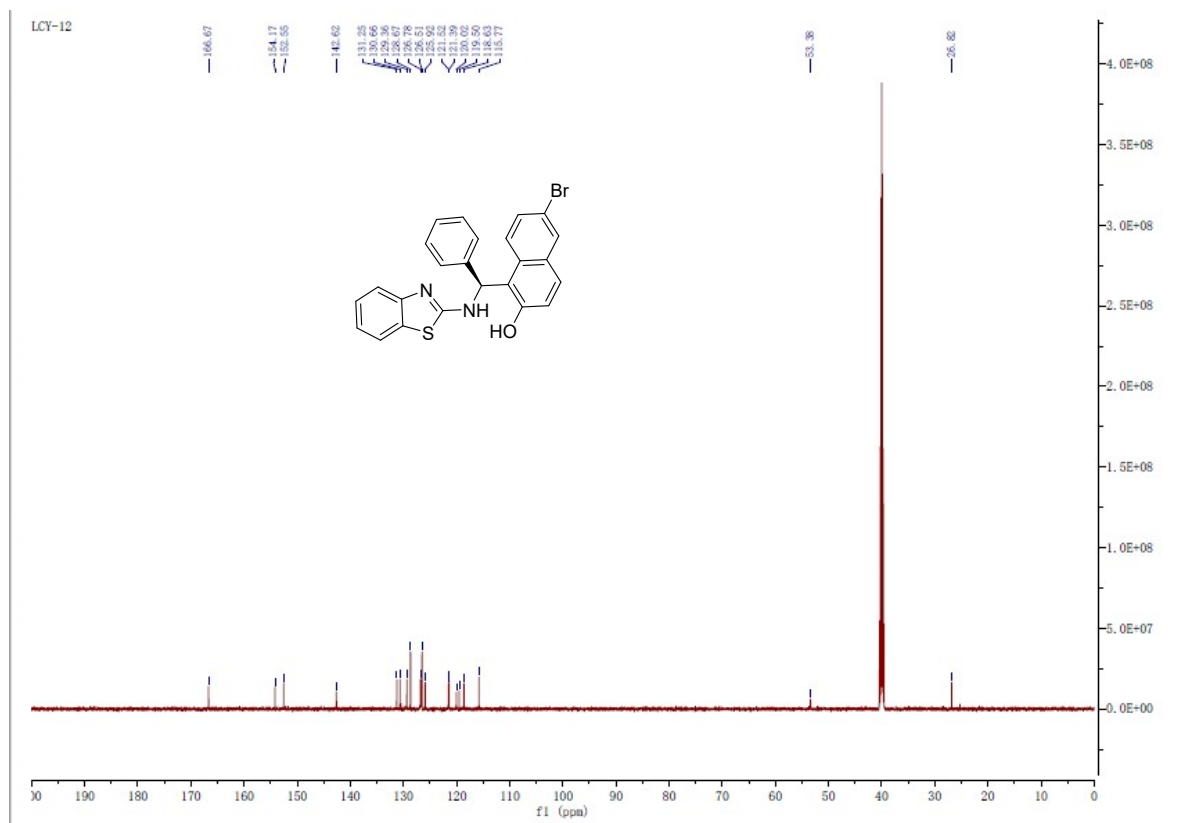
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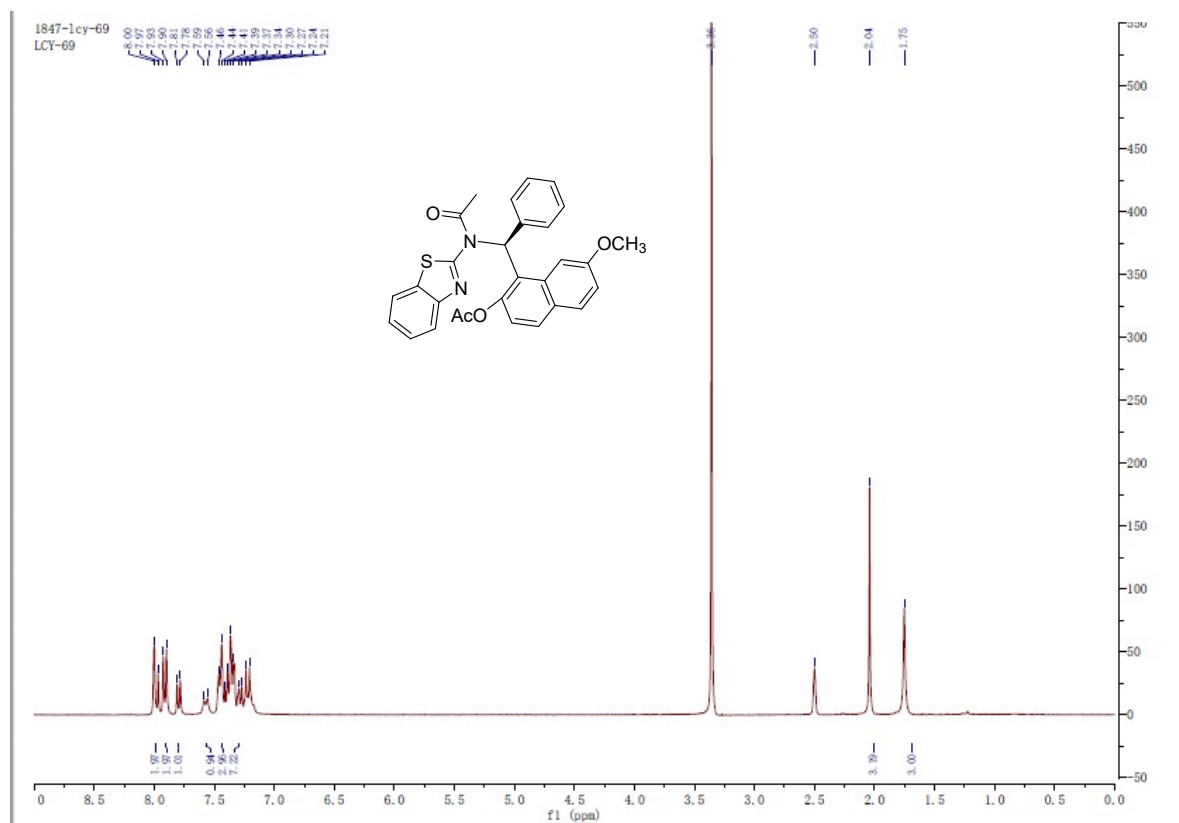


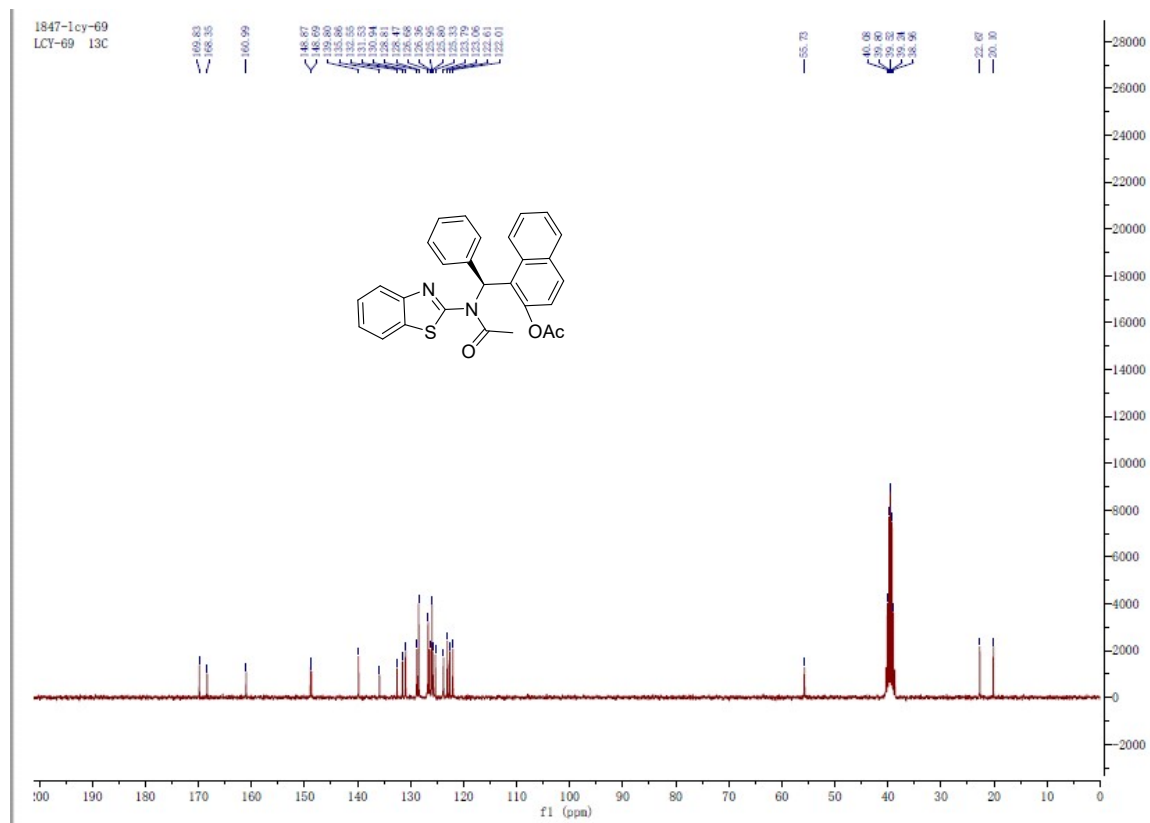
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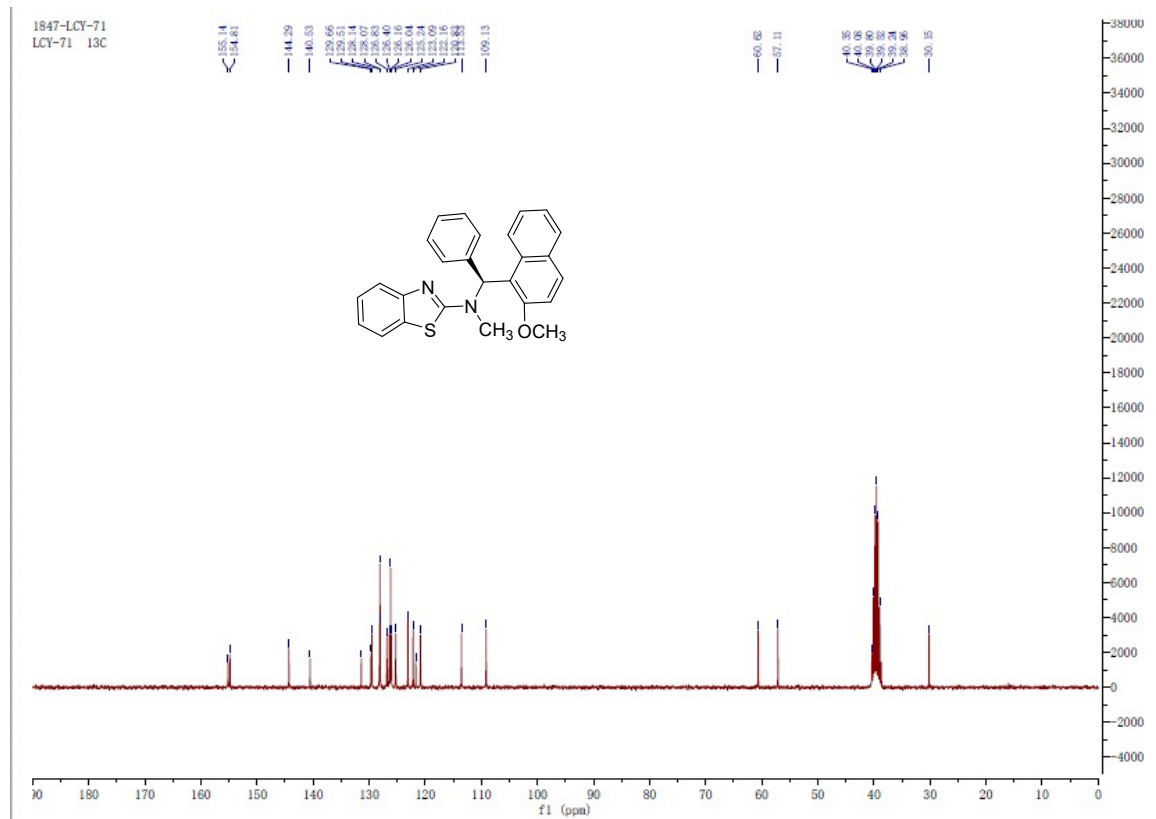
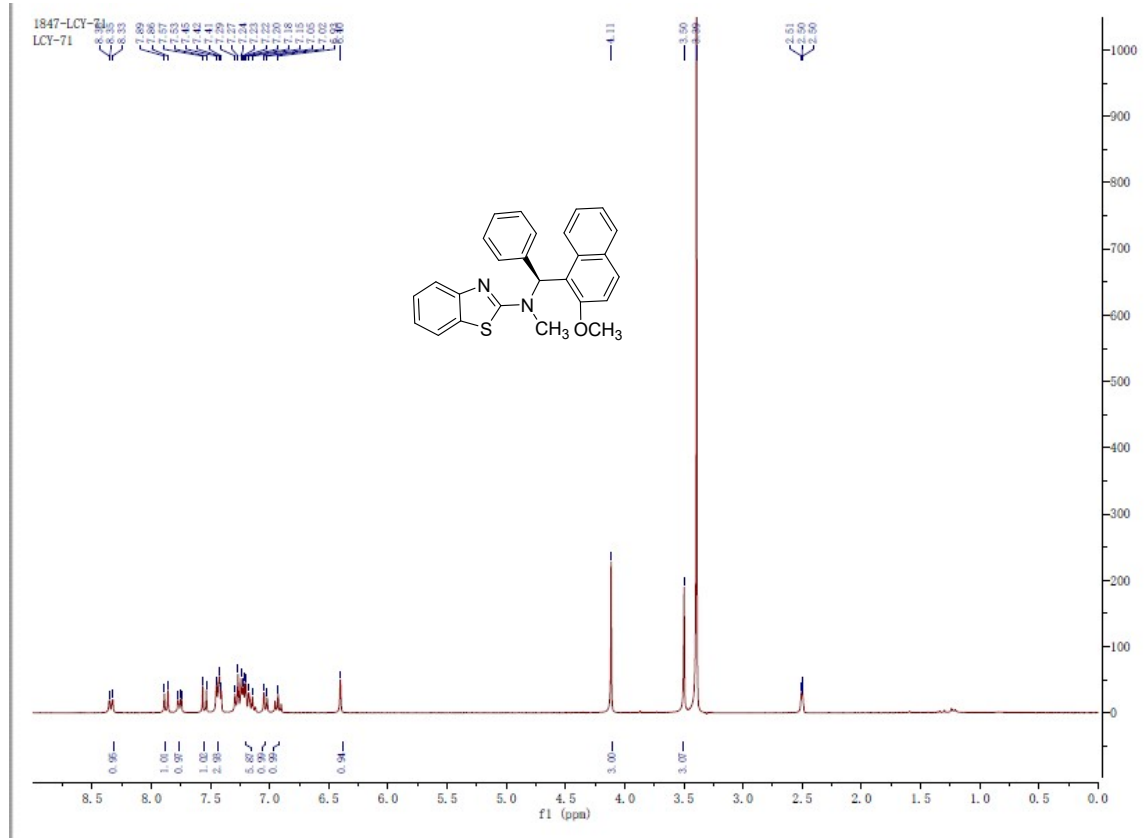
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