

Kinetic Resolution of 2,2-Disubstituted-1,3-Diketones via Carbene Catalysis

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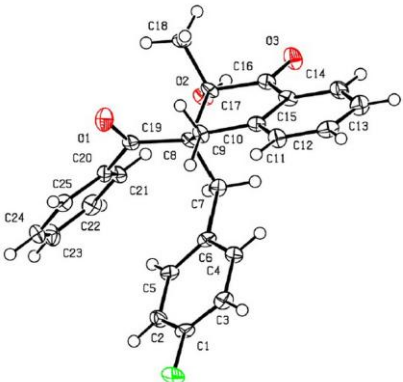
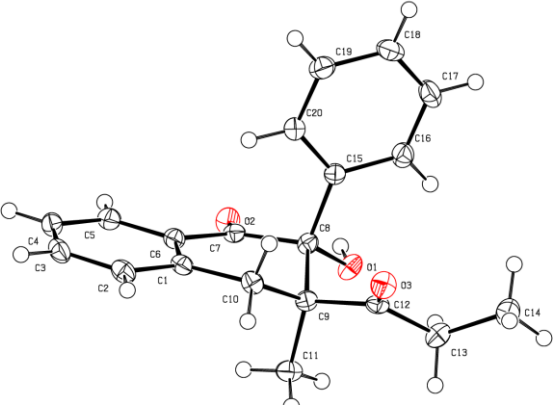
I. General information.

Commercially available materials were used as received, unless otherwise noted, all reactions and manipulations involving air- or moisture-sensitive compounds were performed using standard Schlenk technique. All solvents were purified and dried using standard procedures. Proton nuclear magnetic resonance (¹H NMR) spectra were recorded on a Bruker AVANCE III HD400 (400 MHz) spectrometer. Chemical shifts were recorded in parts per million (ppm, δ) relative to tetramethylsilane (δ = 0.00 ppm) or chloroform (δ = 7.26 ppm). ¹H NMR splitting patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), dd (doublet of doublets); m (multiplet), and etc. All first-order splitting patterns were assigned on the basis of the appearance of the multiplet. Splitting patterns that could not be easily interpreted are designated as multiplet (m) or broad (br). Carbon nuclear magnetic resonance (¹³C NMR) spectra were recorded on a Bruker AVANCE III HD400 (400 MHz) (100 MHz) spectrometer. High resolution mass spectral analysis (HRMS) was performed on Thermo Fisher Scientific LTQ FT Ultra mass spectrometer. The determination of *e.e.* was performed via chiral HPLC analysis using Shimadzu LC-20AD HPLC workstation. X-ray crystallography analysis was performed on Agilent SuperNova X-ray diffractometer. Optical rotations were measured using a 1 mL cell with a 5dm path length on an INESA SGW-1polarimeter and are reported as follows: $[\alpha]_D^{25}$ (c in g per 100 mL solvent). Analytical thin-layer chromatography (TLC) was carried out on WFH-203

F254 pre-coated silica gel plate (0.2 mm thickness). Visualization was performed using a UV lamp or 2,4-dinitrophenylhydrazine or potassium permanganate stain.

II. X-ray crystallographic analysis.

Method for single crystal cultivation: a solid sample of **2g** (30 mg) was dissolved in ethyl acetate (50 μ L) in a vial at room temperature, and petroleum ether (4-6 mL) was added into the above solution slowly while keeping the sample all dissolved. Then the vial was sealed with a piece of parafilm and stayed quietly for several days to allow the slow evaporation of the solvents until a single crystal was obtained. Crystals of **5d** and **8a** were obtained via similar methods.

<i>rac</i>-2g (CCDC 1585556)	34 Y PLATON-Nov 14 07:13:11 2017 - (70316) NOMOVE FORCED Prob = 50 Temp = 100  Z 9 data P 21/c R = 0.09 RES= 0 -40 X
<i>rac</i>-5d (CCDC 1585557)	40 Y PLATON-Nov 14 07:23:28 2017 - (70316) NOMOVE FORCED Prob = 50 Temp = 100  Z -89 2 P -1 R = 0.04 RES= 0 -163 X

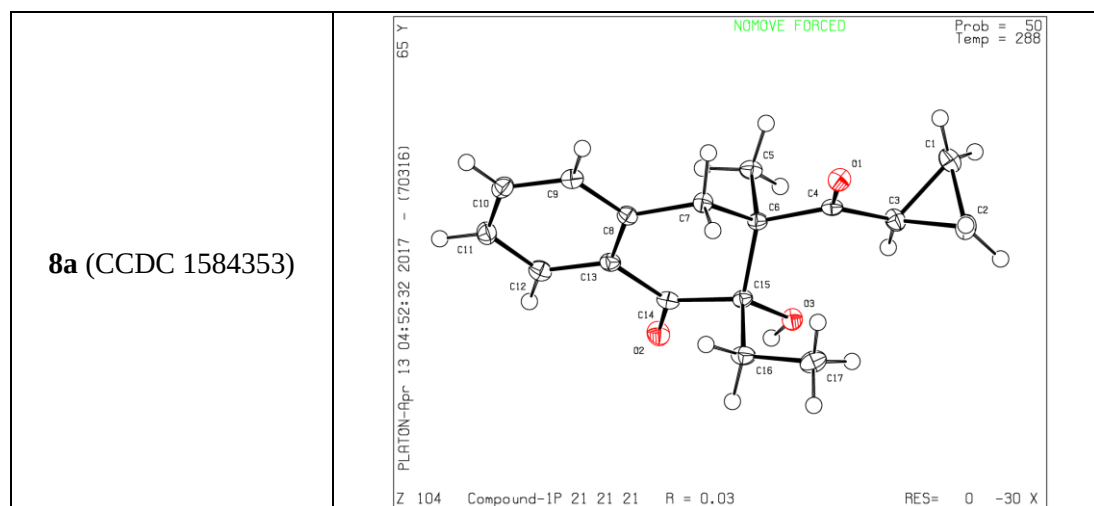


Table S1 Crystal data and structure refinement for 2g (CCDC 1585556)

Identification code	2g		
Empirical formula	C ₂₅ H ₂₁ FO ₃		
Formula weight	388.42		
Temperature (K)	100.0(6)		
Wavelength (Å)	1.54184		
Crystal system	monoclinic		
Space group	P2 ₁ /c		
Unit cell dimensions (Å, °)	a = 9.8733(7)	α =	90
	b = 10.3877(7)	β =	96.893(6)
	c = 37.781(2)	γ =	90
Volume (Å ³)	3846.8(4)		
Z	8		
Calculated density (g cm ⁻³)	1.341		
Absorption coefficient (mm ⁻¹)	0.763		
F ₀₀₀	1632		
Crystal size (mm ³)	0.15 × 0.10 × 0.10		
θ range for data collection (°)	4.417 to 66.581		
Miller index ranges	-11 ≤ h ≤ 11, -12 ≤ k ≤ 12, -44 ≤ l ≤ 30		
Reflections collected	22968		
Independent reflections	6725 [R _{int} = 0.1712]		
Completeness to θ _{max} (%)	0.989		
Max. and min. transmission	0.30077 and 1.00000		
Refinement method	Full-matrix least-squares on F ²		
Data / restraints / parameters	6725 / 30 / 526		
Goodness-of-fit on F ²	1.026		

Final <i>R</i> indices [<i>I</i> > 2σ(<i>I</i>)]	<i>R</i> 1 = 0.0889, <i>wR</i> 2 = 0.1572
<i>R</i> indices (all data)	<i>R</i> 1 = 0.1466, <i>wR</i> 2 = 0.1914
Extinction coefficient	0.00046(10)
Largest diff. peak and hole (e Å ⁻³)	0.362 and -0.507

Table S2 Crystal data and structure refinement for 5d (CCDC 1585557)

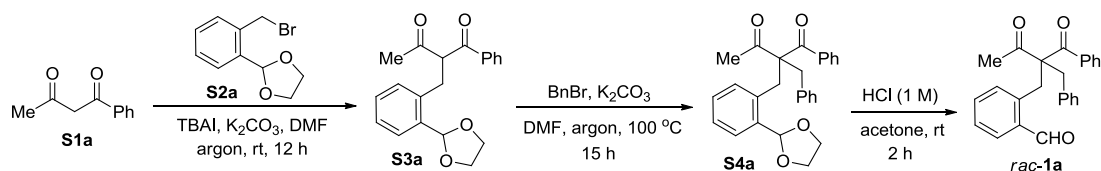
Identification code	5d	
Empirical formula	C ₂₀ H ₂₀ O ₃	
Formula weight	308.36	
Temperature (K)	100.0(1)	
Wavelength (Å)	1.54184	
Crystal system	triclinic	
Space group	<i>P</i> -1	
Unit cell dimensions (Å, °)	<i>a</i> = 8.4310(6)	<i>α</i> = 80.603(4)
	<i>b</i> = 8.6965(5)	<i>β</i> = 87.055(4)
	<i>c</i> = 11.7742(5)	<i>γ</i> = 65.920(6)
Volume (Å ³)	777.47(9)	
<i>Z</i>	2	
Calculated density (g cm ⁻³)	1.317	
Absorption coefficient (mm ⁻¹)	0.701	
<i>F</i> ₀₀₀	328	
Crystal size (mm ³)	0.16 × 0.13 × 0.12	
θ range for data collection (°)	3.806 to 73.290	
Miller index ranges	-10 ≤ <i>h</i> ≤ 10, -10 ≤ <i>k</i> ≤ 9, -14 ≤ <i>l</i> ≤ 9	
Reflections collected	5036	
Independent reflections	3022 [<i>R</i> _{int} = 0.0148]	
Completeness to θ _{max} (%)	0.963	
Max. and min. transmission	0.86741 and 1.00000	
Refinement method	Full-matrix least-squares on <i>F</i> ²	
Data / restraints / parameters	3022 / 0 / 211	
Goodness-of-fit on <i>F</i> ²	1.045	
Final <i>R</i> indices [<i>I</i> > 2σ(<i>I</i>)]	<i>R</i> 1 = 0.0362, <i>wR</i> 2 = 0.0912	
<i>R</i> indices (all data)	<i>R</i> 1 = 0.0425, <i>wR</i> 2 = 0.0961	
Largest diff. peak and hole (e Å ⁻³)	0.290 and -0.205	

Table S3 Crystal data and structure refinement for Data 8a (CCDC 1584353)

Identification code	8a
Empirical formula	C ₁₇ H ₂₀ O ₃
Formula weight	272.33

Temperature/K	288.3(1)
Crystal system	orthorhombic
Space group	P2 ₁ 2 ₁ 2 ₁
a/Å	10.4344(2)
b/Å	11.4942(2)
c/Å	11.5277(2)
$\alpha/^\circ$	90
$\beta/^\circ$	90
$\gamma/^\circ$	90
Volume/Å ³	1382.58(4)
Z	4
$\rho_{\text{calc}}/\text{g}/\text{cm}^3$	1.308
μ/mm^{-1}	0.710
F(000)	584.0
Crystal size/mm ³	0.300 × 0.250 × 0.250
Radiation	CuK α (λ = 1.54184)
2 Θ range for data collection/ $^\circ$	10.87 to 146.694
Index ranges	-8 ≤ h ≤ 12, -13 ≤ k ≤ 12, -13 ≤ l ≤ 14
Reflections collected	6802
Independent reflections	2513 [R_{int} = 0.0227, R_{sigma} = 0.0279]
Data/restraints/parameters	2513/0/184
Goodness-of-fit on F^2	1.062
Final R indexes [$I \geq 2\sigma(I)$]	R_1 = 0.0312, wR_2 = 0.0783
Final R indexes [all data]	R_1 = 0.0333, wR_2 = 0.0804
Largest diff. peak/hole / e Å ⁻³	0.25/-0.18
Flack parameter	-0.03(9)

III. 1. Typical procedures for the preparation of substrates.

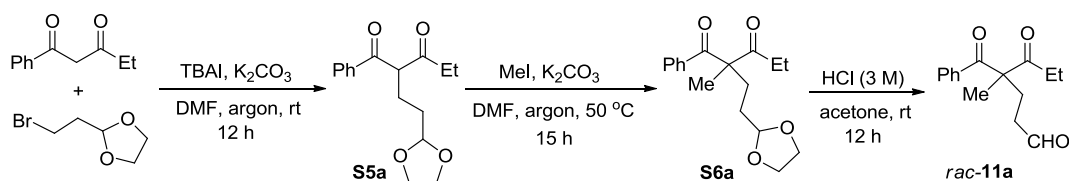


Tetrabutylammonium iodide (369.4 mg, 1.0 mmol) and potassium carbonate (1.38 g, 10.0 mmol) were dissolved in DMF (50 mL) at room temperature under argon atmosphere. 2-(2-(Bromomethyl)phenyl)-1,3-dioxolane **S2a** (1.22 g, 5.0 mmol) and 1-phenylbutane-1,3-dione **S1a** (811.0 mg, 5.0 mmol) were added separately into the suspension at room temperature. After stirring for 12 h, the reaction was quenched

with water, and then extracted between water and CH₂Cl₂ for three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give product **S3a** (843.4 mg, 52% yield).

Potassium carbonate (829.2 mg, 6.0 mmol) was dissolved in DMF (40 mL) at room temperature under argon atmosphere. **S3a** (973.1 mg, 3.0 mmol) and BnBr (1.03 g, 6.0 mmol) were added separately into the suspension at 100 °C. After stirring for 15 h, the reaction was quenched with water, and then extracted between water and CH₂Cl₂ three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give product **S4a** (485.0 mg, 39% yield).

To the solution of **S4a** (414.5 mg, 1.0 mmol) in acetone (5 mL) was added 1 M HCl (5 mL, 5.0 mmol) at room temperature. The reaction was stirred until no **S4a** remained. The reaction was then stopped, extracted between water and CH₂Cl₂ for three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give product *rac*-**1a** (359.3 mg, 97% yield).



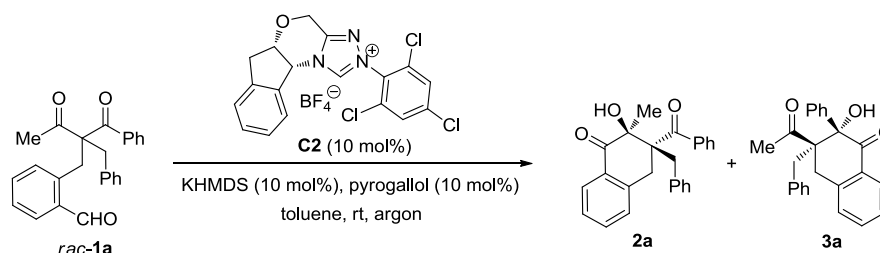
Tetrabutylammonium iodide (369.4 mg, 1.0 mmol) and potassium carbonate (1.38 g, 10.0 mmol) were dissolved in DMF (50 mL) at room temperature under argon atmosphere. 2-(2-Bromoethyl)-1,3-dioxolane (905.2 mg, 5.0 mmol) and 1-phenylpentane-1,3-dione (881.1 mg, 5.0 mmol) were added separately into the suspension at room temperature. After stirring for 12 h, the reaction was quenched with water, and then extracted between water and CH₂Cl₂ for three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give the product **S5a** (1.12 g, 81% yield).

Potassium carbonate (829.2 mg, 6.0 mmol) was dissolved in DMF (40 mL) at room temperature under argon atmosphere. **S5a** (829.0 mg, 3.0 mmol) and MeI (851.64 mg, 6.0 mmol) were added separately into the suspension at 50 °C. After stirring for 15 h, the reaction was quenched with water, and then extracted between water and CH₂Cl₂ for three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give the product **S6a** (557.5 mg, 64% yield).

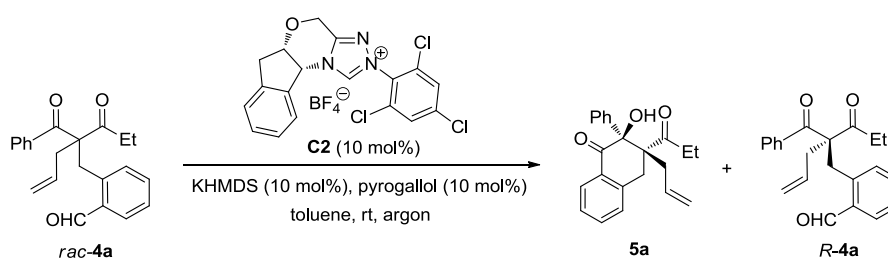
To a solution of **S6a** (290.4 mg, 1.0 mmol) in acetone (5 mL) was added 3 M HCl (13.3 mL, 40.0 mmol) at room temperature. The reaction suspension was monitored through crude NMR until no **S6a** remained. The reaction was then stopped, extracted between water and CH₂Cl₂ for three times. The organic layers were combined, dried and concentrated under reduced pressure. The residue was purified by flash

chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to give the product *rac-11a* (221.5 mg, 90% yield).

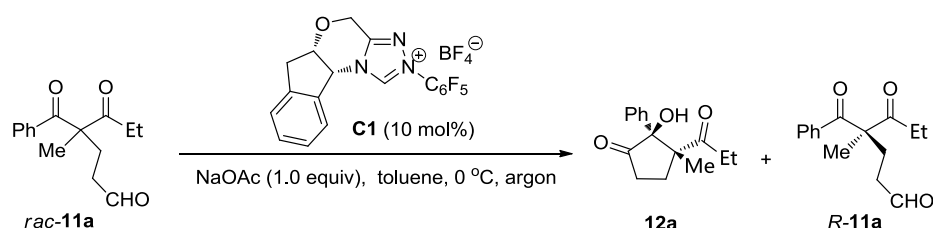
2. Typical procedures for the resolution of 1,3-diketones.



Catalyst **C2** (9.6 mg, 0.02 mmol) and pyrogallol (2.5 mg, 0.02 mmol) were added to toluene (2 mL) at room temperature under argon atmosphere, followed by an injection of KHMDS (0.5 M in toluene, 40 μ L, 0.02 mmol). After 10 min, a solution of *rac-1a* (64.0 mg, 0.2 mmol) in toluene (2 mL) was added into the reaction suspension at room temperature via syringe. And then the reaction system was stirred at room temperature for 3 h. Then the solvent was removed under reduced pressure and the residue was purified by flash chromatography with petroleum ether/ethyl acetate (v:v = 40:1 ~ 20:1) as eluent to afford the products **2a** (37.8 mg, 51% yield) and **3a** (34.1 mg, 46% yield). The corresponding *rac-2a* and *rac-3a* were synthesized using *rac-C2* catalyst.

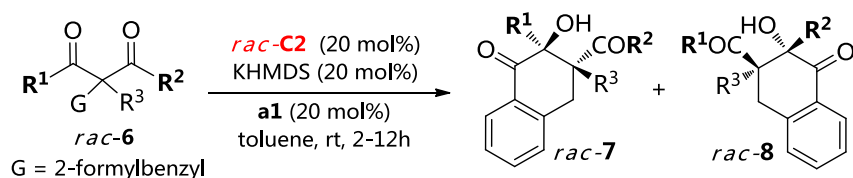


Catalyst **C2** (9.6 mg, 0.02 mmol) and pyrogallol (2.5 mg, 0.02 mmol) were added to toluene (2 mL) at room temperature under argon atmosphere, followed by an injection of KHMDS (0.5 M in toluene, 40 μ L, 0.02 mmol). After 10 min, a solution of *rac-4a* (66.9 mg, 0.2 mmol) in toluene (2 mL) was added into the reaction suspension at room temperature via syringe. And then the reaction system was stirred at room temperature for 3 h. Then the solvent was removed under reduced pressure and the residue was purified by flash chromatography with petroleum ether/ethyl acetate (v:v = 20:1) as eluent to afford the products **5a** (37.4 mg, 56% yield) and *R-4a* (27.4 mg, 41% yield). The corresponding *rac-5a* was synthesized using *rac-C2* catalyst.



Catalyst **C1** (9.3 mg, 0.02 mmol) and NaOAc (16.4 mg, 0.2 mmol) were added to toluene (2 mL) at room temperature under argon atmosphere. After 10 min, a solution of *rac*-**11a** (49.3 mg, 1 mmol) in toluene (2 mL) was added into the reaction suspension at room temperature via syringe. And then the reaction system was stirred at 0 °C for 4 h. Then the solvent was removed under reduced pressure and the residue was purified by flash chromatography with petroleum ether/tetrahydrofuran (v:v = 20:1) as eluent to afford the product **12a** (25.6 mg, 52% yield) and recovered substrate *R*-**11a** (19.7 mg, 40% yield). The corresponding *rac*-**12a** was synthesized using *rac*-**C1** catalyst.

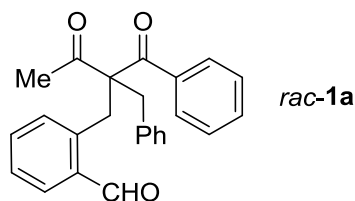
3. Results using racemic catalyst^a



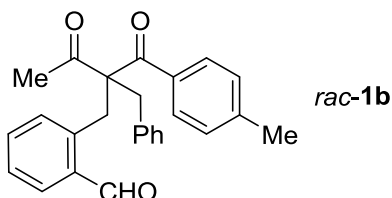
entry	R ¹ /R ² /R ³ (<i>rac</i> - 6)	total yield (%)	<i>rac</i> - 7 : <i>rac</i> - 8
1	cyclopropyl/Et/Me (6a)	98	8.3:1
2	cyclopropyl/Et/allyl (6b)	98	1.7:1
3	cyclopropyl/Et/Bn (6c)	97	2.9:1
4	cyclopropyl/ ⁿ Pr/allyl (6d)	94	2.8:1
5	Bn/cyclopropyl/allyl (6e)	96	1.1:1
6	Bn/cyclopropyl/Bn (6f)	95	1.3:1
7	Et/ ⁿ Pr/allyl (6g)	99	1.1:1
8	Bn/Et/allyl (6h)	97	1.6:1
9	Bn/ ^m Pr/allyl (6i)	96	1.8:1
10	cyclopropyl/cyclobutyl/allyl (6j)	96	1.3:1
11	Me/-(CH ₂) ₄ - (6k)	94	3.0:1
12	4-ClC ₆ H ₄ /4-OMeC ₆ H ₄ /allyl (6l)	97	2.5:1
13	4-MeC ₆ H ₄ /3-MeC ₆ H ₄ /allyl (6m)	92	1.1:1

^aAll reactions were run on a 0.2 mmol scale; all yields were of isolated products; the ratios of **7**:**8** were determined via ¹H NMR analysis of the reaction mixtures.

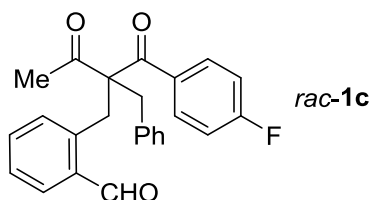
IV. Characterizations of new compounds.



2-(2-benzoyl-2-benzyl-3-oxobutyl)benzaldehyde (*rac-1a*): Yellow oil, 359.3 mg, 97% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.00 (s, 1H), 7.71 (d, $J = 7.7$ Hz, 3H), 7.49 (t, $J = 7.3$ Hz, 1H), 7.43–7.28 (m, 5H), 7.18–7.17 (m, 3H), 6.97–6.95 (m, 2H), 3.99 (d, $J = 14.8$ Hz, 1H), 3.81 (d, $J = 14.8$ Hz, 1H), 3.54 (d, $J = 14.4$ Hz, 1H), 3.43 (d, $J = 14.5$ Hz, 1H), 1.85 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 198.4, 191.9, 139.1, 136.4, 135.9, 135.2, 133.4, 133.2, 132.2, 131.9, 130.4, 129.2, 128.8, 128.4, 127.4, 127.1, 70.5, 40.7, 34.1, 30.1; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{22}\text{O}_3\text{H}^+$ 371.1642, found 371.1642; IR (KBr thin film, cm^{-1}): ν 2926, 2856, 1697, 1672, 1598, 1577, 1496, 1449, 1358, 1231, 1207, 1184, 1164, 934, 756, 701, 661.

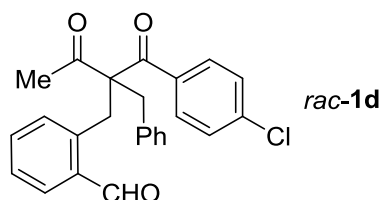


2-(2-benzyl-2-(4-methylbenzoyl)-3-oxobutyl)benzaldehyde (*rac-1b*): Yellow oil, 361.1 mg, 94% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.01 (s, 1H), 7.71 (d, $J = 6.9$ Hz, 1H), 7.64 (d, $J = 7.4$ Hz, 2H), 7.39–7.28 (m, 3H), 7.15 (s, 5H), 6.96 (s, 2H), 3.99 (d, $J = 14.7$ Hz, 1H), 3.78 (d, $J = 14.8$ Hz, 1H), 3.53 (d, $J = 14.4$ Hz, 1H), 3.41 (d, $J = 14.4$ Hz, 1H), 2.34 (s, 3H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 197.6, 191.7, 144.0, 139.1, 135.9, 135.1, 133.6, 133.2, 131.9, 131.5, 130.2, 129.3, 129.2, 128.2, 127.2, 126.9, 70.2, 40.1, 33.9, 30.0, 21.5; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; IR (KBr thin film, cm^{-1}): ν 2925, 2865, 1697, 1669, 1605, 1573, 1495, 1454, 1357, 1234, 1209, 1182, 758, 737, 703.

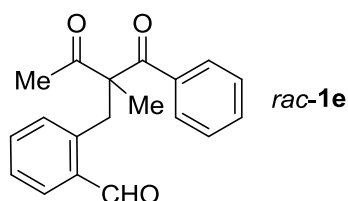


2-(2-benzyl-2-(4-fluorobenzoyl)-3-oxobutyl)benzaldehyde (*rac-1c*): Yellow oil, 368.8 mg, 95% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.98 (s, 1H), 7.73–7.69 (m, 3H), 7.42 (t, $J = 7.5$ Hz, 1H), 7.36–7.28 (m, 2H), 7.18 (t, $J = 2.9$ Hz, 3H), 7.02 (t, $J = 8.5$ Hz, 2H), 6.97–6.96 (m, 2H), 3.95 (d, $J = 14.7$ Hz, 1H), 3.82 (d, $J = 14.7$ Hz, 1H), 3.52 (d, $J = 14.4$ Hz, 1H), 3.42 (d, $J = 14.4$ Hz, 1H), 1.87 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 196.7, 192.1, 166.7, 164.2, 139.0, 135.8, 135.2, 133.4, 132.8 (d, $J =$

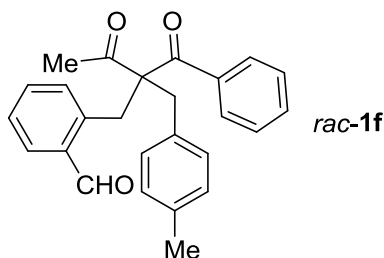
3.2 Hz), 132.3 (d, $J = 5.5$ Hz), 131.9 (d, $J = 9.2$ Hz), 130.4, 128.5, 127.5, 127.2, 115.9 (d, $J = 21.7$ Hz), 70.5, 40.8, 34.2, 30.0; ^{19}F NMR (376 MHz, CDCl_3) δ 104.2; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1547; IR (KBr thin film, cm^{-1}): ν 2925, 2854, 1697, 1673, 1598, 1575, 1506, 1454, 1408, 1359, 1235, 1207, 1159, 847, 758, 703.



2-(2-benzyl-2-(4-chlorobenzoyl)-3-oxobutyl)benzaldehyde (*rac*-1d): Yellow oil, 367.8 mg, 91% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.98 (s, 1H), 7.69 (d, $J = 7.3$ Hz, 1H), 7.62 (d, $J = 7.4$ Hz, 2H), 7.42–7.29 (m, 5H), 7.17 (s, 3H), 6.96 (s, 2H), 3.96 (d, $J = 14.7$ Hz, 1H), 3.82 (d, $J = 14.6$ Hz, 1H), 3.52 (d, $J = 14.5$ Hz, 1H), 3.42 (d, $J = 14.4$ Hz, 1H), 1.87 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.0, 197.1, 192.0, 139.5, 138.7, 135.6, 135.1, 134.6, 133.2, 132.4, 132.2, 130.4, 130.2, 128.9, 128.3, 127.4, 127.1, 70.4, 40.6, 34.1, 29.9; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{ClO}_3\text{H}^+$ 405.1252, found 405.1252; IR (KBr thin film, cm^{-1}): ν 2928, 2855, 1697, 1673, 1588, 1574, 1489, 1454, 1400, 1359, 1230, 1208, 1180, 1094, 1013, 931, 841, 759, 738, 702.

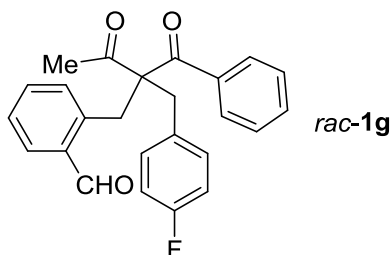


2-(2-benzoyl-2-methyl-3-oxobutyl)benzaldehyde (*rac*-1e): Yellow oil, 291.2 mg, 99% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.13 (s, 1H), 7.83–7.78 (m, 3H), 7.58–7.54 (m, 1H), 7.47–7.39 (m, 4H), 7.00 (d, $J = 6.5$ Hz, 1H), 4.11 (d, $J = 14.1$ Hz, 1H), 3.83 (d, $J = 14.2$ Hz, 1H), 2.15 (s, 3H), 1.26 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.6, 198.6, 192.4, 139.1, 135.8, 135.3, 133.4, 133.3, 132.7, 132.6, 129.1, 129.0, 127.6, 65.8, 34.7, 27.7, 19.8; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{18}\text{O}_3\text{H}^+$ 295.1329, found 295.1326; IR (KBr thin film, cm^{-1}): ν 2963, 2855, 1732, 1680, 1598, 1491, 1448, 1368, 1261, 1095, 1023, 800, 758, 692.

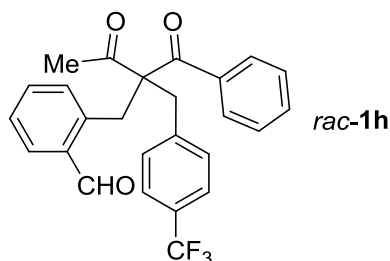


2-(2-benzoyl-2-(4-methylbenzyl)-3-oxobutyl)benzaldehyde (*rac*-1f): Yellow oil, 353.5 mg, 92% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.01 (s, 1H), 7.70 (d, $J = 7.5$ Hz,

3H), 7.48 (t, $J = 7.4$ Hz, 1H), 7.42–7.29 (m, 5H), 6.99 (d, $J = 7.8$ Hz, 2H), 6.85 (d, $J = 7.9$ Hz, 2H), 3.96 (d, $J = 14.8$ Hz, 1H), 3.79 (d, $J = 14.8$ Hz, 1H), 3.52 (d, $J = 14.5$ Hz, 1H), 3.41 (d, $J = 14.5$ Hz, 1H), 2.26 (s, 3H), 1.85 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 198.3, 191.9, 139.2, 136.6, 136.3, 135.1, 133.3, 133.1, 132.6, 132.1, 131.7, 130.1, 129.07, 129.05, 128.7, 127.3, 70.5, 40.3, 33.9, 30.1, 21.0; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; IR (KBr thin film, cm^{-1}): ν 2924, 2861, 1697, 1672, 1598, 1576, 1516, 1448, 1357, 1229, 1206, 1184, 1163, 759, 702.

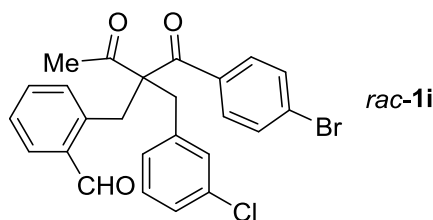


2-(2-benzoyl-2-(4-fluorobenzyl)-3-oxobutyl)benzaldehyde (*rac*-1g): Yellow oil, 357.1 mg, 92% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.04 (s, 1H), 7.71 (d, $J = 7.1$ Hz, 3H), 7.50–7.49 (m, 1H), 7.42–7.35 (m, 4H), 7.28 (d, $J = 6.8$ Hz, 1H), 6.95–6.84 (m, 4H), 4.02 (d, $J = 14.6$ Hz, 1H), 3.82 (d, $J = 14.6$ Hz, 1H), 3.50 (d, $J = 14.4$ Hz, 1H), 3.37 (d, $J = 14.4$ Hz, 1H), 1.84 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.3, 198.1, 192.1, 163.1, 160.6, 138.8, 136.1, 135.1, 133.3 (d, $J = 10.5$ Hz), 132.4, 132.2, 131.9 (d, $J = 7.8$ Hz), 131.6 (d, $J = 3.2$ Hz), 129.1, 128.7, 127.5, 115.2 (d, $J = 21$ Hz), 70.4, 39.8, 34.2, 30.2; ^{19}F NMR (376 MHz, CDCl_3) δ 115.5; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1548; IR (KBr thin film, cm^{-1}): ν 2925, 2854, 1698, 1671, 1600, 1509, 1448, 1360, 1263, 1225, 1160, 1100, 1017, 796, 739, 702.

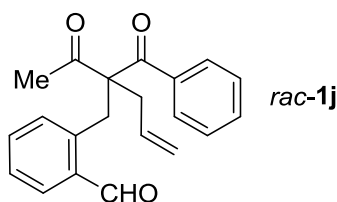


2-(2-benzoyl-3-oxo-2-(4-(trifluoromethyl)benzyl)butyl)benzaldehyde (*rac*-1h): Yellow oil, 394.3 mg, 90% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.03 (s, 1H), 7.71 (d, $J = 7.5$ Hz, 3H), 7.52 (t, $J = 7.4$ Hz, 1H), 7.44–7.36 (m, 6H), 7.29 (d, $J = 7.7$ Hz, 1H), 7.11 (d, $J = 8.0$ Hz, 2H), 4.04 (d, $J = 14.6$ Hz, 1H), 3.85 (d, $J = 14.6$ Hz, 1H), 3.57 (d, $J = 14.3$ Hz, 1H), 3.44 (d, $J = 14.3$ Hz, 1H), 1.85 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.0, 197.9, 192.4, 140.4, 138.6, 136.1, 135.2, 133.4 (d, $J = 5.2$ Hz), 133.1, 132.4, 130.8, 129.5, 129.2, 128.9, 127.6, 125.5, 125.2 (q, $J = 3.6$ Hz), 122.8, 70.5, 40.4, 34.4, 30.2; ^{19}F NMR (376 MHz, CDCl_3) δ 62.5; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{21}\text{F}_3\text{O}_3\text{H}^+$ 439.1516, found 439.1517; IR (KBr thin film, cm^{-1}): ν 2932, 2858,

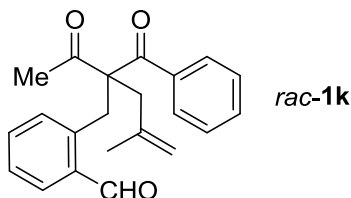
1698, 1673, 1599, 1448, 1326, 1165, 1123, 1069, 1019, 760, 706.



2-(2-(4-bromobenzoyl)-2-(3-chlorobenzyl)-3-oxobutyl)benzaldehyde (*rac*-1i): Yellow oil, 448.3 mg, 93% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.99 (s, 1H), 7.70 (dd, $J = 7.4, 1.4$ Hz, 1H), 7.56–7.49 (m, 4H), 7.46–7.36 (m, 2H), 7.27–7.25 (m, 1H), 7.17–7.09 (m, 2H), 6.94 (s, 1H), 6.84 (d, $J = 7.5$ Hz, 1H), 4.00 (d, $J = 14.7$ Hz, 1H), 3.82 (d, $J = 14.7$ Hz, 1H), 3.46 (d, $J = 14.4$ Hz, 1H), 3.33 (d, $J = 14.4$ Hz, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 206.8, 197.2, 192.4, 138.5, 137.9, 135.2, 135.0, 134.2, 133.4, 133.3, 132.4, 132.1, 130.6, 129.6, 128.6, 128.5, 127.7, 127.4, 70.5, 40.1, 34.3, 30.0; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{20}\text{BrClO}_3\text{H}^+$ 483.0357, found 483.0358; IR (KBr thin film, cm^{-1}): ν 2927, 2854, 1697, 1673, 1598, 1582, 1481, 1359, 1207, 1182, 1076, 1010, 932, 783, 758, 702.

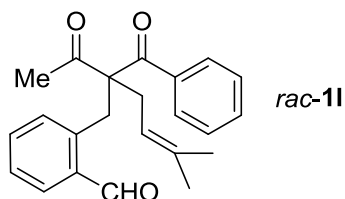


2-(2-acetyl-2-benzoylpent-4-en-1-yl)benzaldehyde (*rac*-1j): Yellow oil, 307.3 mg, 96% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.08 (s, 1H), 7.77–7.74 (m, 3H), 7.54 (t, $J = 7.4$ Hz, 1H), 7.43–7.33 (m, 4H), 7.15 (d, $J = 7.4$ Hz, 1H), 5.66–5.56 (m, 1H), 5.06 (d, $J = 10.1$ Hz, 1H), 4.98 (dd, $J = 16.9, 1.2$ Hz, 1H), 4.09 (d, $J = 14.7$ Hz, 1H), 3.85 (d, $J = 14.7$ Hz, 1H), 2.73 (d, $J = 6.5$ Hz, 2H), 2.05 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 206.9, 197.9, 191.8, 138.7, 136.1, 135.1, 133.21, 133.15, 132.3, 131.84, 131.75, 128.83, 128.75, 127.4, 119.6, 69.2, 37.2, 32.6, 28.9; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{20}\text{O}_3\text{H}^+$ 321.1485, found 321.1485; IR (KBr thin film, cm^{-1}): ν 2925, 2866, 1697, 1598, 1576, 1489, 1448, 1359, 1270, 1209, 1000.4, 926, 761, 694, 661.

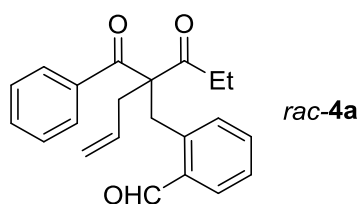


2-(2-acetyl-2-benzoyl-4-methylpent-4-en-1-yl)benzaldehyde (*rac*-1k): Yellow oil, 300.8 mg, 90% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.15 (s, 1H), 7.76 (d, $J = 7.6$ Hz, 1H), 7.70 (d, $J = 7.5$ Hz, 2H), 7.50 (t, $J = 7.2$ Hz, 1H), 7.43–7.32 (m, 4H), 7.21 (d, $J = 7.6$ Hz, 1H), 4.84 (s, 1H), 4.68 (s, 1H), 4.11 (d, $J = 14.8$ Hz, 1H), 3.94 (d, $J = 14.8$ Hz, 1H), 2.78 (s, 2H), 2.04 (s, 3H), 1.54 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 207.5,

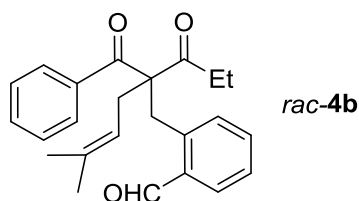
199.2, 191.8, 140.6, 139.3, 136.6, 135.3, 133.3, 133.1, 131.3, 129.0, 128.7, 127.5, 115.1, 69.4, 40.8, 32.9, 29.1, 24.7; HRMS (ESI, m/z): calcd. for $C_{22}H_{22}O_3H^+$ 335.1642, found 335.1642; IR (KBr thin film, cm^{-1}): ν 2925, 2859, 1697, 1672, 1598, 1577, 1448, 1359, 1208, 1185, 916, 763, 699.



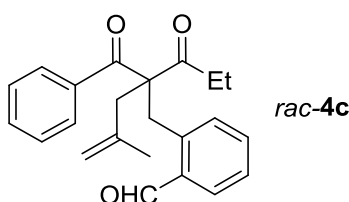
2-(2-acetyl-2-benzoyl-5-methylhex-4-en-1-yl)benzaldehyde (*rac*-11): Yellow oil, 313.4 mg, 90% yield. 1H NMR (400 MHz, $CDCl_3$) δ 10.10 (s, 1H), 7.83 (d, J = 7.4 Hz, 2H), 7.78 (dd, J = 7.6, 1.1 Hz, 1H), 7.54 (t, J = 7.4 Hz, 1H), 7.44–7.36 (m, 3H), 7.31 (t, J = 7.3 Hz, 1H), 7.02 (d, J = 7.5 Hz, 1H), 4.87 (t, J = 5.3 Hz, 1H), 4.07 (d, J = 14.9 Hz, 1H), 3.81 (d, J = 14.8 Hz, 1H), 2.59 (d, J = 6.2 Hz, 1H), 2.08 (s, 3H), 1.62 (s, 3H), 1.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 207.5, 198.4, 190.6, 139.1, 136.8, 136.2, 135.1, 133.4, 133.3, 132.0, 130.4, 129.0, 127.4, 116.9, 32.1, 30.9, 28.5, 26.0, 18.0; HRMS (ESI, m/z): calcd. for $C_{23}H_{24}O_3H^+$ 349.1798, found 349.1798; IR (KBr thin film, cm^{-1}): ν 2924, 2861, 1697, 1672, 1598, 1576, 1516, 1448, 1357, 1229, 1206, 1184, 759, 702.



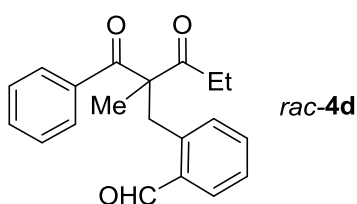
2-(2-benzoyl-2-propionylpent-4-en-1-yl)benzaldehyde (*rac*-4a): Yellow solid, m.p. 111–120 °C, 320.8 mg, 96% yield. 1H NMR (400 MHz, $CDCl_3$) δ 10.07 (s, 1H), 7.75–7.70 (m, 3H), 7.52 (t, J = 6.8 Hz, 1H), 7.39 (t, J = 7.3 Hz, 3H), 7.33 (t, J = 7.3 Hz, 1H), 7.12 (d, J = 7.5 Hz, 1H), 5.62–5.51 (m, 1H), 5.05 (dd, J = 10.1, 1.2 Hz, 1H), 4.96 (dd, J = 16.9, 1.5 Hz, 1H), 4.09 (d, J = 14.7 Hz, 1H), 3.83 (d, J = 14.8 Hz, 1H), 2.79–2.66 (m, 2H), 2.35–2.30 (m, 2H), 0.92 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.7, 198.1, 191.7, 138.9, 136.1, 135.1, 133.2, 132.3, 131.9, 131.5, 128.9, 128.8, 127.4, 119.7, 68.9, 37.3, 34.4, 32.8, 7.8; HRMS (ESI, m/z): calcd. for $C_{22}H_{22}O_3H^+$ 335.1642, found 335.1642; IR (KBr thin film, cm^{-1}): ν 2937, 2843, 1679, 1595, 1446, 1400, 1216, 1204, 1160, 930, 767, 715, 688.



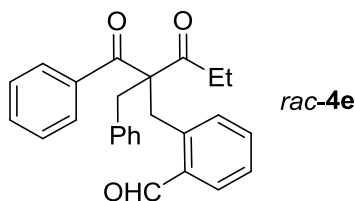
2-(2-benzoyl-5-methyl-2-propionylhex-4-en-1-yl)benzaldehyde (*rac*-4b): Yellow oil, 336.8 mg, 93% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.10 (s, 1H), 7.80–7.77 (m, 3H), 7.56–7.52 (m, 1H), 7.44–7.36 (m, 3H), 7.33–7.29 (m, 1H), 6.97 (d, J = 7.5 Hz, 1H), 4.82 (td, J = 6.0, 1.3 Hz, 1H), 4.07 (d, J = 14.9 Hz, 1H), 3.78 (d, J = 14.9 Hz, 1H), 2.57–2.56 (m, 2H), 2.34 (q, J = 7.2 Hz, 2H), 1.61 (d, J = 1.0 Hz, 3H), 1.27 (s, 3H), 0.95 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.4, 198.6, 190.6, 139.3, 136.7, 136.3, 135.2, 133.28, 133.27, 132.1, 130.2, 129.0, 128.9, 127.4, 117.1, 69.0, 34.0, 32.3, 31.0, 26.0, 18.1, 8.2; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{26}\text{O}_3\text{H}^+$ 363.1955, found 363.1954; IR (KBr thin film, cm^{-1}): ν 2936, 2857, 1716, 1698, 1671, 1541, 1457, 1268, 1209, 757, 712.



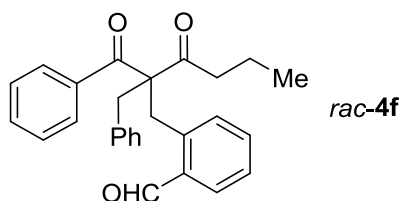
2-(2-benzoyl-4-methyl-2-propionylpent-4-en-1-yl)benzaldehyde (*rac*-4c): Yellow oil, 327.3 mg, 94% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.15 (s, 1H), 7.76 (dd, J = 1.4, 7.6 Hz, 1H), 7.69–7.67 (m, 2H), 7.49 (t, J = 7.4 Hz, 1H), 7.43–7.31 (m, 4H), 7.18 (d, J = 7.6 Hz, 1H), 4.84 (s, 1H), 4.67 (s, 1H), 4.14 (d, J = 14.9 Hz, 1H), 3.94 (d, J = 14.9 Hz, 1H), 2.80 (dd, J = 22.4, 16.8 Hz, 2H), 2.35 (q, J = 7.1 Hz, 2H), 1.53 (s, 3H), 0.88 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.1, 199.3, 191.7, 140.7, 139.5, 136.7, 135.4, 133.3, 133.0, 132.1, 131.1, 129.0, 128.7, 127.4, 114.9, 69.0, 40.7, 34.4, 33.0, 24.7, 7.9; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1798; IR (KBr thin film, cm^{-1}): ν 2934, 2855, 1698, 1672, 1653, 1599, 1449, 1208, 1184, 760, 696.



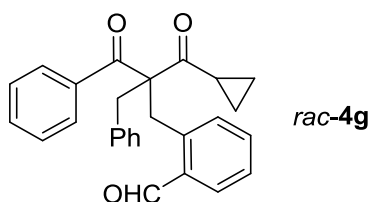
2-(2-benzoyl-2-methyl-3-oxopentyl)benzaldehyde (*rac*-4d): Yellow oil, 295.8 mg, 96% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.14 (s, 1H), 7.78 (d, J = 8.1 Hz, 3H), 7.55 (t, J = 6.8 Hz, 1H), 7.46–7.37 (m, 4H), 6.99 (d, J = 6.8 Hz, 1H), 4.14 (d, J = 14.2 Hz, 1H), 3.82 (d, J = 14.2 Hz, 1H), 2.43 (q, J = 7.2 Hz, 2H), 1.26 (s, 3H), 1.01 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.5, 198.7, 192.3, 139.2, 135.9, 135.4, 133.4, 133.2, 132.7, 132.4, 129.1, 129.0, 127.5, 65.5, 35.0, 33.3, 20.0, 8.4; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{20}\text{O}_3\text{H}^+$ 309.1485, found 309.1485; IR (KBr thin film, cm^{-1}): ν 2937, 2854, 1698, 1674, 1598, 1449, 1262, 1232, 1211, 1186, 958, 761, 703.



2-(2-benzoyl-2-benzyl-3-oxopentyl)benzaldehyde (*rac-4e*): Yellow oil, 368.8 mg, 96% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.98 (s, 1H), 7.72–7.69 (m, 3H), 7.50 (t, J = 7.4 Hz, 1H), 7.44–7.28 (m, 5H), 7.18–7.16 (m, 3H), 6.92–6.90 (m, 2H), 4.00 (d, J = 15.0 Hz, 1H), 3.81 (d, J = 15.0 Hz, 1H), 3.57 (d, J = 14.2 Hz, 1H), 3.46 (d, J = 14.6 Hz, 1H), 2.34–2.24 (m, 1H), 2.18–2.08 (m, 1H), 0.83 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.0, 198.7, 191.9, 139.4, 136.4, 136.1, 135.3, 133.4, 133.1, 132.0, 131.8, 130.3, 129.3, 128.8, 128.5, 127.4, 127.1, 70.2, 40.7, 35.3, 33.9, 7.9; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; IR (KBr thin film, cm^{-1}): ν 2958, 2872, 1696, 1600, 1574, 1454, 1362, 1292, 1187, 756, 702.

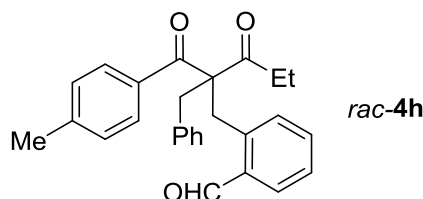


2-(2-benzoyl-2-benzyl-3-oxohexyl)benzaldehyde (*rac-4f*): Yellow oil, 378.3 mg, 95% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.96 (s, 1H), 7.74–7.69 (m, 3H), 7.49 (t, J = 7.4 Hz, 1H), 7.43–7.26 (m, 5H), 7.16–7.15 (m, 3H), 6.91–6.89 (m, 2H), 4.00 (d, J = 15.2 Hz, 1H), 3.83 (d, J = 15.2 Hz, 1H), 3.58 (d, J = 14.7 Hz, 1H), 3.48 (d, J = 14.7 Hz, 1H), 2.33–2.24 (m, 1H), 2.16–2.08 (m, 1H), 1.47–1.26 (m, 2H), 0.67 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.2, 198.6, 191.8, 139.3, 136.3, 136.0, 135.2, 133.3, 133.0, 131.8, 131.7, 130.2, 129.2, 128.7, 128.3, 127.2, 127.0, 70.0, 43.7, 40.3, 33.6, 17.0, 13.4; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{26}\text{O}_3\text{H}^+$ 399.1955, found 399.1955; IR (KBr thin film, cm^{-1}): ν 2963, 2875, 1697, 1671, 1599, 1454, 1261, 1209, 1183, 798, 755, 700.

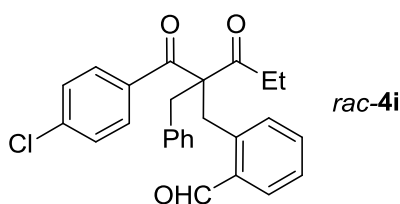


2-(2-benzoyl-2-benzyl-3-cyclopropyl-3-oxopropyl)benzaldehyde (*rac-4g*): Yellow oil, 372.4 mg, 94% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.06 (s, 1H), 7.74–7.71 (m, 3H), 7.48 (t, J = 7.4 Hz, 1H), 7.43–7.29 (m, 5H), 7.18–7.17 (m, 3H), 6.98–6.70 (m, 2H), 3.96 (d, J = 14.7 Hz, 1H), 3.78 (d, J = 14.6 Hz, 1H), 3.64 (d, J = 14.4 Hz, 1H), 3.48 (d, J = 14.4 Hz, 1H), 1.37–1.31 (m, 1H), 1.05–0.99 (m, 1H), 0.95–0.89 (m, 1H), 0.65–0.58 (m, 1H), 0.51–0.44 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.8, 198.7,

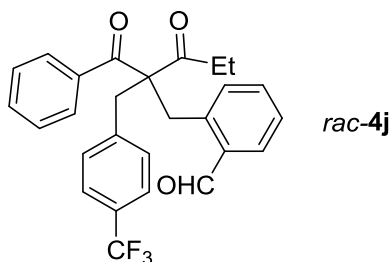
191.7, 139.7, 136.6, 136.1, 135.4, 133.3, 133.1, 132.5, 130.9, 130.7, 129.5, 128.5, 128.3, 127.3, 127.2, 70.6, 41.1, 33.9, 23.2, 15.5, 15.2; HRMS (ESI, m/z): calcd. for $C_{27}H_{24}O_3H^+$ 397.1798, found 397.1799; IR (KBr thin film, cm^{-1}): ν 2928, 2856, 1697, 1669, 1599, 1448, 1378, 1207, 1130, 970, 755, 699.



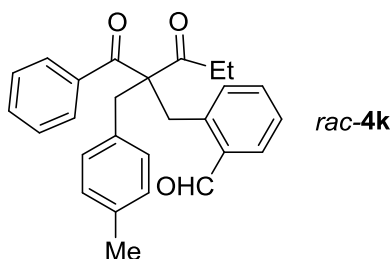
2-(2-benzyl-2-(4-methylbenzoyl)-3-oxopentyl)benzaldehyde (*rac*-4h): Yellow oil, 366.3 mg, 92% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.99 (s, 1H), 7.72 (d, J = 7.5 Hz, 1H), 7.64 (d, J = 8.2 Hz, 2H), 7.42 (t, J = 7.0 Hz, 1H), 7.32 (t, J = 7.4 Hz, 1H), 7.27–7.26 (m, 1H), 7.19–7.16 (m, 5H), 6.92–6.90 (m, 2H), 4.01 (d, J = 15.0 Hz, 1H), 3.77 (d, J = 15.0 Hz, 1H), 3.56 (d, J = 14.6 Hz, 1H), 3.44 (d, J = 14.6 Hz, 1H), 2.37 (s, 3H), 2.31–2.21 (m, 1H), 2.14–2.04 (m, 1H), 0.82 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 210.3, 198.1, 191.8, 144.1, 139.5, 136.1, 135.3, 133.8, 133.4, 132.0, 131.5, 130.3, 129.53, 129.46, 128.4, 127.3, 127.1, 70.0, 40.6, 35.3, 33.9, 21.7, 7.9; HRMS (ESI, m/z): calcd. for $C_{27}H_{26}O_3H^+$ 399.1955, found 399.1955; IR (KBr thin film, cm^{-1}): ν 2939, 2856, 1698, 1672, 1326, 1166, 1124, 1069, 1019, 757, 701.



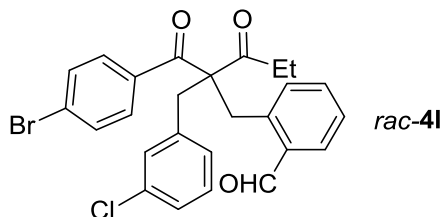
2-(2-benzyl-2-(4-chlorobenzoyl)-3-oxopentyl)benzaldehyde (*rac*-4i): Yellow oil, 397.2 mg, 95% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.97 (s, 1H), 7.70 (dd, J = 7.6, 1.2 Hz, 1H), 7.61–7.63 (m, 2H), 7.42 (td, J = 7.4, 1.5 Hz, 1H), 7.37–7.32 (m, 3H), 7.27–7.26 (m, 1H), 7.19–7.17 (m, 3H), 6.92–6.90 (m, 2H), 3.98 (d, J = 14.9 Hz, 1H), 3.82 (d, J = 15.0 Hz, 1H), 3.55 (d, J = 14.6 Hz, 1H), 3.44 (d, J = 14.6 Hz, 1H), 2.36–2.26 (m, 1H), 2.19–2.09 (m, 1H), 0.85 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.8, 197.4, 192.0, 139.5, 139.0, 135.8, 135.1, 134.7, 133.3, 132.4, 132.0, 130.6, 130.2, 128.9, 128.4, 127.4, 127.1, 70.1, 40.6, 35.1, 34.0, 7.8; HRMS (ESI, m/z): calcd. for $C_{26}H_{23}ClO_3H^+$ 419.1408, found 419.1409; IR (KBr thin film, cm^{-1}): ν 2924, 2872, 1699, 1686, 1600, 1490, 1455, 1283, 1095, 1014, 987, 826, 756, 737, 707.



2-(2-benzoyl-3-oxo-2-(4-(trifluoromethyl)benzyl)pentyl)benzaldehyde (*rac*-4j): Yellow oil, 425.0 mg, 94% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.01 (s, 1H), 7.71–7.69 (m, 3H), 7.51 (t, J = 7.4 Hz, 1H), 7.45–7.34 (m, 6H), 7.27 (d, J = 6.7 Hz, 1H), 7.06 (d, J = 8.1 Hz, 2H), 4.06 (d, J = 14.8 Hz, 1H), 3.84 (d, J = 14.8 Hz, 1H), 3.60 (d, J = 14.5 Hz, 1H), 3.47 (d, J = 14.5 Hz, 1H), 2.31–2.11 (m, 2H), 0.83 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.6, 198.2, 192.3, 140.6 (q, J = 1.1 Hz), 138.9, 136.2, 135.2, 133.5, 133.3, 133.0, 132.2, 130.8, 129.3, 128.9, 127.6, 125.2 (q, J = 3.7 Hz), 70.1, 40.4, 35.4, 34.3, 7.9; ^{19}F NMR (376 MHz, CDCl_3) δ 62.6; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{23}\text{F}_3\text{O}_3\text{H}^+$ 453.1672, found 453.1672; IR (KBr thin film, cm^{-1}): ν 2939, 2856, 1698, 1672, 1326, 1166, 1124, 1069, 1019, 757, 701.

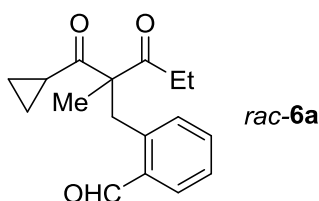


2-(2-benzoyl-2-(4-methylbenzyl)-3-oxopentyl)benzaldehyde (*rac*-4k): Yellow oil, 358.4 mg, 90% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.00 (s, 1H), 7.72–7.68 (m, 3H), 7.51–7.47 (m, 1H), 7.44–7.28 (m, 5H), 6.98 (d, J = 7.9 Hz, 2H), 6.79 (d, J = 8.0 Hz, 2H), 3.97 (d, J = 15.0 Hz, 1H), 3.79 (d, J = 15.0 Hz, 1H), 3.54 (d, J = 14.6 Hz, 1H), 3.44 (d, J = 14.7 Hz, 1H), 2.35–2.28 (m, 1H), 2.27 (s, 3H), 2.16–2.08 (m, 1H), 0.83 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.0, 198.6, 191.8, 139.4, 136.6, 136.4, 135.1, 133.3, 133.0, 132.7, 131.9, 131.6, 131.1, 129.1, 129.0, 128.7, 127.2, 70.1, 40.2, 35.2, 33.7, 21.0, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{26}\text{O}_3\text{H}^+$ 399.1955, found 399.1955; IR (KBr thin film, cm^{-1}): ν 2937, 2877, 1697, 1672, 1598, 1577, 1515, 1448, 1223, 1208, 1183, 759, 699.

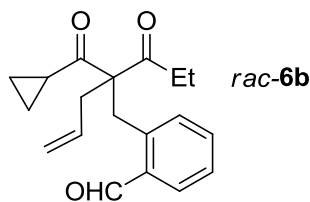


2-(2-(4-bromobenzoyl)-2-(3-chlorobenzyl)-3-oxopentyl)benzaldehyde (*rac*-4l): Yellow oil, 456.4 mg, 92% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.97 (s, 1H), 7.69

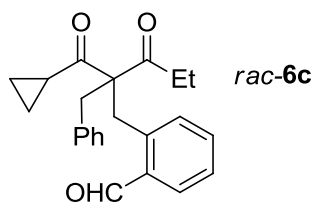
(dd, $J = 7.5, 1.5$ Hz, 1H), 7.55–7.49 (m, 4H), 7.45–7.34 (m, 2H), 7.23 (d, $J = 7.5$ Hz, 1H), 7.16–7.07 (m, 2H), 6.88 (t, $J = 1.6$ Hz, 1H), 6.79 (d, $J = 7.5$ Hz, 1H), 4.04 (d, $J = 14.9$ Hz, 1H), 3.80 (d, $J = 14.9$ Hz, 1H), 3.48 (d, $J = 14.5$ Hz, 1H), 3.34 (d, $J = 14.5$ Hz, 1H), 2.33–2.12 (m, 2H), 0.86 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.5, 197.4, 192.4, 138.7, 138.0, 135.2, 135.0, 134.2, 133.4, 133.2, 132.1, 130.7, 130.6, 129.6, 128.5, 128.4, 127.6, 127.4, 70.1, 40.1, 35.2, 34.2, 7.9; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{22}\text{BrClO}_3\text{H}^+$ 497.0514, found 497.0514; IR (KBr thin film, cm^{-1}): ν 2937, 2876, 1697, 1673, 1598, 1582, 1481, 1451, 1396, 1207, 1074, 1009, 936, 757, 704, 685.



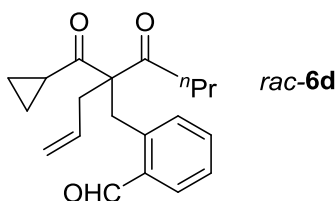
2-(2-(cyclopropanecarbonyl)-2-methyl-3-oxopentyl)benzaldehyde (*rac*-6a): Colorless oil, 239.5 mg, 88% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.18 (s, 1H), 7.80 (dd, $J = 7.6, 1.2$ Hz, 1H), 7.45 (td, $J = 7.5, 1.6$ Hz, 1H), 7.38 (t, $J = 7.5$ Hz, 1H), 7.18 (d, $J = 7.6$ Hz, 1H), 3.85 (d, $J = 14.2$ Hz, 1H), 3.74 (d, $J = 14.2$ Hz, 1H), 2.55–2.32 (m, 2H), 1.95 (dq, $J = 7.7, 4.5$ Hz, 1H), 1.23 (s, 3H), 1.17–1.11 (m, 1H), 1.09–0.99 (m, 4H), 0.99–0.90 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.7, 208.7, 192.4, 139.3, 135.1, 133.3, 132.4, 132.4, 127.3, 67.1, 33.4, 32.7, 18.6, 17.5, 13.2, 12.4, 8.1; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{20}\text{O}_3\text{H}^+$ 273.1485, found 273.1483; IR (KBr thin film, cm^{-1}): ν 3675, 3649, 3342, 3225, 3065, 2917, 2361, 2321, 1748, 1688, 1617, 1475, 1363, 1315, 1076, 967, 716, 600.



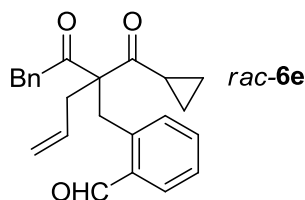
2-(2-(cyclopropanecarbonyl)-2-propionylpent-4-en-1-yl)benzaldehyde (*rac*-6b): Yellow oil, 283.3 mg, 95% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.20 (s, 1H), 7.81 (d, $J = 7.6$ Hz, 1H), 7.47 (dd, $J = 10.5, 4.5$ Hz, 1H), 7.38 (t, $J = 7.4$ Hz, 1H), 7.27 (d, $J = 7.7$ Hz, 1H), 5.59 (ddt, $J = 14.4, 10.5, 7.1$ Hz, 1H), 5.16–4.96 (m, 2H), 3.79 (s, 2H), 2.71 (d, $J = 7.0$ Hz, 2H), 2.51–2.32 (m, 2H), 1.85–1.75 (m, 1H), 1.11–0.97 (m, 5H), 0.93–0.83 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.2, 208.3, 192.1, 139.3, 135.1, 133.3, 132.3, 132.1, 131.8, 127.3, 119.5, 70.8, 36.1, 33.7, 31.3, 19.9, 13.7, 12.9, 7.9; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{22}\text{O}_3\text{H}^+$ 299.1641, found 299.1640; IR (KBr thin film, cm^{-1}): ν 3587, 3350, 3225, 3076, 2361, 2321, 1686, 1617, 1489, 1381, 942, 719, 588, 454.



2-(2-benzyl-2-(cyclopropanecarbonyl)-3-oxopentyl)benzaldehyde (*rac*-6c): Yellow oil, 337.7 mg, 97% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.00 (s, 1H), 7.78 (dd, J = 7.7, 1.5 Hz, 1H), 7.46 (td, J = 7.5, 1.5 Hz, 1H), 7.37 (t, J = 7.1 Hz, 1H), 7.24 (s, 1H), 7.23–7.17 (m, 3H), 7.00–6.92 (m, 2H), 3.76 (s, 2H), 3.41 (s, 2H), 2.54–2.27 (m, 2H), 1.83 (tt, J = 7.7, 4.5 Hz, 1H), 1.16–1.04 (m, 2H), 0.99 (t, J = 7.1 Hz, 3H), 0.94 (ddd, J = 8.5, 5.6, 2.2 Hz, 1H), 0.85 (ddd, J = 9.6, 7.0, 3.6 Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.7, 208.2, 191.9, 139.5, 135.6, 135.1, 133.4, 131.9, 131.4, 129.9, 128.4, 127.2, 126.9, 71.8, 38.5, 34.2, 31.9, 20.4, 13.9, 13.8, 8.1; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1794; IR (KBr thin film, cm^{-1}): ν 3567, 3356, 3225, 3068, 2934, 2364, 1691, 1620, 1495, 1455, 1373, 1205, 1134, 975, 758, 701, 590, 456.

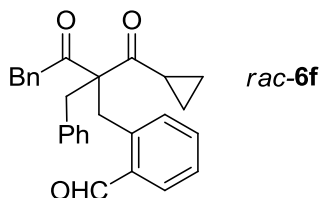


2-(2-allyl-2-(cyclopropanecarbonyl)-3-oxohexyl)benzaldehyde (*rac*-6d): Yellow oil, 262.2 mg, 84% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.22 (s, 1H), 7.81 (dd, J = 7.7, 1.5 Hz, 1H), 7.47 (td, J = 7.5, 1.6 Hz, 1H), 7.38 (td, J = 7.5, 0.9 Hz, 1H), 7.31–7.23 (m, 1H), 5.57 (ddt, J = 17.3, 10.3, 7.1 Hz, 1H), 5.08 (ddd, J = 15.5, 6.0, 1.6 Hz, 2H), 3.80 (q, J = 14.9 Hz, 2H), 2.71 (d, J = 7.1 Hz, 2H), 2.48–2.29 (m, 2H), 1.81 (tt, J = 7.7, 4.5 Hz, 1H), 1.66–1.49 (m, 2H), 1.13–0.98 (m, 2H), 0.92–0.84 (m, 5H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.3, 208.2, 192.0, 139.3, 135.0, 133.3, 132.2, 132.0, 131.6, 127.2, 119.5, 70.8, 42.2, 35.9, 31.1, 19.8, 17.1, 13.8, 13.6, 13.0; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{24}\text{O}_3\text{H}^+$ 313.1798, found 313.1792; IR (KBr thin film, cm^{-1}): ν 3590, 3347, 3230, 3074, 2965, 2361, 1686, 1614, 1492, 1372, 1070, 756, 591, 460.



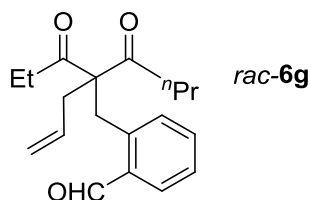
2-(2-(cyclopropanecarbonyl)-2-(2-phenylacetyl)pent-4-en-1-yl)benzaldehyde (*rac*-6e): Yellow oil, 306.2 mg, 85% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.17 (s, 1H), 7.78 (d, J = 7.5 Hz, 1H), 7.42 (t, J = 7.3 Hz, 1H), 7.35 (t, J = 7.3 Hz, 1H), 7.31–7.18 (m, 4H), 7.13 (d, J = 7.6 Hz, 2H), 5.64–5.48 (m, 1H), 5.15–4.99 (m, 2H),

3.85 (q, $J = 14.8$ Hz, 2H), 3.78–3.63 (m, 2H), 2.78 (d, $J = 6.9$ Hz, 2H), 1.85–1.75 (m, 1H), 1.06 (s, 2H), 0.84 (s, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.1, 205.6, 192.3, 139.1, 135.1, 133.6, 133.4, 132.2, 132.2, 129.8, 128.4, 127.4, 127.0, 119.7, 71.1, 46.6, 36.1, 31.4, 20.1, 14.0, 13.4; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{24}\text{O}_3\text{H}^+$ 361.1798, found 361.1793; IR (KBr thin film, cm^{-1}): ν 3564, 3362, 3230, 3068, 2361, 1691, 1623, 1495, 1457, 1381, 1201, 1073, 725, 696, 594.

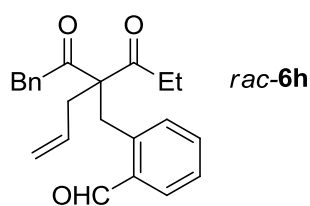


2-(2-benzyl-2-(cyclopropanecarbonyl)-3-oxo-4-phenylbutyl)benzaldehyde

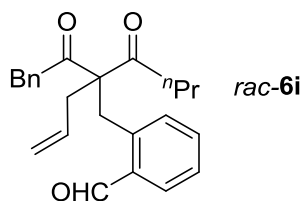
(rac-6f): Yellow oil, 365.1 mg, 89% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.98 (s, 1H), 7.76 (dd, $J = 7.6, 1.3$ Hz, 1H), 7.42 (td, $J = 7.5, 1.5$ Hz, 1H), 7.36 (t, $J = 7.1$ Hz, 1H), 7.30–7.22 (m, 4H), 7.20–7.15 (m, 3H), 7.08 (d, $J = 6.9$ Hz, 2H), 6.95 (dd, $J = 6.0, 3.3$ Hz, 2H), 3.84 (s, 2H), 3.79–3.66 (m, 2H), 3.47 (s, 2H), 1.92–1.82 (m, 1H), 1.19–1.04 (m, 2H), 0.95–0.88 (m, 1H), 0.86–0.81 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.0, 206.3, 192.1, 139.3, 135.9, 135.1, 133.5, 133.5, 132.4, 131.3, 130.0, 129.8, 128.5, 128.4, 127.2, 127.1, 127.0, 72.0, 47.0, 38.3, 31.9, 20.5, 14.3, 14.2; HRMS (ESI, m/z): calcd. for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1958; IR (KBr thin film, cm^{-1}): ν 3590, 3350, 3228, 3059, 2364, 1740, 1671, 1626, 1620, 1497, 1372, 964, 722, 594.



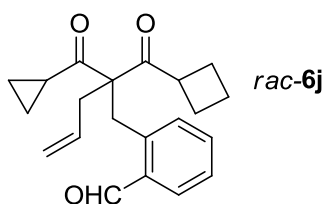
2-(2-allyl-3-oxo-2-propionylhexyl)benzaldehyde (rac-6g): Yellow oil, 261.2 mg, 87% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.15 (s, 1H), 7.81 (dd, $J = 7.6, 1.4$ Hz, 1H), 7.48 (td, $J = 7.5, 1.5$ Hz, 1H), 7.39 (dd, $J = 10.8, 4.1$ Hz, 1H), 7.21 (d, $J = 7.6$ Hz, 1H), 5.55 (ddt, $J = 17.2, 10.3, 7.0$ Hz, 1H), 5.16–5.00 (m, 2H), 3.76 (s, 2H), 2.73 (d, $J = 7.0$ Hz, 2H), 2.50–2.17 (m, 4H), 1.61–1.45 (m, 2H), 0.98 (t, $J = 7.1$ Hz, 3H), 0.85 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.4, 208.6, 192.5, 139.2, 134.9, 133.4, 132.6, 132.2, 131.8, 127.3, 119.6, 70.2, 42.2, 36.0, 33.6, 31.9, 17.0, 13.6, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{24}\text{O}_3\text{H}^+$ 301.1798, found 301.1802; IR (KBr thin film, cm^{-1}): ν 3590, 3359, 3228, 3079, 2364, 1666, 1617, 1483, 1366, 722, 594.



2-(2-(2-phenylacetyl)-2-propionylpent-4-en-1-yl)benzaldehyde (*rac*-6h): Yellow oil, 282.0 mg, 81% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.12 (s, 1H), 7.79 (dd, J = 7.5, 1.6 Hz, 1H), 7.42 (dtd, J = 20.8, 7.4, 1.3 Hz, 2H), 7.31–7.22 (m, 3H), 7.20 (t, J = 5.4 Hz, 1H), 7.14–7.07 (m, 2H), 5.53 (ddt, J = 17.2, 10.4, 7.0 Hz, 1H), 5.09 (ddd, J = 13.2, 7.8, 1.9 Hz, 2H), 3.87–3.77 (m, 2H), 3.68 (dd, J = 38.1, 16.6 Hz, 2H), 2.86–2.70 (m, 2H), 2.50–2.22 (m, 2H), 0.95 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.4, 205.9, 192.8, 139.0, 134.9, 133.5, 133.4, 133.1, 132.1, 132.0, 129.8, 128.5, 127.4, 127.1, 119.7, 70.6, 46.5, 36.2, 33.7, 32.1, 7.7; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1796; IR (KBr thin film, cm^{-1}): ν 3618, 3350, 3225, 3059, 2367, 1694, 1620, 1457, 1318, 919, 699, 588.

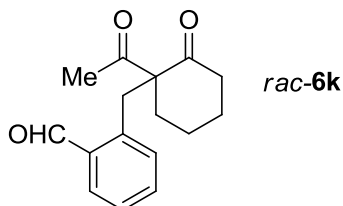


2-(2-allyl-3-oxo-2-(2-phenylacetyl)hexyl)benzaldehyde (*rac*-6i): Yellow oil, 297.0 mg, 82% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.16 (s, 1H), 7.82 (dd, J = 7.5, 1.5 Hz, 1H), 7.51–7.39 (m, 2H), 7.35–7.27 (m, 3H), 7.23 (d, J = 7.2 Hz, 1H), 7.17–7.10 (m, 2H), 5.54 (ddd, J = 14.0, 10.3, 5.1 Hz, 1H), 5.16–5.04 (m, 2H), 3.85 (d, J = 2.0 Hz, 2H), 3.71 (dd, J = 40.8, 16.6 Hz, 2H), 2.82 (dd, J = 7.0, 1.0 Hz, 2H), 2.40 (ddd, J = 18.1, 8.3, 6.3 Hz, 1H), 2.27 (ddd, J = 18.1, 8.2, 6.4 Hz, 1H), 1.60–1.46 (m, 2H), 0.85 (t, J = 7.4 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.7, 206.0, 192.8, 139.0, 134.9, 133.5, 133.4, 133.1, 132.0, 131.9, 129.8, 128.5, 127.4, 127.1, 119.7, 70.5, 46.6, 42.3, 36.1, 32.0, 16.9, 13.6; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{26}\text{O}_3\text{H}^+$ 363.1954, found 363.1957; IR (KBr thin film, cm^{-1}): ν 3649, 3344, 3225, 3068, 2364, 1740, 1674, 1614, 1492, 1363, 956, 722, 594.

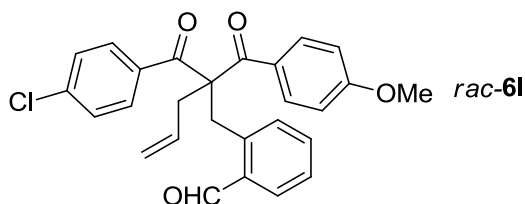


2-(2-(cyclobutanecarbonyl)-2-(cyclopropanecarbonyl)pent-4-en-1-yl)benzaldehyde (*rac*-6j): Yellow oil, 301.5 mg, 93% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.22 (s, 1H), 7.81 (dd, J = 7.7, 1.4 Hz, 1H), 7.45 (td, J = 7.5, 1.5 Hz, 1H), 7.36 (t, J = 7.2 Hz, 1H), 7.22 (d, J = 7.6 Hz, 1H), 5.51 (ddt, J = 17.2, 10.2, 7.1 Hz, 1H), 5.05 (ddd, J = 18.5, 13.6, 1.4 Hz, 2H), 3.81 (d, J = 14.8 Hz, 1H), 3.71 (d, J = 14.8 Hz, 1H), 3.42–3.24 (m, 1H), 2.75–2.60 (m, 2H), 2.35–2.16 (m, 2H), 2.03–1.80 (m, 4H), 1.72–1.64 (m, 1H), 1.10–0.97 (m, 2H), 0.93–0.78 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 210.4, 208.0, 192.0, 139.4, 135.0, 133.3, 132.3, 132.1, 131.4, 127.2, 119.4, 70.9, 43.5, 35.8, 31.0, 26.7, 26.1, 20.1, 17.8, 13.7, 12.9; HRMS (ESI, m/z): calcd. for

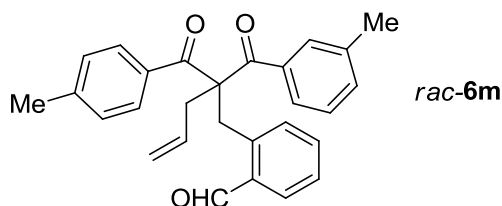
$C_{21}H_{24}O_3H^+$ 325.1798, found 325.1793; IR (KBr thin film, cm^{-1}): ν 3652, 3350, 3228, 3074, 2367, 1677, 1620, 1483, 1358, 1312, 973, 742, 585, 463.



2-((1-acetyl-2-oxocyclohexyl)methyl)benzaldehyde (*rac*-6k): Yellow oil, 203.9 mg, 79% yield. 1H NMR (400 MHz, $CDCl_3$) δ 10.14 (s, 1H), 7.78 (dd, J = 7.5, 1.6 Hz, 1H), 7.48 (td, J = 7.5, 1.7 Hz, 1H), 7.41 (td, J = 7.5, 1.3 Hz, 1H), 7.29–7.24 (m, 1H), 3.74–3.64 (m, 2H), 2.52 (ddd, J = 4.7, 3.9, 1.8 Hz, 1H), 2.35–2.24 (m, 2H), 2.19 (d, J = 7.3 Hz, 3H), 1.95 (dtd, J = 9.1, 6.1, 3.2 Hz, 1H), 1.72–1.63 (m, 1H), 1.60–1.48 (m, 2H), 1.41–1.32 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.2, 206.5, 193.1, 138.8, 135.1, 133.6, 133.4, 133.1, 127.4, 68.7, 41.9, 33.2, 33.1, 26.7, 26.6, 22.2; HRMS (ESI, m/z): calcd. for $C_{16}H_{18}O_3H^+$ 259.1328, found 259.1324; IR (KBr thin film, cm^{-1}): ν 3581, 3333, 3225, 2364, 1660, 1611, 1492, 1369, 964, 719, 597, 451.

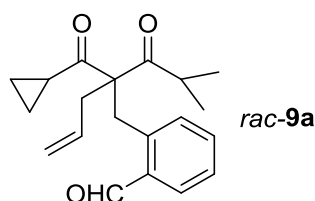


2-(2-(4-chlorobenzoyl)-2-(4-methoxybenzoyl)pent-4-en-1-yl)benzaldehyde (*rac*-6l): Yellow oil, 370.3 mg, 83% yield. 1H NMR (400 MHz, $CDCl_3$) δ 10.00 (s, 1H), 7.75 (ddt, J = 10.9, 4.1, 2.5 Hz, 5H), 7.37 (td, J = 7.5, 1.6 Hz, 1H), 7.34–7.27 (m, 1H), 7.26–7.20 (m, 2H), 7.16 (d, J = 7.6 Hz, 1H), 6.79–6.73 (m, 2H), 5.62 (ddt, J = 17.3, 10.2, 7.2 Hz, 1H), 5.02 (dd, J = 10.3, 1.4 Hz, 1H), 4.84 (dd, J = 16.9, 1.5 Hz, 1H), 4.13–4.01 (m, 2H), 3.78 (d, J = 14.4 Hz, 3H), 3.00–2.82 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.8, 196.5, 191.1, 163.6, 139.6, 138.7, 135.5, 134.6, 133.0, 132.8, 131.6, 131.6, 130.6, 130.6, 129.1, 128.9, 127.5, 120.1, 114.0, 67.0, 55.4, 38.9, 34.0; HRMS (ESI, m/z): calcd. for $C_{27}H_{23}ClO_4H^+$ 447.1357, found 447.1353; IR (KBr thin film, cm^{-1}): ν 3644, 3336, 3222, 3048, 2358, 1740, 1614, 1358, 1021, 725, 597, 460.

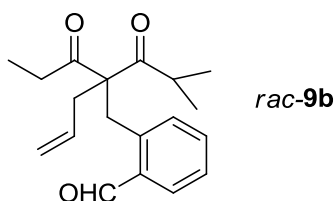


2-(2-(3-methylbenzoyl)-2-(4-methylbenzoyl)pent-4-en-1-yl)benzaldehyde (*rac*-6m): White solid, m.p. 101–104 $^{\circ}C$, 311.8 mg, 76% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.98 (s, 1H), 7.73 (dd, J = 7.7, 1.4 Hz, 1H), 7.69 (d, J = 8.3 Hz, 2H), 7.62 (s,

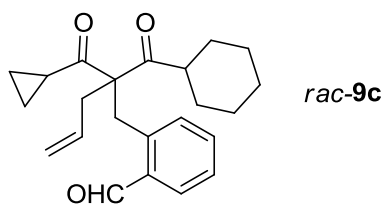
1H), 7.53 (d, $J = 7.8$ Hz, 1H), 7.38 (td, $J = 7.5, 1.5$ Hz, 1H), 7.31 (t, $J = 7.3$ Hz, 1H), 7.22 (d, $J = 7.5$ Hz, 1H), 7.14 (t, $J = 7.7$ Hz, 2H), 7.08 (d, $J = 8.2$ Hz, 2H), 5.60 (ddt, $J = 17.3, 10.2, 7.2$ Hz, 1H), 5.03 (dd, $J = 10.3, 1.4$ Hz, 1H), 4.84 (dd, $J = 16.9, 1.6$ Hz, 1H), 4.07 (s, 2H), 2.92 (d, $J = 7.2$ Hz, 2H), 2.29 (d, $J = 6.9$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 198.9, 198.0, 190.9, 144.2, 139.0, 138.6, 136.3, 135.4, 134.0, 133.9, 133.0, 132.7, 131.7, 130.1, 129.9, 129.4, 129.3, 128.4, 127.4, 126.4, 120.0, 67.3, 38.7, 33.8, 21.6, 21.4; HRMS (ESI, m/z): calcd for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1956; IR (KBr thin film, cm^{-1}): ν 3590, 3359, 3225, 3079, 2364, 1664, 1467, 912, 732, 587, 453.



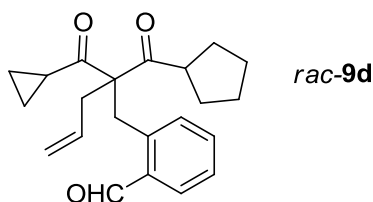
2-(2-(cyclopropanecarbonyl)-2-isobutyrylpent-4-en-1-yl)benzaldehyde (*rac*-9a): Yellow oil, 227.9 mg, 73% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.25 (s, 1H), 7.81 (dd, $J = 7.7, 1.4$ Hz, 1H), 7.46 (td, $J = 7.6, 1.5$ Hz, 1H), 7.37 (t, $J = 7.2$ Hz, 1H), 7.26 (d, $J = 7.7$ Hz, 1H), 5.50 (ddt, $J = 17.0, 10.2, 6.9$ Hz, 1H), 5.04 (ddd, $J = 18.5, 13.6, 1.5$ Hz, 2H), 3.93 (d, $J = 15.3$ Hz, 1H), 3.76 (d, $J = 15.3$ Hz, 1H), 2.91–2.77 (m, 3H), 1.91–1.80 (m, 1H), 1.12–1.02 (m, 8H), 0.89 (ddd, $J = 7.2, 3.6, 1.7$ Hz, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.3, 208.1, 192.2, 139.4, 135.0, 133.3, 132.4, 131.7, 131.5, 127.1, 119.6, 71.3, 37.7, 35.2, 30.6, 20.6, 20.4, 20.0, 13.9, 13.7; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{24}\text{O}_3\text{H}^+$ 313.1798, found 313.1796; IR (KBr thin film, cm^{-1}): ν 3567, 3344, 3222, 3065, 2352, 1686, 1594, 1506, 1460, 1366, 1073, 733, 591, 466.



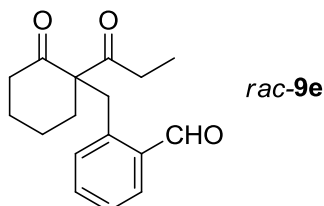
2-(2-isobutyryl-2-propionylpent-4-en-1-yl)benzaldehyde (*rac*-9b): Yellow oil, 228.1 mg, 76% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.17 (d, $J = 1.8$ Hz, 1H), 7.84–7.76 (m, 1H), 7.47 (ddd, $J = 9.0, 2.9, 1.4$ Hz, 1H), 7.39 (t, $J = 7.5$ Hz, 1H), 7.20 (d, $J = 7.7$ Hz, 1H), 5.58–5.41 (m, 1H), 5.13–4.99 (m, 2H), 3.78 (q, $J = 15.0$ Hz, 2H), 2.88–2.74 (m, 3H), 2.53–2.39 (m, 1H), 2.29 (qdd, $J = 6.6, 6.0, 2.4$ Hz, 1H), 1.08–1.01 (m, 3H), 1.01–0.91 (m, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.3, 209.6, 192.6, 139.3, 134.9, 133.3, 132.4, 132.3, 131.6, 127.2, 119.6, 70.8, 37.7, 35.4, 33.6, 31.4, 20.5, 19.9, 7.6; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{24}\text{O}_3\text{H}^+$ 301.1798, found 301.1798; IR (KBr thin film, cm^{-1}): ν 3570, 3359, 3233, 2982, 2931, 2364, 1717, 1697, 1600, 1543, 1457, 1398, 1095, 759.



2-(2-(cyclohexanecarbonyl)-2-(cyclopropanecarbonyl)pent-4-en-1-yl)benzaldehyde (*rac-9c*): Yellow oil, 317.0 mg, 90% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.25 (s, 1H), 7.81 (d, $J = 7.6$ Hz, 1H), 7.45 (t, $J = 7.4$ Hz, 1H), 7.36 (t, $J = 7.5$ Hz, 1H), 7.24 (d, $J = 7.7$ Hz, 1H), 5.48 (ddt, $J = 17.0, 10.2, 6.9$ Hz, 1H), 5.02 (dd, $J = 33.7, 13.6$ Hz, 2H), 3.93 (d, $J = 15.4$ Hz, 1H), 3.73 (d, $J = 15.4$ Hz, 1H), 2.86–2.71 (m, 2H), 2.58 (tt, $J = 11.3, 2.8$ Hz, 1H), 1.86–1.81 (m, 1H), 1.70 (dd, $J = 24.5, 10.6$ Hz, 5H), 1.53–1.33 (m, 2H), 1.25–1.13 (m, 3H), 1.05 (t, $J = 4.0$ Hz, 2H), 0.91–0.86 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.0, 208.1, 192.1, 139.5, 135.1, 133.3, 132.4, 131.5, 131.5, 127.1, 119.5, 71.3, 48.4, 35.2, 30.5, 30.4, 30.2, 25.6, 25.6, 20.1, 14.0, 13.7; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{28}\text{O}_3\text{H}^+$ 353.2111, found 353.2115; IR (KBr thin film, cm^{-1}): ν 3567, 3353, 3225, 2931, 2848, 2361, 1688, 1597, 1503, 1452, 1375, 1198, 756.

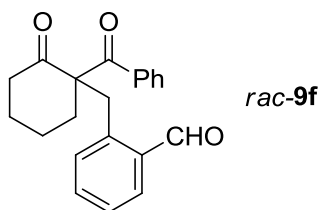


2-(2-(cyclopentanecarbonyl)-2-(cyclopropanecarbonyl)pent-4-en-1-yl)benzaldehyde (*rac-9d*): Yellow oil, 311.1 mg, 92% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.25 (s, 1H), 7.82 (d, $J = 7.6$ Hz, 1H), 7.46 (t, $J = 7.4$ Hz, 1H), 7.36 (t, $J = 7.5$ Hz, 1H), 7.27 (d, $J = 7.7$ Hz, 1H), 5.58–5.42 (m, 1H), 5.06 (dd, $J = 23.4, 13.7$ Hz, 2H), 3.90 (d, $J = 15.1$ Hz, 1H), 3.73 (d, $J = 15.1$ Hz, 1H), 2.93 (p, $J = 7.6$ Hz, 1H), 2.86–2.68 (m, 2H), 1.83–1.68 (m, 6H), 1.69–1.52 (m, 3H), 1.04 (t, $J = 4.1$ Hz, 2H), 0.91–0.82 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.6, 208.1, 192.0, 139.6, 135.0, 133.3, 132.3, 131.8, 131.4, 127.1, 119.6, 71.4, 48.8, 35.5, 32.9, 32.8, 30.6, 26.6, 26.5, 20.3, 13.9, 13.4; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{26}\text{O}_3\text{H}^+$ 339.1954, found 339.1958, IR (KBr thin film, cm^{-1}): ν 3472, 2954, 2866, 2362, 1687, 1650, 1561, 1538, 1407, 1197, 1017, 755, 638.

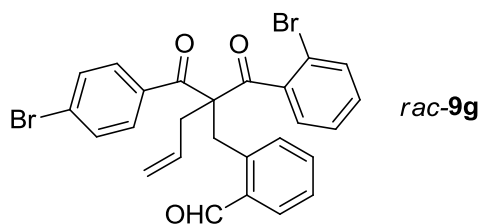


2-((2-oxo-1-propionylcyclohexyl)methyl)benzaldehyde (*rac-9e*): Colorless oil, 141.5 mg, 52% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.15 (s, 1H), 7.78 (dd, $J = 7.5,$

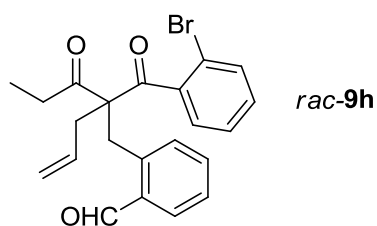
1.2 Hz, 1H), 7.47 (td, $J = 7.5, 1.4$ Hz, 1H), 7.40 (t, $J = 7.1$ Hz, 1H), 7.23 (d, $J = 7.6$ Hz, 1H), 3.68 (s, 2H), 2.66 (dq, $J = 18.4, 7.2$ Hz, 1H), 2.51 (dd, $J = 11.0, 7.1$ Hz, 1H), 2.33 (tdt, $J = 14.4, 12.7, 6.6$ Hz, 3H), 1.94 (ddd, $J = 12.2, 5.9, 3.0$ Hz, 1H), 1.69 (s, 1H), 1.59–1.47 (m, 2H), 1.43–1.31 (m, 1H), 1.02 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.4, 208.8, 192.9, 139.0, 135.2, 133.3, 133.2, 133.1, 127.3, 68.4, 41.9, 33.5, 33.3, 32.0, 26.7, 22.3, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{20}\text{O}_3\text{H}^+$ 273.1485, found 273.1484; IR (KBr thin film, cm^{-1}): ν 3570, 3356, 3233, 2934, 2863, 2361, 1717, 1697, 1651, 1597, 1543, 1512, 1457, 1395, 1218, 768, 668.



2-((1-benzoyl-2-oxocyclohexyl)methyl)benzaldehyde (*rac*-9f): Colorless oil, 291.3 mg, 91% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.10 (s, 1H), 7.88 (d, $J = 7.4$ Hz, 2H), 7.81–7.75 (m, 1H), 7.56 (t, $J = 7.4$ Hz, 1H), 7.44 (t, $J = 7.7$ Hz, 2H), 7.37 (pd, $J = 7.4, 3.9$ Hz, 2H), 7.00 (dd, $J = 8.1, 6.0$ Hz, 1H), 4.07 (d, $J = 14.3$ Hz, 1H), 3.80 (d, $J = 14.3$ Hz, 1H), 2.46 (dt, $J = 12.9, 2.9$ Hz, 2H), 2.16–2.03 (m, 1H), 1.98 (ddd, $J = 11.9, 5.7, 2.8$ Hz, 1H), 1.75–1.56 (m, 3H), 1.49–1.40 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.9, 196.5, 192.0, 138.7, 136.7, 135.2, 133.4, 133.1, 133.0, 131.7, 129.0, 128.9, 127.4, 67.3, 43.4, 37.7, 35.2, 29.2, 22.2; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{20}\text{O}_3\text{H}^+$ 321.1485, found 321.1482; IR (KBr thin film, cm^{-1}): ν 3498, 3381, 2923, 2854, 2370, 1698, 1675, 1553, 1541, 1405, 1211, 1020, 647, 533.

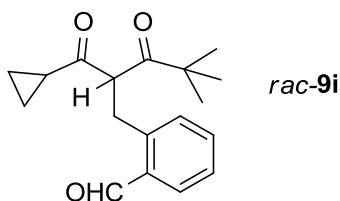


2-(2-(2-bromobenzoyl)-2-(4-bromobenzoyl)pent-4-en-1-yl)benzaldehyde (*rac*-9g): Colorless oil, 421.2 mg, 78% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.05 (s, 1H), 7.75 (dd, $J = 7.4, 1.7$ Hz, 1H), 7.69–7.64 (m, 2H), 7.60 (dd, $J = 7.8, 1.2$ Hz, 1H), 7.50–7.45 (m, 2H), 7.45–7.36 (m, 2H), 7.24 (s, 1H), 7.23–7.10 (m, 3H), 5.61 (ddt, $J = 17.1, 10.2, 7.1$ Hz, 1H), 5.01 (dd, $J = 10.2, 1.4$ Hz, 1H), 4.85 (dd, $J = 16.9, 1.5$ Hz, 1H), 4.26 (d, $J = 14.6$ Hz, 1H), 3.96 (d, $J = 14.6$ Hz, 1H), 2.93 (qd, $J = 15.6, 7.1$ Hz, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 199.1, 197.1, 191.9, 138.3, 138.0, 135.4, 135.4, 135.1, 133.2, 132.8, 132.3, 132.3, 131.8, 131.5, 130.8, 128.7, 128.4, 127.7, 126.8, 122.0, 120.1, 68.9, 39.2, 34.5; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{20}\text{Br}_2\text{O}_3\text{H}^+$ 540.9831, found 540.9825; IR (KBr thin film, cm^{-1}): ν 3652, 3564, 3344, 3236, 3065, 2920, 2358, 2338, 1674, 1617, 1509, 1455, 1398, 1201, 1073, 759, 668.



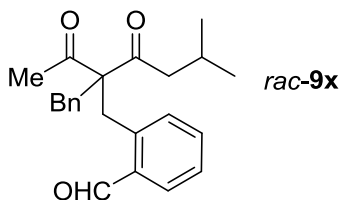
2-(2-(2-bromobenzoyl)-2-propionylpent-4-en-1-yl)benzaldehyde (*rac-9h*):

Colorless oil, 292.6 mg, 71% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.13 (s, 1H), 7.79 (dd, $J = 7.6, 1.5$ Hz, 1H), 7.61 (dt, $J = 7.1, 3.3$ Hz, 1H), 7.47 (td, $J = 7.5, 1.6$ Hz, 1H), 7.41 (td, $J = 7.4, 1.0$ Hz, 1H), 7.31–7.22 (m, 3H), 7.05–6.97 (m, 1H), 5.59 (ddt, $J = 17.0, 10.2, 6.9$ Hz, 1H), 5.01 (ddd, $J = 18.5, 13.6, 1.5$ Hz, 2H), 4.01 (d, $J = 14.5$ Hz, 1H), 3.82 (d, $J = 14.5$ Hz, 1H), 2.84–2.70 (m, 2H), 2.66–2.41 (m, 2H), 0.94 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.8, 201.8, 192.5, 139.8, 138.6, 135.2, 134.3, 133.3, 132.8, 132.4, 132.4, 131.5, 127.5, 127.4, 126.9, 120.0, 119.5, 70.8, 37.3, 33.8, 33.2, 8.0; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{21}\text{BrO}_3\text{H}^+$ 413.0746, found 413.0741; IR (KBr thin film, cm^{-1}): ν 3495, 3065, 2977, 2934, 2740, 2364, 1695, 1595, 1576, 1407, 1205, 1026, 920, 755, 644.



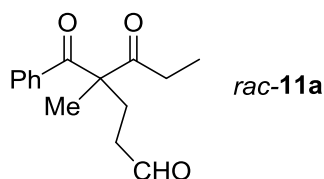
2-(2-(cyclopropanecarbonyl)-4,4-dimethyl-3-oxopentyl)benzaldehyde (*rac-9i*):

Yellow oil, 197.5 mg, 69% yield. ^1H NMR (400 MHz, CDCl_3) δ 10.18 (s, 1H), 7.81 (dd, $J = 7.3, 1.5$ Hz, 1H), 7.52–7.40 (m, 2H), 7.28 (d, $J = 7.3$ Hz, 1H), 4.63 (dd, $J = 8.8, 5.7$ Hz, 1H), 3.66 (dd, $J = 12.8, 5.7$ Hz, 1H), 3.51 (dd, $J = 12.8, 8.9$ Hz, 1H), 2.46–2.32 (m, 1H), 1.05–0.95 (m, 3H), 0.93–0.85 (m, 10H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.7, 205.9, 193.6, 140.4, 135.2, 133.8, 133.7, 132.9, 127.5, 62.4, 45.1, 33.6, 25.5, 19.3, 12.4, 12.1; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{22}\text{O}_3\text{H}^+$ 287.1641, found 287.1646; IR (KBr thin film, cm^{-1}): ν 3647, 3564, 3339, 3230, 3071, 2367, 1714, 1683, 1603, 1475, 1378, 1070, 756.

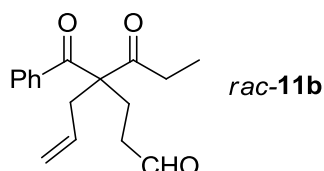


2-(2-acetyl-2-benzyl-5-methyl-3-oxohexyl)benzaldehyde (*rac-9x*): Yellow oil, 259.1 mg, 74% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.93 (s, 1H), 7.75 (d, $J = 7.5$ Hz, 1H), 7.48–7.37 (m, 2H), 7.19–7.15 (m, 4H), 6.87–6.85 (m, 2H), 3.79 (s, 2H), 3.38 (s, 2H), 2.45–2.30 (m, 2H), 2.19 (s, 3H), 2.14–2.06 (m, 1H), 0.86 (d, $J = 6.7$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 207.9, 206.4, 192.2, 139.0, 135.7, 134.7, 133.2, 133.1,

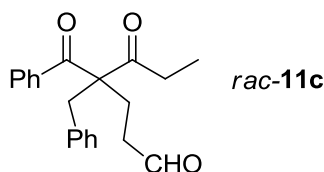
130.6, 129.5, 128.3, 127.0, 126.8, 71.4, 45.6, 37.9, 31.6, 28.1, 23.5, 22.38, 22.36; HRMS (ESI, m/z): calcd. for $C_{23}H_{26}O_3H^+$ 351.1955, found 351.1954; IR (KBr thin film, cm^{-1}): ν 2958, 2872, 1696, 1600, 1574, 1454, 1362, 1292, 1187, 756, 702.



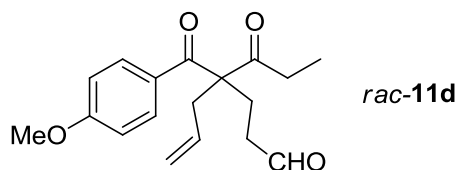
4-benzoyl-4-methyl-5-oxoheptanal (*rac*-11a): Yellow oil, 221.5 mg, 90% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.73 (s, 1H), 7.78–7.70 (m, 2H), 7.58–7.51 (m, 1H), 7.47–7.38 (m, 2H), 2.48–2.25 (m, 6H), 1.46 (s, 3H), 1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.6, 200.8, 198.8, 135.5, 133.2, 128.8, 128.8, 63.5, 38.7, 32.7, 27.6, 20.1, 8.1; HRMS (ESI, m/z): calcd. for $C_{15}H_{18}O_3H^+$ 247.1328, found 247.1327; IR (KBr thin film, cm^{-1}): ν 3590, 3347, 3225, 3065, 2980, 2943, 2358, 1717, 1677, 1620, 1460, 1378, 1258, 1090, 962, 711.



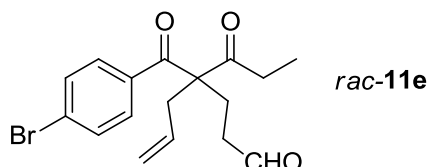
4-benzoyl-4-propionylhept-6-enal (*rac*-11b): Colorless oil, 250.4 mg, 92% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.67 (s, 1H), 7.79–7.72 (m, 2H), 7.55 (t, J = 7.4 Hz, 1H), 7.43 (t, J = 7.8 Hz, 2H), 5.46 (ddt, J = 17.4, 10.2, 7.4 Hz, 1H), 5.13–4.95 (m, 2H), 2.79 (d, J = 7.3 Hz, 2H), 2.48–2.31 (m, 4H), 2.31–2.14 (m, 2H), 0.99 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.7, 200.5, 198.0, 135.8, 133.4, 131.5, 128.9, 128.6, 119.6, 67.0, 37.9, 36.2, 33.4, 23.8, 8.0; HRMS (ESI, m/z): calcd. for $C_{17}H_{20}O_3H^+$ 273.1485, found 273.1485; IR (KBr thin film, cm^{-1}): ν 3567, 3350, 3228, 3082, 2358, 1717, 1671, 1597, 1503, 1455, 1395, 1215, 927, 691.



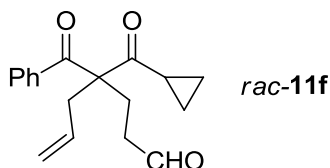
4-benzoyl-4-benzyl-5-oxoheptanal (*rac*-11c): Yellow oil, 283.5 mg, 88% yield. 1H NMR (400 MHz, $CDCl_3$) δ 9.64 (s, 1H), 7.84–7.73 (m, 2H), 7.57 (t, J = 7.4 Hz, 1H), 7.45 (t, J = 7.7 Hz, 2H), 7.18 (dd, J = 6.7, 3.6 Hz, 3H), 6.91–6.80 (m, 2H), 3.49–3.34 (m, 2H), 2.55–2.18 (m, 6H), 1.00 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.0, 200.3, 197.9, 135.8, 135.5, 133.3, 129.8, 129.0, 128.9, 128.5, 127.1, 68.0, 38.2, 37.9, 33.8, 23.7, 7.9; HRMS (ESI, m/z): calcd. for $C_{21}H_{22}O_3H^+$ 323.1641, found 323.1644; IR (KBr thin film, cm^{-1}): ν 3624, 3342, 3228, 3057, 2940, 2723, 2367, 1725, 1668, 1603, 1497, 1457, 1255, 753, 702, 591.



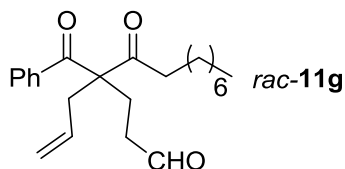
4-(4-methoxybenzoyl)-4-propionylhept-6-enal (*rac*-11d): Colorless oil, 256.8 mg, 85% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.67 (s, 1H), 7.85–7.70 (m, 2H), 6.89 (d, J = 9.0 Hz, 2H), 5.47 (ddt, J = 17.5, 10.3, 7.4 Hz, 1H), 5.04 (dd, J = 20.6, 5.4 Hz, 2H), 3.86 (s, 3H), 2.85–2.70 (m, 2H), 2.46–2.29 (m, 4H), 2.30–2.13 (m, 2H), 0.98 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 210.2, 200.6, 196.0, 163.6, 131.7, 131.1, 128.5, 119.4, 114.1, 66.6, 55.5, 37.9, 36.2, 33.4, 23.9, 8.1; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{22}\text{O}_4\text{H}^+$ 303.1590, found 303.1594; IR (KBr thin film, cm^{-1}): ν 3567, 3356, 3245, 2974, 2361, 2341, 1714, 1663, 1597, 1543, 1503, 1398, 1264, 1172, 1024, 842, 671.



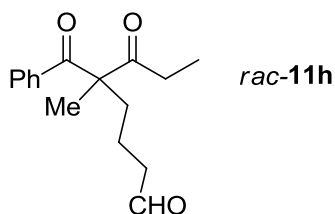
4-(4-bromobenzoyl)-4-propionylhept-6-enal (*rac*-11e): Yellow oil, 238.0 mg, 68% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.67–7.61 (m, 2H), 7.61–7.55 (m, 2H), 5.45 (ddt, J = 17.5, 10.2, 7.4 Hz, 1H), 5.12–4.97 (m, 2H), 2.78 (d, J = 7.4 Hz, 2H), 2.47–2.15 (m, 6H), 1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.5, 200.2, 196.9, 134.4, 132.2, 131.2, 130.1, 128.6, 119.7, 66.9, 37.8, 36.1, 33.4, 23.7, 8.0; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{19}\text{BrO}_3\text{H}^+$ 351.0590, found 351.0589; IR (KBr thin film, cm^{-1}): ν 3635, 3342, 3222, 3071, 2829, 2746, 2361, 1671, 1728, 1623, 1460, 1141, 1070, 922, 716, 588, 460.



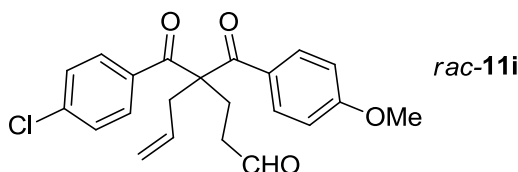
4-benzoyl-4-(cyclopropanecarbonyl)hept-6-enal (*rac*-11f): Colorless oil, 227.3 mg, 80% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.68 (s, 1H), 7.85–7.76 (m, 2H), 7.59–7.51 (m, 1H), 7.42 (t, J = 7.7 Hz, 2H), 5.48 (ddt, J = 17.6, 10.2, 7.4 Hz, 1H), 5.11–4.98 (m, 2H), 2.84 (dd, J = 7.4, 0.8 Hz, 2H), 2.53–2.15 (m, 4H), 1.84 (dq, J = 7.7, 4.5 Hz, 1H), 1.15–1.05 (m, 2H), 0.92–0.78 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.0, 200.6, 198.3, 136.0, 133.2, 131.6, 128.8, 128.8, 128.7, 128.5, 119.5, 67.1, 37.9, 35.9, 23.6, 19.9, 13.3, 13.2; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{20}\text{O}_3\text{H}^+$ 285.1485, found 285.1486; IR (KBr thin film, cm^{-1}): ν 3595, 3353, 3230, 3068, 2364, 1728, 1668, 1614, 1466, 1386, 1070, 922, 699, 597, 451.



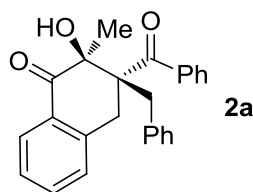
4-allyl-4-benzoyl-5-oxotridecanal (*rac*-11g): Colorless oil, 320.6 mg, 90% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.67 (s, 1H), 7.77 (d, J = 7.5 Hz, 2H), 7.55 (t, J = 7.4 Hz, 1H), 7.43 (t, J = 7.7 Hz, 2H), 5.54–5.38 (m, 1H), 5.04 (dd, J = 14.9, 14.0 Hz, 2H), 2.80 (d, J = 7.3 Hz, 2H), 2.47–2.14 (m, 6H), 1.59–1.43 (m, 2H), 1.27–1.11 (m, 10H), 0.85 (t, J = 7.0 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.0, 200.4, 198.0, 135.8, 133.3, 131.5, 128.8, 128.7, 119.5, 67.0, 40.0, 37.9, 36.1, 31.7, 29.2, 29.0, 28.9, 23.7, 23.6, 22.6, 14.0; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{32}\text{O}_3\text{H}^+$ 357.2424, found 357.2425; IR (KBr thin film, cm^{-1}): ν 3635, 3350, 3228, 3054, 2923, 2364, 1740, 1671, 1614, 1472, 1358, 956, 711, 594, 451.



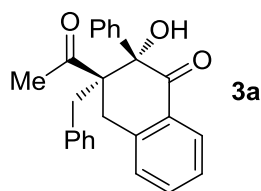
5-benzoyl-5-methyl-6-oxooctanal (*rac*-11h): Colorless oil, 215.9 mg, 83% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.70 (d, J = 1.2 Hz, 1H), 7.79–7.71 (m, 2H), 7.54 (t, J = 7.4 Hz, 1H), 7.42 (t, J = 7.7 Hz, 2H), 2.41 (ddd, J = 21.6, 10.7, 4.1 Hz, 4H), 2.12–1.93 (m, 2H), 1.55–1.34 (m, 5H), 1.00 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 210.8, 201.6, 199.1, 135.8, 133.1, 128.7, 128.7, 64.5, 43.9, 35.0, 32.7, 19.9, 16.5, 8.2; HRMS (ESI, m/z): calcd. for $\text{C}_{16}\text{H}_{20}\text{O}_3\text{H}^+$ 261.1485, found 261.1487; IR (KBr thin film, cm^{-1}): ν 3635, 3342, 3228, 3068, 2908, 2361, 1745, 1671, 1626, 1489, 962, 725, 588, 460.



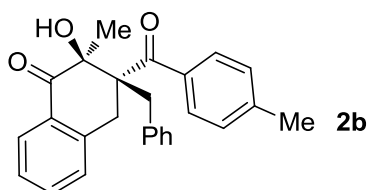
4-(4-chlorobenzoyl)-4-(4-methoxybenzoyl)hept-6-enal (*rac*-11i): Yellow oil, 353.4 mg, 92% yield. ^1H NMR (400 MHz, CDCl_3) δ 9.65 (s, 1H), 7.86–7.81 (m, 2H), 7.81–7.76 (m, 2H), 7.34–7.25 (m, 2H), 6.86–6.76 (m, 2H), 5.46 (ddt, J = 17.5, 10.1, 7.5 Hz, 1H), 5.08–5.02 (m, 1H), 4.98–4.90 (m, 1H), 3.80 (d, J = 7.9 Hz, 3H), 3.01–2.83 (m, 2H), 2.62–2.44 (m, 2H), 2.32–2.16 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 200.5, 197.9, 196.6, 163.7, 139.9, 134.1, 131.4, 131.2, 130.4, 129.1, 128.6, 119.8, 114.1, 64.9, 55.5, 37.7, 37.4, 25.3; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{21}\text{ClO}_4\text{H}^+$ 385.1201, found 385.1202; IR (KBr thin film, cm^{-1}): ν 3635, 3347, 3228, 3068, 2364, 1757, 1663, 1603, 1492, 1355, 947, 711, 588, 466, 409.



(2S,3R)-3-benzoyl-3-benzyl-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1(2H)-one (2a): Yellow oil, 37.8 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (d, J = 7.7 Hz, 1H), 7.80 (d, J = 7.4 Hz, 2H), 7.62 (td, J = 7.4, 1.1 Hz, 1H), 7.50 (t, J = 7.3 Hz, 1H), 7.43–7.39 (m, 3H), 7.22 (d, J = 7.2 Hz, 1H), 7.14–7.04 (m, 3H), 6.52 (d, J = 7.1 Hz, 2H), 4.72 (s, 1H), 4.02 (d, J = 14.4 Hz, 1H), 3.71 (d, J = 18.0 Hz, 1H), 3.05 (d, J = 18.1 Hz, 1H), 2.62 (d, J = 14.4 Hz, 1H), 1.39 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 206.6, 200.2, 141.1, 140.7, 136.8, 135.3, 131.5, 130.3, 129.9, 129.1, 128.9, 128.3, 128.22, 128.17, 127.3, 126.9, 79.0, 62.4, 36.3, 34.0, 23.7; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{22}\text{O}_3\text{H}^+$ 371.1642, found 371.1642; $[\alpha]_{\text{D}}^{20}$: +45.2 (c 0.59, CHCl_3); HPLC analysis: 87% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 5.7 min, R_t (minor) = 5.3 min; IR (KBr thin film, cm^{-1}): ν 3461, 2925, 1683, 1602, 1456, 1373, 1286, 1234, 1174, 1091, 1028, 971, 796, 747, 702.

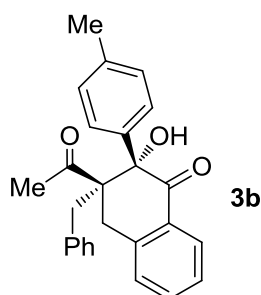


(2S,3R)-3-acetyl-3-benzyl-2-hydroxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (3a): Yellow oil, 34.1 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.21 (d, J = 7.7 Hz, 1H), 7.68 (t, J = 7.2 Hz, 1H), 7.49 (t, J = 7.5 Hz, 1H), 7.31–7.29 (m, 2H), 7.23–7.22 (m, 4H), 7.15–7.14 (m, 3H), 6.73–6.72 (m, 2H), 4.73 (s, 1H), 3.88 (d, J = 14.6 Hz, 1H), 3.39 (d, J = 18.1 Hz, 1H), 2.78 (d, J = 18.1 Hz, 1H), 2.66 (d, J = 14.6 Hz, 1H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.0, 198.6, 142.4, 139.0, 136.6, 135.6, 131.1, 130.4, 129.7, 128.6, 128.5, 128.4, 128.2, 127.6, 126.9, 126.2, 81.7, 62.4, 36.4, 31.8, 30.0; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{22}\text{O}_3\text{H}^+$ 371.1642, found 371.1642; $[\alpha]_{\text{D}}^{20}$: +53.5 (c 11.59, CHCl_3); HPLC analysis: 98% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 7.6 min, R_t (minor) = 6.2 min; IR (KBr thin film, cm^{-1}): ν 3463, 2927, 1683, 1601, 1493, 1447, 1281, 1175, 1030, 906, 744, 702.

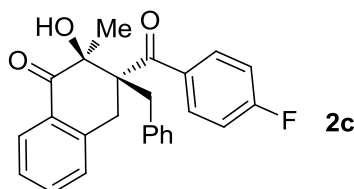


(2S,3R)-3-benzyl-2-hydroxy-2-methyl-3-(4-methylbenzoyl)-3,4-dihydronaphthalen-1(2H)-one (2b): Yellow oil, 46.9 mg, 61% yield. ^1H NMR (400 MHz, CDCl_3) δ

8.12 (d, $J = 7.8$ Hz, 1H), 7.77 (d, $J = 8.3$ Hz, 2H), 7.61 (td, $J = 7.5, 1.4$ Hz, 1H), 7.42 (t, $J = 7.6$ Hz, 1H), 7.23–7.20 (m, 3H), 7.13–7.04 (m, 3H), 6.53 (d, $J = 7.0$ Hz, 2H), 4.73 (s, 1H), 4.03 (d, $J = 15.1$ Hz, 1H), 3.70 (d, $J = 18.2$ Hz, 1H), 3.02 (d, $J = 18.2$ Hz, 1H), 2.61 (d, $J = 14.4$ Hz, 1H), 2.41 (s, 3H), 1.36 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 205.9, 200.3, 142.2, 141.3, 137.8, 136.9, 135.3, 130.2, 129.9, 129.6, 128.9, 128.8, 128.3, 128.2, 127.3, 126.8, 78.9, 62.4, 36.4, 34.1, 23.7, 21.7; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; $[\alpha]_{\text{D}}^{20}$: +30.0 (c 1.65, CHCl_3); HPLC analysis: 70% ee (Chiralcel AS-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 7.0 min, R_t (minor) = 5.9 min; IR (KBr thin film, cm^{-1}): ν 3460, 2924, 1683, 1660, 1605, 1456, 1373, 1286, 1202, 1179, 1090, 971, 743, 703.

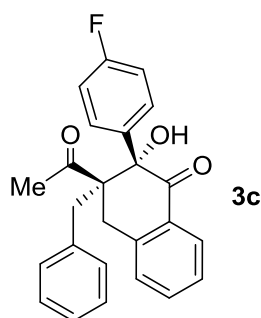


(2S,3R)-3-acetyl-3-benzyl-2-hydroxy-2-(p-tolyl)-3,4-dihydronaphthalen-1(2H)-one (3b): Yellow oil, 29.2 mg, 38% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (dd, $J = 7.8, 1.0$ Hz, 1H), 7.67 (td, $J = 7.5, 1.3$ Hz, 1H), 7.48 (t, $J = 7.6$ Hz, 1H), 7.21 (d, $J = 7.7$ Hz, 1H), 7.17–7.14 (m, 5H), 7.01 (d, $J = 8.2$ Hz, 2H), 6.72–6.69 (m, 2H), 4.67 (s, 1H), 3.85 (d, $J = 14.6$ Hz, 1H), 3.38 (d, $J = 18.1$ Hz, 1H), 2.75 (d, $J = 18.1$ Hz, 1H), 2.64 (d, $J = 14.6$ Hz, 1H), 2.46 (s, 3H), 2.25 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.2, 198.8, 142.4, 138.3, 136.7, 136.0, 135.5, 131.2, 130.4, 129.7, 129.3, 128.5, 128.2, 127.5, 126.9, 126.1, 81.7, 62.5, 36.4, 31.8, 30.0, 21.1; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; $[\alpha]_{\text{D}}^{20}$: +53.0 (c 1.60, CHCl_3); HPLC analysis: 94% ee (Chiralcel AS-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 11.8 min, R_t (minor) = 9.8 min; IR (KBr thin film, cm^{-1}): ν 3461, 2925, 1698, 1683, 1602, 1456, 1360, 1279, 1174, 1093, 1040, 815, 754, 701.

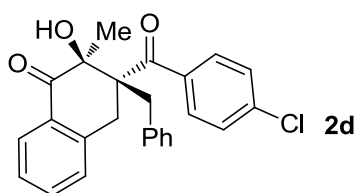


(2S,3R)-3-benzyl-3-(4-fluorobenzoyl)-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1(2H)-one (2c): Colorless oil, 40.4 mg, 52% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13–8.08 (m, 3H), 7.63 (t, $J = 6.9$ Hz, 1H), 7.43 (t, $J = 7.1$ Hz, 1H), 7.22 (d, $J = 7.3$ Hz, 1H), 7.14–7.04 (m, 5H), 6.44 (d, $J = 7.0$ Hz, 2H), 4.74 (s, 1H), 3.97 (d, $J = 14.6$ Hz, 1H), 3.78 (d, $J = 18.2$ Hz, 1H), 2.97 (d, $J = 18.2$ Hz, 1H), 2.62 (d, $J = 14.6$ Hz, 1H), 1.36 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 203.9, 200.4, 166.1, 163.6, 141.4,

136.6, 136.4, 135.5, 132.7 (d, $J = 8.7$ Hz), 130.1, 129.9, 128.7, 128.3, 127.3, 126.9, 115.2 (d, $J = 21.4$ Hz), 78.8, 62.7, 36.2, 33.9, 23.7; ^{19}F NMR (376 MHz, CDCl_3) δ 107.3; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1548; $[\alpha]_{\text{D}}^{20}$: +22.3 (c 1.10, CHCl_3); HPLC analysis: 77% ee (Chiralcel AS-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 5.9 min, R_t (minor) = 5.2 min; IR (KBr thin film, cm^{-1}): ν 3461, 2925, 1684, 1598, 1506, 1457, 1262, 1231, 1161, 1090, 971, 936, 797, 744, 702.

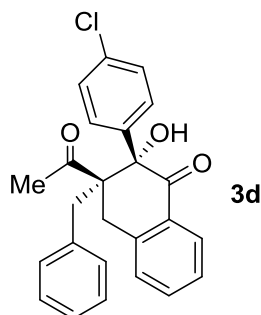


(2S,3R)-3-acetyl-3-benzyl-2-(4-fluorophenyl)-2-hydroxy-3,4-dihydronaphthalen-1-one (2H)-one (3c): Colorless oil, 34.2 mg, 44% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.20 (d, $J = 7.4$ Hz, 2H), 7.69 (t, $J = 6.7$ Hz, 1H), 7.50 (t, $J = 7.2$ Hz, 1H), 7.26–7.16 (m, 6H), 6.90 (t, $J = 8.4$ Hz, 2H), 6.70 (s, 2H), 4.73 (s, 1H), 3.84 (d, $J = 14.7$ Hz, 1H), 3.33 (d, $J = 18.2$ Hz, 1H), 2.76 (d, $J = 18.2$ Hz, 1H), 2.63 (d, $J = 14.5$ Hz, 1H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.0, 198.3, 163.8, 161.4, 142.3, 136.5, 135.8, 134.8 (d, $J = 3.3$ Hz), 130.9, 130.5, 129.7, 128.5, 128.2 (t, $J = 8.4$ Hz), 127.7, 127.0, 115.5 (d, $J = 21.3$ Hz), 81.3, 62.5, 36.4, 31.7, 30.0; ^{19}F NMR (376 MHz, CDCl_3) δ 113.4; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1548; $[\alpha]_{\text{D}}^{20}$: +36.2 (c 0.97, CHCl_3); HPLC analysis: 96% ee (Chiralcel AS-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.8 min, R_t (minor) = 8.7 min; IR (KBr thin film, cm^{-1}): ν 3461, 2926, 1698, 1683, 1601, 1507, 1456, 1361, 1262, 1229, 1163, 1090, 1030, 801, 756, 701.

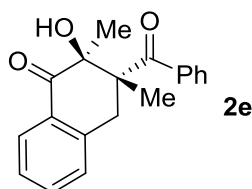


(2S,3R)-3-benzyl-3-(4-chlorobenzoyl)-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1-one (2H)-one (2d): Yellow oil, 44.5 mg, 55% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 7.0, 1.0$ Hz, 1H), 7.97–7.93 (m, 2H), 7.63 (td, $J = 7.5, 1.2$ Hz, 1H), 7.44–7.39 (m, 3H), 7.21 (d, $J = 7.8$ Hz, 1H), 7.13–7.02 (m, 3H), 6.46 (d, $J = 7.2$ Hz, 2H), 4.71 (s, 1H), 3.95 (d, $J = 15.0$ Hz, 1H), 3.75 (d, $J = 18.2$ Hz, 1H), 2.97 (d, $J = 18.2$ Hz, 1H), 2.62 (d, $J = 14.6$ Hz, 1H), 1.35 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 204.4, 200.2, 141.3, 138.6, 138.1, 136.5, 135.5, 131.3, 130.1, 129.9, 128.7, 128.4, 128.3, 128.2, 127.4, 127.0, 78.7, 62.7, 36.2, 33.9, 23.7; HRMS (ESI, m/z): calcd. for

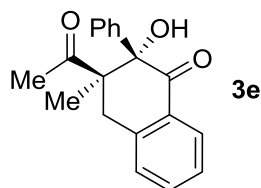
$C_{25}H_{21}ClO_3H^+$ 405.1252, found 405.1252; $[\alpha]_D^{20}$: +20.4 (c 1.66, $CHCl_3$); HPLC analysis: 77% ee (Chiralcel AS-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 5.9 min, R_t (minor) = 5.4 min; IR (KBr thin film, cm^{-1}): ν 3461, 2925, 1683, 1663, 1603, 1456, 1262, 1234, 1174, 1092, 1015, 971, 797, 744, 702.



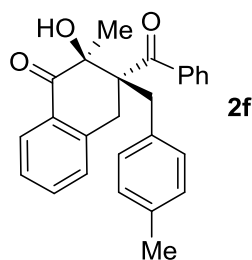
(2S,3R)-3-acetyl-3-benzyl-2-(4-chlorophenyl)-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (3d): Yellow oil, 34.0 mg, 42% yield. 1H NMR (400 MHz, $CDCl_3$) δ 8.19 (d, J = 7.8 Hz, 1H), 7.69 (td, J = 7.6, 1.1 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.23–7.15 (m, 8H), 6.71–6.68 (m, 2H), 4.75 (s, 1H), 3.84 (d, J = 14.7 Hz, 1H), 3.33 (d, J = 18.3 Hz, 1H), 2.76 (d, J = 18.3 Hz, 1H), 2.63 (d, J = 14.7 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.8, 198.1, 142.3, 137.5, 136.4, 135.9, 134.6, 130.9, 130.5, 129.7, 128.8, 128.5, 128.3, 127.7, 127.1, 81.3, 62.5, 36.4, 31.6, 30.0; HRMS (ESI, m/z): calcd. for $C_{25}H_{21}ClO_3H^+$ 405.1252, found 405.1252; $[\alpha]_D^{20}$: +46.5 (c 1.70, $CHCl_3$); HPLC analysis: 92% ee (Chiralcel AS-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 11.6 min, R_t (minor) = 9.8 min; IR (KBr thin film, cm^{-1}): ν 3459, 2925, 1698, 1683, 1602, 1491, 1456, 1361, 1283, 1094, 1013, 823, 736, 700.



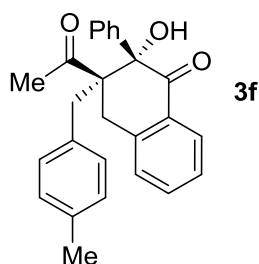
(2S,3R)-3-benzoyl-2-hydroxy-2,3-dimethyl-3,4-dihydronaphthalen-1(2H)-one (2e): White solid, m.p. 105–113 $^{\circ}C$, 30.0 mg, 51% yield. 1H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, J = 7.6 Hz, 1H), 7.95 (d, J = 7.5 Hz, 2H), 7.57 (t, J = 14.9 Hz, 1H), 7.49–7.46 (m, 1H), 7.43–7.35 (m, 3H), 7.28 (s, 1H), 4.38 (s, 1H), 4.10 (d, J = 17.8 Hz, 1H), 2.83 (d, J = 17.8 Hz, 1H), 1.42 (s, 3H), 1.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 206.5, 200.5, 141.6, 139.7, 134.9, 131.2, 129.94, 128.88, 128.83, 127.79, 127.1, 78.1, 56.9, 38.3, 22.8, 19.1; HRMS (ESI, m/z): calcd. for $C_{19}H_{18}O_3H^+$ 295.1329, found 295.1329; $[\alpha]_D^{20}$: +45.2 (c 1.70, $CHCl_3$); HPLC analysis: 77% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 6.5 min, R_t (minor) = 5.8 min; IR (KBr thin film, cm^{-1}): ν 3464, 2964, 1684, 1602, 1457, 1374, 1263, 1229, 1203, 1082, 965, 796, 720, 698, 659.



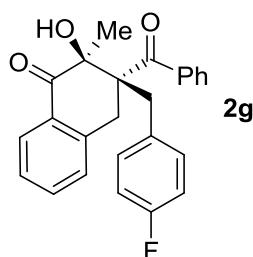
(2S,3R)-3-acetyl-2-hydroxy-3-methyl-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (3e): Yellow oil, 26.5 mg, 45% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (d, J = 7.8 Hz, 1H), 7.63 (t, J = 7.48 Hz, 1H), 7.43 (t, J = 7.5 Hz, 1H), 7.33 (d, J = 7.7 Hz, 1H), 7.19 (s, 5H), 4.62 (s, 1H), 3.59 (d, J = 18.0 Hz, 1H), 2.73 (d, J = 18.0 Hz, 1H), 2.48 (s, 3H), 1.38 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.0, 198.7, 142.9, 139.2, 135.3, 130.9, 130.4, 128.44, 128.38, 128.0, 127.4, 126.1, 81.2, 58.1, 35.7, 28.9, 18.5; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{18}\text{O}_3\text{H}^+$ 295.1329, found 295.1329; $[\alpha]_{\text{D}}^{20}$: +19.3 (c 1.48, CHCl_3); HPLC analysis: 95% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 4.5 min, R_t (minor) = 5.0 min; IR (KBr thin film, cm^{-1}): ν 3447, 2964, 1699, 1684, 1653, 1558, 1541, 1508, 1457, 1262, 1100, 1024, 801, 749, 705.



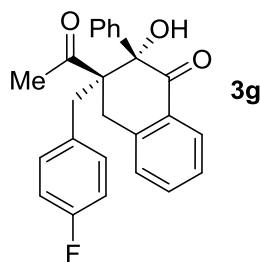
(2S,3R)-3-benzoyl-2-hydroxy-2-methyl-3-(4-methylbenzyl)-3,4-dihydronaphthalen-1(2H)-one (2f): White solid, m.p. 121–128 °C, 39.2 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, J = 7.7 Hz, 1H), 7.82 (d, J = 8.0 Hz, 2H), 7.62 (td, J = 7.4, 1.1 Hz, 1H), 7.51 (t, J = 7.3 Hz, 1H), 7.41 (t, J = 7.3 Hz, 3H), 7.22 (d, J = 7.3 Hz, 1H), 6.86 (d, J = 7.5 Hz, 2H), 6.38 (d, J = 7.7 Hz, 2H), 4.68 (s, 1H), 3.98 (d, J = 14.4 Hz, 1H), 3.69 (d, J = 18.1 Hz, 1H), 3.04 (d, J = 18.1 Hz, 1H), 2.57 (d, J = 14.4 Hz, 1H), 2.23 (s, 3H), 1.38 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 206.6, 200.2, 141.2, 140.7, 136.4, 135.3, 133.6, 131.5, 130.1, 129.9, 129.2, 129.0, 128.9, 128.2, 128.1, 127.3, 78.9, 62.4, 35.8, 34.0, 23.8, 21.1; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1798; $[\alpha]_{\text{D}}^{20}$: +25.9 (c 1.62, CHCl_3); HPLC analysis: 90% ee (Chiralcel IC, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 13.9 min, R_t (minor) = 12.9 min; IR (KBr thin film, cm^{-1}): ν 3468, 2924, 1681, 1660, 1597, 1446, 1283, 1233, 1178, 1093, 1029, 930, 790, 747, 730, 697.



(2*S*,3*R*)-3-acetyl-2-hydroxy-3-(4-methylbenzyl)-2-phenyl-3,4-dihydronaphthalen-1(2*H*)-one (3f): Yellow oil, 36.9 mg, 48% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (d, $J = 7.1$ Hz, 1H), 7.67 (td, $J = 6.6, 1.2$ Hz, 1H), 7.48 (t, $J = 6.8$ Hz, 1H), 7.29–7.19 (m, 6H), 6.95 (d, $J = 7.1$ Hz, 2H), 6.59 (d, $J = 7.4$ Hz, 2H), 4.70 (s, 1H), 3.81 (d, $J = 14.8$ Hz, 1H), 3.36 (d, $J = 18.0$ Hz, 1H), 2.78 (d, $J = 18.2$ Hz, 1H), 2.60 (d, $J = 14.7$ Hz, 1H), 2.44 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.2, 198.7, 142.5, 139.0, 136.5, 135.6, 133.4, 131.2, 130.4, 129.6, 129.2, 128.6, 128.5, 128.2, 127.6, 126.2, 81.7, 62.5, 35.9, 31.7, 30.0, 21.1; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1799; $[\alpha]_{\text{D}}^{20}$: +36.8 (c 1.64, CHCl_3); HPLC analysis: 97% ee (Chiralcel AD-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 15.1 min, R_t (minor) = 13.1 min; IR (KBr thin film, cm^{-1}): ν 3457, 2924, 1699, 1674, 1599, 1447, 1368, 1283, 1161, 1043, 791, 747, 702.

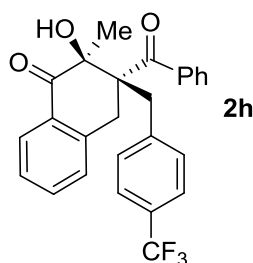


(2*S*,3*R*)-3-benzoyl-3-(4-fluorobenzyl)-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1(2*H*)-one (2g): White solid, m.p. 91–98 °C, 39.6 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 7.6$ Hz, 1H), 7.86 (d, $J = 7.4$ Hz, 2H), 7.63 (t, $J = 7.1$ Hz, 1H), 7.53 (t, $J = 6.9$ Hz, 1H), 7.45–7.43 (m, 3H), 7.22 (d, $J = 7.3$ Hz, 1H), 6.73 (t, $J = 8.4$ Hz, 2H), 6.41 (t, $J = 5.9$ Hz, 2H), 4.67 (s, 1H), 3.97 (d, $J = 14.6$ Hz, 1H), 3.76 (d, $J = 18.1$ Hz, 1H), 2.97 (d, $J = 18.2$ Hz, 1H), 2.59 (d, $J = 14.6$ Hz, 1H), 1.38 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 206.0, 200.2, 163.0, 160.6, 141.1, 140.5, 135.5, 132.4 (d, $J = 3.1$ Hz), 131.8, 131.7 (d, $J = 3.7$ Hz), 129.8, 129.3, 128.9, 128.3, 127.4, 115.1 (d, $J = 21.0$ Hz), 78.9, 62.4, 35.4, 33.9, 23.8; ^{19}F NMR (376 MHz, CDCl_3) δ 115.9; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1548; $[\alpha]_{\text{D}}^{20}$: +30.3 (c 1.30, CHCl_3); HPLC analysis: 90% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 5.4 min, R_t (minor) = 5.8 min; IR (KBr thin film, cm^{-1}): ν 3447, 2932, 1684, 1603, 1541, 1509, 1457, 1286, 1226, 1174, 735, 702.

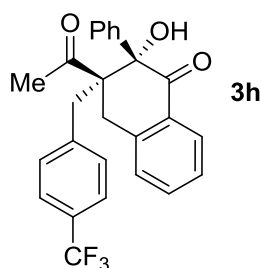


(2*S*,3*R*)-3-acetyl-3-(4-fluorobenzyl)-2-hydroxy-2-phenyl-3,4-dihydronaphthalen-1

(2H)-one (3g): White solid, m.p. 115–119 °C, 35.7 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.20 (d, $J = 7.2$ Hz, 1H), 7.69 (t, $J = 6.9$ Hz, 1H), 7.50 (t, $J = 7.3$ Hz, 1H), 7.29–7.23 (m, 6H), 6.84 (t, $J = 8.5$ Hz, 2H), 6.68–6.64 (m, 2H), 4.70 (br, 1H), 3.82 (d, $J = 14.6$ Hz, 1H), 3.39 (d, $J = 18.0$ Hz, 1H), 2.73 (d, $J = 18.1$ Hz, 1H), 2.62 (d, $J = 14.7$ Hz, 1H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 208.9, 198.5, 163.1, 160.7, 142.1, 138.9, 135.7, 132.3, 131.2 (d, $J = 7.7$ Hz), 130.3, 128.64, 128.59, 128.3, 127.7, 126.2, 115.3 (d, $J = 21.2$ Hz), 81.6, 62.4, 35.6, 31.8, 30.0; ^{19}F NMR (376 MHz, CDCl_3) δ 115.8; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{21}\text{FO}_3\text{H}^+$ 389.1547, found 389.1549; $[\alpha]_{\text{D}}^{20}$: +40.0 (c 1.60, CHCl_3); HPLC analysis: 96% ee (Chiralcel AD-H, 10:90 $^i\text{PrOH}$ /hexane, 1.00 mL/min), R_t (major) = 7.7 min, R_t (minor) = 6.8 min; IR (KBr thin film, cm^{-1}): ν 3462, 2926, 1683, 1602, 1509, 1447, 1263, 1224, 1160, 1099, 796, 747, 702.

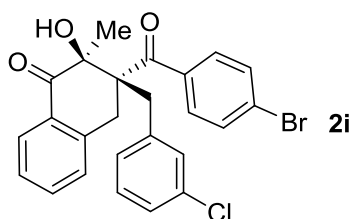


(2S,3R)-3-benzoyl-2-hydroxy-2-methyl-3-(4-(trifluoromethyl)benzyl)-3,4-dihydronaphthalen-1(2H)-one (2h): Colorless oil, 49.1 mg, 56% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (d, $J = 7.7$ Hz, 1H), 7.95 (d, $J = 7.7$ Hz, 2H), 7.64 (t, $J = 7.4$ Hz, 1H), 7.55 (t, $J = 7.1$ Hz, 1H), 7.47–7.42 (m, 3H), 7.28 (d, $J = 6.9$ Hz, 2H), 7.21 (d, $J = 7.6$ Hz, 1H), 6.53 (d, $J = 7.8$ Hz, 2H), 4.68 (s, 1H), 4.06 (d, $J = 14.4$ Hz, 1H), 3.84 (d, $J = 18.2$ Hz, 1H), 2.88 (d, $J = 18.2$ Hz, 1H), 2.68 (d, $J = 14.5$ Hz, 1H), 1.39 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 205.2, 200.2, 141.0, 140.3, 135.6, 131.9, 130.5, 129.8, 129.5, 129.3, 129.0, 128.8, 128.3 (d, $J = 2.5$ Hz), 127.5, 125.5, 125.1 (q, $J = 3.2$ Hz), 122.8, 78.8, 62.5, 36.1, 33.9, 23.7; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{21}\text{F}_3\text{O}_3\text{H}^+$ 439.1516, found 439.1516; $[\alpha]_{\text{D}}^{20}$: +31.4 (c 1.60, CHCl_3); HPLC analysis: 77% ee (Chiralcel IA, 5:95 $^i\text{PrOH}$ /hexane, 1.00 mL/min), R_t (major) = 6.2 min, R_t (minor) = 7.6 min; IR (KBr thin film, cm^{-1}): ν 3462, 2928, 1683, 1603, 1446, 1326, 1116, 972, 934, 855, 794, 741, 698.

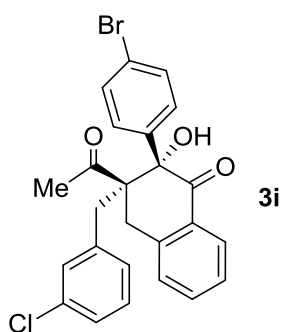


(2S,3R)-3-acetyl-2-hydroxy-2-phenyl-3-(4-(trifluoromethyl)benzyl)-3,4-dihydronaphthalen-1(2H)-one (3h): Colorless oil, 37.7 mg, 43% yield. ^1H NMR (400 MHz,

CDCl₃) δ 7.75–7.68 (m, 1H), 7.53–7.50 (m, 1H), 7.41 (d, J = 7.2 Hz, 2H), 7.27–7.24 (m, 6H), 7.21 (d, J = 6.9 Hz, 1H), 6.83–6.81 (m, 2H), 4.69 (s, 1H), 3.91 (d, J = 14.3 Hz, 1H), 3.43 (d, J = 18.1 Hz, 1H), 2.72–2.66 (m, 2H), 2.38 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 208.5, 198.4, 141.9, 141.0, 138.7, 135.8, 131.1, 130.3, 130.1, 128.7, 128.4, 127.9, 126.2, 125.4 (q, J = 3.5 Hz), 81.6, 62.3, 36.2, 31.8, 30.0; HRMS (ESI, m/z): calcd. for C₂₆H₂₁F₃O₃H⁺ 439.1516, found 439.1516; [α]_D²⁰: +39.4 (c 1.20, CHCl₃); HPLC analysis: 99% ee (Chiralcel IA, 5:95 ⁱPrOH/hexane, 1.00 mL/min), R_t (major) = 8.3 min, R_t (minor) = 8.9 min; IR (KBr thin film, cm⁻¹): ν 3462, 2926, 1683, 1602, 1447, 1326, 1262, 1164, 1113, 1069, 1019, 801, 739, 703.

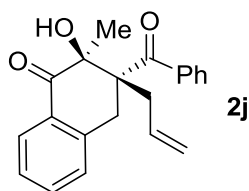


(2S,3R)-3-(4-bromobenzoyl)-3-(3-chlorobenzyl)-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1(2H)-one (2i): Colorless oil, 48.2 mg, 50% yield. ¹H NMR (400 MHz, CDCl₃) δ 8.12 (d, J = 7.7 Hz, 1H), 7.96 (d, J = 8.6 Hz, 2H), 7.67–7.60 (m, 3H), 7.44 (t, J = 7.6 Hz, 1H), 7.22 (d, J = 7.7 Hz, 1H), 7.07 (d, J = 8.1 Hz, 1H), 6.96 (t, J = 8.1 Hz, 1H), 6.31–6.30 (m, 2H), 4.68 (s, 1H), 3.88 (d, J = 7.1 Hz, 1H), 3.84 (d, J = 11.0 Hz, 1H), 2.87 (d, J = 18.3 Hz, 1H), 2.60 (d, J = 14.8 Hz, 1H), 1.36 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 203.9, 200.2, 141.2, 138.8, 138.5, 135.7, 134.0, 131.6, 131.5, 130.3, 129.8, 129.4, 128.7, 128.4, 128.1, 127.5, 127.1, 127.0, 78.5, 62.7, 35.8, 33.9, 23.7; HRMS (ESI, m/z): calcd. for C₂₅H₂₀BrClO₃H⁺ 483.0359, found 483.0357; [α]_D²⁰: +28.7 (c 0.42, CHCl₃); HPLC analysis: 83% ee (Chiralcel AD-H, 5:95 ⁱPrOH/hexane, 1.00 mL/min), R_t (major) = 7.2 min, R_t (minor) = 6.8 min; IR (KBr thin film, cm⁻¹): ν 3459, 2925, 1683, 1666, 1583, 1479, 1286, 1234, 1175, 1076, 971, 936, 791, 732.

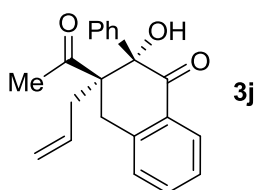


(2S,3R)-3-acetyl-2-(4-bromophenyl)-3-(3-chlorobenzyl)-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (3i): Colorless oil, 44.4 mg, 46% yield. ¹H NMR (400 MHz, CDCl₃) δ 8.18 (dd, J = 7.8, 1.0 Hz, 1H), 7.70 (td, J = 7.6, 1.3 Hz, 1H), 7.49 (t, J = 7.6 Hz, 1H), 7.35–7.31 (m, 2H), 7.23 (d, J = 7.7 Hz, 1H), 7.17–7.13 (m, 3H), 7.08 (t, J = 7.9 Hz, 1H), 6.63–6.61 (m, 2H), 4.75 (s, 1H), 3.78 (d, J = 14.7 Hz, 1H), 3.36 (d, J =

18.3 Hz, 1H), 2.72 (d, J = 18.3 Hz, 1H), 2.61 (d, J = 14.6 Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 208.3, 197.9, 142.0, 138.3, 137.9, 136.0, 134.3, 131.8, 130.8, 130.4, 130.0, 129.8, 128.4, 128.00, 127.95, 127.7, 127.3, 123.0, 81.3, 62.3, 36.1, 31.7, 29.9; HRMS (ESI, m/z): calcd. for $\text{C}_{25}\text{H}_{20}\text{BrClO}_3\text{H}^+$ 483.0357, found 483.0358; $[\alpha]_{\text{D}}^{20}$: +43.3 (c 1.40, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 10.1 min, R_t (minor) = 8.2 min; IR (KBr thin film, cm^{-1}): ν 3458, 2926, 1699, 1683, 1600, 1486, 1359, 1283, 1173, 1080, 1041, 1009, 820, 787, 730, 703.

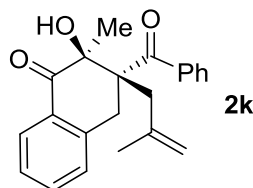


(2S,3R)-3-allyl-3-benzoyl-2-hydroxy-2-methyl-3,4-dihydronaphthalen-1(2H)-one (2j): White solid, m.p. 75–88 °C, 34.6 mg, 54% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.10–8.05 (m, 3H), 7.58 (t, J = 7.0 Hz, 1H), 7.52–7.48 (m, 1H), 7.44–7.36 (m, 3H), 7.28 (s, 1H), 5.32–5.22 (m, 1H), 4.85 (d, J = 10.1 Hz, 1H), 4.54 (d, J = 16.9 Hz, 1H), 4.50 (s, 1H), 3.95 (d, J = 18.1 Hz, 1H), 3.35 (dd, J = 14.7, 4.2 Hz, 1H), 3.06 (d, J = 18.1 Hz, 1H), 2.03 (dd, J = 14.8, 9.0 Hz, 1H), 1.36 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 205.1, 200.6, 141.5, 140.3, 135.2, 133.0, 131.5, 129.9, 129.2, 128.8, 128.1, 128.0, 127.1, 119.7, 78.1, 61.3, 34.4, 33.9, 23.5; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{20}\text{O}_3\text{H}^+$ 321.1485, found 321.1485; $[\alpha]_{\text{D}}^{20}$: +5.2 (c 1.8, CHCl_3); HPLC analysis: 70% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 10.4 min, R_t (minor) = 7.2 min; IR (KBr thin film, cm^{-1}): ν 3463, 2934, 1684, 1603, 1373, 1284, 1219, 1176, 1081, 972, 946, 930, 795, 748, 726, 698, 658.

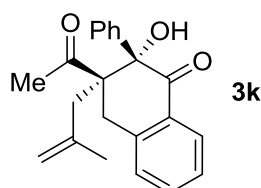


(2S,3R)-3-acetyl-3-allyl-2-hydroxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (3j): Yellow oil, 26.9 mg, 42% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.14 (dd, J = 7.7, 1.0 Hz, 1H), 7.64 (td, J = 7.1, 1.3 Hz, 1H), 7.44 (t, J = 7.6 Hz, 1H), 7.32 (d, J = 7.7 Hz, 1H), 7.20 (s, 5H), 5.51–5.41 (m, 1H), 5.01 (dd, J = 10.1, 0.8 Hz, 1H), 4.84 (dd, J = 16.9, 1.5 Hz, 1H), 4.60 (s, 1H), 3.41 (d, J = 18.1 Hz, 1H), 3.24 (dd, J = 14.8, 5.9 Hz, 1H), 2.94 (d, J = 18.2 Hz, 1H), 2.49 (s, 3H), 2.12 (dd, J = 14.8, 8.3 Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.0, 198.7, 142.4, 139.2, 135.5, 132.5, 131.1, 130.3, 128.51, 128.47, 128.0, 127.5, 126.1, 119.6, 81.3, 61.7, 34.4, 31.6, 29.5; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{20}\text{O}_3\text{H}^+$ 321.1485, found 321.1485; $[\alpha]_{\text{D}}^{20}$: +30.1 (c 1.40, CHCl_3); HPLC analysis: 97% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t

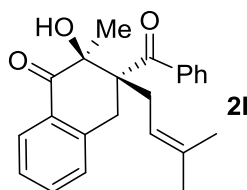
(major) = 5.6 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3462, 2925, 1683, 1602, 1491, 1447, 1361, 1282, 1198, 1022, 774, 750, 701.



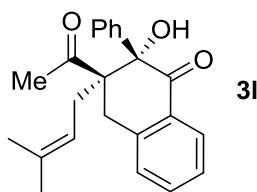
(2S,3R)-3-benzoyl-2-hydroxy-2-methyl-3-(2-methylallyl)-3,4-dihydronaphthalen-1(2H)-one (2k): Yellow solid, m.p. 79–85 °C, 35.4 mg, 53% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.11 (d, J = 6.0 Hz, 2H), 8.06 (d, J = 7.4 Hz, 1H), 7.57 (t, J = 6.7 Hz, 1H), 7.50–7.48 (m, 1H), 7.43–7.35 (m, 3H), 7.28 (s, 1H), 4.64 (s, 1H), 4.53 (s, 1H), 4.15 (s, 1H), 3.97 (d, J = 17.9 Hz, 1H), 3.41 (d, J = 15.6 Hz, 1H), 3.21 (d, J = 18.1 Hz, 1H), 2.15 (d, J = 15.7 Hz, 1H), 1.55 (s, 3H), 1.32 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 205.5, 200.7, 141.9, 141.3, 140.2, 135.2, 131.6, 130.02, 129.96, 128.4, 127.9, 127.0, 115.0, 78.4, 61.0, 38.1, 34.0, 24.2, 23.4; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{22}\text{O}_3\text{H}^+$ 335.1642, found 335.1642; $[\alpha]_{\text{D}}^{20}$: +44.8 (c 1.69, CHCl_3); HPLC analysis: 82% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 6.3 min, R_t (minor) = 5.1 min; IR (KBr thin film, cm^{-1}): ν 3462, 2925, 1684, 1655, 1603, 1457, 1287, 1233, 1203, 1175, 971, 743, 699.



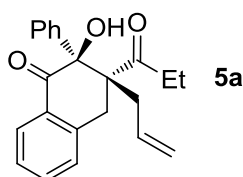
(2S,3R)-3-acetyl-2-hydroxy-3-(2-methylallyl)-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (3k): Yellow oil, 28.1 mg, 42% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.14 (dd, J = 7.4, 0.9 Hz, 1H), 7.63 (td, J = 7.1, 1.2 Hz, 1H), 7.43 (t, J = 6.9 Hz, 1H), 7.30 (d, J = 7.2 Hz, 1H), 7.24–7.17 (m, 5H), 4.69 (s, 1H), 4.59 (s, 1H), 4.15 (s, 1H), 3.49 (d, J = 18.0 Hz, 1H), 3.22 (d, J = 15.2 Hz, 1H), 3.00 (d, J = 18.0 Hz, 1H), 2.49 (s, 3H), 2.17 (d, J = 15.3 Hz, 1H), 1.54 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.0, 198.7, 142.9, 141.0, 138.9, 135.4, 130.8, 130.5, 128.5, 127.9, 127.3, 126.1, 115.2, 81.7, 60.9, 38.4, 31.7, 29.7, 23.6; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{22}\text{O}_3\text{H}^+$ 335.1642, found 335.1642; $[\alpha]_{\text{D}}^{20}$: +17.7 (c 1.70, CHCl_3); HPLC analysis: 96% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 8.0 min, R_t (minor) = 5.5 min; IR (KBr thin film, cm^{-1}): ν 3461, 2926, 1683, 1601, 1490, 1456, 1361, 1263, 1176, 1015, 896, 794, 770, 737, 702.



(2S,3R)-3-benzoyl-2-hydroxy-2-methyl-3-(3-methylbut-2-en-1-yl)-3,4-dihydronaphthalen-1(2H)-one (2I): White solid, m.p. 98–105 °C, 34.8 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.04 (d, J = 7.6 Hz, 3H), 7.56 (td, J = 7.5, 1.2 Hz, 1H), 7.49–7.34 (m, 4H), 7.27–7.26 (s, 1H), 4.68–4.64 (t, J = 5.4 Hz, 1H), 4.49 (s, 1H), 3.92 (d, J = 18.1 Hz, 1H), 3.14 (dd, J = 15.0, 4.4 Hz, 1H), 3.04 (d, J = 18.2 Hz, 1H), 2.12 (dd, J = 15.3, 9.0 Hz, 1H), 1.47 (s, 3H), 1.35 (s, 3H), 1.02 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 205.9, 200.8, 141.9, 140.7, 136.2, 135.0, 131.3, 130.0, 129.1, 128.8, 128.0, 127.8, 127.0, 118.9, 78.1, 62.0, 34.0, 28.7, 26.0, 23.6, 17.8; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1798; $[\alpha]_{\text{D}}^{20}$: +28.2 (c 1.50, CHCl_3); HPLC analysis: 75% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 4.0 min, R_t (minor) = 4.4 min; IR (KBr thin film, cm^{-1}): ν 3461, 2929, 1670, 1684, 1601, 1490, 1447, 1358, 1282, 1127, 1075, 1052, 979, 748, 724, 701.

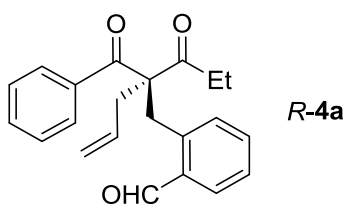


(2S,3R)-3-acetyl-2-hydroxy-3-(3-methylbut-2-en-1-yl)-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (3I): Yellow oil, 30.6 mg, 44% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (dd, J = 7.8, 1.0 Hz, 1H), 7.61 (td, J = 7.5, 1.4 Hz, 1H), 7.42 (t, J = 7.6 Hz, 1H), 7.30 (d, J = 7.7 Hz, 1H), 7.19 (s, 5H), 4.78–4.74 (s, 1H), 4.62 (s, 1H), 3.38 (d, J = 17.8 Hz, 1H), 3.09 (dd, J = 13.9, 4.9 Hz, 1H), 2.90 (d, J = 17.8 Hz, 1H), 2.48 (s, 3H), 2.15 (dd, J = 15.3, 8.7 Hz, 1H), 1.60 (s, 3H), 1.19 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 209.7, 198.8, 143.0, 139.4, 136.1, 135.3, 131.1, 130.4, 128.5, 128.4, 127.8, 127.3, 126.1, 118.2, 81.4, 62.1, 31.7, 29.4, 28.7, 26.1, 17.9; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1798; $[\alpha]_{\text{D}}^{20}$: +9.4 (c 1.40, CHCl_3); HPLC analysis: 94% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 4.7 min, R_t (minor) = 3.8 min; IR (KBr thin film, cm^{-1}): ν 3512, 2936, 1684, 1666, 1599, 1437, 1599, 1437, 1276, 1239, 1203, 1168, 1078, 944, 932, 750, 723, 698.

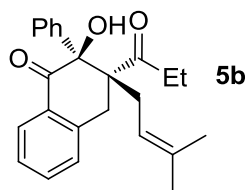


(2S,3R)-3-allyl-2-hydroxy-2-phenyl-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (5a): Yellow oil, 37.4 mg, 56% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.14 (d, J = 7.7

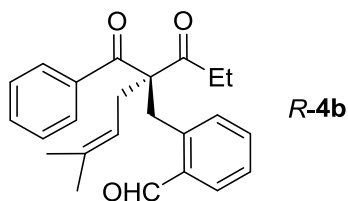
Hz, 1H), 7.64 (t, $J = 6.9$ Hz, 1H), 7.44 (t, $J = 7.5$ Hz, 1H), 7.32 (d, $J = 7.7$ Hz, 1H), 7.20–7.17 (m, 5H), 5.48–5.38 (m, 1H), 4.99 (d, $J = 10.1$ Hz, 1H), 4.80 (d, $J = 16.9$ Hz, 1H), 4.60 (s, 1H), 3.47 (d, $J = 18.0$ Hz, 1H), 3.29–3.18 (m, 2H), 2.96 (d, $J = 18.1$ Hz, 1H), 2.56 (dq, $J = 19.0, 7.1$ Hz, 1H), 2.09 (dd, $J = 14.8, 8.4$ Hz, 1H), 1.02 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.2, 198.8, 142.5, 139.2, 135.5, 132.8, 131.0, 130.3, 128.5, 128.0, 127.4, 126.1, 119.4, 81.3, 61.3, 34.6, 34.4, 31.7, 8.0; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{22}\text{O}_3\text{H}^+$ 335.1642, found 335.1642; $[\alpha]_{\text{D}}^{20}$: +14.9 (c 1.50, CHCl_3); HPLC analysis: 69% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 6.3 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3446, 2924, 1699, 1684, 1558, 1541, 1507, 1457, 1280, 988, 751, 701.



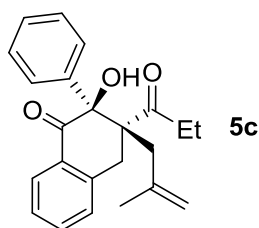
(R)-2-(2-benzoyl-2-propionylpent-4-en-1-yl)benzaldehyde (R-4a): Colorless oil, 27.4 mg, 41% yield. $[\alpha]_{\text{D}}^{20}$: +14.9 (c 1.4, CHCl_3); HPLC analysis: 95% ee (Chiralcel IA, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 11.3 min, R_t (minor) = 8.9 min.



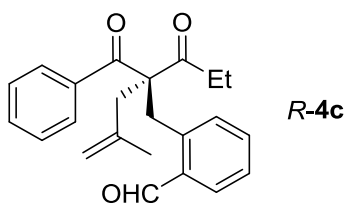
(2S,3R)-2-hydroxy-3-(3-methylbut-2-en-1-yl)-2-phenyl-3-propionyl-3,4-dihydro-1(2H)-naphthalen-1-one (5b): Colorless oil, 39.1 mg, 54% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (d, $J = 7.8$ Hz, 1H), 7.61 (td, $J = 7.5, 1.2$ Hz, 1H), 7.42 (t, $J = 7.6$ Hz, 1H), 7.30 (d, $J = 7.6$ Hz, 1H), 7.21–7.14 (m, 5H), 4.73 (t, $J = 7.3$ Hz, 1H), 4.61 (s, 1H), 3.45 (d, $J = 18.2$ Hz, 1H), 3.27–3.17 (m, 1H), 3.10 (dd, $J = 15.6, 5.0$ Hz, 1H), 2.92 (d, $J = 18.2$ Hz, 1H), 2.61–2.51 (m, 1H), 2.14 (dd, $J = 15.4, 8.7$ Hz, 1H), 1.59 (s, 3H), 1.17 (s, 3H), 1.02 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.8, 198.9, 143.1, 139.5, 135.9, 135.2, 131.1, 130.5, 128.41, 128.36, 127.8, 127.3, 126.1, 118.5, 81.5, 61.8, 34.2, 31.9, 28.9, 26.1, 17.9, 8.0; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{26}\text{O}_3\text{H}^+$ 363.1955, found 363.1955; $[\alpha]_{\text{D}}^{20}$: +25.8 (c 1.28, CHCl_3); HPLC analysis: 70% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 7.0 min, R_t (minor) = 5.3 min; IR (KBr thin film, cm^{-1}): ν 3447, 2927, 1700, 1684, 1602, 1457, 1448, 1281, 1068, 987, 750, 730, 702.



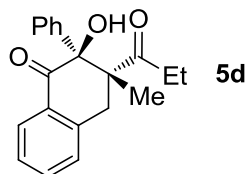
(R)-2-(2-benzoyl-5-methyl-2-propionylhex-4-en-1-yl)benzaldehyde (R-4b): Yellow oil, 30.4 mg, 42% yield. $[\alpha]_D^{20}$: +22.7 (c 1.07, CHCl₃); HPLC analysis: 86% ee (Chiralcel AD-H, 5:95 ⁱPrOH/hexane, 1.00 mL/min), R_t (major) = 14.1 min, R_t (minor) = 11.4 min.



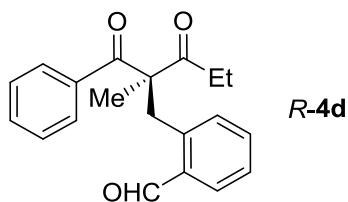
(2S,3R)-2-hydroxy-3-(2-methylallyl)-2-phenyl-3-propionyl-3,4-dihydronaphthalen-1-one (5c): White solid, m.p. 119–123 °C, 39.7 mg, 57% yield. ¹H NMR (400 MHz, CDCl₃) δ 8.14 (dd, J = 7.8, 0.9 Hz, 1H), 7.62 (td, J = 7.5, 1.3 Hz, 1H), 7.43 (t, J = 7.6 Hz, 1H), 7.30 (d, J = 7.7 Hz, 1H), 7.22–7.18 (m, 5H), 4.68 (s, 1H), 4.59 (s, 1H), 4.12 (s, 1H), 3.56 (d, J = 17.9 Hz, 1H), 3.25 (d, J = 15.4 Hz, 1H), 3.16–3.05 (m, 1H), 3.03 (d, J = 18.1 Hz, 1H), 2.60–2.50 (m, 1H), 2.14 (d, J = 15.4 Hz, 1H), 1.50 (s, 3H), 0.99 (t, J = 7.1 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 211.8, 198.7, 142.9, 141.2, 139.0, 135.3, 130.9, 130.5, 128.4, 127.9, 127.3, 126.2, 115.0, 81.7, 60.4, 38.5, 34.5, 31.9, 23.8, 7.9; HRMS (ESI, m/z): calcd. for C₂₃H₂₄O₃H⁺ 349.1798, found 349.1798; $[\alpha]_D^{20}$: +7.5 (c 1.70, CHCl₃); HPLC analysis: 69% ee (Chiralcel AD-H, 5:95 ⁱPrOH/hexane, 1.00 mL/min), R_t (major) = 8.9 min, R_t (minor) = 5.8 min; IR (KBr thin film, cm⁻¹): ν 3447, 2933, 1699, 1684, 1558, 1541, 1508, 1457, 1280, 985, 898, 736, 703.



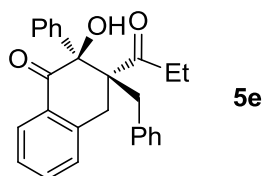
(R)-2-(2-benzoyl-4-methyl-2-propionylpent-4-en-1-yl)benzaldehyde (R-4c): Yellow oil, 29.3 mg, 42% yield. $[\alpha]_D^{20}$: +11.0 (c 1.53, CHCl₃); HPLC analysis: 93% ee (Chiralcel AD-H, 5:95 ⁱPrOH/hexane, 1.00 mL/min), R_t (major) = 7.2 min, R_t (minor) = 6.5 min.



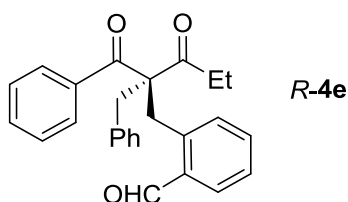
(2S,3R)-2-hydroxy-3-methyl-2-phenyl-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (5d): Yellow solid, m.p. 153–159 °C, 32.7 mg, 53% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (dd, $J = 7.8, 0.8$ Hz, 1H), 7.63 (td, $J = 7.5, 1.3$ Hz, 1H), 7.43 (t, $J = 7.6$ Hz, 1H), 7.34 (d, $J = 7.7$ Hz, 1H), 7.21–7.12 (m, 5H), 4.59 (s, 1H), 3.66 (d, $J = 18.0$ Hz, 1H), 3.23–3.13 (m, 1H), 2.73 (d, $J = 18.0$ Hz, 1H), 2.69–2.59 (m, 1H), 1.38 (s, 3H), 1.04 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 212.2, 198.8, 143.0, 139.3, 135.3, 130.9, 130.4, 128.3, 128.0, 127.3, 126.1, 81.3, 58.0, 35.9, 33.7, 18.5, 8.2; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{20}\text{O}_3\text{H}^+$ 309.1485, found 309.1485; $[\alpha]_{\text{D}}^{20}$: +29.4 (c 1.34, CHCl_3); HPLC analysis: 69% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.6 min, R_t (minor) = 7.4 min; IR (KBr thin film, cm^{-1}): ν 3457, 2933, 1701, 1684, 1558, 1541, 1508, 1489, 1457, 1279, 997, 751, 729, 702.



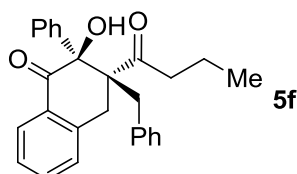
(R)-2-(2-benzoyl-2-methyl-3-oxopentyl)benzaldehyde (R-4d): Yellow oil, 27.1 mg, 44% yield. $[\alpha]_{\text{D}}^{20}$: +10.4 (c 1.00, CHCl_3); HPLC analysis: 85% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.4 min, R_t (minor) = 8.2 min.



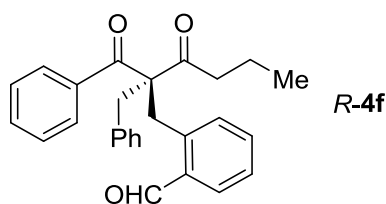
(2S,3R)-3-benzyl-2-hydroxy-2-phenyl-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (5e): Colorless oil, 38.4 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.21 (d, $J = 7.8$ Hz, 1H), 7.67 (t, $J = 7.5$ Hz, 1H), 7.49 (t, $J = 7.5$ Hz, 1H), 7.23–7.13 (m, 9H), 6.68–6.66 (m, 2H), 4.72 (s, 1H), 3.91 (d, $J = 14.4$ Hz, 1H), 3.45 (d, $J = 17.8$ Hz, 1H), 2.81 (d, $J = 17.8$ Hz, 1H), 2.74–2.63 (m, 1H), 2.59 (d, $J = 14.4$ Hz, 1H), 2.46–2.36 (m, 1H), 0.93 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.3, 198.6, 142.3, 139.2, 137.0, 135.5, 131.3, 130.3, 129.8, 128.54, 128.49, 128.4, 128.2, 127.6, 126.9, 81.8, 61.9, 36.7, 35.0, 31.8, 7.7; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{24}\text{O}_3\text{H}^+$ 385.1798, found 385.1800; $[\alpha]_{\text{D}}^{20}$: +7.1 (c 1.28, CHCl_3); HPLC analysis: 88% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 10.0 min, R_t (minor) = 8.4 min; IR (KBr thin film, cm^{-1}): ν 3461, 2925, 1699, 1683, 1601, 1456, 1262, 1098, 1024, 800, 743, 702.



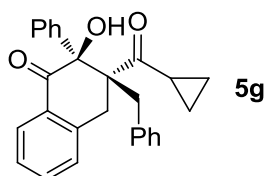
(R)-2-(2-benzoyl-2-benzyl-3-oxopentyl)benzaldehyde (R-4e): Yellow oil, 36.1 mg, 47% yield. $[\alpha]_D^{20}$: -9.2 (c 0.60, CHCl_3); HPLC analysis: 94% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 10.6 min, R_t (minor) = 10.1 min.



(2S,3R)-3-benzyl-3-butyryl-2-hydroxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (5f): White solid, m.p. 120–127 °C, 43.8 mg, 55% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.20 (dd, J = 7.8, 1.1 Hz, 1H), 7.67 (td, J = 7.5, 1.4 Hz, 1H), 7.49 (t, J = 7.6 Hz, 1H), 7.26–7.20 (m, 6H), 7.15–7.12 (m, 3H), 6.70–6.67 (m, 2H), 4.72 (s, 1H), 3.92 (d, J = 14.4 Hz, 1H), 3.46 (d, J = 17.7 Hz, 1H), 2.82 (d, J = 17.8 Hz, 1H), 2.60–2.52 (m, 2H), 2.32–2.23 (m, 1H), 1.51–1.40 (m, 2H), 0.83 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.8, 198.5, 142.2, 139.2, 137.0, 135.5, 131.3, 130.3, 129.9, 128.52, 128.45, 128.4, 128.2, 127.6, 126.8, 126.4, 81.8, 61.7, 43.8, 36.7, 31.9, 16.8, 13.8; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{26}\text{O}_3\text{H}^+$ 399.1955, found 399.1954; $[\alpha]_D^{20}$: $+23.9$ (c 1.85, CHCl_3); HPLC analysis: 71% ee (Chiralcel AD-H, 3:97 i PrOH/hexane, 1.00 mL/min), R_t (major) = 15.6 min, R_t (minor) = 13.8 min; IR (KBr thin film, cm^{-1}): ν 3461, 2930, 1699, 1683, 1602, 1456, 1280, 1003, 905, 742, 703.

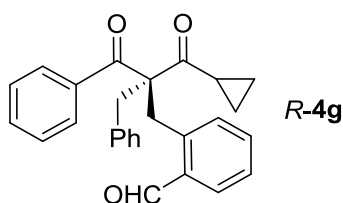


(R)-2-(2-benzoyl-2-benzyl-3-oxohexyl)benzaldehyde (R-4f): Yellow oil, 34.2 mg, 43% yield. $[\alpha]_D^{20}$: -6.8 (c 1.88, CHCl_3); HPLC analysis: 90% ee (Chiralcel AS-H, 10:90 i PrOH/hexane, 1.00 mL/min), R_t (major) = 7.4 min, R_t (minor) = 6.7 min.

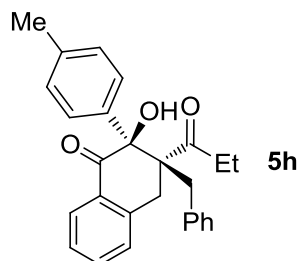


(2S,3R)-3-benzyl-3-(cyclopropanecarbonyl)-2-hydroxy-2-phenyl-3,4-dihydronap

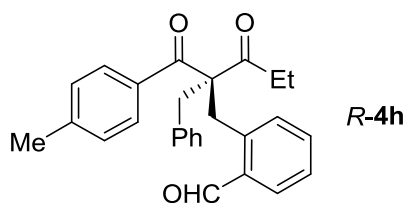
hthalen-1(2H)-one (5g): White solid, m.p. 157–162 °C, 41.5 mg, 53% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.22 (d, J = 7.8 Hz, 1H), 7.68 (td, J = 7.6, 1.2 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.37–7.35 (m, 2H), 7.26–7.13 (m, 7H), 6.80–6.77 (m, 2H), 4.78 (s, 1H), 4.02 (d, J = 14.6 Hz, 1H), 3.29–3.24 (m, 2H), 2.74–2.66 (m, 2H), 1.17–1.14 (m, 2H), 1.08–1.03 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.3, 199.3, 143.0, 139.3, 136.6, 135.6, 131.3, 130.6, 130.0, 128.4, 128.3, 128.2, 128.0, 127.5, 126.9, 126.6, 82.3, 63.0, 36.4, 31.5, 20.3, 14.8, 14.7; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{24}\text{O}_3\text{H}^+$ 397.1798, found 397.1799; $[\alpha]_{\text{D}}^{20}$: +21.3 (c 1.9, CHCl_3); HPLC analysis: 79% ee (Chiralcel AD-H, 10:90 $^i\text{PrOH}$ /hexane, 1.00 mL/min), R_{t} (major) = 9.1 min, R_{t} (minor) = 7.0 min; IR (KBr thin film, cm^{-1}): ν 3462, 2923, 1683, 1653, 1601, 1456, 1280, 1004, 737, 701.



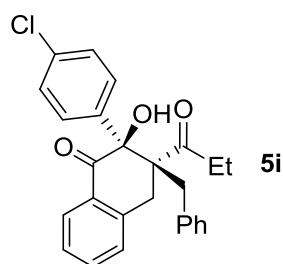
(R)-2-(2-benzoyl-2-benzyl-3-cyclopropyl-3-oxopropyl)benzaldehyde (R-4g): Yellow oil, 35.7 mg, 45% yield. $[\alpha]_{\text{D}}^{20}$: -4.9 (c 1.67, CHCl_3); HPLC analysis: 94% ee (Chiralcel IA, 10:90 $^i\text{PrOH}$ /hexane, 1.00 mL/min), R_{t} (major) = 9.3 min, R_{t} (minor) = 10.0 min.



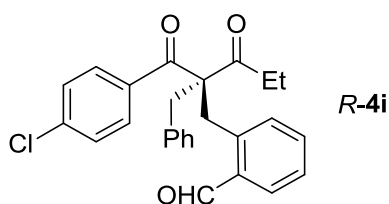
(2S,3R)-3-benzyl-2-hydroxy-3-propionyl-2-(p-tolyl)-3,4-dihydronaphthalen-1(2H)-one (5h): Colorless oil, 40.6 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (dd, J = 7.8, 0.9 Hz, 1H), 7.66 (td, J = 7.5, 1.3 Hz, 1H), 7.48 (t, J = 7.6 Hz, 1H), 7.21 (d, J = 7.7 Hz, 1H), 7.15–7.10 (m, 5H), 7.01–6.99 (m, 2H), 6.69–6.67 (m, 2H), 4.69 (s, 1H), 3.90 (d, J = 14.5 Hz, 1H), 3.45 (d, J = 17.8 Hz, 1H), 2.82–2.70 (m, 2H), 2.60 (d, J = 14.5 Hz, 1H), 2.54–2.44 (m, 1H), 2.25 (s, 3H), 0.96 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.5, 198.7, 142.3, 138.2, 137.0, 136.2, 135.4, 131.3, 130.3, 129.8, 129.2, 128.4, 128.1, 127.5, 126.8, 126.2, 81.7, 61.9, 36.7, 34.9, 31.9, 21.0, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{26}\text{O}_3\text{H}^+$ 399.1955, found 399.1955; $[\alpha]_{\text{D}}^{20}$: +43.9 (c 1.70, CHCl_3); HPLC analysis: 80% ee (Chiralcel AD-H, 5:95 $^i\text{PrOH}$ /hexane, 1.00 mL/min), R_{t} (major) = 11.0 min, R_{t} (minor) = 9.2 min; IR (KBr thin film, cm^{-1}): ν 3447, 2925, 1698, 1670, 1604, 1456, 1262, 1180, 1098, 1029, 804, 758, 701.



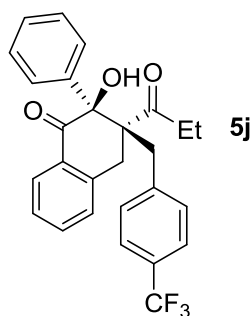
(R)-2-(2-benzyl-2-(4-methylbenzoyl)-3-oxopentyl)benzaldehyde (R-4h): Colorless oil, 35.0 mg, 44% yield. $[\alpha]_D^{20}$: -4.7 (c 1.41, CHCl_3); HPLC analysis: 89% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 12.7 min, R_t (minor) = 14.1 min.



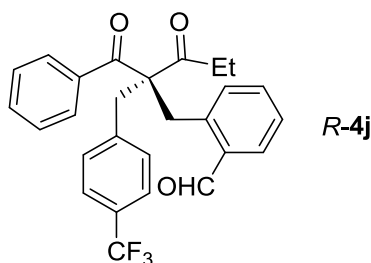
(2S,3R)-3-benzyl-2-(4-chlorophenyl)-2-hydroxy-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (5i): Colorless oil, 48.5 mg, 58% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (d, $J = 7.7$ Hz, 1H), 7.68 (t, $J = 7.5$ Hz, 1H), 7.49 (t, $J = 7.6$ Hz, 1H), 7.23–7.14 (m, 8H), 6.68–6.66 (m, 2H), 4.77 (s, 1H), 3.88 (d, $J = 14.5$ Hz, 1H), 3.40 (d, $J = 18.0$ Hz, 1H), 2.82 (d, $J = 18.0$ Hz, 1H), 2.79–2.69 (m, 1H), 2.60 (d, $J = 14.5$ Hz, 1H), 2.56–2.46 (m, 1H), 0.96 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.2, 198.0, 142.1, 137.7, 136.7, 135.7, 134.5, 131.0, 130.4, 129.7, 128.7, 128.5, 128.3, 127.8, 127.7, 126.9, 81.4, 61.9, 36.7, 35.0, 31.7, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{23}\text{ClO}_3\text{H}^+$ 419.1408, found 419.1410; $[\alpha]_D^{20}$: $+40.4$ (c 1.90, CHCl_3); HPLC analysis: 60% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.7 min, R_t (minor) = 8.0 min; IR (KBr thin film, cm^{-1}): ν 3446, 2937, 1697, 1588, 1489, 1454, 1400, 1209, 1094, 1012, 759, 702.



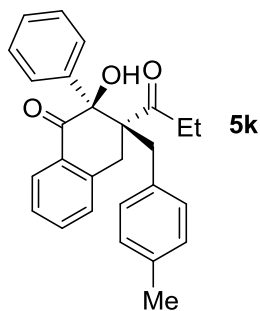
(R)-2-(2-benzyl-2-(4-chlorobenzoyl)-3-oxopentyl)benzaldehyde (R-4g): Yellow oil, 33.5 mg, 40% yield. $[\alpha]_D^{20}$: -7.5 (c 0.72, CHCl_3); HPLC analysis: 90% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 10.7 min, R_t (minor) = 11.5 min.



(2S,3R)-2-hydroxy-2-phenyl-3-propionyl-3-(4-(trifluoromethyl)benzyl)-3,4-dihydronaphthalen-1(2H)-one (5j): Yellow oil, 53.4 mg, 59% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.21 (dd, $J = 7.8, 0.9$ Hz, 1H), 7.69 (td, $J = 7.5, 1.3$ Hz, 1H), 7.51 (t, $J = 7.6$ Hz, 1H), 7.40 (d, $J = 8.1$ Hz, 2H), 7.25–7.20 (m, 6H), 6.79 (d, $J = 7.2$ Hz, 2H), 4.66 (s, 1H), 3.98 (d, $J = 14.4$ Hz, 1H), 3.51 (d, $J = 17.8$ Hz, 1H), 2.72 (d, $J = 17.8$ Hz, 1H), 2.66–2.56 (m, 2H), 2.34–2.24 (m, 1H), 0.93 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.6, 198.4, 141.8, 141.4 (d, $J = 1.1$ Hz), 139.0, 135.7, 131.2, 130.2 (d, $J = 3.3$ Hz), 128.6 (d, $J = 3.3$ Hz), 128.4, 127.9, 126.3, 125.3 (q, $J = 14.8$ Hz), 81.7, 61.8, 36.5, 35.0, 31.8, 7.7; ^{19}F NMR (376 MHz, CDCl_3) δ 62.6; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{23}\text{F}_3\text{O}_3\text{H}^+$ 453.1672, found 453.1673; $[\alpha]_{\text{D}}^{20}$: +30.6 (c 2.0, CHCl_3); HPLC analysis: 61% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.1 min, R_t (minor) = 9.7 min; IR (KBr thin film, cm^{-1}): ν 3464, 2937, 1702, 1684, 1602, 1326, 1282, 1165, 1124, 1069, 1019, 987, 853, 738, 704.

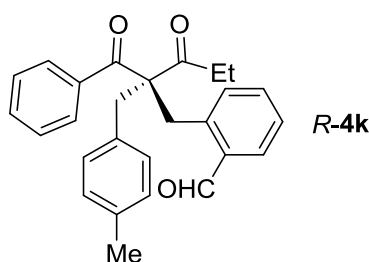


(R)-2-(2-benzoyl-3-oxo-2-(4-(trifluoromethyl)benzyl)pentyl)benzaldehyde (R-4j): Yellow oil, 34.4 mg, 38% yield. $[\alpha]_{\text{D}}^{20}$: -7.2 (c 2.14, CHCl_3); HPLC analysis: 98% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 6.7 min, R_t (minor) = 6.3 min.

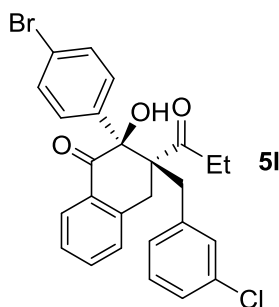


(2S,3R)-2-hydroxy-3-(4-methylbenzyl)-2-phenyl-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (5k): Colorless oil, 43.0 mg, 54% yield. ^1H NMR (400 MHz, CDCl_3) δ

8.20 (dd, $J = 7.8, 0.8$ Hz, 1H), 7.70 (td, $J = 7.5, 1.3$ Hz, 1H), 7.49 (t, $J = 7.6$ Hz, 1H), 7.26–7.19 (m, 6H), 6.94 (d, $J = 7.9$ Hz, 2H), 6.56 (d, $J = 8.0$ Hz, 2H), 4.72 (s, 1H), 3.87 (d, $J = 14.5$ Hz, 1H), 3.43 (d, $J = 17.8$ Hz, 1H), 2.83 (d, $J = 17.9$ Hz, 1H), 2.76–2.66 (m, 1H), 2.56 (d, $J = 14.5$ Hz, 1H), 2.48–2.38 (m, 1H), 2.26 (s, 3H), 0.94 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 211.5, 198.6, 142.3, 139.3, 136.4, 135.5, 133.7, 131.3, 130.4, 129.7, 129.1, 128.5, 128.4, 128.2, 127.6, 126.3, 81.8, 61.9, 36.2, 35.0, 31.8, 21.1, 7.7; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{26}\text{O}_3\text{H}^+$ 399.1955, found 399.1955; $[\alpha]_{\text{D}}^{20}$: +42.0 (c 1.60, CHCl_3); HPLC analysis: 74% ee (Chiralcel IA, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 9.9 min, R_t (minor) = 9.2 min; IR (KBr thin film, cm^{-1}): ν 3462, 2926, 1700, 1682, 1601, 1447, 1280, 1263, 1107, 1063, 1023, 987, 800, 748, 703.

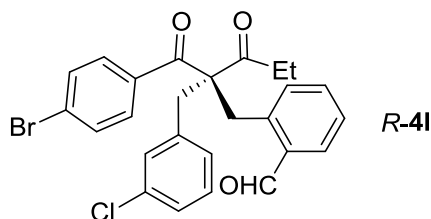


(*R*)-2-(2-benzoyl-2-(4-methylbenzyl)-3-oxopentyl)benzaldehyde (*R*-4k): Yellow oil 35.0 mg, 44% yield. $[\alpha]_{\text{D}}^{20}$: –3.3 (c 1.59, CHCl_3); HPLC analysis: 92% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 12.1 min, R_t (minor) = 12.9 min.

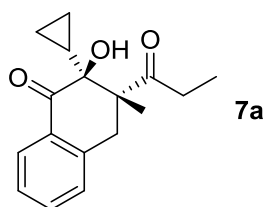


(2*S*,3*R*)-2-(4-bromophenyl)-3-(3-chlorobenzyl)-2-hydroxy-3-propionyl-3,4-dihydro-1(2*H*)-naphthalen-1-one (5l): Colorless oil, 55.6 mg, 56% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (dd, $J = 7.8, 0.9$ Hz, 1H), 7.71 (td, $J = 7.5, 1.3$ Hz, 1H), 7.51 (t, $J = 7.6$ Hz, 1H), 7.35–7.32 (m, 2H), 7.23 (d, $J = 7.7$ Hz, 1H), 7.14–7.06 (m, 4H), 6.61–6.57 (m, 2H), 4.71 (s, 1H), 3.84 (d, $J = 14.5$ Hz, 1H), 3.43 (d, $J = 18.0$ Hz, 1H), 2.77 (d, $J = 18.1$ Hz, 1H), 2.73–2.65 (m, 1H), 2.57 (d, $J = 14.5$ Hz, 1H), 2.50–2.40 (m, 1H), 0.96 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 210.6, 197.8, 141.8, 138.8, 138.1, 135.9, 134.2, 131.7, 130.9, 130.3, 130.0, 129.7, 128.4, 128.1, 127.9, 127.8, 127.2, 122.9, 81.4, 61.7, 36.4, 35.0, 31.8, 7.8; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{22}\text{BrClO}_3\text{H}^+$ 497.0514, found 497.0514; $[\alpha]_{\text{D}}^{20}$: +42.6 (c 1.0, CHCl_3); HPLC analysis: 68% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) =

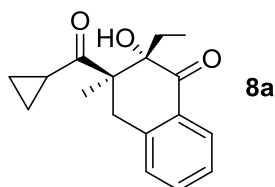
9.4 min, R_t (minor) = 8.8 min; IR (KBr thin film, cm^{-1}): ν 3448, 2925, 1700, 1683, 1598, 1487, 1457, 1261, 1094, 1080, 1011, 802.



(*R*)-2-(2-(4-bromobenzoyl)-2-(3-chlorobenzyl)-3-oxopentyl)benzaldehyde (*R*-4l): Colorless oil, 41.7 mg, 42% yield. $[\alpha]_D^{20}$: +45.8 (c 0.8, CHCl_3); HPLC analysis: 98% ee (Chiralcel IA, 5:95 i PrOH/hexane, 1.00 mL/min), R_t (major) = 8.8 min, R_t (minor) = 8.2 min.

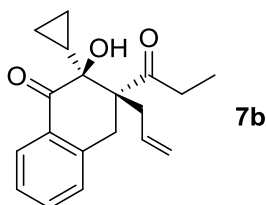


(2*S*,3*R*)-2-cyclopropyl-2-hydroxy-3-methyl-3-propionyl-3,4-dihydronaphthalen-1(2*H*)-one (7a): White semisolid, 34.8 mg, 64% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.99 (d, J = 7.8 Hz, 1H), 7.56 (t, J = 7.5 Hz, 1H), 7.33 (dd, J = 19.2, 7.7 Hz, 2H), 4.18 (d, J = 18.5 Hz, 1H), 3.93 (s, 1H), 3.05–2.91 (m, 1H), 2.71 (d, J = 18.5 Hz, 1H), 2.64–2.49 (m, 1H), 1.24 (s, 3H), 1.12–1.00 (m, 4H), 0.39 (td, J = 9.8, 4.9 Hz, 1H), 0.35–0.26 (m, 1H), 0.22–0.08 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.4, 200.1, 142.2, 135.3, 130.6, 129.4, 128.4, 127.4, 77.7, 57.1, 35.9, 33.8, 18.3, 13.9, 8.6, 2.1, 0.0; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{20}\text{O}_3\text{H}^+$ 273.1485, found 273.1480; $[\alpha]_D^{20}$: +83.5 (c 1.0, CHCl_3); HPLC analysis: 66% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 6.7 min, R_t (minor) = 5.3 min; IR (KBr thin film, cm^{-1}): ν 3843, 3746, 3644, 3344, 2920, 2361, 1694, 1497, 1457, 1286, 939, 722, 417.

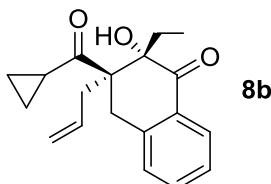


(2*S*,3*R*)-3-(cyclopropanecarbonyl)-2-ethyl-2-hydroxy-3-methyl-3,4-dihydronaphthalen-1(2*H*)-one (8a): White semisolid, 18.5 mg, 34% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.96 (d, J = 7.8 Hz, 1H), 7.55 (t, J = 7.4 Hz, 1H), 7.34 (t, J = 7.5 Hz, 1H), 7.29 (s, 1H), 4.41 (s, 1H), 3.87 (d, J = 18.6 Hz, 1H), 2.73 (d, J = 18.6 Hz, 2H), 1.77 (dt, J = 14.4, 7.1 Hz, 1H), 1.60 (d, J = 6.9 Hz, 1H), 1.33 (s, 3H), 1.19–1.12 (m, 1H), 0.94 (d, J = 7.0 Hz, 3H), 0.70 (t, J = 7.3 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.9, 200.8, 141.3, 134.7, 129.9, 129.1, 127.5, 126.8, 80.2, 56.9, 35.5, 27.1, 18.6,

17.9, 13.0, 11.4, 7.4; HRMS (ESI, m/z): calcd. for $C_{17}H_{20}O_3H^+$ 273.1485, found 273.1486; $[\alpha]_D^{20}$: +41.1 (c 0.3, $CHCl_3$); HPLC analysis: 98% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.6 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3644, 3336, 3230, 3076, 2358, 1751, 1609, 1506, 1361, 964, 722, 585, 460.

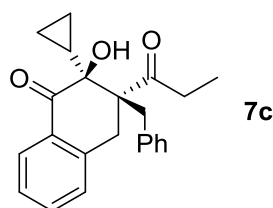


(2S,3R)-3-allyl-2-cyclopropyl-2-hydroxy-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (7b): Colorless oil, 31.6 mg, 53% yield. 1H NMR (400 MHz, $CDCl_3$) δ 8.00 (dd, J = 7.8, 0.9 Hz, 1H), 7.56 (td, J = 7.6, 1.3 Hz, 1H), 7.35 (t, J = 7.6 Hz, 1H), 7.29 (d, J = 7.7 Hz, 1H), 5.44 (dddd, J = 16.6, 10.1, 8.1, 6.2 Hz, 1H), 5.06–4.93 (m, 1H), 4.84 (dd, J = 16.9, 1.4 Hz, 1H), 3.98 (s, 1H), 3.95 (d, J = 19.0 Hz, 1H), 3.10–2.92 (m, 3H), 2.58 (dq, J = 19.0, 7.1 Hz, 1H), 1.97 (dd, J = 14.8, 8.1 Hz, 1H), 1.14–0.98 (m, 4H), 0.45 (tt, J = 9.6, 4.8 Hz, 1H), 0.31 (tdd, J = 8.3, 6.0, 4.2 Hz, 1H), 0.24–0.08 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 210.5, 197.9, 139.9, 133.5, 131.1, 128.5, 127.6, 126.4, 125.4, 118.0, 75.6, 59.0, 32.5, 32.5, 29.7, 12.1, 6.4, 0.0, -2.1; HRMS (ESI, m/z): calcd. for $C_{19}H_{22}O_3H^+$ 299.1641, found 299.1640; $[\alpha]_D^{20}$: +57.7 (c 0.3, $CHCl_3$); HPLC analysis: 92% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.2 min, R_t (minor) = 5.3 min; IR (KBr thin film, cm^{-1}): ν 3852, 3647, 3572, 3364, 2917, 2364, 1768, 1686, 1509, 1466, 1292, 1215, 736, 417.

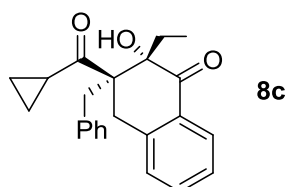


(2S,3R)-3-allyl-3-(cyclopropanecarbonyl)-2-ethyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (8b): White solid, m.p. 42–46 °C, 26.8 mg, 45% yield. 1H NMR (400 MHz, $CDCl_3$) δ 7.97 (dd, J = 7.8, 0.8 Hz, 1H), 7.55 (td, J = 7.6, 1.3 Hz, 1H), 7.34 (t, J = 7.6 Hz, 1H), 7.26 (d, J = 7.7 Hz, 1H), 5.52 (dddd, J = 16.0, 10.0, 8.9, 5.8 Hz, 1H), 5.01 (d, J = 10.1 Hz, 1H), 4.83 (dd, J = 16.9, 1.0 Hz, 1H), 4.45 (s, 1H), 3.65 (d, J = 18.8 Hz, 1H), 3.21 (ddd, J = 14.4, 5.8, 1.2 Hz, 1H), 2.93 (d, J = 18.8 Hz, 1H), 2.86 (ddd, J = 9.1, 7.7, 4.8 Hz, 1H), 1.97 (dd, J = 14.4, 8.8 Hz, 1H), 1.77 (dq, J = 14.6, 7.3 Hz, 1H), 1.54 (dq, J = 14.7, 7.4 Hz, 1H), 1.21–1.10 (m, 1H), 1.04–0.91 (m, 3H), 0.70 (t, J = 7.4 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.8, 200.5, 141.2, 134.9, 132.9, 129.81, 129.2, 127.5, 126.8, 119.5, 80.1, 61.0, 34.0, 31.0, 27.4, 19.1, 13.2, 12.1, 7.3; HRMS (ESI, m/z): calcd. for $C_{19}H_{22}O_3H^+$ 299.1641, found 299.1646; $[\alpha]_D^{20}$: +39.0 (c 0.3, $CHCl_3$); HPLC analysis: 94% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00

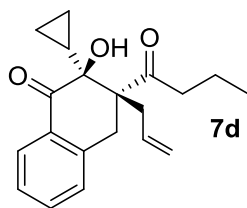
mL/min, 254 nm), R_t (major) = 8.7 min, R_t (minor) = 4.6 min; IR (KBr thin film, cm^{-1}): ν 3567, 3350, 3228, 3079, 2925, 2848, 2364, 1754, 1629, 1492, 1389, 976, 745, 600, 457.



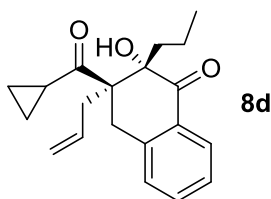
(2S,3R)-3-benzyl-2-cyclopropyl-2-hydroxy-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (7c): Colorless oil, 35.5 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.07 (d, J = 7.8 Hz, 1H), 7.59 (t, J = 7.4 Hz, 1H), 7.39 (t, J = 7.5 Hz, 1H), 7.21 (d, J = 7.7 Hz, 1H), 7.15 (s, 3H), 6.71 (s, 2H), 4.14 (s, 1H), 3.84 (d, J = 18.6 Hz, 1H), 3.65 (d, J = 14.7 Hz, 1H), 3.02–2.81 (m, 3H), 2.52 (d, J = 14.7 Hz, 1H), 1.10 (dd, J = 14.7, 7.8 Hz, 4H), 0.55 (dd, J = 9.5, 4.9 Hz, 1H), 0.40–0.31 (m, 1H), 0.27 (td, J = 9.8, 4.8 Hz, 1H), 0.19 (dd, J = 11.2, 6.5 Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.7, 199.5, 141.7, 137.0, 135.4, 130.2, 129.9, 129.6, 128.8, 128.4, 127.4, 127.2, 78.4, 61.7, 36.6, 35.0, 31.8, 14.1, 8.3, 2.1, 0.0; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1796; $[\alpha]_D^{20}$: +78.1 (c 0.2, CHCl_3); HPLC analysis: 88% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 10.3 min, R_t (minor) = 7.2 min; IR (KBr thin film, cm^{-1}): ν 3590, 3359, 3225, 3065, 2364, 1745, 1674, 1620, 1477, 1358, 973, 699, 594.



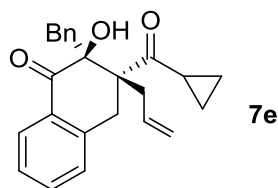
(2S,3R)-3-benzyl-3-(cyclopropanecarbonyl)-2-ethyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (8c): White semisolid, 32.0 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.05 (d, J = 7.8 Hz, 1H), 7.60 (t, J = 7.4 Hz, 1H), 7.39 (t, J = 7.5 Hz, 1H), 7.21 (d, J = 7.7 Hz, 1H), 7.15 (s, 3H), 6.81 (s, 2H), 4.58 (s, 1H), 3.81 (d, J = 14.4 Hz, 1H), 3.48 (d, J = 18.8 Hz, 1H), 3.15 (t, J = 4.6 Hz, 1H), 2.75 (d, J = 18.9 Hz, 1H), 2.53 (d, J = 14.4 Hz, 1H), 1.80 (dt, J = 14.5, 7.3 Hz, 1H), 1.61 (dd, J = 14.6, 7.3 Hz, 1H), 1.18–1.04 (m, 4H), 0.75 (t, J = 7.3 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.8, 200.7, 141.3, 136.5, 135.1, 129.9, 129.8, 129.2, 128.1, 127.8, 127.0, 126.7, 80.9, 62.5, 35.8, 31.1, 27.4, 19.6, 14.1, 13.4, 7.3; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1799; $[\alpha]_D^{20}$: +87.3 (c 0.3, CHCl_3); HPLC analysis: 92% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 11.1 min, R_t (minor) = 5.5 min; IR (KBr thin film, cm^{-1}): ν 3584, 3359, 3222, 3068, 2358, 1751, 1674, 1614, 1472, 1363, 979, 736, 585.



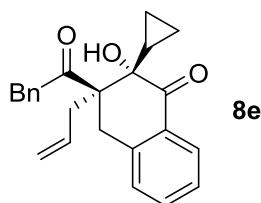
(2S,3R)-3-allyl-3-butyryl-2-cyclopropyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (7d): Colorless oil, 30.6 mg, 49% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.00 (d, J = 7.8 Hz, 1H), 7.56 (t, J = 7.5 Hz, 1H), 7.35 (t, J = 7.5 Hz, 1H), 7.29 (d, J = 7.7 Hz, 1H), 5.45 (dt, J = 16.6, 8.5 Hz, 1H), 5.01 (d, J = 10.1 Hz, 1H), 4.84 (d, J = 16.9 Hz, 1H), 3.98 (s, 1H), 3.94 (d, J = 18.7 Hz, 1H), 3.08–2.89 (m, 3H), 2.58 (dt, J = 18.7, 7.3 Hz, 1H), 1.97 (dd, J = 14.8, 8.3 Hz, 1H), 1.64 (dt, J = 14.8, 7.5 Hz, 2H), 1.11–1.00 (m, 1H), 0.96 (t, J = 7.4 Hz, 3H), 0.48 (td, J = 9.8, 5.3 Hz, 1H), 0.38–0.25 (m, 1H), 0.24–0.09 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.7, 197.7, 139.7, 133.3, 131.0, 128.3, 127.4, 126.2, 125.3, 117.9, 75.5, 58.8, 41.3, 32.5, 29.6, 15.4, 12.4, 12.0, 0.0, -2.2; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{24}\text{O}_3\text{H}^+$ 313.1798, found 313.1795; $[\alpha]_{\text{D}}^{20}$: +32.5 (c 0.3, CHCl_3); HPLC analysis: 89% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 6.6 min, R_t (minor) = 4.6 min; IR (KBr thin film, cm^{-1}): ν 3627, 3344, 3228, 3076, 2358, 1745, 1671, 1620, 1480, 1361, 933, 716, 594.



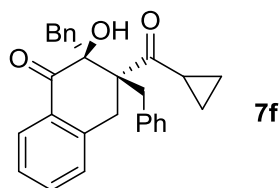
(2S,3R)-3-allyl-3-(cyclopropanecarbonyl)-2-hydroxy-2-propyl-3,4-dihydronaphthalen-1(2H)-one (8d): White semisolid, 28.1 mg, 45% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.97 (d, J = 7.8 Hz, 1H), 7.56 (t, J = 7.5 Hz, 1H), 7.35 (t, J = 7.5 Hz, 1H), 7.28 (s, 1H), 5.53 (dt, J = 15.9, 9.2 Hz, 1H), 5.01 (d, J = 10.1 Hz, 1H), 4.84 (d, J = 16.9 Hz, 1H), 4.47 (s, 1H), 3.67 (d, J = 18.9 Hz, 1H), 3.21 (dd, J = 14.1, 5.5 Hz, 1H), 2.94 (d, J = 18.7 Hz, 1H), 2.90–2.81 (m, 1H), 1.96 (dd, J = 14.3, 8.9 Hz, 1H), 1.76–1.64 (m, 1H), 1.50–1.38 (m, 2H), 1.18 (dd, J = 8.0, 4.5 Hz, 1H), 1.05–0.92 (m, 3H), 0.91–0.82 (m, 1H), 0.76 (t, J = 7.0 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.9, 200.7, 141.1, 134.9, 132.9, 129.8, 129.2, 127.6, 126.9, 119.5, 80.0, 61.1, 36.7, 33.8, 31.0, 19.2, 16.3, 14.1, 13.3, 12.1. HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{24}\text{O}_3\text{H}^+$ 313.1798, found 313.1799; $[\alpha]_{\text{D}}^{20}$: -132.0 (c 0.3, CHCl_3); HPLC analysis: 94% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 9.3 min, R_t (minor) = 4.1 min; IR (KBr thin film, cm^{-1}): ν 3612, 3347, 3228, 3065, 2361, 1751, 1674, 1617, 1477, 1361, 1078, 725, 591.



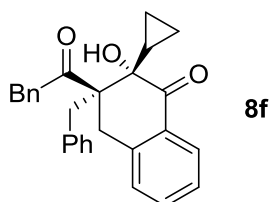
(2S,3R)-3-allyl-2-benzyl-3-(cyclopropanecarbonyl)-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (7e): White semisolid, 36.0 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.92 (d, J = 7.8 Hz, 1H), 7.61 (t, J = 7.5 Hz, 1H), 7.39 (t, J = 7.5 Hz, 1H), 7.34 (d, J = 7.8 Hz, 1H), 7.19 (d, J = 4.7 Hz, 3H), 6.87 (d, J = 4.2 Hz, 2H), 5.56 (dt, J = 16.1, 9.4 Hz, 1H), 5.04 (d, J = 10.2 Hz, 1H), 4.86 (d, J = 16.9 Hz, 1H), 4.11 (s, 1H), 3.79 (d, J = 18.8 Hz, 1H), 3.25 (dd, J = 14.6, 5.6 Hz, 1H), 3.00 (ddd, J = 16.5, 15.4, 11.8 Hz, 3H), 2.78 (d, J = 13.6 Hz, 1H), 2.00 (dd, J = 14.5, 8.9 Hz, 1H), 1.24–1.18 (m, 1H), 1.06 (ddd, J = 27.4, 11.1, 6.1 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 210.7, 198.2, 139.78, 133.9, 133.5, 131.8, 129.5, 128.9, 128.5, 126.8, 126.6, 126.1, 125.9, 118.6, 79.0, 60.0, 40.0, 33.0, 30.0, 18.3, 12.0, 11.4; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{24}\text{O}_3\text{H}^+$ 361.1798, found 361.1801; $[\alpha]_{\text{D}}^{20}$: +76.6 (c 0.3, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.2 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3590, 3347, 3222, 3065, 2361, 1748, 1620, 1475, 1366, 722, 591.



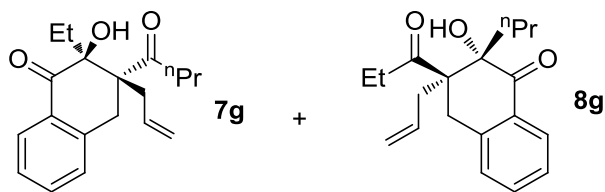
(2S,3R)-3-allyl-2-cyclopropyl-2-hydroxy-3-(2-phenylacetyl)-3,4-dihydronaphthalen-1(2H)-one (8e): White semisolid, 33.1 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.03 (d, J = 7.8 Hz, 1H), 7.57 (t, J = 7.5 Hz, 1H), 7.40–7.26 (m, 5H), 7.23 (d, J = 7.6 Hz, 2H), 5.47 (td, J = 17.0, 7.7 Hz, 1H), 5.05 (d, J = 10.2 Hz, 1H), 4.90 (d, J = 16.9 Hz, 1H), 4.30 (d, J = 17.8 Hz, 1H), 4.12 (s, 1H), 3.99 (dd, J = 28.6, 18.2 Hz, 2H), 3.16 (dd, J = 14.7, 5.8 Hz, 1H), 3.02 (d, J = 18.8 Hz, 1H), 2.07 (dd, J = 14.9, 8.0 Hz, 1H), 1.13–1.05 (m, 1H), 0.61 (dd, J = 9.4, 4.8 Hz, 1H), 0.33 (dd, J = 10.6, 7.0 Hz, 1H), 0.29–0.11 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.0, 199.6, 141.7, 135.5, 135.3, 132.9, 130.7, 130.5, 129.5, 128.8, 128.4, 127.5, 127.2, 120.3, 77.8, 61.3, 47.8, 34.6, 31.8, 14.1, 2.3, 0.0; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{24}\text{O}_3\text{H}^+$ 361.1798, found 361.1799; $[\alpha]_{\text{D}}^{20}$: +76.2 (c 0.3, CHCl_3); HPLC analysis: 94% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 11.9 min, R_t (minor) = 8.0 min; IR (KBr thin film, cm^{-1}): ν 3586, 3350, 3233, 3065, 2362, 1749, 1672, 1618, 1476, 1362, 949, 727, 593.



(2S,3R)-2,3-dibenzyl-3-(cyclopanecarbonyl)-2-hydroxy-3,4-dihydronaphthalen-1-one (7f): White semisolid, 41.0 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.00 (d, $J = 7.8$ Hz, 1H), 7.65 (td, $J = 7.6$, 1.2 Hz, 1H), 7.44 (t, $J = 7.5$ Hz, 1H), 7.28 (d, $J = 7.7$ Hz, 1H), 7.22 (dd, $J = 6.4$, 3.7 Hz, 3H), 7.16 (dd, $J = 6.6$, 3.6 Hz, 3H), 6.90 (dd, $J = 6.5$, 2.9 Hz, 2H), 6.86–6.80 (m, 2H), 4.21 (s, 1H), 3.85 (d, $J = 14.5$ Hz, 1H), 3.61 (d, $J = 19.0$ Hz, 1H), 3.30 (dq, $J = 7.4$, 4.9 Hz, 1H), 3.05 (d, $J = 13.6$ Hz, 1H), 2.90–2.80 (m, 2H), 2.55 (d, $J = 14.5$ Hz, 1H), 1.28–1.14 (m, 4H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.6, 199.4, 141.0, 136.4, 135.2, 134.5, 130.6, 129.9, 129.5, 128.2, 127.9, 127.2, 127.0, 126.8, 80.8, 62.6, 41.06, 35.8, 31.0, 19.9, 14.3, 13.1; HRMS (ESI, m/z): calcd. for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1957; $[\alpha]_{\text{D}}^{20}$: +34.0 (c 0.5, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 11.1 min, R_t (minor) = 7.6 min; IR (KBr thin film, cm^{-1}): ν 3641, 3342, 3222, 3059, 2358, 2338, 1686, 1617, 1509, 1372, 756, 671, 600.

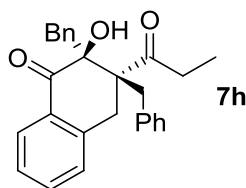


(2S,3R)-3-benzyl-2-cyclopropyl-2-hydroxy-3-(2-phenylacetyl)-3,4-dihydronaphthalen-1-one (8f): White semisolid, 36.9 mg, 45% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.08 (d, $J = 7.8$ Hz, 1H), 7.59 (t, $J = 7.5$ Hz, 1H), 7.40 (t, $J = 7.5$ Hz, 1H), 7.34 (t, $J = 7.2$ Hz, 2H), 7.28 (s, 1H), 7.21 (d, $J = 7.5$ Hz, 3H), 7.15 (d, $J = 4.8$ Hz, 3H), 6.75 (d, $J = 4.9$ Hz, 2H), 4.37–4.19 (m, 3H), 3.88 (d, $J = 18.6$ Hz, 1H), 3.74 (d, $J = 14.9$ Hz, 1H), 2.95 (d, $J = 18.6$ Hz, 1H), 2.65 (d, $J = 14.9$ Hz, 1H), 1.18–1.06 (m, 1H), 0.67 (dd, $J = 9.3$, 4.8 Hz, 1H), 0.33 (ddd, $J = 14.4$, 9.0, 4.8 Hz, 2H), 0.26–0.16 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 206.9, 196.8, 139.0, 134.3, 133.0, 132.6, 128.1, 127.8, 127.5, 127.2, 126.4, 126.3, 125.9, 125.0, 124.8, 124.7, 76.1, 59.6, 45.6, 34.1, 29.6, 11.7, 0.0, -2.3; HRMS (ESI, m/z): calcd. for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1956; $[\alpha]_{\text{D}}^{20}$: +33.4 (c 0.5, CHCl_3); HPLC analysis: 94% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 16.4 min, R_t (minor) = 12.1 min; IR (KBr thin film, cm^{-1}): ν 3473, 3282, 3165, 2917, 2355, 2335, 1700, 1634, 1560, 1412, 1021, 808, 645, 517.

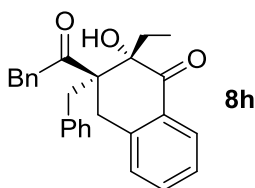


These two products are hard to be separated via column chromatography.

(2S,3R)-3-allyl-3-butyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (7g), (2S,3R)-3-allyl-2-hydroxy-3-propionyl-2-propyl-3,4-dihydronaphthalen-1(2H)-one (8g): White semisolid, 53.4 mg, 89% yield. ^1H NMR (400 MHz, CDCl_3) see details in ^1H NMR spectra of **7g+8g**; ^{13}C NMR (101 MHz, CDCl_3) δ 212.6, 211.9, 200.4, 200.2, 141.1, 141.0, 134.8, 132.5, 129.8, 129.8, 129.2, 129.1, 127.6, 127.5, 126.9, 126.8, 119.4, 79.7, 79.5, 60.9, 60.8, 42.7, 36.4, 33.9, 33.9, 33.7, 31.2, 31.1, 27.0, 17.1, 16.2, 14.0, 13.9, 8.0, 7.1; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{24}\text{O}_3\text{H}^+$ 301.1798, found 301.1799; $[\alpha]_{\text{D}}^{20}$: +30.9 (c 0.3, CHCl_3); HPLC analysis: 73% ee, 73% ee (Chiralcel IF, 1:99 i PrOH/hexane, 1.00 mL/min, 254 nm), see details in HPLC spectra of **7g+8g**; IR (KBr thin film, cm^{-1}): ν 3652, 3339, 3222, 3071, 2923, 2358, 2335, 1700, 1606, 1509, 1363, 967, 671.

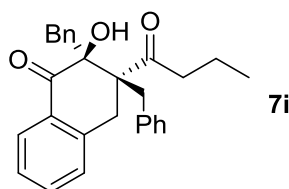


(2S,3R)-2,3-dibenzyl-2-hydroxy-3-propionyl-3,4-dihydronaphthalen-1(2H)-one (7h): White semisolid, 36.9 mg, 53% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.90 (dd, J = 7.8, 0.9 Hz, 1H), 7.61 (td, J = 7.6, 1.3 Hz, 1H), 7.37 (dd, J = 18.1, 7.7 Hz, 2H), 7.21–7.13 (m, 3H), 6.83 (dd, J = 6.5, 2.9 Hz, 2H), 5.45 (dddd, J = 16.7, 10.1, 8.0, 6.4 Hz, 1H), 5.08–4.96 (m, 1H), 4.87 (dd, J = 16.8, 1.4 Hz, 1H), 4.05 (s, 1H), 3.86 (d, J = 18.8 Hz, 1H), 3.14–2.95 (m, 4H), 2.80–2.60 (m, 2H), 1.97 (dd, J = 14.8, 8.0 Hz, 1H), 1.14 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.5, 199.0, 140.7, 134.9, 134.4, 132.4, 130.5, 130.0, 129.5, 127.9, 127.7, 127.1, 127.0, 119.6, 79.7, 60.9, 40.8, 34.1, 34.0, 31.2, 8.2. HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1799; $[\alpha]_{\text{D}}^{20}$: +42.6 (c 1.0, CHCl_3); HPLC analysis: 83% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 6.1 min, R_t (minor) = 4.5 min; IR (KBr thin film, cm^{-1}): ν 3647, 3162, 2923, 2358, 2338, 1700, 1651, 1543, 1403, 1289, 1024, 808, 645, 520.

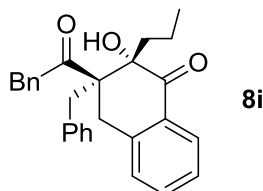


(2S,3R)-3-benzyl-2-ethyl-2-hydroxy-3-(2-phenylacetyl)-3,4-dihydronaphthalen-1(

2H)-one (8h): White semisolid, 30.6 mg, 44% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.98 (dd, $J = 7.8, 1.1$ Hz, 1H), 7.56 (td, $J = 7.5, 1.4$ Hz, 1H), 7.38–7.29 (m, 3H), 7.29–7.26 (m, 2H), 7.24 (dd, $J = 5.3, 2.8$ Hz, 2H), 5.49 (dddd, $J = 16.7, 10.1, 7.8, 6.5$ Hz, 1H), 5.06 (dd, $J = 10.2, 1.6$ Hz, 1H), 4.92 (dd, $J = 16.8, 1.6$ Hz, 1H), 4.51 (s, 1H), 4.40 (d, $J = 17.3$ Hz, 1H), 3.94 (d, $J = 17.3$ Hz, 1H), 3.69 (d, $J = 18.8$ Hz, 1H), 3.17 (ddd, $J = 14.8, 6.5, 1.2$ Hz, 1H), 2.99 (d, $J = 18.8$ Hz, 1H), 2.05 (dd, $J = 14.9, 7.9$ Hz, 1H), 1.78 (dq, $J = 14.6, 7.3$ Hz, 1H), 1.49 (dq, $J = 14.7, 7.4$ Hz, 1H), 0.71 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 209.3, 200.1, 140.9, 135.0, 132.4, 130.2, 129.9, 129.0, 128.3, 127.6, 127.0, 126.7, 119.8, 80.0, 61.2, 47.0, 33.8, 31.2, 27.3, 7.1; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{24}\text{O}_3\text{H}^+$ 349.1798, found 349.1797; $[\alpha]_{\text{D}}^{20}$: +2.7 (c 1.0, CHCl_3); HPLC analysis: 90% ee (Chiralcel AD-H, 2:98 $^i\text{PrOH}$ /hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.8 min, R_t (minor) = 6.2 min; IR (KBr thin film, cm^{-1}): ν 3652, 3324, 3222, 3071, 2358, 2341, 1731, 1611, 1514, 1366, 976, 671.

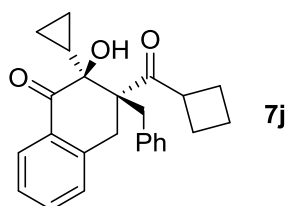


(2S,3R)-2,3-dibenzyl-3-butryl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (7i): White semisolid, 36.2 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.90 (d, $J = 7.8$ Hz, 1H), 7.60 (td, $J = 7.6, 1.2$ Hz, 1H), 7.41–7.32 (m, 2H), 7.21–7.14 (m, 3H), 6.83 (dd, $J = 6.4, 2.9$ Hz, 2H), 5.55–5.39 (m, 1H), 5.03 (d, $J = 10.1$ Hz, 1H), 4.86 (dd, $J = 16.8, 1.4$ Hz, 1H), 4.04 (s, 1H), 3.86 (d, $J = 18.8$ Hz, 1H), 3.16–2.94 (m, 4H), 2.74–2.60 (m, 2H), 1.97 (dd, $J = 14.8, 8.1$ Hz, 1H), 1.83–1.58 (m, 2H), 1.01 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.8, 199.0, 140.7, 134.9, 134.4, 132.4, 130.5, 130.0, 129.6, 127.9, 127.7, 127.1, 127.0, 119.6, 79.8, 60.7, 42.9, 40.7, 33.9, 31.2, 17.2, 14.1; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{26}\text{O}_3\text{H}^+$ 363.1954, found 363.1956; $[\alpha]_{\text{D}}^{20}$: +26.8 (c 1.0, CHCl_3); HPLC analysis: 82% ee (Chiralcel AD-H, 0.5:99.5 $^i\text{PrOH}$ /hexane, 1.00 mL/min, 254 nm), R_t (major) = 13.2 min, R_t (minor) = 9.6 min; IR (KBr thin film, cm^{-1}): ν 3647, 3347, 3062, 2925, 2840, 2364, 1694, 1603, 1506, 1463, 1378, 1212, 756, 756, 423.

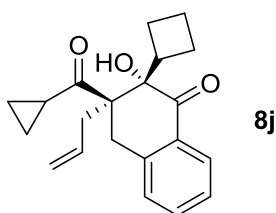


(2S,3R)-3-benzyl-2-hydroxy-3-(2-phenylacetyl)-2-propyl-3,4-dihydronaphthalen-1(2H)-one (8i): White semisolid, 33.3 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.02–7.94 (m, 1H), 7.56 (td, $J = 7.6, 1.3$ Hz, 1H), 7.39–7.30 (m, 3H), 7.28 (d, $J = 6.6$ Hz, 2H), 7.24 (s, 2H), 5.57–5.39 (m, 1H), 5.11–5.01 (m, 1H), 4.91 (dd, $J = 16.8, 1.4$ Hz, 1H), 4.53 (s, 1H), 4.41 (d, $J = 17.2$ Hz, 1H), 3.94 (d, $J = 17.2$ Hz, 1H), 3.69 (d, J

= 18.8 Hz, 1H), 3.15 (dd, J = 14.8, 5.5 Hz, 1H), 2.99 (d, J = 18.8 Hz, 1H), 2.03 (dd, J = 14.9, 7.9 Hz, 1H), 1.74–1.66 (m, 1H), 1.40 (tdd, J = 16.2, 9.7, 3.7 Hz, 2H), 0.87 (ddd, J = 14.1, 9.8, 5.2 Hz, 1H), 0.73 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 208.4, 199.3, 139.9, 133.9, 131.3, 129.1, 128.8, 128.0, 127.2, 126.6, 125.9, 125.6, 118.7, 78.6, 60.3, 45.9, 35.5, 32.6, 30.2, 15.2, 13.0, 0.0; HRMS (ESI, m/z): calcd. for $\text{C}_{24}\text{H}_{26}\text{O}_3\text{H}^+$ 363.1954, found 363.1958; $[\alpha]_{\text{D}}^{20}$: +3.7 (c 1.0, CHCl_3); HPLC analysis: 90% ee (Chiralcel AD-H, 0.5:99.5 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 29.1 min, R_t (minor) = 15.0 min; IR (KBr thin film, cm^{-1}): ν 3350, 3219, 3068, 2914, 2364, 1708, 1506, 1369, 665, 417.

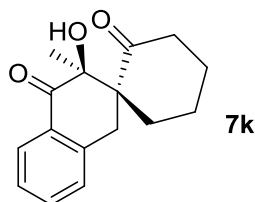


(2S,3R)-3-benzyl-3-(cyclobutanecarbonyl)-2-cyclopropyl-2-hydroxy-3,4-dihydrophthalen-1(2H)-one (7j): Colorless oil, 32.4 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.00 (dd, J = 7.8, 0.8 Hz, 1H), 7.56 (td, J = 7.6, 1.3 Hz, 1H), 7.35 (t, J = 7.6 Hz, 1H), 7.28 (d, J = 8.9 Hz, 1H), 5.39–5.25 (m, 1H), 4.95 (d, J = 10.0 Hz, 1H), 4.74 (dd, J = 16.8, 1.0 Hz, 1H), 4.22–4.09 (m, 1H), 3.99–3.84 (m, 2H), 3.07–2.91 (m, 2H), 2.50–2.38 (m, 1H), 2.24–1.90 (m, 5H), 1.89–1.79 (m, 1H), 1.02 (tt, J = 8.2, 5.3 Hz, 1H), 0.37 (tt, J = 9.4, 4.9 Hz, 1H), 0.30–0.08 (m, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.4, 197.8, 139.8, 133.3, 131.3, 128.3, 127.6, 126.2, 125.3, 117.7, 76.0, 58.6, 40.8, 32.4, 29.6, 26.6, 24.0, 16.3, 12.1, 0.0, -2.0; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{24}\text{O}_3\text{H}^+$ 325.1798, found 325.1800; $[\alpha]_{\text{D}}^{20}$: +66.2 (c 0.3, CHCl_3); HPLC analysis: 85% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 13.1 min, R_t (minor) = 8.2 min; IR (KBr thin film, cm^{-1}): ν 3555, 3362, 3222, 3071, 2840, 2358, 1629, 1765, 1472, 1295, 1007, 722, 585, 483.

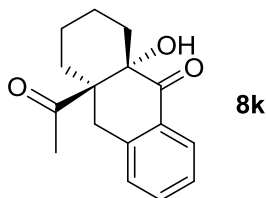


(2S,3R)-3-allyl-2-cyclobutyl-3-(cyclopropanecarbonyl)-2-hydroxy-3,4-dihydrophthalen-1(2H)-one (8j): White solid, m.p. 48–51 $^{\circ}\text{C}$, 29.8 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.94 (d, J = 7.2 Hz, 1H), 7.55 (td, J = 7.6, 1.2 Hz, 1H), 7.33 (t, J = 7.6 Hz, 1H), 7.28 (d, J = 7.4 Hz, 1H), 5.55–5.41 (m, 1H), 4.99 (d, J = 10.0 Hz, 1H), 4.85–4.75 (m, 1H), 4.43 (s, 1H), 3.69 (d, J = 18.7 Hz, 1H), 3.26–3.15 (m, 1H), 2.98–2.86 (m, 2H), 2.80–2.68 (m, 1H), 2.29–2.15 (m, 1H), 1.95 (dd, J = 14.4, 8.9 Hz, 1H), 1.89–1.76 (m, 1H), 1.68–1.56 (m, 3H), 1.39–1.29 (m, 1H), 1.21–1.14 (m, 1H), 1.01–0.88 (m, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.2, 199.1, 141.4, 134.8, 132.8,

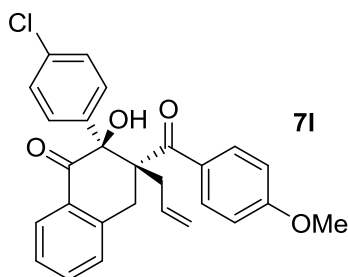
129.9, 129.2, 127.5, 126.8, 119.5, 81.0, 59.4, 38.2, 34.3, 31.1, 23.8, 21.9, 19.6, 17.7, 14.6, 12.3; HRMS (ESI, m/z): calcd. for $C_{21}H_{24}O_3H^+$ 325.1798, found 325.1797; $[\alpha]_D^{20}$: +61.8 (c 0.3, $CHCl_3$); HPLC analysis: 98% ee (Chiralcel AD-H, 1:99 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 13.4 min, R_t (minor) = 4.8 min; IR (KBr thin film, cm^{-1}): ν 3735, 3649, 3338, 3225, 3084, 2361, 2344, 1716, 1684, 1604, 1512, 1460, 1382, 668, 417.



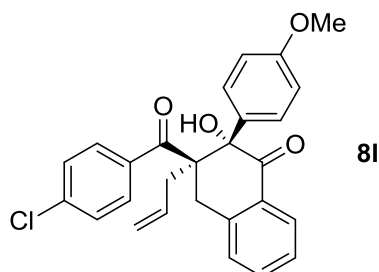
(1*R*,3'*S*)-3'-hydroxy-3'-methyl-1'*H*-spiro[cyclohexane-1,2'-naphthalene]-2,4'(3'*H*)-dione (7k): Yellow semisolid, 31.0 mg, 60% yield. 1H NMR (400 MHz, $CDCl_3$) δ 8.03–7.98 (m, 1H), 7.55 (td, J = 7.6, 1.3 Hz, 1H), 7.35 (t, J = 7.6 Hz, 1H), 7.26 (d, J = 7.2 Hz, 1H), 4.12 (s, 1H), 3.82 (d, J = 18.0 Hz, 1H), 2.89 (ddd, J = 14.1, 11.3, 6.9 Hz, 1H), 2.73 (d, J = 18.0 Hz, 1H), 2.53–2.43 (m, 1H), 2.20–1.96 (m, 3H), 1.80–1.67 (m, 1H), 1.56–1.43 (m, 2H), 1.29 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 212.6, 200.7, 140.9, 134.7, 129.8, 128.8, 127.8, 126.9, 78.5, 56.9, 41.3, 36.4, 33.5, 25.7, 23.3, 22.0; HRMS (ESI, m/z): calcd. for $C_{16}H_{18}O_3H^+$ 259.1328, found 259.1329; $[\alpha]_D^{20}$: -14.9 (c 0.5, $CHCl_3$); HPLC analysis: 18% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.7 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3479, 2923, 2358, 2341, 1702, 1650, 1561, 1408, 1103, 1019, 806, 642, 515.



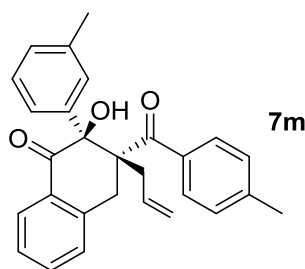
(4a*R*,9a*S*)-4a-acetyl-9a-hydroxy-1,3,4,4a,9a,10-hexahydroanthracen-9(2*H*)-one (8k): Yellow semisolid, 15.5 mg, 30% yield. 1H NMR (400 MHz, $CDCl_3$) δ 8.06 (dd, J = 7.8, 0.9 Hz, 1H), 7.48 (td, J = 7.5, 1.3 Hz, 1H), 7.33 (t, J = 7.6 Hz, 1H), 7.17 (d, J = 7.7 Hz, 1H), 3.82 (s, 1H), 3.60 (d, J = 18.3 Hz, 1H), 2.87 (d, J = 18.3 Hz, 1H), 2.24–2.14 (m, 1H), 2.10 (s, 3H), 1.88–1.82 (m, 2H), 1.81–1.66 (m, 2H), 1.61–1.57 (m, 2H), 1.48–1.41 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.2, 200.6, 138.4, 133.8, 130.1, 128.7, 127.5, 127.1, 75.7, 56.5, 33.0, 32.4, 28.5, 25.6, 20.6, 19.1; HRMS (ESI, m/z): calcd. for $C_{16}H_{18}O_3H^+$ 259.1328, found 259.1327; $[\alpha]_D^{20}$: +54.1 (c 0.3, $CHCl_3$); HPLC analysis: 75% ee (Chiralcel AS-H, 30:70 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.0 min, R_t (minor) = 4.2 min; IR (KBr thin film, cm^{-1}): ν 3646, 3338, 3231, 2920, 2358, 2335, 1702, 1612, 1509, 1457, 1396, 671.



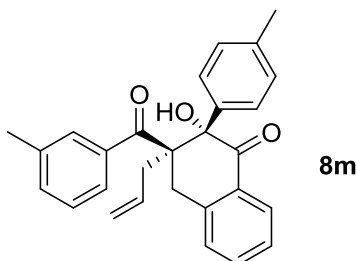
(2S,3R)-3-allyl-2-(4-chlorophenyl)-2-hydroxy-3-(4-methoxybenzoyl)-3,4-dihydronaphthalen-1(2H)-one (7l): White semisolid, 45.5 mg, 51% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.24 (d, J = 9.0 Hz, 2H), 8.18 (d, J = 7.1 Hz, 1H), 7.66 (td, J = 7.5, 1.2 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.32 (d, J = 7.7 Hz, 1H), 7.12–7.04 (m, 2H), 7.04–6.97 (m, 2H), 6.93 (d, J = 9.0 Hz, 2H), 5.35–5.18 (m, 1H), 4.89 (s, 1H), 4.84 (d, J = 9.7 Hz, 1H), 4.57 (d, J = 16.8 Hz, 1H), 3.89 (s, 3H), 3.66 (d, J = 18.0 Hz, 1H), 3.55 (dd, J = 14.7, 4.6 Hz, 1H), 2.99 (d, J = 17.9 Hz, 1H), 2.17 (dd, J = 14.7, 9.0 Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 200.9, 198.6, 162.5, 143.0, 138.4, 135.7, 134.2, 132.7, 132.2, 132.1, 130.5, 130.3, 128.2, 128.0, 127.9, 127.4, 119.4, 113.2, 81.6, 62.3, 55.41, 35.4, 33.8; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{23}\text{ClO}_4\text{H}^+$ 447.1357, found 447.1355; $[\alpha]_{\text{D}}^{20}$: +136.0 (c 0.5, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 20:80 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 16.3 min, R_t (minor) = 5.0 min; IR (KBr thin film, cm^{-1}): ν 3628, 3337, 3231, 3076, 2362, 2339, 1735, 1671, 1599, 1507, 1363, 747, 667.



(2S,3R)-3-allyl-3-(4-chlorobenzoyl)-2-hydroxy-2-(4-methoxyphenyl)-3,4-dihydronaphthalen-1(2H)-one (8l): White semisolid, 41.0 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.18 (d, J = 7.8 Hz, 1H), 8.07 (d, J = 8.7 Hz, 2H), 7.65 (td, J = 7.5, 1.3 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.43–7.37 (m, 2H), 7.30 (d, J = 7.6 Hz, 1H), 7.04–6.96 (m, 2H), 6.69–6.61 (m, 2H), 5.34–5.19 (m, 1H), 4.91–4.75 (m, 2H), 4.56 (d, J = 16.8 Hz, 1H), 3.68 (d, J = 19.3 Hz, 4H), 3.47 (dd, J = 14.7, 5.4 Hz, 1H), 2.97 (d, J = 17.7 Hz, 1H), 2.17 (dd, J = 14.8, 8.8 Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 201.6, 197.7, 158.3, 141.5, 137.0, 136.9, 134.4, 131.4, 130.5, 129.9, 129.7, 129.1, 127.2, 126.8, 126.7, 126.4, 118.6, 112.5, 80.7, 61.4, 54.1, 34.2, 32.8; HRMS (ESI, m/z): calcd. for $\text{C}_{27}\text{H}_{23}\text{ClO}_4\text{H}^+$ 447.1357, found 447.1359; $[\alpha]_{\text{D}}^{20}$: +31.8 (c 1.0, CHCl_3); HPLC analysis: 99% ee (Chiralcel AD-H, 20:80 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 15.4 min, R_t (minor) = 7.8 min; IR (KBr thin film, cm^{-1}): ν 3646, 3332, 3220, 3061, 2364, 2338, 1713, 1618, 1503, 1454, 1379, 993, 674.

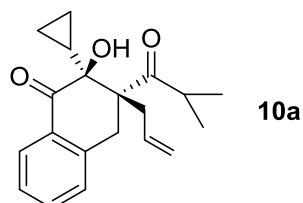


(2S,3R)-3-allyl-2-hydroxy-3-(4-methylbenzoyl)-2-(*m*-tolyl)-3,4-dihydronaphthalen-1-one (7m): White semisolid, 37.7 mg, 46% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.19 (dd, $J = 7.8, 0.8$ Hz, 1H), 7.89 (d, $J = 8.3$ Hz, 2H), 7.64 (td, $J = 7.5, 1.3$ Hz, 1H), 7.46 (t, $J = 7.6$ Hz, 1H), 7.30 (d, $J = 7.7$ Hz, 1H), 7.21 (d, $J = 8.1$ Hz, 2H), 7.05–6.98 (m, 2H), 6.95–6.85 (m, 2H), 5.42–5.20 (m, 1H), 4.87 (d, $J = 9.5$ Hz, 1H), 4.78 (s, 1H), 4.59 (d, $J = 16.8$ Hz, 1H), 3.70 (d, $J = 17.7$ Hz, 1H), 3.57 (dd, $J = 14.6, 5.5$ Hz, 1H), 3.00 (d, $J = 17.7$ Hz, 1H), 2.41 (s, 3H), 2.19 (dd, $J = 19.7, 10.7$ Hz, 1H), 2.14 (s, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 203.4, 199.1, 142.8, 141.9, 139.7, 137.7, 137.4, 135.3, 132.9, 131.0, 130.1, 129.4, 129.0, 128.6, 127.9, 127.8, 127.3, 127.3, 123.6, 119.3, 82.0, 62.1, 35.5, 33.9, 21.6, 21.5; HRMS (ESI, m/z): calcd. for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1957; $[\alpha]_{\text{D}}^{20}$: +106.1 (c 0.5, CHCl_3); HPLC analysis: 97% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 9.4 min, R_t (minor) = 5.2 min; IR (KBr thin film, cm^{-1}): ν 3649, 3502, 3171, 2358, 2341, 1699, 1653, 1546, 1405, 1103, 1019, 806, 642, 521.

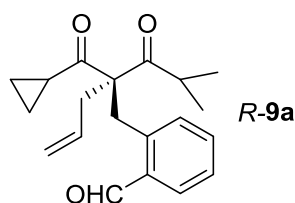


(2S,3R)-3-allyl-2-hydroxy-3-(3-methylbenzoyl)-2-(*p*-tolyl)-3,4-dihydronaphthalen-1-one (8m): White semisolid, 37.7 mg, 46% yield (two diastereomers, 10:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 8.19 (d, $J = 7.8$ Hz, 1H), 7.82–7.76 (m, 1H), 7.63 (td, $J = 7.5, 1.4$ Hz, 1H), 7.46 (dd, $J = 13.8, 6.2$ Hz, 2H), 7.28 (d, $J = 5.2$ Hz, 3H), 7.04 (t, $J = 5.2$ Hz, 2H), 6.96 (d, $J = 8.2$ Hz, 2H), 5.38–5.26 (m, 1H), 4.86 (d, $J = 10.1$ Hz, 1H), 4.75 (s, 1H), 4.56 (d, $J = 16.0$ Hz, 1H), 3.69 (d, $J = 17.6$ Hz, 1H), 3.55 (dd, $J = 14.5, 5.6$ Hz, 1H), 2.35 (s, 3H), 2.25 (s, 3H), 2.16–2.08 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 204.7, 199.0, 142.6, 140.1, 138.0, 137.6, 136.9, 135.3, 133.0, 131.9, 131.0, 130.0, 129.3, 128.9, 127.8, 127.8, 127.3, 126.6, 125.8, 119.3, 82.0, 62.0, 35.6, 33.9, 21.5, 21.0; HRMS (ESI, m/z): calcd. for $\text{C}_{28}\text{H}_{26}\text{O}_3\text{H}^+$ 411.1954, found 411.1951; $[\alpha]_{\text{D}}^{20}$: +54.0 (c 0.3, CHCl_3); HPLC analysis for the major diastereomer: 99% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), 254 nm, R_t (major) = 8.4 min, R_t (minor) = 5.6 min, HPLC analysis for the minor diastereomer: 99% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min), 254 nm, R_t (major) = 6.1 min, R_t (minor)

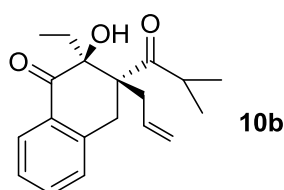
= 5.0 min; IR (KBr thin film, cm^{-1}): ν 3649, 3499, 3162, 2358, 2341, 1699, 1650, 1538, 1402, 1022, 809, 645, 521.



(2S,3R)-3-allyl-2-cyclopropyl-2-hydroxy-3-isobutyryl-3,4-dihydronaphthalen-1(2H)-one (10a): White semisolid, 31.2 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.98 (dd, $J = 7.8, 1.0$ Hz, 1H), 7.54 (td, $J = 7.5, 1.3$ Hz, 1H), 7.34 (t, $J = 7.6$ Hz, 1H), 7.26 (d, $J = 7.7$ Hz, 1H), 5.46 (dddd, $J = 16.8, 10.0, 9.1, 5.3$ Hz, 1H), 4.95 (d, $J = 10.1$ Hz, 1H), 4.71 (dd, $J = 16.9, 1.1$ Hz, 1H), 3.99 (s, 1H), 3.87 (d, $J = 18.2$ Hz, 1H), 3.52 (hept, $J = 6.6$ Hz, 1H), 3.17–3.00 (m, 2H), 1.99 (dd, $J = 14.9, 9.0$ Hz, 1H), 1.16 (d, $J = 6.6$ Hz, 3H), 1.11 (t, $J = 5.4$ Hz, 3H), 1.06 (ddd, $J = 13.6, 6.8, 4.1$ Hz, 1H), 0.56 (td, $J = 9.8, 5.4$ Hz, 1H), 0.41–0.30 (m, 1H), 0.23–0.14 (m, 1H), 0.10 (dt, $J = 10.0, 5.3$ Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 215.1, 196.5, 138.8, 132.6, 131.0, 127.6, 127.4, 125.4, 124.7, 116.9, 76.2, 58.4, 34.7, 32.3, 29.6, 18.8, 18.0, 11.7, 0.0, -1.4; HRMS (ESI, m/z): calcd. for $\text{C}_{20}\text{H}_{24}\text{O}_3\text{H}^+$ 313.1798, found 313.1799; $[\alpha]_{\text{D}}^{20}$: +32.9 (c 0.16, CHCl_3); HPLC analysis: 87% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.8 min, R_t (minor) = 5.2 min; IR (KBr thin film, cm^{-1}): ν 3565, 3352, 3228, 3096, 2358, 2330, 1682, 1607, 1509, 1460, 1399, 1281, 668.

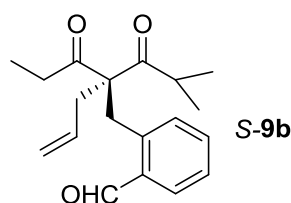


(R)-2-(2-(cyclopropanecarbonyl)-2-isobutyrylpent-4-en-1-yl)benzaldehyde (R-9a): Yellow oil, 29.3 mg, 47% yield. $[\alpha]_{\text{D}}^{20}$: -143.5 (c 0.21, CHCl_3); HPLC analysis: 88% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.1 min, R_t (minor) = 6.8 min.

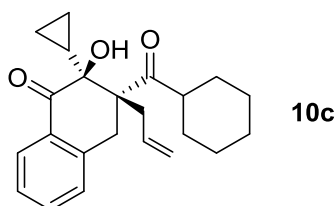


(2S,3R)-3-allyl-2-ethyl-2-hydroxy-3-isobutyryl-3,4-dihydronaphthalen-1(2H)-one (10b): Yellow oil, 27.0 mg, 45% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.96 (dd, $J = 7.8, 1.1$ Hz, 1H), 7.54 (td, $J = 7.5, 1.4$ Hz, 1H), 7.34 (t, $J = 7.6$ Hz, 1H), 7.25 (d, $J = 8.8$ Hz, 1H), 5.44 (dddd, $J = 16.7, 10.1, 8.7, 5.7$ Hz, 1H), 5.04–4.90 (m, 1H), 4.77

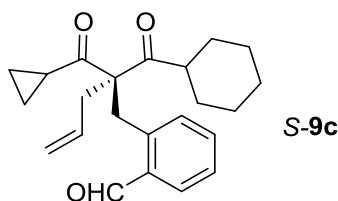
(ddd, $J = 16.8, 3.0, 1.6$ Hz, 1H), 4.32 (d, $J = 5.4$ Hz, 1H), 3.65 (d, $J = 18.6$ Hz, 1H), 3.56 (dt, $J = 13.3, 6.6$ Hz, 1H), 3.18–3.06 (m, 1H), 2.93 (d, $J = 18.6$ Hz, 1H), 2.01 (dd, $J = 15.0, 8.6$ Hz, 1H), 1.76 (dq, $J = 14.6, 7.3$ Hz, 1H), 1.51 (dq, $J = 14.8, 7.5$ Hz, 1H), 1.15 (d, $J = 6.6$ Hz, 3H), 1.09 (d, $J = 6.7$ Hz, 3H), 0.68 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.1, 199.3, 140.0, 133.8, 131.9, 128.8, 128.1, 126.5, 125.8, 118.2, 79.1, 60.5, 35.4, 32.9, 30.3, 26.0, 19.7, 19.5, 5.8; HRMS (ESI, m/z): calcd. for $\text{C}_{19}\text{H}_{24}\text{O}_3\text{H}^+$ 301.1798, found 301.1799; $[\alpha]_{\text{D}}^{20}$: -136.5 (c 0.18, CHCl_3); HPLC analysis: 68% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 4.6 min, R_t (minor) = 3.6 min; IR (KBr thin film, cm^{-1}): ν 3559, 3361, 3150, 2975, 2940, 2353, 2324, 1687, 1601, 1540, 1394, 1097, 976, 800, 636, 518.



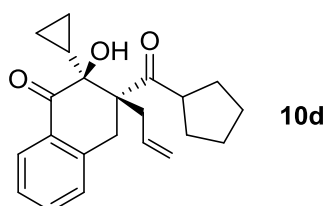
(S)-2-(2-isobutyryl-2-propionylpent-4-en-1-yl)benzaldehyde (S-9b): Yellow oil, 31.8 mg, 53% yield. $[\alpha]_{\text{D}}^{20}$: -98.9 (c 0.23, CHCl_3); HPLC analysis: 64% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.5 min, R_t (minor) = 5.2 min.



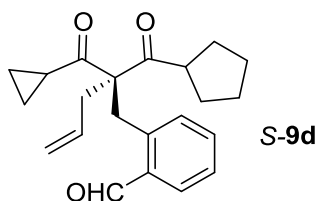
(2S,3R)-3-allyl-3-(cyclohexanecarbonyl)-2-cyclopropyl-2-hydroxy-3,4-dihydro-1H-phthalen-1-one (10c): White semisolid, 33.8 mg, 48% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.99 (dd, $J = 7.8, 0.9$ Hz, 1H), 7.55 (td, $J = 7.6, 1.3$ Hz, 1H), 7.35 (t, $J = 7.5$ Hz, 1H), 7.29–7.25 (m, 1H), 5.54–5.40 (m, 1H), 4.95 (d, $J = 10.1$ Hz, 1H), 4.71 (dd, $J = 16.9, 1.1$ Hz, 1H), 4.00 (s, 1H), 3.87 (d, $J = 18.2$ Hz, 1H), 3.23 (tt, $J = 11.4, 2.9$ Hz, 1H), 3.16–3.01 (m, 2H), 1.99 (dd, $J = 14.8, 9.1$ Hz, 2H), 1.80 (d, $J = 9.3$ Hz, 3H), 1.71 (s, 1H), 1.46–1.37 (m, 2H), 1.33–1.26 (m, 3H), 1.07 (tt, $J = 8.3, 5.3$ Hz, 1H), 0.55 (td, $J = 9.8, 5.4$ Hz, 1H), 0.41–0.31 (m, 1H), 0.26–0.15 (m, 1H), 0.16–0.08 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.9, 196.5, 138.8, 132.5, 131.1, 127.5, 127.4, 125.4, 124.7, 116.8, 76.3, 58.3, 45.6, 32.3, 29.6, 28.5, 27.4, 23.7, 23.7, 11.8, 0.0, -1.3 ; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{28}\text{O}_3\text{H}^+$ 353.2111, found 353.2114; $[\alpha]_{\text{D}}^{20}$: -18.3 (c 0.15, CHCl_3); HPLC analysis: 85% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.3 min, R_t (minor) = 5.5 min; IR (KBr thin film, cm^{-1}): ν 3470, 3162, 2923, 2367, 2324, 1650, 1540, 1405, 1103, 1016, 800, 648, 524.



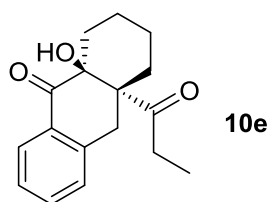
(S)-2-(2-(cyclohexanecarbonyl)-2-(cyclopropanecarbonyl)pent-4-en-1-yl)benzaldehyde (S-9c): Yellow oil, 31.0 mg, 44% yield. $[\alpha]_{\text{D}}^{20}$: -36.2 (c 0.23, CHCl_3); HPLC analysis: 89% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min, 254 nm), R_{f} (major) = 5.0 min, R_{f} (minor) = 4.6 min.



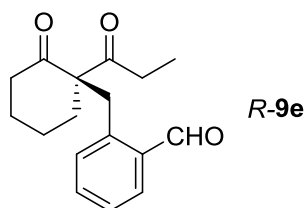
(2S,3R)-3-allyl-3-(cyclopentanecarbonyl)-2-cyclopropyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (10d): White semisolid, 33.8 mg, 50% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.00 (d, J = 7.7 Hz, 1H), 7.55 (t, J = 7.4 Hz, 1H), 7.35 (t, J = 7.4 Hz, 1H), 7.27 (d, J = 7.0 Hz, 1H), 5.46 (td, J = 15.1, 9.1 Hz, 1H), 4.95 (d, J = 10.0 Hz, 1H), 4.72 (d, J = 16.8 Hz, 1H), 4.03–3.83 (m, 2H), 3.80–3.64 (m, 1H), 3.12 (d, J = 13.6 Hz, 1H), 3.01 (d, J = 18.4 Hz, 1H), 2.10–1.71 (m, 6H), 1.61 (s, 3H), 1.12–1.00 (m, 1H), 0.58 (d, J = 3.7 Hz, 1H), 0.33 (d, J = 4.2 Hz, 1H), 0.16 (d, J = 5.9 Hz, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.1, 198.9, 141.1, 134.6, 133.0, 129.6, 129.2, 127.6, 126.69, 118.9, 78.0, 60.4, 47.9, 34.2, 33.5, 32.3, 31.5, 26.8, 26.3, 13.6, 2.0, 0.0; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{26}\text{O}_3\text{H}^+$ 339.1954, found 339.1959; $[\alpha]_{\text{D}}^{20}$: $+82.1$ (c 0.17, CHCl_3); HPLC analysis: 84% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_{f} (major) = 7.7 min, R_{f} (minor) = 5.7 min; IR (KBr thin film, cm^{-1}): ν 3461, 2940, 2356, 2327, 1682, 1653, 1538, 1411, 1281, 1019, 803, 645, 524.



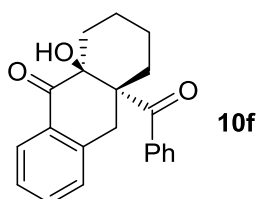
(S)-2-(2-(cyclopentanecarbonyl)-2-(cyclopropanecarbonyl)pent-4-en-1-yl)benzaldehyde (S-9d): Yellow oil, 31.1 mg, 46% yield. $[\alpha]_{\text{D}}^{20}$: $+50.9$ (c 0.15, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_{f} (major) = 8.2 min, R_{f} (minor) = 7.8 min.



(4aR,9aS)-9a-hydroxy-4a-propionyl-1,3,4,4a,9a,10-hexahydroanthracen-9(2H)-one (10e): White semisolid, 28.9 mg, 53% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.04 (dd, $J = 7.8, 1.2$ Hz, 1H), 7.46 (td, $J = 7.5, 1.4$ Hz, 1H), 7.31 (t, $J = 7.6$ Hz, 1H), 7.14 (d, $J = 7.7$ Hz, 1H), 3.83 (s, 1H), 3.58 (d, $J = 18.3$ Hz, 1H), 2.83 (d, $J = 18.3$ Hz, 1H), 2.59–2.34 (m, 2H), 2.24–2.10 (m, 1H), 1.92–1.58 (m, 6H), 1.47–1.35 (m, 1H), 0.88 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 213.6, 200.6, 138.4, 133.8, 130.2, 128.7, 127.4, 127.0, 75.8, 56.3, 33.1, 32.5, 30.2, 28.0, 20.6, 19.1, 7.4; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{20}\text{O}_3\text{H}^+$ 273.1485, found 273.1488; $[\alpha]_{\text{D}}^{20}$: +97.2 (c 0.16, CHCl_3); HPLC analysis: 78% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.7 min, R_t (minor) = 5.7 min; IR (KBr thin film, cm^{-1}): ν 3652, 3338, 3225, 3078, 2920, 1751, 1667, 1612, 1512, 1362, 947, 725, 590.

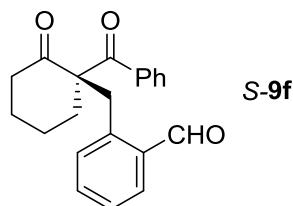


(R)-2-((2-oxo-1-propionylcyclohexyl)methyl)benzaldehyde (R-9e): Colorless oil, 22.3 mg, 41% yield. $[\alpha]_{\text{D}}^{20}$: +169.9 (c 0.22, CHCl_3); HPLC analysis: 92% ee (Chiralcel AS-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.6 min, R_t (minor) = 8.1min.

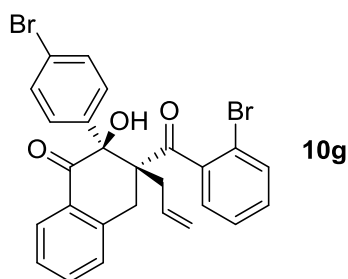


(4aR,9aS)-4a-benzoyl-9a-hydroxy-1,3,4,4a,9a,10-hexahydroanthracen-9(2H)-one (10f): White semisolid, 24.3 mg, 38% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 7.8$ Hz, 1H), 7.49 (td, $J = 7.5, 1.3$ Hz, 1H), 7.46–7.40 (m, 3H), 7.35 (t, $J = 7.3$ Hz, 3H), 7.17 (d, $J = 7.7$ Hz, 1H), 3.96 (s, 1H), 3.80 (d, $J = 18.3$ Hz, 1H), 3.25 (d, $J = 18.3$ Hz, 1H), 2.24–2.13 (m, 1H), 2.03 (d, $J = 13.3$ Hz, 1H), 1.86–1.68 (m, 4H), 1.62–1.56 (m, 1H), 1.51 (d, $J = 13.5$ Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 207.3, 200.5, 138.6, 138.0, 133.8, 130.7, 130.3, 128.7, 128.0, 127.5, 127.2, 76.0, 57.2, 33.7, 32.4, 29.5, 20.6, 19.0; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{20}\text{O}_3\text{H}^+$ 321.1485, found 321.1486; $[\alpha]_{\text{D}}^{20}$: +51.3 (c 0.20, CHCl_3); HPLC analysis: 97% ee (Chiralcel AD-H, 30:70 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 12.7 min, R_t (minor) = 7.0 min;

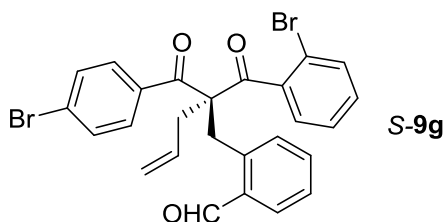
IR (KBr thin film, cm^{-1}): ν 3565, 3358, 3225, 3081, 2923, 2370, 1716, 1618, 1506, 1457, 1359, 720, 593.



(S)-2-((1-benzoyl-2-oxocyclohexyl)methyl)benzaldehyde (S-9f): Colorless oil, 34.6 mg, 54% yield. $[\alpha]_{\text{D}}^{20}$: +132.2 (c 0.23, CHCl_3); HPLC analysis: 78% ee (Chiralcel AD-H, 20:80 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.3 min, R_t (minor) = 4.6 min.

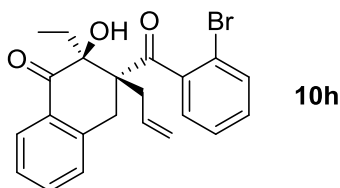


(2S,3R)-3-allyl-3-(2-bromobenzoyl)-2-(4-bromophenyl)-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (10g): White solid, m.p. 136–140 °C, 61.6 mg, 57% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.23 (dd, J = 7.8, 1.5 Hz, 1H), 8.17 (d, J = 6.9 Hz, 1H), 7.66 (td, J = 7.5, 1.3 Hz, 1H), 7.60 (dd, J = 8.0, 0.8 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H), 7.40 (td, J = 7.6, 1.0 Hz, 1H), 7.36–7.30 (m, 3H), 7.28 (dd, J = 7.8, 1.5 Hz, 1H), 7.13–7.07 (m, 2H), 5.52–5.37 (m, 1H), 4.83 (d, J = 10.1 Hz, 1H), 4.72 (s, 1H), 4.44–4.31 (m, 1H), 3.78 (d, J = 17.7 Hz, 1H), 3.19 (dd, J = 15.1, 6.0 Hz, 1H), 3.09 (d, J = 17.7 Hz, 1H), 2.17 (dd, J = 15.1, 8.7 Hz, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 204.0, 197.6, 142.0, 141.2, 138.4, 135.6, 133.8, 132.2, 131.2, 131.0, 130.0, 128.5, 128.0, 127.6, 127.2, 126.6, 122.5, 120.6, 119.4, 82.3, 61.3, 35.6, 34.2; HRMS (ESI, m/z): calcd. for $\text{C}_{26}\text{H}_{20}\text{Br}_2\text{O}_3\text{H}^+$ 540.9831, found 540.9828; $[\alpha]_{\text{D}}^{20}$: +49.5 (c 0.15, CHCl_3); HPLC analysis: 58% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 13.0 min, R_t (minor) = 10.5 min; IR (KBr thin film, cm^{-1}): ν 3649, 3355, 3231, 3076, 2920, 2854, 2358, 2330, 1682, 1618, 1512, 1451, 1362, 1224, 734, 590.

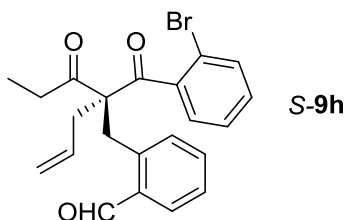


(S)-2-(2-(2-bromobenzoyl)-2-(4-bromobenzoyl)pent-4-en-1-yl)benzaldehyde

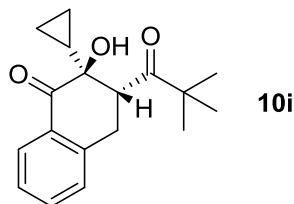
(S-9g): Colorless oil, 38.9 mg, 36% yield. $[\alpha]_D^{20}$: -15.2 (c 0.15, CHCl_3); HPLC analysis: 97% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 10.3 min, R_t (minor) = 9.4 min.



(2S,3R)-3-allyl-3-(2-bromobenzoyl)-2-ethyl-2-hydroxy-3,4-dihydronaphthalen-1(2H)-one (10h): White semisolid, 35.4 mg, 43% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.14 (dd, $J = 7.7, 1.7$ Hz, 1H), 7.99 (dd, $J = 7.8, 1.1$ Hz, 1H), 7.60 (dd, $J = 8.0, 1.0$ Hz, 1H), 7.56 (td, $J = 7.6, 1.4$ Hz, 1H), 7.35 (dt, $J = 7.6, 4.2$ Hz, 2H), 7.26–7.22 (m, 2H), 5.44 (dddd, $J = 16.5, 10.1, 8.5, 6.2$ Hz, 1H), 4.86–4.77 (m, 1H), 4.51–4.41 (m, 2H), 4.06 (d, $J = 18.3$ Hz, 1H), 3.15 (d, $J = 18.2$ Hz, 1H), 3.02–2.91 (m, 1H), 2.09 (dd, $J = 15.0, 8.5$ Hz, 1H), 1.98 (q, $J = 7.4$ Hz, 2H), 0.70 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 205.7, 199.8, 141.7, 140.9, 134.8, 133.5, 132.6, 130.7, 129.6, 129.4, 127.6, 127.5, 127.0, 126.4, 120.2, 119.3, 81.3, 60.7, 35.2, 34.0, 26.5, 7.2; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{21}\text{BrO}_3\text{H}^+$ 413.0746, found 413.0748; $[\alpha]_D^{20}$: $+21.3$ (c 0.13, CHCl_3); HPLC analysis: 65% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.2 min, R_t (minor) = 6.8 min; IR (KBr thin film, cm^{-1}): ν 3568, 3358, 3228, 3113, 2917, 2851, 2356, 2327, 1687, 1604, 1506, 1454, 1399, 1218, 751, 671.

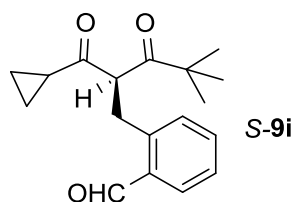


(S)-2-(2-(2-bromobenzoyl)-2-propionylpent-4-en-1-yl)benzaldehyde (S-9h): Colorless oil, 45.3 mg, 55% yield. $[\alpha]_D^{20}$: $+45.2$ (c 0.15, CHCl_3); HPLC analysis: 34% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 5.7 min, R_t (minor) = 5.0 min.

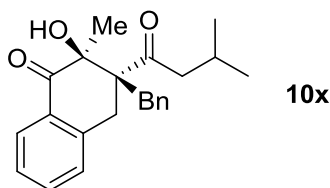


(2S,3R)-2-cyclopropyl-2-hydroxy-3-pivaloyl-3,4-dihydronaphthalen-1(2H)-one (10i): White solid, m.p. 66–69 $^{\circ}\text{C}$, 28.0 mg, 49% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.01 (dd, $J = 7.8, 0.9$ Hz, 1H), 7.54 (td, $J = 7.6, 1.4$ Hz, 1H), 7.37 (t, $J = 7.6$ Hz, 1H),

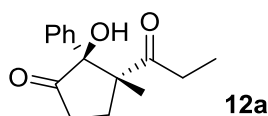
7.24 (s, 1H), 3.92 (dd, $J = 12.4, 4.6$ Hz, 1H), 3.73–3.60 (m, 2H), 2.88 (dd, $J = 17.6, 4.5$ Hz, 1H), 1.38 (ddd, $J = 16.4, 8.1, 5.6$ Hz, 1H), 1.20 (s, 9H), 0.52–0.42 (m, 2H), 0.26–0.16 (m, 1H), 0.11–0.07 (m, 1H); ^{13}C NMR (101 MHz, CDCl_3) δ 212.2, 197.6, 140.8, 132.6, 128.2, 127.2, 126.4, 125.5, 74.0, 47.5, 43.6, 30.1, 24.9, 10.2, 0.0, -1.9; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{22}\text{O}_3\text{H}^+$ 287.1641, found 287.1644; $[\alpha]_{\text{D}}^{20}$: +61.0 (c 0.17, CHCl_3); HPLC analysis: 74% ee (Chiralcel AS-H, 5:95 i PrOH/hexane, 0.30 mL/min, 254 nm), R_t (major) = 10.1 min, R_t (minor) = 9.6 min; IR (KBr thin film, cm^{-1}): ν 3502, 3381, 2923, 2361, 2338, 1650, 1543, 1399, 1019, 800, 653, 530.



(S)-2-(2-(cyclopropanecarbonyl)-4,4-dimethyl-3-oxopentyl)benzaldehyde (S-9i): Yellow oil, 25.2 mg, 44% yield. $[\alpha]_{\text{D}}^{20}$: +34.0 (c 0.17, CHCl_3); HPLC analysis: 49% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 11.0 min, R_t (minor) = 8.3 min.

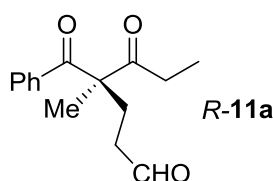


(2S,3R)-3-benzyl-2-hydroxy-2-methyl-3-(3-methylbutanoyl)-3,4-dihydronaphthalen-1-one (10x): White semisolid, 65.9 mg, 94% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.06 (d, $J = 7.8$ Hz, 1H), 7.58 (td, $J = 7.6, 1.2$ Hz, 1H), 7.38 (t, $J = 7.6$ Hz, 1H), 7.18 (d, $J = 7.8$ Hz, 1H), 7.14–7.13 (m, 3H), 6.72–6.70 (m, 2H), 4.48 (s, 1H), 3.58 (d, $J = 14.7$ Hz, 1H), 3.45 (d, $J = 19.9$ Hz, 1H), 3.00–2.94 (m, 1H), 2.89–2.78 (m, 2H), 2.51 (d, $J = 14.7$ Hz, 1H), 2.28–2.18 (m, 1H), 1.27 (s, 3H), 0.99 (d, $J = 6.7$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 211.5, 200.5, 141.2, 136.5, 135.1, 129.8, 129.5, 128.7, 128.2, 127.9, 127.0, 126.7, 78.0, 61.2, 49.9, 35.8, 31.8, 23.6, 23.1, 22.94, 22.93; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{26}\text{O}_3\text{H}^+$ 351.1955, found 351.1955; $[\alpha]_{\text{D}}^{20}$: +22.0 (c 2.40, CHCl_3); HPLC analysis: 5% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 4.3 min, R_t (minor) = 3.6 min; IR (KBr thin film, cm^{-1}): ν 3462, 2957, 1698, 1684, 1603, 1457, 1372, 1287, 1177, 1104, 1057, 972, 798, 751, 703.

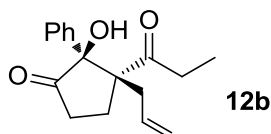


(2S,3R)-2-hydroxy-3-methyl-2-phenyl-3-propionylcyclopentanone (12a): White

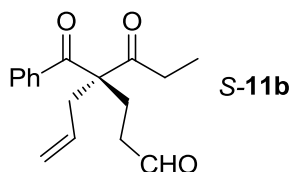
semisolid, 25.6 mg, 52% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.33–7.23 (m, 5H), 3.30 (s, 1H), 2.75–2.60 (m, 2H), 2.55 (ddd, $J = 22.2, 11.1, 7.4$ Hz, 1H), 2.43–2.33 (m, 1H), 2.23 (dq, $J = 18.4, 7.2$ Hz, 1H), 1.91–1.83 (m, 1H), 1.33 (s, 3H), 0.76 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 216.1, 213.4, 138.1, 128.5, 128.3, 126.1, 83.3, 59.4, 32.7, 32.6, 27.1, 19.2, 7.5; HRMS (ESI, m/z): calcd. for $\text{C}_{15}\text{H}_{18}\text{O}_3\text{H}^+$ 247.1328, found 247.1335; $[\alpha]_{\text{D}}^{20}$: -36.8 (c 0.22, CHCl_3); HPLC analysis: 76% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 4.4 min, R_t (minor) = 4.2 min; IR (KBr thin film, cm^{-1}): ν 3646, 3352, 3231, 3073, 2367, 2321, 1751, 1673, 1612, 1471, 1365, 976, 702, 590.



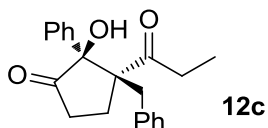
(R)-4-benzoyl-4-methyl-5-oxoheptanal (R-11a): Yellow oil, 19.7 mg, 40% yield. $[\alpha]_{\text{D}}^{20}$: -141.2 (c 0.18, CHCl_3); HPLC analysis: 94% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.9 min, R_t (minor) = 8.1 min.



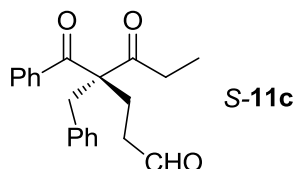
(2S,3S)-3-allyl-2-hydroxy-2-phenyl-3-propionylcyclopentanone (12b): White semisolid, 31.0 mg, 57% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.34–7.22 (m, 5H), 5.65–5.43 (m, 1H), 5.14 (dd, $J = 11.3, 6.2$ Hz, 2H), 3.37 (s, 1H), 2.88 (dd, $J = 14.8, 6.5$ Hz, 1H), 2.77–2.62 (m, 2H), 2.56–2.25 (m, 3H), 2.16 (dd, $J = 14.8, 7.9$ Hz, 1H), 2.12–2.02 (m, 1H), 0.72 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 216.8, 211.6, 138.4, 132.6, 128.7, 128.4, 125.6, 119.5, 83.7, 62.9, 36.4, 33.0, 32.3, 22.2, 7.4; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{20}\text{O}_3\text{H}^+$ 273.1485, found 273.1488; $[\alpha]_{\text{D}}^{20}$: -116.0 (c 0.23, CHCl_3); HPLC analysis: 65% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 4.4 min, R_t (minor) = 4.1 min; IR (KBr thin film, cm^{-1}): ν 3522, 3355, 2923, 2845, 2356, 2341, 1751, 1656, 1538, 1408, 1100, 1019, 795, 645, 527.



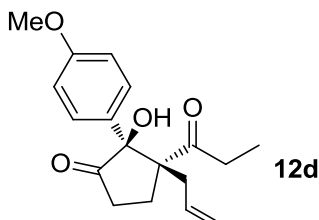
(S)-4-benzoyl-4-propionylhept-6-enal (S-11b): Colorless oil, 20.7 mg, 38% yield. $[\alpha]_{\text{D}}^{20}$: -37.7 (c 0.19, CHCl_3); HPLC analysis: 97% ee (Chiralcel IC, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 7.1 min, R_t (minor) = 6.7 min.



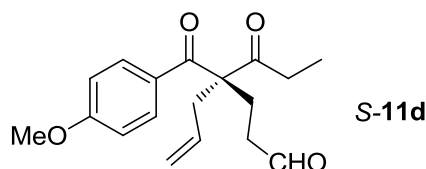
(2S,3S)-3-benzyl-2-hydroxy-2-phenyl-3-propionylcyclopentanone (12c): Yellow semisolid, 37.4 mg, 58% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.35–7.20 (m, 8H), 7.05–6.99 (m, 2H), 3.55 (d, J = 14.7 Hz, 1H), 3.45 (s, 1H), 2.72–2.60 (m, 2H), 2.60–2.49 (m, 1H), 2.39 (dt, J = 18.8, 9.4 Hz, 1H), 2.27 (q, J = 7.1 Hz, 2H), 2.03 (ddd, J = 13.9, 9.5, 1.6 Hz, 1H), 0.74 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.0, 211.8, 138.6, 136.5, 129.7, 128.6, 128.6, 128.4, 127.0, 125.9, 84.7, 63.5, 37.5, 33.9, 32.8, 21.6, 7.3; HRMS (ESI, m/z): calcd. for $\text{C}_{21}\text{H}_{22}\text{O}_3\text{H}^+$ 323.1641, found 323.1643; $[\alpha]_{\text{D}}^{20}$: –69.1 (c 0.16, CHCl_3); HPLC analysis: 58% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 13.1 min, R_t (minor) = 11.6 min; IR (KBr thin film, cm^{-1}): ν 3646, 3346, 3231, 3067, 2914, 2361, 2327, 1748, 1676, 1615, 1474, 1356, 956, 700, 590.



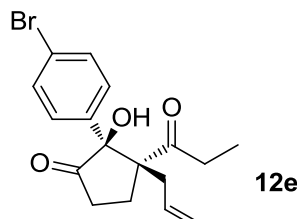
(S)-4-benzoyl-4-benzyl-5-oxoheptanal (S-11c): Yellow oil, 23.8 mg, 37% yield. $[\alpha]_{\text{D}}^{20}$: –128.4 (c 0.21, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 5:95 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 10.5 min, R_t (minor) = 9.4 min.



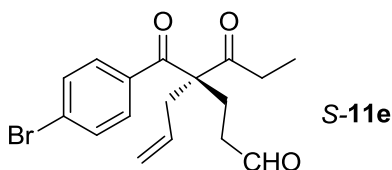
(2S,3S)-3-allyl-2-hydroxy-2-(4-methoxyphenyl)-3-propionylcyclopentanone (12d): White semisolid, 34.5 mg, 57% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.23–7.15 (m, 2H), 6.85–6.79 (m, 2H), 5.60–5.43 (m, 1H), 5.18–5.07 (m, 2H), 3.77 (s, 3H), 3.37 (s, 1H), 2.92–2.81 (m, 1H), 2.73–2.59 (m, 2H), 2.53–2.26 (m, 3H), 2.19–2.01 (m, 2H), 0.76 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 216.8, 211.9, 159.4, 132.7, 130.3, 126.9, 119.4, 114.0, 83.3, 62.7, 55.2, 36.4, 33.0, 32.0, 22.1, 7.5; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{22}\text{O}_4\text{H}^+$ 303.1590, found 303.1593; $[\alpha]_{\text{D}}^{20}$: +154.7 (c 0.17, CHCl_3); HPLC analysis: 62% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 6.7 min, R_t (minor) = 6.0 min; IR (KBr thin film, cm^{-1}): ν 3649, 3352, 3222, 3078, 2920, 2364, 2330, 1748, 1670, 1615, 1471, 1359, 959, 723, 593.



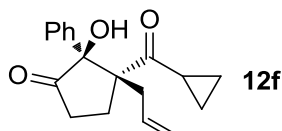
(S)-4-(4-methoxybenzoyl)-4-propionylhept-6-enal (S-11d): Colorless oil, 24.2 mg, 40% yield. $[\alpha]_D^{20}$: +25.8 (c 0.23, CHCl_3); HPLC analysis: 87% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 15.8 min, R_t (minor) = 9.8 min.



(2S,3S)-3-allyl-2-(4-bromophenyl)-2-hydroxy-3-propionylcyclopentanone (12e): White semisolid, 43.4 mg, 62% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.43 (d, J = 8.7 Hz, 2H), 7.16 (d, J = 8.7 Hz, 2H), 5.60–5.45 (m, 1H), 5.22–5.06 (m, 2H), 3.41 (s, 1H), 2.86 (dd, J = 14.8, 5.9 Hz, 1H), 2.74–2.60 (m, 2H), 2.57–2.41 (m, 1H), 2.35 (q, J = 7.2 Hz, 2H), 2.20–2.02 (m, 2H), 0.75 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 216.1, 211.3, 137.5, 132.4, 131.8, 127.4, 122.7, 119.7, 83.3, 62.8, 36.4, 33.0, 32.1, 22.1, 7.5; HRMS (ESI, m/z): calcd. for $\text{C}_{17}\text{H}_{19}\text{BrO}_3\text{H}^+$ 351.0590, found 351.0589; $[\alpha]_D^{20}$: +76.0 (c 0.18, CHCl_3); HPLC analysis: 58% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 6.1 min, R_t (minor) = 5.5 min; IR (KBr thin film, cm^{-1}): ν 3652, 3346, 3231, 3064, 2914, 2364, 2330, 1748, 1670, 1615, 1492, 1353, 1313, 1077, 918, 723, 593.

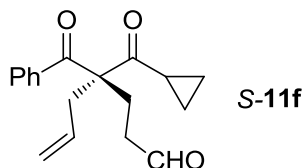


(S)-4-(4-bromobenzoyl)-4-propionylhept-6-enal (S-11e): Yellow oil, 21.0 mg, 30% yield. $[\alpha]_D^{20}$: +149.5 (c 0.16, CHCl_3); HPLC analysis: 98% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.1 min, R_t (minor) = 7.2 min.

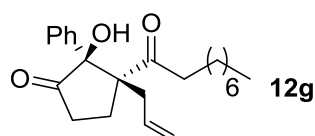


(2S,3S)-3-allyl-3-(cyclopropanecarbonyl)-2-hydroxy-2-phenylcyclopentanone (12f): White semisolid, 34.1 mg, 60% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.41–7.20 (m, 5H), 5.55 (dddd, J = 16.5, 10.0, 8.4, 6.3 Hz, 1H), 5.18–5.05 (m, 2H), 3.51 (s, 1H), 3.03 (ddd, J = 14.6, 6.2, 1.1 Hz, 1H), 2.74–2.54 (m, 2H), 2.53–2.42 (m, 1H), 2.32 (dtd,

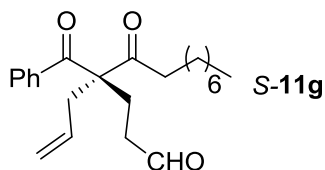
$J = 7.6, 6.2, 4.7$ Hz, 1H), 2.20 (dt, $J = 13.7, 6.9$ Hz, 1H), 2.10–1.99 (m, 1H), 0.93–0.81 (m, 2H), 0.71–0.51 (m, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.3, 210.8, 138.6, 132.8, 128.4, 128.3, 125.9, 119.4, 83.9, 63.2, 36.7, 32.3, 21.8, 18.9, 13.2, 11.6; HRMS (ESI, m/z): calcd. for $\text{C}_{18}\text{H}_{20}\text{O}_3\text{H}^+$ 285.1485, found 285.1489; $[\alpha]_{\text{D}}^{20}$: +69.1 (c 0.17, CHCl_3); HPLC analysis: 60% ee (Chiralcel OJ-H, 10:90 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 7.6 min, R_t (minor) = 6.0 min; IR (KBr thin film, cm^{-1}): ν 3588, 3349, 3225, 3067, 2361, 1751, 1670, 1618, 1468, 1362, 1322, 959, 720, 590.



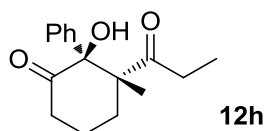
(S)-4-benzoyl-4-(cyclopropanecarbonyl)hept-6-enal (S-11f): Colorless oil, 19.3 mg, 34% yield. $[\alpha]_{\text{D}}^{20}$: –141.2 (c 0.15, CHCl_3); HPLC analysis: 98% ee (Chiralcel AD-H, 7:93 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.3 min, R_t (minor) = 8.0 min.



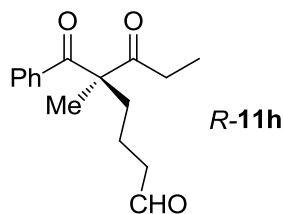
(2S,3S)-3-allyl-2-hydroxy-3-nonanoyl-2-phenylcyclopentanone (12g): White semisolid, 40.6 mg, 57% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.35–7.21 (m, 5H), 5.60–5.47 (m, 1H), 5.19–5.08 (m, 2H), 3.41 (s, 1H), 2.85 (dd, $J = 14.8, 6.0$ Hz, 1H), 2.79–2.62 (m, 2H), 2.47 (ddd, $J = 15.6, 8.7, 4.7$ Hz, 1H), 2.30 (t, $J = 7.0$ Hz, 2H), 2.17 (dd, $J = 14.7, 7.9$ Hz, 1H), 2.12–2.03 (m, 1H), 1.37–1.00 (m, 12H), 0.87 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 216.7, 211.1, 138.4, 132.7, 128.7, 128.4, 125.6, 119.5, 83.6, 62.8, 39.8, 36.7, 32.2, 31.8, 29.3, 29.1, 29.0, 23.2, 22.7, 22.3, 14.1; HRMS (ESI, m/z): calcd. for $\text{C}_{23}\text{H}_{32}\text{O}_3\text{H}^+$ 357.2424, found 357.2425; $[\alpha]_{\text{D}}^{20}$: –47.5 (c 0.16, CHCl_3); HPLC analysis: 68% ee (Chiralcel AD-H, 1:99 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 17.9 min, R_t (minor) = 15.1 min; IR (KBr thin film, cm^{-1}): ν 3646, 3340, 3231, 3070, 2926, 2361, 2332, 1751, 1673, 1612, 1477, 1365, 918, 702, 593.



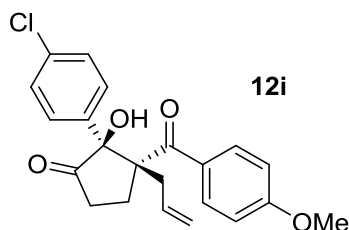
(S)-4-allyl-4-benzoyl-5-oxotridecanal (S-11g): Colorless oil, 27.1 mg, 38% yield. $[\alpha]_{\text{D}}^{20}$: –163.7 (c 0.14, CHCl_3); HPLC analysis: 98% ee (Chiralcel AD-H, 1:99 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.3 min, R_t (minor) = 7.8 min.



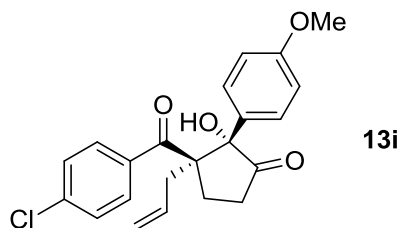
(2S,3R)-2-hydroxy-3-methyl-2-phenyl-3-propionylcyclohexanone (12h): Yellow semisolid, 25.0 mg, 48% yield. ^1H NMR (400 MHz, CDCl_3) δ 7.37–7.21 (m, 5H), 5.17 (s, 1H), 2.75 (dq, J = 18.8, 7.2 Hz, 1H), 2.62–2.45 (m, 2H), 2.44–2.34 (m, 2H), 2.21–2.13 (m, 1H), 2.11–2.01 (m, 1H), 1.89–1.75 (m, 1H), 1.19 (s, 3H), 0.89 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 215.4, 210.6, 139.7, 128.8, 128.1, 127.1, 82.8, 59.2, 36.4, 32.7, 31.6, 21.5, 20.1, 7.9; HRMS (ESI, m/z): calcd. for $\text{C}_{16}\text{H}_{20}\text{O}_3\text{H}^+$ 261.1485, found 261.1487; $[\alpha]_{\text{D}}^{20}$: +103.8 (c 0.22, CHCl_3); HPLC analysis: 93% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 220 nm), R_t (major) = 9.5 min, R_t (minor) = 7.7 min; IR (KBr thin film, cm^{-1}): ν 3603, 3343, 3228, 3076, 2358, 1748, 1670, 1621, 1480, 1362, 979, 708, 584.



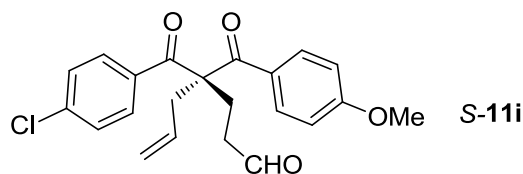
(R)-5-benzoyl-5-methyl-6-oxooctanal (R-11h): Colorless oil, 20.8 mg, 40% yield. $[\alpha]_{\text{D}}^{20}$: –38.7 (c 0.17, CHCl_3); HPLC analysis: 88% ee (Chiralcel AD-H, 2:98 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 8.7 min, R_t (minor) = 8.3 min.



(2S,3S)-3-allyl-2-(4-chlorophenyl)-2-hydroxy-3-(4-methoxybenzoyl)cyclopentanone (12i): White semisolid, 37.6 mg, 49% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.26–8.13 (m, 2H), 7.12 (s, 4H), 6.93–6.82 (m, 2H), 5.41 (dddd, J = 16.3, 10.1, 8.6, 6.0 Hz, 1H), 5.06–4.90 (m, 2H), 3.86 (s, 3H), 3.72 (s, 1H), 3.16 (ddd, J = 14.7, 6.0, 1.2 Hz, 1H), 2.87 (dtd, J = 14.2, 10.5, 1.5 Hz, 1H), 2.74 (ddd, J = 20.3, 10.7, 1.9 Hz, 1H), 2.61–2.48 (m, 1H), 2.20 (ddd, J = 20.2, 13.1, 5.3 Hz, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.4, 199.7, 163.0, 137.3, 134.1, 132.5, 131.8, 130.0, 128.5, 127.2, 119.6, 113.4, 84.3, 62.7, 55.4, 38.0, 32.1, 23.6; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{21}\text{ClO}_4\text{H}^+$ 385.1201, found 385.1200; $[\alpha]_{\text{D}}^{20}$: +11.2 (c 0.21, CHCl_3); HPLC analysis: 33% ee (Chiralcel AD-H, 20:80 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 6.7 min, R_t (minor) = 4.7 min; IR (KBr thin film, cm^{-1}): ν 3648, 3346, 3225, 3076, 2923, 2362, 1755, 1663, 1617, 1473, 1360, 1168, 937, 722, 592.

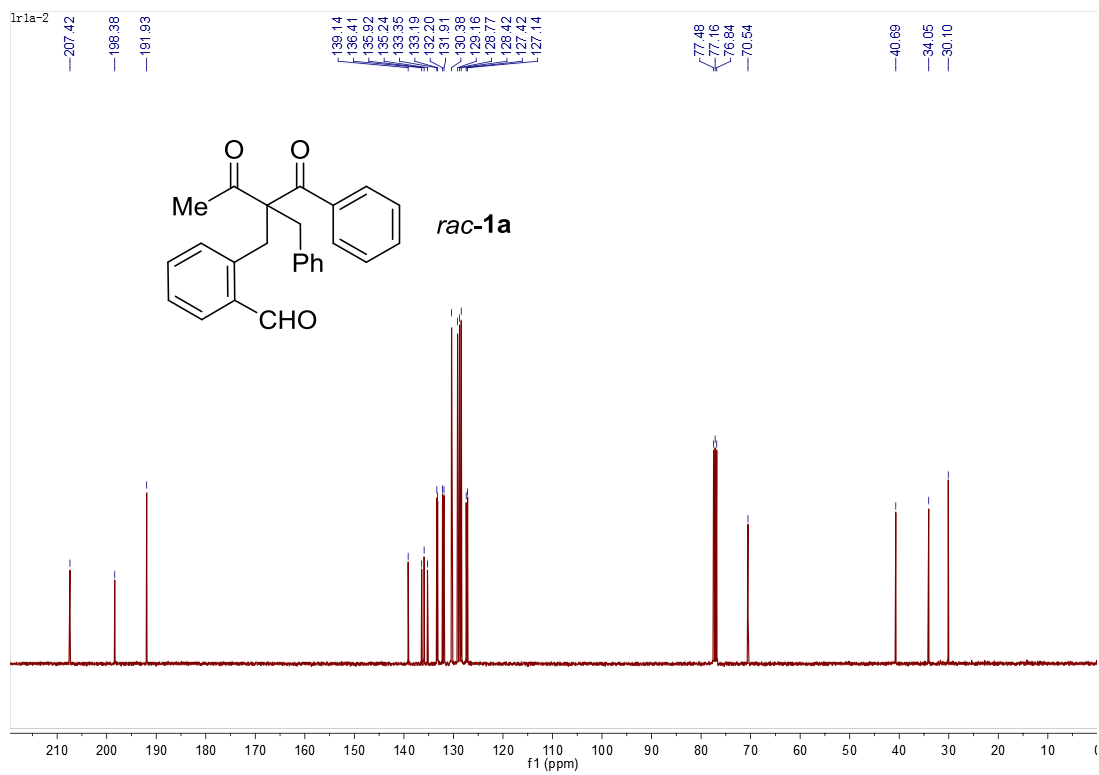
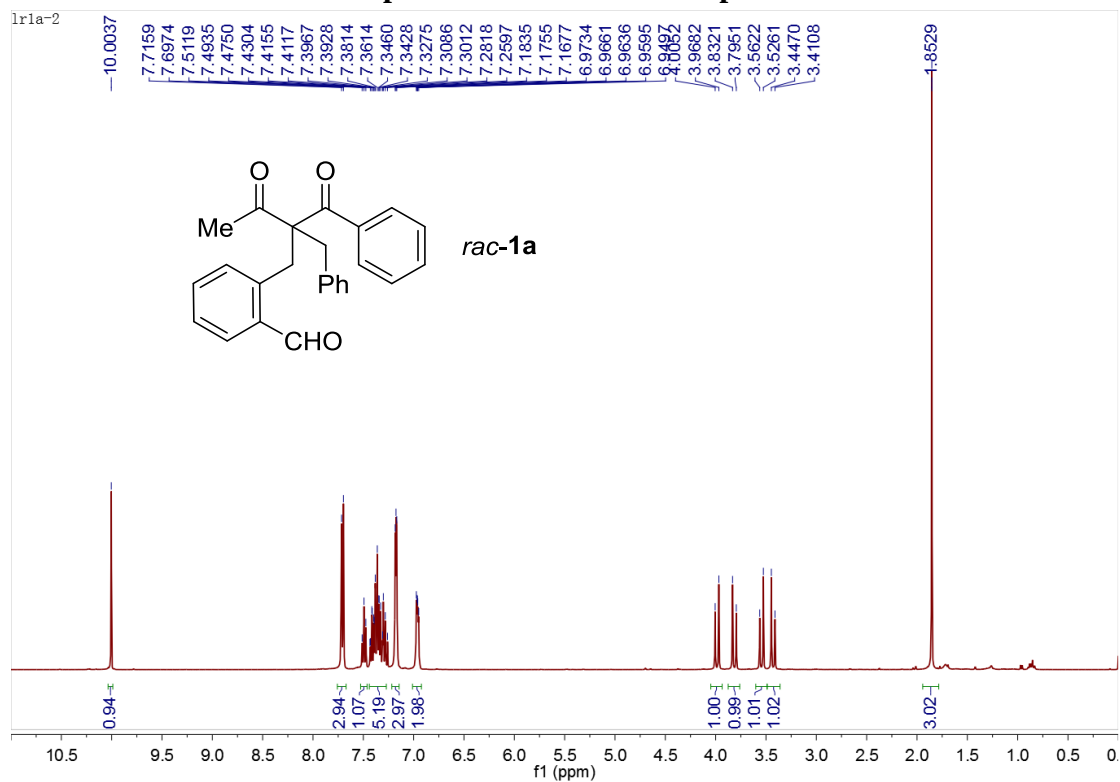


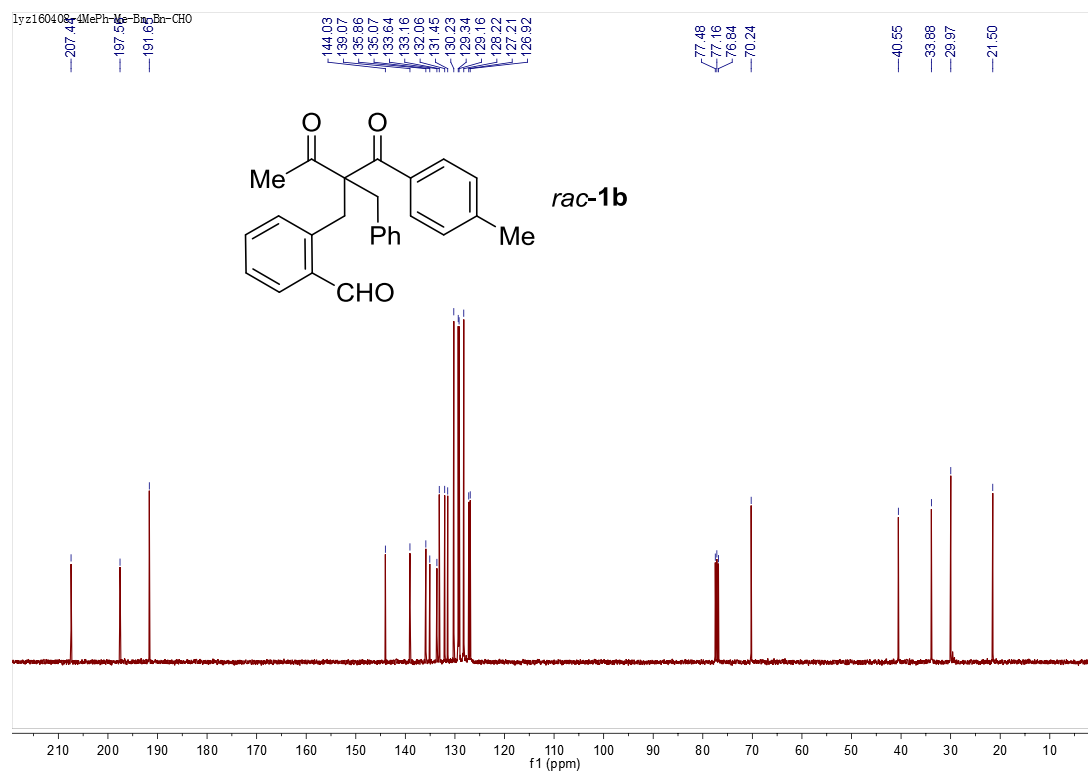
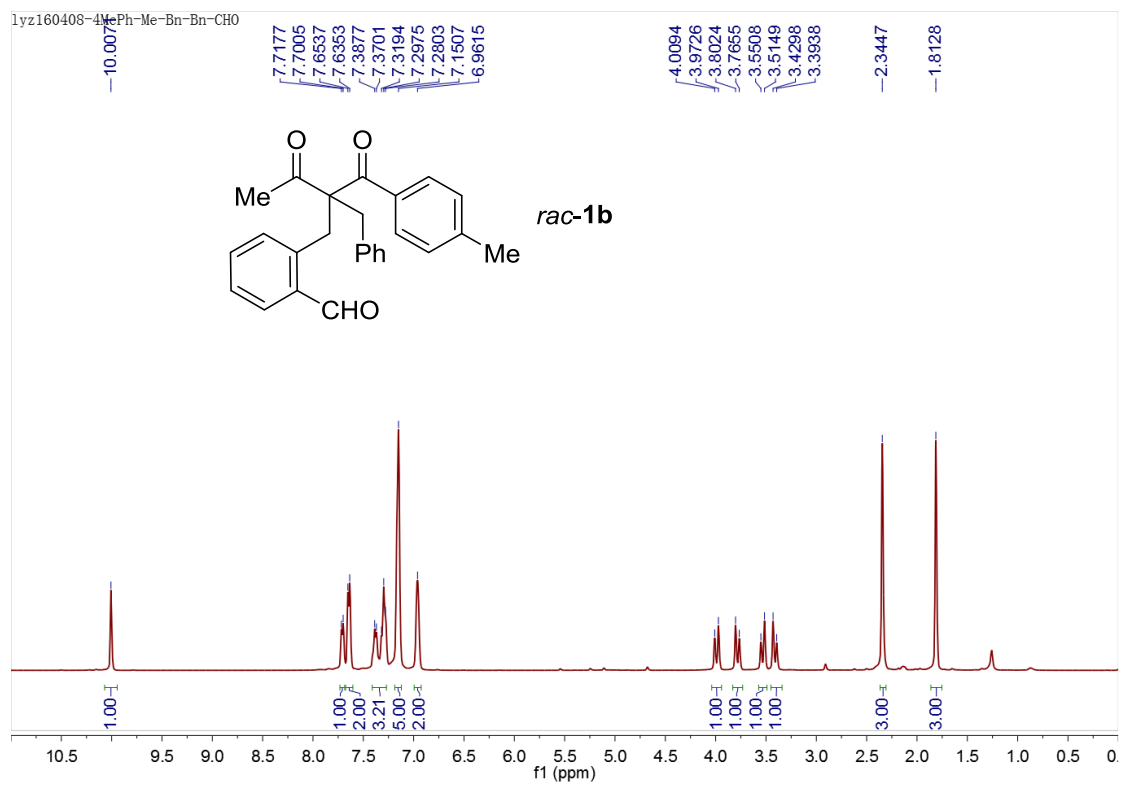
(2S,3S)-3-allyl-3-(4-chlorobenzoyl)-2-hydroxy-2-(4-methoxyphenyl)cyclopentanone (13i): White semisolid, 14.6 mg, 19% yield. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (d, $J = 8.6$ Hz, 2H), 7.37 (d, $J = 8.6$ Hz, 2H), 7.09 (t, $J = 9.7$ Hz, 2H), 6.68 (d, $J = 8.9$ Hz, 2H), 5.39 (td, $J = 16.6, 8.3$ Hz, 1H), 4.97 (dd, $J = 32.1, 13.3$ Hz, 2H), 3.70 (s, 3H), 3.65 (s, 1H), 3.12 (dd, $J = 14.3, 6.0$ Hz, 1H), 2.89–2.68 (m, 2H), 2.54 (dd, $J = 19.7, 9.6$ Hz, 1H), 2.17 (dd, $J = 14.5, 8.4$ Hz, 2H); ^{13}C NMR (101 MHz, CDCl_3) δ 217.5, 200.9, 159.2, 138.7, 135.7, 132.2, 130.8, 130.4, 128.5, 127.0, 119.7, 113.9, 84.4, 62.9, 55.14, 37.5, 32.0, 23.5; HRMS (ESI, m/z): calcd. for $\text{C}_{22}\text{H}_{21}\text{ClO}_4\text{H}^+$ 385.1201, found 385.1204; HPLC analysis: 0% ee (Chiralcel AD-H, 10:90 i PrOH/hexane, 1.00 mL/min, 254 nm); IR (KBr thin film, cm^{-1}): ν 3649, 3349, 3225, 3078, 2920, 2356, 1752, 1668, 1617, 1473, 1360, 1090, 943, 716, 586.

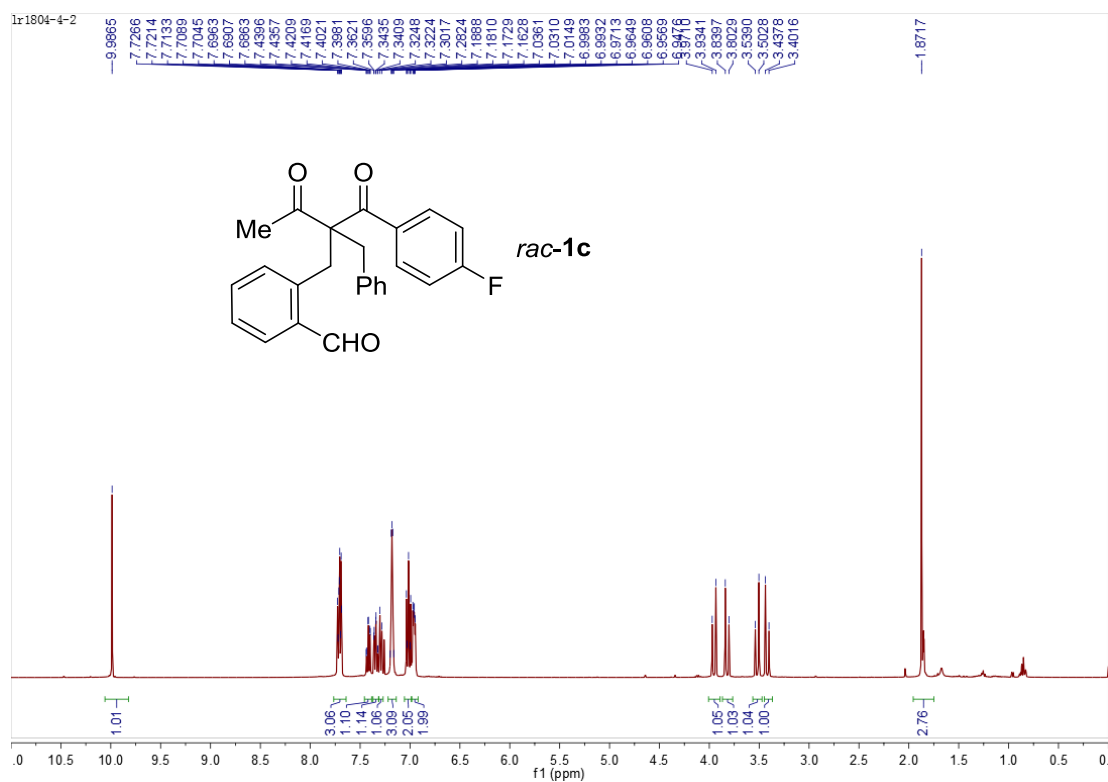


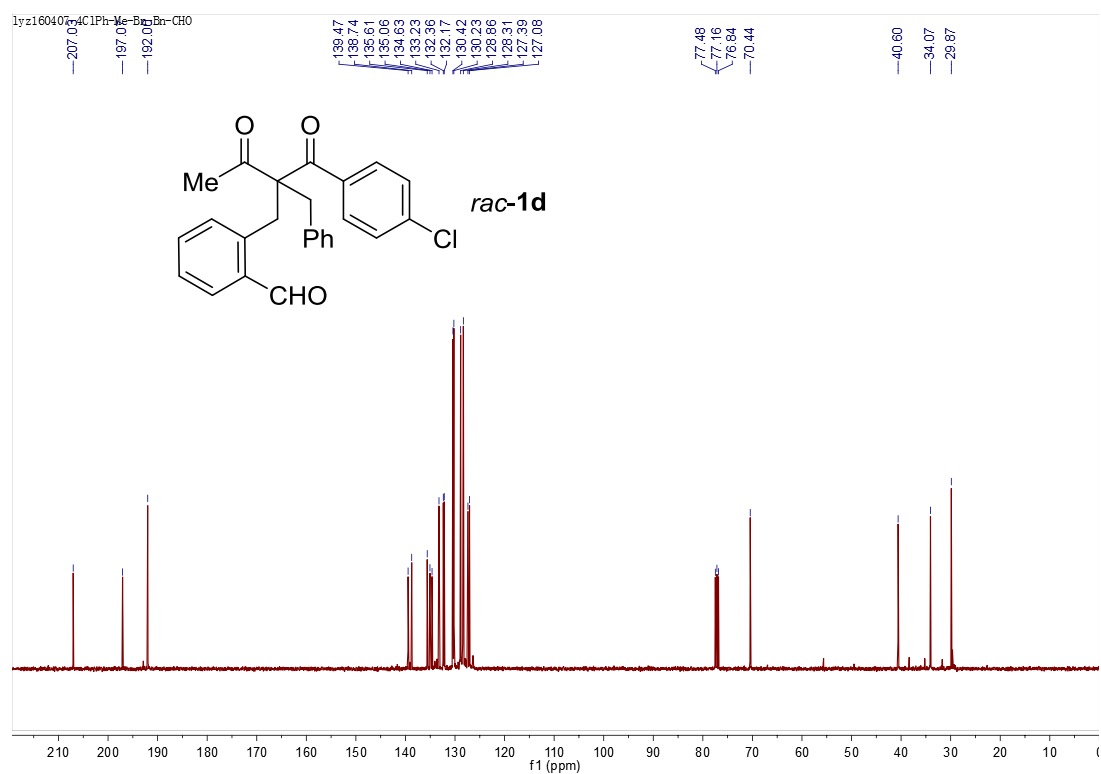
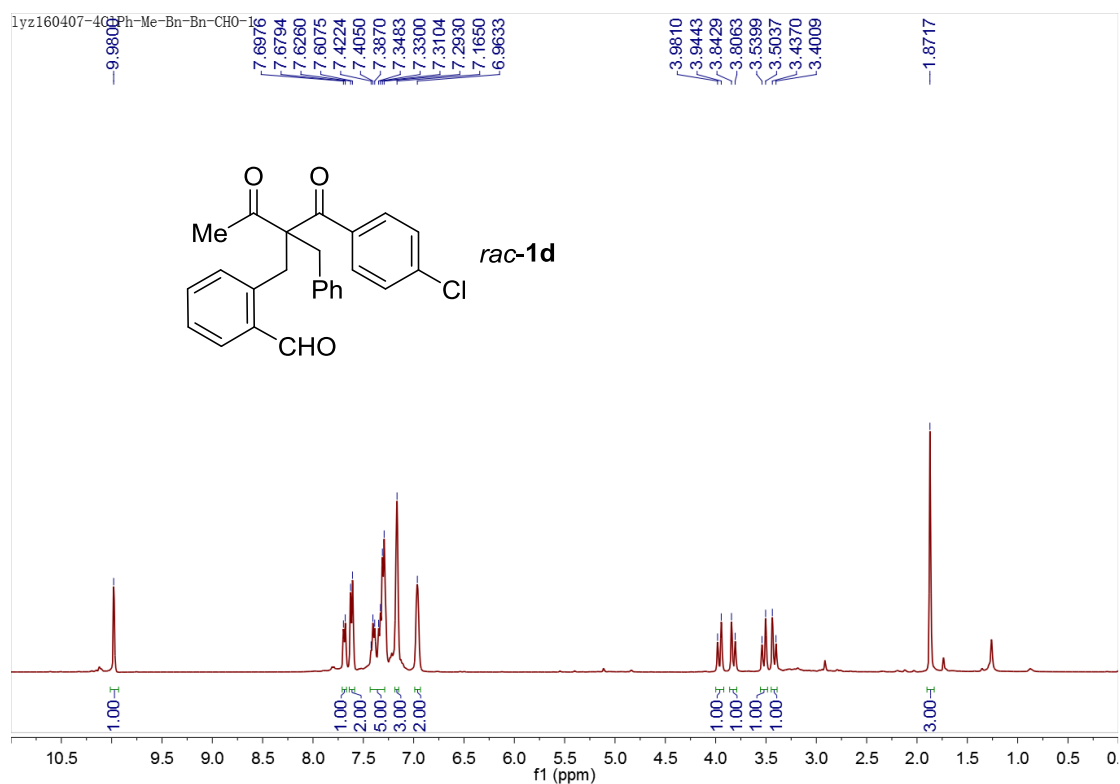
(S)-4-(4-chlorobenzoyl)-4-(4-methoxybenzoyl)hept-6-enal (S-11i): Yellow oil, 14.6 mg, 19% yield. $[\alpha]_{\text{D}}^{20}$: +17.3 (c 0.18, CHCl_3); HPLC analysis: 91% ee (Chiralcel AD-H, 20:80 i PrOH/hexane, 1.00 mL/min, 254 nm), R_t (major) = 10.1 min, R_t (minor) = 9.5 min.

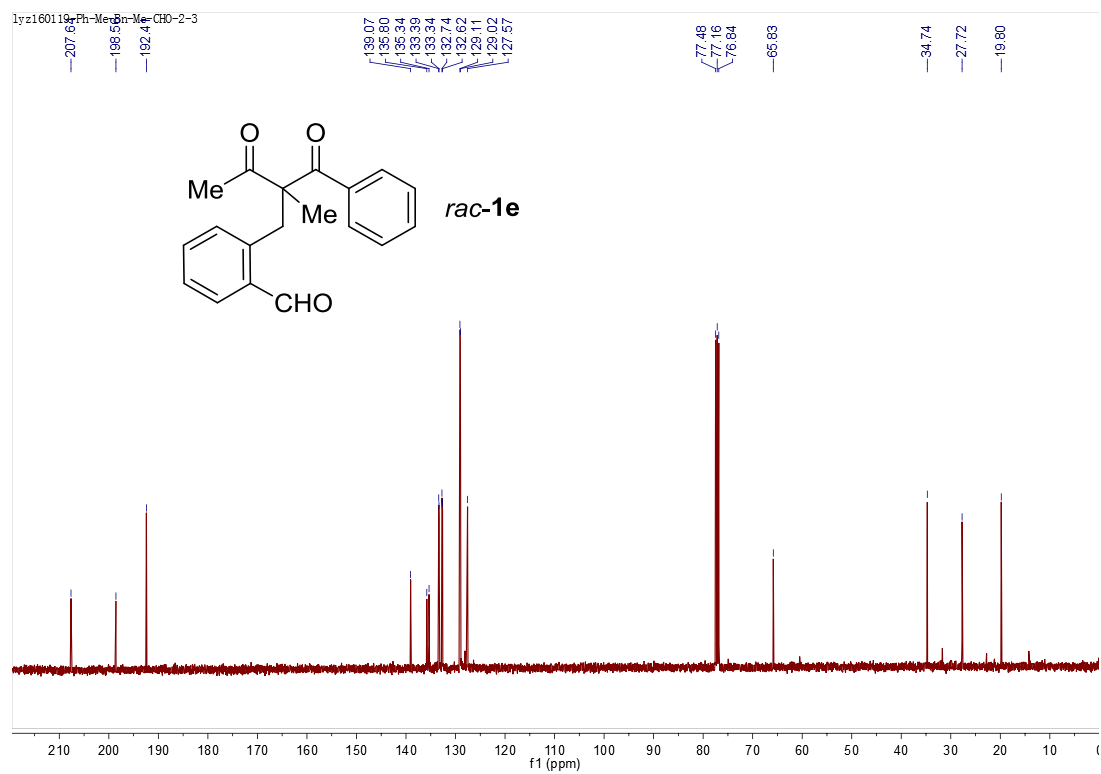
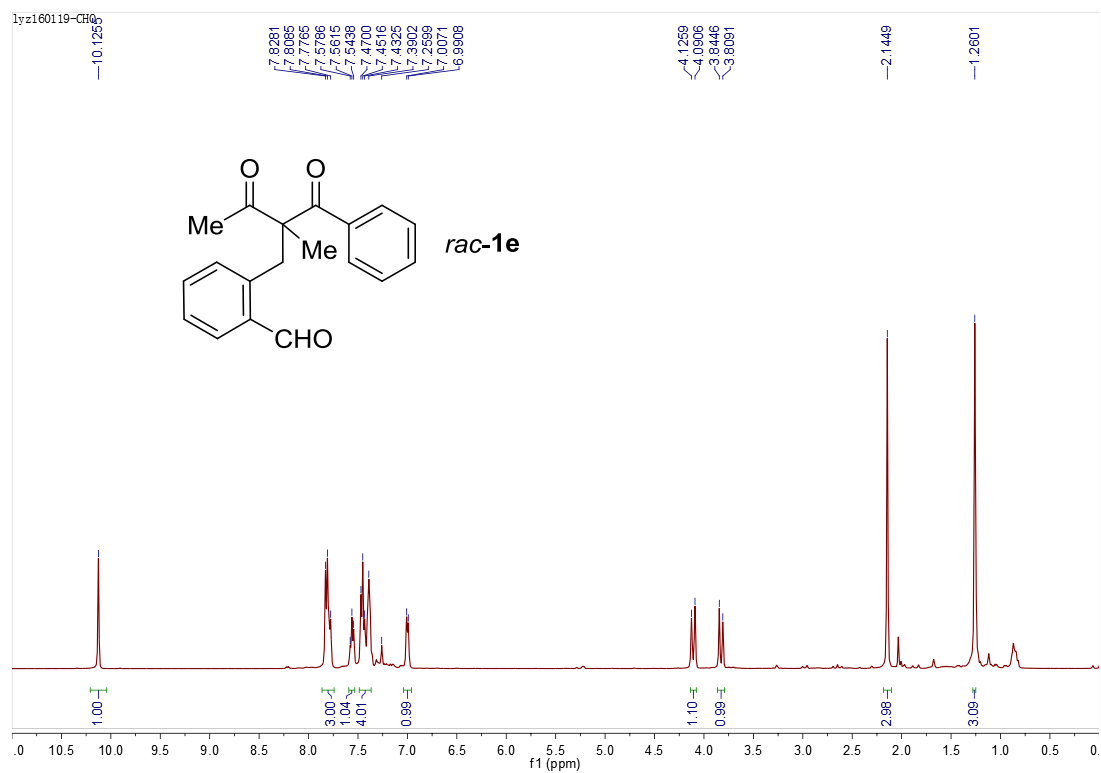
V. ^1H NMR and ^{13}C NMR spectra of substrates and products

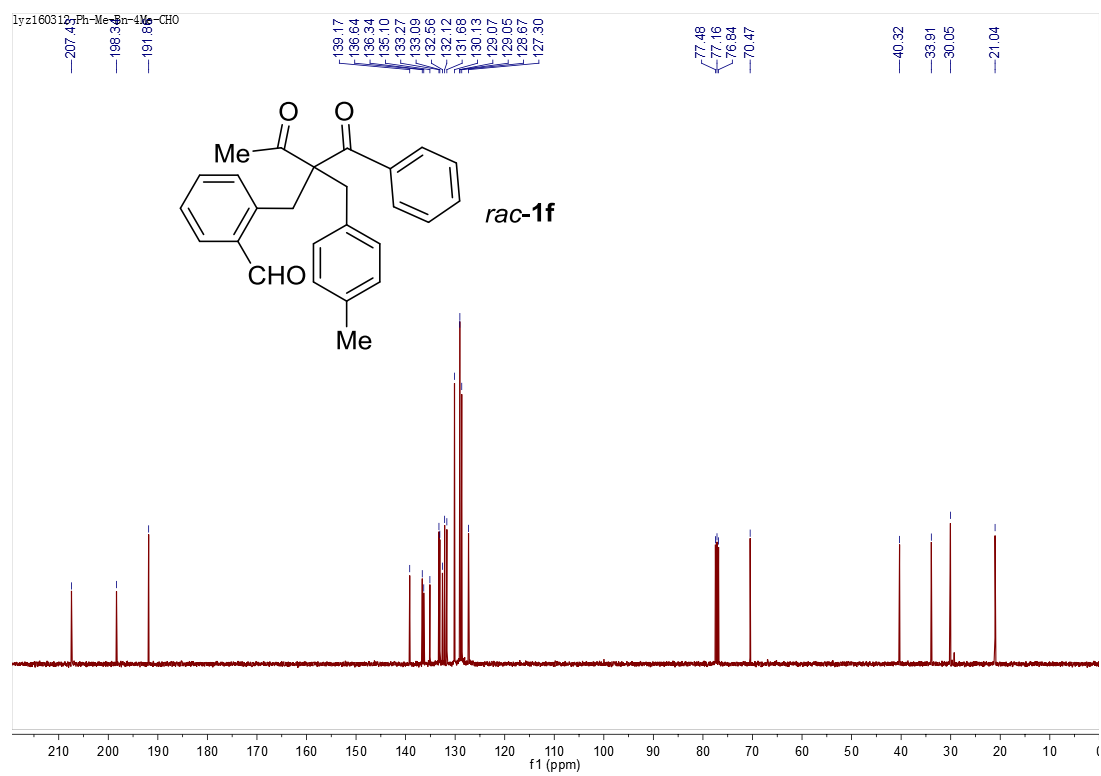
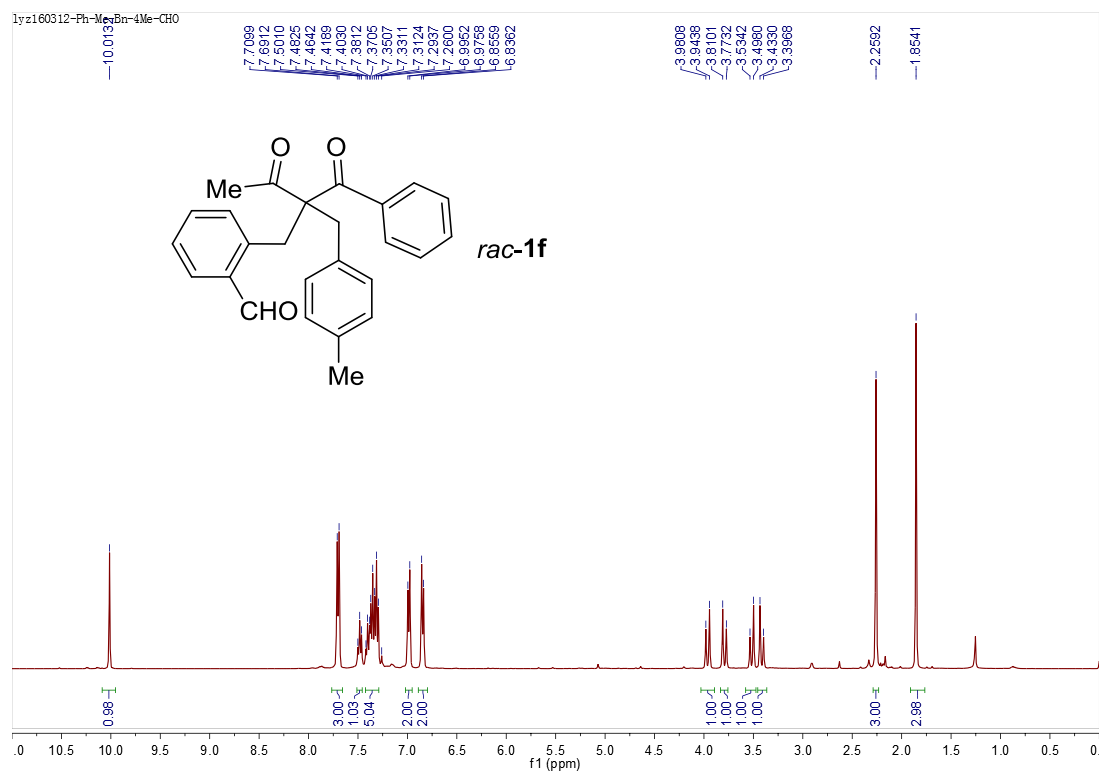


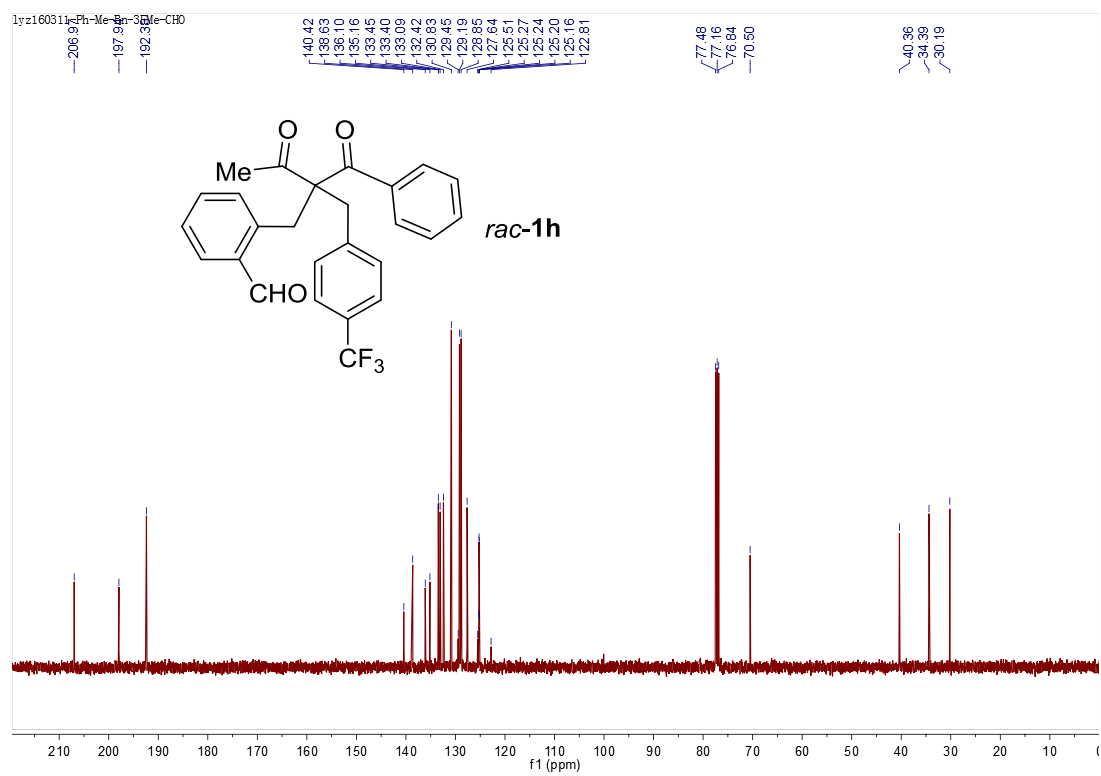
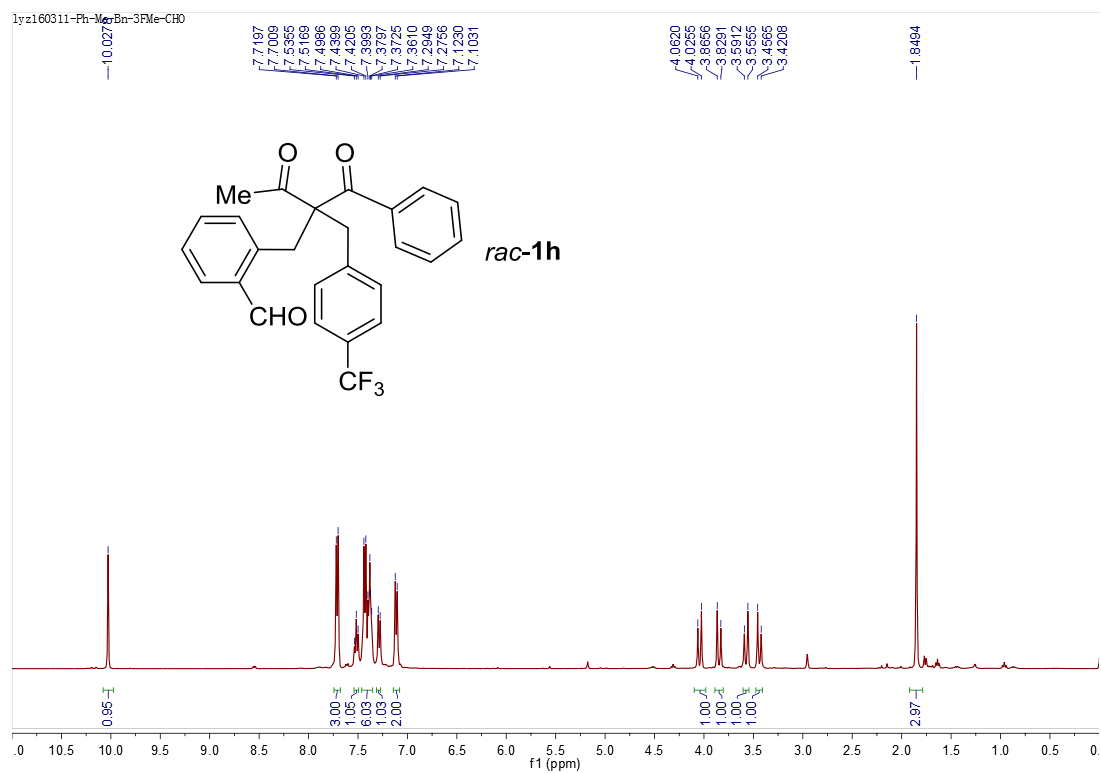


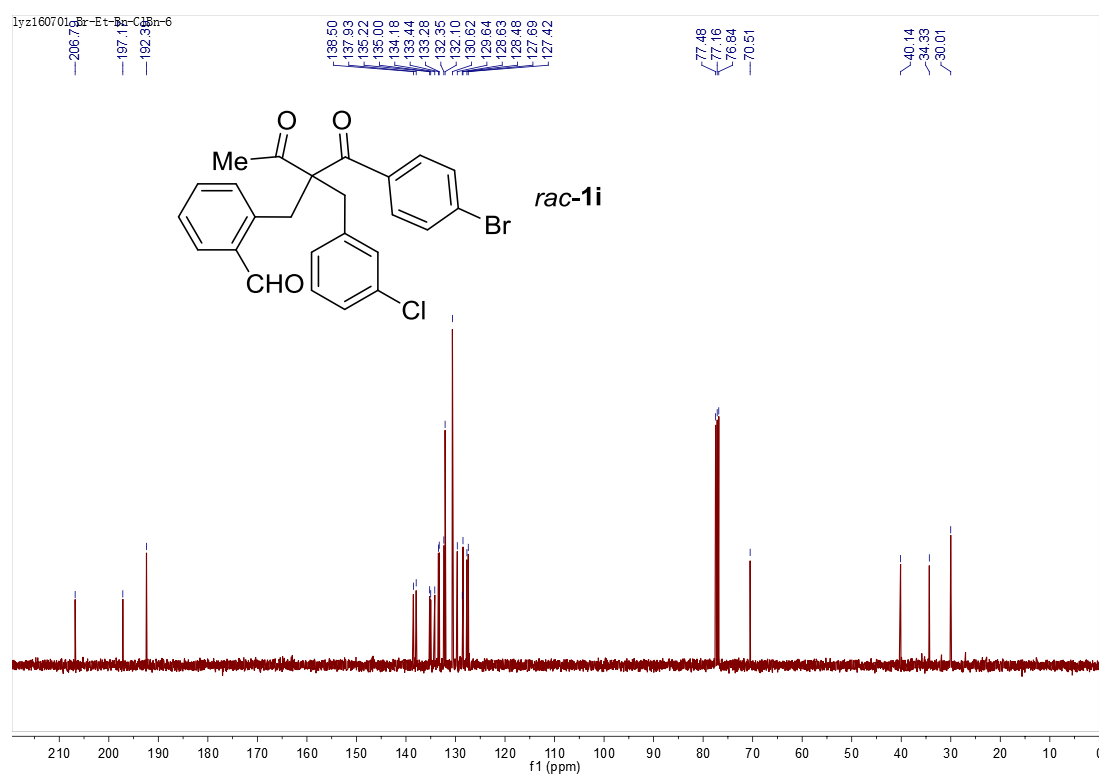
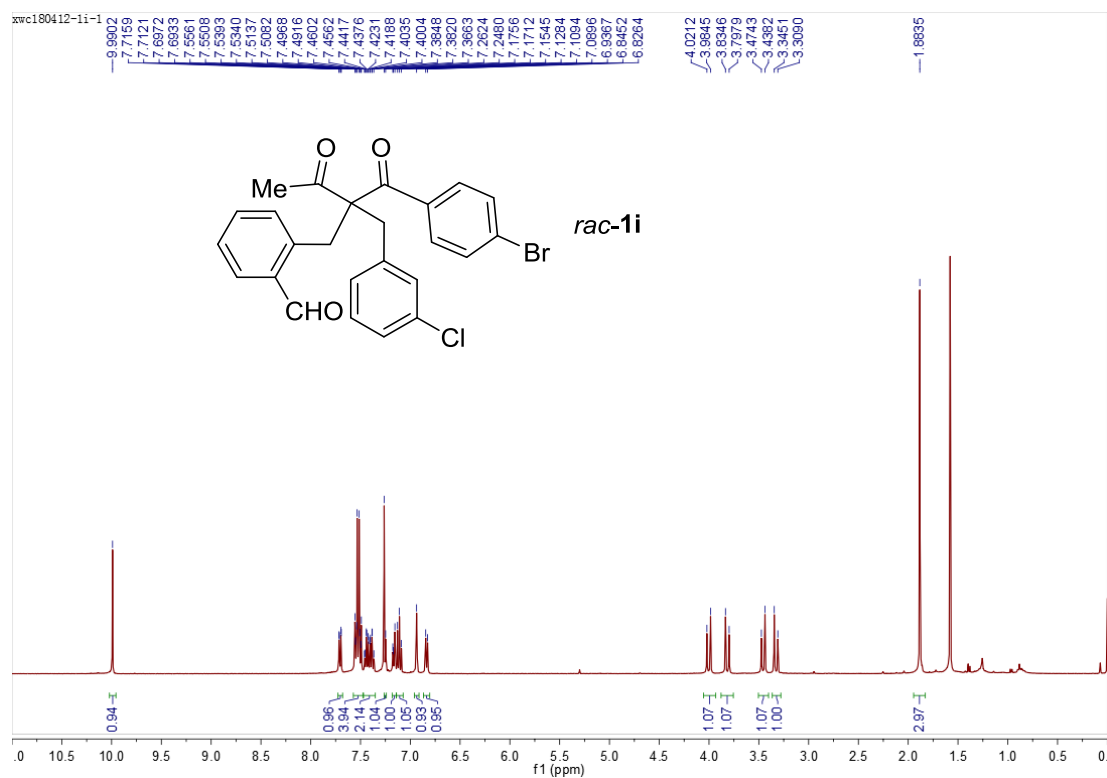


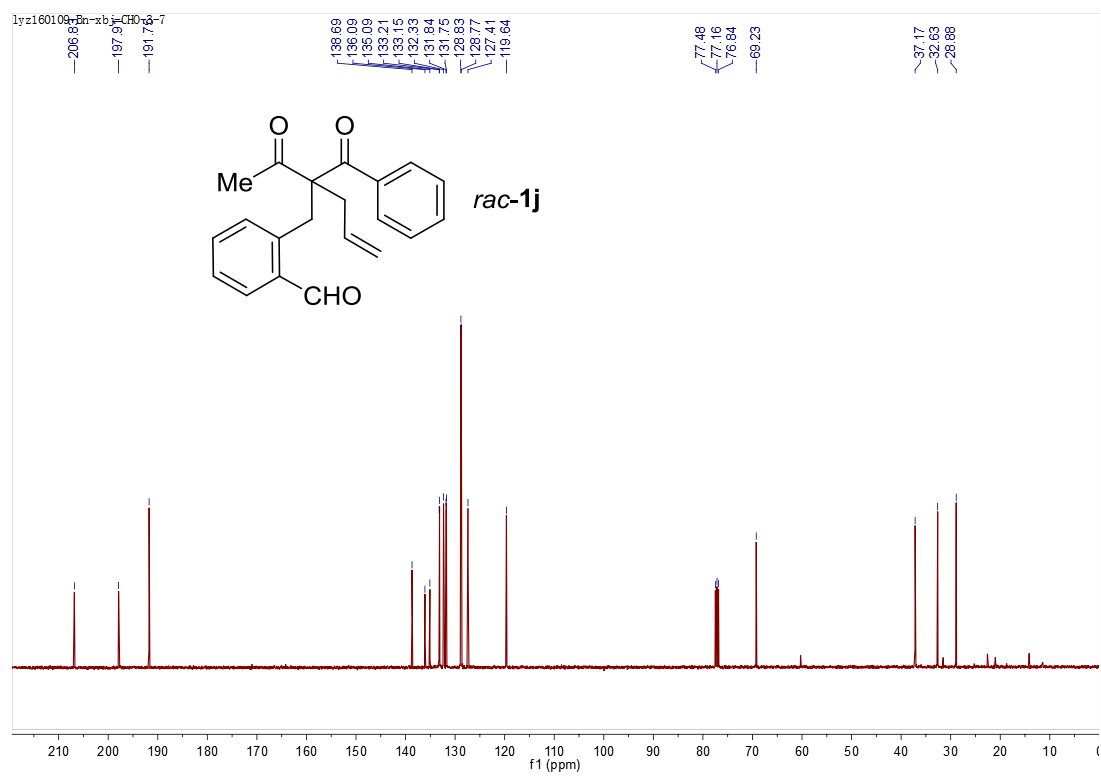
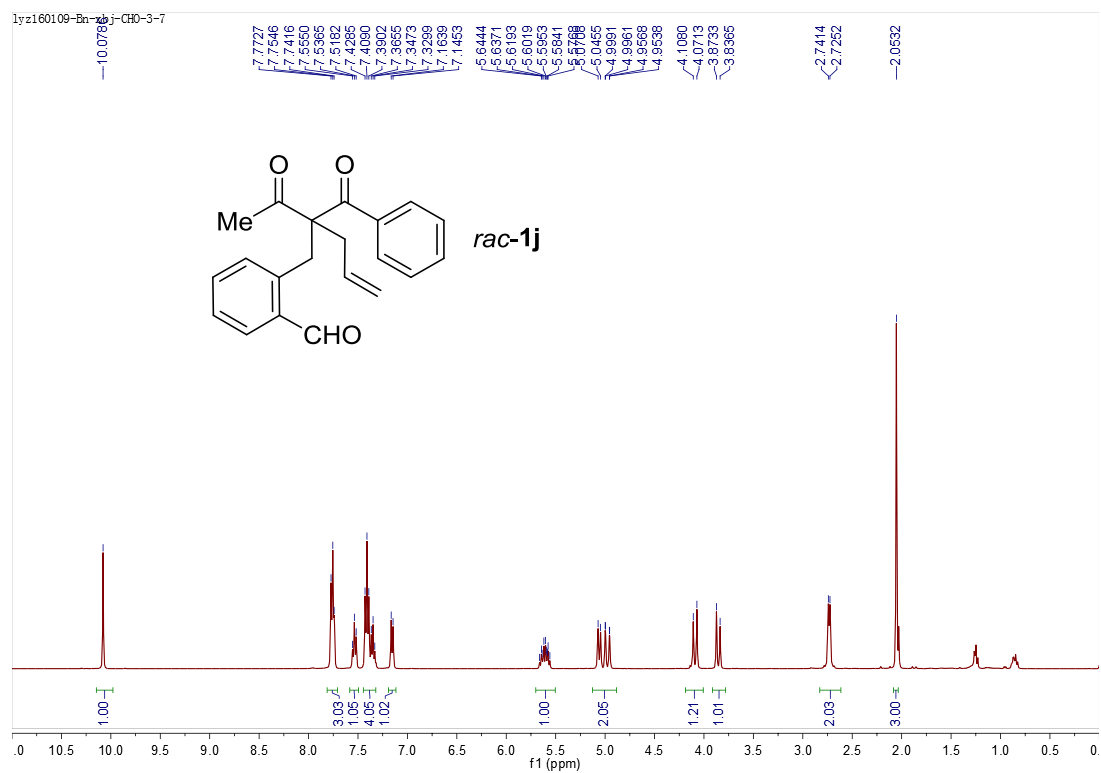


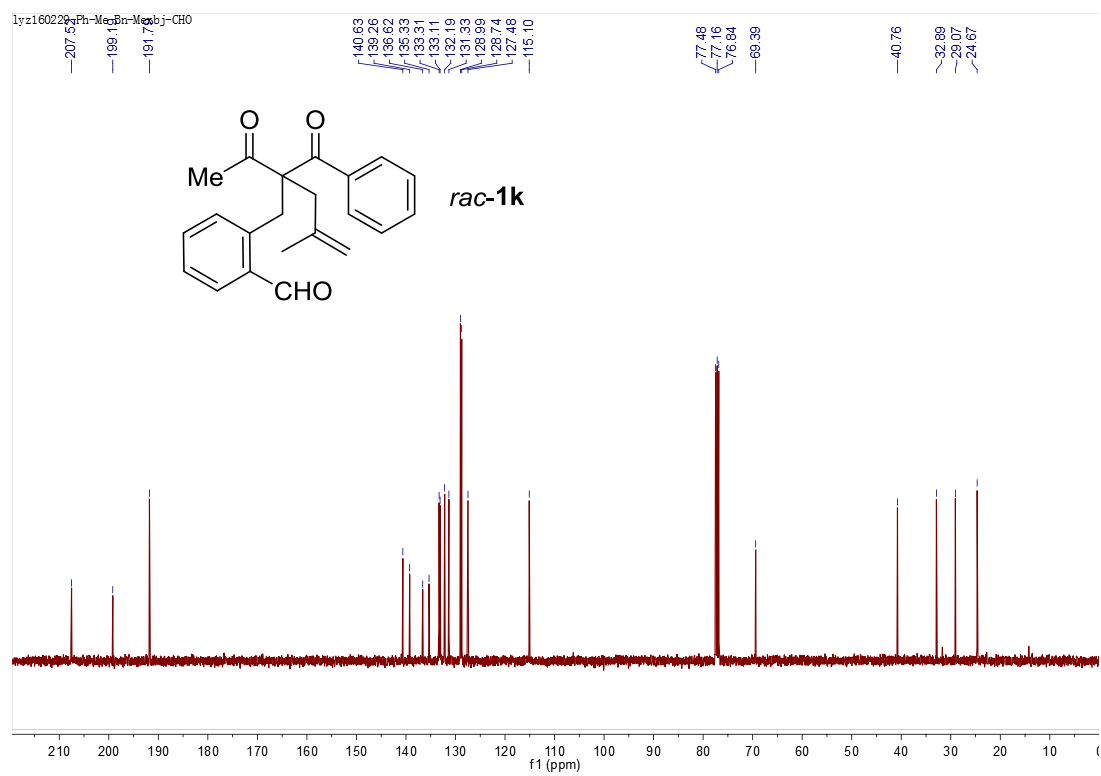
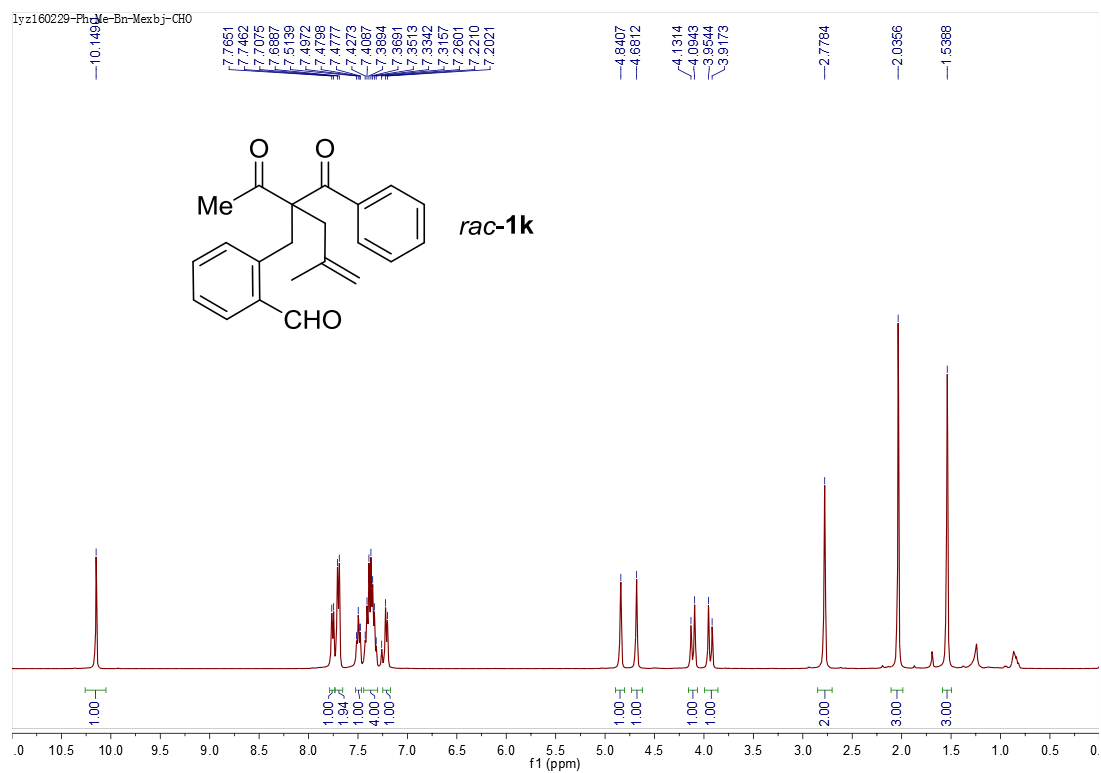


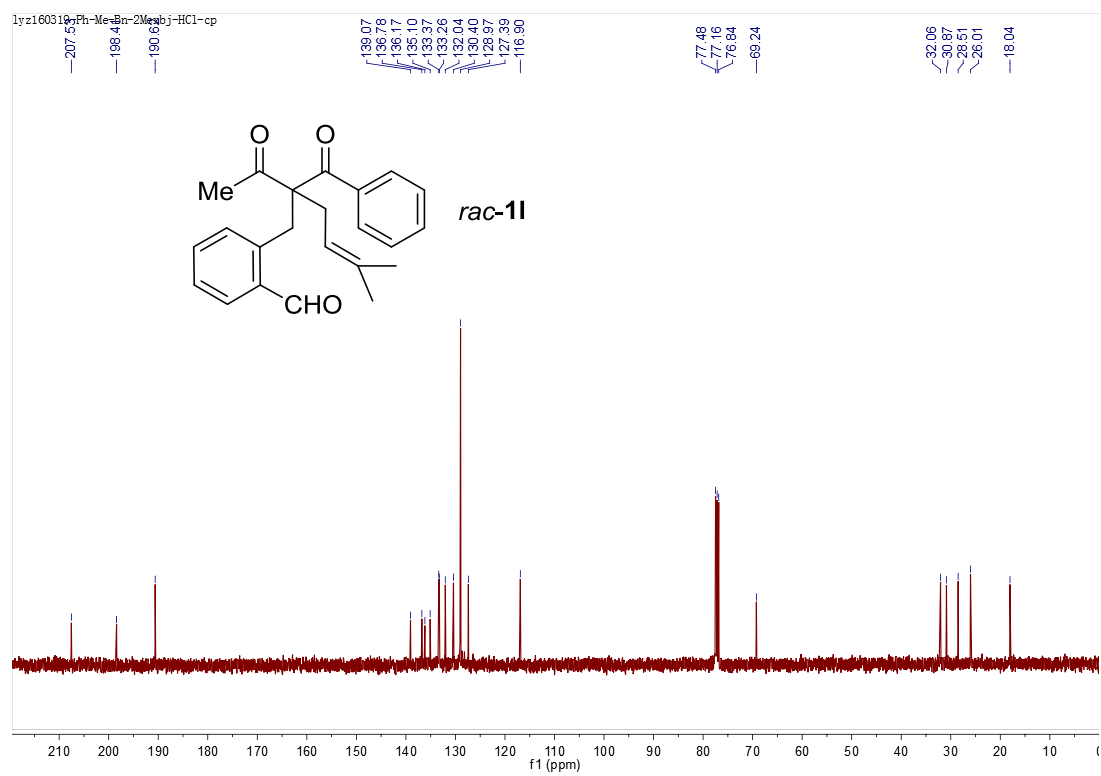
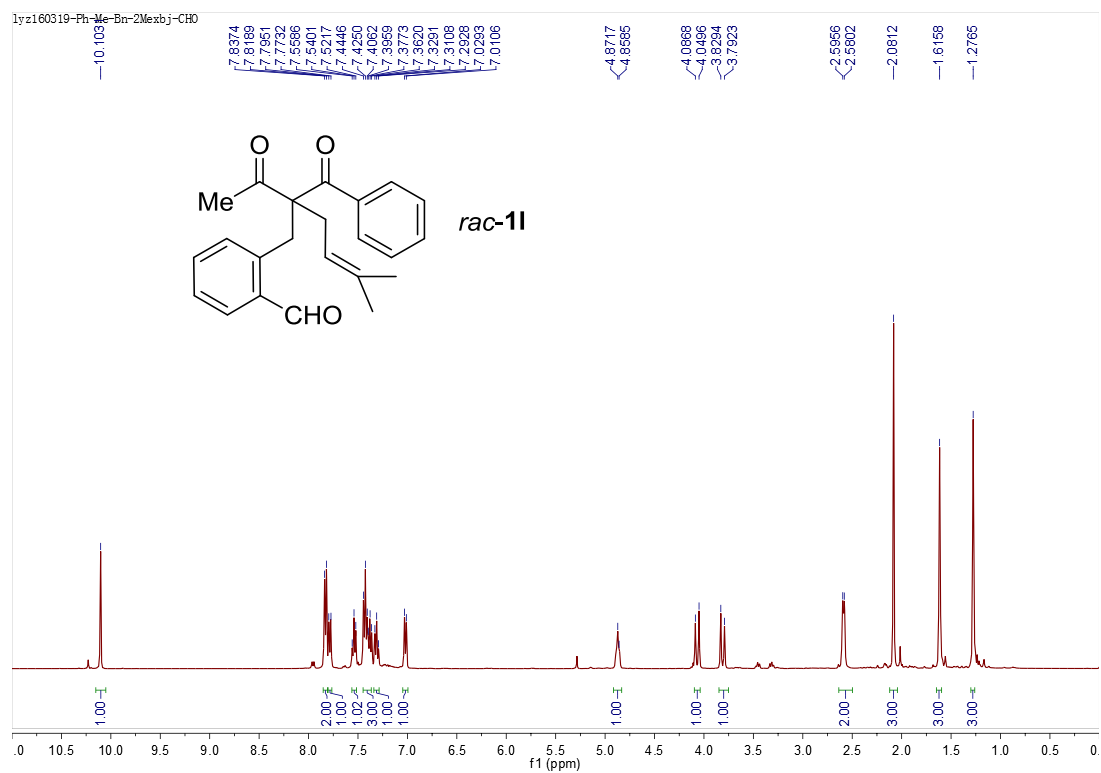


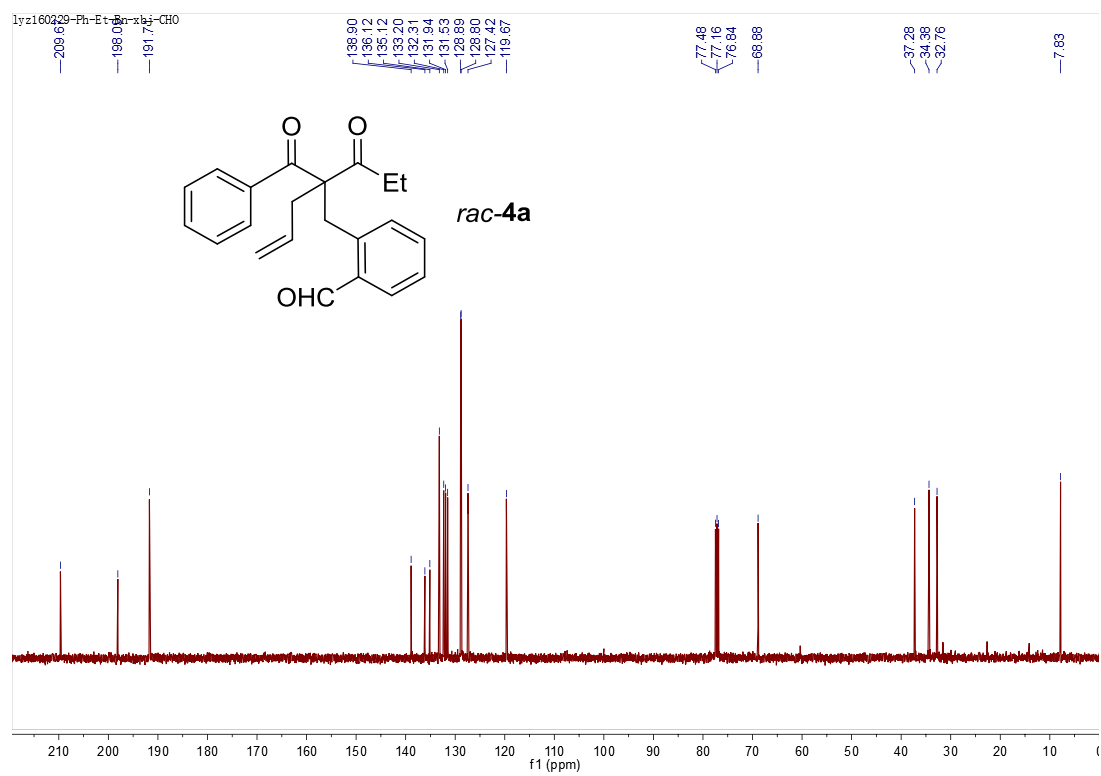
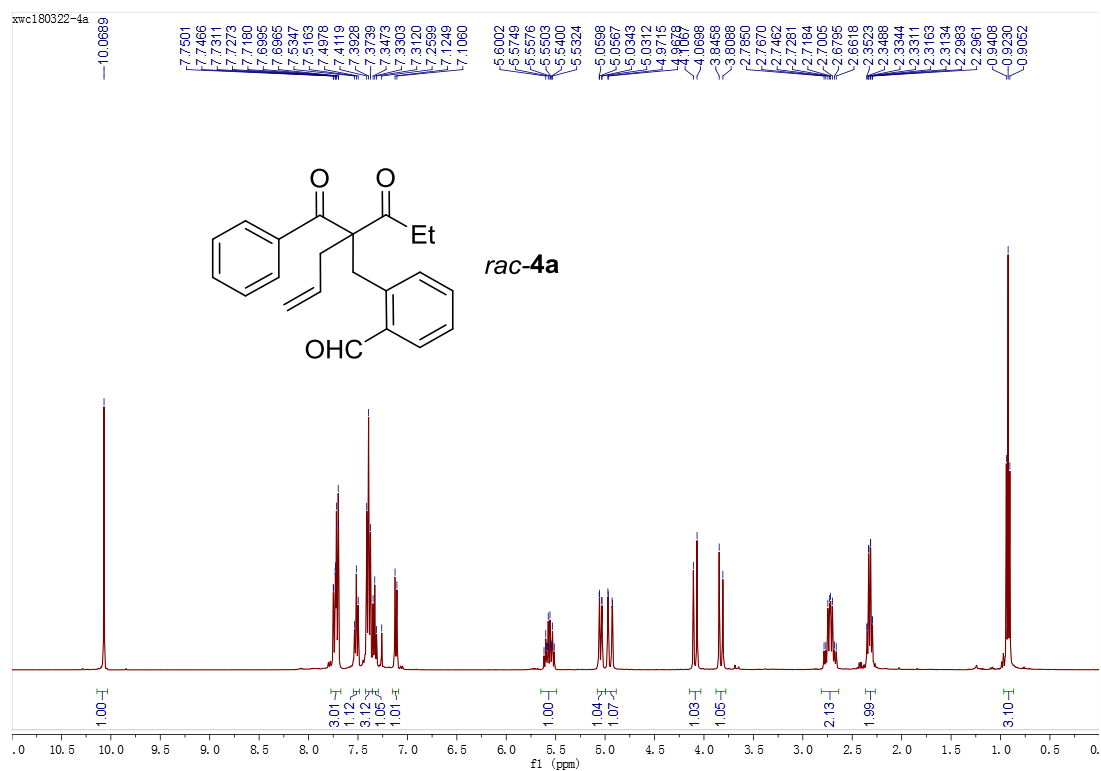


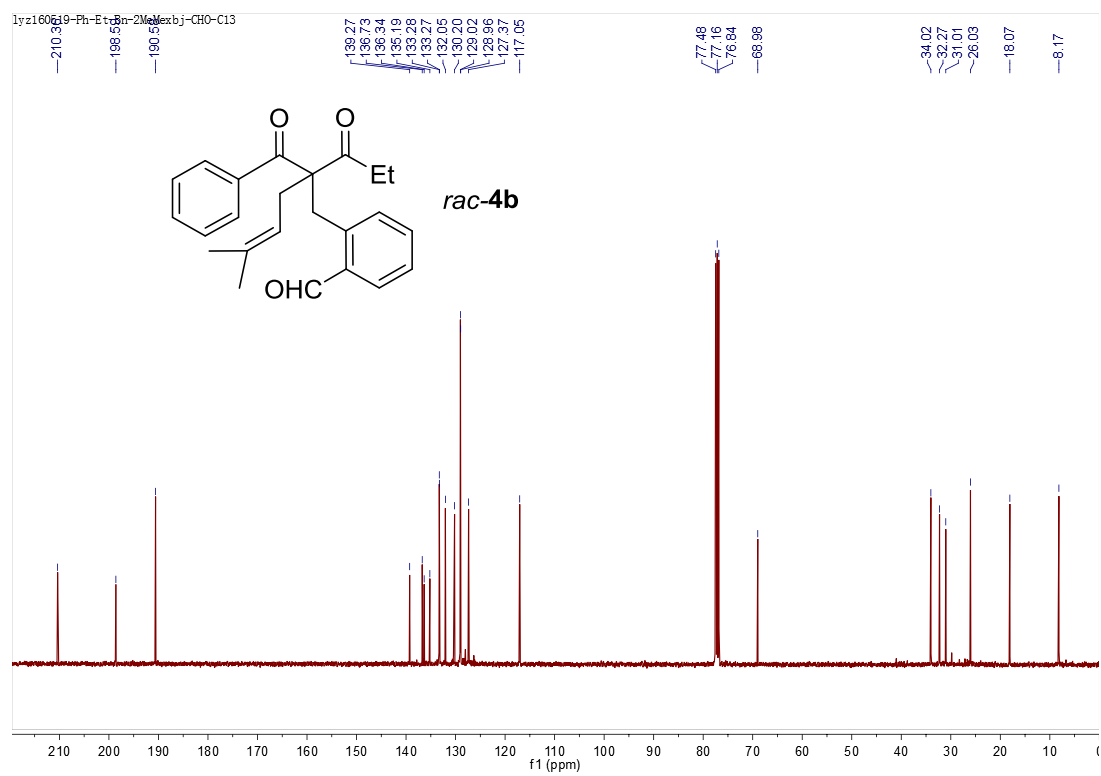
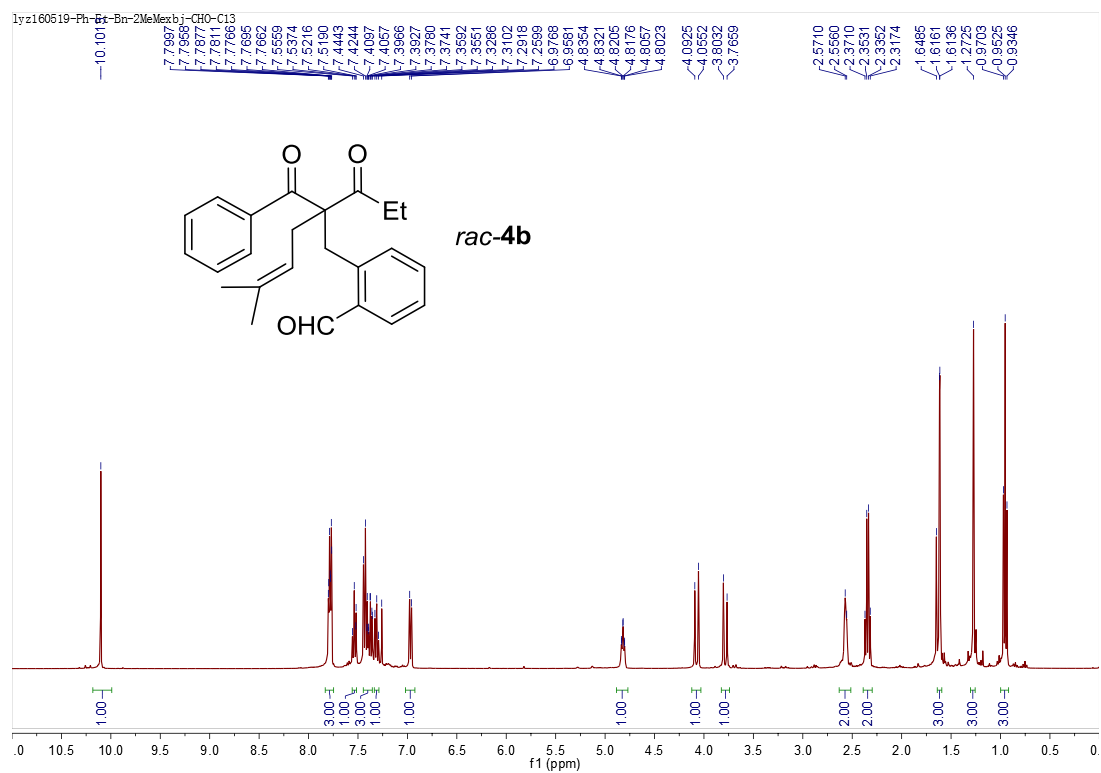


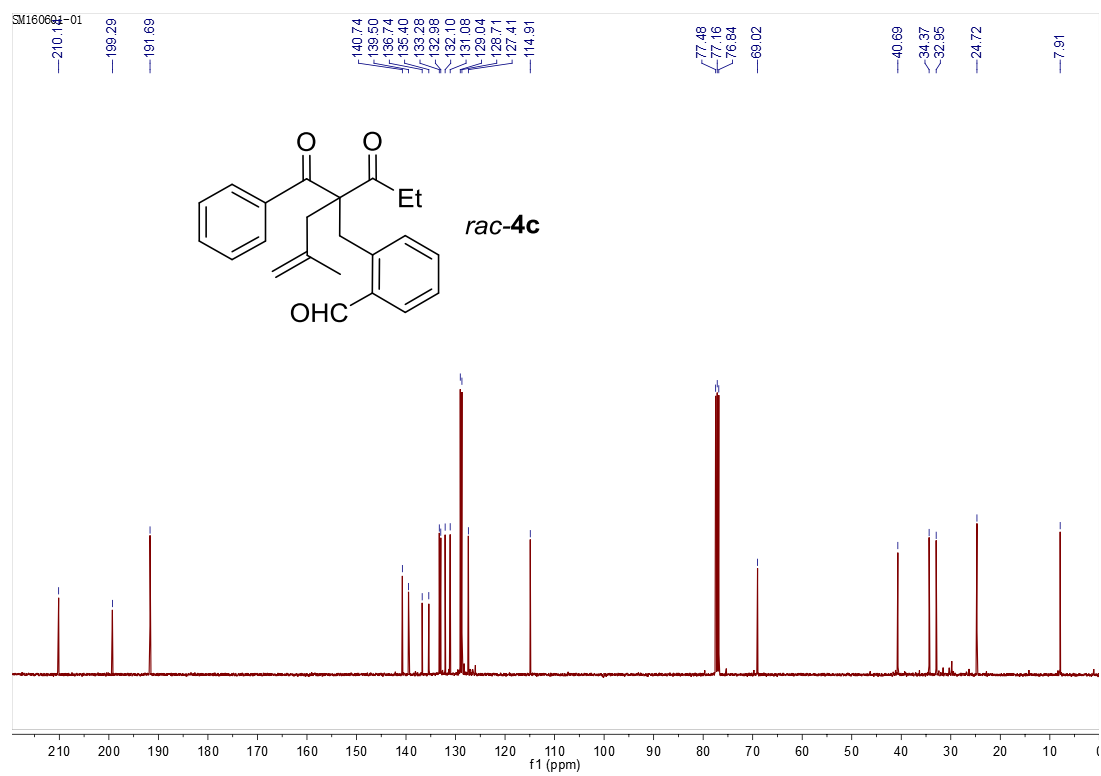
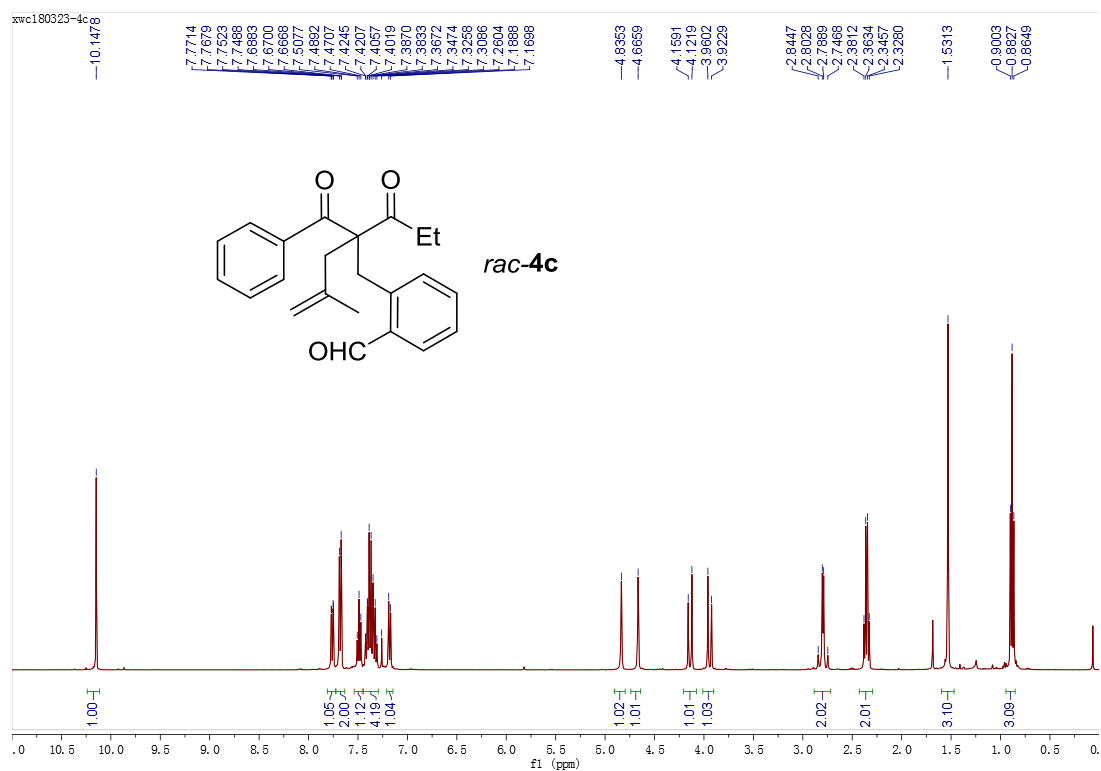


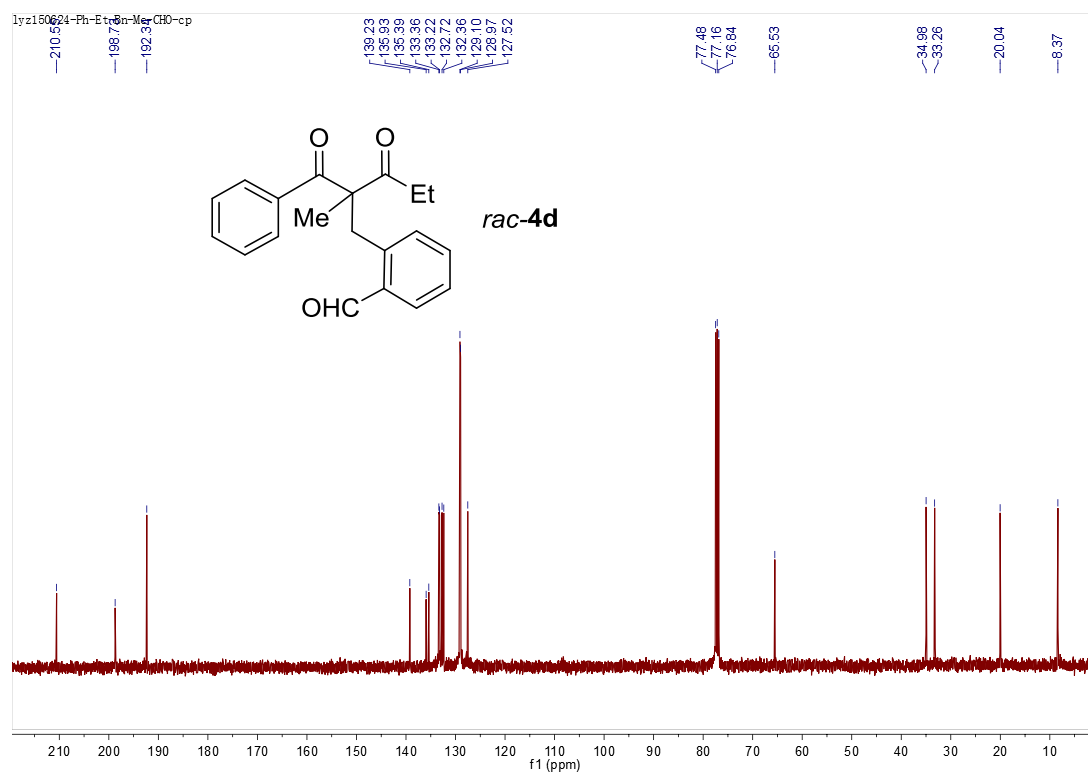
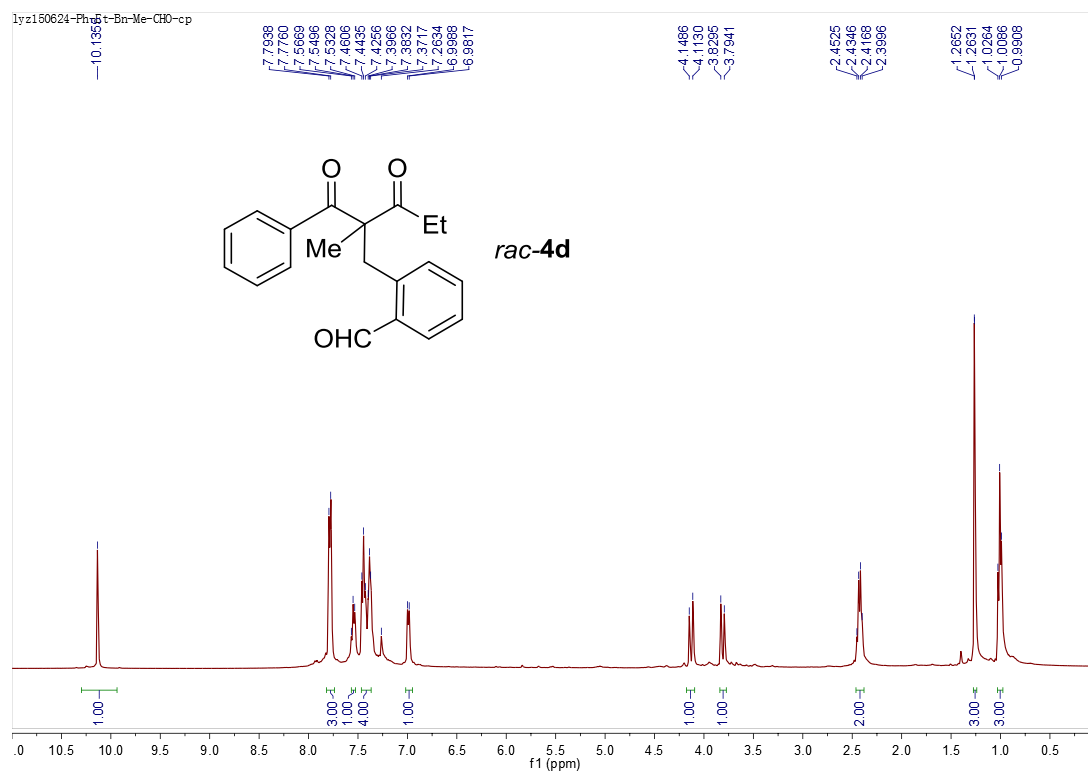


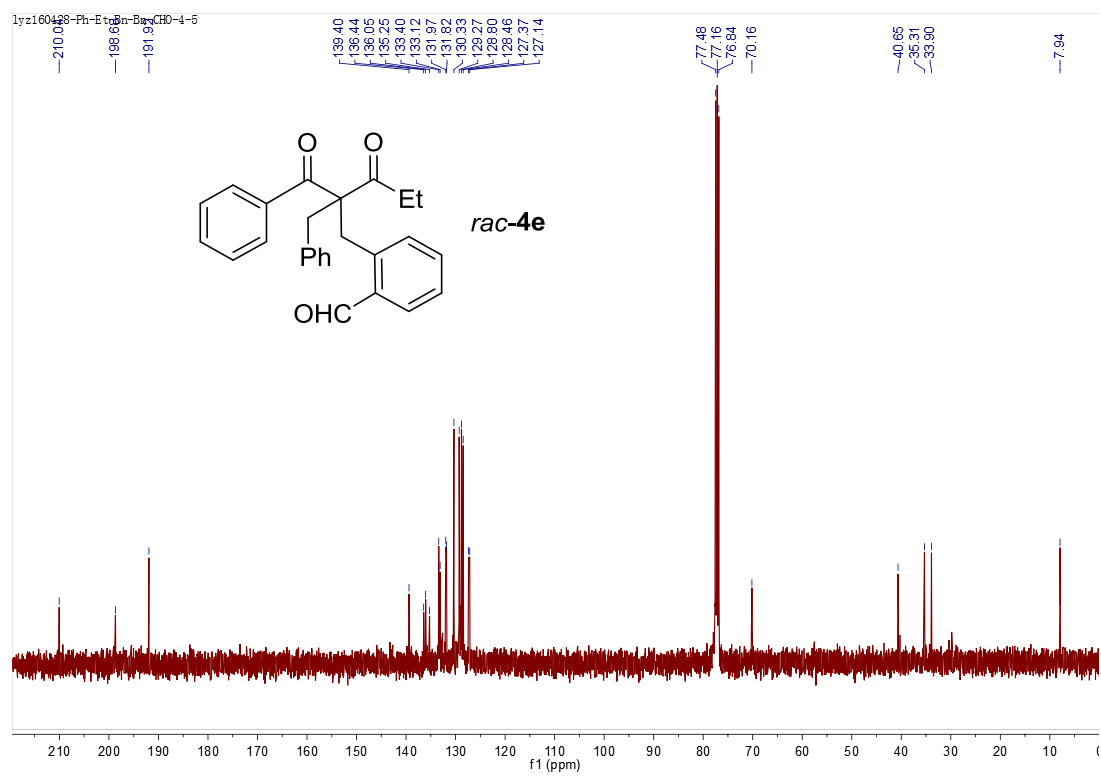
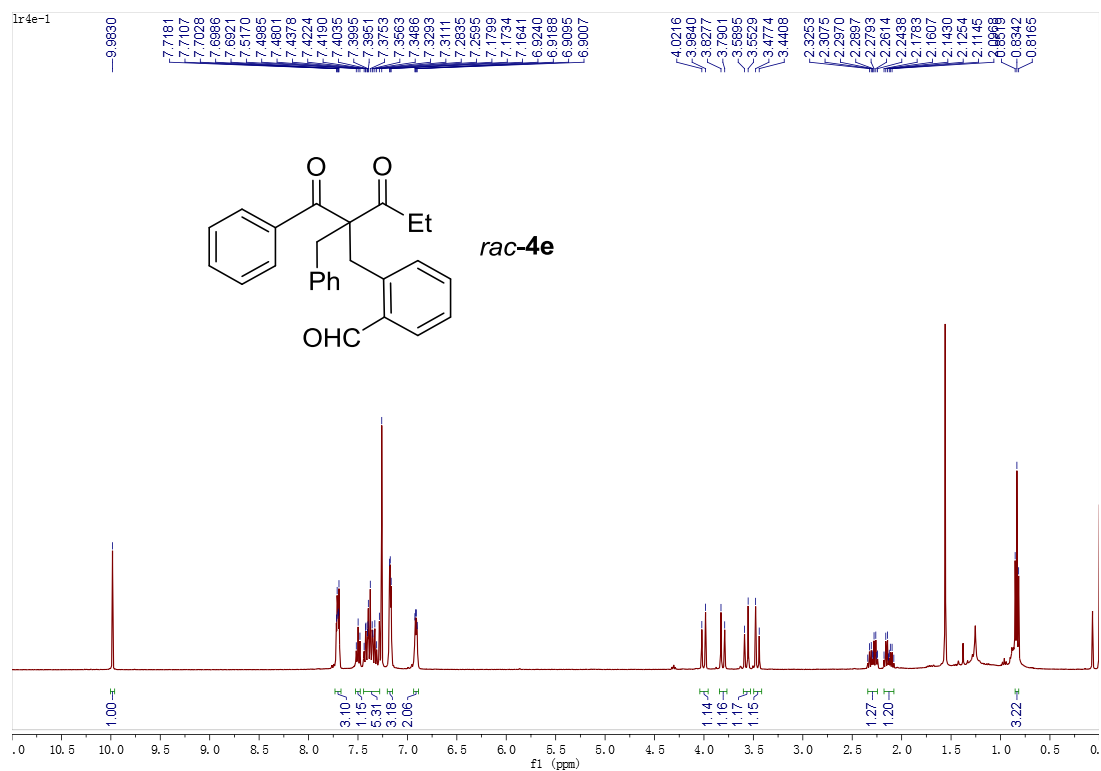


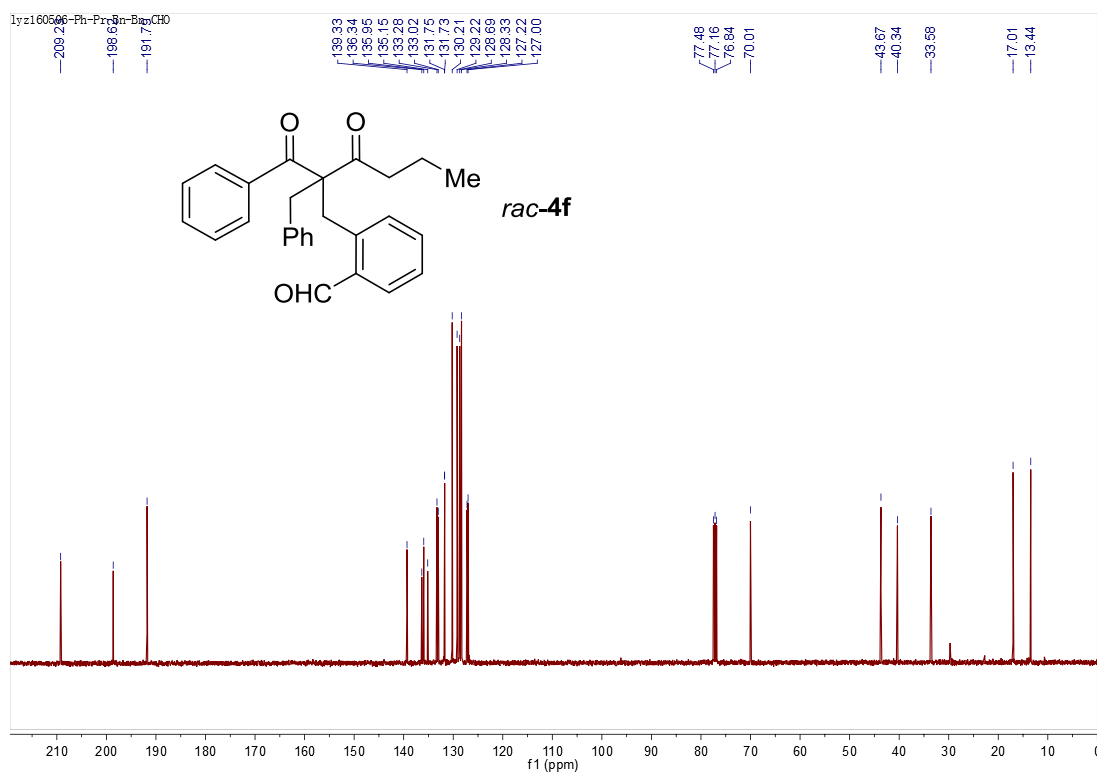
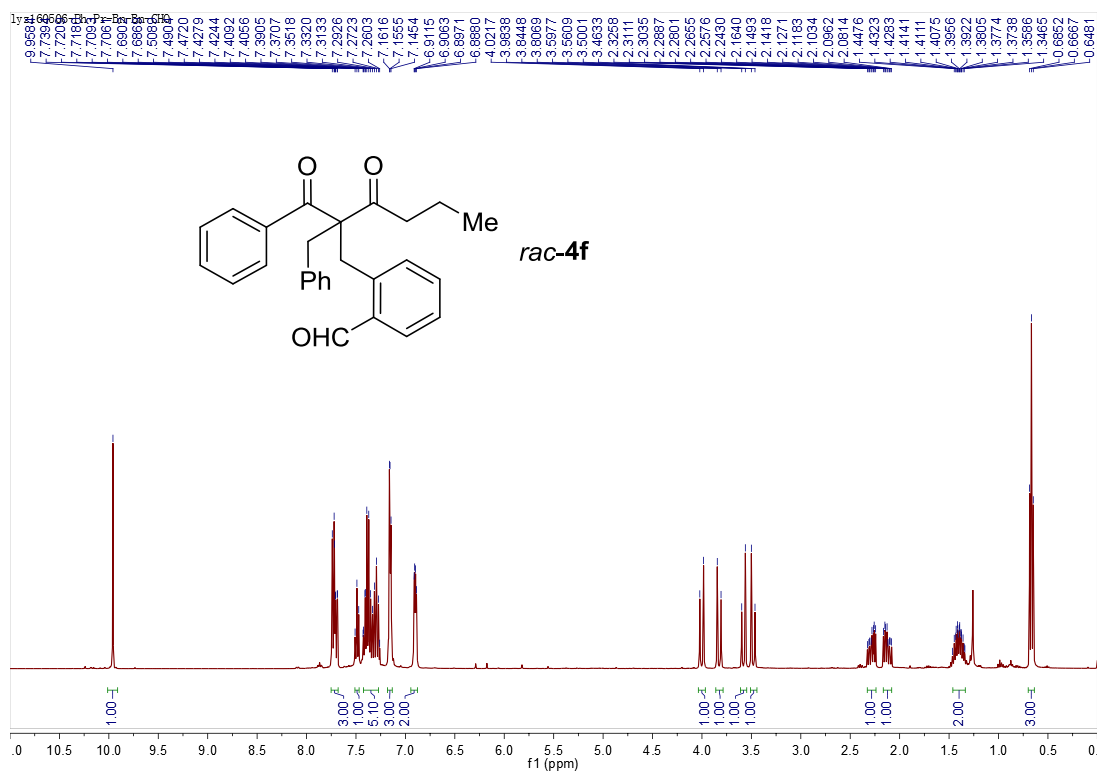


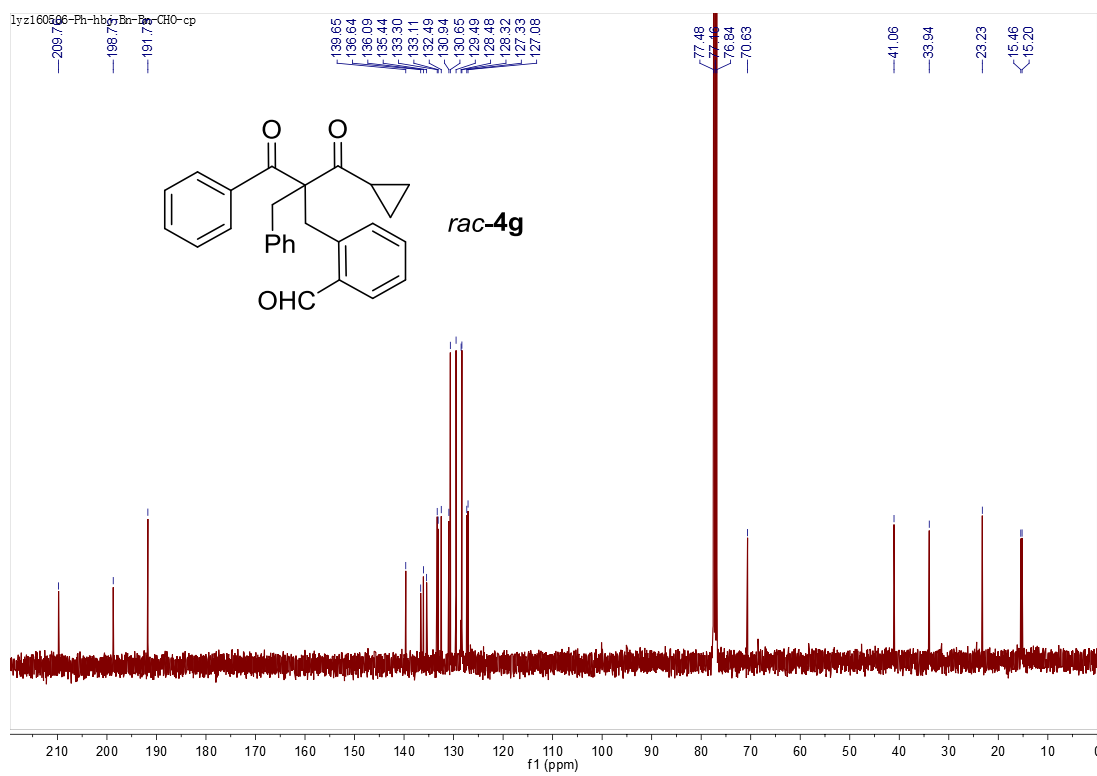
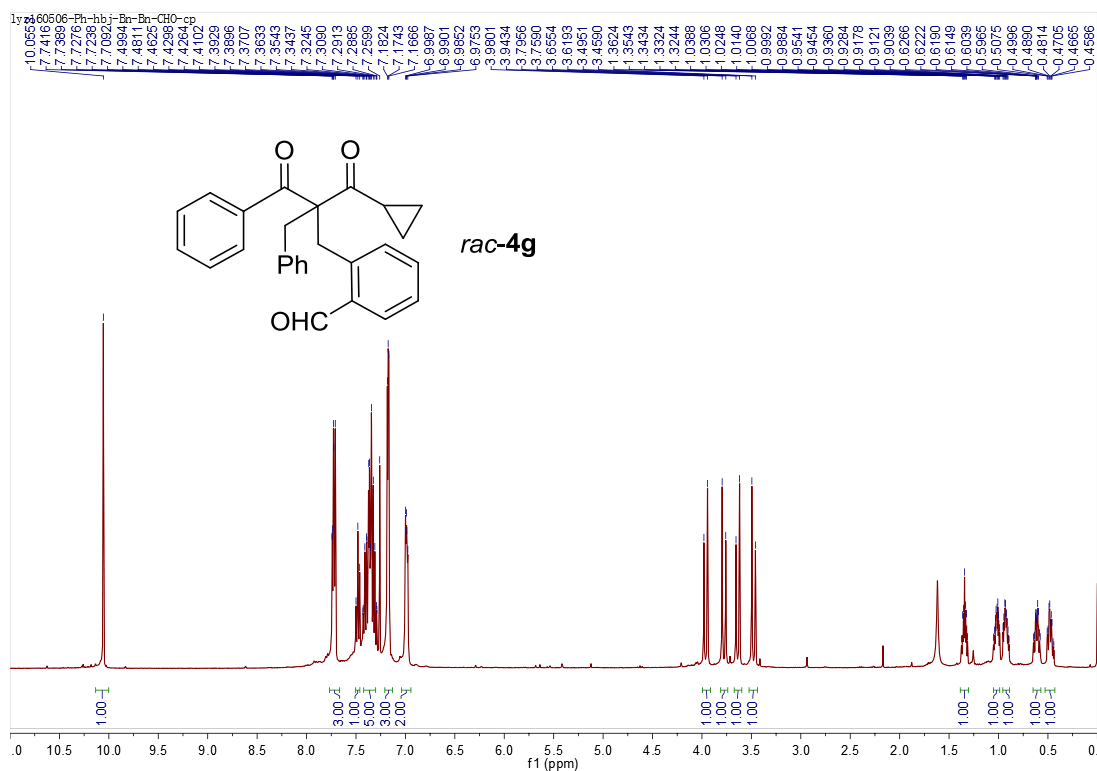


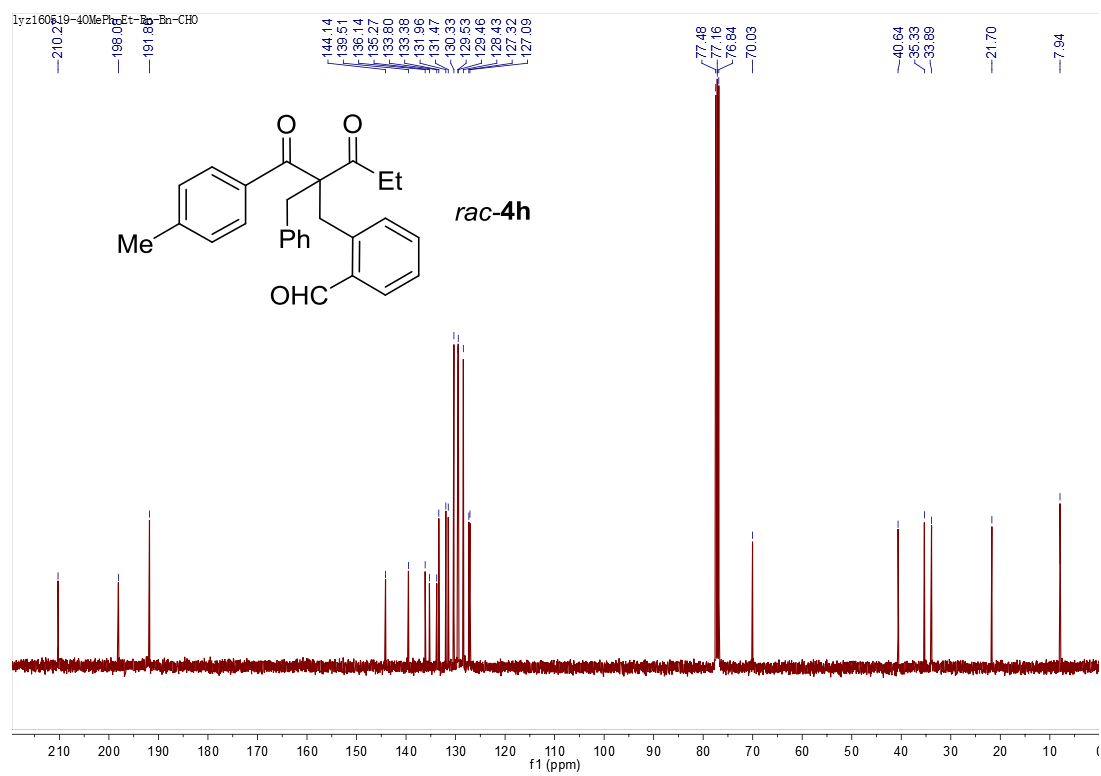
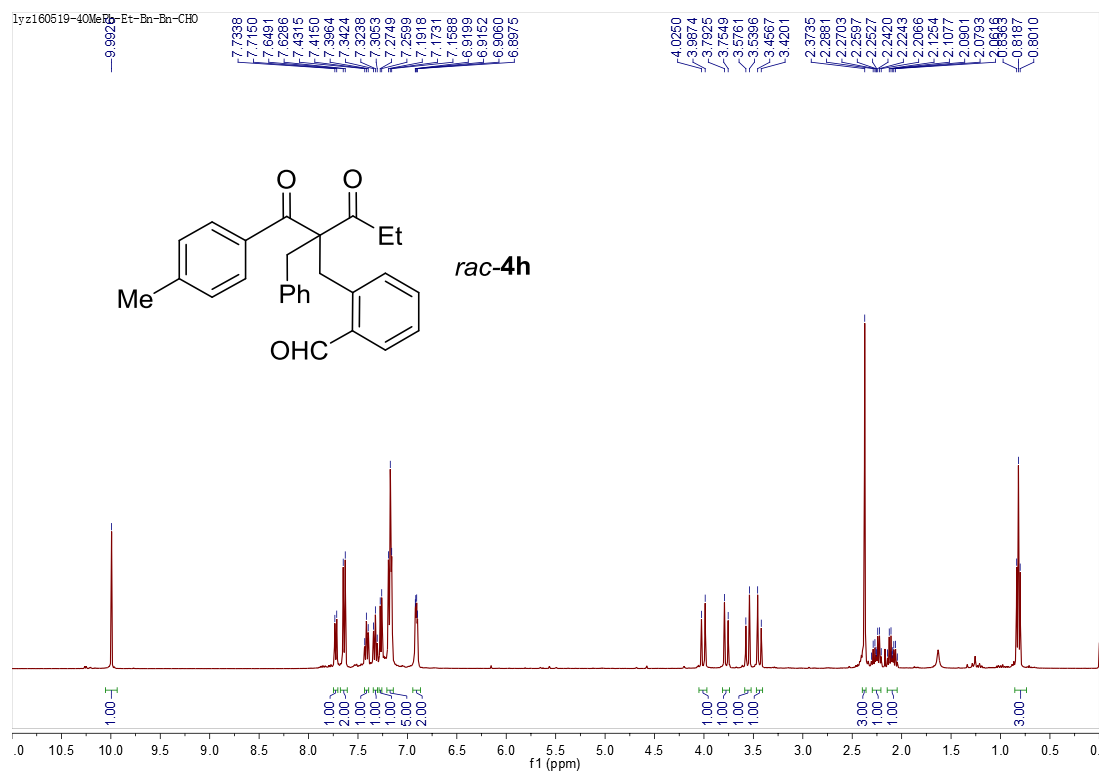


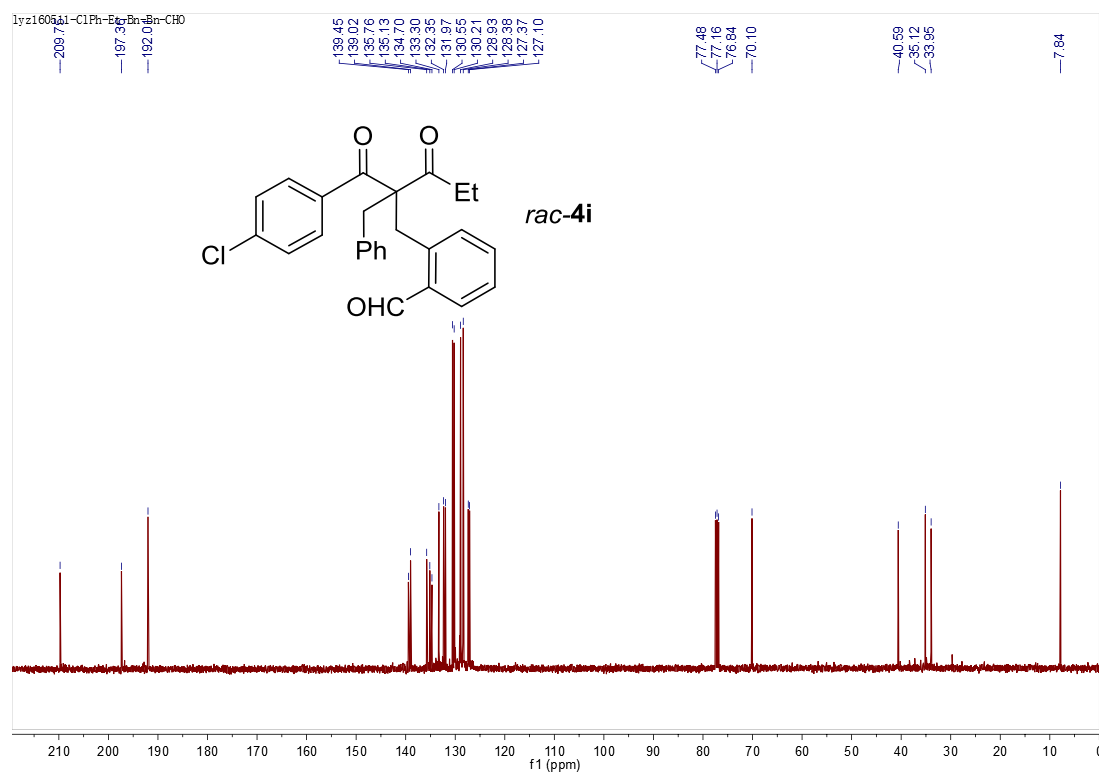
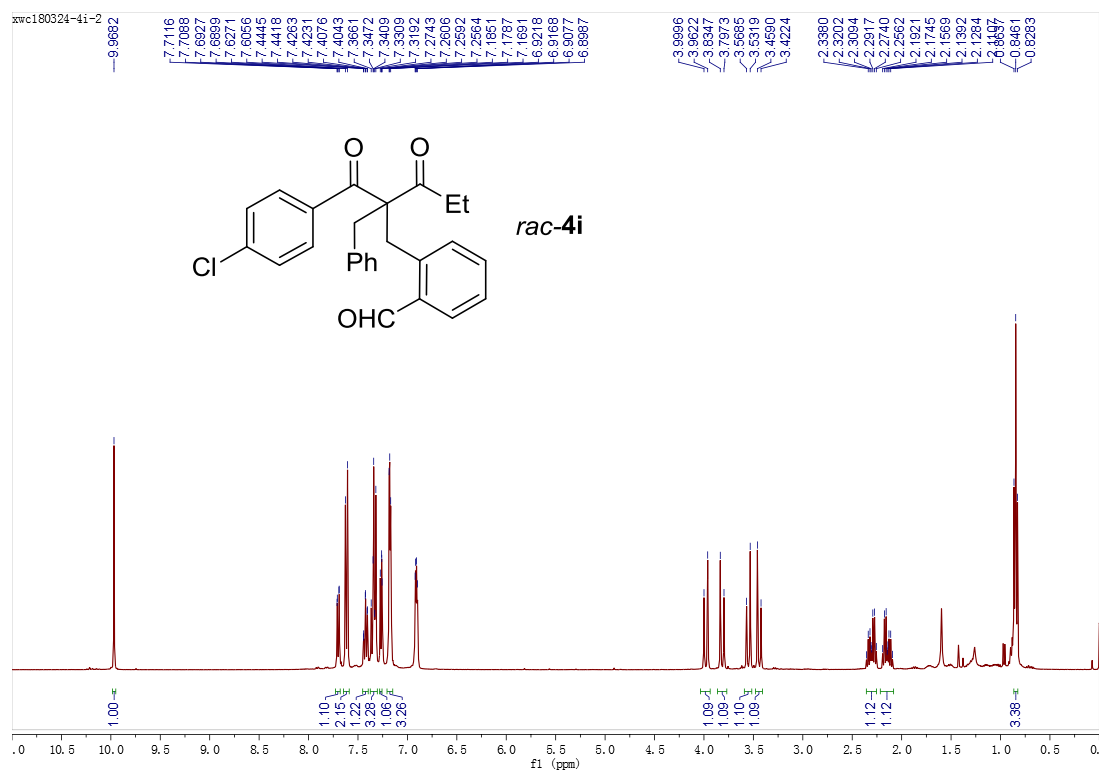


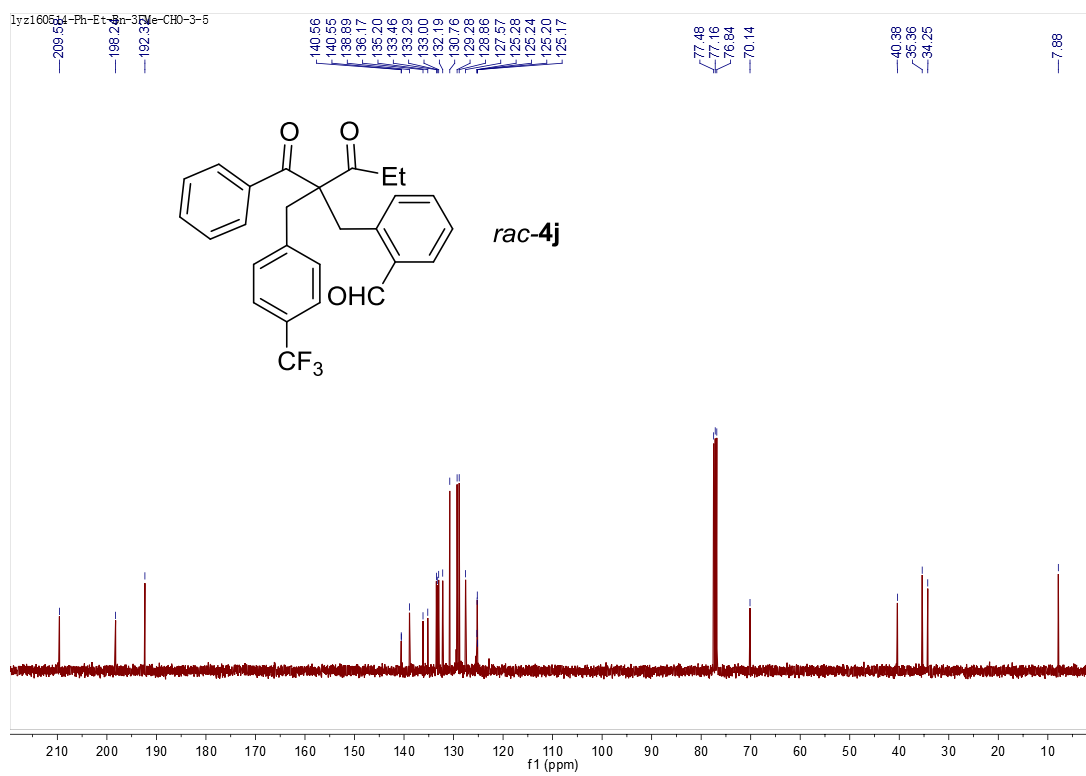
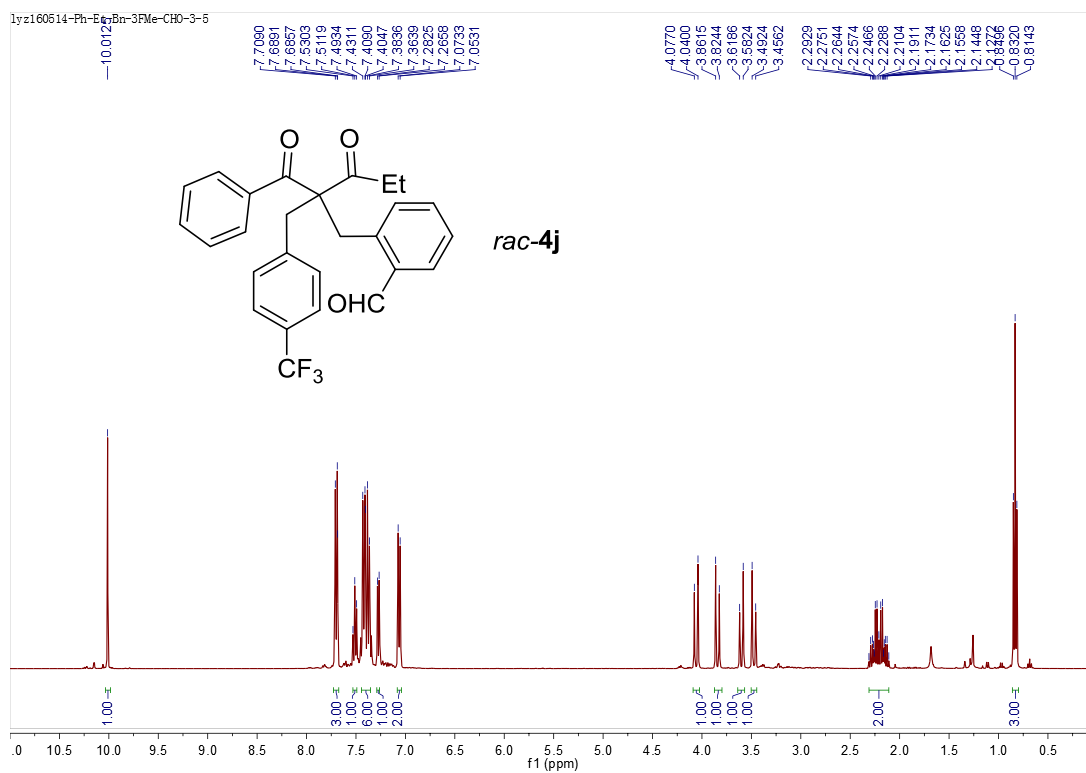


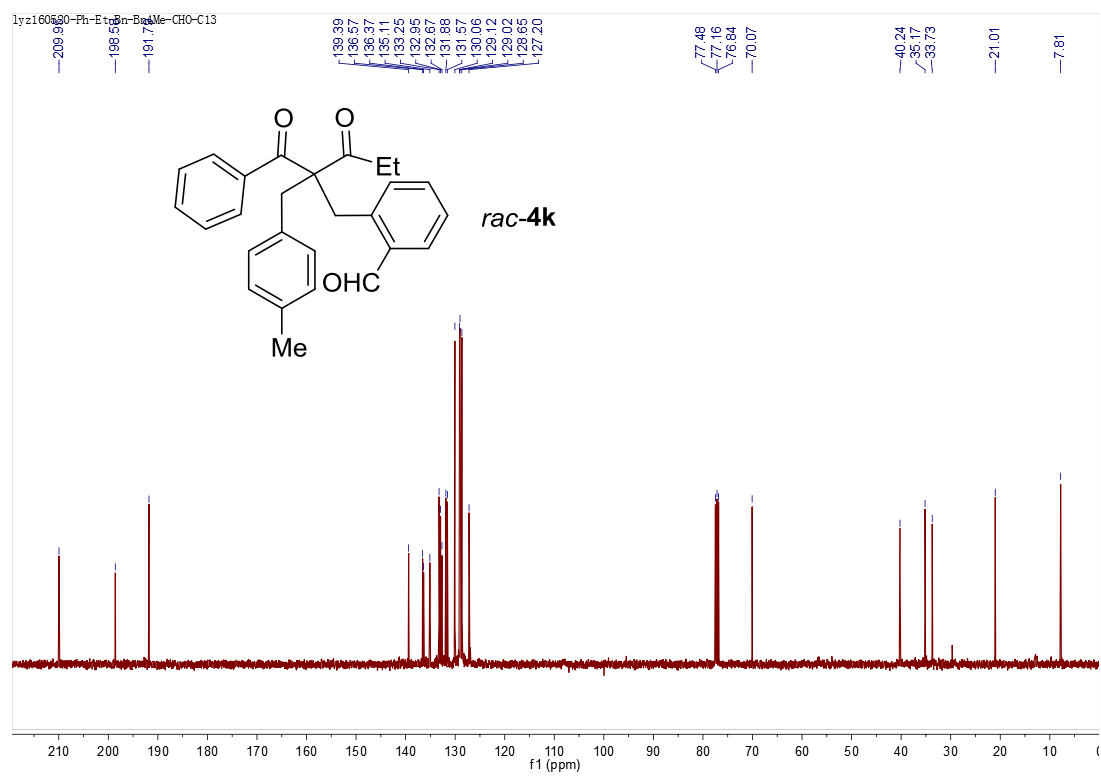
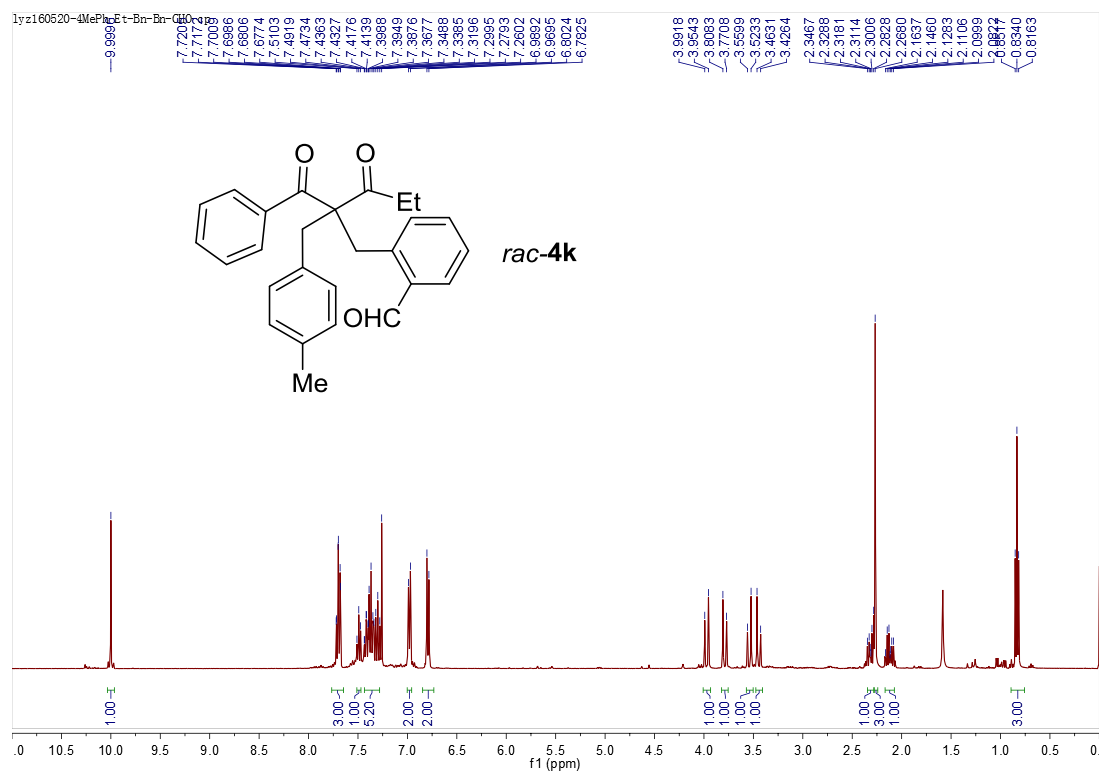


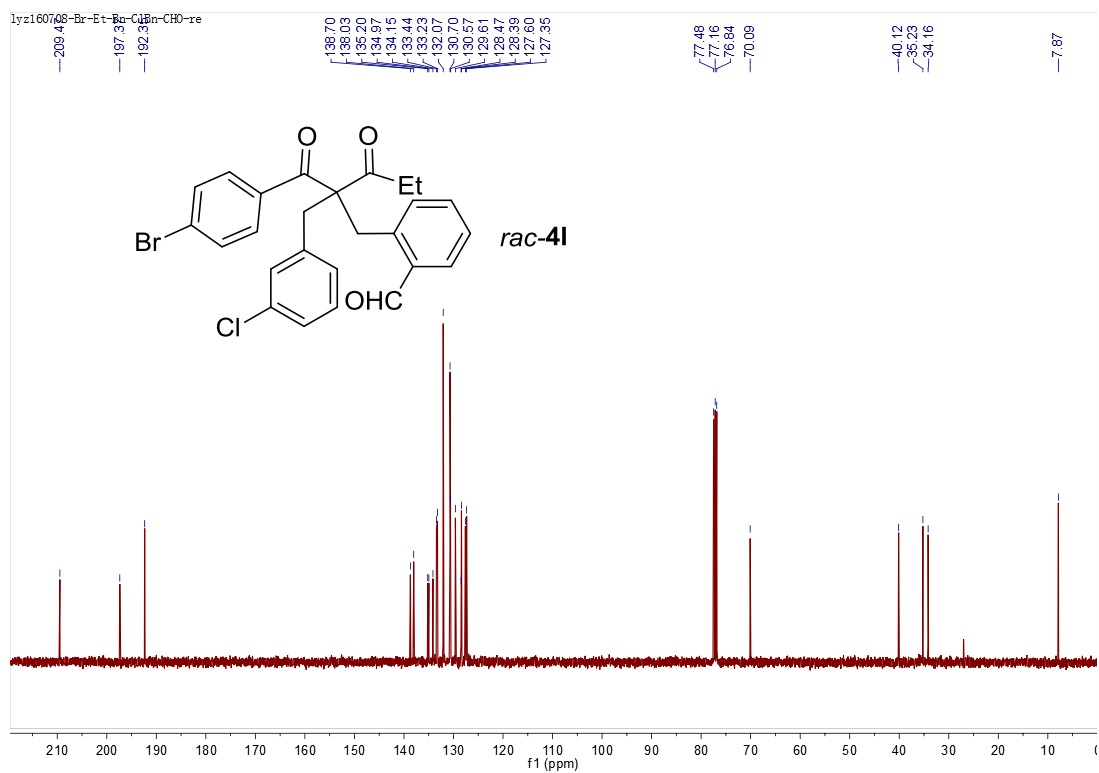
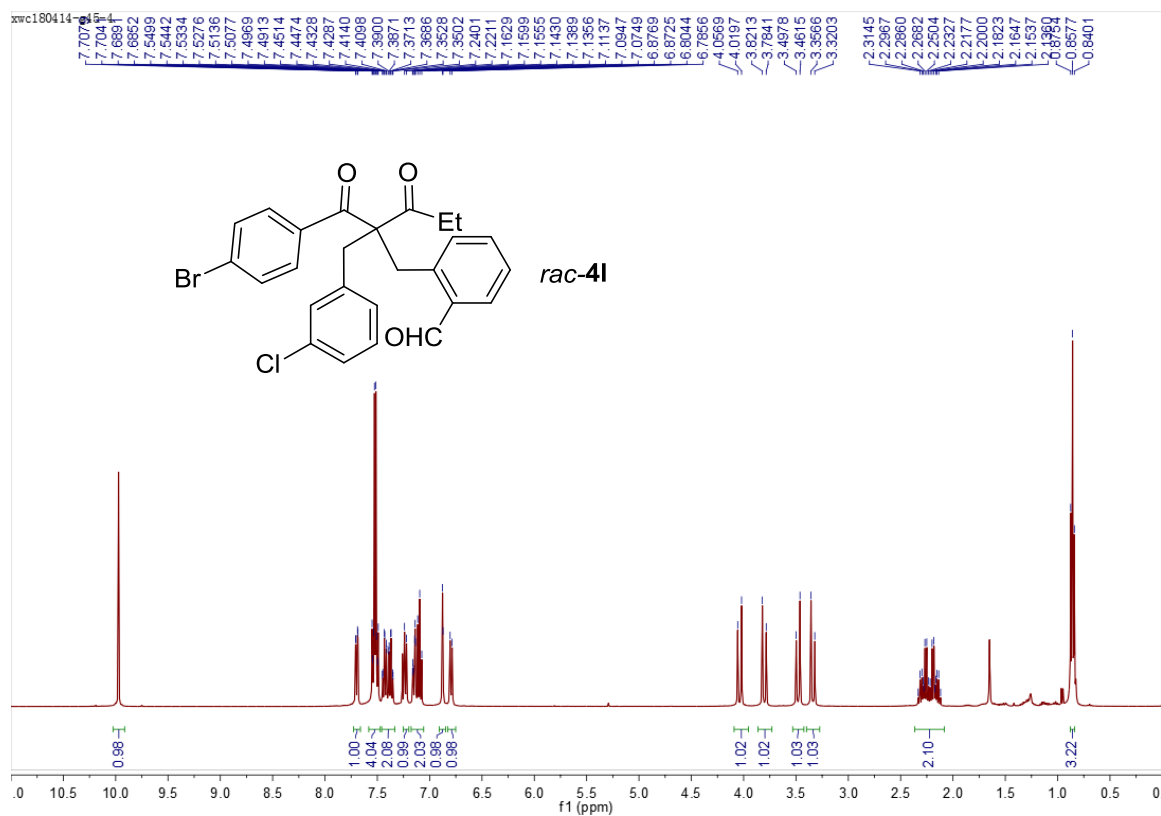


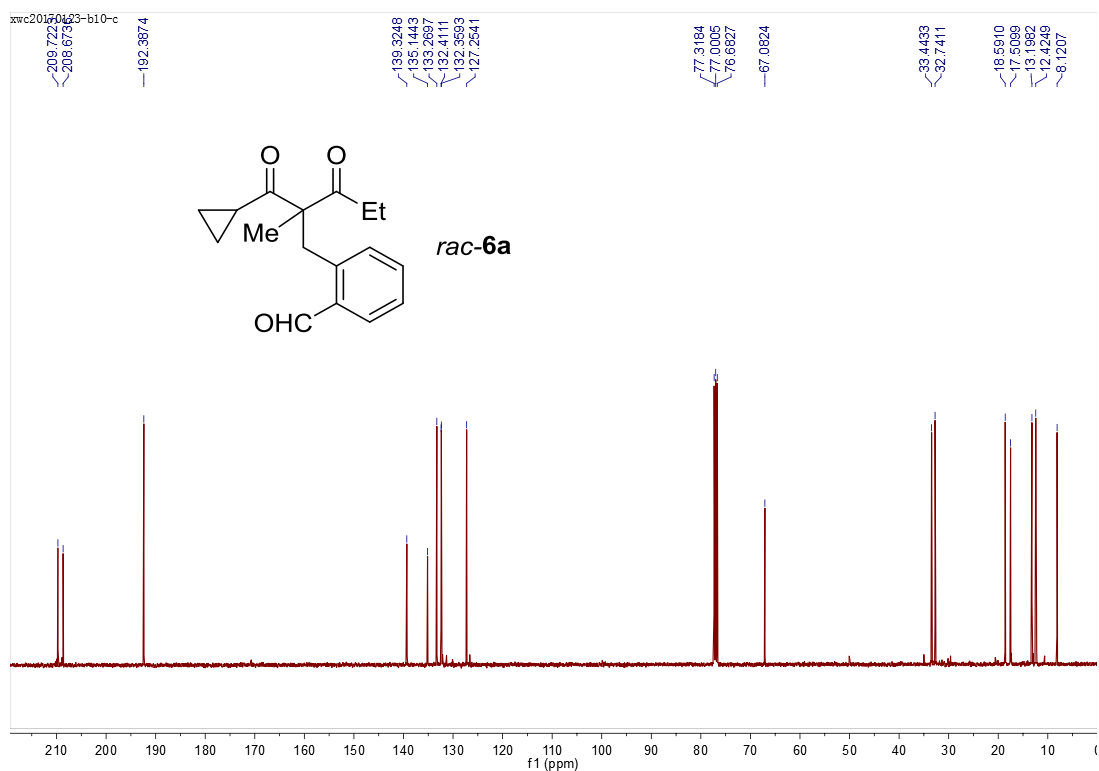
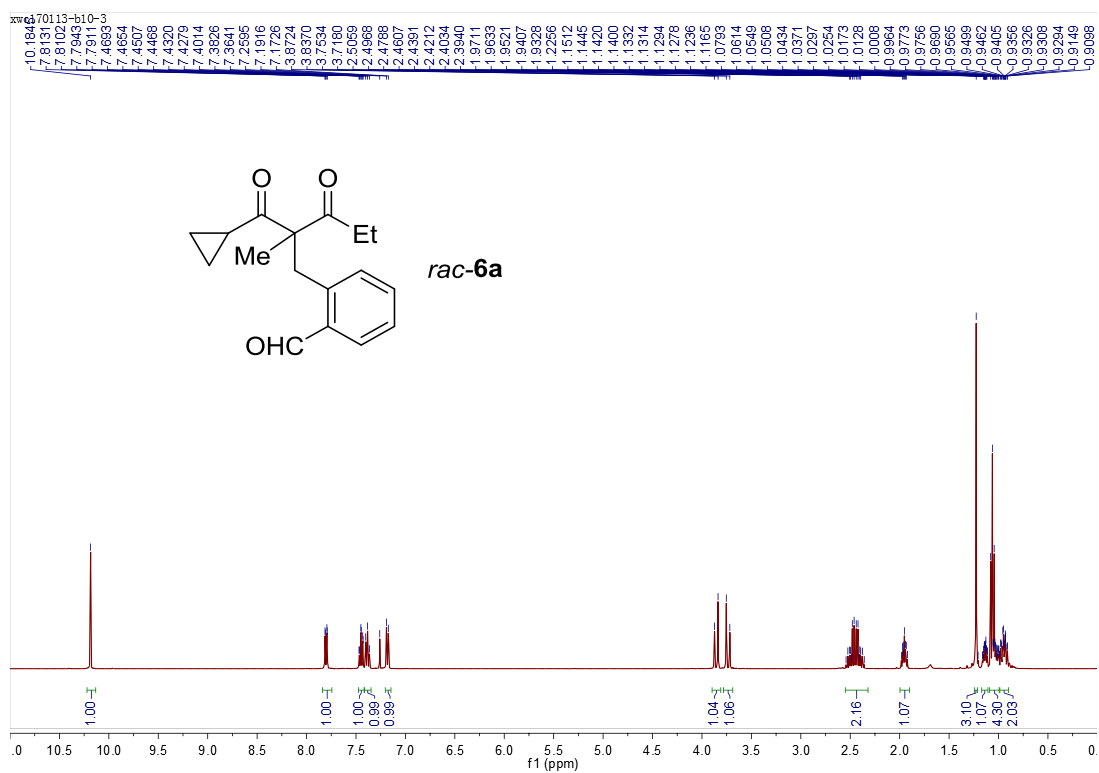


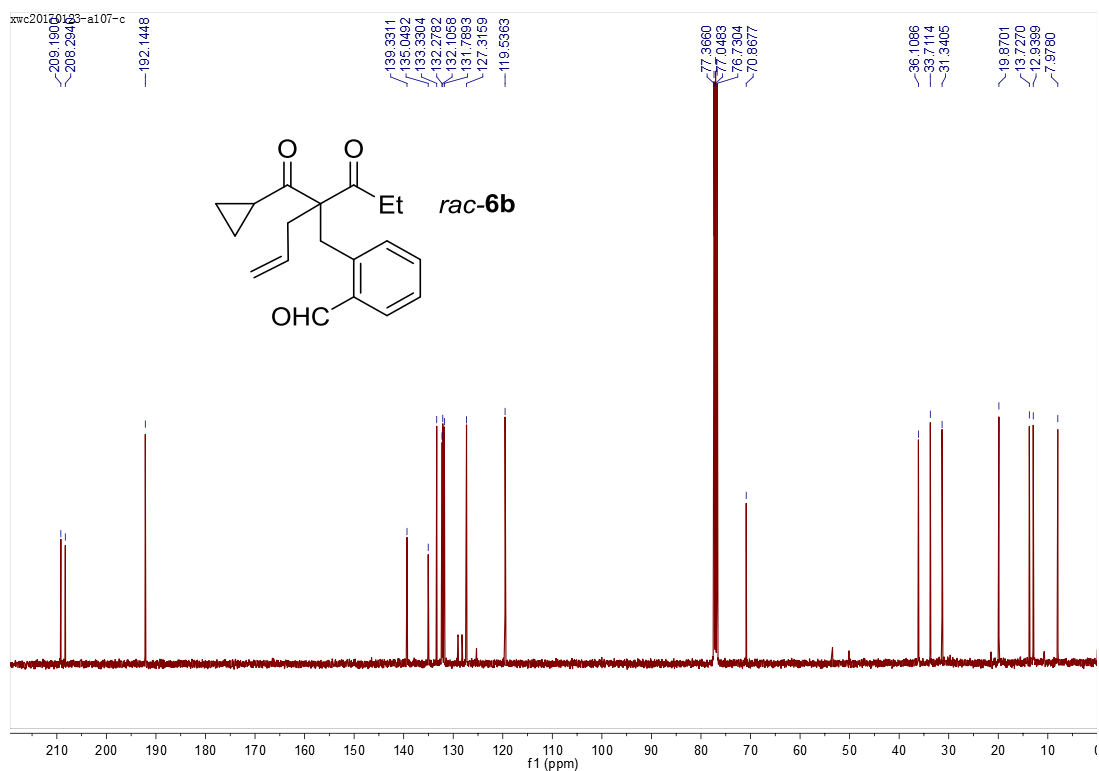
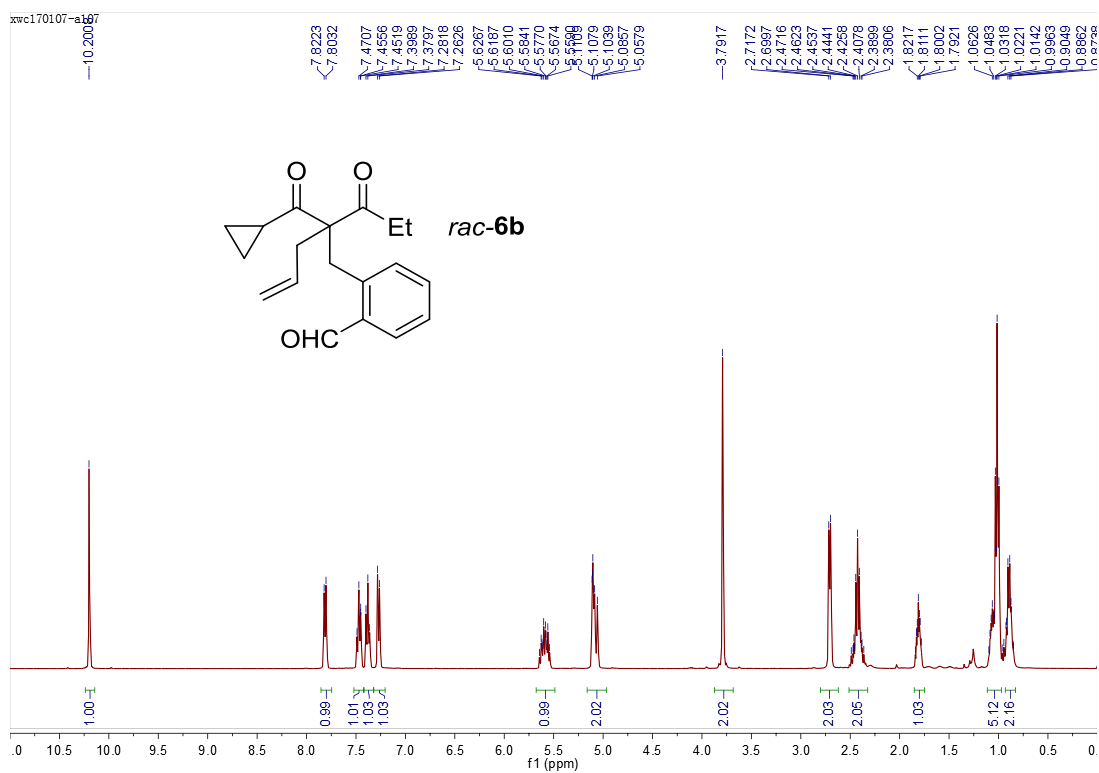


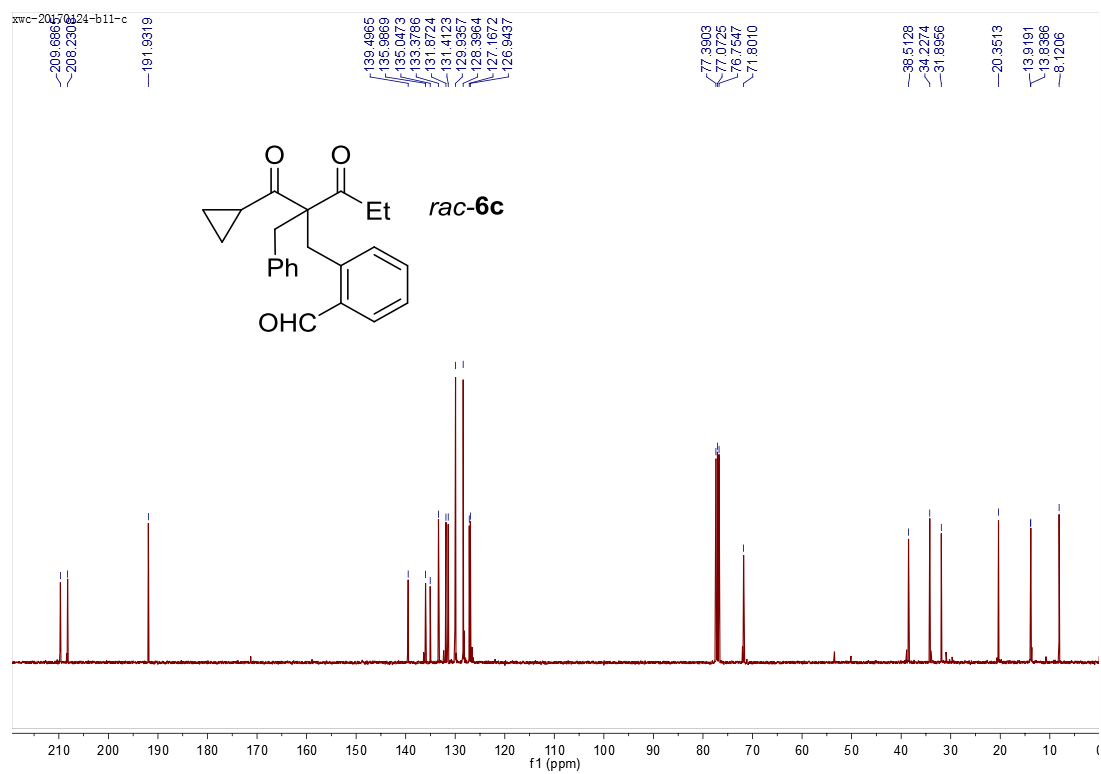
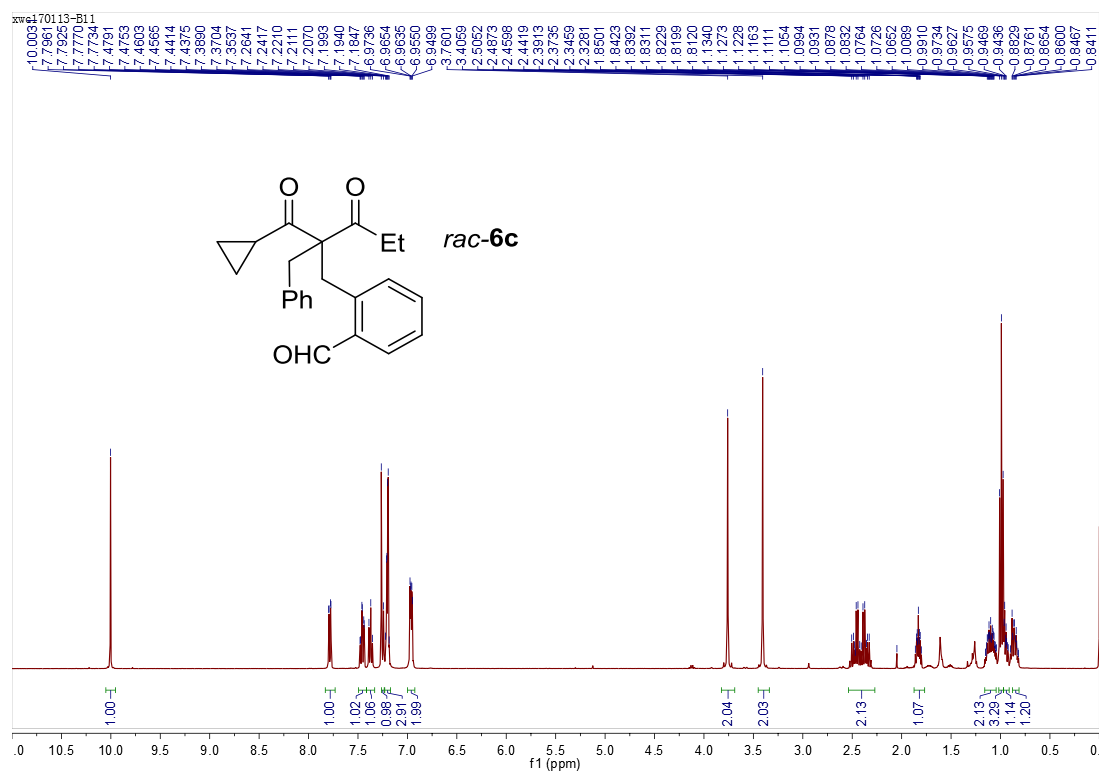


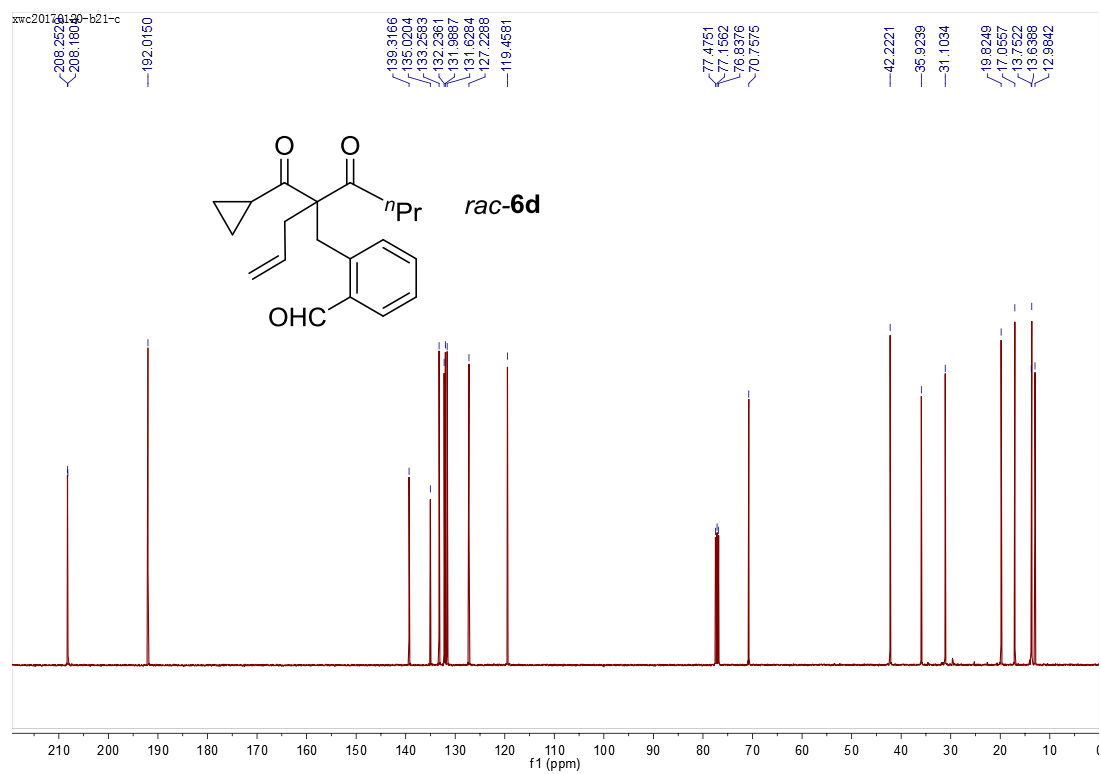
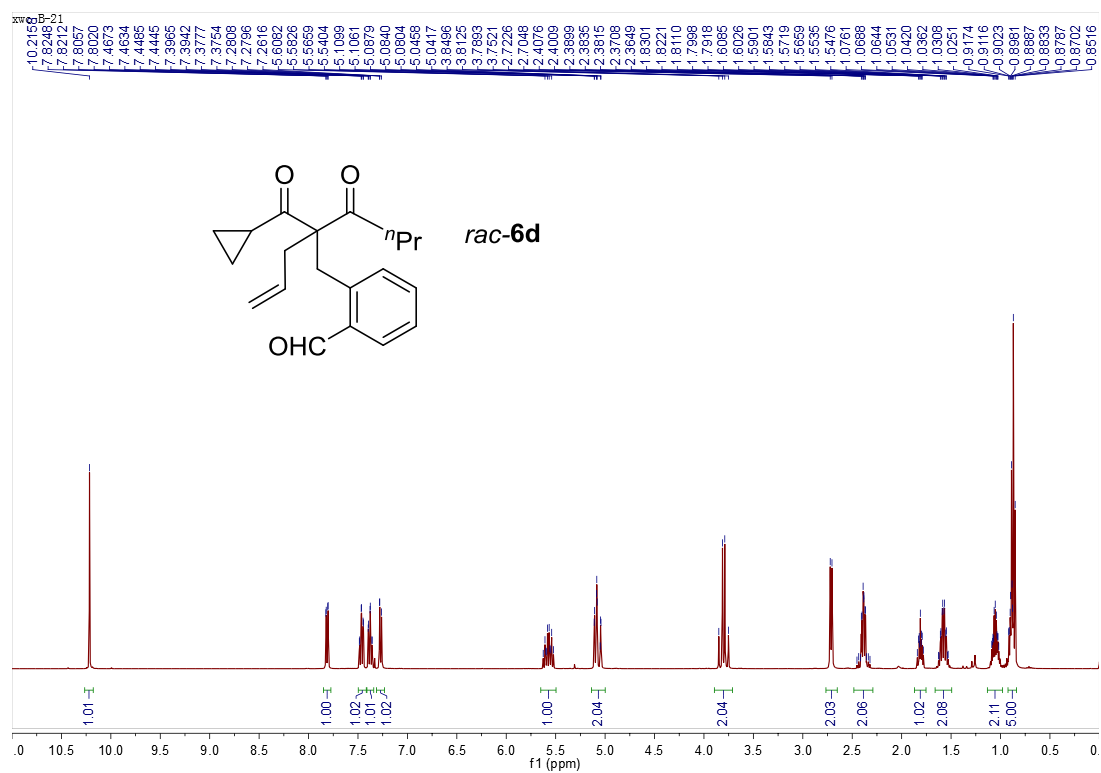


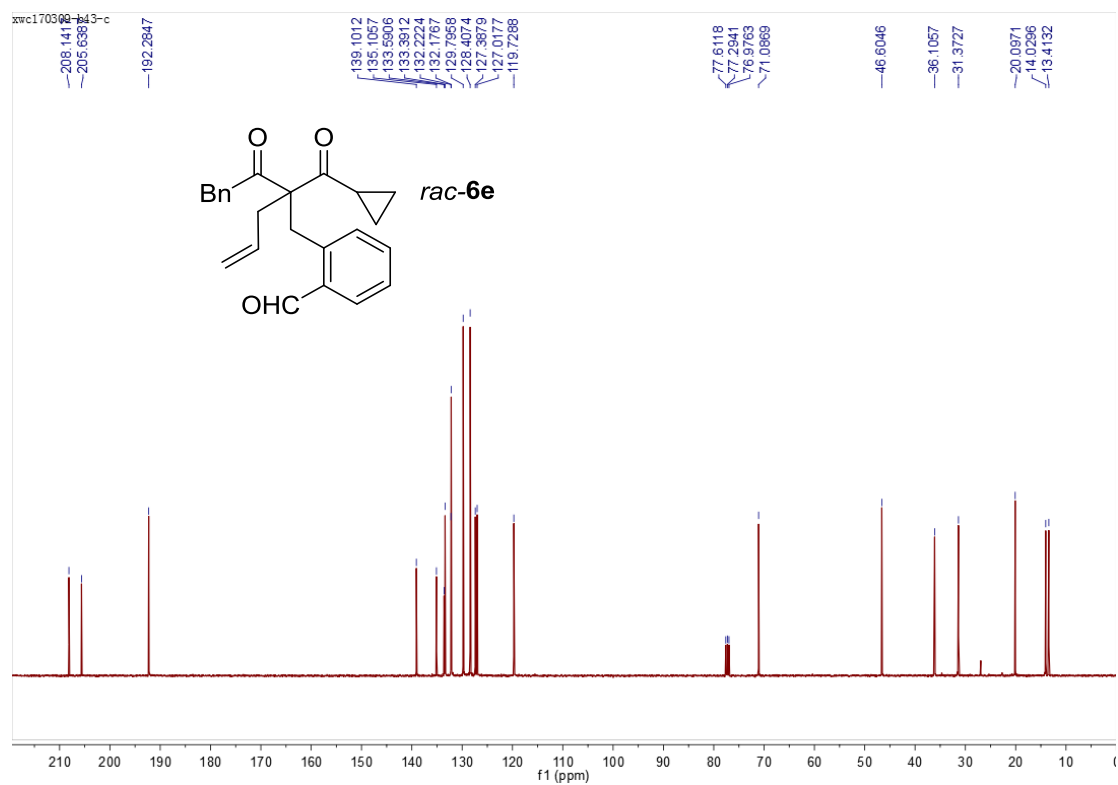
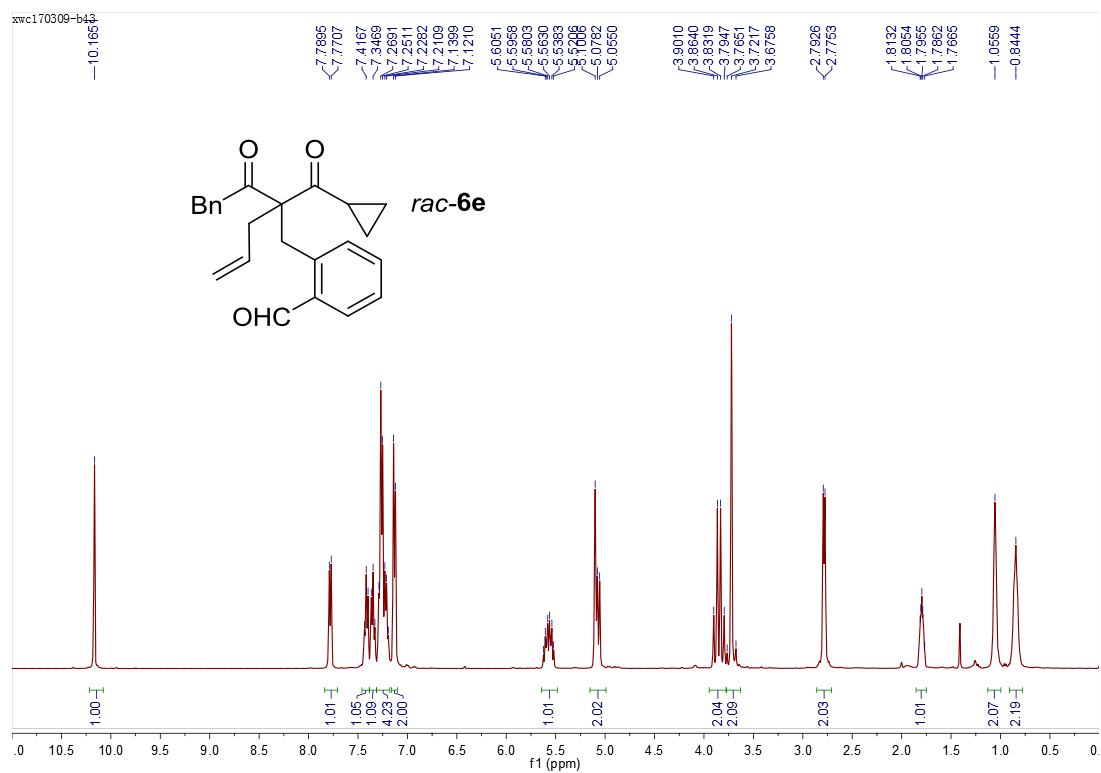


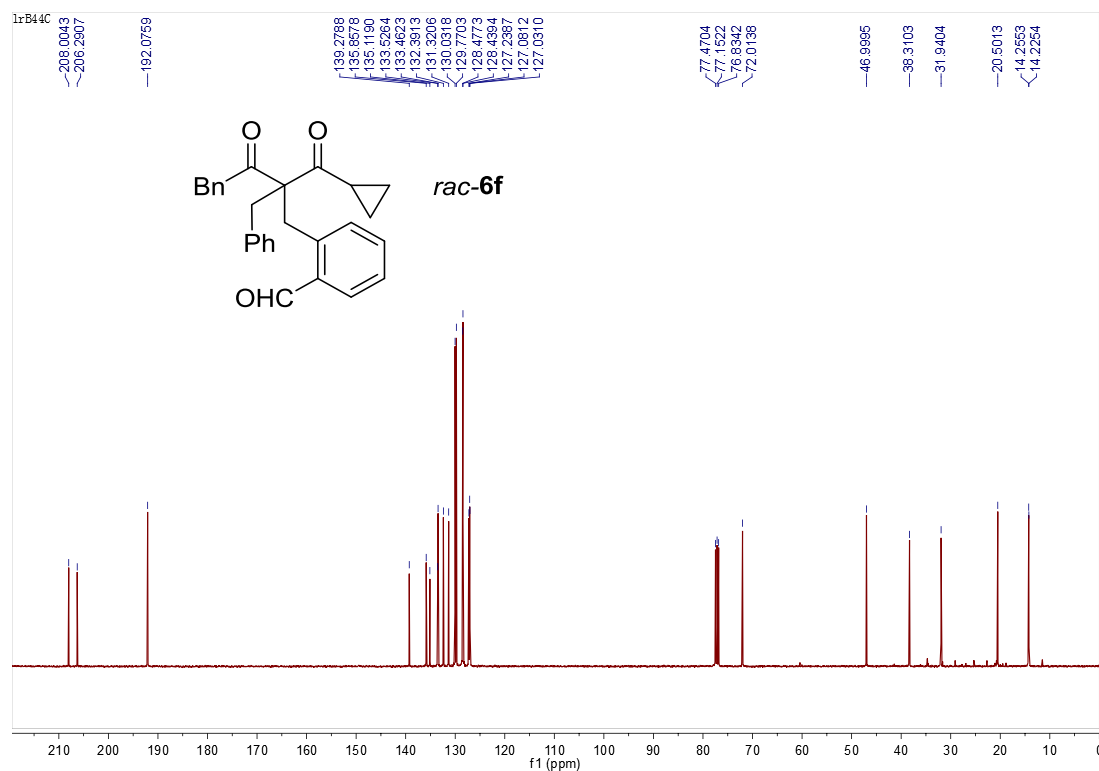
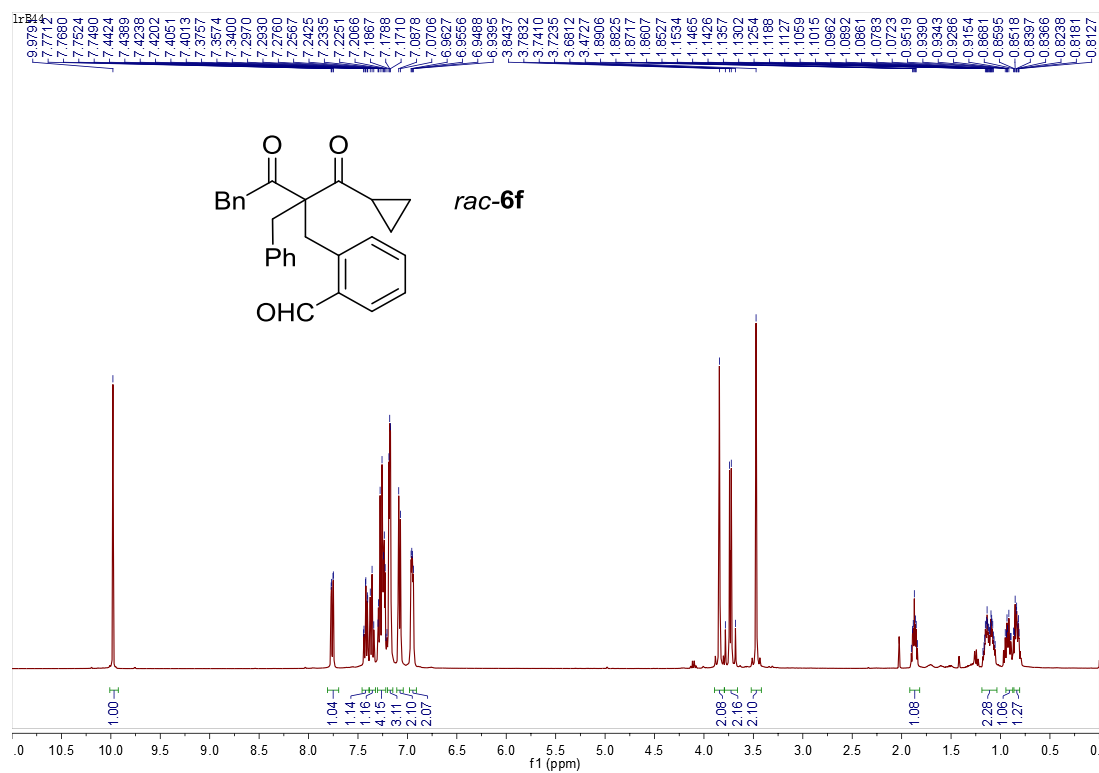


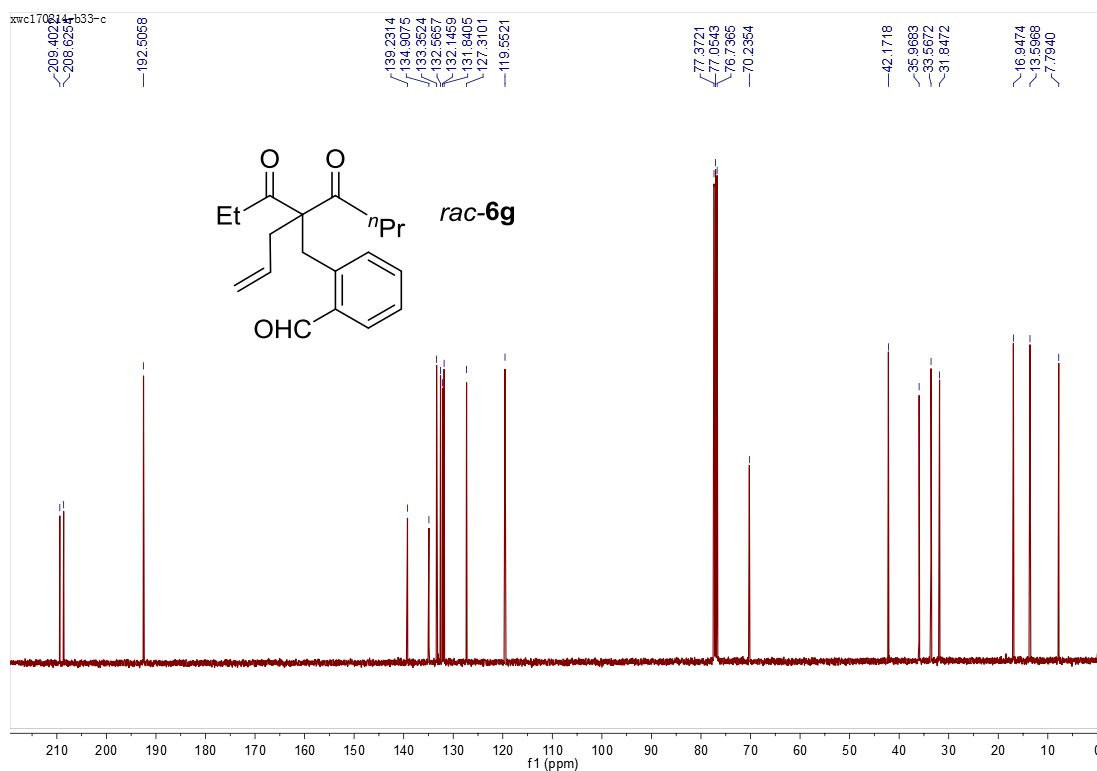
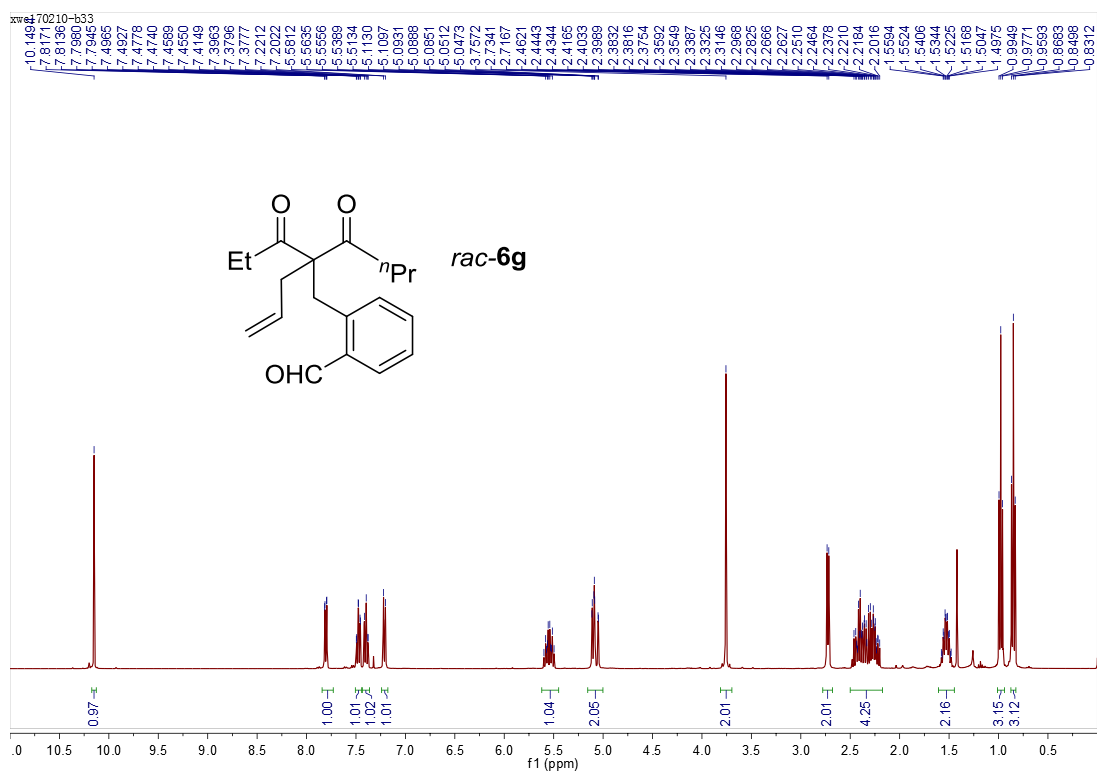


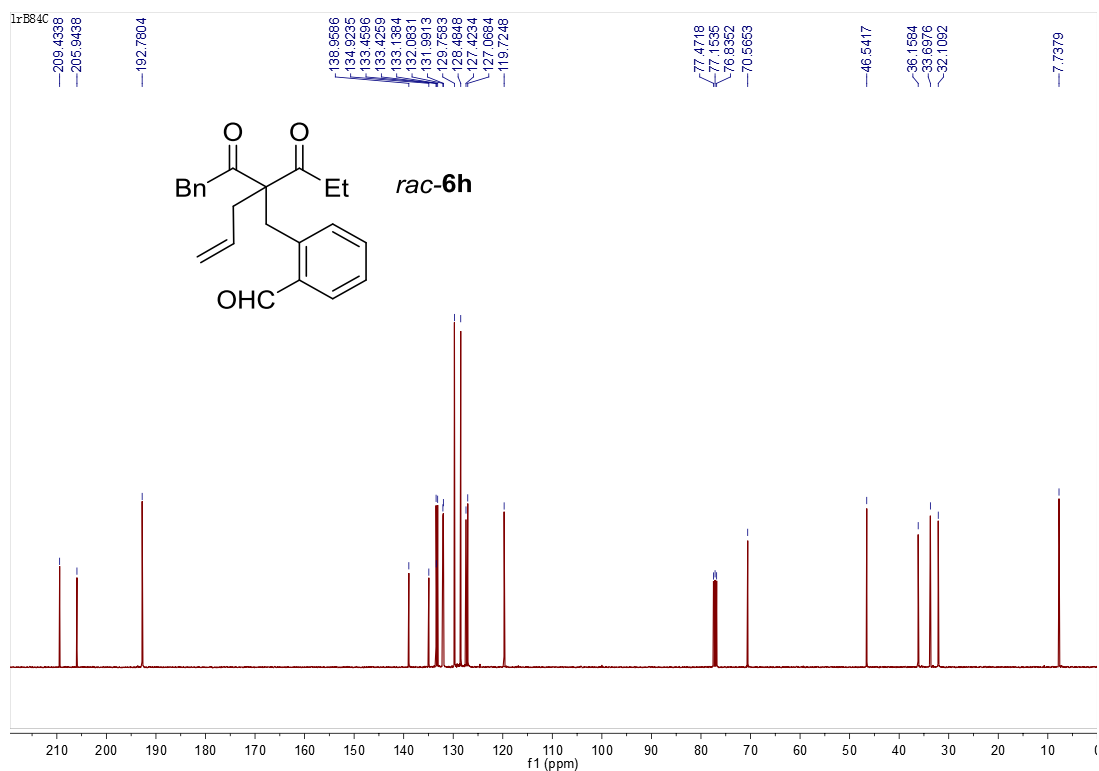
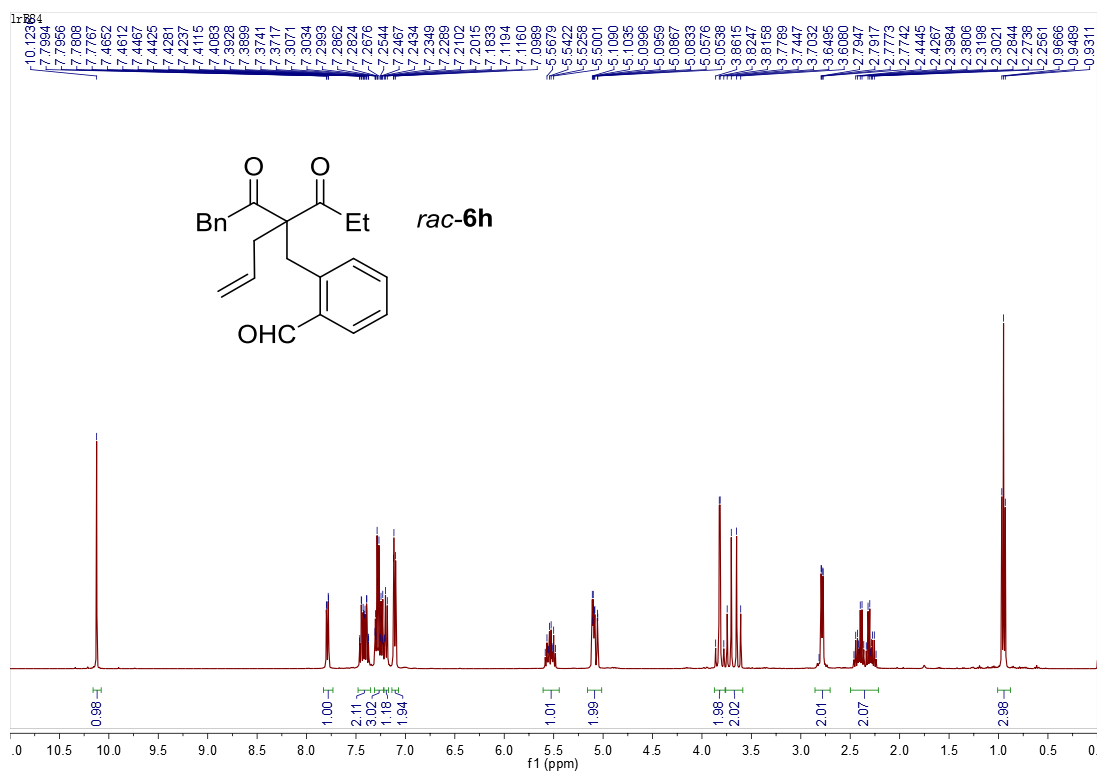


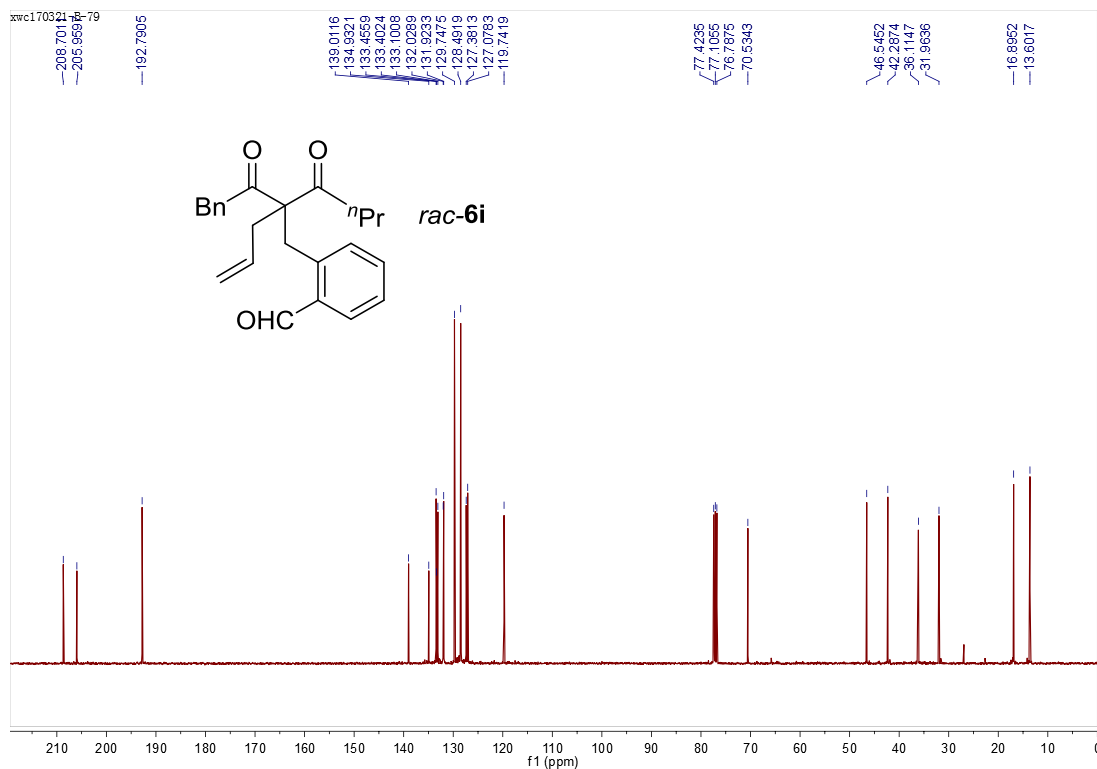
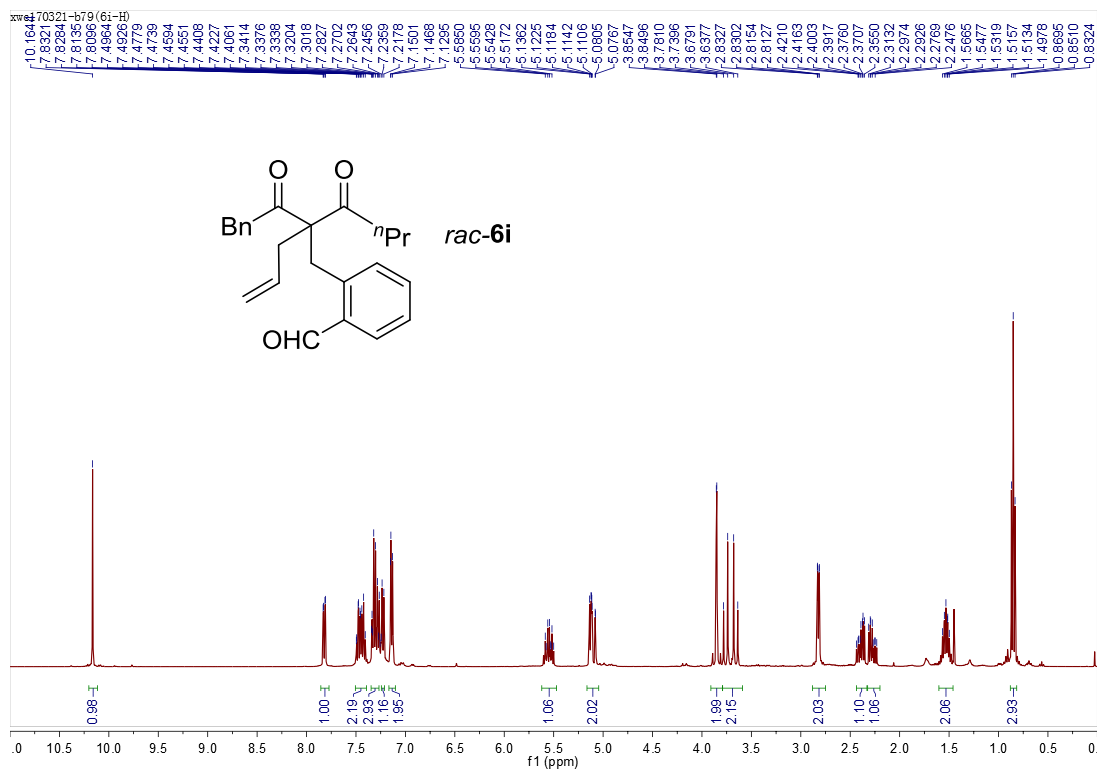


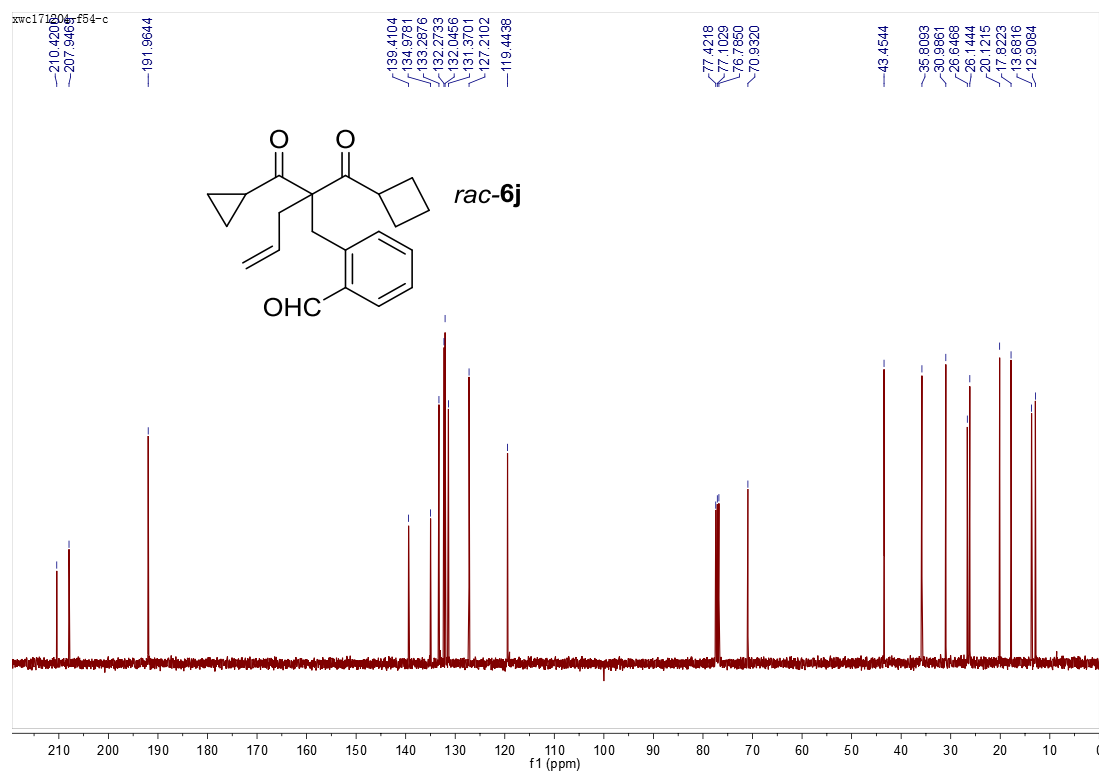
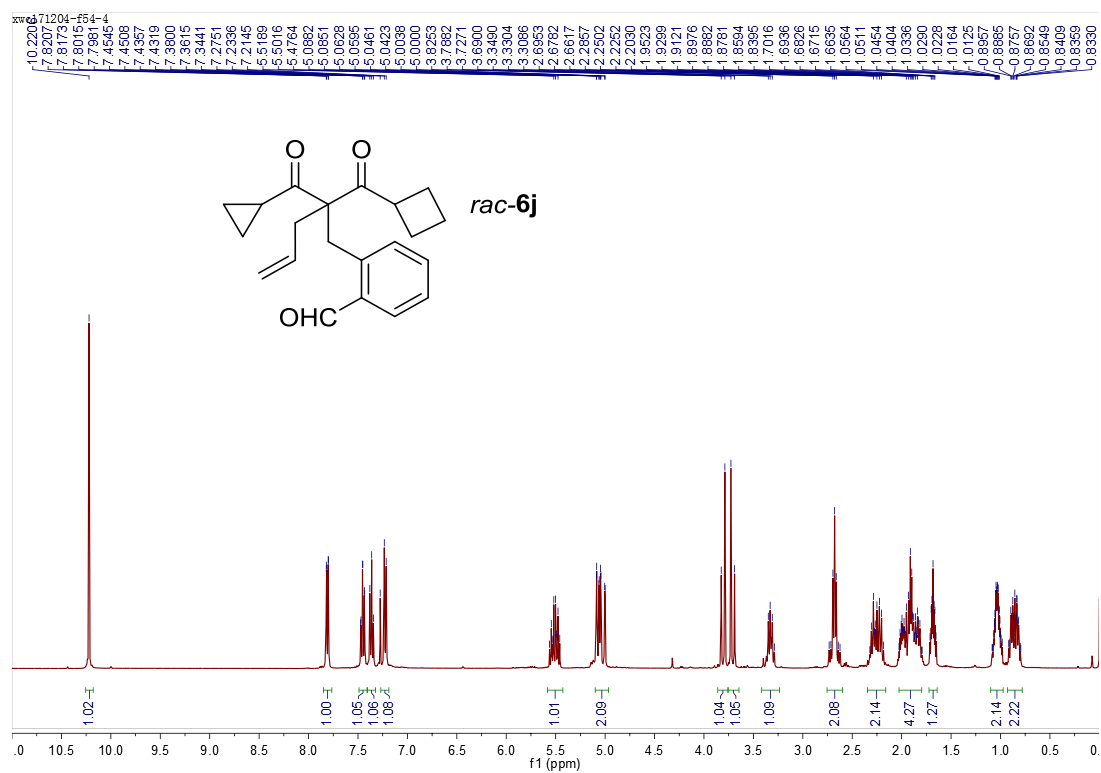


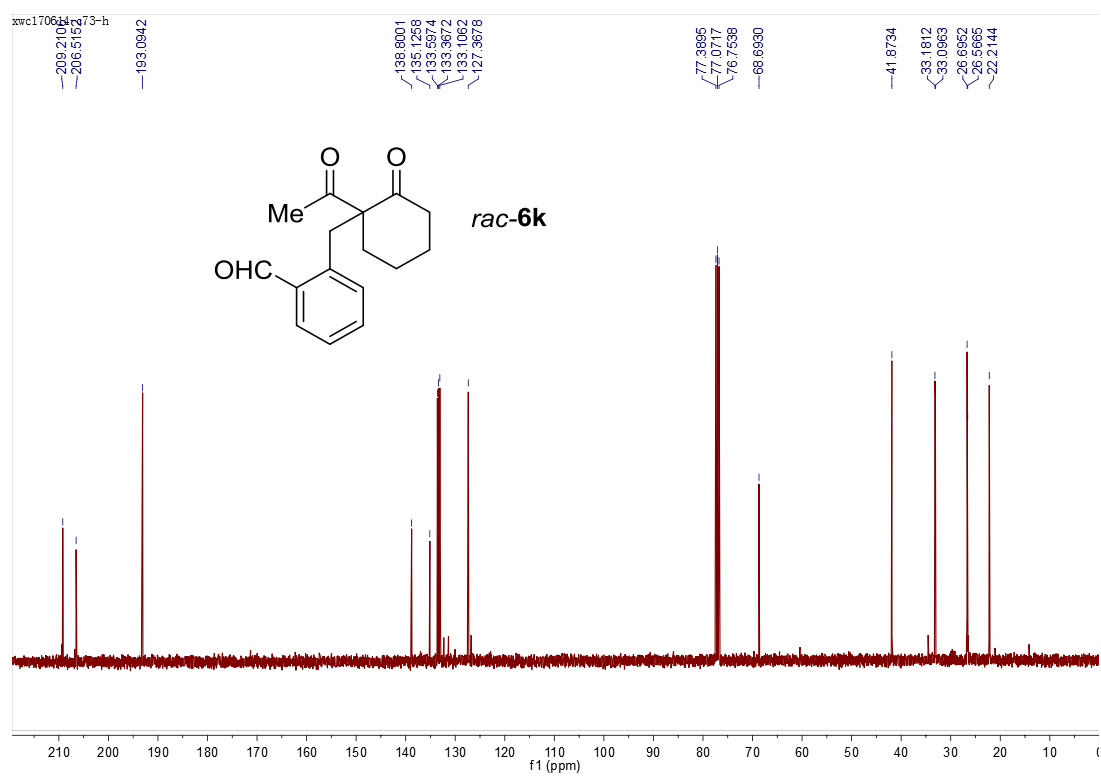
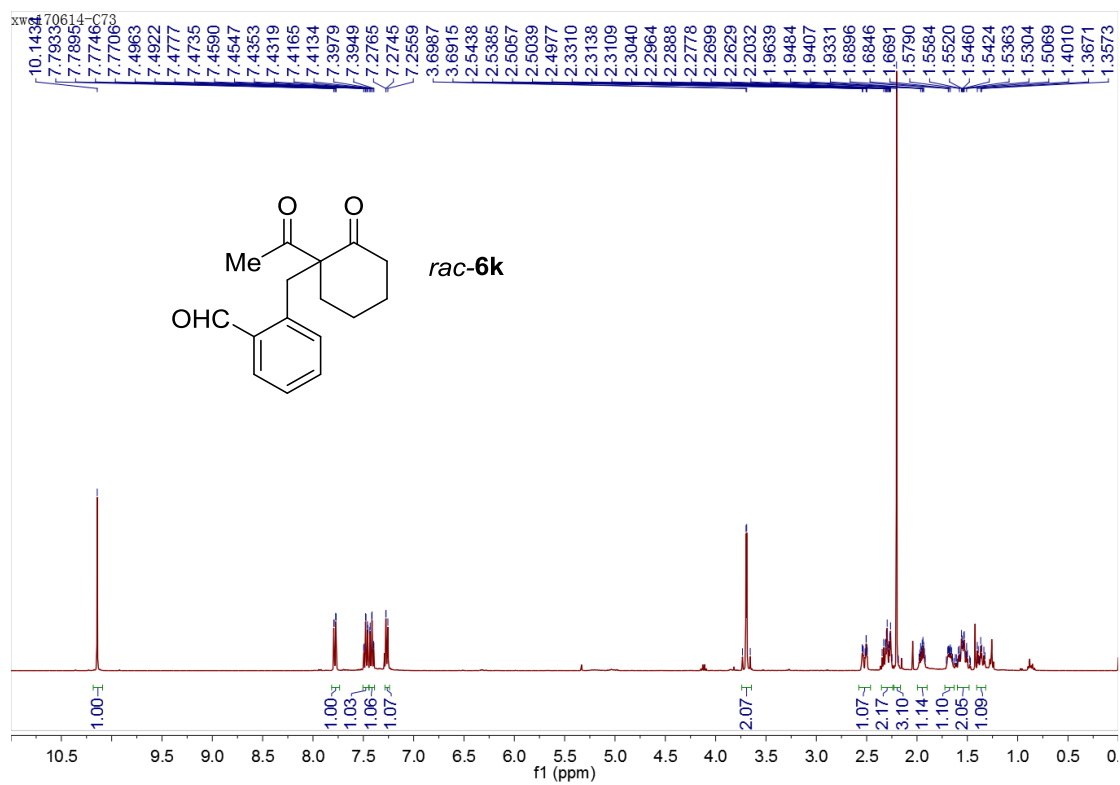


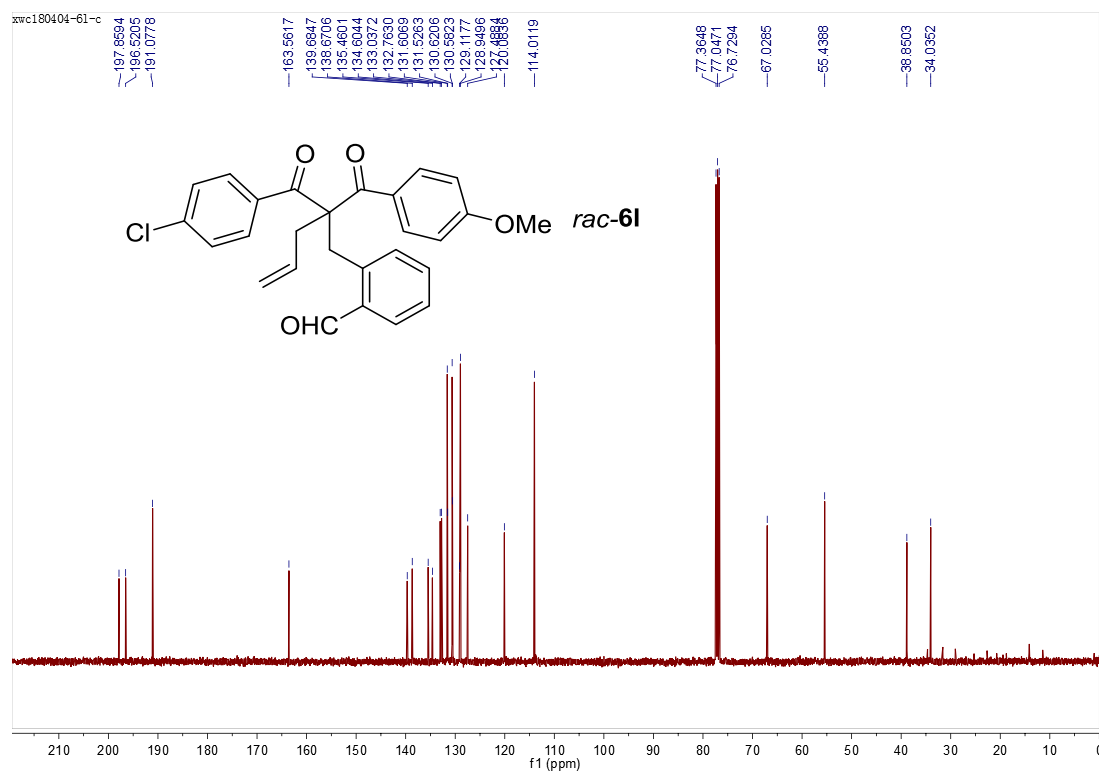
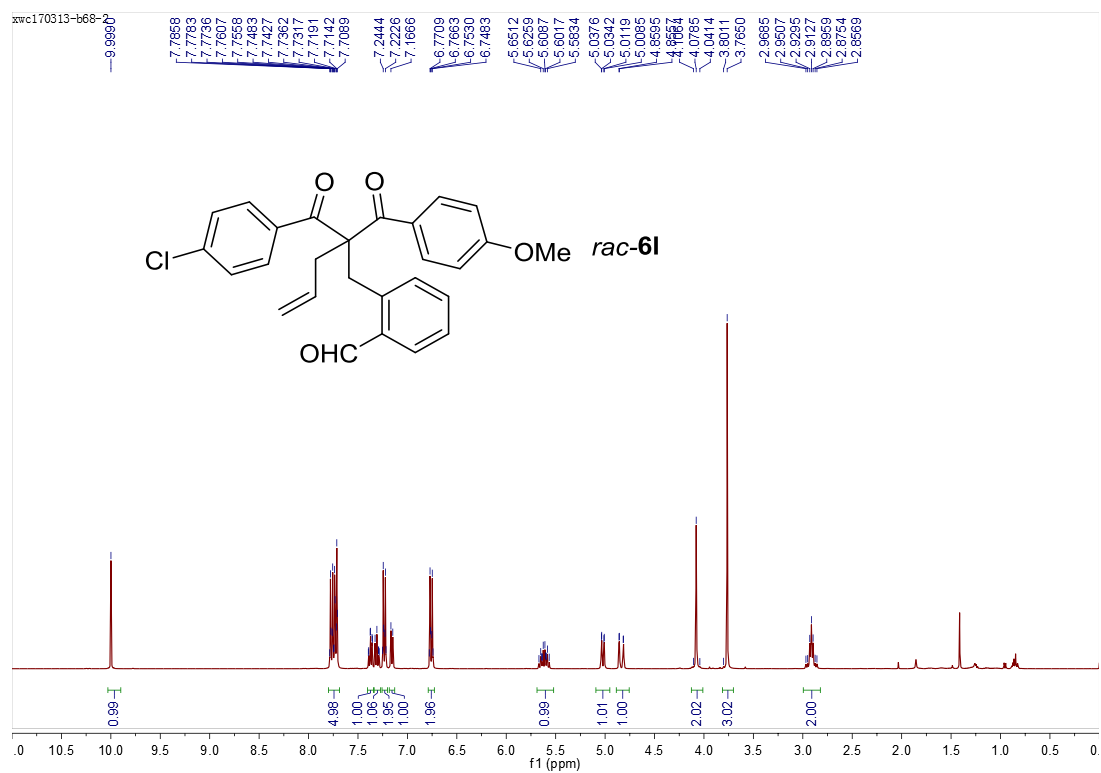


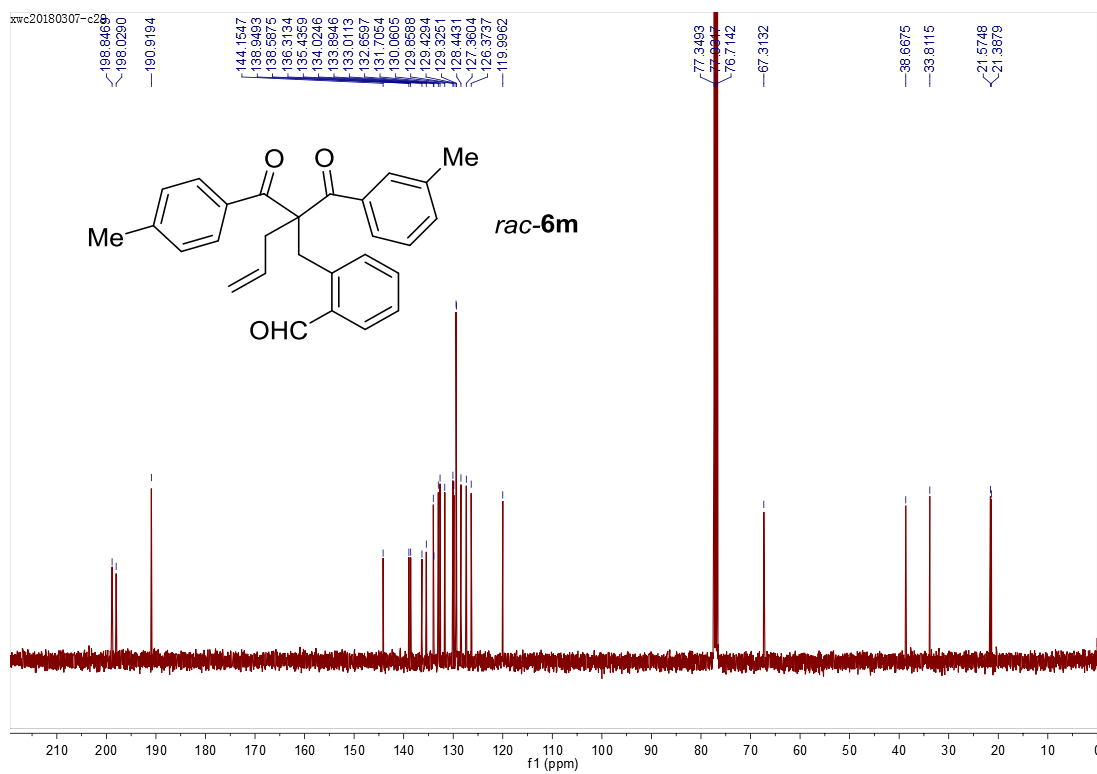
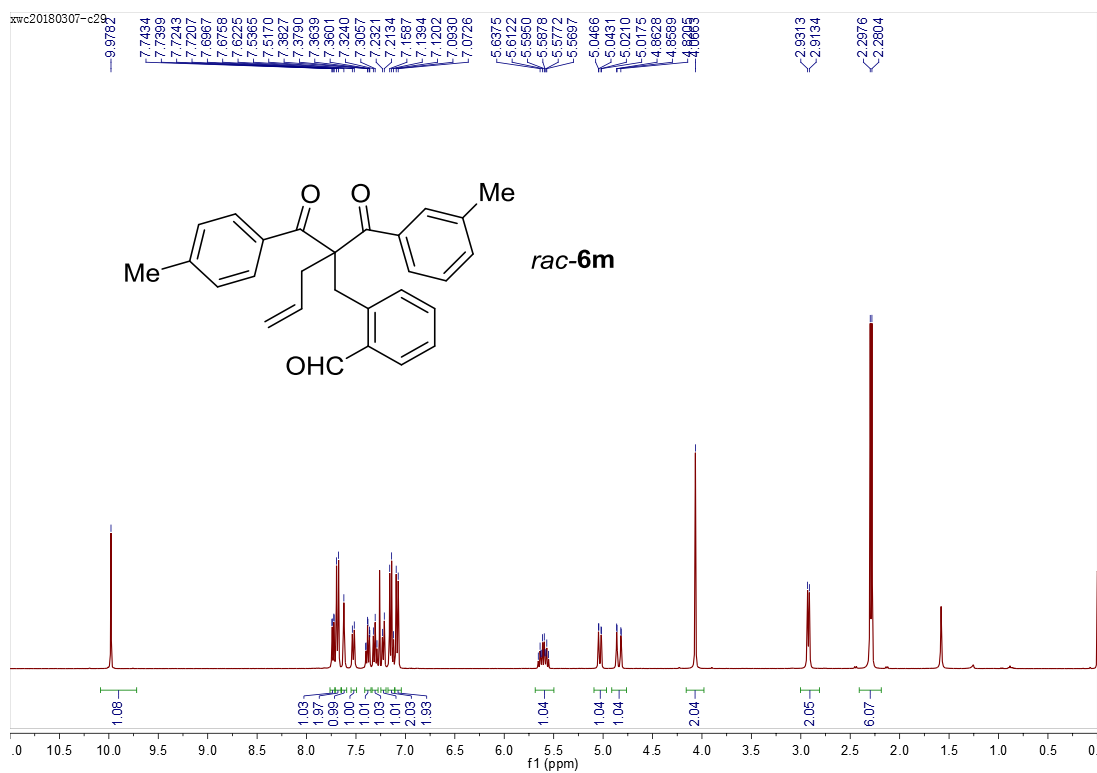


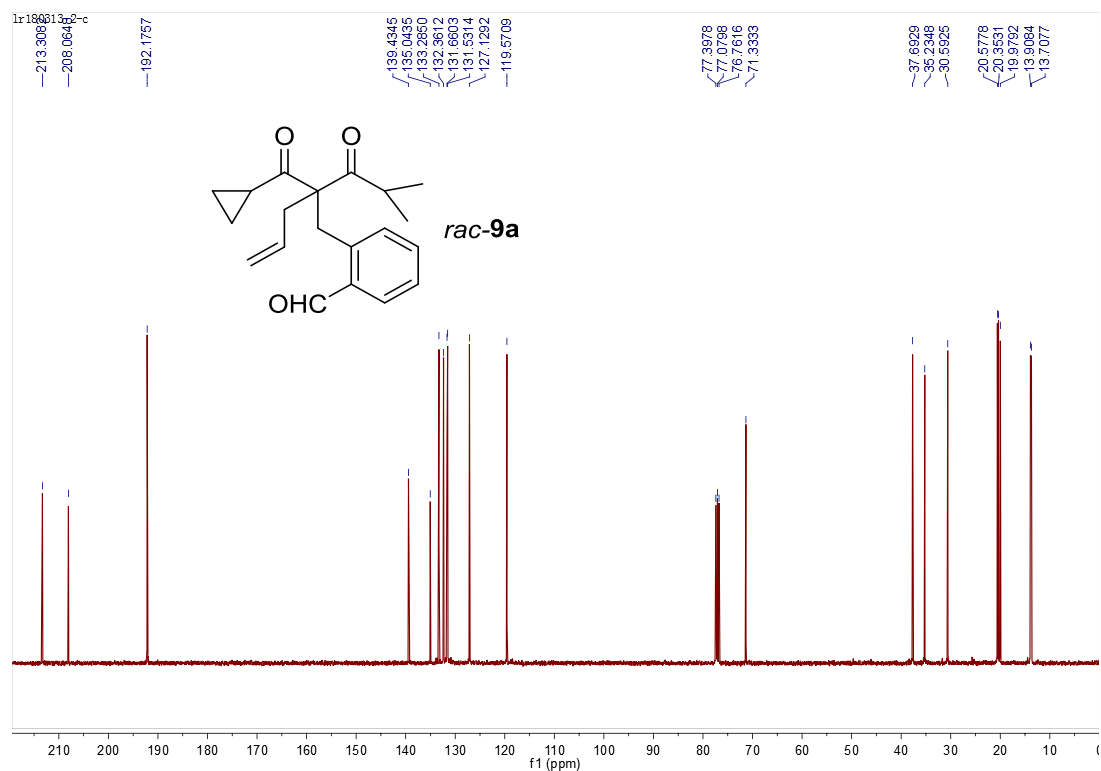
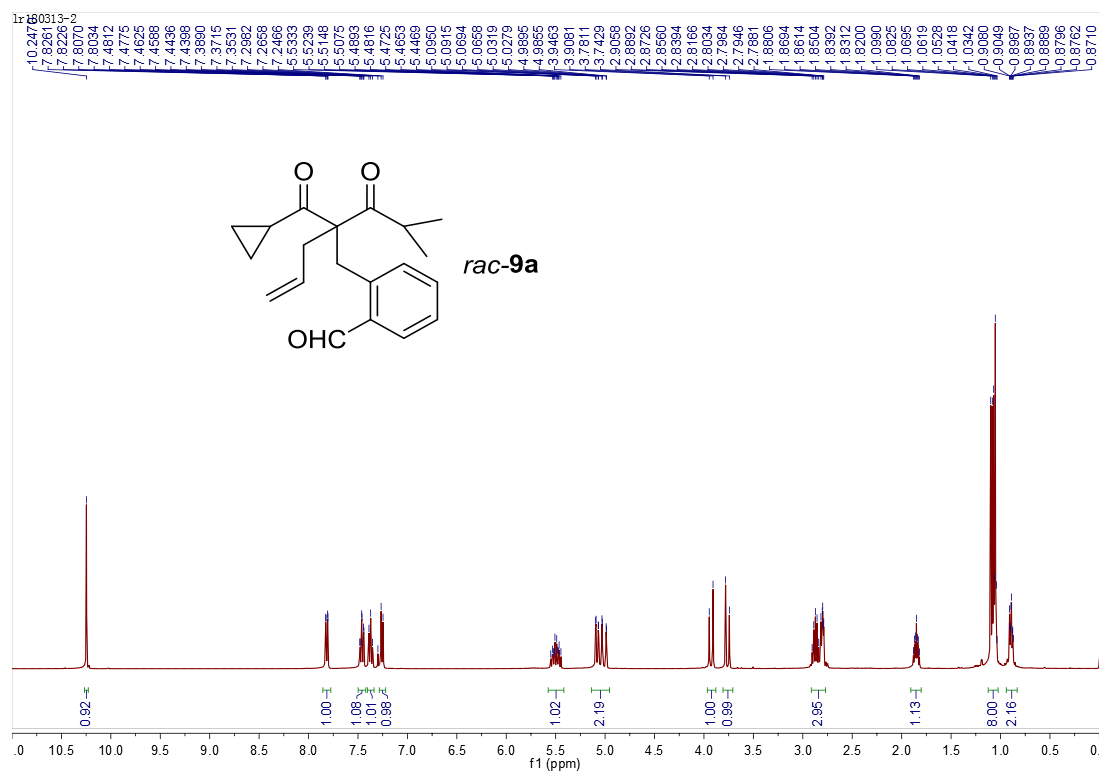


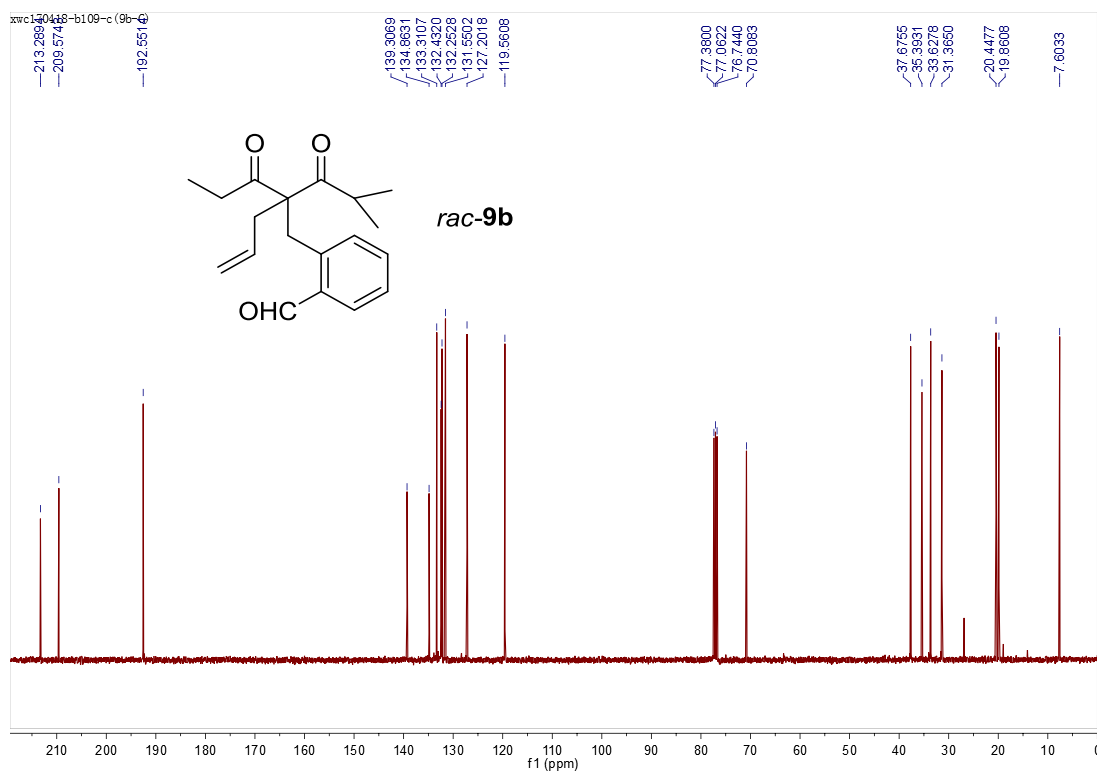
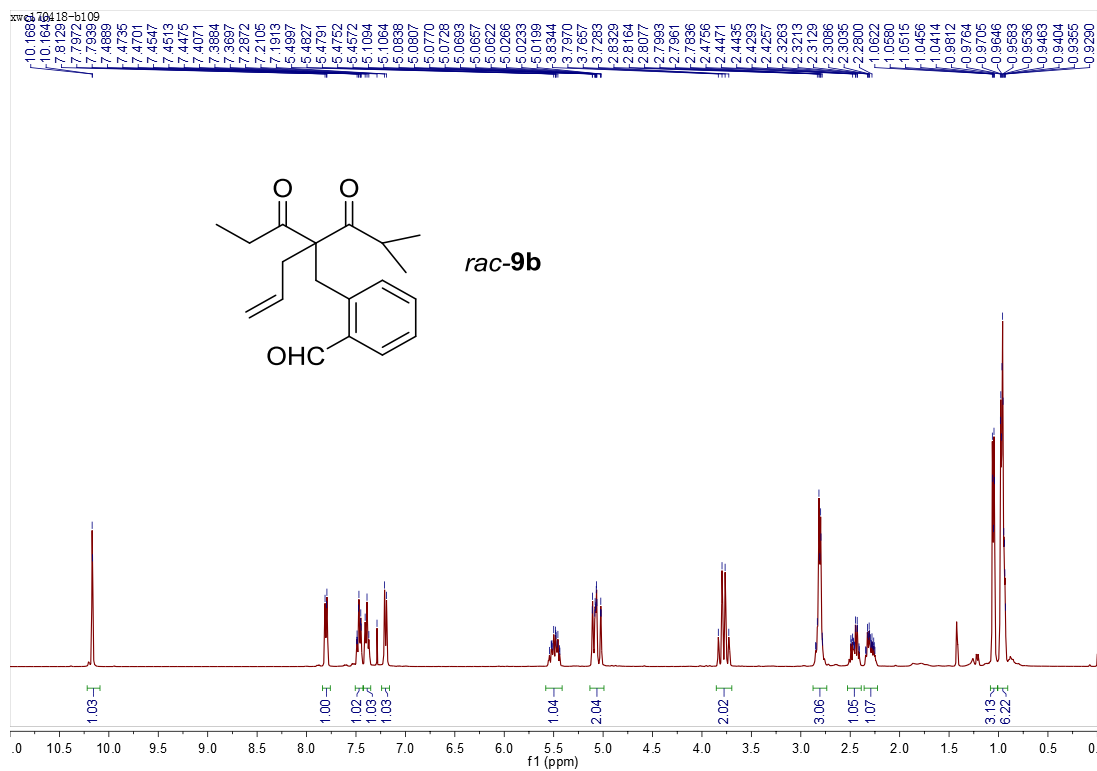


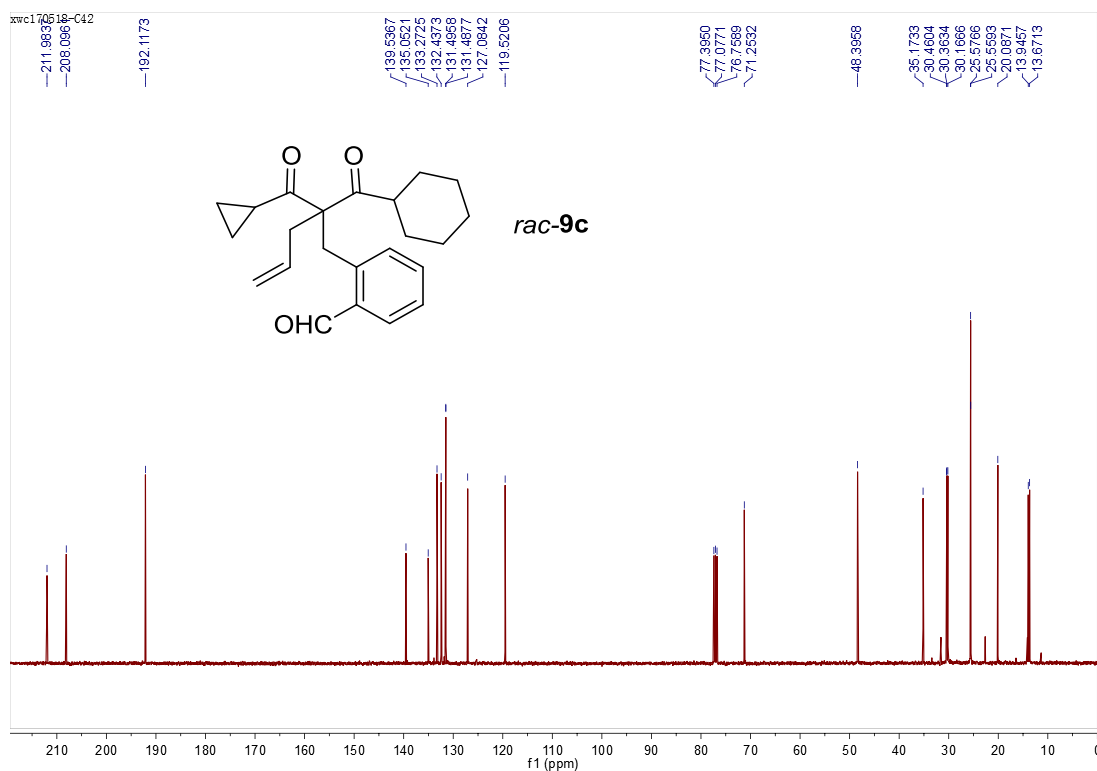
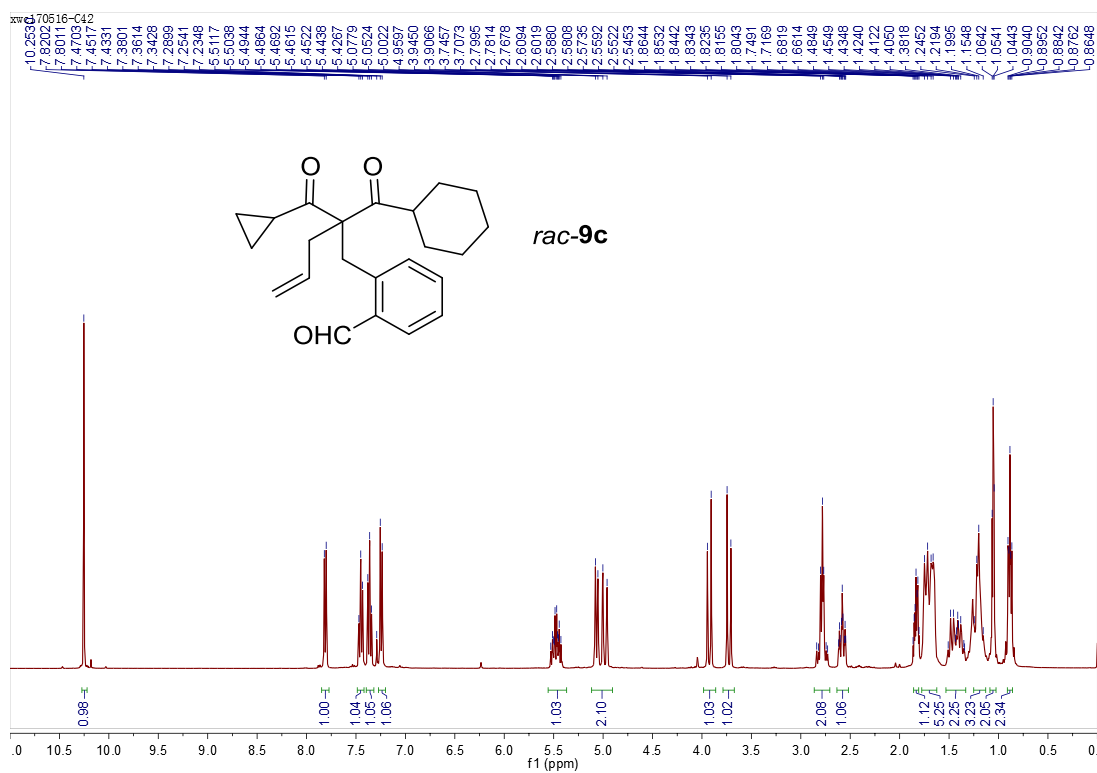


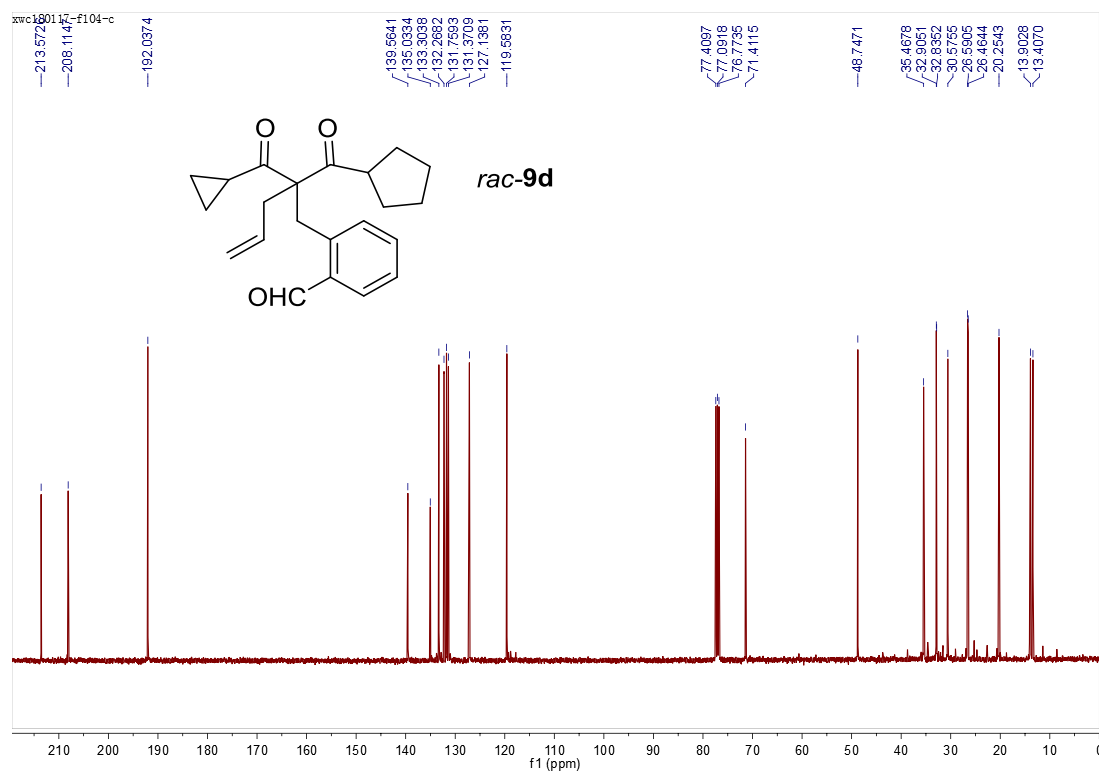
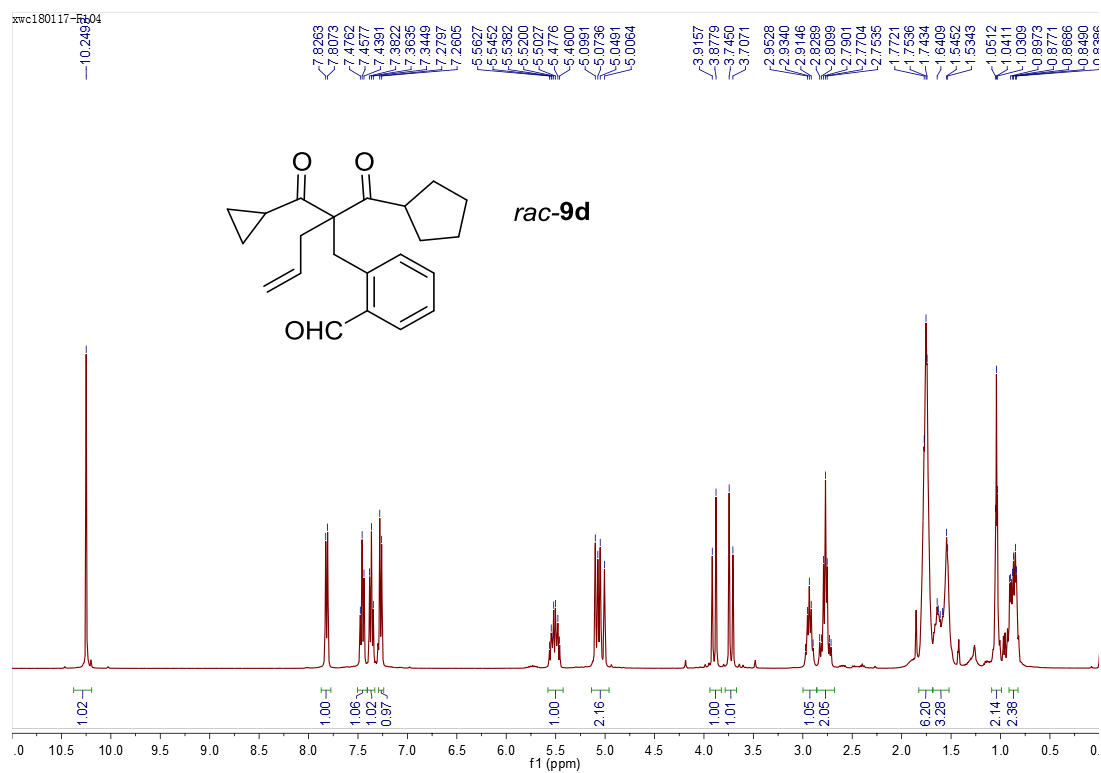


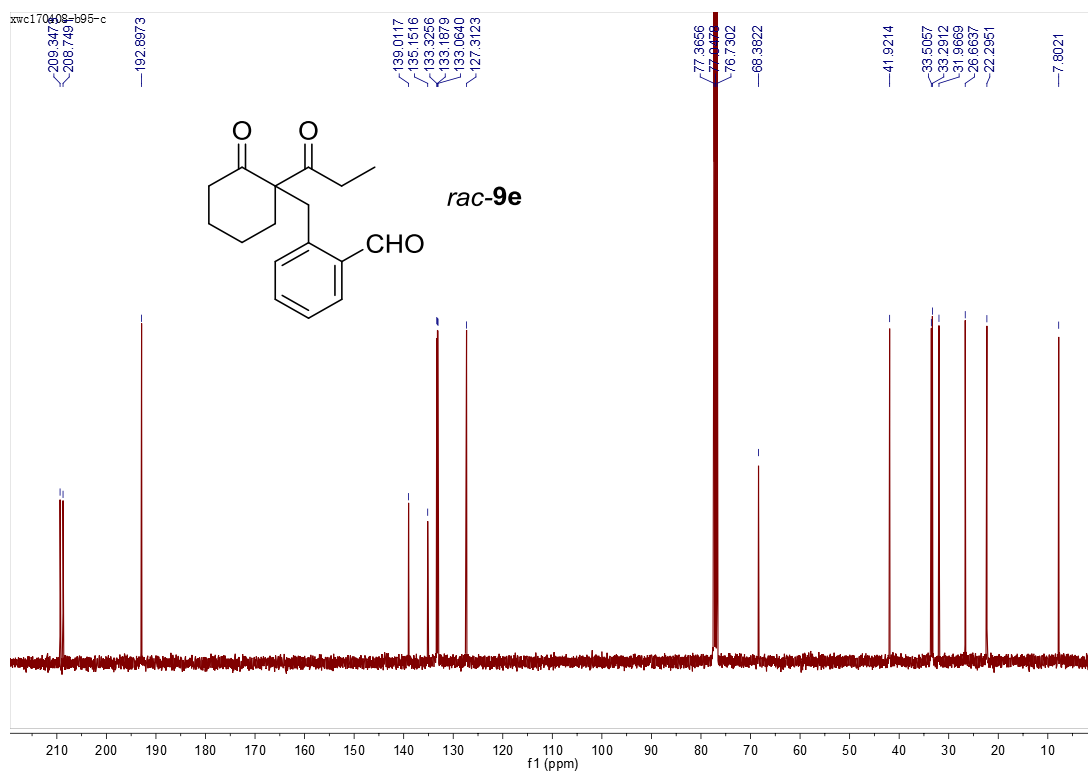
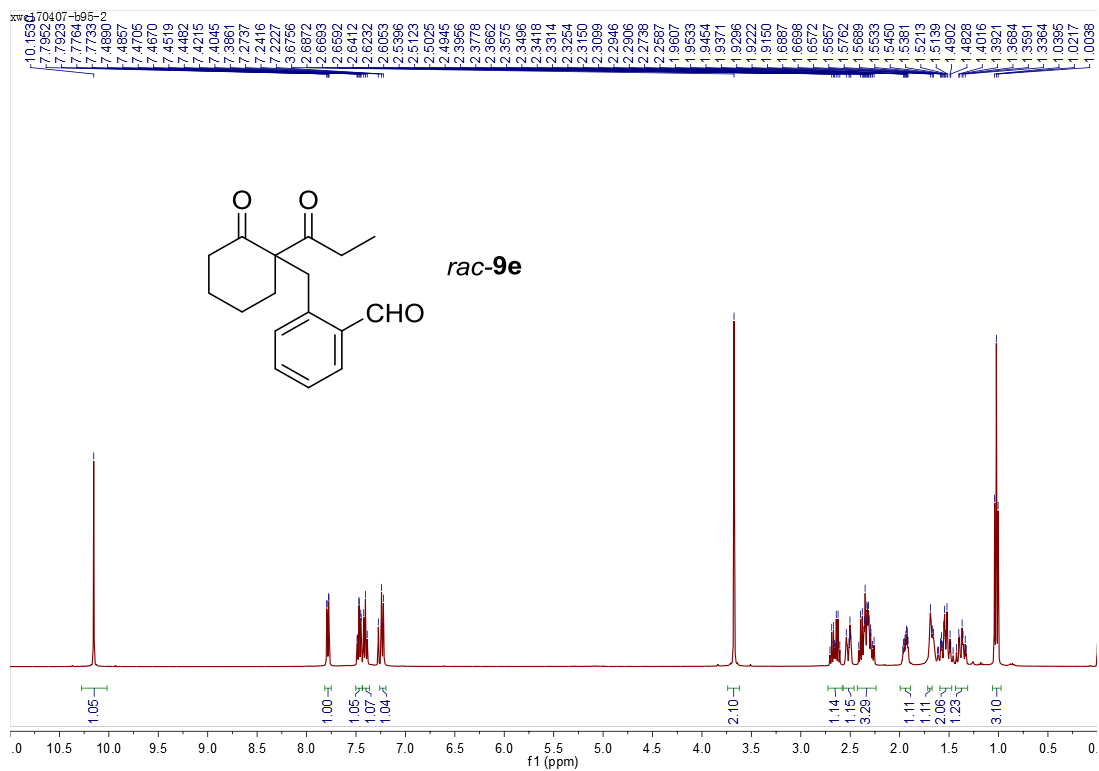


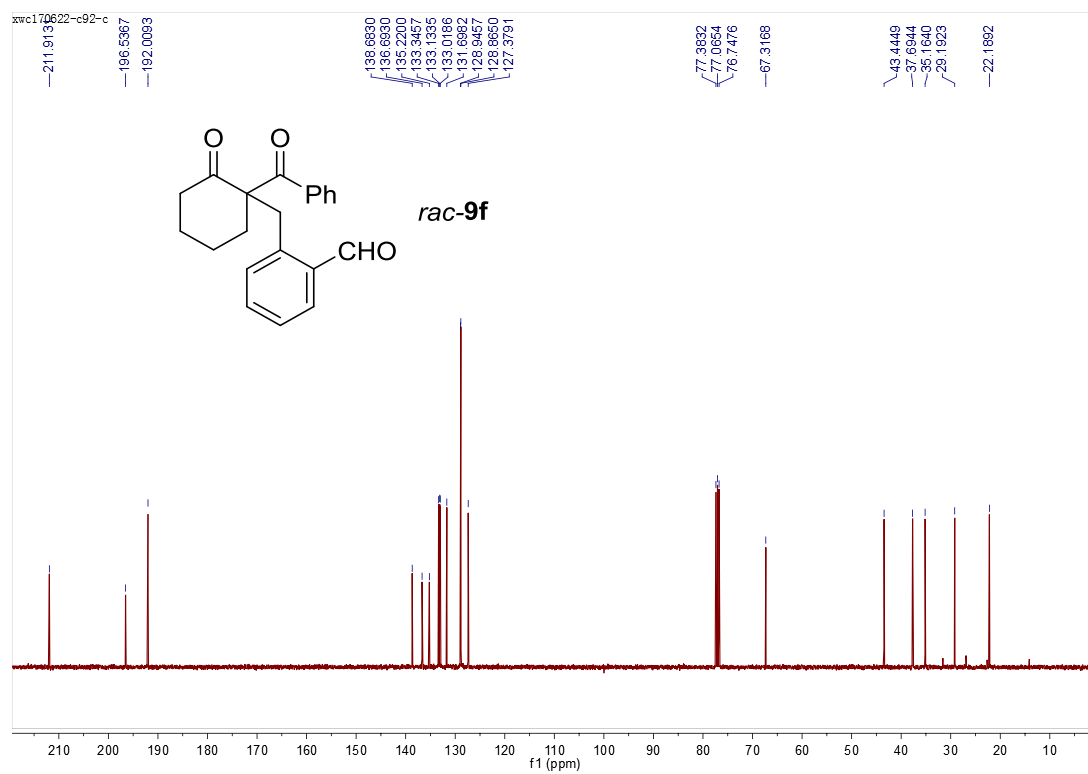
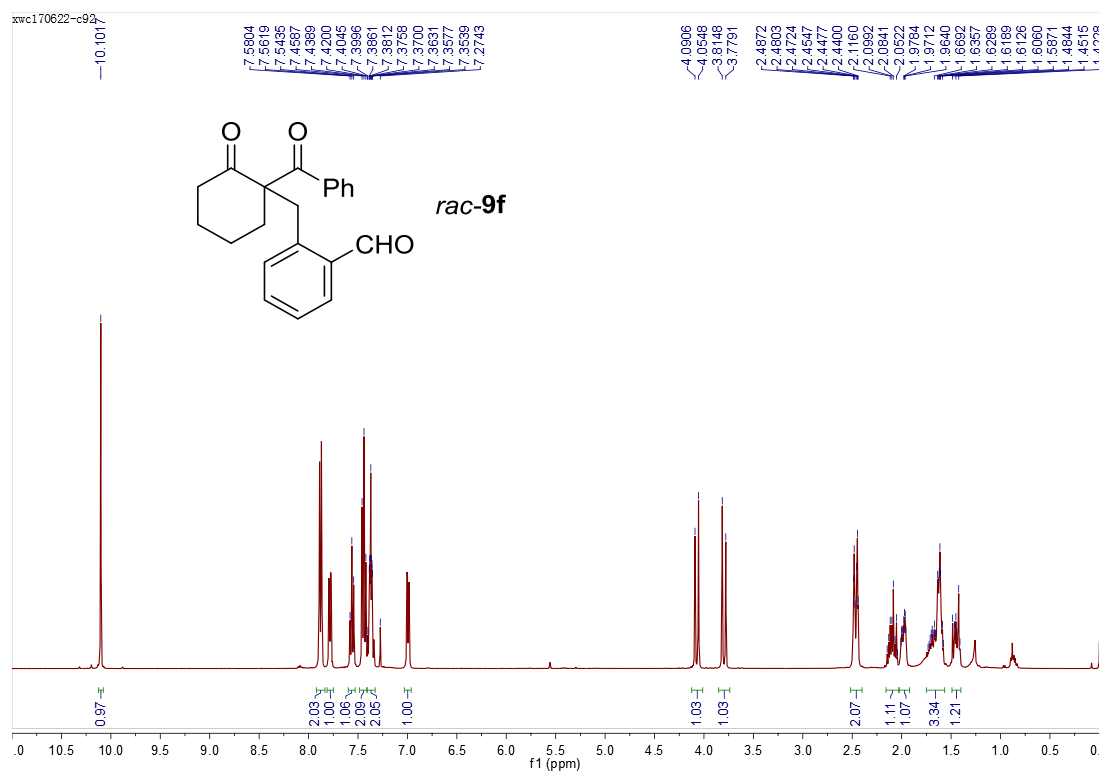


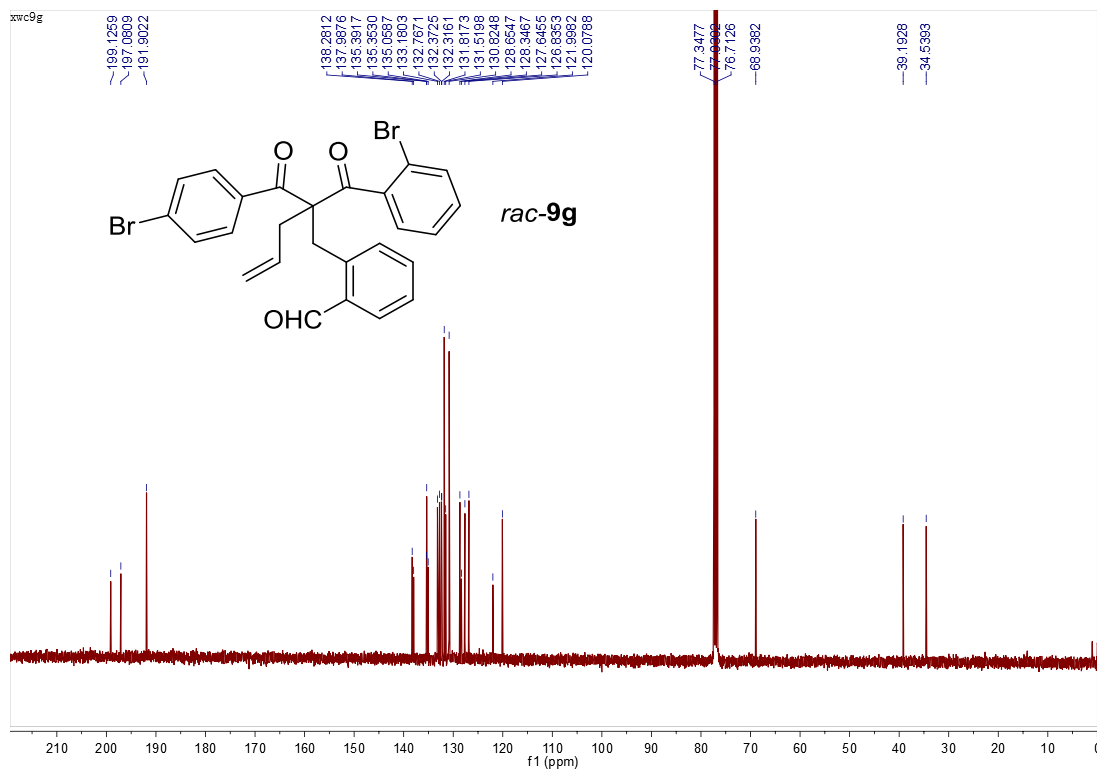
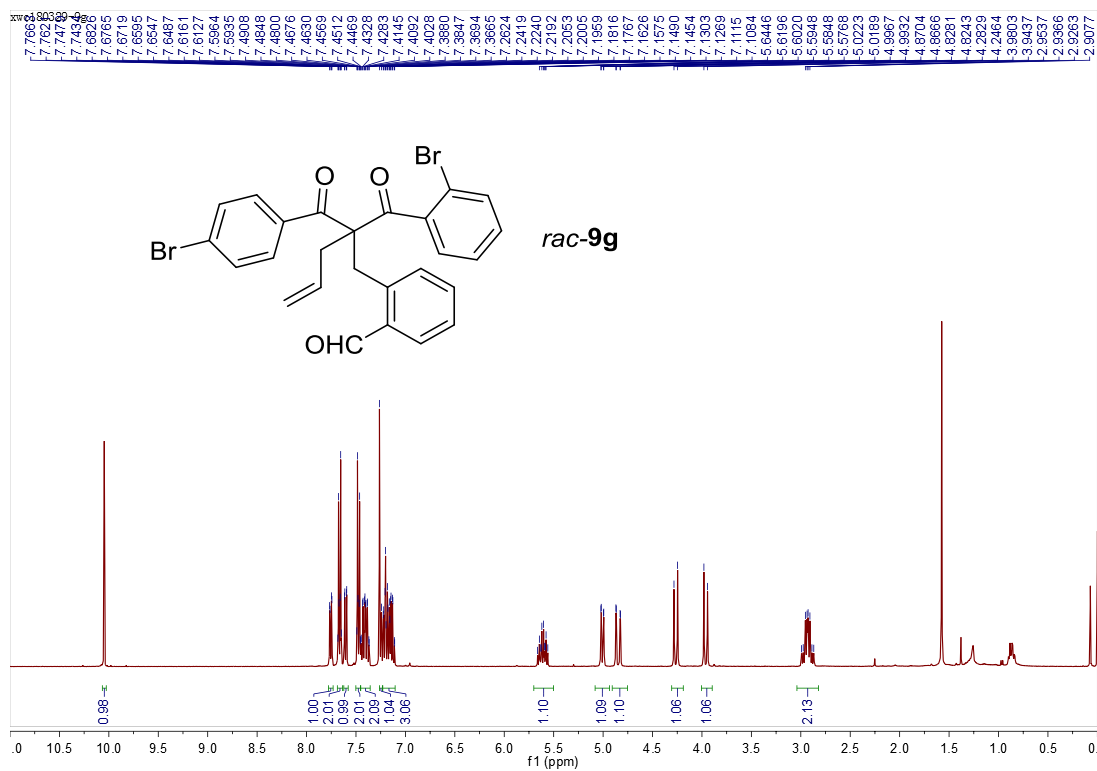


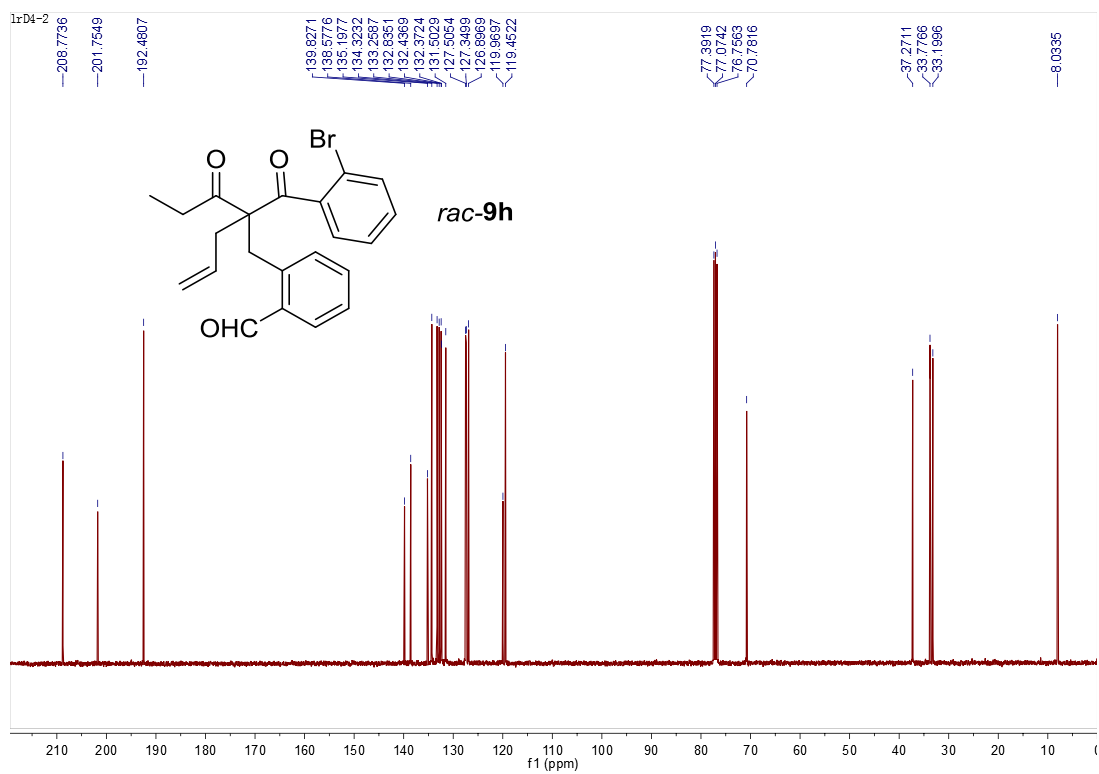
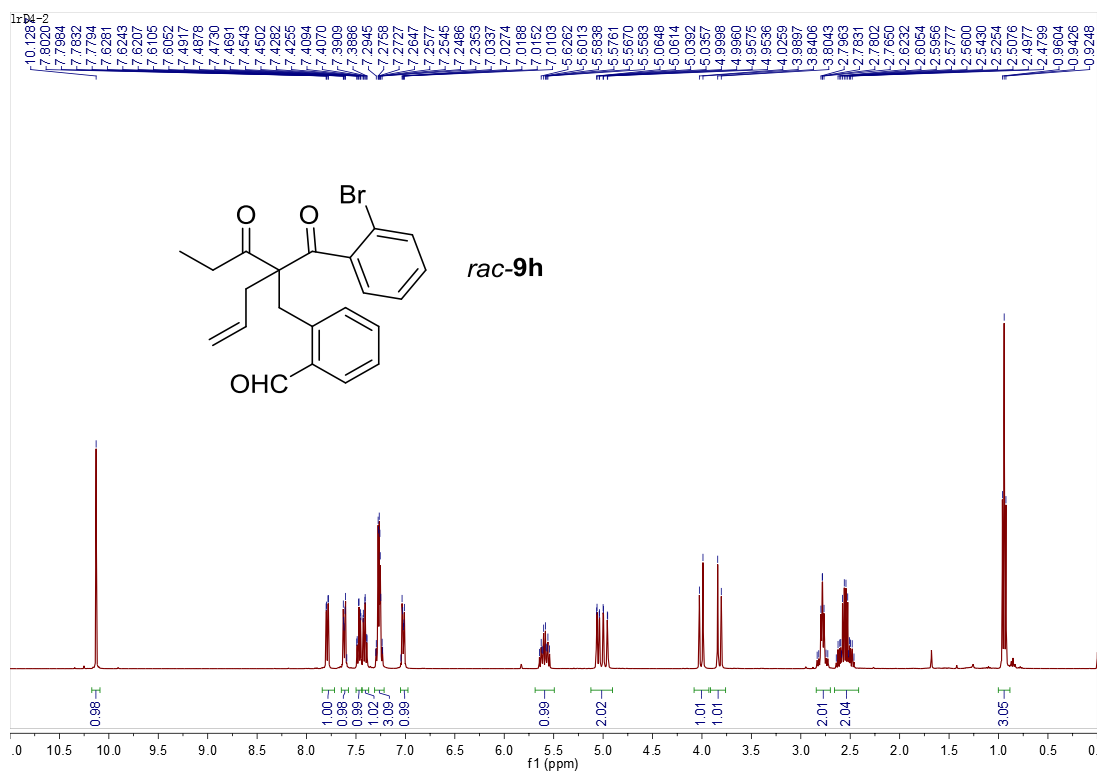


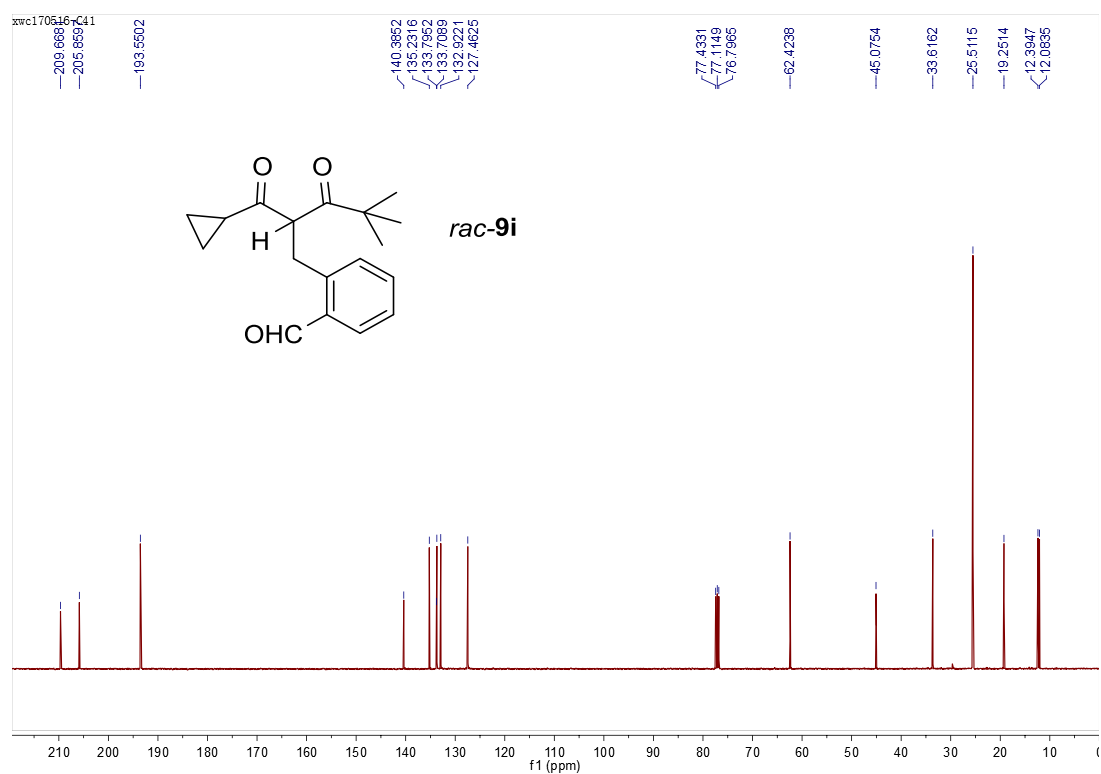
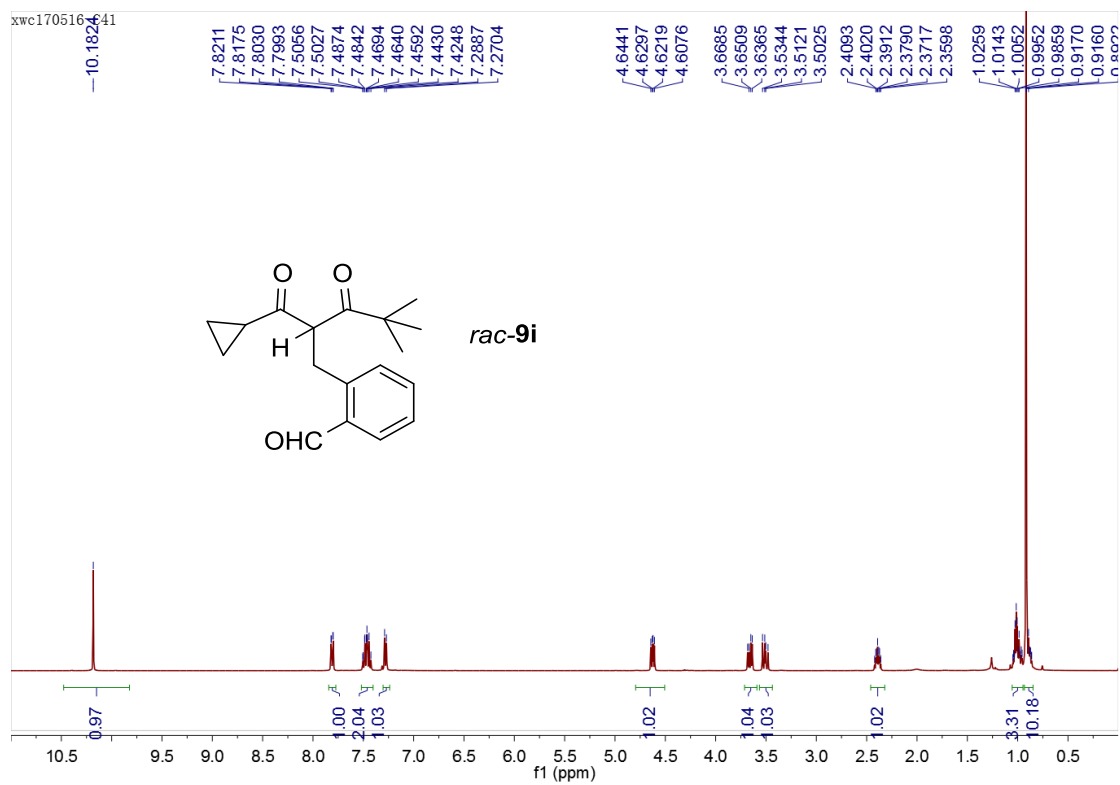


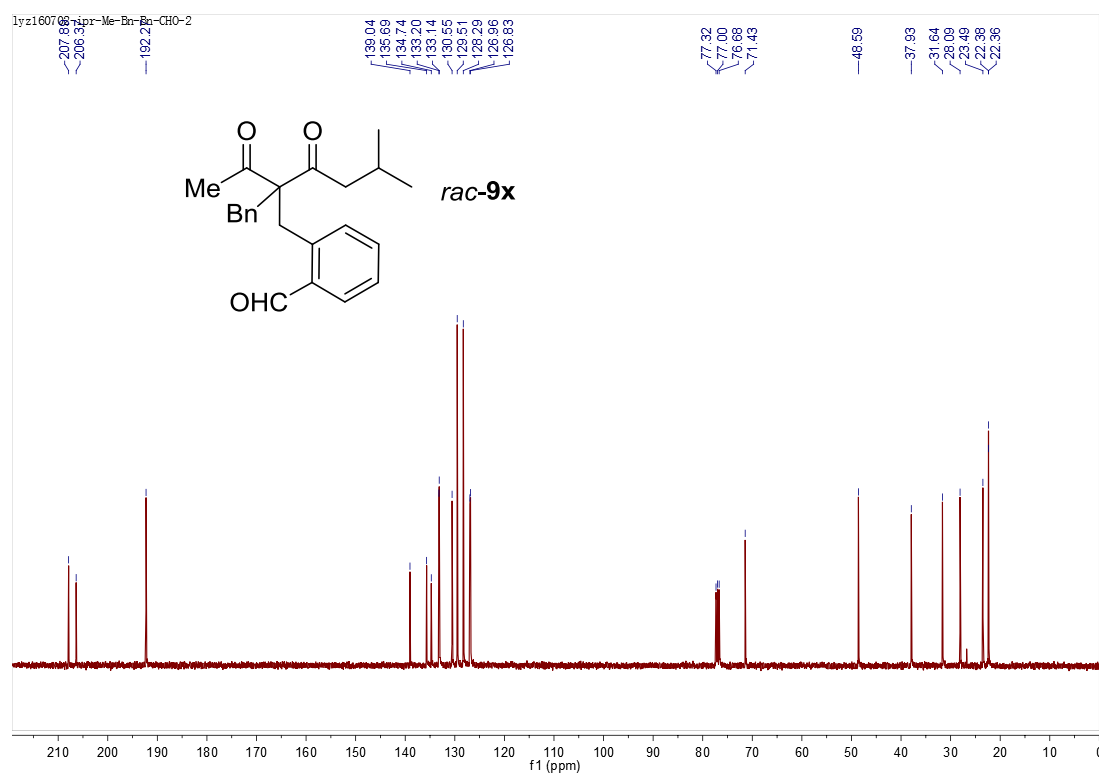
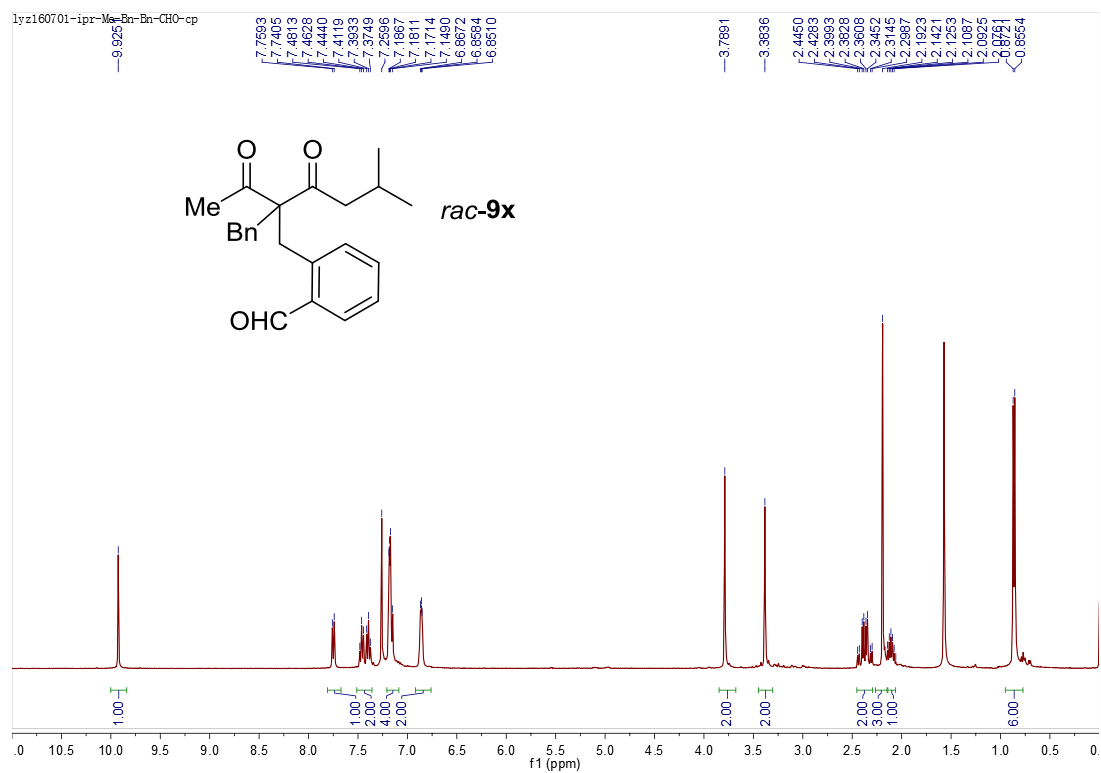


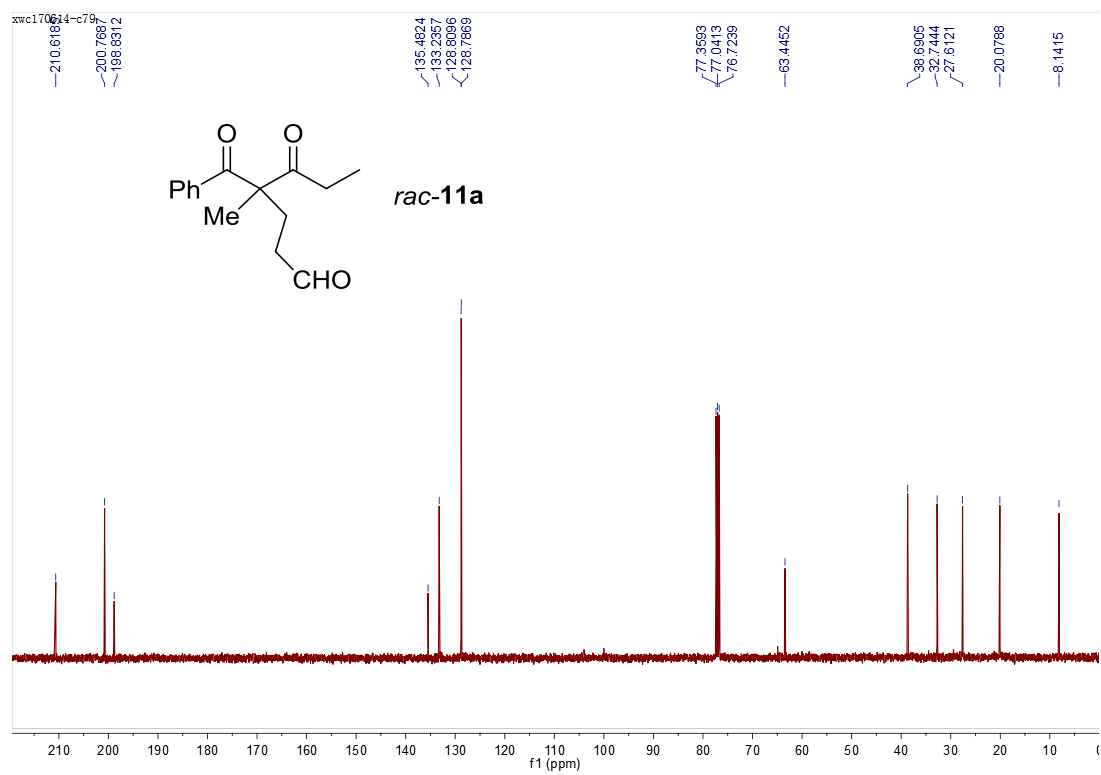
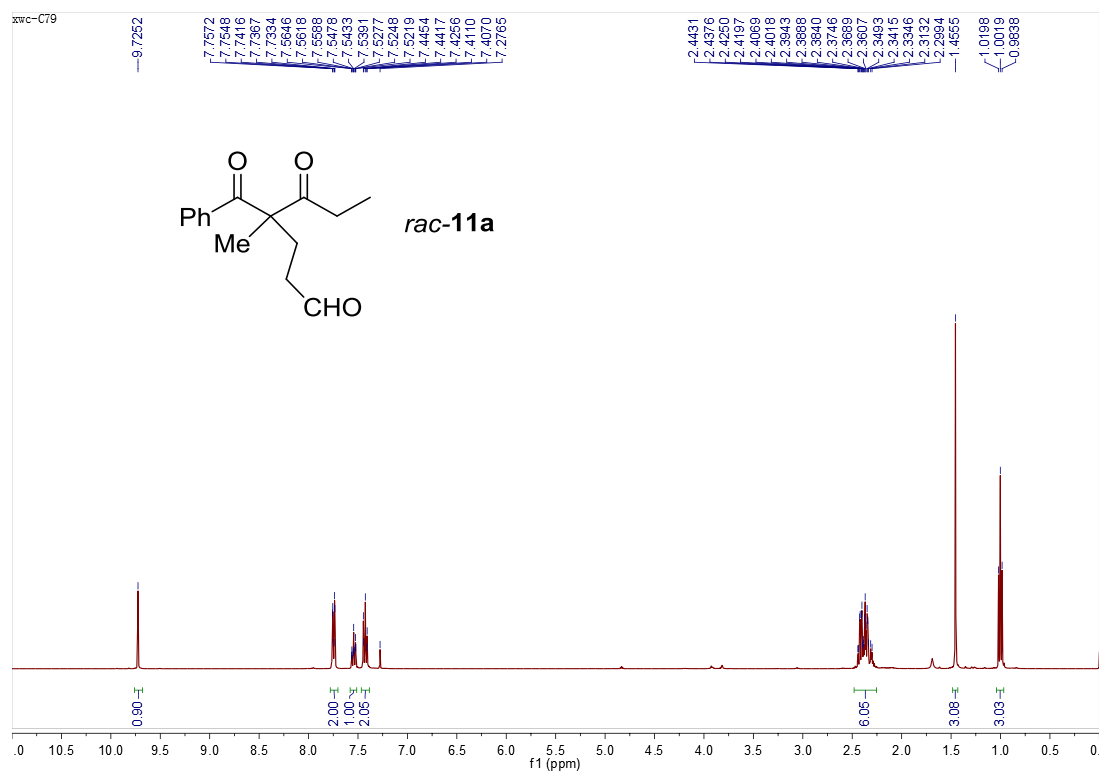


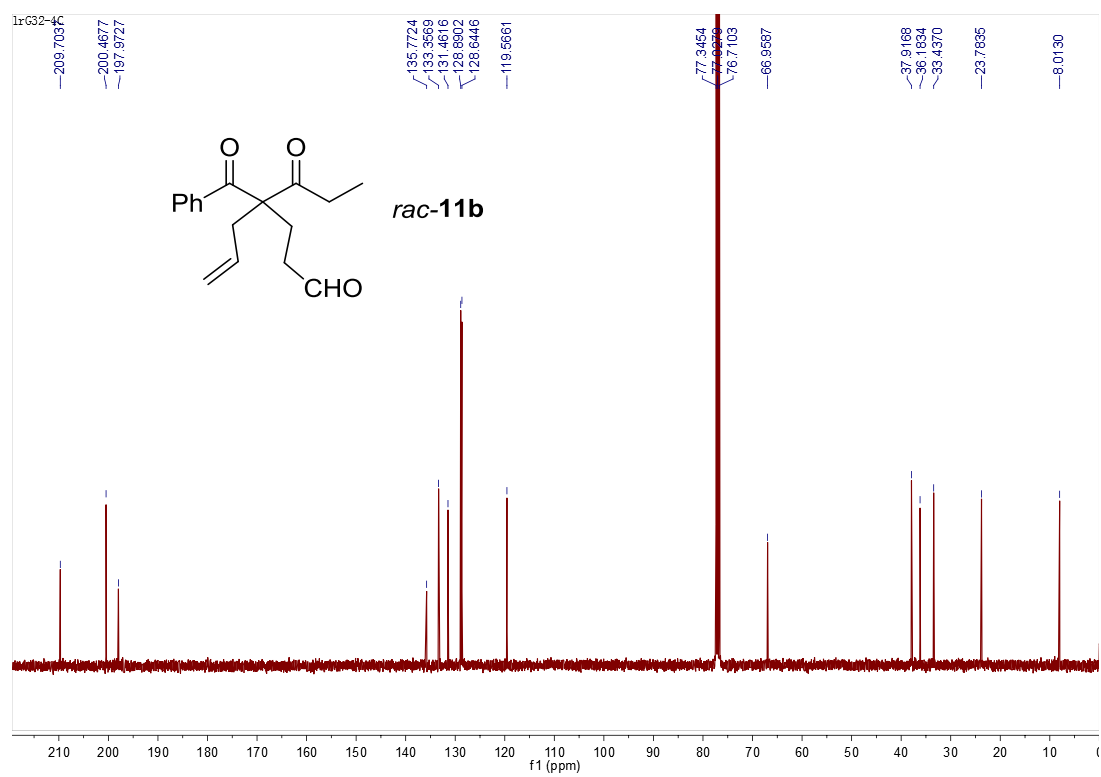
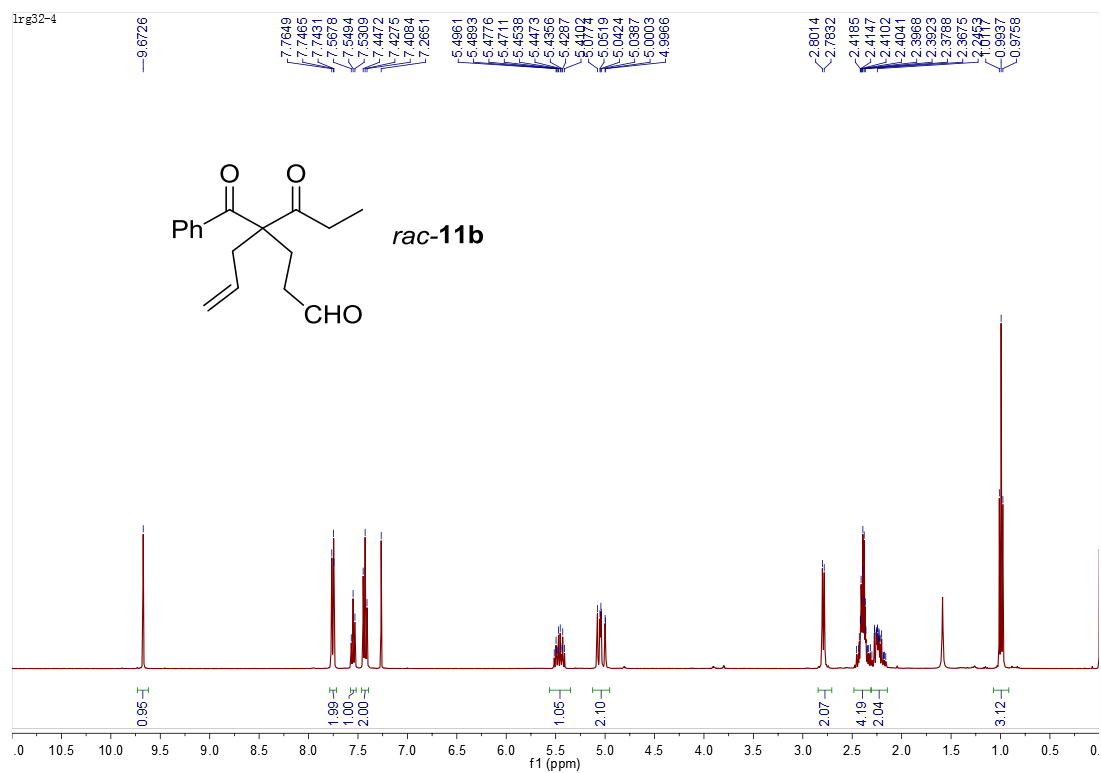


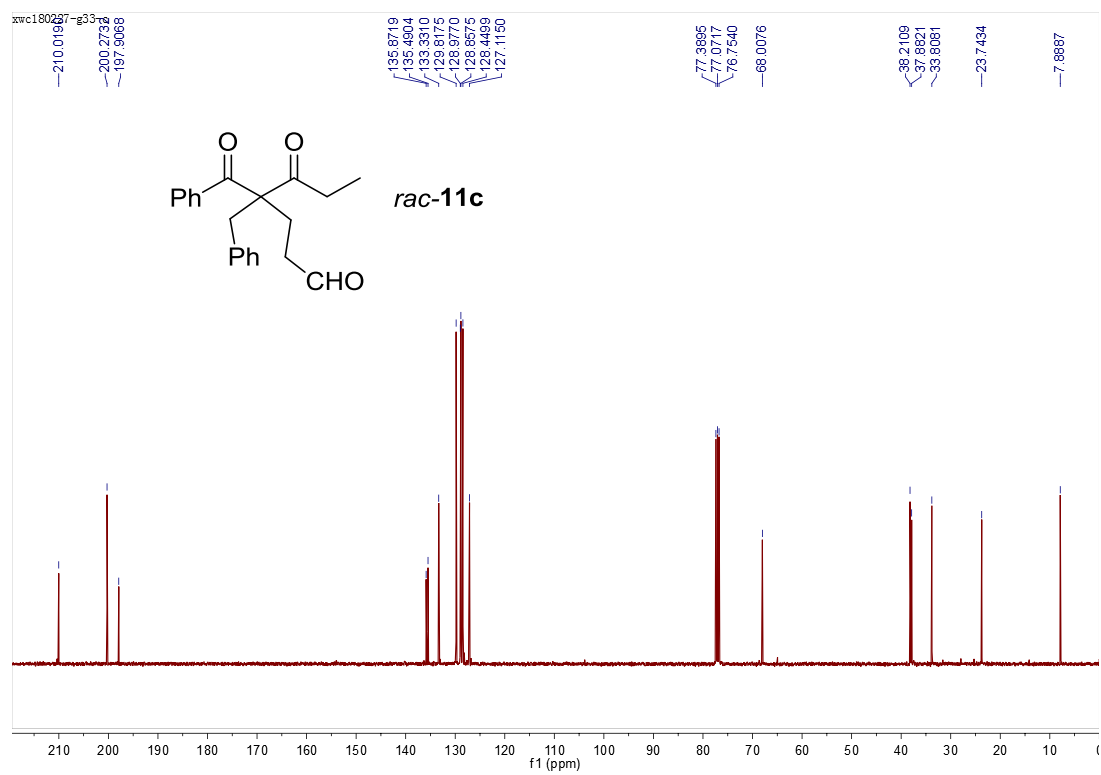
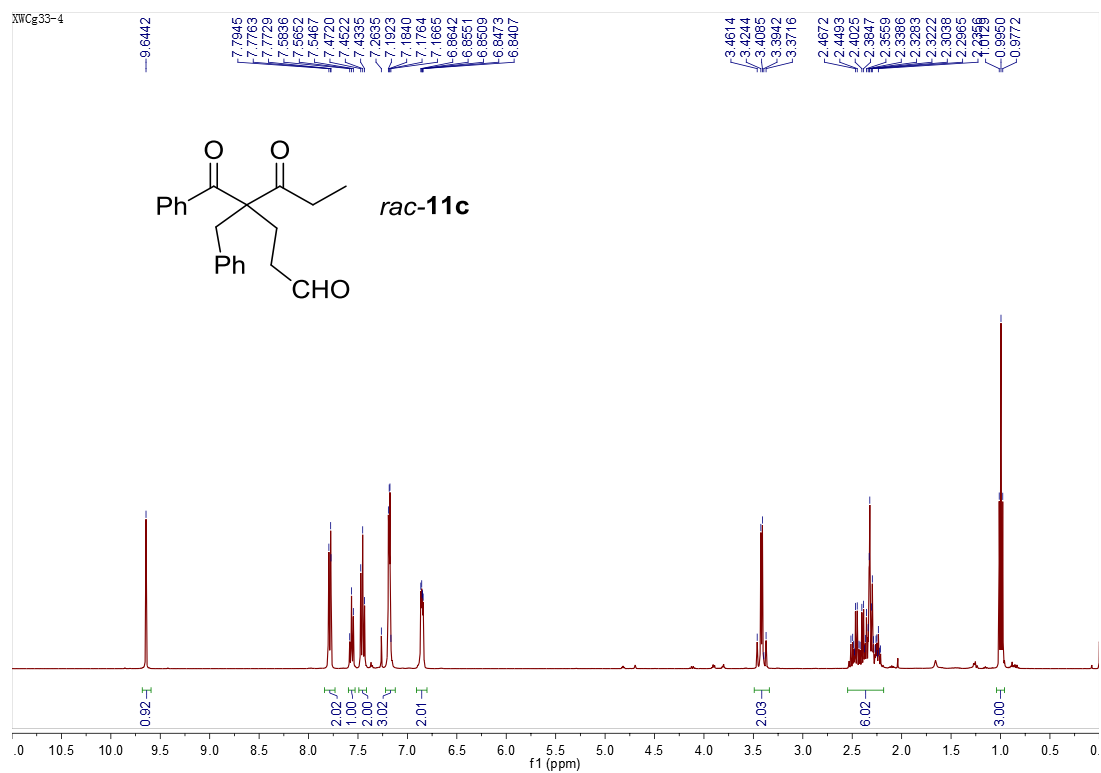


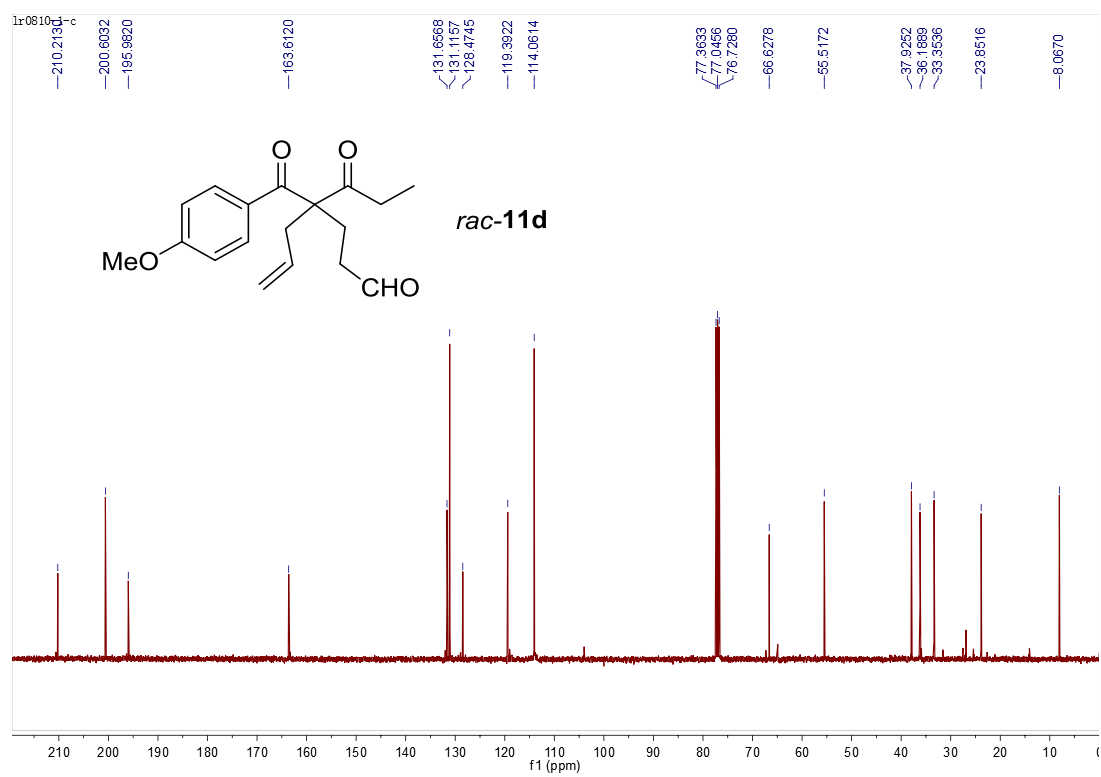
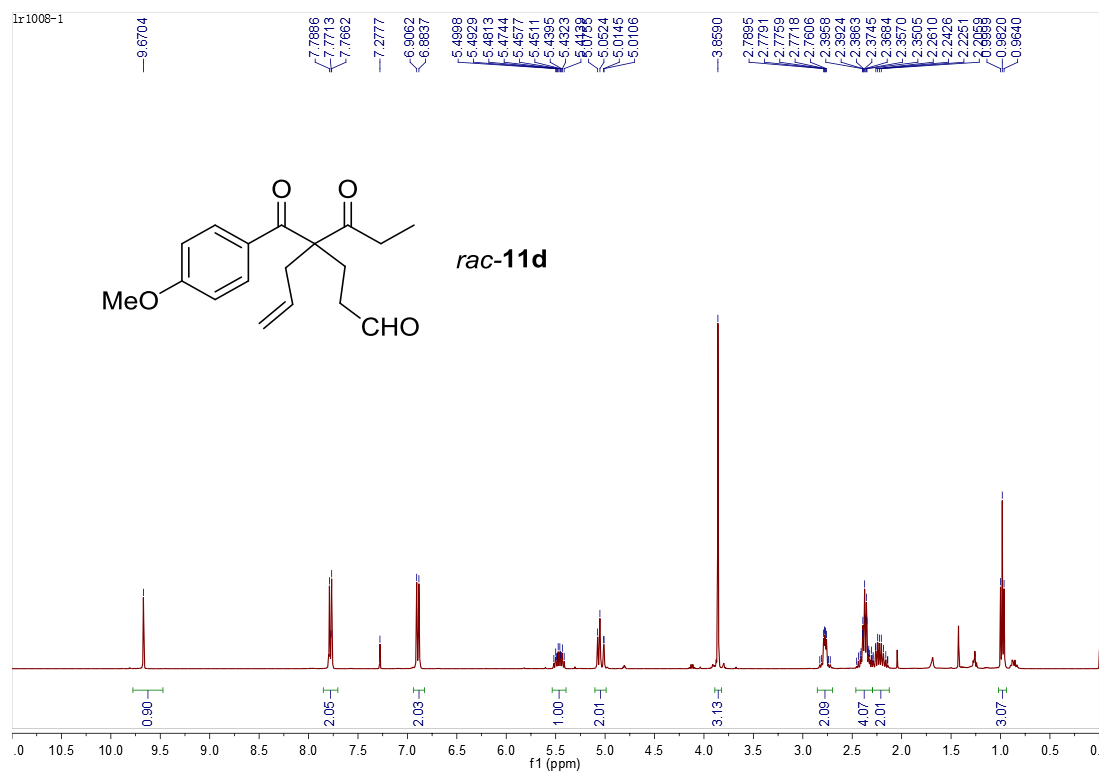


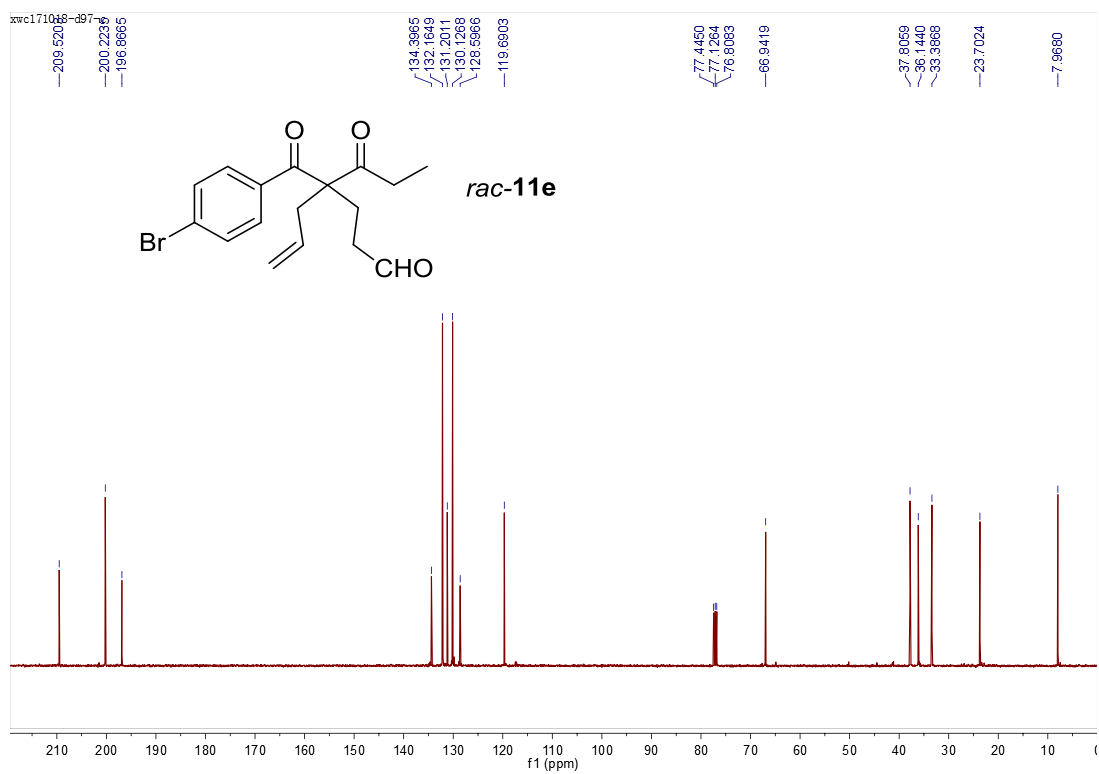
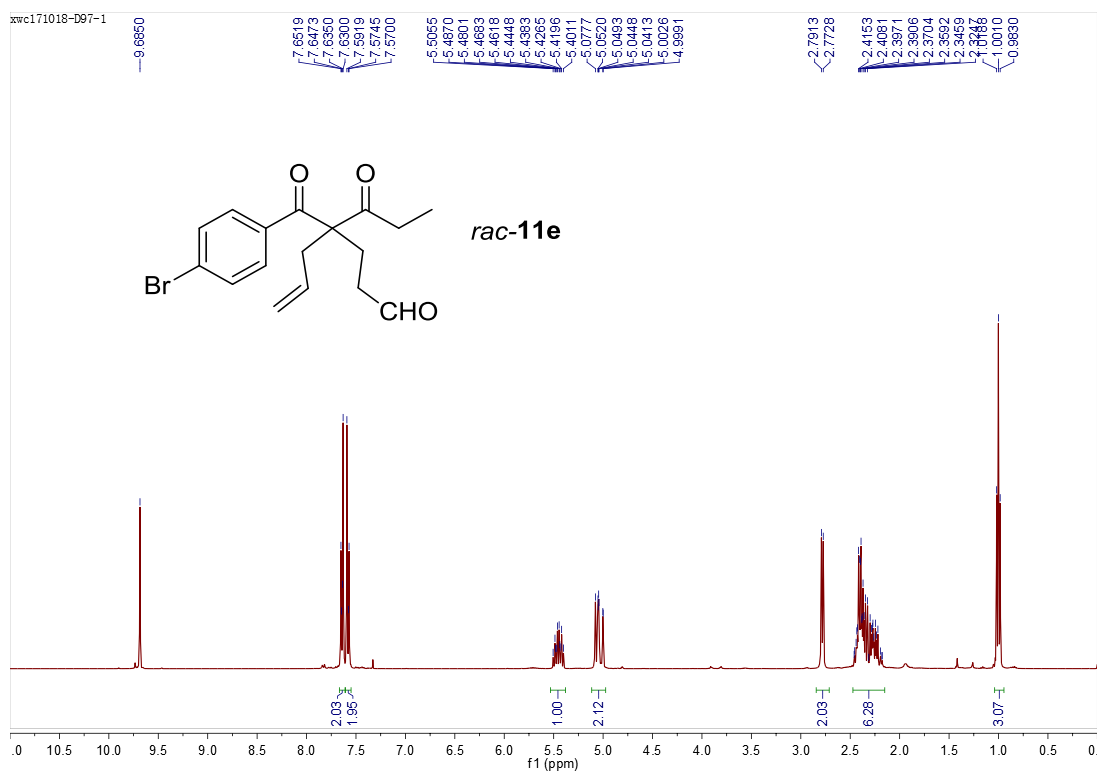


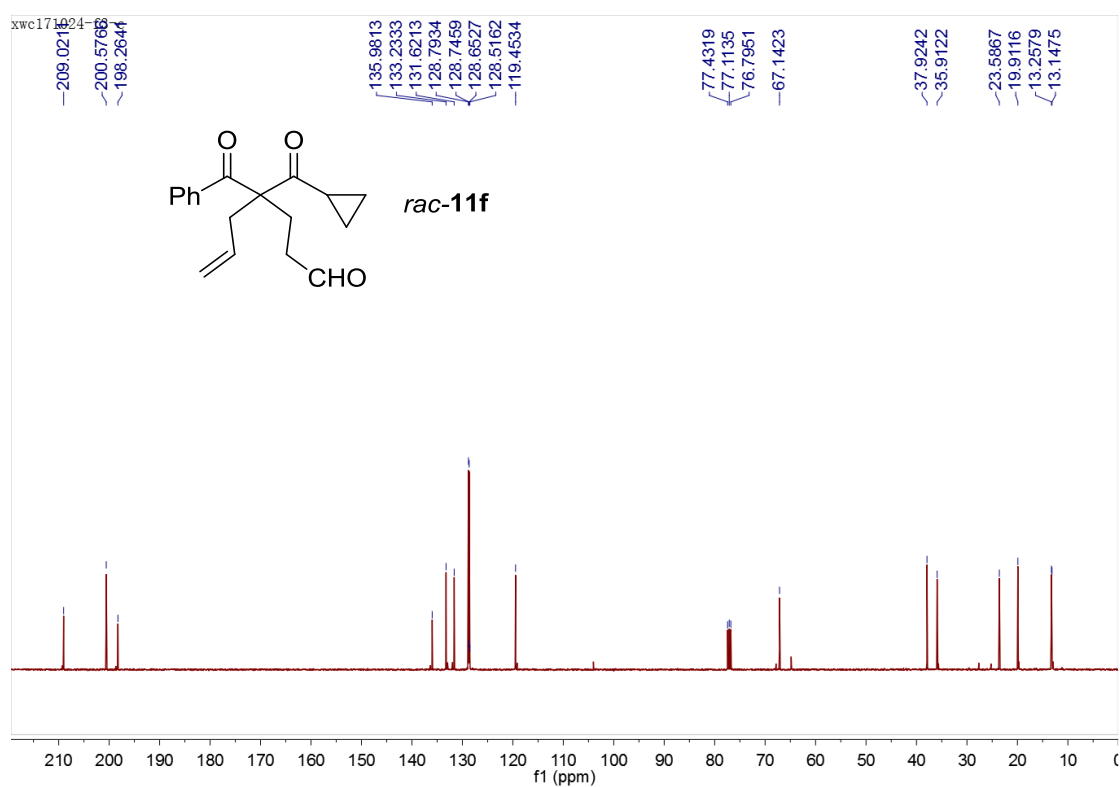
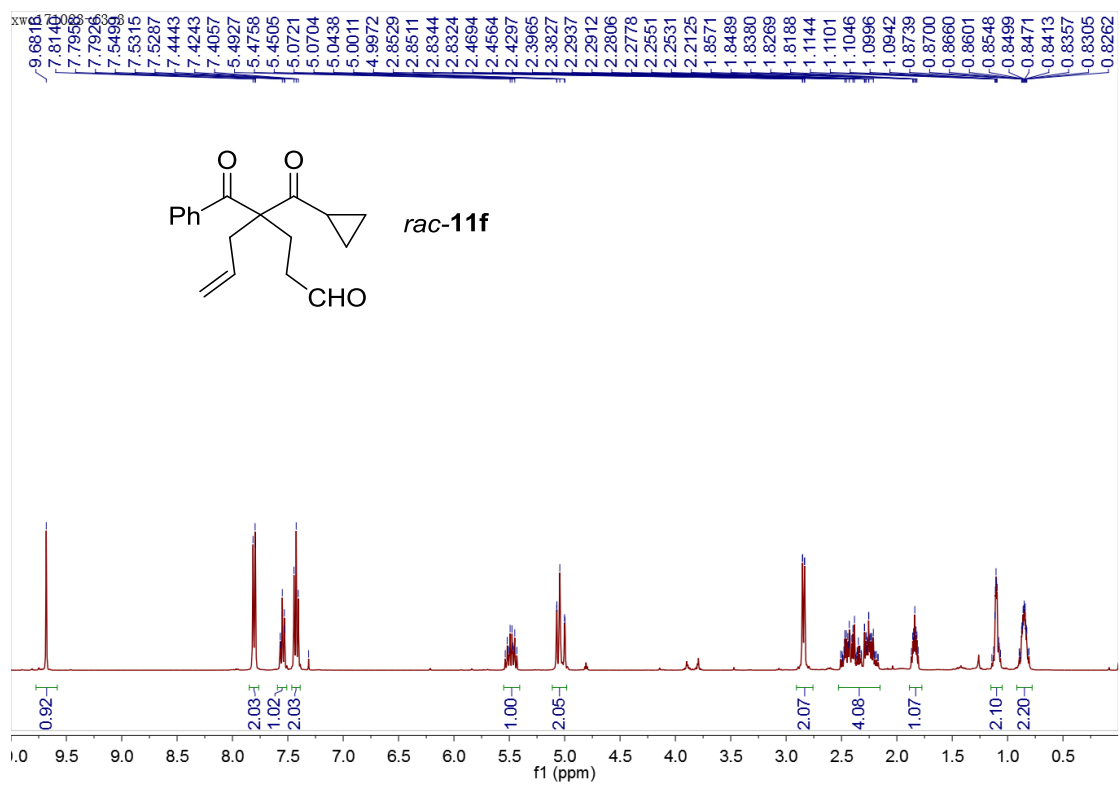


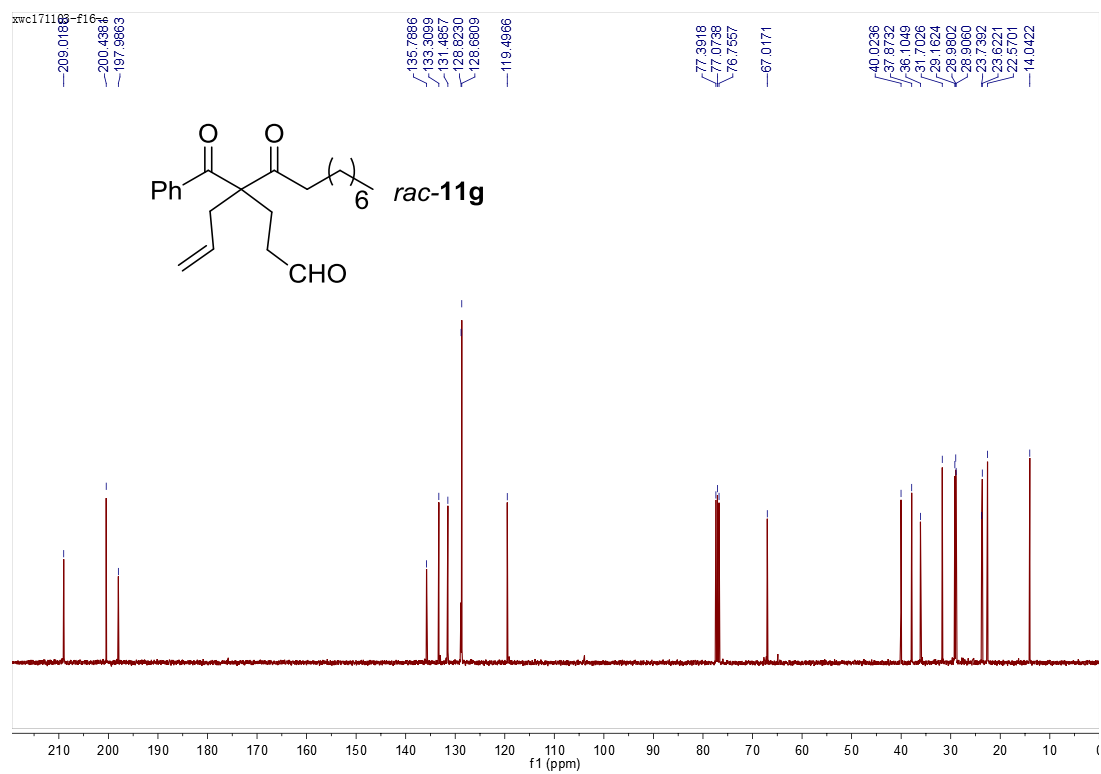
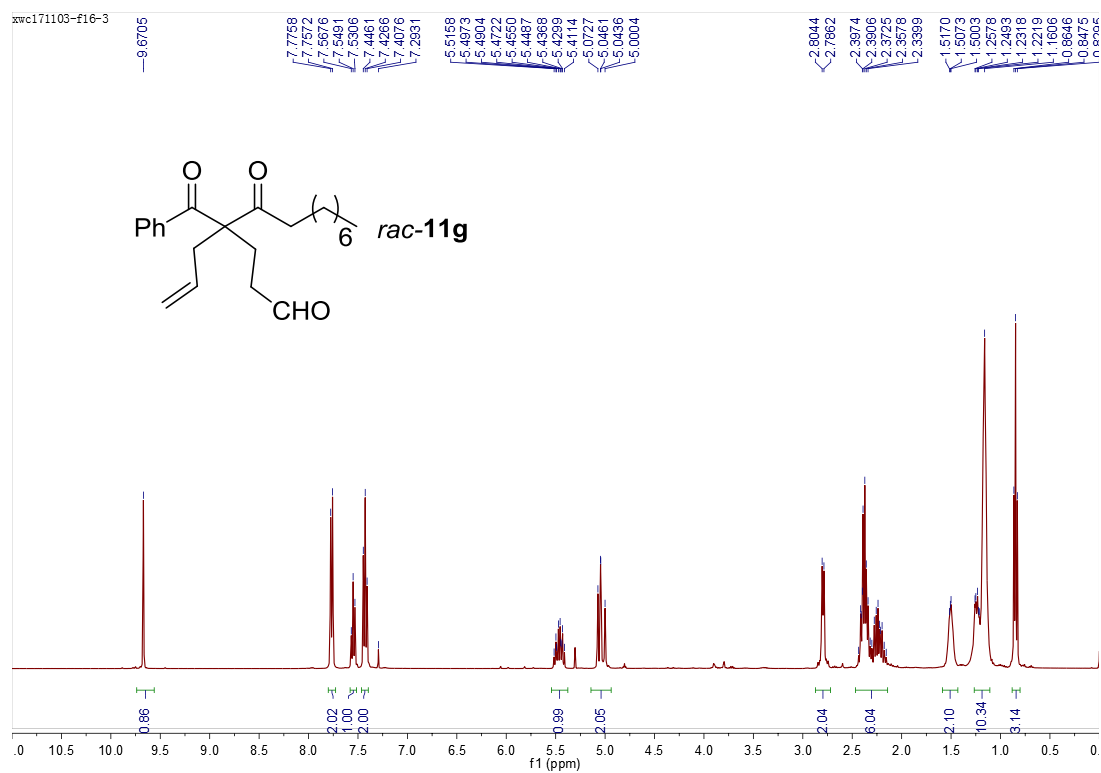


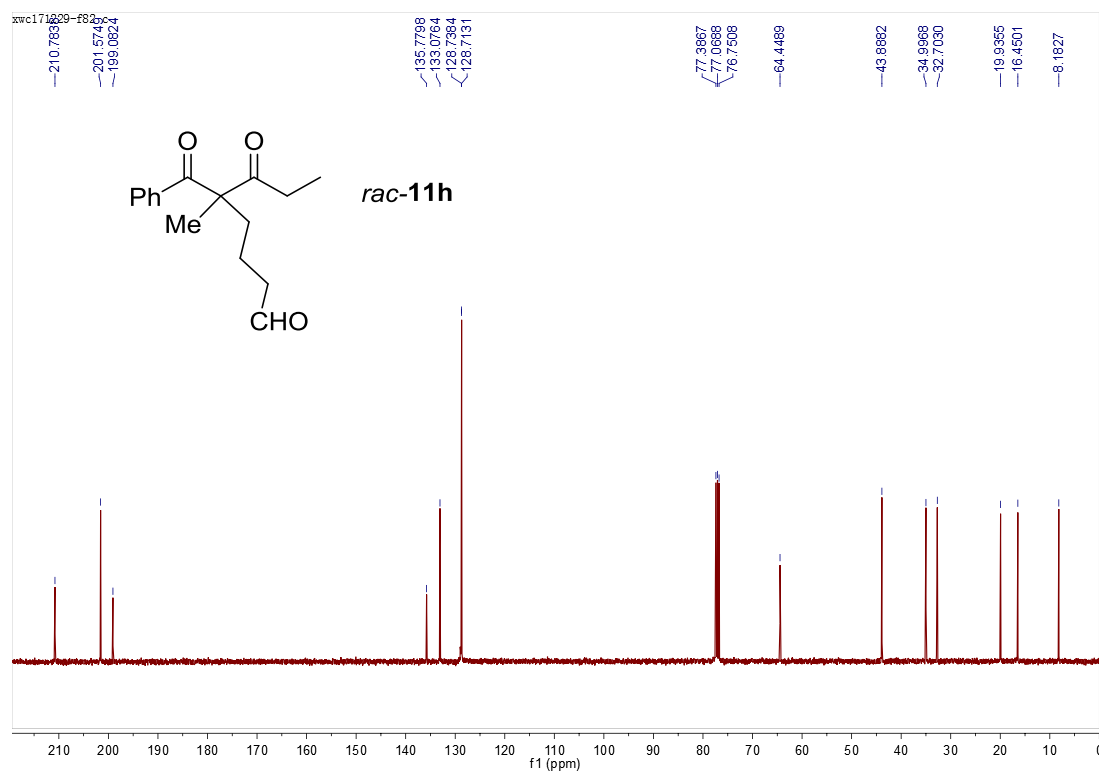
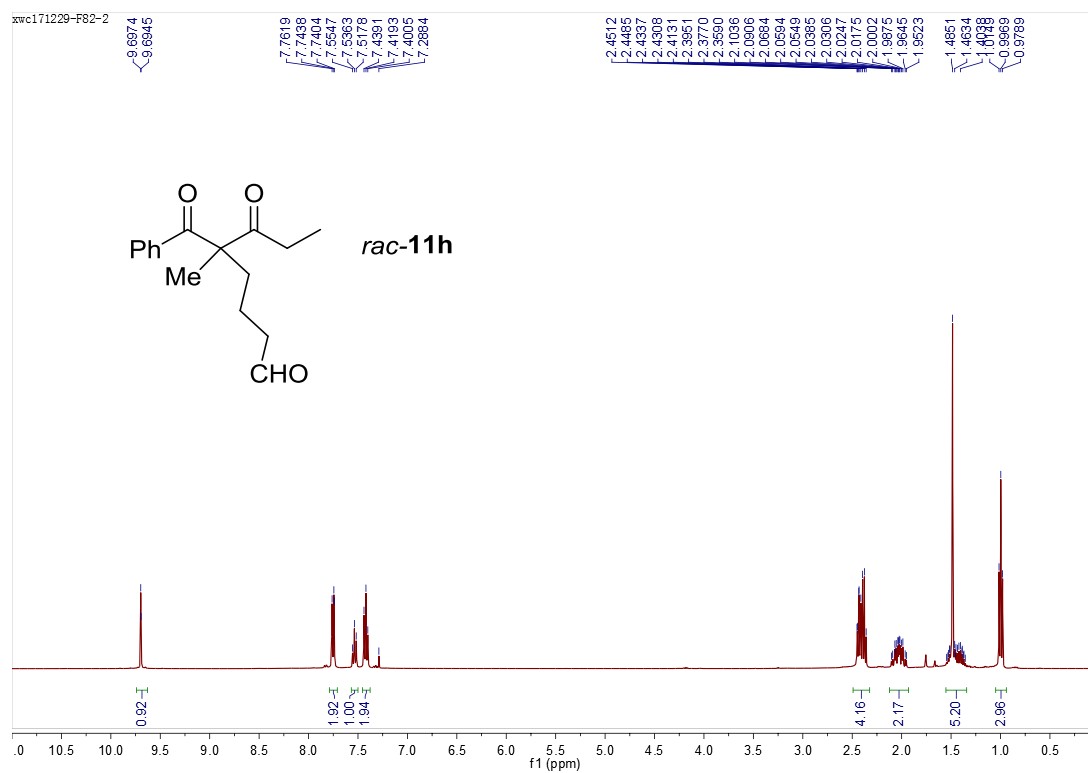


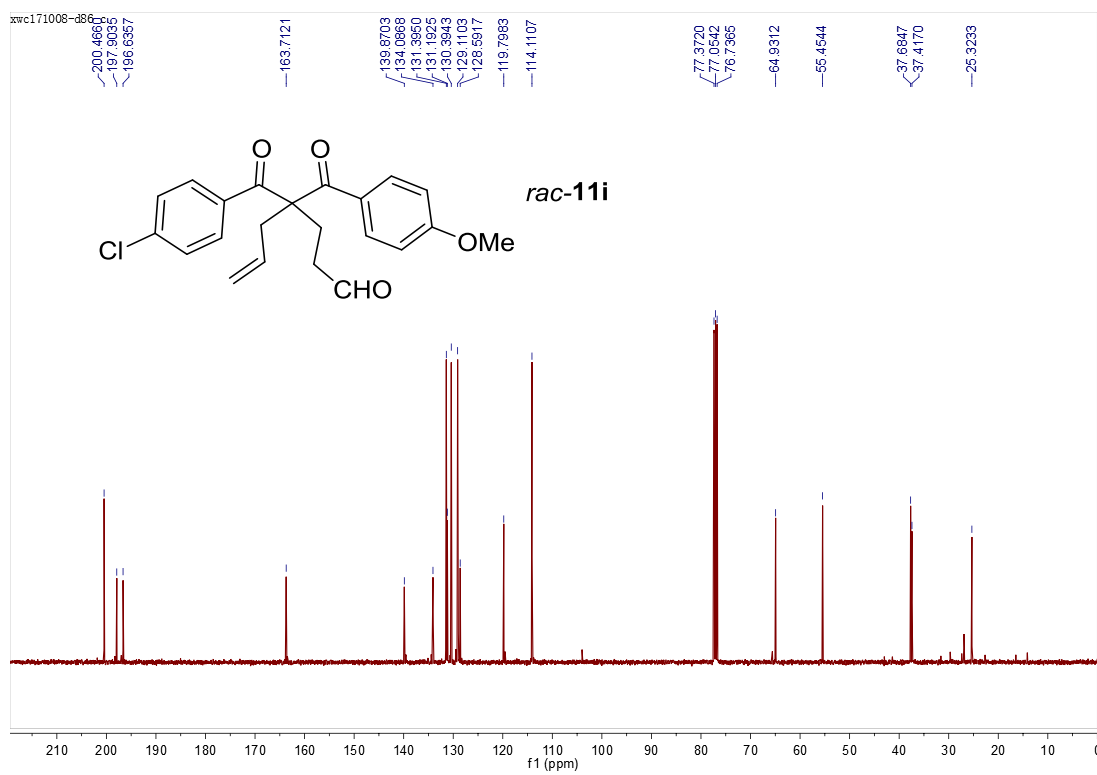
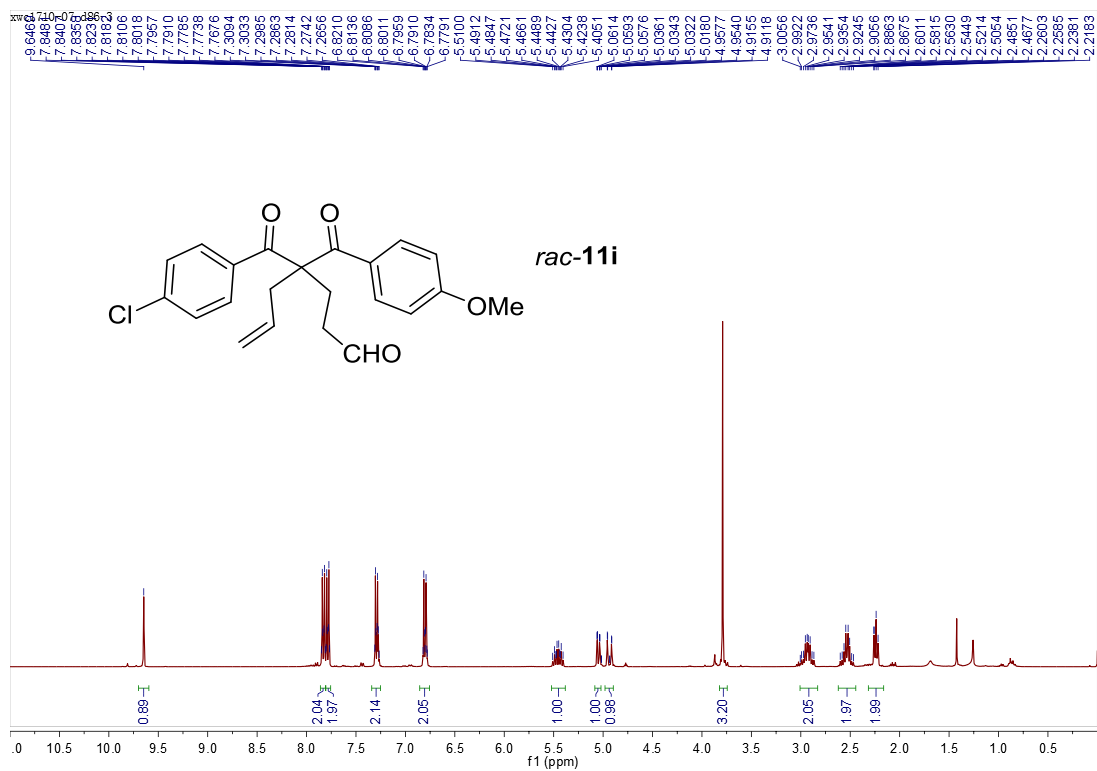


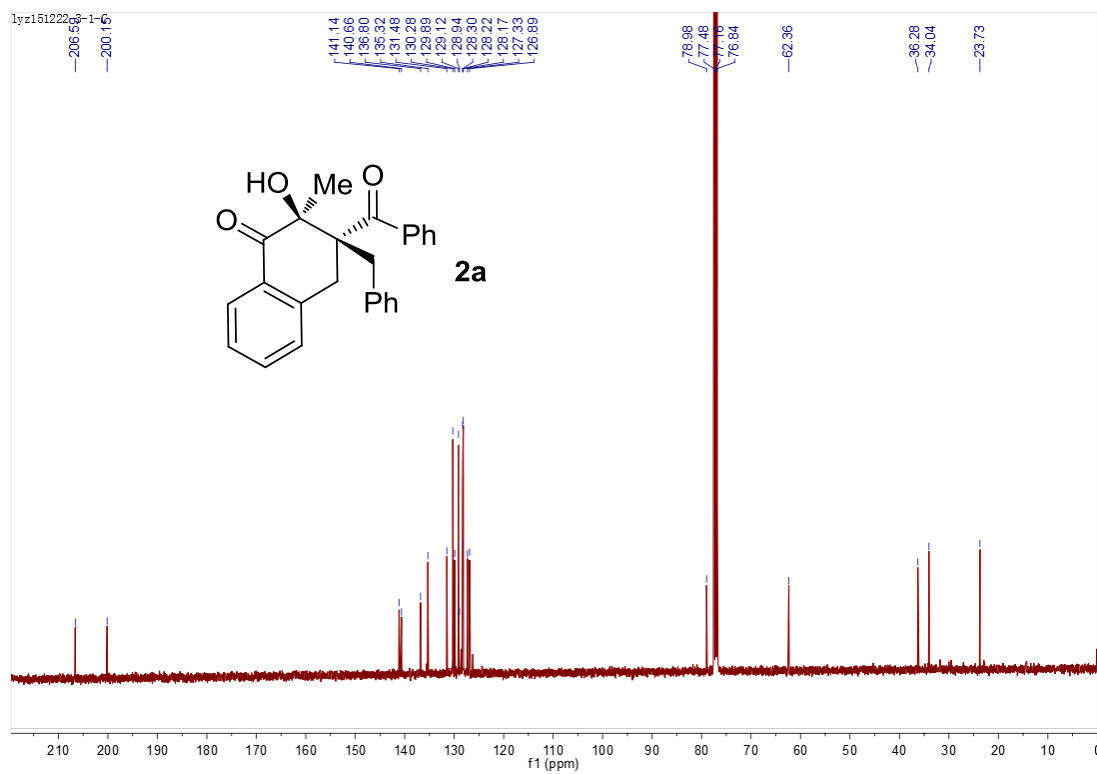
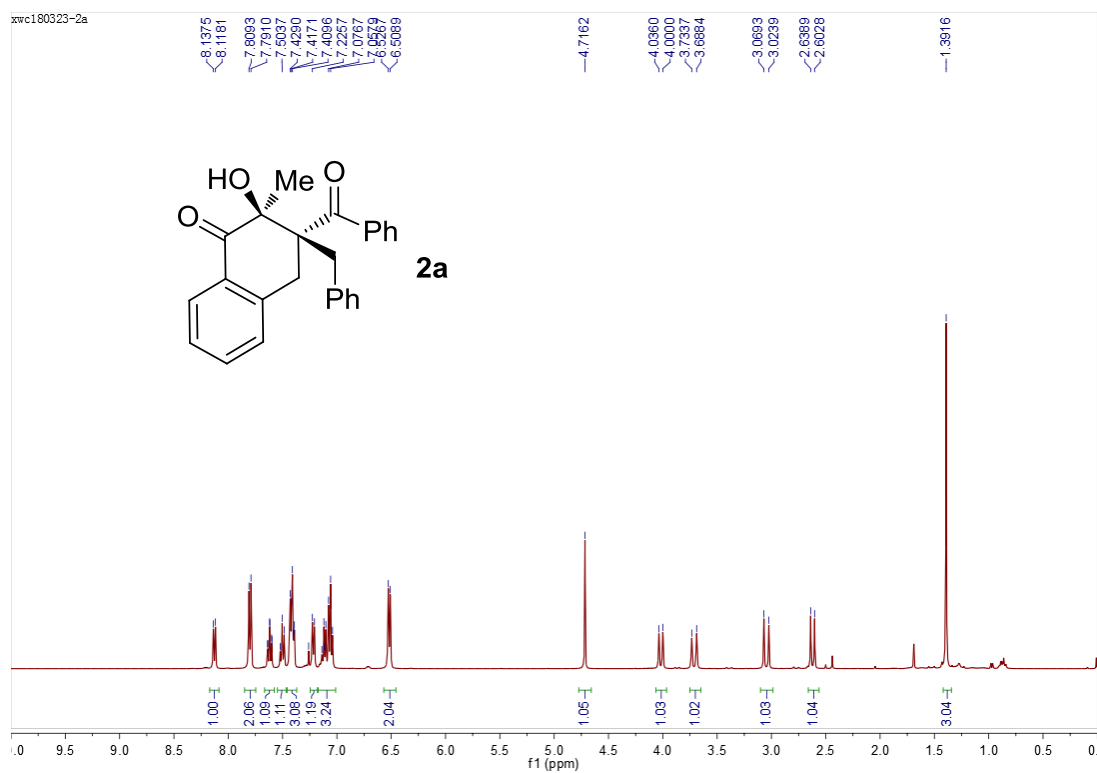


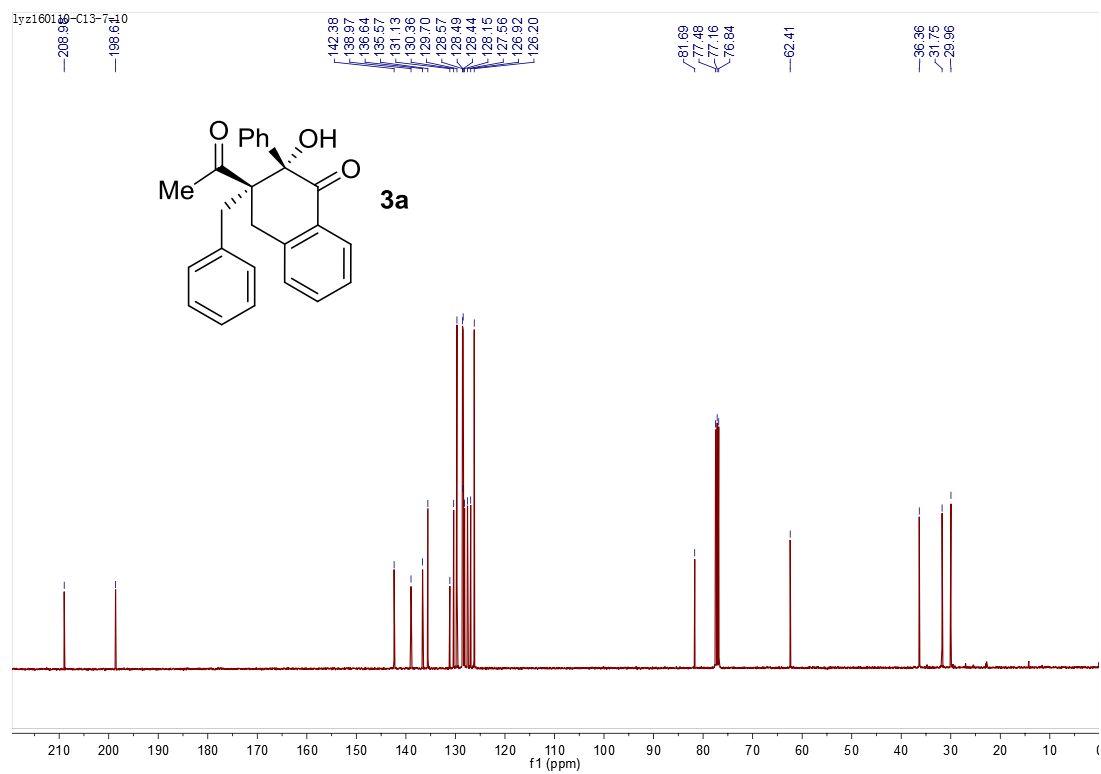
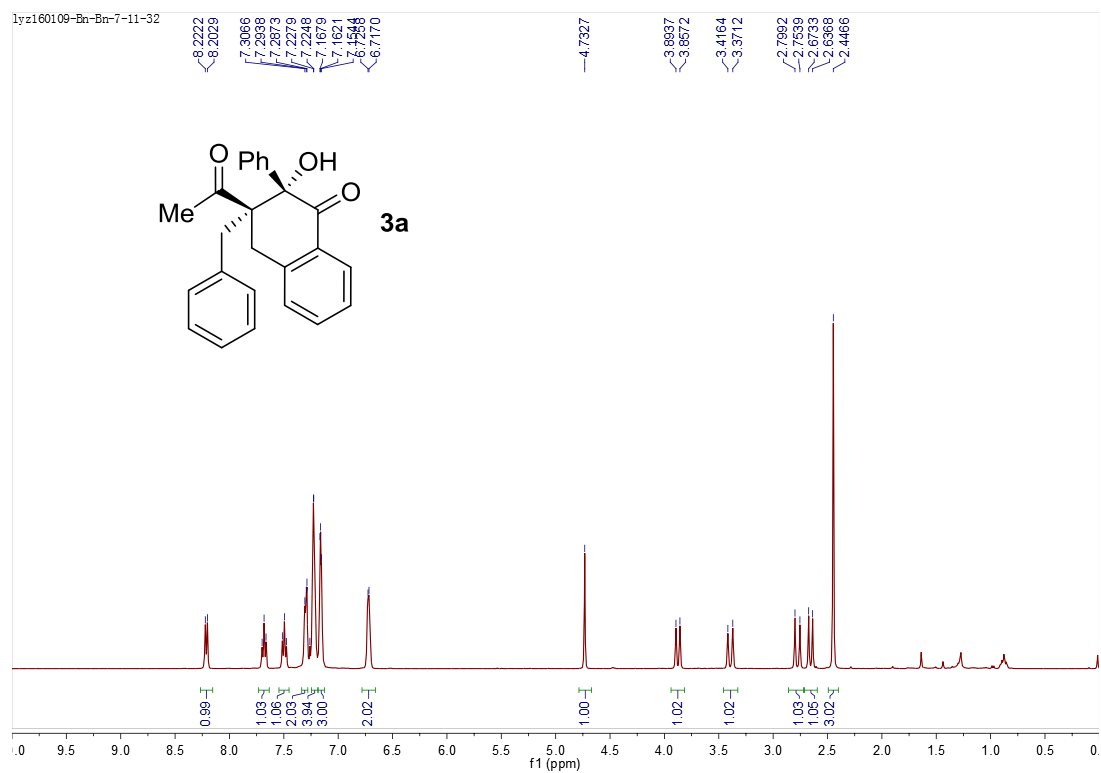


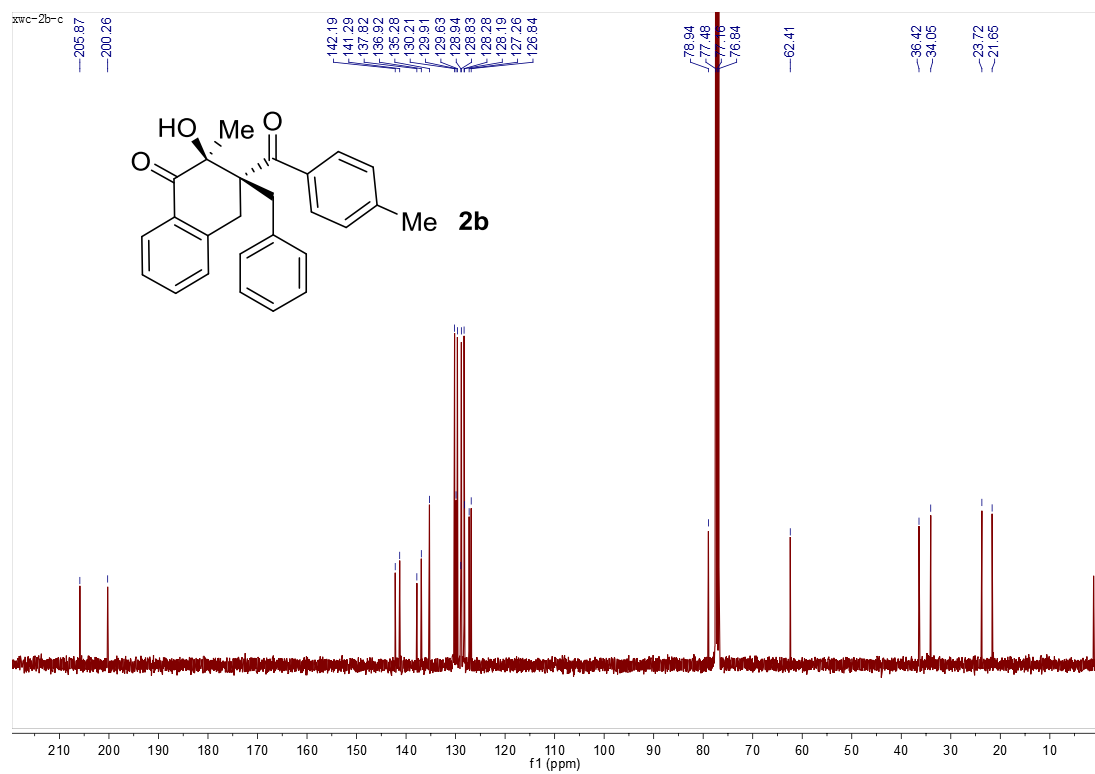
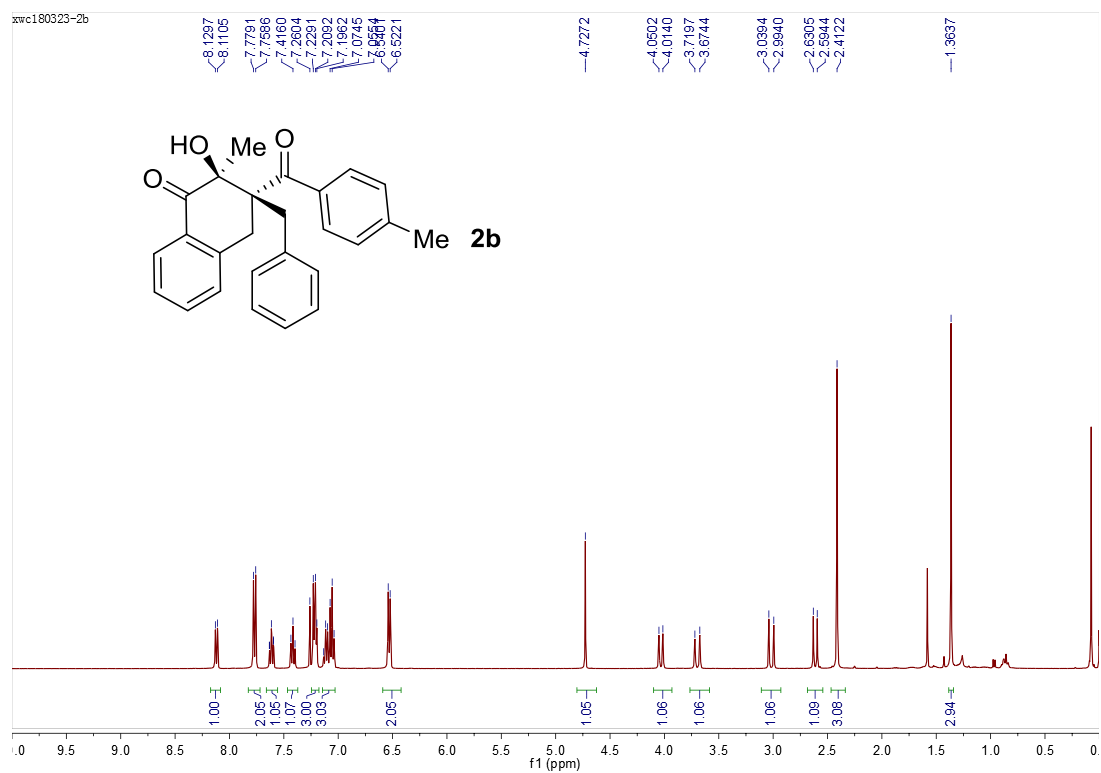


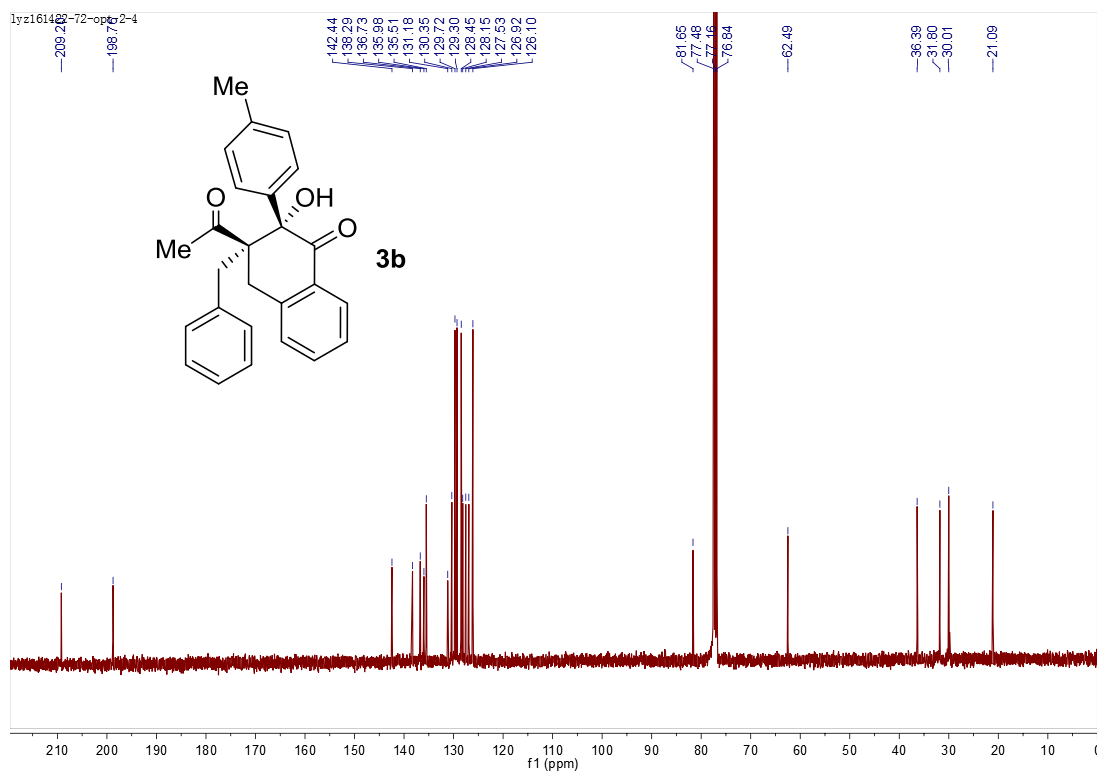
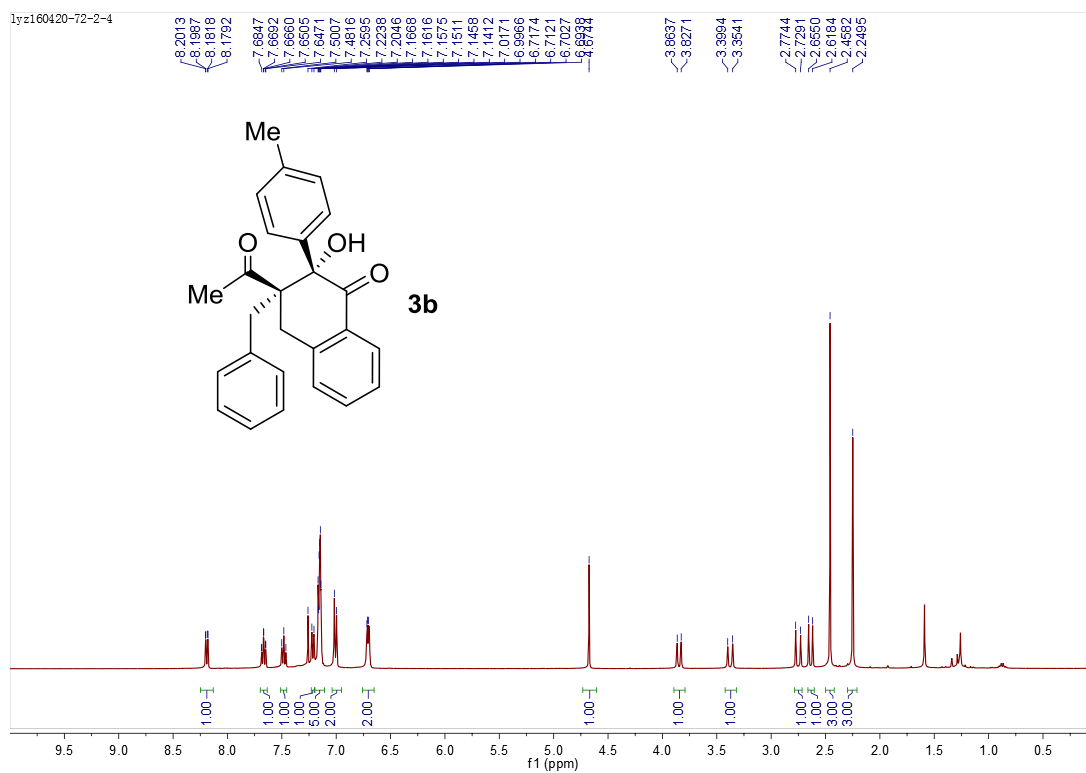


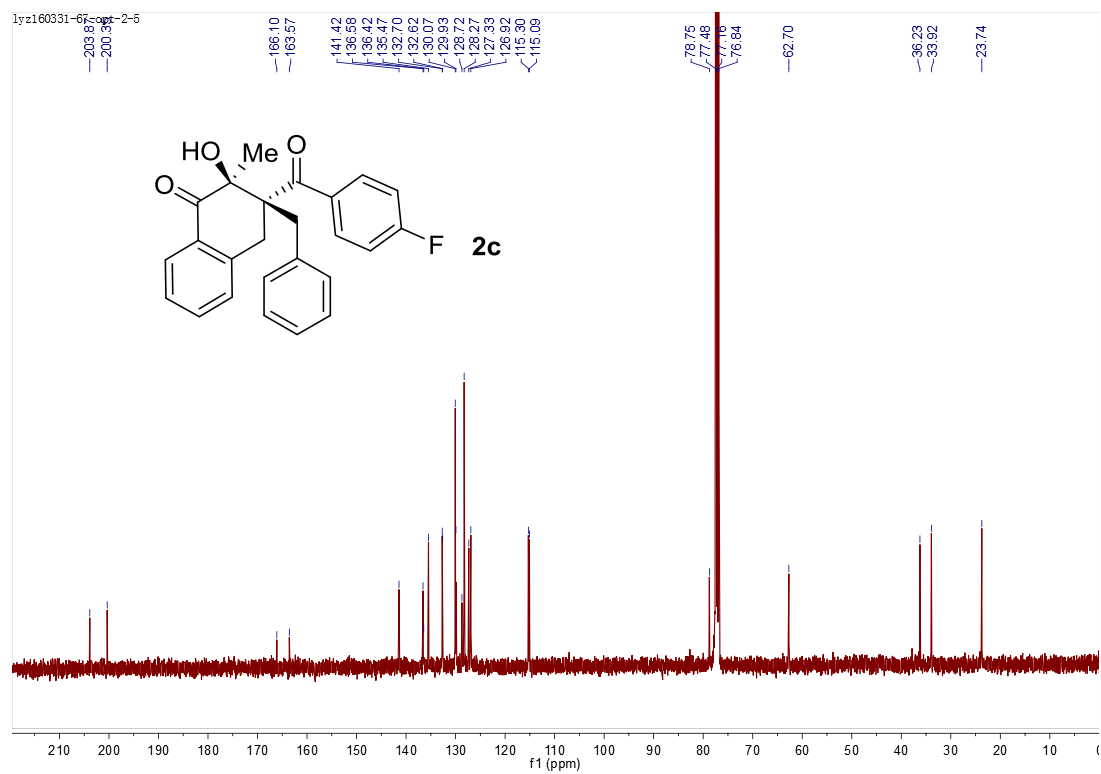
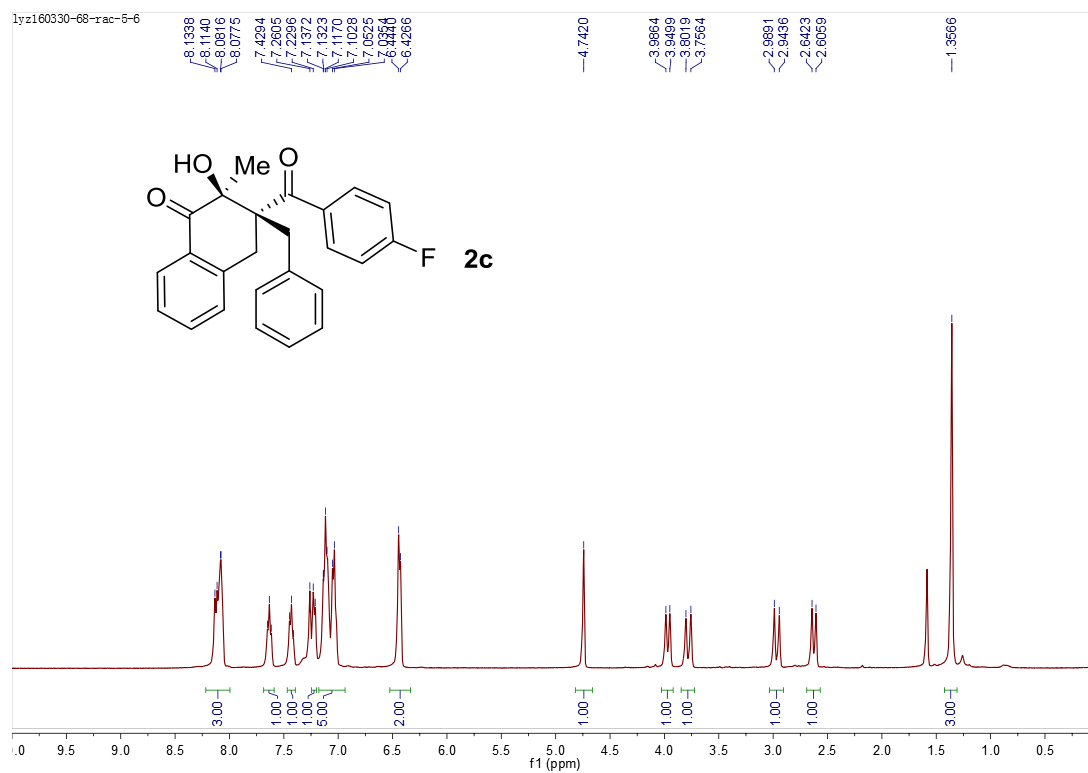


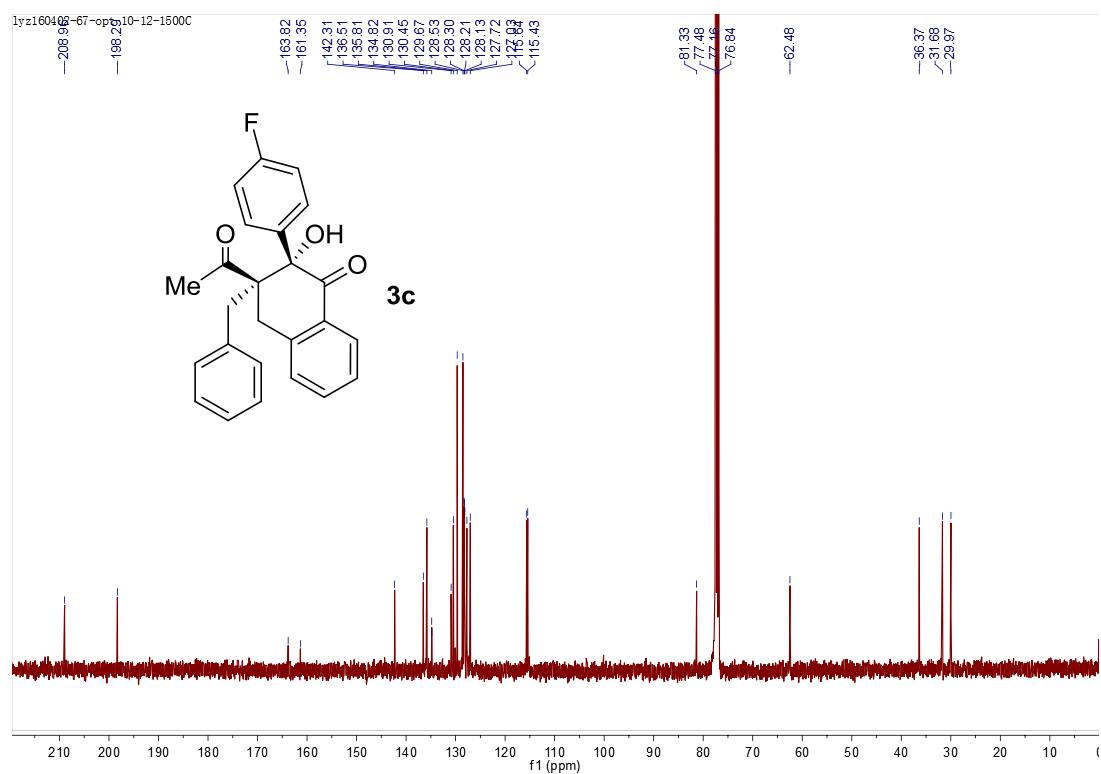
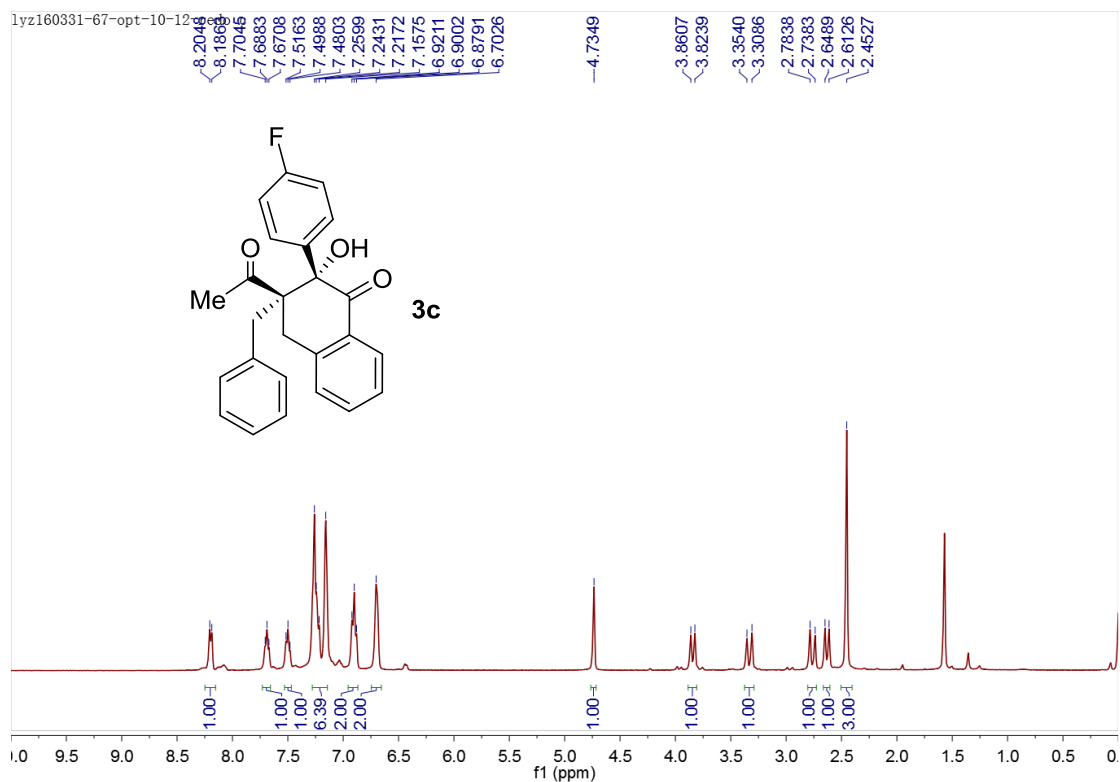


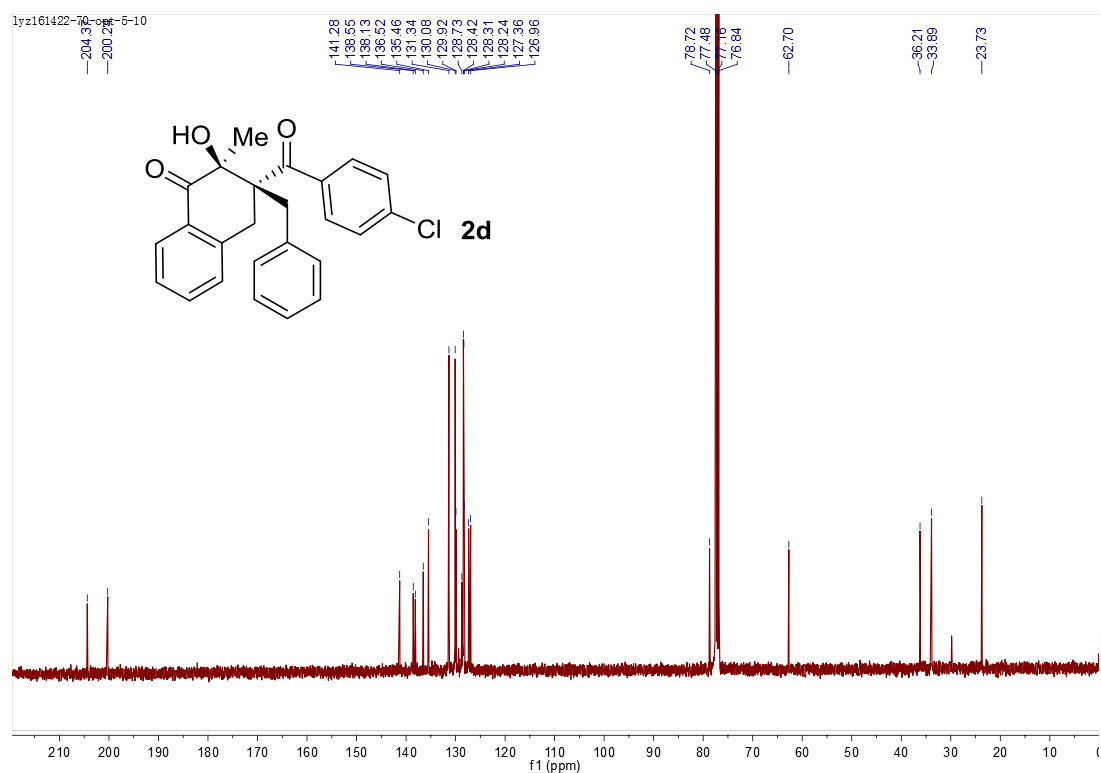
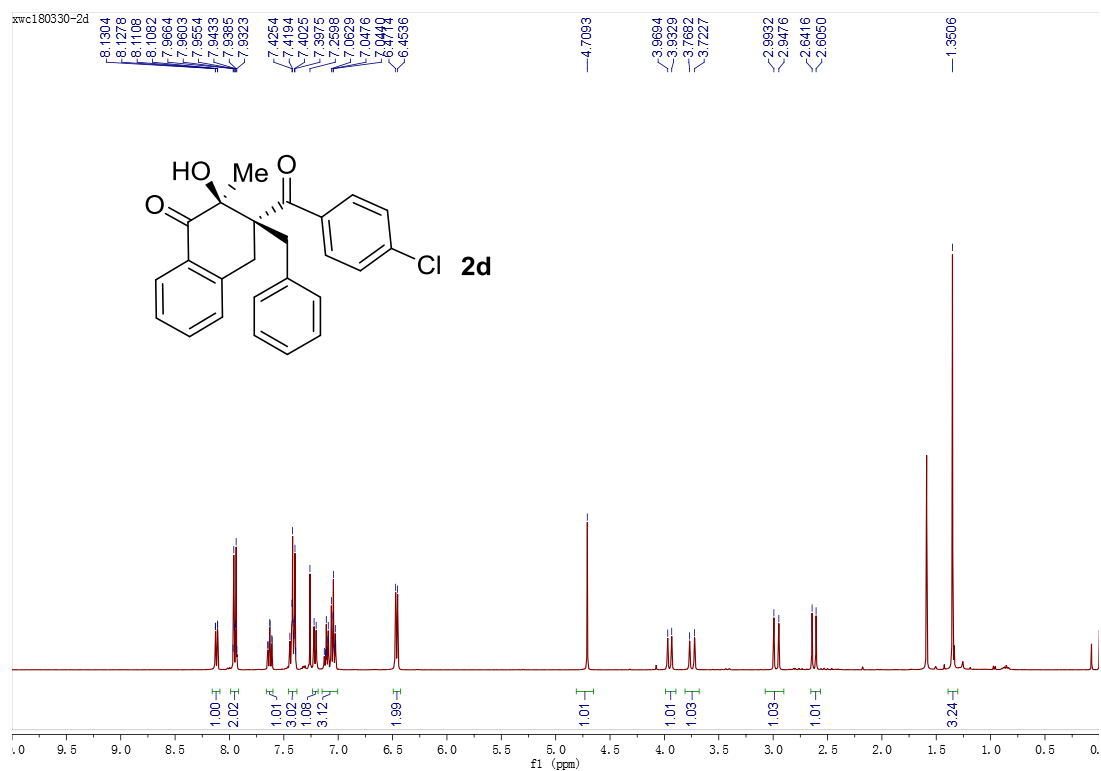


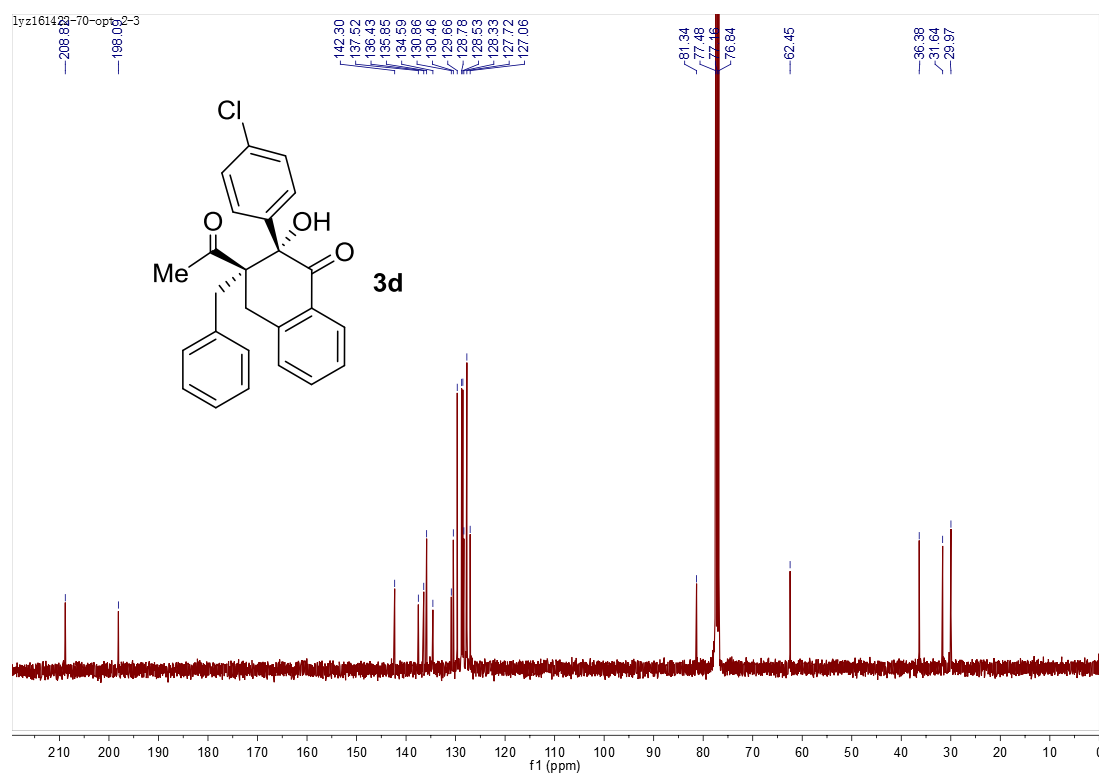
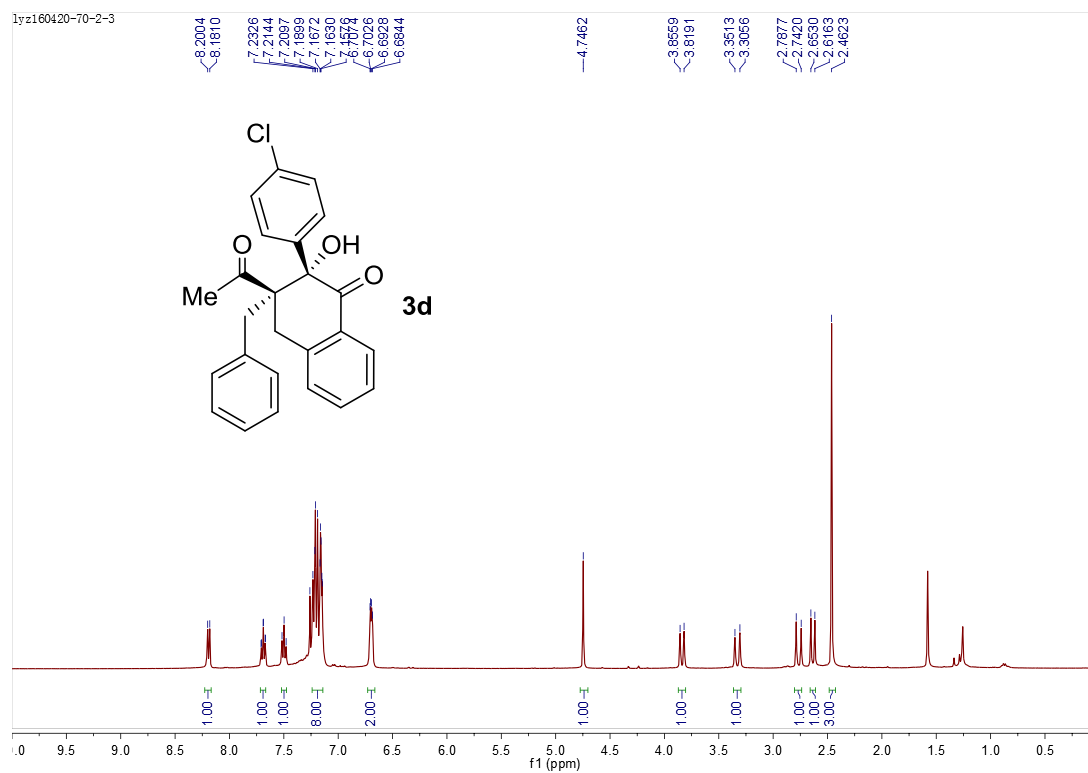


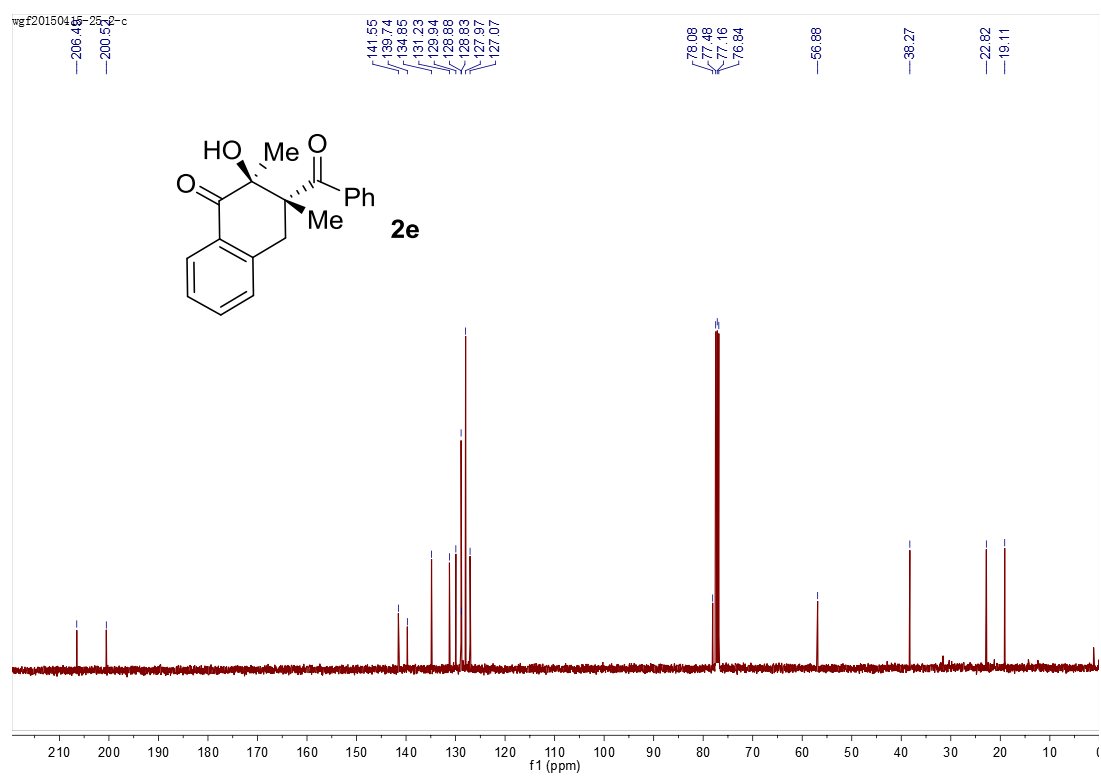
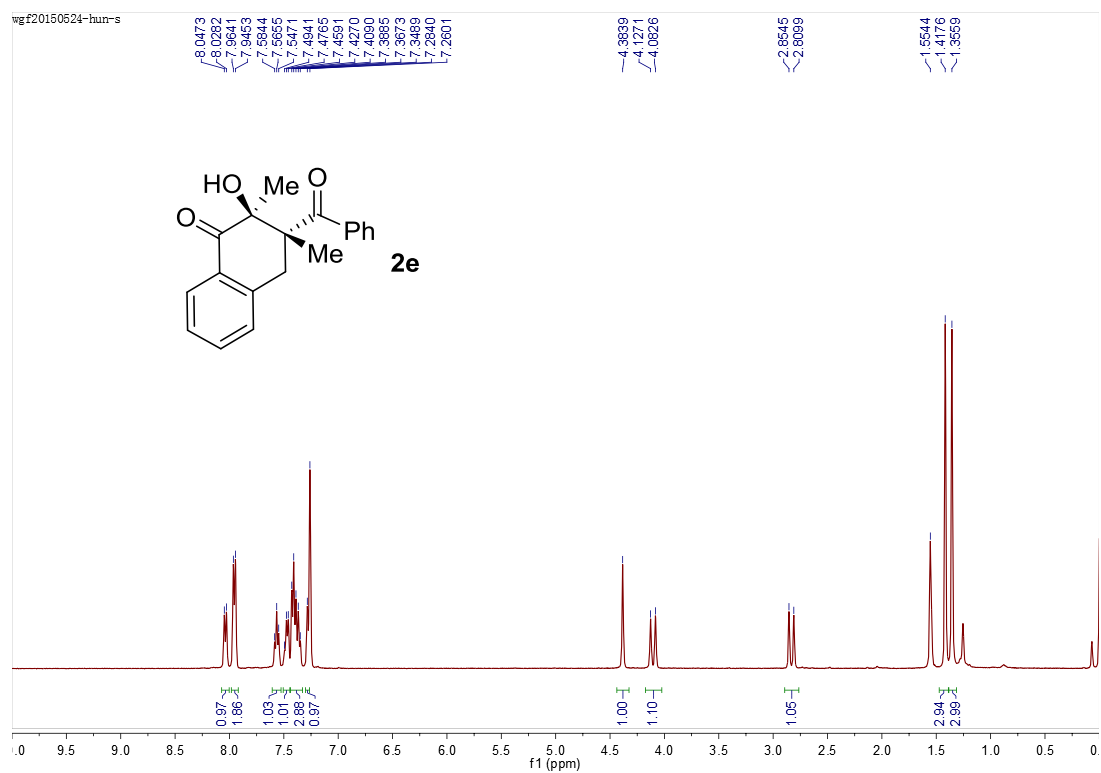


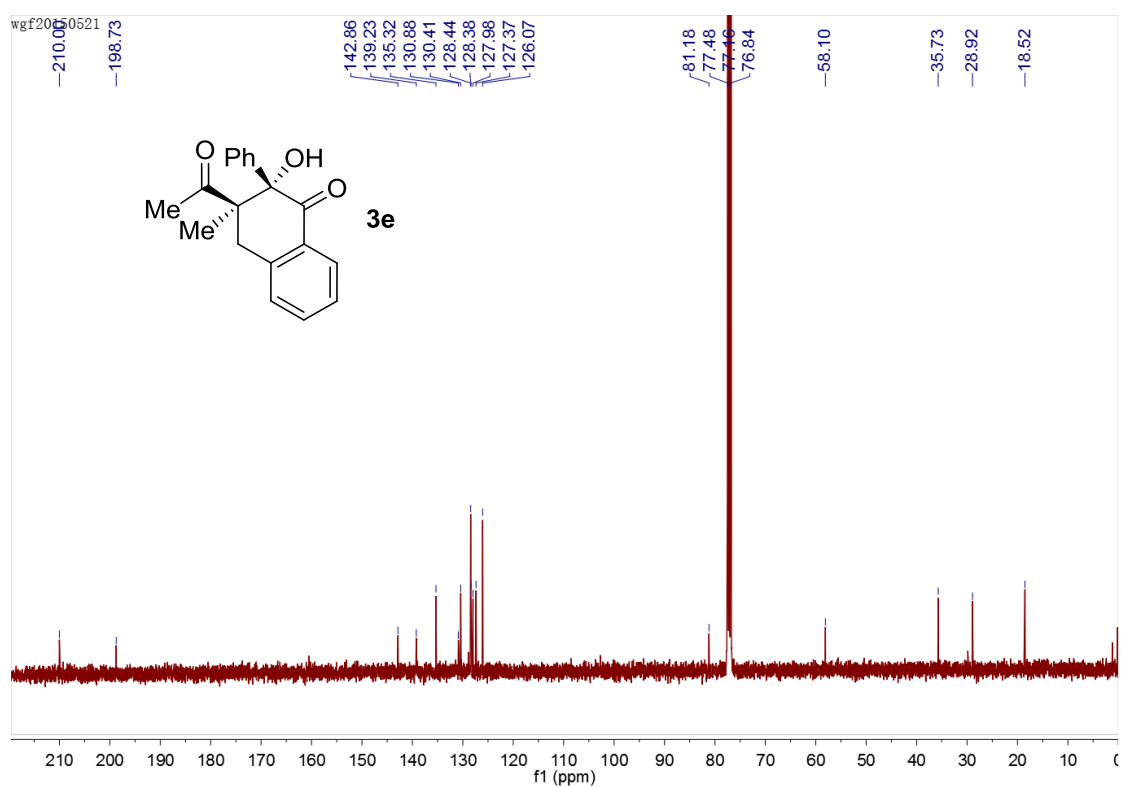
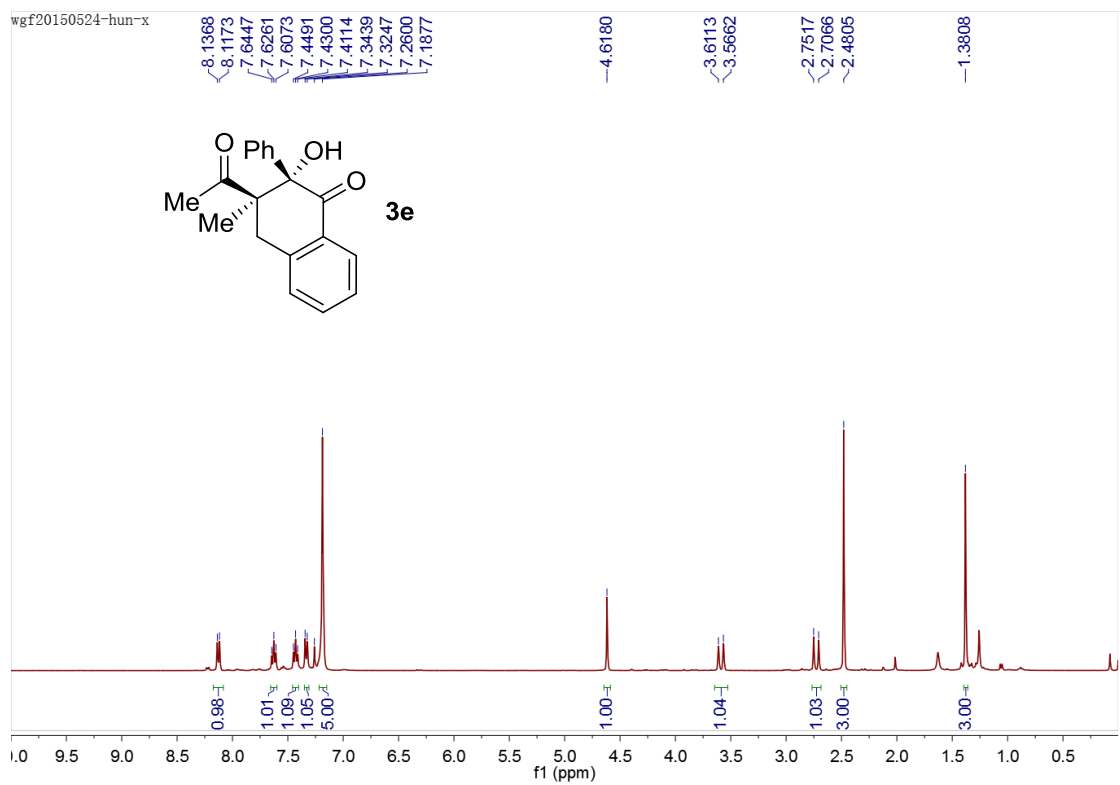


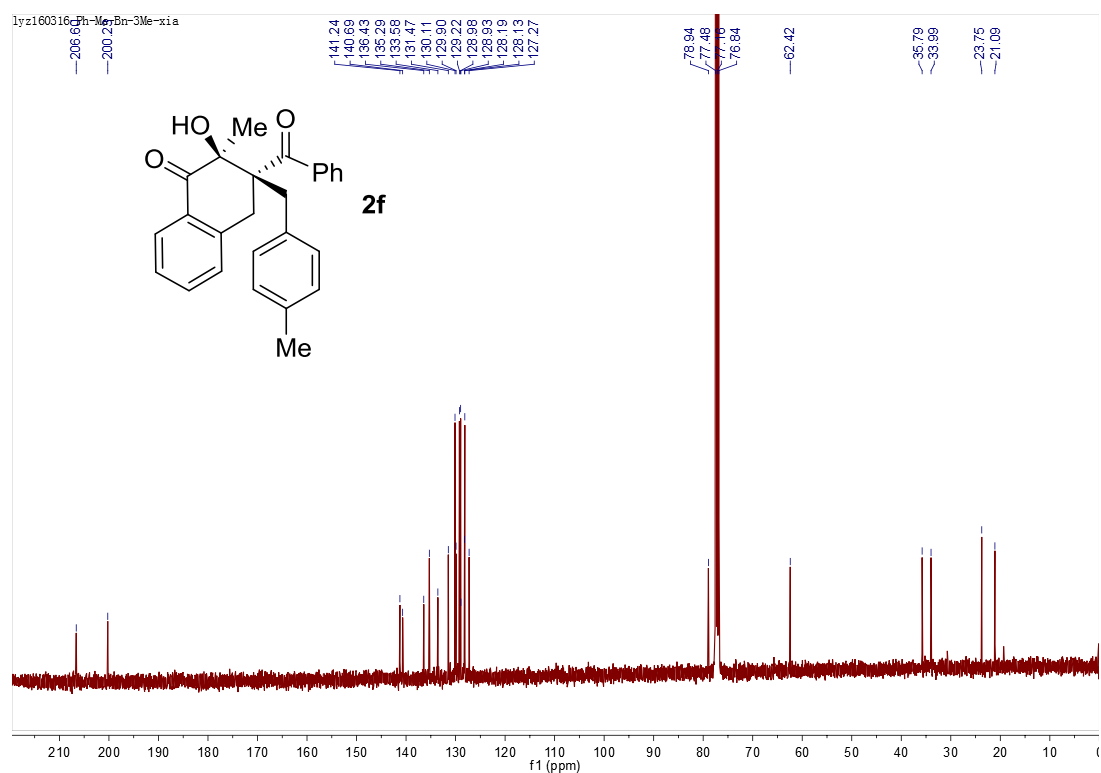
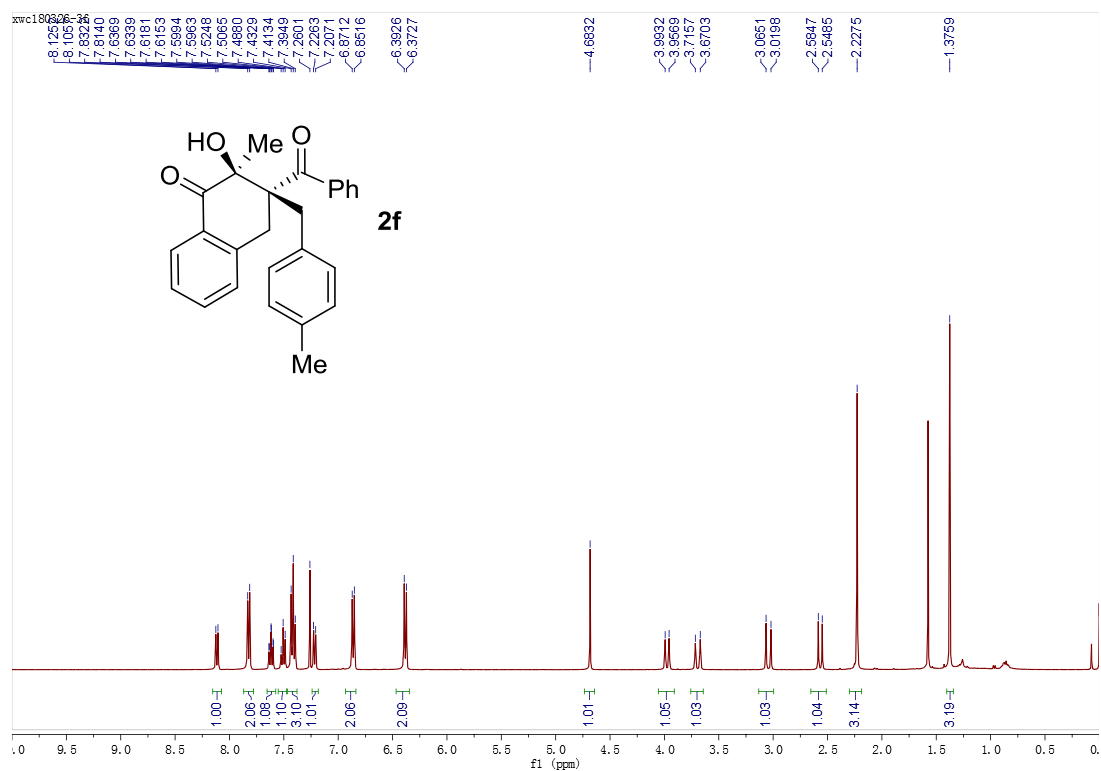


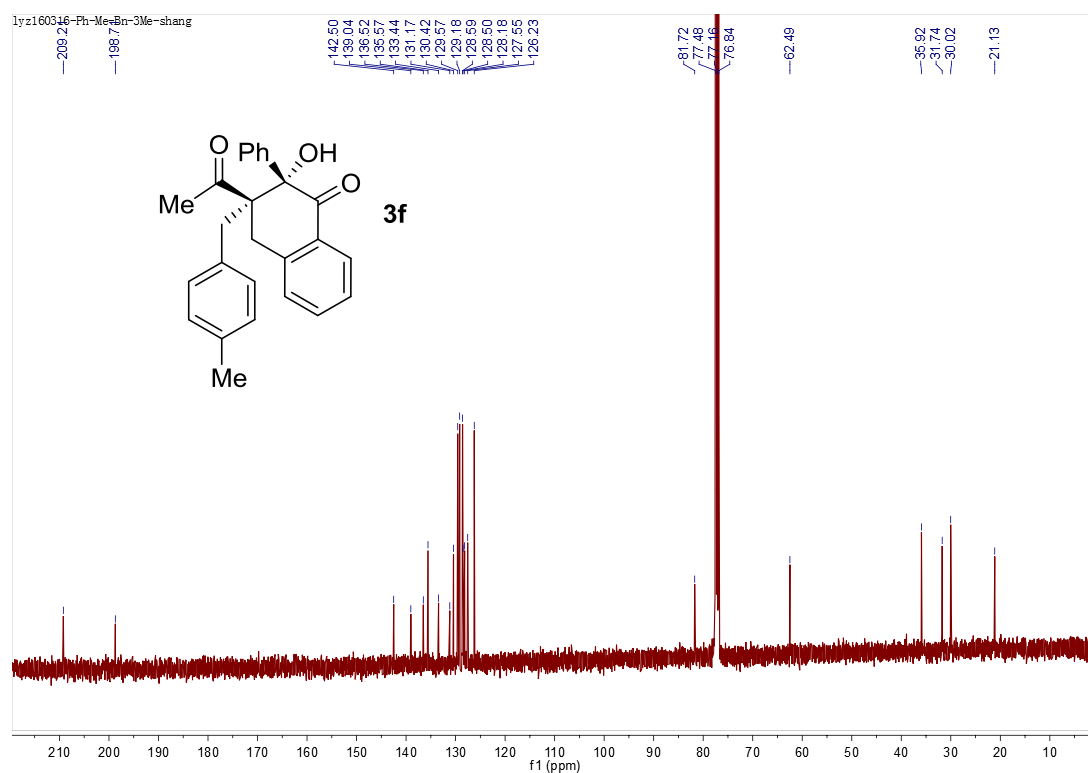
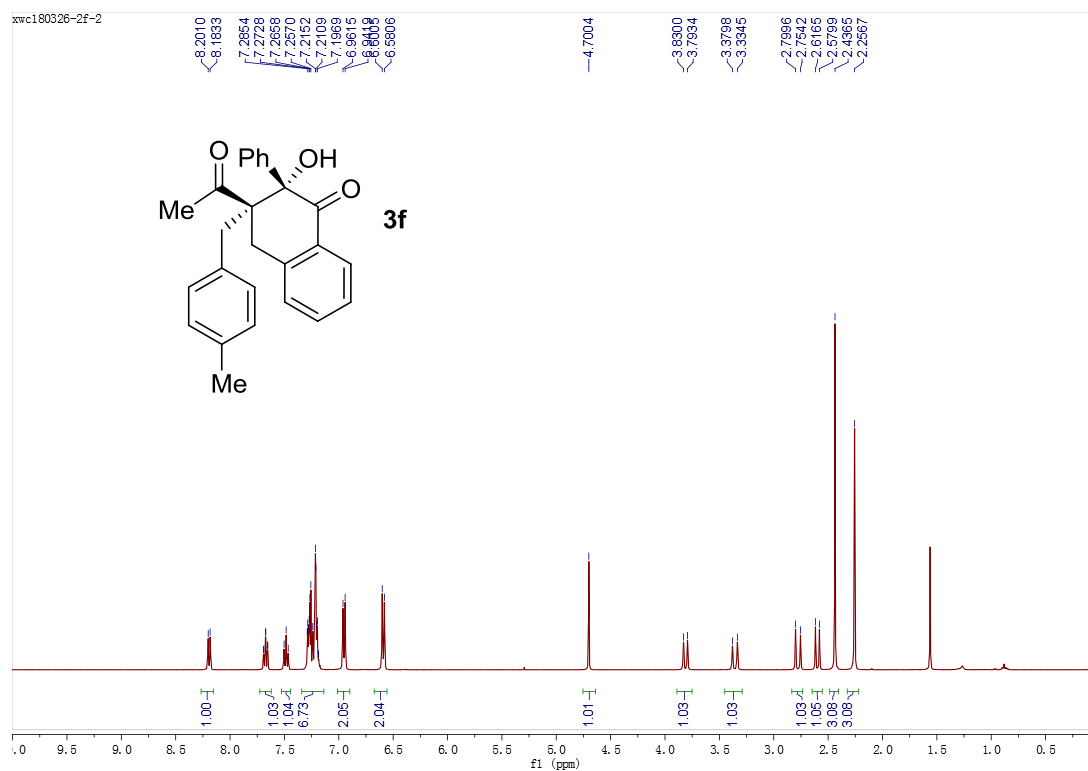


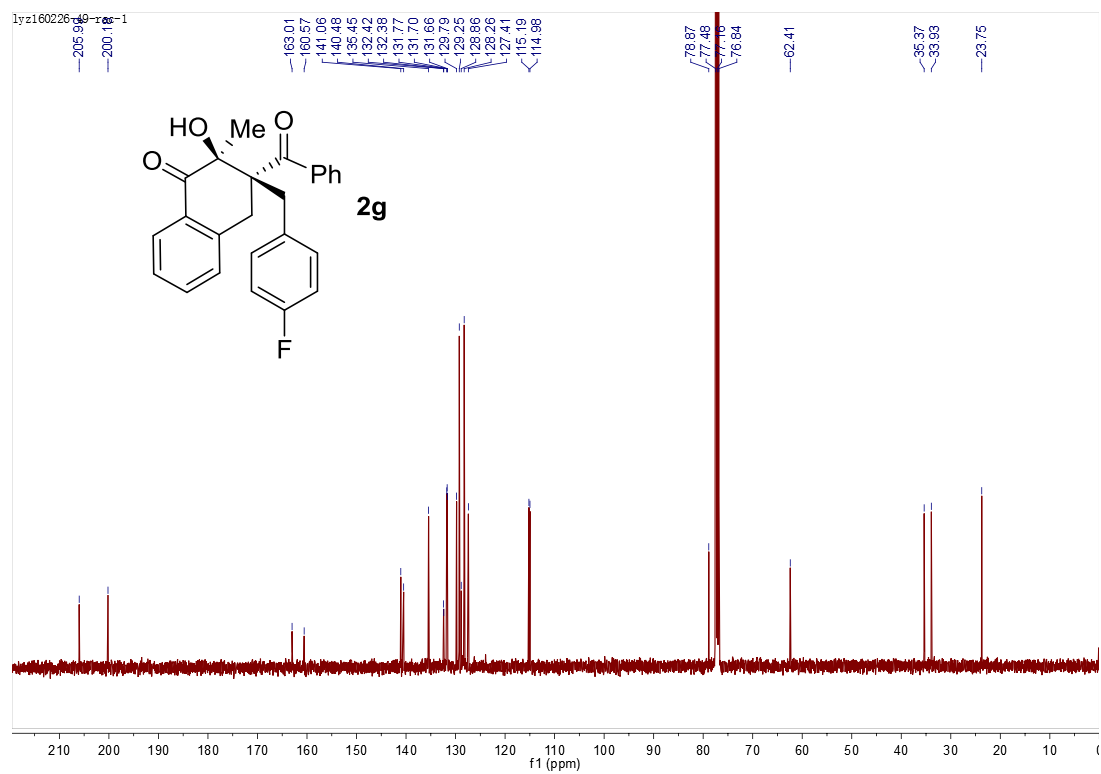
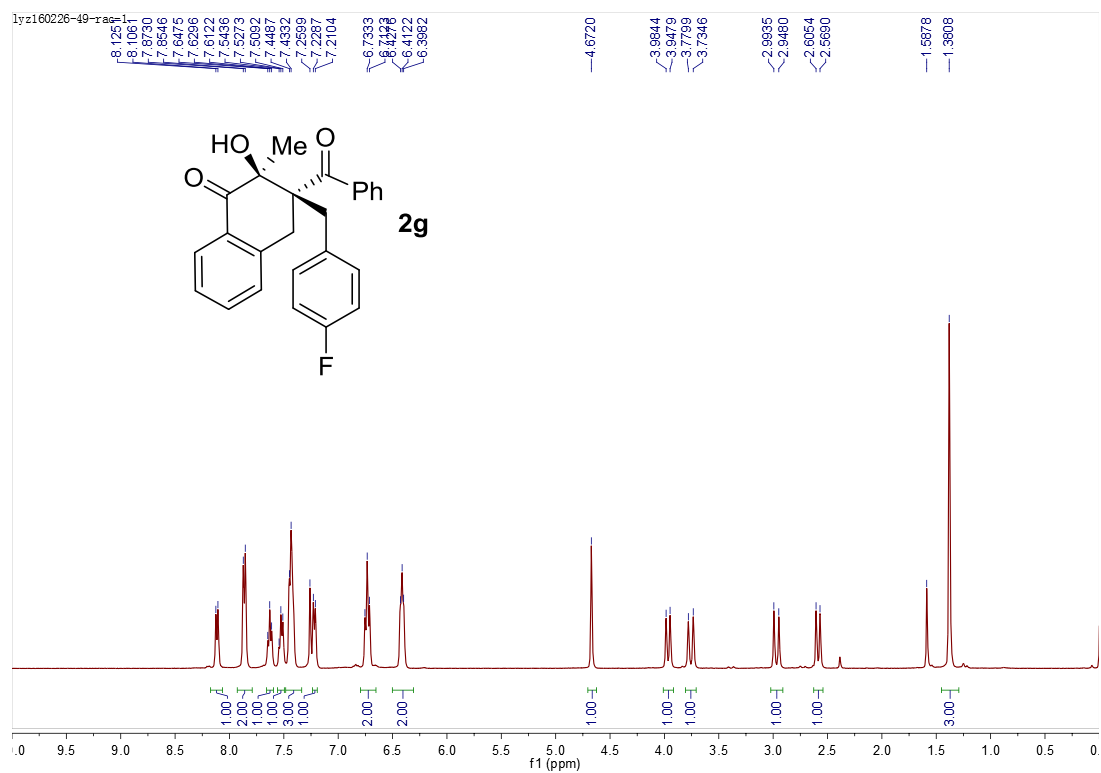


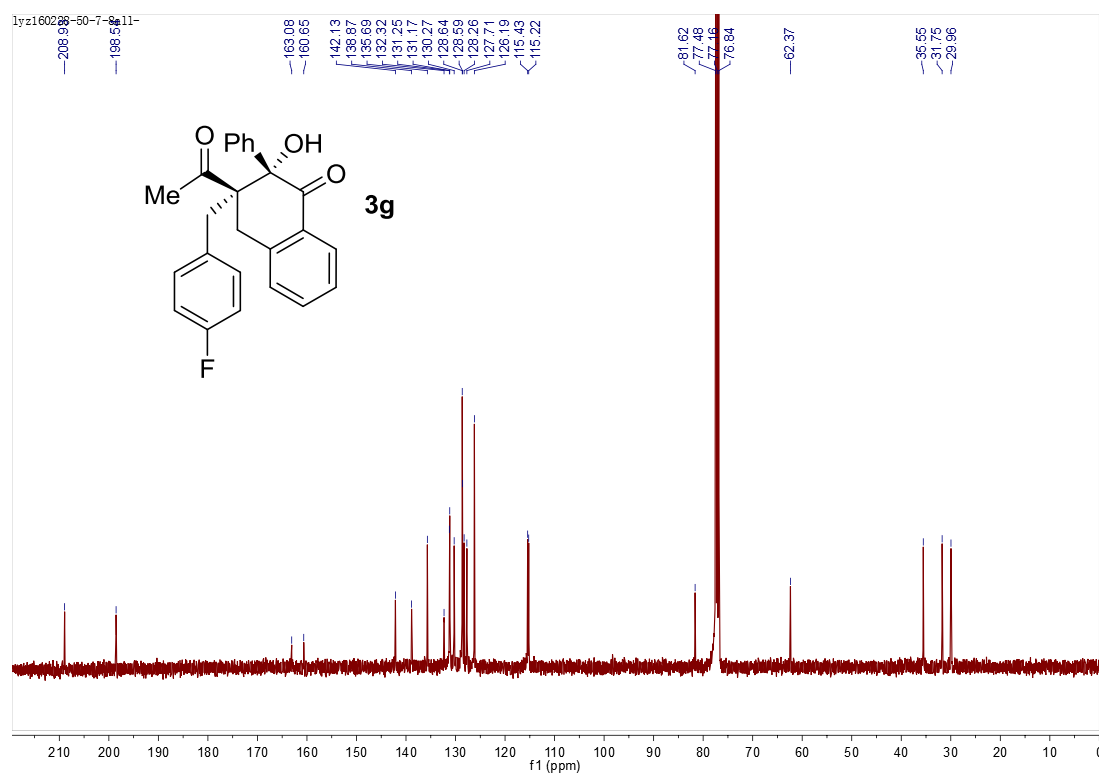
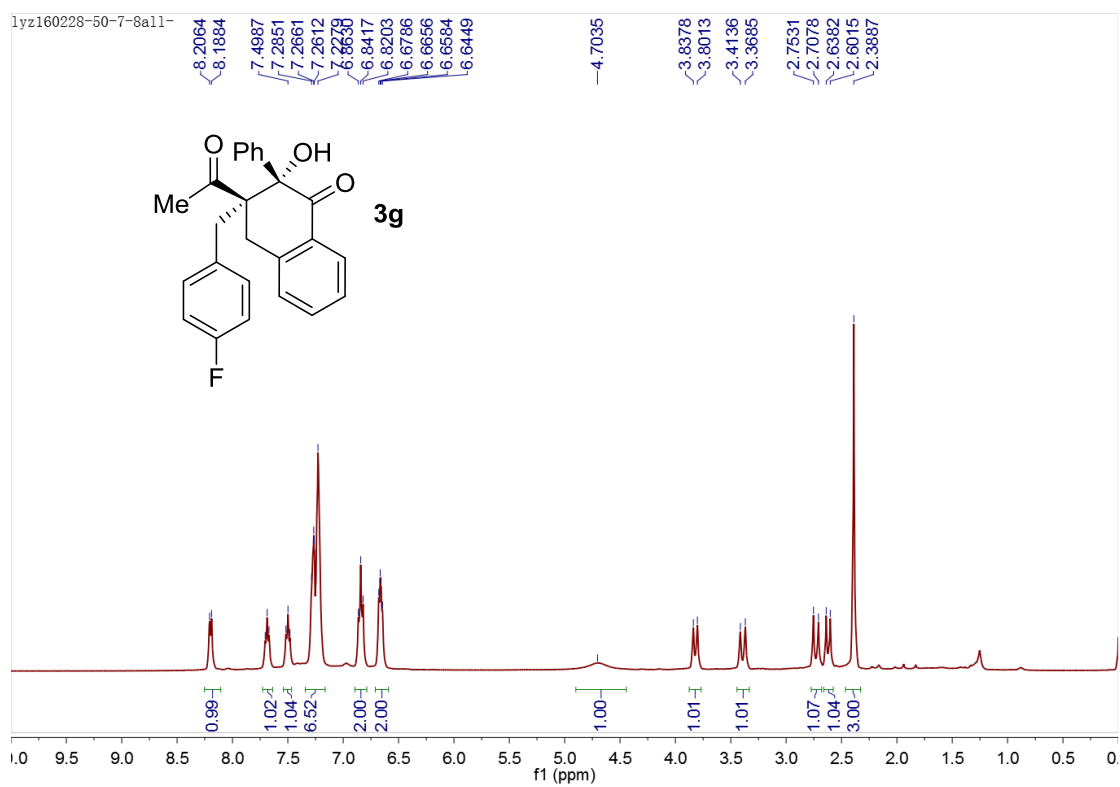


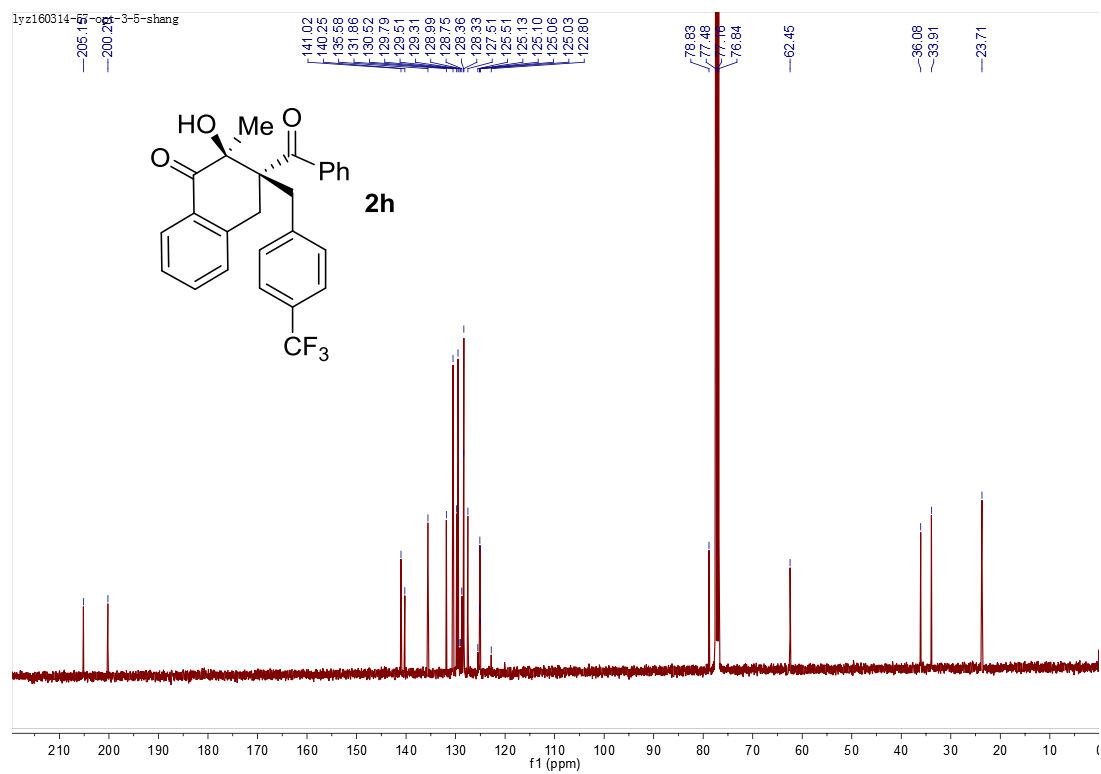
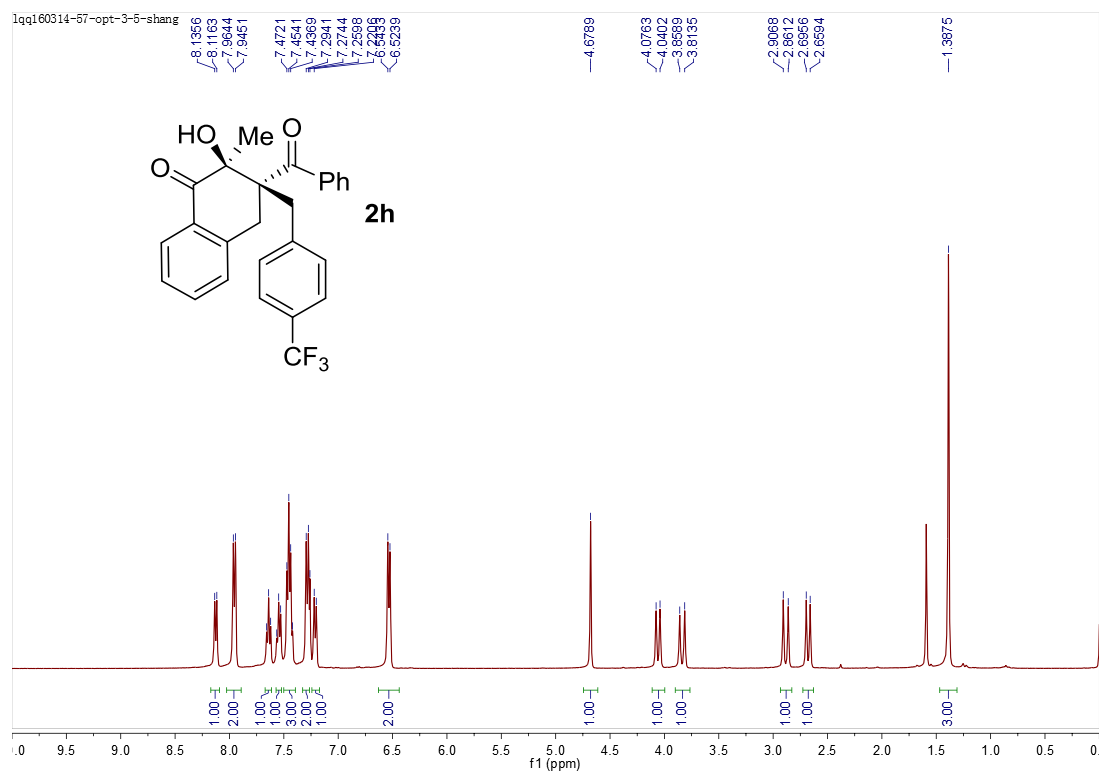


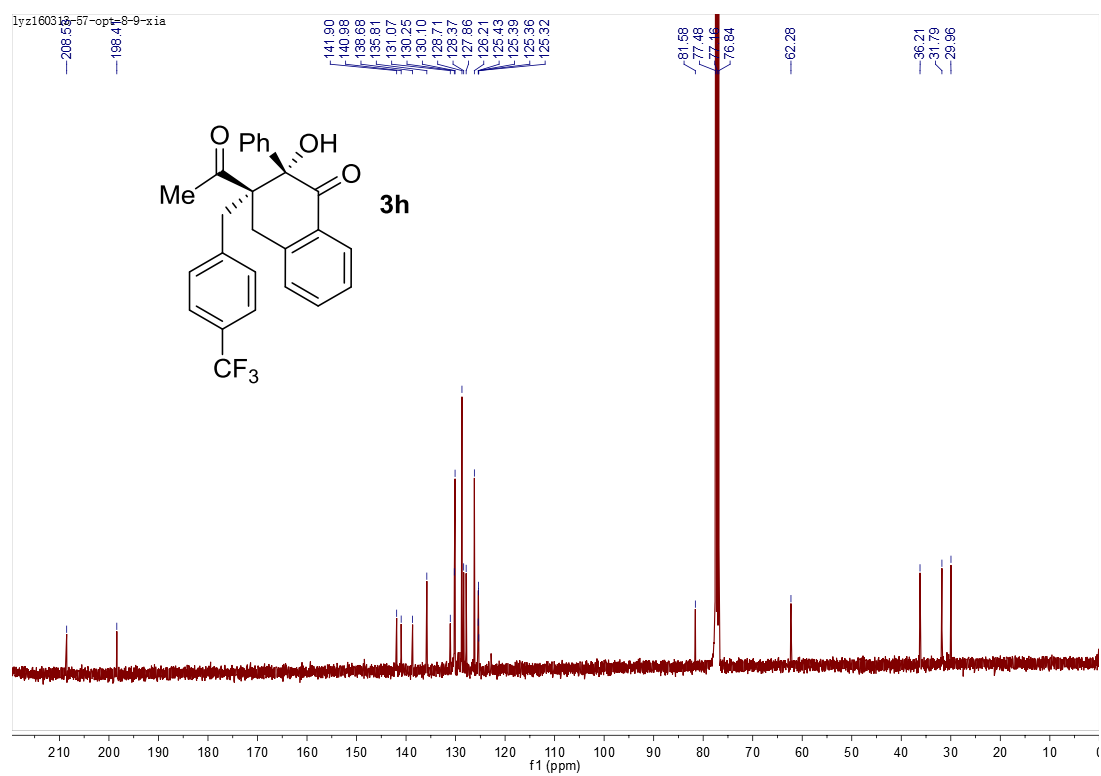
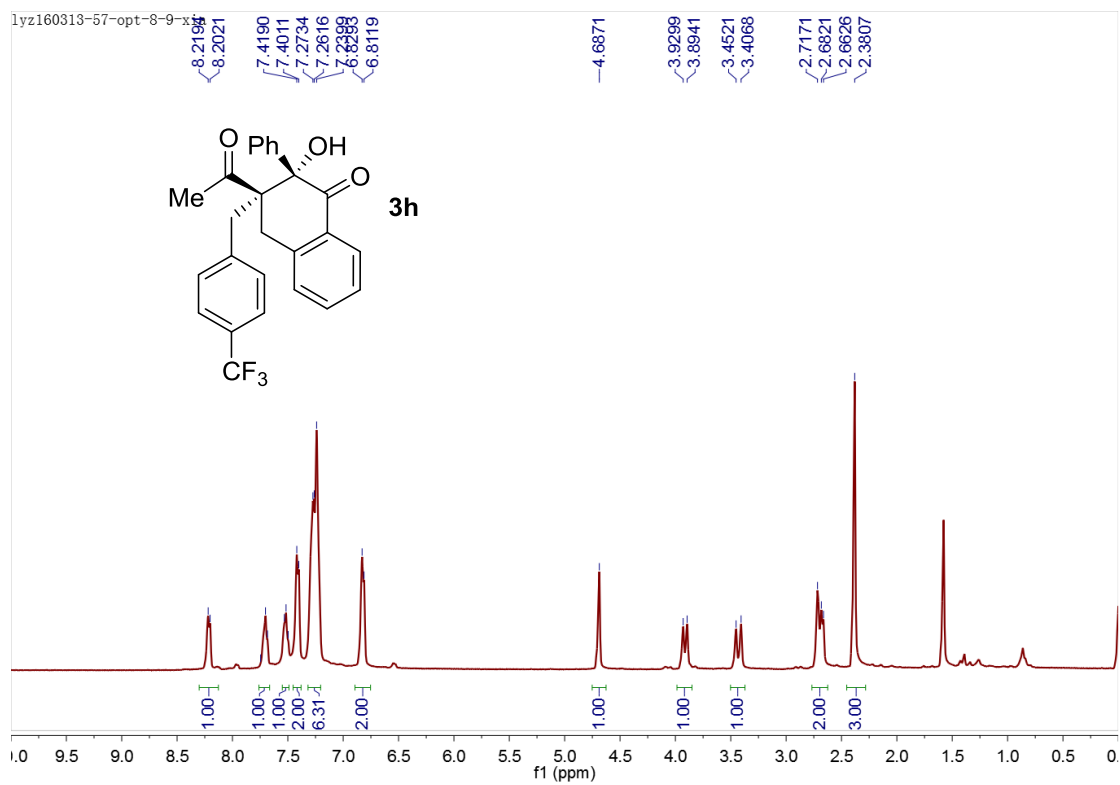


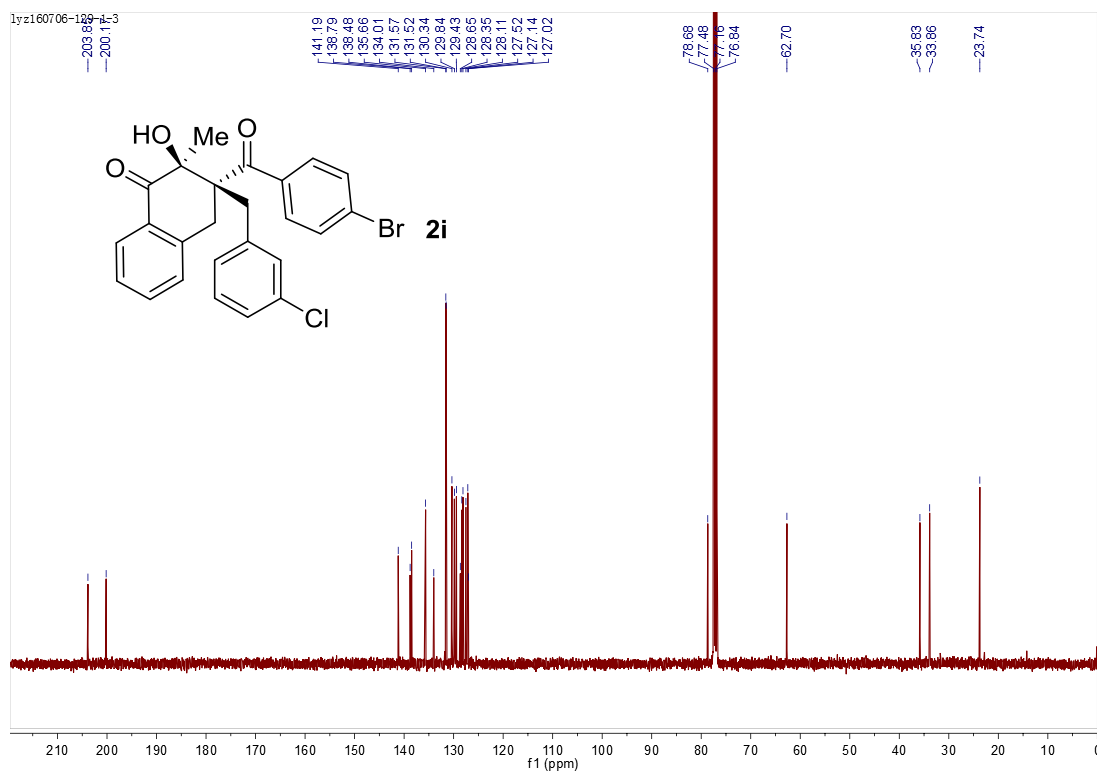
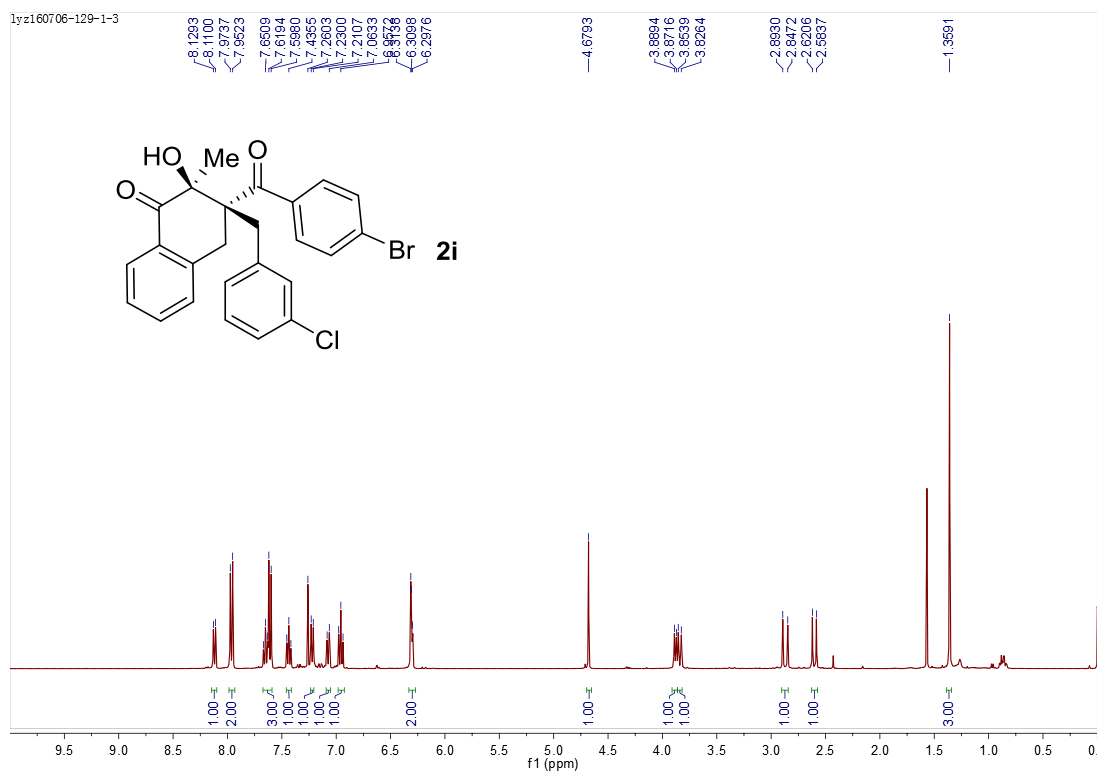


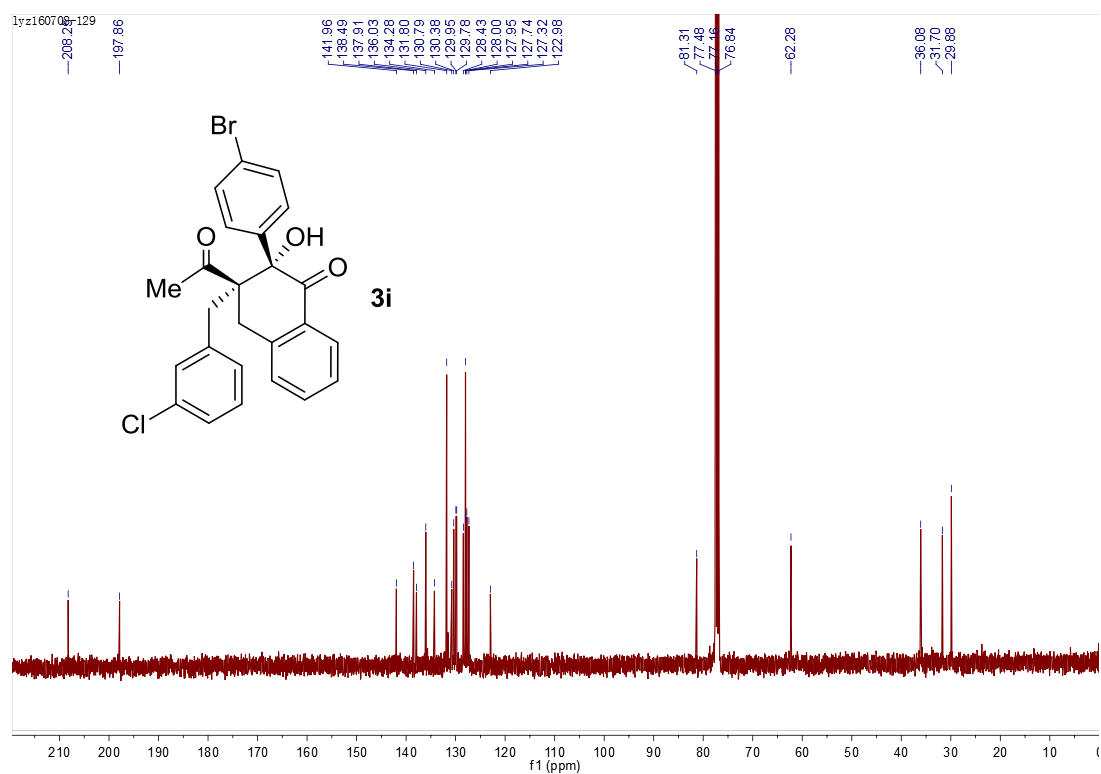
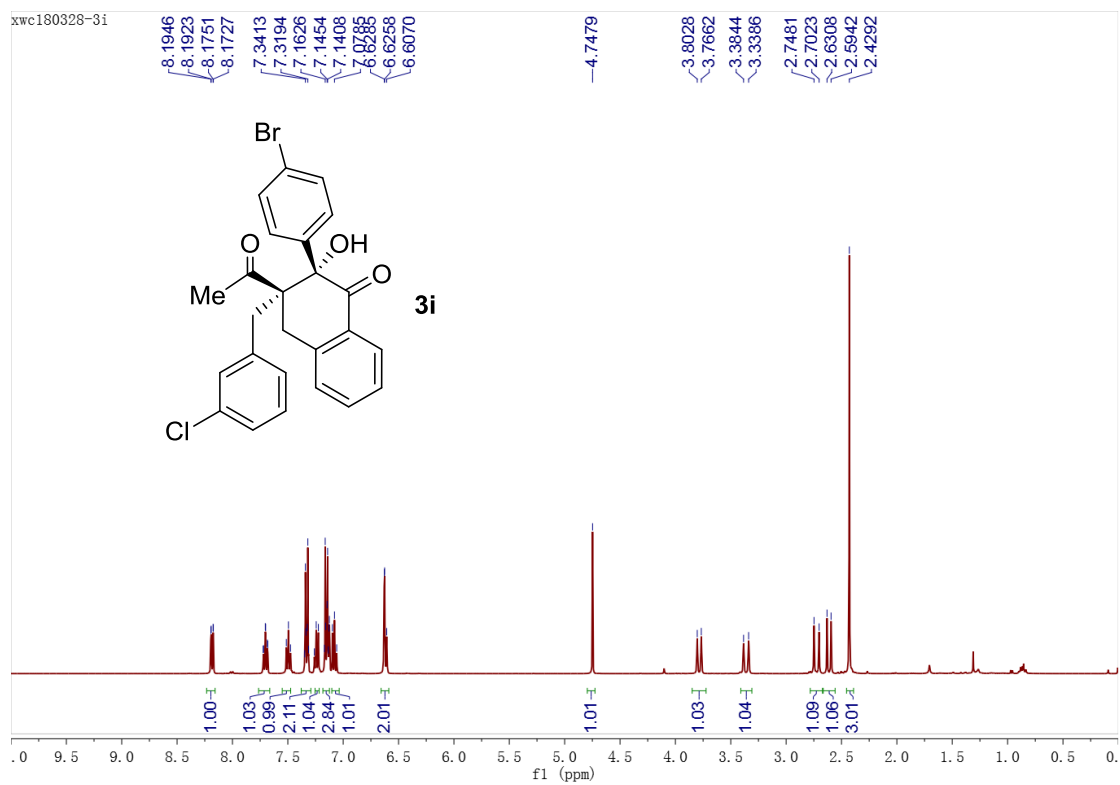


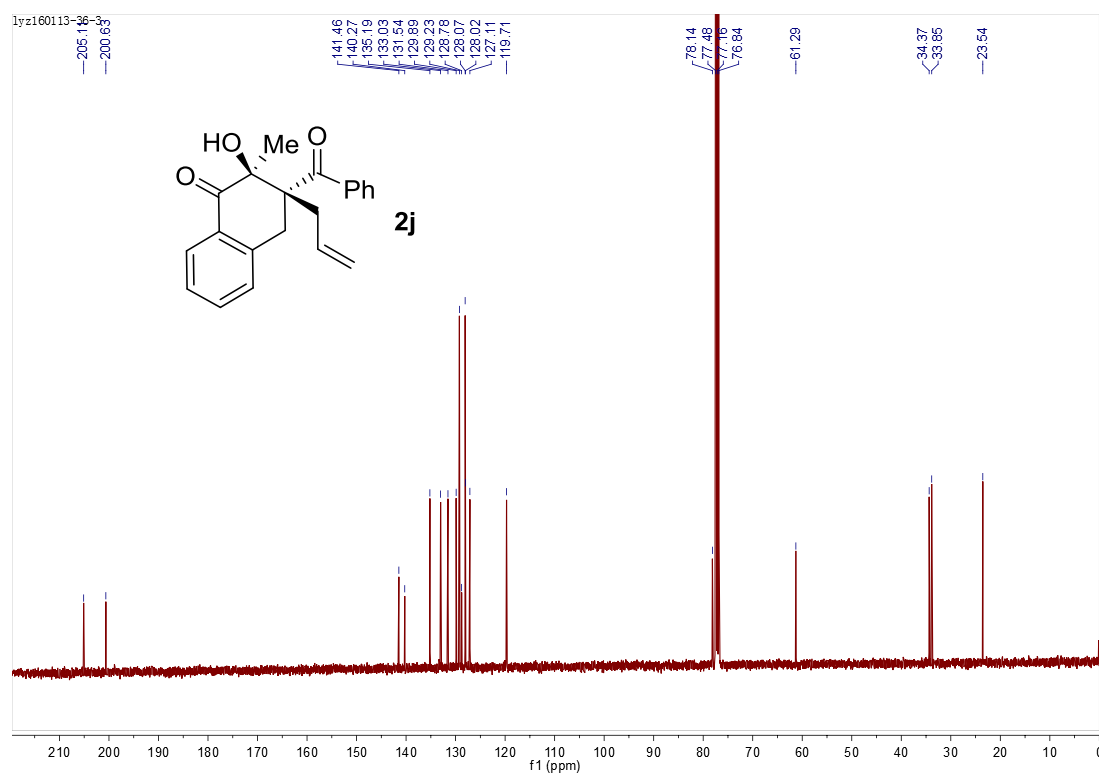
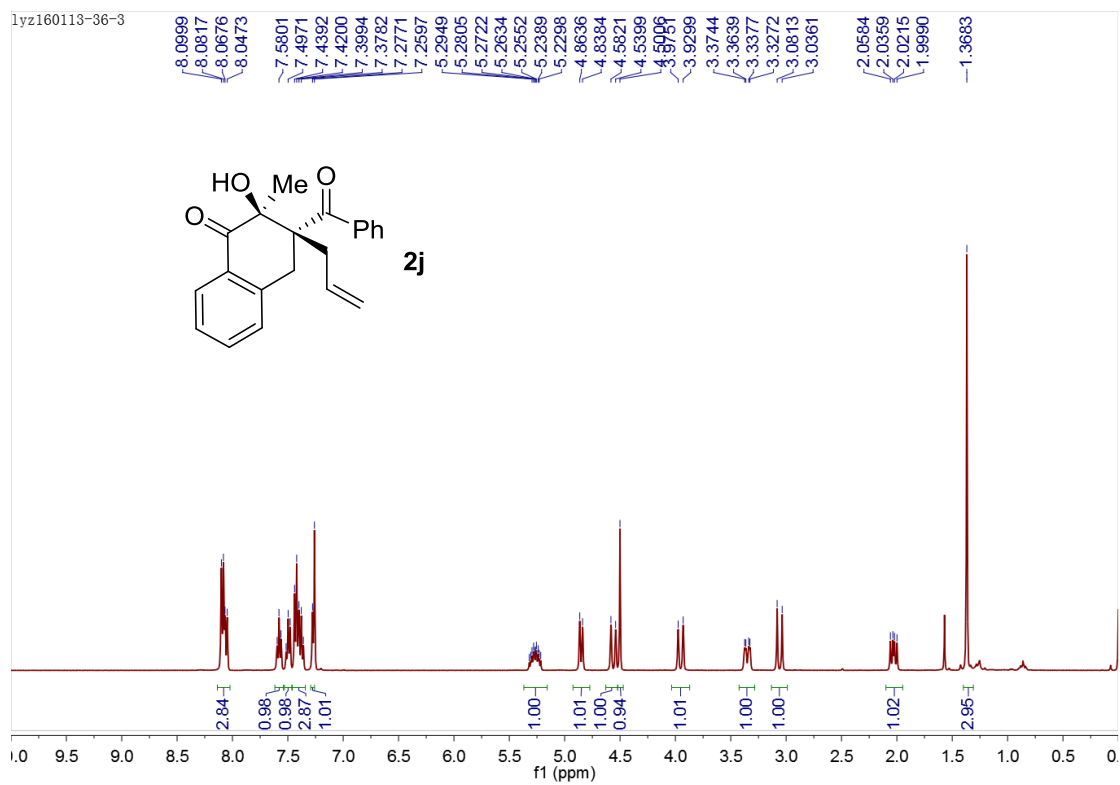


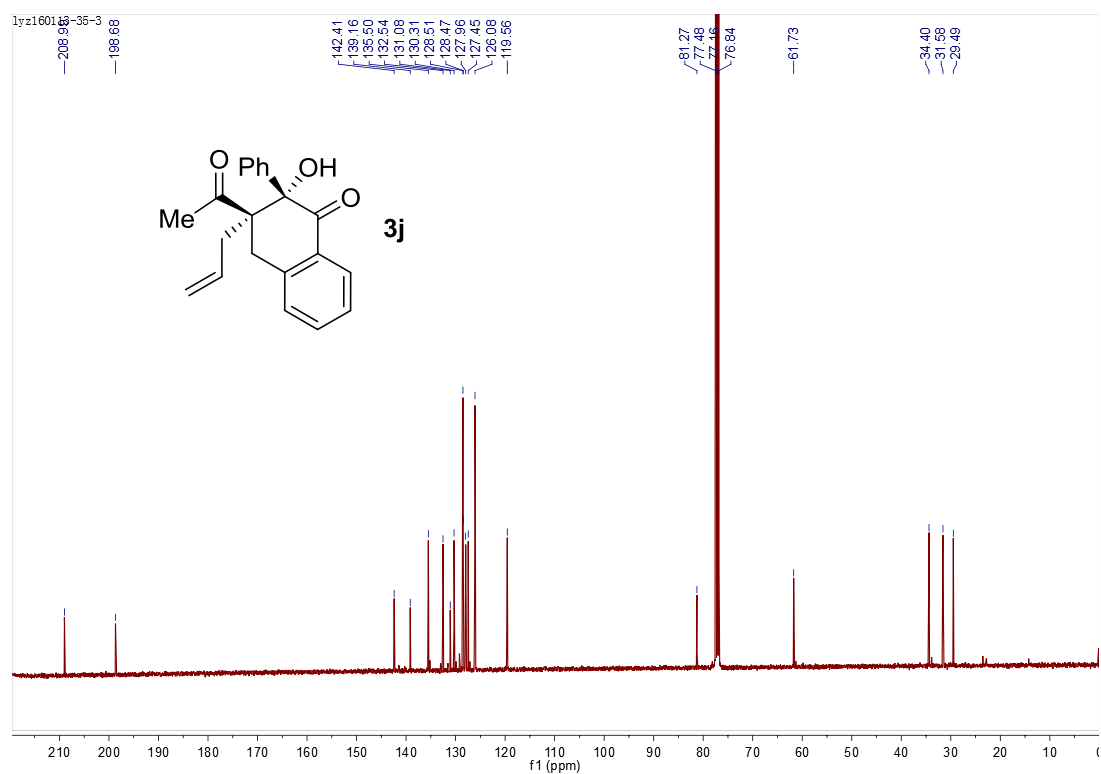
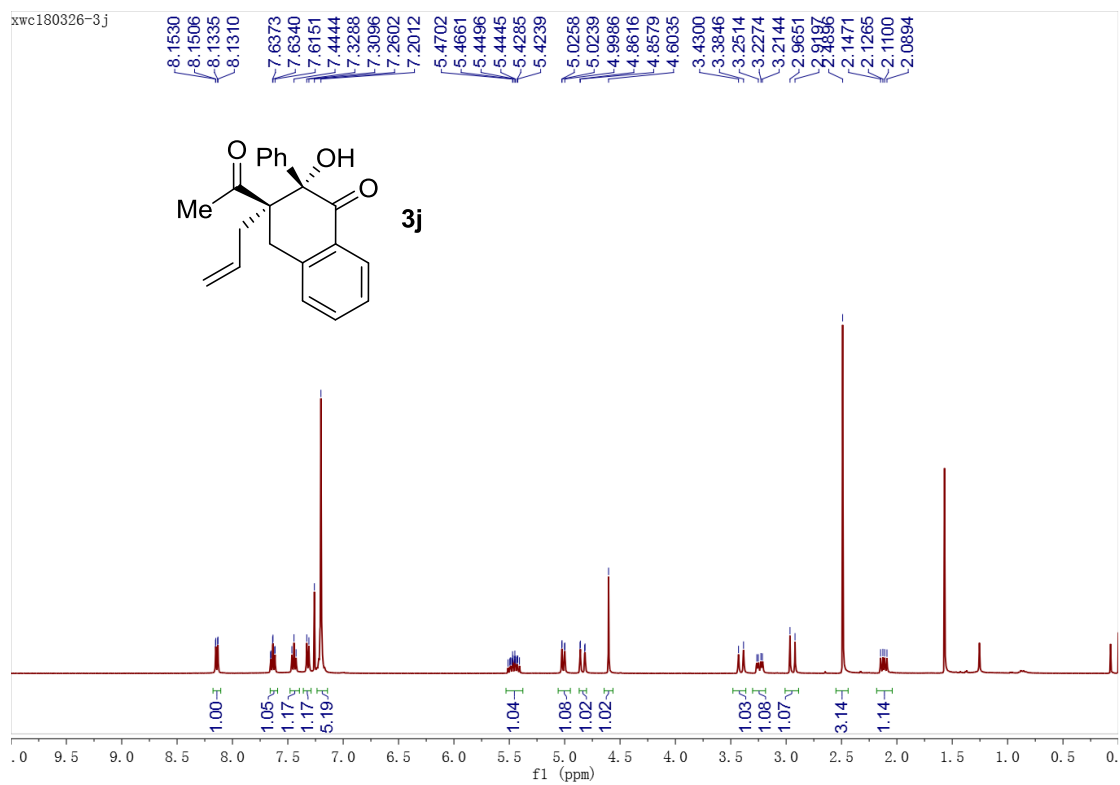


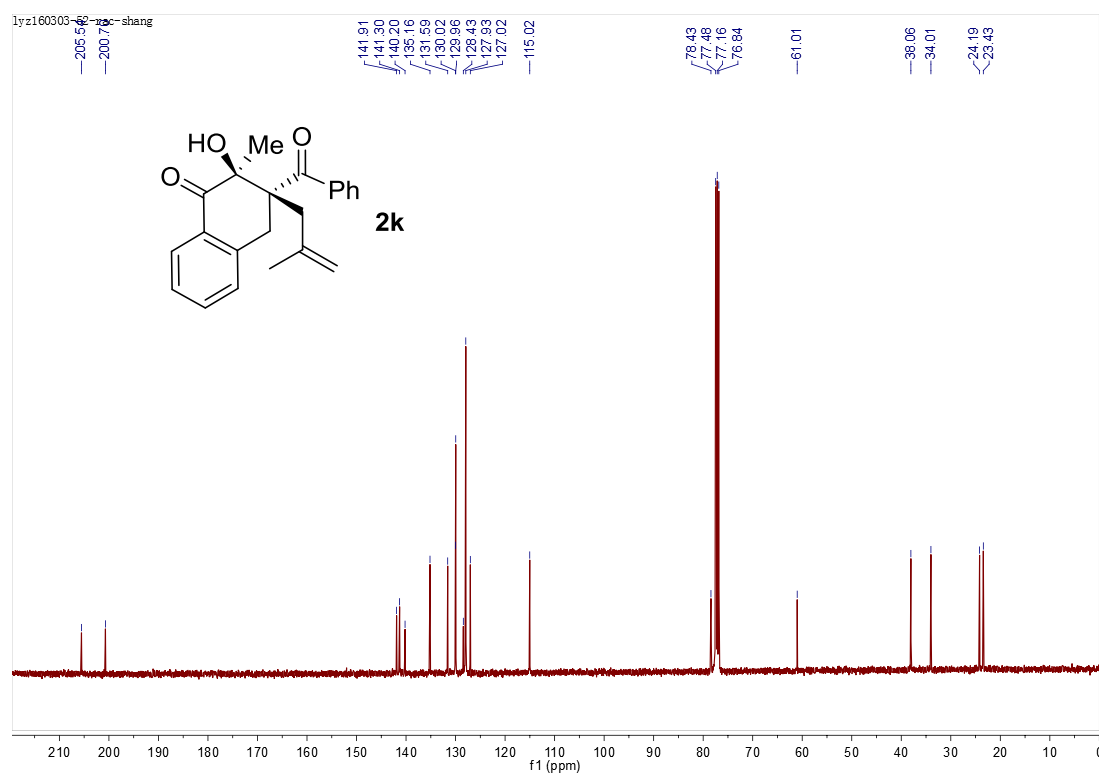
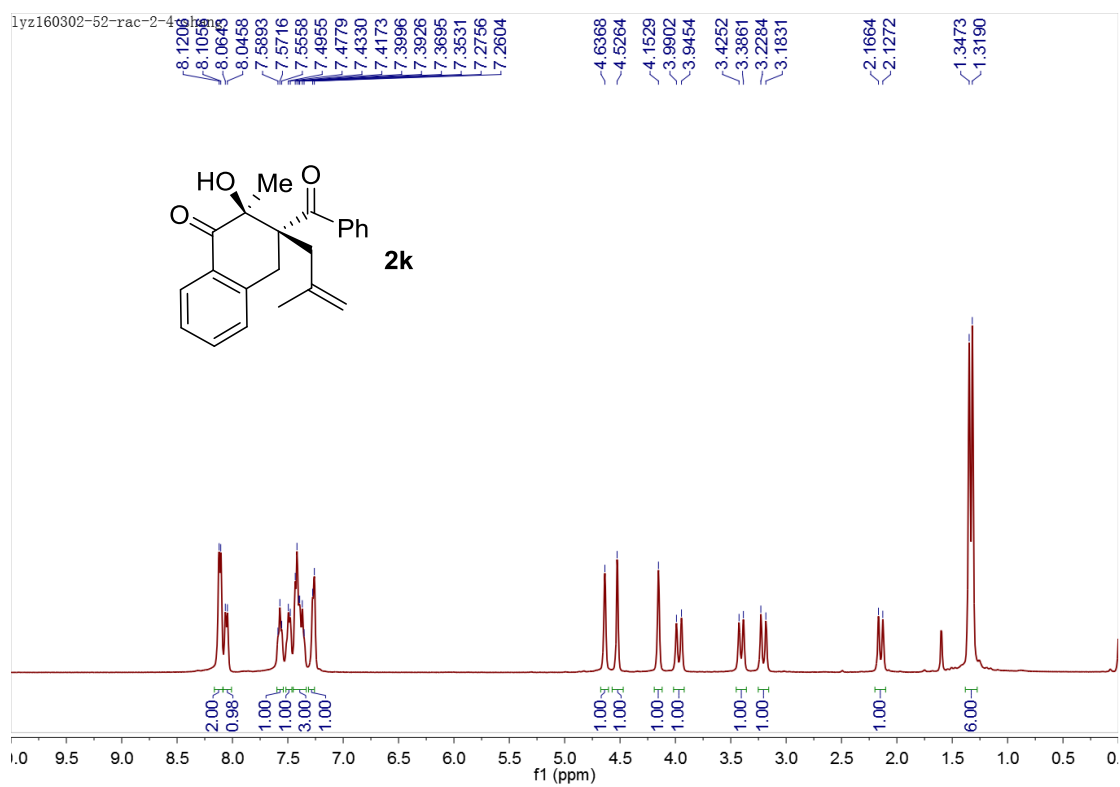


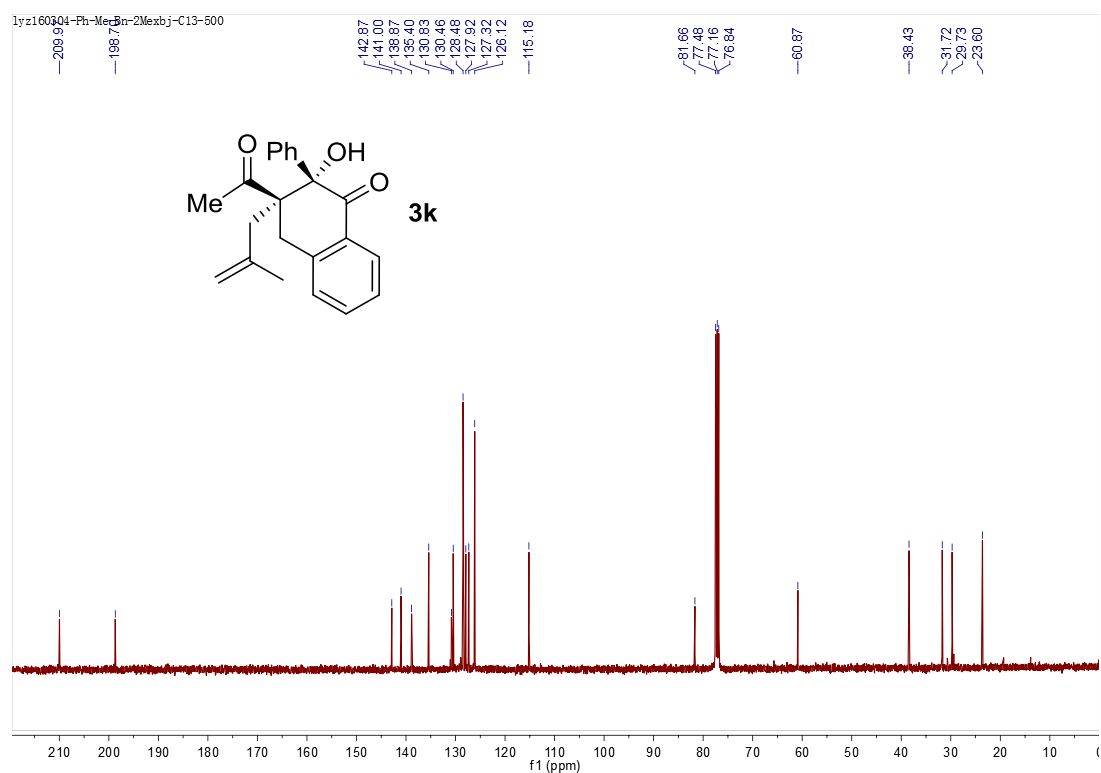
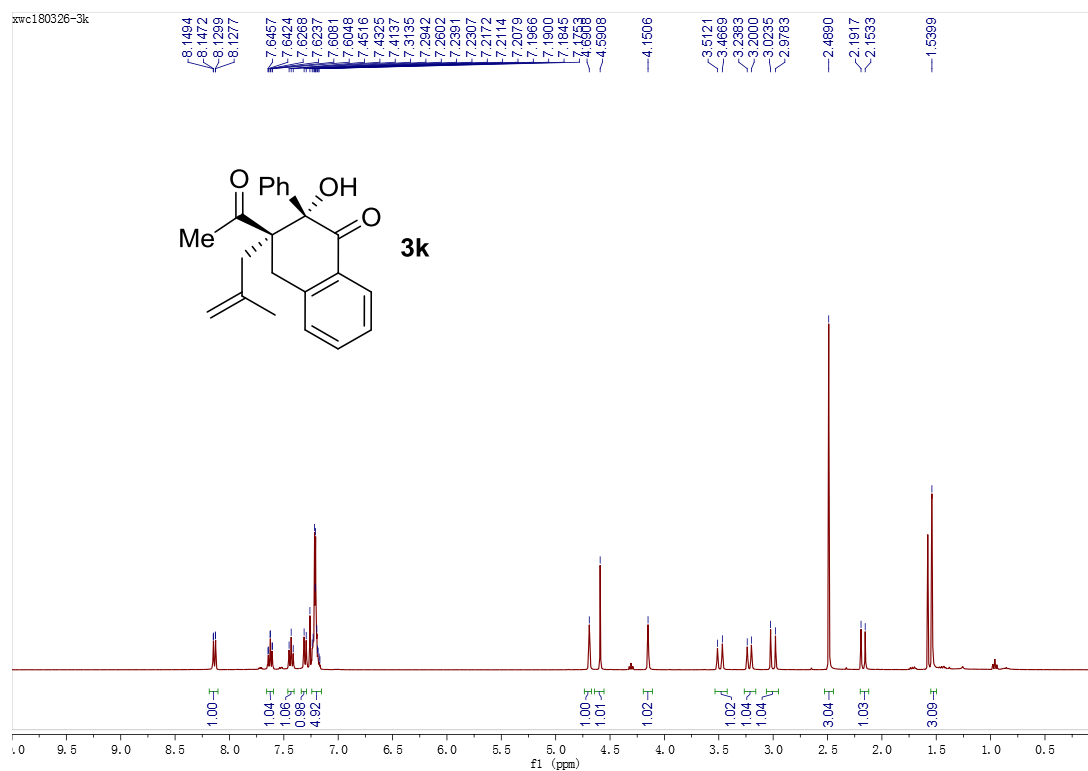


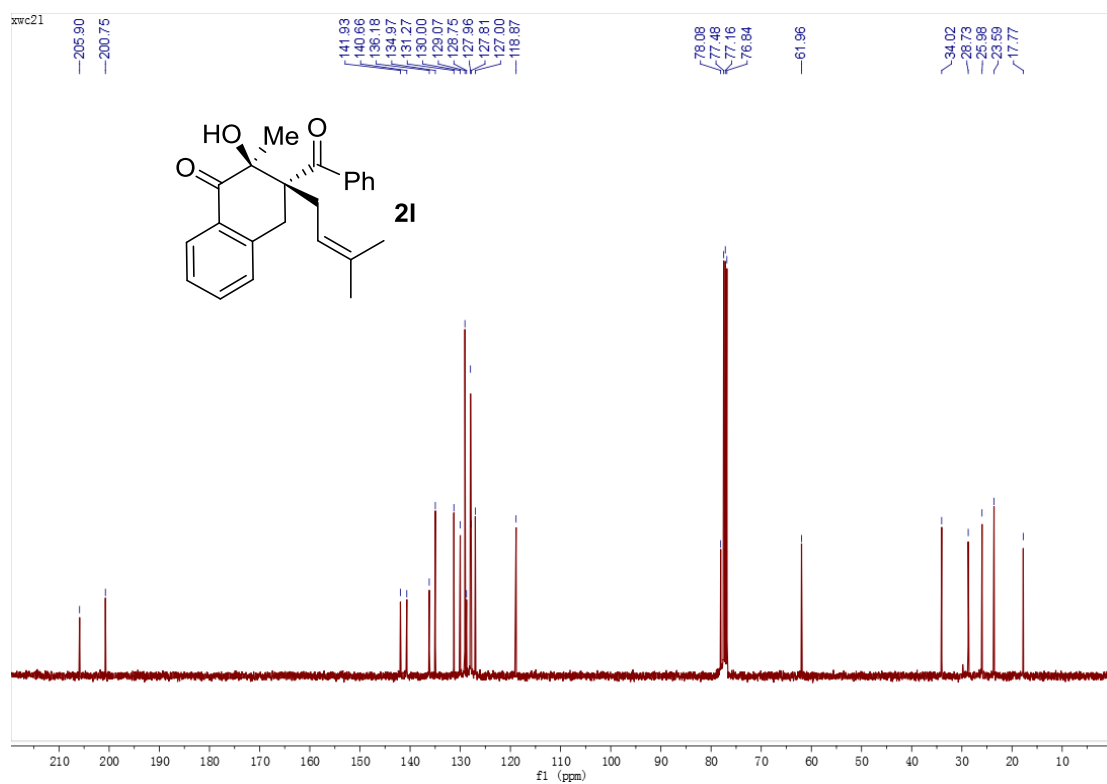
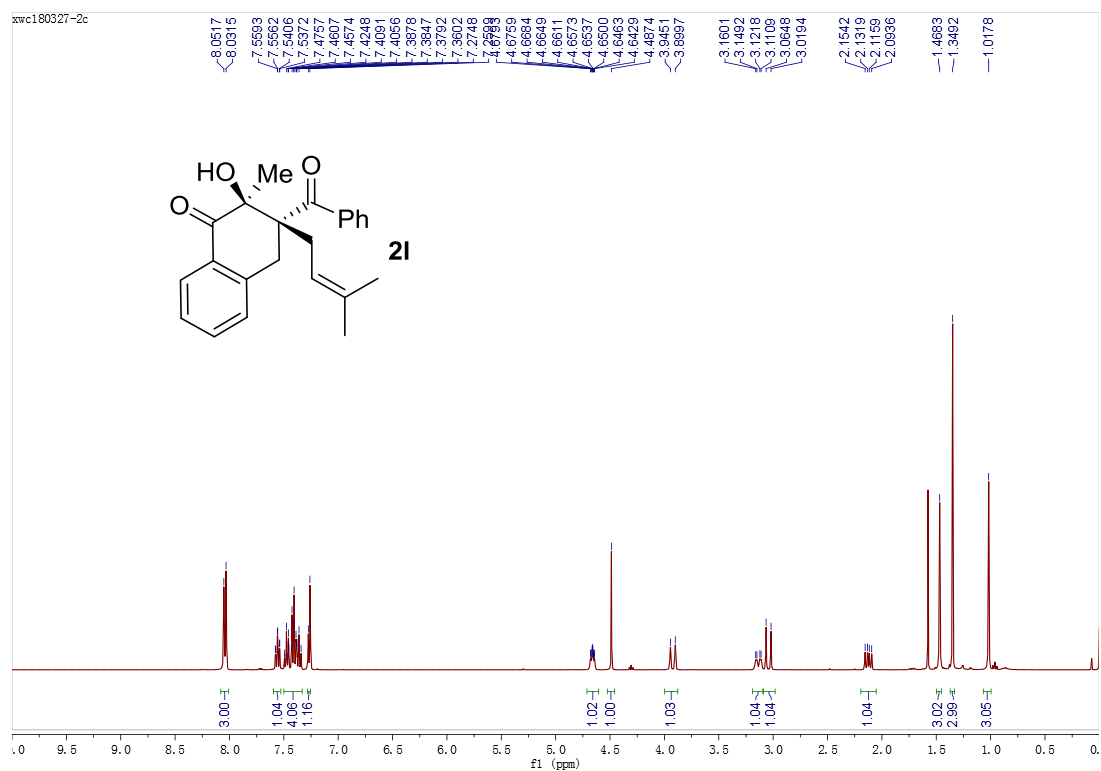


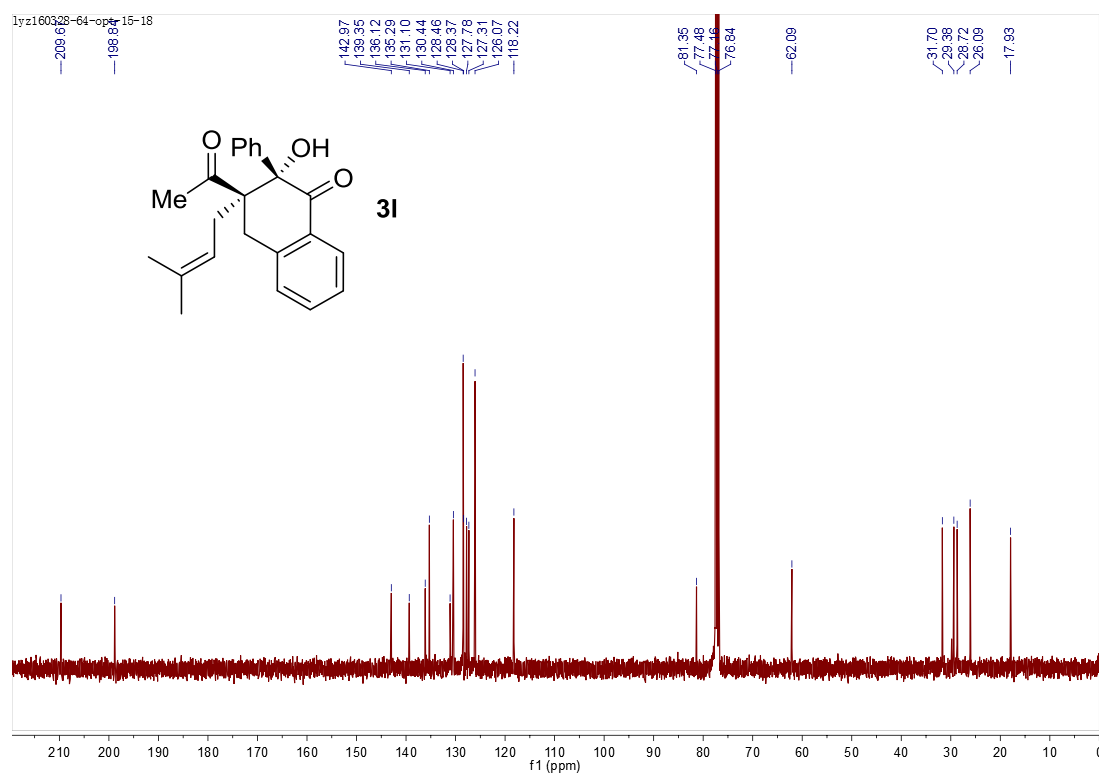
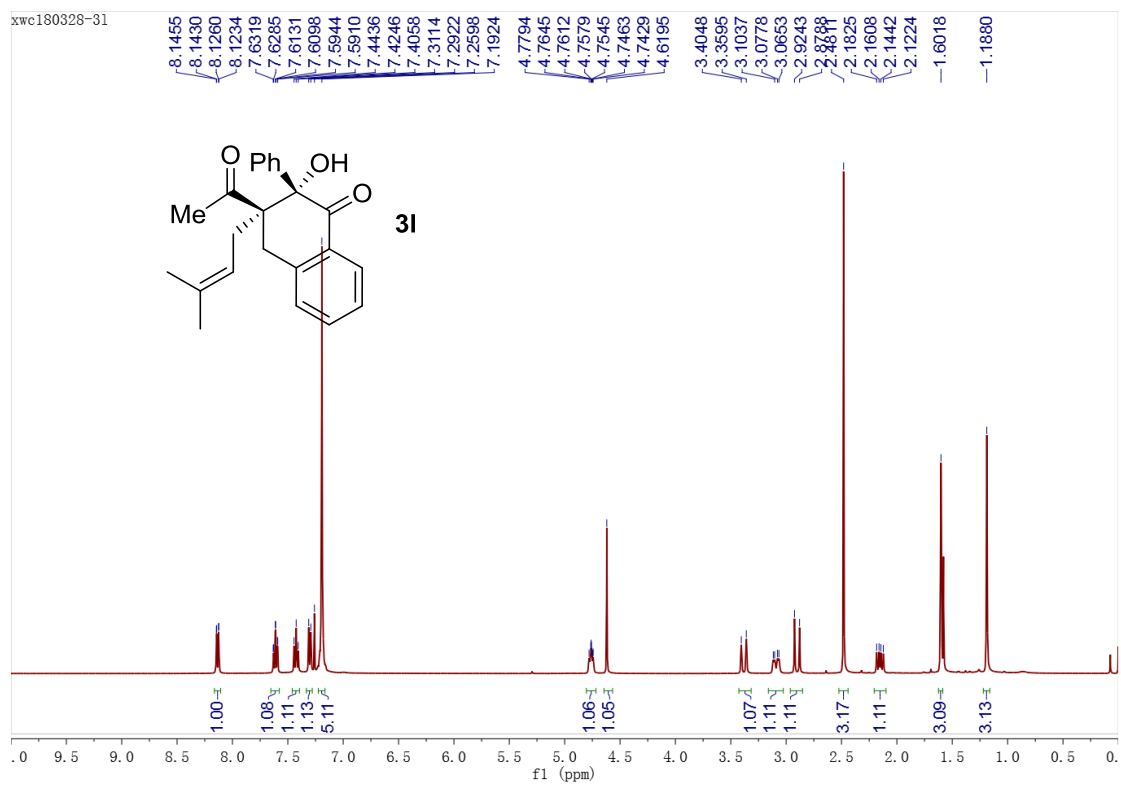


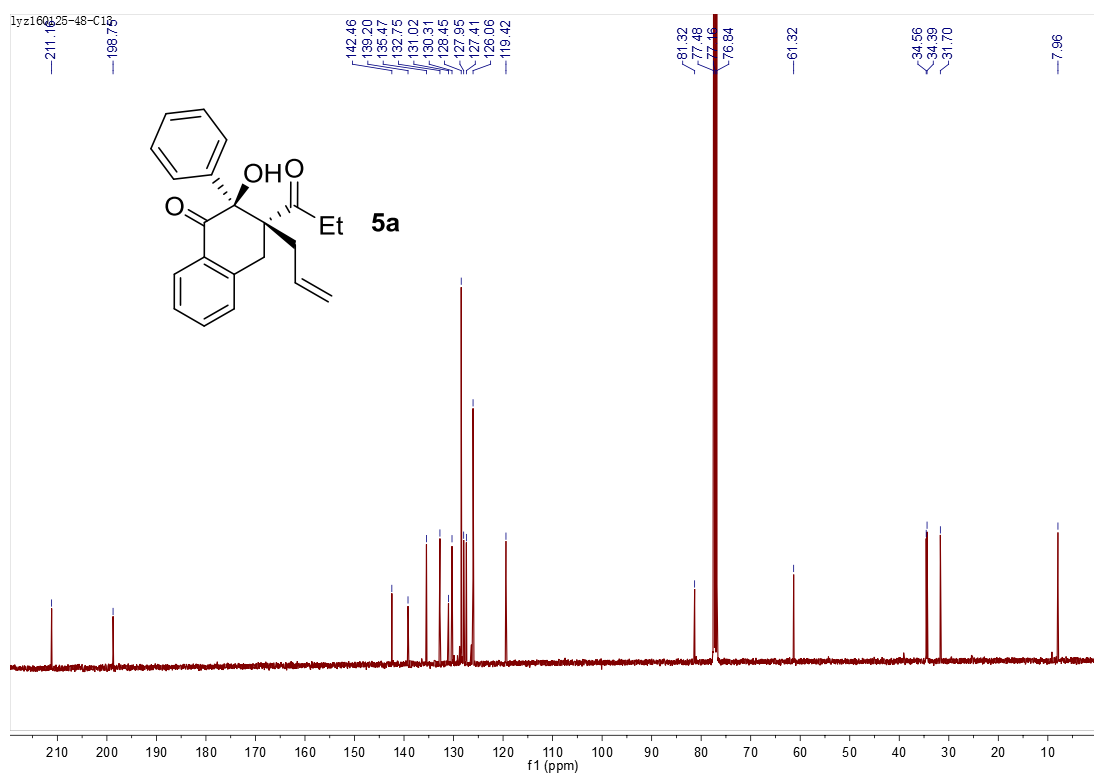
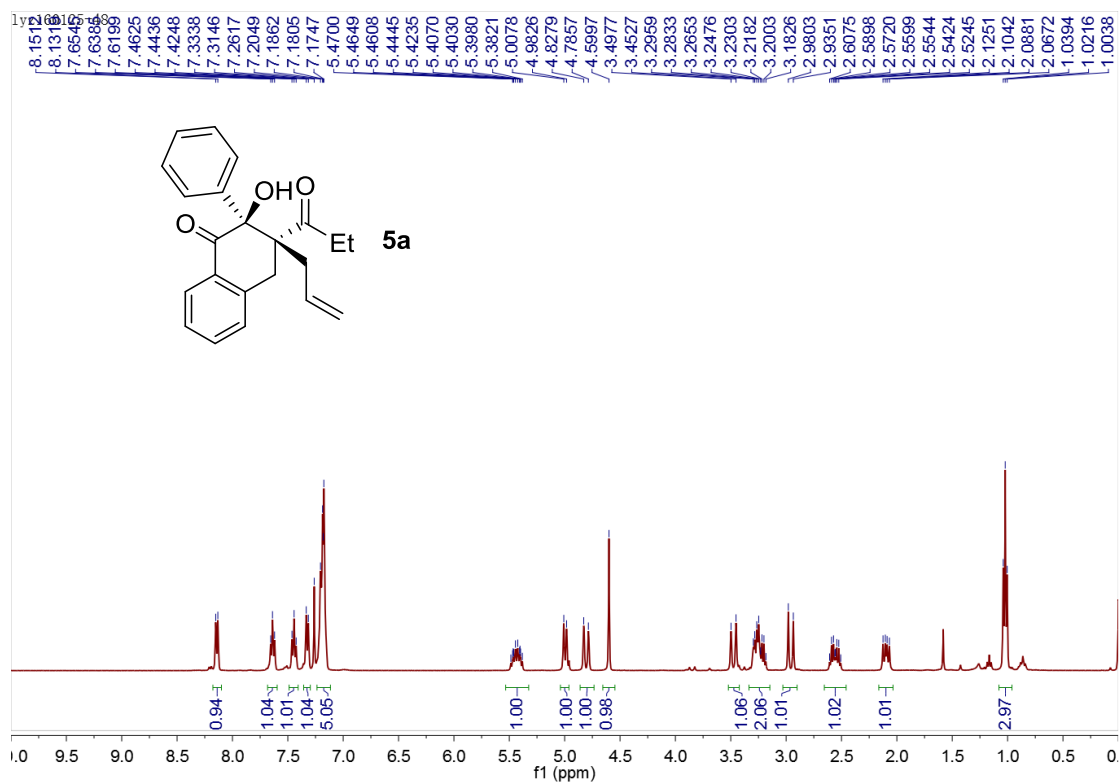


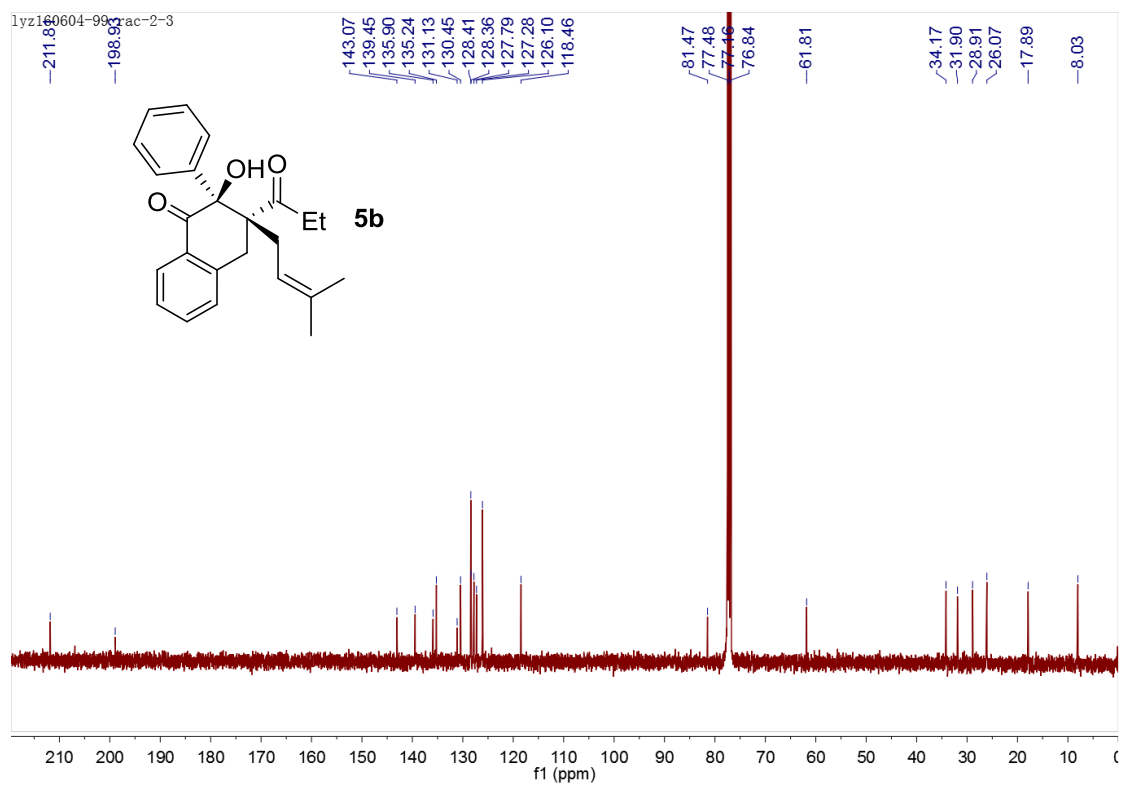
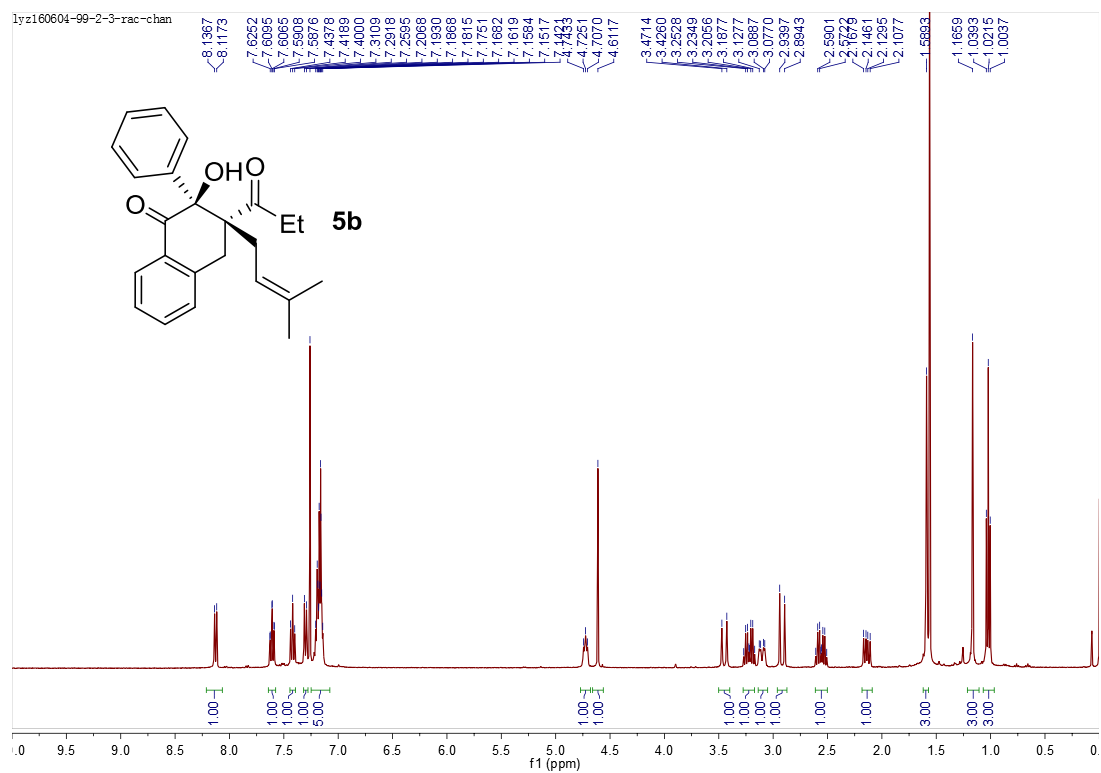


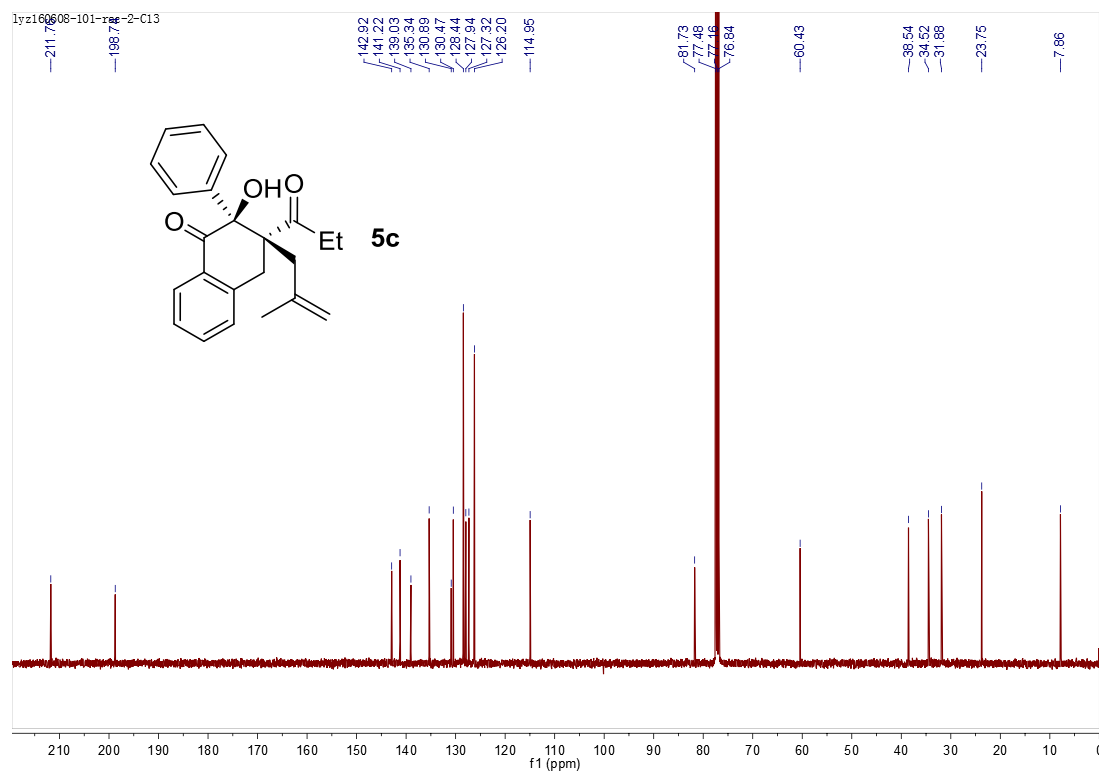
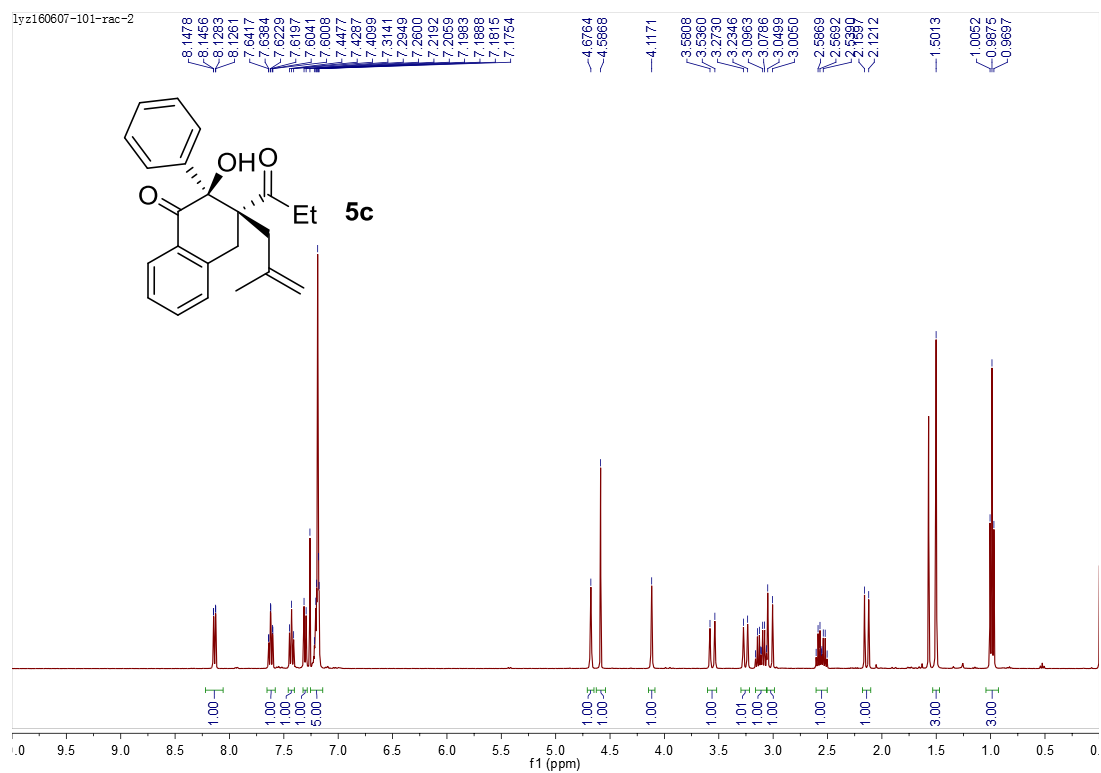


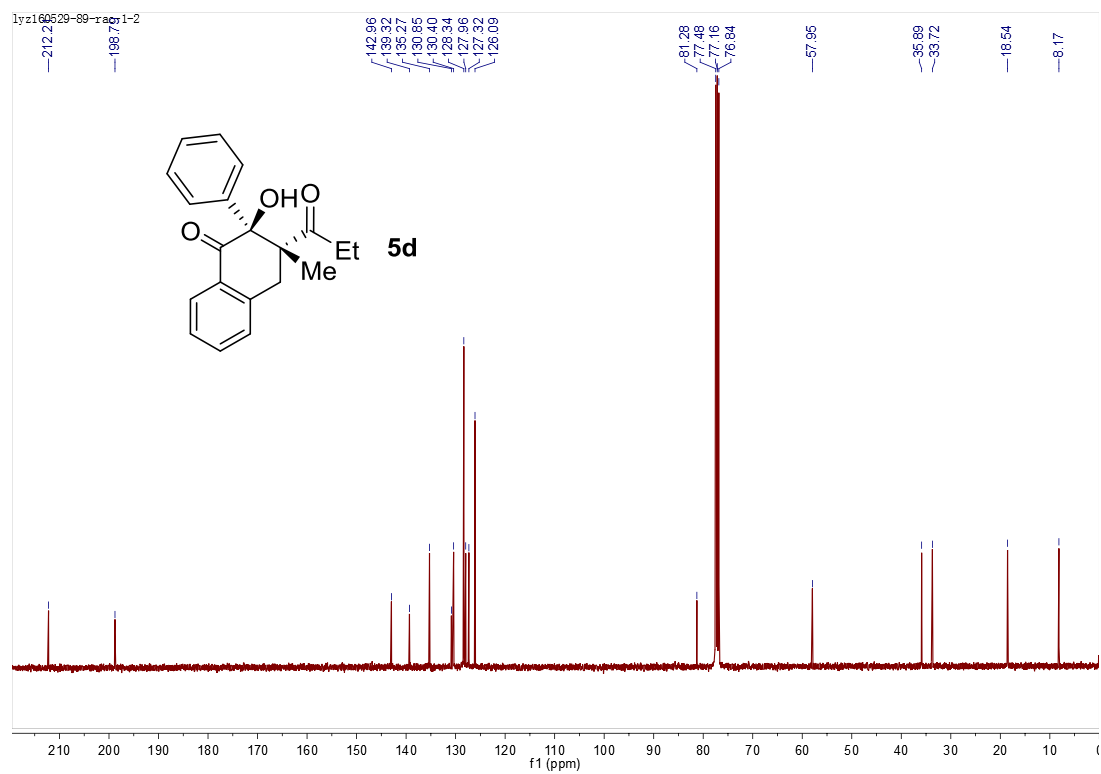
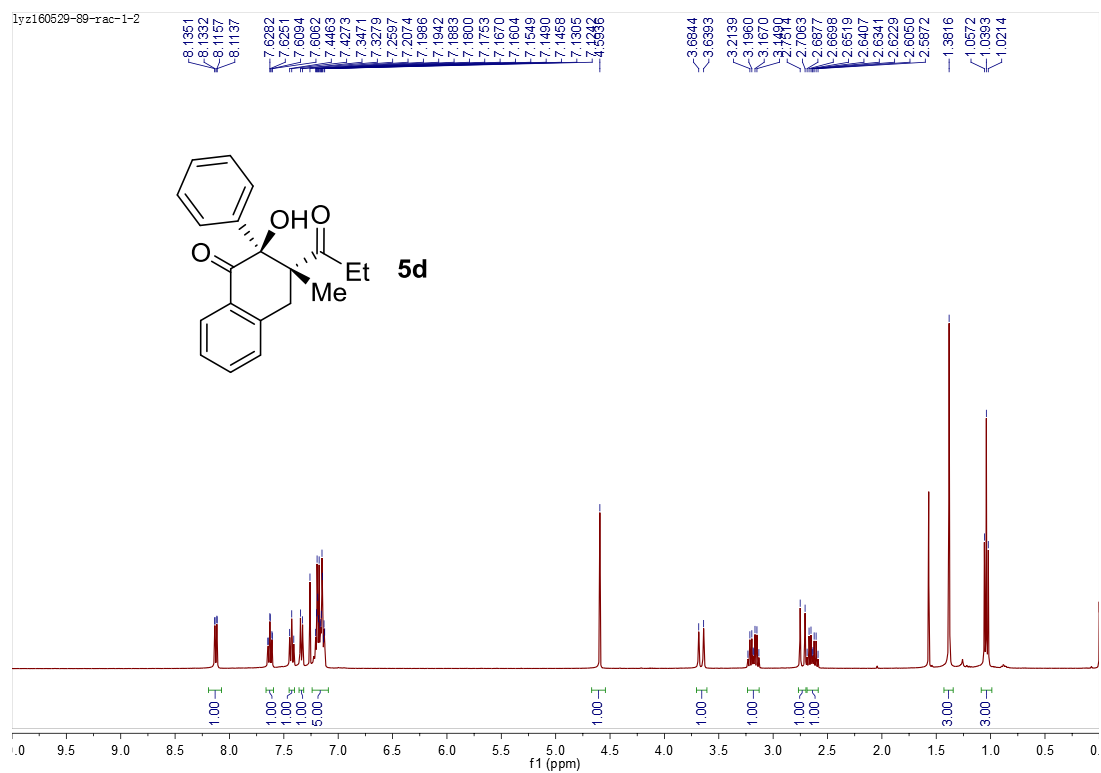


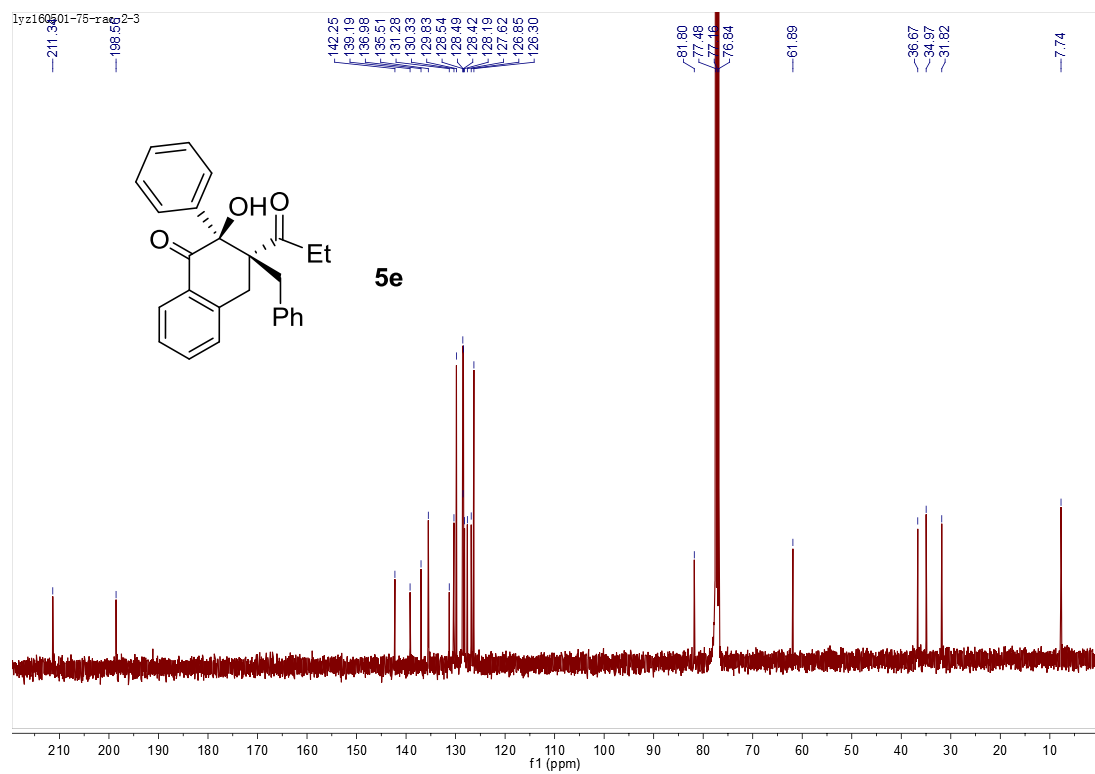
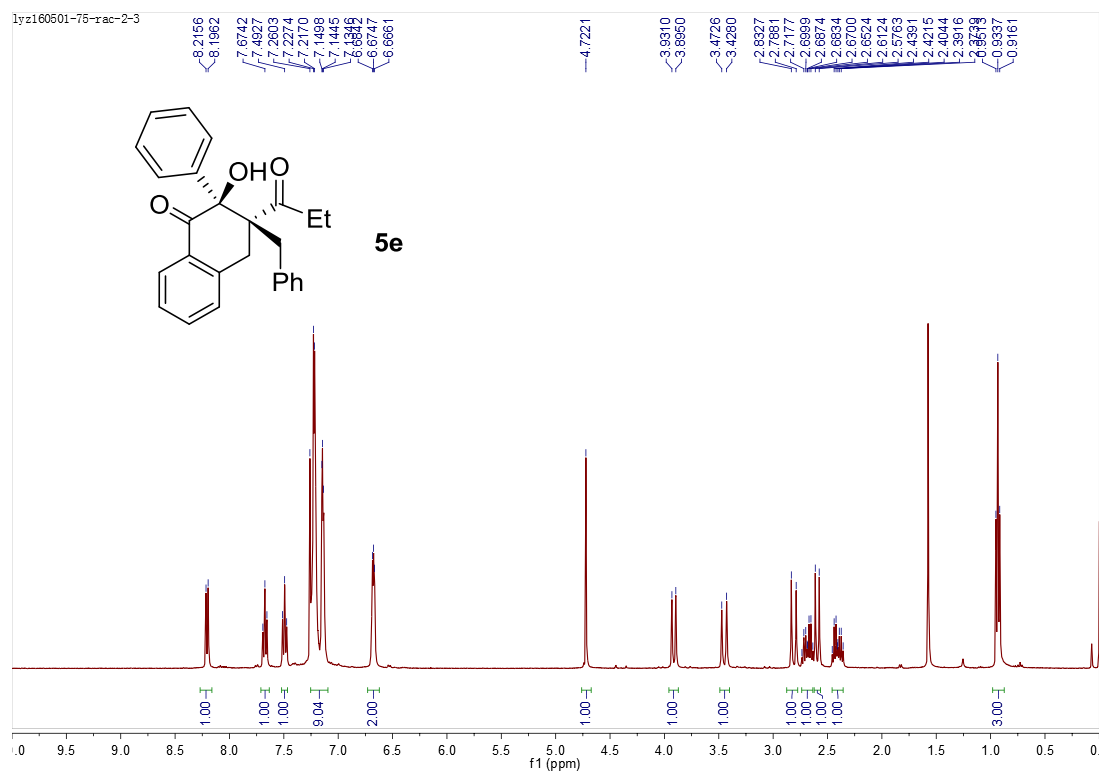


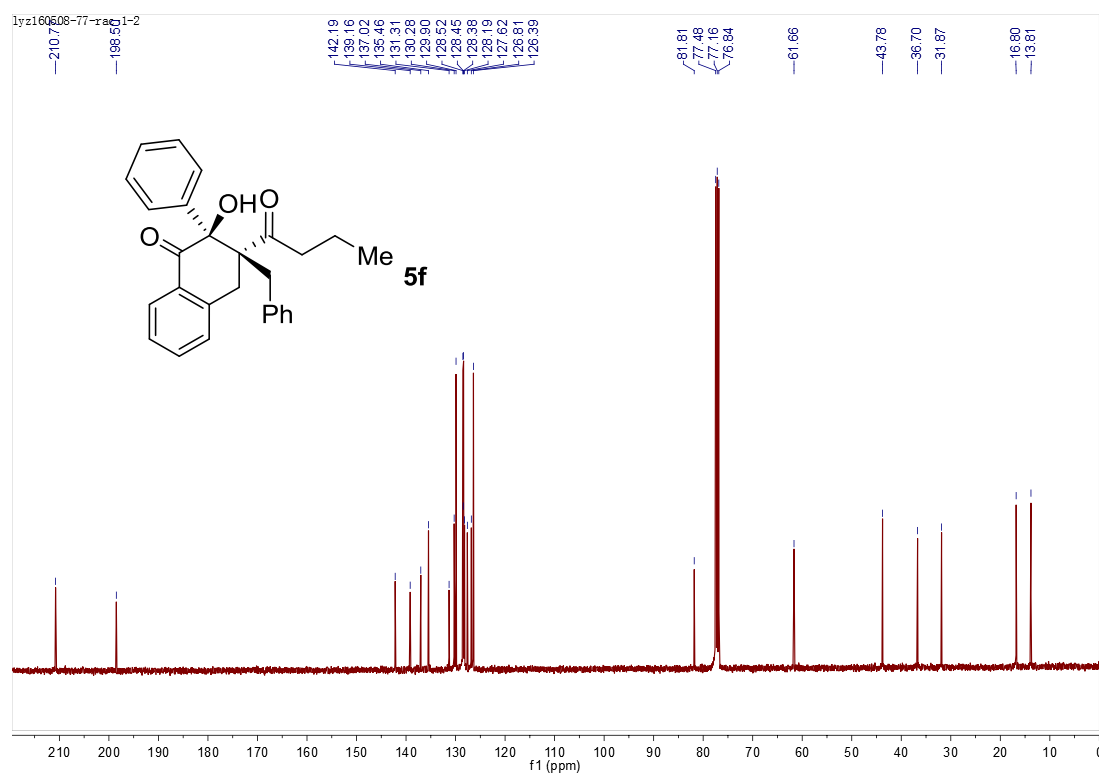
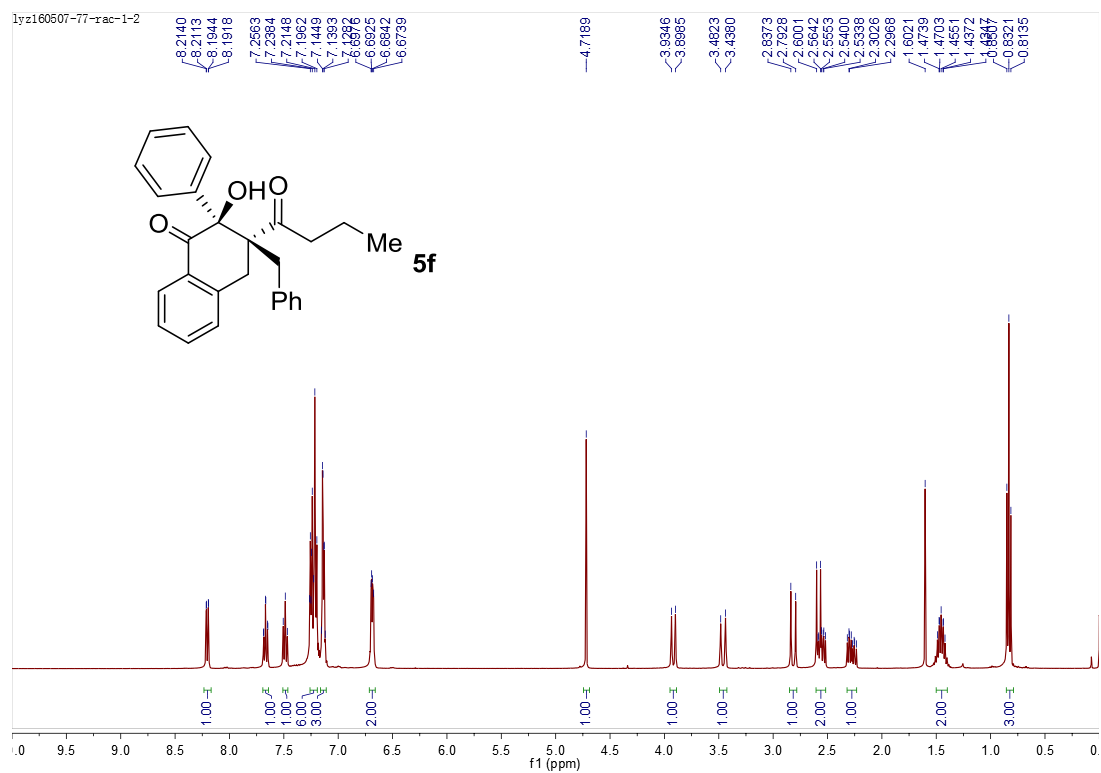


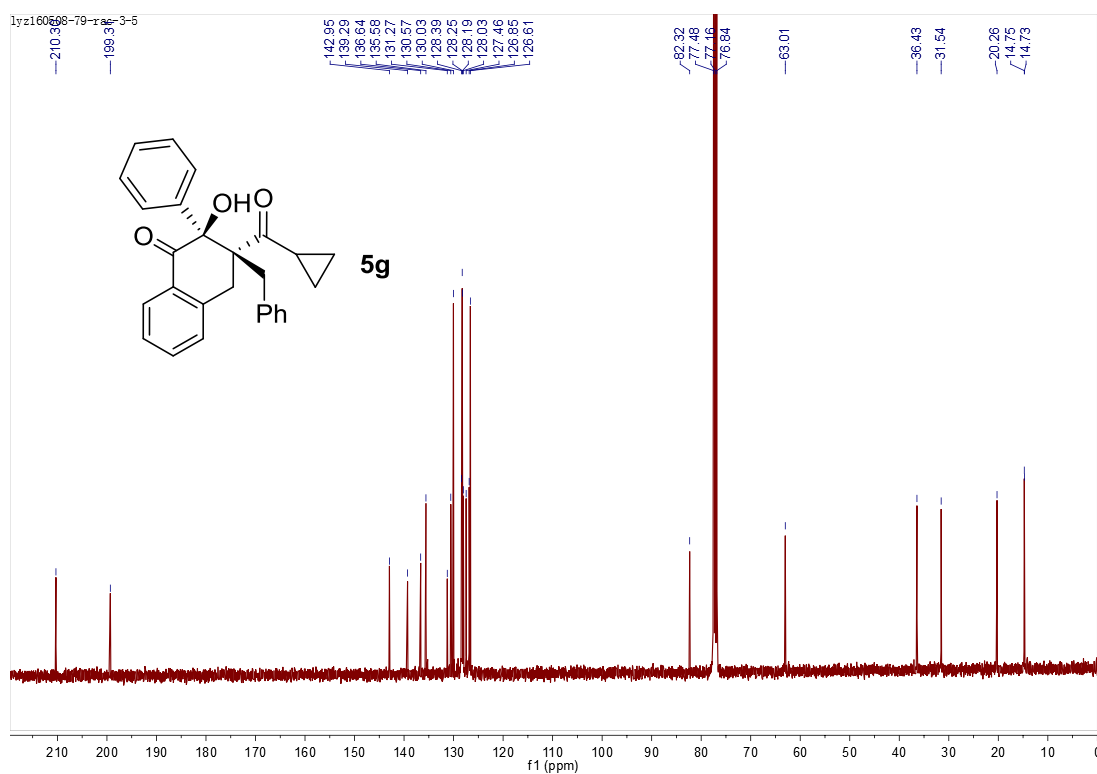
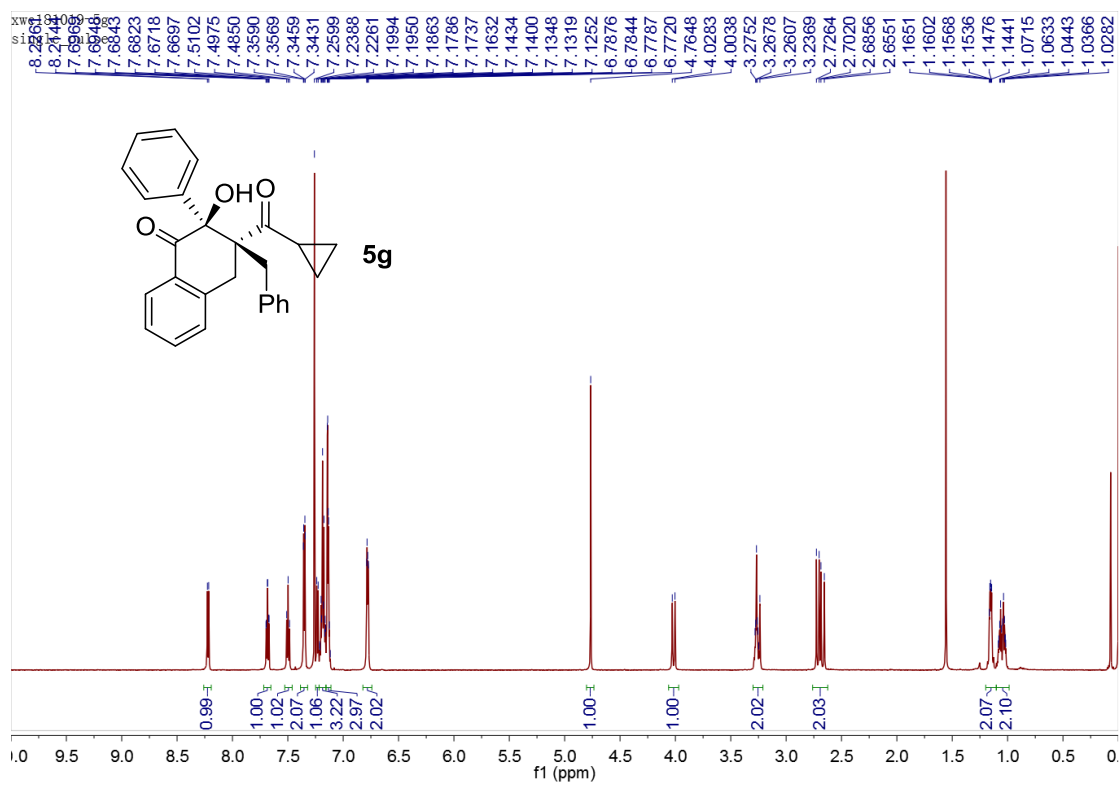


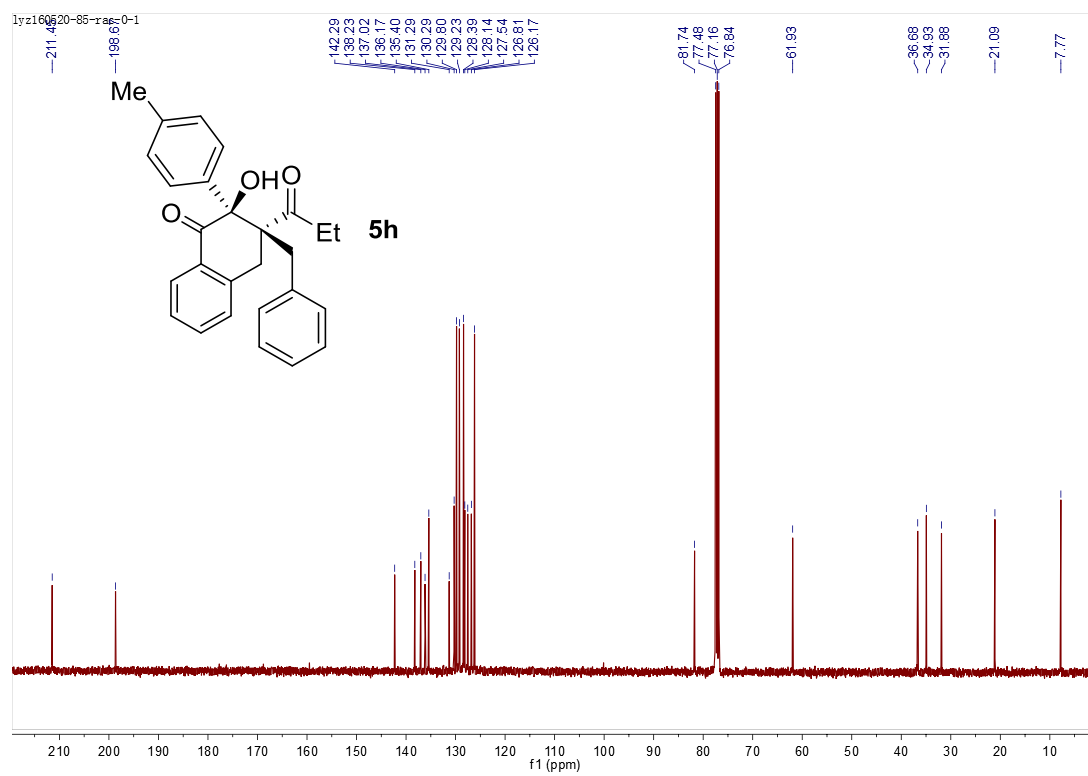
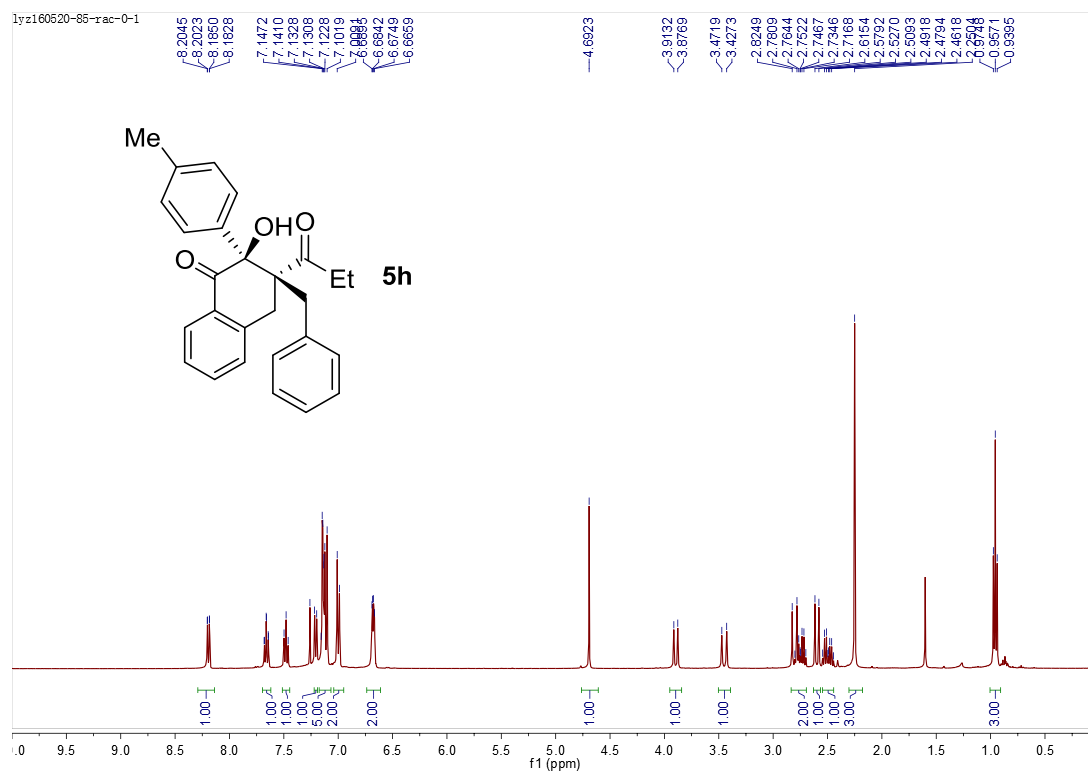


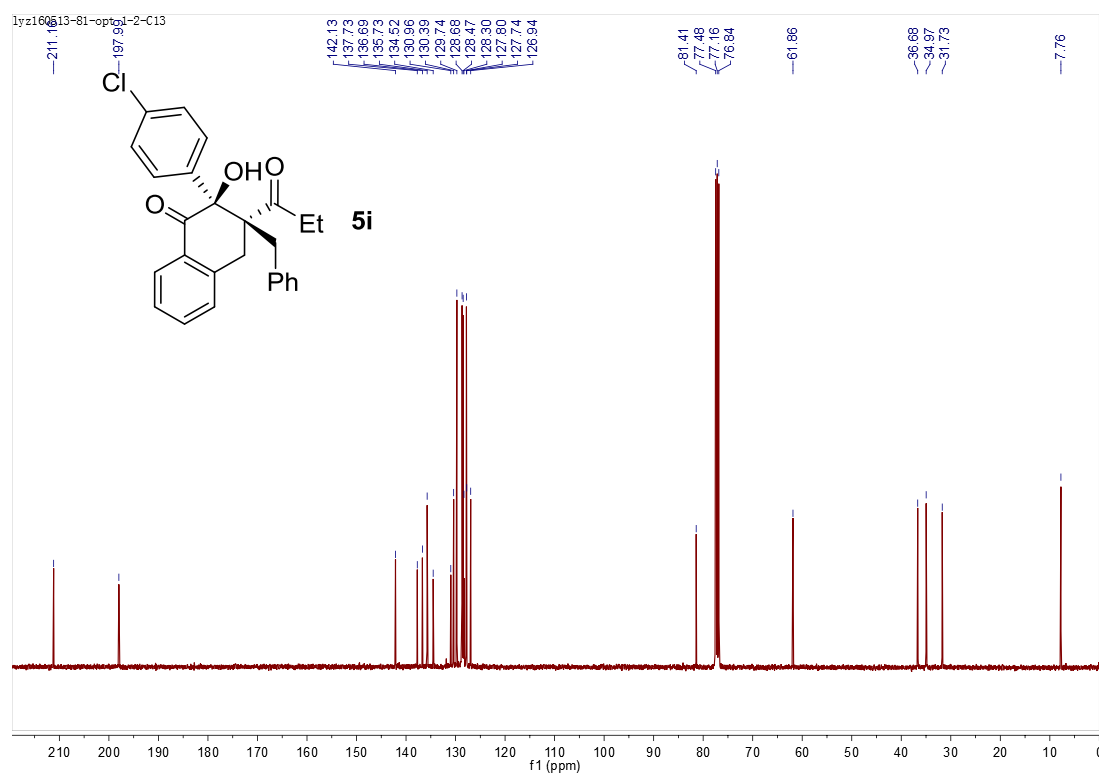
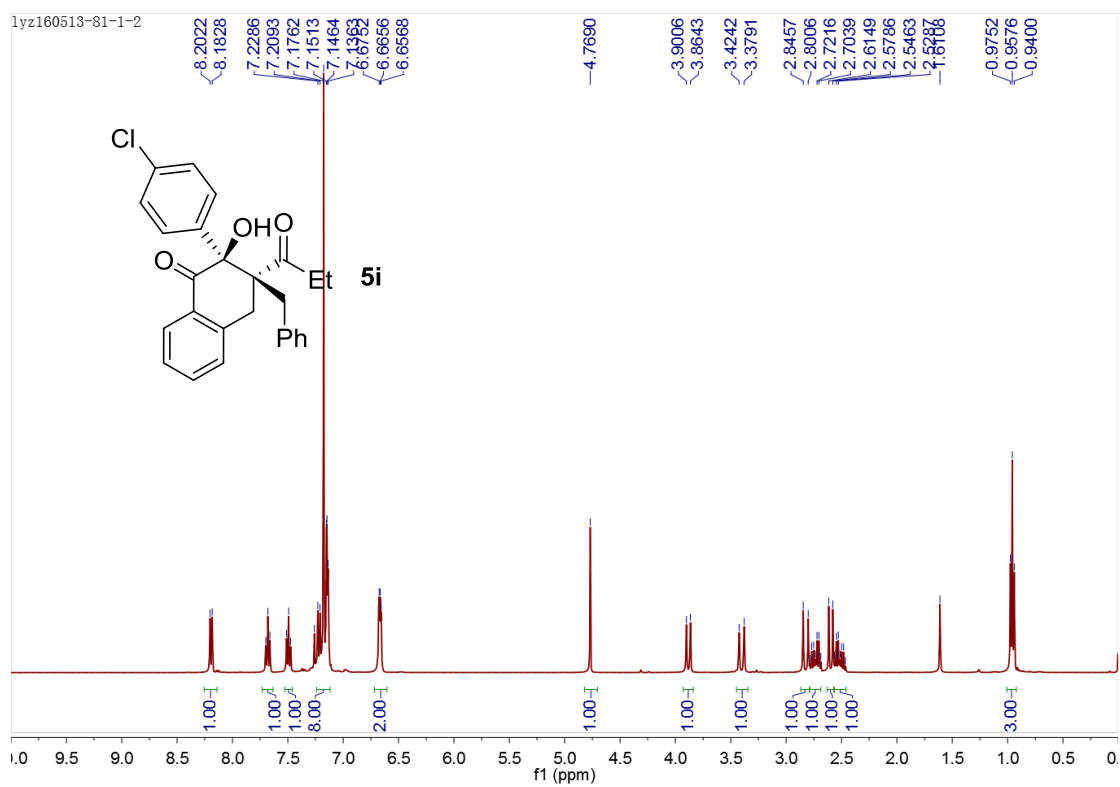


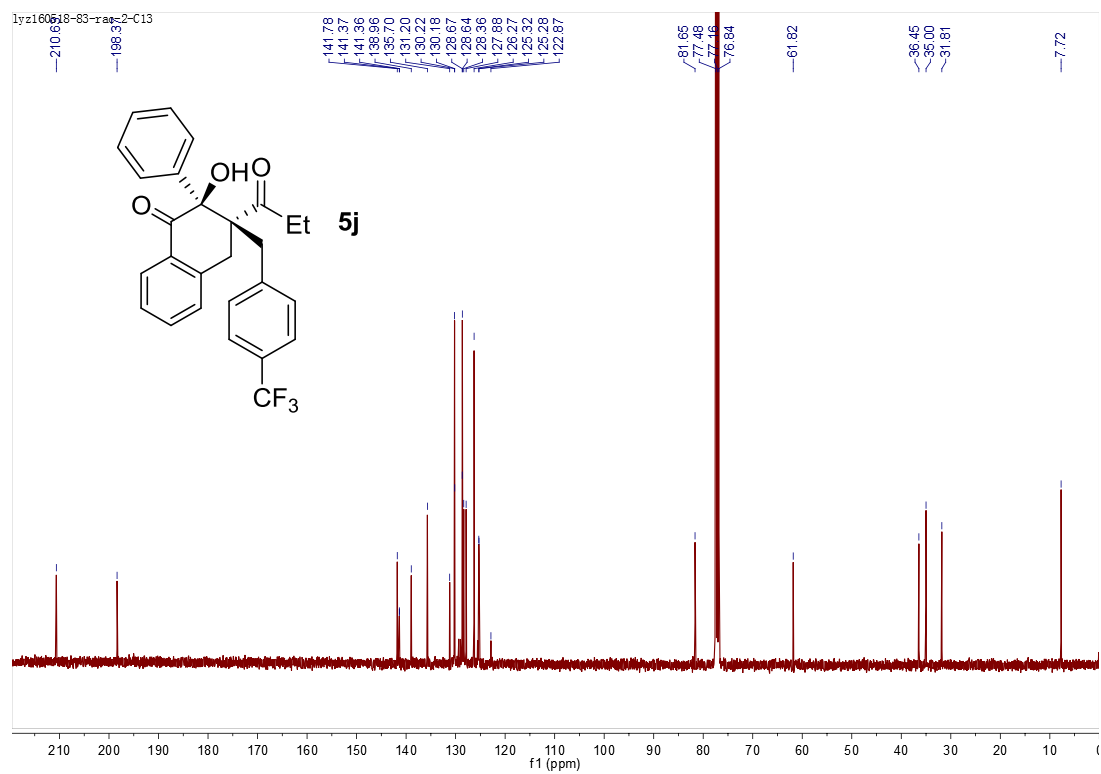
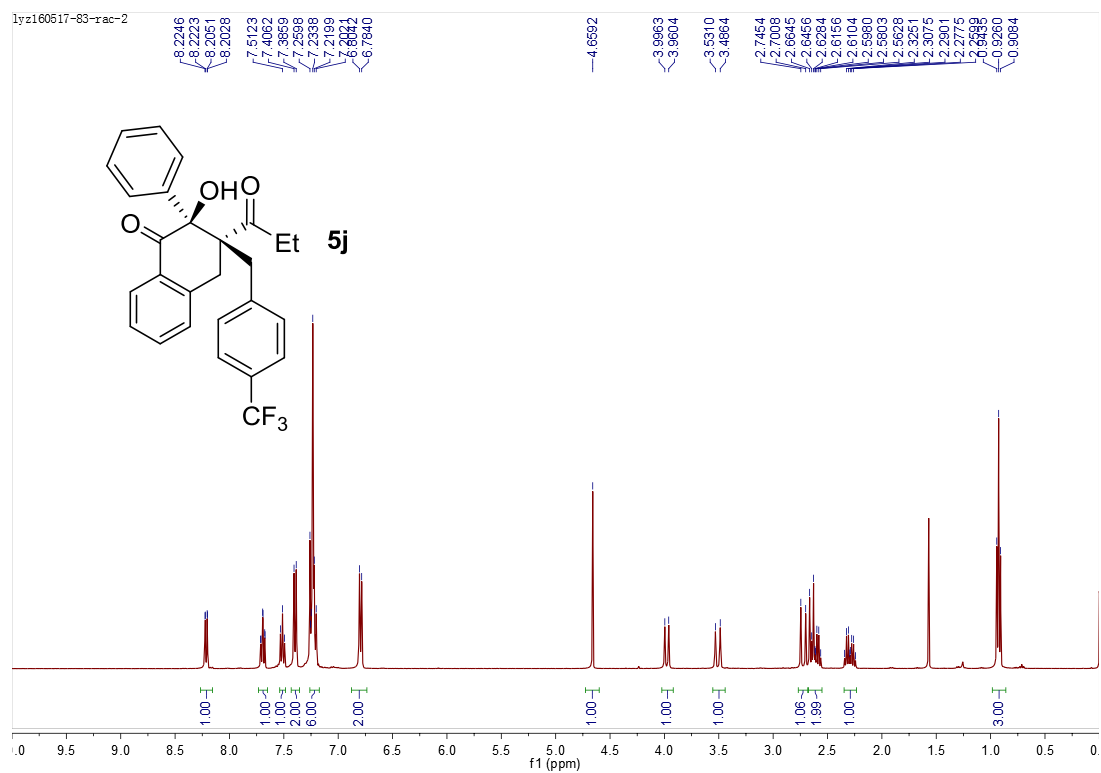


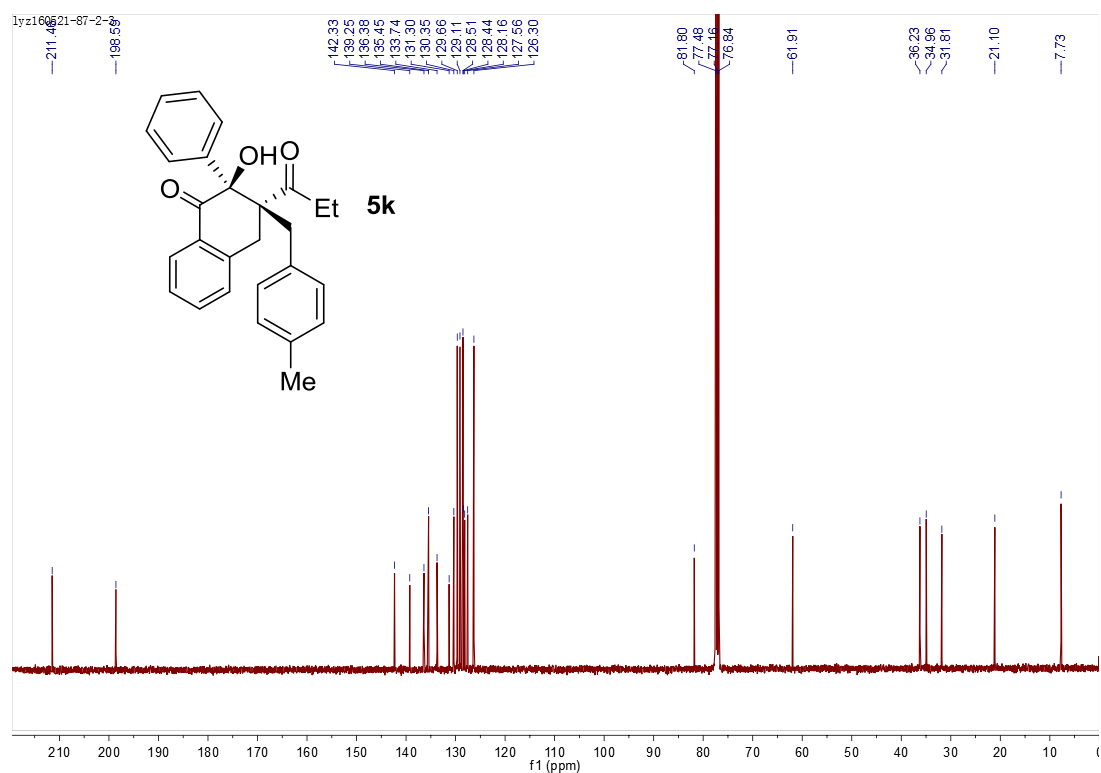
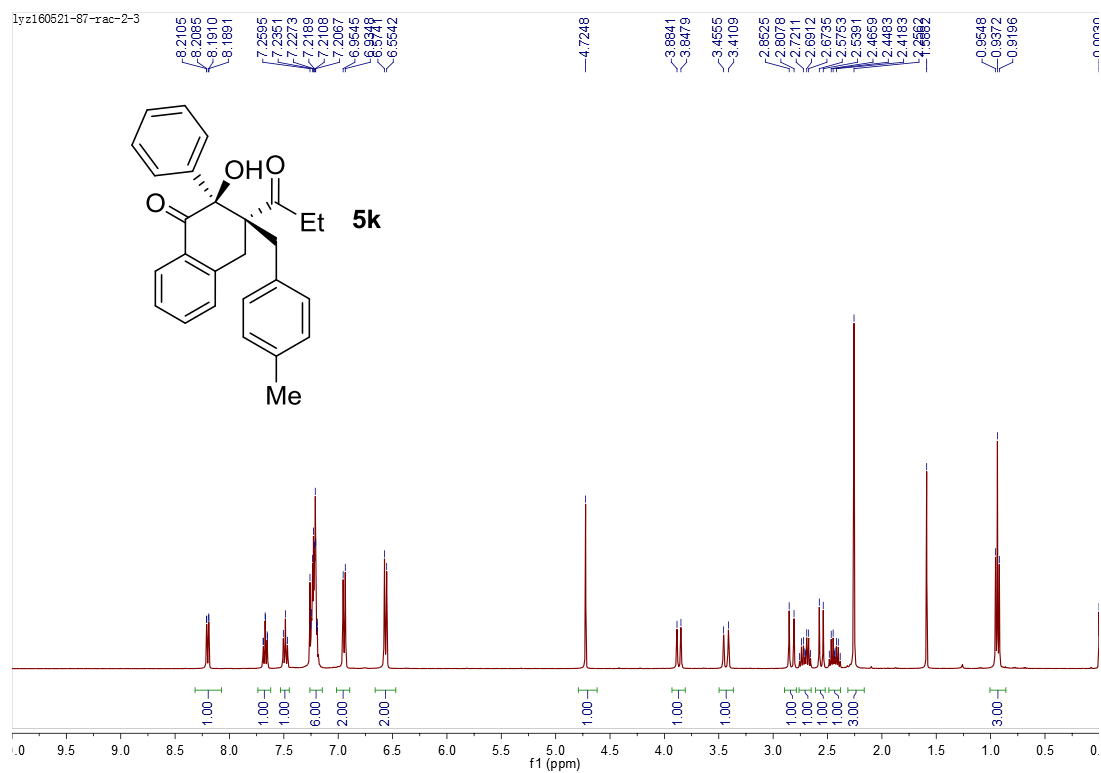


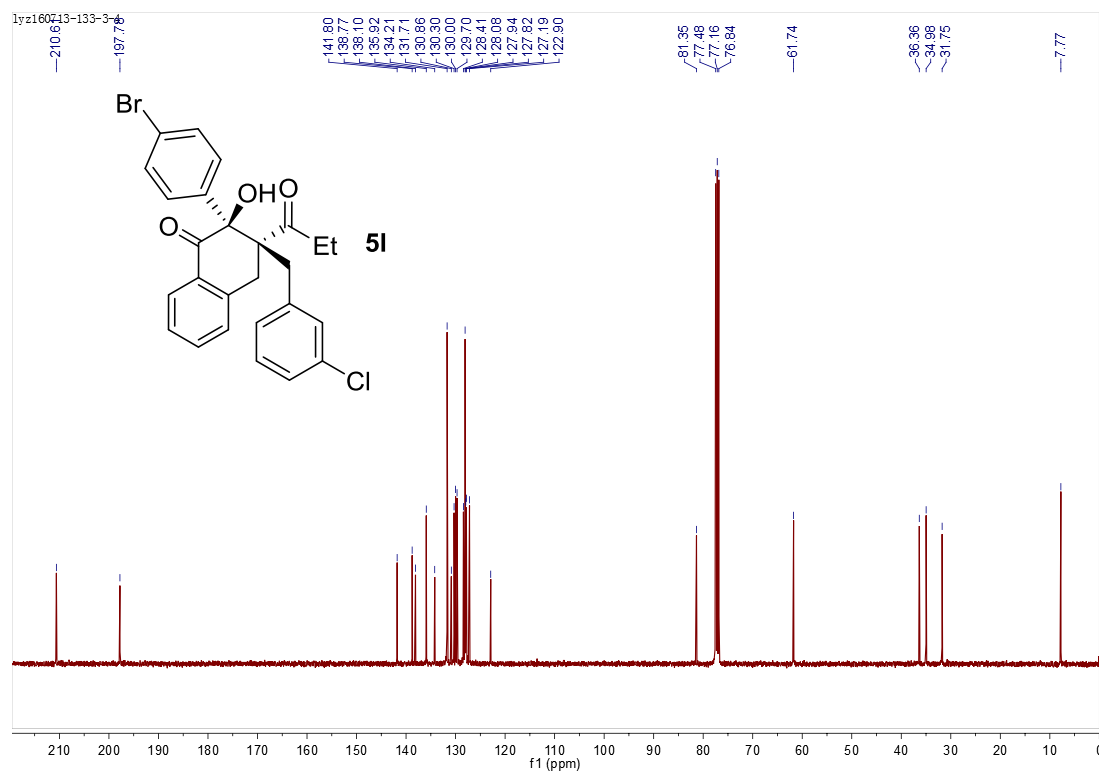
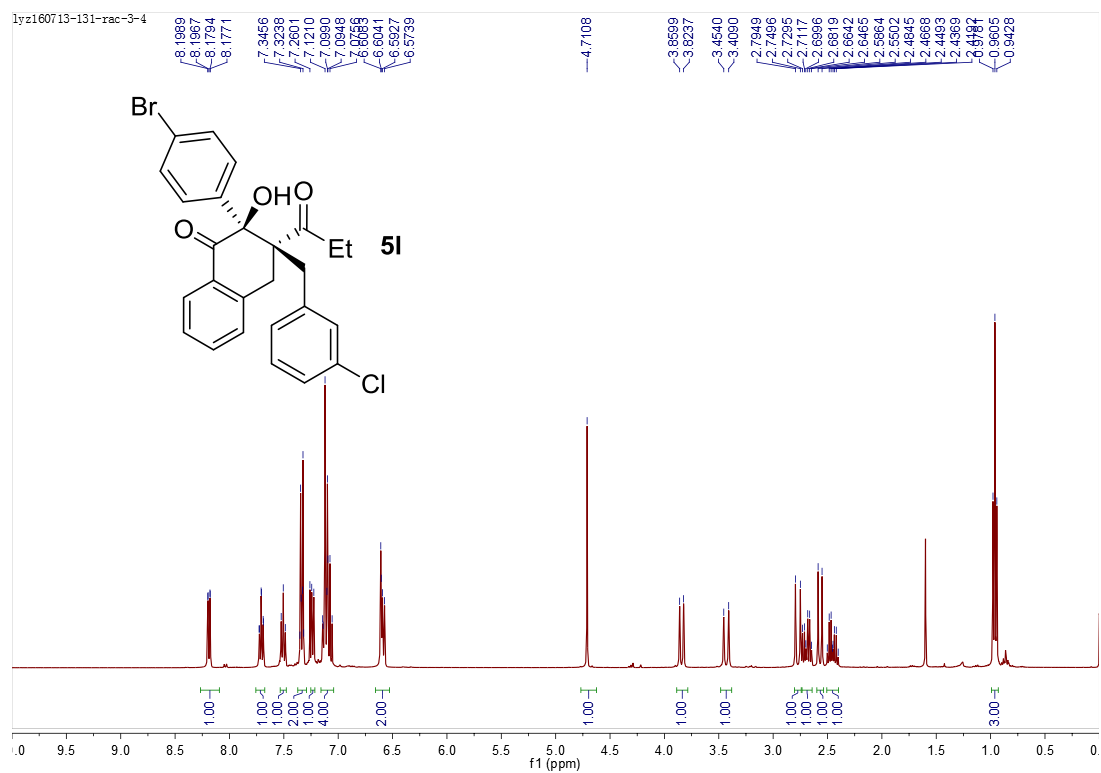


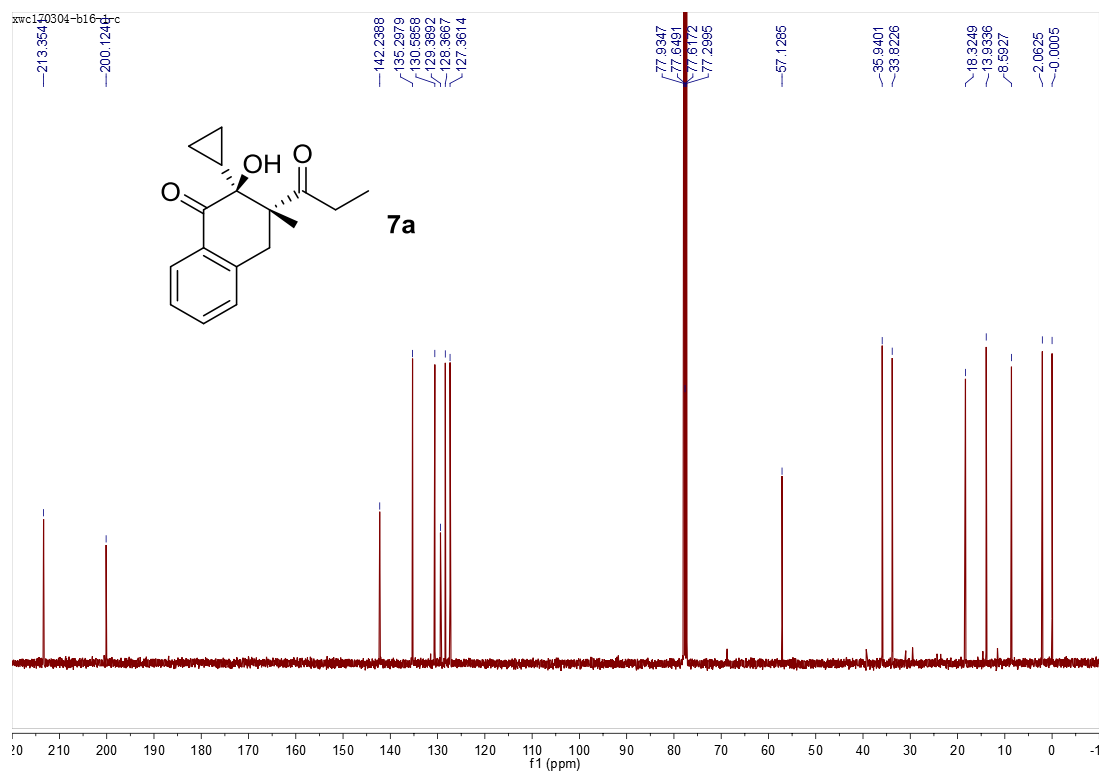
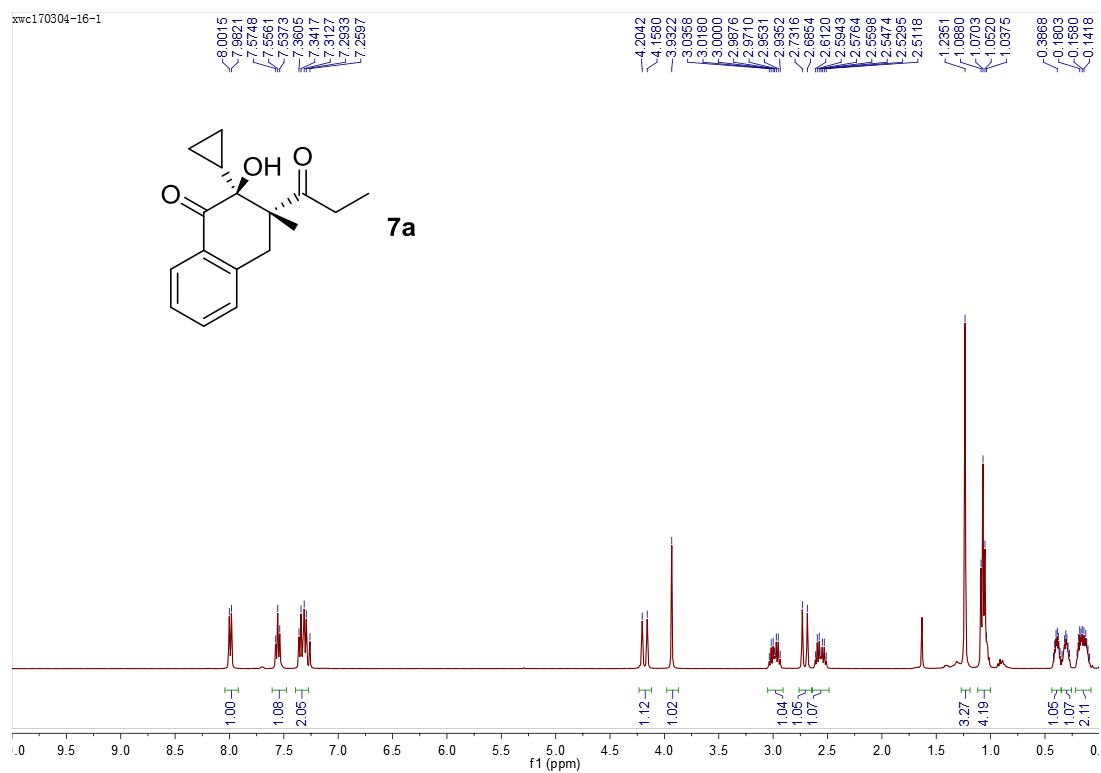


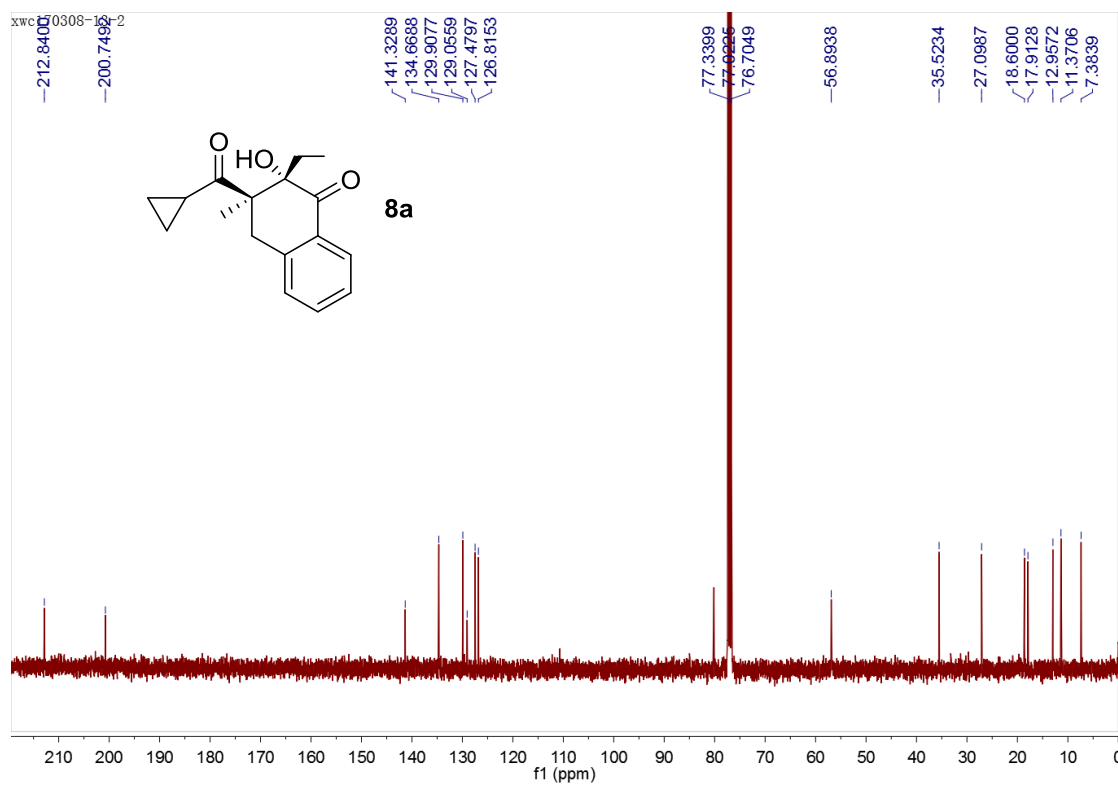
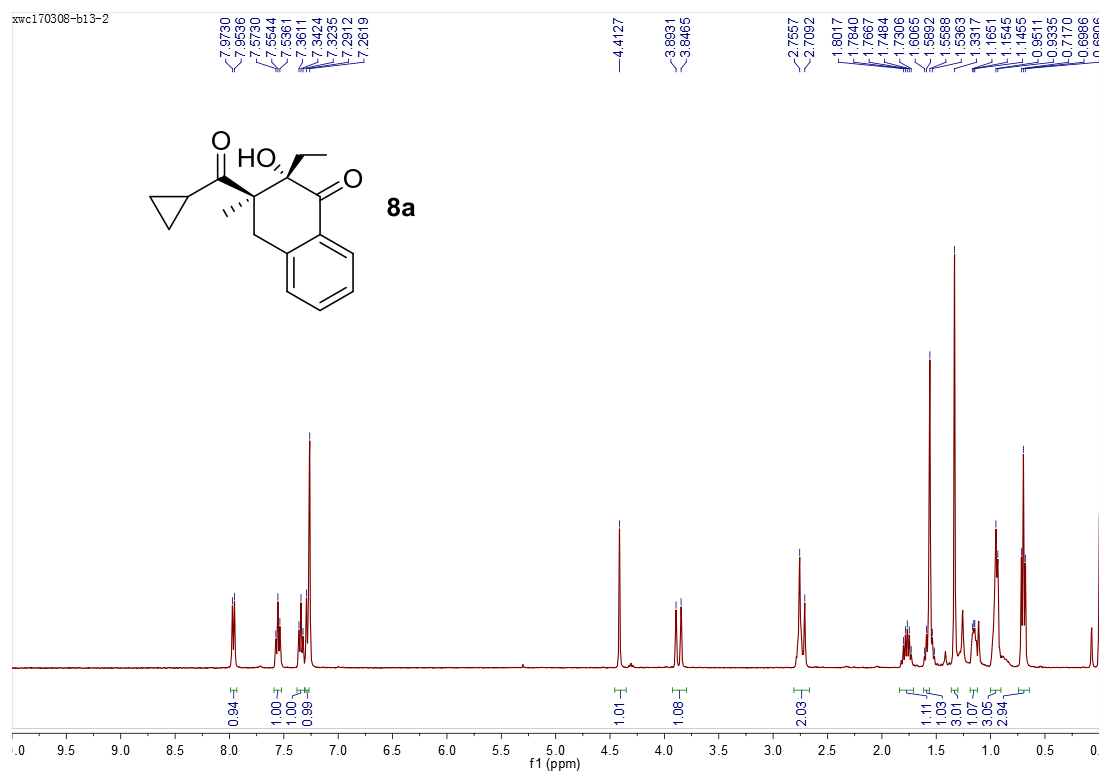


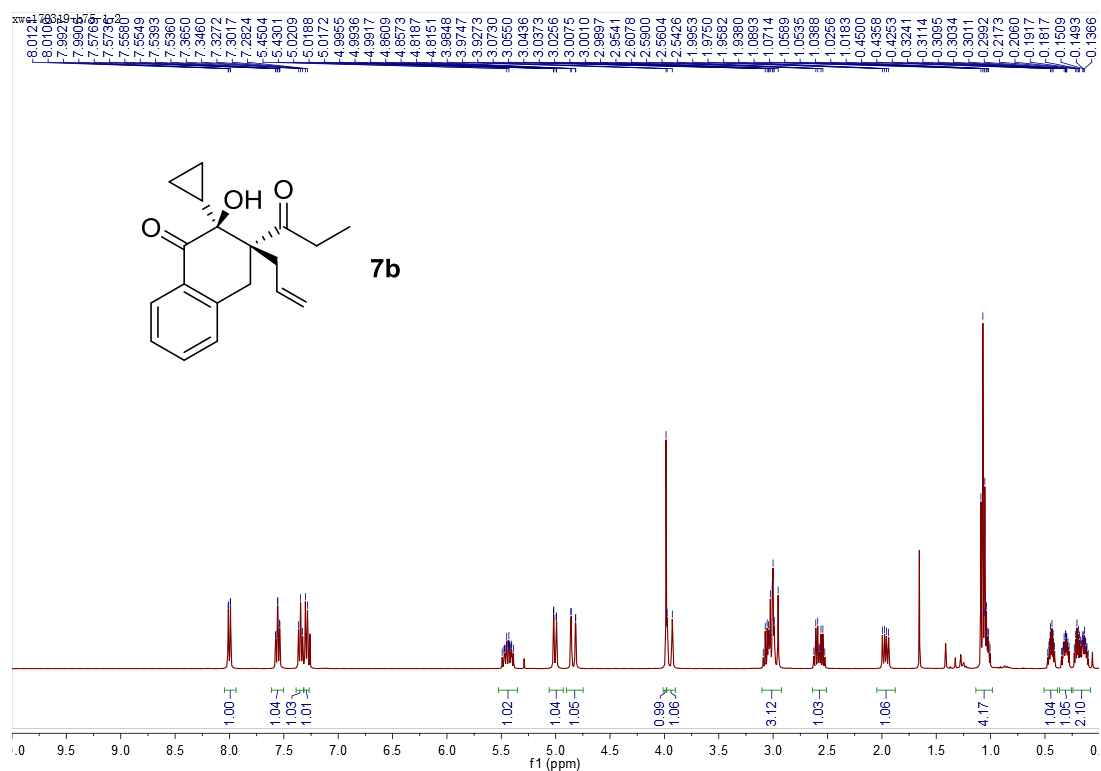


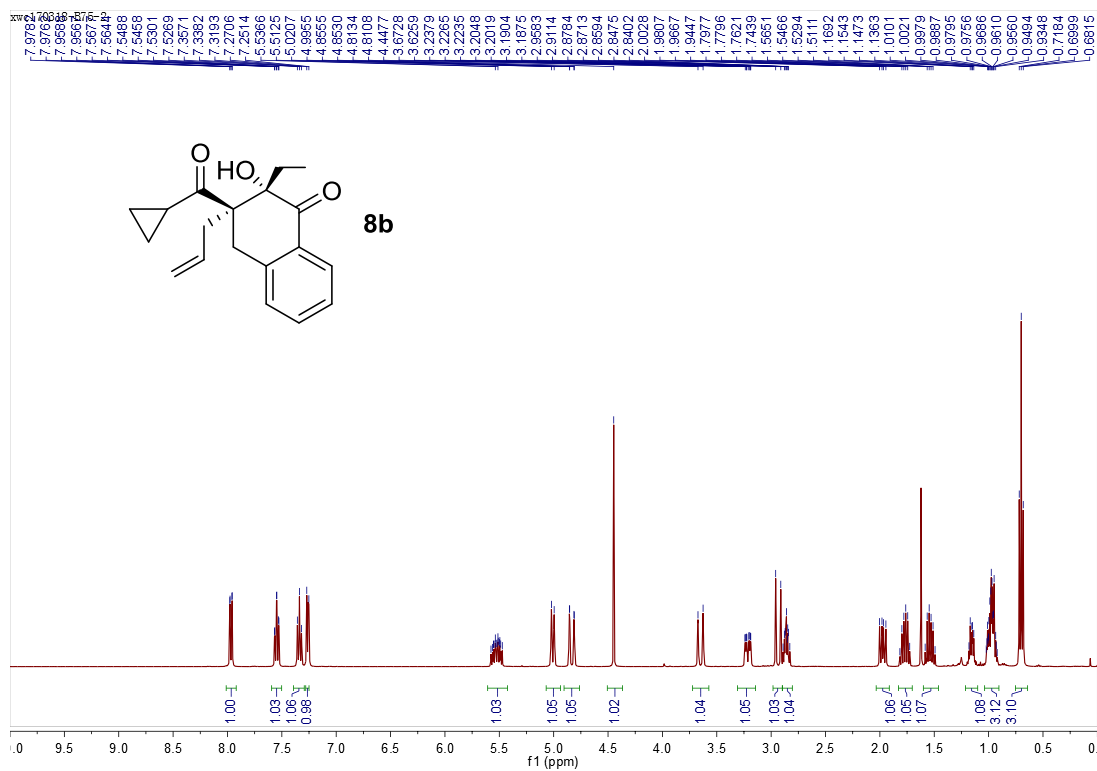


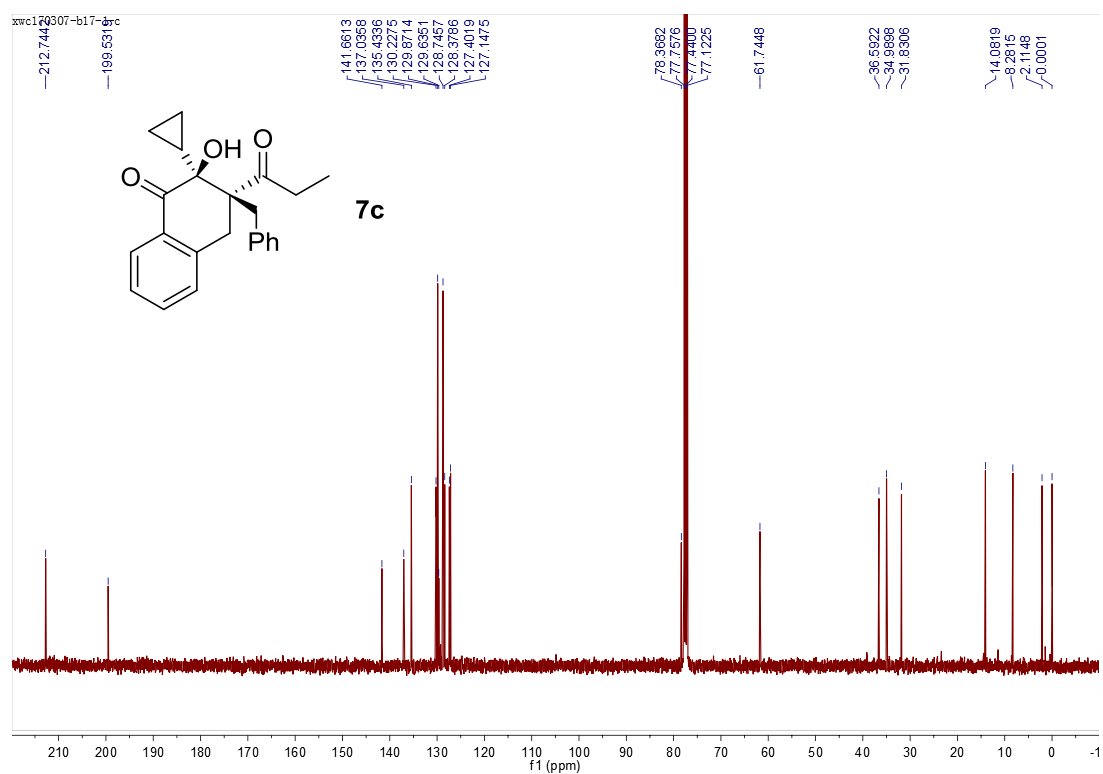
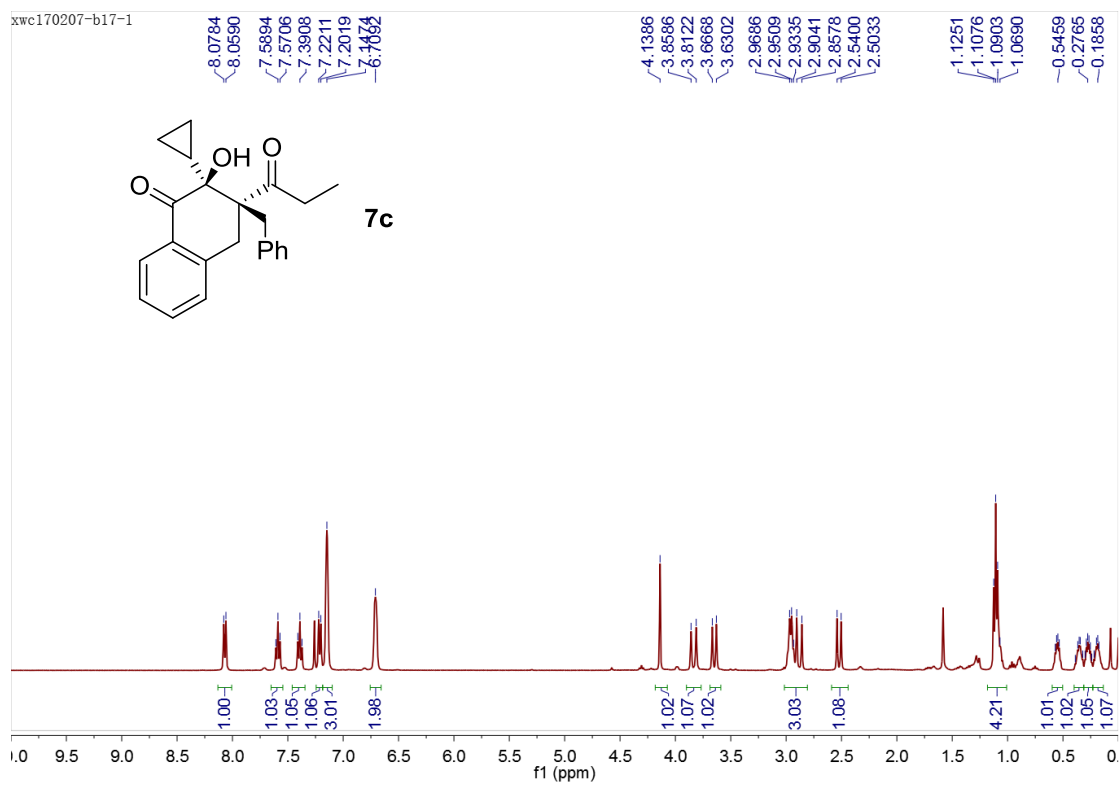


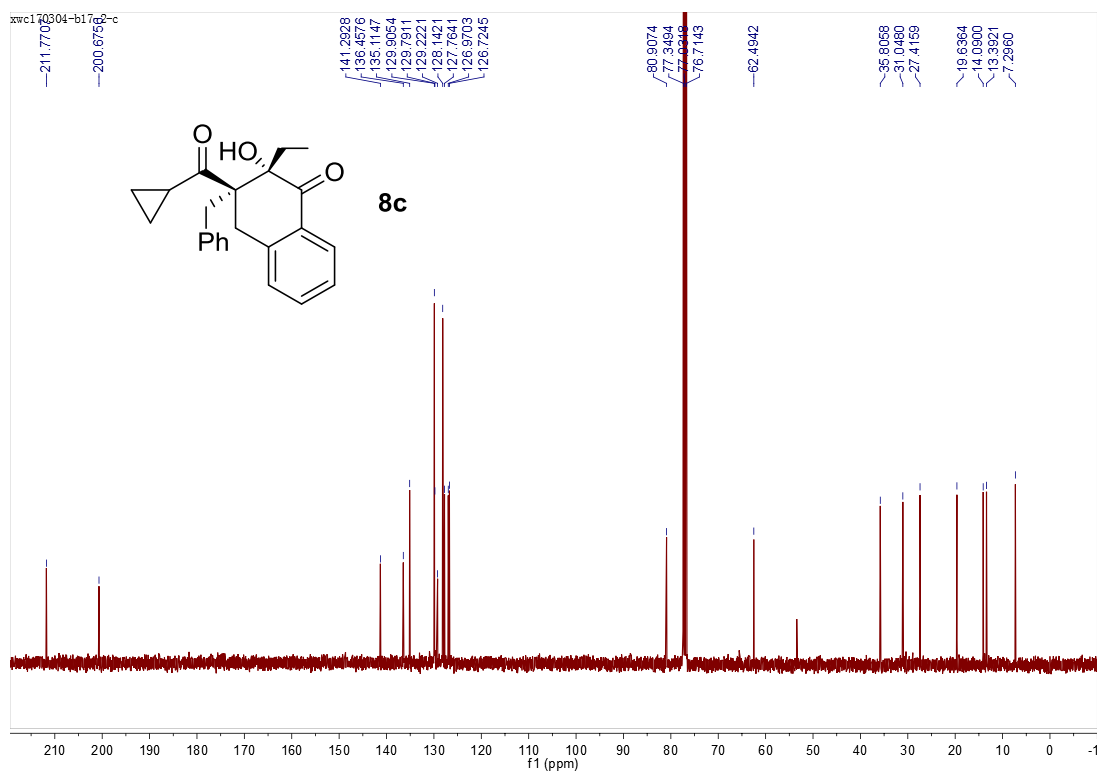
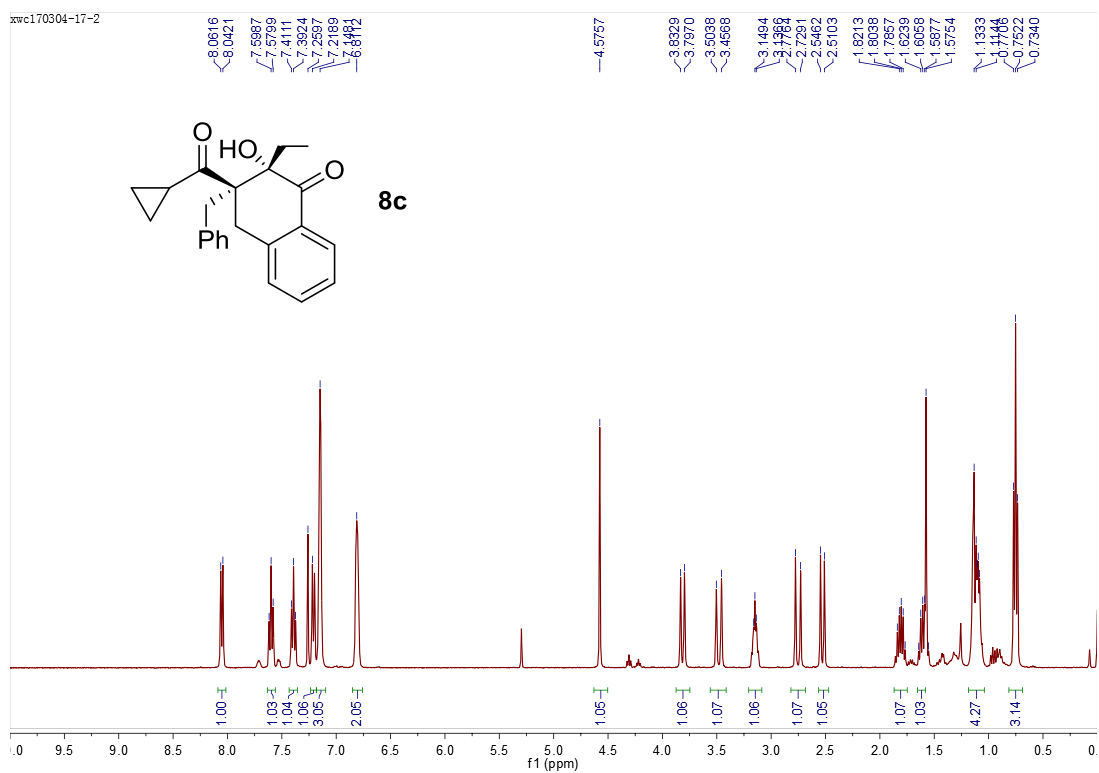


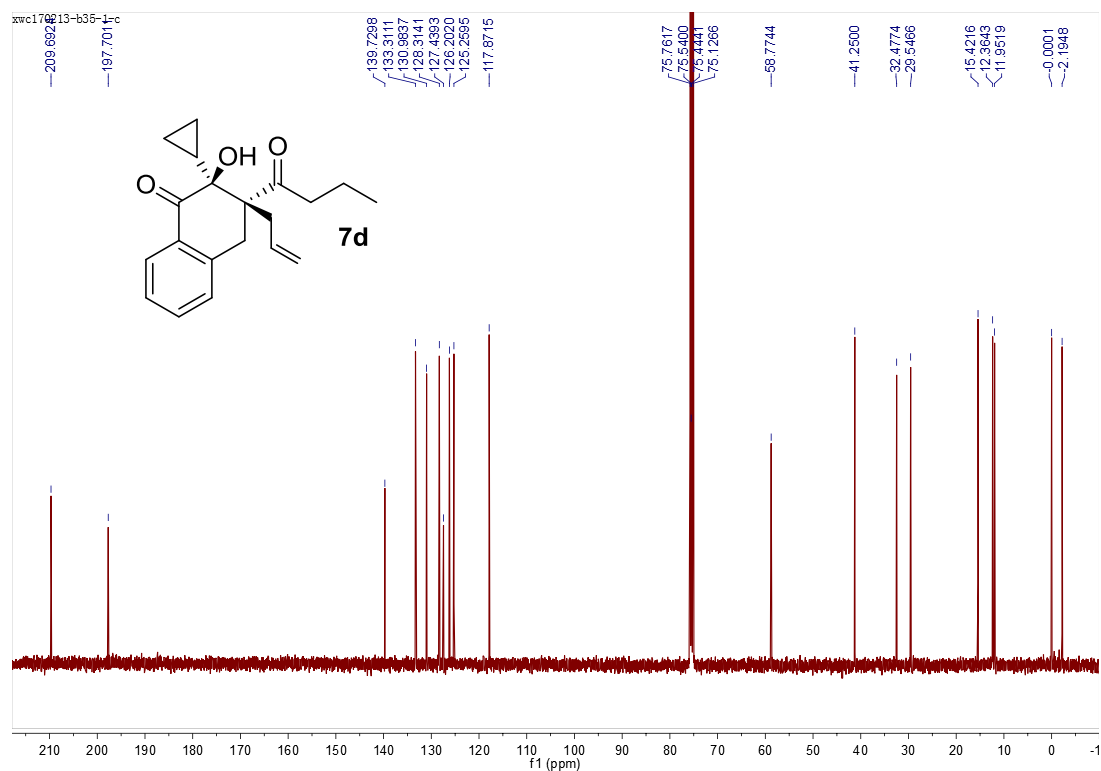
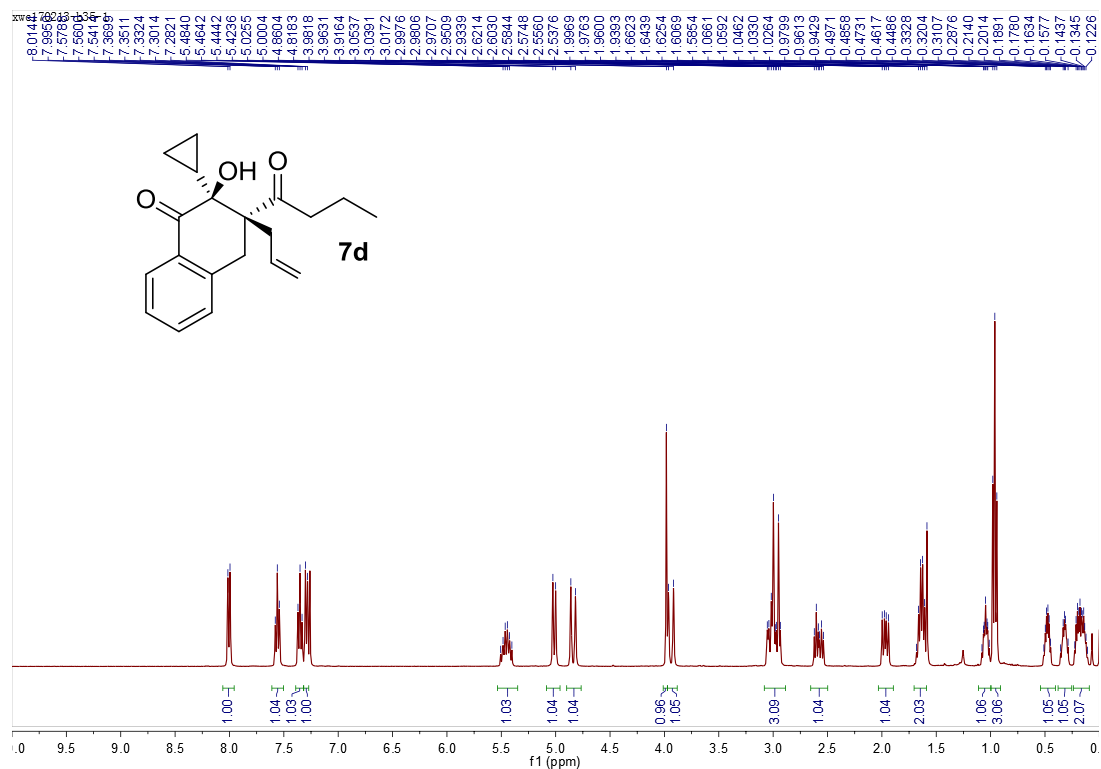


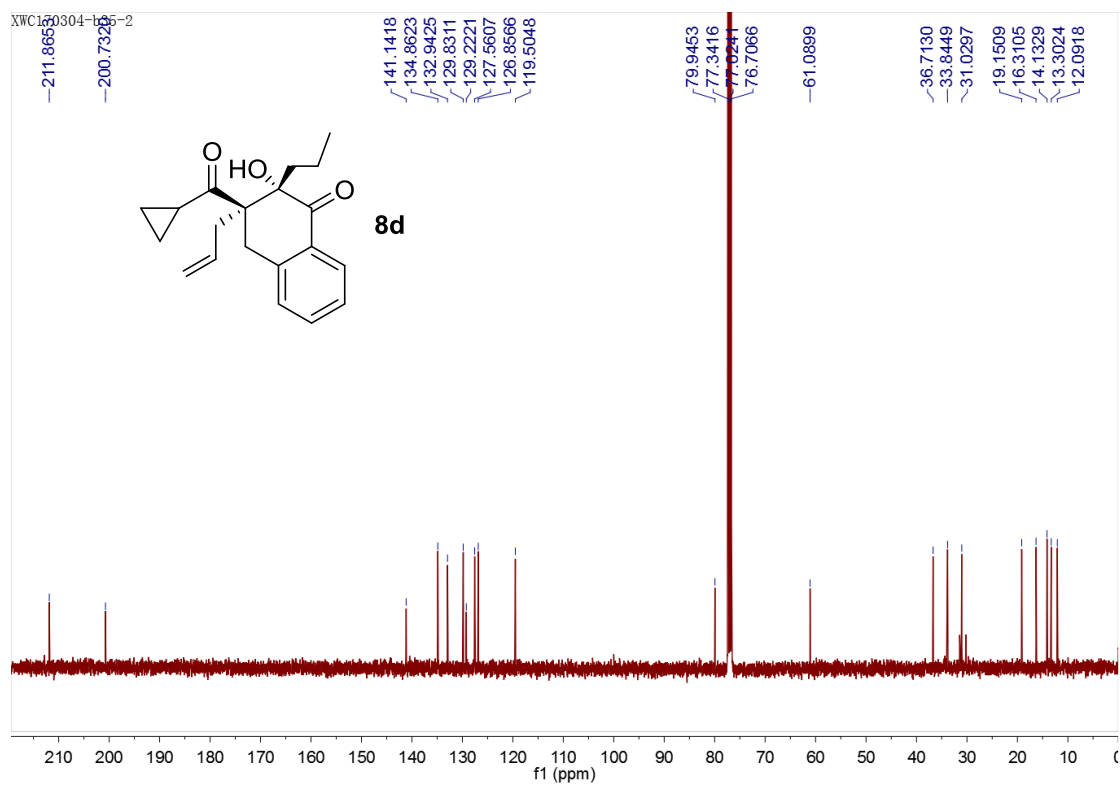
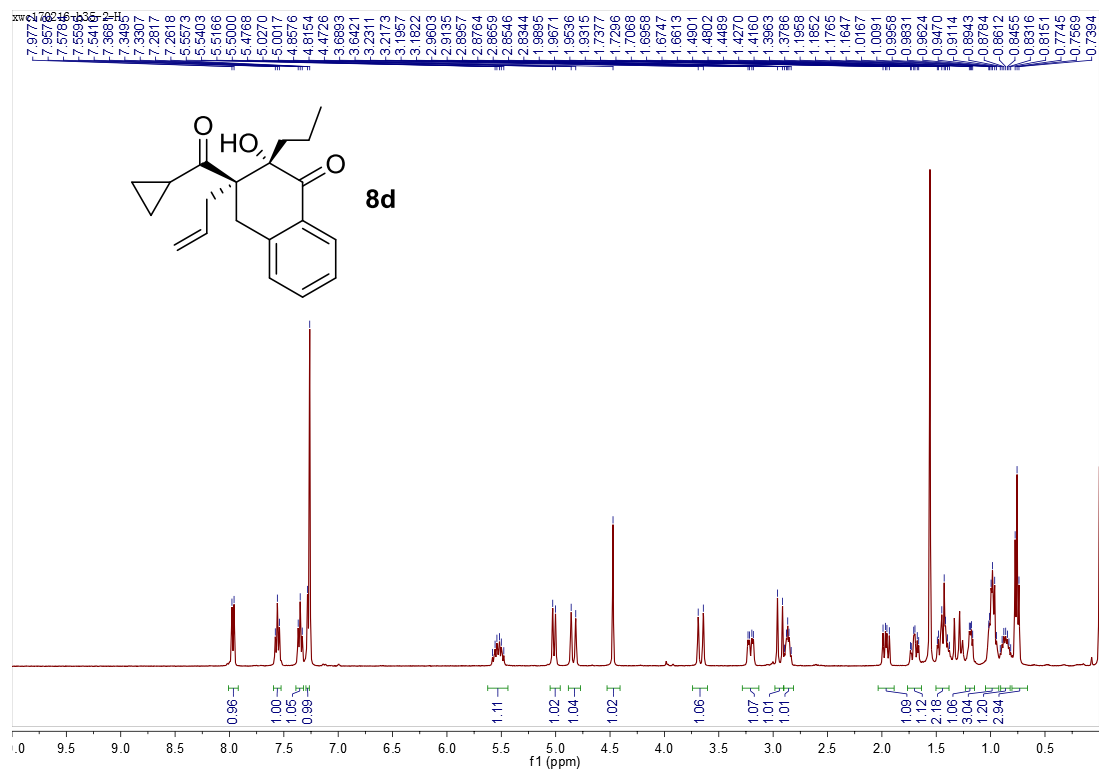


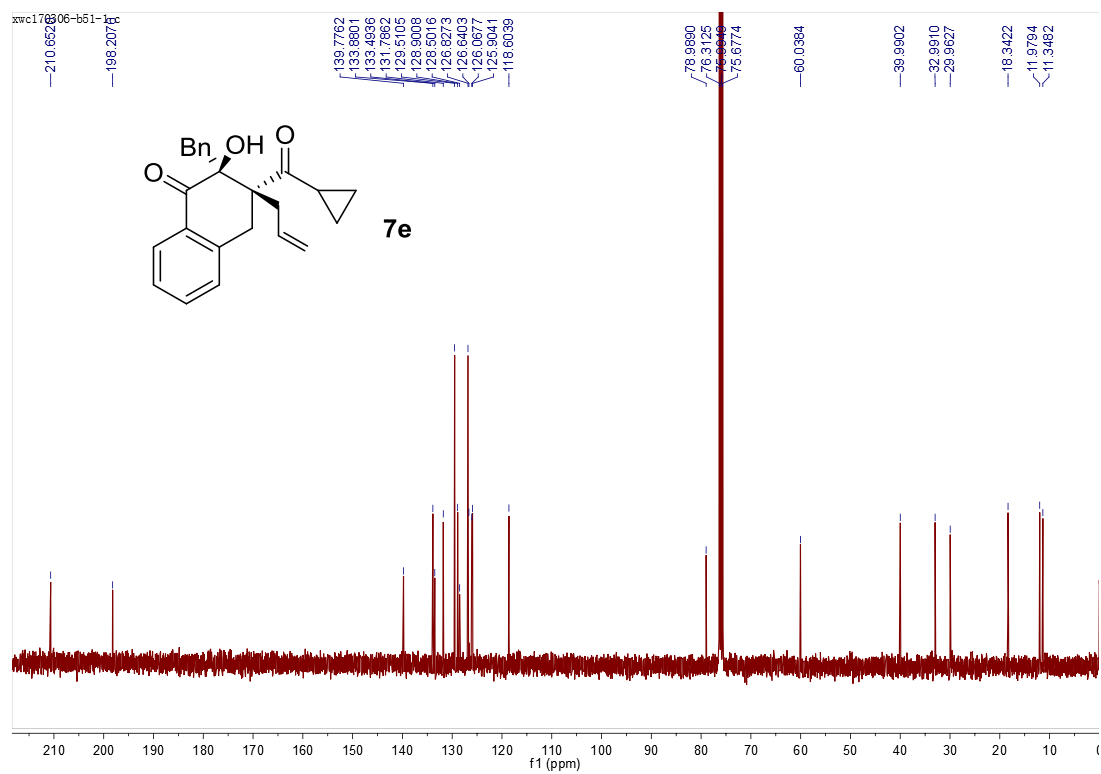
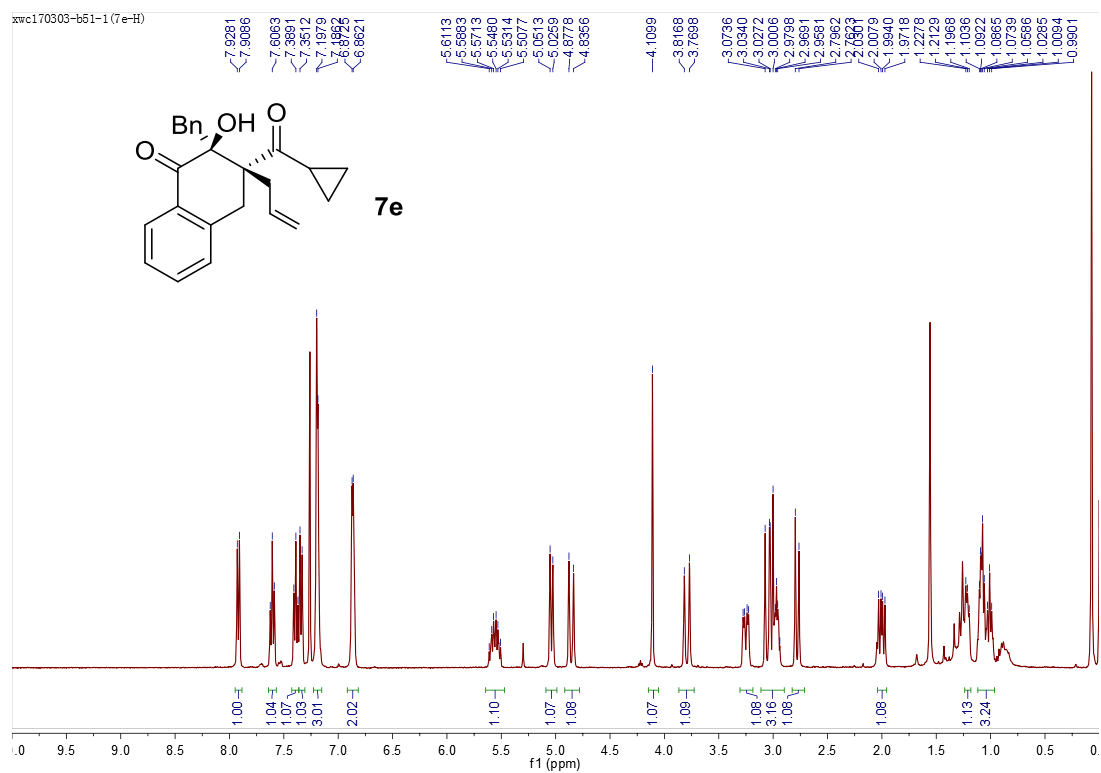


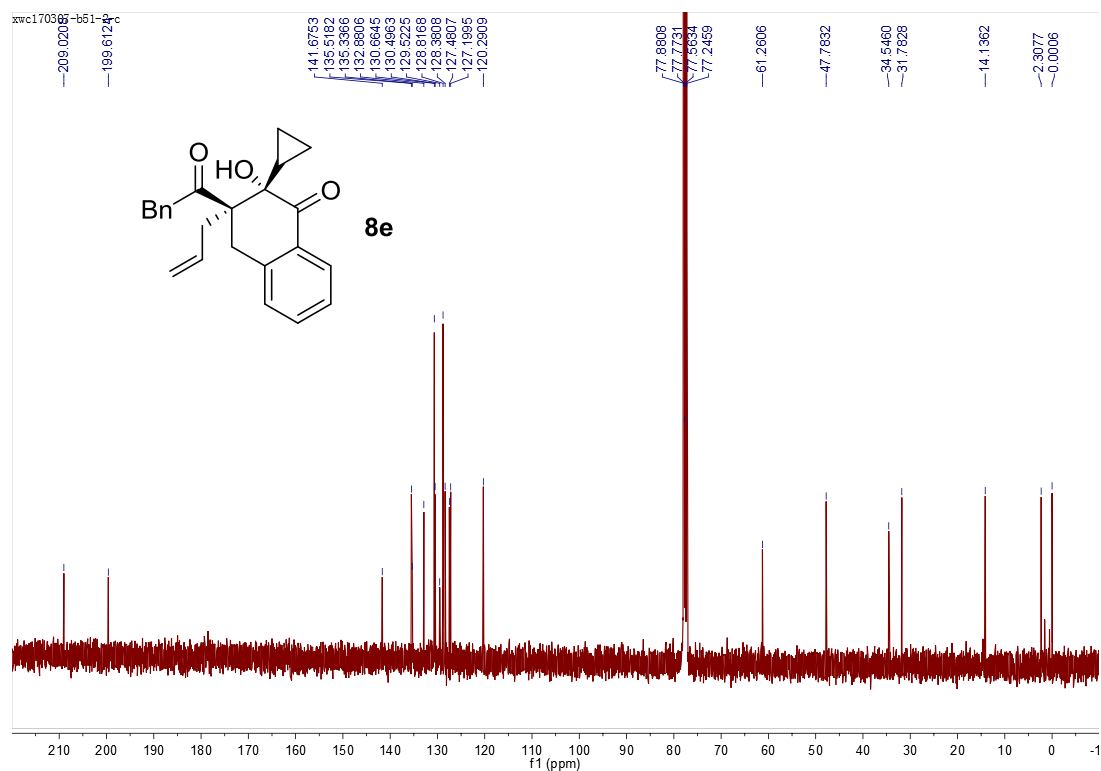
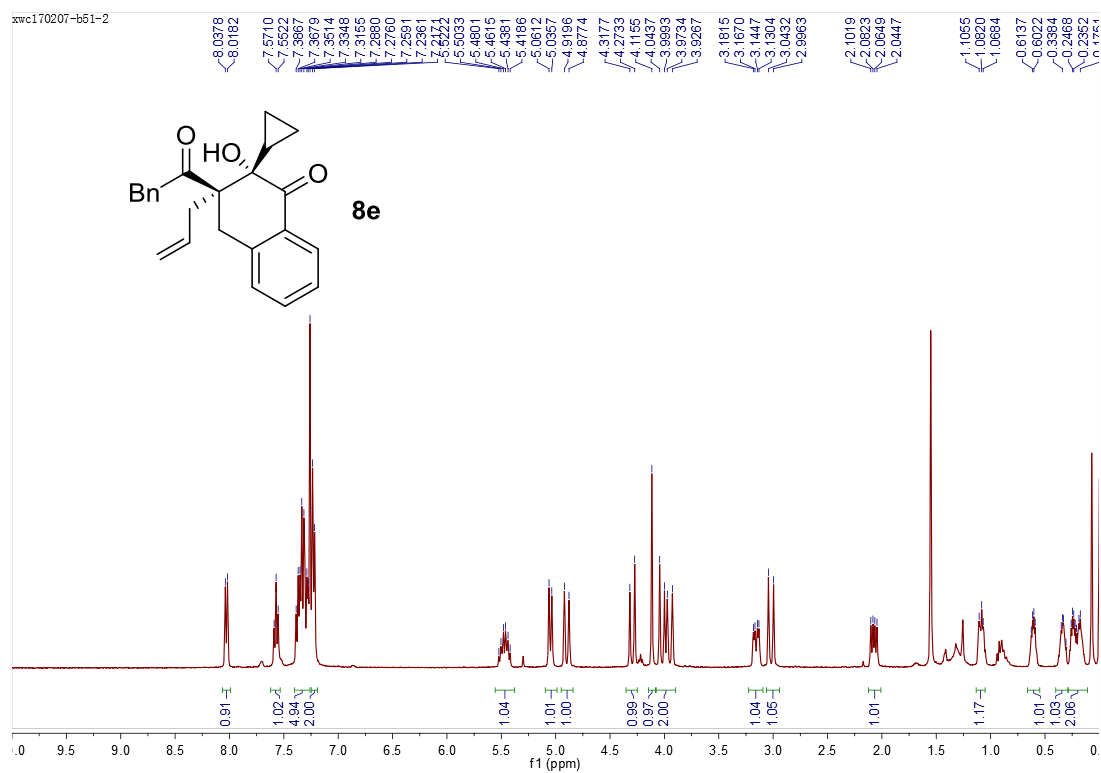


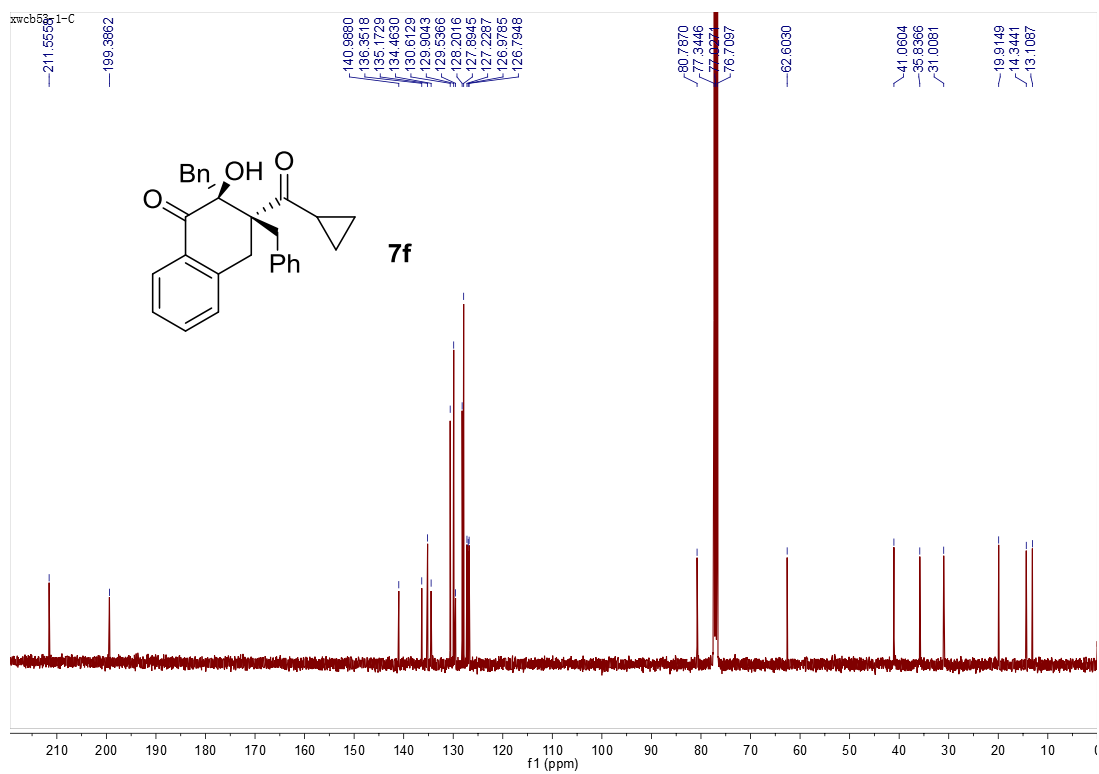
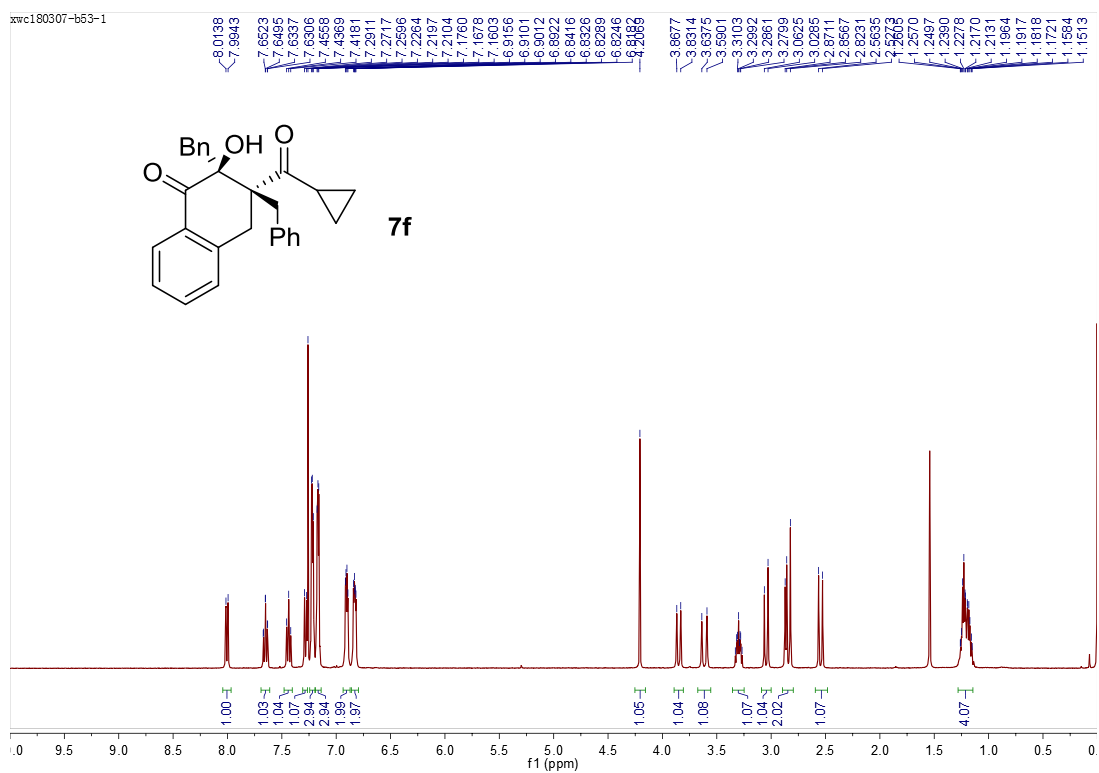


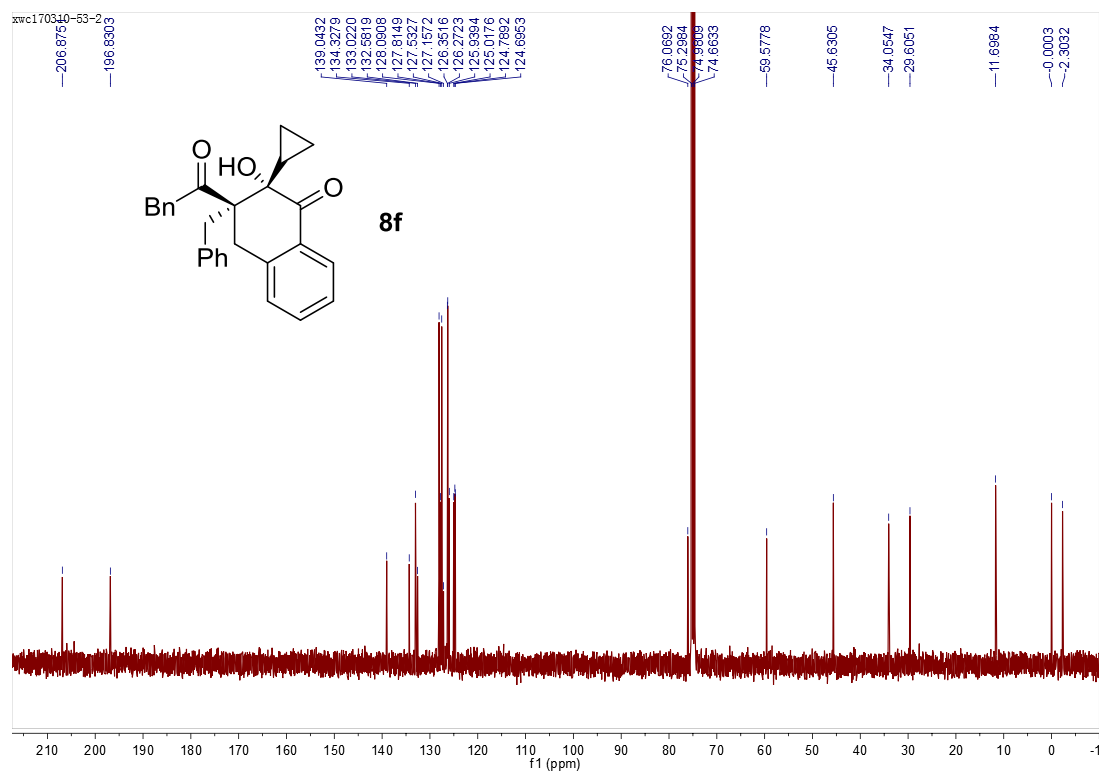
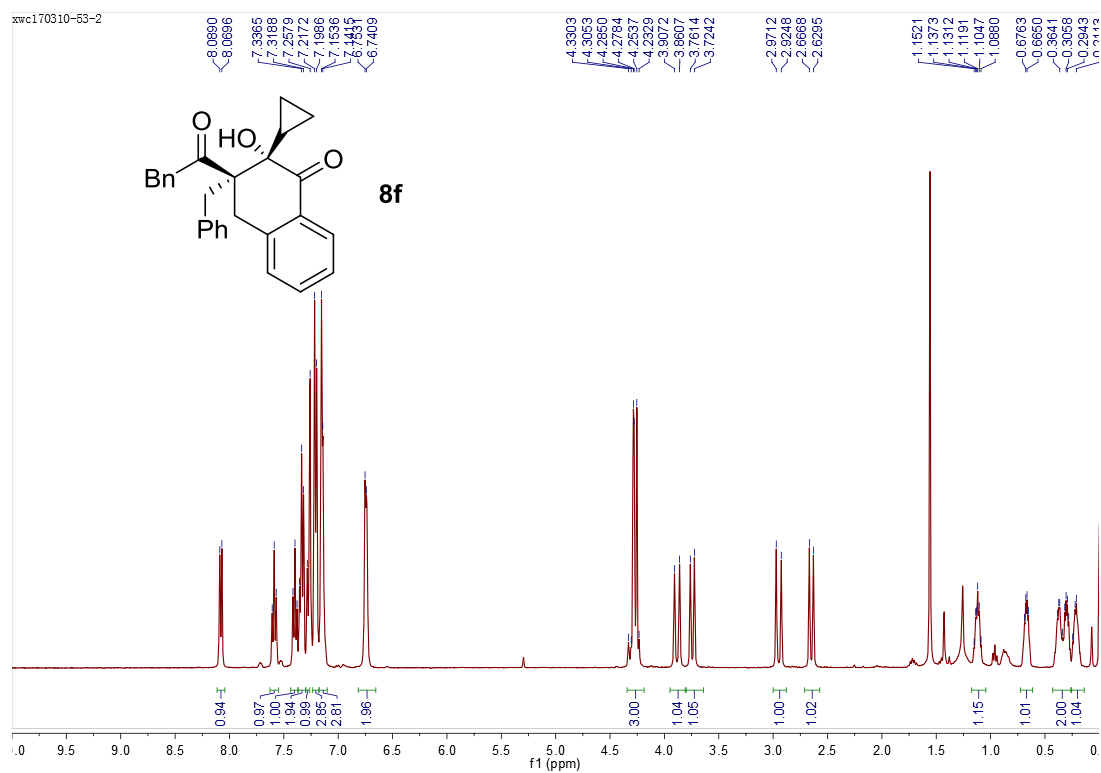


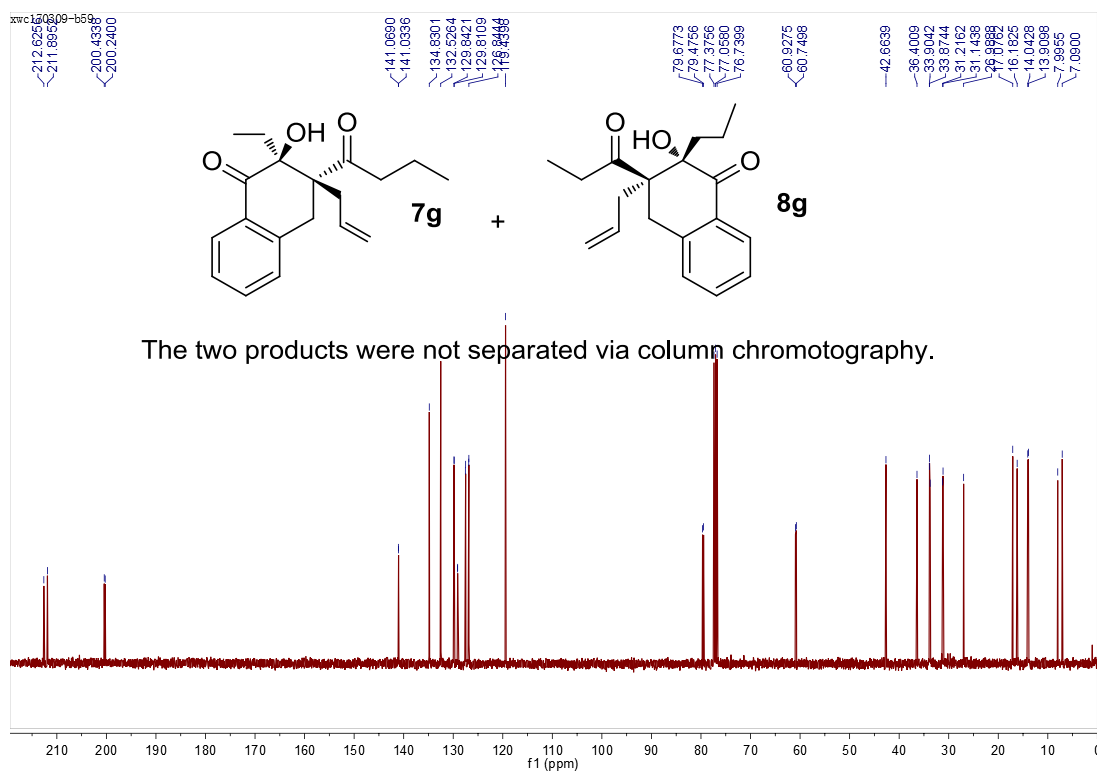
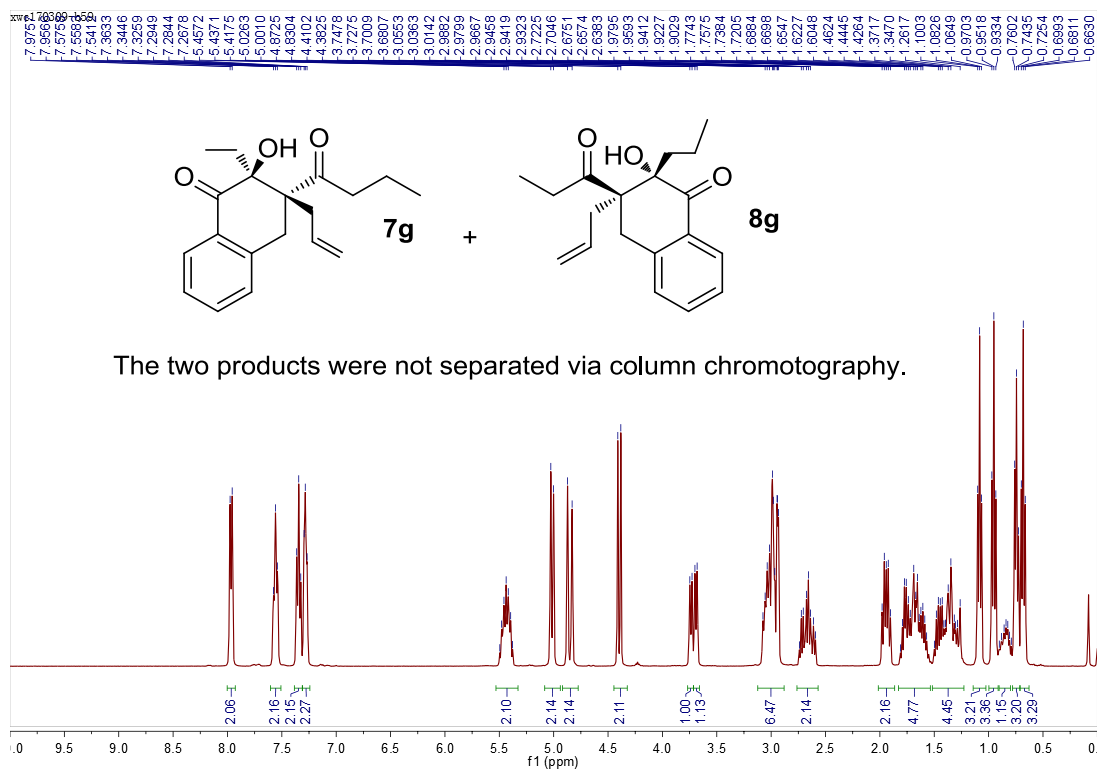


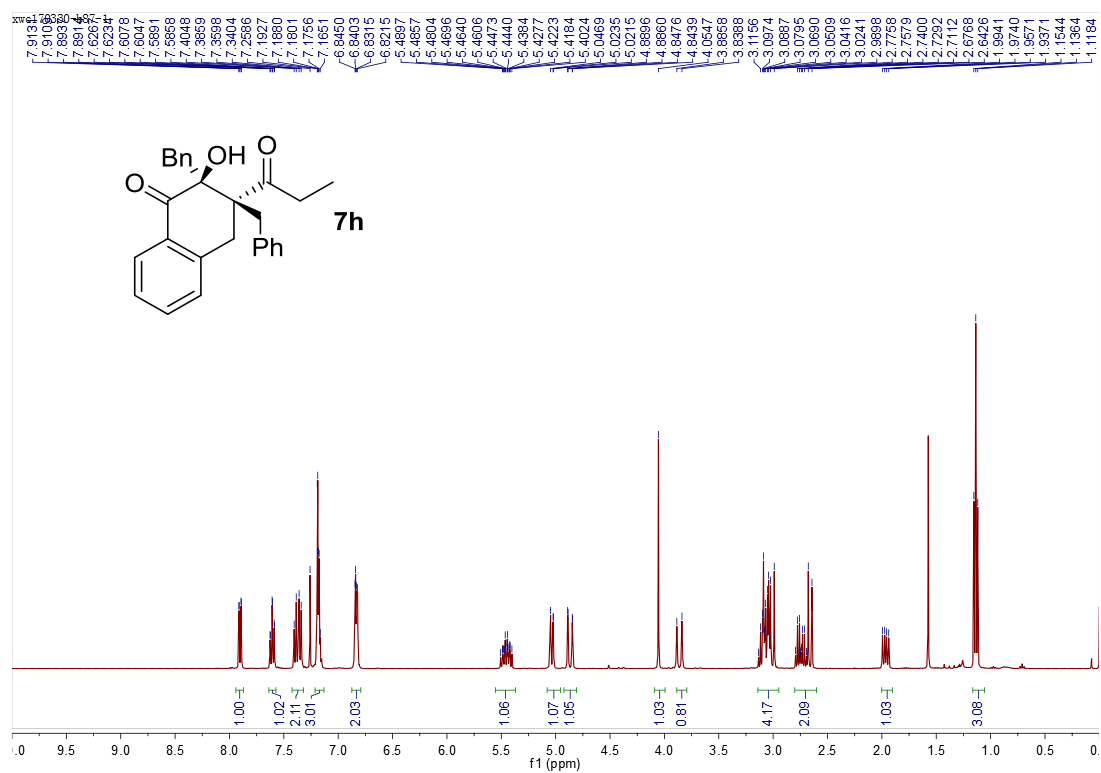


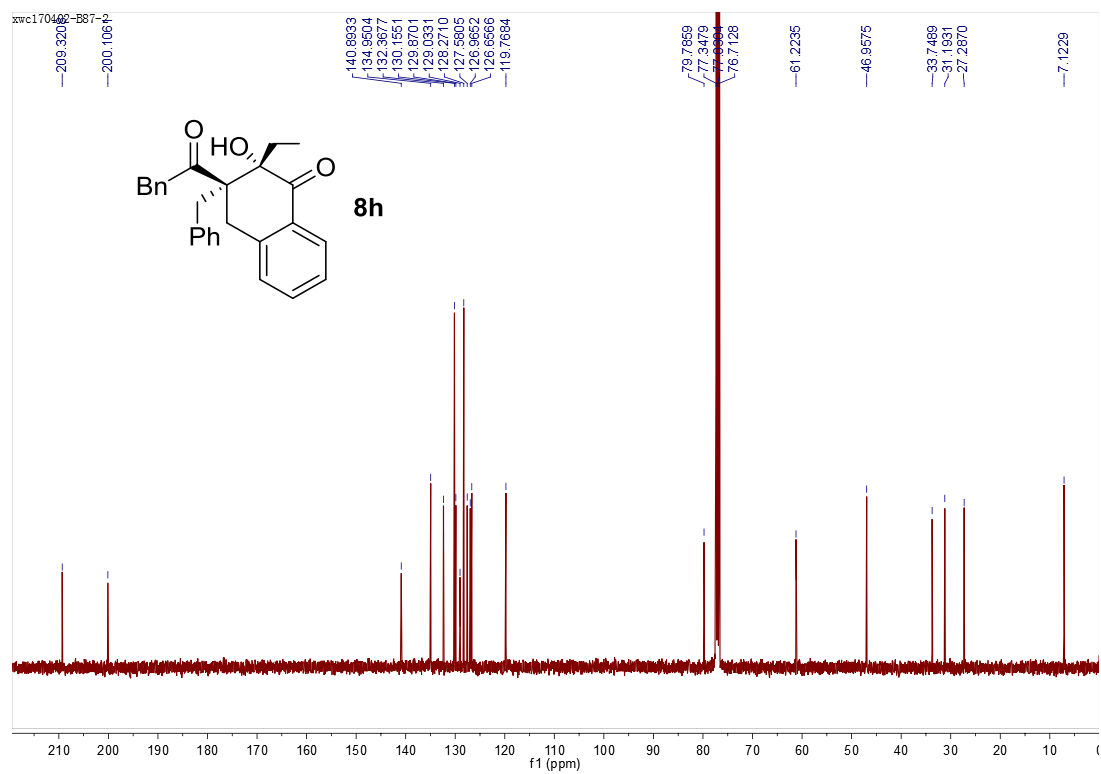
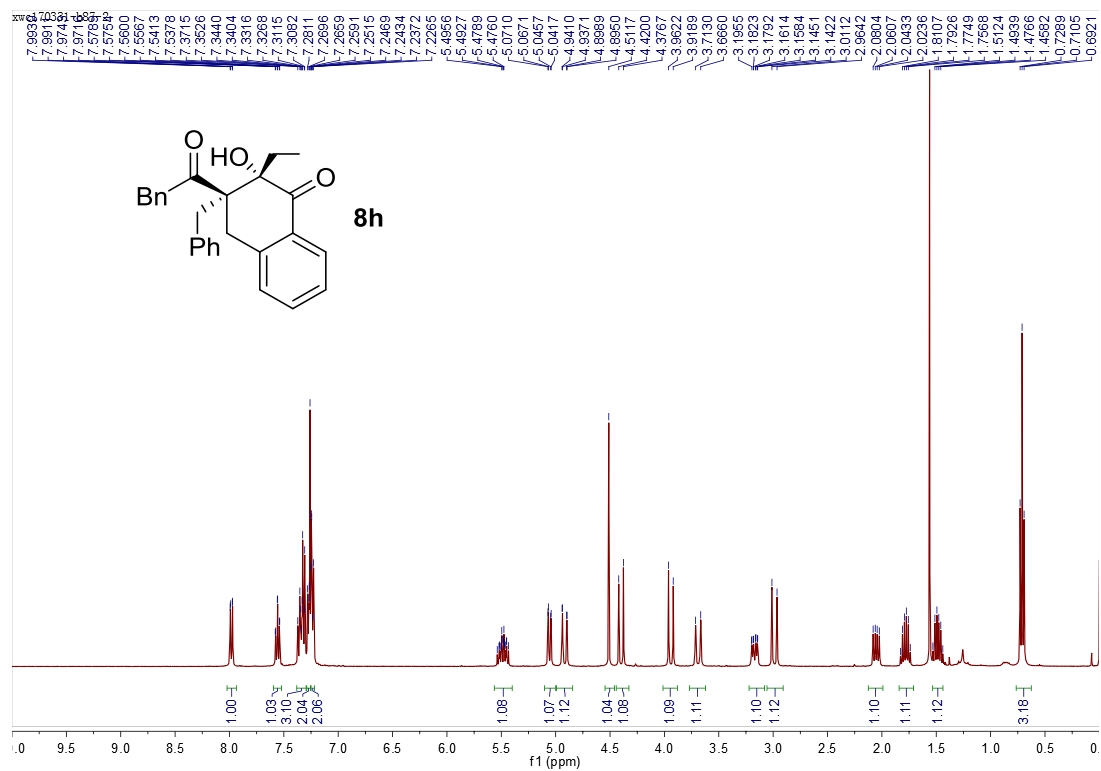


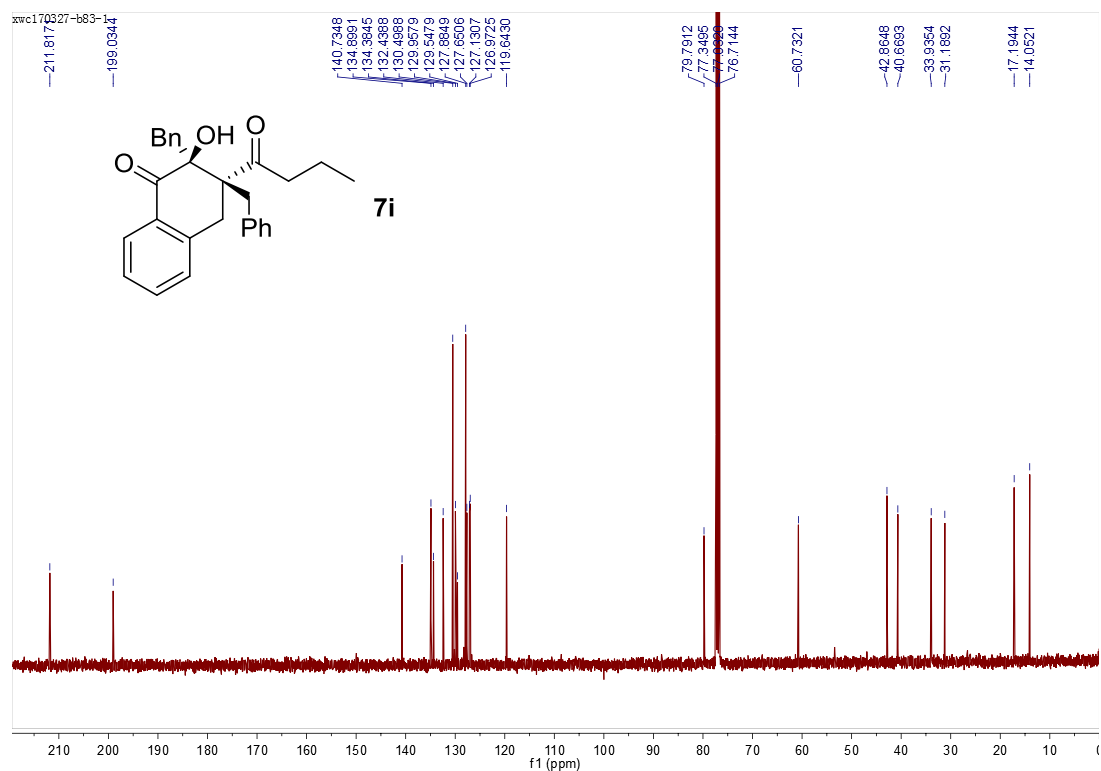
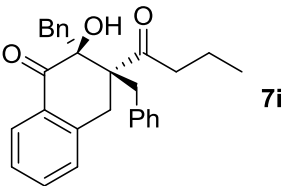


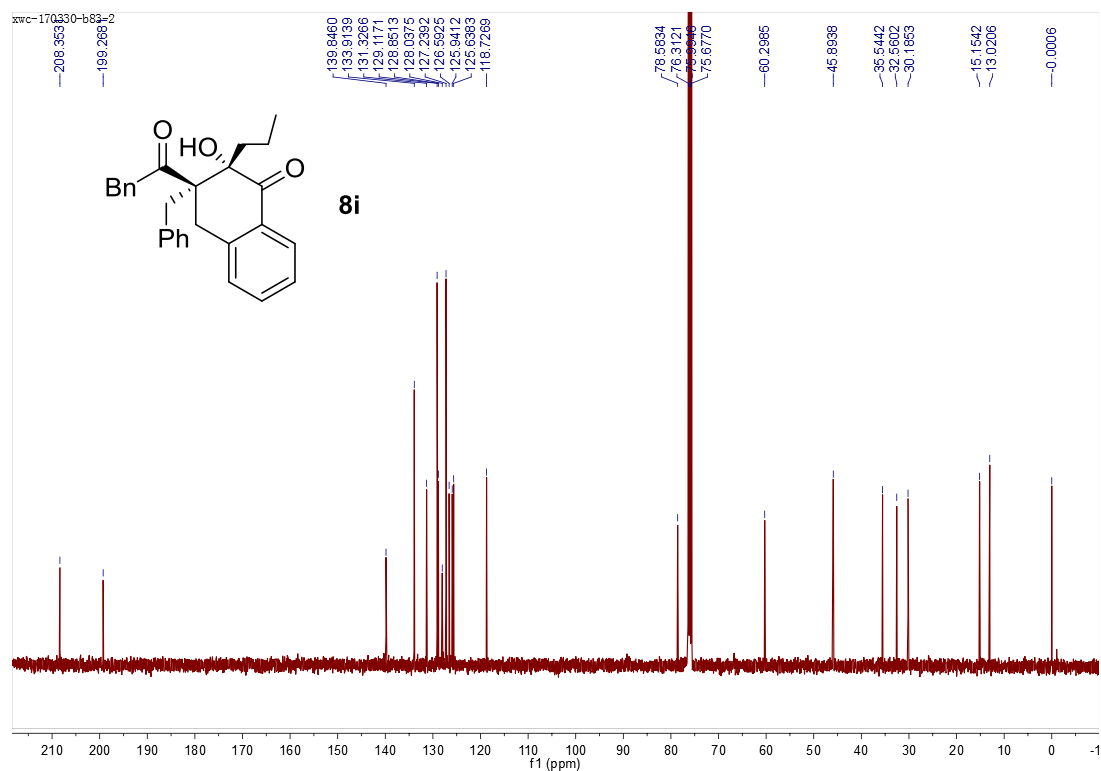
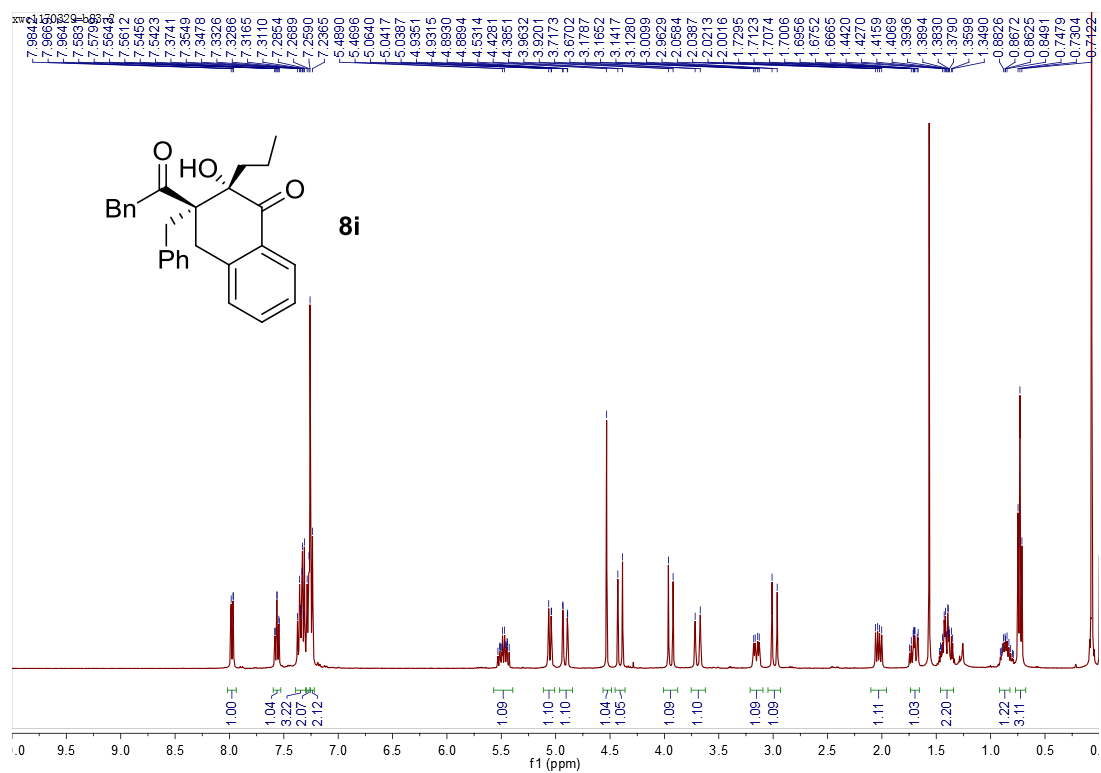


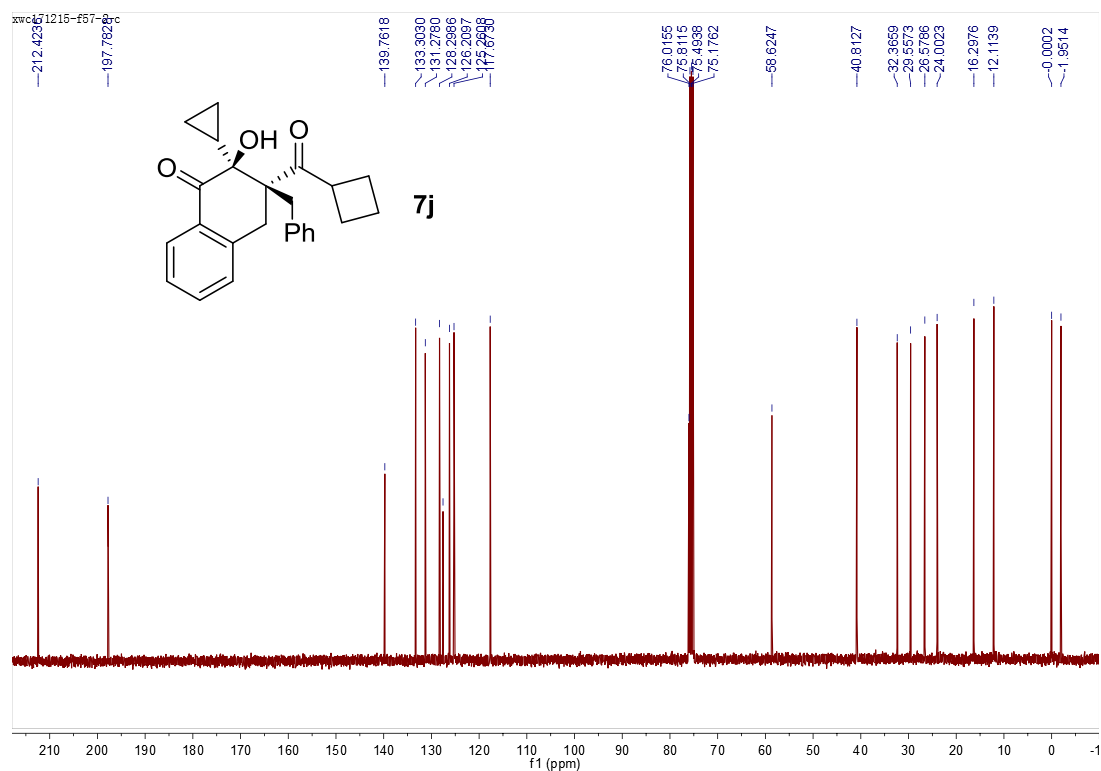
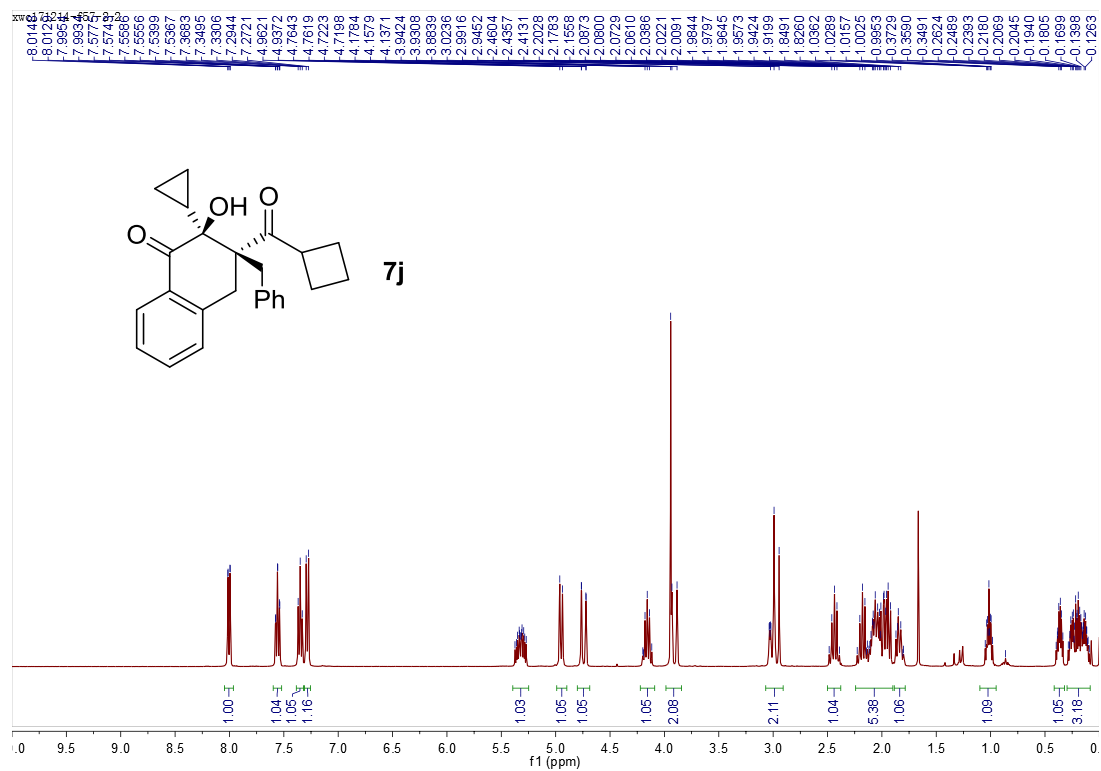


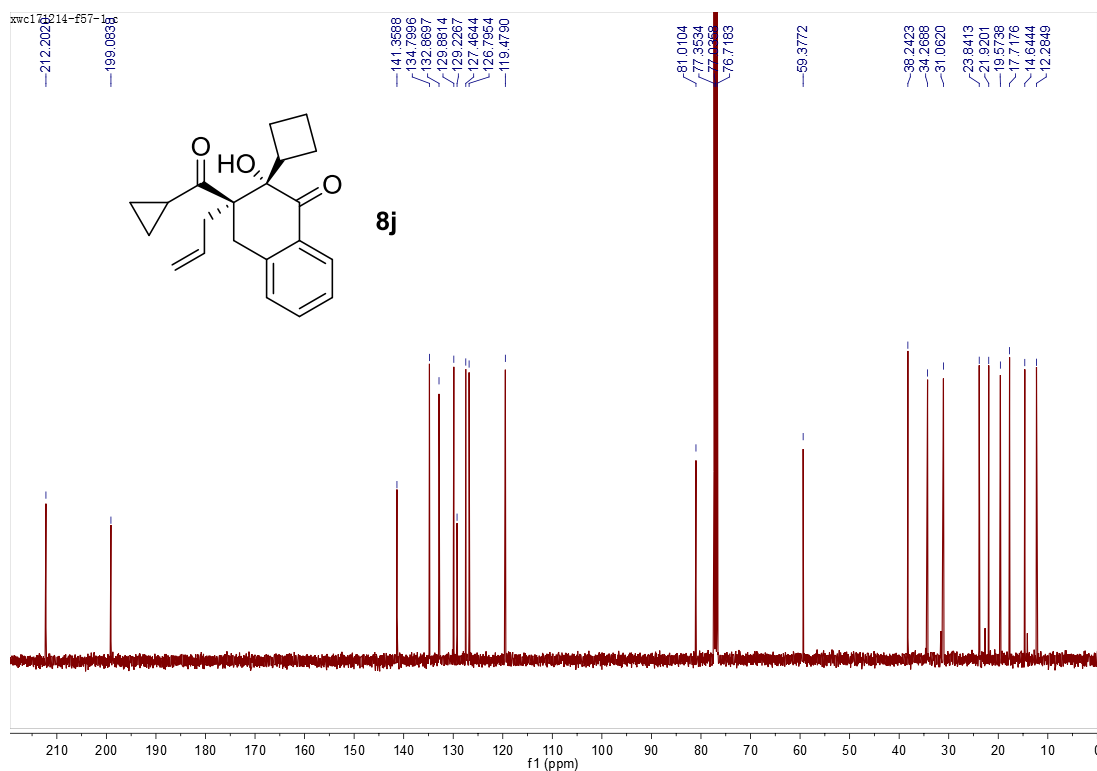
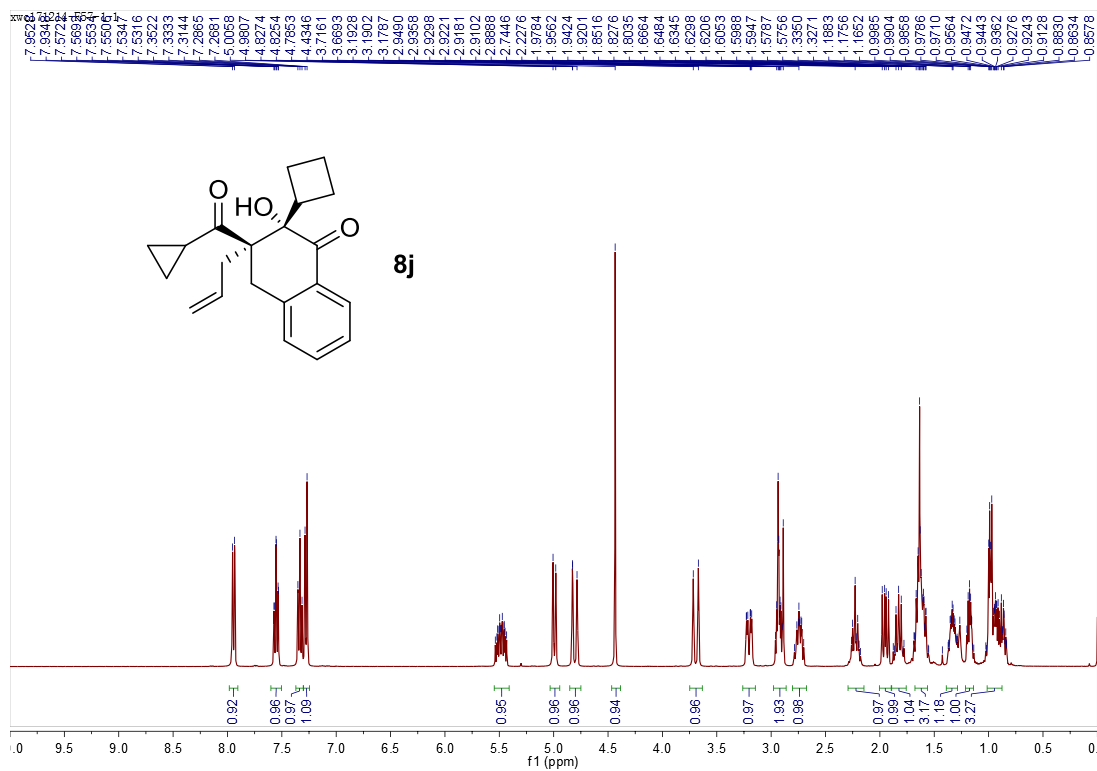


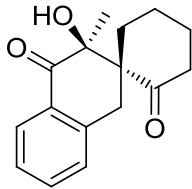
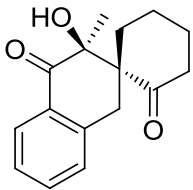


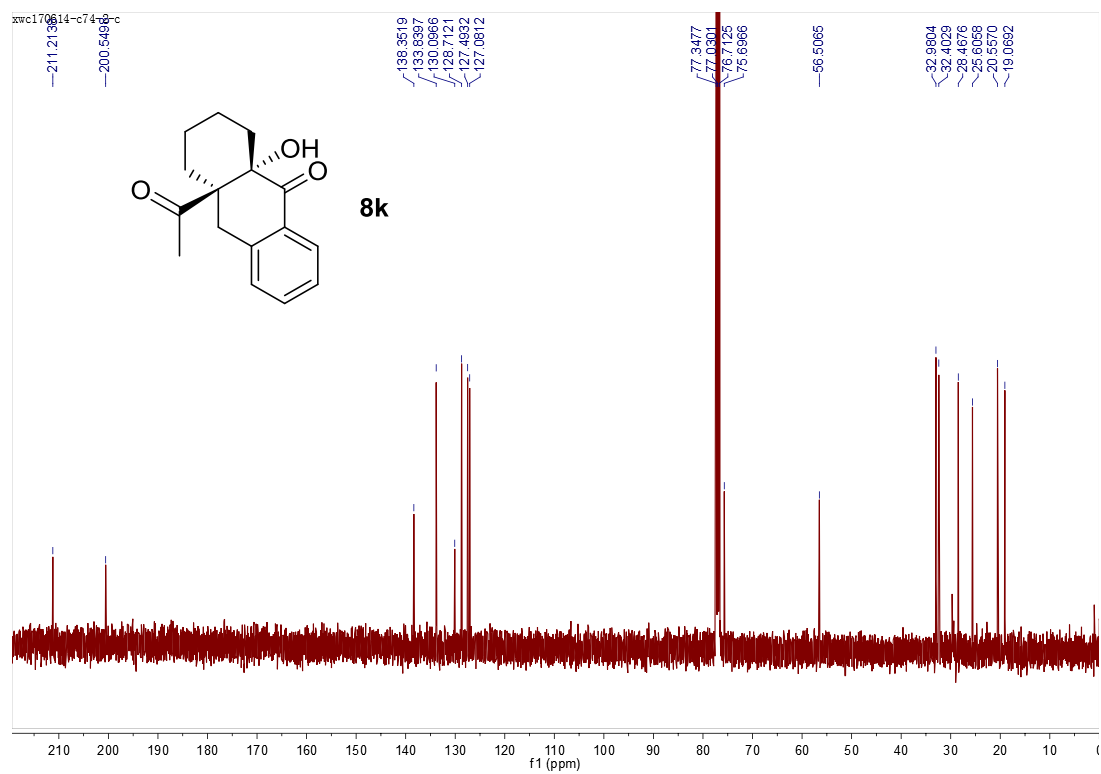
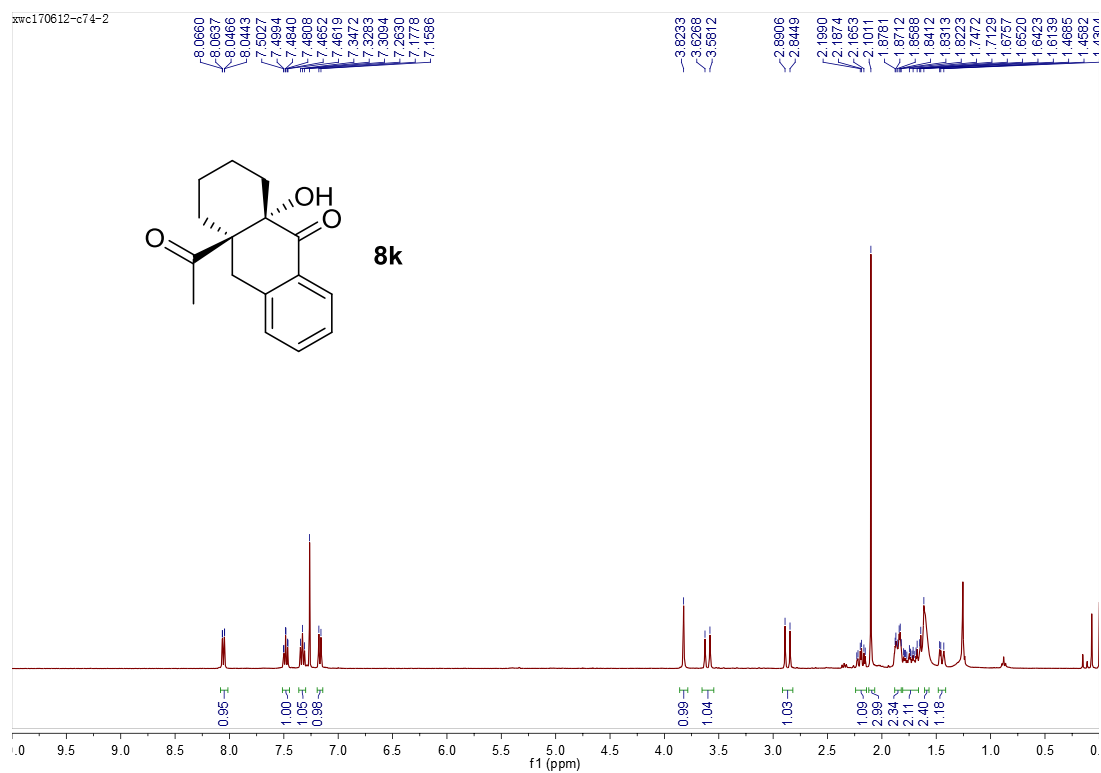


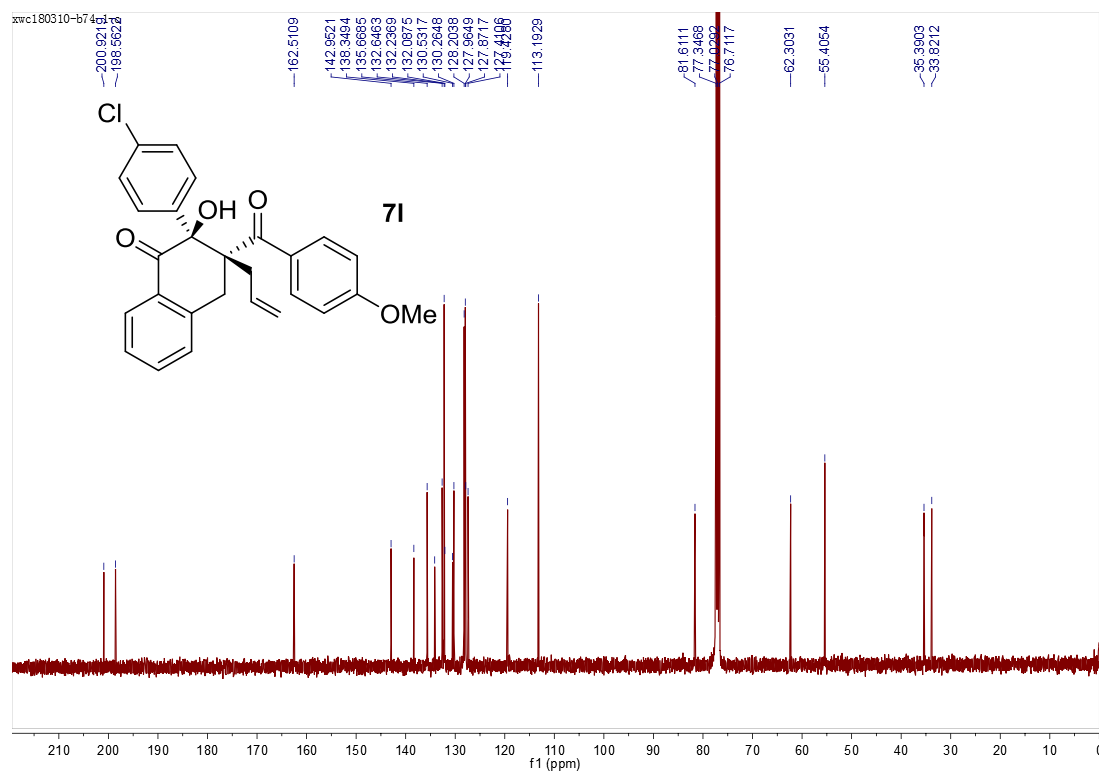
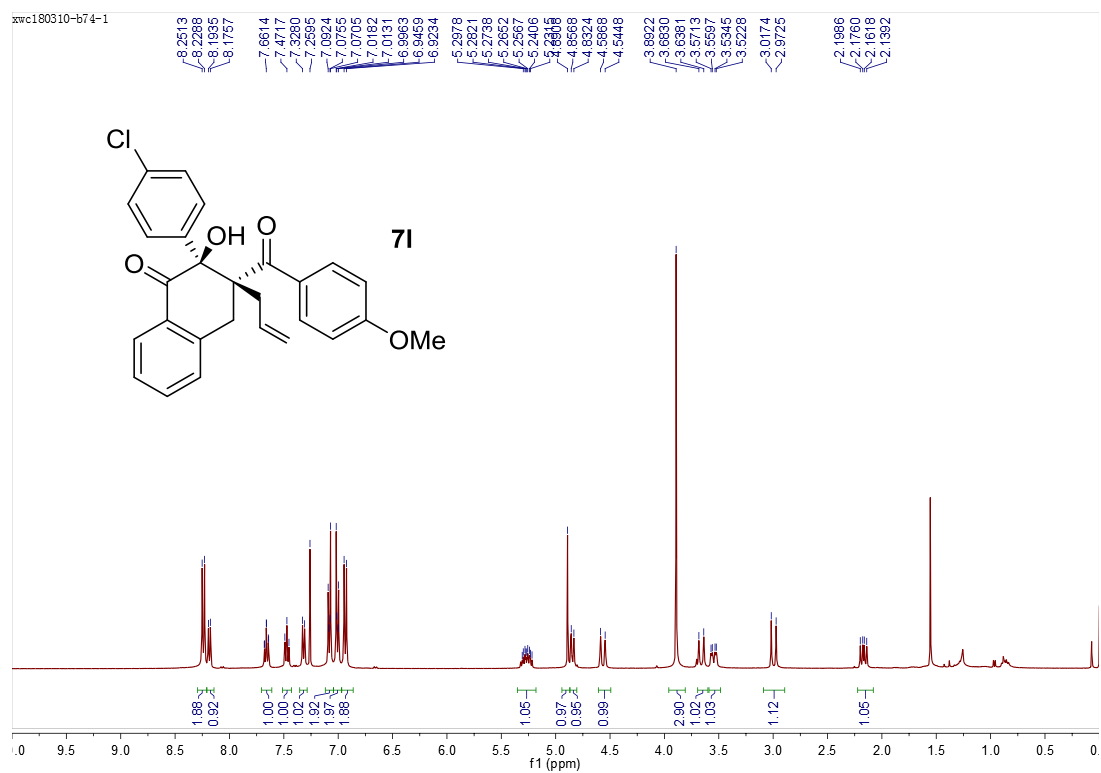


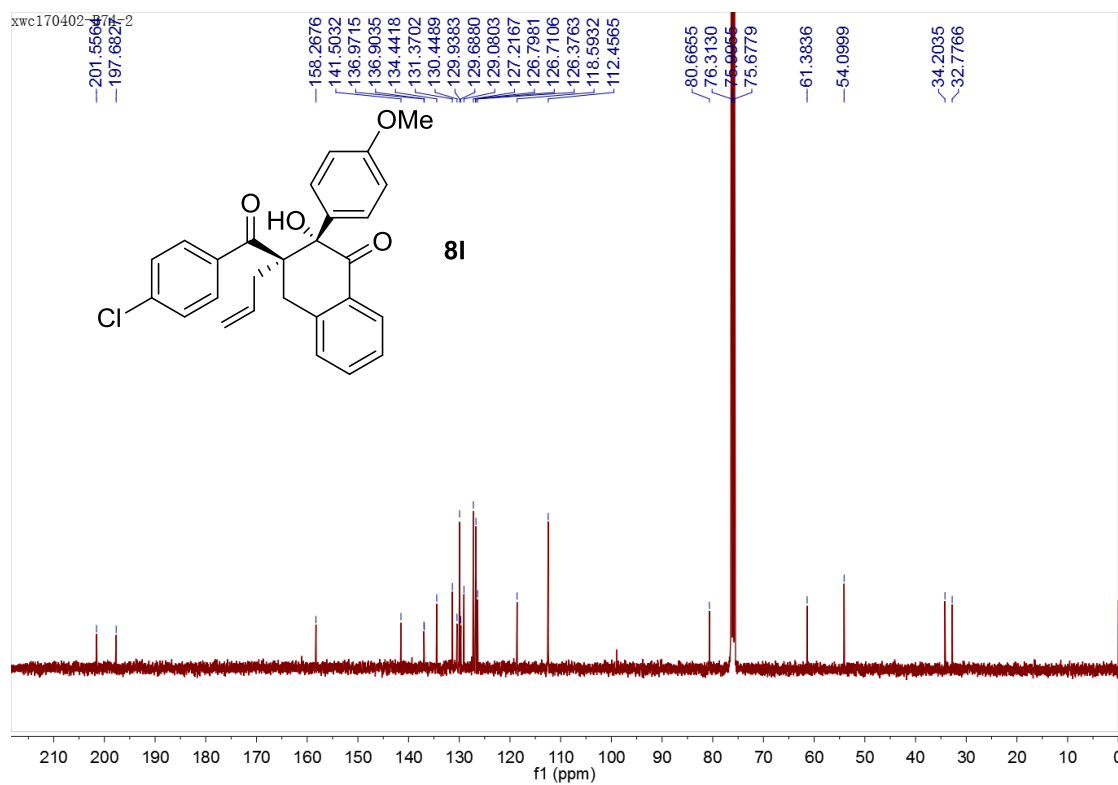
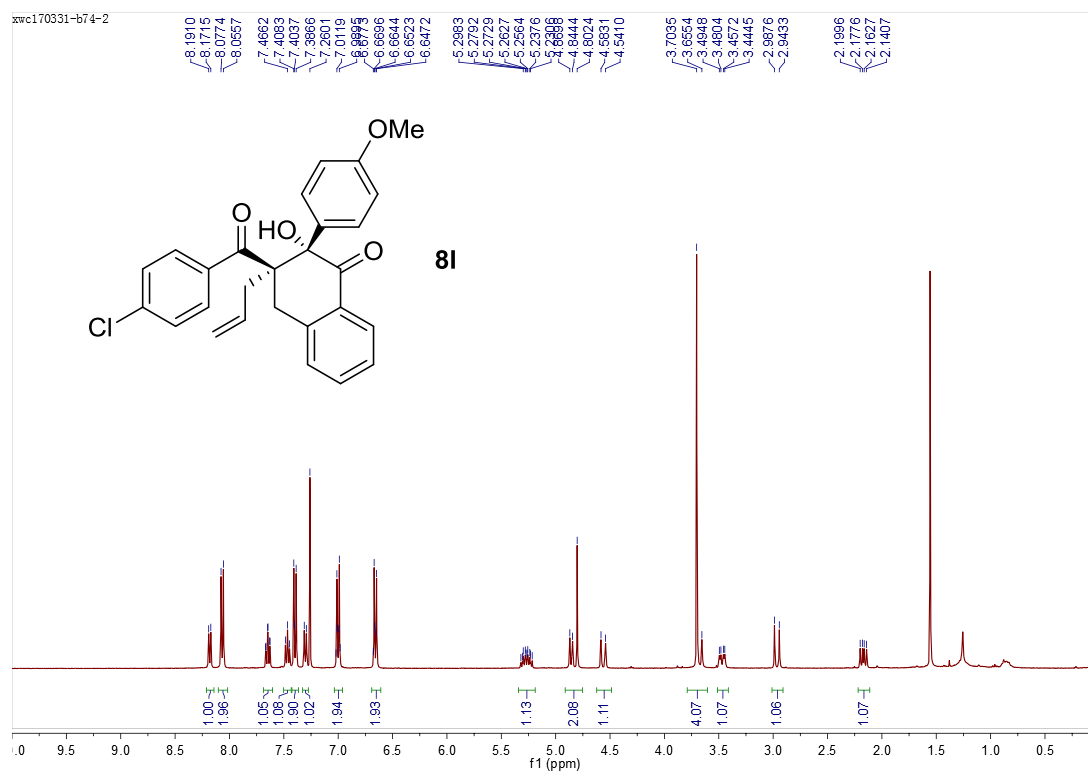


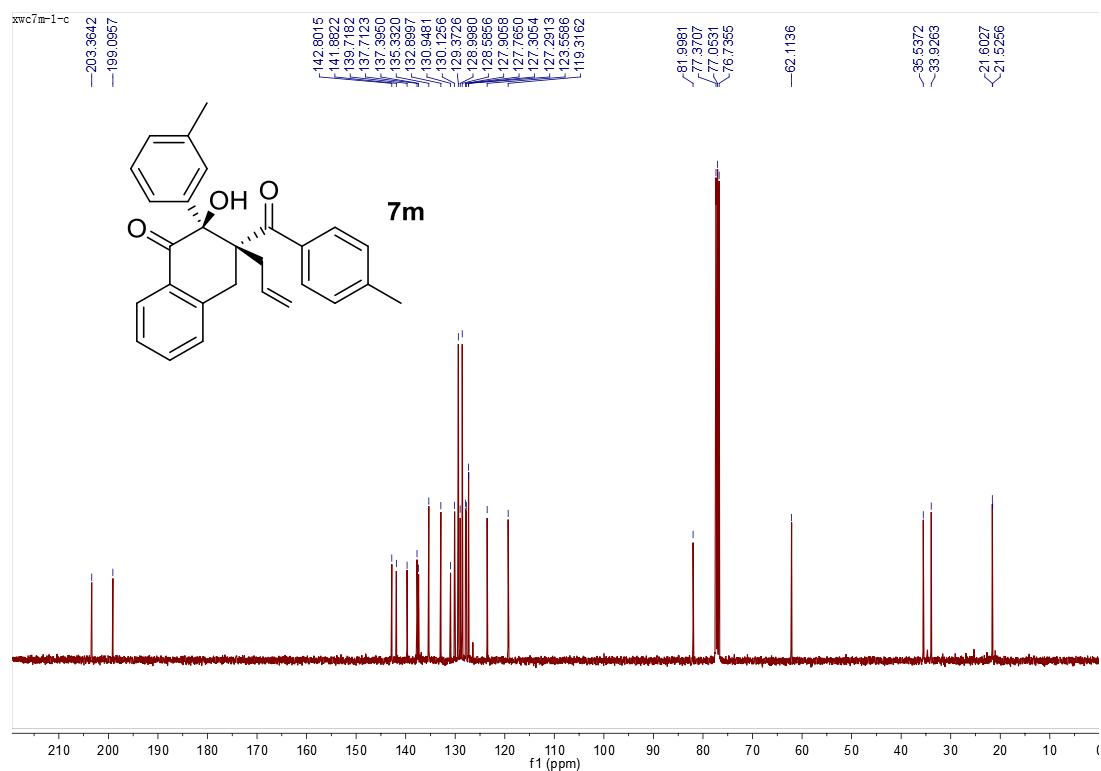
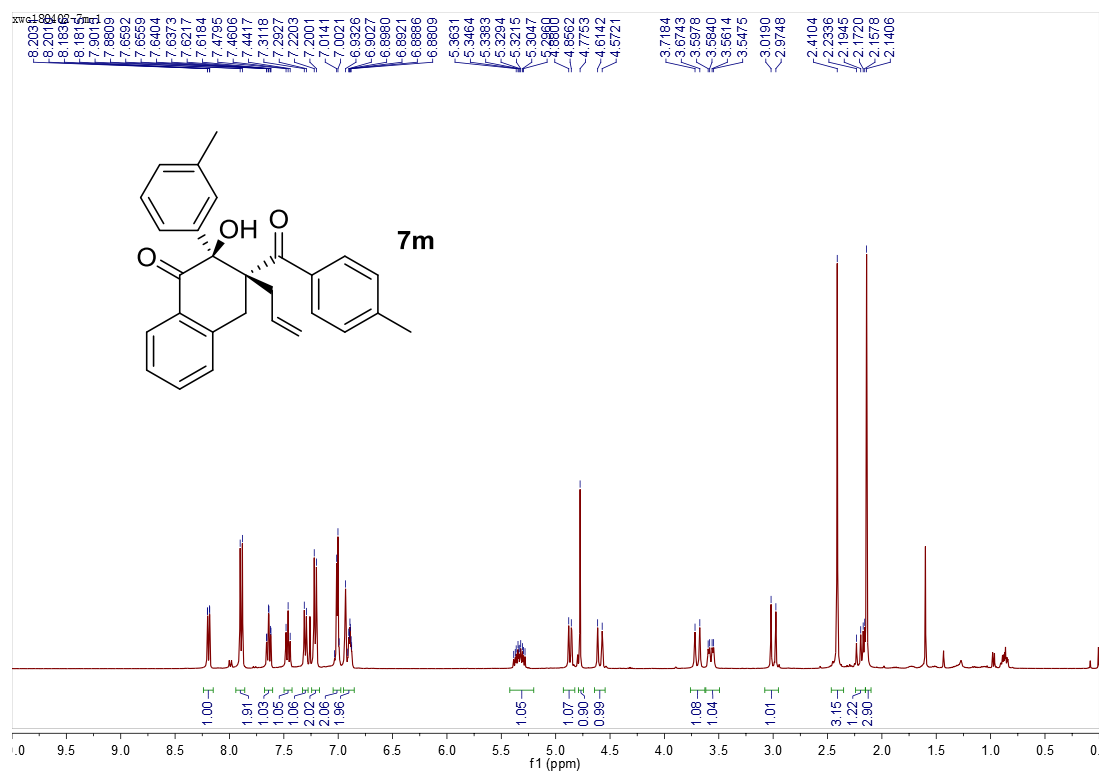


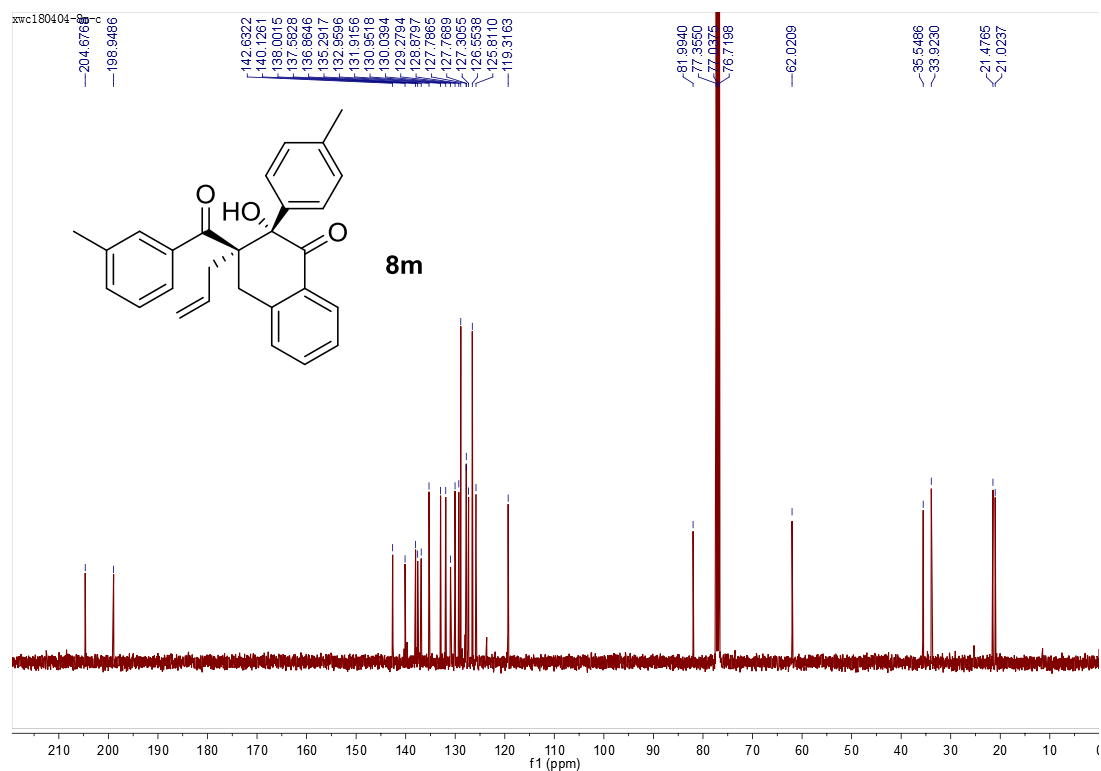
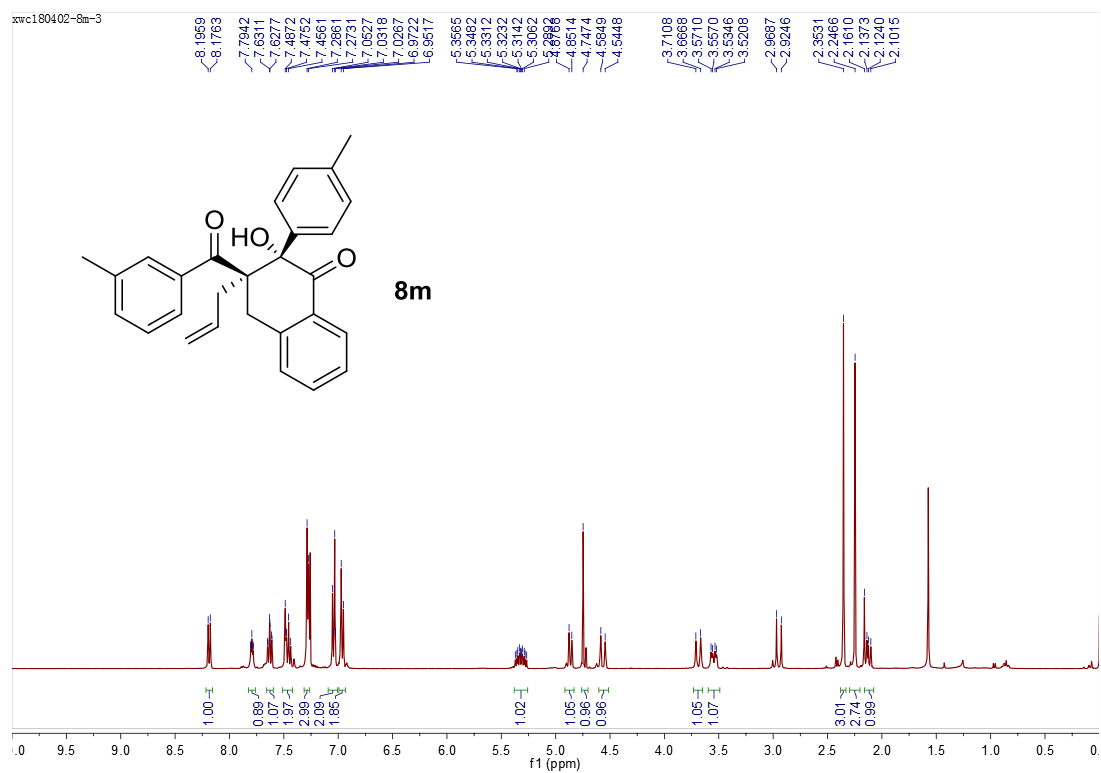


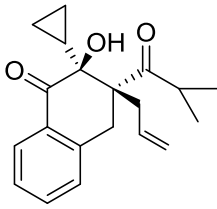
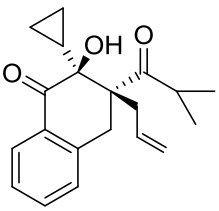


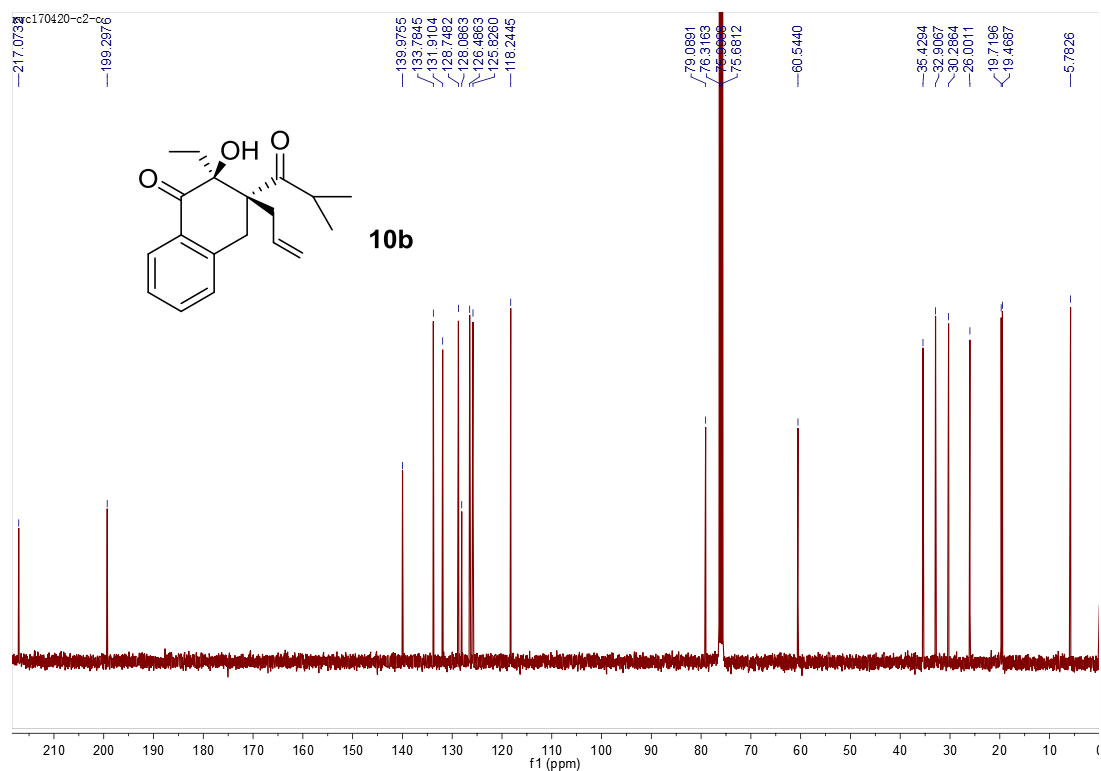
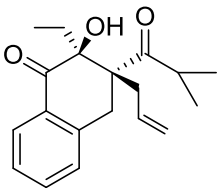


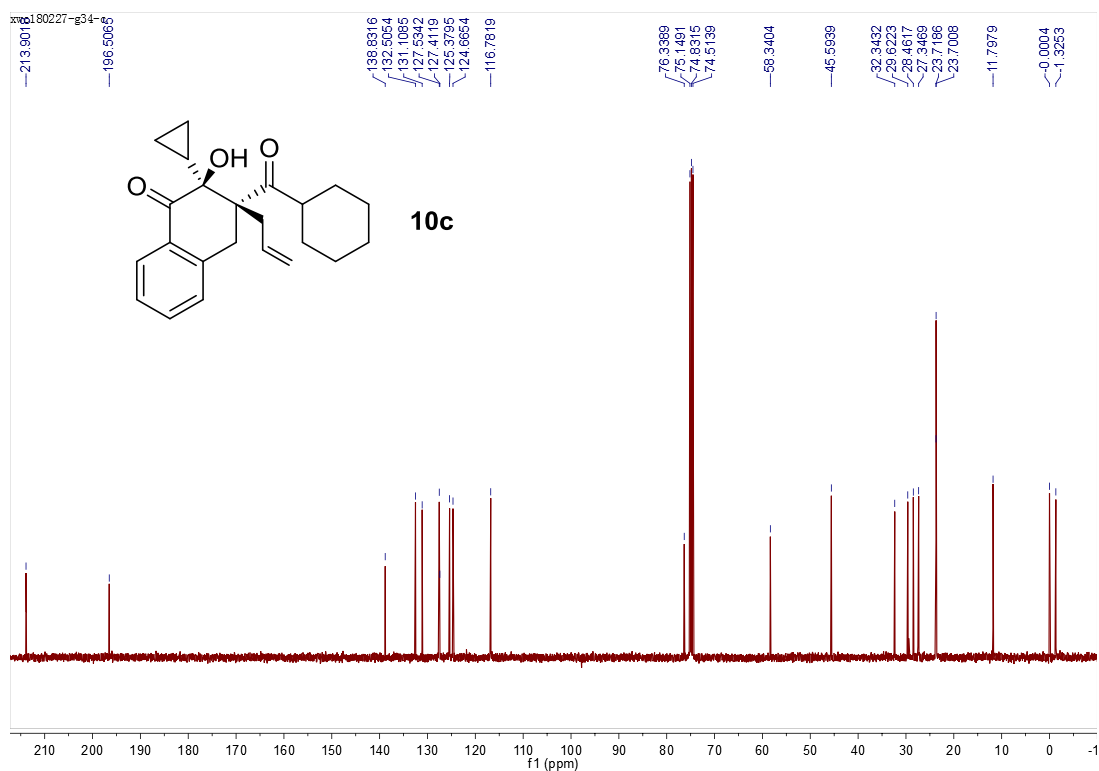
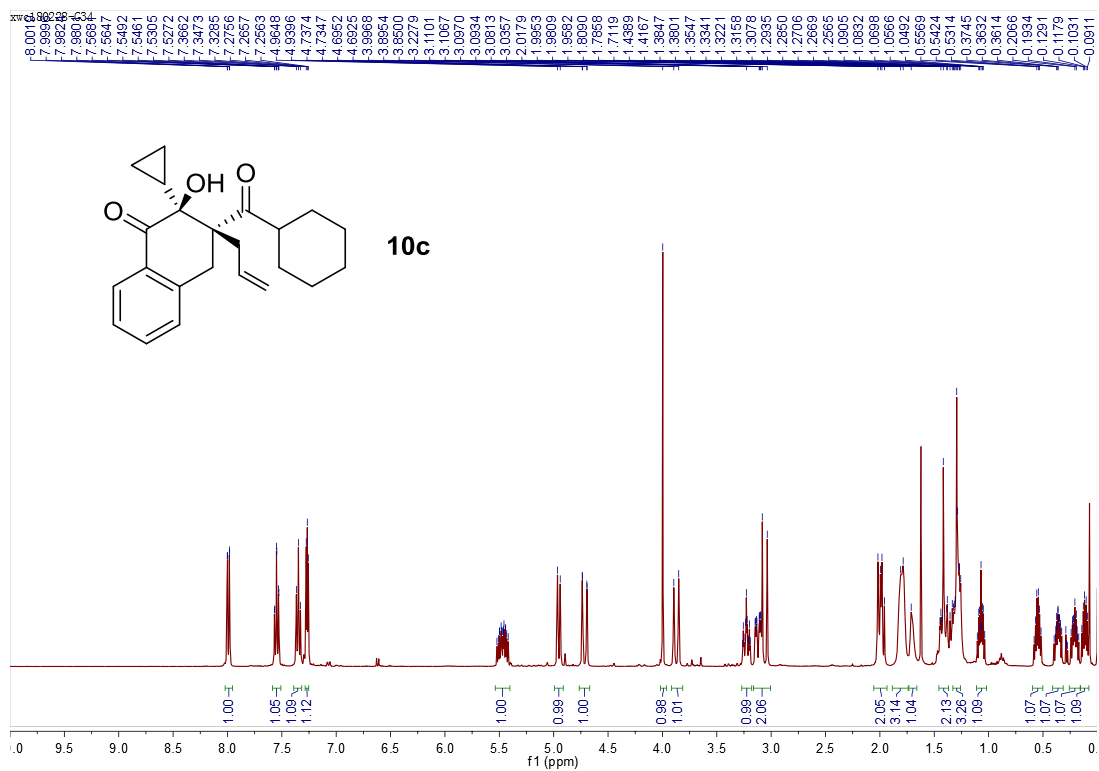


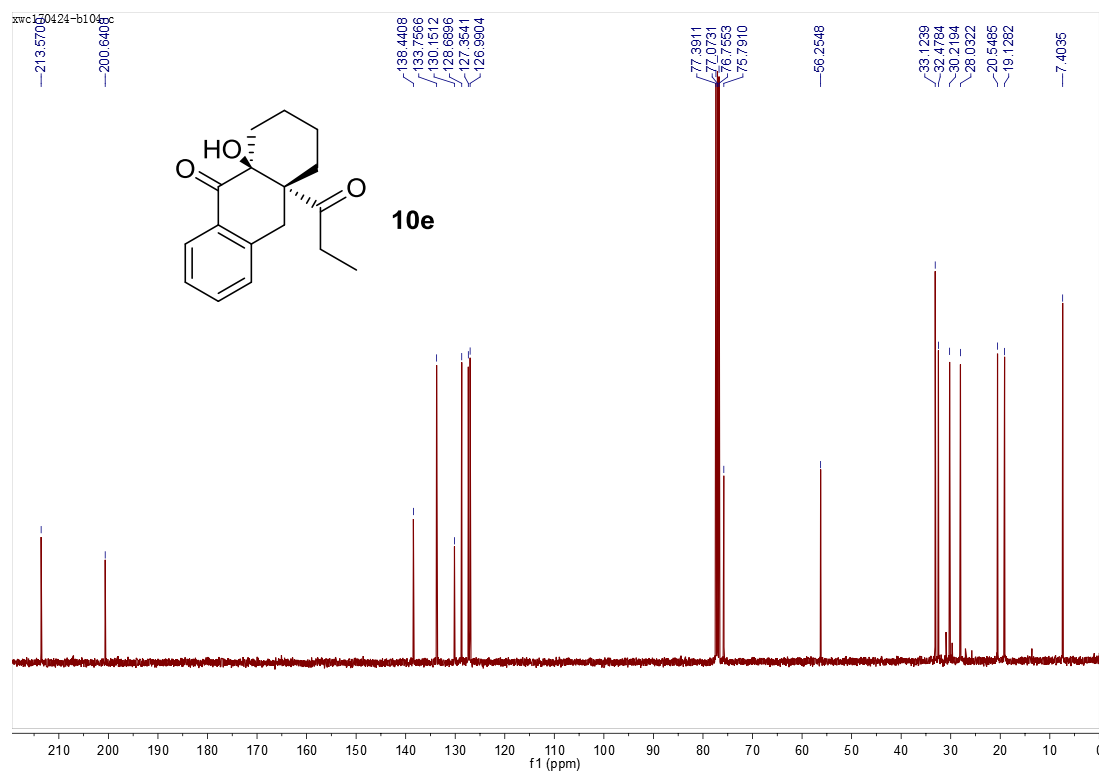
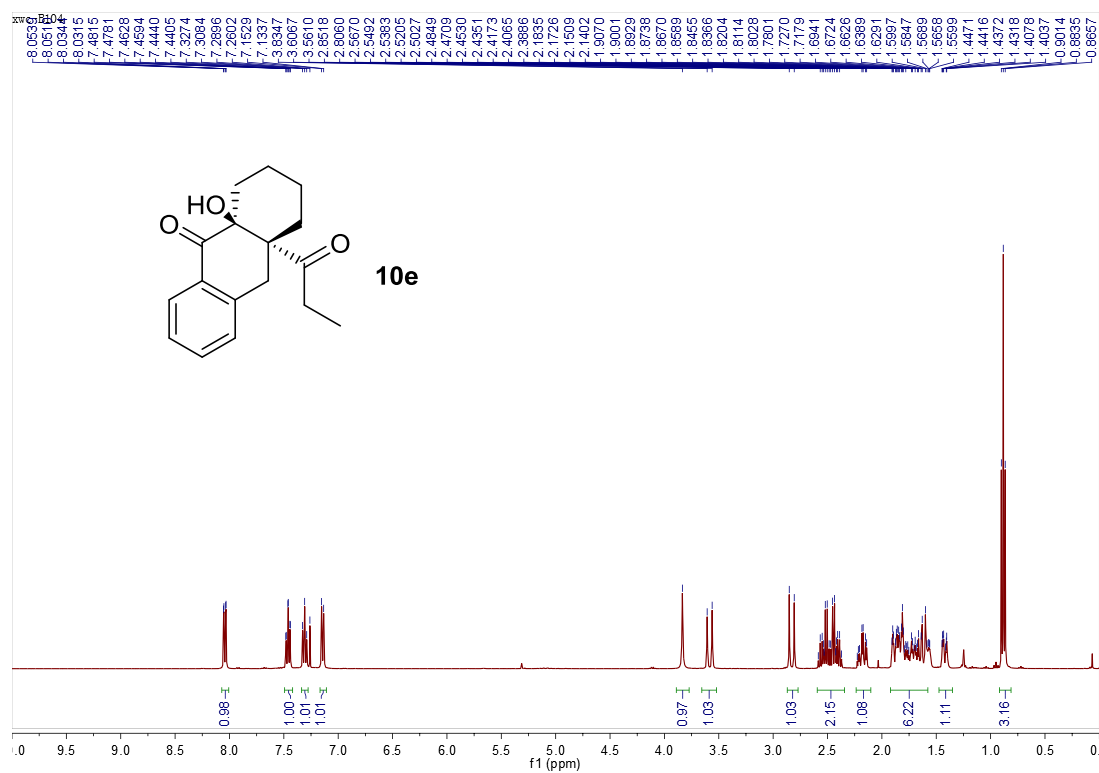


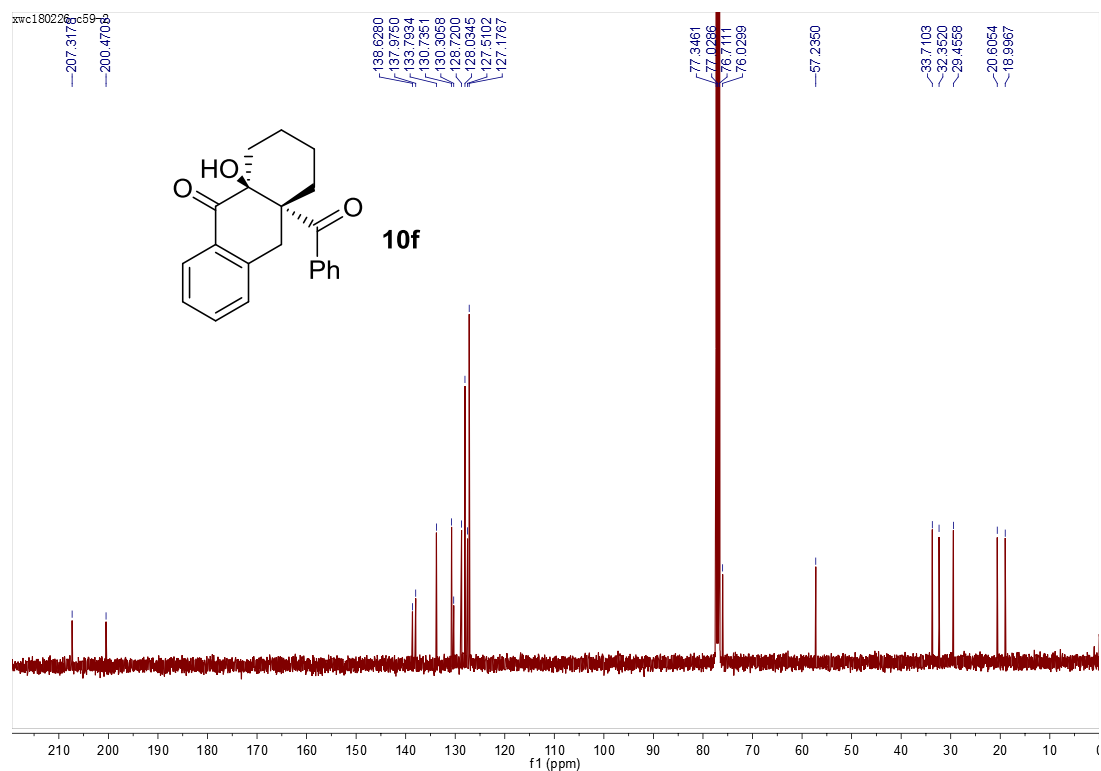
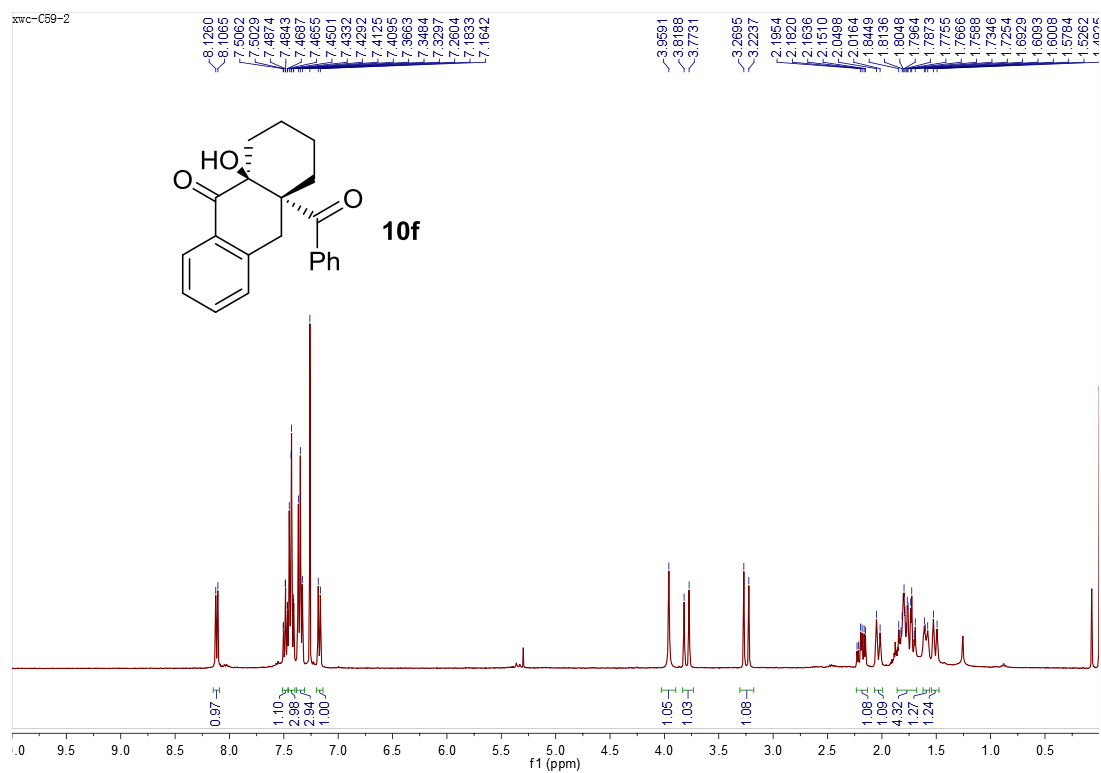


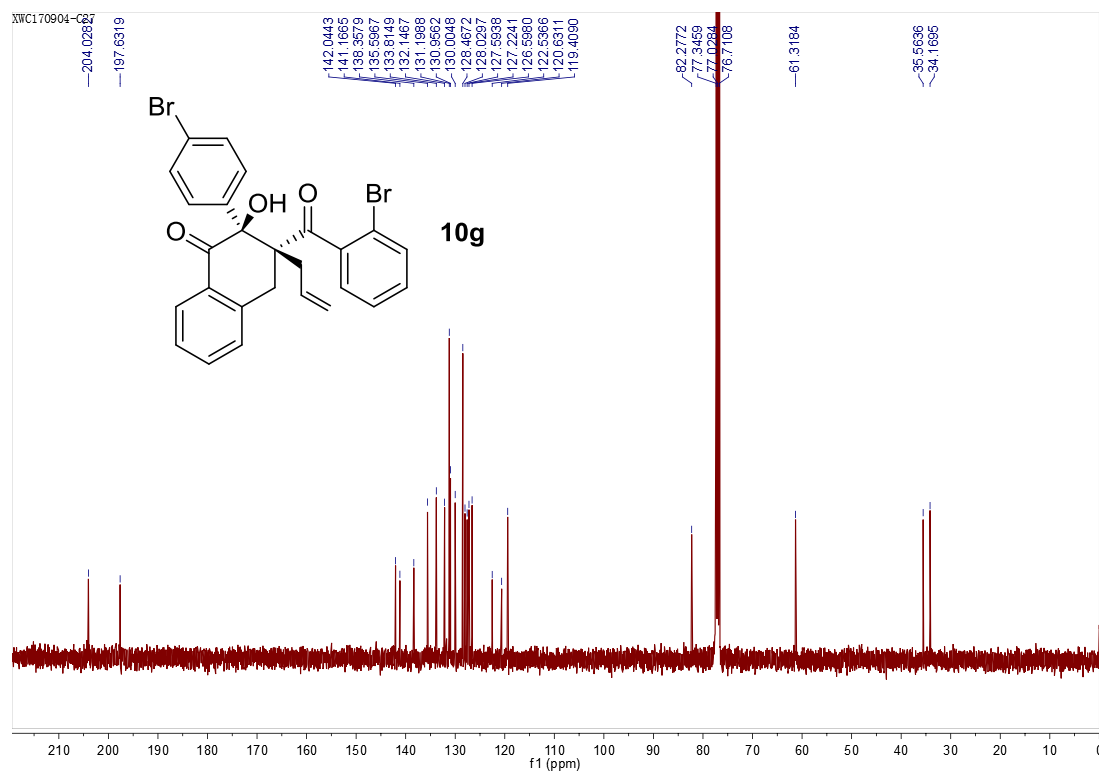
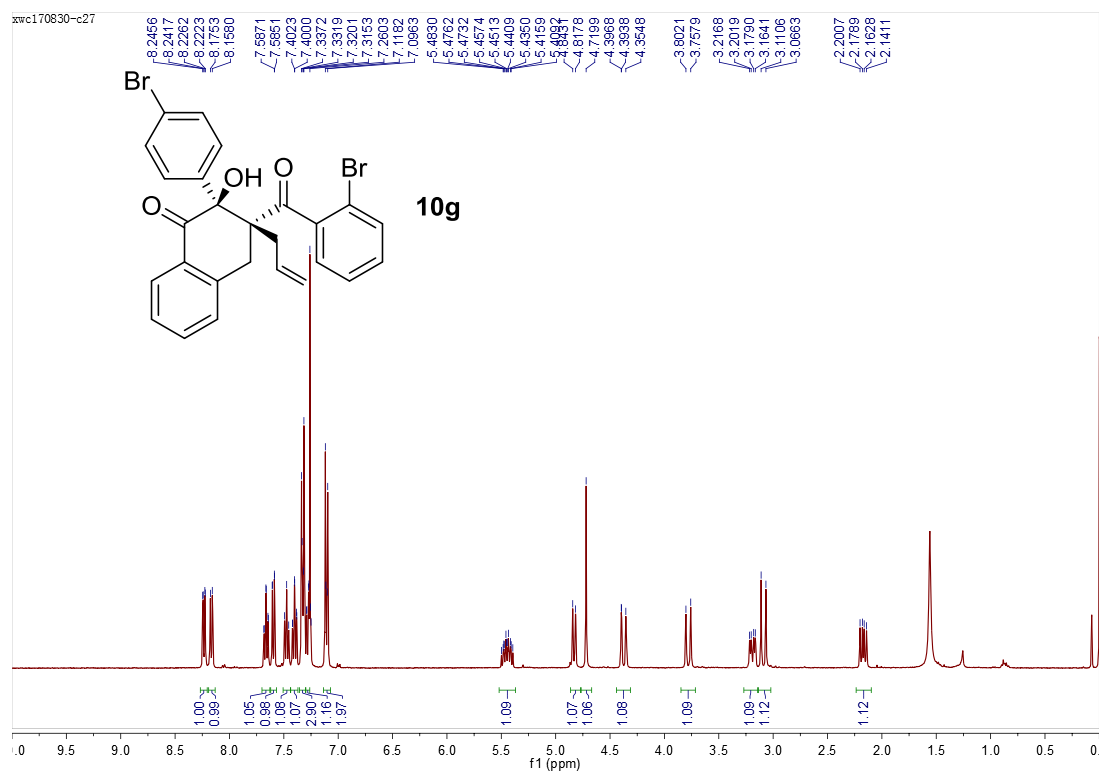


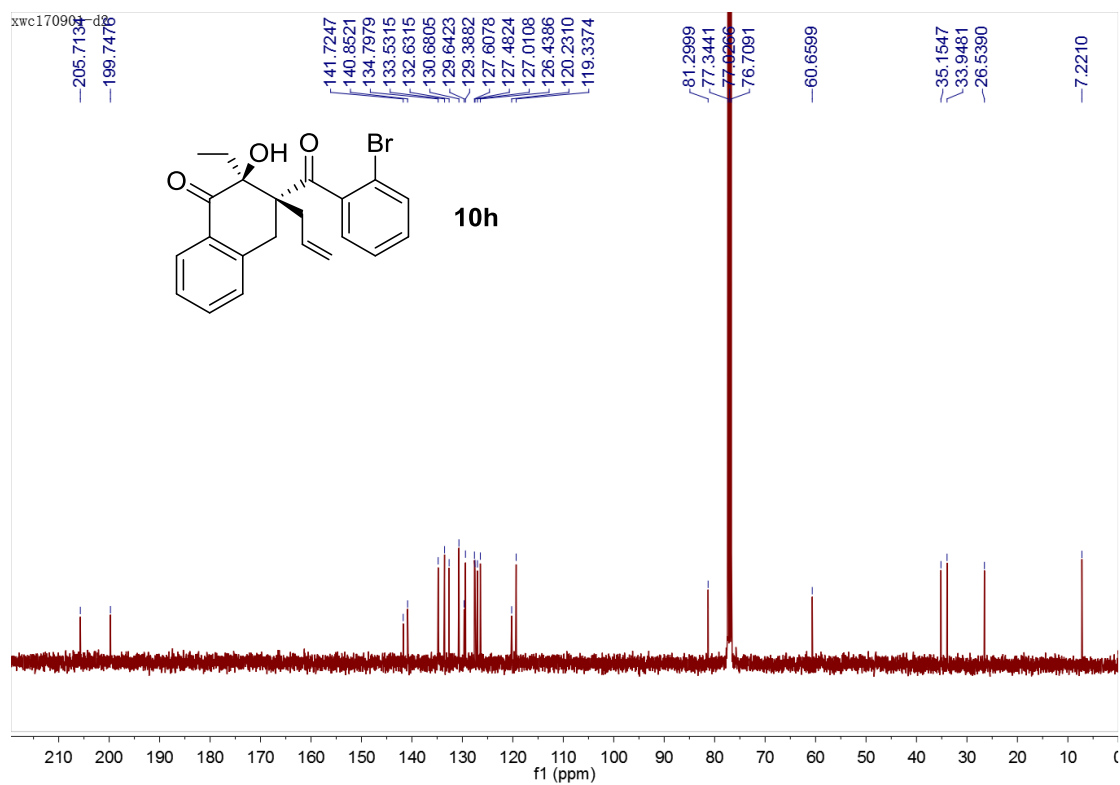
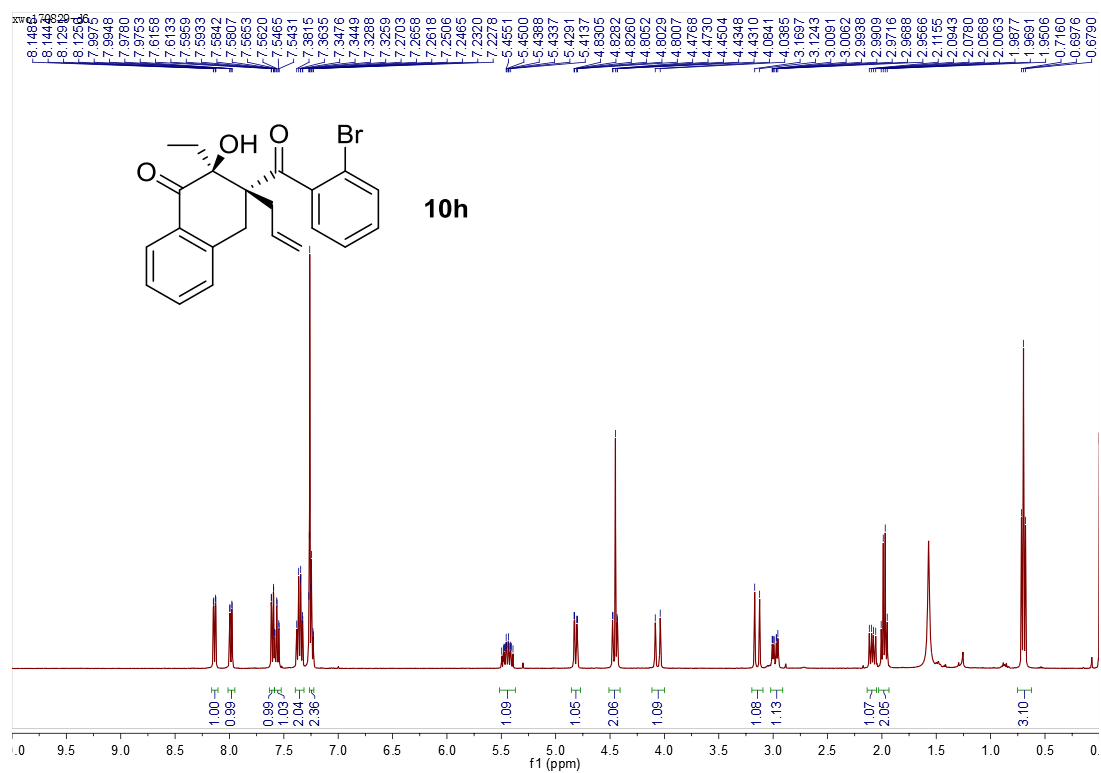


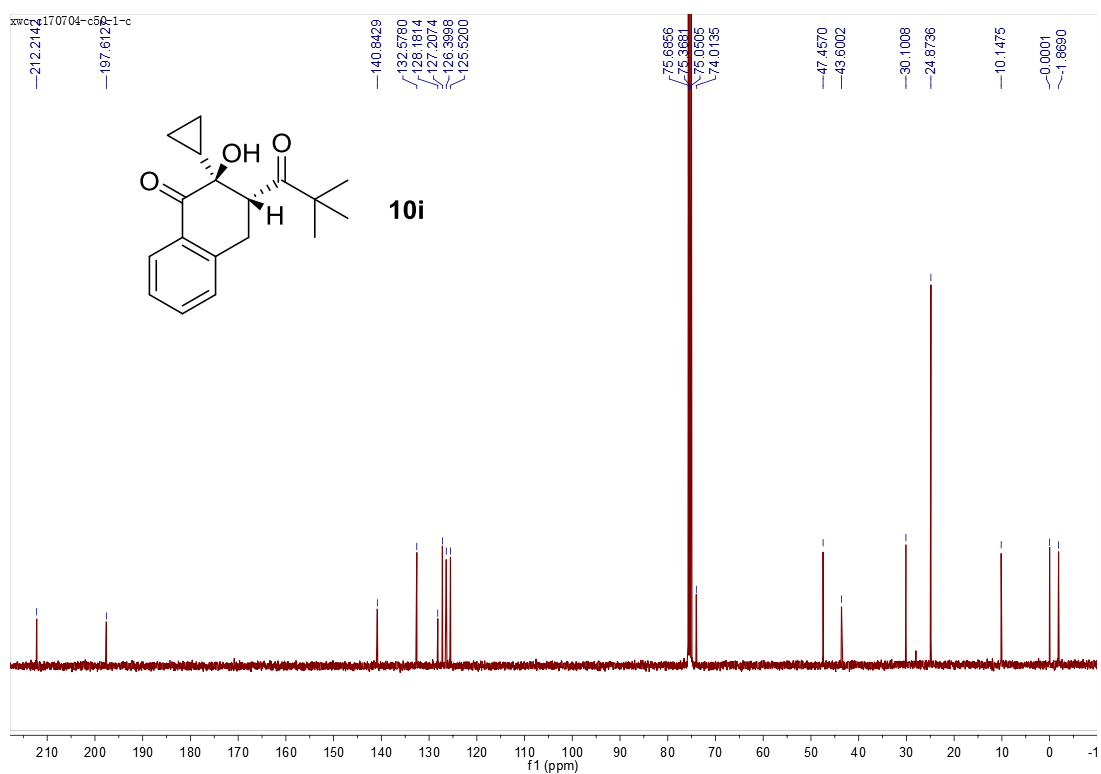
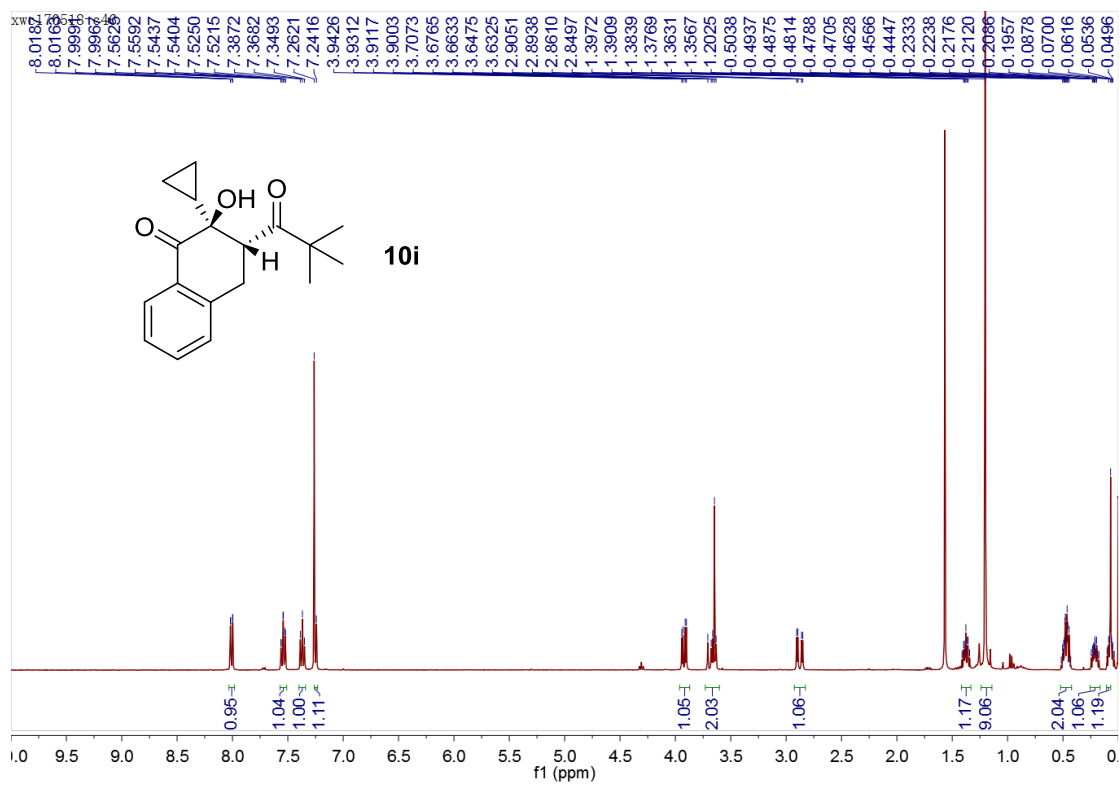


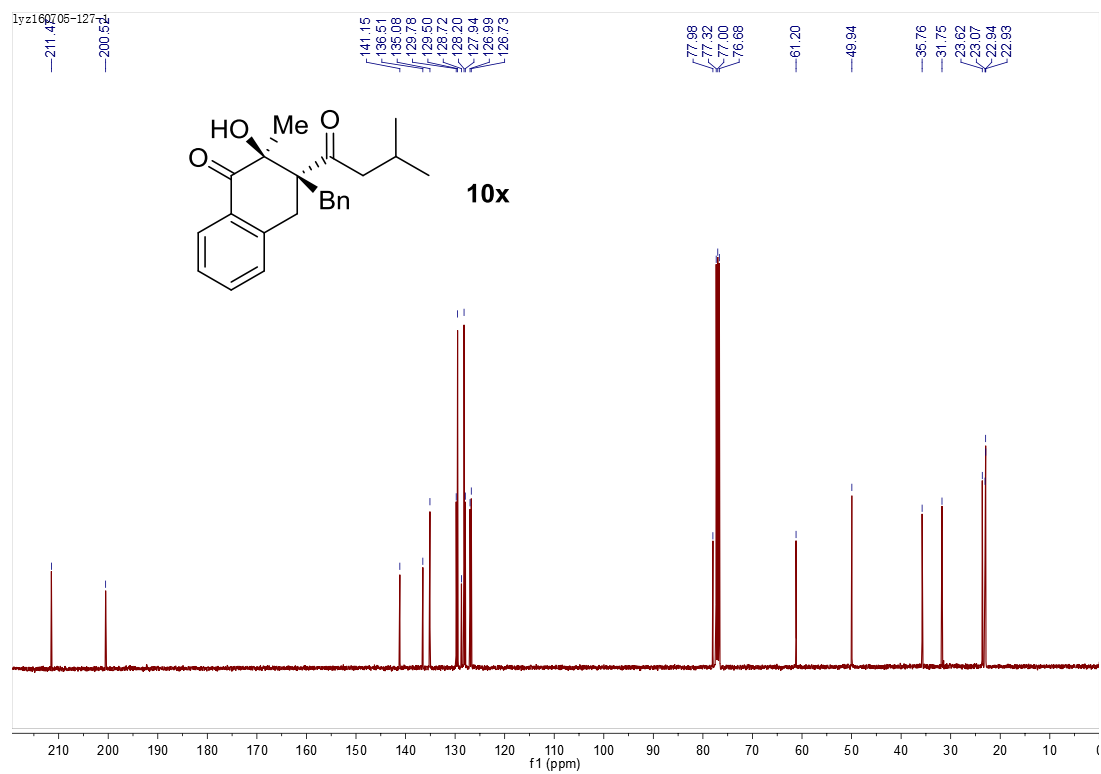
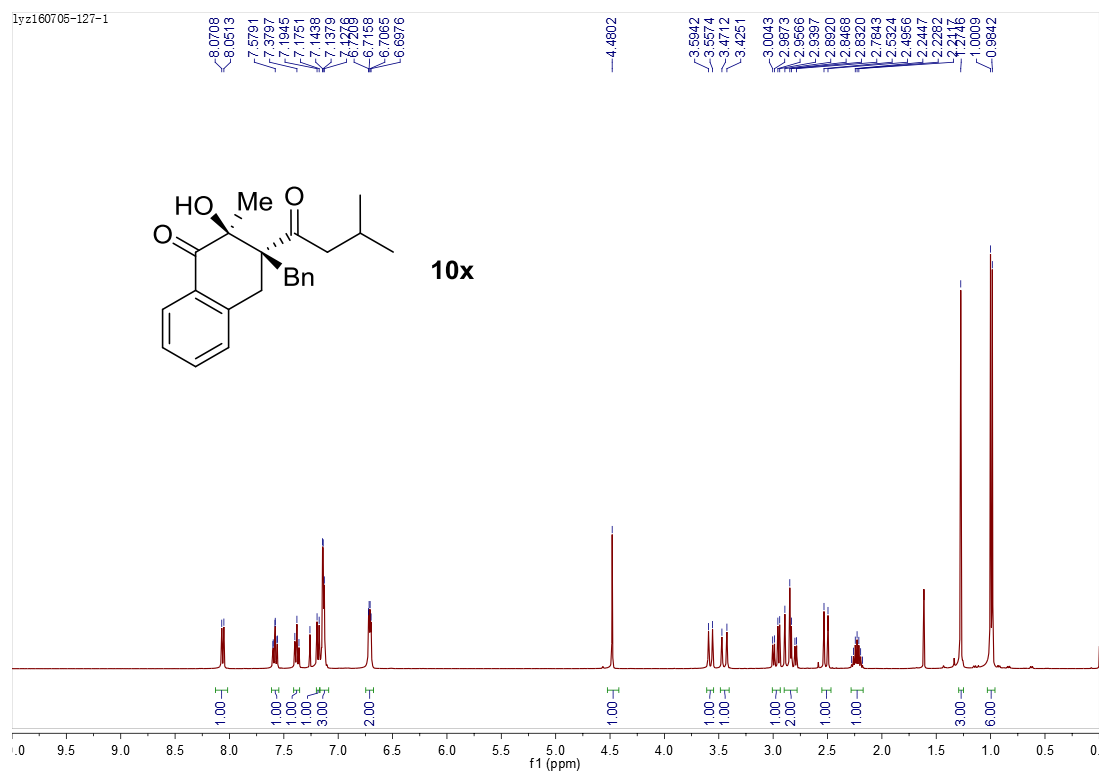


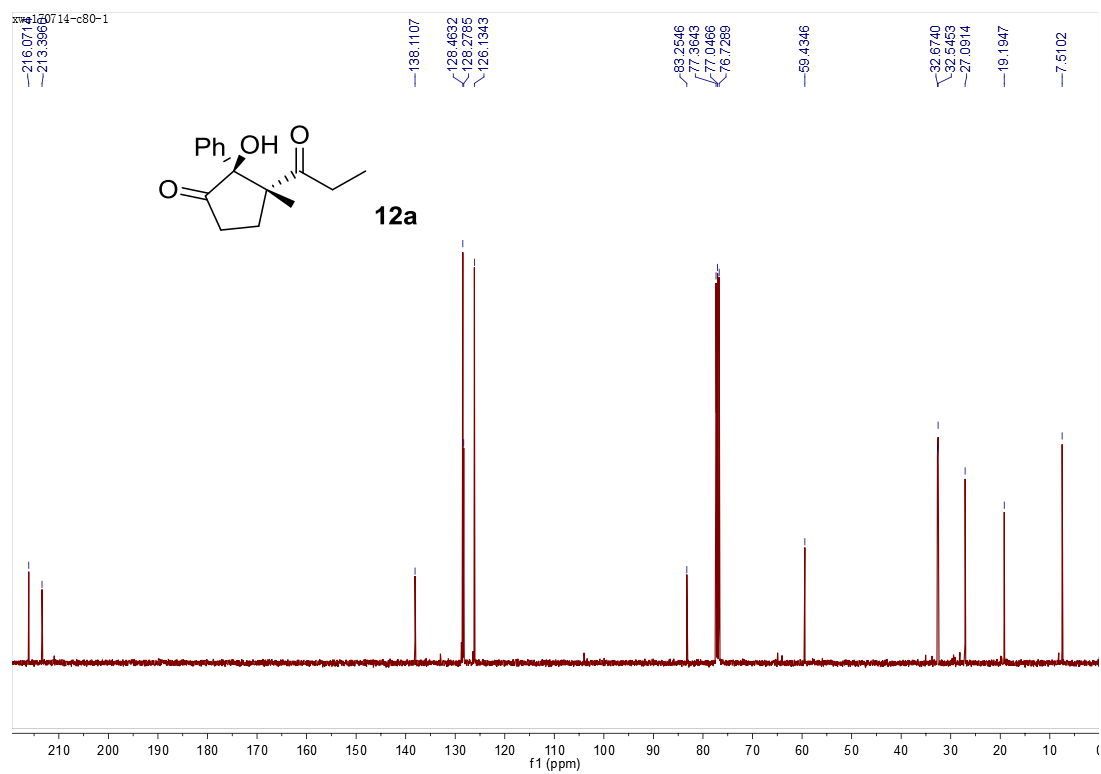
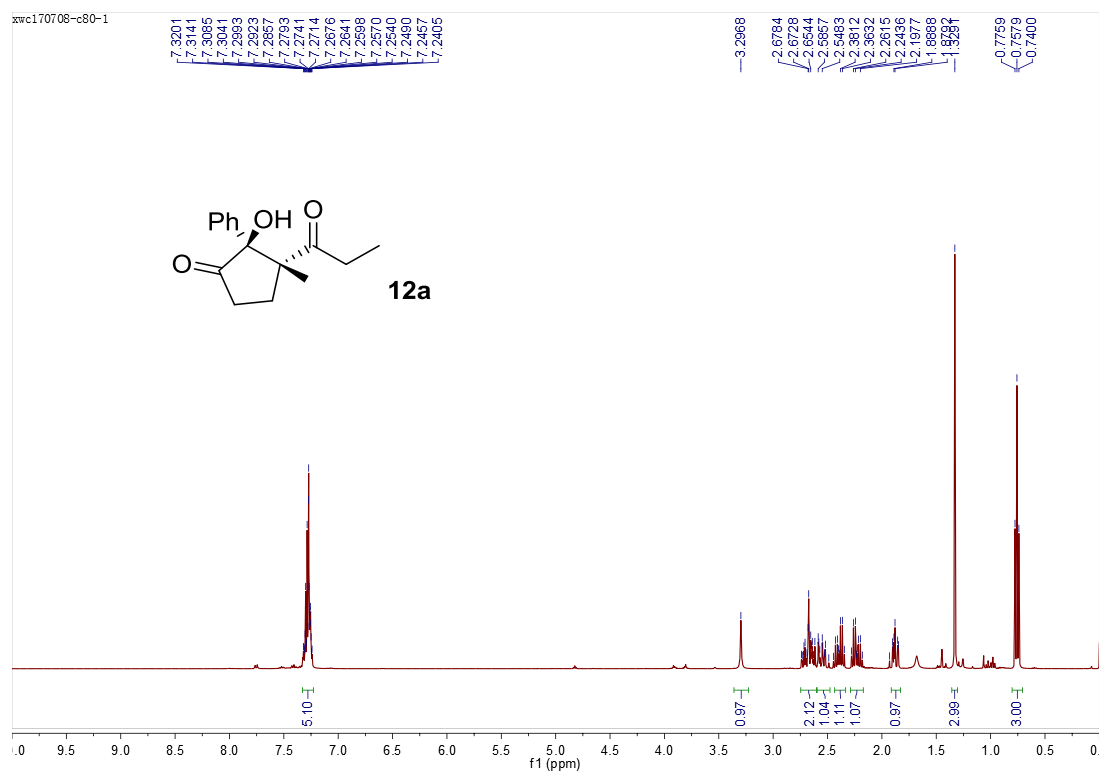


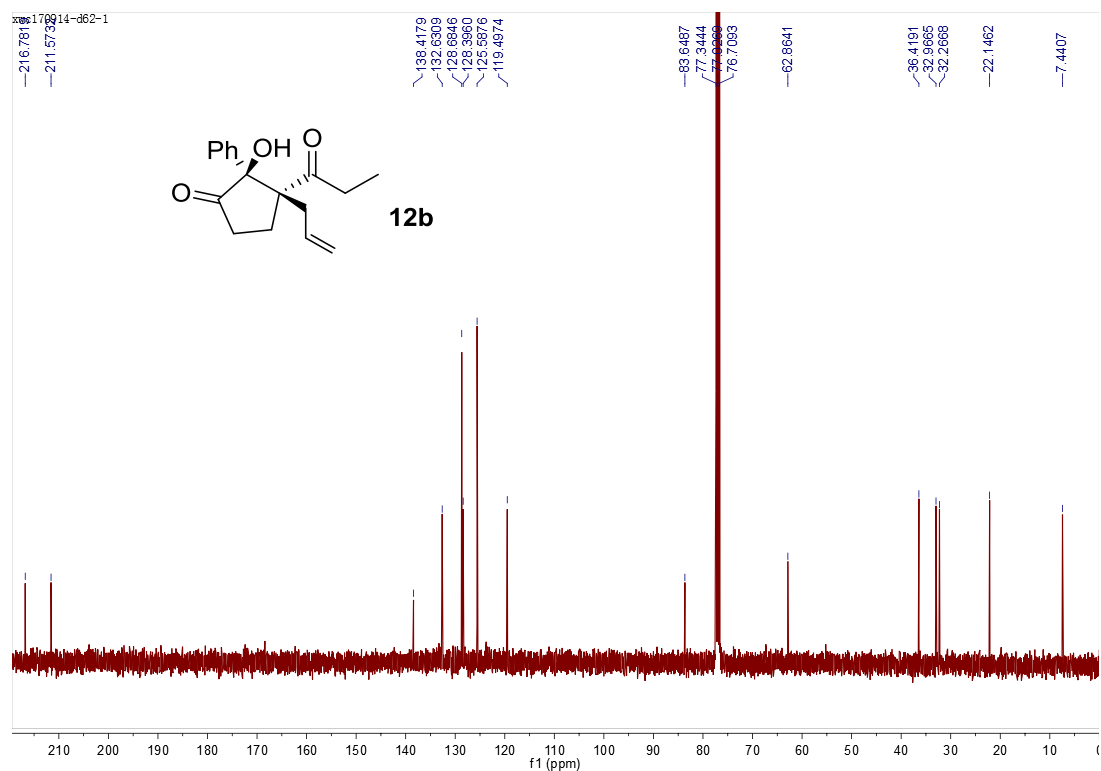
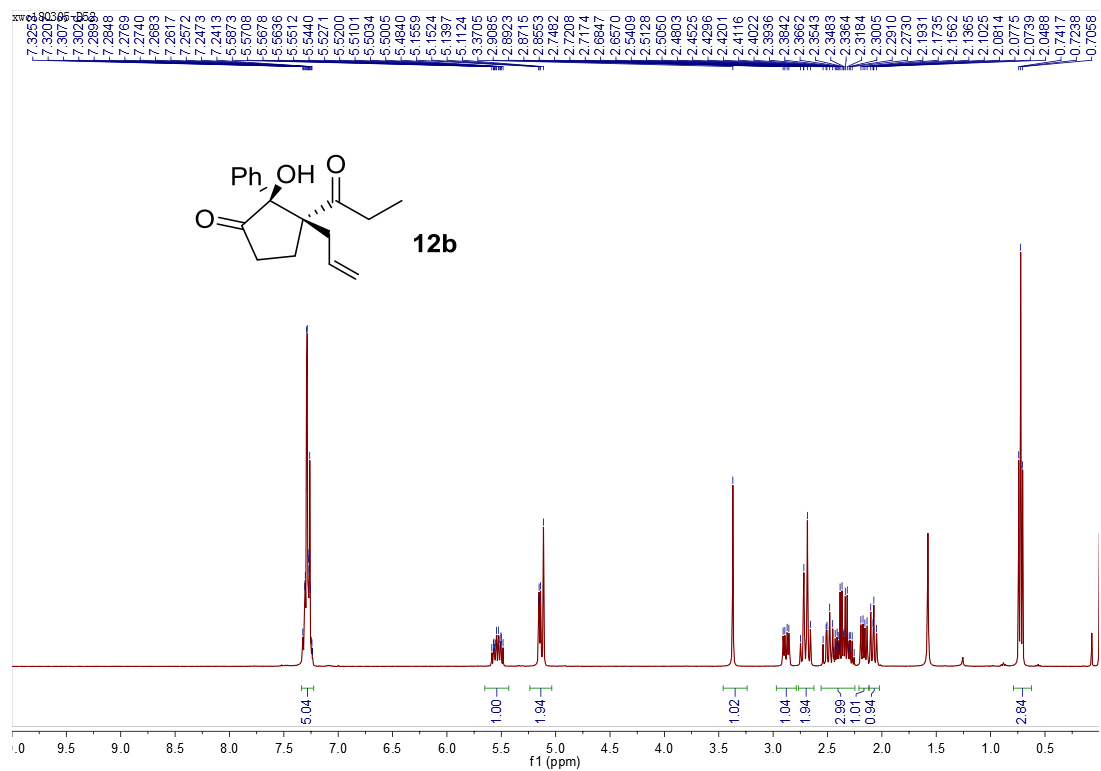


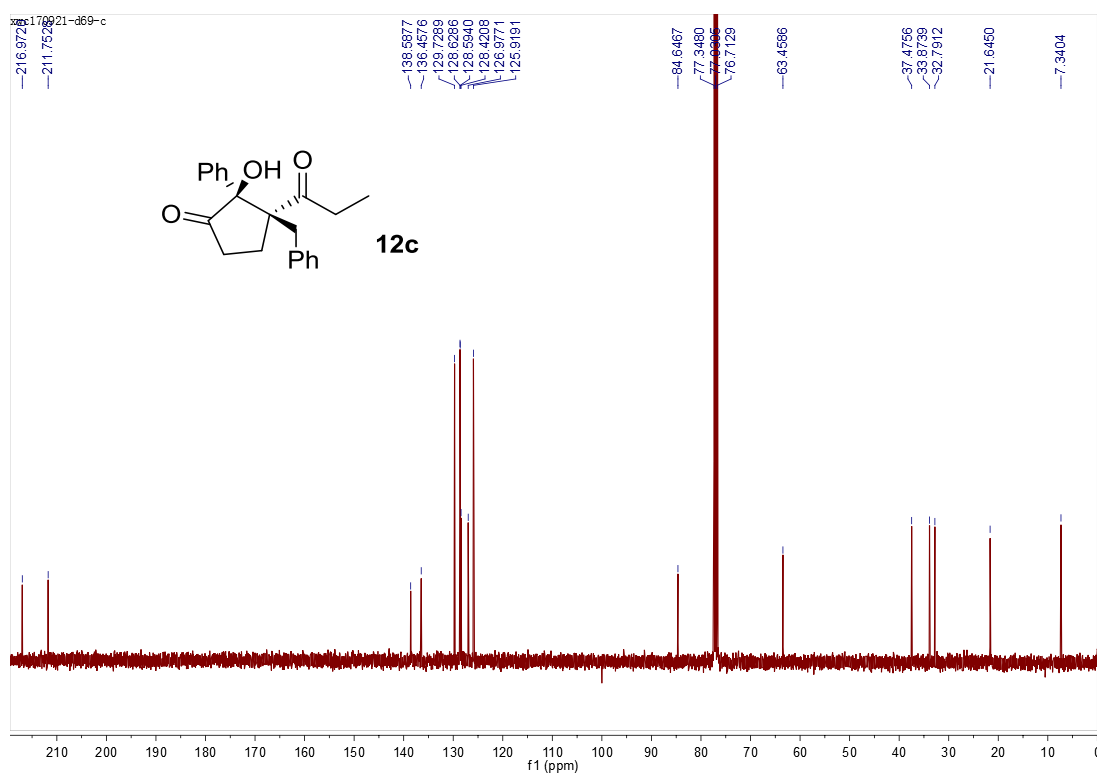
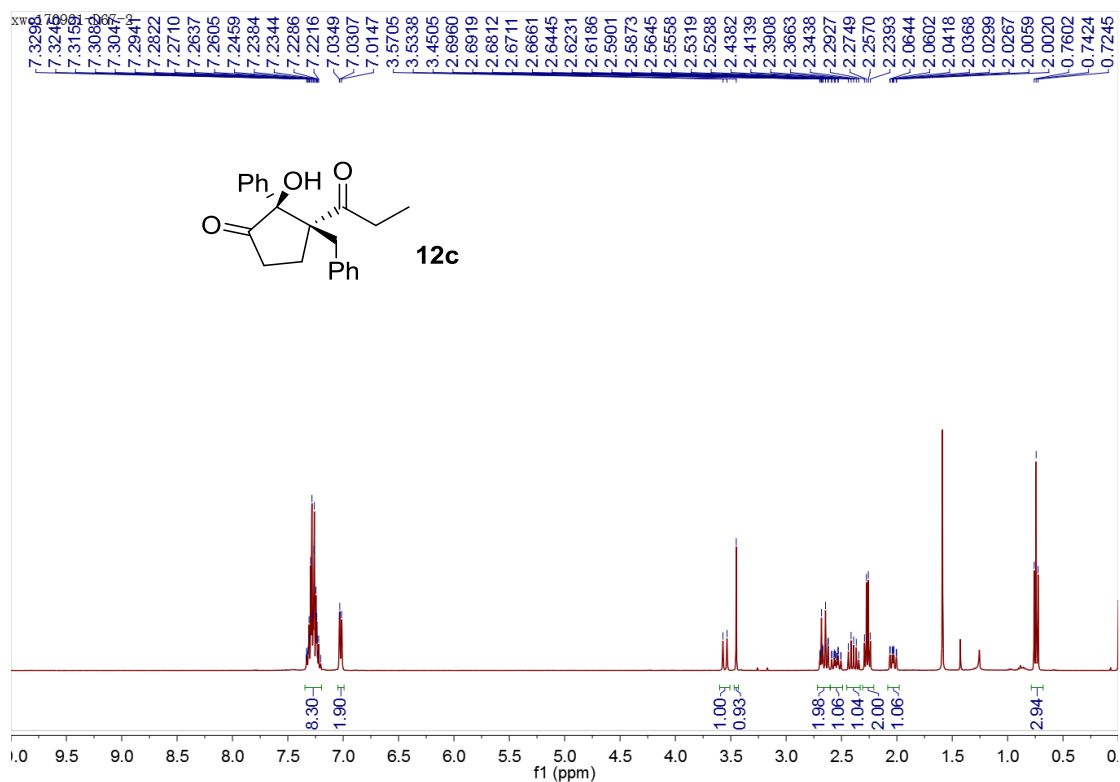


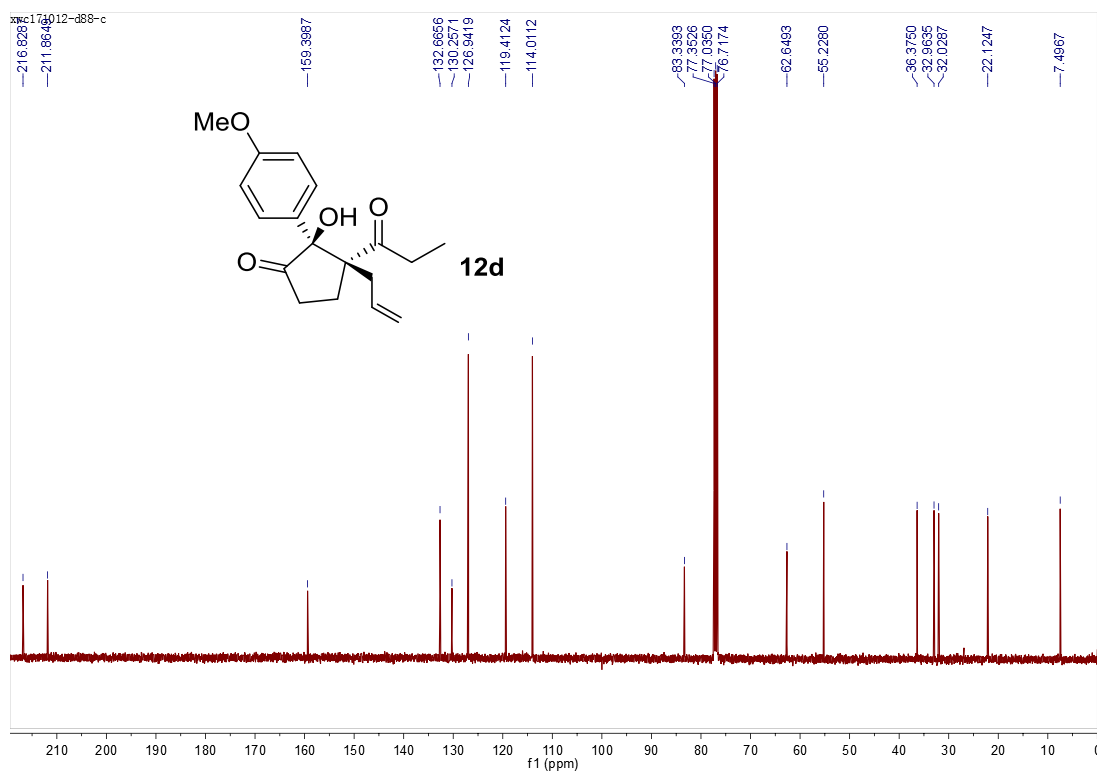
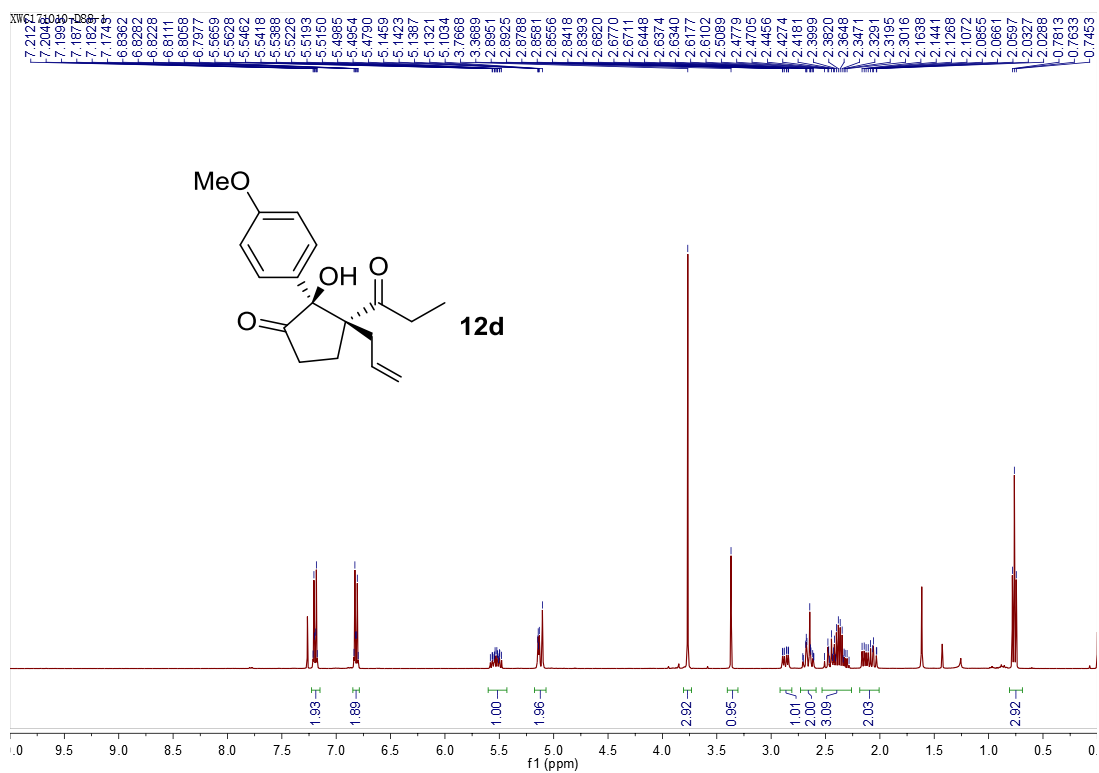


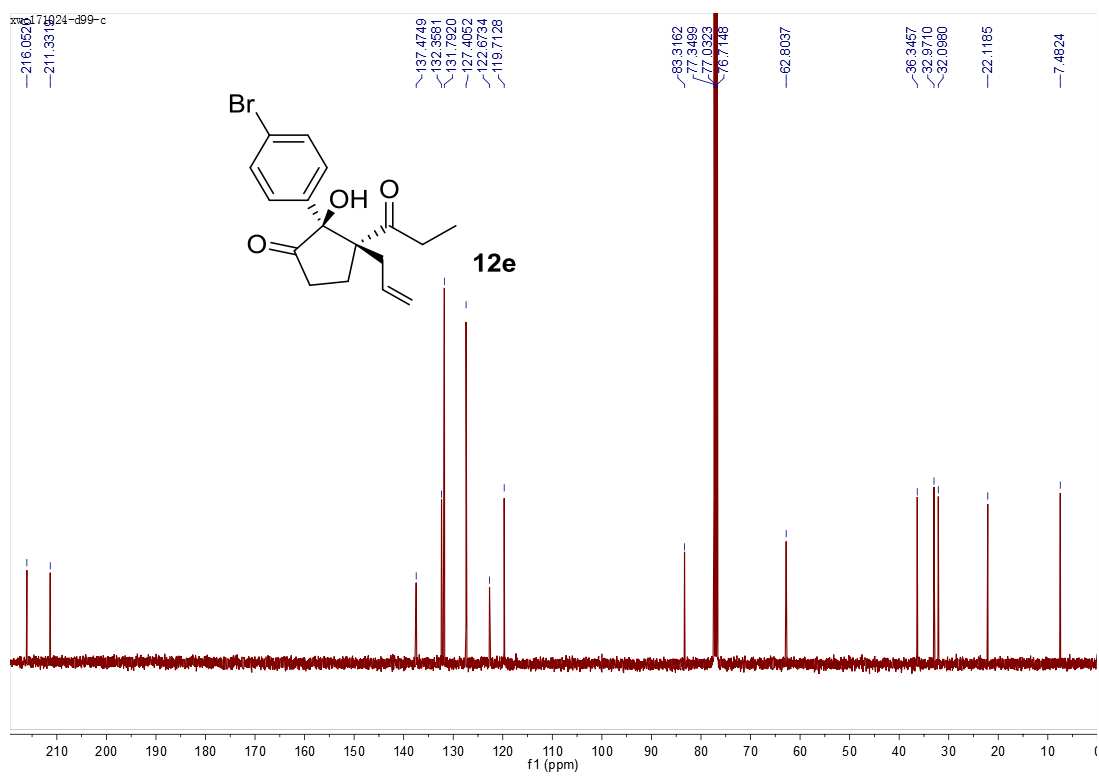
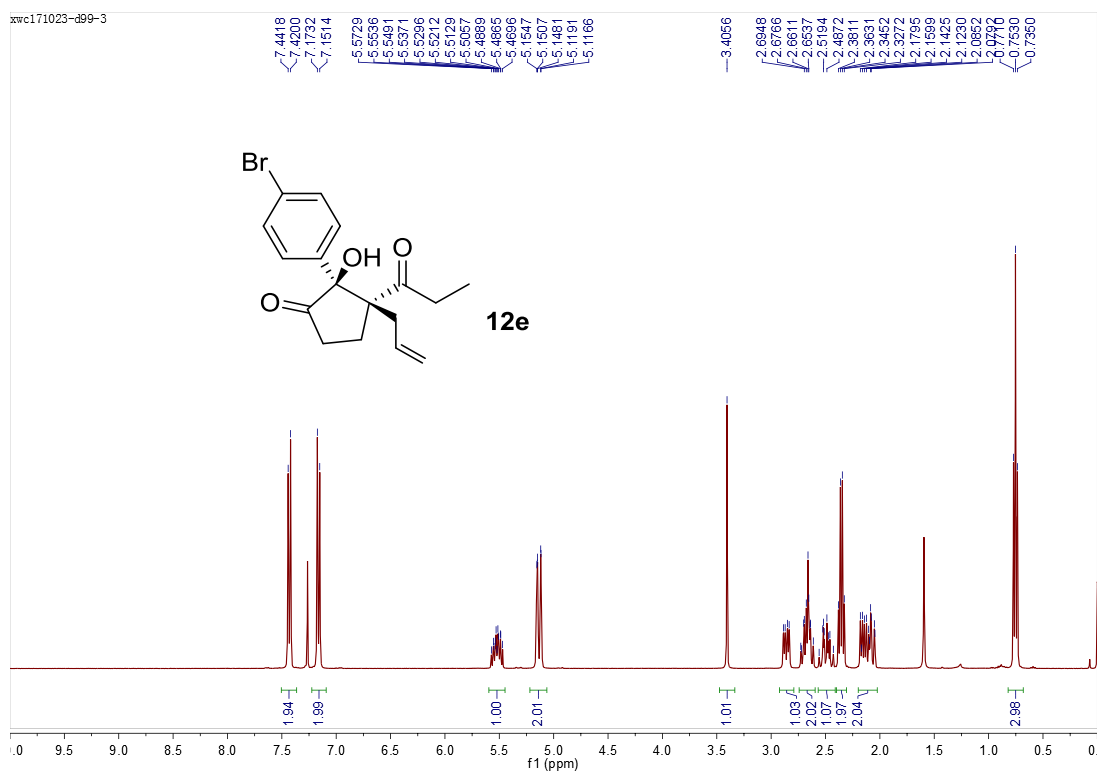


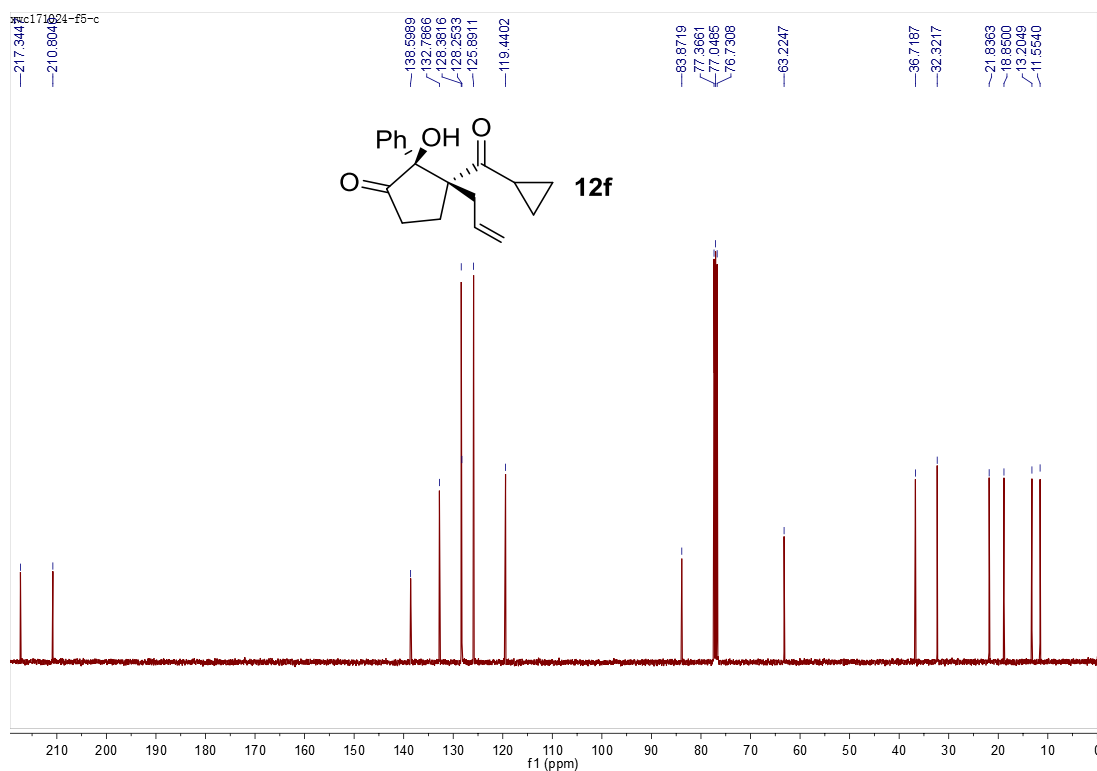
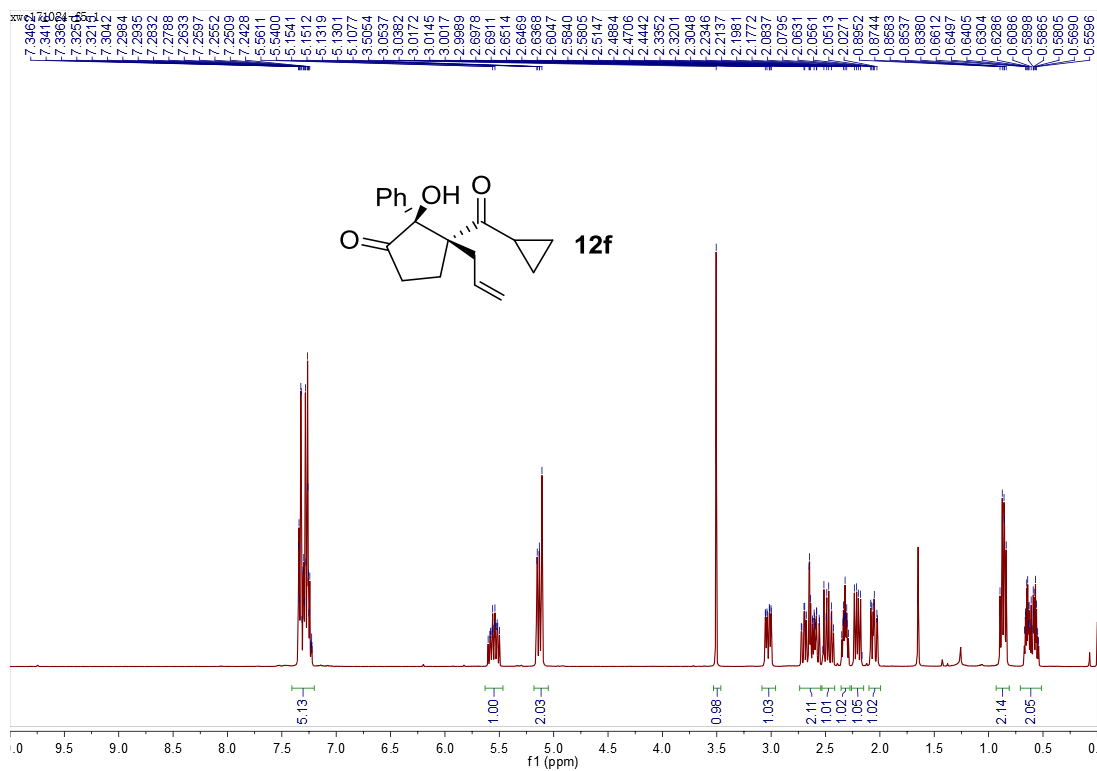


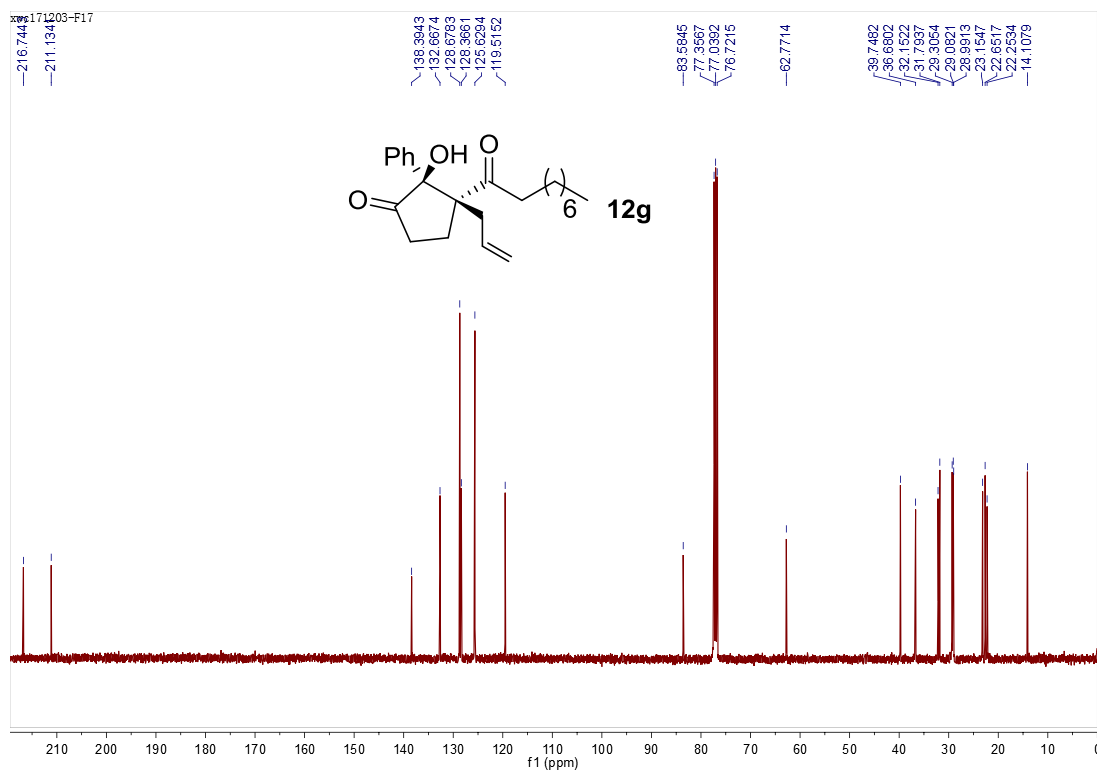
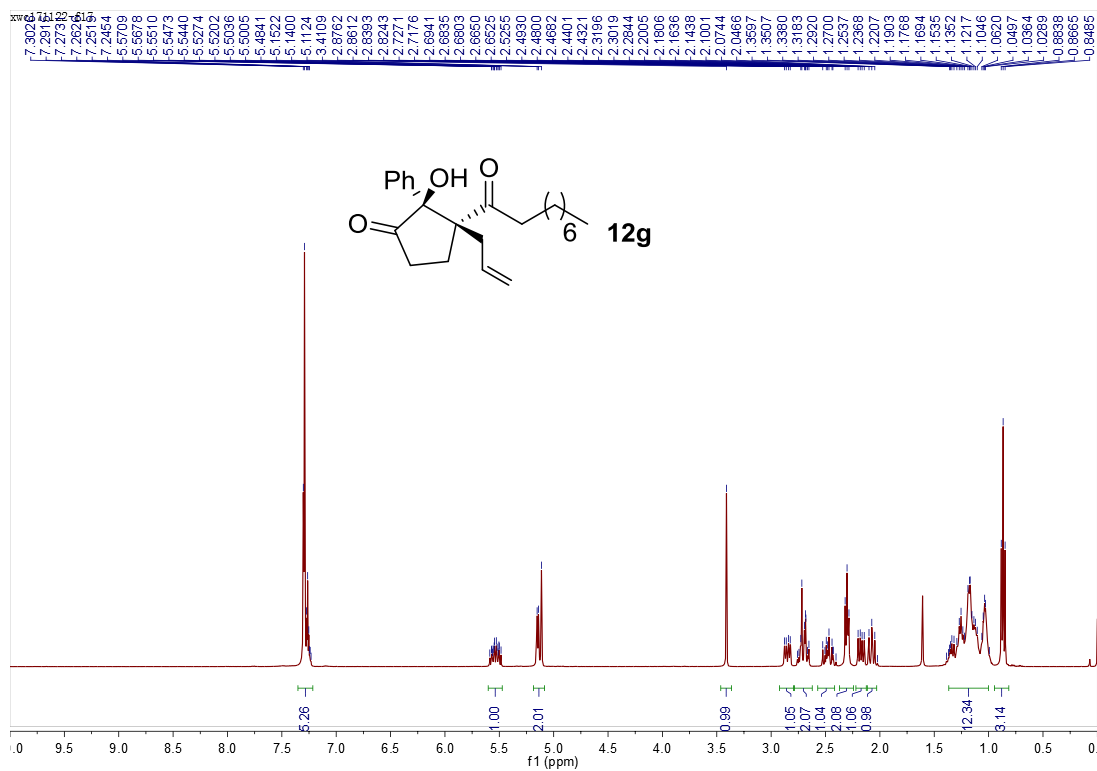


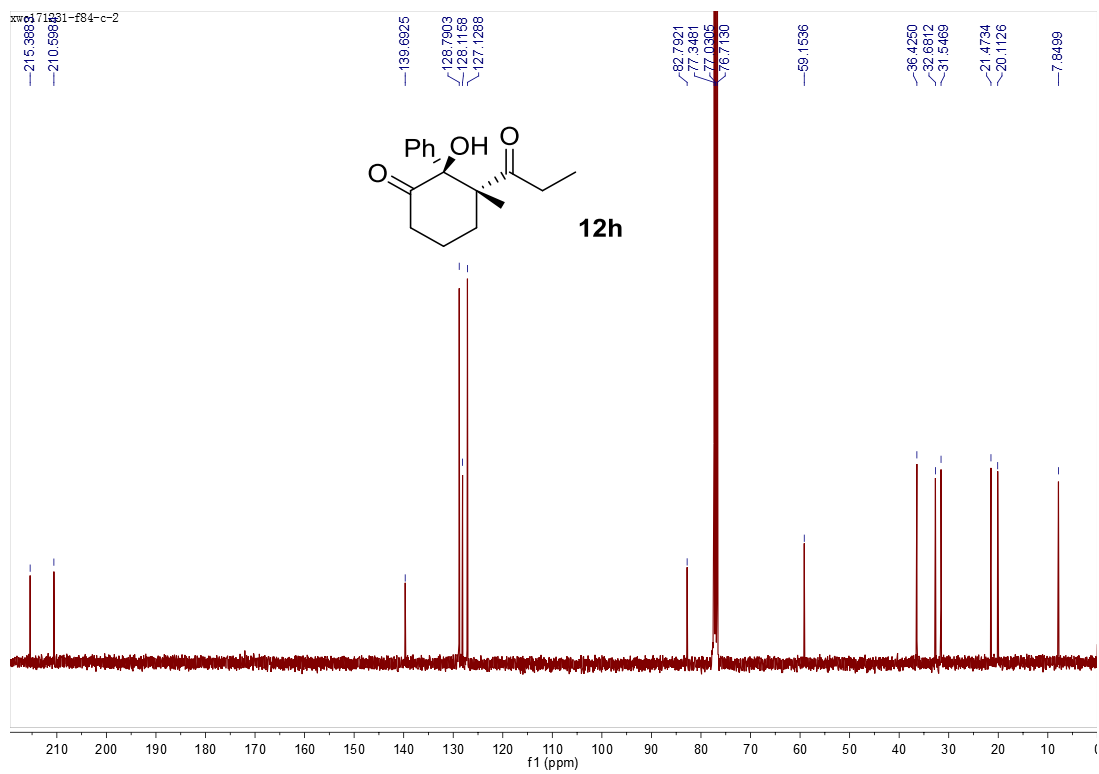
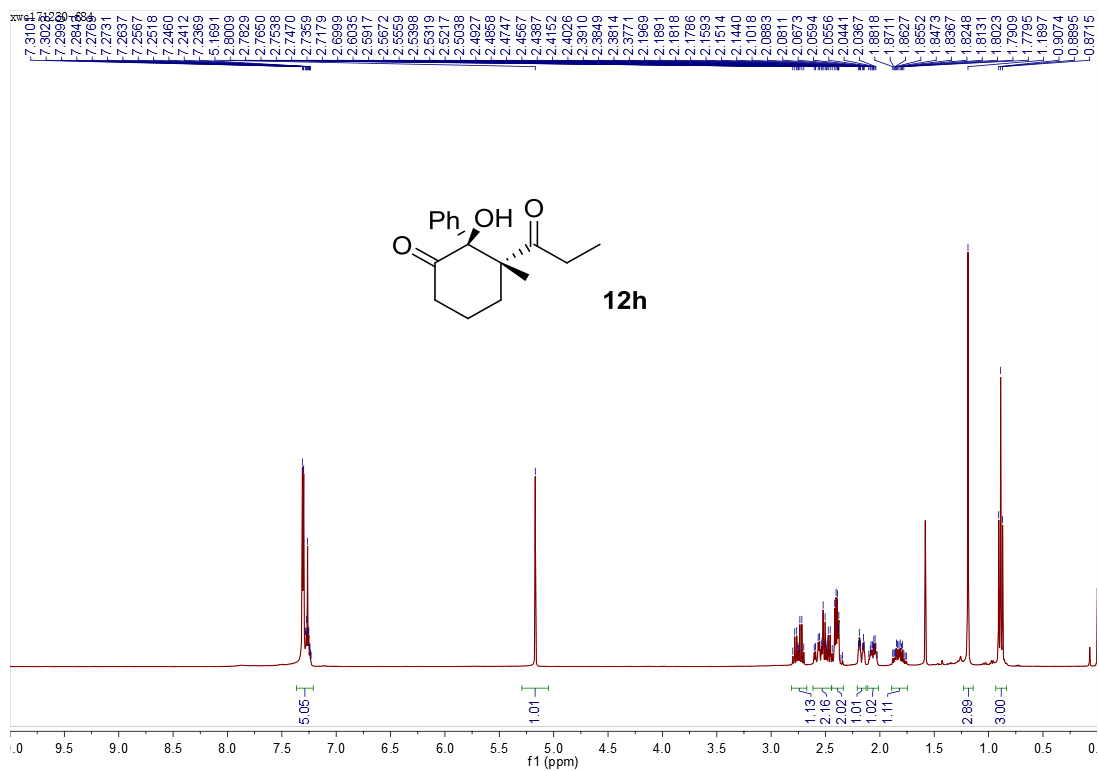


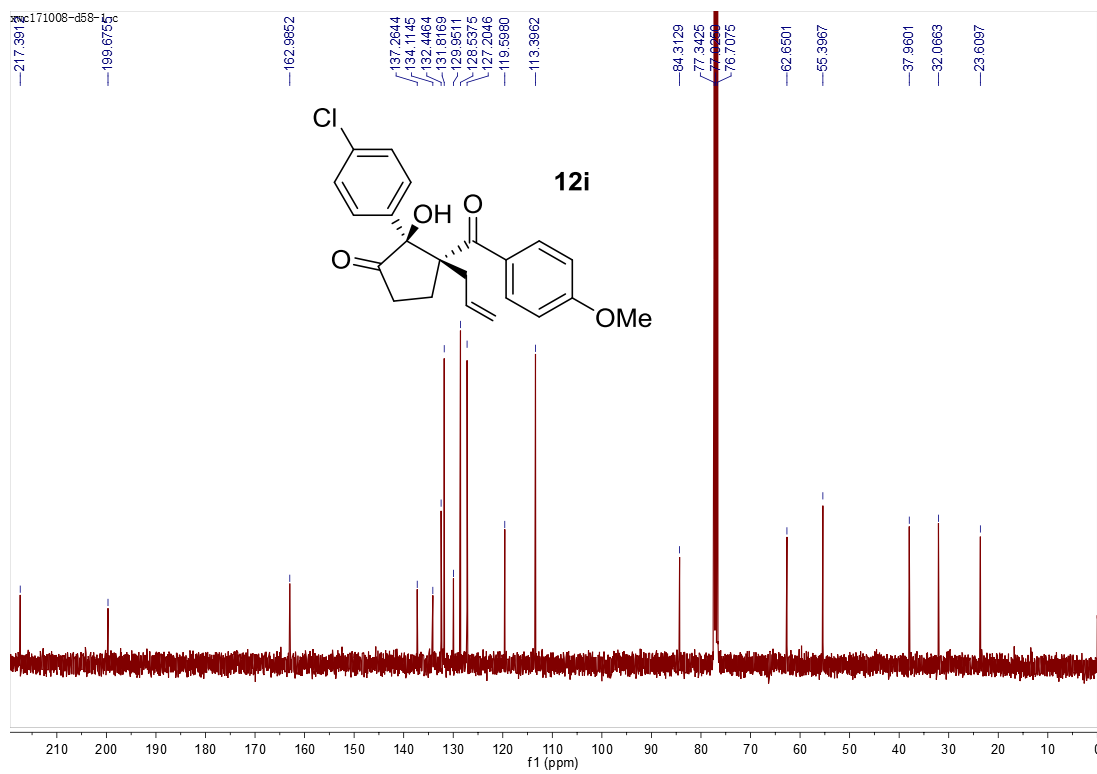
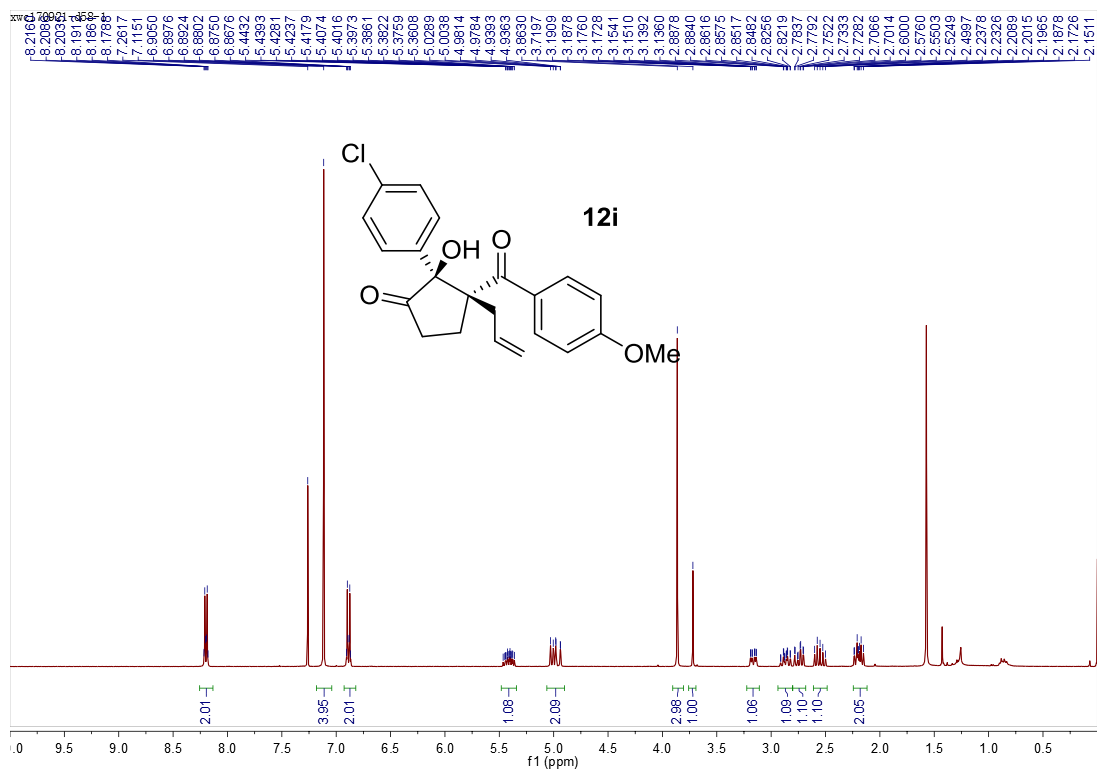


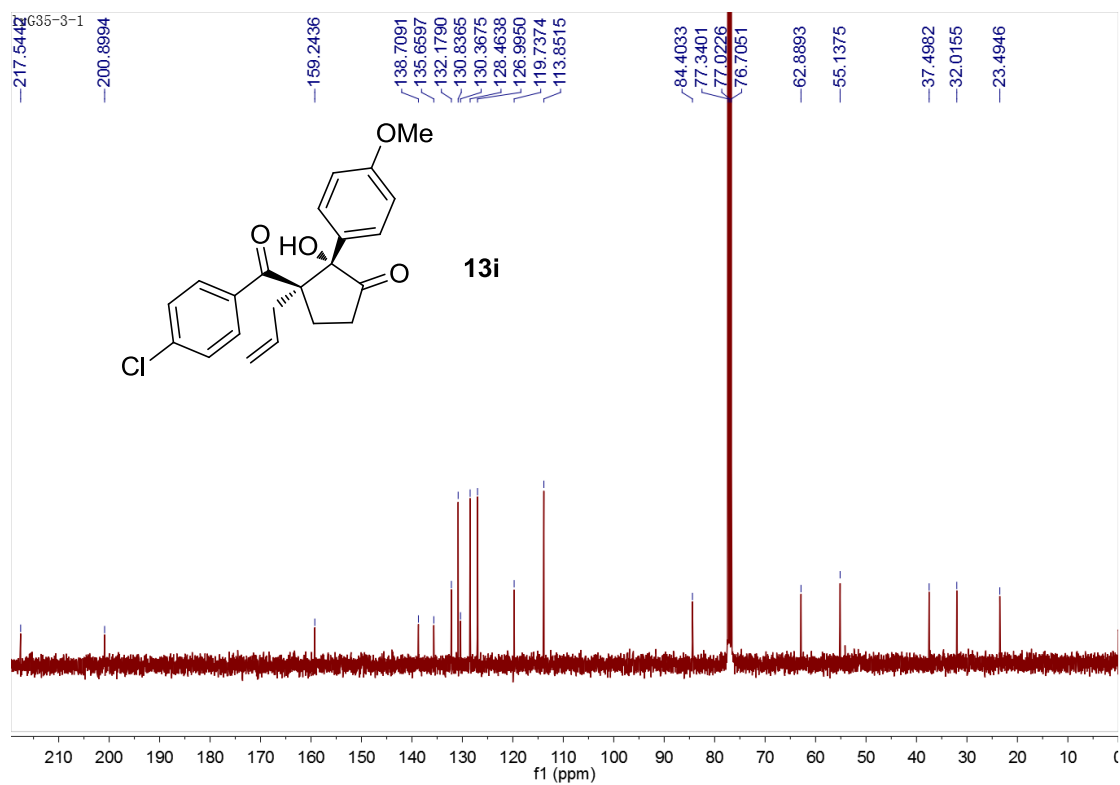
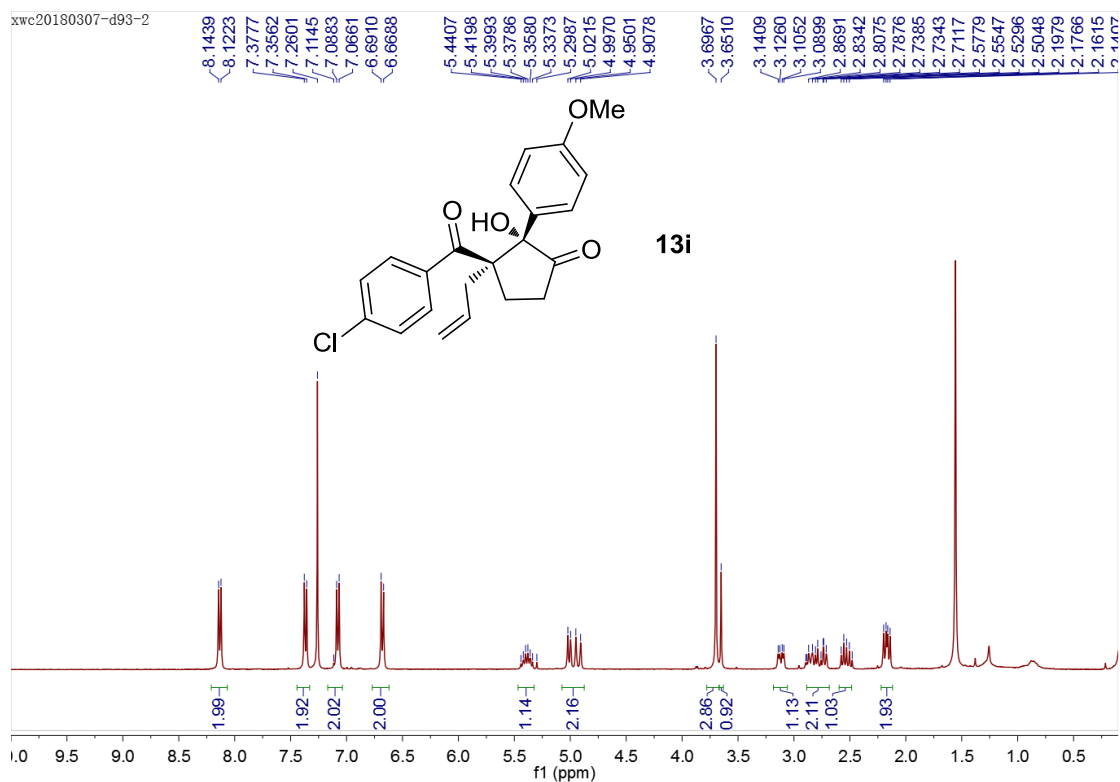




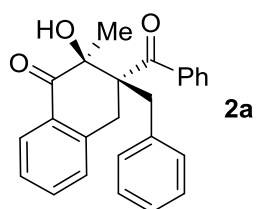






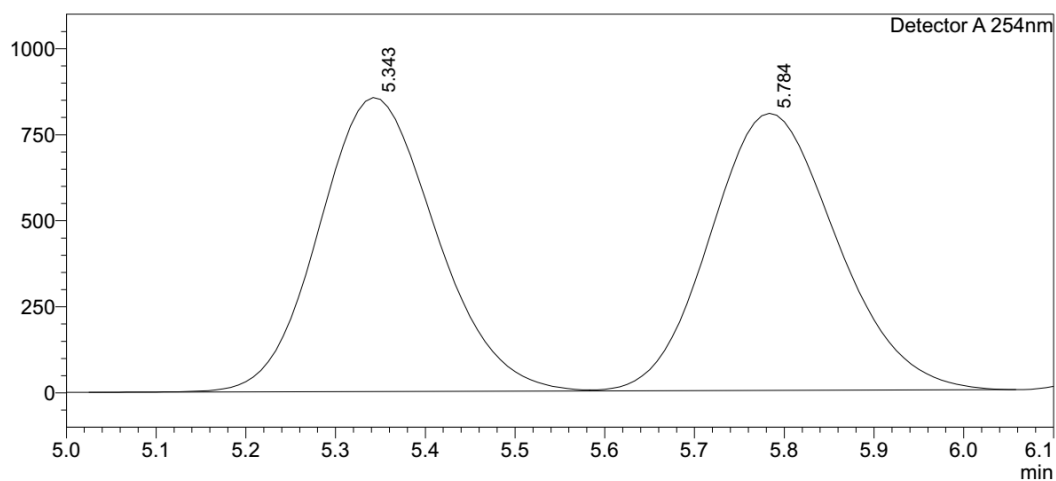


VI. HPLC spectra for ee determination.



<Chromatogram>

mV



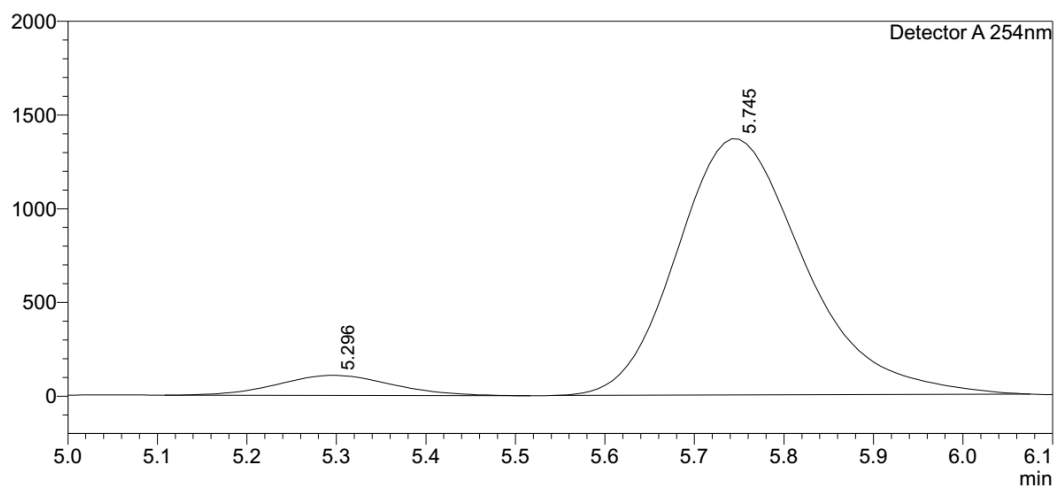
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.343	7747735	854244	49.555			
2	5.784	7886931	805277	50.445		V	
Total		15634667	1659521				

<Chromatogram>

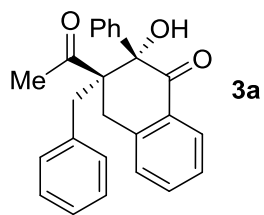
mV



<Peak Table>

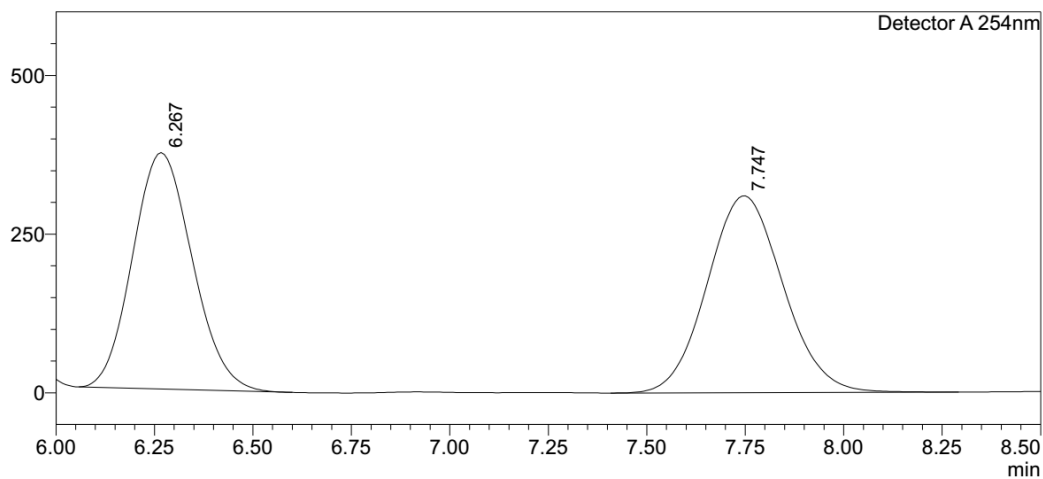
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.296	951600	106938	6.535			
2	5.745	13609797	1366711	93.465		M	
Total		14561397	1473649				



<Chromatogram>

mV



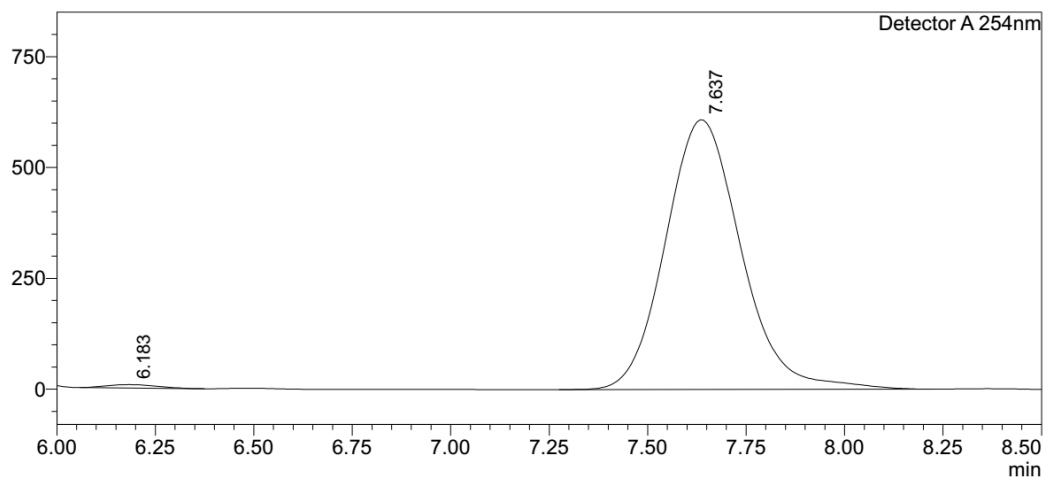
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.267	3927900	372476	48.540			
2	7.747	4164144	309950	51.460			
Total		8092044	682426				

<Chromatogram>

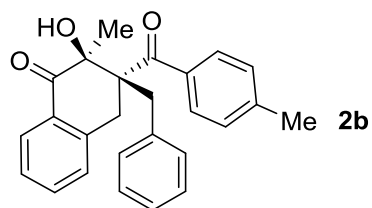
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<Peak Table>

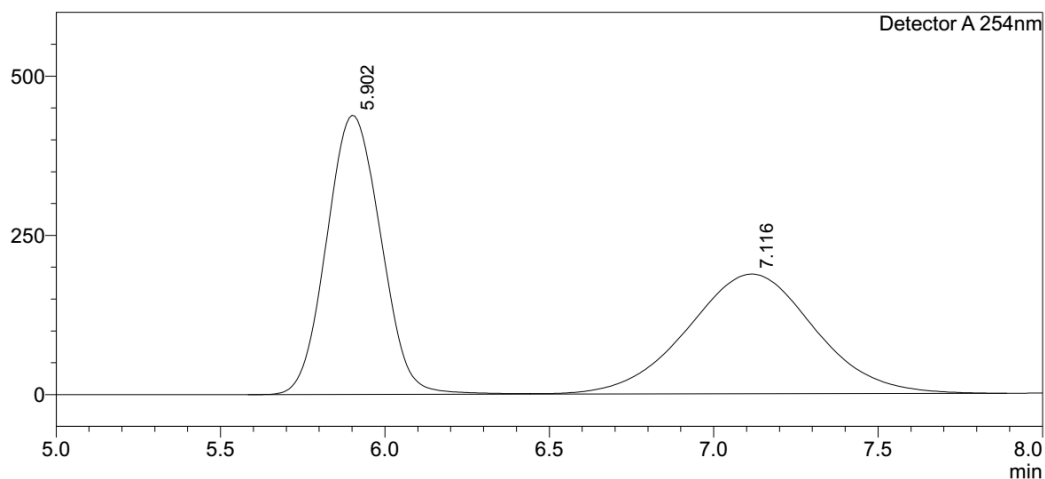
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.183	67996	7690	0.830			
2	7.637	8123214	608137	99.170			
Total		8191209	615827				



<Chromatogram>

mV



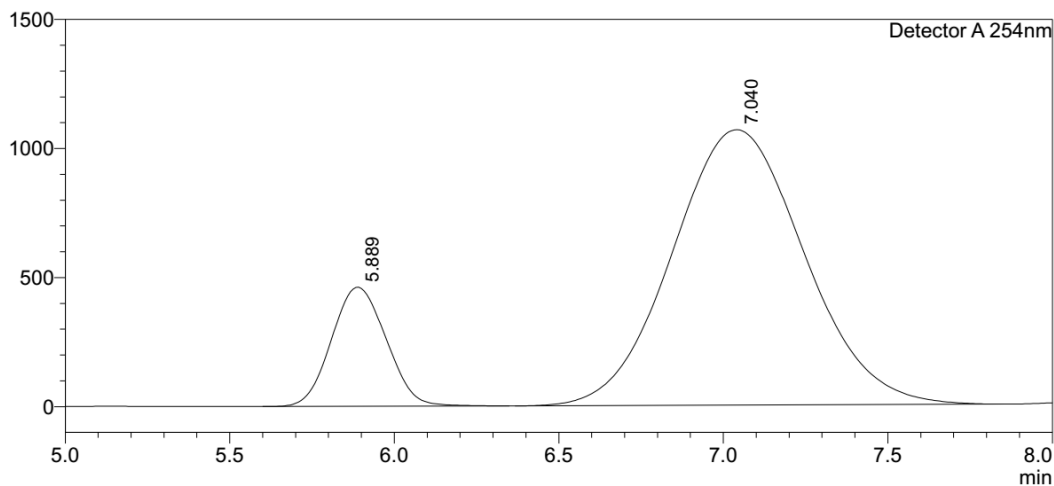
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.902	5024846	438400	49.720			
2	7.116	5081411	187865	50.280		V	
Total		10106257	626265				

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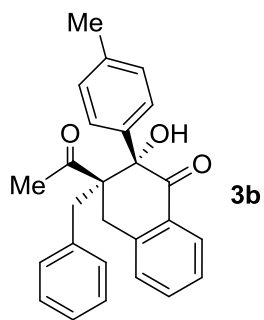
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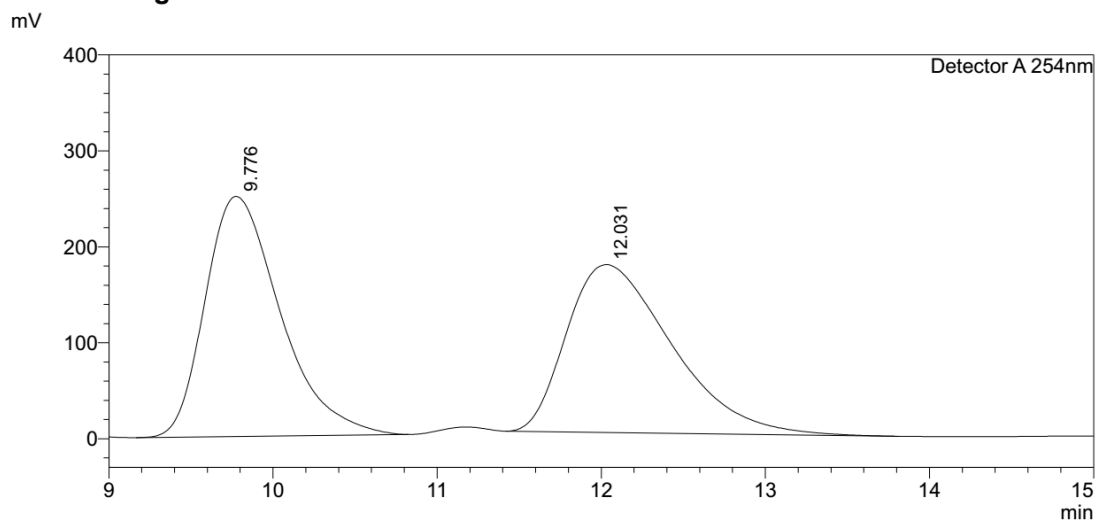
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.889	5339323	461287	15.222			
2	7.040	29738136	1066929	84.778			
Total		35077459	1528216				



<Chromatogram>

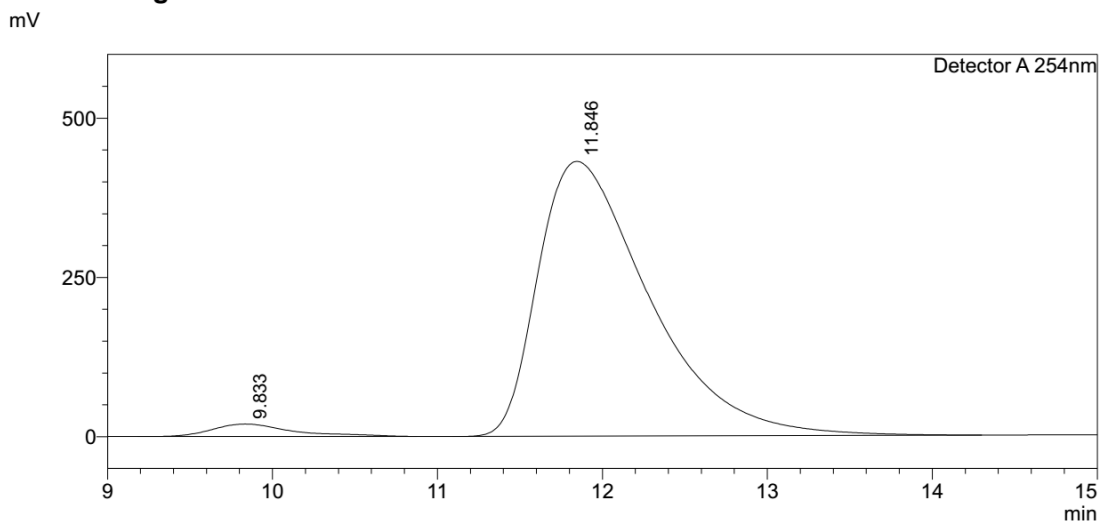


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.776	7960685	250198	50.529			
2	12.031	7793876	174978	49.471			
Total		15754561	425176				

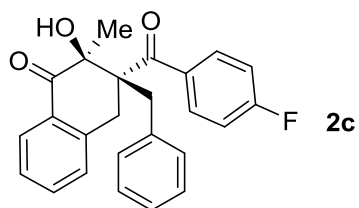
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<Peak Table>

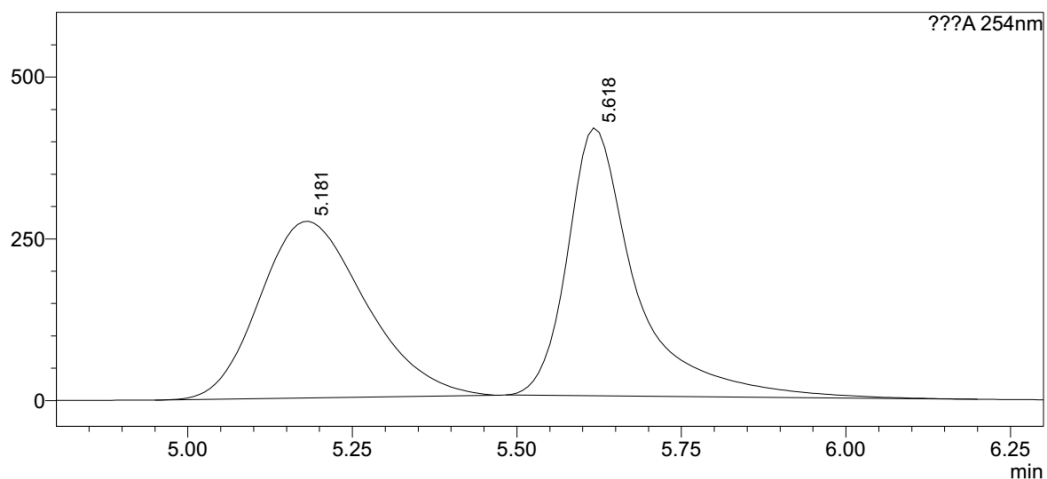
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.833	659906	19529	3.156		M	
2	11.846	20250295	431350	96.844			
Total		20910202	450878				



<Chromatogram>

mV



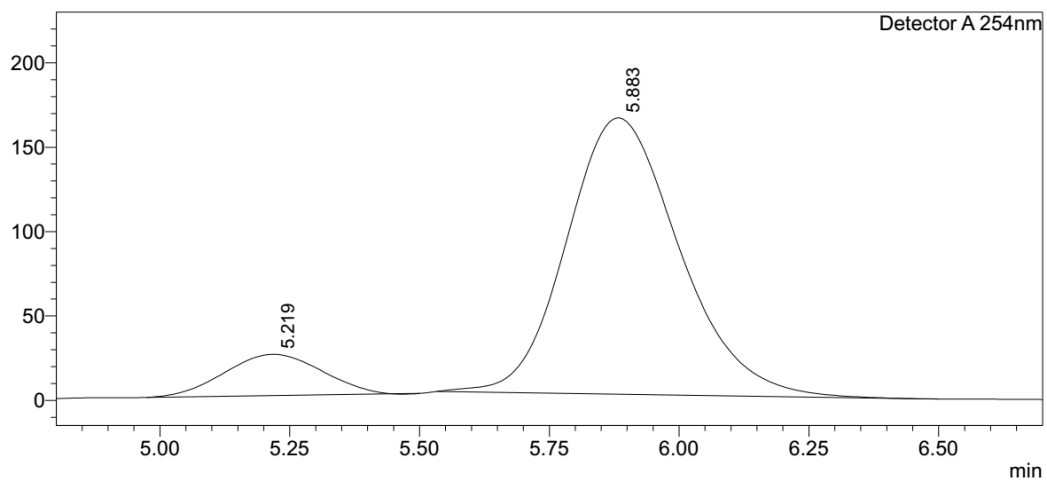
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.181	3059439	273121	50.305		M	
2	5.618	3022360	414186	49.695		M	
Total		6081800	687307				

<Chromatogram>

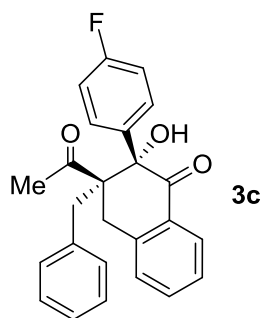
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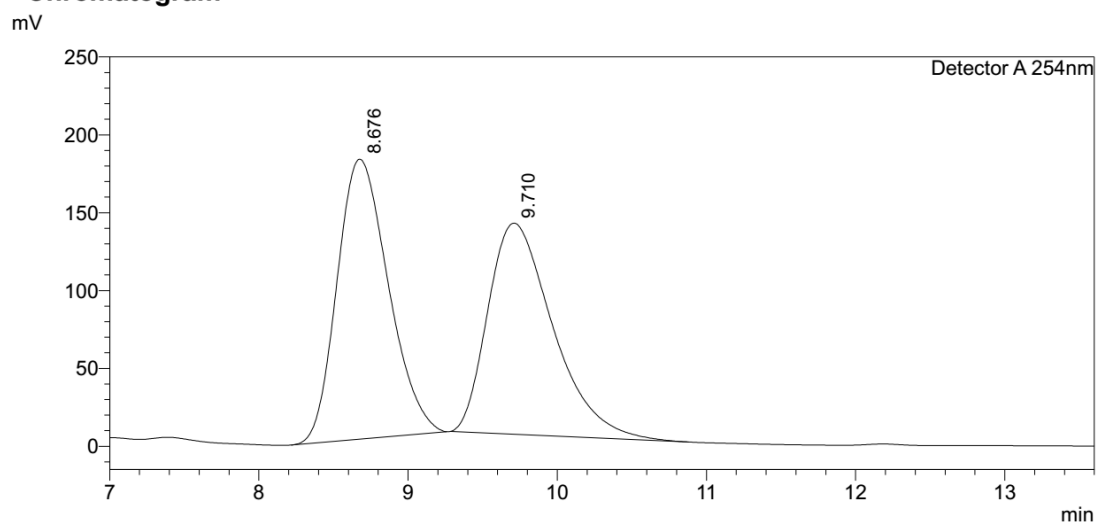
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.219	317680	24413	11.363		M	
2	5.883	2478111	163842	88.637		M	
Total		2795791	188255				



<Chromatogram>

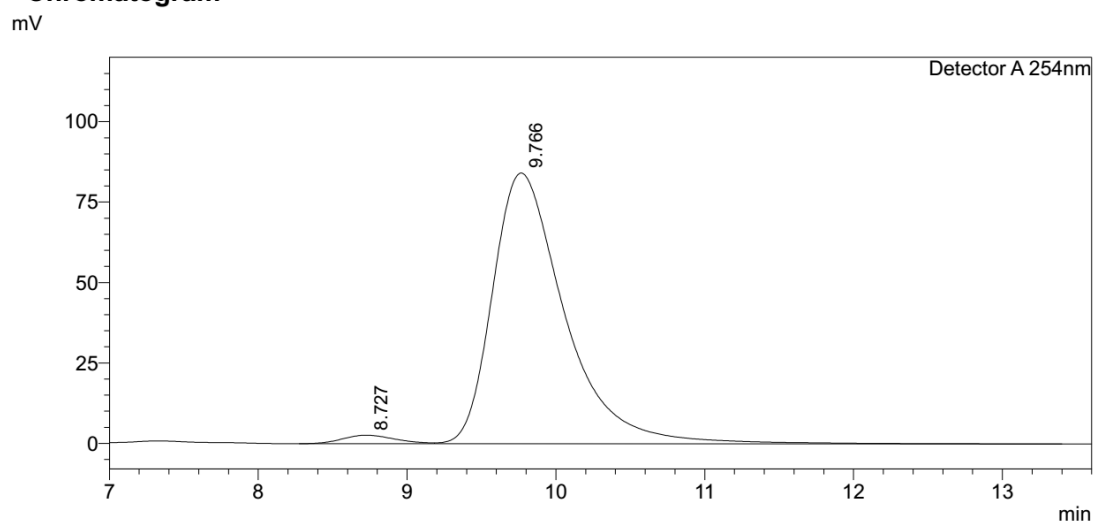


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.676	4290822	179873	51.054		M	
2	9.710	4113608	135619	48.946		M	
Total		8404430	315492				

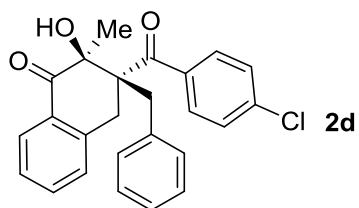
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<Peak Table>

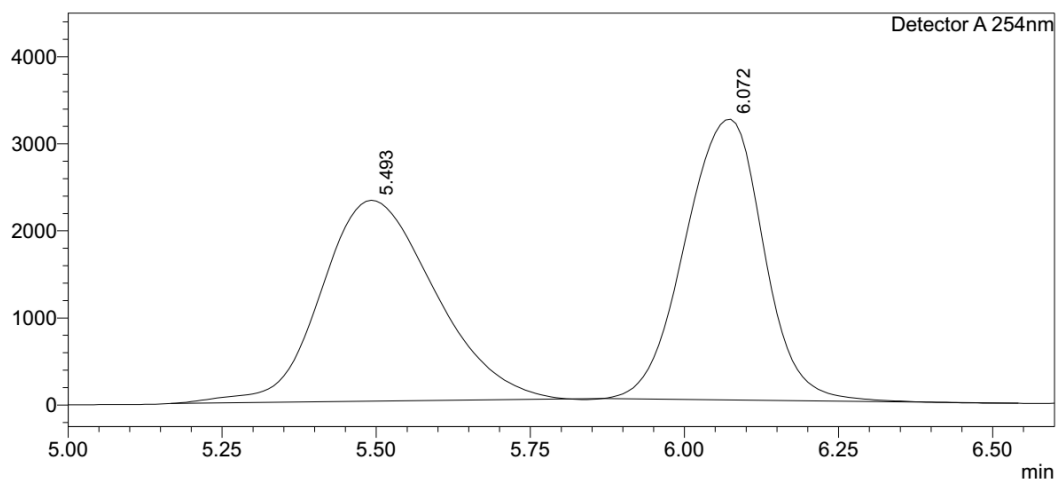
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.727	65171	2649	2.231			
2	9.766	2855356	84170	97.769		V	
Total		2920527	86819				



<Chromatogram>

mV



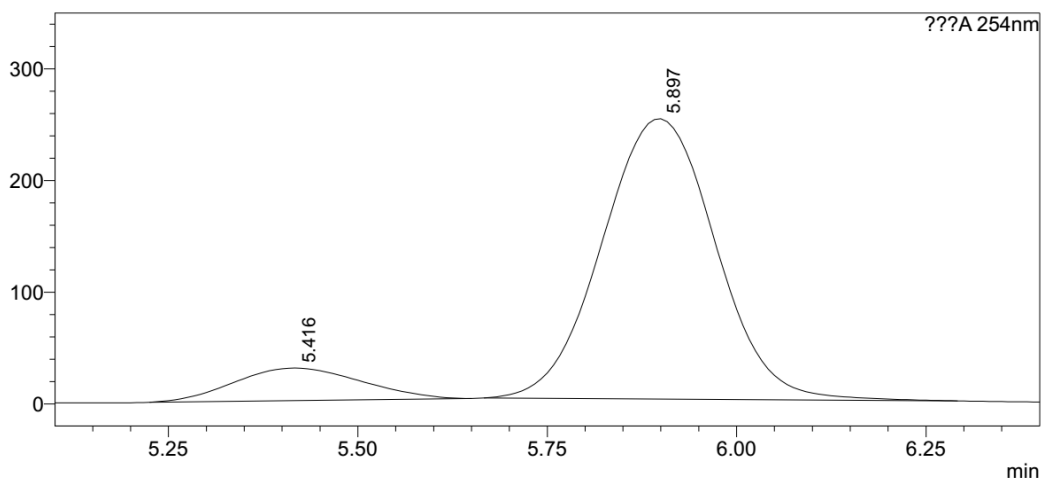
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.493	29675141	2308623	50.923		M	
2	6.072	28599267	3225751	49.077		M	
Total		58274408	5534374				

<Chromatogram>

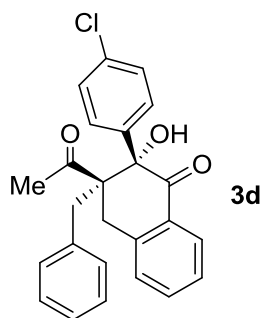
mV



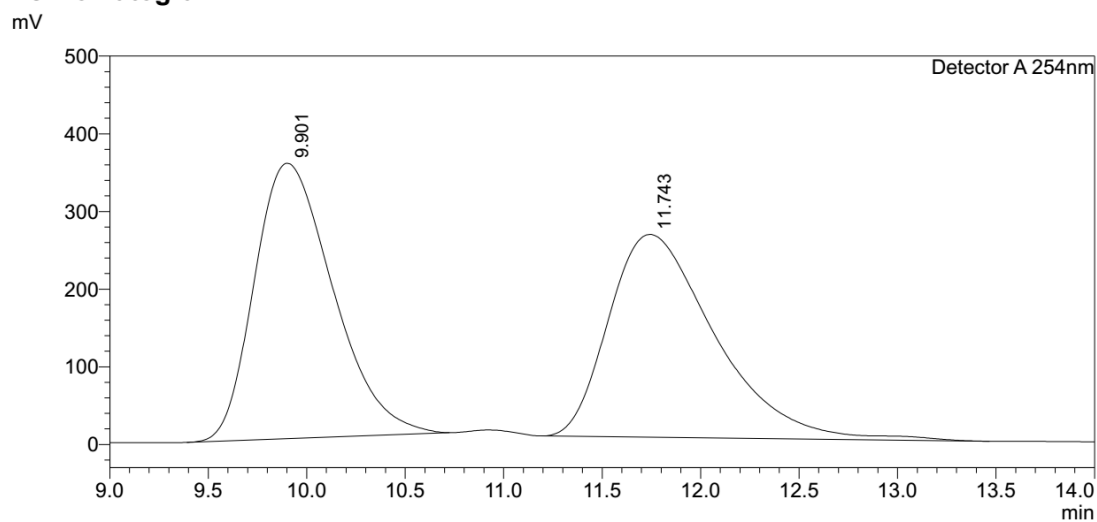
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.416	338988	29052	11.465		M	
2	5.897	2617838	251093	88.535		M	
Total		2956827	280145				



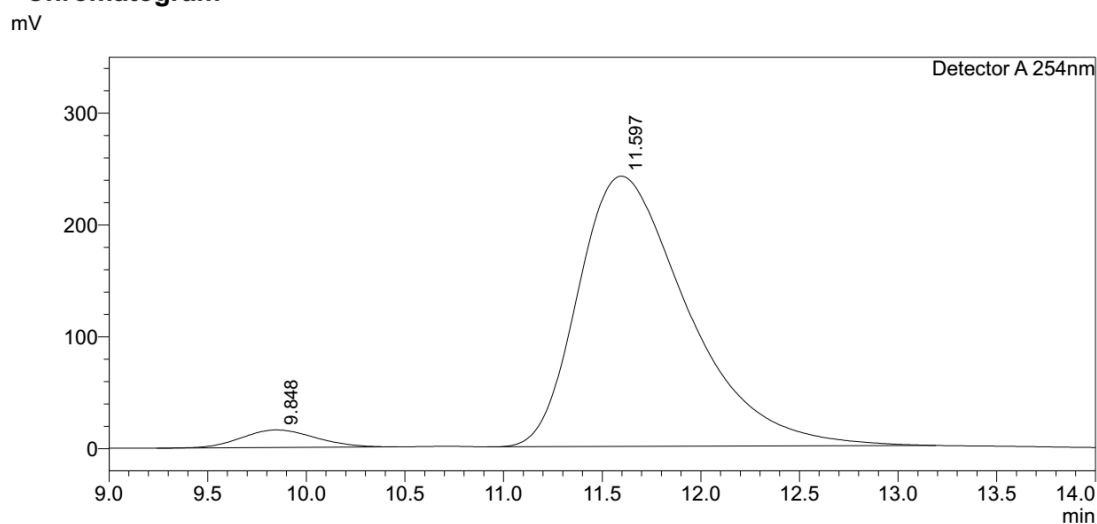
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<Peak Table>

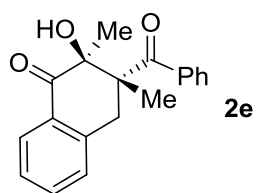
Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.901	9857487	354625	50.081			
2	11.743	9825502	261225	49.919			
Total		19682989	615850				

<Chromatogram>



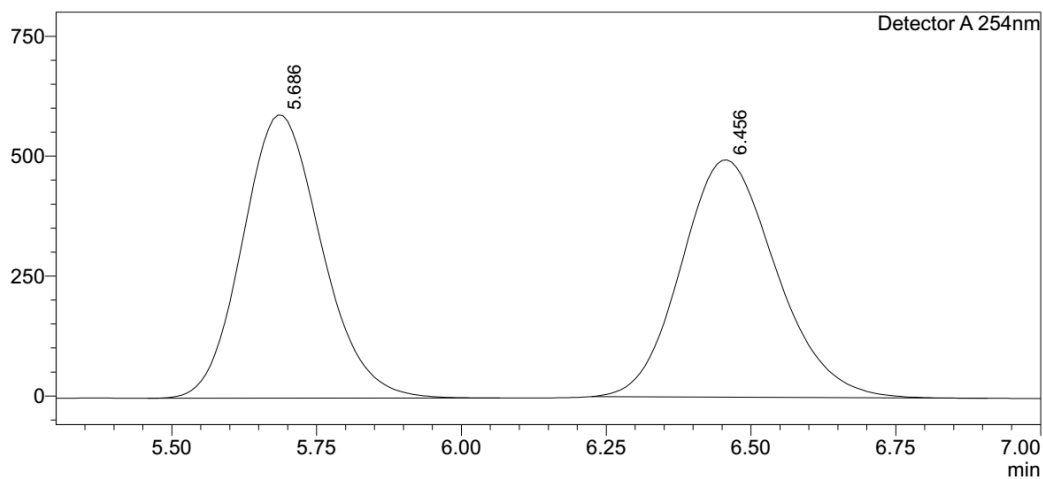
<Peak Table>

Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.848	409249	15720	4.189			
2	11.597	9360264	241862	95.811		M	
Total		9769513	257583				



<Chromatogram>

mV



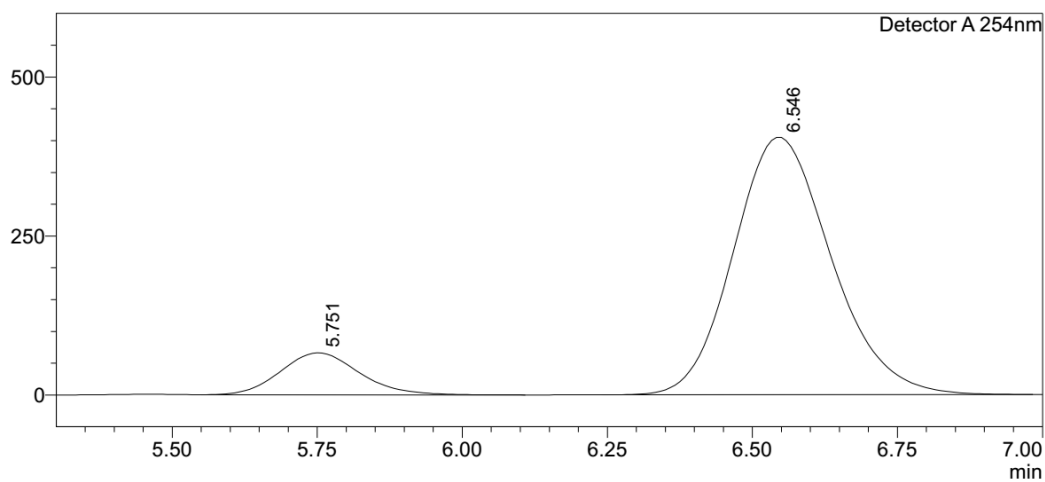
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.686	5617275	590507	49.858			
2	6.456	5649354	494755	50.142		M	
Total		11266629	1085262				

<Chromatogram>

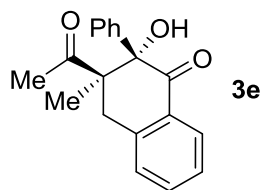
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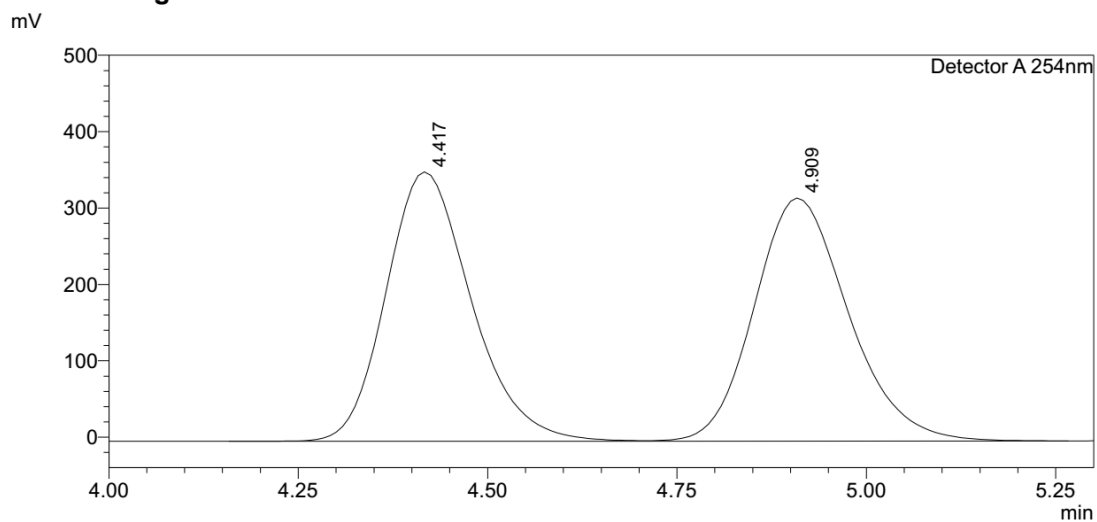
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.751	622667	66030	11.588			
2	6.546	4750604	404664	88.412		M	
Total		5373271	470694				



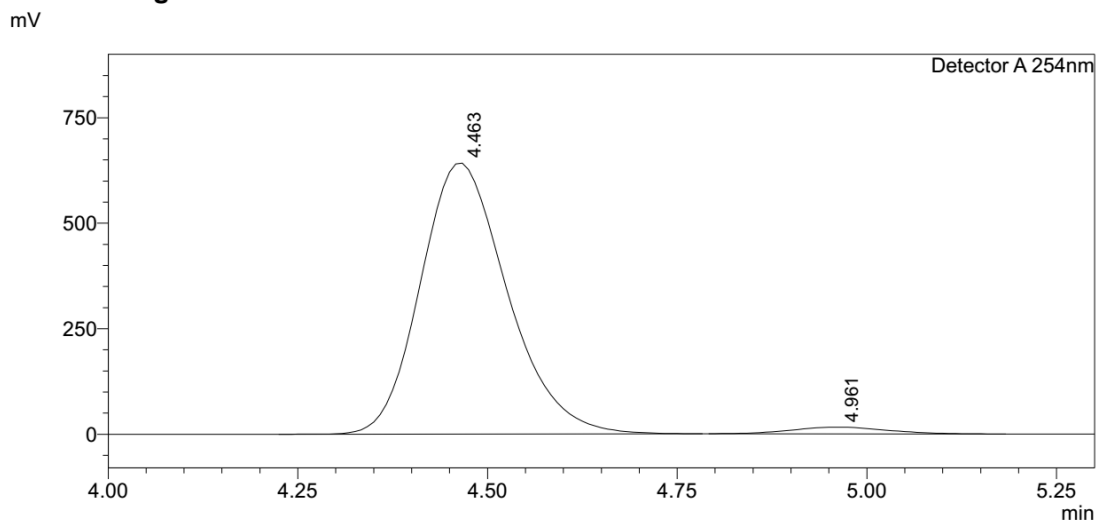
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<Peak Table>

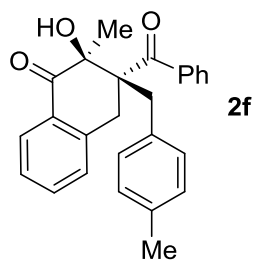
Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.417	2758835	352781	50.088			
2	4.909	2749096	318043	49.912		V	
Total		5507931	670824				

<Chromatogram>



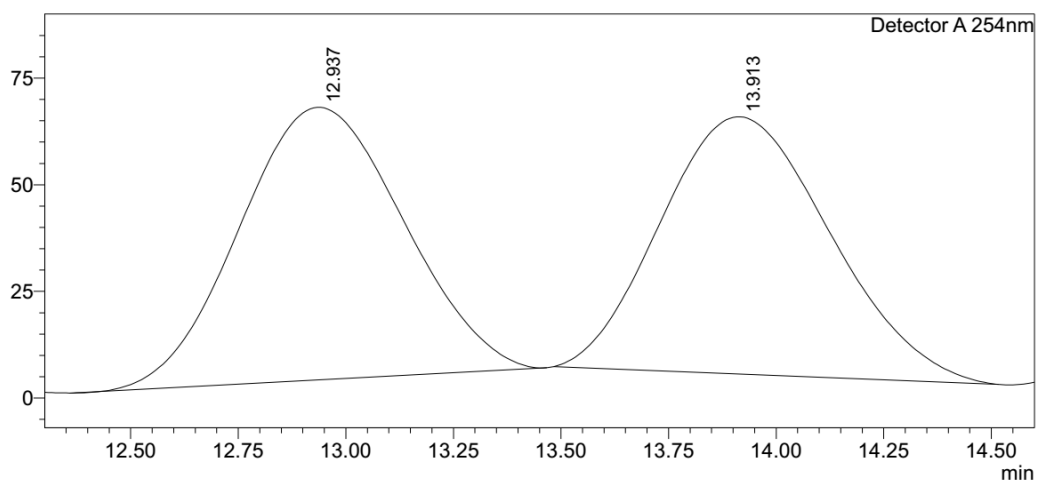
<Peak Table>

Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.463	5113844	641640	97.342			
2	4.961	139626	15992	2.658		M	
Total		5253470	657632				



<Chromatogram>

mV



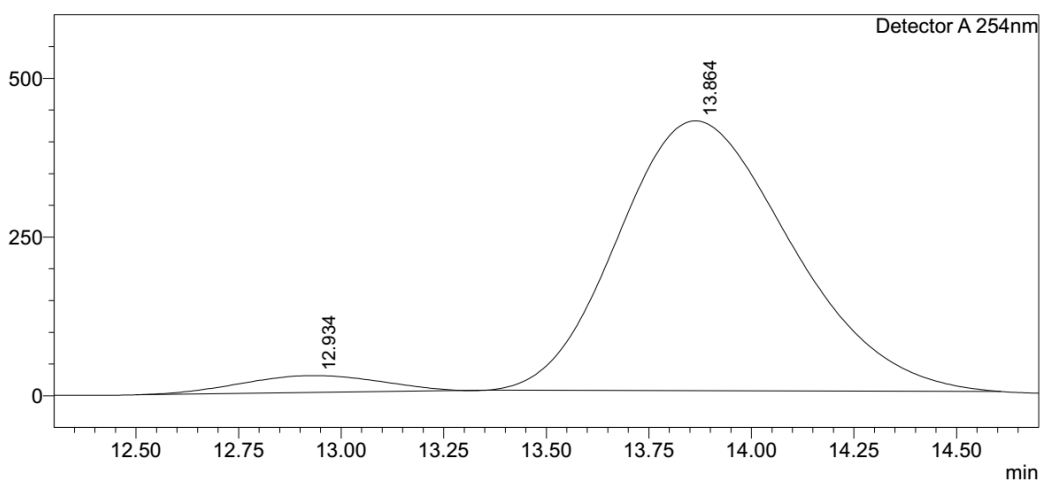
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.937	1689568	63865	50.659		M	
2	13.913	1645616	60282	49.341		M	
Total		3335185	124147				

<Chromatogram>

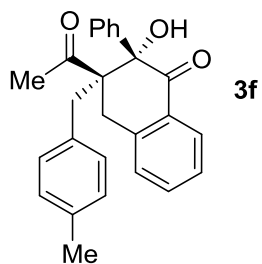
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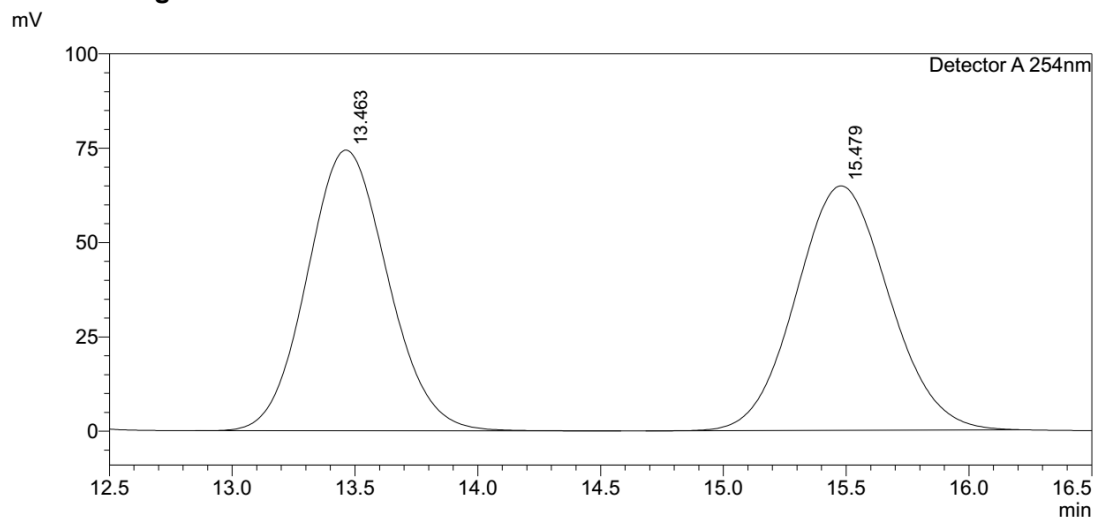
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.934	626734	26528	4.790		M	
2	13.864	12457212	424969	95.210		M	
Total		13083946	451497				



<Chromatogram>

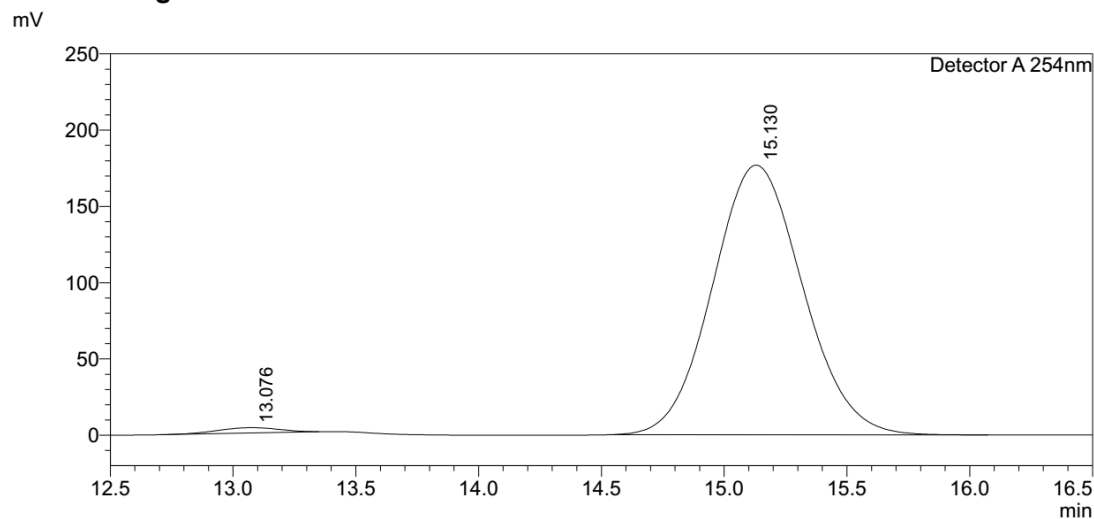


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.463	1701393	74397	49.918			
2	15.479	1706979	64758	50.082		M	
Total		3408371	139155				

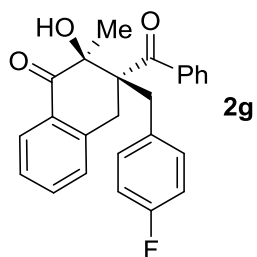
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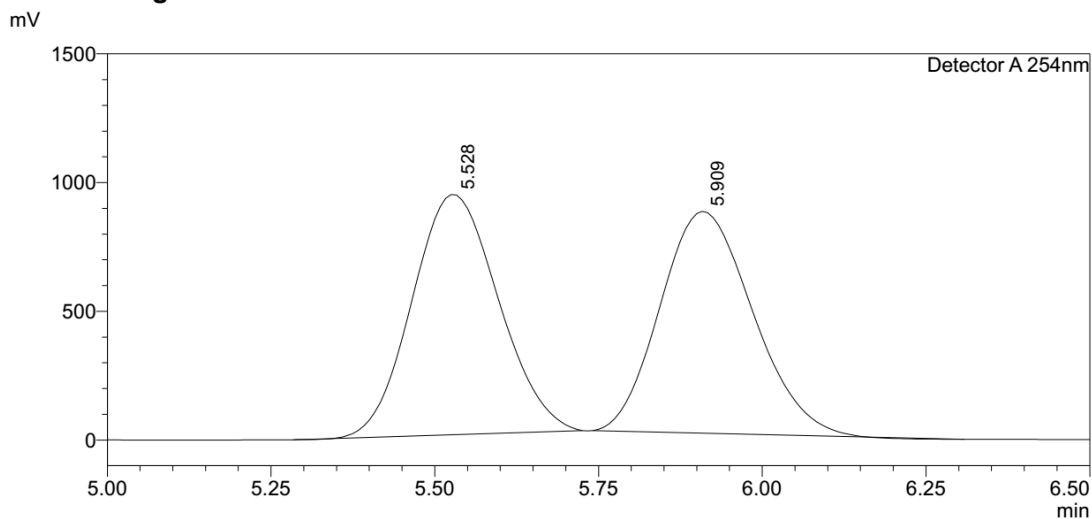
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.076	60492	3451	1.319			
2	15.130	4526254	176779	98.681		M	
Total		4586746	180230				



<Chromatogram>

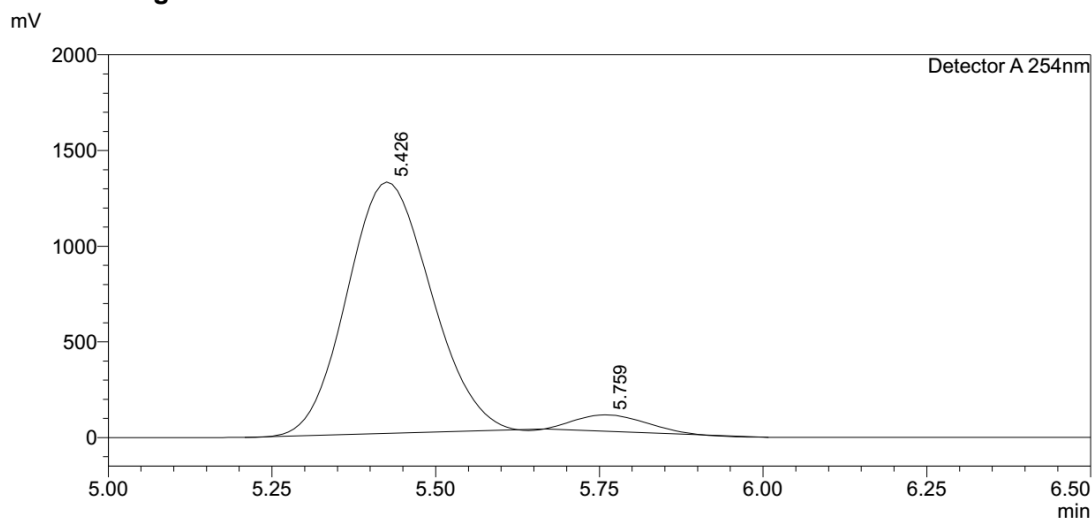


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.528	8554804	933249	50.307		M	
2	5.909	8450511	861595	49.693		M	
Total		17005315	1794844				

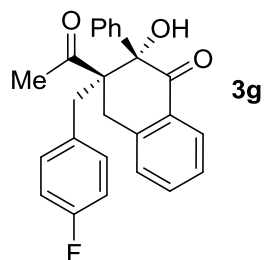
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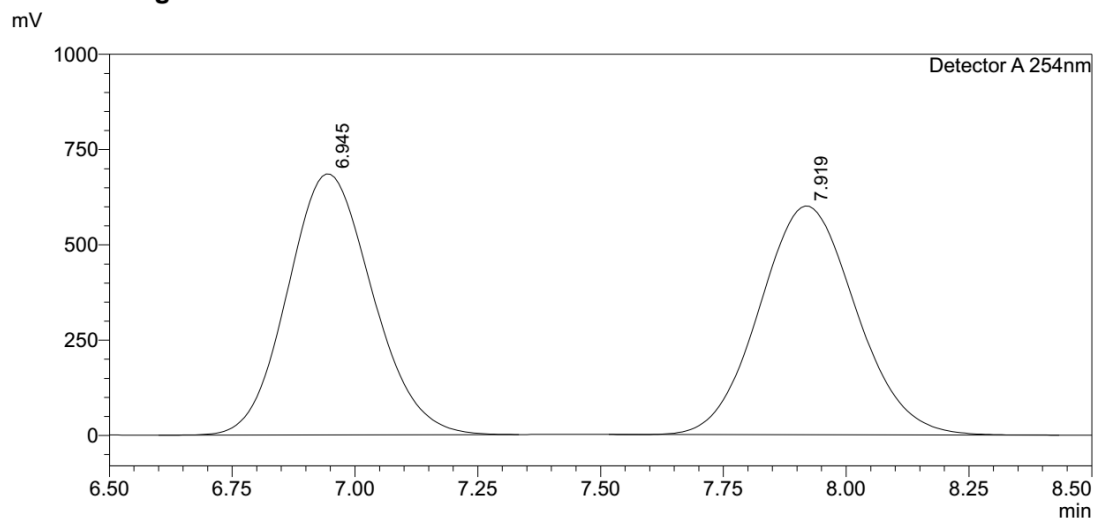
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.426	11720995	1313607	95.010		M	
2	5.759	615578	84999	4.990		M	
Total		12336573	1398606				



<Chromatogram>

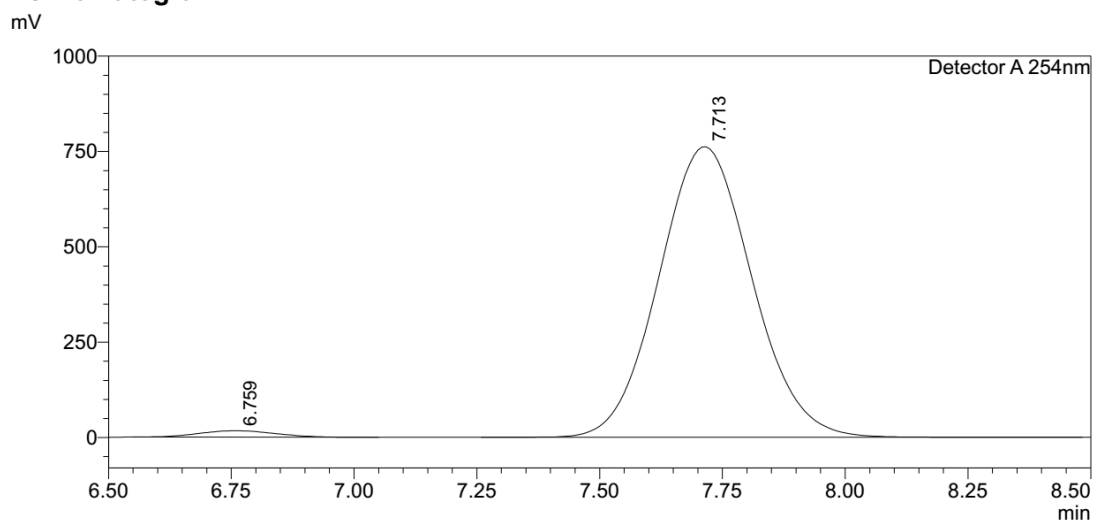


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.945	8225796	684790	50.011			
2	7.919	8222276	600103	49.989		M	
Total		16448072	1284893				

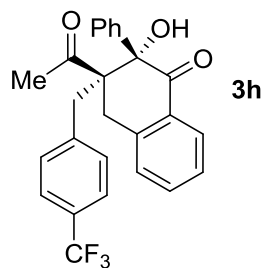
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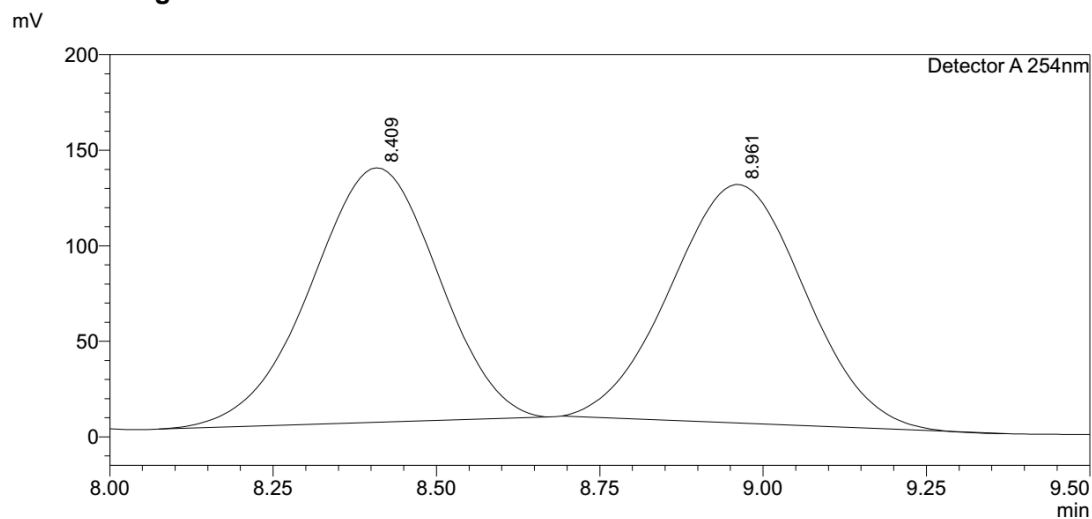
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.759	185785	16945	1.813		M	
2	7.713	10062379	761751	98.187			
Total		10248164	778696				



<Chromatogram>

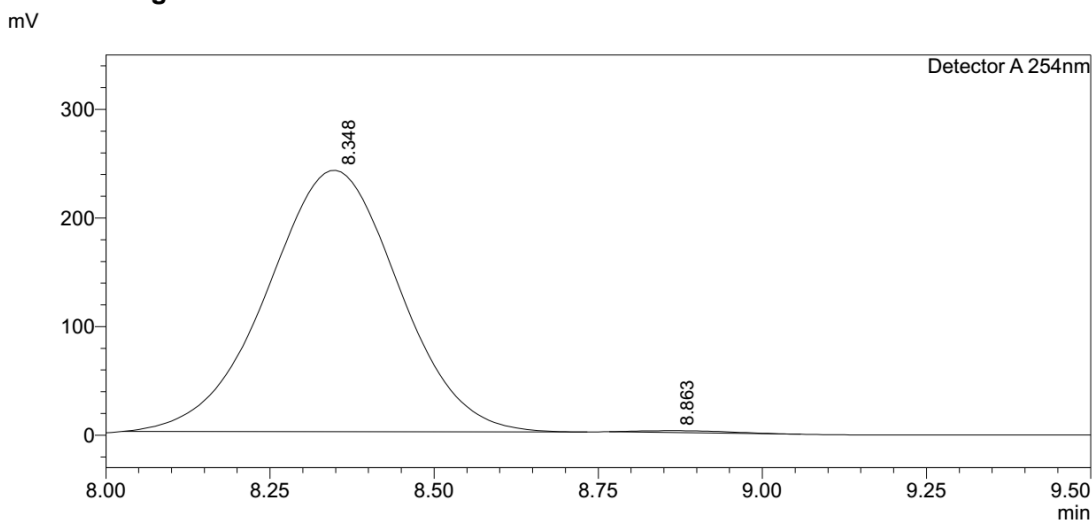


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.409	1812292	133226	50.369		M	
2	8.961	1785767	124820	49.631		M	
Total		3598059	258046				

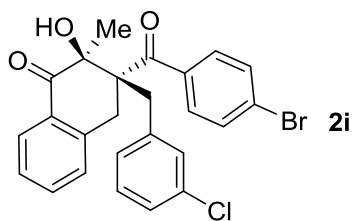
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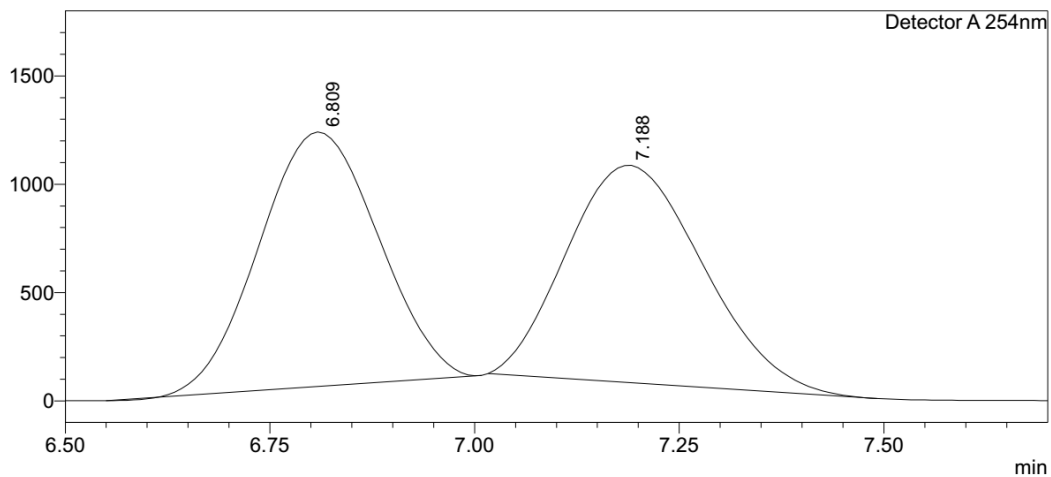
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.348	3364505	240742	99.501		M	
2	8.863	16865	1715	0.499		M	
Total		3381370	242458				



<Chromatogram>

mV



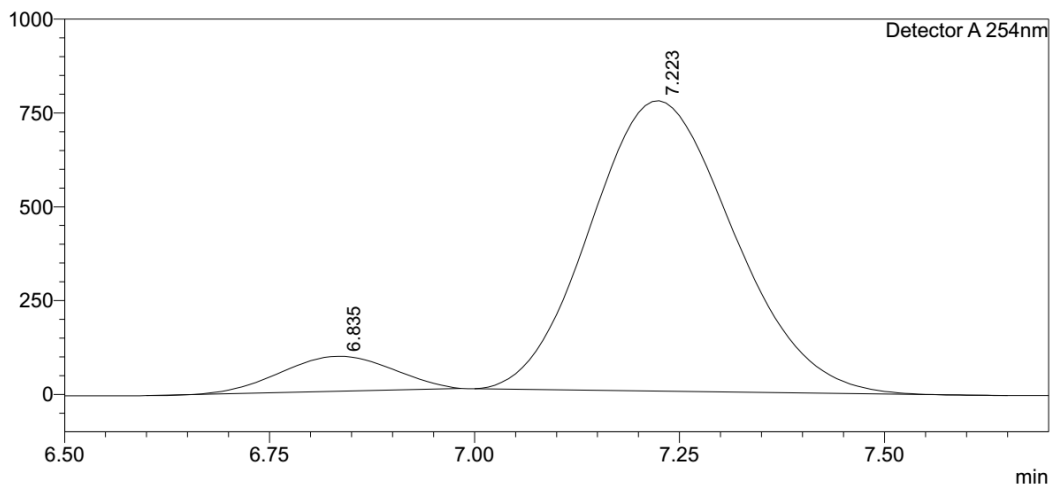
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.809	11896882	1174450	50.634		M	
2	7.188	11599160	1001881	49.366		M	
Total		23496042	2176330				

<Chromatogram>

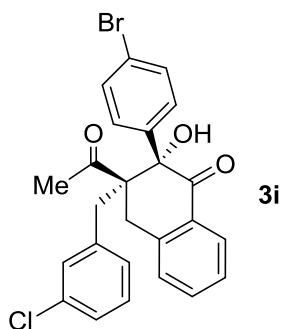
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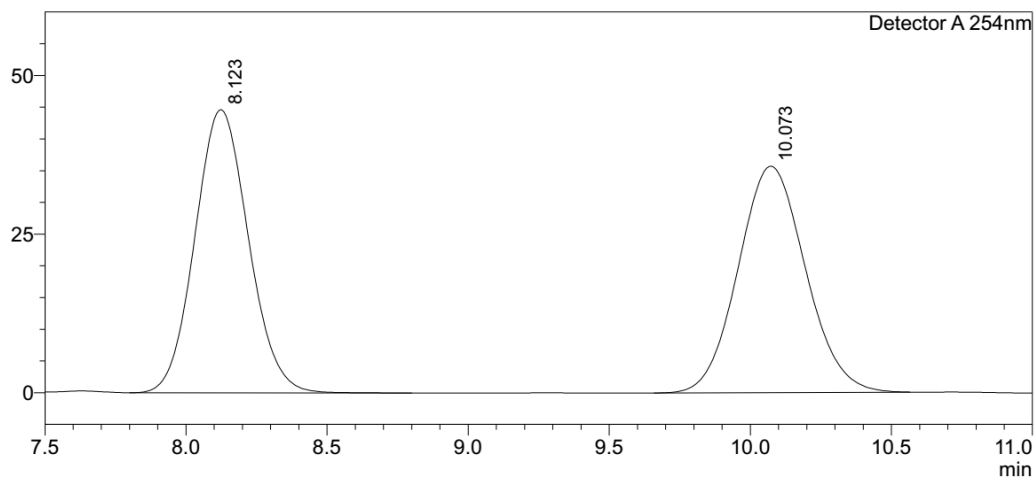
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.835	887180	93097	8.641		M	
2	7.223	9379558	773945	91.359		M	
Total		10266738	867043				



<Chromatogram>

mV



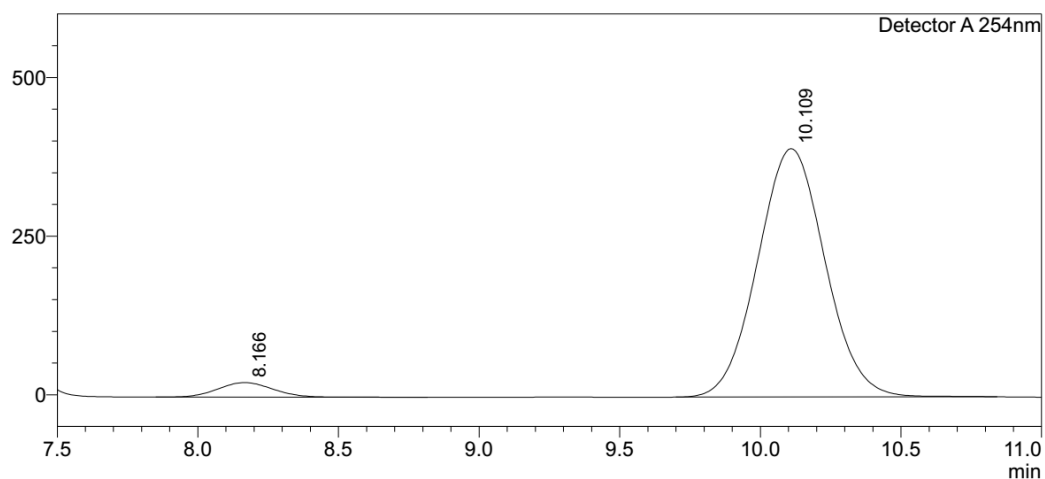
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.123	589225	44627	49.858			
2	10.073	592582	35683	50.142		M	
Total		1181807	80310				

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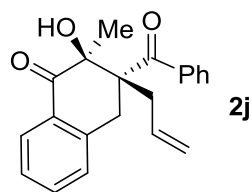
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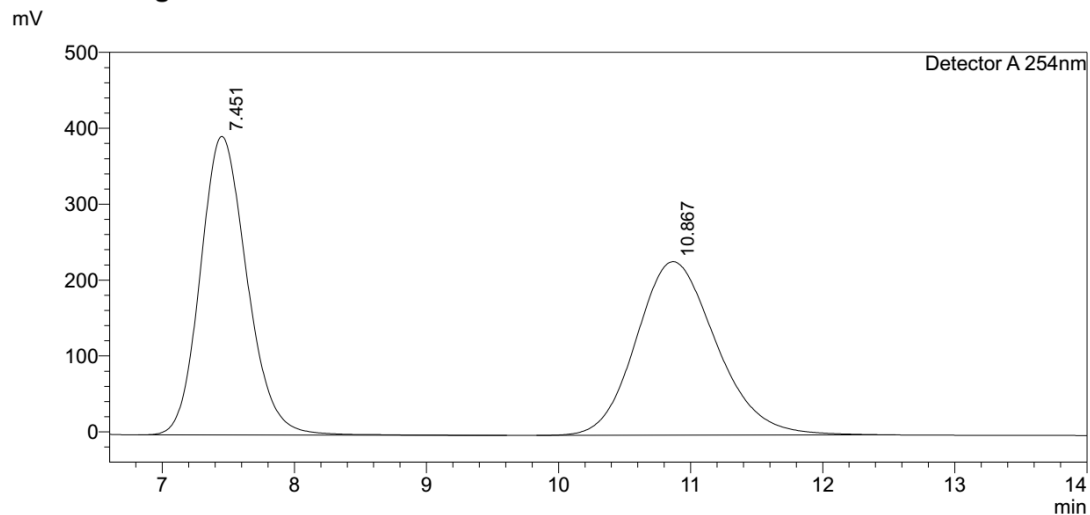
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Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.166	314795	22990	4.602			
2	10.109	6525870	391410	95.398		M	
Total		6840664	414400				



<Chromatogram>

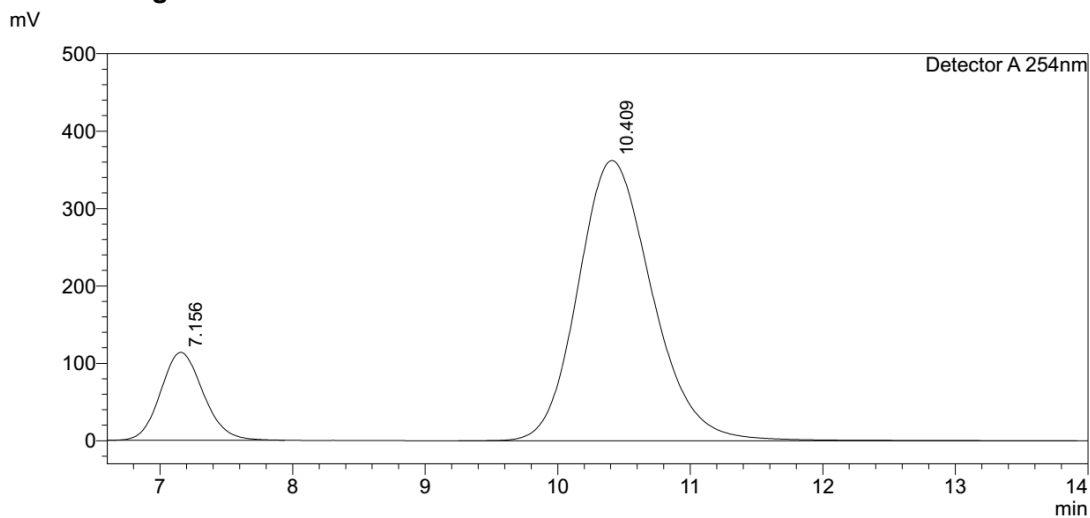


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.451	9654809	393324	50.048			
2	10.867	9636100	228737	49.952		M	
Total		19290909	622061				

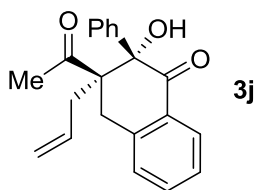
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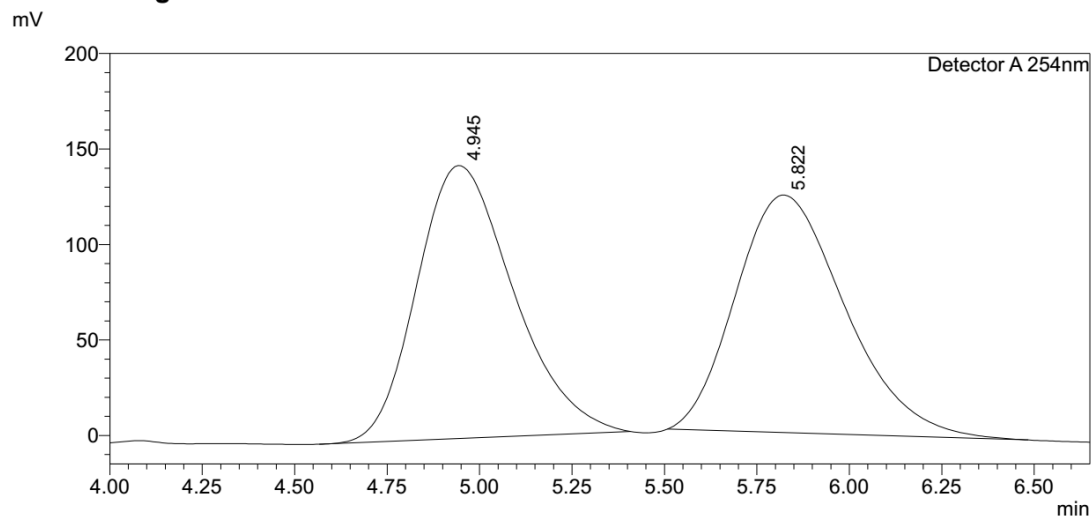
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.156	2541462	113549	15.279		M	
2	10.409	14092129	362093	84.721			
Total		16633592	475641				



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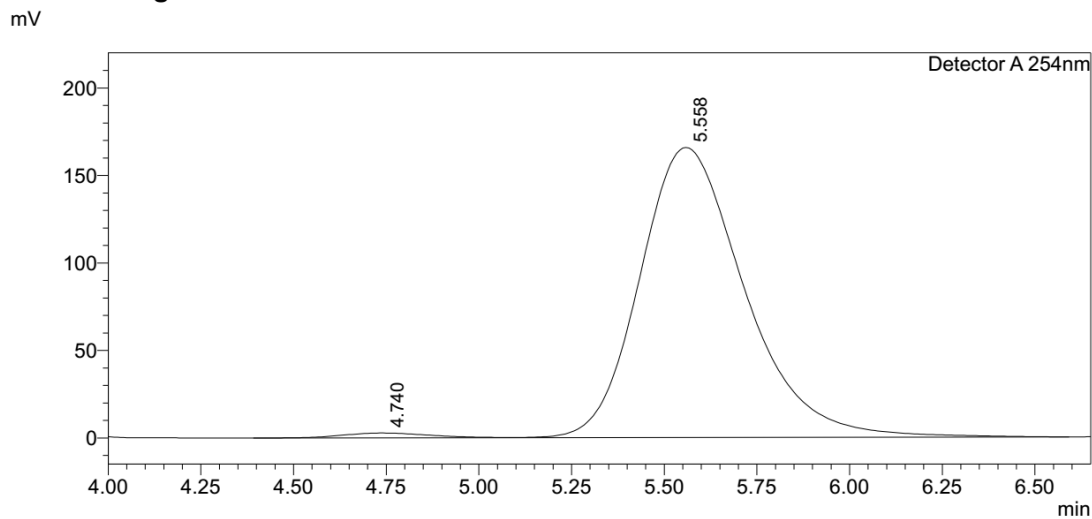


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.945	2598032	142944	50.321		M	
2	5.822	2564918	124420	49.679		M	
Total		5162950	267364				

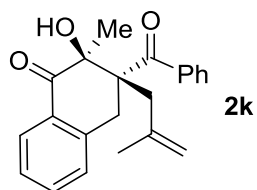
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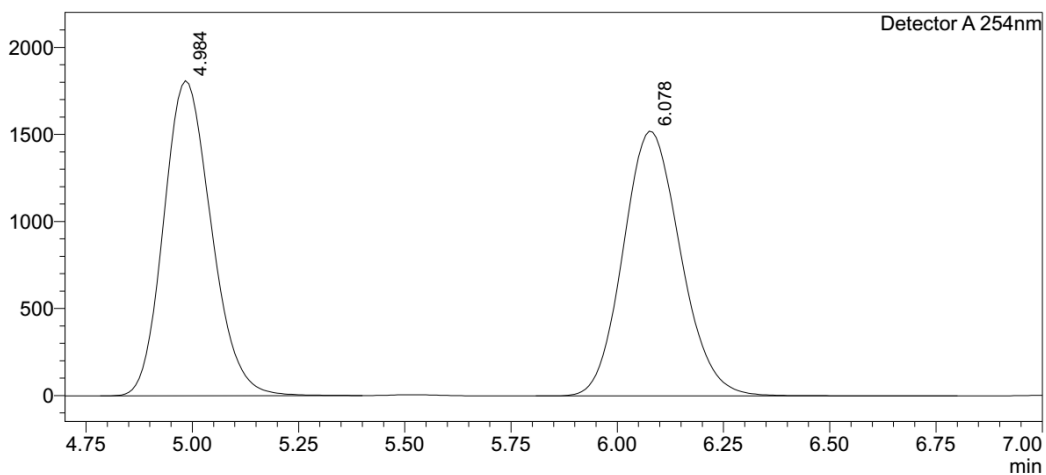
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.740	44713	2763	1.355			
2	5.558	3254569	165701	98.645		V	
Total		3299282	168465				



<Chromatogram>

mV



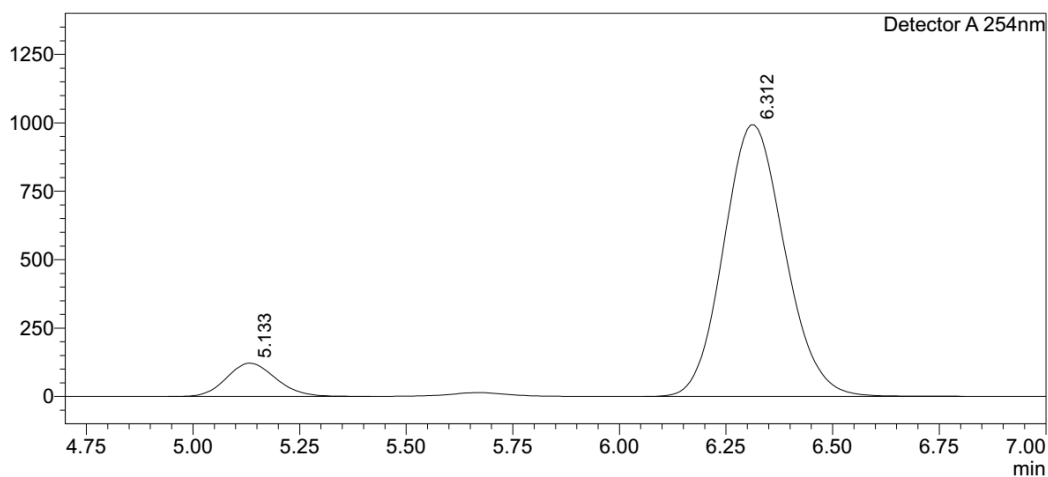
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.984	14130340	1810234	49.688			
2	6.078	14307927	1520722	50.312			
Total		28438267	3330956				

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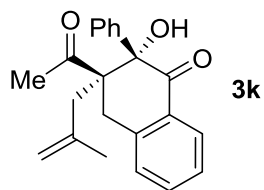
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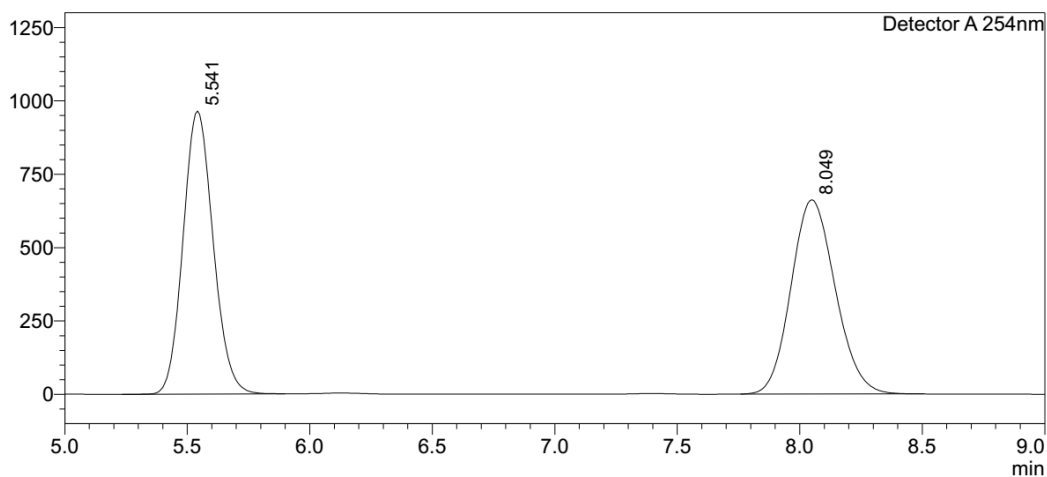
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.133	977513	121818	8.996			
2	6.312	9888117	992506	91.004		M	
Total		10865630	1114324				



<Chromatogram>

mV



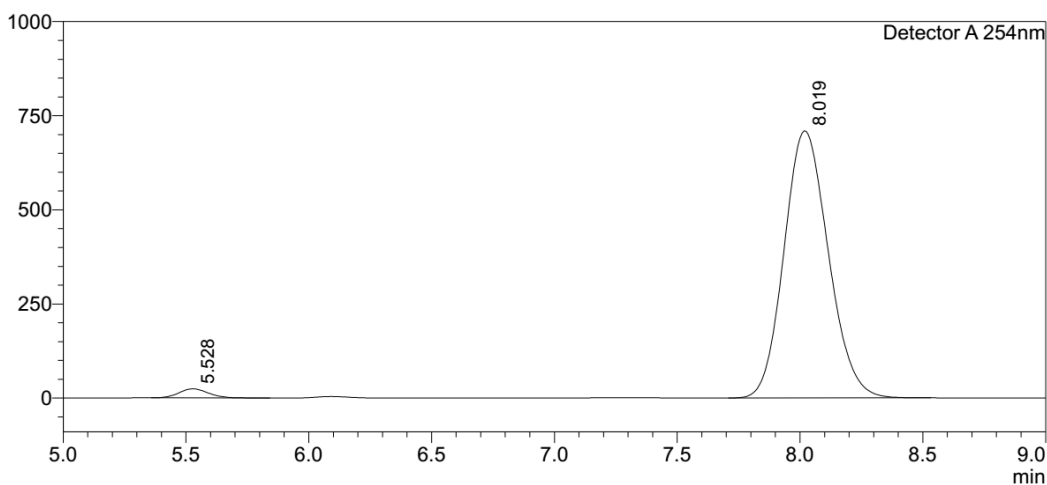
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.541	8242737	964295	49.804			
2	8.049	8307624	662051	50.196		M	
Total		16550361	1626346				

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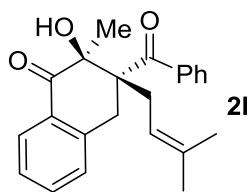
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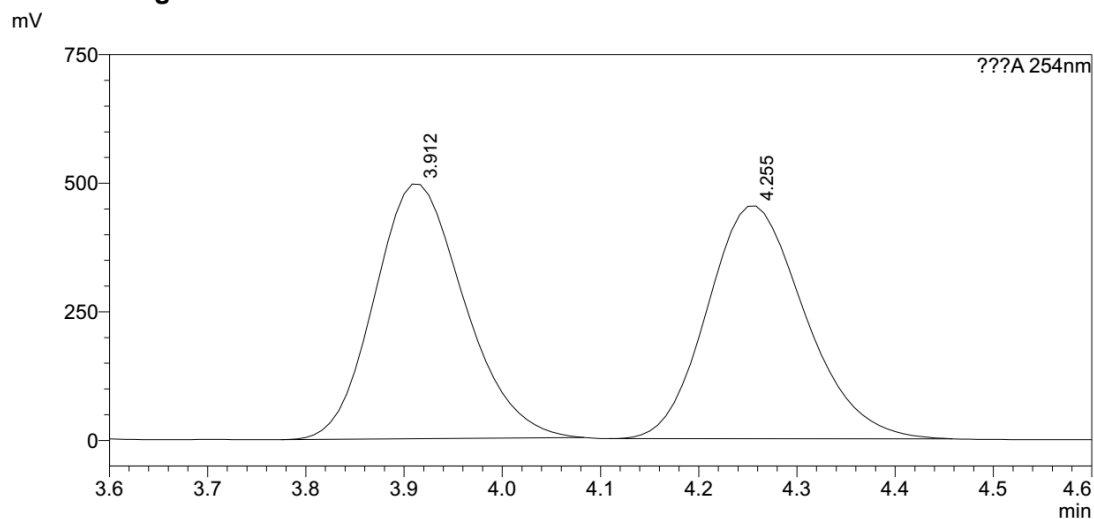
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.528	199607	23976	2.190			
2	8.019	8913651	709737	97.810		M	
Total		9113258	733713				



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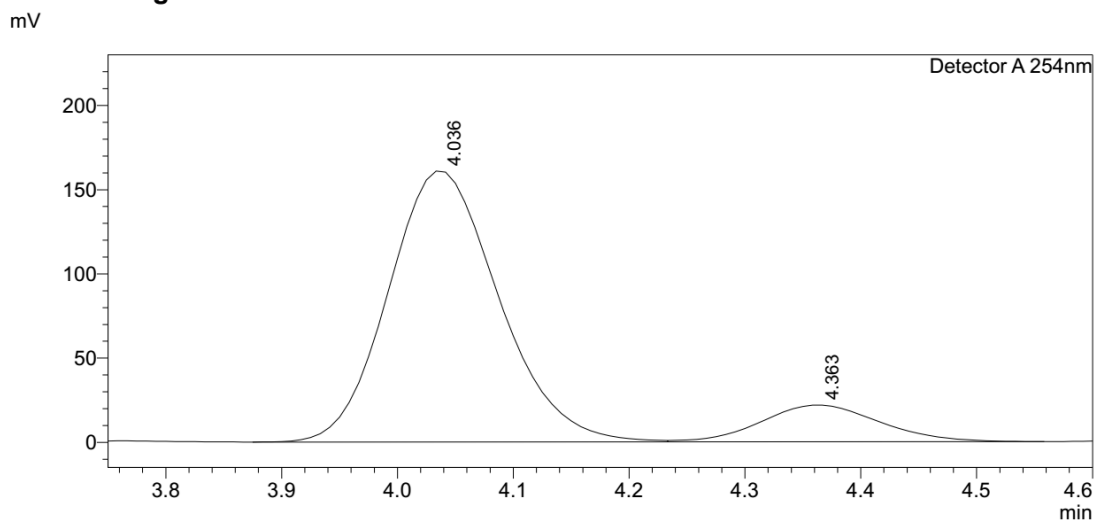


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.912	3153854	495222	50.170		M	
2	4.255	3132448	452684	49.830		M	
Total		6286302	947906				

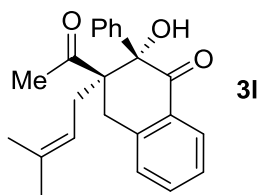
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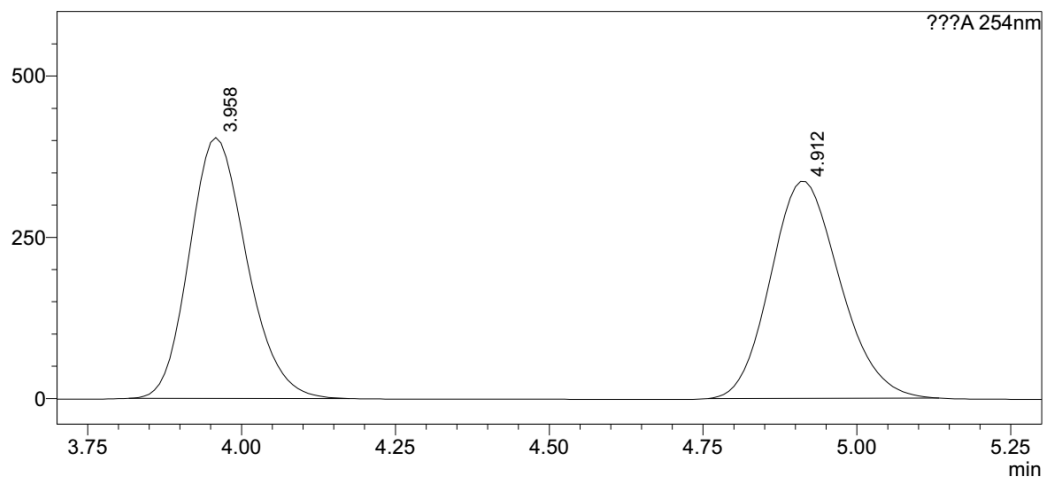
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.036	1065095	160893	87.354			
2	4.363	154195	21703	12.646		V	
Total		1219289	182596				



<Chromatogram>

mV



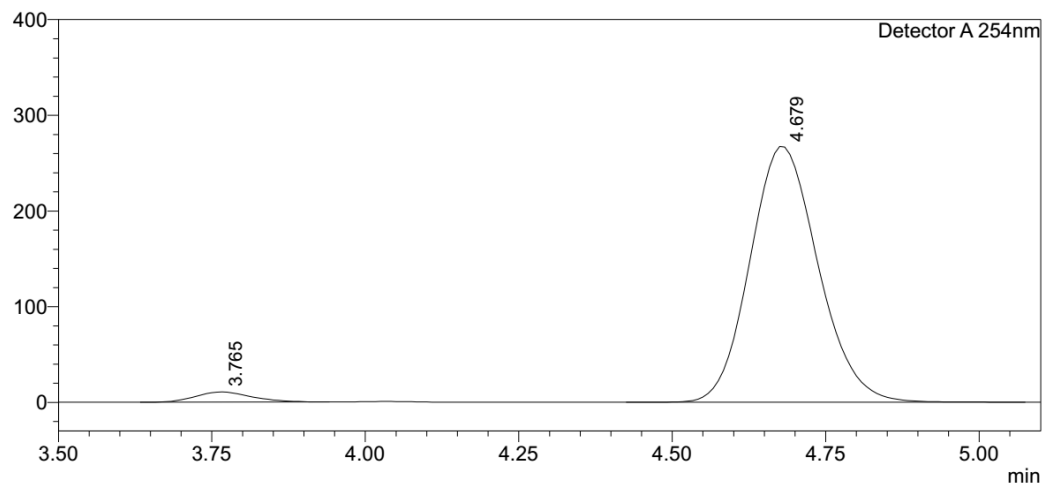
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.958	2633616	404610	49.872		M	
2	4.912	2647184	336501	50.128		M	
Total		5280800	741111				

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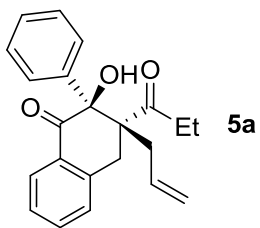
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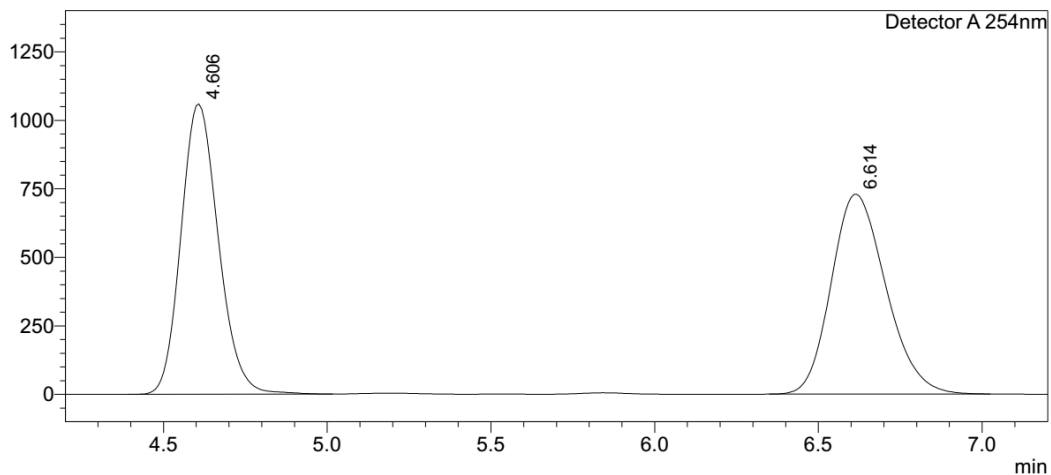
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.765	68824	10653	3.229			
2	4.679	2062531	267094	96.771			
Total		2131355	277747				



<Chromatogram>

mV



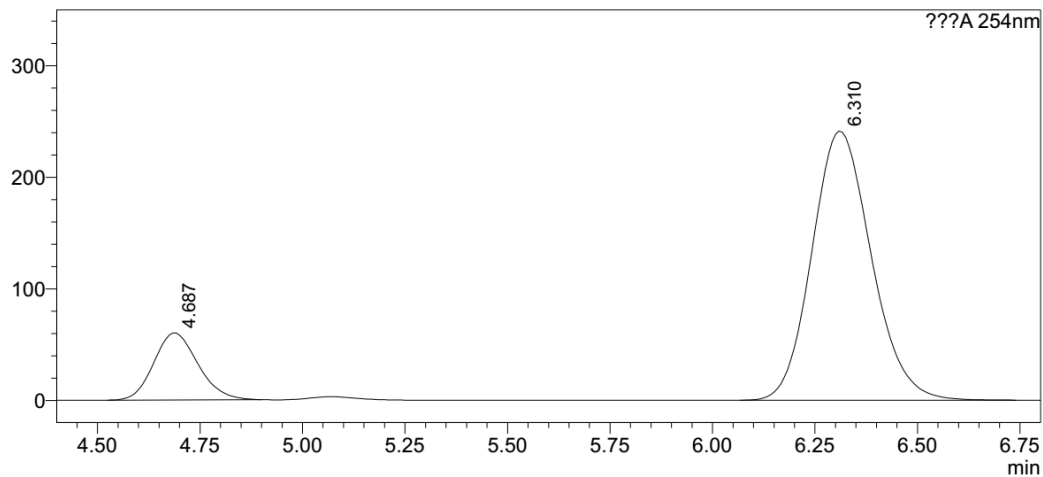
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.606	8411262	1059839	49.835			
2	6.614	8467036	729648	50.165		M	
Total		16878299	1789486				

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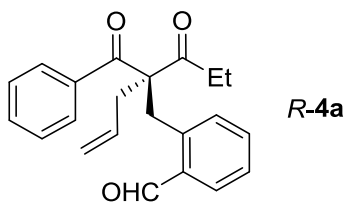
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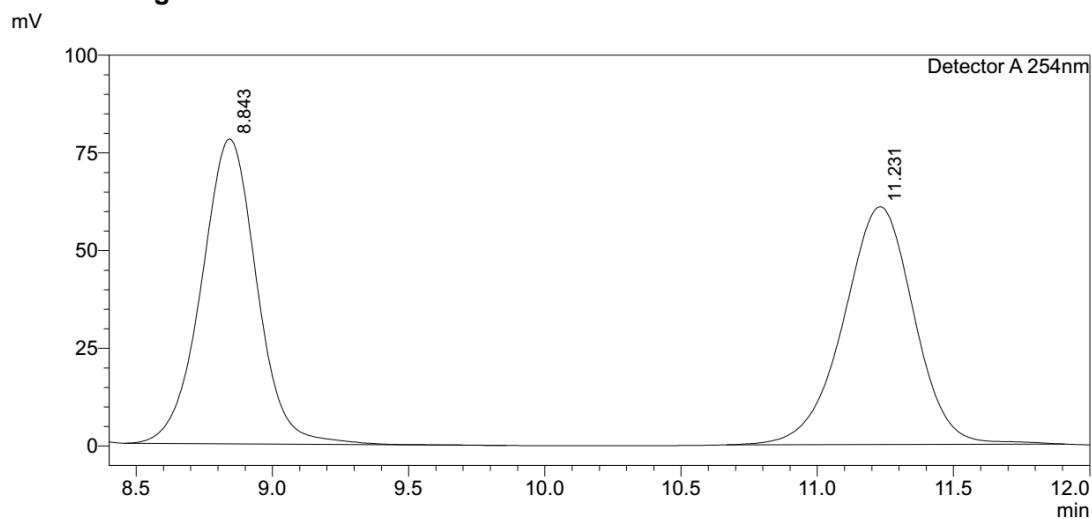
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.687	449855	59986	15.624		M	
2	6.310	2429489	241265	84.376		M	
Total		2879345	301250				



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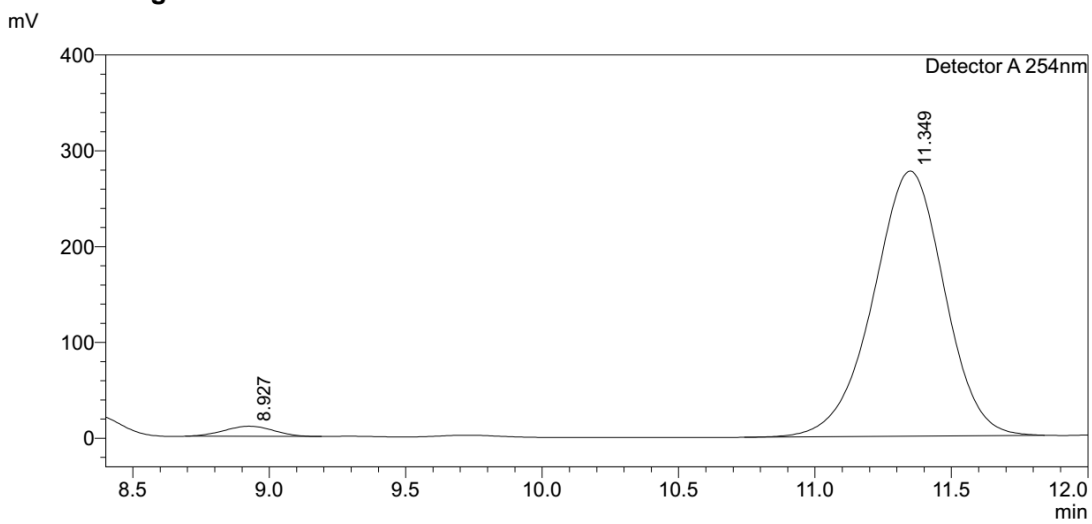


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.843	1105761	78061	50.199			
2	11.231	1096993	60862	49.801		M	
Total		2202754	138923				

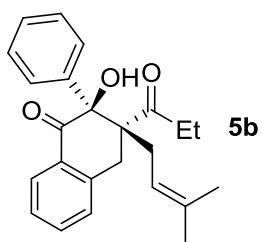
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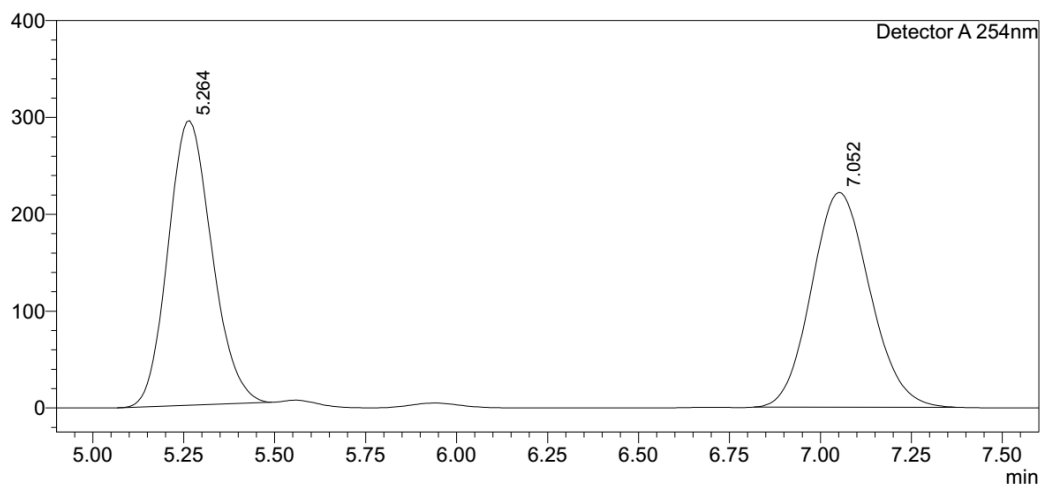
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.927	134118	10586	2.597		M	
2	11.349	5029815	276836	97.403		M	
Total		5163933	287422				



<Chromatogram>

mV



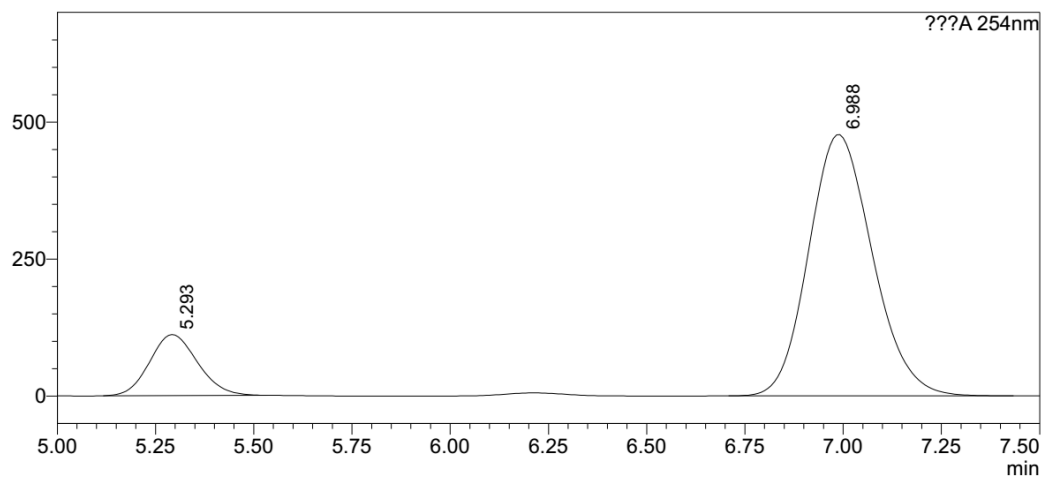
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.264	2469729	293756	49.884			
2	7.052	2481212	222041	50.116		M	
Total		4950941	515797				

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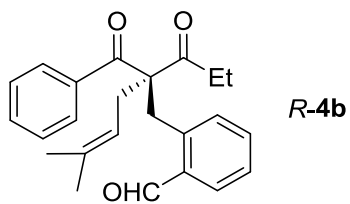
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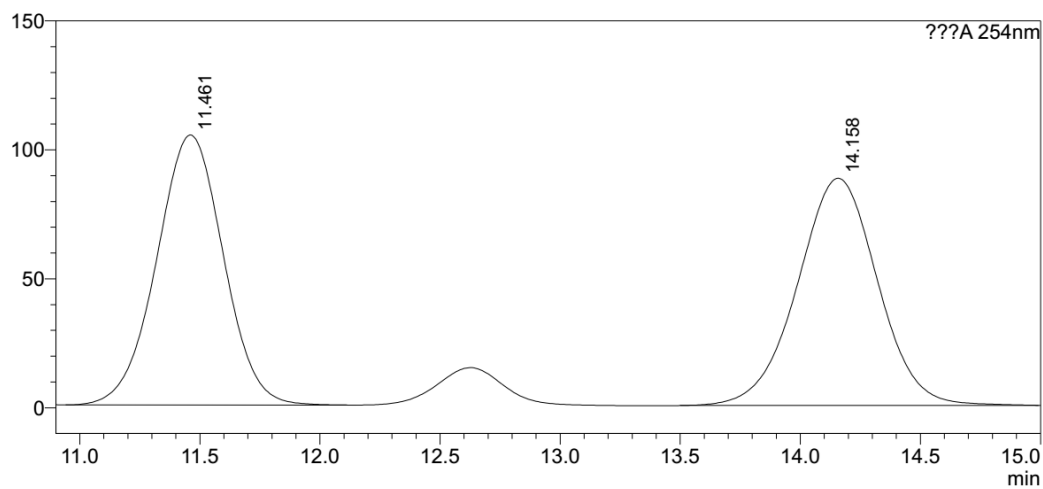
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.293	942629	111367	14.890		M	
2	6.988	5388079	476356	85.110		M	
Total		6330708	587723				



<Chromatogram>

mV



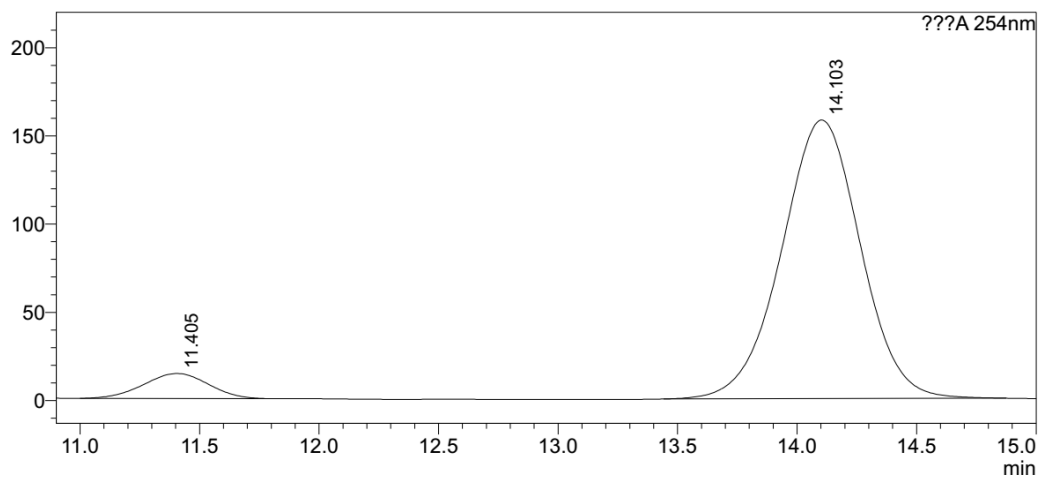
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.461	2024907	104703	49.773			
2	14.158	2043396	88107	50.227		M	
Total		4068304	192810				

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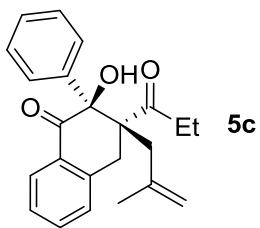
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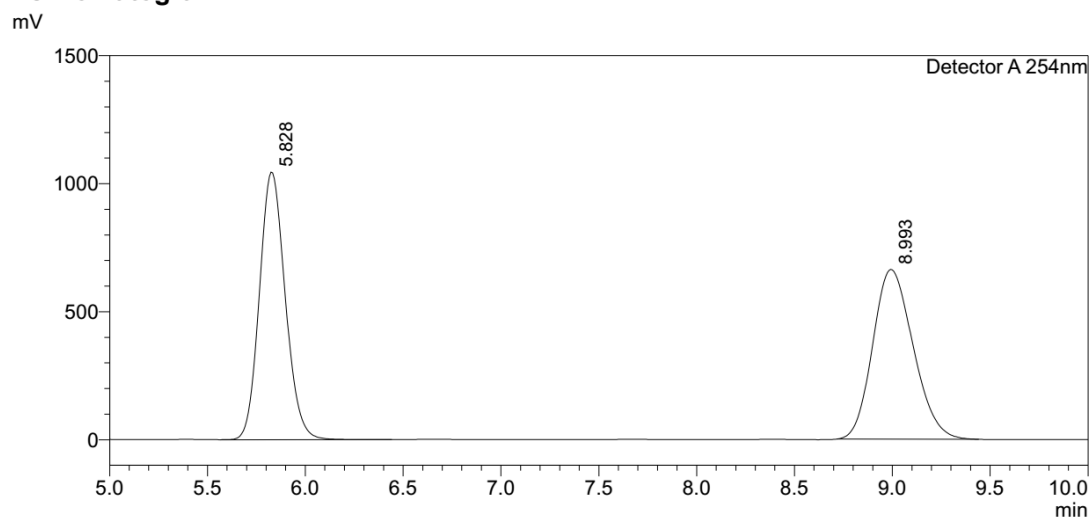
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.405	266860	14135	6.848		M	
2	14.103	3630057	157919	93.152		M	
Total		3896916	172055				



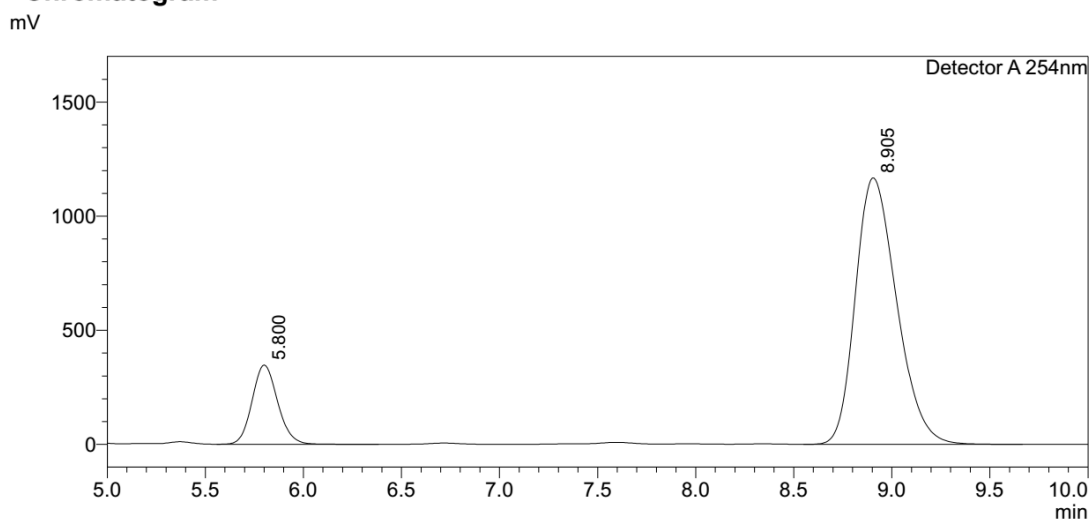
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<Peak Table>

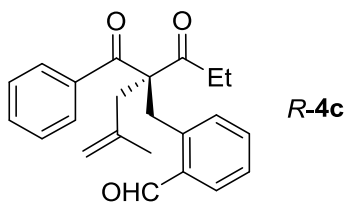
Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.828	9617789	1045176	50.201			
2	8.993	9540673	663141	49.799		M	
Total		19158462	1708317				

<Chromatogram>



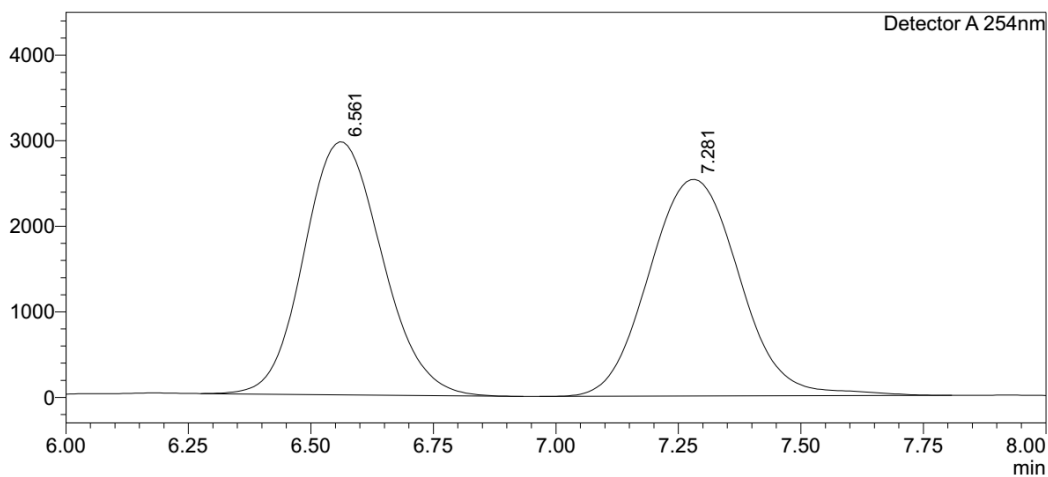
<Peak Table>

Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.800	3154620	347383	15.588			
2	8.905	17082872	1167451	84.412			
Total		20237491	1514834				



<Chromatogram>

mV



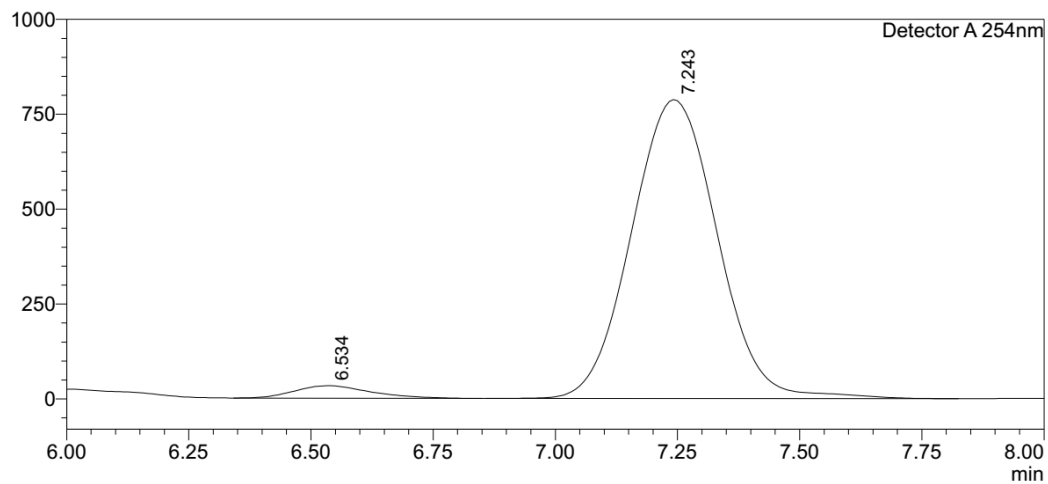
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.561	32824808	2959021	50.142			
2	7.281	32639326	2532188	49.858			
Total		65464133	5491209				

<Chromatogram>

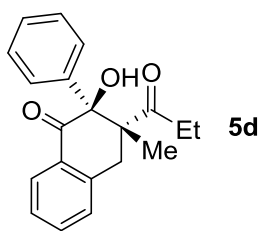
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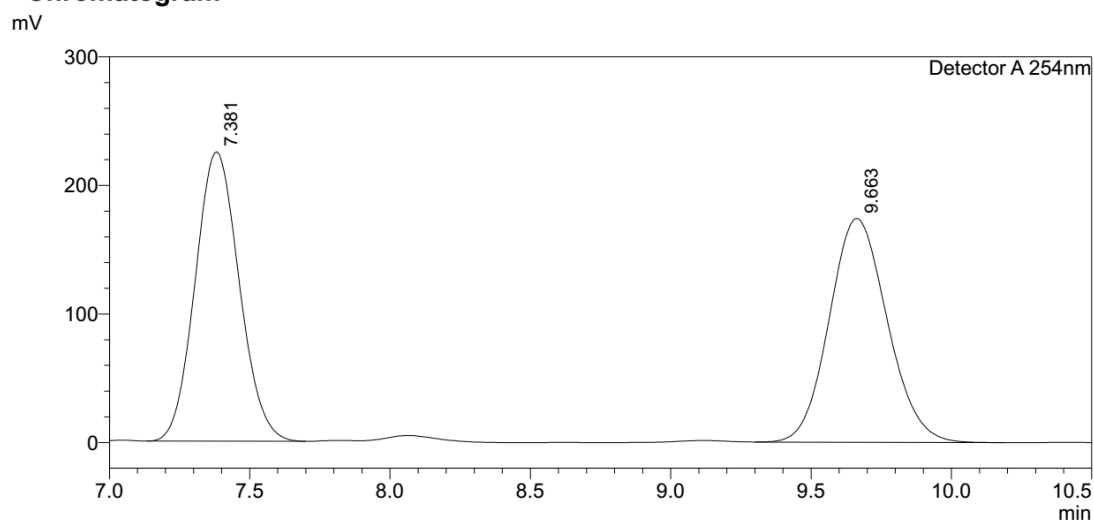
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.534	355646	32849	3.562			
2	7.243	9629818	787440	96.438			
Total		9985465	820289				



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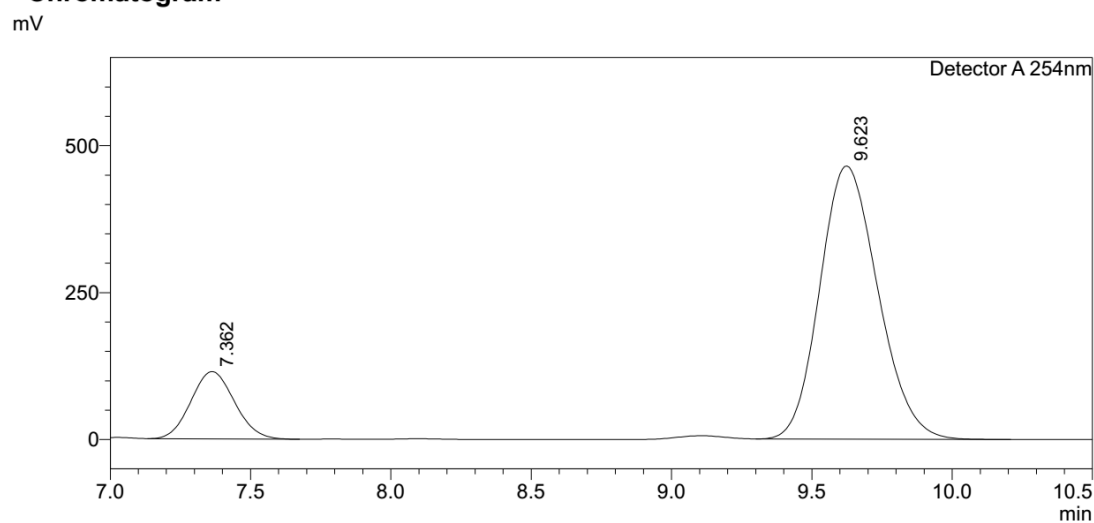


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.381	2462192	225205	49.597			
2	9.663	2502209	174009	50.403			
Total		4964401	399214				

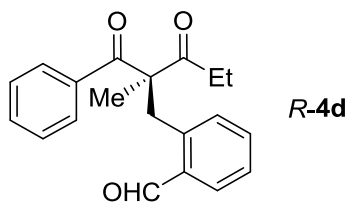
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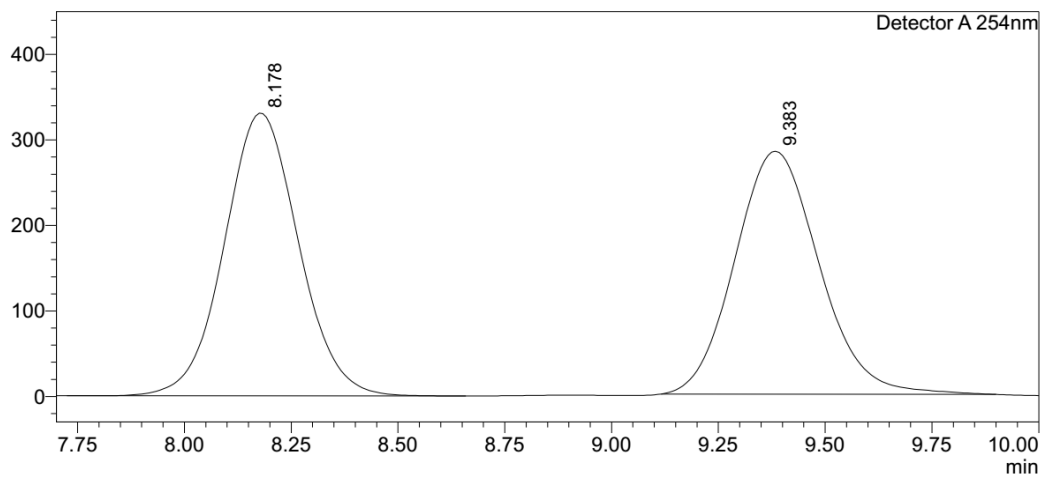
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.362	1236743	114361	15.569			
2	9.623	6706959	465020	84.431			
Total		7943702	579381				



<Chromatogram>

mV



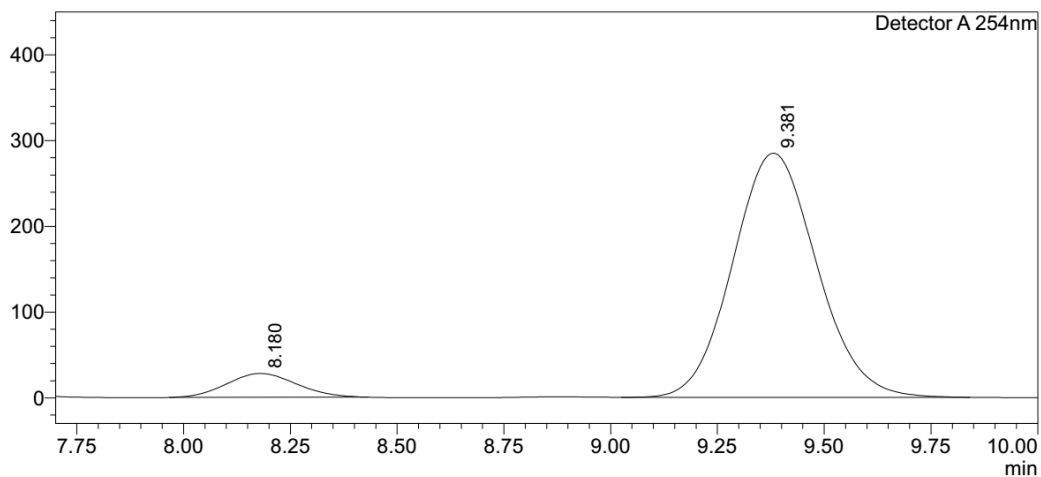
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.178	4001911	330702	50.636			
2	9.383	3901373	284093	49.364		M	
Total		7903284	614795				

<Chromatogram>

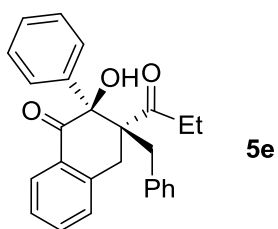
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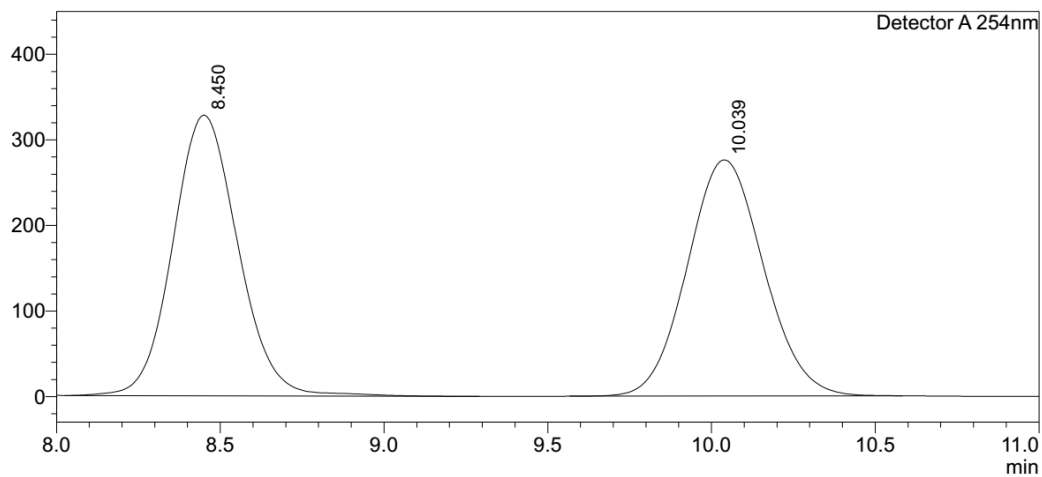
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.180	318681	27786	7.553		M	
2	9.381	3900307	284840	92.447		M	
Total		4218988	312626				



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mV



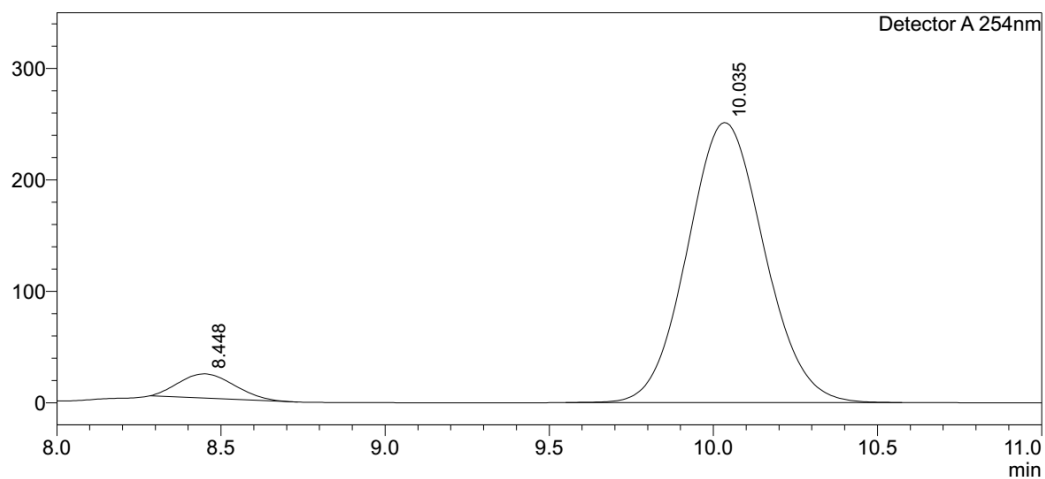
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.450	4543128	328219	50.363			
2	10.039	4477561	276022	49.637		M	
Total		9020690	604241				

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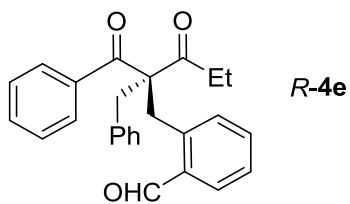
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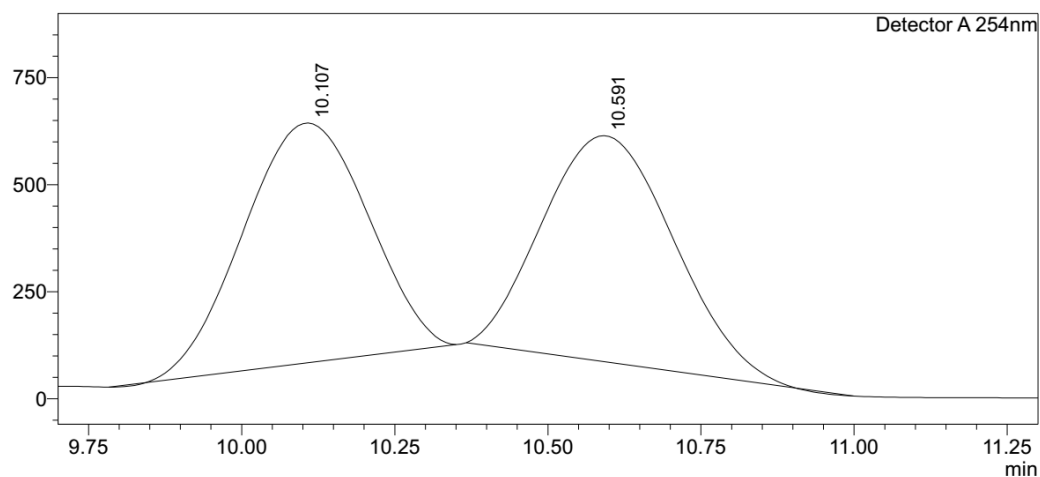
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.448	256530	21737	5.895		M	
2	10.035	4094948	251401	94.105		M	
Total		4351478	273138				



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mV



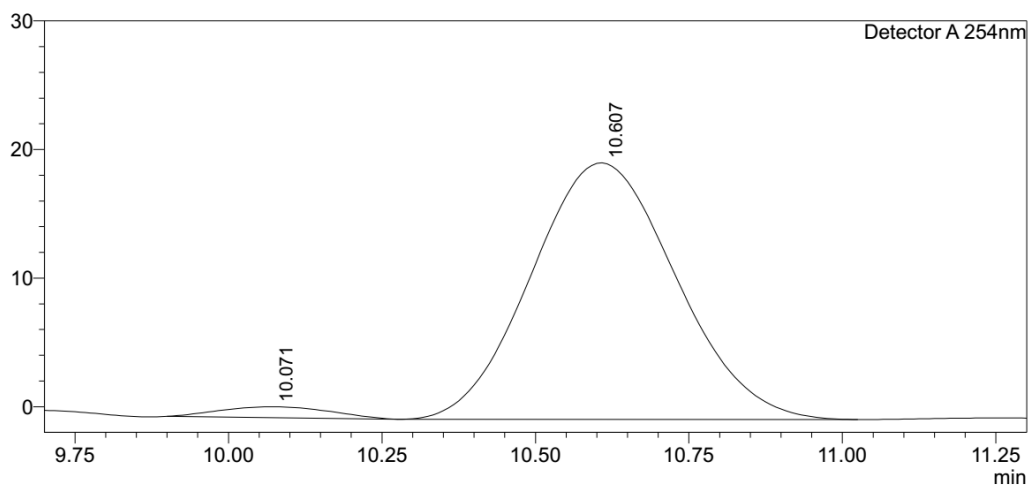
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.107	7945731	560457	50.328		M	
2	10.591	7842086	527981	49.672		M	
Total		15787817	1088438				

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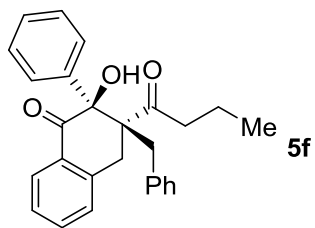
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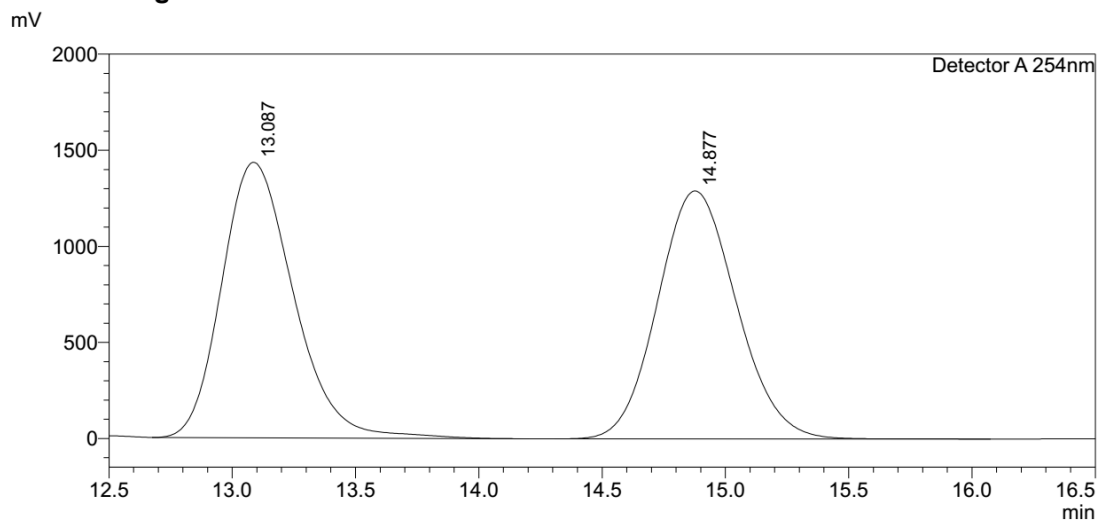
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.071	10496	845	3.116		M	
2	10.607	326370	19947	96.884		M	
Total		336867	20792				



<Chromatogram>

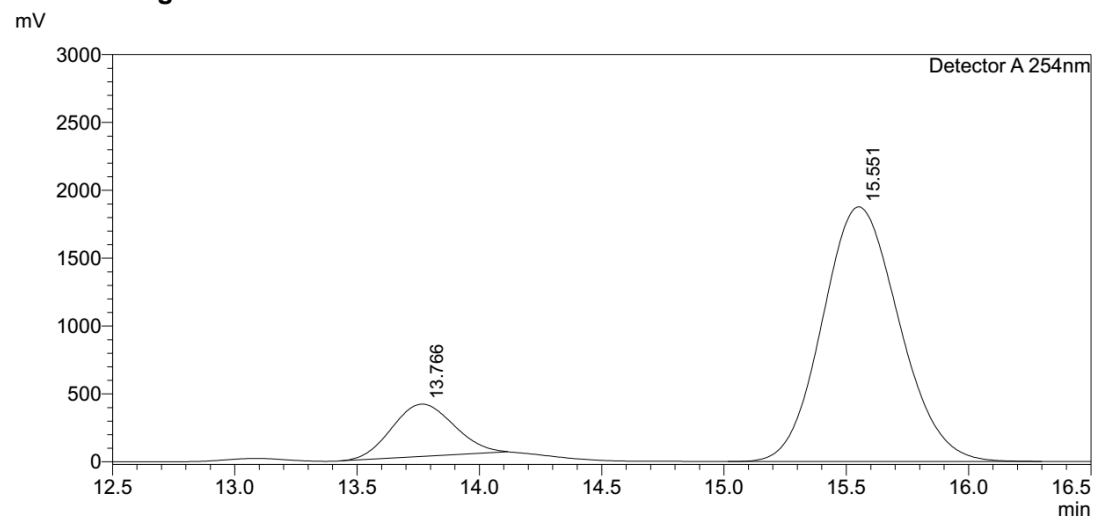


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.087	29080596	1433867	50.332			
2	14.877	28696598	1290584	49.668			
Total		57777194	2724451				

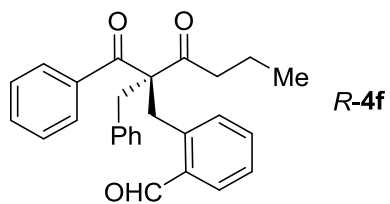
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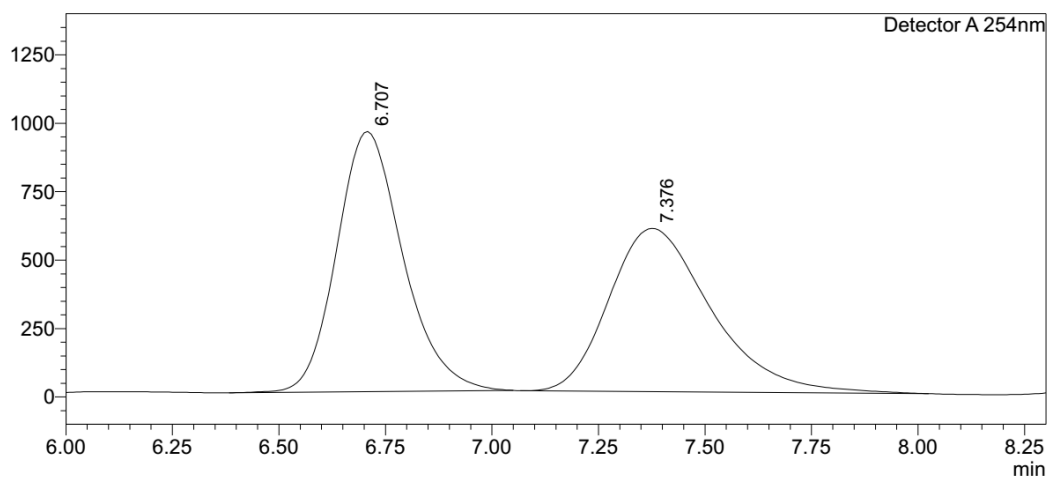
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.766	6828802	385389	14.305		M	
2	15.551	40907167	1876694	85.695		M	
Total		47735969	2262082				



<Chromatogram>

mV



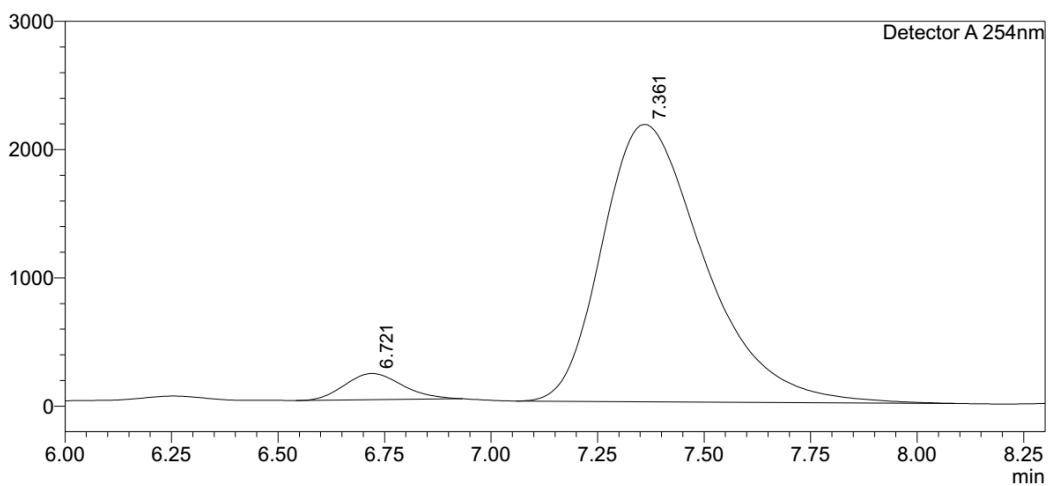
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.707	10299457	950552	50.820		M	
2	7.376	9941248	596423	49.053		M	
3	14.429	5879	231	0.029			
4	15.042	6727	293	0.033		V	
5	15.427	13187	451	0.065		V	
Total		20266498	1547951				

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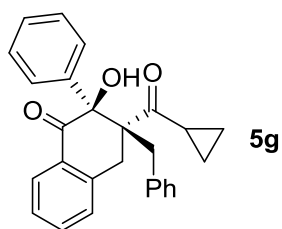
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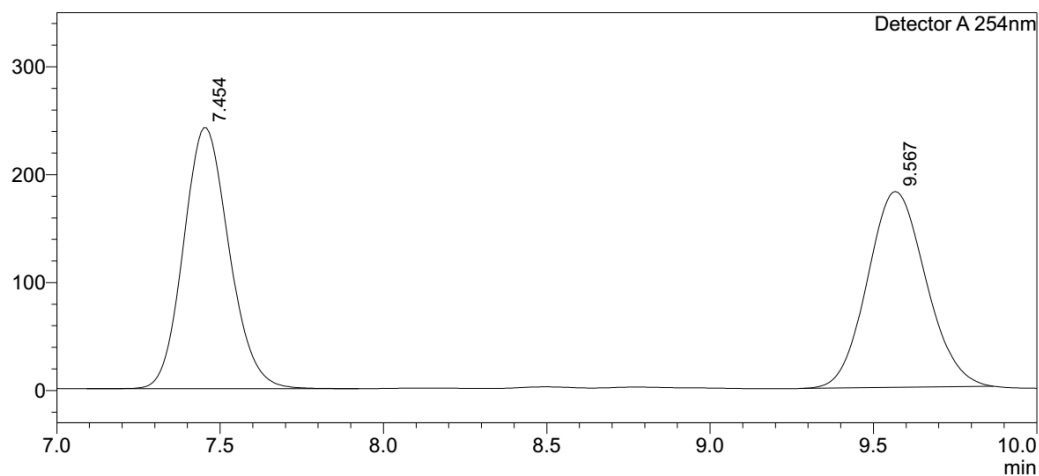
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.721	1934455	204949	5.078		M	
2	7.361	36159428	2163232	94.922		M	
Total		38093883	2368180				



<Chromatogram>

mV



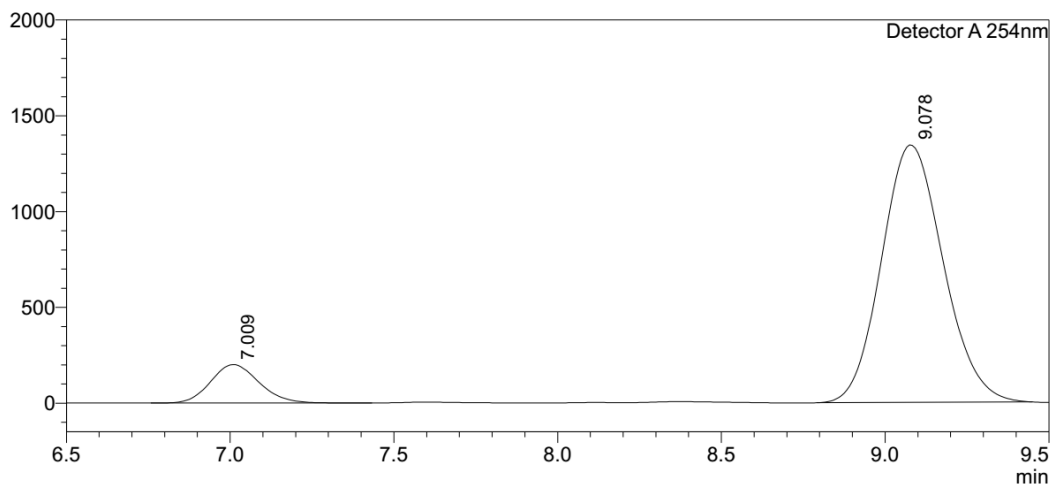
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.454	2352209	241962	51.051			
2	9.567	2255369	181522	48.949		M	
Total		4607578	423484				

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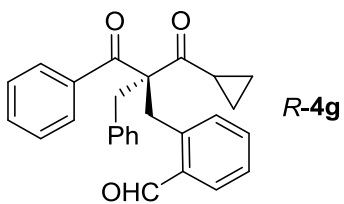
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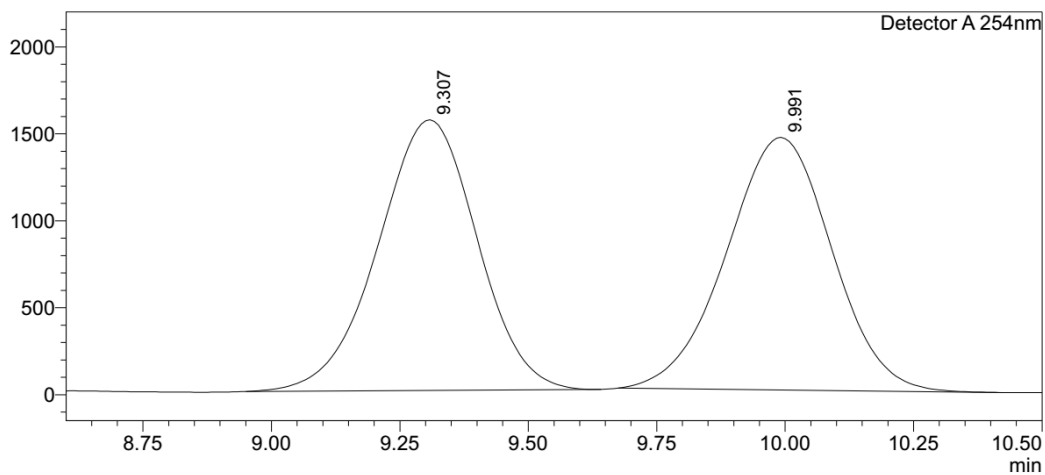
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.009	2059760	200537	10.453			
2	9.078	17645471	1344061	89.547		M	
Total		19705230	1544598				



<Chromatogram>

mV



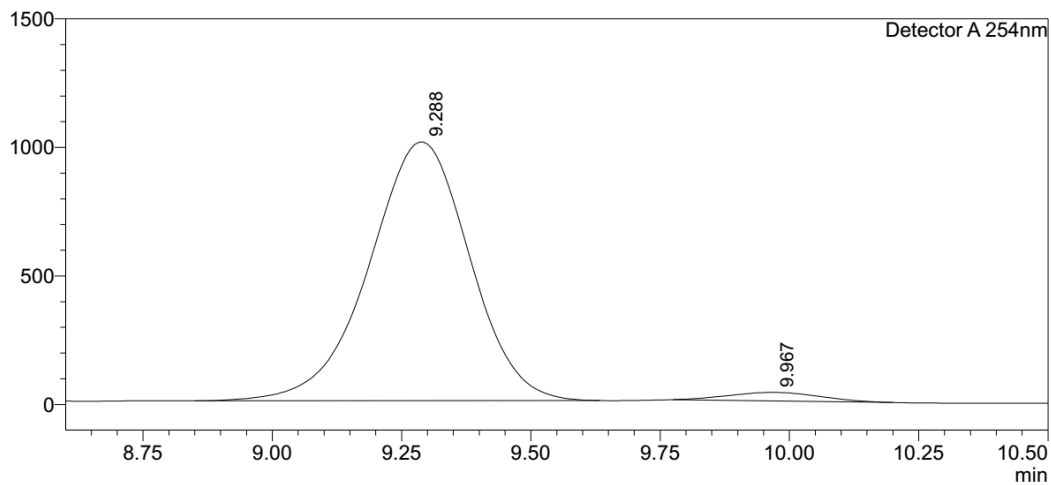
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Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.307	20878365	1555367	50.156		M	
2	9.991	20746802	1452462	49.840		M	
3	16.732	1744	79	0.004			
Total		41626911	3007908				

<Chromatogram>

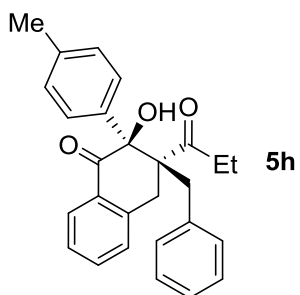
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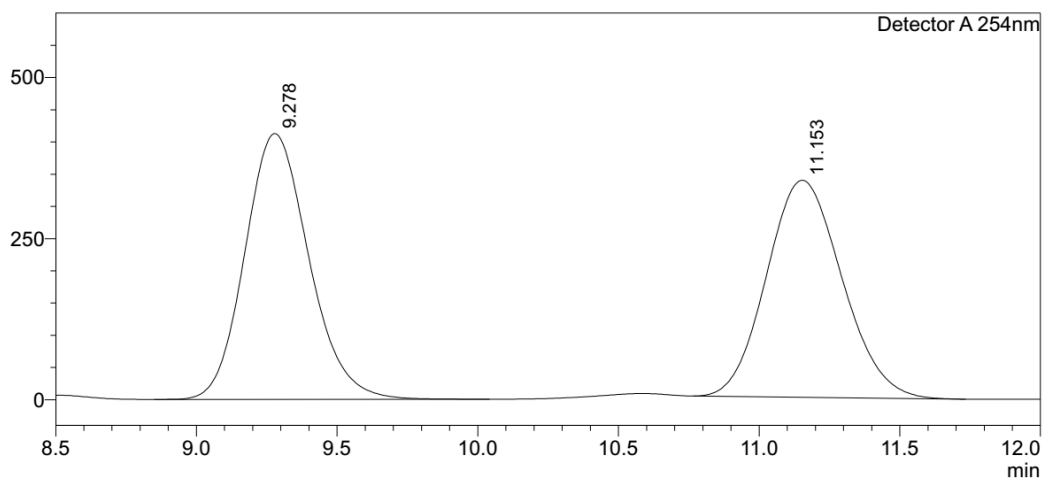
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.288	13613471	1006655	97.123		M	
2	9.967	403250	33126	2.877		M	
Total		14016722	1039781				



<Chromatogram>

mV



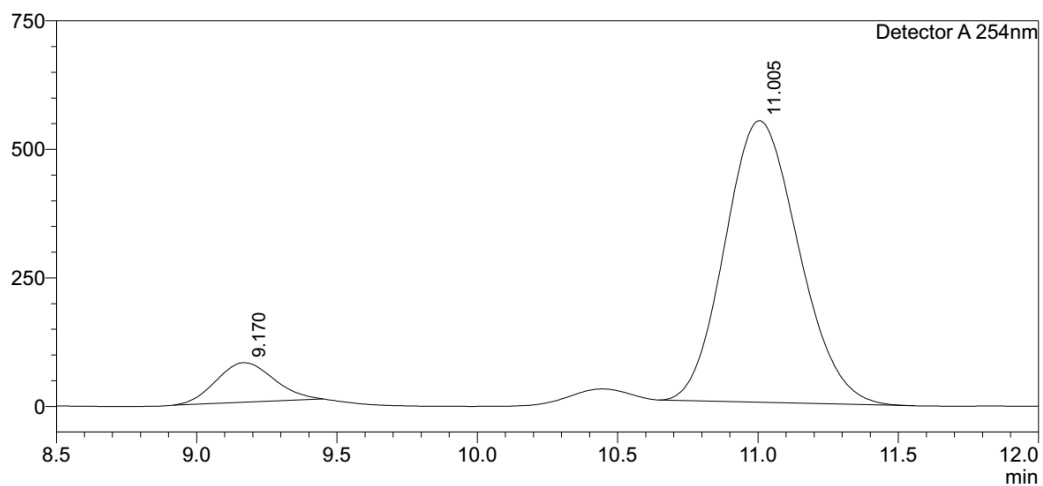
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.278	6532817	412522	50.922			
2	11.153	6296183	336958	49.078			
Total		12828999	749481				

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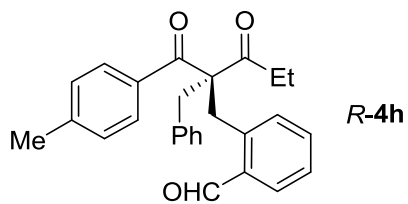
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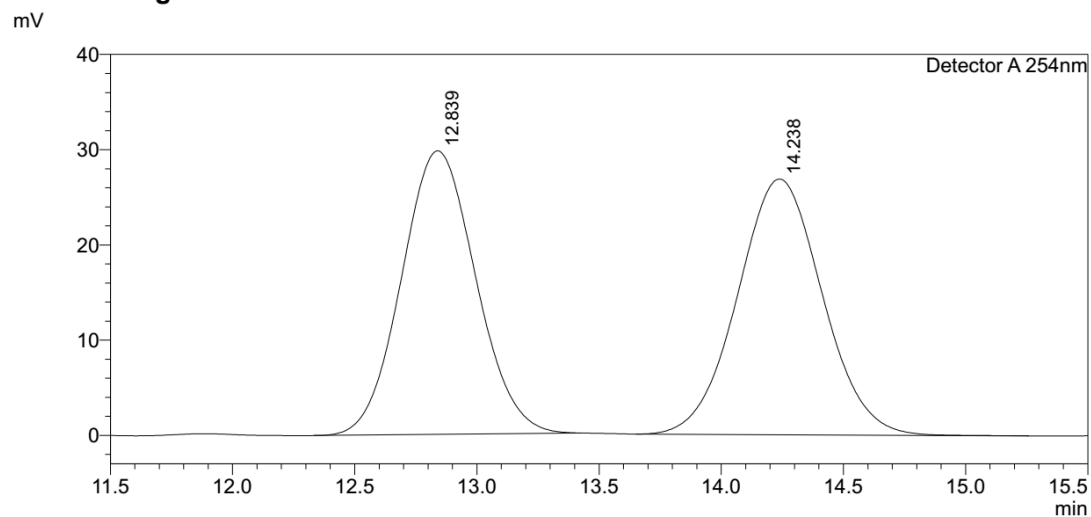
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.170	1103228	76921	9.925		M	
2	11.005	10011944	547712	90.075			
Total		11115172	624633				



<Chromatogram>

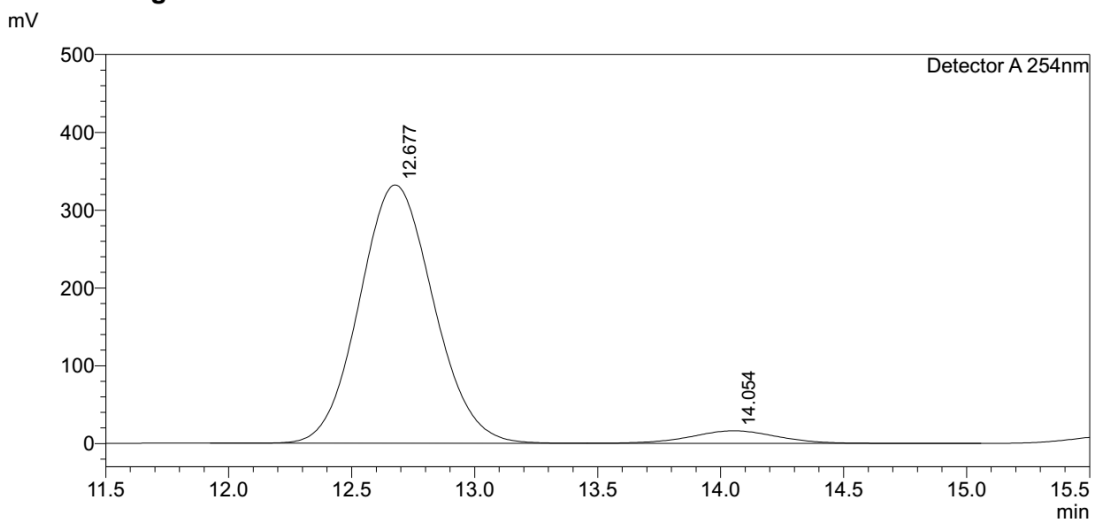


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.839	629552	29779	49.275		M	
2	14.238	648089	26848	50.725			
Total		1277640	56626				

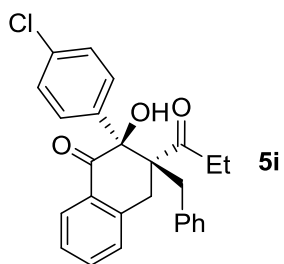
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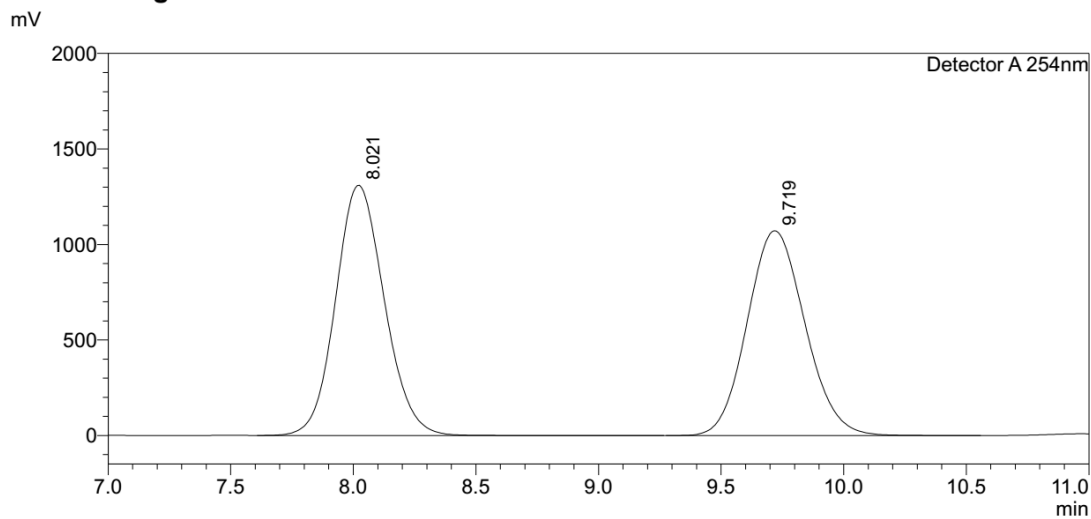
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.677	6959865	332014	94.649			
2	14.054	393498	16059	5.351		SV	
Total		7353363	348073				



<Chromatogram>

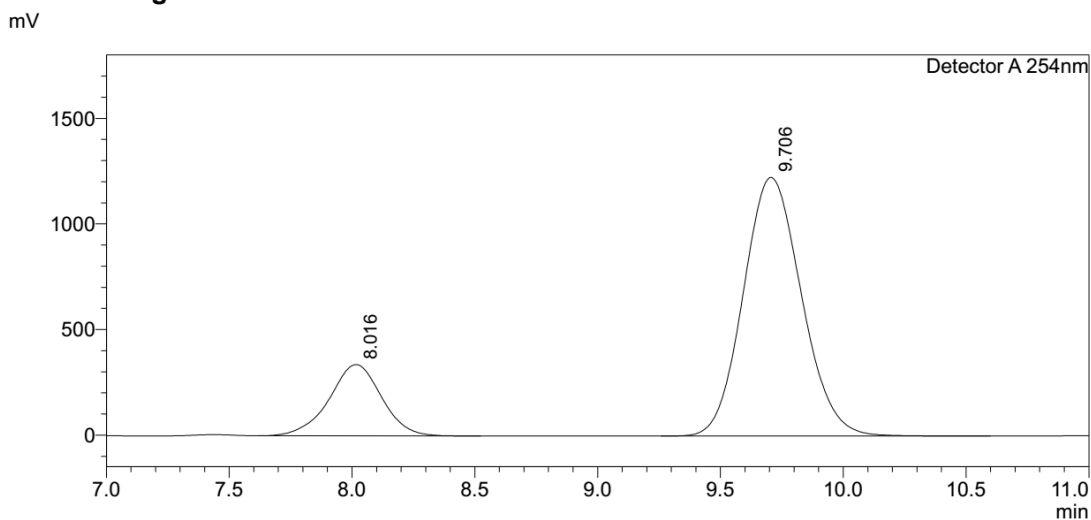


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.021	18110463	1309267	50.743		S	
2	9.719	17580290	1072336	49.257			
Total		35690753	2381603				

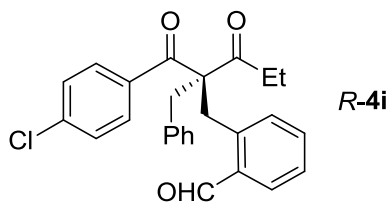
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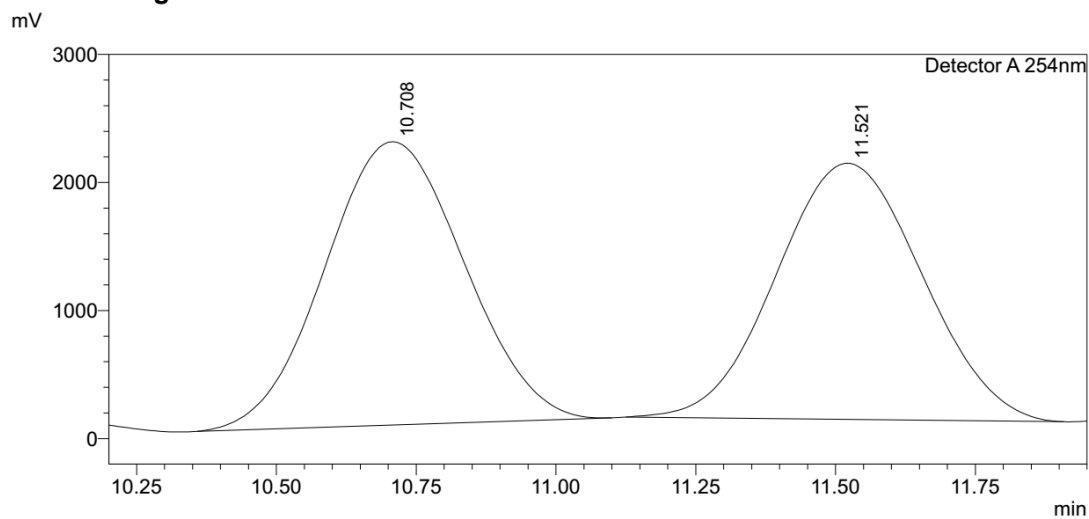
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.016	5022645	338023	19.942			
2	9.706	20163481	1224703	80.058			
Total		25186126	1562726				



<Chromatogram>

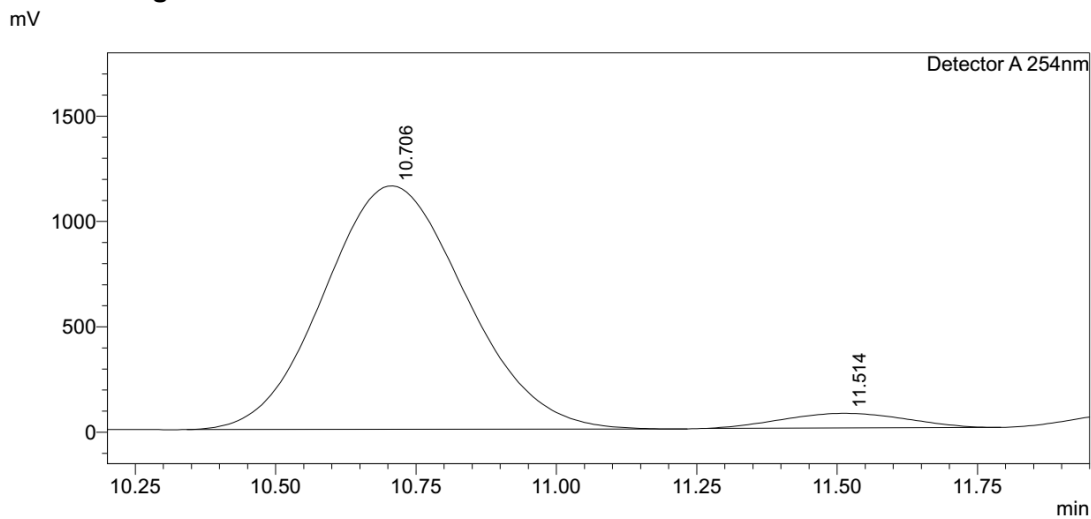


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.708	38243153	2212701	51.364		M	
2	11.521	36212179	2000263	48.636		M	
Total		74455331	4212964				

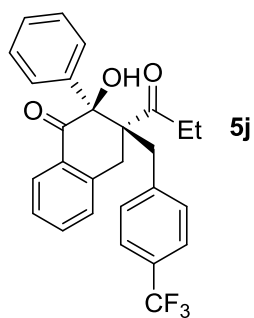
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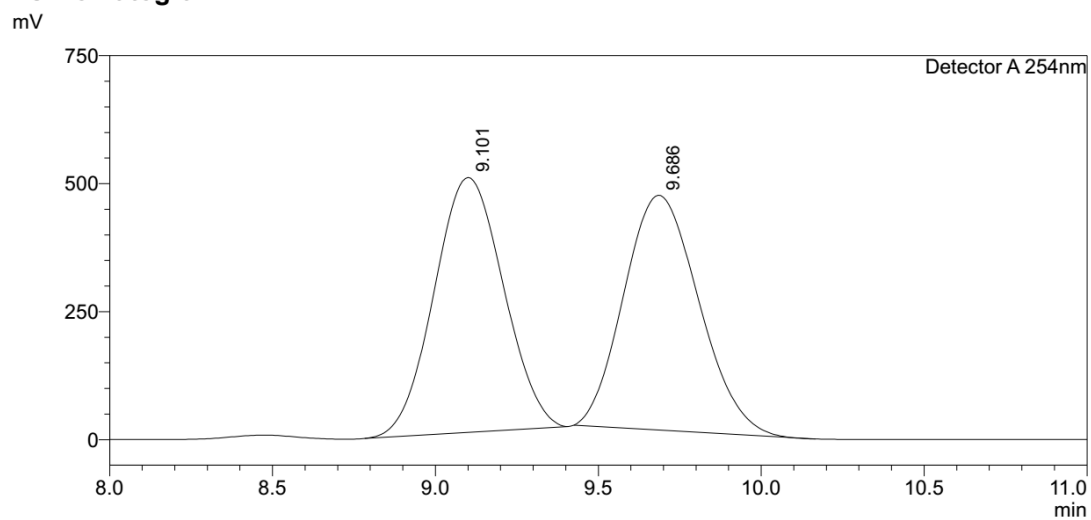
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.706	20266336	1155855	94.984		M	
2	11.514	1070230	69222	5.016		M	
Total		21336566	1225077				



<Chromatogram>

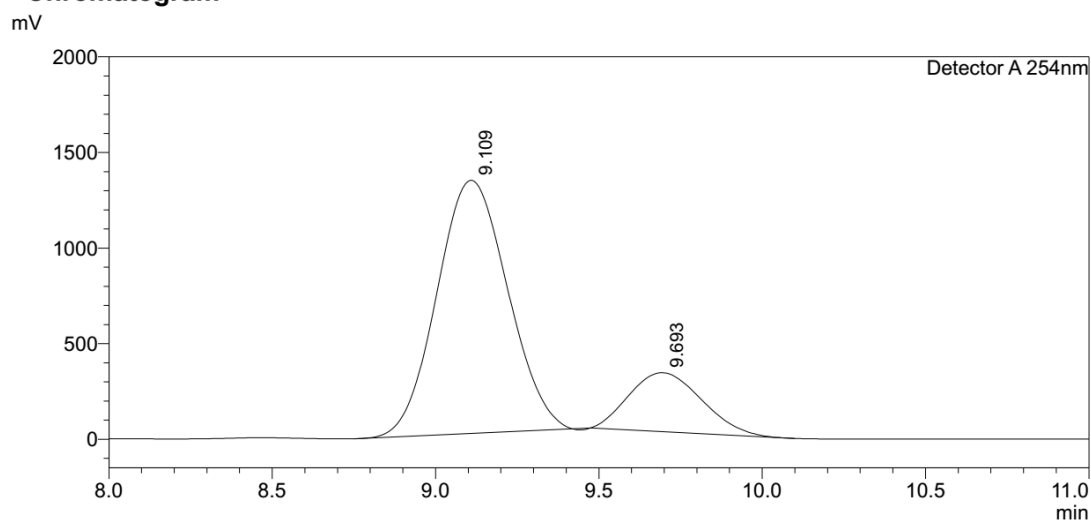


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.101	7363016	497780	50.111		M	
2	9.686	7330472	458486	49.889		M	
Total		14693488	956267				

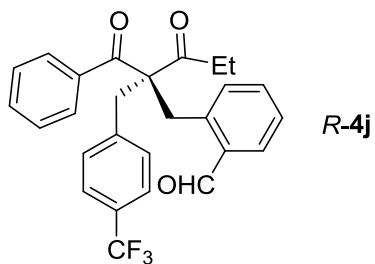
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<Peak Table>

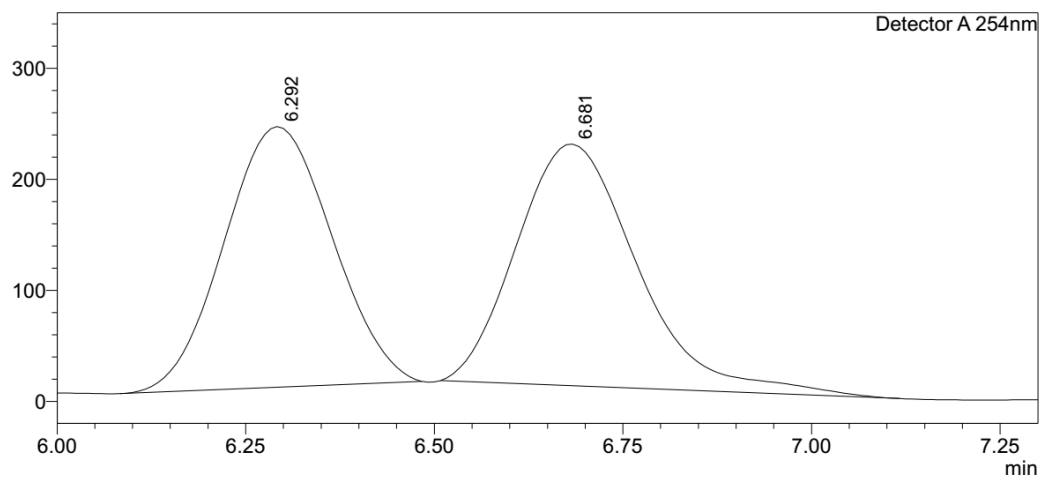
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.109	19928051	1325092	80.662		M	
2	9.693	4777643	308718	19.338		M	
Total		24705694	1633810				



<Chromatogram>

mV



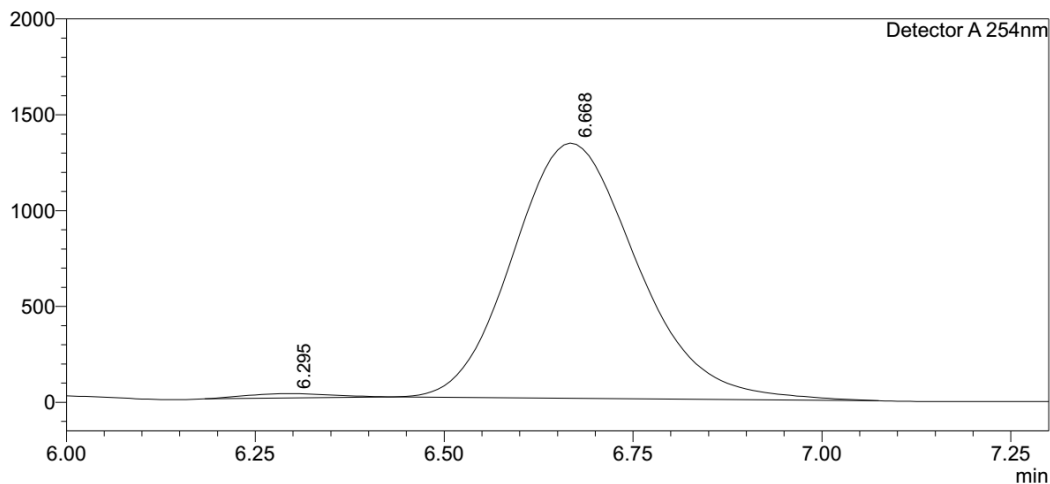
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.292	2335046	234880	49.089		M	
2	6.681	2421745	217786	50.911		M	
Total		4756791	452666				

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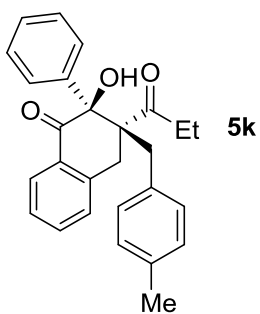
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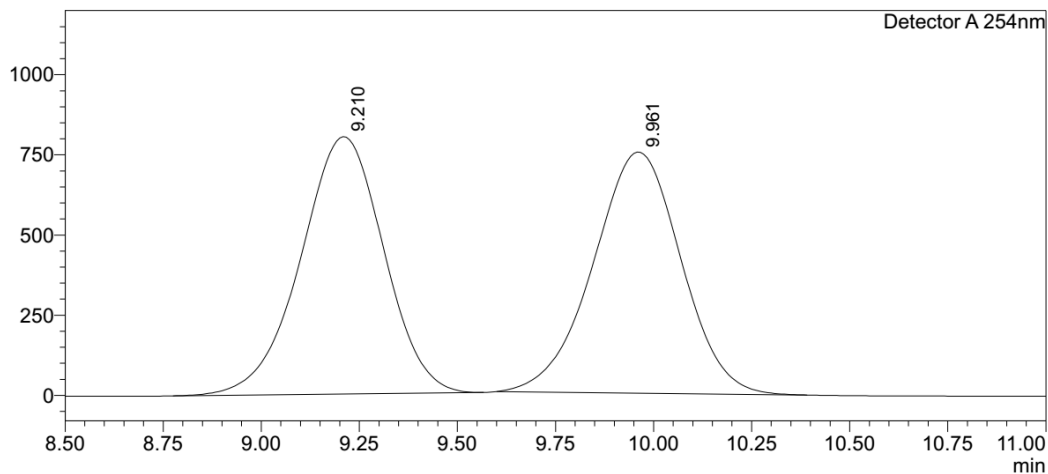
Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.295	183548	22401	1.189		M	
2	6.668	15247792	1331356	98.811		M	
Total		15431340	1353757				



<Chromatogram>

mV



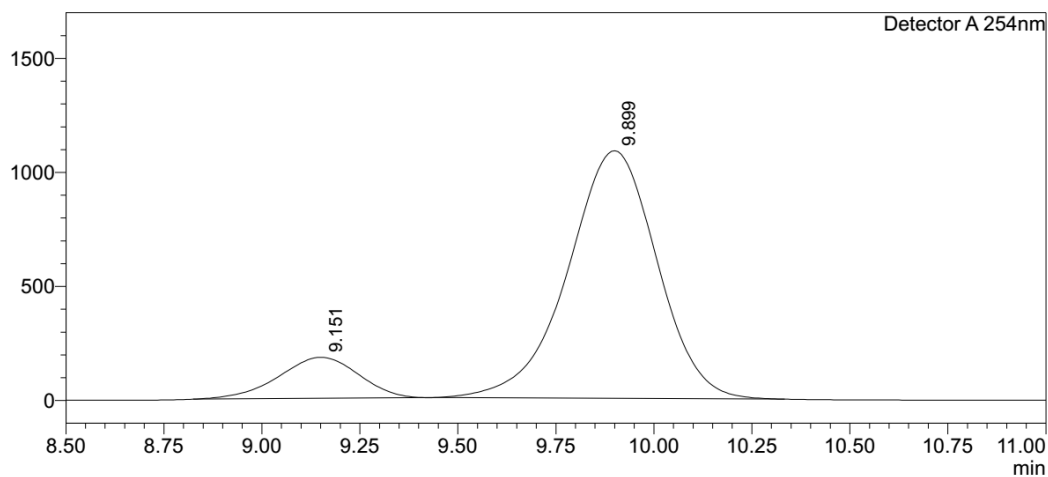
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.210	11820145	802833	50.254		M	
2	9.961	11700454	751719	49.746		M	
Total		23520598	1554553				

<Chromatogram>

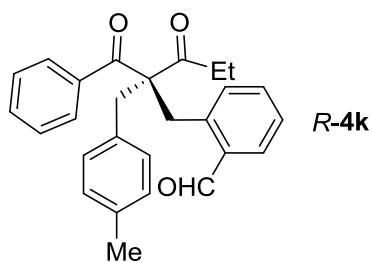
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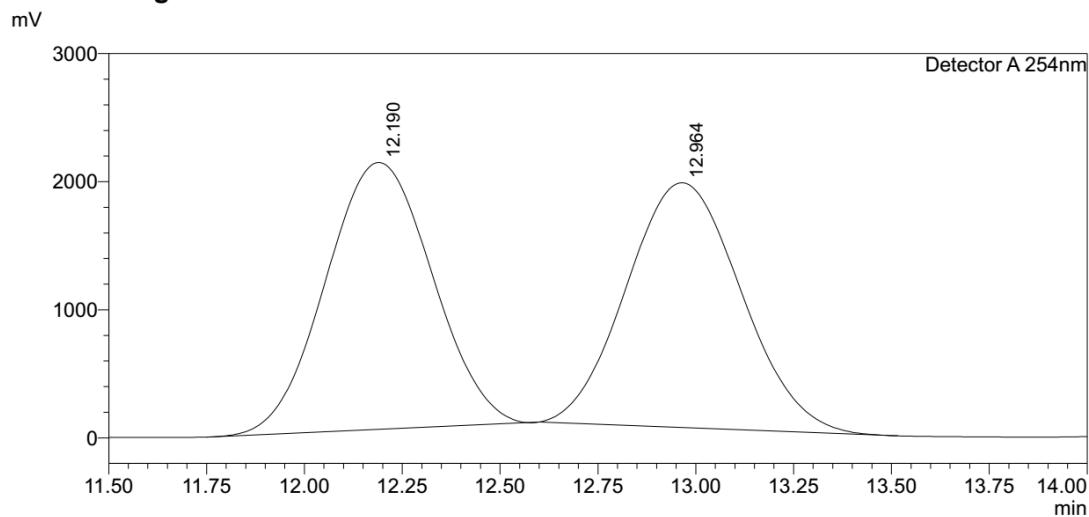
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.151	2547918	179615	12.915		M	
2	9.899	17181061	1085937	87.085		M	
Total		19728979	1265552				



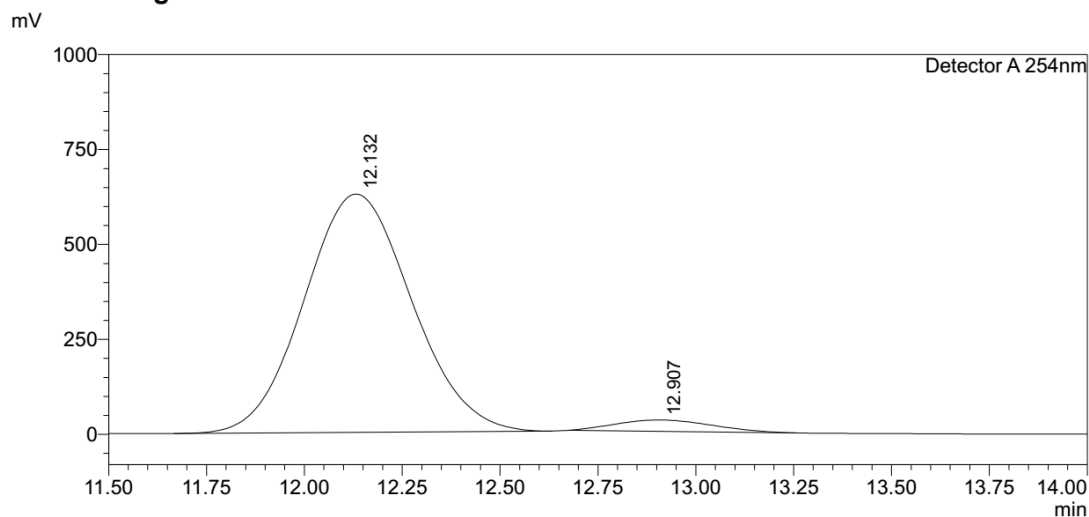
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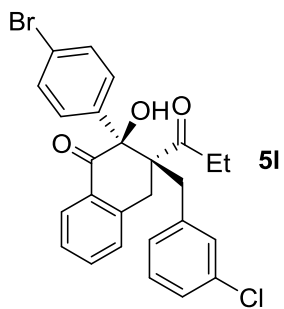
Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.190	39449183	2083843	50.282		M	
2	12.964	39007158	1911957	49.718		M	
Total		78456341	3995800				

<Chromatogram>



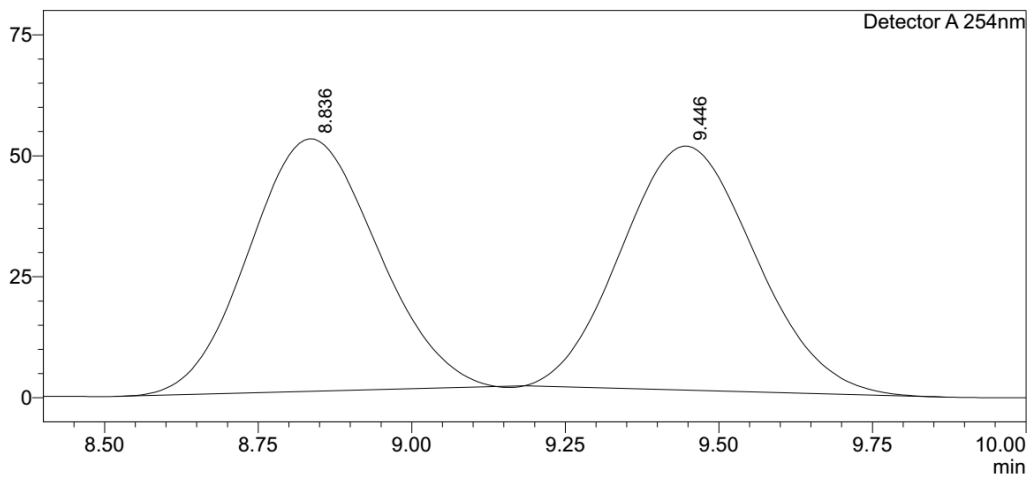
<Peak Table>

Detector A 254nm							
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.132	11988925	627539	95.908		M	
2	12.907	511453	29825	4.092		M	
Total		12500378	657364				



<Chromatogram>

mV



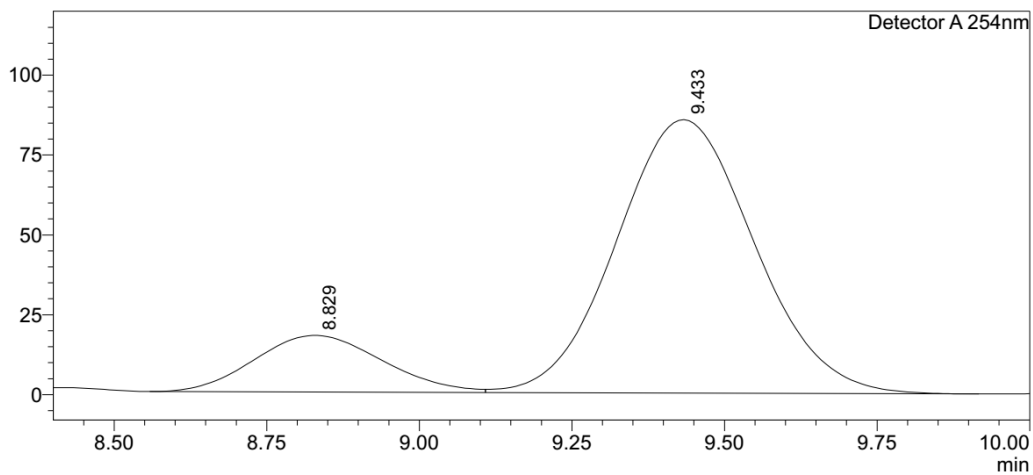
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.836	757977	52190	49.661		M	
2	9.446	766496	50391	50.219		M	
3	16.285	1835	81	0.120			
Total		1526309	102662				

<Chromatogram>

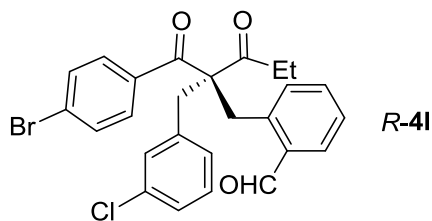
mV



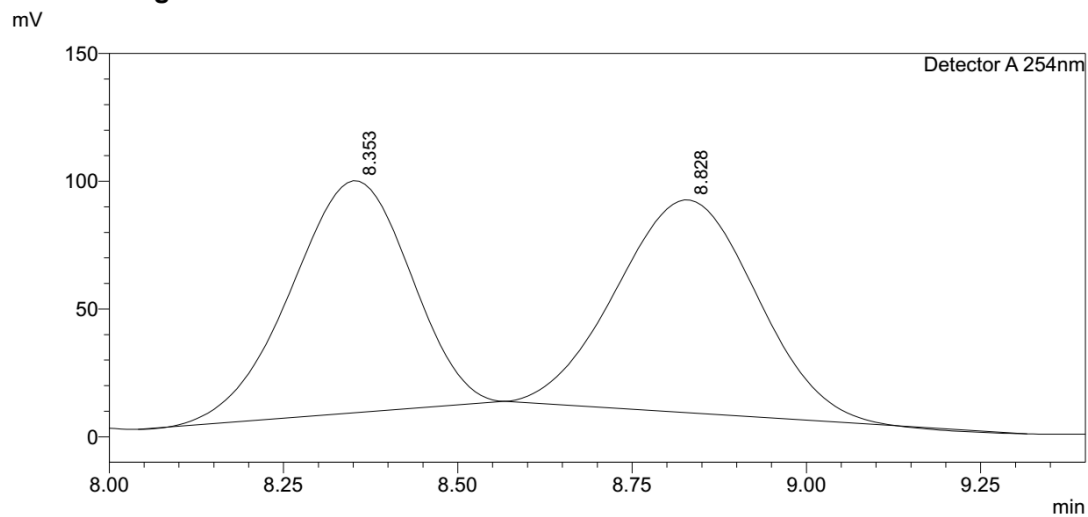
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.829	258754	17720	16.133			
2	9.433	1345119	85622	83.867		V	
Total		1603873	103343				



<Chromatogram>

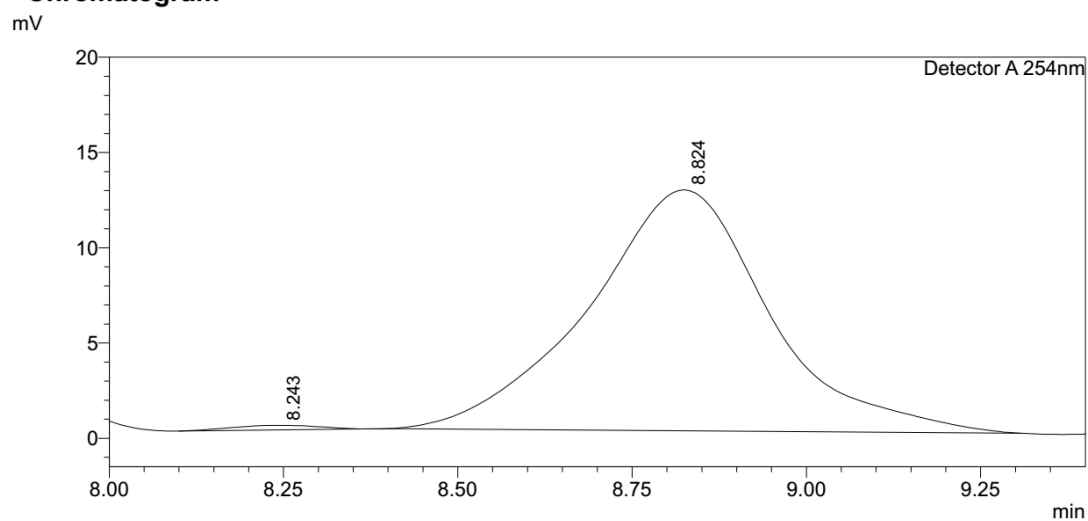


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.353	1088200	90810	48.445		M	
2	8.828	1158081	83268	51.555		M	
Total		2246281	174078				

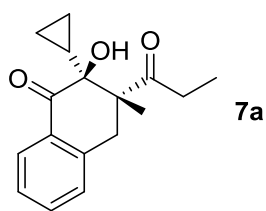
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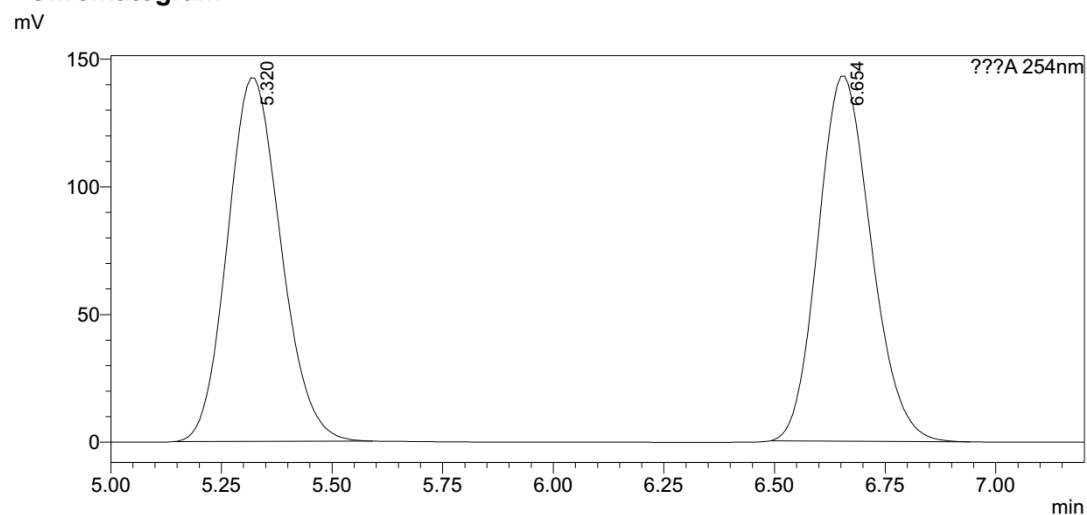
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.243	2026	235	0.880		M	
2	8.824	228146	12646	99.120		M	
Total		230172	12881				



<Chromatogram>

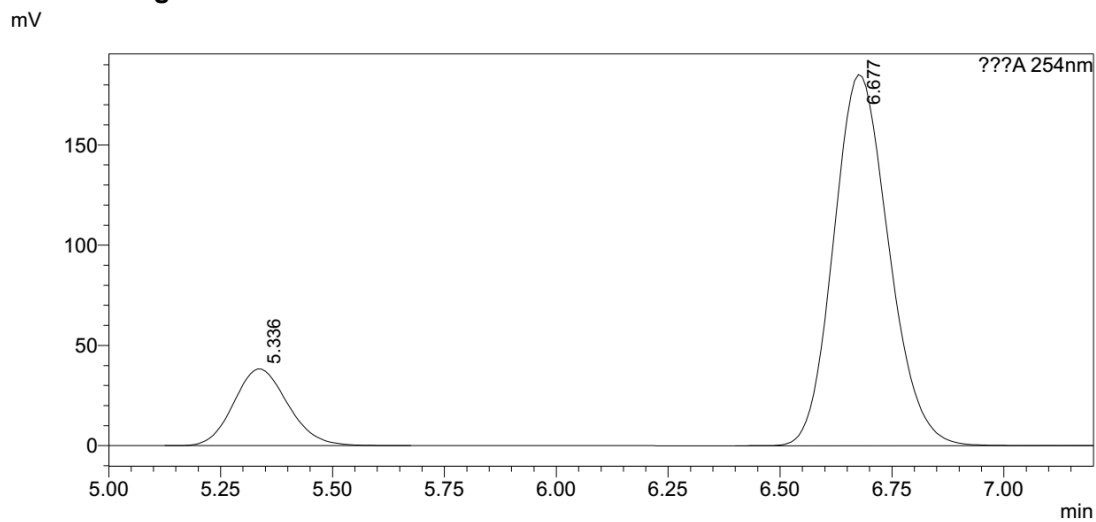


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.320	1197243	142446	50.050		M	
2	6.654	1194860	142805	49.950		M	
Total		2392102	285252				

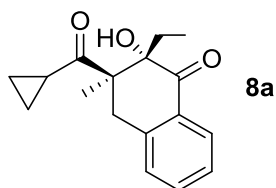
<Chromatogram>



<Peak Table>

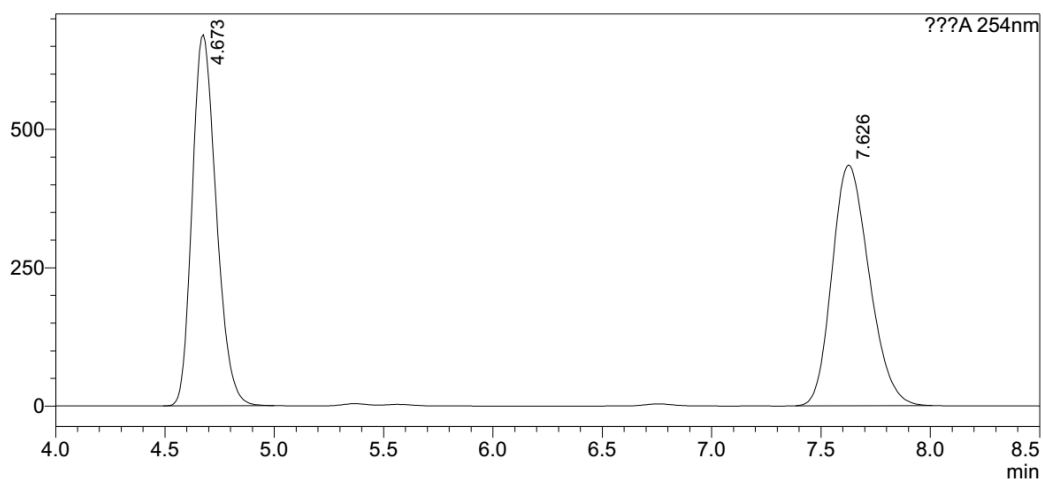
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.336	323123	38256	16.912		M	
2	6.677	1587524	185088	83.088		M	
Total		1910647	223344				



<Chromatogram>

mV



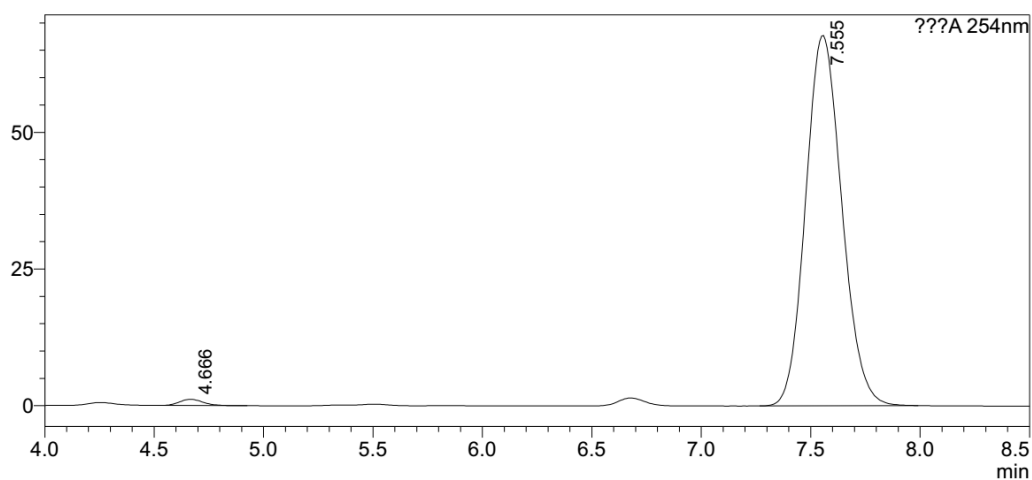
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.673	5132456	670577	49.942		M	
2	7.626	5144342	434947	50.058		M	
Total		10276799	1105523				

<Chromatogram>

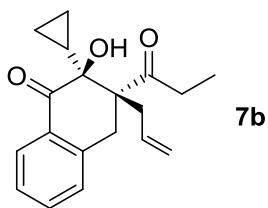
mV



<Peak Table>

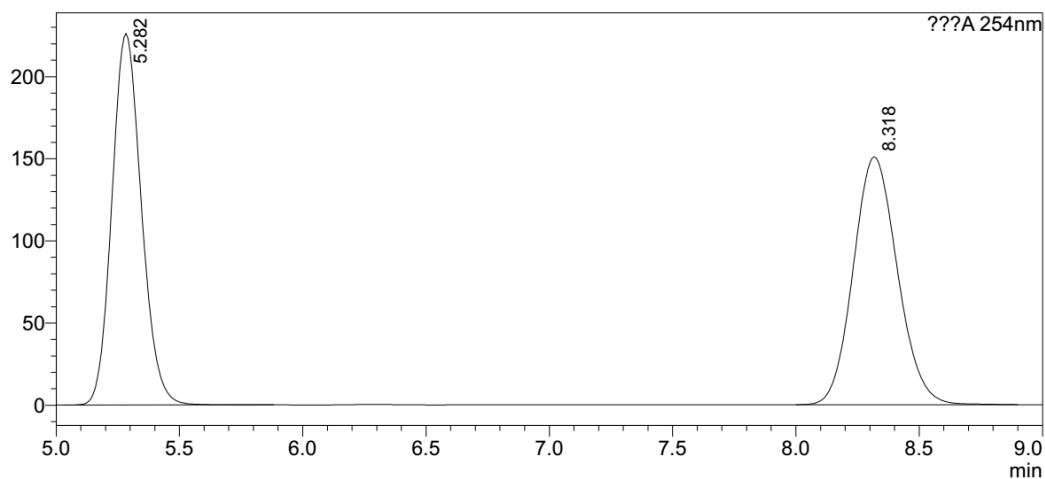
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.666	8723	1149	1.106			
2	7.555	780292	67712	98.894		M	
Total		789015	68861				



<Chromatogram>

mV



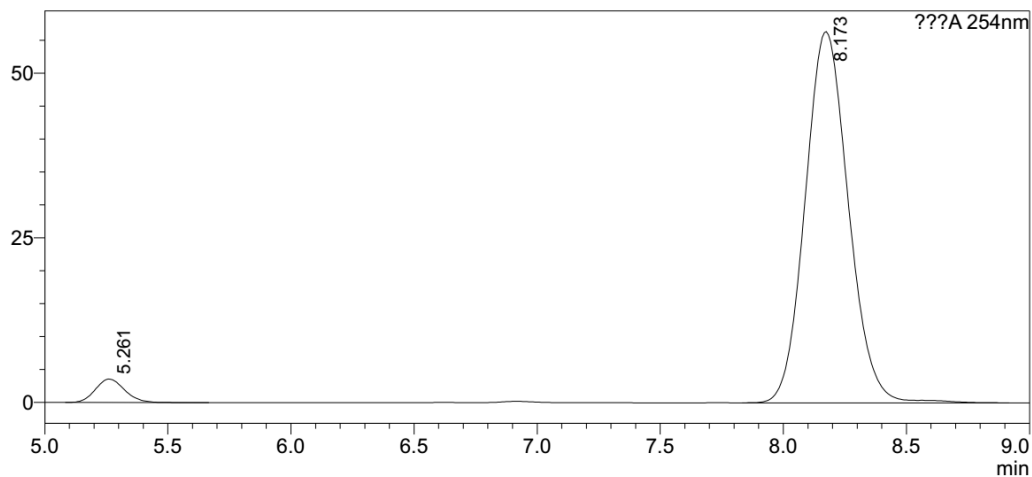
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.282	1878653	226027	49.977			
2	8.318	1880400	150869	50.023		M	
Total		3759053	376896				

<Chromatogram>

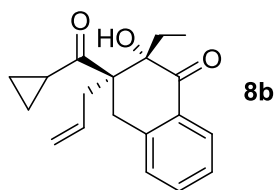
mV



<Peak Table>

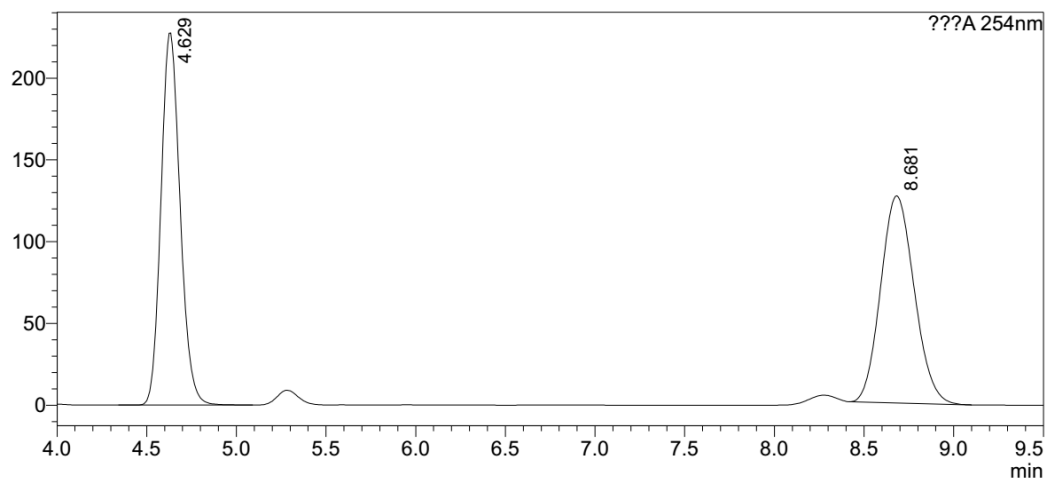
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.261	29591	3569	4.117		V	
2	8.173	689081	56400	95.883			
Total		718672	59970				



<Chromatogram>

mV



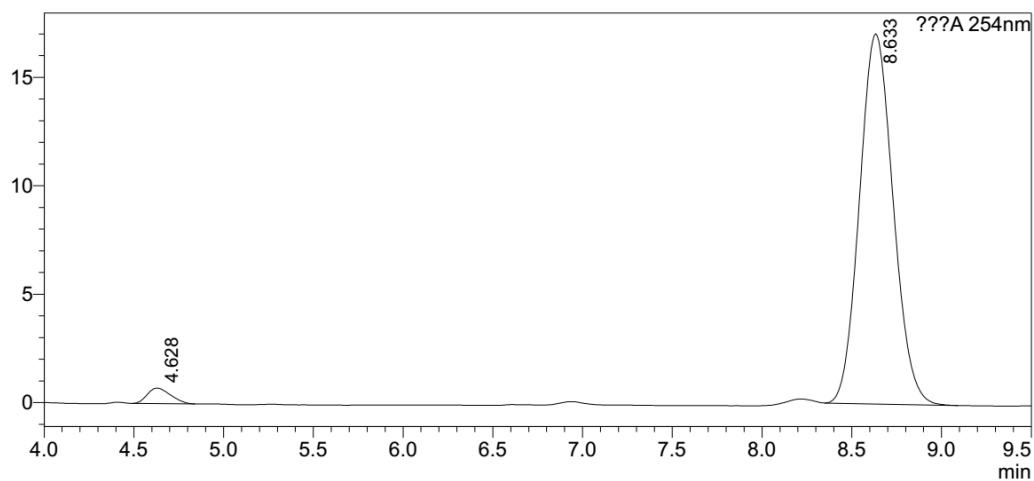
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.629	1693910	227443	50.664			
2	8.681	1649539	126706	49.336			
Total		3343448	354149				

<Chromatogram>

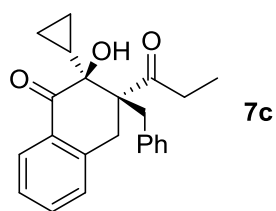
mV



<Peak Table>

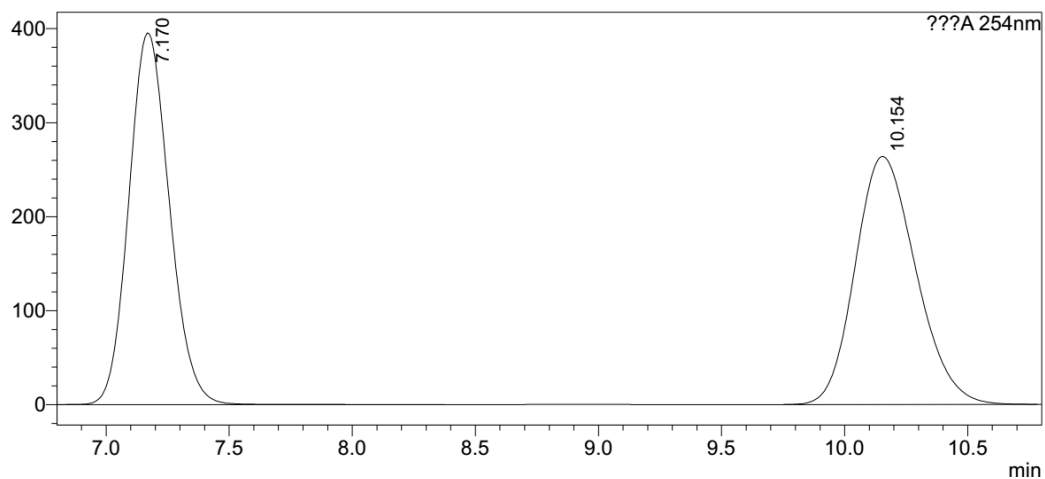
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.628	6430	717	2.813		M	
2	8.633	222128	17063	97.187			
Total		228558	17779				



<Chromatogram>

mV



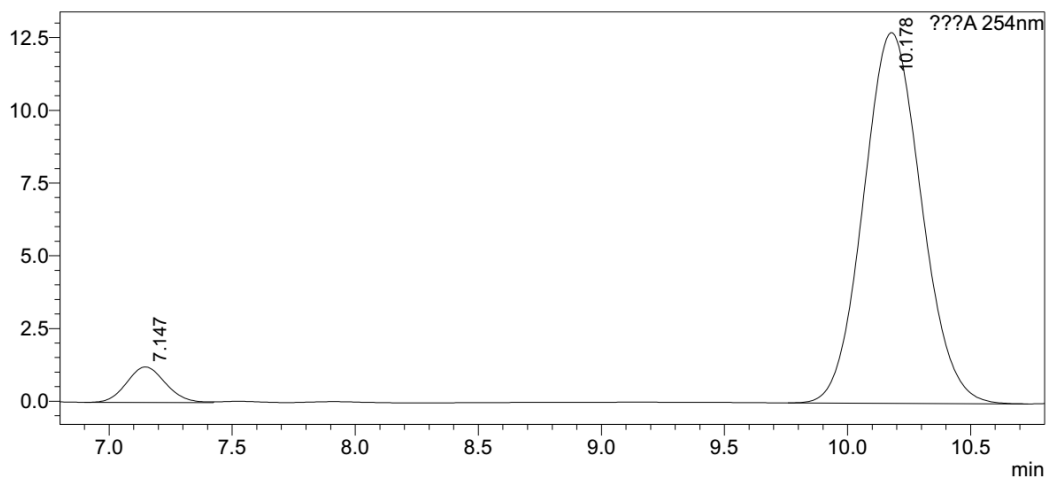
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.170	4529741	395137	50.049		S	
2	10.154	4520915	263618	49.951		M	
Total		9050656	658755				

<Chromatogram>

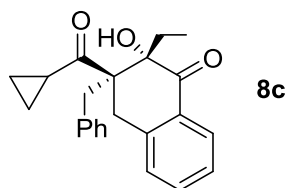
mV



<Peak Table>

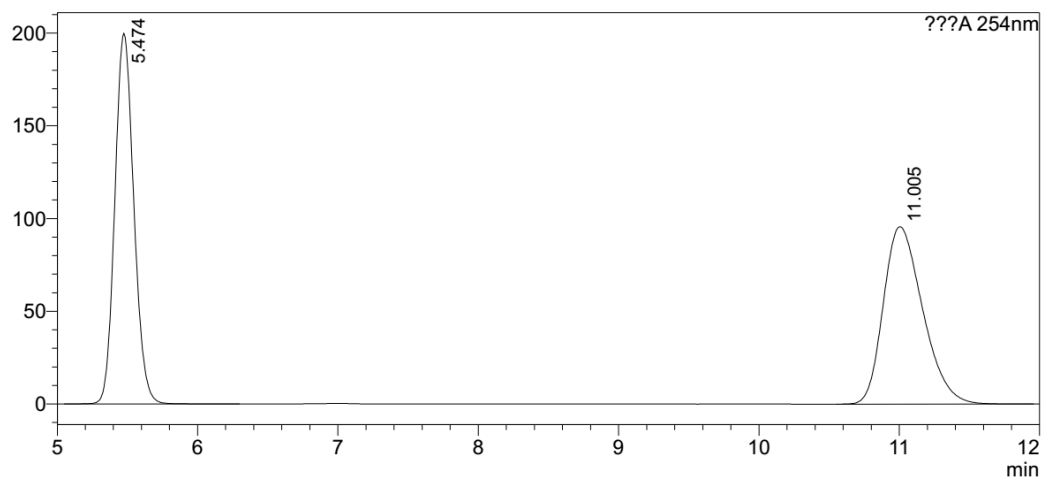
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.147	13416	1219	6.044			
2	10.178	208545	12743	93.956			
Total		221962	13962				



<Chromatogram>

mV



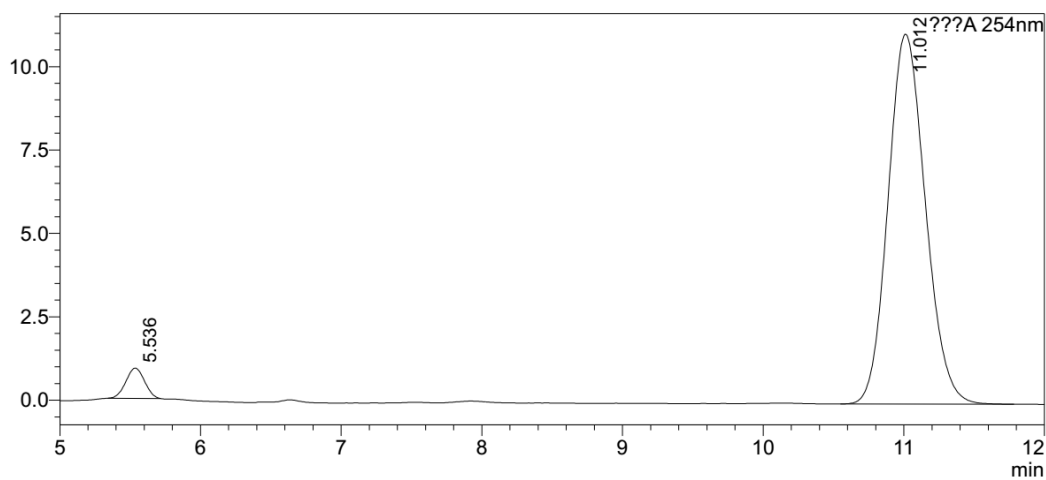
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.474	1881797	199805	50.200			
2	11.005	1866801	95672	49.800		M	
Total		3748597	295477				

<Chromatogram>

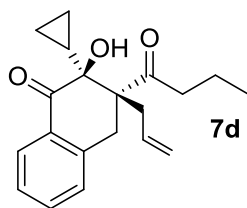
mV



<Peak Table>

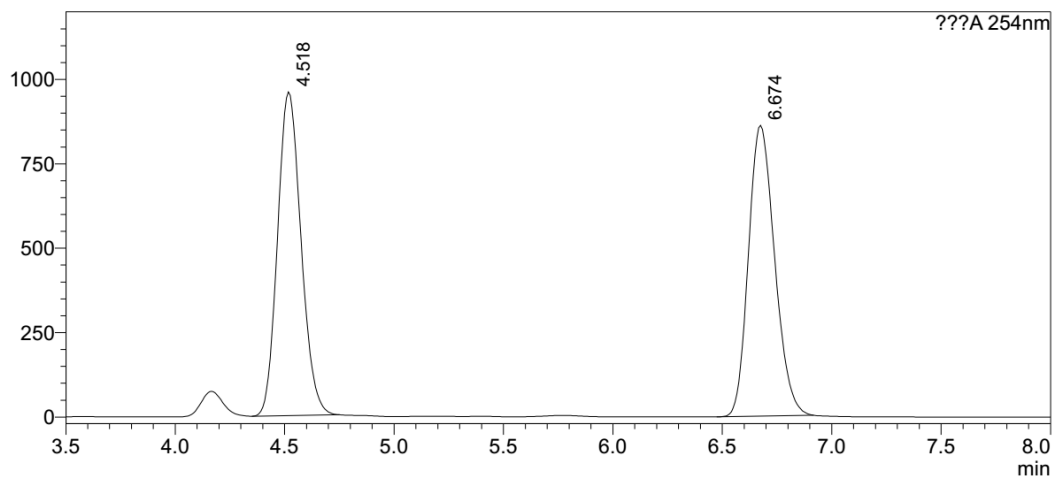
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.536	8370	907	3.927		M	
2	11.012	204762	11085	96.073			
Total		213133	11992				



<Chromatogram>

mV



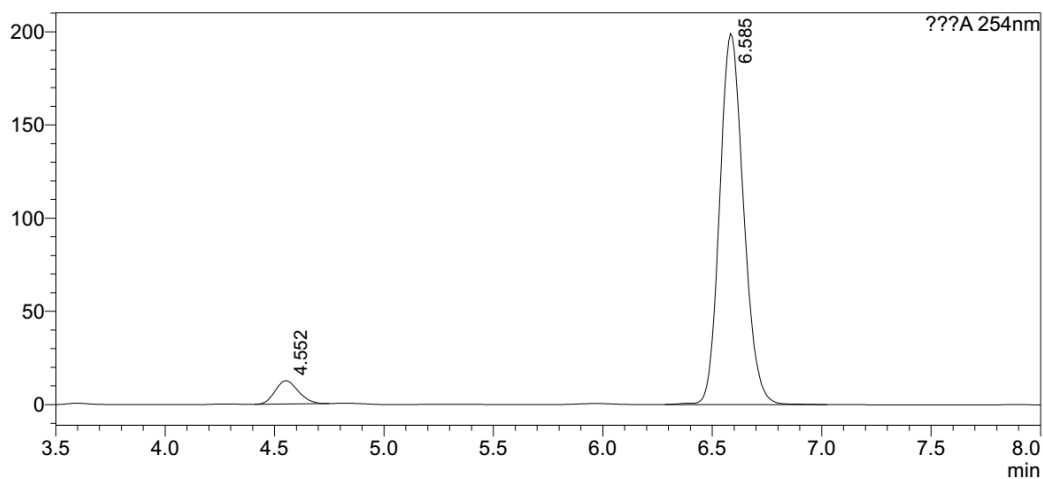
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.518	7163360	958748	49.972		M	
2	6.674	7171463	861668	50.028		M	
Total		14334824	1820416				

<Chromatogram>

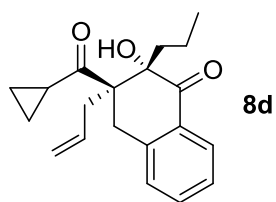
mV



<Peak Table>

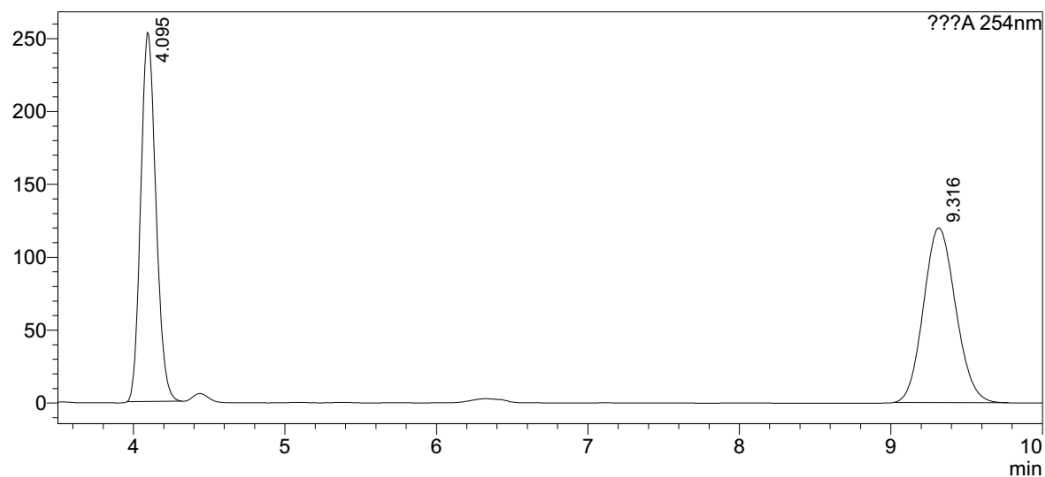
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.552	92352	12466	5.756		M	
2	6.585	1512119	199005	94.244		M	
Total		1604471	211471				



<Chromatogram>

mV



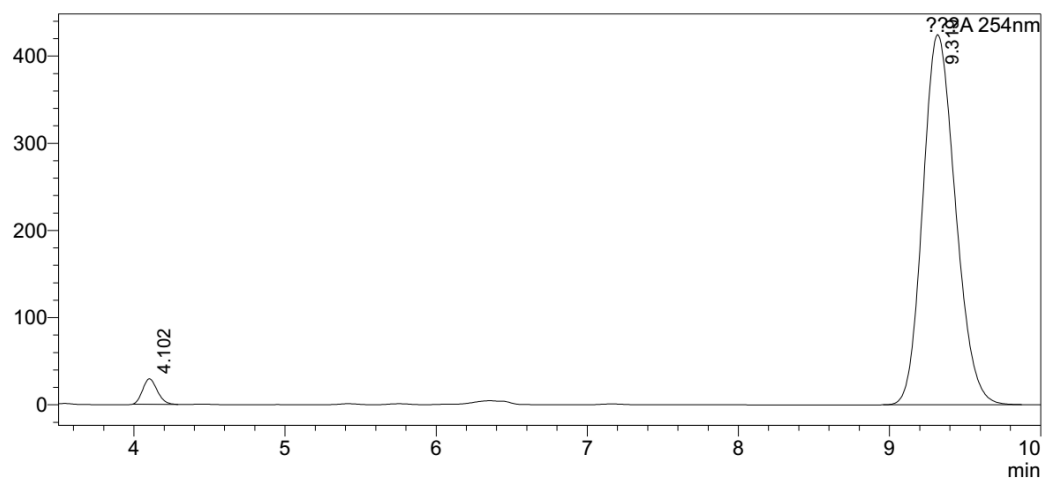
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.095	1766112	252999	49.920		M	
2	9.316	1771803	119889	50.080		M	
Total		3537915	372888				

<Chromatogram>

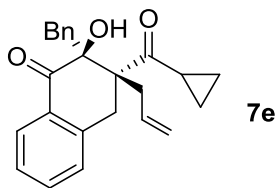
mV



<Peak Table>

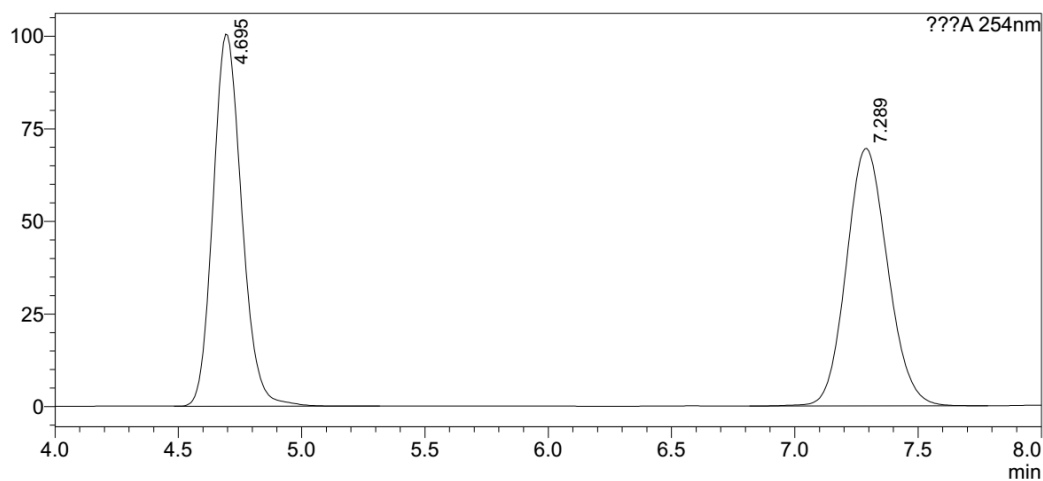
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.102	196014	29148	2.991		M	
2	9.319	6357981	424447	97.009		M	
Total		6553995	453595				



<Chromatogram>

mV



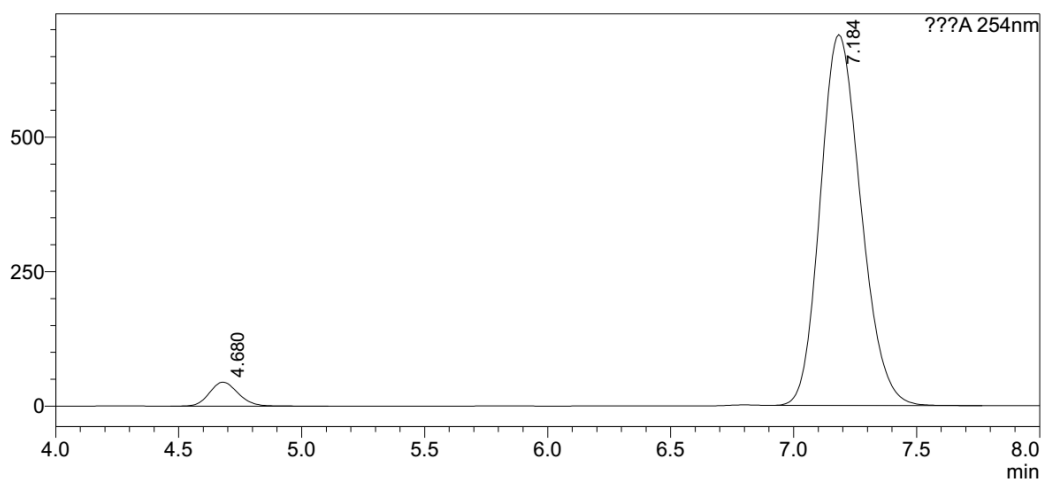
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.695	812438	100441	49.999		V	
2	7.289	812479	69525	50.001			
Total		1624916	169966				

<Chromatogram>

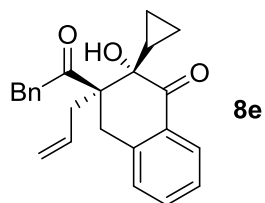
mV



<Peak Table>

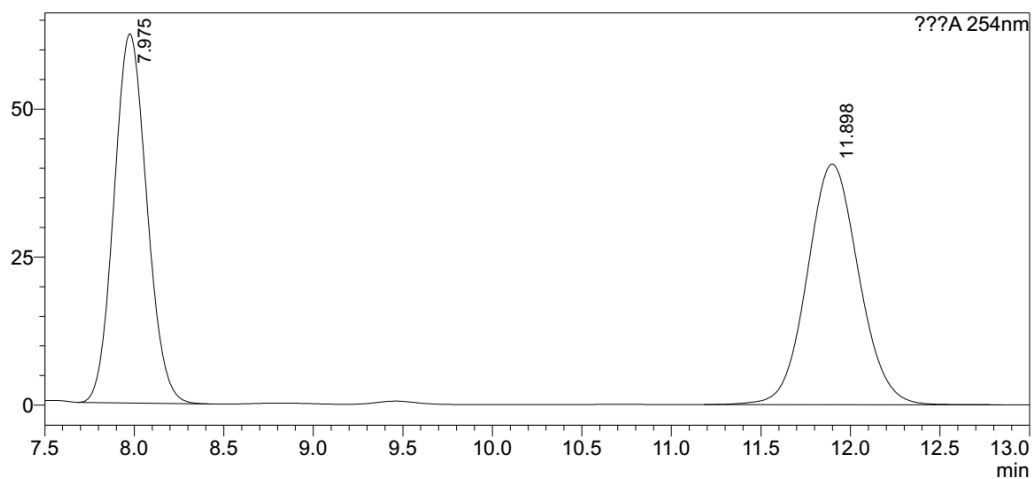
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.680	359432	44549	4.346			
2	7.184	7910901	689250	95.654			
Total		8270334	733799				



<Chromatogram>

mV



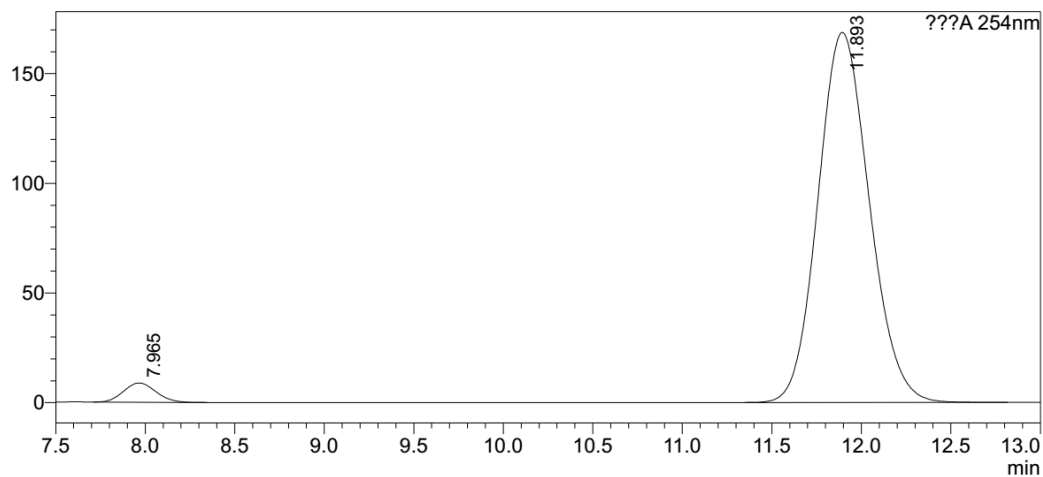
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.975	795821	62387	49.396			
2	11.898	815296	40643	50.604			
Total		1611117	103030				

<Chromatogram>

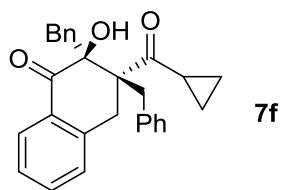
mV



<Peak Table>

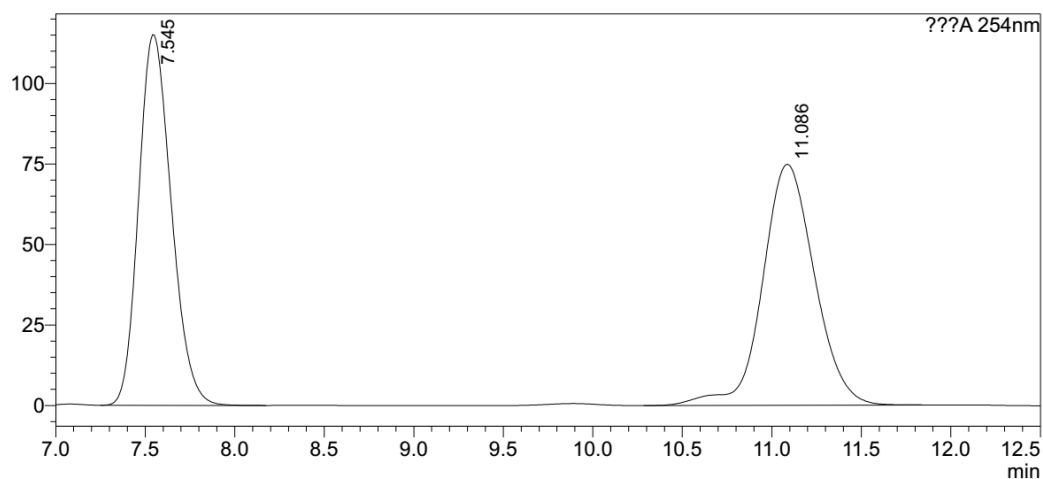
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.965	110630	8791	3.185			
2	11.893	3363282	168684	96.815		M	
Total		3473912	177475				



<Chromatogram>

mV



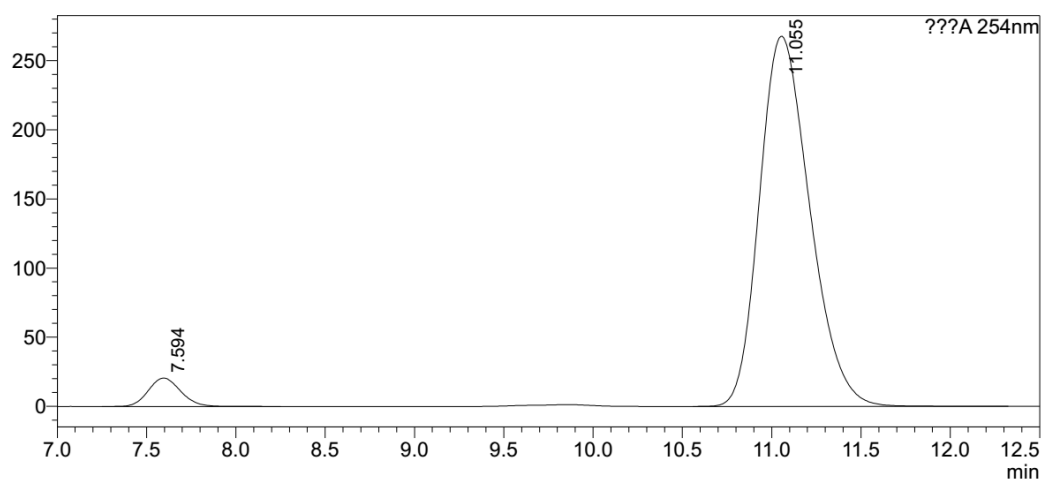
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.545	1460946	115100	49.117			
2	11.086	1513481	74819	50.883			
Total		2974427	189919				

<Chromatogram>

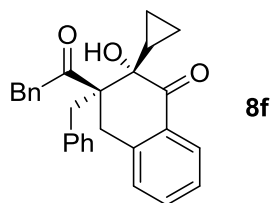
mV



<Peak Table>

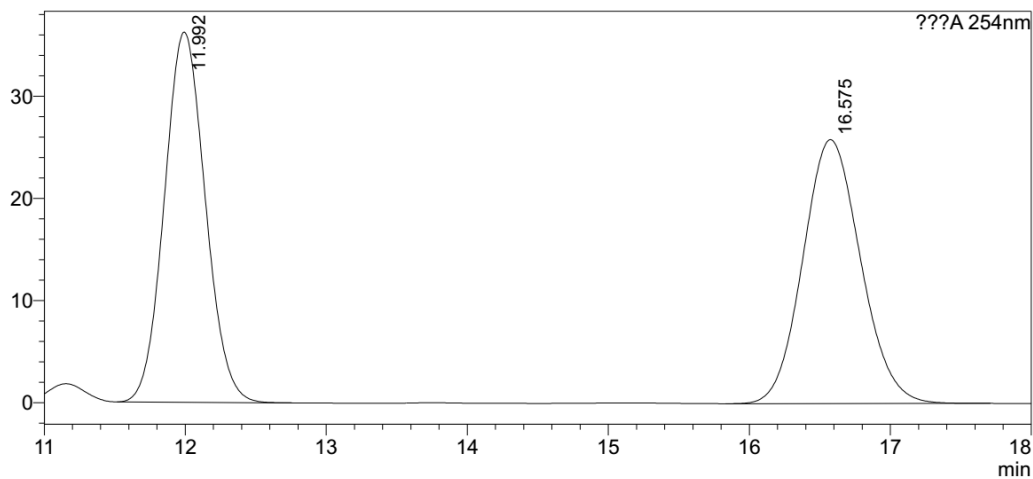
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.594	258599	20557	4.699			
2	11.055	5245240	267580	95.301			
Total		5503839	288138				



<Chromatogram>

mV



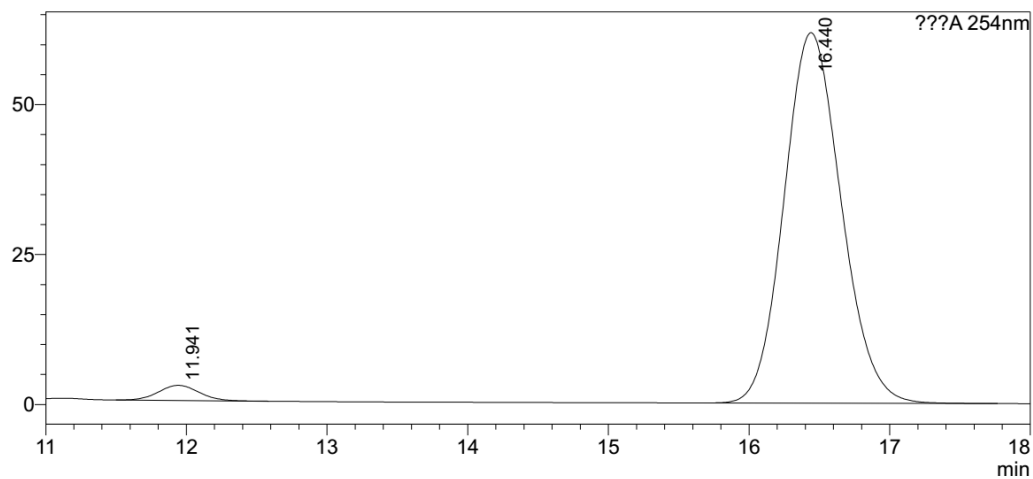
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.992	732217	36244	49.916			
2	16.575	734679	25840	50.084			
Total		1466896	62084				

<Chromatogram>

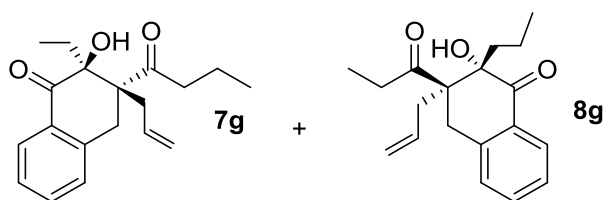
mV



<Peak Table>

???A 254nm

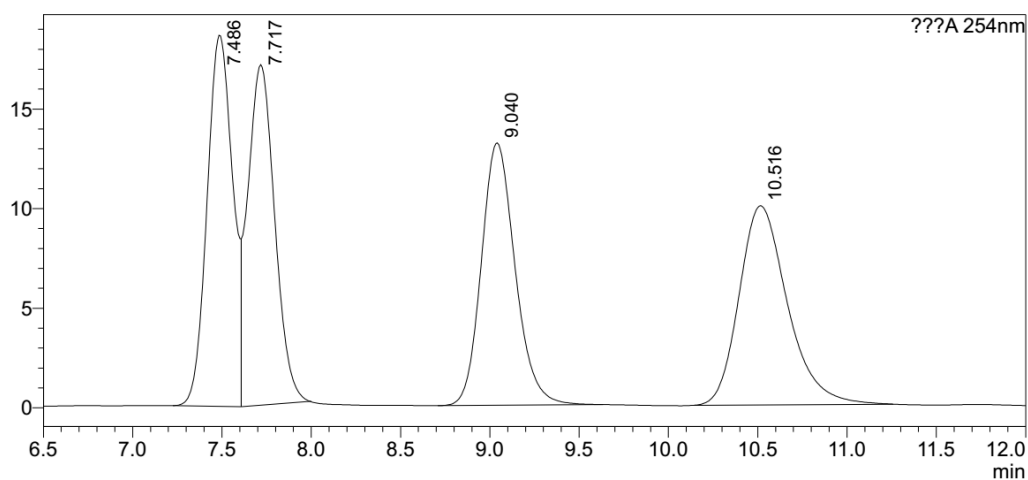
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.941	50843	2534	2.831			
2	16.440	1744824	61793	97.169			
Total		1795666	64327				



The two products can't be separated.

<Chromatogram>

mV



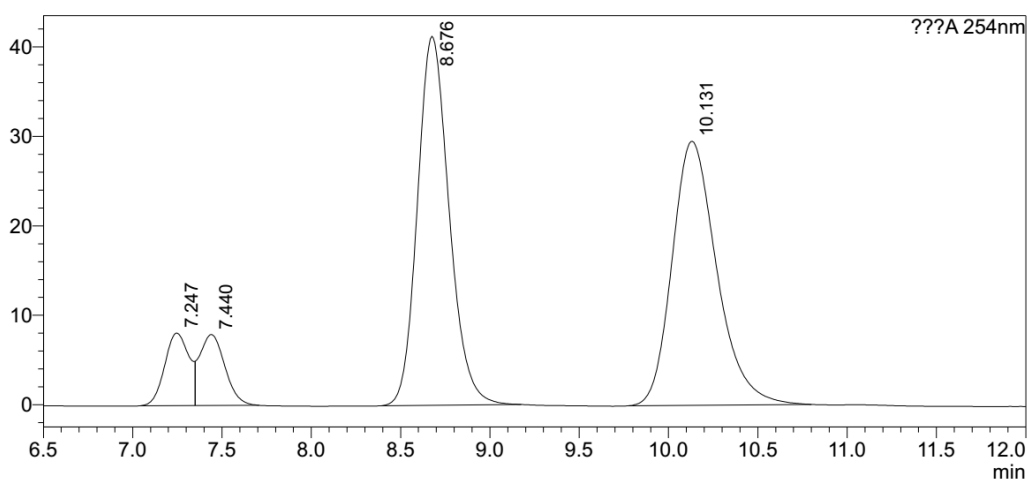
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.486	188924	18632	25.993		M	
2	7.717	176903	17102	24.339		M	
3	9.040	172962	13169	23.797		M	
4	10.516	188036	9999	25.871		M	
Total		726825	58903				

<Chromatogram>

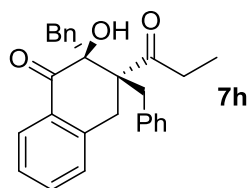
mV



<Peak Table>

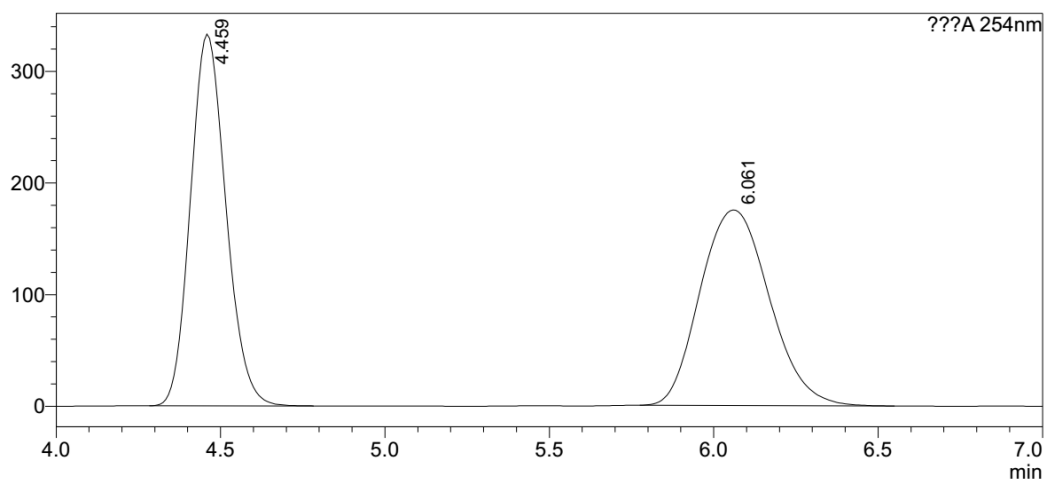
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.247	78899	8123	6.700		M	
2	7.440	76809	7947	6.522		V M	
3	8.676	509406	41248	43.255		M	
4	10.131	512563	29517	43.523		M	
Total		1177678	86836				



<Chromatogram>

mV



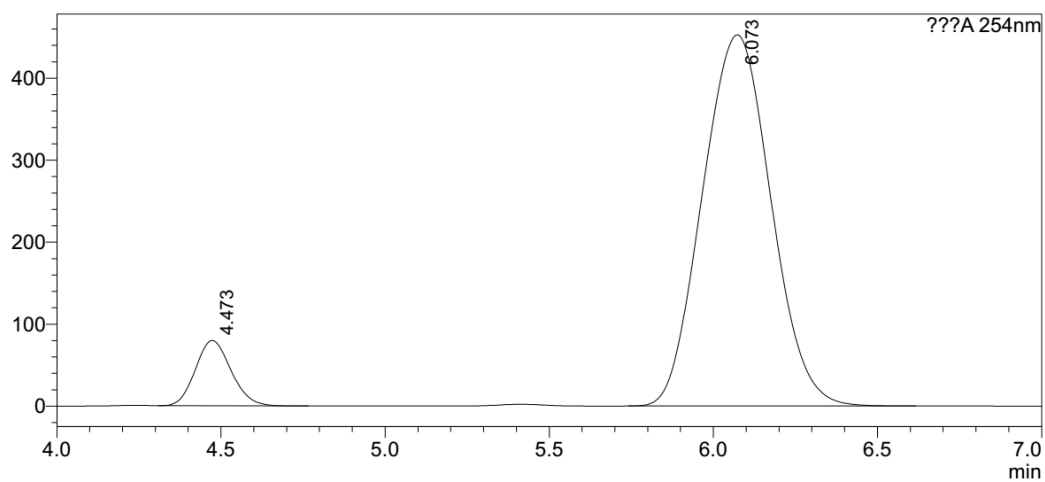
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.459	2500852	332970	49.349		M	
2	6.061	2566853	175209	50.651		M	
Total		5067706	508179				

<Chromatogram>

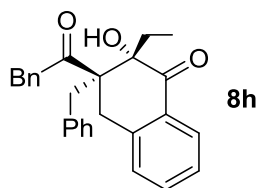
mV



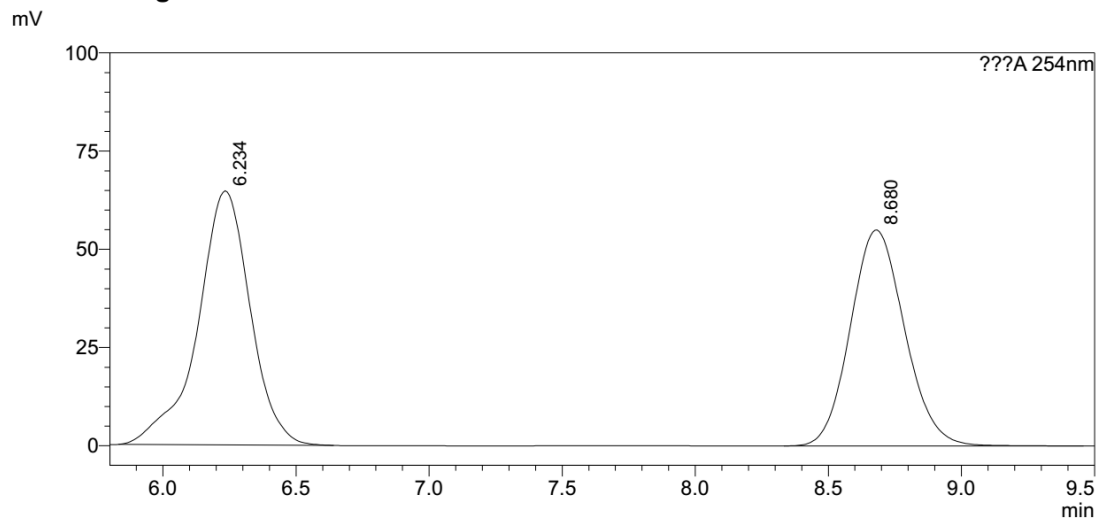
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.473	602568	79724	8.407			
2	6.073	6564781	452712	91.593		M	
Total		7167349	532436				



<Chromatogram>

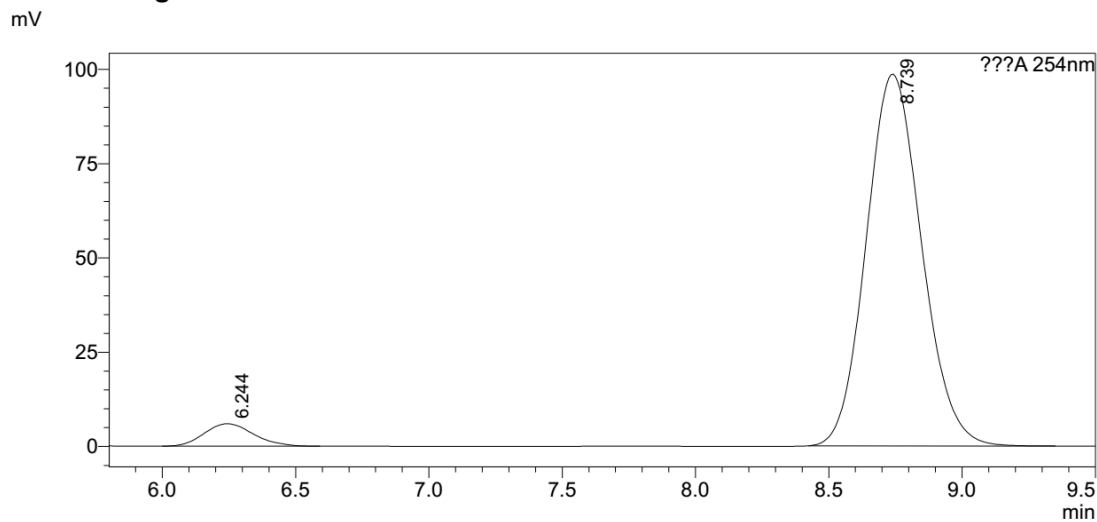


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.234	888228	64674	53.250		M	
2	8.680	779813	54981	46.750		M	
Total		1668041	119655				

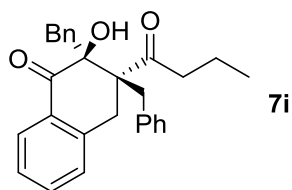
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<Peak Table>

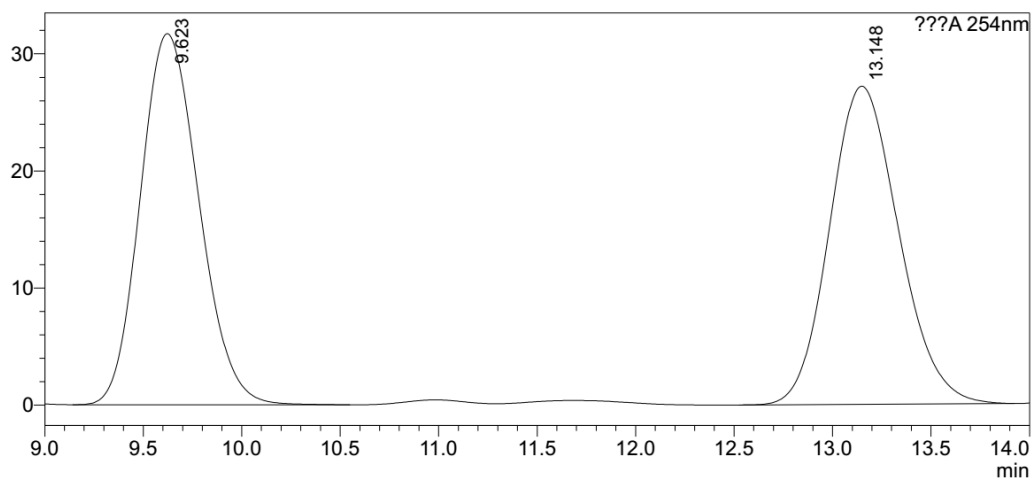
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.244	76394	5964	5.095		M	
2	8.739	1422915	98590	94.905		M	
Total		1499309	104553				



<Chromatogram>

mV



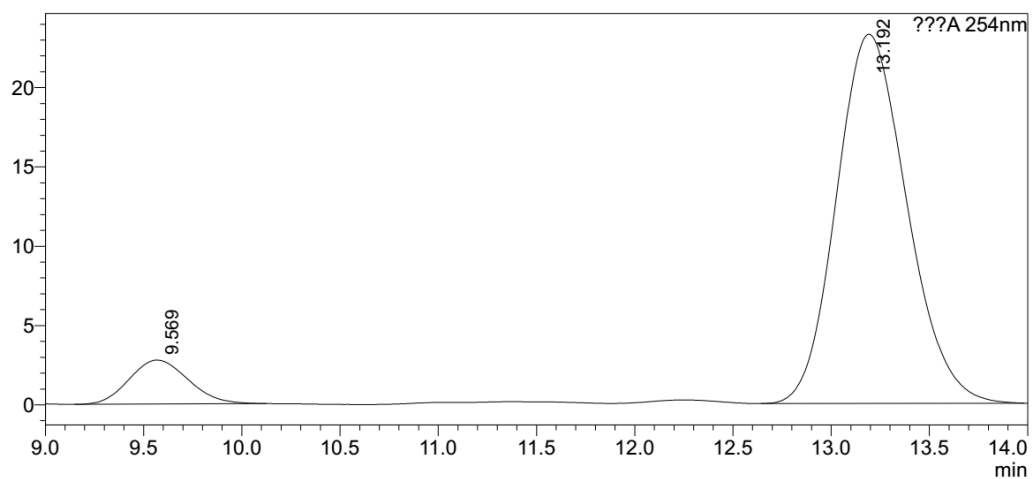
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.623	657735	31702	49.748			
2	13.148	664401	27184	50.252			
Total		1322136	58886				

<Chromatogram>

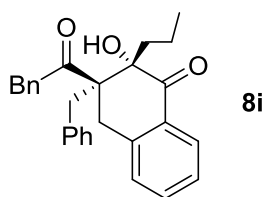
mV



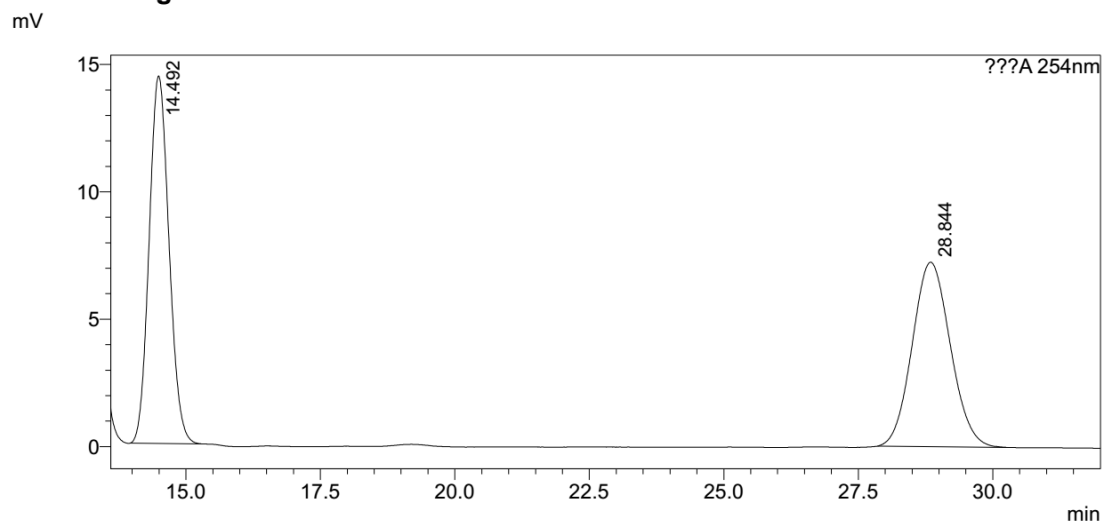
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.569	57901	2775	9.067		M	
2	13.192	580681	23277	90.933		M	
Total		638582	26052				



<Chromatogram>

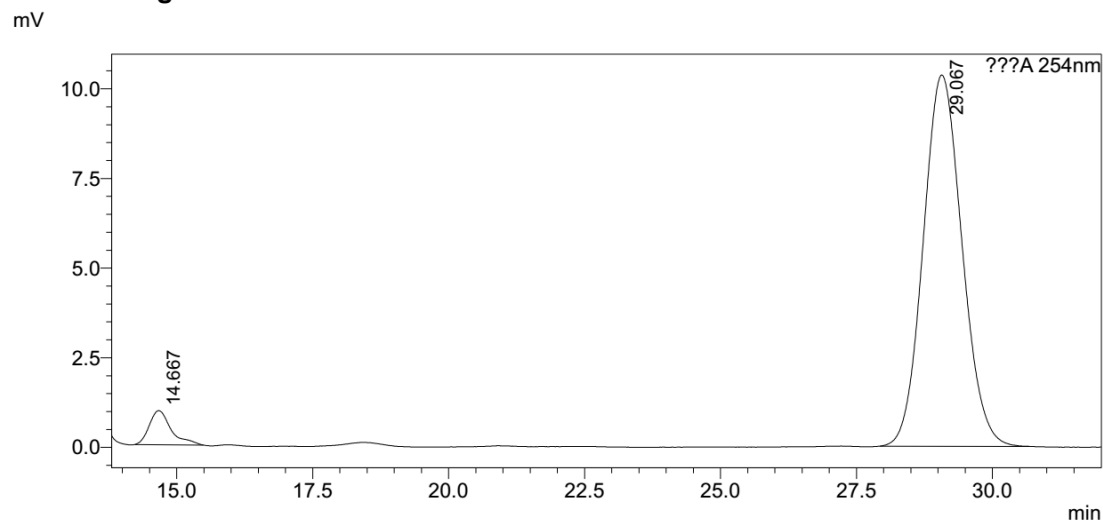


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.492	370034	14424	50.887		M	
2	28.844	357130	7242	49.113		M	
Total		727164	21666				

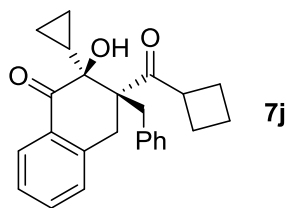
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<Peak Table>

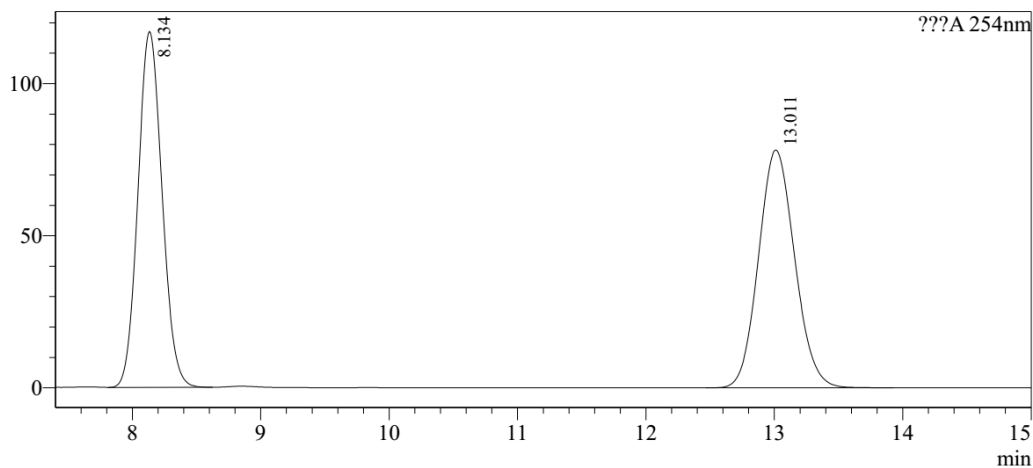
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.667	26513	950	4.907		M	
2	29.067	513763	10355	95.093		M	
Total		540276	11306				



<Chromatogram>

mV



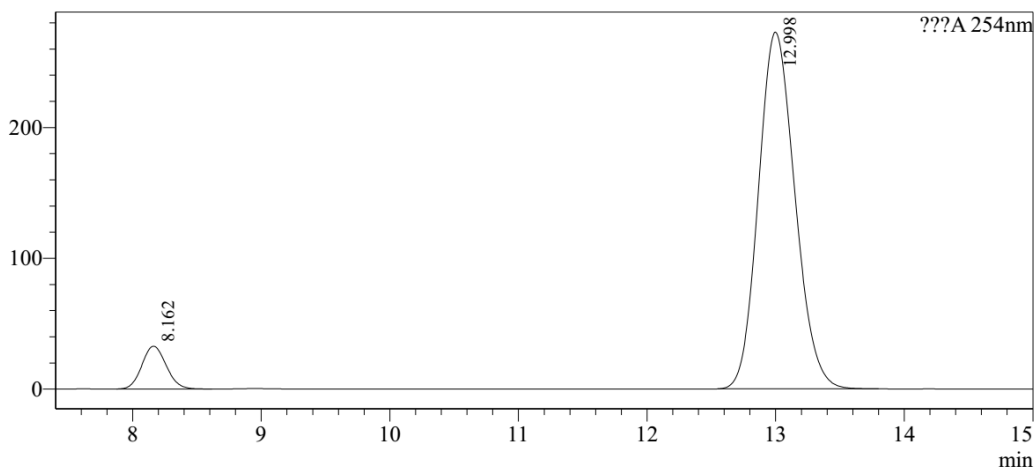
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.134	1525012	116994	49.902			
2	13.011	1530973	78178	50.098			
Total		3055984	195172				

<Chromatogram>

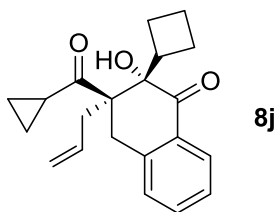
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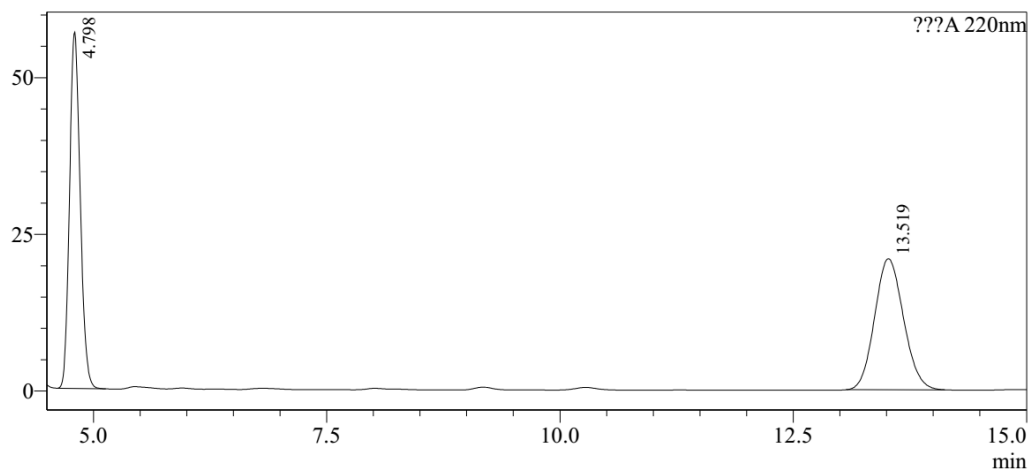
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.162	430515	32712	7.400		M	
2	12.998	5386903	272825	92.600		M	
Total		5817418	305537				



<Chromatogram>

mV



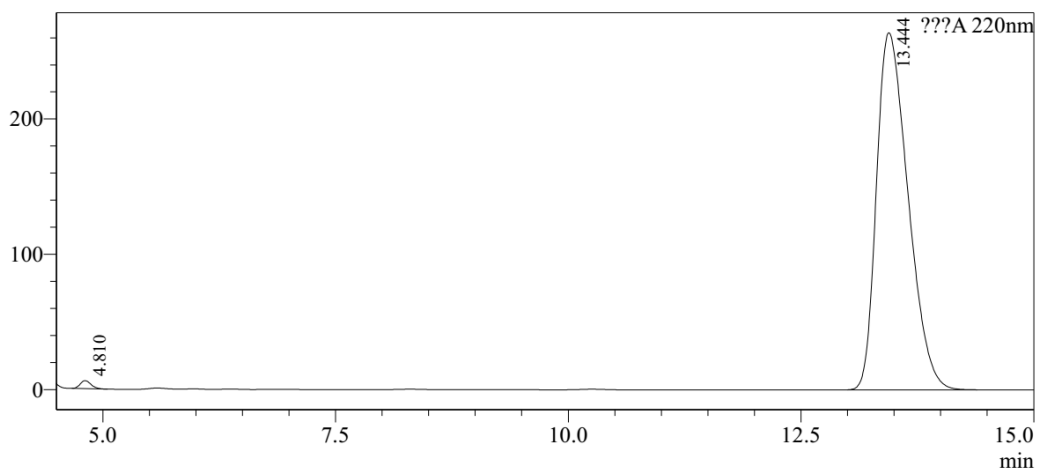
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.798	452705	56847	50.117		M	
2	13.519	450589	20910	49.883		M	
Total		903294	77757				

<Chromatogram>

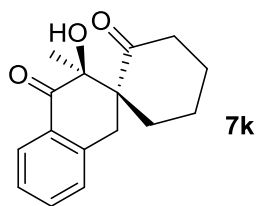
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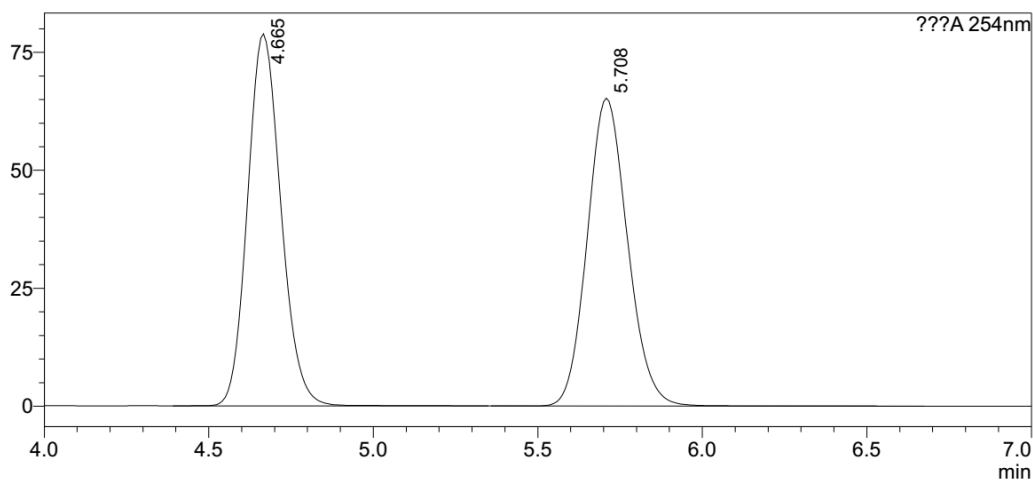
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.810	48334	5967	0.771		M	
2	13.444	6224034	263962	99.229		M	
Total		6272367	269929				



<Chromatogram>

mV



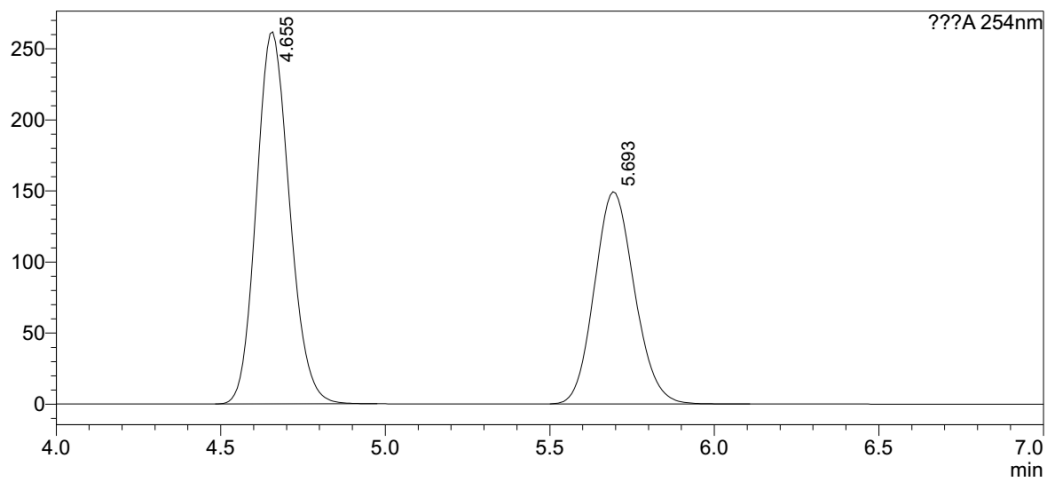
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.665	556650	78847	50.014		SV	
2	5.708	556328	65271	49.986		S	
Total		1112978	144118				

<Chromatogram>

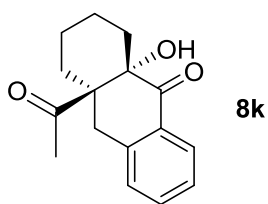
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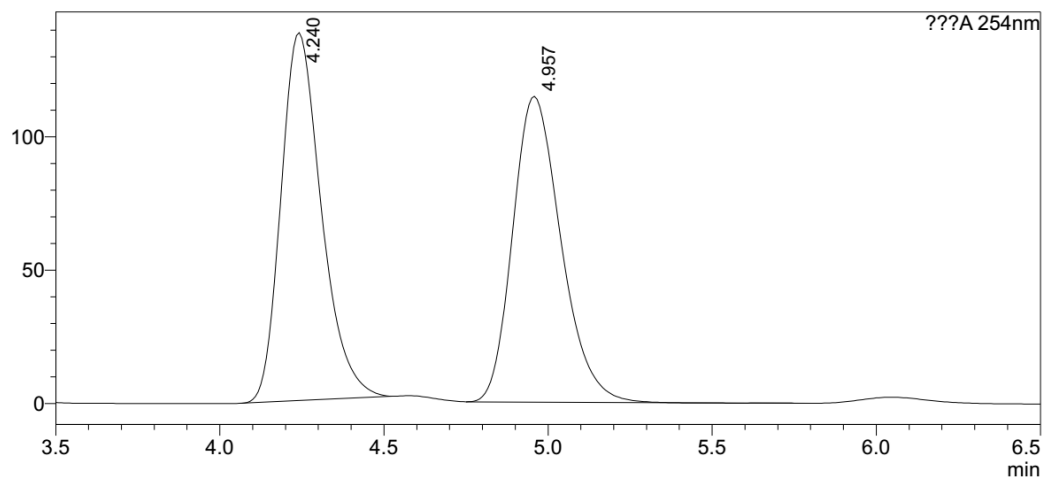
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.655	1834546	261576	59.206		M	
2	5.693	1264040	149214	40.794		M	
Total		3098586	410790				



<Chromatogram>

mV



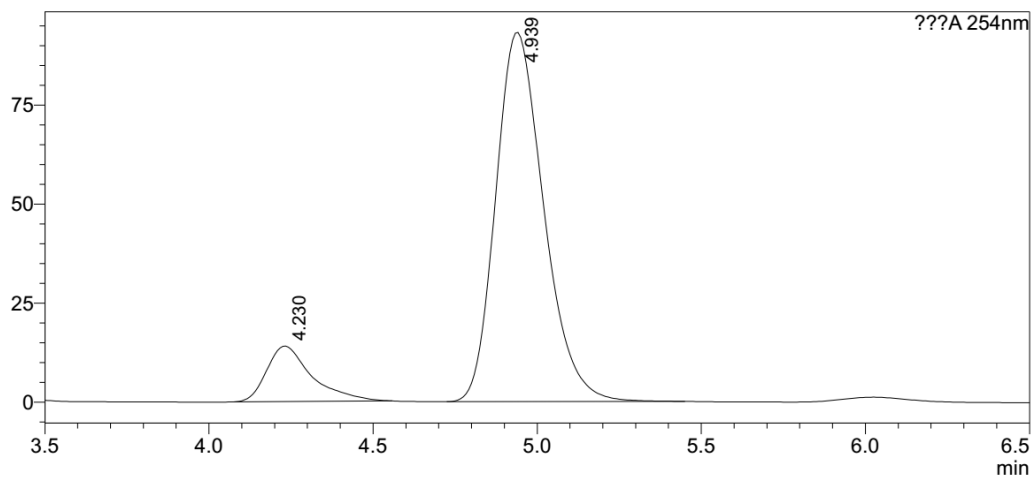
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.240	1182514	137955	50.233			
2	4.957	1171567	114722	49.767		S	
Total		2354082	252677				

<Chromatogram>

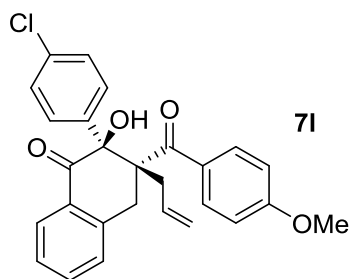
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<Peak Table>

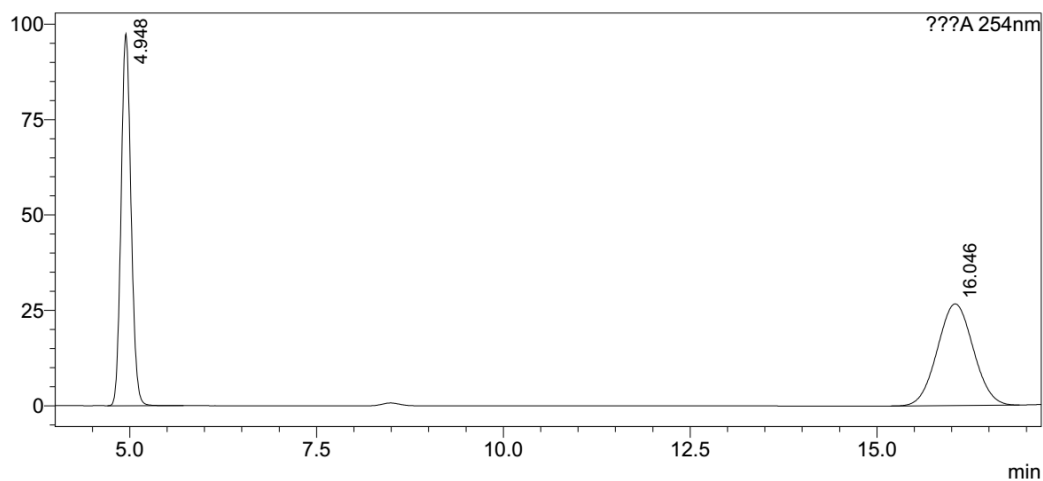
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.230	134723	14029	12.423		M	
2	4.939	949766	93191	87.577		M	
Total		1084490	107220				



<Chromatogram>

mV



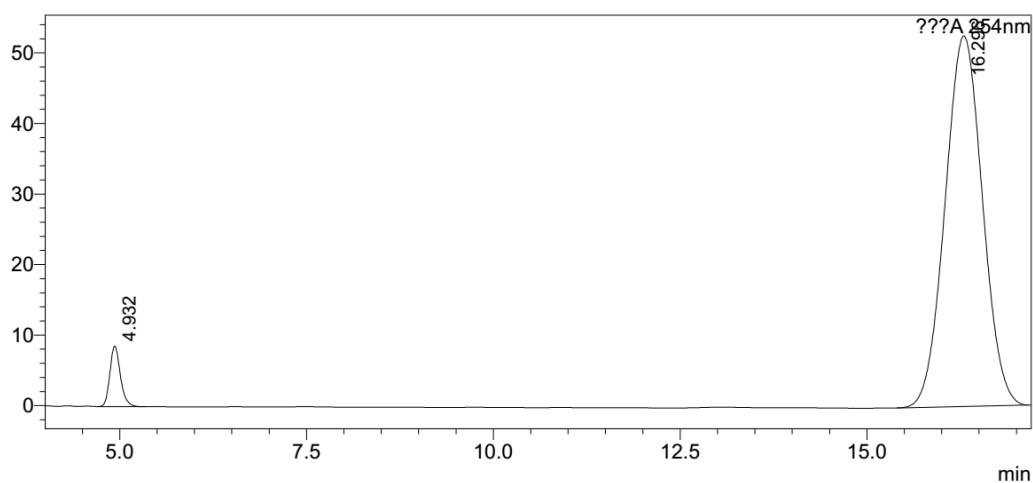
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.948	903577	97458	50.360			
2	16.046	890673	26639	49.640			
Total		1794249	124096				

<Chromatogram>

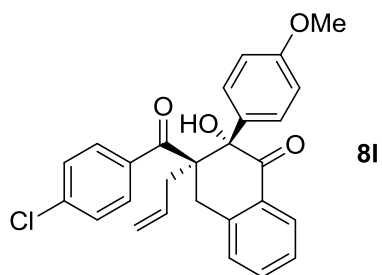
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<Peak Table>

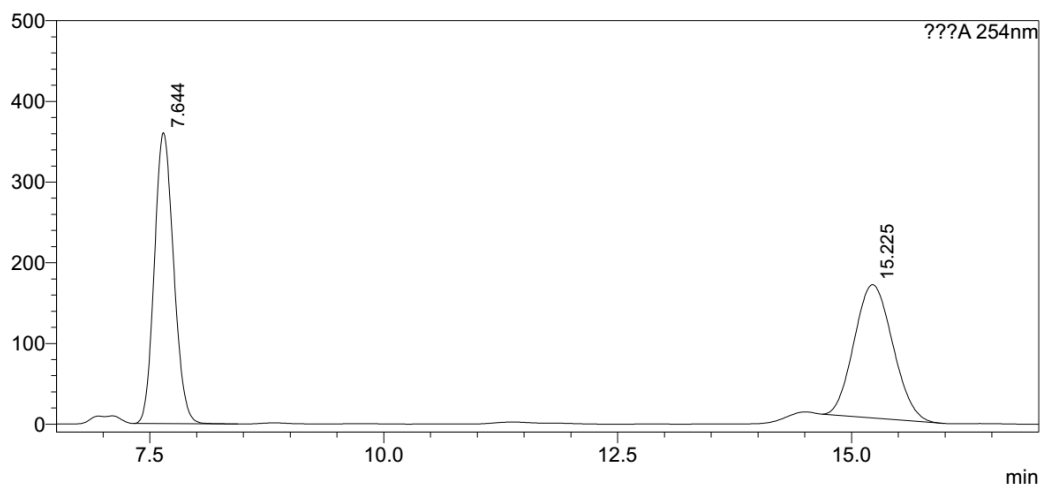
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.932	84477	8598	4.420			
2	16.296	1826960	52523	95.580			
Total		1911437	61121				



<Chromatogram>

mV



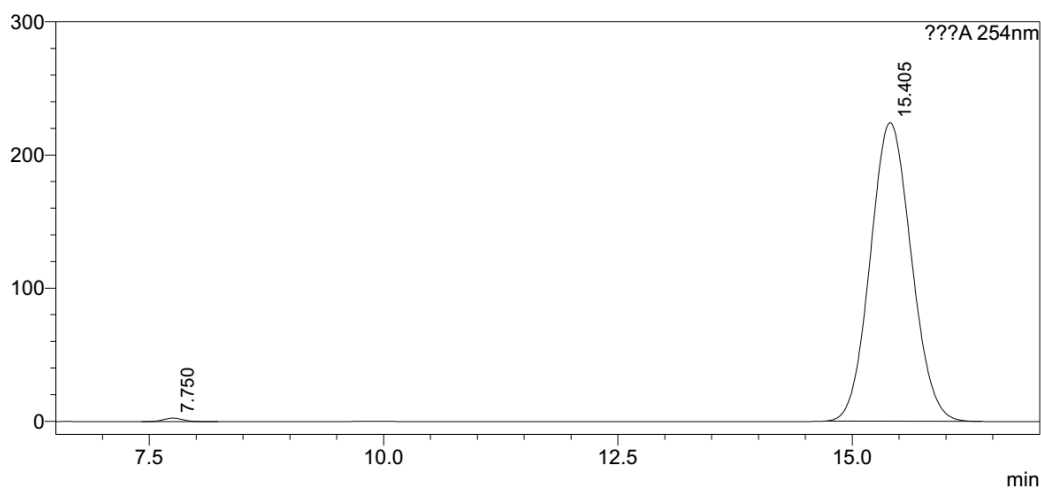
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.644	5169792	360587	52.142			
2	15.225	4745006	165158	47.858		M	
Total		9914798	525745				

<Chromatogram>

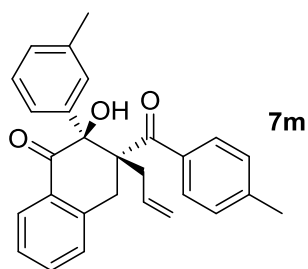
mV



<Peak Table>

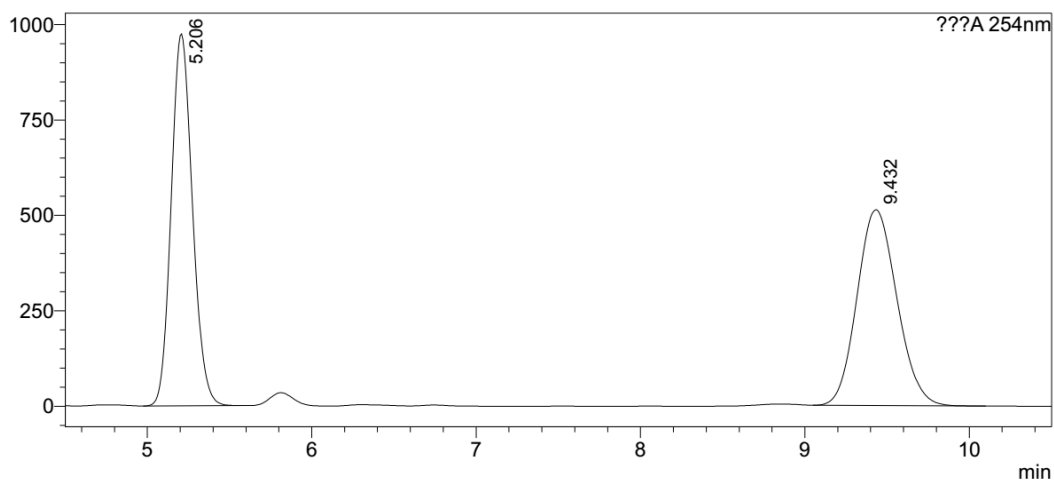
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.750	37658	2594	0.549			
2	15.405	6822353	224275	99.451		M	
Total		6860011	226869				



<Chromatogram>

mV



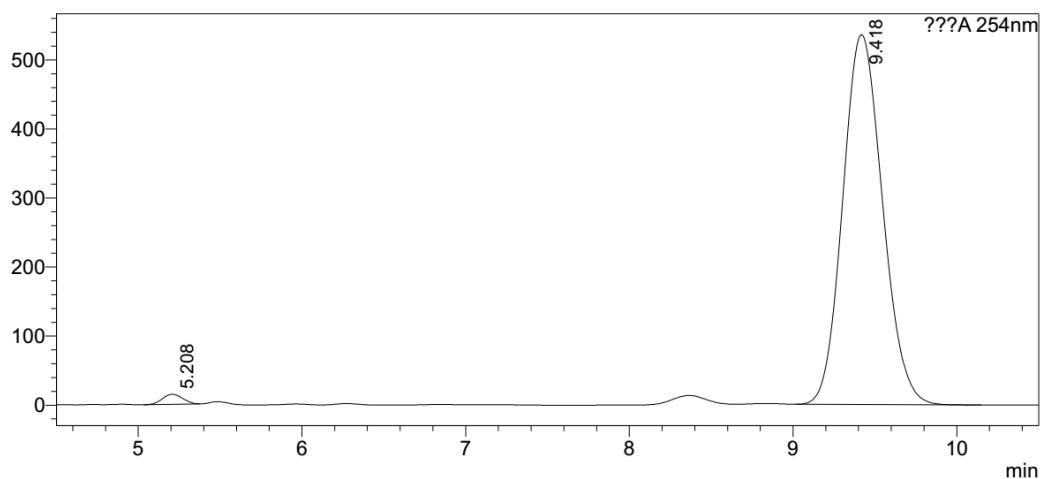
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.206	8786578	974274	50.383			
2	9.432	8653132	513044	49.617			
Total		17439710	1487319				

<Chromatogram>

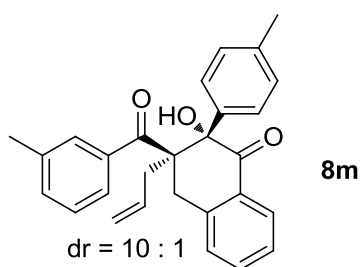
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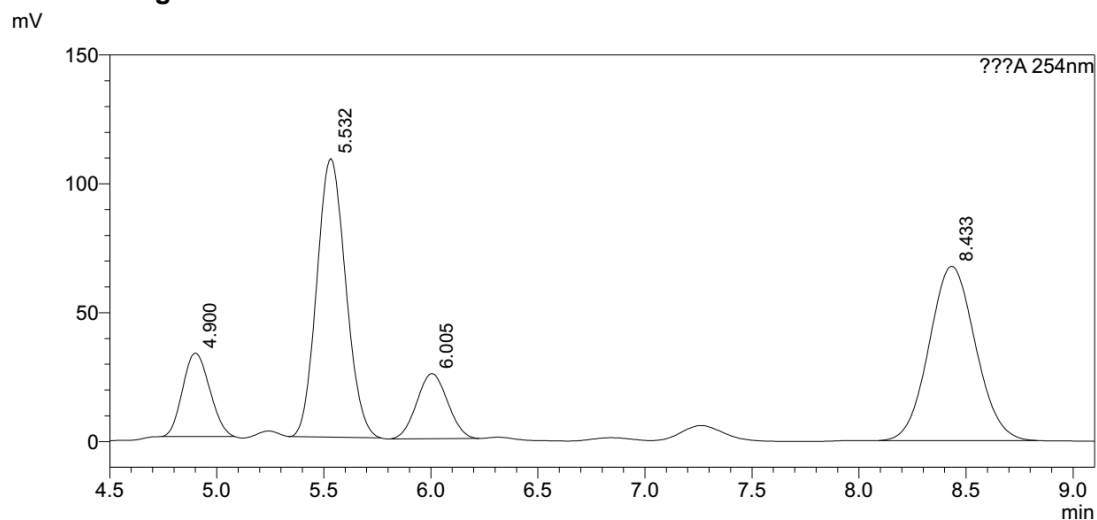
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.208	127905	14687	1.395			
2	9.418	9043350	535887	98.605			
Total		9171255	550574				



<Chromatogram>

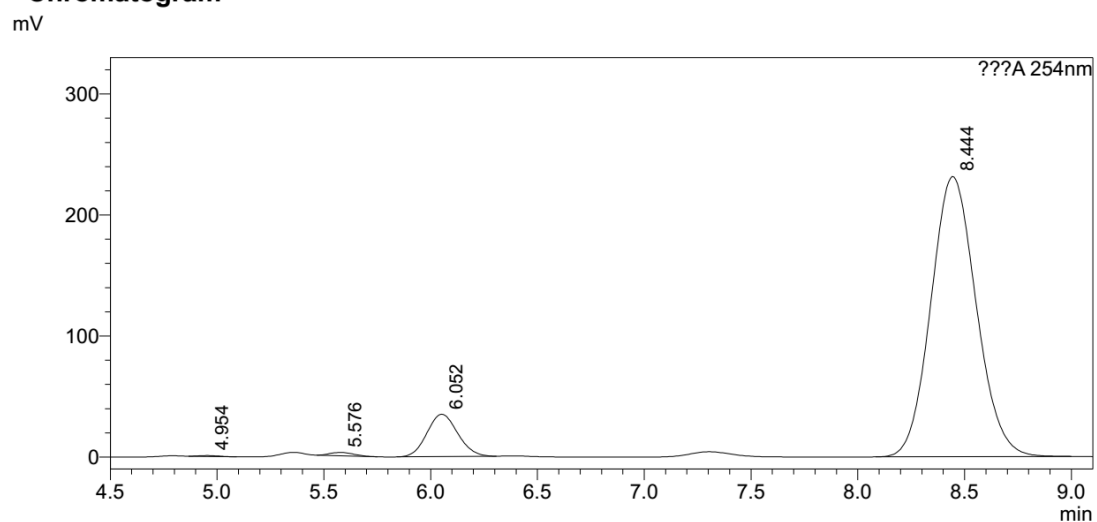


<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.900	284433	32403	11.056		M	
2	5.532	1017387	108145	39.548		M	
3	6.005	253044	25210	9.836		M	
4	8.433	1017692	67641	39.560		M	
Total		2572555	233400				

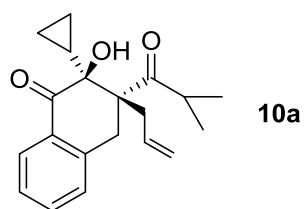
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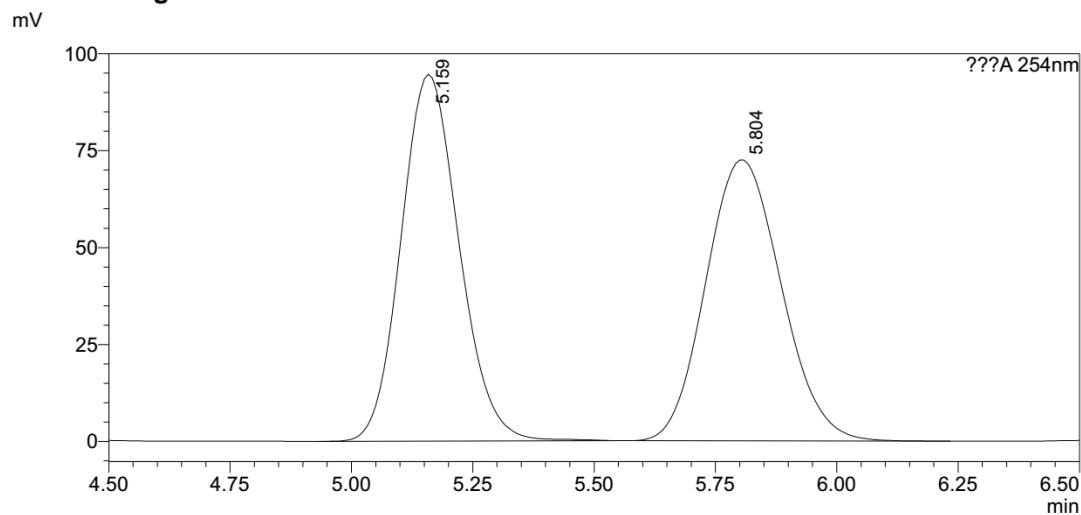
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.954	4696	749	0.124		M	
2	5.576	20897	2746	0.551		M	
3	6.052	350685	35004	9.251		M	
4	8.444	3414676	231497	90.074		M	
Total		3790953	269996				



<Chromatogram>

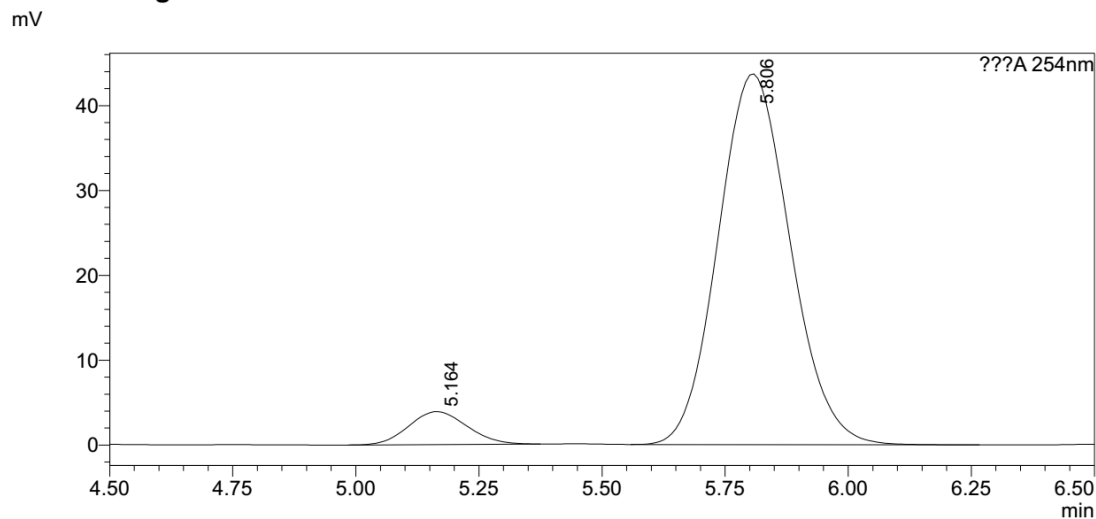


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.159	787084	94610	50.110			
2	5.804	783631	72464	49.890		M	
Total		1570715	167074				

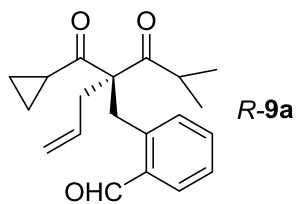
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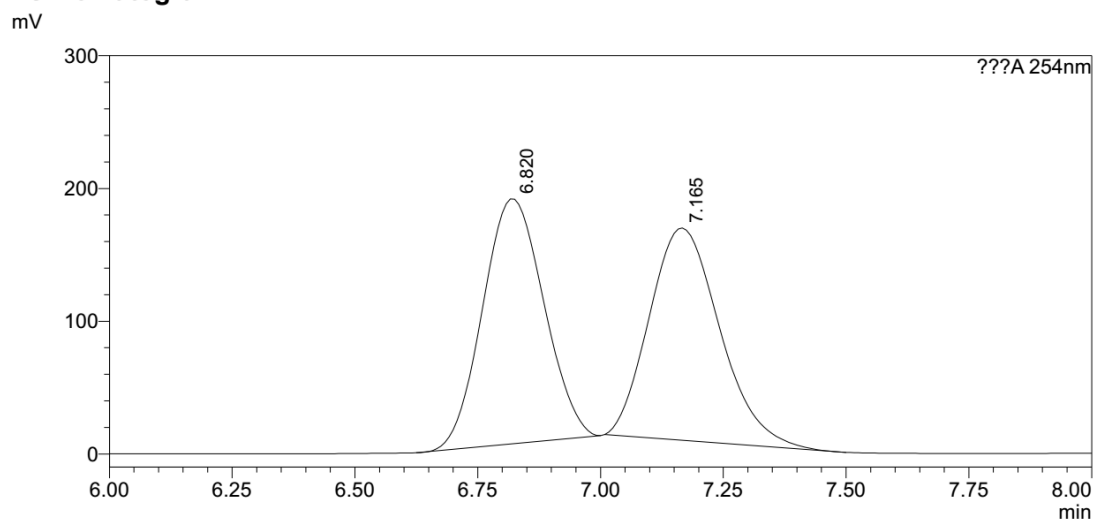
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.164	32143	3891	6.742			
2	5.806	444627	43673	93.258			
Total		476770	47564				



<Chromatogram>

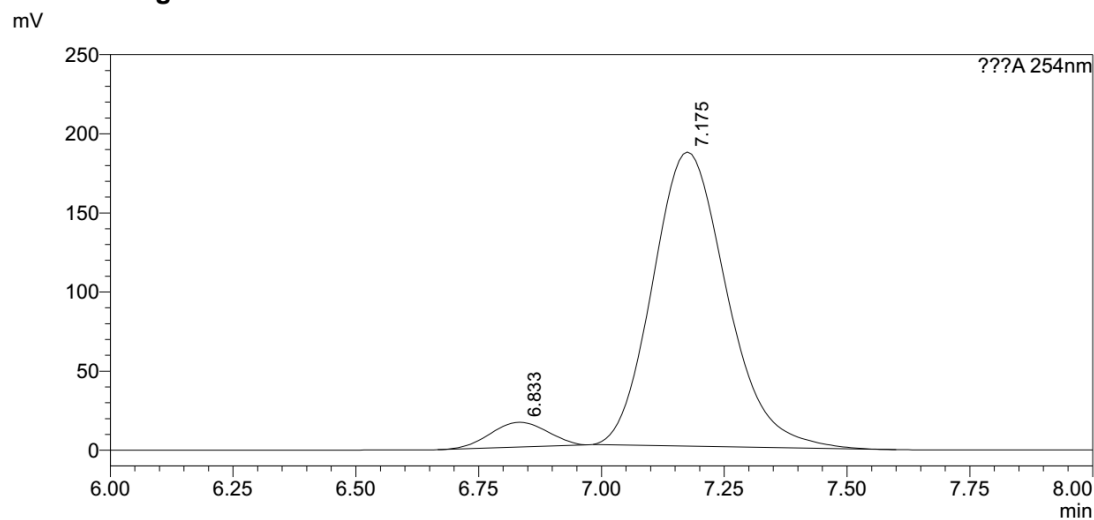


<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.820	1602074	184444	50.168		M	
2	7.165	1591373	159943	49.832		M	
Total		3193447	344387				

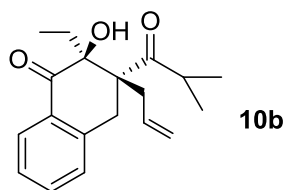
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<Peak Table>

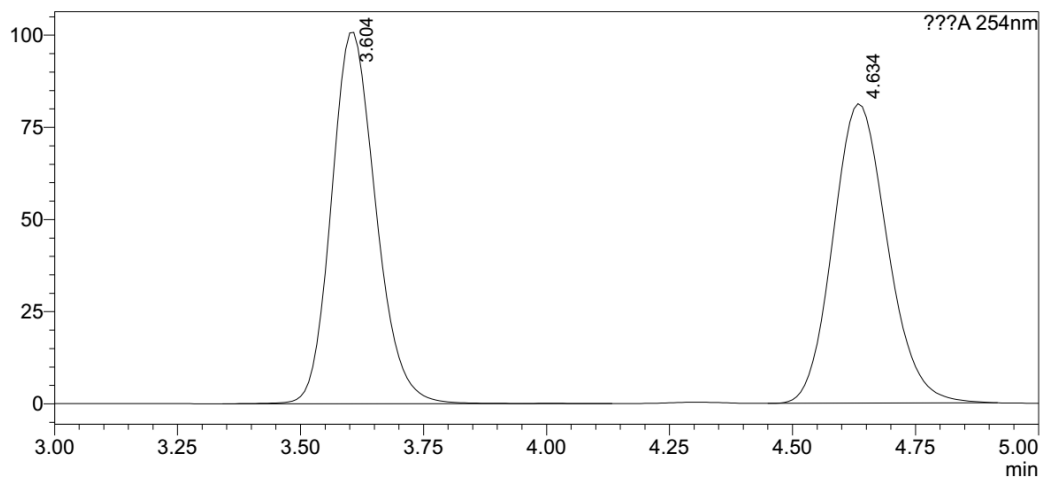
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.833	128345	15714	6.185		M	
2	7.175	1946769	185923	93.815		M	
Total		2075114	201637				



<Chromatogram>

mV



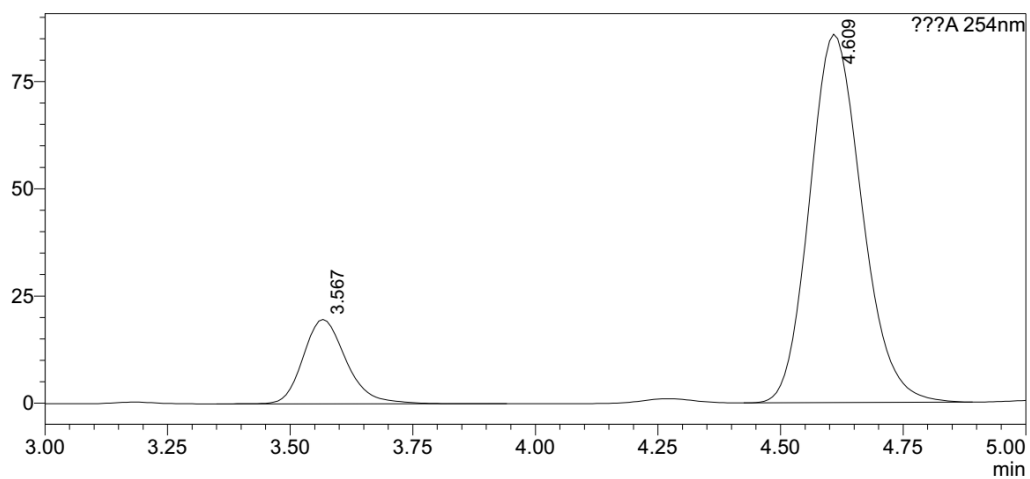
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.604	633404	100604	50.314		S	
2	4.634	625510	81264	49.686		M	
Total		1258914	181868				

<Chromatogram>

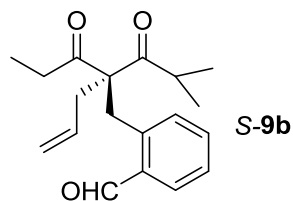
mV



<Peak Table>

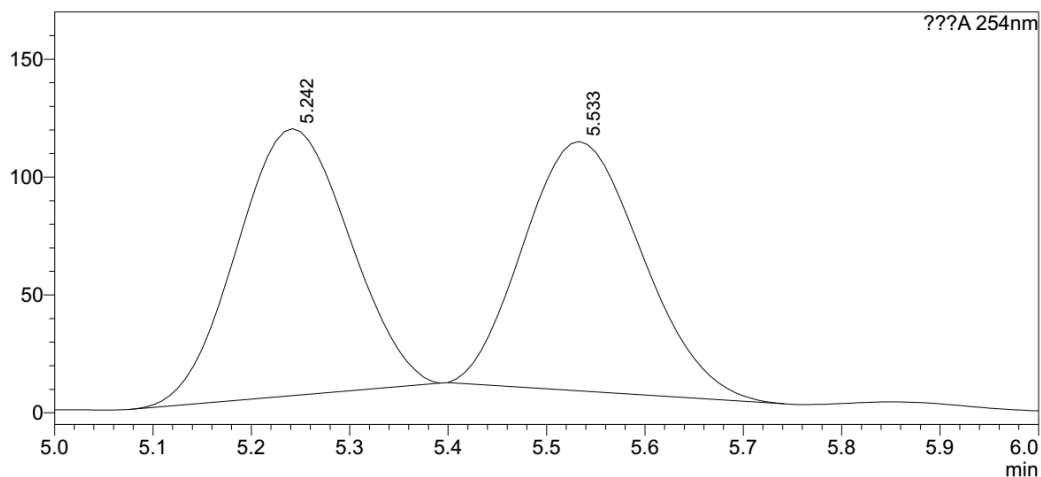
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.567	120457	19702	15.883			
2	4.609	637953	85877	84.117			
Total		758410	105580				



<Chromatogram>

mV



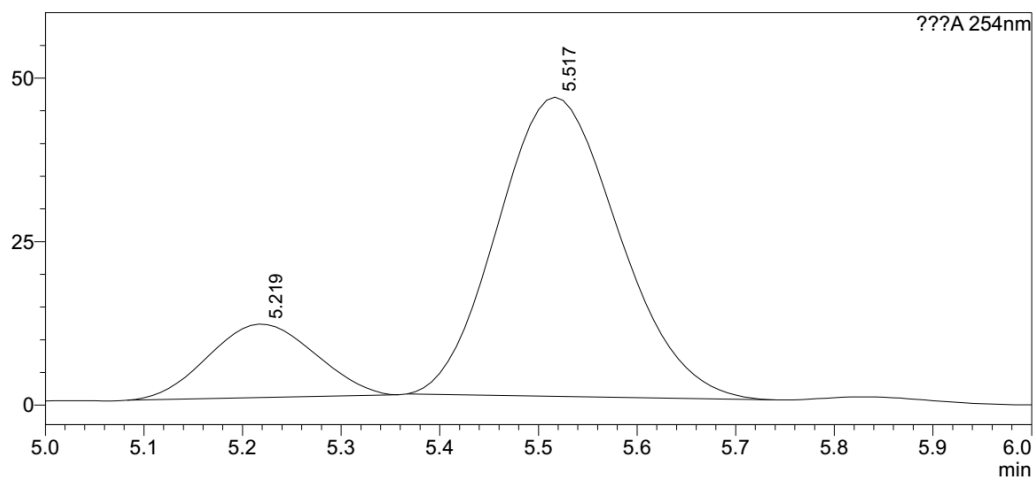
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.242	902624	113223	50.542			
2	5.533	883272	105756	49.458		M	
Total		1785896	218979				

<Chromatogram>

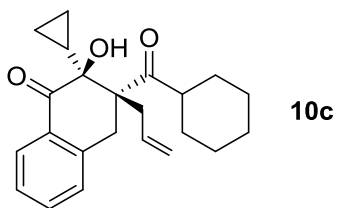
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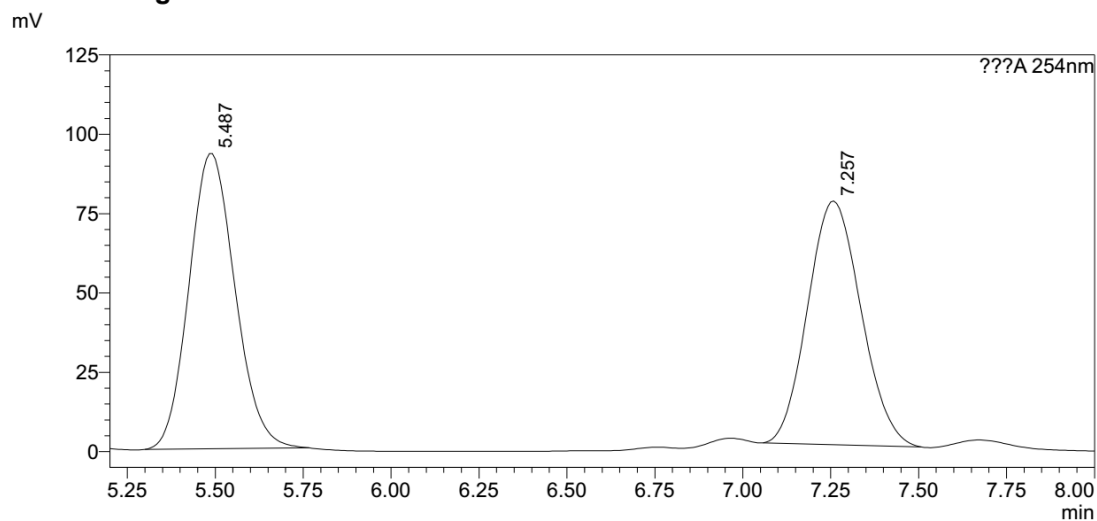
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.219	84636	11233	17.813		M	
2	5.517	390502	45774	82.187		M	
Total		475138	57007				



<Chromatogram>

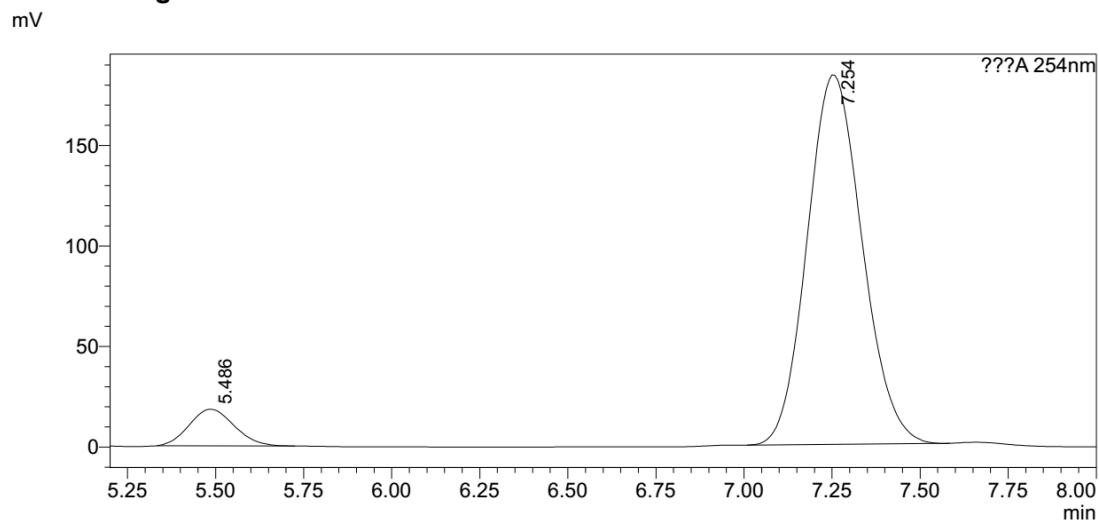


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.487	847838	93020	51.137		M	
2	7.257	810146	76776	48.863		M	
Total		1657984	169796				

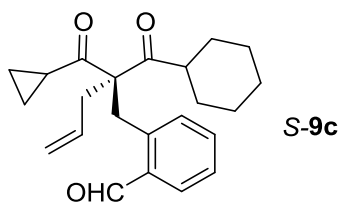
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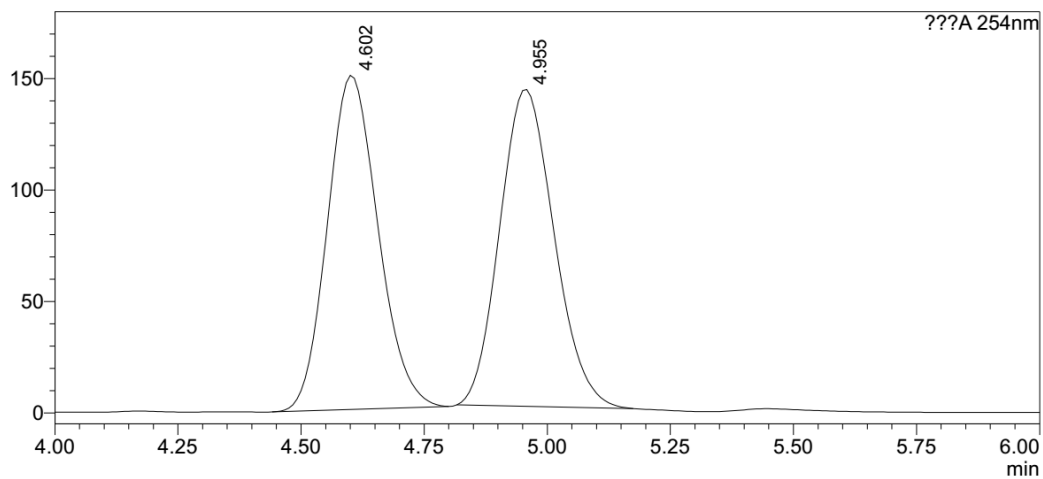
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.486	160861	18177	7.454		M	
2	7.254	1997320	183693	92.546		M	
Total		2158181	201870				



<Chromatogram>

mV



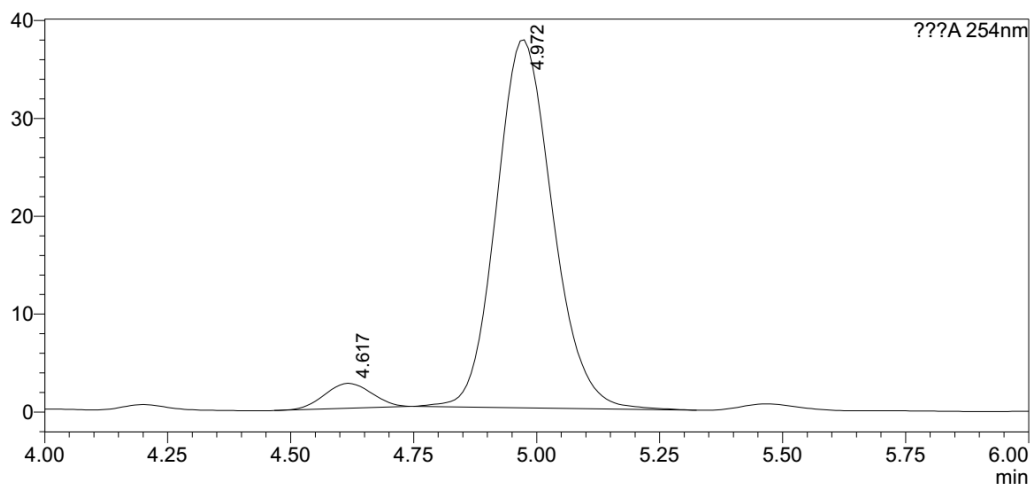
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.602	1074281	150043	49.588		M	
2	4.955	1092128	142246	50.412		M	
Total		2166409	292289				

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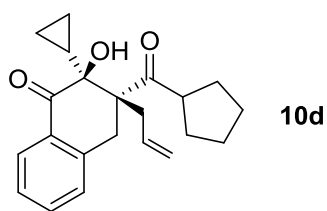
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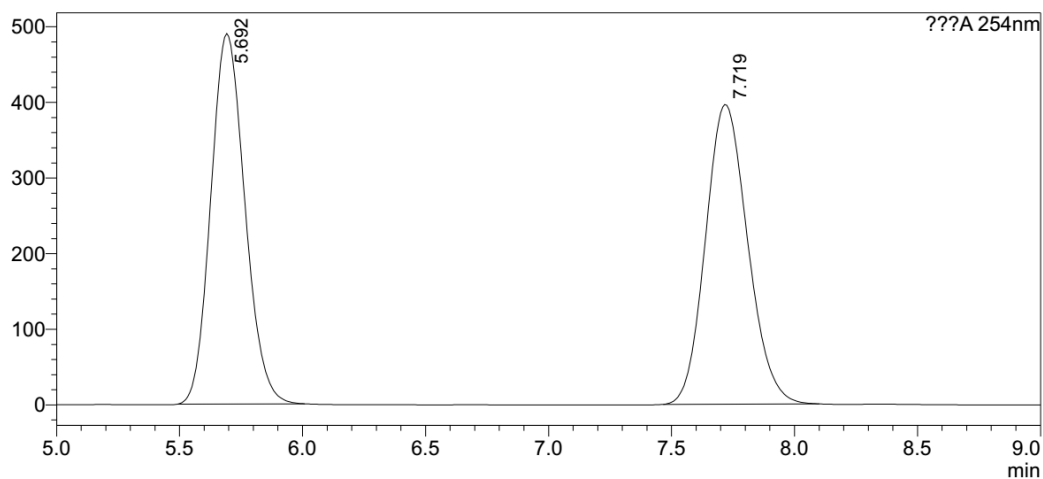
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.617	17037	2546	5.387		M	
2	4.972	299236	37585	94.613		M	
Total		316273	40130				



<Chromatogram>

mV



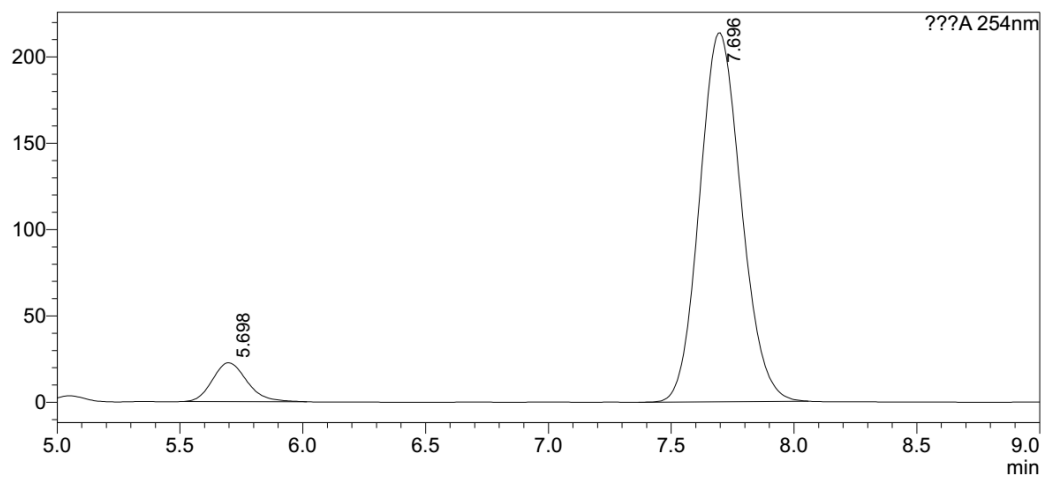
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.692	4714989	489829	49.945		M	
2	7.719	4725310	396399	50.055		M	
Total		9440299	886228				

<Chromatogram>

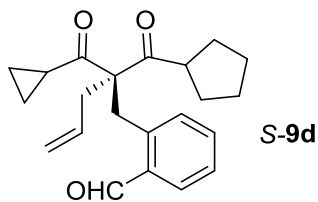
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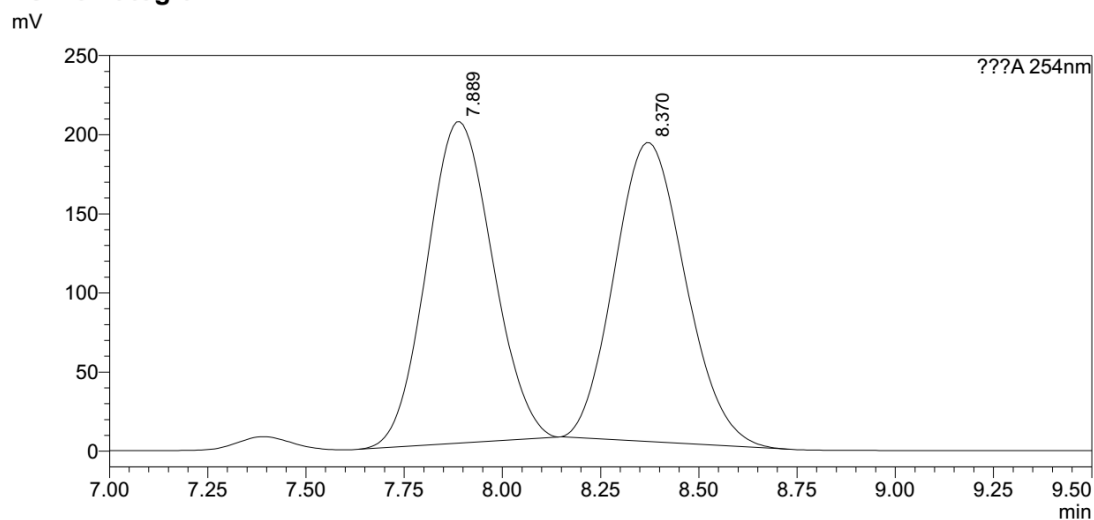
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.698	220355	22516	8.046		M	
2	7.696	2518344	213546	91.954		M	
Total		2738700	236062				



<Chromatogram>

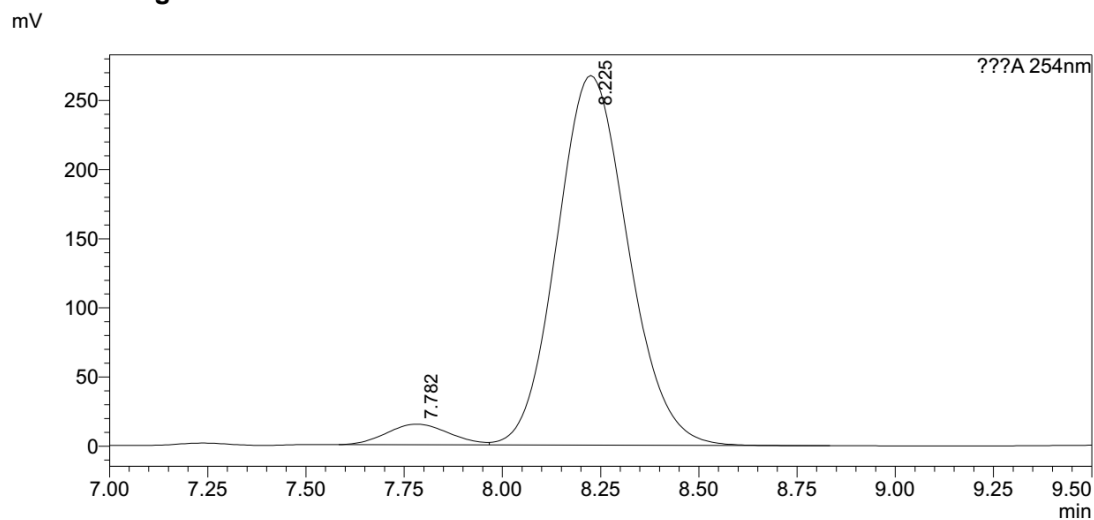


<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.889	2378603	203175	50.097		M	
2	8.370	2369391	188801	49.903		M	
Total		4747994	391977				

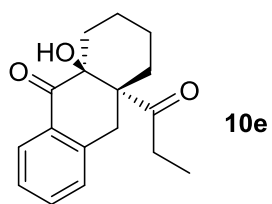
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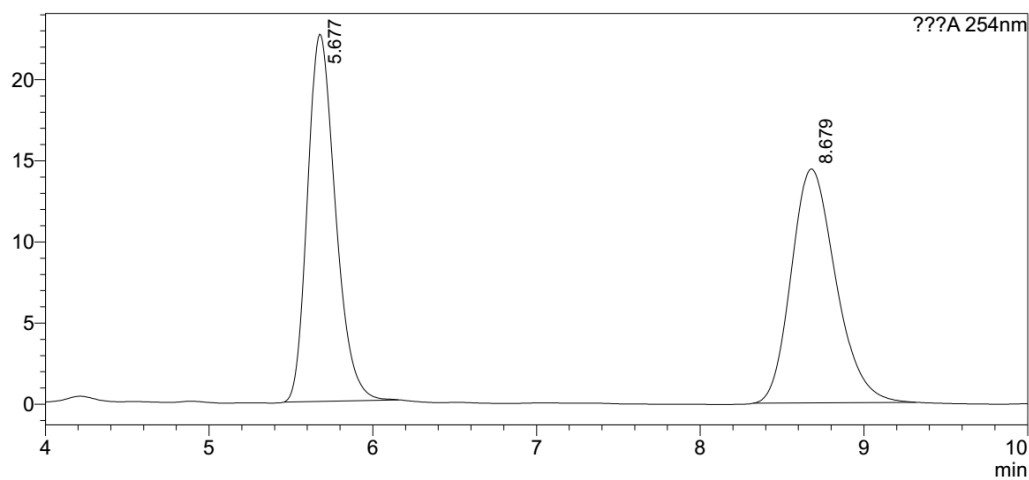
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.782	166621	14905	4.712		M	
2	8.225	3369250	267334	95.288		V M	
Total		3535871	282239				



<Chromatogram>

mV



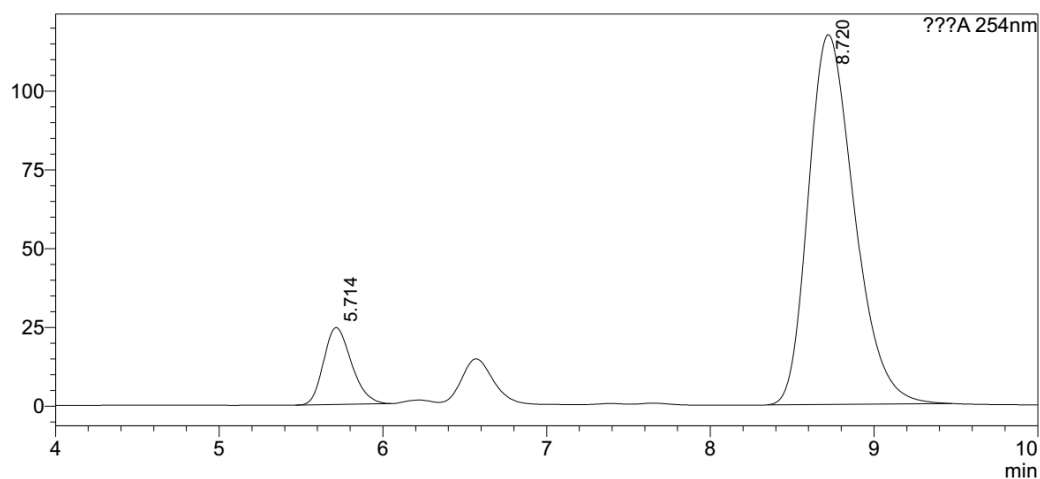
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.677	268151	22620	49.556		M	
2	8.679	272953	14413	50.444		M	
Total		541104	37033				

<Chromatogram>

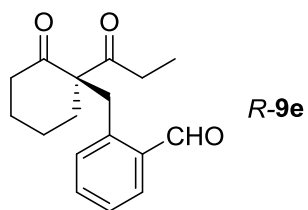
mV



<Peak Table>

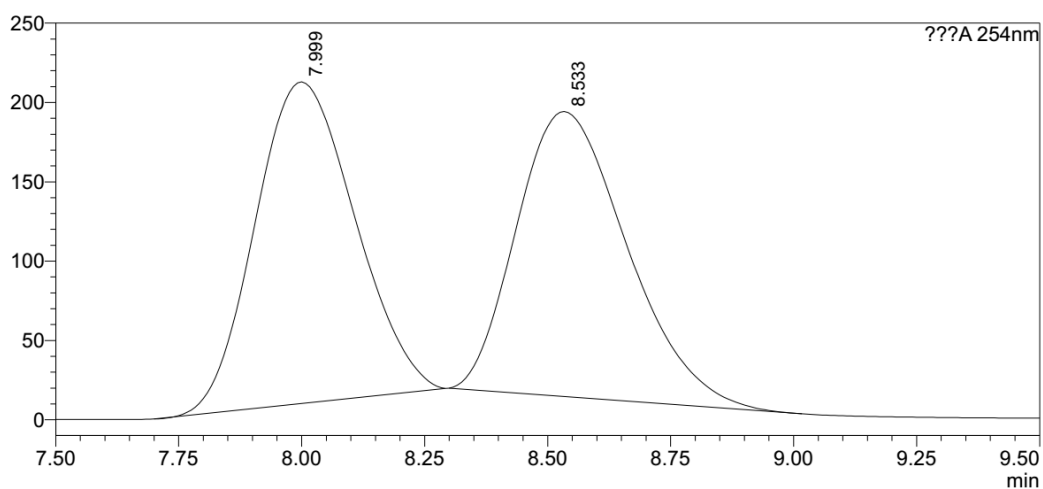
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.714	289552	24420	11.211			
2	8.720	2293213	117288	88.789		M	
Total		2582765	141708				



<Chromatogram>

mV



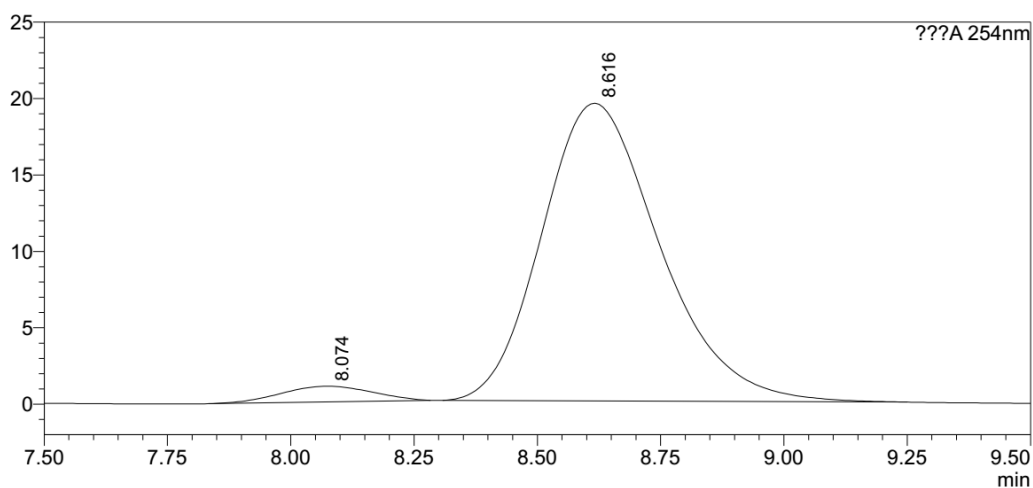
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.999	2856746	202705	50.442		M	
2	8.533	2806679	179675	49.558		M	
Total		5663425	382380				

<Chromatogram>

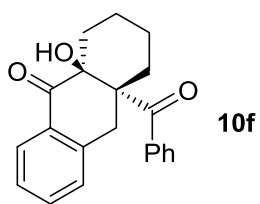
mV



<Peak Table>

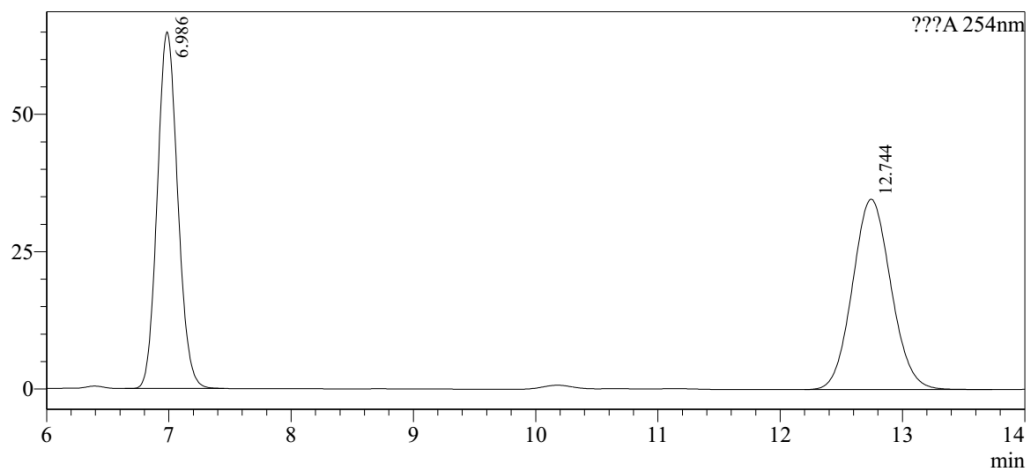
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.074	13223	1023	3.920		M	
2	8.616	324111	19481	96.080		M	
Total		337334	20504				



<Chromatogram>

mV



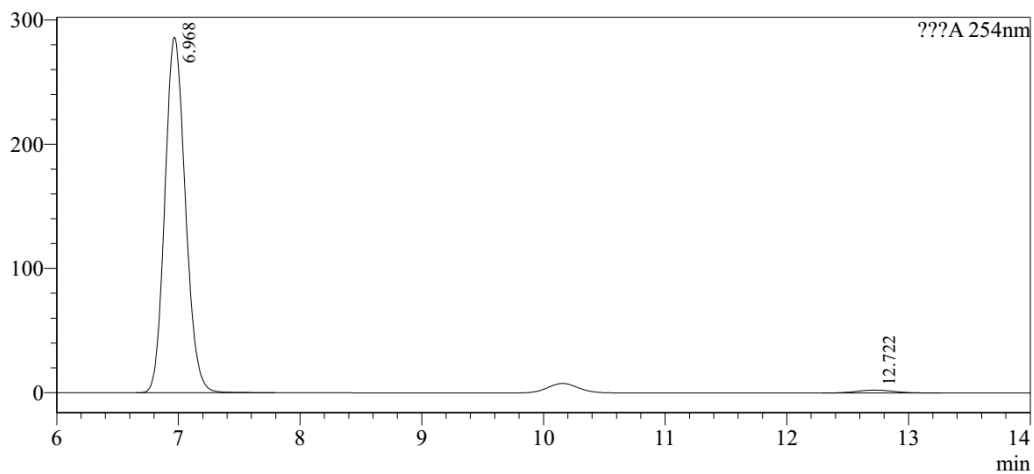
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.986	754650	64941	49.913		M	
2	12.744	757295	34660	50.087		M	
Total		1511945	99602				

<Chromatogram>

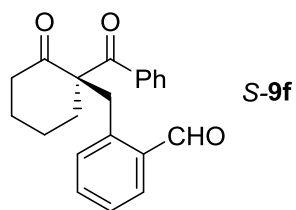
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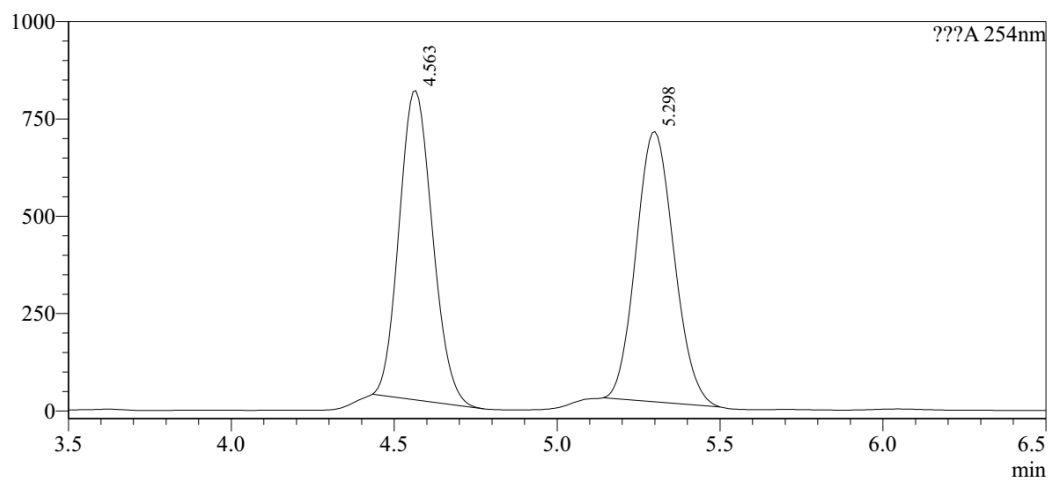
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.968	3352456	286222	98.549		M	
2	12.722	49366	2295	1.451		M	
Total		3401822	288517				



<Chromatogram>

mV



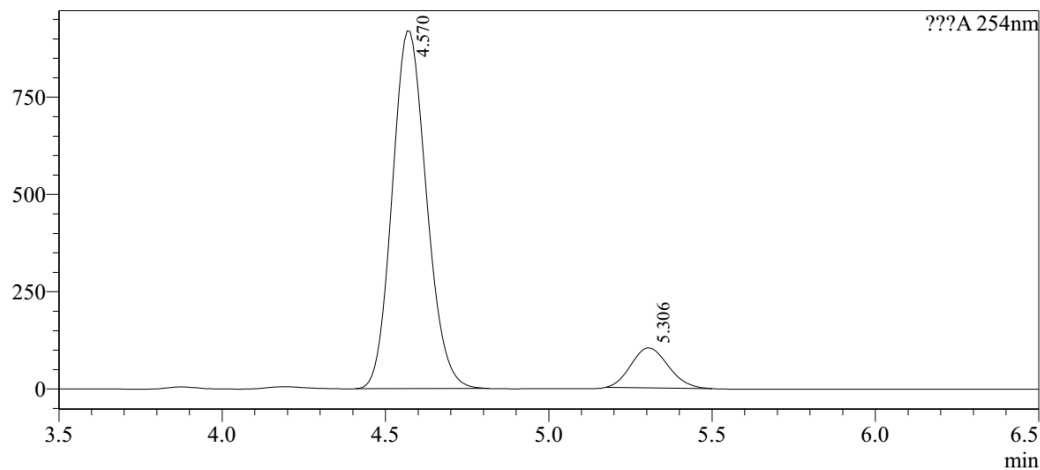
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.563	5620957	794410	49.903		M	
2	5.298	5642846	694561	50.097		M	
Total		11263804	1488971				

<Chromatogram>

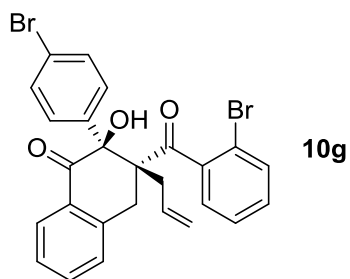
mV



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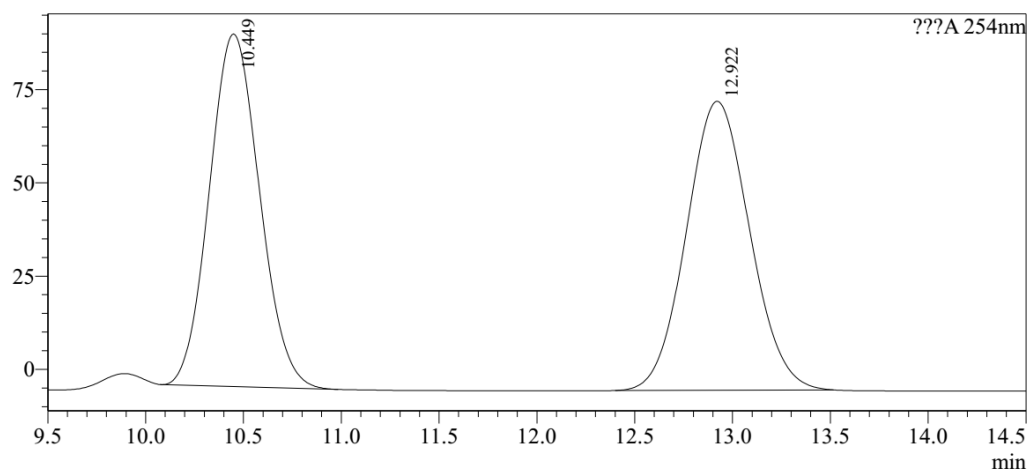
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.570	6678122	919655	89.044		M	
2	5.306	821647	103000	10.956		M	
Total		7499769	1022655				



<Chromatogram>

mV



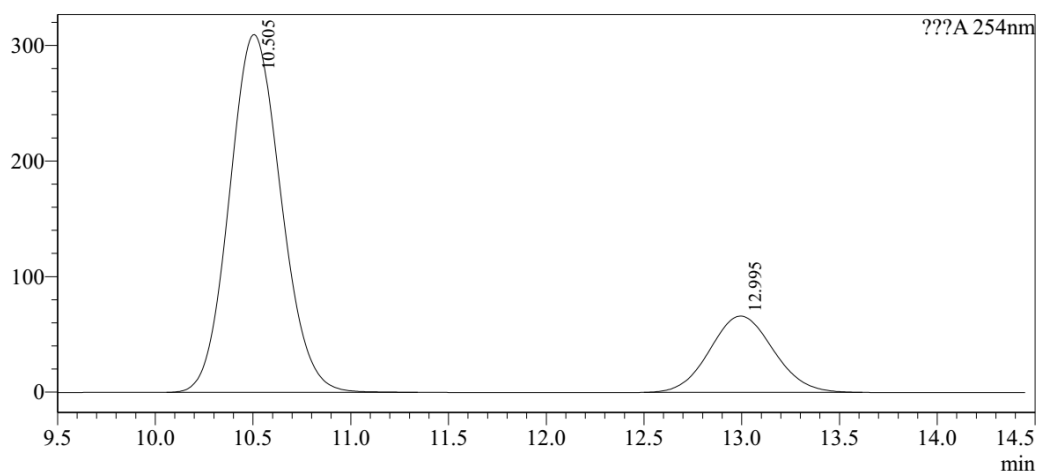
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.449	1689088	94612	49.200		M	
2	12.922	1743991	77478	50.800		M	
Total		3433079	172090				

<Chromatogram>

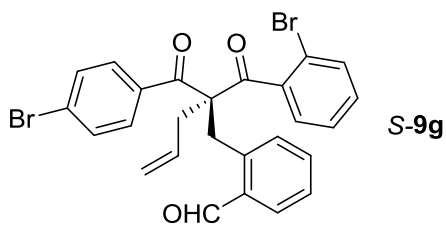
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<Peak Table>

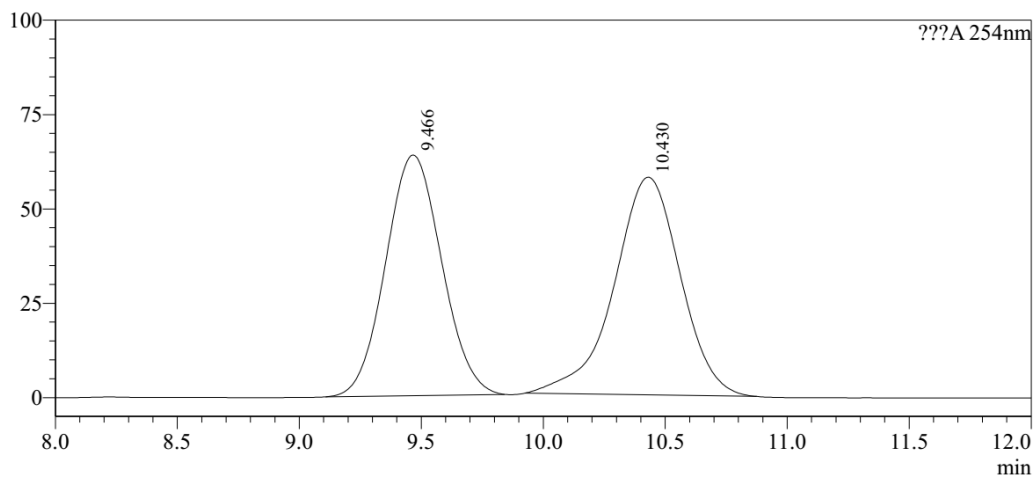
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.505	5681905	309571	79.114		M	
2	12.995	1499981	66039	20.886		M	
Total		7181886	375610				



<Chromatogram>

mV



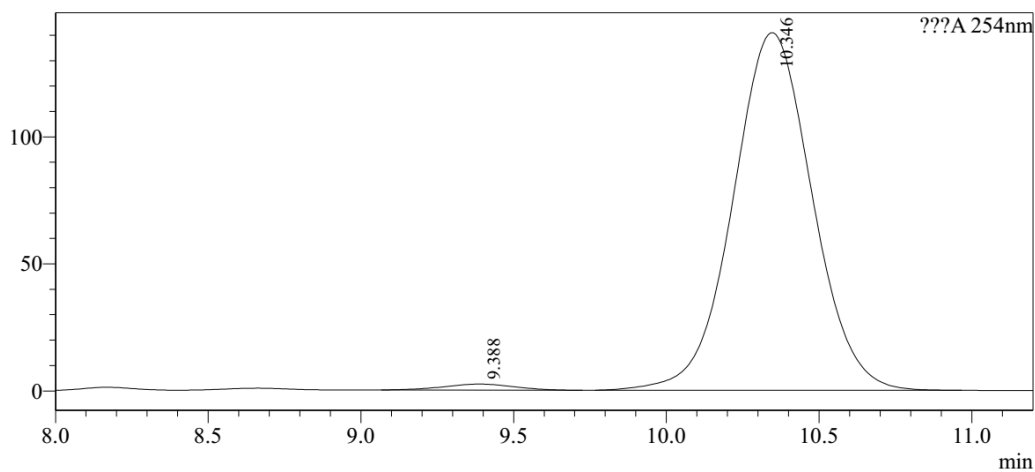
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.466	1018688	63783	48.296		M	
2	10.430	1090573	57696	51.704		M	
Total		2109262	121478				

<Chromatogram>

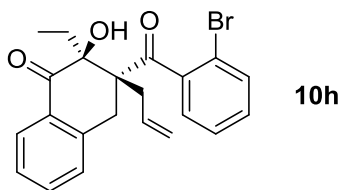
mV



<Peak Table>

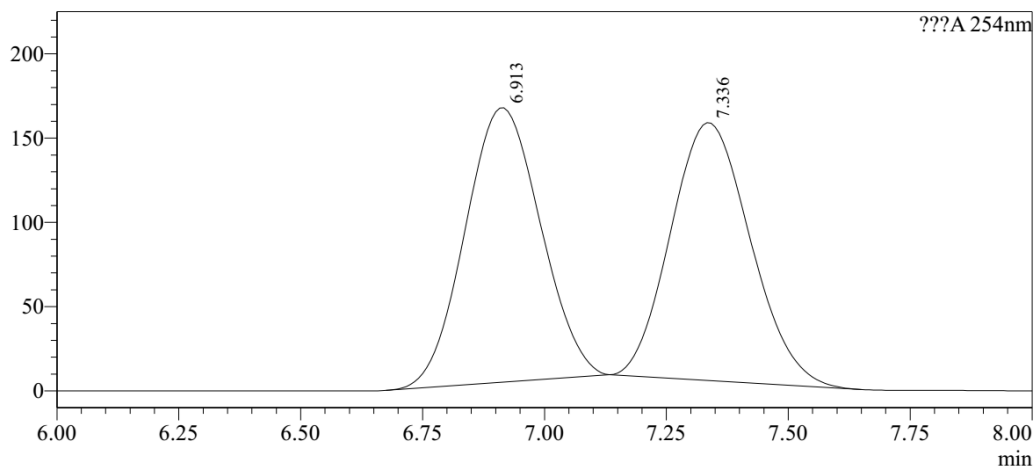
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.388	38450	2380	1.494		M	
2	10.346	2535786	140702	98.506		M	
Total		2574236	143081				



<Chromatogram>

mV



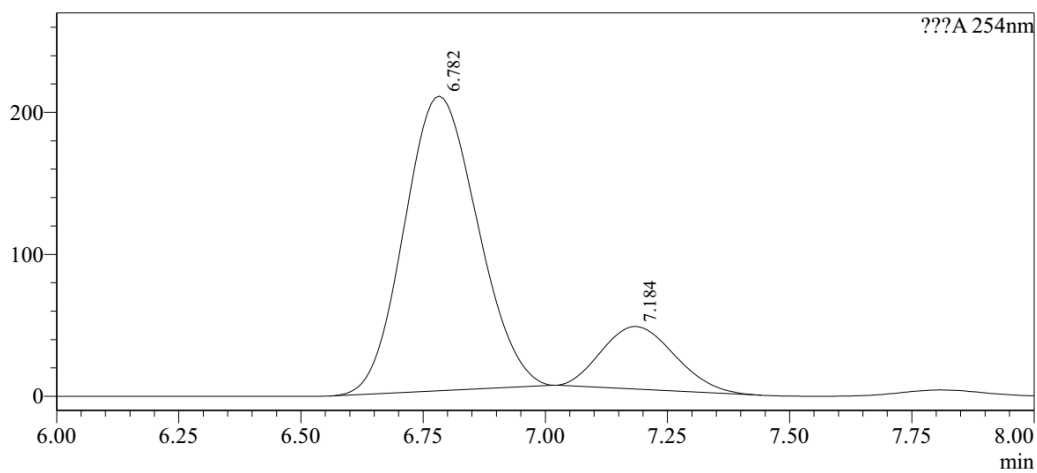
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.913	1753070	162791	50.205		M	
2	7.336	1738725	153044	49.795		M	
Total		3491795	315835				

<Chromatogram>

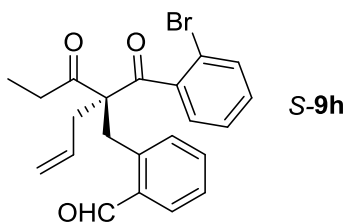
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<Peak Table>

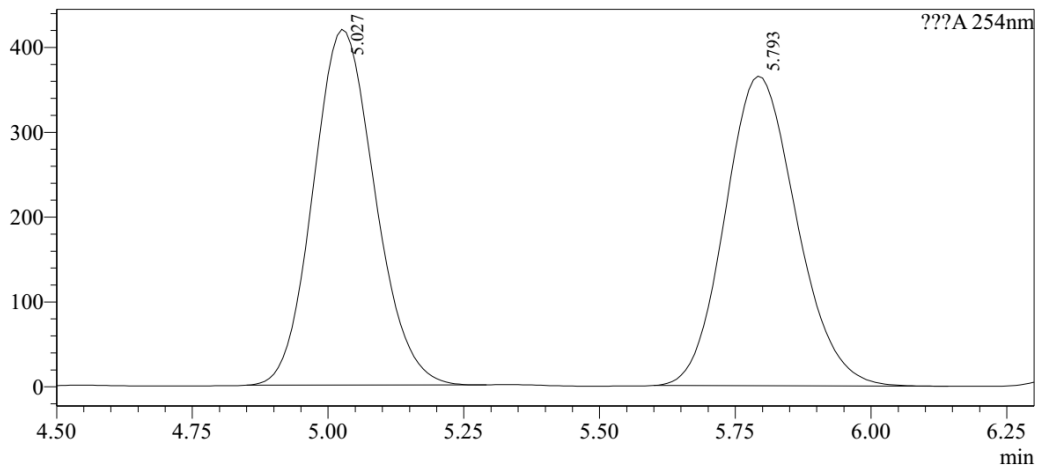
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.782	2164104	207578	82.501		M	
2	7.184	459007	44084	17.499		M	
Total		2623110	251663				



<Chromatogram>

mV



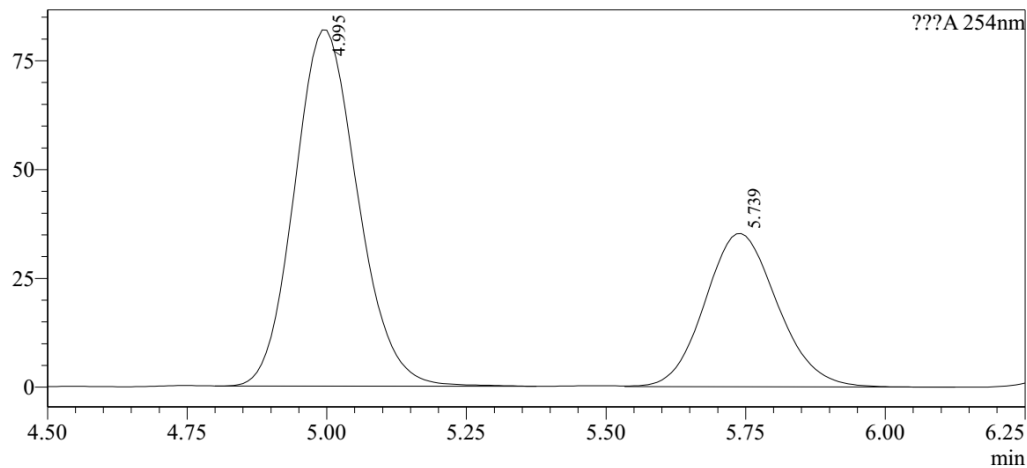
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.027	3314962	419352	49.844		M	
2	5.793	3335714	365028	50.156		M	
Total		6650676	784380				

<Chromatogram>

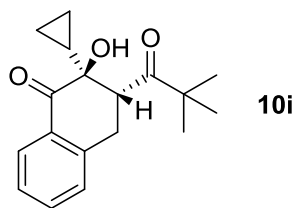
mV



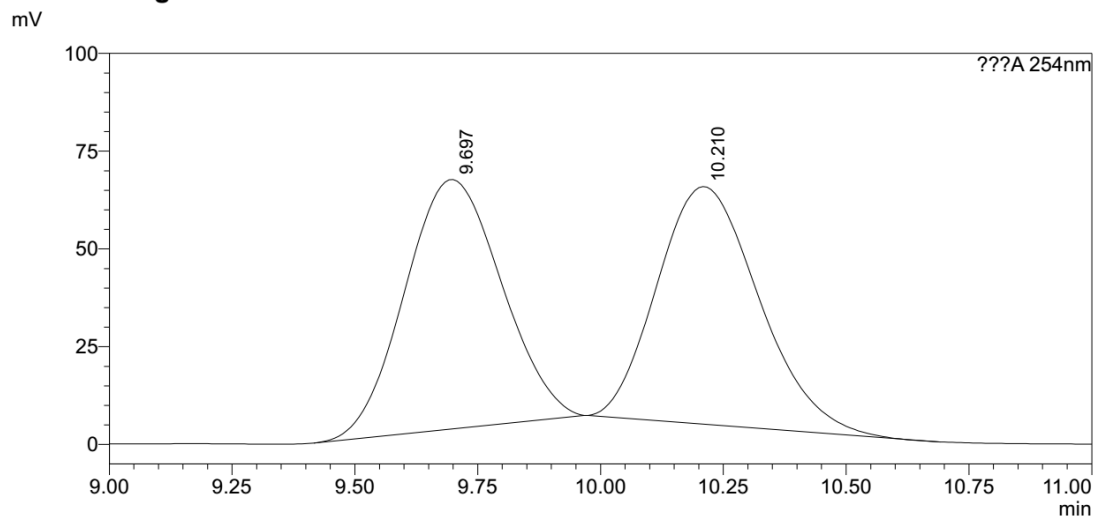
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.995	645591	81844	67.010		M	
2	5.739	317829	35215	32.990		V	
Total		963420	117059				



<Chromatogram>

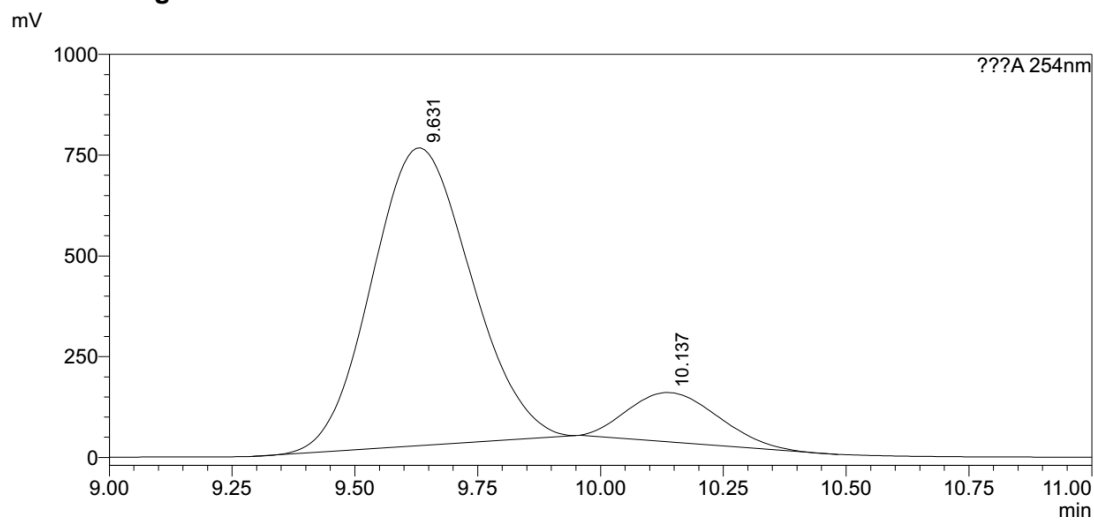


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.697	875006	63781	49.986		M	
2	10.210	875508	60756	50.014		M	
Total		1750515	124536				

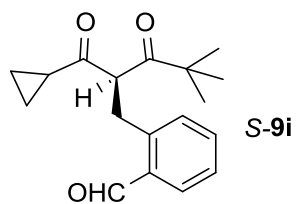
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<Peak Table>

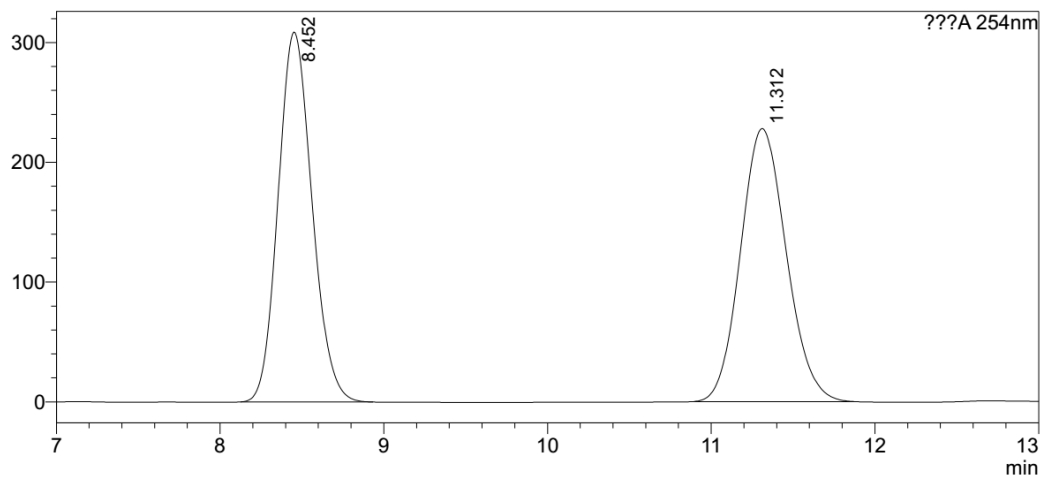
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.631	10398652	739004	87.007		M	
2	10.137	1552899	121980	12.993		M	
Total		11951551	860985				



<Chromatogram>

mV



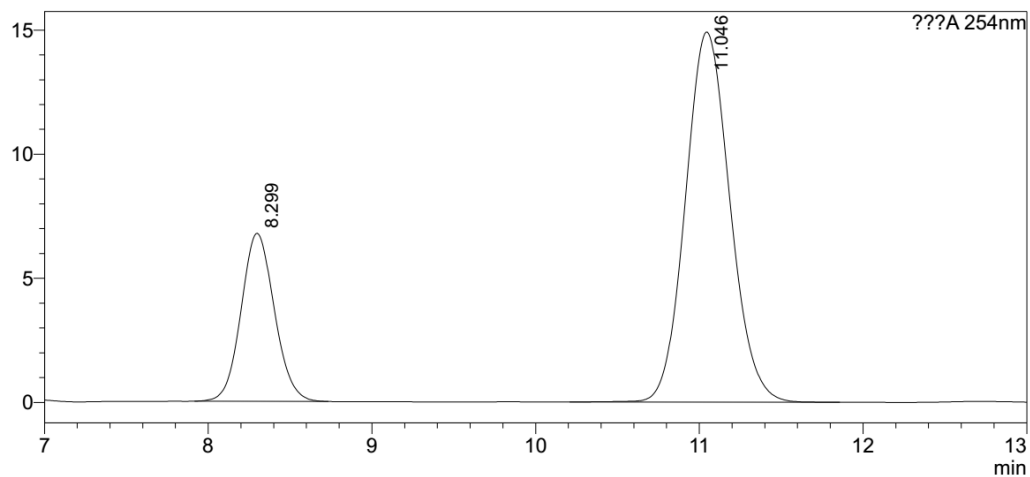
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.452	4449358	308809	50.083		M	
2	11.312	4434626	227912	49.917		M	
Total		8883984	536721				

<Chromatogram>

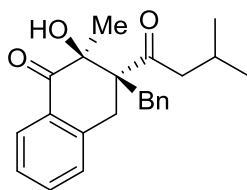
mV



<Peak Table>

???A 254nm

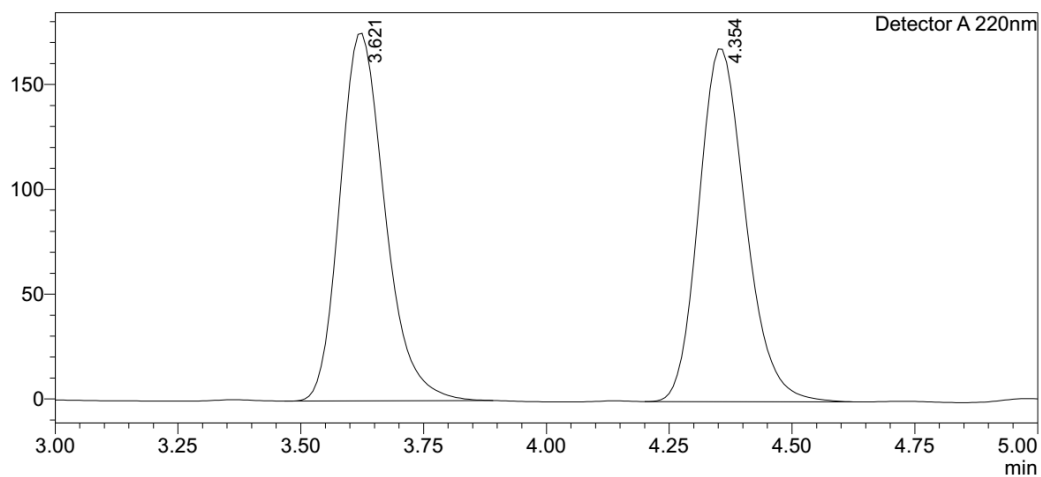
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.299	95804	6770	25.358		M	
2	11.046	282007	14903	74.642		M	
Total		377811	21674				



10x

<Chromatogram>

mV



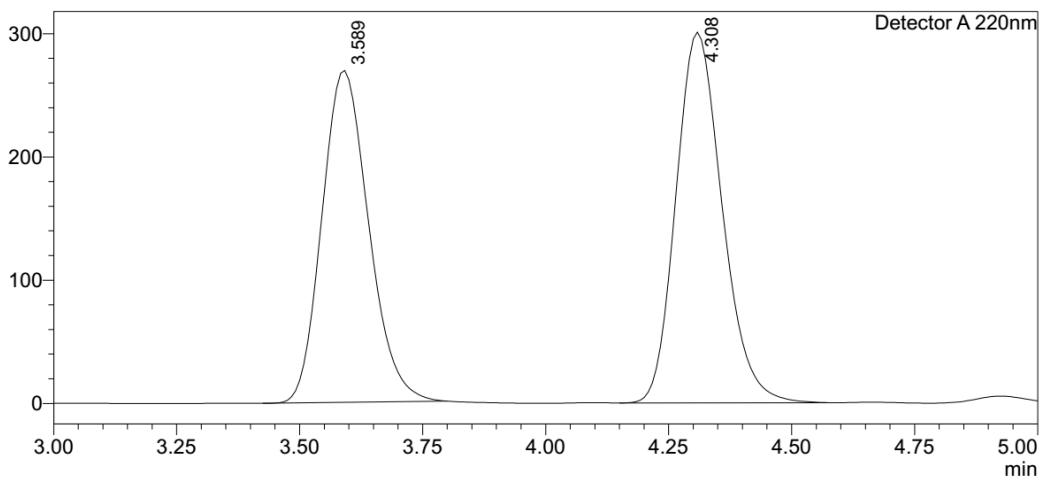
<Peak Table>

Detector A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.621	1119776	175271	50.098		M	
2	4.354	1115406	168189	49.902			
Total		2235182	343461				

<Chromatogram>

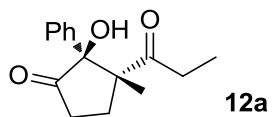
mV



<Peak Table>

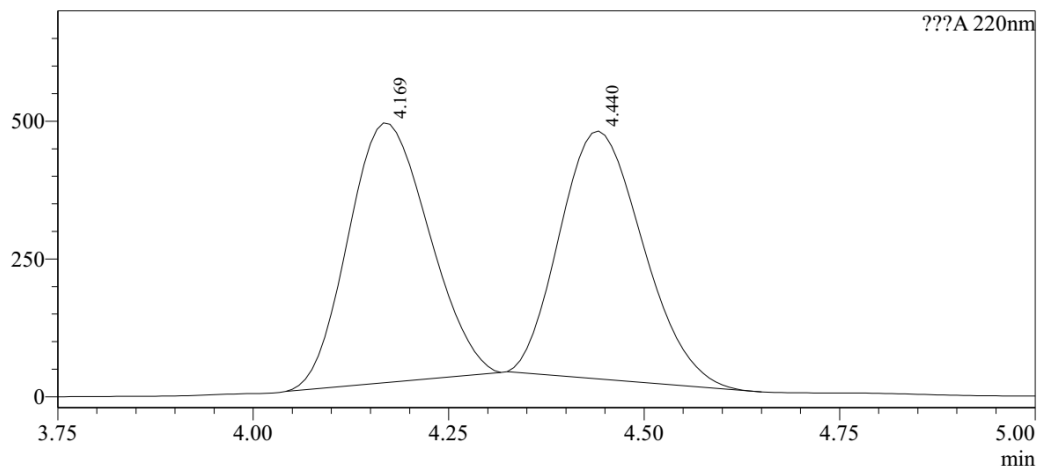
Detector A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	3.589	1781214	269287	47.509		M	
2	4.308	1968004	300730	52.491			
Total		3749218	570017				



<Chromatogram>

mV



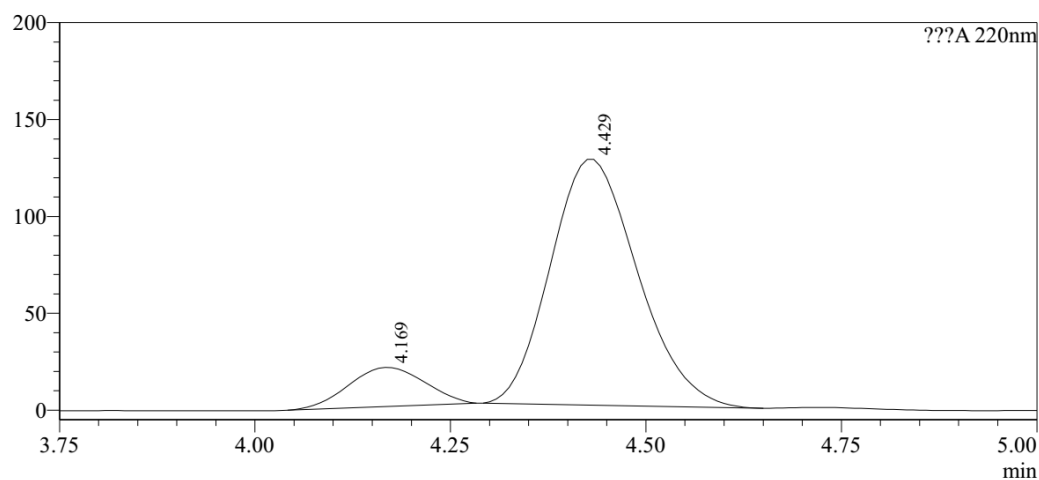
<Peak Table>

??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.169	3385008	471002	50.449		M	
2	4.440	3324743	449736	49.551		M	
Total		6709750	920738				

<Chromatogram>

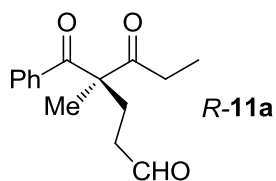
mV



<Peak Table>

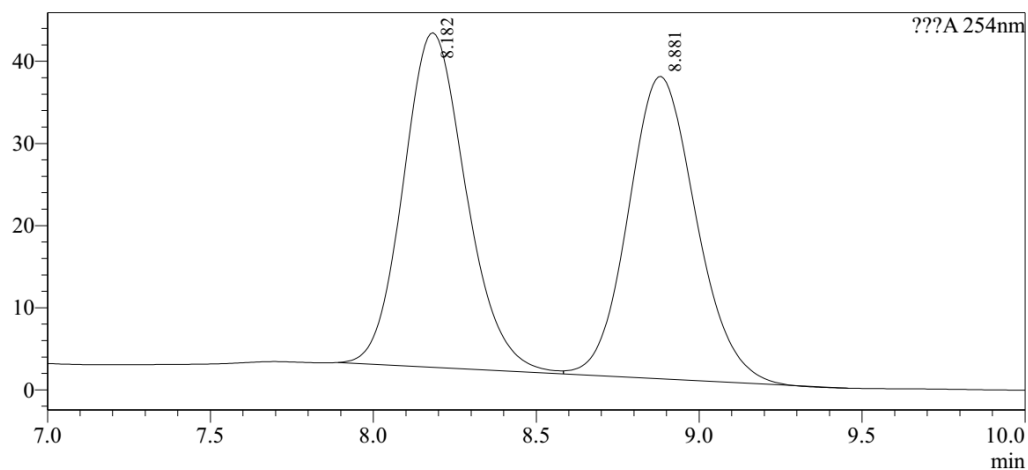
??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.169	137196	20190	12.240		M	
2	4.429	983728	126856	87.760		M	
Total		1120924	147046				



<Chromatogram>

mV



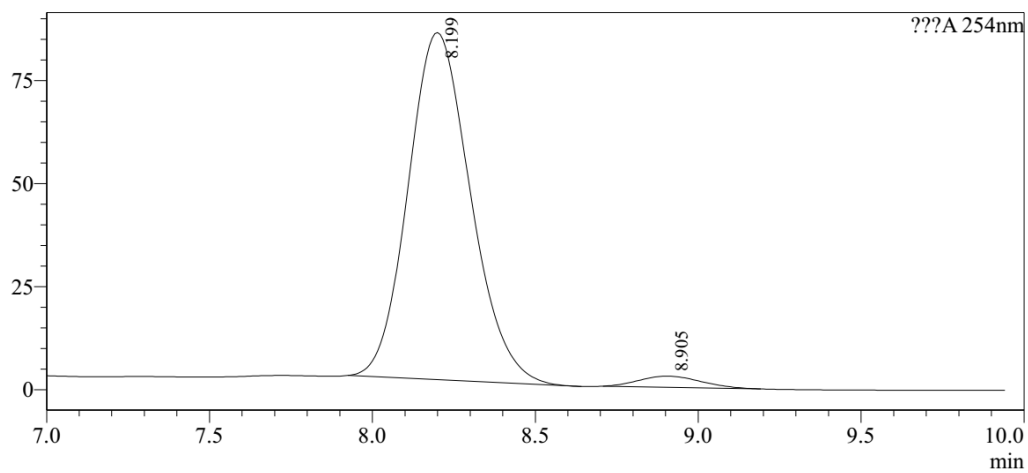
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.182	545905	40729	50.676		M	
2	8.881	531332	36796	49.324		V M	
Total		1077237	77524				

<Chromatogram>

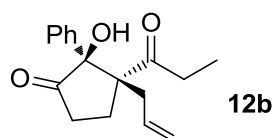
mV



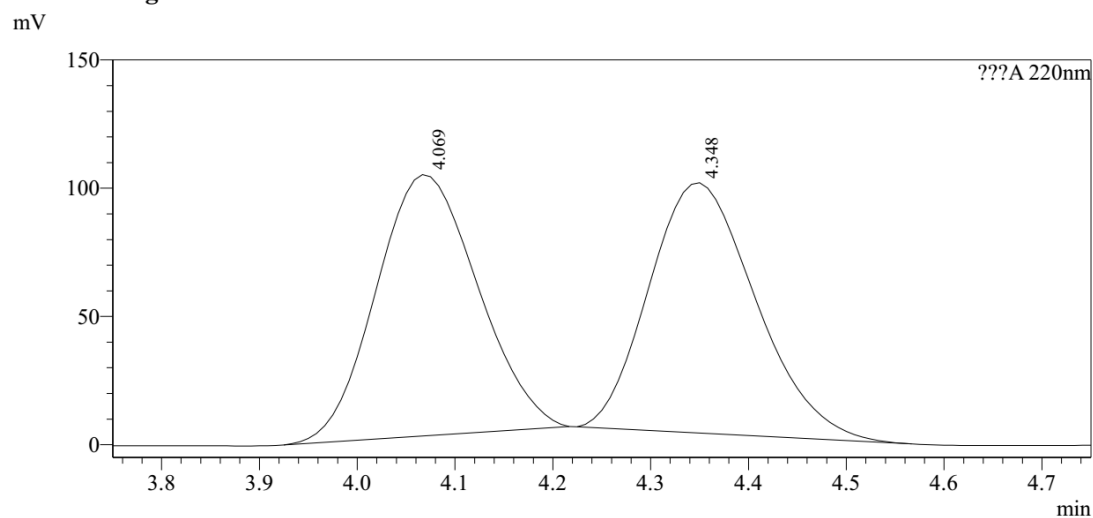
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.199	1121349	84215	96.904		M	
2	8.905	35820	2723	3.096		M	
Total		1157169	86938				



<Chromatogram>

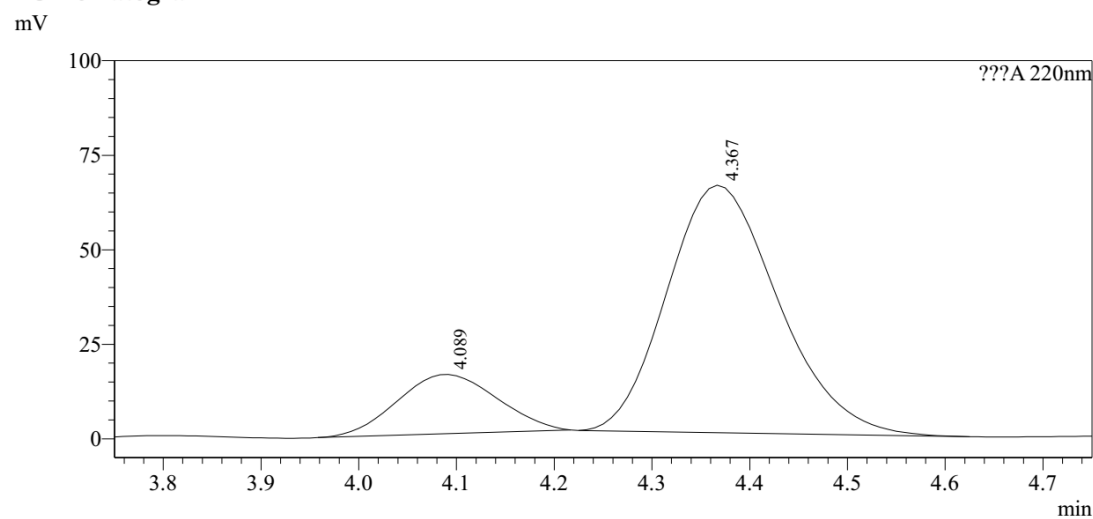


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.069	737176	101888	49.987		M	
2	4.348	737553	97479	50.013		M	
Total		1474729	199366				

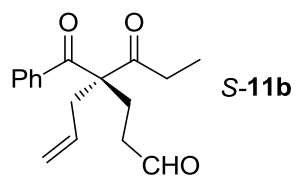
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<Peak Table>

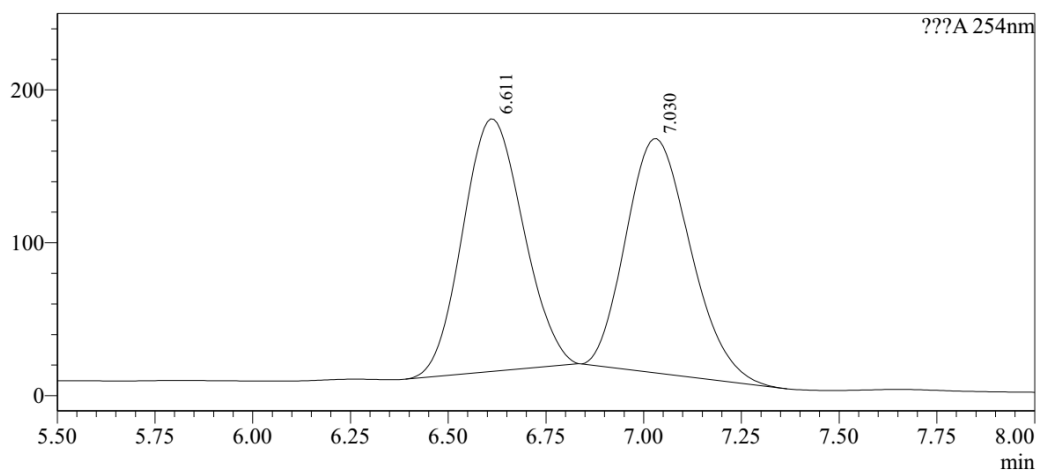
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.089	111548	15687	17.729		M	
2	4.367	517619	65477	82.271		M	
Total		629167	81164				



<Chromatogram>

mV



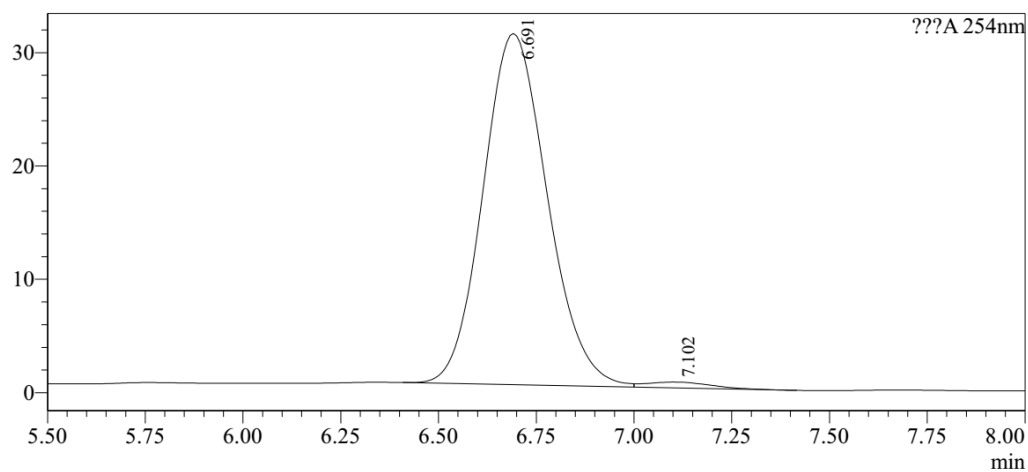
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.611	1782334	165247	50.342		M	
2	7.030	1758100	153140	49.658		M	
Total		3540434	318388				

<Chromatogram>

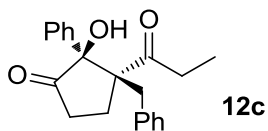
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<Peak Table>

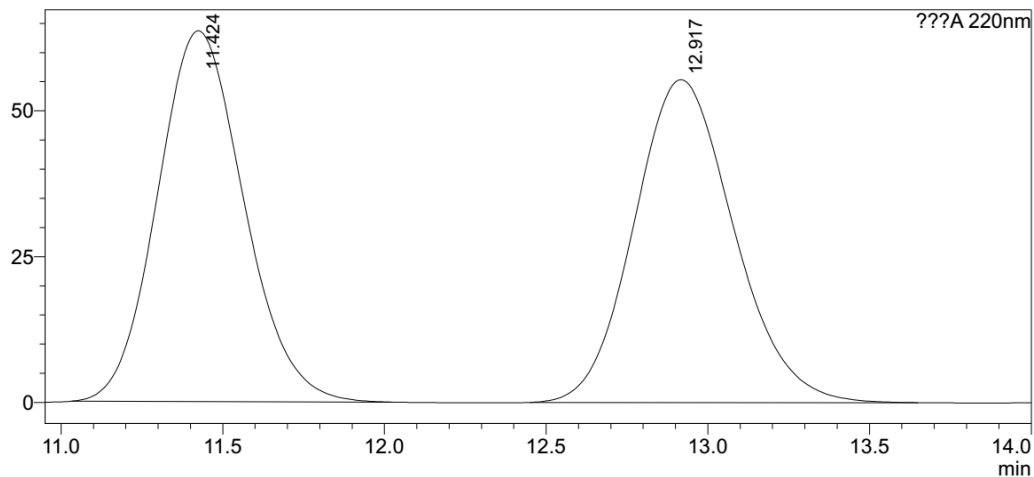
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.691	354216	30980	98.371		M	
2	7.102	5866	517	1.629		V M	
Total		360083	31497				



<Chromatogram>

mV



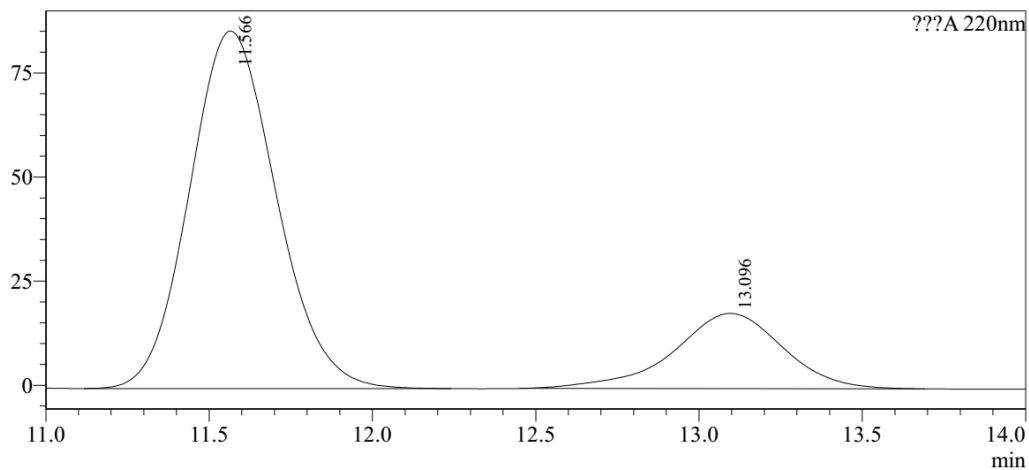
<Peak Table>

??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.424	1182886	63594	49.895		M	
2	12.917	1187874	55358	50.105		M	
Total		2370760	118951				

<Chromatogram>

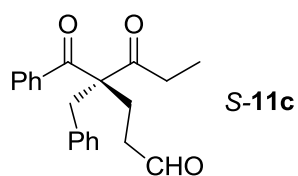
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<Peak Table>

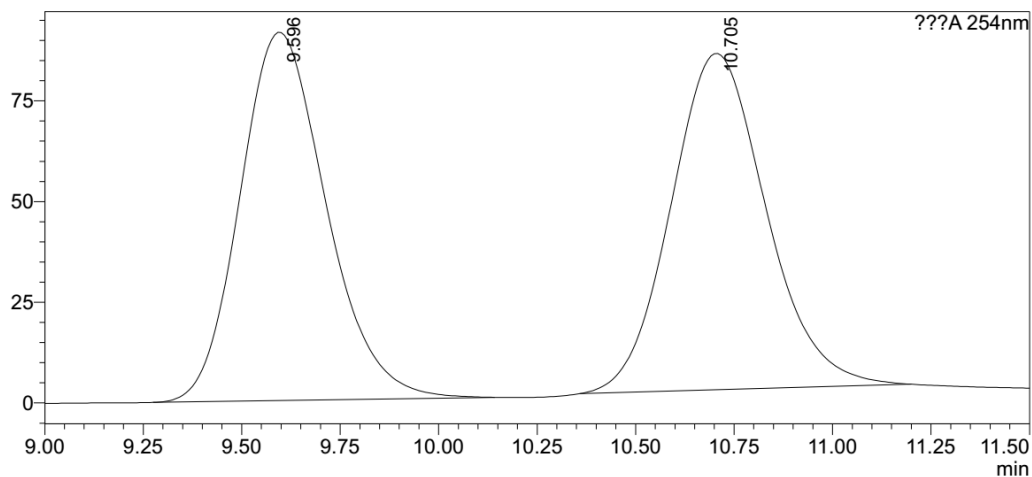
??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.566	1587956	85876	78.969		M	
2	13.096	422908	18054	21.031		M	
Total		2010864	103929				



<Chromatogram>

mV



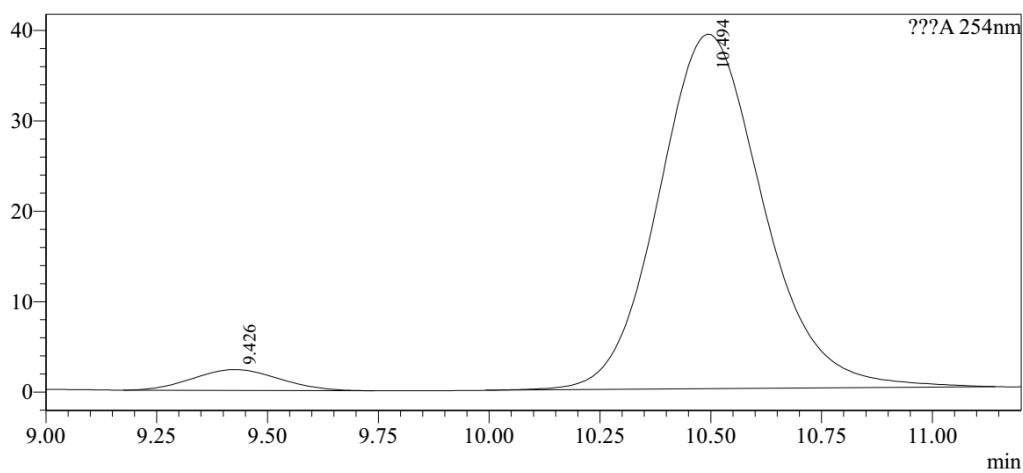
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.596	1390615	91400	49.775		M	
2	10.705	1403193	83463	50.225		M	
Total		2793808	174863				

<Chromatogram>

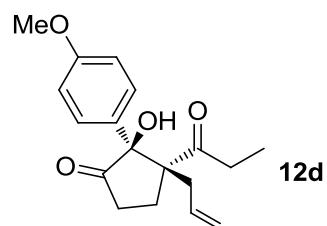
mV



<Peak Table>

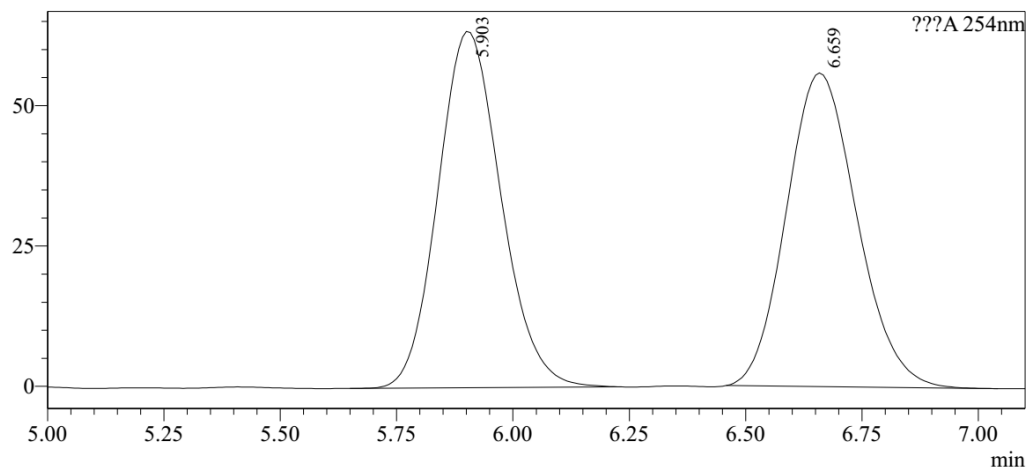
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.426	31235	2296	4.631		M	
2	10.494	643221	39228	95.369		M	
Total		674456	41524				



<Chromatogram>

mV



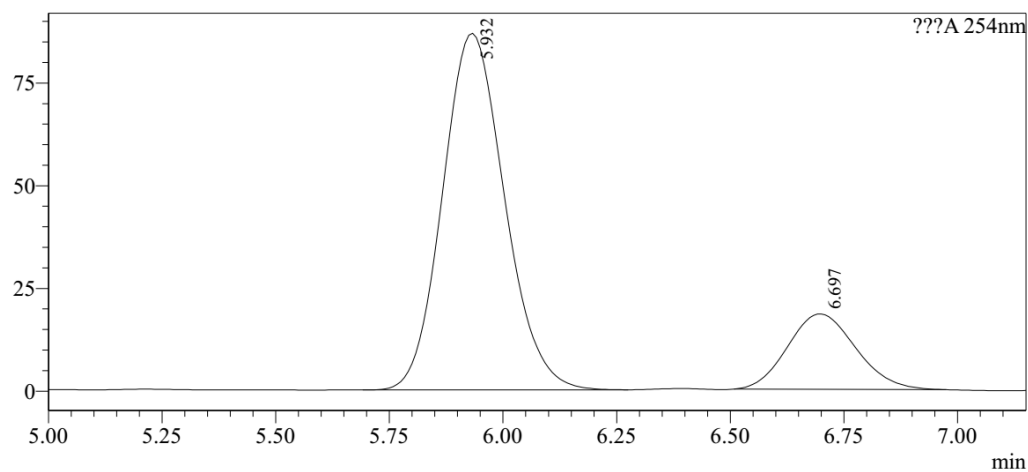
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.903	598291	63472	50.407		M	
2	6.659	588620	55880	49.593		M	
Total		1186911	119352				

<Chromatogram>

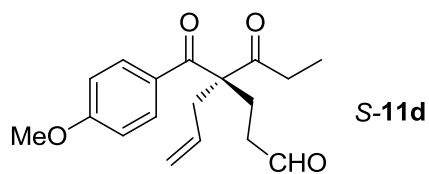
mV



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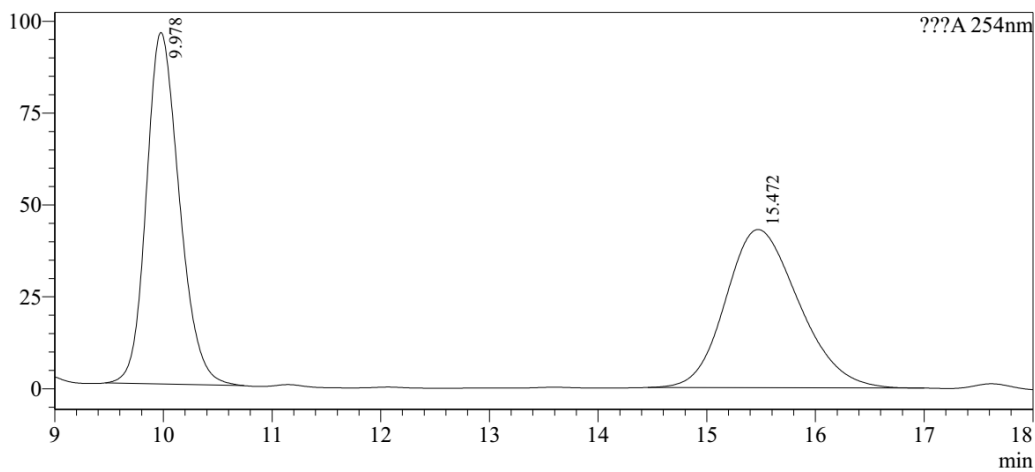
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.932	822684	86827	81.081		M	
2	6.697	191957	18372	18.919		M	
Total		1014641	105199				



<Chromatogram>

mV



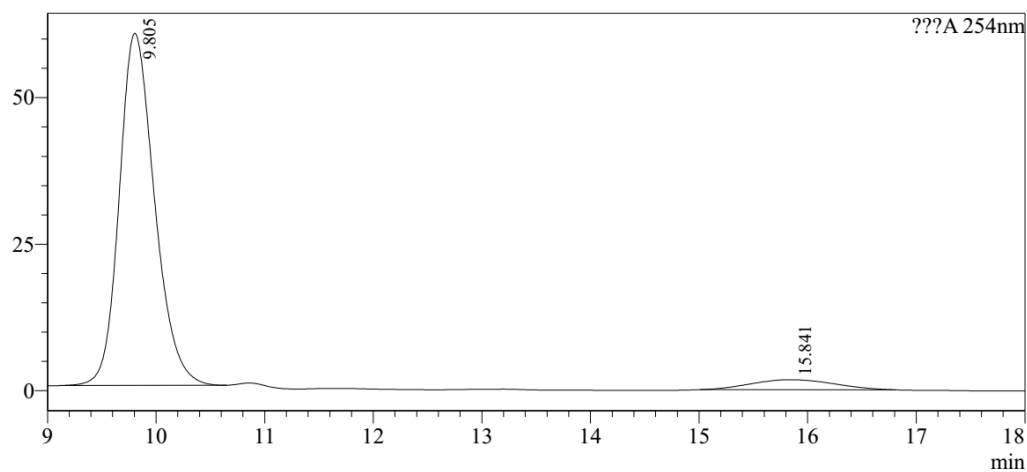
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.978	2022711	95664	50.114		M	
2	15.472	2013490	43046	49.886		M	
Total		4036200	138709				

<Chromatogram>

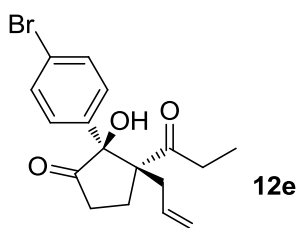
mV



<Peak Table>

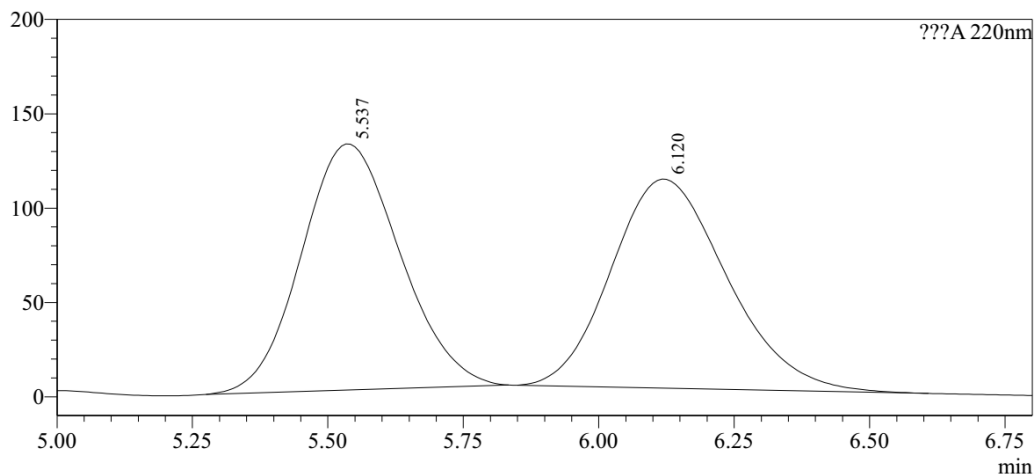
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.805	1361752	60117	93.679		M	
2	15.841	91882	1721	6.321		M	
Total		1453634	61837				



<Chromatogram>

mV



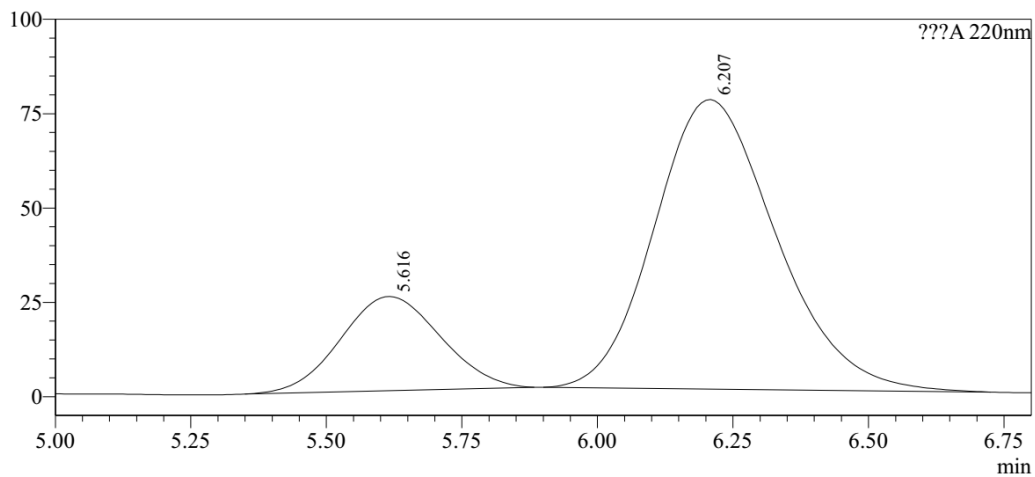
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.537	1650235	130457	50.036		M	
2	6.120	1647834	110763	49.964		M	
Total		3298070	241220				

<Chromatogram>

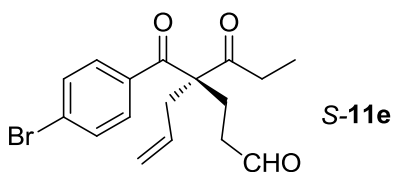
mV



<Peak Table>

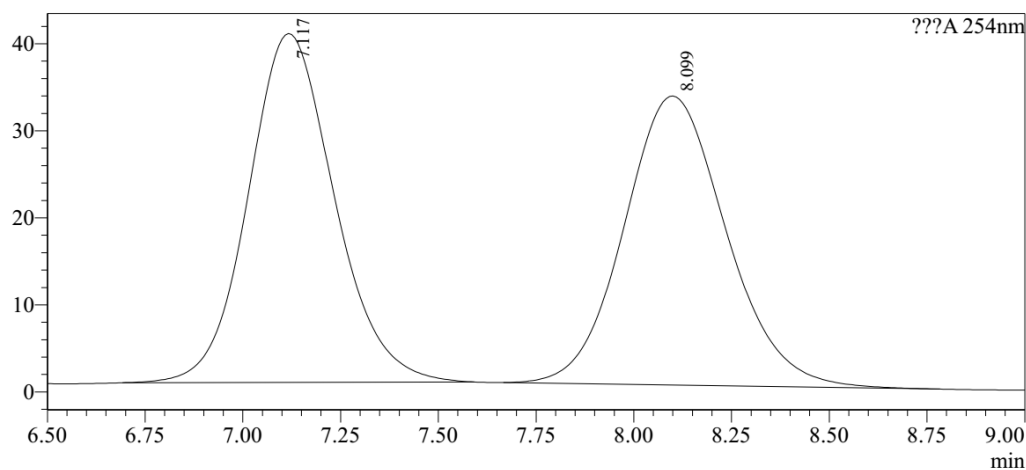
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.616	320053	24963	21.052		M	
2	6.207	1200228	76729	78.948		M	
Total		1520281	101692				



<Chromatogram>

mV



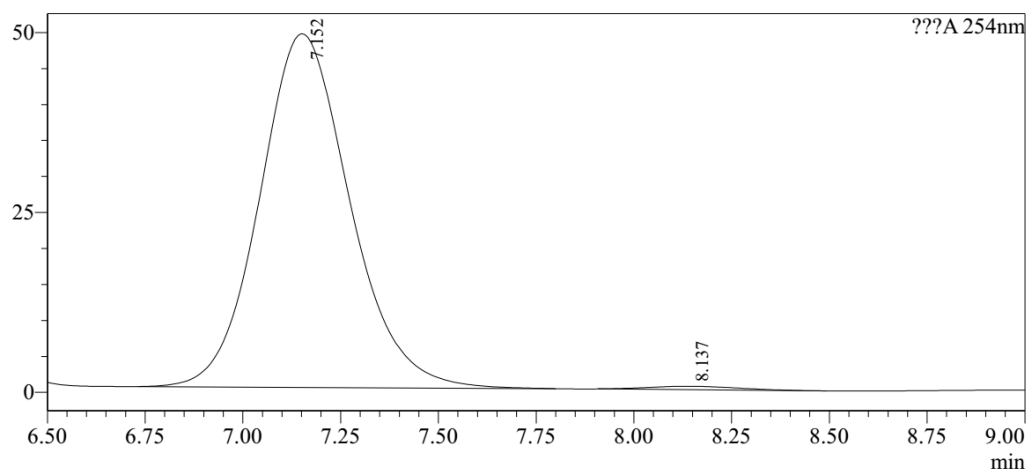
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.117	613535	40089	50.393		M	
2	8.099	603969	33209	49.607		M	
Total		1217504	73299				

<Chromatogram>

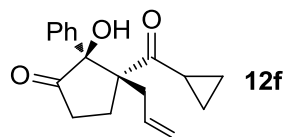
mV



<Peak Table>

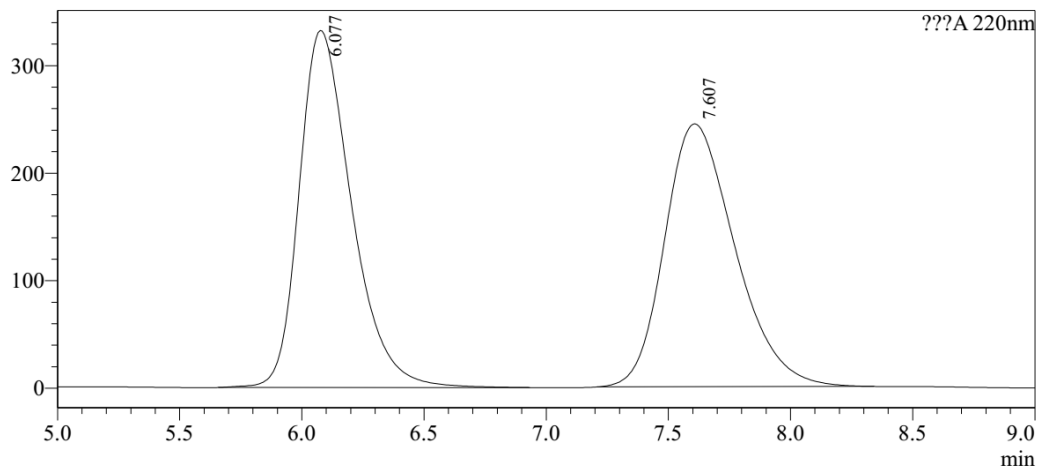
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.152	787874	49148	99.048		M	
2	8.137	7575	472	0.952		M	
Total		795449	49621				



<Chromatogram>

mV



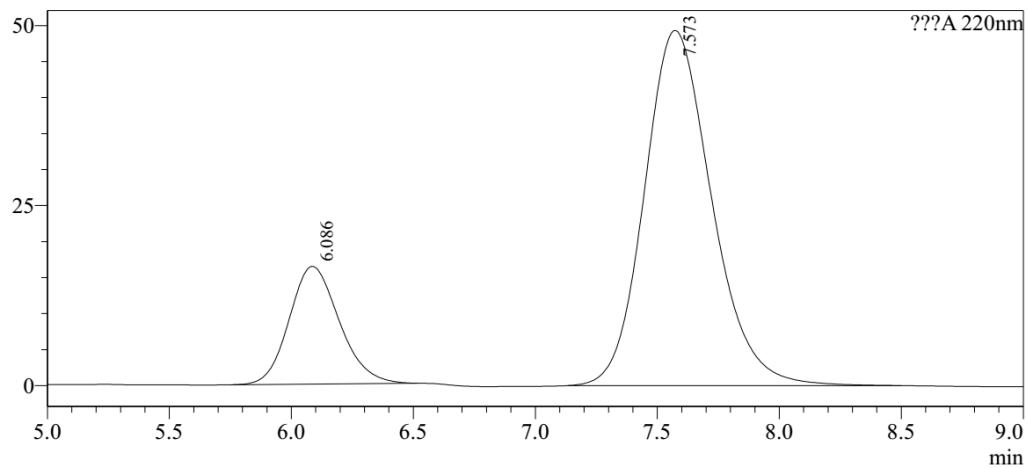
<Peak Table>

??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.077	4952395	332113	50.245		M	
2	7.607	4904009	244551	49.755		M	
Total		9856405	576664				

<Chromatogram>

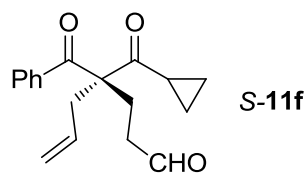
mV



<Peak Table>

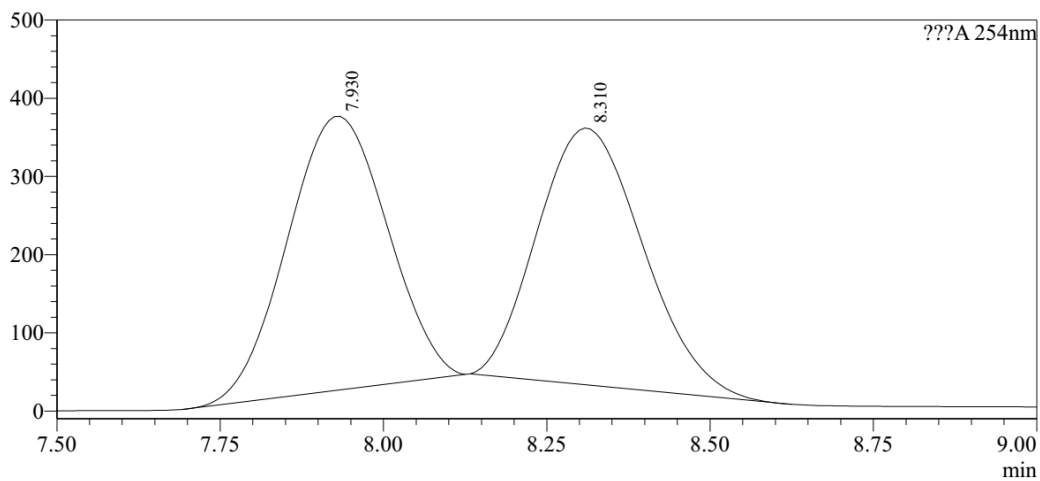
??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.086	233715	16353	19.809		M	
2	7.573	946150	49312	80.191		M	
Total		1179865	65666				



<Chromatogram>

mV



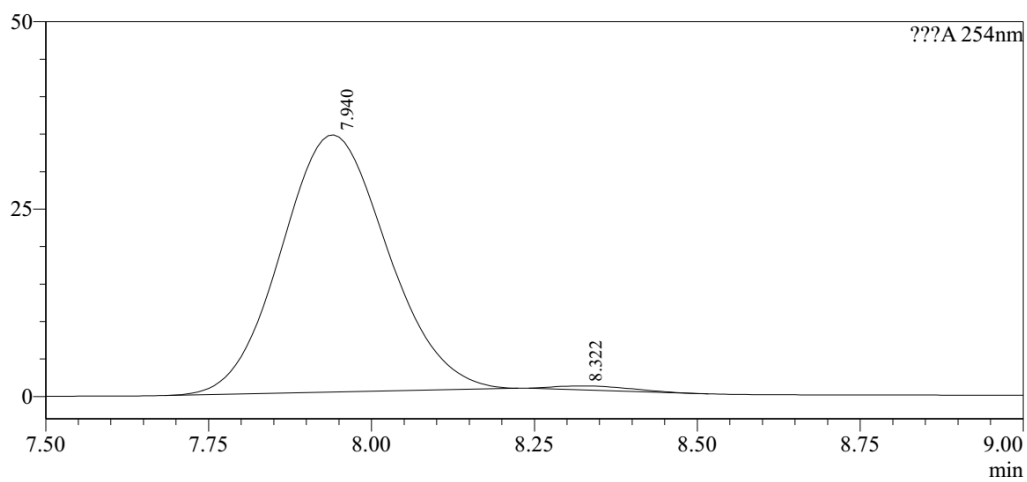
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.930	3737606	350200	50.297		M	
2	8.310	3693416	328271	49.703		M	
Total		7431022	678471				

<Chromatogram>

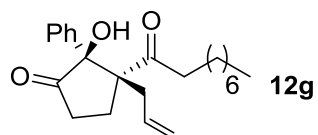
mV



<Peak Table>

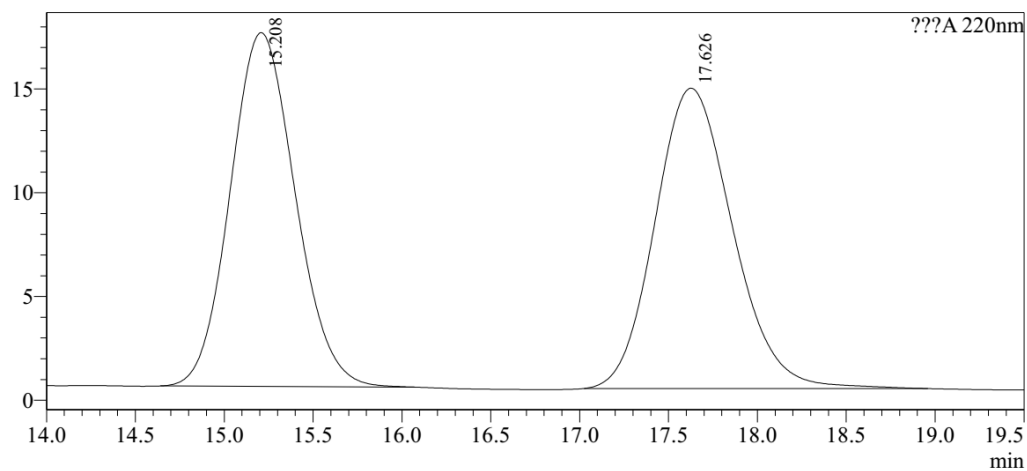
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.940	389988	34332	98.938		M	
2	8.322	4186	514	1.062		M	
Total		394174	34846				



<Chromatogram>

mV



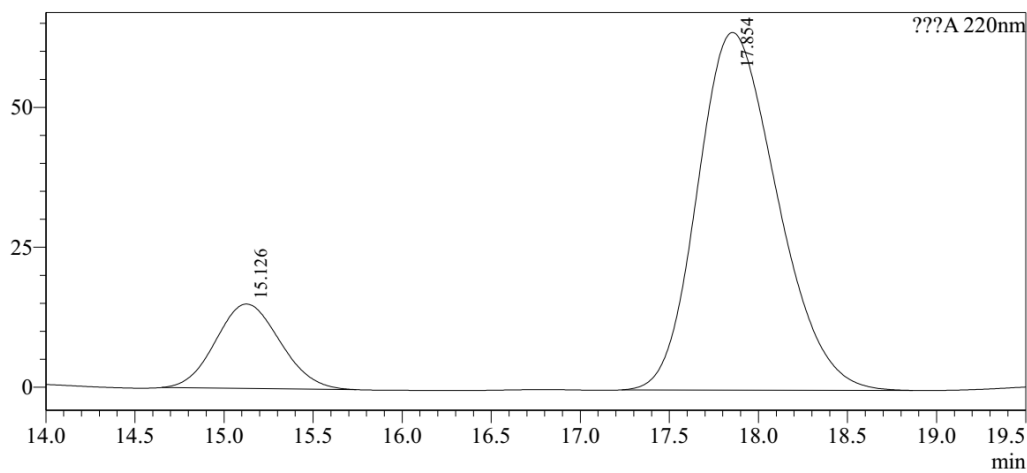
<Peak Table>

??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	15.208	433176	17057	49.590		M	
2	17.626	440345	14478	50.410		M	
Total		873522	31535				

<Chromatogram>

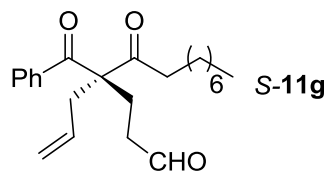
mV



<Peak Table>

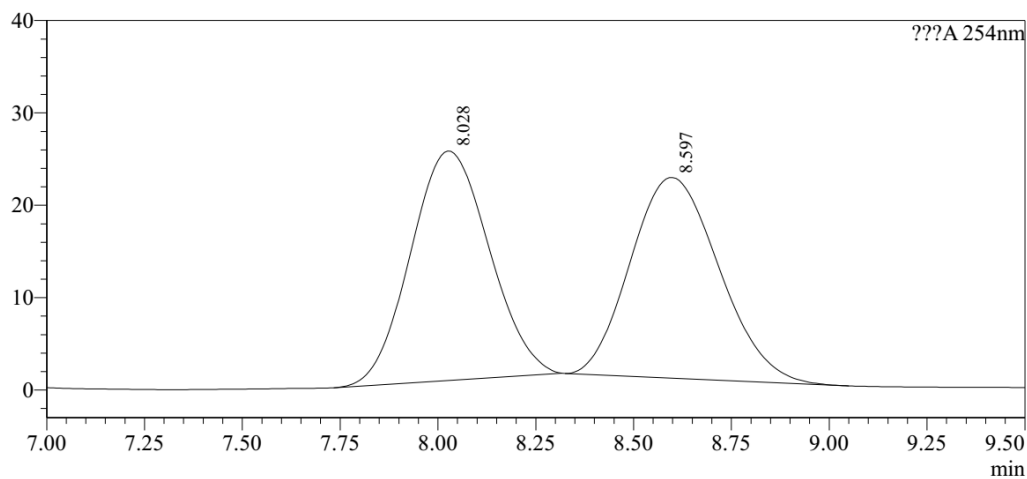
??A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	15.126	380079	15081	16.052		M	
2	17.854	1987662	63869	83.948		M	
Total		2367741	78950				



<Chromatogram>

mV



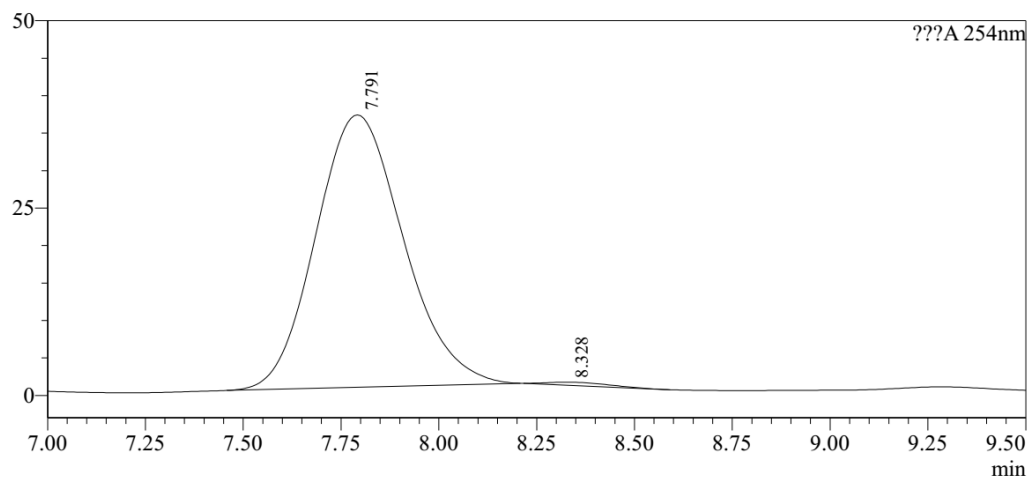
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.028	347512	24846	50.378		M	
2	8.597	342302	21727	49.622		M	
Total		689814	46572				

<Chromatogram>

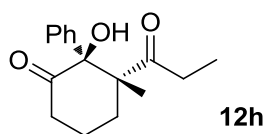
mV



<Peak Table>

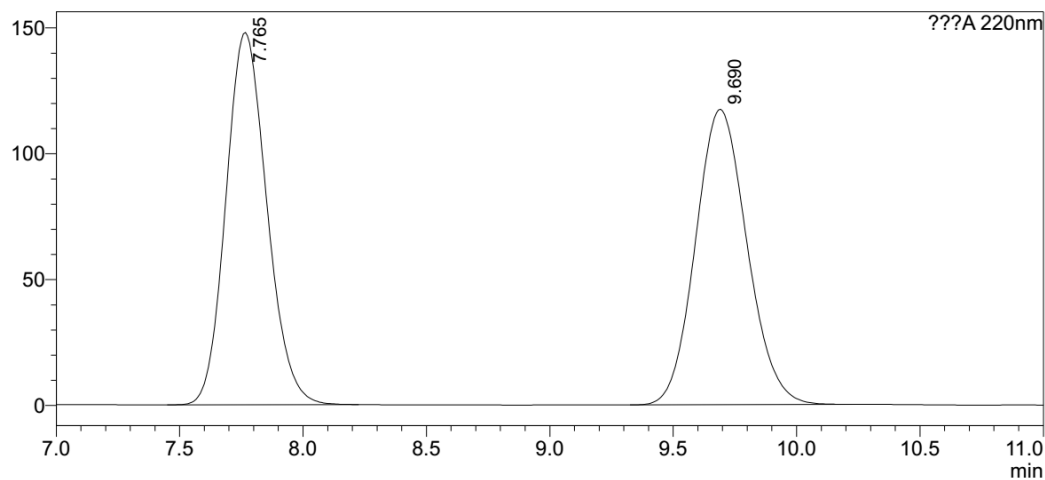
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.791	566719	36360	99.216		M	
2	8.328	4478	400	0.784		M	
Total		571197	36760				



<Chromatogram>

mV



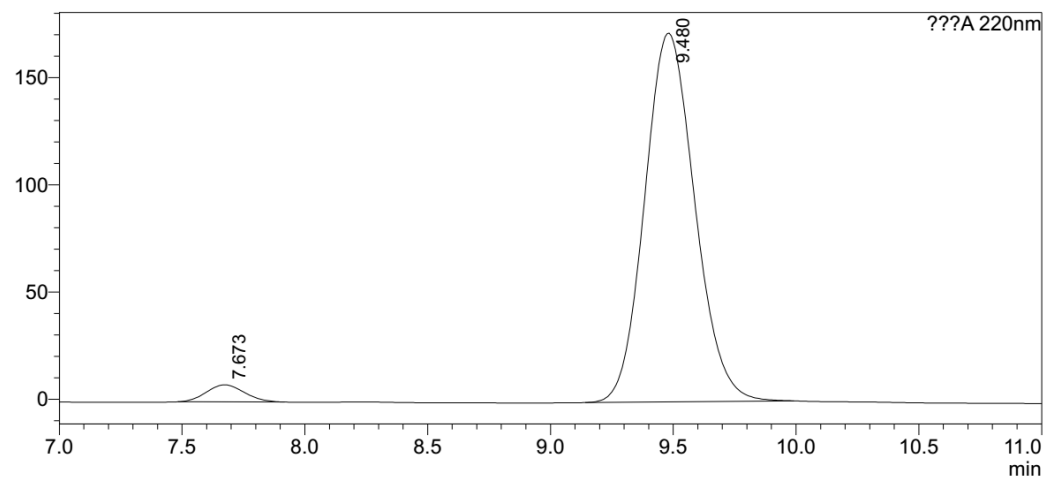
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.765	1706884	147857	50.014		M	
2	9.690	1705932	117350	49.986		M	
Total		3412817	265207				

<Chromatogram>

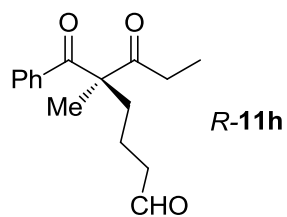
mV



<Peak Table>

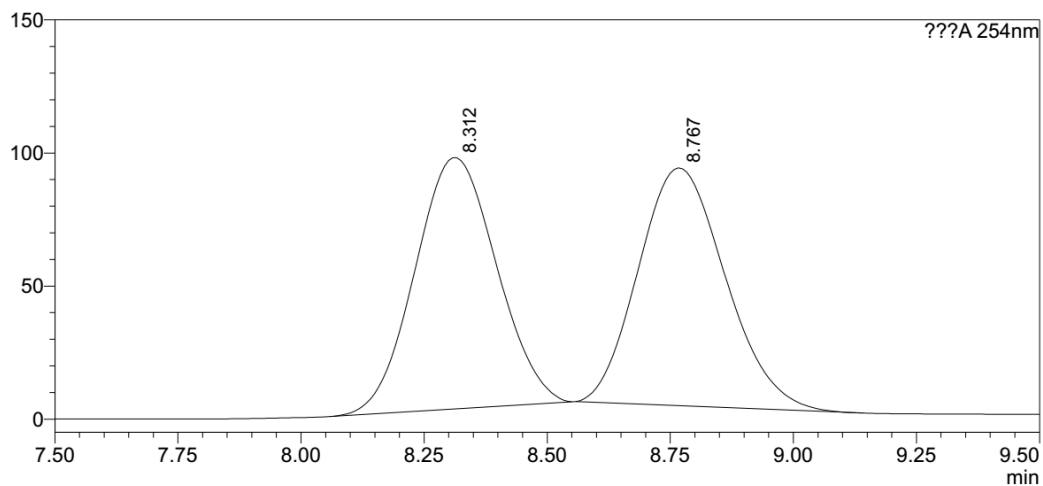
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.673	85726	7940	3.394		M	
2	9.480	2440333	171957	96.606		M	
Total		2526059	179897				



<Chromatogram>

mV



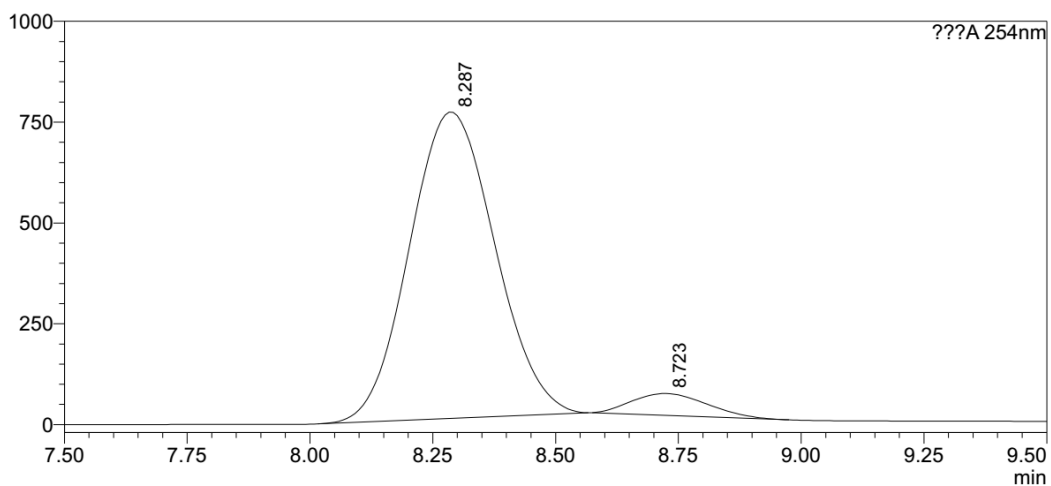
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.312	1088566	94430	49.794		M	
2	8.767	1097591	89378	50.206		M	
Total		2186157	183808				

<Chromatogram>

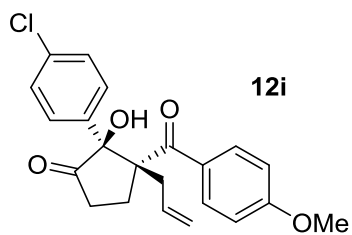
mV



<Peak Table>

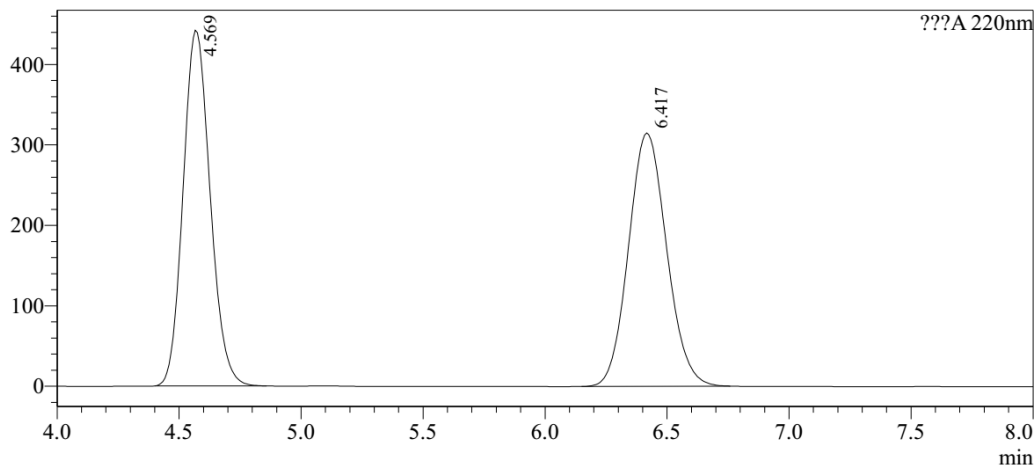
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.287	9203609	759650	94.097		M	
2	8.723	577375	54133	5.903		M	
Total		9780983	813782				



<Chromatogram>

mV



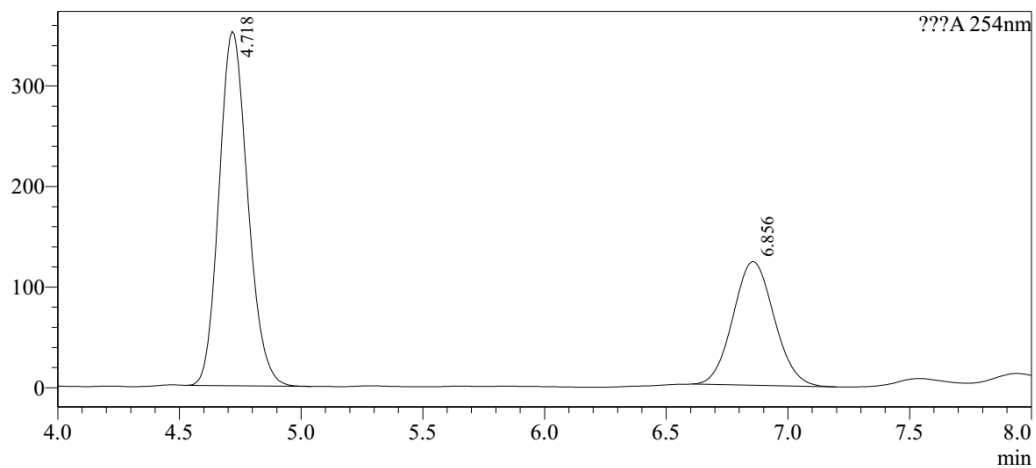
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.569	3407346	442184	49.881		M	
2	6.417	3423620	314886	50.119		M	
Total		6830966	757071				

<Chromatogram>

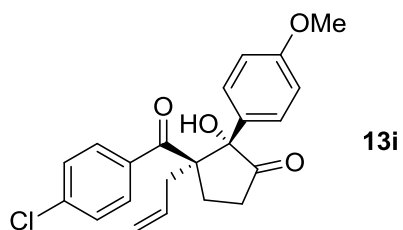
mV



<Peak Table>

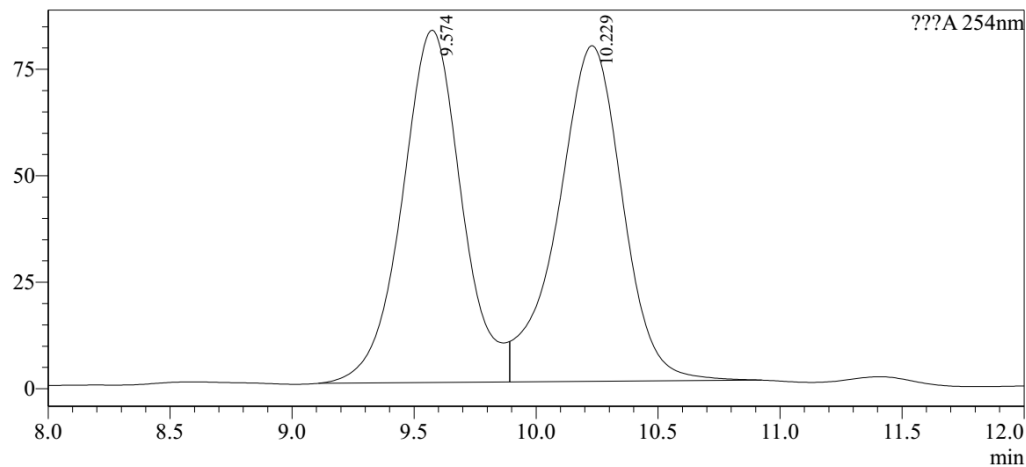
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.718	2882570	352212	66.596		M	
2	6.856	1445846	122927	33.404		M	
Total		4328416	475139				



<Chromatogram>

mV



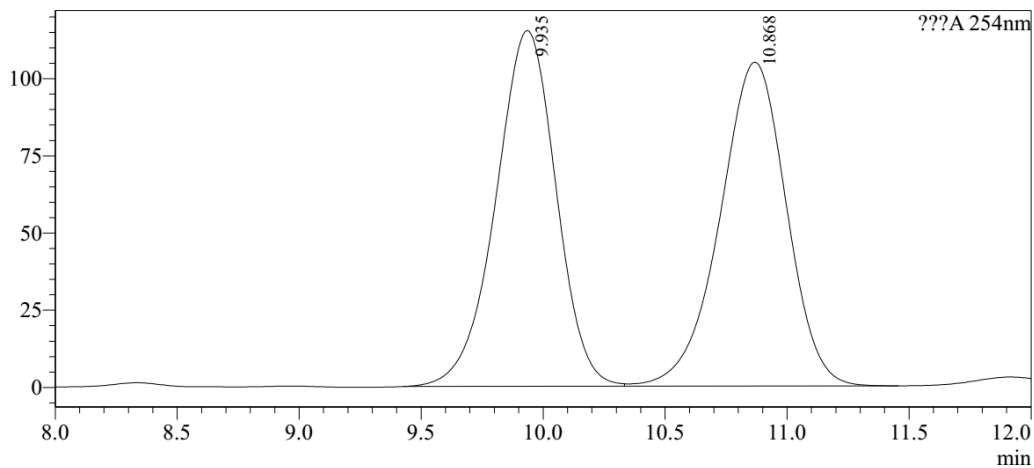
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.574	1405574	82749	49.131		M	
2	10.229	1455305	78774	50.869		V M	
Total		2860879	161523				

<Chromatogram>

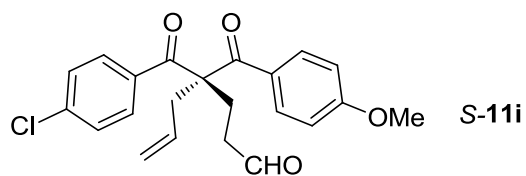
mV



<Peak Table>

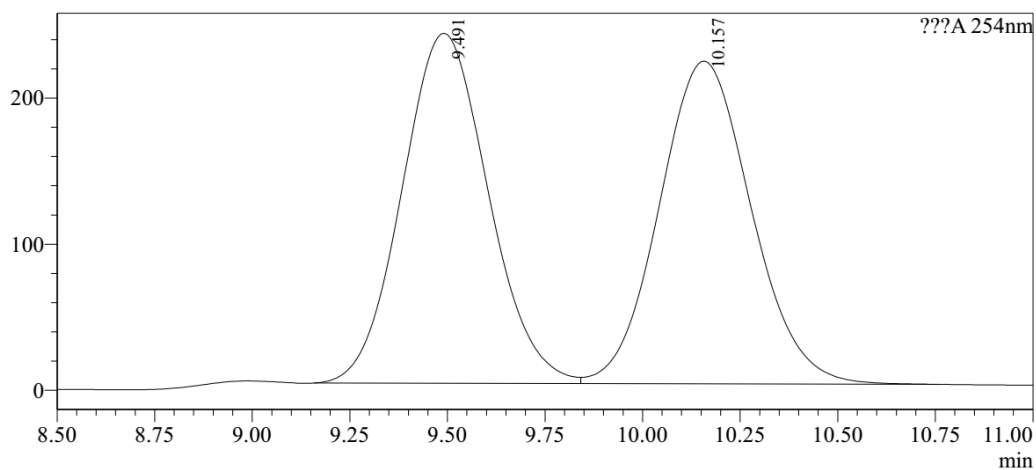
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.935	1982182	115286	49.939		M	
2	10.868	1987060	104927	50.061		V M	
Total		3969242	220214				



<Chromatogram>

mV



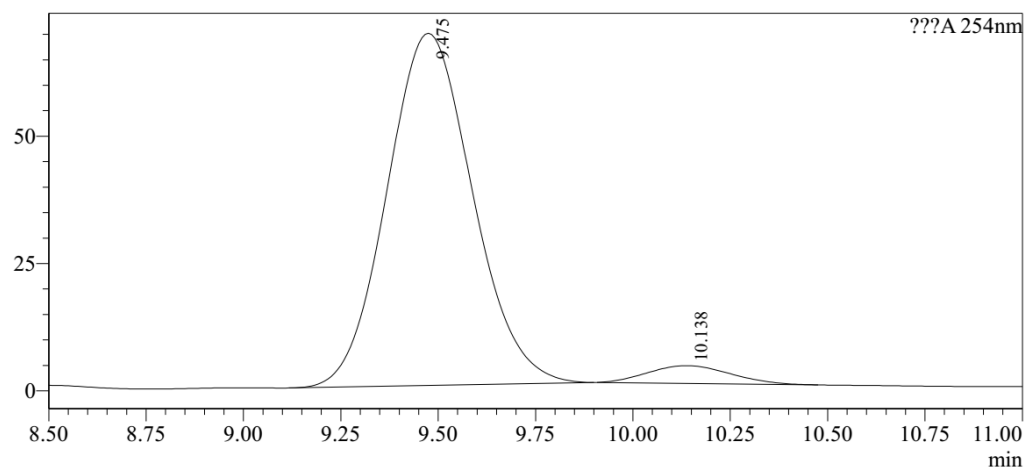
<Peak Table>

??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.491	3673983	239614	50.374		M	
2	10.157	3619470	220915	49.626		V M	
Total		7293453	460528				

<Chromatogram>

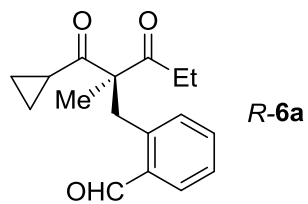
mV



<Peak Table>

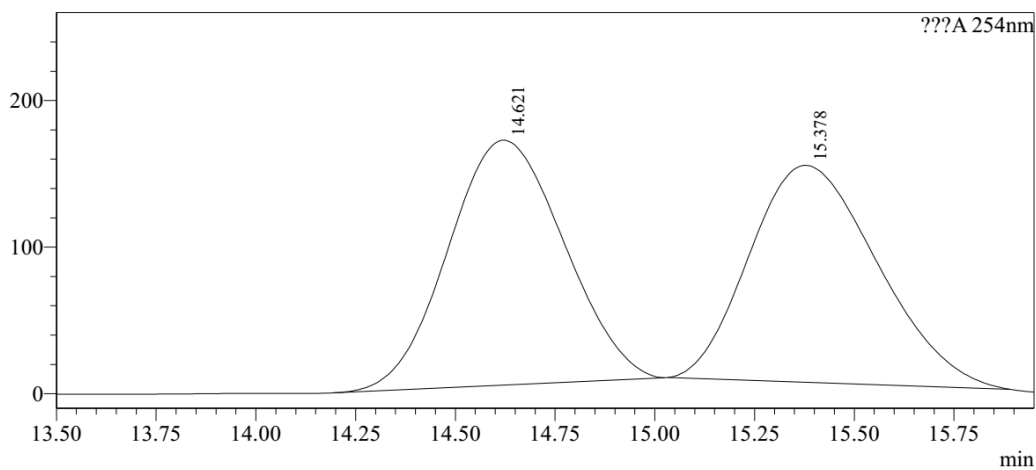
??A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.475	1055818	69177	95.360		M	
2	10.138	51377	3476	4.640		M	
Total		1107195	72652				



<Chromatogram>

mV



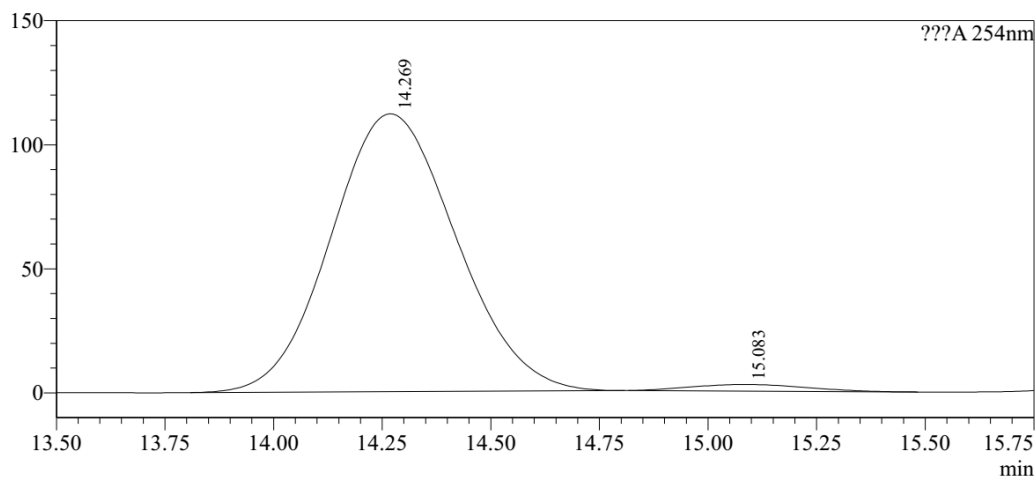
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.621	3369370	166958	50.541		M	
2	15.378	3297195	147991	49.459		M	
Total		6666565	314949				

<Chromatogram>

mV



<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.269	2244608	112050	97.855		M	
2	15.083	49209	2678	2.145		M	
Total		2293817	114728				