Supporting Information

Enantioselective Synthesis of Homoisoflavanones by Asymmetric Transfer Hydrogenation and Their Biological Evaluation for Antiangiogenic Activity

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1. Purity of synthetic compounds

compounds	retention time (min)	purity (area %)
rac-**1**	2.5	>95
(*R*)-**1**	2.5	>95
(*S*)-**1**	2.5	>95
rac-**2**	2.7	>95
(*R*)-**2**	2.6	>95
(*S*)-**2**	2.6	>95
rac-**3**	11.2	>95
(*R*,*S*)-**3**	11.3	>95
(*S*,*S*)-**3**	11.2	>95
(*R*,*R*)-**3**	11.3	>95
(*S*,*R*)-**3**	11.2	>95
cis-**9a**	2.5	>95
trans-**9a**	2.5	>95
(3*R*,4*R*)-**9a**	2.5	>95
(3*S*,4*S*)-**9a**	2.5	>95
rac-**10**	4.1	>95
(*S*)-**10**	4.1	>95
(*R*)-**10**	4.1	>95

HPLC conditions:

System: Agilent 1290 infinity2 binary LC

Detector: Agilent 1290 infinity2 UV detector, 256 nm

Column: Peakman SP column C18, 5 μM 1.5 × 250 mm

Sample diluent: 99.6% methanol

Mobile phase: 60% MeCN/Water

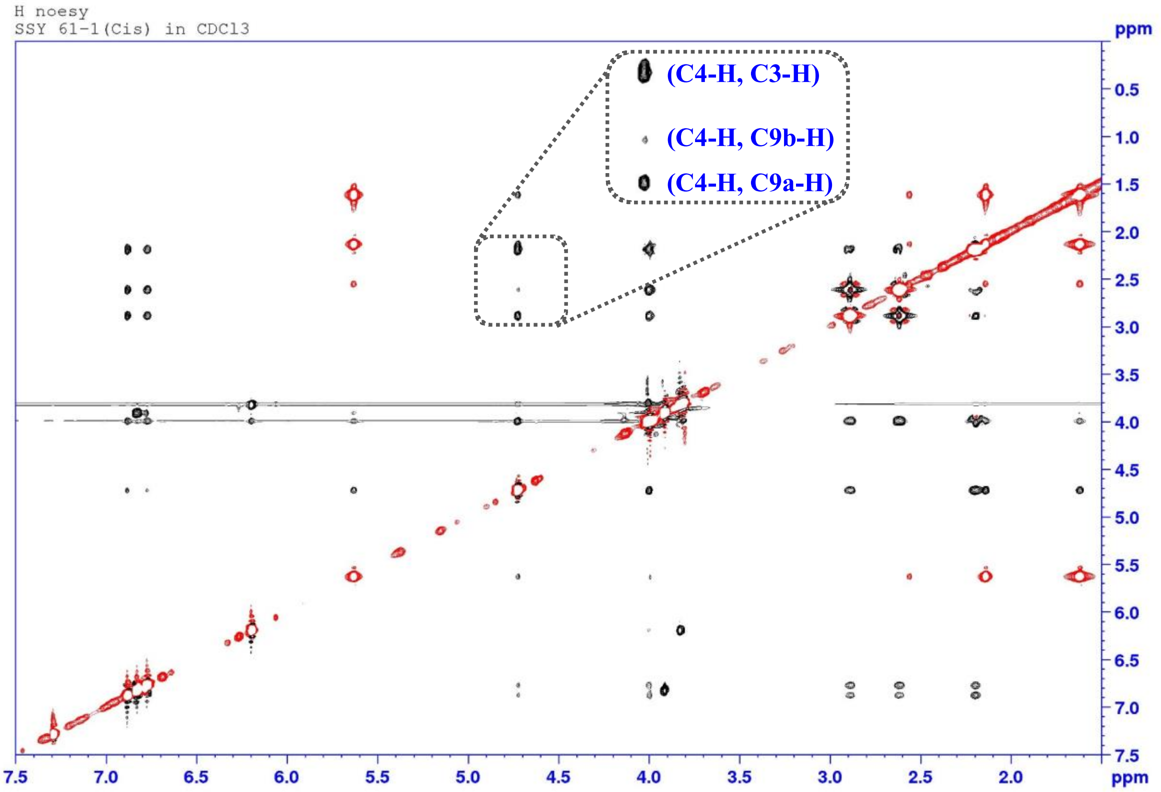
Mode: Isocratic system

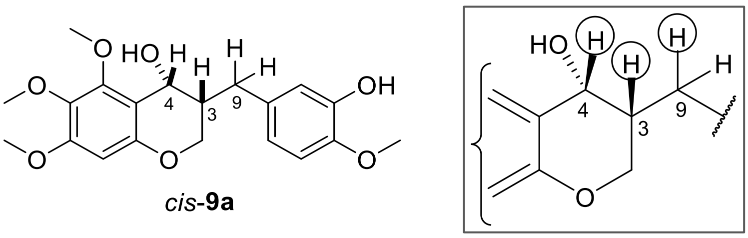
Flow rate: 0.2 mL/min

Injection volume: 2 μL

2. 2D NOESY NMR spectroscopy of *cis*-9a and *trans*-9a

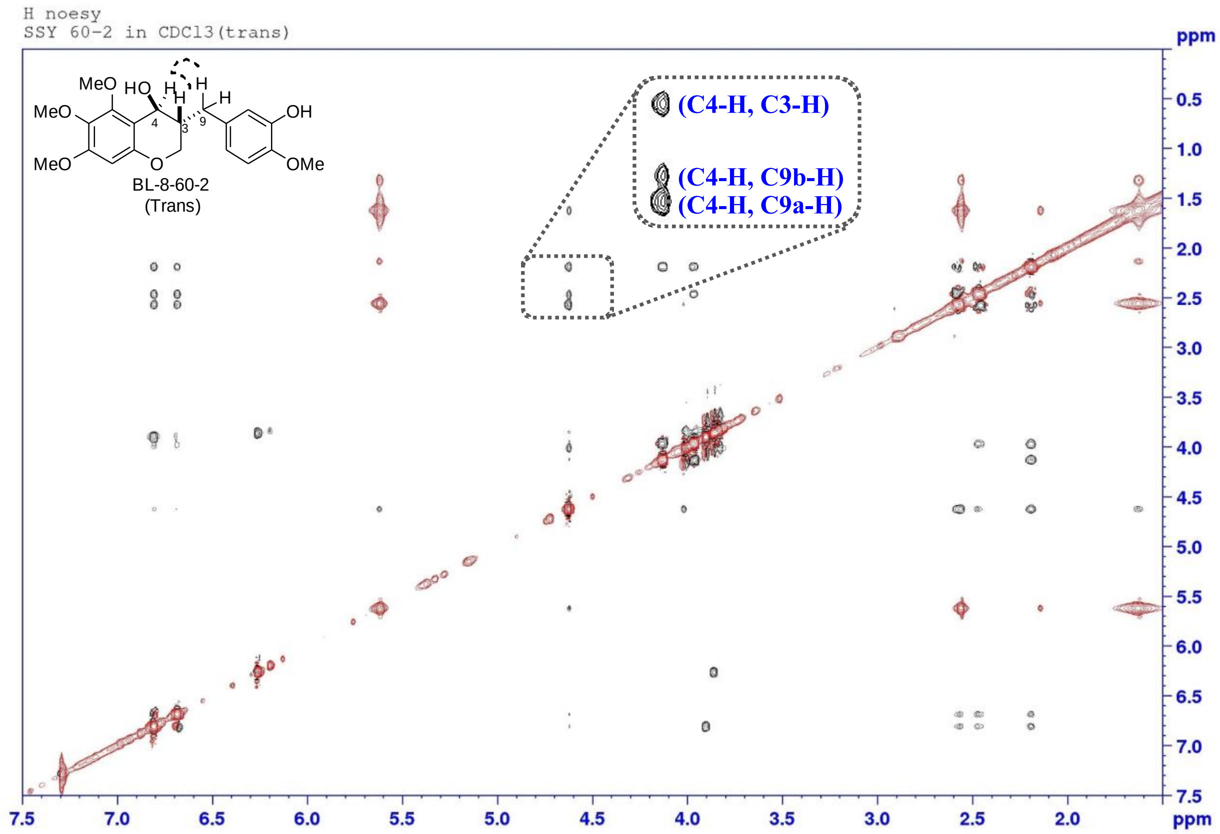
Figure S1. 2D NOESY NMR spectroscopy of *cis*-**9a**

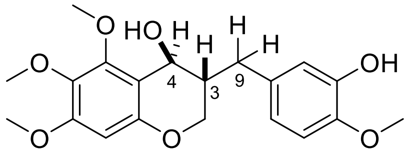




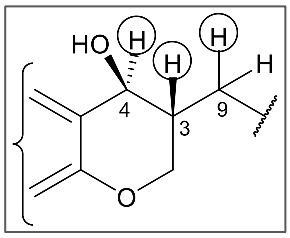
Annotation	ν(F1) [ppm]	ν(F2) [ppm]	Intensity [abs]
C4-C3	4.7132	2.193	3,456,915
C4-C9a	4.7132	2.8779	1,662,996
C4-C4OH	4.7132	2.1383	1,571,514
C4-C9b	4.7132	2.6176	306,140

Figure S2. 2D NOESY NMR spectroscopy of *trans*-**9a**





trans-**9a**



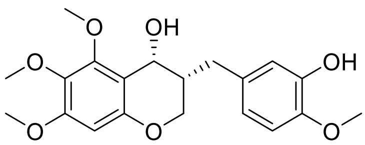
Annotation	ν(F1) [ppm]	ν(F2) [ppm]	Intensity [abs]
C4-C9a	4.5768	2.5628	4,288,817
C4-C3	4.5768	2.193	2,495,161
C4-C4OH	4.5768	2.5224	2,160,369
C4-C9b	4.5768	2.467	1,260,030

3. Determination of absolute configuration of (*R*,*R*)-9a and (*S*,*S*)-9a using ECD spectra

1) Geometry optimization and ECD calculation of (3*R*,4*R*)-**9a**

The computational energy minimization of (3*R*,4*R*)-**9a** was performed using the DMol3 program in Material Studio 2016. In these calculations, we employed generalized gradient approximation (GGA) in the Perdew-Burke-Ernzerhof (PBE) form as well as a Doubl numerical plus d-functions (DND) basis set. The ECD calculations were performed with TD-DFT (time-dependent density functional theory) using the B3LYP functional and the 6-31+G(d) basis set via Gaussian 09. The number of excited states per molecule was 30. Solvent effects were taken into account by using the polarizable continuum model (PCM, MeOH). The ECD spectra were generated by the program SpecDis using a Gaussian band shape with 0.16 eV exponential half-width from dipole-length dipolar and rotational strengths.

Table S1. Geometry optimization of (*3R*,*4R*)-**9a**



(*3R*,*4R*)-9a

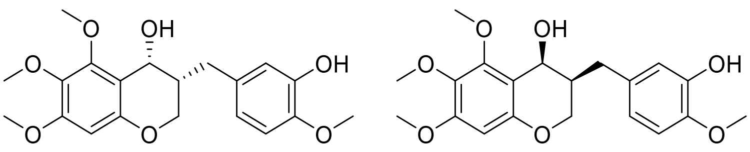
Atom	X	Y	Z	Atom	X	Y	Z
C	-3.44172	1.10762	0.084549	C	-6.32321	-0.77938	1.331584
C	-4.22144	0.008976	0.53464	H	-4.26552	-2.14247	0.854097
C	-3.68106	-1.27726	0.548315	H	0.542259	0.153029	-0.12795
C	-2.35528	-1.48841	0.142064	H	0.436402	-1.94366	0.976948
C	-1.52979	-0.41664	-0.22275	H	-0.21959	3.541239	-0.02238
C	-2.1026	0.872533	-0.25323	H	-0.22281	2.162725	1.127201
O	-1.28765	1.923135	-0.66665	H	-1.68806	3.194886	0.959095
O	-5.50437	0.306866	0.898404	H	-2.97984	3.351466	-1.44204

O	-4.02223	2.357794	0.105718	H	-4.59608	3.984417	-0.96623
C	-0.08376	-0.61961	-0.60712	H	-4.46904	2.482479	-1.93717
C	0.389304	-1.99585	-0.12451	H	-0.84883	-3.02838	-1.57625
O	0.106602	-0.55171	-2.03965	H	-0.36719	-4.04411	-0.17876
O	-1.90934	-2.78541	0.203041	H	1.745374	-2.4515	-1.75058
C	-0.83466	2.751943	0.425268	H	2.031009	-3.38199	-0.27211
C	-4.00091	3.080115	-1.13949	H	2.844074	-1.94514	1.847392
C	-0.66463	-3.03362	-0.48796	H	4.574871	-0.32056	2.507365
C	1.784104	-2.37761	-0.65494	H	3.138724	-0.60667	-2.2329
C	2.870865	-1.40744	-0.24673	H	4.674953	1.010607	-2.6126
C	3.28052	-1.29587	1.085933	H	5.39217	1.836698	2.774409
C	4.268188	-0.37663	1.463728	H	6.993796	2.332958	2.136685
C	4.863532	0.460081	0.516725	H	6.686172	0.611284	2.533656
C	4.451456	0.360973	-0.83284	H	-7.28948	-0.33508	1.59353
C	3.467287	-0.55851	-1.19137	H	-5.89659	-1.27604	2.217632

Total energy = –1302.96222064 Ha (1 Ha = 627.509391 kcal/mol)

2) Experimental and calculated ECD spectra of (*3R*,*4R*)-**9a** and (*3S*,*4S*)-**9a**

To determine the absolute stereochemistry of **(*3R,4R*)-9a**, we compared the experimental ECD spectrum with the calculated ECD spectrum as shown in Figure 3. The calculated ECD spectrum of **(*3R,4R*)-9a** showed good agreement with the experimental spectrum of **(*3R,4R*)-9a** in methanol (1.0 mg/mL). And the calculated ECD spectrum of **(*3S,4S*)-9a** matched with the experimental spectrum of **(*3S,4S*)-9a** too.

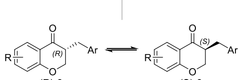
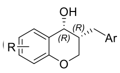
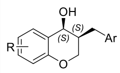
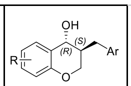
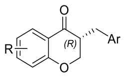
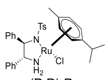
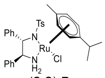


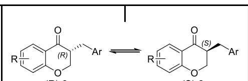
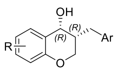
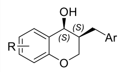
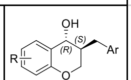
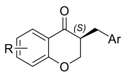
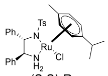
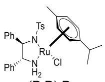
(*3R*,*4R*)-9a (*3S*,*4S*)-9a

4. Matched/mismatched effects on homoisoflavanones ((*R*)-2 and (*S*)-2) in asymmetric transfer hydrogenation using catalysts (*R*,*R*)-4 and (*S*,*S*)-4

To investigate the homoisoflavanone dynamic kinetic resolution (DKR) we prepared (*S*)-**2** and (*R*)-**2** via HPLC (Chiralpak AD-3 column; inject: 0.3 μL; methanol : acetonitrile=50 : 50; flow rate: 1.0 mL/min; 35℃). DBU/formic acid (3:1 (v/v)) were dissolved in acetonitrile. The solution was sparged with nitrogen for 15 min, then warmed to 40 °C. Separately, (*S*)-**2** or (*R*)-**2** (10 mg, 0.027 mmol) and RuCl(*p*-cymene)[(*R*,*R*)-Ts-DPEN] or RuCl(*p*-cymene)[(*S*,*S*)-Ts-DPEN] (30 mol%) were dissolved in acetonitrile, then added to the DBU/formic acid mixture as shown in Figure 4 and Figures S3 and S4. The mixture was stirred at 50 ℃ (3 h, 6 h, 12 h, 24 h and 48 h). Match (the chiral centers of the compound and Ru catalyst are the same) and mismatch (the chiral center of the compound and Ru catalyst are not the same) mixtures were measured by chiral HPLC.

Table S2. Time-course data for asymmetric transfer hydrogenation of (*R*)-**2** and (*S*)-**2**.

	catalyst	time(h)	 (R)-8 ⇌ (S)-8		→	 (R,R)	 (S,S)	 rac-trans		
 (R)-8	 (R,R)-Ru		Ratio(%)			Ratio(%)			%ee	cis:trans
		0	100	0		0	0	0		
		6	7	0.1		72	2	19	97.3	3.9:1
		12	8	4		77	7	4	92	21:1
		24	6	1		83	8	2	91.2	46:1
	 (S,S)-Ru									
		0	100	0		0	0	0		
		3	71	12		1	15	1	93.8	16:1
		6	46	18		1	32	3	97	11:1
		12	16	11		2	64.5	6.5	97	10:1
		24	4	6		2	80	8	98	10:1

	catalyst	time(h)	 (R)-8 ⇌ (S)-8		→	 (R,R)	 (S,S)	 rac-trans		
 (S)-8	 (S,S)-Ru		Ratio(%)			Ratio(%)			%ee	cis:trans
		0	0	100		0	0	0		
		6	11	12		0.1	74	3	99.9	25:1
		12	8	11		0.1	76	5	99.9	15:1
		24	2	2		0.1	89	7	99.9	13:1
	 (R,R)-Ru									
		0	0	100		0	0	0		
		3	10	74		6	4	6	60	1.7:1
		6	20	51		20	4	5	83	4.8:1
		12	17	13		56	6	8	90	7.8:1
		24	14	11		59	6	10	91	6.5:1

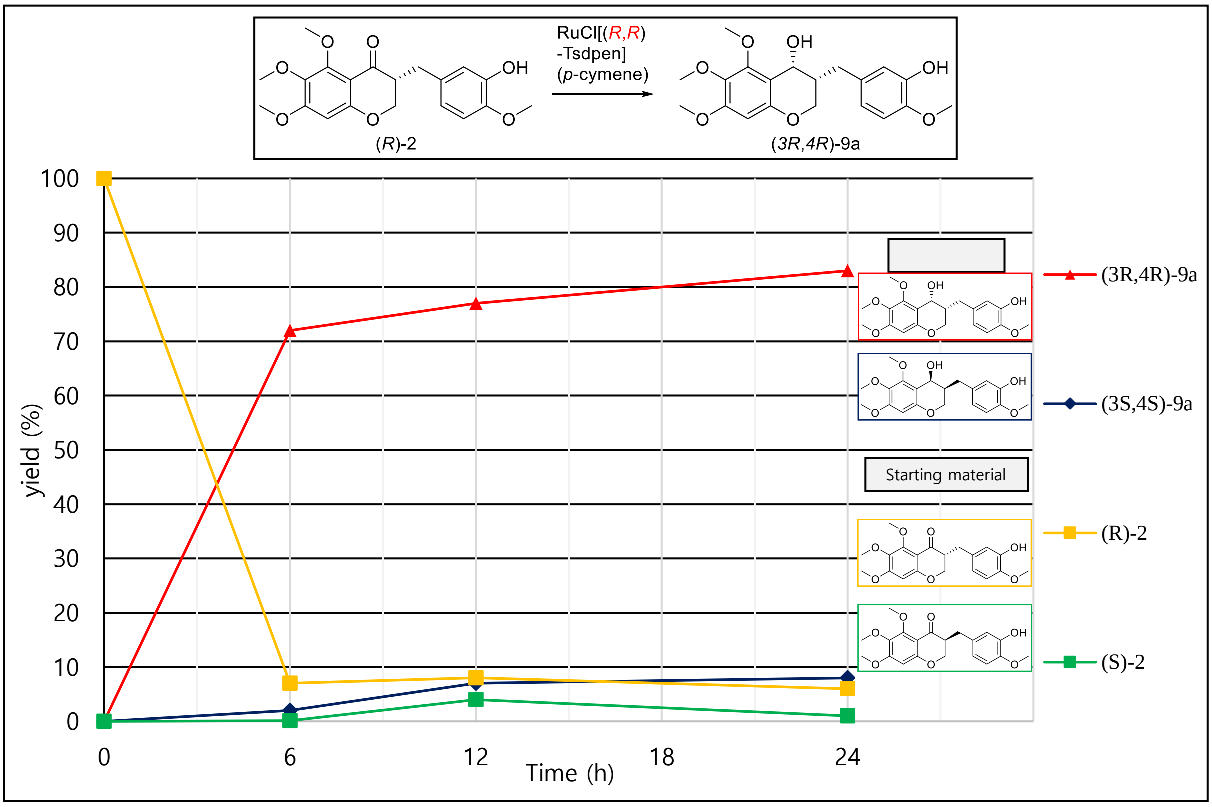


Figure S3. Time-course data for asymmetric transfer hydrogenation of (*R*)-**2** with (*R*,*R*)-**4**.

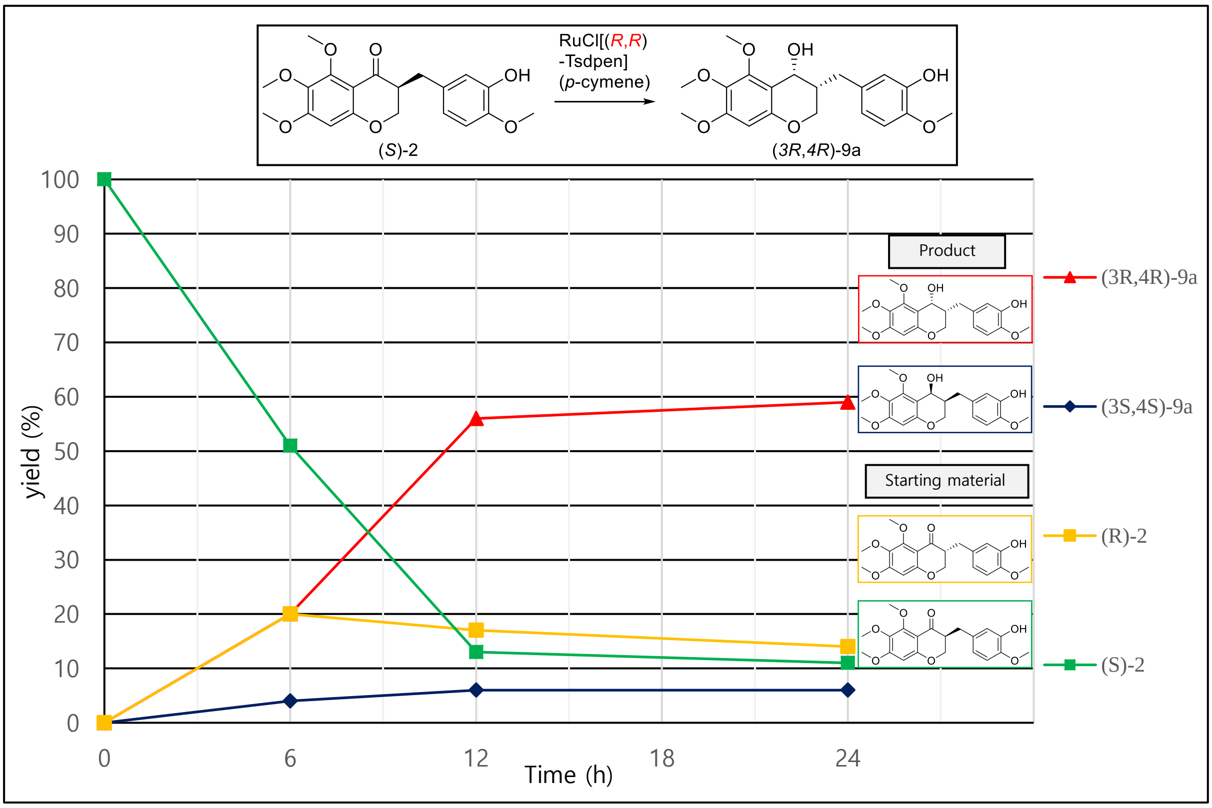


Figure S4. Time-course data for asymmetric transfer hydrogenation of (*S*)-**2** with (*R*,*R*)-**4**.

5. Effect of homoisoflavonoids on tubulin polymerization

The trimethoxyphenyl group in our homoisoflavonoids bears some resemblance to the tubulin polymerization inhibitor combretastatin A4. To assess whether these compounds act by the same mechanism as combretastatin A4, we performed a tubulin polymerization assay.

Compounds were tested for effect on tubulin polymerization using a commercially available fluorometric kit (BK011P, Cytoskeleton, Inc., Denver, CO). Compounds were diluted in DMSO and then water so that final DMSO concentration in the assay was 0.001%. A mix of GTP and tubulin was prepared in a glycerol containing buffer per kit protocol and added to the compounds to a final volume of 30 µL in a black 384-well plate. Tubulin polymerization was observed by reading fluorescence (ex. 360 nm, em. 420 nm) over 90 minutes in a Synergy H1 plate reader (Biotek, Winooski, VT). Combretastatin A4, a potent inhibitor of tubulin polymerization, was included in the assay as a positive control. For quantitative analysis, total tubulin polymerization was calculated by subtracting the fluorescence at t=60 min from t=0 and normalized to this value for the control assay (DMSO alone). GraphPad Prism software (v.7.0) was used for data analysis.

None of our compounds had inhibition of tubulin polymerization comparable to combretastatin A4 (Figures S5, S6). Only compound (*S*)-**2** showed very modest (25%) inhibition at 1 µM, suggesting that tubulin polymerization inhibition is not the major mechanism of antiangiogenic action of these novel compounds.

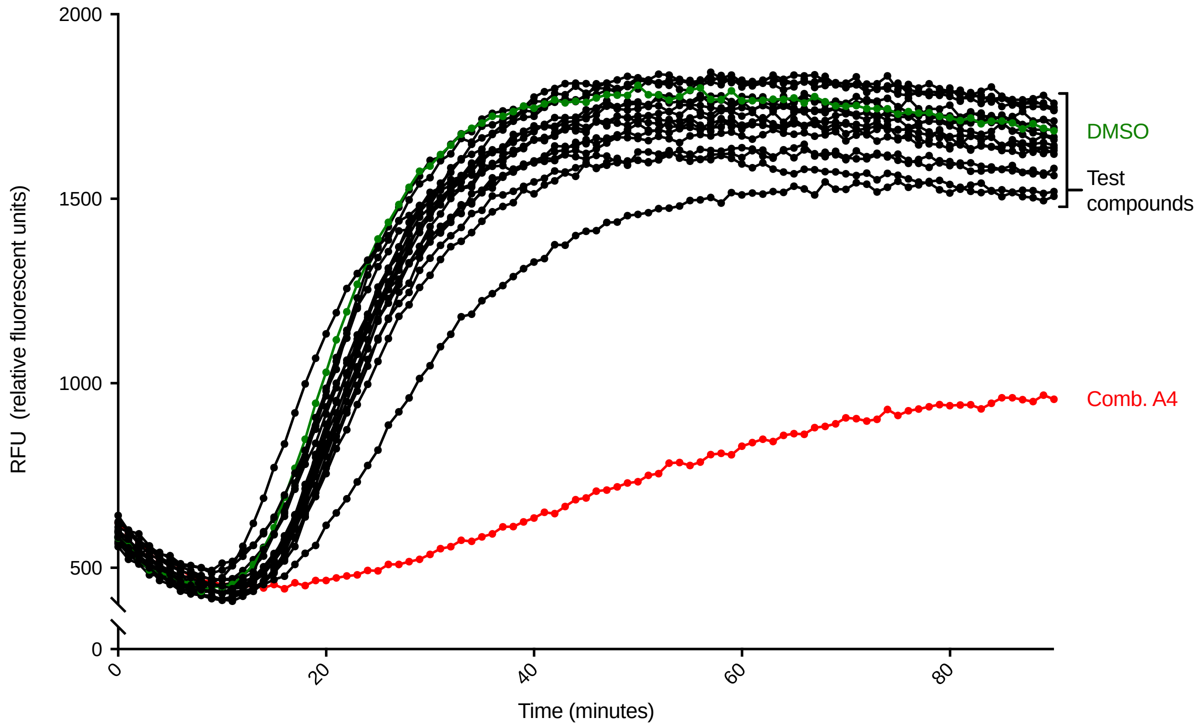


Figure S5. Kinetic traces of tubulin polymerization assay. Assay fluorescence plotted as a function of time. Test compounds in black, DMSO vehicle control in green, known tubulin polymerization inhibitor combretastatin A4 (Comb. A4) in red. All compounds were tested at 1 µM. Mean of duplicate wells indicated.

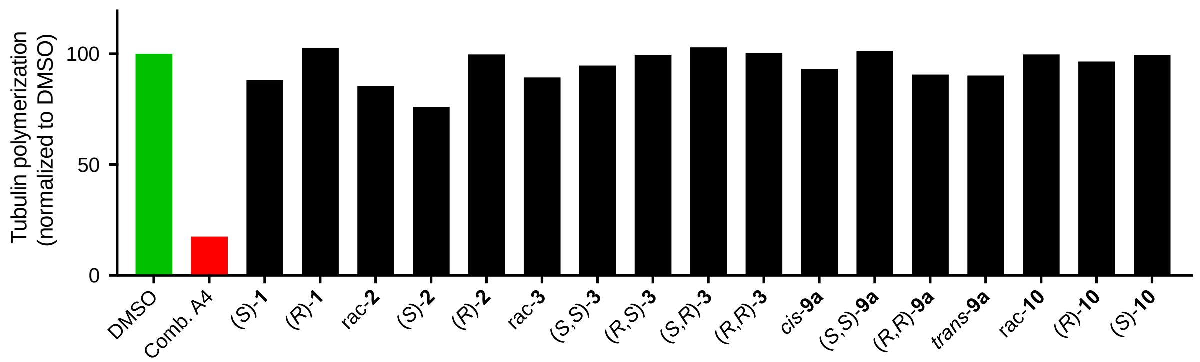
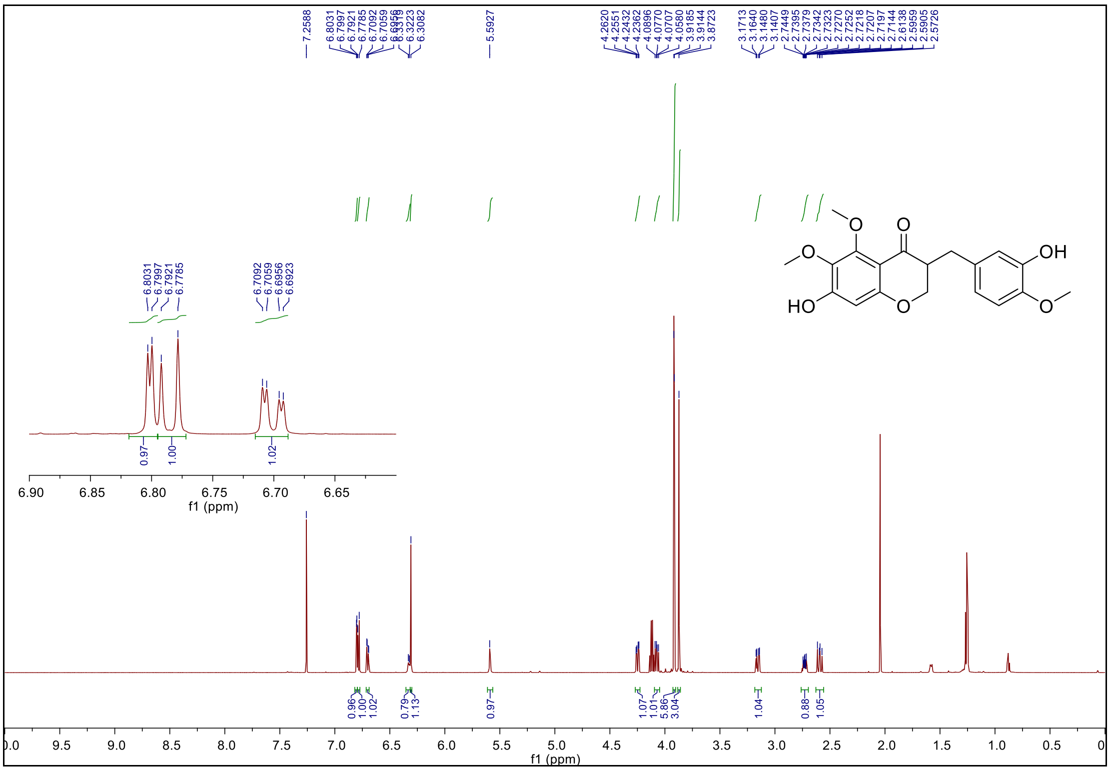


Figure S6. Summary of tubulin polymerization effects of tested compounds. Change in assay fluorescence at *t*=60 minutes plotted, normalized to vehicle control (green) and compared to known tubulin polymerization inhibitor combretastatin A4 (Comb. A4; red). All compounds were tested at 1 µM. Mean of duplicate wells indicated.

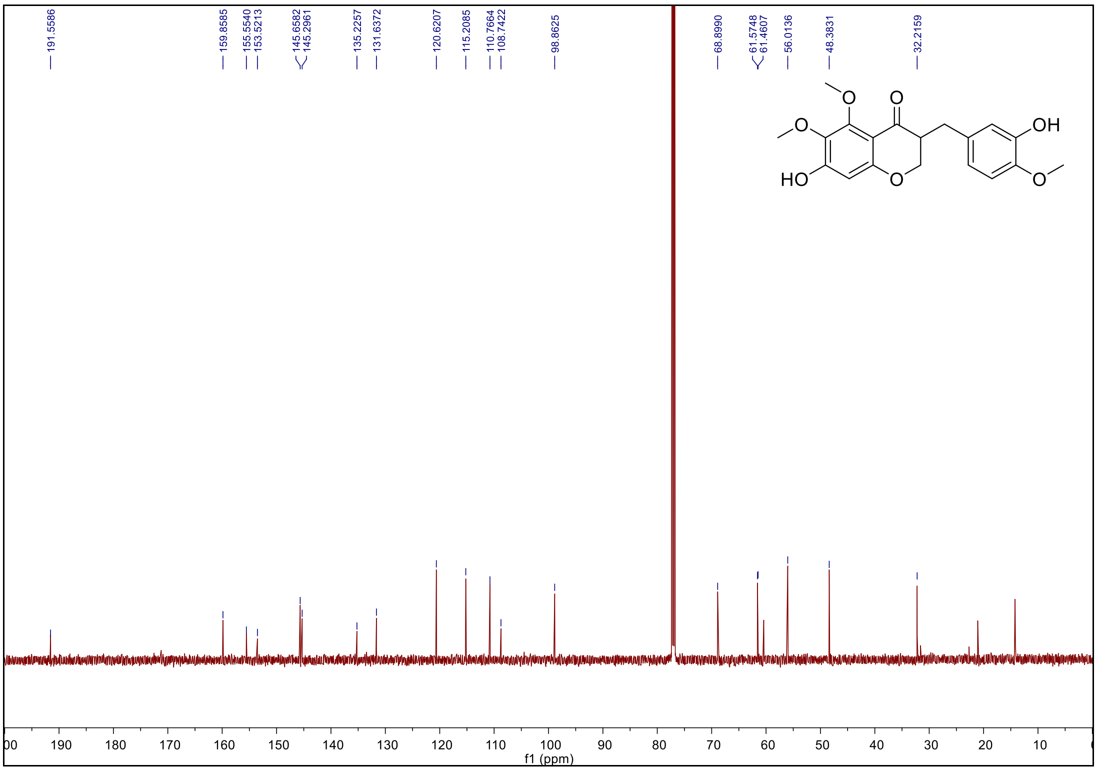
6. Copies of ^{1}H and ^{13}C{^{1}H} NMR spectra

7-Hydroxy-3-(3-hydroxy-4-methoxybenzyl)-5,6-dimethoxychroman-4-one (6)

^{1}H NMR (600 MHz, $CDCl_3$)

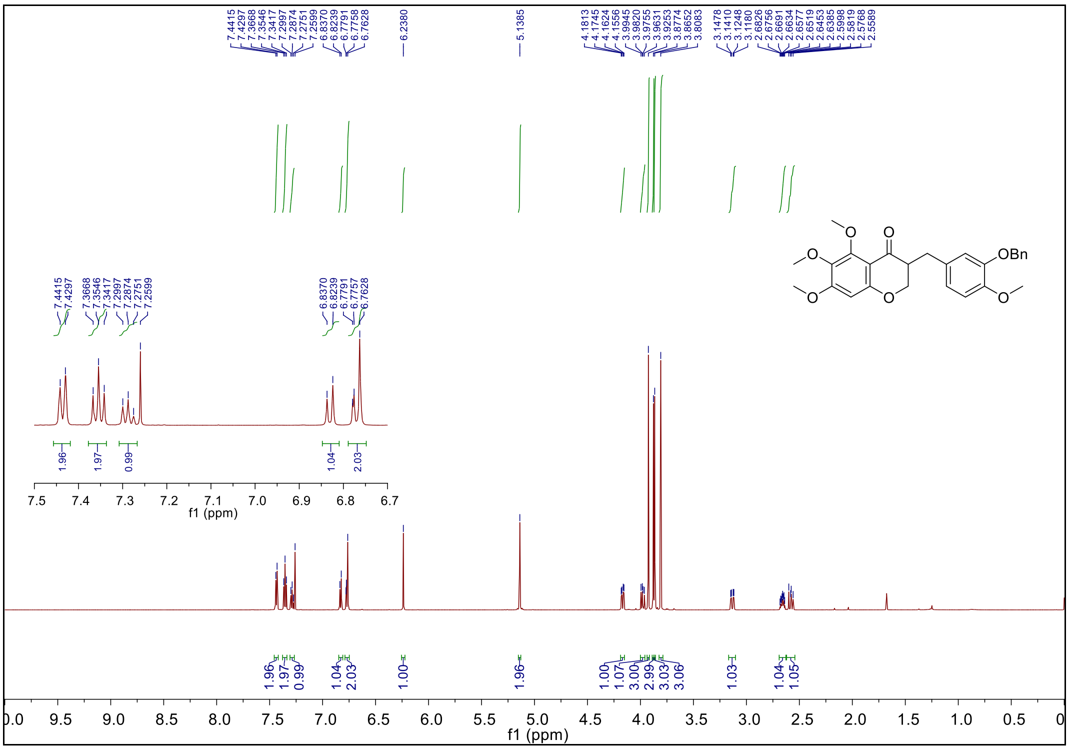


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

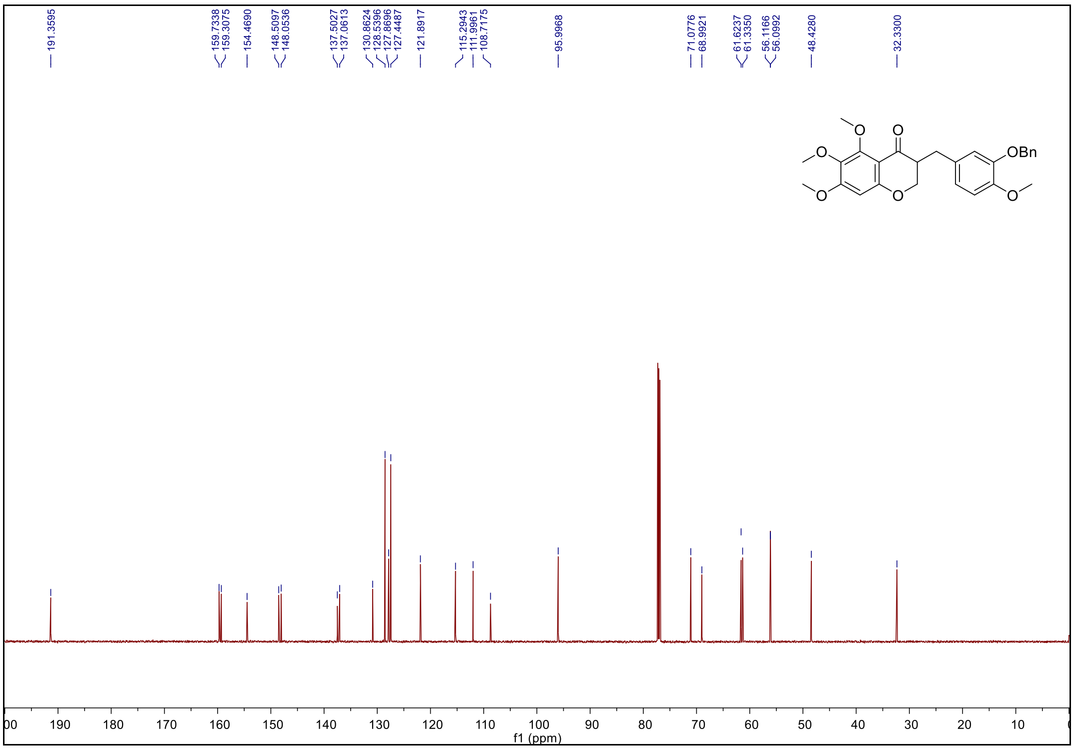


3-(3-(benzyloxy)-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-one) (7)

^{1}H NMR (600 MHz, $CDCl_3$)

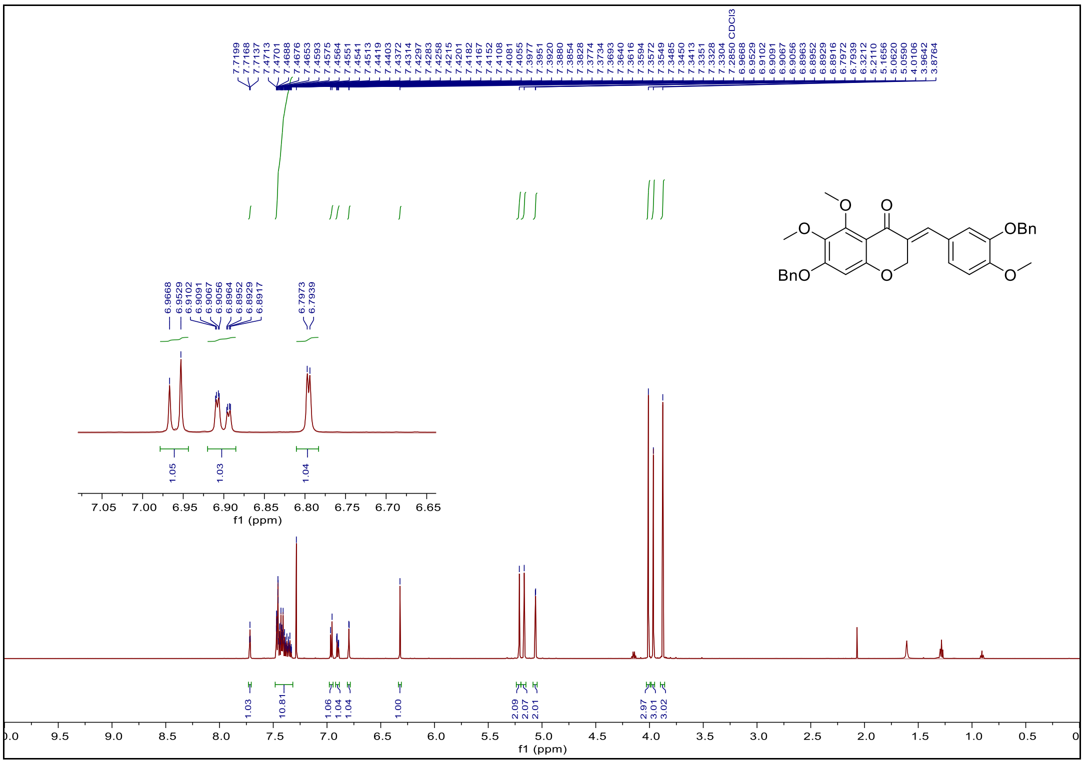


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

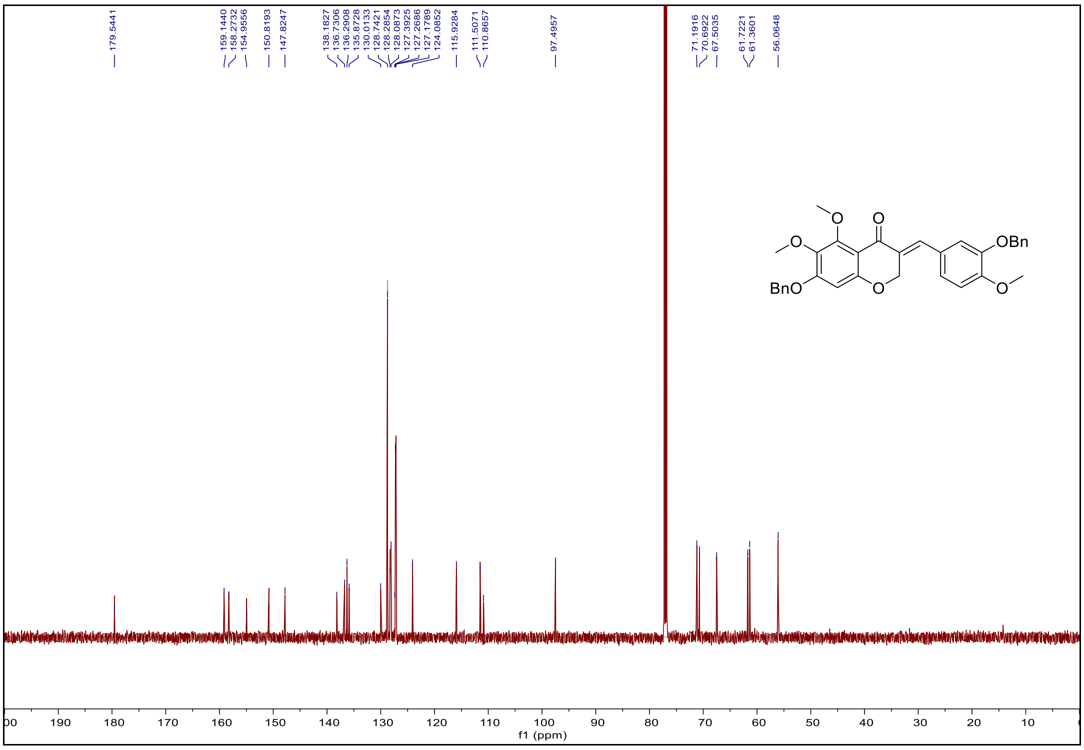


(*E*)-3-(3-hydroxy-4-methoxybenzylidene)-5,6,7-trimethoxychroman-4-one

^{1}H NMR (600 MHz, $CDCl_3$)

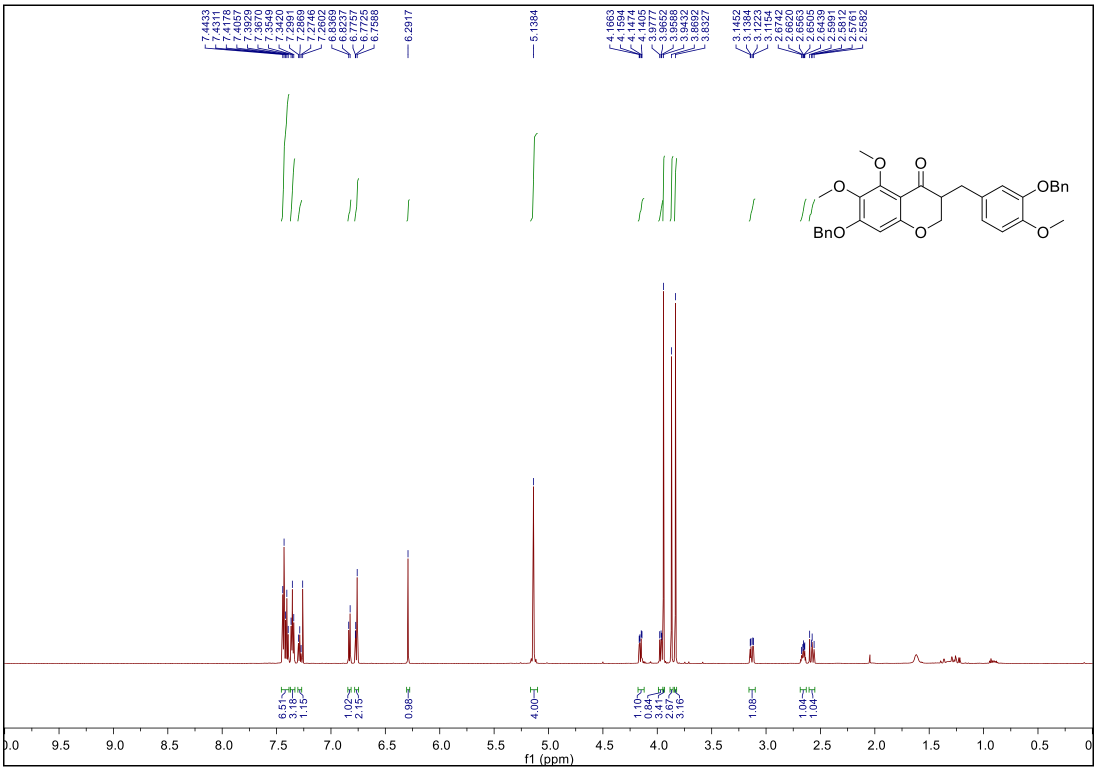


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

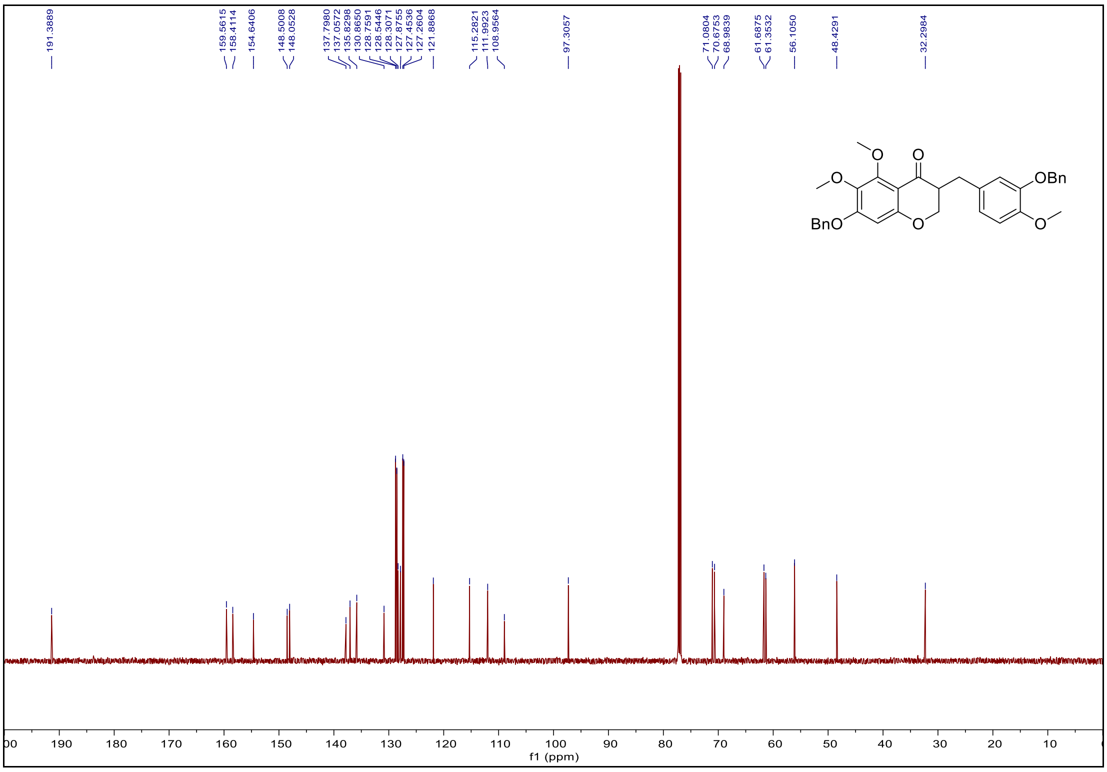


7-(Benzyloxy)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6-dimethoxychroman-4-one (8)

^{1}H NMR (600 MHz, $CDCl_3$)

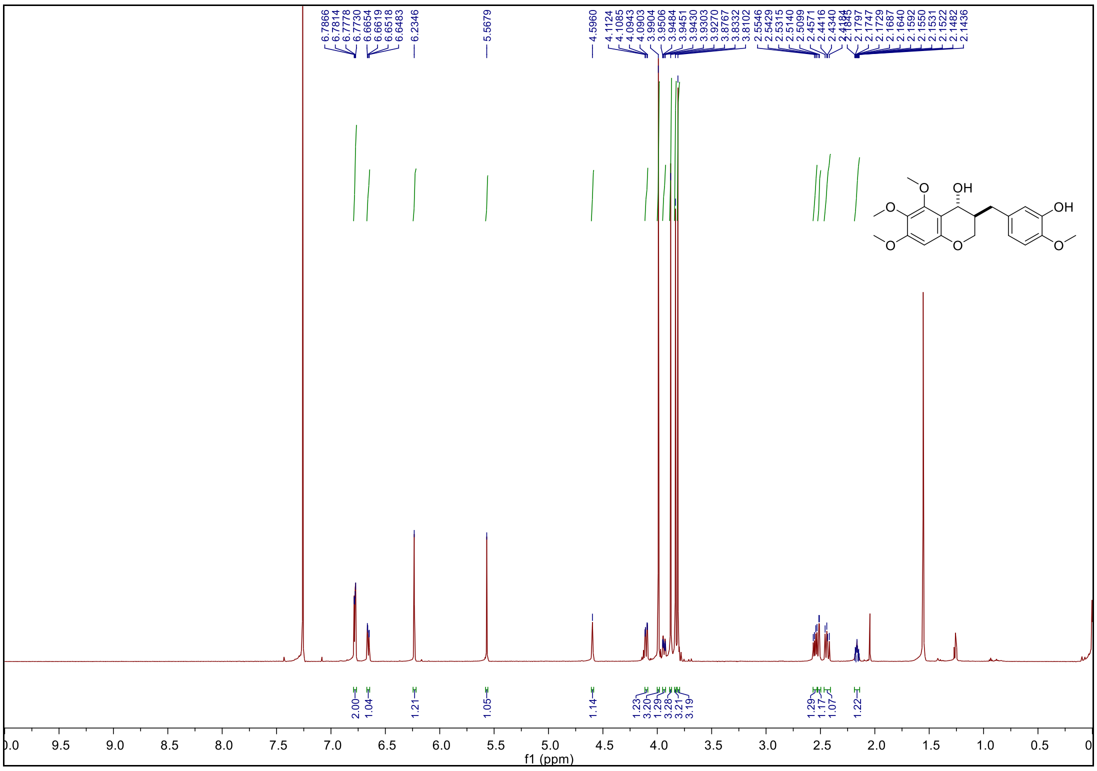


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

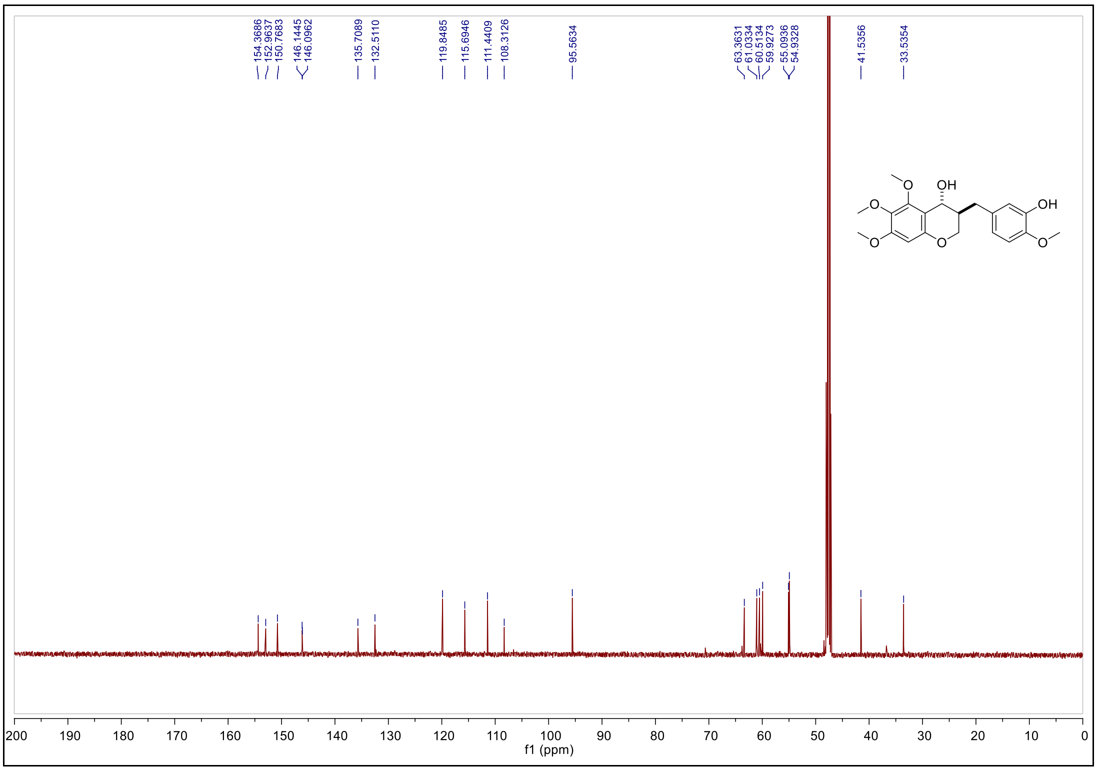


***trans*-3-(3-hydroxy-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-ol (*trans*-9a)**

^{1}H NMR (600 MHz, $CDCl_3$)

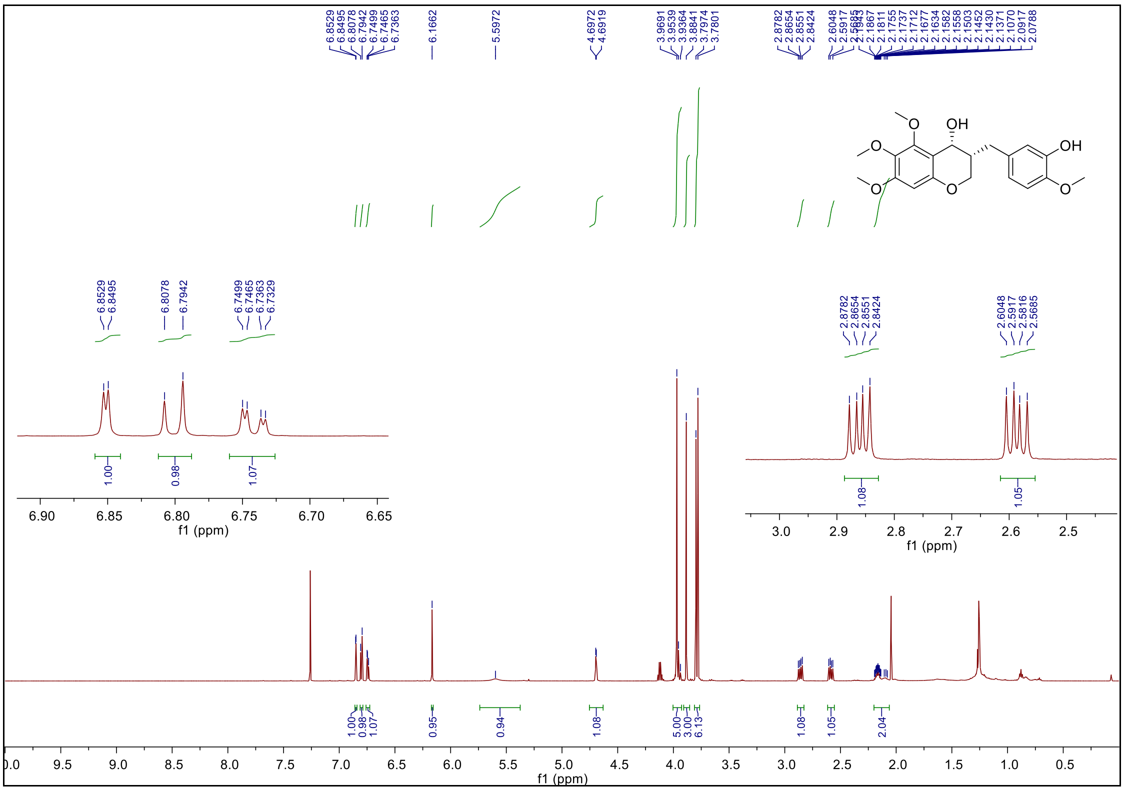


$^{13}C\{^{1}H\}$ NMR (150 MHz, CD_3OD)

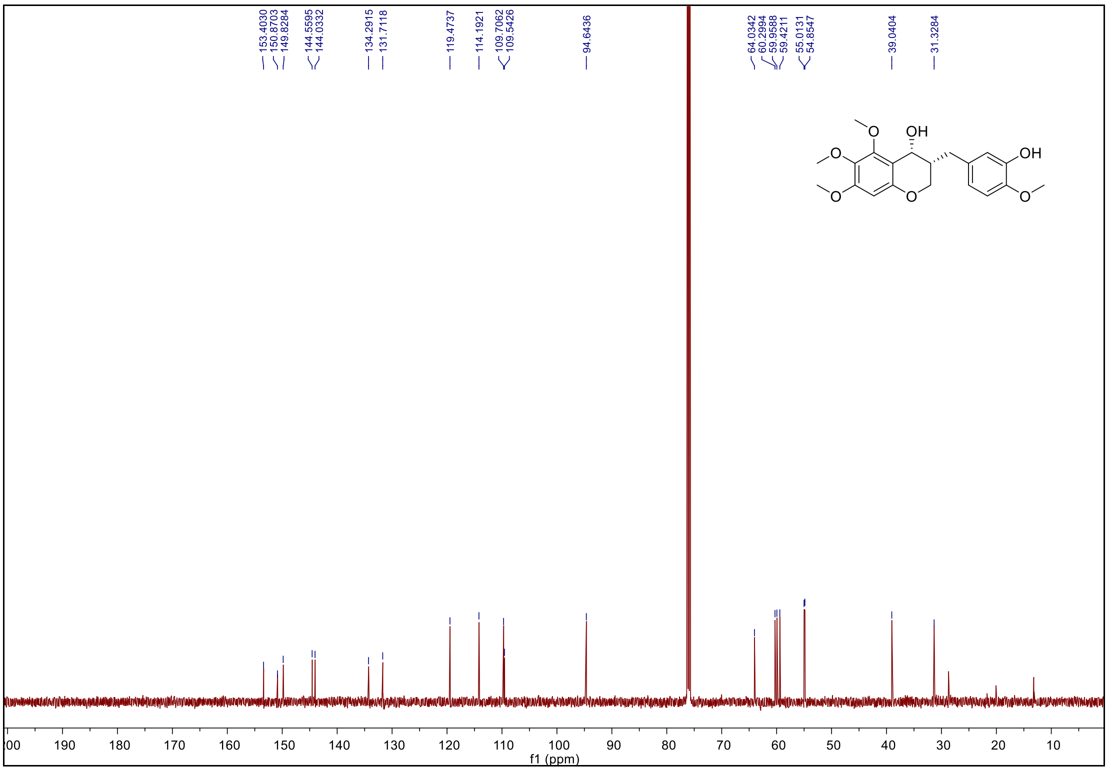


(*3R*,*4R*)-3-(3-hydroxy-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-ol ((*3R*,*4R*)-9a)

^{1}H NMR (600 MHz, $CDCl_3$)

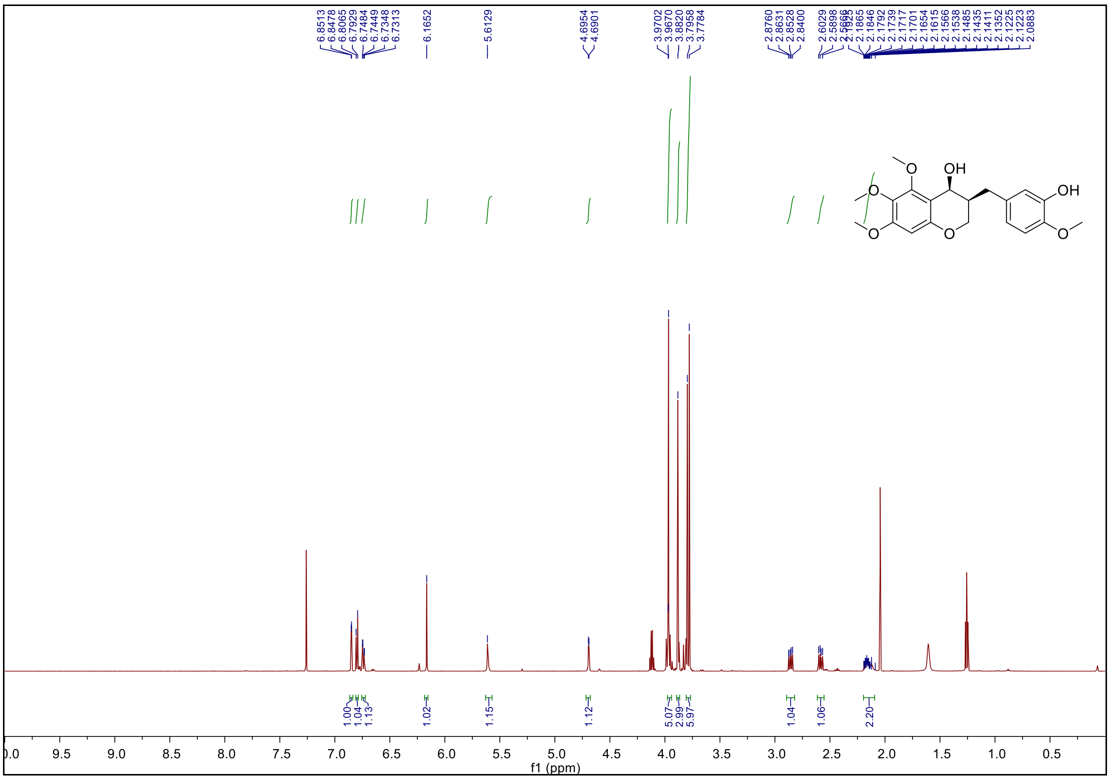


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

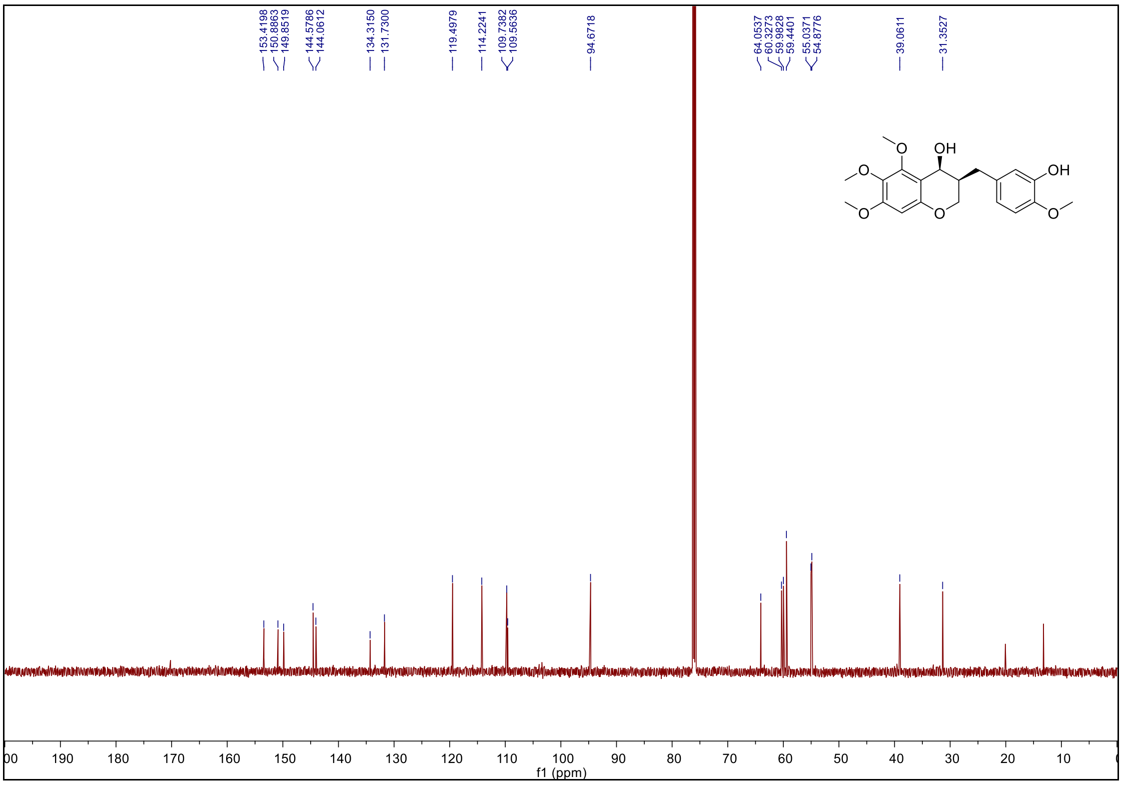


(*3S*,*4S*)-3-(3-hydroxy-4-methoxybenzyl)-5,6-dimethoxychromane-4,7-diol ((*3S*,*4S*)-9a)

^{1}H NMR (600 MHz, $CDCl_3$)

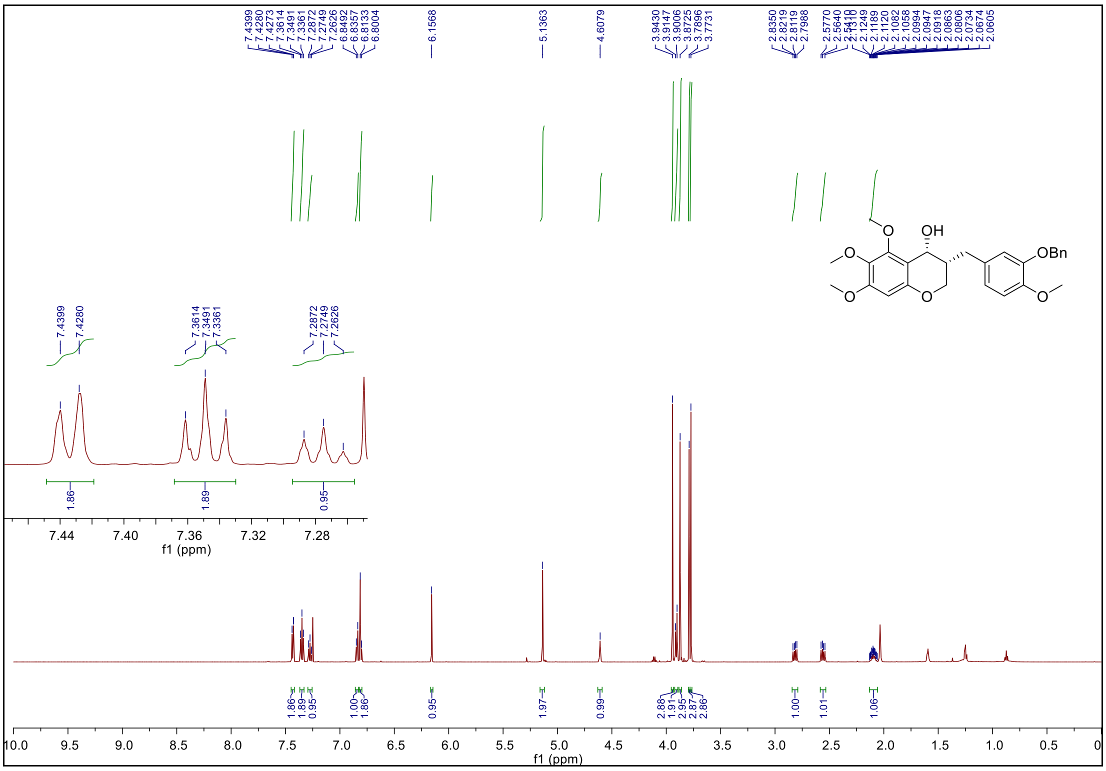


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

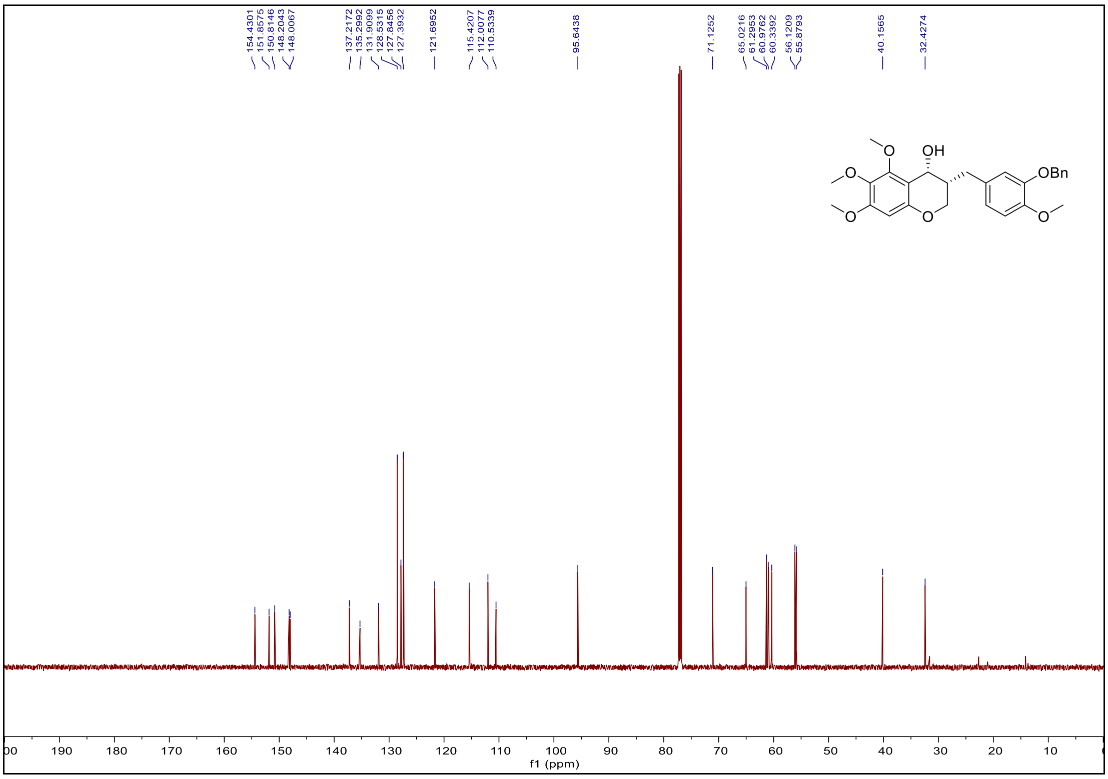


(*3R*,*4R*)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-ol ((*3R*,*4R*)-9c)

^{1}H NMR (600 MHz, CDCl$_3$)

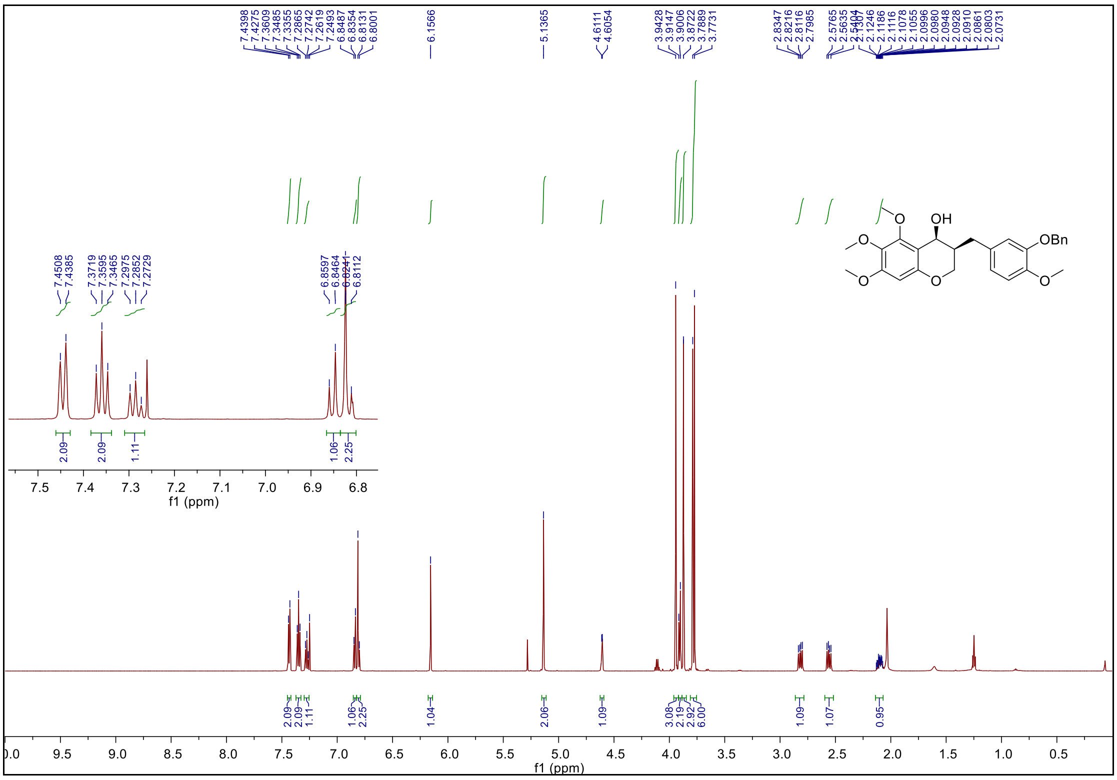


^{13}C{^{1}H} NMR (150 MHz, CDCl$_3$)

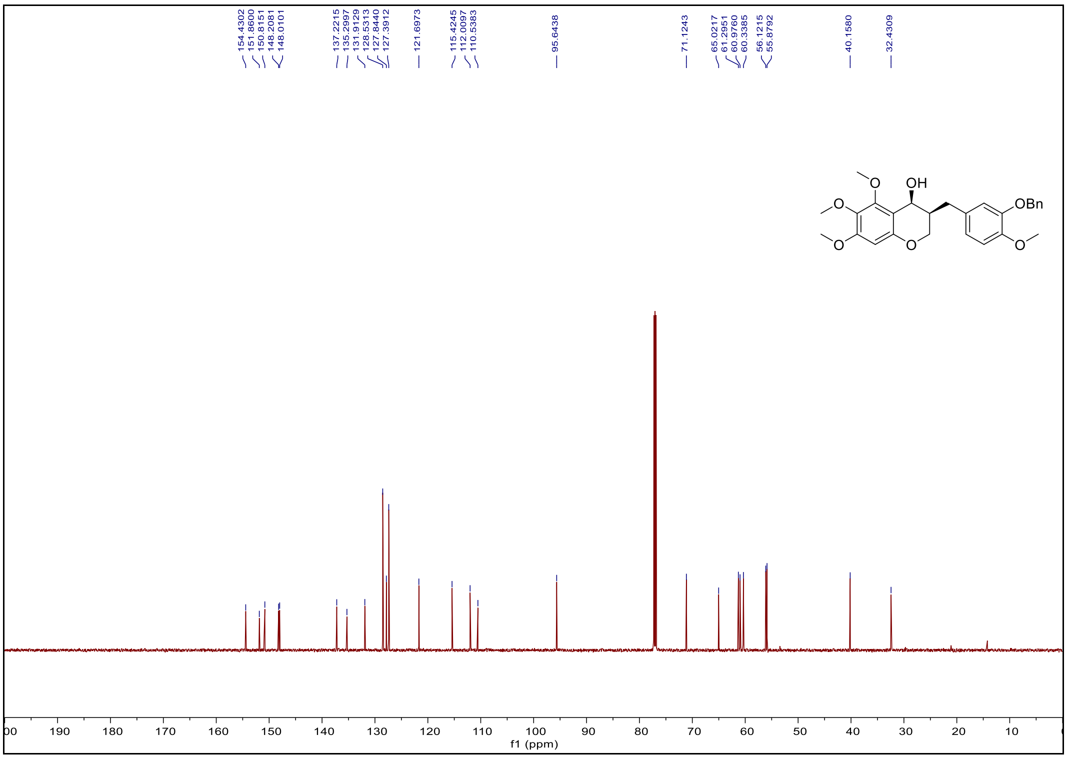


(3S,4S)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-ol ((3S, 4S)-9c)

^{1}H NMR (600 MHz, $CDCl_3$)

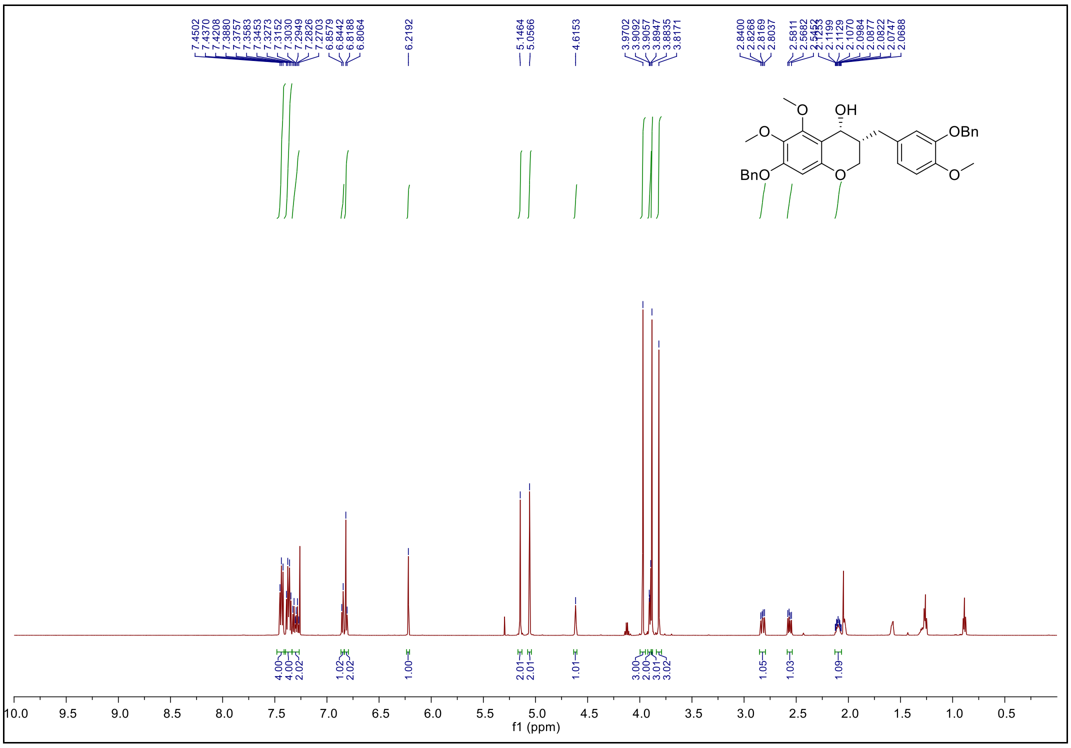


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

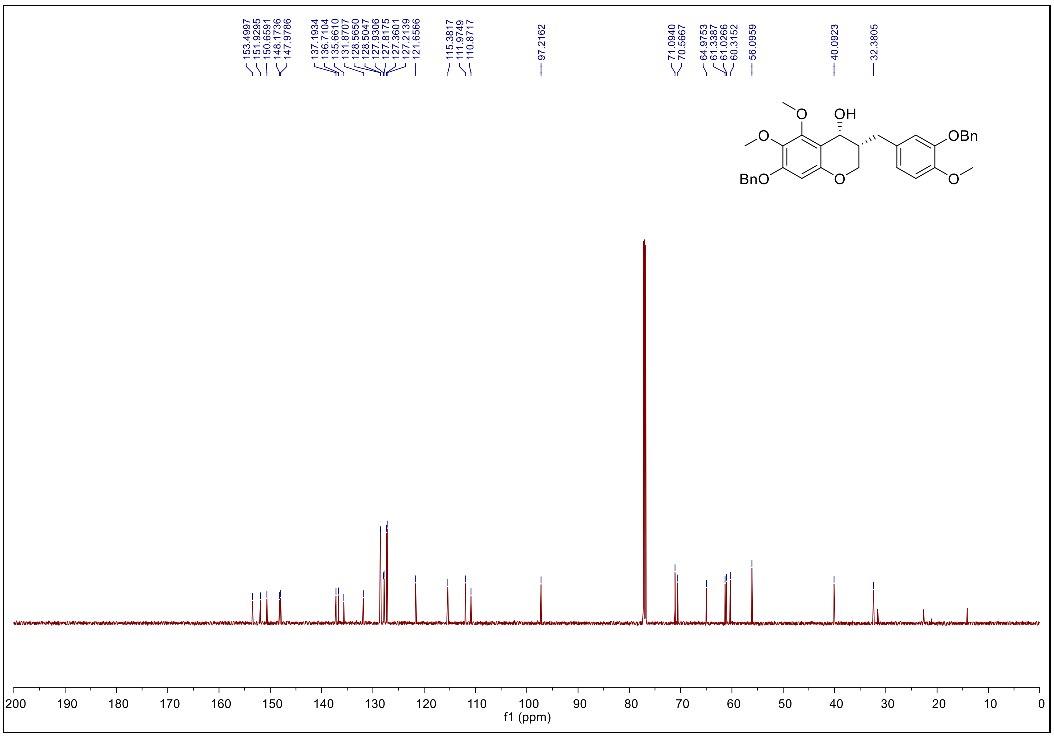


(*3R,4R*)-7-(benzyloxy)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6-dimethoxychroman-4-ol ((*3R,4R*)-9d)

^{1}H NMR (600 MHz, $CDCl_3$)

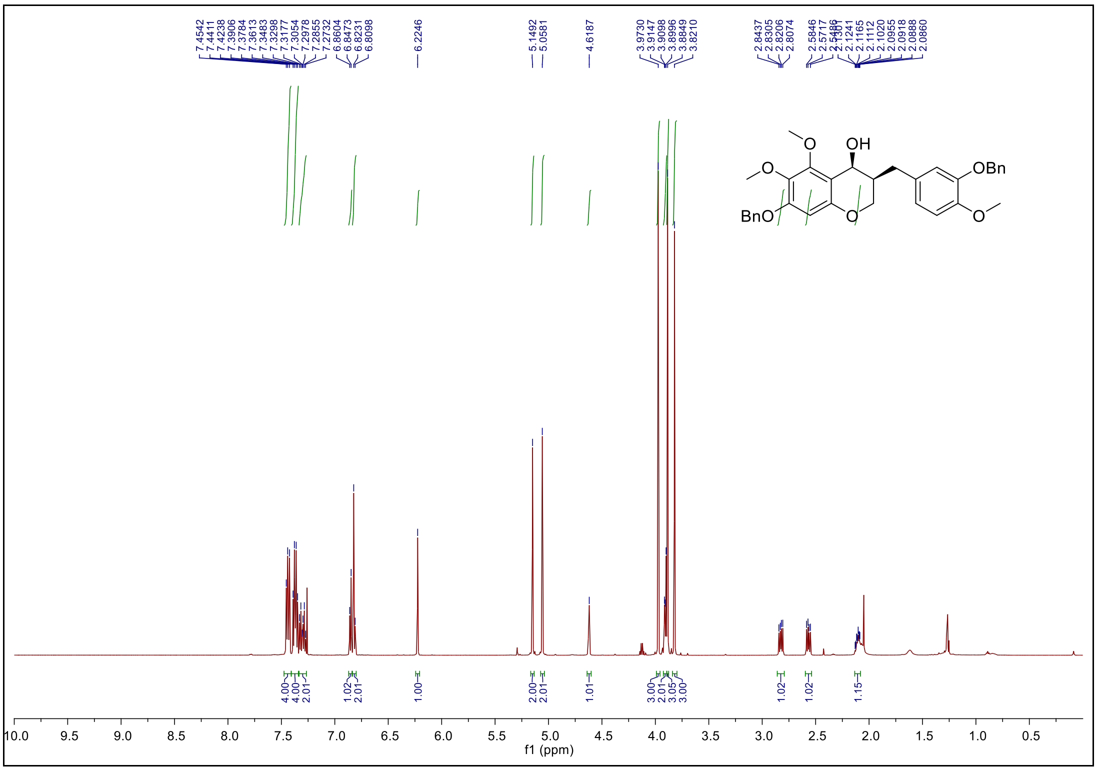


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

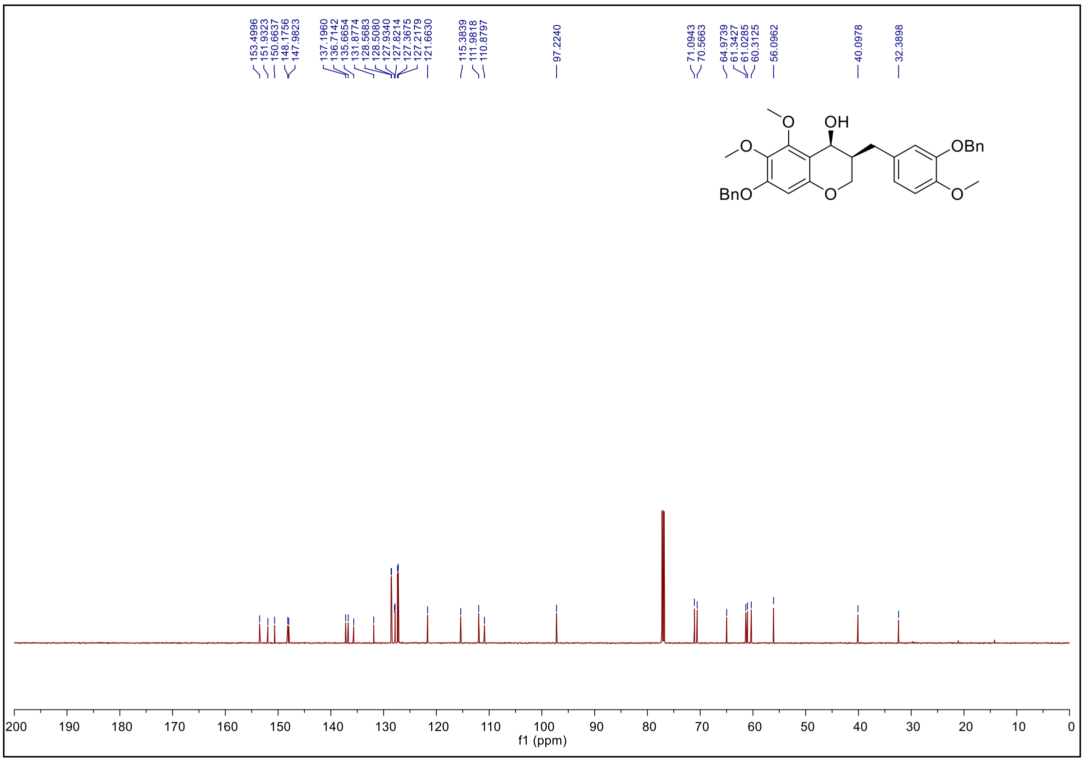


(*3S,4S*)-7-(benzyloxy)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6-dimethoxychroman-4-ol ((*3S,4S*)-9d)

^{1}H NMR (600 MHz, $CDCl_3$)

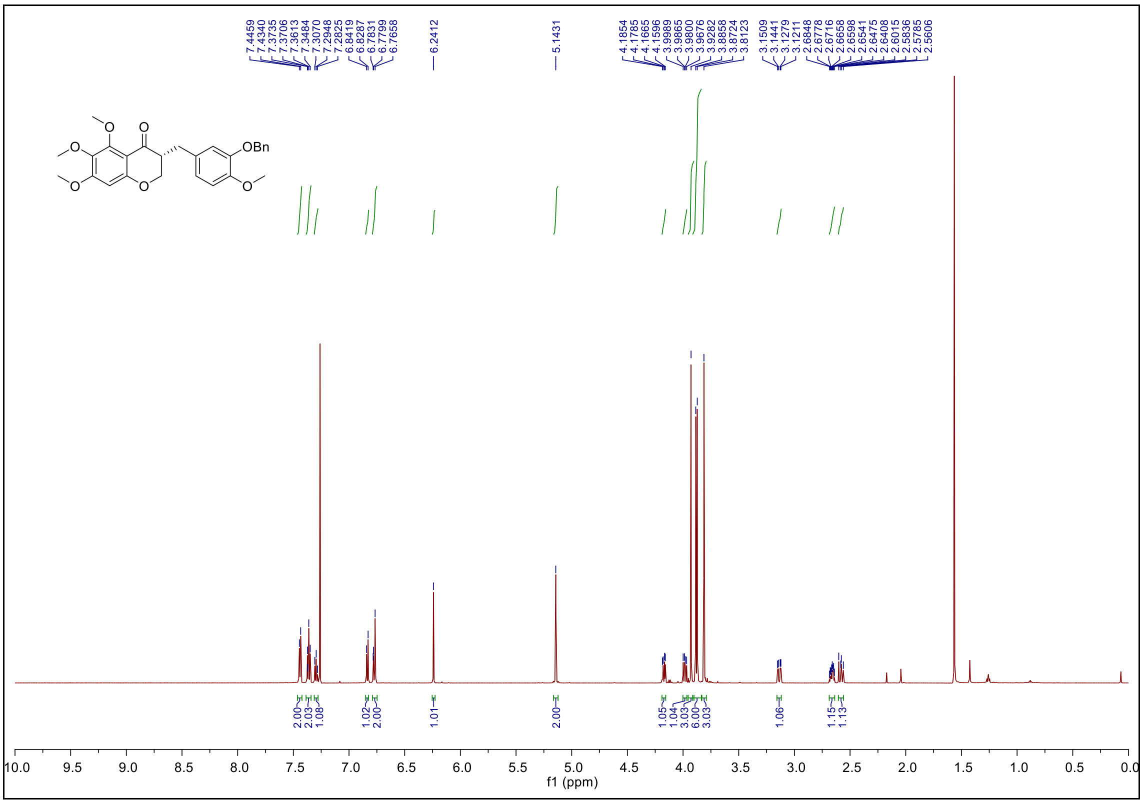


$^{13}C\{^1H\}$ NMR (150 MHz, $CDCl_3$)

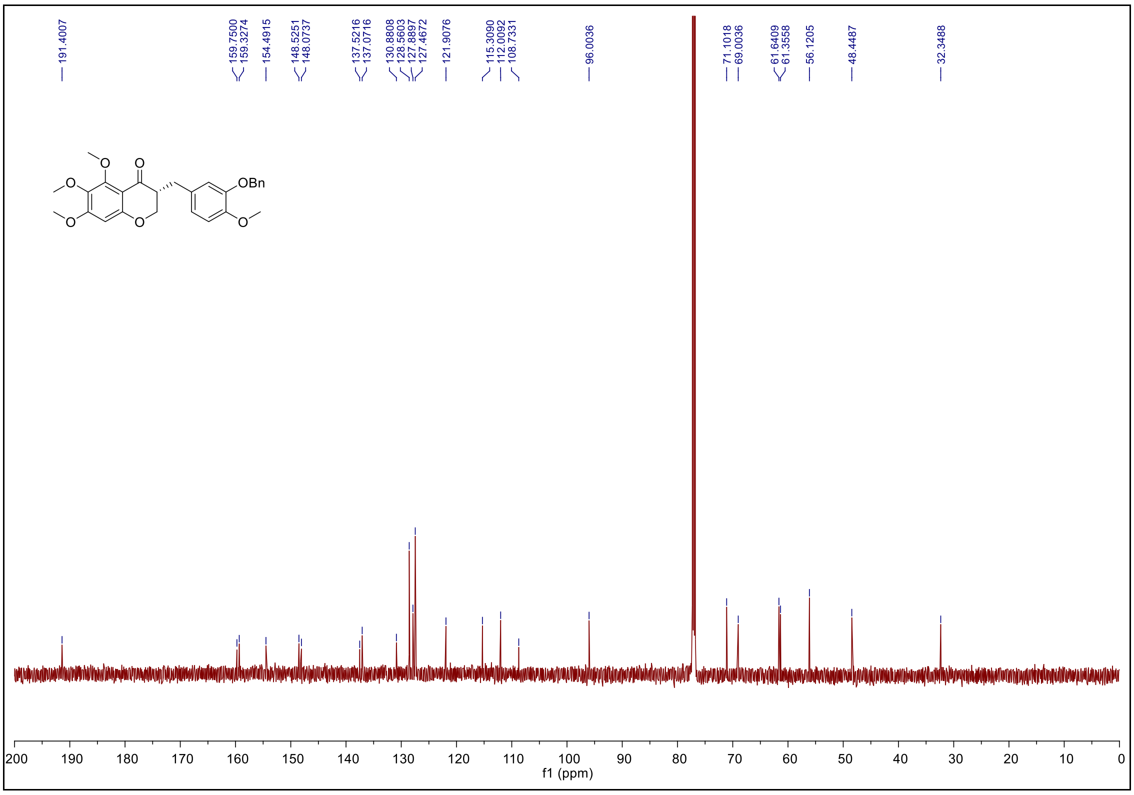


(*R*)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-one ((*R*)-7)

^{1}H NMR (600 MHz, $CDCl_3$)

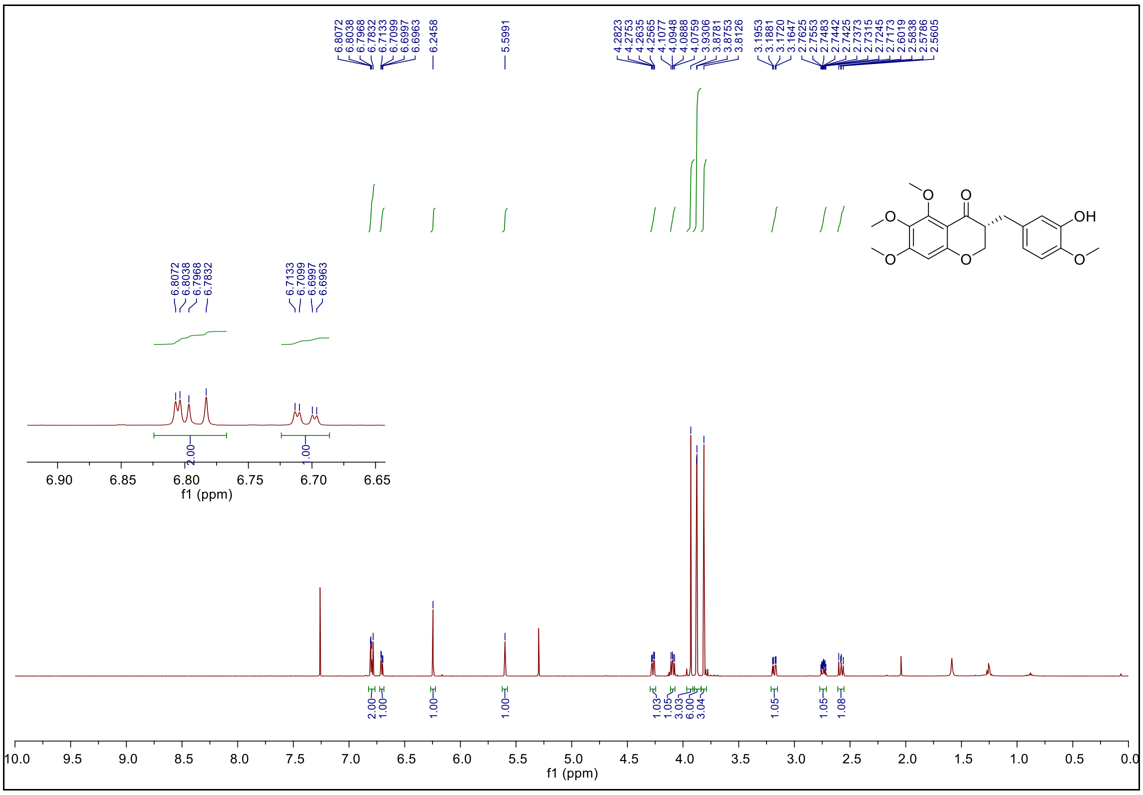


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

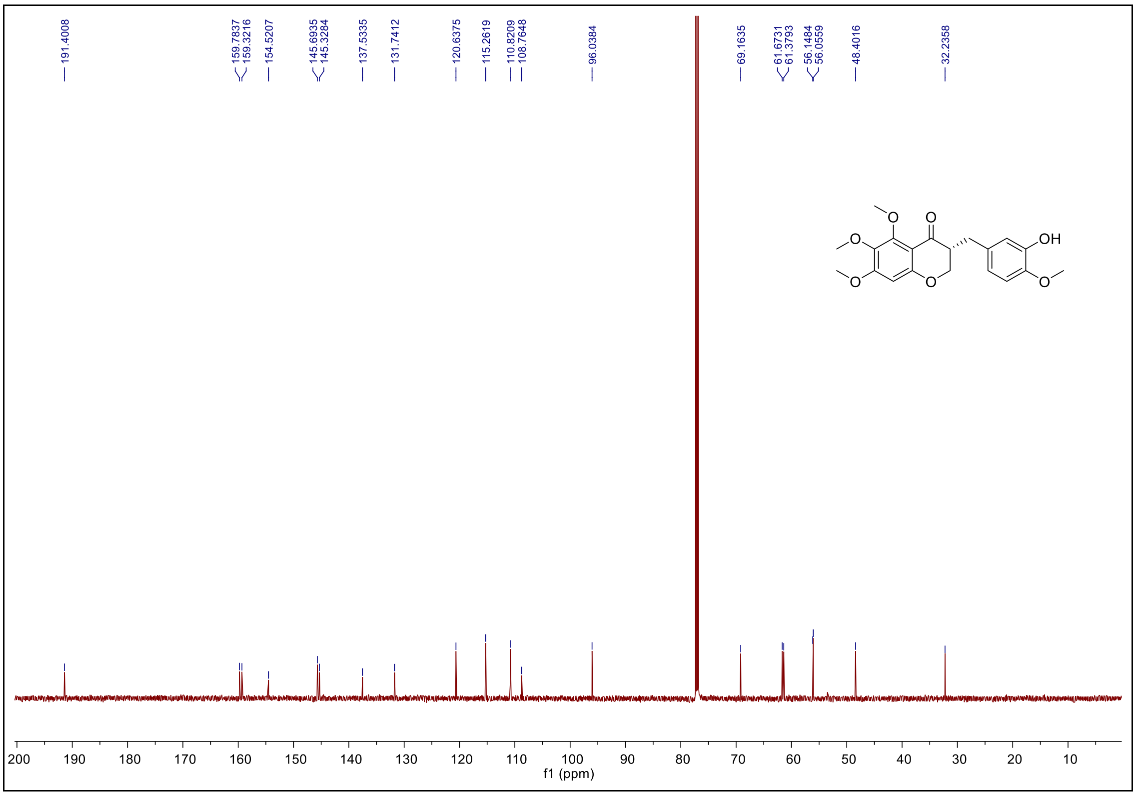


(*R*)-3-(3-hydroxy-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-one ((*R*)-2)

^{1}H NMR (600 MHz, $CDCl_3$)

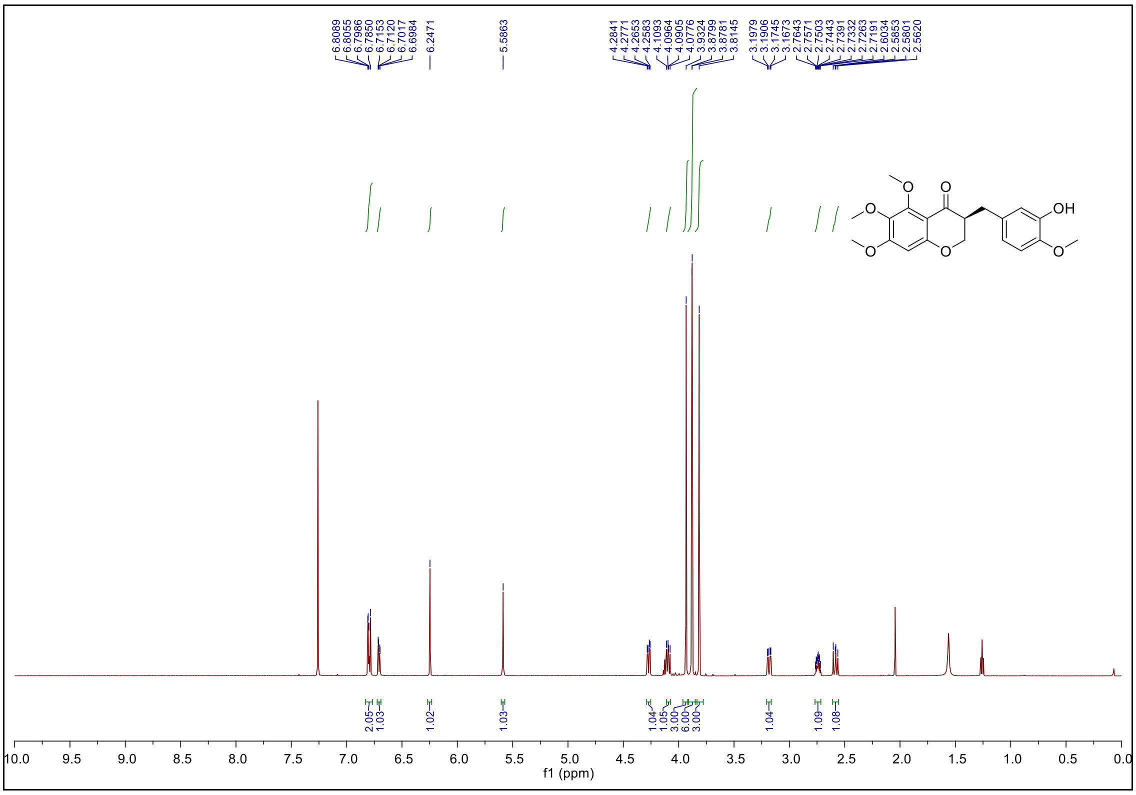


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

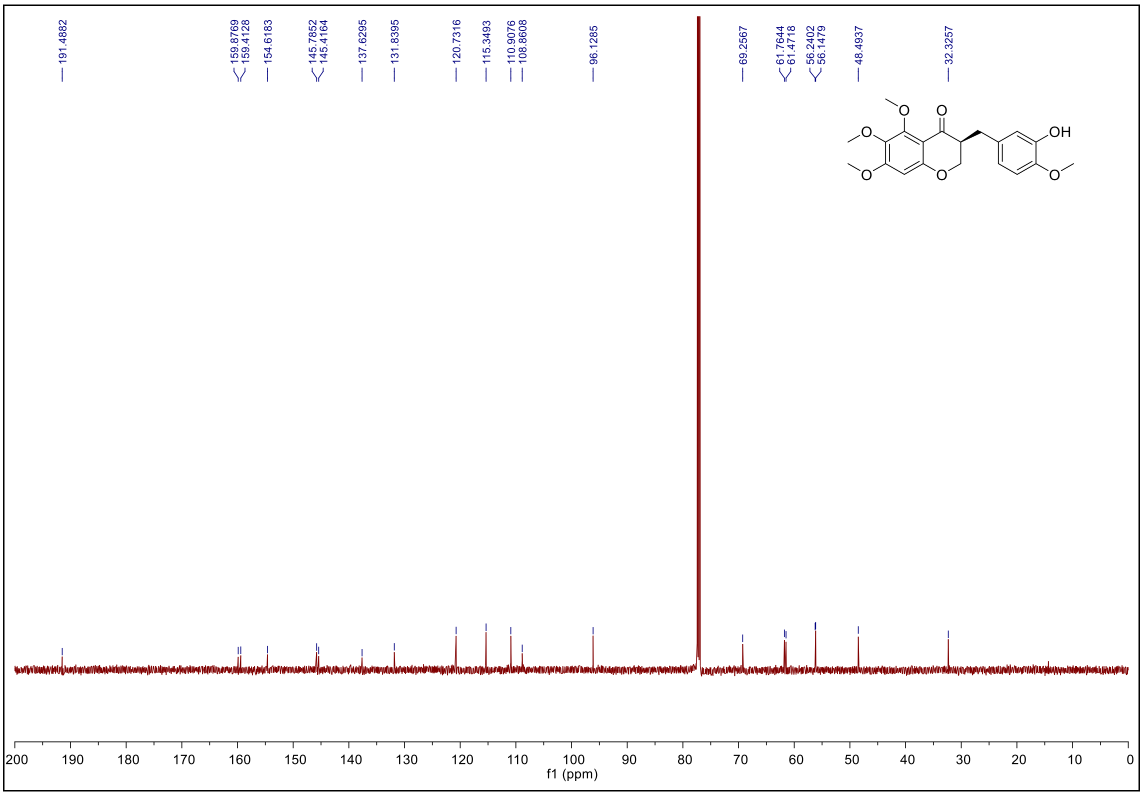


(*S*)-3-(3-hydroxy-4-methoxybenzyl)-5,6,7-trimethoxychroman-4-one ((*S*)-2)

^{1}H NMR (600 MHz, $CDCl_3$)

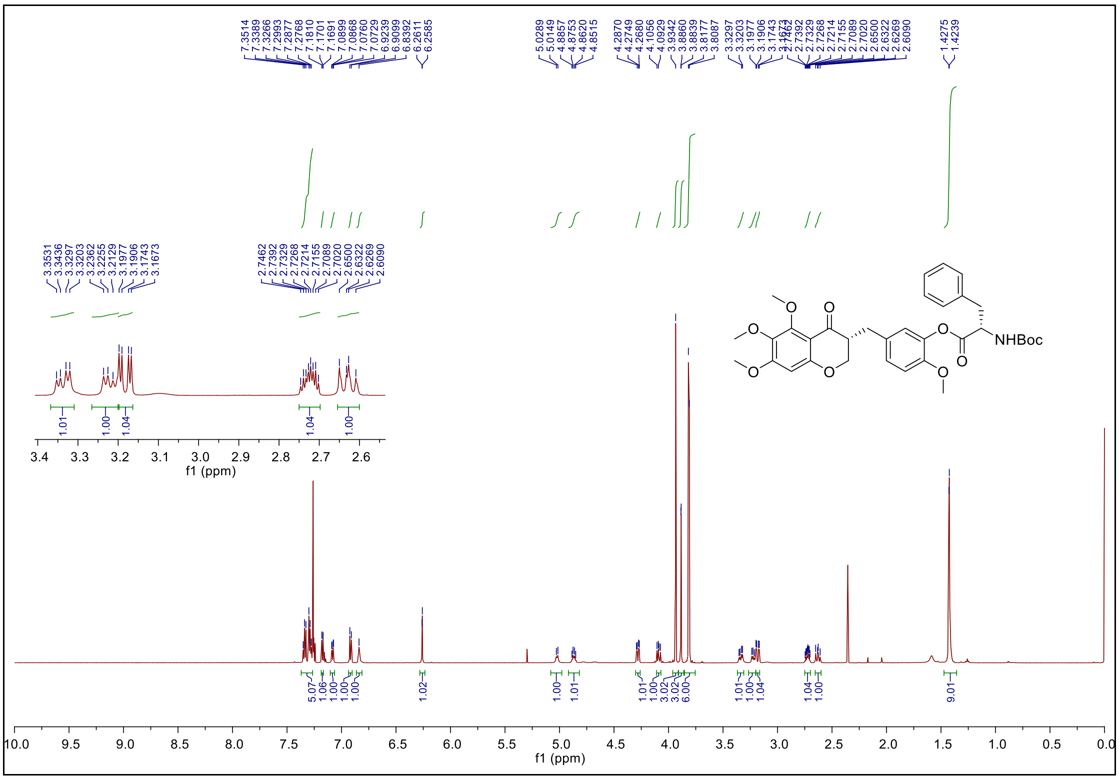


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

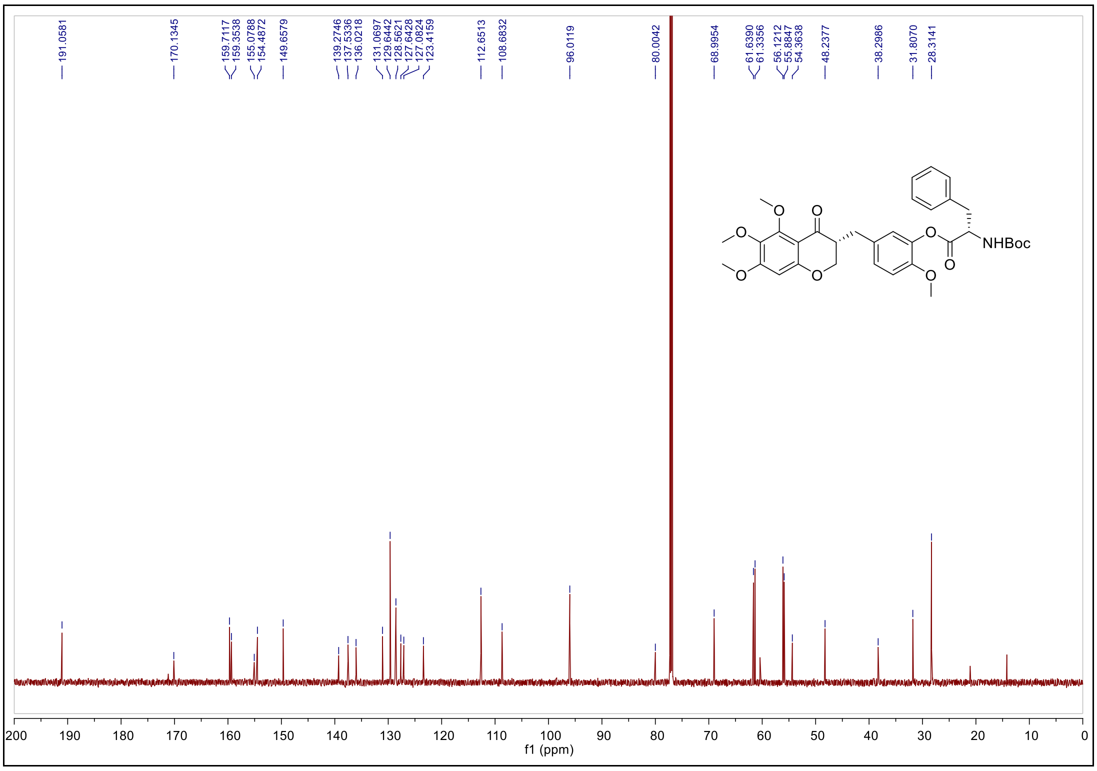


2-Methoxy-5-(((*R*)-5,6,7-trimethoxy-4-oxochroman-3-yl)methyl)phenyl(tert-butoxycarbonyl)-L-phenylalaninate ((*R*,*S*)-3)

^{1}H NMR (600 MHz, $CDCl_3$)

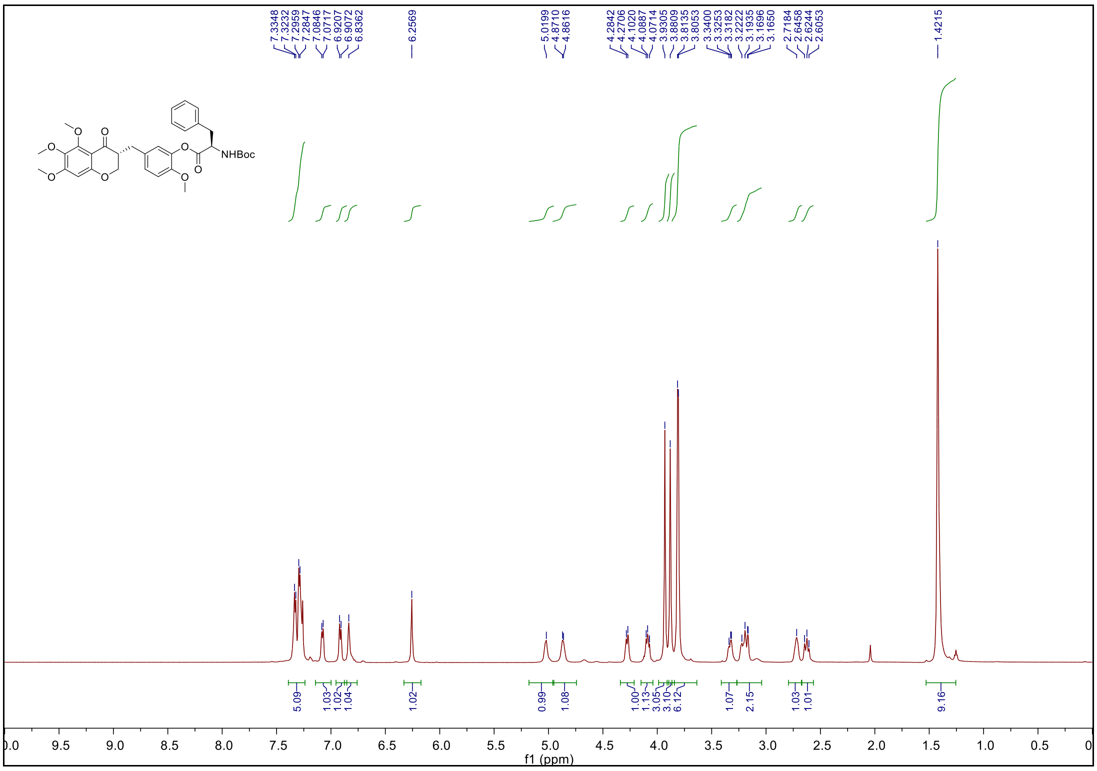


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

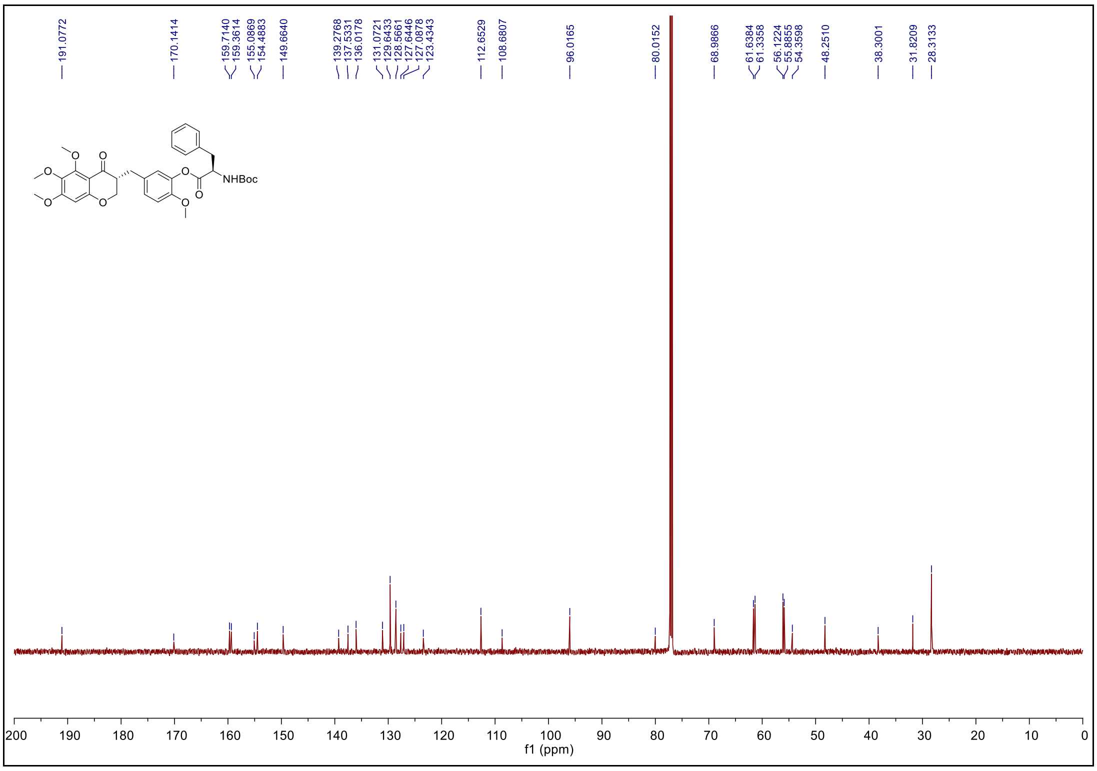


2-Methoxy-5-(((*R*)-5,6,7-trimethoxy-4-oxochroman-3-yl)methyl)phenyl(tert-butoxycarbonyl)-D-phenylalaninate ((*R*,*R*)-3)

^{1}H NMR (600 MHz, $CDCl_3$)

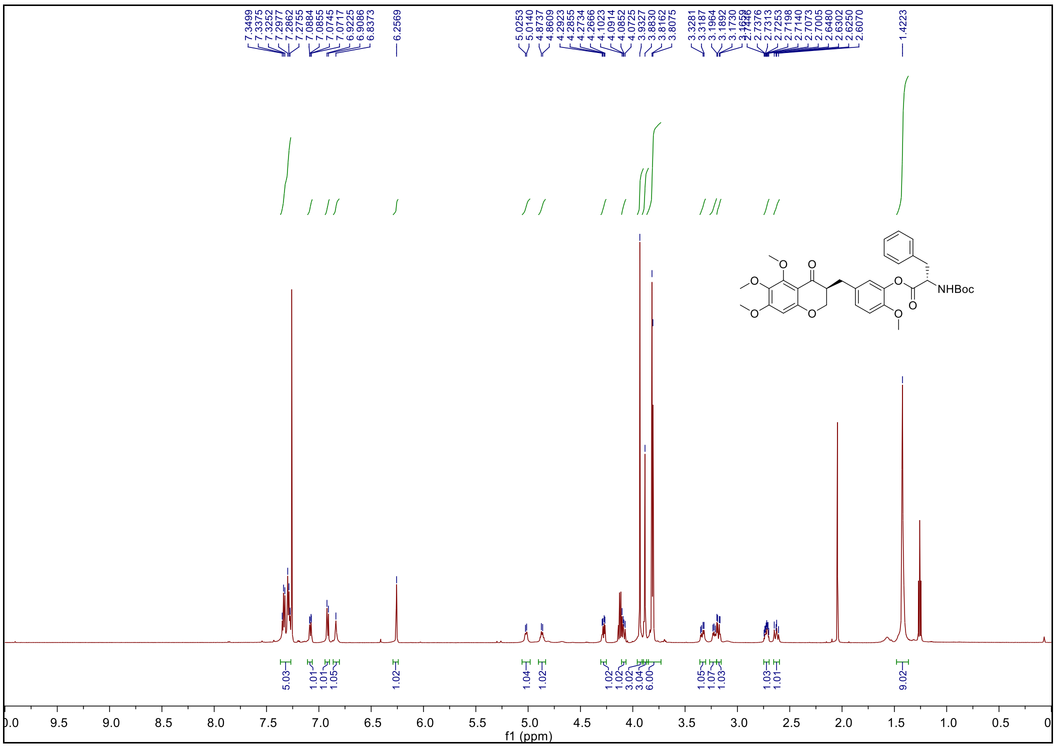


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

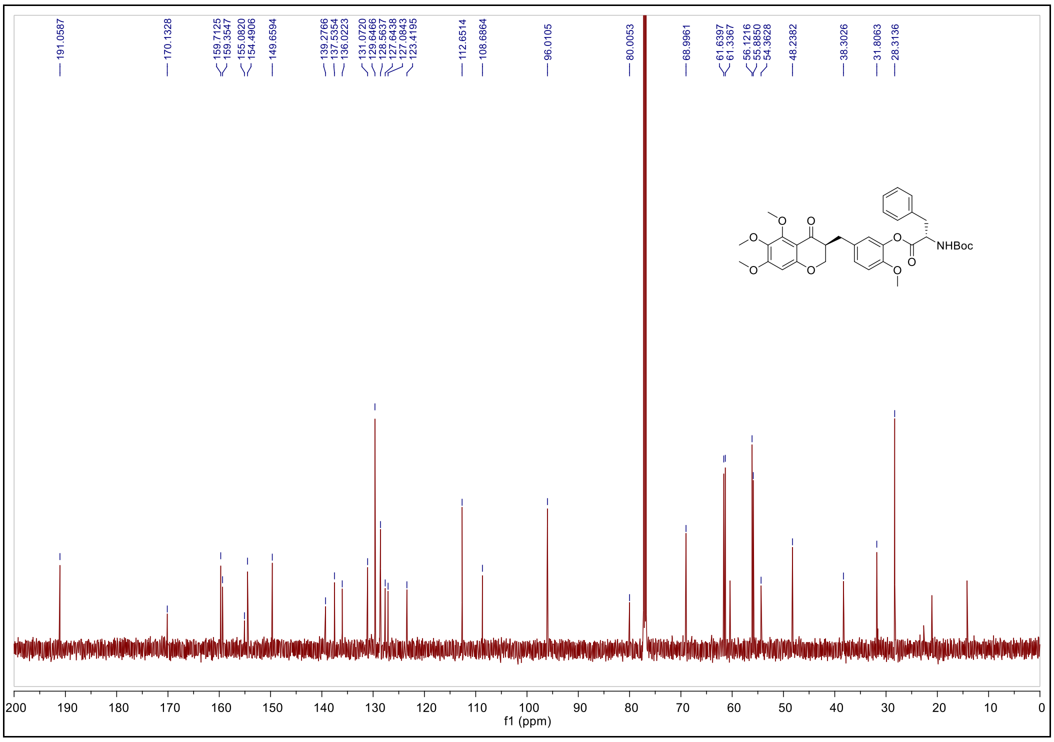


2-Methoxy-5-(((*S*)-5,6,7-trimethoxy-4-oxochroman-3-yl)methyl)phenyl(tert-butoxycarbonyl)-L-phenylalaninate ((*S*,*S*)-3)

^{1}H NMR (600 MHz, $CDCl_3$)

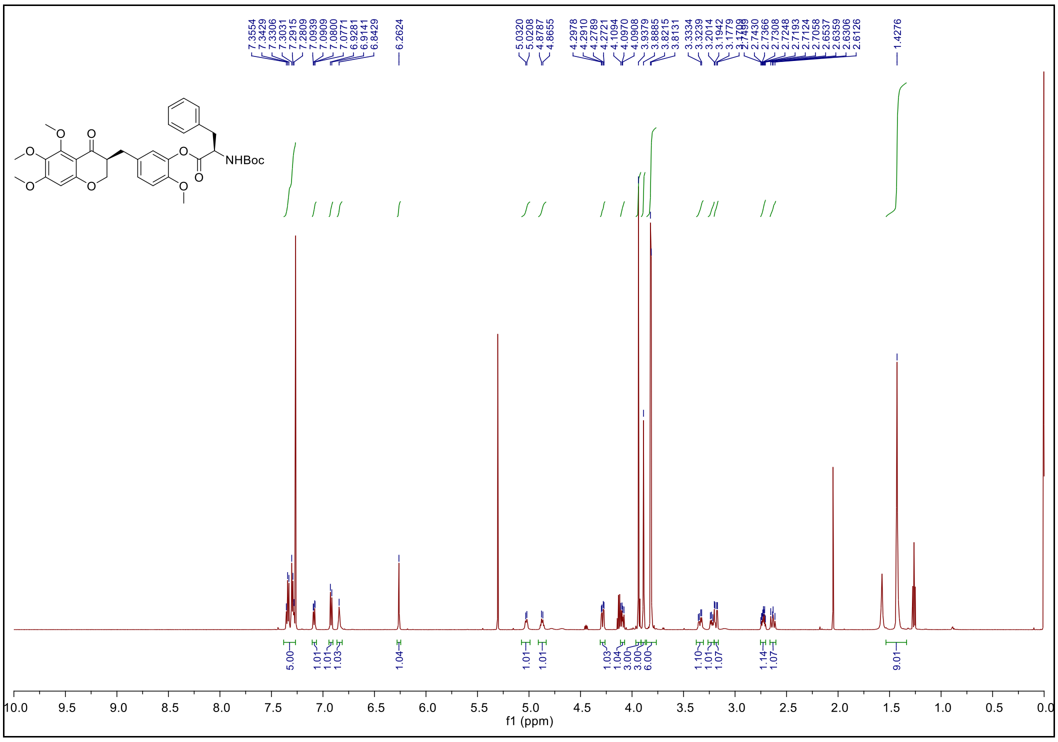


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

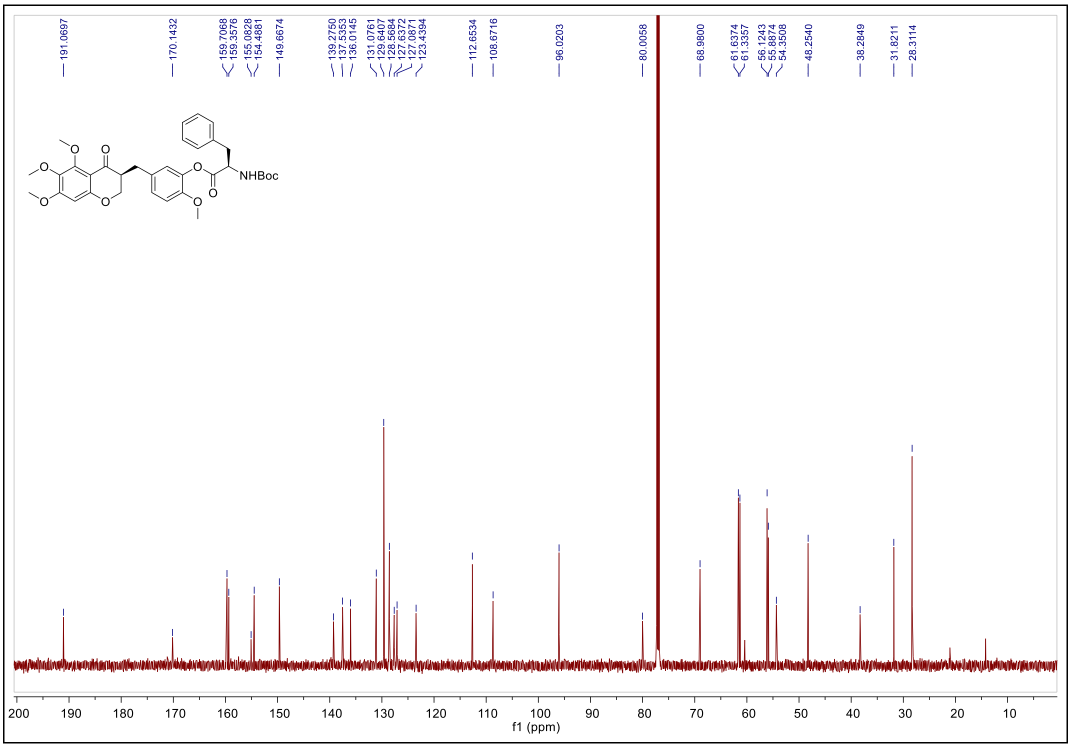


2-Methoxy-5-(((*S*)-5,6,7-trimethoxy-4-oxochroman-3-yl)methyl)phenyl(tert-butoxycarbonyl)-D-phenylalaninate ((*S*,*R*)-3)

^{1}H NMR (600 MHz, $CDCl_3$)

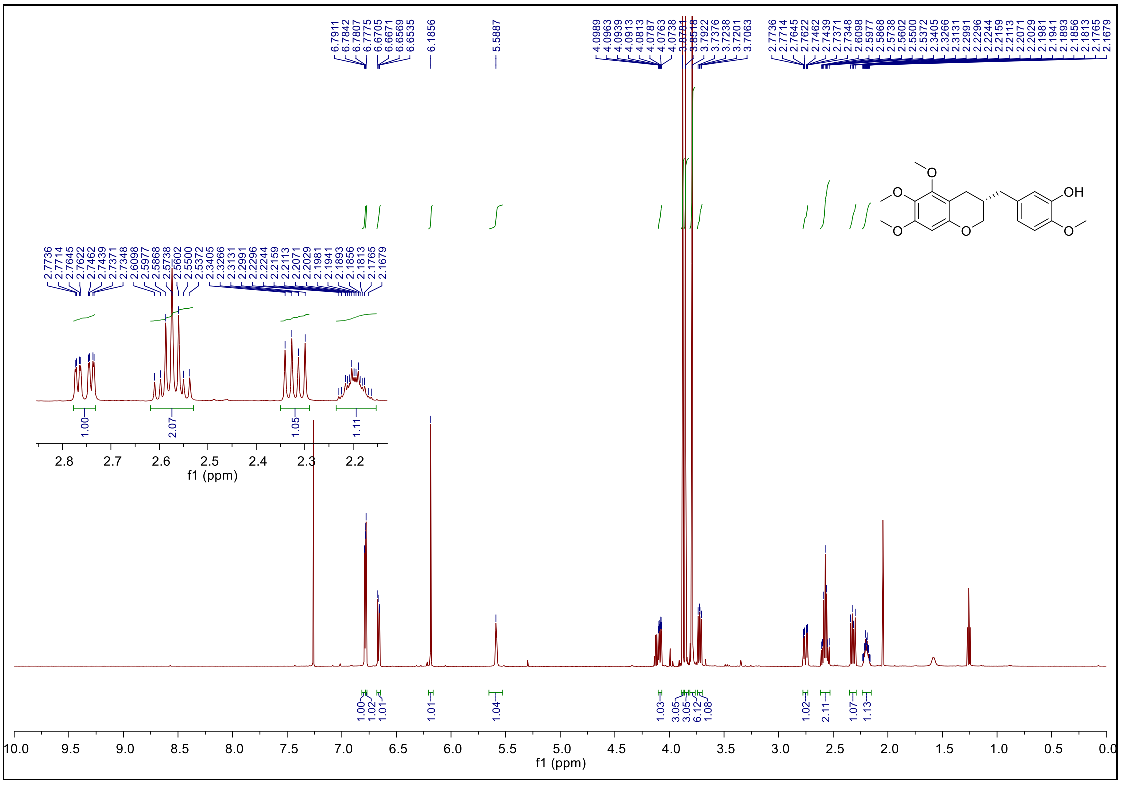


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

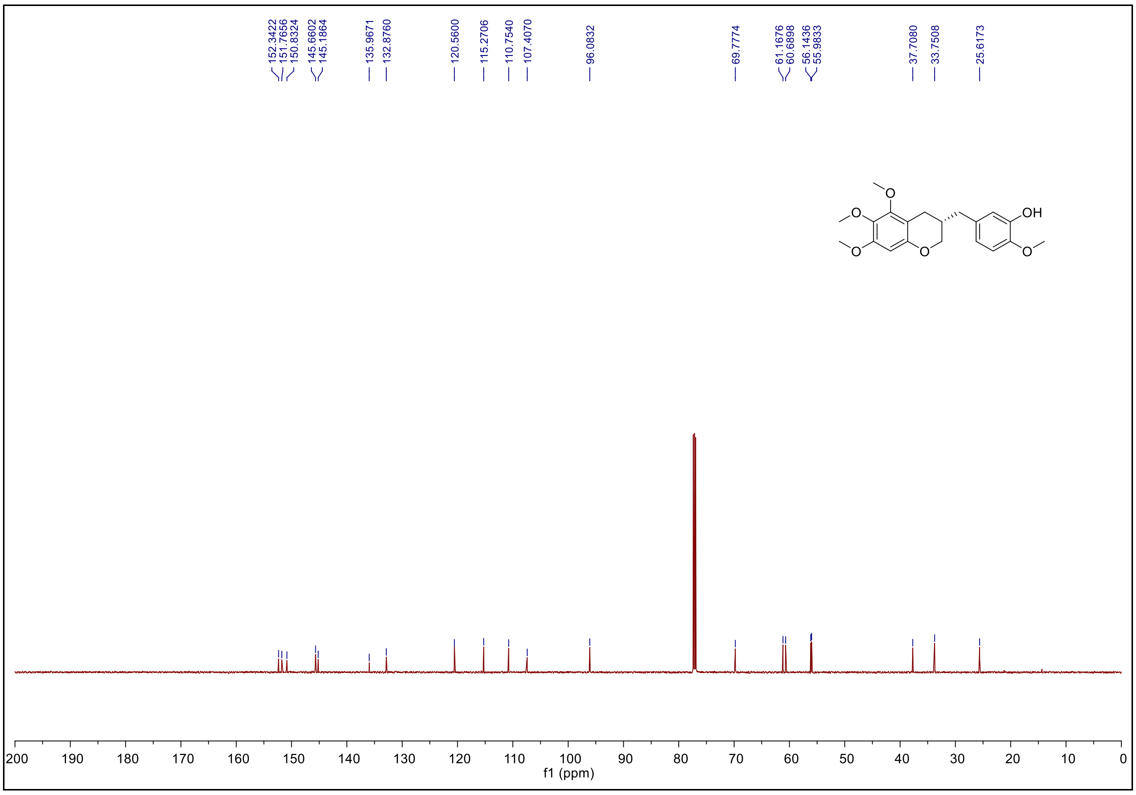


(*S*)-2-methoxy-5-((5,6,7-trimethoxychroman-3-yl)methyl)phenol ((*S*)-10)

^{1}H NMR (600 MHz, $CDCl_3$)

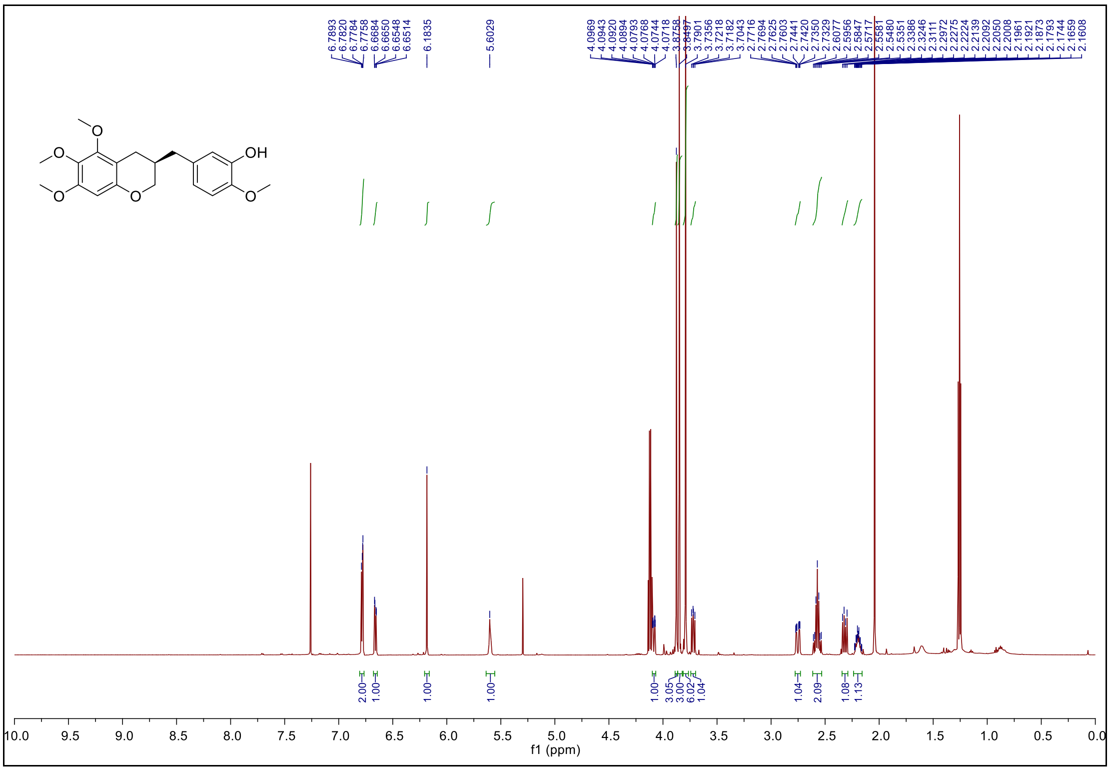


$^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$)

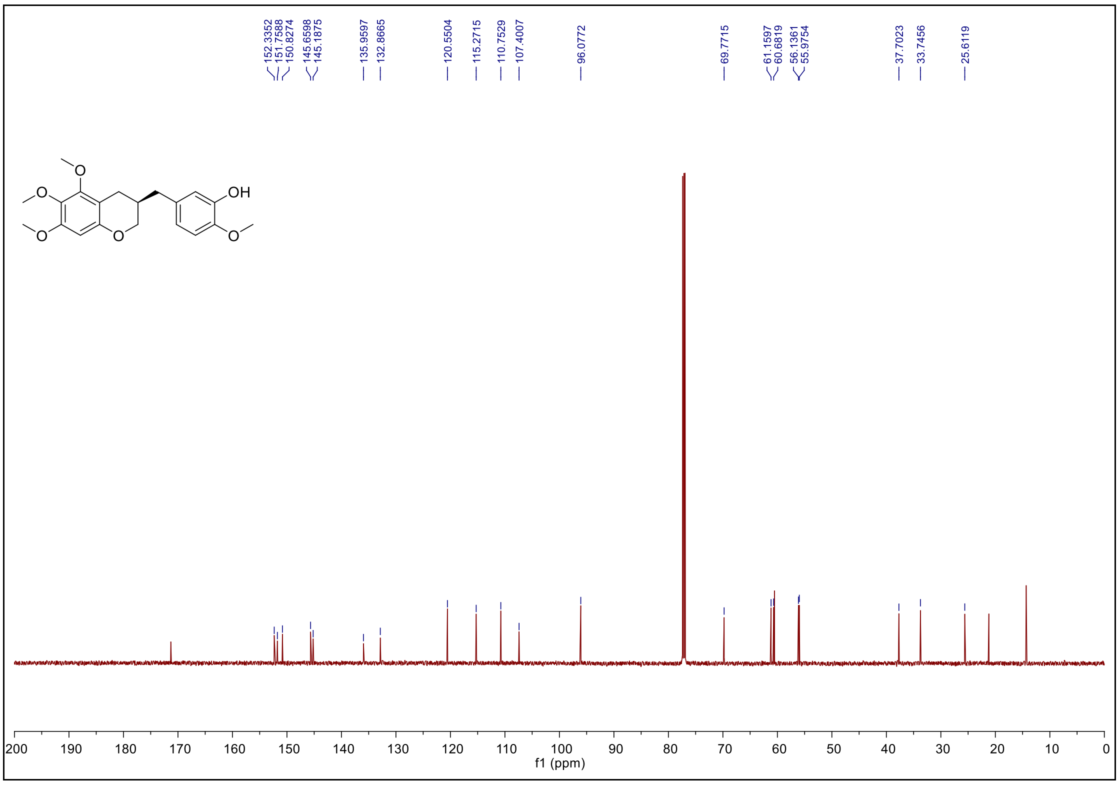


(*R*)-2-methoxy-5-((5,6,7-trimethoxychroman-3-yl)methyl)phenol ((*R*)-10)

^{1}H NMR (600 MHz, $CDCl_3$)

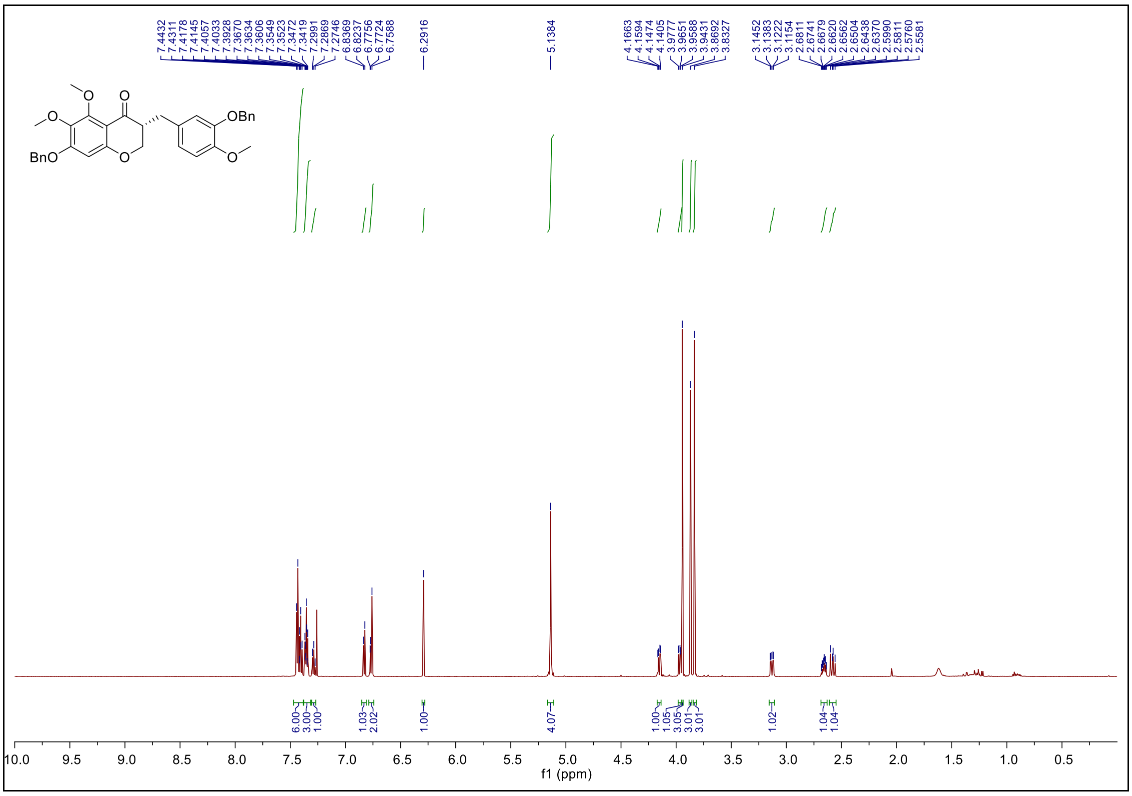


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

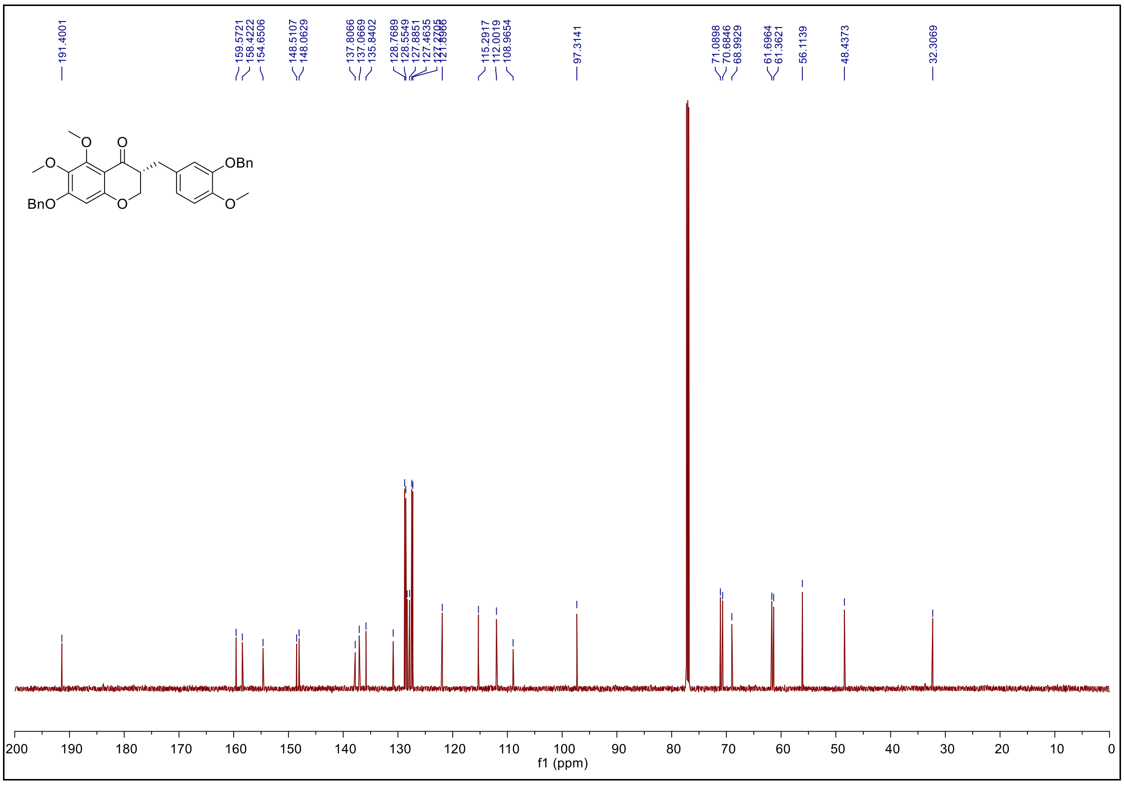


(*R*)-7-(benzyloxy)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6-dimethoxychroman-4-one((*R*)-11)

^{1}H NMR (600 MHz, $CDCl_3$)

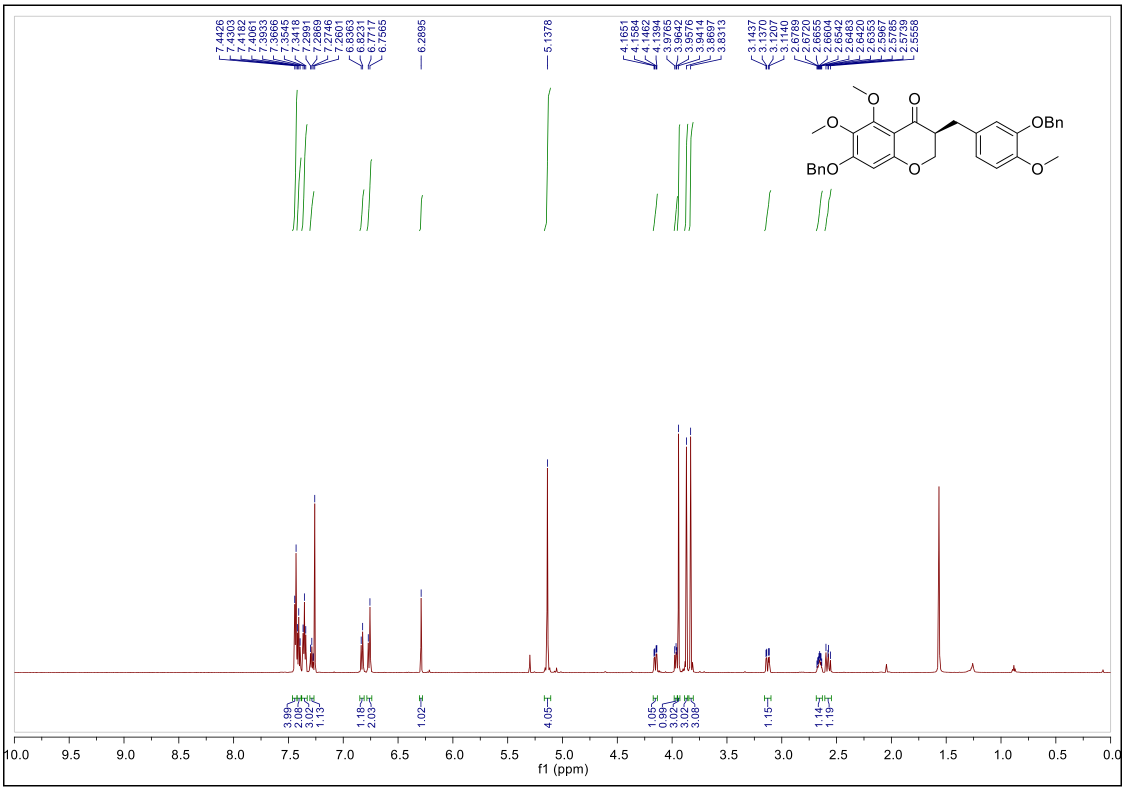


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

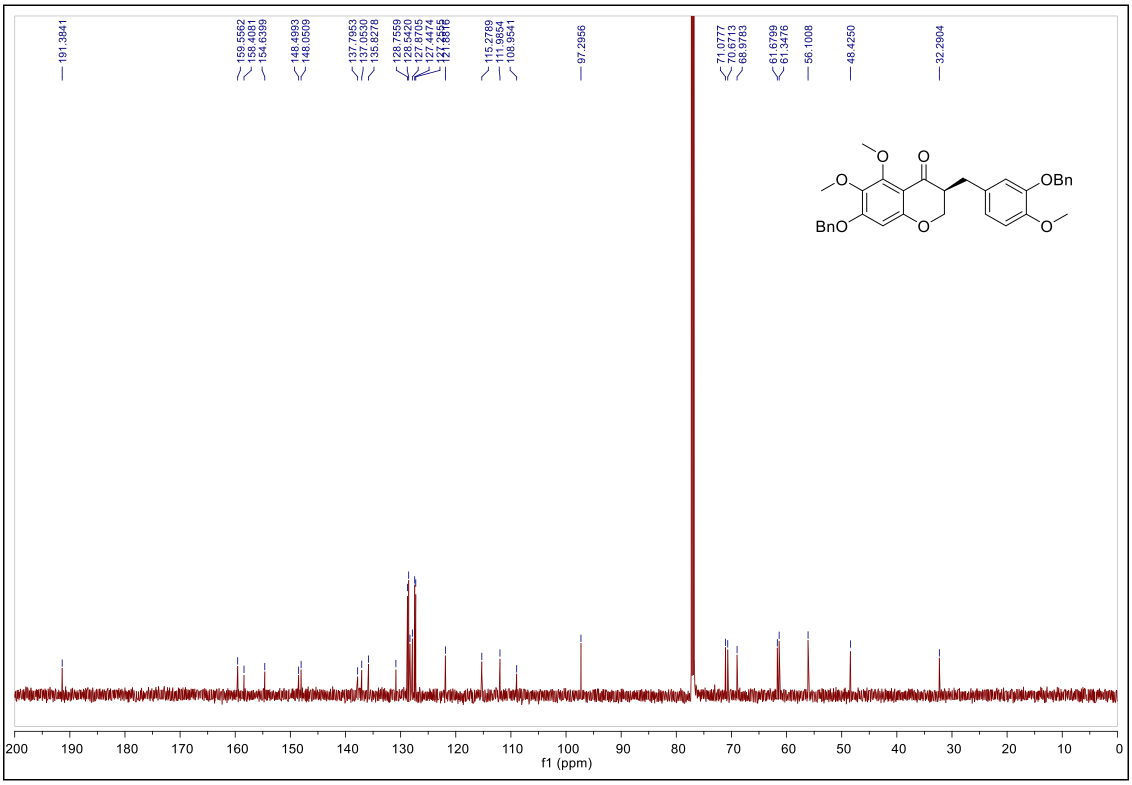


(*S*)-7-(benzyloxy)-3-(3-(benzyloxy)-4-methoxybenzyl)-5,6-dimethoxychroman-4-one ((*S*)-11)

^{1}H NMR (600 MHz, $CDCl_3$)

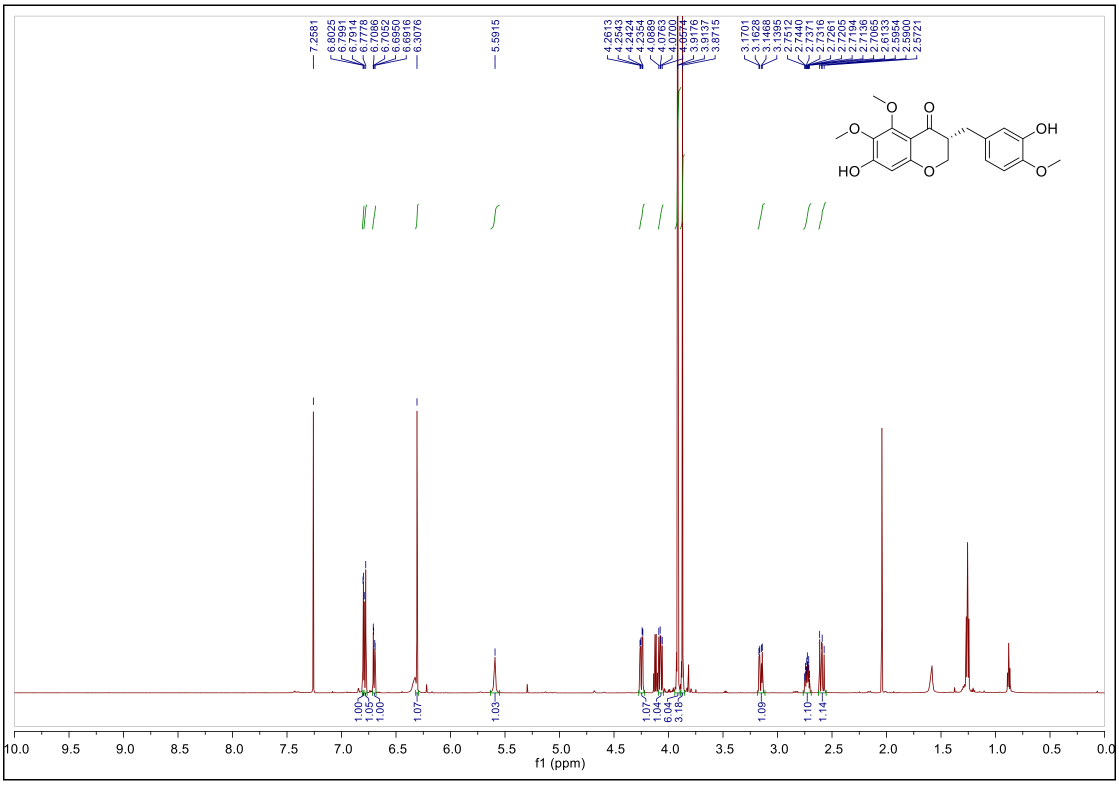


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

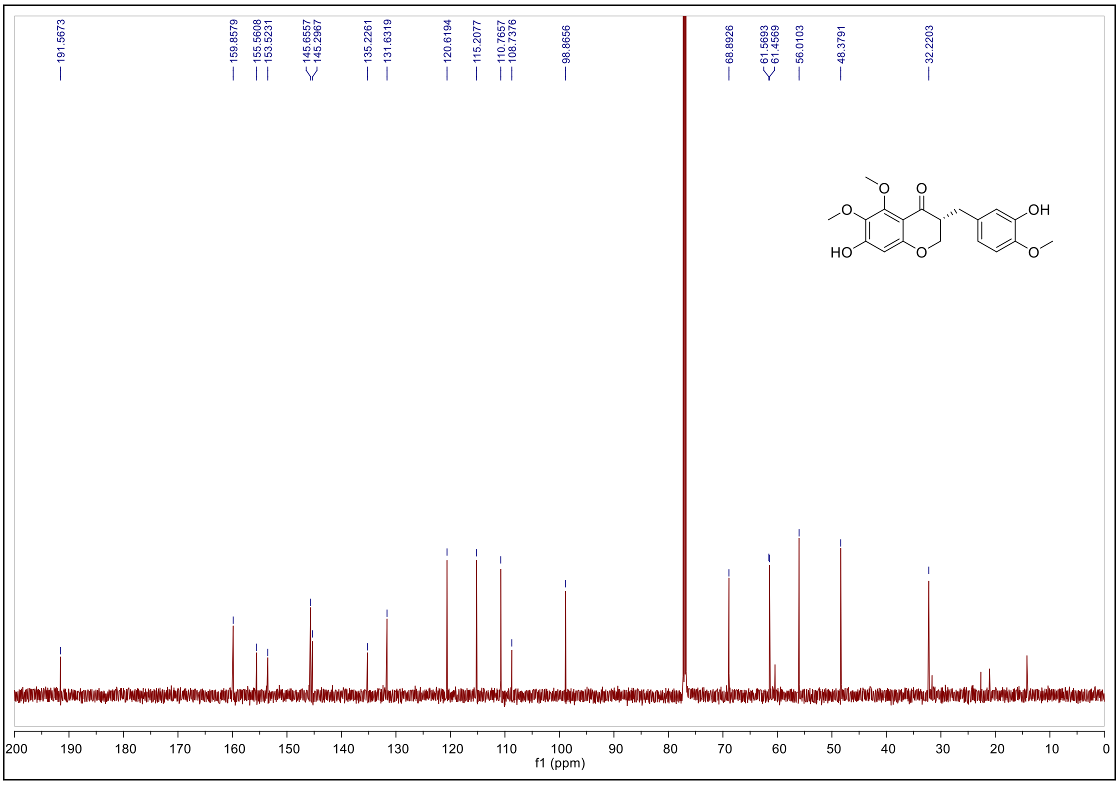


7-Hydroxy-3-(3-hydroxy-4-methoxybenzyl)-5,6-dimethoxychroman-4-one ((*R*)-6)

^{1}H NMR (600 MHz, $CDCl_3$)

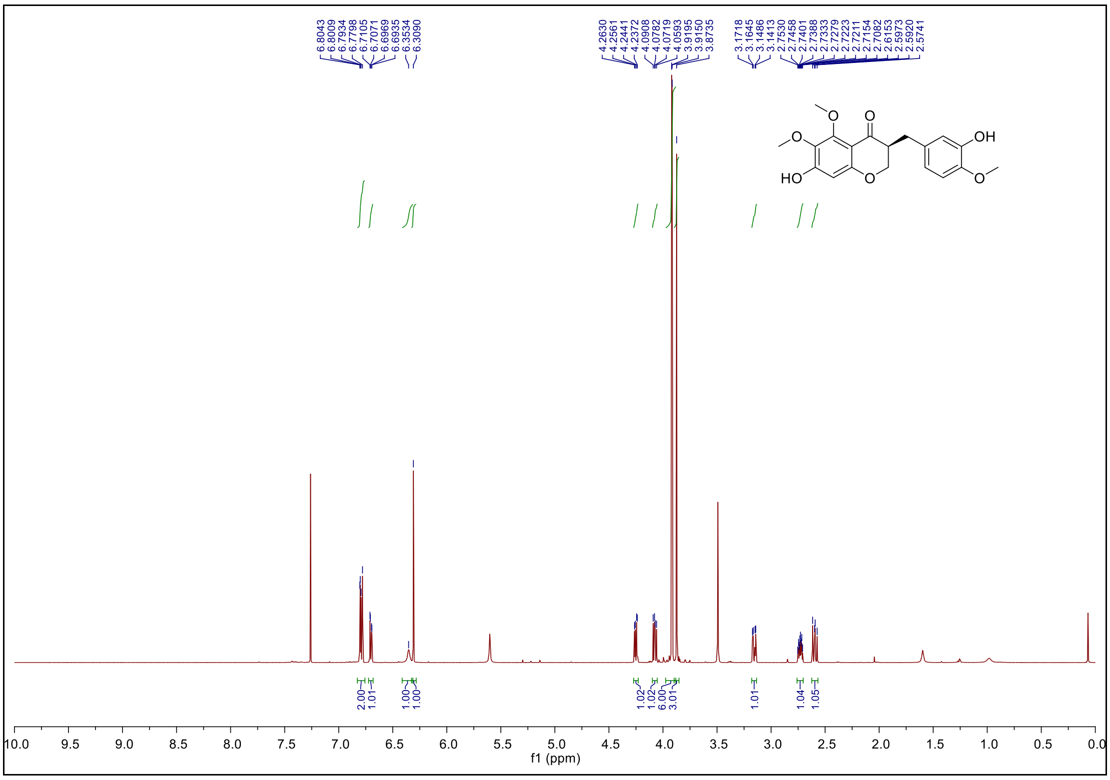


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

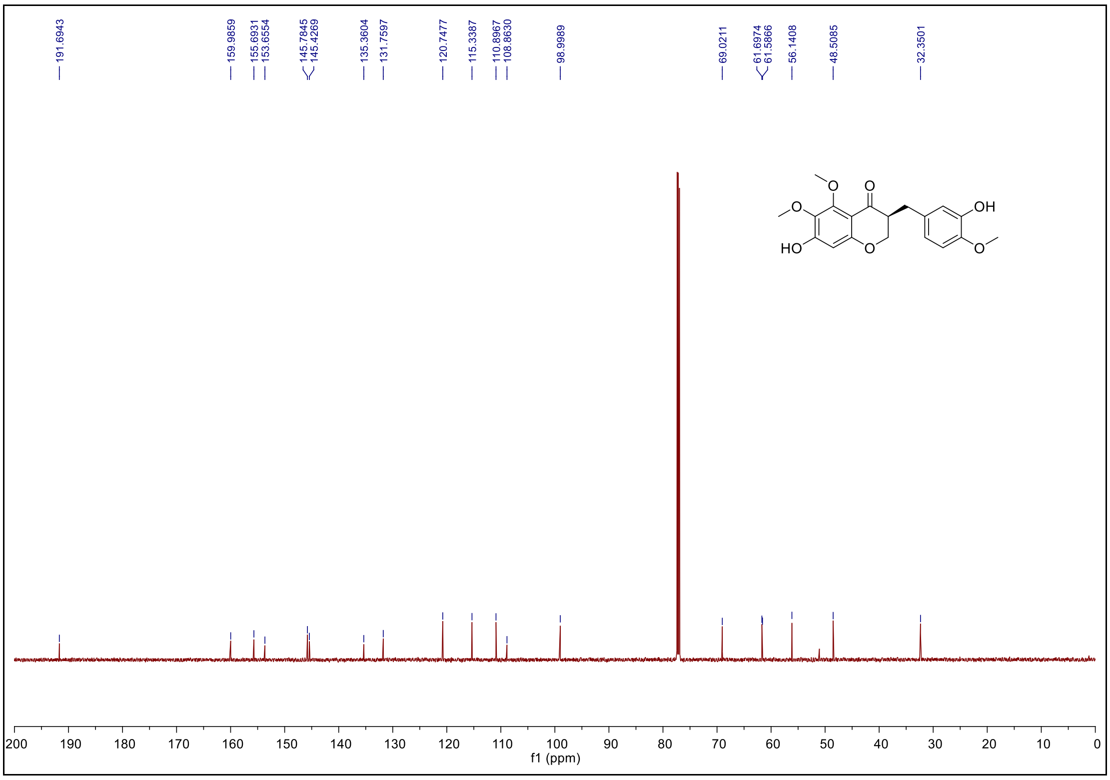


7-Hydroxy-3-(3-hydroxy-4-methoxybenzyl)-5,6-dimethoxychroman-4-one ((*S*)-6)

^{1}H NMR (600 MHz, $CDCl_3$)

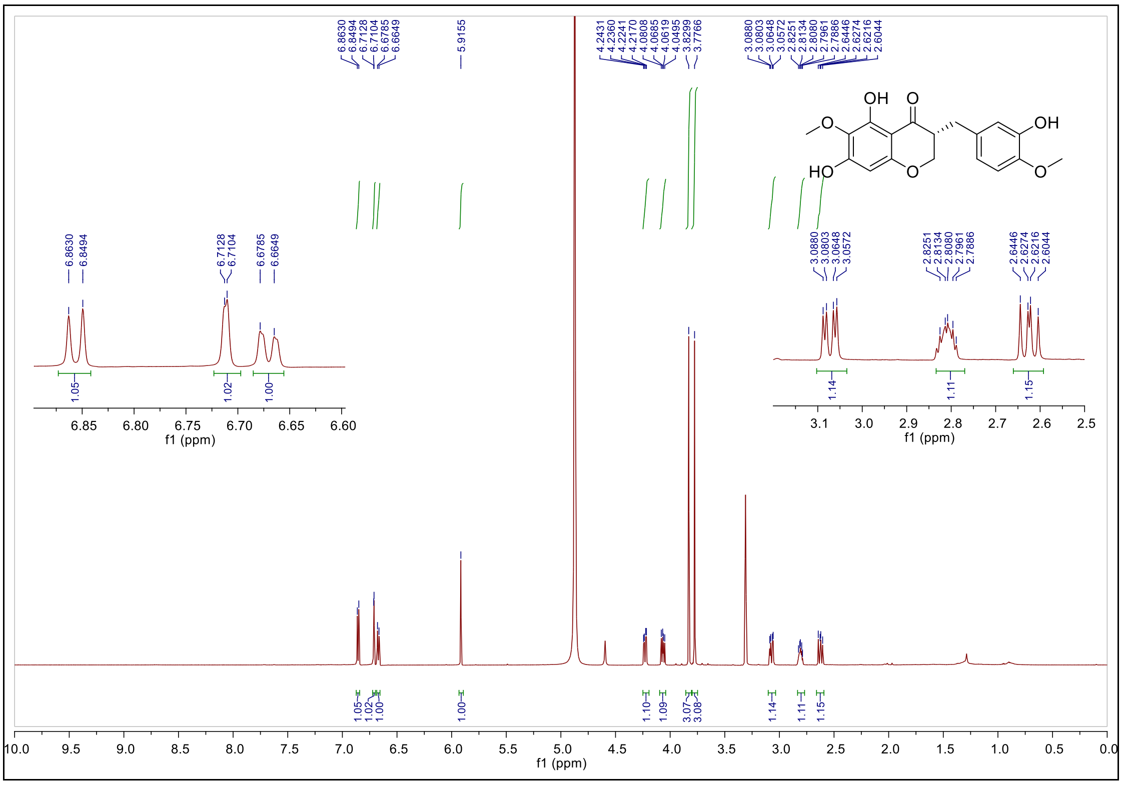


^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$)

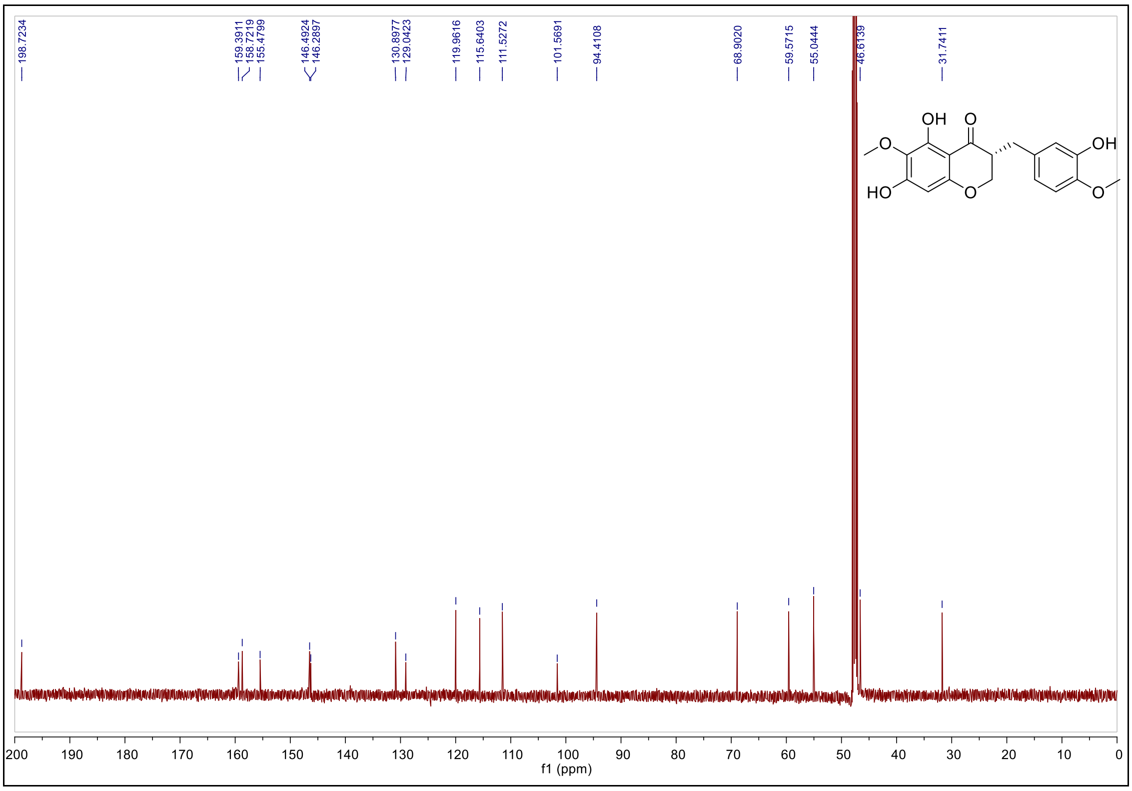


(*R*)-Cremastranone ((*R*)-1)

^{1}H NMR (600 MHz, CD_3OD)

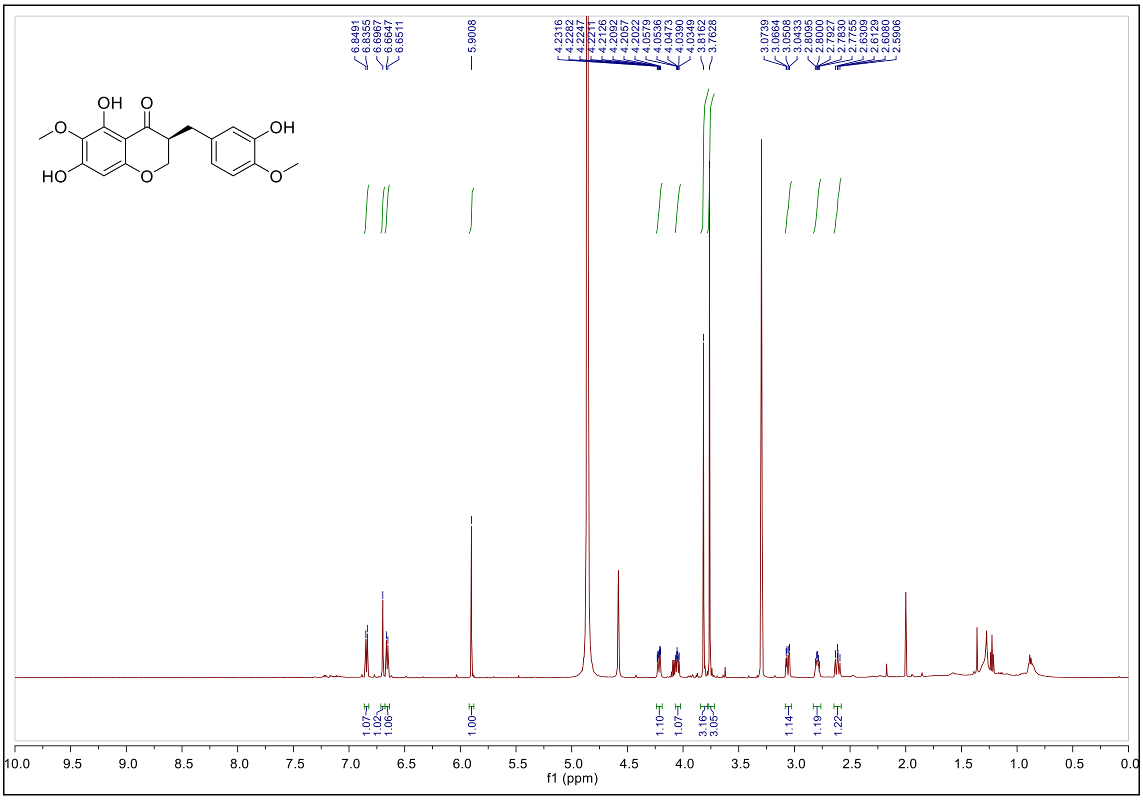


^{13}C{^{1}H} NMR (150 MHz, CD_3OD)

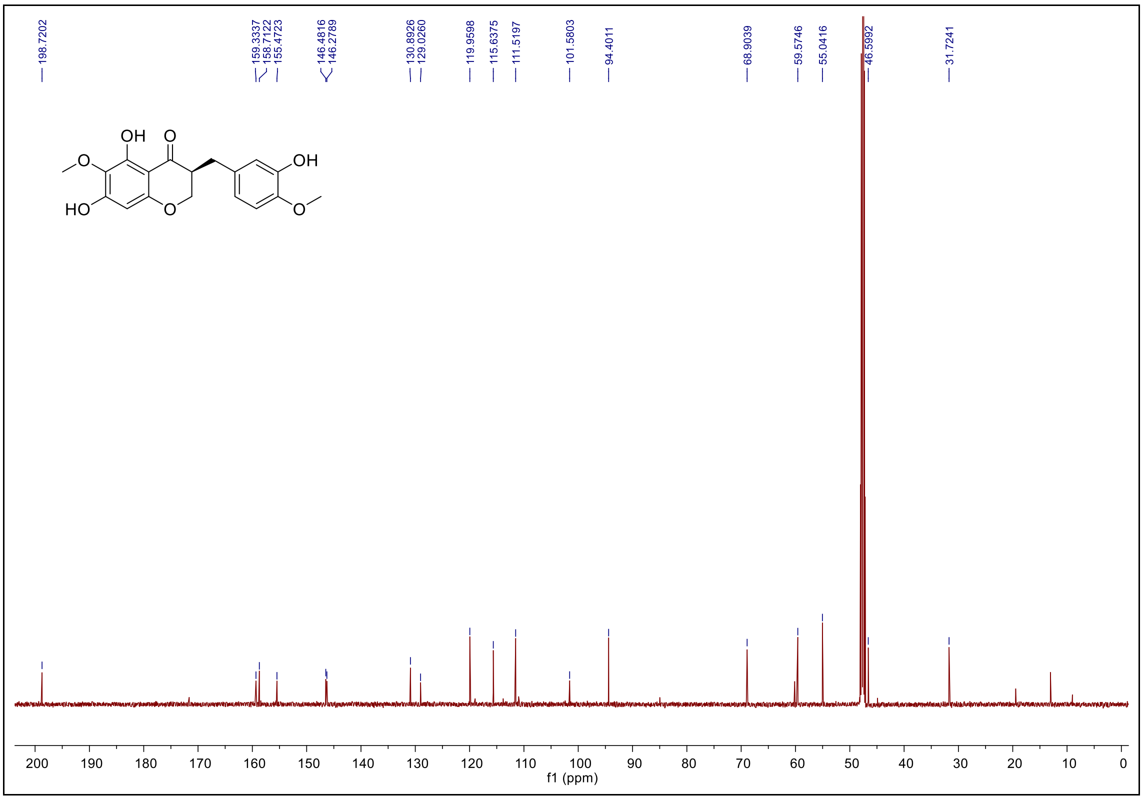


(*S*)-Cremastranone ((*S*)-1)

^1H NMR (600 MHz, CD_3OD)



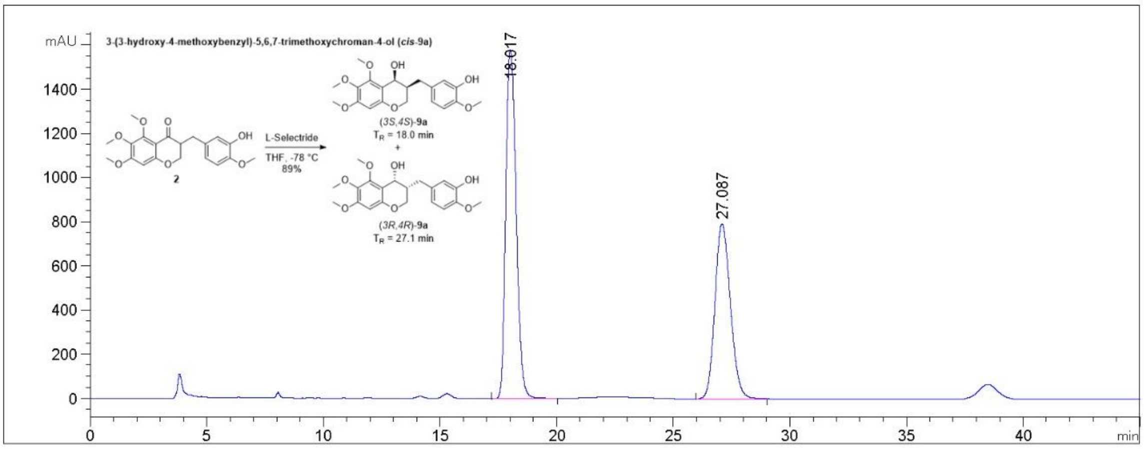
$^{13}C\{^1H\}$ NMR (150 MHz, CD_3OD)



7. Copies of chiral HPLC

1) Racemic **9a**

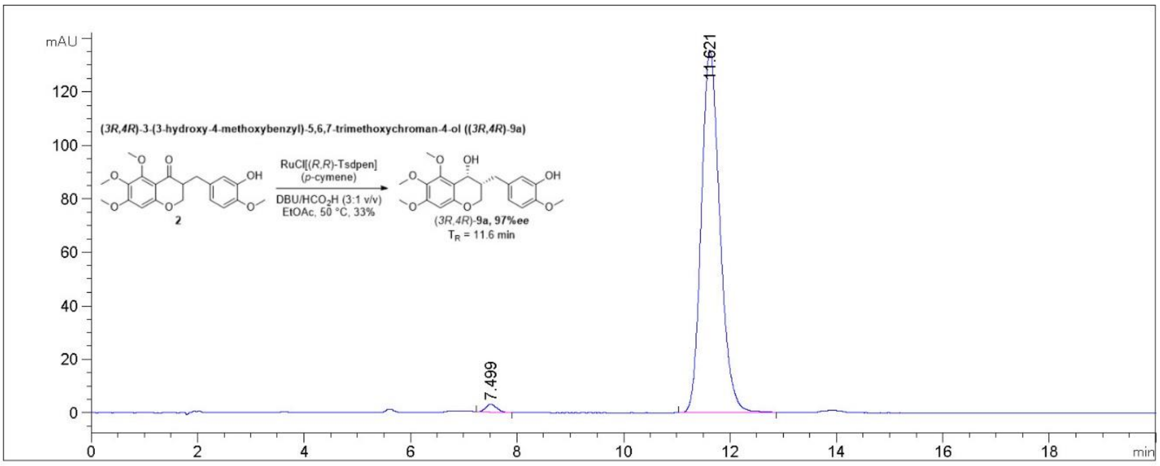
```
Sample Name: mhy 4-74-RS
    =====================================================================
    Acq. Operator   : JHJIN                          Seq. Line :   3
    Acq. Instrument : Instrument 1                    Location : Vial 3
    Injection Date  : 12/4/2018 5:59:42 PM                 Inj :   1
                                                    Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\DEF_LC 2018-12-04 15-43-49\1.M
    Last changed    : 12/4/2018 3:43:47 PM by JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 7:53:02 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3
                      Hex/EtOH=60/40
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 C, Sig=210,8 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1  18.017 BB    0.4878 4.87470e4 1580.82031 57.2661
       2  27.087 BB    0.7093 3.63767e4  792.74335 42.7339

    Totals :                  8.51237e4 2373.56366


    =====================================================================
                          *** End of Report ***
```

2) (3*R*,4*R*)-9a (Table 2, entry 7)

```
Sample Name: BL-9-84
    =====================================================================
    Acq. Operator   :                                  Seq. Line :    5
    Acq. Instrument : Instrument 1                      Location : Vial 61
    Injection Date  : 4/25/2018 9:00:14 PM                   Inj :    1
                                                      Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M
    Last changed    : 4/25/2018 5:53:28 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:01:46 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 E, Sig=280,16 Ref=360,100
```

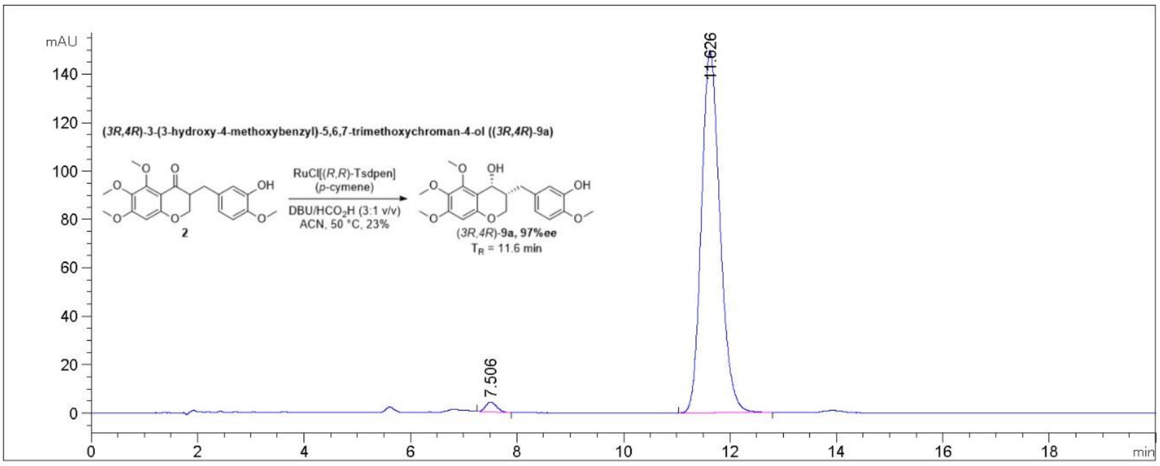
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.499	BB	0.2191	41.94565	2.89343	1.2660
2	11.621	BB	0.3718	3271.36182	135.45758	98.7340

Totals :		3313.30746	138.35101

```
    =====================================================================
                          *** End of Report ***
```

3) (3*R*,4*R*)-9a (Table 2, entry 8)

```
Sample Name: BL-9-8S
    =====================================================================
    Acq. Operator   :                                 Seq. Line :   9
    Acq. Instrument : Instrument 1                     Location : Vial 65
    Injection Date  : 4/26/2018 12:05:45 AM                 Inj :   1
                                                     Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M
    Last changed    : 4/25/2018 5:53:28 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:01:02 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```



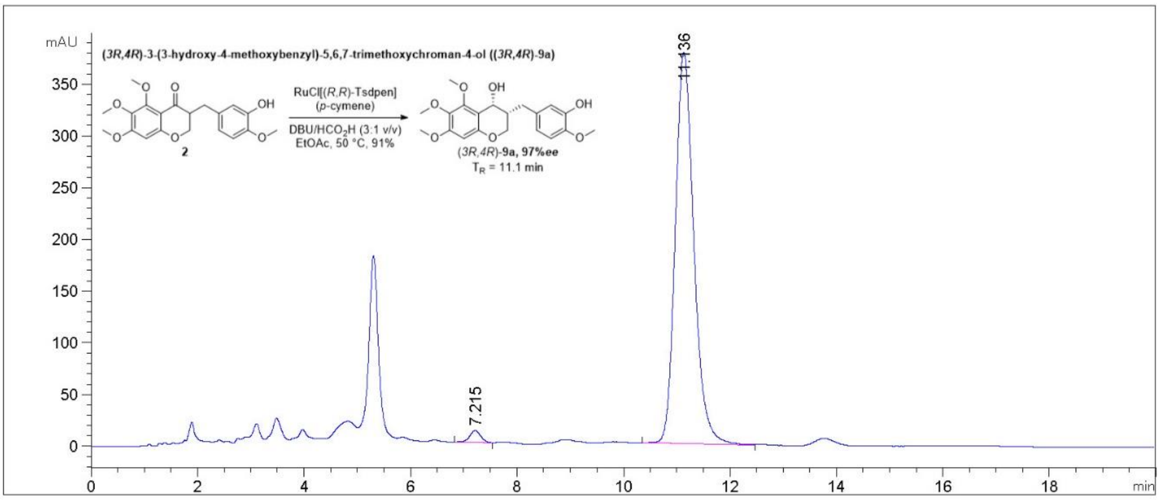

```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 E, Sig=280,16 Ref=360,100
```

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.506	BB	0.2131	57.09267	4.03495	1.5537
2	11.626	BB	0.3718	3617.57837	149.74373	98.4463
Totals :				3674.67104	153.77868	

```
    =====================================================================
                         *** End of Report ***
```

4) (3*R*,4*R*)-9a (Table 2, entry 9)

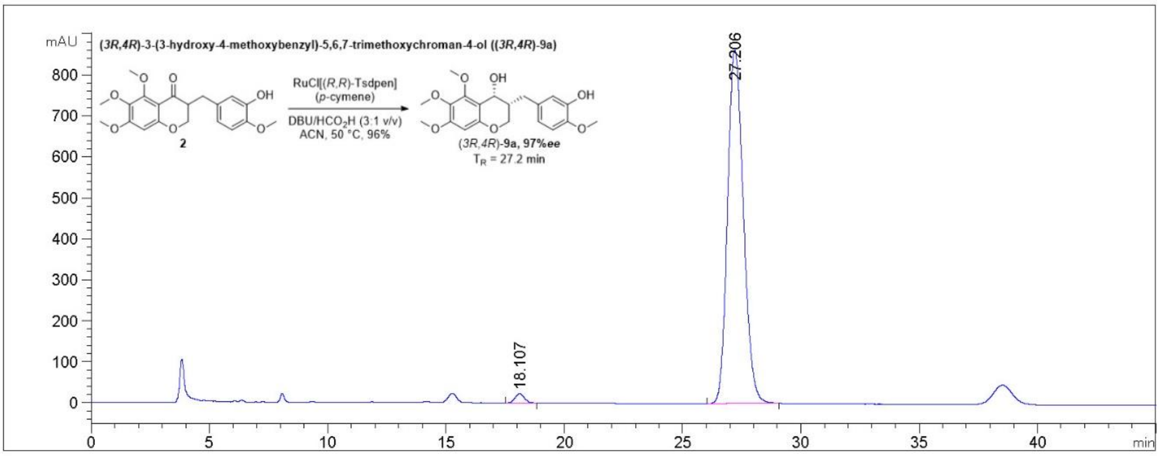
```
Sample Name: BL-120-2
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                  Seq. Line :    4
    Acq. Instrument : Instrument 1                   Location : Vial 94
    Injection Date  : 6/8/2018 6:03:53 AM                 Inj :    1
                                                   Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 6/8/2018 4:57:47 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:00:12 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 A, Sig=215,4 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1   7.215 BB    0.2126  163.92651   11.47643   1.7662
   2  11.136 BV    0.3694 9117.44238  377.95490  98.2338

Totals :                  9281.36890  389.43132


=====================================================================
                          *** End of Report ***
```

5) (3*R*,4*R*)-9a (Table 2, entry 10)

```
Sample Name: mhy 4-74-R
    =====================================================================
    Acq. Operator   : JHJIN                          Seq. Line :   1
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 12/4/2018 4:15:43 PM                 Inj :   1
                                                    Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\DEF_LC 2018-12-04 15-43-49\1.M
    Last changed    : 12/4/2018 3:43:47 PM by JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:11:32 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3
                      Hex/EtOH=60/40
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By          :      Signal
    Multiplier         :      1.0000
    Dilution           :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 C, Sig=210,8 Ref=360,100

    Peak RetTime Type  Width    Area      Height     Area
      #   [min]        [min]   [mAU*s]    [mAU]       %
    ----|-------|----|-------|----------|----------|--------|
       1  18.107 BB     0.3876  628.83606   22.67378   1.5413
       2  27.206 BB     0.7115 4.01703e4   862.27692  98.4587

    Totals :                   4.07991e4   884.95070


    =====================================================================
                          *** End of Report ***
```

6) (3*S*,4*S*)-9a (Table 2, entry 11)

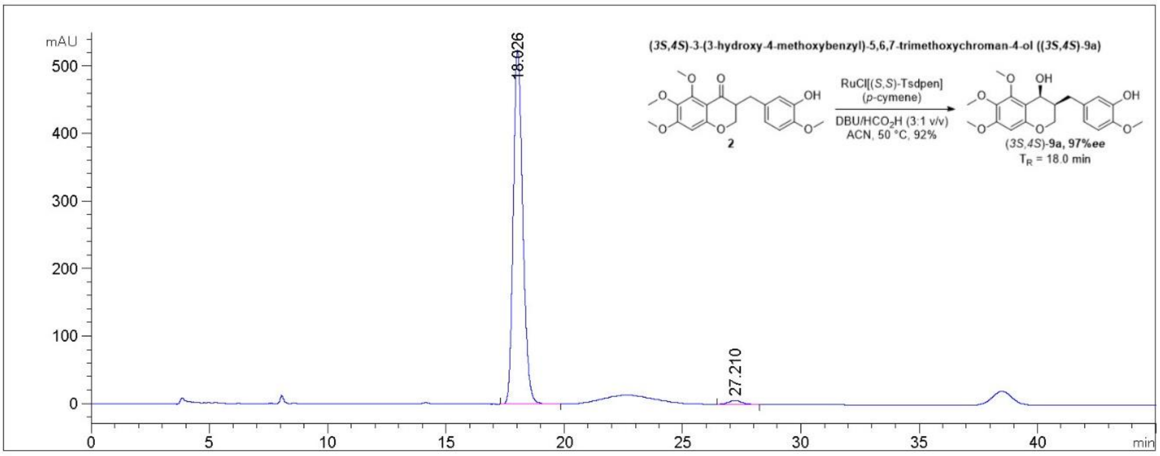
Sample Name: mhy 4-74-S

===

Acq. Operator : JHJIN Seq. Line : 2
Acq. Instrument : Instrument 1 Location : Vial 2
Injection Date : 12/4/2018 5:07:46 PM Inj : 1
Inj Volume : 5.0 µl
Acq. Method : C:\CHEM32\1\DATA\DEF_LC 2018-12-04 15-43-49\1.M
Last changed : 12/4/2018 3:43:47 PM by JHJIN
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 7/3/2019 8:15:28 PM by SYSTEM
(modified after loading)
Sample Info : CHIRALPAK AD-3
Hex/EtOH=60/40
Flow rate:0.5ml/min

Additional Info : Peak(s) manually integrated

===



===

Area Percent Report

===

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Do not use Multiplier & Dilution Factor with ISTDs

Signal 1: DAD1 A, Sig=230,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.026	BB	0.4294	1.46251e4	524.37988	98.3925
2	27.210	BB	0.5127	238.94234	5.58993	1.6075

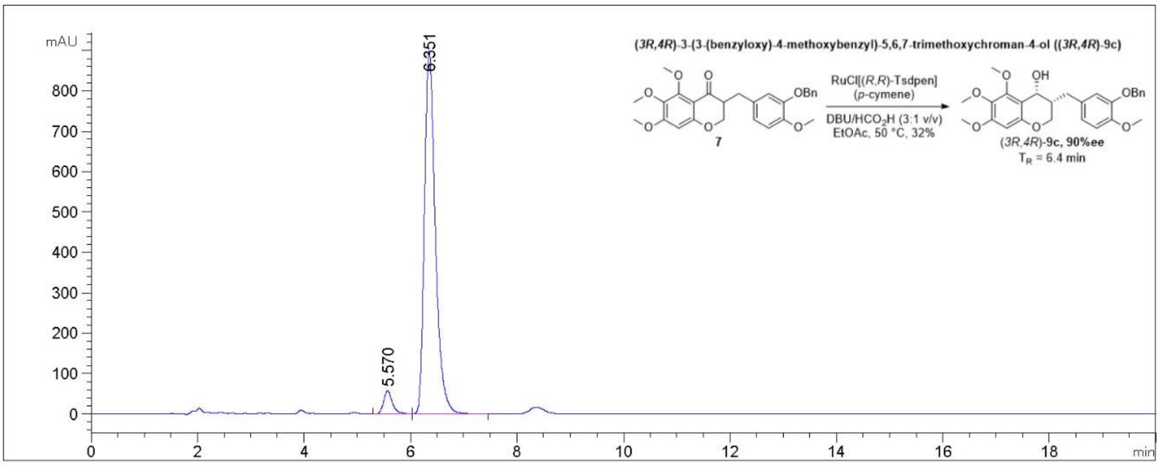
Totals : 1.48640e4 529.96981

===

*** End of Report ***

7) (3*R*,4*R*)-9c (Table 3, entry 3)

```
Sample Name: BL-9-11-2
    =====================================================================
    Acq. Operator   :                                Seq. Line :  10
    Acq. Instrument : Instrument 1                    Location : Vial 66
    Injection Date  : 4/26/2018 12:52:07 AM                Inj :   1
                                                    Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M
    Last changed    : 4/25/2018 5:53:28 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:25:23 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=230,16 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   5.570 BV    0.1755  652.27429   56.99644   4.8632
       2   6.351 VB    0.2174 1.27602e4  900.17999  95.1368

    Totals :                  1.34124e4  957.17644


    =====================================================================
                              *** End of Report ***
```

8) (3*R*,4*R*)-9c (Table 3, entry 4)

Sample Name: BL-9-89

===

Acq. Operator : Seq. Line : 7

Acq. Instrument : Instrument 1 Location : Vial 63

Injection Date : 4/25/2018 10:32:58 PM Inj : 1

Inj Volume : 5.0 µl

Acq. Method : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M

Last changed : 4/25/2018 5:53:28 PM

Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M

Last changed : 7/3/2019 8:27:11 PM by SYSTEM

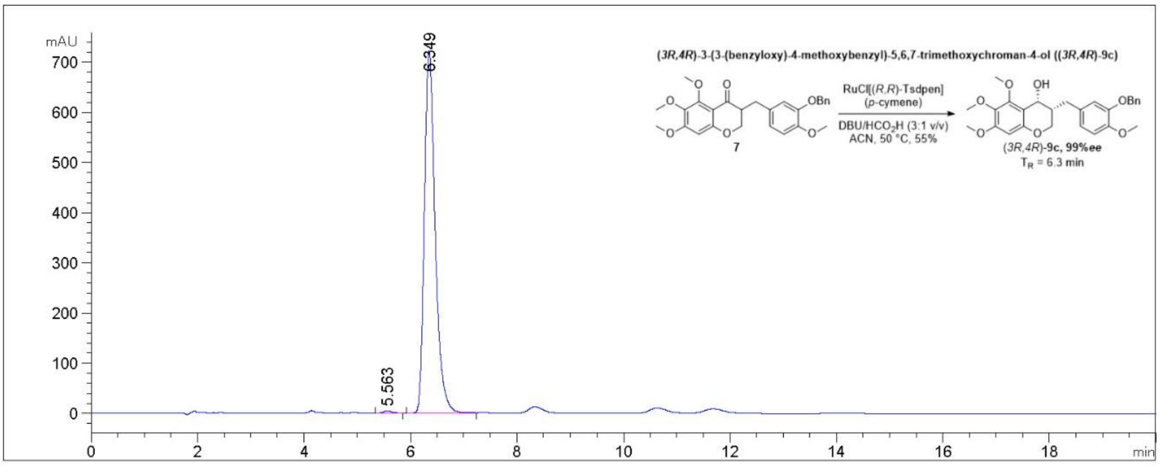
(modified after loading)

Sample Info : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,

Sample conc.: 1.2mg/mL, Temp.:RT

Additional Info : Peak(s) manually integrated

===



===

Area Percent Report

===

Sorted By : Signal

Multiplier : 1.0000

Dilution : 1.0000

Do not use Multiplier & Dilution Factor with ISTDs

Signal 1: DAD1 D, Sig=230,16 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.563	BB	0.1682	50.52208	4.67088	0.4951
2	6.349	BB	0.2159	1.01534e4	722.93781	99.5049

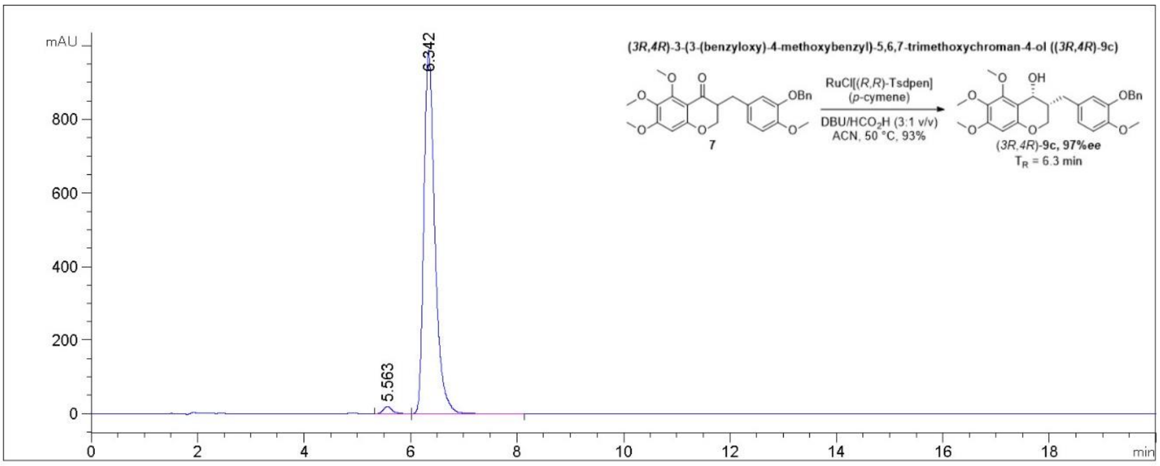
Totals : 1.02039e4 727.60868

===

*** End of Report ***

9) (3*R*,4*R*)-9c (Table 3, entry 6)

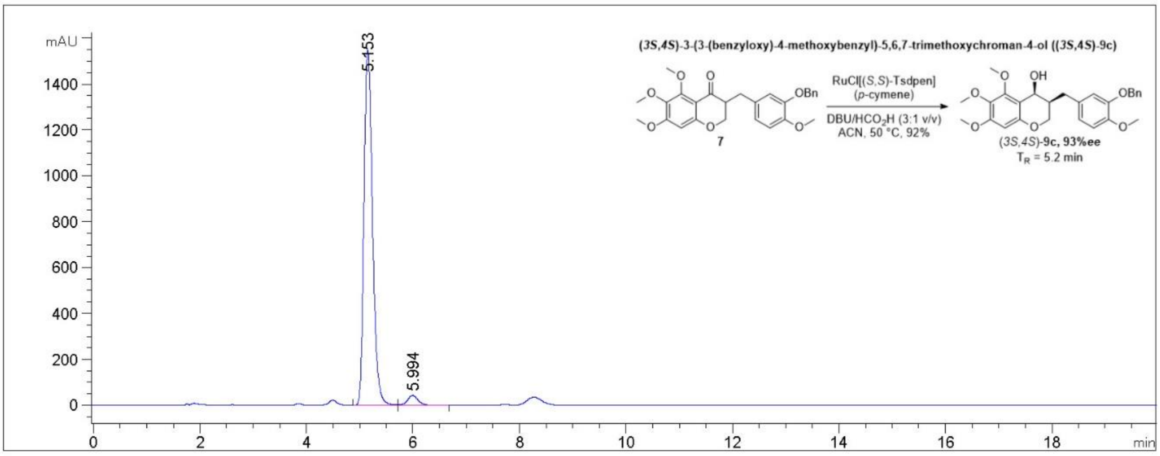
```
Sample Name: BL-9-90
    =====================================================================
    Acq. Operator   :                               Seq. Line :   8
    Acq. Instrument : Instrument 1                   Location : Vial 64
    Injection Date  : 4/25/2018 11:19:22 PM               Inj :   1
                                                   Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M
    Last changed    : 4/25/2018 5:53:28 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:28:22 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 D, Sig=230,16 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1   5.563 BV    0.1754  227.40402   19.88769   1.5827
   2   6.342 VB    0.2191 1.41409e4   987.36163  98.4173

Totals :                  1.43683e4  1007.24932


=====================================================================
                          *** End of Report ***
```

10) (3*S*,4*S*)-9c (Table 3, entry 7)

```
Sample Name: BL-9-101
    =====================================================================
    Acq. Operator    : DAICEL JHJIN                    Seq. Line :  10
    Acq. Instrument : Instrument 1                     Location : Vial 20
    Injection Date  : 5/28/2018 5:59:15 PM                  Inj :   2
                                                     Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/28/2018 11:02:19 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 6:16:18 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3,(4.6*150 mm)
                      MP: Hex/EtOH=60/40
                      Flow rate:1ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                        Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 D, Sig=230,4 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1   5.153 BV    0.1709 1.71049e4  1547.80542  96.7041
   2   5.994 VB    0.2117  582.96771   42.07258   3.2959

Totals :                  1.76879e4  1589.87800


=====================================================================
                         *** End of Report ***
```

1260 HPLC 7/4/2019 6:18:45 PM SYSTEM   Page   1 of 1

11) (3*R*,4*R*)-9d (Table 3, entry 8)

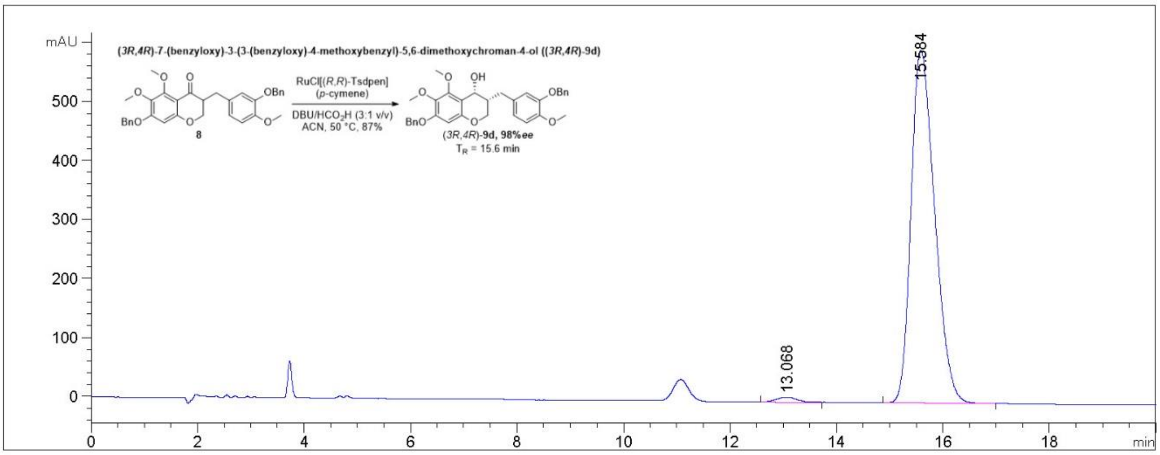
Sample Name: MH 4-58

===

Acq. Operator : JHJIN Seq. Line : 1
Acq. Instrument : Instrument 1 Location : Vial 1
Injection Date : 10/11/2018 3:57:57 PM Inj : 1
Inj Volume : 5.0 µl
Acq. Method : C:\CHEM32\1\DATA\DAICEL 2018-10-11 15-51-49\1.M
Last changed : 10/11/2018 3:19:41 PM by JHJIN
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 7/3/2019 8:28:22 PM by SYSTEM
(modified after loading)
Sample Info : CHIRALPAK AD-3
Hex/EtOH=60/40
Flow rate:1 ml/min

Additional Info : Peak(s) manually integrated

===



===

Area Percent Report

===

Sorted By : Signal
Multiplier : 1.0000
Dilution : 1.0000
Do not use Multiplier & Dilution Factor with ISTDs

Signal 1: DAD1 A, Sig=230,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.068	BB	0.3252	221.99231	8.48510	1.1935
2	15.584	BB	0.4727	1.83782e4	597.70709	98.8065

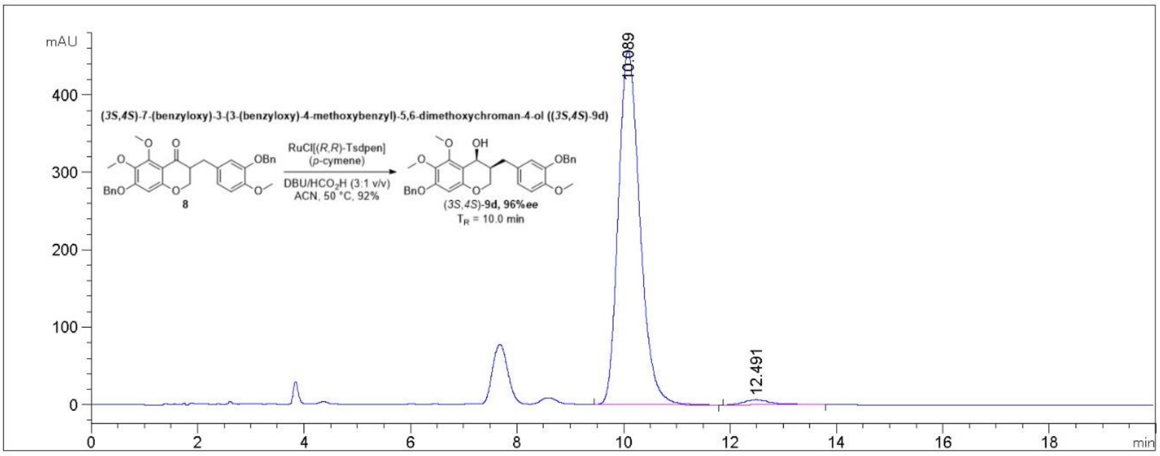
Totals : 1.86002e4 606.19219

===

*** End of Report ***

12) (3*S*,4*S*)-9d (Table 3, entry 9)

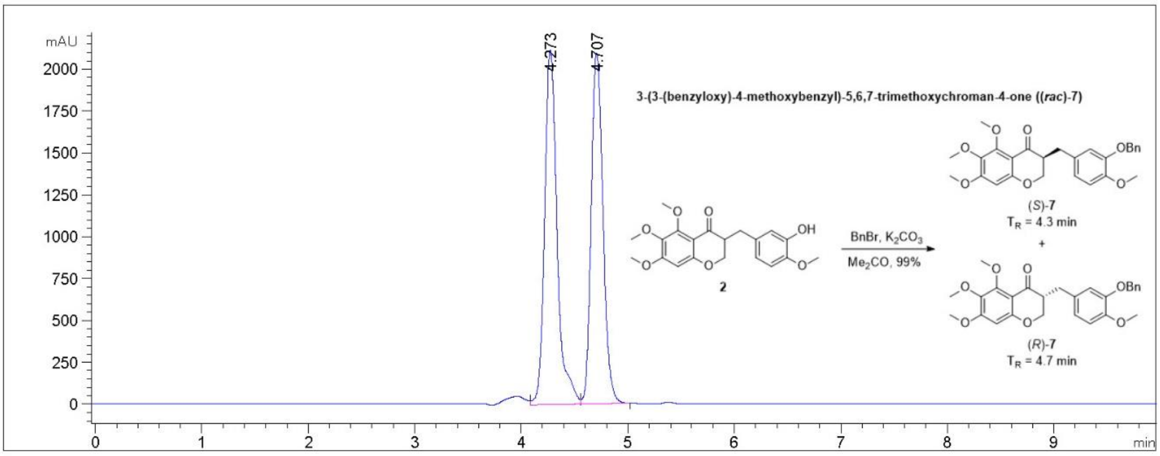
```
Sample Name: BL-9-110
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                      Seq. Line :  12
    Acq. Instrument : Instrument 1                       Location : Vial 22
    Injection Date  : 5/28/2018 7:24:45 PM                    Inj :   2
                                                       Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/28/2018 11:02:19 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 6:25:58 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3,(4.6*150 mm)
                      MP: Hex/EtOH=60/40
                      Flow rate:1ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 D, Sig=230,4 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1  10.089 BB    0.4355 1.28379e4  457.35287  98.2652
   2  12.491 BB    0.4720  226.64784    6.29606   1.7348

Totals :                  1.30646e4  463.64894


=====================================================================
                          *** End of Report ***
```

13) (*rac*)-7 obtained from **2**

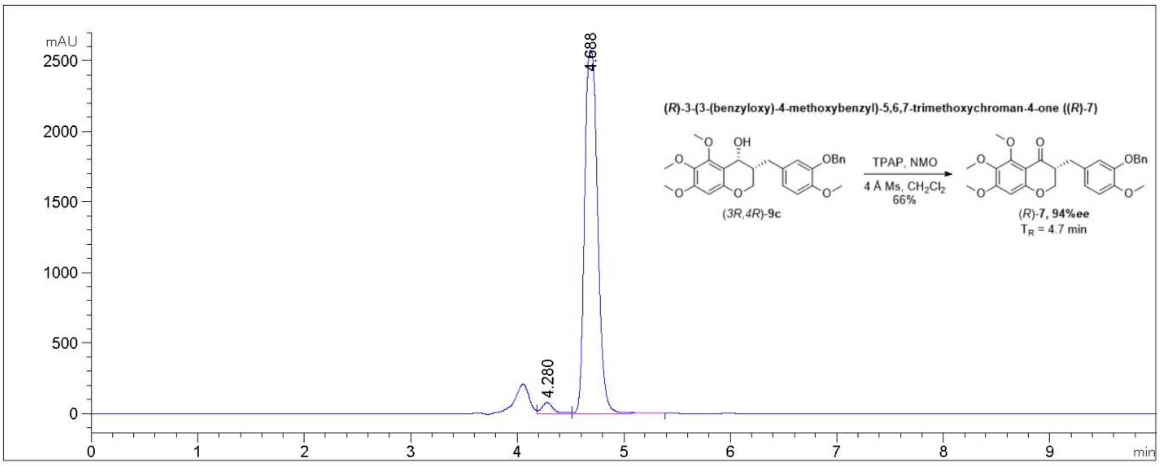
```
Sample Name: SH18053
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                   Seq. Line :   2
    Acq. Instrument : Instrument 1                    Location : Vial 41
    Injection Date  : 5/31/2018 3:15:41 AM                 Inj :   1
                                                    Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/31/2018 3:03:21 AM by DAICEL JHJIN
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 6:16:18 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 D, Sig=230,4 Ref=360,100

Peak RetTime Type  Width     Area      Height      Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1   4.273 VV    0.1248 1.72052e4  2117.92773  51.6316
   2   4.707 VB    0.1198 1.61178e4  2094.03467  48.3684

Totals :                  3.33230e4  4211.96240


=====================================================================
                          *** End of Report ***
```

14) (*R*)-7 obtained from **(3*R*,4*R*)-9c (Scheme 3)**

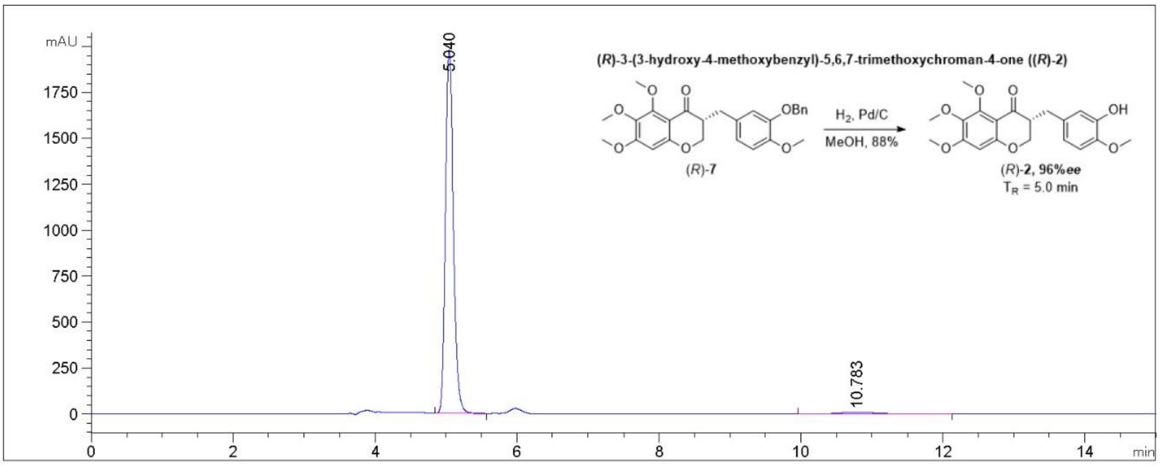
```
Sample Name: SH18053
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                    Seq. Line :    2
    Acq. Instrument : Instrument 1                     Location : Vial 11
    Injection Date  : 5/29/2018 9:47:34 AM                  Inj :    2
                                                     Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/29/2018 7:50:02 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 2:03:54 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   4.280 VV    0.1174  666.17273   83.21376   2.9571
       2   4.688 VB    0.1350 2.18620e4  2576.28809  97.0429

    Totals :                  2.25282e4  2659.50185


    =====================================================================
                             *** End of Report ***
```

15) (*R*)-2 obtained from **(*R*)-7 (Scheme 3)**

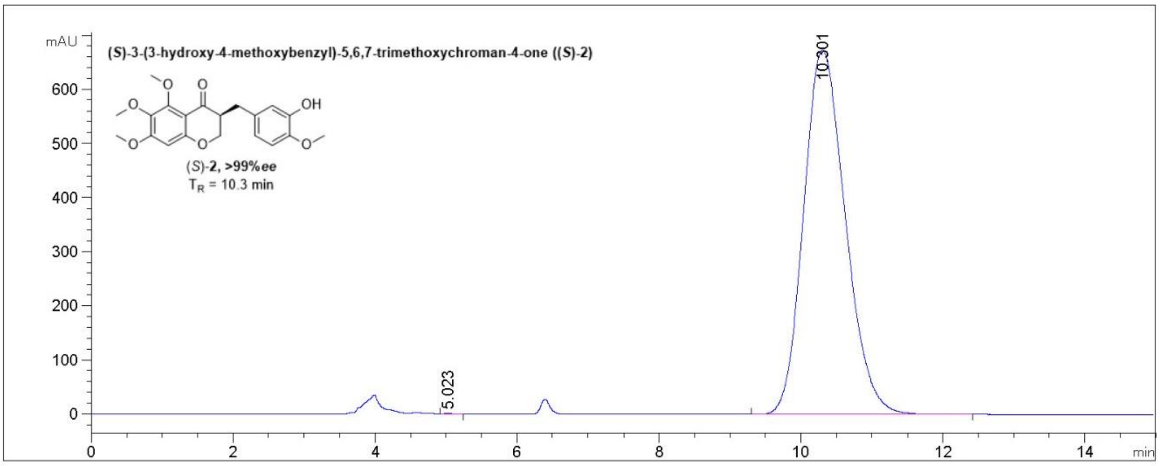
```
Sample Name: SH18060
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                  Seq. Line :   6
    Acq. Instrument : Instrument 1                   Location : Vial 16
    Injection Date  : 5/29/2018 2:00:01 PM                Inj :   2
                                                   Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/29/2018 7:50:02 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 2:05:23 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   5.040 BB    0.1234 1.54880e4 1977.34839 97.9477
       2  10.783 BB    0.5320  324.52756    7.54251   2.0523

    Totals :                  1.58125e4 1984.89090


    =====================================================================
                             *** End of Report ***
```

16) (*S*)-2 obtained from **(*S*)-7 (Scheme 3)**

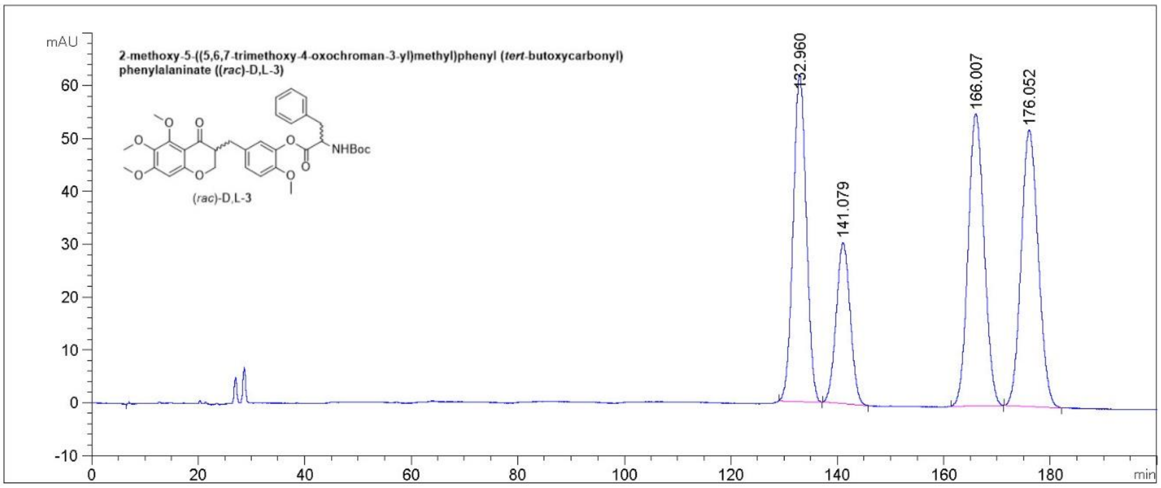
```
Sample Name: SH18022
    =====================================================================
    Acq. Operator   :                                 Seq. Line :   1
    Acq. Instrument : Instrument 1                     Location : Vial 21
    Injection Date  : 4/27/2018 1:25:14 PM                  Inj :   1
                                                     Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-27 13-23-59\1.M
    Last changed    : 4/27/2018 1:23:56 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 6:29:07 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                        Area Percent Report
=====================================================================

Sorted By            :      Signal
Multiplier           :      1.0000
Dilution             :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 D, Sig=230,16 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1   5.023 VB    0.1247   11.79457    1.33968   0.0430
   2  10.301 BB    0.6319 2.74382e4   672.62732  99.9570

Totals :                  2.74500e4   673.96700


=====================================================================
                         *** End of Report ***
```

17) 4 stereoisomers of 3

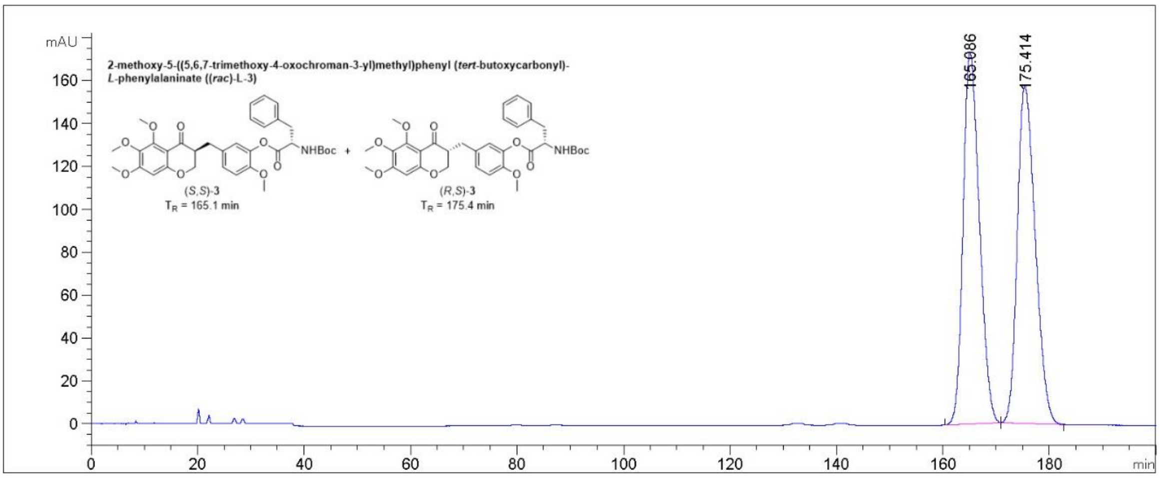
```
Sample Name: (rac)-D,L-3

=====================================================================
Acq. Operator   : LCW                            Seq. Line :   1
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 7/2/2019 6:06:59 PM                  Inj :   1
                                               Inj Volume : 20.0 µl
Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                  M
Last changed    : 7/2/2019 6:05:24 PM by LCW
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/3/2019 8:50:27 PM by SYSTEM
                  (modified after loading)
Additional Info : Peak(s) manually integrated
=====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 D, Sig=275,4 Ref=off

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1 132.960 BB    2.0206 1.06450e4   61.95245  26.9653
   2 141.079 BB    2.1438 5569.94873   30.48312  14.1095
   3 166.007 BB    2.5011 1.15788e4   55.29359  29.3307
   4 176.052 BB    2.6557 1.16829e4   52.30924  29.5945

Totals :                  3.94766e4  200.03840


=====================================================================
                          *** End of Report ***
```

18) A mixture of (*R*,*S*)- and (*S*,*S*)-3

```
Sample Name: (rac)-L-3
    =====================================================================
    Acq. Operator   : LCW                           Seq. Line :   3
    Acq. Instrument : Instrument 1                   Location : Vial 3
    Injection Date  : 7/3/2019 4:10:24 AM                 Inj :   1
                                                   Inj Volume : 20.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                      M
    Last changed    : 7/3/2019 8:15:57 AM by LCW
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:53:22 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```

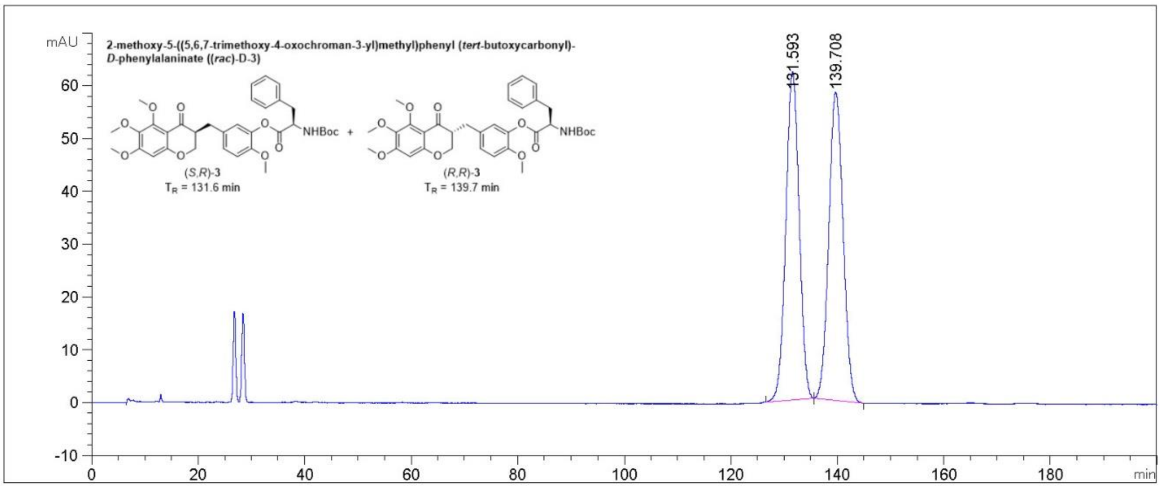



```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 D, Sig=275,4 Ref=off

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1 165.086 BB    2.7931 3.67797e4  173.50591  49.9848
   2 175.414 BB    2.9213 3.68021e4  157.77434  50.0152

Totals :                  7.35818e4  331.28024


=====================================================================
                          *** End of Report ***
```

19) A mixture of (*R*,*R*)- and (*S*,*R*)-3

Sample Name: (*rac*)-D-3

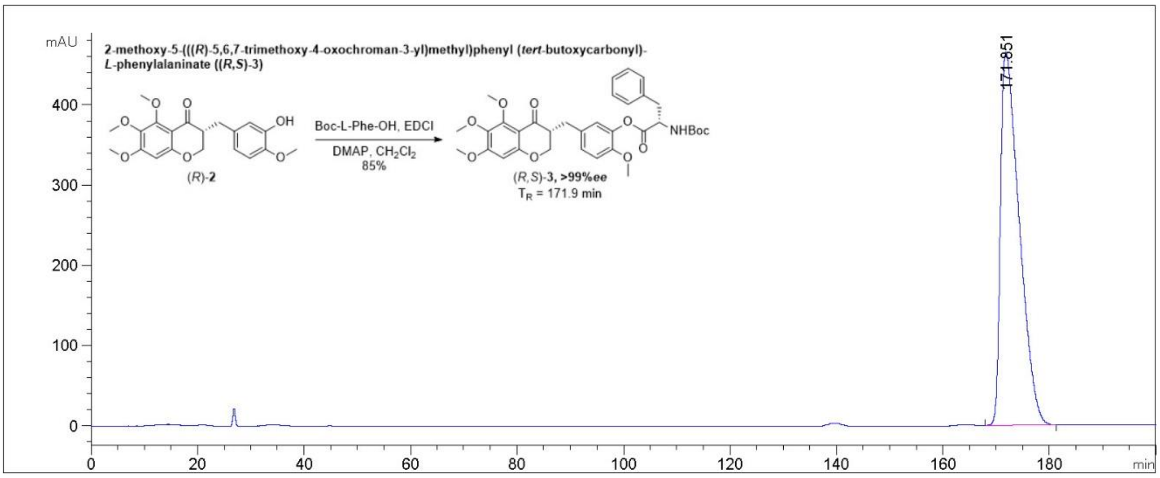
```
=====================================================================
Acq. Operator   : LCW                          Seq. Line :   2
Acq. Instrument : Instrument 1                  Location : Vial 2
Injection Date  : 7/2/2019 11:08:40 PM               Inj :   1
                                              Inj Volume : 20.0 µl
Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                  M
Last changed    : 7/2/2019 6:05:24 PM by LCW
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/3/2019 8:50:27 PM by SYSTEM
                  (modified after loading)
Additional Info : Peak(s) manually integrated
=====================================================================
```




```
=====================================================================
                          Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 D, Sig=275,4 Ref=off

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1 131.593 BB     2.1933 1.08212e4   62.21381  49.8012
   2 139.708 BB     2.1929 1.09076e4   58.40443  50.1988

Totals :                   2.17289e4  120.61823


=====================================================================
                          *** End of Report ***
```

20) (*R*,*S*)-3 obtained from **(*R*)-2 (Scheme 3)**

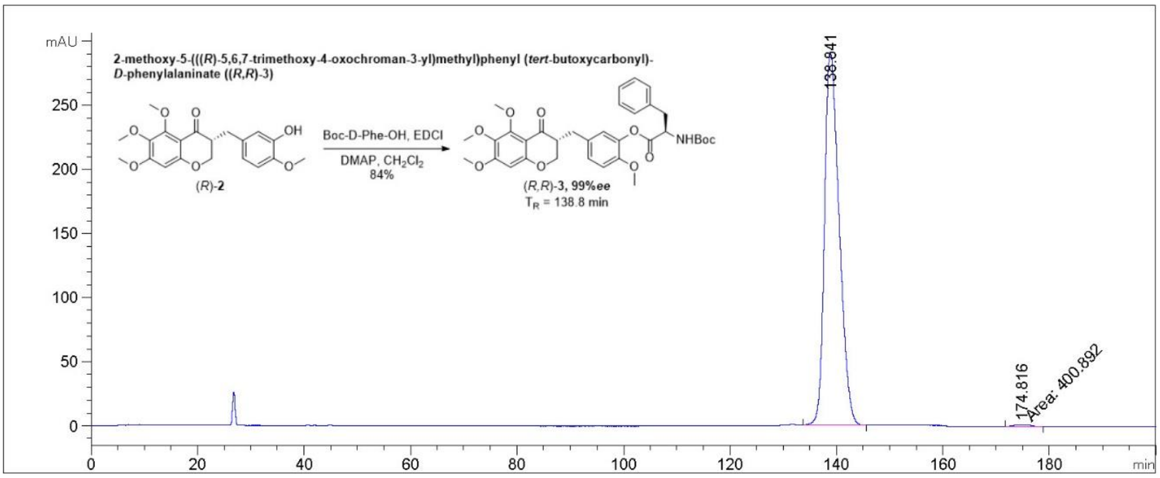
```
Sample Name: (R,S)-3
    =====================================================================
    Acq. Operator   : LCW                           Seq. Line :   4
    Acq. Instrument : Instrument 1                   Location : Vial 4
    Injection Date  : 7/3/2019 8:17:47 AM                 Inj :   1
                                                   Inj Volume : 20.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                      M
    Last changed    : 7/3/2019 12:02:43 PM by LCW
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:56:12 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=275,4 Ref=off

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1 171.851 BB    3.2670 1.13915e5  465.82147 100.0000

    Totals :                  1.13915e5  465.82147


    =====================================================================
                          *** End of Report ***
```

21) (*R*,*R*)-3 obtained from **(*R*)-2 (Scheme 3)**

```
Sample Name: (R,R)-3
    =====================================================================
    Acq. Operator   : LCW                            Seq. Line :    5
    Acq. Instrument : Instrument 1                    Location : Vial 5
    Injection Date  : 7/3/2019 12:29:30 PM                 Inj :    1
                                                    Inj Volume : 20.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                      M
    Last changed    : 7/3/2019 12:02:43 PM by LCW
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:59:40 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=275,4 Ref=off

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1 138.841 BB    2.7745 5.55820e4  291.23993  99.2839
       2 174.816 MM    3.9038  400.89243   1.71155   0.7161

    Totals :                  5.59828e4  292.95148


    =====================================================================
                             *** End of Report ***
```

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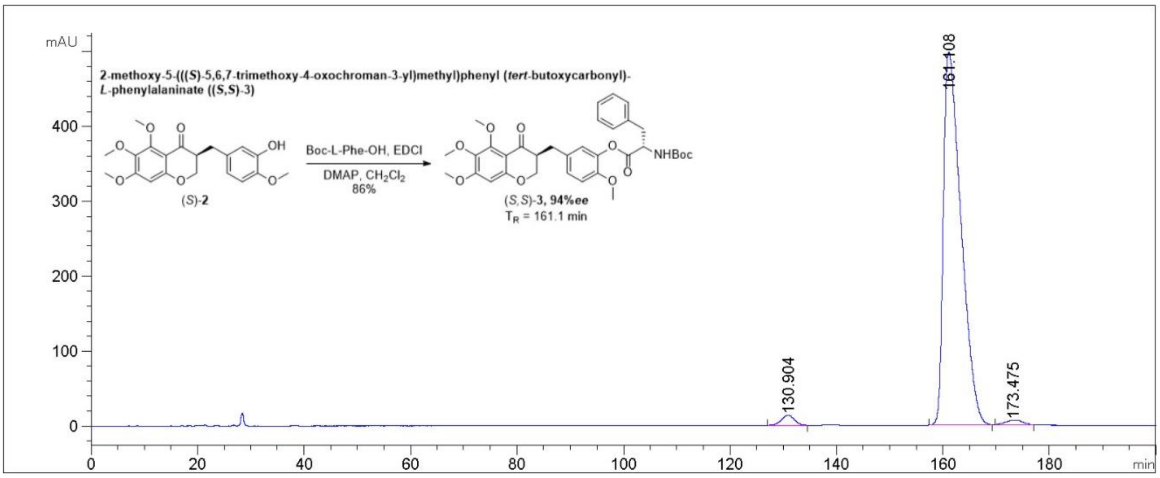
22) (*S*,*S*)-3 obtained from **(*S*)-2 (Scheme 3)**

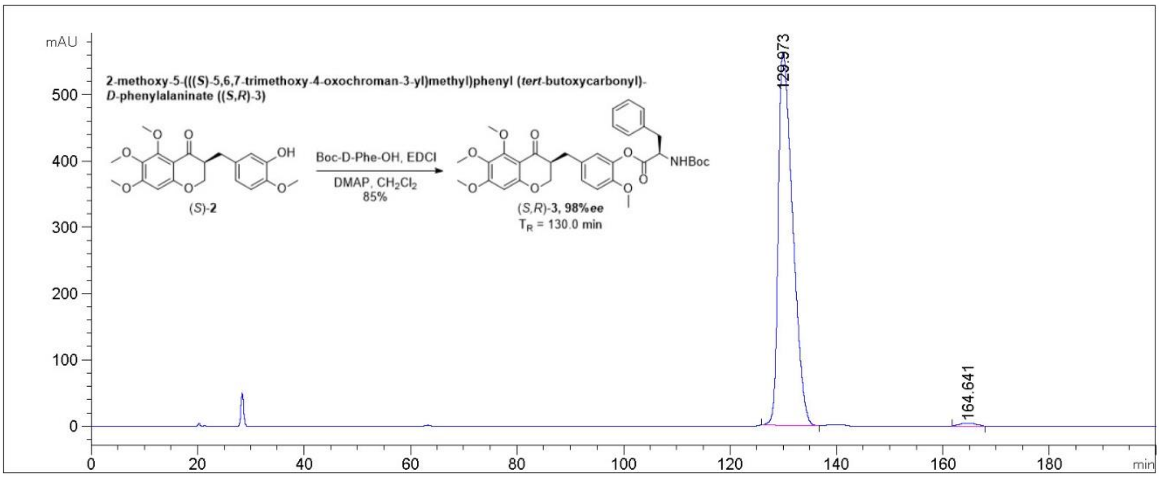
```
Sample Name: (S,S)-3
    =====================================================================
    Acq. Operator   : LCW                            Seq. Line :   6
    Acq. Instrument : Instrument 1                    Location : Vial 6
    Injection Date  : 7/3/2019 4:41:14 PM                  Inj :   1
                                                    Inj Volume : 20.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                      M
    Last changed    : 7/3/2019 12:02:43 PM by LCW
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 1:58:48 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=275,4 Ref=off

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1 130.904 MM    2.8268 2312.83423   13.63641   1.9614
       2 161.108 BB    2.9841 1.14223e5  497.97366  96.8692
       3 173.475 MM    3.6686 1378.80200    6.26395   1.1693

    Totals :                  1.17915e5  517.87402


    =====================================================================
                             *** End of Report ***
```

23) (*S*,*R*)-3 obtained from **(*S*)-2 (Scheme 3)**

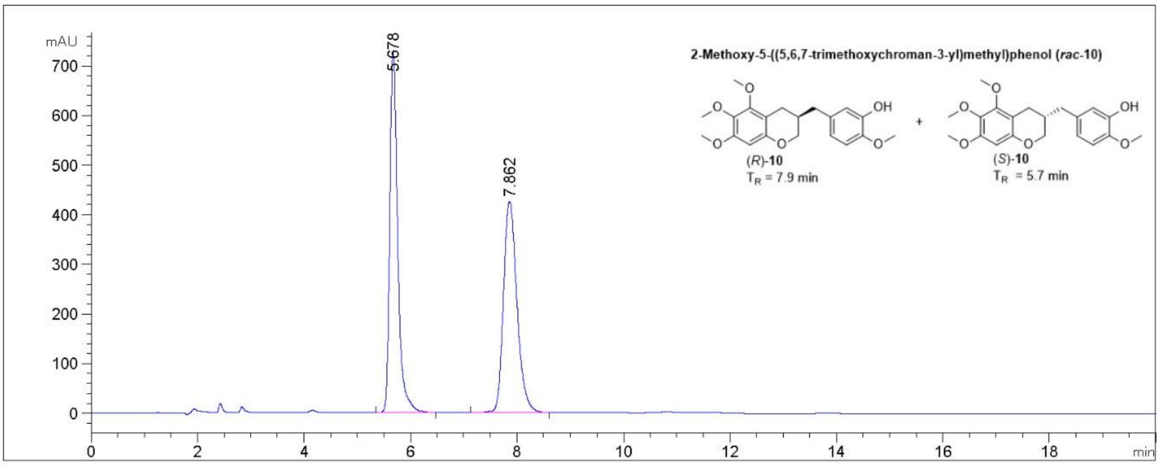
```
Sample Name: (S,R)-3
    =====================================================================
    Acq. Operator   : LCW                           Seq. Line :   7
    Acq. Instrument : Instrument 1                   Location : Vial 7
    Injection Date  : 7/3/2019 8:52:55 PM                 Inj :   1
                                                   Inj Volume : 20.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\Gachon_190702\SCREENING 2019-07-02 18-05-25\Gachon_190626.
                      M
    Last changed    : 7/3/2019 12:02:43 PM by LCW
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/4/2019 2:02:03 PM by SYSTEM
                      (modified after loading)
    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=275,4 Ref=off

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1 129.973 BB    2.4961 1.05976e5  562.98181 99.1107
       2 164.641 MM    3.3504  950.84723   4.73006  0.8893

    Totals :                  1.06926e5  567.71188


    =====================================================================
                              *** End of Report ***
```

24) Racemic **10**

```
Sample Name: 42,43
    =====================================================================
    Acq. Operator   :                                  Seq. Line :   3
    Acq. Instrument : Instrument 1                      Location : Vial 53
    Injection Date  : 4/25/2018 7:27:27 PM                   Inj :   1
                                                      Inj Volume : 5.0 µl
    Acq. Method     : C:\CHEM32\1\DATA\GACHEON\DEF_LC 2018-04-25 17-53-30\1.M
    Last changed    : 4/25/2018 5:53:28 PM
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 9:01:44 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40, Flow rate:1ml/min,
                      Sample conc.: 1.2mg/mL, Temp.:RT

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: DAD1 D, Sig=230,16 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]       %
    ----|-------|----|-------|----------|----------|--------|
       1   5.678 BV    0.1562 7529.20313  730.85236  50.1190
       2   7.862 BB    0.2732 7493.46094  426.08832  49.8810

    Totals :                  1.50227e4  1156.94067


    =====================================================================
                             *** End of Report ***
```

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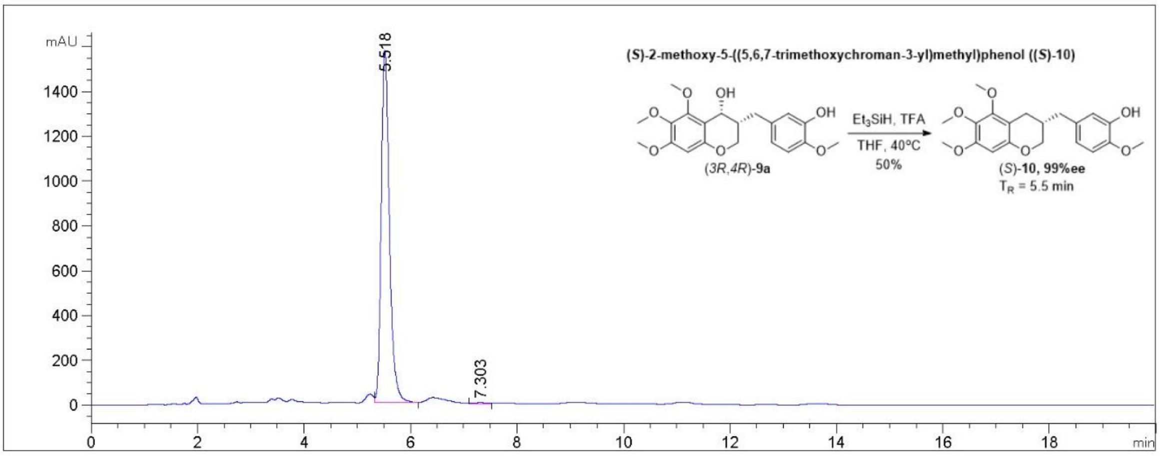
25) (*S*)-10 obtained from **(3*R*,4*R*)-9a (Scheme 3)**

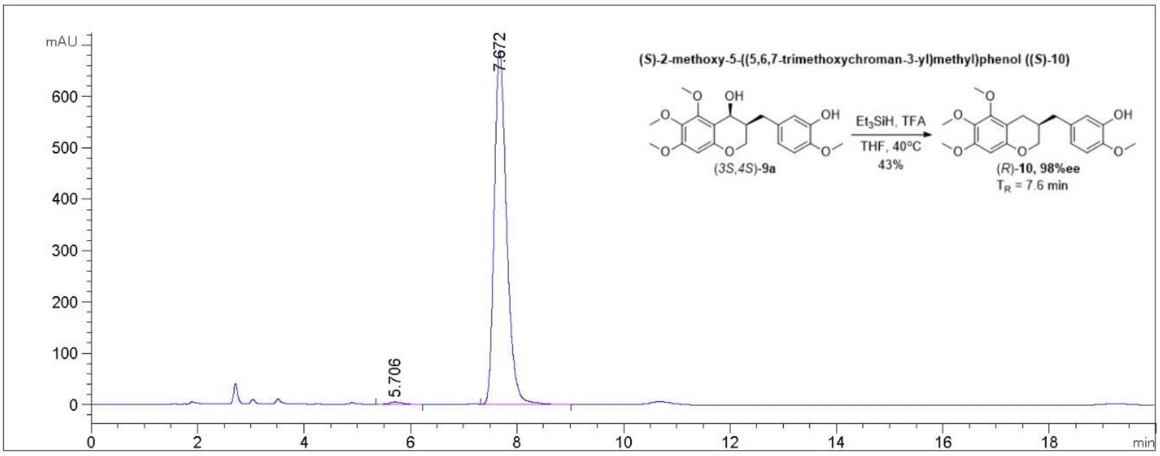
```
Sample Name: SH18062
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                    Seq. Line :   8
    Acq. Instrument : Instrument 1                     Location : Vial 18
    Injection Date  : 5/28/2018 4:33:48 PM                  Inj :   2
                                                     Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/28/2018 11:02:19 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 9:01:44 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3,(4.6*150 mm)
                      MP: Hex/EtOH=60/40
                      Flow rate:1ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                         Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 C, Sig=210,4 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]        %
----|-------|----|-------|----------|----------|--------|
   1   5.518 VB    0.1647 1.68238e4 1574.21606  99.7421
   2   7.303 BV    0.1963   43.50672    2.98027   0.2579

Totals :                  1.68673e4  1577.19633


=====================================================================
                          *** End of Report ***
```

26) (*R*)-10 obtained from **(3*S*,4*S*)-9a (Scheme 3)**

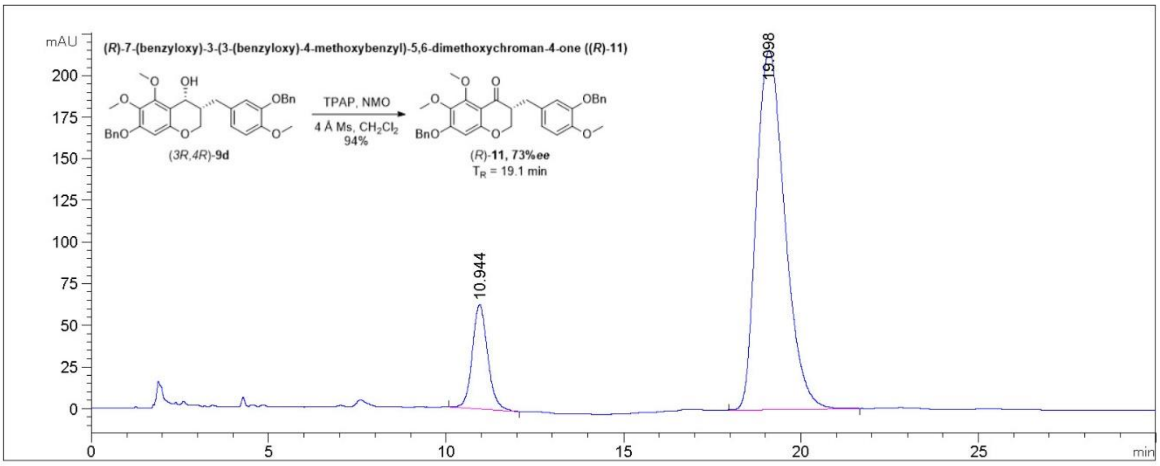
```
Sample Name: BL-9-60
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                    Seq. Line :   7
    Acq. Instrument : Instrument 1                     Location : Vial 17
    Injection Date  : 5/28/2018 3:51:02 PM                  Inj :   2
                                                    Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/28/2018 11:02:19 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 9:01:44 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3,(4.6*150 mm)
                      MP: Hex/EtOH=60/40
                      Flow rate:1ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   5.706 VV    0.2633   91.11793    5.33365   0.8148
       2   7.672 VV    0.2456 1.10920e4  689.64075  99.1852

    Totals :                  1.11831e4  694.97439


    =====================================================================
                          *** End of Report ***
```

27) (*R*)-11 obtained from **(*3R,4R*)-9d (Scheme 4)**

```
Sample Name: BL-9-116
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                   Seq. Line :   1
    Acq. Instrument : Instrument 1                    Location : Vial 23
    Injection Date  : 5/31/2018 6:10:36 AM                 Inj :   1
                                                    Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/31/2018 6:09:11 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:44:27 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, Hex/EtOH=60/40
                      Flow rate:1 ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                             Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100
```

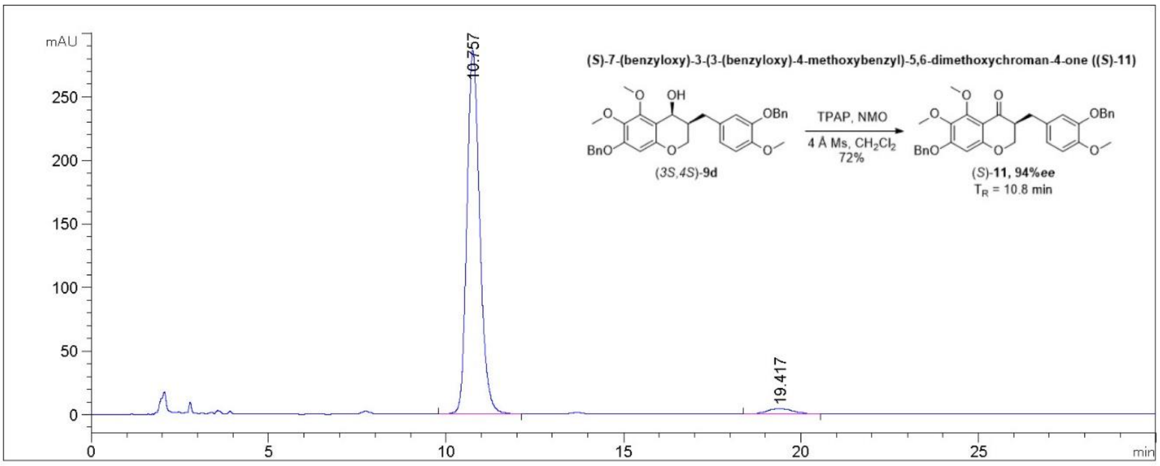
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.944	BB	0.4583	1883.71021	62.73454	13.5821
2	19.098	VV	0.8603	1.19854e4	215.68436	86.4179

Totals : 1.38691e4 278.41889

```
    =====================================================================
                             *** End of Report ***
```

28) (*S*)-11 obtained from **(3*S*,4*S*)-9d (Scheme 4)**

```
Sample Name: BL-9-117
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                   Seq. Line :    2
    Acq. Instrument : Instrument 1                    Location : Vial 24
    Injection Date  : 5/31/2018 6:42:10 AM                 Inj :    1
                                                    Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/31/2018 6:09:11 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 8:44:27 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
=====================================================================
                          Area Percent Report
=====================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Do not use Multiplier & Dilution Factor with ISTDs


Signal 1: MWD1 D, Sig=230,4 Ref=360,100

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1  10.757 BB    0.3862 7159.33008  285.88214  96.9479
   2  19.417 VV    0.6311  225.39233    4.26092   3.0521

Totals :                  7384.72241  290.14306


=====================================================================
                        *** End of Report ***
```

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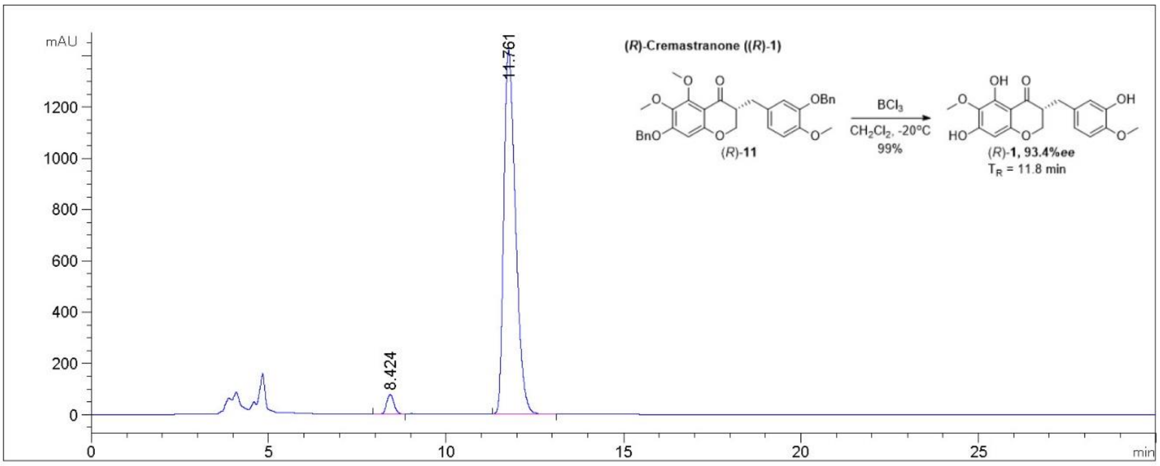
29) (*R*)-1 obtained from **(*R*)-11 (Scheme 4)**

```
Sample Name: SH18055
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                    Seq. Line :   4
    Acq. Instrument : Instrument 1                     Location : Vial 13
    Injection Date  : 5/29/2018 11:52:53 AM                 Inj :   2
                                                    Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/29/2018 7:50:02 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 9:09:21 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   8.424 BV    0.2230 1128.36243   77.89248   3.3472
       2  11.761 VV    0.3555 3.25827e4  1420.93640  96.6528

    Totals :                  3.37111e4  1498.82888


    =====================================================================
                          *** End of Report ***
```

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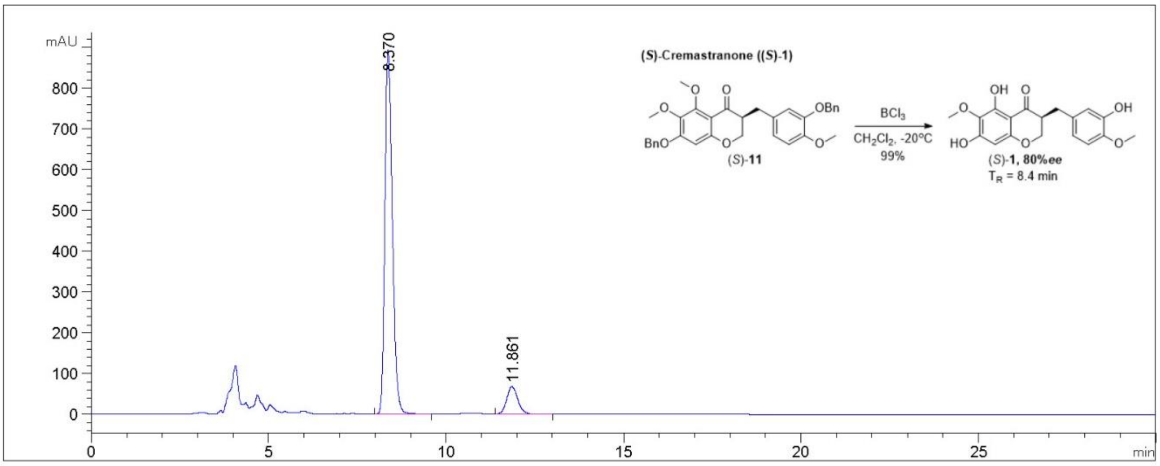
30) (*S*)-1 obtained from **(*S*)-11 (Scheme 4)**

```
Sample Name: SH18054
    =====================================================================
    Acq. Operator   : DAICEL JHJIN                    Seq. Line :    3
    Acq. Instrument : Instrument 1                     Location : Vial 12
    Injection Date  : 5/29/2018 10:50:09 AM                 Inj :    2
                                                     Inj Volume : 5.000 µl
    Acq. Method     : C:\HPCHEM\1\METHODS\1.M
    Last changed    : 5/29/2018 7:50:02 AM by DAICEL JHJIN
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/3/2019 9:09:21 PM by SYSTEM
                      (modified after loading)
    Sample Info     : CHIRALPAK AD-3, ACN/MeOH=50/50
                      Flow rate:0.5ml/min

    Additional Info : Peak(s) manually integrated
    =====================================================================
```




```
    =====================================================================
                         Area Percent Report
    =====================================================================

    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000
    Do not use Multiplier & Dilution Factor with ISTDs


    Signal 1: MWD1 D, Sig=230,4 Ref=360,100

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]   [mAU*s]     [mAU]        %
    ----|-------|----|-------|----------|----------|--------|
       1   8.370 BB    0.2271 1.30802e4  891.95026  89.9499
       2  11.861 VB    0.3372 1461.44934  67.34049  10.0501

    Totals :                  1.45416e4  959.29075


    =====================================================================
                            *** End of Report ***
```